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UPPER DES PLAINES RIVER AND TRIBUTARIES, ILLINOIS AND WISCONSIN: INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY, CIVIL WORKS, DEPARTMENT OF DEFENSE

TRANSMITTING

THE DEPARTMENT'S UPPER DES PLAINES RIVER AND TRIBUTARIES INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT DATED JANUARY 11, 2016

PART 1 OF 3

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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

JAN 29 2016

Honorable Paul Ryan
Speaker of the House of Representatives
U.S. Capitol Building, Room H-232
Washington, DC 20515

Dear Mr. Speaker:

In response to section 419 of the Water Resources Development Act 1999, the Secretary of the Army recommends a plan to manage flood risks, restore ecosystems, and provide additional recreation opportunities along the Upper Des Plaines River and Tributaries in Illinois and Wisconsin. The proposal is described in the report of the Chief of Engineers, dated June 8, 2015, which includes other pertinent documents. The Secretary of the Army plans to implement the project at the appropriate time, considering National priorities and the availability of funds.

The project study was conducted to determine the feasibility of improvements in the interest of flood damage reduction, environmental restoration and protection, water quality, recreation and related purposes on the Upper Des Plaines River and tributaries. The recommended plan is the combined National Economic Development (NED) and National Ecosystem Restoration (NER) plans and includes the following:

The NED plan provides for reducing flood damages and risks by constructing an optimized system of three levee/floodwalls and two floodwater storage reservoirs near or adjacent to the main stem of the Des Plaines River in the city of Des Plaines, and the communities of Franklin Park, Schiller Park, and River Grove, Illinois; and implementing non-structural flood risk management measures at up to 377 structures in nine communities in Lake County and Cook County, Illinois. Non-structural flood risk management measures will include elevating structures, dry flood-proofing, filling basements in combination with dry flood-proofing, wet flood proofing, constructing engineered low-level ring levees at large commercial or public building sites, and evacuating portions of floodplains. Additionally, the NED plan provides for separable, cost-shared, recreation features at three sites where flood risk management features are recommended for implementation.

The NER plan will provide ecosystem restoration benefits by manipulating site conditions to return hydrology, hydraulics and geomorphology to a more natural state, restoring natural stream channels, and by reestablishing native plant communities over an aggregate 6,859 acres (10.7 square miles) at seven sites across the watershed. For all ecosystem restoration projects, the recommended plan includes post-construction monitoring and adaptive management for a period of up to ten years to ensure project performance. The NER plan includes compatible incidental recreation features. The recommended plan will not have significant adverse effects; consequently, no mitigation measures, beyond best management practices and avoidance, or compensation measures will be required.

Based on October 2015 (FY 2016) price levels, the estimated total first cost of the combined NED/NER plan is $309,098,000, which includes the first cost of the NED plan of $146,974,000 and the first cost of the NER plan of $162,124,000. The Federal share of the total project cost would be $200,702,000 (64.9 percent) and the non-Federal share would be $108,396,000 (35.1 percent).

Based on FY 2016 price levels, a 3.125 percent discount rate, and a 50-year period of economic analysis, the total equivalent annual flood risk management costs are estimated to be $5,506,000, including operation, maintenance, repair, replacement and rehabilitation (OMRR&R). The equivalent average annual benefits are estimated to be $10,092,000 with net average annual benefits of $4,586,000. The benefit-to-cost ratio for the flood risk management portion of the NED plan is approximately 1.8 to 1. The recommended plan would reduce overall average annual flood damages across the watershed by about 19 percent, with total average annual residual damages estimated at $43,694,000. About 91 percent ($39,918,000) of the total residual flood damages represent economic opportunity costs that would consist of transportation delay and re-routing costs that result from roadway flooding.

The total equivalent average annual aquatic ecosystem restoration costs are estimated to be $5,526,000, including OMRR&R, monitoring, and adaptive management. The cost of the recommended aquatic ecosystem restoration projects is justified by restoring 9,034 Average Annual Habitat Units (AAHU), at an average cost of $612/AAHU, on more than 6,859 acres of aquatic and riparian habitat. Implementing the NER plan will increase the net watershed habitat units by about 32 percent.

An Environmental Assessment (EA) was prepared in accordance with the National Environmental Policy Act. The recommended plan has been identified as the environmentally preferred plan. Adverse environmental impacts have been avoided and minimized where practicable. The EA resulted in a Finding of No Significant Impact to the environment, therefore, preparation of an Environmental Impact Statement is not required. No compensatory mitigation is required.

The Independent External Peer Review was completed by Battelle Memorial Institute. The review comments resulted in expanded narratives throughout the report to support the decision-making process and justify the recommended plan. All comments from the above referenced reviews have been addressed and incorporated into the final documents.

The Office of Management and Budget (OMB) advises that there is no objection to the submission of the report to Congress and concludes that the report recommendation is consistent with the policy and programs of the President. However, OMB also noted that the project would need to compete with other proposed investments for funding in future budgets. A copy of OMB's letter, dated December 18, 2015, is enclosed. I am providing a copy of this transmittal and the OMB letter to the Subcommittee on Water Resources and Environment of the House Committee on Transportation and Infrastructure, and the Subcommittee on Energy and Water Development of the House Committee on Appropriations. I am also providing an identical letter to the President of the Senate.

Very truly yours,

Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

Enclosures

5 Enclosures

1. OMB Clearance Letter, December 18,2015
2. Report of the Chief of Engineers, June 8, 2015
3. Summary of State and Agency Review
4. Finding Of No Significant Impact, January 7, 2016
5. Final Feasibility Report and Environmental Assessment, May 2015

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

December 18, 2015

The Honorable Jo-Ellen Darcy
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon
Washington, DC 20310-0108

Dear Ms. Darcy:

As required by Executive Order 12322, the Office of Management and Budget has reviewed a January 2015 Army Corps of Engineers (Corps) feasibility study of the Upper Des Plaines River and Tributaries, IL & WI, with a first cost of $307,087,000 (October 2014 price level).

Based on our review of the Corps' report, an authorization to construct this project would be consistent with the programs and policies of the President. The Office of Management and Budget does not object to your submitting this report to Congress. When you do so, please advise the Congress that should the Congress authorize this project for construction, the project would need to compete with other proposed investments for funding in future budgets.

Sincerely,

John Pasquantino
Deputy Associate Director

DEPARTMENT OF THE ARMY
CHIEF OF ENGINEERS
2600 ARMY PENTAGON
WASHINGTON, DC 20310-2600

JUN 08 2015

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THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report on flood risk management, recreation, and ecosystem restoration along the Upper Des Plaines River and its tributaries in northeastern Illinois and southeastern Wisconsin. It is accompanied by the report of the district and division engineers. These reports respond to Section 419 of the Water Resources Development Act (WRDA) of 1999. Section 419 requested a study of the Upper Des Plaines River and Tributaries, Illinois and Wisconsin, upstream of the confluence with Salt Creek at Riverside, Illinois, to determine the feasibility of improvements in the interests of flood damage reduction, environmental restoration and protection, water quality, recreation, and related purposes. Preconstruction engineering and design activities will continue under this authority.

2. The reporting officers recommend authorizing a National Economic Development (NED) plan and a National Ecosystem Restoration (NER) plan to manage flood risks, enhance recreation opportunities, and to restore ecosystems in the Upper Des Plaines River watershed. Analyses of the reporting officers indicate that the proposed NED and NER plans are physically, functionally, hydraulically, and economically independent. The NED plan provides for reducing flood damages and risks by constructing an optimized system of three levee/floodwalls and two floodwater storage reservoirs near or adjacent to the main stem of the Des Plaines River in the city of Des Plaines, and communities of Franklin Park, Schiller Park, and River Grove, Illinois; and implementing non-structural flood risk management measures at up to 377 structures in nine communities in Lake County and Cook County, Illinois. Non-structural flood risk management measures will include elevating structures, dry flood-proofing, filling basements in combination with dry flood-proofing, wet flood proofing, constructing engineered low-level ring levees at large commercial or public building sites, and evacuating portions of floodplains. The floodplain evacuation (i.e., purchase and removal of frequently damaged structures) component of the non-structural plan will, to the extent practicable, be implemented on a willing seller basis; however, eminent domain will be utilized when determined to be warranted. Acquisition of structures for removal will comply with the provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act (P.L. 91-646), as amended, and the uniform regulations contained in 49 Code of Federal Regulations, Part 24, including the provision of payment of relocation assistance benefits to eligible recipients. Additionally, the NED plan provides for separable, cost-shared, recreation features at three sites where flood risk management features are recommended for implementation. The NER plan will provide ecosystem restoration benefits by manipulating site conditions to return hydrology, hydraulics and geomorphology to a more natural state, restoring natural stream channels, and by reestablishing native plant

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communities over an aggregate 6,859 acres (10.7 square miles) at seven sites across the watershed. For all ecosystem restoration projects, the recommended plan includes post-construction monitoring and adaptive management for a period of up to ten years to ensure project performance. The NER plan includes compatible incidental recreation features. The recommended plan will not have significant adverse effects; consequently, no mitigation measures, beyond best management practices and avoidance, or compensation measures will be required. All project sites are located in the states of Illinois or Wisconsin. Project costs are stated at the October 2014 price level. Equivalent annual costs and benefits are based on a 3.375 percent discount rate and a 50-year period of economic evaluation.

3. The estimated total first cost of the combined NED/NER plan, including recreation features, is $307,087,000. All of the proposed flood risk management features are located in Lake and Cook Counties, Illinois. The first cost of the proposed structural and non-structural flood risk management features, not including recreation, is estimated as $144,378,000. This amount includes $96,623,000 allocated to structural flood risk management and $47,755,000 associated with a non-structural flood risk management program. The currently estimated cost of proposed recreation associated with the flood risk management features is $1,425,000. The estimated total cost of the NED plan, including recreation, is $145,803,000. Proposed ecosystem restoration features are located in Kenosha County, Wisconsin, and Lake and Cook Counties, Illinois. The first cost of the recommended ecosystem restoration features is currently estimated as $161,284,000. The federal share of the total project cost for the NED and the NER plans, including cost-shared recreation features, would be about $199,393,000 (64.9 percent) and the non-federal share would be about $107,694,000 (35.1 percent).

a. In accordance with the cost sharing provisions of Section 103 of WRDA 1986, as amended by Section 202 of WRDA 1996, the federal share of the first costs of the flood risk management projects would be about $93,846,000 (65 percent) and the non-federal share would be about $50,532,000 (35 percent). The cost of lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas (LERRD) is estimated at $37,017,000. The project specific non-federal sponsors, the Illinois Department of Natural Resources, the Metropolitan Water Reclamation District of Greater Chicago, and the city of Des Plaines, Illinois, would be responsible for the operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of the project after construction, a cost currently estimated at about $172,000 per year. The sponsors would also be fully responsible for removing and relocating utilities and discharge pipelines on project sites that are non-compensable, at an estimated cost of approximately $5,431,000.

b. In accordance with the cost sharing provisions of Section 103 of WRDA 1986, as amended by Section 210 of WRDA 1996, the federal share of the first costs of the ecosystem restoration projects would be about $104,835,000 (65 percent) and the non-federal share would be about $56,449,000 (35 percent). The cost of LERRD for the ecosystem restoration projects is estimated at $65,361,000. This amount exceeds the 35 percent non-federal share of the total cost of the restoration projects by an estimated $8,912,000. The non-federal sponsors for the ecosystem restoration projects have provided letters indicating their desire to voluntarily forgo reimbursement for the value of LERRD that exceeds the required 35 percent cost share. The total project cost includes $1,490,000 for environmental monitoring and adaptive management. The project-specific non-federal sponsors including the Forest Preserve District of Cook County (FPDCC), Lake County Forest Preserve District (LCFPD), and Kenosha County, would be responsible for the OMRR&R of the project after construction, a cost currently estimated at about $328,000 per year, which includes monitoring and adaptive management beyond the construction phase.

c. The NED/NER plan includes both separable and incidental recreation features. The flood risk management projects include the following separable recreation features, which will be cost-shared 50 percent federal and 50 percent non-federal: recreation trails at Touhy-Miner Levee and Floodwall, recreation trails and picnic areas at Fullerton Woods Reservoir, and recreation trails in Des Plaines, Illinois on lands that will be evacuated as a result of buyout and removal of frequently flooded structures. The $1,425,000 total cost of recreation features will be shared equally, $712,500 federal and $712,500 non-federal, between the government and prospective non-federal project sponsors. The ecosystem restoration projects include incidental recreation features. These projects include the construction of woodchip trails for equipment access. Following construction, these features will be usable as recreation trails and annual OMRR&R will be a non-federal responsibility. Incidental recreation features will be cost-shared in accordance with ecosystem restoration cost sharing provisions.

4. Economic analyses indicate that the proposed flood risk management and recreation features are economically justified. Cost effectiveness and incremental cost analysis techniques were applied to evaluate the proposed ecosystem restoration alternatives to ensure that an efficient NER plan is recommended for authorization.

a. The total equivalent annual flood risk management costs are estimated to be $5,675,000, including OMRR&R. The equivalent average annual benefits are estimated to be $9,923,000 with net average annual benefits of $4,284,000. The benefit-to-cost ratio for the flood risk management portion of the NED plan is approximately 1.7 to 1. The recommended plan would reduce overall average annual flood damages across the watershed by about 19 percent and would leave total average annual residual damages estimated at $42,924,000. About 89 percent ($39,398,000) of the total residual flood damages represent economic opportunity costs that would consist of transportation delay and re-routing costs that result from roadway flooding. Physical flooding damages to automobiles, and public, commercial, industrial, and residential structures would be reduced by about 48 percent, leaving average annual residual damages to automobiles and structures estimated at $5,108,000. The analyses of the proposed levee/floodwall projects indicate that they will provide a greater than 95 percent probability of containing the 1-percent chance (100-year recurrence interval) flood. Full implementation of the proposed structural and non-structural flood risk management measures would remove approximately 1,400 structures from Federal Emergency Management Agency designated special flood hazard areas.

b. The total equivalent average annual aquatic ecosystem restoration costs are estimated to be $5,661,000, including OMRR&R, monitoring, and adaptive management. The cost of the recommended aquatic ecosystem restoration projects is justified by restoring 9,034 Average Annual Habitat Units (AAHU), at an average cost of $627/AAHU, on more than 6,859 acres of aquatic and riparian habitat. Implementing the NER plan will increase the net watershed habitat units by about 32 percent. The NER plan would restore the ecosystem in the most cost-effective manner by naturalizing the watershed hydrology, reestablishing natural fluvial and fire processes, increasing the richness and abundance of the native plant communities, and improving connectivity between natural areas. The restored aquatic habitat includes habitat and life requisites for three federally-listed and 89 state listed threatened and endangered species. The restored habitat will be located within the Great Lakes portion of the Mississippi Flyway, and would provide nationally and internationally significant habitat for migratory birds.

c. The equivalent annual cost of the proposed cost-shared recreation features is $63,000, including OMRR&R. The equivalent average annual benefits are estimated to be $456,000, with net average annual benefits of $393,000. The ratio of benefits-to-cost for the recreation plan is approximately 7.2 to 1.

5. The NED Plan details:

a. Structural Flood Risk Management. The system of structural flood risk management features includes the 11,200 linear foot long Touhy-Miner Levee and Floodwall and the 200 acre-foot capacity Harry Semrow Driving Range Reservoir, both located in Des Plaines, Illinois; the 8,400 linear foot long Belmont-Irving Park Levee and Floodwall located in Franklin Park and Schiller Park, Illinois; and the 6,200 linear foot long Fullerton-Grand Levee and Floodwall and the 150 acre-foot capacity Fullerton Woods Reservoir, both located in River Grove, Illinois. The Illinois Department of Natural Resources, the Metropolitan Water Reclamation District of Greater Chicago, and the city of Des Plaines, Illinois will sponsor and share the costs of implementing these proposed structural flood risk management features. The estimated total first cost of the structural flood risk management features is $96,623,000. The total equivalent annual costs are estimated to be $3,930,000, including OMRR&R. The equivalent average annual benefits are estimated to be $7,649,000, with net average annual benefits of $3,719,000. The benefit-to-cost ratio for structural flood risk management is approximately 1.9 to 1.

b. Non-structural Flood Risk Management. Non-structural flood risk management features will be implemented at about 164 structures located in Gurnee, Lincolnshire, Long Grove, Riverwoods, and Vernon Township, in Lake County Illinois, and about 213 structures located in Des Plaines, Rosemont, Wheeling, and Wheeling Township, in Cook County Illinois. The city of Des Plaines will sponsor non-structural flood risk management treatments within its boundaries. The Illinois Department of Natural Resources will sponsor all other non-structural flood risk management features located in Lake and Cook Counties. The estimated total first cost of the non-structural flood risk management component of the NED plan is $47,755,000.

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The total equivalent annual costs are estimated to be $1,745,000. The equivalent average annual benefits are estimated to be $2,274,000, with net average annual benefits of $529,000. The benefit-to-cost ratio for non-structural flood risk management is approximately 1.3 to 1.

c. Separable Recreation. The city of Des Plaines will sponsor the 11,200- foot-long asphalt Touhy-Miner Levee and Floodwall Recreation Trail and the 4,000-foot-long asphalt Des Plaines Floodway/Big Bend Drive Area Recreation Trail. The Fullerton Woods Reservoir Recreation Area will consist of a landscaped recreation site, picnic shelter, benches, parking lot, restroom, and asphalt trail. The FPDCC will sponsor the Fullerton Woods Reservoir Recreation Area. The estimated total first cost of the city of Des Plaines sponsored separable recreation features is $461,000. The total equivalent annual costs are estimated to be $18,000, including OMRR&R. The equivalent average annual benefits are estimated to be $303,000, with net average annual benefits of $285,000. The benefit-to-cost ratio is approximately 16.8 to 1. The estimated total first cost of the FPDCC sponsored separable recreation features is $964,000. The total equivalent annual costs are estimated to be $45,000, including OMRR&R. The equivalent average annual benefits are estimated to be $153,000, with net average annual benefits of $108,000. The benefit-to-cost ratio is approximately 3.4 to 1.

6. The NER plan details:

a. Kenosha County will act as non-federal sponsor for aquatic ecosystem restoration at two (2) locations: 1,619 acres of riparian habitat at the Bristol Marsh site and 689 acres of riparian habitat at the Dutch Gap Forested Floodplain in Bristol, Wisconsin. The estimated first cost for the Bristol Marsh restoration is approximately $43,112,000. The equivalent average annual cost is $1,341,000. Expected benefits are an increase of 2,251 AAHU. The estimated first cost for the Dutch Gap Forested Floodplain restoration is approximately $18,880,000. Based on a 3.375 percent discount rate and a 50 year period of economic evaluation, the equivalent average annual cost is $612,000. Expected benefits are 1,286 AAHU. The total cost of the Kenosha County-sponsored restoration projects is currently estimated as $61,992,000. The value of LERRD for the Kenosha County-sponsored restoration projects is estimated at $29,372,000. This amount exceeds the 35 percent non-federal share of the total cost of the restoration projects by an estimated $7,674,000. Kenosha County has provided a letter indicating their desire to voluntarily forgo reimbursement for the value of LERRD that exceeds the required 35 percent cost share.

b. The LCFPD will act as non-federal sponsor for aquatic ecosystem restoration at three (3) locations: 1,601 acres of marsh and riparian habitat at Red Wing Slough and Deer Lake Wetland Complex, 429 acres of riparian habitat at Pollack Lake and Hastings Creek Riparian Wetlands, both in Antioch, Illinois, and 698 acres at the Gurnee Woods Riparian Wetlands, in Wadsworth, Illinois. The estimated first cost for the Red Wing Slough and Deer Lake Wetland Complex restoration is approximately $30,219,000. The equivalent average annual cost is $1,093,000. Expected benefits are 1,513 AAHU. The estimated first cost for the Pollack Lake and Hastings Creek Riparian Wetlands restoration is approximately $10,420,000. Based on a 3.375 percent discount rate and a 50 year period of economic evaluation, the equivalent average annual cost is $432,000. Expected benefits are an increase of 626 AAHU. The estimated first cost for the Gurnee Woods Riparian Wetlands restoration is approximately $17,902,000. The equivalent average annual cost is $590,000. Expected benefits are increase of 939 AAHU. The total cost of the LCFPD sponsored restoration projects is currently estimated as $58,541,000. The value of LERRD for the LCFPD sponsored restoration projects is estimated at $20,519,000. This amount exceeds the 35 percent non-federal share of the total cost of the restoration projects by an estimated $30,000. The LCFPD has provided a letter indicating their desire to voluntarily forgo reimbursement for the value of LERRD that exceeds the required 35 percent cost share.

c. The FPDCC will act as non-federal sponsor for aquatic ecosystem restoration at two (2) locations: 811 acres of riparian habitat at the Northbrook Floodplain and Riparian Complex in Wheeling, Illinois, and 1,007 acres of riparian habitat at the Beck Lake Meadow and Floodplain Forest in Des Plaines and Glenview, Illinois. The estimated first cost for the Northbrook Floodplain and Riparian Complex restoration is approximately $20,060,000. The equivalent average annual cost is $827,000. Expected benefits are 925 AAHU. The estimated first cost for the Beck Lake Meadow and Floodplain Forest restoration is approximately $20,691,000. The equivalent average annual cost is $775,000. Expected benefits are 1,494 AAHU. The total cost of the FPDCC-sponsored restoration projects is currently estimated as $40,751,000. The value of LERRD for the FPDCC-sponsored restoration projects is estimated at $15,471,000. This amount exceeds the 35 percent non-federal share of the total cost of the restoration projects by an estimated $1,209,000. The FPDCC has provided a letter indicating their desire to voluntarily forgo reimbursement for the value of LERRD that exceeds the required 35 percent cost share.

7. In accordance with the current Engineer Circular (EC) on review of decision documents, all technical, engineering and scientific work underwent an open, dynamic and vigorous review process to ensure technical quality. This included an Agency Technical Review (ATR), a (Type I) Independent External Peer Review (IEPR), and USACE Headquarters policy and legal review. All concerns of the ATR have been addressed and incorporated into the final feasibility report. USACE conducted the IEPR in accordance with Section 2034 of the Water Resources Development Act of 2007, USACE EC 1165-2-214, and the Office of Management and Budget's Final Information Quality Bulletin for Peer Review (2004). A Section 501(c)(3) (Internal Revenue Code) non-profit science and technology organization, independent and free of conflicts of interest, established and administered the peer review panel. The IEPR panel consisted of five members with expertise in hydraulic engineering, geotechnical engineering, economics, ecology, and plan formulation. The review panel identified and documented sixteen final comments. Of these, two were designated as having high significance, seven as having medium significance, and seven as having low significance. All IEPR review comments have been resolved and resulted in no significant changes to the plan formulation, engineering assumptions, and environmental analyses that supported the decision-making process and plan selection. The final report and environmental assessment also underwent state and agency review. All comments from the above referenced reviews have been addressed and incorporated into the final documents as appropriate. Overall the reviews did result in improvements to the technical clarity

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and overall quality of the report. A safety assurance review (Type II IEPR) of the structural flood risk management components of the project will be conducted during the design phase of the project.

8. Washington level review indicates that the project recommended by the reporting officers is technically sound, environmentally and socially acceptable, cost effective and economically justified. The plan complies with all essential elements of the U.S. Water Resources Council's *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* and complies with other administrative and legislative policies and guidelines. Also, the views of interested parties, including federal, state and local agencies have been considered.

9. I generally concur with the findings, conclusions, and recommendations of the reporting officers. Accordingly, I recommend that the plan to manage flood risks, restore ecosystems, and provide additional recreation opportunities for the Upper Des Plaines River and Tributaries, Illinois and Wisconsin be authorized in accordance with the reporting officers' recommended plan at an estimated cost of $307,087,000 with such modifications as in the discretion of the Chief of Engineers may be advisable. My recommendation is subject to cost sharing, financing, and other applicable requirements of federal and state laws and policies, including Section 103 of WRDA 1986, as amended , 33 U.S.C. § 2213. The non-federal sponsors would provide the non-federal cost share and all LERRD. Further, the non-federal sponsors would be responsible for all OMRR&R. This recommendation is subject to the non-federal sponsors agreeing to comply with all applicable federal laws and policies, including but not limited to:

a. Provide 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work;

b. Provide a minimum of 35 percent, but not to exceed 50 percent of total structural flood risk management costs as further specified below:

(1) Provide, during the first year of construction, any additional funds necessary to pay the full non-federal share of design costs allocated by the government to the structural flood risk management features;

(2) Provide, during construction, a contribution of funds equal to 5 percent of total structural flood risk management costs;

(3) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the government to be required or to be necessary for the construction, operation, and maintenance of the structural flood risk management features;

(4) Provide, during construction, any additional funds necessary to make its total contribution for structural flood risk management equal to at least 35 percent of total structural flood risk management costs;

c. Provide 35 percent total non-structural flood risk management costs as further specified below:

(1) Provide, during the first year of construction, any additional funds necessary to pay the full non-federal share of design costs allocated by the government to the non-structural flood risk management features;

(2) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the government to be required or to be necessary for the construction, operation, and maintenance of the non-structural flood risk management features;

(3) Provide, during construction, any additional funds necessary to make its total contribution for non-structural flood risk management equal to 35 percent of total non-structural flood risk management costs;

d. Provide 35 percent of total ecosystem restoration costs as further specified below:

(1) Provide, during the first year of construction, any additional funds necessary to pay the full non-federal share of design costs allocated by the government to the ecosystem restoration features;

(2) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the government to be required or to be necessary for the construction, operation, and maintenance of the ecosystem restoration features;

(3) Provide, during construction, any additional funds necessary to make its total contribution for ecosystem restoration equal to 35 percent of total ecosystem restoration costs;

e. Provide 50 percent of total recreation costs as further specified below:

(1) Provide, during the first year of construction, any additional funds necessary to pay the full non-federal share of design costs allocated by the government to the recreation features;

(2) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the government to be required or to be necessary for the construction, operation, and maintenance of the recreation features;

(3) Provide, during construction, any additional funds necessary to make its total contribution for recreation equal to 50 percent of total recreation costs;

f. Provide, during construction, 100 percent of the total recreation costs that exceed an amount equal to the sum of the following:

(1) 10 percent of the federal share of total structural flood risk management costs; plus

(2) 10 percent of the federal share of total ecosystem restoration costs; plus

(3) 10 percent of the federal share of total non-structural flood risk management costs;

g. Not less than once each year, inform affected interests of the extent of risk reduction afforded by the flood risk management features;

h. Agree to participate in and comply with applicable federal floodplain management and flood insurance programs;

i. Comply with Section 402 of the WRDA of 1986, as amended (33 U.S.C. 701b-12), which requires a non-federal interest to prepare a floodplain management plan within one year after the date of signing a project partnership agreement, and to implement such plan not later than one year after completion of construction of the flood risk management features;

j. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood risk management features;

k. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the flood risk management features afford, reduce the outputs produced by the ecosystem restoration features, hinder operation and maintenance of the project, or interfere with the project's proper function;

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l. Shall not use the ecosystem restoration features or lands, easements, and rights-of-way required for such features as a wetlands bank or mitigation credit for any other project;

m. Keep the recreation features, and access roads, parking areas, and other associated public use facilities, open and available to all on equal terms;

n. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the federal government, in a manner compatible with the project's authorized purposes and in accordance with applicable federal and state laws and regulations and any specific directions prescribed by the federal government;

o. Give the federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-federal sponsors own or control for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

p. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

q. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the federal government determines to be required for construction, operation, and maintenance of the project. However, for lands that the federal government determines to be subject to the navigation servitude, only the federal government shall perform such investigations unless the federal government provides the non-federal sponsors with prior specific written direction, in which case the non-federal sponsors shall perform such investigations in accordance with such written direction;

r. Assume, as between the federal government and the non-federal sponsors, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the federal government determines to be required for construction, operation, and maintenance of the project; and

s. Agree, as between the federal government and the non-federal sponsor, that the non-federal sponsors shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA.

DAEN
SUBJECT: Upper Des Plaines River and Tributaries, Illinois and Wisconsin

10. The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified before it is transmitted to Congress as a proposal for authorization and implementation funding. However, prior to transmittal to Congress, the sponsors, the states of Illinois and Wisconsin, interested federal agencies, and other parties will be advised of any significant modifications and will be afforded an opportunity to comment further.

THOMAS P. BOSTICK
Lieutenant General, USA
Chief of Engineers

U.S. Department
of Transportation
**Federal Aviation
Administration**

Great Lakes Region
2300 E. Devon Avenue
Des Plaines, Illinois 60018

August 12, 2014

COL Christopher T. Drew
U.S. Army Corps of Engineers
231 S. LaSalle Street, Suite 1500
Chicago, Illinois 60604

Dear Colonel Drew:

Thank you for the opportunity to review the proposed Upper Des Plaines River and Tributaries, Illinois and Wisconsin - Integrated Feasibility Study and Environmental Assessment that proposes several projects within five miles of Chicago O'Hare International Airport, Chicago Executive Airport, and Waukegan Regional Airport. A member of my staff conducted the review and continues to work with the U.S. Department of Agriculture (USDA) on their review. We are pleased to cooperate with the Corps on assessing and addressing potentially hazardous wildlife attractants near these public-use airports.

Based on the current information provided with the current level of design, we believe that the designs for Sites WLRS04, DPLV09, DPLV05, and DPRS04 are consistent with FAA Advisory Circular Hazardous Wildlife on or near Airports (AC 150/5200-33B). At this level of design, the proposed projects at Northbrook Marsh, Beck Lake Meadow, and Site L31 will need further analysis and adjustment/modification to be consistent with our criteria outlined in AC 150/5200-33B. However, we understand that the information presented in your report is at a 30% design level, and that additional design effort would be required before the projects are further designed or constructed.

The Corps of Engineers should ensure that the criteria outlined in AC 150/5200-33B for water management facilities are considered during the detailed design and operation of all proposed projects within 5 miles of the airports listed above. During the detailed design of the proposed projects, the District should re-engage FAA and USDA staff to ensure that projects can be accomplished without inducing a hazard to the flying public at these critical airports. We would expect that monitoring and adaptive management of these sites will also be coordinated with staff from the USDA and FAA to mitigate any new hazards to the flying public in the future.

We look forward to working with you and our partners at Chicago area airports as these plans are further refined so that together we can minimize wildlife risks to aviation and human safety while protecting our Nation's valuable environmental resources.

Sincerely,

Deb Bartell
Acting Manager
Chicago Airports District Office

cc: Travis Guerrant and Scott Beckerman, U.S. Department of Agriculture
Rosemarie Andolino, Chicago O'Hare International Airport
Jim Stanczak, Waukegan National Airport
Jamie Abbott, Chicago Executive Airport
Terrence Schaddel, Illinois Department of Transportation - Division of Aeronautics

CELRC-PM-PL 04 SEP 2014

MEMORANDUM FOR RECORD

SUBJECT: Upper Des Plaines River and Tributaries, Illinois and Wisconsin – Federal Aviation Administration Coordination Meeting, 3 September 2014

1. References

a. Memorandum of Agreement Between the Federal Aviation Administration, the U.S. Air Force, the U.S. Army, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the U.S. Department of Agriculture to Address Aircraft-Wildlife Strikes, July 2003

b. USDOT/FAA AC 150/5200-33B, Hazardous Wildlife Attractants on or near Airports, August 2007

c. Upper Des Plaines River & Tributaries, Illinois and Wisconsin, Feasibility Study and Integrated Environmental Assessment (Draft), May 2014

d. Letter from Commander, Chicago District to Regional Administrator, Federal Aviation Administration Great Lakes Region, 29 May 2014, subject: Upper Des Plaines River and Tributaries, Illinois and Wisconsin, Feasibility Report and Environmental Assessment Coordination

e. Letter from Acting Manager, Federal Aviation Administration Chicago Airports District Office to Commander, Chicago District, 12 August 2014, subject: Summary of review of Upper Des Plaines River and Tributaries, Illinois and Wisconsin, Feasibility Report and Integrated Environmental Assessment

2. As a follow-up to the 12 August 2014 letter from the Federal Aviation Administration (FAA), Chicago District Staff met with FAA staff and United States Department of Agriculture (USDA) staff to discuss remaining concerns and next steps in coordination on the Upper Des Plaines River and Tributaries, Illinois and Wisconsin Feasibility Study (Upper Des Plaines Study) recommendations. The result of this coordination is that all projects can be implemented under the conditions of the MOA and within the guidelines provided in FAA Advisory Circular (AC) 150/5200-33B. However, input from FAA and USDA during the design phase will be needed to ensure that risks to the flying public are minimized.

SUBJECT: Upper Des Plaines River and Tributaries, Illinois and Wisconsin – Federal Aviation Administration Coordination

3. The meeting was held on 3 September 2014 at FAA Offices in Des Plaines and was attended by the following:

USACE, Chicago District	
Susanne Davis (via phone)	Chief of Planning
David Bucaro (via phone)	Chief of Economic Formulation and Analysis
Jeff Zuercher	Project Manager
Sara Brodzinsky	Lead Planner
FAA, Chicago Airports District Office	
Amy Hanson	Environmental Specialist
USDA, Animal and Plant Health Inspection Service, Wildlife Services	
Scott Beckerman	State Director, Illinois Wildlife Services
Travis Guerrant	Wildlife Biologist

4. The Upper Des Plaines Study proposes construction of three levee/floodwalls, two floodwater storage reservoirs, seven aquatic ecosystem restoration projects, and non-structural flood risk management measures at approximately 400 structures across the watershed. Some of the proposed sites are located near area airports. Pursuant to a 2002 Memorandum of Agreement (MOA) with the Federal Aviation Administration (FAA), the Chicago District initiated coordination with the FAA to determine whether any of the projects could increase risks to aviation associated with hazardous wildlife and determine whether any project modifications would be required to reduce that risk. The FAA conducted preliminary wildlife hazard assessments and evaluations of the projects through consultation with wildlife biologists from USDA.

5. In Illinois, FAA and USDA use a tiered approach to evaluate the potential for hazardous wildlife at a project site. If a project is within 10,000 feet of an airport, increases in water surface area as well as the potential for improved habitat for hazardous wildlife are evaluated. For projects further than 10,000 feet but within five miles of an airport, only changes in water surface area are evaluated.

6. The Chicago District summarized the USACE Feasibility Study processes and expected timelines. FAA and USDA were concerned about timing and Chicago District indicated that, under current policy and guidance, it is expected that Final Design for these projects would not start for at least two to three years and possibly longer. For restoration projects in particular, this summary included construction methods, establishment periods, monitoring and adaptive management, and operation and maintenance requirements.

SUBJECT: Upper Des Plaines River and Tributaries, Illinois and Wisconsin – Federal Aviation Administration Coordination

7. Mr. Beckerman (USDA) indicated that the District's evaluation of wildlife hazards was a good first step to address the guidance in the FAA Circular. The following projects were identified by the Chicago District, FAA, and USDA as warranting further coordination.

a. *Floodwater storage reservoirs.* The two proposed reservoirs are not within 10,000 feet of any airports but are within five miles of Chicago O'Hare International Airport (O'Hare) and one is within five miles of Chicago Executive Airport. The AC recommends that reservoirs allow a maximum 48 hour detention period. Some historic floods in the watershed have resulted in flooding that lasts for longer than two days and, in the case of such a storm, the detention period would exceed this recommended maximum.

i. *Alternatives for resolution:* To address this problem, measures to inhibit wildlife can be incorporated in the site design or, if the incidence of longer duration detention is expected to be infrequent, monitoring during site operation can be implemented to ensure that hazardous wildlife do not inhabit the site during these extreme events.

ii. *Next steps:* The Chicago District is conducting an analysis to determine the expected frequency of flood events that would last longer than 48 hours. The results of this analysis would form the basis of a recommendation to either incorporate wildlife inhibition measures in during the design phase or develop a monitoring plan for longer duration flood events as part of the site operation and maintenance plan.

b. *Levee/floodwalls.* Two levee/floodwalls are within10,000 feet of O'Hare and one is within five miles. While the AC does not specifically address levees, Mr. Beckerman noted that vegetation on the levees could potentially provide a food source for hazardous wildlife. Floodwalls are not considered a hazardous wildlife attractant.

i. *Alternatives for resolution:* Mr. Guerrant (USDA) indicated that turf grass, as required by USACE guidance, would be appropriate levee vegetation. USDA has coordinated a seed mix with the Illinois Department of Transportation (IDOT) for regional projects. The seed mix deters geese, in particular.

ii. *Next steps:* Use of the IDOT seed mix in project specifications would address concerns about these projects. Final designs will be coordinated with FAA and USDA.

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SUBJECT: Upper Des Plaines River and Tributaries, Illinois and Wisconsin – Federal Aviation Administration Coordination

c. *Aquatic Ecosystem Restoration.* One aquatic ecosystem restoration project is within 10,000 feet of Chicago Executive Airport and another project is partially within 10,000 feet of Chicago Executive Airport and is within five miles of O'Hare. A third project is within five miles of Waukegan Regional Airport. For these projects, the concern is the potential to change the quantity of hazardous wildlife near the airports. FAA and USDA staff indicated that, through consultation and coordination during the design phase, adjustments to the projects could be made that would accomplish the projected habitat benefits on the proposed site footprint while minimizing attractiveness to hazardous wildlife. In particular, FAA and USDA were encouraged that monitoring and adaptive management would be implemented to ensure that the success of the restoration. Control of invasive plants such as phragmites is of particular concern as it is a desirable food source for geese.

i. *Alternatives for resolution:* These concerns can be addressed through measures such as avoiding plantings that serve as food sources for hazardous wildlife, and controlling invasive species, and limiting increases in areas of open water.

ii. *Next steps:* The Chicago District will provide additional information on the proposed restoration projects and the preliminary assessment of hazardous wildlife attractiveness conducted by the District for review by FAA and USDA. During design, the District will continue to coordinate with FAA. Over the next year, UDSA will be conducting a wildlife hazard study for the Chicago Executive Airport, including surveys of hazardous wildlife on and around the airport. The District will work with the non-Federal sponsor for the Northbrook Marsh project, adjacent to the airport, to possibly support extension of the survey area to include nearby portions of proposed restoration projects. This survey could provide additional data to support a baseline condition assessment of hazardous wildlife at the site.

8. To assist with future coordination, Ms. Davis asked if USDA staff could provide a short training session for Chicago District biologists and planners on the USDA assessment process. Mr. Beckerman agreed, but indicated because they are so short staffed, it would have to be scheduled sometime in the near future.

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SUBJECT: Upper Des Plaines River and Tributaries, Illinois and Wisconsin – Federal Aviation Administration Coordination

9. The Chicago District will complete the actions discussed above and continue to coordinate during the design phase to ensure that the projects do not result in a hazard to the flying public. Chicago District, FAA, and USDA staff agreed that the steps identified above are the most appropriate path forward. The point of contact for this memorandum is the undersigned who can be reached at 312-846-5580 or susanne.j.davis@usace.army.mil.

SUSANNE J. DAVIS, P.E.
Chief, Planning Branch
Chicago District

U.S. Department
of Transportation
**Federal Aviation
Administration**

Great Lakes Region
2300 E. Devon Avenue
Des Plaines, Illinois 60018

October 3, 2014

COL Christopher T. Drew
U.S. Army Corps of Engineers
231 S. LaSalle Street, Suite 1500
Chicago, Illinois 60604

Dear Colonel Drew:

Thank you for the opportunity to review the proposed Upper Des Plaines River and Tributaries, Illinois and Wisconsin - Integrated Feasibility Study and Environmental Assessment that proposes several projects within five miles of Chicago O'Hare International Airport, Chicago Executive Airport, and Waukegan Regional Airport. Based upon the review of the Corps' study, coordination with specialists from the USDA, and the discussion with Corps staff, we do not anticipate the need to modify the boundary of any of the Upper Des Plaines River and Tributaries, Illinois and Wisconsin proposed projects.

We look forward to working with you and our partners at Chicago area airports as these plans are further refined so that together we can minimize wildlife risks to aviation and human safety while protecting our Nation's valuable environmental resources.

Sincerely,

Deb Bartell
Acting Manager
Chicago Airports District Office

cc: Travis Guerrant and Scott Beckerman, U.S. Department of Agriculture
Rosemarie Andolino, Chicago O'Hare International Airport
Jim Stanczak, Waukegan National Airport
Jamie Abbott, Chicago Executive Airport
Terrence Schaddel, Illinois Department of Transportation - Division of Aeronautics

DEPARTMENT OF THE ARMY
CHICAGO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
231 SOUTH LASALLE STREET, SUITE 1500
CHICAGO IL 60604

CELRC-PM-PL 14 OCT 2014

MEMORANDUM THRU COMMANDER, GREAT LAKES AND OHIO RIVER DIVISION (CELRD-PDS-P, MR. ZIMMERMAN)

FOR COMMANDER, HQUSACE (CECW-LRD, MR. WARREN)

SUBJECT: Upper Des Plaines River and Tributaries, IL and WI – Summary of Federal Aviation Administration Coordination

1. References:

a. Upper Des Plaines River & Tributaries, Illinois and Wisconsin, Feasibility Study and Integrated Environmental Assessment (Draft), May 2014.

b. Memorandum, CELRC-PM-PL, 29 May 2014, Subject: Upper Des Plaines River and Tributaries, Illinois and Wisconsin Feasibility Study – Civil Works Review Board, 20 May 2014.

c. Memorandum of Agreement, 29 July 2003, Between the Federal Aviation Administration, the U.S. Air Force, the U.S. Army, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the U.S. Department of Agriculture.

d. Letter, Acting Manager, Federal Aviation Administration Chicago Airports District Office, 12 August 2014, Subject: Summary of review of Upper Des Plaines River and Tributaries, Illinois and Wisconsin, Feasibility Report and Integrated Environmental Assessment.

e. Memorandum, CELRC-PM-PL, 4 September 2014, Subject: Upper Des Plaines River and Tributaries, Illinois and Wisconsin – Federal Aviation Administration Coordination Meeting.

f. USDOT/FAA AC 150/5200-33B, 28 August 2007, Subject: Hazardous Wildlife Attractants on or near Airports.

2. As discussed at the 20 May 2014 Civil Works Review Board for the referenced Feasibility Study, the Chicago District has been coordinating with the Federal Aviation Administration (FAA) to ensure that recommended projects located within Aircraft Operations Areas (AOAs) can both accomplish the project purposes and minimize risks associated with aircraft-wildlife strikes. Recognizing that the level of design for the projects is at a Feasibility level, the FAA would like to further coordinate and review the

designs during the project design phase. However, Chicago District and FAA Chicago Airports District Office Staff agree that the projects can be implemented to meet the project purposes.

3. The Chicago District (LRC) coordinated with the FAA on the individual projects recommended by the Upper Des Plaines River and Tributaries Feasibility Report (ref. 1.a). This coordination was completed in accordance with a 2003 Memorandum of Agreement (ref. 1.c) between USACE and FAA. The coordination was documented in a letter from the Chicago Airports District Office to the Chicago District Commander (ref. 1.d), and the purpose of the coordination with the FAA has been to ensure that the projects can be implemented without increasing risks to the flying public. Recognizing that the level of design for the projects is at a Feasibility level, the FAA would like to further coordinate and review the designs during the project design phase.

4. The Upper Des Plaines River and Tributaries Feasibility Study is a multi-purpose study recommending construction of three levee/floodwalls, two floodwater storage reservoirs, seven aquatic ecosystem restoration projects, and nonstructural flood risk management measures at approximately 400 structures across the watershed. Because some sites are within Airport Operation Areas (AOAs), the Chicago District has coordinated with the Federal Aviation Administration (FAA) in accordance with the terms of the 2003 Memorandum of Agreement (MOA) with the FAA (ref. 1.c).

5. Under the 2003 MOA, ref. 1.c, the U.S. Army, the FAA, and several other federal agencies agreed to work cooperatively within their mission areas to try to reduce the likelihood of aircraft-wildlife strikes. The agencies agreed to consider FAA land use practice recommendations when their projects fell within Airport Operation Areas. Specifically, Section I.H of the MOA states that:

> "Appropriate signatory agencies will cooperatively review proposals to develop or expand wetland mitigation sites, or wildlife refuges that may attract hazardous wildlife. When planning these sites or refuges, the signatory agencies will diligently consider the siting criteria and land use practice recommendations stated in FAA AC 150/5200-33. The agencies will make every effort to undertake actions that are consistent with those criteria and recommendations, but recognize that exceptions to the siting criteria may be appropriate (see Paragraph F of this section)."

6. While the MOA encourages inter-agency coordination and consideration of land use impacts, the agencies have the discretion to not follow the FAA land use recommendations. The MOA does not contain legally binding requirements, and it acknowledges that various factors may be relevant to an agency's decision. (Section II.E)

7. As noted above, the projects identified in the recommended plan for the Upper Des Plaines River and Tributaries Feasibility Study are being coordinated with the FAA consistent with the terms of the MOA. LRC provided the draft Feasibility Report, including proposed site plans at their current level of design to FAA for review. FAA, supported by the U.S. Department of Agriculture (USDA), completed a review and provided a letter to document the coordination (ref. 1.d).[1] A face to face meeting was held to discuss the results of the FAA/USDA review and address any outstanding comments from the reviewers. A memorandum for record documenting the meeting was developed by LRC staff. (ref. 1.e).

8. For the recommended Upper Des Plaines projects, LRC, FAA, and USDA determined that wildlife hazards can be addressed through consideration of FAA and USDA recommendations during detailed design. FAA/USDA did note that some project features, such as invasive species removal, would actually serve as a deterrent for certain hazardous wildlife, (ref 1.e). The preliminary wildlife hazard analysis by USACE determined that the projects within AOAs would not attract hazardous wildlife if appropriately designed, and acknowledged the need to further coordinate with the FAA during detailed design. FAA and USDA agreed with the preliminary assessment conducted by LRC.

9. As noted in the meeting documentation, (ref. 1.e), staff from FAA, USDA and LRC reviewed each proposed project and discussed ways to appropriately consider hazardous wildlife attractiveness in the design, monitoring and operations of each site. These features can be incorporated into the site plans during detailed design. The considerations discussed include avoiding plantings that serve as food sources for hazardous wildlife, controlling invasive species, and limiting increases in areas of open water to the extent possible. The meeting attendees from the FAA and USDA did not object to any of the projects identified in the recommended plan. Coordination with the FAA/USDA will continue as detailed designs are developed during the Preconstruction Engineering and Design (PED) and Construction Phases. This coordination will ensure that detailed designs for the project reasonably follow the guidelines provided in the FAA Circular and minimize risks to the flying public.

10. While designs can be fine-tuned to minimize hazardous wildlife attractants for the restoration sites, the proposed projects are also nationally significant and not only restore floodplain functions and improve the diversity and richness of native species, but also provide habitat for federally-listed species. Thus, the ecosystem projects on these

[1] It should be noted that the MOA does not include a process by which the FAA formally provides a "letter of compliance" to a signatory agency. Instead, the MOA emphasizes coordination between agencies and agency discretion. Such coordination must appropriately continue through detailed design to ensure that the FAA's recommendations and analyses are complete.

particular habitats are also supported by the MOA provisions which acknowledge that certain exceptions to the land use recommendations are appropriate for habitats that provide unique ecological functions or values (e.g., critical habitat for federally-listed endangered or threatened species, ground water recharge) (ref. 1.c, Section 1.F). The MOA recognizes that not all habitat types attract hazardous wildlife and that wetlands provide many important ecological functions and values.[2]

11. USACE has fulfilled its obligations under the MOA by coordinating with the FAA, and it will continue such coordination during detailed design to ensure that the final designs can both accomplish the project purposes and minimize risks associated with aircraft-wildlife strikes.

12. Questions or comments on this memorandum should be directed to Ms. Susanne Davis, District Planning Chief. Ms. Davis can be reached at 312-846-5580 or via email at susanne.j.davis@usace.army.mil.

CHRISTOPHER T. DREW
COL, EN
Commanding

[2] When "there is disagreement among signatory agencies about a particular land use and its potential to attract hazardous wildlife," then the FAA or USFWS will prepare an assessment. MOA, Section I.H. When there is no disagreement, then an assessment is not prepared.

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217)782-2829

PAT QUINN, GOVERNOR LISA BONNETT, DIRECTOR

217/782-3362

SEP 24 2014

Ms. Susanne Davis
U.S. Army Corps of Engineers, Chicago District
231 South LaSalle Street, Suite 1500
Chicago, IL 60604

Re: U.S. Army Corps of Engineers (Lake and Cook County)
Upper Des Plaines River and Tributaries Feasibility Report and Environmental Assessment
Log # C-0449-14

Dear Ms. Davis:

The Illinois Environmental Protection Agency (Illinois EPA) received your email dated August 7, 2014 asking for comments from the Illinois EPA regarding the May 2014 Draft Upper Des Plaines River and Tributaries, Illinois and Wisconsin Integrated Feasibility Report and Environmental Assessment for projects in Lake and Cook Counties. The Facility Evaluation Unit staff has reviewed the submitted documents concerning the above referenced project, and based on the information provided, the following items are offered for your consideration and appropriate action.

The Illinois EPA concurs with the continued development of the proposed project plans and specifications with the goal of Section 401 water quality certification of the projects and eventual project completion. Projects within Illinois including the discharge of dredged or fill material into waters of the U.S. will be reviewed by the Illinois EPA for a water quality certification under Section 401, in accordance with the State of Illinois' certification and water quality regulations, after receipt and review of a completed joint application forms including detailed plans and specifications.

The Illinois EPA recommends that any future submittal for the Section 401 certification address the below listed items. Please be advised that the below listed items are areas that the Illinois EPA has determined will need to be addressed based upon the preliminary information submitted to date. Please also be advised that the inclusion of the below listed items with any future submittals may not provide all of the information necessary to satisfy the Section 401 application review process.

1. In order to complete our review as required under Section 401 of the Clean Water Act, please provide this office with the necessary completed application forms, plans and other pertinent documents so that we may complete our review in a timely manner.

2. For any proposed dam removals, the 401 application shall include a description of all measures taken to assure that the sediment behind the dam(s) does not cause water quality violations once the dam is removed. This may include a description of how the sediment will be removed prior to dam removal or stabilized such that sediment and potentially contaminated sediment is not transported downstream. For projects that will result in the release of sediment downstream, sediment data shall be submitted and compared to typical Illinois stream sediment data.

3. For any projects that will include dewatering of sediment, the application must demonstrate that the discharge of any return water to waters of the U.S. will not cause violation of applicable water quality standards of the Illinois Pollution Control Board, Title 35, Subtitle C: Water Pollution Rules and Regulations.

4. For any project that dredges or disturbs contaminated sediments, the 401 application shall include a discussion of how the sediment will be handled and measures taken to make sure contaminated sediment does not cause a water quality violation. Testing of the sediment may be required.

5. For any project involving the enhancement of flows between existing water bodies with pump stations, the 401 application shall address the water quality effects of that increased flow between water bodies.

6. Applications for a 401 water quality certification shall address any water quality impairments and provide a description of how the proposed project will not add to the impairments. Please be advised that there are several combined sewer overflow discharges and wastewater treatment plant discharges upstream of the proposed reservoirs at the Harry Semrow Driving Range and Fullerton Woods. The joint application for these projects shall include a discussion on how the reservoirs will be managed to assure the reservoirs and downstream receiving waters meet water quality standards including a discussion about nutrients, algae control and dissolved oxygen. Please be advised that the updated 303(d) listings (currently for 2014) can be found on the Agency website here: http://www.epa.state.il.us/water/tmdl/303d-list.html.

7. Applications for a 401 water quality certification shall include a discussion of measures which ensure consistency with the assumptions and requirements of the Total Maximum Daily Load (TMDL) completed for the Des Plaines River / Higgins Creek watershed found here: http://www.epa.state.il.us/water/tmdl/report-status.html#deshig.

8. Applications for a 401 water quality certification shall include documentation of correspondences regarding coordination with the Illinois Historic Preservation Agency (IHPA).

9. Be advised that several projects are proposed in potential Environmental Justice areas including the Harry Semrow Reservoir, Lake Mary Anne pump station, Touhy-Miner Levee, Fullerton-Grand Levee, Belmont-Irving Park Levee, First Avenue Bridge modification and the Fullerton Woods Reservoir. Applications for a 401 water quality certification for projects in Environmental Justice areas shall include any information on public meetings, etc. that were held to notify and inform the public of the project.

10. In order to conduct an antidegradation assessment in accordance with the water quality standards under 35 Il. Adm. Code Part 302, applicants for Section 401 water quality certification are required to provide the following information:

    A. Identification and characterization (e.g., the current physical, biological and chemical conditions) of the water body affected by the proposed project and the water body's existing uses. Please include a complete wetland delineation for impacted wetlands and provide the drainage area (in acres) for the area draining to any impacted streams.

    B. Please provide a complete mitigation plan for the proposed impacts.

    C. The quantity of the pollutant load increase to the water body. The source, type and amount of all fill material placed into waters of the United States must be identified.

    D. The potential impacts of the proposed project on the water body.

    E. The purpose and anticipated benefits of the proposed project.

F. An assessment of the alternatives to the proposed project that will result in a reduced pollutant load to the water body, no load increase or minimal environmental degradation. Alternatives that result in no discharge to the water body and changes in the location of the activity must be addressed in the submittal.

G. All correspondences submitted and received as part of the threatened and endangered species consultation with the Illinois Department of Natural Resources. Consultation may be initiated using the EcoCAT web tool found at http://dnrecocat.state.il.us/ecopublic/. When using this tool, please indicate the Illinois Environmental Protection Agency as the government unit (state agency).

If you have any questions or comments concerning the contents of this letter, please contact Thaddeus Faught at phone number 217-782-3362. Please include the above referenced log number (C-0449-14) on all correspondence.

Sincerely,

Alan Keller, P.E.
Manager, Permit Section
Division of Water Pollution Control

SAK:DLH:TJF:0449-14prc.docx

cc: IEPA, Records Unit
IEPA, DWPC, FOS, Des Plaines
CoE, Chicago District (Regulatory Branch)
IDNR, OWR, DWRM, Bartlett
Ms. Sara Brodzinsky, Chicago Corps of Engineers
Ms. Casey Pittman, Chicago Corps of Engineers

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Chicago Ecological Services Office
1250 Grove Avenue, Suite 103
Barrington, Illinois 60010
Phone: (847) 381-2253 Fax: (847) 381-2285

IN REPLY REFER TO:
FWS/AES-CIFO/03E13000-2014-CPA-0025

Mr. Theodore A. Brown, P.E.
US Army Corps of Engineers
Headquarters
CECW-P (SA)
7701 Telegraph Road
Alexandria, VA 22315-3860

August 26, 2014

Dear Mr. Brown:

This is in response to your request dated July 22, 2014, to review the Corps' Final Integrated Feasibility Report and Environmental Assessment for the Upper DesPlaines River and Tributaries (EA). The proposed project would address combined flood control and ecosystem restoration projects proposed for the Upper DesPlaines watershed extending from Cook and Lake counties, in Illinois, northward to Kenosha and Racine counties, Wisconsin. This also follows our previous comments (dated January 27, 2014) on the draft EA, and a draft Fish & Wildlife Coordination Act Report provided by this office on February 27, 2014.

The EA continues to propose a similar list of projects as commented on by this office earlier, and we have no objection to the final EA.

Because of the eventual in-stream reconnection and allowance of fish passage, we continue our strong support for five proposed dam removals in Cook County (DR1, Wheeling, IL; DR2 DesPlaines, IL; DRD, DesPlaines, IL; DRT, DesPlaines, IL; and DR4, Park Ridge, IL) along the Upper DesPlaines river corridor.

In our previous reviews, we noted that proposed habitat restoration at Red Wing Slough (NER L43, Lake County), and Gurnee Woods Riparian Wetland (NER L31, Lake County) would occur adjacent to known sites for the federally threatened eastern prairie fringed orchid (*Platanthera, leucophaea*). While there are currently no known records of this species in the proposed project areas, we requested that the habitat be assessed or surveyed for the presence of this species before project implementation. If this species is found within the proposed project areas, consultation with the Service should be initiated, and a conservation plan should be developed.

We also noted in our previous reviews that proposed habitat restoration at Northbrook Floodplain and Riparian Complex includes known occupied habitat of the Federal candidate species eastern massasauga rattlesnake (*Sistrurus catenatus*). While we recognize that the proposed project would eventually enhance and expand available habitat for this species, we also note that specific management activities may adversely affect this species. We requested that the Corps work closely with staff from this office and the land owner (Forest Preserve District of Cook County) to develop a plan to include conservation measures to allow restoration activities to proceed without harming individual snakes. We have subsequently met with the Corps' Chicago District Planning Branch, and have initiated discussions with the land owner to develop the proposed conservation plan.

This letter provides comment under the authority of, and in accordance with the provisions of the National Environmental Policy Act of 1969 (83 Stat. 852, as amended P.L. 91-190, 42 U.S.C. 4321 *et seq.*), the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*), and the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 703 *et seq.*).

If you have any questions, please contact me (847/381-2253, ext 11) or my staff contact (Mr. Michael Redmer (847/381-2253 ext 16).

Sincerely,

Louise Clemency
Field Supervisor

Cc: Liz Pelloso, USEPA
Susanne Davis, Corps Chicago District
John McCabe and David Kircher, Forest Preserve District of Cook County
Jim Anderson, Lake County Forest Preserves

USDA United States Department of Agriculture

August 13, 2014

Theodore A. Brown, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works
U.S. Army Corps of Engineers
CECW-P (SA)
7701 Telegraph Road
Alexandria, VA 22315-3860

Dear Mr. Brown:

We have reviewed the feasibility report and environmental assessment on the Upper Des Plaines River and Tributaries, Illinois and Wisconsin. At this time I have no comments concerning the report and environmental assessment related to issues where the NRCS has jurisdiction or special expertise.

Sincerely,

IVAN N. DOZIER
State Conservationist

Natural Resources Conservation Service
2118 W. Park Court, Champaign, Illinois 61821
Voice (217) 353-6600 – FAX2mail (855) 668-0602

Helping People Help The Land.

Warren, Jay E HQ02

From: Bee, Patricia L HQ02
Sent: Wednesday, September 03, 2014 5:20 PM
To: Nicholson, Scott R HQ02
Cc: Warren, Jay E HQ02
Subject: FW: Upper Des Plaines River and Tributaries Project (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

NRCS (WI) response.

-----Original Message-----
From: Bramblett, Jimmy - NRCS, Madison, WI [mailto:Jimmy.Bramblett@wi.usda.gov]
Sent: Wednesday, September 03, 2014 3:41 PM
To: Bee, Patricia L HQ02
Subject: [EXTERNAL] RE: Upper Des Plaines River and Tributaries Project (UNCLASSIFIED)

Trish,

Our staff has reviewed the documents and we had no additional comments to offer at this time.

THANKS!!!

Jimmy Bramblett
State Conservationist
USDA - NRCS
8030 Excelsior Drive, Suite 200
Madison, WI 53717
608-662-4422
Jimmy.bramblett@wi.usda.gov

Classification: UNCLASSIFIED
Caveats: NONE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

AUG 15 2014

REPLY TO THE ATTENTION OF:

E-19J

Scott Nicholson
U.S. Army Corps of Engineers
CECW-P (SA)
7701 Telegraph Rd.
Alexandria, Virginia 22315

RE: Final Integrated Feasibility Report/Environmental Assessment: Upper Des Plaines River and Tributaries – Illinois and Wisconsin; Racine and Kenosha Counties, Wisconsin, and Lake and Cook Counties, Illinois

Dear Mr. Nicholson:

The U.S. Environmental Protection Agency has received U.S. Army Corps of Engineers (USACE) correspondence dated July 22, 2104, requesting EPA's comments on the recently released Upper Des Plaines River and Tributaries, Illinois and Wisconsin - Integrated Feasibility Report/Environmental Assessment, and its associated plates and appendices, (hereafter referred to as Final EA). The original Draft EA was released in September 2013. On February 26, 2014, EPA provided comments on the original Draft EA from 2013, the "Document of Changes" received in January 2014, and a revised[1] "Document of Changes" posted to USACE's website in February 2014. There are multiple non-federal sponsors for this project in both Wisconsin and Illinois.

Communities along the Upper Des Plaines River and its tributaries have experienced major flooding resulting in hundreds of millions of dollars in damages over the past several decades. An earlier study, the Upper Des Plaines River, Illinois Feasibility (Phase I Study) formulated plans to address severe overbank flooding along the Upper Des Plaines River. The Phase I Study recommended six projects[2] to reduce mainstem flooding. This Upper Des Plaines River and Tributaries, Illinois and Wisconsin Feasibility Study (Phase II Study) provides an opportunity to develop a more comprehensive solution to address ongoing occurrences of flooding in the Upper Des Plaines River watershed and the degraded ecosystems within the watershed.

[1] Revised documents were posted in February 2014 to correct inadvertent misrepresentations of the Endangered Species Act and Fish and Wildlife Coordination Act review procedures. The revisions were on p. 211 of the Draft Feasibility Report/Environmental Assessment and on p. 21 of the Documentation of Changes.

[2] While one project is complete and another nears completion, the remaining four projects are not yet designed and are without a start date due to various issues.

The Phase II study authorization directs the evaluation of plans to manage flood risk and address environmental restoration and protection on both the mainstem and tributaries. Additionally, the study authorization includes water quality, recreation, and related purposes. The study considers sites located within tributary watersheds as well as along the mainstem Des Plaines River for both Flood Risk Management (FRM) and Ecosystem Restoration (ER) potential. The baseline conditions for the Phase II Study include the implementation of the six flood risk management projects recommended by the Phase I study that were authorized for construction under Section 101 of the 1999 Water Resources Development Act. Although the six projects, if fully implemented, would reduce flood damages in the watershed, it was estimated during the Phase I Study that even with these six projects constructed, there is a significant residual flood risk in the watershed.

The principal goals of the resulting multi-purpose project are 1) to reduce future flood risk along the mainstem of the upper Des Plaines River; 2) to reduce future flood risk along tributaries to the upper Des Plaines River; 3) to restore the environmental integrity and beneficial uses of the river and its tributaries; and 4) to reestablish hydrology, hydraulics, geomorphology and appropriate native vegetation to set the stage for self regulating and sustainable habitats.

USACE has studied several "plans" with varying ranges of measures to be implemented by each plan. These plans were referred to as the Full Plan, the Continuing Authorities Program (CAP) Plan, and the National Economic Development/National Ecosystem Restoration (NED/NER) Plan. Ultimately, USACE is recommending the NED/NER[3] plan for Congressional authorization. In addition, projects that could reasonably be implemented under CAP[4] are being recommended for conversion to that program for implementation. The recommended projects have been modified several times since the publication of the 2013 Draft EA; these modifications were discussed in the 2014 Document of Changes and in the Final EA. Major project modifications include the removal of the proposed Aptakisic Creek Reservoir (ACRS08) and the substitution of two new reservoirs: Fullerton Woods Reservoir (DPRS04) and Harry Semrow Driving Range Reservoir (WLRS04).

As of the date of this letter, the Recommended Plan includes the following projects:

CAP PLAN – 6 projects

- Five (5) Ecosystem Restoration Projects – dam removals
    - Dam #1 – Wheeling (DR1)
    - Dam #2 – Des Plaines (DR2)
    - Dempster Ave. Dam – Des Plaines (DRD)
    - Touhy Ave. Dam – Des Plaines (DRT)
    - Dam #4 – Park Ridge (DR4)
- One (1) Flood Risk Management project – one levee/floodwall
    - Groveland Ave Levee (DPLV01)

[3] Policy compliant features that are economically justified (for flood risk management features) or cost-effective (for environmental restoration features) and of such scope that they could not reasonably be implemented under CAP authorities are included in a plan designated as the Combined NED/NER Plan.
[4] Includes all policy compliant, separable features that are economically justified (for flood risk management features) or cost-effective (for environmental restoration features) and of such scope that they could reasonably be implemented under the USACE Continuing Authorities Program (CAP).

NED/NER PLAN – 14 projects

- Seven (7) Ecosystem Restoration Projects – environmental restoration sites
  - K47 – Bristol Marsh – Bristol, WI (Kenosha Co.)
  - K41 – Dutch Gap Forested Floodplain – Pikesville, WI (Kenosha Co.)
  - L43 – Red Wing Slough and Deer Lake Wetland Complex – Antioch, IL (Lake Co.)
  - L39 – Pollack Lake and Hastings Creek Riparian Wetlands – Antioch, IL (Lake Co.)
  - L31 – Gurnee Woods Riparian Wetland – Wadsworth, IL (Lake Co.)
  - C09 – Northbrook Marsh – Wheeling, IL (Cook Co.)
  - C15 – Beck Lake Meadow – Des Plaines/Glenview, IL (Cook Co.)
- Seven (7) Flood Risk Management Projects
  - Two (2) Floodwater Storage Reservoirs
    - Fullerton Woods Reservoir (DPRS04)
    - Harry Semrow Driving Range Reservoir (WLRS04)
  - Three (3) Levee/Floodwalls
    - Touhy-Miner Levee[5] (DPLV09)
    - Belmont-Irving Park Levee (DPLV05)
    - Fullerton-Grand Levee[6] (DPLV04)
  - Two (2) Non Structural Flood Risk Management Plans
    - Lake County Non-Structural Measures (NSL)
    - Cook County Non-Structural Measures (NSC)

This letter provides our comments on the Final EA, pursuant to the National Environmental Policy Act (NEPA), the Council on Environmental Quality's NEPA Implementing Regulations (40 CFR 1500-1508), and Section 309 of the Clean Air Act. We very much appreciate the detailed responses to EPA's January 2014 comments on the Draft EA that USACE Chicago District staff provided electronically to Ms. Liz Pelloso of my staff on August 8, 2014.

Based on our review of the Final EA, EPA has developed comments pertaining to threatened and endangered species, wetlands, and protection of existing mitigation sites. Comments are grouped by topic and are as follows.

THREATENED AND ENDANGERED SPECIES

- The U.S. Fish and Wildlife Service's (USFWS) Draft Fish and Wildlife Coordination Act (FWCA) Report, dated February 27, 2014, states that several proposed Environmental Restoration Sites (K47- Bristol Marsh; K41 – Dutch Gap Forested Floodplain; L43 – Red Wing Slough and Deer Lake Wetland Complex; and L39 – Pollack Lake and Hastings Creek Riparian Wetlands) include existing wetlands and wetland habitat that may be suitable for the Federally-threatened Eastern Prairie Fringed Orchid (EPFO). The EPFO has been confirmed at a location within 0.28 mile of Site L43 and at the Wadsworth Prairie Forest Preserve (where there is an extant population of the EPFO), approximately 0.29 mile north of Environmental Restoration Site L31 – Gurnee Woods Riparian Wetland.
  Recommendation: EPA supports USFWS's recommendation that field habitat surveys for the EPFO be undertaken during the orchid blooming season (typically late June

[5] DPLV09, referred to in the Draft EA as the Ashland-Fargo Levee, is now (as of Feb. 2014) referred to as the Touhy-Miner levee.

[6] DPLV04, referred to in the Draft EA as the Fifth Canadian National Railroad levee, is now (as of Feb. 2014) referred to as the Fullerton-Grand Levee.

through July). Specific survey dates should be coordinated with UWFWS. As some of the restoration activities proposed at these sites could affect the EPFO, a conservation plan should be developed to protect the EPFO at these sites, in order to avoid harm to the species. The plan should include monitoring to inform whether conservation measures are effective in avoiding harm to the EPFO and to assess beneficial effects resulting from improvements in habitat quality.

Additionally, EPA recommends that this commitment for coordination, surveys, and an EPFO conservation plan be committed to in the future Finding of No Significant Impact (FONSI) issued for this project.

- Site C09 – Northbrook Marsh, proposed for environmental restoration activities, is also one of the final remaining locations in Illinois with a known population of the Eastern Massasauga rattlesnake. This species is a candidate for Federal listing under the Endangered Species Act, and USFWS is currently drafting a final Species Status Assessment and a listing determination (anticipated for Federal Register publication in September 2015). While the types of restoration activities proposed by USACE may result in greatly improved habitat for this species, some habitat restoration and management activities can also result in adverse effects, including mortality to individuals. Due to the small sizes of remnant populations of Eastern Massasauga rattlesnake, any loss of individuals is significant. USFWS stated in their Draft FWCA Report, "*Loss of this species from this location would be irreversible, and would further increase the vulnerability of the species to extinction.*"
  <u>Recommendation:</u> EPA supports USFWS's recommendation that USACE work closely with USFWS staff and the owner of Site C09 (the Forest Preserve District of Cook County) to jointly develop and approve an Eastern Massasauga conservation plan. The purpose of the plan would be to identify appropriate conservation measures that will allow habitat restoration actions to proceed at this site while avoiding harm to the rattlesnakes. The plan should include monitoring to inform whether conservation measures are effective in avoiding harm to the rattlesnakes and to assess beneficial effects resulting from improvements in habitat quality.

  Additionally, EPA recommends that this commitment for coordination, surveys, and an Eastern Massasauga conservation plan be committed to in the future FONSI to be issued for this project.

<u>MITIGATION</u>

- In addition to potential habitat or populations of the EPFO, correspondence from the Lake County (Illinois) Forest Preserve District (LCFPD) dated October 13, 2014, states that the Gurnee Woods Riparian Wetland parcel (Site L31; proposed for environmental restoration activities) contains wetland mitigation sites.
  <u>Recommendations:</u> The Final EA does not include information about any existing mitigation sites on any proposed environmental restoration site. Future construction plans should outline the location of mitigation sites on these properties, and care should be taken to avoid work in mitigation areas, particularly any mitigation area still under permittee-responsible monitoring.

Thank you for the opportunity to review and comment upon this Final Environmental Assessment. We are available to discuss our comments with you in further detail if requested. We look forward to reviewing future NEPA documents prepared for this project, including the Finding of No Significant Impact (FONSI). If you have any questions about this letter, please contact Ms. Liz Pelloso, PWS, of my staff at 312-886-7425 or via email at pelloso.elizabeth@epa.gov.

Sincerely,

Elizabeth U. Olin acting for

Kenneth A. Westlake, Chief
NEPA Implementation Section
Office of Enforcement and Compliance Assurance

cc: Mike Redmer, USFWS-Chicago Field Office
Susanne Davis, USACE-Chicago District
Jim Anderson, Lake County Forest Preserve District
Alex Ty Kovach, Lake County Forest Preserve District

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
101 S. Webster Street
Box 7921
Madison WI 53707-7921

Scott Walker, Governor
Cathy Stepp, Secretary
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

September 17, 2014

INF-SE-2014-30-03277

Sara Brodzinsky, P.E.
U.S. Army Corps of Engineers, Chicago District
231 S. LaSalle Street
Suite 1500
Chicago, Illinois 60604

Re: Feasibility Report and Integrated Environmental Assessment for the Upper Des Plaines River

Dear Ms. Brodzinsky:

The Wisconsin Department of Natural Resources (Department) received the Feasibility Report and Integrated Environmental Assessment completed by the Army Corps of Engineers (Corps) for the Upper Des Plaines River. The Department appreciates the opportunity to review the Feasibility Report and supports the continued development of the proposed project and plans. We are providing the following comments for your consideration and appropriate action to assist your agency in moving this project forward.

The proposed project will be reviewed by the Department for compliance with state wetland and waterway protection standards, including the floodplain management standards and Wisconsin's 401 water quality standards, after receipt of final plans and specifications. Modeled after the US EPA's 404(b)(1) guidelines, Wisconsin's water quality standards for wetlands are qualitative standards rather than quantitative and require applicants to avoid and minimize wetland impacts and may be found in s.281.36(3n), Wis. Stats. and NR 103.03, Wis. Adm. Code. The Department has attached to this letter those standards for your review. The water quality standards for surface waters may be found in NR 102, Wis. Adm. Code at https://docs.legis.wisconsin.gov/code/admin_code/nr/100/102.pdf.

The state also has additional standards for the protection of navigable waters under Ch. 30, Wis. Stats., which may be found at https://docs.legis.wisconsin.gov/statutes/statutes/30.pdf. Finally the floodplain regulations for the State are modeled after the FEMA regulations and may be found in NR 116, Wisconsin Adm. Code and are available at https://docs.legis.wisconsin.gov/code/admin_code/nr/100/116.pdf

To determine compliance with these standards, the Department recommends the Corps submit the following information.

- Detailed grading and construction plans including erosion control measures to be utilized during construction. Grading and construction plans should also include information regarding any structures, such as weirs or dams to be built within the Dutch Gap Canal.

- A wetland delineation for any areas where there may be filling or grading. Wetland delineations should meet the 1987 U.S. Army Corps of Engineers Wetland Delineation Manual and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region. For more information regarding the state wetland regulations, which includes the 401 Water Quality Certification for wetlands, and information regarding wetland delineations in Wisconsin please see http://dnr.wi.gov/topic/Wetlands/

- A hydraulic and hydrologic analysis of the changes in the floodplain with digital files of computer models used. The hydraulic analysis should contain existing conditions and proposed project. Also submit Digital floodplain, floodway boundaries, stream centerline, cross-section cut lines and DTM or contours in GIS or CAD format. For more information about the Floodplain standards in Wisconsin please see http://dnr.wi.gov/topic/FloodPlains/

Local permits may be necessary for the project and it is recommended that you contact Randy Kerkman, Public Works Director, Town of Bristol, at 262-857-2368 for additional information.

Again the Department supports continued development of the project and looks forward to working with your agency in the development of this project. If you have any questions or concerns about the content of this letter please contact Michelle Lehner at 262-574-2122 or at michelle.lehner@wisconsin.gov.

Sincerely,

Michelle Lehner
Waterways Basin Supervisor

NR 103.03,Wisconsin Administrative Code

Wetland water quality standards. (1) To protect, preserve, restore and enhance the quality of waters in wetlands and other waters of the state influenced by wetlands, the following water quality related functional values or uses of wetlands, within the range of natural variation of the affected wetland, shall be protected:

(a) Storm and flood water storage and retention and the moderation of water level fluctuation extremes;

(b) Hydrologic functions including the maintenance of dry season streamflow, the discharge of groundwater to a wetland, the recharge of groundwater from a wetland to another area and the flow of groundwater through a wetland;

(c) Filtration or storage of sediments, nutrients or toxic substances that would otherwise adversely impact the quality of other waters of the state;

(d) Shoreline protection against erosion through the dissipation of wave energy and water velocity and anchoring of sediments;

(e) Habitat for aquatic organisms in the food web including, but not limited to fish, crustaceans, mollusks, insects, annelids, planktonic organisms and the plants and animals upon which these aquatic organisms feed and depend upon for their needs in all life stages;

(f) Habitat for resident and transient wildlife species, including mammals, birds, reptiles and amphibians for breeding, resting, nesting, escape cover, travel corridors and food; and

(g) Recreational, cultural, educational, scientific and natural scenic beauty values and uses.

(2) The following criteria shall be used to assure the maintenance or enhancement of the functional values identified in sub. **(1)**:

(a) Liquids, fill or other solids or gas may not be present in amounts which may cause significant adverse impacts to wetlands;

(b) Floating or submerged debris, oil or other material may not be present in amounts which may interfere with public rights or interest or which may cause significant adverse impacts to wetlands;

(c) Materials producing color, odor, taste or unsightliness may not be present in amounts which may cause significant adverse impacts to wetlands;

(d) Concentrations or combinations of substances which are toxic or harmful to human, animal or plant life may not be present in amounts which individually or cumulatively may cause significant adverse impacts to wetlands;

(e) Hydrological conditions necessary to support the biological and physical characteristics naturally present in wetlands shall be protected to prevent significant adverse impacts on:

1. Water currents, erosion or sedimentation patterns;
2. Water temperature variations;
3. The chemical, nutrient and dissolved oxygen regime of thewetland;
4. The movement of aquatic fauna;
5. The pH of the wetland; and
6. Water levels or elevations.

(f) Existing habitats and the populations of wetland animals and vegetation shall be maintained by:

1. Protecting food supplies for fish and wildlife,
2. Protecting reproductive and nursery areas, and
3. Preventing conditions conducive to the establishment or proliferation of nuisance organisms

Section 281.36(3n), Wisconsin Statutes REVIEW BY DEPARTMENT.

(a) *Review limits.* For the purpose of issuing a wetland individual permit, during the period between the date on which the application under sub. (3m) (a) is submitted and the date on which a decision under sub. (3r) (a) is rendered, the department shall conduct its review under this subsection. The department shall review the analysis of practicable alternatives presented in the application under sub. (3m) (b). The department shall limit its review to those practicable alternatives that are located at the site of the discharge and that are located adjacent to that site if the applicant has demonstrated that the proposed project causing the discharge will result in a demonstrable economic public benefit, that the proposed project is necessary for the expansion of an existing industrial, commercial, or agricultural facility that is in existence at the time the application is submitted, or that the proposed project will occur in an industrial park that is in existence at the time the application is submitted.

(b) *Factors used in review.* In its review under par. (a), the department shall consider all of the following factors when it assesses the impacts to wetland functional values:

1. The direct impacts of the proposed project to wetland functional values.

2. The cumulative impacts attributable to the proposed project that may occur to wetland functional values based on past impacts or reasonably anticipated impacts caused by similar projects in the area affected by the project.

3. Potential secondary impacts of the proposed project to wetland functional values.

4. The impact on functional values resulting from the mitigation that is required under sub. (3r).

5. The net positive or negative environmental impact of the proposed project.

(c) *Standards for issuing permits.* The department shall make a finding that a proposed project causing a discharge is in compliance with water quality standards and that a wetland individual permit may be issued if the department determines that all of the following apply:

1. The proposed project represents the least environmentally damaging practicable alternative taking into consideration practicable alternatives that avoid wetland impacts.

2. All practicable measures to minimize the adverse impacts to wetland functional values will be taken.

3. The proposed project will not result in significant adverse impact to wetland functional values, in significant adverse impact to water quality, or in other significant adverse environmental consequences.

(d) *Mitigation required.* The department shall require mitigation under the program established under sub. (3r) for wetland individual permits it issues under this subsection. This subsection does not entitle an applicant to a wetland individual permit or any other approval in exchange for conducting mitigation.

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, D.C. 20314-1000

JUN 08 2015

Janet M. Odeshoo
Acting Regional Administrator
Federal Emergency Management Agency
U.S. Department of Homeland Security
Region V
536 South Clark Street, Floor 6
Chicago, IL 60605

Dear Ms. Odeshoo:

Thank you for providing a detailed review of the Upper Des Plaines River and Tributaries, Illinois and Wisconsin Integrated Feasibility Report and Environmental Assessment. Your comments are appreciated and have been considered in the final report.

Through the Civil Works Flood Risk Management Program, the Corps manages flood risks while balancing the benefits and costs to the nation. Rather than meeting a defined level of protection, such as having the first floor elevation at or above the 1% annual chance flood (base flood) elevation, the Corps recommends projects for authorization that maximize net benefits to the nation, as required by the *Economic and Environmental Principles and Guidelines for Water and Related land Resources Implementation Studies*, Water Resources Council, 1983. The planning process includes formulating flood risk reduction measures over a wide range of frequencies, which often includes the 1% annual chance flood, in order to identify a plan that maximizes net benefits. The non-Federal sponsor can request implementation of a locally preferred plan, which, if approved, could impact the Federal and non-Federal cost-sharing for project implementation.

As stated in your letter, the National Flood Insurance Program (NFIP), administered by the Federal Emergency Management Agency (FEMA), requires that communities adopt and enforce local regulations for building and making improvements to existing structures located within the 1% annual chance (base) floodplain. In particular, your letter calls out the FEMA requirement that new construction and substantial improvements to buildings in the base floodplain must have the lowest floor, including basement, elevated to the base flood elevation or higher. While the Corps plan formulation process is not constrained by these requirements, local governments in the project area have adopted them in compliance with the NFIP. Several local governments have also adopted more stringent, cumulative definitions of substantial improvement to capture the cost of improvements made over a period of time.

The Corps fully supports the participation of communities in the NFIP and will work with those communities where non-structural measures are recommended in order to avoid violation of NFIP rules with the implementation of non-structural plans. Of the 377 structures proposed for non-structural flood proofing or buyouts as part of the National Economic Development (NED) Plan, approximately 123 would not result in raising the first floor elevation above the base flood elevation.

Current construction cost estimates indicate that only 22 of the 123 proposed non-structural features have costs that are likely to be considered substantial improvements. During the design and implementation of the proposed non-structural project features, the Corps will verify adherence with NFIP requirements on an individual structure basis in partnership with the local community partners. Community partners may elect to include additional features to further reduce flood risk at structures to meet NFIP or more stringent local community requirements. These additional improvements could be requested and paid for by the non-Federal sponsor as a betterment. For clarification, the Real Estate Plan associated with the Feasibility Report (Appendix I) has been amended to include discussion of this issue. The discussion has been added to the Non-Structural Attachment to the Real Estate Plan.

With respect to your concerns regarding the extent by which benefits of the proposed flood risk management projects were calculated, the Corps recognizes that the Federal Insurance and Mitigation Administration benefit calculations shown in the report are approximate benefits set by USACE policy through an Economic Guidance Memorandum. Care was taken to only include these economic benefits for properties that would be protected by floodwalls or levees that could be certified by FEMA or where non-structural improvements would either remove the structure from the base floodplain or raise the first floor elevation above the base flood. These benefits are an extremely small portion of total project benefits and were not the basis for project justification. Therefore, the approximate per project benefit used in the study is appropriate for this analysis by the Corps.

Your letter also notes that there are additional costs associated with allowing structures to remain in the base floodplain. Such costs, including subsidized insurance, casualty tax deductions, flood emergency costs, and flood damages to utilities are not expected to be reduced if structures remain in the base floodplain. Reducing these costs could be considered as a project benefit when structures (through non-structural measures) or neighborhoods (through levee or floodwall construction) are removed from the base floodplain. However, it is our experience that costs associated with emergency response and damages to public utilities tend to be small relative to individual property losses. These costs are therefore not typically studied or used in justifying flood risk management projects by the Corps.

Once this project is authorized by Congress, we look forward to continuing to coordinate with FEMA to ensure that project implementation meets Federal flood risk management goals.

THEODORE A. BROWN, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works

U.S. Department of Homeland Security
Region V
536 South Clark Street, Floor 6
Chicago, IL 60605

FEMA

November 13, 2014

Theodore A. Brown, PE
Chief, Planning and Policy Division
Headquarters
U.S. Army Corps of Engineers
CECW-P (SA)
7701 Telegraph Road
Alexandria, VA 22315-3860

Re: Upper Des Plaines River and Tributaries, Illinois and Wisconsin

Dear Mr. Brown:

Thank you for the opportunity to comment on the May 2014 draft of the *Upper Des Plaines River and Tributaries, Illinois and Wisconsin Integrated Feasibility Report and Environmental Assessment* ("Report"), prepared by the US Army Corps of Engineers Chicago District (USACE). We hope that our comments will provide USACE a context to assess the feasibility of the nonstructural flood hazard reduction projects that your Agency recommends for funding under authorities provided by Congress, and for funding by other sources.

The Report presents the results of the *Upper Des Plaines River and Tributaries, Illinois and Wisconsin Feasibility Study*, which USACE conducted to determine the feasibility of improvements within communities for the primary purposes of reducing flood damage, and restoring and protecting the environment. The Report evaluates both structural measures such as floodwater storage reservoirs, levees and floodwalls, and nonstructural measures such as floodproofing and elevating structures as means of reducing flood damage. In contrast to the bulk of the recommendations in the Report, which regard structural flood reduction and ecosystem restoration, FEMA's flood mitigation programs focus almost exclusively on nonstructural flood reduction measures. The National Flood Insurance Program (NFIP) identifies the location and severity of flood hazards, encourages local and state land use regulation designed to protect life and property in flood prone areas, provides flood insurance for eligible buildings and personal property contents in participating communities, and makes available targeted financial assistance for flood mitigation activities, including acquisition or elevation of flood prone buildings. As a result, our comments will focus on the Report's analysis of nonstructural projects.

In accordance with the National Flood Insurance Act of 1968, Pub. L. No. 90-448 (1968) (codified as amended at 42 U.S.C. § 4001 *et seq.*) FEMA has established comprehensive criteria to be met by local governments' building and land use regulations in flood prone areas as a condition of each local government's participation in the NFIP. Together with other detailed requirements, the local governments throughout the project area have adopted, and enforce, land use regulations that require that new construction and substantial improvements of buildings within the 1% annual chance floodplain have the lowest floor, including basement, elevated to or above the water surface elevation of the 1% annual chance flood ("base flood elevation"). A substantial improvement is any reconstruction, rehabilitation, addition, or other improvement of a building, the cost of which equals or exceeds 50% of the market value of the building before the start of construction of the improvement. Many local governments in the project area have also adopted more stringent, cumulative definitions of substantial improvement designed to capture the cost of improvements made over a period of time.

We are concerned that the evaluation of nonstructural measures described on pages 84-87 of the Report leads toward the consideration of measures that may violate local regulations adopted and enforced in order to participate in the NFIP. Specifically, dry-floodproofing of residential buildings, wet-floodproofing of buildings, and combining improvements to buildings with other measures such as nonstructural berms or filling of basements, could result in substantial improvements. As noted above, a community that participates in the NFIP must require that substantial improvements to buildings in the 1% annual chance floodplain have the lowest floor, including basement, elevated to at least the base flood elevation. The Report summarizes, on page 87, that of the 430+ buildings retained for continued consideration, 40 were proposed for dry-floodproofing, 50 for wet-floodproofing, 30 for filling of a basement possibly combined with dry-floodproofing, and 40 for nonstructural berms. The Report, however, does not evaluate whether the recommended nonstructural measures for each of these buildings would comply with the local regulations the community is required to enforce in order to participate in the NFIP.

Prior independent expert peer review of this Report performed by the Battelle Memorial Institute noted that the manner in which projects' costs and benefits were considered in aggregate might both overstate and understate the cost-benefit ratios for individual projects. Given the potential problems described above, we add that the economic analysis described in Appendix E of the Report, which justifies the cost and benefit comparison used to recommend the funding of the nonstructural projects, is significantly incomplete in its evaluation of the existing nationwide flood hazard mitigation scheme's impacts on both costs and benefits. The following discussion addresses the Report's consideration of the proposed projects' relation to the administrative costs of the NFIP, then provides an overview of some potentially important facets of the NFIP that are absent from the Report's analyses.

Following a sophisticated calculation of the anticipated direct physical damages to buildings in the project area from flooding, with and without the projects, the Report describes the incorporation of several additional flood risk benefits and some residual costs (pages E-72 through E-80 in Appendix E). On page E-72, the Report notes that the Federal Insurance Administration (now the Federal Insurance and Mitigation Administration) "expends significant time and effort administering each flood insurance policy under the National Flood Insurance Program," describing this cost as approximately $192 annually per policy, and goes on to calculate the purported decrease in NFIP administrative expenditures where the projects remove buildings from the floodplain. This raises several related concerns.

First, building elevation, floodproofing, or protection with a levee or nonstructural berm that is not accredited in accordance with FEMA regulations for levee accreditation (44 C.F.R. §65.10) generally will not remove buildings from the Special Flood Hazard Area and will not completely remove the time and effort of administering flood insurance policies. Such measures may reduce the number and the magnitude of claims by reducing the actual frequency and extent of physical damage to buildings, but federal agency lenders and lenders regulated by federal entities for lending regulation will continue to require flood insurance as a condition of making, increasing, renewing, or extending loans secured by such buildings (See, e.g., Loans in Areas Having Special Flood Hazards, 12 C.F.R. pt. 339 (2013)). Furthermore, Corps regulations implementing Section 102 of the Flood Disaster Protection Act of 1973 (42 U.S.C. §4012a (2012)) would require that such buildings continue to be insured against flood, for the life of the property, in an amount at least equal to the amount of financial assistance provided.

Second, the cost of administering flood insurance policies under the NFIP is borne by policyholders, who pay, as a portion of the annual premium, a federal policy fee currently set at $44 ($22 for the inexpensive Preferred Risk rate available to buildings and personal property located outside the SFHA). The cost of administration is thus not routinely transferred to the taxpayer at large. Since the requirement to purchase flood insurance will not be affected by building elevation, floodproofing, or protection with an unaccredited levee, such measures will not remove the administrative cost for the policyholder, and will represent only a marginal reduction in administration for the NFIP, conceivably through a reduction in the number and magnitude of claims.

A more significant factor than the Report's analysis of the per-policy administrative cost of operating a national flood insurance program is the lack of analysis of the cost, to the policyholder, of flood damage when viewed within the existing national scheme for flood hazard mitigation, and by extension, the cost, to the nation, of providing additional financial assistance that promotes the continued occupation of Special Flood Hazard Areas. The Report models the costs for flood damage to individual properties almost entirely through its calculation of direct physical damage to buildings. This methodology significantly understates the cost to policyholders of living in floodprone buildings located in Special Flood Hazard Areas, and may overstate the economic benefit of some nonstructural flood mitigation activities by failing to account for high residual costs.

The cost of flood insurance is a common complaint among the occupants of buildings in Special Flood Hazard Areas. Premiums for flood insurance policies using subsidized rates, which remain available in many cases for buildings that were built prior to the availability of flood hazard data and prior to the imposition of local floodplain management regulations, are relatively high in comparison to premiums for similar dollar values of coverage for standard homeowners' insurance. In Special Flood Hazard Areas, the full-risk rates that apply to new or substantially improved buildings that do not meet or exceed the low-floor elevation requirements are often much higher. Under current regulations, a levee that is not accredited in accordance with 44 C.F.R. §65.10, and any improvement to an existing non-compliant building in a Special Flood Hazard Area that does not result in the elevation of the lowest floor to or above the base flood elevation, will not qualify the building for the low full-risk rates that apply to properly elevated buildings. Thus, it appears that following completion of at least some of the nonstructural measures proposed in the Report, the existing buildings will not have been brought into conformity with local floodplain management regulations, and the investment of additional federal funding into these buildings will contribute to the potential for flood damage. In some cases in which the improvements exceed the threshold for substantial improvement, the improvements may violate the local floodplain management regulations and thereby be subjected to extremely costly flood insurance premiums. In either situation, the financial regulators' lending regulations will continue to require flood insurance, and the routine costs (to the property owner) of owning the flood prone building will either remain the same or will increase.

We are concerned that providing federal financial assistance for construction of (albeit well-intended) measures for the reduction of flood damage potential, that will not result in compliance with local regulations adopted and enforced to meet NFIP minimum standards, is not consistent with the intent of the National Flood Insurance Act of 1968, Pub. L. No. 90-448 and the Flood Disaster Protection Act of 1973, Pub. L. 93-234 (codified as amended at 42 U.S.C. § 4001 *et seq.)*. We are also concerned that the economic consequences of such funding will include increasing costs to the affected property owners in the form of increasing flood insurance premiums, and continued local government expenses for emergency services and the maintenance and renewal of infrastructure in such areas.

We hope this information is helpful to you. If you need additional information or assistance, please contact Frank Shockey, Natural Hazards Program Specialist, FEMA Region V, at (312) 408-5321.

Sincerely,

Janet M. Odeshoo
Acting Regional Administrator

21 October 2014

Upper Des Plaines River and Tributaries, Illinois and Wisconsin
Nonstructural Components of Combined NED/NER Plan

Summary of structure values and costs associated with non-structural measures that do not raise the first floor elevation above the base flood elevation[1]

	Dry Floodproofing	Wet Floodproofing	Fill Basement/Dry Floodproofing[2]	Non-structural Berm[3]
Number of Structures	33	45	22	23
Number over 50% (cost/value)[4]	0	2	16	4
Structure Value[5]				
Mean	$1,150,000	$571,000	$170,000	$1,250,000
Median	$410,000	$303,000	$122,000	$664,000
Maximum	$7,016,000	$6,081,000	$381,000	$5,495,000
Minimum	$33,000	$61,000	$83,000	$106,000
Cost[6]				
Mean	$24,000	$51,000	$124,000	$191,000
Median	$20,000	$4,000	$121,000	$167,000
Maximum	$58,000	$672,000	$240,000	$409,000
Minimum	$15,000	$4,000	$92,000	$90,000

(FY2014 Price Level)

[1] Additional non-structural measures (buyout and elevation) were also evaluated.

[2] "Fill basement/dry floodproofing" eliminates damages by removing the basement as an accessible part of the structure. Any remaining flood risk at elevations above the first floor would be addressed with dry floodproofing.

[3] The non-structural berm recommended for a large convention center was removed from this summary as the structure value far exceeds the value of other structures (60 times the average of all other structures). The cost of the non-structural berm would be 1% of the structure value.

[4] The National Flood Insurance Program requires that, when substantial improvements to a structure (cost exceeds 50% of the market value) are completed, the structure be brought up to current floodplain management standards.

[5] Structure value is depreciated replacement value estimated for the Upper Des Plaines River and Tributaries Feasibility Study. Estimating depreciated replacement value is one of the methods accepted by FEMA for determining a structure's market value. Procedures required by local ordinances may differ.

[6] Cost estimate includes cost contingency (37.5%); planning, engineering, and design (15%); and construction management (7%).

DEPARTMENT OF THE ARMY
CHICAGO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
231 SOUTH LASALLE STREET, SUITE 1500
CHICAGO IL 60604

FINDING OF NO SIGNIFICANT IMPACT

UPPER DES PLAINES RIVER AND TRIBUTARIES, ILLINOIS AND WISCONSIN

INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

January 2016

The U.S. Army Corps of Engineers, Chicago District (USACE), has conducted an environmental analysis in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended. USACE assessed the effects of the implementation of the recommended plans contained in the Final Integrated Feasibility Report and Environmental Assessment (FR/EA), dated January 2015, for the Upper Des Plaines River and Tributaries, Illinois and Wisconsin. The FR/EA recommends congressional authorization and implementation of a Combined National Economic Development/National Ecosystem Restoration (NED/NER) Plan and implementation of multiple Continuing Authorities Program (CAP) projects under existing USACE authorities.

The USACE has prepared this Finding of No Significant Impact (FONSI) in accordance with NEPA, the Council on Environmental Quality's Regulations For Implementing The Procedural Provisions Of The National Environmental Policy Act (40 CFR Parts 1500 to 1508), and USACE NEPA regulations and policies.

The Combined NED/NER Plan includes fourteen projects: a structural flood risk management (FRM) system consisting of three levee/floodwalls and two floodwater storage reservoirs providing compensatory storage and additional flood risk management benefits; non-structural measures to be implemented in Lake and Cook Counties in Illinois; and, seven aquatic ecosystem restoration sites located throughout the watershed. The FRM portion of the plan reduces physical flooding damages to public, commercial, industrial, and residential structures and automobiles across the watershed by 48%. The ecosystem restoration portions of the plan would restore hydrology and geomorphology by filling an estimated 4,000 feet of manmade ditch, disabling miles of agricultural drain tiles, and allowing streams to meander within the restoration sites. Over 6,800 acres of scarce native community types would be restored in Illinois and Wisconsin.

The CAP projects include construction of a levee/floodwall, reducing flood damages to an estimated 73 structures, and removal of five low-head dams along the mainstem of the Des Plaines River, restoring in-stream connectivity within the watershed.

All discussion, analysis, and findings related to the potential impacts of construction, operation and maintenance of various flood risk management and ecological restoration alternatives are contained in the FR/EA which is incorporated herein by reference.

The FR/EA examined the potential environmental impacts of the proposed construction and operation of various flood risk management and ecosystem restoration alternatives, including the No Action Alternative. All practicable means to avoid and minimize adverse environmental effects have been incorporated into the recommended plans. The recommended plans would not result in any impacts to federally-listed threatened or endangered species or their designated critical habitat, would have no impact to sites listed on or eligible for inclusion on the National Register of Historic Places, and would not adversely affect any wetlands or waters of the U.S. nor any important wildlife habitat. Therefore, no compensatory mitigation is required.

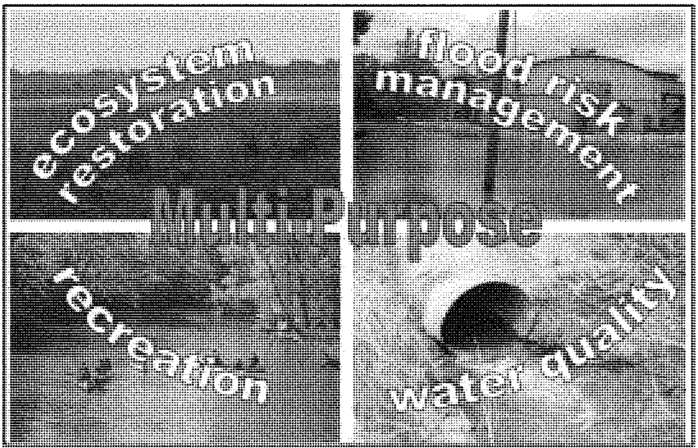
Technical and economic criteria used in the formulation of alternative plans were those specified in the Water Resource Council's 1983 Economic and Environmental Principles for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in the evaluation of the alternatives. It is my determination that each of the recommended plans do not constitute a major federal action that would significantly affect the human environment; therefore, preparation of an Environmental Impact Statement is not required.

Christopher T. Drew
Colonel, U.S. Army
District Commander

Date: 7 Jun 16

UPPER DES PLAINES RIVER AND TRIBUTARIES, ILLINOIS AND WISCONSIN

INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT



January 2016

Study Partnership

Cook County Highway Department (CCHD)
Forest Preserve District of Cook County (FPDCC)
Kenosha County
Lake County Stormwater Management Commission (LCSMC)
Lake County Forest Preserve District (LCFPD)
Metropolitan Water Reclamation District of Greater Chicago (MWRDGC)
Illinois Department of Natural Resources (IDNR)
Southeastern Wisconsin Regional Planning Commission (SEWRPC)
U.S. Army Corps of Engineers (USACE)
U.S. Fish and Wildlife Service (USFWS)

US Army Corps
of Engineers®
Chicago District

Executive Summary

The Upper Des Plaines River watershed originates in Racine and Kenosha counties of southeastern Wisconsin. The watershed then extends south into Illinois through Lake County and then Cook County, where it converges with the Salt Creek watershed near Riverside, Illinois. The Des Plaines River then flows southwest on to its confluence with the Kankakee River, where the two rivers combine to form the Illinois River. The study area for this Study includes the entire drainage area upstream of the confluence with Salt Creek, including 12 major tributaries to the river. The Upper Des Plaines watershed covers approximately 477 square miles, an area that spans approximately 60 miles from north to south and 8 miles from east to west. The Upper Des Plaines River travels over 87 miles before its confluence with Salt Creek. Tributaries within the study area include about 330 miles of perennial and intermittent streams.

Development in the watershed coincided with the development of the Chicago metropolitan area. Although the southern portion of the watershed in and around Chicago is more urbanized than the northern portion within Lake County in Illinois and Kenosha and Racine Counties in Wisconsin, land use changes have impacted the entire study area. Significant portions of the watershed in northern Lake County and in the two Wisconsin counties are primarily agricultural. Only 9% of the current land use remains as natural open space. Communities along the Upper Des Plaines River and its tributaries have experienced major flooding resulting in hundreds of millions of dollars in damages over the past several decades.

An earlier study, the *Upper Des Plaines River, Illinois Feasibility Study* (Phase I Study), formulated plans to address severe overbank flooding along the Upper Des Plaines River. Two particularly severe events in 1986 and 1987, which combined resulted in over $100 million in damages, prompted initiation of that study. Federal interest in flood risk management (FRM) in the Upper Des Plaines watershed was established in a Reconnaissance Report that preceded the Phase I Study and was approved in 1989. The Phase I Study recommended six projects to reduce mainstem flooding. The Feasibility Report was approved in 1999 and the recommended projects were authorized in Section 101 of the Water Resources Development Act (WRDA) of 1999. Project benefits for the authorized project would provide an estimated 25% reduction in flood damages.

This *Upper Des Plaines River and Tributaries, Illinois and Wisconsin Feasibility Study* (Phase II Study), was authorized by Section 419 of the WRDA of 1999 (P.L. 106-53). The Phase II Study provides an opportunity to develop a more comprehensive solution to address ongoing occurrences of flooding and restore the degraded aquatic ecosystems within the Upper Des Plaines River watershed. The study authorization directs the Secretary to evaluate plans to manage flood risk and address environmental restoration and protection on both the mainstem and tributaries. Additionally, the study authorization includes water quality, recreation and related purposes. Further reduction of flooding along the mainstem Des Plaines River and its tributaries, and environmental restoration of degraded ecosystems within the basin have been prioritized as the primary purposes of the study. Improving water quality and enhancing recreational opportunities throughout the basin are secondary to the identified primary purposes. The study considers sites located within tributary watersheds and along the mainstem for both Flood Risk Management (FRM) and Ecosystem Restoration (ER) potential. It also evaluates the effects of FRM sites within tributary watersheds on mainstem flooding.

An assessment of existing and projected future without project conditions determined that a significant risk of overbank flooding exists and that the aquatic ecosystem is severely degraded across most of the watershed. Expeeted annualized flood damages are estimated at $52,253,000 across the watershed and the aquatic ecosystems of approximately 39,000 acres containing scarce wet prairie, savanna, forested floodplain woodlands, isolated wetlands, and floodplain wetlands located within the riparian zones will remain highly fragmented and degraded. The need to manage flood risk within the watershed was highlighted by major flooding that occurred in the spring of 2013. On April 18, 2013, the Chicago area received an average of 5 inches of rainfall, with localized precipitation of over 7 inches over an 18 to 24 hour period. The study area received widespread rainfall between 0.25 and 1.5 inches several days before the event, which saturated the ground and increased the potential for overbank flooding when heavier rains fell a few days later. These antecedent conditions resulted in significant flooding throughout northeast Illinois with the greatest impacts on the Des Plaines River, Fox River, and East Braneh of the DuPage River.

Major flood stages were reached across the entire Upper Des Plaines study area. New record stages were reached at the Des Plaines (0.02-ft over previous 1986 record) and Riverside (0.67-ft over previous 1987 record) U.S. Geologieal Survey USGS gage stations. These record stages resulted in widespread overbank flooding along the majority of the study area. Thousands of structures were inundated and many road crossings and parallel roads were closed for several days. The Federal Emergency Management Agency issued a Major Disaster Declaration (DR-4116) on May 10, 2013.

The feasibility study evaluated a range of measures to meet both the FRM and ER purposes. To develop the FRM plan, structural measures such as floodwater storage reservoirs, levees and floodwalls, road raises, and non-structural measures such as floodproofing and elevating structures were evaluated individually to determine whether they were economically justified. Individually justified sites were then combined to form an incrementally justified plan, optimizing benefits throughout the watershed. To develop the ER plan, undeveloped lands throughout the watershed were evaluated to determine whether cost-effective aquatic ecosystem restoration at that site was possible and what measures would provide the lowest incremental cost per unit of habitat output. Cost-effective ecosystem restoration sites were then grouped to determine the most incrementally cost effective plan that would best improve habitat quality and quantity throughout the watershed. The FRM and ER plans were then compared to determine whether there was competition between purposes. Since there is no physical overlap between the indentified FRM and ER plans and their effects, it was determined there is no competition between the plans and a combined FRM/ER plan that includes all features of both plans was identified.

Three plans, as discussed below, are identified by this study: a *Combined NED/NER Plan*, a *CAP Plan*, and a *Comprehensive Plan*. A combined National Economic Development / National Ecosystem Restoration (NED/NER) plan is recommended for congressional authorization. In addition, projects that could reasonably be implemented under the Continuing Authorities Program (CAP) are recommended for conversion to that program for implementation. All economically justified features, regardless of USACE policy compliance, are included in the *Comprehensive Plan*. Non-policy compliant portions of the *Comprehensive Plan* are recommended for implementation by the appropriate state and local agencies.

Policy compliant features that are either economically justified (for FRM projects) or cost-effective (for ER projects) and of such scope that they could not reasonably be implemented under CAP authorities are included in a plan designated as the *Combined NED/NER Plan*, as shown in Table ES.1. This plan, upon approval by the Chief of Engineers, will be recommended for specific authorization by Congress.

There are 14 projects in the *Combined NED/NER Plan*. The projects in this plan include a structural FRM system consisting of three levee/floodwalls and two floodwater storage reservoirs providing compensatory storage and additional flood risk management benefits as well as non-structural measures to be implemented in two counties (Lake and Cook) and seven ER projects throughout the watershed where aquatic ecosystems will be restored to more natural conditions. The *Combined NED/NER Plan* is recommended for Congressional authorization.

A *CAP Plan*, as shown in Table ES.2, has also been identified that includes all policy compliant, separable features that are economically justified (for FRM projects) or cost-effective (for ER projects) and of such scope that they could reasonably be implemented under the Continuing Authorities Program. This program allows USACE to plan, design, and construct smaller projects using delegated program authorities provided by Congress. Small FRM projects with a Federal cost under $7 million are authorized by Section 205 of the Flood Control Act of 1948, as amended. Small Ecosystem Restoration projects with a Federal cost under $5 million are authorized by Section 206 of the WRDA of 1996, as amended. Individual projects within the *CAP Plan* are recommended for implementation by USACE under these existing authorities.

There are 6 projects in the *CAP Plan*. The projects in this plan include one FRM project consisting of a levee/floodwall and five ER projects consisting of dam removals along the Des Plaines River. Projects included in the *CAP Plan* will be converted to this program upon approval by the Division Engineer.

Table ES.1 – Combined NED/NER Plan

ID	Project Name	Purpose	Measure	Municipality	Total First Cost	Annual OMRR&R[1]
Kenosha County, WI						
K47	Bristol Marsh	ER	Restoration	Bristol	$43,112,000	$117,000
K41	Dutch Gap Forested Floodplain	ER	Restoration	Pikesville	$18,880,000	$59,000
Lake County, IL						
L43	Red Wing Slough and Deer Lake Wetland Complex	ER	Restoration	Antioch	$30,219,000	$70,000
L39	Pollack Lake and Hastings Creek Riparian Wetlands	ER	Restoration	Antioch	$10,420,000	$20,000
L31	Gurnee Woods Riparian Wetland	ER	Restoration	Wadsworth	$17,902,000	$28,000
--	Lake County Non-structural	FRM	Non-structural	Gurnee	$15,514,000	Nominal
Cook County, IL						
C09	Northbrook Floodplain and Riparian Complex	ER	Restoration	Wheeling	$20,060,000	$18,000
C15	Beck Lake Meadow and Floodplain Forest	ER	Restoration	Des Plaines/Glenview	$20,691,000	$16,000
WLRS04	Harry Semrow Driving Range Reservoir	FRM	Floodwater Storage	Des Plaines	$16,640,000	$56,000
DPLV09	Touhy-Miner Levee[2]	FRM	Levee/Floodwall	Des Plaines	$27,670,000	$12,000
DPLV05	Belmont-Irving Park Levee	FRM	Levee/Floodwall	Schiller Park/Franklin Park	$19,217,000	$25,000
DPLV04	Fullerton-Grand Levee	FRM	Levee/Floodwall	River Grove	$21,215,000	$19,000
DPRS04	Fullerton Woods Reservoir[2]	FRM	Floodwater Storage	River Grove	$13,028,000	$59,000
--	Cook County Non-structural[2]	FRM	Non-structural	Various	$32,519,000	$1,000

[1] Operation, Maintenance, Repair, Rehabilitation, and Replacement

[2]Touhy-Miner Levee, Fullerton Woods Reservoir, and Cook-County Non-structural include cost-shared recreation features.

(FY2015 Price Level)

Table ES.2 – CAP Plan

ID	Project Name	Purpose	Measure	Municipality	Total First Cost	Annual OMRR&R
Cook County, IL						
--	Dam #1 Removal	ER	Dam Removal	Wheeling	$684,000	$0
--	Dam #2 Removal	ER	Dam Removal	Des Plaines	$692,000	$0
--	Dempster Ave Dam Removal	ER	Dam Removal	Des Plaines	$591,000	$0
--	Touhy Ave Dam Removal	ER	Dam Removal	Park Ridge	$730,000	$0
--	Dam #4 Removal	ER	Dam Removal	Park Ridge	$626,000	$0
DPLV01	Groveland Ave Levee	FRM	Levee	Riverside	$5,925,000	$15,000

(FY2015 Price Level)

The study authorization directs the Secretary to *"not exclude from consideration and evaluation flood damage reduction measures based on restrictive policies regarding the frequency of flooding, the drainage area, and the amount of runoff."* Sites along tributaries that do not meet the minimum criteria for USACE participation in urban flood risk management as outlined in 33 CFR Part 238 (flows greater than 800 cfs during the 10% annual chance of exceedance event) were therefore included in the formulation and evaluation. In addition, implementation of road raises and bridge modifications for the sole purpose of addressing flood-induced road closures, which have not traditionally been included in the USACE mission, were also included. In order to meet the study authority, these measures, which are not compliant with current USACE policy, are included in a plan designated as the *Comprehensive Plan*. This is the plan that includes all economically justified FRM features and cost-effective ecosystem restoration features evaluated during the course of the study, regardless of USACE policy compliance.

The *Comprehensive Plan* is the most inclusive plan and includes 23 projects as shown in Table ES.3. It includes all of the projects identified in the Combined NED/NER Plan and CAP Plan along with economically justified projects regardless of policy compliance. The projects in the *Comprehensive Plan* include 11 FRM projects consisting of two floodwater storage reservoirs, four levees/floodwalls, one road raise, one modification to an existing structure and non-structural measures to be implemented in three counties (Kenosha, Lake and Cook), seven ER projects throughout the watershed, and five dam removals along the Des Plaines River.

Projects included in the *Comprehensive Plan* that are not compliant with current USACE policy, and therefore not included in the *Combined NED/NER Plan* or *CAP Plan*, include the First Avenue Bridge Modification (DPBM04), Lake Mary Anne Pump Station (FPCI01), and economically justified non-structural sites that are in portions of tributaries not meeting the minimum flow criteria. These features are recommended for implementation by state or local agencies.

Table ES.3 – Comprehensive Plan

ID	Project Name	Purpose	Measure	Municipality	Total First Cost	Annual OMRR&R
Kenosha County, WI						
K47	Bristol Marsh	ER	Restoration	Bristol	$43,112,000	$117,000
K41	Dutch Gap Forested Floodplain	ER	Restoration	Pikesville	$18,880,000	$59,000
--	Kenosha County Non-structural (Comprehensive Plan)	FRM	Non-structural	Various	$1,189,000	Nominal
Lake County, IL						
L43	Red Wing Slough and Deer Lake Wetland Complex	ER	Restoration	Antioch	$30,219,000	$70,000
L39	Pollack Lake and Hastings Creek Riparian Wetlands	ER	Restoration	Antioch	$10,420,000	$20,000
L31	Gurnee Woods Riparian Wetland	ER	Restoration	Wadsworth	$17,902,000	$28,000
--	Lake County Non-structural	FRM	Non-structural	Gurnee	$15,514,000	Nominal
Cook County, IL						
C09	Northbrook Floodplain and Riparian Complex	ER	Restoration	Wheeling	$20,060,000	$18,000
--	Dam #1 Removal	ER	Dam Removal	Wheeling	$684,000	$0
--	Dam #2 Removal	ER	Dam Removal	Des Plaines	$692,000	$0
C15	Beck Lake Meadow and Floodplain Forest	ER	Restoration	Des Plaines/Glenview	$20,691,000	$16,000
--	Dempster Ave Dam Removal	ER	Dam Removal	Des Plaines	$591,000	$0
WLRS04	Harry Semrow Driving Range	FRM	Floodwater Storage	Des Plaines	$16,640,000	$56,000
FPCI01	Lake Mary Anne Pump Station	FRM	Structure Mod.	Maine	$1,296,000	$33,000
DPLV09	Touhy-Miner Levee[1]	FRM	Levee/Floodwall	Des Plaines	$27,670,000	$12,000
--	Touhy Ave Dam Removal	ER	Dam Removal	Park Ridge	$730,000	$0
--	Dam #4 Removal	ER	Dam Removal	Park Ridge	$626,000	$0
DPLV05	Belmont-Irving Park Levee	FRM	Levee/Floodwall	Schiller Park/Franklin Park	$19,217,000	$25,000
DPLV04	Fullerton-Grand Levee	FRM	Levee/Floodwall	River Grove	$21,215,000	$19,000
DPRS04	Fullerton Woods Reservoir[1]	FRM	Floodwater Storage	River Grove	$13,028,000	$59,000
DPBM04	First Avenue Bridge Modification	FRM	Bridge Mod.	River Grove	$15,410,000	$23,000
DPLV01	Groveland Ave Levee	FRM	Levee	Riverside	$5,925,000	$15,000
--	Cook County Non-structural[1]	FRM	Non-structural	Various	$32,519,000	$1,000
--	Cook County Non-structural (Comp Plan Increment)	FRM	Non-structural	Various	$3,106,000	Nominal

[1]Touhy-Miner Levee, Fullerton Woods Reservoir, and Cook-County Non-structural include cost-shared recreation features.

(FY2015 Price Level)

Overall, the cumulative impact of all three identified plans is beneficial economically, environmentally and socially. The *Combined NED/NER Plan* provides flood protection to 862 homes and businesses along the Des Plaines River and non-structural flood risk management for 377 structures across the watershed resulting in $4,641,000 in annual net economic benefits. The plan also restores hydrology and geomorphology on over 6,800 acres by filling an estimated 4,000 feet of manmade ditch and disabling hundreds of thousands of feet of agricultural drain tiles, restore scarce native community types such as marsh, sedge meadow, wet prairie, savanna, forested floodplain, woodlands, and forest resulting in 9,034 net average annual habitat units (AAHUs). The *CAP Plan* provides additional flood protection to 73 homes and businesses totaling $193,000 in annual net economic benefits and removes five dams along the Des Plaines River totaling 81 net AAHUs. The *Comprehensive Plan* provides flood protection to 935 homes and businesses along the Des Plaines River, non-structural flood risk management for 486 structures across the entire watershed, and protection for a major four-lane arterial road totaling $8,636,000 in annual net economic benefits and restoration and connectivity of over 6,800 acres of scarce marsh, sedge meadow, wet prairie, savanna, forested floodplain woodlands and forest habitat and connectivity of the Des Plaines River totaling 9,115 net average annual habitat units (AAHUs).

The total costs for the NED/NER Plan and CAP plan, along with the Federal and non-Federal shares, are presented in Table ES.4. Operation, Maintenance, Repair, Rehabilitation, and Replacement of project features will be required to ensure the sustainability of the projects and is a non-Federal responsibility. A summary of annualized costs and benefits for the recommended FRM and ecosystem restoration plans is presented in Table ES.5.

Table ES.4 –Total Costs by Plan

Plan	Federal	Non-Federal	Total Implementation	Annual OMRR&R (Non-Federal)
NED/NER Plan	$199,393,000	$107,694,000	$307,087,000	$500,000
CAP Plan	$6,011,000	$3,236,000	$9,247,000	$15,000
Comprehensive Plan	$205,404,000	$131,932,000	$337,336,000	$571,000

(FY2015 Price Level)

Table ES.5 – Economic Summary

		Comprehensive Plan	NED/NER Plan	CAP Plan
Flood Risk Management	Annualized First Cost	$6,657,000	$5,566,000	$247,000
	Annualized OMRR&R	$237,000	$172,000	$15,000
	Total Annualized Cost	$6,894,000	$5,738,000	$262,000
	Annual Benefits	$15,530,000	$10,379,000	$455,000
	Net Benefits	$8,636,000	$4,641,000	$193,000
	BCR	*2.3*	*1.8*	*1.7*
Ecosystem Restoration	Annualized First Cost	$5,562,000	$5,432,000	$130,000
	Annualized OMRR&R	$229,000	$229,000	$0
	Total Annualized Cost	$5,791,000	$5,661,000	$130,000
	Net Habitat Units	*9,115 AAHUs*	*9,034 AAHUs*	*81 AAHUs*

(FY2015 Price Level, Federal Discount Rate 3.375%)

DEPARTMENT OF THE ARMY
CHICAGO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
231 SOUTH LASALLE STREET, SUITE 1500
CHICAGO IL 60604

FINDING OF NO SIGNIFICANT IMPACT

UPPER DES PLAINES RIVER AND TRIBUTARIES, ILLINOIS AND WISCONSIN

INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

January 2016

The U.S. Army Corps of Engineers, Chicago District (USACE), has conducted an environmental analysis in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended. USACE assessed the effects of the implementation of the recommended plans contained in the Final Integrated Feasibility Report and Environmental Assessment (FR/EA), dated January 2015, for the Upper Des Plaines River and Tributaries, Illinois and Wisconsin. The FR/EA recommends congressional authorization and implementation of a Combined National Economic Development/National Ecosystem Restoration (NED/NER) Plan and implementation of multiple Continuing Authorities Program (CAP) projects under existing USACE authorities.

The USACE has prepared this Finding of No Significant Impact (FONSI) in accordance with NEPA, the Council on Environmental Quality's Regulations For Implementing The Procedural Provisions Of The National Environmental Policy Act (40 CFR Parts 1500 to 1508), and USACE NEPA regulations and policies.

The Combined NED/NER Plan includes fourteen projects: a structural flood risk management (FRM) system consisting of three levee/floodwalls and two floodwater storage reservoirs providing compensatory storage and additional flood risk management benefits; non-structural measures to be implemented in Lake and Cook Counties in Illinois; and, seven aquatic ecosystem restoration sites located throughout the watershed. The FRM portion of the plan reduces physical flooding damages to public, commercial, industrial, and residential structures and automobiles across the watershed by 48%. The ecosystem restoration portions of the plan would restore hydrology and geomorphology by filling an estimated 4,000 feet of manmade ditch, disabling miles of agricultural drain tiles, and allowing streams to meander within the restoration sites. Over 6,800 acres of scarce native community types would be restored in Illinois and Wisconsin.

The CAP projects include construction of a levee/floodwall, reducing flood damages to an estimated 73 structures, and removal of five low-head dams along the mainstem of the Des Plaines River, restoring in-stream connectivity within the watershed.

All discussion, analysis, and findings related to the potential impacts of construction, operation and maintenance of various flood risk management and ecological restoration alternatives are contained in the FR/EA which is incorporated herein by reference.

The FR/EA examined the potential environmental impacts of the proposed construction and operation of various flood risk management and ecosystem restoration alternatives, including the No Action Alternative. All practicable means to avoid and minimize adverse environmental effects have been incorporated into the recommended plans. The recommended plans would not result in any impacts to federally-listed threatened or endangered species or their designated critical habitat, would have no impact to sites listed on or eligible for inclusion on the National Register of Historic Places, and would not adversely affect any wetlands or waters of the U.S. nor any important wildlife habitat. Therefore, no compensatory mitigation is required.

Technical and economic criteria used in the formulation of alternative plans were those specified in the Water Resource Council's 1983 Economic and Environmental Principles for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in the evaluation of the alternatives. It is my determination that each of the recommended plans do not constitute a major federal action that would significantly affect the human environment; therefore, preparation of an Environmental Impact Statement is not required.

Christopher T. Drew
Colonel, U.S. Army
District Commander

Date: 7 Jan 16

UPPER DES PLAINES RIVER AND TRIBUTARIES
ILLINOIS & WISCONSIN
INTEGRATED FEASIBILITY REPORT AND
ENVIRONMENTAL ASSESSMENT

**Sections pertain to Environmental Assessment*

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FIGURES

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Appendix B – FRM Plan Formulation
Appendix C – ER Plan Formulation
Appendix D – Civil Design
Appendix E – Economic Analysis
Appendix F – Cost Engineering
Appendix G – Geotechnical Analysis
Appendix H – HTRW Report
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Appendix M – Monitoring Plan
Appendix N – Documentation of Changes to the Draft Integrated Feasibility Report and EA

1 Study Overview*

1.1 Introduction

This report presents the results of the *Upper Des Plaines River and Tributaries, Illinois and Wisconsin Feasibility Study* (Phase II Study). The report is organized into several sections describing the plan formulation process and conclusions and separate technical appendices:

1.1.1 Study Authority

This feasibility study was authorized by Section 419 of the Water Resources Development Act (WRDA) of 1999 (P.L. 106-53), and is identified as the Upper Des Plaines River and Tributaries, Illinois and Wisconsin. The authority provides the following:

"Sec. 419. Upper Des Plaines River and Tributaries, Illinois and Wisconsin

a) In General. –The Secretary shall conduct a study of the Upper Des Plaines River and tributaries, Illinois and Wisconsin, upstream of the confluence with Salt Creek at Riverside, Illinois, to determine the feasibility of improvements in the interests of flood damage reduction, environmental restoration and protection, water quality, recreation, and related purposes.

b) Special Rule. – In conducting the study, the Secretary may not exclude from consideration and evaluation flood damage reduction measures based on restrictive policies regarding the frequency of flooding, the drainage area, and the amount of runoff.

c) Consultation and Use of Existing Data. – In carrying out this section, the Secretary shall – (1) consult with appropriate Federal and State agencies; and (2) make maximum use of data in existence on the date of enactment of this Act and ongoing programs and efforts of Federal agencies and States."

1.1.2 Study Purpose

This Phase II Study builds on the work completed in the *Upper Des Plaines River Flood Damage Reduction Feasibility Study* (Phase I Study), conducted under the Chicago – South End of Lake Michigan (C-SELM) Urban Water Damage Study Authority, contained in Section 206 of the 1958 Flood Control Act (P.L. 85-500). The Phase I Study was initiated to address severe overbank flooding along the Upper Des Plaines River. Two particularly severe events in 1986 and 1987 together caused over $100 million in damages. Federal interest in flood risk management (FRM) in the Upper Des Plaines watershed was established in a Reconnaissance Report that preceded the Phase I Study and was approved in 1989. The Phase I Study investigated plans for urban FRM in the Upper Des Plaines River watershed and recommended six projects to reduce mainstem flooding. The Feasibility Report was approved in 1999 and the recommended projects were authorized in Section 101 of WRDA 1999. Project benefits, if all projects are built, would result in a 25% reduction in flood damages. This Phase II Study provides an opportunity to develop a more comprehensive solution to ongoing occurrences of flooding in the Upper Des Plaines River watershed, evaluating plans to manage flood risk on both the mainstem and tributaries.

The study area for the Phase II study encompasses the Phase I study area as well as the Des Plaines headwaters in Wisconsin and all tributaries to the mainstem. Additionally, the Phase II study authorization directs the Secretary to develop plans that also address environmental restoration and protection, water quality, recreation, and related purposes.

The study team, including USACE and the non-Federal sponsors, identified two primary purposes: 1) further reduction of flooding along the mainstem and tributaries, and 2) environmental restoration of degraded ecosystems within the basin. Improving water quality and enhancing recreational opportunities throughout the basin were identified as secondary purposes. The study considers sites located within tributary watersheds and along the mainstem for both FRM and Ecosystem Restoration (ER) potential. The effects of FRM sites within tributary watersheds on mainstem flooding were also evaluated.

1.1.3 Study Sponsors and Participants

During the development process for this study, key state and local agencies formed an Advisory Committee. The Advisory Committee includes a broad group of stakeholders, interested parties and resource agency personnel who advised the non-Federal members of the Project Delivery Team (PDT). Participants in the Advisory Committee included the Illinois Department of Natural Resources (IDNR); Cook County Highway Department (CCHD); Lake County Stormwater Management Commission (LCSMC); Southeastern Wisconsin Regional Planning Commission (SEWRPC); the Forest Preserve District of Cook County (FPDCC); the Lake County Forest Preserve District (LCFPD); the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC); and representatives from local communities throughout the study area. It is the intent of this committee that the feasibility study be undertaken with a spirit of collaboration and mutual trust.

The Advisory Committee appointed an Executive Steering Committee to identify ways to: 1) provide a higher level of flood protection than the 25% damage reduction that could be achieved through the implementation of the Phase I project authorized in WRDA 1999, and 2) incorporate ecosystem restoration, water quality improvements and enhancement of recreational opportunities as additional study purposes. Study goals have been developed in collaboration with the committee and the findings of this study presented herein are fully supported by the Executive Steering Committee. This committee has provided the appropriate avenue for full collaboration between project partners.

In August 2000, the Upper Des Plaines River Sponsors & Stakeholders Alliance was formed by members of the Advisory Committee. The Alliance, a working group of the Executive Steering Committee, was developed in a collaborative fashion and produced a Recommendation and Guidance Report focusing on a scope of work for use as a basis for this feasibility study. The report, which also ensured direct community input into the development of this feasibility study, included the efforts of the states, local sponsors, and stakeholders.

A coalition of state and local agencies is acting as non-Federal sponsors with the USACE for this study. The partnering agencies are the IDNR, CCHD, LCSMC, and Kenosha County, Wisconsin. A Feasibility Cost Sharing Agreement was signed between the sponsors and the USACE in 2002. Study costs are shared 50%-50% between the USACE and the non-Federal sponsors.

As the Alliance recommended, the USACE and the key local sponsors have been full partners in the development of this feasibility study. This study focuses on the development of a multi-purpose FRM and ecosystem restoration plan for the Upper Des Plaines River watershed. This report also identifies additional measures, not implementable under USACE authorities, to address the study authority as well as finding opportunities for further study and implementation. The preliminary efforts of the alliance and committees have allowed the Corps and non-Federal sponsors to proceed with the feasibility study with a clear direction.

1.1.4 Study Area

The Upper Des Plaines River watershed originates in the agricultural landscape of Racine and Kenosha counties of southeastern Wisconsin. The watershed then slopes south into Illinois through Lake County and then Cook County, where it converges with the Salt Creek watershed near Riverside, Illinois. The Des Plaines River then flows southwest on to its confluence with the Kankakee River, where the two rivers combine to form the Illinois River. The study area for this Phase II Study includes the entire drainage area upstream of the confluence with Salt Creek, including 12 major tributaries to the river.

The Upper Des Plaines watershed covers approximately 477 square miles, an area that spans approximately 60 miles from north to south and 8 miles from east to west. The Upper Des Plaines River travels over 87 miles before its confluence with Salt Creek. Tributaries within the study area include about 330 miles of perennial and intermittent streams. The study area is shown in Plate 1, and includes 73 municipalities in Illinois and Wisconsin. The municipalities are located in the following congressional districts, as shown on Plate 2, and represented by the noted members of the 113th U.S. Congress:

IL-4 (Gutierrez-D)	IL-5 (Quigley-D)	IL-6 (Roskam-R)
IL-7 (Davis-D)	IL-8 (Duckworth-D)	IL-9 (Schakowsky-D)
IL-10 (Schneider-D	IL-14 (Hultgren-R)	WI-1 (Ryan-R)

Illinois is represented in the Senate by Durbin-D and Kirk-R. Wisconsin is represented by Baldwin-D and Johnson-R.

1.1.5 Prior and Ongoing Studies and Reports

1.1.5.1 U.S. Army Corps of Engineers

The Chicago District conducted three studies investigating flooding in the Des Plaines Watershed under the Chicago – South End of Lake Michigan (C-SELM) Urban Water Damage Study Authority, contained in Section 206 of the 1958 Flood Control Act (P.L. 85-500). The 1989 Reconnaissance Report led to the 1999 Phase I Study.

- *Plan of Study C-SELM – Urban Water Damage Study*; 1976.
- *C-SELM, Interim III Lower Des Plaines River Basin Reconnaissance Report*; 1981.
- *Upper Des Plaines River Flood Damage Reduction Reconnaissance Report;* 1989.
- *Upper Des Plaines River Flood Damage Reduction Study*; 1999 (Phase 1 Study).

Additional related reports prepared by the Chicago District include:

- *Summary of Urban Water Damage Characteristics on the Des Plaines River in Lake County, Illinois*; 1974. (Prepared by Greeley and Hansen)
- *After Action Flood Report, Flooding in the Des Plaines, Fox River and North Branch Basins, September to October 1986*; 1986 inter-office report.
- *Inventory and Analysis of Urban Water Damage Problems, Farmer's and Prairie Creeks, Cook County, Illinois*, 1988. (Prepared for the State of Illinois)
- *North Libertyville Estates Section 205 Detailed Project Report*, 1995.
- *Hofmann Dam Section 206 Detailed Project Report, 2006*

1.1.5.2 State of Illinois

In 1943, the 63rd Illinois General Assembly appointed a Commission to investigate flooding in the state. This Commission submitted a report to the Illinois General Assembly in 1947 that outlined a scope for survey of the Des Plaines River area by the Illinois Division of Waterways. Reports on Addison Creek (1950), Salt Creek (1955), and the basin (1958) were submitted. In 1961, a *Report on Plan for Flood Control and Drainage Development for Cook, Lake and DuPage Counties* was prepared. This 1961 report outlined plans and cost estimates for major channel modifications, bridge and dam structural modifications, and two large (25,000 and 30,000 acre-ft) upstream reservoirs on the mainstem of the Des Plaines River and its Mill Creek tributary in Lake County. Channel, bridge, and dam modifications were to be constructed from Hodgkins upstream to the Village of Gurnee. Reservoirs were planned to be constructed upstream of the Village of Gurnee in Lake County. Many of the structures recommended in this report have been built and are part of the existing conditions of the Upper Des Plaines River and its tributaries.

The Illinois Department of Transportation (IDOT) Division of Water Resources (now the IDNR Office of Water Resources [IDNR-OWR]) has implemented regulations to minimize the adverse effects of construction in the Des Plaines River flood plain:

- State of Illinois; Administrative Code, *Section 3708: Floodway Construction in Northeastern Illinois*; 1989.
- Illinois Department of Transportation Division of Water Resources; *Report on the Regulations of Construction within the Floodplain of the Des Plaines River, Cook and Lake Counties*; 1978.

The IDNR- OWR has also developed local Flood Control Plans for various communities in the Upper Des Plaines River watershed:

- Crystal Creek Flood Control Project
- Farmer/Prairie Creek Flood Control Plan
- Gurnee Flood Control Plan

The Illinois Department of Energy and Natural Resources (now the IDNR) conducted a number of studies investigating natural resources in the Upper Des Plaines River watershed:

- Illinois Department of Energy and Natural Resources (now IDNR); *The Changing Illinois Environment: Critical Trends* (Summary Report and Volumes 1-7 Technical Report); 1994.
- IDNR; *Upper Des Plaines River Basin: An Inventory of the Region's Resources;* 1998.
- IDNR; *Upper Des Plaines River Area Assessment Volume 1, Geology;* Critical Trends Assessment Project; 1998.
- IDNR; *Upper Des Plaines River Area Assessment Volume 2, Water Resources*; Critical Trends Assessment Project; 1998.
- IDNR; *Upper Des Plaines River Area Assessment Volume 3, Living Resources*; Critical Trends Assessment Project; 1998.
- IDNR; *Upper Des Plaines River Area Assessment; Volume 4, Socio-Economic Profile, Environmental Quality and Archaeological Resources*; Critical Trends Assessment Project, 1998.

1.1.5.3 Soil Conservation Service/Natural Resources Conservation Service

The Soil Conservation Service (SCS), now the Natural Resources Conservation Service (NRCS) has partnered with state and local organizations to investigate and analyze flooding along the Des Plaines River. The results of these studies were published in the following reports:

- SCS and MWRDGC; *Floodwater Management Plan, Des Plaines River*; 1976.
- SCS and Illinois Division of Water Resources; *Flood Hazard Analysis, Des Plaines River Tributaries*; 1981.
- SCS, MWRDGC, and Illinois Division of Water Resources; *Final Watershed Plan and Environmental Impact Statement, Lower Des Plaines Tributaries Watershed*; 1985 and 1987.

- SCS, MWRDGC, and Illinois Division of Water Resources; *Lower Des Plaines Tributaries Watershed, Floodplain Information Maps and Profiles*; 1987.

1.1.5.4 Regional and Local Organizations

In Cook and Lake Counties, stormwater management is regulated countywide:

- MWRDGC; *Cook County Stormwater Management Plan*; 2007. MWRDGC assumed authority over stormwater management in Cook County in 2004, pursuant to Illinois Public Act 93-1049. The Stormwater Management plan has been developed as a precursor to the Cook County Stormwater Management Ordinance, currently in progress.
- LCSMC; *Lake County Watershed Development Ordinance (as amended)*; 2008. The Watershed Development Ordinance establishes minimum countywide standards for stormwater management including floodplains, detention, soil erosion / sediment control, water quality treatment, and wetlands.

The MWRDGC has completed a number of watershed plans to address flooding in Cook County, including the Des Plaines watershed:

- MWRDGC; *Lower Des Plaines River Detailed Watershed Plan;* 2011. This report evaluates measures to address flooding in communities along the Des Plaines River and its tributaries.

The LCSMC is conducting several studies investigating opportunities for ecological restoration in the study area:

- LCSMC; *Des Plaines River Wetland Restoration Study – DRAFT;* 2000. This report, funded by a U. S. Environmental Protection Agency (USEPA) Region 5 Grant, prioritizes wetland restoration opportunity sites in Lake County and assesses flood flow reduction possibilities.
- LCSMC and Northeastern Illinois Planning Commission; *Des Plaines Water Resources Action Strategy*. This report outlines multi-objective action priorities for watershed restoration.
- LCSMC; *Bull Creek/Bull's Brook Watershed Based Plan*; 2008. This report, funded by a 319 Grant from the Illinois Environmental Protection Agency (IEPA) addresses ways to control stormwater and improve water quality.
- LCSMC; Indian Creek Watershed Based Plan; in progress. This report, funded by a 319 Grant from IEPA will address ways to control stormwater and improve water quality.
- LCSMC; *Newport Draining Ditch Sub-watershed*; This project is a preliminary assessment of wetland restoration feasibility of three specific, privately owned sites in preparation for a C-2000 Grant Application.

In Illinois, the Northeastern Illinois Planning Commission (now the Chicago Metropolitan Agency for Planning) has participated in several studies investigating restoration opportunities in the Illinois portion of the study area:

- Northeastern Illinois Planning Commission and Liberty Prairie Foundation; *Upper Des Plaines River Watershed Restoration Action Strategy*; 2000.
- Northeastern Illinois Regional Planning Commission, Openlands Project, and the Illinois Paddling Council; *Northeastern Illinois Regional Water Trail Plan*; 1990.
- Northeastern Illinois Regional Planning Commission and Openlands Project; *Northeastern Illinois Regional Greenways Plan*; 1990.
- Northeastern Illinois Regional Planning Commission and Openlands Project; *Year 2000 Regional Trails & Greenways Plan*; 2000 (Draft).
- Northeastern Illinois Regional Planning Commission and Liberty Prairie Foundation; *Watershed Restoration Action Strategy for the Upper Des Plaines River*; 2000 (Draft).

In Wisconsin, the SWRPC has conducted several studies investigating restoration opportunities in the Wisconsin portion of study area and has collected comprehensive rainfall and groundwater data:

- SWRPC; *Planning Report No. 44, A Comprehensive Plan for the Des Plaines River Watershed*; 2003. This comprehensive study of the Wisconsin portion of the Des Plaines River watershed provides a guide to the future development of the 133-square-mile watershed in Kenosha and Racine Counties. The plan, which investigates water resource-related problems and presents recommendations to address those problems, is intended to be adopted and implemented by County and local governments and State and Federal agencies. The plan envisions that the Counties, along with the Watershed Advisory Committee, will coordinate plan implementation in partnership with a diverse group of governmental and private sector organizations.
- SWRPC; *Community Assistance Planning Report No. 58 (2nd Edition), A Lake Management Plan for Pewaukee Lake*, 2003. This report describes the physical, chemical, and biological characteristics of Pewaukee Lake. It also contains information about the feasibility of various watershed and in-lake management measures, which may be applied to enhance water quality conditions, biological communities, and recreational opportunities of the Lake.
- SWRPC; *Community Assistance Planning Report No. 66, A Park and Open Space Plan for the City of New Berlin*; 2003. This report led to the development of a new plan for a park and open space in New Berlin. The New Berlin Common Council approved the plan May 13, 2003. The plan updated an earlier plan adopted in 1995. The new plan calls for the acquisition and development of a variety of parks and related outdoor recreation facilities to meet the outdoor recreation needs of city residents. The plan also includes an open space preservation element, intended to protect important natural resource areas within the city.
- SWRPC; *Technical Report No. 40, Rainfall Frequency in the Southeastern Wisconsin Region*; 2000. This report presents the most current rainfall depth-duration-frequency information for the seven-county Southeastern Wisconsin Region. The data are recommended by the Commission staff for use in stormwater management applications.
- SWRPC; *Technical Report No. 37, Groundwater Resources of Southeastern Wisconsin*; 2002. This report presents the results of an inventory and analysis of groundwater

resources of the Region. The report was prepared by SEWRPC and the Wisconsin Geological and Natural History Survey in cooperation with the Wisconsin Department of Natural Resources (WDNR).

1.1.6 USACE Authorized Projects

Six FRM projects within the Upper Des Plaines River watershed were authorized by Section 101 of the WRDA of 1999 (P.L. 106-53), and include:

- Van Patton Woods Lateral Storage in Wadsworth and Russell, IL
- North Fork Mill Creek Dam Modification in Old Mill Creek, IL
- Buffalo Creek Reservoir Expansion in Buffalo Grove, IL
- Big Bend Lake Reservoir Expansion in Des Plaines, IL
- Levee 37 in Prospect Heights and Mount Prospect, IL
- Levee 50 in Des Plaines, IL

In addition to the Phase I projects listed above, USACE has participated in two projects that were implemented under the USACE Continuing Authorities Program (CAP):

- A levee for flood risk management at North Libertyville Estates was constructed as authorized under Section 205 of the CAP. North Libertyville Estates is a residential subdivision located on the east bank of the Des Plaines River in southern Lake County, approximately 2 miles northeast of Libertyville, Illinois. The project included construction of 5,500 linear feet of earthen levee, 150 linear feet of steel sheetpile floodwall, realignment of an existing drainage ditch, and implementation of an interior drainage plan and a flood warning system. The levee encircles the subdivision and ties into Buckley Road on the east and west sides of the subdivision. Interior drainage is provided by pipes through the levee with flexible check valves to prevent backflow into the subdivision. Additional drainage is provided by a permanent 2,000 gpm pump station and portable pumps used on an as-needed basis.
- The Chicago District, in partnership with IDNR, has completed an Ecosystem Restoration Project at the southern end of the watershed. *Hofmann Dam Section 206 Ecosystem Restoration* included removal of Armitage and Fairbanks Dams as well as notching Hofmann Dam. Armitage and Fairbanks Dams were removed in January and February 2012, respectively. The notching of Hofmann Dam was completed in September 2012. Implementation has reconnected 58 miles of riverine habitat, allowing the recolonization of fishes in the Upper Des Plaines River, and restoring natural riverine hydraulics to support the fish communities. Armitage Dam is within the study area, Hofmann Dam is at the downstream end of the study area (the dam itself is outside the study area but a portion of the pool is within the study area), and Fairbanks Dam is downstream of the study area. The dam removals are being monitored for three years to ensure the effectiveness of the project in accomplishing its restoration goals.

1.2 Study Team

1.2.1 Study Team Organization

The study team is organized into committees that oversee, review, and conduct the study activities. The Executive Steering Committee, representing the USACE and the non-Federal sponsors for the study, was appointed by the Advisory Committee to direct the study efforts. The Advisory Committee includes key state and local agencies involved in the study. Members of these and additional interested organizations constitute the PDT which conducts the actual work of the study. The PDT is organized into Technical Committees organized to focus on particular aspects of this complex multi-purpose study. Technical committees focused on Hydrology and Hydraulics, Ecosystem Restoration, Transportation, Water Quality, and Plan Formulation.

Study Team Component	**Agency**
Executive Steering Committee	
	County of Cook, Illinois
	County of Kenosha, Wisconsin
	IDNR
	LCSMC
	USACE Chicago District
Advisory Groups	
	Chicago Metropolitan Agency for Planning (CMAP)
	FPDCC
	LCFPD
	Northwest Municipal Conference
	SEWRPC
	Upper Des Plaines River Partnership
	WDNR
Project Delivery Team	
	CCHD
	County of Kenosha, Wisconsin
	FPDCC
	IDNR
	LCFPD
	LCSMC
	MWRDGC
	SEWRPC
	USACE, Chicago District
	U.S. Fish and Wildlife Service (USFWS)
Technical Committees	
	Membership drawn from agencies and groups listed above

1.3 Public Coordination*

1.3.1 Stakeholders

In addition to the non-Federal sponsors and state and local agencies who participated in the study as members of the PDT, representatives and citizens of the following communities have expressed concern and provided input to the planning process: Addison, Antioch, Arlington Heights, Barrington, Beach Park, Bensenville, Brookfield, Buffalo Grove, Des Plaines, Franklin Park, Glenview, Grayslake, Gurnee, Harwood Heights, Hawthorn Woods, Kenosha, Lake Zurich, Libertyville, Lincolnshire, Lindenhurst, Long Grove, Morton Grove, Mount Prospect, Mundelein, Niles, Norridge, Northbrook, Northlake, Oak Park, Paddock Lake, Palatine, Park Ridge, Prospect Heights, River Forest, Riverside, Riverwoods, Round Lake Beach, Round Lake Park, Schiller Park, Third Lake, Wadsworth, Waukegan, Wheeling, Wood Dale, and Zion.

1.3.2 Public/Agency Scoping Coordination

Public scoping and coordination of the study has been conducted in accordance with the requirements of the National Environmental Policy Act (NEPA). Additional details of mailings and meetings held can be found in Section 9 – Environmental Assessment, as well as in Appendix L.

2 Planning Overview*

2.1 The Planning Process

This feasibility study followed the six-step planning process defined in the Principles and Guidelines (P&G) adopted by the Water Resource Council and the Planning Guidance Notebook, ER 1105-2-100. The six steps are:

Step 1 – Identifying problems and opportunities
Step 2 – Inventorying and forecasting conditions
Step 3 – Formulating alternative plans
Step 4 – Evaluating alternative plans
Step 5 – Comparing alternative plans
Step 6 – Selecting a plan

Identification of problems and opportunities begins at the outset of the study and forms the foundation of the planning process. The identified problems and opportunities for the Upper Des Plaines Watershed, as developed in Step 1, are described below. These problems and opportunities can be expressed through overall study goals, aligning the goals of the participating organizations.

These problems, opportunities and goals give rise to specific planning objectives and constraints. The objectives state the intended outcome of the planning process and the constraints describe the limitations. Measures and alternative plans can then be evaluated with respect to these criteria. The objectives and constraints for this study are outlined in Section 2.4.

Developing a detailed inventory of existing conditions and forecast of future conditions, Step 2, creates a comprehensive picture of the study area. By gathering both qualitative and quantitative data, the study team can develop and evaluate alternative plans with respect to the unique variables within the study area. Forecasted conditions provide a basis for comparison and evaluation of alternative plans. An overview of the existing and forecasted conditions is presented in Section 3.

Plan formulation is an iterative process that involves formulating, evaluating, comparing, and re-formulating plans until an array of alternatives that meet the identified objectives within constraints are determined. Section 2.1.1 discusses the plan formulation process that encompasses Steps 3 through 6 and the unique challenges presented in formulating a combined plan that achieves both FRM and ecosystem restoration.

2.1.1 Creating a Combined Flood Risk Management/Ecosystem Restoration Plan

The Corps Environmental Operating Principles (EOPs) (see Section 9.6.2 for further discussion of the EOPs) strive to achieve environmental sustainability by: seeking balance and synergy among human development activities and natural systems; and designing economic and environmental solutions that support and reinforce one another. This study uses these principles with the formulation of plans that serve both FRM and ecosystem restoration purposes. Corps planning guidance promotes the formulation of combined plans that serve both economic and environmental purposes whenever possible.

Formulation options when developing plans with measures that serve both flood risk management and ecosystem restoration purposes depend on whether measures within the plan are physically or functionally interdependent versus independent. Combined plans that have interdependent measures either share the same physical location or functions. Interdependent measures can sometimes negatively impact each other or compete for the same resources. In those cases, the outputs from the measures that impact each other or are in competition with each other must be traded off. Trade offs are not necessary for outputs from those measures that do not impact or even benefit each other. Plans that have independent measures will include all measures of the separately identified flood risk management and ecosystem restoration plans. Below is a summary of the formulation options:

1. Physically and/or functionally interdependent (combined plan)
    a. Without trade-offs (no impacts on each other)
    b. With trade-offs (impacts on or competition with each other)
2. Physically and functionally independent (separate plans)

To formulate a combined plan, single purpose FRM and ecosystem restoration plans must be formulated and evaluated separately to form the basis for a trade-off analysis, if needed, and to ensure the plan that maximizes net economic and environmental outputs is identified. The respective single purpose plans are determined to be the most efficient, effective, complete and acceptable plans. The combined plans results in the "best" Recommended Plan so that no alternative plan or scale has a higher excess of national economic development (NED) benefits plus national ecosystem restoration (NER) benefits over total project costs. This plan attempts to maximize the sum of net NED and NER benefits, and to offer the best balance between two Federal objectives. Recommendations for multipurpose projects are based on a combination of NED benefit-cost analysis, and NER benefits analysis, including cost effectiveness and incremental cost analysis.

Formulating plans that have interdependent elements where there is a competition for resources, meaning more of one output (e.g., NER) can only be obtained by accepting less of another (e.g., NED), requires a trade-off analysis. Trade-offs between NED outputs and NER outputs can be made as long as the value of what is gained exceeds its implementation cost plus the value of what is foregone. Since the unit of measure is different between NED and NER accounts, a method is needed to normalize the units and compare benefits where necessary. Corps guidance dictates the use of the Separable Cost-Remaining Benefit (SC-RB) method for obtaining an equitable distribution of the costs of a multipurpose project among the purposes. Incremental costs are the added cost necessary to realize added environmental outputs minus the reduced cost of reduced NED outputs. Trades of one output for another are made until it is not possible to make further trades to improve the total project. The potential trades can go in both directions: more NER output for less NED output and more NED output for less NER output. The result of this process is an optimized Combined Plan.

Detailed plan formulation discussions of the FRM and ecosystem restoration plans are presented in Section 4 and Section 5, respectively. Formulation and evaluation of the combined Plan is presented in Section 6.

2.1.2 Integrating Evaluation of Water Quality and Recreation Benefits

Once a Combined Plan has been identified the study team will investigate opportunities for implementing features to improve water quality and provide additional recreational opportunities in the watershed. Individual plans will not be formulated to meet these secondary purposes. Instead, the study team will assess the potential for implementing measures that meet these purposes in conjunction with the Combined FRM/ER Plan and within existing USACE policy. Additional measures that could improve water quality and recreational opportunities within the watershed will be identified as incidental costs or for implementation by others.

2.2 Planning Model Certification and Approval

Evaluating and forecasting existing and projected Future Without Project (FWOP) conditions and the impacts of potential measures and plans requires systematic evaluation procedures. Analytic tools used to support decision making in USACE studies – planning models – are reviewed and approved or certified by HQUSACE. This review process ensures that the analysis is technically and theoretically sound. The review requirements are provided in EC 1105-2-412: Assuring Quality of Planning Models. The review is conducted by the associated USACE Planning Center of Expertise and the model is either certified (for general or regional use) or approved (for one time use) by a model certification panel at HQUSACE. The planning models used in this study and their review status are presented in Table 2.1. Reviews for ecosystem models are conducted by the Ecosystem Restoration Planning Center of Expertise (ECO-PCX). Reviews for models used to evaluate measures to address flood damages are conducted by the Flood Risk Management Planning Center of Expertise (FRM-PCX).

Table 2.1 – Study Planning Models

Model Name and Version	Brief Description of the Model and How It Will Be Applied in the Study	Certification / Approval Status
Qualitative habitat Evaluation Index (QHEI)	Evaluation of stream habitat quality based on physical characteristics, providing a quantitative index.	Approved for study-specific use
Index of Biotic Integrity (IBI)	Quantifies response of the in-stream fish community to disturbance and/or restoration.	Approved for study-specific use
Floristic Quality Assessment (FQA)	Assigns to plant species a rating that reflects the fundamental conservatism that the species exhibits for natural habitats and quantities changes in plan community composition.	Approved for regional use
Habitat Evaluation Procedures (HEP)	Using the Habitat Evaluation Procedure, these models quantify changes in community attributes (e.g., function and structure) that are targeted for ecosystem restoration.	Approved for study-specific use
Hydrogeomorphic Models (HGM)	Using the Hydrogeomorphic Approach, these models quantify changes in wetland structure and function that are expected to respond based on alternative restoration scenarios	Approved for study-specific use
Flood Damage Analysis (HEC-FDA) ver 1.2.4	Based on economic and hydrologic inputs, computes risk based equivalent annual damages for various hydrologic conditions.	Certified for general use
Visual Interactive System for Transportation Algorithms (VISTA)	This commercial off-the-shelf transportation model was developed for the Chicago Area Transportation Study (CATS). Based on road characteristics and conditions as well as user demand data, estimates travel distance and times in a transportation network.	Approved for study-specific use

2.3 Problems and Opportunities

The problems associated with the Upper Des Plaines River watershed are system-wide; therefore, a system-wide approach to FRM and large-scale restoration of natural ecotypes and hydrology is needed to develop holistic solutions for the Upper Des Plaines River watershed. The study area, however, is politically diverse and crosses state boundaries. The development of integrated solutions would be difficult if not impossible without Federal involvement.

The long and narrow study area includes many smaller tributary watersheds connecting to the mainstem Des Plaines River along its length. Flooding along tributaries impacts not only residential, commercial, industrial, and public structures in the subwatershed, but also along the mainstem. Similarly, ecosystem habitats within subwatersheds are linked to each other by their connection to mainstem habitat. Therefore, the most appropriate approach is a watershed wide definition of problems and opportunities, guiding the study to formulate plans and consider the interconnected benefits and impacts throughout the watershed.

This study enables local communities and agencies to work in cooperation and develop plans that efficiently use both Federal and non-Federal resources to address identified problems and opportunities. The amount of resources available to individual agencies would be ineffective at addressing problems across the entire watershed.

This study works within Corps FRM, ecosystem restoration, and recreation authorities to develop a Recommended Plan. Unlike a Watershed Study, as authorized by Section 729 of WRDA 1986, this study will result in a Recommended Plan for implementation.

2.3.1 Problems

Several problems in the study area were identified:

1. **Impacts of Agriculture and Development on Natural Hydrology and Processes:** Watershed development, agriculture, and the presence of features that modify the natural hydrology such as drain tile systems, channelization, bank armoring, low head dams, bridge footings and foreign debris all have significantly contributed to the degradation of natural palustrine and riverine processes. These are manifested through poor water and sediment quality, unnatural and erratic stream flows, loss of instream complexity, unbalanced sediment budgets, disproportion of nutrient influx and uptake, poor biological integrity, and ultimately an overall loss in aquatic diversity.

2. **Ongoing and Increasing Flood Risk:** Not only are the natural systems affected, but the changes caused by development have also led to an increase in the frequency and severity of floods in the watershed. Additionally, the draining of land for agricultural and urban development has reduced the amount of natural floodplain. Most communities along the Upper Des Plaines River including Gurnee, Libertyville, Vernon Hills, River Grove, Wheeling, Mount Prospect, Prospect Heights, Des Plaines, Schiller Park, Franklin Park, Elmwood Park, and Riverside have suffered significant flood damages in the past.

3. **Lack of Open Spaces Available to Natural Plant and Wildlife Communities:** As agriculture and urban communities occupied lands, the natural processes that drive diversity in the ecosystems they supported were removed or impaired. Additionally, invasive species take advantage of these modifications, dominating the affected area and inhibiting ecosystem diversity.

4. Diminished Recreation Opportunities: As open space becomes less available and water quality decreases, opportunities for recreation within the watershed are diminished. Urbanization and development impede interaction with the river and nearby lands as human contact with the river is restricted by impaired water quality and established areas for outdoor activities become less available.

2.3.2 Opportunities

Watershed-wide opportunities exist within the watershed to lessen the effects of the described holistic problems. These include:

1. Reduce Flood Risk: Reducing the risk of severe and frequent flooding and associated flood damages can improve the financial security of property owners and local agencies responsible for maintaining the roads and infrastructure impacted by flood events.

2. Improve the Quality and Increase Acres of Naturally Functioning Ecosystems: The health of streams, as measured by the Index of Biotic Integrity, declined significantly when the amount of urban land use measured as impervious cover exceeded 13.8%. The quality of physical habitat fell below expectations consistent with Clean Water Act goals when impervious cover exceeded 27.1% (Miltner et al 2004). Declining biological integrity was noted in several streams with suburbanizing watersheds at levels of total urban land use as low as 4% and biological integrity was maintained where the floodplain and riparian buffer were relatively undeveloped, demonstrating the impact of urbanization on streams. Miltner (2004) recommends an aggressive stream protection policy prescribing mandatory riparian buffer widths, preserving sensitive areas and minimizing hydrologic alteration. As a response to these findings and recommendations, this study affords the opportunity to determine effective means for the restoration of the hydrology, hydraulics, and geomorphology. This, in turn, would restore significant habitat, resulting in increased species richness and abundance in faunal communities. Incidental to the ecosystem benefits, the naturalized functions may also provide flood attenuation, water storage during periods of drought, water quality enhancement and increased opportunities for recreation.

3. Restore Connections Between Natural Spaces: Reconnecting aquatic and riparian/buffering habitats will allow for greater interaction between species populations to improve genetic heterogeneity and provide for dispersal routes of native plant and animal species, while lessening the adverse effects of sink/source populations of native plants and animals. Four dams fragmenting the watershed riverine system have been removed, but there are dams that remain along the Des Plaines mainstem that continue to fragment the system.

4. Improve Water Quality: Improved water quality can enhance both wildlife habitat and recreational opportunities.

2.3.3 Goals

The Federal (USACE) and non-Federal sponsors' goals and objectives for water resources implementation studies establish the overall goals for this feasibility study.

The Federal goal of water and related land resources planning is to contribute to National Economic Development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. These contributions are the direct net economic benefits that accrue in the planning area and the rest of the nation. The non-Federal partners also have FRM goals similar to the national NED goals.

USACE also has a Federal goal of ecosystem restoration in response to legislation and administration policy. This goal is to contribute to the nation's ecosystems or NER by restoring degraded aquatic ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. Contributions to NER are increases in ecosystem value and productivity and are measured in non-monetary units such as acres or linear feet of habitat, increased habitat function, average annual habitat units, or increased species number or diversity. The study non-Federal partners have general goals for ecosystem restoration that include both increasing land holdings for ecosystem purposes and reestablishing natural communities to support sustainable natural areas.

As a team, USACE and the non-Federal sponsors aim to further the restoration of the Upper Des Plaines River watershed, harmonizing the benefits of ecosystem restoration and FRM. These two goals can be met to form a single overall multi-purpose plan.

Study Goal: The primary goal of this study is to determine a cost effective and implementable plan for FRM and ecological restoration, while considering improvements to water quality and enhanced recreational opportunities as secondary goals.

Project Goal: The principal goals of a resulting multi-purpose project are: 1) to reduce future flood risk along the mainstem of the upper Des Plaines River; 2) to reduce future flood risk along tributaries to the upper Des Plaines River; 3) to restore the environmental integrity and beneficial uses of the river and its tributaries; and 4) to reestablish hydrology, hydraulics, geomorphology and appropriate native vegetation to set the stage for self regulating and sustainable habitats.

2.4 Objectives and Constraints

The problems, opportunities and goals described above give rise to objectives and constraints which will inform the planning process. These parameters are specific and measurable and are used to evaluate the ability of potential measures to resolve identified problems and take advantage of opportunities. The NER objectives were developed to set the stage for integrating plan formulation with USACE policy on appropriate measures that focus on hydrology, hydraulics, geomorphology and native vegetation.

2.4.1 Objectives

Planning objectives were established in concert with the entire study team and in cooperation with stakeholders. The principal goal of this study is to reduce existing flood risk and prevent increases in future risk while protecting and restoring the environmental integrity and beneficial uses of the river and its tributaries. This goal can be accomplished through cooperative, watershed-based efforts to identify and incrementally implement multiple projects that cumulatively achieve the following objectives:

1. **Reduction in mainstem flood risk:** This objective seeks to build upon the Phase I Study and the six flood risk reduction projects that were authorized as a result of the study. Only a portion of mainstem damages will be reduced (approximately 25%) from the implementation of these six authorized projects. Since significant residual flood risks remain within on the Upper Des Plaines

River watershed, this study will seek to further reduce residual flood risks. Specific plans will be developed to address flood damages associated with overbank flooding and transportation delays and damages along the mainstem Upper Des Plaines River.

2. **Reduction in tributary flood risk:** This objective seeks to identify and reduce flood risks associated with tributary flooding. Previous studies concentrated on damages associated with the mainstem Upper Des Plaines River. Specific plans will be developed to address flood risks associated with overbank flooding and transportation delays and damages on the tributaries.

3. **Naturalize watershed hydrology, hydraulics and geomorphology:** This objective seeks to naturalize hydrogeomorphic functions and features for the primary purpose of ecosystem restoration. Soil structure and composition are an integral part of geomorphology and are the functional drivers of any ecosystem. Evident impairment exists throughout the watershed in the form of drain tile systems, ditches, control structures, dams, bank armoring, stream channelization, floodplain and wetland filling, etc. In order to establish secondary drivers, the impairments to the primary drivers must be addressed.

4. **Increase acreage of native community types:** Currently, very little natural land cover remains in the 477 square mile watershed and over 90% of the streams have been modified or channelized. As little as 30% land cover disturbance causes significant impairments to biodiversity, especially in aquatic systems. To improve the quality of ecosystems on a watershed scale, increases in native community types should be considered on a large scale.

5. **Reduce/control/eradicate non-native plant and animal species:** This objective seeks to remove the adverse effects of invasive and non-native species on native communities. Non-native and invasive species, particularly plants, have had significant adverse impacts in the watershed. Typically, these species gain a foothold and eventually dominate a site due to existing impairments, particularly hydrologic, soil, or anthropogenic chemical. Once the hydrologic and geomorphic impairments are repaired, invasive plant species may be addressed quite effectively, often keeping invasive plant species cover to less than 1% of the site after a period of establishment. This target has been achieved at several restoration projects in the region. Ongoing monitoring has shown that these projects have successfully achieved less than 1% invasive species spatial coverage not only upon completion of construction, but also for as long as 15 years after construction.

6. **Increase connectivity of natural areas:** This objective seeks to increase both riverine and greenway connectivity. It is well documented that habitat fragmentation leads to many ecological and biological problems, such as inbreeding, sink populations, food chain collapse, road kill, etc. This objective should guide measures, alternatives and plans to consider removing impediments to faunal migration and creating greenways or restoring adjacent parcels to high quality areas to increase the transfer of native species and their associated local genotypes.

7. **Increase watershed biodiversity:** Biodiversity, as defined for restoration purposes, is the total number of native species, abundance, genetic heterogeneity, and population health of the study area's open lands and stream corridors. Currently, the number of native species within the Upper Des Plaines watershed is not much different than what historically occurred before disturbance by man, meaning there are only a few species that have been completely removed from area. The vast majority of the remaining native species are located in small isolated populations. The abundance and health of the remaining native species/populations have been dramatically reduced and impaired. Dominant land uses in the watershed support very few native species. Once hydrology, hydraulics, geomorphology and invasive species issues are addressed through restoration, these sites would have the potential to

provide life requisites for vast numbers of native fungi, plant, insect, fish, amphibian, reptile, bird, and mammal species. The major increases in biodiversity would be detected through increases in abundance and population health for restored native species on tracts of land that did not previously contain these species. Any restoration measures, alternatives or plans selected should provide life requisites for a variety of plant communities providing a diversity of habitat types, which would facilitate the return of hundreds, if not thousands of native species to areas once void of their presence. It is expected, based on previous hydrologic and hydraulic restoration projects that the Chicago District has implemented, that species start to colonize the site as soon as the impairments to the functional drivers are disabled. Immediate recolonization of birds and crayfish has resulted through the disablement of drain tiles within several Chicago District projects. Biodiversity benefits are primarily expected for those parcels of land that are directly restored; however, spillover effects could be expected up and downstream for riverine work, and in any natural areas that are adjacent/directly connected to the restored sites.

8. Preserve existing natural resources: This objective seeks to preserve areas of existing significant natural resources. This may be accomplished through simple procurement of land, restoration and management. Adding buffers to existing natural areas (i.e. riparian corridors) and avoiding the implementation of FRM plans that change natural land use, will also serve this objective. The USACE is not able to participate in ecosystem preservation projects where the sole purpose is the acquisition of land; however, by working with non-Federal sponsors to restore adjacent lands and avoid converting land use from its natural state, this objective would be met.

9. Improve water quality for aquatic organisms: This objective seeks to reduce non-point source runoff, point source discharges and combined sewer overflows (CSOs). Improved water quality may result in upgraded water quality use designations throughout mainstem and tributaries of the Upper Des Plaines River watershed. The USACE is not able to participate in implementation of projects for the sole purpose of improving water quality or pollution problems where other parties would have a legal responsibility; however, incidental water quality benefits resulting from implementation of ecosystem restoration or FRM projects would support this objective.

10. Increase open space and recreational opportunities: This objective seeks to incorporate passive recreation into ecosystem restoration or flood risk management projects. The USACE is not able to participate in projects where the sole or primary purpose is recreation; however, where recreational uses would be compatible with the primary purposes, recreational features may be considered. There may also be an opportunity to create active recreational facilities within the footprint of a flood risk management project.

2.4.2 Constraints

Planning constraints are items of consideration, specific to the study, that limit the planning process and are used along with the objectives in the formulation and evaluation of solutions. Planning constraints were identified in concert with the entire study team and in cooperation with stakeholders. The constraints identified for this study are:

1. Compatibility with multipurpose planning: Through the planning process, measures and plans will be identified to meet the study objectives. However, while each measure may meet the requirements of a single purpose, the measures must not violate additional study objectives.

2. Minimize adverse impacts to hydraulic & hydrologic regimes: Small changes in flood stages can have significant impacts in the study area due to the flat topography. Identified measures must ensure that implementation will not result in adverse effects or induced damages to other parts of the watershed.

3. Minimize adverse impacts to local drainage districts: Although flooding resulting from local drainage issues is not considered in this study, the impacts of proposed measures on existing infrastructure must be evaluated and avoided.

4. Compatibility with existing development: The majority of the study area is highly urbanized. Measures and plans must avoid adverse impacts to existing features providing flood risk management, ecosystem, water quality, and recreation benefits.

3 Study Area Inventory and Forecast*

3.1 Existing Conditions

A comprehensive inventory of the study area is an essential step in defining the scope of the issues to be addressed. The inventory is also used to identify and evaluate appropriate measures to address the identified problems and opportunities.

In general, elevations used in this study are in North American Vertical Datum (NAVD) 1988. However, the mainstem hydraulic model and several tributary models were developed using National Geodetic Vertical Datum (NGVD) 1929. Some existing FEMA floodplain maps use NGVD 1929 and the models have been extensively verified in their accuracy within this datum. Therefore, the hydraulic and economic models for these streams were maintained in NGVD 1929 and data used from these models for the design of features were carefully reviewed and converted for NAVD 1988. The NAVD 1988 will be used in the design of all recommended features as required by ER 1110-2-8160, Policies for Referencing Project Elevation Grades to nationwide Vertical Datums. Within this watershed, the difference between NVGD 1929 and NAVD 1988 is approximately 0.3 feet. See Appendix A (Hydrology and Hydraulics) and Appendix D (Civil Design) for further discussion of elevation data.

The study team developed the following inventory of physical, ecological, and cultural resources to guide the study process. Sections 4 and 5 discuss the development of quantifiable FWOP conditions for each primary study purpose.

3.1.1 Physical Resources

3.1.1.1 Climate

The climate in northeastern Illinois and southeastern Wisconsin is classified as humid continental, characterized by warm summers, cold winters, and daily, monthly, and yearly fluctuations in temperature and precipitation. Average annual rainfall is usually between 30 to 40 inches per year, with greater amounts falling between April and August. Annual seasonal snowfall averages approximately 28 inches. Early spring floods occur when snow accumulations extend into a period of increasing temperatures that result in melting. If extensive melting of accumulated snow occurs when soils are already saturated, the associated runoff increases dramatically because of the large area of impervious surfaces located within the basin, which are largely a result of urban development.

3.1.1.2 Bedrock Stratigraphy

The oldest rocks found on Earth are of the Precambrian period, which can be located in and around the Chicago area and are approximately 1-1.5 billion years old. This stratum of rock occurs from depths ranging from 2,500 to 5,500 feet. The only Precambrian rock present at the surface in the Upper Des Plaines River basin are glacial erratics, igneous and metamorphic rocks transported by glaciers from the north found in glacial drift. Overlying the Precambrian stratum is the Cambrian System, which is also deeply buried. The next layer is Ordovician System in which strata range from 1,100 to 7,000 feet thick. There are few isolated areas where the glacial till of the basin lies directly over the Maquoketa Group (Om) (Scales Shale, Fort Atkinson Limestone, Brainard Shale, Neda Formation) of the

Cincinnatian Series. The majority of the glacial drift within the Upper Des Plaines River basin overlies the Silurian System. Silurian rocks are predominantly dolomite. The Silurian System consists of the Alexandrian Series (Edgewood & Kankakee Dolomites) and the Niagaran Series (Joliet, Waukesha & Racine Dolomites). Bedrock is not exposed at the surface within the Upper Des Plaines River basin.

The underlying bedrock forms a series of valleys, lowlands and uplands. These formations were probably formed and in place before the continental glaciers encroached over the area. The bedrock valleys include important and productive aquifers, formed from the deposition of sand and gravel when the valleys were buried from proceeding glacial activities. The current river course flows in a perpendicular direction relative to the buried valleys. Within the watershed, the depth of the bedrock below the ground surface ranges from as much as 400 feet in the northern area to less than 25 feet at the southern end.

3.1.1.3 Glacial Stratigraphy

The study area has been impacted by four major glaciation events, lasting from approximately 1.6 million to 10,000 years ago. The last major glacial advance was called the Wisconsinan cycle and evidence of its existence is prominently displayed throughout the study area. Glaciers sculpted the underlying landscape by abrasion, erosion and deposition. Continental glaciers, such as the types of glaciers that passed over the study area, tended to produce a more rounded topography, by scraping away at the bedrock in some areas and depositing the accumulated debris in other areas. The deposition of accumulated materials by glaciers is referred to as glacial drift, which can be further identified by how and where it was deposited. The two general categories of drift are referred to as till and outwash.

The underlying bedrock of the study area is covered by various depths of a complex layering of beds and lenses of outwash with different layers of till left by surging and retreating glaciers. In addition, the study area is laced with several clustered end moraines (ridges left by retreating glaciers), which are oriented in a north-south direction that roughly parallels the shore of Lake Michigan as shown in Plate 3. The importance of glacial history is the profound effect that the deposited drift had on the area's modern and moderately productive soils. These deposits range from 20 to 35 feet thick and some extend down to bedrock. The parent material for soils in this area are loess (windblown silt) and till, mainly a compact matrix of clay, silt and sand mixed with other larger sized grains.

3.1.1.4 Soils

There are 13 soil associations found within the study area as shown in Plate 4 and of these, the most widespread are the Morely-Markham-Ashkum (30%), Urbanland-Markham-Ashkum (18%) and Elliott-Ashkum-Varna (14%). Typically, these soil associations are slowly permeable and can be subject to hydric conditions. Higher frequencies of wetlands and poorly drained soils, along with the most agriculturally productive soils, occur in the northern portion of the study area. The moderately slow permeability exhibited by many soils in the agricultural and urbanized portions of the study area create conditions conducive to flooding and standing water during periods of high water table or heavy precipitation. Many soils in Cook County were modified by human activities and are overlaid by a few feet of miscellaneous fill and/or regraded top soil. Additional discussion of the soils and subsurface conditions can be found in Appendix G (Geotechnical Analysis).

3.1.1.5 Hydrology, Hydraulics & Land Use

The study area includes the mainstem of the Des Plaines River and all tributary streams above the confluence with Salt Creek, encompassing a portion of four counties including Kenosha and Racine counties in Wisconsin and Lake and Cook counties in Illinois. The Upper Des Plaines River watershed is approximately 477 square miles with 133 square miles in Wisconsin and 344 square miles in Illinois. The watershed is aligned primarily along a north-south axis with a length of approximately 60 miles and average width of 8 miles. Elevations in the Upper Des Plaines River watershed upstream of Salt Creek vary from nearly 900 to 600 feet NAVD88. From the junction with Salt Creek in Illinois upstream to the junction with Root River in Wisconsin, the Des Plaines River rises 76 feet over 86 miles for an average gradient of 1.1 ft/mi.

Historically, the Des Plaines River system was a narrow elongated depression within the late Wisconsinan Age glacial drift. The Upper Des Plaines River, from the confluence of Salt Creek northward, was very shallow and averaged about 30 feet wide with banks of accumulated sediments and soils and covered with aquatic vegetation. As European settlement increased, the watershed was stripped of natural plant communities, initially due to agricultural practices. Streams became more entrenched and began to exhibit signs of altered hydrology with increased peak flows and reduced base flows. Land use in many areas of the watershed was gradually converted to urban and suburban use dominated by rooftops, pavement and other impervious surfaces. Table 3.1 below shows a breakdown of existing land use based on data collected by SEWRPC and Northern Illinois Planning Commission (NIPC), now the CMAP. Data in the table reflects land use in 1995 and 2001. Plate 5 illustrates existing land use across the watershed. As of 1995, land use in the Wisconsin portion of the watershed consisted of 68.3% agriculture, 14.7% open space, and 11.8 % urban. As of 2001, land use in the Illinois portion of the watershed consists of 57.4% urban, 23% open space, and 19.6% agriculture. These landscape-scale changes in land-use, and subsequent hydrologic and hydraulic alterations, contribute to increased flooding and subsequent flood damages, decreased habitat quality, degraded water quality and reduced species richness.

Table 3.1 – Land Use in the Upper Des Plaines River Watershed, 1995 and 2001

Land Use	Description	Area (ac)	Area (mi^2)	Percent
Residential	single & multi-family dwellings	96,614	151	32%
Commercial	retail and general merchandise	14,371	22	5%
Industrial	manufacturing, warehousing, etc.	15,197	24	5%
Public	government, education, hospital, etc.	9,514	15	3%
Infrastructure	roads, railroads, utilities, etc.	16,724	26	5%
Recreational	parks & fields	30,612	48	10%
Agricultural	farmland	77,970	122	26%
Open	vacant previously developed land	288	0.5	<1%
Forest/grassland	forest, prairie, grasslands	24,556	38	8%
Wetland	wetlands	12,887	20	4%
Water	open water	6,776	11	2%
Total		**305,508**	**477**	**100%**

Source: Northern Illinois Planning Commission (NIPC, now CMAP) and SWRPC

Development and agriculture in the Upper Des Plaines River watershed have altered the natural hydrologic regime. An increase in impervious areas has increased the average daily and peak flows. This trend can be shown through long term stream gage data. There are eight stream gaging stations currently operating within the study area as shown in Table 3.2 and Plate 6. Historically, there were an additional 20 stream gages that were located along the mainstem Des Plaines River and tributaries, but these gages are no longer in service.

The longest continuously operating gage is USGS gage number 05532500, Des Plaines River at Riverside, IL, located just downstream of the study area. This gage has been continuously recording since 1914. Annual flow statistics are shown in Table 3.3 below. As shown in the table, average daily flows in the Upper Des Plaines River have steadily increased with watershed development.

Table 3.2 – USGS Stream Gages Currently Operating in the Upper Des Plaines River Watershed

Gage ID (link)	Site Name	Drainage Area (mi²)	Gage Datum (NGVD29)	Dates of Operation	
				From	To
05527800	Des Plaines River at Russell, IL	123	662.00	4/2/1960	current
05528000	Des Plaines River near Gurnee, IL	232	650.30	1/11/1946	current
05529000	Des Plaines River near Des Plaines, IL	360	626.31	7/4/1938	current
05532500	Des Plaines River at Riverside, IL[1]	630	594.68	5/14/1914	current
05527950	Mill Creek at Old Mill Creek, IL	61	668.00	3/31/1960	current
05528500	Buffalo Creek near Wheeling, IL	19.6	658.60	3/15/1953	current
05529500	McDonald Creek near Mt Prospect, IL	7.93	638.12	3/15/1953	current
05530000	Weller Creek at Des Plaines, IL	13.2	634.02	2/19/1951	current

[1]Note – Des Plaines River at Riverside, IL is located just downstream of study area. This gage was moved approximately 400 feet in January of 2011. While the relocation does not affect flow measurements, measured stages are impacted. Adjustments to account for changes in stage have been calculated to provide continuity.

Table 3.3 – Annual Flow Statistics at USGS Gage 05532500, Des Plaines River at Riverside, IL

Water Years	Minimum Daily Flow (cfs)	Average Daily Flow (cfs)	Peak Recorded Flow	
			cfs	year
1944-1956	0.5	359	6,510	1948
1957-1966	0.0	380	5,950	1957
1967-1976	20	598	5,460	1972
1977-1986	48	670	6,360	1985
1987-1996	126	723	9,770	1987
1997-2006	101	695	6,990	1997

A number of flow modifications including dams, channel modifications, and reservoirs have been constructed over the past century. Table 3.4 lists the existing major watershed modifications and the years the projects were completed. Plate 7 shows the locations of the projects within the watershed.

Table 3.4 – Existing Major Watershed Modifications within Upper Des Plaines River Watershed

River or Tributary	Project	Size	Year Completed
Des Plaines River	Channel Modification (Hofmann Dam to North Ave.)	8 miles	1932
	Channel Modification (Upstream of Wadsworth Rd.)	0.3 miles	1935
	Ryerson Dam downstream of Deerfield Rd. (RM 78.6)	2 ft	1956
	Dam near Armitage Ave. (RM 51.5)	2 ft	1957
	Berm at Big Bend Lake (RM 66.1 to 66.5)	0.4 miles	1978
	Levee at North Libertyville Estates (RM 91.1 to 90.2)	1 mile	1999
	Hofmann Dam Replacement (RM 43.5)	12 ft	1950
	Hofmann Dam Notching (RM 43.5)	12 ft	2012
	Dam #4 upstream of Higgins Rd. (RM 59.5)	2 ft	1922
	Dam upstream of Touhy Ave. (RM 61.2)	2 ft	
	Dam downstream of Dempster St. (RM 63.5)	2 ft	
	Dam #2 downstream of Euclid Ave. (RM 69.0)	4 ft	
	Dam #1 downstream of Hintz Rd. (RM 73.5)	4 ft	
	Wright Dam upstream of Half Day Rd. (RM 83.4)	2 ft	
Indian Creek	Channel Modification at Forest Lake	0.3 miles	1996
Buffalo-Wheeling Creek	Heritage Park Reservoir	151 ac-ft	1982
	Buffalo Creek Reservoir	700 ac-ft	1990
	Diversion Channel	0.2 miles	1999
	Strum Subdivision Buyouts & Modifications	Varies	1999
McDonald Creek	White Pine Ditch Reservoir	50 ac-ft	1986
	Lake Arlington Reservoir	540 ac-ft	1990
Weller Creek	Crumley Basin	40 ac-ft	1969
	Wilke-Kirchoff Reservoir	100 ac-ft	1973
	Clearwater Park Reservoir	160 ac-ft	1977
	Mount Prospect Reservoir	130 ac-ft	1978
Willow-Higgins Creek	CUP O'Hare Reservoir	1050 ac-ft	1998
	Touhy Avenue Reservoir	1,178 ac-ft	2004
	Willow-Higgins Reservoir	1200 ac-ft	2005
	Willow-Higgins Channel Improvement	1.0 mile	
Crystal Creek	Lake O'Hare Reservoir	1120 ac-ft	1965
	Crystal Creek Channel Improvements	0.5 miles	
Silver Creek	Jack B. Williams Reservoir	245 ac-ft	1990
	Silver Creek Reservoir	500 ac-ft	1992

All dams currently present within the study area are low-head, run-of-the-river type structures. They were originally designed to maintain a minimum channel depth during low flows for water quality and recreational purposes. Several were once used as fords across the river for livestock and early automobiles. These dams do not possess any appreciable impoundment characteristics that contribute to flood risk management (FRM).

Channel modifications and reservoirs were constructed within the study area to combat flooding caused by urban development. Despite the presence of these structures, flooding continues to pose significant risk to the communities of the Upper Des Plaines watershed as described further in Section 4.

The baseline conditions for the Phase II Study include the implementation of FRM projects recommended by the Phase I study and authorized for construction under Section 101 of WRDA 1999.

Although the six projects, if fully implemented, would reduce flood damages in the watershed, it was estimated during the Phase I Study that even with construction of the recommended projects constructed, there is a significant residual flood risk in the watershed. Additional discussion of the Phase I authorized projects is included in Section 4.

The hydrology of the Upper Des Plaines River watershed in Illinois has been modeled using the USACE Hydrologic Engineering Center's HEC-1 hydrologic model. The mainstem model was originally developed during the Phase I study. The baseline hydrologic conditions of this model were based on land use mapping for 1995 conditions, and the future conditions were based on predictions of land use changes in 2010. In order to ensure the mainstem hydrologic model is representative of current and future conditions for this Phase II study, a detailed analysis consisting of extending and updating the four mainstem gage records for urbanization and reservoir construction and comparing frequency analysis results with that used to calibrate the Phase I mainstem H&H models was performed. The analysis showed that, while there were minor changes, there is not a statistically significant change in the flow data; therefore the mainstem models from the Phase I Study are still valid for use in hydrologic analyses for the Phase II Study. A summary of the analysis and a white paper documenting the analysis are included in Appendix A (Hydrology and Hydraulics).

Table 3.5 shows peak flood flows by frequency as computed by the mainstem HEC-1 model for 1995 baseline conditions, which includes the implementation of FRM projects authorized from the Phase I study. These results represent baseline conditions on the mainstem for this Phase II study.

Table 3.5 – Peak Flows Computed by Mainstem HEC-1 Model, Baseline Conditions

	Peak Flow at USGS Gage (cfs)			
Flood Event (% Chance)	Russell Rd ID#5527800	Gurnee ID#5528000	Des Plaines ID#5529000	Riverside ID#5532500
99%	323	782	2,005	2,874
50%	624	1,262	2,604	4,540
20%	1,230	2,152	3,535	5,821
10%	1,727	2,898	4,138	6,643
4%	2,468	3,991	4,974	7,588
2%	3,086	4,741	5,594	8,225
1%	3,773	5,586	6,075	8,726
0.2%	5,580	7,853	7,386	10,098

The hydraulics of the mainstem Upper Des Plaines River was modeled using the USACE Hydrologic Engineering Center's HEC-2 hydraulic model. This model was also originally developed for the Phase I study.

Both mainstem models have undergone extensive calibration and review by both the IDNR and the Federal Emergency Management Agency (FEMA). Review and updates have occurred during the Phase I study, design of Phase I projects, and a full remapping of the floodplain that was completed along the mainstem Des Plaines River. These models are also used as the regulatory models for the watershed.

A series of new hydrologic and hydraulic models were developed for 15 of the tributaries in the basin. In order to allow the new more detailed tributary models to be incorporated into the mainstem model, HEC-1 was used to model the hydrology of the tributaries. The hydraulic models were developed from newly surveyed geographic and cross-section data using USACE Hydrologic Engineering Center's River Analysis System (HEC-RAS). Previously developed hydrologic and hydraulic models of the Wisconsin tributaries and the Upper Des Plaines River mainstem in Wisconsin used Hydraulic Simulation Program FORTRAN for the hydrologic analysis and HEC-2 for the hydraulic analysis. These existing models were used to extend the study area to the northern end of the Des Plaines River watershed.

Several study partners participated in the development of the models. Table 3.6 lists the tributaries from upstream to downstream and the agencies responsible for developing models.

Table 3.6 – Hydrologic and Hydraulic Models

Tributary	County	Responsible Agency	Year Completed
Brighton Creek	Kenosha	SEWRPC	2003
Dutch Gap Canal	Kenosha	SEWRPC	2003
Salem Branch	Kenosha	SEWRPC	2003
Unnamed Tributary No. 6	Kenosha	SEWRPC	2003
Kilbourn Road Ditch	Kenosha	SEWRPC	2003
Newport Drainage Ditch	Lake	LCSMC	2008
Mill Creek	Lake	LCSMC	2008
Bull Creek	Lake	USACE	2005
Indian Creek	Lake	USACE	2007
Buffalo Creek	Lake/Cook	IDNR	2006
McDonald Creek	Cook	USACE	2008
Weller Creek	Cook	USACE	2004
Farmer-Prairie Creek	Cook	IDNR	2005
Willow-Higgins Creek	Cook	CCHD	2005
Silver Creek	Cook	USACE	2007
Des Plaines River Mainstem	Lake/Cook	USACE	1999

3.1.1.6 Fluvial Geomorphology & Topography

Landforms and topography were created by the erosional and depositional processes of glacial activity and flowing rivers. Plate 8 shows how the streams and rivers of the upper Des Plaines River system have influenced topography after the glaciers retreated about 10,000 years ago. The isolated depressions are scattered across the area. These depressions, combined with a general lack of an extensive drainage network, strongly influence soil development and drainage. Rivers flowing across the landscape generally increase in size and merge with other rivers. The network of rivers formed is a drainage system, which is dendritic in this watershed due to the regional topography and underlying geology. Rivers and streams are not only conduits of water, but also of sediment that the water entrains from working the land. As the water flows, it is able to mobilize sediment from the channel, banks and floodplain and deposit them at different points downstream. The rate and amount of sediment transport depends on the availability of sediment, particle size and stream discharge. One of the most evident instances of this is where a bank erodes on one side of the stream and a bar forms on the opposite side. This process is called cut and fill alluviation, and without it, the diverse habitat mosaic of the floodplain and river channel would not exist. Therefore, natural erosion and deposition processes are quite important and should not be halted if the goal is to preserve biodiversity. Excessive erosion due to increased discharge from urbanized areas may require engineered solutions.

3.1.1.7 Air Quality

The IEPA and the WDNR list nonattainment area designations for counties in Illinois and Wisconsin, respectively, which do not meet the National Ambient Air Quality Standards (NAAQS). Cook County and Lake County in Illinois and Racine County and Kenosha County in Wisconsin are moderate nonattainment areas for ozone. Cook County and Lake County in Illinois and Racine County in Wisconsin are nonattainment areas for PM2.5 (particulate matter with a diameter equal or less than 2.5 microns). Nonattainment areas are regions within the country where the concentration of one or more criteria pollutants exceeds the level set as the federal air quality standards. Particulate concentration and ozone trends are generally downward, but are still elevated in the study area, and are often above the national standards. The national standard for PM-2.5 is 35 μg/m3 (24 hour average) and 15 μg/m3 as an annual mean, while the national standard for ozone 0.075 ppm (8 hour average) and 0.12 ppm (1 hour average).

3.1.2 Ecological Resources

The ecology of the watershed has been severely impacted since the late 1800s through human modifications to land use, hydrology and stream channels. Typical of highly urbanized and agricultural areas, human modification to the landscape has negatively affected and altered the surface and ground water processes. Accordingly, a large portion of the native floral and associated faunal communities have been lost. Only 9% of the current land use is natural open space; however, most of these areas have become degraded and overrun by non-native and invasive plant species. Riverine communities are valued as "moderately to highly degraded" through fish community assessment. The riverine system is also fragmented by 21 dams and structures, negatively affecting riverine community diversity. In comparison, there is much greater diversity in the unfragmented reaches beyond the most downstream dam. Illinois and Wisconsin have 36 bird, 3 reptile, 1 amphibian, 5 insect, 5 fish, 4 mussel, and 31 plant species listed as threatened or endangered. A detailed description is presented in the following sections.

Before European settlement, the Upper Des Plaines River and associated streams had catchments fully covered with native vegetation. As with most natural processes in the region and elsewhere, human modifications to landscape vegetation negatively affect and alter the natural hydraulics and hydrologic regime of wetland and riverine systems. Accordingly, a large portion of the native vegetation and associated faunal communities have been lost to agricultural, urban or industrial conversion. Most historic records suggest that there were four major types of plant communities present in the study area: prairie, savanna, woodland, and wetland. The communities that were once located within the study area are described in detail below. Table 3.7 provides a summary of all community types present in the Upper Des Plaines watershed.

Table 3.7 – Plant Community/Habitat types of the Upper Des Plaines River Watershed

Community / Habitat Type	General Location	General Hydrology
Prairie	Flat- to mid-slopes, adjacent to wetlands	dry-mesic; mesic; wet-mesic; wet
Savanna	East and north facing slopes	dry-mesic; mesic; wet-mesic; wet
Woodland	Riparian	dry-mesic; mesic; wet-mesic; northern flatwoods
	Floodplain	mesic; wet-mesic; wet
Wetland	Isolated depression / floodplain depression	marsh; shrub swamp; calcareous floating mat
		fen; graminoid fen; sedge meadow; seep
Riverine	Stream	medium gradient; low gradient
	River	medium gradient; low gradient
Other	Lake	glacial; artificial
	Ponds	vernal; artificial
	Ruderal (human induced)	urbanland; cropland; pastureland; successional fields

Four of the above listed communities provide habitat associated with a distinct plant community. The two most dominant types of habitat were oak savanna and prairie, with lesser amounts of woodland and wetland. Wetland communities include restored wetland areas such as mitigation banks. Development has led to significant changes in the plant communities. Table 3.8 describes the degree of changes to the native communities from pre-European settlement to present. By far the most dramatic change has been the loss of prairie and savanna in both Wisconsin and Illinois. As wild fires were suppressed as part of the expansion of human settlement, savanna and prairie were either converted to agricultural uses or were allowed to succeed to woodland. The vast majority of the remaining areas designated as prairie or savanna is of poor habitat quality and requires restorative actions.

Table 3.8 – Plant Community Change From Pre-European Settlement to Present Conditions

Community / Habitat Type	Wisconsin		Illinois	
	1800s	Present	1800s	Present
Prairie	26%	5.3%	34%	9%
Savanna	17%	0.0%	27%	~0%
Woodland	43%	5.6%	13%	18%
Wetland	14%	8.0%	26%	6%

The ecological resources of the Upper Des Plaines River watershed are described below by vegetation cover type. A description of the dominant vegetation and associated animal species that occupy them are presented to paint a picture of the degraded current conditions. Please note that the plant scientific names were used for the first reference of each species, but were not used for each successive reference. Also, scientific names were not listed for non-plant species because there is more consensus among researchers and professionals on the use of common names for these species. The descriptions are focused on remnant high quality areas left in the watershed, since this quality is what should be aimed for in recommending restoration plans. The Upper Des Plaines River watershed is quite degraded, with only 38,500 acres of natural area left, 9% of the total watershed acres. Of these acres, 528 are considered high quality or remnant, and the remaining area is dominated by invasive and non-native plant species. The 528 acres of high quality, remnant parcels are not targeted for restoration, but are used as reference sites to calibrate habitat suitability models.

3.1.2.1 Prairie

Prairie communities are dominated by grass species and are likely the result of frequent fires, which retard the growth of woody species and allow the development of a rich assortment of deep-rooted herbaceous species. Prairie communities were able to establish on a wide variety of soil types. There are 18 acres of high-quality prairie remnants located within the study area. A few degraded prairie remnants exist along railroad right-of-ways. Disturbance to prairie communities includes lack of fire, conversion to agricultural and farm uses, habitat fragmentation, establishment of invasive species and altered hydrology and water quality. Prairie habitats within the study area can be further characterized as *dry-mesic prairie, mesic prairie, wet-mesic prairie* and *wet prairie* based on topographical location, soil type and moisture. In larger intact sections of prairie, community subtypes would seamlessly interweave with one another to form wetland prairie complexes depending on the level of moisture.

Dry-mesic prairie: Dry-mesic prairie communities previously occurred on crests and upper slopes of major moraines with well-drained and somewhat permeable soils of moderate water-holding capacity. No areas of high-quality dry-mesic prairie have been identified from the study area. Listed species are not associated with dry-mesic prairies. Community synonyms of the dry-mesic prairie include dry fine-textured-soil prairie (Chicago Wilderness) and Midwest dry-mesic prairie (The Nature Conservancy). The dry-mesic prairies are experiencing an encroachment of invasive species and opportunistic woody plants which are shading out herbaceous prairie plants. Degraded conditions within the study area due to fire suppression and fragmentation have invited non-native and invasive species such as common teasel (*Dipsacus laciniatus*), Queen Anne's lace (*Daucus carota*), wild parsnip (*Pastinaca sativa*), white and yellow sweet clover (*Melilotos sp.*), Hungarian brome (*Bromus inermis*), and Kentucky blue grass (*Poa pratensis*), which collectively have outcompeted and inhibited the establishment of native species. Dry-mesic prairies used for agricultural purposes in the past suffer from legacy effects of high nutrient levels which enabled the establishment of many non-native and invasive species adapted to such conditions and thus have outcompeted native plants adapted to low nutrient levels.

Mesic prairie: Mesic prairie communities occur on crests of the landscape between dry-mesic prairie and wet-mesic prairie. Soil moisture is intermediate, moderately well drained and often saturated for short durations throughout the growing period. There are 11 acres of high-quality mesic prairie identified within the study area, totaling 4% of the high-quality mesic prairie in the state of Illinois. High quality remnants possess high species richness, from 100 to 130 species found in small parcels. Anthropogenic disturbances and potential restoration activities for the mesic prairie community are consistent with other prairie community types. Animal species associated with mesic prairie include the Franklin's ground squirrel, bobolink and meadowlark. Illinois state listed species associated with mesic prairie include small sundrops (*Oenothera perennis*), mountain blue-eyed grass (*Sisyrinchium montanum*) and possibly ear-leaved fox glove (*Tomanthera auriculata*). The Wisconsin state endangered loggerhead shrike is associated with the prairie community type. Community synonyms of the mesic prairie include mesic fine-textured-soil prairie (Chicago Wilderness) and Central mesic tallgrass prairie (The Nature Conservancy). Most mesic prairie areas within the watershed have succeeded into degraded woodlands comprised of invasive and opportunistic woody and herbaceous vegetation including common buckthorn (*Rhamnus cathartica*), white mulberry (*Morus alba*), box elder (*Acer negundo*), multiflora rose (*Rosa multiflora*), European highbush cranberry (*Viburnum opulus*), Japanese honeysuckle (*Lonicera japonica*), garlic mustard (*Alliaria petiolata*), and Japanese knotweed (*Polygonum cuspidatum*). Other areas have experienced an invasion of non-native leguminous species such as crown vetch (*Securigera varia*), bird's foot trefoil (*Lotus corniculatus*), and black locust (*Robinia pseudoacacia*), which have carpeted large acreages of prairie habitat and enriched the soil with excess nitrogen that favor the establishment of other non-native and invasive species adapted to high-nutrient conditions.

Wet-mesic prairie: Wet-mesic prairie communities occur between mesic prairie and wet prairie. Soil moisture is intermediate, poorly drained, with shorter inundation periods than wet prairie communities. There are 2.6 acres of high-quality wet-mesic prairie identified within the study area, totaling 2% of the high-quality wet-mesic prairie in the state of Illinois. Wet-mesic prairie and wet prairie would typically be found adjacent to or intermingled with sedge meadows, marshes and fens forming a mosaic of communities across the landscape. Anthropogenic disturbances and potential restoration activities for the wet-mesic prairie community are consistent with other prairie community types, although altered hydrology does pose a larger threat to this system then dry prairie community types. The federally-endangered prairie-fringed orchid (*Platanthera leucophaea*) is associated with wet-mesic prairie. Illinois state listed species include white lady's slipper (*Cypripedium canadidum*) and queen of the prairie (*Filipendula rubra*). Community synonyms of the wet-mesic prairie are Central wet-mesic tallgrass prairie (The Nature Conservancy). Most of the wet-mesic prairies within the study area have been heavily impacted by stormwater runoff from urban and agricultural lands allowing sedimentation, altered hydrologic conditions, and high nutrient and sodium inputs to significantly alter soil structure and chemistry. Most of these areas are now occupied by monospecific stands of the invasive species reed canary grass (*Phalaris arundinacea*), common reed (*Phragmites australis*), and purple loosestrife (*Lythrum salicaria*), which have eliminated or significantly reduced native species richness. Encroachment of opportunistic and invasive woody species are also creating stands within the prairie including sandbar willow (*Salix interior*), gray dogwood (*Cornus racemosa*), quaking aspen (*Populus tremuloides*), smooth arrow-wood (*Viburnum recognitum*), and glossy buckthorn (*Frangula lanceolata*).

Wet prairie: Wet prairie communities occur on poorly drained and slowly permeable soils. There are 4.3 acres of high-quality wet prairie identified within the study area, totaling 2.4% of the high-quality wet prairie in the state of Illinois. Wet prairie would typically be found adjacent to or intermingled with wet-mesic prairie, sedge meadows, marshes and fens forming a mosaic of communities across the landscape. Anthropogenic disturbances and potential restoration activities for the wet prairie community are consistent with other prairie community types, although altered hydrology does pose a larger threat to this system then dry prairie communities. The federally-endangered prairie-fringed orchid is associated with wet prairie. Within 1 mile of the study area boundary, a population of the Illinois state endangered American slough grass (*Beckmannia syzigachne*) occurs in a wet prairie community. Community synonyms of the wet-mesic prairie include wet fine-textured-soil prairie (Chicago Wilderness) and Central wet-mesic prairie / cordgrass wet prairie (The Nature Conservancy). Areas within the study area have become invaded with monospecific stands of common reed, reed canary grass and cattail (*Typha* sp.) with encroaching stands of opportunistic and invasive woody species including sandbar willow, quaking aspen, and glossy buckthorn. Agricultural drain tiles are known to exist in wet prairie and other communities and have disrupted the natural hydrologic regimes that wet prairie species depend on, creating drier conditions where the drain tiles exist and unnaturally flooding areas where drain tile water is directed.

3.1.2.2 Savanna

Savanna communities are typically a mix of forest and grassland species, described as an intermediate community type between closed canopy forests and open prairie. Features that are characteristic of savannas include open-canopied structures, canopy dominance by a few species of oak, ground cover usually rich in species associated with tall grass prairie and fire dependence. Impacts to savanna communities include habitat fragmentation and fire suppression, which have caused a shift in species composition within this community type. The absence of a natural fire regime has allowed woody growth to crowd out the herbaceous cover and to change the structure and composition of savanna communities to more of a typical forest community. Very little savanna occurs in the study area and high-quality areas do not remain. Savanna restoration efforts should focus on removal of subcanopy/shrub growth and non-native species and establishment of a managed fire regime. Although state listed species are not associated with the savanna community, species richness has a tendency to be higher in transitional habitats. Subclasses of savanna communities within the region of assessment can be characterized as *dry-mesic savanna, mesic savanna, wet-mesic savanna* and *wet savanna* based on soil type and moisture.

Dry-mesic savanna: Dry-mesic savanna communities would have been located on well-drained sites exposed to periodic fire. High quality dry-mesic savanna areas do not remain in the study area. The lack of regular or periodic fire allows woody undergrowth to crowd out herbaceous vegetation and convert the community to forested or woodland. Other possible disturbances to the dry-mesic savanna community include grazing pressure and invasive species establishment. Animal species associated with dry-mesic savanna include eastern bluebird, redheaded woodpecker, field sparrow, fox squirrel and prairie deer mouse. Illinois state listed species associated with the dry-mesic savanna community include veery, Swainson's hawk, hoary elfin and the federally endangered Karner blue butterfly. Community synonyms of the dry-mesic savanna include dry-mesic fine-textured-soil savanna (Chicago Wilderness) and North-central bur oak openings (The Nature Conservancy). Nearly all dry-mesic savanna communities within the study area are now degraded successional woodlands with very low native species richness. Fire intolerant woody species such as green ash, sugar maple, common buckthorn and non-native honeysuckle species (*Lonicera* sp.) have shaded the once open canopy that herbaceous savanna flora depend on.

Mesic savanna: Mesic savanna communities were located adjacent to prairie groves on level to slightly rolling terrain and along riparian segments. Mesic savanna communities are one of the rarest presettlement floral communities in the Midwest and high quality areas are currently absent from the study area. Mesic savannas are highly dependent on fire and easily affected by human activities. Two degraded areas remain in the study area and appear to have strong potential for restoration. Animal species associated with mesic savanna include silvery blue butterfly, redheaded woodpecker, eastern bluebird, northern flicker, eastern kingbird, black-billed cuckoo, and blue-winged warbler. The Illinois state threatened pale vetchling (*Lathyrus ochroleucus)* occurs in the mesic savanna remnant areas. Community synonyms of the mesic savanna include mesic fine-textured-soil savanna (Chicago Wilderness) and North-central bur oak openings (The Nature Conservancy). Most mesic savannas within the study area have impenetrable thickets of the invasive common buckthorn, do not support new generations of oak (*Quercus sp.*) and hickory (*Carya sp.*) species, and lack or contain only small patches of remnant herbaceous savanna flora.

Wet-mesic and wet savanna: Wet-mesic and wet savanna communities were located adjacent to streams and according to historical records along the mainstem Des Plaines River. Wet-mesic/wet savanna communities are very similar to mesic savannas in terms of rarity and fire dependence. Wet-mesic/wet savanna remnants are currently absent from the study area. Subsequent to fire suppression, wet-mesic/wet savanna communities would have rapidly converted to floodplain forests. Animal species associated with wet-mesic and wet savanna include hobomok skipper and silvery checker spot. Illinois state listed species associated with wet-mesic/wet savannas include Kirtland's water snake, sharp-shined hawk and, also the newly federally-listed candidate species, eastern massasauga. Community synonyms of the wet-mesic/wet savanna include wet-mesic fine-textured-soil savanna (Chicago Wilderness) and Bur oak terrace woodland (The Nature Conservancy).

3.1.2.3 Woodland

Plant communities dominated by woody vegetation resulted from a certain level of protection from the intensity and frequency of pre-European settlement fires, which allowed the development of structural and compositional features characteristic of forests. Forests primarily exist along slopes, ravines and floodplains and other protected areas. Disturbance to forest communities includes habitat fragmentation, establishment of invasive species, altered hydrology and water quality, and fire absence. Direct habitat degradation is typically associated with overgrazing by not only domesticated livestock but also native deer.

Common insect species associated with forest habitat are the giant swallowtail, northern pearly eye, Appalachian eyed brown, and Juvenal's dusky wing. Common amphibian and reptile species associated with forest habitat include the blue-spotted salamander, Cope's grey treefrog, eastern gray treefrog and the brown snake. Common mammal species associated with forest habitat include hoary bat, silver-haired bat, eastern chipmunk, gray and fox squirrels, southern flying squirrel, woodland vole, and gray fox. Common bird species associated with forest habitat include Cooper's hawk, wild turkey, great horned owl, redheaded woodpecker, northern flicker, bluejay, black-capped chickadee, least flycatcher. Tree dominated habitats within the region of assessment can be further characterized as *dry-mesic forest, mesic forest, wet-mesic forest, mesic floodplain forest, wet-mesic floodplain forest, wet floodplain forest*, and *northern flatwoods* based on topographical location, soil type and moisture.

Dry-mesic forest: Dry-mesic forest communities are located on the Upper slopes and ridges of dissected terrain bordering the Des Plaines River and its major tributaries. Since oak species can tolerate a higher level of fire disturbance than other canopy species, this community is primarily oak dominated. In Illinois, there are 111 acres of high quality dry-mesic forest located in the study area, which is approximately 8% of the total undegraded dry-mesic forest remaining in the state. Fire absence and over grazing are the leading causes of degradation in this forest community, and as a result, cover is shifting from oak to other substratum species such as sugar maple. Illinois state listed endangered species associated with the dry-mesic forest community are the northern cranesbill (*Geranium bicknellii*), the sharp-shinned hawk, veery and brown creeper. Two Wisconsin state listed threatened species associated with the dry-mesic forest are the Acadian flycatcher and cerulean warbler. Community synonyms of the dry-mesic forest include dry-mesic woodland (Chicago Wilderness) and white oak-red oak dry-mesic forest (The Nature Conservancy). Fire intolerant woody species such as green ash, sugar maple, common buckthorn, and non-native honeysuckle species (*Lonicera* sp.) have established within this community and are preventing favorable oaks and other fire tolerant trees from establishing along with their associative conservative flora.

Mesic forest: Mesic forest communities are located along lower slopes, in ravines, on higher terraces of the major streams and tributaries, and occasionally as isolated remnants of former larger blocks of forest. The mesic forest community is relatively rich, at times with no true dominance displayed by one species. The wood thrush and ovenbird are characteristic bird species of the mesic forest. Sources of ecological disturbance arise from grazing pressure, habitat fragmentation from urban development and invasive species. In addition, the effect of fire absence is similar to the dry-mesic forest in the reduction of oak and the increase in the frequency of sugar maple. An overabundance of deer, as in most other communities, has also significantly decreased the number of conservative and rare flora that occur within this habitat such as large-flowered trillium (*Trillium grandiflorum*), white baneberry (*Actaea pachypoda*), and dwarf raspberry (*Rubus pubescens*). In Illinois there are 115 acres of high quality dry-mesic forest located in the study area, approximately 4.5% of the total undegraded dry-mesic forest remaining. Species listed as threatened or endangered by the state of Illinois associated with the mesic forest community within the study area are the northern grape fern (*Botrychium multifidum*), pretty sedge (*Carex woodii*), pale vetchling, millet grass (*Milium effusum*), black-seeded rice grass (*Oryopsis racemosa*), downy Solomon's seal (*Polygonatum pubescens*), dwarf raspberry (*Rubus pubescens*), American dog violet (*Viola conspera*), hairy white violet (*Viola incognia*), the sharp-shinned hawk, veery and brown Creeper. Community synonyms of the mesic forest include North-central maple-basswood forest (The Nature Conservancy).

Wet-mesic forest: Wet-mesic forest communities are not identified in the study area, nor does the community appear to be mentioned as a separate continuous community in this region. However, some small, degraded, localized examples are present in forested areas where drainage is particularly poor. Poor drainage in these areas is probably a result of a slowly permeable subsoil horizon and seepage that may contribute to locally saturated soils. Chicago Wilderness recognizes this community as very different in structure, function and composition as compared to floodplain forests. Common species associated with wet-mesic forests include swamp white oak, shagbark hickory, white ash and wetland adapted sedges and ferns. State listed species are not associated with the wet-mesic forest community within the study area.

Mesic floodplain forest: Mesic floodplain forest communities are located on high terraces adjacent to rivers and streams. Flood frequency and duration are shorter than wet-mesic or wet floodplain forests. The less intensive flood regime allows a more diverse species component for mesic floodplain forest communities. Changes in the hydrologic regime of the watershed have increased the frequency and depth of floodwater, which has resulted in a less diverse plant community for impacted mesic floodplain forests. Two sites, totaling 63 acres, have been located as high quality mesic floodplain forests within the study area. Swollen sedge (*Carex intumescens*) is an Illinois state listed species associated with the mesic floodplain forest community within the study area.

Wet-mesic floodplain forest: Wet-mesic floodplain forest communities are located along terraces adjacent to rivers and streams. Relative to flood frequency and duration, wet-mesic floodplain forest communities are intermediate of mesic and wet floodplain forests. Although the wet-mesic floodplain forest community has fewer drier species than a mesic floodplain forest, the understory is more species rich and structurally well developed. Changes in the hydrologic regime of the watershed have increased the frequency and depth of floodwater, which has resulted in a less diverse plant community for floodplain forests. Other impacts to this community include high intensity grazing and invasive species colonization. High quality remnants of this community have not been discovered in the study area. Animal species associated with wet-mesic floodplain forests include the Federally-listed candidate massasauga rattlesnake, also the barred owl, red-shouldered hawk, Acadian flycatcher, yellow-throated vireo and prothonotary warbler. Illinois and Wisconsin state listed snake species within the study area is the Kirtland's water snake. Community synonyms of the wet-mesic floodplain forest include Central green ash-elm-hackberry forest (The Nature Conservancy). The invasive garlic mustard (*Alliaria petiolata*) has almost entirely colonized the understory of this community; some areas to the exclusion of native flora.

Wet floodplain forest: Wet floodplain forest communities are located within floodplains adjacent to the river and associated streams. Wet floodplain forests are flooded for portions of the year, typically in the spring and late winter. Generally, species richness is less in areas of intense flooding and as a result, wet floodplain forests have fewer tree species then the other subtypes of floodplain forest communities. Changes in the hydrologic regime of the watershed have increased the frequency and depth of floodwater. Other impacts to this community include high intensity grazing and invasive species colonization. Exotic species found in this community are similar to wet-mesic floodplain forest. High quality remnants of this community have not been discovered in the study area. Animal species associated with wet floodplain forests include the Federally-listed candidate massasauga rattlesnake, also the barred owl, red-shouldered hawk, Acadian flycatcher, yellow-throated vireo and prothonotary warbler. State listed species associated with this community are not found within the study area. Community synonyms of the wet floodplain forest include Central green ash-elm-hackberry forest (The Nature Conservancy). Wet floodplain forest communities within the study are either void of herbaceous vegetation or only allow for the establishment of non-native and invasive species as more frequent and intense floods from urban development inhibit establishment of native flora and significantly decrease the function of floodplain forests.

Northern flatwoods: Northern flatwood communities are located in level and terraces that occur on impervious subsoil horizons (claypans) and have seasonally wet and dry soils. Small depressions on relatively flat landscapes will hold standing water for portions of the year forming a mosaic of wet and dry areas within the flatwoods community. The herbaceous diversity associated with flatwoods is dependent on periodic fires. There are 54 acres of high quality northern flatwoods identified from a single site located within the study area. This site represents 64% of the known high quality northern flatwoods throughout the state of Illinois. Disturbance to northern flatwoods communities include absence of fire, grazing pressure, invasive species establishment and altered hydrologic regime. Altered hydrology has changed the duration and frequency of flooding within these communities. Animal species associated with northern flatwoods include Appalachian eyed-brown butterfly, blue-spotted salamander, tiger salamander, wood frog, tree frog, spring peeper, chorus frog, wood duck, solitary sandpiper, and redheaded woodpecker. Plant species associated with the northern flatwoods community within the study area and designated as Illinois state listed species are the Tuckerman's Sedge (*Carex tuckermanii*), downy willow herb (*Epilobium strictum*) purple fringed orchid (*Platanthera psycodes*), dwarf raspberry (*Rubus pubescens*), American dog violet (*Viola conspera*) and hairy white violet (*Viola incognia*). Community synonyms of the northern flatwoods include northern flatwood forest (Chicago Wilderness) and northern flatwood (The Nature Conservancy).

3.1.2.4 Wetland

The low-lying areas where water either inundates or saturates the soil for portions of the year and the vegetation is dominated by hydrophytic species are considered wetland communities. Wetlands can be found along side streams and rivers and situated in isolated depressions. There are 149 acres of high-quality wetland areas located within the study area, mostly mesic floodplain forest, sedge meadow, calcareous floating mat and marsh. Overall, the study area within Illinois contains 12,140 acres of wetland, mostly consisting of marsh habitat. Disturbances to wetland communities are mainly linked to altered hydrology by anthropogenic development, which results in increased sedimentation, erratic hydrology, agricultural practices and invasive species infestation. Wetland habitats within the region of assessment can be further characterized as *mesic prairie, wet prairie, floodplain forests, marsh, shrub swamp, bog, calcareous floating mat, gramminoid, sedge meadow, calcareous seep* and *seep* based on topographical location, soil type and moisture. In larger intact sections of prairie, community subtypes would seamlessly interweave with one another depending on moisture level to form wetland prairie complexes. Great egret are Illinois and Wisconsin state listed as threatened in the study area and are associated with wetland communities.

Marsh: Marsh communities are characterized as having water at or near the surface during most of the growing season and being dominated by herbaceous vegetation. There are 13 acres of high-quality marsh identified within the study area, totaling 0.6% of the high-quality marsh in the state of Illinois. Marsh would typically be found adjacent to or intermingled with wet prairie and sedge meadows. Disturbance to marsh communities is mainly linked to increased sedimentation, erratic hydrology, agricultural pollution input and establishment of invasive species. Most species currently within the study area are invasive and form monocultures within the marsh; these species include common reed, cattail, purple loosestrife, and reed canary grass. Lack of fire has also allowed woody species such as green ash (*Fraxinus lanceolata*) and sandbar willow (*Salix interior*) to inhabit this community and decrease native species richness. Marsh restoration efforts should include maintaining and improving natural hydrologic cycles and removal of invasive species. Animal species associated with marsh communities include broad-winged skipper; purplish copper; Illinois state listed Blanding's turtle; muskrat; Illinois state listed yellow-headed blackbird; least bittern; sora; Virginia rail; map turtle; green heron and central mudminnow. Illinois state listed plant species associated with marsh communities listed include beaked sedge (*Carex rostrata*); marsh speedwell (*Veronica scutellata*) and *Scirpus hattorianus*. Within 1 mile of the study area boundary, a population of the Illinois state endangered Crawford's sedge (*Carex crawfordii*) was recently discovered in two disjunct marsh communities. Community synonyms of marsh include basin marsh and streamside marsh (Chicago Wilderness) and Bulrush-cattail-burreed shallow marsh, Midwest mixed emergent deep marsh, River bulrush marsh (The Nature Conservancy).

Shrub swamp: Shrub swamp communities are characterized as having at least 50% cover of shrub species. High quality shrub swamp areas are not identified in the study area; however, shrub swamp communities intermingle with marsh, sedge meadow and seep communities forming diverse complexes. Many species associated with shrub swamps also occur in other wetland communities. Activities which degrade shrub swamp communities are shared by other wetland communities. Animal species associated with shrub swamp include Acadian hairstreak, silvery checkerspot, common yellowthroat, willow flycatcher, woodcock and yellow warbler. State listed species are not specifically associated with the shrub swamp, although the swollen sedge (*Carex intumescens*) is found in a mixed shrub swamp/marsh habitat within 1 mile of the study area boundary. Community synonyms of shrub swamp communities include wet-mesic fine-textured-soil shrubland (Chicago Wilderness) and Dogwood-mixed willow shrub meadow (The Nature Conservancy).

Bog: Bog communities are characterized as acid peatlands, mostly oligotrophic (poorly nutrient fed) in Illinois. Bogs are located within the Morainal Section of the Northeast Moraine, are hydrologically isolated and fed by precipitation. Bog communities do not exist in the study area, although high-quality bogs occur to the west within the adjacent Fox River drainage system. Animal species associated with bog communities include willow flycatcher and yellow warbler. Although no bog communities occur in the study area, two bogs in Lake County, Illinois occur within 1 mile of the study area boundaries. Numerous Illinois state listed species are associated with bog habitat. These include larch (*Larix laricina*); high-bush blueberry (*Vaccinium corymbosum*); dwarf birch (*Betula pumila*); three-seeded bog sedge (*Carex trisperma*); rusty cotton grass (*Eriophorum virginicum*); alder buckthorn (*Rhamnus alnifolia*); inland shadbush (*Amelanchier interior*); red-berried elder (*Sambucus pubens*); white beak rush (*Rhynchospora alba*); large cranberry (*Vaccinium macrocarpon*); round-leaved sundew (*Drosera rotundifolia*); and cord root sedge (*Carex chordorrhiza*).

Fen: Fen communities are characterized as calcareous peatlands. Fens are fed by mineral rich groundwater discharge. Fens can form when groundwater emerges from the edges of moraines usually in a basin, but some form on the sloping edges of the moraines. Species that occur in fens are typically specialized to live in the alkaline conditions created by the amount of groundwater discharge. Fens are most common within the adjacent Fox River drainage system. Two subtypes of fens occur or previously occurred in the study area, *calcareous floating mat* and *gramminoid fen.*

Calcareous floating mat: Calcareous floating mat communities are located as a buoyant mat of sedge accumulated peat usually over a pond or lake. Fire helps maintain the herbaceous (sedges and grasses) structure of the community. There are 16 acres of high-quality calcareous floating mat identified in the Illinois portion of the study area, totaling 10% of high-quality calcareous floating mat in the state. Disturbance of these communities include polluted runoff from roads and developed areas and altered hydrology through artificial drainage systems. Altered nutrient dynamics from increased urban and agricultural development has introduced increased amounts of nitrogen and phosphorus, allowing for higher productivity in invasive species and their establishment within the study area. One animal species associated with calcareous floating mat is the swamp sparrow. Plant species associated with the calcareous floating mat community listed as threatened or endangered in the State of Illinois include downy willow herb (*Epilobium strictum*), bog bedstraw (*Galium labradoricum*), common bog arrow grass (*Triglochin maritimum*), and little green sedge (*Carex viridula*). Community synonyms of calcareous floating mat include Midwest calcareous floating mat (The Nature Conservancy).

Graminoid fen: Graminoid fen communities are located along a slope or as an elevated island in the middle of either marsh or sedge meadow. Fire helps maintain the herbaceous (sedges and grasses) structure of the community. There is 0.1 acre of high-quality graminoid fens identified in the Illinois portion of the study area, totaling 0.08% of high-quality calcareous floating mat in the state. Graminoid fens are composed of a mix of prairie, sedge meadow, and seep species. Disturbance to this community include fire deprivation, grazing pressure and altered hydrology through artificial drainage systems. Eutrophication within the study area allowed for the dominance of a fewer number of taller herbaceous and woody vegetation where the fens would otherwise have been dominated by a diverse assemblage of native short vegetation with low nutrient levels. Animal species associated with the graminoid fen include Baltimore checkerspot, mulberrywing skipper, swamp metalmark, elfin skimmer and *Nanothemis bella*. A plant species associated with the graminoid fen community listed as threatened in the state of Illinois is the slender bog arrow grass (*Triglochin palustris*). Graminoid fens host a variety of rare and unique species. Efforts should focus on preserving the last remnants of this community and identifying areas where these formerly existed for restoration purposes. Community synonyms of graminoid fen communities include Cinquefoil-sedge prairie fen (The Nature Conservancy).

Sedge meadow: Sedge meadow communities are characterized as sedge dominated grasslands, typically located adjacent to wet prairie and marsh communities. Soils are saturated throughout most of the year and shallowly inundated for short periods. Fire helps maintain the herbaceous structure of the community, allowing the sedges to build hummocks (mounds), dominated by *Carex stricta*. There are 50 acres of high-quality sedge meadow identified in the Illinois portion of the study area, totaling 7.3% of high-quality sedge meadow in the state of Illinois. Disturbances to this community include fire depravation, grazing pressure, altered hydrology, excessive siltation from agricultural practices, and invasive species infestation. Most sedge meadows within the study area are currently occupied by reed canary grass and purple loosestrife. Animal species associated with sedge meadow habitats include Baltimore checkerspot, eyed brown, black dash skipper, dion skipper, American bittern, sandhill crane, sedge wren, swamp sparrow and pygmy shrew. Plant species associated with the sedge meadow community listed as threatened or endangered in the state of Illinois include the beaked sedge. The federally-endangered prairie white-fringed orchid and federally-listed candidate eastern massasauga is also associated with sedge meadow. Community synonyms of the sedge meadow community include lake sedge meadow and tussock sedge wet meadow (The Nature Conservancy).

Seep: Seep communities are located along lower slopes of moraines, ravines and terraces. Seeps are characterized as small areas where ground water slowly discharges to the surface. The boundary of the seep is delineated by the area of saturation of the soil. There are different types of seeps depending on the type of material the ground water flows through. Possibly two subtypes of seep occurs in the study area, seep (neutral) and calcareous seep. Because of the small areas designated as seep communities, seeps are generally seen as inclusions contained in other larger habitats such as sedge meadows, marshes, forests, fens and wet to wet-mesic prairie. High quality seep communities are not identified in the study area. Disturbance to this community include altered hydrology, excessive siltation from agricultural practices, grazing pressure and invasive species infestation. Animal species associated with the seep habitat include brook stickleback (*Culaea inconstans*) and mottled sculpin (*Cottus bairdii*) (when seeps collect into runs flowing into headwater streams). State listed species are not specifically associated with the seep community. Community synonyms of the seep community include neutral seep (Chicago Wilderness) and Skunk cabbage seepage meadow (The Nature Conservancy).

Calcareous seep: Calcareous seep communities are located at the base of river valley walls and moraines and sometimes occur within fen communities. Many species associated with fens are found within the calcareous seep community. High quality calcareous seep communities are not identified in the study area. . Animal species associated with the calcareous seep include the federally-endangered Hine's emerald dragonfly, also the pickerel frog and blacknose dace. State listed species are not specifically associated with the seep community. A community synonym of the seep community is Cinquefoil-sedge prairie fen (The Nature Conservancy).

3.1.2.5 Riverine

The riverine community consists of small to medium sized streams that flow into the mainstem Des Plaines River. Most of the stream miles are fairly flat. These segments are sluggish flowing, have substrates primarily of sand and silt, and have aquatic macrophytes as the main structure of habitat. Other stream miles have some slope and do exhibit some riffles of small cobble and gravel. These segments have more hydraulic diversity, have substrates primarily of sand and gravels, and have woody debris, undercut banks, small riffles and shallow pools as the main structure of habitat.

Riverine structure and function of the Upper Des Plaines River watershed are severely impacted based on observations and data from surveys performed for this study and past surveys. Most of the river and stream miles have been modified. Low gradient streams are easily degraded through anthropogenically sourced sediment deposition and decreased water quality. Human activities in the watershed (e.g. agriculture, residential, and industrial development), have caused changes in riverine structure and function and decreased overall riverine species richness. To further compound the effects of land use change, direct impacts to channel morphology, instream habitat complexity, side stream vegetation, and hydraulic regimes have completely compromised the pre-European riverine ecology of the Upper Des Plaines River system. The construction of dams has prevented the recolonization of fishes and has disallowed genetic flow between fish populations.

In 2002, 43 native species of fishes were found, 23 less than the reconstructed pre-settlement fish assemblage. One species not native to the Upper Des Plaines River system, redear sunfish (*Lepomis microlophus*), and four species not native to the North American continent, common carp (*Cyprinus carpio*) goldfish (*Carassius auratus)*, tinfoil barb (*Barbonymus schwanenfeldii*) and sailfin catfish (*Pterogloplichthys disjunctivis*), were also collected. The Index of Biotic Integrity (IBI) developed by the IEPA was utilized to assess biological integrity. IBI scores ranged from 0 to 44, with most in the range classified as "limited aquatic resource". Although some of the stations in the Upper watershed received higher IBI scores, overall scores were similar in the agricultural areas of Wisconsin and the urbanized areas in Illinois. The Qualitative Habitat Evaluation Procedure (QHEI) developed by the Ohio Environmental Protection Agency was utilized to assess riverine habitat quality. The average QHEI score of 44 classifies the Upper Des Plaines River system as a "moderate aquatic resource" in terms of riverine habitat. Fish and habitat survey results suggest Newport Ditch, Kilbourn Road Ditch, Brighton Creek, Bull Creek, Center Creek and the Upper reaches of the Des Plaines River subwatersheds as high restoration priorities. See Appendix C for a more detailed discussion of riverine quality and a list of fish species.

3.1.2.6 Other

Lake: Lake communities are characterized by open water and are located in pothole depressions left by the last retreating glacier. Lakes are typically deeper and larger (>20 acres) than ponds. Thermal stratification may occur depending on lake depth. The depth of the water prohibits colonization of most rooted plant species. High quality lake communities do not occur in the study area, although, there are 502 acres of degraded lake habitat in the study area. Disturbances to lakes are caused by artificial drainage, anthropogenic recreational use, septic and sewer contamination, siltation from agricultural practices and vegetation removal. The Illinois state listed endangered grass-leaved pondweed (*Potamogeton gramineus*) is associated with lake communities. Two other plant species that are Illinois state listed as endangered and found within 1 mile of the study boundary are the fern pondweed (*Potamogeton robbinsii*) and white-stemmed pondweed (*Potamogeton praelongus*). Illinois state listed endangered fish species include pugnose shiner (*Notropis anogenus*), blackchin shiner (*Notropis heterodon*), blacknose shiner (*Notropis heterolepis*), banded killifish (*Fundulus diaphanus)*, and the Iowa darter (*Etheostoma exile*). A community synonym of the lake community is glacial (kettle) lake.

Pond: Pond communities are characterized by shallow water and are less than 20 acres in size. There are no high-quality pond communities, although, there are 468 acres of degraded pond habitat in the study area, mostly located in the northern half of the study area. Disturbances to pond communities are caused by artificial drainage, grazing pressures, siltation from agricultural practices in surrounding landscape and establishment of invasive species. There are around 1,412 acres of artificial ponds in the study area such as sewage lagoons, excavated and impounded ponds. In general, artificial ponds have little value as habitat and are not considered in this study.

Cultural: Cultural communities are directly influenced and controlled by human activities. Examples are cropland, pasture, artificial lakes and ponds, tree plantations, urban parks and recreational areas. Around 57% of the land located within the study boundary can be classified as cultural habitat.

3.1.2.7 Threatened & Endangered Species

Threatened and endangered species are discussed in this section by habitats. A complete list of threatened and endangered species is found in Appendix C. Preliminary coordination with the USFWS and plan formulation methodologies have recognized and considered threatened and endangered species from the study's onset. USFWS participated early in the planning process as a cooperating agency and has therefore provided significant input on the plan formulation. Formulation was formally reviewed and critiqued by the agency through a Fish & Wildlife Coordination Act Report.

The following Federally-listed species and their critical habitats are identified by the USFWS as occurring within Cook and Lake Counties, Illinois and Kenosha County, Wisconsin:

Kenosha County

The County Distribution of Federally-listed Threatened, Endangered, Proposed and Candidate Species was reviewed for Kenosha County by the Chicago District. The following Federally listed species and their critical habitats are identified by the USFWS as occurring within Kenosha County:

- Northern long-eared bat (*Myotis septentrionalis*) – Proposed as Endangered – Hibernates in caves and mines - swarming in surrounding wooded areas in autumn. Roosts and forages in upland forests and woods
- Whooping crane (*Grus americanus*) – Non-essential experimental population – Open wetlands and lakeshores
- Eastern prairie fringed orchid (*Platanthera leucophaea*) – Threatened – Wet grasslands

Lake County

The County Distribution of Federally-listed Threatened, Endangered, Proposed and Candidate Species was reviewed for Lake County by the Chicago District. The following Federally listed species and their critical habitats are identified by the USFWS as occurring within Lake County:

- Piping plover (*Charadrius melodus*) – Endangered – Wide, open, sandy beaches with very little grass or other vegetation
- Eastern massasauga (*Sistrurus catenatus*) – Candidate – Graminoid dominated plant communities (fens, sedge meadows, peat lands, wet prairies, open woodlands, and shrublands)
- Karner blue butterfly (*Lycaeides melissa samuelis*) – Endangered – Pine barrens and oak savannas on sandy soils and containing wild lupines (*Lupinus perennis*), the only known food plant of the larvae
- Eastern prairie fringed orchid (*Platanthaera leucophaea*) – Threatened – Moderate to high quality wetlands, sedge meadow, marsh, and mesic to wet prairie.
- Pitcher's thistle (*Cirsium pitcheri*) – Threatened – Lakeshore dunes

Cook County

The County Distribution of Federally-listed Threatened, Endangered, and Candidate Species was reviewed for Cook County by the Chicago District. The following federally listed species, their status, and critical habitat are identified by the USFWS as occurring with Cook County:

- Piping plover (*Charadrius melodus*) – Endangered – Wide, open, sandy beaches with very little grass or other vegetation
- Eastern massasauga (*Sistrurus catenatus*) – Candidate – Graminoid dominated plant communities (fens, sedge meadows, peatlands, wet prairies, and shrublands)
- Hine's emerald dragonfly (*Somatochlora hineana*) – Endangered – Spring fed wetlands, wet meadows, and marshes
- Eastern prairie fringed orchid (*Platanthera leucophaea*) – Threatened – Moderate to high quality wetlands, sedge meadow, marsh, and mesic to wet prairie
- Leafy-prairie clover (*Dalea foliosa*) – Endangered – Prairie remnants on thin soil over limestone
- Mead's milkweed (*Asclepias meadii*) – Threatened – Late successional tallgrass prairie, tallgrass prairie converted to hay meadow, and glades or barrens with thin soil

3.1.3 Cultural & Archeological Resources

3.1.3.1 Prehistoric Archeological Sites

Most prehistoric sites in the Upper Des Plaines River watershed, with the exception of megafauna and paleo-indian sites, occupy high or well-drained ground, in areas unlikely to be affected by flood control or ecosystem restoration measures. Areas recommended for prairie restoration were selected to avoid known prehistoric archeological sites. A number of burial mounds and hilltop cemeteries were reported during the last half of the 19th century, and were subsequently destroyed by urban development and gravel mining; these included occupation sites at the Robinson Reserve Forest Preserve (11-Ck-2, 3, 4), Late Archaic burials at Half Day (11-L-64), Russell/Rosecrans (11-L-65, 11-L-85), and the Kennicott Mounds (11-Ck-671) at Elmwood Park. Conventional archaeological survey in wetlands is difficult or impossible, but construction monitoring in wetlands will be undertaken, in view of the number of mammoth and mastodon finds from Kenosha County wetlands.

The two miles of floodplain immediately south of Wadsworth Road in Lake County contain 23 known sites. Surveys of this area were done by McGimsey/King/Wiant in 1986 and Lurie/MARS Inc. in 1989 for a wetland demonstration project developed by The Wetlands Initiative.

Cook County Forest Preserve land at Big Bend Lake in Des Plaines was once part of the De Mayorga farm; in the 1890s Joseph De Mayorga had a large collection of prehistoric tools from a multi-component prehistoric site (11-Ck-93) on his property. The Mayorga farm parcel is of particular interest because of the large number of stone tools found there. This site was probably part of a cluster of sites; its exact location is uncertain, and it appears to have been destroyed by Illinois Tollway construction.

3.1.3.2 Historic Archeological Sites

There are a number of historic sites in the Upper Des Plaines River watershed. In Illinois on the Des Plaines River just southeast of downtown Libertyville prior to 1906 was the White Sulphur Springs; this may have been a medicinal spa in the late nineteenth century, and has probably been obliterated by modern construction. At Forest Park, the Forest Home cemetery was the site of a Potawatomi town and cemetery in the 1830s; a collection of Native American artifacts from this site is on display at the Forest Park Public Library. In close proximity to Mill Creek near Millburn are two pre-Civil War mill sites and the Millburn Cemetery. Millburn Cemetery was moved to its present location in the mid-1860s, and is of local and state-wide significance

In Wisconsin, an 1878 atlas shows the Bristol Mineral Springs now known as the Bristol Soda Springs, which is currently a spa and tourist attraction on the south bank of the Des Plaines River about 1 mile southwest of the Woodford railroad station. Bain Station was a railroad depot in the late 19th and early 20th centuries; this site was just north of present Pleasant Prairie Power Station and just south of the power station's landfill, about 1½ miles east of Pleasant Prairie; named for Bain Wagon Works of Kenosha. The Hercules Powder Company operated a powder mill at Pleasant Prairie during 1899-1930. The plant closed in April-May 1930; structures and rail spur were removed sometime before 1958. The powder mill is said to have occupied a square-mile complex southwest of town; however, the 1905 USGS topographic map shows a large building at the end of a railroad spur about ¾ mile west-northwest of Pleasant Prairie, on a site now occupied by a post-1960 residential subdivision.

3.1.3.3 Megafauna and Paleo-Indian Sites

Wetlands in northeastern Illinois have potential to contain mammoth or mastodon bones associated with Paleo-Indian tools. At least nine mastodon finds are known from Cook, McHenry, Lake, Kane, and DuPage counties in northeastern Illinois. There have been numerous finds of mammoth or mastodon in southeastern Wisconsin (all associated with marshes); portions of the Des Plaines River watershed were topographically similar to extreme southeastern Wisconsin 12,000 years ago. Paleo-Indian campsites are known from moraine crests in the Des Plaines valley, and more are probably buried under later alluvium in floodplains.

Wetlands in southeastern Wisconsin are likely to contain megafauna remains, including mammoth bones associated with Paleo-Indian tools. There have been over 30 accidental finds of mammoth or mastodon in Kenosha County, all associated with marshes. Kenosha County was about 30% marsh 12,000 years ago, and has yielded more mammoth/mastodon finds than any other county in the United States. Paleo-Indian people lived near the moving glacier and were butchering mammoth, musk ox and caribou (at the Schaefer, Mud Lake, Fenske, and Hebior sites) in Kenosha County 12,500 years ago. Paleo-Indian campsites are known from moraine crests; the Lucas site (47-Kn-226) lies near Pleasant Prairie, the multi-component Chesrow site (47-Kn-40) lies south of Kenosha, and more are probably buried under later alluvium in floodplains.

3.1.3.4 Historic Structures

There are numerous historic structures within the Des Plaines watershed. In Illinois, properties listed on the National Register of Historic Places occur at Millburn (Millburn Historic District); at Deerfield (Ryerson Conservation Area Historic District); at Mettawa (Adlai Stevenson Farm); at Des Plaines (Des Plaines Methodist Campground); at Maywood (Masonic Temple, Maywood Fire Department, and 13 historic houses); at River Forest (River Forest Historic District); at Riverside (Riverside Landscape Architecture District); and at Lyons (the Hofmann Tower, on the river at Barry Point Road). At Forest Park and River Forest the Des Plaines River runs through the historic Forest Home and Waldheim cemeteries. There is potential for additional historic structures at Aptakisic, Druce Lake, Half Day, Des Plaines, Franklin Park, Gurnee, Wheeling, Russell, and Wadsworth.

In Wisconsin, properties listed on the National Register of Historic Places occur at Kenosha (Civic Center, Library Park, and Third Avenue historic districts); and at Racine (Sixth Street, Northside, Old Main Street, and Southside historic districts); and at Union Grove (Southern Wisconsin Center for the Developmentally Disabled). There is potential for additional historic structures at Brighton, Bristol, Paddock Lake, Paris, Pleasant Prairie, Salem, Salem Oaks, and Woodworth.

3.1.3.5 Social and Economic Setting

The major portion of the project study area lies within the Chicago metropolitan area and has moderate to high housing values and income levels, a diverse ethnic demographic composition that is predominately Caucasian, and good recreational facilities. The most densely populated areas are located in Cook County. Municipalities that lie in or intersect the watershed have a total estimated 2010 population of approximately 500,000. Municipalities in Lake County that lie in or intersect the watershed have an estimated 2010 population of approximately 350,000. Municipalities in Kenosha and Racine Counties that lie in or intersect the watershed have an estimated 2010 population of over 100,000. Recent population growth has been greatest in Kenosha and Racine Counties (11.4%) as compared to Lake County (3.2%) and Cook County (-1.3%) from 2000 to 2010. These trends are projected to continue to at least 2020 (Table 3.9).

Table 3.9 – Population Trends in Primary Upper Des Plaines River Basin Communities

State	County	Municipality	2000[1]	2010[2]	% Change 2000-2010	2020[3]	% Change 2010-2020
WI	Racine	Union Grove Village	4,322	4,915	13.72%	5,410	25.17%
	Kenosha	Kenosha City	90,352	99,218	9.81%	106,837	18.25%
		Paddock Lake Village	3,012	2,992	-0.66%	3,708	23.11%
		Pleasant Prairie Village	16,136	19,719	22.21%	20,215	25.28%
IL	Lake	Gurnee Village	28,834	31,295	8.54%	33,472	16.09%
		Hawthorn Woods Village	6,002	7,663	27.67%	12,635	110.51%
		Libertyville Village	20,742	20,315	-2.06%	21,293	2.66%
		Lincolnshire Village	6,108	7,275	19.11%	9,004	47.41%
		Long Grove Village	6,735	8,043	19.42%	9,476	40.70%
		Mettawa Village	367	547	49.05%	1,073	192.37%
		Mundelein Village	30,935	31,064	0.42%	33,062	6.88%
		Old Mill Creek Village	251	178	-29.08%	3,575	1324.30%
		Riverwoods Village	3,843	3,660	-4.76%	3,935	2.39%
		Vernon Hills Village	20,120	25,113	24.82%	23,312	15.86%
		Wadsworth Village	3,083	3,815	23.74%	5,730	85.86%
		Waukegan City	87,901	89,078	1.34%	91,110	3.65%
	Cook/ Lake	Arlington Heights Village	76,031	75,101	-1.22%	80,304	5.62%
		Barrington Village	10,168	10,327	1.56%	10,342	1.71%
		Buffalo Grove Village	42,909	41,496	-3.29%	44,475	3.65%
		Deer Park Village	3,102	3,200	3.16%	3,598	15.99%
		Deerfield Village	18,420	18,225	-1.06%	19,734	7.13%
		Wheeling Village	34,496	37,648	9.14%	39,376	14.15%

1 - U.S. Census Bureau 2000

2 - https://www.census.gov/popest/data/cities/totals/2011/index.html

3 - (NIPC, now CMAP endorsed 2030 forecasts interpolated down to 2020 and SWRPC endorsed 2020 forecasts

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Table 3.9 – Population Trends in Primary Upper Des Plaines River Basin Communities

State	County	Municipality	2000[1]	2010[2]	% Change 2000-2010	2020[3]	% Change 2010-2020
IL	Cook	Bellwood Village	20,535	19,071	-7.13%	21,064	2.58%
		Des Plaines City	58,720	58,364	-0.61%	59,802	1.84%
		Elmwood Park Village	25,405	24,883	-2.05%	25,854	1.77%
		Forest Park Village	15,688	14,167	-9.70%	15,720	0.20%
		Franklin Park Village	19,434	18,333	-5.67%	19,860	2.19%
		Lyons Village	10,255	10,729	4.62%	10,777	5.09%
		Maywood Village	26,987	24,090	-10.73%	26,122	-3.21%
		Melrose Park Village	23,171	25,411	9.67%	22,486	-2.96%
		Mount Prospect Village	56,265	54,167	-3.73%	57,454	2.11%
		Niles Village	30,068	29,803	-0.88%	31,943	6.24%
		Norridge Village	14,582	14,572	-0.07%	14,450	-0.91%
		North Riverside Village	6,688	6,672	-0.24%	7,014	4.87%
		Northlake City	11,878	12,323	3.75%	11,260	-5.20%
		Park Ridge City	37,775	37,480	-0.78%	37,005	-2.04%
		Prospect Heights City	17,081	16,256	-4.83%	16,426	-3.83%
		River Forest Village	11,635	11,172	-3.98%	11,632	-0.03%
		River Grove Village	10,668	10,227	-4.13%	10,838	1.59%
		Riverside Village	8,895	8,875	-0.22%	9,190	3.32%
		Rosemont Village	4,224	4,202	-0.52%	4,111	-2.68%
		Schiller Park Village	11,850	11,793	-0.48%	11,669	-1.53%
		Stone Park Village	5,127	4,946	-3.53%	4,611	-10.06%
WI	Racine & Kenosha County Totals		113,822	126,844	11.44%	136,170	19.63%
IL	Lake County Totals		344,029	354,970	3.18%	382,798	11.27%
	Cook County Totals		482,949	476,609	-1.31%	491,996	1.87%

1 - U.S. Census Bureau 2000
2 - https://www.census.gov/popest/data/cities/totals/2011/index.html
3 - (NIPC, now CMAP endorsed 2030 forecasts interpolated down to 2020 and SWRPC endorsed 2020 forecasts

In 2005, median housing values and household incomes for the project study area were moderate to high. In Kenosha and Racine Counties, these values ranged from $108,000 (Kenosha) to $159,800 (Pleasant Prairie) for housing, and $41,902 (Kenosha) to $62,856 (Pleasant Prairie) for median household income. For Lake County, these values ranged from $118,200 (Waukegan) to $823,300 (Mettawa) for housing and $42,335 (Waukegan) to $158,990 (Riverwoods) for median household income. For Cook County the median housing values ranged from $105,400 (Maywood) to $386,600 (River Forest) and median household income from $40,050 (River Grove) to $89,284 (River Forest).

Much of the land adjacent to the Des Plaines River in Illinois is owned by the Lake and Cook County Forest Preserve Districts. These lands are maintained principally as plant and wildlife preserves. As such, they provide major aesthetic, picnicking, hiking, and recreational opportunities to the communities within the project study area.

Current and projected population data for 43 primary Des Plaines River communities is shown in Table 3.9. The five communities affected by Des Plaines River overbank flooding having the greatest populations as of 2010 are Arlington Heights (74,620), Des Plaines (56,551), Mount Prospect (54,482), Park Ridge (36,983), and Gurnee (30,772).

3.1.4 Hazardous, Toxic, and Radioactive Wastes (HTRW)

The preliminary hazardous, toxic, and radioactive waste (HTRW) investigations included a preliminary screening followed by full Phase I investigations. The HTRW site screening is included in Appendix H. The preliminary site screening, completed in March 2010, assessed whether FRM and ecosystem restoration sites considered for implementation during alternative development were enrolled in any regulatory remedial program. Data obtained from the IEPA, the WDNR, and the USEPA suggested that none of the sites under investigation were currently, or had previously been, enrolled in any regulatory remedial program. Due to the limited scope of the preliminary HTRW screening, Phase I HTRW investigations were recommended for project sites recommended for implementation during the final stages of the feasibility study.

Phase I HTRW investigations for all recommended sites have been completed in accordance with ER 1165-2-132 and are included in Appendix H. A list of unresolved issues, short-term actions, and future project recommendations to resolve potential environmental concerns are provided and included in Section 9. Sites with known HTRW concerns were avoided. Potential risks associated with unknown recognized environmental concerns were considered in the development of project cost contingencies.

3.1.5 Water Quality

The Des Plaines River watershed is generally characterized as impaired in terms of water quality. Section 303(d) of the Clean Water Act requires that all states maintain and publish lists of impaired waterways, waters that do not meet water quality standards set by those states. Water quality standards and characterizations are prepared independently for the Illinois and Wisconsin portions of the watershed by the IEPA and WDNR, respectively.

3.1.5.1 Illinois

In Illinois, the Upper Des Plaines River and tributaries are classified as general use water bodies by the IEPA. The general use water quality standards apply to almost all waters of the state and are intended to protect aquatic life, wildlife, agricultural, primary contact, secondary contact, and most industrial uses. The general use standards are also designed to ensure the aesthetic quality of the aquatic environment and to protect human health from disease or other harmful effects that could occur from ingesting aquatic organisms taken from surface waters.

Aquatic life use assessments in streams are typically based on the interpretation of biological information, physiochemical water data, and physical habitat information. The assessment of primary contact use is based on fecal coliform bacteria data. The assessment of fish consumption use is based on water body-specific fish-tissue data and resulting fish-consumption advisories issued by the Fish Contaminant Monitoring Program. Public and food processing water supply is only assessed in water bodies where the use is currently occurring (as evidenced by the presence of an active intake).

Various portions of the study area in Illinois have been assessed for all or some of their designated uses. Mill Creek, Indian Creek, Buffalo Creek, Willow and Higgins Creeks, and the Des Plaines mainstem are listed as impaired streams in the IEPA 2006 Integrated Water Quality Report and 303(d) list (IEPA 2006) due to an inability to achieve the applicable general use water quality standards. Mill Creek and Bull Creek have been assessed for aquatic life use and fully support this function. Smaller systems, including McDonald, Silver, Crystal, and North Mill Creeks have not been assessed by IEPA.

Some segments of the Des Plaines River do not support the aquatic life, fish consumption, or primary contact designated uses. The potential causes for aquatic life impairment include elevated levels of chloride, nitrogen, phosphorous, total dissolved and suspended solids, zinc, and silver; excessive sedimentation and siltation caused primarily from combined sewer overflows municipal point source discharges, urban runoff, storm sewers, highway/road/bridge runoff, site clearance and land development, hydrostructure flow regulation; and the presence of sediment contaminated with various chemicals. Sediments with elevated concentrations of mercury and PCBs of unknown origin have resulted in fish consumption advisories in several reaches of the study area. Elevated levels of fecal coliform, resulting from combined sewer overflows, urban runoff, and storm sewers have impaired primary contact recreation uses in many areas.

Willow Creek is an aquatic life impaired waterway due to the presence of elevated levels of phosphorous and dissolved solids from municipal point sources, urban runoff, and storm sewers; the same types of sources impact Higgins and Buffalo Creeks. Higgins Creek is an aquatic life and primary contact impaired waterway due to the presence of elevated levels of chloride, fluoride, nickel, nitrogen, phosphorous, silver, total dissolved solids, zinc, and fecal coliform. Buffalo Creek is impaired for aquatic life and primary contact recreation due to the presence of elevated levels of manganese, silver, and fecal coliform. Indian Creek is an aquatic life impaired waterway due the presence of contaminated sediment containing endrin, methoxychlor, and nitrogen at highly elevated levels (Short 1997).

3.1.5.2 Wisconsin

In Wisconsin, the Des Plaines River and its tributaries are not included in the state's 303(d) list of impaired waterways. The WDNR is responsible for protecting, maintaining, improving and managing the state's surface waters, including the Des Plaines River and its tributaries. WDNR establishes water quality standards for individual surface waters based on the potential or attainable uses of the water, divided into four categories: fish and aquatic life, recreational, public health and welfare, and wildlife. Ideally, all surface waters in the state should meet the water quality standards associated with the proposed Diverse Fish and Aquatic Life (DFAL) use sub-category. DFAL surface waters generally support both warm and cool water ecosystems with the potential to contain fish and macroinvertebrate communities that include some species relatively intolerant of low dissolved oxygen levels. This use designation encompasses a large range of aquatic communities, habitats, and ecosystem types (WI 2004).

The Pleasant Prairie tributary and one other unnamed tributary to the Des Plaines River in Wisconsin are proposed for listing as limited aquatic life (LAL) waters. This designation indicates the surface water only supports a small number of forage fish species and other non-fish aquatic like species that are very tolerant to organic pollutants. LAL or very tolerant aquatic life ecosystems (VTAL) do not have the potential to maintain a fish community and have either limited natural capacity or irretrievable water quality conditions that prevent them from fully supporting aquatic life forms. These waters may contain macroinvertebrate communities dominated by species that are very tolerant of low levels of dissolved oxygen. Some VTAL or LAL waters may briefly contain a few stray fish during high-flow periods when water quality and habitat conditions allow for their existence. These waters may have extreme variation in flow, temperature and/or water quantity, yet may contain macroinvertebrate communities dominated by very tolerant species.

The mainstem of the Des Plaines River downstream of State Highway 50 historically did not fully meet water quality standards associated with the recommended water use objectives prior to 1976. Data collected between 1979 and 2001 indicate that the standards associated with the recommended water use objectives were not fully achieved from 1976 to 2001. Violations of dissolved oxygen, total phosphorus, and fecal coliform levels occurred at one station on the mainstem of the Des Plaines River just south of the Wisconsin-Illinois border. However, based upon review of the water quality sampling and water quality simulation data developed under the regional water quality management plan and the state of implementation of that plan, it is likely that violations of the dissolved oxygen, fecal coliform, and phosphorus standards also occurred at upstream stations at that time. This finding is consistent with the presence of pollution-tolerant fish species in the watershed.

3.1.6 Recreation Resources

There are many recreation opportunities available to the public throughout the Upper Des Plaines watershed. Table 3.10 presents a summary of existing recreation and open space lands in the watershed. Plate 9 shows the distribution of the lands within the study area. Properties included in this list are public and privately owned parks and open spaces that are available for a variety of recreation activities.

As shown in the table, the majority of the recreational and open space acreage available in Cook and Lake Counties is owned by those counties. The bulk of this land consists of County Forest Preserve sites. In Cook County, there are extensive Forest Preserves along the Des Plaines River which connect to the lands and trail networks managed by Lake County Forest Preserve District. The Lake County Forest Preserve District lands extend north along the Des Plaines River mainstem and along the tributaries as well. Both Forest Preserve Districts maintain amenities such as hiking, biking, horse riding, and cross-country skiing trails; access to the river for fishing and boating; and golf courses.

In Wisconsin, however, most of the land is owned by private entities or the state. The private lands consist mainly of land owned by sport, recreation, or community clubs. The largest portion of the state lands in Wisconsin, over 1,300 acres, is part of the Bong State Recreation Area. The recreation area differs from other state owned parks and forest in that it provides additional opportunities such as areas for flying a variety of items from model airplanes to hot air balloons, dog and falcon training, hunting, and all-terrain vehicle and horse riding. Other state lands are primarily nature areas and forests.

Table 3.10 – Watershed Recreation Sites

State	County	Ownership	Sites	Acres
WI	Kenosha/Racine	State	9	1,787
		County	5	594
		Local	23	486
		Private	27	2,359
		Total	64	5,226
IL	Lake	State	13	803
		County	185	14,746
		Local	276	5,506
		Private	52	2,503
		Total	526	23,558
	Cook/DuPage	State	0	0
		County	106	9,941
		Local	217	2,186
		Private	22	1,061
		Total	345	13,188
Watershed Total		State	22	2,590
		County	294	23,427
		Local	512	8,033
		Private	103	5,924
		Total	931	39,973

3.2 Expected FWOP Conditions*

The without-project condition of the Upper Des Plaines River watershed is the basis for comparing the outputs of alternative plans and is the "No Action Alternative" as described in the NEPA. In forecasting these conditions, an effort is made to describe foreseeable changes to the most important aspects of the study area over the next several decades. This forecasting is based on an assessment of the existing conditions within the study area. The without-project condition describes the future conditions that will exist if no new Federal action is taken. Expected conditions, previous trends, and predicted trends are considered in describing the without-project condition. Forecasted environmental conditions can be based on a variety of key assumptions and different sources of information available from Federal, State, local agencies and private conservation entities. National and State environmental and health standards and regulations are recognized. Water quality, air quality, public health, wetlands protection, and floodplain management are given specific consideration in forecasting the without-project condition.

3.2.1 Urbanization and Land Use Conditions

Expectations are for the continued development of the upper portions of the watershed encompassing Lake, Kenosha and Racine Counties. Since the lower portion of the watershed is almost fully developed, the Cook County portion of the watershed is not projected to have new development other than renewal, removal, and replacement of existing structures. The watershed is urbanizing from downstream to upstream, and future higher urbanization rates in upstream areas will likely impact the entire watershed.

Future land use conditions in the watershed were computed by using population projections and estimating the increase in footprint area from new development within existing municipalities. These estimates were based on local planning commission population projections; trends in city growth were extrapolated to 2020. The SEWRPC and CMAP compute population projections for each community every five years. Population projection data for municipalities within the watershed as shown in Table 3.9 above was used to compute future land use. Table 3.11 below shows the predicted land use changes due to urbanization for Cook and Du Page Counties, Lake County, and for Kenosha and Racine Counties.

Cook County is almost fully developed; therefore, changes to land use in this area were minimal. Kenosha and Racine Counties show the greatest percentage change to urban land uses because most of the area in those counties is currently agricultural and development stemming from Chicago and Milwaukee is impinging on these counties. As the population in the Upper Des Plaines River watershed grows, the resulting modifications to the landscape will negatively affect the existing ecosystem and hydrology. Although remaining natural areas are unlikely to be converted to other uses, increases in impervious surfaces resulting from increased urbanization will increase run-off impacts to the ecosystem.

Table 3.11 – Predicted 2020 Future Land Use Changes Within Study Area

	Cook/DuPage County			Lake County		
	Baseline 2001	**Future 2020**	**Diff**	**Baseline 2001**	**Future 2020**	**Diff**
Land Use	Area (ac)	Area (ac)	Change (%)	Area (ac)	Area (ac)	Change (%)
Residential	41,349	41,579	1%	45,569	50,761	11%
Commercial	7,376	7,422	1%	6,737	7,775	15%
Industrial	11,021	11,036	0%	3,373	3,719	10%
Public	5,360	5,375	0%	2,965	3,311	12%
Infrastructure	9,236	9,236	0%	2,659	2,659	0%
Recreational	12,219	12,070	-1%	18,355	18,351	0%
Agricultural	400	373	-7%	26,353	19,452	-26%
Open	97	97	0%	191	191	0%
Forest/grassland	1,997	1,873	-6%	13,563	13,551	0%
Wetland	115	108	-6%	5,667	5,662	0%
Water	1,021	1,021	0%	4,487	4,487	0%
Total	**90,191**			**129,919**		

	Kenosha/Racine County			Entire Study Area		
	Baseline 1995	**Future 2020**	**Diff**	**Baseline 1995/2001**	**Future 2020**	**Diff**
Land Use	Area (ac)	Area (ac)	Change (%)	Area (ac)	Area (ac)	Change (%)
Residential	9,696	15,192	57%	96,614	107,532	11%
Commercial	258	637	147%	14,371	15,834	10%
Industrial	804	1,130	41%	15,198	15,886	5%
Public	1,189	1,515	27%	9,514	10,202	7%
Infrastructure	4,829	4,829	0%	16,724	16,724	0%
Recreational	38	38	0%	30,612	30,459	0%
Agricultural	51,217	44,696	-13%	77,970	64,521	-17%
Open	0	0	0%	288	288	0%
Forest/grassland	8,998	8,993	0%	24,558	24,416	-1%
Wetland	7,106	7,105	0%	12,888	12,875	0%
Water	1,268	1,268	0%	6,776	6,776	0%
Total	**85,403**			**305,513**		

3.2.2 Hydrologic and Hydraulic Conditions

SEWRPC completed a comprehensive study of the Wisconsin portion of the Des Plaines River watershed in 2003 and provides a guide to the future development of the 133-square-mile watershed in Kenosha and Racine Counties. The plan investigates water resource-related problems and presents recommendations to address those problems. The Lake County Forest Preserve District has and continues to acquire floodplain lands along the Upper Des Plaines River in Lake County. The Forest Preserve District of Cook County has, through land acquisitions, prevented considerable development on the floodplain along the mainstem Des Plaines River, but most of the watershed in Cook County has become highly urbanized as a direct result of outgrowth of the metropolitan area of Chicago.

These actions alone will not prevent future flood conditions from worsening as open space in Lake and Kenosha Counties becomes developed by the continuing outgrowth of the metropolitan area.

Even if future development in the basin is controlled through sound land use planning and storm water runoff ordnances, the experience in the Chicago metropolitan area in this watershed and on adjacent watersheds has shown that increased development causes an increase in peak discharges within receiving rivers and streams through increases in impervious areas. These increases in discharges result in increased flood stages for the given frequency storm event and a proportionate increase in flood damages to existing structures within the floodplain. Increases in flood flows and stages also increase the footprint area of floodplains making more structures susceptible to flood risks.

A detailed assessment of projected FWOP conditions using hydrologic and hydraulic modeling utilized for this study can be found in Section 4.

3.2.3 Habitat Conditions

As discussed above, the Upper Des Plaines watershed is urbanizing and open space is projected to be developed as populations increase. Development of unprotected natural areas will destroy the few remaining ecosystems and habitat structure left in the study area. In addition to habitat destruction from development, adverse impacts to existing hydrology and water quality will cause further decline in habitat quality and ecosystem function. As a result, FWOP habitat quantity and quality are expected to decline without large-scale intervention. State and Local governmental activities are not expected to be able to provide the type of landscape-level changes needed to beneficially affect altered hydrology and restore ecological functions.

The non-Federal sponsors for the feasibility study have strong missions in ecological restoration and do have some limited funding streams to implement small scale projects. The extent and focus of these projects is limited by agency jurisdictions and overall goals. Federal partnership with multiple agencies across the jurisdictional boundaries allows for the development of an ecosystem restoration plan optimized on a watershed scale, leveraging Federal and non-Federal funding and expertise. Without Federal involvement, implemented restoration projects will not be of the scale and focus required to create significant improvements in the watershed habitat.

A detailed assessment of projected FWOP conditions using habitat assessment methodologies utilized for this study can be found in Section 5.

3.2.4 Water Quality

Water quality impairments are related to the watershed hydrology and hydraulics, and human impacts to these processes. The increased water stages and velocities during flood events result in erosion and transport of pollutants within the waterways. During some events, CSOs also introduce untreated sewer and stormwater directly to the waterways. In the FWOP condition for the study area, watershed hydrology and hydraulics would not be significantly changed and, as a result the water quality would remain impaired.

A detailed assessment of projected FWOP water quality conditions in the watershed can be found in Section 7.

3.2.5 Recreation

Open space conservation and improvement of trail networks are priorities for agencies within the watershed. Realizing these goals would increase and improve opportunities for recreation. Federal involvement could aid state and local agencies in providing linkages between recreation sites across agencies.

A detailed assessment of projected FWOP recreational opportunities in the watershed can be found in Section 8.

3.2.6 Climate Change

Although some changes in precipitation patterns in the watershed are possible as a result of climate change, there is insufficient data to support a detailed analysis of the impact of these changes on flooding and aquatic habitats in the watershed. This uncertainty poses the risk that the formulated plans will not achieve the intended effects. To address this risk, the team evaluated the potential impacts of climate change on flooding and habitat and identified mitigation strategies as discussed below.

Illinois State Water Survey (ISWS) Bulletin 70 rainfall is the current state standard for expected extreme rainfall and was used in the hydrologic and hydraulic analysis of this study. The frequency distributions are based on analysis of precipitation data from 1901 to 1983. NOAA Atlas 14 precipitation became available in 2004 and included an additional 20 years of data. A comparison of the 99% through the 1% chance exceedance event with a 10-hour critical duration shows that Bulletin 70 rainfall totals are slightly greater than the Atlas 14 totals for all frequencies. All frequencies, with the exception of the 1% chance total, were within the upper limit of the 90% confidence interval. This comparison of the two precipitation studies does not indicate an increase in total precipitation from more recent data. However, there is other evidence that long term shifts in precipitation frequencies with increased storm intensities are possible in the future. Shifts towards greater intensity storms would likely result in an increase in flood damages within the study area.

Based on these predictions, the proposed FRM projects may provide greater benefits in this future condition than currently estimated. In terms of impacts to life safety, proposed excavated reservoirs are inherently low risk. When their capacity is reached, diversion to the reservoir automatically ceases and they retain flood waters until river stages recede and they can be emptied. As such, these reservoirs will continue to provide flood risk reduction benefits, just at a greater frequency than planned. For levees, shifts in the storm frequency distribution could ultimately change the level of protection afforded by the proposed levees. As increased storm intensities are realized in the future, it will be important for USACE to work with the non-Federal sponsor and local community to help them understand the protection level and risks associated with living behind a levee.

For the proposed ecosystem restoration projects, native plantings have an associated risk of not establishing due to a variety of unforeseen events. Predation from herbivorous animals and insects is a possibility and can be reasonably estimated based on baseline surveys of the existing flora and fauna;

however, weather also plays a large role in the establishment success of new plantings. Periods of drought or early frost may alter the survival percentage of plantings. Although historical records can help to predict the best possible location and timing of new plantings, a single unforeseen event may lead to failure. To mitigate these risks, planting over several years, overplanting and/or adaptive management and monitoring may be incorporated into the overall plan. In addition, climate change in the years to come may play a role in impacting the project outputs. Increased temperatures or rainfall may lead to changes in the ecosystem of the project area; however, in this study area Lake Michigan can drive weather patterns in the Chicagoland area and may partly buffer /mitigate changes to ecosystems as a result of climate change.

4 Flood Risk Management

4.1 USACE Flood Risk Management Program

Every year floods affect communities across the United States taking lives, destroying property, shutting down businesses, impacting the environment, and causing millions of dollars in damages. Nearly 94 million acres of land in the United States are at risk for flooding and the nation averages over $4 billion in flood damages annually. One of the primary missions of the USACE is to support the flood risk management (FRM) activities of communities in both urban and rural areas throughout the United States.

The goal of the USACE FRM mission is to reduce flood risk by saving lives and reducing property damage in the event of floods and coastal storms. By supplying technical and geographical data, the USACE assists communities in developing responses to flood risks and hazards. The USACE also directly enhances public safety with structural and non-structural measures and emergency action. Specific USACE activities geared towards preparing individuals and communities for potential floods include:

Flood Risk Management Structures: The USACE is responsible for the construction and operation of 383 major lake and reservoir projects, construction of over 8,500 miles of levees and dikes, building of hundreds of smaller local flood risk reduction projects that have been turned over to non-Federal authorities for operation and maintenance (O&M), construction of about 90 major shoreline protection projects along 240 miles of the nation's 2,700 miles of shoreline, and implementation of several non-structural projects to reduce susceptibility to flood damages

Advance Measures: When it appears that a flood is imminent in a specific area, the USACE can take a number of immediate steps to protect life and property, such as constructing temporary flow restriction structures and removing log debris blockages.

Floodplain Management Services Program: The USACE provides information, technical assistance and planning guidance (paid for by the Federal Government) to states and local communities to help them address floodplain management issues. Typical focus areas are wetland assessment, dam safety/failure, flood damage reduction, floodplain management and coastal zone management and protection.

Federal Emergency Management Agency (FEMA) Mapping: Over the past 40 years, the USACE has completed 3,000 studies for FEMA, mapping the flood potential of various areas of the country and has been instrumental in training private firms to carry out similar studies.

Flood Hazard Mitigation Measures: The USACE assists in coordinating Federal and state agency efforts to assist local communities with flood hazard mitigation measures. This includes the work of the Silver Jackets Program.

Levee Inspections, Certification and Emergency Rehabilitation: The USACE periodically inspects completed projects and assists local communities with obtaining certification of their projects in the Federal program. USACE assists in both Federal and non-Federal emergency rehabilitation of damaged levees.

Planning and Design of Structural and Nonstructural Flood Risk Reduction Projects: Districts throughout the USACE partner with state and local interests to plan and implement flood risk reduction projects. Through comprehensive planning and strong partnerships the USACE is helping reduce flood risks across the nation.

Since the Flood Control Act of 1936 when the USACE was given authority to address flooding across the nation, numerous FRM projects have been implemented. These projects have prevented an estimated $706 billion in riverine and coastal flood damage, most of that within the last 25 years.

For more information on the national USACE Flood Risk Management Program including ongoing activities, partners and future challenges, visit the USACE "Value to the Nation" website at: http://www.corpsresults.us/flood

For the Upper Des Plaines River and its tributaries, the Chicago District has identified and evaluated structural and non-structural FRM projects. The overall plan developed for this study incorporates the identified FRM projects into a multi-purpose plan with the additional goals of ecosystem restoration, water quality improvement, and recreation enhancement.

4.2 Flood Risk Inventory and Forecasting

Flood risk assessment phases include: a review of study area population growth trends needed to establish current and likely future conditions; historic flooding research to determine the location, scale, and impacts of previous flooding; a review of existing floodplain mapping; and assembly of data needed to develop damage assessment models for use in the evaluation alternative flood risk mitigation plans. This data gathering phase includes the assembly of floodplain structure inventories (residential, commercial, industrial and public structures) as well as data to reflect the road system and traffic patterns subject to flood impacts.

The Upper Des Plaines River and its tributaries have experienced major flooding resulting in hundreds of millions of dollars in damages over the past several decades. Local, state, and Federal agencies have taken steps to reduce flooding, yet many instances of residual flooding and subsequent damages continue throughout the study area.

Following record flooding in 1986 and 1987 on the Upper Des Plaines River, the Chicago District completed a reconnaissance study in 1989 that recommended further evaluation of risk reduction measures to address flooding within the watershed. In partnership with the IDNR, USACE completed the Upper Des Plaines River Flood Damage Reduction Feasibility Study (Phase I Study), which was approved in November 1999. The Phase I Study focused on alleviating flooding along the Upper Des Plaines River from the confluence of Salt Creek upstream to the Illinois/Wisconsin Stateline. The WRDA of 1999 authorized a Locally Preferred Plan consisting of six structural FRM components.

The need for additional FRM in the watershed was highlighted by major flooding during the spring of 2013. On April 18, 2013, the Chicago area received on average 5 inches of rain, with localized precipitation of over 7 inches over an 18 to 24 hour period. The study area received widespread rainfall between 0.25 and 1.5 inches several days before the event, which saturated the ground and increased the potential for overbank flooding when heavier rains fell a few days later. These

antecedent conditions resulted in significant flooding throughout northeast Illinois with the greatest impacts on the Des Plaines, Fox, and East Branch DuPage Rivers.
Major flood stage was reached along the entire Des Plaines study area. New record stages were reached at the Des Plaines (0.02-ft over previous 1986 record) and Riverside (0.67-ft over previous 1987 record). These record stages resulted in widespread overbank flooding along the majority of the study area. Thousands of structures were inundated and many road crossings and parallel roads were closed for several days. FEMA declared this a Major Disaster Declaration (DR-4116) on May 10, 2013 and as of July 2013 approved over 60,000 applications totaling nearly $150M in individual disaster relief.

This study, while building on the work of the Phase I Study, is different in significant ways. The study authorization is different: ecosystem restoration, not considered in the Phase I Study, was added as an additional purpose of the Phase II Study. In addition, the Phase II study area includes tributaries to the mainstem and the Wisconsin headwaters. Also, Federal (Corps) planning guidance and computer analysis tools continue to evolve. Geographic Information Systems (GIS) are heavily used in the economic analysis for managing flood risks for this study: structure inventories located within both mainstem and tributaries floodplains and information from public records concerning the parcel improvements are relied on where actual structure inventories are lacking. Similarly, the analysis of transportation impacts is migrated to a new and technically proven platform. A spreadsheet model was used in the Phase I Study. A dynamic computer simulation model of traffic flows and the flooding impact on those flows has been used for this study.

Due to the emphasis on the use of proven and tested models within the Federal planning community, the two major flood damage assessment models to be used in this Phase II study evaluations are the USACE Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) for structure impacts and the Visual Interactive System for Transportation Algorithms (VISTA) for transportation impacts. VISTA was created by a team of researchers and developers, primarily from Northwestern University, at the forefront of the research in traffic modeling, and has been evolving since 1995. The model has been used by several state and Federal agencies including the U.S. Department of Transportation, Alabama Department of Transportation, the National Science Foundation, and USACE.

VISTA was originally developed by Northwestern University in association with other universities. The model is now maintained by the VISTA Transportation Group, established in 2004. VISTA is a collection of several models and modules which dynamically simulate and route traffic over a network of roads, finding an equilibrium condition in which no vehicle can shorten its travel time or mileage between origins and destinations. The basic procedure is to define a road network and route all traffic over the network to determine the base condition total travel times and mileage for the known average daily traffic on the system for passenger cars and heavy vehicles. For analyzing the effects of flooding on traffic, the network is modified to close certain roads and intersections to simulate flood conditions. The total time and distance is recalculated as the model algorithms search for the "best" routes between origins and destinations given the closures to determine effects on the system due to flooding. The differences between the with-flood condition and the normal condition are the disruption effects due to flooding. VISTA has great flexibility in its reporting, which includes the reporting of time and distance traveled by vehicle type and distributes delays versus vehicle counts. Time effects are monetized by applying the value of time for vehicle occupants to the additional minutes of travel. Detour distances are monetized by applying per-mile vehicle operating costs. This is repeated over the range of flood events selected for analysis.

4.2.1 Inventory of Historic Flooding

Severe floods have occurred in the Upper Des Plaines River basin over the past several decades resulting in millions of dollars in damages. Two major floods that occurred in 1986 and 1987 in and around the Upper Des Plaines River basin (FEMA declarations #776 and #798 respectively) together caused more than $100 million in damages to more than 10,000 residential, commercial and public structures as well as damages attributed to traffic impacts. More than 15,000 residents were evacuated during the 1986 flood alone. Over 40 river crossings and numerous roads running parallel to the Des Plaines River flooded, causing traffic delays, prolonged detouring, and physical damage to the roadways.

There are several ways in which flooding across the study area results in structural and transportation damages, including:

- Mainstem overbank flooding
- Tributary overbank flooding caused by backwater flood stages on mainstem
- Tributary overbank flooding (non-mainstem backwater)
- Storm sewer backup due to downstream stages on mainstem and tributaries
- Combined sewer backup due to downstream stages on mainstem and tributaries
- Groundwater seepage into structure basements

This study will focus on addressing structure and content damages caused by overbank flooding and transportation impacts from detours and delays caused by flooded roadways on both the mainstem Upper Des Plaines River and its tributaries within the study area. Flooding associated with sewer backup and groundwater seepage is outside the scope of this study and is being addressed through construction of the Chicago Underflow Plan and local initiatives in upgrading sewer systems.

Major flood events that have occurred in the Upper Des Plaines River watershed over the past 25 years are listed in Table 4.1, including the two large flood events recorded on the system in 1986 and 1987 as well as a recent large event in 2013. Flood event return periods for gages on the mainstem Des Plaines River are based on frequency curves that were adjusted for urbanization and watershed modifications such as the construction of reservoirs up through water year 2005. Return periods for the gages on the tributaries are based on unadjusted frequency curves. Gages are listed in order of upstream to downstream within the watershed. The location of the gages is shown in Plate 6.

Table 4.1 – Historical floods Within the Upper Des Plaines River Watershed (1986-2013)

Water Year	Gage Station	Peak Stage (ft NGVD29)	Flow (cfs)	Annual Chance of Exceedance
1986	Des Plaines River at Russell, IL	672.80	1,640	12%
	Des Plaines River near Gurnee, IL	662.30	3,530	7%
	Buffalo Creek near Wheeling, IL	665.40	581	20%
	Des Plaines River near Des Plaines, IL	637.20	4,900	6%
	Des Plaines River at Riverside, IL	603.55	7,625	4%
1987	Buffalo Creek near Wheeling, IL	665.94	717	10%
	McDonald Creek near Mt Prospect, IL	646.20	806	2%
	Des Plaines River near Des Plaines, IL	635.08	3,370	29%
	Weller Creek at Des Plaines, IL	648.92	1,490	5%
	Des Plaines River at Riverside, IL	604.58	9,770	0.3%
1990	Weller Creek at Des Plaines, IL	645.06	1,190	10%
	Des Plaines River at Riverside, IL	602.69	5,950	20%
1993	Des Plaines River at Russell, IL	670.89	1,750	10%
	Mill Creek at Old Mill Creek, IL	680.06	1,090	13%
	Des Plaines River near Gurnee, IL	660.19	2,370	22%
1996	Des Plaines River at Russell, IL	670.31	1,200	22%
	Mill Creek at Old Mill Creek, IL	679.94	1,020	14%
	Buffalo Creek near Wheeling, IL	665.76	670	13%
	Des Plaines River near Des Plaines, IL	634.98	3,850	21%
1997	Mill Creek at Old Mill Creek, IL	679.9	1,000	17%
	Des Plaines River near Des Plaines, IL	634.36	3,540	26%
	Weller Creek at Des Plaines, IL	644.47	1,040	20%
	Des Plaines River at Riverside, IL	603.13	6,990	8%
1999	Des Plaines River at Russell, IL	670.38	1,250	21%
	Mill Creek at Old Mill Creek, IL	680.21	1,160	11%
	Buffalo Creek near Wheeling, IL	665.59	621	14%
	Des Plaines River near Des Plaines, IL	634.11	3,420	28%
	Des Plaines River at Riverside, IL	602.34	5,680	23%
2000	Des Plaines River at Russell, IL	671.95	2,130	6%
	Mill Creek at Old Mill Creek, IL	680.01	1,060	13%
	Des Plaines River near Gurnee, IL	660.6	2,690	20%
2001	Buffalo Creek near Wheeling, IL	665.85	680	13%
2002	Weller Creek at Des Plaines, IL	643.86	1,070	20%
	Des Plaines River at Riverside, IL	602.57	6,050	18%
2004	Des Plaines River at Russell, IL	673.09	3,500	1.4%
	Des Plaines River near Gurnee, IL	662.06	3,890	5%
	Des Plaines River near Des Plaines, IL	634.82	3,760	22%
2007	Des Plaines River at Russell, IL	672.57	1,610	12%
	Des Plaines River at Gurnee, IL	660.15	2,390	21%
	Des Plaines River at Des Plaines, IL	634.91	3,780	22%
	Des Plaines River at Riverside, IL	602.41	5,790	22%
2008	Des Plaines River at Russell, IL	671.47	1,910	8%
	Des Plaines River at Gurnee, IL	659.29	1,900	31%
	Des Plaines River at Des Plaines, IL	636.31	3,010	42%
	Des Plaines River at Riverside, IL	604.55	9,560	0.4%
2010	Des Plaines River at Riverside, IL	602.96	6,720	11%
2013	Des Plaines River at Russell, IL	671.96	2,240	5%
	Des Plaines River at Gurnee, IL	661.73	3,460	8%
	Des Plaines River at Des Plaines, IL	637.24	4,970	6%
	Des Plaines River at Riverside, IL	605.25	12,200	0.2[1]%

[1]Flows were more than 1,800 cfs greater than the 0.2% annual chance of exceedance.

4.2.2 Summary of Previously Reported Flood Damages

4.2.2.1 Phase I Study

The six authorized projects recommended by the Phase I Study, if fully implemented, would reduce flooding and flood damages along the Upper Des Plaines River mainstem. According to a Limited Reevaluation Report (LRR) approved in 2007, the authorized project has an estimated initial cost of $54.7 million, average annual reduction in damages of $9.2 million and a benefit to cost ratio (BCR) of 2.6.

The authorized Phase I project includes the expansion of two existing reservoirs, the construction of one lateral storage area, two levee units and the modification of an existing earthen dam to provide additional flood storage. Table 4.2 lists the names, locations, and flood storage volume, where appropriate, of each of the project elements. Plate 10 shows the location of each project within the watershed. The total additional floodwater storage volume provided is 1,975 acre-feet. A flood warning preparedness plan and a remapping of the mainstem Upper Des Plaines River floodplain were also included in the authorized project.

Table 4.2 – Authorized Projects Included in Baseline and Future Conditions

Authorized Project	Location (City, State)	Additional Storage (acre-ft)	Current Status
Van Patton Woods Lateral Storage	Wadsworth/Russell, IL	412	In Design
North Fork Mill Ck. Dam Modification	Old Mill Creek, IL	500	On hold[1]
Buffalo Creek Reservoir Expansion	Buffalo Grove, IL	476	On hold[2]
Big Bend Lake Reservoir Expansion	Des Plaines, IL	587	In Design
Levee 37	Prospect Heights/ Mount Prospect, IL	N/A	Complete
Levee 50	Des Plaines, IL	N/A	Complete
	Total Storage Volume:	**1,975**	

[1]Implementation of the North Fork Mill Creek Dam Modification is being reevaluated.
[2]Expansion of Buffalo Creek Reservoir is on hold pending resolution of landowner considerations with the site owner, Lake County Forest Preserve District.

The Van Patton Woods Lateral Storage Area is located south of Russell Road and east of the Milwaukee Road Railroad in the Wadsworth area. This site is on property owned by Lake County Forest Preserve District. The Van Patton Woods design includes two bermed storage areas, one to the east and the other to the west of the river. This site covers approximately 66 acres and provides approximately 412 acre-feet of flood storage.

The North Fork Mill Creek Dam is located in Lake County on the north fork of Mill Creek, tributary to the Des Plaines River. An existing dam was constructed on private property just north of Kelly Road creating Rasmussen Lake. This dam is approximately 550 feet in length with a 30-foot crest width at an elevation of 743.2 feet NGVD29. The primary spillway is 30 feet in length at an elevation of 738.9 feet NGVD29. The authorized plan is to raise the existing dam by 3 feet to an elevation of 746.2 feet NGVD29, providing an additional 500 acre-feet of storage. To tie into the existing topography a new section approximately 900 feet in length would be added. With this modification the maximum storage volume would increased to 1,040 acre-feet. Implementation of this project is being reevaluated due to changes in land availability as discussed in Section 4.4.1.

The Buffalo Creek Reservoir Expansion involves expanding the existing Buffalo Creek Reservoir to Schaefer Road to obtain 476 acre-feet of floodwater storage. The plan combines revised contouring and lowering of the design water elevation of the two existing permanent pools to create one permanent pool.

The Big Bend Lake Reservoir Expansion expands the existing Big Bend Lake to obtain an additional 587 acre-feet of storage. The lake bottom and side slopes will be expanded and re-contoured. The plan also calls for a lower normal lake level to accommodate additional floodwater storage. Two storm sewer lines which currently empty into the lake will be rerouted to the Des Plaines River as well. This will eliminate the reduction in the lake's available storage caused by the stormwater discharge.

Levee 37 is located in Mount Prospect and Prospect Heights along the east side of River Road and Milwaukee Avenue. The levee was initially proposed by local interests as a project to raise roads to hold back floodwater, effectively operating as a levee. A Value Engineering (VE) study during the design phase led to the revision of the project from a road raise to an equivalent length, 9,600 feet, of earthen levee and concrete floodwall at the authorized crest elevation of 641.0 feet NGVD29. The project also includes interior drainage structures. The revisions to the design reduce costs and do not significantly impact project benefits, as documented in the LRR approved in 2007.

Levee 50 is located in the City of Des Plaines on the east side of the Des Plaines River, between Dempster Road on the west and the Tollway on the east. The length of this levee is about 2,600 feet, with its height varying from 3.8 to 9.0 (average 5.3) feet and crest widths from 8 to 10 (mostly 8) feet. Levee 50 also includes interior drainage features.

The Phase I projects, when constructed, will reduce the flood risk along the main stem and provide valuable benefits to local communities. However, a significant amount of flood risk remains on the Des Plaines River mainstem. Table 4.3 shows remaining damages by category with Phase I authorized projects implemented for the baseline year, 1995, and future, 2010, conditions, as documented in the Economics Appendix of the 1999 Feasibility Report. Tributary damages are not included in this summary, as these subwatersheds were not part of the authorized Phase I study area.

As can be seen in the table, significant flood damages remain on the mainstem of the Upper Des Plaines River even after the implementation of the authorized projects from the Phase I study. In addition to the residual damages in the study's baseline conditions, increased urbanization in the watershed, as illustrated by the future 2010 condition shown in Table 4.3, causes an increase in flood damages by 25%.

The Phase I Study calculated damages using six major categories; three structural (residential, apartments, and commercial) and three road and traffic related (detours due to flooding, detours due to road repairs, and road repair expense). Flood fighting and relief costs as well as FEMA policy administration costs were also evaluated.

Table 4.3 – Phase I Mainstem Des Plaines River With-Project Damages

	Expected Annual Damages ($1,000)		
Damage Category	**Phase I Baseline (1995)**	**Phase I Future (2010)**	**Damage Increase (1995-2010)**
Apartments	$1,468	$1,925	31%
Commercial/Industrial/Public	$1,404	$1,918	37%
Residential	$2,151	$2,714	26%
Road Closures Due to Flooding	$4,143	$5,736	38%
Road Closures Due to Repairs	$8,226	$9,577	16%
Roadway Repair Costs	$1,257	$1,571	25%
TOTAL	**$18,648**	**$23,441**	**26%**

The Phase I Study formulated and evaluated several potential sites for implementing structural flood risk reduction measures by either capturing floodwater (reservoirs and lateral storage areas) or protecting homes and businesses from flood stages (levees and floodwalls). Most of the measures that were evaluated would have reduced flood risk but were either not implementable due to land availability issues or did not have positive net benefits.

This Phase II study builds upon the results of the Phase I Study and considers sites located both within tributary watersheds and along the mainstem to address flood damages across the watershed. Phase I authorized projects are included as part of the without project conditions of this study, with modifications as discussed in Section 4.4.1.

4.2.2.2 Other Reported Flood Damages

Many damage areas reported in the Phase I Study are located at the mouth of tributaries (e.g., Farmer-Prairie Creek at mile 63.7, Aptakisic Creek at mile 75.5). However, these damages are calculated solely based on the flood stages on the mainstem Des Plaines River. In addition to damages from stages on the mainstem Des Plaines River, this Phase II Study includes estimated damages caused by flood stages along the entire length of major tributaries. See Table 4.7 for a listing of Average Annual Damages (AADs), including tributaries.

In addition to results from the Phase I Study, previous estimates of AADs on several tributaries over the past 40 years were compiled. Average Annual Damage estimates were escalated using the Bureau of Labor Statistics historical Universal Consumer Price Indices (CPI-U). Sources of flood damages in these estimates include residential and non-residential structures, their contents, and traffic impacts. A summary list of previous average annual flood damage estimates by tributary is shown in Table 4.4.

Table 4.4 – Previous Estimated Average Annual Flood Damages; Various Studies

Tributary	County	AAD	Price Level Year (CPI-U)	Escalation Factor[1]	AAD 2012 Prices
Gurnee Tributary[2]	Lake	$198,542	1989 (126.8)	1.76	$349,526
Buffalo-Wheeling Creek[3]	Cook/Lake	$351,000	1984 (105.1)	2.12	$745,506
McDonald Creek[3]	Cook	$136,300	1984 (105.1)	2.12	$289,494
Farmers-Prairie Creek[4]	Cook	$666,364	2005 (197.9)	1.13	$751,644
Willow-Higgins Creek[3]	Cook/DuPage	$47,700	1984 (105.1)	2.12	$101,312
Crystal Creek[5]	Cook	$711,968	2003 (185.8)	1.20	$855,385
Silver Creek[3]	Cook/DuPage	$1,090,600	1984 (105.1)	2.12	$2,316,378

[1] Bureau of Labor Statistics CPI-U for 2012 is 223.23
[2] IDOT Div of Water Resources; Strategic Planning Study for Flood Control, Des Plaines River, Gurnee, IL; 1989
[3] USDA SCS; Lower Des Plaines Tributaries Final Watershed Plan and Environmental Impact Statement; June 1985.
[4] IDNR, OWR; Strategic Planning Study for Farmers/Prairie Creek, Cook County, Illinois; 2007. (unpublished)
[5] IDOT, Div of Water Resources, Strategic Planning Study for Flood Control, Crystal Creek, Mar 1991 as amended.

4.3 Flood Risk Analysis

A comprehensive flood risk analysis was performed for the watershed. The analysis accounted for the following categories: structural and content damages to buildings, damages to vehicles that are parked or abandoned during flooding, and damages caused by flood-induced transportation detours and delays. Damages to buildings and parked vehicles together are presented as structural damages and damages attributed to vehicles detoured and delayed on the impacted transportation network are presented as transportation damages.

Although location and intensification benefits may be considered as NED benefits, these categories were not included in benefit calculations for this study. Location benefits, benefits accrued by making development possible on land that had been previously subject to frequent flooding, would be minimal in this study area. Most available land in the floodplain has already been developed and additional development is not likely to occur. Intensification benefits, benefits resulting from increased income due to a reduction in flood risk, have similarly limited application for urban, developed lands. Any increases in net income over the cost of intensification reduction would be small and difficult to verify.

4.3.1 Structure Damage Assessment

Structural Damages were estimated using the Hydrologic Engineering Center Flood Damage Assessment (HEC-FDA) model. Structures within the 1% and 0.2% annual chance of exceedance (100-year and 500-year) floodplain of the Upper Des Plaines River and the modeled tributaries were included in the analysis. A preliminary assessment of potential structural flood damages was completed for the entire watershed using GIS. Plate 11 shows the existing 1% chance (100-year) floodplain in the study area. In Illinois, existing floodplains were extracted from FEMA digital flood insurance rate maps across the watershed. In Wisconsin, a detailed mapping of the floodplain was performed by SEWRPC.

A structure inventory was compiled consisting of specific information for individual structures within the floodplain including location, use, elevation, and value. Table 4.5 presents the number of structures inventoried in each watershed by category. The 1% chance floodplain, FEMA hazard data (HAZUS), and block information from the 2000 Census were used to determine the number of structures located within the 1% chance floodplain by structure category. A buffer of 250 feet was added to capture any additional structures that may be impacted. As shown in the table, over 10,000 structures and vehicles are included in the inventory.

Structures are grouped in six categories: apartment (multi-unit residential), commercial, industrial, public (tax-exempt structures in the public ownership), residential, and automobiles. Building structure types were determined using local tax assessor category information for individual properties. First floor and low entry point elevations for all structures within the 1% chance floodplain were surveyed. Data previously collected for the Phase I Study by the Chicago District and for other local studies by IDNR and others were used where available. Surveys were conducted by MWRDGC in Cook County, IDNR in Lake County, and SEWRPC in Kenosha County for the remaining structures. For structures within the 0.2% chance floodplain but not captured by the survey, an offset was applied to available Light Detection and Ranging (LIDAR) land surface data. Further discussion of this procedure is included in Appendix E (Economic Analysis).

Table 4.5 – Structures in HEC-FDA Inventory

Watershed	APT	COM	IND	PUB	RES	AUTO	TOTAL
Brighton Creek	0	0	0	0	0	0	0
Unnamed Tributaries	0	0	0	0	24	0	24
Kilbourn Road Ditch	0	0	0	0	1	0	1
Jerome Creek	0	0	0	0	10	0	10
Dutch Gap Canal	0	0	0	0	8	0	8
Hooker Lake	0	0	0	0	3	0	3
Des Plaines River Mainstem (WI)	0	0	0	0	5	0	5
Newport Drainage Ditch	0	0	1	0	29	7	37
Mill Creek	8	28	10	5	496	104	651
Bull Creek	0	4	0	2	69	16	91
Indian Creek	1	4	1	0	138	31	175
Buffalo Creek	37	80	31	6	1,089	211	1,454
McDonald Creek	0	1	4	1	179	35	220
Weller Creek	0	1	1	0	413	78	493
Farmer-Prairie Creek	78	68	1	9	864	157	1,177
Willow-Higgins Creek	32	16	3	2	100	18	171
Silver Creek	6	57	19	4	1,004	193	1,283
Des Plaines River Mainstem (IL)	288	220	96	32	3,220	627	4,483
TOTAL	**450**	**479**	**167**	**61**	**7,601**	**1,477**	**10,235**

For residential structures, depreciated replacement values were estimated by correlating the results of a limited survey to structure values listed in tax assessor databases for each county. For residential structures, a random sample of 10% of structures within the 1% chance floodplain was surveyed. Based on this survey, a relationship to tax assessor valuation data by county was determined and the values of the remaining structures were estimated by applying this relationship. For non-residential structures, depreciated replacement values developed for the Phase I Study were verified and updated and a survey was conducted to incorporate new structures.

For residential and non-residential structures generic depth damage relationships developed for use nationally by the USACE were used where applicable and direct depth-damage relationships were developed for high-valued and non-typical non-residential structures. Direct depth-damage relationships were developed through use of a survey and, for selected structures, an interview.

In estimating damages to parked or abandoned vehicles, procedures outlined in EGM 09-04: Generic Depth-Damage Relationships for Vehicles (June 2009) were utilized. A distribution of vehicle types obtained from the Illinois Secretary of State was combined with generic depth-damage relationships by vehicle type and applied to the list of residential structures. Depreciated replacement values were assigned by vehicle category and distributed among the vehicles assigned to residential structures. The number of vehicles per residence was assigned according to 2000 Census block data. Based on analysis previously conducted by SEWRPC and the small number of residential structures in the inventory with which to associate vehicles, automobiles were not included for the portion of the watershed in Wisconsin.

Structure inventory data and associated uncertainties were input to HEC-FDA resulting in calculated depth-damage relationships by reach. The hydrologic and hydraulic modeling results developed for the Des Plaines River and tributaries were also input to HEC-FDA for estimating the depth of flooding at each structure by modeled flood event. This data allows the model to perform simulations of flood damage experienced during various events.

4.3.2 Transportation Damages

Impacts to the road network were estimated based on increases in vehicle delay and distance traveled caused by flood induced detours. Simulations of flood induced detours on vehicles traveling the area transportation network were obtained through Visual Interactive System for Transport Algorithms (VISTA) Transportation modeling.

Flood hydrographs, showing modeled flood stages and durations, were created for each major roadway section susceptible to overbank flooding. Low-point elevations on the roadways, reviewed and confirmed by local transportation agencies, were used to determine the timing, duration, and depth of flooding. Roads crossing the mainstem and tributaries along with parallel roads were included in the inventory. Table 4.6 presents the number of crossings included in the analysis for each watershed.

The modeled damages include only those attributable to overbank flooding. Records of pavement flooding maintained by the of IDOT indicate that the modeled results showing inundation during storm events as frequent as the 50% annual chance of exceedance reflect actual conditions.

USACE provided these flood schedules for use in the VISTA model. The model was used to calculate the impact of flood events on travel time and distance traveled. Damages associated with flooded crossings are based on delays and detours and assess impacts to passenger and commercial vehicles as separate categories. Detour damages are based on vehicle operating costs. Delay damages are based on the value of time associated with trips for vehicles in each category. A direct depth-damage function was assigned to individual road crossings. Additional discussion of the methodology used to determine transportation damages can be found in Appendix E (Economic Analysis). Physical damages to roads and delays associated with those damages are not included in the flood damages calculated for this study.

Table 4.6 – Road Crossings included in HEC-FDA inventory

Watershed	Crossings
Newport Drainage Ditch	4
Mill Creek	13
Bull Creek	4
Indian Creek	6
Buffalo Creek	13
McDonald Creek	2
Weller Creek	2
Farmer-Prairie Creek	6
Willow-Higgins Creek	7
Silver Creek	7
Des Plaines River Mainstem[1]	62
TOTAL	108

[1] Includes all 18 crossings in Wisconsin

4.4 Without Project Condition

The without-project condition of the Upper Des Plaines River watershed is the basis for comparing the outputs of alternative plans. In forecasting these conditions, an effort is made to describe foreseeable changes to the most important aspects of the study area over the next several decades. This forecasting is based on an assessment of existing conditions within the study area. The without-project condition describes the future conditions that will exist if no action is taken. Expected conditions, previous trends, and predicted trends are considered in describing the without-project condition. Projected hydrologic and hydraulic, land use, and population trends are discussed in Section 3. The period of analysis used for the study is 50 years. 2010 conditions represent existing conditions. Projected 2020 conditions represent future conditions, which were then held constant for the remainder of the period of analysis.

The without project conditions incorporate benefits accrued by implementation of various FRM projects throughout the watershed, including projects authorized by the Phase I Study, by including the projects in the hydrologic and hydraulic model development. Although, as shown in Table 4.2, four of the six Phase I projects have not yet been constructed, they are considered in the without project conditions, as discussed in the following section. The Phase I projects have been authorized independently of this study and the benefits associated with their implementation have been accounted for in that authorization. If significant changes in design, cost, or benefits result in the need for changes to the authorized plan, approval for these changes will be sought through the appropriate reporting mechanism as outlined in ER 1105-2-100.

The benefits for various FRM projects in the same study area can overlap; for example, a reservoir may reduce flood stages at a proposed levee site, reducing the benefits associated with the levee. To prevent double-counting of benefits between projects, a "last added analysis" was used in both the Phase I study and this study (see Section 4.6.6). The 1,975 acre-feet of storage authorized by the Phase I project provides benefits throughout the watershed by reducing flood stages. Incorporation of these reduced flood stages in the without project conditions for this study prevents allocation of benefits that have already been used to justify federally-authorized projects to evaluations conducted in this study.

This approach ensures that the Recommended Plan will be justified with or without construction of the Phase I storage; and, until those projects are constructed, the benefits of each FRM project recommended by this study will actually be greater than those presented here.

The hydrologic and hydraulic models developed for the watershed, as discussed in Section 3, were combined with the depth-damage relationships developed using the methodology described above in HEC-FDA. Once the HEC-FDA model was developed, the expected and AADs of the without-project condition were calculated. The without project condition is used as a benchmark to compare the output of all proposed projects and their performance. HEC-FDA accounts for uncertainties in the input data by performing a Monte Carlo simulation incorporating the many uncertainties associated with the input data. Numerous iterations are performed, with inputs randomly varied according to their probability of occurrence. The mean value calculated by this process is reported here as the equivalent annual damages.

Average annual damages are synonymous with Expected Annual Damages (EAD), the terminology used by HEC-FDA. EAD is the sum of the weighted values of estimated damages resulting from modeled flood events. The damages are weighted according to the likelihood of occurrence of the flood. Equivalent annual damages (EqAD) were estimated in HEC-FDA using a 50-year period of analysis (2010–2059) using the Federal discount rate at the time of the analysis. Equivalent annual damage is calculated by first calculating expected annual damage over the analysis period (base and most likely future analysis years), discounting those values to present worth, and then annualizing. Figure 4.1 below illustrates the calculation of Equivalent Annual Damages and Expected Annual Damages (also AADs). Table 4.7 shows without-project equivalent annual damage by reach and damage category.

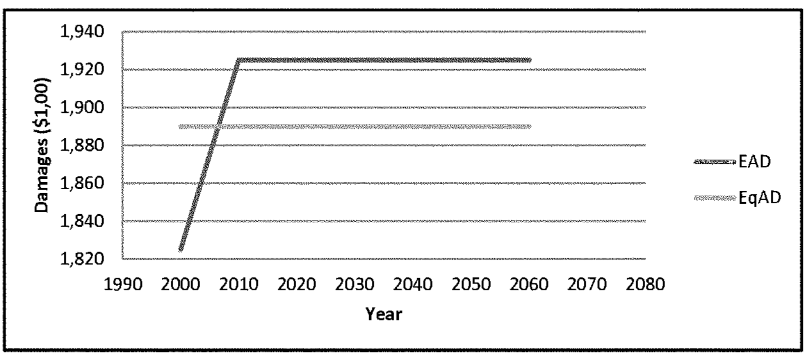

Figure 4.1 – Computation of Average Annual Damages

4.4.1 Updates to Without Project Conditions

During the course of the study, the need for three revisions to the without project condition model inputs were identified. Due to the scale and complexity of the study, both the H&H and economic analyses that had been accomplished at the time these revisions were identified had required a considerable investment of time. Before attempting to repeat the analyses, an evaluation of the effects of each revision was conducted before proceeding.
The first revision came about as a result of a technical review within the USACE. The work produced by the PDT underwent Agency Technical Review (ATR) at key points in the study process. During the review immediately prior to finalization of the FRM plans, a need for revisions to the estimated value of time delays incurred as a result of flooded road crossings that were identified, as discussed in Appendix E (Economics Analysis). The revision resulted in a decrease in calculated damages and a parallel decrease in project benefits.

The need for the second revision was identified as a result of an investigation by IDNR into projects at the downstream end of the watershed near the community of Riverside (see Attachment 1 to Appendix B (FRM Plan Formulation). In developing hydraulic modeling of the flood event in that specific area, IDNR found that the H&H model developed for the study did not accurately reflect hydraulic conditions verified by recent flooding. IDNR adjusted the model as discussed in Appendix A (Hydrology & Hydraulics) for analysis of alternatives in this portion of the watershed. While the revised model was able to more accurately reflect actual hydraulic conditions, the impacts of the changes to the model propagated upstream with increased flood stages. In order to evaluate potential FRM sites as a group, a consistent set of boundary conditions was needed. The increased flood stages, while resulting in increased damages, had the greatest impact on transportation damages. This increase in damages would be mitigated by the implementation of the first revision.

Examination of the model near Riverside also led to discussion of the partial removal of Hofmann Dam at the south end of the watershed as part of a CAP Section 206 Ecosystem Restoration project (as discussed in Section 1.1.6) The project was completed in 2012, prior to the future condition used for this study. Notching the dam was modeled by IDNR as part of their investigation of alternatives at Riverside. As with the adjustments to the model by IDNR for the without project conditions of their study, the notching of Hofmann Dam resulted in lower flood stages and corresponding decreased benefits when applied to projects upstream of Riverside. This project also included removal of two additional dams. One site, Armitage Dam, is upstream of Hofmann Dam but this low head structure did not effect on flows in the river. The other site, Fairbanks Dam, was downstream of the study area are there for did not affect flows. The Hofmann Dam project implementation includes a three year monitoring period to ensure the effectiveness of the restoration measures.

At the site identified by the Phase I Study for the North Fork Mill Creek Dam Modification, Lake County has pursued partial removal of the dam. With the dam notching, this site can no longer be used for the authorized storage expansion. To more accurately reflect existing conditions, the hydrologic model for the mainstem was revised to remove the extra storage and, in the future condition, include the effects of the dam removal. To evaluate options for providing this valuable storage at an alternate location in the watershed, the District and non-Federal sponsor are discussing the initiation of a post-authorization change study.

The without project condition data presented here is the most current and includes all updates and revisions. However, due to the scale and complexity of the study, both the H&H and economic analyses that had been accomplished at the time these revisions were identified had required a considerable investment of time. As each revision was made, the team considered the impacts to the completed analyses. The investigations were repeated only where it was likely that eliminated measures would be retained using the revised models. Therefore, where the PDT determined that the results would not change, the data was not updated.

4.4.2 Without Project Condition Equivalent Annual Damages

The largest portion of damages is on the Des Plaines River mainstem, as shown in Table 4.7. As discussed above, Phase I authorized projects are considered in the without project condition. The reduced flood stages resulting from the storage are incorporated in the hydrologic and hydraulic models and the protection provided by Levee 37 and Levee 50 has been incorporated in the economic model.

Table 4.7 – Equivalent Annual Damages for Without Project Conditions

Watershed		County	State	Equivalent Annual Damages ($1,000)		
				Structural	Transportation	Total
US	Brighton Creek	Kenosha/Racine	WI	$145	$0	$145
	Dutch Gap Canal	Kenosha	WI	$33	$0	$33
	Center Creek	Kenosha	WI	$4	$0	$4
	Kilbourn Road Ditch	Kenosha/Racine	WI	$45	$0	$45
	Jerome Creek	Kenosha	WI	$32	$0	$32
	Des Plaines Mainstem (WI)	Kenosha/Racine	WI	$45	$187	$232
	Newport Ditch	Lake	IL	$0	$0	$0
	Mill Creek	Lake	IL	$179	$82	$261
	Bull Creek	Lake	IL	$117	$17	$135
	Indian Creek	Lake	IL	$36	$51	$87
	Buffalo-Wheeling Creek	Cook/Lake	IL	$344	$8	$351
	McDonald Creek	Cook	IL	$0	$0	$0
	Weller Creek	Cook	IL	$139	$3	$142
	Farmer-Prairie Creek	Cook	IL	$140	$4	$144
	Willow-Higgins Creek	Cook/DuPage	IL	$21	$22	$43
DS	Silver Creek	Cook/DuPage	IL	$881	$229	$1,110
	Des Plaines Mainstem (IL)	Cook/Lake	IL	$7,396	$42,093	$49,489
			TOTALS	**$9,556**	**$42,696**	**$52,253**

[1]Wisconsin Transportation Damages are not attributed to individual tributaries. This amount represents the total average annual transportation damages on the Des Plaines mainstem and tributaries in Wisconsin. (FY2014 Price Level, FDR 3.5%)

4.5 Evaluation of Flood Risk Management Measures

The formulation, evaluation, and comparison of alternative plans comprise the third, fourth, and fifth steps of the Corps' planning process. These steps are often referred to collectively as plan formulation. Plan formulation is an iterative process that involves cycling through these steps to develop a reasonable range of alternatives, and then narrow those plans down to a final plan.

Plan formulation for FRM presents a challenge because the evaluation of alternative plans involves estimating both project costs and FRM benefits through rigorous analyses. To facilitate plan formulation, a series of intermediate steps were developed to successively screen the measures carried forward to more rigorous evaluation. Non-compatible and low performing measures were eliminated through this screening process. A flowchart describing this process is shown in Figure 4.2.

As shown in Figure 4.2, only sites determined to be individually justified are evaluated as part of the multi-site FRM plan. These sites, referred to as "first added," are then combined with other individually justified sites in a "last added" analysis as discussed in Section 4.6.5.

4.5.1 Flood Risk Management Measures

Management measures are the building blocks of alternative plans. Formulation of potential measures to be utilized across the entire Upper Des Plaines River watershed has been completed in collaboration with the all of the study team. Flood risk management measures consist of two basic techniques: structural and non-structural.

Structural measures aim to reduce the risk of flooding by altering the frequency, stage and duration of floodwaters and include measures such as levees, floodwalls, reservoirs, and channel modifications. Structural measures have historically been the technique most utilized throughout the nation to alleviate flooding.

Non-structural measures take the reverse approach by reducing potential damages from the risk of flooding. Non-structural flood risk reduction techniques consist of measures such as relocation, acquisition, flood proofing, flood insurance, flood preparedness/warning/response and public education. Historically non-structural techniques have not been utilized to their fullest potential. They are not generally desired by the public because they involve disruption to existing private properties. A full description of each management measure considered for reducing flood risk is presented in the following sections.

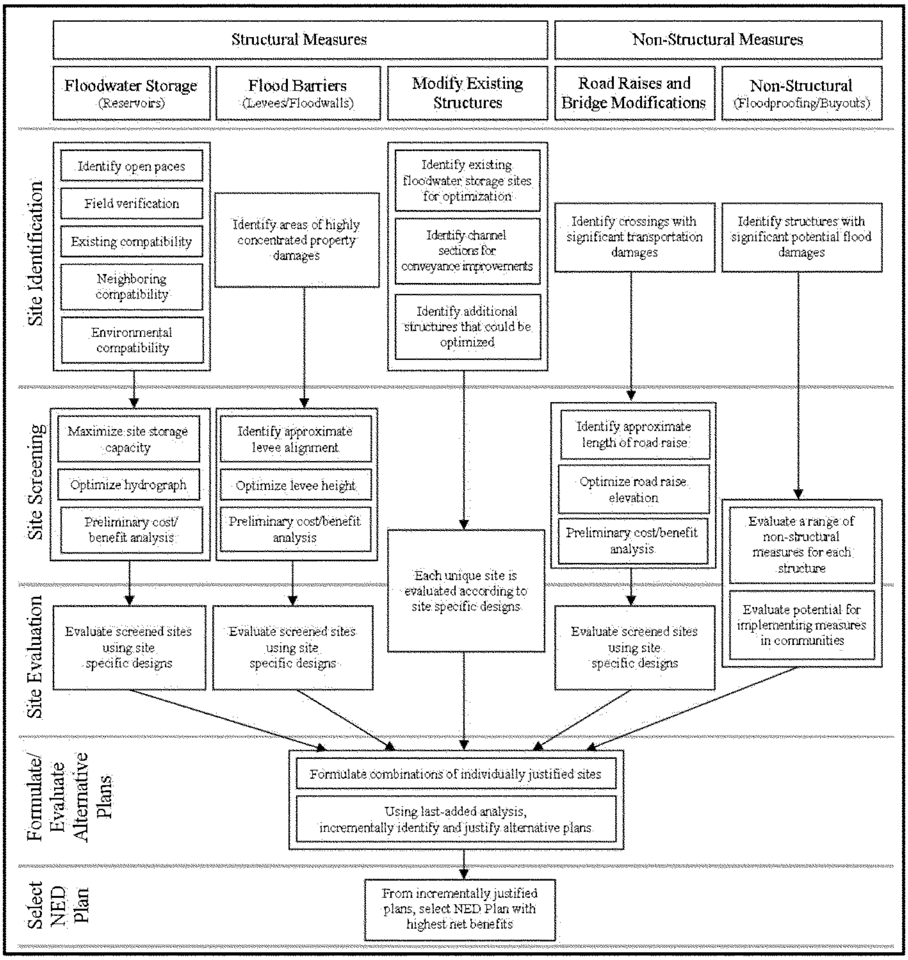

Figure 4.2 – Plan Formulation Process for Determining Flood Risk Management Plans

4.5.1.1 Structural Measures

Floodwater Storage Reservoirs

The purpose of reservoirs is to capture and store floodwater during the rising limb of a flood event to reduce flood stages downstream. Depending on the configuration of the floodwater storage reservoir in relation to the channel they are classified as either online or offline reservoirs.

Offline Reservoirs: Offline storage reservoirs receive water during a flood event, thereby reducing peak flows and subsequent water surface elevations. Once the flood hydrograph is receding and downstream stages have decreased to a suitable elevation, the stored water can be returned via pump or gravity to the stream. The inlet structure, such as an overflow weir, is designed to optimize the storage capacity of the reservoir by capturing the peak flows that cause the greatest flood damages. The configuration and elevation of the inlet controls the amount of water diverted to the storage reservoir; if the inlet is too large or low, the reservoir would fill up too quickly and early during a flood event, making it useless for reducing the peak discharge. Determining the reservoir size and inlet control structure is an iterative process targeting peak stage reductions.

Online Reservoirs*:* Online storage reservoirs are placed along a channel and function to attenuate a flood hydrograph by ponding water during a flood event. The effectiveness of an online reservoir in reducing flood peaks is less than an offline reservoir because flow is not removed from the system, however online reservoirs can be easier to construct as wide areas in the floodplain can be utilized for storage. The outlet structure, such as an inline weir, is designed to optimize the storage capacity of the reservoir. Design of the reservoir size and outlet control structure is an iterative process targeting peak stage reductions.

Flood Barriers

The purpose of flood barriers is to reduce flood risk in areas subject to overbank flooding. In areas where significant and concentrated potential flood damages exist, structural measures such as levees and floodwalls can be effective. The type of structure selected depends on several factors including required height above existing grade, real estate requirements, mitigation requirements and geotechnical stability. Since these types of structures remove areas from the floodway and/or floodplain, increases in stages upstream and downstream must be mitigated through compensatory storage or other means.

Levees*:* Levees are embankments designed to protect areas from flooding. The height of the levee provides a level of protection corresponding to the frequency and scale of flood damages reduced. Levees require a relatively large footprint area for geotechnical stability and seepage requirements.

Floodwalls*:* Floodwalls protect areas from flooding the same way as levees do. Since floodwalls require a significantly smaller footprint area than levees, they tend to be utilized in developed urban areas where real estate availability is more limited. In many cases the increased costs of constructing a floodwall over a levee are offset by reductions in real estate and mitigation requirements.

Modifications to Existing Structures

Large portions of the Upper Des Plaines River watershed and waterway have been developed without considering the hydraulic effects to the watershed as a whole. Additionally, there are existing FRM structures that could be improved or optimized to increase their flood risk mitigation effects within the watershed. These measures look at ways these structures can be beneficially altered.

Bridge Modifications: Bridge Modifications in this category look at the influence of the bridge piers on flow in the channel and ways to optimize the influence of the structure.

Channel Improvements*:* Channel improvements increase the flow-carrying capacity of a stream's channel and thereby reduce flood stages. Various types of alterations include: straightening, deepening, or widening the channel; removing debris; raising or enlarging culverts; and removing dams and other obstructions.

Modify Existing Structures: There are numerous existing FRM structures within the watershed, as shown in Table 3.4 in Section 3.1.1.5. This study provides an opportunity to evaluate the efficiency of these structures and opportunities for expanding or improving them. This category looks in particular at reservoirs for opportunities to expand or otherwise increase the capacity of the existing structures.

Other Modifications

In order to develop an optimal plan that utilizes the full experience and insight of the project development team, additional measures that do not fit into traditional categories analyzed in FRM studies were evaluated. Such measures include clearing trees in the riparian greenway of the Des Plaines River mainstem and coordinating and optimizing reservoir operations within the watershed.

4.5.1.2 Non-Structural Measures

Manage Risk to Transportation Network

The purpose of measures in this category is to reduce flood risk associated with road closures. At crossings and intersections where significant damages are caused by transportation delays, elevating a road section or bridge can alleviate these damages.

Road Raises: Road raises target roads parallel to the waterway that are overtopped during flood events. Raising the elevation of the road can reduce the incidence of flood-flood induced road closures and thereby reduce the risk of transportation damages.

Bridge Modifications*:* Bridge Modifications in this category target sites where roadways cross the Des Plaines River or a tributary and are overtopped during flood events. As with road raises, raising the elevation of the bridge can reduce the incidence of flood-induced road closures and thereby reduce the risk of transportation damages.

Manage Risk at Individual Homes and Businesses

Although USACE may not implement plans that benefit individual homes or businesses, implementation of a non-structural plan benefitting multiple owners collectively can be the best way to manage flood risk in a community. Where these measures are investigated, implementation will be considered for neighboring structures collectively or to efficiently include more isolated structures in the protection provided by structural measures.

Flood Proofing: Flood proofing includes any effort to reduce flood damage to individual structures and their contents. Flood proofing measures either reduce the number of times the structure is flooded or limit the potential damage to the structure and its contents when it is flooded. There are three general approaches to flood proofing:

1) elevating the structure to reduce the frequency of flooding;

2) constructing small barriers such as berms to stop floodwaters from reaching the structure; and,

3) modifying the susceptibility of the structure to damages through wet and dry flood proofing to minimize flood damage.

Other techniques reduce damages by anchoring floatable structures and facilities and locating damageable contents and utilities above flood levels. Flood proofing measures are implemented voluntarily with the consent of the property owner.

Structure Relocations and Buyouts: Relocation looks at removing all businesses and residences located within a floodplain subject to flood damages. The alternative would include the purchase of properties, moving or demolition of structures, and compensation for moving and relocation expenses for current property owners, residents, and tenants.

Floodplain Acquisitions: In the upper reaches of the watershed in Lake, Kenosha, and Racine Counties some of the floodplains have been retained mainly as agriculture and preserved open space. Current and future acquisition of floodplain lands by conservation agencies in both Illinois and Wisconsin have a major impact on future flood damages in the Upper basin since development pressures from outgrowth of the Chicago region are projected to be intense during the next 50 years. Acquisition measures include obtaining undeveloped lands within the floodplain by either purchase or a permanent open space or conservation easement to ensure future development does not occur.

Manage Risk within Communities

Flood Insurance: All communities are required to participate in the National Flood Insurance Program (NFIP) in order to qualify for Federal investment in FRM measures. Participation in the NFIP provides a means of compensation for flood damages suffered and mandates the local governments to adopt and enforce floodplain regulations that require all future development within the 1% chance floodplain to be elevated above the 1% chance flood elevation. Flood insurance measures include the revision of local building ordinances where necessary to conform to NFIP regulations. The majority of the communities in the Upper Des Plaines watershed participate in the NFIP.

Flood Preparedness: The goal of flood preparedness is to enhance the local and Federal agency network for flood emergency forecasting. A Flood Warning Plan is a system with the capability to collect precipitation and river stage information and transmit the data to a central processing station where the flood threat severity can be determined and from which a warning can be sent to key local officials and affected citizens. An emergency response plan will then guide local officials and citizens through the steps necessary to minimize adverse flooding impacts (e.g., closure structure placement, evacuation, flood fighting). Other Flood Warning Plan elements include plans for recovery and plan improvement based on post flood lessons learned.

Public Awareness: Outreach programs can educate the public about flooding, FRM projects, and residual risks within their community. Public awareness can increase support and helps local citizens become more involved in the process of FRM.

4.5.2 Flood Risk Management Site Identification

Numerous sites within the watershed where potential flood risk reduction measures should be evaluated were identified. The goal of this step is to acquire a large sample of potential sites based on general criteria. Site selection was an iterative process conducted over a number of months by the entire study team. In order to efficiently identify sites for selection, a visual GIS analysis of the flood damage analysis results from the HEC-FDA model was coupled with aerial photography. From these maps, problem areas as well as all potential open spaces within the Upper Des Plaines River were identified. Criteria used to identify potential sites varied by problem area and type of flood risk reduction measure formulated to address flood damages as explained below. Plate 12, Plate 13, and Plate 14 show all of the identified structural FRM sites.

4.5.2.1 Floodwater Storage

The Phase I Study identified floodwater storage as a critical measure to alleviate major damages caused by overbank flooding and/or provide compensatory storage for flood barriers, due to the urbanized nature of the lower half of the study area. Open spaces in the watershed were digitized and boundaries were determined based on features such as land use, roads, important property lines, watershed boundaries, stakeholder ownership, and land designations. The following site identification criteria were established for identifying potential floodwater storage sites:

1. **Sites classified as currently open or undeveloped:** It was assumed that conversion of developed sites would not be cost effective or supportable.

2. **Sites with an area of at least 10 acres:** It was assumed that smaller areas would not gain enough benefits to justify the implementation costs.

3. **Sites within at least 250-ft of an existing stream channel:** It was assumed that it would be too costly to convey floodwaters into and out of a site over greater distances.

Using these criteria, 200 potential floodwater storage sites were identified throughout the entire Upper Des Plaines River watershed study area for screening. The locations of the sites are shown in Plate 12, Plate 13, and Plate 14.

A set of four screening criteria was developed to identify potential floodwater storage sites with compatibility issues and those with the greatest likelihood of being implementable. At this step in the plan formulation process, the study team decided to exclude existing real estate ownership as a factor in screening sites. The study team reached a consensus decision for each identified sites to either keep it for further evaluation or eliminate it from consideration based on the following criteria:

A. **Field Verification:** Site identification was originally done using GIS-based land-use data provided by the Northern Illinois Planning Commission (NIPC), now the CMAP, and SEWRPC from 2001. Sites that were coded as "open or undeveloped" in the land-use data may not actually be available for site implementation due to either coding errors or new development within the basin since the dataset was compiled. Using aerial photography and field verification, each site was checked to determine whether or not the site was actually undeveloped. Developed sites were eliminated from further consideration.

B. Existing Compatibility: Some sites that were identified during the site selection process based on "open or undeveloped" land use may actually serve a critical hydrologic, recreational, cultural, social or other purpose thus making significant alterations for floodwater storage impractical. Examples of existing compatibility constraints include: important established recreational lands, unique culturally significant lands, historic properties, waste disposal areas, etc.

C. Neighboring Compatibility: Adding potential floodwater storage at a given site needs to be compatible with adjacent lands in order for it to be supported by local interests. Adjacent properties were checked to ensure adding floodwater storage would not be detrimental. Examples of neighboring compatibility constraints include: safety concerns (nearby schools, playgrounds, and airports), aesthetics, property values, etc.

D. Environmental Compatibility: It is impractical to propose a floodwater storage site on lands that currently possess significant ecological habitats. In addition to protected areas and those possessing threatened and endangered species, the high cost of mitigation and the inability to replace significant ecosystems makes this practice undesirable. Examples of environmental compatibility constraints include: natural areas, protected tracts, conservancy set-aside lands, etc.

Through this preliminary screening process, 130 of the 200 floodwater storage sites were eliminated, leaving 70 sites for further consideration as shown in Table 4.8. The eliminated sites are shown in the plates as red polygons, and the retained sites are green.

Table 4.8 – Summary of Preliminary Screening Results for Identified Floodwater Storage Sites

ID	Watershed	County	State	Identified	Eliminated	Kept
BR	Brighton Creek	Kenosha/Racine	WI	7	4	3
CC	Center Creek	Kenosha	WI	7	7	0
KR	Kilbourn Road Ditch	Kenosha/Racine	WI	7	2	5
JC	Jerome Creek	Kenosha	WI	0	-	-
ND	Newport Ditch	Lake	IL	7	4	3
NM	North Mill Creek	Lake/Kenosha	IL/WI	8	3	5
ML	Mill Creek	Lake	IL	14	11	3
CT	Sub. Country Club Trib.	Lake	IL	0	-	-
DR	Delaney Road Tributary	Lake	IL	0	-	-
GT	Gurnee Tributary	Lake	IL	1	0	1
BC	Bull Creek	Lake	IL	4	3	1
IN	Indian Creek	Lake	IL	11	7	4
AC	Aptakisic Creek	Cook/Lake	IL	9	4	5
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	41	28	13
MD	McDonald Creek	Cook	IL	7	5	2
FD	Feehanville Ditch	Cook	IL	3	0	3
WL	Weller Creek	Cook	IL	3	2	1
FP	Farmer-Prairie Creek	Cook	IL	1	1	0
WH	Willow-Higgins Creek	Cook/DuPage	IL	9	5	4
CR	Crystal Creek	Cook	IL	1	1	0
SC	Silver Creek	Cook/DuPage	IL	3	2	1
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	57	41	16
			TOTAL	**200**	**130**	**70**

4.5.2.2 Flood Barriers

To identify sites for potential construction of levees or floodwalls, areas of concentrated damages were identified using GIS mapping of without project condition damages. Areas where there were several structures with significant damages clustered together were identified as potential flood barrier sites. Both the magnitude and frequency at which structural damages occurred were used as criteria for selecting sites. The majority of clustered damages were identified along the Des Plaines River, although potential sites were also identified in the Buffalo-Wheeling Creek and Silver Creek watersheds. Table 4.9 provides a summary of identified potential flood barrier sites. The potential sites are shown as brown lines in Plate 12, Plate 13, and Plate 14.

Table 4.9 – Summary of Identified Flood Barrier Sites

ID	Watershed	County	State	Levees/ Floodwalls
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	2
SC	Silver Creek	Cook/DuPage	IL	4
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	17
			TOTAL	**23**

4.5.2.3 Modifications to Existing Structures

Using the GIS mapped flood damage analyses results and through collaboration with study partners and stakeholders, 16 potential modifications to existing structures were identified. These measures address a variety of identified structural and transportation flood damages. Table 4.10 provides a summary of existing structures identified for further evaluation. The types of measures are discussed in further detail in Section 4.5.4.4. The potential sites are shown as purple lines or points in Plate 12, Plate 13, and Plate 14.

In the Buffalo-Wheeling Creek Farmer-Prairie Creek, and Silver Creek watersheds, site where channel or flow improvements that could potentially relieve overbank flooding were identified. In the Buffalo-Creek and Farmer-Prairie Creek watersheds, expansion of existing lakes to improve flood retention capacity was identified for further investigation. In the Weller Creek, Willow-Higgins Creek, and Silver Creek watersheds, existing reservoirs were identified for investigation of potential expansion. On the Upper Des Plaines mainstem, two bridges at the southern end of the watershed were identified for investigation due to their impact on flows. Other identified measures include investigation of interbasin flow concerns in the Silver Creek Watershed, evaluation of the flow diversion from Salt Creek, reducing channel roughness along the mainstem by improving maintenance practices, and optimizing operations at existing reservoirs to ensure efficient use of the structures.

Table 4.10 – Summary of Identified Potential Structure Modification Sites

ID	Watershed	County	State	Modify Existing Structure	Drain/Channel Improve	Other
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	1	2	0
WL	Weller Creek	Cook	IL	1	0	0
FP	Farmer-Prairie Creek	Cook	IL	1	1	0
WH	Willow-Higgins Creek	Cook/DuPage	IL	1	0	0
SC	Silver Creek	Cook/DuPage	IL	2	2	1
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	2	0	3
			TOTAL	**8**	**5**	**3**

4.5.2.4 Road Raises and Bridge Modifications

Using analysis of transportation damages provided by the VISTA study, 25 sites with high transportation damages were identified for evaluation of potential road or bridge raisings. Implementation of these measures would prevent flooding of the roadway at the event where the highest net benefits could be gained. The highest transportation damages are concentrated along the mainstem of the Des Plaines River, and these 25 sites are all along the mainstem. The potential sites are shown as green points in Plate 12, Plate 13, and Plate 14.

4.5.2.5 Non-Structural Measures

A number of sites throughout the watershed were identified for potential implementation of non-structural measures including acquisition and flood proofing. Using the GIS mapped flood damage analyses results of structures damaged by frequency, structures damaged at or before the 1% chance flood were identified for potential implementation of non-structural measures.

Structures were grouped by municipality. By grouping structures, evaluations could be made addressing implementation of measures at all structures as a group to prevent preference for one owner over another and to ensure that benefits are shared appropriately within the community. The tables below provide a summary of the sites identified for further evaluation by county.

Table 4.11 – Summary of Identified Non-Structural Flood Risk Reduction Sites

County	Municipality	Structures in Municipality	Structures in County
Cook	Riverside	6	1,084
	River Forest	22	
	Elmwood Park	54	
	River Grove	132	
	Franklin Park	130	
	Schiller Park	20	
	Rosemont	2	
	Des Plaines	243	
	Prospect Heights	9	
	Wheeling	239	
	Park Ridge	47	
	Melrose Park	16	
	Franklin Park	130	
	Buffalo Grove	34	
Lake	Riverwoods	55	385
	Buffalo Grove	30	
	Lincolnshire	50	
	Mettawa	2	
	Libertyville	198	
	Gurnee	50	
Kenosha	Pleasant Prairie	16	58
	Salem	6	
	Bristol	12	
	Somers	1	
	Paddock Lake	23	

4.5.3 Flood Risk Management Site Screening

Identified FRM sites were screened based on the development of preliminary BCRs at each site. Benefits were estimated based on conceptual hydrologic and hydraulic modeling results and associated reductions in flood damages calculated using HEC-FDA. Costs were estimated using idealized designs that could be applied to all sites independent of specific site conditions, and estimated operations and maintenance costs based on similar studies. General estimates of real estate costs were developed either based on county-wide averages of tax assessed market values for sites in private ownership and escalated real estate values of sites in public ownership.

4.5.3.1 Floodwater Storage

Individual floodwater storage sites were screened for flood risk reduction potential using conceptual designs that targeted storage at the 4%, 2%, and 1% annual chance of exceedance flood events. Available storage capacity was estimated based on the size of each site. Volume was removed from each of the respective peak hydrographs corresponding to the maximum estimated available storage on a given site. Detailed discussion on the procedure used to evaluate the hydrologic output of potential floodwater storage sites is presented in Appendix A.

Conceptual-level cost estimates were prepared for floodwater storage sites. These estimates are not reflective of actual construction costs at a given site, but rather provide a general estimate for screening individual sites for detailed evaluation. A range of scales were estimated including variable floodwater storage volumes with associated combinations of excavation and berm heights. Detailed discussion on the procedure used to develop screening costs is presented in Appendices D and F.

Flood risk management potential was translated to economic reductions in damages as discussed in Appendix B (FRM Plan Formulation), and the potential reduction in damages was compared to the screening level costs developed for each site. Preliminary benefit-to-cost ratios were used to screen sites. Floodwater storage sites with preliminary analyses resulting in a BCR greater than 1.0 were retained for further analysis.

Only 9 of the 70 floodwater storage sites identified for further evaluation had preliminary benefits that outweighed costs. A summary of screening results for floodwater storage sites by watershed is presented in Table 4.12. Floodwater storage sites retained through the site screening are presented in Table 4.13, including the screening-level estimated benefits and costs.

Table 4.12 – Summary of Floodwater Storage Site Screening Results

ID	Watershed	County	State	Identified	Eliminated	Kept
BR	Brighton Creek	Kenosha/Racine	WI	3	3	0
KR	Kilbourn Road Ditch	Kenosha/Racine	WI	5	5	0
ND	Newport Ditch	Lake	IL	3	3	0
NM	North Mill Creek	Lake/Kenosha	IL/WI	5	5	0
ML	Mill Creek	Lake	IL	3	3	0
GT	Gurnee Tributary	Lake	IL	1	1	0
BC	Bull Creek	Lake	IL	1	0	1
IN	Indian Creek	Lake	IL	4	4	0
AC	Aptakisic Creek	Cook/Lake	IL	5	3	2
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	13	12	1
MD	McDonald Creek	Cook	IL	2	2	0
FD	Feehanville Ditch	Cook	IL	3	1	2
WL	Weller Creek	Cook	IL	1	1	0
WH	Willow-Higgins Creek	Cook/DuPage	IL	4	4	0
SC	Silver Creek	Cook/DuPage	IL	1	1	0
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	16	14	2
				70	62	8

Table 4.13 – Summary of Retained Floodwater Storage Sites

Site ID	Storage Volume (acre-ft)	Total Equivalent Annual Damages	Equivalent Annual Costs	BCR ($/$)
BCRS02	177	$2,517,606	$788,083	3.2
ACRS03	248	$1,559,100	$796,651	2.0
ACRS08	418	$3,311,900	$1,087,945	1.5
BWRS31	383	$1,381,251	$1,027,954	1.3
FDRS01	4,400	$16,594,600	$4,010,543	4.1
FDRS03	24	$1,214,100	$413,268	2.9
DPRS07	1,000	$2,523,600	$1,890,603	1.3
DPRS23	330	$1,388,200	$914,274	1.5

(FY2011 Price Level, FDR 4.125%)

4.5.3.2 Flood Barriers

Identified flood barrier sites were screened individually for flood risk reduction potential using conceptual designs and costs over a range of elevations. Crest elevations were optimized by determining which elevation at each site had the highest net benefits.

The constructability of the identified sites, incorporating considerations such as tie-back requirements and floodplain impacts, was reviewed prior to the development of preliminary costs and benefits. The local topography made identification of tie-back locations challenging for several levees and limited the height to which the levee could be built. Seven sites along the mainstem were eliminated through this analysis: DPLV02, DPLV11, DPLV12, DPLV13, DPLV14, DPLV16 and DPLV17. Although tie-back limitations were also identified at sites DPLV06, DPLV07, DPLV08, and DPLV10, these adjacent sites were combined into a single levee system, DPLV09. The highest possible tie-back elevation for DPLV01 was identified as 618 feet (NAVD 1988). For DPLV15, the highest possible tie-back was 660 feet.

Benefits and costs were calculated over a range of elevations corresponding with a range of flood events including the 10%, 2%, 1%, and 0.02% annual chance of exceedance events. As a maximum elevation, benefits and costs for a crest elevation two feet above the 1% chance flood event water surface elevation were also calculated.

Conceptual levee construction costs were based on the berm construction costs developed for use in the floodwater storage site screening. Construction costs at DPLV01, where an existing levee is in place, were adjusted to account for the potential cost savings incurred by incorporation of the existing structure into the new design. Net benefits for each levee at each crest elevation were calculated by subtracting the estimated costs from estimated benefits. For sites that showed positive net benefits at one or more crest elevation, the elevation which had the highest net benefits was selected for further evaluation.

Sites with positive net benefits were retained for further analysis, and the crest elevation at which net benefits were maximized was used as the basis for site evaluation. The screening results for flood barrier sites that had positive net benefits are presented in Table 4.14. Two of the 23 flood barrier sites had positive net benefits and were retained for further evaluation. A summary of screening results by watershed is presented in Table 4.15.

A detailed discussion on the procedure used in the screening analysis is presented in Appendix B (FRM Plan Formulation). Detailed discussion on the procedure used to develop screening costs is presented in Appendices D (Civil Design) and F (Cost Engineering).

Table 4.14 – Summary of Retained Flood Barrier Sites

Site ID	Max. Net Benefits	Length (ft)	Approximate Grade (ft)	1% Annual Chance Flood Elev (ft NGVD29)	Optimized Crest Elev (ft NGVD29)
DPLV01	$324,000	2,800	610	616.3	618.3[1]
DPLV04	$1,604,000	6,400	618	625.8	627.8
DPLV05	$1,091,000	7,400	616	627.4	629.4
DPLV09[2]	$1,357,000	11,000	621	631.6-634.1	635.0-636.5

[1]Although higher levee elevations resulted in greater net benefits, the indicated crest elevation is the maximum achievable due to tie back considerations.
[2]Due to the length of DPLV09, the site was evaluated along fonr reaches with varied crest elevations at each reach.
(FY2011 Price Level, FDR 4.125%)

Table 4.15 – Summary of Flood Barrier Site Screening Results

ID	Watershed	County	State	Total	Eliminated	Kept
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	2	2	0
SC	Silver Creek	Cook/DuPage	IL	4	4	0
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	14	10	4
			TOTAL	**20**	**16**	**4**

4.5.3.3 Road Raises and Bridge Modifications

Road raises and bridge modifications at high transportation damage sites were screened for FRM potential in coordination with the IDOT, the owner of the majority of these major arterial roads. Implementation of these measures would occur in conjunction with planned major rehabilitation of roads and bridges to minimize impacts to roadway users and optimize use of Federal and state funds.

Road and bridge rehabilitation is prioritized by IDOT according to the agency's highway planning and programming objectives: preserve and maintain the existing highway system of roads and bridges, upgrade existing facilities for congestion mitigation and safety improvements, and expand the system to enhance economic development. Several roadway characteristics are used to select roads for major rehabilitation. Primary factors are capacity, age, and structural soundness. IDOT also monitors reports of flooding and maintains a priority list of roadways impacted by flooding: roadways where a flood has been reported to IDOT within the past two years and more than twice since this information has been recorded – are included in this "flood priority list." However, due to limited funding, other concerns such as structural soundness can take priority.

The design life used by IDOT is 50 years for bridges and 90 years for box culverts. Parallel roads are not assigned a design life, but instead undergo major rehabilitation when required for safety or capacity improvements. Using the age of each identified bridge or road segment identified and whether IDOT has identified the site for consideration in their multi-year plan, three sites were identified as likely to undergo rehabilitation within the study's period of analysis: DPBM04 (First Avenue Bridge in River Grove), DPBM06 (Rand Road Bridge in Des Plaines), and DPBM13 (IL Route 120 in Grayslake). Additional discussion of this preliminary screening procedure can be found in Appendix B (FRM Plan Formulation).

For each of the sites, conceptual-level designs were prepared to provide a general cost estimate for screening. The extents of the project were determined using LIDAR mapping of elevations along the roadway. General costs for roadway construction and fill, coordinated with IDOT, were used to determine the approximate cost. It was also assumed that the design would include mitigation for the effects of the increased roadway elevation on the floodplain, and an estimate of the associated costs was included. Lands and damages and utility relocations, however, were not included in the estimates.

A range of elevations were considered, corresponding to flood stages used in the transportation modeling. The comparison of benefits to costs resulted in positive net benefits at each site. The elevation that maximized net benefits was selected for further evaluation. The results, including estimated net benefits and optimized elevation, are presented in Table 4.16.

Table 4.16 – Summary of Retained Road Raise and Bridge Modification Sites

Site ID	Annual Benefits	Annual Costs	Max Net Benefits	1% ACE Flood Elevation (ft NGVD29)	Pavement Elev (ft NGVD29)		Approx Extent (ft)
					Lowest Existing	Optimized	
DPBM04	$5,339,000	$235,000	$5,104,000	626.0	620.0	625.5	1,900
DPBM06	$1,182,000	$618,000	$564,000	634.5	632.0	634.2	3,000
DPBM13	$736,000	$151,000	$586,000	665.1	661.5	664.7	1,000

(FY2011 Price Level, FDR 4.125%)

4.5.3.4 Modifications to Existing Structures

Due to the uniqueness of each site considered for modification to existing structures, no parameters for site screening were available. Instead, site specific evaluations as discussed in Section 4.5.4.4 were conducted for each identified site.

4.5.3.5 Non-Structural Measures

Within each municipality where non-structural measures were identified, each structure was individually evaluated for implementation of a range of measures: elevation, wet and dry floodproofing, filling the basement combined with floodproofing, construction of nonstructural berms, and buyouts. The decision-making procedure for determining which structure would be implemented is shown in Figure 4.3 for residential structures and Figure 4.4 for non-residential structures. Measure benefits and costs that maximized net benefits at each structure were then aggregated within communities to determine whether implementation of non-structural measures is economically justified within a community. Table 4.17 shows the results of this analysis.

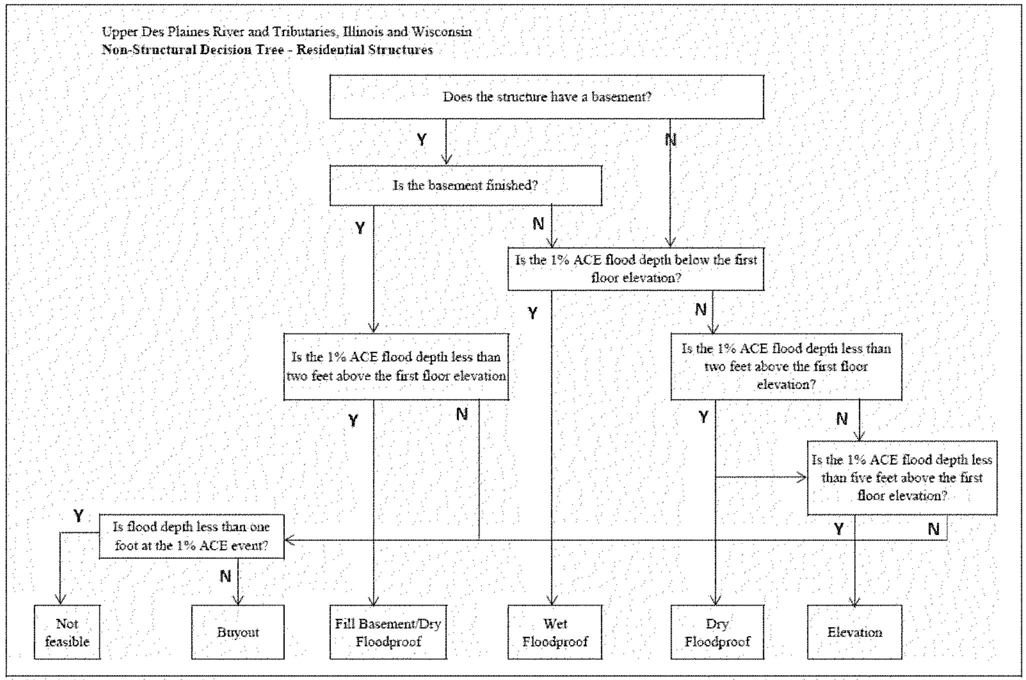

Figure 4.3 – Residential Non-Structural Measure Decision Tree

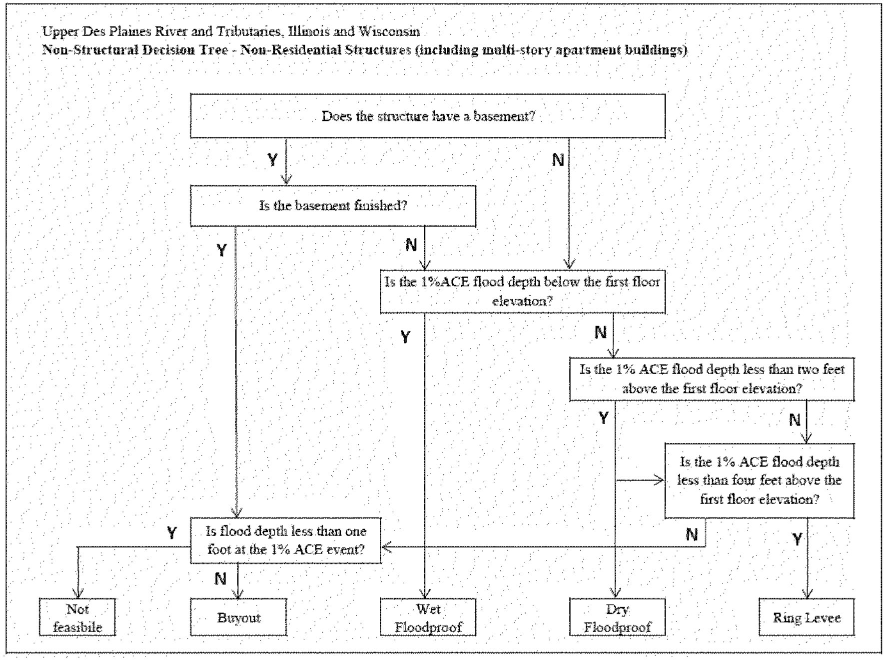

Figure 4.4 – Non-residential Non-structural Decision Tree

In the City of Des Plaines, where a large number of structures are located in the floodway, these higher risk structures were evaluated separately. In coordination with the City of Des Plaines, this group of structures was evaluated for buyout with replacement of the homes by a natural area and recreational trails. This buyout group, in combination with the recreation improvements, was economically justified as shown in the table. Discussion of the recreation formulation is included in Section 8.

Detailed discussion of the procedures used to screen the non-structural sites is in Appendix B (FRM Plan Formulation). Discussion of the procedures used to develop screening level costs is in Appendix F (Cost Engineering). A summary of retained non-structural measures in the watershed is shown in Table 4.17 and Table 4.18. As shown in the Tables, approximately 430 total sites were retained. These sites are in the communities of Buffalo Grove, Des Plaines, Leyden Township, Rosemont, Schiller Park, Wheeling, Wheeling Township, Gurnee, Lincolnshire, Long Grove, Riverwoods, and Vernon Township in Illinois and Salem and Somers in Wisconsin. The approximate number of proposed measures would include 250 structure elevations, dry floodproofing at 40 structures, wet floodproofing at 50 structures, 30 structures where the basement would be filled and any portion of the first floor at risk of flooding would be floodproofed, construction of nonstructural berms at 40 structures, and 100 buyouts. Participation in the non-structural plan would be voluntary and implementation subject to verification of the structure characteristics, first floor elevation, and low water entry point. With regard to the buyouts, to the extent practicable, acquisition would be on a willing seller basis, but eminent domain could be utilized when determined to be warranted.

Table 4.17 – Summary of Non-structural Screening Results

County	Community	Structures in Community	WOP Damages ($1,000)	Optimized Floodproofing Measures				
				Structures		Benefits ($1,000)	Annual Costs ($1,000)	Net Benefits ($1,000)
				Number	% of Total			
Cook	Buffalo Grove	34	$23.9	31	91%	$22.1	$18.7	$3.4
	Des Plaines	568	$1,536.5	374	65%	$1,090.7	$1,977.9	($887.2)
	Des Plaines (Floodway)	109	$990.9	79	100%	$679.3	$802.5	$32.9
	Elmwood Park	54	$107.5	48	89%	$100.1	$248.6	($148.5)
	Franklin Park	109	$103.5	49	45%	$53.0	$139.5	($86.5)
	Leyden Township	21	$90.7	16	76%	$78.1	$34.7	$43.4
	Maine Township	34	$60.5	32	94%	$60.0	$98.5	($38.5)
	Maywood	2	$0.7	2	100%	$0.6	$0.8	($0.2)
	Melrose Park	16	$7.3	15	94%	$7.0	$18.7	($11.8)
	Park Ridge	5	$1.4	3	60%	$0.6	$3.8	($3.2)
	Prospect Heights	9	$25.9	9	100%	$26.4	$56.4	($30.0)
	River Forest	22	$57.5	14	64%	$40.3	$69.4	($29.1)
	River Grove	127	$400.6	102	80%	$205.8	$455.6	($249.8)
	Riverside	8	$44.5	5	71%	$32.2	$41.6	($9.4)
	Rosemont	2	$291.3	2	100%	$295.0	$24.6	$270.5
	Schiller Park	20	$110.6	20	0%	$111.0	$46.3	$64.8
	Wheeling	221	$287.0	166	75%	$231.3	$207.3	$24.0
	Wheeling Township	23	$134.8	21	91%	$134.2	$55.8	$78.4
Lake	Gurnee	48	$957.5	39	81%	$797.5	$160.5	$637.0
	Libertyville	28	$57.6	21	75%	$15.5	$403.9	($388.4)
	Lincolnshire	40	$63.4	38	95%	$63.0	$48.9	$14.1
	Long Grove	2	$16.4	2	100%	$16.4	$13.7	$2.7
	Mettawa	2	$3.0	2	100%	$3.0	$28.0	($25.0)
	Riverwoods	49	$171.9	45	92%	$169.3	$150.4	$18.9
	Libertyville Township	80	$147.4	63	79%	$135.7	$481.4	($345.7)
	Newport Township	3	$1.7	2	67%	$1.3	$8.3	($7.0)
	Vernon Township	46	$166.7	40	87%	$161.0	$107.7	$53.4
	Warren Township	1	$1.1	1	100%	$1.1	$2.8	($1.6)
Kenosha	Pleasant Prairie	16	$81.3	16	100%	$81.3	$100.8	($19.6)
	Salem	6	$52.1	6	100%	$52.1	$32.9	$19.2
	Bristol	12	$44.9	12	100%	$44.9	$73.0	($28.1)
	Somers	1	$59.3	1	100%	$59.3	$14.1	$45.2
	Paddock Lake	23	$85.1	23	100%	$85.1	$122.4	($37.3)

(FY2013 Price Level, FDR 3.75%)

Table 4.18 – Summary of Non-structural Screening Results by County

County	Total Structures	Benefits	Project Costs	Annual Costs	Net Benefits
Cook	335	$1,720,000	$28,273,000	$1,203,000	$517,000
Lake	164	$1,207,000	$11,781,000	$481,000	$726,000
Kenosha	7	$111,000	$1,105,000	$47,000	$64,000
Total	506	$3,039,000	$41,159,000	$1,731,000	$1,308,000

(FY2013 Price Level, FDR 3.75%)

4.5.4 Flood Risk Management Site Evaluation

Site specific designs and cost estimates were developed for all sites retained in the site screening process. Benefits were estimated using HEC-FDA based on hydrologic and hydraulic modeling results for the optimized site. Costs were estimated using site specific designs taking into account site specific concerns. Estimates of real estate costs were also refined based on site specific information.

4.5.4.1 Floodwater Storage

To evaluate potential floodwater storage sites, a review of the site configuration and likely soil conditions at each site was conducted. Sites where installation of a reservoir would be impractical were eliminated from further analysis. Optimized hydraulic models and site designs of the remaining sites were developed. Reductions in damages and total estimated costs were calculated for the sites based on site specific considerations. Further discussion of the evaluation procedure can be found in Appendix B (FRM Plan Formulation).

Two sites still had positive net benefits after this more detailed analysis and were retained for inclusion in formulated FRM plans. The retained floodwater storage sites are presented in Table 4.19. Once economic justification was established, each potential reservoir was evaluated to determine whether construction could cause any adverse impacts to natural resources on the site. Site ACRS08 is currently agricultural land and the project would not cause significant adverse impacts to natural resources. Additional investigation of site BCRS02 showed that there is a wetland complex on the site consisting of marsh and wet prairie communities.

The wetland at BCRS02 provides 135.5 average annual habitat units, providing habitat for marsh and prairie species of insects, amphibians, reptiles, and birds. The team evaluated strategies for implementing storage at the site while avoiding impacts to the wetland and determined that even a limited or reduced size would impact the wetland by inundating the site for an extended period during a flood event. Therefore, a mitigation plan was developed. A nearby site that is currently in the public ownership was identified for restoration. The mitigation site, L22, contains lands that were historically marsh and wet prairie and could be restored to compensate for the impacts of construction of BCRS02. Although the Lake County Forest Preserve District and the Libertyville Township Open Space District have acquired these lands for the purposes of land preservation, no funding is available for restoration of these agricultural lands to provide quality habitat for native marsh and prairie species. Mitigation includes restoration of the site's hydrology and plantings to reestablish native communities. The total costs for BCRS02 presented below include these mitigation costs. Additional discussion of the determination that mitigation would be required and the procedure used to select the mitigation plan can be found in Appendix B (FRM Plan Formulation).

Table 4.19 – Floodwater Storage Site Evaluation Results

Site ID	Storage Vol. (acre-ft)	Annual Damages Reduced	Total Costs	Annual O&M	Equivalent Annual Costs	Net Benefits	BCR ($/$)
BCRS02	177	$1,502,000	$24,463,000	$104,000	$1,317,000	$185,000	1.1
ACRS08	420	$928,000	$16,372,000	$111,000	$923,000	$5,000	1.0

(FY2011 Price Level, FDR 4.125%)

4.5.4.2 Flood Barriers

Flood barrier sites were evaluated according to site-specific considerations. Using the optimized crest elevations developed during site screening, site specific designs and costs were developed for the retained flood barrier sites.

Table 4.20 presents the retained flood barrier sites. Hydraulic modeling of the optimized levee height at each levee site was conducted to determine whether the structure would cause stage impacts. Modeling at DPLV01 showed that the proposed barrier did not have an effect on the water surface profile. The combination of DPLV04, DPLV05, and DPLV09 did cause increased flood stages and damages. Although the maximum stage increase was less than 0.2 feet for each levee individually, the impacts typically extend over a large area, impacting hundreds of properties. A real estate takings analysis determined that when considering the levees individually, the stage impacts would not result in any takings due to the small increment of flooding at infrequent events.

The magnitude of induced damages for each levee are summarized below. The goal of the screening and evaluation steps is to identify economically justified projects that can be combined to form alternative plans. Because the flood barrier sites would likely be combined with other projects, mitigation requirements are determined based on the Recommended Plan. Where possible, induced damages would be accounted for and mitigated. The mitigation requirements would be based on the combined impacts of economically justified levees. See Section 4.6.4 for this analysis.

Table 4.20 – Flood Barrier Site Evaluation Results

Site ID	DPLV01	DPLV04	DPLV05	DPLV09
Approximate Grade (ft NGVD 29)	610	618	618	621
Crest Elevation (ft NGVD 29)	618.3[1]	628.7	629.6	633.6-635.1[2]
Approximate Height (ft)	8.30	10.7	11.6	12.5-14.0
1% Chance Flood Elevation (ft NGVD 29)	616.5	626.7	627.6	631.6-633.1
Approximate Length (ft)	2,500	6,200	8,400	11,200
Equivalent Annual Damages Reduced	$397,000	$2,350,000	$1,805,000	$2,560,000
Equivalent Annual Damages Induced	NA[3]	($206,000)	($214,000)	($492,000)
Equivalent Annual Costs	$282,000	$547,000	$499,000	$1,056,000
Net Benefits	$136,000	$1,597,000	$1,092,000	$1,504,000
BCR ($/$)	1.5	3.9	3.2	2.4

[1] Maximum elevation limited by available tie-back elevations.
[2] Due to the length of DPLV09, the structure was evaluated along 4 reaches with the structure at varying heights for each reach.
[3] Hydraulic modeling showed that this flood barrier did not have an effect on the water surface profile and floodplain mitigation is not required.

(FY2011 Price Level, FDR 4.125%)

4.5.4.3 Road Raises and Bridge Modifications

To evaluate road raise sites, detailed designs and costs were developed for the screened sites. At DPBM06, the length of road required to tie into high elevations made the design impractical and it was eliminated from further consideration. Based on a hydraulic analysis, the length of the remaining bridges was extended onto land to allow flood waters to flow unimpeded through the surrounding forest preserve lands and prevent adverse stage impacts. The increased bridge length resulted in increased costs at both sites. The results of the site evaluations are presented in Table 4.21. As shown in the table, site DPBM04 remained justified and was retained for further evaluation. The estimated costs for constructing DPBM13, however, exceed the estimated benefits and the site was eliminated. Further discussion of the evaluation procedure can be found in Appendix B (FRM Plan Formulation).

Table 4.21 – Road Raise Site Evaluation Results

	Elevation					
Site ID	Feet NGVD29	Annual % Chance Flood	Total Equivalent Annual Damages	Equivalent Annual Costs	Net Benefits	BCR $/$
DPBM04	627.1	1%	$5,339,000	$863,000	$4,476,000	6.2
DPBM13	639.4	1%	$736,000	$1,919,000	($1,183,000)	0.4

(FY2011 Price Level, FDR 4.125%)

4.5.4.4 Modifications to Existing Structures

Evaluations of structure modifications were conducted on a site by site basis. At each of the sixteen sites, an evaluation of the whether the project would be implementable was conducted before developing site specific designs, costs and hydraulic models. Benefits and costs were then used to calculate a BCR for each site.

Implementable sites with a BCR greater than one were retained for inclusion in formulated alternative plans. Table 4.22 presents the retained measure. Further discussion of the evaluation procedure can be found in Appendix B (FRM Plan Formulation).

FPCI01 looks at opportunities to increase the storage capacity at Lake Mary Anne. This measure optimizes storage capacity by connecting the lake, located at Golf Road and Interstate 294, to nearby Dude Ranch Pond.

Table 4.22 – Modification to Existing Structure Site Evaluation Results

Site ID	Total Equivalent Annual Damages Reduced	Equivalent Annual Costs	Net Benefits	BCR ($/$)
FPCI01	$105,000	$79,000	$26,000	1.3

(FY2011 Price Level, FDR 4.125%)

4.5.4.5 Non-Structural Measures

A large number of sites were identified for possible implementation of non-structural measures. Because this information can only be evaluated at a detailed level using site specific information, site evaluations were not conducted for each of the structures retained in the screening. Additional evaluation was conducted during the formulation of alternative plans. However, a more detailed investigation of implementation requirements at individual structures will be conducted during the Preconstruction Engineering and Design (PED) Phase.

4.5.5 Individually Justified Sites

Through the identification, screening, and evaluation steps several individually justified sites were developed. Each site was reviewed to ensure that the design maximized net benefits and that all site specific concerns had been addressed.

Based on the previous analyses, the following FRM sites were identified for further evaluation: BCRS02, ACRS08, DPLV01, DPLV09, DPBM04, and implementation of non-structural measures at approximately 700 structures throughout the watershed.

A site specific estimate of lands, easements, relocations, rights of way, and disposal areas (LERRDs) required for implementation of each structural project was included in the estimated costs. Details of the estimated LERRD requirements can be found in Appendix I (Real Estate).

For the levee sites, an estimate of flood-fighting costs that would be avoided with project implementation was estimated as discussed in Appendix E (Economics). Additional opportunities for optimizing site DPLV09 through the inclusion of multi-purpose recreation trails in the site design (DPLV09R). Adding recreation trails to the site, however, increased the overall net benefits and the DPLV09R alternative was retained. Additional discussion of the recreation evaluation procedure, including costs and benefits, can be found in Section 8. Further discussion of the levee and floodwall evaluation procedure can be found in Appendix B (FRM Plan Formulation).

For the reservoir sites, the hydrologic and hydraulic modeling was updated to optimize reductions in flood stages on the mainstem. The ACRS08 optimization did not result in significant changes.

However, at BCRS02, refinement of the sub-basin delineations for the tributary hydrologic model resulted in a significant decrease in benefits. The reduced benefits resulted in negative net benefits for the project and BCRS02 was therefore eliminated.

An additional update to the without project conditions was made to capture changes in Phase I projects: changes in the design of Van Patten Woods Lateral Storage Area were incorporated in the model and the North Fork Mill Creek Dam Modification was removed from the model as Lake County is in the process of notching the dam for ecosystem restoration purposes. The notched dam was incorporated in the future condition model. Updated benefits and costs are presented in Table 4.23. As shown in the table, all sites except BCRS02 remain individually justified when considering the updated cost and benefit calculations.

Table 4.23 – Structural Measure First Added Benefits and Costs

	Benefits ($1,000)							
Site	**Flood Damage Reduced**	**FIA Savings**	**Flood Fighting Prevente**	**Recreation**	**Total**	**Annual Costs ($1,000)**	**Net Benefits ($1,000)**	**BCR**
DPBM04	$4,287				$4,287	$767	$3,520	5.6
DPLV04	$2,144	$35			$2,179	$557	$1,622	3.9
DPLV09	$2,029	$190	$60	$187	$2,466	$1,281	$1,184	1.9
DPLV05	$1,591	$38			$1,629	$490	$1,139	3.3
ACRS08	$1,290				$1,290	$858	$432	1.5
DPLV01	$418	$23			$441	$325	$116	1.4
FPCI01	$107				$107	$72	$35	1.5
BCRS02[1]	$433				$433	$895	($462)	0.5

[1] Costs for BCRS02 include fish and wildlife mitigation.

(FY2013 Price Level, FDR 3.75%)

4.6 Formulation of Flood Risk Management Plans

4.6.1 Tributary Minimum Flows

In evaluating benefits for FRM projects in urban areas, USACE participates in projects addressing discharges that represent a serious threat to life and property. Discharges in this category are defined in 33 CFR Part 238, Water Resources Policies and Authorities: Flood Damage Reduction Measures in Urban Areas, as those from the portion of a natural stream or modified natural waterway where the drainage area is at least 1.5 square miles and discharge from the 10% chance flood is greater than 800 cfs, although exceptions may be granted where the discharge for the 1% flood exceeds 1800 cfs and a hydrologic disparity between the 10% and 1% floods can be demonstrated.

However, not all streams in the watershed meet the requirements of 33 CFR Part 238. The flows in the mainstem and tributaries where benefits are accrued for both structural and non-structural individually justified projects were assessed to compare the drainage area and flows to the policy requirements. The mainstem meets the 800 cfs flow criteria throughout the watershed. However, as shown in Table

4.24, although a portion of some tributaries meet the criteria, none of the modeled tributaries meet the criteria along their entire length.

The severity of overbank flooding in these tributary watersheds is due to their highly urbanized condition. The complex hydraulics of the channels includes features such as channelized and conduit flows with sharp turns. The streams flow underground in several locations and grates have been installed in the channels to prevent debris accumulation. Additionally, existing development in the floodplain extends right up to the channel banks. In these watersheds, structural damages due to overbank flooding occur in events as frequent as the 50% chance flood. Flood risk management projects on these tributaries meet study objectives of reducing the risk of flood induced damages in the watershed. However, USACE policy defines the damages addressed by these projects as local drainage issues and precludes Corps participation.

Table 4.24 – Tributary Drainage Areas and Flows

State		Tributary	Drainage Area (mi²)	Average. Watershed Slope (ft/ft)	Stream Length (mi)	Station at Which Tributary Meets Minimum Flow Requirement (mi)	
						10% chance	1% chance
DS	WI	Brighton Creek	20.7	0-0.06	9.0	--	--
↓	WI	Center Creek	9.8	0-0.06	5.6	--	--
↓	WI	Dutch Gap Canal	13.6	0-0.06	4.1	--	--
↓	WI	Kilbourn Road Ditch	23.7	0-0.06	12.6	1.3	--
↓	WI	Jerome Creek	5.9	0-0.06	1.7	--	--
↓	IL	Newport Drainage Ditch	7.9	0.0013	8.2	0.3	--
↓	IL	Mill Creek	66.4	0.0013	18.6	5.0	5.0
↓	IL	Bull Creek	11.3	0.0045	7.4	0.9	0.9
↓	IL	Indian Creek	37.8	0.0025	14.0	6.6	6.6
↓	IL	Buffalo-Wheeling Creek	26.8	0.0053	15.9	3.1-2.4, 1.1-0[1]	6.5-2.4[1]
↓	IL	McDonald Creek	10.2	0.0038	8.9	--	--
↓	IL	Weller Creek	18.7	0.0025	7.3	2.0-1.4[1]	2.8-1.4[1]
↓	IL	Farmer-Prairie Creek	4.4	0.0025	5.3	--	--
↓	IL	Willow-Higgins Creek	19.7	0.0017	9.7	5.2	--
US	IL	Silver Creek	13.0	0.0032	8.9	1.0	--

[1]Flows achieve policy threshold within the listed area(s), but drop below the threshold downstream due to a flow diversion.

4.6.2 Measures Formulated to Address Only Transportation Damages

Benefits for the evaluated measures include prevention of flood damages to residences; apartment buildings; commercial, industrial, and public structures; and parked automobiles. An additional damage category consists of delays and detours caused by flood-induced road closures. While benefits resulting from prevention of these damages, calculated according to the requirements of ER 1105-2-100, Planning Guidance Notebook, Appendix D, Paragraph 4.f, are policy compliant, implementation of measures formulated solely to address these transportation damages are not. Road raises or bridge modifications designed to elevate the road surface above flood stages fall within this category.

4.6.3 Continuing Authorities Program

The CAP is a group of legislative authorities under which the Secretary of the Army, acting through the Chief of Engineers, is authorized to plan, design, and implement certain types of water resources projects without additional project specific congressional authorization. Section 205 of WRDA 1992 includes FRM projects for which the Federal share does not exceed $7 million.

Individually justified projects meeting the requirements of Section 205 will be converted to CAP and implemented under that program. The recommendations of this Feasibility Study and the associated Environmental Assessment (EA) will serve as the decision document for these projects. The conversion to CAP will occur at the start of the PED Phase.

4.6.4 Mitigation for Levee Induced Damages

As discussed in Section 4.5.4.2, the hydraulic model showed that construction of DPLV04, DPLV05, and DPLV09 would result in increased stages outside of the proposed levee reaches. Each levee is individually justified according to federal rules, regulations and policies even when accounting for the induced damages; however, they are not permissible according to state rules and regulations. Additional analysis was conducted to identify and evaluate alternatives so that the levees would be permissible according to state rules and regulations and any induced damages would be avoided. USACE guidance provides for mitigation of induced flooding (see ER 1105-2-100, Paragraph 3-3). Mitigation for induced damages should be investigated and recommended if appropriate. Mitigation is appropriate when economically justified or there are overriding reasons of safety, economic or social concerns, or a determination of a real estate taking has been made. Because these levees are relatively close to each other along the mainstem, they were modeled together to ensure that the impacts were fully accounted for, as discussed in Appendix A (H&H Analysis).

The increased stages, while relatively small (they were never more than three inches and were typically less than an inch), spread over miles within the watershed, impacting hundreds of properties and structures. An analysis was conducted to determine whether the induced stages would result in a taking of property under the Fifth Amendment to the U.S. Constitution. Based on the small increase in stage (less than two inches) during more frequent (10% and 4% ACE) flood events, it was determined that these levees would not result in a taking of property (see Appendix I – Real Estate Plan).

The combined levees resulted in compounded impacts resulting in more significant stage increases and induced damages. The total induced damages for the combined levees, including transportation damages, would be $2,855,000. Because of the large extent of the impacts, purchasing flowage easements for all impacted properties was determined to be impractical. As alternatives to address the induced stages, four compensatory storage alternatives were evaluated for mitigating for the induced damages:

1. Site ACRS08 is individually justified as a floodwater storage reservoir, based on flood damage reduction benefits. Because this site had been shown to be effective for reducing flood stages, it was also evaluated as a compensatory storage site to address the levee induced damages. The annualized cost of constructing the reservoir, $819,000, is less than the total induced damages. The levees were modeled in combination with this reservoir and the combination resulted in stage increases in a very limited area. The impacts of the increased stages at three cross-sections, located between the alignments of the existing Rand Park Levee and the proposed DPLV09, would be to a parcel along the river owned by the Forest Preserve District of Cook County. The stage increases, between 0.04 and 0.05 feet, would have minimal impact on this undeveloped land. A preliminary estimate of the value of the flowage easements was prepared as discussed in Appendix I (Real Estate Plan). The estimated value is $1,000. The net benefits of the levees when combined with ACRS08 are greater than for any of the sites individually. However, during public review of the proposed plan, the public expressed significant opposition to use of this site for floodwater storage. In addition to hundreds of letters from citizens and stakeholders, the neighboring community of Buffalo Grove passed a resolution in opposition to construction of a reservoir at the site. As a result, the site was removed from consideration not only as a compensatory storage site, but also as an element of the formulated plan.

2. DPRS15 had previously been eliminated from consideration as a reservoir, but was evaluated for compensatory storage as it is located near the impacted area. The site is located in the Forest Preserve District of Cook County's (FPDCC's) Campground Road Woods, south of Algonquin Road. The optimized storage at the site was determined to be 220 acre-ft. The total annualized estimated cost for the compensatory storage, including required fish and wildlife mitigation, was $904,000. Although the cost of this site is much less than induced flood damages, the site was not able to mitigate for all of the induced stages. This alternative was therefore eliminated.

3. Site WHRS01 had previously been eliminated from consideration based on the minimal benefits that would result from the reservoir. The site is located along Mannheim Road in Rosemont, just east of O'Hare airport. Two factors, however, led to the reconsideration of this site: removal of an existing spoil pile is planned, impacting the quantity of spoil removal required and the resulting cost of construction; the site is close enough to the mainstem Des Plaines River that a pipe or ditch could be configured to capture mainstem backwater in the tributary. The site would then be storing floodwaters from the mainstem rather than the Willow-Higgins Creek tributary, allowing the site to more effectively reduce mainstem stages and mitigate for the levee impacts. Because the site is also in close proximity to O'Hare airport, consideration of restrictions associated with open water near runways would be incorporated in the designs. Hydrologic and Hydraulic modeling showed that 600 acre-feet of storage would mitigate for the induced stages. This site, however, has been acquired by the City of Chicago for use in the O'Hare Modernization Plan and is not available for development as a floodwater storage site.

4. Much of the undeveloped land near the proposed levee sites is owned by the FPDCC. A search for unforested Forest Preserve District lands, reducing the likely environmental impacts of reservoir construction, led to the identification of two sites:

> **DPRS04,** located south of River Road between First and Fifth Avenues in River Grove, had previously been eliminated during the site identification phase due to the presence of stockpiles of stone and construction fill. However, since that time the material has been removed. Because this site had been previously been deforested it was recommended for investigation by FPDCC. Trails and picnic facilities, similar to those found at other FPDCC sites in the area, were included in the site design and costs. A cost-benefit analysis of the recreation features was conducted as discussed in Section 8, and the features are economically justified at this site.
>
> **WLRS04** is an existing Driving Range along Golf Road in Des Plaines that was not previously identified as a potential storage site. The site is not immediately adjacent to a waterway and is actively used as a recreation site. However, a route for a potential ditch or pipeline connecting the site to the Des Plaines River was identified. FPDCC agreed that investigation of this site would be acceptable contingent upon continued availability of the site for use as a Driving Range.
>
> H&H modeling showed that, while neither site could address the induced stages independently, a combination of 150 acre-feet of storage at DPRS04 and 200 acre-feet of storage at WLRS04 would address the induced stages. For both of these sites, FPDCC requested that compatible recreation uses be incorporated in the designs. Cost-shared recreation features were incorporated in the site designs for DPRS04. Reconstruction of the existing recreation features at WLRS04 would be a non-Federal requirement.
>
> Ecological assessments of the proposed storage sites were conducted to determine whether construction would cause impacts to significant environmental resources. As discussed in Section 9.4.2.2 , the assessments determined that the sites had very little ecological resources and that mitigation would not be required.

The total annualized cost of providing the compensatory storage at DPRS04 and WLRS04 is $1,319,000. This is much less than the $2,855,000 in induced damages that would result from construction of the levees without mitigation. This analysis demonstrates that the induced stages caused by the levees can be addressed through implementation of compensatory storage. The storage capacity at DPRS04 and WLRS04 is economically justified by the reduction in flood losses (mitigated damages).

In addition to an evaluation of DPRS04 and WLRS04 as compensatory storage, the sites were evaluated as stand-alone reservoir projects. A summary of the benefits, costs, and net benefits associated with each individual site is presented in Table 4.25. As shown in the table, each site is individually justified.

Table 4.25 – Compensatory Storage Project Individual Benefits and Costs

Project	Flood Damage Reduced	Recreation Benefits	Total Benefits	Annual Costs	Net Benefits
WLRS04	$981,000	$0	$981,000	$715,000	$266,000
DPRS04	$498,000	$150,000	$648,000	$604,000	$44,000

(FY 2014 Price Level, FDR 3.5%)

4.6.5 Flood Risk Management Plans

The authorization for this study directs USACE to "not exclude from consideration and evaluation flood damage reduction measures based on restrictive policies regarding the frequency of flooding, the drainage area, and the amount of runoff." (WRDA 1999, Sec. 419.b) Therefore, a broad range of measures throughout the watershed have been investigated and evaluated. However, not all of the individually justified projects are compliant with current USACE policy as discussed in Sections 4.6.1 and 4.6.2, above: measures justified by benefits in portions of tributaries not meeting the minimum flow requirements and measures formulated solely to address transportation damages.

In order to fully respond to the study authority while also considering existing policy and guidance, four distinct plans have been formulated:

1. **No Action Plan:** Assumes that no projects would be implemented by USACE. Projects planned for implementation by local interests are included in this plan.
2. **Comprehensive Plan:** A plan that fully responds to the study authority and includes all economically justified, environmentally acceptable separable projects evaluated during the course of the study. This plan includes projects the USACE recommends be implemented by appropriate non-Federal agencies, projects that USACE may address under its CAP, and projects for which USACE will seek congressional authorization for implementation. The CAP Plan and NED Plan are subsets of the Comprehensive Plan.
3. **CAP Plan:** All policy compliant, economically justified, environmentally acceptable separable projects of such scope that they could reasonably be implemented under CAP.
4. **NED Plan:** All policy compliant, economically justified, environmentally acceptable separable projects of such scope that they could not be implemented under CAP.

As required by USACE policy and guidance, a No Action plan, synonymous with the FWOP condition will be evaluated in comparison to other identified plans. The No Action plan assumes that no new projects would be implemented by USACE. Projects planned for implementation by local interests are included in this plan. This alternative would result in continued occurrence of flood damages throughout the watershed. Damages to structures and traffic delays and detours would continue, causing significant economic impacts, as discussed in Section 4.4. The benefits, costs, and net benefits of the No Action Plan are $0.

4.6.6 Last Added Analysis

Flood risk management plans are formulated to maximize NED net benefits. To determine the optimal combination of measures for evaluation, the screened and evaluated sites shown to be individually justified ("first added") were further evaluated using a "last added" analysis. Through the screening and evaluation process, each site has been individually justified and optimized with respect to without project conditions. Since the benefits of implementation of many of the measures are interdependent, the last added analysis ensures that benefits are not claimed by two projects in the same plan.

The individually justified projects are presented in Table 4.26, below. The locations of the sites within the watershed are shown in Plate 15. Combinations of these projects form the basis of the flood risk management plans. To formulate the plans, projects were first evaluated to determine which plan they would be part of (NED, CAP, or Comprehensive). Policy compliant projects were added to the formulated plan first to determine the NED and CAP Plans. The remaining non-policy compliant projects were then added to determine the Comprehensive Plan.

Table 4.26 – Summary of Individually Justified Projects

Site	Description	Plan[1]	Total Benefits[2,3]	Annual Costs[2]	Net Benefits	BCR
DPLV04	Fullerton-Grand Levee	NED	$2,186	$864	$1,322	2.5
DPLV05	Belmont-Irving Park Levee	NED	$1,762	$789	$973	2.2
DPRS04	Fullerton Woods Reservoir	NED	$648	$604	$44	1.1
DPLV09	Touhy-Miner Levee	NED	$2,488	$1,176	$1,312	2.1
WLRS04	Semrow Driving Range Reservoir	NED	$981	$715	$265	1.4
--	Policy Compliant Non-Structural	NED	$2,831	$1,835	$996	1.5
DPLV01	Groveland Avenue Levee	CAP	$441	$264	$177	1.7
DPBM04[4]	First Ave Bridge Modification	Comprehensive	$4,258	$656	$3,602	6.5
FPCI01[4]	Lake Mary Anne Pump Station	Comprehensive	$107	$85	$22	1.3
--	Non-policy compliant Non-Structural	Comprehensive	$270	$157	$113	1.7

[1] HQUSACE has directed the District to prepare a plan that includes all individually justified sites, a plan that includes all policy compliant plans that could not be implemented under the CAP, and sites for implementation under CAP. Comprehensive, NED, or CAP is shown to indicate which plan they would fall within.

[2] Benefits and costs are annualized over a 50 year period of analysis, using a 3.5% discount rate.

[3] Additional benefit categories include Flood Insurance Administration cost savings for structures removed from the floodplain, reductions in flood fighting costs, and recreation benefits.

[4] Road Raises formulated to solely address transportation damages, such as DPBM04, and projects that accrue benefits in portions of watersheds where 10% ACE flows are less than 800 cfs, such as FPCI01, are non-policy compliant. These projects would be implemented by the appropriate non-Federal agency and would not be cost-shared with USACE.

(FY 2014 Price Level, FDR 3.5%)

For this analysis, the policy compliant increment with the highest net benefits is the starting point, using the with-project hydraulic and economic models of that site as the formulated plan. The remaining projects are then each added to the plan, and net benefits are calculated for each combination. An increase in net benefits indicates that the new element is incrementally justified within the plan. The combination with the highest net benefits becomes the new formulated plan.

The remaining projects are added to the hydraulic and economic model of the new formulated plan to determine the next site to be included in the plan. The analysis is repeated until either all sites have been added or there are no combinations of remaining sites with the formulated plan that result in increased net benefits.

The levee and reservoir system that includes DPLV04, DPLV05, DPLV06, DPRS04, and WLRS04 has the highest net benefits, with a total of $3,982,000 in net benefits for the individual projects. However, for the last added analysis, the system was broken into two increments to ensure that net benefits would be maximized by the system: the first increment DPLV04, DPLV05, and DPRS04 and the second increment includes DPLV09 and WLRS04. As discussed below, the analysis demonstrated that the combined increments do maximize net benefits.

A summary of the formulated plans is presented in Table 4.27. The mainstem levee and reservoir system increments were added to the plan first. The policy compliant non-structural projects were then added to the plan, followed by the CAP project, DPLV01, and the non-policy compliant projects. The analysis showed that net benefits continued to increase and that all sites remain justified in combination with each other.

The incrementally justified non-structural measures were determined using screened non-structural sites as a basis. The previous non-structural analysis considered measures at structures regardless of their location along tributaries. However, some of the structures are in portions of tributaries that do not meet the minimum flow requirements discussed in 4.6.1. The structures in Kenosha County, Buffalo Grove, Leyden Township, and some of the structures in Wheeling fall in this category, and are therefore would only be included in the Comprehensive Plan. A summary of the NED non-structural measures is presented in Table 4.28 and the Non-policy complaint portion is presented in Table 4.29. The non-structural measures include structure elevations, dry floodproofing, wet floodproofing, filling basements in combination with floodproofing of any portion of the first floor at risk of flooding, nonstructural berms, and buyouts in 13 communities across the watershed. The non structural measures would be implemented on a voluntary basis, subject to verification of the structural characteristics, first floor elevation, and low water entry point. With regard to the buyouts, to the extent practicable, acquisition would be on a willing seller basis, but eminent domain could be utilized when determined to be warranted.

Table 4.27 –Last Added Analysis Summary

Round of Analysis	Plan Components	Total Benefits	Total Costs	Cumulative Net Benefits	Incremental Net Benefits
1	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee	$4,802,000	$2,250,000	$2,552,000	--
2	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irviug Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner Levee	$7,964000	$3,982,000	$3,982,000	$1,430,000
3	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner Levee Policy Compliant Non-structural	$10,380,000	$5,737,000	$4,643,000	$661,000
4	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner Levee Policy Compliant Non-structural DPLV01 - Groveland Ave Levee	$10,835,000	$5,999,000	$4,836,000	$193,000
5	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner Levee Policy Compliant Non-structural DPLV01 - Groveland Ave Levee DPBM04 - First Ave Bridge Modification	$15,180,000	$6,652,000	$8,528,000	$3,885,000
6	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner Levee Policy Compliant Non-structural DPLV01 - Groveland Ave Levee DPBM04 - First Ave Bridge Modification Non-policy Compliant Non-structural	$15,421,000	$6,809,000	$8,612,000	$84,000
7	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner Levee Policy Compliant Non-structural DPLV01 - Groveland Ave Levee DPBM04 - First Ave Bridge Modification Non-policy Compliant Non-structural FPCI01 - Lake Mary Anne Pump Station	$15,530,000	$6,894,000	$8,636,000	$27,000

(FY2015 Price Level, FDR 3.375%)

Table 4.28 – Summary of NED Plan Non-structural Measures

County	Elevation	Dry Floodproof	Wet Floodproof	Fill Basement	Ring Levee	Buyout	Total Structures
Cook	79	15	24	9	5	81	213
Lake	80	18	21	12	19	14	164
Total	159	33	45	21	24	95	377

County	Total Structures	Benefits	Project Costs	Annual Costs	Net Benefits
Cook	213	$1,315,000	$32,520,000	$1,188,000	$127,000
Lake	164	$1,100,000	$15,514,000	$567,000	$533,000
Total	377	$2,415,000	$48,034,000	$1,755,000	$660,000

(FY2015 Price Level, FDR 3.375%)

Table 4.29 – Summary of Non-policy Compliant Non- Structural Measures

County	Elevation	Dry Floodproof	Wet Floodproof	Fill Basement	Ring Levee	Buyout	Total Structures
Cook	92	1	1	4	2	2	102
Kenosha	1	0	3	0	0	3	7
Total	93	1	4	4	2	5	109

County	Total Structures	Benefits	Project Costs	Annual Costs	Net Benefits
Cook	102	$142,000	$3,106,000	$113,000	$29,000
Kenosha	7	$99,000	$1,189,000	$43,000	$56,000
Total	109	$2413,000	$4,295,000	$156,000	$85,000

(FY2015 Price Level, FDR 3.375%)

4.6.7 Acceptability, Completeness, Effectiveness, and Efficiency

Completeness, effectiveness, efficiency, and acceptability are the four evaluation criteria outlined in the P&G and used by USACE in evaluating alternative plans. Alternatives are evaluated against these criteria in fulfilling the established planning objectives.

Completeness: Plan formulation has included a complete accounting of life-cycle costs, which includes both the costs associated with construction and the operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) required to ensure sustained realization of the project benefits. In addition, formulation has accounted for appropriate mitigation of adverse effects as an integral part of each plan including the regulations set in place by local floodplain management agencies to ensure that the projects will be implementable under these rules.

Effectiveness: The proposed plans meet the study objectives of reducing flood risk within the study area. Although significant residual flood risk would remain, the Comprehensive Plan reduces estimated annual flood damages in the watershed by 27%. The NED Plan would reduce those damages by 18% and the CAP Plan would add an additional 1% increment to the NED Plan damage reduction.

Efficiency: Plans meeting NED criteria must maximize net economic benefits. A last-added plan formulation procedure was utilized to ensure net benefits are maximized by retaining only those combinations of projects that result in increased net benefits.

Acceptability: FRM plan formulation has been conducted in close coordination with the study non-Federal sponsors and stakeholders to ensure that the analysis accurately reflects the flooding issues experienced within the watershed and that plans are acceptably addressing those problems. The formulated alternative plans are acceptable in terms of applicable laws, regulations and public policies.

4.7 Description of Flood Risk Management Plans*

4.7.1 Plan Elements

The incrementally justified FRM sites include two reservoirs, four levees, one road raise, modification of an existing structure and four types of non-structural measures. The reservoirs provide storage during a flood event and until flood elevations decrease and the water can flow into the channel without impacting structures in the floodplain. The levees protect homes and businesses by constructing a barrier between the floodwaters and the structures. Each of the levee sites was optimized to maximize the net benefits, taking into consideration the cost of construction. At the road raise site traffic delays and detours are prevented by raising the elevation of the road. Modifications to existing structures were identified through PDT and stakeholder knowledge of the watershed and are described below. A preliminary implementation schedule is summarized in Table 4.30. An economic summary of each plan is shown in Table 4.31. Plate 15 shows the location of the sites in the watershed. Plate 16 through Plate 22 shows conceptual site plans for each structural measure.

Table 4.30 –Preliminary Implementation Schedule for Flood Risk Management Projects

Plan	Site ID	Project	Engineering and Design Start	Real Estate Acquisition Start	Construction Start	Construction Completion
CAP 205	DPLV01	Groveland Avenue Levee	10/2014	4/2015	10/2016	10/2018
NED	DPRS04	Fullerton Woods Reservoir	10/2014	10/2017	4/2018	4/2020
	DPLV04	Fullerton-Grand Levee	10/2016	10/2017	10/2019	10/2021
	DPLV05	Belmont-Irving Park Levee	10/2016	10/2017	10/2019	10/2021
	WLRS04	Harry Semrow Driving Range Reservoir	10/2019	10/2019	10/2020	10/2022
	DPLV09	Touhy-Miner Levee	10/2020	10/2018	10/2021	10/2023
		Cook County Non-structural	10/2017	10/2017	10/2019	10/2025
		Lake County Non-structural	10/2017	10/2017	10/2019	10/2025
Comprehensive[1]	DPBM04	First Avenue Bridge Modification	10/2014	4/2015	10/2015	10/2017
	FPCI01	Lake Mary Anne Pump Station	10/2014	4/2015	10/2015	10/2017
		Cook County Non-structural (Comprehensive Plan)	10/2017	10/2017	10/2019	10/2025
		Kenosha County Non-structural	10/2017	10/2017	10/2019	10/2025

[1]Road Raises formulated to solely address transportation damages, such as DPBM04, and projects that accrue benefits in portions of watersheds where 10% ACE flows are less than 800 cfs, such as FPCI01, are non-policy compliant. These projects would be implemented by the appropriate non-Federal agency and would not be cost-shared with USACE.

Table 4.31 – Summary of Flood Risk Management Plans

Plan	Sites	Benefits ($1,000)	Costs ($1,000)	Net Benefits ($1,000)	BCR
Comprehensive[1]	DPBM04 + DPLV04 + DPLV05 + DPLV09 + WLRS04 + DPRS04 + DPLV01 + FPCI01 + non-structural measures (13 communities)	$15,530	$6,894	$8,636	2.3
NED	DPLV04 + DPLV05 + DPLV09 + WLRS04+DPRS04+ non-structural measures (9 communities)	$10,379	$5,738	$4,641	1.8
CAP	DPLV01	$455	$262	$193	1.7

[1]Road Raises formulated to solely address transportation damages, such as DPBM04, and projects that accrue benefits in portions of watersheds where 10% ACE flows are less than 800 cfs, such as FPCI01, are non-policy compliant. These projects would be implemented by the appropriate non-Federal agency and would not be cost-shared with USACE.

(FY2015 Price Level, FDR 3.375%)

The sites below are the individual elements of the Flood Risk Management Plans. The NED Plan would be recommended for congressional authorization, projects in the CAP Plan would be recommended for implementation under existing USACE authorities for implementation of small projects. Sites in both of NED and CAP Plans are also included in the Comprehensive Plan. In addition, the Comprehensive Plan includes projects that would not be implemented by USACE, but rather by local FRM or transportation agencies. These additional projects—DPBM04, FPCI01, and non-structural measures that are not along portions of streams that meet the 800 cfs criteria—are economically justified, but do not meet current USACE policy and guidance.

National Economic Development Plan:

The NED Plan includes two separable components: structural and non-structural. The NED Plan is recommended for authorization by Congress and implementation by USACE.

Structural: As discussed above, the structural projects form a levee and storage system that provides flood risk management benefits without inducing flood stages or damages in the watershed. A description of each project included in this system is presented below.

WLRS04: The Harry Semrow Driving Range Reservoir would be a 200 acre-foot floodwater storage reservoir in Des Plaines. The site, located along Golf Road just east of Rand Road, is the location of an existing golf driving range and the reservoir design will allow for continued recreational use of the site. The reservoir would be connected to the Des Plaines River through a ditch at the east side of the site. This site, in combination with DPRS04, would serve as compensatory storage for DPLV09, DPLV05, and DPLV04.

DPLV09: The Touhy-Miner Levee would be a 11,200 floodwall and levee along the west bank of the Des Plaines from Touhy Avenue to Miner Street in Des Plaines. The floodwall and levee would have a greater than 95% chance of not being overtopped during a 100 year flood event. Multi-purpose recreation trails would be included in the project, extending along the floodwall from Oakton Street to Algonquin Road and connecting to the existing Des Plaines River Trail system.

DPLV05: The Belmont-Irving park Levee would be an 8,400 foot levee and floodwall along the west bank of the Des Plaines River in Schiller Park. The structure would protect homes and businesses along the mainstem Des Plaines River from Belmont to Irving Park Road. The crest elevation is 2 feet above the 1% annual chance of exceedance flood elevation. The probability that this levee would not be overtopped during the 1% annual chance of exceedance flood event will be greater than 95%.

DPLV04 : The Fullerton-Grand Levee would be a 6,200 foot levee and floodwall along the west bank of the Des Plaines River in River Grove. The structure would protect homes and businesses along the mainstem Des Plaines River from south of Fullerton Avenue at Fifth Avenue along Fifth Avenue and River Road, extending north of Grand Avenue. The crest elevation is two feet above the 1% annual chance of exceedance flood elevation. The probability that this levee would not be overtopped during the 1% annual chance of exceedance flood event will be greater than 95%.

DPRS04: The Fullerton Woods Reservoir would be a 150 acre-foot floodwater storage reservoir in River Grove. The site is located south of River Road between First and Fifth Avenues. The project would include trails, picnic facilities, and a parking lot to allow for use of the site as a recreation area. This site, in combination with WLRS04, would serve as compensatory storage for DPLV09, DPLV05, and DPLV04.

Non-structural: Non-structural measures recommended for implementation include floodproofing, structure elevations, construction of non-structural berms, and buyout and evacuation of properties in flood prone areas. These measures would be implemented at 377 structures in nine communities across the watershed. These communities include Rosemont, Wheeling, Wheeling Township, Riverwoods, Lincolnshire, Long Grove, Vernon Township, and Gurnee in Illinois. Non-structural buyouts in Des Plaines would also include construction of recreational trails on the vacated lands. Participation will be on a voluntary basis and structure eligibility will be verified prior to implementation. With regard to the buyouts, to the extent practicable, acquisition would be on a willing seller basis, but eminent domain could be utilized when determined to be warranted.

Continuing Authorities Program:

The project below is a separable element that is within the scope of the flood risk management authority delegated to USACE by Section 205 of the Flood Control Act of 1948, as amended. This authority allows USACE to construct, without specific authorization, small flood risk management projects where the Federal share of the cost does not exceed $7 million.

DPLV01: The Groveland Avenue Levee would raise and extend an existing levee in Riverside, tying back the structure to high ground. The levee would have a greater than 95% chance of not being overtopped during a 100 year flood event. This levee would not impact the water surface profile and will not require compensatory storage.

Non-Policy Compliant Projects:

Additional projects that address flood risk in the watershed and are economically justified were identified by this study. These projects, however, are not compliant with current USACE policy and are therefore recommended for implementation by the appropriate state and local agencies.

DPBM04: The First Avenue Bridge Modification would raise the pavement elevation of First Avenue Bridge in River Grove above the 1% annual chance of exceedance flood elevation The site would be designed to prevent adverse impacts to surrounding structures by extending the bridge length, providing greater conveyance capacity under the roadway.

FPCI01: The Lake Mary Anne Pump Station would increase the storage capacity of Lake Mary Anne by connecting the lake to Dude Ranch Pond. Lake Mary Anne is located at Golf Road and I-294 and the pond is immediately south of the lake across Golf Road.

Non-structural: Non-structural measures along portions of tributaries that do not meet minimum flow requirements would be implemented at structures in 5 communities across the watershed. These communities include Wheeling, Buffalo Grove, and Leyden Township in Illinois and Salem and Somers in Wisconsin. Participation would be on a voluntary basis and structure eligibility will be verified prior to implementation.

4.7.2 Costs of Plan Elements

The costs used to compare plan elements are annualized over the 50 year period of analysis. These first costs are implementation; supervision and administration; LERRDs; and interest during construction. These costs, annualized at the current federal discount rate (3.375%), together with the annual O&M costs are the basis for the average annual costs. The first costs, O&M costs, and average annual cost of each element of the FRM plans are presented in Table 4.32.

Table 4.32 – Flood Risk Management Plan Costs

Site	Plan[1]	Economic Costs[2]	Annual OMRR&R	Average Annual Costs
DPRS04[3]	NED	$13,038,000	$59,000	$602,000
DPLV04	NED	$21,587,000	$19,000	$861,000
DPLV05	NED	$19,558,000	$24,000	$787,000
WLRS04	NED	$16,664,000	$56,000	$706,000
DPLV09[3]	NED	$28,730,000	$12,000	$1,026,000
Lake County Non-structural	NED	$15,514,000	Nominal	$567,000
Cook County Non-structural[3]	NED	$32,520,000	$1,000	$1,188,000
DPLV01	CAP	$5,941,000	$15,000	$262,000
DPBM04	Comprehensive	$15,672,000	$21,000	$653,000
FPCI01	Comprehensive	$1,300,000	$30,000	$84,000
Kenosha County Non-Structural (Comprehensive Plan)	Comprehensive	$1,189,000	Nominal	$43,000
Cook County Non-structural (Comprehensive Plan Increment)	Comprehensive	$3,106,000	Nominal	$113,000

[1]The NED and CAP Plans only include indicated projects. The Comprehensive Plan includes NED, CAP, and non-policy compliant projects (DPBM04, FPCI01, and non-structural along portions of tributaries that do not meet the 800 cfs criteria)

[2] Economic Costs include implementation, preconstruction engineering and design, supervision and administration, estimated lands and damages, and Interest During Construction.

[3]DPRS04, DPLV09, and Cook County Non-Structural include cost-shared recreation features.

(FY2015 Price Level, FDR 3.375%)

4.7.3 Long-Term Risk

The FRM measures identified for inclusion in the Recommended Plans are designed to maximize the net benefits at that site. Levees and floodwalls are often perceived as total protection from flood risk; however, with the implementation of any FRM measure, there will be remaining residual risks of flooding due to the chance of extreme events exceeding the design capacity.

The HEC-FDA model used to calculate FRM benefits also calculates the long-term risk associated with implementation. The risk associated with the two levees selected for inclusion in the FRM plans is presented in Table 4.33. The table presents the data in three ways to more completely depict the risk associated with each project. The annual probability of flooding is the chance that the top of the levee will be reached in any year. The long term risk of flooding shows the likelihood that the levee or floodwall will be overtopped at least once during a 10, 30 , or 50 year period. The conditional probability of flood avoidance (also known as the conditional non-exceedance probability) is the percent chance that the structure will *not* be overtopped during a variety of flood exceedance probabilities.

The risk presented in the table reflects the design analysis and hydraulic modeling conducted to date. Geotechnical analyses have not been conducted. Due to the fact that the levee designs will be required to follow current guidelines there is little additional risk from the geotechnical analysis. During the design phase, the analyses of each structure will be further developed, refining the assessment of the long-term risk.

A preliminary evaluation of levee superiority and overtopping considerations was conducted for each proposed levee sites. The intent of this analysis is to ensure that risk to life-safety is minimized as required by ER 1110-1405 and ETL 1110-2-299. A summary of the evaluation for each site is provided below.

DPLV01 parallels the river for approximately one third of a mile tying into high ground at both ends. The current design of the levee is at one elevation, therefore it would overtop at the upstream tieback which will be incorporated in a road raise. This hardened road surface would provide additional protection against sudden levee failure. There would be broad sheet flow as the levee cell fills to the level of the river. It is unlikely that a breach will form as the levee fills, as the levee is a substantial structure that serves as a roadway. The area protected by the levee consists of dense residential development and there are no available undeveloped sites. Any overflow, regardless of the location, will fill the low lying area along the portion of the levee that parallels the river first. Use of the hardened road raise as the current location of the overflow provides an optimal overtopping location for this small levee system.

DPLV04 and DPLV05 both parallel the river for just over a mile, tying into high ground at both ends. The current designs for these levees are each at one elevation unique to that project, so overtopping would occur first at the upstream end. River Road provides a significant setback buffer of approximately 200 feet between the levee and residential and commercial structures in the areas of primary overflow for both levee systems. The low lying areas that would fill first lie between the levee and River Road, where there are no structures. River Road would act as a natural energy dissipater and provide additional erosion protection riverward of structures in the event of a breach, giving added protection for the structures which are all located west of River Road.

DPLV09 parallels the river for approximately two miles, tying into high ground at both ends. Because the design water surface profile drops over two feet across this levee reach, the current design of this levee is stair-stepped into four crest elevations. The extent of each of the four segments is: from the railroad tie in at the upstream/north end to Algonquin Road, Algonquin Road to Oakton Avenue, Oakton Avenue to approximately 1,000 feet downstream/south of Oakton Avenue, and from that point to the tie in at the Interstate 94 interchange. With the current design, overtopping would likely occur at the ends/break points of the elevation changes. At the upstream end at the railroad, River Road provides a buffer of only about 100 feet. At the Algonquin and Oakton breakpoints, there are structures between fifteen to twenty feet from the proposed floodwall. Due to this higher level of risk, some adjustments to these break points will be investigated during the design phase. Possible locations for planned overtopping include road crossings along the levee alignment such Oakton Avenue or the small lake between Algonquin and Oakton.

The levee design and locations of likely and planned overtopping will be coordinated with the impacted communities. For all sites, USACE will partner with the non-Federal sponsors and local communities to develop appropriate warning, response, and evacuation plans.

The potential impacts of climate change on the long term risk were also evaluated as discussed in Section 3.2.6.

Table 4.33 – Levee/Floodwall Long Term Risk (Analysis Year 2020)

		Site ID			
		DPLV01	**DPLV04**	**DPLV05**	**DPLV09**
Annual Probability of Flooding	Median	0.01%	0.01%	0.01%	0.01%
	Expected	0.002%	0.002%	0.002%	0.02%
Long-Term Risk of Flooding (years)	10	0.02%	0.02%	0.02%	0.02%
	30	0.05%	0.05%	0.06%	0.1%
	50	0.09%	0.09%	0.10%	0.10%
Conditional Probability of Flood Avoidance by Events (Annual Percent Chance of Exceedance)	10%	100%	100%	100%	100%
	4%	100%	100%	100%	100%
	2%	100%	99.9%	99.9%	100%
	1%	100%	99.7%	99.6%	100%
	0.40%	99.9%	99.3%	99.1%	99%
	0.20%	99.9%	99.1%	99.0%	99%

4.7.4 Residual Risk

Implementation of this Flood Risk Management Plan will provide significant relief to communities in the watershed at risk of flooding. However, it is important to emphasize that the plan does not address all potential flood damages in the watershed and that even where potential flood damages are addressed, risk of flooding remains.

The Upper Des Plaines River watershed is very large and the impact of storm events varies according to the location, duration, and intensity of rainfall. Communities in the watershed use the established river gage network to monitor potential flood events. Using National Weather Service forecasts for rainfall and stages at gages in the watershed, communities respond according to procedures outlined in their Flood Hazard Mitigation Plans. As discussed above, flood warning and response plans will be developed for each recommended levee project to supplement the existing community response plans. The plans will address the installation of any required closure structures, monitoring of flood levels, and plans for emergency response and/or evacuation in the event of levee overtopping or failure. These plans will be developed in conjunction with the non-Federal sponsors and the local community concurrent with development of Operations and Maintenance manuals.

Should a levee overtopping event occur, there are risks associated with the inundation of homes and businesses as well as access to evacuation routes. In areas where homes and businesses are floodproofed, evacuation in the event of a flood remains as a significant concern. Fatalities that have occurred in the watershed during flood events have been associated with flooding in homes, evacuation, and access to emergency services. Due to the flat topography of the watershed, high velocity overbank flooding is unlikely, so primary risks are associated with the length of the warning time and the depth and duration of flooding.

The amount of warning time available to a community for execution of evacuation plans varies, and can be as little as a few hours in advance of a flood event, but is typically about a day prior to significant flooding. Similarly, the duration of a flood can vary as well, lasting from a few hours to a few days. Longer duration flood events will build slowly before reaching the peak stage and receding.

If an overtopping event occurs during an extreme flood event, the majority of flooding would occur on surface streets and in basements. The majority of structures protected by the levees are homes, as shown in Table 4.34. and the inundation can last several days. During this time, access to structures by emergency vehicles is limited, and boats or helicopters would be used to access stranded residents.

Table 4.34 – Summary of Structures Behind Levees

		Type of Structure				
		Residential and Apartment		Commercial, Industrial, and Public		Maximum Flood Depth (ft above First Floor Elevation)
Levee	# of Structures	Number	Percent	Number	Percent	
DPLV01	73	72	99%	1	1%	4.6
DPLV04	196	177	90%	19	10%	3.6
DPLV05	108	68	63%	40	37%	3.9
DPLV09	558	504	90%	53	10%	3.2

In addition to the areas where flood risks are reduced, discussed above, there are many areas in the watershed where flood risk is not reduced. It is estimated that the Comprehensive Plan would reduce watershed flood damages by approximately 27%. The NED Plan would only reduce those damages by 19% and the CAP Plan would reduce an additional 1% increment of flood damages. The majority of the flood risk reduction is along the Des Plaines River, with some additional risk reduction in tributary watersheds. Additional detail regarding the residual risk can be found in Appendix E (Economics).

5 Ecosystem Restoration

5.1 Ecological History & Setting

The ecology of the watershed has been severely impacted since the late 1800s through modifications to land use, geomorphology, hydrology, and hydraulics. Typical of highly urbanized and agricultural areas, human modification to the landscape has negatively affected and altered the native communities of the watershed. Accordingly, a large portion of the native floral and associated faunal communities were lost. Only 9% of the current land use is natural open space; however, most of these areas have become degraded and overrun with non-native and invasive plant species. Riverine communities are valued as "moderately to highly degraded" through fish community assessment. Eutrophication, sedimentation, geomorphic manipulation and changes in the hydrologic regime has allowed for the establishment of invasive plant species within all community types of the watershed, thus having created habitats that favor generalists over specialists, thereby decreasing or eliminating foraging and breeding habitat for native fauna.

Their establishment in a significant portion of the watershed has created monospecific stands of reed canary grass (*Phalaris arundinacea*), common reed (*Phragmites australis*), and cattail (*Typha sp.*) that have entirely displaced native vegetation and severely disrupting the structure and function of the watershed. Some of these invasive plant species, such as buckthorn, have also impaired fluvial geomorphic functions and soil quality. Fire suppression and hydrologic impairments have allowed most open habitats such as prairies and savannas to succeed into degraded woodlands, inhibiting critical interrelationships between the watershed's flora and fauna. The riverine system is also fragmented by 21 significant dams or structures, which have negatively affected riverine community diversity when compared to reaches below the most downstream dam that are not fragmented.

Additionally, Illinois and Wisconsin have 36 bird, 3 reptile, 1 amphibian, 5 insect, 5 fish, 4 mussel, and 31 plant species listed as State threatened or endangered. Most large mammals, including the American bison, had been hunted to local extinction and several bird species such as the sharp-tailed grouse and the yellow rail have vanished from the basin. Forty-three mammal species are still known or are thought to still occur here, along with 16 amphibian,23 reptile, and about 270 bird species (Krohe 1998).

Before European settlement, the Upper Des Plaines River and associated streams had catchments. As with most natural processes in the region and elsewhere, human modifications to landscape vegetation negatively affect and alter the natural hydraulics and hydrologic regime of wetland and riverine systems. Accordingly, a large portion of the native vegetation and associated faunal communities have been lost to agricultural, urban or industrial conversion. Most historic records suggest that there were four major types of plant communities present in the study area. The communities that were once located within the study area are described in detail below; Table 5.1 provides a summary of the types of communities.

Table 5.1 – Habitat Types/Plant Communities of the Upper Des Plaines River Watershed

Community / Habitat Type	General Location	General Hydrology
Prairie	Flat- to mid-slopes, adjacent to wetlands	dry-mesic; mesic; wet-mesic; wet
Savanna	East and north facing slopes	dry-mesic; mesic; wet-mesic; wet
Woodland	Riparian	dry-mesic; mesic; wet-mesic; northern flatwoods
	Floodplain	mesic; wet-mesic; wet
Wetland	Isolated depression/floodplain depression	marsh; shrub swamp; calcareous floating mat
		fen; graminoid fen; sedge meadow; seep
Riverine	Stream	medium gradient; low gradient
	River	medium gradient; low gradient
Other	Lake	glacial; artificial
	Ponds	vernal; artificial
	Ruderal (human induced)	urbanland; cropland; pastureland; successional fields

The two most dominant types of habitat were oak savanna and prairie, with lesser amounts of wetland and woodland. Forest communities in southern Lake County and Cook County were situated along the east side of the Des Plaines River along with small pockets of savanna, prairie, and marsh. Areas west of the river, being exposed to fire, were predominately prairie, marsh, and savanna. According to the General Land Office survey conducted in 1820, the Upper Des Plaines River watershed was made up of about 40% prairie and 60% savanna and forest (Anderson 1970). These savanna and prairie communities were largely dependent on fires, varying in frequency and intensity. Half of Lake County was historically savanna; today's acreage of high quality savanna is almost non-existent (Table 5.2). However, degraded savanna habitat still exists across the basin. Nearly 90,000 acres of prairie are believed to have been present in 1840, of which currently only about 18 acres are considered as high-quality. The basin is predicted to have about the same amount of forest as would have been present prior to 1840, however, only 343 acres is considered to be in an undisturbed state of high ecological quality (Krohe 1998). Most wetlands in the study area were comprised of wet prairie, sedge meadow, floodplain forest, and prairie pothole marsh. Assuming the watershed had a similar proportion of wetlands compared with Lake County, presettlement acreage of wetlands would be roughly around 57,600 acres (26 percent) (IDNR 1998).

Table 5.2 – Plant Community Change from Pre-European Settlement to Present Conditions

Community / Habitat Type	Wisconsin		Illinois	
	1800s	**Present**	**1800s**	**Present**
Prairie	26%	5.3%	34%	9%
Savanna	17%	0.0%	27%	~0%
Woodland	43%	5.6%	13%	18%
Wetland	14%	8.0%	26%	6%

The Upper Des Plaines study area currently includes twenty sites identified by the Illinois Natural Areas Inventory (INAI) as natural areas with significant features, with an additional six sites occurring at or near the basin's boundary. Fourteen of these sites have been identified as Category I (high quality, undegraded) natural areas, containing twenty-one high quality remnants of ten different natural communities; a total of 440 acres. These high quality, remnant natural communities include marsh, sedge meadow, graminoid fen, calcareous floating mat, wet prairie, wet-mesic prairie, mesic prairie, northern flatwoods, mesic floodplain forest, mesic forest, and dry-mesic forest. The remaining natural areas were identified as Category II (threatened and endangered species localities). The total area of all Category I and II INAI natural areas, including buffer areas, totals about 2,271 acres (IDNR, 1998).

The study area also contains nine sites that are dedicated as Illinois Nature Preserves, totaling 1,475.7 acres with eight occurring in Lake County and one in Cook County (440 acres). Nature Preserves exist to protect and preserve significant natural features for the purposes of conserving biodiversity, scientific research, education, and esthetic enjoyment. These nature preserves as well as the INAI and other natural areas are vital to the Upper Des Plaines study area as there are no state or federally-owned parks, conservation areas, fish and wildlife areas, or forest preserves within the watershed (IDNR 1998).

5.2 Ecosystem Inventory and Forecasting

Consideration of ecosystems within or encompassing a watershed provides a useful organizing tool to approach ecosystem-based restoration planning. Ecosystem restoration projects that are conceived as part of a watershed planning initiative or other regional resources management strategies are likely to more effectively meet ecosystem management goals than those projects and decisions developed independently. Independently developed ecosystem restoration projects, especially those formulated without a system context, partially and temporarily address symptoms of a chronic/systemic problem. This section outlines the past, present and FWOP conditions of the Upper Des Plaines River watershed's biological and human environment.

In order to derive the current, FWOP and future with project (FWP) ecological value of the Upper Des Plaines River watershed, both as a whole and in significant pieces, several specific assessments/surveys were completed. Assessments conducted included a riverine survey of fish assemblages and habitat, and a vegetation survey to obtain a general trend of species richness, plant community quality and plant community structure in terms of wildlife habitat. All of these data collected from these surveys were used to develop a watershed specific Habitat Evaluation Procedure (HEP) model and Hydrogeomorphic Model (HGM). These surveys and results are detailed in Appendix C – *NER Plan Formulation*, HEP documentation section:

- Burks-Copes, K., A. Web. 2009. Community Models for the Upper Des Plaines River Watershed, Illinois and Wisconsin. ERDC/EL TR-SWWRP-09-X.
- Jeff P. Lin. 2009. A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Depressional Wetlands in the Upper Des Plaines River Basin. ERDC/EL TR-06-4.
- Veraldi, F.M., S.M. Pescitelli, & T.M. Slawski. 2005. A Survey of Riverine Fish Assemblages and Habitat of the Upper Des Plaines River System.
- Slawski, T.M., F.M. Veraldi, S.M. Pescitelli, and M.J. Pauers. 2008. Effects of Tributary Spatial Position, Urbanization, and Multiple Low-Head Dams on Warmwater Fish Community Structure in a Midwestern Stream. North American Journal of Fisheries Management: 28:1020-1035.

5.2.1 Riverine Survey

Fish community and habitat surveys were conducted in the Upper Des Plaines River system to determine the current status of fish species distribution, to assess overall stream quality and to evaluate the potential for ecosystem restoration. During the period from 2002 to 2004, forty-nine sites upstream of Salt Creek in Illinois and the entire watershed in Wisconsin were surveyed for fish species richness, biological integrity and riverine habitat. Fish and habitat survey results suggest Newport Ditch, Kilbourn Road Ditch, Brighton Creek, Bull Creek, Center Creek and the Upper reaches of the Des Plaines River subwatersheds have areas of high ecological quality.

Fishes. Forty-three native species of fishes were found; twenty-three less than the reconstructed pre-settlement fish assemblage, which was based on historic records and voucher specimens (Appendix C, p.343, Table 9). One species not native to the Upper Des Plaines River system and four species not native to the North American continent were also present.

5.2.2 Vegetation & Wetland Surveys

In order to assess the current conditions of the various native cover types, classified by soil, hydrologic and plant community characteristics (e.g., wet prairie, northern flatwoods), that could be restored, systematic and statistically robust sampling methods were developed. The main focus of the data collection was to ensure proper calibration of the plant community index for the HEP model. Reference sites were chosen based on the range of variability that occurs throughout the watershed, high quality though degraded. In addition, reference sites were chosen based on their predominant cover type. This is to ensure a robust assessment of the range of function among specific cover types. Reference sites represented a range of conditions, from low disturbance (high quality) to high disturbance (low quality), based on the amount of human activity within the site. Reference cover type assessment was used to calibrate the HEP and HGM models. The variables chosen to measure through empirical data collection represent ecological functions and biological community structures known to affect the ecological integrity of the specific cover types. In other words, there is a relationship that can be mathematically quantified between the measured variable and the overall quality and health of the biodiversity contained within the watershed. The sampling scheme was designed to optimize the precision with which each variable was measured. The sampling scheme was also developed with the ability to appropriately calculate the Floristic Quality Index (FQI), which is treated as a variable within the ecosystem models.

5.3 Ecosystem Analysis

Ecosystem is a term used to describe organisms and their physical and chemical environments and can be described and delineated at various scales. For example, a pond or an ocean can be equally referred to as an ecosystem. Communities are naturally occurring groups of species that live and interact together as a relatively self-contained unit, such as a sedge meadow. Habitat refers to the living space of an organism or community of interacting organisms, and can be described by its physical or biotic properties, such as substrate, woody debris or depression. Ecosystems may contain many communities and habitat types. These are usually assessed by describing and/or quantifying the physical structure, function and/or present organism community contained in the area of interest. They may also be assessed at various scales, depending on the level of resolution needed to answer specific questions.

To achieve the objectives of the proposed project, the different types of ecosystems or communities, referred to as cover types, contained in the study area were described and delineated based on their respective geomorphic position, soils series, dominant species assemblages and physical structure of respective habitats. Biodiversity is a term that is used to describe all aspects of biological diversity including species richness, ecosystem complexity and genetic variation. Biodiversity is decreased through the loss of hydrogeomorphic function, fluvialgeomorphic function, native vegetation loss and land use change, which in turn leads to a reduction in ecosystem complexity. These are manifested through a decreased level of natural services such as flood moderation, maintenance of adequate water quality, wildlife habitat, etc. For this study, a period of analysis of 50 years was used.

Historically, the Upper Des Plaines River watershed was dominated by several naturally occurring cover types such as wetlands, forests, savannas and prairies. By the late 1800s, many of these cover types, particularly prairies, savannas and wetlands, were converted to agricultural, urban or industrial use. Subsequently, there was a significant loss of biodiversity within the last hundred plus years. Furthermore, the remnant parcels of natural cover types are under pressure from continued human activities. Human induced disturbances to the remaining natural areas include fire suppression, altered hydrology, increase colonization of invasive species and fragmentation. While cover types can be described in terms of dominant organisms, the quality of their habitat is directly related to the level at which natural processes function, such as groundwater discharge, fire or fluvial erosion and deposition. Habitat quality displays a negative relationship to the amount of human disturbance, in which the disturbance affects natural areas in direct or indirect ways.

For this study, a period of analysis of 50 years was used. The projected without project conditions during this time period are discussed in Section 5.3.2.

5.3.1 Habitat Assessment Methodology

Many methods and models are available to measure ecosystem function and structure and to predict their future conditions base on differing scenarios. Habitat models developed for individual species may have limitations when used to assess more holistic ecosystem problems and restoration objectives. Individual species models do not include consideration for communities of organisms and typically consider habitat in isolation from its ecosystem context. The assessment methodology chosen for this study is community based and meets the needs of the study goals, objectives, and level of detail. The assessment methodologies, Habitat Evaluation Procedure (HEP) and Hydrogeomorphic Wetland Assessment (HGM), focus on specific habitat parameters designed to capture changes in function, structure and health of the ecosystems within the Upper Des Plaines River watershed. These methodologies were developed with the Corps Environmental and Research Development Center (ERDC).

The baseline condition, FWOP condition, and future with proposed alternatives were evaluated with a consistent and quantifiable set of environmental metrics to allow for comparison of outputs and costs. A multi-agency working group was formed to aid ERDC in the development of these numerical models that serve as a quantifiable description of project outputs. This group, also known as the Ecosystem Team (E-Team), consists of biologists from:

SEWRPC	LCSMC	FPDCC
LCFPD	ISWS	IDNR
NRCS	USFWS	USACE

A detailed description of the assessment methodologies, modeling and variable sampling procedures are provided in Appendix C:

- USACE. 2005. A Survey of Riverine Fish Assemblages and Habitat of the Upper Des Plaines River System.
- USACE. 2006. A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Depressional Wetlands in the Upper Des Plaines River Basin.
- USACE. 2009. Community Models for the Upper Des Plaines River Watershed, IL and WI.

Two methods were used to quantify the quality of identified cover types, the Habitat Evaluation Procedure (HEP) and the Hydrogeomorphic Assessment of Wetlands (HGM). Both methods have a long history of use by several federal, state and local agencies and have been used extensively throughout North America. The HEP methodology uses an ecologically based mathematic model called the Habitat Suitability Index (HSI). In the past, the HSI was primarily used for a single species' habitat requirements; however, the model has evolved to utilize multiple species or community level characteristics to assess the quality of habitats. The HGM method utilizes a model referred to as the Functional Capacity Index (FCI), which is an ecologically based mathematical model, derived from the assessment of physical and biological functions of wetlands. This study uses the FCI to assess the functionality and quality of isolated and floodplain wetlands, while other cover types are assessed using the HSI model. Both models were developed and calibrated specifically for the study area.

Cover type (Table 5.3) quality was quantified by measuring an array of habitat variables through data collection from reference sites, previous scientific studies, and historical accounts. Variables are attributes of the habitat that can be directly measured such as, species richness (number of species), proportion of edge to core area of the habitat, source of water, and type of adjacent land use practices. Typically, several measures of each variable are taken for each cover type contained within the designated sampling site. The arithmetic mean was then calculated per variable per cover type. Each variable per cover type is normalized by assigning a score based on Suitability Index (SI) curves, where scores range from 0.0 (lowest quality) to 1.0 (highest possible quality or optimum range), are based on data collected in the field and are calibrated according to the range of variable means measured from natural areas displaying the least disturbance within the study area. The variable scores are then aggregated step-wise into mathematical formulas to generate a geometric mean that numerically represents the quality of each cover type, again ranging from 1.0 to 0.0.

Table 5.3 – Des Plaines River Watershed Habitat Cover Types

Acronym	Cover Type	Community Type	Assessment Method
LAKEGLACL	glacial lakes	Natural	HGM / Isolated Depression
STREAMS	rivers & streams	Natural	Riverine / IBI - QHEI Indices
MARSHBASIN	basin marshes	Natural	HGM / Isolated Depression
MARSHSTRMS	streamside marshes	Natural	HGM / Floodplain Depression
MEADOW	sedge meadows	Natural	HGM / Isolated Depression
FENS	fens	Natural	HGM / Isolated Depression
PRAIRIEDRY	dry & mesic prairies	Natural	HEP Prairie Model
PRAIRIEWET	wet prairies	Natural	HEP Prairie Model
SAVANNADRY	dry-mesic & mesic savannas	Natural	HEP Savanna Model
SAVANNAWET	wet-mesic savannas	Natural	HEP Savanna Model
WOODLNDDRY	dry-mesic & mesic woodlands	Natural	HEP Woodland Model
FORFLPLWET	wet-mesic & wet floodplain forests	Natural	HEP Woodland Model
FORNFLATS	northern flatwoods	Natural	HEP Woodland Model
FORUPLWET	wet-mesic forests & woodlands	Natural	HEP Woodland Model
LAKEARTIFC	artificial lakes	Anthropogenic	HGM / Isolated Depression
DETENTION	detention ponds & borrow pits	Anthropogenic	HGM / Isolated Depression
AGCROPLAND	agricultural croplands	Anthropogenic	HEP Prairie Model
PARKS	parks, open recreation	Anthropogenic	HEP Prairie Model
PASTURES	pastures, haylauds and urban fields	Anthropogenic	HEP Prairie Model
URBAN	urban lands (residential, roads, etc)	Anthropogenic	HEP Prairie Model

Baseline data (i.e., curve calibration is the standard protocol for the HEP/HGM methods) was developed from the average of the variable data collected from all the reference sites in the field for a specific cover type. In some instances, the county average of the variable data for a specific cover type was used. Ultimately, the curves developed for the watershed were the result of an iterative process where the E-Team (Interagency Ecosystem Assessment Team) directed the model developers (Burkes-Copes and Webb 2009) to refine the curves to better reflect reality as they perceived it "in-the-field". These changes are a part of the standard protocol implemented during the HEP/HGM process and are documented in Burkes-Copes & Webb 2009, found in Appendix C. In the documentation, curves that had been altered as directed by the E-Team "expert judgment" are presented as "red" curves in the graphs and supporting text. For example, after reviewing the preliminary results, the percent forb canopy cover variable curve was adjusted based on the opinion of the E-Team to better reflect the broader watershed conditions. The variable data was then used to calculate HSI/FCI scores for all sites. To achieve overall outputs, the HSI/FCI scores were multiplied by the amount of area within each respective cover type associated with the individual HSI model or HGM subclass. The results from this equation are referred to as Habitat Units or Functional Capacity Units (HU/FCU).

Based on an analysis of soil unit classification descriptions, hydrologic influences and aerial maps of vegetation structure the current condition of the watershed was mapped for the above described cover types. This analysis identified around 5,128 acres of prairie cover type, 3,593 acres of savanna cover type, 22,175 acres of woodland cover type, 6,109 acres of isolated wetland cover type, and 2,288 acres of floodplain wetland cover type identified within the watershed. An average and a range for each variable for each cover type were calculated from the sampled reference sites (Plate 25). A baseline score was generated from the HEP/HGM models using the reference site based variable data for each cover type (Table 5.4). The total baseline Habitat Units, calculated by multiplying the total acres of each cover type by the HSI/FCI score for that cover type is shown in the table.

Table 5.4 – Watershed Baseline Habitat Units

Cover Type	Acres	HSI/FCI	HUs
Prairie	5,128	0.26	1,333
Savanna	3,593	0.19	686
Woodland	22,175	0.40	8,870
Isolated Wetlands	6,109	0.73	4,460
Floodplain Wetlands	2,288	0.72	1,647

The difference between the north (agriculture dominated) and the south half (urban dominated) of the watershed translates into different types and frequencies of stressors effecting the ecological function of natural areas located within the two relatively distinct regions of the watershed. Because of this disparity the HEP and HGM models were developed with two different baselines and future variable projections, one for the south half (urban) and one for the north half (rural). Based on the knowledge that ecological function is heavily influenced by the dominant landscape use, the alternatives developed for sites located within these two regions were also developed separately. However, both urban and rural restoration alternatives were developed based on the same set of measures described in Section 4. The rural alternatives were evaluated using the rural baseline and variable projections for selected sites located within Kenosha, Racine and north Lake Counties. The urban restoration alternatives were evaluated using the urban baseline and future variable projections for sites located in Cook and south Lake Counties.

Two HEP methods were used to assess riverine ecosystems in the Upper Des Plaines River watershed, the IBI and QHEI. The Region 4 Illinois IBI employs fish the assemblage as the indicator of biological form and function. Fish are not only a highly visible part of the aquatic resource, but they are quite sensitive to the surrounding water and habitat quality. This does not suggest that the use of other organisms is insufficient or inappropriate (Simon 1991).

The ambient condition of the Upper Des Plaines River system was evaluated using the IBI (Karr 1981, Karr et. al. 1986, Simon 1991, Smogor 2002). This method makes use of a systematic process to set quantitative criteria that enables the measurement of riverine stream quality. This index employs ten parameters or "metrics" based on structural and functional components of the fish assemblage. Structural components include diversity, taxonomic guilds, and abundance. Functional components include feeding or trophic guilds, reproductive behavior, tolerance to adverse environmental stressors, and individual stresses (Simon 1991, Smogor 2002). These metrics are calibrated for differences in stream size and geographic region. The following 10 metrics may each receive a score 0 to 6, based on comparison to unaltered reference sites, with a total IBI score ranging from 0 to 60 (Smogor 2002):

1. Number of native fish species
2. Number of native Catostomid species
3. Number of native Centrarchid species
4. Number of native intolerant species
5. Number of native Cyprinid species

6. Number of native benthic insectivore species
7. Proportion of individuals as specialist benthic insectivores
8. Proportion of individuals as generalist feeders
9. Proportion of individuals as obligate course-mineral substrate spawners and intolerant
10. Proportion of tolerant species

The Qualitative Habitat Evaluation Index (QHEI), developed by the Ohio EPA was employed to assess the habitat quality of the Upper Des Plaines River system. The QHEI consists of eight criteria with a maximum total of 100 points:

1. Characterization of substrate types and the effects of siltation
2. Characterization of in-stream cover
3. Characterization of channel morphology
4. Characterization of the riparian zone and bank erosion
5. Assessment of the pool / glide & riffle / run
6. Gradient
7. Shade
8. Channel incision

Five transects were completed for each site. The sites were assessed from a river right descending perspective. The transects were dependent and based on the area sampled for fishes and began some distance up or downstream from evident bridge disturbance to the stream; however, the impacts from these structures should be taken into consideration when developing restoration measures. A variable of impoundment was added to the QHEI for this particular study under the channel morphology section to give weight to stream connectivity. If backwater effects from a downstream structure impacted the stream section, a score of zero was received, if the stream section was free flowing, a score of nine was received. Other impacts of dams were indirectly reflected in stream morphology and function parameter.

5.3.2 Future Without Project (FWOP) Conditions

The FWOP conditions in general would continue to degrade in several specific areas including dominance of non-native vegetation, low remnant habitat acreage and overall poor native habitat structure, and visual aesthetics. Invasive species would continue to spread and replace native plant species, creating habitats that favor generalists over specialists, thereby decreasing or eliminating foraging and breeding habitat for native fauna. Acreage of successional woodlands would continue to expand and eventually eliminate rare and significant ecosystems. Any remaining seed banks of remnant habitats would become depleted as fire-suppressed areas with resultant woody growth would continue the current inhibition of their germination. Hydrological processes and nutrient cycling would continue to function in an impaired state, further disrupting and inhibiting critical interrelationships between hydrology and the watershed's flora and fauna.

As the structure and function of the current habitat declines through these stressors, the watershed's ability to supply migratory and resident birds with resting and foraging habitat would decline. The Upper Des Plaines River watershed is a key component of the Lake Michigan Flyway. Lake Michigan's shoreline is acknowledged as a globally significant flyway and one of the most important flyways for migrant songbirds in the United States by ornithologists and bird watchers worldwide. An estimated 5,000,000 migrant songbirds which represents a noticeable fraction of the total number of migrant songbirds moving through the entire North American continent use the shoreline as their north-south reference in addition to many other species of birds. Many migratory birds must pass twice yearly above a continent suffering huge development pressures and offering fewer and fewer productive stop-over sites for birds. Without locations that provide the right kind of high calorie, high protein food such as seeds, fruit and insects and shelter sufficient to protect them from predators and extremes of weather, the long-distance journey becomes more arduous and even fatal. When migratory birds cross into Illinois, they encounter a monoculture of corn and soybean fields throughout most of the state which are not fertile stop-overs.

Analysis focusing on watershed streams and rivers suggests the FWOP condition to be the current present condition. Data from a 30 year period show that stream conditions have not changed much in terms of biological integrity and habitat quality. If no in-stream restoration activities were to occur, these streams would be roughly in the same condition in 50-years based on reasonable foresight. The Hofmann, Fairbanks, Armitage, and Ryerson dams are removed, and the Dan Wright and MacArthur Woods dams (scheduled for removal in 2013) will be removed under the conditions. These actions will improve certain reaches of river, but the five remaining dams still fragment lower system from the upper system. These actions were considered in the future without and with conditions for those sites that would benefit. It was assumed there would be improvement in riverine habitat and an increase is species richness since free flowing hydraulics and fish passage would then be possible. These dams are scheduled to be removed by 2013. There have been no significant riverine restoration projects in the past nor are any reasonably foreseen within the 50 year period of analysis.

In the broader sense FWOP conditions would observe lost opportunities for significant mitigation of greenhouse gas emissions and sequestration of carbon dioxide through wetland restoration. The declining health of the ecosystem and continued reduction of remnant natural communities will also reduce opportunities for research, education, recreation, and aesthetic pleasures.

The problems associated with the watershed are system-wide; therefore, a systems approach to large-scale restoration of native vegetation cover is needed to develop holistic solutions for the Upper Des Plaines River watershed. The study area is politically diverse and the development of system-wide solutions would be very difficult without Federal involvement. A piece-meal approach to addressing watershed problems will not effectively solve or moderate these wide spread issues. There is limited local funding to properly restore the watershed's ecology with sustainable and beneficial habitats. If an initiative were taken by one township or municipality to implement a restoration project, it would not address the overarching problems plaguing neighboring communities within the watershed. This Phase II study affords the opportunity to implement a comprehensive watershed plan, which can only be realized by concurrently leveraging federal and local resources. A watershed approach will help moderate the negative effects of human alterations to the landscape and will effectively reverse or severely limit the long-term trend decreasing biodiversity.

Future without project conditions were modeled with the Riverine, HEP, and HGM models. FWOP conditions are expected to decline minimally without restorative intervention. The reason for the assumption, of minimal decline, is because of the current low quality of the majority of open space within this watershed, which has been described in the above sections. This is to be expected based on massive land cover conversions and habitat fragmentation as a result of intensive anthropogenic activities. The riverine model output is presented as an example of FWOP conditions in comparison with FWP conditions based on the five alternatives that integrate riparian modifications (e.g., stream remeandering, dam removal, etc.). Model output is presented as average annual habitat units (AAHUs). For instance, the riverine model has an output of 1,737 AAHUs for FWOP for all sites under consideration. All restoration alternatives (Alt5-Alt9) result in an increase in AAHUs, which indicates that restorative actions will increase the overall quality of the riverine and riparian zone and provide benefits to the environment.

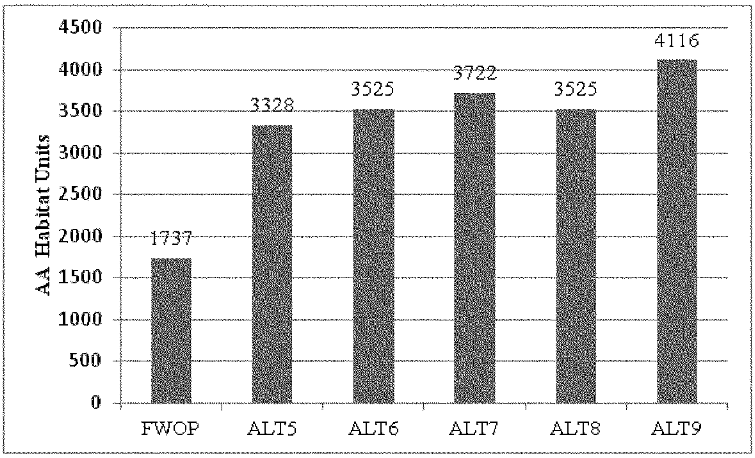

Figure 5.1 – Riverine FWOP vs. FWP Model Output Comparison.

While climate change could have an impact on the future conditions in the watershed, native plantings have an associated risk of not establishing due to a variety of unforeseen events. Predation from herbivorous animals and insects is a possibility and can be reasonably estimated based on baseline surveys of the existing flora and fauna. However, weather also plays a large role in the establishment success of new plantings. Periods of drought or early frost may alter the survival percentage of plantings. Although historical records can help to predict the best possible location and timing of new plantings, single unforeseen events may lead to failure. To mitigate these risks, planting over several years, overplanting and/or adaptive management and monitoring may be incorporated into the overall plan. In addition, climate change in the years to come may play a role in impacting the project outputs. Increased temperatures or rainfall may lead to changes in the ecosystem of the project area; however, in this study area Lake Michigan can drive weather patterns in the Chicagoland area and will partly buffer /mitigate changes to ecosystems as a result of climate change.

5.4 Ecosystem Restoration Plan Formulation and Evaluation

The formulation, evaluation, and comparison of alternative plans comprise the third, fourth, and fifth steps of the Corps' planning process. These steps are often referred to collectively as plan formulation. Plan formulation is an iterative process that involves cycling through these steps to develop a reasonable range of alternatives, and then narrow those plans down to a final plan, which is incrementally cost effective for implementation.

Plan formulation for ecosystem restoration (ER) presents a challenge because alternatives have non-monetary benefits. The methodology outlined in the Corps' Engineering Circular 1105-2-404, "Planning Civil Work Projects under the Environmental Operating Principles," 1 May 2003 was used to guide the formulation process. These principles, reissued in October 2012, are defined in Section 9.6.2. The steps in the methodology are summarized below:

1. Identify a primary project purpose. For this portion of the study, ecosystem restoration (ER) is identified as the primary purpose.
2. Formulate management measures to achieve planning objectives and avoid planning constraints. Measures are the building blocks of alternative plans.
3. Identify and select those sites most beneficial for ecological restoration.
4. Formulate, evaluate, and compare an array of alternatives to achieve the primary purpose (ER) and identify cost effective plans.
5. Perform an incremental cost assessment on the cost effective plans to determine the NER plan.

5.4.1 Ecosystem Restoration Measures

Ecological restoration measures are the basic building blocks for developing alternatives. Some measures, such as dam removal, stand on their own and provide significant ecological output. Others, such as invasive species removal and soil nitrogen depletion, are dependent on each other to support restoration. All measures include activities requiring Corps expertise to restore ecosystem structure and function over the entire evaluated footprint. Only lands needed for restoration activities were identified for acquisition. The goal of aquatic ecosystem restoration is to provide stream, wetland, and riparian habitat for higher level organisms such as fish, amphibians, reptiles, birds and mammals. The quality and success of these habitats and resultant colonization is dependent on the three fold interaction between hydrology-hydraulics, geomorphology-soils, and plant-fungus-microbe structure. Measures were identified that would result in synergy between these critical aspects to achieve sustainable and functioning ecosystems within the Upper Des Plaines River watershed.

5.4.1.1 Hydrologic Restoration Measures

These restoration measures would result in the repair of hydrologic functions as a first effort to store water naturally and to restore native plant communities that are characteristic of the site. This group of measures would include tile breaking, ditch filling/plugging, removing soil compaction. Hydrologic restoration would be quite beneficial in enhancing soil infiltration, reducing initial runoff and increasing base flow during dry periods.

H1 Tile Disablement: Agricultural drain tile fields are known to exist throughout the Upper Des Plaines River watershed. These effectively disrupt the natural hydrologic regimes of both the and the wetlands, especially in the large marsh basins in the headwaters. Tile disablement is one of the best and most cost effective methods of hydrologic restoration. This is because it typically recreates the natural hydrologic regime of the site, the one to which the species native to the site are adapted, and does not require intensive maintenance in most cases.

There are several methods for the disablement of drain tile and their applicability varies from location to location. In flat lands, tiles are typically valved and/or crushed at select intervals. In more rolling topography, plugs are installed much closer. Disablement could also be accomplished by excavation and removal of the tile from the entire field; however, this would require significant site disturbance. Installation of valves and/or plugs, which requires very little disturbance, has been shown to be equally effective. It should be noted that many drain tiles eventually collapse in the absence of maintenance and replacement. Use of valves and plugs also allows for adjustment of the design to avoid negative impacts to neighboring properties.

H2 Ditch Filling / Plugging: Agricultural ditches are located throughout the Des Plaines River watershed. These effectively disrupt the natural hydrologic regimes of native plant communities, especially when natural streams were excavated. Ditch filling and plugging is another cost effective method of hydrologic restoration. These measures will typically recreate the natural hydrologic regime and landscape of the site and do not require periodic maintenance, thereby maximizing biodiversity and minimizing future artificial disturbances to the site.

There are several methods for ditch remediation and their applicability varies from location to location. Small ditches that were never a natural drainage channel could easily be filled with a small dozer by pushing fill into the ditch and finishing to landscape grade. Large unnatural ditches can be plugged with earth or structures, the result would include a long open body of water that is not characteristic of the landscape-aimed restoration. A ditch that was once a natural stream may be remedied through the stream restoration measure described in H3.

The decision whether to implement ditch filling or plugging depends on a number of site specific factors that will be uncertain until detailed analysis is completed during the design phase. The critical factors in feasibility level decisions are whether restoring the hydrology will provide benefits, whether the anticipated costs are justified, and whether adverse effects can be avoided. Although ditch filling is the preferred restoration method, the feasibility level cost estimate assumes a combination of ditch filling and plugging to account for adaptation to site conditions and design requirements.

H3 Cobble Riffle as Naturalization Structures: Cobble riffles can be installed to raise the water levels in ditches and channelized streams and to prevent further channel incision. Adjusting the riffle crest to the desired elevation would influence the ground water table upstream of the riffle, while allowing for fish passage. The placement of a riffle would also increase habitat diversity in terms of substrata and flow. Compared to the uniform flow conditions of a channelized reach, cobble riffles increase and diversify the velocity of flow, which in turn increases the complexity of in-stream habitat, which is essential for a diverse riverine community. These riffles provide substrate and flow velocity for microorganisms and macroinvertebrates, and improve water quality by facilitating gas exchange.

These riffles would be created from alluvial material consisting of boulders, cobbles, and gravel resembling substrates of the region, and would be sized properly to withstand peak discharge events. Riffle material would be deposited at a staging area at the restoration site, sorted by stone size, and then placed in the river to specified elevations.

H4 Soil Compaction Removal: Compaction is a mechanical process that increases soil density or unit weight, accompanied by a decrease in interstitial space for air and water percolation and subsurface flow. Agricultural fields become compacted overtime from machinery. Compaction discourages the growth of native plant species and disrupts hydrology by ponding too much water or not allowing natural subsurface groundwater process to occur.

Minor soil compaction can be relieved through aeration, which consists of the removal of small plugs of soil to make space for aeration and water transfer. More significant soil compaction can be alleviated through disking or deep plowing.

H5 Excavation: This measure would focus on removing layers of sediments that currently cover natural soil types or removing layers of soil to achieve proper hydrology (in particular to remove beds of reed canary grass *(Phalaris arundinacea)*. Layers of sediment may have accumulated over the years due to poor erosion control methods and the lack of Best Management Practices. Removing these depositions would aid in the restoration of native plant communities and may expose the native seed bank below. Removing layers of soil that have fully established beds of reed canary grass may be necessary if a native plant community is to be restored. By removing the seed contaminated layers and creating areas of standing water would create situations that do not favor this highly invasive species.

H6 Impervious Surface Removal: This measure would remove old parking lots or former roads where native habitat could be restored. Very few sites would be in need of this measure.

5.4.1.2 Riverine Restoration

R1 Dam Removal / Bypass: Most of the dams and impoundments within the Upper Des Plaines River system are classified as small, run-of-the-river low-head dams. Very few of these dams currently serve a purpose and were constructed in the past to service gristmills and recreational pools. This measure would address the resource problems associated with dams that impound and fragment streams and rivers. Dam removal will benefit fish passage, habitat restoration and water quality. This measure applies to the mainstem Des Plaines River dams for complete removal only.

R2 Sinuosity Reestablishment: A method to restore a previously channelized section of a stream first involves deciphering historic flow paths to return the stream to a sinuous form, and if possible to re-engage the stream or river with its floodplain. Historical aerial photographs and topographic maps of the reach may be used to determine where the original channel geometry was located prior to channelization. The historic stream valley may also be used to identify topographic elevations and soil types.

Methods used to restore stream sinuosity are physically meandering the stream by excavating a new channel or simply setting the stream back in motion, allowing natural processes to restore meanders. Channel excavation requires significant environmental disruption and has much higher costs than natural meandering. Therefore, natural meandering is the method selected for this study. The stream channel would be redirected with a series of directional riffles. A temporary, quasi-graded floodplain would allow the stream to establish its functions more quickly. The shifting habitat mosaic of the riverine system may again be established by restoring cut and fill alleviation and returning stream power to the floodplain. At sites where this is not possible, such as urban / residential streams, bank terracing and stream grade control will be considered, as described below.

Restoring natural instream complexity includes the addition of large and/or small woody debris from natural sources to the stream channel. Woody debris and large boulders are essential for pool formation, exposure of hard substrates, flow velocity diversification, and cut and fill alluviation. Removal of riprap and foreign debris from the stream channel will actually increase the natural stream complexity by allowing cut and fill alluviation to go unimpeded. Riparian corridors may be restored in varying widths, which are dependent on site characteristics and other restoration features, such as plant community restoration. This measure would restore riverine habitat that could be recolonized by native herpetofauna, fishes, mussels and macroinvertebrates.

R3 Cobble Riffles: Riffle-pool sequences are one of the preferred methods to restore degraded agricultural and urban stream habitat, and to prevent further channel incision. The placement of a riffle would increase habitat diversity in terms of substrata and flow. Compared to the uniform flow conditions of a channelized reach, cobble riffles increase and diversify the velocity of flow, which in turn increases the complexity of in-stream habitat, which is essential for a diverse riverine community. These riffles provide substrate and flow velocity for microorganisms and macroinvertebrates, and improve water quality by facilitating gas exchange.

Riffles would be created from alluvial material including boulders, cobbles, and gravel resembling substrates of the region, and would be sized properly to withstand peak discharge events. Riffle material would be deposited at a staging area at the restoration site, sorted by stone size, and then placed in the river to specified elevations.

5.4.1.3 Plant Community Restoration

These restoration measures would result in the re-establishment of plant community functions and, as a secondary effect, increase capacity of the site to store water. This will restore the physical habitat structure that is characteristic of the given site. This group of measures would include removal of invasive species and reestablishing native flora through planting seeds, plugs, bushes and trees. There may be some instances where the flora may recover independently from a remnant seed bank once the hydrology is returned. Some areas would have to be seeded with the appropriate native seed mixes for a particular community type, which is based on elevations, soils and hydrology.

P1 Invasive Woody Vegetation Removal: Many natural areas are densely wooded with invasive and/or non-native species, at least partly due to fire suppression. Fire suppression causes numerous problems that include: loss of native ground cover species through the reduction in light levels and other mechanisms, reduced reproduction of native trees such as oaks, which require minimum light levels to survive, increased soil erosion because of the loss of ground cover species, loss of forage species especially graminoids and mast producing shrubs, and loss of habitat for native fauna

The most efficient way to remove invasive woody shrubs and small trees is to cut stems, treat the stumps with herbicide, and perform follow-up herbicide treatment and prescribed burning (see below). Herbicide treatment of resprouts is typically required. Cutting alone will result in an increase in stem count for most woody invasive species due to stump sprouting, because these species are often adapted to grazing and browsing. Follow-up herbicide application will ensure removal of these woody invasives.

Girdling can kill most trees except white poplar and black locust. It is a highly cost effective method for invasive woody control especially of larger trees. Girdling is best implemented in late spring/early summer. The method requires two parallel cuts, to the depth of the smooth wood of the xylem, that are several inches apart. Thus it severs the phloem and prevents photosynthetic energy from leaves from reaching roots, which results in the death of the tree in 1-3 years. The presence of inaccessible shunts may somewhat prolong the life of the tree. The parallel cuts must be separated enough that bark cannot reform over the girdle. Cuts lower on the trunk are preferred for aesthetic reasons, but require more effort. Suckers must be removed. Herbicide can be painted over the girdle and on suckers if an immediate result is desired but this adds expense. These now dead trees are termed "snags", which provide habitat for many species, but are not favored in prairie restorations where grassland birds may recolonize. Grassland birds will not nest on sites with live or dead trees. It is thought that this is an adaptation to predation by raptors.

P2 Invasive Herbaceous Vegetation Removal: Mowing should be used to control annual weeds after an area is cleared, whether or not it has been planted. The seed bank of adventive and ruderal species can be quickly exhausted by mowing at the appropriate time of year, before seed has set but after the plant has flowered and the start of seed production. Mowing as well can deplete some perennial weeds.

Mowing should not be used as a primary method for the removal of invasive species, especially shrubs. It will cause many shrubs to send up suckers, thus adding to the problem rather than solving it. Mowing also may destroy habitat for insects in less disturbed areas, compact the soil, and kill larger animals.

Once sufficient plant material is established to provide fine fuels, prescribed burns are an important component of the restoration and long-term management of the site. Dormant seeds of invasive species can germinate after an area is cleared and light again reaches the soil. Burns are a cost effective and less risky method for the control of young growth compared to the extensive use of herbicide on juvenile plants. A sufficient matrix of grasses must be present to fuel the fire. Fire should be used on an annual basis for two-three years after clearing to control germination of invasive species and on a less frequent rotational basis for longer-term maintenance of the restored area. All controlled burns will require the contractor(s) to acquire various permits depending on where the project is located. These permits dictate safety and coordination requirements. Also, during the PED phase, specific coordination with adjacent land owners would take place to ensure controlled burns are understood and supported locally. Considerations for burns include, but are not limited to weather and wind patterns, notification of local fire and police departments, and strategic plans provided by contractors as a submittal requirement.

P3 Soil Nitrogen Depletion/ Soil Amendments: This measure seeks to deplete nitrogen (N) levels in areas with excess inorganic nitrogen where monospecific stands of invasive species have established using soil microbial processes triggered by the addition of high carbon-to-nitrogen (C:N) soil amendments. This measure limits the establishment of invasive vegetation, allowing favorable conditions for desired native species to outcompete invasive species. Specific tasks would include the incorporation of a high C:N sawdust into the top 20 cm of soil in the fall (immediately preceding seeding). In urban situations, additional amendments would need to be added to unnatural soils to increase carbon content and reduce compaction, such as organic materials or sand.

P4 Native Seed Bank: In many areas where landscape and the natural soils are still intact, a diverse and somewhat high quality seed bank is likely to be present. Restoration of hydrology and the discontinued anthropogenic uses of the site may allow the native plant community to reestablish itself.

Management of non-native and invasive plant species accompany this measure, which may include sowing of a cover crop, mowing, burning and selective herbicide application.

P5 Seeding: The use of local genotypes is strongly favored in ecosystem restorations because local genotypes are likely to be the best adapted for the specific conditions of any given site. This must be balanced by the following concerns.

If a site has been disturbed, especially in its hydrology, the local genotype may no longer be adapted to that site. More diverse seed sources should be considered under that circumstance, with the goal of introducing a wide genetic variation that, over time, will result in a genotype that is adapted to the contemporary conditions. The plants needed for seed may be rare in the vicinity and the removal of propagules cannot be justified from any site. The cost of seed collection may be too high. If the local sponsor or an active volunteer program cannot supply skilled collectors, professionals must be employed to collect the seed. Often a sufficient quantity of locally collected seed to revegetate a large site is not available. In this circumstance, growers must be employed to produce a large enough volume of seed to produce a viable population. This also increases project duration and cost.

Nevertheless, collection and contract growing of species indigenous to the site and not available in the trade may be required to achieve a diverse and healthy plant community. If the plant is regionally rare, there may be a special concern to maintain that genotype.
Seed collection should occur throughout the growing season as different species reproduce in spring, summer, and fall. A frequent problem with restorations is that species that flower at a particular time of year are favored because of the seed collection time. Many, but not all seeds can be stored for different periods of time, but some species, particularly some *Carex* sp., need to be sowed immediately. Nurseries carry premixed seed mixes that provide an inexpensive method for site revegetation, but it may not include local genotypes or the seeds may not meet site-specific conditions. Nurseries can also be employed to grow seed collected from the site and its immediate environs or to produce a custom mix of native species.

P6 Plugging: While many desired native species can be readily established directly from seed, other species do not respond as well. In addition, concerns about competition from weeds may require a faster establishment of the desired native vegetation matrix. Thus planting plugs (small container grown plants) and rootstock of some species is desired. While possibly more expensive than seeding, many restorations employ a mix of seeding and introduction of plugs at varying densities to maximize establishment of an appropriately diverse native plant community.

P7 Tree/Shrub Planting: While many desired native species can be readily established directly from seed, trees and shrubs do not respond as well. In addition, consumption by deer and small browsing mammals require a faster establishment of the desired native tree to combat this situation. Thus planting trees and shrubs from 1 to 5-gallon root balls and rootstock is desired.

5.4.2 Site Screening and Selection

This step of the planning process uses a large array of sites based on open space available in the watershed. Using aerial photos (captured in 2005 and reassessed in 2012), GIS analysis of the watershed was completed to identify all potential open spaces within the Upper Des Plaines River watershed. Most boundaries for sites were based on features such as land use, roads, watershed boundaries, property boundaries, and land designations. Sites that are currently developed or less than 5 acres were eliminated from consideration in the selection process. The GIS analysis resulted in 713 total sites that could be assessed with the Ecosystem Restoration (ER) screening criteria (Plate 26).

The next step was to identify those sites that had the greatest restoration potential within the USACE mission to be carried further along in the plan formulation process. The Ecosystem Committee (E-Team) developed a list of criteria that each site should meet in order to identify those sites that are most consistent with USACE restoration projects and in providing benefits to the Upper Des Plaines River watershed (Table 5.5). These criteria were established by local ecologists and scientists that are well versed in the flora, fauna and systems of the Upper Des Plaines River watershed.

The goal of ecosystem restoration is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. Restored ecosystems should mimic, as closely as possible, conditions which would occur in the area in the absence of human changes to the landscape and hydrology with a minimum of maintenance. This includes an emphasis on materials and species native to the project location. Those restoration opportunities that are associated with wetlands, riparian and other floodplain, and aquatic systems are most appropriate for USACE involvement.

The criteria in Table 5.5 were developed with the intent to maintain a nationwide perspective to assure that available funding is used to provide the most cost effective restoration of nationally and regionally significant resources. The intent of using these criteria was to identify sites that required hydrologic (wetland/floodplain), hydraulic (riverine), geomorphic (riverine/wetland) and riparian restoration that would maximize habitat diversity for a variety of native species including endangered species, and provide connectivity to other natural areas. Each of the objectives and criteria for this study was designed to select a restoration plan is consistent with the Ecosystem Restoration goals. The criteria in Table 5.5 correspond to the Ecosystem Ranking Criteria in EC 11-2-194, Appendix II-2-10:

- Habitat Scarcity: A & B
- Connectivity: C, E, & F
- Special Status Species: F
- Hydrologic Character: C & D
- Geomorphic Condition: B, C & D
- Self-Sustaining: All
- Plan Recognition: E & F

Table 5.5 – Ecosystem Restoration Site Selection Criteria

#	Screening Criteria	Score	Description	Policy Correlation
A	Potential Restoration Acreage (based on site polygon size)	3	greater than 100 acres	Habitat Scarcity
		2	between 50 & 100 acres	Self-Sustaining
		1	between 20 & 50 acres	Biodiversity
		0	less than 20 acres	Limiting Habitat
B	Number of Potential Cover Types (based on NRCS soil mapping)	3	6 or more	Habitat Scarcity
		2	4:5	Geomorphic Condition
		1	2:3	Self-Sustaining
		0	0:1	Biodiversity
C	Proximity to a Stream (based on USGS streams coverage)	3	direct riparian zone	Connectivity
		2	between 0 & 200 feet	Hydrologic Character
		1	between 201 & 500 feet	Geomorphic Condition
		0	over 500 feet	Self-Sustaining
D	% of Site as Hydric Soils (based on NRCS soil mapping)	3	75:100%	Hydrologic Character Geomorphic Condition Self-Sustaining
		2	50:74%	
		1	25:54%	
		0	0:24%	
E	Proximity to an existing natural area (based ou IDNR and WDNR datasets)	3	within ¼ mile buffer	Connectivity Self-Sustaining Plan Recognition
		2	between ¼ & ½ mile buffer	
		1	betweeu ½ & 1 mile buffer	
		0	over 1 mile buffer	
F	Proximity to species that are state listed (based on IDNR and WDNR state endangered species datasets)	3	within ¼ mile buffer	Connectivity
		2	between ¼ & ½ mile buffer	Special Species Status
		1	between ½ & 1 mile buffer	Self-Snstaiuiug
		0	over 1 mile buffer	Plan Recognition
Maximum Points		18		
Minimum Points		0		

Each site could receive a maximum point score of 18, which would equate to having a high potential for ER benefits, whereas a minimum score of 0 would equate to a site having a very low potential for ER benefits. The potential restoration sites were evaluated through screening criteria using ArcView 9.0 GIS software in order to provide a list of sites that had the greatest potential for ecological restoration. Sites with a total of eleven points were selected for further consideration. A site with 12 or more points would have an average score of at least two of the six criteria, with any low scores balanced by higher scores in other criteria. These sites, therefore, are ones that are most likely to succeed in meeting the planning objectives. However, in order to avoid eliminating sites with good aquatic ecosystem restoration potential, the cut-off was set at 11 points to include any additional significant areas that would be considered borderline by these criteria. The cost-effective/incremental cost analysis would then determine the final array. The result of this initial analysis was that 131 sites were retained. These sites are shown in Plate 27.

5.4.3 Measure Costs & Assumptions

Detailed discussion on planning level feature costs is presented in Appendices C and F. Conceptual, planning level cost estimates were prepared for measures/features that were identified by the study team. These measures/features were quantified by measuring distances, acres, square feet, etc utilizing geospatial analysis tools; therefore, each site was custom fitted with measures and appropriate quantities and costs. These cost estimates do not represent complete project construction cost estimates, but rather individual measures of work or components of the entire project. The measures were used to provide an economic basis for the development of project alternatives. Once the alternative plan formulation process was completed, and additional design information was developed for the Recommended Plan, a more detailed and reliable cost estimate was performed (Appendix F). Estimates were developed using cost information from previous studies, lump sum and unit prices, for plant, and labor and material methods.

Implementation Cost: The planning level costs were based on quantities for a 60 acre site. An average construction duration of 12 months was assumed. 10% profit was included for the prime contractor. There was only one sub-contractor used in the estimate for drain tile disablement. Depending on the contracting mechanism for these jobs, it may be reasonable to adjust to account for an earthwork contractor as a sub or a prime with a landscape contractor as the sub. A 25% contingency was applied. Escalation was accounted for through year 2019. Fuel rates are currently shown as $4.00 for unleaded gasoline, and $4.25 for diesel fuel (on-road) and $4.00 for diesel fuel (off-road). Labor rates were derived from the following: Service Contract Wage Determination 03-0288 (Rev. -9) dated 02 June 2009: for Forestry and Land Management Services. Because some of the work is demolition, and earthwork, it is reasonable to use wage rates for construction, as these are in keeping with current market conditions. Therefore, the Davis-Bacon Wage Rates were used for heavy landscaping. See Appendices C and F for detailed assumptions per measure.

Monitoring: Section 2039 of WRDA 2007 directs the Secretary of the Army to ensure that, when conducting a feasibility study for a project (or component of a project) under the USACE ecosystem restoration mission, the recommended project includes a monitoring plan to measure the success of the restoration. For complete details on the monitoring plan and associated measures, see Appendix M.

Annual Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R): The OMRR&R costs estimated during the feasibility phase will vary from project to project depending on the restoration measures described within the recommended alternative. If no annual OMRR&R is recommended then the annual cost is zero. For projects that have recommended alternatives that call for any type of vegetation reestablishment or control, management of native vegetation will be required such as prescribed burns for certain cover types, mowing, invasive species removal/control and reseeding of with native plant species. OMRR&R costs are projected to occur after the completion of the construction phase and continue for the period of analysis, 50 years. Costs for any management measures were predicted per year per site (based on area affected and frequency of treatment) and these costs were annualized for the period of analysis. The OMRR&R cost is included in the annualized project cost estimate and will not be cost shared.

Costs per OMRR&R activity were based on the unit costs used to calculate the total planning level construction costs per site. The unit costs are shown in Table 5.6. These are typical activities conducted within naturalized areas to maintain a targeted level of ecosystem integrity. Every activity is not needed every year. For example, burning is not recommended every year. Research indicates that the historical fire regime in this area was around every three years and even then it was patchy in nature. Current practices follow a 3-year rotation while limiting burning anywhere between a quarter to half of the site at a time. Management regimes also vary between community types. A wet floodplain forest would not require burning, but may include more intensive invasive species control for woody species. OMRR&R costs for each site were calculated based on the amount each specific community type, the reoccurrence and frequency of activities, and the site location (urban or rural).

Table 5.6 – OMRR&R Unit Costs

Activity	Reoccurrence (Years)	Cost per Acre
Burning	3	$1,051.76
Mowing	3	$302.11
Invasive Control (herbaceous)	1	$2,469.02
Invasive Control (Woody)	2	$2,469.02
Seeding	5	$1,200.70

(FY2010 Price Level)

Total OMRR&R costs are a small percentage of the initial construction costs. This is due to both the financial and technical aspects of the upfront construction activities. The current conceptual designs per site would result in a self-sustaining and self-organizing native community that will need very low input of energy and effort to maintain. The main construction work includes two to five years of controlling invasive species and maintaining a diverse native plant community. Once this work has been completed, maintaining at the same level of ecological integrity requires a much lower level of effort then the original contract. While the cost per activity is the same used to calculate total construction costs per site, the difference in the magnitude and frequency of implementing these activities results in a much lower total cost.

Total Annualized Cost: Equivalent annualized cost is calculated amortizing project costs, discounted to a base year, over the period of analysis. The base year for this project was determined to be the year in which the first phase of the project is to be completed. Costs that occur prior to this year need to be compounded to the base year, while those occurring after the base year need to be discounted to the base year. The period of analysis for this project is 50 years. Discounting to the base year is the present value method. Costs are compounded or discounted to present value at the base year then amortized over the 50-year period of analysis to give the equivalent annual cost. The Federal Discount rate current at the time of the analysis, 4.375%, was utilized for the analysis. (Economic Guidance Memorandum 10-01, Federal Interest Rates for Corps of Engineers Projects.) Examples of several site's cost annualization per alternative are presented in Appendix C.

LERRD Value: Preliminary real estate costs, based on estimated per acre values, were used for planning level analyses. Lands, easements, rights-of-way, relocations, and disposal areas (LERRD) values were incorporated in the second round of CE/ICA when sites are compared against each other. LERRD values were not used for the first round since comparing alternatives within the same site is not affected by the site's own real estate value.

Pre-construction, Engineering and Design (PED) Phase: PED Costs are set at a standard of 7% of the total construction cost and was used for this cost element to conservatively reflect further work to be completed on the Recommended Plan. This cost includes any required future sampling, testing, and modeling, as well as more typical design analysis activities.

5.4.4 Ecosystem Restoration Alternatives

5.4.4.1 Rural Restoration Alternatives and Associated Measures (Table 5.7)

Rural restoration alternatives would be applied at sites in Racine and Kenosha Counties as well as the northern portion of Lake County.

Alternative R1: This alternative plan consists of restoring the site's hydrology only. This would include removal of farm drain tiles, soil compaction removal, filling unnatural ditches, adding cobble riffle control structures to raise the ground water table and adding ditch plugs in at strategic points to raise the groundwater table as well. There would be no invasive species control or seeding or plugging. This alternative relies on recolonization of the native plant community from nearby source populations and any remaining native seed bank communities. The plant community would be allowed to follow an unmanaged successional pathway.

The decision whether to implement ditch filling or plugging depends on a number of site specific factors that will be uncertain until detailed design is developed and construction is underway. Although ditch filling is the preferred restoration method, the feasibility level cost estimate assumes a combination of ditch filling and plugging to account for adaptation to site conditions and design requirements.

Alternative R2: This alternative plan consists of restoring the site's hydrology, as in Alternative R1. In addition, this alternative includes invasive species control and sowing native seed to the appropriate cover types. Appropriate maintenance would be implemented by the non-Federal sponsors to ensure native plant growth and eliminate invasive species threats.

Alternative R3: This alternative plan is identical to alternative R2, with the addition of soil nitrogen depletion, planting cover types with native herbaceous plugs and woody tree and shrubs. This will expedite site recovery and provide for a quicker accumulation of ecological benefits.

Alternative R4: This alternative plan consists of restoring the site's hydrology, as in Alternative R1, with the exception that certain portions of the floodplain would be excavated to further the influence (or interaction) of riparian flooding cycles (or hydrological regime) within the excavated portions. In addition, this alternative includes invasive species control and sowing native seed to the appropriate cover types. There would be no planting of native herbaceous plugs or woody trees and shrubs. Appropriate maintenance would be implemented by the non-Federal sponsors to ensure native plant growth and eliminate invasive species threats.

Alternative R5: This alternative plan is identical to alternative R1, with the addition of restoring riverine habitat. Riverine habitat restoration consists of stream sinuosity repair, contouring of banks to a more natural condition, cobble riffle placement and woody debris placement.

Alternative R6: This alternative plan is identical to alternative R2, with the addition of restoring riverine habitat. Riverine habitat restoration consists of stream sinuosity repair, contouring of banks to a more natural condition, cobble riffle placement and woody debris placement.

Alternative R7: This alternative plan is identical to alternative R3, with the addition of restoring riverine habitat. Riverine habitat restoration consists of stream sinuosity repair, contouring of banks to a more natural condition, cobble riffle placement and woody debris placement.

Alternative R8: This alternative plan is identical to alternative R4, with the addition of restoring riverine habitat. Riverine habitat restoration consists of stream sinuosity repair, contouring of banks to a more natural condition, cobble riffle placement and woody debris placement.

Alternative R9: This alternative plan is identical to alternative R7, with the addition of removing five (5) dams on the mainstem Des Plaines River to restore connectivity and fish passage. Removal of these dams has implications to benefits at each and every site with the riverine habitat type present.

Table 5.7 – Rural Restoration Alternatives and Associated Measures

		Rural Alternatives								
Measure	**Code**	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**
Hydrologic Restoration										
Tile Disablement	H1	X	X	X	X	X	X	X	X	X
Ditch Filling and Plugging	H2	X	X	X	X	X	X	X	X	X
Cobble Riffle Control Structures	H3	X	X	X	X					
Soil Compaction Removal	H4	X	X	X	X	X	X	X	X	X
Excavation	H5				X				X	
Riverine Restoration										
Dam Removal/Bypass	R1									X
Sinuosity Reestablishment	R2					X	X	X	X	X
Cobble Riffles	R3					X	X	X	X	X
Plant Community Restoration										
Invasive Woody Veg. Removal	P1		X	X	X		X	X	X	X
Invasive Herbaceous Veg. Removal	P2		X	X	X		X	X	X	X
Soil Nitrogen Depletion	P3			X				X		X
Native Seed Bank	P4									
Seeding	P5		X	X	X		X	X	X	X
Plugging	P6			X				X		X
Tree & Shrub Planting	P7			X				X		X

5.4.4.2 Urban Restoration Alternatives and Associated Measures (Table 5.8)

Urban restoration alternatives would be applied at sites in southern Lake County and Cook County.

Alternative U1: This alternative plan consists of restoring the site's hydrology. This would include removal of farm drain tiles, soil compaction removal, filling unnatural ditches, adding cobble control structures to raise the ground water table and adding ditch plugs in at strategic points to raise the groundwater table as well. This includes invasive (herbaceous and woody) species control through mechanical and chemical means, sowing native seed to the appropriate cover types and a 5-year burning cycle and invasive species control for maintenance that continues for the life of the project.

Alternative U2: This alternative is the same combination of measures as U1, plus, converting all urban areas to natural habitat type by removing impervious surfaces and amending substrate to support a native plant community.

Alternative U3: This alternative is the same combination of measures as U2, plus, floodplain wetland restoration, which includes excavating an area within the existing floodplain to restore depressions. These floodplain wetlands will be allowed to succeed to forested communities.

Alternative U4: This alternative is the same combination of measures as U3, plus, installation of shrubs and trees into restored savanna and forested habitat types.

Alternative U5: This alternative is the same combination of measures as U4, plus, installation of live herbaceous plugs into the appropriate habitat types.

Alternative U6: This alternative is the same combination of measures as U5, plus, removal of dams and minimal regrading to re-meander stream (if present on-site) and cobble riffles.

Alternative U7: This alternative is the same combination of measures as U2, plus, floodplain wetland restoration, which includes excavating an area within the existing floodplain to restore depressions. These floodplain wetlands will be seeded and managed as emergent marsh communities.

Alternative U8: This alternative is the same combination of measures as U7, plus, installation of shrubs and trees into restored savanna and forested habitat types and live herbaceous plugs into the appropriate habitat types.

Alternative U9: This alternative is the same combination of measures as U8, plus, removal of dams and minimal regrading to re-meander stream (if present on-site) and the installation of cobble riffles.

Table 5.8 – Urban Alternatives and Associated Measures.

		Urban Alternatives [1]								
Measure	**Code**	**U1**	**U2**	**U3**	**U4**	**U5**	**U6**	**U7**	**U8**	**U9**
Hydrologic Restoration										
Tile Disablement	H1	X	X	X	X	X	X	X	X	X
Ditch Filling and Plugging	H2	X	X	X	X	X	X	X	X	X
Cobble Riffle Control Structures	H3	X	X	X	X	X		X	X	
Soil Compaction Removal	H4	X	X	X	X	X	X	X	X	X
Excavation	H5			X	X	X	X	X	X	X
Impervious Surface Removal	H6		X	X	X	X		X	X	X
Riverine Restoration										
Dam Removal/Bypass	R1						X			X
Sinuosity Reestablishment	R2						X			X
Cobble Riffles	R3						X			X
Plant Community Restoration										
Invasive Woody Veg. Removal	P1	X	X	X	X	X	X	X	X	X
Invasive Herbaceous Veg. Removal	P2	X	X	X	X	X	X	X	X	X
Soil Nitrogen Depletion/Amend Soil	P3		X	X	X	X		X	X	X
Seeding	P5	X	X	X	X	X	X	X	X	X
Plugging	P6					X	X		X	X
Tree & Shrub Planting	P7				X	X	X		X	X

[1] Alts U3, 4, 5, & 6 allow for excavated wetlands to succeed to forest, where Alts U7, 8 & 9 maintain the excavated wetlands as marsh.

5.4.5 Alternative Benefits

Ecosystem benefits predicted to occur from the proposed restoration measures and combined in the different alternatives were analyzed using the Riverine, HEP and HGM models. Through the use of the various ecological indices, predicted benefits were calculated for "FWP" conditions over the entire 50-year period of analysis per alternative per selected site (131 selected sites x 9 alternatives = 1,179 possible future scenarios). The scores generated from the models were then annualized over the entire period of analysis. The calculation of predicted benefits and the annualization of benefits were generated using the software HEAT (Habitat Evaluation Assessment Tools, produced and managed by the USACE ERDC, and for riverine benefits, IBI was used. The FWOP condition for areas that experience land conversion, such as replacing natural cover type with non-natural cover type (e.g., agriculture, urban, detention pond, etc.) were assumed to lose natural structure and therefore function. Areas that are not predicted to undergo land conversion and have been degraded to a point where it is no longer likely to degrade further were assumed to be stable in structure and function. Loss of ecosystem function equates to a significant decrease in "future without project" habitat value. Modeling results suggest there is an overall increase in ecosystem value as alternatives to reduce unnatural disturbances are implemented and further increase when the returned natural structure of selected sites are combined. However, a further analysis of the results does show a close relationship between the size of the area under examination and predicted benefits. This is an expected side effect of using area (in this case acres) to calculate Habitat Units. Although this is an overall trend, the following analysis also takes into account the quality of the site and the cost per benefit. These results suggest that there is a good deal of potential ecosystem benefits to gain within the watershed and that restoration of the function and structure of these selected sites is possible within the watershed. A summary of outputs for each alternative per county is shown in Table 5.9.

Table 5.9 – Summary of Countywide Net Average Annual Habitat Units per Alternative.

		Cook[1]	S Lake[1]	Racine	Kenosha	N Lake	Total
	Acres	5705.55	12653.33	3229.48	46215.93	9558.31	**77,363**
ALT1	**Score**	0.50	0.69	1.02	0.82	0.90	
	Output	2827.26	8703.257	3294.161	37866.622	8638.175	**61,329**
ALT2	**Score**	0.52	0.72	0.91	0.96	1.10	
	Output	2976.104	9051.224	2954.533	44542.288	10482.166	**70,006**
ALT3	**Score**	0.55	0.57	1.02	0.91	0.93	
	Output	3129.43	7616.741	3280.52	41946.738	8851.921	**64,825**
ALT4	**Score**	0.56	0.63	1.02	1.00	1.17	
	Output	3187.15	7984.166	3284.41	46111.8	11195.517	**71,763**
ALT5	**Score**	0.71	0.76	1.04	0.84	0.92	
	Output	4035.72	9676.218	3357.326045	38945.98981	8817.268427	**64,833**
ALT6	**Score**	0.71	0.80	0.94	0.99	1.12	
	Output	4035.72	10153.218	3026.669458	45703.74593	10683.87764	**73,603**
ALT7	**Score**	0.78	0.76	1.04	0.94	0.95	
	Output	4426.46	9561.089	3361.62787	43283.14604	9076.250847	**69,709**
ALT8	**Score**	1.05	0.92	1.04	1.02	1.19	
	Output	5968.4	11580.966	3356.546458	47244.31793	11397.22864	**79,547**
ALT9	**Score**	1.05	0.95	1.05	1.03	1.20	
	Output	5968.4	12057.766	3383.460695	47615.93827	11466.08327	**80,492**

[1]Cook and S. Lake are (U) urban alternatives and Racine, Kenosha and N. Lake are (R) rural alternatives. Output is net average annual habitat units and the score is an overall indicator value based on model output scores.

5.4.6 Cost Effectiveness & Incremental Cost Analysis

The cost effective (CE) and incremental cost analysis (ICA) are two distinct analyses that are conducted to evaluate the effects of alternative plans and for this study are twofold. A first CE/ICA was run to ascertain the best alternative to restore a particular site, and then a second CE/ICA was run to ascertain the most beneficial sites to restore per county, to obtain a watershed plan.

First, it must be shown through a CE analysis that a restoration plan's output cannot be produced more cost effectively by another means. Cost effective means that, for a given level of non-monetary output, no other plan costs less and no other plan yields more output at a lower cost.

Through ICA, a variety of various-sized alternatives are evaluated to arrive at a best level of output within the limits of both the sponsor's and the USACE capabilities. The subset of cost effective plans are examined sequentially (by increasing scale and increment of output) to ascertain which plans are most efficient in the production of environmental benefits. Those most efficient plans are called "best buys." They provide the greatest increase in output for the least increases in cost. They have the lowest incremental costs per unit of output. In most analyses, there will be a series of best buy plans, in which the relationship between the quantity of outputs and the unit cost is evident. As the scale of best buy plans increases (in terms of output produced), average costs per unit of output and incremental costs per unit of output will increase as well. Usually, the incremental analysis by itself will not point to the selection of any single plan. The results of the incremental analysis must be synthesized with other decision-making criteria (i.e., significance of outputs, acceptability, completeness, effectiveness, efficiency, risk/uncertainty, reasonableness of costs) to help the study team select and recommend a particular plan.

The USACE's Institute for Water Resources (IWR) developed procedures and software to assist in conducting CE/ICA. The IWR Report 94-PS-2, *Cost Effectiveness Analysis for Environmental Planning: Nine EASY Steps*; IWR Report 95-R-1, *Evaluation of Environmental Investments Procedures Manual Interim: Cost Effectiveness and Incremental Cost Analyses*; and IWR Report 98-R-1, *Making More Informed Decisions in Your Watershed When Dollars Aren't Enough* were utilized as guidance for this study. The Windows-based IWR-PLAN Decision Support Software Beta Version was used as the tool for this CE/ICA analyses.

Alternatives per Site CE/ICA

The alternatives presented above in Section 5.4.4 are combinations of proposed restoration measures. Alternatives were categorized into two sets, one set of nine alternatives for sites located in the rural north (R) and one set of nine alternatives for sites located in the urban south (U) of the watershed. Alternatives are not combinable because the alternatives were specifically constructed from the measures, presented in Section 5.4.3, in order to meet specific restoration benefit thresholds,. This first cut of the CE/ICA determined cost effective and "best buy" alternatives per site. This analysis indicated the best implementable plan per site (Table 5.10 and Table 5.11).

Table 5.10 – Rural (R) Best Buy Alternatives per Site

Sites	Alt #	Net AAHUs	AA Costs
K01	3	199	$ 311,032
K02	6	779	$ 1,001,860
K03	2	260	$ 467,452
K04	3	204	$ 678,250
K05	2	1,089	$ 1,136,652
K06	9	1,201	$ 1,227,530
K07	9	590	$ 580,696
K08	9	55	$ 244,828
K09	9	1,124	$ 710,010
K10	9	957	$ 1,414,993
K11	9	464	$ 542,251
K12	2	1,481	$ 1,762,130
K13	2	31	$ 106,890
K14	9	264	$ 382,385
K15	9	302	$ 604,599
K16	2	91	$ 653,577
K17	2	195	$ 196,168
K18	9	722	$ 1,501,027
K19	2	495	$ 543,101
K20	7	270	$ 494,642
K21	6	140	$ 270,072
K22	9	398	$ 672,885
K23	9	1,268	$ 1,876,416
K24	2	59	$ 431,313
K25	2	222	$ 548,272
K26	2	121	$ 323,219
K27	9	1,079	$ 1,719,657
K28	2	142	$ 403,082
K29	9	488	$ 800,355
K30	9	977	$ 1,470,448
K31	2	709	$ 789,313
K32	6	327	$ 497,729
K33	9	2,621	$ 2,479,799
K34	9	1,046	$ 914,527
K35	2	807	$ 637,986
K36	9	2,146	$ 2,023,603
K37	2	322	$ 496,185
K38	2	392	$ 1,044,447
K40	2	434	$ 906,197
K41	6	1,286	$ 1,050,026
K42	2	584	$ 1,144,141
K43	2	348	$ 617,534
K44	9	1,755	$ 2,540,822
K45	9	1,748	$ 1,573,204
K46	2	585	$ 1,000,652
K47	9	2,332	$ 1,695,581
K48	2	717	$ 870,470
K49	3	455	$ 784,364
K50	9	792	$ 1,328,918
K51	2	128	$ 307,138
K52	2	257	$ 423,856
K53	9	589	$ 1,026,729
K54	4	1,221	$ 1,683,974
K55	2	429	$ 897,742
K56	9	809	$ 909,133
K57	2	1,313	$ 1,550,874
K58	3	661	$ 1,361,201
K59	4	2,243	$ 2,871,271
K60	2	744	$ 1,120,660
K61	9	2,287	$ 2,219,563
K62	9	1,303	$ 1,115,051
K63	4	1,008	$ 1,427,412
K64	9	1,890	$ 1,426,074
K65	9	115	$ 348,452
L31	4	939	$ 2,819,167
L33	4	415	$ 537,474
L34	2	251	$ 1,188,221
L35	2	337	$ 802,247
L36	9	1,168	$ 3,943,747
L37	4	837	$ 2,416,109
L38	7	647	$ 3,509,006
L39	6	626	$ 497,067
L40	6	329	$ 855,504
L41	9	1,281	$ 2,819,167
L42	9	152	$ 669,253
L43	2	1,513	$ 5,130,113
L45	2	250	$ 633,786
L46	6	324	$ 1,119,022
L47	9	286	$ 633,184
R01	6	663	$ 1,101,127
R02	3	377	$ 508,061
R03	6	912	$ 1,208,697
R04	5	324	$ 454,626
R05	7	438	$ 1,292,749
R06	3	438	$ 715,579

(FY2011 Price Level, FDR 4.125%)

Table 5.11 – Urban (U) Best Buy Alternatives per Site.

Sites	Alt #	Net AAHUs	AA Costs	Sites	Alt #	Net AAHUs	AA Costs
C1	6	287	$2,153,102	L11	8	271	$1,104,410
C3	8	486	$2,120,141	L12	6	258	$647,234
C4	6	61	$406,552	L13	6	518	$2,009,403
C5	4	194	$1,216,424	L14	6	109	$993,226
C7	3	212	$871,299	L15	6	91	$304,437
C8	6	82	$231,920	L16	6	97	$348,139
C9	8	925	$3,345,753	L17	6	81	$348,462
C10	6	181	$405,850	L18	9	392	$1,430,558
C11	8	488	$2,144,591	L19	9	1788	$5,328,667
C13	6	7	$145,712	L20	6	120	$385,098
C14	6	20	$151,182	L21	6	184	$1,308,821
C15	8	1494	$3,989,931	L22	6	514	$2,910,666
C16	8	329	$1,518,097	L23	9	1015	$3,496,017
C17	8	153	$695,152	L24	6	434	$2,440,174
C18	6	20	$222,966	L25	8	294	$1,069,665
L01	2	390	$727,118	L26	8	160	$816,937
L02	9	475	$2,120,227	L27	6	253	$904,758
L03	6	504	$1,901,600	L28	9	812	$4,553,527
L05	8	234	$87,329	L29	9	400	$3,061,277
L06	9	777	$3,440,622	L30	6	254	$1,275,340
L09	7	366	$1,551,920	L32	6	437	$1,501,488
L10	7	254	$1,891,131	L44	8	652	$1,478,842

(FY2011 Price Level, FDR 4.125%)

Site Comparison

Once the best buy alternatives were identified per site, a second round of CE analysis was performed comparing the 85 rural and 44 urban sites with each other. The urban and rural sub-groups were used to account for disparities in costs associated with implementing the different measures that would be used for restoration at the two types of sites. To develop a plan that will fully meet the planning objectives across the watershed, cost effective rural and urban sites were identified independently and then used to formulate watershed ecosystem restoration plans.

For this second round of CE analysis, estimated per acre real estate values were incorporated in the average annual costs. Based on recent restoration projects implemented in the region, per acre land values were established: $10,000 for publicly owned lands and privately owned farmland and $20,000 for other privately owned lands. The cost effective analysis is presented below in Figure 5.2 and Figure 5.3 and the results are presented in Table 5.12 and Table 5.13. As a result of this analysis, 17 rural and 9 urban cost-effective sites were identified.

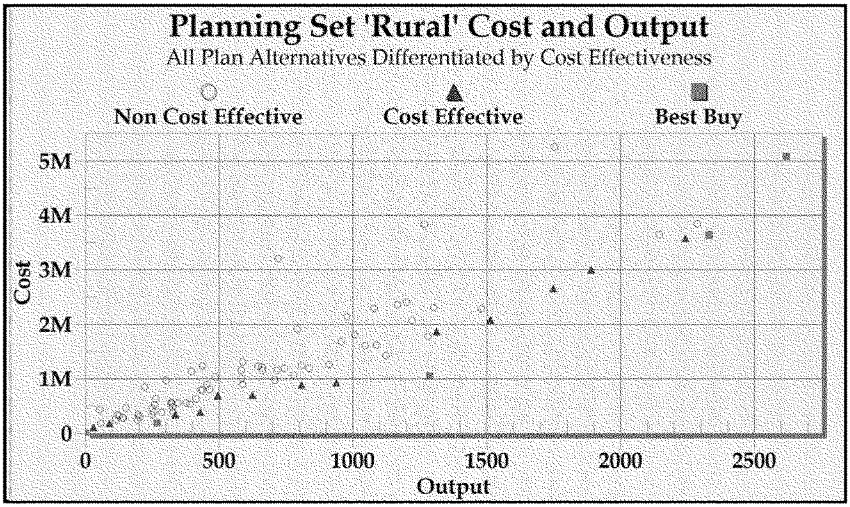

Figure 5.2 – Rural Site Cost Effective Analysis

Table 5.12 – Rural Cost Effective Sites

Site	Alt#	AA Cost	Net AAHUs	Average Cost/HU
K13	2	$104,002	31	$3,355
K16	2	$178,758	91	$1,964
K20	7	$191,245	270	$708
L35	2	$338,338	337	$1,004
K55	2	$390,039	429	$909
K19	2	$694,557	495	$1,403
L39	6	$695,630	626	$1,111
K35	2	$885,014	807	$1,097
L31	4	$924,126	939	$984
K41	6	$1,051,019	1,286	$817
K57	2	$1,872,305	1,313	$1,426
L43	2	$2,081,794	1,513	$1,376
K45	9	$2,659,903	1,748	$1,522
K64	9	$3,000,885	1,890	$1,588
K59	4	$3,574,344	2,243	$1,594
K47	9	$3,631,178	2,332	$1,557
K33	9	$5,080,549	2,621	$1,938

(FY2014 Price Level, FDR 3.5%)

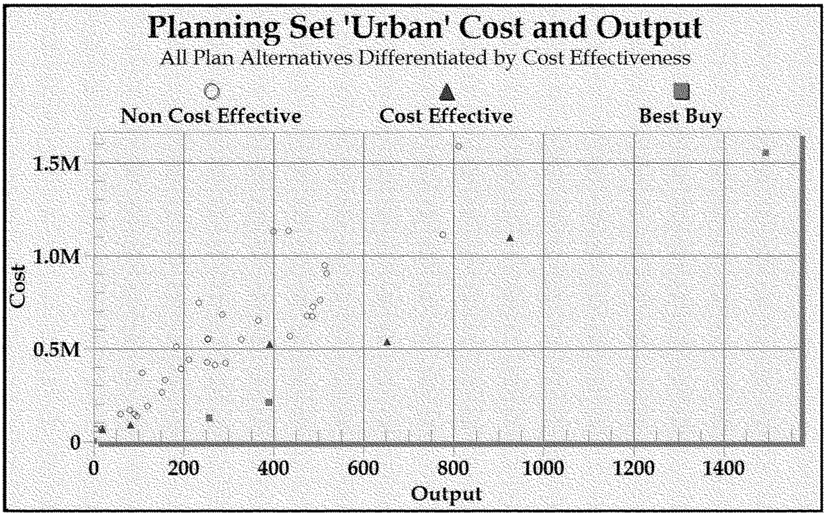

Figure 5.3 – Urban Cost Effective Analysis

Table 5.13 – Urban Cost Effective Sites.

Site	Alt#	AA Cost	Net AAHUs	Average Cost/HU
C14	6	$64,597	20	$3,230
C08	6	$90,181	82	$1,100
L12	6	$126,562	258	$491
L01	2	$208,837	390	$535
L18	9	$523,369	392	$1,335
L44	8	$536,266	652	$822
C09	8	$1,098,619	925	$1,188
C15	8	$1,550,212	1,494	$1,038

(FY2014 Price Level, FDR 3.5%)

Secondary Site Screening

The 26 rural and urban cost-effective sites were further evaluated to ensure that they would contribute to meeting the planning goals and objectives. To meet these goals and objectives, retained sites must provide:

a) Significant habitat connectivity through proximity to natural areas and riparian corridors within the watershed; and

b) Habitats critical for special status species or native habitat types considered rare or uncommon; and

c) Diversity of native habitat types that support a high number of native species; and

d) The ability to sustainably restore habitat types that are rare in the watershed by providing large contiguous areas, thereby minimizing edge effects.

Connecting natural areas within a highly fragmented watershed is important as it will increase the likelihood of successful dispersal of individuals, energy, and genetic information between patches of native habitat. Increased dispersal will ensure a greater likelihood of maintaining sustainable populations of native species through time and especially during periods of environmental change, including future climate change. Connectivity may be increased by decreasing the distance between sites or by creating stepping stones between suitable habitat patches. Connectivity may also be increased within open areas by increasing the amount of optimal habitat within the chosen open area. Sites which are located near current natural areas and along riparian corridors that act as stepping stones increase the overall watershed connectivity. Sites that include riverine restoration along the mainstem or major tributaries would provide connectivity across the watershed. Sites that provide large, contiguous parcels of critical habitat types would provide connectivity between habitats within the site.

The rare and uncommon aquatic habitat types critical to the watershed are sedge meadow, wet prairie, and wet savanna. As a result of past and current land use activities, these pre-settlement habitat types are now rare and uncommon. Because the habitats types are rare and uncommon, many native species that depend on them are also rare uncommon (e.g., Federally-listed candidate eastern massasaugua - wet prairie dependent). Sites that provide at least 50 acres of these three critical habitat types would support these special status species.

Diversity of native aquatic habitat types and hydrogeomorphic features found within a site of concern is critical to support the greatest number of native plant and wildlife species. Many of the remaining open areas have a homogenous land cover type (e.g., one plant community) or stream substrate (e.g., channelized silty bottom), which does not support a diverse suite of native species. Higher habitat heterogeneity, or number of different habitat types, will support the highest diversity of species. In order to address the loss of biodiversity within the watershed, there needs to be a diversity of restorable habitat types available within the selected sites. Sites that support a high number (at least 3) of restorable habitat types provide an opportunity to restore high levels of biodiversity within the watershed.

Restoring large contiguous areas provides opportunities for area sensitive species to successfully reproduce and maintain consistent populations within the watershed. Area sensitive species are species that are adapted to low levels of human disturbance and large unfragmented continuous open habitats endemic to the Midwest region. Grassland breeding birds (e.g., Henslow's sparrow, Short-eared owl, etc.) are good examples of area sensitive species that once occurred in great numbers within the region. Walk and Warner's (1999) research suggests that a small population of Henslow's sparrow requires at least 200 acres of continuous grassland to maintain a population. These species are now rare or uncommon in our area because the majority of remaining natural areas are small and isolated. Small and isolated natural areas experience greater levels of disturbance as a result of increased edge effects, in other words, the amount of buffered (e.g., protected) core area is decreased. Small core areas provide suboptimal habitat for area sensitive species. Bollinger and Switzer (2002) suggest that even minimum areas needed for some populations to be present are not really big enough to overcome edge effects in order to sustain successful reproduction. As the area of the contiguous habitat increases, more individuals of an area sensitive species may co-exist, increasing the chances of sustaining a population on that tract of land over the long-term. Large contiguous open areas are now rare within the watershed. For example, the median size of the remaining 25 sites under consideration for restoration within this watershed is 461 acres, indicating that many of the remaining natural areas within the entire watershed are less than 450 acres in size. Kane County Forest Preserve, located adjacent to the Upper Des Plaines Watershed, has a goal of trying to purchase and preserve parcels that are at least 400 acres in size (Toth et al., 2009). This decision is driven in a large part by the need to provide suitable habitat to area sensitive species. Large contiguous sites provide a unique advantage over smaller isolated sites. Large sites, over 400 acres in size, would provide suitable habitat to support area sensitive species.

The sites were evaluated with respect to these criteria, as shown in Table 5.14. Only sites that met all of the criteria were retained for consideration in formulated restoration plans. This screening process resulted in the selection of a total of eight sites, located throughout the watershed that would contribute to the planning goals and objectives.

Table 5.14 – Secondary Site Screening

	CRITERIA				
	a	b	c	d	
Site	Provides increased connectivity	Provides at least 50 acres of one or more critical habitat type	Includes three or more habitat types	Provides large, contiguous area (400 acres or more)	# of Criteria Met
K59		X		X	2
K33	X	X	X	X	4
K47	X	X	X	X	4
L43	X	X	X	X	4
K64	X			X	2
K57		X			1
K45	X			X	2
C15	X	X	X	X	4
K35	X	X		X	3
C09	X	X	X	X	4
L31	X	X	X	X	4
K41	X	X	X	X	4
K19		X		X	2
L39	X	X	X	X	4
L44	X	X	X		3
L18	X	X	X		3
K55	X	X	X		3
L01	X	X	X		3
L35		X	X		2
K20		X	X		2
K16		X	X		2
L12		X	X		2
K13	X	X	X		3
C08		X	X		2
C14		X	X		2

Watershed Plan Formulation

To formulate watershed plans, a third round of CE analysis was conducted for the eight retained sites. The sites are located throughout the watershed and would all contribute to accomplishing the planning goals and objectives. The retained sites are summarized in Table 5.15.

Table 5.15 – Screened Cost-Effective Sites (ranked by output)

Site	Alt#	AA Cost	Net AAHUs	Average Cost/HU
L39	Rural 6	$695,630	626	$1,111
C09	Urban 8	$1,098,619	925	$1,188
L31	Rural 4	$924,126	939	$984
K41	Rural 6	$1,051,019	1,286	$817
C15	Urban 8	$1,550,212	1,494	$1,038
L43	Rural 2	$2,081,794	1,513	$1,376
K47	Rural 9	$3,631,178	2,332	$1,557
K33	Rural 9	$5,080,549	2,621	$1,938

(FY2014 Price Level, FDR 3.5%)

A full range of plans was generated using these screened cost-effective sites identified above (two in Cook County, three in Lake County, and three in Kenosha County). All combinations were generated using these eight sites. No constraints or dependencies were applied to the plan generator (i.e. all sites were included in this analysis at one time). A total of 256 plans of varied scale were generated. An additional round of cost effective and incremental cost analysis (CE-ICA) was conducted on the full range of plans generated. The CE-ICA analysis resulted in 38 plans identified as cost-effective and a subset of 8 plans in addition to the No Action Plan identified as "best-buys" having the lowest incremental cost per unit of output as shown in Figure 5.4. The incremental cost per unit output for each best-buy plan is show graphically in Figure 5.5. The average and incremental cost of each "best-buy" plan is shown in Table 5.16.

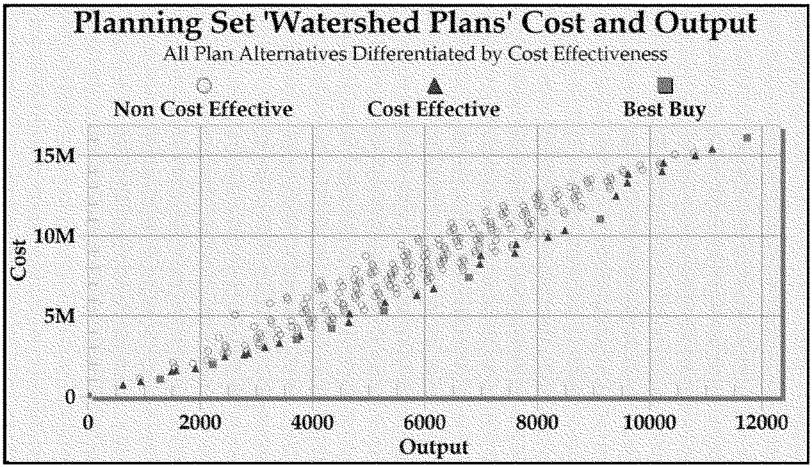

Figure 5.4 – Differentiation of Plans by Cost Effectiveness

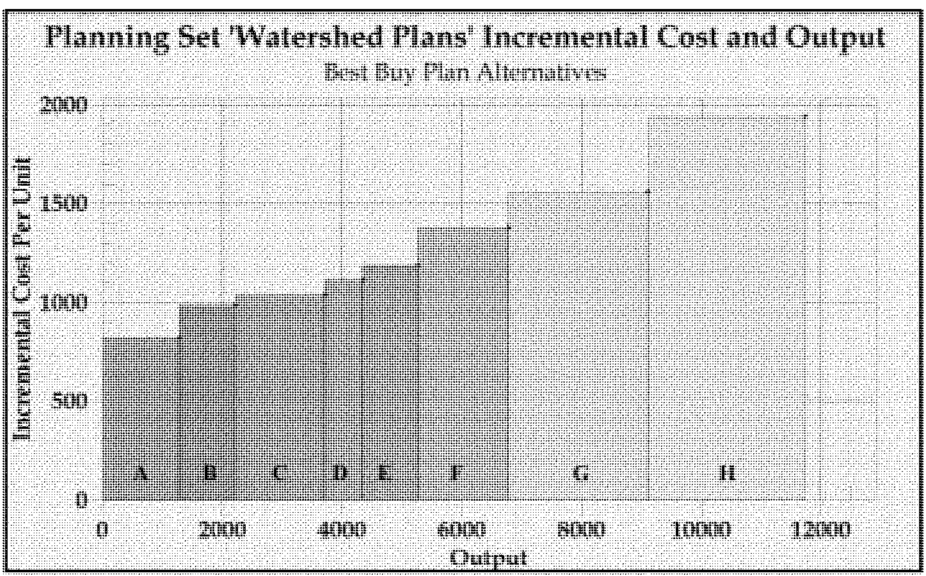

Figure 5.5 – Incremental Cost of Best Buy Plans

Table 5.16 – Incremental Cost of Best Buy Watershed Plans

Name	Plan Summary	AA Cost	Net AAHUs	Average Cost/HU	Increase in Avg Cost/ HU
0	No Action	$0	0	$0	--
A	K41	$1,051,019	1,286	$817	$817
B	K41 L31	$1,975,145	2,225	$888	$71
C	K41 L31 C15	$3,525,357	3,719	$948	$60
D	K41 L31 C15 L39	$4,220,987	4,345	$971	$23
E	K41 L31 C15 L39 C09	$5,319,606	5,270	$1,009	$38
F	K41 L31 C15 L39 C09 L43	$7,401,400	6,783	$1,091	$82
G	K41 L31 C15 L39 C09 L43 K47	$11,032,578	9,115	$1,210	$119
H	K41 L31 C15 L39 C09 L43 K47 K33	$16,113,127	11,736	$1,373	$163

(FY2014 Price Level, FDR 3.5%)

There are four distinct break points from the incremental cost analysis shown above:

Plan C: AAHU = 3,719; Average cost per HU = $948

Plan F: AAHU = 6,783; Average cost per HU = $1,091
(This plan provides an incremental increase over *Plan C* of 3,064 AAHUs for an incremental cost of $3,876,000. The resulting increase in average cost per habitat unit is $143.)

Plan G: AAHU = 9,115; Average cost per HU = $1,210
(This plan provides an incremental increase over *Plan F* of 2,332 AAHUs for an incremental cost of $3,631,178 equating to an incremental cost/output of $119.)

Plan H: AAHU = 11,736; Average cost per HU = $1,373
(This plan provides an incremental increase over *Plan G* of 2,621 AAHUs for an incremental cost of $5,080,549 equating to an incremental cost/output of $163.

These four plans were identified for further consideration and selection as the NER Plan.

5.4.7 Alternative Plan Trade-Off Analysis

The four "best-buy" plans where a distinct break point existing in the incremental cost analysis were compared against each other in order to identify a single plan to be recommended for implementation. A comparison of the effects of various plans must be made and tradeoffs among the differences between plans will be used to support the final recommendation. The effects include a measure of how well the plans do with respect to planning objectives including NER benefits and costs. Effects required by law or policy and those important to the stakeholders and public are to be considered. Previously in the evaluation process, the effects of each plan were considered individually and compared to the without-project condition. In this current step, plans are compared against each other, with emphasis on the important effects or those that influence the decision-making process. This plan comparison step concludes with a ranking of plans.

Ecosystem Plans: Four Ecosystem Plans and the No Action Plan are discussed in the following sections. The No Action Plan is always considered and required by NEPA. The four action plans are: 1) Ecosystem Plan C, which includes two additional sites (one in Cook county) and at a greater incremental cost, 2) Ecosystem Plan F, which includes three additional sites (two in Cook County) at an even greater incremental cost, 3) Ecosystem Plan G, which includes one additional site (the second largest cost-effective site in watershed) at an even greater incremental cost, and, 4) Ecosystem Plan H, which includes one additional site (the largest cost-effective site in the watershed) at an even greater incremental cost.

Table 5.17 – Ecosystem Plans Considered for Implementation

County	Site	Alternative	No Action	C	F	G	H
Cook	C9	Urban 8			X	X	X
	C15	Urban 8		X	X	X	X
Lake	L31	Rural 4		X	X	X	X
	L39	Rural 6			X	X	X
	L43	Rural 2			X	X	X
Kenosha	K33	Rural 9					X
	K41	Rural 6		X	X	X	X
	K47	Rural 9				X	X

5.4.7.1 Ecological Benefits of Identified Plans

Plan G was identified as the NER Plan due to its ability to most completely and efficiently achieve the planning objectives for restoration of this watershed. Plan G includes two of the three largest cost effective sites within the watershed, K47 (1,619 acres) and K43 (1,401 acres). Large contiguous sites, such as K47 and K43, represent the last remnants of large open areas left in the watershed and in many respects the Chicago metropolitan region. The ecological significance of these sites includes the ability to support species that require contiguous uninterrupted tracts of habitat. These include species of concern ranging from grassland breeding birds to the Federally-listed eastern prairie fringed orchid to the plains garter snake, both require high quality aquatic habitat. These species are rare and in decline through much of their range. The ability to provide adequate habitat for area sensitive species can only be accomplished by restoring large contiguous tracts of land such as those present within K47 and K43. In addition to providing suitable habitat for area sensitive species, large continuous sites provide larger core areas that have greater likelihood of sustaining a highly diverse array of all types of species, ranging from wetland sedges to reptiles and amphibians. A higher diversity of species from all functional groups (e.g., functional redundancy) has a higher likelihood of persisting under changing climatic conditions.

Plan G also includes restoration within the southern portion of the watershed that is highly fragmented and yet has some of the largest tracts of undeveloped land directly adjacent to the mainstem of the Des Plaines River. Reconnection of a high quality functioning riparian zone along large rivers is one of most well understood techniques for aquatic restoration. The interface of rivers and floodplains displays high levels of biodiversity and ecosystem function. Restoring large tracts of land (C15 is 1,007 acres and C9 is 815 acres) along the Des Plaines River mainstem floodplain will provide a high quality functioning riparian zone for wildlife that require both river and floodplain habitat to survive and reproduce, especially migratory birds (e.g., Illinois state listed Black-crowned night heron), reptiles (e.g., Federally-listed candidate eastern massasauga) and amphibians (e.g., green frog). Sites C15 and C9, which are both included in Plan G, are two of the largest undeveloped tracts left along the

Des Plaines River in Cook County and provide a unique opportunity to achieve the study's restoration goals and objectives within the watershed.

Although Plan H provides more output (11,736 Net AAHUs) than Plan G (9,115 Net AAHUs), the increase of output requires a bigger increase in cost per unit output. This increase in output and cost is driven by the addition of one site (K33). Plan H does provide opportunities to address the identified problems (e.g., K33 has 2,134 acres, is the largest site within the watershed, reference Table 5.14) within the watershed, but at a less efficient cost than Plan G. The incremental difference in cost between Plan G and Plan H is $163, which is the largest increase in cost per unit output between any of the "Best Buy" plans (Table 5.16), disregarding the NA alternative. Similar sites, and with a similar amount of area, such as L41combined with L43, were compared to K33. Both sites are located in the upper part of the watershed and to the south of K33. L41 and L43 provide restoration of a total of 2,274 acres with an output of 2,794 Net AAHUs for an average annual cost of $3,585,597 vs. K33, that has 2,134 acres with an output of 2,621 Net AAHUs for an average annual cost of $5,080,549, as shown in Table 5.18. Restoration of the combination of L41 and L43 provides for more environmental output with less cost than the restoration of K33. In conclusion, Plan H is a less efficient plan than Plan G, because the increase in incremental costs is not justified based on the output of environmental benefits in comparison to the other "Best Buy" plans.

Table 5.18 – Comparison of Site K33 (additional site in Plan H) to similar sites within watershed

Site	Acres	AA Cost	Net AAHU
K33	2,134	$5,080,549	2,621
L41	673	$1,503,803	1,281
L43	1,601	$2,081,794	1,513
L41+L43	2,274	$3,585,597	2,794

(FY2014 Price Level, FDR 3.5%)

The total with and without project ecological benefits per plan are displayed in Table 5.19 and Figure 5.6. The FWOP condition for the entire Upper Des Plaines River watershed was determined to be 28,881 habitat units. Since these habitat units are already being provided by the system, each alternative was considered in terms of net benefit gain. The most beneficial and cost efficient plan is Ecosystem Plan G since it is able to increase the overall habitat quality of the entire Upper Des Plaines River watershed by 32% with the most efficient use of funds. No Action Plan provides no improvement.

Table 5.19 – Upper Des Plaines River Watershed Total With & Without Project Habitat Units

Plan	FWOP AAHUs	Net FWP AAHUs	Total FWP AAHUs	% Improvement
No Action	28,881	0	28,881	0%
C	28,881	3,719	32,600	13%
F	28,881	6,783	35,664	23%
G	28,881	9,115	37,996	32%
H	28,881	11,736	40,617	41%

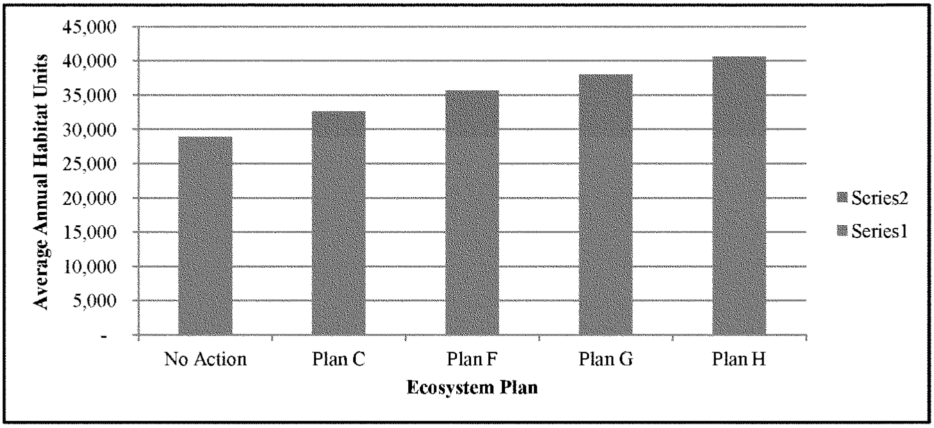

Figure 5.6 – Upper Des Plaines River Watershed Total With & Without Project Habitat Units

5.4.7.2 Significance of Ecosystem Habitat Outputs

Because of the challenge of dealing with non-monetized benefits, the concept of significance of outputs plays an important role in ecosystem restoration evaluation. Along with information from cost effectiveness and incremental cost analyses, information on the significance of ecosystem habitat units will help determine whether the proposed environmental investment is worth its cost and whether a particular alternative should be recommended. Statements of significance provide qualitative information to decision makers regarding the value of the ecosystem proposed for restoration

The alternative plans identified for restoration of ecosystems in the Upper Des Plaines River watershed were systematically developed through the efforts of a collaborative study partnership. The core study team included professionals representing local, state and federal resource agencies as well as the USACE. Implementation of the alternative plans identified through this rigorous process will restore and preserve ecosystems within the highly developed Upper Des Plaines River watershed. The cost-effective plan maximizes the output based on the environmental investment and will compliment the ongoing activities of state and local agencies as well as public groups to maintain the remaining scarce natural habitats within the watershed. The addition of seven restoration sites totaling over 6,800 acres will serve to increase connectivity of the highly fragmented ecosystems located within the riparian zone of the Upper Des Plaines River, and significantly increase structure and function within the river and in the adjacent floodplains. The restoration plan will increase the number of acres of scarce high quality habitat and thereby provide significant resources for native flora and fauna. The plan will also provide habitat for 3 federally listed and 89 state listed species.

It is USACE policy that all projects, including flood risk management and ecosystem restoration projects, are guided by seven Environmental Operating Principles (EOPs). These EOPs are the USACE commitment to sustainability, preservation, accountability, stewardship, and restoration of our Nation's natural resources. They guide USACE efforts to foster and promote the general welfare, to create and maintain productive harmony, and to fulfill the social and economic requirements of present and future generations. The Upper Des Plaines River and Tributaries feasibility study, if implemented, exemplifies and strengthens the USACE environmental commitment by providing protection and/or restoration to significant natural resources. The significance of those resources is discussed in the following sections in terms of three categories: institutional recognition, public recognition, and technical recognition.

Institutional Recognition

Significance based on institutional recognition means that the importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups. Sources of institutional recognition include public laws, executive orders, rules and regulations, treaties, and other policy statements of the Federal Government; plans, laws, resolutions, and other policy statements of states with jurisdiction in the planning area; laws, plans, codes, ordinances, and other policy statements of regional and local public entities with jurisdiction in the planning area; and charters, bylaws, and other policy statements of private groups.

Migratory Bird Treaty Act (1918): The Migratory Bird Treaty Act is the domestic law that implements the United States' commitment to four international conventions for the protection of migratory birds and their habitats. The Act protects species or families of birds that live, reproduce, or migrate within or across international borders at some point during their annual life cycle. The four Migratory Bird Conventions are:

- Convention for the Protection of Migratory Birds with Great Britain on behalf of Canada (1916)
- Convention for the Protection of Migratory Birds and Game Mammals - Mexico (1936)
- Convention for the Protection of Migratory Birds and Their Environment - Japan (1972)
- Convention for the Protection of Migratory Birds and Their Environment - Union of Soviet Socialist Republics (1978)

The Mississippi Flyway*:* There are four principal North American flyways, the Atlantic, Mississippi, Central and Pacific. Except along the coasts, such as Lake Michigan, the flyway boundaries are not always sharply defined. Its eastern boundary runs along western Lake Erie and the western boundary is ambiguous, as the Mississippi Flyway merges unnoticeably into the Central Flyway. The longest migration route in the Western Hemisphere lies in the Mississippi Flyway; from the Arctic coast of Alaska to Patagonia, spring migration of some shorebird species fly this nearly 3,000 mile route twice. Parts of all four flyways merge together over Panama.

The flyway route which includes the Des Plaines River watershed is ideal for all migratory birds, but especially waterfowl because it is uninterrupted by mountains, dotted with tens of thousands of lakes, wetlands, ponds, streams and rivers, and is well timbered in certain reaches. The Des Plaines River watershed is located in the Mississippi Flyway and about 300 to 400 species of birds pass over annually. This urbanized reach of the flyway is also one of America's most important migration routes for songbirds, with more than 5 million individuals (a noticeable fraction of the total number of birds migrating through the entire North American continent) passing through during the migration season. Many migratory birds must pass twice yearly above a continent suffering huge development pressures and thus offering birds fewer and fewer productive stop-over sites. The Upper Des Plaines Watershed when restored will provide essential foraging, nesting and resting habitat. It will provide the right kind of high calorie, high protein food such as seeds, fruit and insects and shelter sufficient to protect them from predators and extremes of weather. Unless these provisions are readily available along the flyway, the long-distance journey becomes more arduous and even fatal. When migratory birds cross into Illinois, they encounter a monoculture of corn and soybean fields throughout most of the state which are not fertile stop-overs. Upper Des Plaines River Watershed will provide comparatively rich feeding and resting opportunities, makes a huge contribution to the survival of many migratory birds that pass through Illinois, Indiana and Wisconsin. The NER Plan restoration projects have great potential to provide 6,800-acres of critical migratory bird habitat.

E.O. 13186 Responsibilities of Federal Agencies to Protect Migratory Birds (2001): Federal agencies shall restore or enhance the habitat of migratory birds and prevent or abate pollution or detrimental alteration of the environment for migratory birds. This project would restore native riparian/riverine and buffering communities, thus providing forage and shelter to numerous migratory bird species. This project will serve to increase connectivity of the highly fragmented ecosystem located within the riparian zone of the Upper Des Plaines River, and significantly increase structure and function within the river and in the adjacent floodplains. The Upper Des Plaines River watershed provides an important stopover for the Mississippi Flyway. Vulnerable migratory birds are expected to increase their usage of restored areas within the watershed. Restoration of native habitat types is a powerful tool to positively influence the success of migratory species through this area. As evidence of migratory bird use by important species, Chicago District biologists have observed great flocks of American Pelican and Sand Hill Cranes heavily utilizing the Des Plaines River and associated wetlands.

Alternative Plans C through E would have benefits added for migratory and residential birds, with F, G and H being the most beneficial in terms of providing habitat lost to agriculture and urbanization effects. Implementation of Plans F, G or H would fulfill the USACE's role and Federal responsibility by utilizing its high priority Ecosystem Restoration mission, authority and supporting polices to restore diverse habitats for migratory waterfowl and fishes that support these bird species.

Endangered Species Act of 1973: All Federal departments and agencies shall seek to conserve endangered and threatened species. The purpose of the act is to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved and to provide a program for the conservation of such endangered and threatened species. Project features would restore critical habitats (stream, marsh, sedge meadow, wet prairie, mesic prairie, savanna, floodplain forest, woodland) for the Federally-listed Karner blue butterfly (*Lycaeides melissa samuelis*); eastern prairie fringed orchid (*Platanthera leucophaea*); eastern massasauga (*Sisturus catenatus*); an experimental recovery population of Whooping Crane and the proposed Northern long-eared bat (*Myotis septentrionalis*). There are 89 state endangered and threatened species within 1 mile of the study area including the Illinois state endangered short-eared owl (*Asio flammeus*); yellow-headed blackbird (*Xanthocephalus xanthocephalus*); sandhill crane (*Grus Canadensis*); yellow rail (*Coturnicops noveboracensis*); blacknose shiner (*Notropis heterolepis*); slippershell mussel (*Alasmidonta viridis*); hoary elfin (*Incisalia polia*); swamp metalmark (*Calephelis mutica*); eastern massasauga (*Sistrurus catenatus*); Tuckerman's sedge (*Carex tuckermanii*); ; white-stemmed pondweed (*Potamogeton praelongus*); and purple fringed orchid (*Platanthera psycodes*). Illinois state threatened species include the double-crested cormorant (*Phalarocorax auritus*); great egret (*Ardea* *albus*); loggerhead shrike (*Lanius ludovicianus*); elephant ear (*Elliptio crassidens*); ironcolor shiner (*Notropis chalybaeus*); ottoe skipper (*Hesperia ottoe*); kirtland's water snake (*Clonophis kirtlandii*); American dog violet (*Viola conspersa*); beaked rush (*Rhynchospora alba*); crawe's sedge (*Carex crawei*); and dwarf raspberry (*Rubus pubescens*). Wisconsin state endangered species include the common tern (*Sterna hirundo*); forster's tern (*Sterna forsteri*); blanchard's cricket frog (*Acrid crepitans blanchardi*); and purple milkweed (*Asclepias purpurascens*). Wisconsin state threatened species include sullivant's milkweed (*Asclepias sullivantii*); prairie Indian plantain (*Cacalia tuberosa*); Acadian flycatcher (*Empidonax virescens*); cerulean warbler (*Dendroica cerulea*); blanding's turtle (*Emydonidea blandingi*); and redfin shiner (*Lythrurus umbratilis*). The Chicago region is a very important biodiversity hotspot within the Midwest (Chicago Wilderness Biodiveristy Recovery Plan).The recommended measures would directly and indirectly benefit an array of valued species found in the Midwest. Many of the habitat types that are proposed for restoration could potentially support migratory or permanent breeding populations of many of the species listed.

As required, the USACE requested that the USFWS provide a report under the Fish and Wildlife Coordination Act. In the draft Fish and Wildlife Coordination Act Report for the Upper Des Plaines River and Tributaries, the USFWS noted that they support ecological restoration at all of the sites identified in the restoration plan. In particular they indicate strong support for the removal of five small dams in Cook County and restoration at six of the seven sites identified in the restoration plan. Several of the restoration sites might include two T&E species, the eastern prairie fringed orchid and the eastern massasauga rattlesnake. Additional site evaluations are recommended for the eastern prairie fringed orchid. The FWS also recommends the development of a conservation plan for the eastern massasauga rattlesnake. FWS indicated they do not object to proposed levees, floodwalls and reservoirs, but recommend that the Corps consider other measures during the formulation of regional solutions to address flooding. Finally, the USFWS also indicated that extensive tree clearing may affect declining bat species and could require mitigation. The draft Fish and Wildlife Coordination Act Report is located in Appendix L.

Alternative Plans C through E would have benefits added for Federal and State listed species, with Plans F, G and H being the most beneficial in terms of restoring habitat lost to agriculture and urbanization effects. Ongoing coordination with USFWS will be continued during design and implementation to avoid and minimize impacts to bats and T&E species habitat as noted in the draft FWCAR. Implementation of Plan F, G or H would fulfill the USACE's role and responsibility complying and supporting the Endangered Species Act of 1973.

Fish and Wildlife Conservation Act of 1980: All Federal departments and agencies, to the extent practicable and consistent with the agency authorities, should conserve and promote conservation of non-game fish and wildlife and their habitats. Restoring different types of habitat, focusing on habitat for native non-game species, and in-stream structures within the Upper Des Plaines watershed will result in an increase in ecosystem function (e.g., net annual primary native plant growth) and habitat diversity of the system. Increases in ecosystem function and structure would also result in an overall increase in native species diversity. By restoring sites located along the mainstem and major tributaries of the Upper Des Plaines River, the overall connectivity of the watershed will increase. Increased connectivity will provide increased dispersal of individuals, energy and genetic information, thereby increasing the likelihood of isolated populations of native species to persist over time and under changing environmental conditions. Restoring in-stream habitat will decrease impediments to native fish migration as well as increase habitat structure and availability for in-stream native species. Removal of ruderal (unnatural/human induced) habitats such as drained farm fields, thickets, and successional woodlands would reduce the abundance and resulting propagule pressure from exotic/invasive species on native species populations. All proposed habitat improvements would benefit native plants, invertebrates, fish, birds, amphibians, reptiles and other wildlife.

Alternative plans C through E would have benefits added for all species of fish and wildlife; however, F, G and H would be the most beneficial in terms of providing habitat lost to agriculture and urbanization effects. Maximizing the diversity of plant community types and their spatial coverage is necessary within the Des Plaines Watershed due to the massive loss in habitat acres through history (88% loss) and would fulfill the USACE's role and responsibility for complying and supporting the Fish and Wildlife Conservation Act of 1980.

Clean Water Act of 1972: The Clean Water Act provides for the protection and restoration of the chemical and biological integrity of the Nation's waters. Restoration of native plant communities within the watershed will not only improve habitat diversity, but also biogeochemical and evapotranspirative processes important in the filtering and recycling of precipitation. Water quality within the Upper Des Plaines River will be improved through the restoration of natural landscape plant communities and the restoration of stream channel morphology. For example, conversion of Eurasian thickets would also remove the noxious chemical produced by such plants as European Buckthorn (*Rhamnus cathartica*) which has been shown to harm or kill amphibians.

Alternative plans C through E would add minor water quality improvements due to the very small scale of the project; however, F, G and H would approach the scale of restored land needed to begin naturally filtering through groundwater recharge, evapotranspiring, and absorbing and breaking down harmful pollutants and chemicals humans produce within the watershed. Implementation of Plans F, G or H would fulfill the USACE's role in supporting the Clean Water Act.

E.O. 11514 Protection and Enhancement of Environmental Quality (1970): The Federal Government shall provide leadership in protecting and enhancing the quality of the Nation's environment to sustain and enrich human life. Improvements to the quality of the Upper Des Plaines watershed include, but are not limited to, restoring ruderal plant communities to remove species such as Tiger mosquito that are potentially harmful to humans as well as poisonous/noxious plants, providing agricultural and urban buffers for healthy water, reducing floodwaters collecting harmful pollutants, providing a greater variety of edible plants for humans in case of disaster. Natural areas are of great importance to residents of the highly urbanized Chicago region, and restoration of natural landscapes and hydrology would improve the ability of the region to support native flora and fauna valuable to humans.

Alternative plans C through E would have benefits that improve the quality of the human environment; however plans F, G and H are the most beneficial in terms of converting ruderal and noxious habitats into human friendly and high quality natural areas for passive recreation. These plans would also greatly improve water quality due to ground water recharge, evapotranspiration, and the filtering abilities of certain native plant species. Implementation of Plans F, G or H would fulfill the USACE's role in supporting the E.O. 11514 for improving the quality of the human environment.

E.O. 11988 Floodplain Management (2012): Each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains. Reestablishing aquatic and terrestrial habitats as functioning, viable and sustainable ecosystems will restore the value of floodplains by minimizing impacts of floods through increases in stormwater storage capacity and improvement of water quality.

Alternative Plans C through E would provide minimal benefits to the watershed scale restoration of floodplains to their natural conditions, floodplain benefits require large tracts of floodplain. Plans F, G and H are the most beneficial in terms of providing natural floodplain areas to help evapotranspirative functions, infiltration, and the storing and attenuation of flood pulses. Larger naturalized floodplain and recharge areas supports a larger volume of water that is retained naturally, supporting the NED Plan. Implementation of Plans F, G or H would fulfill the USACE's role in providing floodplain management leadership.

E.O. 11990 Protection of Wetlands (1977): Each agency shall provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. There are 149-acres of high-quality wetland areas located within the study area, mostly mesic floodplain forest, sedge meadow, calcareous floating mat and marsh. The Illinois portion of the study area alone contains 12,140 acres of wetland, but most these areas have been impacted by increased sedimentation, erratic hydrology, agricultural practices (e.g., drainage tiles), increased nutrient loading, and invasive species infestation. Wetland restoration efforts will address these disturbances throughout the restoration of hydrologic, geomorphic and floristic features that were once characteristic of the Upper Des Plaines River watershed wetlands.

Alternative Plans C through E would minimally increase the quality and quantity of wetlands in the watershed. Plans F, G and H are would restore a much larger wetland footprint, providing more significant benefits. Implementation of Plans F, G or H would fulfill the USACE's role in supporting the E.O. 11990 by protecting and restoring wetlands across the watershed.

E.O. 13112 Invasive Species (1999): "Each Federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law...subject to the availability of appropriations, and within Administration budgetary limits, use relevant programs and authorities to: (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and (vi) promote public education on invasive species and the means to address them."

Alternative Plans C through E would have localized benefits added for reducing the richness and abundance of invasive plant and animal species. Plans F, G and H are the most beneficial in terms of reducing the watershed's spatial distribution of primarily invasive and noxious plant species. The removal of dams and restoration of riverine hydraulics would reduce abundance of the Asian Common Carp (*Cyprinus carpio*), which is validated from the Hofmann Dam Section 206 Monitoring Results. Implementation of Plans F, G or H would fulfill the USACE's role in supporting E.O.13112, with Plan

H maximizing the reduction in spatial distribution of invasive plant and animal species, while preventing viable population recolonization via hydrologic, geomorphic and native plant community restoration.

Institutional Significance Summary: Considering the above institutional recognition and its nexus with the suite of best buy plans, all of the considered alternative ecosystem plans would benefit the Upper Des Plaines River watershed. However, Ecosystem Plans F, G, and H would be most significant since they provide for and maximize watershed recovery for migratory bird habitat, Federally listed species, more habitat area throughout the watershed, and better quality habitat to support these institutional principles with an efficient use of funds.

Public Recognition

Public recognition means that some segment of the general public recognizes the importance of an environmental resource, as evidenced by people engaged in activities that reflect an interest or concern for that particular resource. Such activities may involve membership in an organization, financial contributions to resource-related efforts, and providing volunteer labor and correspondence regarding the importance of the resource.

The Upper Des Plaines watershed is rich with areas that offer hiking, picnicking, boating, and other recreational opportunities. The 22-mile long Des Plaines River Trail is a popular hiking/biking trail that weaves past many of the watershed's natural areas. Several nature centers such as the River Trail Nature Center are well received within the study area. The second oldest continual canoe race in the United States, The Des Plaines River Canoe Marathon, began in 1957 and occurs on 18.5 miles of the Des Plaines River. An ecosystem restoration movement is well established within the Chicago Region and is rapidly growing. Many groups including volunteers dedicated to the preservation and restoration of the Des Plaines watershed exist and perform such tasks as monitoring native ecosystems and their rare or endangered/threatened flora and fauna, providing educational opportunities, creating work days to remove invasive species and collect native seed, conducting guided nature walks and bird watching, and maintaining detailed yearly surveys on populations of rare flora and fauna. The strong public involvement in outdoor recreation and restoration work within the study area directly relates to the importance of an environmental resource for a growing population involved in protecting their natural areas.

These upper Des Plaines River natural areas are a part of a nationally recognized network of 370,000 acres of protected natural areas within the Chicago Region.

National Plans

C2000 Program Nationally Recognized Conservation Plan: In 2004, the C2000 Program was nationally recognized, which includes the upper Des Plaines ecosystem within Illinois. The National Association of Resource Conservation and Development Councils awarded the C2000 Ecosystems Program as the National Supporting Organization of the Year. To date, 41 Ecosystem Partnerships cover 86% of the state and represent 98% of the state's population. These coalitions of local stakeholders are united by a common interest in protecting the natural resources of their watershed. The program is unique in that anyone can volunteer to be a member of an Ecosystem Partnership. By being a designated Partnership, C2000 provides financial and technical support to assist in addressing local watershed concerns. The largest component of the C2000 program is the Ecosystem Project Grants. These grants are awarded annually in the following categories: Habitat, Land Acquisition, Research, Outreach, Planning, and Resource Economics.

Northeastern Illinois Invasive Plant Partnership (NIIPP): The Des Plaines River watershed is included in the NIIPP, which coordinates efforts to manage invasive plant species across the region. NIIPP coordinates with the North American Invasive Species Network that is a national program aimed at combating and controlling invasive species. The Recommended Plan addresses the national goals of control and management of invasive species.

The North American Bird Conservation Initiative (NABCI): The NABCI was created in recognition that many bird species, across taxa and habitats, are experiencing significant and in some cases severe population declines. A variety of bird conservation partnerships (see above) have been initiated to address the needs of various bird groups. While these individual partnerships have generated many notable successes, overlap in effort was apparent, thus common interests of all may be achieved more effectively through integrated national planning and delivery. In short, the goal of NABCI is to better coordinate the efforts of multiple bird conservation partnerships on a national landscape level. In order to facilitate the integrated conservation of all bird species at a regional scale, NABCI developed a geographical network of Bird Conservation Regions (BCRs), or Joint Ventures, based on similar landscape cover types and associated bird species.

The Upper Des Plaines watershed is part of the Oaks and Prairies Joint Venture. A Joint Venture (JV) is a collaborative, regional partnership of government agencies, non-profit organizations, corporations, tribes, and individuals that conserves habitat for priority bird species, other wildlife, and people. Joint Ventures bring these diverse partners together under the guidance of national and international bird conservation plans to design and implement landscape-scale conservation efforts. Joint Ventures have been widely accepted as the model for collaborative conservation in the 21st century. They use state of the art science to ensure that a diversity of habitats is available to sustain migratory bird populations for the benefit of those species, other wildlife, and the public. JV actions include:

- biological planning, conservation design, and prioritization;
- project development and implementation;
- monitoring, evaluation, and research;
- communications, education, and outreach; and
- funding support for projects and activities.

Nationwide, 18 habitat-based JVs address the bird habitat conservation issues found within their geographic area. Additionally, three species-based Joint Ventures, all with an international scope, work to further the scientific understanding needed to effectively manage specific bird species. JVs have a 25-year history of success in leveraging public and private resources to bring together partners and focus on regional conservation needs.

Regional & Local Recognition

The Upper Des Plaines River Ecosystem Partnership: The Upper Des Plaines River Ecosystem Partnership is a nonprofit organization dedicated to restoring and protecting the Upper Des Plaines River Watershed through collaboration, stakeholder education, and technical assistance, while also providing annual watershed tours, rain garden workshops, annual meetings that celebrate their conservation achievements, and lunchtime gatherings that feature speakers and updated news about the watershed.

Plants of Concern: Plants of Concern is another organization devoting time to many sites within the Upper Des Plaines watershed, engaging citizen scientists to monitor the area's rarest plants, document trends in their populations, and provide valuable data used to help preserve and restore areas with rapidly declining rare and listed species.

RiverWatch: RiverWatch is a program developed to train and certify volunteers to collect scientific data on streams and watersheds, which then can be used by professionals and the general public to gauge long-term trends in stream health, identify degraded waters, develop land management strategies, and assess the effectiveness of restoration projects. The very successful RiverWatch Discovery Program provides youth with an outdoor educational opportunity to learn about, care for, and protect local streams by integrating stream sampling with stewardship activities such as plantings and cleanups.

"Friends of ____": There are many "Friends of" groups , one example is the Friends of Ryerson Woods, like many other community and landowner based non-profit groups within the watershed, assemble restoration workdays and work to educate individuals and organizations to preserve, restore and protect native plant and animal communities.

Public Recognition Summary: Considering the above points on National, Regional and Local Public recognition, Alternative Plans C through E would garner minimal interest from National Groups and Plans; whereas, regional and local groups would be interested in any ecosystem restoration projects to support their plans. Plans F, G and H would be the most supported by a National Plan due to the contributions not only to the Des Plaines River watershed ecosystem, but the Mississippi Flyway and adjacent Fox River and Chicago River watersheds. Implementation of Plans F, G or H would fulfill the USACE's role in supporting the three identified National Plans and the many local and regional restoration and watershed groups/plans; however, Plan G is provides a the best return on environmental investment for the watershed..

Technical Recognition

Technical recognition means that the resource qualifies as significant based on its "technical" merits, which are based on scientific knowledge or judgment of critical resource characteristics. Whether a resource is determined to be significant may vary based on differences across geographical areas and spatial scale. While technical significance of a resource may depend on a local, regional, or national perspective is undertaken, typically a watershed or larger (e.g., ecosystem, landscape, or ecoregion) scalet should be considered. Technical significance should be described in terms of one or more of the following criteria or concepts: scarcity, representation, status and trends, connectivity, limiting habitat, and biodiversity.

Scarcity: Scarcity is a measure of a resource's relative abundance within a specified geographic range. Generally, scientists consider a habitat or ecosystem to be rare if it occupies a narrow geographic range (i.e., limited to a few locations) or occurs in small groupings. Unique resources, unlike any others found within a specified range, may also be considered significant, as well as resources that are threatened by interference from both human and natural causes.

The study area contains nine sites that are dedicated as Illinois Nature Preserves, totaling 1,475.7 acres. Nature preserves exist to protect and preserve significant natural features for the purposes of conserving biodiversity, scientific research, education, and aesthetic enjoyment. These nature preserves as well as other natural areas are vital to the Upper Des Plaines watershed as there is no state or federally owned park, conservation area, fish and wildlife area, or state or federally owned forest preserve. The Nature Serve conservation status system rated several habitats within the study area as either critically imperiled globally (G1), imperiled globally (G2), and very rare globally (G3). G1 habitats within the study area include dry-mesic and wet-mesic savanna; G2 habitats include wet prairie and mesic prairie, while sedge meadows are considered to be globally rare and nationally significant.

The remaining natural areas have suffered a considerable amount of human induced disturbances including fire suppression, high nutrient input, and altered hydrology. The altered natural areas created a functional loss to natural processes that facilitated natural and human induced disturbances including the establishment of non-native, invasive species and changes in landuse. The significant reduction in natural area acreage coupled with altered natural processes and declining biodiversity makes the Des Plaines watershed a scarce and significant resource in need of ecological restoration.

Representativeness: Representativeness is a measure of a resource's ability to exemplify the natural habitat or ecosystems within a specified range. The presence of a large number and percentage of native species, and the absence of exotic species, implies representativeness as does the presence of undisturbed habitat.

Areas currently designated as nature preserves represent a tiny, fragmented portion of what once existed within the Des Plaines watershed. If restored, historic natural communities with a diverse array of native species would have the opportunity to establish or expand in areas now dominated by invasive species, unnatural woody succession, old fields, and abandoned or unproductive agricultural land. Current high quality habitats would have the opportunity to expand and increase connectivity, while seed banks of remnant natural communities could germinate following the completion of restoration measures.

The restoration plan will restore hydrology and natural processes and improve water quality as the restored riverine wetlands and floodplains interact with surface water, floodwater and groundwater of surrounding habitats. These riparian areas have great potential for buffering streamwaters entering the watershed from human activities by lowering nutrient content, reducing rapid flooding and drying cycles, and acting as a deposition for eroded soils.

Areas not directly impacted by surface water serve as critical habitats for federally and state endangered and threatened flora and fauna. Therefore, these existing intact, high-quality areas need to be protected from human induced disturbances such as high nutrient input, altered hydrology, and sediment deposition. The restoration of riverine wetlands and floodplains of the Des Plains watershed, in conjunction with invasive species removal and reintroduction of fire, will create favorable conditions for a healthy establishment of natural areas that will support a watershed of restored ecosystem structure and function characterized by stable hydrologic regimes and nutrient cycling, high biodiversity, and reoccurrence of fire - allowing for symbiotic relationships between native fauna and flora to exist in areas where such interactions had been lost.

Status and Trend: Status and Trend is an evaluation of the occurrence and extent of the resource over time, how it has changed, and why. Historically, the Upper Des Plaines River watershed was dominated by several naturally occurring cover types such as wetlands, forests, savannas and prairies. By the late 1800s, most of these cover types, particularly prairies, savannas and wetlands, were converted to agricultural, urban or industrial use. Subsequently, there was a significant loss of biodiversity within the last one hundred years. Biodiversity decreased through the loss of hydrogeomorphic function, fluvialgeomorphic function, and land use change, which in turn has lead to a reduction in ecosystem complexity. Biogeochemical processes are functional within the Upper Des Plaines River watershed; however, they have been degraded through alteration of habitat. Function of the riverine system (erosion, transportation, deposition) has been altered through the construction of dams, channelization, and the rivers restricted use of its natural floodplain. These are manifested through a decreased level of natural services such as flood moderation, maintenance of adequate water quality, wildlife habitat, etc. Furthermore, the remnant parcels of natural cover types are under pressure from continued human activities. Nearly 90,000 acres of prairie are believed to have been present in 1840, of which currently only about 18 acres are considered as high-quality. Human induced disturbances to the remaining natural areas include fire suppression, altered hydrology, increase colonization of invasive species, and fragmentation. The recommended plan would significantly increase the footprint of nationally and globally rare ecosystems.

Connectivity: Connectivity is the measure of the potential for movement and dispersal of species throughout a given area or ecosystem. Connectivity within the Upper Des Plaines River watershed has been aided through the formation of the Des Plaines Greenway in Lake County, Illinois. Approximately 3,025 acres of land divided into 10 forest preserves, portions of which comprise the Des Plaines River floodplain, are maintained by the Lake County Forest Preserve as part of the greenway. Restoration of adjacent parcels of land within the watershed will provide additional high quality habitat for wildlife. Furthermore, fragmentation of natural areas would be reduced providing unimpeded dispersal routes between habitats for wildlife.

Aquatic life will benefit greatly through the restoration of connectivity within the Upper Des Plaines River. Removal of small dams will aid reducing impediments to fish movement as well as macroinvertebrates. The river will also be reconnected with portions of its natural floodplain, in turn providing nursery grounds for larval fish species. Finally, with the addition of in-stream habitat within the system, available habitat to niche specific species will improve as well as the overall function of the river.

As noted earlier in the discussion of Institutional Recognition, the Mississippi River flyway is ideal for all migratory birds. It is uninterrupted by mountains, dotted with tens of thousands of lakes, wetlands, ponds, streams and rivers, and is well timbered in certain reaches. However, the Mississippi River Flyway portion in and adjacent to Upper Des Plaines River is significantly urbanized with few productive stopover sites needed for essential foraging, nesting, and resting habitat. As a result, this portion of the flyway is one of North America's most important flyways for migrant songbirds per the Bird Conservation Network. Ornithologists at the Chicago Field Museum estimate on average more than five million migrating songbirds pass through this heavily urbanized area during the migration season. The five million birds are a noticeable fraction of the total number of migrant songbirds moving through the entire North American continent per the Bird Conservation Network. The Upper Des Plaines Watershed when restored will provide essential foraging, nesting and resting habitat in addition to connectivity that is globally significant.

Limiting Habitat: Limiting habitat, habitat that is essential for the conservation, survival, or recovery of one or more species, exists within the Upper Des Plaines River watershed. Federally-threatened and endangered species as well as numerous state rare, endangered, and threatened species would benefit from restoration measures. Project features would be beneficial to the federally-endangered butterfly Karner blue butterfly (*Lycaeides melissa samuelis*) and the prairie white-fringed orchid (*Platanthera leucophaea*), including the Federal candidate species eastern massasauga (*Sisturus catenatus*). There are also over 89 state endangered and threatened species within 1 mile of the study area including the Illinois state endangered short-eared owl (*Asio flammeus*); yellow-headed blackbird (*Xanthocephalus xanthocephalus*); sandhill crane (*Grus Canadensis*); yellow rail (*Coturnicops noveboracensis*); blacknose shiner (*Notropis heterolepis*); slippershell mussel (*Alasmidonta viridis*); hoary elfin (*Incisalia polia*); swamp metalmark (*Calephelis mutica*); eastern massasauga (*Sistrurus catenatus*); Tuckerman's sedge (*Carex tuckermanii*); ; white-stemmed pondweed (*Potamogeton praelongus*); and purple fringed orchid (*Platanthera psycodes*). Illinois state threatened species include the double-crested cormorant (*Phalarocorax auritus*); great egret (*Ardea albus*); loggerhead shrike (*Lanius ludovicianus*); elephant ear (*Elliptio crassidens*); ironcolor shiner (*Notropis chalybaeus*); ottoe skipper (*Hesperia ottoe*); kirtland's water snake (*Clonophis kirtlandii*); American dog violet (*Viola conspersa*); beaked rush (*Rhynchospora alba*); crawe's sedge (*Carex craweii*); and dwarf raspberry (*Rubus pubescens*). Wisconsin state endangered species include the common tern (*Sterna hirundo*); forster's tern (*Sterna forsteri*); blanchard's cricket frog (*Acrid crepitans blanchardi*); and purple milkweed (*Asclepias purpurascens*). Wisconsin state threatened species include sullivant's milkweed (*Asclepias sullivantii*); prairie Indian plantain (*Cacalia tuberosa*); Acadian flycatcher (*Empidonax virescens*); cerulean warbler (*Dendroica cerulea*); blanding's turtle (*Emydonidea blandingi*); and redfin shiner (*Lythrurus umbratilis*). The Chicago region is a very important biodiversity hotspot within the Midwest (Chicago Wilderness Biodiveristy Recovery Plan).The restoration plans would directly and indirectly benefit an array of valued species found in the Midwest. For example, the section 206 Aquatic Ecosystem Restoration project, Orland Tract Grassland, now supports two small populations of the Crawe's sedge (*Carex craweii*). Orland Tract Grassland is located in the Lower Des Plaines River watershed, in Cook County, IL.

National Significance Metrics & Summary: Based on the above discussions, Plans F, G and H qualify as Nationally Significant Plans, with Plan G representing the most cost-effective restoration plan. The purpose of this study is to determine the most effective manner in providing improved habitats within a highly agricultural and urbanized watershed that is part of a Nationally Significant Migratory Bird Flyway and possesses the potential to restore critical habitat for several federally-endangered species. The project(s) would also eradicate invasive plant species from sites and maintain native plant community structure. The following metrics are assigned to a project based upon the site meeting the requirements identified in the Corps Budget Guidance EC 11-2-206:

- **Habitat Scarcity:** The loss of 88% of natural habitats within the Upper Des Plaines River watershed is documented. The restoration plan proposes to restore scarce high quality habitats, reduce fragmentation within the riparian corridor and connected floodplains to provide habitat for native species including 3 federally listed and 89 state listed species.

- **Connectivity:** This is supported by the removal of five dams, removing inhospitable habitats that fragment certain low vagility species and adds patches of critical habitat within the a major north-south riverine system which is also a component of the Mississippi Flyway.
- **Special Species Status:** Several critical habitats are being restored that would support Federally-listed species. Coordination ongoing with USFWS regarding habitat and species requirements for these species. There are 3 federally listed and 89 state listed species within the study area.
- **Hydrologic Character:** One of the main impairments to the Upper Des Plaines River watershed ecosystems is alteration/degradation of wetland and floodplain hydrology. All Plans currently have a component to restore hydrology back to natural hydro-periods and spatial coverage.
- **Geomorphic Condition:** Another main impairment to the Upper Des Plaines River watershed is the channelization of streams and grading out of micro-topography. All Plans currently have a component to restore fluvialgeomorphic and hydrogeomorphic features back to natural configurations and processes.
- **Plan Recognition:** The Upper Des Plaines River watershed is recognized by three National Plans and many regional and local plans as well.
- **Self Sustaining:** All Plans currently utilize natural sources of hydrology, follow geomorphic patterns and utilize plant genetic material within the regionally accepted radius to maintain local genetic heterogeneity. Since the use of locally adapted species and resurgence of hydrogeomorphic features, O&M will require a small investment. The primary O&M requirements relate to invasive species management and would include annual spot treat of individuals or small patches invasive plant species. Once established, these areas should be self-sustaining, and only minimal effort would be needed in the future to maintain these sites as high quality and critical habitat areas.

5.4.7.3 Acceptability, Completeness, Effectiveness and Efficiency

Acceptability, completeness, effectiveness, and efficiency are the four evaluation criteria the USACE uses in the screening of alternative plans. Alternatives considered in any planning study, not just ecosystem restoration studies, should meet minimum subjective standards of these criteria in order to qualify for further consideration and comparison with other plans.

Acceptability

An ecosystem restoration plan should be acceptable to state and Federal resource agencies and local governments. There should be evidence of broad-based public consensus and support for the plan. A Recommended Plan must be acceptable to the non- Federal cost-sharing partner. However, this does not mean that the Recommended Plan must be the locally preferred plan.

Preliminary coordination with state and Federal resource agencies indicate that ecosystem restoration within the Upper Des Plaines River watershed is a priority and will benefit threatened and endangered species and their critical habitats. Not only was coordination part of agency support, but a multi-agency team was established to develop habitat models and restoration alternatives specifically for this study. This team was termed the E-Team, and consisted of members from the USFWS, USEPA, USACE, NRCS, Illinois Geological Survey, IDNR, WDNR, South Eastern Wisconsin Planning Commission, Kenosha County, Lake County SMC, Lake County Forest Preserve District, and the Forest Preserve District of Cook County. The ecosystem restoration measures were developed in conjunction with this team to develop alternative plans that would improve habitat quality throughout the Upper Des Plaines River watershed in line with preliminary studies conducted by several of these agencies as master plans or watershed assessments.

The primary non-Federal sponsors for this study and subsequent projects are the Lake County Forest Preserve, Kenosha County, Forest Preserve District of Cook County and the IDNR. These agencies would ultimately hold the responsibility for providing real estate and easements, and perform O&M of these sites once restored. Ecosystem Plans F, G and H were acceptable to the non-Federal sponsors as they would provide restoration in each county and within areas that provide the highest environmental benefits; however, Ecosystem Plan G provides a more balanced plan and is in line with the master plans and acquisition capabilities of all partnering agencies across the watershed. Overall, the No Action Plan and Ecosystem Plan C, which only restores habitat in Cook and Kenosha Counties, is unacceptable to the listed agencies and non-Federal sponsors above, while Ecosystem Plan G is the most acceptable for performing ecological restoration at a watershed scale and with the most efficient use of funds.

Completeness

A plan must provide and account for all necessary investments or other actions needed to ensure the realization of the planned restoration outputs. This may require relating the plan to other types of public or private plans if these plans are crucial to the outcome of the restoration objective. Real estate, operations and maintenance, monitoring, and sponsorship factors must be considered. Where there is uncertainty concerning the long term functioning of certain restoration features, and an adaptive management plan has been proposed, it must be accounted for in the plan. The recommended Ecosystem Plan G is considered complete since it restores a significant portion of the Upper Des Plaines River watershed and the proposed sites are located in areas where the highest benefits will be derived. The recommend sites and restoration alternatives per site were formulated with the exact same restoration techniques that were previously planned or implemented by federal, state and local agencies. For instance, the Lake County Forest Preserve District has restored several important tracts of land, such as Rollins and Wadsworth Savannas, and the plans presented in this study will be invaluable additions to them in terms of connectivity and hydrology. In the winter of 2010/2011, the Ryerson Woods Dam on the Des Plaines River was removed by the Lake County Forest Preserve District. In addition, the planning and design phases have been completed for the removal of the Dan Wright and MacArthur Woods dams. The IDNR, Forest Preserve District of Cook County and USACE have notched the largest dam and biggest impediment to fishes recolonizing the Upper Des Plaines River watershed in the Hoffman dam, along with two smaller dams, the Armitage and Fairbanks dams. The WDNR and SEWRPC have also completed several small fish passage projects and wetland restorations along the Des Plaines River that will result in the same benefits as proposed in Ecosystem Plan G.

As stated in the Acceptability section above, the primary non-Federal sponsors for project implementation will be the Lake County Forest Preserve District, Kenosha County, Forest Preserve District of Cook County and the IDNR. These agencies would ultimately hold the responsibility for providing real estate and easements, and perform O&M of these sites once restored. Ecosystem Plans

F, G and H were acceptable to the non-Federal sponsors across the watershed; however, Ecosystem Plans G and H also provides projects that are in line with the master plans and acquisition capabilities of Kenosha County sponsors. All of the agencies and non-Federal sponsors intend on monitoring the results of any implemented restoration plans under this study.

Effectiveness

An ecosystem restoration plan must make a significant contribution to addressing the specified restoration problems or opportunities (i.e. restore important ecosystem structure or function to some meaningful degree). The objectives developed for this study were directed at alleviating the watershed problems that may be addressed under the given ecosystem authority and USACE policies. The following is a discussion of how plans meet the study objectives:

Increase species richness, abundance and health: This objective will specifically look to increase total native species richness of restoration sites. This may be monitored using the HEP and HGM data collection techniques used to derive habitat suitability curve values. These assessment procedures and indices are calibrated for the region of study and are sensitive enough to capture improvements in quality. All alternative ecosystem plans would be effective at increasing species richness and abundance within the Upper Des Plaines River watershed. The removal of the last five dams on the Des Plaines River would allow for species to disperse from and recolonize from the lower Des Plaines River, such as silver redhorse (*Moxostoma anisurum*), skipjack herring (*Alosa chrysochloris*), freckled madtom (*Noturus nocturnus*) and sauger (*Sander canadense*). Thousands of acres would be restored that would reestablish hundreds of species of native plants back to the landscape. These healthy plant and stream communities would then attract a diverse array of resident and migratory birds and local insect, reptile, amphibian and mammal species. Results of past restoration activities of lesser extent in the region has shown a remarkable unassisted resurgence of regionally and nationally important wildlife species (e.g., Rollins Savanna, Orland Tract Grassland, Eugene Field, Wadsworth Savanna and Wet Prairie, etc.). These restoration projects used the same techniques that are described in the Recommended Plan that will be applied over a greater extent of the landscape. Since the techniques rely to a great extent on unaided natural processes, which are facilitated and reestablished during construction to maintain ecosystem structure and function. These techniques have been shown to be very cost efficient in restoring self-sustaining target ecosystems.

Increase connectivity of natural areas: Through creating high quality large contiguous tracts of native habitat, high functioning riparian corridors and stepping stones between remaining natural areas, this objective seeks to connect fragmented habitat patches, whether they are currently in a healthy state or they are in need of restoration. Ecosystem Plan G is the most effective and efficient at meeting the connectivity objective (Plate 41). All sites are located along the mainstem or major tributaries of the Upper Des Plaines River, which are major dispersal corridors for numerous vagile (i.e., able to move around in a landscape) species within the region. This has been proven to be a very effective and cost efficient method of restoring connectivity of within the landscape. Sites are also located near to other open/natural areas, allowing a greater chance of successful dispersal between fragmented native species populations. Increased dispersal along major riparian corridors and between isolated populations ensures these remaining native species populations have a greater likelihood of remaining genetically diverse and able to adapt to and persist during periods of environmental change.

Increase acreage of native community types: The increase in overall acreage of natural areas within a given subwatershed is not only beneficial to the targeted ecosystems, but also aids in alleviating hydrology and hydraulic problems for in-stream and wetland dependent species. For example, a subwatershed that is primarily agricultural land would see improvements in ecological function (e.g., hydrologic regime) if drain tiles were disabled and natural wetland plant communities were restored. Ecosystem Plan G is effective at meeting the need for increased size of native communities and subsequent hydrologic improvements. To improve hydrology, an estimated 17,900 feet of unnatural ditch would be filled along with hundreds of thousands of feet of drain tiles disabled. Natural stream sinuosity would be restored increasing total length from 68,400 feet to 85,500 feet and 7,000 feet of stream would receive instream habitat treatments. Over 6,800 acres of native aquatic community types would be restored including: marsh, sedge meadow, wet prairie, wet savanna, floodplain forest, and woodland ephemeral depressions. Riparian and buffering communities of prairie, savanna, woodland, and forest would also be restored to ensure sustainability and provide connectivity for multi-habitat life cycle species (i.e. Eastern Newt (*Notophthalmus viridescens*) require connectivity between marsh and woodland habitats). Ecosystem Plan G increases the quality of watershed ecosystem communities by 32% of what currently exists, an increase of almost 10% over the next smaller plan (Figure 5.6).

Reduce/control/eradicate non-native plant and animal species: This objective looks to ease the impacts of non-native and invasive species, particularly plant species. It is very difficult to eradicate invasive species; however, with hydrologic restoration, long-term maintenance and reintroduction of prescription burns that mimic per-settlement frequencies, local impacts from invasive plant species may be greatly minimized. Overall, all alternative ecosystem plans are effective at reducing the impacts of non-native plant species. The proposed plan would return hundreds of acres, ranging from sites that are 416 acres to over 1,000- acres in size, of land back to native communities free of invasive species effects. Ecosystem Plan G would be the most effective, restoring over 2,000 acres more than the next smaller plan. Based on previous restoration efforts within the study area that were aimed at controlling invasive species, there is good evidence that invasive species can be controlled and managed at low levels of effort in the years after completion of construction in community types that have a high native species richness. By allowing natural competitive interactions to occur within restoration areas, by establishing species rich native communities, these restoration techniques provide a cost effective way to ensure greater control of invasive species with minimal long term effort.

Preserve existing natural resources: This objective seeks to preserve acres of existing natural areas and sources of natural resources. This may be accomplished through simple procurement of land, restoration, management and by adding buffers to existing natural areas (i.e. riparian corridors). Ecosystem Plan G is more efficient at providing connectivity by including sites throughout the watershed. Ecosystem Plan G connects a total of 85,000-feet of greenway on the mainstem Des Plaines River.

Improve water quality for aquatic organisms: This objective seeks to reduce non-point source runoff, point source discharge and CSOs, and up-grade water quality use designations throughout mainstem and tributaries of the Upper Des Plaines River watershed. As identified in the increase of native community type objective, returning native vegetation, disabling drain tiles, filling in ditches and restoring streams for the purpose of habitat restoration has positive effects on water quality. Returning water into the ground through retention and groundwater infiltration, and reestablishing naturally meandering streams will provide the means for filtering out nutrients and particulate matter that currently foul the waters of the Upper Des Plaines River. Although this is not a solution to the watershed's water quality issues, it is a starting point for projects to set an example how water quality can be restored through utilizing natural ecosystem functions. Ecosystem Plan G would be effective at achieving this initial level of water quality improvement.

The following are points of how plans comply with planning constraints:

Compatibility with flood damage reduction plans: All proposed alternative ecosystem plans compliment flood damage reduction projects since they would assist in attenuating water leaving the sites, infiltrate water back into the ground, provide a significant amount of acres for native plant evapotranspiration, and removes hydraulic impediments from the Upper Des Plaines River.

Compatibility with local watershed development plans: Watershed plans and initiatives within the Upper Des Plaines River watershed discuss opportunities for ecological restoration and preserving open space. All proposed alternative ecosystem plans were initially based off of their concepts and have the potential to bring them to fruition.

Avoid increases in flood damages, Avoid adverse effects to existing flood damage reduction projects and Minimize adverse affects to local drainage districts: The proposed alternative ecosystem plans all require additional site specific analyses during the PED Phase. Water budgets, hydraulic analyses, infiltration and evapotranspiration analyses would be completed to determine the fate of water that enters and leaves the restoration sites. Based on current information and past studies, it is likely that these restoration projects will complement FRM projects.

Efficiency

An ecosystem restoration plan must represent a cost-effective means of addressing the ecological problem or opportunity. It must be determined that the plan's restoration outputs cannot be produced more cost effectively by another agency or institution. The cost effectiveness of alternatives and sites were analyzed using IWR-Plan software and are presented in Section 5.4.6. As presented, the most cost effective alternatives were chosen per site, then the most cost efficient sites were identified, then the best of the best sites were screened in order to identify those sites that most effectively address problems and opportunities identified within the watershed for the given costs. These eight sites were then allowed to be developed into the alternative ecosystem plans. All inefficient alternatives and sites were removed from consideration and only "best buys" (plans A-H) were retained for further consideration. In addition to the CE/ICA, the efficiency of the specific restoration techniques described in the Recommended Plan has a long history of refinement in the region. Enabling regional practitioners to be reasonably assured of the results of these specific restoration techniques. Long-term past and ongoing restoration projects within the area (e.g., Somme Prairie) has served as examples of these techniques in providing physical evidence that they are effective and cost efficient.

5.4.7.4 Risk and Uncertainty

When the costs and outputs of alternative restoration plans are uncertain and/or there are substantive risks that outcomes will not be achieved, the selection of a recommended alternative becomes more complex. It is essential to document the assumptions made and uncertainties encountered during the course of the planning analyses. Restoration of some types of ecosystems may have relatively low risk. For example, removal of drainage tiles to restore hydrology to a wetland area. Numerous successful examples of this technique are located within the watershed. Other activities may have higher associated risks such as restoration of a coastal marsh in an area subject to hurricanes. When identifying the NER plan the associated risk and uncertainty of achieving the proposed level of outputs must be considered. For example, if two plans have similar outputs but one plan costs slightly more, according to cost effectiveness guidelines, the more expensive plan would be dropped from further consideration. However, it might be possible that, due to uncertainties beyond the control or knowledge of the planning team, the slightly more expensive plan will actually produce greater ecological output than originally estimated, in effect qualifying it as a cost effective plan. But without taking into account the uncertainty inherent in the estimate of outputs, that plan would have been excluded from further consideration.

Overall, there is very low risk associated with the selected NER plan not performing as predicted. Investigations appropriate for the level of project complexity were performed to ensure that the restored plant communities would not revert to invasive, weedy species again by a) gathering lessons learned from similar completed projects such as Orland Tract Section 206, Orland Perimeter 506, Calumet Prairie 506, and Red Mill Pond 506; b) designing plant communities compatible with the hydrology and geomorphology instead of fighting it, i.e. the overall design replicates plant communities indicative of the Upper Des Plaines River system as dictated by the historic vegetation maps and soil series; c) restoring hydrologic, hydraulic and fire processes to sustain and facilitate native plant communities; d) planting enough native plant material to prevent or lessen the ability of invasive and weedy plant species to effect the native plants; and e) implementing the projects in partnership with dedicated non-Federal sponsors that have natural area programs and protocols that will maintain the project as constructed with the intended ecological benefits.

Control of invasive species always presents a certain level of risk and uncertainty as the chances of reinvasion are likely without proper management, increasingly so when native species have not yet established. A prominent issue is that invasive plant species are adapted for colonizing areas that are disturbed and have altered soils (e.g., high nutrient content or unconsolidated urban fill). Ruined soil properties maybe alleviated by adding leaf litter compost to the top 6" of soil during late summer or early fall. Incorporating soil amendments decreases bulk density, holds moisture longer, and increases organic matter and microbial activity. This furthers the soil's ability to provide for native plants and reduces the vulnerability of the plant community to noxious weed invasion. This measure has been effective on several Chicago District habitat restoration projects where the soils were physically altered. Where soils with very high organic content are encountered, inorganic substrates (e.g., free carbon) are added to balance the soil properties.

Native plantings also have an associated risk of not establishing due to a variety of unforeseen events. Predation from herbivorous animals is likely since common carp and Canada geese are quite abundant in the area. Weather also plays a large role in the establishment success of new plantings. Periods of drought, flood or early frost can alter the survival percentage of plantings. To mitigate these risks, planting over several years, overplanting and/or adaptive management and monitoring will be incorporated into the overall plan. In addition, climate change may or may not affect project outcomes. Consideration of climate change was incorporated in the study forecasting and alternative analysis as discussed in Section 5.3.2. In addition, effects of climate change on populations of native plants may be moderated by choosing a diversity of source material (different populations with different genetic characteristics), selecting a high number of species (high species richness) and increasing the functional redundancy of the community by choosing many species that perform a similar role. All of these decisions will increase the ability of the native plant community to effectively respond, adapt and persist during periods of environmental change.

5.4.7.5 Partnership Context

The ecosystem restoration portion of this project was planned in cooperation with Federal, state and local resource agencies, termed the E-Team. This plan includes an opportunity for public comment, a description of the work to be undertaken, the methods to be used for ecological restoration, the roles and responsibilities of the Secretary and non-Federal sponsors, and the identification of funding sources. Similarly, this restoration project makes a significant contribution to regional, national, and international programs under the North American Waterfowl Management Plan. This project was coordinated and is in congruence with the Upper Des Plaines River Ecosystem Partnership, the Kenosha / Racine Land Trust, Openlands, the Chicago Wilderness, etc. There are over 50 entities with a stake in restoring ecosystems within the Upper Des Plaines River watershed http://upperdesplainesriver.org/links.htm#nonprofit1.

5.4.8 Selection of the Recommended Plans

When selecting a single alternative plan for recommendation from those that have been considered, the criteria used to select the plan include all the evaluation criteria discussed above. Plan selection requires careful consideration of the plan that meets planning objectives and constraints and reasonably maximizes environmental benefits while passing tests of cost effectiveness and incremental cost analyses, significance of outputs, acceptability, completeness, efficiency, and effectiveness. Table 5.20 is a summary of the preceding Trade-off analysis to determine the recommended Ecosystem Plan. The plan that maximizes net NER benefits and has shown great merit in the trade-off analysis is Ecosystem Plan G.

Table 5.20 – Alternative Plan Trade-off Analysis

Trade-Off Criteria	Ecosystem Plan A	Ecosystem Plan C	Ecosystem Plan F	Ecosystem Plan G	Ecosystem Plan H
Ecological Benefits	medium	medium	medium	high	highest
Output Significance					
Institutional	minimally	moderately	moderately	very	very
Public	minimally	moderately	moderately	very	very
Technical	minimally	moderately	moderately	very	very
Planning Criteria					
Acceptability	low	medium	medium	high	high
Completeness	high	high	high	high	high
Effectiveness	medium	medium	medium	high	high
Efficiency	high	high	high	highest	high
Risk	low	low	low	low	low
Uncertainty	low	low	low	low	low
Partnership Context	full support	full support	full support	full support	full support
Cost Reasonableness	reasonable	reasonable	reasonable	reasonable	reasonable

The authorization for this study directs USACE to "not exclude from consideration and evaluation flood damage reduction measures based on restrictive policies regarding the frequency of flooding, the drainage area, and the amount of runoff." (WRDA 1999, Sec. 419.b). Although certain FRM projects are not policy compliant as discussed in Section 4.6.5, all proposed ecosystem restoration projects are fully compliant with current USACE guidance. However, certain projects could reasonable be implemented under the USACE CAP. To respond to the study authority while also considering existing policy and guidance, three distinct plans have been formulated:

1. **Comprehensive Plan:** A plan that fully responds to the study authority and includes all cost-effective, environmentally acceptable separable projects evaluated during the course of the study. The CAP Plan and NER Plan are subsets of the Comprehensive Plan.
2. **CAP Plan:** All policy compliant, cost-effective, environmentally acceptable separable projects of such scope that they could reasonably be implemented under the CAP.
3. **NER Plan:** All policy compliant, cost-effective, environmentally acceptable projects of such scope that they could not be implemented under CAP.

All of the recommended Ecosystem Plan elements are policy compliant. However, some of the plan elements could reasonably be implemented under the CAP program. The NER Plan and CAP Plans are subsets of this Comprehensive Plan as detailed below. Aquatic Ecosystem Restoration projects may be implemented under CAP if the total Federal cost is less than $5,000,000. Sites that meet this criteria are identified as part of the CAP Plan. The remaining sites are part of the NER Plan.

5.5 Description of the Ecosystem Restoration Plans*

Restoration measures to be implemented per site under the Ecosystem Plan G are detailed in Table 5.21 and estimated costs for each site are presented in Table 5.22. Detailed descriptions of each site's restoration plan are provided in Section 10. The plan formulation process was fashioned so that site selection and restoration activities would fall within Corps aquatic ecosystem restoration policy. The formulation was geared towards restoring those sites that were in most need of hydrologic-hydraulic, geomorphic, and aquatic native plant structure repair, all of which interact with each other to provide stream, wetland, and riparian habitat for higher level organisms such as fish, amphibians, reptiles, birds and mammals. Also, it is imperative for the Corps and non-Federal sponsors to recommend sites and restoration methodologies that would lead to sustainable and functioning ecosystems that would require limited operations and maintenance. Benefits include:

1. Naturalize watershed hydrology, hydraulics and geomorphology
2. Increase acreage of native community types
3. Reduce/control/eradicate non-native plant and animal species
4. Increase connectivity of natural areas
5. Increase watershed biodiversity
6. Preserve existing natural resources via adding adjacent habitat acres, not through acquisition
7. Incidental improvements in water quality for aquatic organisms
8. Increase naturalized open space and recreational opportunities

9. Aid in naturalization of main stem and tributary flood pulses

A period of monitoring and, if needed, adaptive management will follow initial construction at each site. The structural sustainability and biological response of the restored ecosystem will be assessed to determine whether the project is meeting the planning goals and objectives.

Once the projects have been established, sites will be maintained by the non-Federal sponsors according to detailed OMRR&R plans developed for each site. Maintenance will include activities such as prescribed burns, periodic mowing, control of herbaceous and woody invasive species, and additional seeding to build species richness.

Table 5.21 – Summary of Ecosystem Restoration Plan Components.

	Site						
Measure	**C09**	**C15**	**L31**	**L39**	**L43**	**K41**	**K47**
Stream Remeander				X		X	X
Bank Grading 20:1				X		X	
Swale Grading							
Cobble Riffles				X		X	
Fill Ditch				X			X
Drain Tile Survey	X	X	X	X	X	X	X
Drain Tile Valves	X	X	X	X	X	X	X
Tree & Understory Trimming	X	X	X	X	X		X
Tree Removal	X	X	X		X	X	X
Herbaceous Management		X	X	X	X	X	X
Native Plant Establishment	X	X	X	X	X	X	X

Table 5.22 – Preliminary Ecosystem Restoration Costs

County	ID	Plan	Total Implementation[1]	Preliminary Lands and Damages[2]	Total Project Cost	Annual OMRR&R
Kenosha	K47	NER	$22,754,000	$20,358,000	$43,113,000	$117,000
	K41	NER	$9,865,000	$9,014,000	$18,880,000	$59,000
Lake	L43	NER	$18,035,000	$12,183,000	$30,217,000	$70,000
	L39	NER	$7,208,000	$3,213,000	$10,422,000	$20,000
	L31	NER	$12,779,000	$5,123,000	$17,901,000	$28,000
Cook	C09	NER	$13,057,000	$7,003,000	$20,059,000	$18,000
	Dam #1	CAP	$676,000	$8,000	$684,000	$0
	Dam #2	CAP	$684,000	$8,000	$691,000	$0
	C15	NER	$12,223,000	$8,468,000	$20,690,000	$16,000
	Dempster Ave Dam	CAP	$583,000	$8,000	$591,000	$0
	Touhy Ave Dam	CAP	$722,000	$8,000	$730,000	$0
	Dam #4	CAP	$618,000	$8,000	$626,000	$0
NER Plan Total			**$95,921,000**	**$65,362,000**	**$161,282,000**	**$328,000**
CAP Total			**$3,283,000**	**$40,000**	**$3,322,000**	**$0**
Comprehensive Plan Total			**$99,204,000**	**$65,402,000**	**$164,604,000**	**$328,000**

[1]Total Implementation includes construction; planning, engineering and design; construction management; monitoring and adaptive management.

[2] Corps ecosystem restoration policy requires that land acquisition in ecosystem restoration plans be kept to a minimum. Project proposals that consist primarily of land acquisition are not appropriate. As a target, land value should not exceed 25 percent of total project costs. Projects with land costs exceeding this target level are not likely to be given a high priority for budgetary purposes.

(FY2015 Price Level)

Additional Studies Needed: Additional focused studies are needed at the beginning of the design phase to ensure that adequate data is available for design plans and specifications development. This is a list of possible future studies, this list is not exhaustive:

- Hydrologic and hydraulic modeling for stream restoration and dam removal projects. This would provide information for proper placement and sizing of in-stream structures to remeander streams.
- Drain tile surveys would entail finding the location and condition of all drain tiles within previous and current agriculture fields and provide a valve installation plan
- Site assessments and floristic surveys would include but not limited to locating trees and shrubs and/or invasive species to be removed, verifying areas to be seeded and special areas (remnant patches) of flora diversity to be preserved.

6 Interdependence Analysis

6.1 Introduction

The combined plan developed for the Upper Des Plaines and Tributaries Feasibility Study (Phase II Study) has been formulated to build on and extend the benefits achieved by the Upper Des Plaines River Flood Damage Reduction Feasibility Study (Phase I Study). The authorized plan developed through the Phase I Study addressed flood risk within the Upper Des Plaines River watershed in Illinois. This Phase II Study recommends a plan that further manages flood risk on the Des Plaines mainstem in both Illinois and Wisconsin, manages flood risk on tributaries to the mainstem, and, additionally, restores degraded ecosystems within the study area.

The watershed scale of the study has allowed for a systems approach, by evaluating the basin-wide flood risk management (FRM) and ecosystem restoration (ER) potential, evaluating individual sites by purpose and then evaluating sites in combination with each other. As discussed in Sections 2 through 5, separate plans were formulated to meet the FRM and ecosystem restoration study purposes resulting in distinct FRM and ER plans. These plans have been combined into a multipurpose FRM/ER combined plan, as discussed in this section.

To formulate the combined plan, an evaluation of the effects of the FRM and ER plans with respect to the other was conducted. The Comprehensive FRM and ER Plans include all features of the Comprehensive, NED, NER, and CAP Plans. The single-purpose plans can be compared to determine if any components are interdependent. Interdependent elements share the same physical location, resources, or functions and have the potential to either negatively impact each other or compete for the same resources. When interdependence occurs, the outputs from the elements that cause impacts or are in competition with each other must be traded off. If the elements are independent – there is no competition for the resources – and do not impact each other, trade-offs are not necessary. If the plans are independent, the combined plan will simply include each element identified in the single purpose plans. This process is illustrated in Figure 6.1.

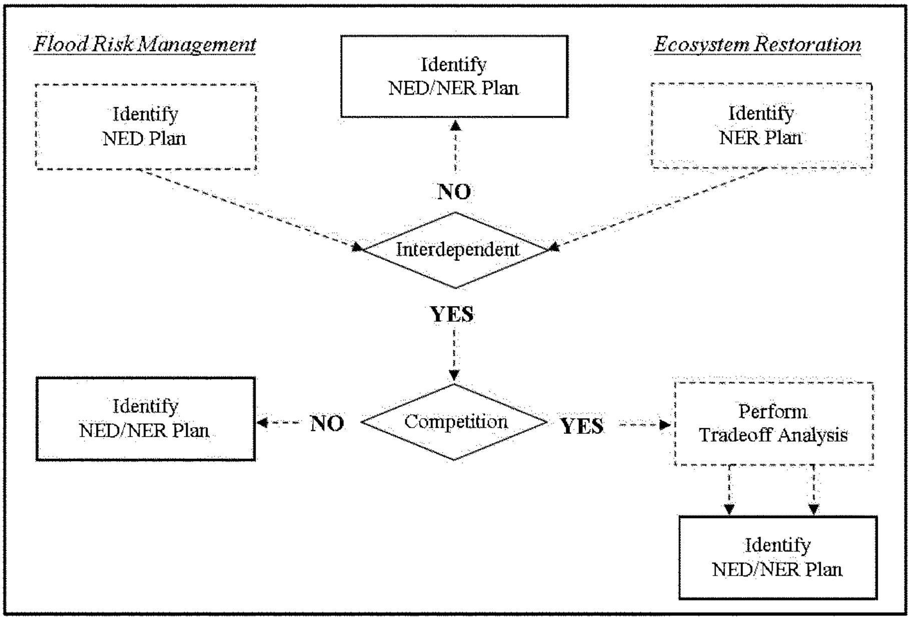

Figure 6.1 – Plan Formulation Process for Determining Combined FRM/ER Plan

6.2 Interdependence Analysis

The recommended FRM and ER plans identified in Sections 4 and 5 each identified several measures and sites throughout the watershed. The locations of each site are shown in Plate 42. The FRM Plan was formulated to manage flood risk on both the mainstem Upper Des Plaines River and along its tributaries. The ER Plan was formulated to naturalize the primary ecosystem drivers of hydrology, hydraulics and geomorphology and the secondary drivers of native plan communities. Naturalizing these drivers would restore functioning, viable and sustainable ecosystems within the watershed of the Upper Des Plaines River and its tributaries. After each plan was independently developed, maximizing the benefits within each study purpose, a comparison was conducted to determine interdependence between plan elements.

Both plans were formulated considering the existing hydrologic and hydraulic conditions and evaluated use of all open and vacant land in the watershed. Each plan identified the most effective and efficient sites for implementation of the FRM and ER plans. The most complete plan will be the plan that implements both the FRM and ER plans while accounting for any interdependence between sites.

Interdependency between plan elements can be either physical or functional. The FRM and ER plans are physically independent, with no measures selected for implementation on overlapping sites. Analysis is required, however, to determine whether there is other interdependency or if functional competition exists between sites. Since the NED, NER, and CAP Plans are all subsets of the Comprehensive Plan for each purpose, the analysis was conducted between the FRM and ER Comprehensive Plans. If interdependence were found, the process would be repeated for the additional plans.

The potential impacts of one site on another are dependent on the distance between the sites. The primary cause of interdependence would be the hydraulic impacts of implemented projects. The hydraulic analyses conducted in conjunction with the development of the single purpose plans showed that the hydraulic impacts of a site do not extend more than a few miles from the project location. To allow for variation and add a buffer to the estimate, a distance of 10 miles was selected as the maximum distance over which the hydraulic impacts of a site could be felt.

Nearby sites, however, could impact the functional output of one another. To determine any potential impacts between nearby sites, the hydraulic distance in river miles between FRM sites and the nearest ER site was determined using GIS mapping. Potential impacts were then assessed for each site according to the type of sites and the distance between them. Where an FRM site is adjacent to or within ten miles of an ER site, nearby sites were assessed for potential impacts.

Four types of impact assessments resulted from the analysis:

- D Hydrologic and hydraulic modeling of the study area indicates that the effects of proposed projects are insignificant at distances greater than 10 miles. Therefore, where the hydraulic distance between sites is over 10 river miles, sites will not impact each other. (Shown as D in Table 6.1)
- L The levees included in the FRM plan are not expected to impact the water surface profile. Stage increases that could be caused by the levees will be mitigated by construction of a compensatory storage reservoir. Hydraulic analysis conducted as part of FRM plan formulation showed that DPLV01 would not cause stage increases. (Shown as L in Table 6.1)
- R Sites such as dam removals and road raises are not expected to alter the hydrology or hydraulics of the system. The dams are all low head run of the river type structures. Dam removals are not expected to have any adverse hydraulic impacts; however, local hydraulic changes of turning lentic habitat into lotic habitat are highly beneficial for riverine specialist species. The road raise site, DPBM04, will be designed to extend the bridge to prevent stage impacts. (Shown as R in Table 6.1)
- S Nominal benefits will be accrued by ecosystem restoration sites downstream of a floodwater storage reservoir due to reductions in the depth and duration of flooding. These benefits, however, were not quantified and are not part of the habitat assessment conducted as part of the ER plan formulation process. The justification of restoration, therefore, is not dependant on these nominal benefits. (Shown as S in Table 6.1)

The results of the comparison are shown in Table 6.1. This analysis shows that the only expected impacts are nominal and the two plans are independent. The combined plan, therefore, includes all elements identified as part of the FRM and ER plans.

Table 6.1 – FRM/ER Site Interdependence Analysis

FRM Site	Watershed	Nearby ER Site	Approximate Location of ER Site	Potential Impacts
FPCI01	Farmer-Prairie Creek	Dempster Ave Dam	2 miles downstream to mainstem, 1/2 mile upstream to dam removal	R
	Farmer-Prairie Creek	Touhy Ave Dam	4 miles downstream to dam removal	R
WLRS04	Des Plaines River[1]	Touhy Avenue Dam	3 miles downstream to dam removal	R
	Des Plaines River[1]	C15	1 1/2 miles upstream to restoration site	S
DPLV09	Des Plaines River	Touhy Ave Dam	less than 1 mile downstream	R,L
	Des Plaines River	Dempster Ave Dam	less than 1 mile upstream	R,L
DPLV05	Des Plaines River	Dam #4	3 1/2 miles upstream	R,L
DPLV04	Des Plaines River	Dam #4	5 miles upstream	R,L
DPRS04	Des Plaines River	Dam #4	6 miles upstream	R
DPBM04	Des Plaines River	Dam #4	6 miles upstream	R
DPLV01	Des Plaines River	Dam #4	over 10 miles upstream	D

[1] WLRS04 is located in the Weller Creek watershed, but will be hydraulically connected to the Des Plaines River through a constructed channel.

Potential Impacts:
D Sites are over 10 miles apart, therefore no impact
L Levee does not impact water surface profile, therefore no impact
R Dam removals and road raises do not impact hydraulics; therefore no impact
S Nominal benefits to ER site due to reduction of depth and duration of flooding from floodwater storage

7 Water Quality*

7.1 Water Quality Inventory and Forecasting

Various factors in both urban and rural watersheds can impact water quality. States are required by Section 303(d) of the Clean Water Act to list impaired waters that within the state. The 303(d) water quality assessments identify not only impairments, but also the sources of the impairments and potential causes. Table 7.1 presents the sources and potential causes of listed impairments on tributaries to the Upper Des Plaines River. Table 7.2 presents the sources and potential causes of listed impairments on the Upper Des Plaines River mainstem.

Although the Des Plaines River and its tributaries in Wisconsin are not listed as 303(d) impaired waters by the state of Wisconsin, water quality in this portion of the watershed was investigated by the SWRPC in 2003. The investigation found that dissolved oxygen, phosphorus, and fecal coliform parameters were in excess of recommended standards at least some of the time. Low dissolved oxygen levels caused violations of warmwater fishery water quality standards and the levels of fecal coliform caused violations of recreational water use objectives.

In the more rural, northern parts of the watershed, a major cause of impairments are crop production and livestock feeding operations. Runoff, storm sewers, combined sewer overflows, and contaminated sediments in the waterway are commonly identified causes in the southern urban areas. Municipal point source, or wastewater treatment plant, discharges and hydrostructure flow regulation and modification are potential causes for impairments in both urban and rural areas.

Table 7.1 – Tributary 303d Water Quality Impairments

Waterway	Impairment	Source	Potential Cause
Mill Creek	Aquatic Life	Oxygen, Dissolved	Municipal Point Source Discharge
		Phosphorus (Total)	Municipal Point Source Discharge
		Sedimentation/Siltation	Crop Production
Indian Creek	Aquatic Life	Endrin	Contaminated Sediments
		Methoxychlor	Contaminated Sediments
		Nitrogen (Total)	Municipal Point Source Discharge
			Contaminated Sediments
		Phosphorus (Total)	Municipal Point Source Discharge
		Sedimentation/Siltation	Channelization
		Total Suspended Solids	Agricultural Practices
		Manganese	Petroleum, Natural Gas Activities
		Oxygen, Dissolved	Urban Runoff / Storm Sewers
Buffalo Creek	Aesthetic Quality	Phosphorus (Total)	Unknown
		Total Suspended Solids	Unknown
	Aquatic Life	Manganese	Urban Runoff / Storm Sewers
		Silver	Urban Runoff / Storm Sewers
		Oxygen, Dissolved	Unknown
		Phosphorus (Total)	Municipal Point Source Discharge
		Total Suspended Solids	Unknown
		Heptachlor	Contaminated Sediments
		pH	Unknown
	Primary Contact Recreation	Fecal Coliform	Urban Runoff / Storm Sewers
Willow Creek	Aesthetic Quality	Phosphorus (Total)	Unknown
		Total Suspended Solids	Unknown
	Aquatic Life	Phosphorus (Total)	Municipal Point Source Discharge
		Total Dissolved Solids	Urban Runoff / Storm Sewers
Higgins Creek	Aquatic Life	Total Dissolved Solids	Municipal Point Source Discharge
		Chloride	Urban Rnnoff / Storm Sewers
			Municipal Point Source Discharge
		Fluoride	Municipal Point Source Discharge
		Nickel	Municipal Point Source Discharge
		Nitrogen (Total)	Municipal Point Source Discharge
		Phosphorus (Total)	Municipal Point Source Discharge
			Urban Runoff / Storm Sewers
		Silver	Municipal Point Source Discharge
		Total Dissolved Solids	Municipal Point Source Discharge
			Urban Runoff / Storm Sewers
		Zinc	Municipal Point Source Discharge
		Oxygen, Dissolved	Urban Runoff / Storm Sewers
	Primary Contact Recreation	Fecal Coliform	Urban Runoff / Storm Sewers
			Municipal Point Source Discharge

Note: The remaining tributaries have either not been assessed for water quality impairments or are not impaired.

Table 7.2 – Des Plaines River Mainstem Water Quality Impairments

Source	Potential Causes
Cadmium	Combined Sewer Overflows, Urban Runoff/Storm Sewers
Chloride	Combined Sewer Overflows, Urban Runoff/Storm Sewers, Municipal Point Source Discharge, Highway/Road/Bridge Runoff
Copper	Industrial Point Source Discharge, Municipal Point Source Discharge, Urban Runoff/Storm Sewers
DDT	Contaminated Sediments
Hexachlorobenzene	Contaminated Sediments
Lindane	Contaminated Sediments
Methoxychlor	Contaminated Sediments
Nickel	Contaminated Sediments, Municipal Point Source Discharge, Combined Sewer Overflows, Urban Runoff/Storm Sewers
Nitrogen (Total)	Municipal Point Source Discharge, Combined Sewer Overflows, Contaminated Sediments
Oxygen, Dissolved	Combined Sewer Overflows, Hydrostructure flow regulation/modification, Municipal Point Source Discharge, Urban Runoff/Storm Sewers, Crop Production
pH	Combined Sewer Overflows, Urban Runoff/Storm Sewers, Municipal Point Source Discharge, Crop Production
Phosphorus (Total)	Municipal Point Source Discharge, Combined Sewer Overflows, Contaminated Sediments
PCBs	Contaminated Sediments
Sedimentation/Siltation	Urban Runoff/Storm Sewers, Combined Sewer Overflows, Hydrostructure flow regulation/modification, Crop Production, Site Clearance
Silver	Combined Sewer Overflows, Municipal Point Source Discharge, Urban Runoff/Storm
Total Dissolved Solids	Combined Sewer Overflows, Highway/Road/Bridge Runoff, Urban Rnnoff/Storm Sewers
Total Suspended Solids	Combined Sewer Overflows, Urban Runoff/Storm Sewers, Site Clearance, Crop
Zinc	Combined Sewer Overflows, Urban Runoff/Storm Sewers, Municipal Point Source

7.2 Sources

The following is a summary of water quality impairments identified within the Upper Des Plaines watershed. Based on data collected and analyzed by SEWRPC (2003), wet weather conditions generally had a much greater impact on the mass of pollutants transported from the watershed to the river system than on the concentration of pollutants being transported within the river system.

7.2.1 General Water Quality Parameters

Temperature: Temperature is one of the most important factors affecting the rate of chemical reaction and biological activities (growth) in an aquatic environment. Unnatural temperatures stem from impervious surface runoff and removal of riparian and catchment vegetation.

Dissolved Oxygen: Concentrations of oxygen in water are controlled by temperature and biological activity. Higher dissolved oxygen (DO) concentrations are found in cooler water. Photosynthesis as a result of biological activity increases DO and decreases respiration.

pH: The pH value, or hydrogen ion concentration, is a measurement of the acidity or alkalinity of water. It is generally considered that pH values above 8.0 in natural waters are produced by photosynthesis when a plant's use of CO_2 exceeds the production of CO_2 respiration and decomposition. The pH is also controlled by the presence of minerals, mainly carbonates, in the sediment that buffer changes in pH by solution and precipitation. Any chemicals, salts, or metals entering a stream or lake can unnaturally affect pH.

Sedimentation: Sediment is a natural part of riverine functions; however, when natural land cover has been converted to agricultural and urban uses, the amounts that enter the stream from non-point sources increase and change in composition, resulting in a higher proportion of fine sediments. These fine sediments such as silts, clays, and "urban dirt" smother habitat for fish and aquatic macroinvertebrates and bind contaminants such as phosphorus, PCBs, and heavy metals.

Fecal Coliform: Fecal coliform impairments originate from combined sewer and sanitary sewer overflows as well as agricultural runoff. The presence of this bacteria is considered and indicator for pathogens in water.

Total Solids (TS): The amount of TS in a water sample is the sum of the total dissolved solids (TDS) and the total suspended solids (TSS). TS can affect water clarity impacting photosynthesis and water temperature. TDS can affect the water balance in aquatic organisms causing them to migrate to water elevations to which they are not adapted. High concentrations of TSS can act as carriers for contaminants which readily attach to the suspended particles.

Chlorides: Chloride in surface waters can be attributed to the use of chloride compounds for street de-icing during the winter. Exposure to elevated levels of chloride in water can impair the survival, growth, and reproduction of aquatic organisms.

7.2.2 Nutrients

Ammonia: Ammonia usually results from the decomposition of nitrogenous organic matter. They also can result from municipal and industrial waste discharges to streams and lakes. Ammonia is toxic to fish and other aquatic organisms.

Nitrogen: The forms of Nitrogen found in surface waters are Nitrates and Nitrites. Nitrite is the end product of the aerobic stabilization of organic nitrogen and is found in polluted waters that have undergone self-purification or aerobic treatment processes. Nitrite can also occur in discharging ground waters. Nitrite has adverse physiological effects on bottle-fed infants and traditional water treatment processes are not able to remove it. Nitrates are a major ingredient of farm fertilizers and can stimulate the growth of plankton and other aquatic plants. Excessive growth can limit oxygen levels in the water, impacting fish and other aquatic organisms.

Phosphorus: Phosphorus and phosphate may occur in surface water or ground water as a result of leaching from minerals or ores, natural processes of degradation, or agricultural and urban drainage. Phosphorus is an essential nutrient for plant and animal growth and, like nitrogen, can stimulate the growth of plankton and other aquatic plants. Excessive growth can limit oxygen levels in the water, impacting fish and other aquatic organisms.

7.2.3 Metals

Cadmium: Cadmium is a known teratogen and carcinogen, a probable mutagen, and has been implicated as the cause of severe deleterious effects on fish and wildlife.

Chromium: At high environmental concentrations, chromium is a mutagen, teratogen, and carcinogen, although sensitivity to chromium varies widely, even among closely related species.

Copper: Long-term exposure to copper can cause irritation of the nose, mouth and eyes and it causes headaches, stomachaches, dizziness, vomiting and diarrhea. Intentionally high uptakes of copper may cause liver and kidney damage and even death. Whether copper is carcinogenic has not been determined.

Mercury: Mercury and its compounds have no known biological function, and the presence of the metal in the cells of living organisms is undesirable and potentially hazardous. Forms of mercury with relatively low toxicity can be transformed into forms of very high toxicity, such as methylmercury, through biological and other processes. Mercury is a mutagen, teratogen, and carcinogen and causes embryocidal, cytochemical, and histopathological effects.

Nickel: Nickel is a dietary requirement for many organisms, but may be toxic in larger doses. Metallic nickel and some other nickel compounds are teratogenic and carcinogenic to mammals.

Zinc: Zinc is not attributed a water hazard class, because it is not considered a hazard. However this only concerns elementary zinc; some zinc compounds, such as zinc arsenate and zinc cyanide may be extremely hazardous.

Silver: Silver ions are very toxic to microorganisms. Free silver ion has been found lethal to representative species of sensitive aquatic plants, invertebrates, and fishes.

Lead: Lead is neither essential nor beneficial to living organisms. All measured effects are adverse, including those on survival, growth, reproduction, development, behavior, learning, and metabolism. Exposure to waterborne lead has adverse effects on aquatic biota such as reduced survival, impaired reproduction, and reduced growth.

7.2.4 Organic Compounds

Pesticides and Insecticides: This category includes compounds such as Aldrin, alpha-BHC / Hexachlorobenzene, DDT, Endrin, Heptachlor, Lindane, and Methoxychlor. These compounds have various biologic and toxic effects in wildlife and humans including birth defects, reproductive failure, liver damage, nervous system damage, tumors, and even death. Although most of these compounds are no longer in use, they persist in water and sediments.

Polychlorinated biphenyls (PCBs): PCBs are a group of 209 synthetic halogenated aromatic hydrocarbons. PCBs elicit a variety of biologic and toxic effects including death, birth defects, reproductive failure, liver damage, tumors, and a wasting syndrome. Although virtually all uses of PCBs as well as their manufacture have been prohibited in the United States since 1979, the compound is very stable and persists in water and sediments.

7.3 Potential Causes

7.3.1 Agricultural Practices

The USEPA ranks agricultural activities as the most significant cause of impaired water quality in streams and lakes. Studies indicate that agricultural activities can impact both surface and ground water. For instance, long-term tributary monitoring programs throughout the US clearly document agricultural impacts (e.g. high nutrient loads) on the water resources. Excessive applications of animal manure and agricultural chemicals on cropland deteriorate ground water quality in intensively farmed areas. Research throughout North America suggests that agricultural practices can deteriorate surface and ground water quality resulting in significant public health and environmental impacts. Agricultural production can generate contaminants that can have many negative effects on surface or ground water supplies. Impairment sources are associated with cropping and livestock practices include sedimentation, nutrients (nitrogen and phosphorus) from inorganic fertilizers and organic livestock wastes, crop protection chemicals such as herbicides and insecticides, microorganisms from livestock wastes, and salts and trace elements from irrigation residues. Contaminants are transported, either bound to sediment or dissolved in water, to surface and ground water through all phases of the water or hydrologic cycle. Impaired water quality can restrict water uses for livestock watering, irrigation, drinking water supplies, sport fisheries, aquatic life, and recreation.

Livestock practices that can cause impacts to water quality include both intensive and non-intensive operations. Intensive operations include feedlots (>500 head of cattle), dairies and wintering sites while non-intensive operations include pasture, cow-calf operations and watering sites for cattle. Waste management and disposal can also impact water quality. Livestock density is not the only factor affecting water quality as sitting and management are also important considerations. Water quality parameters related to livestock production include nutrients (nitrogen and phosphorus), microorganisms (e.g. bacteria, fecal coliform, *Cryptosporidium, Giardia*) and organic material such as livestock wastes. Water quality concerns include impacts on receiving streams and aquatic life, and reuse of the water downstream for agricultural, recreational and drinking water purposes.

Cropping practices that can impact water quality include the use of organic and inorganic fertilizers, herbicides, insecticides, tillage, and irrigation and drainage practices. The amount, timing, and placement of fertilizer, herbicide, and insecticide applications can impact water quality. Other factors that can influence water quality include row or non-row cropping, the sequence of crop rotations, soil characteristics and weather conditions. Agricultural contaminants related to cropping practices include nutrients (nitrogen and phosphorus), herbicides and insecticides, sediments, salts and trace elements.

The following impairment parameters are attributed to agricultural practices within the Upper Des Plaines River watershed:

- pH
- Dissolved Oxygen
- Total Phosphorus
- Total Nitrogen
- Total Suspended Solids
- Sedimentation/Siltation

7.3.2 Urban Runoff and Storm Sewers

Impervious Surfaces

The amount of runoff generated within a watershed increases steadily with development. The presence of impervious areas such as roofs, parking lots and highways limits the volume of rain water infiltrated into the soil, and increases the amount of runoff generated. Urbanizing areas also tend to have reduced storage capacities for runoff because of regrading, paving, and the removal of vegetative cover. Decreases in infiltration and evapotranspiration and an increase in runoff are the result of urbanization, with runoff volume linked to the percent of impervious area.
Impacts on stream quality usually become apparent when the portion of impervious surfaces within a watershed exceeds 10% (Schueler 1994). Impervious surfaces such as roads, parking lots, sidewalks, and rooftops cause a rapid increase in the rate at which water is transported through the watershed to its stream channels. Common impacts include more variable steam flows, increased erosion from runoff, channel instability, increased non-point source pollutant loading, elevated temperatures, and excessive nutrient loading. Other stressors resulting from urbanization include the loss of natural vegetation throughout the watershed, particularly riparian vegetation, which supports many important stream processes. Effects on sensitive species may occur at levels even below this threshold. With even more impervious surface, most notably at 25-30% of the catchment area, numerous aspects of the stream quality may become degraded including biological integrity, water quality, and physical habitat quality (Schueler 1994, Miltner et al 2004, Walton et al 2006). Based on the watershed land use characteristics discussed in Section 3.1.1.5, it is estimated that over 47% of the Upper Des Plaines River watershed is covered with impervious surfaces.

Storm Sewers
Separate storm sewer systems convey only storm water runoff. In a municipality with a separate storm sewer system, sanitary sewer flows are conveyed in a distinct sanitary sewer system to municipal wastewater treatment plants. Storm water is funneled to storm sewers from parking lots, roofs, roads, highways, bridges, lawns, parks, etc and this urban runoff is discharged, untreated, to the waterways.

Site Clearance

Also associated with development is the practice of clearing sites of vegetation or existing structures for the construction of new buildings. These activities can lead to significant erosion if controls are not instituted, causing sedimentation and an increase in total suspended solids.

The following impairment parameters are attributed to urban runoff and storm sewers as well as runoff from highways, roads, and bridges within the Upper Des Plaines River watershed:

- pH
- Dissolved Oxygen
- Fecal Coliform
- Sedimentation/Siltation
- Total Suspended Solids
- Total Dissolved Solids
- Total Phosphorus
- Manganese
- Zinc
- Silver
- Nickel
- Cadmium
- Copper
- Chloride

7.3.3 Municipal Point Sources

A major portion of flows in the Des Plaines River basin, approximately 25%, consists of effluent from wastewater treatment plants. In the Upper Des Plaines River mainstem, treated water accounts for roughly 50% and 95% of flow during medium and low flow conditions, respectively. Although the effluent is treated and permitted by the appropriate regulating agency, the Illinois Environmental Protection Agency or WDNR, the plants add to the TSS and carbonaceous biochemical oxygen demand in the receiving water bodies. In addition, municipal point sources are identified as potential causes of a number of impairment sources in the watershed including metals, sediment and silt accumulation, phosphorus, and nitrogen.

The following impairment parameters are attributed municipal point sources within the Upper Des Plaines River watershed:

- pH
- Dissolved Oxygen
- Fecal Coliform
- Total Suspended Solids
- Total Dissolved Solids
- Total Phosphorus
- Total Nitrogen
- Manganese
- Zinc
- Silver
- Nickel
- Copper
- Chloride
- Fluoride

7.3.4 Industrial Point Sources

In addition to the wastewater treatment plants operated by local and countywide agencies, several commercial and industrial facilities treat wastewater and discharge to the waterways in the study area. The following impairment parameters are attributed to industrial point sources and industrial practices within the Upper Des Plaines River watershed: Copper and Manganese

7.3.5 Combined Sewer Overflows

In a combined sewer system, storm water runoff is combined with sanitary sewer flows for conveyance. Flows from combined sewers are treated by municipal wastewater treatment plants prior to discharge to receiving streams. During large rainfall events however, the volume of water conveyed in combined sewers can exceed the storage and treatment capacity of the wastewater treatment system. As a result, discharges of untreated storm water and sanitary wastewater directly to receiving streams can frequently occur in these systems. These types of discharges are known as CSOs.

During the period of major development in the Upper Des Plaines watershed, construction of separate sanitary and storm sewer systems was not common practice. As society and science matured, the practice of sanitary treatment rather than dilution became more widespread. In the early days of sanitary treatment, only "primary treatment" was conducted, consisting of removing solids and discharging the remaining effluent into receiving water bodies. During this early period in sanitary engineering, the sewer system collected both sanitary waste and storm water from roads and buildings. Interceptor basins were constructed within the sewer systems to direct dry weather sanitary waste to a collection and treatment facility. During a significant rainfall event, however, the comingled rainfall runoff and sanitary waste would flow over the dry weather weir and be directed into the receiving water body. This method collected the majority of the sanitary waste for treatment prior to its discharge into a receiving water body. However, the pollution created from a combined sewer overflow event would still create environmental problems.

Legislation to address public health issues related to these practices began as early as 1912 with the creation of the Public Health Services Act. In 1948, Congress enacted the Federal Water Pollution Control Act which authorized the Surgeon General, in cooperation with other Federal, state and local entities, to create programs to eliminate and/or reduce pollution in interstate waters and to improve the sanitary condition of surface and ground water. The 1965 amendment to the Act, also known as the Water Quality Act, established the first water standards and mandated water quality assessment programs for the nation's waters. These standards, however, were not enforced.

By the time this act was made law, the practice of combined sanitary system design was no longer common practice. However, urban development had already occurred in within the Upper Des Plaines River Watershed and a number of communities have combined sewer systems. The MWRDGC, providing wastewater collection and treatment for most of the study area communities in Cook County, has increased the capacity of its system to reduce the frequency of CSO events. However, combined sanitary and sewer waste continues to discharge in the study area during extreme storm events.

The following impairment parameters are attributed to CSOs within the Upper Des Plaines River watershed:

- pH
- Chloride
- Total Nitrogen
- Dissolved Oxygen
- Total Phosphorus
- Total Dissolved Solids
- Total Suspended Solids
- Fecal Coliform
- Zinc
- Silver
- Nickel
- Cadmium
- Sedimentation/Siltation

7.3.6 Hydraulic Structures

Various modifications to the natural hydraulics of the watershed impact water quality. Manmade structures that are purposefully placed within a stream or river to manipulate hydraulics or flow are termed hydrostructures. The Des Plaines River watershed hydrostructures include dams, weirs, and on-line reservoirs. These hydrostructures are often constructed in conjunction with FRM measures or to improve agricultural production. It has been well documented that these structures can impair water quality as well as other ecological functions.

Dams

There are ten mainstem and twelve tributary dams in the Upper Des Plaines watershed. These run-of-the river, low-head structures have water quality impacts as well as the ecosystem impacts as discussed in Section 5. Increased temperature and reduced dissolved oxygen are among the major impacts. A list of dams in the watershed is presented in Table 7.3. Additional fragmentation of the river occurs throughout the watershed at road crossings.

Table 7.3 – Dams in Study Area

County	Tributary	Dam
Kenosha	Brighton Creek	East Lake Dam
		Paddock Lake Dam
		Hooker Lake Dam
Kenosha/Lake	Mill Creek	Lake Shangri-La
		Lake George
		Third Lake
		St. Rollins Savanna
		Rasmussen Lake
		Temple/Smith Reservoirs
Lake	Bull Creek	Lach Lombard
		St. Mary's Lake
		Butler Lake
	Indian Creek	Reservoir Dam
Kenosha/Lake/Cook	Des Plaines River Mainstem	Dam #4
		Touhy Avenue Dam
		Dempster Street Dam
		Dam #2
		Dam #1
		Ryerson Dam
		Wright Forest Preserve Dam
		Wagon Trails Dam
		Hollister Dam

Drain Tile Systems

Drain tile is installed to make land available for agricultural use by lowering and removing subsurface water. This subsurface drainage is used where the soil is permeable enough to allow economical spacing of the drains and productive enough to justify the investment. A drain tile system consists of a surface or subsurface outlet and subsurface main drains and laterals. Water is carried into the outlet by main drains, which receive water from the laterals. Sub-mains are sometimes used off the main drain to collect water. Much of the Upper Des Plaines River watershed is or was in agricultural production. Based on the soil types, it is estimated that over 40,000 acres are artificially drained by these tile systems in order to provide appropriate conditions for growing crops of choice. Draining 40,000 acres of agricultural land results in an estimated 300 cfs of average daily flow, contributing to the discharge of nutrients and pollutants into the watershed's streams. Directly draining soils and not allowing natural filtering processes to occur continually allows the unnatural discharge of phosphorus, nitrogen and organic compounds into the watershed's streams.

Channelization

Channelizing small streams and creating ditches where no waterway previously existed is another way to aid in draining land for agricultural purposes or expediting floodwaters downstream. Most drain tile systems work in conjunction with these ditches. About 85-90% of the streams in the Upper Des Plaines River watershed are channelized for conveyance of agricultural water and to expedite floodwaters downstream; some are actually placed within a subsurface pipe. Additionally, these ditches are designed to contain large floods and not allow waters to reach formerly associated floodplains. A significant decrease in retention time and altering abiotic and biotic interactions within the floodplain adds to the poor water quality of the basin. Thusly, these ditches are merely conduits for nutrient and pollutant loaded water.

The following impairment parameters are attributed to hydrostructures within the Upper Des Plaines River watershed:

- Dissolved oxygen
- Sedimentation/Siltation
- Flow regime alteration
- Temperature increase
- Gas exchange alteration
- Nutrient entrapment
- Concentration of pollutants

7.3.7 Contaminated Sediment

Impairment sources that exist in the sediment in a waterway are often transmitted to the water itself. Although some water quality impairments will improve over time if the sources are addressed, some metals and organic compounds persist in sediments and continue to impact the surrounding water.

The following impairment parameters are attributed to the presence of contaminated sediments in the waterways:

- Endrin
- Methoxychlor
- Heptachlor
- Hexachlorobenzene
- Lindane
- DDT
- PCBs
- Nickel
- Total Phosphorus
- Total Nitrogen

7.4 Water Quality Analysis

7.4.1 Hydraulics

The volume and flow rate of stormwater discharges and runoff can have significant impacts on receiving streams. In many cases, the impacts on receiving streams due to high stormwater flow rates or volumes can be more significant than those attributable to the contaminants found in the discharges. While studies linking increased stormwater flows due to urbanization to stream degradation are generally lacking in quantitative data, there are a number of studies that support this hypothesis. EPA summarized studies which contain documented evidence of impacts on steams due to urbanization.

Stream bank erosion is a natural phenomenon and source of both substrates and nutrients. However, urbanization can greatly accelerate the process of stream bank erosion. As the amount of impervious area increases, a greater volume of stormwater is discharged directly to receiving waters, often at a much higher velocity. The increased volume and velocity of the runoff can overwhelm the natural carrying capacity of the stream network. In addition, streams in urbanized areas can experience an increase in bankfull flows. Since bankfull flows are highly erosive, substantial alterations in stream channel morphology can result. Excessive bank erosion occurs as streams become wider and straighter to accommodate greater flows. Watershed sediment inputs can lead to deposition in areas where the water slows, causing the degradation of benthic habitat. This ultimately results in a greater potential for further erosion.

7.4.2 Ground Water Recharge

Urbanization and hydrostructures such as drain tile can have a major impact on ground water recharge. As the watershed is altered, both shallow and deep infiltration decrease and ground water recharge is reduced, lowering the water table. This change in watershed hydrology alters the baseflow contribution to stream flow and is most pronounced during dry periods. Ferguson (1990) points out that "base flows are of critical environmental and economic concern for several reasons. Base flows must be capable of absorbing pollution from sewage treatment plants and non-point sources, supporting aquatic life dependent on stream flow, and replenishing water-supply reservoirs for municipal use in the seasons when water levels tend to be lowest and water demands highest."

7.4.3 Aquatic Ecosystem Impacts

Natural ecosystems are a complex arrangement of interactions between the land, water, plants, and animals. Habitat is impacted by changes in both water quality and quantity, and the volume and quality of sediment. As reported by Schueler (1987), "no single factor is responsible for the progressive degradation of stream ecosystems. Rather, it is probably the cumulative impacts of many individual factors such as sedimentation, scouring, increased flooding, lower summer flows, higher water temperatures, and pollution."

The loss in riverine diversity is related in part to the degradation of water quality in the watershed (IDNR 1998; Arnold et al. 1999). For example, there are limited riparian buffers along the Des Plaines River and associated tributaries in the urbanized areas of this system. Riparian buffers are major determinants of fish and in-stream biotic integrity (Wang et al. 1997; Stewart et al. 2001; Roth et al. 1996). Changes to surface water characteristics such as temperature, dissolved oxygen, and sedimentation as well as introduction of pollutants such as nutrients, metals, and organic compounds result from urbanization and increased point and non-point source discharges. Therefore, it is very likely that the fishery communities within the Upper Des Plaines River watershed are responding to the reduction in water quality associated with increased urbanization in this watershed (Harris et al. 2005).

As discussed in Section 5, a survey of stream fish communities and habitat was conducted in the Upper Des Plaines River watershed to determine the current status of species distribution, and to evaluate the effects of urbanization and multiple low-head dams on fish community diversity and species composition. Based on the Qualitative Habitat Evaluation Index there were two sites on Bull Creek (BLC-03 and BLC-01) classified as a Unique Aquatic Resource. These sites had excellent habitat and stream morphology although bank erosion and down cutting may indicate potential hydraulic problems. Five sites in the Upper Des Plaines basin (10%) were classified as a Highly Valued Resource, 22 sites (46%) were classified as a Moderate Aquatic Resource, 17 sites (35%) were classified as Limited Aquatic Resource and 2 sites (4%) were classified as an Imperiled Aquatic Resource. The average QHEI score of 44 classifies the Upper Des Plaines River system as a "moderate aquatic resource" habitat wise.

7.4.4 Public Health Impacts

Public health impacts associated with water quality occur when humans ingest or come in contact with pathogens. While these impacts are not widely reported, they do occur, and some impacts have been documented. CSO events, discharges from municipal point sources, agricultural runoff and point sources can all contribute to the presence of pathogens. In addition, the presence of contaminants such as metals, pesticides, and PCBs can adversely impact human health.

7.5 Water Quality Plan Formulation

While all activities in which USACE participates or partners comply with Clean Water Act regulations, improvements for the sole purpose of water quality do not fall under USACE authority. Water quality planning for this study, therefore, is confined to an evaluation of the incidental water quality benefits resulting from the combined FRM/ER plans and recommendations for implementation by the study non-Federal sponsors.

7.5.1 Impacts of the FRM and ER Plans

Ecosystem Restoration: Implementation of the ecosystem restoration sites will benefit water quality by restoring the hydrology and native plant communities and the hydraulics of meandering streams that had been channelized. Improved hydrology will reduce stormwater flows, increase base flows, and provide natural filtration through soils. These naturalized hydraulics will positively affect parameters such as temperature, dissolved oxygen, total suspended solids, and sediment distribution.

Dam Removals: Implementation of the five dam removals along the mainstem Des Plaines River will improve fish passage and riverine functions. Hydrostructures in the watershed have been linked to adverse sediment transport, habitat impairments, and water quality impairments. With the dams removed from the waterway, the bed load of cobble, gravel, and sand will no longer be trapped behind the structures. The wash load, fine silts and clays, typically move over the existing low-head dams during storm events.

Reservoirs: Reservoirs DPRS04 and WLRS04 would both benefit water quality by trapping sediment and excessive flows from two highly urbanized watersheds. Such watersheds generally have high nutrient and contaminant levels due to everyday practices, including but not limited to automotive use and maintenance, lawn care, impervious surfaces, etc. The sediments and any associated pollutants may be collected within the reservoir site, preventing further water quality impairment downstream of the two reservoirs.

Levees: The configuration of the levees may actually halt some urban runoff from entering the Des Plaines River. Flow of runoff will be constrained by the levee's interior drainage structures. The contaminants carried in this runoff such as chlorides, metals, dissolved solids, and suspended solids will also be constrained, thus helping to improve water quality.

7.5.2 Law and Ordinance Enforcement

Section 303 of the Clean Water Act (CWA) delegates the responsibility for the development of interstate water quality standards to states. Under this program, states must review and update water quality standards every three years. CWA Section 510 requires that these standards meet Federal minimums, but does not preclude states from setting higher standards.

7.5.2.1 Point Source Regulations

At the state level, the IEPA and the WDNR administer the National Pollution Discharge Elimination System (NPDES). This program prohibits the discharge of pollutants to waters of the U.S. through a point source without a permit. Industrial and commercial facilities including animal feeding operations, municipal point sources, combined sewer systems, and construction sites are all required to obtain permits documenting their pollution prevention activities and limiting discharge of pollutants.

7.5.2.2 Non-point Source Controls

Counties and municipalities participate in water quality improvement by modernizing infrastructure, regulating land use, and updating stormwater ordinances. Agencies such as MWRDGC and LCSMC as well as local governments are actively partnering with communities to promote stormwater best management practices (BMPs) to improve the quality of water entering watershed streams and rivers. BMPs are promoted through the development of watershed plans and revisions to local stormwater management ordinances.

8 Recreation

8.1 USACE Recreation Planning and Development

It is USACE policy to fully consider the recreation potential that may be afforded at civil works projects and to capitalize on that potential for the benefit and enjoyment of the public on a sustained basis. Projects must:

1. Fully consider potential opportunities that may be afforded for both recreation and fish and wildlife enhancement
2. Respond to public input and consider a range of activities and their compatibility with the regional setting and the project's natural and cultural resources
3. Be consistent with the State Comprehensive Outdoor Recreation Plan (SCORP)
4. Ensure that project resources are considered as an integrated whole with continuing concern for environmental quality
5. Be coordinated with other Federal, state, regional and local agencies and other groups and organizations as appropriate
6. Be prepared cooperatively by USACE and the project non-Federal sponsors
7. Be maintained for the benefit of the general public

For this study, recreation is a secondary purpose. All recreation features must be compatible with primary project purposes. As a secondary project purpose, recreation benefits are considered incidental and are not considered in project justification.

8.2 Recreation Inventory and Forecasting

Existing recreational facilities in the study area, summarized in Section 3.1.6, are spread throughout the watershed. Plate 9 shows the distribution of open lands and recreation areas throughout the watershed.

Illinois and Wisconsin have both developed SCORPs. The most recent SCORPs were published in 2009 for Illinois and 2005 for Wisconsin. An updated SCORP for Wisconsin is currently in development. A prominent feature of these plans is an assessment of interest in and need for recreation features. In both Illinois and Wisconsin "pleasure walking" is the most popular outdoor recreation activity. This activity is very important to 80% of the population in Illinois and is an activity in which 85% of the state population participates in Wisconsin. Both plans emphasize the need for natural resource conservation and the development of greenways and trails.

Regional plans developed by the CMAP and the SEWRPC have similar emphases. The plans identify a need for increasing the amount of conservation open space and greenways as well as the development of extended trail networks.

8.3 Recreation Analysis

The Combined FRM/ER Plan includes several types of measures with varying opportunities for implementation of recreation features. Ecosystem restoration, reservoir, and levee sites offer the greatest opportunity for recreation, as these are the most land intensive types of measures. Dam removals impact only a small area and, in general, are already within publicly accessible forest preserves. Structure modifications and road raise sites are at previously developed locations where public safety concerns would preclude use of the sites for recreation. Non-structural measures will be implemented at private properties where recreation features would not be appropriate. The types of measures and opportunities at each are summarized in Table 8.1.

Table 8.1– Recreation Opportunities at Incrementally Justified Sites

Measure	Recreation Opportunities
Ecosystem Restoration	Multipurpose trails, walkways, and canoe launches
	Picnic tables and benches
	Educational/informational signs and displays
Reservoirs	Multipurpose trails and walkways, picnic facilities
Levees	Multipurpose trails and walkways
Dam Removals	none
Structure Modifications	none
Road Raises	none
Non-structural Buyout	Multipurpose trails and walkways

8.4 Recreation Plan Formulation and Evaluation

The goal of this recreation plan is to optimize public use of project sites in harmony with the primary project purposes, the capacity of project resources, and the interests of the non-Federal sponsors and the public.

8.4.1 Flood Risk Management Site Recreation Opportunities

Three FRM sites at which interest in recreation features were identified. For these sites, an economic analysis was conducted and benefits were associated with the projects as discussed below. Estimated costs for the proposed recreation features are shown in Table 8.2.

Touhy-Miner Levee (DPLV09)

As discussed in Section 4, recreation opportunities were investigated as a part of site evaluation at the Touhy-Miner Levee (DPLV09). A segment of multipurpose trail along the floodwall between Oakton Street and Algonquin Road was identified for implementation. This trail would provide safe and scenic access to the 50 mile Des Plaines River trail system for local residents.

To determine the economic benefits associated with the proposed trail, an estimate of the annual use at the site and the unit day value (UDV) of that use was determined according to procedures outlined in ER 1105-2-100, Appendix E and EGM 14-03. For the FWOP condition, where existing sidewalks are used to access the trail, an estimated 500 users will walk along Des Plaines River Road to get to the

Des Plaines River Trail. The UDV assigned to current conditions is $5.47 providing total FWOP condition benefits of $3,000. With improved safety, capacity, and accessibility, the number of users would increase to 22,000. This projection is based on counts of trail users at a nearby Forest Preserve District site. The improved experience is reflected in an increase in UDV to $8.17, providing total with project condition benefits of $180,000 and an incremental benefit of $177,000. The estimated annualized cost for the trails, including operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) costs, is $7,000. The trails would therefore provide $170,000 in net benefits. A detailed discussed of the analysis is presented in Section 4.2 of Appendix E (Economic Analysis).

Fullerton Woods Reservoir (DPRS04)

As discussed in Section 4, recreation opportunities were investigated as a part of site optimization at the Fullerton Woods Reservoir (DPRS04). This site, although part of the Cook County Forest Preserve District, was previously deforested and used as a stone storage site. Currently, the site is not well maintained and is difficult to access. The proposed recreation features would include a parking area, multipurpose trails allowing for walking, running, and bicycling around the site, and picnic facilities.

To determine the economic benefits associated with the proposed trail, an estimate of the annual use at the site and the unit day value (UDV) of that use was determined according to procedures outlined in ER 1105-2-100, Appendix E and EGM 14-03. Because the site is currently difficult to access, the UDV assigned to the existing conditions at the site, $4.06, was very low and attributed to the presence of other similar recreation sites in the vicinity of the project area (availability of opportunity). However, since the site is not currently used, the without project condition benefits are $0. The with project UDV, $7.06, accounts for improved access and quality of experience for users of the site. Projected usage is estimated to similarly to that for the trails at DPLV09. With 22,000 average annual users, the total estimated benefits are $155,000. The estimated annualized cost for the recreation facilities, including OMRR&R costs, is $45,000. The site would therefore provide $110,000 in net benefits. A detailed discussed of the analysis is presented in Section 4.2 of Appendix E (Economic Analysis).

Des Plaines Floodway/Big Bend Drive Area

At the Des Plaines Floodway/Big Bend Drive Area, there are currently no recreation facilities. Therefore, any recreational facilities developed at the site would be new rather than modification of existing features. The proposed recreation features include approximately 4,000 feet of asphalt trail connecting to existing roads and the Des Plaines River trail network on the opposite bank.

To determine the economic benefits associated with the proposed trail, an estimate of the annual use at the site and the unit day value (UDV) of that use was determined according to procedures outlined in ER 1105-2-100, Appendix E and EGM 14-03. For the FWOP condition, there was assume to be non-existent or limited recreational experience, opportunity, capacity, or accessibility because the land is occupied by private residential homes. As such, a low UDV of $4.06 was assigned to the current conditions which when applied to zero assumed users (due to limited access) provides zero FWOP conditions benefits. With the recreation features, the number of users would increase to 22,000. The improved experience, availability, accessibility, and environmental quality is reflected in an increase in UDV to $7.78, providing total with project condition benefits of $171,000. The estimated annualized cost for the trails, including OMRR&R costs, is $10,000. The trails would therefore provide $161,000 in net benefits. A detailed discussed of the analysis is presented in Section 4.2 of Appendix E (Economic Analysis).

Table 8.2 – Estimated Costs of Recreation Features

Site ID	Site Name	Total Project Cost ($1,000)	Recreation Feature Cost ($1,000)
DPLV09	Touhy-Miner Levee	$27,181,000	$179,000
DPRS04	Fullerton Woods Reservoir	$12,791,000	$949,000
NS	Des Plaines Floodway/Big Bend Drive Area	$29,743,000	$275,000

(FY2014 Price Level)

8.4.2 Ecosystem Restoration Site Recreation Opportunities

Preliminary coordination has been conducted with the study non-Federal sponsors to evaluate interest in the additional recreation opportunities afforded by the Combined FRM/ER Plans. There was significant interest in the development of features such as trails at ecosystem restoration sites. The benefits associated with these wood chip trails would be incidental to project benefits and the there would be no incremental cost associated with providing these trails. Therefore a detailed cost/benefit analysis was not conducted. A summary of site conditions and available local resources at these sites is presented below.

Bristol Marsh (K47). Development of trails within this site connecting to the planned regional hiking and biking trail network is compatible with the ecosystem restoration features of the site and with non-Federal recreation development interest.

Dutch Gap Forested Floodplain (K41). Development of trails within this site connecting to the planned regional hiking and biking trail network is compatible with the ecosystem restoration features of the site and with non-Federal recreation development interest.

Red Wing Slough and Deer Lake Wetland Complex (L43). Development of trails within this site is compatible with the ecosystem restoration features and with non-Federal recreation development interest and regional plans for development of a trail network along greenway corridors connected by rivers and streams.

Pollack Lake and Hastings Creek Riparian Wetlands (L39). Development of trails within this site is compatible with the ecosystem restoration features and with non-Federal recreation development interest and regional plans for development of a trail network along greenway corridors connected by rivers and streams.

Gurnee Woods Riparian Wood Land (L31). Development of trails within this site is compatible with the ecosystem restoration features and with non-Federal recreation development interest and regional plans for development of a trail network along greenway corridors connected by rivers and streams.

Northbrook Floodplain and Riparian Complex (C09). A substantial trail system along the Des Plaines River has already been developed by the Forest Preserve District of Cook County. Additional trails will improve access to natural areas at the site by users of the trail system.

Beck Lake Meadow and Floodplain Forest (C15). A substantial trail system along the Des Plaines River has already been developed by the Forest Preserve District of Cook County. Additional trails will improve access to natural areas at the site by users of the trail system.

8.5 Description of Recreation Plan*

Based on site compatibility and non-Federal interest, recreation features will be incorporated at the sites listed in Table 8.2, to consist primarily of multipurpose trails and educational signage for use by the public. Detailed plans for these features will be developed in partnership with the non-Federal sponsors for those sites and based on public interest. As required by USACE guidance, the Federal cost for sites where recreation features are implemented will not exceed the Federal cost of the project without recreation features by more than 10%. The non-Federal sponsors must assume at least one-half of the separable first costs of construction of recreation facilities, including project lands acquired specifically for recreation and access, and all cost and full responsibility for the operation, maintenance, replacement, and management of recreation lands, areas, and facilities.

Table 8.3 – Recreation Plan Summary

Site ID	Site Name	Recreation Features	Cost ($1,000)
K47	Bristol Marsh	Maintenance of woodchip trails installed during project construction.	Incidental
K41	Dutch Gap Forested Floodplain	Maintenance of woodchip trails installed during project construction.	Incidental
L43	Red Wing Slough and Deer Lake Wetland Complex	Maintenance of woodchip trails installed during project construction.	Incidental
L39	Pollack Lake and Hastings Creek Riparian Wetlands	Maintenance of woodchip trails installed during project construction.	Incidental
L31	Gurnee Woods Riparian Wetland	Maintenance of woodchip trails installed during project construction.	Incidental
C09	North Brook Marsh	Maintenance of woodchip trails installed during project construction.	Incidental
C15	Beck Lake Meadow and Floodplain Forest	Maintenance of woodchip trails installed during project construction.	Incidental
DPLV09	Touhy-Miner Levee	Asphalt trails connecting existing segments of the Des Plaines River trail.	$179
DPRS04	Fullerton Woods Reservoir	Trails, picnic area, and parking facilities to support use of site.	$949
NS	Des Plaines Floodway/Big Bend Drive Area	Asphalt trails connecting existing segments of the Des Plaines River trail	$275

(FY2014 Price Level)

9 Environmental Assessment*

9.1 Coordination

Consistent with USACE's Engineering Regulation 1105-2-100, Appendix B the feasibility study included comprehensive public involvement, collaboration and coordination, in addition to compliance with applicable Federal statues and executive orders. The President's Council on Environmental Quality (CEQ) requires that the environmental impacts of a project are identified and made available to the public and decision makers before decisions are made and actions are taken. CEQ's implementing regulations and the USACE procedures for implementing the NEPA provided the process for public participation in conjunction with the preparation of this EA.

9.1.1 Notice of Intent

The non-Federal sponsors and the USACE initiated the NEPA requirements of a public notice inviting the participation of affected agencies and the public after the Project Management Plan was finalized and the Feasibility Cost Sharing Agreement was approved for the Phase II feasibility study. Finalization and approval of a communications plan was followed by preparation of a newsletter, fact sheet, and poster generally describing the feasibility study process for flood damage reduction and ecological restoration within the Upper Des Plaines River watershed. These materials, along with updates, were distributed to local citizens and interested parties by mailing, internet postings, and were handed out at public meetings. As a kick-off for the feasibility study, a series of informational meetings were presented to provide background on the watershed and the feasibility study process.

The Chicago District prepared a Notice of Intent to Prepare a Draft Environmental Impact Statement, which appeared in the 31 May 2002 Federal Register. Public scoping meetings (held as part of the NEPA process) were announced in letters (dated 15 May 2002) sent to the governors of Illinois and Wisconsin; to 26 United States senators and representatives from Illinois and Wisconsin; and to over 220 state and local elected officials, state and local agencies, libraries, organizations, and interested individuals from Illinois and Wisconsin.

The Chicago District also sent a press release in May-June 2002 to the Kenosha News (Kenosha; WI); Bulletin (Salem; WI); Milwaukee Journal Sentinel (Sturtevant; WI); Racine Reporter (Racine; WI); Journal-Times (Racine; WI); News-Sun (Waukegan; IL); Daily Herald (Vernon Hills; IL); Arlington Heights Journal (Des Plaines; IL); Mt. Prospect Journal (Des Plaines; IL); Des Plaines Journal (Des Plaines; IL); Wheeling Journal & Topics (Des Plaines; IL); Libertyville Review (Libertyville; IL); Franklin Park Herald-Journal (Oak Park; IL); and Forest Park Review (Oak Park, IL).

The Notice of Intent submitted to the Federal Register on May 31, 2002 indicated the USACE would be pursuing an Environmental Impact Statement (EIS). However, after further development of the alternative plans, USACE determined that significant impacts were not obvious. Therefore, it was more appropriate to perform an environmental assessment to determine if significant impacts would result from the proposed alternatives and to issue a Finding of No Significant Impact if warranted rather than an EIS and Record of Decision as noted in the May 31, 2002 Federal Register.

While the benefits provided by the NER portion of the proposed project are significant in terms of USACE policy via providing regional habitat for migratory water fowl and neo tropical birds, as well as local fish and wildlife (See Section 5.4.7.2 for USACE Significance for decision making purposes), the changes to watershed processes and functions are not spatially large enough to cause change to the human environment. In terms of significance to the human environment as cited from CEQ, the resulting effects from the proposed NER and NED plans would be negligible not only to the human environment, but for example the riverine environment as well. Riverine biological integrity is grossly spoiled once a watershed reaches 8 – 20% impervious surfaces (Schuler 1994, Karr and Chu 2000), and is thought by some to be beyond repair between 25 – 60% (Karr & Chu 2000). Miltner et al (2004) found that there is significant decline when impervious surfaces exceed 14% and complete loss in aquatic life attainment at 27% in the Columbus, Ohio metro area.

Section 3.1.1.5 provides the current land use percentage of about 12% for remaining natural plant communities; conversely 88% of the watershed would be considered ecologically spoiled by literature cited. Based on these assessments, significant effects would then be noticed if the NER plan provided enough acres to restore between 50 - 70% of the watershed acres to natural plant communities. The preferred NER plan proposes to restore about 6,800 acres, or about 1.5% of the watershed. This increase in watershed natural habitats provide significance in terms of USACE benefits by increasing watershed AAHUs by 32%, but is not significant in terms of CEQ guidance on affects to the human environment supported by peer reviewed published journals cited here and provided by reference in Appendix C.

9.1.2 Scoping Meetings

2002 Scoping

Public scoping meetings for the Upper Des Plaines River and Tributaries Feasibility Study were held in June 2002. The evening meetings included a slide show, public comment opportunity, and question-answer session; the agency panel included staff from the USACE, IDNR, WDNR, Cook County Highway Department, LCSMC, and Kenosha County Planning & Development.

- June 4, 2002, 7–9 PM - Kenosha County Center, 19600 75th Street, Bristol, WI.
- June 5, 2002, 7–9 PM - Byron Colby Barn at Prairie Crossing, Jones Point Road west of Route 45, Grayslake, IL.
- June 6, 2002, 7–9 PM - Oakton Community College Conference Center, 1600 E. Golf Road, Des Plaines, IL.

2009 Scoping

The study was rescoped in 2009 when it was determined that an EA rather than an Environmental Impact Statement would be prepared. Notification letters were set out to regulatory agencies and public officials in Illinois and Wisconsin. No public meetings were held in conjunction with this 2009 scoping.

2013 Public Review

A series of meetings were held as part of the public review of the draft EA in the fall of 2013. A PowerPoint presentation was and each meeting included a public comment period and question and answer session.

- September 23, 2013, Mt. Prospect Village Hall, Mt. Prospect, IL
- September 24, 2013, LCSMC, Libertyville, IL
- September 25, 2013, Kenosha County Building, Bristol, WI

As part of the public review, the public was provided with several methods for submitting scoping comments or suggestions on the draft EA: an online comment form on the project Website; standard mail; or in person at the public meetings, either by testifying or submitting written comments. Nearly 600 individuals, organizations, and state and local government agencies provided scoping comments.

Based on the comments received a FRM project, ACRS08, was removed and two alternative sites were added, WLRS04 and DPRS04. This change was coordinated with the public release of the revised Draft Integrated Feasibility Report and Environmental Appendix. To support the public review, documentation of the changes was prepared and is provided as Appendix N. This EA has been updated to incorporate the changes and reflect the revised proposed plan. The Documentation of Changes was provided to the public for review in January of 2014. Three comment letters were received as a result of the review.

9.1.3 Upper Des Plaines Advisory Committee

As discussed in Section 1.1.3, an Advisory Committee was established to support the study process. This committee includes the study non-Federal sponsors, communities from within the watershed, state and Federal government representatives, and interested parties and resource agency personnel. The committee meets four times a year to review the feasibility study status and progress including discussion of the formulation process and preliminary results. The meetings are coordinated by the Northwest Municipal Conference (NMC). Prior to each meeting, the NMC sends an invitation to all advisory committee members along with a meeting agenda and minutes from the previous meeting. These served as a reminder and a communication tool to all of the members that might not be able to make it to the meeting. There were also newsletters written to give further updates. The Advisory Committee provided a forum for engagement with and feedback from stakeholder agencies. The Advisory Committee also provided expertise on study team, with participation by several representatives from member organizations.

9.2 Affected Environment

The affected environment for this study is detailed in Section 3 and in Appendix C.

9.3 Alternative Plans

The analysis resulting in the determination of alternative plans is detailed in Section 4 for Flood Risk Management and Section 5 for Ecosystem Restoration. Section 6 discusses the selection of a combined plan considering effects of Flood Risk Management and Ecosystem Restoration sites on each other. Section 8 details the analysis used to select recreation features. This plan formulation is also discussed in Appendices B and C.

This report presents three plans: a "Comprehensive Plan" which includes all economically justified, environmentally acceptable separable projects evaluated during the course of the study; a "NED/NER Plan" which includes all policy compliant, economically justified, environmentally acceptable separable projects of such scope that they could not reasonable be implemented under the CAP; and a "CAP Plan" which includes all policy compliant, economically justified, environmentally acceptable separable projects of such scope that they could reasonable be implemented under CAP. The assessment of direct, indirect and cumulative effects as presented is comprehensive of these plans.

9.4 Direct and Indirect Effects

9.4.1 Ecosystem Restoration Plan Assessment

This section evaluates the direct and indirect effects of the Ecosystem Restoration Plan. An evaluation of the Flood Risk Management Plan is included in Section 9.4.2. The interaction of the restored hydrology-hydraulics, modified geomorphology-soils and plant-fungus-microbe structures will help restore the 6,800 acres of habitat by improving the plant species richness and reducing invasive species. This will provide the necessary structure for a wider variety and increased number of fish, amphibians, reptiles, birds and mammals, helping ensure a sustainable resource. Each of the seven restored sites will increase connectivity among the existing restored, remnant and remaining sites in the Des Plaines River Study area. The restored sites can provide a seed source for adjacent sites increasing the footprint of restoration. Many of the estimated 300 species of birds recorded in the Chicagoland area will benefit. Migratory birds will benefit substantially from the restoration because these restored sites will provide the right kind of high caloric, high protein foods such as seeds, fruits, and insects along with places to rest and hide from predators and the extremes of weather. The migratory bird benefit is not restricted to the Upper Des Plaines River and Chicago Metro area; the western shoreline of Lake Michigan is a globally significant portion of the Mississippi River Flyway. A significant portion of the total North American population of neo-tropic migrants (estimated at 5,000,000) use it as their north-south sight line during migration. The lack of significant habitat from north of Milwaukee, WI to east of Gary, IN for migratory birds to rest, refuel, and seek shelter makes the restoration in the Upper Des Plaines River very significant. Some migratory birds along this portion of the flyway fly from as far south as the tip of South America to as far north as the Arctic Circle.

9.4.1.1 Physical Resources

Climate

The minor scale of the recommended ER projects in the Comprehensive Plan would not affect the regional climate. The increase in acreage of natural plant communities would increase evapotranspiration in a minor way, but still not great enough to affect weather patterns or rainfall within the region. No significant adverse effects will result to climate from implementing the ER projects are expected.

Geology

The ER projects would have beneficial preservation effects associated with implementation. Geologic features and deposits would be preserved through restoring the site to native plant communities and disallowing development to occur, which would have the potential to change the surficial geology at those particular sites. Since implementation of the ER projects does not disturb geologic features or deposits, no significant adverse effects resultant from implementing the ER projects are expected.

Hydrology, Hydraulics & Land Use

Hydrology: Implementation of the ER projects would result in beneficial effects to watershed hydrology. Water that currently falls on these sites is immediately drained into ditches, then streams and ultimately the Upper Des Plaines River, with no chance of ever establishing a natural hydroperiod for wetlands and native aquatic vegetation to occur, and in turn compounds the environmental impacts associated with abnormal flooding. Through restoring the native aquatic vegetation at each of these sites and disabling drain tile systems and small ditches, groundwater would be recharged as well as surficial waters that are typical of wetland habitats. During the design phase a water budget would be developed to determine the amount of water each site would retain to ensure local flooding would not result and to provide the proper hydroperiods for wetland and native aquatic plant community reestablishment. As a result, no significant adverse effects from implementing the ER projects are expected.

Riverine Hydraulics: Implementation of the ER projects would result in beneficial effects to riverine hydraulics within the watershed. Currently, dams and channelized streams prevent proper hydraulics to support diverse and native riverine communities. Through stream remeandering and increasing channel roughness (cobble riffles, woody debris), the proper hydraulics would be restored for these riverine communities to increase species richness and abundance. Temporary disturbance of the waterways would be necessary and may cause a short term adverse condition for the tolerant organisms that occupy the restoration areas; however, several years after the restoration, the aquatic assemblage would be more species rich and abundant than the existing assemblage. Since the ER plan would be implemented in a fashion as to not increase local flooding, to attenuate flood waters and to provide the proper channel roughness for riverine organisms, no significant long-term adverse effects are expected from implementing the ER projects.

Land Use: Implementation of the ER projects would result in beneficial effects to land use within the watershed. Currently, about 90% of the land use of the preferred plan sites is in agricultural production, with the remaining 10% as degraded habitat in the form of non-native and invasive plant species plots. The ecological perspective of land use for these sites is that they are of minimal quality and ineffective in terms of habitat structure. The human perspective of land use for these sites is that they produce minimal amounts of food crop (as compared with more productive farmlands in southern and middle Illinois) (USDA 2010), and provide a small amount of open space for passive recreational activities. Since the ER projects would be implemented in a fashion as to return land use to its natural condition, no significant adverse affects resultant from implementing the ER projects are expected.

Fluvial Geomorphology & Topography

Implementation of the ER projects would result in beneficial effects to fluvial geomorphology and natural topography within the watershed. Currently, 90% of the streams and rivers are channelized to some degree, with the greater part of these as extremely incised and inactive in terms of fluvial processes (cut and fill alluviation, sediment transport, helical flow, etc.). Restoring fluvial geomorphic processes of streams that flow through large sites is very practical, since active floodplains would be contained within hundreds of feet and stay within the site boundaries. Each site during the design phase would have a hydraulic analysis completed to ensure local flooding would not result. Intact topography would not be altered from its natural state. It is important to design an ecological restoration to the hydrology and topography that exists on a particular site, since this is what drives plant community position on the landscape. Any grading performed would be to assist in returning natural geomorphology and topography characteristic of Des Plaines River watershed landscapes, and not done with the intention of creating non-functional detention basins. Since the ER projects would be implemented to return riverine segments to its natural physical form and plant communities to their natural position on the landscape, no significant adverse effects are expected from implementing the ER projects.

Soils

Implementation of the ER projects would result in beneficial effects to natural soils within the watershed. Currently at the restoration sites, natural soils are still intact, with exception of disruption to their A horizons due to years of tilling, fertilization, carbon stripping, removal of microbe-fungi interaction, and unnatural drainage. Through the reestablishment of groundwater and surficial hydrology, returning native plant communities, and the return of mycorrihizzal fungi/bacterial interactions, over time the top layer or A horizons of the soils would heal, thus feeding back to diversify the native plant and animal assemblages of those restored sites. Since the ER projects would be implemented in a fashion as to facilitate the return of natural soil structure, no significant adverse soil effects resultant from implementing the ER projects are expected.

Air Quality

Implementation of the ER projects would result in negligible effects to air quality within the watershed and regionally. Mobile source emissions were estimated using USEPA guidance and models, and were found to be *de minimis* for criteria air pollutants. General recommendations to be considered during the construction phase are post-construction stabilization of earth areas to prevent water or wind erosion and dust control during construction. Based on these findings, the proposed Upper Des Plaines River and Tributaries project Feasibility Study demonstrates conformity. The project as proposed is compliant with the Clean Air Act, and will not result in significant or long-term adverse affects on air quality.

Water Quality

Implementation of the ER projects would result in beneficial effects to water quality within the watershed. Major portions of the Des Plaines River and confluent streams are not supportive of aquatic life, fish consumption, or primary contact 303(d) designated uses. The potential causes include elevated levels of chloride, nitrogen, phosphorous, total dissolved and suspended solids, zinc, and silver, and excessive sedimentation and siltation caused primarily from combined sewer overflows, municipal point source discharges, urban runoff, storm sewers, highway/ road/bridge runoff, site clearance and land development, hydrostructure flow regulation, and the presence of sediment contaminated with various chemicals. Elevated levels of fecal coliform, resulting from combined sewer overflows, urban runoff, and storm sewers have impaired primary contact recreation in many areas. Through the resurgence of hydrology, hydraulics, and native plant communities, water quality will benefit; however, the brunt of the water quality impairment stems from urban conditions of impervious surfaces and chemicals associated with these (i.e. gasoline, oils, salts from roads and parking lots). Since the ER projects would be implemented in a fashion as to facilitate the reduction of water discharging overland directly into streams, no significant adverse effects resultant from implementing the ER projects are expected.

9.4.1.2 Ecological Resources

The primary objective of any ecosystem restoration project is to return the structure and function of habitat types as close as possible to the original conditions before human disturbance. Any ecosystem restoration project that has associated significant effects stemming from implementation would not be acceptable. All trees removed in the restoration sites will likely be cut at ground level with the stumps remaining and trees in the flood risk management sites will be cut and grubbed. There will be some loss to native trees, but we do not anticipate any losses to high quality or remnant woodlands. Additionally, the impacted sites will be restored with native plants that will be sustainable based upon the best scientific information, along with sound engineering and design. The following ecological community types are the focus of the Upper Des Plaines River watershed restoration project, all of which are slated to provide beneficial effects to the ecosystem as a whole and the human environment through floodwater attenuation, addition of open space and aesthetics, education opportunities, carbon sequestering, urban heat island reduction, etc.

Native Plant Communities

Implementation of the ER projects would result in the restoration of over 6,800 acres of native community types including: marsh, sedge meadow, wet and dry prairie, wet and dry savanna, woodland and forest. Converting agricultural fields, old field, and successional woodlands to native plant communities has beneficial effects to themselves and to each other. Remnant parcels of native habitat would be delineated and protected. Local seed genotypes, to the extent possible, would be used, and seed would only be acquired from sources within 250-miles of the restoration site. Site maintenance to ensure native species diversity and eradication of invasive species would be implemented to ensure sustainability of restored community types. Since the ER projects would be implemented in a fashion as to increase quantity and quality of these native plant communities, no significant adverse effects are expected from implementing the ER projects.

Riverine

Implementation of the ER projects would result in the restoration of about 85,500 feet (16.2-miles) of prairie slough, stream and river habitat. Converting ditches and restoring impaired streams has beneficial effects to themselves to each other, as well as the riparian hydrology. Any functioning reaches of riverine habitat would be delineated and protected. Site maintenance to ensure native species diversity and eradication of invasive species would be implemented to ensure sustainability of restored community types. Since the ER projects would be implemented in a fashion as to increase quantity and quality of riverine communities, no significant adverse effects resultant from implementing the ER projects are expected.

Threatened & Endangered Species

Threatened and endangered species are discussed in 3.1.2 within the cover type (habitats) that they live. A complete list of threatened and endangered species is found in Appendix C.

Preliminary coordination with the USFWS and plan formulation methodologies have recognized and considered threatened and endangered species from the study's onset. USFWS and State involvement in the project has assured that the plan formulation process would be in compliance with Section 7 of the Endangered Species Act. USFWS participated early in the project as a cooperating agency and has therefore provided significant input on the plan formulation. Formulation was formally reviewed and critiqued by the agency through a Fish & Wildlife Coordination Act Report.

Since the ER projects would be implemented in a fashion to transform agricultural and oldfield land use into critical habitats for several of the listed T&E species within the watershed, no significant adverse effects are expected from implementing the ER projects. Site specific surveys, if warranted, for T&E species will commence under PED phase before any restoration activities would be implemented. These surveys would be coordinated with the USFWS and State DNRs.

9.4.1.3 Social, Cultural & Archaeological Resources

Kenosha County Sites K47 and K41

Archaeological & Historical Properties

Two archaeological sites are the only properties in Kenosha County listed on the National Register of Historic Places that are located within the Des Plaines River drainage basin. These will be avoided.

The project areas are primarily former farm and dairy land. Drainage tiles have been installed across large areas and some slopes have been graded for farming and livestock grazing. Intact cultural deposits may be present in undisturbed areas. However, no ground disturbing activities are planned for undisturbed areas. The planned restoration work at K41, & K47 will have no direct or indirect adverse effects on cultural resources.

Social Properties

Schools: There will be no direct or indirect adverse effects to local Pleasant Prairie schools [Somers Elementary School and Shoreland Lutheran High School] or direct or indirect adverse affects to Bristol schools [Paris Elementary School & Provenance Catholic School, and Pikeville School (K41 & K47)].

Hospitals: There will be no direct adverse affect on Kenosha hospitals, Bonaventure Medical Group (K), and United Hospital System and Paddock Lake Medical Clinic (K41, & K47).

Prime Farmland: The project area is not Prime Farmland since K9 is incorporated within the Pleasant Prairie village limits, and K41, & K47 are incorporated within the Bristol village limits.

Lake County Sites: L43, L39 & L31

Archaeological & Historical Properties

No properties or historical districts listed on the National Register of Historic Properties in Lake County are located within or near the project area. The L31, L43 and L39 project areas are lands recently acquired by the Lake County Forest Preserve District.

L39 is now known as the Raven Glen Forest Preserve. Portions of these project locations are former farm land. Drainage tiles have been installed in some areas, and some slopes have been graded for farming and livestock grazing. Intact cultural deposits may be present in undisturbed areas. However no ground disturbing activities are planned for undisturbed areas.

The L31 project area is Gurnee Woods Forest Preserve, owned by the Lake County Forest Preserve District. This area is primarily flood plain and is unlikely to contain cultural deposits except possibly on higher elevations.

Planned ecological restoration at L43, L39, & L31 will have no direct or indirect adverse affects on cultural resources.

Social Properties

Schools: There will be no direct or indirect adverse effects to local schools in Lake County: Wilmot Elementary School, Kipling Elementary School, and Caruso Junior High School (L01); St. Mary's School, Goddard School, and Park West School in Round Lake Park, and Grayslake St. Gilberts School, Woodlawn Elementary School, and Westlake Christian Academy (L19).

Hospitals: There will be no direct or indirect adverse effects on Lake County hospitals, Condell Hospital, Northwestern Lake Forest Hospital, & United Health Systems.

Prime Farmland: None of the project area is prime farmland. Sites L43, L39, & L31 have been established as public parks.

Cook County Sites C09 & C15

Archaeological & Historical Properties

No properties or historical districts listed on the National Register of Historic Properties in Cook County are located within or near the project area.

The C09 and C15 project areas are primarily low flood plain and are not likely to contain cultural deposits. Intact cultural deposits may be present in undisturbed areas. However no ground disturbing activities are planned for undisturbed areas. Planned ecological restoration at C09 and C15 will have no direct or indirect adverse affects on cultural resources.

Social Properties

Schools: There will be no direct or indirect adverse affects to local schools in Walt Whitman Elementary School and Oliver Wendell Holmes Elementary School in Wheeling and Wood Oaks Junior High School in Northbrook (C09), or West Northfield, Apollo Elementary School, and Glen Grove Elementary School in Glenview, St. Emily Elementary School in Mount Prospect, and Indian Grove School in Prospect Heights (C15)

Hospitals: There will be no direct or indirect adverse affects on local hospitals, Holy Family Medical Center and Northwest Community Hospital (C09), and Glenbrook Hospital and Children's Memorial Hospital (C15)

Prime Farmland: The project area is not Prime Farmland since CO9 is incorporated within the Wheeling village limits and C15 is incorporated within the village limits of Prospect Heights, and Glenview.

Dams: Dam # 2, Dempster Dam, Touhy Dam, and Dam #4- Because of its severely impacted integrity Dam #2 is not eligible for the national register. The dam has subsided and extensive erosion at both ends has undermined the ends causing portions of the structure to collapse and its removal will not be an adverse affect. Removal of all of these dams will have no direct or indirect adverse effects on cultural resources.

Hazardous, Toxic, & Radioactive Wastes

Hazardous, toxic, and radioactive waste investigations included a preliminary screening followed by full Phase I investigations. The preliminary HTRW site screening is included in Appendix H. The preliminary site screening, complete in March 2010, assessed whether FRM and ecosystem restoration sites considered for implementation during alternative development were enrolled in any regulatory remedial program. Data obtained from the IEPA, the WDNR, and the USEPA suggested that none of the sites under investigation were currently, or had previously been, enrolled in any regulatory remedial program. Due to the limited scope of the preliminary HTRW screening, Phase I HTRW investigations were recommended for project sites recommended for implementation during the final stages of the feasibility study.

A Phase I HTRW investigation for the ecosystem restoration, completed in accordance with ER 1165-2-132, is included in Appendix H. Results of the investigation were based on an existing information review, database research, historical topographic map and aerial photograph review, and a site visit. The level of review conducted at each individual site considered the scope of the project, the amount of information available for review at each site, and the time and cost constraints of completing a Phase I HTRW investigation. Results reduce the uncertainty regarding the potential to encounter HTRW at any given site. A list of unresolved issues, short-term actions, and future project recommendations to resolve potential environmental concerns are provided for the ecosystem restoration sites, summarized in Table 9.1. The short term data needs will be addressed early in the design phase.

Table 9.1 – HTRW Results and Recommendations for Future Action: Restoration Sites

Site	Issue	Short-Term Data Needs	Potential Future Actions
Dam Removals (Touhy Dam, Dam#4, Dempster Dam, Dam #1, Dam #2)	Sediment within project limits *(fine-grained sediments in DP River contain elevated PNAs, metals, &PCB)*	None	1. Conduct sediment investigations during design to determine the volume of fine-grained sediment impounded upstream of the dams. 2. If significant quantities of fine-grained sediment are present and cannot be stabilized prior to dam removal, sediment sampling and geotechnical/ environmental analysis may be necessary to determine disposal options for sediments.
Beck Lake Meadow and Floodplain Forest (C15)	John Sexton Landfill	Revise the restoration limits to exclude the landfill area on the southwest quadrant of the site from the USACE restoration area	
	Camp Pine Woods POW FUDS	None	1. Confirm design/excavation assumptions. 2. Conduct additional phase II investigations, if required.
Bristol Marsh (K47)	USTs adjacent	None	Confirm the location of adjacent USTs during design phase to avoid disturbance of utilities during restoration.
Northbrook Floodplain and Riparian Complex (C09)	Historical topographic maps indicate business present along Willow Road 1953 and 1972 with foundations remaining onsite	Confirm the scope and scale of activity with land owner	1. Collect all demolition debris during restoration and dispose in accordance with Federal, State, and local laws and regulations. 2. Perform phase II investigation to determine scope and scale of site impacts from regulated activities, if required.
Gurnee Woods Riparian Wetland (L31)	Two LUSTs (EDR #1 and B13/14) within recommended search distance with unknown status	Confirm scope and scale of the LUST incidents with	1. Confirm design/excavation assumptions 2. Perform phase II investigation to determine scope and scale of site impacts from adjacent regulated LUST activities, if required.
	SRP Site (EDR #21) adjacent to the restoration site with 2 acres of groundwater use restriction.	None	1. Confirm design/excavation assumptions. 2. Perform phase II investigation to determine scope and scale of site impacts from adjacent regulated LUST activities, if required.
Gurnee Woods Riparian Wetland (L31), Red Wing Slough and Deer Lake Wetland Complex (L43)	Inadequate historical aerial photograph coverage	None	More comprehensive historical aerial photograph coverage must be obtained and reviewed to determine if there are any isolated RECs onsite that may impact project implementation.
All Ecosystem Restoration Sites	Site Visit	None	More intensive field visits should be conducted when the restoration design is identified to determine if there are any isolated RECs onsite that may impact project implementation.
	USTs adjacent	None	Confirm the location of adjacent USTs during design phase to avoid disturbance of utilities during restoration.

9.4.2 Flood Risk Management Assessment

9.4.2.1 Physical Resources

Climate

The small scale of the Flood Risk Management (FRM) projects contained within the Comprehensive Plan would not be able to affect the regional climate. The increase in acreage of standing water would increase evaporation in a minor way, but still not great enough to affect weather patterns or rainfall within the region. No significant adverse effects to the regional climate are expected from implementing the Comprehensive Plan.

Geology

The FRM projects contained within the Comprehensive Plan would have no detrimental effects on local geology upon implementation. Construction needed to implement these projects would not disturb any significant geologic features or deposits or disrupt any geologic processes from their natural states. Most of the area in the project area has already been disturbed over the last 150-years and the current project will not alter the geology further. Because implementation of these projects will not disturb significant geologic features or deposits, it is expected that no significant adverse effects to geology would result from implementing the Comprehensive Plan.

Hydrology & Hydraulics

The hydrology and hydraulics of the Des Plaines River watershed have been drastically altered by human modifications to the landscape. Most of the watershed is now urbanized or agricultural, which allows rainfall to immediately runoff to streams instead of draining into the soil and recharging groundwater. In order to alleviate some of the adverse cultural effects associated with watershed development, three reservoirs, four levees, modifications to existing hydraulic structures and several small scale non-structural flood proofing measures have been recommended for implementation. These elements are intended to reduce the risk of overbank flooding within the Upper Des Plaines River watershed.

Reservoirs: Two reservoirs are included in the Comprehensive Plan. These structures would capture and store floodwaters until the flood pulse recedes to a non-threatening level. These reservoirs provide additional storage that naturally was contained in the floodplain areas and have been lost due to development. Since the affected tributaries have been channelized, and their watersheds dominated by impervious surface, it has lead to an unnatural flow regime that is unhealthy for both man and ecosystem. While the constructed reservoirs will help stabilize the surficial hydrology and hydraulics, there may be adverse effects to groundwater in the immediate area where the reservoirs will be constructed. It is expected that a cone of depression would form around the reservoirs; however, there are no significant natural areas within this influence to be affected. It is expected that groundwater wells would not be affected either. No significant adverse effects to the regional hydrology or hydraulics are expected to result from implementing the reservoirs identified in the Comprehensive Plan.

Levees: Four levees are included as part of the Comprehensive Plan. These structures would protect existing homes, businesses and roadways from overbank flooding. Levees remove inundation floodplain areas from the river by essentially channelizing the stream and creating an artificially incised channel. Flood waters that would naturally exceed normal bank full levels are not allowed to inundate the floodplain and are conveyed downstream. Scour and erosion can occur due to the increased flow velocities; however, the areas where the levees are to be constructed currently hold no or very little ecological value. Inundation of the floodplain in these areas would not benefit aquatic organisms since the floodplain has been developed. To address the changes in the hydrology and hydraulics upstream and downstream of the constructed levees, compensatory storage reservoir projects are included as needed. It is, therefore anticipated that there would be no significant adverse effects to hydrology and hydraulics as a result of constructing the levees identified in the Comprehensive Plan.

Road Raises: One bridge modification is included as part of the Comprehensive Plan. Raising this bridge would allow for additional conveyance of flood waters downstream. It is anticipated that there would be no significant adverse effects to downstream hydrology and hydraulics as a result of constructing the planned road raise. No significant adverse effects to the regional hydrology or hydraulics are expected to result from implementing the road raises identified in the Comprehensive Plan.

Structure Modifications: One modification to an existing hydraulic structure is included as part of the Comprehensive Plan and would take place on a facility that already has flood management functions. No significant adverse effects to the regional hydrology or hydraulics are expected to result from implementing the structure modification identified in the Comprehensive Plan.

Non-Structural: The non-structural flood proofing projects included as part of the Comprehensive Plan would be implemented on existing structures or adjacent areas that have already had their land use altered from the natural state. No significant adverse effects to the regional hydrology or hydraulics are expected to result from implementing the non-structural measures identified in the Comprehensive Plan.

Land Use

Whenever there is construction of new features, there is a possibility of a change in land use. Some of these changes can be detrimental to the environment, even if the new structures are intended to protect human interests; however, when features are built on ecologically degraded lands, then effects are usually negligible.

Reservoirs: The two reservoirs included in the Comprehensive Plan are located on lands currently owned by the Cook County Forest Preserve District and are currently used for recreational purposes. These reservoirs will be constructed to ensure existing recreational activities are still possible at WLRS04 and to promote recreation at DPRS04. Only short-term impacts to recreation will occur during flooding events. The construction of a reservoir in these areas will not have an impact to current land use.

Levees: The four levees included as part of the Comprehensive Plan would be built in urban areas to protect existing homes and businesses. No significant adverse effects to land use are expected to result from implementing the levees identified in the Comprehensive Plan.

Road Raises: No significant adverse effects to land use are expected to result from implementing the road raise project identified in the Comprehensive Plan.

Structure Modifications: No significant adverse effects to land use are expected to result from implementing structure modification identified in the Comprehensive Plan.

Non-Structural: No significant adverse effects to land use are expected to result from implementing non-structural flood proofing projects identified in the Comprehensive Plan.

Fluvial Geomorphology & Topography

The fluvial geomorphology of the Des Plaines River watershed has been negatively impacted for over a century due to human development and agricultural practices. Impacts to geomorphology include installing dams, stream channelization, mass earth moving and grading, draining and filling of wetlands, development within floodplains, urban and agricultural runoff, etc. All of the measures proposed by the FRM projects included as part of the Comprehensive Plan will not have major adverse affects on fluvial geomorphology and topography since the scale is minute in relation to watershed functions and the features actually aid in reducing large, unnatural flood events that ruin stream geomorphology that has formed over time.

Reservoirs: The two reservoirs included in the Comprehensive Plan would be constructed on highly developed and channelized sections of the Des Plaines River and will not impact fluvial geomorphic function. No significant adverse effects to fluvial geomorphology and topography are expected to result from implementing the reservoirs identified in the Comprehensive Plan.

Levees: In naturally functioning rivers, construction of levees would be detrimental to the fluvial geomorphology of a stream; however, these levees are being placed in highly urban areas where the stream is not allowed to meander freely within its active floodplain. No significant adverse effects to fluvial geomorphology and topography are expected to result from implementing the levees identified in the Comprehensive Plan.

Road Raises: The one road raise project will improve conveyance of flood waters and thus prevent more damage to fluvial geomorphology. No significant adverse effects to fluvial geomorphology and topography are expected to result from implementing the road raise identified in the Comprehensive Plan.

Structure Modifications: No significant adverse effects to fluvial geomorphology and topography are expected to result from implementing the one structure modification identified in the Comprehensive Plan.

Non-Structural: No significant adverse effects to fluvial geomorphology and topography are expected to result from implementing the non-structural flood proofing projects identified in the Comprehensive Plan.

Soils

Whenever there is construction of new features, there is a possibility of soils becoming modified from their natural state through grading, digging and filling. Some of these changes can be detrimental to the environment, even if the new structures are intended to protect human interests; however, when features are built on already modified lands, then effects are usually negligible.

Reservoirs: The two reservoirs included in the Comprehensive Plan are located within highly urbanized areas where the soils are already highly degraded. The construction of these reservoirs would modify the soils; however, the action would be negligible in terms of the extent of soil modification that has already occurred in the watershed.

Levees: Soils in the area where the levees would be built have been adversely affected and/or modified by decades of urbanization and industrial development. No significant adverse effects to soils are expected to result from implementing the levees identified in the Comprehensive Plan.

Road Raises: No significant adverse effects to soils are expected to result from implementing the road raise identified in the Comprehensive Plan.

Structure Modifications: No significant adverse effects to soils are expected to result from implementing the structure modification identified in the Comprehensive Plan.

Non-Structural: No significant adverse effects to soils are expected to result from implementing the non-structural flood proofing projects identified in the Comprehensive Plan.

Air Quality

Implementation of the FRM projects included as part of the Comprehensive Plan would result in negligible effects to air quality within the watershed and regionally. Mobile source emissions were estimated using USEPA guidance and models, and were found to be *de minimis* for criteria air pollutants. General recommendations to be considered during the construction phase are post-construction stabilization of earth areas to prevent water or wind erosion and dust control during construction.

Water Quality

Overall water quality in the Upper Des Plaines River is impaired for aquatic life, fish consumption, or primary contact 303(d) designated uses. The potential causes include elevated levels of chloride, nitrogen, phosphorous, total dissolved and suspended solids, zinc, and silver, and excessive sedimentation and siltation caused primarily from combined sewer overflows, municipal point source discharges, urban runoff, storm sewers, highway/road/bridge runoff, site clearance and land development, hydro structure flow regulation, and the presence of sediment contaminated with various chemicals. Elevated levels of fecal coliform, resulting from combined sewer overflows, urban runoff, and storm sewers have impaired primary contact recreation in many areas.

Reservoirs: The two reservoirs included in the Comprehensive Plan may actually have benefits to water quality since it will trap sediment and excessive flows from impervious surfaces, which may have high nutrient levels. No significant adverse effects to water quality are expected.

Levees: The configuration of the levees may actually halt some urban run-off from entering the Upper Des Plaines River, thus helping to improve water quality given there is no instance where the levees are cutting off natural floodplain; therefore, nutrient absorption is not being lost. No significant adverse effect to water quality is expected to result from implementing the levees identified in the Comprehensive Plan.

Road Raises: No significant adverse effects to water quality is expected to result from implementing the road raise identified in the Comprehensive Plan.

Structure Modifications: No significant adverse effects to water quality is expected to result from implementing structure modifications identified in the Comprehensive Plan.

Non-Structural: No significant adverse effects to water quality is expected to result from implementing non-structural measures identified in the Comprehensive Plan.

9.4.2.2 Ecological Resources

The primary objective of any FRM project is to protect human lives, as well as lessen or eliminate costly damages to infrastructure or business practices. Flood risk management can be accomplished with either structural or non-structural measures. When implementing structural measures, ecological resources can be compromised; however, if the ecological structure and function has already been compromised, then effects are usually considered negligible.

Plant Communities

Reservoirs: The existing conditions for reservoirs DPRS04 (Fullerton Woods Forest Preserve) and WLRS04 (Harry Semrow Driving Range Reservoir) are severely degraded, as discussed below. The sites were assessed through a field survey in October 2013.

Fullerton Woods Forest Preserve is approximately 43 acres in size. The site has very little existing ecological resources. The site was previously used for spoil storage and stone stockpiling for the deep tunnel project. The storage activities effectively destroyed the hydrogeomorphic conditions of the site. While the materials have been removed, the habitat remains degraded. The area used for spoil storage is now overgrown with invasive plant species. The perimeter of the site is dominated by tree and shrub species with an abundant population of Common Buckthorn. Overall, the site is listed as a degraded plant community with approximately 32% of the species non-native and a mean C of 2.6 and FQI of 15.4 for native species. As an ecosystem, this site is most likely dominated by tolerant mammal, reptile, bird and insect species that are common in heavily urbanized areas.

Harry Semrow Driving Range is approximately 37 acres. The ecological resources at this site are also degraded. The site is used as a driving range for the public and the majority of the area is mowed lawn. Mowed lawn provides no structure or function for native species. Within the driving range, a small pond exists and is dominated by Cattail and the invasive Common Reed. Much of the perimeter of the area is forested. These forested areas contain a number of non-native species mixed with some mature native trees. Pockets of mature White and Burr Oak are located within the property. However, the site is still considered a degraded ecosystem with approximately 45% of the plant species found within the study site listed as non-native and a mean C of 1.8 and FQI of 6.4 for native species. Tolerant organisms found within highly urbanized areas are expected to inhabit the study site.

Based on these assessments, no significant adverse effects to native plant communities are expected to result from implementing these reservoirs. Because the perimeters of the proposed reservoirs will be seeded, plant communities will be more diverse and consist of native plants after construction. Due to the degraded condition of the sites, no habitat mitigation would be required. This assessment is currently being coordinated with USFWS.

Levees: Minor tree clearing would need to take place, but these are in residential areas where the trees are non-native and provide minimal functional habitat. Any areas of earth disturbance and the levees themselves would be planted with native prairie grasses to ensure soil stability and prevent non-native and invasive species from colonizing. Recreational trails would be designed to run within the levee footprints, which would not require additional clearing and grubbing of plant communities to implement. No significant adverse effects to native plant communities are expected to result from implementing the levees.

Road Raises: Any areas of earth disturbance would be planted with native prairie grasses to ensure soil stability and prevent non-native and invasive species from colonizing. No significant adverse effects to native plant communities are expected to result from implementing road raises.

Structure Modifications: Any areas of earth disturbance would be planted with native prairie grasses to ensure soil stability and prevent non-native and invasive species from colonizing. No significant adverse effects to native plant communities are expected to result from implementing structure modifications.

Non-Structural: Any areas of earth disturbance would be planted with native prairie grasses to ensure soil stability and prevent non-native and invasive species from colonizing. No significant adverse effects to native plant communities are expected to result from implementing non-structural measures.

Riverine

Reservoirs: DPRS04 would be constructed adjacent to the Des Plaines River. Floodwater will be pumped into the reservoir and slowly released; therefore, operations would not impact the riverine channel. The storage and slow release of flood waters may assist in enhancing riverine function. No adverse impacts to riverine habitats are expected from the construction of this reservoir.

WLRS04 is in between the Des Plaines River and the tributary, Weller Creek. The reservoir could be connected to either the river or creek or to both. This would result in the construction of a pipe or ditch to connect the reservoir to the Des Plaines River watershed. Weller Creek is already highly channelized and surrounded by urban development with very little riverine function. Connecting to Weller will not result in any impact to riverine function or resources. In addition, connecting to the Des Plaines River will not impact riverine function. The reservoir will assist with minimizing the impacts from flooding events.

Levees: Any areas of earth disturbance along banks or riparian corridors would be planted with native grasses to ensure soil stability and prevent non-native and invasive species from colonizing. No significant adverse effects to riverine habitats are expected to result from implementing road raises.

Road Raises: Any areas of earth disturbance along banks or riparian corridors would be planted with native grasses to ensure soil stability and prevent non-native and invasive species from colonizing. No significant adverse effects to riverine habitats are expected to result from implementing road raises.

Structure Modifications: Any areas of earth disturbance along banks or riparian corridors would be planted with native grasses to ensure soil stability and prevent non-native and invasive species from colonizing. No significant adverse effects to riverine habitats are expected to result from implementing structure modifications.

Non-Structural: Any areas of earth disturbance along banks or riparian corridors would be planted with native grasses to ensure soil stability and prevent non-native and invasive species from colonizing. No significant adverse effects to riverine habitats are expected to result from implementing non-structural measures.

Threatened & Endangered Species

Threatened and endangered species are discussed in Section 3.1.2. Threatened & Endangered Species within the cover type (habitats) that they live. A complete list of threatened and endangered species is found in Appendix C.

Coordination with the USFWS and plan formulation methodologies have recognized and considered threatened and endangered species from the study's onset. USFWS participated early in the planning process as a cooperating agency and has therefore provided significant input on the plan formulation. Formulation was formally reviewed and critiqued by the agency through a Fish & Wildlife Coordination Act Report.

Since the plan formulation of the FRM plan took threatened and endangered species' presence and critical habitats into consideration within the watershed, significant adverse effects resultant from implementing the FRM plan have been avoided. No significant adverse effects to threatened and endangered species are expected to result from implementing any features.

9.4.2.3 Social, Cultural & Archaeological Resources

Archaeological & Historic Properties

Reservoirs: Initial assessment of DPRS04 and WLRS04, conducted in coordination with the Illinois State Historic Preservation Agency, determined that a Phase II Archaeological Survey will be required for both sites prior to construction. Any archaeological sites found during this survey will be avoided where possible. If avoidance of any known archaeological site is not possible, consultations will be conducted with the Illinois Historic Preservation Agency (IHPA) and if needed, a Section 106 mitigation plan will be developed that meets IHPA requirements. In the event of accidental discovery of intact archaeological or cultural features or deposits during construction, work will cease and consultations will be conducted with the Illinois Historic Preservation Agency.

Levees: Four levees (DPLV01, DPLV04, DPLV05 & DPLV09) are planned for this project. Initial assessments indicate that all four levee locales have previously been surveyed for cultural resources, and that no archaeological or historical resources are present. None of the levees will have a direct significant affect on cultural resources.

Road Raises: One road raise (DPBM04) is planned for this project. This locale is within the existing road right-of-way. This right-of-way area has been heavily modified by blading, grading, and filling connected with repeated road construction and maintenance. Based on Illinois Historic Preservation Agency (IHPA) records, no intact archaeological or historical deposits are present. This planned road raise will have no direct or indirect adverse affects on cultural resources.

Structure Modifications: Structure modification is planned at one site, FPCI01. Modification will take place within the existing site footprint on areas that have been heavily modified by construction and maintenance. Initial assessment indicates that no intact archaeological or historical deposits are present. The planned structural modification will have no direct or indirect adverse affects to cultural resources.

In the event of accidental discovery of intact archaeological or cultural features or deposits, work will cease and consultations will be conducted with the Illinois State Historic Preservation Agency.

Social Properties

Schools

Reservoirs: There will be no direct or indirect adverse affects on local area schools from the construction of the reservoirs (DPRS04 and WLRS04).

Levees: There will be no direct or indirect adverse affects on local schools from the construction of the levees.

Road Raises: There will be no direct or indirect adverse affects to schools in the general project areas from the road raise (DPBM04).

Structure Modifications: The Planned structural modification (FPCI01) will have no direct or indirect adverse affects on local schools in the general project areas.

Hospitals

Reservoirs: There will be no direct or indirect adverse affects on local area hospitals from the construction of the reservoir (DPRS04 and WLRS04).

Levees: There will be no direct or indirect adverse affects on local hospitals from the construction of the levees.

Road Raises: There will be no direct or indirect adverse affects to hospitals in the general project areas from the road raise (DPBM04).

Structure Modifications: The planned structural modification (FPCI01) will have no direct or indirect adverse affects on hospitals in the general project areas.

Hazardous, Toxic, & Radioactive Wastes

The HTRW investigations included a preliminary screening followed by full Phase I investigations. The preliminary hazardous, toxic, and radioactive waste (HTRW) site screening is included in Appendix H. The preliminary site screening, complete in March 2010, assessed whether FRM and ecosystem restoration sites considered for implementation during alternative development were enrolled in any regulatory remedial program. Data obtained from the IEPA, the WDNR, and the USEPA suggested that none of the sites under investigation were currently, or had previously been, enrolled in any regulatory remedial program. Due to the limited scope of the preliminary HTRW screening, Phase I HTRW investigations were recommended for project sites recommended for implementation during the final stages of the feasibility study.

A Phase I HTRW investigation for the FRM sites (reservoir, levee/floodwall, and structural modification project sites), completed in accordance with ER 1165-2-132, is included in Appendix H. Results of the investigation were based on an existing information review, database research, historical topographic map and aerial photograph review, and a site visit. The level of review conducted at each individual site considered the scope of the project, the amount of information available for review at each site, and the time and cost constraints of completing a Phase I HTRW investigation. Results reduce the uncertainty regarding the potential to encounter HTRW at any given site. A list of unresolved issues, short-term actions, and future project recommendations to resolve potential environmental concerns are provided for the reservoir, levee/floodwall, and structural modification sites, summarized in Table 9.2, Table 9.3, Table 9.4,and Table 9.5. The short term data needs will be addressed early in the design phase.

Table 9.2 – HTRW Results and Recommendations for Future Action: Road Raises

Site	Issue	Short-Term Data Needs	Potential Future Actions
First Ave Bridge Modification (DPBM04)	Historical aerial photographs suggest that between 1999 & 2007 property adjacent to Des Plaines River Rd (staging area) are highly disturbed and vegetation removed. Current topographic maps indicate filling; it is unclear where the fill materials originated.	The landowner should be identified and past and current uses of the property identified.	Phase II investigation may be required at the project site if the project activities disturb the property where fill has been placed.

Table 9.3 – HTRW Results and Recommendations for Future Action: Structure Modifications

Site	Issue	Short-Term Data Needs	Potential Future Actions
Lake Mary Anne Pump Station (FPCI01)	Site debris *(debris generally consists of roadside garbage, construction debris, and old structures associated with commercial activities at Dude Ranch Pond)*	None	Collect all debris during construction and dispose in accordance with Federal, State, and local laws and regulations

Table 9.4 – HTRW Results and Recommendations for Future Action: Reservoirs

Site	Issue	Short-Term Data Needs	Potential Future Actions
Fullerton Woods Reservoir (DPRS04)	Database entries suggest that the site contains an unauthorized laudfill, but this information could not be replicated, nor did historical maps and photographs indicate the site has ever been used for landfill.	Confirm that the landfill was misuapped and is not present onsite (FOIA request through IEPA).	Perform phase II investigation to determine scope and scale of site impacts from landfill, if confirmed present.
	Site Visit suggests that all limestone from Deep Tunnel construction has been removed from the site, but could not be confirmed.	None	Conduct borings onsite to determine the type and quality of soils present onsite, and confirm that limestone has been removed from site.
	Spoil generated for reservoir construction	None	Due to the volume of material that will be generated and the unknown quality of the excavated material, management of spoil materials on-site is advised. If spoil will be removed from project site, phase II investigations may be necessary to determine the quality of the soils and disposal options.
Harry Semrow Driving Range Reservoir (WLRS04)	There are multiple LUST sites with the ASTM search distance with unkuown status (EDR #L43, L44, and 52). Several of the LUSTs are presumed to be down gradient of the reservoir site; but one appears to be up gradient.	Confirm scope and scale of the LUST incidents with IEPA (FOIA request)	Perform phase II investigation to determine scope and scale of site impacts from adjacent regulated LUST activities, if required.
	Spoil generated for reservoir construction	None	Due to the volume of material that will be generated and the unknown quality of the excavated material, management of spoil materials on-site is advised. If spoil will be removed from project site, phase II investigations may be necessary to determine the quality of the soils and disposal options.

Table 9.5 – HTRW Results and Recommendations for Future Action: Levees

Site	Issue	Short-Term Data Needs	Potential Future Actions
Touhy-Miner Levee/Floodwall (DPLV09)	Site debris *(debris generally consists of roadside garbage, construction, or landscape debris)*	None	Collect all debris during construction and dispose in accordance with Federal, State, and local laws and regulations
	Three LUSTs up gradient	Confirm scope & scale of the LUST incidents w IEPA	Perform phase II investigation to determine scope and scale of site impacts from adjacent regulated LUST activities, if required
Groveland Ave Levee (DPLV01)	None	None	None
Belmont-Irving Park Levee (DPLV04)	Several historical gas stations, and one SRP site with groundwater use restrictions, located hydraulically up gradient to project with multiple SPILL and LUST actions	None	1. Confirm design/excavation assumptions and groundwater handling requirements 2. Confirm status of all LUST and SPILL actions 3. Perform phase II investigation to determine scope and scale of site impacts from adjacent regulated activities, if required.
	Landfill located adjacent to staging area	None	Confirm the limits of the staging area and the limits of the landfill to determine if areas overlap. Insert any contractual restrictions required to prevent disturbance of the landfill area.
	Site Visit	None	Site visits must be conducted to determine if there are any isolated RECs onsite that may impact project implementation.
	Database Search review	None	Additional review of database results of all sites within the ASTM search limits (beyond the limits of the levee/floodwall alignment documented herein) should be conducted to identify a comprehensive list of RECs that may impact project implementation.
Fullerton-Grand Levee (DPLV05)	Four SRP sites with groundwater use restrictions, located hydraulically up gradient to project	None	1. Confirm design/excavation assumptions and groundwater handling requirements 2. Perform phase II investigation to determine scope and scale of site impacts from adjacent regulated activities, if required
	Site Visit	None	Site visits must be conducted to determine if there are any isolated RECs onsite that may impact project implementation.
	Database Search review	None	Additional review of database results of all sites within the ASTM search limits (beyond the limits of the levee/floodwall alignment documented herein) should be conducted to identify a comprehensive list of RECs that may impact project implementation.

9.4.3 17 Points of Environmental Quality

As specified by Section 122 of Rivers, Harbors & Flood Control Act of 1970 (P.L. 91-611), seventeen environmental quality categories of impacts were reviewed and considered in arriving at the final determination. As laid out in Table 9.6, the following categories were considered: noise, displacement of people, aesthetic values, community cohesion, desirable community growth, tax revenues, property values, public facilities, public services, desirable regional growth, employment, business and industrial activity, displacement of farms, man-made resources, natural resources, air and water. Long term significant impacts from the preferred alternative plan to these identified points are not expected. Temporary minor impacts from constructions activities would occur on some categories.

Table 9.6 – 17 Points of Environmental Quality Affects Considered

Points of Environmental Quality	ER Affects	FRM Affects
Noise	Minor & Temporary	Minor & Temporary Negative
Displacement of people	No Affects	No Affects
Aesthetic values	Long Term Beneficial	See Below
Community cohesion	No Affects	No Affects
Desirable community growth	No Affects	No Affects
Tax revenues	No Affects	No Affects
Property values	No Affects	No Affects
Public facilities	No Affects	No Affects
Public services	No Affects	No Affects
Desirable regional growth	No Affects	No Affects
Employment	No Affects	No Affects
Business and industrial activity	No Affects	Beneficial Affects
Displacement of farms	No Affects	No Affects
Man-made resources	No Affects	No Affects
Natural resources	Long Term Beneficial	Minor & Temporary Negative
Air and water	Long Term Beueficial	Minor & Temporary Negative
Water	Long Term Beneficial	Minor & Temporary Negative

Environmental Justice

The proposed ER and FRM plans would not cause adverse human health effects or adverse environmental effects on minority populations or low-income populations. Executive Order 12898 (environmental justice) requires that, to the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands.

Aesthetics

Natural resources, landforms vegetation and man-made structures that generate one or more sensory reactions and evaluations by the observer, particularly in regard to pleasurable response, are required to be assessed for adverse effects. These sensory reactions are traditionally categorized as visual, auditory and olfactory responses.

All components under the ER and FRM Plans have minimal affect on sight, sound and smells. Visual improvements at the reservoir site would include the use of native vegetation and designing the reservoir to be more park-like, than just a "hole-in-the-ground".

The proposed levees would make the adjacent forest preserve lands have more of a sense of solace, since they would block the site of homes and human activities from the Forest Preserve's perspective; however, from a home owner's perspective, the levee may impair the visual line of sight to the Forest Preserve.

Road raises and structural modifications have minimal affect on sight, sound and smell since these structures are maintaining their characteristics and are just being elevated. Elevating of these structures is not expected to impair any scenic or visual vistas.

9.5 Cumulative Effects Assessment

Consideration of cumulative effects requires a broader perspective than examining just the direct and indirect effects of a proposed action. It requires that reasonably foreseeable future impacts be assessed in the context of past and present effects to important resources. Often it requires consideration of a larger geographic area than just the immediate "project" area. One of the most important aspects of cumulative effects assessment is that it requires consideration of how actions by others (including those actions completely unrelated to the proposed action) have and will affect the same resources. In assessing cumulative effects, the key determinant of importance or significance is whether the incremental effect of the proposed action will alter the sustainability of resources when added to other present and reasonably foreseeable future actions.

Cumulative environmental effects for the proposed ecosystem restoration (ER) and FRM project were assessed in accordance with guidance provided by the Council on Environmental Quality (CEQ) and U.S. Environmental Protection Agency (USEPA 315-R-99-002). This guidance provides an eleven-step process for identifying and evaluating cumulative effects in NEPA analyses.

The overall cumulative impact of the proposed Upper Des Plaines Phase II ecosystem restoration and FRM project is considered to be beneficial environmentally, socially and economically.

The ecological restoration portion of this project would improve hydrology by filling an estimated 17,900 feet of unnatural ditch would be filled along with hundreds of thousands of feet of drain tiles disabled. Natural stream sinuosity would be restored increasing total length from 68,400 feet to 85,500 feet and 7,000 feet of stream would receive instream habitat treatments. Over 6,800 acres of native aquatic community types would be restored including: marsh, sedge meadow, wet prairie, wet savanna, floodplain forest, and woodland ephemeral depressions. Riparian and buffering communities of prairie, savanna, woodland and forest would also be restored to ensure sustainability and provide connectivity for multi-habitat life cycle species (i.e. Eastern Newt (*Notophthalmus viridescens*) require connectivity between marsh and woodland habitats). Ecosystem Plan G increases the quality of watershed ecosystem communities by 34% of what currently exists.

The FRM portion of this project would provide $8,636,000 net economic benefits through implementing two reservoirs, four levees, one road raise, one structural modification, and a vast array of non-structural components. Minor ecological improvements resulting from the FRM plans include reducing the flashiness of the Des Plaines River watershed and minor water quality improvements.

9.5.1 Scope of Cumulative Effects Analysis

Through this environmental assessment, the cumulative effects issues and assessment goals are established, the spatial and temporal boundaries are determined, and the reasonably foreseeable future actions are identified. Cumulative effects are assessed to determine if the sustainability of any of the resources is significantly affected with the goal of determining the incremental impact to key resources that would occur should the proposal be permitted.

The spatial boundary for the assessment has been broadened to consider effects of the whole Upper Des Plaines River watershed. The spatial boundary being considered is normally in the general area of the proposed ecological restoration; however, this area may be expanded on a case-by-case basis if some particular resource condition necessitates broadening the boundary. For this analysis, the spatial boundary is the entire Upper Des Plaines River watershed.
Three temporal boundaries were considered:

- *Past* –1830s because this is the approximate time that the landscape was in its natural state, a vast prairie/wetland/woodland mosaic
- *Present* – 2014 when the decision is being made on the most beneficial ecological restoration and FRM projects
- *Future* – 2064, the year used for determining project life end, although the ecological restoration should last until a geologic event disturbs the area

Projecting the reasonably foreseeable future actions is difficult. The proposed action (ecosystem restoration and FRM) is reasonably foreseeable; however, the actions by others that may affect the same resources are not as clear. Projections of those actions must rely on judgment as to what are reasonable based on existing trends and where available, projections from qualified sources. Reasonably foreseeable does not include unfounded or speculative projections. Some future projections were taken from completed watershed plans by the Lake County Stormwater Management and Southeastern Wisconsin Planning Commission. In this case, reasonably foreseeable future actions include:

- Stable growth in both population and water consumption within the watershed
- Continued urban development within the watershed
- Continued increase in tourism/recreation within open space and natural lands
- Continued application of environmental requirements such as those under the Clean Water Act
- Implementation of various programs and projects to reduce runoff, erosion and sewer overflows
- Increased value placed not only the open space but the biodiversity and water quality of the watershed

9.5.2 Cumulative Effects on Resources

The plan formulation process took into account existing and planned FRM projects, watershed studies and known ecological restoration projects in the study area. Prior studies and reports, listed in Section 1.1.5, were reviewed to ensure that the modeled conditions are the best possible representation of actual conditions. In Section 3.1.1.5, Table 3.4 provides a list of existing major watershed modifications, including FRM projects. The detailed hydrologic and hydraulic models used in this study include the listed modifications. The study team also worked with state and local agencies to coordinate ongoing FRM planning to address additional flood damages in the watershed. Upon approval and implementation of a Recommended Plan, the with-project conditions will be used to evaluate the effectiveness of future projects.

Physical Resources: The past has brought much alteration to the physical resources of the Upper Des Plaines River watershed. Geology, soils, topography, hydrology, and fluvial geomorphology have all been modified to suit man's needs for purposes of habitation, commerce and recreation. Over 86% of the landscape has been modified from its natural form and the rate of land reclamation vs. development is almost equal. As a result, water and sediment quality are impacted due to site-specific and watershed-scale alterations, as well as daily activities such as road salting, industrial and municipal discharge, poor agricultural practices and the untidy nature of transportation/vehicles.

It is reasonably foreseeable that agricultural land will be converted to small residential subdivisions or purchased by conservation organization for ecological restoration purposes. In some cases this can potentially improve water quality in terms of nutrient loading, but in other instances it may introduce other types of contaminants such as oils and grease, surfactants and other nutrients (sewage and lawn fertilizers). Municipalities have adopted development and stormwater management ordinances; however, they are not always utilized to their full intentions. Best management practices are not numerous enough to prevent the influx of nutrients into streams and wetlands from existing agricultural land. Given the past, current and future condition of the Upper Des Plaines River watershed, the implementation of the ecosystem restoration and FRM projects are minor repairs in terms of the vast array and quantity of adverse effects caused by development and agriculture; however, they are significant in terms of beginning to address all the human induced problems the watershed suffers. There are no irrecoverable loss of resources identified in terms of geology, soils, topography, hydrology, water quality and fluvial geomorphology due to implementation of the preferred ER and FRM Plans. Cumulative beneficial effects to the Upper Des Plaines River are anticipated in terms of geology, soils, topography, hydrology, water quality and fluvial geomorphology.

Ecological Resources: The ecological diversity of the Upper Des Plaines River watershed has suffered greatly as a result of previous significant physical resource alterations. The watershed was once a diverse mosaic of marsh, prairie, savanna, woodland, glacial ponds and lakes and streams that had a steady and dependable hydrology. Extreme landscape modification has caused about 86% of the natural land use to be converted into agriculture or residential/commercial land uses. It is estimated that only about 2% of the remaining 14% of open space is considered high quality ecosystem, and that this 2% also suffers from fragmentation. No longer is there enough natural landscape to provide enough natural lands for fish and wildlife habitat or to attenuate large rainfall events. Considering these past, current and future conditions of the Upper Des Plaines River watershed, the implementation of the ecosystem restoration and FRM projects are minor repairs in terms of the vast array and quantity of significant effects caused by development and agriculture; however, they are instrumental in beginning to address the human induced problems the watershed suffers. Therefore, there are no irrecoverable losses of resources identified in terms of plant, insect, fish, amphibian, reptile, bird, mammal taxa or to their habitats they occupy due to implementation of the preferred ER and FRM Plans. Cumulative beneficial effects to the Upper Des Plaines River are anticipated in terms of fish and wildlife and their preferred habitats.

Archaeological & Cultural Resources: Cumulative effects are not expected to archaeological or cultural resources.

9.5.3 Cumulative Effects Summary

Along with direct and indirect effects, cumulative effects of the preferred combined ER and FRM Plans were assessed. There have been numerous effects to resources from past and present actions, and reasonably foreseeable future actions can also be expected to produce both beneficial and adverse affects. In this context, the increments of effects from the proposed project are relatively minor. Assessment of cumulative effects indicates that long-term healing of the Upper Des Plaines River watershed resources is beneficial with the implementation of the preferred alternative plan; however, it will take considerable time for counties, municipalities and local organizations to continue to repair and mitigate losses caused by past hydrologic, hydraulic, and ecologic adverse effects. Based on the expectation of continued sustainability of all resources, and the magnitude of the watershed circumstances, cumulative effects are not considered significant or adverse, but highly beneficial to the environment, its people, and the economy.

9.6 Compliance Determination

9.6.1 Federal Statues and Regulation Compliance

This feasibility study complies with applicable environmental laws, regulations, and Executive Orders for the current stage of the study. Table 9.7 provides a summary of the compliance status for the primary environmental requirements associated with the study.

Table 9.7 – Compliance with Environmental Statutes and Executive Orders

Reference	Environmental Regulation	Compliance Status*
16 USC 1531, et seq.	Endangered Species Act, as amended	C
16 USC 460 (L),(12)	Federal Water Project Recreation Act, as amended	C
16 USC 4601-4, et seq.	Land and Water Conservation Fund Act, as amended	C
16 USC 470a, et seq.	National Historic Preservation Act (NHPA), as amended	C
16 USC 661	Fish and Wildlife Coordination Act, as amended	C
16 USC 703 et seq.	Migratory Bird Treaty Act of 1918,as amended	C
16 USC469, et seq.	Archaeological and Historical Preservation Act as amended	C
25 USC 3001, et seq.	Native American Graves Protection and Repatriation Act	C
33 USC. 1251 et seq.	Clean Water Act, of 1977, as amended	C
42 USC 1962	Water Resources Planning Act of 1965	C
42 USC 1996	American Indian Religious Freedom Act of 1978	C
42 USC 201	Safe Drinking Water Act of 1986 as amended	C
42 USC 4321, et seq.	NEPA, as amended	C
42 USC 4901, et seq.	Quiet Communities Act of 1978	C
42 USC 6901, et seq.	Resource Conservation and Recovery Act of 1976, as amended	C
42 USC 7401	Clean Air Act (CAA) of 1970 as amended	C
42 USC 9601	CERCLA of 1980	C
7 USC 4201, et seq.	Farmland Protection Policy Act	C
CEQ Memo 08-11-80	Prime or Unique Agricultural Lands NEPA	C
E.O. 11514	Protection and Enhancement of Environmental Quality	C
E.O. 11593	Protection and Enhancement of the Cnltural Environment	C
E.O. 11988 (1977)	Floodplain Management	C
E.O. 11990 (1977)	Protection of Wetlands	C
E.O. 12088 (1978)	Federal Compliance with Pollution Control Standards	C
E.O. 12898 (1994)	Federal Actions to Address EJ in Minority and Low-Income Populations	C
E.O. 13007 (1996)	Indian Sacred Sites	C
E.O. 13045 (1997)	Protection of Children from Environmental Health Risks & Safety Risks	C
E.O. 13186	Responsibilities of Federal Agencies to Protect Migratory Birds	C
E.O. 13340	Great Lakes Designation of National Significance to Promote Protection	C
PL 79-525, 60 Stat 634	Rivers and Harbors Act of 1946	C

*Compliance Status indicated as compliant (C), non-compliant (N), or pending (P).

The NEPA (40 CFR 1501.6) requires the action agency to establish a cooperating agency relationship with other Federal agencies that have jurisdiction by law or special expertise relevant to the project. The USACE established a cooperating interagency agreement with the USFWS, in which they are serving as a member on the PDT, and have significantly contributed to the study.

9.6.2 Implementation of Environmental Operating Principles

In assessing environmental effects, the USACE implemented the following Environmental Operating Principles as part of this feasibility study.

Foster sustainability as a way of life throughout the organization: Development of feasibility level measures and alternatives took into consideration sustainability over time. Ecosystem features were developed to use natural hydrology and processes to sustain their integrity and functions as opposed to relying on hard engineered solutions that require continual maintenance. Allowing streams, wetlands and plant communities to both ebb and wan along with the natural processes that sustain them (fire, stream meandering, flood pulses), maintenance costs and activities are invariable reduced to minor activities (invasive species spot treatments). The projects were designed to ensure that the restored plant communities would not revert to invasive, weedy species again by 1) incorporating lessons learned from similar completed projects such as Orland Tract Section 206, Orland Perimeter 506, Calumet Prairie 506, Red Mill Pond 506 and 63rd Street Beach and Dune 506; 2) designing plant communities compatible with the restored hydrology and geomorphology, i.e. the overall design replicates plant communities indicative of the Upper Des Plaines River system as dictated by the historic soils; 3) restoring hydrologic, hydraulic and fire processes to sustain and drive native plant communities; 4) planting enough native plant material to prevent and/or reduce the potential for the invasion of invasive and weedy plant species; and 5) implementing the projects in partnership with dedicated non-Federal sponsors that have natural area programs and protocols that will maintain the project as constructed with the intended ecological benefits.

Proactively consider environmental consequences of all Corps activities and act accordingly: Potential impacts of engineering projects were considered during the planning process and, where impacts were identified, alternatives to avoid, minimize, rectify, reduce, eliminate, or compensate for the impacts were incorporated in alternative plans. The planning process attempted to avoid and/or minimize adverse affects to all critical, unique, and diverse fish and wildlife areas where large scale engineering projects were proposed. Flood Risk Management Planning accounted for valued fish, wildlife and habitat through a preliminary screening process, which ruled out those areas of ecological significance. The preferred plan addresses existing watershed habitat degradation in a manner to allow long-term recovery of the ecosystem. Maximizing the amount of ecological restoration within an extremely modified watershed not only aids in reversing trends that are both adverse to the ecological environment, but also the human environment. Ecosystem restoration components inherently reverse or prevent adverse human environmental consequences, such as water quality degradation, disease, flooding, carbon emissions, uncontrollable wild fires, food shortages, economics of invasive species, etc.

Create mutually supporting economic and environmentally sustainable solutions: The multi-purpose planning process used for this study considered potential conflicts and any necessary trade-offs to between the plans maximizing NED and National Environmental Restoration benefits. Opportunity was sought to design risk management features to provide incidental riverine and wetland habitat. Reestablishing these habitat features would benefit the natural environment by providing a low-cost and judicious method of habitat restoration. In addition, ecosystem restoration measures were developed in concert with our Local Sponsors and Study Partners that currently engage in natural area management. This mutual partnership has been a source of information during the feasibility phase such that their long term efforts of natural area management has resulted in the latest and most cost effective methods for maintaining a sustainable native biodiversity.

Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps which may impact human and natural environments: Potential impacts of the proposed project were considered as documented in this EA. These potential impacts were assessed by reviewing existing data and through coordination with the public and with resource agencies.

Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs: Monitoring and adaptive management plans are an integral part of ecosystem restoration project implementation. Flood risk management projects will include robust O&M plans that incorporate sustainable practices.

Leverage scientific, economic, and social knowledge to understand the environmental context and effects of Corps actions in a collaborate manner: Many scientific and ecological studies have been initiated in advance of and during this study, which provide the public and resource agencies with a valuable insight of the historic and current diversity, and its positive affects once the project is complete. The USACE, Chicago District will also develop a long-term monitoring program in conjunction with USFWS and the non-Federal sponsors that will continually add information to these baseline studies. A GIS database was developed to allow the study team, as well as other users, to access and apply the scientific information.

Employ an open, transparent process that respects views of individuals and groups interested in Corps activities: The study team has met numerous times with the resource agencies, local industry, and environmental interests through scoping, teleconference calls, public meetings and has attempted to be responsive in addressing concerns. All problems were addressed as they arose and solutions were developed. The USACE agrees with the resource agencies that long-term monitoring and adaptive management will be required.

9.6.3 Discussion of Major Environmental Compliance

Section 404 of the Clean Water Act: All projects proposed under the preferred plan would comply with the regulations and statutes set forth in Section 404 of the Clean Water Act and do not impact any wetlands. There are no outstanding reasons to believe that Section 404 would not be in compliance for any given project. A preliminary 404(b)(1) analysis has been completed for the Recommended Plan, included in Appendix L. However, each feature that requires 404 compliance would complete a Section 404(b)(1) analysis and provide the information on a per project basis during the design phase to regulating agencies. No project requiring 404 compliance would begin construction without the completion of the analysis.

Section 401 of the Clean Water Act: All projects proposed under the preferred plan would comply with the regulations and statutes set forth in Section 401 of the Clean Water Act. There are no outstanding reasons to believe that 401 WQ Certification would not be granted for any given project, seeing that they all restore the environment and subsequently water quality, or they beneficially quell those adverse water quality affects associated with unnatural flooding. Currently, the Chicago District has about 15 ecosystem restoration projects similar to the projects recommended by this study under construction or being implemented. All of these projects have been granted Section 401 certification or fall under the Regional 401 Program. Each project that requires Section 401 Certification would complete appropriate applications and provided information on a per project basis during the design phase when plan sheets are suitable for review. No project requiring Section 401 Certification would begin construction without the certificate issued.

Endangered Species Act and Fish and Wildlife Coordination Act: Preliminary coordination with the USFWS and plan formulation methodologies have recognized and considered threatened and endangered species from the study's onset. USFWS and State involvement in the project has assured that the preferred plan would be in compliance with Section 7 of the Endangered Species Act. USFWS participated early in the planning process as a cooperating agency and has therefore provided significant input on the plan formulation. However, formulation that has occurred since that time will be formally reviewed and critiqued by the agency through a Fish & Wildlife Coordination Act Report.

Section 106 of the National Historic Preservation Act: Preliminary coordination with the State SHPOs and plan formulation methodologies have recognized and considered archaeological and cultural resources from the study's onset. The preferred plan was not identified to have adverse affects on historic or archaeological resources.

Clean Air Act Conformity Rule: The Clean Air Act (42 U.S.C. §7401 et seq.), as amended in 1977 and 1990 was established to protect and enhance the quality of the nation's air resources to promote public health and welfare and the productive capacity of its population. The Act authorizes the USEPA to establish National Ambient Air Quality Standards to protect public health and the environment. The Act establishes emission standards for stationary sources, volatile organic compound emissions, hazardous air pollutants, and vehicles and other mobile sources. The Act requires the states to develop implementation plans applicable to particular industrial sources. Title IV of the Act includes provisions for complying with noise pollution standards.

The preferred alternative is expected to be in compliance with the Act. Clean Air Act general conformity analysis (Appendix N) suggests that the proposed Upper Des Plaines River and Tributaries project will have minimal impact on air quality in the project area. Mobile source emissions were estimated using USEPA guidance and models, and were found to be de minimis for criteria air pollutants. Based on these findings, the proposed Upper Des Plaines River and Tributaries project Feasibility Study demonstrates conformity.

Farmland Protection Policy Act: Unique and prime farmland was not identified as being part of the preferred plan's project footprint.

Environmental Justice E.O. 12898: Analysis of census and EPA environmental justice data indicates this project will have no adverse affects on minority or low income populations. No low-income agricultural communities are present in the general tri-county study area. Low-income minority populations do exist within the tri-county project area; however none are located along the Des Plaines River or in major flood zone areas; these areas consist of middle-class to upper middle-case suburban residential communities. All ecosystem projects are slated for public property, or property that would be acquired by a non-Federal public entity. The planned ecological restoration and flood management improvements will benefit everyone in the region equally. The preferred plan would not cause adverse human health effects or adverse environmental effects on minority populations or low-income populations.

Executive Order 11988: Floodplain Management: The Recommended Plan complies with and supports this executive order. Under this order, USACE is directed to avoid development in the floodplain, reduce the hazard and risk associated with floods, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values of the floodplain. The FRM components of the Recommended Plan reduce flood hazards in the study area by providing floodwater storage, flood barriers to protect potentially flooded structures, non-structural measures to avoid damages to structures, and other measures that reduce flood impacts to homes and businesses at risk of flooding. The ER components of the Recommended Plan restore natural floodplain structure and function and prevent development by using lands for ecosystem restoration. During the design phase, USACE will ensure that all components of the Recommended Plan continue to comply with this order and all other applicable laws and regulations.

Compliance with EO11988 is demonstrated through an 8-step process that agencies should carry out as part of their decision-making on projects that have potential impacts to or within the floodplain. The eight step process and the District's determination of compliance are listed below:

1. ***Determine if a proposed action is in the base floodplain.*** The proposed action consists of several projects located throughout the watershed. Many of them are either entirely or partly located in the base floodplain. All of the ecosystem restoration sites incorporate actions in the base floodplain. The levees, structure modification, road raise, and non-structural measures are also located in the base floodplain. One reservoir site is in the base floodplain, the other is outside of this area.

2. ***Conduct early public review, including public notice.*** The general public was advised/ informed of the proposed action through public meetings, the distribution of the NEPA document for public review, Public Notice, and the District website. Comments have been reviewed and considered as documented in Appendix L.

3. ***Identify and evaluate practicable alternatives to locating in the base floodplain, including alterative sites outside of the floodplain.*** For projects located in the base floodplain, no practicable alternatives were identified that would locate the action outside of the base floodplain. The purpose of the project is to reduce the risk of flood hazards and to restore the natural floodplain. Because the damages occur in the floodplain, it cannot be accomplished through actions located outside the base floodplain.

4. ***Identify impacts of the proposed action.*** Beneficial economic impacts of the proposed action include reduced flood hazards by providing floodwater storage, constructing flood barriers, and implementing non-structural measures. Beneficial ecological impacts would be the restoration of natural floodplain structure and function and the prevention of future floodplain development at restoration sites and non-structural buyout areas. Any adverse impacts to the existing base flood elevation would be mitigated through design modifications or the construction of compensatory storage. Structural FRM projects are located in a fully developed urban area, therefore the benefits provided by the project are only to existing development. Ecosystem restoration projects would enhance the base floodplain by restoring more natural hydrologic conditions and preventing development at these sites.

5. ***Minimize threats to life and property and to natural and beneficial floodplain values. Restore and preserve natural and beneficial floodplain values.*** The proposed action will reduce the

hazard and risk associated with floods; minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values of the floodplain. Since the structural FRM projects are located in a fully developed area, significant new development is not anticipated behind proposed flood barriers. Non-structural measures will manage flood risk at existing structures without impacting the floodplain and, in the case of buyouts, provide opportunities to restore and preserve natural and beneficial floodplain values. The establishment of restoration sites across the watershed will restore and preserve natural and beneficial floodplain values and further prevent future adverse impacts to the floodplain.

6. ***Reevaluate alternatives.*** The proposed action could not be relocated outside of the base floodplain and still meet the purpose, needs, goals, and objectives of the project.

7. ***Present the findings and a public explanation.*** The public has remained informed throughout the study process in accordance with NEPA. Information was disseminated through public meetings, the distribution of the NEPA document, public notices, and the District website.

8. ***Implement the action.*** The Recommended Plan is the most responsive to the planning objectives established by the study and consistent with this E.O. The proposed project would be in full compliance with EO11988.

Hazardous Wildlife Attractants on or Near Airports: In 2003, the Assistant Secretary of the Army for Civil Works entered into a Memorandum of Agreement (MOA) with the Federal Aviation Administration (FAA) along with Air Force, US Department of Agriculture (USDA), and the US Fish and Wildlife Service (USFWS). The purpose of the MOA is to try to diminish aircraft-wildlife strikes. Under the MOA, the Secretary has agreed to avoid "the establishment of land uses attractive to hazardous wildlife" within 5,000 feet of airports serving piston-powered aircraft and 10,000 feet of airports serving turbine powered aircraft. The definition of "hazardous wildlife" includes geese, crows, hawks, sparrows, ducks, and many other birds species. However, exceptions to these separation zone provisions are considered for "habitats that provide unique ecological functions or values (e.g., critical habitat for federally-listed endangered or threatened species, ground water recharge)."

The proximity of airports was considered in the identification of potential sites where proposed measures would result in a change in land use. Of particular concerns are sites that could result in additional open water areas or that could attract populations of hazardous wildlife. Sites that were within 10,000 feet of local airports were only retained if it was determined that the proposed measures would not increase the attractiveness of the site to hazardous wildlife. Proposed floodwater storage sites within existing airspace operation areas (AOA) were eliminated during formulation. Proposed reservoirs outside the AOA will remain dry and only retain water during and immediately after flood events. Restoration projects within existing AOA were reviewed to determine whether restoration activities would result in an increased hazard.

Two NER Plan elements are located within 10,000 feet of the Chicago Executive Airport; C-09, Northbrook Marsh and C15, Beck Lake Meadow and Floodplain Forest. Both sites are existing natural areas/forest preserves, owned by the Forest Preserve District of Cook County. Restoration will include the protection of habitat for threatened and endangered species and the restoration of scarce and unique sedge meadow habitat. An analysis of the restoration plans in accordance with FAA

Advisory Circular (USDOT/FAA AC No. 150/5200-33B, Hazardous Wildlife Attractants on or near Airports, August 2007) determined that the NER Plan should not be considered an attractive nuisance for high hazard wildlife for airports within the study area. Coordination with FAA, as per the MOA is underway.

Wetland Mitigation Bank Regulations: Two historic wetland mitigation banks are within the boundaries of the ecosystem restoration area under the NER plan. The NER plan does not violate any regulations pertaining to wetland mitigation banks, since compatible uses, such as enhancing the quality of the wetland, are allowed. See 33 C.F.R. § 332.7(a)(2). In addition, these historic wetland mitigation banks are not actively generating credits and no longer require active monitoring. Thus, ecosystem restoration enhancing these mitigation banks does not conflict with the prohibitions against use of federal funds to generate mitigation bank credits, 33 C.F.R. § 332.3(j)(2). USACE has engaged in preliminary coordination with the Interagency Review Team (IRT) with regard to the NER plan. The IRT consists of USACE, USEPA and USFWS. Although USACE is the lead agency on review and authorization of mitigation banking instruments, USACE utilizes the IRT to coordinate with USEPA and USFWS on review and decision-making regarding mitigation banks. Based on preliminary coordination, the IRT does not object to the NER plan, and the IRT will review and approve the final plan to ensure that there is no conflict with the mitigation bank requirements. At a minimum, the NER plan shall maintain at least the same number of quality wetland acres already existing within the bank to ensure no net loss of wetland acres previously used to offset impacts to waters of the US.

Cumulative Effects: Based on the expectation of continued sustainability of all resources, and the magnitude of the watershed circumstances, cumulative effects are not considered significant or adverse.

Public Interest: Public scoping meetings were held in 2002 in which public comment was sought on what the study scope should include. This information was utilized in the formulation of a preferred plan. This preferred plan was presented to the public and comments and concerns identified by the public through letters, e-mails, and orally during public meetings have been addressed.

9.7 Conclusion

In accordance with the NEPA of 1969 and Section 122 of the River and Harbor and Flood Control Act of 1970, the U.S. Army Corps of Engineers (Chicago District) has assessed the environmental impacts associated with this project. The purpose of this EA is to evaluate the impacts that would be associated with the preferred plan.

The assessment process indicates that this project would not cause significant effects on the quality of the human environment in the areas of construction and have only beneficial impacts upon the ecological, biological, social, cultural, or physical resources of the Upper Des Plaines River watershed as a whole. The findings indicate that that the proposed action is not a major Federal action significantly affecting the quality of the human environment.

10 Combined Plans

The projects in the combined plans are distributed throughout the watershed. A summary of the combined plan elements is presented below. Plate 42 shows the location of the FRM and ER sites within the study area.

10.1 Description of Combined Plans

The study area includes two states, four counties, and numerous municipalities. Table 10.1 presents a summary of the plan elements. Each element is described below, grouped by county and listed in order from upstream to downstream within the watershed. Plate 42 shows the location of each site. The individual sites within each plan are shown on Plate 16 through Plate 22 and Plate 29 through Plate 40.

This report presents three plans: a "NED/NER Plan" which includes all policy compliant, economically justified, environmentally acceptable separable projects of such scope that they could not reasonable be implemented under the CAP; a "CAP Plan" which includes all policy compliant, economically justified, environmentally acceptable separable projects of such scope that they could reasonable be implemented under CAP; and a "Comprehensive Plan" which includes all economically justified, environmentally acceptable separable projects evaluated during the course of the study;.

Combined NED/NER Plan: The projects in this plan, designated as "NED/NER" in Table 10.1, include a structural FRM system consisting of three levee/floodwalls and two floodwater storage reservoirs providing compensatory storage and additional flood risk management benefits as well as non-structural measures to be implemented in two counties (Lake and Cook) and seven ER projects throughout the watershed where aquatic ecosystems will be restored to more natural conditions. The *Combined NED/NER Plan* is recommended for Congressional authorization.

CAP Plan: The policy compliant projects that could reasonably be implemented under CAP are designated as "CAP" in Table 10.1. This program allows USACE to plan, design, and construct smaller projects using delegated program authorities provided by Congress. Small FRM projects with a Federal cost under $7 million are authorized by Section 205 of the Flood Control Act of 1948, as amended. Small Ecosystem Restoration projects with a Federal cost under $5 million are authorized by Section 206 of the WRDA of 1996, as amended. Individual projects within the *CAP Plan* are recommended for implementation by USACE under these existing authorities. There are 6 projects in the *CAP Plan*. The projects in this plan include one FRM project consisting of a levee/floodwall and five ER projects consisting of dam removals along the Des Plaines River. Projects included in the *CAP Plan* will be converted to this program upon approval by the Division Engineer.

Comprehensive Plan: The Comprehensive Plan is the most inclusive plan. The Comprehensive Plan projects include projects for which USACE will seek congressional authorization for implementation, projects that will be implemented under CAP, and projects that are not compliant with current USACE policy and will therefore be recommended for implementation by the appropriate state and local agencies. All of the sites shown in Table 10.1 would be included in the Comprehensive Plan. Projects that are only included in the Comprehensive Plan are designated as "Comprehensive" in the table. The additional projects in this plan include the First Avenue Bridge Modification (DPBM04), Lake Mary Anne Pump Station (FPCI01), and economically justified non-structural projects that are in portions of tributaries not meeting the minimum flow criteria.

Table 10.1 – Summary of Projects included in Combined Plans

County	ID	Site Name	Purpose	Plan	Measure	Municipality
Kenosha	K47	Bristol Marsh	ER	NED/NER	Restoration, Rural Alternative 9	Bristol
	K41	Dutch Gap Forested Floodplain	ER	NED/NER	Restoration, Rural Alternative 6	Bristol
		Kenosha County Non-structural (Comp Plan)[1]	FRM	Comprehensive	Elevation, Floodproofing, Buyouts	Salem, Somers
Lake	L43	Red Wing Slough & Deer Lake Wetland Complex	ER	NED/NER	Restoration, Rural Alternative 2	Antioch
	L39	Pollack Lake &Hastings Creek Riparian Wetlands	ER	NED/NER	Restoration, Rural Alternative 6	Antioch
	L31	Gurnee Woods Riparian Wetland	ER	NED/NER	Restoration, Rural Alternative 4	Wadsworth
		Lake County Non-structural	FRM	NED/NER	Elevation, Floodproofing, Nonstructural berms, Buyouts	Gurnee , Riverwoods, Long Grove, Lincolnshire, Vernon Township
Cook	C09	Northbrook Floodplain and Riparian Complex	ER	NED/NER	Restoration, Urban Alternative 8	Wheeling
	--	Dam #1 Removal	ER	CAP	Dam Removal	Wheeling
	--	Dam #2 Removal	ER	CAP	Dam Removal	Des Plaines
	C15	Beck Lake Meadow and Floodplain Forest	ER	NED/NER	Restoration, Urban Alternative 8	Des Plaines/Glenview
	--	Dempster Ave Dam Removal	ER	CAP	Dam Removal	Des Plaines
	FPCI01	Lake Mary Anne Pump Station[1]	FRM	Comprehensive	Structure Modification	Des Plaines
	WLRS04	Harry Semrow Driving Range Reservoir	FRM	NED/NER	Floodwater Storage Reservoir	Des Plaines
	DPLV09	Touhy-Miner Levee	FRM	NED/NER	Levee/Floodwall	Des Plaines
	--	Touhy Ave Dam Removal	ER	CAP	Dam Removal	Park Ridge
	--	Dam #4 Removal	ER	CAP	Dam Removal	Park Ridge
	DPLV05	Belmont-Irving Park Levee	FRM	NED/NER	Levee/Floodwall	Schiller Park
	DPLV04	Fullerton-Grand Levee	FRM	NED/NER	Levee/Floodwall	River Grove
	DPRS04	Fullerton Woods Reservoir	FRM	NED/NER	Floodwater Storage Reservoir	River Grove
	DPBM04	First Ave Bridge Modification[1]	FRM	Comprehensive	Bridge Modification	River Grove
	DPLV01	Groveland Ave Levee	FRM	CAP	Levee/Floodwall	Riverside
	--	Cook County Non-structural	FRM	NED/NER	Elevation, Floodproofing, Nonstructural berms, Buyouts	Des Plaines, Rosemont, Wheeling, Wheeling Township
	--	Cook County Non-structural (Comp Plan)[1]	FRM	Comprehensive		Buffalo Grove, Leyden Township, Wheeling

[1]Road Raises formulated to solely address transportation damages, such as DPBM04, and projects that accrue benefits in portions of watersheds where 10% ACE flows are less than 800 cfs, such as FPCI01 and some non-structural measures, are non-policy compliant. These projects would be implemented by the appropriate non-Federal agency and would not be cost-shared with USACE.

10.1.1 Kenosha County, Wisconsin

Bristol Marsh (NER K47 Rural Alternative 9), Bristol (Plate 30)

Bristol Marsh would restore native plant communities of open water, marsh, wet prairie, mesic and dry prairie, wet and dry oak savanna, wet forest, flat woods and open woodland. Once agricultural practices cease, the hydrology, geomorphology would be naturalized. This allows for the restoration and establishment of native plant and animal species over the 1,619 acre site.

Hydrology and hydraulics would be repaired through the disablement of the drain tile system, filling of unnatural waterways, manipulation of geomorphic conditions, and native plant community establishment. Drain tile valves would be strategically placed across the 1,619 acre site. The purpose for this during the PED phase is to determine if there would be off-site impacts and to improve the understanding where plant communities would reside on the landscape. Once the boundary conditions are acceptable for the resurged hydrology, the valves would be grouted with bentonite to ensure they could not be opened again. The resulting condition is that the drain tiles would fill with soil over time and, due to hydrostatic pressure build-up, collapse on themselves.

The main waterway that is conduit for water through the site is Dutch Gap Canal (9,400-feet). To return this segment back into its naturally marsh-like flow conditions, banks would be removed to allow water flowing into the site to be spread out and re-form the flowage. Banks would be graded out and ditch plugs placed at points in the channel to disable draining effects the ditch may have once its banks removed. About 2,500-feet of waterway would be excavated to drain several depressions, which would be filled in before the drain tile system is disabled. Further, about 251 acres of trees would be removed and about 253 acres of woodland would be established to help resurge hydrology since trees significantly drain the water table.

Various activities would repair geomorphology to the wetland flowage and surrounding riparian landforms, including drain tile disablement, ditch disablement, other minor grading, and native vegetation reestablishment. Native vegetation would be restored through repairing hydrology and geomorphology, removing invasive and non-native species, and sowing native seed and live plugs.

To remove soil compaction, light disking could be implemented or other methods such as alfalfa cropping to botanically break up the soils and remove nutrients at the same time. There may be a need to add organic carbon to soils in order to establish former plant communities. This would be accomplished through the use of organic leaf litter compost as a soil amendment. Another alternative for soil amendments could be pine sawdust if soils are overly nitrified. The sawdust would activate bacteria whose metabolic processes begin to denitrify the soils.

Due to the dramatic drying out of the former wetland communities, weedy tree species have taken over about 251 acres and would be removed. Woodland communities have also been impaired by hydrologic regime shifts and have become riddled with invasive tree, shrub, and herbaceous plant species. About 253 acres of woodland community would be thinned and cleared of these noxious species. About 150 acres of oldfield and old wetland patches would need herbaceous management to rid them of weeds. All other acres of plant communities would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for the site would be to keep invasive plant species from recolonizing. Once the site becomes more robust with native plant diversity and densities, the upkeep on invasive plant species recolonization should decline. Considerations for the stream would focus on entry and exit from the site. Keyed in stone riffles would be used to ensure the stream exits the site through the existing road bridge culvert properly. Occasional adjustment or replenishment of these stones may be required.

Costs associated with this project are identified in Table 10.2 at the end of this section.

Dutch Gap Forested Floodplain (NER K41 Rural Alternative 6), Pikesville (Plate 29)

Dutch Gap Forested Floodplain would restore native plant communities of marsh, wet prairie, mesic and dry prairie, wet and dry oak savanna, wet forest, flat woods and open woodland. Once agricultural practices cease, the hydrology, geomorphology would be naturalized. This would allow for the restoration and establishment of native plant and animal species over the 689 acre site.

Hydrology and hydraulics would be restored by placing drain tile valves over the 689 acre site. The purpose and methods are the same as those described for Site K47. The main waterway that is conduit for water through the site is Dutch Gap Canal (5,500-feet). To return this segment to a naturally functioning stream, the water would be put back in motion over the landscape. The site has sufficient space within a defined stream valley to confine the meandering stream within the site boundaries. The ditch banks would be graded to a slope of 20:1 and cobble riffles would be placed at various points within the channel. A 3,000-foot segment of small tributary flowing into the creek would also be restored, utilizing the same methods. To further resurge hydrology, about 251 acres of trees would be removed and about 253 acres of woodland would be thinned to allow surface water wetlands to resurge.

The geomorphology of the site was modified from its natural condition to support agricultural use of land. To restore the site to wetland basins, stream channel, and active floodplain, various activities including drain tile disablement, ditch filling or plugging, bank grading, riffle placement, minor grading and native vegetation reestablishment would be implemented as described under Site K47.

Native vegetation would be restored through repairing hydrology and geomorphology, removing invasive/non-native species and sowing native seed and live plugs. To remove soil compaction, light disking could be implemented or other methods such as alfalfa cropping to botanically break up the soils and remove nutrients at the same time. There may be a need to add organic carbon to soils in order to establish former plant communities. This would be accomplished through the use of organic leaf litter compost as a soil amendment. Another alternative for soil amendments could be pine sawdust if soils are overly nitrified. The sawdust would activate bacteria whose metabolic processes begin to denitrify the soils.

Trees would be removed from about 23 acres to remove old farm field windbreaks. About 48 acres of oldfield would be managed to remove herbaceous invasive species. All other acres of plant community would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period the site would be to keep invasive plant species from recolonizing. Once the site becomes robust with native plant diversity and densities, the upkeep on invasive plant species recolonization should decline. Maintenance activities for the stream would focus on the stream's entry and exit of the site. Keyed in stone riffles would be used to ensure the stream exits the site through the existing road bridge culvert properly. Occasional adjustment or replenishment of these stones may be required.

Costs associated with this project are identified in Table 10.2.

Kenosha County Non-structural (Comprehensive)

The incrementally justified non-structural component of the FRM plan in Kenosha county would protect homes and businesses through a variety of measures. The non-structural measures would be implemented at structures at risk of flooding in Salem and Somers. The measure implemented at each site would be determined according to the feasibility and cost-effeetiveness of implementation determined through a site specific evaluation of the structure. Implementation of non-structural measures at individual properties will be voluntary and dependant on verification of structure characteristics and first floor elevations.

The measures considered for implementation include:

- Elevation – the usable area raised above flood elevations
- Dry floodproofing – modifications prevent floodwaters from entering the structure
- Wet floodproofing – modifications to allow floodwaters to flow through the structure
- Fill/Removal of basement in combination with floodproofing – any utilities located in basements would be relocated to a new addition elevated above flood elevations and the basement would be filled and removed from use. Any flood damages above the first floor elevation would be addressed through floodproofing.
- Nonstructural berm – a low berm or floodwall encircling a structure or group of structures preventing flood damage
- Buyouts – removal of the structure from the floodplain was considered for structures where no other measures were feasible and significant damages occur during the 1% annual change of exceedance flood event

The identified non-structural measures in Kenosha county are all along portions of streams that do not meet the minimum flow criteria for USACE participation in FRM measures (800 cfs during the 10% annual change of exceedance flood event). These measures are therefore recommended for implementation by local FRM authorities as part of the Comprehensive Plan.

Costs associated with the non-structural measures are identified in Table 10.2.

Table 10.2 – Kenosha County Estimated Costs ($1,000)

ID	Plan	Prelim LERRDs[1]	Construction	PED	Construction Mgmt [2]	Total First Costs	Annual OMRR&R
K47	NED/NER	$20,358	$19,617	$1,964	$1,173	$43,113	$117
K41	NED/NER	$9,014	$8,498	$852	$515	$18,880	$59
Non-Structural	Comprehensive	$1,093	$80	$11	$5	$1,189	Nominal
Total Kenosha County Comprehensive Plan		$30,466	$28,196	$2,828	$1,693	$63,182	$176
Total Kenosha County NED/NER Plan		$29,372	$28,116	$2,817	$1,689	$61,994	$176

[1] Includes Lands & Damages and Relocations
[2] Includes Construction Management, Monitoring, and Adaptive Management

(FY2015 Price Level)

10.1.2 Lake County, Illinois

Red Wing Slough and Deer Lake Wetland Complex, Antioch (NER L43 Rural Alternative 2) (Plate 31)

Red Wing Slough and Deer Lake Wetland Complex would restore native plant communities of lake, marsh, wet meadow, wet prairie, mesic and dry savanna, wet forest, flat woods and open woodland. Once agricultural practices cease, the hydrology, geomorphology would be naturalized. This would allow for the restoration and establishment of native plant and animal species over the 1,601 acre site.

Hydrology and hydraulics would be restored by placing drain tile valves at locations across 892 acres of the 1,601 acre site; the remaining acres are open water. The purpose and methods are the same as those described for Site K47. This restoration site does not have a typical stream flowing through it; however, the Red Wing Slough and Deer Lake wetlands form a huge sluggish flowage that eventually discharges into North Mill Creek. A 1,000-foot segment of stream drains Deer Lake and other flowage wetlands; however, drain tile disablement and vegetation restoration would drown the stream allow marsh communities would take over. Aside from identifying and disabling any present drain tiles, hydrology would be restored and naturalized through the removal of invasive and non-native trees. About 69 acres of trees would be removed from wetlands and wind breaks. In addition, 34 acres of woodland would have non-native trees removed, furthering hydrologic resurgence since trees have a significant impact on draining down the water table.

The topography and geomorphology of the site is largely intact. Repair to the geomorphology of floodplain forest complex would be needed, This repair would be accomplished through various activities including drain tile disablement, tree removal, minor grading and native vegetation reestablishment.

Native vegetation would be restored by repairing hydrology and geomorphology, removing invasive/non-native species, and sowing native seed and live plugs. To remove soil compaction, light disking could be implemented or other methods such as alfalfa cropping to botanically break up the soils and remove nutrients at the same time. There may be a need to add organic carbon to soils in order to establish former plant communities. This would be accomplished through the use of organic leaf litter compost as a soil amendment. Another alternative for soil amendments could be pine sawdust if soils are overly nitrified. The sawdust would activate bacteria whose metabolic processes begin to denitrify the soils.

Trees would be removed from about 69 acres to restore wet meadows and flat woods. Non-native trees and shrubs would be removed from about 34 acres of woodland and flat woods. To restore oldfield, 252 acres would need herbaceous management. All other acres of plant community would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for the site would be to keep invasive plant, tree, and shrub species from recolonizing. Once the site becomes robust with native plant diversity and densities, the upkeep on invasive plant species recolonization should decline.

Costs associated with this project are identified in Table 10.3 at the end of this section.

Pollack Lake and Hastings Creek Riparian Wetlands, Antioch (NER L39 Rural Alternative 6) (Plate 32)

Pollack Lake and Hastings Creek Riparian Wetlands would restore native plant communities of lake, marsh, wet meadow, wet prairie, wet prairie, mesic and dry prairie, and open woodland. Once agricultural practices cease, the hydrology, geomorphology would be naturalized. This would allow for the restoration and establishment of native plant and animal species over the 429 acre site.

The hydrology would be restored by placing drain tile valves at locations across the site. The purpose and methods are the same as those described for Site K47. There are two small tributaries that flow through the site: a 3,000 foot prairie swale that drains Pollack Lake into Mill Creek and a 3,600 foot segment of Hastings Creek which has been channelized. Drain tile disablement and vegetation restoration would repair the hydrologic conditions of the prairie swale and no action would be recommended. To restore the segment of Hastings Creek, water would be set back in motion over the landscape. The ditch banks would be graded to a slope of 20:1. Cobble riffles would be placed at various points within the channel to engage the meandering process. If certain portions of the ditch are extremely incised, higher riffle crests may be necessary. Hydraulic modeling of the site would ensure riffles would not cause water to back up into neighboring parcels. The riffle stone would consist of natural glacial or fluvial stone.

Topography and geomorphology of the site has been modified from its natural condition to support agricultural use of the land. The hydrologic restoration activities would also repair the geomorphology to wetland basins, stream channel and active floodplain. These include drain tile disablement, ditch filling or plugging, bank grading, and riffle placement. Further geomorphic and soils repair would occur over time.

Native vegetation would be restored by repairing hydrology and geomorphology, removing invasive/non-native species, and sowing native seed and live plugs. To remove soil compaction, disking could be implemented or other methods such as alfalfa cropping could be used to both botanically break up the soils and remove nutrients. There may be a need to add organic carbon to the soils in order to establish former plant communities. This would be accomplished through the use of organic leaf litter compost as a soil amendment. Another alternative for soil amendments could be pine sawdust if soils are overly nitrified. The sawdust would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

The main activity during the operations and maintenance period for the site would be to keep invasive plant species from recolonizing. Once the site becomes robust with native plant diversity and densities, the upkeep on invasive plant species management should decline. Maintenance activities for the stream should be minimal since the stream is already naturally meandering. Stream maintenance would focus on entry and exit from the site. Keyed in stone riffles would be used to ensure the stream exits the site through the existing road bridge culvert properly. Occasional adjustment or replenishment of these stones may be required.

Costs associated with this project are identified in Table 10.3 at the end of this section.

Gurnee Woods Riparian Wetlands (NER L31 Rural Alternative 4), Wadsworth (Plate 33)

Gurnee Woods Riparian Wetlands would restore native plant communities of open water, marsh, wet meadow, wet prairie, mesic and dry prairie, mesic and dry oak savanna, floodplain and wet forest, and open woodland. Once agricultural practices cease, the hydrology and geomorphology would be naturalized, allowing for restoration and establishment of native plant and animal species over the 698 acre site.

The hydrology would be restored by placing drain tile valves at locations across the site. The purpose and methods are the same as those described for Site K47. The main conduit for water through the site is the Des Plaines River (21,500-feet). This once marshy floodplain has been invaded by invasive trees due to the presence of drain tile systems across the site. Colonization by trees has further dried out the floodplain through evapotranspiration; therefore, the trees would be removed first, followed by drain tile disablement. These actions would allow hydrology to resurge within the floodplain and further resurge hydrology to the stream.

The topography and geomorphology of the site has been modified from its natural condition support agricultural use of the land. To repair geomorphology to the wetland floodplain and stream channel, various activities including drain tile disablement, minor grading, tree removal and native vegetation reestablishment would be implemented as described under Site K47.

Native vegetation would be restored by repairing hydrology and geomorphology, removing invasive/non-native species, and sowing native seed and live plugs. To remove soil compaction, disking could be implemented or other methods such as alfalfa cropping could be used to both botanically break up the soils and remove nutrients. There may be a need to add organic carbon to the soils in order to establish former plant communities. This would be accomplished through the use of organic leaf litter compost as a soil amendment. Another alternative for soil amendments could be pine sawdust if soils are overly nitrified. The sawdust would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

Trees would be removed over approximately 15 acres of former marshy areas. Invasive trees, shrubs, and herbaceous species would be thinned over approximately 516 acres of marsh and woodland. About 203 acres of oldfield would need herbaceous management, which could include herbicide application, controlled burns, or mowing. All other acres of plant community would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for the site would be to prevent recolonization of invasive plant species. Once the site becomes robust with native plant diversity and densities, the upkeep on invasive plant species management should decline.

Costs associated with this project are identified in Table 10.3 at the end of this section.

Lake County Non-structural (NED)

The incrementally justified non-structural component of the FRM plan in Lake County would protect homes and businesses through a variety of measures. The non-structural measures would be implemented at structures at risk of flooding in the communities of Gurnee, Lincolnshire, Long Grove, Riverwoods, and Unincorporated Vernon Township. The measure implemented at each site will be determined according to the feasibility and cost-effectiveness of implementation determined through a site specific evaluation of the structure. Implementation of non-structural measures at individual properties will be voluntary and dependant on verification of structure characteristics and first floor elevations. With regard to the buyouts, to the extent practicable, acquisition would be on a willing seller basis, but eminent domain could be utilized when determined to be warranted.

The measures considered for implementation include:

- Elevation – the usable area raised above flood elevations
- Dry floodproofing – modifications prevent floodwaters from entering the structure
- Wet floodproofing – modifications to allow floodwaters to flow through the structure
- Fill/Removal of basement in combination with floodproofing – any utilities located in basements would be relocated to a new addition elevated above flood elevations and the basement would be filled and removed from use. Any flood damages above the first floor elevation would be addressed through floodproofing.
- Nonstructural berm – a low berm or floodwall encircling a structure or group of structures preventing flood damage
- Buyouts – removal of the structure from the floodplain was considered for structures where no other measures were feasible and significant damages occur during the 1% annual chance of exceedance flood event

Costs associated with the non-structural measures are identified in Table 10.3.

Table 10.3 – Lake County Estimated Costs ($1,000)

ID	Plan	Prelim LERRDs[1]	Construction	PED	Construction Mgmt [2]	Total First Costs	Annual OMRR&R
L43	NED/NER	$12,183	$15,550	$1,557	$928	$30,217	$70
L39	NED/NER	$3,213	$6,210	$623	$375	$10,422	$20
L31	NED/NER	$5,123	$11,009	$1,102	$668	$17,901	$28
Non-Structural	NED/NER	$5,497	$8,202	$1,238	$577	$15,514	Nominal
Total Lake County NED/NER Plan		$26,015	$40,971	$4,520	$2,548	$74,055	$118

[1] Includes Lands & Damages and Relocations
[2] Includes Construction Management, Monitoring, and Adaptive Management

(FY2015 Price Level)

10.1.3 Cook County, Illinois

Northbrook Floodplain & Riparian Complex (NER C09 Urban Alternative 8), Wheeling (Plate 35)

Northbrook Floodplain and Riparian Complex would restore native plant communities of marsh, wet meadow, wet prairie, mesic and dry prairie, wet oak savannah, mesic and dry oak savannah, wet forest, flat woods, and open woodland. The hydrology and geomorphology would be natnralized, allowing for restoration and establishment of native plant and animal species over the 811 acre site.

The hydrology would be restored by placing drain tile valves at locations across the site. The purpose and methods are the same as those described for Site K47. This restoration site is in the floodplain and immediate riparian zone for the Des Plaines River. Once the hydrology is repaired, wetland swales would flow directly into the Des Plaines River. Aside from identifying and disabling any present drain tiles, hydrology would be restored and naturalized through the removal of invasive and non-native trees. About 479 acres of trees would be removed from prairie, wet sedge meadow, and marsh plots. In addition, non-native trees would be removed over 330 acres of woodland, furthering hydrologic resurgence. Trees have a significant impact on draining down the water table.

Topography and geomorphology of the site is for the most part intact. To repair the geomorphology of this floodplain complex, various activities would be implemented including drain tile disablement, tree removal, minor grading, and native vegetation reestablishment.

Native vegetation would be restored through repairing hydrology and geomorphology, removing invasive and non-native species, and sowing native seed and live plugs. To remove soil compaction, disking could be implemented or other methods such as alfalfa cropping could be used to both botanically break up the soils and remove nutrients. There may be a need to add organic carbon to the soils in order to establish former plant communities. This would be accomplished through the use of organic leaf litter compost as a soil amendment. Another alternative for soil amendments could be pine sawdust if soils are overly nitrified. The sawdust would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

Trees would be removed from about 88 acres to restore wet meadows and flat woods. Non-native trees and shrubs would be removed over about 330 acres of woodland and savanna. All other acres of plant community would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for site C09 would be to keep invasive plant species from recolonizing. Once the site becomes robust with native plant diversity and densities, the upkeep on invasive plant species management should decline.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Dam #1 Removal, (CAP) Wheeling (Plate 36)

This two foot high run-of-the-river dam would be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation would restore the habitat to a more natural condition.

Historical data indicates that the dam is made of reinforced concrete. Based on completed removals of similar dams along the Des Plaines River, it is expected that the dam will be demolished in-the-wet by driving excavators into the river to perform the work without the use of a coffer dam or water diversion structure.

Clearing and grubbing would be performed only in areas necessary to build temporary access road and staging areas need to access the dams and store construction equipment. The access roads and staging acres will be constructed with stone. Once construction is complete, all gravel will be removed from temporary access roads and the site will be returned to its original contours and revegetated and reforested appropriately.

Costs associated with this site are identified in Table 10.4 at the end of this section.

Dam #2 Removal (CAP), Des Plaines (Plate 37)

This two foot high run-of-the-river dam would be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation would restore the habitat to a more natural condition.

Historical data indicates that the dam is made of reinforced concrete. Based on completed removals of similar dams along the Des Plaines River, it is expected that the dam will be demolished in-the-wet by driving excavators into the river to perform the work without the use of a coffer dam or water diversion structure.

Clearing and grubbing would be performed only in areas necessary to build temporary access road and staging areas need to access the dams and store construction equipment. The access roads and staging acres will be constructed with stone. Once construction is complete, all gravel will be removed from temporary access roads and the site will be returned to its original contours and revegetated and reforested appropriately.

Costs associated with this site are identified in Table 10.4 at the end of this section.

Beck Lake Meadow & Floodplain Forest (NER C15 Urban Alt. 8), Des Plaines & Glenview (Plate 34)

Beck Lake Meadow and Floodplain Forest would restore native plant communities of marsh, wet meadow, wet prairie, mesic and dry prairie, wet oak savannah, mesic and dry oak savannah, wet forest, flat woods and open woodland. The hydrology and geomorphology would be naturalized, allowing for restoration and establishment of native plant and animal species over the 1,007 acre site.

The hydrology would be restored by placing drain tile valves at locations across the site. The purpose and methods are the same as those described for Site K47. This restoration site is the floodplain and immediate riparian zone for the Des Plaines River. Once the hydrology is repaired, wetland swales and woodland hollows would flow directly into the Des Plaines River. In addition to identifying and disabling any drain tiles on the site, hydrology would be restored through the removal of invasive and non-native trees. About 479 acres of trees would be removed from prairie, wet sedge meadow, and marsh plots. In addition, non-native trees would be removed from about 330 acres of woodland, furthering hydrologic resurgence, since trees have an impact on draining down the water table.

Topography and geomorphology of the site is for the most part intact. To repair geomorphology to this floodplain complex, various activities would be implemented including drain tile disablement, tree removal, minor grading, and native vegetation reestablishment.

Native vegetation would be restored by repairing hydrology and geomorphology, removing invasive/non-native species, and sowing native seed and live plugs. To remove soil compaction, disking could be implemented or other methods such as alfalfa cropping could be used to both botanically break up the soils and remove nutrients. There may be a need to add organic carbon to the soils in order to establish former plant communities. This would be accomplished through the use of organic leaf litter compost as a soil amendment. Another alternative for soil amendments could be pine sawdust if soils are overly nitrified. The sawdust would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

Non-native tree, shrub, and herbaceous species would be removed over about 396 acres of forest, woodland, and savanna. All other plant communities would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for the site would be to keep invasive plant species from recolonizing, especially during the early stages of site recovery. Once the site becomes more robust with native plant diversity and densities, the upkeep on invasive plant species management should decline.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Dempster Ave Dam Removal (CAP), Des Plaines (Plate 38)

This two foot high run-of-the-river dam would be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation would restore the habitat to a more natural condition.

Historical data indicates that the dam is made of reinforced concrete. Based on completed removals of similar dams along the Des Plaines River, it is expected that the dam will be demolished in-the-wet by driving excavators into the river to perform the work without the use of a coffer dam or water diversion structure.

Clearing and grubbing would be performed only in areas necessary to build temporary access road and staging areas need to access the dams and store construction equipment. The access roads and staging acres will be constructed with stone. Once construction is complete, all gravel will be removed from temporary access roads and the site will be returned to its original contours and revegetated and reforested appropriately.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Lake Mary Anne Pump Station (Comprehensive FPCI01), Maine Township (Plate 21)

Lake Mary Anne Pump Station would link existing storage at Lake Mary Anne and Dude Ranch Pond along the Farmer-Prairie Creek tributary to the mainstem. The pump station and a connector pipe routed under Golf Road would maximize storage capacity and lower flood stages downstream. The pump station would discharge into a pipe routed under Golf Road to Dude Ranch Pond. Additionally, discharge from two existing pumps would be directed to the Dude Ranch Pond through a pipe in the existing right overbank between the pond and the creek.

Two existing outlet pipes collect runoff from the adjacent Interstate 294 and direct flows to Lake Mary Anne. Implementation would include disconnection of these outlets and runoff from the toll way would no longer drain to Lake Mary Anne.

Operations and Maintenance activities at the pump station would include annual inspections and maintenance and removal of any accumulated debris. The pumps would be reconditioned and rehabilitated as needed, approximately every 20 years. The pump station would have a 50 year life expectancy and may require replacement after that time. Gate structures would be inspected annually and repaired or replaced as needed, approximately every 20 years.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Harry Semrow Driving Range Reservoir (NED WLRS04), Des Plaines (Plate 18)

The Harry Semrow Driving Range Reservoir would provide approximately 200 acre-feet of storage. Although the site is located in the Weller Creek Tributary watershed, the site would be connected to the mainstem Des Plaines River through a ditch extending east from the site. The reservoir, along with the Fullerton Woods Reservoir, would reduce stages on the mainstem, preventing increased flood stages that would otherwise be caused by Touhy-Miner Levee, Belmont-Irving Park Levee, and Fullerton-Grand Levee. The 22 acre site, located at Golf Road and Rand Road, is currently the Harry Semrow Driving Range. The reservoir design would allow for continued use of the Driving Range.

The reservoir would be excavated to a depth of 10 feet below grade and a berm would be constructed around the perimeter with a top elevation of 652 feet NAVD88, to establish a total depth of 20 feet. The berm would be constructed from impervious material excavated for the reservoir, covered with six inches of topsoil, and seeded. The reservoir would be considered a Class III dam in accordance with IDNR regulations (17 IAC 3702), having a capacity more than 50 acre feet with a height greater than 6 feet. Appropriate permits and reporting would be obtained for construction and operations.

Stormwater would be pumped into the reservoir from the Des Plaines River from a intake ditch extending east from the site. After an event, stored water would be discharged through the same ditch by gravity.

Recreation facilities associated with the Driving Range that are impacted by project implementation would be incorporated in the site design and replaced, allowing for a return to use at the end of construction.

Operations and maintenance activities at the reservoir would include annual inspections and control of vegetation through moving, trimming of trees and brush, and removal of any accumulated debris. As needed, the berm would be filled or repaired. The inlet pump station would be regularly inspected and maintained, with reconditioning and rehabilitation as needed, approximately every 20 years. The pump station would have a 50 year life expectancy and may require replacement at that time. Gate structures would be inspected annually and repaired or replaced as needed, approximately every 20 years.

Costs associated with this projeet are identified in Table 10.4 at the end of this section.

Touhy-Miner Levee (NED DPLV09), Des Plaines (Plate 19)

This 11,200 foot levee and floodwall would protect homes and businesses along the mainstem between Touhy Avenue and Miner Street in the City of Des Plaines. The crest elevation would be two feet above the 1% annual change of exceedance flood elevation. The probability that this levee would not be overtopped during 1% annual chance of exceedanee flood event would be greater than 95%. The eommunity may request the Corps to apply to FEMA for accreditation of the levees under the National Flood Insurance Program (NFIP) at the completion of construction. Increased flood stages and damages induced by the levee and floodwall would be mitigated by construction of the Harry Semrow Driving Range Reservoir and Fullerton Woods Reservoir.

The levee/floodwall would extend from Touhy Avenue to Miner Street along the west side of the Des Plaines River. The total length of levee and floodwall would be approximately 3,300 and 7,900 feet, respectively. The earthen levee would have a crest width of 10 feet. The crest of the levee and top of the floodwall range from 633.3 feet NAVD88 at the downstream end (Touhy Avenue) to 634.8 feet NAVD88 at the upstream end (Dempster Avenue). The project would also include two road closure structures where the line of protection crosses Oakton Street and Algonquin Road.

Asphalt trail along the levee alignment from Algonquin Road to Oakton Street would be built to provide recreation opportunities for area residents. The trail would connect to the existing Des Plaines River trail system on the east side of the river.

The levee and floodwall alignment would be inspected annually. Annual maintenance activities at levee segments would include landscaping, control of vegetation, fill and/or repair as needed, control of vermin that could comprise the structure. Toe drains will be inspected regularly and flushed as needed. Annual maintenance activities at floodwall segments would include cleaning and treating the structure with repairs to waterstops, cracks, railings, and walkways as needed. Road closure structures would be inspected annually and periodic maintenance would include painting, cleaning, and repairs.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Touhy Ave Dam Removal (CAP), Park Ridge (Plate 39)

This two foot high run-of-the-river dam would be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation would restore the habitat to a more natural condition.

Historical data indicates that the dam is made of reinforced concrete. Based on completed removals of similar dams along the Des Plaines River, it is expected that the dam will be demolished in-the-wet by driving excavators into the river to perform the work without the use of a coffer dam or water diversion structure.

Clearing and grubbing would be performed only in areas necessary to build temporary access road and staging areas need to access the dams and store construction equipment. The access roads and staging acres will be constructed with stone. Once construction is complete, all gravel will be removed from temporary access roads and the site will be returned to its original contours and revegetated and reforested appropriately.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Dam #4 Removal (CAP), Park Ridge (Plate 40)

This two foot high run-of-the-river dam would be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation would restore the habitat to a more natural condition.

Historical data indicates that the dam is made of reinforced concrete. Based on completed removals of similar dams along the Des Plaines River, it is expected that the dam will be demolished in-the-wet by driving excavators into the river to perform the work without the use of a coffer dam or water diversion structure.

Clearing and grubbing would be performed only in areas necessary to build temporary access road and staging areas need to access the dams and store construction equipment. The access roads and staging acres will be constructed with stone. Once construction is complete, all gravel will be removed from temporary access roads and the site will be returned to its original contours and revegetated and reforested appropriately.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Belmont-Irving Park Levee (NED DPLV05), Schiller Park (Plate 20)

This 8,400 foot levee and floodwall would protect homes and businesses along the mainstem Des Plaines River in the city of Schiller Park. The crest elevation would be two feet above the 1% annual chance of exceedance flood elevation. The probability that this levee would not be overtopped during the 1% annual chance of exceedance flood event will be greater than 95%. The community may request the Corps to apply to FEMA for accreditation of the levees under the National Flood Insurance Program (NFIP) at the completion of construction. Increased flood stages and damages induced by the levee and floodwall would be mitigated by construction of the Harry Semrow Driving Range Reservoir and Fullerton Woods Reservoir.

The levee/floodwall would extend along the east side of the Des Plaines River from Irving Park Road to south of Belmont Avenue. The total length of the levee and floodwall sections would be 5,100 and 3,300 feet, respectively. The earthen levee would have a 10 foot crest width. The levee crest and top of the floodwall would be at 629.3 feet NAVD88. The project would also include road closure structures where the line of protection crosses Belmont Avenue and at Irving Park Road and River Road.

The levee and floodwall alignment would be inspected annually. Annual maintenance activities at levee segments would include landscaping and control of vegetation, fill and/or repair as needed, and control of vermin that could comprise the structure. Toe drains would be inspected regularly and flushed as needed. Annual maintenance activities at floodwall segments would include cleaning and treating the structure with repairs to waterstops, cracks, railings, and walkways as needed. Road closure structures would be inspected annually and periodic maintenance would include painting, cleaning, and repairs.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Fullerton-Grand Levee (NED DPLV04), River Grove (Plate 21)

This 6,200 foot levee and floodwall would protect homes and businesses along the mainstem Des Plains River in the city of River Grove. The crest elevation would be two feet above the 1% annual chance of exceedance flood elevation. The probability that this levee will not be overtopped during the 1% annual chance of exceedance flood event would be greater than 95%. The community may request the Corps to apply to FEMA for accreditation of the levees under the National Flood Insurance Program (NFIP) at the completion of construction. Increased flood stages and damages induced by the levee and floodwall would be mitigated by construction of the Harry Semrow Driving Range Reservoir and Fullerton Woods Reservoir.

The levee/floodwall would extend from Franklin Street, north of Grand Avenue, Fifth Avenue at Palmer Street along the east side of River Road. The total length of the levee and floodwall sections would be 3,000 and 3,200, respectively. The earthen levee would have a crest width of 10 feet. The crest of the levee and top of the floodwall would be at 628.4 feet NAVD88. The project would also include a road closure structure where the line of protection crosses Grand Avenue and a road raise at Fifth Avenue and Palmer Street, allowing Fifth Avenue to remain open during a flood event.

The levee and floodwall alignment would be inspected annually. Annual maintenance activities at levee segments would include landscaping and control of vegetation, fill and/or repair as needed, and control of vermin that could comprise the structure. Toe drains would be inspected regularly and flushed as needed. Annual maintenance activities at floodwall segments would include cleaning and treating the structure with repairs to waterstops, cracks, railings, and walkways as needed. Road closure structures would be inspected annually and periodic maintenance would include painting, cleaning, and repairs.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Fullerton Woods Reservoir (NED DPRS04), River Grove (Plate 22)

The Fullerton Woods Reservoir would provide approximately 150 acre-feet of storage. The 30 acre site is located south of River Road between First and Fifth Avenues in River Grove. The reservoir, in combination with the Harry Semrow Driving Range Reservoir, would reduce stages on the mainstem preventing increased flood stages that would otherwise be caused by Touhy-Miner Levee, Belmont-Irving Park Levee, and Fullerton-Grand Levee. The site would also be used for recreation. A parking area, picnic facilities, and asphalt trails would be incorporated into the design, providing for seasonal use of the site by area residents. Stormwater will be pumped into the reservoir from the Des Plaines River through an intake pipe. After an event, stored water would be discharged by gravity.

The reservoir would be excavated to a depth of 611.5 feet NAVD88 and a berm surrounding the reservoir would be constructed to a height of 635 feet NAVD88. The height of berm would range from four to twelve feet above the surrounding area. The berm would be constructed from impervious material excavated for the reservoir, covered with six inches of topsoil, and seeded. The reservoir would be considered a Class III dam in accordance with IDNR regulations (17 IAC 3702), having a capacity more than 50 acre feet with a height greater than 6 feet. Appropriate permits and reporting would be obtained for construction and operations.

Operations and Maintenance activities at the reservoir would include annual inspections and control of vegetation through moving, trimming of trees and brush, and removal of any accumulated debris. As needed the berm would be filled and/or repaired. The inlet pump station would also be regularly inspected and maintained, with reconditioning and rehabilitation as needed, approximately every 20 years. The pump station would have a 50 year life expectancy and may require replacement at that time. Gate structures would be inspected annually and repaired or preplaced as needed, approximately every 20 years.

Costs associated with this project are identified in Table 10.4 at the end of this section.

First Avenue Bridge Modification (Comprehensive DPBM04), River Grove (Plate 23)

The First Avenue Bridge crossing the mainstem Des Plaines River, which currently overtops during a 50% annual chance of exceedance (2-year) flood event, would be raised above the 1% annual chance of exceedance (100-year) flood elevation and provide greater conveyance capacity under the roadway. The site would be designed to prevent adverse impacts to surrounding structures.

First Avenue is a four lane highway with a design speed of 65 MPH, as documented in the as-built drawings for the existing roadway. The existing bridge is constructed from concrete with 3.5 feet deep beams and a 7.5 inch slab. Due to the high traffic volume, 2,501 vehicles per hour and 25,010 vehicles per day, traffic maintenance would be required during construction. The reconstruction would be performed in stages, with at least two lanes are open to traffic at all times.

The design pavement elevation for the bridge modification is 629.1 ft NAVD88. Existing storm drainage lines and inlets would be evaluated and the inlets would be raised as appropriate. Traffic signals at the intersection of River Rd and First Ave would also be evaluated and raised as appropriate.

Operation and maintenance of the roadway would continue according to current IDOT practices. The embankments would be inspected annually and filled and/or repaired as needed. Maintenance activities would include control of vegetation, debris removal, and cleaning and repair of retaining walls and culverts.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Groveland Avenue Levee (CAP DPLV01), Riverside (Plate 24)

The existing Groveland Avenue levee would be extended horizontally to tie back the structure to high ground and vertically to provide additional protection to apartments and residences between Park and Pine Avenues. Two feet would be added to the existing levee height, with the levee tying in to existing high ground at elevation 618 ft NAVD88. The probability that this levee would not be overtopped during a 100 year flood event would be greater than 95%. The community may request the Corps to apply to FEMA for accreditation of the levees under the National Flood Insurance Program (NFIP) at the completion of construction.

The height of the existing levee at Groveland Avenue would be increased using a sheet pile wall along the levee, extending approximately 870 feet. At the north end, approximately 1,250 feet of Park Lane and Lincoln Avenue would be raised to connect the levee to high ground. At the south end of the existing levee, a floodwall would extend approximately 700 feet south from Forest Avenue to tie in to high ground, with a road closure structure connecting the segments at Forest Avenue.

The levee and floodwall alignment would be inspected annually. Annual maintenance activities at levee segments would include landscaping and control of vegetation, fill and/or repair as needed, control of vermin that could comprise the structure. Toe drains would be inspected regularly and flushed as needed. Annual maintenance activities at floodwall segments would include cleaning and treating the structure with repairs to waterstops, cracks, railings, and walkways as needed. Road closure structures would be inspected annually with and periodic maintenance would include painting, cleaning, and repairing the gates.

Costs associated with this project are identified in Table 10.4.

Cook County Non-structural (NED Plan and Comprehensive Plan Increment)

The incrementally justified non-structural component of the NED plan in Cook County would protect homes and businesses through a variety of measures. The non-structural measures would be implemented at structures at risk of flooding in the communities of Buffalo Grove, Rosemont, Des Plaines, Wheeling, Unincorporated Wheeling Township and Unincorporated Leyden Township. The measure implemented at each site will be determined according to the feasibility and cost-effectiveness of implementation determined through a site specific evaluation of the structure. Implementation of non-structural measures at individual properties would be voluntary and dependant on verification of structure characteristics and first floor elevations. With regard to the buyouts, to the extent practicable, acquisition would be on a willing seller basis, but eminent domain could be utilized when determined to be warranted.

The measures considered for implementation include:

- Elevation – the usable area raised above flood elevations
- Dry floodproofing – modifications prevent floodwaters from entering the structure
- Wet floodproofing – modifications to allow floodwaters to flow through the structure
- Fill/removal of basement in combination with floodproofing – any utilities located in basements would be relocated to a new addition elevated above flood elevations and the basement would be filled and removed from use. Any flood damages above the first floor elevation would be addressed through floodproofing.
- Nonstructural berm – a low berm or floodwall encircling a structure or group of structures preventing flood damage
- Buyouts – removal of the structure from the floodplain was considered for structures where no other measures were feasible and significant damages occur during the 1% annual chance of exceedance flood event

A group of homes located in the floodway in the City of Des Plaines were identified for buyout and evacuation. Recreation trails constructed on the evacuated lands would connect to the existing Des Plaines River trail network.

Additional non-structural measures in Cook County are along portions of streams that do not meet the minimum flow criteria for USACE participation in FRM measures (800 cfs during the 10% annual change of exceedance flood event). Implementation of these measures in Buffalo Grove and Leyden Township are therefore recommended for implementation by local FRM authorities as part of the Comprehensive Plan. Costs associated with non-structural measures included in the NED/NER Plan as well as the additional structures included only in the Comprehensive Plan are identified in Table 10.4.

Table 10.4 – Cook County Estimated Costs ($1,000)

Project	Plan	Preliminary LERRDs[1]	Construction	PED	Construction Mgmt [2]	Total First Costs	Annual OMRR&R
C09	NED/NER	$7,003	$11,260	$1,127	$670	$20,059	$18
Dam #1	CAP	$8	$594	$52	$30	$684	N/A
Dam #2	CAP	$8	$601	$53	$30	$691	N/A
C15	NED/NER	$8,468	$10,529	$1,055	$639	$20,690	$16
Dempster Ave Dam	CAP	$8	$512	$45	$26	$591	N/A
WLRS04	NED/NER	$1,228	$12,525	$1,969	$918	$16,640	$56
DPLV09	NED/NER	$2,687	$20,263	$3,219	$1,501	$27,670	$12
Touhy Ave Dam	CAP	$8	$634	$56	$32	$730	N/A
Dam #4	CAP	$8	$543	$48	$27	$626	N/A
DPLV05	NED/NER	$1,112	$14,684	$2,333	$1,088	$19,217	$25
DPLV04	NED/NER	$2,829	$14,588	$2,590	$1,208	$21,215	$19
DPRS04	NED/NER	$836	$9,888	$1,571	$733	$13,028	$59
DPLV01	CAP	$1,452	$3,560	$628	$285	$5,925	$15
Non-Structural	NED/NER	$22,828	$7,935	$1,198	$559	$32,520	$1
Non-Structural (Comp)	Comprehensive	$599	$2,096	$287	$124	$3,106	Nominal
FPCI01	Comprehensive	$146	$959	$131	$60	$1,296	$33
DPBM04	Comprehensive	$474	$12,464	$1,706	$766	$15,411	$23
Total Cook County Comprehensive Plan		$49,701	$123,636	$18,068	$8,695	$200,099	$277
Total Cook County NED/NER Plan		$46,991	$101,672	$15,062	$7,314	$171,039	$206
Total Cook County CAP Plan		$1,491	$6,444	$882	$430	$9,247	$15

[1] Includes Lands & Damages and Relocations
[2] Includes Construction Management, Monitoring, and Adaptive Mgmt

(FY2015 Price Level)

Ecosystem Restoration Measure Quantities

The ecosystem restoration plans will provide significant habitat to the Upper Des Plaines River watershed. Table 10.5 presents a summary of the measures to be implemented at each site. As shown in the table, thousands of feet of stream and acres of habitat will be restored.

Table 10.5 – Ecosystem Restoration Site Measure Quantities

Measure	Unit[1]	Site						
		K47	K41	L43	L39	L31	C09	C15
stream remeander	FT	9,400	8,500	0	0	0	0	0
bank grading 20:1	FT	9,400	8,500	0	0	0	0	0
swale grading	FT	10	30	0	0	0	0	0
cobble riffles	EA	2,500	0	0	0	0	0	0
fill ditch	FT	1,619	689	892	393	475	0	0
drain tile survey	AC	1,619	689	892	393	475	811	670
drain tile valves	AC	253	0	34	168	516	811	670
tree & understory thinning	AC	251	23	69	0	15	330	396
tree removal	AC	150	48	252	129	203	479	428
herbaceous management	AC	1,619	689	1,578	429	698	0	36
native plant establishment	AC	9	0	241	38	80	811	862
open water	AC	545	81	280	81	400	14	56
basin marsh	AC	101	130	0	0	0	26	50
side stream marsh	AC	0	0	166	15	20	160	0
sedge meadow	AC	247	2	87	49	12	93	320
wet prairie	AC	53	45	0	34	26	103	36
mesic/dry prairie	AC	76	65	0	0	0	94	0
wet savanna	AC	83	59	112	112	51	11	85
mesic/dry savanna	AC	0	0	0	0	5	165	17
floodplain forest	AC	3	8	22	22	73	0	0
wet forest	AC	69	154	5	5	0	122	263
flat woods	AC	434	145	664	664	33	0	0
open woodland	AC	0	0	0	0	0	25	35

[1] Units are presented in feet (FT), each (EA), and acres (AC).

10.2 Benefits Summary

Each element of the Recommended Plan was incrementally justified according to the plan purpose. The plan formulation and evaluation process are detailed in Section 4 (Flood Risk Management Plan Formulation) and Section 5 (Ecosystem Restoration Plan Formulation). Table 10.6, summarizes the benefits for each of the plans developed in this study.

Table 10.6 – Summary of Plan Benefits

Formulated Plan	Net Benefits
Comprehensive Plan. Includes 8 structural Flood Risk Management projects – FPCI01, DPLV09, DPLV05, DPLV04, DPRS04, WLRS04, DPBM04, DPLV01 – and non-structural measures in 13 communities in Cook, Lake and Kenosha Counties and 12 Ecosystem Restoration projects – K47, K41, L43, L39, L31, C09, C15, and five dam removals.	$8,636,000 NED net benefits 9,115 NER net HUs
NED/NER Plan Includes 5 structural Flood Risk Management projects – DPLV09, DPLV05, DPLV04, DPRS04, WLRS04 – and non-structural measures in 9 communities in Cook and Lake Counties and 7 ecosystem restoration projects –K47, K41, L43, L39, L31, C09, C15.	$4,641,000 NED net benefits 9,034 NER net HUs
CAP Plan Includes 1 structural Flood Risk Management project – DPLV01 – and 5 Ecosystem Restoration projects – removal of Dam #1, Dam #2, Dam #4, Touhy Ave Dam, and Dempster Ave Dam.	$193,000 NED net benefits 81 NER net HUs

(FY2015 Price Level, FDR 3.755%)

10.3 Design and Construction Considerations

Additional Studies Needed

Additional, focused studies are needed at the beginning of the design phase to ensure that adequate data are available for future design work and for plans and specifications development. The specific studies needed include:

- ***Hydrologic and Hydraulic Modeling.*** Stream restoration and dam removal features would require information for proper placement of in-stream structures and alignment of new stream channel and floodplain. Updated modeling of structural FRM projects will be conducted to ensure that the projects do not cause adverse flooding impacts. This modeling will also be completed in order to obtain State Floodway and Dam Removal Permits.
- ***Drain Tile and Hydrology Mapping.*** Drain tile surveys would entail finding the location and condition of all drain tiles within previous and current agriculture fields. Once the drain tiles are located and mapped, temporary valves would be placed strategically to allow hydrology to temporarily resurge in order to obtain an understanding of where the water will come back and how much. This will be utilized for planting schemes.
- ***Hydrology and Water Budgets.*** These include studies that determine if disabling drain tiles and ditches would have flooding effects outside of the project footprint. Also,

evapotranspiration and groundwater infiltration rates could be calculated for incidental floodwater retention and native vegetation restoration.

- ***Floristic Surveys.*** Site assessments and floristic surveys would include but not be limited to locating trees and shrubs and/or invasive species to be removed, verifying areas to be seeded and special areas of flora diversity to be preserved.
- ***In Depth Subsurface Investigation.*** Initial subsurface investigations were completed at several, but not all, sites to gather general information about the soils on site which assisted in the estimates for constructing new structures. Additional data is required to develop a final design. An average of 3 soil borings per 1,000 ft of levee/reservoir perimeter is the minimum amount recommended.
- ***Value Engineering and Future Work.*** Any large project represents multiple opportunities for innovation and cost savings, and this project is no exception. Although a Value Engineering (VE) study for the Recommended Plan was completed during the feasibility phase, VE studies for each feature of the plan will be conducted during the design phase. The VE study will be conducted in coordination with the Chicago District VE Coordinator.

10.4 Real Estate

The estimates for lands and damages were prepared by an appraiser. Projects that are likely to include utility relocations include an estimate for that cost. Two levee projects, DPLV01 and DPLV04, include road raise elements that are also included in the relocation estimate. For measures such as reservoirs resulting in significant spoils, disposal areas are included as part of the conceptual site plan. A Real Estate Plan has been developed to refine these assumptions and is included as Appendix I. The estimated costs are summarized in Table 10.7. These costs are subject to change.

Table 10.7 – Estimated LERRD Values

Program	Site ID	Site Name	County	Preliminary Lands & Damages[1]	Relocations[2]	Total Preliminary LERRDs
CAP 205	DPLV01	Groveland Ave Levee	Cook	$486,000	$966,000	$1,452,000
FRM	DPRS04	Fullerton Woods Reservoir	Cook	$319,000	$517,000	$836,000
	DPLV04	Fullerton-Grand Levee	Cook	$263,000	$2,567,000	$2,830,000
	DPLV05	Belmont-Irving Park Levee	Cook	$340,000	$772,000	$1,112,000
	WLRS04	Harry Semrow Driving Range	Cook	$711,000	$517,000	$1,228,000
	DPLV09	Touhy-Miner Levee	Cook	$1,629,000	$1,058,000	$2,687,000
	NSC	Cook County Non-Structural	Cook	$22,828,000	-	$22,828,000
	NSL	Lake County Non-structural	Lake	$5,497,000	-	$5,497,000
CAP 206	DR1	Dam #1 Removal	Cook	$8,000	-	$8,000
	DR2	Dam #2 Removal	Cook	$8,000	-	$8,000
	DRD	Dempster Ave Dam Removal	Cook	$8,000	-	$8,000
	DRT	Touhy Ave Dam Removal	Cook	$8,000	-	$8,000
	DR4	Dam #4 Removal	Cook	$8,000	-	$8,000
ER	C09	Northbrook Marsh	Cook	$7,003,000	-	$7,003,000
	L43	Red Wing Slough and Deer Lake Wetland Complex	Lake	$12,183,000	-	$12,183,000
	C15	Beck Lake Meadow	Cook	$8,468,000	-	$8,468,000
	L39	Pollack Lake and Hastings Creek Riparian Wetlands	Lake	$3,213,000	-	$3,213,000
	L31	Gurnee Woods Riparian Wetland	Lake	$5,123,000	-	$5,123,000
	K41	Dutch Gap Forested Floodplain	Kenosha	$9,014,000	-	$9,014,000
	K47	Bristol Marsh	Kenosha	$20,358,000	-	$20,358,000
Non-USACE	FPCI01	Lake Mary Anne Pump Station	Cook	$98,000	$48,000	$146,000
	DPBM04	First Avenue Bridge Modification	Cook	$25,000	$449,000	$474,000
	NSC (Comp)	Cook County Non-Structural (Comprehensive Plan)	Cook	$599,000	-	$599,000
	NSK	Kenosha County Non-structural (Comprehensive Plan)	Kenosha	$1,093,000	-	$1,093,000
		Total Cost		**$99,290,000**	**$6,894,000**	**$106,184,000**

[1] Preliminary Lands and Damages estimate includes estimated value, administrative costs, and a cost contingency.
[2] Relocation costs include facility and utility relocations.

(FY2015 Price Level)

10.5 Operation and Maintenance

Site specific preliminary estimates of OMRR&R requirements were developed for both FRM and ER Plan elements. Requirements vary by the type of measure being implemented at the site. Table 10.8 presents the preliminary OMRR&R requirements for each type of measure. Based on these requirements and site specific considerations such as size and location, costs were developed for each site as detailed in Table 10.10. A detailed OMRR&R plan will be developed during the PED phase. The non-Federal sponsors will be responsible for OMRR&R as outlined in each site's plan.

The Dam Removal sites would not require OMRR&R. Implementation of the five dam removals involves removing the existing structures. Once they are removed, there would be no structure to operate or maintain. Monitoring at these sites, as with all ER sites, is part of implementation. Monitoring costs, however, are a shared Federal and non-Federal responsibility and are included in project costs.

OMRR&R of structures retrofitted by means of non-structural FRM measures shall be the responsibility of the individual property owner(s). Elevated and wet floodproofed structures, would typically have no additional costs to the property owner beyond normal maintenance requirements. Dry floodproofed structures would require normal maintenance of the structure as well as periodic inspection, maintenance and repair (if required) of the waterproof barrier and associated features and equipment such as closures, interior drainage, pumps, check valves and emergency generator or power supply. Nonstructural berms would require periodic inspection, maintenance and repair (if required) of the levee structure, including mowing and vegetation control, as well as maintenance and repair of associated features and equipment such as closures, interior drainage, pumps, check valves, and emergency generator or power supply. Costs associated with operation, maintenance, and repair of these dry floodproofed structures and nonstructural berms would be nominal. The non-Federal sponsors shall be responsible for conducting periodic inspections and floodplain management of sites and structures in the project area to ensure that use of mitigated properties comply with the Project Partnering Agreement (PPA), Floodproofing Agreement, restrictions on the property, the floodplain management plan, zoning regulations, and building codes. Project inspection and floodplain management activities are standard FRM project requirements and will incur minor costs.

The proposed levees would be entered into the Corps levee safety program and recorded in the National Levee Database (NLD). At the completion of construction, an initial periodic inspection would be performed to document the design and construction of the levee and to serve as a baseline report. The levee would also be screened into the Corps Levee Screening Tool. In addition, upon request of the community with O&M responsibility for the levee, the Corps would prepare a Levee System Evaluation for the National Flood Insurance Program to recommend FEMA to accredit the levee as part of remapping the floodplain and obtain relief from required flood insurance for the areas behind the levees.

All structural FRM features would be inspected regularly under the Inspection of Completed Works program to ensure they are being properly maintained and remain eligible for assistance under PL84-99 if any damage occurs during flood events.

Table 10.8 – Preliminary OMRR&R Requirements

Measure	OMRR&R Requirements
Ecosystem Restoration	Burning
	Mowing
	Invasive species control (herbaceous and woody)
	Additional Seeding to Build Species Richness
Dam Removal	No OMRR&R required
Reservoirs	Inspection
	Mowing
	Fill/Repair
	Debris and sediment removal
	Tree & brush trimming
	Pump station inspection & maintenance
	Pump station reconditioning/rehabilitation & replacement
	Gate inspection & maintenance
	Gate repair & replacement
Levees	Inspection
	Debris removal
	Fill/Repair
	Landscaping & vermin control
	Toe drain inspection & flushing
	Access road maintenance & repair
	Pump Station Inspection & Maintenance
	Pump station reconditioning/rehab & replacement
Floodwalls	Inspection
	Cleaning/Treating
	Repair to waterstops, cracks, railings & walkways
Road Raises	Inspection
	Debris Removal
	Embankment & retaining wall fill/repair
	Landscaping
	Culvert cleaning/flushing/repair
Elevation[1]	Maintain property and comply with property restrictions
	Floodplain management & enforcement of property restrictions by non-Federal sponsor
Wet Floodproofing[1]	Maintain property and comply with property restrictions
	Floodplain management & enforcement of property restrictions by non-Federal sponsor
Dry Floodproofing[1]	Maintain property and comply with property restrictions
	Periodic inspection of the retrofit features/equipment
	Maintain & repair waterproof barrier, closures, pumps, check valves, & emergency generator/power supply
	Floodplain management & enforcement of property restrictions by non-Federal sponsor
Nonstructural Berm[1]	Maintain property and comply with property restrictions
	Periodic inspection of berm to ensure structural integrity
	Maintain and repair berm structure, mowing and vegetation control
	Maintain & repair closures, pumps, check valves, & emergency generator/power supply
	Floodplain management and enforcement of property restrictions non-Federal sponsor

[1] OMRR&R at properties where non-structural FRM measures have been constructed is the responsibility of the individual property owner. The non-Federal sponsor is responsible for ensuring that the homeowner continues to comply with the terms of the floodproofing agreement.

Table 10.9 – Estimated Major OMRR&R Costs by Activity

Measure		Major OMRR&R Requirements	Recurrence Interval	Approx Unit Cost	Unit
Ecosystem Restoration		Burning & mowing	3 years	$1,400	AC
		Invasive species control (herbaceous)	annual	$2,500	AC
		Invasive species control (woody)	2 years	$2,500	AC
		Additional seeding to build species richness	5 years	$1,200	AC
Reservoirs	General	Perimeter inspection	annual	$1,300	MI
		Mowing, debris, and sediment removal	annual	$1,000	AC
		Tree & brush trimming	2 years	$2,900	AC
		Fill/repair	5 years	$20,900	MI
	Pump Statiou	Quarterly inspection and semi-annual report	semi-annual	$7,800	YR
		Clean, oil, grease and maintain pump and gates	annual	$2,000	EA
		Electrical supply	annual	$11,900	YR
		Recondition/rehab pump, repair & replace gates	20 years	$250,900	EA
		Replace pump	50 years	$1,254,70	EA
Levees & Floodwalls	Levees & Overflow Embankments	Inspection	2 years	$3,400	MI
		Fill/Repair	5 years	$5,100	MI
		Tree & brush removal/trimming	5 years	$16,100	MI
		Debris removal, litter control, vermin control	annual	$26,900	MI
		Inspect toe drains	5 years	$2,700	MI
		Flush toe drains	10 years	$800	EA
		Regrade access roads	annual	$13,600	MI
		Repair access roads	5 years	$42,300	MI
		Survey access roads	10 years	$8,700	MI
	Floodwalls	Inspection (per foot of height)	2 years	$1,700	MI
		Clean and treat concrete (per foot of height)	10 years	$6,800	MI
		Repair waterstops (replace 70%)	20 years	$967,300	MI
		Repair cracks on walkways	10 years	$158,100	MI
	Closure Structures	Inspect and clean	annual	$3,700	EA
		Repair	6 years	$3,000	EA
	Interior Drainage	Quarterly inspection and semi-annual report	semi-annual	$7,800	YR
		Clean, oil, grease and maintain pump and gates	annual	$2,000	EA
		Electrical supply	annual	$11,900	YR
		Recondition/rehab pump, repair and replace gates	20 years	$250,900	EA
		Replace pump	50 years	$1,254,70	EA
Road Raises		Inspection	2 years	$3,400	MI
		Fill/repair	5 years	$5,100	MI
		Debris removal, litter control, vermin control	annual	$26,900	MI
		Tree & brush removal/trimming	5 years	$16,100	MI

(FY2014 Price Level)

Table 10.10 – Estimated OMRR&R Costs by Project

Site ID	Site Name	Purpose	Plan	County	Est. Annual OMRR&R
DPLV01	Groveland Ave Levee	FRM	CAP	Cook	$15,000
	CAP 205 Total				**$15,000**
DPRS04	Fullerton Woods Reservoir	FRM	NED/NER	Cook	$59,000
DPLV04	Fullerton-Grand Levee	FRM	NED/NER	Cook	$19,000
DPLV05	Belmont-Irving Park Levee	FRM	NED/NER	Cook	$25,000
WLRS04	Harry Semrow Driving Range	FRM	NED/NER	Cook	$56,000
DPLV09	Touhy-Miner Levee	FRM	NED/NER	Cook	$12,000
NSC	Cook County Non-Structural	FRM	NED/NER	Cook	$1,000
NSL	Lake County Non-structural	FRM	NED/NER	Lake	Nominal
	NED Plan Total				**$172,000**
DR1	Dam #1 Removal	ER	CAP	Cook	$0
DR2	Dam #2 Removal	ER	CAP	Cook	$0
DRD	Dempster Ave Dam Removal	ER	CAP	Cook	$0
DRT	Touhy Ave Dam Removal	ER	CAP	Cook	$0
DR4	Dam #4 Removal	ER	CAP	Cook	$0
	CAP 206 Total				**$0**
C09	Northbrook Marsh	ER	NED/NER	Cook	$18,000
L43	Red Wing Slough and Deer Lake Wetland	ER	NED/NER	Lake	$70,000
C15	Beck Lake Meadow	ER	NED/NER	Cook	$16,000
L39	Pollack Lake and Hastings Creek Riparian	ER	NED/NER	Lake	$20,000
L31	Gurnee Woods Riparian Wetland	ER	NED/NER	Lake	$28,000
K41	Dutch Gap Forested Floodplain	ER	NED/NER	Kenosha	$59,000
K47	Bristol Marsh	ER	NED/NER	Kenosha	$117,000
	NER Plan Total				**$328,000**
FPCI01	Lake Mary Anne Pump Station	FRM	Comprehensive	Cook	$33,000
DPBM04	First Avenue Bridge Modification	FRM	Comprehensive	Cook	$23,000
NSC(Comp)	Cook County Non-Structural (Comprehensive)	FRM	Comprehensive	Cook	Nominal
NSK	Kenosha County Non-structural (Comprehensive)	FRM	Comprehensive	Kenosha	Nominal
	Non-USACE Total				**$56,000**
	Comprehensive Plan Total				**$571,000**

(FY2014 Price Level, FDR 3.5%)

10.6 Ecosystem Restoration Monitoring and Adaptive Management

Section 2039 of WRDA 2007 directs the Secretary of the Army to ensure, that when conducting a feasibility study for a project (or component of a project) under the Corps ecosystem restoration mission, that the recommended project includes a monitoring plan to measure the success of the ecosystem restoration. The implementation guidance for section 2039 requires a contingency or adaptive management plan in case the desired outputs/ results are not achieved during or after initial construction. This monitoring and adaptive management plan shall include a description of the monitoring activities, the criteria for success, and the estimated cost and duration of the monitoring as well as specify that monitoring will continue until such time as the Division Commander determines that the success criteria have been met.

The adaptive management plan must be appropriately scoped to the scale of the project. The information generated by the monitoring plan will be used by the District in consultation with the Federal and State resources agencies and the MSC to guide decisions on operational or structural changes that may be needed to ensure that the ecosystem restoration project meets the success criteria.

An effective monitoring program is necessary to assess the status and trends of ecological health and biota richness and abundance on a per project basis, as well as to report on regional program success within the United States. Assessing status and trends includes both spatial and temporal variations. Gathered information under this monitoring plan will provide insights into the effectiveness of current restoration projects and adaptive management strategies, and indicate where goals have been met, if actions should continue, and/or whether more aggressive management is warranted.

Monitoring the changes at a project site is not always a simple task. Ecosystems, by their very nature, are dynamic systems where populations of macroinvertebrates, fish, birds, and other organisms fluctuate with natural cycles. Water quality also varies, particularly as seasonal and annual weather patterns change. The task of tracking environmental changes can be difficult, and distinguishing the changes caused by human actions from natural variations can be even more difficult. This is why a focused monitoring protocol tied directly to the planning objectives needs to be followed.

A monitoring and adaptive management plan is included as Appendix M. The plan accounts for monitoring the structural sustainability and biological response of the ecosystem restoration projects and provides a preliminary estimate of the level of effort required for the monitoring. During the design phase, a monitoring and adaptive management plan specific to each project will be developed.

Adaptive management measures are not the same as typical operation and maintenance activities. These measures are response actions to changes that adversely affect how the system was predicted to respond. Because they are adaptive to unknown future events, there are no absolute measures that can be defined prior to the issue arising. However, general concerns and examples of adaptive management processes can be identified at this stage. The primary concerns for this project is the success of the fluvial manipulation, primarily the remeandering of the stream channel, and the success of the native plantings. Once final designs are complete, potential adaptive management needs can be predicted. Primary concerns and examples are outlined in Appendix M. This is necessary since the adaptive management measures will need to be based upon final feature designs and predicted adverse responses.

11 Recommendation

This study tentatively recommends authorization of the NED/NER Plan. Sites that could reasonably be implemented under the CAP will be converted to that program for implementation as individual projects in accordance with ER 1105-2-100, Appendix F, paragraph F-8.c. Sites that are only included in the Comprehensive Plan are recommended for implementation by others.

11.1 Cost of Recommended Plan

A summary of the estimated cost of the NED/NER Plan and the CAP Plan and the cost sharing responsibilities for each site is presented in Table 11.1. Total project costs includes implementation; planning, engineering and design; construction management; and LERRDs. For ecosystem restoration sites only, the construction management costs include monitoring and adaptive management. All costs underwent a Cost and Schedule Risk Analysis and were certified by the Walla Walla Cost Engineering Mandatory Center of Expertise.

Table 11.1 – Summary of Project Costs

				Implementation					Lands, Easements, Relocations, Rights-of-way and Disposal Areas				
Program	ID	Site Name	County	Construction	Recreation Features	Planning, Engineering, and Design	Construction Management[1]	Total	Lands & Damages	Relocations	Total	Total Project Cost[2]	Annual OMRR&R[3]
CAP 205	DPLV01	Groveland Ave Levee	Cook	$3,560,000	-	$628,000	$285,000	$4,473,000	$486,000	$966,000	$1,452,000	$5,925,000	$15,000
		CAP 205 TOTAL		**$3,560,000**	**$0**	**$628,000**	**$285,000**	**$4,473,000**	**$486,000**	**$966,000**	**$1,452,000**	**$5,925,000**	**$15,000**
FRM	DPRS04	Fullerton Woods Reservoir	Cook	$9,097,000	$791,000	$1,571,000	$733,000	$12,192,000	$319,000	$517,000	$836,000	$13,028,000	$59,000
	DPLV04	Fullerton-Grand Levee	Cook	$14,588,000	-	$2,590,000	$1,208,000	$18,386,000	$263,000	$2,567,000	$2,830,000	$21,215,000	$19,000
	DPLV05	Belmont-Irving Park Levee	Cook	$14,684,000	-	$2,333,000	$1,088,000	$18,105,000	$340,000	$772,000	$1,112,000	$19,217,000	$25,000
	WLRS04	Harry Semrow Driving Range[1]	Cook	$12,525,000	-	$1,969,000	$918,000	$15,412,000	$711,000	$517,000	$1,228,000	$16,640,000	$56,000
	DPLV09	Touhy-Miner Levee	Cook	$20,114,000	$150,000	$3,219,000	$1,501,000	$24,984,000	$1,629,000	$1,058,000	$2,687,000	$27,670,000	$12,000
	NSC	Cook County Non-Structural	Cook	$7,706,000	$229,000	$1,198,000	$559,000	$9,692,000	$22,828,000	-	$22,828,000	$32,520,000	$1,000
	NSL	Lake County Non-structural	Lake	$8,202,000		$1,238,000	$577,000	$10,017,000	$5,497,000	-	$5,497,000	$15,514,000	Nominal
		NED PLAN TOTAL		**$86,916,000**	**$1,170,000**	**$14,118,000**	**$6,584,000**	**$108,788,000**	**$31,587,000**	**$5,431,000**	**$37,018,000**	**$145,804,000**	**$172,000**
CAP 206	DR1	Dam #1 Removal	Cook	$594,000	-	$52,000	$30,000	$676,000	$8,000	-	$8,000	$684,000	$0
	DR2	Dam #2 Removal	Cook	$601,000	-	$53,000	$30,000	$684,000	$8,000	-	$8,000	$691,000	$0
	DRD	Dempster Ave Dam Removal	Cook	$512,000	-	$45,000	$26,000	$583,000	$8,000	-	$8,000	$591,000	$0
	DRT	Touhy Ave Dam Removal	Cook	$634,000	-	$56,000	$32,000	$722,000	$8,000	-	$8,000	$730,000	$0
	DR4	Dam #4 Removal	Cook	$543,000	-	$48,000	$27,000	$618,000	$8,000	-	$8,000	$626,000	$0
		CAP 206 TOTAL		**$2,884,000**	**$0**	**$254,000**	**$145,000**	**$3,283,000**	**$40,000**	**$0**	**$40,000**	**$3,322,000**	**$0**
ER	C09	Northbrook Floodplain and Riparian Complex	Cook	$11,260,000	-	$1,127,000	$670,000	$13,057,000	$7,003,000	-	$7,003,000	$20,059,000	$18,000
	L43	Red Wing Slough and Deer Lake Wetland Complex	Lake	$15,550,000	-	$1,557,000	$928,000	$18,035,000	$12,183,000	-	$12,183,000	$30,217,000	$70,000
	C15	Beck Lake Meadow and Floodplain Forest	Cook	$10,529,000	-	$1,055,000	$639,000	$12,223,000	$8,468,000	-	$8,468,000	$20,690,000	$16,000
	L39	Pollack Lake and Hastings Creek Riparian	Lake	$6,210,000	-	$623,000	$375,000	$7,208,000	$3,213,000	-	$3,213,000	$10,422,000	$20,000
	L31	Gurnee Woods Riparian Wetland	Lake	$11,009,000	-	$1,102,000	$668,000	$12,779,000	$5,123,000	-	$5,123,000	$17,901,000	$28,000
	K41	Dutch Gap Forested Floodplain	Kenosha	$8,498,000	-	$852,000	$515,000	$9,865,000	$9,014,000	-	$9,014,000	$18,880,000	$59,000
	K47	Bristol Marsh	Kenosha	$19,617,000	-	$1,964,000	$1,173,000	$22,754,000	$20,358,000	-	$20,358,000	$43,113,000	$117,000
		NER PLAN TOTAL		**$82,673,000**	**$0**	**$8,280,000**	**$4,968,000**	**$95,921,000**	**$65,362,000**	**$0**	**$65,362,000**	**$161,282,000**	**$328,000**
Non-USACE	FPCI01	Lake Mary Anne Pump Station	Cook	$959,000	-	$131,000	$60,000	$1,150,000	$98,000	$48,000	$146,000	$1,296,000	$33,000
	DPBM04	First Avenue Bridge Modification	Cook	$12,464,000	-	$1,706,000	$766,000	$14,936,000	$25,000	$449,000	$474,000	$15,411,000	$23,000
	NSC(Comp)	Cook County Non-Structural (Comprehensive Plan)	Cook	$2,096,000	-	$287,000	$124,000	$2,507,000	$599,000	-	$599,000	$3,106,000	Nominal
	NSK	Kenosha County Non-Structural	Kenosha	$80,000	-	$11,000	$5,000	$96,000	$1,093,000	-	$1,093,000	$1,189,000	Nominal
		NON-USACE TOTAL		**$15,599,000**	**$0**	**$2,135,000**	**$955,000**	**$18,689,000**	**$1,815,000**	**$497,000**	**$2,312,000**	**$21,002,000**	**$56,000**
		TOTAL COST		**$191,632,000**	**$1,170,000**	**$25,415,000**	**$12,937,000**	**$231,154,000**	**$99,290,000**	**$6,894,000**	**$106,184,000**	**$337,335,000**	**$571,000**

[1] Construction management includes monitoring and adaptive management for ER sites.
[2] Total project cost includes total implementation costs and total LERRD values.
[3] OMRR&R is a non-Federal responsibility.
(FY2015 Price Level)

11.2 Federal and Non-Federal Responsibilities

Each site in the Recommended Plan will be cost shared between the Federal government and the non-Federal sponsors, with a minimum 35% contribution from the non-Federal sponsors as required by ER 1105-2-100, Planning Guidance Notebook. The estimated Federal and non-Federal share for the NED/NER and CAP Plans are detailed in Table 11.2 and Table 11.3.

For structural FRM sites, the non-Federal sponsors must provide a minimum cash contribution equal to 5 percent of total project costs allocated to structural FRM projects, as well as all LERRDs determined by the Government to be required for the project. If the sum of the sponsor's total cash and LERRD contributions is less than 35 percent of the costs assigned to FRM, the non-Federal sponsors will pay the difference in cash. If it is greater than 35 percent, total non-Federal costs shall not exceed 50 percent of total project costs assigned to flood control. Contributions in excess of 50 percent will be reimbursed by the Federal Government to the non-Federal sponsors, subject to the availability of funds. For non-structural FRM sites, there is no minimum non-Federal cash contribution and where LERRDs are more than 35% of total project costs, an agreement between the sponsor and the Federal Government on the most efficient and practical means for acquiring the excess LERRDs is required. (See ER 1105-2-100, Appendix E, Paragraphs E-21 a and b)

For Ecosystem Restoration sites, the non-Federal sponsors must provide a minimum 35% contribution in LERRDs, cash, or work-in-kind. Per ER 1105-2-100, LERRD contributions in excess of 35% of the total project cost, are to be reimbursed by the Federal government, subject to the availability of funds. However, EP 1165-2-502, Ecosystem Restoration - Supporting Policy Information, states that, as a general rule, land value should not exceed 25% of the total project cost. (See ER 1105-2-100, Appendix E, Paragraph E-31 and EP 1165-2-502, Paragraph 7m).

Due to the urban nature of the study area, land values are high and LERRDs for recommended ecosystem restoration projects exceed the 25% target set by EP 1165-2-502. The ecosystem restoration plans have been formulated so that only lands necessary to implement the project are included in the project requirements. The estimated value of all LERRD has been considered in comparison of alternatives for plan selection. The non-Federal sponsors for the ecosystem restoration projects have indicated in their Letters of Intent that they have voluntarily agreed to waive reimbursement for any LERRD value above 35% of the total project cost. The preliminary estimate of LERRD reimbursements that would be waived is $3,776,000.

Prior to initiation of the PED phase, the Federal government and the non-Federal sponsors will execute a PED agreement. The LERRDs and OMRR&R of the project will be the responsibility of the non-Federal sponsors for the proposed project. The costs, LERRD values, and OMRR&R costs provided above are estimated and are likely to change.

Table 11.2 – NED/NER Plan Cost Sharing Summary ($1,000)

Item	Federal Cost	Non-Federal Cost	Total Cost
Structural Flood Risk Management (FRM)			
Planning, Engineering, and Design	$7,503	$4,040	$11,543
Construction Management	$3,498	$1,884	$5,382
LERRD	$0	$8,692	$8,692
Flood Risk Management Features (Structural)	$51,804	$19,202	$71,006
Subtotal	$51,804	$27,894	$79,698
Structnral FRM Subtotal	$62,805	$33,818	$96,623
Non-Structural Flood Risk Management (FRM)			
Planning, Engineering, and Design	$2,403	$0	$2,403
Construction Management	$1,120	$0	$1,120
LERRD	$11,611	$16,714	$28,325
Flood Risk Management Features	$15,907	$0	$15,907
Subtotal	$27,518	$16,714	$44,232
Non-Structural FRM Subtotal	$31,041	$16,714	$47,755
Ecosystem Restoration (ER)			
Planning, Engineering, and Design	$8,280	$0	$8,280
Construction Management	$4,968	$0	$4,968
LERRD	$8,912	$56,449	$65,361
Ecosystem Restoration Features	$82,674	$0	$82,674
Subtotal	$91,586	$56,449	$148,036
ER Subtotal	$104,834	$56,449	$161,284
Recreation			
Planning, Engineering, and Design	$86	$86	$172
Construction Management	$41	$41	$82
LERRD	$0	$0	$0
Recreation Features	$585.5	$585.5	$1,171
Subtotal	$585.5	$585.5	$1,171
Recreation Subtotal	$713	$713	$1,425
Total Project Costs	**$199,393**	**$107,694**	**$307,087**

(FY2015 Price Level)

Table 11.3 – CAP Plan Cost Sharing Summary ($1,000)

Item	Federal Cost	Non-Federal Cost	Total Cost
Structural Flood Risk Management (FRM)			
Planning, Engineering, and Design	$408	$220	$628
Construction Management	$185	$100	$285
LERRD	$0	$1,452	$1,452
Flood Risk Management Features	$3,258	$302	$3,560
Subtotal	$3,258	$1,754	$5,012
FRM Subtotal	$3,851	$2,074	$5,925
Ecosystem Restoration (ER)			
Planning, Engineering, and Design	$165	$88	$253
Construction Management	$94	$51	$145
LERRD	$0	$39	$39
Restoration Features	$1,900	$985	$2,885
Subtotal	$1,900	$1,023	$2,924
ER Subtotal	$2,159	$1,163	$3,322
Total Project Costs	**$6,011**	**$3,236**	**$9,247**

(FY2015 Price Level)

Federal implementation of the recommended project would be subject to the non-Federal sponsors agreeing to comply with applicable Federal laws and policies, including but not limited to:

a. Provide a minimum of 35 percent, but not to exceed 50 percent of total flood damage reduction costs as further specified below:

   1. Provide the required non-Federal share of design costs allocated by the Government to flood damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for the flood damage reduction features;

   2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to flood damage reduction;

   3. Provide, during construction, a contribution of funds equal to 5 percent of total flood damage reduction costs;

   4. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the flood damage reduction features;

   5. Provide, during construction, any additional funds necessary to make its total contribution for flood damage reduction equal to at least 35 percent of total flood damage reduction costs;

b. Provide 35 percent of total ecosystem restoration costs as further specified below:
   1. Provide the required non-Federal share of design costs allocated by the Government to ecosystem restoration in accordance with the terms of a design agreement entered into prior to commencement of design work for the ecosystem restoration features;
   2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to ecosystem restoration;
   3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the ecosystem restoration features;
   4. Provide, during construction, any additional funds necessary to make its total contribution for ecosystem restoration equal to 35 percent of total ecosystem restoration costs;

c. Provide 50 percent of total recreation costs as further specified below:
   1. Provide the required non-Federal share of design costs allocated by the Government to recreation in accordance with the terms of a design agreement entered into prior to commencement of design work for the recreation features;
   2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to recreation;
   3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the recreation features;
   4. Provide, during construction, any additional funds necessary to make its total contribution for recreation equal to 50 percent of total recreation costs;

d. Provide, during construction, 100 percent of the total recreation costs that exceed an amount equal to 10 percent of the sum of the Federal share of total flood damage reduction costs and the Federal share of total ecosystem restoration costs;

e. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;

f. Not less than once each year, inform affected interests of the extent of protection afforded by the flood damage reduction features;

g. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;

h. Comply with Section 402 of the WRDA of 1986, as amended (33 U.S.C.701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of the flood damage reduction features;

i. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood damage reduction features;

j. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the flood damage reduction features afford, reduce the outputs produced by the ecosystem restoration features, hinder O&M of the project, or interfere with the project's proper function;

k. Shall not use the ecosystem restoration features or lands, easements, and rights-of-way required for such features as a wetlands bank or mitigation credit for any other project;

l. Keep the recreation features, and access roads, parking areas, and other associated public use facilities, open and available to all on equal terms;

m. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C.4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

n. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

o. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

p. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

q. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

r. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C.2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C.3141- 3148 and 40 U.S.C.3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C.276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C.327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C.276c et seq.);

s. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C.9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

t. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

u. Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and

v. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C.1962d-5b), and Section 103(j) of the WRDA of 1986, Public Law 99-662, as amended (33 U.S.C.2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

11.3 Plan Effects and Accomplishments

The NED/NER Plan and the CAP Plan will provide ecosystem restoration, FRM, recreation, and incidental water quality benefits.

The ecological restoration portion of the NED/NER Plan would provide 9,115 net habitat units. Hydrology would be improved by filling an estimated 4,000 feet of unnatural ditch along with hundreds of thousands of feet of drain tiles dismantled. Natural stream sinuosity would be restored increasing the total length. Over 6,800 acres of native community types would be restored including: marsh (668 acres), sedge meadow (810 acres), prairie (532 acres), savanna (700 acres), woodland (1,450 acres) and forest (1,000 acres). This ecosystem restoration plan cumulatively increases the quality of watershed ecosystem communities by 32% of what currently exists.

The FRM portion of the NED/NER Plan would provide $4,641,000 net benefits through the implementation of two (2) reservoirs, three (3) levee/floodwall, and an array of non-structural components in Cook and Lake Counties of Illinois. Minor ecological improvements resulting from the NED plan include reducing the flashiness of the Des Plaines River watershed and water quality improvements.

The CAP Plan would provide $193,000 NED net benefits through implementation of one levee/floodwall and 81 net habitat units by restoring aquatic habitat. Five dams would be removed on the mainstem Des Plaines River, opening up a 16-mile stretch of the mainstem river.

Along with direct and indirect effects of each site, cumulative effects of the NED/NER Plan and CAP Plan were assessed. There have been numerous effects to resources from past and present actions, and reasonably foreseeable future actions can also be expected to produce both beneficial and adverse affects. In this context, the increments of effects from the proposed project are relatively minor. Assessment of cumulative effects indicates that long-term healing of the Upper Des Plaines River watershed resources is dependent on implementation of the preferred alternative plans; however, it will take considerable time for counties, municipalities and local organizations to continue to repair and mitigate losses caused by past hydrologic and ecologic adverse effects aside from this proposed plan. Based on the expectation of continued sustainability of all resources, and the magnitude of the watershed circumstances, cumulative effects are not considered significant or adverse.

11.4 Plan Implementation

11.4.1 Implementation Priority

Implementation priority will be established by site purpose and program. The four programs under which these project falls are the CAP Section 205 FRM; Specifically Authorized FRM; CAP Section 206 ER; and Specifically Authorized ER. Table 11.4 shows the implementation with projects grouped by program. Flood risk management sites will be implemented from highest net benefits to lowest, taking into consideration compensatory storage requirements for levees. Ecosystem restoration sites will be implemented according to the plan shown below. This plan assumes that all funding and Lands, Easements, Rights-of-Way, Relocations, and Disposal Areas (LERRDs) needed to accomplish each project would be provided prior to construction and that LERRD acquisition for subsequent projects would be ongoing.

Table 11.4 – Project Implementation Plan

Program	Site ID	Project	Engineering and Design Start	Real Estate Acquisition Start	Construction Start	Construction Completion
CAP 205	DPLV01	Groveland Avenue Levee	10/2014	4/2015	10/2016	10/2018
FRM	DPRS04	Fullerton Woods Reservoir	10/2014	10/2017	4/2018	4/2020
	DPLV04	Fullerton-Grand Levee	10/2016	10/2017	10/2019	10/2021
	DPLV05	Belmont-Irving Park Levee	10/2016	10/2017	10/2019	10/2021
	WLRS04	Harry Semrow Driving Range Reservoir	10/2019	10/2019	10/2020	10/2022
	DPLV09	Touhy-Miner Levee	10/2020	10/2018	10/2021	10/2023
		Cook County Non-structural	10/2017	10/2017	10/2019	10/2025
		Lake County Non-structural	10/2017	10/2017	10/2019	10/2025
CAP 206		Dam Removal #1	10/2017	12/2017	6/2018	12/2018
		Dam Removal #2	4/2018	12/2018	6/2019	12/2019
		Dempster Ave Dam Removal	4/2019	12/2019	6/2020	12/2020
		Touhy Ave Dam Removal	10/2020	12/2020	6/2021	12/2021
		Dam #4 Removal	10/2021	12/2021	6/2022	12/2022
ER	C09	North Brook Marsh	10/2017	4/2022	10/2023	10/2028
	L43	Red Wing Slough & Deer Lake Wetland Complex	4/2018	4/2026	10/2026	10/2031
	C15	Beck Lake Meadow and Floodplain Forest	4/2019	4/2024	10/2025	10/2030
	L39	Pollack Lake & Hastings Creek Riparian Wetlands	10/2019	4/2019	10/2019	10/2024
	L31	Gurnee Woods Riparian Wetland	10/2022	4/2021	10/2021	10/2026
	L05	Grainger Woods Floodplain Forest	10/2024	4/2022	10/2022	10/2027
	K41	Dutch Gap Forested Floodplain	10/2026	10/2024	10/2027	10/2032
	K47	Bristol Marsh	10/2027	10/2025	10/2028	10/2033
Non-USACE	FPCI01	Lake Mary Anne Pump Station	10/2014	4/2015	10/2015	10/2017
	DPBM04	First Avenue Bridge Modification	10/2014	4/2015	10/2015	10/2017
		Cook County Non-structural (Comprehensive Plan)	10/2017	10/2017	10/2019	10/2025
		Kenosha County Non-structural	10/2017	10/2017	10/2019	10/2025

11.4.2 Non-Federal Sponsors

Implementation will be accomplished by multiple non-Federal sponsors. The study's non-Federal sponsors plan to sponsor the implementation of the portions of the Recommended Plan that fall within their jurisdiction, along with other state and local agencies. The following agencies have submitted or plan to submit letters stating their intent to act as non-Federal sponsors for implementation of projects in the Recommended Plan as listed below along with financial self-certifications indicating that they would be able to finance the non-Federal portion of the costs: DNR, MWRDGC, the City of Des Plaines, FPDCC, LCFPD, and Kenosha County. The specific projects to be sponsored by each agency are summarized in Table 11.5.

In addition to providing letters of intent, each non-Federal sponsor has provided a self-certification of financial capability signed by the chief financial officer or equivalent of the sponsor. The letters clearly state that the sponsor understand the partnership requirements.

Table 11.5 – Non-Federal Sponsors

Program	Site ID	Project	Non-Federal Sponsor(s)
CAP 205	DPLV01	Groveland Avenue Levee	IDNR, MWRDGC
FRM	DPRS04	Fullerton Woods Reservoir	IDNR, MWRDGC, FPDCC[1]
	DPLV04	Fullerton-Grand Levee	IDNR, MWRDGC
	DPLV05	Belmont-Irving Park Levee	IDNR, MWRDGC
	WLRS01	Harry Semrow Driving Range Reservoir	IDNR, MWRDGC, Des Plaines
	DPLV09	Touhy-Miner Levee	INDR, MWRDGC, Des Plaines[1]
	NSC	Cook County Non-structural	IDNR, Des Plaines[1]
	NSL	Lake County Non-structural	IDNR
CAP 206	DR1	Dam Removal #1	FPDCC, IDNR
	DR2	Dam Removal #2	FPDCC, IDNR
	DRD	Dempster Ave Dam Removal	FPDCC, IDNR
	DRT	Touhy Ave Dam Removal	FPDCC, IDNR
	DR4	Dam #4 Removal	FPDCC, IDNR
ER	C09	North Brook Marsh	FPDCC
	C15	Beck Lake Meadow and Floodplain Forest	FPDCC
	L43	Red Wing Slough & Deer Lake Wetland Complex	LCFPD
	L39	Pollack Lake & Hastings Creek Riparian Wetlands	LCFPD
	L31	Gurnee Woods Riparian Wetland	LCFPD
	K41	Dutch Gap Forested Floodplain	Kenosha County
	K47	Bristol Marsh	Kenosha County

[1] FPDCC will be the sponsor of the recreation features at Fullerton Woods Reservoir. The City of Des Plaines with be the sponsor of the recreation features at Touhy-Miner Levee at for trails associated with non-structural floodway buyouts in Des Plaines.

11.4.3 Environmental Assessment

See Effects Assessment in Section 9. Final assessment is pending public review of the EA.

11.4.4 Public/Other Agency Views and Comments

Public scoping meetings for Phase II of the Upper Des Plaines River project were held in June 2002 at Bristol, WI (4 June at Kenosha County Center); at Grayslake, IL (5 June at Byron Colby Barn at Prairie Crossing); and at Des Plaines, IL (6 June at Oakton Community College Business Center). The evening meetings included a slide show, public comment opportunity, and question-answer session; the agency panel included staff from the USACE, IDNR, WDNR, Cook County Highway Department, LCSMC, and Kenosha County Planning & Development.

To date, assistance from agencies in terms of providing reports, studies, technical support, endangered species lists, etc has been completed. Appendix L is a collection of coordination letters to date with Federal, State and Local agencies. Through the NEPA process and 30-day public review the Feasibility Report and EA, public and agency coordination will be finalized.

11.4.5 Permits Required

Section 404 of the Clean Water Act – Since the projects identified under this study are all USACE Civil Works, a 404 Permit is not required. All projects proposed under the preferred plan would comply with the regulations and statutes set forth in Section 404 of the Clean Water Act. There are no outstanding reasons to believe that Section 404 would not be in compliance for any given project, seeing that they all restore the environment and subsequently water quality, or they beneficially quell those adverse water quality affects associated with unnatural flooding. A preliminary 404(b)(1) analysis has been completed for the Recommended Plan, in Appendix L. However, each feature that requires 404 compliance would complete a Section 404(b)(1) analysis and provide the information on a per project basis during the design phase to regulating agencies. No project requiring 404 compliance would begin construction without the analysis completed.

Section 401 of the Clean Water Act – All projects proposed under the preferred plan would comply with the regulations and statutes set forth in Section 401 of the Clean Water Act. There are no outstanding reasons to believe that 401Water Quality (WQ) Certification would not be granted for any given project, seeing that they all restore the environment and subsequently water quality, or they beneficially quell those adverse water quality affects associated with unnatural flooding. Each project that requires 401 WQ Certification would complete appropriate applications and provided information on a per project basis during the design phase. No project requiring 401 WQ Certification would begin construction without the certification issued.

Floodway Construction Permitting – All projects proposed under the preferred plan that involve construction in a regulatory floodway would comply with the rules set forth in 17 Ill. Adm. Code, Chapter I, Part 3708 (Floodway Construction in Northeastern Illinois). There are no outstanding reasons to believe that floodway construction permits would not be granted for any given project, seeing that one of the major objectives of the projects is to reduce flood risk. Every project that requires a floodway construction permit would complete appropriate engineering analysis and permit applications during the design phase. This information would be provided to the IDNR, OWR on a per project basis unless the project qualified for a statewide or regional permit. No project requiring a floodway construction permit would begin construction without the permit issued.

Dam Removal Permitting: All dam removal projects proposed under the preferred plan would comply with the rules set forth 17 Ill. Adm. Code, Chapter I, Part 3702, Construction, Operation, and Maintenance of Dams. There are no outstanding reasons to believe that dam removal permits would not be granted for any given project, seeing that coordination with IDNR-OWR will occur during studies and the development of permit applications as recommended by the regulatory agency. Every project that requires a dam removal permit would complete appropriate engineering analysis and permit applications during the design phase. This information would be provided to IDNR-OWR on a per project basis. No project requiring a dam removal permit would begin construction without the permit issued.

Roadway Permitting: Any work performed within the IDOT Right-of-Way (ROW) requires a Highway Permit from IDOT. During the design phase, IDOT requires review of the proposed design plans and specifications. Coordination is required to ensure that all comments are adequately addressed prior to completion of the design. Permitting requirements include completion of the Highway Permit Form (BT-1045), Individual Highway Permit Bond Form (BT-1046) to include the owner's and contractor's signatures, and a bond in the amount of $1,000,000 submitted by the contractor.

Utility Coordination: Similar to the City of Chicago Office of Underground Coordination utility review requirements, some local municipalities require review of the proposed design for possible impacts to utilities. Local municipalities will be contacted to determine their requirements for addressing utility impacts.

11.5 Recommendation

I have considered all significant aspects of the problems and opportunities as they relate to the Flood Risk Management and Ecosystem Restoration in the watershed of the Upper Des Plaines River and its tributaries in the overall public interest. Those aspects include environmental, social, and economic effects, as well as engineering feasibility.

I recommend the approval and implementation of the NED/NER Plan as described above and the conversion of sites included in the CAP Plan to that program for implementation under appropriate authorities. These plans will provide FRM, ecosystem restoration, recreation, and incidental water quality benefits. The estimated cost for implementation of all elements of the NED/NER Plan is $307,087,000 with $161,284,000 for the NER portion and $145,803,000 for the NED portion. The estimated cost for implementation of all elements of the CAP Plan is $9,247,000.

Corps ecosystem restoration policy requires that land acquisition in ecosystem restoration plans be kept to a minimum. Project proposals that consist primarily of land acquisition are not appropriate. As a target, land value should not exceed 25 percent of total project costs. Projects with land costs exceeding this target level are not likely to be given a high priority for budgetary purposes.

This plan is being recommended with such modifications thereof as in the discretion of the Commander of the US Army Corps of Engineers may be advisable. The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Secretary of the Army as proposals for authorization and implementation funding. However, the non-Federal interests, the State of Illinois, interested Federal agencies, and other parties will be advised of any modification and will be afforded an opportunity to comment further.

In accordance with the NEPA of 1969 and Section 122 of the River and Harbor and Flood Control Act of 1970, the U.S. Army Corps of Engineers (Chicago District) has assessed the environmental impacts associated with this project. The purpose of this Environmental Assessment is to evaluate the impacts that would be associated with the preferred plan.

The assessment process indicates that this project would not cause significant effects on the quality of the human environment in the areas of construction and have only beneficial impacts upon the ecological, biological, social, cultural, or physical resources of the Upper Des Plaines River watershed as a whole. The findings indicate that the proposed action is not a major Federal action significantly affecting the quality of the human environment. Therefore, I have determined that an Environmental Impact Statement is not required.

Christopher T. Drew
Colonel, U.S. Army
District Commander

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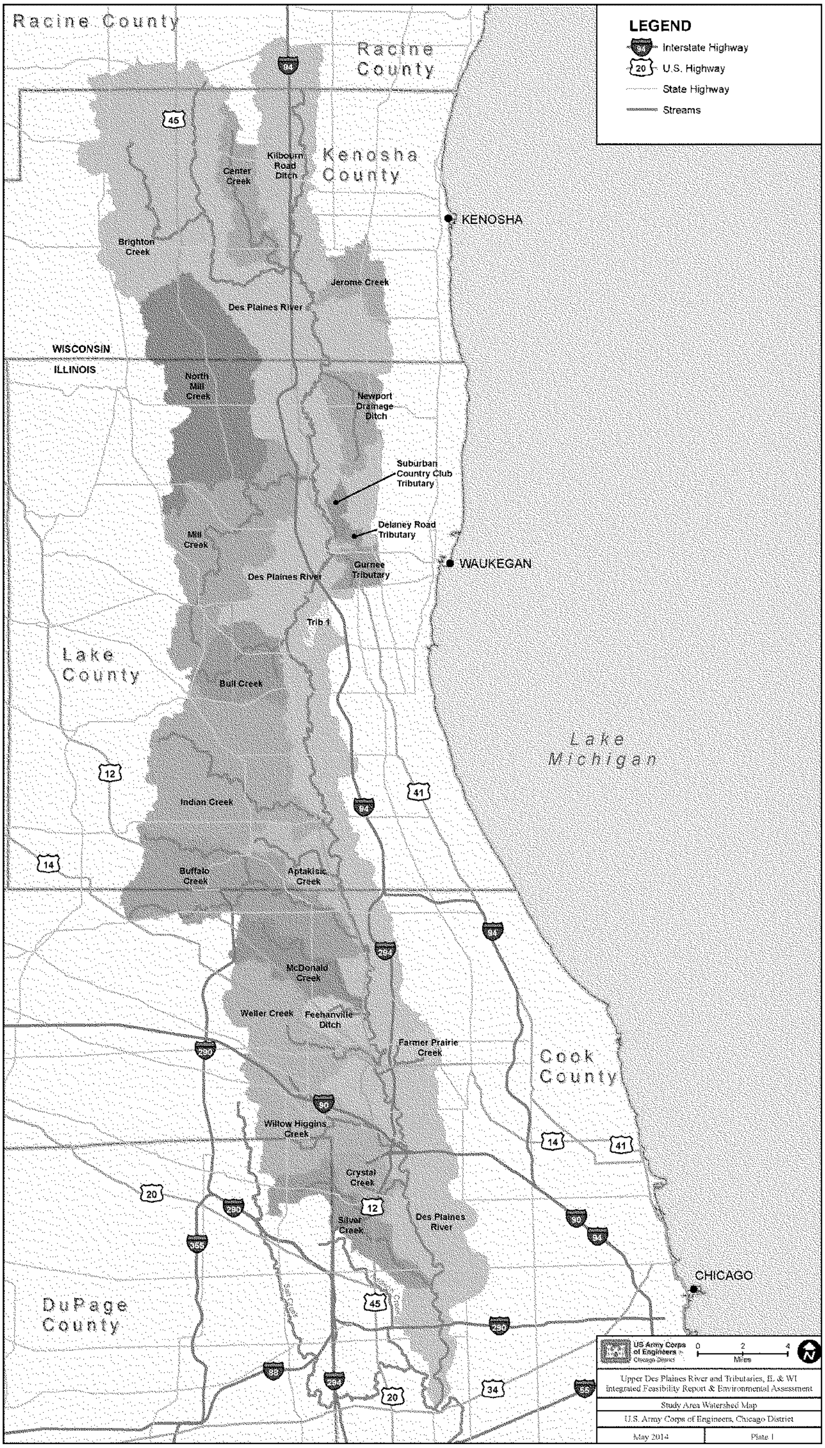
13 Acronyms and Abbreviations

AAD	Average Annual Damages
AFB	Alternative Formulation Briefing
ASTM	American Society for Testing and Materials
ATR	Agency Technical Review
BCR	Benefit to Cost Ratio
BMP	Best Management Practices
CCHD	Cook County Highway Department
CE	Cost Effective
CELRB	USACE Buffalo District
CELRC	USACE Chicago District
CELRL	USACE Louisville District
CELRN	USACE Nashville District
CEMVR	USACE Rock Island District
CENWW	USACE Walla Walla District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMAP	Chicago Metropolitan Agency for Planning
C:N	Carbon to Nitrogen
CPI-U	Universal Consumer Price Indices
C-SELM	Chicago – South End of Lake Michigan Urban Water Damage Study
CSO	Combined Sewer Overflow
CWA	Clean Water Act
DNR	Department of Natural Resources
DFAL	Diverse Fish and Aquatic Life
DFIRM	Digital Flood Insurance Rate Maps
DO	Dissolved Oxygen
DP	Dissolved Phosphorus
EAD	Equivalent Annual Damages
ECO PCX	National Ecosystem Planning Center of Expertise
EGM	Engineering Guidance Memorandum
EOP	Environmental Operating Principle
EPA	Environmental Protection Agency
ER	Ecosystem Restoration
ERDC	Engineer Research and Development Center
E-Team	Interagency Ecosystem Assessment Team
FCI	Functional Capacity Index
FCU	Functional Capacity Units
FEMA	Federal Emergency Management Agency
FPDCC	Forest Preserve District of Cook County
LCFPD	Lake County Forest Preserve District
FQI	Floristic Quality Index
FRM	Flood Risk Management
FRM PCX	Flood Risk Management Planning Center of Expertise
FWOP	FWOP Conditions
FWP	Future With Project

GIS	Geographic Information Systems
HAZUS	FEMA Hazard Data
HCB	Hexachlorobenzene
HEC-1	USACE Hydrologic Engineering Center hydrologic model
HEC-2	USACE Hydrologic Engineering Center hydraulic model
HEC-FDA	Hydrologic Engineering Center Flood Damage Analysis Model
HEC-RAS	Hydrologic Engineering Center River Analysis System
HEP	Habitat Evaluation Procedure
HGM	Hydrogeomorphic Assessment
HSI	Habitat Suitability Index
HQUSACE	U.S. Army Corps of Engineers Headquarters
HTRW	Hazardous, Radioactive and Toxic Waste
HUs	Habitat Units
IBI	Index of Biotic Integrity
ICA	Incremental Cost Analysis
IDNR	Illinois Department of Natural Resources
IDNR-OWR	Illinois Department of Natural Resources-Office of Water Resources
IDOT	Illinois Department of Transportation
IEMA	Illinois Emergency Management Agency
IEPA	Illinois Environmental Protection Agency
INAI	Illinois Natural Areas of Inventory
ISWS	Illinois State Water Survey
IWR	Institute for Water Resources
LCFPD	Lake County Forest Preserve District
LCDOT	Lake County Department of Transportation
LCSMC	Lake County Stormwater Management Commission
LER	Lands, Easements, and Rights-of-way
LERRDs	Lands, Easements, Right-of-Way, Relocations, and Disposal Areas
LIDAR	Light Detection and Ranging
LRR	Limited Reevaluation Report
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NFIP	National Flood Insurance Program
NIPC	Northern Illinois Planning Commission
NAVD 1988	North American Vertical Datum 1988
NGVD 1929	National Geographic Vertical Datum 1929
NPDES	National Pollution Discharge Elimination System
NRCS	National Resources Conservation Service
O&M	Operation and Maintenance
OMRR&R	Operation, Maintenance, Repair, Rehabilitation and Replacement
P&G	Principles & Guidelines
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenals
PED	Preconstruction Engineering and Design
PDT	Project Delivery Team

P.L.	Public Law
PPA	Project Partnership Agreement
QHEI	Qualitative Habitat Evaluation Index
SC-RB	Separable Cost-Remaining Benefit
SCS	Soil Conservation Service
SEWRPC	Southeastern Wisconsin Regional Planning Commission
SI	Suitability Index
SMC	Stormwater Management Commission
TDS	Total Dissolved Solids
TP	Total Phosphorus
TS	Total Solids
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VISTA	Visual Interactive System for Transportation Algorithms
WDNR	Wisconsin Department of Natural Resources
WQ	Water Quality



LEGEND
Interstate Highway
U.S. Highway
State Highway
Streams
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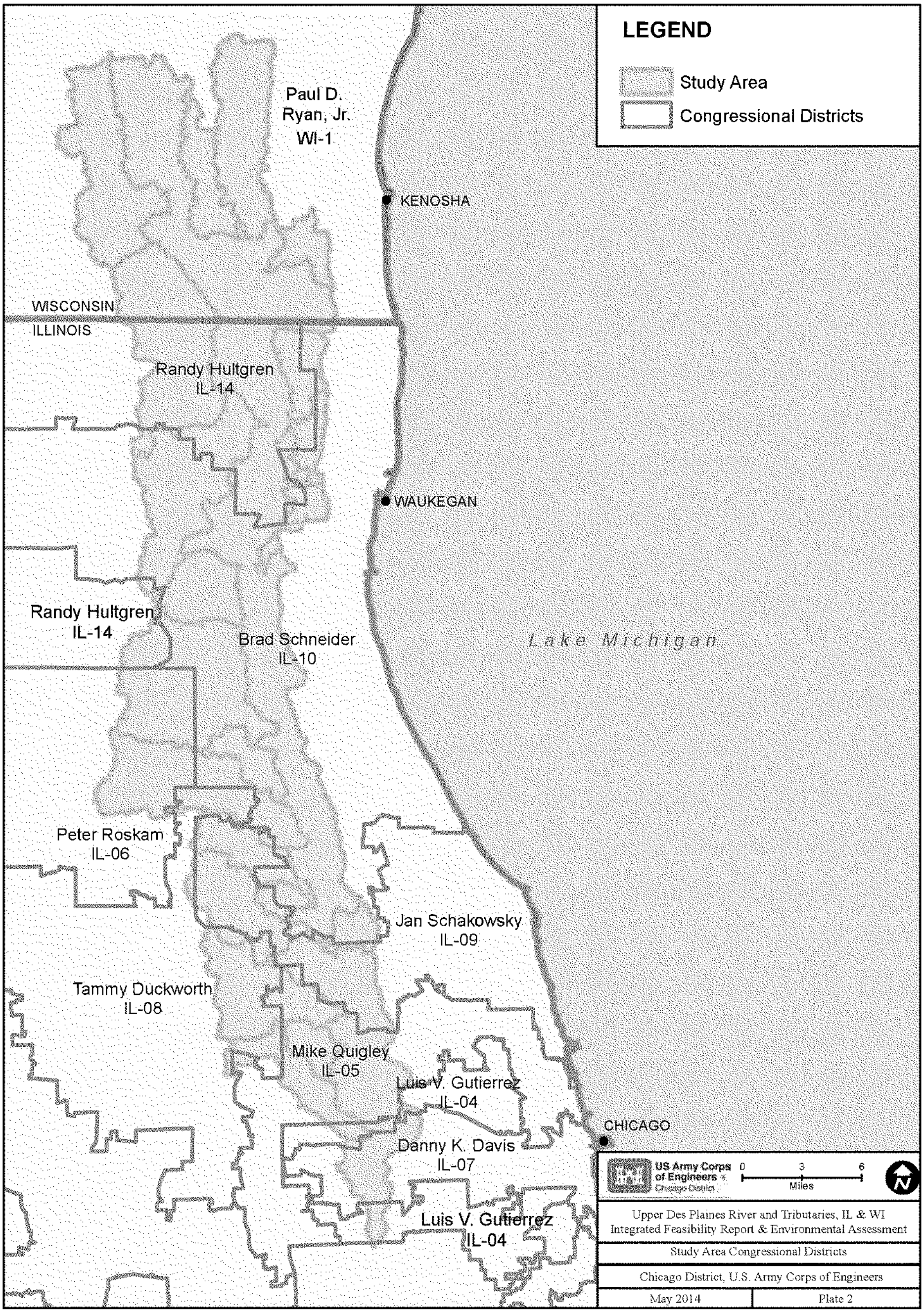
Racine County
Kenosha County
KENOSHA
WAUKEGAN
CHICAGO
Lake County
Cook County
DuPage County
Lake Michigan
WISCONSIN
ILLINOIS
Brighton Creek
Center Creek
Kilbourn Road Ditch
Jerome Creek
Des Plaines River
North Mill Creek
Newport Drainage Ditch
Suburban Country Club Tributary
Delaney Road Tributary
Mill Creek
Gurnee Tributary
Des Plaines River
Trib 1
Bull Creek
Indian Creek
Buffalo Creek
Aptakisic Creek
McDonald Creek
Weller Creek
Feehanville Ditch
Farmer Prairie Creek
Willow Higgins Creek
Crystal Creek
Silver Creek
Des Plaines River
US Army Corps of Engineers
Miles
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Study Area Watershed Map
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 1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Study Area
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KENOSHA
WISCONSIN
ILLINOIS
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WAUKEGAN
Randy Hultgren IL-14
Brad Schneider IL-10
Lake Michigan
Peter Roskam IL-06
Jan Schakowsky IL-09
Tammy Duckworth IL-08
Mike Quigley IL-05
Luis V. Gutierrez IL-04
CHICAGO
Danny K. Davis IL-07
Luis V. Gutierrez IL-04
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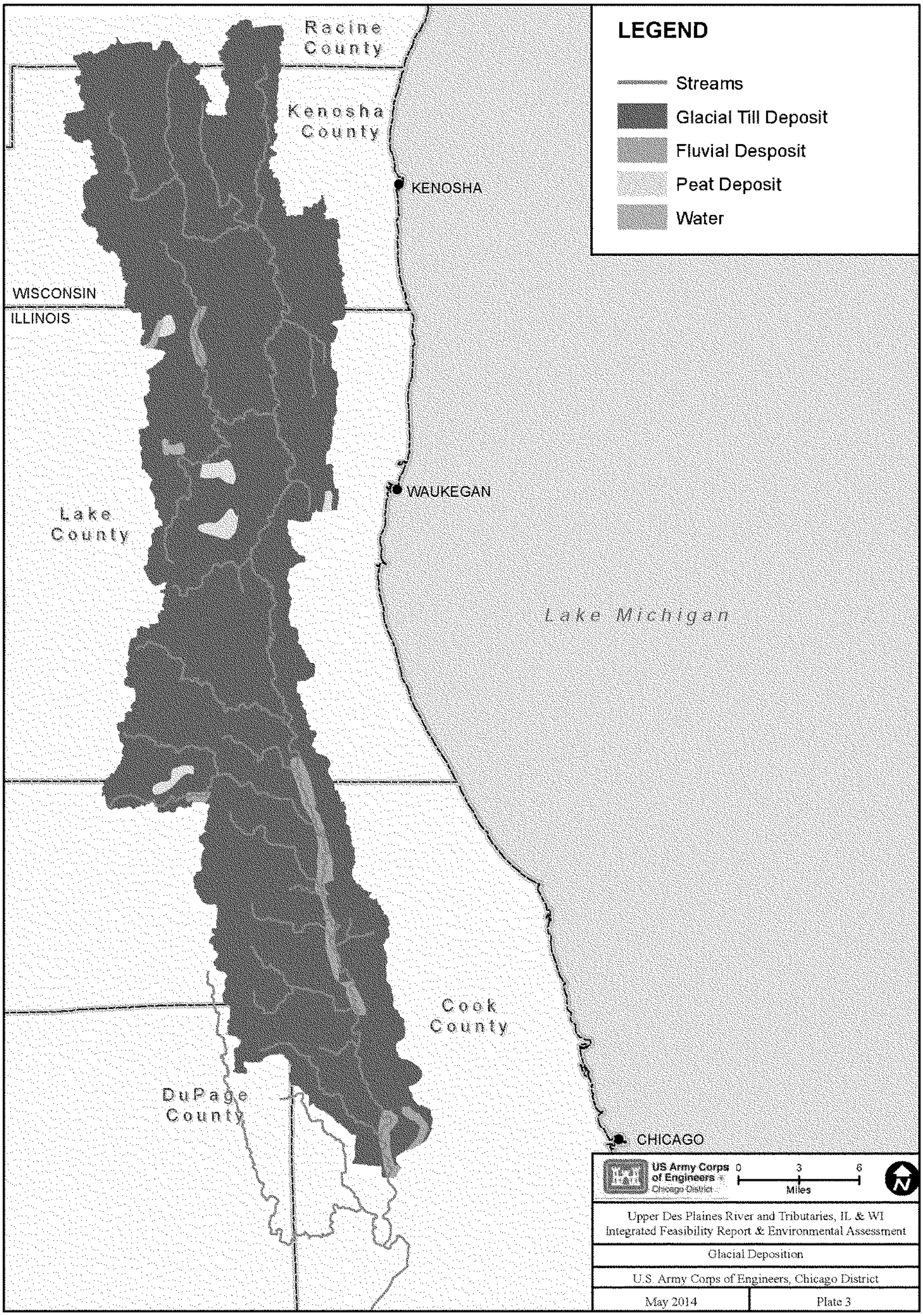
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Study Area Congressional Districts
Chicago District, U.S. Army Corps of Engineers
May 2014
Plate 2


LEGEND
Streams
Glacial Till Deposit
Fluvial Desposit
Peat Deposit
Water
Racine County
Kenosha County
KENOSHA
WISCONSIN
ILLINOIS
WAUKEGAN
Lake County
Lake Michigan
Cook County
DuPage County
CHICAGO
US Army Corps of Engineers
Chicago District
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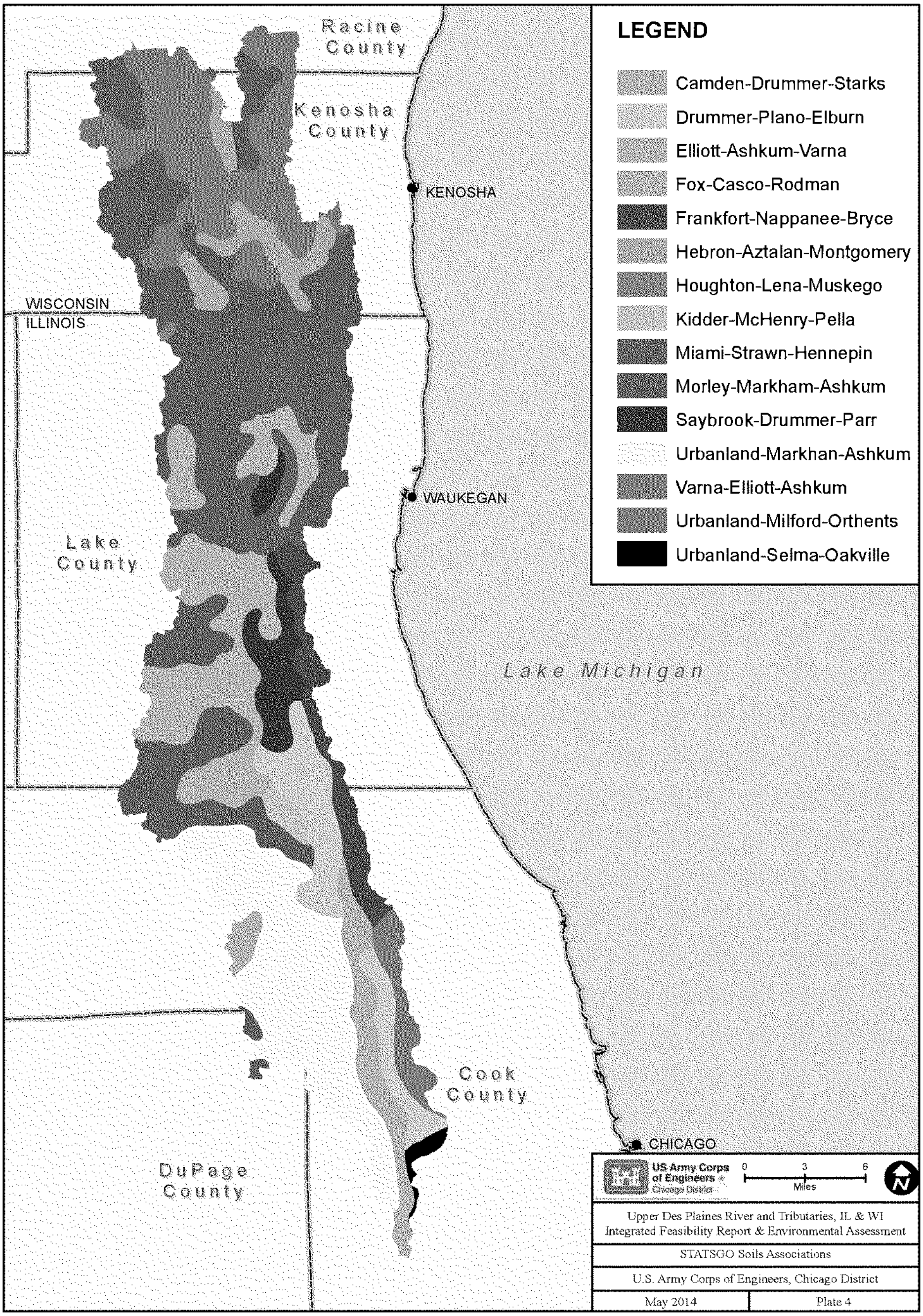
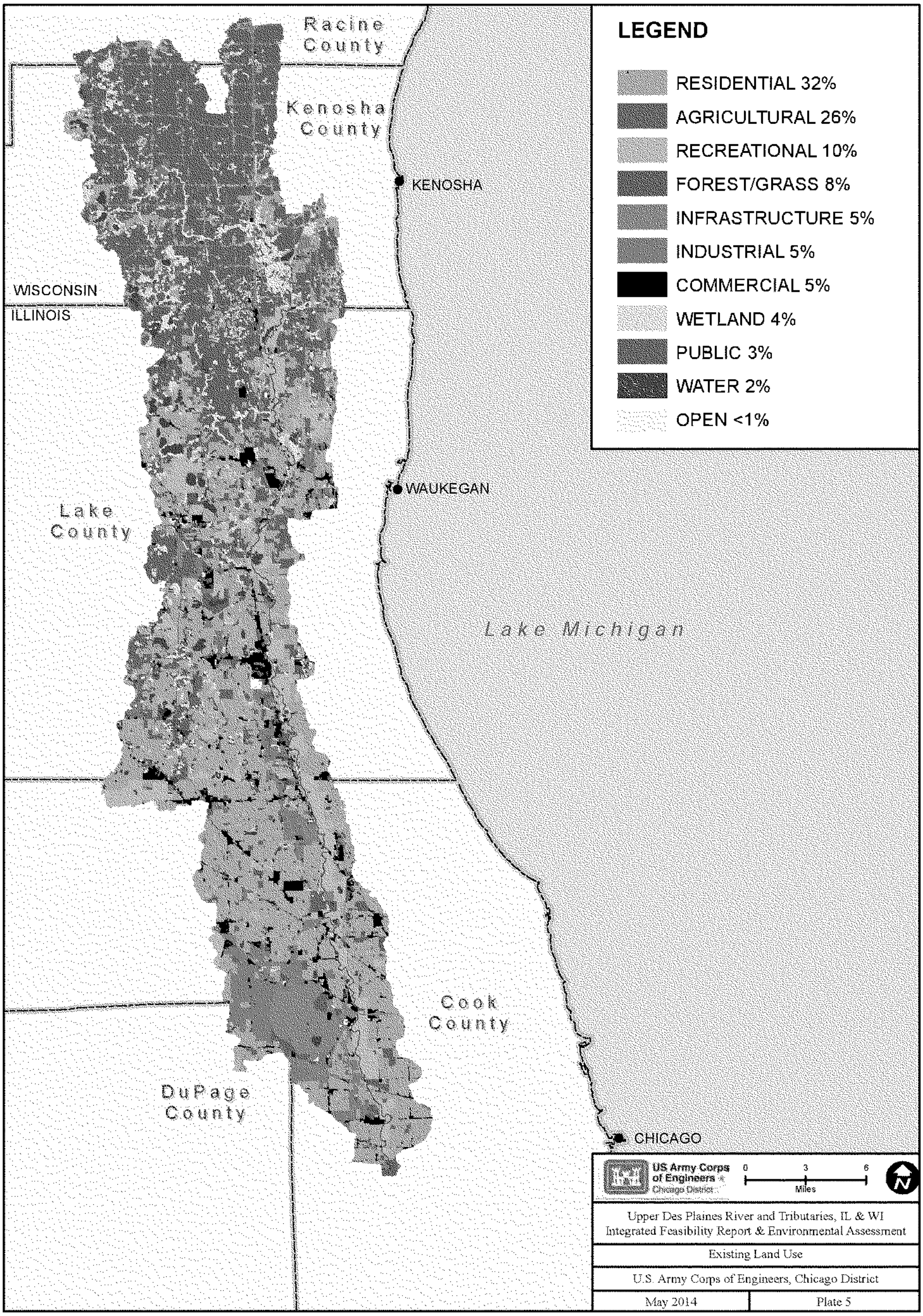
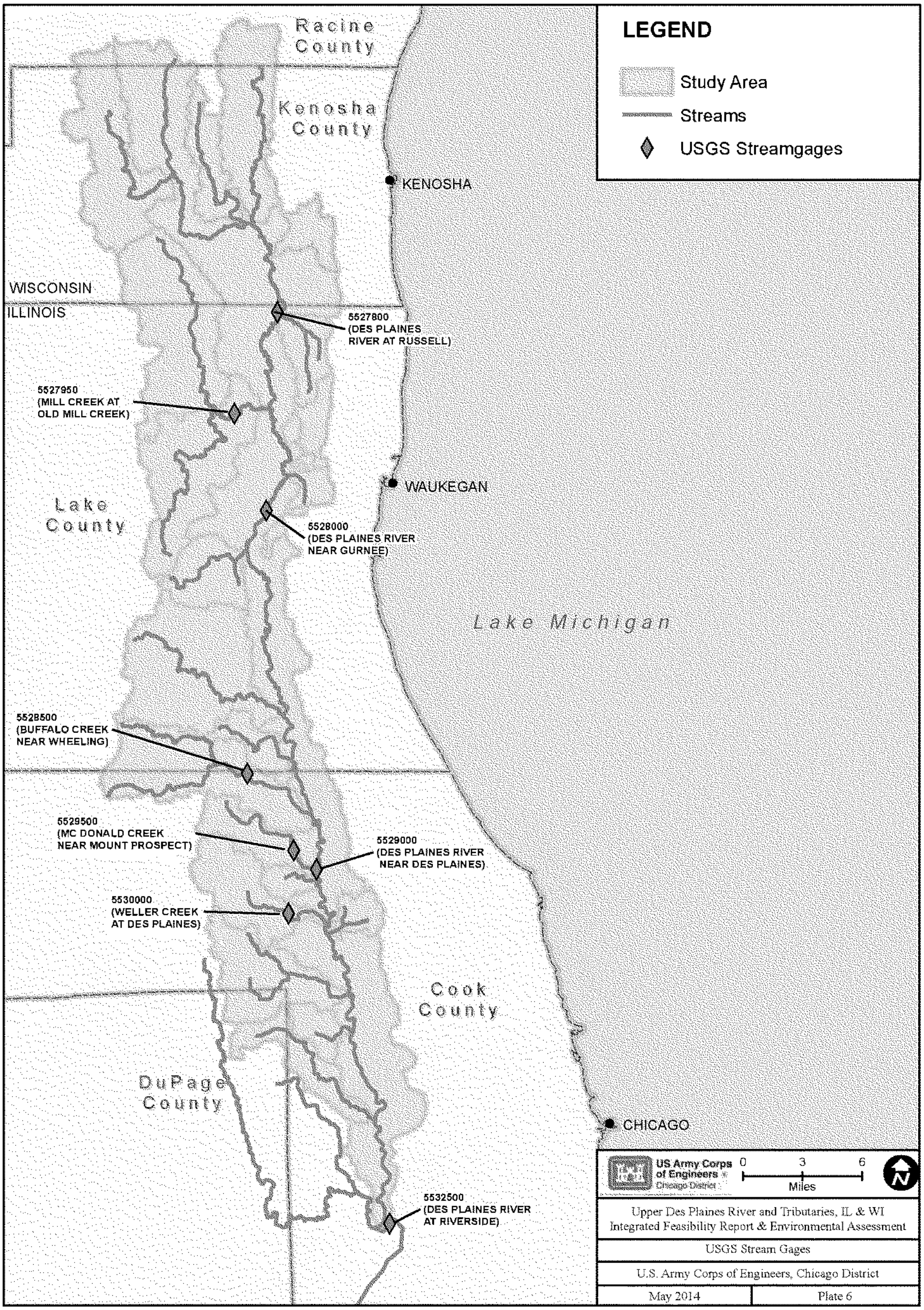
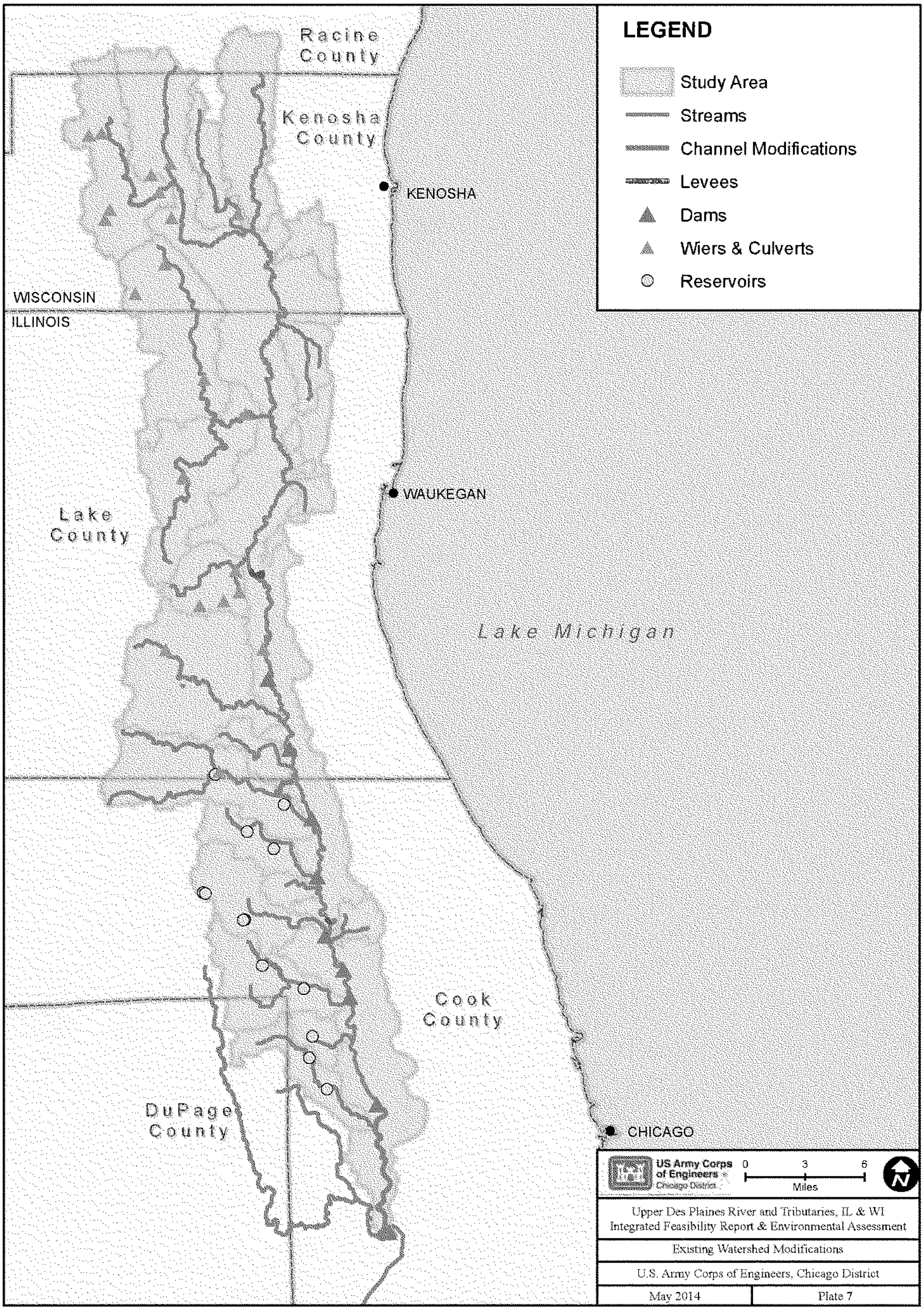
Miles
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Glacial Deposition
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 3

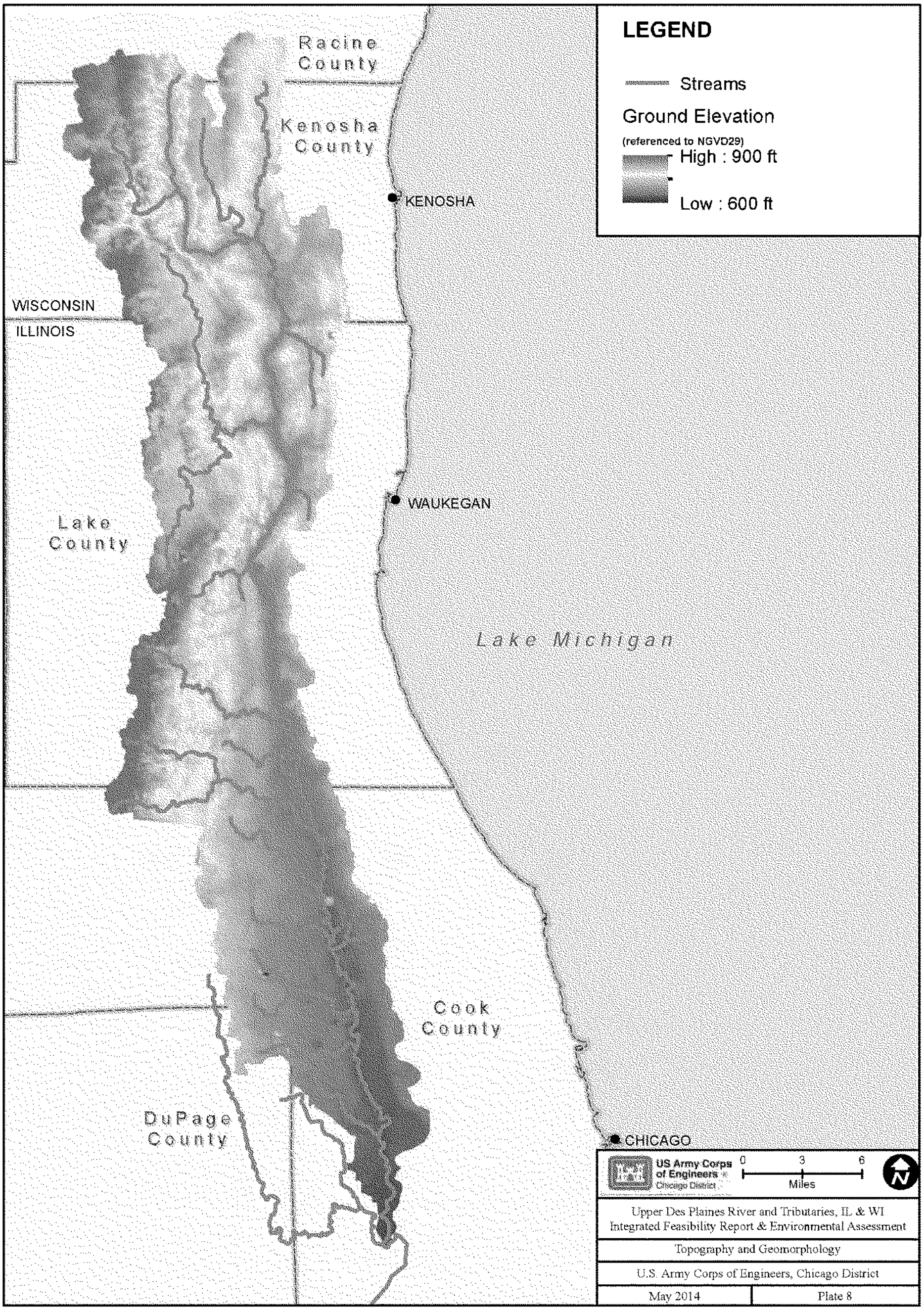


Racine County
Kenosha County
KENOSHA
WISCONSIN
ILLINOIS
WAUKEGAN
Lake County
Lake Michigan
Cook County
DuPage County
CHICAGO
LEGEND
Camden-Drummer-Starks
Drummer-Plano-Elburn
Elliott-Ashkum-Varna
Fox-Casco-Rodman
Frankfort-Nappanee-Bryce
Hebron-Aztalan-Montgomery
Houghton-Lena-Muskego
Kidder-McHenry-Pella
Miami-Strawn-Hennepin
Morley-Markham-Ashkum
Saybrook-Drummer-Parr
Urbanland-Markhan-Ashkum
Varna-Elliott-Ashkum
Urbanland-Milford-Orthents
Urbanland-Selma-Oakville
US Army Corps of Engineers
Chicago District
0 3 6
Miles
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
STATSGO Soils Associations
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 4


Racine County
Kenosha County
KENOSHA
WISCONSIN
ILLINOIS
WAUKEGAN
Lake County
Lake Michigan
Cook County
DuPage County
CHICAGO
LEGEND
RESIDENTIAL 32%
AGRICULTURAL 26%
RECREATIONAL 10%
FOREST/GRASS 8%
INFRASTRUCTURE 5%
INDUSTRIAL 5%
COMMERCIAL 5%
WETLAND 4%
PUBLIC 3%
WATER 2%
OPEN <1%
US Army Corps of Engineers
Chicago District
0 3 6
Miles
N
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Existing Land Use
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 5


LEGEND
Study Area
Streams
USGS Streamgages
Racine County
Kenosha County
KENOSHA
WISCONSIN
ILLINOIS
5527800 (DES PLAINES RIVER AT RUSSELL)
5527950 (MILL CREEK AT OLD MILL CREEK)
WAUKEGAN
Lake County
5528000 (DES PLAINES RIVER NEAR GURNEE)
Lake Michigan
5528500 (BUFFALO CREEK NEAR WHEELING)
5529500 (MC DONALD CREEK NEAR MOUNT PROSPECT)
5529000 (DES PLAINES RIVER NEAR DES PLAINES)
5530000 (WELLER CREEK AT DES PLAINES)
Cook County
DuPage County
CHICAGO
5532500 (DES PLAINES RIVER AT RIVERSIDE)
US Army Corps of Engineers Chicago District
0 3 6
Miles
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
USGS Stream Gages
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 6


Racine County
Kenosha County
KENOSHA
WISCONSIN
ILLINOIS
WAUKEGAN
Lake County
Lake Michigan
Cook County
DuPage County
CHICAGO
LEGEND
Study Area
Streams
Channel Modifications
Levees
Dams
Wiers & Culverts
Reservoirs
US Army Corps of Engineers
Chicago District
0 3 6
Miles
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Existing Watershed Modifications
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 7

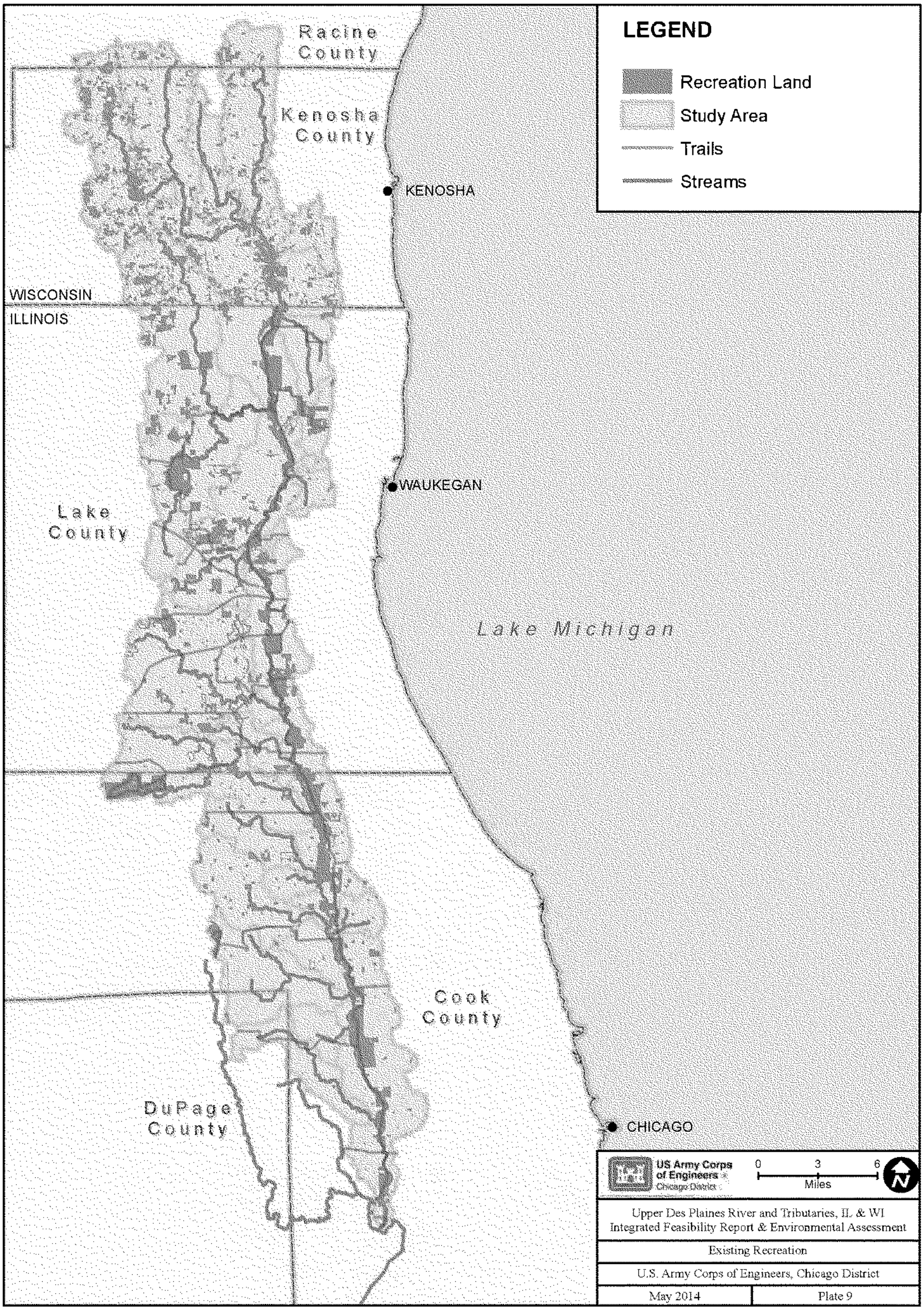


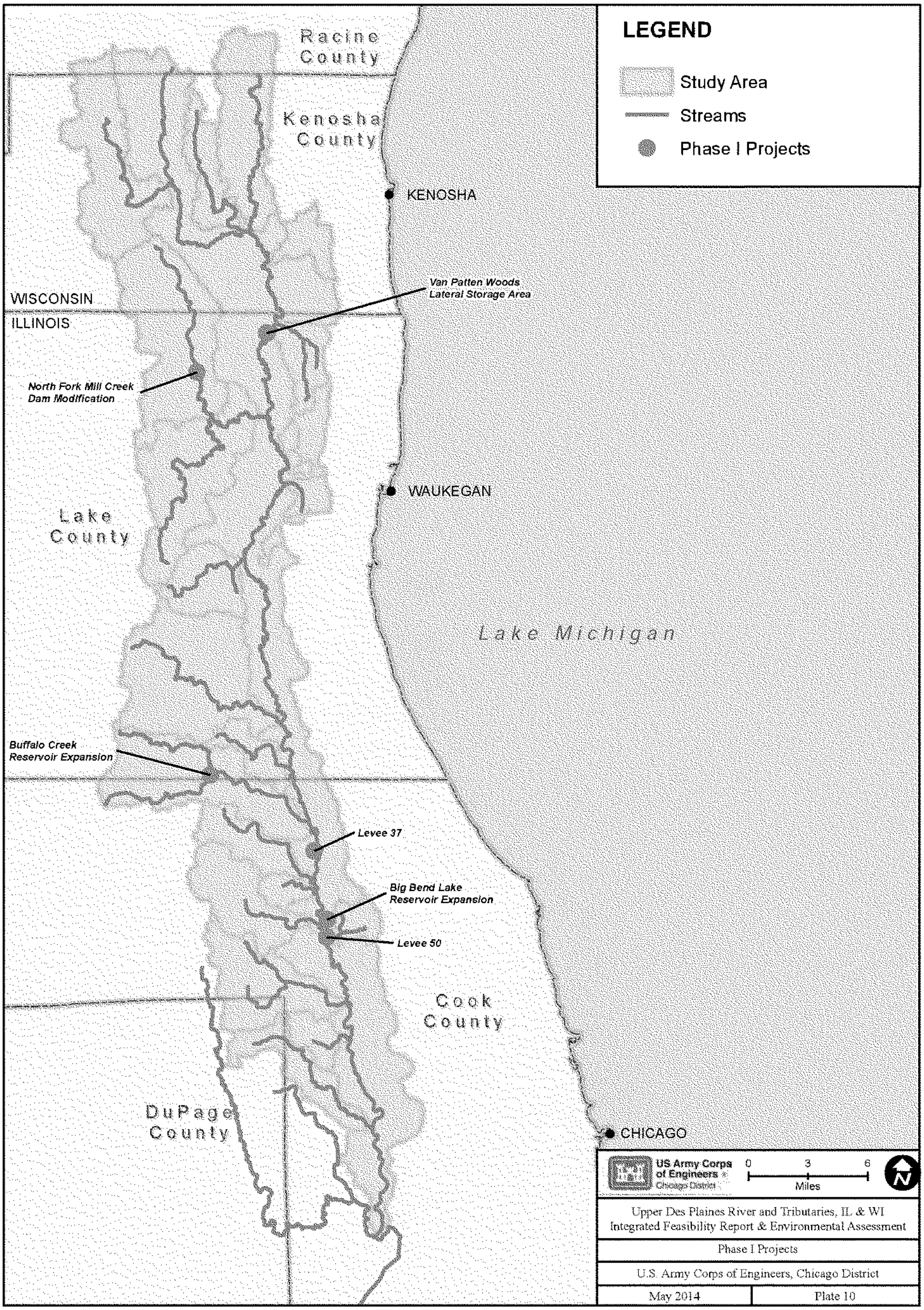
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment

Topography and Geomorphology

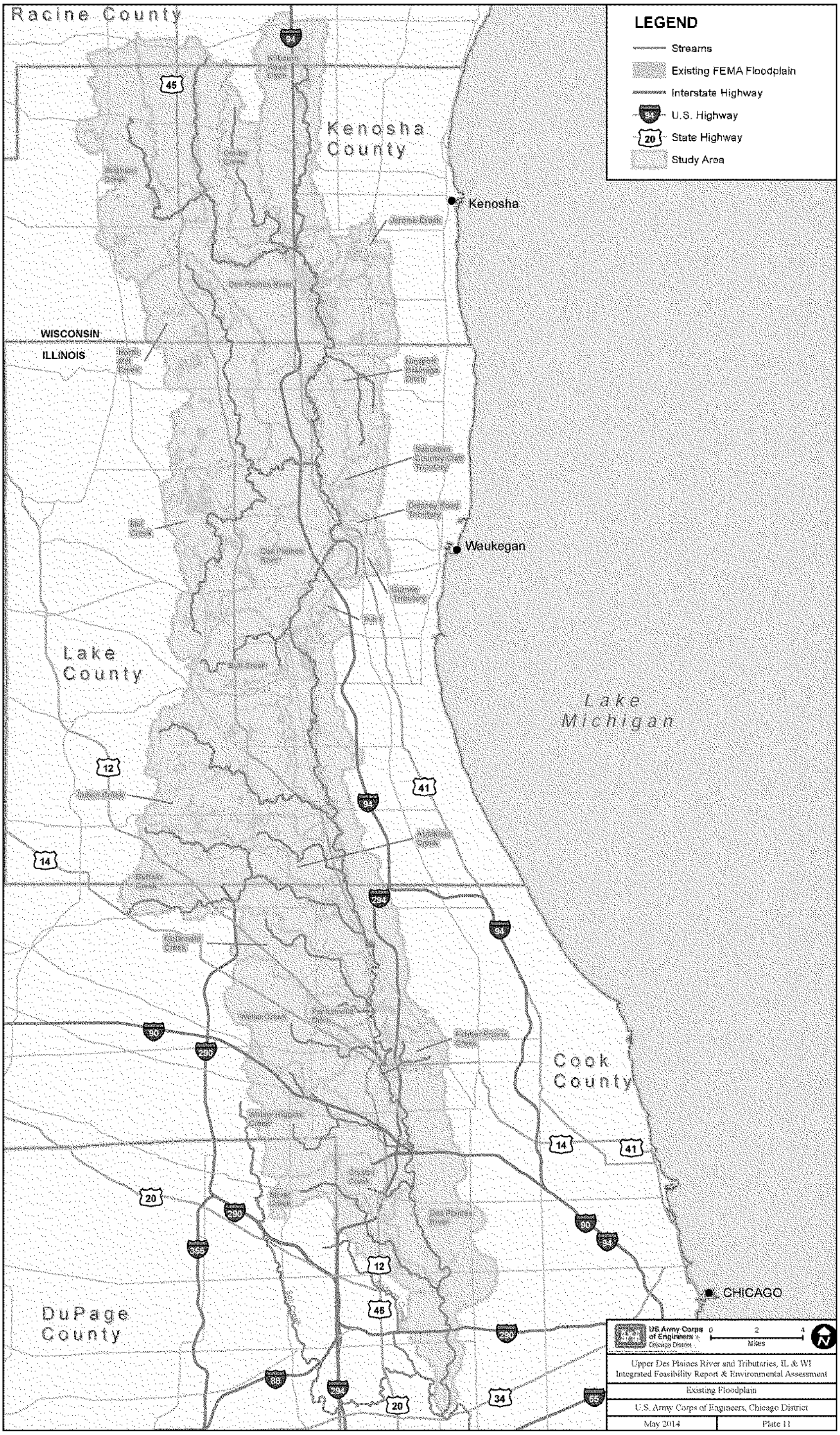
U.S. Army Corps of Engineers, Chicago District

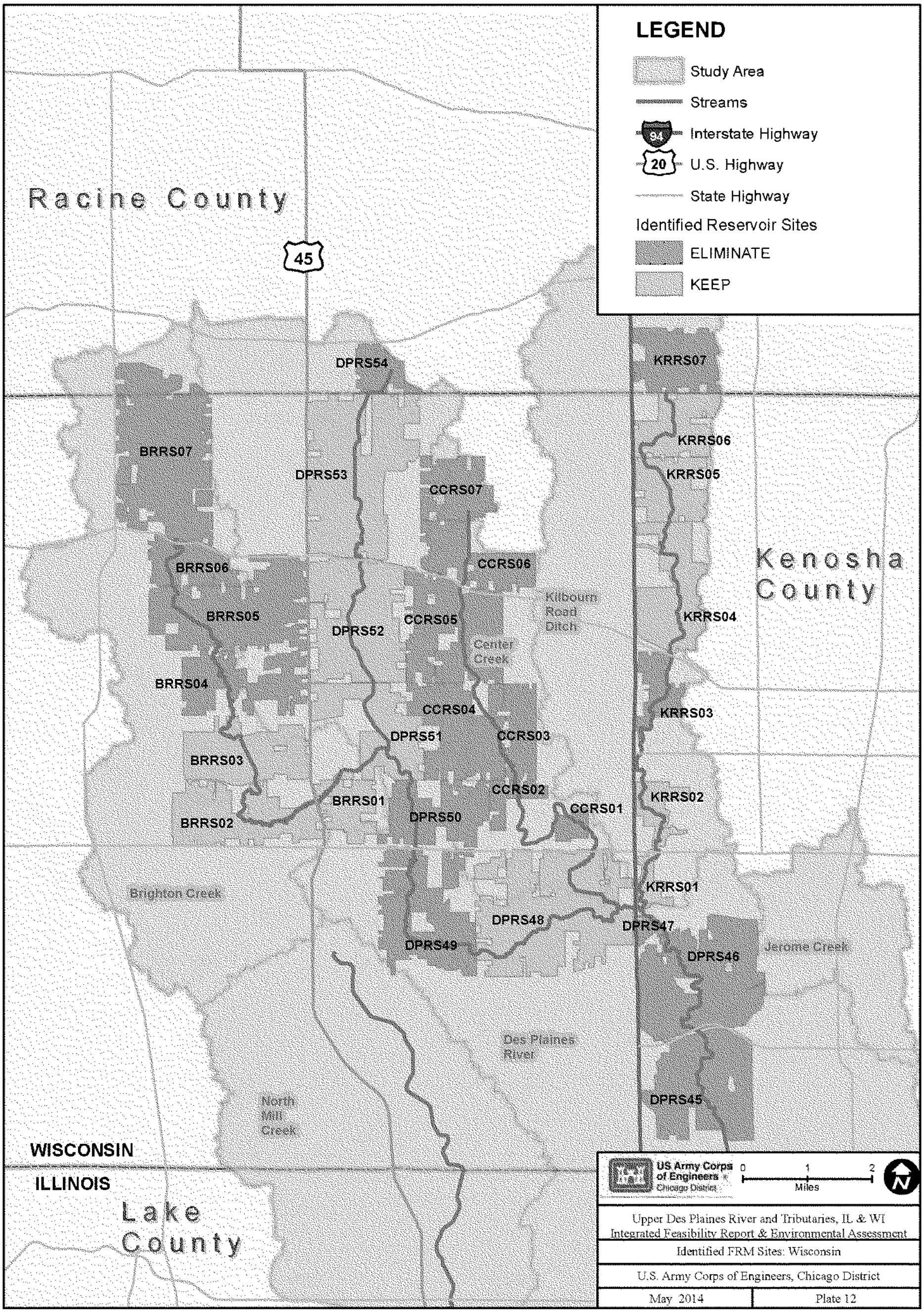
May 2014 | Plate 8

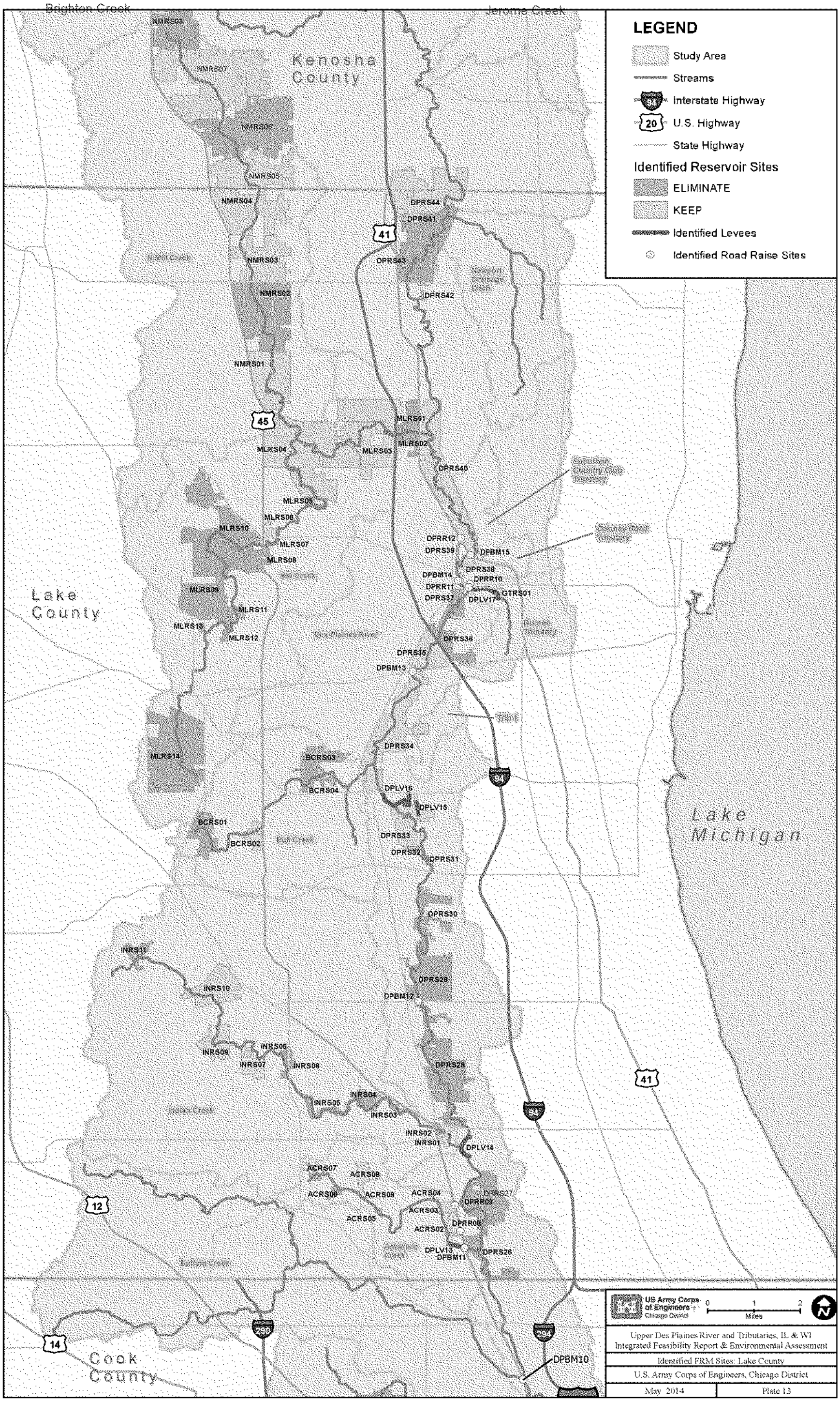

LEGEND
Recreation Land
Study Area
Trails
Streams
Racine County
Kenosha County
KENOSHA
WISCONSIN
ILLINOIS
WAUKEGAN
Lake County
Lake Michigan
Cook County
DuPage County
CHICAGO
US Army Corps of Engineers
Chicago District
0 3 6
Miles
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Existing Recreation
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 9

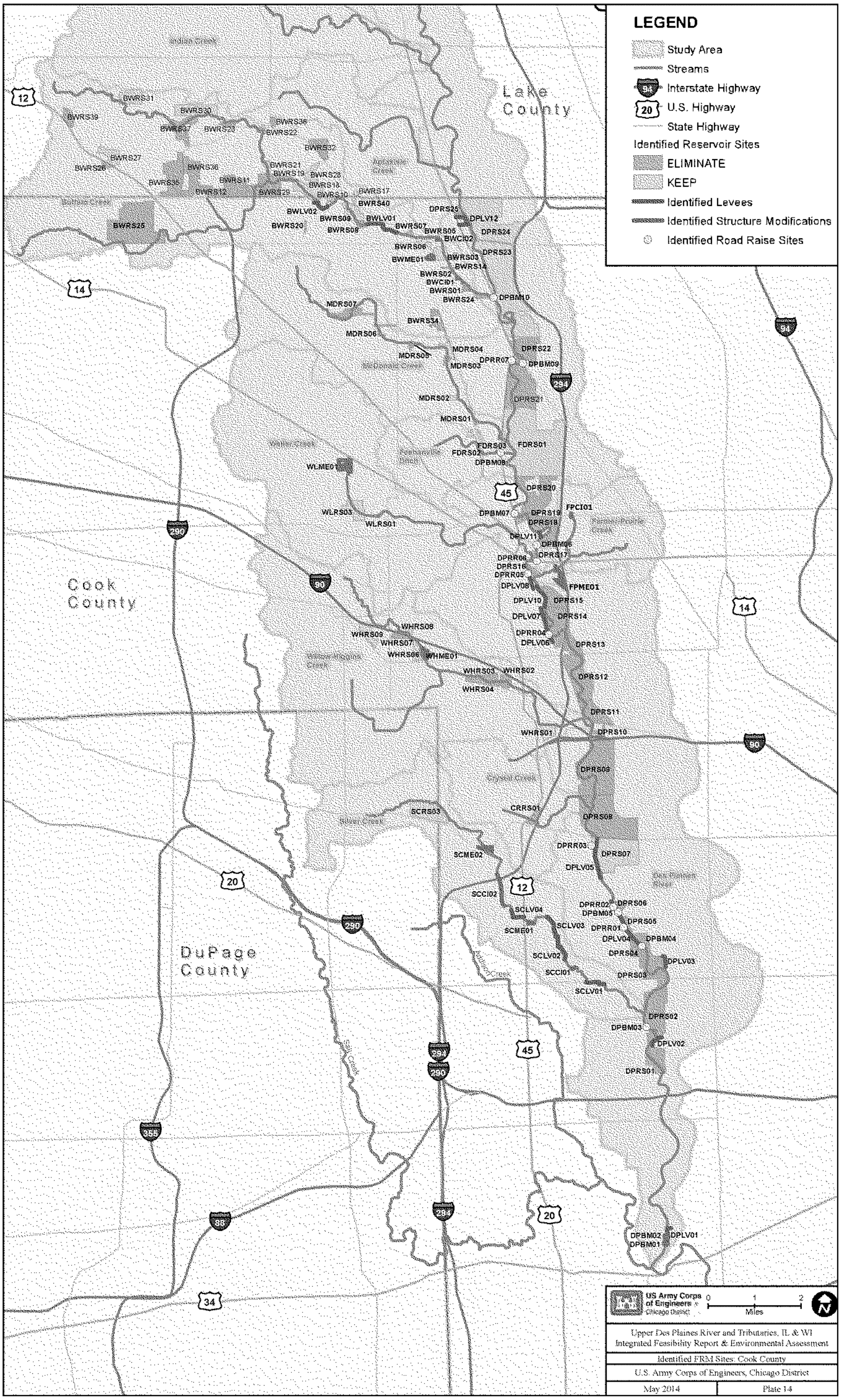


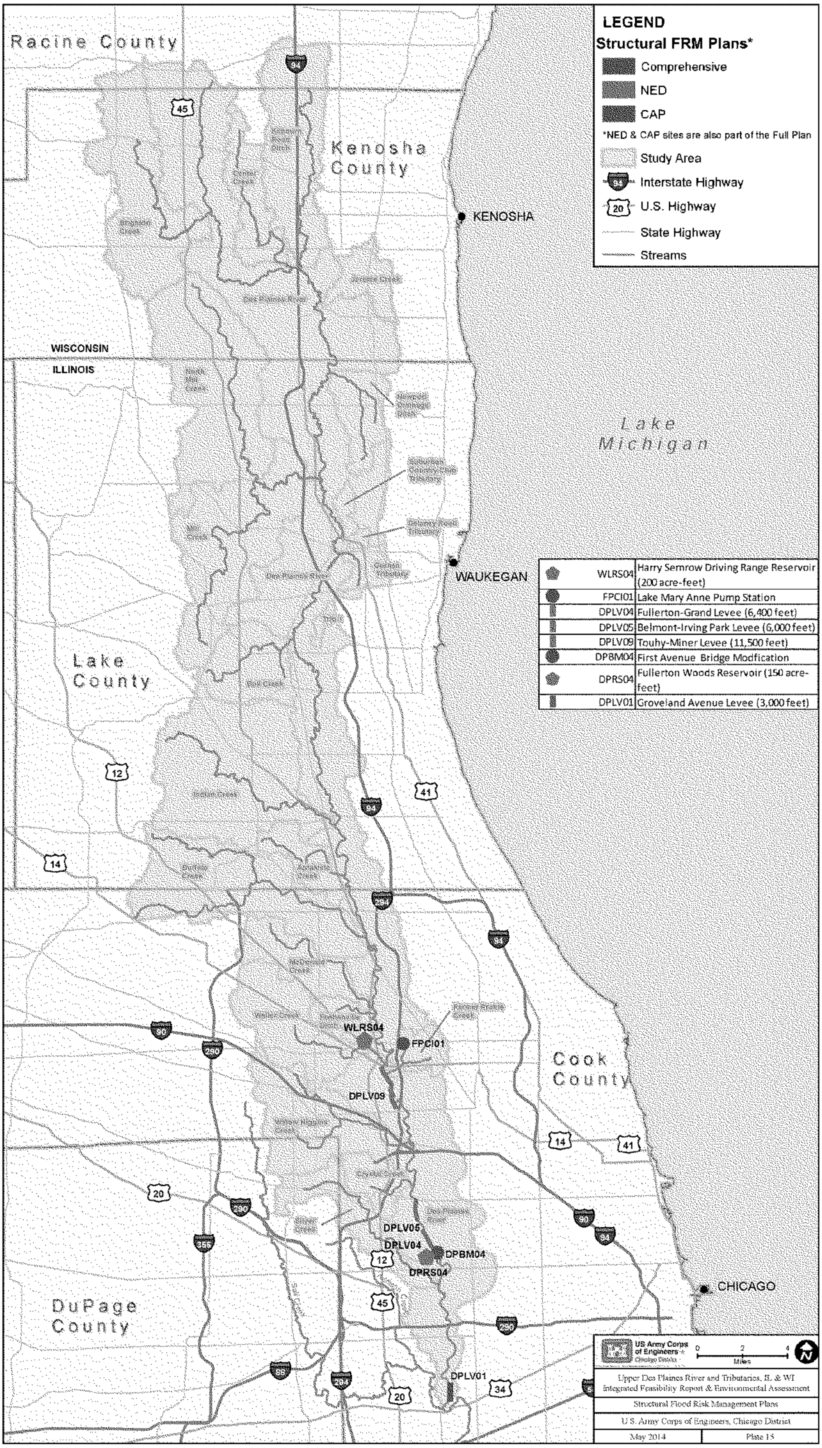
LEGEND
Study Area
Streams
Phase I Projects
Racine County
Kenosha County
KENOSHA
Van Patten Woods Lateral Storage Area
WISCONSIN
ILLINOIS
North Fork Mill Creek Dam Modification
WAUKEGAN
Lake County
Lake Michigan
Buffalo Creek Reservoir Expansion
Levee 37
Big Bend Lake Reservoir Expansion
Levee 50
Cook County
DuPage County
CHICAGO
US Army Corps of Engineers Chicago District
0 3 6
Miles
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Phase I Projects
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 10

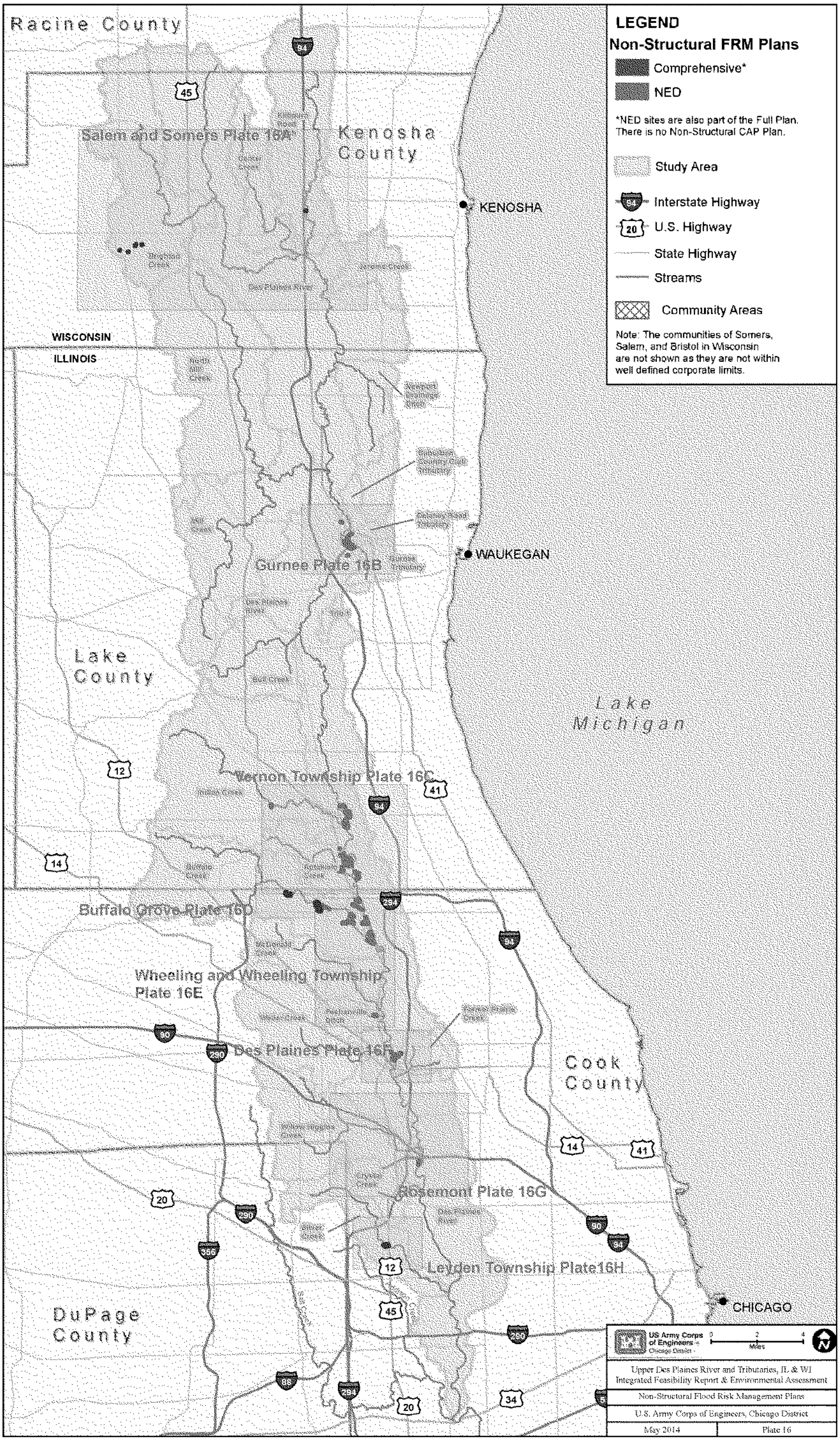

Racine County
Kenosha County
Kenosha
WISCONSIN
ILLINOIS
Waukegan
Lake County
Lake Michigan
Cook County
CHICAGO
DuPage County
LEGEND
Streams
Existing FEMA Floodplain
Interstate Highway
U.S. Highway
State Highway
Study Area
US Army Corps of Engineers
Miles
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Existing Floodplain
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 11

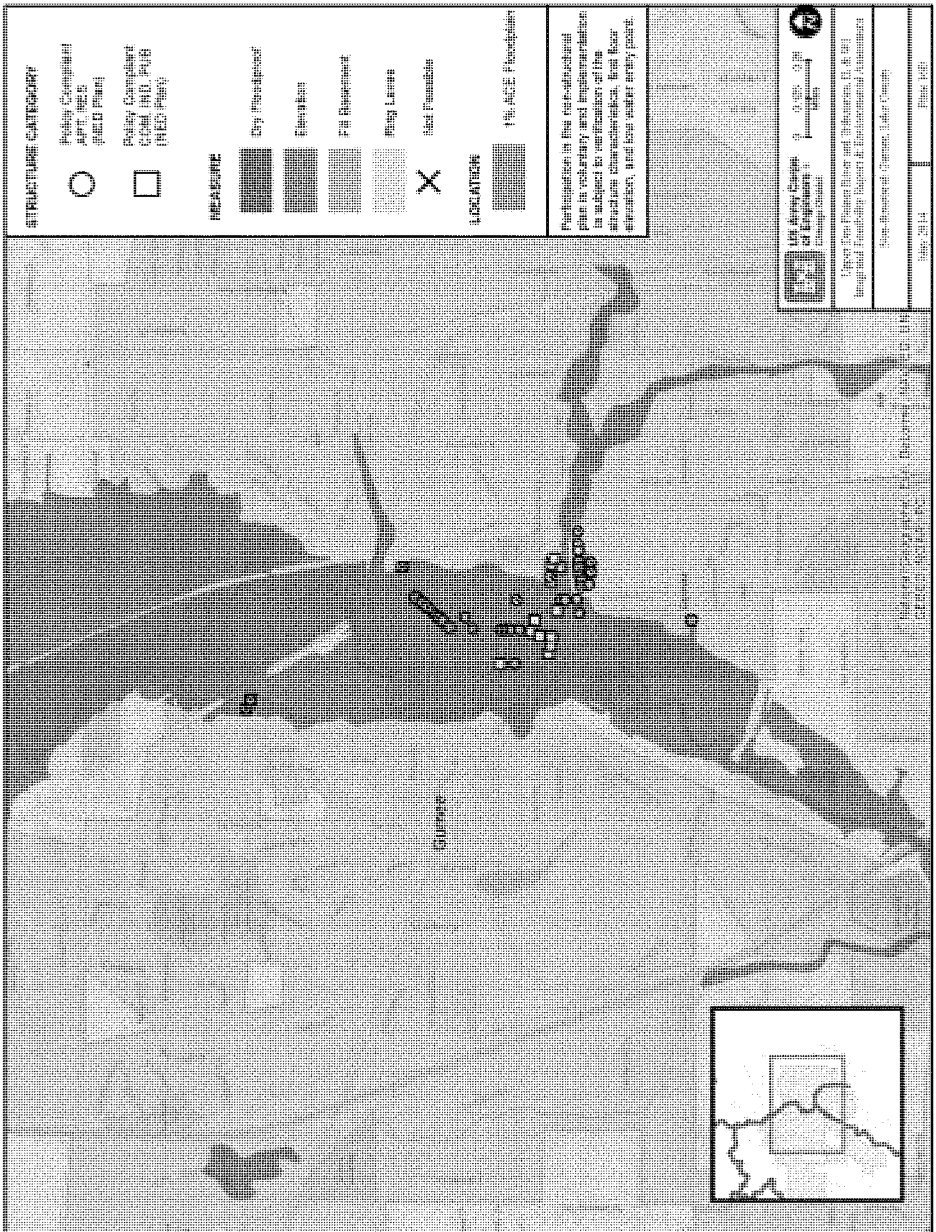

LEGEND
Study Area
Streams
Interstate Highway
U.S. Highway
State Highway
Identified Reservoir Sites
ELIMINATE
KEEP
Racine County
Kenosha County
Lake County
WISCONSIN
ILLINOIS
45
DPRS54
KRRS07
BRRS07
DPRS53
CCRS07
KRRS06
KRRS05
BRRS06
CCRS06
Kilbourn Road Ditch
BRRS05
CCRS05
DPRS52
KRRS04
Center Creek
BRRS04
CCRS04
KRRS03
DPRS51
CCRS03
BRRS03
CCRS02
KRRS02
BRRS01
CCRS01
DPRS50
BRRS02
Brighton Creek
KRRS01
DPRS48
DPRS47
DPRS49
DPRS46
Jerome Creek
Des Plaines River
DPRS45
North Mill Creek
US Army Corps of Engineers
Chicago District
0 1 2
Miles
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Identified FRM Sites: Wisconsin
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 12

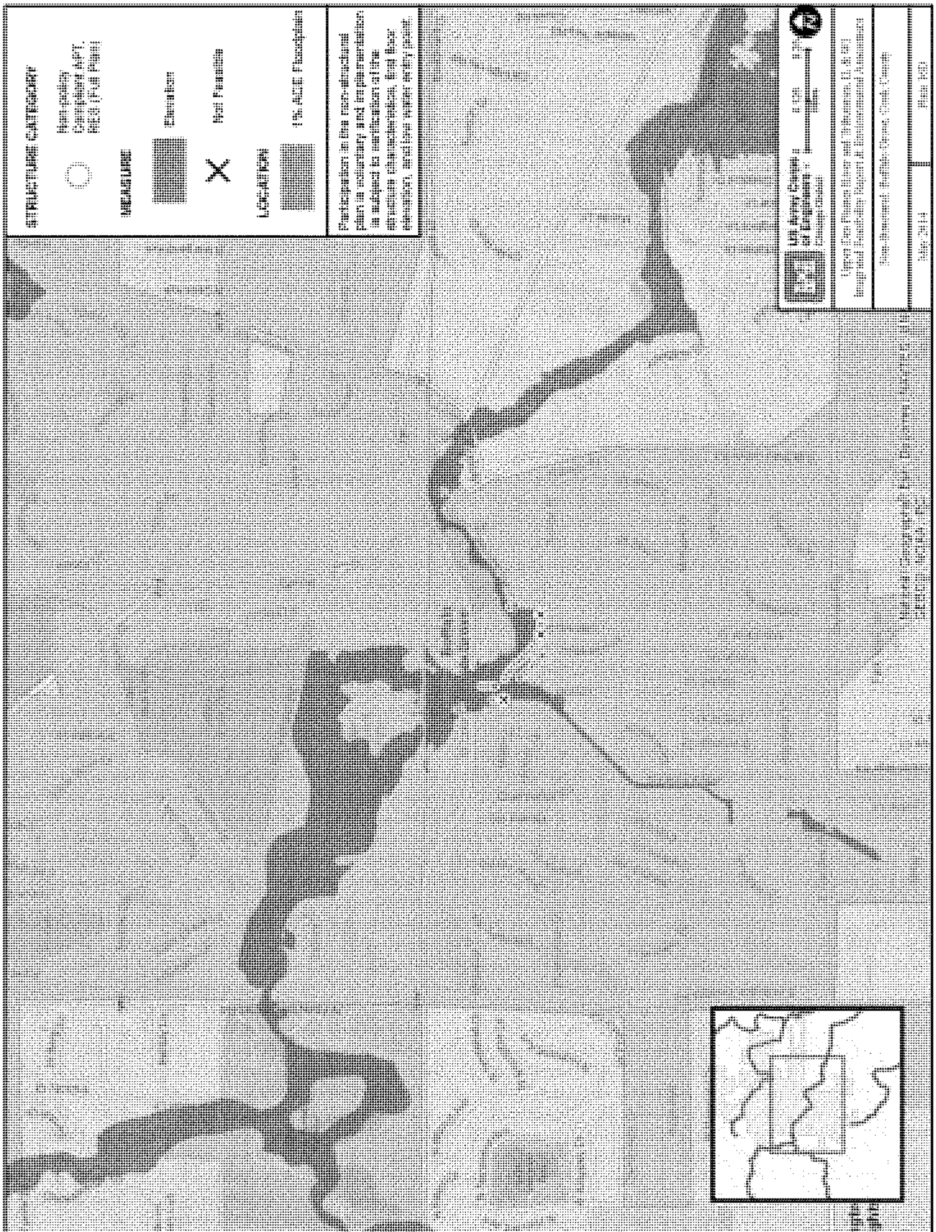

LEGEND
Study Area
Streams
Interstate Highway
U.S. Highway
State Highway
Identified Reservoir Sites
ELIMINATE
KEEP
Identified Levees
Identified Road Raise Sites
Kenosha County
Lake County
Cook County
Lake Michigan
Brighton Creek
Jerome Creek
US Army Corps of Engineers
Upper Des Plaines River and Tributaries, IL & WI Integrated Feasibility Report & Environmental Assessment
Identified FRM Sites: Lake County
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 13

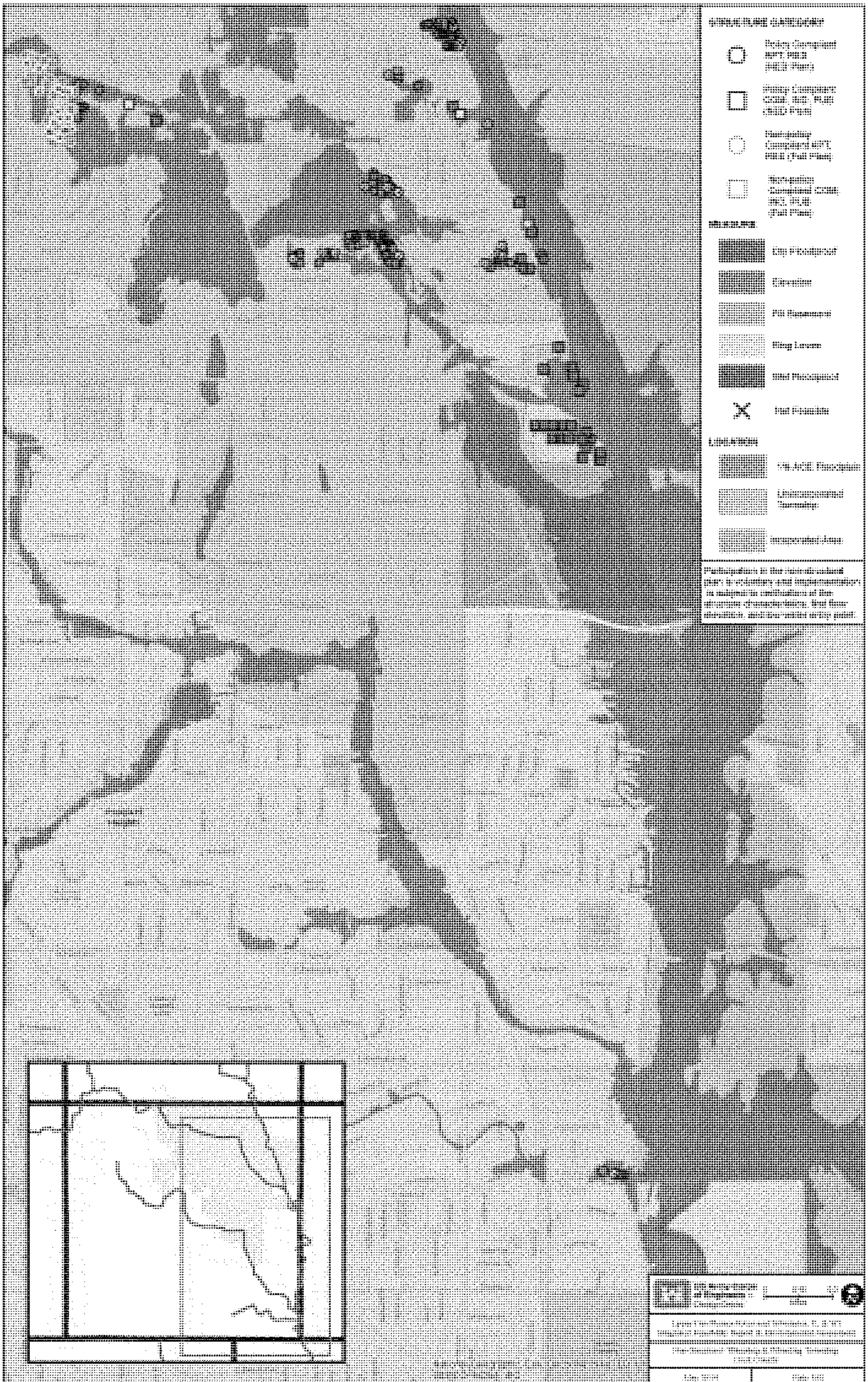

LEGEND
Study Area
Streams
Interstate Highway
U.S. Highway
State Highway
Identified Reservoir Sites
ELIMINATE
KEEP
Identified Levees
Identified Structure Modifications
Identified Road Raise Sites
Lake County
Cook County
DuPage County
BWRS31
BWRS39
BWRS30
BWRS37
BWRS23
BWRS38
BWRS22
BWRS32
BWRS27
BWRS26
BWRS36
BWRS35
BWRS11
BWRS12
BWRS21
BWRS19
BWRS28
BWRS18
BWRS10
BWRS29
BWRS17
BWRS40
BWRS25
BWLV02
BWRS20
BWRS09
BWLV01
BWRS08
BWRS07
BWRS05
BWCI02
BWRS06
BWME01
BWRS03
BWRS14
BWRS02
BWCI01
BWRS01
BWRS24
BWRS34
DPRS25
DPLV12
DPRS24
DPRS23
DPBM10
MDRS07
MDRS06
MDRS04
MDRS05
MDRS03
DPRS22
DPRR07
DPBM09
DPRS21
MDRS02
MDRS01
FDRS03
FDRS01
FDRS02
DPBM08
WLME01
DPRS20
FPCI01
WLRS03
DPBM07
DPRS19
DPRS18
WLRS01
DPLV11
DPBM06
DPRR06
DPRS17
DPRS16
DPRR05
DPLV08
FPME01
DPLV10
DPRS15
DPLV07
DPRS14
WHRS08
WHRS09
DPRR04
WHRS07
DPLV06
DPRS13
WHRS06
WHME01
WHRS03
WHRS02
DPRS12
WHRS04
DPRS11
WHRS01
DPRS10
DPRS09
CRRS01
SCRS03
DPRS08
DPRR03
DPRS07
SCME02
DPLV05
SCCI02
DPRR02
DPRS06
SCLV04
DPBM05
SCME01
SCLV03
DPRR01
DPRS05
DPLV04
DPBM04
DPRS04
SCLV02
DPLV03
SCCI01
DPRS03
SCLV01
DPRS02
DPBM03
DPLV02
DPRS01
DPBM02
DPLV01
DPBM01
US Army Corps of Engineers
Chicago District
0
1
2
Miles
N
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Identified FRM Sites: Cook County
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 14

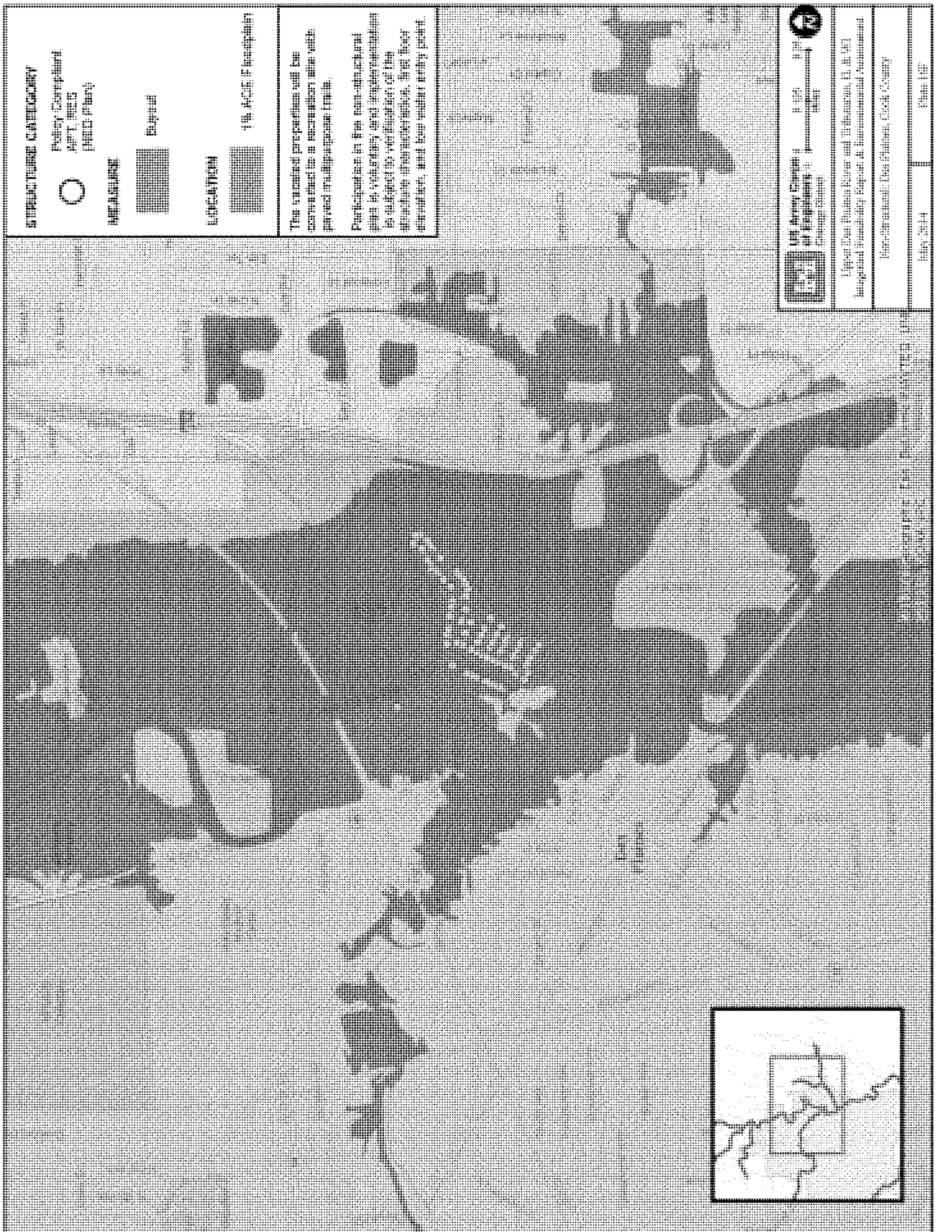

LEGEND
Structural FRM Plans*
Comprehensive
NED
CAP
*NED & CAP sites are also part of the Full Plan
Study Area
Interstate Highway
U.S. Highway
State Highway
Streams
WLRS04 Harry Semrow Driving Range Reservoir (200 acre-feet)
FPCI01 Lake Mary Anne Pump Station
DPLV04 Fullerton-Grand Levee (6,400 feet)
DPLV05 Belmont-Irving Park Levee (6,000 feet)
DPLV09 Touhy-Miner Levee (11,500 feet)
DPBM04 First Avenue Bridge Modfication
DPRS04 Fullerton Woods Reservoir (150 acre-feet)
DPLV01 Groveland Avenue Levee (3,000 feet)
Racine County
Kenosha County
KENOSHA
WISCONSIN
ILLINOIS
Lake Michigan
WAUKEGAN
Lake County
Cook County
DuPage County
CHICAGO
WLRS04
FPCI01
DPLV09
DPLV05
DPLV04
DPBM04
DPRS04
DPLV01
US Army Corps of Engineers
Miles
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Structural Flood Risk Management Plans
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 15

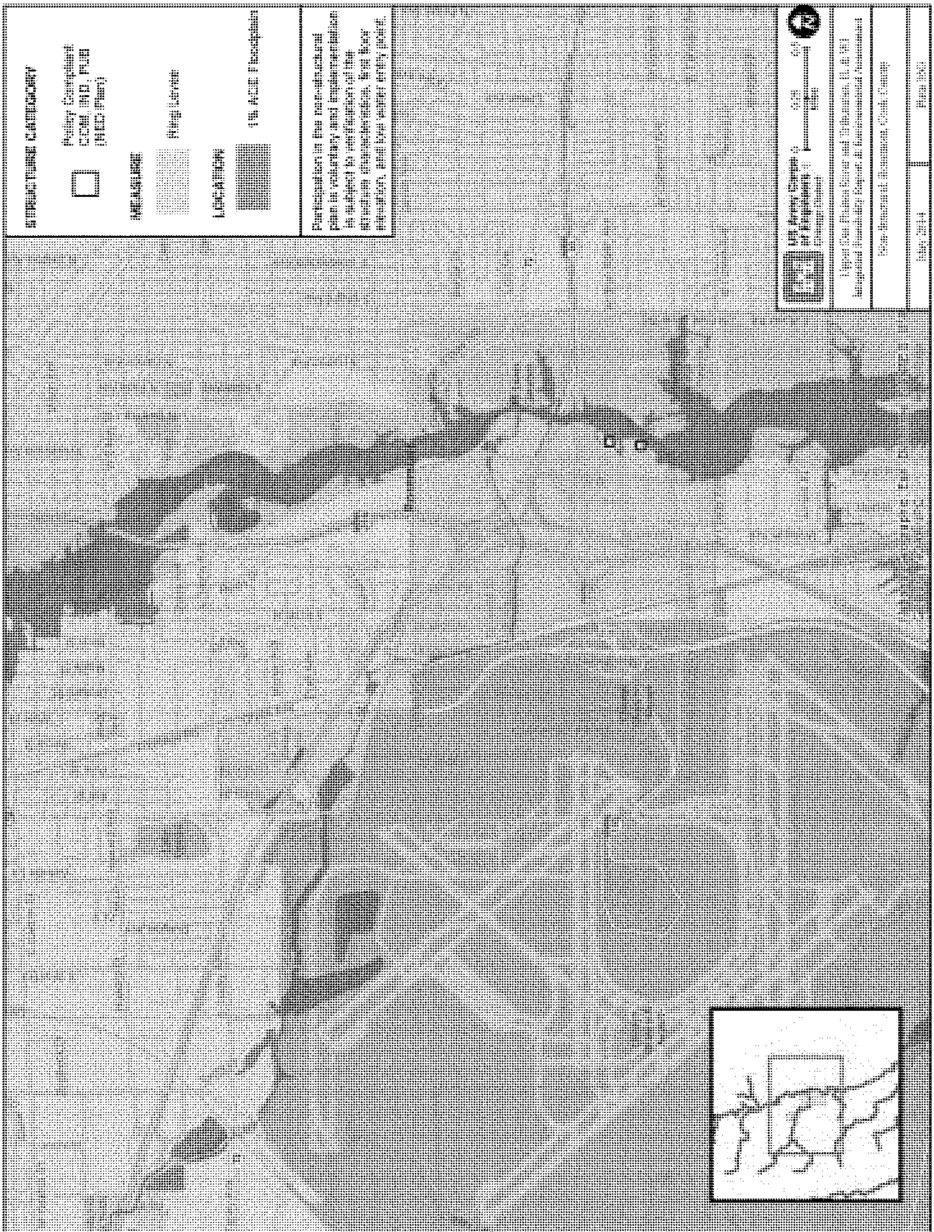

LEGEND
Non-Structural FRM Plans
Comprehensive*
NED
*NED sites are also part of the Full Plan. There is no Non-Structural CAP Plan.
Study Area
Interstate Highway
U.S. Highway
State Highway
Streams
Community Areas
Note: The communities of Somers, Salem, and Bristol in Wisconsin are not shown as they are not within well defined corporate limits.
Racine County
Kenosha County
KENOSHA
Salem and Somers Plate 16A
WISCONSIN
ILLINOIS
WAUKEGAN
Gurnee Plate 16B
Lake County
Lake Michigan
Vernon Township Plate 16C
Buffalo Grove Plate 16D
Wheeling and Wheeling Township Plate 16E
Des Plaines Plate 16F
Cook County
Rosemont Plate 16G
Leyden Township Plate16H
DuPage County
CHICAGO
US Army Corps of Engineers
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Non-Structural Flood Risk Management Plans
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 16

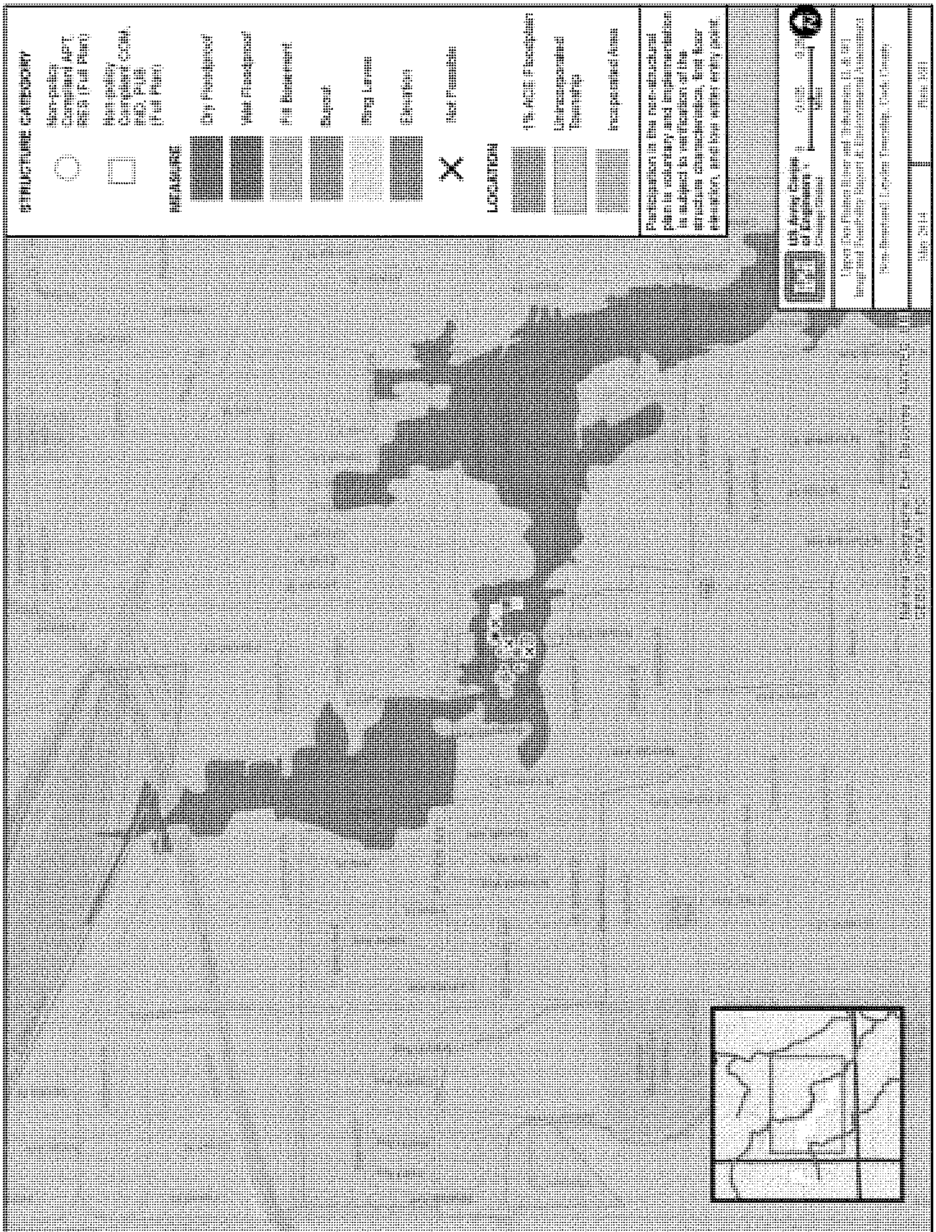


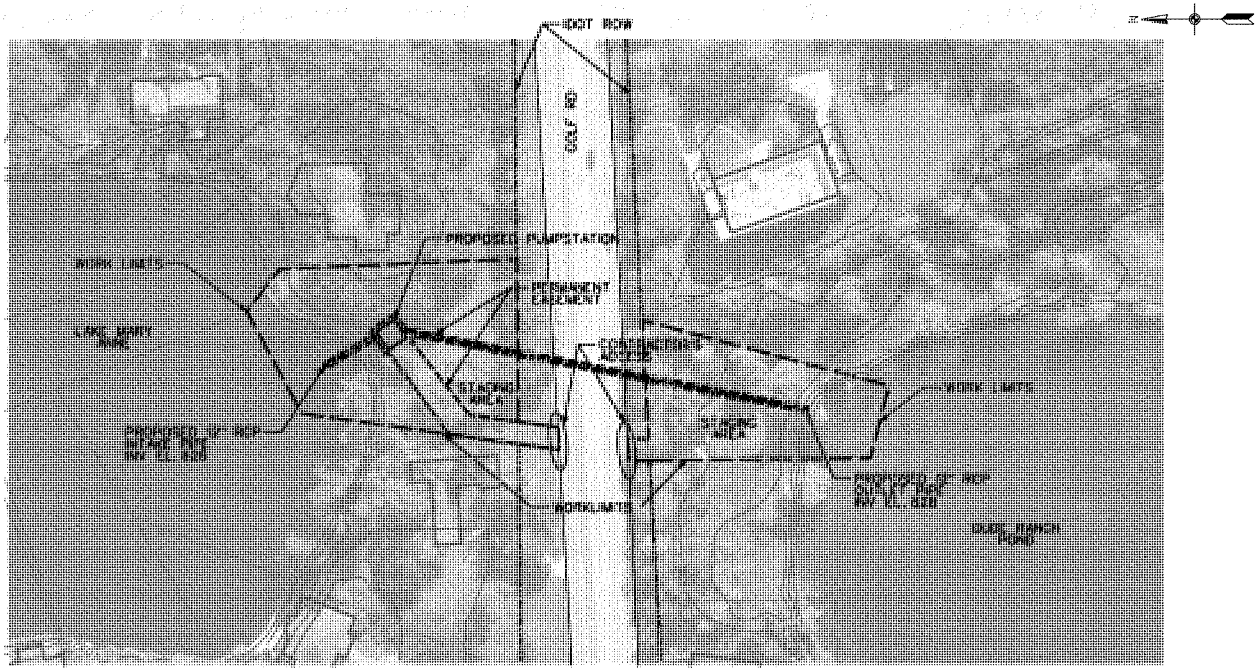





STRUCTURE CATEGORY
MEASURE
LOCATION







NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME. REFER TO THE CIVIL APPENDIX FOR THE SURVEY DATA SOURCES.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.

4. THE 12" RCP UNDER GOLF RD. WILL BE PLACED BY PIPE JACKING.

80 40 0 80 160

1 INCH = 80 FEET

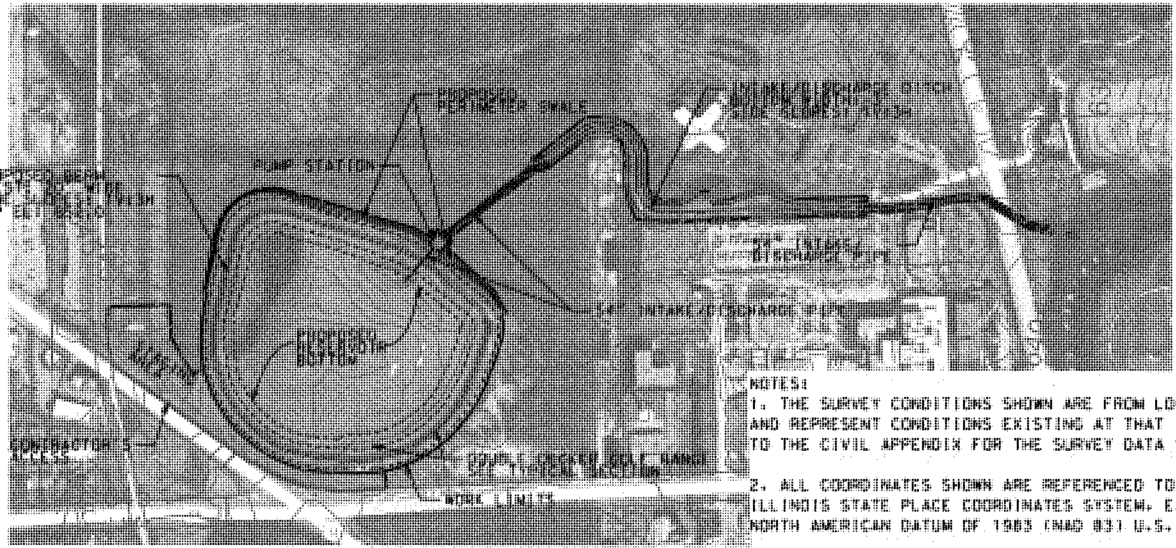
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

FPCI01 PUMPSTATION
CONCEPTUAL SITE PLAN
DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
AS SHOWN	MAR 2014	FPCI01_Site Plan.DGN

PLATE 17

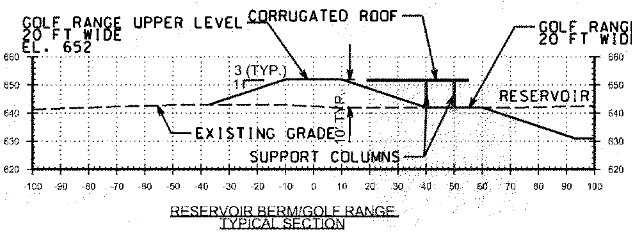


NOTES:

1. THE SURVEY CONDITIONS SHOWN ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME. REFER TO THE CIVIL APPENDIX FOR THE SURVEY DATA SOURCES.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLACE COORDINATES SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD 83) U.S. FOOT.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD) U.S. FEET.



RESERVOIR BERM/GOLF RANGE TYPICAL SECTION

RESERVOIR DATA:
TOP AREA = 14.7 AC
BOTTOM OF RESERVOIR EL = VARIES 629-635
STORAGE = 200 AC-FT DESIGN VOLUME (100-YR)
249 AC-FT DESIGN VOLUME (100-YR + 3FT FREEBOARD)

0 300' 600'

U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

WLRS04 RESERVOIR CONCEPTUAL SITE PLAN DES PLAINES, IL

SCALE:	DATE:	DRAWING CODE:
1IN:300FT	MAR 2014	WLRS04-CS101.dgn

PLATE 18

N

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD 83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88) U.S. FEET.

4. THE PROPOSED FLOOD WALL LENGTH IS 3020 FEET, WHICH INCLUDES 500 OF RAISING AN EXISTING RETAINING WALL (STA. 2+00 TO 7+00). THE FLOODWALL TOP ELEVATION IS 634.6.

5. ONE ROAD CLOSURE STRUCTURE WILL BE NECESSARY TO COMPLETE THE LINE OF PROTECTION.

0 300' 600'

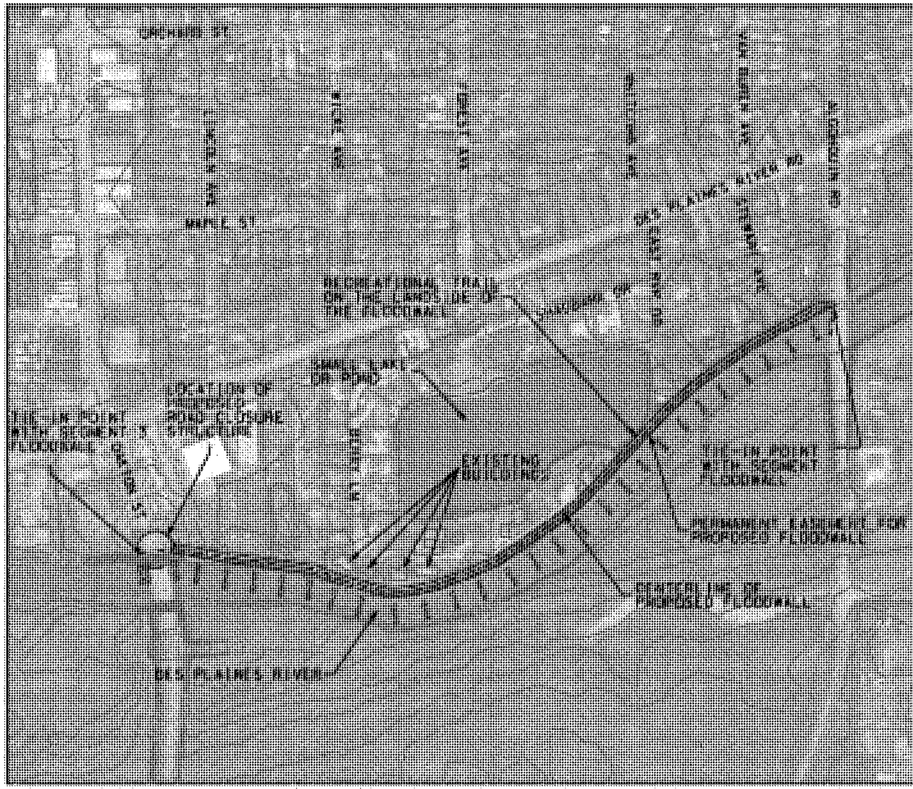
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

DPLV09SEG1 LEVEE CONCEPTUAL SITE PLAN DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
AS SHOWN	MAR 2014	DPLV09SEG1-CS101.dgn

PLATE 19A



N

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENTS CONDITIONS EXISTING AT THAT TIME.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM. EAST ZONE. NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
4. THE PROPOSED FLOODWALL IS 2.718 LF WITH AN ELEVATION OF 635.0 FT.
5. ONE ROAD CLOSURE STRUCTURE WILL BE NECESSARY TO COMPLETE THE LINE OF PROTECTION.
6. THIS SEGMENT OF FLOODWALL SHALL HAVE A PAVED RECREATIONAL TRAIL ALONG ITS ENTIRE LENGTH.

0 300' 600'

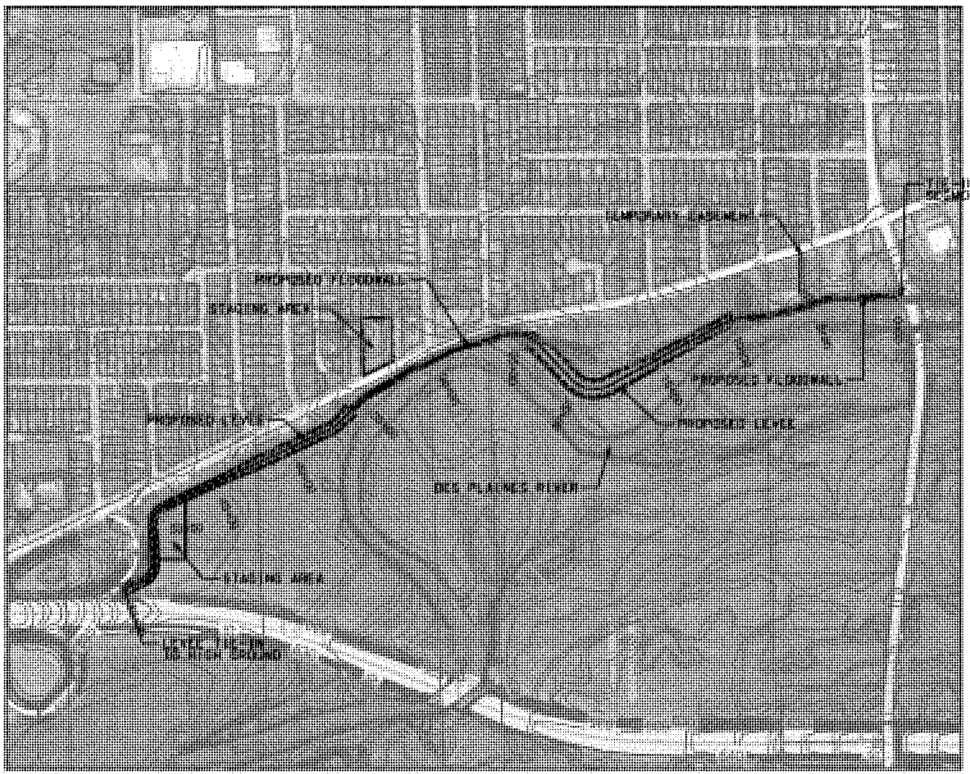
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

DPLV09 - SEGMENT 2
FLOODWALL SITE PLAN
DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
AS-SHOWN	MAR 2014	DPLV09_S2_Siteplan.dgn

PLATE 19B



NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD 83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88) U.S. FEET.

4. THE PROPOSED FLOOD WALL LENGTH IS 2200 FEET, AND LEVEE LENGTH IS 3250 FEET. TOP OF FLOODWALL/LEVEE: STA. 0+00 TO STA. 14+20, EL. 633.7; STA. 14+40 TO STA. 54+50, EL. 633.4.

0 500' 1000'

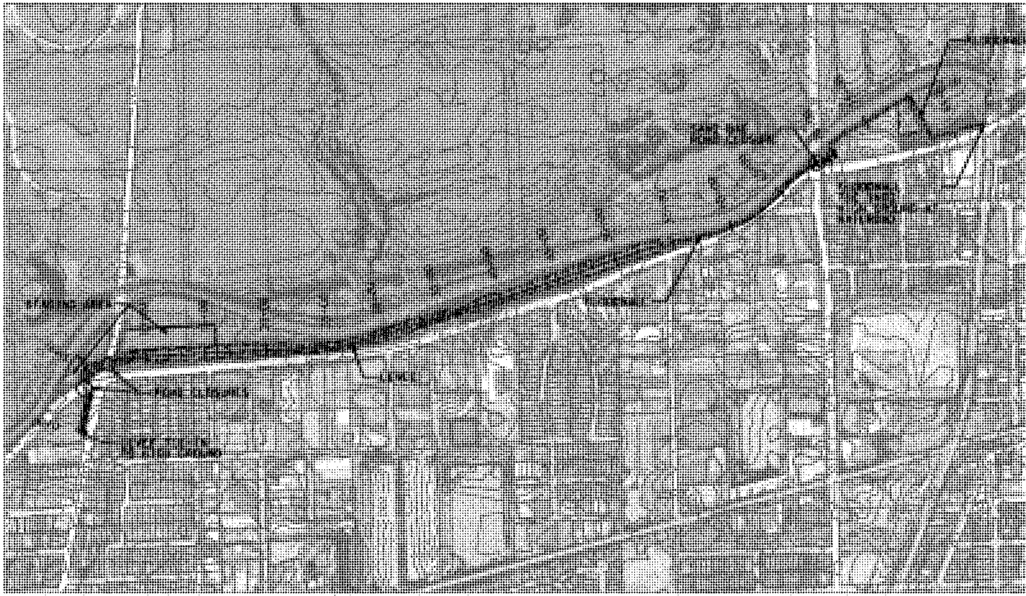
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

DPLV09SEG3 LEVEE
CONCEPTUAL SITE PLAN
DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
AS SHOWN	MAR 2014	DPLV09SEG3-CS101.dgn

PLATE 19C



NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENTS CONDITIONS EXISTING AT THAT TIME.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD 83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88) U.S. FEET.

4. THE PROPOSED FLOOD WALL LENGTH IS [illegible] FEET AND INCLUDES RAISING [illegible] FEET OF EXISTING RETAINING WALL TO THE DESIGN ELEVATION. SEE NOTE 7. LEVEE LENGTH IS 5,150 FEET. THE LEVEE/FLOODWALL CREST ELEVATION IS 629.31.

5. TWO ROAD CLOSURE STRUCTURES AND ONE SAND BAG ROAD CLOSURE WILL BE NECESSARY TO COMPLETE THE LINE OF PROTECTION.

6. THE EXISTING RETAINING WALL LOCATED APPROXIMATELY BETWEEN STA. [illegible] AND STA. 65+00 SHALL BE RAISED AND STRENGTHENED TO ACT AS A FLOODWALL.

0 700' 1400'

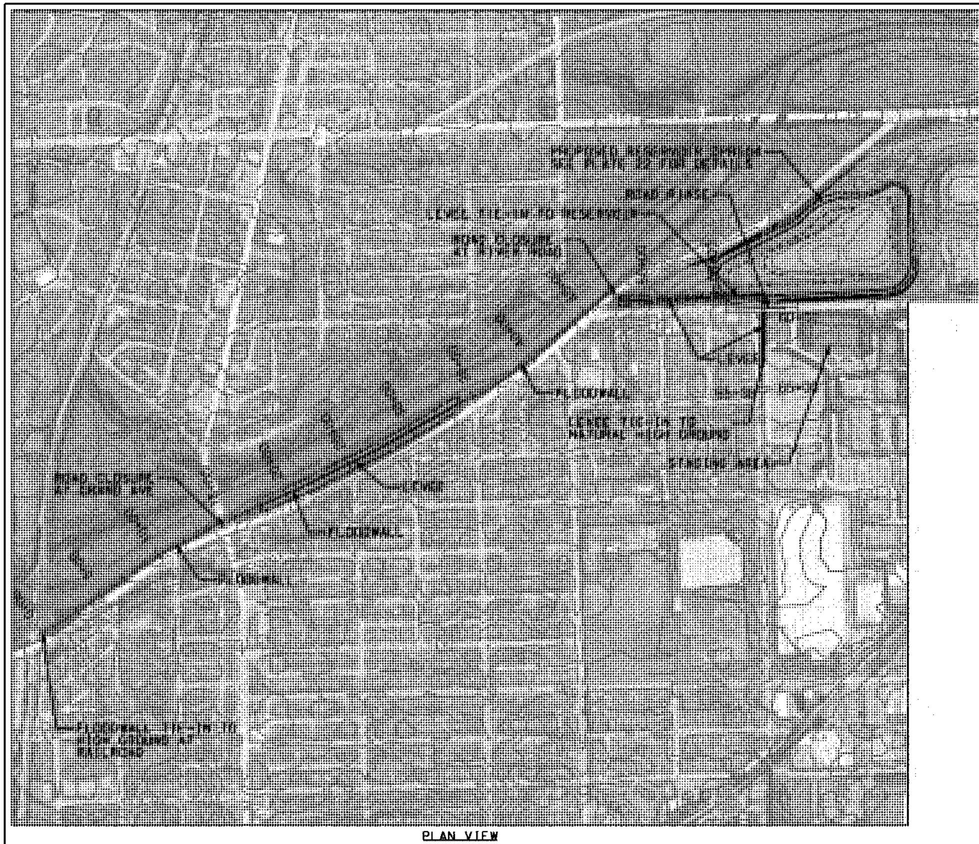
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

OPLV05 LEVEE
CONCEPTUAL SITE PLAN
SCHILLER PARK & FRANKLIN PARK,
COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
AS SHOWN	MAR 2014	OPLV05-CS101.DGN

PLATE 20



NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD 83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88) U.S. FEET.

4. THE PROPOSED FLOOD WALL LENGTH IS 3134 FEET AND LEVEE LENGTH IS 3031 FEET. THE FLOODWALL/LEVEE CREST ELEVATION IS 628.39.

5. TWO ROAD CLOSURE STRUCTURES WILL BE NECESSARY TO COMPLETE THE LINE OF PROTECTION. THE ROAD WILL BE RAISED AT 5TH AVE.

6. THE LEVEE AT THE SOUTH END WILL TIE INTO THE PROPOSED RESERVOIR (DPRSO4). SEE PLATE 22 FOR DETAILS OF THE RESERVOIR.

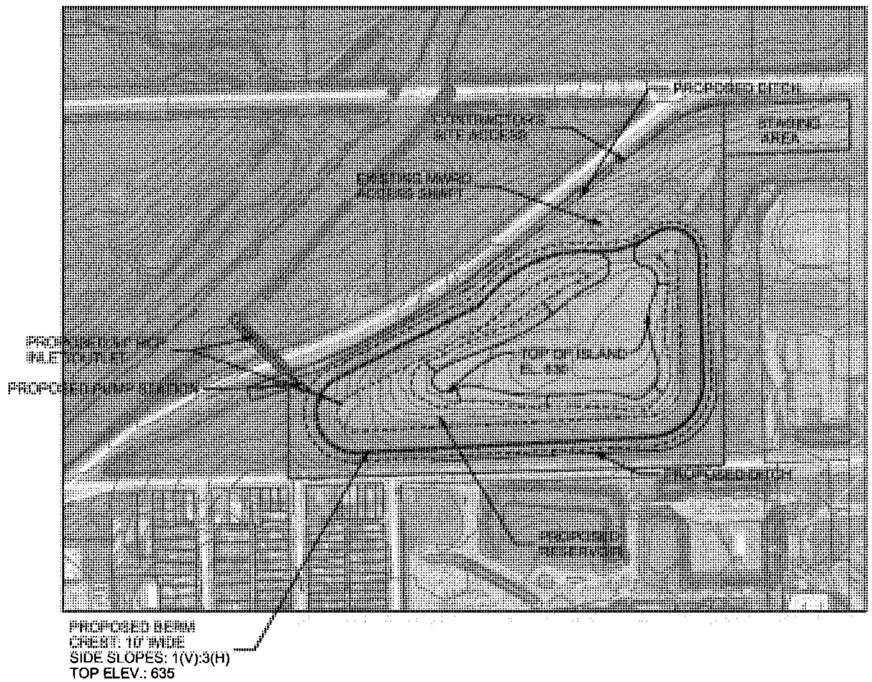
U.S. Army Corps of Engineers
Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES
FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

DPLV04 LEVEE
CONCEPTUAL SITE PLAN
RIVER GROVE, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
AS SHOWN	MAR 2014	DPLV04-CS101.DGN

PLATE 21



RESERVOIR DATA

TOP AREA = 16.5 AC
BOTTOM OF RESERVOIR EL. = 611.5
STORAGE = 150 AC-FT DESIGN VOLUME (100-YR)
200 AC-FT VOLUME (100-YR + 3FT FREEBOARD)

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS AT THAT TIME. REFER TO THE CIVIL APPENDIX FOR THE SURVEY DATA SOURCES.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLAN COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD) US FEET.

4. THE EXISTING MWRD ACCESS SHAFT SHALL BE PROTECTED.

0 300' 600'

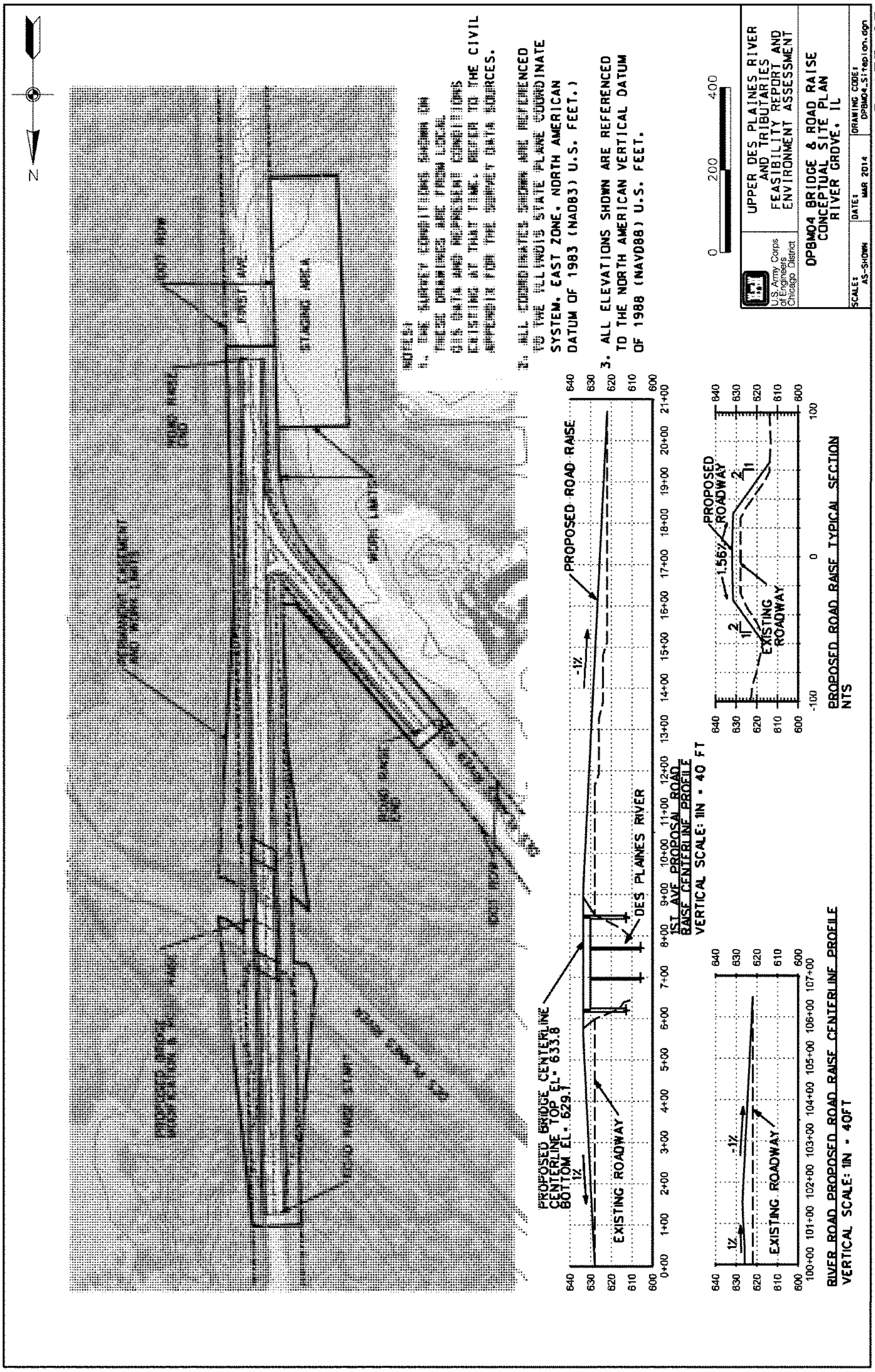
U.S. Army Corps of Engineers Chicago District

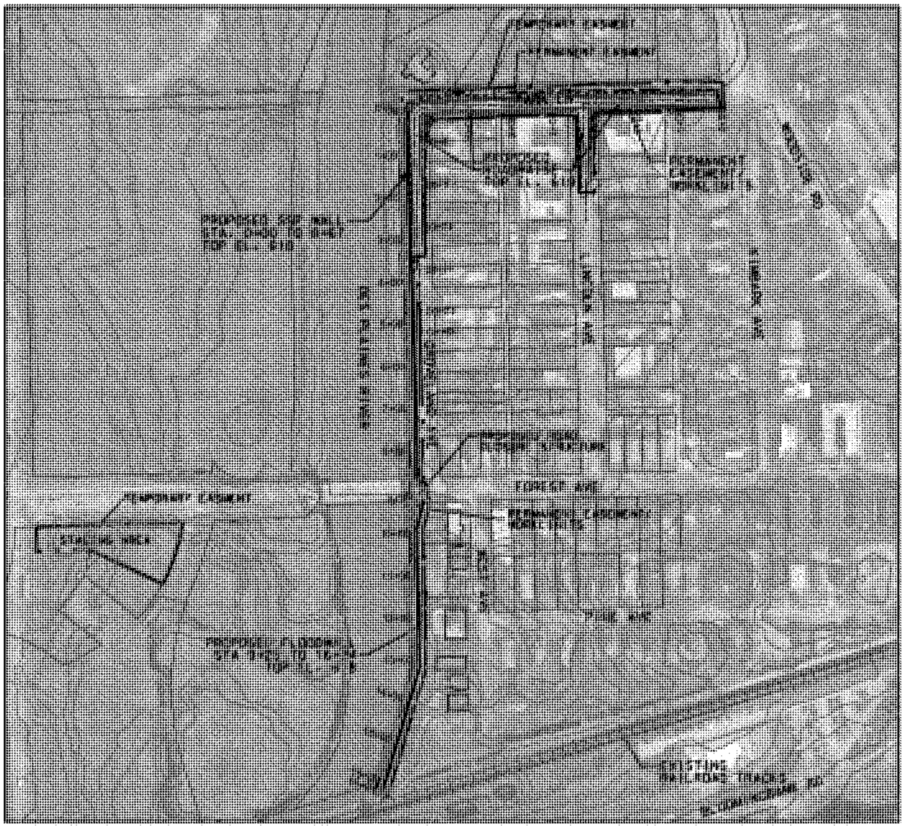
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

DPRS04 RESERVOIR CONCEPTUAL SITE PLAN RIVER GROVE, IL

SCALE:	DATE:	DRAWING CODE:
1" = 300'	MAR 2014	DPRS04_Siteplan.DGN

PLATE 22


N
NOTES:
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
PROPOSED ROAD RAISE
PROPOSED BRIDGE CENTERLINE
CENTERLINE TOP EL= 633.8
BOTTOM EL= 629.1
EXISTING ROADWAY
DES PLAINES RIVER
1ST AVE PROPOSAL ROAD RAISE CENTERLINE PROFILE
VERTICAL SCALE: 1IN = 40 FT
PROPOSED ROADWAY
EXISTING ROADWAY
PROPOSED ROAD RAISE TYPICAL SECTION
NTS
RIVER ROAD PROPOSED ROAD RAISE CENTERLINE PROFILE
VERTICAL SCALE: 1IN = 40FT
U.S. Army Corps of Engineers Chicago District
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT
DPBM04 BRIDGE & ROAD RAISE CONCEPTUAL SITE PLAN RIVER GROVE, IL
SCALE: AS-SHOWN
DATE: MAR 2014
DRAWING CODE: DPBM04_Siteplan.dgn
PLATE 23



NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
4. STEEL SHEET PILE WILL BE DRIVEN INTO THE EXISTING LEVEE ALONG GROVELAND AVE. TO RAISE THE TOP ELEVATION TO 618. THE LENGTH OF SHEET PILE IS 867 LF.
5. THE PROPOSED FLOODWALL ON THE SOUTH SIDE OF FOREST AVE HAS A LENGTH OF 699 LF AND TOP ELEVATION OF 618.
6. THE PROPOSED ROADRAISE HAS A TOP ELEVATION OF 618 AND SIDE SLOPES OF 1(V):2(H).
7. ONE ROAD CLOSURE STRUCTURE WILL BE REQUIRED AT FOREST AVE TO CONTINUE THE LINE OF FLOOD PROTECTION.

N

200' 100' 0 200'

SCALE: 1'' = 200'-0"

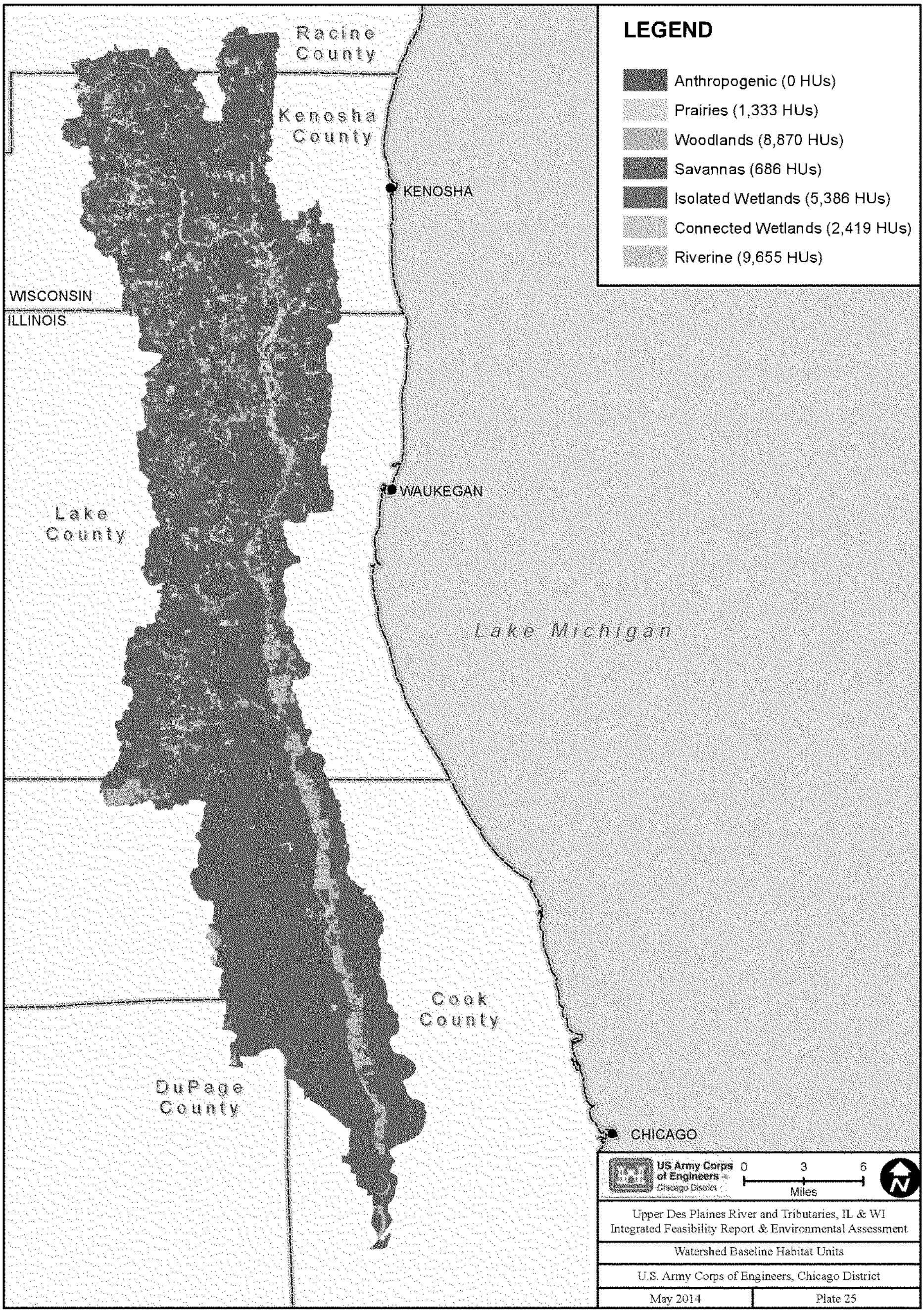
U.S. Army Corps of Engineers Chicago District

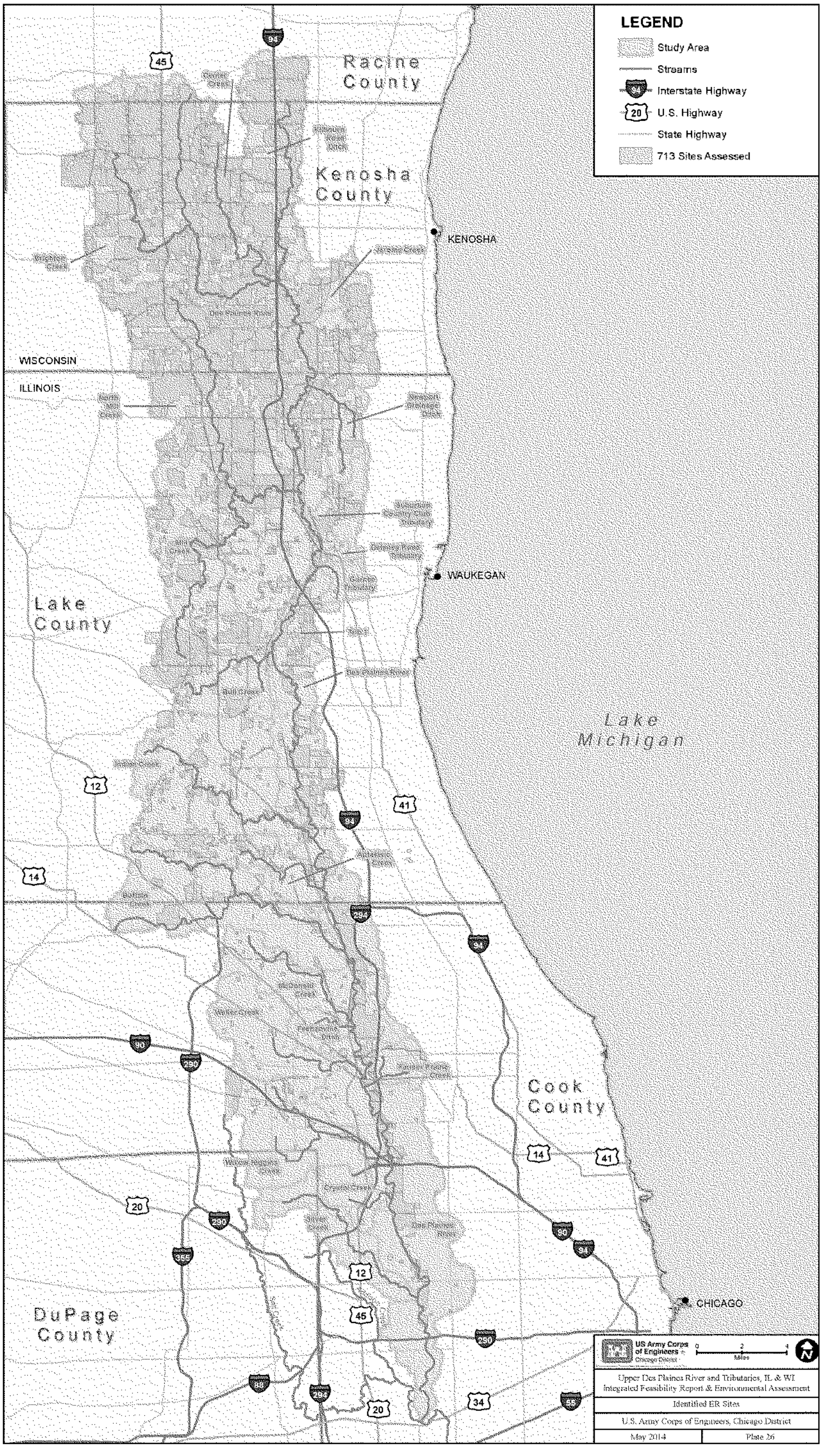
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

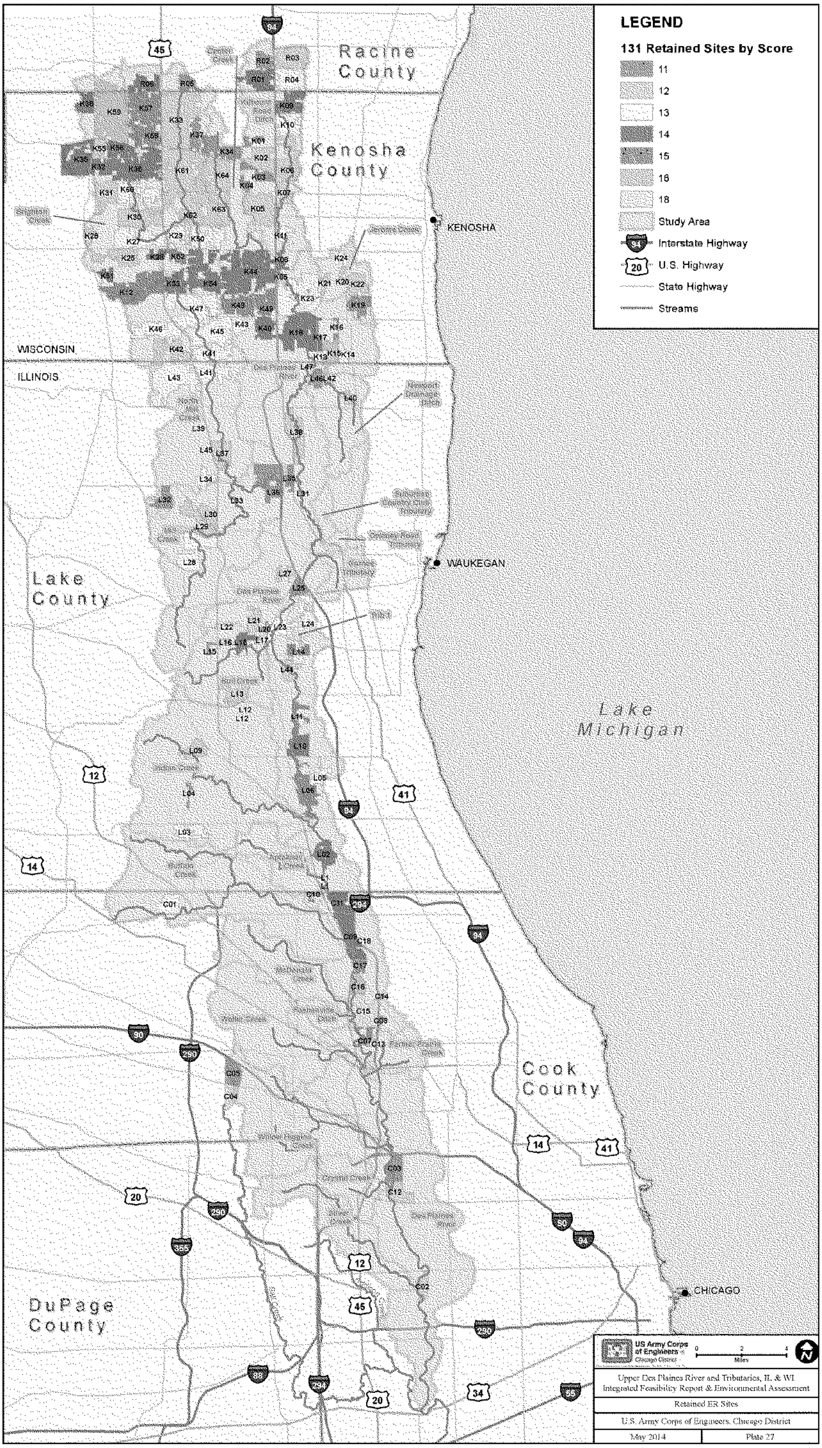
DPLV01 FLOODWALL
CONCEPTUAL SITE PLAN
RIVERSIDE , COOK COUNTY, IL

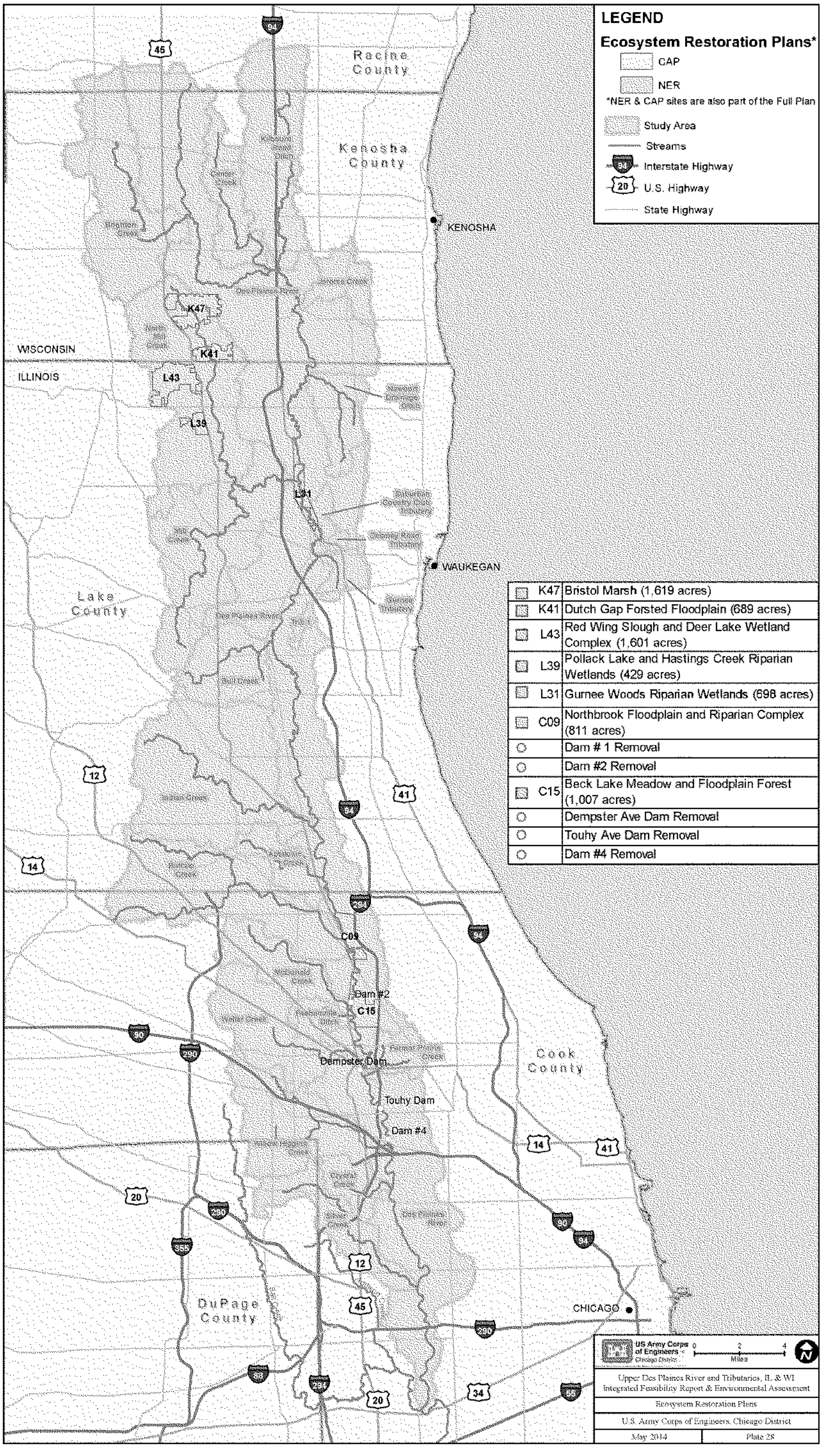
SCALE:	DATE:	DRAWING CODE:
1" = 200'	MAR 2014	DPLV01_Siteplan.dgn

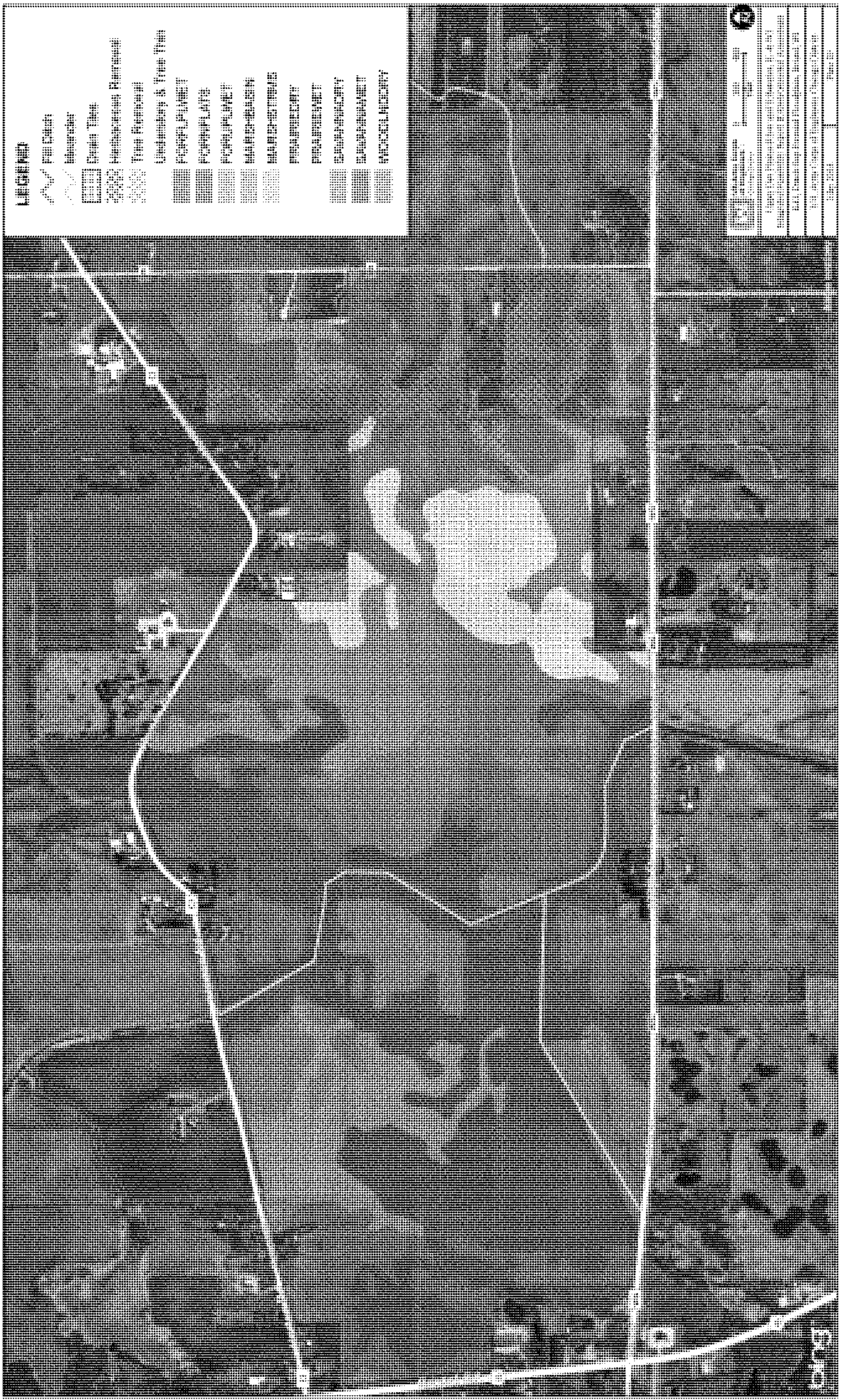
PLATE 24

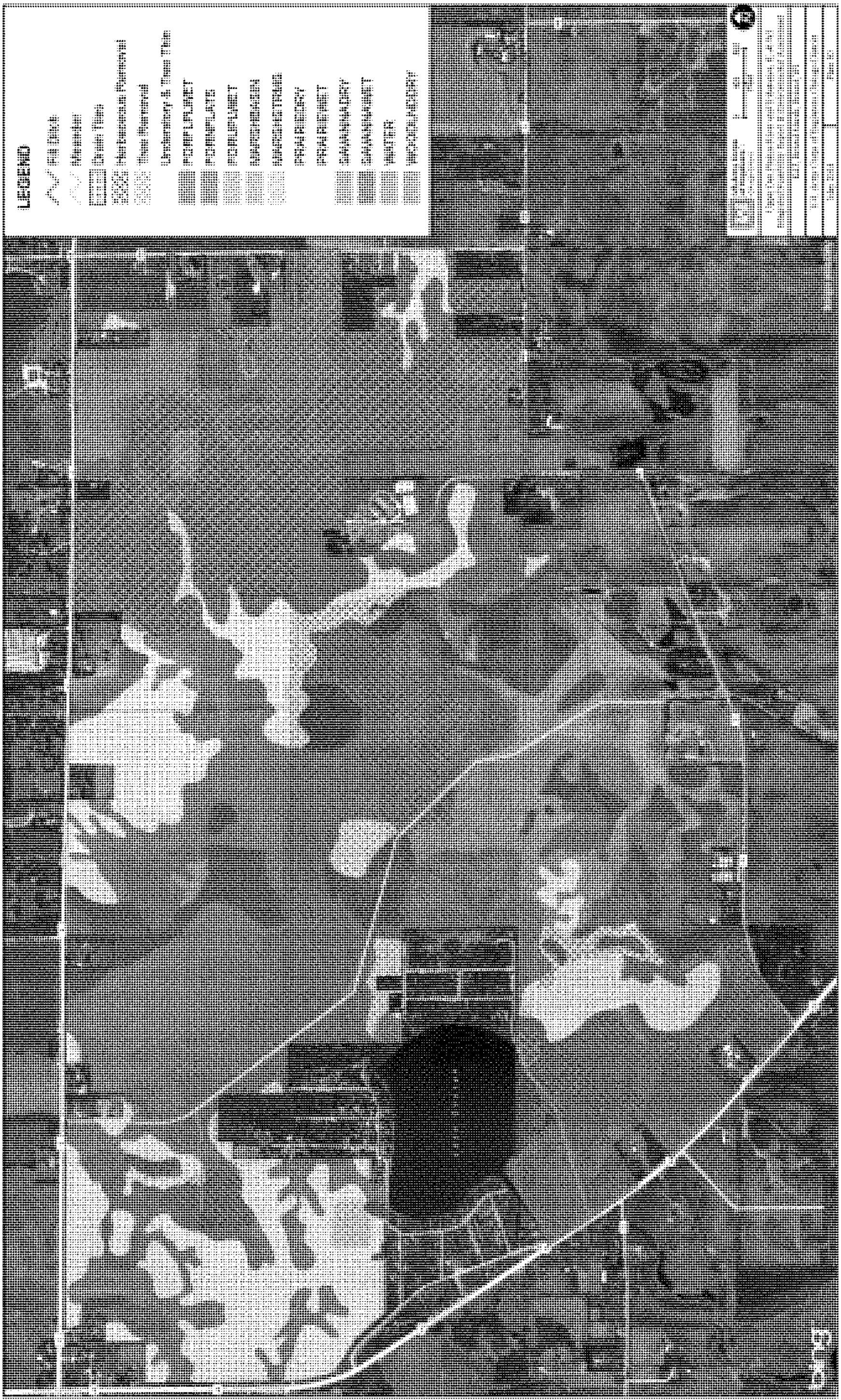

LEGEND
Anthropogenic (0 HUs)
Prairies (1,333 HUs)
Woodlands (8,870 HUs)
Savannas (686 HUs)
Isolated Wetlands (5,386 HUs)
Connected Wetlands (2,419 HUs)
Riverine (9,655 HUs)
Racine County
Kenosha County
KENOSHA
WISCONSIN
ILLINOIS
WAUKEGAN
Lake County
Lake Michigan
Cook County
DuPage County
CHICAGO
US Army Corps of Engineers
Chicago District
0 3 6
Miles
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Watershed Baseline Habitat Units
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 25

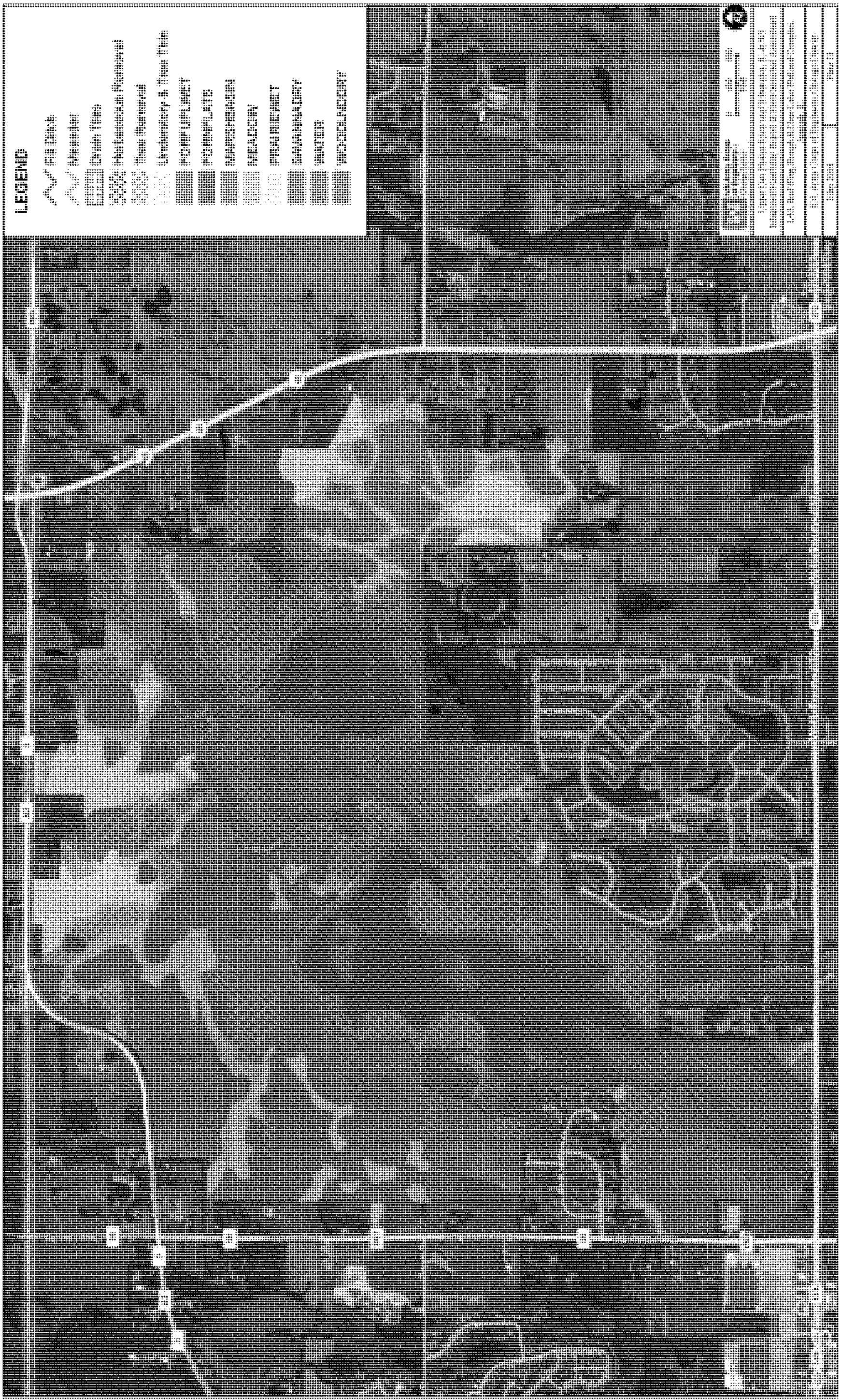

LEGEND
Study Area
Streams
Interstate Highway
U.S. Highway
State Highway
713 Sites Assessed
Racine County
Kenosha County
KENOSHA
WISCONSIN
ILLINOIS
WAUKEGAN
Lake County
Lake Michigan
Cook County
CHICAGO
DuPage County
US Army Corps of Engineers
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Identified ER Sites
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 26

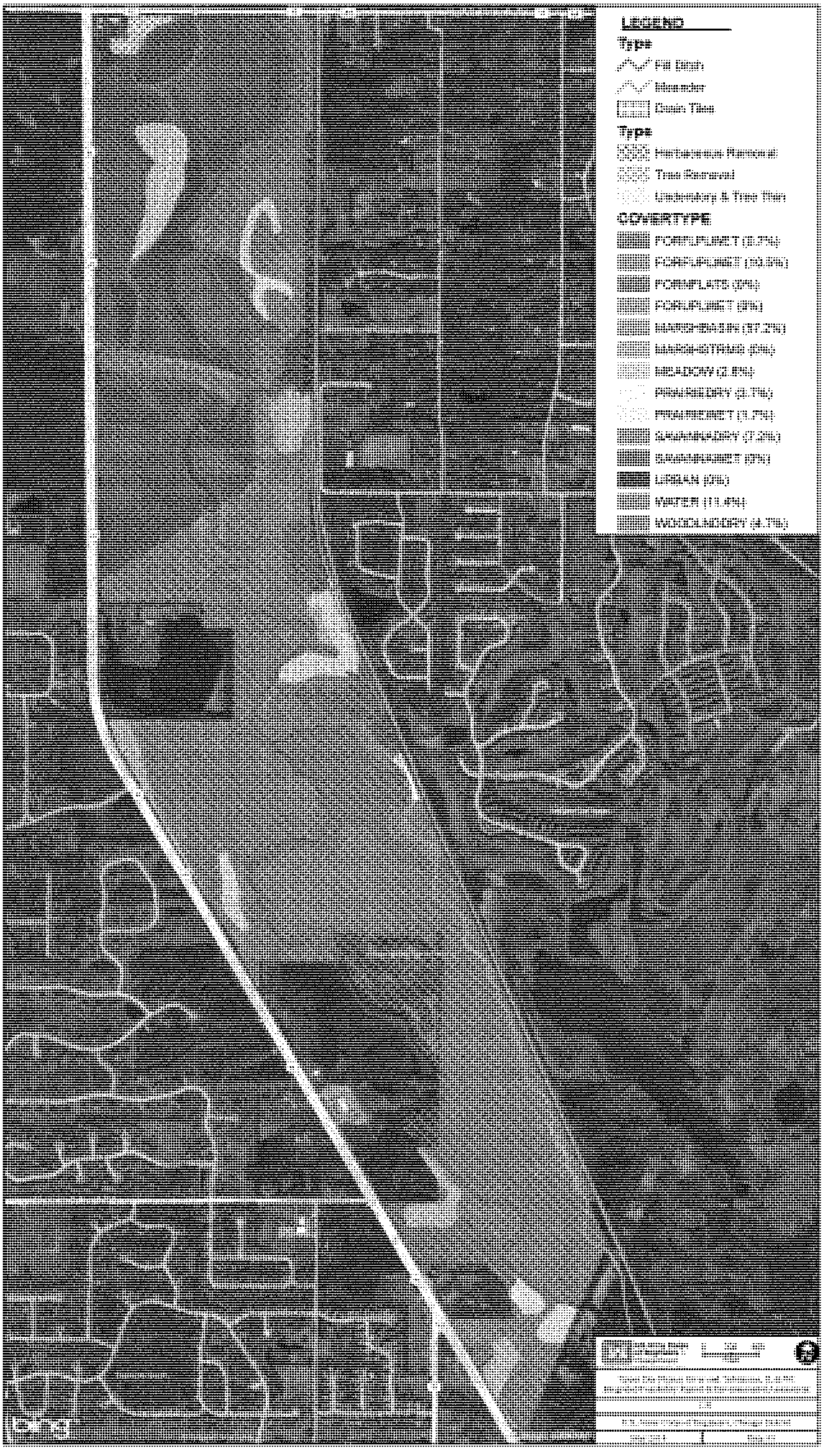

LEGEND
131 Retained Sites by Score
11
12
13
14
15
16
18
Study Area
Interstate Highway
U.S. Highway
State Highway
Streams
Racine County
Kenosha County
KENOSHA
WAUKEGAN
Lake County
Lake Michigan
WISCONSIN
ILLINOIS
Cook County
DuPage County
CHICAGO
US Army Corps of Engineers
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Retained ER Sites
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 27


LEGEND
Ecosystem Restoration Plans*
CAP
NER
*NER & CAP sites are also part of the Full Plan
Study Area
Streams
Interstate Highway
U.S. Highway
State Highway
Racine County
Kenosha County
KENOSHA
WISCONSIN
ILLINOIS
K47
K41
L43
L39
L31
WAUKEGAN
Lake County
K47 Bristol Marsh (1,619 acres)
K41 Dutch Gap Forsted Floodplain (689 acres)
L43 Red Wing Slough and Deer Lake Wetland Complex (1,601 acres)
L39 Pollack Lake and Hastings Creek Riparian Wetlands (429 acres)
L31 Gurnee Woods Riparian Wetlands (698 acres)
C09 Northbrook Floodplain and Riparian Complex (811 acres)
Dam # 1 Removal
Dam #2 Removal
C15 Beck Lake Meadow and Floodplain Forest (1,007 acres)
Dempster Ave Dam Removal
Touhy Ave Dam Removal
Dam #4 Removal
C09
Dam #2
C15
Dempster Dam
Touhy Dam
Dam #4
Cook County
DuPage County
CHICAGO
US Army Corps of Engineers
Miles
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Ecosystem Restoration Plans
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 28

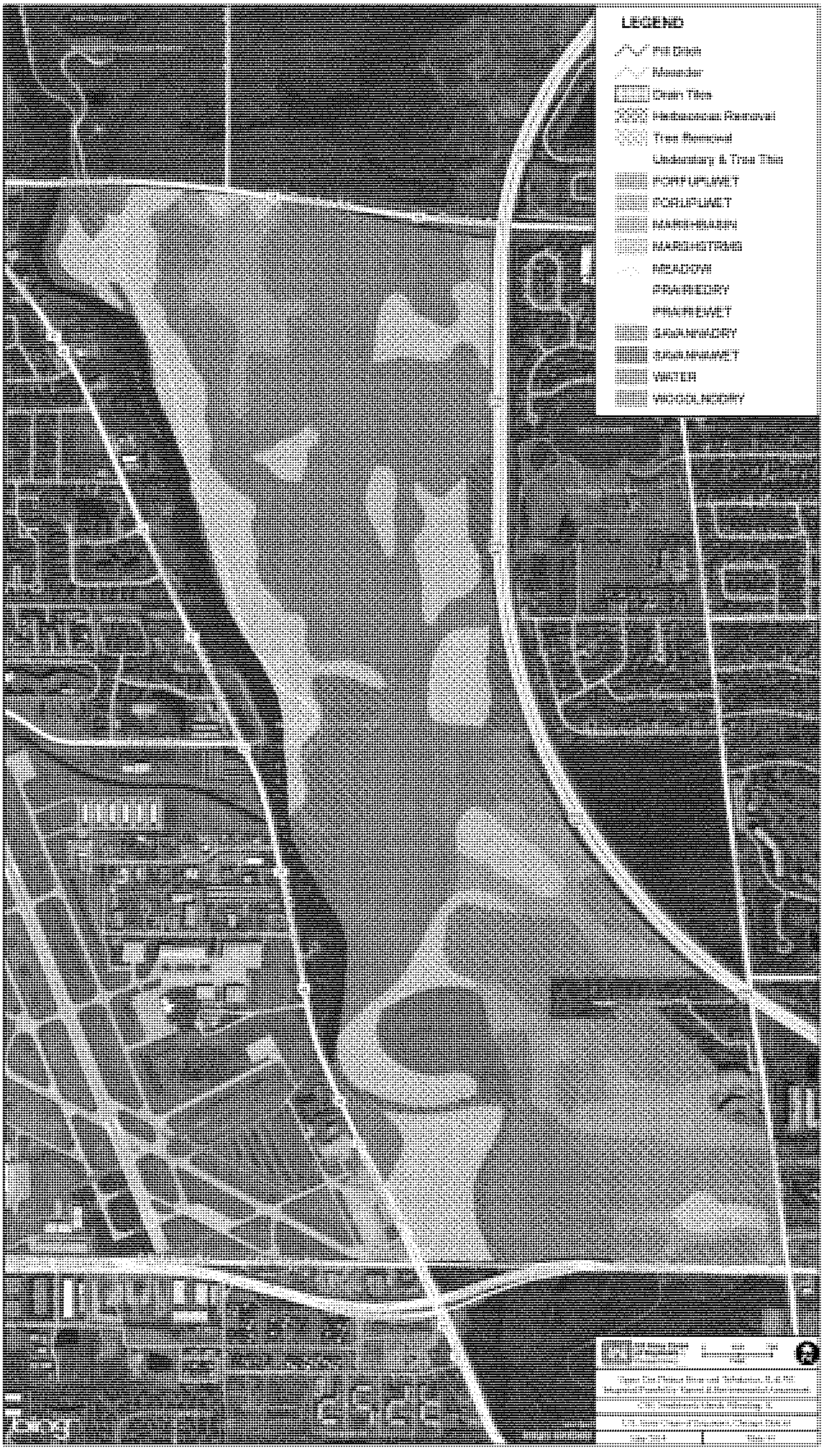


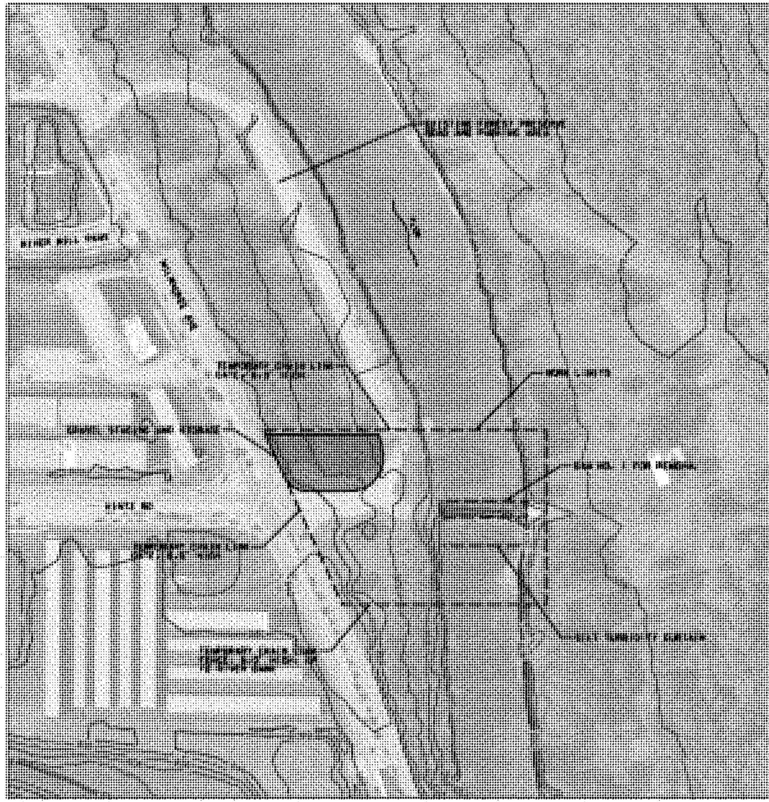

LEGEND

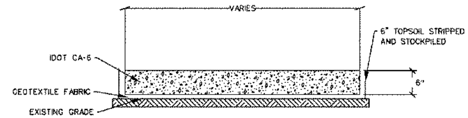

LEGEND


LEGEND
Type
Fill Ditch
Meander
Type
Herbaceous Removal
Tree Removal
COVERTYPE


LEGEND


LEGEND
Fill Ditch
Meander
Drain Tiles
Herbaceous Removal
Tree Removal
Understory & Tree Thin
MEADOW
PRAIRIEDRY
PRAIRIEWET
SAVANNADRY
SAVANNAWET
WATER
WOODLANDDRY





DAM NO. 1 GRAVEL STAGING & STORAGE (TYP)
N.T.S.

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
4. STAGING AND STORAGE AREAS SHALL BE CONSTRUCTED AS SHOWN ON TYPICAL SECTION.
5. ALL GRAVEL AND GEOTEXTILE FABRIC SHALL BE REMOVED AFTER DEMOLITION ACTIVITIES ARE COMPLETED AND PROPERLY DISPOSED.
6. STRIPPED TOPSOIL SHALL BE REPLACED AND THE ACCESS ROAD AND STAGING/STORAGE AREA SHALL BE RESTORED TO PRE-CONSTRUCTION CONDITION.
7. AT A MINIMUM CLEARING AND GRUBBING SHALL TAKE PLACE ON THE AREA COVERED BY THE TEMPORARY GRAVEL ACCESS ROAD AND STAGING/STORAGE AREA TO ALLOW THE CONTRACTOR ACCESS TO THE DAM.

0 150' 300'
SCALE:1"=150'

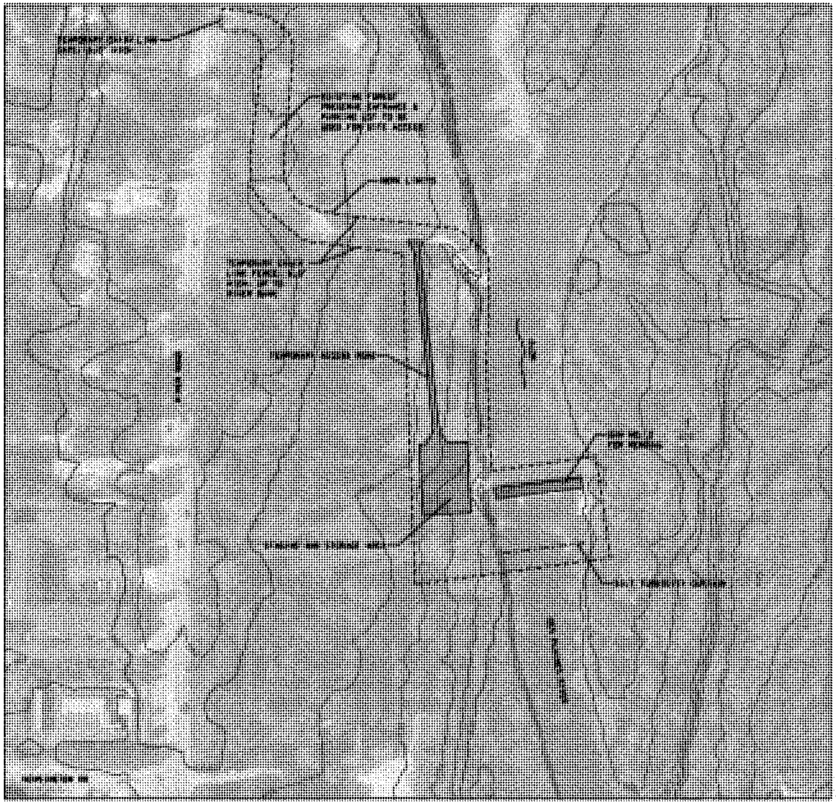
U.S. Army Corps of Engineers Chicago District

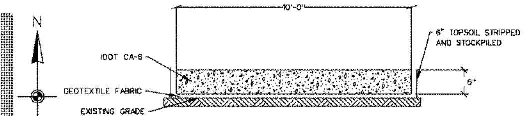
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

DAM NO. 1 REMOVAL SITE PLAN
WHEELING, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
1" = 150'-0"	MAR 2014	DAM_NO_1_SITE_PLAN.DGN

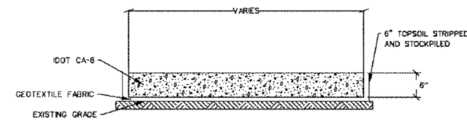
PLATE 36





DAM NO. 2 GRAVEL ACCESS ROAD (TYP)

N.T.S.



DAM NO. 2 GRAVEL STAGING & STORAGE (TYP)

N.T.S.

NOTES:

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3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
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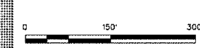
5. ALL GRAVEL AND GEOTEXTILE FABRIC SHALL BE REMOVED AFTER DEMOLITION ACTIVITIES ARE COMPLETED AND PROPERLY DISPOSED.
6. STRIPPED TOPSOIL SHALL BE REPLACED AND THE ACCESS ROAD AND STAGING/STORAGE AREA SHALL BE RESTORED TO PRE-CONSTRUCTION CONDITION.
7. AT A MINIMUM CLEARING AND GRUBBING SHALL TAKE PLACE ON THE AREA COVERED BY THE TEMPORARY GRAVEL ACCESS ROAD AND STAGING/STORAGE AREA TO ALLOW THE CONTRACTOR ACCESS TO THE DAM.



SCALE:1"=150'

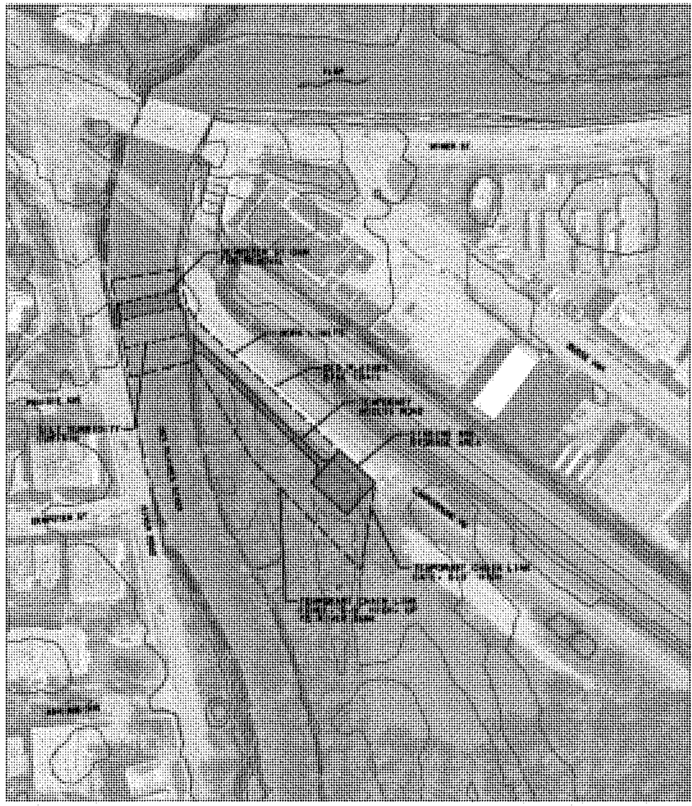
U.S. Army Corps of Engineers Chicago District

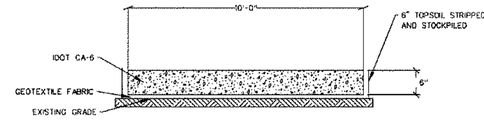
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIROMENTAL ASSESSMENT

DAM NO. 2 REMOVAL SITE PLAN
MOUNT PROSPECT, COOK COUNTY, IL

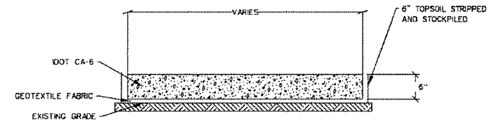
SCALE:	DATE:	DRAWING CODE:
1" = 150'- 0"	MAR 2014	DAM_NO_2_SITE_PLAN.DGN

PLATE 37





DEMPSTER ST. DAM GRAVEL ACCESS ROAD (TYP)
N.T.S.



DEMPSTER ST. DAM GRAVEL STAGING & STORAGE (TYP)
N.T.S.

NOTES:

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2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
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5. ALL GRAVEL AND GEOTEXTILE FABRIC SHALL BE REMOVED AFTER DEMOLITION ACTIVITIES ARE COMPLETED AND PROPERLY DISPOSED.
6. STRIPPED TOPSOIL SHALL BE REPLACED AND THE ACCESS ROAD AND STAGING/STORAGE AREA SHALL BE RESTORED TO PRE-CONSTRUCTION CONDITION.
7. AT A MINIMUM CLEARING AND GRUBBING SHALL TAKE PLACE ON THE AREA COVERED BY THE TEMPORARY GRAVEL ACCESS ROAD AND STAGING/STORAGE AREA TO ALLOW THE CONTRACTOR ACCESS TO THE DAM.

SCALE:1"=150'

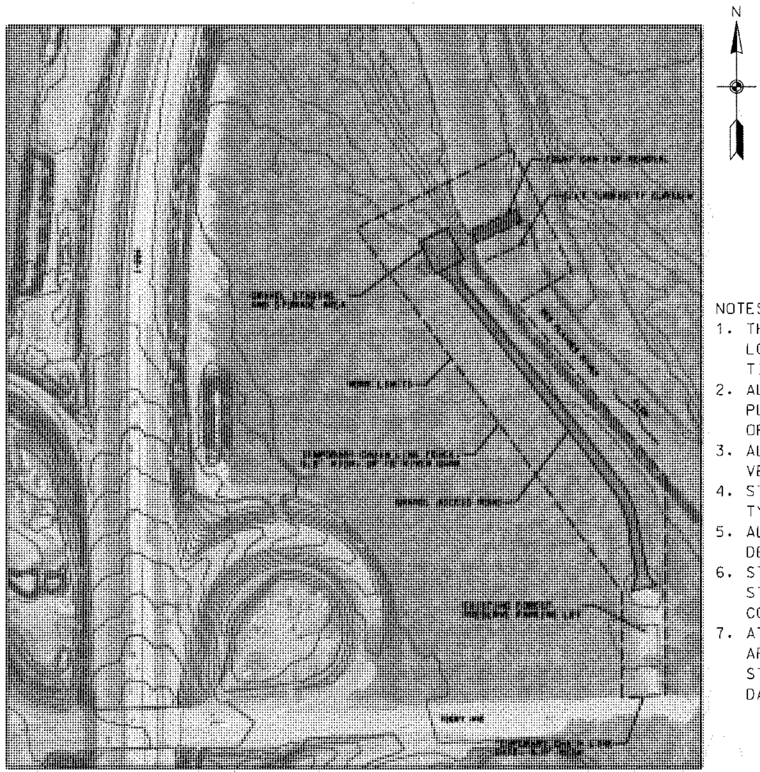
U.S. Army Corps of Engineers Chicago District

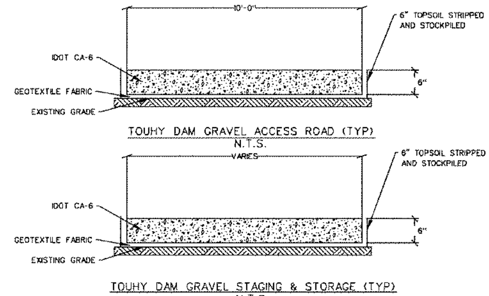
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

DEMPSTER ST. DAM REMOVAL SITE PLAN
DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
1" = 150'- 0"	MAR 2014	DEMPSTER_DAM_SITE_PLAN.DGN

PLATE 38





NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
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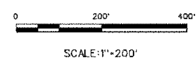
5. ALL GRAVEL AND GEOTEXTILE FABRIC SHALL BE REMOVED AFTER DEMOLITION ACTIVITIES ARE COMPLETED AND PROPERLY DISPOSED.
6. STRIPPED TOPSOIL SHALL BE REPLACED AND THE ACCESS ROAD AND STAGING/STORAGE AREA SHALL BE RESTORED TO PRE-CONSTRUCTION CONDITION.
7. AT A MINIMUM CLEARING AND GRUBBING SHALL TAKE PLACE ON THE AREA COVERED BY THE TEMPORARY GRAVEL ACCESS ROAD AND STAGING/STORAGE AREA TO ALLOW THE CONTRACTOR ACCESS TO THE DAM.



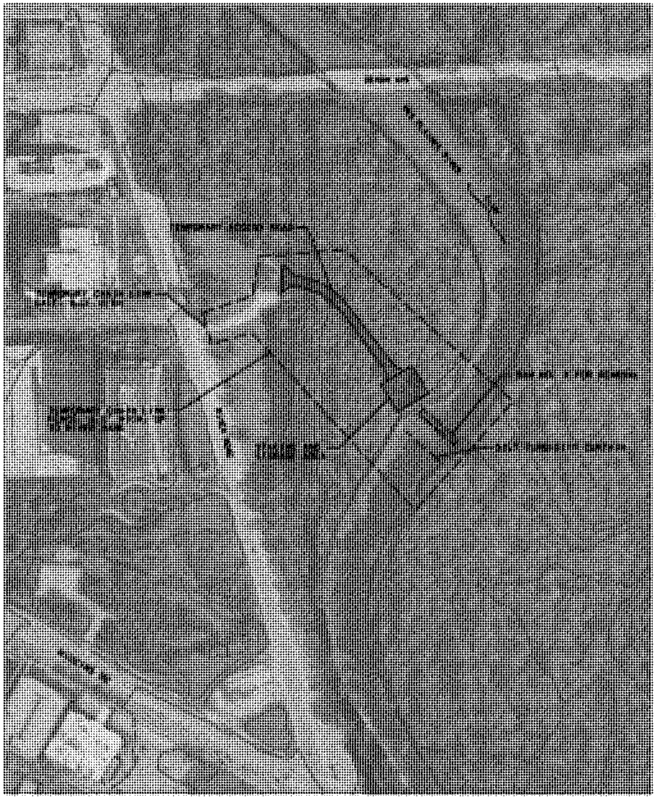
U.S. Army Corps of Engineers Chicago District

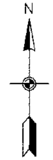
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

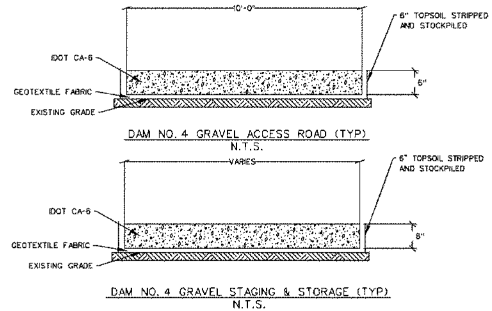
TOUHY DAM REMOVAL SITE PLAN
DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
1" = 200'- 0"	MAR 2014	TOUHY_DAM_SITE_PLAN.DGN

PLATE 39







NOTES:

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2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
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5. ALL GRAVEL AND GEOTEXTILE FABRIC SHALL BE REMOVED AFTER DEMOLITION ACTIVITIES ARE COMPLETED AND PROPERLY DISPOSED.
6. STRIPPED TOPSOIL SHALL BE REPLACED AND THE ACCESS ROAD AND STAGING/STORAGE AREA SHALL BE RESTORED TO PRE-CONSTRUCTION CONDITION.
7. AT A MINIMUM CLEARING AND GRUBBING SHALL TAKE PLACE ON THE AREA COVERED BY THE TEMPORARY GRAVEL ACCESS ROAD AND STAGING/STORAGE AREA TO ALLOW THE CONTRACTOR ACCESS TO THE DAM.

0 200' 400'

SCALE:1"=200'

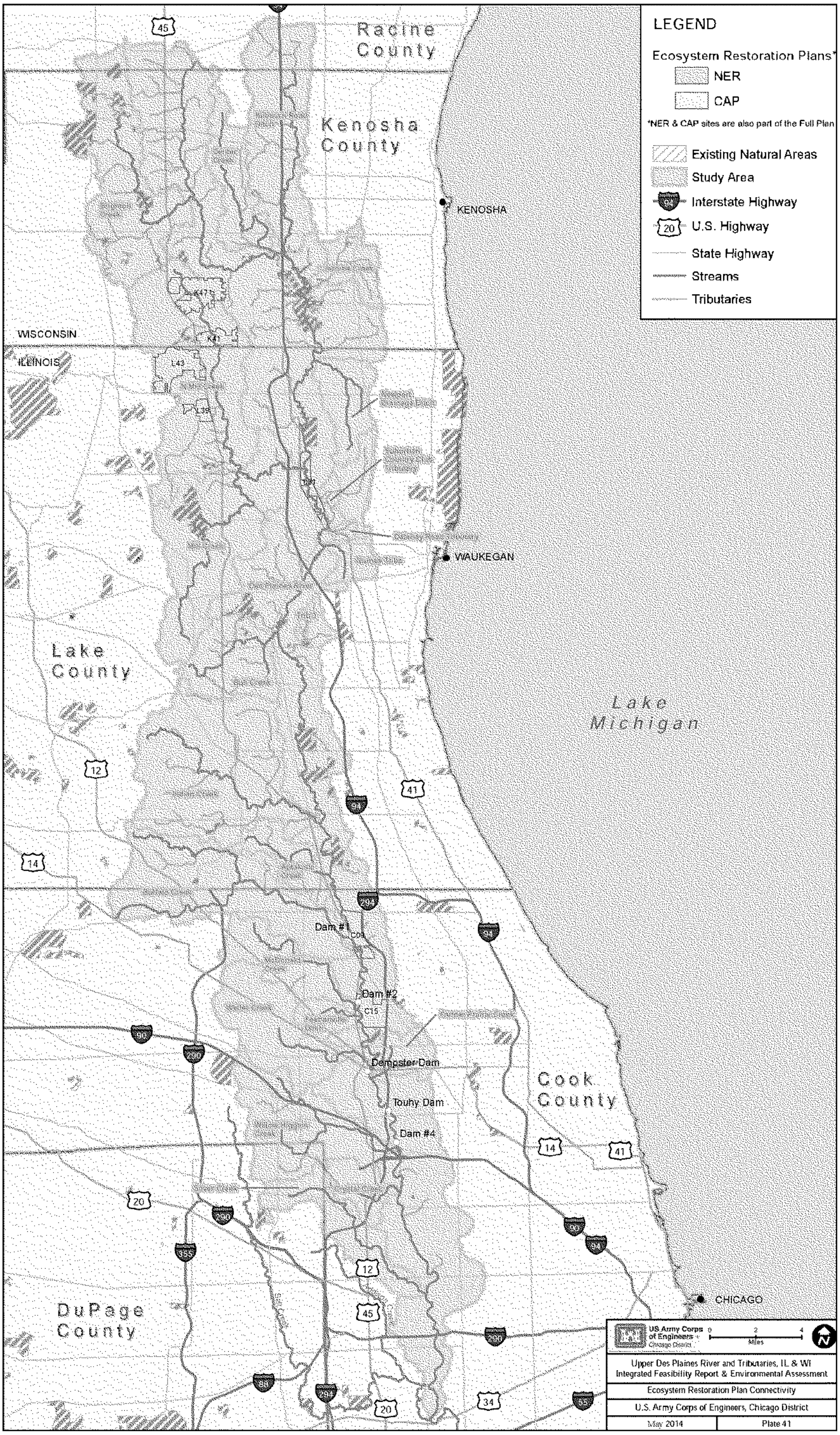
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

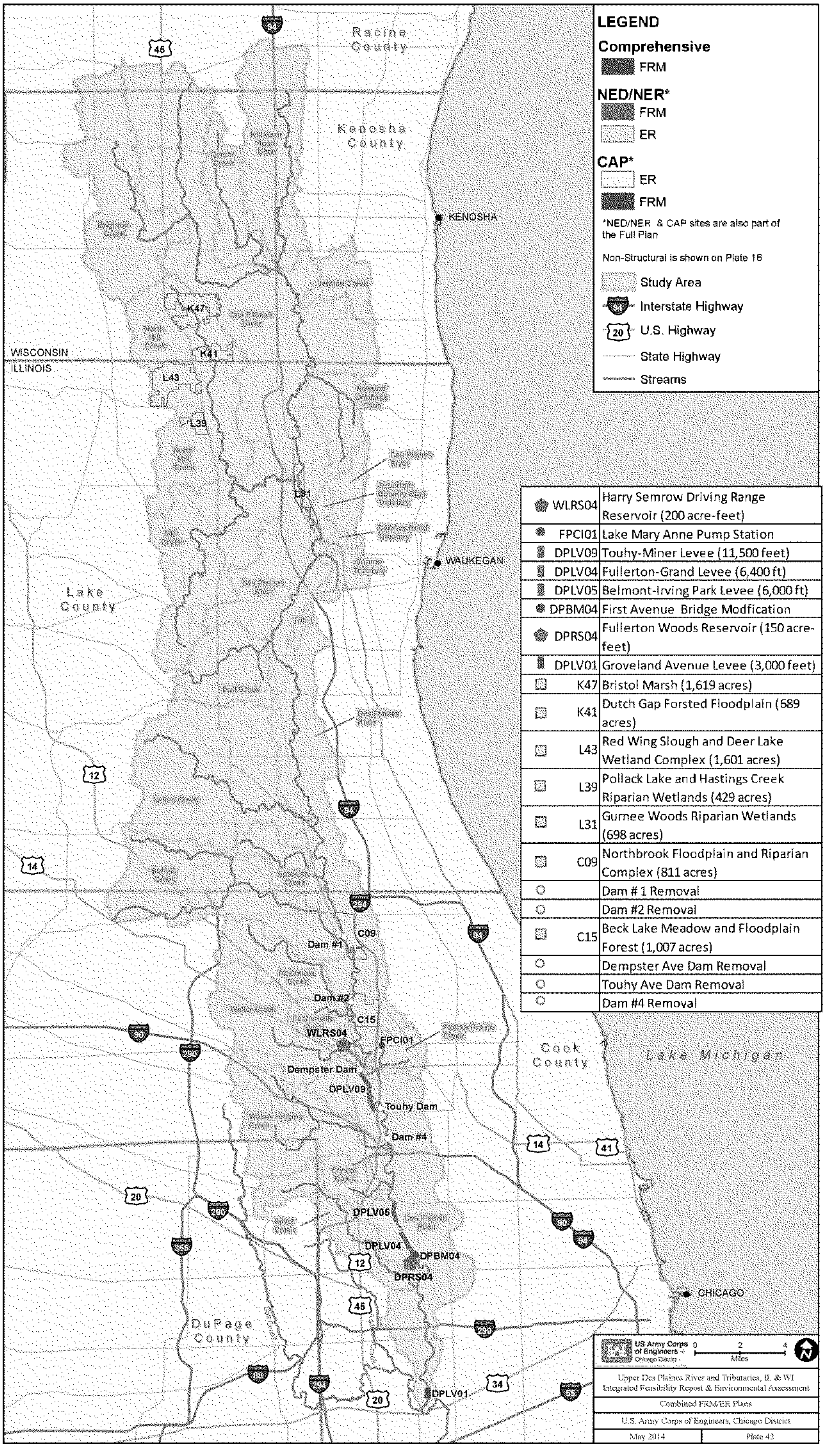
DAM NO. 4 REMOVAL SITE PLAN
DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
1" = 200'- 0"	MAR 2014	DAM_NO_4_SITE_PLAN.DGN

PLATE 40



LEGEND
Ecosystem Restoration Plans*
NER
CAP
*NER & CAP sites are also part of the Full Plan
Existing Natural Areas
Study Area
Interstate Highway
U.S. Highway
State Highway
Streams
Tributaries
Racine County
Kenosha County
KENOSHA
WISCONSIN
ILLINOIS
WAUKEGAN
Lake County
Lake Michigan
Dam #1
Dam #2
Dempster Dam
Touhy Dam
Dam #4
Cook County
CHICAGO
DuPage County
US Army Corps of Engineers Chicago District
Miles
Upper Des Plaines River and Tributaries, IL & WI
Integrated Feasibility Report & Environmental Assessment
Ecosystem Restoration Plan Connectivity
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 41


LEGEND
Comprehensive
FRM
NED/NER*
FRM
ER
CAP*
ER
FRM
*NED/NER & CAP sites are also part of the Full Plan
Non-Structural is shown on Plate 16
Study Area
Interstate Highway
U.S. Highway
State Highway
Streams
WLRS04 Harry Semrow Driving Range Reservoir (200 acre-feet)
FPCI01 Lake Mary Anne Pump Station
DPLV09 Touhy-Miner Levee (11,500 feet)
DPLV04 Fullerton-Grand Levee (6,400 ft)
DPLV05 Belmont-Irving Park Levee (6,000 ft)
DPBM04 First Avenue Bridge Modfication
DPRS04 Fullerton Woods Reservoir (150 acre-feet)
DPLV01 Groveland Avenue Levee (3,000 feet)
K47 Bristol Marsh (1,619 acres)
K41 Dutch Gap Forsted Floodplain (689 acres)
L43 Red Wing Slough and Deer Lake Wetland Complex (1,601 acres)
L39 Pollack Lake and Hastings Creek Riparian Wetlands (429 acres)
L31 Gurnee Woods Riparian Wetlands (698 acres)
C09 Northbrook Floodplain and Riparian Complex (811 acres)
Dam # 1 Removal
Dam #2 Removal
C15 Beck Lake Meadow and Floodplain Forest (1,007 acres)
Dempster Ave Dam Removal
Touhy Ave Dam Removal
Dam #4 Removal
Racine County
Kenosha County
KENOSHA
WISCONSIN
ILLINOIS
WAUKEGAN
Lake County
Cook County
Lake Michigan
DuPage County
CHICAGO
K47
K41
L43
L39
L31
C09
Dam #1
Dam #2
C15
WLRS04
FPCI01
Dempster Dam
DPLV09
Touhy Dam
Dam #4
DPLV05
DPLV04
DPBM04
DPRS04
DPLV01
US Army Corps of Engineers Chicago District
Miles
Upper Des Plaines River and Tributaries, IL & WI Integrated Feasibility Report & Environmental Assessment
Combined FRM/ER Plans
U.S. Army Corps of Engineers, Chicago District
May 2014
Plate 42

Upper Des Plaines River and Tributaries, Illinois and Wisconsin

Appendix A – Hydrology and Hydraulics

March 2014

US Army Corps
of Engineers®
Chicago District

APPENDIX A Upper Des Plaines River and Tributaries, Illinois and Wisconsin
Hydrology and Hydraulics

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INTRODUCTION

WATERSHED DESCRIPTION

The Upper Des Plaines River watershed originates in Racine and Kenosha counties of southeastern Wisconsin. The watershed then extends south into Illinois through Lake County and then Cook County, where it converges with the Salt Creek watershed near Riverside, Illinois. The Des Plaines River then flows southwest on to its confluence with the Kankakee River, where the two rivers combine to form the Illinois River. The study area for this Study includes the entire drainage area upstream of the confluence with Salt Creek, including 12 major tributaries to the river. The Upper Des Plaines watershed covers approximately 477 square miles, an area that spans approximately 60 miles from north to south and 8 miles from east to west. The Upper Des Plaines River travels over 69 miles before its confluence with Salt Creek. Tributaries within the study area include about 330 miles of perennial and intermittent streams. (See Main Report Plate 1).

Most of the southern half of the watershed is fully developed. The open areas remaining in that part of the watershed are primarily golf courses, forest preserves, parks, and cemeteries. The northern portion of the watershed continues to be developed as a primarily residential area with some commercial development.

PROJECT DESCRIPTION

This study is a continuation and extension of the Upper Des Plaines River Flood Damage Reduction Feasibility Study (Phase I Study) (USACE 1999). The Phase I Study was initiated to address severe overbank flooding along the Upper Des Plaines River. It investigated plans for urban flood risk management in the Upper Des Plaines River watershed and recommended six projects to reduce the main stem flooding. This Upper Des Plaines River and Tributaries Feasibility Study (Phase II Study) provides an opportunity to develop a more comprehensive solution to ongoing occurrences of flooding in the Upper Des Plaines River watershed in addition to the Phase I projects. The Phase II Study has three primary objectives: further reduction of mainstem flooding, reduction of tributary flooding, and environmental restoration of degraded ecosystems within the basin. Secondary objectives are improving water quality and enhancing recreational opportunities throughout the basin. The study will consider sites located within tributary watersheds and along the mainstem for both Flood Risk Management (FRM) and Ecosystem Restoration (ER) potential. The effects of flood-risk management sites within tributary watersheds on mainstem flooding will also be evaluated.

The study area for this project is the Upper Des Plaines River watershed and its tributaries upstream of the confluence with Salt Creek(See Main Report Plate 1). In support of this study, updated hydrologic and hydraulic modeling were developed for 15 tributaries: in Wisconsin, Unnamed Tributary No. 6, Salem Branch, Brighton Creek, Kilbourn Ditch, and Dutch Gap Canal; and in Illinois, Mill Creek, Newport Drainage Ditch, Bull Creek, Indian Creek, Buffalo-Wheeling Ditch, McDonald Creek, Weller Creek, Farmer-Prairie Creek, Willow-Higgins Creek, and Silver Creek. Various governmental agencies were responsible for hydrologic and hydraulic modeling of the tributaries of the Des Plaines River. The work contributed by each agency is summarized in Table 1 below. General information about the tributary models appears in this Appendix; detailed reports on individual tributary models are cited in the References section.

Table 1. Tributary Model Completion Dates.

Tributary Name	**Agency**	**Date Completed**
Unnamed Trib. No. 6	SEWRPC	2005
Salem Branch	SEWRPC	2005
Brighton Creek	SEWRPC	2005
Kilbourn Road Ditch	SEWRPC	2005
Newport Drainage Ditch	LCSMC	2008
Dutch Gap Canal	SEWRPC	2005
Mill Creek	LCSMC	2008
Bull Creek	USACE	2005
Indian Creek	USACE	2007
Buffalo-Wheeling Ditch	IDNR	2006
McDonald Creek	USACE	2008
Weller Creek	USACE	2004
Farmer/Prairie Creek	IDNR	2005
Willow-Higgins Creek	CCHD	2005
Silver Creek	USACE	2007

Note: CCHD – Cook County Highway Department, IDNR – Illinois Department of Natural Resources, LCSMC – Lake County Stormwater Management Commission, SEWRPC – Southeastern Wisconsin Regional Planning Commission, USACE – US Army Corps of Engineers, Chicago District.

HYDROLOGY

MODEL DEVELOPMENT

The computer application HEC-1 was used for the Upper Des Plaines River model in the Phase I study. HEC-1 was also the preferred model for the Illinois tributaries. HEC-1 simulates the surface-runoff response of a watershed to precipitation. Simulations are limited to a single storm because the application does not include parameters for soil moisture recovery. This recommendation was based on the desire to eventually integrate these hydrology models for tributaries into the Phase I Des Plaines River watershed model, which was developed in HEC-1. More detailed information about the modeling effort on the Des Plaines River can be found in USACE (1999).

The tributaries in Wisconsin were modeled using the USEPA's Hydrological Simulation Program-Fortran, HSPF. This application performs continuous, long-term simulations of the hydrologic cycle in a watershed. Information on the hydrologic modeling for Wisconsin is summarized briefly in the next section; more detailed information on these tributaries can be found in SEWRPC (2003).

HSPF MODELING IN WISCONSIN

The Southeastern Wisconsin Regional Planning Commission (SEWRPC) used HSPF, a water resource simulation model, for the Des Plaines River watershed. It combined hydrologic, hydraulic, and water quality submodels in an effort to assess the need for an evaluation of existing and future flood control measures in the watershed. Plate A-1 shows the subbasin delineations in the Wisconsin portion of the Des Plaines River watershed.

The hydrologic submodel determines the volume and rate of runoff based on meteorological and land use inputs. Hydrologic Land Segment Types are assigned to areas of the watershed based on a combination of hydrologic soil groups, land cover, and proximity to meteorological station. Soil groups were determined by the National Resources Conservation Service (NRCS) regional soil survey. Land cover was determined by base maps and aerial photographs maintained by SEWRPC. A Theissen polygon network was constructed to subdivide the watershed into areas lying closest to each of three weather stations in Kenosha, WI, Union Grove, WI, and Antioch, IL. Large-scale topographic mapping, with 2-foot contours and a 1"=200' scale, was also used for the hydrologic submodel.

The first hydraulic submodel, HSPF accepts as inputs the surface runoff and groundwater discharges from the hydrologic submodel and routes it through the stream system. Reach routing is accomplished using a reservoir routing technique. HSPF outputs are discharge time series. Flow frequency analysis of the annual peak flows generates the various recurrence interval flood discharges that are then input to the second hydraulic submodel, HEC-2, for stage calculations.

Historical streamflow and flood stage data from USGS gages as well as Wisconsin DNR and SEWRPC were used to calibrate the models.

HEC-1 MODEL PARAMETERS

To develop an HEC-1 model of a watershed, various parameters need to be developed to describe it. These parameters include subbasin delineation, drainage area, curve numbers, unit hydrograph parameters such as time of concentration or lag time, base flow, and parameters for routing calculations. The derivation of these parameters is summarized in the following paragraphs.

Basin Delineation and Drainage Area

Drainage basins were re-delineated during the development of new hydrologic models. Plates A-2 through A-11 show the subbasin delineation for the tributaries. Many models used LIDAR data of the watershed from IDNR. The effort for Newport Ditch used 2-ft contours from LCSMC data. The subbasins in Buffalo-Wheeling Creek were delineated by hand.

The total drainage area of each stream was compared to the drainage area of the stream in the main stem Des Plaines HEC-1 Phase I model. The results are listed in Table 2 below. For all new tributary modeling (Phase II), the re-delineated drainage area is within +/-15% of the drainage area used in the Phase I Des Plaines River model.

Table 2. Drainage Area Comparison.

Stream	Drainage Area (mi^2) Mainstem Model	Tributary Model	Percent Difference
Brighton Creek	18.45	20.70	-12%
Center Creek (Root River)	9.82	NA	
Kilbourn Road Ditch	24.60	23.70	4%
Newport Drainage Ditch	7.59	7.85	-3%
Mill Creek	63.27	66.37	-5%
Gurnee Trib.	11.41	NA	
Bull Creek	12.06	11.27	7%
Indian Creek	37.61	37.82	-1%
Aptakisic Creek	13.18	NA	
Buffalo-Wheeling Creek	27.17	26.82	1%
McDonald Creek	10.64	10.23	4%
Feehanville Ditch	3.59	NA	
Weller Creek	17.95	18.67	-4%
Farmers'-Prairie Creek	4.74	4.35	8%
Willow-Higgins Creek	19.11	19.67	-3%
Crystal Creek	5.22	NA	
Silver Creek	11.36	12.98	-14%

The difference in delineated drainage area could be due to the availability of improved topographic data and GIS. No changes in drainage area were made after this assessment. The hydrologic modeling for Buffalo-Wheeling Creek was incorporated into the mainstem Des Plaines River HEC-1 model. It was found that baseflow parameters had to be adjusted in the new Buffalo-Wheeling Creek modeling to maintain the calibration of the Des Plaines hydrologic model. There are no plans to integrate any other tributary modeling into the mainstem HEC-1 model.

Curve Number

Losses due to infiltration were represented with curve numbers, computed using the method described in TR-55 (NRCS 1986). The curve number method was developed to represent the effects of soil type, land use, and antecedent moisture conditions on a basin's capacity for infiltration. Land use data used in many of the tributary modeling came from the Northeastern Illinois Planning Commission (NIPC); the Buffalo Creek model used land use data from the State of Illinois. The land use in the Newport Ditch watershed was determined using local zoning maps. The soil types were obtained from NRCS. The soil moisture conditions were assumed to be AMC II. Curve numbers were adjusted for future conditions based on NIPC projections of population growth and known public works projects, such as O'Hare Airport expansion. Table 3 summarizes the range of curve number values used in the hydrologic models.

Table 3. Range of Curve Numbers in Hydrologic Models.

River Name	CN
Des Plaines River	46 – 96
Newport Drainage Ditch	72 – 94
Mill Creek	66 – 92
Bull Creek	77 – 88
Indian Creek	72 – 87
Buffalo-Wheeling Ditch	68 – 82
McDonald Creek	75.1 – 83
Weller Creek	74 – 91
Farmer/Prairie Creek	72 – 98
Willow-Higgins Creek	70 – 96
Silver Creek	76 – 92

Unit Hydrograph

The unit hydrograph is a method used to transform excess rainfall into a runoff hydrograph. Most of the modeling done for this project utilized the Clark unit hydrograph (Clark 1943), which is based on models of watershed storage. The parameters used in HEC-1 to describe the Clark unit hydrograph for each subbasin are the time of concentration, Tc, and a storage coefficient, R. Some models used the SCS dimensionless unit hydrograph (NRCS 1969), for which HEC-1 requires a lag time, tp. Table 4 below summarizes the unit hydrograph methods used in the hydrologic modeling, and it includes notes on references used to compute the unit hydrograph parameters when cited by the modelers.

Table 4. Unit Hydrograph Methods.

	Unit Hydrograph		
River Name	Clark	SCS	**Reference**
Des Plaines River	X	X	
Newport Drainage Ditch		X	
Mill Creek	X		Lake Co regression equations USGS WRI 82-22 (Graf et al. 1982)
Bull Creek	X		USGS Open File 96-474 (Melching and Marquardt 1997)
Indian Creek	X		USGS WRI 82-22
Buffalo-Wheeling Creek	X		USGS WRI 82-22, USGS Open File 96-474
McDonald Creek	X		USGS WRI 82-22
Weller Creek	X		USGS WRI 82-22
Farmer/Prairie Creek		X	
Willow-Higgins Creek		X	
Silver Creek	X		USGS WRI 82-22

The Willow-Higgins Creek HEC-1 model was designed with a customized SCS dimensionless unit hydrograph. The modeler used a non-standard peak rate factor that had been used in prior

studies. This necessitated pairing the model with a modified form of HEC-1 because the standard peak rate factor is a hard-coded value in that application. The Chicago District decided to run the HEC-1 input file for Willow-Higgins Creek with a standard version of HEC-1 to be consistent with the other models in the study. The issue of integration of a basin-wide hydrologic model is discussed in a separate paragraph at the end of the Hydrology section.
Base Flow

Base flow is the discharge in a stream during non-rainy periods. Base flow parameters were estimated through analysis of streamflow gage records, although not every tributary model included base flow. These stream models did account for base flow: Des Plaines River, Indian Creek, and Buffalo Creek.

These streams did not include baseflow in hydrologic modeling: Newport Ditch, Mill Creek, Bull Creek, McDonald Creek, Weller Creek, Farmer-Prairie Creek, Silver Creek, and Willow-Higgins Creek.

Routing Reaches

Hydrograph routing was performed using various methods depending on the conditions at the location in the watershed and the availability of appropriate data. Much of the channel routing in the hydrologic models developed for this study was performed using the Modified Puls method as described in the USACE Hydrologic Engineering Center's Training Document 30 (Bonner 1990). This method simulates the movement of the flood wave in a river by defining storage volume vs. elevation relationships for discrete river reaches. Other methods used for routing include Muskingum-Cunge, direct hydrograph lag, and normal depth channel routing. Channel routing was not included in the hydrologic models for Mill Creek and Newport Ditch; unsteady-state hydraulic models were developed for these streams so routing was not required in HEC-1.

Synthetic Storm Development

The precipitation depths for the various storm frequencies were obtained from Circular 172 (Huff and Angel 1989). The temporal distribution of the storms was obtained from Circular 173 (Huff 1990). Eight storm frequencies were used, with chance of occurrence in any given year of 99% (1-year), 50% (2-year), 20% (5-year), 10% (10-year), 4% (25-year), 2% (50-year), 1% (100-year) and .2% (500-year).

MODEL CALIBRATION

Calibration is a critical activity in hydrologic modeling: in order for a model to be useful the modeler must be confident that the model is representing the rainfall-runoff response appropriately. The calibration procedure involves selecting a rainfall event, entering precipitation data into HEC-1, and then comparing the computed hydrographs at one or more locations to measured discharges. Parameters such as curve number and time of concentration can be adjusted to cause the HEC-1 model to produce hydrographs with similar shape, peak flow, and total runoff volume as measured data.

Records from several United States Geological Survey (USGS) stream gages were used for calibration of the HEC-1 model. The primary flood events used for calibration were the September 21 - October 5, 1986 and the August 13 - 16, 1987 storms. Since all of the gages were not active during those particular events, other, more recent events were analyzed for some sites. Additional events were also used to improve the understanding of the watershed response to precipitation events. Individual models were established for each event to correspond to the watershed characteristics that were present at the time of the event. For example, the reservoir configuration had to be revised for each model to represent only those reservoirs that had been constructed at the time of the event. In addition, an assessment of antecedent moisture conditions was made for calibration purposes.

Precipitation information for the storms that produced these floods was obtained from the National Weather Service (NWS) Illinois stations at Antioch, Aurora, Barrington, Chicago Botanical Garden, Chicago Midway Airport, Elgin, Joliet, Lake Villa, Morengo, McHenry, Park Forest, Waukegan, and Wheaton. Stations used in Wisconsin included those at Burlington, Kenosha, Lake Geneva, Milwaukee Airport, Racine and Union Grove. Additional precipitation information was gathered from stream gages that also had precipitation gages and from waste water treatment plants in the watershed which collect precipitation data.

Both temporal distributions and rainfall amounts were used as input with the developed loss rates, base flows, unit hydrographs, and routing parameters. The computed discharge hydrographs at the stream gage locations were compared to the recorded values. The modeling of all the major tributaries to the Des Plaines River was calibrated to available gage sites. When satisfactory results were attained the tributary models were combined for development of the full Des Plaines River HEC-1 model.

Due to the long duration of some of the storms which were used for calibration there were some days of minimal or no precipitation. To represent the multiple day storms and the losses which occurred, the storms were broken into segments of several days each. The antecedent moisture conditions, base flows, and reservoir water surface elevations were adjusted for the beginning of each segment. The computed segments were then combined to represent the full storm duration for the comparison to the hydrographs recorded at the gages.

The combined computed hydrographs from the HEC-1 segmented model up to the Russell gage were compared against the recorded discharge hydrograph at the Russell gage. For the Gurnee stream gage the calibration of the HEC-1 model was accomplished first by inputting the Russell Road observed hydrographs and all tributary hydrographs (either observed or computed) between the Russell Road and Gurnee gages. The model output for the computed hydrograph at the Gurnee gage was compared to observed values. Once the comparison between the computed and observed gage was reasonable, the observed Gurnee gage values were input along with the tributary hydrographs (observed or computed) between the Gurnee and Des Plaines gage. The model output for the computed hydrograph at the Des Plaines gage was compared to observed values. This same procedure was repeated down to the Riverside gage. These comparisons provided support for the routing parameters and combination locations which had been chosen for the Des Plaines River.

Next the computed non-segmented hydrographs from the tributaries were used in the same sequence along the Des Plaines River for the 1986 and 1987 events. Progressing downstream, the observed hydrographs at Russell, Gurnee, Des Plaines and Riverside were again used as input to be added with the computed tributary hydrographs. Comparisons were made between the computed and observed hydrographs at each of the gages. These comparisons provided information regarding the influence of all the modeled tributaries on the Des Plaines River.

The final step ran the non-segmented model for the entire event, both 1986 and 1987, from upstream to downstream. Again, comparisons were made between computed and observed hydrographs. These comparisons provided information on the functionality of the entire Des Plaines River HEC-1 model. The computed hydrographs showed the impact of excess runoff from the multiple days of precipitation resulting from the curve number loss rate function and its inability to account for the reintroduction of losses due to intermediate days without precipitation. The calibration to historic events was conducted by IDNR-OWR.

Discrepancies between modeled and observed peak flows can be attributed to the complexity of the watershed, the extensive existing development and modifications, and limitations associated with developing models for such a complex watershed. Examples of complexities to which these discrepancies could be attributed include:

- There are 64 bridges in the approximate 65 river miles of mainstem channel alone. Inclusion of the tributary channels adds hundreds of additional channel crossings. The location and degree of accumulation and movement of debris through bridges and culverts throughout the system during the 1986, 1987, and subsequent events, along with the effects of this accumulated debris on conveyance and attenuation, is not known.
- The model calibration events simulated in the model accounted for the spatial variability of rainfall, but only to the extent possible. The large basin experienced rainfall variability greater than could be accounted for due to gaps in the rain gage network.
- In addition to providing the estimated flood stages for the Phase I and Phase II feasibility studies, the hydrologic and hydraulic models are also used for regulatory modeling and therefore need to be readily usable for this purpose. To make the model more accessible, loss parameters were applied consistently for each frequency. While adjusted loss rates may have resulted in a better calibration for the 1986 or 1987 storms, it would have limited the usability of the models.

Mill Creek, Buffalo Creek, McDonald Creek, and Weller Creek each had one streamflow gage in their respective watersheds that was used for calibration. The streamflow gage on Bull Creek had a period of record of only seven years; this model was calibrated using synthetic events and flow frequency analysis of gage records for a gage on McDonald Creek which had a period of record of nearly 50 years. Indian Creek modeling was calibrated both to historic events compared to an Indian Creek streamflow gage and synthetic events compared to frequency analysis of gages in similar watersheds.

These tributaries did not contain streamflow gages at the time of this study: Newport Ditch, Farmer-Prairie Creek, Willow-Higgins Creek and Silver Creek. The modeling for Willow-Higgins Creek was adjusted to match the results of a TR-20 model completed for a previous study. For the other streams, stage data was used to calibrate the HEC-1 and HEC-RAS models simultaneously.

CRITICAL DURATION ANALYSIS

The critical durations determined for the tributaries to the Des Plaines River in Illinois are summarized in Table 5 below.

Table 5. Critical Duration of Storms.

River Name	Critical Duration (hr)
Des Plaines River	240
Newport Drainage Ditch	12
Mill Creek	48
Bull Creek	24
Indian Creek	24
Buffalo-Wheeling Ditch	24
McDonald Creek	24
Weller Creek	24
Farmer/Prairie Creek	6
Willow-Higgins Creek	24
Silver Creek	24

A critical duration analysis was performed for each tributary. The analysis began with modeling the complete range of storm frequencies using various storm durations. Next the peak discharges were obtained for various locations along the tributary. The results were examined to determine whether a particular storm duration produced higher peak flows at those points. The critical duration storm was used to determine the structural damages along each tributary. It was noted that the critical duration could change based on changing watershed conditions and would need to be recalculated. It was also noted that transportation damages may not be calculated with the critical duration storm since the amount of traffic damage is a function of both peak discharge and duration of road inundation, and the duration (or "spread") of a hydrograph was not included in the critical duration analysis. Because a continuous simulation model was used for Wisconsin, critical duration analyses were not performed for those tributaries.

BASELINE AND FUTURE CONDITIONS

The Existing Conditions models were based on current land use conditions with only functional ecosystem, stormwater, or flood control projects included. The Baseline Conditions models used a base year of 2004. This year was selected based on the projected time frame for model completion. The year 2020 was selected as the Future Conditions year. At the time that the tributary modeling was initiated, 2020 was the latest year with predictions of land use and population as developed by the Northeastern Illinois Planning Commission. Future watershed hydrology was modeled by varying the loss rate function to reflect changes in population and land use. In practice this involved adjusting the curve numbers and unit hydrograph parameters.

BASIN-WIDE MODEL DISCUSSION

Except for Wisconsin, all models were developed using the same application, HEC-1. The Phase II study team developed a document, the Hydrology and Hydraulics User Manual, which listed assumptions, references, and recommendations to ensure that the models were developed in a consistent way. The Manual recommended the use of the HEC-1 application based on the desire to eventually integrate the hydrology models for tributaries into the Phase I Des Plaines River watershed model. The Buffalo-Wheeling Creek model was brought into the mainstem model. A white paper on the mainstem hydrologic and hydraulic modeling was developed in January 2008 and is included as Attachment A-1. The white paper outlined flow frequency analysis that confirmed that the Phase I hydrology model would still be appropriate for Phase II analysis of the mainstem Des Plaines. The study team considered incorporating updated hydrology into a basin-wide hydrology model but did not consider the work to be a high-priority task given the results of the white paper. Tributary models are valuable on a tributary scale because of the greater detail, and the mainstem HEC-1 is appropriate on a Des Plaines watershed scale.

HYDRAULICS

MODEL DEVELOPMENT

The computer application HEC-2 was used for the hydraulic analysis in the Phase I study. HEC-RAS, run in steady state, was the preferred method for hydraulic analysis of the tributaries in the Phase II study. The hydraulic models for two streams, Newport Ditch and Mill Creek, used unsteady HEC-RAS but steady-state runs were also performed using the resultant peak flows to be consistent with the other tributary models in the study. The models for Mill Creek, Buffalo-Wheeling Creek, and Silver Creek used the NAVD88 vertical datum; the remainder of the hydraulic models used NGVD29. HEC-RAS schematics for the tributaries in Illinois can be found in Plates A-12 through A-21. More information on the HEC-2 modeling of the Des Plaines River can be found in USACE (1999).

The tributaries in Wisconsin were modeled using HEC-2. Historical streamflow and flood stage data from USGS gages as well as Wisconsin DNR were used to calibrate those models. More information on the hydraulic modeling for the Wisconsin tributaries can be found in SEWRPC (2003).

MODEL PARAMETERS

The hydraulic models HEC-2 and HEC-RAS require three categories of input data: physical characteristics of the stream, discharge data, and boundary conditions. The physical characteristics include the geometry of cross sections and structures, reach lengths, and surface roughness. The discharge data used in this study were peak flows computed in HEC-1 at various locations in the watershed for eight synthetic storms. Since the majority of the modeling was performed assuming steady flows and the Des Plaines watershed is in a relatively flat part of the country, most models only required one boundary condition, at the downstream end. The physical characteristics and boundary conditions are described further in the following paragraphs.

Cross Section Geometry

Cross section geometry data and reach lengths were obtained from field surveys, USGS topographic maps, LIDAR data for the watershed, and previous hydraulic studies. In many models, detailed survey data defined the channel geometry, and other topographic data sources were used to extend the cross section into the floodplain.

Channel Roughness

Channel roughness, represented by Manning's n, was generally determined using observations gathered from site visits, site photography, and aerial photography. Manning's n values from prior studies of the streams were also used. Newport Ditch, Mill Creek, Bull Creek, and Silver Creek used the method described in Cowan (1956) to assign Manning's n values. Buffalo Creek used the method described in Chow (1959). Table 6 summarizes the range of Manning's n values used in the hydraulic modeling of the Des Plaines River and its tributaries in Illinois.

Table 6. Range of Manning's n Values in Hydraulic Models.

River Name	Channel "n"	Overbank "n"
Des Plaines River	0.019 – 0.065	0.07 – 0.19
Newport Drainage Ditch	0.017 – 0.055	0.017 – 0.075
Mill Creek	0.03 – 0.10	0.04 – 0.10
Bull Creek	0.034 – 0.040	0.04 – 0.19
Indian Creek	0.01 – 0.058	0.035 – 0.10
Buffalo-Wheeling Ditch	0.035 – 0.0495	0.030 – 0.138
McDonald Creek	0.03 – 0.04	0.035 – 0.055
Weller Creek	0.035 – 0.07	0.035 – 0.15
Farmer/Prairie Creek	0.025 – 0.04	0.03 – 0.08
Willow-Higgins Creek	0.02 – 0.065	0.03 – 0.085
Silver Creek	0.034 – 0.04	0.04 – 0.19

Downstream Boundary Conditions

The downstream boundary condition for the Upper Des Plaines River was a rating curve at Hoffman Dam, at River Mile 44.451.

The downstream boundary conditions of most of the tributary models were based on modeled flood stages in the Des Plaines River. The Office of Water Resources performed coincident frequency analysis on stream gages along Weller, McDonald, and Buffalo Creeks in conjunction with gages along the Des Plaines River. It is more typical that a precipitation event will occur over only a small portion of the basin than over the whole basin. A 1% chance (100-year) precipitation event over a tributary, in general, would not typically produce a 1% chance (100-year) coincident stage on the main stem of the Des Plaines River.

Analysis of the Weller and McDonald Creek gages showed that large tributary floods occur at times when the Des Plaines River is at a 6-year recurrence (16.7% chance) interval or less. The analysis of the Buffalo Creek gage showed that large floods in that stream occur when the Des Plaines River is experiencing a 2-year (50% chance) or smaller storm. Based on this analysis, the downstream boundary condition for most tributaries was set to a 5-year (20% chance) flood stage on the Des Plaines River. The Corps of Engineers provided the water surface elevations at tributary confluences to the responsible agency performing a hydraulic analysis. The downstream boundary conditions used in the Illinois tributary models are summarized in Table 7. The downstream boundary condition for Newport Drainage Ditch varied with discharge.

At the mouth of Indian Creek, the normal depth boundary condition was used with an energy slope of 0.0002. Information about tributaries in Wisconsin can be found in SEWRPC (2003).

It should be noted that flood damages along a tributary caused by main stem tailwater are not ignored: the main stem flood damages in the 1% chance (100-year) Des Plaines tail water areas are still taken into account by the 1% chance (100-year) flood profiles on the Des Plaines River.

Table 7. Downstream Boundary Conditions.

Tributary Name	Downstream B.C.
Newport Drainage Ditch	VARIES
Mill Creek	665.79
Bull Creek	656.00
Indian Creek	N/A
Buffalo-Wheeling Ditch	637.65
McDonald Creek	635.08
Weller Creek	632.31
Farmer/Prairie Creek	629.79
Willow-Higgins Creek	625.70
Silver Creek	620.22

Other Boundary Conditions

Other boundary conditions were used in some tributary hydraulic models. The unsteady-state runs of Newport Ditch and Mill Creek required initial conditions and an upstream boundary condition. The initial conditions were defined flows, and the upstream boundary conditions were flow hydrographs. While most of the hydraulic models were limited to subcritical flow conditions, three streams (Bull Creek, Indian Creek, and Silver Creek) were run under mixed flow conditions. The mixed-flow option in HEC-RAS allows for supercritical flow conditions. Since supercritical flow is upstream-controlled, the model requires an upstream boundary condition in case supercritical flow is computed at the upstream end of the model. This boundary condition is only used when necessary; otherwise, the stage at the upstream end is computed as part of a backwater curve. Bull Creek and Silver Creek used the normal depth assumption as the upstream boundary condition, while Indian Creek used critical depth.

MODEL CALIBRATION

The hydraulic models developed for this study were calibrated against rating curves, high water marks, or stage records at gages. The procedure involved inputting peak flow data from HEC-1 simulations of historic events and then comparing the computed stages to measured data. The parameters that could be adjusted in a hydraulic model during calibration are Manning's n, effective flow limits, changing bridge data, and rating curves.

The Des Plaines River hydraulic model was calibrated using rating curves at four streamflow gages and high water marks taken at various locations. The HEC-2 model results were also used to make a comparison against high water data obtained for the 1986 flood event. Flood discharges were estimated for the 1986 event based on available information throughout the reach where high water marks were available. The HEC-2 output, from the range of synthetic events tested, was then used to interpolate stages for the estimated 1986 flood discharge values at the high water mark locations. These values, all within plus/minus 1 foot, were considered reasonable considering the intended accuracy of the HEC-2 model and the accuracy of high water data in general and how it is collected. For additional details regarding the calibration of the mainstem Des Plaines River model, see the Phase I H & H Appendix.

Other models that used high water marks in calibration were Newport Ditch, Farmer-Prairie Creek, and Silver Creek. The Weller Creek model was calibrated using a rating curve at a streamflow gage. Stage records at streamflow gages were used to calibrate hydraulic models of Indian Creek, Buffalo Creek, and McDonald Creek.

As noted in the Hydrology section, a few streams were ungaged, so the entire calibration was based on stage measurements. These streams are Newport Ditch, Farmer-Prairie Creek, and Silver Creek. The hydraulic models for Bull Creek and Willow-Higgins Creek did not undergo calibration due to lack of stage measurements.

HISTORICAL STORMS AND FLOODS

Severe floods have occurred in the Upper Des Plaines River basin over the past several decades resulting in millions of dollars in damages. Two major floods that occurred in 1986 and 1987 in and around the Upper Des Plaines River basin (FEMA declarations #776 and #798 respectively) together caused more than $100 million in damages to more than 10,000 residential, commercial and public structures as well as damages attributed to traffic impacts. More than 15,000 residents were evacuated during the 1986 flood alone. Over 40 river crossings and numerous roads running parallel to the Des Plaines River flooded, causing traffic delays, prolonged detouring, and physical damage to the roadways. More recently, the Des Plaines River has seen large events in May 2004, August 2007, September 2008, December 2008, and April 2013 which resulted in significant flood damages and disaster declarations.

EXISTING FLOOD CONTROL MEASURES

Six flood risk management projects within the Upper Des Plaines River watershed were authorized as a result of the Phase I Study, and include:

- Van Patton Woods Lateral Storage in Wadsworth and Russell, IL
- North Fork Mill Creek Dam Modification in Old Mill Creek, IL
- Buffalo Creek Reservoir Expansion in Buffalo Grove, IL
- Big Bend Lake Reservoir Expansion in Des Plaines, IL
- Levee 37 in Prospect Heights and Mount Prospect, IL
- Levee 50 in Des Plaines, IL

The Van Patton Woods lateral storage area, North Fork Mill Creek Dam Modification, and Buffalo Creek Reservoir expansion are on hold due to landowner considerations, therefore the 25% reduction in flood damages had not been realized. Initial designs have been prepared for Big Bend Lake Reservoir expansion and the Van Patton Woods lateral storage area and are being coordinated with the non-Federal sponsors. Levee 37 is under construction and Levee 50 is complete.

A levee for flood risk management at North Libertyville Estates was constructed as authorized under Section 205 of the Continuing Authorities Program. North Libertyville Estates is a residential subdivision located on the east bank of the Des Plaines River in southern Lake County, approximately 2 miles northeast of Libertyville, Illinois. The project included construction of 5,500 linear feet of earthen levee, 150 linear feet of steel sheetpile floodwall, realignment of an existing drainage ditch, and implementation of an interior drainage plan and a flood warning system. The levee encircles the subdivision and ties into Buckley Road on the east and west sides of the subdivision. Interior drainage is provided by pipes through the levee with flexible check valves to prevent backflow into the subdivision. Additional drainage is provided by a permanent 2,000 gpm pump station and portable pumps used on an as-needed basis. A mitigation plan is being implemented to mitigate for the loss of habitat for the levee construction.

PRINCIPLE FLOOD PROBLEMS

This Phase II study builds upon the results of the Phase I Study and considers sites located both within tributary watersheds and along the mainstem to address flood damages across the watershed.

Many damage areas reported in the Phase I Study are located at the mouth of tributaries (e.g., Farmer- Prairie Creek at mile 63.7, Aptakistic Creek at mile 75.5). However, these damages are calculated solely based on the flood stages on the mainstem Des Plaines River. In addition to damages from stages on the mainstem Des Plaines River, this Phase II Study includes estimated damages caused by flood stages along the entire length of the tributaries.

In addition to results from the Phase I Study, previous estimates of average annual flood damages (AAD) on several tributaries over the past 40 years were compiled. Average annual damage estimates were escalated using the Bureau of Labor Statistics historical Universal Consumer Price Indices (CPI-U). Sources of flood damages in these estimates include residential and non-residential structures, their contents, and traffic impacts.

Impacts to the road network were estimated based on increases in vehicle delay and distance traveled caused by flood induced detours. Simulation of flood induced detours on vehicles traveling the area transportation network were obtained through Visual Interactive System for Transport Algorithms (VISTA) Transportation modeling.

Flood hydrographs, showing modeled flood stages and durations, were created for each major roadway section susceptible to overbank flooding. Low-point elevations on the roadways, reviewed and confirmed by local transportation agencies, were used to determine the timing, duration, and depth of flooding. Roads crossing the mainstem and tributaries along with parallel roads were included in the inventory.

MODEL RESULTS

The without-project water-surface profiles for the Des Plaines River and its tributaries in Illinois can be found in Plates A-22a through A-42. Hydraulic model results for Wisconsin tributaries can be found in SEWRPC (2003).

PLAN FORMULATION

Three analyses were performed for plan formulation. First, hydrologic and hydraulic data were collected to aid in the determination of transportation damages for the baseline conditions. Then various proposed flood risk managmenet projects were evaluated. The major types of structural measures included in this analysis were reservoirs and levees. The resulting water-surface profiles were provided to Planning for further assessment. First-added and last-added economic analysis used modeling results to ensure that the system of proposed reservoirs was economically justified.

STRUCTURE DAMAGE ANALYSIS

Structural Damages were estimated using the Hydrologic Engineering Center Flood Damage Assessment (HEC-FDA) model. Structures within the 1% and 0.2% annual chance of exceedance (100-year and 500-year) floodplain of the Upper Des Plaines River and the modeled tributaries were included in the analysis. A preliminary assessment of potential structural flood damages was done for the entire watershed using GIS. Plate 11 in the Main Report, shows the existing 1% chance (100-year) floodplain in the study area. In Illinois, existing floodplains were extracted from FEMA digital flood insurance rate maps (DFIRMs) across the watershed. In Wisconsin, a detailed mapping of the floodplain was performed by Southeastern Wisconsin Regional Planning Commission (SEWRPC).

A structure inventory was compiled consisting of specific information for individual structures within the floodplain including location, use, elevation, and value. The 1% chance floodplain, FEMA hazard data (HAZUS), and block information from the 2000 Census were used to determine the number of structures located within the 1% chance floodplain by structure category. A buffer of 250 feet was added to capture any additional structures that may be impacted. Over 10,000 structures and vehicles are included in the inventory.

Structures are grouped in six categories: apartment (multi-unit residential), commercial, industrial, public (tax-exempt structures in the public ownership), residential, and automobiles. Building structure types were determined using local tax assessor category information for individual properties. First floor and low entry point elevations for all structures within the 1% chance floodplain were surveyed. Data previously collected for the Phase I Study by the Chicago District and for other local studies by IDNR and others were used where available. Surveys were conducted by MWRDGC in Cook County, IDNR in Lake County, and SEWRPC in Kenosha County for the remaining structures. For structures within the 0.2% chance floodplain but not captured by the survey an offset was applied to available Light Detection and Ranging (LIDAR) land surface data. Further discussion of this procedure is included in Appendix E (Economic Analysis).

BASELINE TRANSPORTATION DAMAGES ANALYSIS

The purpose of this analysis was to determine road segments that cross a stream or run parallel to it and are affected by flooding in the Des Plaines River watershed. The duration and schedule of road closures were computed for eight synthetic storm events of varying frequency. The final product of the analysis was a database of flood depth and duration information that was used by VISTA, a transportation systems model. Depth-damage curves were developed from the baseline conditions and were used in the with-project damages analysis.

VISTA, or Visual Interactive System for Transport Algorithms, is a route-based traffic simulator that was developed at Northwestern University. It simulates vehicles traveling on the major roads in a region based on measured traffic levels. Traffic is affected by controls such as stop signs and signals. Closures due to flooding can also be entered as controls in the simulation. Road closures during a flood event would force the simulated vehicles to find alternate routes. The impacts of flooding on traffic can be reported by VISTA in terms of extra travel time, extra mileage, or extra emissions, for example. The results of the VISTA model are discussed in the Economics Appendix; what follows is a description of the hydrologic analysis used to compute input data for VISTA.

Overview

Geographic, hydrologic, and hydraulic data were compiled in order to compute the duration and depth of flooding on roads in the portion of the Des Plaines River watershed in Illinois. The geographic data included the VISTA transportation network, road maps, and topographic data. The hydrologic data included hydrographs generated by HEC-1 simulation of synthetic storm events. The hydraulic data included rating curves from HEC-2 or HEC-RAS modeling, rating curves from FEMA flood insurance studies FIS, and bridge cross sections. The methodology used in this analysis is described below. Plate A-43 is a graphical depiction of the depth and duration calculations.

Locate Flooded Roads

First, the VISTA network was compared to the stream alignments in GIS. A new layer was generated that consisted of the points of intersection between these two layers. The location of links in the VISTA network did not necessarily correspond to a road's actual location. Because of this, the next step was to compare the new point layer to a road map to ensure that each point actually marked a road crossing. Points were moved to the actual location of the crossing, or deleted if the actual road location did not cross the stream.

Flooding could occur on roads that run along a stream but do not cross it. These "parallel" roads were manually added to the list of potentially flooded locations by comparing the 1% chance (100-year) floodplains defined by FEMA to the VISTA network in GIS.

Find Minimum Roadway Elevation

It was assumed that a road would be closed due to flooding once water inundated the lowest point on the top of the road. Road elevation data came from three sources: hydraulic models, FIS, and GIS. Where detailed hydraulic modeling was available, bridge cross section information was used to obtain the road elevation. If a stream was outside the range of the available hydraulic models, then the FIS was checked to see whether the road was noted on the flood profile plots. Roads are often indicated on those plots with a vertical line or "I" shape. The top of the line was used as the top of road. If the road did not appear either in a hydraulic model or FIS, then digital elevation data was used. GIS was used to estimate the road elevation for all parallel roads. The road elevations obtained from these sources by the Chicago District were provided to state and county transportation departments for their review. The agencies that reviewed the data were the Illinois Department of Transportation (IDOT), Illinois Tollway Authority, Cook County Highway Department (CCHD), Lake County Department of Transportation (LCDOT), and Wheeling Township. Those agencies provided updated road elevations where data and time allowed.

Select Appropriate Flood Hydrograph

Hydrographs were taken from HEC-1 models of the streams in the Des Plaines watershed. The hydrographs represent the discharge over time resulting from storms of various magnitudes. Eight storms were simulated, representing precipitation with 99% (1-year), 50% (2-year), 20% (5-year), 10% (10-year), 4% (25-year), 2% (50-year), 1% (100-year) and .2% (500-year) chance of recurrence (return periods). The storm duration varied by model. During the development of each model, an investigation into the critical duration was made. The critical duration is the storm duration that would produce the highest peak flows throughout the watershed. Those storm durations were maintained for this analysis. The critical duration for the main stem of the Des Plaines River is 10 days, and it was generally 24 hours for the tributaries, although it ranged from 6 to 48 hours. Notes in the HEC-1 input file and GIS layers of subbasin delineations, where available, were used to assign a hydrograph to each potentially flooded point. Some smaller tributaries in the Des Plaines model, such as Gurnee Tributary, were located in areas that were only coarsely subdivided into subbasins. The nearest hydrographs to points along that tributary seemed to greatly overestimate peak flows. For those points, the peak flows in the modeled hydrographs were compared to peak flows in the FIS. The flows in these hydrographs were multiplied by a factor that would bring the peak flow closer to the FIS value.

Select or Generate Rating Curve

Rating curves used in this analysis came from two sources: hydraulic models or FIS. If detailed hydraulic modeling existed for a location, then the curve computed by HEC-2 or HEC-RAS was used. If the stream was a smaller tributary that was not modeled hydraulically, then profiles and discharges listed in the county FIS were used. Parallel roads were assigned rating curves that corresponded to the stream cross section that came closest to intersecting the point that represented the parallel road.

Compute Flood Duration

Combining the data in each points hydrographs (flow versus time) and rating curve (stage versus flow), curves of stage versus time were constructed. Comparing the stage versus time curves for each storm to the "trigger" road elevation determined the duration and depth of flooding for each storm event. The start time and end time of the road closures were also included in the results. The flood depths and durations were computed within DSS using code written by the Chicago District. The flood depth, duration, and start time information for points in Wisconsin were provided to the Chicago District by SEWRPC. The data was reformatted and combined with the Illinois data.

Set Road Closure Schedule

The start times were adjusted to fit in with the mainstem schedule. This was done by comparing the time to peak at each tributary mouth as modeled in the mainstem HEC-1 model to the time to peak at the mouth in each tributary HEC-1 model. Then every start time in the tributary dataset would be adjusted by the difference between the peak times in the two models. The schedule shifts were determined using Excel. Attachment A-2 includes the road closure schedule used in VISTA for the eight synthetic storm events under baseline and future conditions. For the transportation analysis, the base year was set to 2010 and the future year was set to 2020.

PROJECTS CONSIDERED AND MODELING TECHNIQUES

Two main types of structural flood-damage reduction measures were included in the alternatives analysis: reservoirs and levees. The proposed reservoirs were divided up into three categories: off-line or excavated reservoirs, in-line reservoirs, and expansions of existing reservoirs.

Off-Line / Excavated Reservoirs

The concept for off-line reservoirs used in this study is similar to the concept used in the Phase I study, which in turn was similar to off-line reservoirs constructed along the North Branch Chicago River. At those sites, channel side-drop spillways direct water into the excavated offline reservoir when river elevations exceed the spillway crest. The diversion of flood waters to the facility stops when the reservoir is at capacity; after this point all flows are passed downstream. At the point when the reservoir is full and the water surface in the river is the same as that in the full reservoir, the area acts as if no reservoir were present and the surface of the reservoir becomes part of the floodplain. An excavated design also minimizes the potential for failure. While the reservoirs along the North Branch Chicago River are sized to control a large percentage of the design event volume, the potential reservoir volumes along the Des Plaines River are small compared to design flood volumes. If storage volume is to be preserved for high-damage events, water from the Des Plaines may not be diverted into the reservoir until a relatively high target flow is reached. This type of system may require a berm around the reservoir site in order to accomplish the desired response.

Off-line reservoirs were modeled as diversions in HEC-1. A relationship between river flow and flow diverted to the reservoir was developed, and the volume of diverted flow was limited to the storage capacity of the reservoir.

In-Line Reservoirs

An in-line reservoir would be placed directly on a stream or existing flow path. A berm and weir would be constructed to create additional retention time for the flow passing through the storage area in accordance with EM 1110-8-2(FR). In-line reservoirs were modeled as routing reaches in HEC-1, and a storage-discharge relationship was developed or adjusted as needed based on the configuration of the berm.

Expansions of Existing Reservoirs

Several existing reservoirs were investigated to see whether increasing storage volume would provide any reduction in flood damages. The expansions were based on the availability of adjacent open space. If open space was available, then the reservoir was expanded using the existing depth. If no open space was available, then the reservoir was excavated further. The reservoir expansions were assessed assuming that the existing inlet and outlet structures would be maintained.

Reservoir expansions were modeled in HEC-1 by adjusting the elevation-storage-outflow relationships that represented the existing structures in the model.

Levees

Levees or floodwalls remove areas from the floodplain by holding back floodwaters. The proposed levee locations were set based on the baseline damage analysis and the regulatory floodplain extents.

Levees were modeled in the hydraulic models by setting encroachment elevations in HEC-2 or by setting levee elevations in HEC-RAS. A levee height equal to 2 ft above the 1% chance (100-year) flood profile was used. This was based on Risk & Uncertainty analysis that indicated the two foot increase would provide the 95% certainty needed for FEMA certification. Because the presence of levees changes the available floodplain area, new channel routing reaches were computed and entered into the hydrologic model as well.

Greenway

A modified riparian greenway was investigated to evaluate whether clearing snags and other vegetation would improve conveyance. This was modeled by decreasing channel roughness in HEC-2.

Bridge Modification / Road Raise

Bridge modifications and road raises raise the height of a roadway to reduce damages due to road closures. The proposed bridge modification and road raise locations were set based on the baseline transportation damages analysis. Proposed bridge modification project DPBM01 was modeled by the Illinois Department of Natural Resources (IDNR) as described in the October 2009 Groveland Avenue Limited Strategic Study, which is attached to Appendix B. The analysis used a combination of HEC-RAS and HEC-2 to assess changes in bridge piers to provide smoother flow transitions through the structure. Bridge modifications/road raises DPBM04 (First Avenue Bridge Modification and DPBM13 (Route 120, Belvidere Road Bridge Modification) were also modeled with HEC-2 and checked with HEC-RAS.

Other Measures: Channel Improvements

Other site-specific measures were considered that did not fit into any other category. Other drainage improvements that were considered involved increasing the cross-sectional area at a culvert or in a reach of a stream. These were modeled by changing the geometry in HEC-RAS. The other measures are described in more detail in the Results and Discussion section of this report.

Table 8 is a summary of the projects considered and modeling techniques used.

Table 8. Summary of Project Categories.

Projects Considered	Modeling Techniques
Off-line reservoir	Diversion in HEC-1
In-line reservoir	Routing in HEC-1
Expansion of reservoir	Reservoir routing in HEC-1
Levees	Encroachment (HEC-2) or levee (HEC-RAS), adjust channel routing in HEC-1 as needed
Greenway	Decrease channel roughness in HEC-2
Bridge modiication / road raise	Model changes in structure in HEC-RAS (DPBM01) or none (all others)
Channel improvements	Increase cross-sectional area in HEC-RAS, adjust channel routing in HEC-1 as needed

EVALUATION OF ALTERNATIVES

This section summarizes the procedure developed to evaluate flood-damage reduction measures in the Illinois portion of the Upper Des Plaines River watershed. A more detailed discussion of the plan formulation procedure can be found in Volume 2 of the Main Report. For the most part, the study team decided to assess the Wisconsin portion of the Des Plaines River watershed separately from the Illinois portion. Analysis described in SEWRPC (2003) and in Attachment A-3 (SEWRPC, March 2009) indicated that floodwater storage would not be an effective mitigation measure to affect flood problems in Wisconsin. Additionally, any decreases in peak flows or stages that would travel to Illinois would be small. This was attributed to the flow-attenuating affect of a large floodplain wetland complex located along the eight-mile reach of the river extending upstream from the Illinois-Wisconsin state line. In light of these factors, the study team decided to focus the assessment of structural measures in Illinois.

The first step in the evaluation of structural measures in Illinois was site identification, which assessed whether site conditions were compatible with proposed measures. The second step was site screening, which used hydrologic and hydraulic modeling to examine whether proposed sites would provide reduction in flood damages. The third step was site evaluation, which refined the modeling of the most promising sites to improve the estimate of flood risk management.

Site Identification

The site identification step used four criteria to evaluate sites. They were field verification, existing compatibility, neighboring compatibility, and environmental compatibility. These criteria are described in detail in Section 4 of the Main Report. No technical analyses were performed during this step. At the beginning of this step, 200 potential storage sites and 23 potential levees were identified. The site identification process eliminated 130 reservoir sites.

Site Screening

The site screening step was a preliminary assessment of project feasibility for the sites that made it through the initial identification process. The modeling techniques used in this step were developed to provide a relatively rapid assessment of a project's impact on flood flows and stages. Projects located along tributaries to the Des Plaines River were modeled with the tributary models and with the mainstem models in order to see whether the projects impacted flood stages on the Des Plaines River. Once the with-project water surface profiles were generated, they were provided to Planning for further analysis using HEC-FDA.

Site screening of levee projects is described in Section 2.2 of Appendix B. The baseline water-surface profiles were combined with the levee locations within HEC-FDA to determine the areas removed from the floodplain for varying levels of protection. No additional hydraulic modeling was used in this step.

Reservoirs were modeled in the hydrologic model for a stream. Storage capacities were estimated based on the area of each site. For new reservoirs, a relationship between site area and storage volume was developed based on CDM (2004), which studied potential storage sites along Buffalo Creek. In that study, it was assumed that all excavated material would be stored on-site and that the reservoirs would be 10 ft deep with 4H:1V side slopes. Multiplying the site area, in acres, by 4.41 provided a volume, in ac-ft, that was in line with the proposed projects in that study. The concept of the diversion relationship was to "cut-off" the peak of the hydrograph and to divert it into the potential reservoir. Essentially, a volume of water equal to the storage capacity would be removed at the time of highest flows during the storm events. Three design storms were used: the 4% (25-), 2% (50-), and 1% (100-year) chance storm events.

No in-line reservoirs were modeled during the site screening step.

For reservoir expansions such as SCME01 and SCME02, storage was increased by expanding the size of the reservoir in an available direction. The existing depth was maintained in the expansion when adjacent open space was available. If no open space was available then the reservoir was made deeper. The inlet and outlet structures remained unchanged. New elevation-storage-discharge relationships were computed for the expanded reservoirs and were incorporated into HEC-1 for the with-project conditions.

Proposed greenway project DPOT02 was modeled by decreasing Manning's n by 0.001 between River Miles 46.01 and 73.095. The technique was based on analysis described in a June 2002 memorandum titled "Des Plaines Levee 37, Hydraulic Analysis for Tree Trimming to Mitigate for Project Induced Stage Increases Beyond State Regulatory Limits." The memorandum is included in Attachment A-4.

Proposed greenway projects DPOT02-A and DPOT02-B were modeled by decreasing Manning's n in the overbank from 0.19 to 0.08, and in the channel by an increment of 0.001. These reductions were made in areas both owned by the Forest Preserve and inundated by the 50% chance (2-year) storm. The technique is described in an August 2010 memorandum titled, "Des Plaines Levee 37, Hydraulic Analysis for Tree Trimming to Mitigate for Project Induced Stage Increases Beyond State Regulatory Limits," which is also included in Attachment A-4. Proposed channel improvement project SCCI01 was modeled by increasing the cross-sectional area of culverts in the hydraulic model. Proposed project BWCI01 was modeled as a diversion near the confluence of Buffalo Creek and the Des Plaines River as a screening-level estimate of performance because the site had been modeled as an offsite reservoir previously during development of the Feasibility Scoping Meeting materials (USACE 2007).

Proposed bridge modification project DPBM01 was modeled by the Illinois Department of Natural Resources (IDNR) as described in the October 2009 Groveland Avenue Limited Strategic Study, which is attached to Appendix B. This project extends each of the bridge piers upstream and downstream to reduce their effective width and provide smoother flow transitions.

Structure modification project FPCI01 was modeled by the Illinois Department of Natural Resources (IDNR) as described in the September 2009 Farmers/Prairie Creek Strategic Planning Study, which is attached to Appendix B. This project would lower flood stages on Lake Mary Anne by adding a 10cfs pump station and routing the discharge under Golf Road to Dude Ranch Pond.

Site Evaluation

The results of the site screening were used in HEC-FDA to determine preliminary benefit-cost ratios for the proposed projects. Projects with a preliminary BCR greater than 1 were carried through to the next step, site evaluation. In this step, a feasibility-level design was developed for each site, and more detailed hydraulic modeling could be implemented. The resulting water-surface profiles were provided to Planning in order to refine the flood risk management computations. During this step, 9 reservoirs and 6 levees were evaluated.

Four of the 9 reservoirs were eliminated before modeling took place, for reasons summarized in Table 12. Another four of the 9 reservoirs were modeled as new, off-line reservoirs. After the initial run of off-line reservoir sites, an additional step was taken to refine the diversion relationship based on the actual reservoir characteristics and inlet structure with a focus on reducing peak flows for the design storm that provided the greatest reduction in flood damages. Each reservoir was designed to receive the diverted flow by means of a lateral overflow weir running parallel to the bank of the river. Once the river stage exceeds the elevation of the weir, water flows over the weir and into the reservoir. First, a representative cross section near the reservoir diversion was chosen, and the corresponding HEC-2 or HEC-RAS rating curve from the without project conditions was used to determine the initial weir elevation. The site topography was examined to determine if the weir elevation was feasible for the site. Based on this elevation, a preliminary weir length was chosen by matching the preliminary diversion relationship (used in the site screening) with the diversion relationship determined from the use of the cross section rating curve and the equation for a broad-crested weir. This new diversion relationship was then inserted into the HEC-1 model and was run iteratively to optimize the weir configuration (elevation and length) and corresponding diversion. After finding a configuration optimizing peak flow reduction and reservoir storage capacity, the diversion relationship was inserted into the HEC-1 model and run as in the first evaluation to obtain the HEC-FDA input files for the proposed project.

One reservoir, BCRS02 in the Bull Creek watershed, was modeled as an inline structure. This concept was chosen for this site because of its location. It was upstream of a defined channel and the topography suggested multiple drainage paths that converged at a culvert. It was modeled as a routing reach in HEC-1. A berm and weir would be constructed to create additional retention time for the flow passing through the storage area and to decrease the outflow to the culvert. This site was modeled as a routing reach in HEC-1, and a storage-discharge relationship was developed or adjusted as needed based on the configuration of the berm.

Preliminary estimates of compensatory storage and interior drainage requirements were initiated for the levees that passed site screening and are described in the Additional Levee Considerations section of this report.

No additional modeling was done for reservoir expansions during this step.

Results and Discussion

Site identification

No technical analyses were performed during this step. Detailed descriptions of the results of this step can be found in Section 4 of the Main Report.

Site screening

Water-surface profiles of the with-project conditions were provided to Planning. The hydraulic modeling results were used along with damage and cost information to compute a benefit-cost ratio for each proposed project. Detailed descriptions of the results of this step can be found in the Volume 2 of this report. The sites that passed the site screening and moved on to the site evaluation step are listed in Table 9, Table 10, and Table 11.

Table 9. Reservoirs that Passed Site screening.

Site	Stream	Volume (ac-ft)	Drainage Area (mi^2)
ACRS03	Aptakistic Creek	248	3.90
ACRS08	Aptakistic Creek	418	3.90
BCRS02	Bull Creek	243	5.25
BWRS31	Buffalo-Wheeling Creek	383	2.51
DPRS07	Des Plaines River	1,000	438.48
DPRS23	Des Plaines River	330	357.57
FDRS01	Feehanville Ditch	2,000	373.29
FDRS03	Feehanville Ditch	24	2.17
WHRS06	Willow-Higgins Creek	586	7.02

Table 10. Levees that Passed Site screening.

Site	Stream	Length (ft)
DPLV01	Des Plaines	2,098
DPLV07	Des Plaines	1,722
DPLV09	Des Plaines	4,018
DPLV15	Des Plaines	1,793

SCLV02	Silver Creek	6,007
SCLV03	Silver Creek	4,901

Table 11. Modification of Existing Structures that Passed Site Evaluation

Project	Stream	Description
DPBM01	Des Plaines	Realign bridge piers to run parallel with flow
DPOT02-A	Des Plaines	Replace trees with greenway from RM 50.46 – 51.62
DPOT02-B	Des Plaines	Replace trees with greenway from RM 53.83 – 55.35
DPOT02	Des Plaines	Replace trees with greenway along 30-mile stretch of river
FPCI01	Farmer-Prairie Creek	Modify pump and provide a connection at Lake Mary Anne to Dude Ranch Pond
SCCI01	Silver Creek	Expand culvert at 31st St.
SCME01	Silver Creek	Expand structure 106
SCME02	Silver Creek	Expand structure 102

Site Evaluation

When initiating this step, some of the proposed sites that appeared to provide flood-damage reduction benefits due to their location in the Des Plaines River watershed were found to be infeasible. Four proposed reservoirs were eliminated based on factors other than modeling results. The sites that were eliminated are summarized in Table 12.

Table 12. Reservoirs Eliminated in Site Evaluation.

Site	Reason for Elimination
ACRS03	20-ft hill adjacent to stream, lower ground >650 ft away
BWRS31	Half of site now developed, other half has 15-20 ft hills
DPRS07	Eliminated Due to Poor Soil Conditions
FDRS01	Eliminated due to BCR<1
FDRS03	Small volume of 24 ac-ft
WHRS06	Eliminated Due to Detailed Analysis of H&H Profile Corrected H&H demonstrated BCR<1

Site ACRS03 was eliminated because constructing an excavated reservoir on very high ground would require excessive excavation and the resulting spoil may have to be hauled off-site, increasing costs. Site BWRS31 was eliminated due to unavailability of real estate and difficult terrain. Site FDRS03 was eliminated at this stage because of the small storage volume.

The reservoirs that were modeled during the site evaluation are summarized in Table 13. Preliminary designs for each proposed project can be found in the Civil Appendix, Appendix D. Volume-storage curves for each of the proposed new reservoirs listed in **Table 13**, as well as for the reservoir expansion SCME02, can be found in these plates: Plate A-44 (BCRS02), Plate A-45 (ACRS08), Plate A-46 (DPRS23), and Plate A-47 (SCME02).

Table 13. Reservoirs Modeled in Site Evaluation and Considered for Further Evaluation.

Site	Design Storm (year)	Notes

ACRS08	100	Pump to and from site (far away and uphill)
BCRS02	-	Modeled as inline storage
DPRS23	25	Not justified individually, only as comp. storage for DPLV07
DPRS15	100	Compensatory storage for DPLV09

While the initial concept for the reservoirs was a channel side-drop spillway, this was only used to model DPRS23. Conditions at the two other sites suggested different design concepts. Site ACRS08 was more than 250 ft away from Aptakisic Creek and located on high ground. A pump station would convey water to and from the site. Site BCRS02 in the Bull Creek watershed was modeled as an inline structure. This concept was chosen for this site because it was upstream of a defined channel and the topography suggested multiple drainage paths that converged at a culvert. A berm and weir would be constructed to create additional retention time for the flow passing through the storage area and to decrease the outflow to the culvert.

Table 14. Levees Modeled in Site Evaluation and Considered for Further Evaluation.

Levee	Design Storm (year)	Notes
DPLV01	45	Modeled by IDNR
DPLV07	500	Paired with DPRS23 for compensatory storage
DPLV09	100	Created DPRS15 for compensatory storage
DPLV15	10	No compensatory storage necessary
SCLV02	25	Levee on both banks. Paired with SCME02 for comp. storage.
SCLV03	10	Levee on both banks. Paired with SCME02 for comp. storage.

The design storms for the levees were determined through economic analysis as described in Section 2.2 of Appendix B.

No additional modeling was done for DPOT02 or BWCI01 after site screening. To refine the modeling of SCCI01, a routing reach was adjusted in the hydrologic model to account for the change in the hydraulics at the project area. The resulting adjusted flows were input to HECRAS to obtain revised flood profiles.

ADDITIONAL LEVEE CONSIDERATIONS

Compensatory Storage

Because levees remove areas from the floodplain, they change the area available for active conveyance and hydrograph routing, which often induce backwater effects that increase flood stages upstream. Compensatory storage requirements were investigated for the 5 levees that passed site screening. The goal was to provide a rough estimate of the size of a reservoir that could be paired with a levee to offset any adverse impacts. To quickly provide order-of magnitude values, the volume of floodplain that would be cut off by the levee was estimated. Hydraulic model results were used to compute the volume of water in the proposed levee reaches for different flood events, and these volumes were compared to the baseline conditions. The change in floodplain volume as computed by the hydraulic modeling is shown in Table 15.

Table 15. Change in Reach Volume during Levee Model Runs.

Levee	Bank	Floodplain Change (ac-ft)				
		10-yr (1%)	25-yr (4%)	50-yr (2%)	100-yr (1%)	500-yr (0.5%)
DPLV07	R	0	-5	-13	-28	-44
DPLV15	L	0	-4	-15	-26	-36
SCLV02	R+L	-20	-51	-141	-173	-192
SCLV03	R+L	-2	-17	-90	-143	-186
DPLV04	R	-1	-11	-7	-16	-44
DPLV05	R	-3	-15	-40	-57	-165
DPLV09	R	-2	-21	-52	-64	-180

A more refined estimate of compensatory storage was initiated, and it was completed for four of the seven levees, DPLV07, DPLV04, DPLV05, and DPLV09 (and also the combined DPLV04, DPLV05, and DPLV09 Levee). The channel routing was updated in the HEC-1 models to account for the reduction in flow area caused by each levee. Constant flows were run through the HEC-2 model to determine the modified volume-storage relationship of the modeled cross sections as described in Bonner (1990). These adjusted relationships were then incorporated into the HEC-1 model, and the modeling process repeated.

Compensatory storage sites would be limited to those reservoirs being considered for construction on their own merit. The levees DPLV07 and DPLV09 were paired with proposed reservoirs in an attempt to eliminate significant upstream stage increases caused by the levee. The reservoirs were designed independently of the levees, so the levee-reservoir pairings had varying levels of success. It was found that DPRS23 could be configured to eliminate upstream impacts of some events, but more analysis will be completed in a later stage of this project to finalize the levee-reservoir pairings. Since the volume of DPRS23 is 330 ac-ft, this suggests that the storage estimates listed in Table 15 should be multiplied by a factor of 2 or 3 to obtain a better estimate of required storage.

The mitigation reservoirs were investigated to find stage mitigation that would satisfy Illinois Department of Natural Resources – Office of Water Management (IDNR-OWR), construction in a floodway permit requirements. No stage impacts are allowed for the one percent chance exceedence flood event (100 year recurrence interval), and all the flood events more frequent than the one percent event. IDNR-OWR interprets no stage impacts as 0.0 ft. (0.044 ft stage increase and less is rounded to zero as a courtesy). Also stage impacts that do not impact structures can be mitigated with flowage easements. The baseline condition models were used to determine stage differences for permitting for these analyses.

Interior Drainage

While a levee protects an area from flooding due to a rising river, the structure can block natural drainage paths and cause the backup of water on the landward side of the levee. The purpose of interior drainage analysis is to identify the nature of interior flooding and to formulate alternatives to reduce it. Measures such as pumping stations, gravity outlets, or interior storage areas could be developed to address this issue. The interior drainage calculations are included as Attachment A-5.

An interior drainage analysis for levees was performed using HEC-RAS version 4.1.0 and HEC-HMS version 3.4. HEC-HMS was used to develop an interior hydrograph for a period of record between 1969 and 2009 using hourly rainfall from the rainfall gage in McHenry, Illinois. The drainage basin delineation was assumed to follow existing topography. Land use and NRCS soils data were used to develop the basin model inputs. A Clark unit hydrograph was used along with the Green-Ampt loss method. Table 16 summarizes the interior basin model inputs.

Table 16. DPLV15 Interior Basin Model Inputs.

Parameter	Value
Drainage Area	0.83 mi2
Time of concentration, Tc	1.1 hr
Storage coefficient, R	1.7 hr
Initial loss	0.40 in
Moisture deficit	0.20
Suction	18.3 in
Conductivity	0.2 in/hr
Percent Impervious	20%

The interior hydrographs were developed using a period of record analysis, as well as the 1% chance (100-year) synthetic storm. The exterior stages were developed using flow data from the Gurnee gage and the unsteady HEC-RAS model of a short reach of the Des Plaines River. The unsteady HEC-RAS results were compared to stage measurements at Gurnee to verify the model.

The interior drainage analysis showed that interior drainage features would be required for levees. Interior drainage features would include both gravity drainage and a pump station for the minimum required facility.

Conditional Non-Exceedance Probability

Overtopping is not a risk for greenway projects or bridge modifications. The proposed reservoirs are excavated, which minimizes the potential for failure and causes the site to simply revert to the without-project conditions when the storage capacity is reached. Overtopping of levees, however, can lead to significant landside erosion of the levee or even be the mechanism for complete breach. Table 17 below summarizes the non-exceedance probabilities for each of the proposed levees. According to Engineering Manual EM 1110-2-1619, a levee can be said to provide a certain level of protection if the non-exceedance probability is greater than 95%.

Table 17. Conditional Non-Exceedance Probability Levees.

Levee	Description	Non-Exceedance Probablility at Event: 10% (10-yr)	4% (25-yr)	2% (50-yr)	1% (100-yr)	0.5% (500-yr)
DPLV01	Tie back existing Riverside	1.00	1.00	1.00	1.00	1.00

	levee					
DPLV04	6,165 ft floodwall and levee	1.00	1.00	1.00	1.00	0.99
DPLV05	8,057 ft floodwall and levee	1.00	1.00	1.00	1.00	0.99
DPLV09	13,190 ft floodwall and levee	1.00	1.00	1.00	1.00	0.99

FIRST / LAST ADDED ANALYSIS

A first-added analysis and a series of last added analyses were performed in an effort to determine the performance of the potential detention components individually and together. Once the final array of potential NED detention alternatives was considered a first-added analysis was performed to justify each component individually. The HEC-FDA runs completed during the primary design analysis were used for this purpose. For each run, one NED detention component was tested and the resulting residual damages were compared against those computed by HEC-FDA for the without-project conditions. This shows the effects that a particular NED component would have if it were to be the first component incorporated. The difference between the residual damages of the baseline conditions and the residual damages of the with-project conditions is equal to the benefit of the proposed project. The potential projects were ranked by net benefits.

The first added analysis and round 1 of last added analysis included the project DPBM04, the modification of the bridge at First Avenue. Round 2 of last added analysis showed that the proposed project DPBM04 paired with the combined DPLV04, DPLV05, DPLV09 levee combined with reservoirs WLRS04 and DPRS04 produced the highest net benefits. This became the fixed component of last added Round 3. The remaining potential projects were added individually. This process was repeated for the additional project: DPLV01. Each round, the highest ranking project would be selected to serve as the base for the subsequent round. After Round 3, projects evaluated for economic benefits produced no hydraulic impacts, so the last added Round 3 hydraulics were used. The results of the last added analysis are shown in Table 18.

Table 18. First Added and Last Added Analysis Results Summary.

Round	**Project with Rank = #1**
Last Added 1	DPBM04
Last Added 2	DPBM04 + DPLV04 + DPLV05 + DPLV09 + WLRS04 + DPRS04
Last Added 3	DPBM04 + DPLV04 + DPLV05 + DPLV09 + WLRS04 + DPRS04 + DPLV01

All projects included in the last added analysis provided incremental benefits to the system as they were added. A full description of the economic component of the first-and last added analyses, and more detailed results, can be found in Appendix E of this report.

RISK AND UNCERTAINTY

A risk analysis was performed for this study using HEC-FDA. This program incorporates a Monte Carlo simulation to sample the interaction among the various hydrologic, hydraulic, and economic uncertainties. Uncertainties in the hydrology and hydraulics include the uncertainties associated with the discharge-frequency curve and the stage-discharge curve. Both of these relationships have statistical confidence bands that define the uncertainty of the relationships at various target frequencies. The Monte Carlo simulation routine randomly samples within these confidence bands over a range of frequencies until a representative sample is developed. Reliability statistics are based on the results of the Monte Carlo random sampling.

The uncertainty in the discharge probability was determined using the graphical method in HEC-FDA. The uncertainty in flood stages was based on the uncertainty in Manning's n. Manning's n was varied by +15% and -15% in the hydraulic models. To capture the maximum error at each particular cross section, the maximum value was selected to represent the stage error for that cross section. A single stage error value was then generated by taking the average stage errors over all cross sections for each particular model. A detailed discussion of the risk and reliability analyses can be found in the Economics Appendix.

DISCUSSION OF FLOOD DAMAGE ANALYSIS

Flood damages were calculated through the HEC-FDA program, and a detailed discussion can be found in Appendix E. In a watershed characterized by relatively flat terrain, slight changes in stage potentially result in dramatic reductions in damages. That was the case in this study. The stage reductions for more frequent events (1-year (95% chance) through 25-year (4% chance) return periods) provided the highest damage reduction because the storms occur more often: approximately 72% of the damage reduction was claimed in the smaller-magnitude events. Larger storms [50-year (2% chance) through 500-year 0.5% chance) return periods] incur higher damages, but because they occur less frequently they have a lower weight in the expected valuation calculation.

SYNTHETIC EVENT MODELING OF THE NED PLAN

Plates A-48 through A-55 show the with-project conditions on the Des Plaines River and Silver Creek. The plates include both water-surface profiles and the change in flood stage from the without-project conditions.

DESCRIPTION OF SELECTED RESERVOIRS

The reservoirs in the NED plan are shown on the Reservoirs Location Map, Plate D-0 in Appendix D. Section 1 of Appendix D includes several paragraphs on the design for each proposed reservoir describing the location, top and bottom area, volumetric storage capacity, weir elevation, and culverts. All proposed reservoirs are lateral storage areas except for BCRS02, in the Bull Creek watershed, which was modeled as an inline structure.

Fullerton Woods Reservoir (DPRS04)

DPRS04 is located in River Grove in Cook County, Illinois. The site is bounded by River Rd and 5th Ave. on the north, River Rd. on the east, and 5th Ave. on the West. The entire site is located on Cook County Forest Preserve property and is partially forested.

The proposed reservoir is designed for a 100-year (1% chance) flood event, a storage volume of 150 AC-FT, and pump station flow capacity of 115 CFS. The reservoir will fill in approximately 16 hrs during a flood event. The pump on elevation (Des Plaines River) is at 618.4 ft NAVD, which is near the one year (95% chance) flood recurrence interval. The reservoir includes a three feet freeboard, which results in a total storage of 200 AC-FT. The top area of the reservoir is 16.5 AC. The reservoir bottom elevation is 611.5 FT (without topsoil and seeding). Storm water from the Des Plaines River is pumped into the reservoir through a proposed 54" RCP. After a storm event, water will drain out of the reservoir through the pump station to Des Plaines River by gravity. The pump station will utilize two 100 CFS pumps, which includes one 100 CFS pump for redundancy. Refer to the Plates in Appendix D for the DPRS04 site plan.

Harry Semrow Driving Range Reservoir (WLRS04)

WLRS04 is located in Des Plaines in Cook County, Illinois. This site is an existing golf driving range located at the corner of Golf Rd. and Rand Rd. The entire site is located on Cook County Forest Preserve property and is partially forested.

The proposed reservoir is designed for a 100-year (1% chance) flood event, storage volume of 208 AC-FT, and pump station flow capacity of 70 CFS. The reservoir will fill in approximately 35 hours.
The pump on elevation (Des Plaines River) is 633.9 ft NAVD, which is between the ten (10% chance) and twenty-five year (4% chance) flood recurrence interval. The reservoir includes a three feet freeboard, which results in a total storage of 250 AC-FT. The top area of the reservoir is 14.7 AC. The reservoir bottom elevation varies between 635 and 629 (without topsoil and seeding). Storm water from the Des Plaines River is pumped into the reservoir through proposed 54" RCPs and ditch. The intake/discharge ditch has a 3 feet wide bottom width, 3H:1V side slopes, and a minimum of 4 feet in depth. After a storm event, water will drain out of the reservoir though the pump station to Des Plaines River by gravity. The pump station will utilize two 70 CFS pumps, which includes one 70 CFS pump for redundancy. Refer to the Plates in Appendix D for the WLRS04 site plan.

DESCRIPTION OF SELECTED LEVEES

Des Plaines Levee DPLV01

Site DPLV01 project features includes road raises at Park Ln, Groveland Ave., and Lincoln Ave. See Plate 22 in Appendix D. The road will be raised to elevation 618 with total lengths of 1250 feet to provide a portion of the flood protection. The existing levee along Groveland Ave will also be raised from elevation 616 to 618. Sheet pile will be driven into the design to obtain the designed top elevation of 618. The sheet pile is approximately 870 feet in length. A floodwall is proposed south of Forest Ave and along the Des Plaines River. The floodwall top elevation is 618.0 and approximately 699 feet in length. The floodwall will tie into the railroad embankment at the south termination and the proposed road closure structure at the north termination.

Pump stations and gate wells are included in the report and would also be included in final design. These features are intended to mitigate interior drainage issues. Refer to Plate 24 in Appendix D for the DPLV01 Site Plan.

Des Plaines Levee DPLV09

Site DPLV09 is a levee/floodwall combination from Miner St. to the north, the Illinois Tollway ramp at the south end, andalong the west side of the Des Plaines River. The site is located in the City of Des Plaines in Cook County, Illinois. The levees have a total length of 3,200 feet with a crest width of 10 feet. The floodwalls have a total length of 9,990 feet. The levee crest and top of floodwall elevations are shown on the site plans. The crest of the levee and the top of the floodwall includes 2 feet , at minimum, above the 1% chance flood elevation, which gives a 95% chance that a 1% chance (100-year) flood would not overtop the levee. DPLV09 is located between river miles 62.88 and 64.60 in the Mainstem Des Plaines River HEC-2 model. Pump Stations, gate wells and closure structures are part of the recommended plan. See plates 18A, 18B, and 18C in Appendix D for additional site plan details.

Des Plaines Levee DPLV05

DLPV05 is located in Schiller Park in Cook County, Illinois. The site extends just north of Irving Park Rd. to the north and Belmont Ave. Franklin St./Kennedy Street, just north of the railroad, at the south end. A levee/floodwall will be placed at the river side of River Rd. The levee and floodwall will have lengths of 5153 feet and 2904 feet respectively. . The crest elevation is two feet, at minimum, above the 1% annual chance of exceedance flood elevation. The probability that this levee will not be overtopped during the 1% annual chance of exceedance flood event will be greater than 95%. DPLV05 is located between river miles 55.99 and 56.93 in the Mainstem Des Plaines River HEC-2 model. See Plate 19 in Appendix D for DPLV05 Site Plan.

Des Plaines Levee DPLV04

DPLV04 is located in the city of River Grove in Cook County, Illinois. The site extends from Franklin St./Kennedy St. Railroad to the north and Palmer St. to the South. A levee/floodwall will be placed at the river side of River Rd. and along 5th Ave. on the south end. The levee and floodwall will have lengths of 3031 feet and 3134 feet respectively. The floodwall between Henrrick Ave. and Fullerton Ave. will be in close proximity with the River. Therefore, toe protection will be necessary along the floodwall. The crest elevation is, at minimum, two feet above the 1% annual chance of exceedance flood elevation. The probability that this levee will not be overtopped during the 1% annual chance of exceedance flood event will be greater than 95%. DPLV04 is located between river miles 54.29 and 55.27 in the Mainstem Des Plaines River HEC-2 model.See Plate 20 in Appendix D for DPLV04 Site Plan.

DESCRIPTION OF OTHER SELECTED PROJECTS

DPBM04 - 1st Avenue Bridge Raise

Plate D-24 presents the 1st Avenue Bridge raise. The bridge was raised to 631.84 along with the approach ramps and connecting roadways. This puts the roads above the 1% annual chance of exceedance flood elevation. The site will be designed to prevent adverse impacts to surrounding structures by extending the bridge length, providing greater conveyance capacity under the roadway.

OPERATIONS AND MAINTENANCE ESTIMATES

Operations and maintenance requirements were identified for each of the proposed projects for cost estimation purposes only. Design-level O&M plans have not been developed during the Feasibility Study phase. In general, O&M requirements for reservoirs will include: Inspection, Mowing, Fill/Repair, Debris Removal, and Tree and Brush Trimming. In general, O&M requirements for pump stations will include: Semi-Annual Reporting, Inspection, quarterly Oil & Grease, Trash Rack Equipment Maintenance, Electrical Consumption, and Mechanical Reconditioning, Rehabilitation and Replacement. Gates will require Inspection, Cleaning/Lube, Debris Removal, and Repair/Replacement. A summary of O&M costs for each of the evaluated projects is shown in Appendix B.

OFFSITE IMPACTS DISCUSSION

In general, levee projects are accompanied by the risk of upstream and downstream stage increases. Bridge pier modifications can also potentially hold back water and affect stages upstream. The greenway projects all increase conveyance by reducing roughness in the channel and overbank, which decreases hydrograph attenuation and can potentially increase stages downstream. These risks were considered in the NED plan formulation process. In accordance with Illinois State Law, which requires that construction will not reduce floodway conveyance or storage, and will not increase velocities and flood heights, NED projects were designed to cause stage increases no greater than 0.04 ft.

SUMMARY

Updated hydrologic and hydraulic models were developed for the major tributaries to the Upper Des Plaines River. The modeling was used to develop relationships between flood depth and transportation damages for major roads that could be impacted by flooding in the watershed. Potential structural flood-damage reduction measures such as reservoirs and levees were identified and screened. Preliminary designs were developed for proposed projects that passed the screening phase. The resulting water-surface profiles were provided to Planning for further assessment. Preliminary estimates of compensatory storage and interior drainage requirements for the levees were developed. First-added and last-added analyses provided economic justification for the system of detention components.

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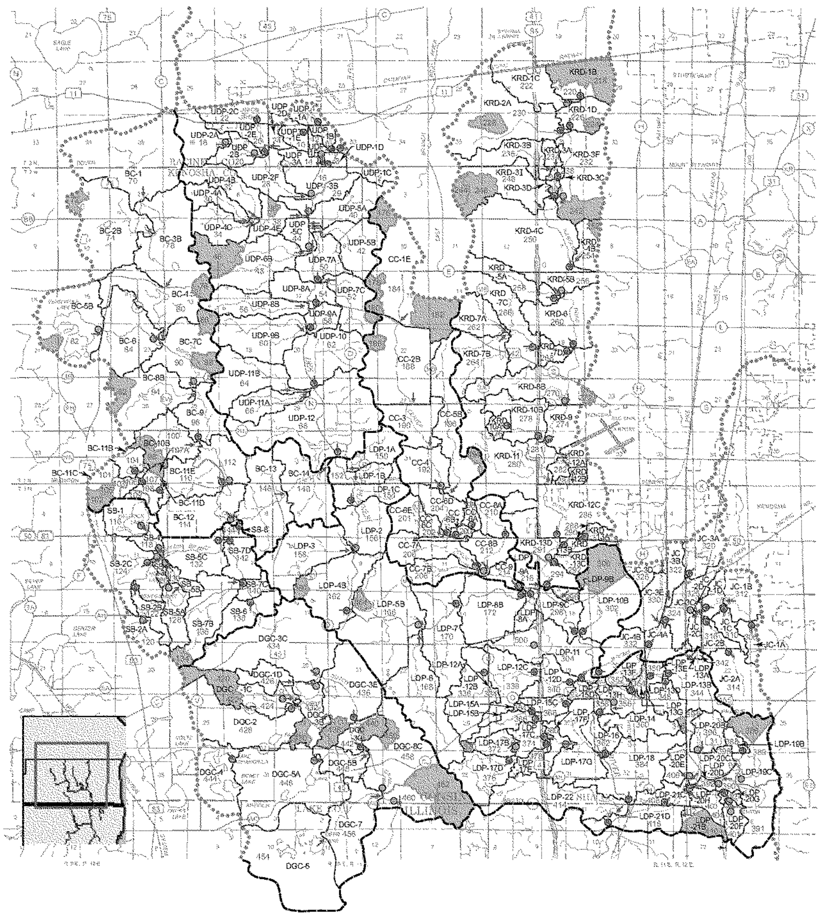
PLATES

Map 54

REPRESENTATIONS OF THE DES PLAINES RIVER WATERSHED FOR HYDROLOGIC-HYDRAULIC SIMULATION



DES PLAINES RIVER WATERSHED BOUNDARY AS DELINEATED BY SEWRPC USING FIELD CHECKED DATA AND LARGE SCALE MAPPING, SUPPLEMENTED WITH STORM SEWER MAPS WHERE AVAILABLE.

SUBWATERSHED BOUNDARY

SUBBASIN BOUNDARY

SUBBASIN DISCHARGE POINT

UDP-9B SUBBASIN IDENTIFICATION CODE

HYDROLOGIC LAND SEGMENT BOUNDARY

192 HYDROLOGIC LAND SEGMENT IDENTIFICATION

SIMULATED STREAMFLOW OUTPUT LOCATION

INTERNALLY DRAINED SUBBASIN — FOR SIMULATION PURPOSES THESE AREAS CONTRIBUTE TO SUBSURFACE FLOW ONLY

IDENTIFICATION OF SUBWATERSHEDS

BC	BRIGHTON CREEK	KRD	KILBOURN ROAD DITCH
CC	CENTER CREEK	LDP	LOWER DES PLAINES RIVER
DGC	DUTCH GAP CANAL	SB	SALEM BRANCH OF BRIGHTON CREEK
JC	JEROME CREEK	UDP	UPPER DES PLAINES RIVER

GRAPHIC SCALE
0 1/2 1 MILE

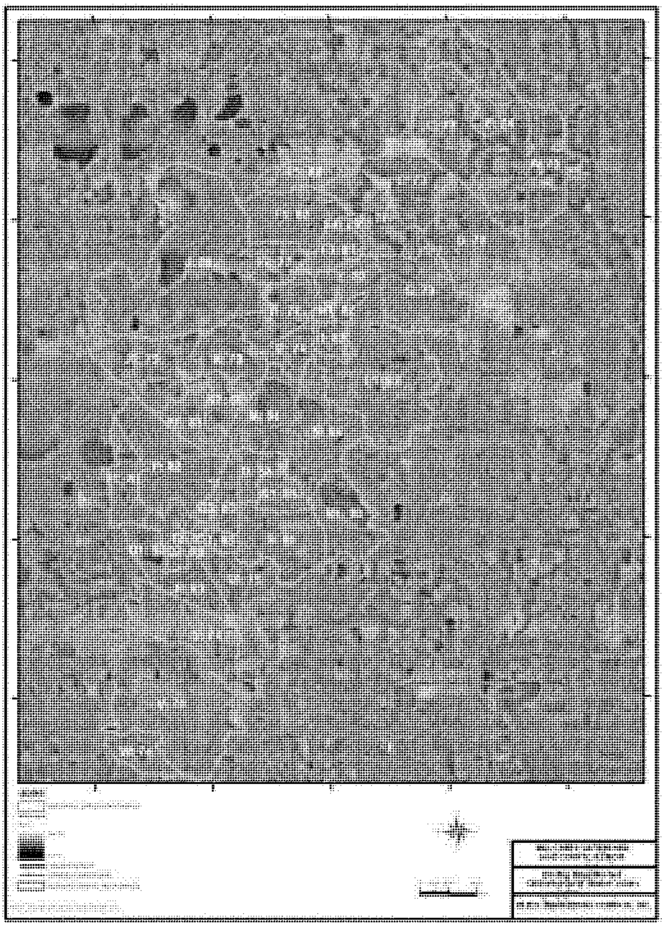
For purposes of hydrologic-hydraulic modeling, the watershed land surface was partitioned into 192 hydrologic land segments and co hydrologic land segment type has a particular combination of soil type, land cover, and proximity to a meteorologic station and is used w conversion of rainfall and snowmelt to streamflow. Each hydrologic land segment has unique hydrologic-hydraulic characteristics in the runoff from land surface in the stream system and the transport of that flow through the watershed.

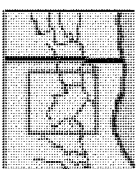
Source: SEWRPC.

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Wisconsin Tributaries Subbasins	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-1

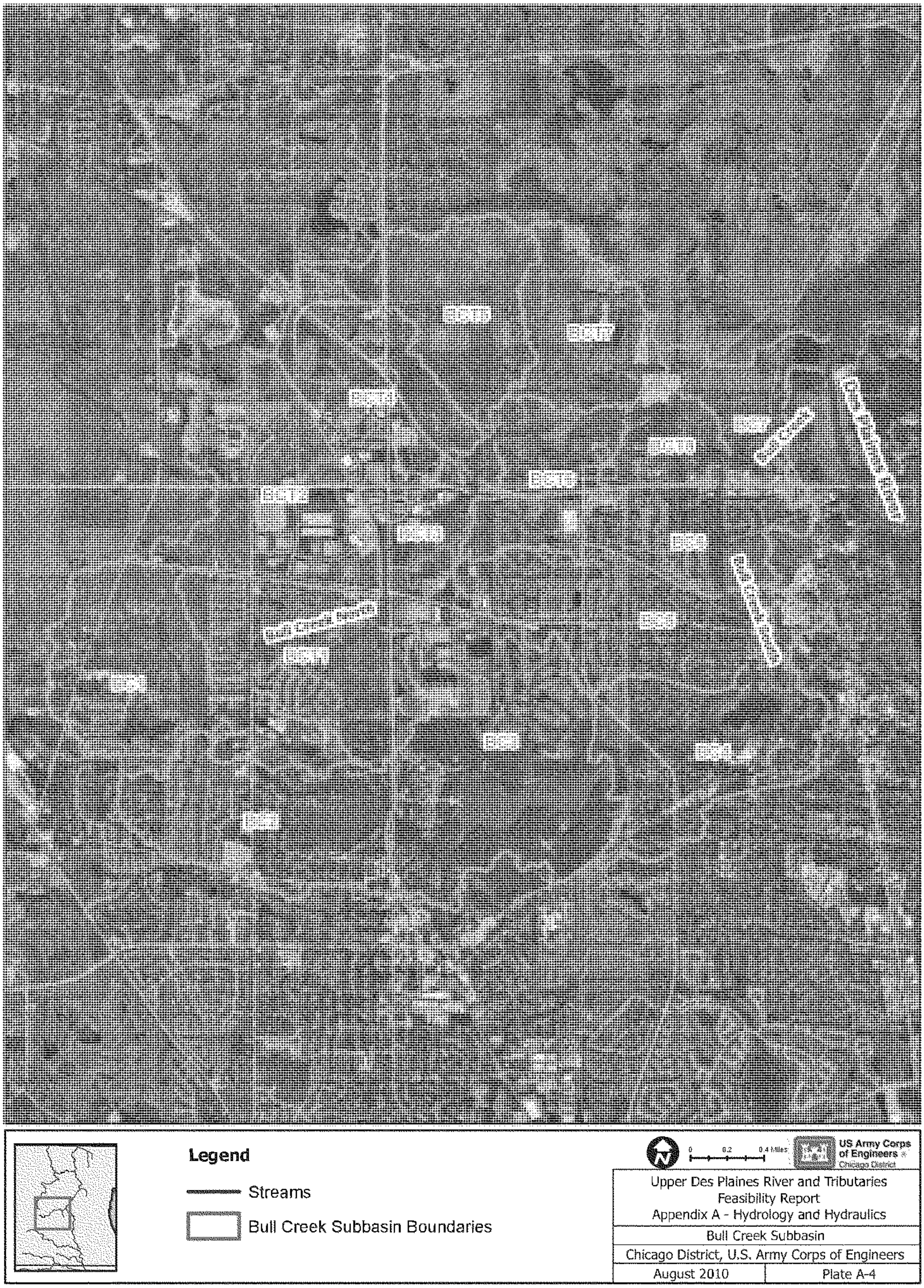

Legend
Streams
Newport Drainage Ditch Subbasin Boundaries
0 0.125 0.25 Miles
US Army Corps of Engineers
Chicago District
Upper Des Plaines River and Tributaries
Feasibility Report
Appendix A - Hydrology and Hydraulics
Newport Drainage Ditch Subbasin
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-2

FIGURE 3. SUBWATERSHED DELINEATION

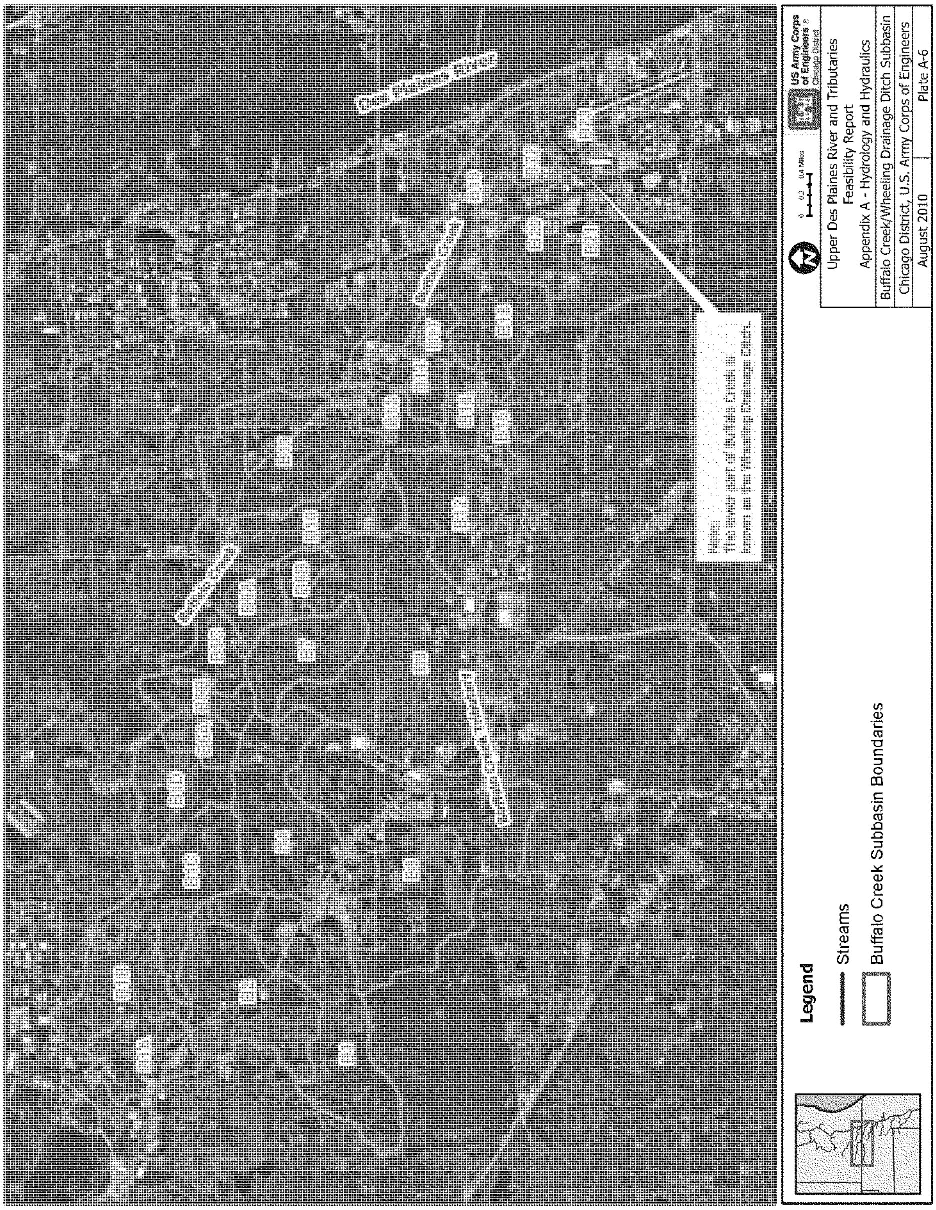


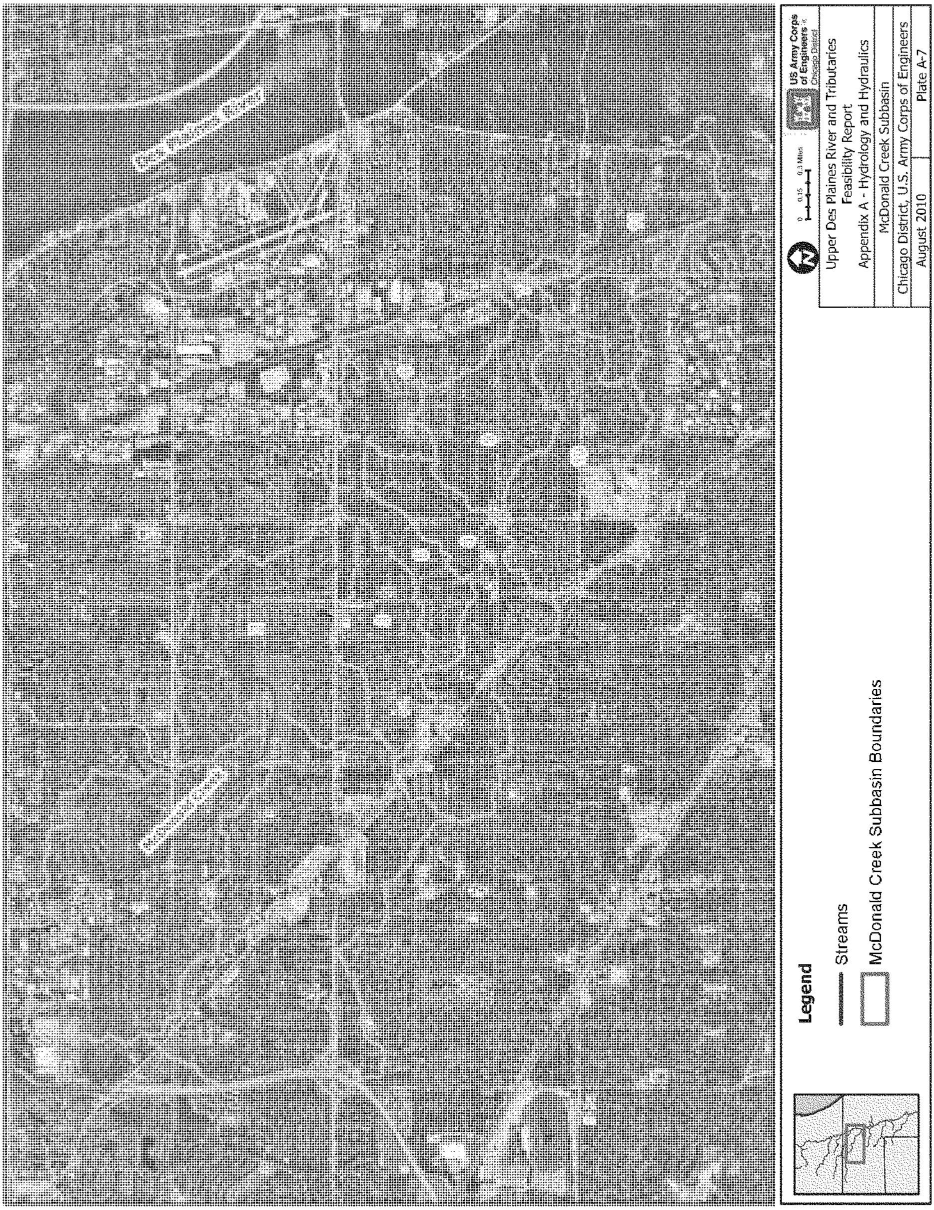


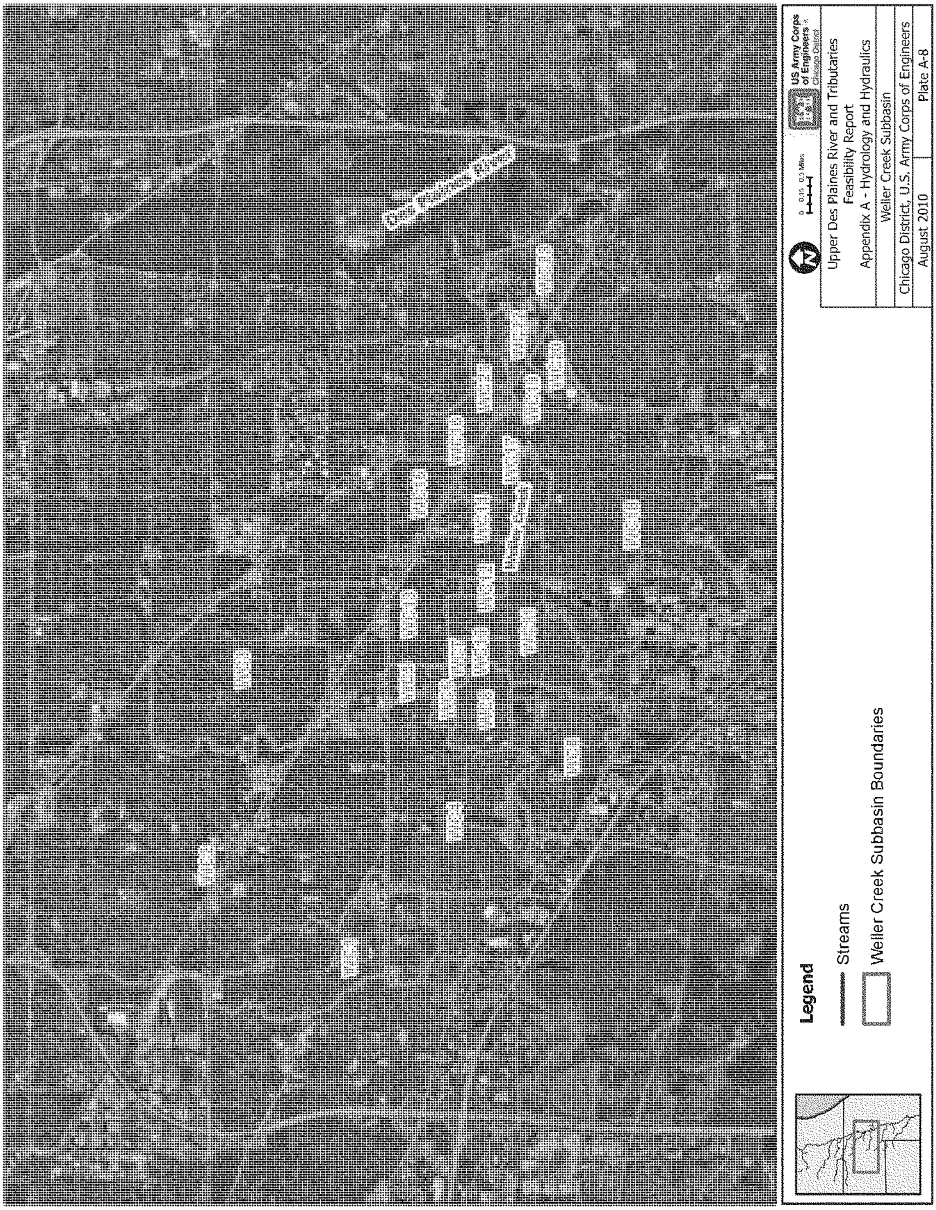
Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Mill Creek Subbasin	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-3


Legend
Streams
Bull Creek Subbasin Boundaries
0 0.2 0.4 Miles
US Army Corps of Engineers
Chicago District
Upper Des Plaines River and Tributaries
Feasibility Report
Appendix A - Hydrology and Hydraulics
Bull Creek Subbasin
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-4

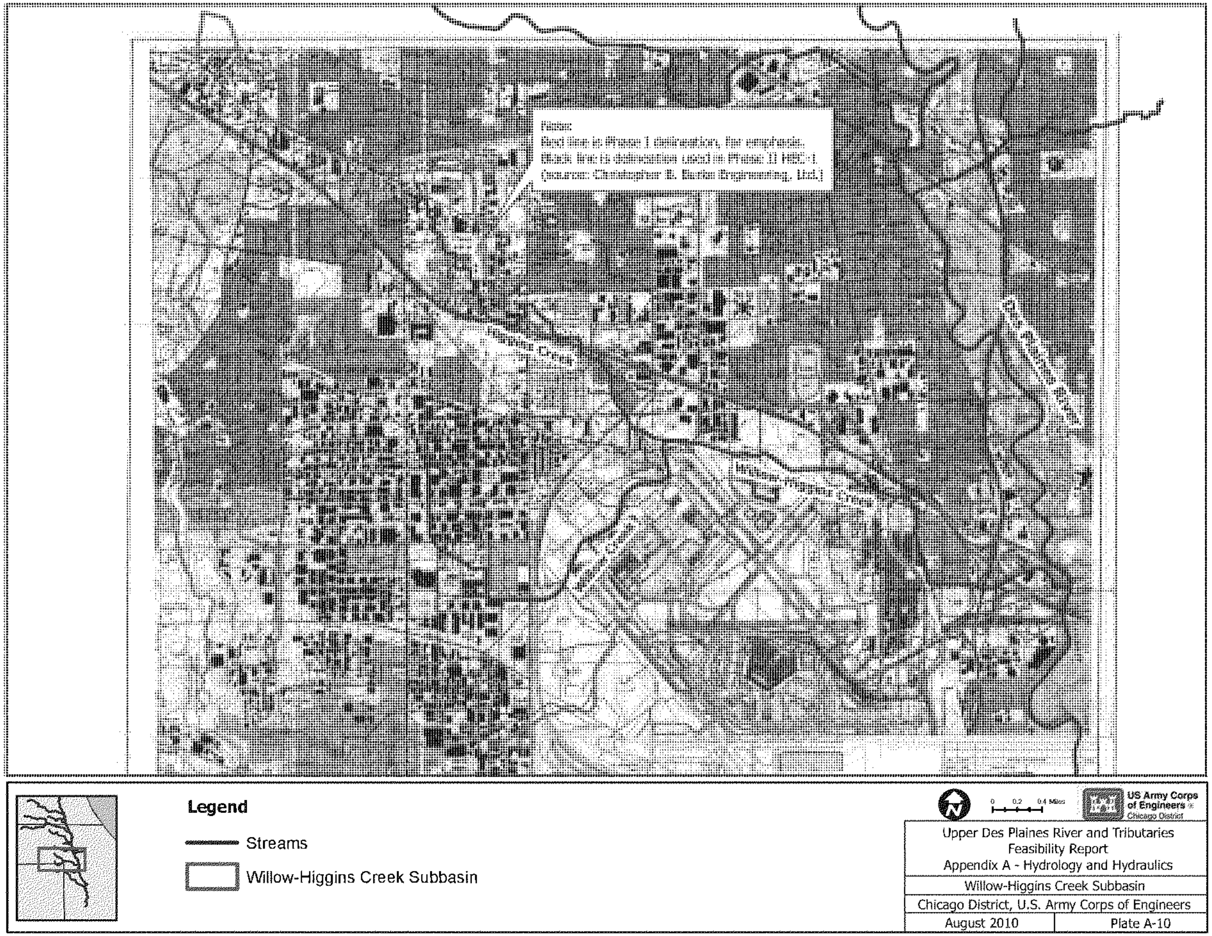

Legend
Streams
Indian Creek Subbasin Boundaries
0 0.3 0.6 Miles
US Army Corps of Engineers
Chicago District
Upper Des Plaines River and Tributaries
Feasibility Report
Appendix A - Hydrology and Hydraulics
Indian Creek Subbasin
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-5

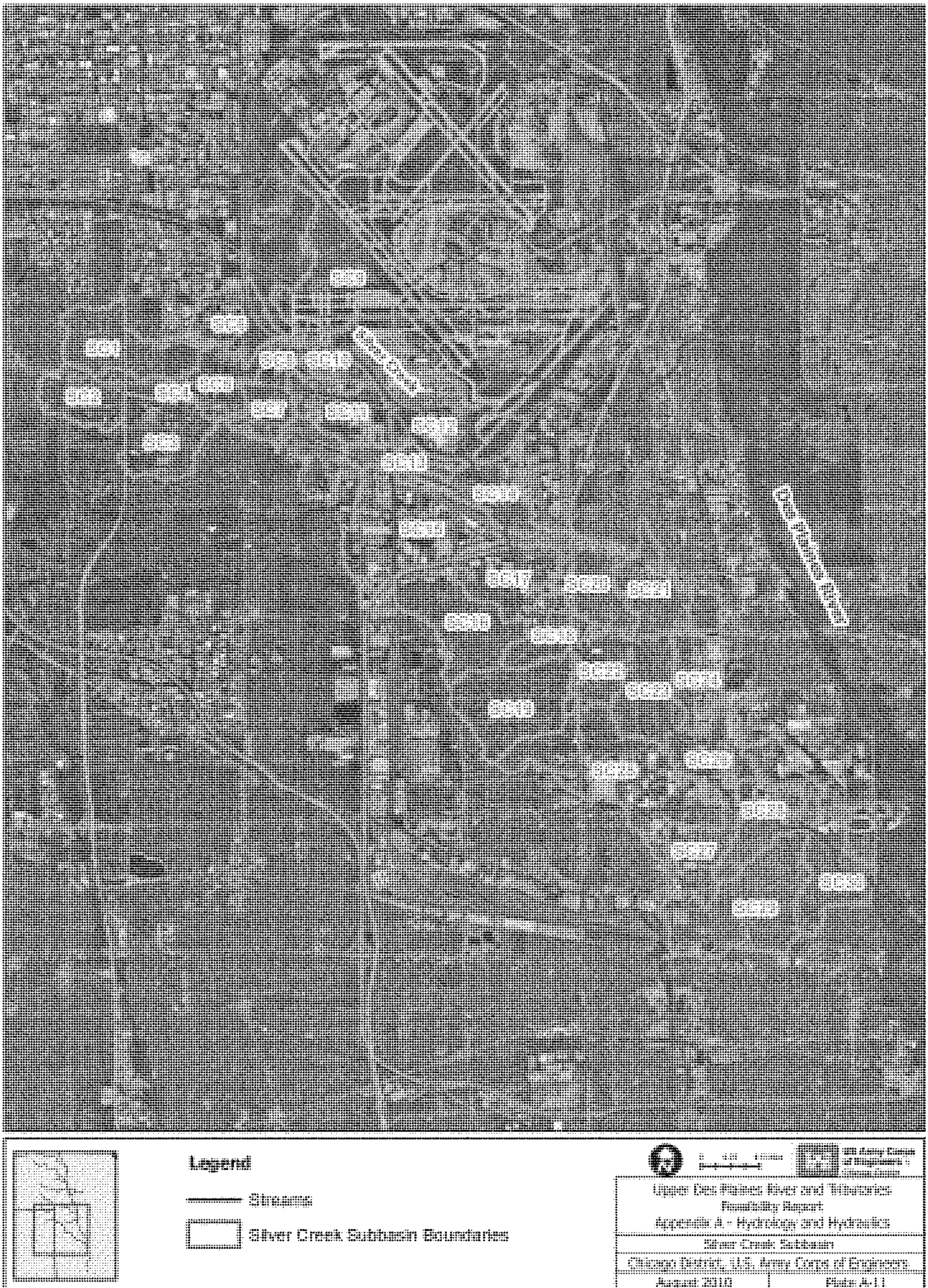

Legend
Streams
Buffalo Creek Subbasin Boundaries
0 0.2 0.4 Miles
US Army Corps of Engineers
Chicago District
Upper Des Plaines River and Tributaries
Feasibility Report
Appendix A - Hydrology and Hydraulics
Buffalo Creek/Wheeling Drainage Ditch Subbasin
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-6

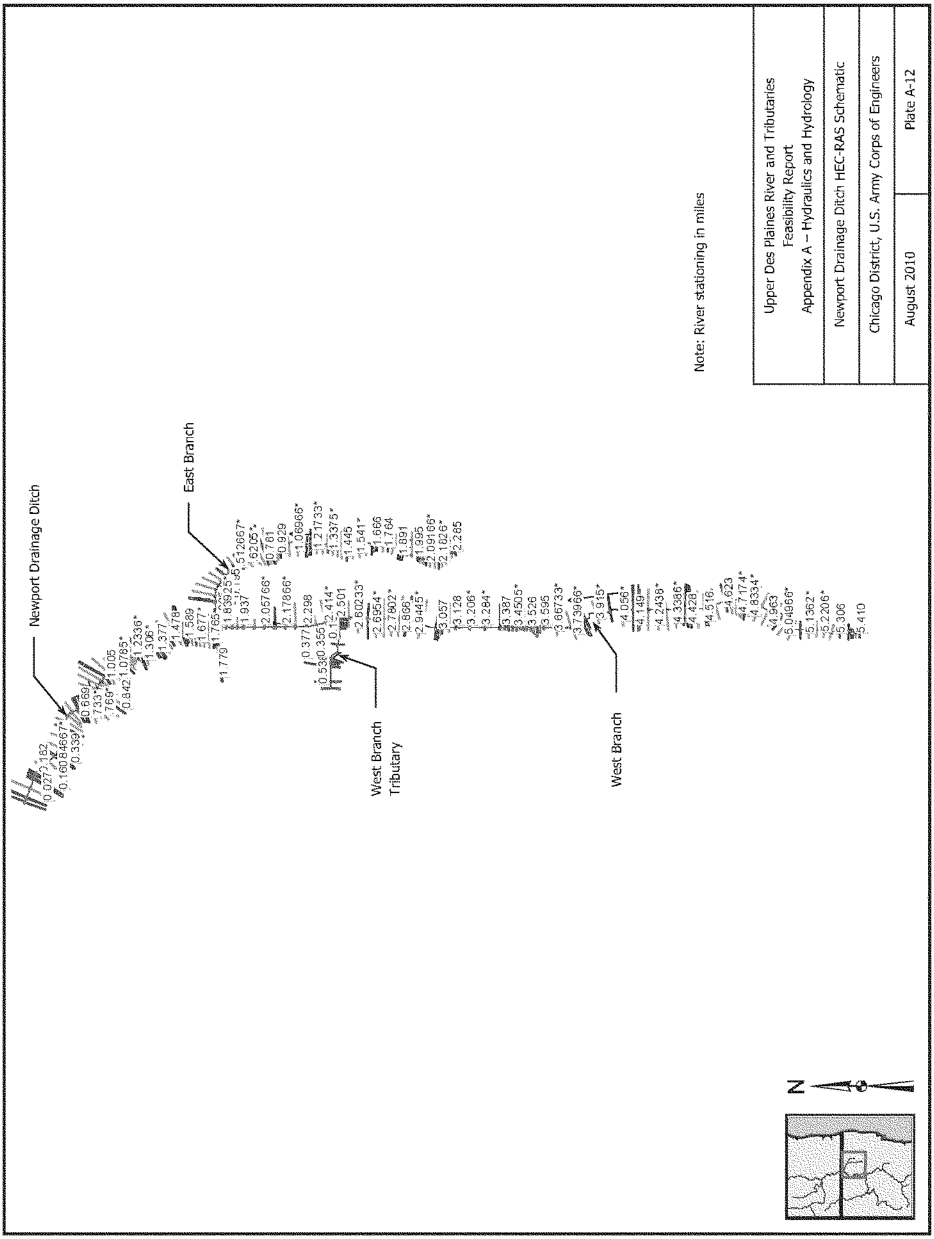

Legend
Streams
McDonald Creek Subbasin Boundaries
US Army Corps of Engineers
Chicago District
Upper Des Plaines River and Tributaries
Feasibility Report
Appendix A - Hydrology and Hydraulics
McDonald Creek Subbasin
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-7

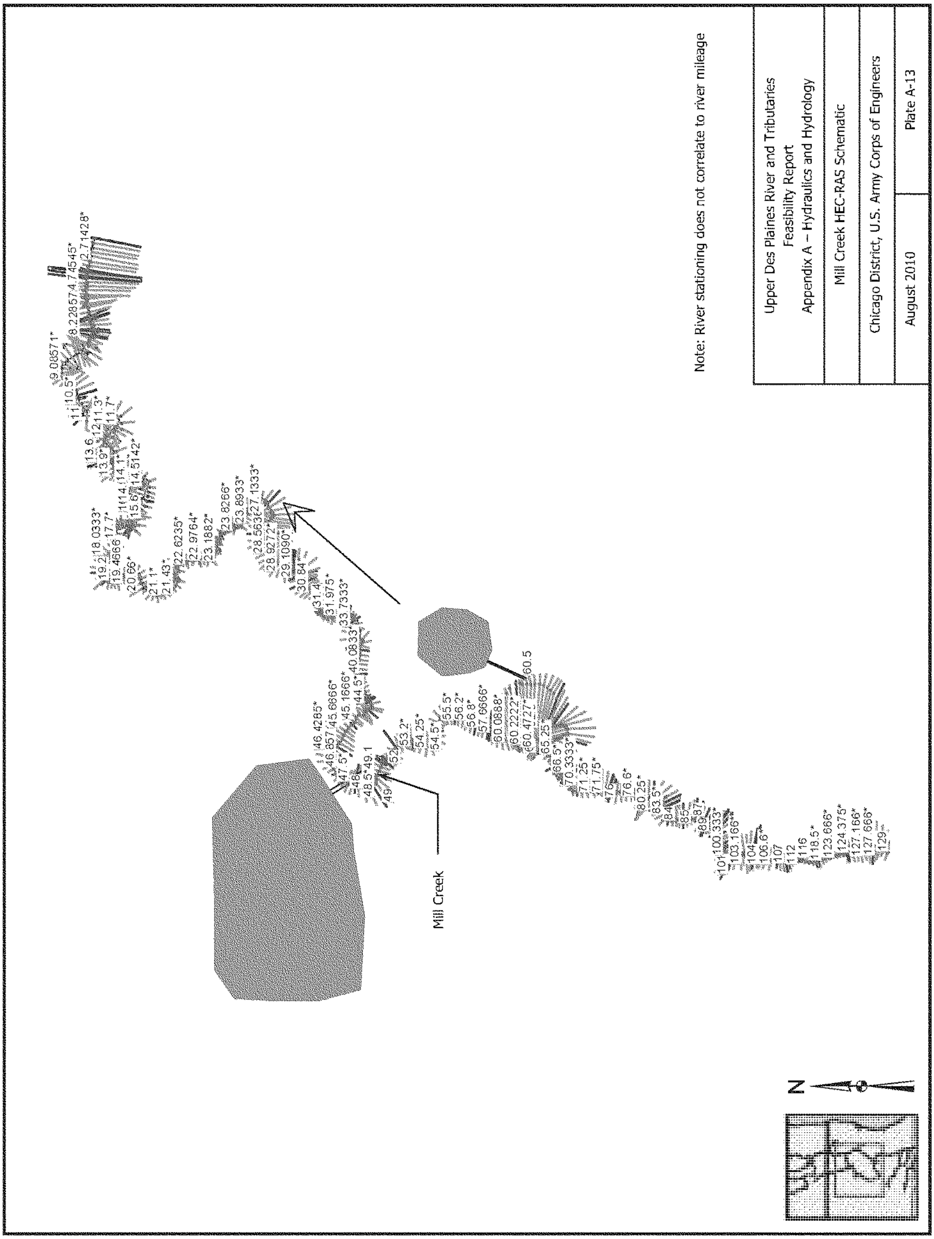

Legend
Streams
Weller Creek Subbasin Boundaries
US Army Corps of Engineers
Chicago District
Upper Des Plaines River and Tributaries
Feasibility Report
Appendix A - Hydrology and Hydraulics
Weller Creek Subbasin
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-8

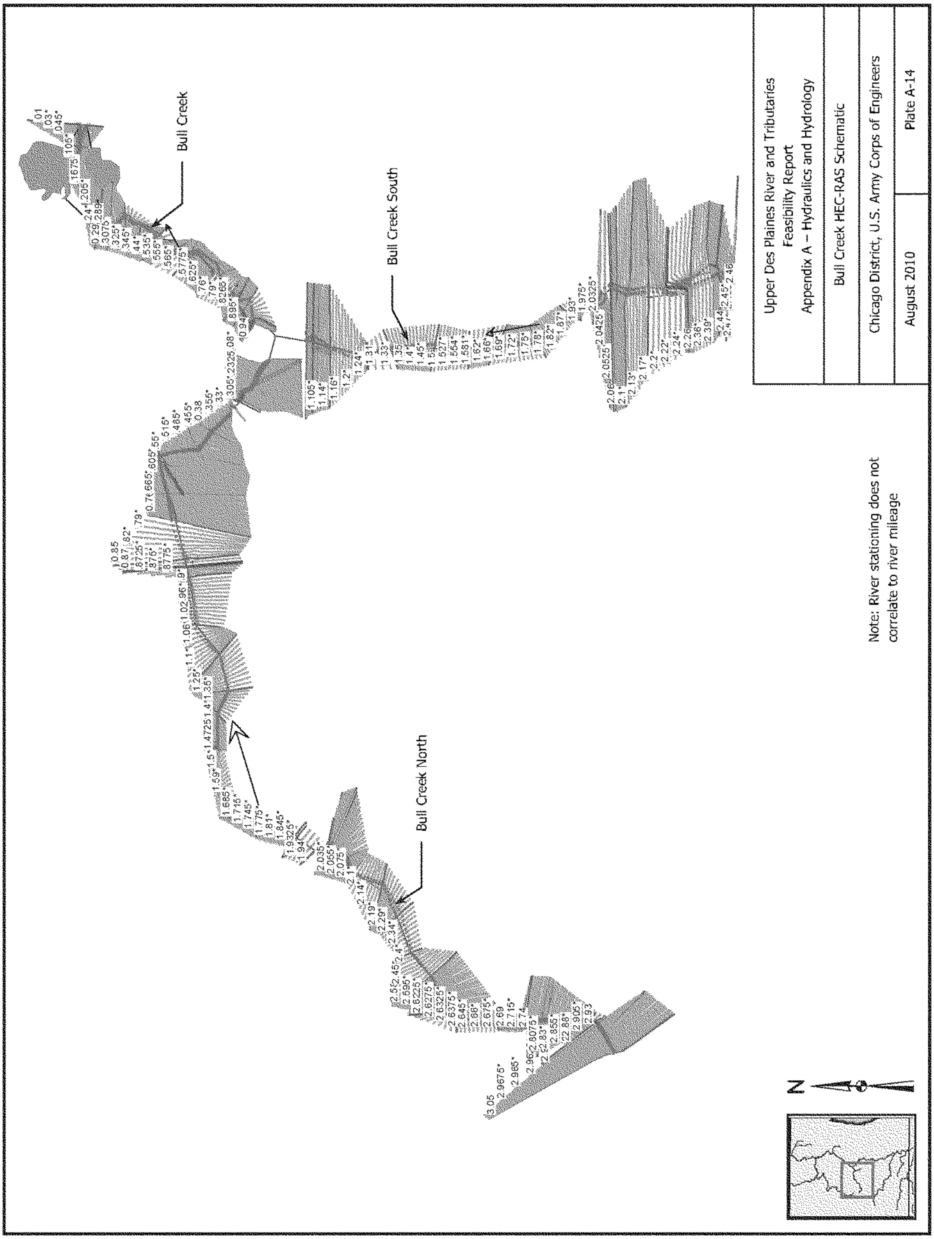
Upper Des Plaines River and Tributaries Feasibility Report Appendix A - Hydrology and Hydraulics	
Farmers-Prairie Creek Subbasin	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-9

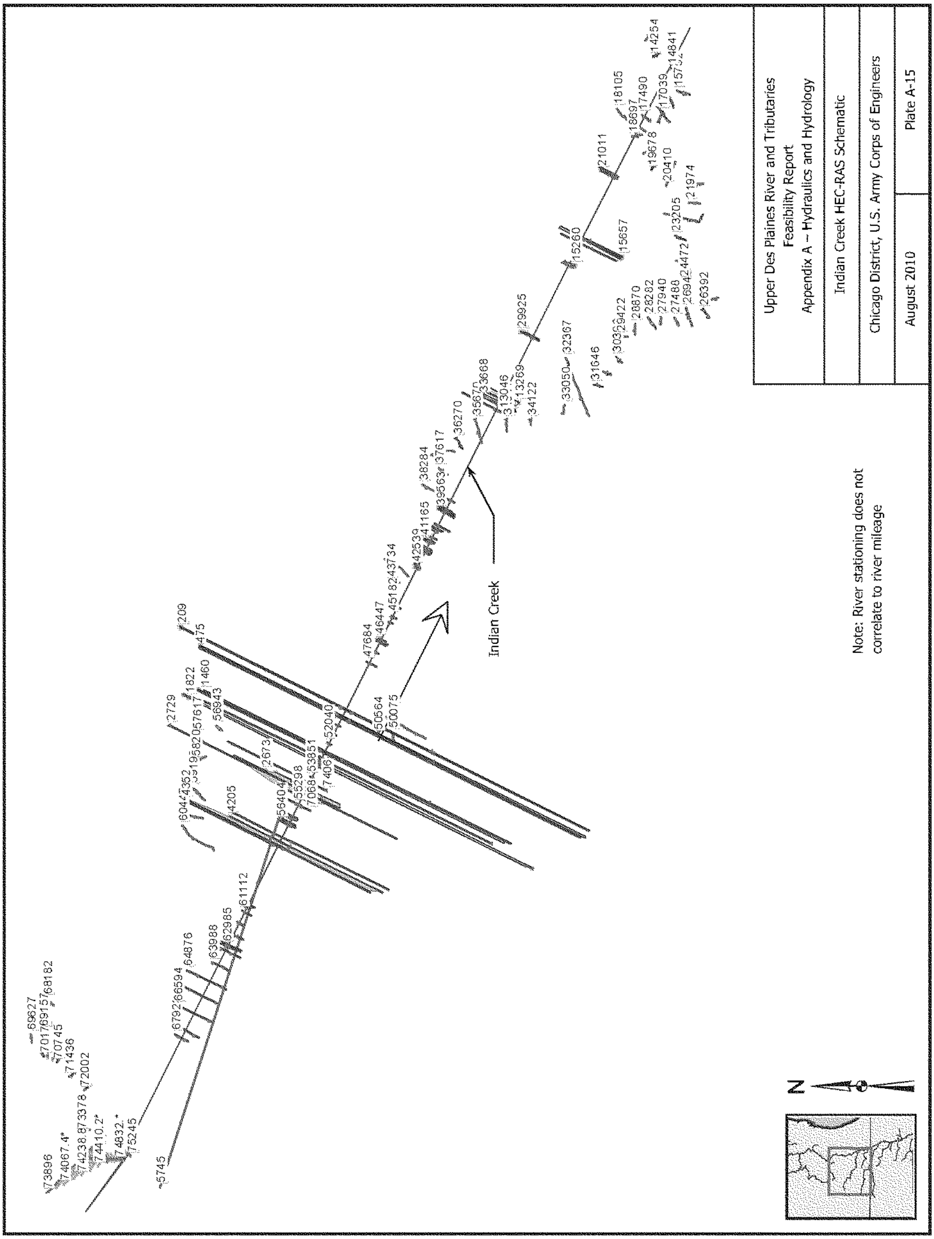

Note:
Red line is Phase I delineation, for emphasis.
Black line is delineation used in Phase II HEC-1.
(source: Christopher B. Burke Engineering, Ltd.)
Legend
Streams
Willow-Higgins Creek Subbasin
0 0.2 0.4 Miles
US Army Corps of Engineers
Chicago District
Upper Des Plaines River and Tributaries
Feasibility Report
Appendix A - Hydrology and Hydraulics
Willow-Higgins Creek Subbasin
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-10

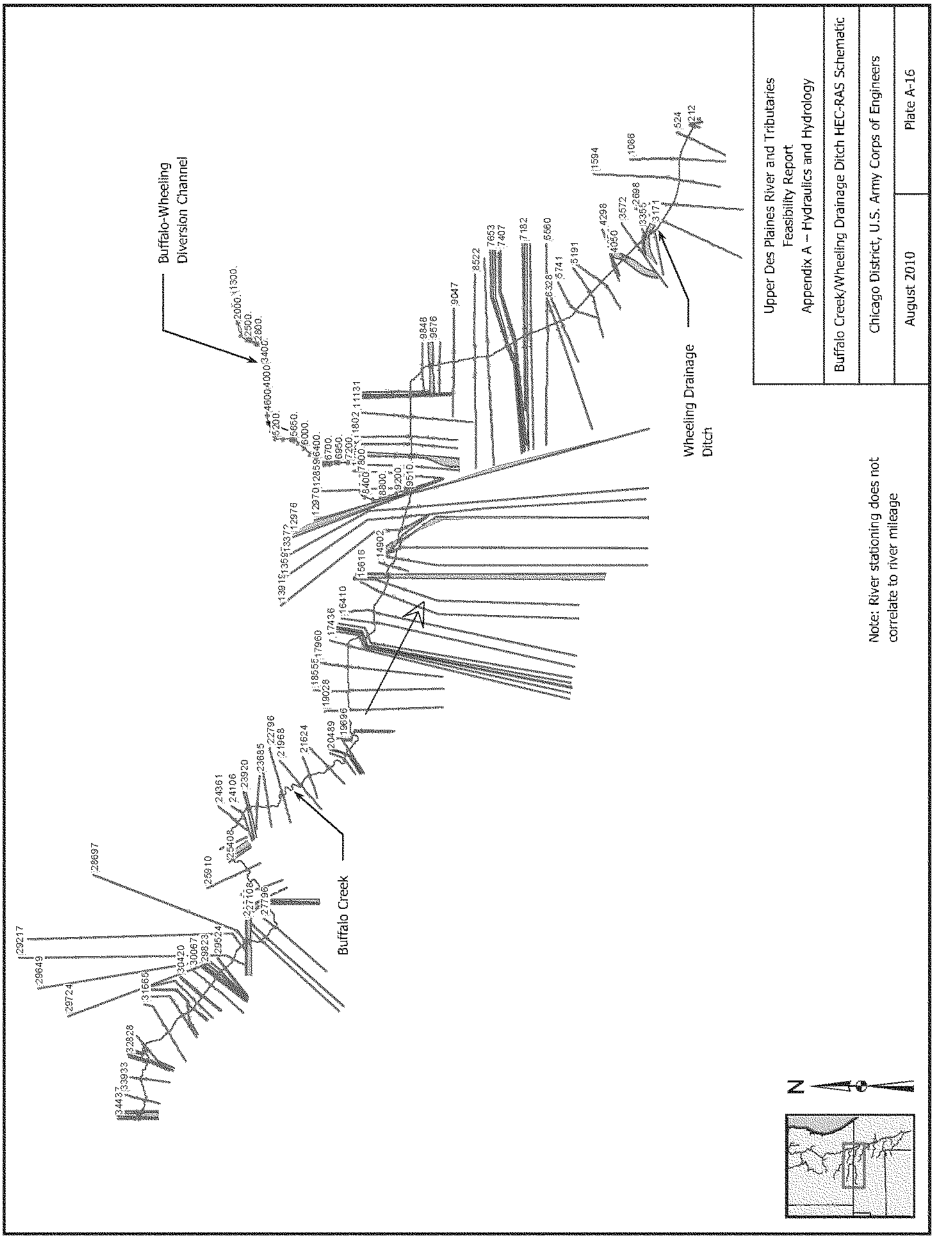

Legend
Streams
Silver Creek Subbasin Boundaries
Upper Des Plaines River and Tributaries
Feasibility Report
Appendix A - Hydrology and Hydraulics
Silver Creek Subbasin
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-11

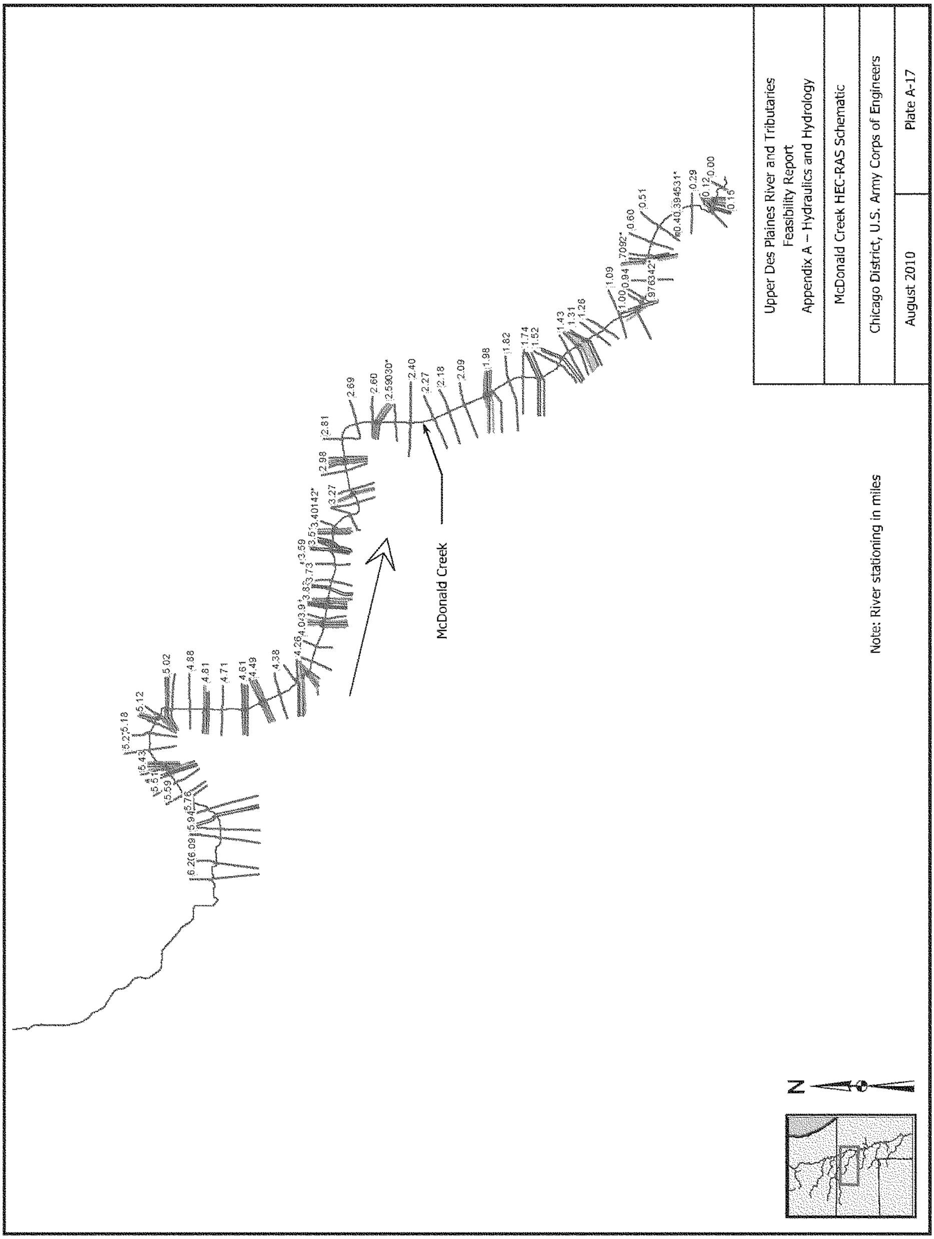

Newport Drainage Ditch
East Branch
West Branch
Tributary
West Branch
Note: River stationing in miles
Upper Des Plaines River and Tributaries
Feasibility Report
Appendix A – Hydraulics and Hydrology
Newport Drainage Ditch HEC-RAS Schematic
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-12
N


Note: River stationing does not correlate to river mileage
Upper Des Plaines River and Tributaries
Feasibility Report
Appendix A – Hydraulics and Hydrology
Mill Creek HEC-RAS Schematic
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-13
Mill Creek
N


Bull Creek
Bull Creek South
Bull Creek North
Note: River stationing does not correlate to river mileage
Upper Des Plaines River and Tributaries
Feasibility Report
Appendix A – Hydraulics and Hydrology
Bull Creek HEC-RAS Schematic
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-14


Upper Des Plaines River and Tributaries
Feasibility Report
Appendix A – Hydraulics and Hydrology
Indian Creek HEC-RAS Schematic
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-15
Note: River stationing does not correlate to river mileage
Indian Creek
N


Buffalo-Wheeling Diversion Channel
Buffalo Creek
Wheeling Drainage Ditch
Note: River stationing does not correlate to river mileage
Upper Des Plaines River and Tributaries Feasibility Report
Appendix A – Hydraulics and Hydrology
Buffalo Creek/Wheeling Drainage Ditch HEC-RAS Schematic
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-16
N


Upper Des Plaines River and Tributaries
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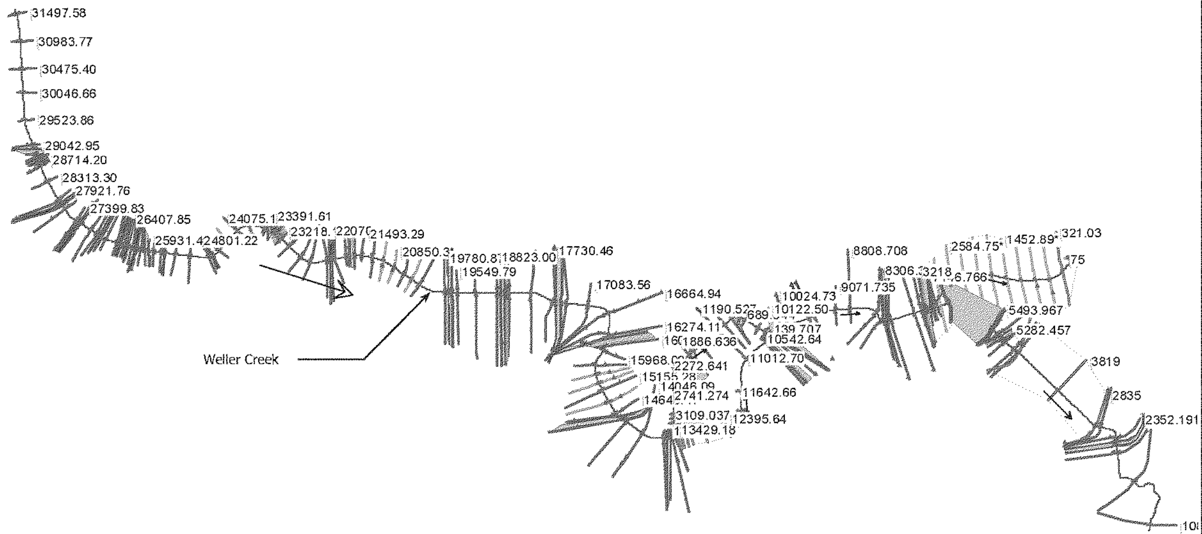
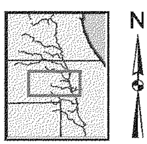
Appendix A – Hydraulics and Hydrology
McDonald Creek HEC-RAS Schematic
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-17
McDonald Creek
Note: River stationing in miles
N





Note: River stationing in feet

Upper Des Plaines River and Tributaries
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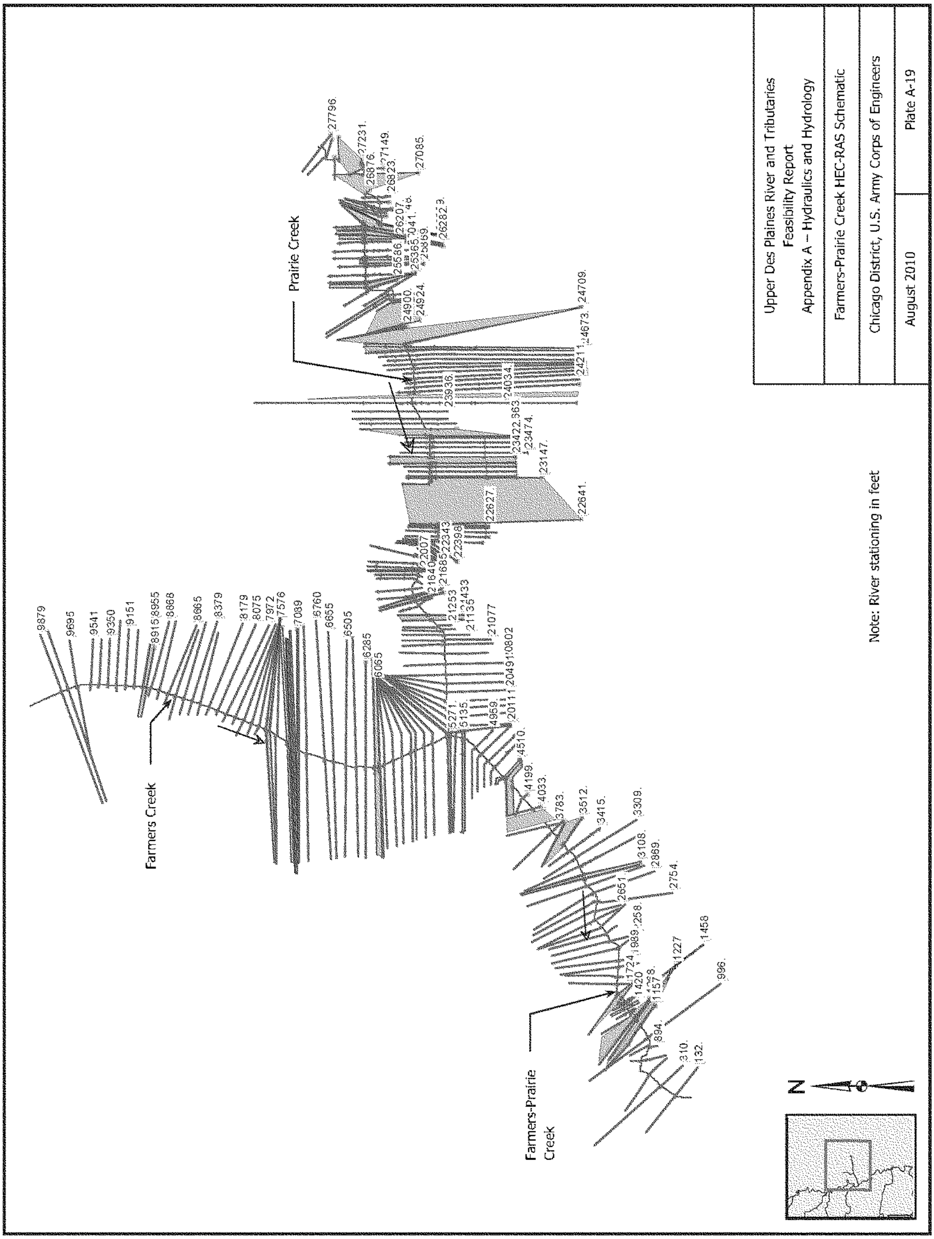
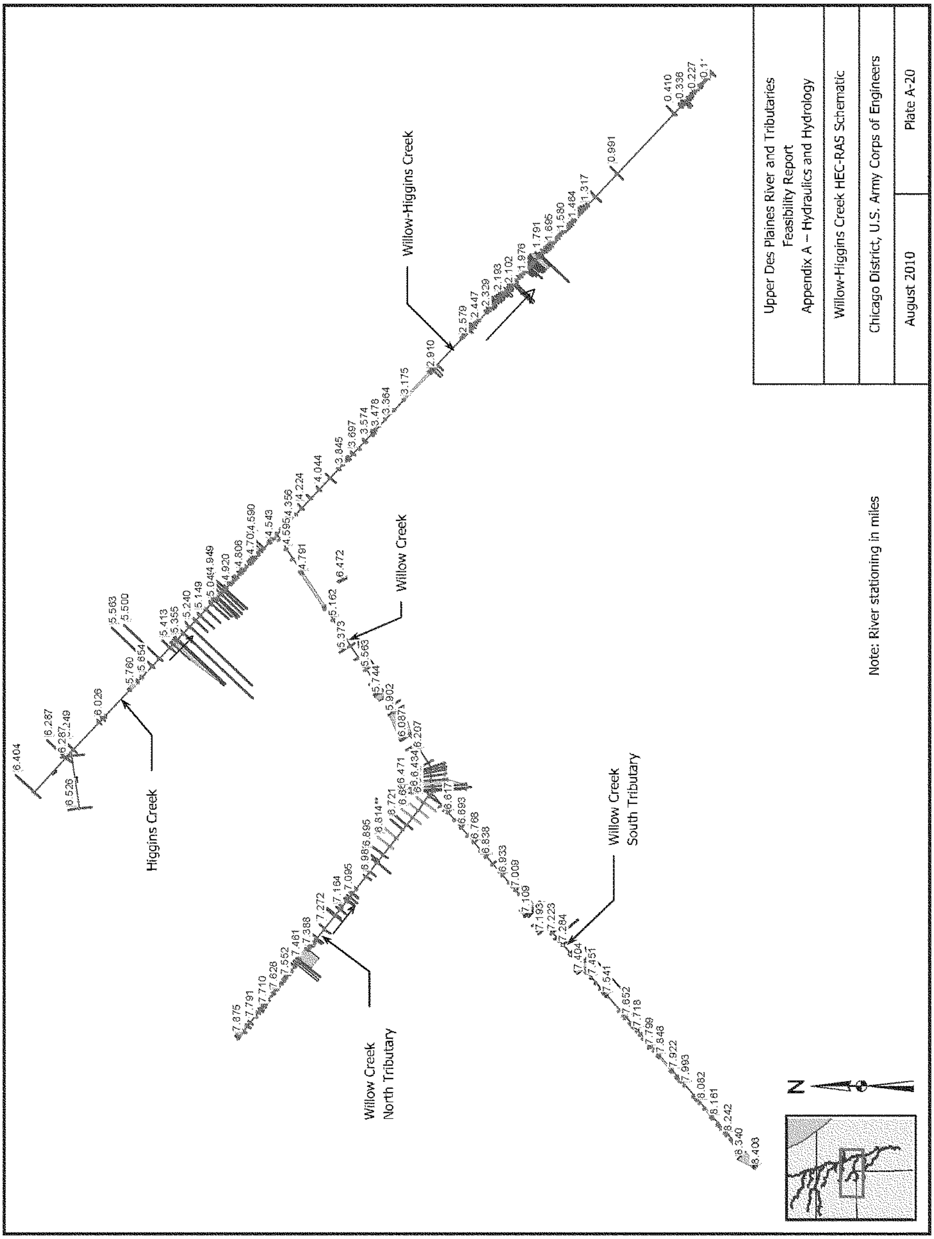
Appendix A – Hydraulics and Hydrology

Weller Creek HEC-RAS Schematic

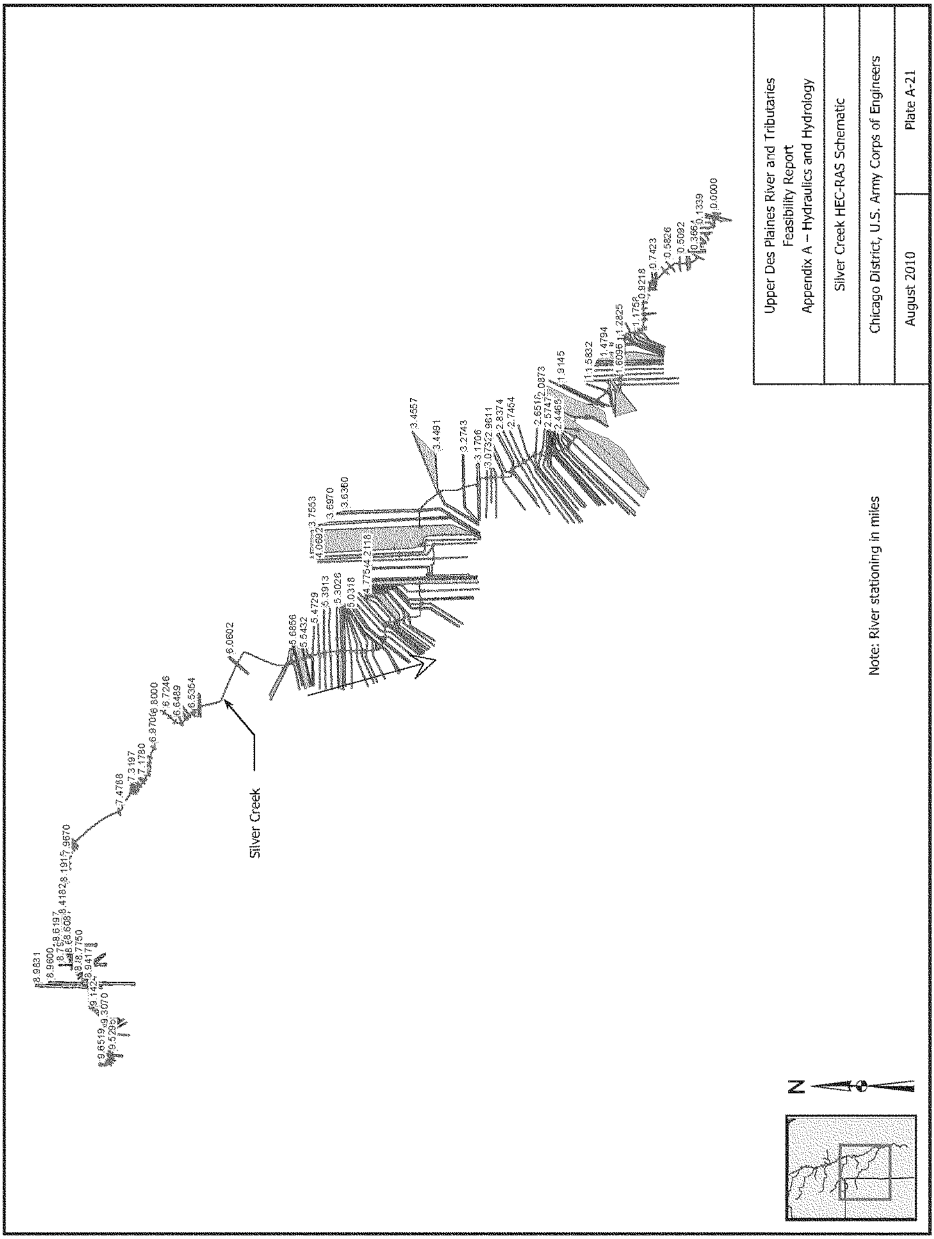
Chicago District, U.S. Army Corps of Engineers

August 2010 | Plate A-18


Upper Des Plaines River and Tributaries
Feasibility Report
Appendix A – Hydraulics and Hydrology
Farmers-Prairie Creek HEC-RAS Schematic
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-19
Note: River stationing in feet
Farmers Creek
Prairie Creek
Farmers-Prairie Creek
N



Upper Des Plaines River and Tributaries
Feasibility Report
Appendix A – Hydraulics and Hydrology
Willow-Higgins Creek HEC-RAS Schematic
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-20
Note: River stationing in miles
Willow-Higgins Creek
Willow Creek
Higgins Creek
Willow Creek
South Tributary
Willow Creek
North Tributary
N


Silver Creek
Note: River stationing in miles
Upper Des Plaines River and Tributaries
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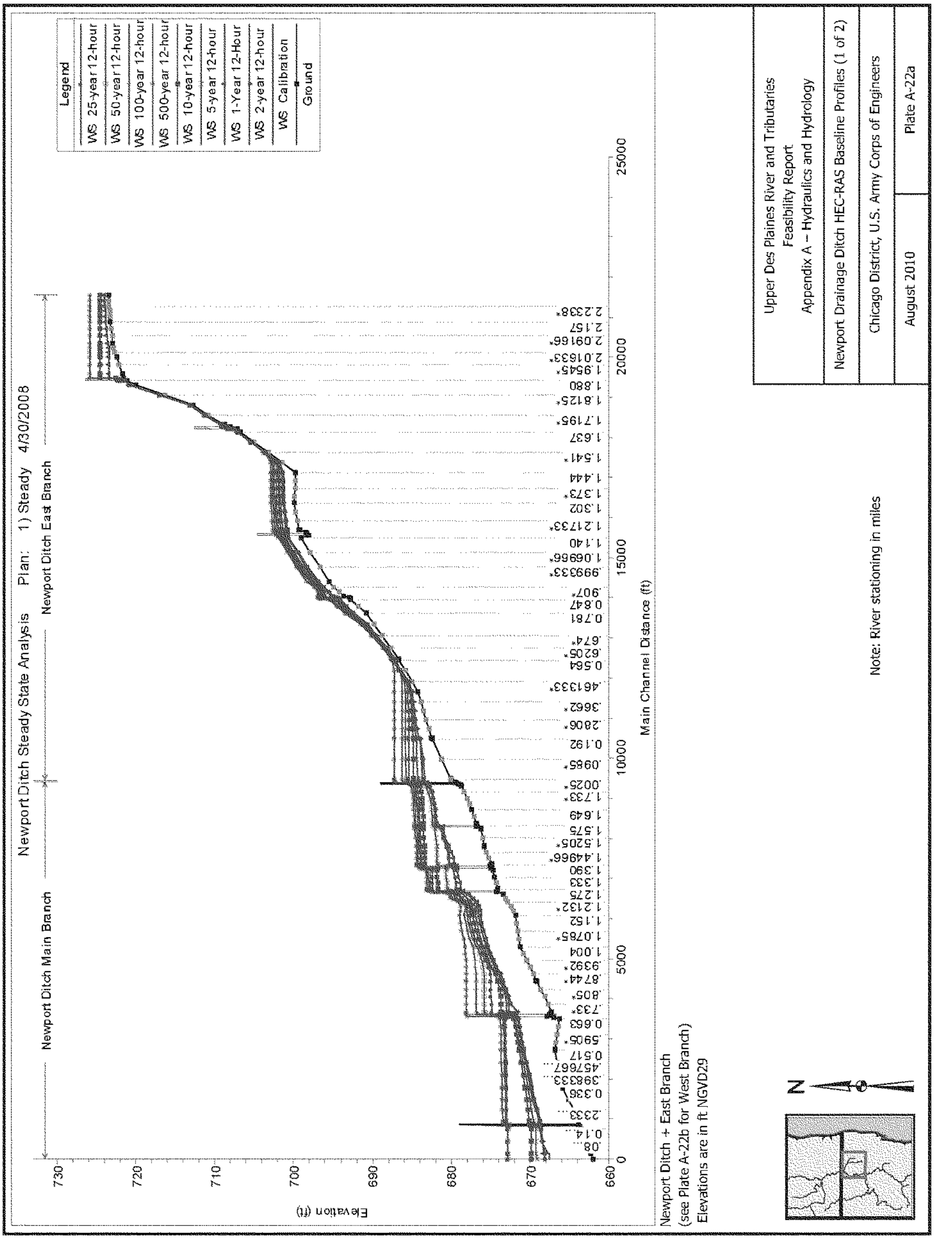
Appendix A – Hydraulics and Hydrology
Silver Creek HEC-RAS Schematic
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-21


Newport Ditch Steady State Analysis Plan: 1) Steady 4/30/2008
Newport Ditch Main Branch
Newport Ditch East Branch
Legend
WS 25-year 12-hour
WS 50-year 12-hour
WS 100-year 12-hour
WS 500-year 12-hour
WS 10-year 12-hour
WS 5-year 12-hour
WS 1-Year 12-Hour
WS 2-year 12-hour
WS Calibration
Ground
Elevation (ft)
Main Channel Distance (ft)
Newport Ditch + East Branch
(see Plate A-22b for West Branch)
Elevations are in ft NGVD29
Note: River stationing in miles
Upper Des Plaines River and Tributaries
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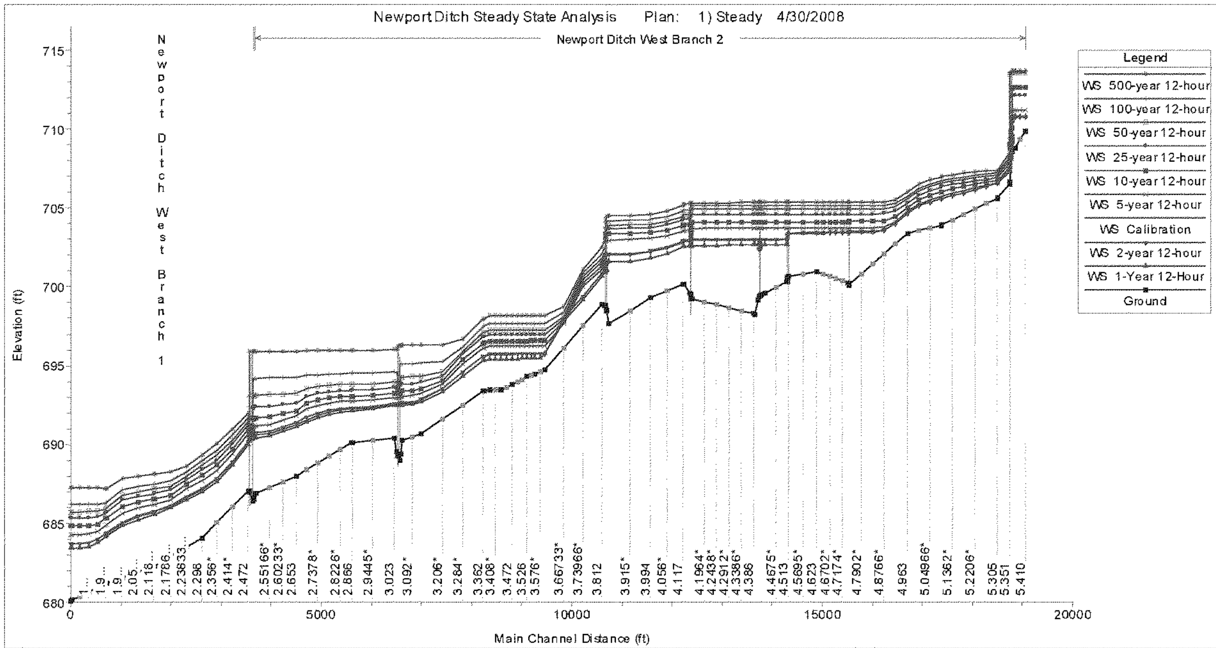
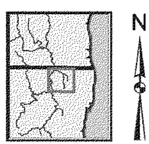
Appendix A – Hydraulics and Hydrology
Newport Drainage Ditch HEC-RAS Baseline Profiles (1 of 2)
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-22a



West Branch
(see Plate A-22a for Newport Ditch)
Elevations are in ft NGVD29



Note: River stationing in miles

Upper Des Plaines River and Tributaries
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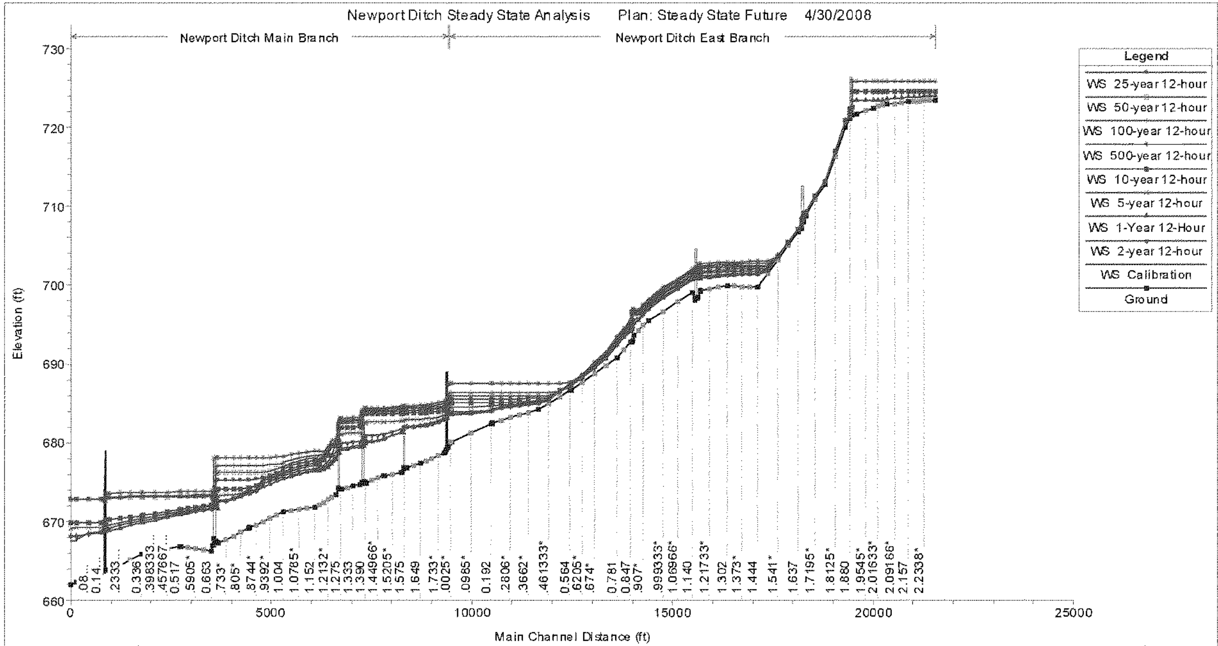
Appendix A – Hydraulics and Hydrology

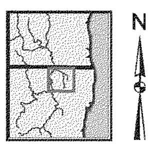
Newport Drainage Ditch HEC-RAS Baseline Profiles (2 of 2)

Chicago District, U.S. Army Corps of Engineers

August 2010 | Plate A-22b

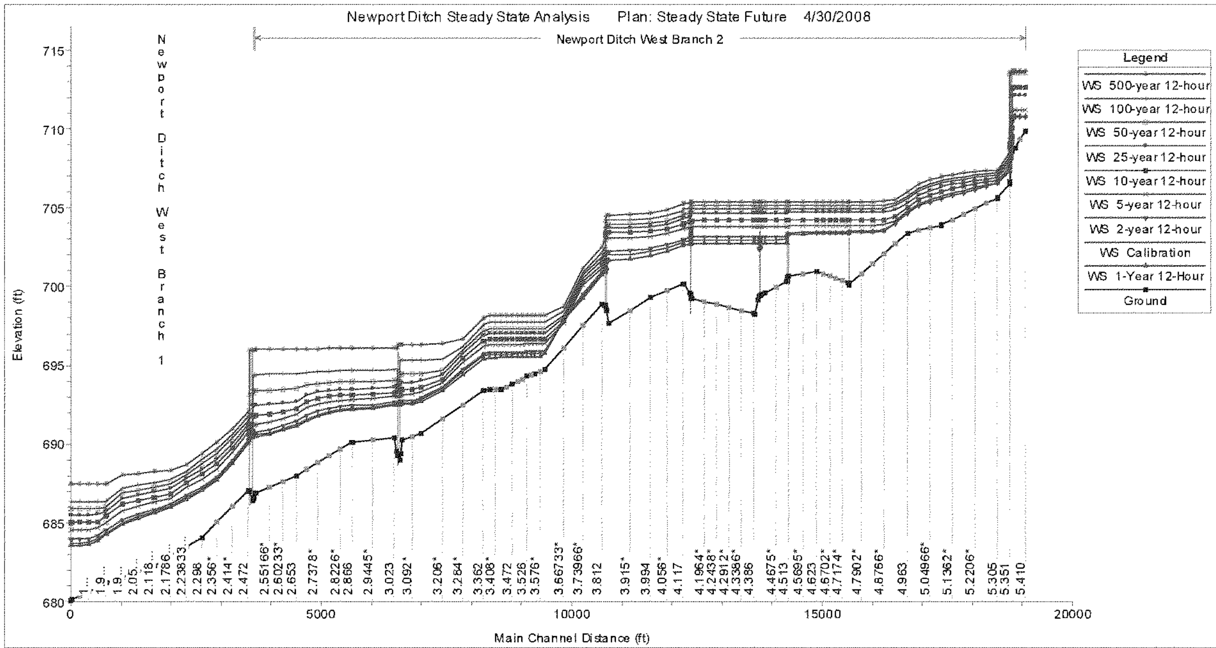


Newport Ditch + East Branch
(see Plate A-23b for West Branch)
Elevations are in ft NGVD29

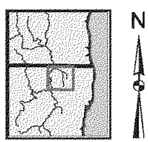


Note: River stationing in miles

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Newport Drainage Ditch HEC-RAS Future Profiles (1 of 2)	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-23a

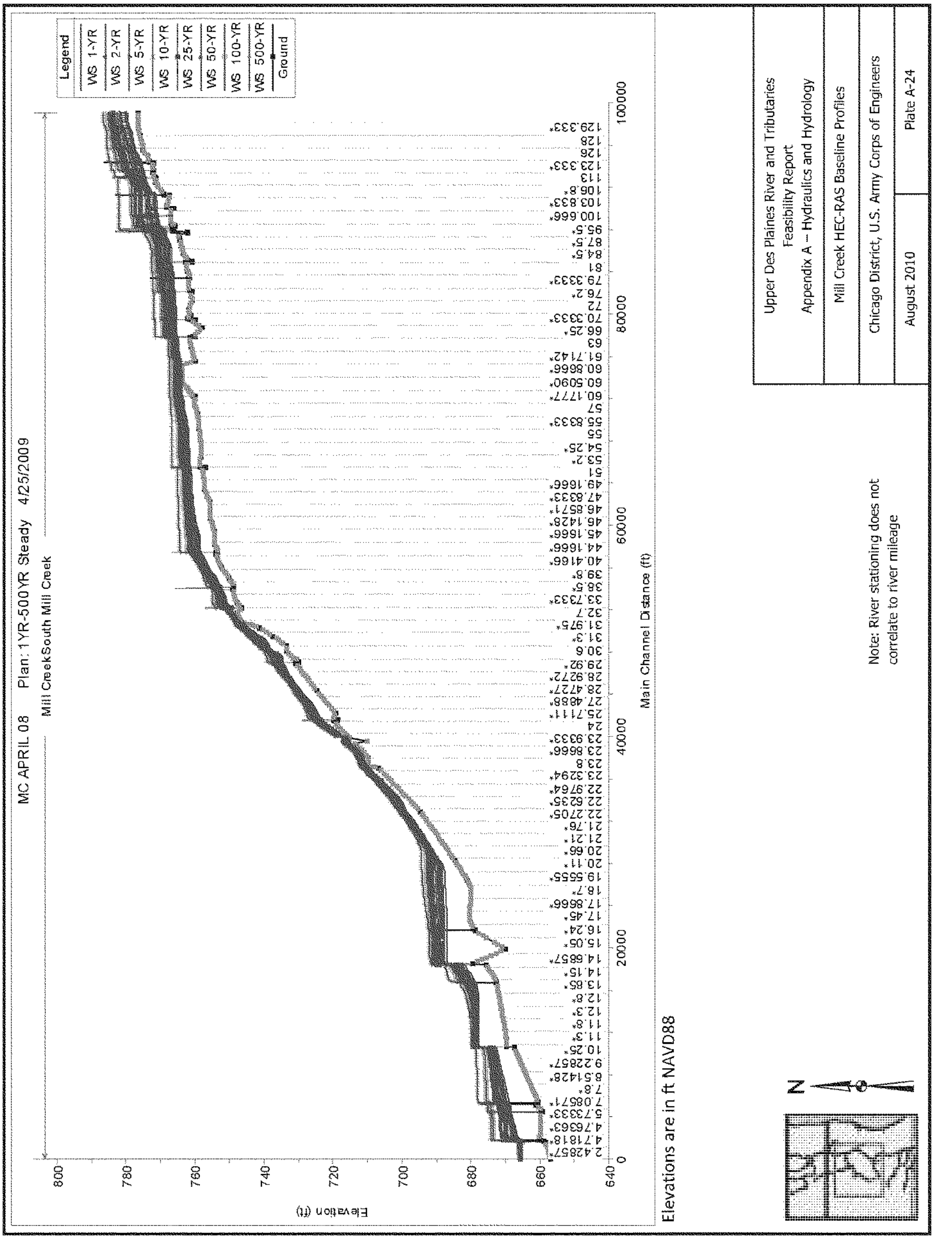


West Branch
(see Plate A-23a for Newport Ditch)
Elevations are in ft NGVD29



Note: River stationing in miles

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Newport Drainage Ditch HEC-RAS Future Profiles (2 of 2)	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-23b


MC APRIL 08 Plan: 1YR-500YR Steady 4/25/2009
Mill Creek South Mill Creek
Legend
WS 1-YR
WS 2-YR
WS 5-YR
WS 10-YR
WS 25-YR
WS 50-YR
WS 100-YR
WS 500-YR
Ground
Elevation (ft)
Main Channel Distance (ft)
Elevations are in ft NAVD88
Note: River stationing does not correlate to river mileage
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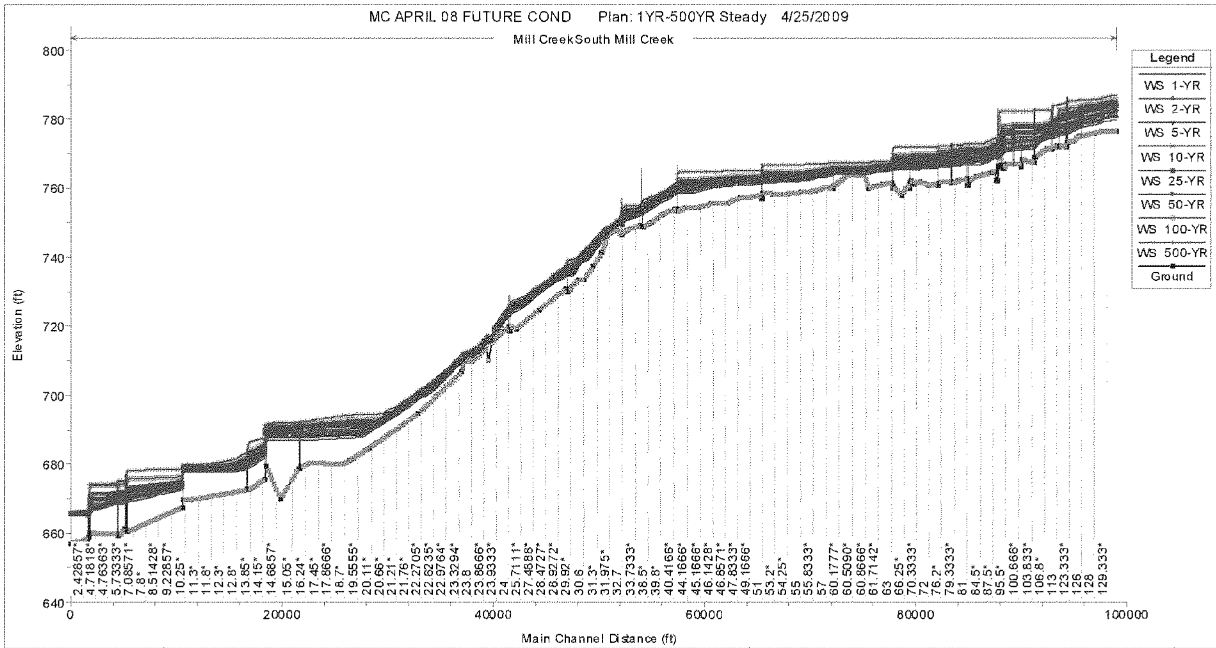
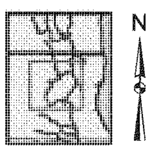
Mill Creek HEC-RAS Baseline Profiles
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-24

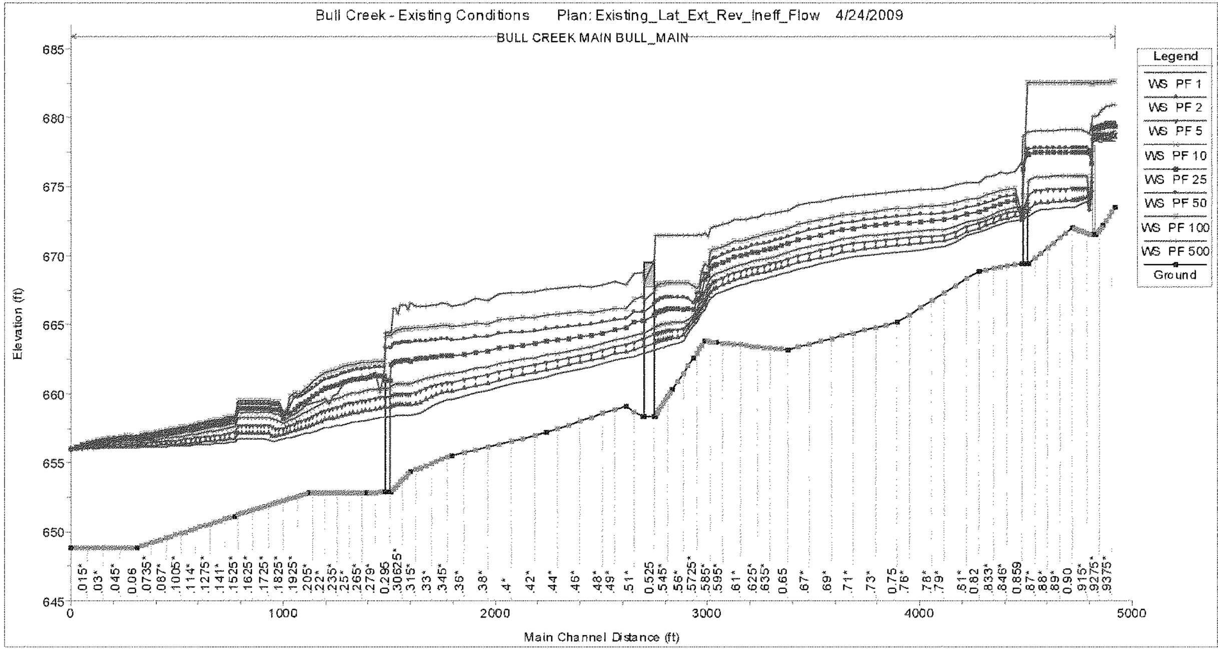


Elevations are in ft NAVD88

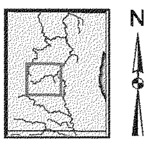


Note: River stationing does not correlate to river mileage

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Mill Creek HEC-RAS Future Profiles	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-25

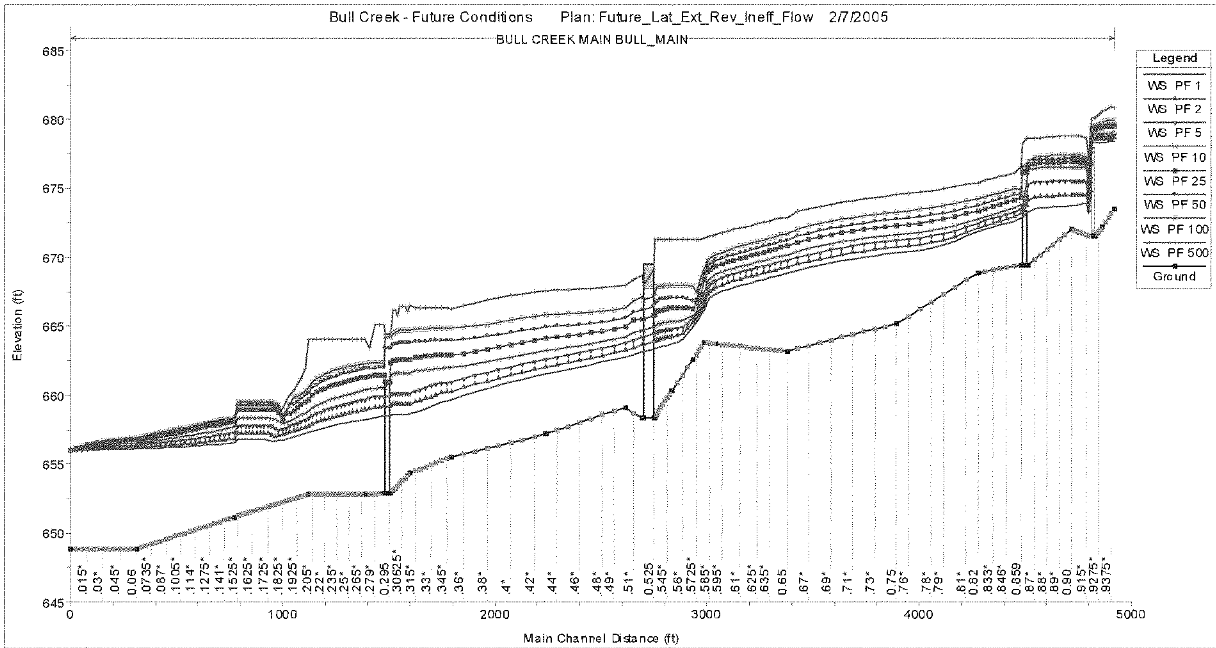


Elevations are in ft NGVD29

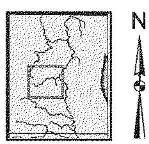


Note: River stationing does not correlate to river mileage

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Bull Creek HEC-RAS Profiles	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-26

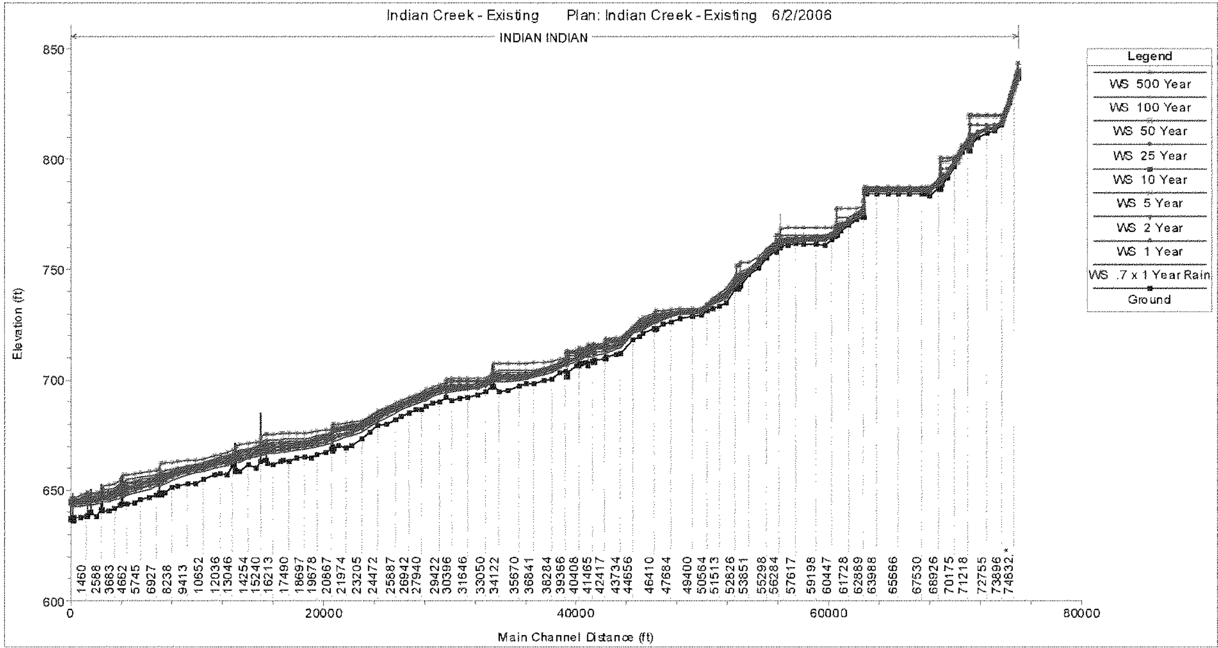


Elevations are in ft NGVD29

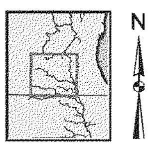


Note: River stationing does not correlate to river mileage

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Bull Creek HEC-RAS Future Profiles	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-27

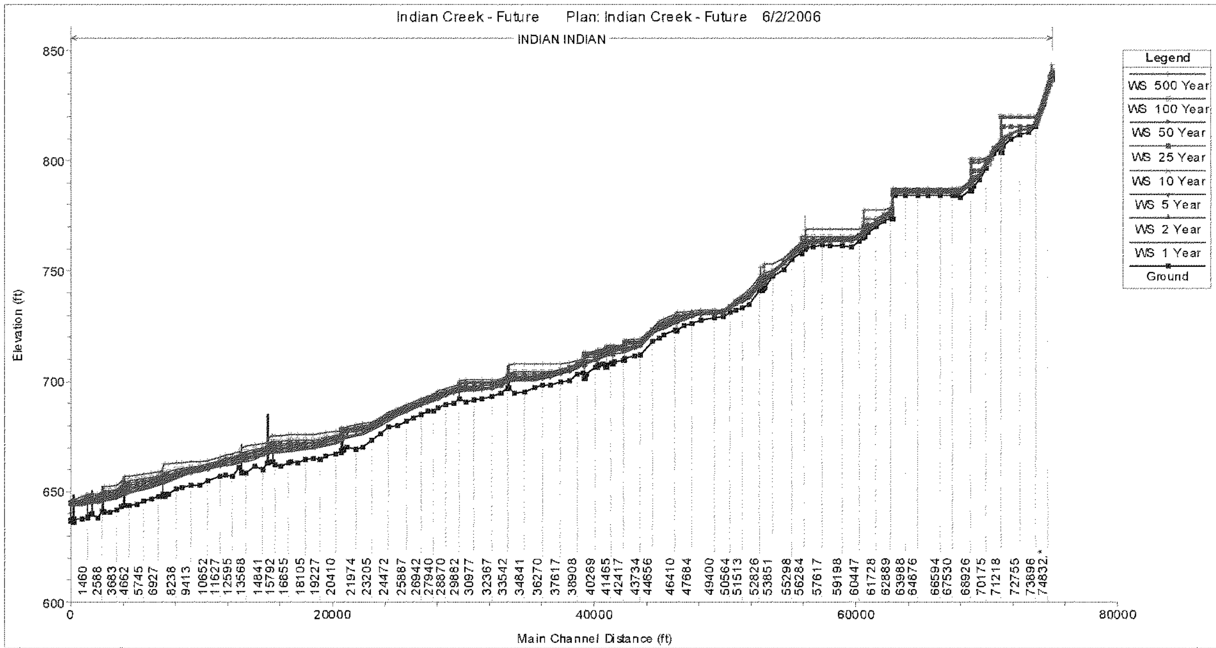


Elevations are in ft NGVD29

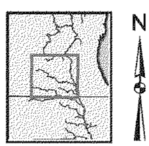


Note: River stationing does not correlate to river mileage

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Indian Creek HEC-RAS Baseline Profiles	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-28

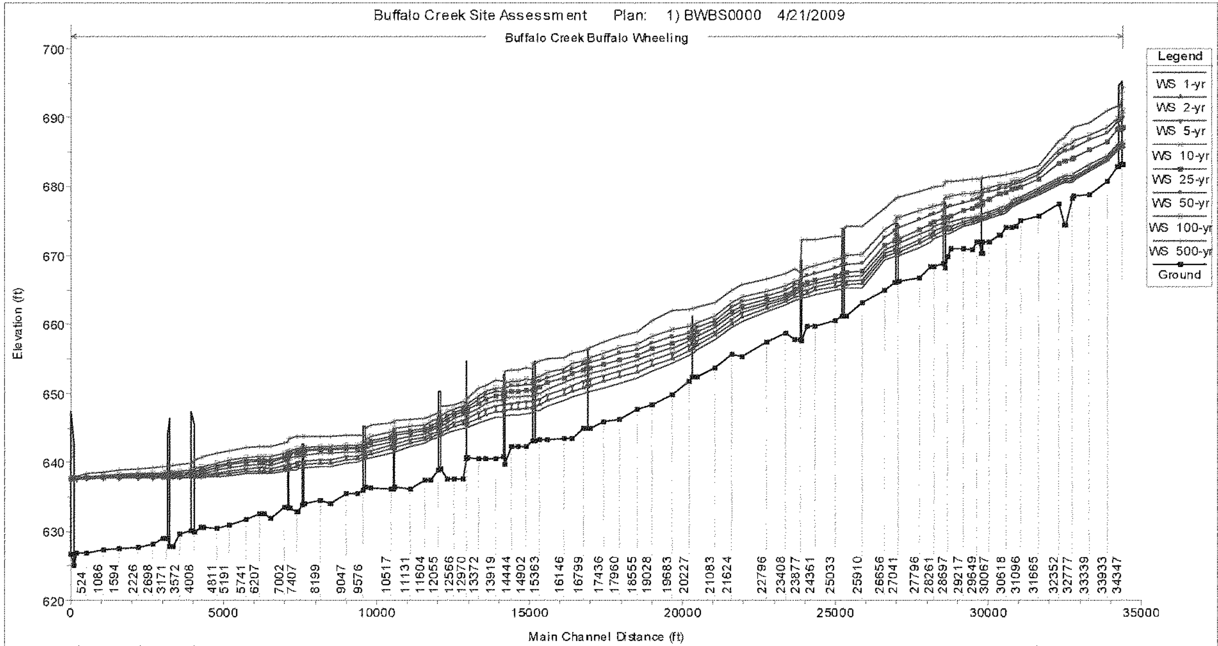


Elevations are in ft NGVD29

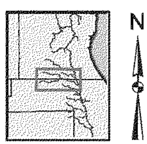


Note: River stationing does not correlate to river mileage

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Indian Creek HEC-RAS Future Profiles	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-29

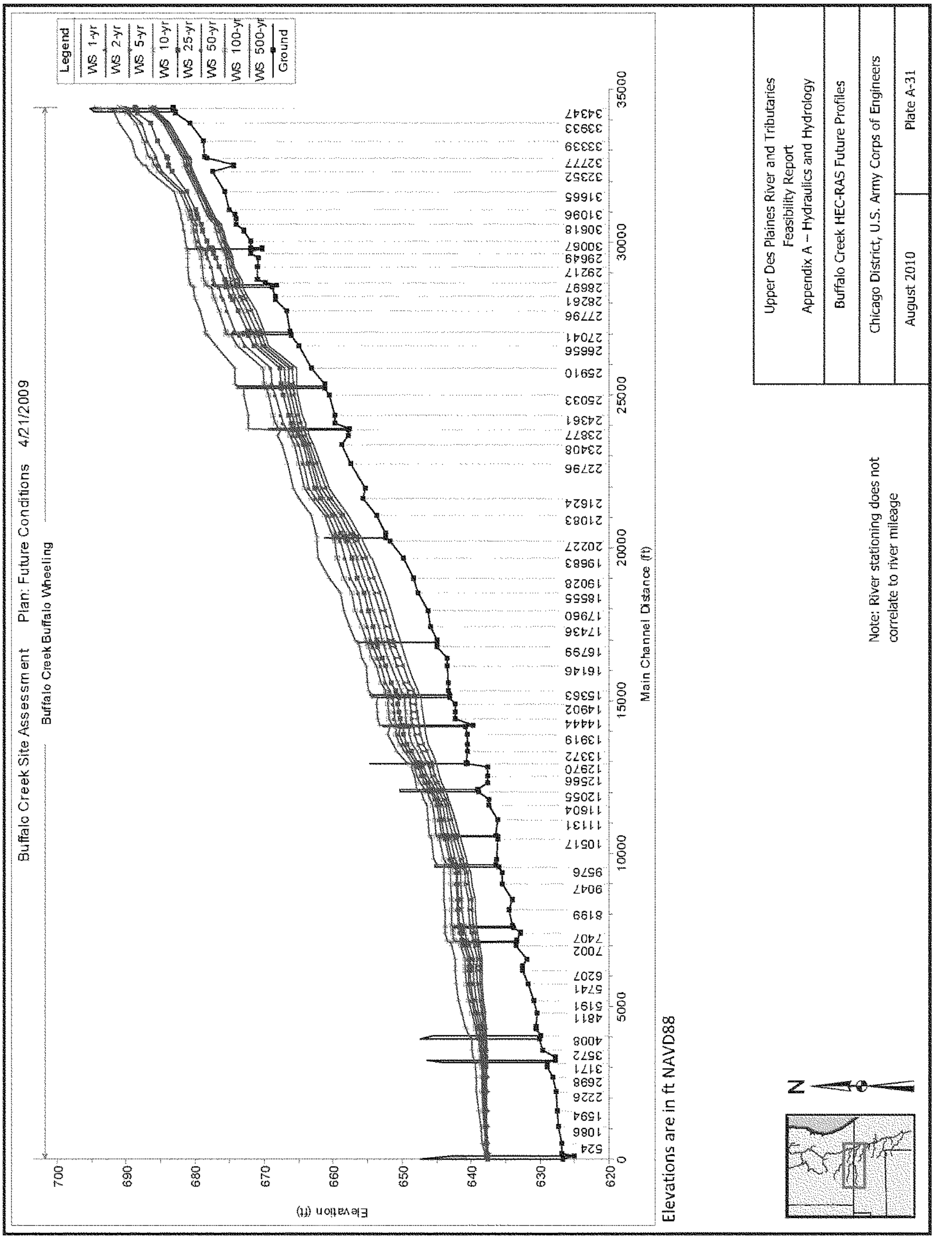


Elevations are in ft NAVD88



Note: River stationing does not correlate to river mileage

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Buffalo Creek HEC-RAS Baseline Profiles	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-30


Buffalo Creek Site Assessment Plan: Future Conditions 4/21/2009
Buffalo Creek Buffalo Wheeling
Legend
WS 1-yr
WS 2-yr
WS 5-yr
WS 10-yr
WS 25-yr
WS 50-yr
WS 100-yr
WS 500-yr
Ground
Elevation (ft)
Main Channel Distance (ft)
Elevations are in ft NAVD88
Note: River stationing does not correlate to river mileage
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Buffalo Creek HEC-RAS Future Profiles
Chicago District, U.S. Army Corps of Engineers
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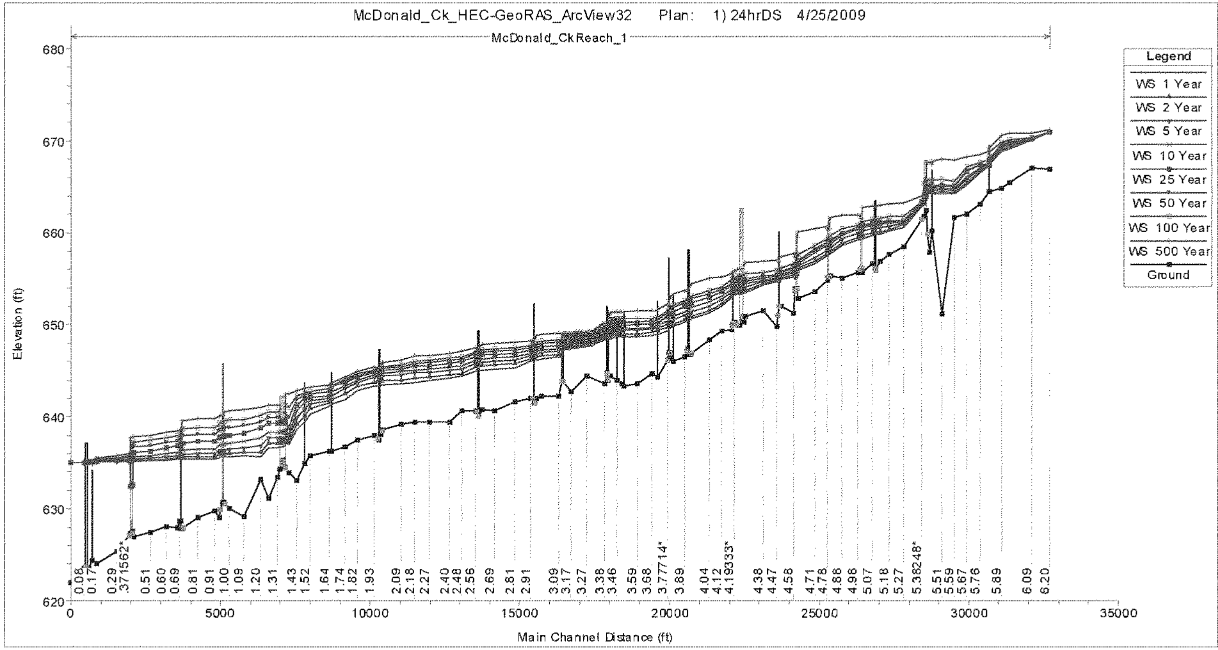
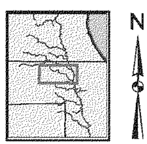
Plate A-31

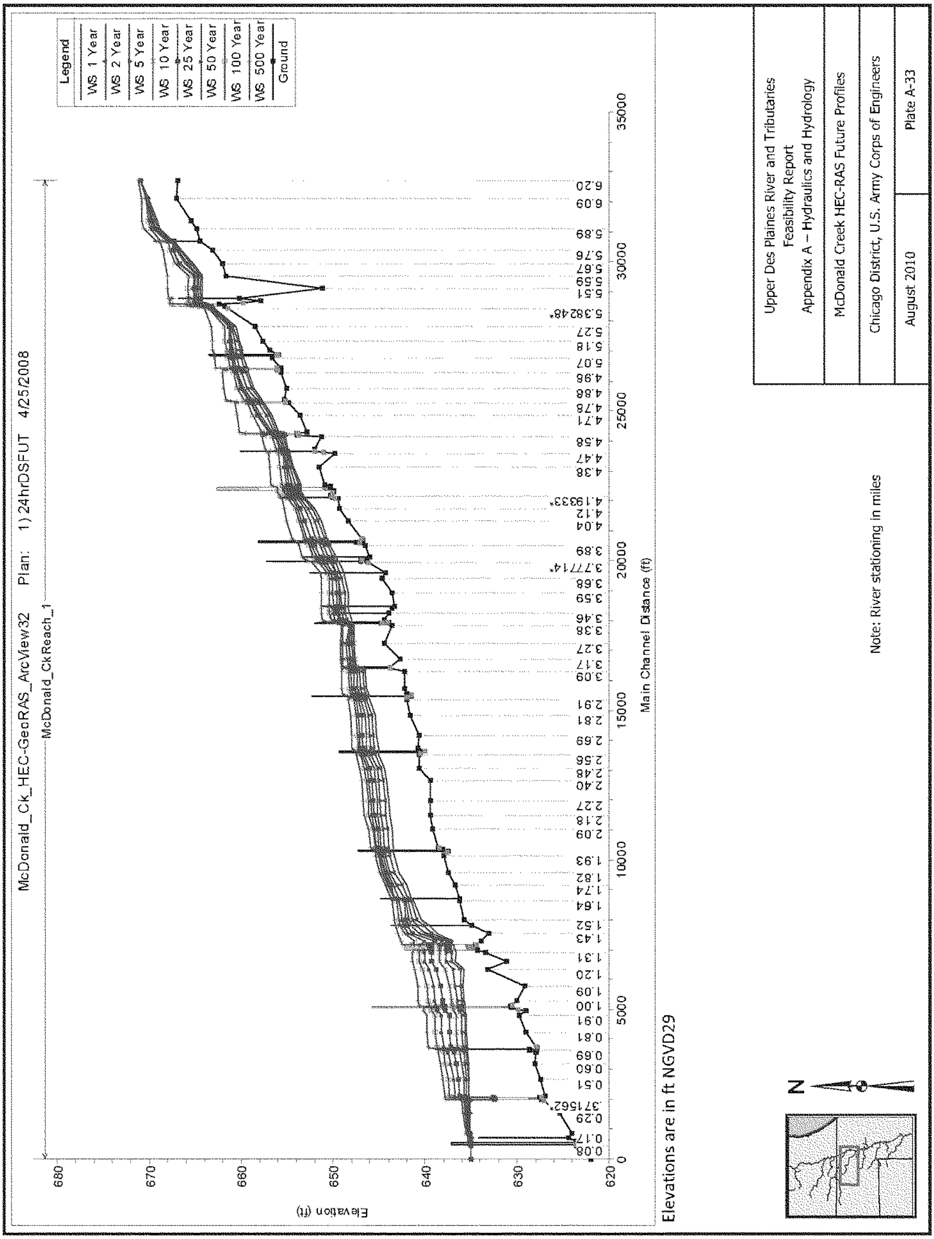


Elevations are in ft NGVD29



Note: River stationing in miles

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
McDonald Creek HEC-RAS Baseline Profiles	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-32


McDonald_Ck_HEC-GeoRAS_ArcView32 Plan: 1) 24hrDSFUT 4/25/2008
McDonald_CkReach_1
Legend
WS 1 Year
WS 2 Year
WS 5 Year
WS 10 Year
WS 25 Year
WS 50 Year
WS 100 Year
WS 500 Year
Ground
Elevation (ft)
Main Channel Distance (ft)
0.08 0.17 0.29 .371562* 0.51 0.60 0.69 0.81 0.91 1.00 1.09 1.20 1.31 1.43 1.52 1.64 1.74 1.82 1.93 2.09 2.18 2.27 2.40 2.48 2.56 2.69 2.81 2.91 3.09 3.17 3.27 3.38 3.46 3.59 3.68 3.77714* 3.89 4.04 4.12 4.19333* 4.38 4.47 4.58 4.71 4.78 4.88 4.98 5.07 5.18 5.27 5.38248* 5.51 5.59 5.67 5.76 5.89 6.09 6.20
Elevations are in ft NGVD29
Note: River stationing in miles
N
Upper Des Plaines River and Tributaries
Feasibility Report
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McDonald Creek HEC-RAS Future Profiles
Chicago District, U.S. Army Corps of Engineers
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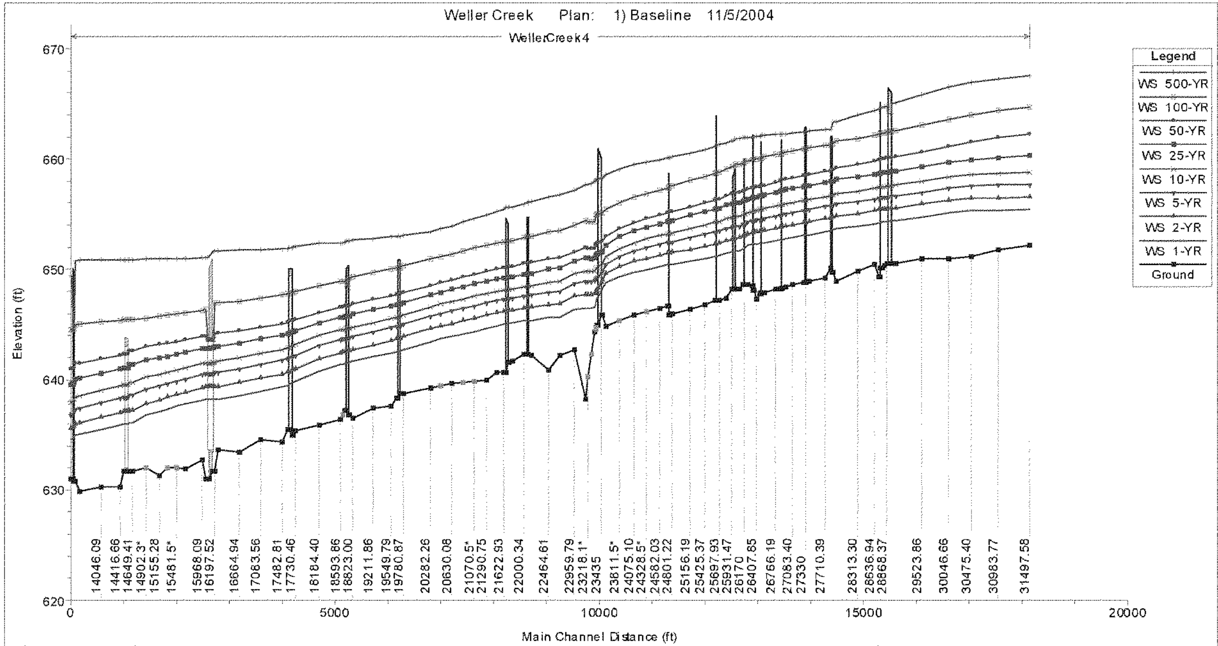
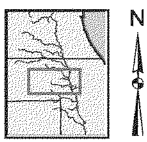
Plate A-33

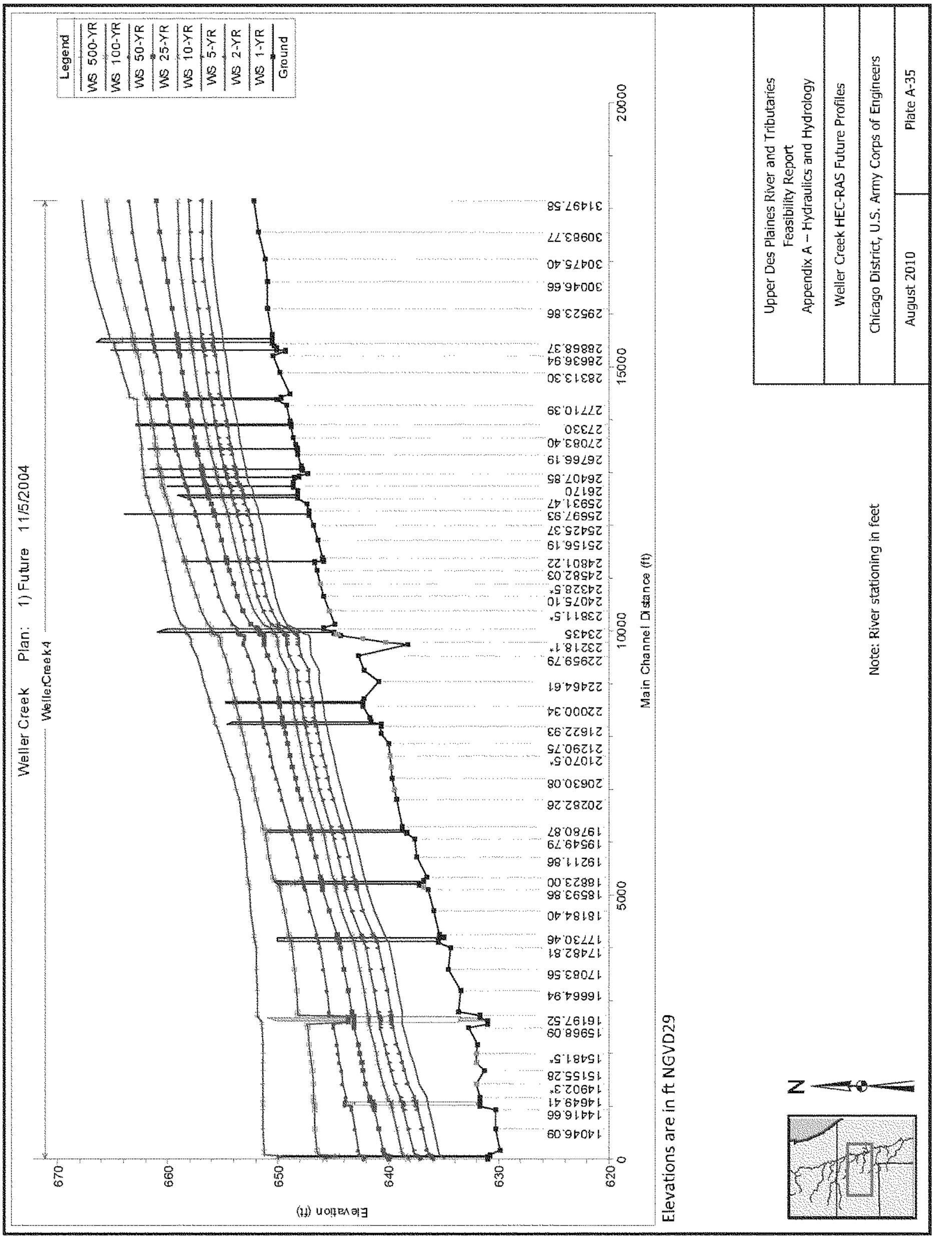


Elevations are in ft NGVD29



Note: River stationing in feet

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Weller Creek HEC-RAS Baseline Profiles	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-34



Weller Creek Plan: 1) Future 11/5/2004
WellerCreek4
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
WS 5-YR
WS 2-YR
WS 1-YR
Ground
Elevation (ft)
Main Channel Distance (ft)
Elevations are in ft NGVD29
Note: River stationing in feet
N
Upper Des Plaines River and Tributaries
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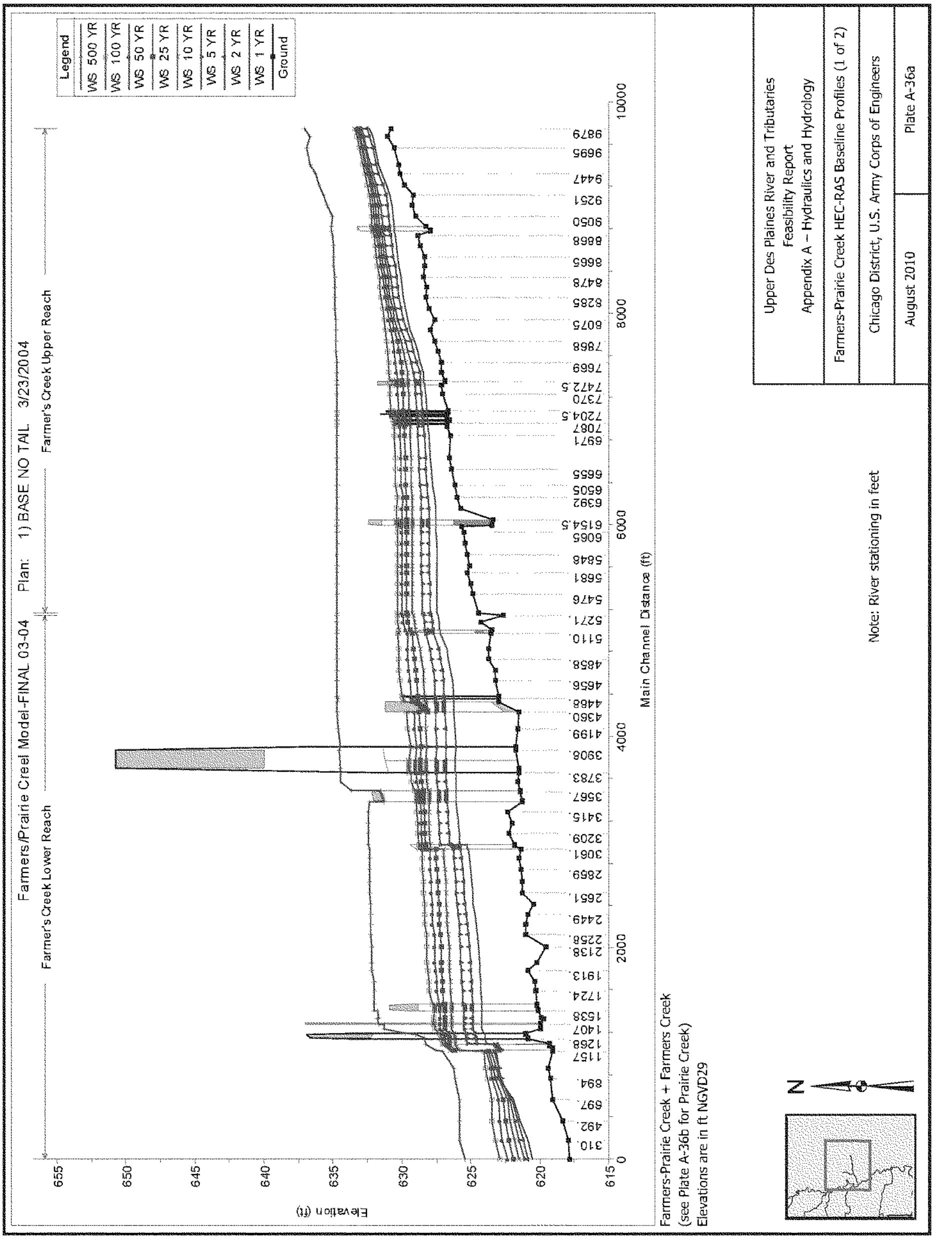
Weller Creek HEC-RAS Future Profiles
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-35


Farmers/Prairie Creel Model-FINAL 03-04 Plan: 1) BASE NO TAIL 3/23/2004
Farmer's Creek Lower Reach
Farmer's Creek Upper Reach
Legend
WS 500 YR
WS 100 YR
WS 50 YR
WS 25 YR
WS 10 YR
WS 5 YR
WS 2 YR
WS 1 YR
Ground
Elevation (ft)
Main Channel Distance (ft)
Farmers-Prairie Creek + Farmers Creek
(see Plate A-36b for Prairie Creek)
Elevations are in ft NGVD29
Note: River stationing in feet
Upper Des Plaines River and Tributaries
Feasibility Report
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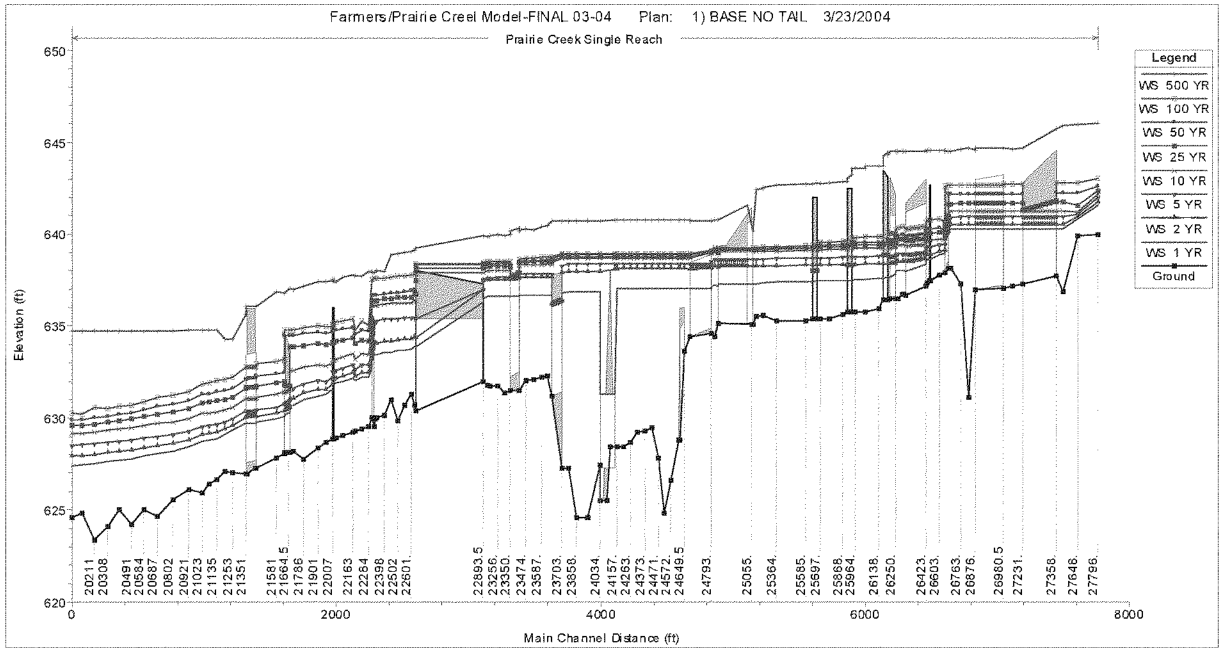
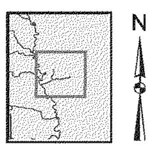
Farmers-Prairie Creek HEC-RAS Baseline Profiles (1 of 2)
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-36a

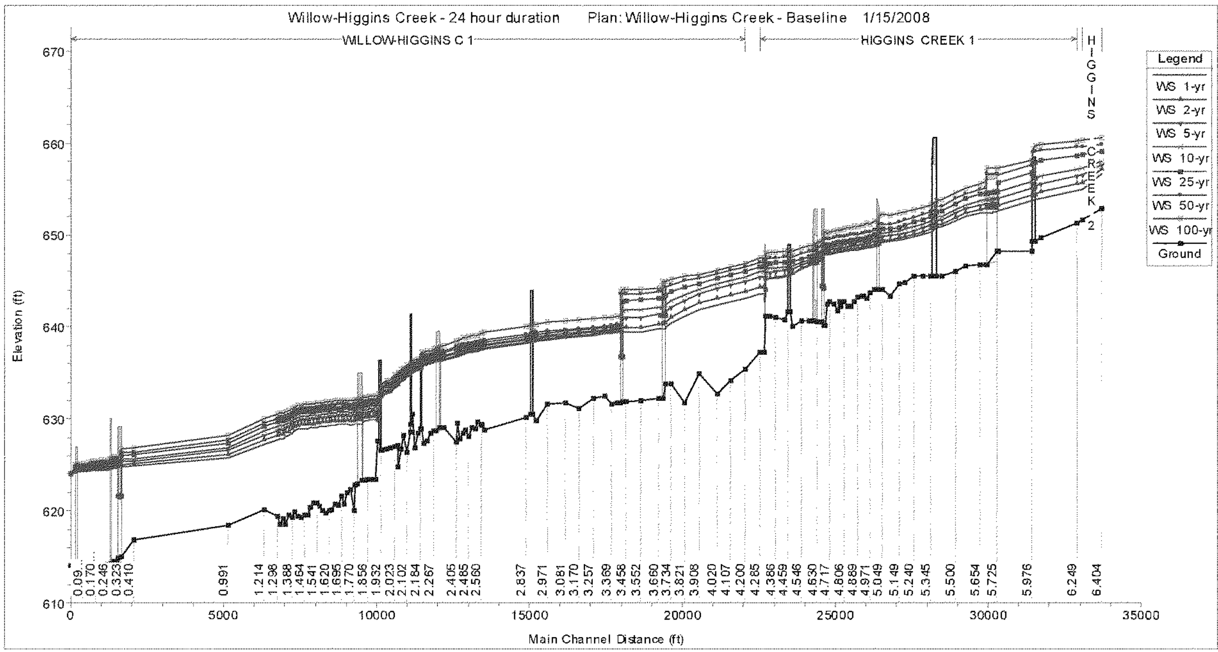


Prairie Creek
(see Plate A-36a for Farmers-Prairie Creek)
Elevations are in ft NGVD29

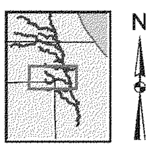


Note: River stationing in feet

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Farmers-Prairie Creek HEC-RAS Baseline Profiles (2 of 2)	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-36b

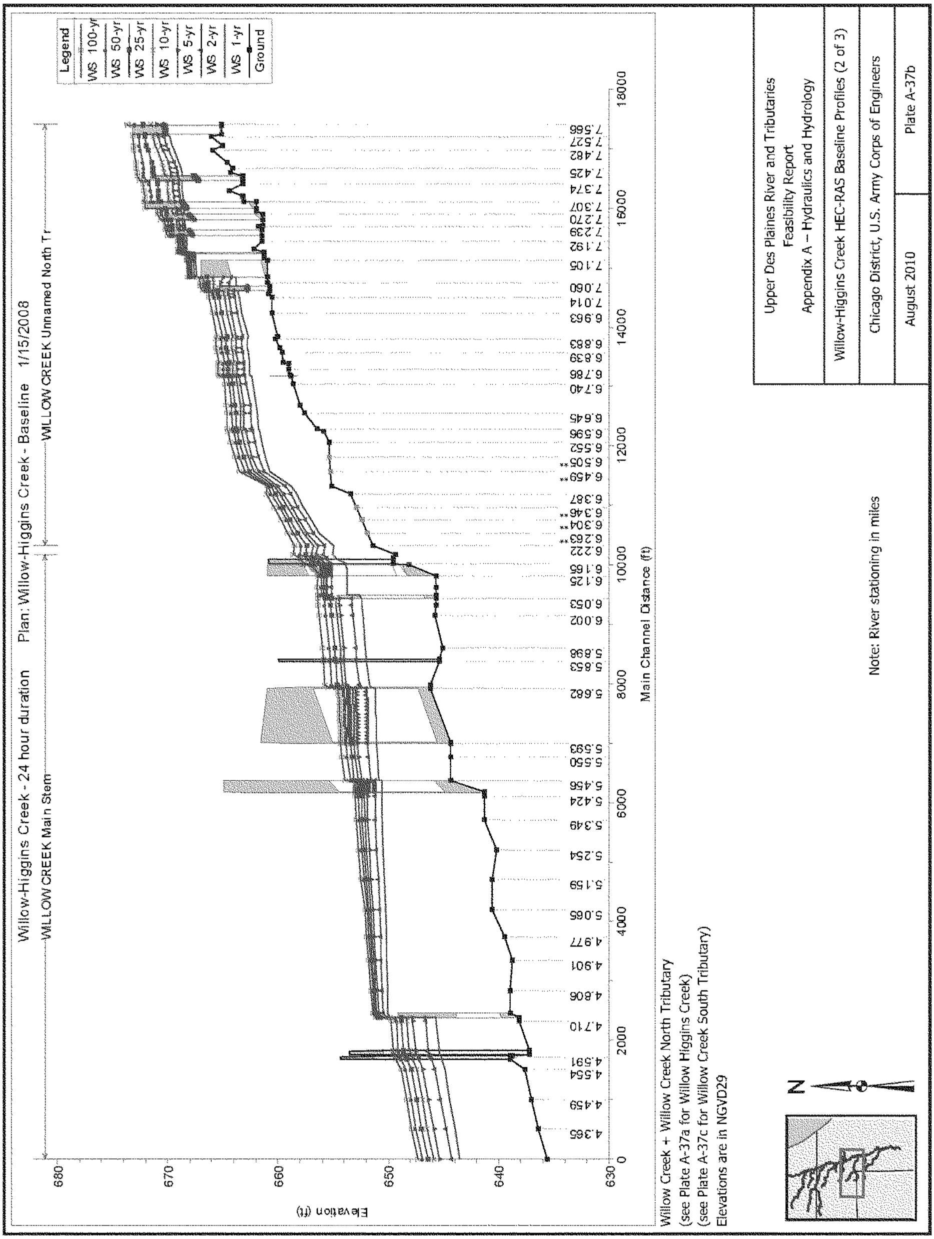


Willow-Higgins Creek + Higgins Creek
(see Plate A-37b for Willow Creek)
Elevations are in ft NGVD29



Note: River stationing in miles

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Willow-Higgins Creek HEC-RAS Baseline Profiles (1 of 3)	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-37a



Willow-Higgins Creek - 24 hour duration Plan: Willow-Higgins Creek - Baseline 1/15/2008
WILLOW CREEK Main Stem
WILLOW CREEK Unnamed North Tr
Legend
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
WS 5-yr
WS 2-yr
WS 1-yr
Ground
Elevation (ft)
Main Channel Distance (ft)
Willow Creek + Willow Creek North Tributary
(see Plate A-37a for Willow Higgins Creek)
(see Plate A-37c for Willow Creek South Tributary)
Elevations are in NGVD29
Note: River stationing in miles
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Willow-Higgins Creek HEC-RAS Baseline Profiles (2 of 3)
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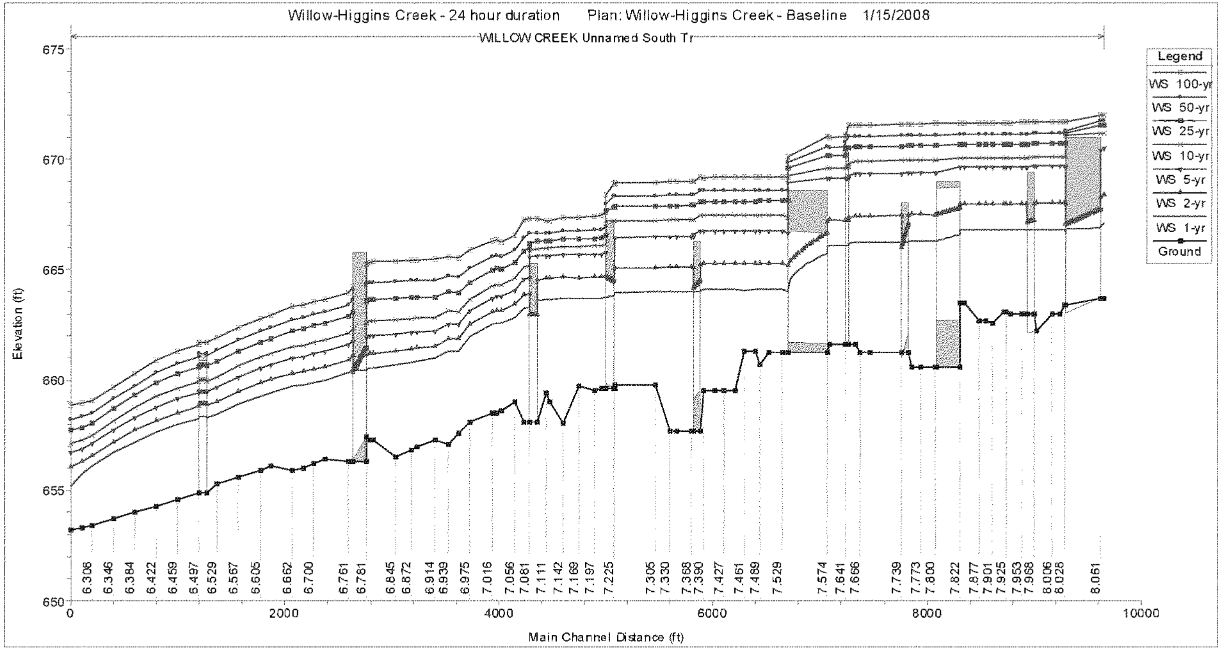
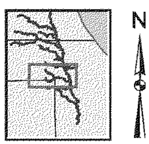
Plate A-37b

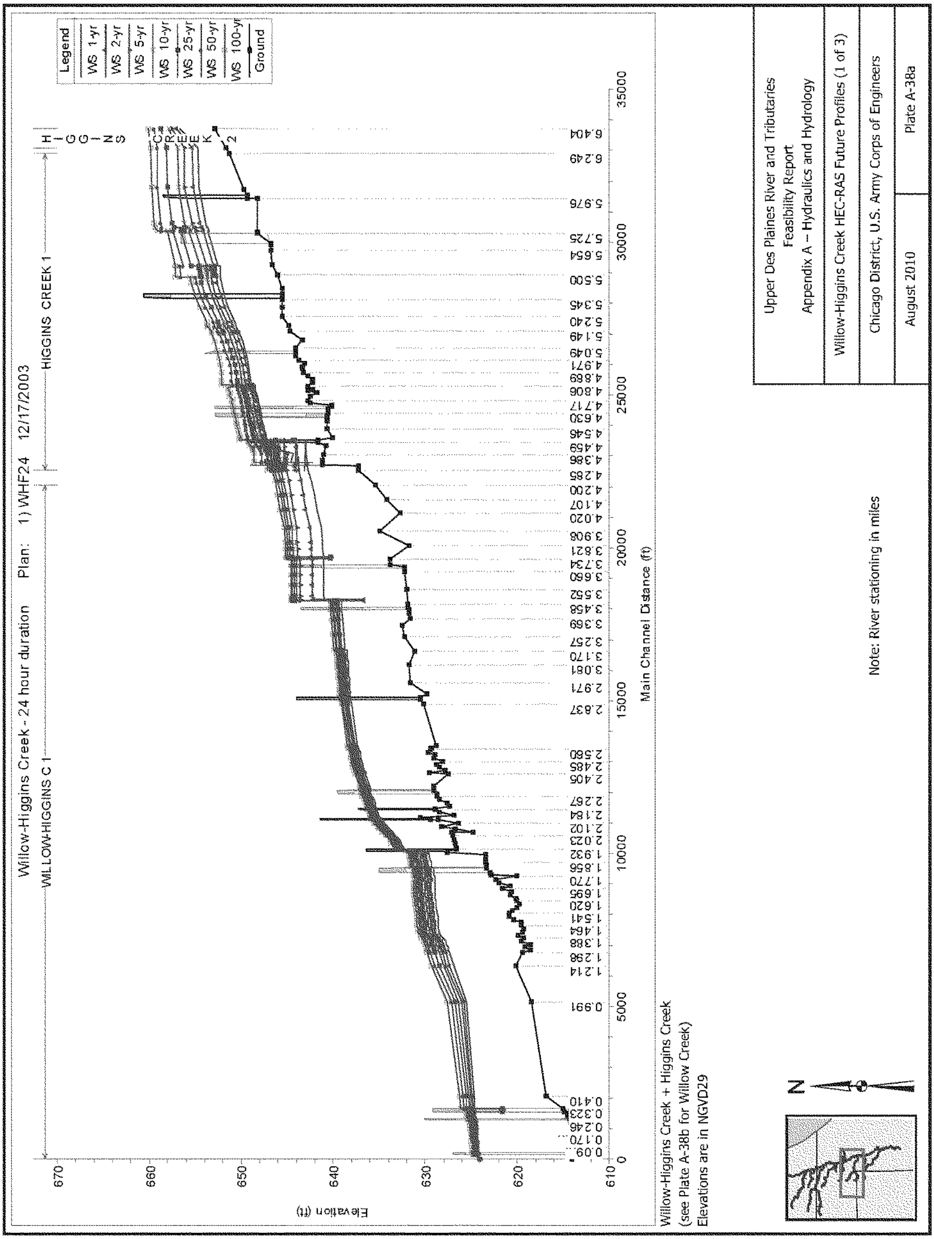


Willow Creek South Tributary
(see Plate A-37b for Willow Creek)
Elevations are in NGVD29



Note: River stationing in miles

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Willow-Higgins Creek HEC-RAS Baseline Profiles (3 of 3)	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-37c


Willow-Higgins Creek - 24 hour duration Plan: 1) WHF24 12/17/2003
WILLOW-HIGGINS C 1
HIGGINS CREEK 1
Legend
WS 1-yr
WS 2-yr
WS 5-yr
WS 10-yr
WS 25-yr
WS 50-yr
WS 100-yr
Ground
Elevation (ft)
Main Channel Distance (ft)
Willow-Higgins Creek + Higgins Creek
(see Plate A-38b for Willow Creek)
Elevations are in NGVD29
Note: River stationing in miles
Upper Des Plaines River and Tributaries
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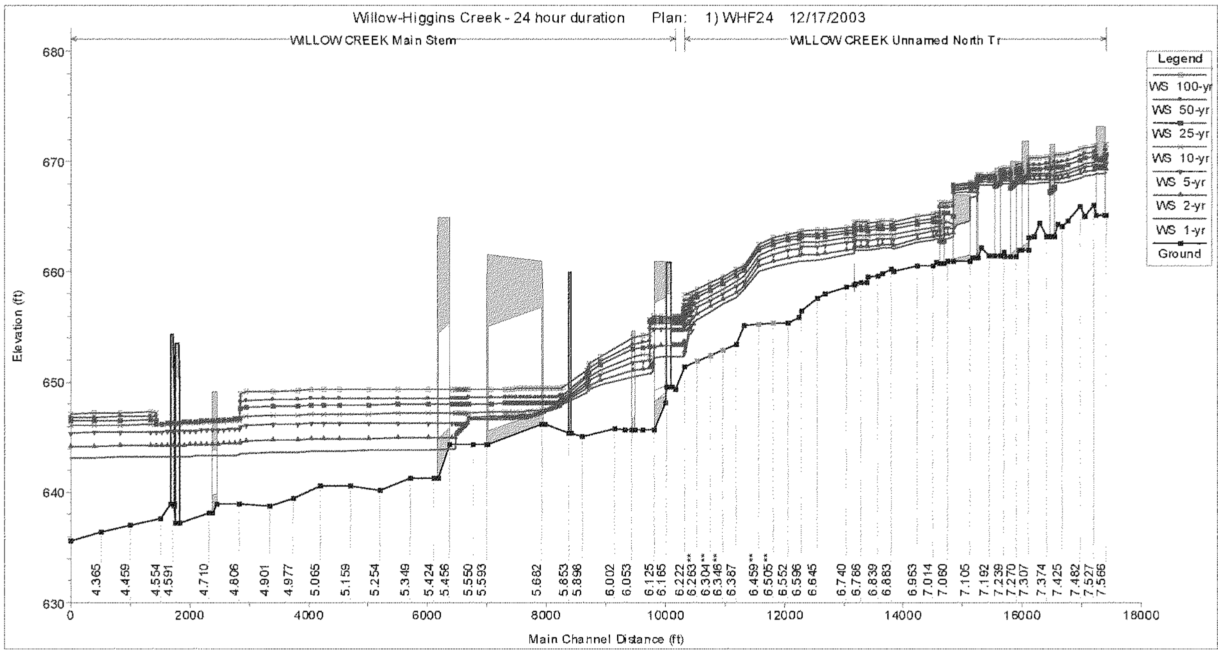
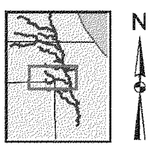
Willow-Higgins Creek HEC-RAS Future Profiles (1 of 3)
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-38a



Willow Creek + Willow Creek North Tributary
(see Plate A-38a for Willow Higgins Creek)
(see Plate A-38c for Willow Creek South Tributary)
Elevations are in NGVD29



Note: River stationing in miles

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Willow-Higgins Creek HEC-RAS Future Profiles (2 of 3)	
Chicago District, U.S. Army Corps of Engineers	
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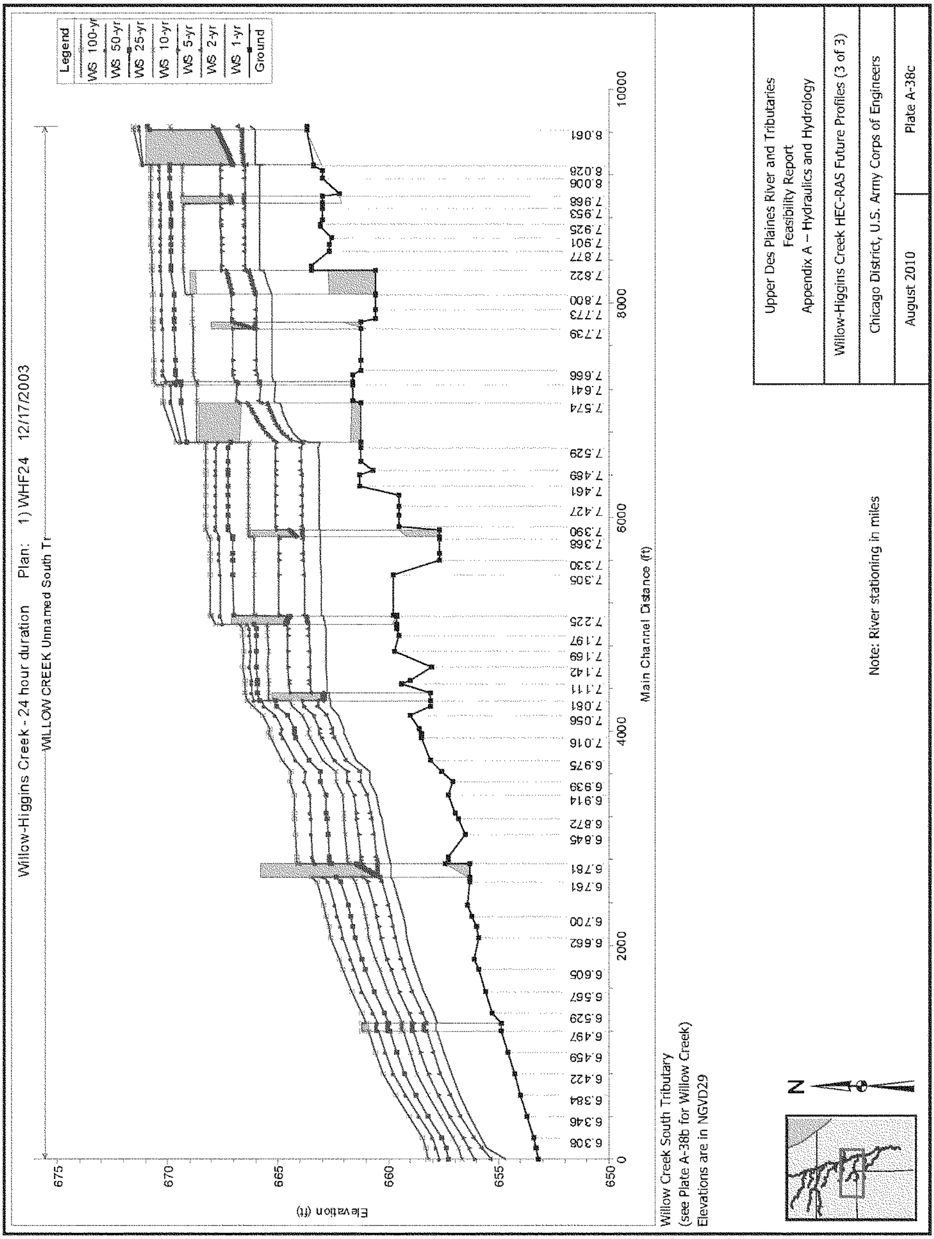

Willow-Higgins Creek - 24 hour duration Plan: 1) WHF24 12/17/2003
WILLOW CREEK Unnamed South Tr
Legend
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
WS 5-yr
WS 2-yr
WS 1-yr
Ground
Elevation (ft)
675
670
665
660
655
650
Main Channel Distance (ft)
0
2000
4000
6000
8000
10000
6.308
6.346
6.384
6.422
6.459
6.497
6.529
6.567
6.605
6.662
6.700
6.761
6.781
6.845
6.872
6.914
6.939
6.975
7.016
7.056
7.081
7.111
7.142
7.169
7.197
7.225
7.305
7.330
7.368
7.390
7.427
7.461
7.489
7.529
7.574
7.641
7.666
7.739
7.773
7.800
7.822
7.877
7.901
7.925
7.953
7.966
8.006
8.026
8.061
Willow Creek South Tributary
(see Plate A-38b for Willow Creek)
Elevations are in NGVD29
N
Note: River stationing in miles
Upper Des Plaines River and Tributaries
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Willow-Higgins Creek HEC-RAS Future Profiles (3 of 3)
Chicago District, U.S. Army Corps of Engineers
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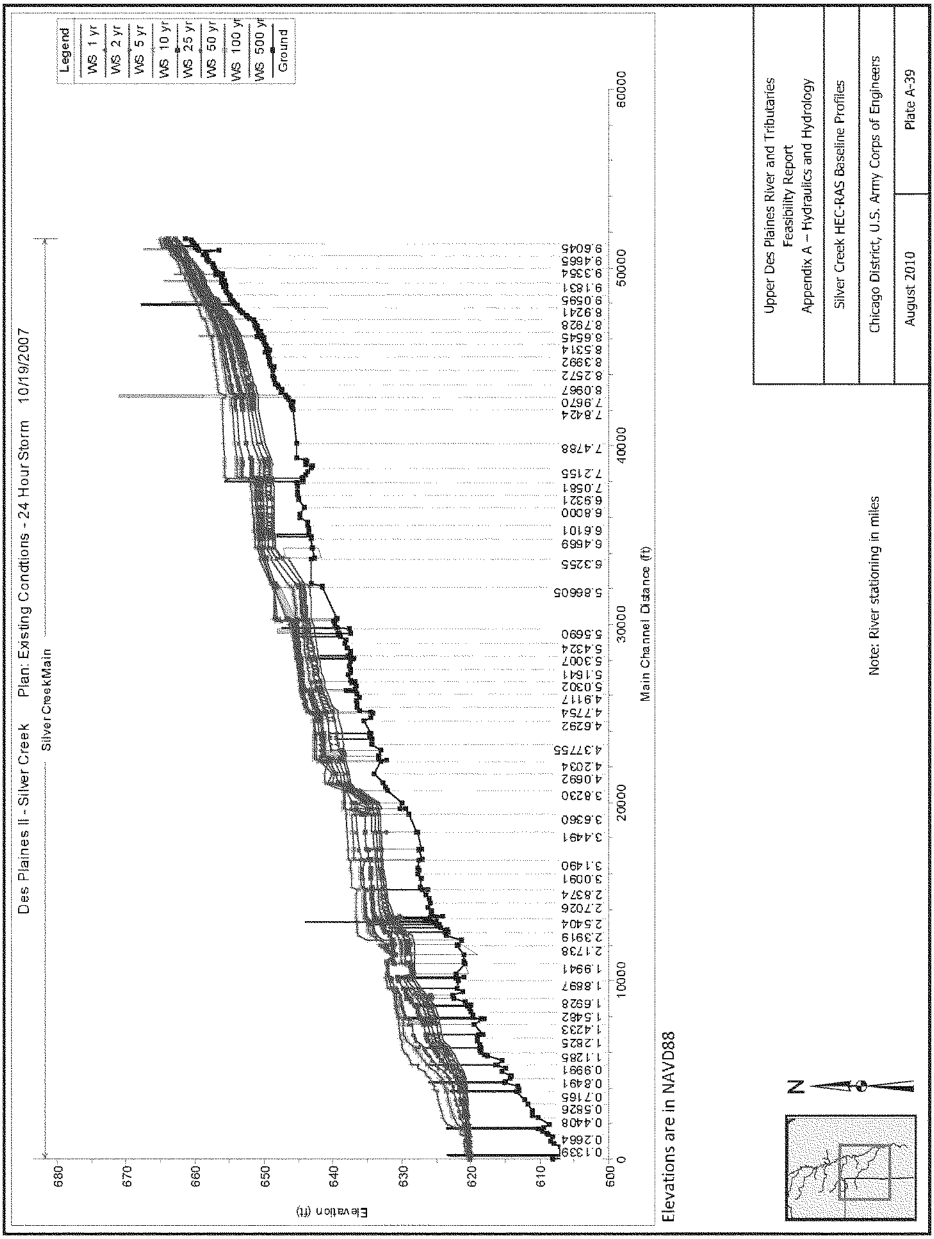
Plate A-38c


Des Plaines II - Silver Creek Plan: Existing Conditions - 24 Hour Storm 10/19/2007
Silver CreekMain
Legend
WS 1 yr
WS 2 yr
WS 5 yr
WS 10 yr
WS 25 yr
WS 50 yr
WS 100 yr
WS 500 yr
Ground
Elevation (ft)
Main Channel Distance (ft)
Elevations are in NAVD88
Note: River stationing in miles
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Silver Creek HEC-RAS Baseline Profiles
Chicago District, U.S. Army Corps of Engineers
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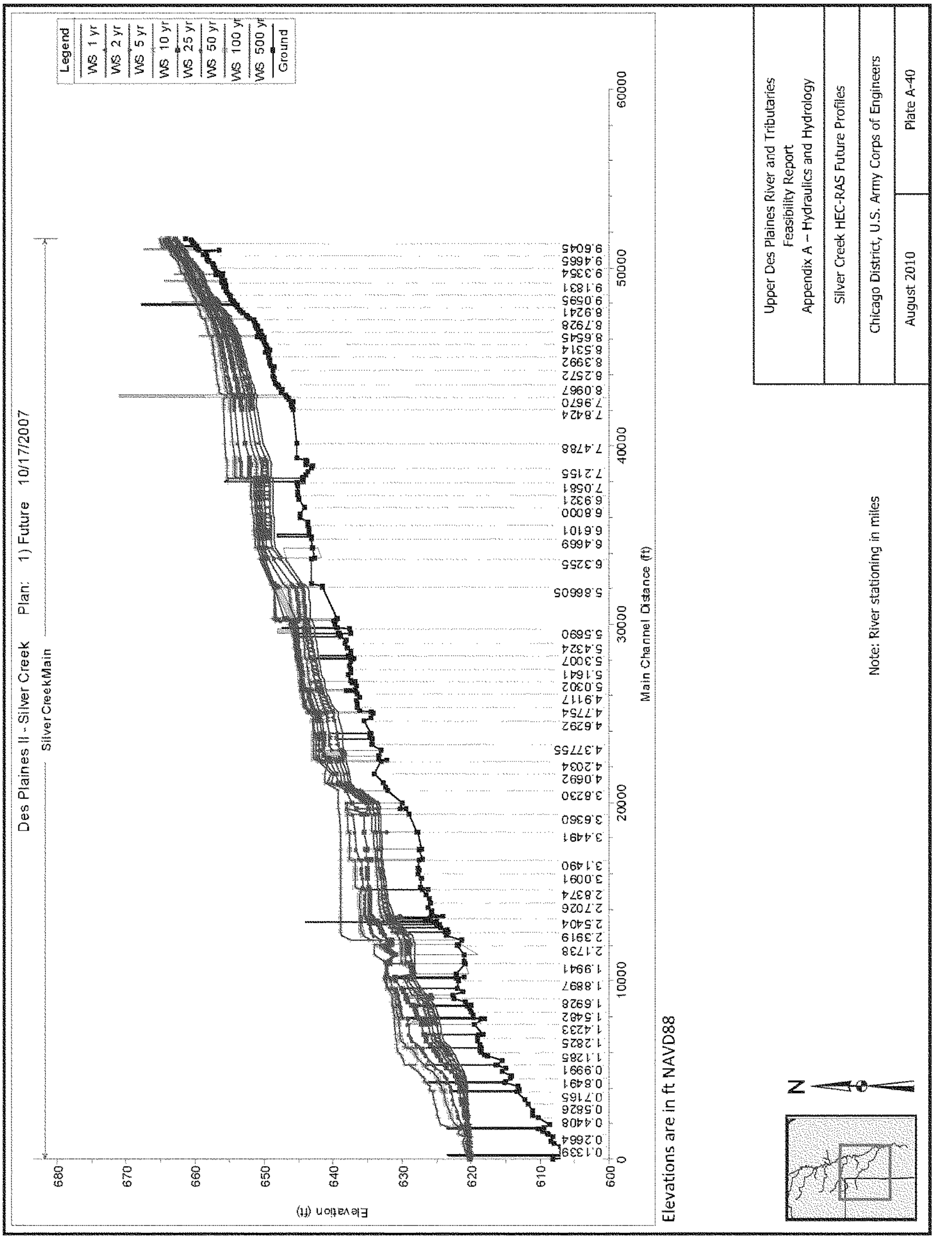
Plate A-39


Des Plaines II - Silver Creek Plan: 1) Future 10/17/2007
SilverCreekMain
Legend
WS 1 yr
WS 2 yr
WS 5 yr
WS 10 yr
WS 25 yr
WS 50 yr
WS 100 yr
WS 500 yr
Ground
Elevation (ft)
Main Channel Distance (ft)
Elevations are in ft NAVD88
Note: River stationing in miles
N
Upper Des Plaines River and Tributaries
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Silver Creek HEC-RAS Future Profiles
Chicago District, U.S. Army Corps of Engineers
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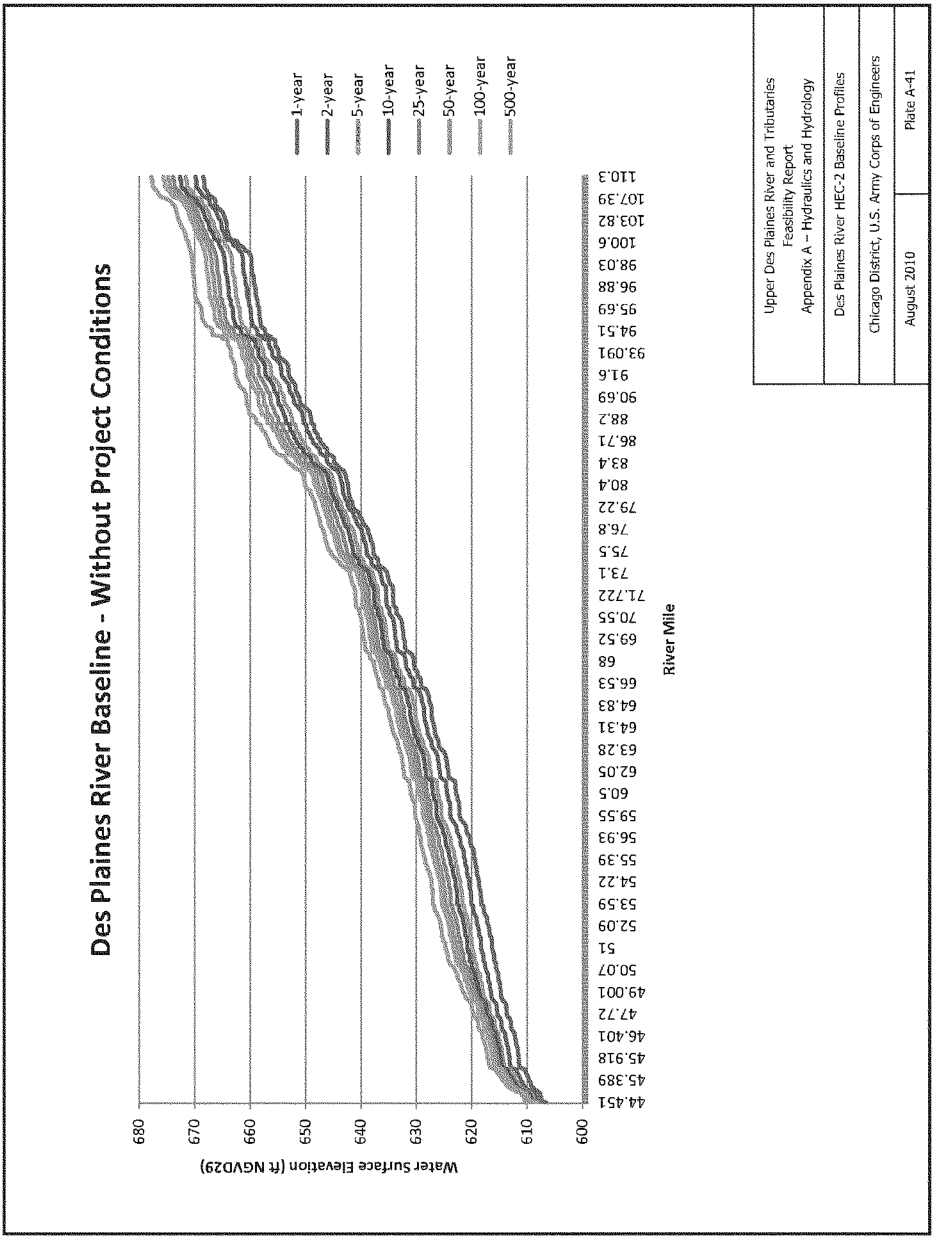
Plate A-40


Des Plaines River Baseline - Without Project Conditions
Water Surface Elevation (ft NGVD29)
680
670
660
650
640
630
620
610
600
River Mile
44.451
45.389
45.918
46.401
47.72
49.001
50.07
51
52.09
53.59
54.22
55.39
56.93
59.55
60.5
62.05
63.28
64.31
64.83
66.53
68
69.52
70.55
71.722
73.1
75.5
76.8
79.22
80.4
83.4
86.71
88.2
90.69
91.6
93.091
94.51
95.69
96.88
98.03
100.6
103.82
107.39
110.3
1-year
2-year
5-year
10-year
25-year
50-year
100-year
500-year
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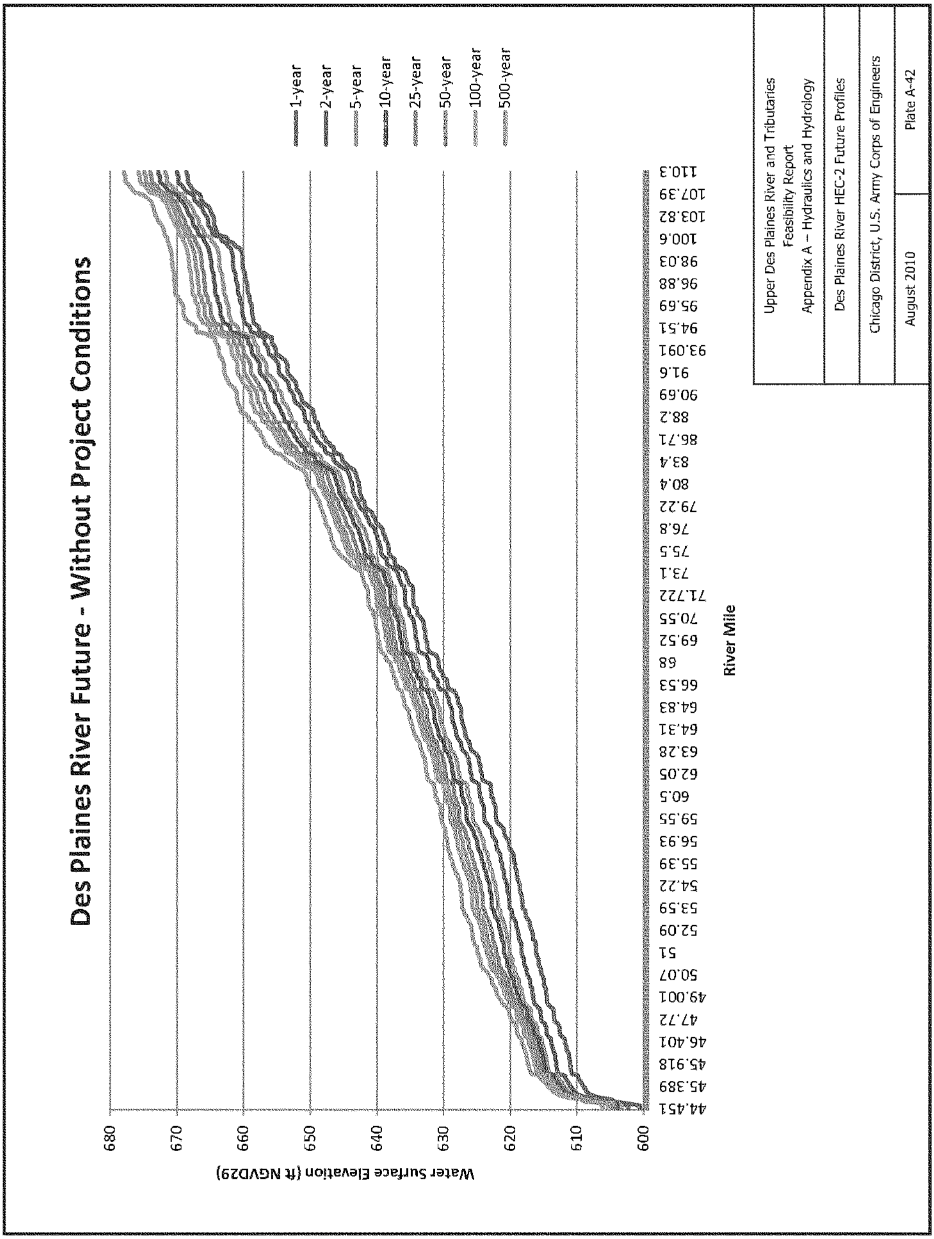
Des Plaines River HEC-2 Baseline Profiles
Chicago District, U.S. Army Corps of Engineers
August 2010
Plate A-41


Des Plaines River Future - Without Project Conditions
Water Surface Elevation (ft NGVD29)
680
670
660
650
640
630
620
610
600
River Mile
44.451
45.389
45.918
46.401
47.72
49.001
50.07
51
52.09
53.59
54.22
55.39
56.93
59.55
60.5
62.05
63.28
64.31
64.83
66.53
68
69.52
70.55
71.722
73.1
75.5
76.8
79.22
80.4
83.4
86.71
88.2
90.69
91.6
93.091
94.51
95.69
96.88
98.03
100.6
103.82
107.39
110.3
1-year
2-year
5-year
10-year
25-year
50-year
100-year
500-year
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Des Plaines River HEC-2 Future Profiles
Chicago District, U.S. Army Corps of Engineers
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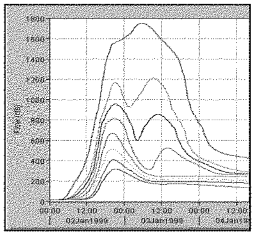
Plate A-42

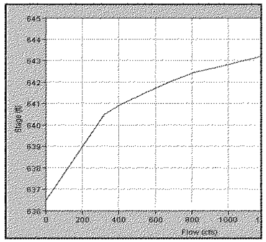
Procedure for Flood Depth and Duration Calculations

Hydrograph



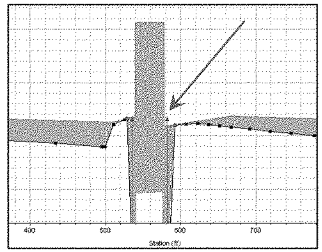
+

Rating Curve



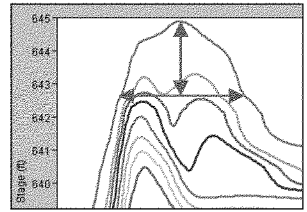
+

Lowest Road Elevation



=

Depth & Duration



Discharge over time

Source: HEC-1

8 synthetic events:
1-, 2-, 5-, 10-, 25-,
50-, 100-, 500-yr

2 hydrologic conditions:
Baseline (2010), Future (2020)

Water surface elevation for different discharges

Source: HEC-RAS
***OR** HEC-2, FIS*

Some curves extrapolated for high flows

Lowest road elevation where water will first inundate

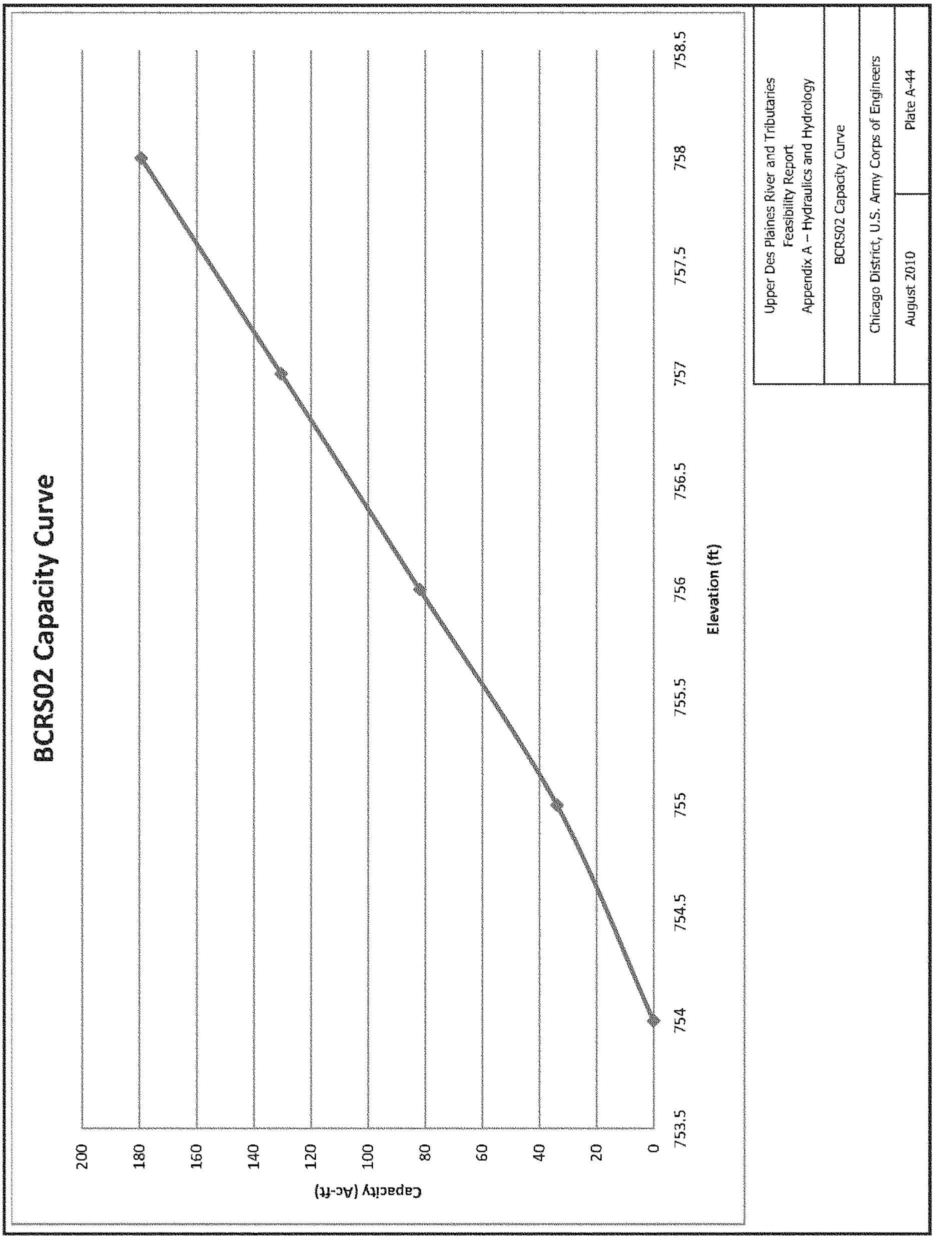
Source: HEC-RAS
***OR** HEC-2, FIS, GIS terrain*

Water surface elevation over time

(Calculated)

Duration of flooding and maximum depth computed for each frequency

Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Transportation Design Calculations	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-43


BCRS02 Capacity Curve
Capacity (Ac-ft)
0
20
40
60
80
100
120
140
160
180
200
Elevation (ft)
753.5
754
754.5
755
755.5
756
756.5
757
757.5
758
758.5
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BCRS02 Capacity Curve
Chicago District, U.S. Army Corps of Engineers
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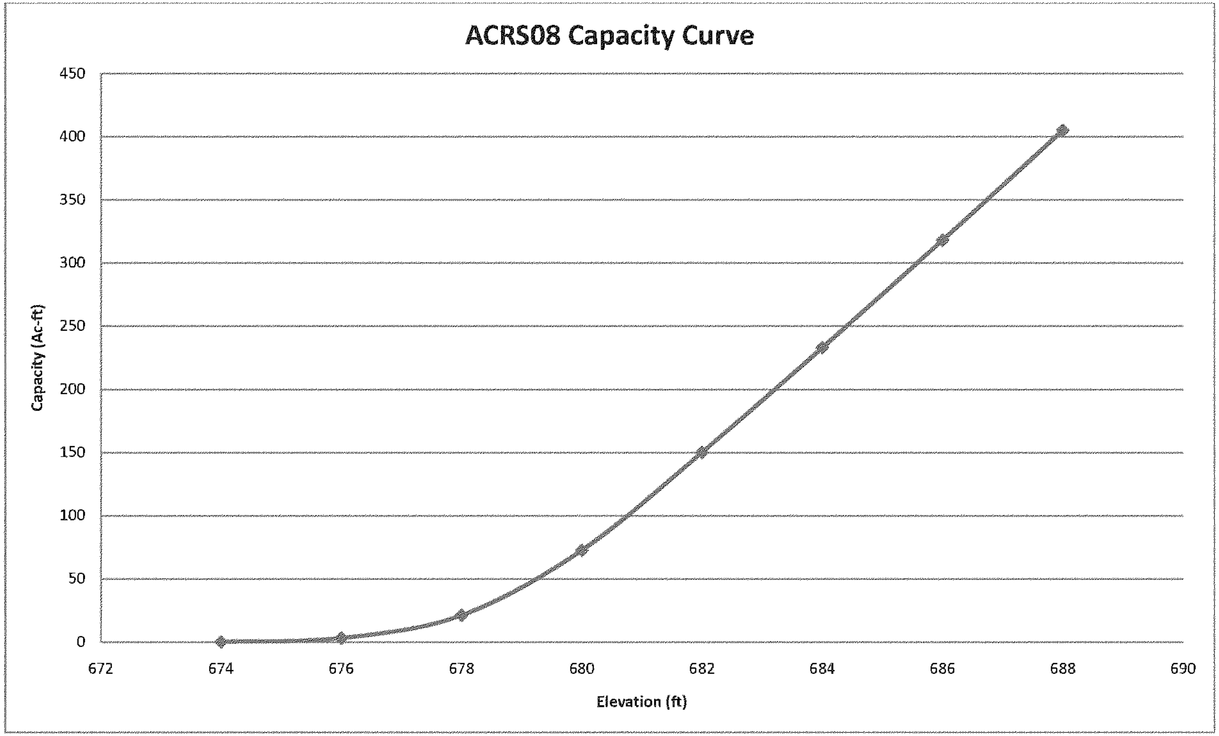
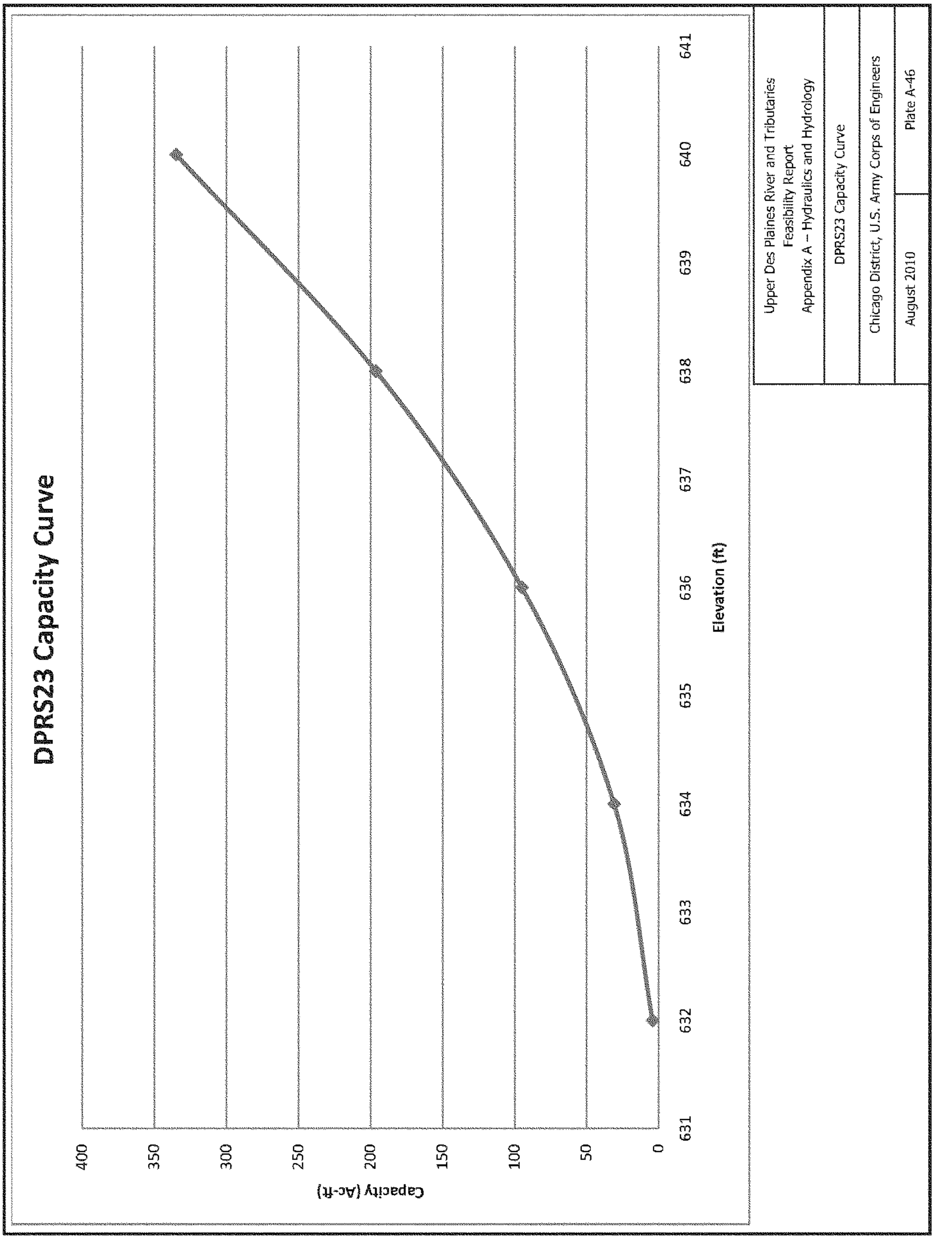
Plate A-44



Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
ACRS08 Capacity Curve	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-45


DPRS23 Capacity Curve
Capacity (Ac-ft)
0
50
100
150
200
250
300
350
400
631
632
633
634
635
636
637
638
639
640
641
Elevation (ft)
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DPRS23 Capacity Curve
Chicago District, U.S. Army Corps of Engineers
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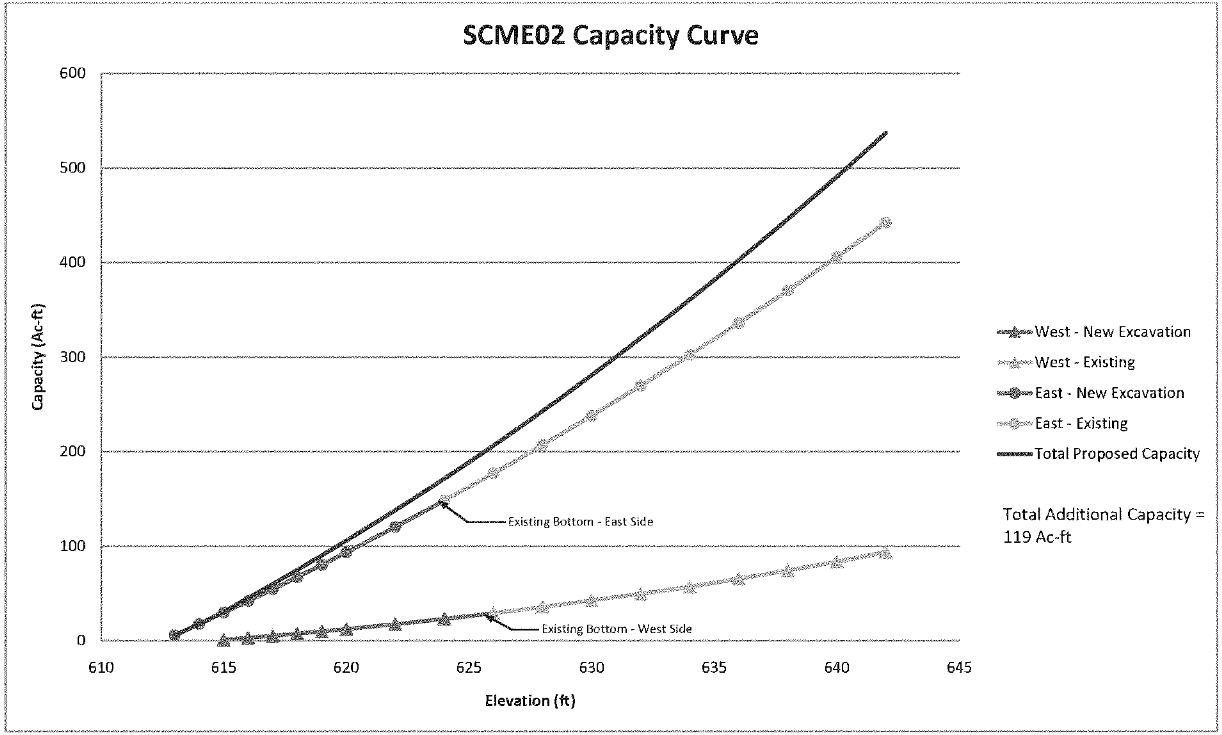
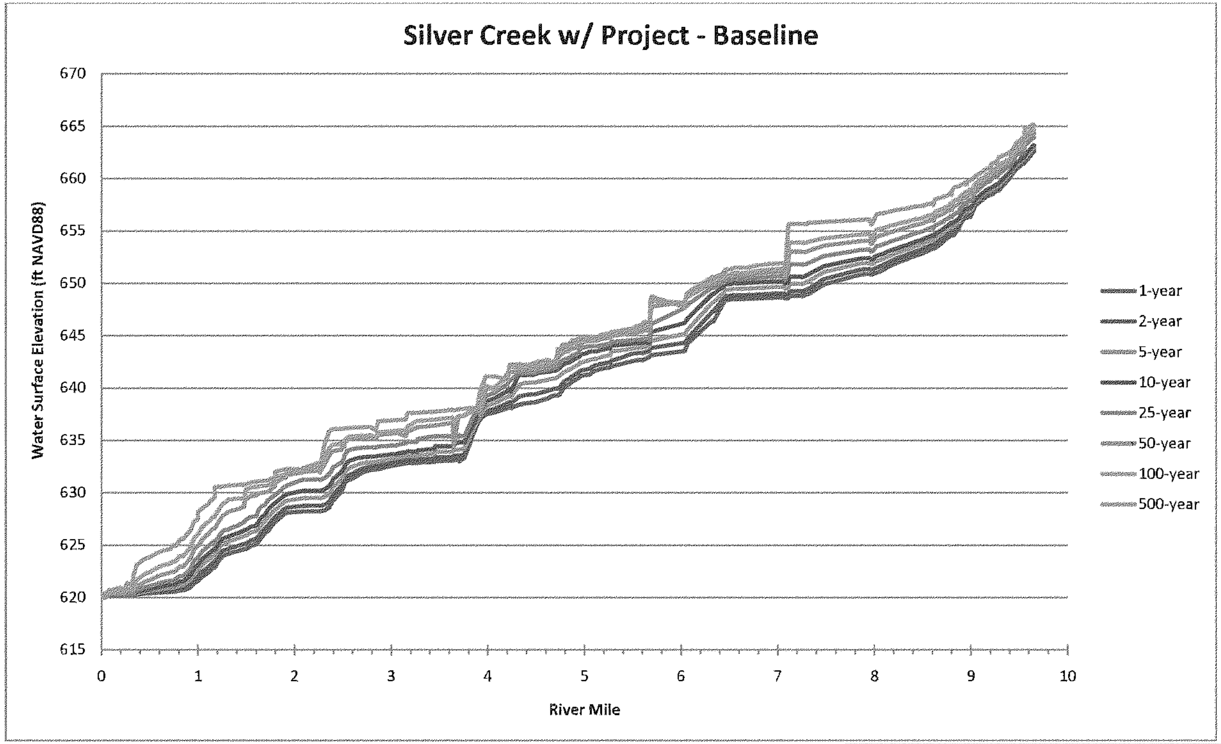
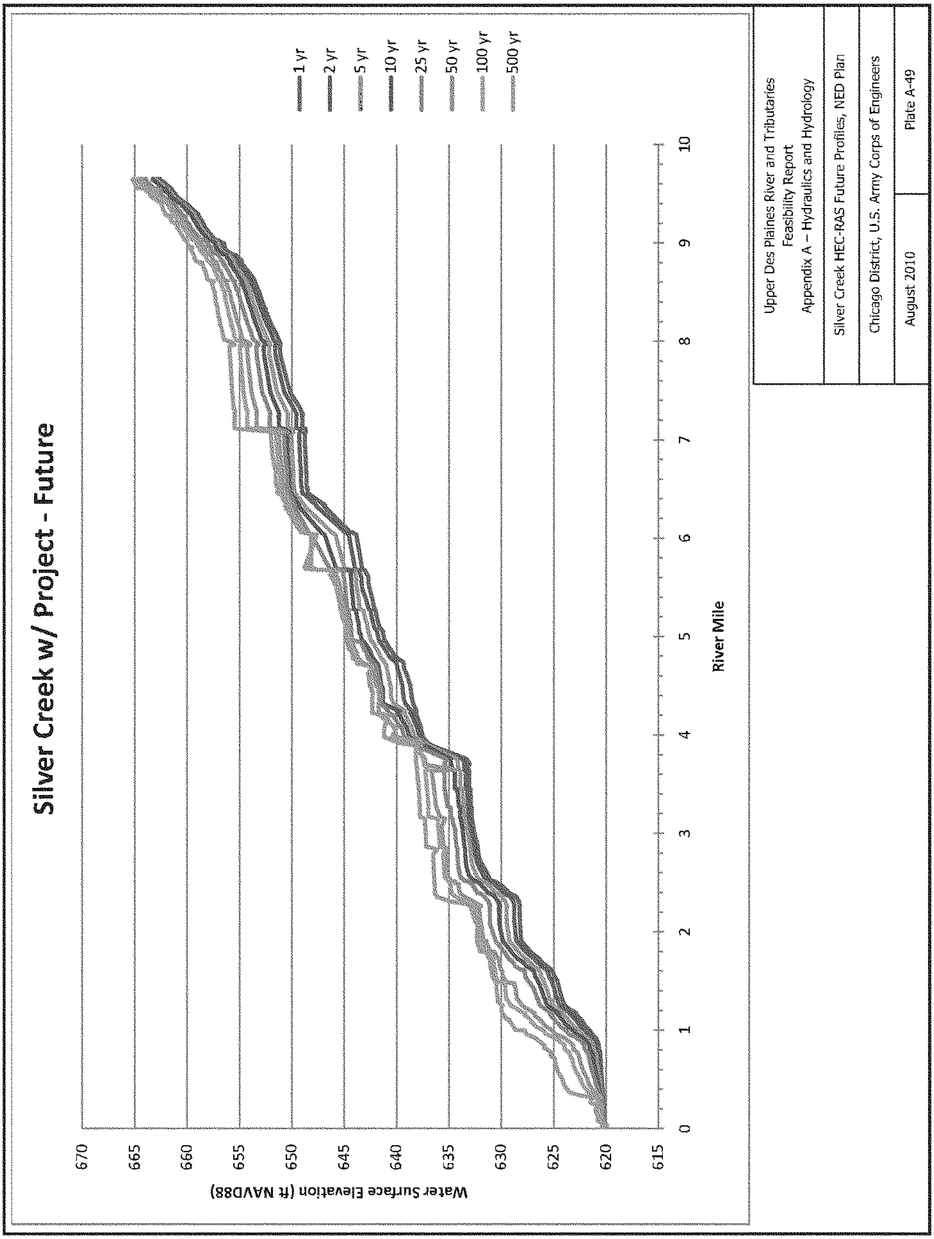
Plate A-46



Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
SCME02 Capacity Curve	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-47



Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Silver Creek HEC-RAS Baseline Profiles, NED Plan	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-48


Silver Creek w/ Project - Future
Water Surface Elevation (ft NAVD88)
670
665
660
655
650
645
640
635
630
625
620
615
0
1
2
3
4
5
6
7
8
9
10
River Mile
1 yr
2 yr
5 yr
10 yr
25 yr
50 yr
100 yr
500 yr
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Silver Creek HEC-RAS Future Profiles, NED Plan
Chicago District, U.S. Army Corps of Engineers
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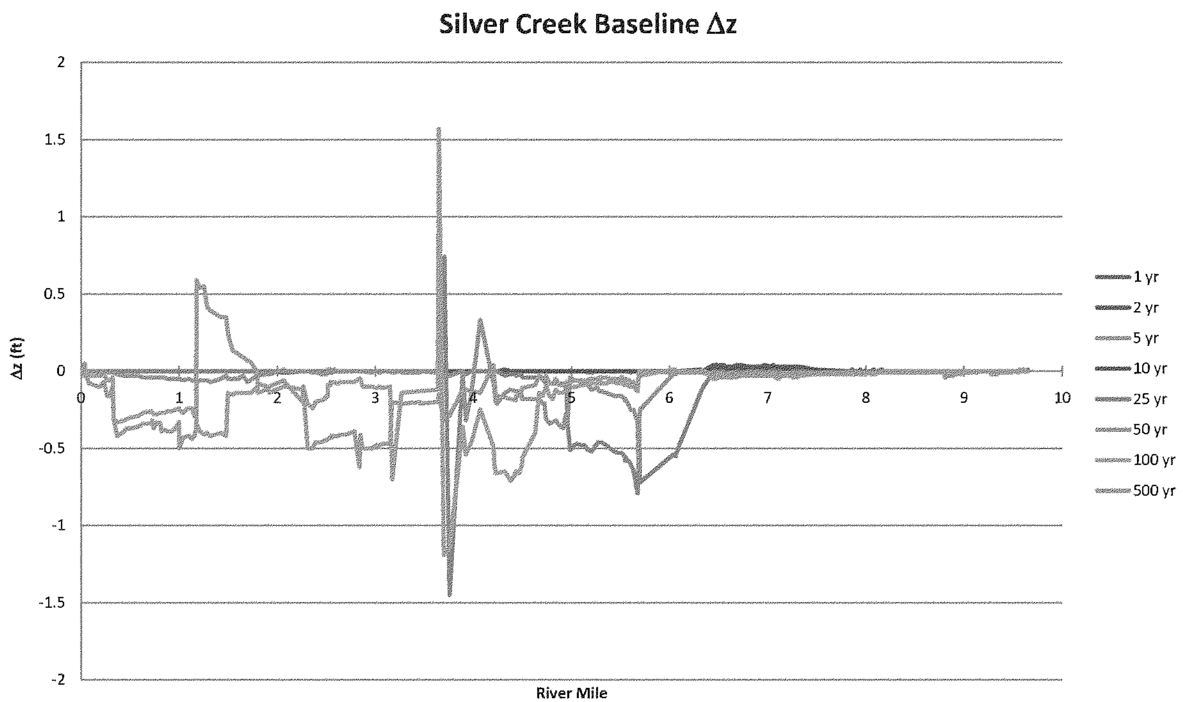
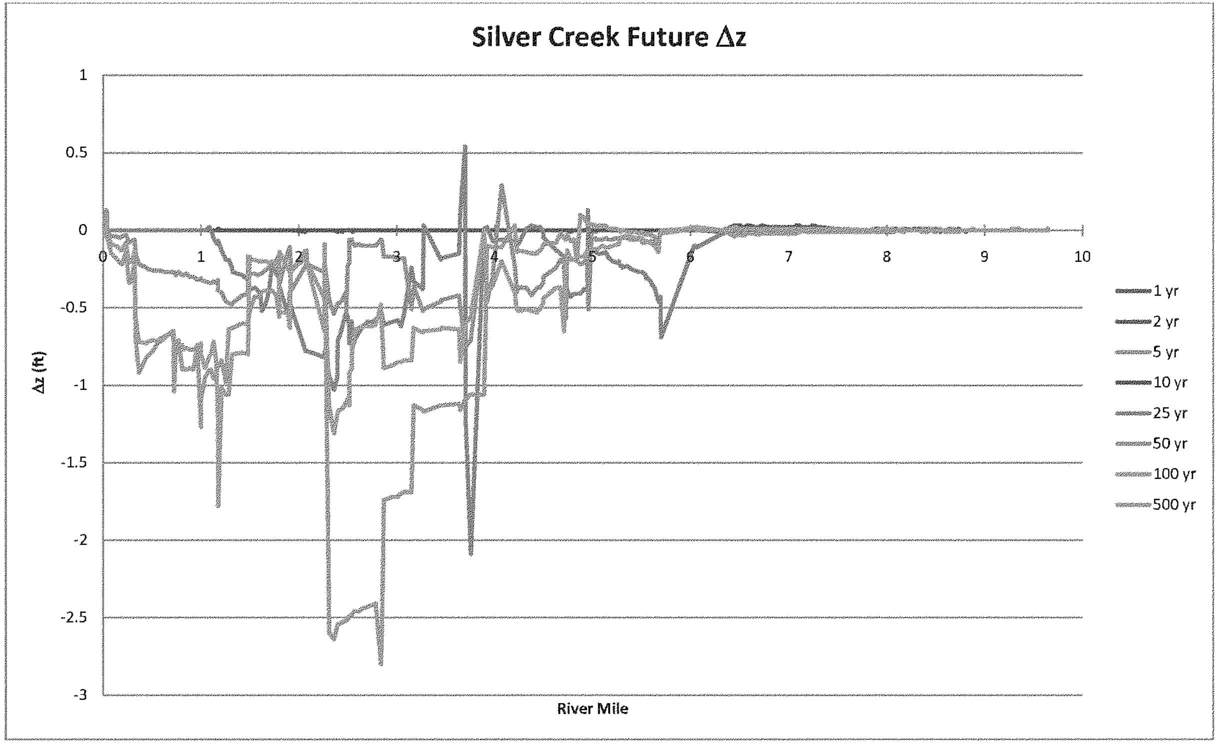
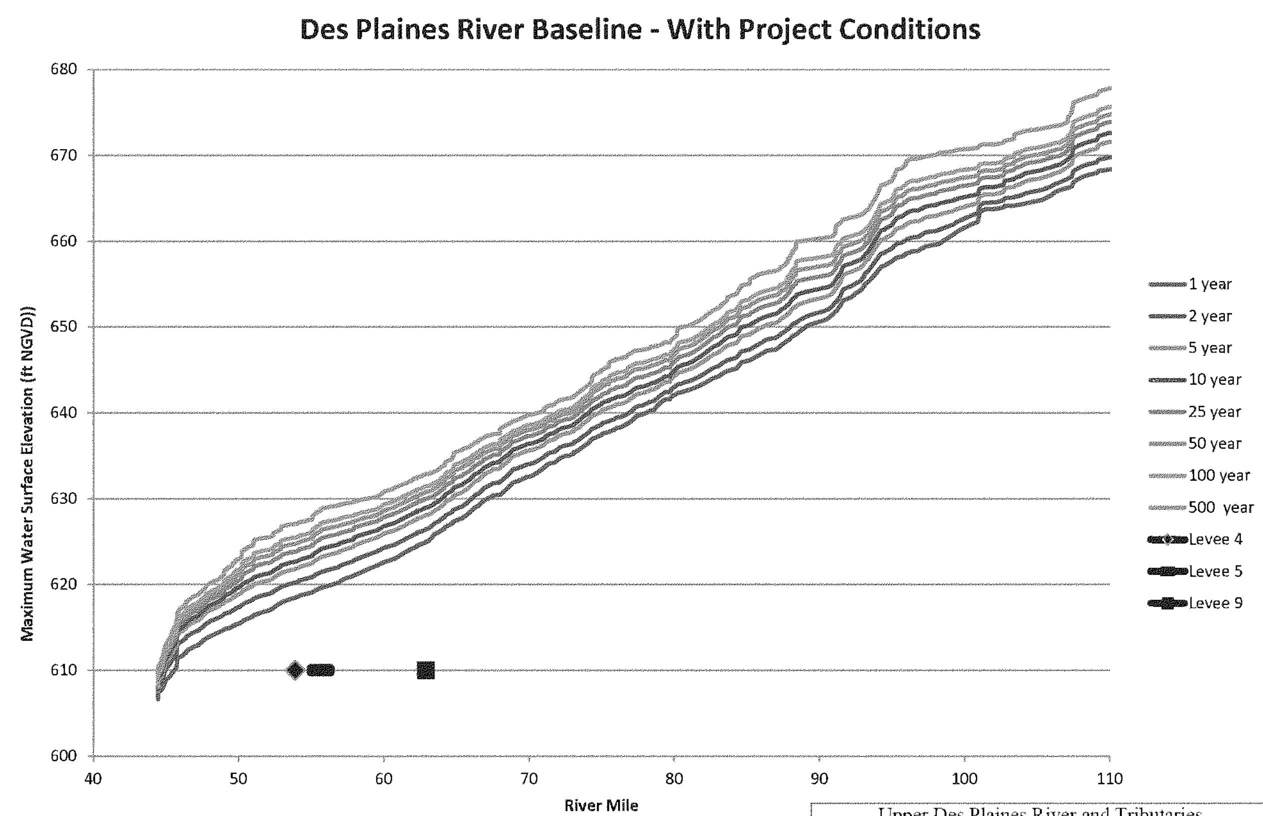
Plate A-49



Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Silver Creek Δz Baseline Profiles, NED Plan	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-50

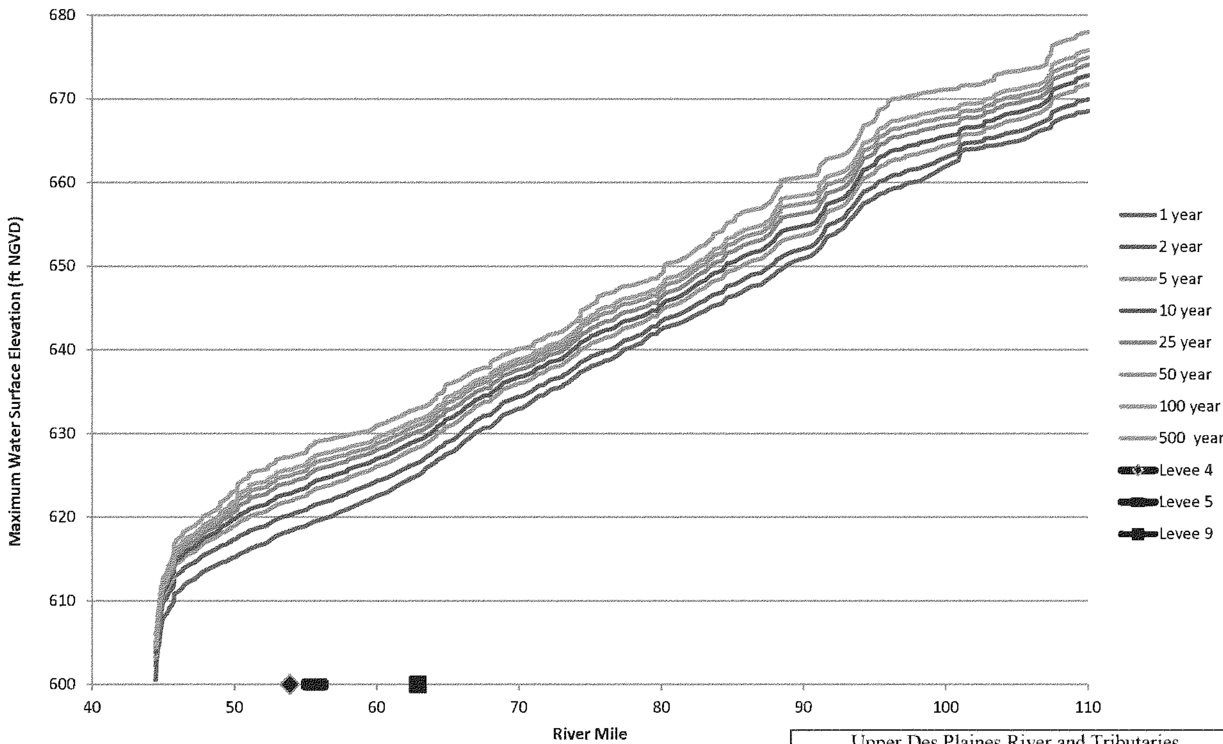


Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Silver Creek Δz Future Profiles, NED Plan	
Chicago District, U.S. Army Corps of Engineers	
August 2010	Plate A-51



Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Des Plaines River HEC-2 Baseline Profiles, NED Plan	
Chicago District, U. S. Army Corps of Engineers	
August 10	Plate A-52

Des Plaines River Future - With Project Conditions



Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Des Plaines River HEC-2 Future Profiles, NED Plan	
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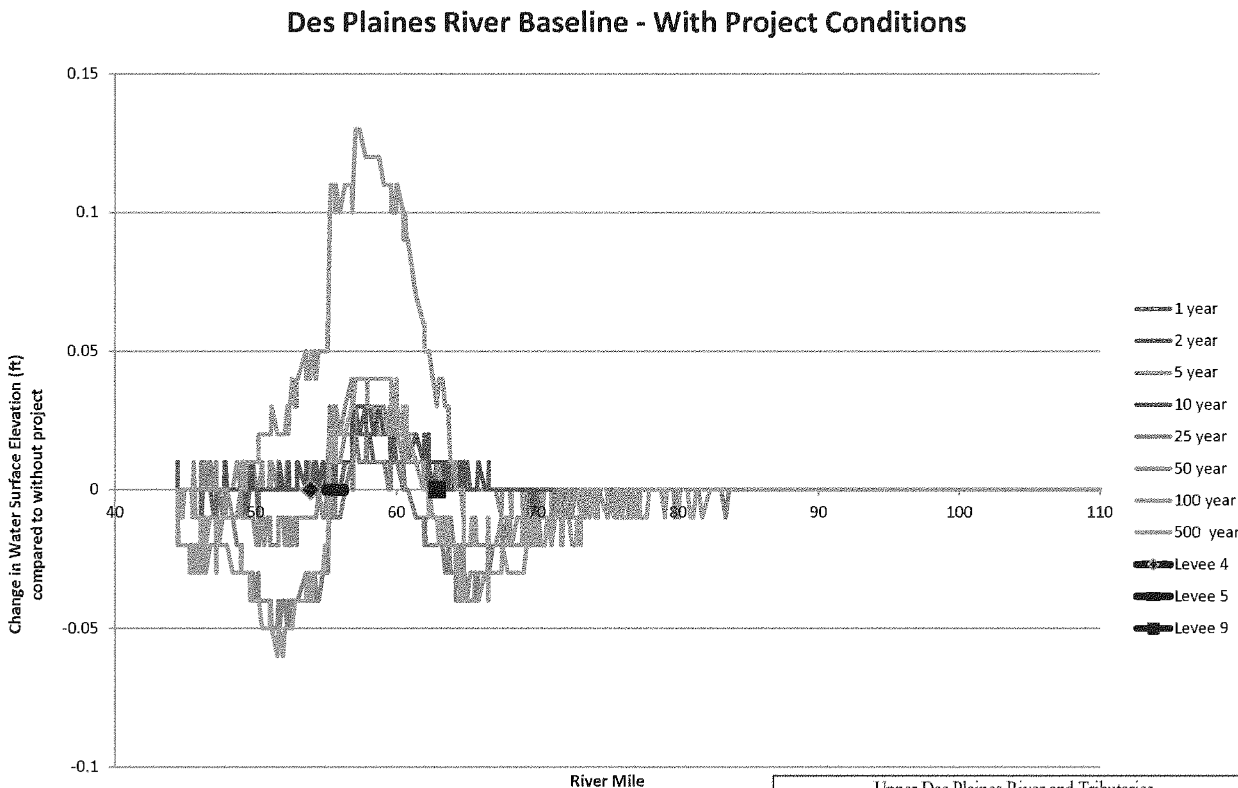
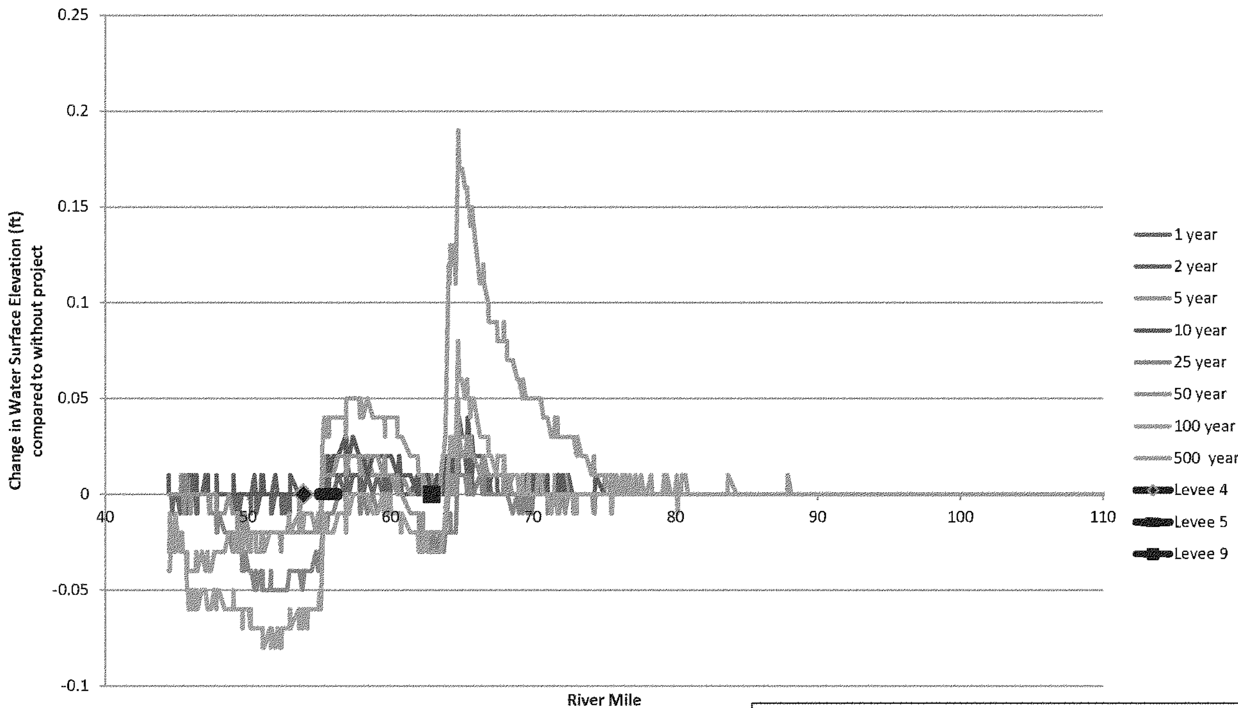
August 10	Plate A-53



Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Des Plaines River HEC-2 Difference Baseline Profiles, NED Plan	
Chicago District, U. S. Army Corps of Engineers	
August 10	Plate A-54

Des Plaines River Future - With Project Conditions



Upper Des Plaines River and Tributaries Feasibility Report Appendix A – Hydraulics and Hydrology	
Des Plaines River HEC-2 Difference Future Profiles, NED Plan	
Chicago District, U. S. Army Corps of Engineers	
August 10	Plate A-55

ATTACHMENT A-1

Issue White Paper: Upper Des Plaines River Mainstem H&H Modeling

UPPER DES PLAINES RIVER FEASIBILITY PHASE II STUDY

ISSUE WHITE PAPER
UPPER DES PLAINES RIVER MAINSTEM H&H MODELING

January 2008

ISSUE:

What is the applicability of using the Phase I mainstem H&H modeling as the basis for baseline, future and with-project conditions mainstem damages and benefits for the Phase II Study?

BACKGROUND:

The Upper Des Plaines River watershed in northeastern Illinois was extensively studied by the Chicago District after the 1986 and 1987 floods that together caused more than $100 million in damages to more than 10,000 residential, commercial and public structures along with major damages attributed to traffic impacts. The Corps completed the Upper Des Plaines River Feasibility Phase I Study, which was approved in November 1999. The Phase I study focused primarily on flooding problems along the mainstem of the Upper Des Plaines River and authorized the implementation of six projects to reduce main stem flooding. Study recommendations were authorized in the Water Resources Development Act of 1999 (P.L. 106-53). A Limited Reevaluation Report (LRR) was recently completed and approved in June 2007. The purpose of the LRR was to provide current estimates of project benefits, construction costs, value of real estate requirements, and economic justification for the authorized project as required for execution of a Project Cooperation Agreement (PCA). The analysis contained in this issue white paper was completed during the development of the LRR.

The Upper Des Plaines River Feasibility Phase II Study is a continuation and extension of the Phase I Study. The Phase II study has three primary objectives: further reduction of main stem flooding; reduction of tributary flooding; and environmental restoration of degraded ecosystems within the basin. The study will consider sites located within tributary watersheds and along the main stem for both Flood Damage Reduction (FDR) and Ecosystem Restoration (ER) potential. The affects of FDR sites within tributary watersheds on main stem flooding will also be evaluated.

As part of the Phase II Study, the hydrology and hydraulics of several tributaries have been updated and new H&H models developed. The new tributary models incorporate finer sub-basin delineation, updated landuse conditions, and model calibration for each tributary. The Phase II study team would prefer to use the mainstem H&H models that were developed for the Phase I Study if possible. Watershed conditions have changed since the development of the Phase I mainstem models including additional development, increased impervious areas, construction of hydraulic structures, and bridge improvements. Updating the mainstem H&H models would be a significant effort requiring additional study funds and time.

The purpose of this issue white paper is to assess the applicability of the Phase I mainstem H&H modeling as the basis for baseline and with-project conditions damages and benefits for the Phase II Study. This evaluation involves a re-examination of the flow-frequency relationships at 4 long-term mainstem gages for current conditions versus the flow-frequency relationships developed for the 1999 Phase I Feasibility Report. The flow-frequency relationships at the mainstem gages were the basis for the development and calibration of the hydrologic modeling for the mainstem Upper Des Plaines River. The hydrologic modeling output becomes one of the primary inputs to the hydraulic modeling. The water surface profiles which are output from the hydraulic modeling for baseline, future and with-project conditions represent one of the primary inputs for project economic analyses. The Phase I H&H modeling should only be used for the Phase II Study if the models can accurately represent current watershed conditions.

MAINSTEM H&H MODEL UPDATES:

Since the completion of the Phase I Study in 1999, the numerical modeling has not remained static and has been updated as needed during Pre-Construction, Engineering and Design (PED) phase. The current version of the numerical models (HEC-1 and HEC-2) is an updated version of the feasibility study modeling. In a joint effort between the Chicago District and IDNR-OWR, the baseline hydrologic and hydraulic models were revised in the area of the Levee 37 project from those that were used in the Phase I Study to better represent cross section geometry, better agreement of cross section placement with existing topographic mapping and the addition of modifications associated with the reconstruction of Euclid Avenue bridge. This modeling was completed in October 2001 and was accepted by both agencies as the current modeling to be carried forward for analysis of Levee 37 and other Phase I projects.

WATERSHED DESCRIPTION:

The Des Plaines River flows generally southerly from its headwaters in Racine County, Wisconsin to its confluence with Salt Creek near Riverside, Illinois, then southwesterly to its confluence with the Chicago Sanitary and Ship Canal near Lockport, Illinois. The study area includes the mainstem of the Des Plaines River and all tributary streams above the confluence with Salt Creek. The study area encompasses a portion of four counties including Kenosha and Racine counties in Wisconsin and Lake and Cook counties in Illinois. The upper Des Plaines River watershed is approximately 475 square miles with 135 square miles in Wisconsin and 340 square miles in Illinois. The watershed is aligned primarily along a north-south axis with a length of 82 miles and average width of 9 miles. Elevations in the upper Des Plaines River watershed upstream of Salt Creek vary from nearly 900 to 600 feet NGVD. From the junction with Salt Creek upstream to the junction with Root River, the Des Plaines River rises 76 feet over 69 miles for an average gradient of 1.1 ft/mi.

Most of the southern areas of the Upper Des Plaines River watershed within Cook County are fully developed. The open areas currently remaining in the southern portion are primarily golf courses, forest preserves, parks, and cemeteries. The northern portion of the watershed continues to be developed primarily as residential area with commercial development to support the residential area. In general, urbanization of the watershed is occurring from south to north. Flood and flow control modifications have occurred on the Upper Des Plaines River and its tributaries primarily in the southern half of its length.

The Upper Des Plaines River Feasibility Phase I Study was completed under a joint effort between the Chicago District, the Illinois Department of Natural Resources, Office of Water Resources (IDNR-OWR) and several local water resources agencies in both Cook and Lake Counties in Illinois. Detailed modeling was completed as part of the study, including greater sub-basin detail; revised loss rates and hydrograph parameters; and calibration of the hydrologic and hydraulic modeling against revised flow-frequency relationships at 4 mainstem gages, and flood events which were of significant magnitude. The HEC-1 model for the Upper Des Plaines River watershed has 271 sub-basins which include the mainstem Des Plaines River and 15 major tributaries in Cook, Lake and Kenosha Counties. The HEC-2 model contained detailed cross section modeling extending approximately 93 river miles from the Illinois-Wisconsin Stateline to the confluence with Salt Creek. The Hydrology and Hydraulics Appendix A of the Phase I Feasibility Study (Chicago District 1999) contains a detailed description of the baseline model development, calibration and evaluation of with-project conditions.

TECHNICAL ANALYSIS APPROACH:

The intent of this analysis is to evaluate the applicability of the Phase I mainstem H&H modeling as the basis for baseline and with-project conditions damages and benefits for the Phase II Study. This evaluation involves a re-examination of the flow-frequency relationships at 4 long term mainstem gages for current watershed conditions versus the flow-frequency relationships developed for the 1999 Phase I Feasibility Report.

Since the major change in the Upper Des Plaines River watershed has been continued development in the northern portions of the watershed (Lake County, Illinois and Kenosha County, Wisconsin), a re-examination of the flow-frequency at the northern gages should capture the changes in runoff that would in turn result in significant changes to water surface profiles for the mainstem Des Plaines River. New flow-frequency relationships were developed for the four mainstem gages located at Russell Road (near the Illinois-Wisconsin Stateline), Gurnee (major damage area during the May 2004 event), Des Plaines (perpetual major damage area) and Riverside. The gage records were adjusted to take into account urbanization changes and reservoir construction in order to develop a more uniform period of record at each of the gages. The same process for adjusting the gage records to account for urbanization and reservoir construction utilized during the development of the Phase I Study was used. The process as applied to the gage records as outlined in the Hydrology and Hydraulics Appendix A of the Phase I

Feasibility Study (Chicago District 1999) used a procedure developed by USGS for Northeastern Illinois (USGS, WRI 79-36) to account for urbanization effects.

The USGS procedure for adjusting a gage record to account for urbanization involves relating population density (persons per square mile) to the percentage of imperviousness per total land area. Weighted percent imperviousness values were then used to determine ratios of urban to rural flood magnitudes for each decade. The ratios of flood magnitudes, from urban to rural, varied by decade depending on the percent imperviousness and the frequency storm observed. For historical data adjustment purposes, the base condition frequency-discharge relationship was set at 1940. An urban adjustment multiplier was determined for each decade based on the ratio of a given decade urban to rural ratio to the baseline ratio. The gage record was modified by decade based on the urban adjustment multiplier.

The construction of reservoirs that would impact the gage record was accounted for by first compiling an inventory of all reservoirs constructed in the basin. Based on the inventory and location of each reservoir, it was determined if reservoirs impacted the gage record and if so when the gage record was impacted. Only the Des Plaines and Riverside gages were determined to be impacted by reservoir construction. These records were adjusted by creating a no-reservoir hydrologic model and comparing discharges to current conditions.

The gage records at the four mainstem stream gages were adjusted to take into account urbanization effects and reservoir construction that occurred between 1995 and 2005. Comparing gage frequency analysis results between the adjusted period of record used to calibrate the mainstem H&H models developed for the Phase I Study to an updated period of record taking into account additional urbanization and reservoir construction since the development of the mainstem H&H models would determine whether the existing mainstem models are applicable for use in the Phase II Study.

GAGE FREQUENCY ANALYSIS:

Four mainstem stream gages were reanalyzed by extending the gage records to 2005 and making adjustments for urbanization and reservoir construction. An effort was made to adjust the gage record to account for added imperviousness as a result of urbanization and any flood control projects (i.e. reservoirs) that had been implemented since the frequency analysis was last updated in 1995. The extended annual maximum series was used as input to the Flood Frequency Analysis software package developed by the Hydrologic Engineering Center, HEC-FFA. The generalized skew and mean square error of -0.16 and 0.20, respectively, were held consistent with the previous analysis. The HEC-FFA analysis was performed for the Russell Road, Gurnee, Des Plaines and Riverside gages. HEC-FFA output from the current analysis is contained in attachment 1 to this appendix. For comparison reasons, computed urban and reservoir adjustments were translated back to the Des Plaines I Study baseline year of 1995.

A comparison of peak flows for various frequency events is presented in *Table 1*. The Phase I mainstem H&H models results are shown in *Column A* (baseline 1995 land use conditions) and *Column B* (future 2010 land use conditions). The Phase I study gage frequency analysis results used in calibrating the mainstem H&H models is shown in *Column C*. The updated frequency analysis based on an extended period of record corrected for urbanization effects and reservoir construction is shown in *Column D*. Comparing peak flows from the Phase I frequency analysis (*Column C*) with the updated frequency analysis (*Column D*) showed a reasonable comparison (approximately 10% difference or less, but usually less). The Russell Road Gage showed the largest change. The updated frequency analysis for the Russell Gage includes the effects of urbanization where the Phase I analysis did not. Also there was an event of record (May 2004) in the updated analysis which had an impact on the updated results. Adjustments to the hydrologic model upstream of the Russell gage may be necessary.

In order to check the reasonableness of the H&H model future landuse conditions results, the calculated urban and reservoir construction adjustments were applied to the Phase I frequency analysis results (*Column C*) as shown in *Column F*. As shown in *Column G*, there is a reasonable comparison with the mainstem H&H model future conditions results.

Table 1 – Comparison of Gage Frequency Analyses Results and Simulated Peak Flows at Mainstem Upper Des Plaines River Gage Locations

	A	B	C	D	E	F	G
Recurrence Interval (Years)	(1995) Phase I Baseline Model (cfs)[1]	(2010) Phase I Future Model (cfs)[2]	(1995) Phase I Frequency Analysis (cfs)[3]	(1995) Updated Frequency Analysis (cfs)	Percent change (D-C)/C	(2010) Adjusted Frequency Analysis (cfs)	Percent change (F-B)/B
Russell Rd. Gage							
2 yr	624	658	624	694	11%	636	3%
5 yr	1230	1283	1230	1340	9%	1242	3%
10 yr	1727	1792	1730	1860	8%	1747	3%
25 yr/20yr*	2468	2547	2280*	2430*	7%	2303*	N/A*
50 yr	3086	3174	3090	3260	6%	3152	1%
100 yr	3773	3863	3770	3950	5%	3808	1%
500 yr	5580	5688	5580	5770	3%	5636	1%
Gurnee Gage							
2 yr	1323	1504	1320	1290	-2%	1492	1%
5 yr	2294	2486	2280	2210	-3%	2508	-1%
10 yr	3062	3255	3000	2900	-3%	3270	0%
25 yr/20yr*	4050	4277	3750*	3610*	-4%	4050*	N/A*
50 yr	4829	5097	4790	4580	-4%	5077	0%
100 yr	5644	5910	5620	5370	-4%	5957	-1%
500 yr	7647	8021	7720	7320	-5%	8183	-2%
Des Plaines Gage							
2 yr	2599	2866	2610	2660	2%	2714	6%
5 yr	3610	3950	3610	3550	-2%	3718	6%
10 yr	4226	4584	4240	4150	-2%	4325	6%
25 yr/20yr*	4992	5340	4840*	4710*	-3%	4937*	N/A*
50 yr	5564	5900	5590	5410	-3%	5702	3%
100 yr	6144	6455	6140	5920	-4%	6201	4%
500 yr	7386	7711	7400	7090	-4%	7474	3%

Riverside Gage							
2 yr	4505	4620	4580	4620	1%	4626	0%
5 yr	5797	5971	5940	5940	0%	5881	2%
10 yr	6623	6814	6780	6740	-1%	6712	2%
25 yr/20yr*	7570	7744	7550*	7460*	-1%	7475*	N/A*
50 yr	8225	8399	8490	8340	-2%	8405	0%
100 yr	8827	9017	9160	8980	-2%	9068	-1%
500 yr	10108	10333	10700	10400	-3%	10593	-2%

* readily available data is presented , 25 yr from models and 20 yr from freq. analysis, 20 yr values are marked with an asterisk *

[1] Peak flows from Phase I mainstem HEC-1 model at gage locations from revised baseline modeling.

[2] Peak flows from Phase I mainstem HEC-1 modeling for 2010 future conditions.

[3] Excerpted from Hydrology and Hydraulics Appendix A, 1999 Feasibility Study.

Flow-frequency curves were developed from HEC-FFA runs, as well as the statistical analyses documented in Hydrology and Hydraulics Appendix A of the 1999 Feasibility Study. The updated flow-frequency relationships were plotted along with the Phase I relationships utilizing computed probability curves as well as the upper and lower confidence intervals for the Phase I gage frequency analysis. Peak flow results from the mainstem HEC-1 model at the gage locations for baseline and future conditions were also incorporated into the plots. The plots for Russell Road, Gurnee, Des Plaines and Riverside gages are contained on *Plates 1-4*.

For three of the four gages (Gurnee, Des Plaines and Riverside), the trend shows a decrease in flows for a given frequency despite increases in watershed urbanization. This is due to the extended period of record, which experienced smaller peak flows resulting in lower overall frequency analysis results. The extended Russell Road gage record included an extreme event in May 2004 and urbanization effects that resulted in greater peak flows and increased frequency analysis results. The revised frequency curves fall well within the upper and lower confidence intervals of the original Phase I gage frequency analysis, indicating that the changes observed within the watershed still fall within the statistical reliability of the gage analysis. Since there is not a statistically significant change in the frequency record, the original frequency analysis for the numerical modeling is still valid. Therefore, since there is no significant statistical change in the flow data, the mainstem H&H models developed as part of the Phase I Study are still valid for use in developing baseline, future and with-project flow and stage information used in NED economic analyses.

RECCOMENDATION:

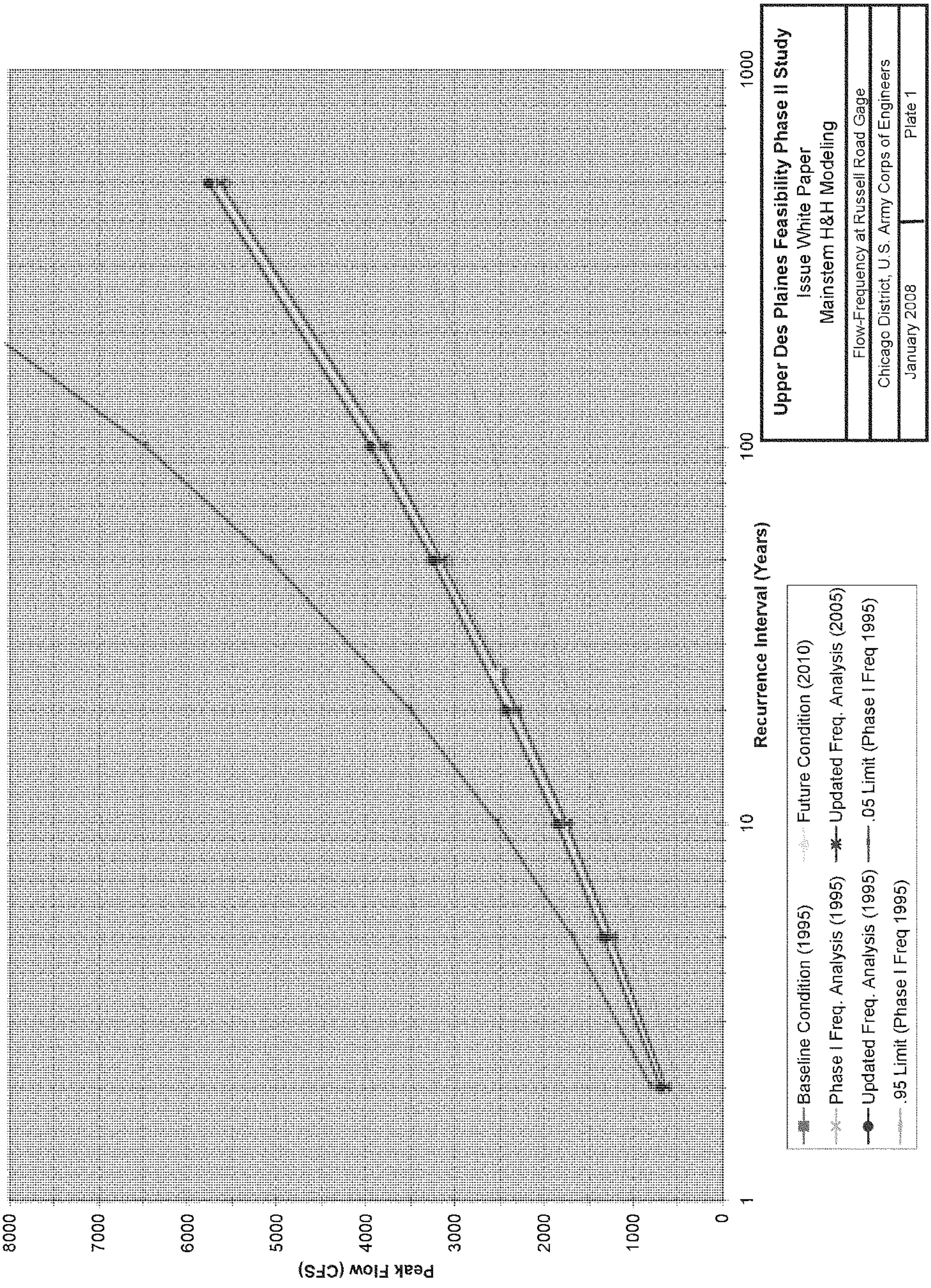
Through the above analyses of extending and updating the mainstem gage records for urbanization and reservoir construction and comparing frequency analysis results with that used to calibrate the Phase I mainstem H&H models, it can been shown that the existing mainstem H&H produces reasonable results. The mainstem H&H model produces results that are within 6% for both baseline and future conditions for all gages except the Russell Road gage. Due to an extremely large event occurring in the extended period of record for the Russell Road gage and incorporating urbanization effects, the baseline frequency analysis results increased. The other three gages showed a decrease in the gage frequency analyses with the updated period of record. Comparisons to the updated frequency curves indicate that the mainstem H&H models developed for the Phase I Study will estimate with reasonable closeness the baseline, future and with-project conditions for evaluation of damages and benefits associated with Phase II Study project features. As noted above the trend in the watershed is for continued development in the northern portions of the watershed in Lake and Kenosha Counties. It is anticipated that growth in the watershed will continue, and with it increases in runoff volumes and flooding. This trend is noted in the increase in peak flows for the Russell Road gage, however reduced flows observed at the downstream gages is a result of extended period of record. Comparisons of the revised flow-frequency results versus those developed for the 1999 Phase I Feasibility Report indicate that the changes are within the statistical limits of the original analysis.

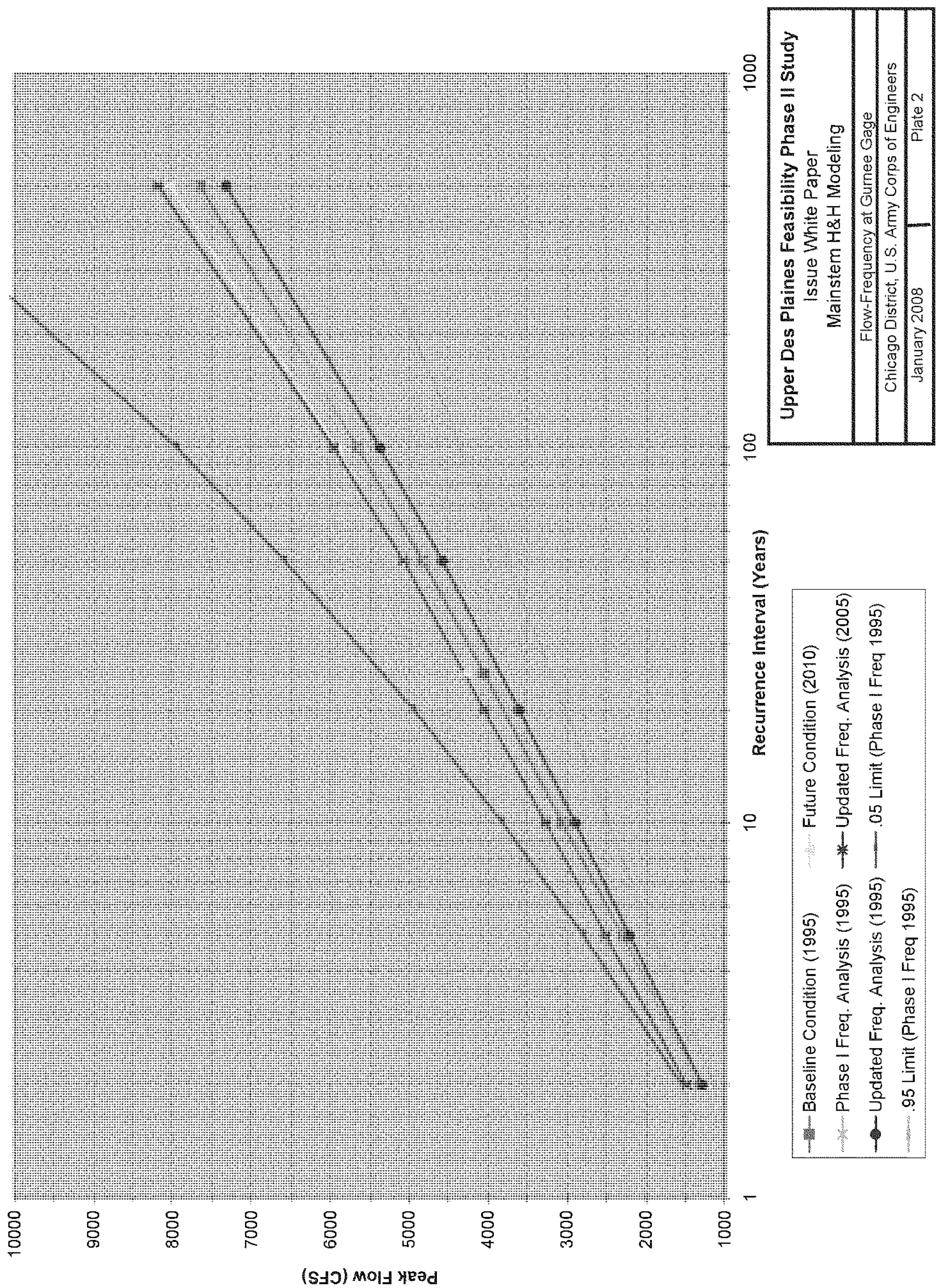
Based on the above analyses, it is applicable to use the Phase I mainstem H&H models as the basis for baseline, future and with-project conditions analyses in the computation of mainstem damages and benefits for the Phase II Study.

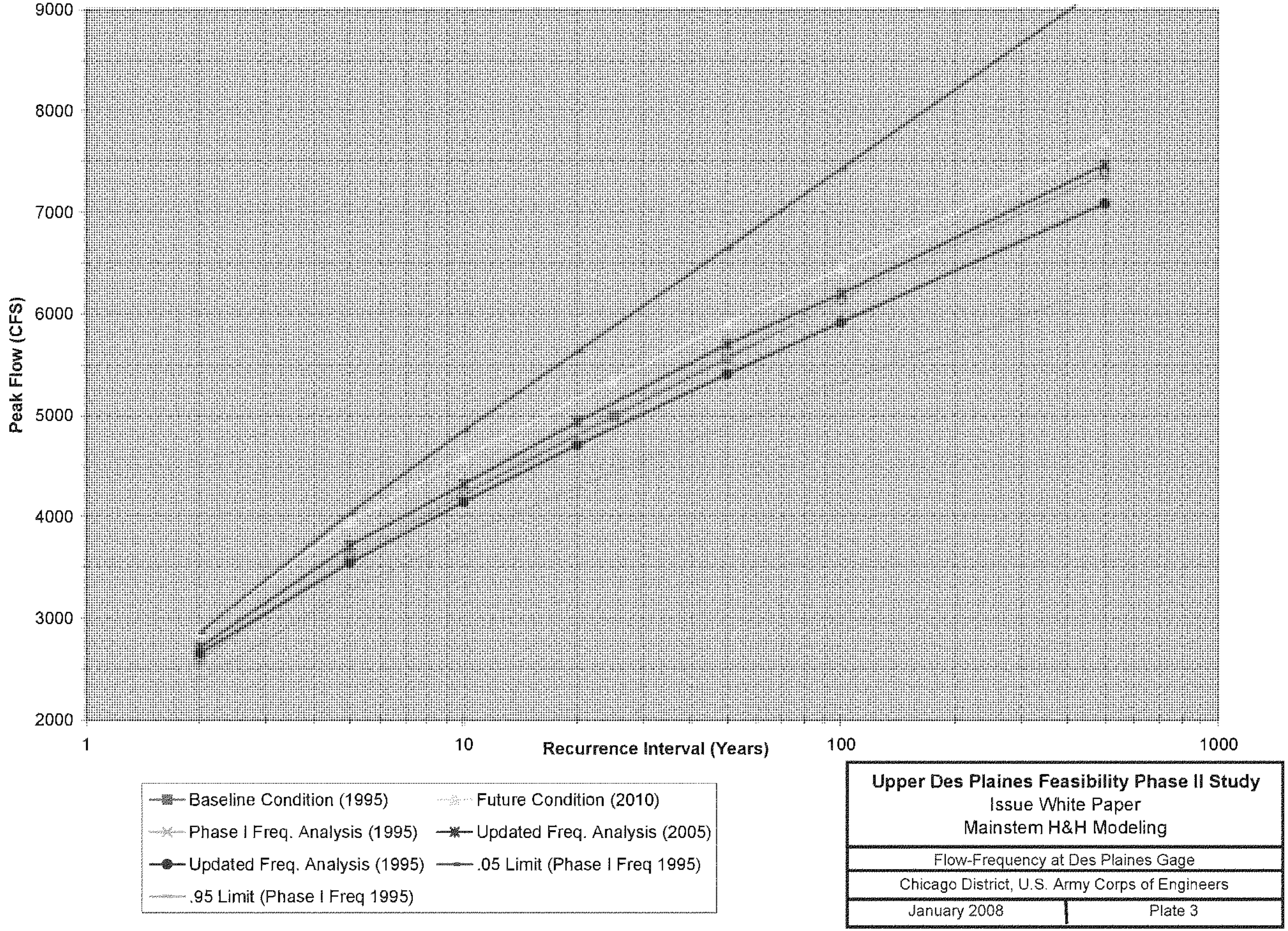
REFERENCES:

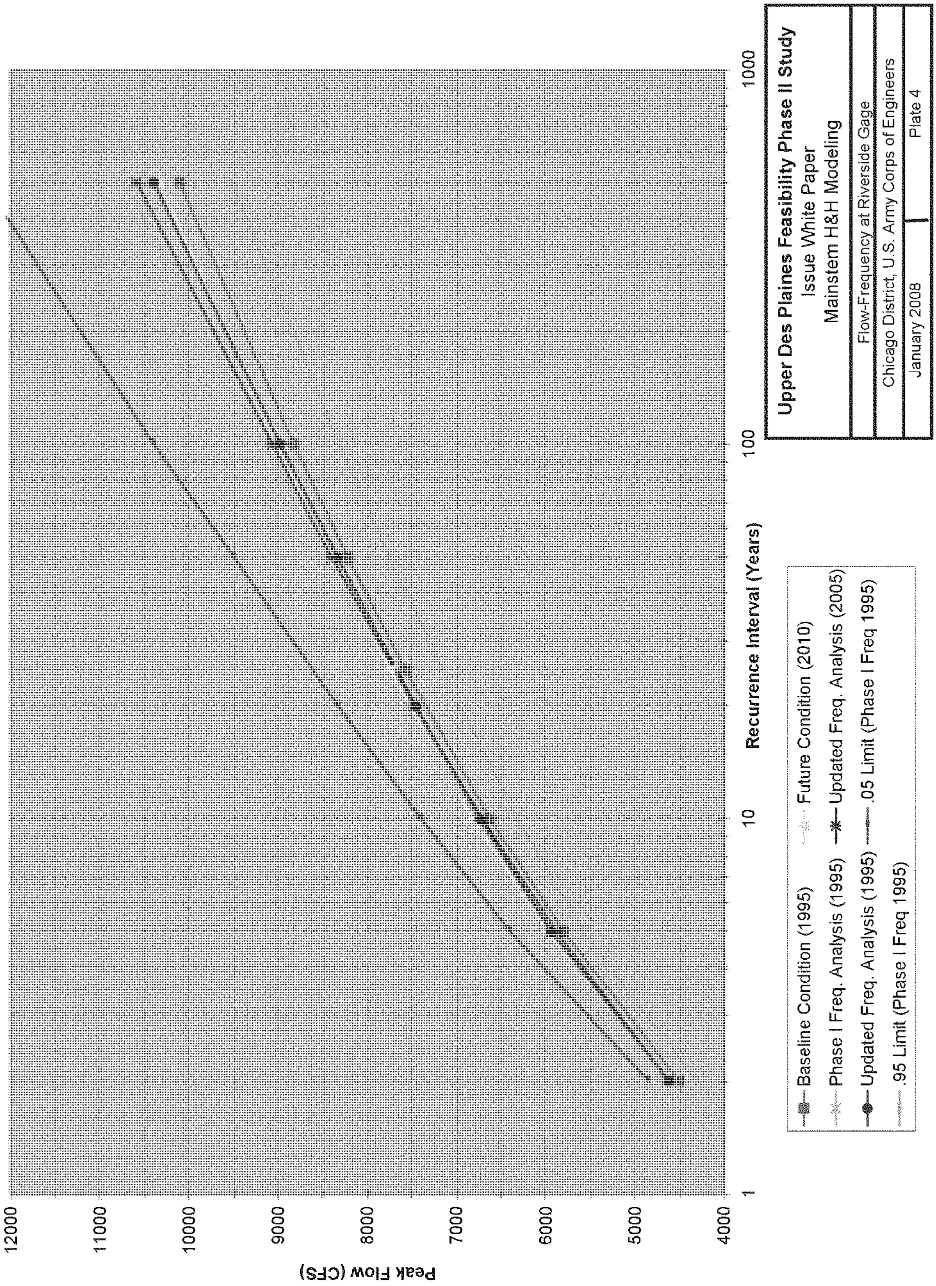
Upper Des Plaines River, Flood Damage Reduction Study, Appendix A, Hydrology and Hydraulics, U.S. Army Corps of Engineers Chicago District, June 1999.

Effects of Urbanization on the Magnitude and Frequency of Floods in Northeastern Illinois, Water Resources Investigations Report 79-36, U.S. Geological Survey, 1979.


Upper Des Plaines Feasibility Phase II Study
Issue White Paper
Mainstem H&H Modeling
Flow-Frequency at Russell Road Gage
Chicago District, U.S. Army Corps of Engineers
January 2008
Plate 1
Peak Flow (CFS)
Recurrence Interval (Years)
0
1000
2000
3000
4000
5000
6000
7000
8000
1
10
100
1000
Baseline Condition (1995)
Future Condition (2010)
Phase I Freq. Analysis (1995)
Updated Freq. Analysis (2005)
Updated Freq. Analysis (1995)
.05 Limit (Phase I Freq 1995)
.95 Limit (Phase I Freq 1995)


Peak Flow (CFS)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
1
10
100
1000
Recurrence Interval (Years)
Baseline Condition (1995)
Future Condition (2010)
Phase I Freq. Analysis (1995)
Updated Freq. Analysis (2005)
Updated Freq. Analysis (1995)
.05 Limit (Phase I Freq 1995)
.95 Limit (Phase I Freq 1995)
Upper Des Plaines Feasibility Phase II Study
Issue White Paper
Mainstem H&H Modeling
Flow-Frequency at Gurnee Gage
Chicago District, U.S. Army Corps of Engineers
January 2008
Plate 2


Peak Flow (CFS)
9000
8000
7000
6000
5000
4000
3000
2000
1
10
100
1000
Recurrence Interval (Years)
Baseline Condition (1995)
Future Condition (2010)
Phase I Freq. Analysis (1995)
Updated Freq. Analysis (2005)
Updated Freq. Analysis (1995)
.05 Limit (Phase I Freq 1995)
.95 Limit (Phase I Freq 1995)
Upper Des Plaines Feasibility Phase II Study
Issue White Paper
Mainstem H&H Modeling
Flow-Frequency at Des Plaines Gage
Chicago District, U.S. Army Corps of Engineers
January 2008
Plate 3



Peak Flow (CFS)
12000
11000
10000
9000
8000
7000
6000
5000
4000
1
10
100
1000
Recurrence Interval (Years)
Baseline Condition (1995)
Future Condition (2010)
Phase I Freq. Analysis (1995)
Updated Freq. Analysis (2005)
Updated Freq. Analysis (1995)
.05 Limit (Phase I Freq 1995)
.95 Limit (Phase I Freq 1995)
Upper Des Plaines Feasibility Phase II Study
Issue White Paper
Mainstem H&H Modeling
Flow-Frequency at Riverside Gage
Chicago District, U.S. Army Corps of Engineers
January 2008
Plate 4

ATTACHMENT A-2

VISTA Model Inputs: Road Closure Schedule and Duration

Flooded Roads, 1-year Storm, 2010 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_1YR	DUR_1YR
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	17.31	338
184	HUTCHINS	MILL CREEK	RS 47038	33.38	1411

Flooded Roads, 2-year Storm, 2010 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_2YR	DUR_2YR
157	WINCHESTER	BULL CREEK	RS 14652	14.12	178
17	1ST	DESPLAINES RIVER	RS 54.201	125.06	1442
78	GOLF	DESPLAINES RIVER	RS 66.911G	108.16	345
238	OLD GRAND	DESPLAINES RIVER	RS 97.02	89.75	4050
307	TOBIN	DESPLAINES RIVER	RS 1.09	18.71	30
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	16.91	438
184	HUTCHINS	MILL CREEK	RS 47038	27.94	2656
26	IRVING PARK	SILVER CREEK	RS 34306.8	16.90	280

Flooded Roads, 5-year Storm, 2010 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_5YR	DUR_5YR
111	NORTHGATE	BUFFALO CREEK	RS 12111	14.60	312
224	WHEELING	BUFFALO CREEK	RS 7653	14.31	367
157	WINCHESTER	BULL CREEK	RS 14652	13.13	314
17	1ST	DESPLAINES RIVER	RS 54.201	125.06	3944
78	GOLF	DESPLAINES RIVER	RS 66.911G	108.16	10145
210	RIVER	DESPLAINES RIVER	RS 56.84	120.78	3112
213	RIVER	DESPLAINES RIVER	RS 64.50R	110.19	1633
247	BUSSE	DESPLAINES RIVER	RS 64.50B	110.19	1356
246	MINER	DESPLAINES RIVER	RS 65.03	108.16	231
214	RIVER	DESPLAINES RIVER	RS 71.033R	103.41	9997
98	MILWAUKEE	DESPLAINES RIVER	RS 72.86	103.41	8042
238	OLD GRAND	DESPLAINES RIVER	RS 97.02	89.75	11334
251	MILWAUKEE	DESPLAINES RIVER	RS 97.08M	89.75	3142
239	IL ROUTE 132	DESPLAINES RIVER	RS 97.08L	89.75	4382
237	KILBOURNE	DESPLAINES RIVER	RS 97.81	89.75	4876
252	US HIGHWAY 41	DESPLAINES RIVER	RS 98.59	89.75	6899
244	RIVER	DESPLAINES RIVER	RS 2500R	19.41	8220
273	GREENLEAF	DESPLAINES RIVER	RS 8550	18.91	1343
307	TOBIN	DESPLAINES RIVER	RS 1.09	17.96	60
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	16.61	593
82	RIVER	FEEHANVILLE DITCH	RS 1780	107.06	432
184	HUTCHINS	MILL CREEK	RS 47038	13.56	4324
200	IL-173	MILL CREEK	RS 27800	17.86	361
194	KELLEY	MILL CREEK	RS 18400	20.69	15
193	ADAMS	NEWPORT DITCH	RS 23258	19.76	300
26	IRVING PARK	SILVER CREEK	RS 34306.8	14.80	533

Flooded Roads, 10-year Storm, 2010 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_10YR	DUR_10YR
301	60TH	BRIGHTON CREEK	RS 0.84A	15.46	30
313	85TH	BRIGHTON CREEK	RS 1.29	16.21	90
111	NORTHGATE	BUFFALO CREEK	RS 12111	13.21	544
224	WHEELING	BUFFALO CREEK	RS 7653	13.06	583
157	WINCHESTER	BULL CREEK	RS 14652	12.48	465
10	CHICAGO	DESPLAINES RIVER	RS 51.63	114.00	2547
17	1ST	DESPLAINES RIVER	RS 54.201	125.06	11122
78	GOLF	DESPLAINES RIVER	RS 66.911G	108.16	12481
91	MILWAUKEE	DESPLAINES RIVER	RS 71.033M	103.41	322
179	GRAND	DESPLAINES RIVER	RS 97.12	89.75	1882
180	US HIGHWAY 41	DESPLAINES RIVER	RS 98.08H	89.75	453
218	RIVER	DESPLAINES RIVER	RS 54.78	119.97	2764
219	RIVER	DESPLAINES RIVER	RS 55.27	120.09	2656
210	RIVER	DESPLAINES RIVER	RS 56.84	120.78	9791
212	RIVER	DESPLAINES RIVER	RS 63.04	116.38	2240
213	RIVER	DESPLAINES RIVER	RS 64.50R	110.19	9533
247	BUSSE	DESPLAINES RIVER	RS 64.50B	110.19	8552
246	MINER	DESPLAINES RIVER	RS 65.03	108.16	8371
248	COLLEGE CIRCLE	DESPLAINES RIVER	RS 67.48	108.16	7644
214	RIVER	DESPLAINES RIVER	RS 71.033R	103.41	12287
98	MILWAUKEE	DESPLAINES RIVER	RS 72.86	103.41	10868
215	RIVER	DESPLAINES RIVER	RS 76.8	40.50	2210
238	OLD GRAND	DESPLAINES RIVER	RS 97.02	89.75	15901
251	MILWAUKEE	DESPLAINES RIVER	RS 97.08M	89.75	7080
239	IL ROUTE 132	DESPLAINES RIVER	RS 97.08L	89.75	7843
237	KILBOURNE	DESPLAINES RIVER	RS 97.81	89.75	8287
252	US HIGHWAY 41	DESPLAINES RIVER	RS 98.59	89.75	10748
244	RIVER	DESPLAINES RIVER	RS 2500R	19.41	13315
177	OPLAINE	DESPLAINES RIVER	RS 1125	18.91	1142
273	GREENLEAF	DESPLAINES RIVER	RS 8550	18.91	1588
307	TOBIN	DESPLAINES RIVER	RS 1.09	17.71	75
339	I-94	DESPLAINES RIVER	RS 6.36	28.71	2505
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	16.45	727
82	RIVER	FEEHANVILLE DITCH	RS 1780	107.06	7399
184	HUTCHINS	MILL CREEK	RS 47038	12.13	4914
200	IL-173	MILL CREEK	RS 27800	15.36	729
194	KELLEY	MILL CREEK	RS 18400	16.04	611
193	ADAMS	NEWPORT DITCH	RS 23258	17.42	748
201	DELANEY	NEWPORT DITCH	RS 7321D	19.36	109
202	9TH	NEWPORT DITCH	RS 6710	19.37	142
230	9TH	NEWPORT DITCH	RS 7321N	17.89	336
14	NORTH	SILVER CREEK	RS 9030.912	14.40	163
19	MANNHEIM	SILVER CREEK	RS 22601.568	16.10	61
26	IRVING PARK	SILVER CREEK	RS 34306.8	13.77	657

Flooded Roads, 25-year Storm, 2010 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_25YR	DUR_25YR
301	60TH	BRIGHTON CREEK	RS 0.84A	14.71	90
309	60TH	BRIGHTON CREEK	RS 1.14	23.46	330
313	85TH	BRIGHTON CREEK	RS 1.29	15.46	300
106	DUNDEE	BUFFALO CREEK	RS 56983	12.50	300
111	NORTHGATE	BUFFALO CREEK	RS 12111	12.20	1579
224	WHEELING	BUFFALO CREEK	RS 7653	12.08	1645
157	WINCHESTER	BULL CREEK	RS 14652	11.63	593
159	US HWY 45	BULL CREEK	RS 13780.8	13.92	248
160	PETERSON	BULL CREEK	RS 10560	14.25	203
10	CHICAGO	DESPLAINES RIVER	RS 51.63	114.00	4056
17	1ST	DESPLAINES RIVER	RS 54.201	125.06	13791
21	GRAND	DESPLAINES RIVER	RS 55.101	119.97	1777
23	BELMONT	DESPLAINES RIVER	RS 55.651	120.09	287
60	ALGONQUIN	DESPLAINES RIVER	RS 64.221	116.38	1437
70	RAND	DESPLAINES RIVER	RS 65.391	107.06	1855
78	GOLF	DESPLAINES RIVER	RS 66.911G	108.16	15178
91	MILWAUKEE	DESPLAINES RIVER	RS 71.033M	103.41	8991
148	IL ROUTE 60	DESPLAINES RIVER	RS 83.66	106.94	779
152	ROCKLAND	DESPLAINES RIVER	RS 87.31	18.28	1985
154	OAK SPRING	DESPLAINES RIVER	RS 88.41	60.28	3137
166	IL ROUTE 120	DESPLAINES RIVER	RS 94.51	18.44	6370
179	GRAND	DESPLAINES RIVER	RS 97.12	89.75	6589
180	US HIGHWAY 41	DESPLAINES RIVER	RS 98.08H	89.75	6069
199	IL ROUTE 173	DESPLAINES RIVER	RS 107.11	63.53	2823
205	RUSSELL	DESPLAINES RIVER	RS 109.60	19.41	2968
218	RIVER	DESPLAINES RIVER	RS 54.78	119.97	8704
219	RIVER	DESPLAINES RIVER	RS 55.27	120.09	4033
210	RIVER	DESPLAINES RIVER	RS 56.84	120.78	12743
212	RIVER	DESPLAINES RIVER	RS 63.04	116.38	10339
213	RIVER	DESPLAINES RIVER	RS 64.50R	110.19	12258
247	BUSSE	DESPLAINES RIVER	RS 64.50B	110.19	11541
246	MINER	DESPLAINES RIVER	RS 65.03	108.16	11283
248	COLLEGE CIRCLE	DESPLAINES RIVER	RS 67.48	108.16	10855
214	RIVER	DESPLAINES RIVER	RS 71.033R	103.41	15027
98	MILWAUKEE	DESPLAINES RIVER	RS 72.86	103.41	13398
215	RIVER	DESPLAINES RIVER	RS 76.8	40.50	9948
216	RIVER	DESPLAINES RIVER	RS 77.8	40.50	2011
238	OLD GRAND	DESPLAINES RIVER	RS 97.02	89.75	21193
251	MILWAUKEE	DESPLAINES RIVER	RS 97.08M	89.75	10903
239	IL ROUTE 132	DESPLAINES RIVER	RS 97.08L	89.75	11867
237	KILBOURNE	DESPLAINES RIVER	RS 97.81	89.75	12391
252	US HIGHWAY 41	DESPLAINES RIVER	RS 98.59	89.75	15057
243	BUCKLEY	DESPLAINES RIVER	RS 2500T	19.41	963
244	RIVER	DESPLAINES RIVER	RS 2500R	19.41	17580
177	OPLAINE	DESPLAINES RIVER	RS 1125	18.91	1481
273	GREENLEAF	DESPLAINES RIVER	RS 8550	18.91	2094
294	122ND	DESPLAINES RIVER	RS 0.69	49.21	1635
295	GREEN BAY	DESPLAINES RIVER	RS 0.69A	19.21	15
307	TOBIN	DESPLAINES RIVER	RS 1.09	17.46	75
311	SPRINGBROOL	DESPLAINES RIVER	RS 1.18	18.46	30
339	I-94	DESPLAINES RIVER	RS 6.36	24.46	3360
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	16.30	983
82	RIVER	FEEHANVILLE DITCH	RS 1780	107.06	10923

Flooded Roads, 25-year Storm, 2010 Conditions (continued).

VISTA ID	Road Name	Watershed	RoadStation	TIME_25YR	DUR_25YR
146	DIAMOND LAKE	INDIAN CREEK	RS 39463	10.22	311
305	93RD	JEROME CREEK	RS 1.04JC	19.68	60
254	WILLOW	MCDONALD CREEK	RS 1850	18.79	86
184	HUTCHINS	MILL CREEK	RS 47038	10.26	5821
228	BARRON	MILL CREEK	RS 84067	20.11	478
206	128TH	MILL CREEK	RS 39650	14.19	782
200	IL-173	MILL CREEK	RS 27800	12.93	1146
194	KELLEY	MILL CREEK	RS 18400	13.44	1041
274	GRAND	MILL CREEK	RS 26200	15.31	520
193	ADAMS	NEWPORT DITCH	RS 23258	16.14	1259
201	DELANEY	NEWPORT DITCH	RS 7321D	16.76	444
202	9TH	NEWPORT DITCH	RS 6710	16.86	459
230	9TH	NEWPORT DITCH	RS 7321N	16.22	563
13	15TH	SILVER CREEK	RS 6966.432	14.19	171
14	NORTH	SILVER CREEK	RS 9030.912	13.19	774
19	MANNHEIM	SILVER CREEK	RS 22601.568	13.85	743
20	SCOTT	SILVER CREEK	RS 19226.592	21.89	273
26	IRVING PARK	SILVER CREEK	RS 34306.8	12.74	784
44	DEVON	WILLOW-HIGGINS CREEK	RS 38634	15.28	194
56	WILLE	WILLOW-HIGGINS CREEK	RS 30413	13.84	166
57	ELMHURST	WILLOW-HIGGINS CREEK	RS 31638	14.69	42

Flooded Roads, 50-year Storm, 2010 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_50YR	DUR_50YR
292	75TH	BRIGHTON CREEK	RS 0.58	14.71	30
300	89TH	BRIGHTON CREEK	RS 0.84	15.96	30
301	60TH	BRIGHTON CREEK	RS 0.84A	14.46	105
309	60TH	BRIGHTON CREEK	RS 1.14	20.96	705
313	85TH	BRIGHTON CREEK	RS 1.29	14.96	465
106	DUNDEE	BUFFALO CREEK	RS 56983	11.58	462
111	NORTHGATE	BUFFALO CREEK	RS 12111	11.45	1799
112	MCHENRY	BUFFALO CREEK	RS 14213	13.43	1064
113	RAND	BUFFALO CREEK	RS 50820	14.21	30
124	CHECKER	BUFFALO CREEK	RS 37164.41	21.95	396
222	DUNDEE	BUFFALO CREEK	RS 14444	13.25	1098
224	WHEELING	BUFFALO CREEK	RS 7653	11.33	1864
155	LAKE	BULL CREEK	RS 12856.8	24.08	614
158	WINCHESTER	BULL CREEK	RS 11008.8	23.70	688
157	WINCHESTER	BULL CREEK	RS 14652	11.05	693
159	US HWY 45	BULL CREEK	RS 13780.8	13.07	337
160	PETERSON	BULL CREEK	RS 10560	13.38	302
209	IRVING PARK	CRYSTAL CREEK	RS 20121	15.60	103
10	CHICAGO	DESPLAINES RIVER	RS 51.63	114.00	10916
15	NORTH	DESPLAINES RIVER	RS 52.93	125.06	1023
17	1ST	DESPLAINES RIVER	RS 54.201	125.06	15628
21	GRAND	DESPLAINES RIVER	RS 55.101	119.97	3313
23	BELMONT	DESPLAINES RIVER	RS 55.651	120.09	2880
60	ALGONQUIN	DESPLAINES RIVER	RS 64.221	116.38	8467
70	RAND	DESPLAINES RIVER	RS 65.391	107.06	9863
78	GOLF	DESPLAINES RIVER	RS 66.911G	108.16	17336
91	MILWAUKEE	DESPLAINES RIVER	RS 71.033M	103.41	10971
148	IL ROUTE 60	DESPLAINES RIVER	RS 83.66	106.94	5059
152	ROCKLAND	DESPLAINES RIVER	RS 87.31	18.28	5529
154	OAK SPRING	DESPLAINES RIVER	RS 88.41	60.28	5906
166	IL ROUTE 120	DESPLAINES RIVER	RS 94.51	18.44	8633
179	GRAND	DESPLAINES RIVER	RS 97.12	89.75	8728
180	US HIGHWAY 41	DESPLAINES RIVER	RS 98.08H	89.75	8131
199	IL ROUTE 173	DESPLAINES RIVER	RS 107.11	63.53	4734
205	RUSSELL	DESPLAINES RIVER	RS 109.60	19.41	4570
218	RIVER	DESPLAINES RIVER	RS 54.78	119.97	11823
219	RIVER	DESPLAINES RIVER	RS 55.27	120.09	11696
210	RIVER	DESPLAINES RIVER	RS 56.84	120.78	14545
212	RIVER	DESPLAINES RIVER	RS 63.04	116.38	12353
213	RIVER	DESPLAINES RIVER	RS 64.50R	110.19	14081
247	BUSSE	DESPLAINES RIVER	RS 64.50B	110.19	13384
246	MINER	DESPLAINES RIVER	RS 65.03	108.16	13059
248	COLLEGE CIRCLE	DESPLAINES RIVER	RS 67.48	108.16	12651
214	RIVER	DESPLAINES RIVER	RS 71.033R	103.41	17158
98	MILWAUKEE	DESPLAINES RIVER	RS 72.86	103.41	15365
215	RIVER	DESPLAINES RIVER	RS 76.8	40.50	11942
216	RIVER	DESPLAINES RIVER	RS 77.8	40.50	5701
238	OLD GRAND	DESPLAINES RIVER	RS 97.02	89.75	23515
251	MILWAUKEE	DESPLAINES RIVER	RS 97.08M	89.75	13699
239	IL ROUTE 132	DESPLAINES RIVER	RS 97.08L	89.75	14725
237	KILBOURNE	DESPLAINES RIVER	RS 97.81	89.75	15273
252	US HIGHWAY 41	DESPLAINES RIVER	RS 98.59	89.75	17886
243	BUCKLEY	DESPLAINES RIVER	RS 2500T	19.41	5038

Flooded Roads, 50-year Storm, 2010 Conditions (continued).

VISTA ID	Road Name	Watershed	RoadStation	TIME_50YR	DUR_50YR
244	RIVER	DESPLAINES RIVER	RS 2500R	19.41	20008
241	GUERIN	DESPLAINES RIVER	RS 7025	19.41	4187
177	OPLAINE	DESPLAINES RIVER	RS 1125	18.91	1620
273	GREENLEAF	DESPLAINES RIVER	RS 8550	18.91	2515
294	122ND	DESPLAINES RIVER	RS 0.69	44.71	2595
295	GREEN BAY	DESPLAINES RIVER	RS 0.69A	18.71	45
307	TOBIN	DESPLAINES RIVER	RS 1.09	17.46	90
311	SPRINGBROOL	DESPLAINES RIVER	RS 1.18	18.21	45
312	COUNTY LINE	DESPLAINES RIVER	RS 1.25	7.21	15
339	I-94	DESPLAINES RIVER	RS 6.36	19.46	3795
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	16.20	1263
82	RIVER	FEEHANVILLE DITCH	RS 1780	107.06	12868
146	DIAMOND LAKE	INDIAN CREEK	RS 39463	8.54	664
150	GILMER	INDIAN CREEK	RS 71326	9.95	69
305	93RD	JEROME CREEK	RS 1.04JC	19.43	75
254	WILLOW	MCDONALD CREEK	RS 1850	16.46	451
184	HUTCHINS	MILL CREEK	RS 47038	8.71	6474
228	BARRON	MILL CREEK	RS 84067	16.68	1087
206	128TH	MILL CREEK	RS 39650	12.41	1103
200	IL-173	MILL CREEK	RS 27800	11.53	1422
194	KELLEY	MILL CREEK	RS 18400	11.96	1318
274	GRAND	MILL CREEK	RS 26200	13.66	773
193	ADAMS	NEWPORT DITCH	RS 23258	15.57	1396
201	DELANEY	NEWPORT DITCH	RS 7321D	15.94	570
202	9TH	NEWPORT DITCH	RS 6710	16.04	585
230	9TH	NEWPORT DITCH	RS 7321N	15.61	688
13	15TH	SILVER CREEK	RS 6966.432	13.07	675
14	NORTH	SILVER CREEK	RS 9030.912	12.39	935
19	MANNHEIM	SILVER CREEK	RS 22601.568	12.99	911
20	SCOTT	SILVER CREEK	RS 19226.592	13.99	862
22	GRAND	SILVER CREEK	RS 24899.424	20.17	70
26	IRVING PARK	SILVER CREEK	RS 34306.8	11.90	882
44	DEVON	WILLOW-HIGGINS CREEK	RS 38634	14.36	323
56	WILLE	WILLOW-HIGGINS CREEK	RS 30413	13.09	273
57	ELMHURST	WILLOW-HIGGINS CREEK	RS 31638	13.56	198

Flooded Roads, 100-year Storm, 2010 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_100YR	DUR_100YR
125	MILWAUKEE	APTAKISIC CREEK	RS 1950	107.94	4171
292	75TH	BRIGHTON CREEK	RS 0.58	14.21	45
300	89TH	BRIGHTON CREEK	RS 0.84	15.46	180
301	60TH	BRIGHTON CREEK	RS 0.84A	14.21	135
309	60TH	BRIGHTON CREEK	RS 1.14	19.71	990
313	85TH	BRIGHTON CREEK	RS 1.29	14.46	615
340	31ST	BRIGHTON CREEK	RS 7.85	19.71	150
106	DUNDEE	BUFFALO CREEK	RS 56983	10.95	597
111	NORTHGATE	BUFFALO CREEK	RS 12111	10.80	1989
112	MCHENRY	BUFFALO CREEK	RS 14213	12.55	1320
113	RAND	BUFFALO CREEK	RS 50820	12.28	305
118	APTAKISIC	BUFFALO CREEK	RS 23920	23.55	231
119	LAKE COOK	BUFFALO CREEK	RS 28633	22.05	404
124	CHECKER	BUFFALO CREEK	RS 37164.41	20.18	609
223	DUNDEE	BUFFALO CREEK	RS 15616	14.51	974
222	DUNDEE	BUFFALO CREEK	RS 14444	12.43	1335
224	WHEELING	BUFFALO CREEK	RS 7653	10.66	2064
155	LAKE	BULL CREEK	RS 12856.8	21.65	948
158	WINCHESTER	BULL CREEK	RS 11008.8	21.42	1005
157	WINCHESTER	BULL CREEK	RS 14652	10.27	796
159	US HWY 45	BULL CREEK	RS 13780.8	12.47	411
160	PETERSON	BULL CREEK	RS 10560	12.77	378
162	PETERSON	BULL CREEK	RS 5913.6	23.48	362
209	IRVING PARK	CRYSTAL CREEK	RS 20121	14.92	219
9	LAKE	DESPLAINES RIVER	RS 51.041	114.00	2067
10	CHICAGO	DESPLAINES RIVER	RS 51.63	114.00	12832
15	NORTH	DESPLAINES RIVER	RS 52.93	125.06	3016
17	1ST	DESPLAINES RIVER	RS 54.201	125.06	17300
21	GRAND	DESPLAINES RIVER	RS 55.101	119.97	9983
23	BELMONT	DESPLAINES RIVER	RS 55.651	120.09	3920
27	IRVING PARK	DESPLAINES RIVER	RS 56.921	120.78	2132
60	ALGONQUIN	DESPLAINES RIVER	RS 64.221	116.38	10541
70	RAND	DESPLAINES RIVER	RS 65.391	107.06	11309
78	GOLF	DESPLAINES RIVER	RS 66.911G	108.16	19067
91	MILWAUKEE	DESPLAINES RIVER	RS 71.033M	103.41	12298
110	DUNDEE	DESPLAINES RIVER	RS 74.341	40.50	3902
126	DEERFIELD	DESPLAINES RIVER	RS 76.76	40.50	3576
148	IL ROUTE 60	DESPLAINES RIVER	RS 83.66	106.94	7051
152	ROCKLAND	DESPLAINES RIVER	RS 87.31	18.28	7448
154	OAK SPRING	DESPLAINES RIVER	RS 88.41	60.28	7792
166	IL ROUTE 120	DESPLAINES RIVER	RS 94.51	18.44	10856
179	GRAND	DESPLAINES RIVER	RS 97.12	89.75	10865
180	US HIGHWAY 41	DESPLAINES RIVER	RS 98.08H	89.75	10178
199	IL ROUTE 173	DESPLAINES RIVER	RS 107.11	63.53	6235
205	RUSSELL	DESPLAINES RIVER	RS 109.60	19.41	6059
218	RIVER	DESPLAINES RIVER	RS 54.78	119.97	13345
219	RIVER	DESPLAINES RIVER	RS 55.27	120.09	13227
210	RIVER	DESPLAINES RIVER	RS 56.84	120.78	16098
212	RIVER	DESPLAINES RIVER	RS 63.04	116.38	13796
213	RIVER	DESPLAINES RIVER	RS 64.50R	110.19	15631
247	BUSSE	DESPLAINES RIVER	RS 64.50B	110.19	14903
246	MINER	DESPLAINES RIVER	RS 65.03	108.16	14514
248	COLLEGE CIRCLE	DESPLAINES RIVER	RS 67.48	108.16	14079

Flooded Roads, 100-year Storm, 2010 Conditions (continued).

VISTA ID	Road Name	Watershed	RoadStation	TIME_100YR	DUR_100YR
214	RIVER	DESPLAINES RIVER	RS 71.033R	103.41	18906
98	MILWAUKEE	DESPLAINES RIVER	RS 72.86	103.41	16974
215	RIVER	DESPLAINES RIVER	RS 76.8	40.50	13632
216	RIVER	DESPLAINES RIVER	RS 77.8	40.50	10086
238	OLD GRAND	DESPLAINES RIVER	RS 97.02	89.75	24798
251	MILWAUKEE	DESPLAINES RIVER	RS 97.08M	89.75	16241
239	IL ROUTE 132	DESPLAINES RIVER	RS 97.08L	89.75	17275
237	KILBOURNE	DESPLAINES RIVER	RS 97.81	89.75	17819
252	US HIGHWAY 41	DESPLAINES RIVER	RS 98.59	89.75	20188
243	BUCKLEY	DESPLAINES RIVER	RS 2500T	19.41	6982
244	RIVER	DESPLAINES RIVER	RS 2500R	19.41	21777
241	GUERIN	DESPLAINES RIVER	RS 7025	19.41	6350
242	GUERIN	DESPLAINES RIVER	RS 4650	19.41	4669
177	OPLAINE	DESPLAINES RIVER	RS 1125	18.91	1951
172	WASHINGTON	DESPLAINES RIVER	RS 4350W	18.91	559
273	GREENLEAF	DESPLAINES RIVER	RS 8550	18.91	4767
294	122ND	DESPLAINES RIVER	RS 0.69	41.71	3255
295	GREEN BAY	DESPLAINES RIVER	RS 0.69A	18.46	75
307	TOBIN	DESPLAINES RIVER	RS 1.09	17.21	90
310	TIMBER RIDGE	DESPLAINES RIVER	RS 1.17	19.46	15
311	SPRINGBROOL	DESPLAINES RIVER	RS 1.18	17.96	45
312	COUNTY LINE	DESPLAINES RIVER	RS 1.25	6.96	30
339	I-94	DESPLAINES RIVER	RS 6.36	17.71	4200
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	16.11	1534
65	MINER/DEMSTER	FARMERS-PRAIRIE CREEK	RS 4409	18.21	60
69	BALLARD	FARMERS-PRAIRIE CREEK	RS 26980.5	17.25	58
82	RIVER	FEEHANVILLE DITCH	RS 1780	107.06	14296
84	FEEHANVILLE	FEEHANVILLE DITCH	RS 7870	20.38	569
146	DIAMOND LAKE	INDIAN CREEK	RS 39463	7.42	1196
150	GILMER	INDIAN CREEK	RS 71326	7.50	406
151	CHEVY CHASE	INDIAN CREEK	RS 69013	9.14	217
225	US HIGHWAY 45	INDIAN CREEK	RS 8238	13.60	446
227	IL ROUTE 83	INDIAN CREEK	RS 34841	9.47	468
264	GILMER	INDIAN CREEK	RS 3850G	7.67	552
267	TOWNLINE	INDIAN CREEK	RS 13350	11.35	603
305	93RD	JEROME CREEK	RS 1.04JC	19.18	75
298	I-94	KILBOURN DITCH	RS 0.78	17.44	15
341	12TH	KILBOURN DITCH	RS 8.01	22.19	120
86	KENSINGTON	MCDONALD CREEK	RS 2059	16.61	254
99	HINTZ	MCDONALD CREEK	RS 38122	15.44	204
254	WILLOW	MCDONALD CREEK	RS 1850	15.59	606
167	IL ROUTE 83	MILL CREEK	RS 89335	19.76	470
184	HUTCHINS	MILL CREEK	RS 47038	6.58	7263
189	DILLEYS	MILL CREEK	RS 4469	16.64	483
190	US HIGHWAY 41	MILL CREEK	RS 1838	19.19	517
228	BARRON	MILL CREEK	RS 84067	14.46	1229
229	CENTER	MILL CREEK	RS 89420	21.21	14
206	128TH	MILL CREEK	RS 39650	10.74	1443
200	IL-173	MILL CREEK	RS 27800	9.66	1748
194	KELLEY	MILL CREEK	RS 18400	10.29	1632
191	MILLBURN	MILL CREEK	RS 5900	16.61	362
274	GRAND	MILL CREEK	RS 26200	12.11	1035
193	ADAMS	NEWPORT DITCH	RS 23258	15.12	1488

Flooded Roads, 100-year Storm, 2010 Conditions (continued).

VISTA ID	Road Name	Watershed	RoadStation	TIME_100YR	DUR_100YR
201	DELANEY	NEWPORT DITCH	RS 7321D	15.42	690
202	9TH	NEWPORT DITCH	RS 6710	15.49	705
230	9TH	NEWPORT DITCH	RS 7321N	15.14	796
13	15TH	SILVER CREEK	RS 6966.432	12.50	747
14	NORTH	SILVER CREEK	RS 9030.912	11.90	1012
18	FULLERTON	SILVER CREEK	RS 16683.744	17.69	107
19	MANNHEIM	SILVER CREEK	RS 22601.568	12.54	981
20	SCOTT	SILVER CREEK	RS 19226.592	13.19	955
22	GRAND	SILVER CREEK	RS 24899.424	18.14	264
26	IRVING PARK	SILVER CREEK	RS 34306.8	11.34	945
44	DEVON	WILLOW-HIGGINS CREEK	RS 38634	13.68	418
56	WILLE	WILLOW-HIGGINS CREEK	RS 30413	12.51	364
57	ELMHURST	WILLOW-HIGGINS CREEK	RS 31638	12.89	294

Flooded Roads, 500-year Storm, 2010 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_500YR	DUR_500YR
125	MILWAUKEE	APTAKISIC CREEK	RS 1950	107.94	10907
129	DEERFIELD	APTAKISIC CREEK	RS 15150	19.72	335
292	75TH	BRIGHTON CREEK	RS 0.58	13.71	75
300	89TH	BRIGHTON CREEK	RS 0.84	14.71	315
301	60TH	BRIGHTON CREEK	RS 0.84A	13.96	195
309	60TH	BRIGHTON CREEK	RS 1.14	18.21	1500
313	85TH	BRIGHTON CREEK	RS 1.29	14.21	795
340	31ST	BRIGHTON CREEK	RS 7.85	15.96	555
106	DUNDEE	BUFFALO CREEK	RS 56983	9.41	820
111	NORTHGATE	BUFFALO CREEK	RS 12111	8.71	2844
112	MCHENRY	BUFFALO CREEK	RS 14213	10.90	1718
113	RAND	BUFFALO CREEK	RS 50820	10.56	630
115	HICKS	BUFFALO CREEK	RS 54492	11.95	333
117	BALDWIN	BUFFALO CREEK	RS 47397	13.05	673
118	APTAKISIC	BUFFALO CREEK	RS 23920	13.08	1178
119	LAKE COOK	BUFFALO CREEK	RS 28633	15.86	1054
120	BUFFALO GROVE	BUFFALO CREEK	RS 25322	19.63	288
124	CHECKER	BUFFALO CREEK	RS 37164.41	16.23	1067
116	STATE HWY 53	BUFFALO CREEK	RS 46107.14	18.56	310
133	ROBERT PARKER COFFIN	BUFFALO CREEK	RS 47614.24	18.06	453
135	CUBA	BUFFALO CREEK	RS 69025.67	14.83	180
223	DUNDEE	BUFFALO CREEK	RS 15616	11.91	1434
222	DUNDEE	BUFFALO CREEK	RS 14444	10.80	1734
224	WHEELING	BUFFALO CREEK	RS 7653	8.50	3165
279	LAKE	BULL CREEK	RS 3160	14.67	428
155	LAKE	BULL CREEK	RS 12856.8	18.57	1451
158	WINCHESTER	BULL CREEK	RS 11008.8	18.43	1515
157	WINCHESTER	BULL CREEK	RS 14652	7.78	1436
159	US HWY 45	BULL CREEK	RS 13780.8	11.20	566
160	PETERSON	BULL CREEK	RS 10560	11.50	529
162	PETERSON	BULL CREEK	RS 5913.6	14.17	1313
304	75TH	CENTER CREEK	RS 1.04	19.47	15
30	25TH	CRYSTAL CREEK	RS 6278	15.05	276
209	IRVING PARK	CRYSTAL CREEK	RS 20121	13.85	393
7	MADISON	DESPLAINES RIVER	RS 50.211	113.44	2828
9	LAKE	DESPLAINES RIVER	RS 51.041	114.00	10857
10	CHICAGO	DESPLAINES RIVER	RS 51.63	114.00	15756
15	NORTH	DESPLAINES RIVER	RS 52.93	125.06	12119
17	1ST	DESPLAINES RIVER	RS 54.201	125.06	20761
21	GRAND	DESPLAINES RIVER	RS 55.101	119.97	13700
23	BELMONT	DESPLAINES RIVER	RS 55.651	120.09	13278
27	IRVING PARK	DESPLAINES RIVER	RS 56.921	120.78	11495
36	LAWRENCE	DESPLAINES RIVER	RS 57.921	120.78	1475
53	TOUHY	DESPLAINES RIVER	RS 62.001	116.38	674
60	ALGONQUIN	DESPLAINES RIVER	RS 64.221	116.38	13361
70	RAND	DESPLAINES RIVER	RS 65.391	107.06	13934
78	GOLF	DESPLAINES RIVER	RS 66.911G	108.16	22584
91	MILWAUKEE	DESPLAINES RIVER	RS 71.033M	103.41	15132
110	DUNDEE	DESPLAINES RIVER	RS 74.341	40.50	10594
126	DEERFIELD	DESPLAINES RIVER	RS 76.76	40.50	9828
148	IL ROUTE 60	DESPLAINES RIVER	RS 83.66	106.94	12554
152	ROCKLAND	DESPLAINES RIVER	RS 87.31	18.28	12351
153	PARK	DESPLAINES RIVER	RS 87.81	18.28	6696
154	OAK SPRING	DESPLAINES RIVER	RS 88.41	60.28	12931

Flooded Roads, 500-year Storm, 2010 Conditions (continued).

VISTA ID	Road Name	Watershed	RoadStation	TIME_500YR	DUR_500YR
161	BUCKLEY	DESPLAINES RIVER	RS 91.11	60.28	3453
166	IL ROUTE 120	DESPLAINES RIVER	RS 94.51	18.44	15886
179	GRAND	DESPLAINES RIVER	RS 97.12	89.75	15946
180	US HIGHWAY 41	DESPLAINES RIVER	RS 98.08H	89.75	15168
192	WADSWORTH	DESPLAINES RIVER	RS 103.41	70.91	3694
199	IL ROUTE 173	DESPLAINES RIVER	RS 107.11	63.53	10471
205	RUSSELL	DESPLAINES RIVER	RS 109.60	19.41	10339
211	RIVER	DESPLAINES RIVER	RS 51.67	114.00	3906
218	RIVER	DESPLAINES RIVER	RS 54.78	119.97	16191
219	RIVER	DESPLAINES RIVER	RS 55.27	120.09	16064
210	RIVER	DESPLAINES RIVER	RS 56.84	120.78	19381
212	RIVER	DESPLAINES RIVER	RS 63.04	116.38	16776
213	RIVER	DESPLAINES RIVER	RS 64.50R	110.19	18849
247	BUSSE	DESPLAINES RIVER	RS 64.50B	110.19	18081
246	MINER	DESPLAINES RIVER	RS 65.03	108.16	17609
248	COLLEGE CIRCLE	DESPLAINES RIVER	RS 67.48	108.16	17137
214	RIVER	DESPLAINES RIVER	RS 71.033R	103.41	21730
98	MILWAUKEE	DESPLAINES RIVER	RS 72.86	103.41	20204
215	RIVER	DESPLAINES RIVER	RS 76.8	40.50	17322
216	RIVER	DESPLAINES RIVER	RS 77.8	40.50	13419
238	OLD GRAND	DESPLAINES RIVER	RS 97.02	89.75	29531
251	MILWAUKEE	DESPLAINES RIVER	RS 97.08M	89.75	21503
239	IL ROUTE 132	DESPLAINES RIVER	RS 97.08L	89.75	22494
237	KILBOURNE	DESPLAINES RIVER	RS 97.81	89.75	23050
252	US HIGHWAY 41	DESPLAINES RIVER	RS 98.59	89.75	25090
253	KILBOURNE	DESPLAINES RIVER	RS 110.3	19.41	4015
243	BUCKLEY	DESPLAINES RIVER	RS 2500T	19.41	11707
244	RIVER	DESPLAINES RIVER	RS 2500R	19.41	21777
241	GUERIN	DESPLAINES RIVER	RS 7025	19.41	10884
242	GUERIN	DESPLAINES RIVER	RS 4650	19.41	8663
177	OPLAINE	DESPLAINES RIVER	RS 1125	18.91	3801
178	IL ROUTE 132	DESPLAINES RIVER	RS 2500G	18.91	1344
172	WASHINGTON	DESPLAINES RIVER	RS 4350W	18.91	1455
273	GREENLEAF	DESPLAINES RIVER	RS 8550	18.91	12207
288	I-94	DESPLAINES RIVER	RS 0.34	18.71	135
294	122ND	DESPLAINES RIVER	RS 0.69	37.21	4545
295	GREEN BAY	DESPLAINES RIVER	RS 0.69A	18.21	120
307	TOBIN	DESPLAINES RIVER	RS 1.09	17.21	120
310	TIMBER RIDGE	DESPLAINES RIVER	RS 1.17	18.71	60
311	SPRINGBROOL	DESPLAINES RIVER	RS 1.18	17.71	75
312	COUNTY LINE	DESPLAINES RIVER	RS 1.25	6.71	75
324	I-94	DESPLAINES RIVER	RS 2	18.71	45
339	I-94	DESPLAINES RIVER	RS 6.36	13.96	6120
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	15.86	1991
62	BUSSE	FARMERS-PRAIRIE CREEK	RS 1566	18.43	286
65	MINER/DEMSTER	FARMERS-PRAIRIE CREEK	RS 4409	16.38	506
67	POTTER	FARMERS-PRAIRIE CREEK	RS 21392	18.63	83
68	BALLARD	FARMERS-PRAIRIE CREEK	RS 6154.5	17.20	373
69	BALLARD	FARMERS-PRAIRIE CREEK	RS 26980.5	16.25	249
82	RIVER	FEEHANVILLE DITCH	RS 1780	107.06	17364
83	WOLF	FEEHANVILLE DITCH	RS 6620	20.38	904
84	FEEHANVILLE	FEEHANVILLE DITCH	RS 7870	20.38	1804
143	PORT CLINTON	INDIAN CREEK	RS 7238	15.89	60
146	DIAMOND LAKE	INDIAN CREEK	RS 39463	5.69	2108

Flooded Roads, 500-year Storm, 2010 Conditions (continued).

VISTA ID	Road Name	Watershed	RoadStation	TIME_500YR	DUR_500YR
147	INDIAN CREEK	INDIAN CREEK	RS 52877	20.50	335
149	MIDLOTHIAN	INDIAN CREEK	RS 60783	13.42	372
150	GILMER	INDIAN CREEK	RS 71326	5.59	773
151	CHEVY CHASE	INDIAN CREEK	RS 69013	6.19	773
225	US HIGHWAY 45	INDIAN CREEK	RS 8238	9.40	1236
227	IL ROUTE 83	INDIAN CREEK	RS 34841	6.95	1297
226	PORT CLINTON	INDIAN CREEK	RS 520	7.47	1019
259	HALF DAY	INDIAN CREEK	RS 3475	10.29	372
264	GILMER	INDIAN CREEK	RS 3850G	5.54	996
267	TOWNLINE	INDIAN CREEK	RS 13350	8.39	1096
268	BUTTERFIELD	INDIAN CREEK	RS 24500	11.22	185
289	BAIN STATION	JEROME CREEK	RS 0.48	19.93	210
305	93RD	JEROME CREEK	RS 1.04JC	18.68	120
335	93RD	JEROME CREEK	RS 4.45	19.93	75
291	75TH	KILBOURN DITCH	RS 0.51	17.94	15
298	I-94	KILBOURN DITCH	RS 0.78	16.94	75
315	248TH	KILBOURN DITCH	RS 1.33	27.94	150
329	60TH	KILBOURN DITCH	RS 2.81	16.94	540
332	52ND	KILBOURN DITCH	RS 3.46	16.94	570
341	12TH	KILBOURN DITCH	RS 8.01	19.44	480
86	KENSINGTON	MCDONALD CREEK	RS 2059	15.23	658
99	HINTZ	MCDONALD CREEK	RS 38122	14.24	392
254	WILLOW	MCDONALD CREEK	RS 1850	14.64	774
165	BELVIDERE	MILL CREEK	RS 92963	17.21	244
167	IL ROUTE 83	MILL CREEK	RS 89335	14.98	1378
168	CENTER	MILL CREEK	RS 88133	22.48	317
171	ATKINSON	MILL CREEK	RS 82208	16.01	1431
182	ROLLINS	MILL CREEK	RS 65515	30.76	148
184	HUTCHINS	MILL CREEK	RS 47038	1.96	8685
187	HUNT CLUB	MILL CREEK	RS 16756	14.43	564
188	I 94	MILL CREEK	RS 5368	17.76	317
189	DILLEYS	MILL CREEK	RS 4469	12.88	1297
190	US HIGHWAY 41	MILL CREEK	RS 1838	14.66	1330
228	BARRON	MILL CREEK	RS 84067	10.98	1854
229	CENTER	MILL CREEK	RS 89420	15.06	1185
206	128TH	MILL CREEK	RS 39650	7.08	2109
200	IL-173	MILL CREEK	RS 27800	5.26	2417
194	KELLEY	MILL CREEK	RS 18400	5.96	2295
191	MILLBURN	MILL CREEK	RS 5900	12.16	1010
274	GRAND	MILL CREEK	RS 26200	8.74	1552
281	GRAND	MILL CREEK	RS 60846	30.46	2525
193	ADAMS	NEWPORT DITCH	RS 23258	14.61	1865
198	IL ROUTE 173	NEWPORT DITCH	RS 13144	19.12	64
201	DELANEY	NEWPORT DITCH	RS 7321D	14.84	844
202	9TH	NEWPORT DITCH	RS 6710	14.92	857
204	KILBOURNE	NEWPORT DITCH	RS 3627	17.51	489
230	9TH	NEWPORT DITCH	RS 7321N	14.61	932
13	15TH	SILVER CREEK	RS 6966.432	11.80	858
14	NORTH	SILVER CREEK	RS 9030.912	11.35	1128
18	FULLERTON	SILVER CREEK	RS 16683.744	16.12	292
19	MANNHEIM	SILVER CREEK	RS 22601.568	11.77	1100
20	SCOTT	SILVER CREEK	RS 19226.592	12.32	1080
22	GRAND	SILVER CREEK	RS 24899.424	14.69	550
26	IRVING PARK	SILVER CREEK	RS 34306.8	10.25	1059

Flooded Roads, 500-year Storm, 2010 Conditions (continued).

VISTA ID	Road Name	Watershed	RoadStation	TIME_500YR	DUR_500YR
74	GOLF	WELLER CREEK	RS 16100	5.52	129
76	MOUNT PROSPECT	WELLER CREEK	RS 17645	3.29	296
43	RIVER	WILLOW-HIGGINS CREEK	RS 1774	23.29	534
44	DEVON	WILLOW-HIGGINS CREEK	RS 38634	12.59	568
46	HIGGINS	WILLOW-HIGGINS CREEK	RS 10243	22.09	677
47	MANNHEIM	WILLOW-HIGGINS CREEK	RS 12181	21.91	719
50	BUSSE	WILLOW-HIGGINS CREEK	RS 39922	13.89	219
51	WOLF	WILLOW-HIGGINS CREEK	RS 19557	13.74	1022
52	TOUHY	WILLOW-HIGGINS CREEK	RS 24520	21.13	372
56	WILLE	WILLOW-HIGGINS CREEK	RS 30413	11.49	543
57	ELMHURST	WILLOW-HIGGINS CREEK	RS 31638	11.88	479
49	LUNT	WILLOW-HIGGINS CREEK	RS 39072	14.79	98

Flooded Roads, 1-year Storm, 2020 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_1YR	DUR_1YR
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	15.72	338
184	HUTCHINS	MILL CREEK	RS 47038	50.59	1486

Flooded Roads, 2-year Storm, 2020 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_2YR	DUR_2YR
157	WINCHESTER	BULL CREEK	RS 14652	14.47	105
17	1ST	DESPLAINES RIVER	RS 54.201	148.50	1634
78	GOLF	DESPLAINES RIVER	RS 66.911G	125.97	1367
214	RIVER	DESPLAINES RIVER	RS 71.033R	106.31	944
238	OLD GRAND	DESPLAINES RIVER	RS 97.02	86.38	5690
273	GREENLEAF	DESPLAINES RIVER	RS 8550	18.59	957
307	TOBIN	DESPLAINES RIVER	RS 1.09	17.59	30
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	15.32	438
184	HUTCHINS	MILL CREEK	RS 47038	45.25	2682
26	IRVING PARK	SILVER CREEK	RS 34306.8	25.46	327

Flooded Roads, 5-year Storm, 2020 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_5YR	DUR_5YR
111	NORTHGATE	BUFFALO CREEK	RS 12111	17.56	324
224	WHEELING	BUFFALO CREEK	RS 7653	17.29	380
157	WINCHESTER	BULL CREEK	RS 14652	13.30	274
10	CHICAGO	DESPLAINES RIVER	RS 51.63	155.59	907
17	1ST	DESPLAINES RIVER	RS 54.201	148.50	4319
78	GOLF	DESPLAINES RIVER	RS 66.911G	125.97	10814
218	RIVER	DESPLAINES RIVER	RS 54.78	141.56	1613
219	RIVER	DESPLAINES RIVER	RS 55.27	141.69	1348
210	RIVER	DESPLAINES RIVER	RS 56.84	142.28	3506
212	RIVER	DESPLAINES RIVER	RS 63.04	143.19	1070
213	RIVER	DESPLAINES RIVER	RS 64.50R	136.34	2177
247	BUSSE	DESPLAINES RIVER	RS 64.50B	136.34	1912
246	MINER	DESPLAINES RIVER	RS 65.03	125.97	1378
248	COLLEGE CIRCLE	DESPLAINES RIVER	RS 67.48	125.97	1125
214	RIVER	DESPLAINES RIVER	RS 71.033R	106.31	10725
98	MILWAUKEE	DESPLAINES RIVER	RS 72.86	106.31	9215
238	OLD GRAND	DESPLAINES RIVER	RS 97.02	86.38	12608
251	MILWAUKEE	DESPLAINES RIVER	RS 97.08M	86.38	4466
239	IL ROUTE 132	DESPLAINES RIVER	RS 97.08L	86.38	5409
237	KILBOURNE	DESPLAINES RIVER	RS 97.81	86.38	5879
252	US HIGHWAY 41	DESPLAINES RIVER	RS 98.59	86.38	8063
244	RIVER	DESPLAINES RIVER	RS 2500R	19.16	9905
177	OPLAINE	DESPLAINES RIVER	RS 1125	18.59	963
273	GREENLEAF	DESPLAINES RIVER	RS 8550	18.59	1501
307	TOBIN	DESPLAINES RIVER	RS 1.09	17.09	45
339	I-94	DESPLAINES RIVER	RS 6.36	34.59	1695
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	15.02	593
82	RIVER	FEEHANVILLE DITCH	RS 1780	124.25	1499
184	HUTCHINS	MILL CREEK	RS 47038	30.95	4309
200	IL-173	MILL CREEK	RS 27800	35.45	361
194	KELLEY	MILL CREEK	RS 18400	38.29	15
193	ADAMS	NEWPORT DITCH	RS 23258	21.15	433
230	9TH	NEWPORT DITCH	RS 7321N	20.92	196
26	IRVING PARK	SILVER CREEK	RS 34306.8	23.69	540

Flooded Roads, 10-year Storm, 2020 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_10YR	DUR_10YR
301	60TH	BRIGHTON CREEK	RS 0.84A	26.09	30
313	85TH	BRIGHTON CREEK	RS 1.29	26.59	135
111	NORTHGATE	BUFFALO CREEK	RS 12111	16.23	551
224	WHEELING	BUFFALO CREEK	RS 7653	16.06	591
157	WINCHESTER	BULL CREEK	RS 14652	12.60	363
10	CHICAGO	DESPLAINES RIVER	RS 51.63	155.59	3015
17	1ST	DESPLAINES RIVER	RS 54.201	148.50	11909
78	GOLF	DESPLAINES RIVER	RS 66.911G	125.97	13067
91	MILWAUKEE	DESPLAINES RIVER	RS 71.033M	106.31	6167
98	MILWAUKEE	DESPLAINES RIVER	RS 72.86	106.31	11631
166	IL ROUTE 120	DESPLAINES RIVER	RS 94.51	18.22	2369
177	OPLAINE	DESPLAINES RIVER	RS 1125	18.59	1330
179	GRAND	DESPLAINES RIVER	RS 97.12	86.38	3271
180	US HIGHWAY 41	DESPLAINES RIVER	RS 98.08H	86.38	2072
210	RIVER	DESPLAINES RIVER	RS 56.84	142.28	10738
212	RIVER	DESPLAINES RIVER	RS 63.04	143.19	2631
213	RIVER	DESPLAINES RIVER	RS 64.50R	136.34	10333
214	RIVER	DESPLAINES RIVER	RS 71.033R	106.31	12959
215	RIVER	DESPLAINES RIVER	RS 76.8	38.97	7779
218	RIVER	DESPLAINES RIVER	RS 54.78	141.56	3212
219	RIVER	DESPLAINES RIVER	RS 55.27	141.69	3106
237	KILBOURNE	DESPLAINES RIVER	RS 97.81	86.38	9251
238	OLD GRAND	DESPLAINES RIVER	RS 97.02	86.38	17097
239	IL ROUTE 132	DESPLAINES RIVER	RS 97.08L	86.38	8713
244	RIVER	DESPLAINES RIVER	RS 2500R	19.16	14618
246	MINER	DESPLAINES RIVER	RS 65.03	125.97	9098
247	BUSSE	DESPLAINES RIVER	RS 64.50B	136.34	9464
248	COLLEGE CIRCLE	DESPLAINES RIVER	RS 67.48	125.97	8688
251	MILWAUKEE	DESPLAINES RIVER	RS 97.08M	86.38	7824
252	US HIGHWAY 41	DESPLAINES RIVER	RS 98.59	86.38	12011
273	GREENLEAF	DESPLAINES RIVER	RS 8550	18.59	1688
295	GREEN BAY	DESPLAINES RIVER	RS 0.69A	18.09	15
307	TOBIN	DESPLAINES RIVER	RS 1.09	16.59	60
311	SPRINGBROOL	DESPLAINES RIVER	RS 1.18	17.59	30
339	I-94	DESPLAINES RIVER	RS 6.36	27.34	2580
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	14.85	727
82	RIVER	FEEHANVILLE DITCH	RS 1780	124.25	8688
305	93RD	JEROME CREEK	RS 1.04JC	28.81	15
184	HUTCHINS	MILL CREEK	RS 47038	29.59	4887
194	KELLEY	MILL CREEK	RS 18400	33.64	611
200	IL-173	MILL CREEK	RS 27800	32.95	729
193	ADAMS	NEWPORT DITCH	RS 23258	19.40	839
201	DELANEY	NEWPORT DITCH	RS 7321D	20.12	227
202	9TH	NEWPORT DITCH	RS 6710	20.02	303
230	9TH	NEWPORT DITCH	RS 7321N	18.87	467
19	MANNHEIM	SILVER CREEK	RS 22601.568	25.26	67
26	IRVING PARK	SILVER CREEK	RS 34306.8	22.76	655

Flooded Roads, 25-year Storm, 2020 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_25YR	DUR_25YR
292	75TH	BRIGHTON CREEK	RS 0.58	25.34	30
301	60TH	BRIGHTON CREEK	RS 0.84A	25.34	90
309	60TH	BRIGHTON CREEK	RS 1.14	34.34	300
313	85TH	BRIGHTON CREEK	RS 1.29	25.84	315
106	DUNDEE	BUFFALO CREEK	RS 56983	15.39	322
111	NORTHGATE	BUFFALO CREEK	RS 12111	15.23	1594
222	DUNDEE	BUFFALO CREEK	RS 14444	18.39	58
224	WHEELING	BUFFALO CREEK	RS 7653	15.09	1661
157	WINCHESTER	BULL CREEK	RS 14652	11.84	544
159	US HWY 45	BULL CREEK	RS 13780.8	13.77	255
160	PETERSON	BULL CREEK	RS 10560	14.07	109
10	CHICAGO	DESPLAINES RIVER	RS 51.63	155.59	4560
17	1ST	DESPLAINES RIVER	RS 54.201	148.50	14389
21	GRAND	DESPLAINES RIVER	RS 55.101	141.56	2444
23	BELMONT	DESPLAINES RIVER	RS 55.651	141.69	1752
60	ALGONQUIN	DESPLAINES RIVER	RS 64.221	143.19	2080
70	RAND	DESPLAINES RIVER	RS 65.391	124.25	7825
78	GOLF	DESPLAINES RIVER	RS 66.911G	125.97	15770
91	MILWAUKEE	DESPLAINES RIVER	RS 71.033M	106.31	9798
148	IL ROUTE 60	DESPLAINES RIVER	RS 83.66	115.25	3158
152	ROCKLAND	DESPLAINES RIVER	RS 87.31	18.75	3610
154	OAK SPRING	DESPLAINES RIVER	RS 88.41	70.22	4303
166	IL ROUTE 120	DESPLAINES RIVER	RS 94.51	18.22	6876
179	GRAND	DESPLAINES RIVER	RS 97.12	86.38	7095
180	US HIGHWAY 41	DESPLAINES RIVER	RS 98.08H	86.38	6529
199	IL ROUTE 173	DESPLAINES RIVER	RS 107.11	53.06	3320
205	RUSSELL	DESPLAINES RIVER	RS 109.60	19.34	3288
218	RIVER	DESPLAINES RIVER	RS 54.78	141.56	10309
219	RIVER	DESPLAINES RIVER	RS 55.27	141.69	10141
210	RIVER	DESPLAINES RIVER	RS 56.84	142.28	13332
212	RIVER	DESPLAINES RIVER	RS 63.04	143.19	10809
213	RIVER	DESPLAINES RIVER	RS 64.50R	136.34	12843
247	BUSSE	DESPLAINES RIVER	RS 64.50B	136.34	12108
246	MINER	DESPLAINES RIVER	RS 65.03	125.97	11712
248	COLLEGE CIRCLE	DESPLAINES RIVER	RS 67.48	125.97	11428
214	RIVER	DESPLAINES RIVER	RS 71.033R	106.31	15677
98	MILWAUKEE	DESPLAINES RIVER	RS 72.86	106.31	14141
215	RIVER	DESPLAINES RIVER	RS 76.8	38.97	10917
216	RIVER	DESPLAINES RIVER	RS 77.8	38.97	4125
238	OLD GRAND	DESPLAINES RIVER	RS 97.02	86.38	21197
251	MILWAUKEE	DESPLAINES RIVER	RS 97.08M	86.38	11674
239	IL ROUTE 132	DESPLAINES RIVER	RS 97.08L	86.38	12733
237	KILBOURNE	DESPLAINES RIVER	RS 97.81	86.38	13329
252	US HIGHWAY 41	DESPLAINES RIVER	RS 98.59	86.38	16264
243	BUCKLEY	DESPLAINES RIVER	RS 2500T	19.16	2947
244	RIVER	DESPLAINES RIVER	RS 2500R	19.16	18600
241	GUERIN	DESPLAINES RIVER	RS 7025	19.16	1230
177	OPLAINE	DESPLAINES RIVER	RS 1125	18.59	1564
273	GREENLEAF	DESPLAINES RIVER	RS 8550	18.59	2413
294	122ND	DESPLAINES RIVER	RS 0.69	48.84	1500
295	GREEN BAY	DESPLAINES RIVER	RS 0.69A	17.59	45
307	TOBIN	DESPLAINES RIVER	RS 1.09	16.59	75
311	SPRINGBROOL	DESPLAINES RIVER	RS 1.18	17.34	30

Flooded Roads, 25-year Storm, 2020 Conditions (continued).

VISTA ID	Road Name	Watershed	RoadStation	TIME_25YR	DUR_25YR
312	COUNTY LINE	DESPLAINES RIVER	RS 1.25	6.34	30
339	I-94	DESPLAINES RIVER	RS 6.36	22.59	3405
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	14.70	983
82	RIVER	FEEHANVILLE DITCH	RS 1780	124.25	11528
146	DIAMOND LAKE	INDIAN CREEK	RS 39463	14.96	312
305	93RD	JEROME CREEK	RS 1.04JC	28.56	45
254	WILLOW	MCDONALD CREEK	RS 1850	17.95	149
184	HUTCHINS	MILL CREEK	RS 47038	27.79	5777
228	BARRON	MILL CREEK	RS 84067	36.79	636
206	128TH	MILL CREEK	RS 39650	31.79	782
200	IL-173	MILL CREEK	RS 27800	30.52	1146
194	KELLEY	MILL CREEK	RS 18400	31.04	1041
274	GRAND	MILL CREEK	RS 26200	32.90	520
193	ADAMS	NEWPORT DITCH	RS 23258	18.34	1232
201	DELANEY	NEWPORT DITCH	RS 7321D	18.45	475
202	9TH	NEWPORT DITCH	RS 6710	18.52	506
230	9TH	NEWPORT DITCH	RS 7321N	17.97	633
13	15TH	SILVER CREEK	RS 6966.432	23.46	538
14	NORTH	SILVER CREEK	RS 9030.912	23.01	667
19	MANNHEIM	SILVER CREEK	RS 22601.568	23.06	781
20	SCOTT	SILVER CREEK	RS 19226.592	31.11	103
26	IRVING PARK	SILVER CREEK	RS 34306.8	21.74	777
44	DEVON	WILLOW-HIGGINS CREEK	RS 38634	21.33	193
51	WOLF	WILLOW-HIGGINS CREEK	RS 19557	21.04	185
56	WILLE	WILLOW-HIGGINS CREEK	RS 30413	19.89	165
57	ELMHURST	WILLOW-HIGGINS CREEK	RS 31638	20.73	41

Flooded Roads, 50-year Storm, 2020 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_50YR	DUR_50YR
125	MILWAUKEE	APTAKISIC CREEK	RS 1950	118.19	2731
292	75TH	BRIGHTON CREEK	RS 0.58	24.84	30
300	89TH	BRIGHTON CREEK	RS 0.84	26.84	30
301	60TH	BRIGHTON CREEK	RS 0.84A	25.09	120
309	60TH	BRIGHTON CREEK	RS 1.14	31.84	705
313	85TH	BRIGHTON CREEK	RS 1.29	25.34	495
106	DUNDEE	BUFFALO CREEK	RS 56983	14.53	480
111	NORTHGATE	BUFFALO CREEK	RS 12111	14.48	1809
112	MCHENRY	BUFFALO CREEK	RS 14213	16.44	1080
113	RAND	BUFFALO CREEK	RS 50820	16.59	118
124	CHECKER	BUFFALO CREEK	RS 37164.41	24.93	406
222	DUNDEE	BUFFALO CREEK	RS 14444	16.26	1111
224	WHEELING	BUFFALO CREEK	RS 7653	14.34	1877
155	LAKE	BULL CREEK	RS 12856.8	23.87	617
158	WINCHESTER	BULL CREEK	RS 11008.8	23.64	656
157	WINCHESTER	BULL CREEK	RS 14652	11.20	636
159	US HWY 45	BULL CREEK	RS 13780.8	12.94	339
160	PETERSON	BULL CREEK	RS 10560	13.24	304
209	IRVING PARK	CRYSTAL CREEK	RS 20121	17.38	103
10	CHICAGO	DESPLAINES RIVER	RS 51.63	155.59	11846
15	NORTH	DESPLAINES RIVER	RS 52.93	148.50	1895
17	1ST	DESPLAINES RIVER	RS 54.201	148.50	16255
21	GRAND	DESPLAINES RIVER	RS 55.101	141.56	3806
23	BELMONT	DESPLAINES RIVER	RS 55.651	141.69	3438
60	ALGONQUIN	DESPLAINES RIVER	RS 64.221	143.19	9434
70	RAND	DESPLAINES RIVER	RS 65.391	124.25	10428
78	GOLF	DESPLAINES RIVER	RS 66.911G	125.97	17913
91	MILWAUKEE	DESPLAINES RIVER	RS 71.033M	106.31	11561
110	DUNDEE	DESPLAINES RIVER	RS 74.341	38.97	1528
126	DEERFIELD	DESPLAINES RIVER	RS 76.76	38.97	1610
148	IL ROUTE 60	DESPLAINES RIVER	RS 83.66	115.25	5954
152	ROCKLAND	DESPLAINES RIVER	RS 87.31	18.75	6212
154	OAK SPRING	DESPLAINES RIVER	RS 88.41	70.22	6596
166	IL ROUTE 120	DESPLAINES RIVER	RS 94.51	18.22	9132
179	GRAND	DESPLAINES RIVER	RS 97.12	86.38	9232
180	US HIGHWAY 41	DESPLAINES RIVER	RS 98.08H	86.38	8585
199	IL ROUTE 173	DESPLAINES RIVER	RS 107.11	53.06	5115
205	RUSSELL	DESPLAINES RIVER	RS 109.60	19.34	4808
218	RIVER	DESPLAINES RIVER	RS 54.78	141.56	12480
219	RIVER	DESPLAINES RIVER	RS 55.27	141.69	12354
210	RIVER	DESPLAINES RIVER	RS 56.84	142.28	15122
212	RIVER	DESPLAINES RIVER	RS 63.04	143.19	12659
213	RIVER	DESPLAINES RIVER	RS 64.50R	136.34	14676
247	BUSSE	DESPLAINES RIVER	RS 64.50B	136.34	13930
246	MINER	DESPLAINES RIVER	RS 65.03	125.97	13464
248	COLLEGE CIRCLE	DESPLAINES RIVER	RS 67.48	125.97	13174
214	RIVER	DESPLAINES RIVER	RS 71.033R	106.31	17832
98	MILWAUKEE	DESPLAINES RIVER	RS 72.86	106.31	16118
215	RIVER	DESPLAINES RIVER	RS 76.8	38.97	12883
216	RIVER	DESPLAINES RIVER	RS 77.8	38.97	9401
238	OLD GRAND	DESPLAINES RIVER	RS 97.02	86.38	24536
251	MILWAUKEE	DESPLAINES RIVER	RS 97.08M	86.38	14457
239	IL ROUTE 132	DESPLAINES RIVER	RS 97.08L	86.38	15557

Flooded Roads, 50-year Storm, 2020 Conditions (continued).

VISTA ID	Road Name	Watershed	RoadStation	TIME_50YR	DUR_50YR
237	KILBOURNE	DESPLAINES RIVER	RS 97.81	86.38	16158
252	US HIGHWAY 41	DESPLAINES RIVER	RS 98.59	86.38	18966
243	BUCKLEY	DESPLAINES RIVER	RS 2500T	19.16	5768
244	RIVER	DESPLAINES RIVER	RS 2500R	19.16	20780
241	GUERIN	DESPLAINES RIVER	RS 7025	19.16	5024
242	GUERIN	DESPLAINES RIVER	RS 4650	19.16	2611
177	OPLAINE	DESPLAINES RIVER	RS 1125	18.59	1697
172	WASHINGTON	DESPLAINES RIVER	RS 4350W	18.59	93
273	GREENLEAF	DESPLAINES RIVER	RS 8550	18.59	3114
294	122ND	DESPLAINES RIVER	RS 0.69	44.34	2445
295	GREEN BAY	DESPLAINES RIVER	RS 0.69A	17.34	90
307	TOBIN	DESPLAINES RIVER	RS 1.09	16.34	75
311	SPRINGBROOL	DESPLAINES RIVER	RS 1.18	17.09	45
312	COUNTY LINE	DESPLAINES RIVER	RS 1.25	6.09	45
339	I-94	DESPLAINES RIVER	RS 6.36	18.09	3840
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	14.60	1263
82	RIVER	FEEHANVILLE DITCH	RS 1780	124.25	13416
146	DIAMOND LAKE	INDIAN CREEK	RS 39463	13.28	666
150	GILMER	INDIAN CREEK	RS 71326	14.69	69
267	TOWNLINE	INDIAN CREEK	RS 13350	19.79	100
305	93RD	JEROME CREEK	RS 1.04JC	28.31	60
335	93RD	JEROME CREEK	RS 4.45	29.56	30
254	WILLOW	MCDONALD CREEK	RS 1850	16.00	469
184	HUTCHINS	MILL CREEK	RS 47038	26.24	6422
228	BARRON	MILL CREEK	RS 84067	33.89	1181
206	128TH	MILL CREEK	RS 39650	30.00	1103
200	IL-173	MILL CREEK	RS 27800	29.12	1422
194	KELLEY	MILL CREEK	RS 18400	29.55	1318
274	GRAND	MILL CREEK	RS 26200	31.25	773
193	ADAMS	NEWPORT DITCH	RS 23258	17.82	1489
201	DELANEY	NEWPORT DITCH	RS 7321D	17.87	591
202	9TH	NEWPORT DITCH	RS 6710	17.94	617
230	9TH	NEWPORT DITCH	RS 7321N	17.50	743
13	15TH	SILVER CREEK	RS 6966.432	22.29	674
14	NORTH	SILVER CREEK	RS 9030.912	21.99	809
19	MANNHEIM	SILVER CREEK	RS 22601.568	22.17	914
20	SCOTT	SILVER CREEK	RS 19226.592	28.02	382
22	GRAND	SILVER CREEK	RS 24899.424	28.36	36
26	IRVING PARK	SILVER CREEK	RS 34306.8	20.89	873
44	DEVON	WILLOW-HIGGINS CREEK	RS 38634	20.39	322
51	WOLF	WILLOW-HIGGINS CREEK	RS 19557	19.98	434
56	WILLE	WILLOW-HIGGINS CREEK	RS 30413	19.13	273
57	ELMHURST	WILLOW-HIGGINS CREEK	RS 31638	19.59	197

Flooded Roads, 100-year Storm, 2020 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_100YR	DUR_100YR
125	MILWAUKEE	APTAKISIC CREEK	RS 1950	118.19	8321
292	75TH	BRIGHTON CREEK	RS 0.58	24.59	45
300	89TH	BRIGHTON CREEK	RS 0.84	26.09	180
301	60TH	BRIGHTON CREEK	RS 0.84A	24.84	150
309	60TH	BRIGHTON CREEK	RS 1.14	30.34	975
313	85TH	BRIGHTON CREEK	RS 1.29	25.09	630
340	31ST	BRIGHTON CREEK	RS 7.85	30.09	180
106	DUNDEE	BUFFALO CREEK	RS 56983	13.91	610
111	NORTHGATE	BUFFALO CREEK	RS 12111	13.81	1999
112	MCHENRY	BUFFALO CREEK	RS 14213	15.58	1327
113	RAND	BUFFALO CREEK	RS 50820	15.23	322
118	APTAKISIC	BUFFALO CREEK	RS 23920	26.18	270
119	LAKE COOK	BUFFALO CREEK	RS 28633	24.79	429
124	CHECKER	BUFFALO CREEK	RS 37164.41	23.18	616
223	DUNDEE	BUFFALO CREEK	RS 15616	17.49	988
222	DUNDEE	BUFFALO CREEK	RS 14444	15.46	1343
224	WHEELING	BUFFALO CREEK	RS 7653	13.68	2078
155	LAKE	BULL CREEK	RS 12856.8	21.52	931
158	WINCHESTER	BULL CREEK	RS 11008.8	21.39	960
157	WINCHESTER	BULL CREEK	RS 14652	10.55	744
159	US HWY 45	BULL CREEK	RS 13780.8	12.37	410
160	PETERSON	BULL CREEK	RS 10560	12.64	379
162	PETERSON	BULL CREEK	RS 5913.6	23.27	364
304	75TH	CENTER CREEK	RS 1.04	28.38	15
209	IRVING PARK	CRYSTAL CREEK	RS 20121	16.70	219
9	LAKE	DESPLAINES RIVER	RS 51.041	155.59	2866
10	CHICAGO	DESPLAINES RIVER	RS 51.63	155.59	13508
15	NORTH	DESPLAINES RIVER	RS 52.93	148.50	3543
17	1ST	DESPLAINES RIVER	RS 54.201	148.50	17956
21	GRAND	DESPLAINES RIVER	RS 55.101	141.56	11050
23	BELMONT	DESPLAINES RIVER	RS 55.651	141.69	10418
27	IRVING PARK	DESPLAINES RIVER	RS 56.921	142.28	2724
60	ALGONQUIN	DESPLAINES RIVER	RS 64.221	143.19	11153
70	RAND	DESPLAINES RIVER	RS 65.391	124.25	11787
78	GOLF	DESPLAINES RIVER	RS 66.911G	125.97	19745
91	MILWAUKEE	DESPLAINES RIVER	RS 71.033M	106.31	12861
110	DUNDEE	DESPLAINES RIVER	RS 74.341	38.97	4738
126	DEERFIELD	DESPLAINES RIVER	RS 76.76	38.97	4813
148	IL ROUTE 60	DESPLAINES RIVER	RS 83.66	115.25	7936
152	ROCKLAND	DESPLAINES RIVER	RS 87.31	18.75	8113
153	PARK	DESPLAINES RIVER	RS 87.81	18.75	2176
154	OAK SPRING	DESPLAINES RIVER	RS 88.41	70.22	8485
166	IL ROUTE 120	DESPLAINES RIVER	RS 94.51	18.22	11325
179	GRAND	DESPLAINES RIVER	RS 97.12	86.38	11375
180	US HIGHWAY 41	DESPLAINES RIVER	RS 98.08H	86.38	10625
199	IL ROUTE 173	DESPLAINES RIVER	RS 107.11	53.06	6703
205	RUSSELL	DESPLAINES RIVER	RS 109.60	19.34	6337
218	RIVER	DESPLAINES RIVER	RS 54.78	141.56	13927
219	RIVER	DESPLAINES RIVER	RS 55.27	141.69	13803
210	RIVER	DESPLAINES RIVER	RS 56.84	142.28	16706
212	RIVER	DESPLAINES RIVER	RS 63.04	143.19	14075
213	RIVER	DESPLAINES RIVER	RS 64.50R	136.34	16237
247	BUSSE	DESPLAINES RIVER	RS 64.50B	136.34	15459

Flooded Roads, 100-year Storm, 2020 Conditions (continued).

VISTA ID	Road Name	Watershed	RoadStation	TIME_100YR	DUR_100YR
246	MINER	DESPLAINES RIVER	RS 65.03	125.97	14918
248	COLLEGE CIRCLE	DESPLAINES RIVER	RS 67.48	125.97	14605
214	RIVER	DESPLAINES RIVER	RS 71.033R	106.31	19743
98	MILWAUKEE	DESPLAINES RIVER	RS 72.86	106.31	17718
215	RIVER	DESPLAINES RIVER	RS 76.8	38.97	14570
216	RIVER	DESPLAINES RIVER	RS 77.8	38.97	10935
238	OLD GRAND	DESPLAINES RIVER	RS 97.02	86.38	25874
251	MILWAUKEE	DESPLAINES RIVER	RS 97.08M	86.38	16915
239	IL ROUTE 132	DESPLAINES RIVER	RS 97.08L	86.38	18015
237	KILBOURNE	DESPLAINES RIVER	RS 97.81	86.38	18606
252	US HIGHWAY 41	DESPLAINES RIVER	RS 98.59	86.38	21075
243	BUCKLEY	DESPLAINES RIVER	RS 2500T	19.16	7664
244	RIVER	DESPLAINES RIVER	RS 2500R	19.16	22394
241	GUERIN	DESPLAINES RIVER	RS 7025	19.16	7006
242	GUERIN	DESPLAINES RIVER	RS 4650	19.16	5411
177	OPLAINE	DESPLAINES RIVER	RS 1125	18.59	2261
178	IL ROUTE 132	DESPLAINES RIVER	RS 2500G	18.59	328
172	WASHINGTON	DESPLAINES RIVER	RS 4350W	18.59	1149
273	GREENLEAF	DESPLAINES RIVER	RS 8550	18.59	6665
294	122ND	DESPLAINES RIVER	RS 0.69	41.34	3060
295	GREEN BAY	DESPLAINES RIVER	RS 0.69A	17.34	105
307	TOBIN	DESPLAINES RIVER	RS 1.09	16.34	90
310	TIMBER RIDGE	DESPLAINES RIVER	RS 1.17	18.59	15
311	SPRINGBROOL	DESPLAINES RIVER	RS 1.18	16.84	60
312	COUNTY LINE	DESPLAINES RIVER	RS 1.25	5.84	60
317	I-94	DESPLAINES RIVER	RS 1.63	18.34	45
339	I-94	DESPLAINES RIVER	RS 6.36	16.34	4260
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	14.52	1534
65	MINER/DEMSTER	FARMERS-PRAIRIE CREEK	RS 4409	16.62	60
69	BALLARD	FARMERS-PRAIRIE CREEK	RS 26980.5	15.65	58
82	RIVER	FEEHANVILLE DITCH	RS 1780	124.25	14856
84	FEEHANVILLE	FEEHANVILLE DITCH	RS 7870	20.28	43
146	DIAMOND LAKE	INDIAN CREEK	RS 39463	12.16	1199
150	GILMER	INDIAN CREEK	RS 71326	12.24	406
151	CHEVY CHASE	INDIAN CREEK	RS 69013	13.88	217
264	GILMER	INDIAN CREEK	RS 3850G	12.41	552
267	TOWNLINE	INDIAN CREEK	RS 13350	15.98	616
305	93RD	JEROME CREEK	RS 1.04JC	28.31	60
335	93RD	JEROME CREEK	RS 4.45	29.06	75
298	I-94	KILBOURN DITCH	RS 0.78	26.13	15
341	12TH	KILBOURN DITCH	RS 8.01	31.13	120
86	KENSINGTON	MCDONALD CREEK	RS 2059	16.08	280
99	HINTZ	MCDONALD CREEK	RS 38122	15.08	206
254	WILLOW	MCDONALD CREEK	RS 1850	15.17	618
167	IL ROUTE 83	MILL CREEK	RS 89335	36.59	576
171	ATKINSON	MILL CREEK	RS 82208	40.09	470
184	HUTCHINS	MILL CREEK	RS 47038	24.07	7205
189	DILLEYS	MILL CREEK	RS 4469	34.37	468
190	US HIGHWAY 41	MILL CREEK	RS 1838	36.60	533
228	BARRON	MILL CREEK	RS 84067	31.79	1326
229	CENTER	MILL CREEK	RS 89420	37.59	38
206	128TH	MILL CREEK	RS 39650	28.34	1443
200	IL-173	MILL CREEK	RS 27800	27.25	1748

Flooded Roads, 100-year Storm, 2020 Conditions (continued).

VISTA ID	Road Name	Watershed	RoadStation	TIME_100YR	DUR_100YR
194	KELLEY	MILL CREEK	RS 18400	27.89	1632
191	MILLBURN	MILL CREEK	RS 5900	34.20	361
274	GRAND	MILL CREEK	RS 26200	29.70	1035
193	ADAMS	NEWPORT DITCH	RS 23258	17.40	1569
201	DELANEY	NEWPORT DITCH	RS 7321D	17.42	711
202	9TH	NEWPORT DITCH	RS 6710	17.49	734
204	KILBOURNE	NEWPORT DITCH	RS 3627	22.10	142
230	9TH	NEWPORT DITCH	RS 7321N	17.09	845
13	15TH	SILVER CREEK	RS 6966.432	21.74	744
14	NORTH	SILVER CREEK	RS 9030.912	21.54	884
18	FULLERTON	SILVER CREEK	RS 16683.744	26.86	8
19	MANNHEIM	SILVER CREEK	RS 22601.568	21.74	984
20	SCOTT	SILVER CREEK	RS 19226.592	26.71	498
22	GRAND	SILVER CREEK	RS 24899.424	26.66	226
26	IRVING PARK	SILVER CREEK	RS 34306.8	20.29	937
44	DEVON	WILLOW-HIGGINS CREEK	RS 38634	19.71	417
51	WOLF	WILLOW-HIGGINS CREEK	RS 19557	19.24	654
52	TOUHY	WILLOW-HIGGINS CREEK	RS 24520	30.76	121
56	WILLE	WILLOW-HIGGINS CREEK	RS 30413	18.54	364
57	ELMHURST	WILLOW-HIGGINS CREEK	RS 31638	18.93	294

Flooded Roads, 500-year Storm, 2020 Conditions.

VISTA ID	Road Name	Watershed	RoadStation	TIME_500YR	DUR_500YR
125	MILWAUKEE	APTAKISIC CREEK	RS 1950	118.19	11536
129	DEERFIELD	APTAKISIC CREEK	RS 15150	19.72	335
292	75TH	BRIGHTON CREEK	RS 0.58	24.34	75
300	89TH	BRIGHTON CREEK	RS 0.84	25.34	315
301	60TH	BRIGHTON CREEK	RS 0.84A	24.59	195
309	60TH	BRIGHTON CREEK	RS 1.14	28.84	1485
313	85TH	BRIGHTON CREEK	RS 1.29	24.59	825
340	31ST	BRIGHTON CREEK	RS 7.85	26.34	570
106	DUNDEE	BUFFALO CREEK	RS 56983	12.38	829
111	NORTHGATE	BUFFALO CREEK	RS 12111	11.71	2872
112	MCHENRY	BUFFALO CREEK	RS 14213	13.94	1723
113	RAND	BUFFALO CREEK	RS 50820	13.54	638
115	HICKS	BUFFALO CREEK	RS 54492	14.93	343
117	BALDWIN	BUFFALO CREEK	RS 47397	16.01	682
118	APTAKISIC	BUFFALO CREEK	RS 23920	16.11	1183
119	LAKE COOK	BUFFALO CREEK	RS 28633	18.79	1065
120	BUFFALO GROVE	BUFFALO CREEK	RS 25322	22.43	310
124	CHECKER	BUFFALO CREEK	RS 37164.41	19.19	1075
116	STATE HWY 53	BUFFALO CREEK	RS 46107.14	21.56	318
133	ROBERT PARKER COFFIN	BUFFALO CREEK	RS 47614.24	21.06	460
135	CUBA	BUFFALO CREEK	RS 69025.67	17.76	191
223	DUNDEE	BUFFALO CREEK	RS 15616	14.96	1439
222	DUNDEE	BUFFALO CREEK	RS 14444	13.83	1739
224	WHEELING	BUFFALO CREEK	RS 7653	11.48	3226
279	LAKE	BULL CREEK	RS 3160	14.64	428
155	LAKE	BULL CREEK	RS 12856.8	18.50	1416
158	WINCHESTER	BULL CREEK	RS 11008.8	18.42	1447
157	WINCHESTER	BULL CREEK	RS 14652	8.57	1099
159	US HWY 45	BULL CREEK	RS 13780.8	11.10	567
160	PETERSON	BULL CREEK	RS 10560	11.39	532
162	PETERSON	BULL CREEK	RS 5913.6	14.10	1289
304	75TH	CENTER CREEK	RS 1.04	27.88	45
30	25TH	CRYSTAL CREEK	RS 6278	16.83	276
209	IRVING PARK	CRYSTAL CREEK	RS 20121	15.63	393
7	MADISON	DESPLAINES RIVER	RS 50.211	155.41	3666
9	LAKE	DESPLAINES RIVER	RS 51.041	155.59	11995
10	CHICAGO	DESPLAINES RIVER	RS 51.63	155.59	16339
15	NORTH	DESPLAINES RIVER	RS 52.93	148.50	12822
17	1ST	DESPLAINES RIVER	RS 54.201	148.50	21198
21	GRAND	DESPLAINES RIVER	RS 55.101	141.56	14234
23	BELMONT	DESPLAINES RIVER	RS 55.651	141.69	13869
27	IRVING PARK	DESPLAINES RIVER	RS 56.921	142.28	12145
36	LAWRENCE	DESPLAINES RIVER	RS 57.921	142.28	2441
53	TOUHY	DESPLAINES RIVER	RS 62.001	143.19	7961
60	ALGONQUIN	DESPLAINES RIVER	RS 64.221	143.19	13844
70	RAND	DESPLAINES RIVER	RS 65.391	124.25	14386
78	GOLF	DESPLAINES RIVER	RS 66.911G	125.97	23427
91	MILWAUKEE	DESPLAINES RIVER	RS 71.033M	106.31	15685
110	DUNDEE	DESPLAINES RIVER	RS 74.341	38.97	11031
126	DEERFIELD	DESPLAINES RIVER	RS 76.76	38.97	10606
141	HALF DAY	DESPLAINES RIVER	RS 80.21	115.25	1100
148	IL ROUTE 60	DESPLAINES RIVER	RS 83.66	115.25	13291
152	ROCKLAND	DESPLAINES RIVER	RS 87.31	18.75	13007
153	PARK	DESPLAINES RIVER	RS 87.81	18.75	7276

Flooded Roads, 500-year Storm, 2020 Conditions (continued).

VISTA ID	Road Name	Watershed	RoadStation	TIME_500YR	DUR_500YR
154	OAK SPRING	DESPLAINES RIVER	RS 88.41	70.22	13740
161	BUCKLEY	DESPLAINES RIVER	RS 91.11	70.22	4127
166	IL ROUTE 120	DESPLAINES RIVER	RS 94.51	18.22	16181
179	GRAND	DESPLAINES RIVER	RS 97.12	86.38	16389
180	US HIGHWAY 41	DESPLAINES RIVER	RS 98.08H	86.38	15563
192	WADSWORTH	DESPLAINES RIVER	RS 103.41	63.38	4323
199	IL ROUTE 173	DESPLAINES RIVER	RS 107.11	53.06	10966
205	RUSSELL	DESPLAINES RIVER	RS 109.60	19.34	10682
211	RIVER	DESPLAINES RIVER	RS 51.67	155.59	4672
218	RIVER	DESPLAINES RIVER	RS 54.78	141.56	16770
219	RIVER	DESPLAINES RIVER	RS 55.27	141.69	16634
210	RIVER	DESPLAINES RIVER	RS 56.84	142.28	19920
212	RIVER	DESPLAINES RIVER	RS 63.04	143.19	17039
213	RIVER	DESPLAINES RIVER	RS 64.50R	136.34	19441
247	BUSSE	DESPLAINES RIVER	RS 64.50B	136.34	18622
246	MINER	DESPLAINES RIVER	RS 65.03	125.97	17994
248	COLLEGE CIRCLE	DESPLAINES RIVER	RS 67.48	125.97	17654
214	RIVER	DESPLAINES RIVER	RS 71.033R	106.31	22716
98	MILWAUKEE	DESPLAINES RIVER	RS 72.86	106.31	21091
215	RIVER	DESPLAINES RIVER	RS 76.8	38.97	18144
216	RIVER	DESPLAINES RIVER	RS 77.8	38.97	14212
238	OLD GRAND	DESPLAINES RIVER	RS 97.02	86.38	30799
251	MILWAUKEE	DESPLAINES RIVER	RS 97.08M	86.38	22314
239	IL ROUTE 132	DESPLAINES RIVER	RS 97.08L	86.38	23362
237	KILBOURNE	DESPLAINES RIVER	RS 97.81	86.38	24266
252	US HIGHWAY 41	DESPLAINES RIVER	RS 98.59	86.38	25694
253	KILBOURNE	DESPLAINES RIVER	RS 110.3	19.34	4199
243	BUCKLEY	DESPLAINES RIVER	RS 2500T	19.16	12425
244	RIVER	DESPLAINES RIVER	RS 2500R	19.16	22394
241	GUERIN	DESPLAINES RIVER	RS 7025	19.16	11634
242	GUERIN	DESPLAINES RIVER	RS 4650	19.16	9302
177	OPLAINE	DESPLAINES RIVER	RS 1125	18.59	5224
178	IL ROUTE 132	DESPLAINES RIVER	RS 2500G	18.59	1404
172	WASHINGTON	DESPLAINES RIVER	RS 4350W	18.59	1500
273	GREENLEAF	DESPLAINES RIVER	RS 8550	18.59	13603
231	DELANEY	DESPLAINES RIVER	RS 11625	18.59	181
288	I-94	DESPLAINES RIVER	RS 0.34	17.59	135
294	122ND	DESPLAINES RIVER	RS 0.69	36.84	4320
295	GREEN BAY	DESPLAINES RIVER	RS 0.69A	16.84	150
307	TOBIN	DESPLAINES RIVER	RS 1.09	16.09	105
310	TIMBER RIDGE	DESPLAINES RIVER	RS 1.17	17.59	60
311	SPRINGBROOL	DESPLAINES RIVER	RS 1.18	16.59	75
312	COUNTY LINE	DESPLAINES RIVER	RS 1.25	5.59	75
316	88TH	DESPLAINES RIVER	RS 1.41	17.09	210
317	I-94	DESPLAINES RIVER	RS 1.63	17.84	90
324	I-94	DESPLAINES RIVER	RS 2	17.59	45
339	I-94	DESPLAINES RIVER	RS 6.36	12.84	6180
342	160TH	DESPLAINES RIVER	RS 9.82	13.34	465
61	CHICAGO	FARMERS-PRAIRIE CREEK	RS 1296.5	14.27	1991
62	BUSSE	FARMERS-PRAIRIE CREEK	RS 1566	16.84	286
65	MINER/DEMSTER	FARMERS-PRAIRIE CREEK	RS 4409	14.79	506
67	POTTER	FARMERS-PRAIRIE CREEK	RS 21392	17.04	83
68	BALLARD	FARMERS-PRAIRIE CREEK	RS 6154.5	15.60	373
69	BALLARD	FARMERS-PRAIRIE CREEK	RS 26980.5	14.65	249

Flooded Roads, 500-year Storm, 2020 Conditions (continued).

VISTA ID	Road Name	Watershed	RoadStation	TIME_500YR	DUR_500YR
82	RIVER	FEEHANVILLE DITCH	RS 1780	124.25	17928
83	WOLF	FEEHANVILLE DITCH	RS 6620	20.28	564
84	FEEHANVILLE	FEEHANVILLE DITCH	RS 7870	20.28	1604
143	PORT CLINTON	INDIAN CREEK	RS 7238	19.98	135
146	DIAMOND LAKE	INDIAN CREEK	RS 39463	10.43	2112
147	INDIAN CREEK	INDIAN CREEK	RS 52877	25.23	337
149	MIDLOTHIAN	INDIAN CREEK	RS 60783	18.16	372
150	GILMER	INDIAN CREEK	RS 71326	10.33	773
151	CHEVY CHASE	INDIAN CREEK	RS 69013	10.93	773
225	US HIGHWAY 45	INDIAN CREEK	RS 8238	16.19	758
227	IL ROUTE 83	INDIAN CREEK	RS 34841	12.66	725
226	PORT CLINTON	INDIAN CREEK	RS 520	12.09	1055
259	HALF DAY	INDIAN CREEK	RS 3475	14.74	416
264	GILMER	INDIAN CREEK	RS 3850G	10.28	996
267	TOWNLINE	INDIAN CREEK	RS 13350	13.06	1101
268	BUTTERFIELD	INDIAN CREEK	RS 24500	15.64	227
272	DIAMOND LAKE	INDIAN CREEK	RS 10875	40.46	1592
289	BAIN STATION	JEROME CREEK	RS 0.48	29.56	105
305	93RD	JEROME CREEK	RS 1.04JC	28.06	105
335	93RD	JEROME CREEK	RS 4.45	28.81	150
291	75TH	KILBOURN DITCH	RS 0.51	26.63	15
298	I-94	KILBOURN DITCH	RS 0.78	25.63	75
315	248TH	KILBOURN DITCH	RS 1.33	35.63	240
329	60TH	KILBOURN DITCH	RS 2.81	25.88	405
332	52ND	KILBOURN DITCH	RS 3.46	25.63	570
341	12TH	KILBOURN DITCH	RS 8.01	28.38	480
86	KENSINGTON	MCDONALD CREEK	RS 2059	14.78	672
88	WOLF	MCDONALD CREEK	RS 7181	17.27	60
99	HINTZ	MCDONALD CREEK	RS 38122	13.90	393
254	WILLOW	MCDONALD CREEK	RS 1850	14.23	783
165	BELVIDERE	MILL CREEK	RS 92963	34.14	318
167	IL ROUTE 83	MILL CREEK	RS 89335	32.22	1430
168	CENTER	MILL CREEK	RS 88133	39.55	360
171	ATKINSON	MILL CREEK	RS 82208	33.27	1483
173	WASHINGTON	MILL CREEK	RS 77902	40.00	436
182	ROLLINS	MILL CREEK	RS 65515	46.79	358
184	HUTCHINS	MILL CREEK	RS 47038	19.50	8611
187	HUNT CLUB	MILL CREEK	RS 16756	31.90	574
188	I 94	MILL CREEK	RS 5368	34.94	386
189	DILLEYS	MILL CREEK	RS 4469	30.52	1287
190	US HIGHWAY 41	MILL CREEK	RS 1838	32.12	1342
228	BARRON	MILL CREEK	RS 84067	28.27	1902
229	CENTER	MILL CREEK	RS 89420	32.40	1186
206	128TH	MILL CREEK	RS 39650	24.67	2109
200	IL-173	MILL CREEK	RS 27800	22.85	2417
194	KELLEY	MILL CREEK	RS 18400	23.55	2295
191	MILLBURN	MILL CREEK	RS 5900	29.75	1010
274	GRAND	MILL CREEK	RS 26200	26.34	1552
281	GRAND	MILL CREEK	RS 60846	47.24	2655
193	ADAMS	NEWPORT DITCH	RS 23258	16.89	2067
198	IL ROUTE 173	NEWPORT DITCH	RS 13144	20.79	139
201	DELANEY	NEWPORT DITCH	RS 7321D	16.87	867
202	9TH	NEWPORT DITCH	RS 6710	16.94	886
204	KILBOURNE	NEWPORT DITCH	RS 3627	19.35	509

Flooded Roads, 500-year Storm, 2020 Conditions (continued).

VISTA ID	Road Name	Watershed	RoadStation	TIME_500YR	DUR_500YR
230	9TH	NEWPORT DITCH	RS 7321N	16.52	980
13	15TH	SILVER CREEK	RS 6966.432	21.02	857
14	NORTH	SILVER CREEK	RS 9030.912	20.92	1001
18	FULLERTON	SILVER CREEK	RS 16683.744	25.29	204
19	MANNHEIM	SILVER CREEK	RS 22601.568	20.97	1102
20	SCOTT	SILVER CREEK	RS 19226.592	23.39	762
22	GRAND	SILVER CREEK	RS 24899.424	24.74	449
26	IRVING PARK	SILVER CREEK	RS 34306.8	19.14	1053
74	GOLF	WELLER CREEK	RS 16100	5.53	148
76	MOUNT PROSPECT	WELLER CREEK	RS 17645	3.09	379
43	RIVER	WILLOW-HIGGINS CREEK	RS 1774	27.91	293
44	DEVON	WILLOW-HIGGINS CREEK	RS 38634	18.63	568
46	HIGGINS	WILLOW-HIGGINS CREEK	RS 10243	26.58	751
47	MANNHEIM	WILLOW-HIGGINS CREEK	RS 12181	26.54	760
50	BUSSE	WILLOW-HIGGINS CREEK	RS 39922	19.93	219
51	WOLF	WILLOW-HIGGINS CREEK	RS 19557	18.09	1252
52	TOUHY	WILLOW-HIGGINS CREEK	RS 24520	25.21	732
56	WILLE	WILLOW-HIGGINS CREEK	RS 30413	17.53	543
57	ELMHURST	WILLOW-HIGGINS CREEK	RS 31638	17.91	479
49	LUNT	WILLOW-HIGGINS CREEK	RS 39072	20.83	98

ATTACHMENT A-3

Correspondence: Wisconsin Floodwater Storage Letter

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
W239 N1812 ROCKWOOD DRIVE • PO BOX 1607 • WAUKESHA, WI 53187-1607• TELEPHONE (262) 547-6721
FAX (262) 547-1103

Serving the Counties of: KENOSHA MILWAUKEE OZAUKEE RACINE WALWORTH WASHINGTON WAUKESHA

May 21, 2010

Mr. David F. Bucaro, P.E.
Chief, Economic Formulation & Analysis Section
U.S. Army Corps of Engineers
Chicago District (CELRC)
111 N. Canal Street, Suite 600
Chicago, IL 60606

Dear Mr. Bucaro:

We are writing to provide you with the results of a hydrologic analysis of the effects on peak flood flows of providing additional floodwater storage at selected locations in the Des Plaines River watershed in Wisconsin. This analysis, which was initially discussed during an August 24, 2009 meeting involving you, Laura C. Vandenberg of your staff, and Michael G. Hahn of the Commission staff, was performed in support of the Upper Des Plaines River and Tributaries Phase II Feasibility Study that the Chicago District is conducting along with Kenosha County, Wisconsin; the Southeastern Wisconsin Regional Planning Commission (SEWRPC); Cook and Lake Counties, Illinois; and the Illinois Department of Natural Resources Division of Water Resources. The purpose of the study documented herein was to prepare a screening-level analysis of the effects on peak flood flows of providing additional floodwater storage in the overbanks along the main stem of the Des Plaines River, Brighton Creek, Kilbourn Road Ditch, and Dutch Gap Canal, all in Wisconsin.

Potential floodwater storage sites were initially identified by the Chicago District staff in March of 2009. Those sites were reviewed by the staff of the Kenosha County Department of Planning and Development in March of 2009, and the areal extents of the sites were reduced to remove areas of planned urban development, higher-quality agricultural areas that are intended to be preserved, and wetlands that are regulated by the State of Wisconsin. Mr. Hahn reviewed those adjusted areas with the Phase II Feasibility Study Project Delivery Team at its March 26, 2009 meeting.

As shown in Exhibit A and on Exhibit B, 27 possible floodwater storage sites were identified. For purposes of the hydrologic analysis, some storage areas were combined, resulting in a total of 16 stream reaches for which enhanced floodwater storage was analyzed. One of the areas identified under the initial screening (the southwestern part of DPRS48) was eliminated because the entire site is contained within the one-percent-probability floodplain and offers little opportunity for creation of additional floodwater storage. For the remaining locations, the additional floodwater storage volume was generally provided above the 50-percent-annual-probability flood stage elevation in each reach, and the storage areas were configured to maximize the volume provided, without consideration of minimizing excavation and the associated costs. Thus, the storage sites were configured to provide an upper bound estimate of the degree of peak flood flow reduction that could be achieved. For the stream reaches along the Des Plaines River, Brighton Creek, and Kilbourn Road Ditch in which potential storage sites are located, the existing volume within the one-percent-probability floodplain could be increased by about 83 percent through the addition of floodwater storage. For Dutch Gap Canal, the increase in volume could be about 19 percent.

The current study was conducted using the U.S. Environmental Protection Agency HSPF continuous simulation hydrologic model developed by the SEWRPC staff under the 2003 Des Plaines River watershed study, documented in SEWRPC Planning Report No. 44. Under the watershed study and the current study, flood flows were simulated for the period of meteorological record from 1940 through 1994 under buildout land use conditions. Statistical analyses of the annual peak flows generated with HSPF were performed using the U.S. Army Corps of Engineers HEC-FFA flood frequency analysis program that follows the procedures set forth in U.S. Water Resources Council Bulletin 17B, *Guidelines for Determining Flood Flow Frequency,* September 1981.

Based on the analyses performed for the 2003 SEWRPC Des Plaines River watershed study, it is estimated that, during a one-percent-annual-probability flood occurring under buildout land use and existing channel conditions, 101 buildings in the Wisconsin portion of the watershed could be flooded to some degree. Because those buildings are generally scattered throughout the watershed in Wisconsin, the watershed study concluded that, for most buildings, nonstructural approaches to flood mitigation would be the most cost-effective means for resolving flooding problems. The exceptions where structural measures are recommended to provide flood protection include 16 houses along Unnamed Tributary No. 6 to Brighton Creek and two houses along Unnamed Tributary No. 1 to Hooker Lake. Thus, the provision of floodwater storage is not seen as a flood mitigation measure to address problems in Wisconsin, but rather as a possible approach to reducing peak flood flows and stages in areas of potential flood damage in Illinois.

Because of the focus on flood damage reduction in Illinois, a relative comparison was made of peak flood flows in the main stem of the Des Plaines River and in Dutch Gap Canal (North Mill Creek) at the Wisconsin-Illinois State line (see Exhibit C). As seen from Exhibit C, if the additional floodwater storage volume were provided, the peak 50-, 10-, 2-, 1-, and 0.2-percent-annual-probability flood flows in the Des Plaines River main stem at the State line could decrease by up to 2.5, 3.7, 4.8, 5.1, and 5.6 percent, respectively. (The manner in which the storage areas were configured resulted in provision of additional storage below a 50-percent-probability flood stage in several storage areas, thus, some decrease was computed in the 50-percent-probability flood flow.) The peak 10-, 2-, 1-, and 0.2-percent-annual-probability flood flows in Dutch Gap Canal at the State line could decrease by up to 5.8, 10.7, 12.6, and 16.9 percent, respectively. The relatively small potential decreases in peak flood flows in the Des Plaines River main stem are in large part attributable to the flow-attenuating effect of the large floodplain wetland complex located along the eight-mile reach of the River extending upstream from the State line.

We trust that this information will be useful to you, the Plan Formulation Subcommittee, and the Project Delivery Team. Should you have any questions regarding this matter, please contact Mr. Hahn directly.

Sincerely,

Kenneth R. Yunker, P.E.
Executive Director

KRY/MGH/pk
#151567 V1 - UDPRW PH II - WIS FLOODWATER STORAGE LETTER

Enclosures

cc: Mr. George E. Melcher, Kenosha County
Mr. Richard Gosch, IDNR, Division of Water Resources

Exhibit A

UPPER DES PLAINES RIVER AND TRIBUTARIES PHASE II FEASIBILITY STUDY
EVALUATION OF POTENTIAL ADDITIONAL FLOODWATER STORAGE AREAS IN WISCONSIN
BRIGHTON CREEK, DUTCH GAP CANAL, AND KILBOURN ROAD DITCH AND DES PLAINES RIVER MAINSTEM

							Stream Totals for Reaches Evaluated Only		
POTENTIAL STORAGE AREA DESIGNATION	ADJACENT STREAM	Storage Location/ Side of Stream	Original Total HSPF Reach Volume (acre-feet)	Reach Additional Volume 2-100 Year (acre-feet)	Reach New Total Volume (acre-feet)	Reach Change in Total Volume (percent)	Total Original Volume by Stream (acre-feet)	Total Additional Volume by Stream (acre-feet)	Total Change in Volume by Stream (percent)
DPRS53 WEST (53A)	Des Plaines River	West side north of STH 142	105	558	663	531%			
DPRS 53 EAST (53B)	Des Plaines River	East side north of STH 142	with 53A						
DPRS52 WEST (52B)	Des Plaines River	Mid east side north of CTH N	with 52A						
DPR52 EAST (52A)	Des Plaines River	East side between STH 142 and CTH N	1136	133	1269	12%			
DPRS51 NW (51A)	Des Plaines River	East side south of CTH N - west of CTH D	882	86	968	10%			
DPRS51 NE (51B)	Des Plaines River	East side south of CTH N - just west of CTH D	with 51A						
DPRS51 SW (51C)	Brighton Creek	East side north of CTH K	230	89	319	39%			
DPRS51 SC (51D)	Des Plaines River	West side north of CTH K	352	314	666	89%			
DPRS51 SE (51E)	Des Plaines River	East side north of CTH K	with 51D						
DPRS48 NW (48A)	Des Plaines River	North side at CTH U/136th Ave extended	645	255	900	40%			
DPRS48 SE (48B)	Des Plaines River	South side just west of IH 94	NA	0	--	--			
			TOTAL FOR DES PLAINES RIVER ONLY				3120	1346	43%
BRRS03 NE (3A)	Brighton Creek	East side south of CTH NN	897	540	1437	60%			
BRRS03 SW (3B)	Brighton Creek	West side north of CTH K	with BR3A						
BRRS02 N (2A)	Brighton Creek	Northwest side north of STH 50	261	33	294	13%			
BRRS02 S (2B)	Brighton Creek	Southeast side north of STH 50	with BR2A						
BRRS01	Brighton Creek	West side south of CTH K - east of USH 45	with DPR 51C						
				TOTAL FOR BRIGHTON CREEK			1388	662	48%

Exhibit A (continued)

POTENTIAL STORAGE AREA DESIGNATION	ADJACENT STREAM	Storage Location/ Side of Stream	Original Total HSPF Reach Volume (acre-feet)	Reach Additional Volume 2-100 Year (acre-feet)	Reach New Total Volume (acre-feet)	Reach Change in Total Volume (percent)	Stream Totals for Reaches Evaluated Only		
							Total Original Volume by Stream (acre-feet)	Total Additional Volume by Stream (acre-feet)	Total Change in Volume by Stream (percent)
KRRS06 W (6A)	Kilbourn Road Ditch	West side south of CTH KR	331	755	1086	228%			
KRRS06 E (6B)	Kilbourn Road Ditch	East side between CTH KR and CTH A	with KR6A						
KRRS05 N (5A)	Kilbourn Road Ditch	East side between CTH A and CTH E	462	1360	1822	294%			
KRRS05 S (5B)	Kilbourn Road Ditch	East side south of CTH E	113	428	541	379%			
KRRS04	Kilbourn Road Ditch	East side north of STH 142	334	425	759	127%			
KRRS02	Kilbourn Road Ditch	Both sides south of CTH K	274	46	320	17%			
				TOTAL FOR KILBOURN ROAD DITCH			1514	3014	199%
	TOTAL FOR STREAMS TRIBUTARY TO THE DES PLAINES RIVER AT THE STATE LINE						6022	5022	83%
NMRS07	Dutch Gap Canal	West side north of CTH Q	1136	52	1188	5%			
NMRS05 N (5A)	Dutch Gap Canal	Both sides south of CTH CJ	486	172	658	35%			
NMRS05 CTR (5B)	Dutch Gap Canal	Northeast side just north of State line	48	89	137	185%			
NMRS05 S (5C)	Dutch Gap Canal	West side at State line - west of 5D	with DGC5B						
NMRS05 (5D)	Dutch Gap Canal	West side at State line	with DGC5B						
				TOTAL FOR DUTCH GAP CANAL			1670	313	19%
				STUDY TOTAL			7692	5335	69%

Exhibit C

UPPER DES PLAINES RIVER AND TRIBUTARIES PHASE II FEASIBILITY STUDY

FLOOD DISCHARGE COMPARISON
DES PLAINES RIVER WATERSHED STUDY VERSUS WITH CORPS OF ENGINEERS SUGGESTED FLOODWATER STORAGE SITES

Buildout Land Use, Existing Channel Condition

HSPF Reach No.	Stream	Location	50-Percent-Annual-Probability Floodplain (2-Year R.I.)			10-Percent-Annual-Probability Floodplain (10-Year R.I.)			2-Percent-Annual-Probability Floodplain (50-Year R.I.)			1-Percent-Annual-Probability Floodplain (100-Year R.I.)			0.2-Percent-Annual-Probability Floodplain (500-Year R.I.)		
			DPRWS	With Floodwater Detention	Percent Difference	DPRWS	With Floodwater Detention	Percent Difference	DPRWS	With Floodwater Detention	Percent Difference	DPRWS	With Floodwater Detention	Percent Difference	DPRWS	With Floodwater Detention	Percent Difference
384	Des Plaines River	State Line	855	834	-2.5	1,620	1,560	-3.7	2,290	2,180	-4.8	2,570	2,440	-5.1	3,210	3,030	-5.6
460	Dutch Gap Canal	State Line	205	205	0.0	431	406	-5.8	673	601	-10.7	787	688	-12.6	1,080	897	-16.9

ATTACHMENT A-4

Memoranda Supporting Tree-Trimming / Greenway Analysis

CELRC-ED-HH

MEMORANDUM FOR CELRD-PM-M

SUBJECT: Des Plaines Levee 37, Hydraulic Analysis for Tree Trimming to Mitigate for Project Induced Stage Increases Beyond State Regulatory Limits

1. The Des Plaines River Levee 37 project induces stage increases greater than the 0.04 ft maximum increase allowed by the state. The maximum increase with the levee project is 0.12 ft. The proposed improvement to raise Milwaukee Avenue bridge reduces the maximum increase to 0.08 ft. The levee project increases stages above the regulatory limit for approximately 10 miles downstream of the project.

2. The Buffalo Creek Reservoir project combined with the Levee 37 project brings stages below the required regulatory limits, however, Levee 37 is scheduled to be built first. To mitigate for the project induced stage increases we propose a one time trimming of trees along the river. This would include selective trimming of small overhanging branches up to the 100 year event water level (15 to 20 feet above the channel invert).

3. HEC-1 and HEC-2 models of the Des Plaines River were used to estimate the amount of tree trimming required to bring stages within regulatory limits. The base model is a model developed conjointly between the Corps and IDNR. This model is the FIS that has been corrected for errors with some of the cross sections and updated with the new bridge at Euclid Avenue. This was the existing condition base model used for comparing with project, with road raise and with tree trimming conditions.

4. Various tree trimming scenarios were tried until one was found to bring stages within regulatory limits for two proposed conditions. These were the with project alone and the combined with project/with road raise conditions.

5. Tree trimming was simulated by reducing Manning's "n" values for the channel. "n" values were reduced between river miles 46.01 and 73.095. Existing channel "n" values range from 0.040 to 0.050 for this reach. "n" value reductions were applied as follows:

CELRC-ED-HH
SUBJECT: Des Plaines Levee 37, Hydraulic Analysis for Tree Trimming to Mitigate for Project Induced Stage Increases Beyond State Regulatory Limits

Table 1 – Manning's "n" Reduction for Tree Trimming Simulation

River mile range	Approximate Landmarks	"n" value reduction
46.01 to 60. 721	Forest Ave. to Devon Ave.	0.0005
60.77 to 69.61	Devon Ave. to Euclid Ave.	0.001
69.70 to 73.095	Euclid to Dam # 1 (D. S. Dundee Rd.)	0.002

6. As a crude method to give some quantification to the tree trimming, output from the HEC-2 model runs were used along with tables from an ERDC (formerly WES) report on determining drag forces for vegetation.

7. Channel shear stress was output for each cross section for both with and without tree trimming scenarios. The difference in the shear stress between the two conditions was then determined for each cross section.

8. The shear stress was multiplied by the area of the channel bottom to find the difference in force applied to the water between the with and without tree trimming conditions. Wetted perimeter of the channel is not an output variable available in HEC-2, so it was estimated by using the difference in the channel stations (channel top width) plus two times the depth. This estimated wetted perimeter was multiplied by the channel length to estimate the area of the channel bottom.

9. Tables 2 and 3 (enclosures 1 and 2) in the appendix to the ERDC report number TN-EMRRP-SR-08, titled "Determining Drag Coefficients and Area for Vegetation" by Craig Fischenich and Syndi Dudley (http://www.wes.army.mil/el/emrrp/pdf/sr08.pdf), was used to estimate the force applied to the water by a single branch. The average 100 year velocity of the tree trim reach is 2.26 ft/sec. Drag forces were interpolated from the values in tables 2 and 3 of the report for this velocity for both with leaves and without leaves from both tables. The four values were averaged with a result of 0.28 pounds of drag force per branch.

10. The difference in the forces determined from the HEC-2 runs was equated to the number of branches needed to provide an equal force (i.e. branches to be trimmed for stage mitigation). This was computed for each of the reaches in table 1. The results are provided in table 2.

CELRC-ED-HH
SUBJECT: Des Plaines Levee 37, Hydraulic Analysis for Tree Trimming to Mitigate for Project Induced Stage Increases Beyond State Regulatory Limits

Table 2 – Trimming Requirements

Reach	Branches trimmed per 100 foot river length
Forest Ave. to Devon Ave.	180
Devon Ave. to Euclid Ave.	300
Euclid to Dam # 1 (D. S. Dundee Rd.)	590

11. Photos are enclosed as an aid in visualizing some of the typical tree and branch situations along the river.

12. It should be noted that the average channel width in the model was 183 feet wide for the tree trimming reach. The reach was canoed and from this field trip, the estimated average width between overhanging branches from one side of the river to the other would be about 100 feet or less, so the trees encroach into the channel on the average about 40 to 50 feet on each side.

13. Branches would be trimmed on both sides of the river (except in a few areas where there are no trees or where trees are in private residential yards). They would be trimmed from trees immediately adjacent to the river or up to 50 feet landward of branches overhanging the river. They could be trimmed anywhere on the trees up to height 10 feet above the waterline. Individual trimmed branches are relatively small branches, assumed to be between one and a half to two feet in length with stems approximately three eights to one half inch in diameter (to reflect ERDC report tables).

14. Contractor quantities could be developed to determine a weight per mile of trimmed branches, rather than counting individual branches.

15. Please refer questions to Mr. Jim Mazanec at extension 3113 or Rick Ackerson at extension 3119.

LINDA M. SORN, P.E.
Chief H&E Engineering Branch

Encls

RA 6/12/02
Ackerson
(X3119)
CELRC-ED-HH
SAB 6/12
CELRC-ED-HH
CELRC-ED-H

Table 2 Parametric Data for Dogwood (Fischenich 1995)

Plant Type	Dogwood 1-1		Drag and Velocity Data										
					With Leaves					Without Leaves			
Height (in)	17	Run #	Vel. (ft/sec)	Drag (lbs)	Cd_d	Cd_f	Cd_w	Vel. (ft/sec)	Drag (lbs)	Cd_d	Cd_f	Cd_w
Stem to First Branch (in)												
Stem Diameter (in)	0.375	1	1.68	0.108	0.0556	0.0485	0.0598	1.41	0.108	0.00246	0.00214	0.00264
No. Stems	1	2	2.01	0.162	0.0583	0.0509	0.0626	2.04	0.206	0.00224	0.00195	0.00240
No. Branches	11	3	2.18	0.201	0.0615	0.0537	0.0661	2.51	0.294	0.00211	0.00184	0.00227
No. Leaves	50	4	2.62	0.245	0.0519	0.0453	0.0558	3.31	0.412	0.00170	0.00148	0.00183
Leaf Thickness (in)		5	3.26	0.392	0.0536	0.0468	0.0576	3.61	0.451	0.00156	0.00137	0.00168
Leaf Width (in)	0.5	6	3.53	0.480	0.0560	0.0489	0.0602	3.92	0.451	0.00133	0.00116	0.00143
Leaf Length (in)	3	7	4.22	0.593	0.0484	0.0422	0.0520	4.44	0.623	0.00143	0.00125	0.00154
Ave. Branch Diameter (in)		8	4.44	0.618	0.0456	0.0398	0.0490	4.50	0.627	0.00140	0.00122	0.00150
Height Leaf Area (in)	13	9	4.55	0.647	0.0454	0.0396	0.0488	4.55	0.657	0.00143	0.00125	0.00154
Width Leaf Area (in)	9	10	4.53	0.642	0.0455	0.0397	0.0489	4.75	0.588	0.00118	0.00103	0.00127

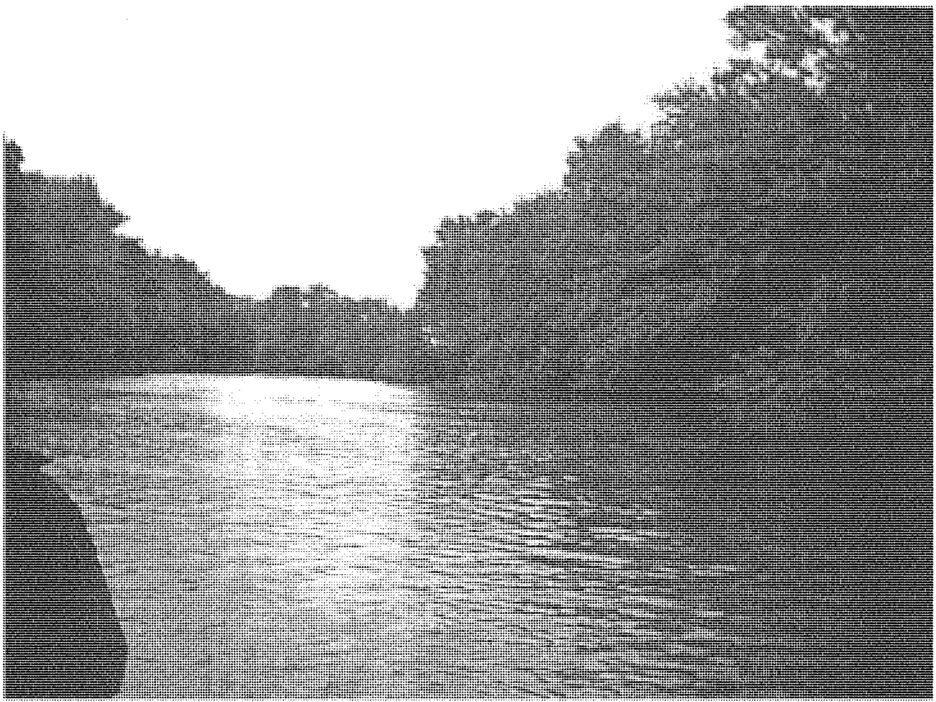
Computed A_d (ft^{-1})	0.7091503
Computed A_f (ft^2)	0.8125
Computed A_w (ft^2)	0.6598438

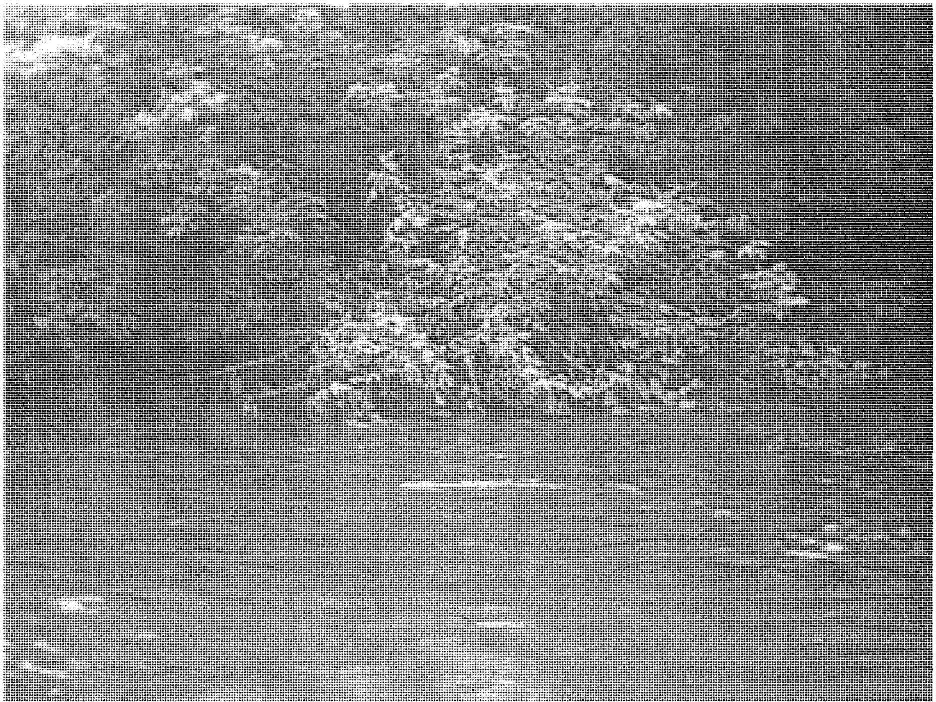
Table 3 Parametric Data for Willow (Fischenich 1995)

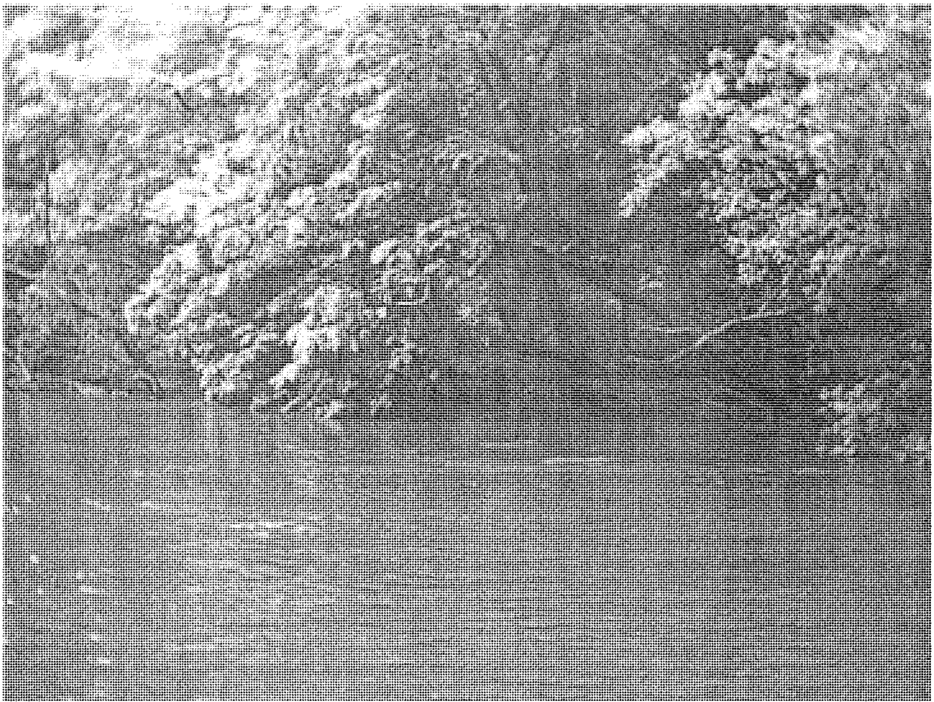
Plant Type	Arctic Blue Willow (Salix purpurea nana)
Height (in)	22
Stem to First Branch (in)	2
Stem Diameter (in)	0.509
No. Stems	1
No. Branches	50
No. Leaves	700
Leaf Thickness (in)	0.014
Leaf Width (in)	0.125
Leaf Length (in)	1
Ave. Branch Diameter (in)	0.114
Height Leaf Area (in)	20
Width Leaf Area (in)	10
Computed A_H (ft^{-1})	0.849261 8
Computed A_f (ft^2)	1.395958 3
Computed A_w (ft^2)	1.473275 8

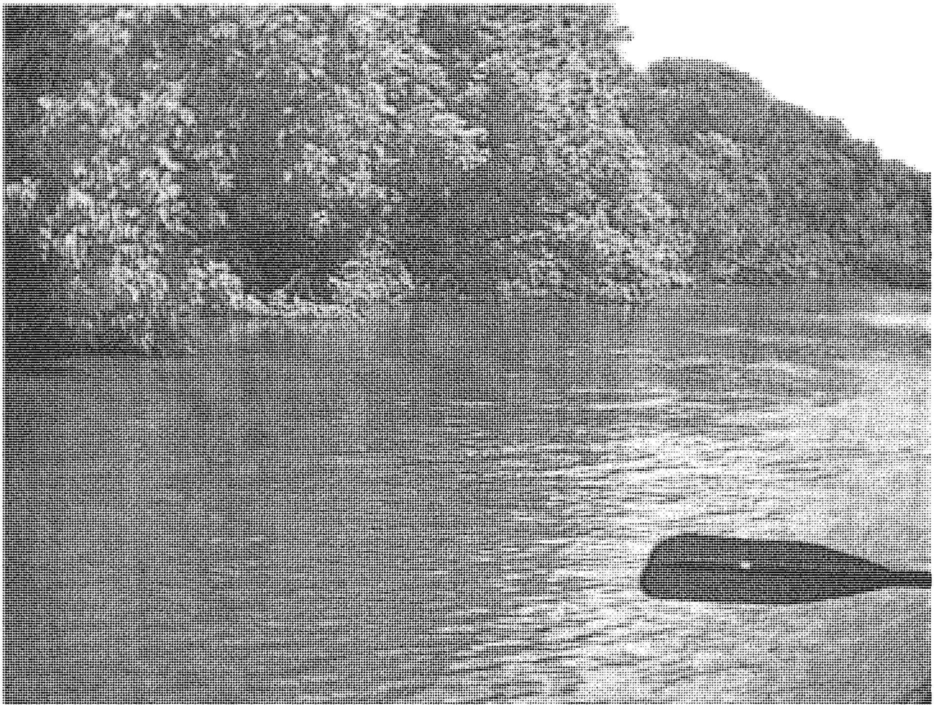
Drag and Velocity Data

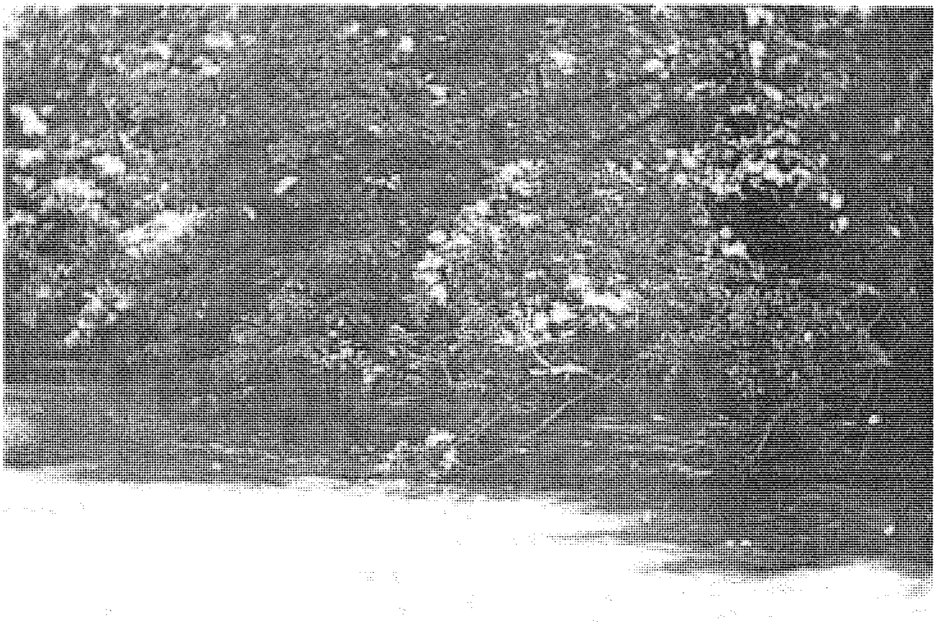
	With Leaves					Without Leaves				
Run #	Vel. (ft/sec)	Drag (lbs)	Cd_d	Cd_f	Cd_w	Vel. (ft/sec)	Drag (lbs)	Cd_d	Cd_f	Cd_w
1	1.02	0.207	0.24 15	0.14 69	0.13 92	1.43	0.129	0.0023 8	0.0014 5	0.0013 7
2	1.32	0.289	0.20 13	0.12 25	0.11 60	1.82	0.155	0.0017 7	0.0010 7	0.0010 2
3	1.79	0.366	0.13 86	0.08 43	0.07 99	2.46	0.207	0.0012 9	0.0007 9	0.0007 4
4	2.15	0.431	0.11 32	0.06 88	0.06 52	2.95	0.224	0.0009 7	0.0005 9	0.0005 6
5	2.34	0.483	0.10 71	0.06 51	0.06 17	3.50	0.272	0.0008 4	0.0005 1	0.0004 8
6	2.73	0.526	0.08 57	0.05 21	0.04 94	4.25	0.345	0.0007 2	0.0004 4	0.0004 2
7	2.92	0.560	0.07 97	0.04 85	0.04 60	4.66	0.397	0.0006 9	0.0004 2	0.0004 0
8	2.98	0.578	0.07 90	0.04 81	0.04 55	4.77	0.440	0.0007 3	0.0004 4	0.0004 2
9	3.48	0.733	0.07 35	0.04 47	0.04 23	4.94	0.466	0.0007 2	0.0004 4	0.0004 2
10	4.39	0.922	0.05 81	0.03 53	0.03 35	5.19	0.517	0.0007 2	0.0004 4	0.0004 2

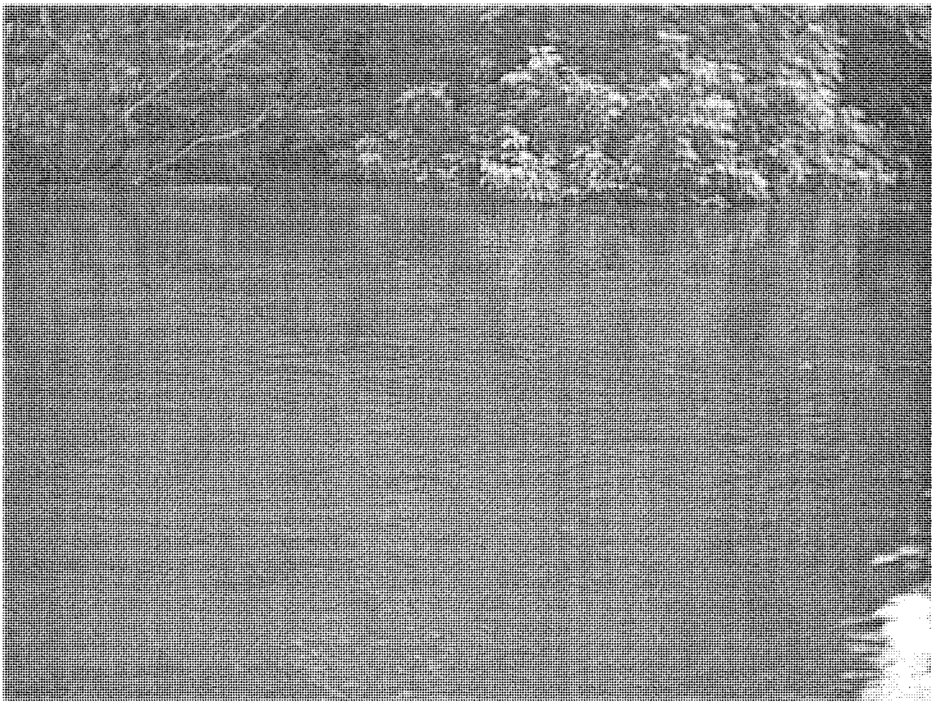


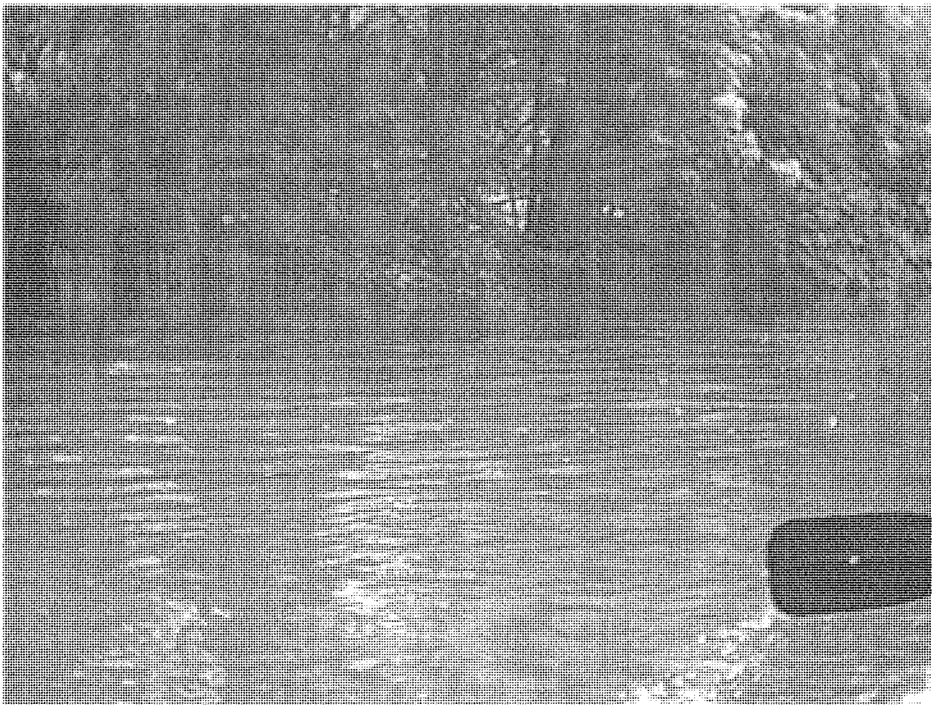












CELRC-TS-D-HH August 25, 2010

MEMORANDUM FOR RECORD

SUBJECT: Des Plaines Greenway, Hydraulic Analysis for Tree Trimming to Mitigate for Project Induced Stage Increases Beyond State Regulatory Limits

1. The Des Plaines River Levee 37 project induces stage increases greater than the 0.04 ft maximum increase allowed by the state. In 2002 the Chicago District used the HEC-1 and HEC-2 models to estimate tree-trimming along the river as a means to mitigate for these project-induced stages. Tree trimming was simulated by reducing Manning's "n" in the channel over a 27-mile reach of the river.

2. The Greenway Analysis was refined in August 2010 to consider six shorter reaches in greater detail. The six reaches were delineated by selecting the union of the inundation area for the two-year storm and Forest Preserve property where tree-trimming could conceivably be performed. Proximity to threatened structures was also considered. In these areas, overbank "n" was reduced from 0.19 to 0.08, and channel "n" values were reduced by an increment of 0.001. The steps followed in this analysis are described below.

3. Channel geometry was exported from HEC-2 into HEC-RAS, and then to an .xml that was imported into GIS. However, the scale of the cross-sections transferred incorrectly in this case; the cross-sections fell at the correct stationing along the river, but the lateral extent of each cross-section was exaggerated. To correct this problem we split each cross-section at the center of the channel and trimmed the left and right overbank to the length specified in the HEC-2 geometry. The split cross-sections were then reunified (using Data Management Tools/Generalization/Dissolve).

4. The inundation area for the two year storm was drawn in GIS by adding a field to the attribute table of the river cross-section layer. This additional column included the water surface elevations associated with each cross-section from the HEC-2 base model output. Then a Digital Elevation Model (DEM) for the project area terrain was subtracted from the water surface elevation layer (using Spatial Analyst/Math/Minus). The two-year inundation area is equal to wherever [WSEL-terrain>0]. *Note: split the layer into two classes using (Reclass/Reclassify/2 classes/Classify/Equal Interval/Break value=0). Using 3D Analyst, convert the raster to polygon and delete the polygon(s) where values are less than zero. What remains is the two-year inundation area. Clip two-year inundation area to Forest Preserve boundaries (using Analysis Tools/Extract/Clip).*

5. Next, we placed points at each intersection of the river cross-sections and the clipped inundation area (using the ET GeoWizards add-in). The distance between the left end of each cross section and the clipped floodplain was found (using Linear Referencing Tools/Create Routes/Locate Features Along Routes). With these distances we were able to modify the NH cards in the HEC 2 input to reduce the Manning's "n" value in the proposed

Greenway reaches. The "n" values outside of the Forest Preserve/two-year storm inundation area remained the same as in the base model.

6. The routing was changed using HEC-1 to reflect the resultant flow changes due to trimming. The routing changes produced some stage increases downstream, so the initial Greenway reaches were shortened to reduce the downstream impacts. The Flood Damage Reduction Analysis (HEC-FDA) model was run for each Greenway reach. Reaches 1-4 showed a BCR greater than one, but reaches 5 and 6 did not prove to be economically justified. In the last-added analysis, where the benefits of the Greenway projects were ranked among the other Des Plaines Flood Damage Reduction projects, all but Greenway Reach 2 were eliminated.

Table 1 – "Greenway" Tree-Trimming Project Reaches

Reach	Reach code	RM range	Approximate Landmarks
Reach 1	GW21	50.46 – 51.62	Washington Blvd. to Chicago Ave.
Reach 2	GW32	53.83 – 55.35	Armitage Ave. to south of Belmont Ave.
Reach 3	GW13	62.3 – 64.18	Touhy Ave. to Algonquin Rd.
Reach 4	GW24	69.93 – 72.86	West Lake St. to Hintz Rd.
Reach 5	GW05	76.4 – 78.82	Aptakistic Creek to end of FP
Reach 6	GW06	91.67 – 97.11	Bull Creek to IL Route 132

ATTACHMENT A-5

Interior Drainage Analysis

CELRC-TS-D-HH September 3, 2010

MEMORANDUM FOR RECORD

SUBJECT: Interior Drainage Facilities for Levee 15

The proposed location of Levee 15 (DPLV15) south of Buckley Road (Route 137) and just south of the previously constructed North Libertyville Estates Levee in Lake County, Illinois on the east side of the Des Plaines River. To develop interior drainage facility alternatives, a general comparison was made between the existing North Libertyville Estates Levee and the proposed DPLV15. The North Libertyville Estates Levee System has several gravity drainage outlets, as well as a 2,000 GPM pump station. The interior drainage area of DPLV15 is approximately 0.8 sq. miles, or 4 times the size of the interior drainage area of North Libertyville Estates. The following interior drainage facilities were evaluated; 4-24 inch diameter gravity, 4-48 inch diameter gravity, 4-48 inch diameter gravity with a 2,000 GPM pump station, and 4-48 inch diameter gravity with a 20,000 GPM pump station. Since there is little space for a constructed ponding area, the existing stage-storage relationship was used for the interior drainage analysis (Attachment 1).

An interior drainage analysis for LV15 was performed using HEC-RAS (4.1.0) and HEC-HMS (3.4). HEC-HMS was used to develop an interior hydrograph for a period of record (POR) between 1969 and 2009 using hourly rainfall from the rainfall gage in McHenry, Illinois. The drainage basin delineation was assumed to follow existing topography. Land use and NRCS soils data were used to develop the basin model inputs. A Clark Unit Hydrograph was used with the Green-Ampt loss method. The 100 year synthetic event was also modeled with a 6 hour, 12 hour, and 24 hour duration for each alternative. Table 1 contains model inputs used for the interior hydrograph development.

Table 1 – DPLV 15 Interior Basin Model Inputs

Area (Sq. Miles)	0.83	Moisture Deficit	0.20
Tc (hr)	1.1	Suction (in)	18.3
Storage Coef. (hr)	1.7	Conductivity (in/hr)	0.2
Initial Loss (in)	0.40	Impervious (%)	20

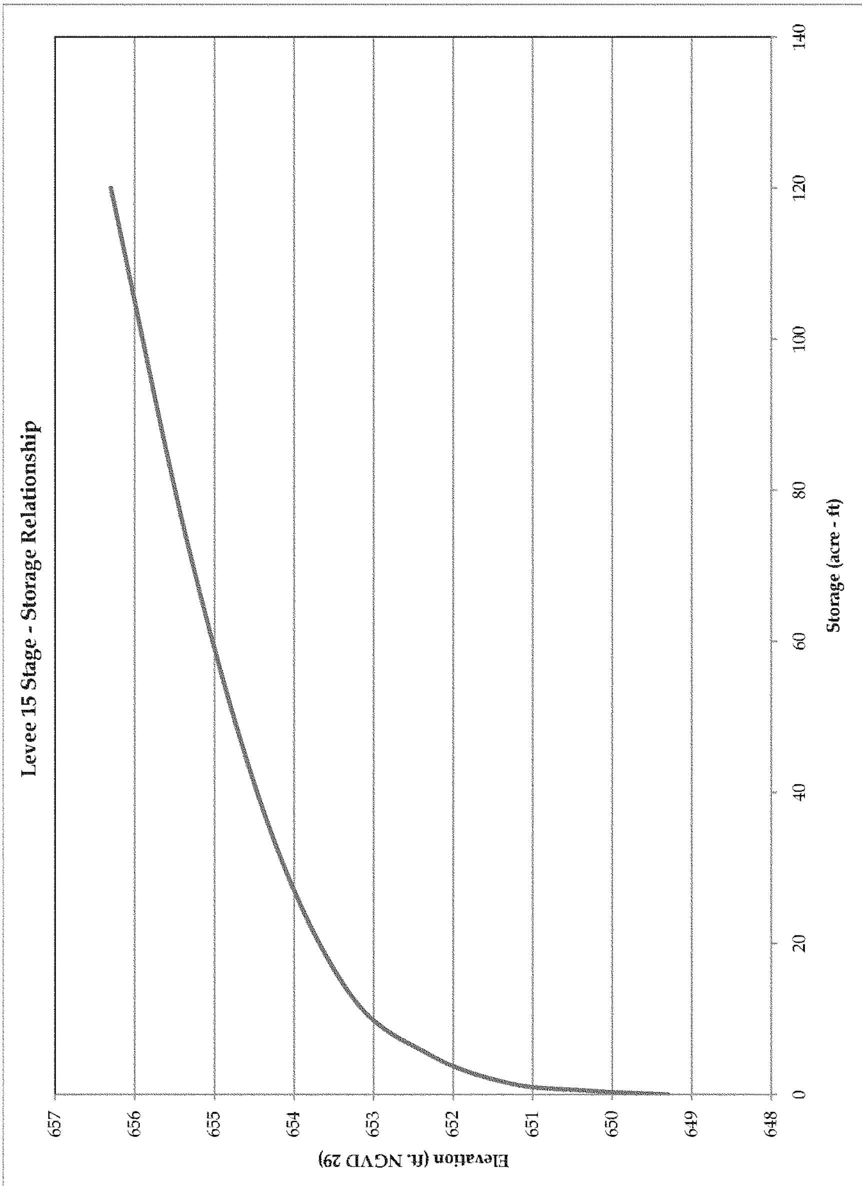
A section of the Des Plaines mainstem river model between the Gurnee gage and downstream of DPLV15 (RS 95.0 to RS 79.9) was used to develop an unsteady flow model for the period of record. The interior drainage basin was modeled as an overbank storage area in HEC-RAS with a lateral weir connection to the Des Plaines River. Historic daily flows from the Gurnee gage were used as the upstream boundary condition, and the stage-discharge relationship from the synthetic events was used for the downstream boundary condition. A USGS gage (Drainage Ditch at Libertville, 05528035) just upstream of the proposed DPLV15 has operated from 1999 to present and allows for a comparison between the modeled stage hydrograph and the observed stages. This data was used as verification that the model provides a reasonable exterior stage hydrograph for the interior drainage analysis.

The annual interior stages for each alternative were plotted using Weibull plotting positions and are shown on Attachment 2 along with the 100 year synthetic event. The largest event in 1986 produced high interior stages for all alternatives; however, the 20,000 GPM pump station provides significant reduction in the flood stages for this event. Attachment 2 also shows the 100 year, 6 hour synthetic event since the short duration event produced the highest interior stages. Since the Des Plaines River response significantly lags the smaller interior response, the exterior stages have little effect on the interior drainage facilities. Table 2 contains a comparison of the 100 year events for each alternative.

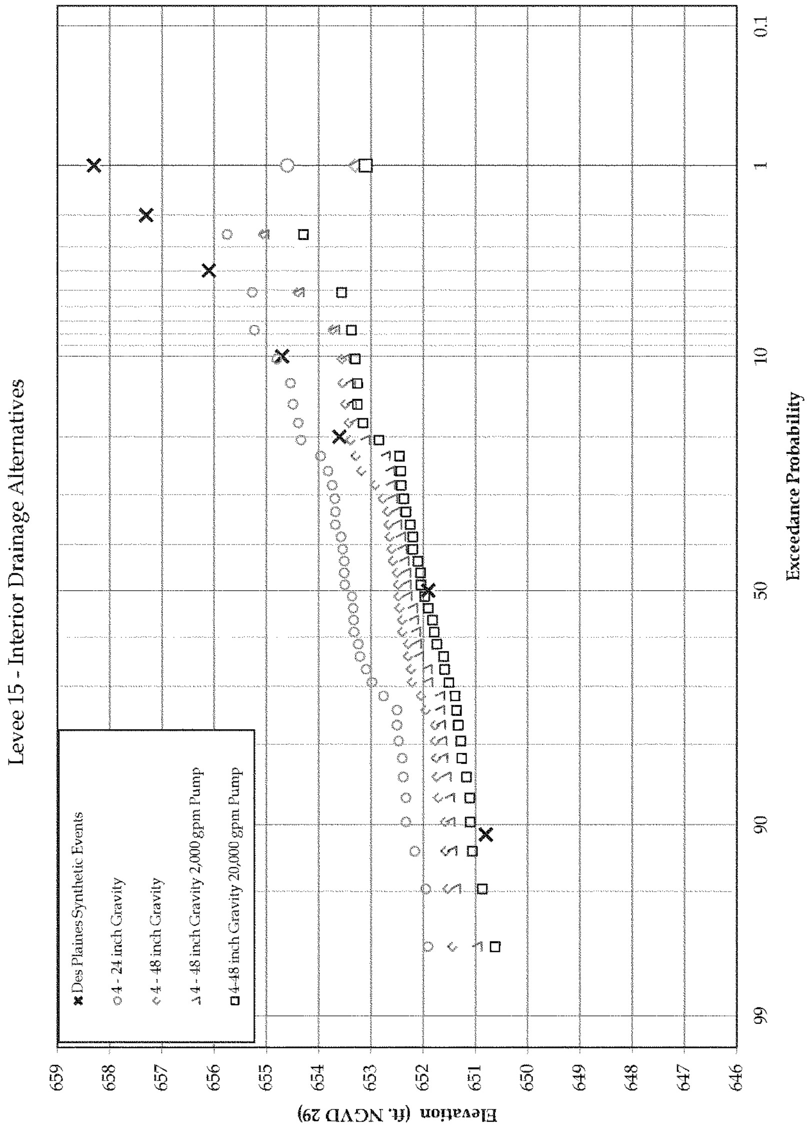
Table 2 – Maximum Interior Stages for the 100 Year Event (ft NGVD 29)

Alternative	6 Hour Event	12 Hour Event	24 Hour Event	Max POR
4 – 24 inch Dia.	654.6	654.6	653.9	655.8
4 - 48 inch Dia.	653.3	653.3	652.6	655.1
4 - 48 inch Dia. 2,000 GPM PS	653.3	653.2	652.5	655.0
4 - 48 inch Dia. 20,000 GPM PS	653.1	652.9	652.2	654.3

The period of record analysis demonstrates that exterior stages affect interior drainage. The 20,000 GPM pump station results in significant stage reductions for both the period of record and the 100 year synthetic events. Base on this analysis, the interior drainage facility will require both gravity outlets and a pump station as the minimum facility.



Attachment 1



Attachment 2

ATTACHMENT A-6

Levee 4 and Levee 5 Analysis Memorandum

CELRC-TS-DH

0 5 AUG 2013

MEMORANDUM FOR CELRC-PM-PL

SUBJECT: Des Plaines River Phase II Feasibility Study – H & H Analyses of Levees 4, 5 and Combination Levee 945.

1. A request was made by PM-PL to provide HH documentation regarding the analysis of recent levee additions to the Des Plaines Phase II study, Levee 4 and Levee 5 and the Combination Levee that includes levees 9, 4 and 5. In addition to these levee analyses, the request included the analyses of mitigation measures in conjunction with these levees.
2. These levees were analyzed using the latest relevant DP II HEC-1 and HEC-2 models. In the HEC-2 model, Levee 4 is located between cross sections at river miles 54.29 and 55.27, Levee 5 between river miles 55.99 and 56.93 and in addition to these new levees, Levee 9 is located between river miles 62.88 and 64.60 and is included in the combination levee that includes levees 9, 4 and 5.
3. Three basic mitigation reservoirs were considered for the combination levee 9, 4 and 5, and included; the Aptakisic Creek Reservoir as proposed in the Des Plaines Phase II Feasibility Report, the Aptakisic Creek Reservoir expanded to 550 acre-ft (not included in the previous report) and Reservoir DPRS15, also previously included in the report.
4. The mitigation reservoirs were investigated to find stage mitigation that would satisfy Illinois Department of Natural Resources – Office of Water Management (IDNR-OWR), construction in a floodway permit requirements. No stage impacts are allowed for the one percent chance exceedence flood event (100 year recurrence interval), and all the flood events more frequent than the one percent event. IDNR-OWR interprets no stage impacts as 0.0 ft. (0.044 ft stage increase and less is rounded to zero as a courtesy). Also stage impacts that do not impact structures can be mitigated with flowage easements. The baseline condition models were used to determine stage differences for permitting for this analysis.
5. Baseline condition stage impacts without mitigation are shown for Levees 4, 5 and the combination levee in figures 1, 2 and 3 below, respectively.
6. Both the Aptakisic Reservoir as proposed in the Feasibility Study and Reservoir DPRS15 did not provide sufficient stage reductions to satisfy the IDNR-OWR permit requirements for the Combination Levee 9, 4, and 5. Only the Aptakisic reservoir expanded to 550 acre-ft satisfied the IDNR-OWR permitting requirements. The stage differences for the three mitigation reservoir conditions on figures 4, 5, and 6 respectively, below. Only one small area located in the Cook County Forest preserve will require a flowage easement (stage impact of 0.05 ft). see area in pink on figure 7

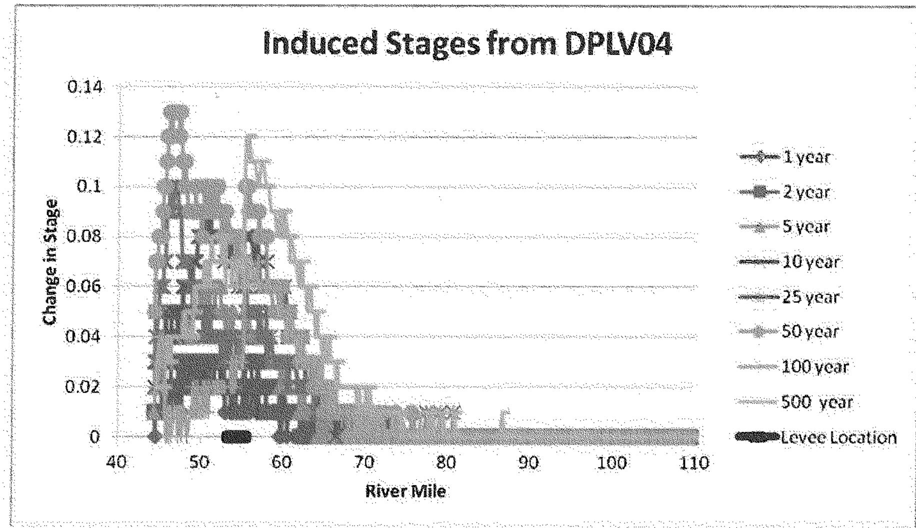


Figure 1 – Induced Stage Impacts for Levee 04

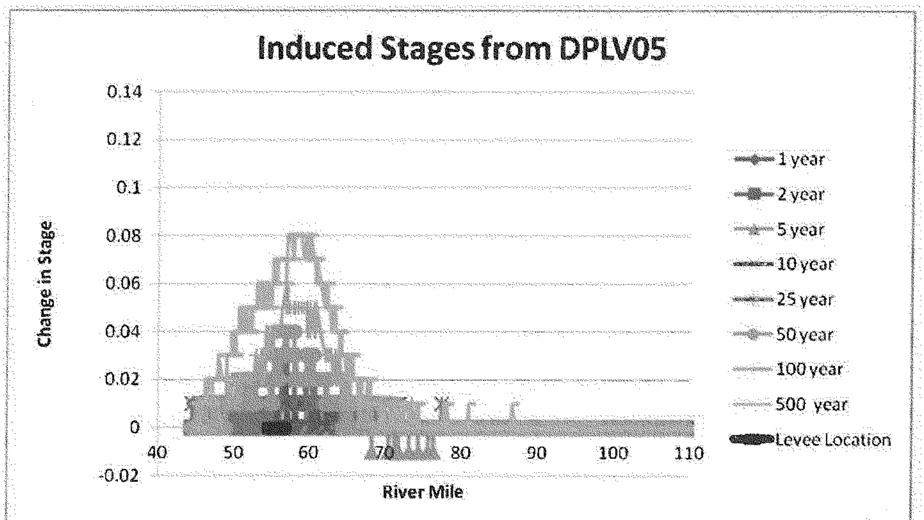


Figure 2 – Induced Stage Impacts for Levee 05

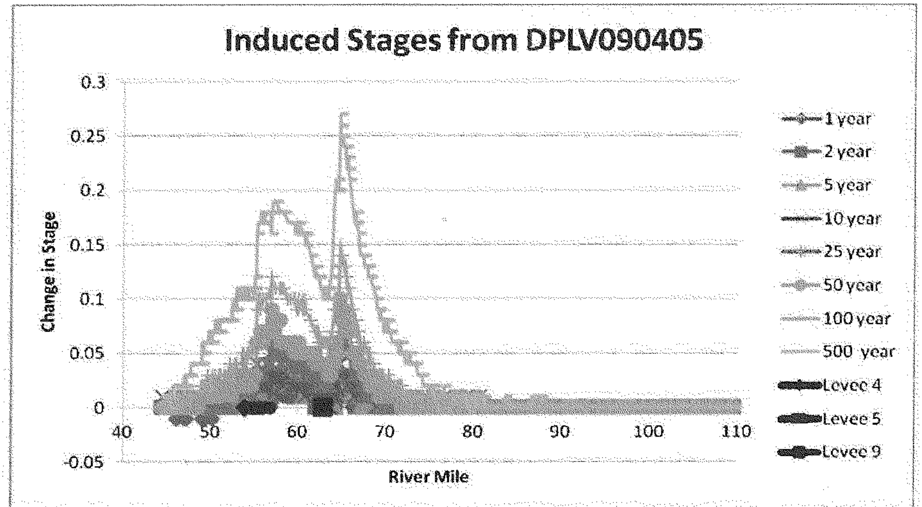


Figure 3 – Induced Stage Impacts for Combination Levee 090405

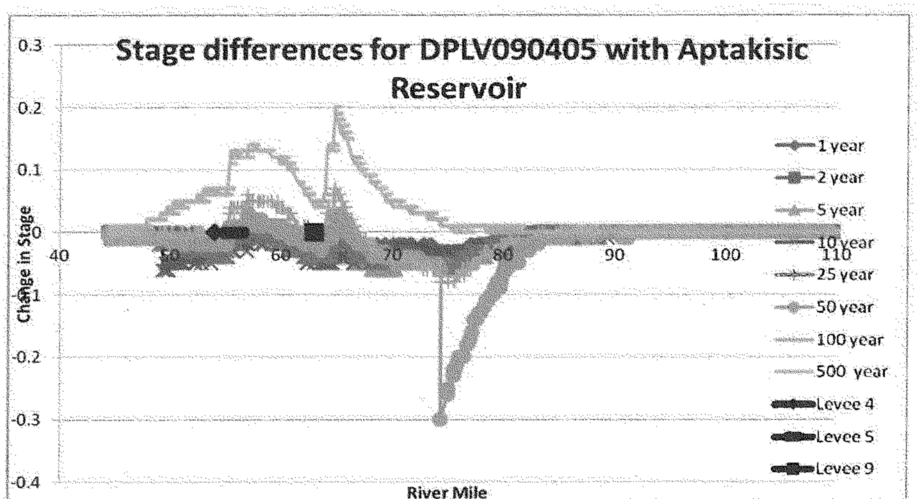


Figure 4 – Induced Stage Differences for Combination Levee 090405 with Aptakisic Reservoir (note: 50 yr spike is due to class A vs pressure flow at bridge)

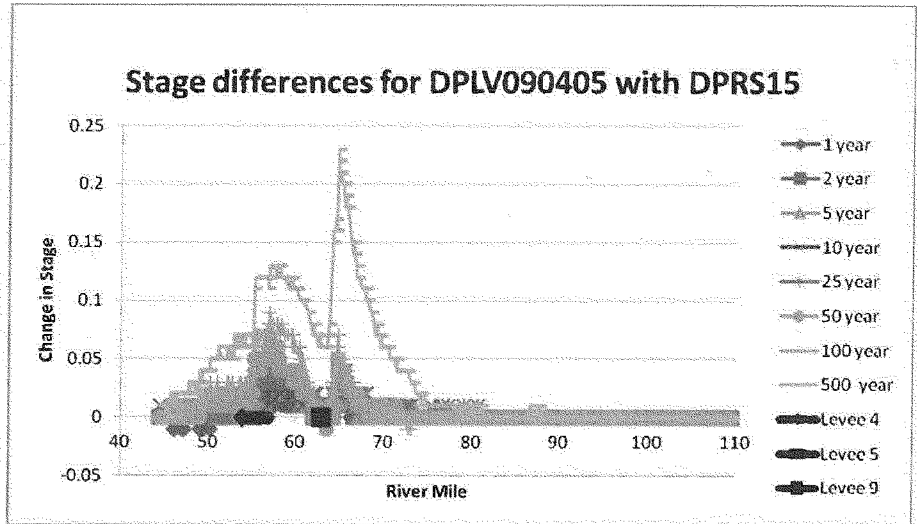


Figure 5 – Induced Stage Differences for Combination Levee 090405 with DPRS15

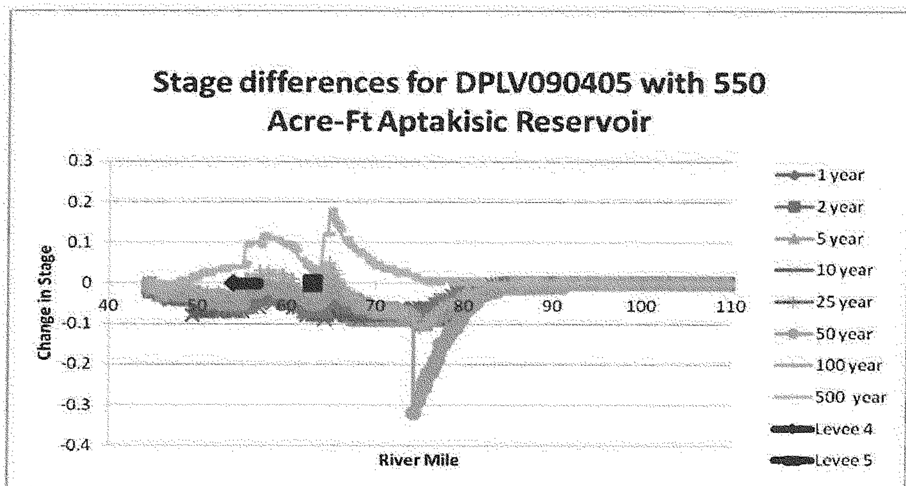


Figure 6 – Induced Stage Differences for Combination Levee 090405 with the 550 Acre-Ft Aptakisic Reservoir (note: 50 yr spike is due to class A vs pressure flow at bridge)

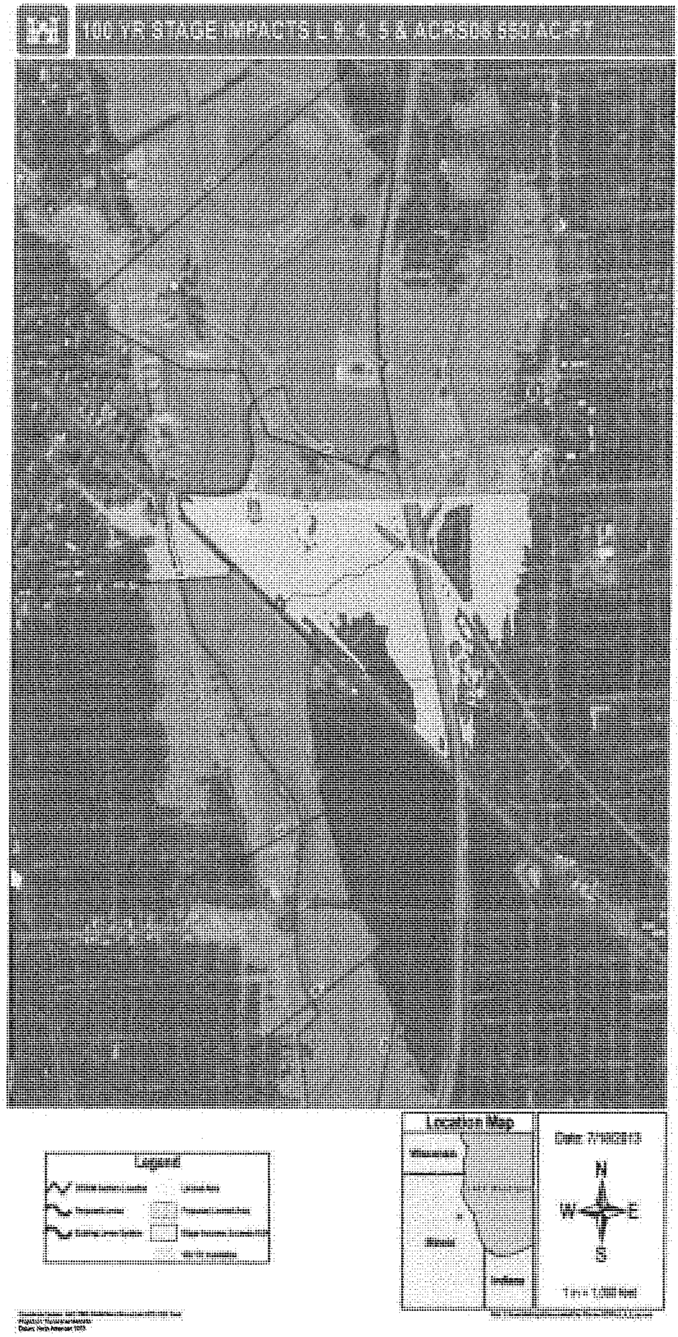


Figure 7 – Area (pink) requiring a flowage easement in Cook County Forest Preserve

7. Please contact Mr. Rick Ackerson of the Hydraulic and Environmental Engineering Section at extension 5511 if you have further questions.

Joseph Schmidt

Jay A. Semmler, P.E
for Chief, Hydraulic and Environmental Engineering Section

Upper Des Plaines River and Tributaries, Illinois and Wisconsin Integrated Feasibility Report and Environmental Assessment

Appendix B – Flood Risk Management (FRM) Plan Formulation

May 2014

US Army Corps
of Engineers®
Chicago District

May 2014

Upper Des Plaines River and Tributaries
Illinois & Wisconsin
Integrated Feasibility Report and Environmental Assessment

Appendix B – Flood Risk Management (FRM) Plan Formulation

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SECTION 1 – IDENTIFICATION OF FLOOD RISK MANAGEMENT SITES

Potential sites for implementation of flood risk management measures were identified collaboratively by the Chicago District and study partners. Using the hydraulic models developed for the watershed, the Chicago District created GIS maps of potential areas of concentrated damage (included in Appendix E). The maps show the location of potential damages, the annual chance of exceedance of the modeled flood which caused the damages, and the relative magnitude of the damages. Areas of clustered damages on these maps, stakeholder knowledge of areas affected by previous events, records of reported damages from previous events, and the results of investigations conducted during the Phase I Study were used to identify areas to be considered as sites for both structural and non-structural measures.

Due to the large footprint required and limited available open land for floodwater storage, a broader approach was used for identifying sites for potential reservoirs. From land use data provided by NIPC and SEWRPC, all sites close to the river and its tributaries coded as "open or undeveloped" were included in the preliminary screening process.

To aid in tracking the large number of sites identified, a coding system was developed to give each site a unique identifier. Six digit identification codes for each site beginning with a two letter watershed code are designated below, in **Table 1**. The watershed designation is followed by a two letter code for the type of measure and a two digit number. The measure codes are presented in **Table 2**.

Table 1 – Watershed Codes Used in Site Identification System

Watershed	Code	County
Brighton Creek	BR	Kenosha/Racine
Center Creek	CC	Kenosha
Kilbourn Road Ditch	KR	Kenosha/Racine
Jerome Creek	JC	Kenosha
Newport Ditch	ND	Lake
North Mill Creek	NM	Lake/Kenosha
Mill Creek	ML	Lake
Suburban County Club Tributary	CT	Lake
Delaney Road Tributary	DR	Lake
Gurnee Tributary	GT	Lake
Bull Creek	BC	Lake
Indian Creek	IN	Lake
Aptakisic Creek	AC	Cook/Lake
Buffalo-Wheeling Creek	BW	Cook/Lake
McDonald Creek	MD	Cook
Feehanville Ditch	FD	Cook
Weller Creek	WL	Cook
Farmer-Prairie Creek	FP	Cook
Willow-Higgins Creek	WH	Cook/DuPage
Crystal Creek	CR	Cook
Silver Creek	SC	Cook/DuPage
Des Plaines River Mainstem	DP	Cook/Lake/Kenosha

Table 2 – Measure Codes Used in Site Identification System

Measure	Code
Floodwater Storage / Reservoir	RS
Floodwater Protection / Levee / Floodwall	LV
Other Structural – Bridge Modification	BM
Other Structural – Road Raise	RR
Other Structural – Modify Existing Structure	ME
Other Structural – Drain / Channel Improvement	CI
Other Structural – General	OT
Non-Structural	NS

As required by the study authorization, sites were not excluded from consideration and evaluation "based on restrictive policies regarding the frequency of flooding, the drainage area, and the amount of runoff." Sites throughout the watershed were considered and benefits in all locations were considered during the screening and evaluation process. An assessment of the flows in channels where individually justified projects are identified was conduced after this process as discussed in Volume 2 (NED Plan Formulation) Section 3.7.

1.1 – Floodwater Storage Site Identification

As discussed above, sites along the Upper Des Plaines River and its tributaries coded as "open or undeveloped" were identified as potential floodwater storage sites. A total of 200 potential floodwater storage sites were identified throughout the entire Upper Des Plaines River watershed study area.

A preliminary site screening was conducted for the 200 sites, to narrow the list of analyzed sites to sites with a higher likelihood of being available for use as reservoirs. A set of four screening criteria was developed in order to identify potential floodwater storage sites with compatibility issues and those with the greatest likelihood of being implementable. At this step in the plan formulation process, the study team decided to exclude existing real estate ownership as a factor in screening sites. The study team reached a consensus decision for each identified site to either keep it for further evaluation or eliminate it from consideration based on the following criteria:

A. *Field Verification* – Sites were initially identified using GIS-based landuse data provided by the Northern Illinois Planning Commission (NIPC), now the Chicago Metropolitan Agency for Planning (CMAP), and SEWRPC from 2001. These sites that were coded as "open or undeveloped" in the landuse data may not actually be available for site implementation due to either coding errors or new development within the basin since the dataset was compiled. Using aerial photography and field verification, each site was checked to determine whether or not the site was undeveloped. Developed sites were immediately eliminated from further consideration.

B. *Existing Compatibility* – Some sites that were identified during the site selection process based on "open or undeveloped" land use may actually serve a critical hydrologic, recreational, cultural, social or other purpose; making significant alterations for floodwater storage impractical. Examples of existing compatibility constraints include: important established recreational lands, unique culturally significant lands, historic properties, waste disposal areas, etc.

C. *Neighboring Compatibility* – Adding potential floodwater storage at a given site needs to be compatible with adjacent lands in order for it to be supported by local interests. Adjacent properties were checked to ensure adding floodwater storage would not be detrimental. Examples of neighboring compatibility constraints include: safety concerns (schools, playgrounds, and airports), aesthetics, property values, etc.

D. *Environmental Compatibility* – It is impractical to propose a floodwater storage site on lands that currently possess significant ecological habitats. In addition to protected areas and those possessing threatened and endangered species, the high cost of mitigation and the inability to replace significant ecosystems makes this practice undesirable. Examples of environmental compatibility constraints include: natural areas, protected tracts, conservancy set-aside lands, etc.

Table 3 through **Table 21** detail the sites investigated and the results of application of each of the screening criteria to the site. Sites are grouped according to watershed. **Table 22** presents a summary of sites considered, sites eliminated, and sites kept for further consideration by watershed.

Table 3 – Reservoir Site Preliminary Site Screening Results: Brighton Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	a Field Verification	b Existing Compatibility	c Neighboring Compatibility	d Environmental Compatibility	Screening Decision	Reason for Screening Decision
BR01	Near Bristol	Kenosha	Agriculture	415	Yes	Yes	Yes	Yes	Keep	A portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided.
BR02	Near Bristol	Kenosha	Forested & Grassland / Agriculture	1063	Yes	Yes	Yes	Yes	Keep	A small portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided.
BR03	Near Bristol	Kenosha	Forested & Grassland / Agriculture	995	Yes	Yes	Yes	Yes	Keep	A portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as designated within the 100-year floodplain for planned landuse and existing channel conditions.
BR04	Near Paris	Kenosha	Mainly Agriculture / Some Forested & Grassland	824	Yes	No	NA	NA	Eliminate	A small portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
BR05	Near Paris	Kenosha	Agriculture	1588	Yes	No	NA	NA	Eliminate	Site was not identified in the SEWRPC Comprehensive Plan, March 2003, Map 65. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
BR06	Near Paris	Kenosha	Forested & Grassland / Agriculture	515	Yes	No	NA	NA	Eliminate	Site was not identified in the SEWRPC Comprehensive Plan, March 2003, Map 65. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
BR07	Near Paris	Kenosha and Racine	Agriculture	2147	Yes	No	NA	NA	Eliminate	An extremely small portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
Total 7 Sites				7,547	7 Yes 0 No 0 NA	3 Yes 4 No 0 NA	3 Yes 0 No 4 NA	3 Yes 0 No 4 NA	3 Keep 4 Eliminate	

Table 4 – Reservoir Site Preliminary Site Screening Results: Center Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
CC01	Near Woodworth	Kenosha	Agriculture / Small amount of Residential / Small amount of Forested & Grassland	145	Yes	No	NA	NA	Eliminate	The entire site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided, a small portion of the site was designated within the 100-year floodplain for planned landuse and existing channel conditions. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
CC02	Near Woodworth	Kenosha	Agriculture	204	Yes	No	NA	NA	Eliminate	The entire site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided, a small portion of the site was designated within the 100-year floodplain for planned landuse and existing channel conditions. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
CC03	Near Woodworth	Kenosha	Agriculture / Small amount of Forested & Grassland	431	Yes	No	NA	NA	Eliminate	Site was not identified in the SEWRPC Comprehensive Plan, March 2003, Map 65. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
CC04	Near Woodworth	Kenosha	Agriculture	1054	Yes	No	NA	NA	Eliminate	Site was not identified in the SEWRPC Comprehensive Plan, March 2003, Map 65. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
CC05	Near Paris	Kenosha	Agriculture	1328	Yes	No	NA	NA	Eliminate	Site was not identified in the SEWRPC Comprehensive Plan, March 2003, Map 65. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
CC06	Near Paris	Kenosha	Agriculture	690	Yes	No	NA	NA	Eliminate	Site was not identified in the SEWRPC Comprehensive Plan, March 2003, Map 65. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
CC07	Near Paris	Kenosha	Agricultural	584	Yes	No	NA	NA	Eliminate	Site was not identified in the SEWRPC Comprehensive Plan, March 2003, Map 65. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
Total 7 Sites				3,852	7 Yes 0 No 0 NA	0 Yes 7 No 0 NA	0 Yes 0 No 7 NA	0 Yes 0 No 7 NA	0 Keep 7 Eliminate	

Table 5 – Reservoir Site Preliminary Site Screening Results: Kilbourn Road Ditch

					a	b	c	d		
Site #	Community	County	NIPC Existing Landuse	Area (acres)	Field Verification	Existing Compatibility	Neighboring Compatibility	Environmental Compatibility	Screening Decision	Reason for Screening Decision
KR01	Near Kenosha	Kenosha	Primarily wetland surrounded by residential	176	Yes	Yes	Yes	Yes	Keep	A portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided.
KR02	Near Kenosha	Kenosha	Wetland, Residential, Agriculture, and Forest & Grassland	303	Yes	Yes	Yes	Yes	Keep	Majority of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided.
KR03	Near Kenosha	Kenosha	Agriculture	368	Yes	No	NA	NA	Eliminate	Majority of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
KR04	Near Somers	Kenosha	Agriculture	982	Yes	Yes	Yes	Yes	Keep	A small portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided, a larger portion of the site was designated within the 100-year floodplain for planned landuse and existing channel conditions.
KR05	Near Somers	Kenosha	Agriculture	604	Yes	Yes	Yes	Yes	Keep	Majority of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as designated within the 100-year floodplain for planned landuse and existing channel conditions.
KR06	Near Somers	Kenosha	Agriculture	628	Yes	Yes	Yes	Yes	Keep	Majority of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as designated within the 100-year floodplain for planned landuse and existing channel conditions.
KR07	Near Sturtevant	Kenosha	Agriculture / Small portion of Forest & Grassland	723	Yes	No	NA	NA	Eliminate	A portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as designated within the 100-year floodplain for planned landuse and existing channel conditions. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
Total 7 Sites				3,784	7 Yes 0 No 0 NA	5 Yes 2 No 0 NA	5 Yes 0 No 2 NA	5 Yes 0 No 2 NA	5 Keep 2 Eliminate	

Table 6 – Reservoir Site Preliminary Site Screening Results: Newport Ditch

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
ND01	Unincorporated	Lake	agricultural	254	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site would be configured to take both flow from mainstem and Newport.
ND02	Unincorporated	Lake	agricultural / residential / grassland	147	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site would be configured to take both flow from mainstem and Newport by linking with ND01
ND03	Zion / Wadsworth	Lake	wetland / agricultural / residential	189	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Potential for ecosystem compatibility problem.
ND04	Wadsworth	Lake	agricultural	29	Yes	No	Yes	No	Eliminate	Eliminated from further analysis because the site contains the headwaters of the stream which is serving important ecological functions for the watershed.
ND05	Unincorporated	Lake	wetland / utilities	17	Yes	No	Yes	No	Eliminate	Eliminated from further analysis because the site contains the headwaters of the stream which is serving important ecological functions for the watershed.
ND06	Wadsworth / Beach Park	Lake	forested & grassland / wetland / water / residential	336	No	NA	NA	NA	Eliminate	Eliminated from further analysis due to field verification showing site is being developed.
ND07	Wadsworth	Lake	wetland / agricultural	85	Yes	No	Yes	No	Eliminate	Eliminated from further analysis because the site contains the headwaters of the stream which is serving important ecological functions for the watershed.
Total 7 Sites				1,057	6 Yes 1 No	3 Yes 2 No 1 NA	5 Yes 0 No 1 NA	3 Yes 2 No 1 NA	3 Keep 4 Eliminate	

Table 7 – Reservoir Site Preliminary Site Screening Results: North Mill Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
NM01	Old Mill Creek	Lake	agricultural / wetland	601	Yes	Yes	Yes	TBD	Keep	Keep for further analysis. Potential for ecosystem compatibility problem.
NM02	Old Mill Creek	Lake	agricultural / wetland / residential	989	Yes	No	No	No	Eliminate	Site is Ethel's Woods Forest Preserve. Eliminated from further analysis because site is planned for ecosystem restoration, serves important ecological functions and contains significant constraints including T&E species and property deed restrictions. Eliminated by LCFPD per 23-Mar-09 letter.
NM03	Antioch	Lake	agricultural / grassland / residential	546	Yes	Yes	Yes	Yes	Keep	Keep for further analysis.
NM04	Unincorporated	Lake	agricultural / grassland / residential / cemetery	673	Yes	Yes	Yes	TBD	Keep	Keep for further analysis. Potential for ecosystem compatibility problem as there may be a mitigation bank at this site.
NM05	Unincorporated	Kenosha	agricultural / wetland / industrial	689	Yes	Yes	Yes	TBD	Keep	Keep for further analysis. Potential for ecosystem compatibility problem.
NM06	Unincorporated	Kenosha	agricultural / forest / wetland / residential	1,183	Yes	No	Yes	No	Eliminate	Eliminated from further analysis because site contains the headwaters of the stream which are serving important ecological functions as a high quality natural area. Eliminated by SEWPRC per 26-Mar-09 Mtg.
NM07	Unincorporated	Kenosha	agricultural / forest / wetland / / industrial / water / residential	1,619	Yes	No	Yes	TBD	Keep	Keep for further analysis. Potential for ecosystem compatibility problem.
NM08	Unincorporated	Kenosha	agricultural / forest / wetland / / industrial / water / residential	522	Yes	No	Yes	No	Eliminate	Eliminated from further analysis because the site contains the headwaters of the stream which are serving important ecological functions as a high quality natural area. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
Total 8 Sites				6,822	8 Yes 0 No	5 Yes 3 No	8 Yes 0 No	2 Yes 3 No 3 TBD	5 Keep 3 Eliminate	

Table 8 – Reservoir Site Preliminary Site Screening Results: Mill Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
ML01	Wadsworth	Lake	forested & grassland / wetland / agriculture / residential	213	Yes	No	No	Yes	Eliminate	Eliminated from further analysis because the site is bisected by the creek and bounded by roads. Due to these constraints the site is not conducive to efficient alterations.
ML02	Wadsworth	Lake	forested & grassland	22	Yes	No	No	Yes	Eliminate	Eliminated from further analysis because the site is bisected by the creek and bounded by roads. Due to these constraints the site is not conducive to efficient alterations.
ML03	Old Mill Creek	Lake	forested & grassland / wetland / agriculture / residential	951	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site has been identified as a potential area for ecological restoration
ML04	Old Mill Creek	Lake	forested & grassland / wetland / agriculture / residential	1481	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site has been identified as a potential area for ecological restoration
ML05	Old Mill Creek / Grandwood Park	Lake	agriculture / wetland / residential	51	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis because the site is the riparian corridor of the creek and is serving important ecological functions in this capacity.
ML06	Grandwood Park	Lake	agriculture / wetland / residential	46	Yes	Yes	Yes	Yes	Keep	Keep for further analysis.
ML07	Unincorporated	Lake	residential / wetland	17	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis because the site is the riparian corridor of the creek and is serving important ecological functions in this capacity.
ML08	Unincorporated	Lake	residential / grassland / vacant / commercial	34	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis because the site is disconnected from the stream by a road.

Table 8 (cont) – Reservoir Site Preliminary Site Screening Results: Mill Creek

					a	*b*	*c*	*d*		
Site #	Community	County	NIPC Existing Landuse	Area (acres)	Field Verification	Existing Compatibility	Neighboring Compatibility	Environmental Compatibility	Screening Decision	Reason for Screening Decision
ML09	Grayslake / Third Lake	Lake	agriculture / residential	1064	Yes	No	Yes	No	Eliminate	This is Rollins Savanna Forest Preserve where significant ecosystem restoration has taken place. Site eliminated by LCFPD per 23-Mar-09 letter.
ML10	Third Lake / Venetian Village / Lindhurst	Lake	agriculture / wetland / residential	730	Yes	No	Yes	No	Eliminate	This is Fourth Lake Forest Preserve and is a state-dedicated Illinois Nature Preserve. Site eliminated by LCFPD per 23-Mar-09 letter.
ML11	Third Lake / Grayslake	Lake	agriculture / wetland / residential	53	Yes	No	Yes	Yes	Eliminate	This is part of Rollins Savanna Forest Preserve where wetland restoration has already taken place. Site eliminated by LCFPD per 23-Mar-09 letter.
ML12	Grayslake	Lake	agriculture / wetland / residential	50	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis because the site is the riparian corridor of the creek and is serving important ecological functions in this capacity.
ML13	Grayslake	Lake	agriculture / wetland / residential	16	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis due to size of site and location within the watershed separate from the creek,
ML14	Grayslake / Round Lake Park	Lake	agriculture / wetland / residential	1210	Yes	No	Yes	No	Eliminate	Eliminated from further analysis because the site contains the headwaters of the stream and its riparian corridor which are serving important ecological functions as a high quality natural area.
Total 14 Sites				5,938	14 Yes 0 No	3 Yes 11 No	12 Yes 2 No	11 Yes 3 No	3 Keep 11 Eliminate	

Table 9 – Reservoir Site Preliminary Site Screening Results: Gurnee Tributary

					a	b	c	d		
Site #	Community	County	NIPC Existing Landuse	Area (acres)	Field Verification	Existing Compatibility	Neighboring Compatibility	Environmental Compatibility	Screening Decision	Reason for Screening Decision
GT01	Gurnee	Lake	forested	15	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. This site was evaluated during the Phase I analysis. Potential during reevaluation.
Total 1 Sites				15	1 Yes 0 No	1 Yes 0 No	1 Yes 0 No	1 Yes 0 No	1 Keep 0 Eliminate	

Table 10 – Reservoir Site Preliminary Site Screening Results: Bull Creek

					a	b	c	d		
Site #	Community	County	NIPC Existing Landuse	Area (acres)	Field Verification	Existing Compatibility	Neighboring Compatibility	Environmental Compatibility	Screening Decision	Reason for Screening Decision
BC01	Mundelein	Lake	forested & grassland / agricultural / residential	251	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis because the site contains the headwaters of the stream which is serving important ecological functions for the watershed.
BC02	Mundelein	Lake	golf course / wetland / grassland / residential	111	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Adjacent to a damage site and a good candidate for additional storage.
BC03	Libertyville	Lake	forested & grassland / agricultural / residential / utilities	337	Yes	No	Yes	No	Eliminate	Eliminated from further analysis due to site being a preserved high quality ecosystem. It should be noted that any proposed ecosystem restoration measures should consider enhancing the floodwater storage capabilities of this site.
BC04	Libertyville	Lake	forested & grassland / wetland	24	Yes	Yes	Yes	No	Eliminate	Eliminated from further analysis due to site being an important forested ecosystem.
Total 4 Sites				723	4 Yes 0 No	2 Yes 2 No	4 Yes 0 No	2 Yes 2 No	1 Keep 3 Eliminate	

Table 11 – Reservoir Site Preliminary Site Screening Results: Indian Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
IN01	Lincolnshire	Lake	forested & grassland / wetland / urban mix	37	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site has stream to the east of the site. There is a potential to connect adjacent area west of Milwaukee Ave to this area.
IN02	Lincolnshire	Lake	forested & grassland / urban mix / residential	13	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis because the site is primarily occupied by the creek and therefore the site would have a low storage efficiency.
IN03	Vernon Hills / Buffalo Grove	Lake	forested & grassland / industrial / residential	46	Yes	No	No	No	Eliminate	Eliminated from further analysis because the site is the riparian corridor of the river and is serving important ecological functions. In addition, there are compatibility constraints in regard to residential homes immediately adjacent to the site.
IN04	Vernon Hills / Buffalo Grove	Lake	forested & grassland / wetland / utilities / residential	62	Yes	No	No	No	Eliminate	Eliminated from further analysis due to having ecosystem significance as a high quality forested area. In addition there are compatibility constraints in regard to residential homes immediately adjacent to the site.
IN05	Vernon Hills / Buffalo Grove / Long Grove	Lake	forested & grassland / wetland / utilities / residential	160	Yes	No	No	No	Eliminate	Eliminated from further analysis because the site is the riparian corridor of the river and is serving important ecological functions as a high quality natural area. In addition, there are compatibility constraints in regard to residential homes immediately adjacent to the site.
IN06	Long Grove	Lake	forested & grassland / wetland / residential	44	Yes	No	No	No	Eliminate	Eliminated from further analysis because the site is the riparian corridor of the river and is serving important ecological functions as a high quality natural area. In addition, there are compatibility constraints in regard to residential homes immediately adjacent to the site.
IN07	Long Grove	Lake	forested & grassland / wetland / agriculture / utilities / residential	156	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site appears to be utilized as an existing nursery.

Table 11 (cont) – Reservoir Site Preliminary Site Screening Results: Indian Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
IN08	Long Grove / Hawthorn Woods	Lake	forested & grassland / wetland / agriculture / residential	25	Yes	No	No	Yes	Eliminate	Eliminated from further analysis due to an existing reservoir and road on the site. In addition, there are compatibility constraints in regard to residential homes immediately adjacent to the site.
IN09	Long Grove / Hawthorn Woods	Lake	forested & grassland / wetland / agriculture / residential	224	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Potential site with trimming of boundary
IN10	Long Grove / Hawthorn Woods	Lake	forested & grassland / wetland / agriculture	410	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Potential site with trimming of boundary
IN11	Mundelein	Lake	forested & grassland	108	Yes	No	No	No	Eliminate	Eliminated from further analysis because the site contains the headwaters of the stream and its riparian corridor which are serving important ecological functions as a high quality natural area.
Total 11 Sites				1,485	11 Yes 0 No	4 Yes 7 No	5 Yes 6 No	6 Yes 5 No	4 Keep 7 Eliminate	

Table 12 – Reservoir Site Preliminary Site Screening Results: Aptakisic Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
AC01	Unincorporated	Lake	forested & grassland / water / residential	13	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Western portion of the site is already a reservoir. Expansion to the east is a potential. Potential to link with AC02 as well.
AC02	Buffalo Grove	Lake	forested & grassland / industrial	18	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Area west of the site is open water. Potential expansion to the east. Potential to link with AC01 as well.
AC03	Buffalo Grove	Lake	forested & grassland / industrial / utilities	56	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. This site was looked at for DPI. Appears to be an existing landfill from the aerial and contours.
AC04	Buffalo Grove	Lake	wetland / industrial	18	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis due to the site's shape is a narrow strip of the river corridor and would not be conducive to efficient alterations.
AC05	Buffalo Grove	Lake	residential / recreation	11	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis because the majority of the site is currently occupied by the channel, an existing lake and ball fields. The remaining land area is too small for efficient alterations.
AC06	Buffalo Grove / Long Grove	Lake	forested & grassland / wetland / residential	31	Yes	No	Yes	No	Eliminate	Eliminated from further analysis due to the site already being a wetland and having ecosystem significance.
AC07	Long Grove	Lake	forested & grassland / water / residential	51	Yes	No	No	Yes	Eliminate	Eliminated from further analysis due to the site being adjacent to residential area and currently functions as a floodwater retention area for the sub-division.
AC08	Buffalo Grove	Lake	agricultural	95	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. This site is slightly farther away than 250-ft, but is a large open space. This site was added due to proximity to stream
AC09	Buffalo Grove	Lake	wetland / grassland	21	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. This triangular area is adjacent to the creek. Potential for storage.
Total 9 Sites				314	9 Yes 0 No	5 Yes 4 No	8 Yes 1 No	8 Yes 1 No	5 Keep 4 Eliminate	

Table 13 – Reservoir Site Preliminary Site Screening Results: Buffalo-Wheeling Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
BW00	Wheeling	Cook	forested & grassland / aircraft transportation	21	Yes	Yes	No	Yes	Eliminate	Eliminated from further analysis due to neighboring airport runway. FAA regulations prohibit constructing an open water area that would attract hazardous wildlife within 10,000-ft of an air operations area. (FAA Advisory Circular AC150/5200-33A)
BW01	Wheeling	Cook	forested & grassland / residential	9	Yes	Yes	Yes	Yes	Eliminate*	Keep for further analysis of other measures. Due to location neighboring airport, only non-open water measures should be considered. Potential measures include floodplain alterations such as stream bank and floodplain terracing.
BW02	Wheeling	Cook	forested & grassland / industrial / residential	11	Yes	No	No	Yes	Eliminate	Eliminated from further analysis due to existing low-lying area that currently serves as floodplain storage and neighboring compatibility constraints due to residential homes immediately adjacent to the site. In addition, the site is oddly shaped and not conducive to efficient alterations.
BW03	Wheeling	Cook	parks / residential / government	48	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Due to a small (possibly low quality?) wetland in the northern part of the site, mitigation may be necessary. Potential added costs for replacement and/or relocation of existing recreational facilities.
BW04	Wheeling	Cook	forested & grassland / business / residential / educational	6	Yes	Yes	Yes	Yes	Eliminate*	Keep for further analysis of other measures. Due to location adjacent to stream and small size of site, viable potential measures to be considered include floodplain alterations such as stream bank and floodplain terracing. Potential municipal owned piece of property that may have interest in parkland due to neighboring library.
BW05	Wheeling	Cook	residential / business	7	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis due to existing site being owned by multiple residential land owners that would require acquisition. It was determined that none of these structures were buy-out candidates by comparing the existing structure elevations to the 100-yr flood profiles.

* These sites retained for analysis of other options, see "Modifications to Existing Structures."

Table 13 (cont) – Reservoir Site Preliminary Site Screening Results: Buffalo-Wheeling Creek

					a	b	c	d		
Site #	Community	County	NIPC Existing Landuse	Area (acres)	Field Verification	Existing Compatibility	Neighboring Compatibility	Environmental Compatibility	Screening Decision	Reason for Screening Decision
BW06	Wheeling	Cook	forested & grassland	11	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site is within 100-yr floodplain, but with depths less than 2-ft. Neighboring parcels are roads and businesses. Unclear why this site has not been developed; possible municipal owner.
BW07	Wheeling	Cook	water / utilities / urban mix / residential	12	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis due to existing utilities (water tower, high tension power lines, waste facilities, etc.) and the high costs of relocation.
BW08	Wheeling	Cook	forested & grassland / residential / agricultural	19	Yes	No	Yes	No	Eliminate	Eliminated from further analysis due to existing site being primarily inundated by the 100-yr floodplain with limited areas for additional storage and possible environmental significance and the high costs of mitigation.
BW09	Wheeling	Cook	agricultural / urban mix	78	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Existing site has agricultural landuse, large size, and is near damage areas. One of the last large open tracts in watershed adjacent to the stream.
BW10	Buffalo Grove	Cook	parks / cemeteries / urban mix / residential	16	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site location in the watershed near damage areas. This site is not in the 100-yr floodplain and has potential for additional storage. Site is bisected by Lake-Cook Road.
BW11	Long Grove / unincorporated	Lake	agricultural / parks / wetlands / residential	129	Yes	No	Yes	Yes	Eliminate	Existing site has undeveloped landuse, large size, and located adjacent to Buffalo Creek Reservoir Site 29. This site was previously investigated for Levee 37 mitigation. Site eliminated by LCFPD per 23-Mar-09 letter
BW12	Long Grove / unincorporated	Lake	agricultural	54	Yes	Yes	Yes	Yes	Eliminate	Eliminated from further analysis due to dependence on Site 11 as link to the stream. Existing site has undeveloped landuse, large size, and location near Buffalo Creek Reservoir Site 29. Potential conflict of compatibility with IDOT plans to expand Route 53.
BW13	Wheeling / unincorporated	Cook	forested & grassland / residential	5	Yes	No	No	Yes	Eliminate	Eliminated from further analysis due to existing floodplain inundation depths for the 100-yr event and neighboring airport.

Table 13 (cont) – Reservoir Site Preliminary Site Screening Results: Buffalo-Wheeling Creek

					a	*b*	*c*	*d*		
Site #	Community	County	NIPC Existing Landuse	Area (acres)	Field Verification	Existing Compatibility	Neighboring Compatibility	Environmental Compatibility	Screening Decision	Reason for Screening Decision
BW14	Wheeling	Cook	educational	9	Yes	No	No	Yes	Eliminate	Eliminated from further analysis due to existing floodplain inundation with deep depths for the 100-yr event and neighboring school currently uses the site for recreation, may be a safety hazard if altered.
BW15	Wheeling	Cook	parks / business	9	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site is adjacent to Site 03 and could be combined. Potential compensatory storage site for IDOT road improvements on Dundee Road. Also, may be opportunity to increase opening of Dundee Rd bridge over Buffalo Creek.
BW16	Wheeling	Cook	business	2	No	NA	NA	NA	Eliminate	Eliminated from further analysis due to field verification showing site already developed.
BW17	Wheeling / Buffalo Grove	Lake	business	6	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Potential dependence with Site 40 as a link to the stream. Potential measures include relief of road drainage along Weiland Avenue, field verification is needed.
BW18	Buffalo Grove	Lake	golf course / business / residential / parks	125	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site is large and near damage areas. Potential conflict with existing recreational landuse. Site was not eliminated as measures could be configured with smaller storage volumes to minimize impacts to existing landuse.
BW19	Buffalo Grove	Lake	parks / residential	15	Yes	Yes	Yes	No	Eliminate	Eliminated from further analysis due to existing floodplain inundation with deep depths for 100-yr event and a high quality conservation area. It should be noted that any proposed ecosystem restoration measures should consider enhancing the floodwater storage capabilities of this site.
BW20	Buffalo Grove	Cook	forested & grassland / residential	6	Yes	No	No	Yes	Eliminate	Eliminated from further analysis due to size, location within the watershed separate from the Buffalo Creek, and adjacent neighboring residential landuse.
BW21	Long Grove	Lake	residential / golf course	20	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site has areas not within 100-yr floodplain. Investigate owner-ship for possible use adjacent to Site 29.

Table 13 (cont) – Reservoir Site Preliminary Site Screening Results: Buffalo-Wheeling Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
BW22	Long Grove	Lake	forested & grassland / residential	14	Yes	Yes	Yes	No	Eliminate	Eliminated from further analysis due to having ecosystem significance.
BW23	Long Grove	Lake	residential / wetlands	23	Yes	Yes	Yes	No	Eliminate	Eliminated from further analysis due to having ecosystem significance.
BW24	Wheeling	Cook	forested & grassland / aircraft transportation	9	Yes	Yes	No	Yes	Eliminate	Eliminated from further analysis due to location adjacent to neighboring airport runway.
BW25	unincorporated	Cook	parks / forested & grassland / residential / business	529	Yes	Yes	Yes	No	Eliminate	Eliminated from further analysis due to site being a high quality conservation area. It should be noted that any proposed ecosystem restoration measures should consider enhancing the floodwater storage capabilities of this site.
BW26	Deer Park / unincorporated	Lake	forested & grassland	21	No	NA	NA	NA	Eliminate	Eliminated from further analysis due to field verification showing site already developed.
8W27	Kildeer / unincorporated	Lake	forested & grassland / residential / lakes / business	70	Yes	Yes	Yes	Yes	Keep	Keep for further analysis with reduced footprint area to avoid existing trees. Questionable hydrologic effectiveness due to location in watershed. Potential high land value due to intersection of two major streets to the south.
BW28	Buffalo Grove	Lake	parks / residential	46	Yes	Yes	Yes	Yes	Keep	Keep for further analysis with increased footprint area encompassing additional open space in the center. Potential high land value due to location in the basin.
BW29	Long Grove / unincorporated	Lake	parks / water / residential	186	Yes	Yes	Yes	Yes	Eliminate	Eliminated from further analysis because site was selected and recommended for expansion in the Upper Des Plaines River Phase I Feasibility Study.
BW30	Long Grove	Lake	residential / forested & grassland / agricultural / wetlands	142	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site is large and undeveloped. Possible hydrologic effectiveness issues due to location within the watershed.
BW31	Kildeer	Lake	agricultural / residential	87	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site is large and undeveloped. Possible hydrologic effective-ness issues due to location within watershed.

Table 13 (cont) – Reservoir Site Preliminary Site Screening Results: Buffalo-Wheeling Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	a Field Verification	b Existing Compatibility	c Neighboring Compatibility	d Environmental Compatibility	Screening Decision	Reason for Screening Decision
BW32	Buffalo Grove	Lake	agricultural / forested & grassland / wetlands / business	75	No	NA	NA	NA	Eliminate	Eliminated from further analysis due to field verification showing site already developed.
BW33	Wheeling	Cook	water / parks / industrial / residential	19	Yes	Yes	Yes	Yes	Eliminate*	Keep for further analysis of other measures. Site currently has flood retention capability. Potential measures include alterations to pump operation, modification to inlet/outlet structures, berming, deepening of the lake.
BW34	Wheeling	Cook	unidentified / industrial / utilities	46	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis due to location within the watershed separate from the Buffalo Creek
BW35	Long Grove / unincorporated	Lake	agricultural / lakes / residential / wetlands	196	Yes	Yes	Yes	No	Eliminate	Eliminated from further analysis due to having ecosystem significance.
BW36	Long Grove / unincorporated	Lake	agricultural / wetlands / residential / industrial / utilities	147	Yes	Yes	Yes	Yes	Eliminate	Eliminated from further analysis due to dependence on sites 11 and 12 or site 37 for link to stream. Potential conflict of compatibility with IDOT plans to expand Route 53. Possible hydrologic effectiveness issues due to location within the watershed.
BW37	Long Grove / Kildeer	Lake	wetlands / lakes / agricultural / residential	124	Yes	Yes	Yes	No	Eliminate	Eliminated from further analysis due to having ecosystem significance.
BW38	Long Grove	Lake	agricultural	15	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis due to size, location within the watershed separate from Buffalo Creek. This site straddles the watershed divide / boundary.
BW39	Lake Zurich / Kildeer	Lake	forested & grassland / residential	48	Yes	No	Yes	No	Eliminate	Eliminated from further analysis due to size, location within watershed separate from Buffalo Creek. Potential ecosystem significance.
BW40	Wheeling	Cook	agricultural	6	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Potential link between Site 09 or Site 17.
Total 41 Sites				2,421	38 Yes 3 No	27 Yes 9 No 3 NA	32 Yes 6 No 3 NA	30 Yes 8 No 3 NA	13 Keep 28 Eliminate	

* These sites retained for analysis of other options, see "Modifications to Existing Structures."

Table 14 – Reservoir Site Preliminary Site Screening Results: McDonald Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
MD01	Mount Prospect	Cook	forested & grassland / utilities / residential	11	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis due to existing utilities (high tension power lines) and long, narrow shape of site is not conducive to efficient alterations.
MD02	Mount Prospect / Prospect Heights	Cook	forested / recreation	10	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Existing park district land. Area to the east is forested and the west appears to be a driving range.
MD03	Wheeling / Prospect Heights	Cook	forested & grassland / industrial / residential	14	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis due to existing floodplain with limited areas for additional storage and environmental significance.
MD04	Wheeling / Prospect Heights	Cook	forested & grassland / utilities / recreation	35	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Northwest portion of the site appears to be unusable but eastern portion appears to be usable. Area may be floodplain making efficiency of storage lacking.
MD05	Prospect Heights	Cook	wetland / recreation	14	Yes	No	No	Yes	Eliminate	Eliminated from further analysis due to compatibility constraints in regard to residential homes immediately adjacent to site. Also, site is oddly shaped, bisected by a creek and therefore not conducive to efficient alterations.
MD06	Prospect Heights	Cook	residential / recreation / utilities	19	Yes	No	No	Yes	Eliminate	Eliminated from further analysis due to compatibility constraints in regard to residential homes immediately adjacent to site. Also, site is oddly shaped, bisected by a creek and therefore not conducive to efficient alterations.
MD07	Arlington Heights / Prospect Heights	Cook	forested & grassland / residential / utilities / wetland / water	66	Yes	Yes	Yes	Yes	Eliminate*	Keep for further analysis of other structural measures. Site is adjacent to Lake Arlington. Potential to expand the lake to the north. A lot of design analysis was done for the initial expansion.
Total 7 Sites				169	7 Yes 0 No	3 Yes 4 No	5 Yes 2 No	7 Yes 0 No	2 Keep 5 Eliminate	

* This site retained for analysis of modifications to existing structure, see "Modifications to Existing Structures."

Table 15 – Reservoir Site Preliminary Site Screening Results: Feehanville Ditch

					a	*b*	*c*	*d*		
Site #	Community	County	NIPC Existing Landuse	Area (acres)	Field Verification	Existing Compatibility	Neighboring Compatibility	Environmental Compatibility	Screening Decision	Reason for Screening Decision
FD01	Des Plaines	Cook	religious	1,007	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Existing Maryville property owned by the archdiocese. Potential storage site in area adjacent to Feehanville Ditch. The ditch originally ran through this site, but was relocated in the 1970s.
FD02	Des Plaines / Mount Prospect	Cook	grassland	55	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Existing open space north of Feehanville Ditch. Potentially difficult layout.
FD03	Unincorporated Wheeling Township	Cook	residential	5	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. About 7 frequently flooded structures exist on the site. Two have been acquired. Foreclosure properties and willing sellers are likely. Site could be converted to storage.
Total 3 Sites				1,103	3 Yes 0 No	3 Yes 0 No	3 Yes 0 No	3 Yes 0 No	3 Keep 0 Eliminate	

Table 16 – Reservoir Site Preliminary Site Screening Results: Weller Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
WL01	Mount Prospect	Cook	recreation	14	Yes	No	No	Yes	Eliminate	Eliminated from further analysis due to compatibility constraints in regard to residential homes immediately adjacent to the site. In addition, site is a narrow strip of land along creek and would not be conducive to efficient alterations.
WL02	Mount Prospect / Arlington Heights	Cook	recreation / government / industrial / transportation	62	Yes	Yes	Yes	Yes	Eliminate*	Keep for further analysis of other measures. There is an existing reservoir in northeast portion of this site. There is a spoil pile just south of the existing reservoir site. Potential to expand the reservoir to the western portion of this site where there are existing ball fields. However the ball fields are being relocated to the spoil area. This site is owned by MWRD and portions are leased to Mt. Prospect Park District.
WL03	Mount Prospect	Cook	golf course	104	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. This is an existing golf course; therefore acquisition costs may be high. Additional site information needed before proceeding.
Total 3 Sites				180	3 Yes 0 No	2 Yes 1 No	2 Yes 1 No	3 Yes 0 No	1 Keep 2 Eliminate	

* This site retained for analysis of modifications to existing structure, see "Modifications to Existing Structures."

Table 17 – Reservoir Site Preliminary Site Screening Results: Farmer-Prairie Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
FP01	Des Plaines / Park Ridge	Cook	forested & grassland / water / interstate tollway	46	Yes	Yes	Yes	Yes	Eliminate*	Keep for further analysis of other measures. This is Belleau Lake. IDNR looked at deepening this lake in their analysis. Land is owned by the Cook County Forest Preserve.
Total 1 Site				46	1 Yes 0 No	1 Yes 0 No	1 Yes 0 No	1 Yes 0 No	0 Keep 1 Eliminate	

* This site retained for analysis of modifications to existing structure, see "Modifications to Existing Structures."

Table 18 – Reservoir Site Preliminary Site Screening Results: Willow-Higgins Creek

					a	*b*	*c*	*d*		
Site #	Community	County	NIPC Existing Landuse	Area (acres)	Field Verification	Existing Compatibility	Neighboring Compatibility	Environmental Compatibility	Screening Decision	Reason for Screening Decision
WH01	Chicago / Rosemont	Cook	grassland / residential	57	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. This site needs further evaluation because the contours show a 50-ft hill at this site. It may be a landfill or spoil pile.
WH02	Chicago / Rosemont	Cook	golf course / air transportation / interstate tollway	39	Yes	Yes	No	Yes	Eliminate	Eliminated from further analysis due to neighboring airport runway. FAA regulations prohibit constructing an open water area that would attract hazardous wildlife within 10,000-ft of an air operations area. (FAA Advisory Circular AC150/5200-33A)
WH03	Chicago	Cook	air transportation	30	No	NA	NA	NA	Eliminate	Eliminated from further analysis due to this site being developed for the O'Hare expansion and is currently being constructed as a future runway.
WH04	Chicago / Rosemont	Cook	air transportation	50	No	NA	NA	NA	Eliminate	Eliminated from further analysis due to this site being developed for the O'Hare expansion and is currently being constructed as a future runway.
WH05	Des Plaines	Cook	grassland / warehouse district	28	Yes	Yes	Yes	Yes	Eliminate*	Keep for further analysis of other measures. Site is an existing reservoir. Potential to interconnect with adjacent site WH06. This is the Touhy Avenue Reservoir that was recently expanded by the City of Chicago.
WH06	Des Plaines	Cook	grassland / warehouse district / government / residential	42	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site partially contains the west cell of the Touhy Avenue reservoir. Potential to expand the existing reservoir to the south. This site is currently owned by the O'Hare Airport
WH07	Des Plaines	Cook	grassland / wetland / interstate tollway	21	No	NA	NA	NA	Eliminate	Eliminated from further analysis due to field verification showing site already developed.

Table 18 (cont) – Reservoir Site Preliminary Site Screening Results: Willow-Higgins Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
WH08	Des Plaines	Cook	recreation	28	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. The eastern portion of this site is an existing reservoir. The rest of the site is occupied by Majewski Metro Park. The land is owned by MWRD and leased to the Mt. Prospect Park District. MWRD is evaluating long term plans for the site since it is adjacent to the Kirie Water Reclamation Plant. There is a potential to expand the existing reservoir to the west.
WH09	Des Plaines	Cook	grassland / wetland	56	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. The existing spoil for CUP O'Hare Reservoir is here. The cost of removing the material may outweigh real estate acquisition. MWRDGC owns the site and may have future plans to utilize existing wetland for sewage treatment operations of Kirie Water Reclamation Plant. Connection to Willow-Higgins would involve boring under the Tollway.
Total 9 Sites				344	6 Yes 3 No	6Yes 0 No 3 NA	5Yes 1 No 3 NA	6Yes 0 No 3 NA	4 Keep 5 Eliminate	

* This site retained for analysis of modifications to existing structure, see "Modifications to Existing Structures."

Table 19 – Reservoir Site Preliminary Site Screening Results: Crystal Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
CR01	Schiller Park / Chicago	Cook	forested & grassland / interstate tollway	27	Yes	No	Yes	Yes	Eliminate	Eliminated from further analysis due to location in watershed. Eliminated because upstream drainage at O'Hare is captured on site. Damage areas are downstream of site and floodwaters come from area south of Irving Park Rd. This site would not alleviate flooding to damage area.
Total 1 Site				27	1 Yes 0 No	0 Yes 1 No	1 Yes 0 No	1 Yes 0 No	0 Keep 1 Eliminate	

Table 20 – Reservoir Site Preliminary Site Screening Results: Silver Creek

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
SC01	Franklin Park	Cook	business / grassland / residential	11	Yes	Yes	Yes	Yes	Eliminate*	Keep for further analysis of other measures. Currently structure 106 reservoir that was optimized with the right of way available at the time. There are a set of ball diamonds about 800-ft southeast of the site that could be interconnected. This reservoir is currently pumped dry. Options include: operational changes, deepening/expanding existing reservoir, and interconnecting with nearby open space.
SC02	Franklin Park	Cook	grassland / vacant	29	Yes	Yes	Yes	Yes	Eliminate*	Keep for further analysis of other measures. Currently structure 102 reservoir that was optimized with the right of way available at the time. There is a small triangular area northeast of the site and an area just went that could be interconnected. This reservoir is currently pumped dry. Options include: operational changes, deepening/expanding existing reservoir, and interconnecting with nearby open space.
SC03	Chicago	Cook	transportation	163	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. This site is currently spoil pile from existing reservoir on site SC02. Site is owned by the O'Hare Airport, but is currently not planned for development during the expansion project.
Total 3 Sites				203	3 Yes 0 No	3 Yes 0 No	3 Yes 0 No	3 Yes 0 No	1 Keep 2 Eliminate	

* These sites retained for analysis of other options, see "Modifications to Existing Structures."

Table 21 – Reservoir Site Preliminary Site Screening Results: Des Plaines River

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
DP01	River Forest	Cook	conservation / education / river	125	Yes	No	NA	No	Eliminate	Site includes Grand Army of the Republic Woods, Thomas Jefferson Woods, and Quercus Woods. Grand Army of the Republic and Jeferson Woods are considered one of the finest remnants of mesic oak savanna in the Midwest. Site was identified as CC8 in DPI Final Feasibility Report, June 1999.
DP02	Maywood / River Forest / Melrose Park	Cook	conservation / river residential / religious / education	328	Yes	No	NA	No	Eliminate	Site includes Thatcher Woods, Hal Tyrrell Trailside Museum and Naturre Center. Thatcher woods are considered one of the finest remants of mesic oak savanna in the Midwest. The site is also activiely used as a recreation area. A portion of the site was identified as CC7 in DPI Final Feasibility Report, June 1999, estimated to have an approximate max storage volume of 410 acre ft.
DP03	River Grove / Elmwood Park	Cook	golf course / conservation / river / residential / education	204	Yes	No	NA	Yes	Eliminate	Site includes Jerome Huppert Woods and Evens Field Picnic Grove. Site is actively used as a recreation area. Site was identified as CC5 in DPI Final Feasibility Report, June 1999.
DP04	River Grove	Cook	education / mineral extraction / residential	44	Yes	No	NA	Yes	Eliminate	Site is the Fullerton Woods Forest Preserve. Site is currently used for stockpiling of stone and construction fill. Site was identified as CC11 in DPI Final Feasibility Report, June 1999. The site was estimated to have an approximate max storage volume of 280 acre ft.
DP05	River Grove	Cook	conservation /river / education	77	No	No	NA	Yes	Eliminate	Site is part of LaFramboise Reserve. Eliminated due to limitations to of site shape and configuration. Site was identified as CC5 in DPI Final Feasibility Report, June 1999.
DP06	River Grove	Cook	conservation / river	32	Yes	No	NA	Yes	Eliminate	Site is part of LaFramboise Reserve.
DP07	Chicago / Franklin Park / Schiller Park	Cook	conservation / river / golf course	400	Yes	Yes	Yes	Yes	Keep	Site includes Schiller Woods South and Inidan Boundary Golf Course. Part of site is actively used for recreation. Evaluate use the remaining portion of site (1,000 ac.ft.) for storage.
DP08	Chicago / Schiller Park	Cook	lake / river / open space	555	Yes	No	NA	No	Eliminate	Site is Schiller Woods North Forest Preserve. Site includes lands in Illinois Natural Areas Inventory and T&E species habitat.

Table 21 (cont) – Reservoir Site Preliminary Site Screening Results: Des Plaines River

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
DP09	Chicago / Rosemont / Schiller Park	Cook	river / open / industrial / tollway / residential / commercial	536	Yes	No	NA	No	Eliminate	Site includes Chevalier Woods. Eliminated due to presence of T&E species habitat.
DP10	Chicago / Rosemont	Cook	river / open / cemetery / commercial	20	Yes	No	NA	Yes	Eliminate	Eliminated due to small side and odd shape and presence of two cemeteries on site.
DP11	Chicago / Rosemont / Park Ridge	Cook	river / open	136	Yes	No	NA	No	Eliminate	Site is Dam No. 4 South Woods. Eliminated due to presence of thick mature floodplain forest, ciritcal migratory bird habitat.
DP12	Des Plaines / Park Ridge	Cook	lake / river / open space / tollway / residential / commercial	272	Yes	No	NA	No	Eliminate	Site includes Dam No. 4 Woods East, Chippewa Woods, and Axehead Lake. Eliminated due to presence of thick mature floodplain forest, ciritcal migratory bird habitat.
DP13	Park Ridge	Cook	river / open / tollway	94	Yes	No	NA	No	Eliminate	Site is Iroquois Woods Forest Preserve. Eliminated due to presence of thick mature floodplain forest, ciritcal migratory bird habitat.
DP14	Des Plaines / Park Ridge	Cook	river / open / tollway residential	201	Yes	No	NA	No	Eliminate	Site is Algonquin Woods Forest Preserve. Eliminated due to presence of thick mature floodplain forest, ciritcal migratory bird habitat. A portion of the site was identified as CC4 in DPI Final Feasibility Report, June 1999, estimated max storage volume of 570 acre ft.
DP15	Des Plaines	Cook	river / open / tollway	106	Yes	No	NA	No	Eliminate	Site is as Campground Road Woods Forest Preserve. Eliminated due to presence of thick mature floodplain forest, ciritcal migratory bird habitat.
DP16	Des Plaines	Cook	river / open	29	Yes	No	NA	Yes	Eliminate	Site is Northwestern Woods Forest Preserve. Eliminated due to small site size.
DP17	Des Plaines	Cook	river / wetland / open	14	Yes	No	NA	Yes	Eliminate	Eliminated due to small size.
DP18	Des Plaines	Cook	river / lake / open / tollway	173	Yes	No	NA	Yes	Eliminate	Site is Big Bend Lake. This site was identified as CC3 in DPI Final Feasibility Report, June 1999 and was authorized as part of that plan.
DP19	Des Plaines	Cook	river / commercial / industrial	41	Yes	No	NA	Yes	Eliminate	Site is Lions Woods Forest Preserve. Eliminated due to small size.

Table 21 (cont) – Reservoir Site Preliminary Site Screening Results: Des Plaines River

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
DP20	Des Plaines	Cook	river / wetland / open / residential	233	Yes	No	NA	No	Eliminate	Site includes Kloempkin Prairie and Carle Woods Forest Preserve. Eliminated due to presence of T&E species habitat on site and Illinois Natural Areas Inventory listing.
DP21	Mount Prospect / Prospect Heights	Cook	river / open / church / cemetery / hotel	365	Yes	No	NA	No	Eliminate	Site is Lake Avenue Woods. Eliminated due to small size.
DP22	Prospect Heights	Cook	river / open/ commercial / toll way	161	Yes	No	NA	No	Eliminate	Site is Allison Woods. Eliminated due to presence of T&E species habitat on site.
DP23	Glenview / Northbrook	Cook	river / open/ commercial / tollway	815	Yes	Yes	Yes	Yes (portions No)	Keep	Keep for further analysis. This site was identified as CC1 in DPI Final Feasibility Report, June 1999. The area was much smaller in DPI study and was estimated to have an approximate max storage volume of 330 acre ft. Evaluate 330 acre feet storage volume to avoid conflict with existing site features.
DP24	Northbrook / Wheeling	Cook	river /open / commercial / tollway / residential	511	Yes	Yes	Yes	Yes (portions No)	Keep	Keep for further analysis. Site is Potawatomi Woods Forest Preserve.
DP25	Wheeling	Cook	river / open/ commercial / tollway	33	Yes	No	NA	No	Eliminate	Site is part of Potawatomi Woods Forest Preserve. Eliminated due to small site size and presence of T&E species habitat on site.
DP26	Buffalo Grove / Riverwoods	Lake	river / wetland / open / residential / roadway	219	Yes	No	Yes	No	Eliminate	This is part of Ryerson Woods Conservation Area. Eliminated from further analysis because the site serves important ecological functions and supports several T&E species. Site eliminated by LCFPD per 23-Mar-09 letter.
DP27	Lincolnshire / Riverwoods	Lake	river / open / church / grassland / residential	530	Yes	No	Yes	No	Eliminate	This is part of Ryerson Woods Conservation Area. Eliminated from further analysis because site serves important ecological functions, supports several T&E species, significant resources were used to restore area and a permanent conservation easement exists over most of site. Eliminated by LCFPD per 23-Mar-09 letter.
DP28	Lincolnshire / Mettawa / Vernon Hills	Lake	river / open / grassland / wetland / residential	859	Yes	No	Yes	No	Eliminate	This site contains Wright Woods Forest Preserve, Half Day Forest Preserve, Adlai E. Stevenson Historic Home, and Lloyd's Woods Nature Preserve. Eliminated from further analysis because the site serves multiple important ecological functions, supports several T&E species. Site eliminated by LCFPD per 23-Mar-09 letter.

Table 21 (cont) – Reservoir Site Preliminary Site Screening Results: Des Plaines River

Site #	Community	County	NIPC Existing Landuse	Area (acres)	a Field Verification	b Existing Compatibility	c Neighboring Compatibility	d Environmental Compatibility	Screening Decision	Reason for Screening Decision
DP29	Libertyville / Mettawa / Mundelein / Vernon Hills	Lake	river / open/ agricultural /commercial / utilities	551	Yes	No	Yes	No	Eliminate	This is MacArthur Woods Forest Preserve. Eliminated from further analysis because the site serves important ecological functions, supports several T&E species and significant resources were used to restore the area. Site eliminated by LCFPD per 23-Mar-09 letter.
DP30	Libertyville / Mettawa / Mundelein / Vernon Hills	Lake	river / lake / open / golf course	289	Yes	No	NA	NA	Eliminate	Eliminated from further analysis due to its odd shape making the site not conducive to efficient alterations.
DP31	Libertyville	Lake	river / open / residential	25	Yes	No	NA	NA	Eliminate	Eliminated from further analysis due to its odd shape making the site not conducive to efficient alterations.
DP32	Libertyville	Lake	river / grassland / open	29	Yes	No	NA	NA	Eliminate	Eliminated from further analysis due to the site's small size making it not conducive to efficient alterations.
DP33	Libertyville	Lake	lake / open / residential	380	Yes	Yes (portions No)	Yes	Yes (portions No)	Keep	This site was identified as site 14c in the DPI Final Feasibility Report, June 1999. This site contains Lake Minear. Potential to expand this lake. The northeast portion of this site contains Wilmot Woods Forest Preserve. This portion should be eliminated because it serves an important ecological function as per the LCFPD letter dated 23-Mar-09. The remaining portions of the site should be reevaluated under DPII.
DP34	Waukegan	Lake	river / lake / church / agriculture / residential / utilities	846	Yes	No	Yes	No	Keep	Keep for further analysis. This site was identified as sites 13A, 13B, and LS6 in the DPI Final Feasibility Report, June 1999. The majority of the site contains Independence Grove Forest Preserve. Significant resources were used to restore this site for recreational uses. A portion of the site identified by LCFPD will be used for analysis.
DP35	Gurnee	Lake	river / lake / open / utilities / grassland / wetland	272	Yes	Yes	Yes	Yes	Keep	Majority of the site is owned by the LCFPD. This site contains Riverhill and Lake Carina Forest Preserves. Alterations could be supported by LCFPD as per letter dated 23-Mar-09 given existing recreational facilities are accommodated. This site was identified as sites 12A, and LS5 in the DPI Final Feasibility Report, June 1999. Keep for further analysis. Reevaluate under DPII.
DP36	Gurnee	Lake	river / lake / open/tollway / agricultural / residential / utilities	205	Yes	No	Yes	No	Eliminate	Eliminated from further analysis due to its odd shape, making this site not conducive to efficient alterations, and environmental significance.

Table 21 (cont) – Reservoir Site Preliminary Site Screening Results: Des Plaines River

					a	b	c	d		
Site #	Community	County	NIPC Existing Landuse	Area (acres)	Field Verification	Existing Compatibility	Neighboring Compatibility	Environmental Compatibility	Screening Decision	Reason for Screening Decision
DP37	Gurnee	Lake	river / lake / open / residential / grassland / utilities	113	Yes	No	Yes	No	Eliminate	The site should be eliminated because it serves an important ecological function as per the LCFPD letter dated 23-Mar-09.
DP38	Gurnee	Lake	river / lake / wetland / open / education	72	Yes	No	Yes	No	Keep	Keep for further analysis. Site identified for use by LCFPD in combination with Site 40. Potential conflict with existing utility crossing the site. In addition, there is the potential a berm will be constructed along the utility corridor to protect the nearby grade school.
DP39	Gurnee	Lake	river / open / residential / utilities	21	Yes	No	NA	NA	Eliminate	Eliminated from further analysis due to its odd shape making the site not conducive to efficient alterations.
DP40	Wadsworth / Waukegan	Lake	river / lake / wetland / open / utilities / residential	907	Yes	No	Yes	No	Keep	Keep for further analysis. This site is Gurnee Woods Forest Preserve and recently constructed Wetlands Restoration Demonstration Project. LCFPD identified a portion of site that could be used for detention storage.
DP41	Wadsworth	Lake	river / lake / wetland / residential / commercial	838	Yes	No	Yes	No	Keep	Keep for further analysis. This is Wadsworth Savanna Forest Preserve. LCFPD identified portion of site for analysis to avoid conflicts. Site serves important ecological functions, supports several T&E species, significant resources were used to restore area and permanent conservation easement exists over most of site.
DP42	Unincorporated	Lake	grassland / residential	11	Yes	No	NA	NA	Eliminate	Eliminated from further analysis due to its small size making the site not conducive to efficient alterations.
DP43	Unincorporated	Lake	river / open / grassland / nursery / residential / commercial	841	Yes	No	NA	NA	Eliminate	This is Van Patten Woods Forest Preserve. Eliminated from further analysis as the site is an existing project authorized under DPI.
DP44	Pleasant Prairie	Kenosha	river / lake / wetland / agriculture / public / residential / grassland / tollway	779	Yes	Yes	Yes	TBD	Keep	Keep for further analysis. This site was identified as 1C in the DPI Final Feasibility Report, June 1999. The construction of an instream dam structure was evaluated; the results showed backwater impacts in Wisconsin. Eastern portion of the site contains Van Patten Woods Forest Preserve. Potential conflict with ecosystem plans. Reevaluate under DPII.

Table 21 (cont) – Reservoir Site Preliminary Site Screening Results: Des Plaines River

					a	*b*	*c*	*d*		
Site #	Community	County	NIPC Existing Landuse	Area (acres)	Field Verification	Existing Compatibility	Neighboring Compatibility	Environmental Compatibility	Screening Decision	Reason for Screening Decision
DP45	Pleasant Prairie	Kenosha	wetland / forest / agriculture / residential	1,463	Yes	No	Yes	NA	Eliminate	The western half of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided, the eastern half was designated within the 100-year floodplain for planned landuse and existing channel conditions. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
DP46	Pleasant Prairie	Kenosha	wetland / agriculture / commercial / residential / utilities	1,785	Yes	No	NA	NA	Eliminate	The western half of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided, the eastern half was designated within the 100-year floodplain for planned landuse and existing channel conditions. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
DP47	Pleasant Prairie	Kenosha	wetland / agriculture / forest / residential	78	Yes	No	NA	NA	Eliminate	The western half of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided, the eastern half was designated within the 100-year floodplain for planned landuse and existing channel conditions. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
DP48	Unincorporated	Kenosha	wetland / agriculture / forest / residential / industrial	2,363	Yes	Yes	Yes	Yes	Keep	A small portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided, another small portion was designated within the 100-year floodplain for planned landuse and existing channel conditions.
DP49	Unincorporated	Kenosha	wetland / agriculture / forest / industrial / public / residential	1,272	Yes	No	NA	NA	Eliminate	A small portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided, another small portion was designated within the 100-year floodplain for planned landuse and existing channel conditions. Site eliminated by SEWPRC per 26-Mar-09 Mtg.

Table 21 (cont) – Reservoir Site Preliminary Site Screening Results: Des Plaines River

Site #	Community	County	NIPC Existing Landuse	Area (acres)	*a* Field Verification	*b* Existing Compatibility	*c* Neighboring Compatibility	*d* Environmental Compatibility	Screening Decision	Reason for Screening Decision
DP50	Unincorporated	Kenosha	wetland / agriculture / forest / residential	786	Yes	No	NA	NA	Eliminate	A portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as an area of planned urban development where detention storage would be provided, another smaller portion was designated within the 100-year floodplain for planned landuse and existing channel conditions. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
DP51	Unincorporated	Kenosha	wetland / agriculture / forest / residential	949	Yes	Yes	Yes	Yes	Keep	A portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as designated within the 100-year floodplain for planned landuse and existing channel conditions.
DP52	Unincorporated	Kenosha	wetland / agriculture / forest / residential	1,608	Yes	Yes	Yes	Yes	Keep	A portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as designated within the 100-year floodplain for planned landuse and existing channel conditions.
DP53	Unincorporated	Kenosha	wetland / agriculture / forest / residential / public	2,134	Yes	Yes	Yes	Yes	Keep	A portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as designated within the 100-year floodplain for planned landuse and existing channel conditions.
DP54	Unincorporated	Racine	wetland / agriculture / forest / residential	311	Yes	No	NA	NA	Eliminate	A portion of the site was identified in the SEWRPC Comprehensive Plan, March 2003, Map 65 as designated within the 100-year floodplain for planned landuse and existing channel conditions. Site eliminated by SEWPRC per 26-Mar-09 Mtg.
DP55	Libertyville	Lake		18	Yes	No	Yes	Yes	Eliminate	Site eliminated due to small size. Site is currently Red Top Pond Park.
DP56	Gurnee	Lake		200	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Use site for offline storage and compensatory storage for Gurnee Levee.
DP57	Maywood	Cook		158	Yes	Yes	Yes	Yes	Keep	Keep for further analysis. Site was identified as potential storage site in Phase I Study.
Total 57 Sites				26,072	57 Yes 0 No	12 Yes 45 No	24 Yes 0 No 33 NA	27 Yes 10 No 12 NA 1 TBD	16 Keep 41 Eliminate	

Table 22 – Summary of Preliminary Screening Results for Identified Floodwater Storage Sites

ID	Watershed	County	State	Identified	Eliminated	Kept
BR	Brighton Creek	Kenosha/Racine	WI	7	4	3
CC	Center Creek	Kenosha	WI	7	7	0
KR	Kilbourn Road Ditch	Kenosha/Racine	WI	7	2	5
JC	Jerome Creek	Kenosha	WI	0	-	-
ND	Newport Ditch	Lake	IL	7	4	3
NM	North Mill Creek	Lake/Kenosha	IL/WI	8	3	5
ML	Mill Creek	Lake	IL	14	11	3
CT	Sub. Country Club Trib.	Lake	IL	0	-	-
DR	Delaney Road Tributary	Lake	IL	0	-	-
GT	Gurnee Tributary	Lake	IL	1	0	1
BC	Bull Creek	Lake	IL	4	3	1
IN	Indian Creek	Lake	IL	11	7	4
AC	Aptakisic Creek	Cook/Lake	IL	9	4	5
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	41	28	13
MD	McDonald Creek	Cook	IL	7	5	2
FD	Feehanville Ditch	Cook	IL	3	0	3
WL	Weller Creek	Cook	IL	3	2	1
FP	Farmer-Prairie Creek	Cook	IL	1	1	0
WH	Willow-Higgins Creek	Cook/Dupage	IL	9	5	4
CR	Crystal Creek	Cook	IL	1	1	0
SC	Silver Creek	Cook/Dupage	IL	3	2	1
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	57	41	16
				200	130	70

1.2 – Flood Barrier Site Identification

Locations with high concentrations of flood damage were identified as potential flood barrier sites. Concentrated damage areas included groups of both residential and commercial, industrial, and public (CIP) structures. With input from the study partners and stakeholders, several sites were identified for screening including sites where levees or floodwalls had previously been constructed. **Table 23** shows all flood barrier sites considered, by watershed. **Table 24** provides a summary of the sites.

Table 23 – Identified Flood Barrier Sites

Site ID	Location	Municipality	County	River Miles	Bank (looking downstream)	Proposed Modification
Buffalo-Wheeling Creek						
BWLV01	Valley Stream Dr west of Elmhurst Rd	Wheeling	Cook	2.87 - 3.63	Right	Protect large area of residential structures (25-500 yr)
BWLV02	St. Mary's Pkwy	Buffalo Grove	Cook	5.12 - 5.55	Right	Protect damage pocket of residential structures (50-500 yr)
Silver Creek						
SCLV01	South of North Ave (near Frenzel Dr & 19th Ave)	Melrose Park	Cook	1.25 - 1.70	Right	Protect damage pocket of residential structures (25-100 yr)
SCLV02	Between Fullerton Ave & Armitage Ave	Franklin Park - Leyden	Cook	2.55 - 3.15	Both	Protect damage pocket of residential and CIP structures (25-500 yr)
SCLV03	Between Fullerton Ave & Scott Ave	Franklin Park - Leyden	Cook	3.15 - 3.64	Both	Protect damage pocket of residential and CIP structures (25-100 yr)
SCLV04	Between Mannheim Rd & Grand Ave	Franklin Park - Leyden	Cook	4.30 - 4.71	Left	Protect damage pocket of residential and CIP structures (25-100 yr)
Des Plaines River						
DPLV01	Groveland Ave	Riverside	Cook	45.76-46.09	Left	Tie- back and/or raise existing berm
DPLV02	near Central Ave & Lake St	River Forest	Cook	54.26-51.15	Left	Raise existing berm
DPLV03	Thatcher near Armitage - Golf Course Trib	River Grove	Cook	53.16-53.90	Left	Protect damage pocket of residential structures (25-500 yr)
DPLV04	Des Plaines River Rd between First Ave & Fullerton	River Grove	Cook	54.20-55.35	Right	Protect structures near intersection of River Rd and Fullerton (10 -500 yr) and lane closures on River Rd
DPLV05	Des Plaines River Rd between Irving & Belmont	Schiller Park	Cook	55.92-56.92	Right	Protect structures along river road and lane closures on River Road
DPLV06[1]	River Rd between Fargo & Howard	Des Plaines	Cook	62.90-63.36	Right	Protect damage pocket of residential structures
DPLV07[1]	River Rd between Everett & Oakton	Des Plaines	Cook	63.36-63.70	Right	Protect damage pocket of residential structures
DPLV08[1]	River Rd between Van Buren & Oakwood	Des Plaines	Cook	64.22-64.62	Right	Protect damage pocket of residential structures
DPLV10[1]	Des Plaines River Rd between Algonquin & Oakton (Shagbark Lake)	Des Plaines	Cook	63.70-64.22	Right	Protect residential structures (5-500 yr); interior drainage issues with Shagbark Lake
DPLV11	Big Bend Dr	Des Plaines	Cook	66.41 - 66.96	Right	Protect damage pocket of residential structures
DPLV12	Krause, Edgewood and Prairie View Lanes (east of Milwaukee)	Wheeling	Cook	74.71-74.91	Right	Protect damage pocket of residential structures (25-500 yr)
DPLV13	Pekara Rd (Aptakisic Creek)	Unincorporated Vernon Twnshp	Lake	77.60	Right (trib)	Protect damage pocket of residential structures (5-500 yr)
DPLV14	South of Lincolnshire Rd	Lincolnshire	Lake	79.45-80.05	Left	Protect damage pocket of residential structures
DPLV15	East of Libertyville Estates btwn Spruce and Idlewood	Libertyville	Lake	90.62-91.11	Left	Protect damage pocket of residential structures (25-50yr)
DPLV16	Libertyville Estates Levee	Libertyville	Lake	90.70-91.11	Left	Increase existing 40-yr level of protection
DPLV17	Gurnee Area	Gurnee	Lake	98.41	Left	Protect structures south of Route 132. A levee in this area was evaluated as Levee 5 in Phase I Study.

[1] During site screening DPLV06, DPLV07, DPLV08, DPLV10 were combined into DPLV09. See Section 2.2.

Table 24 – Summary of Identified Flood Barrier Sites

ID	Watershed	County	State	Levees
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	2
SC	Silver Creek	Cook/Dupage	IL	4
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	16
			TOTAL	22

1.3 – Road Raise and Bridge Modification Site Identification

From baseline transportation damage data provided by the Visual Interactive System for Transportation Algorithms (VISTA) study, the 25 sites with the highest transportation damages were identified as possible road raise sites to prevent flooding of the roadway. All of the identified sites were along the Des Plaines River mainstem. **Table 25** lists the identified sites.

Table 25 – Identified Potential Road Raise and Bridge Modification Sites

Site ID	Location	Municipality	County	River Mile	Structure Type	Proposed Modification
DPBM03	Chicago Ave	River Forest	Cook	51.62	Bridge Mod.	Raise Bridge - currently floods at 10 yr
DPBM04	First Ave	River Grove	Cook	54.20	Bridge Mod.	Raise bridge - currently floods at 2 yr
DPRR01	River Road	River Grove	Cook	54.78	Road Raise	Raise road - currently floods at 10 yr
DPBM05	Grand Ave	River Grove	Cook	55.10	Bridge Mod.	Raise bridge - currently floods at 25 yr
DPRR02	River Road	River Grove	Cook	55.27	Road Raise	Raise road - currently floods at 10 yr
DPRR03	River Road	Schiller Park	Cook	56.84	Road Raise	Raise road - currently floods at 5 yr
DPRR04	River Road	Des Plaines	Cook	63.04	Road Raise	Raise road - currently floods at 5 yr
DPRR05	River Road	Des Plaines	Cook	64.50	Road Raise	Raise road - currently floods at 5 yr
DPRR06	Miner Street	Des Plaines	Cook	65.03	Road Raise	Raise road - currently floods at 5 yr
DPBM06	Rand Road	Des Plaines	Cook	65.39	Bridge Mod.	Raise bridge - currently floods at 25 yr
DPBM07	Golf Road	Des Plaines	Cook	66.91	Bridge Mod.	Raise bridge - currently floods at 5 year
DPBM08	River Road	Glenview	Cook	69.52	Bridge Mod.	Raise bridge - currently floods at 5 yr
DPBM09	Milwaukee Ave	Prospect Heights	Cook	71.03	Bridge Mod.	Raise bridge - currently floods at 5 yr
DPRR07	River Road	Prospect Heights	Cook	71.03	Road Raise	Raise road - currently floods at 5 yr
DPBM10	Milwaukee Ave	Prospect Heights	Cook	72.86	Bridge Mod.	Raise Bridge - currently floods at 5 yr
DPRR08	River Road	Buffalo Grove	Lake	77.97	Road Raise	Raise road - currently floods at 10 yr
DPBM11	Milwaukee Ave	Long Grove	Lake	77.37	Bridge Mod.	Raise bridge - currently floods at 100 yr
DPRR09	River Road	Buffalo Grove	Lake	78.82	Road Raise	Raise road - currently floods at 25 yr
DPBM12	IL Route 60	Libertyville	Lake	83.66	Bridge Mod.	Raise bridge - currently floods at 25 yr
DPBM13	IL Route 120	Grayslake	Lake	94.51	Bridge Mod.	Raise bridge - currently floods at 25 yr
DPRR10	Old Grand Ave	Gurnee	Lake	97.02	Road Raise	Raise road - currently floods at 2 yr
DPRR11	IL Route 32	Gurnee	Lake	97.08	Road Raise	Raise road - currently floods at 5 yr
DPBM14	Grand Ave	Gurnee	Lake	97.12	Bridge Mod.	Raise bridge - currently floods at 10 yr
DPBM15	US Hwy 41	Gurnee	Lake	98.08	Bridge Mod.	Raise bridge - currently floods at 25 yr
DPRR12	US Hwy 41	Gurnee	Lake	98.59	Road Raise	Raise road - currently floods at 5 yr

1.4 – Modifications to Existing Structures Site Identification

From the results of GIS mapped flood damages and through collaboration with study partners and stakeholders, several sites where modifications to existing structures could reduce flood risk were identified.**Table 26** shows all sites considered by watershed. **Table 27** provides a summary of these sites.

Table 26 – Identified Potential Structure Modifications

Site ID	Location	Municipality	County	River Mile	Structure Type	Proposed Modification
Buffalo-Wheeling Creek						
BWCI01	Wolf Rd & Hintz Rd	Wheeling	Cook	0.88	Channel Improvements	Due to location of airport, only non-open water measures should be considered including streambank and floodplain terracing.
BWCI02	Wolf Rd & Dundee Rd	Wheeling	Cook	1.92	Channel Improvements	Due to size, streambank and floodplain terracing should be considered. Potential municipal owner.
BWME01	Wolf Rd & Dundee Rd	Wheeling	Cook	1.53	Modify Existing Structure	This site, Heritage Lake, has flood retention capability. Look at potential for expansion.
Weller Creek						
WLME01	Central Rd & Northwest Hwy	Mount Prospect / Arlington Heights	Cook	5.97	Modify Existing Structure	Mt Prospect Reservoir is in the northeast portion of this site and a spoil pile is just south of existing reservoir. Potential to expand reservoir to western portion of site where there are existing ball fields. Site is owned by MWRD and portions are leased to Mt. Prospect Park District.
Farmer-Prairie Creek						
FPCI01	Golf Road & I-294	Unincorporated	Cook	0.95	Drainage Improvement	Modify pump and provide a connection at Lake Mary Anne to Dude Ranch Pond, across Golf Road
FPME01	Busse Rd & I-294	Des Plaines and Park Ridge	Cook	0.59	Modify Existing Structure	This site, Belleau Lake, could be deepened and expanded to increase capacity.
Willow-Higgins Creek						
WHME01	Touhy Rd & Mt. Prospect Ave	Des Plaines	Cook	4.73	Modify Existing Structure	This site is Touhy Avenue Reservoir that was recently expanded by the City of Chicago. Potential to interconnect with adjacent site, WHRS06.
Silver Creek						
SCCI01	Underground Creek, Upstream of RR Culvert (N of North Ave)	Melrose Park	Cook	2.25	Drainage Improvements	Evaluate improvements to drainage including replacement of culverts
SCCI02	Between N. Wolf Rd & Lee St	Franklin Park - Leyden	Cook	5.27	Drainage Improvements	Evaluate improvements to drainage including replacement of culverts
SCME01	Grand & Mannheim	Franklin Park	Cook	4.30	Modify Existing Structure	Modify structure 106. Look at potential for expansion.
SCME02	Irving Park Rd & Mannheim Rd	Franklin Park	Cook	6.42	Modify Existing Structure	Modify structure 102. Look at potential for expansion.
SCOT01	Indian Boundary Dr	Melrose Park - Stone Park	Cook	2.42	Interbasin Flow Issue	Review topography and evaluate potential for interbasin flow associated with Addison Creek/Silver Creek.

Table 26 (cont.) – Identified Potential Structure Modifications

Site ID	Location	Municipality	County	River Mile	Structure Type	Proposed Modification
Des Plaines River						
DPBM01	BNSF RR Bridge	Riverside	Cook	46.56	Bridge Modification	Extend bridge piers to reduce head loss through skewed structure
DPBM02	Forest Ave	Riverside	Cook	46.69	Bridge Modification	Modify bridge channel section.
DPOT01	near Brookfield Zoo	Riverside	Cook	47.05	Salt Creek Diversion	Re-evaluate diversion of flow from Salt Creek.
DPOT02	Varies	Varies	Cook	Varies	Modified Riparian Greenway	Evaluate improvements to conveyance by removing snags and other existing vegetation along the riparian corridor to reduce channel roughness
DPOT03	Varies	Varies	Cook / Lake	Varies	Optimize Existing Structures	Optimize operations at existing reservoirs within watershed to ensure efficient use of structures.

Table 27 – Summary of Identified Structure Modification Sites

ID	Watershed	County	State	Modify Existing Struct.	Drain/ Channel Improve	Bridge Mod.	Other
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	1	2	0	0
WL	Weller Creek	Cook	IL	1	0	0	0
FP	Farmer-Prairie Creek	Cook	IL	1	1	0	0
WH	Willow-Higgins Creek	Cook/Dupage	IL	1	0	0	0
SC	Silver Creek	Cook/Dupage	IL	2	2	0	1
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	0	0	2	3
			TOTAL	6	5	2	3

1.5 – Non-Structural Measure Site Identification

A number of structures throughout the watershed were identified for potential non-structural flood risk management measures such as acquisition, flood proofing, or elevation. In addition to structures damaged during events up to and including the 1% annual change of exceedance flood, repetitive loss structures compiled from information collected by the Illinois Emergency Management Agency (IEMA) and the Federal Emergency Management Agency (FEMA) were identified for further evaluation. Repetitive loss structures not captured by the structure survey conducted for this study or that showed $0 Equivalent Annual Damages in the HEC-FDA model were assumed to be incurring damages as a result of local drainage issues rather than overbank flooding and were removed from consideration.

A total of 1,527 structures were identified as potential candidates for non-structural FRM methods. Of these, 71% are in Cook County, 25% in Lake County, and 4% in Kenosha County. Residential structures make up the majority with 88% of the total. The non-residential portion contains largely commercial and industrial structures, with a few unique, large structures (hotels and a convention center). **Table 28** shows a summary of sites considered for non-structural measures.

Table 28 – Summary of Identified Non-Structural Flood Risk Management Sites

County	Community	Structures in Community	Structures in County
Cook	Buffalo Grove	34	1,384
	Des Plaines	677	
	Elmwood Park	54	
	Franklin Park	109	
	Leyden Township	21	
	Maine Township	34	
	Maywood	2	
	Melrose Park	16	
	Park Ridge	5	
	Prospect Heights	9	
	River Forest	22	
	River Grove	127	
	Riverside	8	
	Rosemont	2	
	Schiller Park	20	
	Wheeling	221	
	Wheeling Township	23	
Lake	Gurnee	48	299
	Libertyville	28	
	Lincolnshire	40	
	Long Grove	2	
	Mettawa	2	
	Riverwoods	49	
	Libertyville Township	80	
	Newport Township	3	
	Vernon Township	46	
	Warren Township	1	
Kenosha	Pleasant Prairie	16	58
	Salem	6	
	Bristol	12	
	Somers	1	
	Paddock Lake	23	

SECTION 2 – FLOOD RISK MANAGEMENT SITE SCREENING

Identified flood risk management sites were screened based on the development of benefit to cost ratios (BCRs) at each site. Benefits were estimated based on conceptual hydrologic and hydraulic modeling results and associated reductions in flood damages using the Hydrologic Engineering Center – Flood Damage Analysis (HEC-FDA) model. Costs were estimated using idealized designs that could be factored to all measures independent of specific site conditions and escalated operations and maintenance costs from similar studies. General estimates of real estate costs were developed based on county-wide averages of tax assessed market values for sites in private ownership and escalated real estate values of sites in public ownership.

2.1 – Floodwater Storage Site Screening

See Appendix A (Hydrology and Hydraulics) for discussion and details on the conceptual Hydrologic and Hydraulic analysis performed at this stage.

See Appendix D (Civil Design) for discussion and details on development of site design and cost estimates used in site screening.

Table 29 through **Table 44** presents the damage reduction calculations for the identified potential floodwater storage sites. APT, VEH, COM, IND, PUB, RES and TRAFFIC are damage categories as discussed in Appendix E (Economics).

Table 29 – Reservoir Screening Damage Reduction Calculation: Brighton Creek

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
BRRS01	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								
BRRS02	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								
BRRS03	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								

Table 30 – Reservoir Screening Damage Reduction Calculation: Kilbourn Road Ditch

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
KRRS01	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								
KRRS02	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								
KRRS04	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								
KRRS05	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								
KRRS06	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								

Table 31 – Reservoir Screening Damage Reduction Calculation: Newport Ditch

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
Mainstem									
NDRS01	565	$0	$0	$5,000	$1,000	$3,000	$3,000	$26,000	$38,000
NDRS02	309	$0	$0	$0	$0	$0	$0	$0	$0
NDRS03	574	$1,000	$1,000	$30,000	$11,000	$30,000	$30,000	$325,000	$427,000

(FY 2010 Price Level, FDR 4.375%)

Table 32 – Reservoir Screening Damage Reduction Calculation: North Mill Creek

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
NMRS01	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								
NMRS03	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								
NMRS04	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								
NMRS05	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								
NMRS07	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								

(FY 2010 Price Level, FDR 4.375%)

Table 33 – Reservoir Screening Damage Reduction Calculation: Mill Creek

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
Mainstem									
MLRS03	4195	$0	$0	$0	$0	$0	$0	$0	$0
MLRS04	6535	$0	$0	$0	$0	$0	$0	$0	$0
MLRS06	205	$0	$0	$0	$0	$0	$0	$0	$0
Tributary									
MLRS03	4195	$0	$0	$0	$0	$0	$0	$0	$0
MLRS04	6535	$0	$0	$0	$0	$0	$0	$0	$0
MLRS06	205	$0	$0	$0	$0	$0	$0	$0	$0
Total									
MLRS03	4195	$0	$0	$0	$0	$0	$0	$0	$0
MLRS04	6535	$0	$0	$0	$0	$0	$0	$0	$0
MLRS06	205	$0	$0	$0	$0	$0	$0	$0	$0

(FY 2010 Price Level, FDR 4.375%)

Table 34 – Reservoir Screening Damage Reduction Calculation: Gurnee Tributary

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
Mainstem									
GTRS01	67	$0	$0	$1,000	$0	$0	$0	$0	$1,000

*Gurnee Tributary was not modeled, thus tributary damage reductions are not included for this reservoir.
(FY 2010 Price Level, FDR 4.375%)

Table 35 – Reservoir Screening Damage Reduction Calculation: Bull Creek

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
Mainstem									
BCRS02	177	$35,000	$1,000	$528,000	$57,000	$9,000	$163,000	$1,708,000	$2,500,000
Tributary									
BCRS02	177	$0	$0	$0	$0	$0	$1,000	$17,000	$18,000
Total									
BCRS02	177	$35,000	$1,000	$528,000	$57,000	$9,000	$164,000	$1,725,000	$2,518,000

(FY 2010 Price Level, FDR 4.375%)

Table 36 – Reservoir Screening Damage Reduction Calculation: Indian Creek

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
Mainstem									
INRS01	165	$0	$0	$4,000	$0	$0	$1,000	$0	$5,000
INRS07	441	$2,000	$0	$30,000	$4,000	$1,000	$7,000	$66,000	$110,000
INRS09	499	$3,000	$0	$55,000	$6,000	$2,000	$12,000	$151,000	$229,000
INRS10	549	$7,000	$0	$122,000	$15,000	$4,000	$34,000	$380,000	$561,000
Tributary									
INRS01	165	$0	$0	$0	$0	$0	$0	$51,000	$51,000
INRS07	441	$0	$0	$0	$0	$0	$11,000	$51,000	$62,000
INRS09	499	$0	$0	$0	$0	$0	$13,000	$51,000	$64,000
INRS10	549	$0	$0	$0	$0	$0	$5,000	$51,000	$55,000
Total									
INRS01	165	$0	$0	$4,000	$0	$0	$0	$51,000	$56,000
INRS07	441	$2,000	$0	$30,000	$4,000	$1,000	$18,000	$117,000	$172,000
INRS09	499	$3,000	$0	$55,000	$6,000	$2,000	$25,000	$201,000	$293,000
INRS10	549	$7,000	$0	$122,000	$15,000	$4,000	$39,000	$430,000	$617,000

(FY 2010 Price Level, FDR 4.375%)

Table 37 – Reservoir Screening Damage Reduction Calculation: Aptakisic Creek

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
*Mainstem**									
ACRS01	56	$2,000	$0	$33,000	$5,000	$0	$9,000	$84,000	$133,000
ACRS02	79	$3,000	$0	$46,000	$8,000	$1,000	$13,000	$133,000	$204,000
ACRS03	248	$23,000	$1,000	$395,000	$45,000	$5,000	$101,000	$990,000	$1,559,000
ACRS08	418	$51,000	$1,000	$810,000	$85,000	$17,000	$225,000	$2,122,000	$3,312,000
ACRS09	93	$4,000	$0	$65,000	$11,000	$1,000	$18,000	$194,000	$293,000

*Aptakisic Creek Tributary was not modeled, thus tributary damage reductions are not included for these reservoirs.
(FY 2010 Price Level, FDR 4.375%)

Table 38 – Reservoir Screening Damage Reduction Calculation: Buffalo-Wheeling Creek

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
Mainstem									
BWRS03	165	$0	$0	$0	$0	$0	$0	$0	$0
BWRS06	49	$0	$0	$3,000	$0	$0	$0	$0	$3,000
BWRS09	345	$5,000	$0	$68,000	$9,000	$3,000	$18,000	$144,000	$247,000
BWRS10	72	$0	$0	$3,000	$0	$0	$0	$1,000	$4,000
BWRS15	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								
BWRS17	26	$5,000	$0	$68,000	$9,000	$3,000	$18,000	$144,000	$247,000
BWRS18	552	$12,000	$0	$187,000	$21,000	$6,000	$43,000	$479,000	$748,000
BWRS21	86	$0	$0	$0	$0	$0	$0	$0	$0
BWRS27	308	$0	$0	$8,000	$1,000	$0	$2,000	$17,000	$27,000
BWRS28	204	$1,000	$0	$12,000	$2,000	$0	$4,000	$25,000	$44,000
BWRS30	628	$7,000	$0	$105,000	$13,000	$3,000	$23,000	$320,000	$472,000
BWRS31	383	$14,000	$0	$259,000	$36,000	$5,000	$58,000	$873,000	$1,245,000
BWRS40*	25	$5,000	$0	$63,000	$8,000	$3,000	$17,000	$141,000	$237,000
Tributary									
BWRS03	165	$7,000	$2,000	$11,000	$4,000	$0	$86,000	$8,000	$118,000
BWRS06	49	$6,000	$2,000	$11,000	$4,000	$0	$82,000	$8,000	$112,000
BWRS09	345	$11,000	$2,000	$14,000	$5,000	$0	$115,000	$8,000	$155,000
BWRS10	72	$8,000	$2,000	$11,000	$4,000	$0	$89,000	$8,000	$122,000
BWRS15	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								
BWRS17	26	$11,000	$2,000	$14,000	$5,000	$0	$115,000	$8,000	$155,000
BWRS18	552	$11,000	$2,000	$13,000	$4,000	$0	$110,000	$8,000	$148,000
BWRS21	86	$7,000	$2,000	$12,000	$4,000	$0	$93,000	$8,000	$126,000
BWRS27	308	$8,000	$2,000	$12,000	$4,000	$0	$95,000	$8,000	$129,000
BWRS28	204	$9,000	$2,000	$15,000	$4,000	$0	$101,000	$8,000	$140,000
BWRS30	628	$9,000	$3,000	$16,000	$5,000	$0	$132,000	$8,000	$173,000
BWRS31	383	$8,000	$2,000	$13,000	$4,000	$0	$102,000	$8,000	$137,000
BWRS40*	25	$11,000	$2,000	$14,000	$5,000	$0	$113,000	$8,000	$153,000
Total									
BWRS03	165	$7,000	$2,000	$11,000	$4,000	$0	$86,000	$8,000	$118,000
BWRS06	49	$7,000	$2,000	$13,000	$4,000	$0	$82,000	$8,000	$115,000
BWRS09	345	$16,000	$2,000	$82,000	$14,000	$3,000	$133,000	$152,000	$402,000
BWRS10	72	$8,000	$2,000	$14,000	$4,000	$0	$90,000	$9,000	$126,000
BWRS15	H&H analysis did not show a significant effect on the water surface profile, site eliminated from further analysis.								
BWRS17	26	$16,000	$2,000	$82,000	$14,000	$3,000	$133,000	$152,000	$402,000
BWRS18	552	$22,000	$3,000	$200,000	$25,000	$6,000	$153,000	$487,000	$896,000
BWRS21	86	$7,000	$2,000	$12,000	$4,000	$0	$93,000	$8,000	$126,000
BWRS27	308	$8,000	$2,000	$20,000	$4,000	$0	$96,000	$25,000	$156,000
BWRS28	204	$10,000	$2,000	$27,000	$6,000	$0	$105,000	$33,000	$184,000
BWRS30	628	$16,000	$3,000	$121,000	$19,000	$3,000	$155,000	$328,000	$644,000
BWRS31	383	$23,000	$2,000	$271,000	$40,000	$5,000	$160,000	$881,000	$1,381,000
BWRS40*	25	$16,000	$2,000	$77,000	$13,000	$3,000	$131,000	$149,000	$390,000

*BWRS40 was run as a combination of sites BWRS09 and BWRS40. BWRS17 was run as a combination of sites BWRS09, BWRS40 and BWRS 17.
(FY 2010 Price Level, FDR 4.375%)

Table 39 – Reservoir Screening Damage Reduction Calculation: McDonald Creek

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
Mainstem									
MDRS02	44	$0	$0	$0	$0	$0	$0	$0	$0
MDRS04	119	$1,000	$0	$11,000	$2,000	$0	$3,000	$19,000	$36,000
Tributary									
MDRS02	44	$0	$0	$0	$0	$0	$0	$0	$0
MDRS04	119	$0	$0	$0	$0	$0	$0	$0	$0
Total									
MDRS02	44	$0	$0	$0	$0	$0	$0	$0	$0
MDRS04	119	$1,000	$0	$11,000	$2,000	$0	$3,000	$19,000	$36,000

(FY 2010 Price Level, FDR 4.375%)

Table 40 – Reservoir Screening Damage Reduction Calculation: Feehanville Ditch

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
*Mainstem**									
FDRS01	4,400	$214,000	$13,000	$2,971,000	$372,000	$234,000	$1,225,000	$11,565,000	$16,595,000
FDRS02	243	$1,000	$0	$7,000	$2,000	$0	$3,000	$26,000	$39,000
FDRS03	24	$24,000	$0	$256,000	$37,000	$20,000	$73,000	$804,000	$1,214,000

*Feehanville Ditch Tributary was not modeled, thus tributary damage reductions are not included for these reservoirs.
(FY 2010 Price Level, FDR 4.375%)

Table 41 – Reservoir Screening Damage Reduction Calculation: Weller Creek

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
Mainstem									
WLRS03	322	$3,000	$0	$30,000	$8,000	$1,000	$10,000	$48,000	$99,000
Tributary									
WLRS03	322	$0	$1,000	$0	$0	$0	$51,000	$3,000	$54,000
Total									
WLRS03	322	$3,000	$1,000	$30,000	$8,000	$1,000	$61,000	$51,000	$153,000

(FY 2010 Price Level, FDR 4.375%)

Table 42 – Reservoir Screening Damage Reduction Calculation: Willow-Higgins Creek

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
Mainstem									
WHRS01	250	$5,000	$0	$52,000	$9,000	$6,000	$13,000	$164,000	$248,000
WHRS06	586	$36,000	$1,000	$28,000	$6,000	$68,000	$51,000	$662,000	$852,000
WHRS08	93	$0	$0	$0	$0	$0	$0	$0	$0
WHRS09	246	$0	$0	$0	$0	$0	$0	$0	$0
Tributary									
WHRS01	250	$0	$0	$14,000	$0	$0	$1,000	$21,000	$36,000
WHRS06	586	$0	$0	$14,000	$0	$0	$1,000	$21,000	$36,000
WHRS08	93	$0	$0	$14,000	$0	$0	$1,000	$21,000	$36,000
WHRS09	246	$0	$0	$14,000	$0	$0	$1,000	$21,000	$36,000
Total									
WHRS01	250	$5,000	$0	$65,000	$9,000	$6,000	$14,000	$185,000	$284,000
WHRS06	586	$36,000	$1,000	$42 ,000	$6,000	$68,000	$54,000	$683,000	$890,000
WHRS08	93	$0	$0	$14,000	$0	$0	$1,000	$21,000	$36,000
WHRS09	246	$0	$0	$14,000	$0	$0	$1,000	$21,000	$36,000

(FY 2010 Price Level, FDR 4.375%)

Table 43 – Reservoir Screening Damage Reduction Calculation: Silver Creek

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
Mainstem									
SCRS03	718	$3,000	$0	$20,000	$12,000	$1,000	$12,000	$104,000	$151,000
Tributary									
SCRS03	718	$2,000	$3,000	$193,000	$148,000	$0	$223,000	$245,000	$813,000
Total									
SCRS03	718	$4,000	$3,000	$213,000	$160,000	$2,000	$234,000	$349,000	$964,000

(FY 2010 Price Level, FDR 4.375%)

Table 44 – Reservoir Screening Damage Reduction Calculation: Des Plaines River Mainstem

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
DPRS07	1000	$35,000	$1,000	$290,000	$158,000	$8,000	$108,000	$1,924,000	$2,524,000
DPRS23	330	$24,000	$1,000	$356,000	$32,000	$5,000	$81,000	$890,000	$1,388,000
DPRS24	1000	$24,000	$1,000	$372,000	$30,000	$8,000	$74,000	$751,000	$1,261,000
DPRS33	1678	$0	$0	$17,000	$10,000	$28,000	$25,000	$172,000	$252,000
DPRS34	500	$0	$0	$23,000	$12,000	$33,000	$25,000	$296,000	$391,000
DPRS35	1200	$1,000	$1,000	$43,000	$20,000	$60,000	$50,000	$728,000	$902,000
DPRS38	200	$0	$0	$15,000	$6,000	$20,000	$14,000	$248,000	$304,000
DPRS40	1000	$2,000	$1,000	$54,000	$25,000	$84,000	$63,000	$1,329,000	$1,560,000
DPRS41	1200	$3,000	$1,000	$58,000	$20,000	$50,000	$47,000	$557,000	$737,000
DPRS44	3436	$3,000	$1,000	$71,000	$22,000	$57,000	$57,000	$538,000	$748,000
DPRS48	1220	$1,000	$0	$26,000	$6,000	$15,000	$19,000	$120,000	$187,000
DPRS51	697	$1,000	$0	$13,000	$3,000	$7,000	$9,000	$48,000	$80,000
DPRS52	489	$1,000	$0	$14,000	$4,000	$12,000	$12,000	$61,000	$102,000
DPRS53	1004	$1,000	$0	$19,000	$5,000	$16,000	$19,000	$115,000	$175,000
DPRS56	1230	$3,000	$2,000	$65,000	$31,000	$97,000	$79,000	$1,384,000	$1,661,000
DPRS57	698	$6,000	$0	$9,000	$5,000	$4,000	$14,000	$95,000	$132,000

(FY 2010 Price Level, FDR 4.375%)

Screening cost estimates used several assumptions. To estimate first cost of construction, cost estimates were developed for several sites covering a range of sizes, capacities, and site conditions, as discussed in Appendix F (Cost Engineering). These estimates were used to create a linear relationship between the reservoir size and the first cost of construction. Estimated Lands and Damages were calculated based on an area-wide cost per acre of $52,835. This value was determined using the average value of land per acre in Cook County, as discussed in Appendix E (Economics). Supervision and administration (S&A) costs were estimated as 25% of the first costs, and Operation & Maintenance (O&M) costs were estimated as $225 per acre-foot of storage up to 444 acre-feet. The cost at 444 acre-feet, $100,000, was considered an upper limit for the O&M cost estimate. **Table 45** presents the screening cost calculations used in the benefit to cost ratio screening.

Table 45 – Reservoir Screening Cost Calculations

ID	Storage Volume (acre-ft)	Footprint Area (acres)	Estimated First Costs	Estimated Lands and Damages	Estimated S&A Costs	Total Implementation Costs	Estimated O&M Costs	Equivalent Annual Total Costs
Newport Ditch								
NDRS01	565	128	$14,144,000	$6,763,000	$3,536,000	$24,443,000	$100,000	$1,312,000
NDRS02	309	70	$10,454,000	$3,698,000	$2,613,000	$16,766,000	$70,000	$901,000
NDRS03	574	130	$14,274,000	$6,869,000	$3,568,000	$24,711,000	$100,000	$1,325,000
Mill Creek								
MLRS03	4,195	951	$66,467,000	$50,246,000	$16,617,000	$133,329,000	$100,000	$6,710,000
MLRS04	6,535	1,481	$100,195,000	$78,249,000	$25,049,000	$203,493,000	$100,000	$10,189,000
MLRS06	205	46	$8,955,000	$2,430,000	$2,239,000	$13,624,000	$46,000	$722,000
Gurnee Tributary								
GTRS01	67	15	$6,966,000	$793,000	$1,741,000	$9,500,000	$15,000	$486,000
Bull Creek								
BCRS02	177	55	$9,503,000	$2,906,000	$2,376,000	$14,784,000	$55,000	$788,000
Indian Creek								
INRS01	165	37	$8,378,000	$1,955,000	$2,095,000	$12,428,000	$37,000	$653,000
INRS07	441	100	$12,357,000	$5,284,000	$3,089,000	$20,729,000	$99,000	$1,127,000
INRS09	499	113	$13,193,000	$5,970,000	$3,298,000	$22,461,000	$100,000	$1,214,000
INRS10	549	124	$13,913,000	$6,552,000	$3,478,000	$23,943,000	$100,000	$1,287,000
Aptakisic Creek								
ACRS01	56	13	$6,807,000	$687,000	$1,702,000	$9,196,000	$13,000	$469,000
ACRS02	79	18	$7,139,000	$951,000	$1,785,000	$9,874,000	$18,000	$507,000
ACRS03	248	56	$9,575,000	$2,959,000	$2,394,000	$14,927,000	$56,000	$796,000
ACRS08	418	95	$12,025,000	$5,019,000	$3,006,000	$20,051,000	$94,000	$1,088,000
ACRS09	93	21	$7,341,000	$1,110,000	$1,835,000	$10,285,000	$21,000	$531,000
Buffalo-Wheeling Creek								
BWRS03	165	37	$8,378,000	$1,955,000	$2,095,000	$12,428,000	$37,000	$653,000
BWRS06	49	11	$6,706,000	$581,000	$1,677,000	$8,964,000	$11,000	$455,000
BWRS09	345	78	$10,973,000	$4,121,000	$2,743,000	$17,837,000	$78,000	$962,000
BWRS10	90	90	$7,297,000	$4,755,000	$1,824,000	$13,877,000	$20,000	$708,000
BWRS17	552	125	$13,957,000	$6,604,000	$3,489,000	$24,050,000	$100,000	$1,292,000
BWRS18	86	20	$7,240,000	$1,057,000	$1,810,000	$10,106,000	$19,000	$520,000
BWRS21	308	70	$10,440,000	$3,698,000	$2,610,000	$16,748,000	$69,000	$900,000
BWRS27	204	46	$8,940,000	$2,430,000	$2,235,000	$13,606,000	$46,000	$720,000
BWRS28	628	142	$15,052,000	$7,503,000	$3,763,000	$26,318,000	$100,000	$1,405,000
BWRS30	383	87	$11,521,000	$4,597,000	$2,880,000	$18,997,000	$86,000	$1,028,000
BWRS31	84	84	$7,211,000	$4,438,000	$1,803,000	$13,452,000	$19,000	$686,000
McDonald Creek								
MDRS02	44	10	$6,634,000	$528,000	$1,659,000	$8,821,000	$10,000	$447,000
MDRS04	119	27	$7,715,000	$1,427,000	$1,929,000	$11,071,000	$27,000	$576,000

(FY 2010 Price Level, FDR 4.375%)

Table 45 (cont.) – Reservoir Screening Cost Calculations

ID	Storage Volume (acre-ft)	Footprint Area (acres)	Estimated First Costs	Estimated Lands and Damages	Estimated S&A Costs	Total Implementation Costs	Estimated O&M Costs	Equivalent Annual Total Costs
Feehanville Ditch								
FDRS01	2,000	1,007	$34,828,000	$53,205,000	$8,707,000	$96,740,000	$100,000	$4,896,000
FDRS02	243	55	$9,503,000	$2,906,000	$2,376,000	$14,784,000	$55,000	$788,000
FDRS03	24	5	$6,346,000	$264,000	$1,586,000	$8,197,000	$5,000	$412,000
Weller Creek								
MLRS03	4,195	951	$66,467,000	$50,246,000	$16,617,000	$133,329,000	$100,000	$923,000
Willow-Higgins Creek								
WHRS01	250	57	$9,604,000	$3,012,000	$2,401,000	$15,016,000	$56,000	$801,000
WHRS06	586	21	$14,447,000	$1,110,000	$3,612,000	$19,168,000	$100,000	$1,050,000
WHRS08	93	21	$7,341,000	$1,110,000	$1,835,000	$10,285,000	$21,000	$531,000
WHRS09	246	56	$9,546,000	$2,959,000	$2,386,000	$14,891,000	$55,000	$794,000
Silver Creek								
SCRS03	718	163	$16,349,000	$8,612,000	$4,087,000	$29,049,000	$100,000	$1,540,000
Des Plaines River								
DPRS07	1,000	200	$20,414,000	$10,567,000	$5,104,000	$36,085,000	$100,000	$1,889,000
DPRS23	330	66	$10,757,000	$3,487,000	$2,689,000	$16,933,000	$74,000	$914,000
DPRS24	1,000	200	$20,414,000	$10,567,000	$5,104,000	$36,085,000	$100,000	$1,889,000
DPRS33	1,678	380	$30,187,000	$20,077,000	$7,547,000	$57,811,000	$100,000	$2,966,000
DPRS34	500	100	$13,207,000	$5,284,000	$3,302,000	$21,792,000	$100,000	$1,180,000
DPRS35	1,200	272	$23,297,000	$14,371,000	$5,824,000	$43,492,000	$100,000	$2,256,000
DPRS38	200	40	$8,883,000	$2,113,000	$2,221,000	$13,217,000	$45,000	$700,000
DPRS40	1,000	200	$20,414,000	$10,567,000	$5,104,000	$36,085,000	$100,000	$1,889,000
DPRS41	1,200	240	$23,297,000	$12,680,000	$5,824,000	$41,801,000	$100,000	$2,172,000
DPRS44	3,436	779	$55,527,000	$41,158,000	$13,882,000	$110,567,000	$100,000	$5,582,000
DPRS48	1,220	276	$23,585,000	$14,582,000	$5,896,000	$44,064,000	$100,000	$2,285,000
DPRS51	697	158	$16,047,000	$8,348,000	$4,012,000	$28,406,000	$100,000	$1,508,000
DPRS52	489	111	$13,048,000	$5,865,000	$3,262,000	$22,175,000	$100,000	$1,199,000
DPRS53	1,004	228	$20,472,000	$12,046,000	$5,118,000	$37,636,000	$100,000	$1,966,000
DPRS56	1,230	200	$23,729,000	$10,567,000	$5,932,000	$40,229,000	$100,000	$2,094,000
DPRS57	698	140	$16,061,000	$7,397,000	$4,015,000	$27,473,000	$100,000	$1,462,000

(FY 2010 Price Level, FDR 4.375%)

The costs and benefits presented in the above tables were used to calculate a BCR for each site, presented in
Table 46. Sites with BCRs greater than 1.0 were kept for further analysis. **Table 47** presents a summary of these results by watershed.

Table 46 – Reservoir Screening Benefit to Cost Ratio Results

Site ID	Storage Volume (acre-ft)	Equivalent Annual Damages Reduced	Equivalent Annual Costs	BCR	Screening Result
Newport Ditch					
NDRS01	565	$38,000	$1,312,000	0	Eliminated: BCR<1
NDRS02	309	$0	$901,000	0	Eliminated: BCR<1
NDRS03	574	$427,000	$1,325,000	0.3	Eliminated: BCR<1
Mill Creek					
MLRS03	4,195	$0	$6,710,000	0	Eliminated: BCR<1
MLRS04	6,535	$0	$10,189,000	0	Eliminated: BCR<1
MLRS06	205	$0	$722,000	0	Eliminated: BCR<1
Gurnee Tributary					
GTRS01	67	$1,000	$486,000	0	Eliminated: BCR<1
Bull Creek					
BCRS02	177	$2,518,000	$788,000	3.2	Kept for further analysis
Indian Creek					
INRS01	165	$56,000	$653,000	0.1	Eliminated: BCR<1
INRS07	441	$172,000	$1,127,000	0.2	Eliminated: BCR<1
INRS09	498	$293,000	$1,214,000	0.2	Eliminated: BCR<1
INRS10	549	$617,000	$1,287,000	0.5	Eliminated: BCR<1
Aptakisic Creek					
ACRS01	56	$133,000	$469,000	0.3	Eliminated: BCR<1
ACRS02	79	$204,000	$507,000	0.4	Eliminated: BCR<1
ACRS03	248	$1,559,000	$796,000	2	Kept for further analysis
ACRS08	418	$3,312,000	$1,088,000	3	Kept for further analysis
ACRS09	93	$293,000	$531,000	0.6	Eliminated: BCR<1
Buffalo-Wheeling Creek					
BWRS03	165	$118,000	$653,000	0.2	Eliminated: BCR<1
BWRS06	49	$115,000	$455,000	0.3	Eliminated: BCR<1
BWRS09	345	$402,000	$962,000	0.4	Eliminated: BCR<1
BWRS10	72	$126,000	$494,000	0.3	Eliminated: BCR<1
BWRS17	396	$402,000	$708,000	0.6	Eliminated: BCR<1
BWRS18	552	$896,000	$1,292,000	0.7	Eliminated: BCR<1
BWRS21	86	$126,000	$520,000	0.2	Eliminated: BCR<1
BWRS27	308	$156,000	$900,000	0.2	Eliminated: BCR<1
BWRS28	204	$184,000	$720,000	0.3	Eliminated: BCR<1
BWRS30	628	$644,000	$1,405,000	0.5	Eliminated: BCR<1
BWRS31	383	$1,381,000	$1,028,000	1.3	Kept for further analysis
BWRS40	370	$390,000	$686,000	0.6	Eliminated: BCR<1

(FY 2010 Price Level, FDR 4.375%)

Table 46 (cont.) – Reservoir Screening Benefit to Cost Ratio Results

Site ID	Storage Volume (acre-ft)	Equivalent Annual Damages Reduced	Equivalent Annual Costs	BCR	Screening Result
McDonald Creek					
MDRS02	44	$0	$447,000	0	Eliminated: BCR<1
MDRS04	119	$36,000	$576,000	0.1	Eliminated: BCR<1
Feehanville Ditch					
FDRS01	2,000	$16,595,000	$4,896,000	3.4	Kept for further analysis
FDRS02	243	$39,000	$788,000	0	Eliminated: BCR<1
FDRS03	24	$1,214,000	$412,000	2.9	Kept for further analysis
Weller Creek					
WLRS03	322	$153,000	$923,000	0.2	Eliminated: BCR<1
Willow-Higgins Creek					
WHRS01	250	$284,000	$801,000	0.4	Eliminated: BCR<1
WHRS06	586	$890,000	$1,050,000	0.8	Eliminated: BCR<1
WHRS08	93	$36,000	$531,000	0.1	Eliminated: BCR<1
WHRS09	246	$36,000	$794,000	0	Eliminated: BCR<1
Silver Creek					
SCRS03	718	$964,000	$1,540,000	0.6	Eliminated: BCR<1
Des Plaines River					
DPRS07	1,000	$2,524,000	$1,889,000	1.3	Kept for further analysis
DPRS23	330	$1,388,000	$914,000	1.5	Kept for further analysis
DPRS24	1,000	$1,261,000	$1,889,000	0.7	Eliminated: BCR<1
DPRS33	1,678	$252,000	$2,966,000	0.1	Eliminated: BCR<1
DPRS34	500	$391,000	$1,180,000	0.3	Eliminated: BCR<1
DPRS35	1,200	$902,000	$2,256,000	0.4	Eliminated: BCR<1
DPRS38	200	$304,000	$700,000	0.4	Eliminated: BCR<1
DPRS40	1,000	$1,560,000	$1,889,000	0.8	Eliminated: BCR<1
DPRS41	1,200	$737,000	$2,172,000	0.3	Eliminated: BCR<1
DPRS44	3,436	$748,000	$5,582,000	0.1	Eliminated: BCR<1
DPRS48	1,220	$187,000	$2,285,000	0.1	Eliminated: BCR<1
DPRS51	697	$80,000	$1,508,000	0.1	Eliminated: BCR<1
DPRS52	489	$102,000	$1,199,000	0.1	Eliminated: BCR<1
DPRS53	1,004	$175,000	$1,966,000	0.1	Eliminated: BCR<1
DPRS56	1,230	$1,661,000	$2,094,000	0.8	Eliminated: BCR<1
DPRS57	698	$132,000	$1,462,000	0.1	Eliminated: BCR<1

(FY 2010 Price Level, FDR 4.375%)

Table 47 – Summary of Reservoir Site Screening Results

ID	Watershed	County	State	Identified	Eliminated	Kept
BR	Brighton Creek	Kenosha/Racine	WI	3	3	0
KR	Kilbourn Road Ditch	Kenosha/Racine	WI	5	5	0
ND	Newport Ditch	Lake	IL	3	3	0
NM	North Mill Creek	Lake/Kenosha	IL/WI	5	5	0
ML	Mill Creek	Lake	IL	3	3	0
GT	Gurnee Tributary	Lake	IL	1	1	0
BC	Bull Creek	Lake	IL	1	0	1
IN	Indian Creek	Lake	IL	4	4	0
AC	Aptakisic Creek	Cook/Lake	IL	5	3	2
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	13	12	1
MD	McDonald Creek	Cook	IL	2	2	0
FD	Feehanville Ditch	Cook	IL	3	1	2
WL	Weller Creek	Cook	IL	1	1	0
WH	Willow-Higgins Creek	Cook/Dupage	IL	4	4	0
SC	Silver Creek	Cook/Dupage	IL	1	1	0
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	16	14	2
				70	62	8

2.2 – Flood Barrier Site Screening

As a preliminary step, the potential flood barrier sites were evaluated with respect to practical site considerations. Several sites were eliminated or modified:

- DPLV02 was elimintated because no high ground tie-in spot was available in the area.
- No high ground tie-in spots for DPLV06, 07, 10, and 08 as individual structures were available. As these sites are adjacent and tie back is feasibile at the north and south ends, the sites were combined into a single levee system. The revised site was named DPLV09.
- DPLV11 was eliminated because no high ground tie-in spot was available in the area.
- DPLV12 was eliminated because no high ground tie-in spot was available in the area.
- DPLV13 was eliminated due to the large amount of floodplain removed by the structure, making floodplain mitigation impractical.
- DPLV14 was eliminated because no high ground tie-in spot was available in the area.
- DPLV16 was eliminated because the existing structure had been tied in to the highest available elevation.
- DPLV17 was eliminated due to the large amount of floodplain removed by the structure, making floodplain mitigation impractical.

For the remaining sites, preliminary reductions in damages were calculated in HEC-FDA using baseline water surface profiles created as described in Appendix A (Hydrology & Hydraulics). Reductions in damages are shown in **Table 49**. In order to find the optimal levee height at each location, reductions in damages were calculated for levees heights at flood stages for 10%, 2%, 1%, 0.02% annual chance of exceedance flood events. These flood stages are shown in **Table 48**. An additional crest elevation of two feet above the 1% chance flood stage was modeled as a maximum elevation. The length of the levee was determined as discussed in

Appendix D (Civil Design). Initial calculations were performed assuming that the structure would not impact the water surface profile and no floodplain mitigation would be required.

Table 48 – Flood Barrier Site Water Surface Profile Elevations

Site ID	Grade Elev. (ft NGVD 29)	Flood Elevation by Flood Event (% chance of exceedance)				
		10%	2%	1%	0.02%	1% + 2 ft
Buffalo-Wheeling Creek						
BWLV01	652	653.11	654.61	655.27	656.61	657.27
BWLV02	674	674.54	676.46	677.62	680.33	679.62
Silver Creek						
SCLV01	626	626.56	627.98	628.31	628.97	630.31
SCLV02	632	633.67	634.69	635.02	635.40	637.02
SCLV03	633	634.46	635.70	635.96	636.42	637.96
SCLV04	639	641.73	641.99	642.27	642.85	644.27
Des Plaines River						
DPLV01	610	614.8	616.0	616.3	617.2	618.3
DPLV03	622	622.6	624.7	625.4	627.0	627.4
DPLV04	618	623.1	625.2	625.9	627.4	627.9
DPLV05	621	624.4	626.6	627.4	629.0	629.4
DPLV09[1]	621	629.1-630.7	630.9-632.5	631.6-633.1	633.0-634.5	633.6-635.1
DPLV15	650	655.1	657.6	658.6	660.7	660.6

[1]Since DPLV09 is significantly longer than other levee sites, flood elevations at DPLV09 were determined for four reaches of the levee to optimize costs.

(FY 2010 Price Level, FDR 4.125%)

Table 49 – Flood Barrier Site Screening Calculation of Reduction in Damages

Site ID	Length (ft)	Total Equivalent Annual Damages Reduced at Crest Elevation (Annual Chance of Exceedance) Flood Stage				
		10%	2%	1%	0.02%	1% + 2 feet
Buffalo-Wheeling Creek						
BWLV01	4,010	$25,000	$25,000	$25,000	$25,000	$25,000
BWLV02	2,082	$3,000	$3,000	$11,000	$35,000	$35,000
Silver Creek						
SCLV01	2,392	$0	$9,000	$13,000	$17,000	$17,000
SCLV02	6,247	$240,000	$367,000	$393,000	$423,000	$430,000
SCLV03	5,145	$3,000	$44,000	$60,000	$85,000	$91,000
SCLV04	2,098	$96,000	$124,000	$140,000	$184,000	$189,000
Des Plaines River						
DPLV01	2,098	$185,600	$342,300	$365,700	$409,200	$422,700
DPLV03	1,360	$1,200	$35,600	$58,900	$104,200	$117,700
DPLV04	6,072	$145,000	$826,000	$1,207,000	$1,960,000	$2,344,000
DPLV05	6,050	$438,000	$992,000	$1,277,000	$1,575,000	$1,781,000
DPLV09	9,081	$435,000	$1,400,300	$1,775,000	$2,401,900	$2,576,000
DPLV15	1,417	$3,300	$37,100	$55,600	no tie-in	no tie-in

(FY 2010 Price Level, FDR 4.125%)

Although some sites would require construction of floodwalls rather than levees because of space constraints, levee construction costs were used in this preliminary screening. Since levees are cheaper to construct than floodwalls, this assumption provides conservative results.

Using the approximate grade at the site, the baseline flood elevation, and an approximate levee length, screening costs were calculated using a cost per linear foot based on the levee height, shown in **Table 50**. The cost per linear foot was estimated as described in Appendix F (Cost Engineering). The baseline flood elevation at each site for each event is shown in **Table 48**. The calculated levee height is the difference between the crest elevation and the approximate grade.

Table 50 – Cost of Levee Construction per Linear Foot

Height (ft)	1	2	3	4	5	6	7	8	9
Cost/LF	$1,587	$1,652	$1,729	$1,805	$1,920	$2,305	$2,161	$2,299	$2,357
Height (ft)	10	11	12	13	14	15	16	17	
Cost/LF	$2,459	$2,561	$2,663	$2,765	$2,866	$2,968	$3,070	$3,172	

(FY 2010 Price Level)

To estimate the levee costs during this screening step, only first costs of construction were used. Estimated construction costs were annualized over the 50 year period of analysis at 4.375%. The construction costs calculated based on these parameters are shown in **Table 51**. These costs were then compared with the equivalent annual damages reduced for each levee height at each location to determine the net benefits (equivalent annual damages reduced minus annualized construction costs), shown in **Table 52**.

Table 51 – Flood Barrier Annualized Screening Costs

Site ID	Length (ft)	Grade Elev. (ft)	Cost of Flood Barrier at Annual Chance of Exceedance Flood Stage				
			10%	2%	1%	0.02%	1%+2 feet
Buffalo-Wheeling Creek							
BWLV01	4,010	652	$344,000	$382,000	$382,000	$430,000	$430,000
BWLV02	2,082	674	$179,000	$186,000	$210,000	$237,000	$237,000
Silver Creek							
SCLV01	2,392	626	$188,000	$196,000	$196,000	$205,000	$214,000
SCLV02	6,247	632	$512,000	$536,000	$536,000	$536,000	$595,000
SCLV03	5,145	633	$405,000	$441,000	$441,000	$441,000	$490,000
SCLV04	2,098	639	$180,000	$180,000	$180,000	$188,000	$200,000
Des Plaines River							
DPLV01[1]	2,098	616	$83,000	$88,000	$88,000	$93,000	$99,000
DPLV03	1,360	622	$107,000	$117,000	$117,000	$129,000	$129,000
DPLV04	6,072	618	$578,000	$650,000	$692,000	$710,000	$740,000
DPLV05	6,050	621	$519,000	$610,000	$610,000	$690,000	$690,000
DPLV09	9,081	621	$1,016,000	$1,104,000	$1,128,000	$1,191,000	$1,219,000
DPLV15	1,417	650	$63,000	$75,000	$77,000	no tie-in	no tie-in

[1]A previously constructed levee at 616 covers approximately 940 feet of this alignment. Grade over this portion of the site is assumed to be at 616 to account for possible savings incurred by incorporation of the existing structure into the design.
(FY 2010 Price Level, FDR 4.125%)

Table 52 – Flood Barrier Site Net Benefits

Site ID	Net Benefits at Flood Stage (% Chance of Exceedance)				
	10%	2%	1%	0.02%	1%+2 ft
Buffalo-Wheeling Creek					
BWLV01	($319,000)	($357,000)	($357,000)	($405,000)	($405,000)
BWLV02	($176,000)	($183,000)	($199,000)	($202,000)	($202,000)
Silver Creek					
SCLV01	($188,000)	($187,000)	($183,000)	($188,000)	($197,000)
SCLV02	($272,000)	($169,000)	($143,000)	($113,000)	($165,000)
SCLV03	($402,000)	($397,000)	($381,000)	($356,000)	($399,000)
SCLV04	($84,000)	($56,000)	($40,000)	($4,000)	($11,000)
Des Plaines River					
DPLV01	$103,000	$254,000	$278,000	$316,000	$324,000
DPLV03	($106,000)	($81,000)	($58,000)	($25,000)	($11,000)
DPLV04	($433,000)	$176,000	$515,000	$1,250,000	$1,604,000
DPLV05	($252,000)	$224,000	$509,000	$746,000	$952,000
DPLV09	($581,000)	$296,000	$647,000	$1,211,000	$1,357,000
DPLV15	($60,000)	($38,000)	($21,000)	no tie-in	no tie-in

(FY 2010 Price Level, FDR 4.125%)

Two levees had positive net benefits at various elevations when considering levee construction costs alone, as shown in **Table 52**. The crest elevation maximizing net benefits was selected for further investigation. A summary of the screening net benefits is presented in **Table 53**. As shown the table, the screening resulting in positive net benefits at two feasible sites: DPLV01 and DPLV09. The table shows the elevation and corresponding flood frequency at which the highest net benefits occurred. **Table 54** presents a summary of the screening results by watershed.

Table 53 – Flood Barrier Site Screening Results

Site ID	Max. Net Benefits	Screening Decision	Optimized Levee		
			Length (ft)	Appx. Grade (ft)	Crest Elev. (ft)
Buffalo-Wheeling Creek					
BWLV01	($221,976)	Eliminate: Net Benefits<0	--	--	--
BWLV02	($164,700)	Eliminate: Net Benefits<0	--	--	--
Silver Creek					
SCLV01	($183,000)	Eliminate: Net Benefits<0	--	--	--
SCLV02	($113,000)	Eliminate: Net Benefits<0	--	--	--
SCLV03	($381,000)	Eliminate: Net Benefits<0	--	--	--
SCLV04	($4,000)	Eliminate: Net Benefits<0	--	--	--
Des Plaines River					
DPLV01	$324,000	Keep	2,098	610	618.0
DPLV03	($11,000)	Eliminate: Net Benefits<0	--	--	--
DPLV04	$1,604,000	Keep	6,072	618	627.8
DPLV05	$1,091,000	Keep	6,050	616	629.4
DPLV09	$1,357,000	Keep	9,081	621	633.6-635.1
DPLV15	($21,000)	Eliminate: Net Benefits<0	--	--	--

(FY 2010 Price Level, FDR 4.125%)

Table 54 – Summary of Flood Barrier Site Screening Results

ID	Watershed	County	State	Total	Eliminated	Kept
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	0	2	0
SC	Silver Creek	Cook/Dupage	IL	4	4	0
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	16	12	4
			TOTAL	22	20	2

2.3 – Road Raise and Bridge Modification Site Screening

Before conducting economic and cost analyses for each site, a preliminary screening was conducted to determine which sites would be likely to undergo major rehabilitation within the study period of analysis. To minimize impacts to roadways users and optimize use of Federal and state funds, implementation of road raises and bridge modifications would only occur in conjunction with planned major rehabilitation of the road or bridge.

Each site was also reviewed to determine its location with respect to other identified sites. Nearby sites, where the road raise and/or bridge modification would be conducted concurrently, were combined. In coordination with the Illinois Department of Transportation (IDOT), the age and remaining design life of each structure was determined as well as whether the site is currently included in the IDOT multi-year plan for major rehabilitation. The design life used by IDOT is 50 years for bridges and 90 years for box culverts. Parallel roads are not assigned a design life, but instead undergo major rehabilitation when required for safety or capacity improvements.

The road segments were first evaluated against three criteria:

1. Planned major rehabilitation
2. At or near end of design life
3. Contribute more than 10% of total delays

Sites that meet at least one of the criteria were further evaluated to determine whether any physical limitations at the site (e.g. existing underpasses) would prevent raising the road. **Table 55** presents a summary this initial screening evaluation for each site.

Three of the identified sites are included in the IDOT multi-year plan: DPRR04/DPRR05 (River Road in Des Plaines), DPBM06 (Rand Road Bridge in Des Plaines), and DPRR11/DPBM14 (Grand Avenue in Gurnee). DPRR04/DPRR05, however, is scheduled for construction in 2012, making coordination infeasible. Site DPRR11/DPBM14 is near a railroad bridge crossing and a road raise would reduce clearance at the brige, limiting capacity of the roadway. DPBM06, however, was retained for further analysis.

One additional IDOT road, although not on IDOT's priority list, is at the end of its design life: DPBM13 (Route 120 in Grayslake). The age of the structure suggests that major rehabilitation is likely to occur within the 50 year period of analysis for this study. Based on these considerations DPBM13 was retained for further analysis.

DPBM04 (First Avenue Bridge in River Grove), was responsible for approximately 15% of all delays in the VISTA model. This site is also at the top of the flood priority list maintained by IDOT (roadways are ranked according to the frequency of pavement flooding as reported to

IDOT). While the site has 20 years of remaining design life, the significance of flooding at this location suggests that major rehabilitation may be prioritized prior to that time.

One of the identified roads, DPRR10 (Old Grand Avenue in Gurnee) is not owned by IDOT. Review of this site, however, showed that the numerous access points along the roadway would make elevation of the road infeasible and the site was eliminated from further consideration.

Screening level cost estimates for raising the roads were developed by IDNR-OWR. To generate the estimates, LIDAR topography was used to establish the extent of roadway that would need to be raised and the average height of raise required. The range of elevations used in the analysis corresponds to the flood elevations used in the VISTA model. Fill and paving costs were based on approximate prices provided by IDOT. The approximate length and height of the road raise was used to calculate a volume of fill required using an estimated price of $25 per cubic yard of fill. Repaving costs were calculated using a price of $1.1 million per lane per mile of roadway. **Table 56** shows the data used to estimate screening costs. **Table 57** shows the approximate cost estimtated for raising the roadway to each evaluated elevation.

Benefits for the retained sites were calculated for each evaluated elevation using depth-damage relationships developed for use in HEC-FDA. The benefits, annualized costs, and net benefits for each site are shown in **Table 58**. Each site had positive net benefits. The elevation with the highest net benefits was retained for further evaluation. A summary of the screening results is shown in **Table 59**.

Table 55 – Road Raise and Bridge Modification Structure Preliminary Screening

ID	Name	Municipality	Structure Type	Percent of Total Delays	Planned Work	Last Major Work	Age as of 2010	Remainig Design Life	Screening Decision[1]
DPBM03	Chicago Ave	River Forest	Bridge	1.32%	N	1989	21	29	Eliminate: does not meet criteria
DPBM04	First Ave	River Grove	Bridge	14.98%	N	1980	30	20	*Retain: contributes over 10% of delays*
DPRR01	River Road	River Grove	Parallel	2.40%	N	2003	7	--	Eliminate: does not meet criteria
DPRR02				1.19%					
DPBM05	Grand Ave	River Grove	Bridge	2.26%	N	1985	25	25	Eliminate: does not meet criteria
DPRR03	River Road	Schiller Park	Parallel	4.87%	N	1928	82	--	Eliminate: does not meet criteria
DPRR04 DPRR05	River Road	Des Plaines	Parallel	6.64%	Y	1990	20	--	Eliminate: planned work will be completed in 2012
DPRR06	Miner Street	Des Plaines	Parallel	2.00%	N	1986	24	--	Eliminate: does not meet criteria
DPBM06	Rand Road	Des Plaines	Bridge	2.91%	Y				*Retain: IDOT planned work in future years*
DPBM07	Golf Road	Des Plaines	Bridge	4.66%	N	2004	6	44	Eliminate: does not meet criteria
DPBM08	River Road	Glenview	Box Culvert	2.78%	N	1984	26	64	Eliminate: does not meet criteria
DPBM09	Milwaukee Ave	Prospect Hgts	Bridge	1.67%	N	1990	20	30	Eliminate: does not meet criteria
DPRR07	River Road	Prospect Hgts	Parallel	4.03%	N	2009	1	--	Eliminate: does not meet criteria
DPBM10	Milwaukee Ave	Prospect Hgts	Box Culvert	7.74%	N	1990	20	70	Eliminate: does not meet criteria
DPBM11	Milwaukee Ave/ River Road	Buffalo Grove	Box Culvert	6.45%	N	2000	10	80	Eliminate: does not meet criteria
DPRR08 DPRR09			Parallel						
DPBM12	IL Route 60	Libertyville	Bridge	1.33%	N	1987	23	27	Eliminate: does not meet criteria
DPBM13	IL Route 120	Grayslake	Bridge	1.49%	N	1959	51	-1	*Retain: structure age is at design life*
DPRR10	Old Grand Ave	Gurnee	Parallel	8.45%	N	NOT IDOT			Eliminate: site limitations
DPRR11	IL Route 132/ Grand Ave	Gurnee	Parallel	5.19%	Y	1995	15	35	Eliminate: site limitations
DPBM14			Bridge						
DPBM15	US Hwy 41	Gurnee	Bridge	6.81%	N	1981	29	21	Eliminate: does not meet criteria
DPRR12			Parallel						

[1]Sites were retained if they met one of three criteria: work is planned by IDOT at the site; the site construbites over 10% of total delays; or the structure age is at or near its design life. Sites that met these criteria were further screened for site specific limitations that would prevent construction of a higher road surface elevation.

Table 56 – Bridge Modification Site Screening Quantity Estimates

Site (Existing Low Point ft NGVD29)	New Road Elevation (ft NGVD29)	Elev. Length (ft)	Avg. Elev. Height (ft)	Avg. Fill Area (sq. ft.)	Fill Volume (cu. ft.)
DPBM04 (620.0)	621.9	20	0.4	24.6	18
	622.8	839	0.8	47.8	1,485
	623.8	1,019	1.6	109.5	4,130
	624.9	1,608	2.0	136.3	8,120
	625.5	1,928	2.3	158.9	11,347
	627.1	3,927	2.1	140.8	20,471
DPBM06 (632.0)	632.7	3,281	1.3	70.6	8,575
	633.6	5,178	1.6	89.1	17,086
	634.2	6,325	1.9	106.0	24,834
	635.7	6,405	3.3	203.0	48,161
DPBM13 (661.5)	661.6	459	0.8	63.9	1,087
	662.9	779	1.6	122.1	3,523
	663.8	928	2.2	176.0	6,052
	664.7	998	2.9	240.5	8,894
	666.8	1,587	3.6	308.1	18,115

Table 57 – Bridge Modification Site Screening Estimated Costs

Site	Fill Cost ($1,000)	Pvmt. Cost ($1,000)	Conveyance ($1,000)	Total Cost ($1,000)	Annual Costs ($1,000)
DPBM04	$1	$26	$3	$30	$1
	$47	$1,108	$263	$1,419	$70
	$131	$1,346	$693	$2,170	$108
	$258	$2,124	$1,335	$3,717	$184
	$360	$2,546	$1,833	$4,740	$235
	$650	$5,187	$3,353	$9,189	$456
DPBM06	$272	$3,467	$1,799	$5,538	$275
	$542	$5,472	$3,502	$9,516	$472
	$788	$6,683	$4,991	$12,463	$618
	$1,529	$6,768	$8,789	$17,086	$847
DPBM13	$35	$728	$161	$924	$46
	$112	$1,234	$503	$1,849	$92
	$192	$1,472	$838	$2,502	$124
	$282	$1,582	$1,190	$3,055	$151
	$575	$2,516	$2,347	$5,438	$270

(FY 2010 Price Level, FDR 4.125%)

Table 58 – Road Raise Site Screening Benefit-Cost Summary

Site (Existing Low Point ft NGVD29)	New Elevation (ft NGVD29)	Added Height (ft)	Approx Extent (ft)	Annual Benefits ($1,000)	Annual Costs ($1,000)	Net Benefits ($1,000)
DPBM04 (620.0)	621.9	1.9	20	$3,803	$1	$3,802
	622.8	2.8	839	$4,615	$70	$4,545
	623.8	3.8	1,019	$4,979	$108	$4,872
	624.9	4.9	1,608	$5,127	$184	$4,943
	625.5	5.5	1,928	$5,188	$235	$4,953
	627.1	7.1	3,927	$5,215	$456	$4,760
DPBM06 (632.0)	632.7	0.7	3,281	$552	$275	$277
	633.6	1.6	5,178	$1,013	$472	$541
	634.2	2.2	6,325	$1,171	$618	$553
	635.7	3.7	6,405	$1,257	$847	$410
DPBM13 (661.5)	661.6	0.1	459	$92	$46	$46
	662.9	1.4	779	$383	$92	$291
	663.8	2.3	928	$486	$124	$362
	664.7	3.2	998	$575	$151	$423
	666.8	5.3	1,587	$606	$270	$336

(FY 2010 Price Level, FDR 4.125%)

Table 59 – Road Raise Site Screening Results

Site ID	Annual Benefits ($1,000)	Annual Costs ($1,000)	Max Net Benefits ($1,000)	1% Annual Chance Flood Elevation (ft NGVD29)	Lowest Existing Pavement Elevation (ft NGVD29)	Optimized Pavement Elevation (ft NGVD29)	Approximate Extent (ft)
DPBM04	$5,188	$235	$4,953	626.0	620.0	625.5	1,900
DPBM06	$1,171	$618	$553	634.5	632.0	634.2	6,300
DPBM13	$575	$151	$423	665.1	661.5	664.7	1,000

(FY 2010 Price Level, FDR 4.125%)

2.4 – Modifications to Existing Structures Site Screening

Due to the uniqueness of each site in this category, no parameters for screening were available. Instead, site specific evaluations as discussed in Section 3.4 were conducted for each site.

2.5 – Non-Structural Measure Site Screening

Each of the potential non-structural sites was evaluated for all non-structural flood risk management measures applicable to that structure. The evaluated measures for individual structures were: elevation, dry floodproofing, wet floodproofing, and construction of a ring levee. While implementation costs were evaluated for individual structures to determine the optimal floodproofing method, the screening looked at net benefits for groups of homes within to avoid implementing a plan that would benefit individual homeowners rather than the community as a whole. Therefore, only groups with positive total net benefits for implementation at all feasible structures were considered for further evaluation.

Benefits for implementation of measures at individual structures are equal to the equivalent annual damages for the site as modeled by HEC-FDA, since these are the damages foregone with implementation of the measure. Details of flood elevations and equivalent annual damages were derived from the "FDA_StrucDetail.out" file generated by HEC-FDA when computing reach stage-damage functions with uncertainty.

Costs for non-structural measures were estimated as discussed in Appendix F (Cost Engineering). Supervision and Administration Costs were estimated as 25% of construction costs.

Applicability of each measure to a structure was determined as discussed below.The estimated implementation costs calculated for each measure were amortized over the 50 year period of analysis using a discount rate of 4.375%.

Elevation

Elevation was considered for residential structures only. USACE practice dictates a maximum elevation of 12 feet, although the majority of the structures fell within the range of two to five feet. Elevations were calculated based on raising the structure at least one foot above the 1% chance flood elevation.

Wet Floodproofing

Wet floodproofing was considered for both residential and non-residential structures. In order to use this measure, the 1% chance flood elevation must be below the first floor elevation of the structure. In addition, the structure must contain an unfinished basement area to be waterproofed and remain unused. Detailed information was not available as to whether structure basements are finished. Most structures with basements in this area have finished basements, therefore structures that were not coded as having basements but showed damages at the 1% chance flood elevation below the first floor were assumed to have an unfinished basement or crawlspace area and therefore eligible for this method.

Dry Floodproofing

Dry floodproofing was considered for both residential and non-residential structures. Dry floodproofing can be utilized up to three feet above the first floor elevation. To implement the measure at least 1 foot above the 1% chance flood elevation, the 1% chance flood must be no more than two feet above the first floor elevation. The structure must also be constructed of masonry or masonry veneer with no basement.

Fill Basement/Dry Floodproofing

For residential structures with finished basements, the dry floodproofing measure was combined with filling the basement and removing it from use. Any utilities located in the basement would be relocated to a new addition installed above the first floor elevation and the basedment would be filled and prepared to allow floodwaters to flow through safely as for wet floodproofing.

Ring Levee

A levee encircling the structure was considered for non-residential structures where other options were not feasible, especially large high damage structures such as hospitals. The maximum feasible height for these ring levees was four feet, although a few exceptions were considered for large urban structures.

Buyouts
Because of the high cost and potential community disruption caused by buyouts, this measure was evaluated only for structures where no other measure was feasible and where flood damages at the 1% annual chance of exceedance flood event are estimated to be at least 1 foot above the first floor elevation.

Costs considered include demolition and debris removal, the value of the home and land. Demolition and debris removal costs were estimated as discussed in Appendix F (Cost Engineering). Based on input from the Real Estate section, current land and improvement values reported by the assessor were used to estimate the cost of purchasing the property. For residential clusters, improvement and land values per square foot were determined for a random sample of homes in the cluster. These values were then generalized to the group of properties based on the average size of each home and the total land that would be acquired. For commercial and industrial structures, the total assessed value for all properties in the cluster was used.

Des Plaines Floodway
In general, structures at risk of flooding are located in the 1% ACE floodplain. However, in the City of Des Plaines, a large number of structures are located in the floodway. Because of the higher hazard and greater impacts associated with these structures, they were evaluated separately. This group is designated as "Des Plaines FW" in the table below. In addition, these structures form a large group of frequently damaged structures. In coordination with the City of Des Plaines, this group of structures was evaluated for buyout with replacement of the homes by a natural area and recreational trails. As shown in the table, the buyouts and recreation improvements together had positive net benefits and this alternative was retained for consideration in the flood risk management plans. A summary of the recreation analysis is discussed in Appendix E (Economic Analysis).

Table 61 presents a summary of the analysis of floodproofing measures by county, showing the net benefits for implementation of non-structural measures within each cluster and the number of structures where each type of measure would be implemented. Details of the analysis for individual structures are not shown here to protect the privacy of property owners. Where benefits are shown as $0 and no measures are listed for potential implementation, none of the measures were feasible for structures in that group.

Table 60 shows a summary of screening results for non-structural measures by County. As shown in the table, approximately 600 were retained for further evaluation with the majority in the more urbanized southern portion of the watershed.

Table 60 – Non- Structural Screening Results Summary by County

County	Elevation	Dry Floodproof	Wet Floodproof	Fill Bsmt	Ring Levee	Buyout	Total Structures	Benefits ($1,000)	Project Costs ($1,000)	Annual Costs ($1,000)	Net Benefits ($1,000)
Cook	171	20	25	15	26	83	335	$1,720	$28,273	$1,203	$517
Lake	80	18	21	12	19	14	164	$1,207	$11,781	$481	$726
Kenosha	1	0	3	0	0	3	7	$111	$1,105	$47	$64
Total	252	38	49	27	45	100	506	$3,039	$41,159	$1,731	$1,308

(FY2013 Price Level, FDR 3.5%)

Table 61 – Non-Structural Measure Site Screening

County	Community	Structures in Community	WOP Damages ($1,000)	Optimized Floodproofing Measures (Structures)						Total Structures	% Structures in Community	Benefits ($1,000)	Project Costs ($1,000)	Annual Costs ($1,000)	Net Benefits ($1,000)
				Elevation	Dry Floodproof	Wet Floodproof	Fill Basement	Ring Levee	Buyout						
Cook	Buffalo Grove	34	$23.9	31	0	0	0	0	0	31	91%	$22.1	$438.9	$18.7	$3.4
	Des Plaines	577	$1,542.9	10	53	4	150	26	131	374	65%	$1,090.7	$46,563.8	$1,977.9	($887.2)
	Des Plaines FW[1]	79	$679.3	0	0	0	0	0	79	79	100%	$848.3	$19,104.2	$815.5	$32.9
	Elmwood Park	54	$104.5	7	2	0	31	0	8	48	89%	$100.1	$5,835.0	$248.6	($148.5)
	Franklin Park	109	$103.5	4	7	2	32	2	2	49	45%	$53.0	$3,305.7	$139.5	($86.5)
	Leyden Township	21	$90.7	7	1	1	3	2	2	16	76%	$78.1	$816.0	$34.7	$43.4
	Maine Township	34	$60.5	0	1	0	31	0	0	32	94%	$60.0	$2,312.7	$98.5	($38.5)
	Maywood	2	$0.6	0	2	0	0	0	0	2	100%	$0.6	$24.3	$0.8	($0.2)
	Melrose Park	16	$7.3	3	8	1	3	0	0	15	94%	$7.0	$466.1	$18.7	($11.8)
	Park Ridge	5	$1.4	0	2	0	1	0	0	3	60%	$0.6	$92.3	$3.8	($3.2)
	Prospect Heights	9	$26.4	0	3	5	0	1	0	9	100%	$26.4	$1,332.2	$56.4	($30.0)
	River Forest	22	$56.6	1	0	0	9	2	2	14	64%	$40.3	$1,627.7	$69.4	($29.1)
	River Grove	127	$397.5	4	7	0	51	13	27	102	80%	$205.8	$10,707.9	$455.6	($249.8)
	Riverside	7	$33.6	0	1	0	2	1	1	5	71%	$32.2	$978.7	$41.6	($9.4)
	Rosemont	2	$295.0	0	0	0	0	2	0	2	100%	$295.0	$576.6	$24.6	$270.5
	Schiller Park	20	$111.0	0	2	0	0	18	0	20	0%	$111.0	$1,098.5	$46.3	$64.8
	Wheeling	221	$287.3	132	10	11	10	3	0	166	75%	$231.3	$4,903.1	$207.3	$24.0
	Wheeling Township	23	$135.2	1	5	13	0	0	2	21	91%	$134.2	$1,336.0	$55.8	$78.4
Lake	Gurnee	48	$957.5	9	1	0	5	14	10	39	81%	$797.5	$4,100.6	$160.5	$637.0
	Libertyville	28	$57.6	2	4	2	4	0	9	21	75%	$15.5	$9,484.8	$403.9	($388.4)
	Lincolnshire	40	$63.4	19	8	9	2	0	0	38	95%	$63.0	$1,175.2	$48.9	$14.1
	Long Grove	2	$16.4	0	0	0	2	0	0	2	100%	$16.4	$322.0	$13.7	$2.7
	Mettawa	2	$3.0	1	0	0	0	0	1	2	100%	$3.0	$656.9	$28.0	($25.0)
	Riverwoods	49	$171.9	26	5	9	1	1	3	45	92%	$169.3	$3,548.2	$150.4	$18.9
	Libertyville Township	80	$147.4	20	0	1	4	3	35	63	79%	$135.7	$11,382.4	$481.4	($345.7)
	Newport Township	3	$1.7	0	0	1	0	0	1	2	67%	$1.3	$196.4	$8.3	($7.0)
	Vernon Township	46	$166.7	26	4	3	2	4	1	40	87%	$161.0	$2,634.5	$107.7	$53.4
	Warren Township	1	$1.1	1	0	0	0	0	0	1	100%	$1.1	$64.9	$2.8	($1.6)
Kenosha	Pleasant Prairie	16	$81.3	0	0	8	0	1	7	16	100%	$81.3	$2,369.2	$100.8	($19.6)
	Salem	6	$52.1	1	0	3	0	0	2	6	100%	$52.1	$774.6	$32.9	$19.2
	Bristol	12	$44.9	0	0	5	1	2	4	12	100%	$44.9	$1,715.2	$73.0	($28.1)
	Somers	1	$59.3	0	0	0	0	0	1	1	100%	$59.3	$330.2	$14.1	$45.2
	Paddock Lake	23	$85.1	2	0	5	0	0	16	23	100%	$85.1	$2,874.3	$122.4	($37.3)

[1] The Des Plaines FW group was evaluated as a buyout area with implementation of recreation features on the vacated lands.
(FY2013 Price Level, FDR 3.5%)

SECTION 3 –FLOOD RISK MANAGEMENT SITE EVALUATION

3.1 – Floodwater Storage Site Evaluation

Hydrology and Hydraulics and Civil Design performed initial site specific analysis of floodwater storage sites retained after the screening, as discussed in Appendix A (Hydrology and Hydraulics) and Appendix D (Civil Design). The results of the initial assessment are presented in **Table 62**, below:

Table 62 – Floodwater Storage Site H&H and Civil Design Site Evaluation

Site ID	Evaluation Result
BCRS02	Kept for further analysis
ACRS03	Eliminated due to site configuration (H&H)
ACRS08	Kept for further analysis
BWRS31	Eliminated due to development on site (H&H)
FDRS01	Kept for further analysis
FDRS03	Eliminated due to site configuration (H&H)
DPRS07	Eliminated due to poor soil conditions (Civil Design)
DPRS23	Kept for further analysis

For the five retained sites, design and hydraulic analyses were performed in greater detail, refining the costs and benefits associated with each site. Details of these analyses are presented in Appendix A (Hydrology and Hydraulics) and Appendix D (Civil Design). Estimates of the first cost of construction and Operation & Maintenance were developed as discussed in Appendix F (Cost Engineering). Interest During Construction (IDC) was also added to the costs, as discussed in Appendix E (Economic Analysis). **Table 63** shows the revised calculation of reduction in damages and **Table 64** shows the revised cost estimates.

Table 63 – Reservoir Site Evaluation Damage Reduction Calculation

Site ID	Volume (acre-ft)	Equivalent Annual Damages Reduced by Category							Total EAD Reduced
		APT	VEH	COM	IND	PUB	RES	TRAFFIC	
Mainstem									
BCRS02	177	$25,535	$335	$65,500	$42,696	$14,090	$103,000	$1,232,400	$1,483,500
ACRS08	418	$18,289	$404	$48,440	$19,149	$5,610	$83,380	$752,200	$927,500
FDRS01	1,000	$41,000	$1,000	$663,000	$41,000	$8,000	$147,000	$1,161,000	$2,063,000
DPRS23	330	$23,000	$1,000	$347,000	$30,000	$4,000	$89,000	$920,000	$1,413,000
Tributary									
BCRS02	177	$0	$0	$0	$0	$0	$1,000	$17,000	$18,000
Total									
BCRS02	177	$25,535	$335	$65,500	$42,696	$14,090	$104,000	$1,249,400	$1,502,000
ACRS08	418	$18,000	$0	$48,000	$19,000	$6,000	$83,000	$753,000	$929,000
FDRS01	1,000	$41,000	$1,000	$663,000	$41,000	$8,000	$147,000	$1,161,000	$2,063,000
DPRS23	330	$23,000	$1,000	$347,000	$30,000	$4,000	$89,000	$920,000	$1,413,000

*Aptakisic Creek and Feehanville Ditch were not modeled, thus ACRS08 and FDRS01tributary damage reductions are not included.
(FY 2010 Price Level, FDR 4.125%)

Table 64 – Reservoir Site Evaluation Cost Estimates

Site ID	Area (acres)	Constr. Duration (months)	First Cost	Lands and Damages	S&A	IDC	Total Cost	Annual O&M	Equivalent Annual Cost
ACRS08	49	16	$9,041,000	$2,604,800	$2,260,300	$379,100	$14,285,200	$111,500	$820,000
FDRS01	1,007	72	$57,977,000	$53,204,800	$14,494,300	$17,365,000	$143,041,100	$172,300	$7,264,000
DPRS23	352	30	$21,153,000	$18,608,500	$5,288,300	$2,414,900	$47,464,700	$121,900	$2,475,000

(FY 2010 Price Level, FDR 4.125%)

An existing wetland complex at site BCRS02 would require mitigation. An appropriate mitigation site and mitigation measures were formulated according to mitigation planning guidance. The mitigation planning is included as Attachment 3 to this Appendix. The costs for implementation of BCRS02, including mitigation, are presented in **Table 65**, bleow.

Table 65 – BCRS02 Total Implementation Costs

	Footprint Area (acres)	Constr. Duration (months)	First Cost	Lands and Damages	S&A	IDC	Total Cost	Annual O&M	Equivalent Annual Cost
Reservoir	111	12	$9,041,000	$5,870,000	$2,260,000	$342,000	$17,513,000	$103,000	$971,000
Mitigation	112	6	$2,919,000	$5,918,000	$242,000	$82,000	$9,160,600	$889	$455,000
Total			$11,960,000	$11,788,000	$2,502,000	$424,000	$26,673,600	$103,889	$1,426,000

(FY 2010 Price Level, FDR 4.125%)

Sites with net benefits close to or greater than zero were retained for further evaluation. **Table 66** shows the results of this evaluation. A summary of the site evaluation results is shown in **Table 67**.

Table 66 – Reservoir Site Evaluation Results

Site ID	Total Equivalent Annual Damages Reduced	Equivalent Annual Costs	Net Benefits	BCR	Evaluation Result
BCRS02	$1,502,000	$1,426,000	$76,000	1.1	Keep
ACRS08	$928,000	$930,000	($2,000)	1.0	Keep
FDRS01	$2,063,000	$7,026,000	($4,963,000)	0.3	Eliminate: Net Benefits<0
DPRS23	$1,413,000	$2,294,000	($881,000)	0.6	Eliminate: Net Benefits<0

*BCRS02 is modeled as an inline reservoir and the weir elevation was set based on the topography rather than a design storm.
(FY 2010 Price Level, FDR 4.125%)

Table 67 – Summary of Reservoir Site Evaluation Results

ID	Watershed	County	State	Total	Eliminated	Kept
BC	Bull Creek	Lake	IL	1	0	1
AC	Aptakisic Creek	Cook/Lake	IL	2	1	1
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	1	1	0
FD	Feehanville Ditch	Cook	IL	2	2	0
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	2	2	0
				8	6	2

3.2 – Flood Barrier Site Evaluation

The optimized flood barrier sites selected during the screening step were examined in greater detail. Along with detailed site designs, hydraulic modeling was conducted to determine whether the proposed features would cause stage impacts outside of the leveed reaches. In Illinois any structure causing an increase of more than 0.0 feet the water surface profile for any storm up to and including the 1% annual chance of exceedance flood event requires floodplain mitigation.

Impacts to the water surface profile caused by DPLV01 were investigated by IDNR, as documented in Appendix A (Hydrology & Hydraulics). The investigation concluded that the maximum increase in stage caused by the levee was 0.03 feet. The investigation included levee heights up to elevation 618. As discussed in Appendix D (Civil Design), it was determined that this was the maximum practical height for tying back the levee to high ground.

Sites DPLV04, DPLV05, and DPLV09 did, however, impact the water surface elevation beyond this regulatory threshold. Although the maximum stage increase was less than 0.2 feet for each levee individually, the impacts typically extend over a large area, impacting over hundreds of properties. A real estate takings analysis determined that, due to the small increment of flooding at infrequent events, the stage impacts would not result in any takings. The takings analysis is documented in Appendix I (Real Estate).

Table 68 shows the modeled reduction in damages as well as the induced damages that would result from implementation at each of the proposed levee sites. The goal of the screening and evaluation steps is to identify economically justified features that can be combined to form alternative plans. Because the flood barrier sites would likely be combined with other features such as reservoirs, it was determined that mitigation requirements would be determined based on the tentatively selected plan.

Table 68 – Flood Barrier Sites: Damage Reductions

Site ID	Equivalent Annual Damages Reduced by Category ($1,000)							
	APT	VEH	COM	IND	PUB	RES	TRAFFIC	TOTAL
DPLV01	$331	$0	$0	$0	$0	$87	$0	$418
DPLV04 (Benefits)	$42	$0	$96	$1	$0	$157	$2,054	$2,350
DPLV04 (Induced Damages)	($8)	($0)	($15)	($7)	($5)	($17)	($155)	($206)
DPLV04 Total	$35	($0)	$81	($6)	($5)	$140	$1,899	$2,144
DPLV05 (Benefits)	$47	$0	$5	$130	$0	$4	$1,619	$1,805
DPLV05 (Induced Damages)	($5)	($0)	($17)	($3)	($2)	($22)	($166)	($214)
DPLV05 Total	$42	($0)	($12)	$127	($2)	($17)	$1,453	$1,591
DPLV09 (Benefits)	$323	$47	$202	$2	$13	$732	$1,241	$2,560
DPLV09 (Induced Damages)	($8)	($0)	($25)	($8)	($1)	($38)	($412)	($492)
DPLV09 Total	$315	$46	$176	($5)	$12	$694	$829	$2,068

(FY 2013 Price Level, FDR 3.75%)

Site specific design and cost estimates for the flood barriers were developed as discussed in Appendix D (Civil Design) and Appendix F (Cost Engineering). **Table 69** presents the cost estimate for each levee or floodwall. The site specific cost estimate is shown as first cost of construction. The total cost also includes estimated lands and damages, supervision and administration (S&A) costs, and operation & maintenance (O&M) costs. Lands and damages were estimated, as for reservoirs, at $52,000 per acre. This value was determined using the average value of land per acre in Cook County, as discussed in Appendix E (Economics). S&A costs were estimated as 25% of the first costs. O&M costs were estimated as discussed in Appendix F (Cost Engineering).

Table 69 – Flood Barrier Site Evaluation Cost Estimates

Site ID	Project Area (ac)	Constr. Duration (months)	First Cost ($1,000)	Land & Damages (1,000)	S&A ($1,000)	IDC ($1,000)	Total Cost ($1,000)	Annual O&M ($1,000)	Eq. Annual Cost ($1,000)
Levee									
DPLV01	3	12	$4,190	$125	$1,048	$424	$5,787	$24	$282
DPLV04	7	24	$7,877	$350	$1,969	$807	$11,003	$56	$547
DPLV05	8	24	$7,118	$400	$1,780	$736	$10,033	$51	$499
DPLV09	8	29	$15,849	$1,050	$3,962	$1,650	$22,512	$52	$1,056

(FY 2013 Price Level, FDR 4.125%)

Using the revised costs and reductions in damages, net benefits and a benefit to cost ratio were calculated for each site, as shown in **Table 70**. Both sites were retained as individually justified for consideration in the last added analysis.

Table 70 – Flood Barrier Site Evaluation Results

Site ID	DPLV01	DPLV04	DPLV05	DPLV09
Approximate Grade (ft NGVD 29)	610	618	618	621
Crest Elevation (ft NGVD 29)	618.3[1]	628.7	629.6	633.6-635.1[2]
Approximate Height (ft)	8.30	10.7	11.6	12.5-14.0
1% Chance Flood Elevation (ft NGVD 29)	616.5	626.7	627.6	631.6-633.1
Approximate Length (ft)	2,500	6,400	6,000	11,000
Equivalent Annual Damages Reduced	$397,000	$2,350,000	$1,805,000	$2,560,000
Equivalent Annual Damages Induced	NA[3]	($206,000)	($214,000)	($492,000)
Equivalent Annual Costs	$282,000	$547,000	$499,000	$1,056,000
Net Benefits	$136,000	$1,597,000	$1,092,000	$1,504,000
BCR ($/$)	1.5	3.9	3.2	2.4

[1] Maximum elevation limited by available tie-back elevations.
[2] Due to the length of DPLV09, the structure was evaluated along four reaches with the structure at varying heights for each reach.
[3] Hydraulic modeling showed that this flood barrier did not have an effect on the water surface profile or induce damages.

(FY 2013 Price Level, FDR 3.75%)

3.3 – Road Raise and Bridge Modification Site Evaluation

Site specific investigations were conducted for the three retained Road Raise and Bridge Modification Sites, as discussed in Appendix D (Civil Design). At DPBM06, the length of road required to tie into high elevations made the design impractical. For DPBM04 and DPBM13, a hydraulic analysis was conducted to determine design requirements to prevent adverse stage impacts resulting from the changed bridge alignment. For each site, the length of the bridge was extended onto land to allow flood waters to flow unimpeded through the surrounding forest preserve district lands during a flood event. Additional discussion of the design requirements can be found in Appendix D (Civil Design) and Appendix A (Hydrology and Hydraulics).

Using the estimated land requirements identified in Appendix D, land acquisition costs were estimated at $52,835 per acre, as with other sites. Supervision and administration (S&A) costs were estimated as 25% of implementation costs and Operation & Maintenance (O&M) costs were estimated as discussed in Appendix F (Cost Engineering). **Table 71** presents a summary of estimated annual costs for each site. Benefits for each site are the transportation damages avoided with implementation of the of the road raise. **Table 72** presents these benefits as well as the annual costs and the resulting benefit to cost ratio and net benefits for each site. As shown in **Table 72**, site DPBM04 had positive net benefits and was retained for further analysis but costs for implementation of DPBM13 exceeded the benefits and the site was eliminated from further consideration.

Table 71 – Road Raise Site Evaluation Cost Estimates

Site ID	Site Area (ac)	Constr. Duration (months)	First Cost	Lands & Damages	S&A	IDC	Total Cost	Annual O&M	Total Annual Cost
DPBM04	8.7	18	$12,476,000	$459,700	$3,119,000	$497,200	$16,551,900	$42,000	$863,000
DPBM13	5.7	18	$29,195,000	$301,200	$7,299,000	$1,139,600	$37,934,800	$38,000	$1,919,000

(FY 2010 Price Level, FDR 4.125%)

Table 72 – Road Raise Site Evaluation Results

Site ID	Total Equivalent Annual Damages Reduced	Annualized Cost	Net Benefits	BCR	Evaluation Decision
DPBM04	$5,339,000	$863,000	$4,476,000	6.2	Keep
DPBM13	$736,000	$1,919,000	($1,183,000)	0.4	Eliminiate: Net Benefits<0

(FY 2010 Price Level, FDR 4.125%)

3.4 – Modification to Existing Structure Site Evaluation

For measures involving modifications to existing reservoirs, channel improvements, or other modifications to existing structures, site specific evaluations of benefits and costs are detailed below.

Buffalo-Wheeling Creek Watershed

BWCI01: Channel Improvements at Wolf Road & Hintz Road

This measure would involve excavation of open space in this area above the normal water elevation to add to the amount of available storage in the floodplain. A reservoir would not be acceptable in this area due to the proximity of runways at O'Hare airport. According to Federal Aviation Administration (FAA) rules, open water structures are not allowed in such areas. As an approximation of the benefits that could be gained by adding to the undeveloped floodplain area, a 70 acre-ft reservoir was modeled for a nearby site, as discussed in Appendix A (Hydrology & Hydraulics). **Table 73** shows the resulting reduction in damages as calculated by HEC-FDA.

Table 73 – Channel Improvement at Wolf Road & Hintz Road Damage Reduction

Equivalent Annual Damages Reduced by Category							Total Equivalent Annual Damages Reduced
APT	VEH	COM	IND	PUB	RES	TRAFFIC	
$2,000	$0	$33,000	$2,000	$0	$6,000	$48,000	$92,000

(FY 2010 Price Level, FDR 4.125%)

Using GIS, an approximation of the additional floodplain volume available from excavation was calculated as 20 acre-feet, less than one third of the modeled reservoir's volume. Due to the minimal benefits that would be gained from such a project, this site was eliminated from further evaluation.

Evaluation Decision: Eliminate

BWCI02: Channel Improvements at Wolf Road & Dundee Road
This site has been designated for use as compensatory storage for Levee 37, a Phase I project, and is not available for further modification.

Evaluation Decision: Eliminate

BWME01: Modification of Heritage Lake Reservoir
This site has been designated for use as compensatory storage for Levee 37, a Phase I project, and is not available for further modification.

Evaluation Decision: Eliminate

Weller Creek Watershed

WLME01: Modification of Mt. Prospect Reservoir
The existing reservoir was modeled with a 151 acre-foot expansion, based on available area, as discussed in Appendix A (Hydrology & Hydraulics). Using the new profiles, damage reductions were calculated by HEC-FDA as shown in **Table 74**. A design and cost estimate were developed for the site as discussed in Appendix D (Civil Design) and Appendix F (Cost Engineering) and resulted in the calculated equivalent annual costs shown in **Table 75**. Lands and damages were calculated as for other sites, at $52,835 per acre. Supervision and administration were calculated as 25% of the first cost. The resulting benefit to cost ratio is 0.8, therefore this site was eliminated from further analysis.

Table 74 – Mt. Prospect Reservoir Modification Damage Reduction

Reach	Equivalent Annual Damages Reduced by Category							Total Equivalent Annual Damages Reduced
	APT	VEH	COM	IND	PUB	RES	TRAFFIC	
Mainstem	$6,000	$0	$90,000	$8,000	$2,000	$24,000	$178,000	$308,000
Tributary	$0	$0	$0	$0	$0	$22,000	$3,000	$25,000
Total	$6,000	$1,000	$90,000	$8,000	$2,000	$46,000	$181,000	$333,000

(FY 2010 Price Level, FDR 4.125%)

Table 75 – Mt. Prospect Reservoir Modification Cost Estimate

Easement Area (ac)	Constr. Duration (months)	First Cost	Lands & Damages	S&A	IDC	Total Costs	Annual O&M	Eq. Annual Costs
46.3	8	$3,556,000	$2,446,300	$889,000	$86,800	$6,978,100	$91,000	$437,000

(FY 2010 Price Level, FDR 4.125%)

Evaluation Decision: Eliminate

Farmer-Prairie Creek Watershed

IDNR conducted a detailed analysis of a number of sites in this watershed (see Attachment 2: Farmers/Prairie Creek Strategic Planning Study, September 2009). The hydraulic modeling and preliminary cost estimates developed by IDNR were used to identify the two sites below for further analysis.

<u>FPCI01: Golf Road Connector at Lake Mary Anne</u>
To maintain lower flood stages on Lake Mary Anne, at Golf Road and Interstate 294, the outlet of the lake would be supplemented by a 10 cubic foot per second pump station. This pump station would discharge into an 18 inch diameter discharge pipe that would be routed under Golf road and over a 96 inch diameter Golf Road interceptor pipe to the Dude Ranch Pond. The existing routing of tollway runoff to Lake Mary Anne would be eliminated by gating the existing 12 and 18 inch outlet pipes. Discharge from two-5 cubic foot per second pumps would be directed to Dude Ranch pond through a 12 inch outlet pipe in the existing right overbank between the pond and Farmer-Prairie Creek.

Expected damage reductions resulting from implementation of this alternative were calculated in HEC-FDA using modeling developed by IDNR. **Table 76** shows the calculated reduction in damages resulting from implementation of this project. Costs developed in the IDNR analysis were used as preliminary project costs, with adjustments made to reflect the FY10 depreciation rate. **Table 77** shows the costs estimated by IDNR.

Table 76 – Golf Road Connector at Lake Mary Anne Damage Reduction

Equivalent Annual Damages Reduced by Category							Total Equivalent Annual Damages Reduced
APT	VEH	COM	IND	PUB	RES	TRAFFIC	
$200	$0	$0	$0	$0	$107,000	$0	$107,000

(FY 2010 Price Level, FDR 4.125%)

Table 77 – Golf Road Connector at Lake Mary Anne Costs: Preliminary IDNR Estimate

Item	Quantity	Unit	Unit Cost	Total Cost
Elevate existing pipe by 36 inches	48	ft	$500	$24,000
36" Reinforced Concrete Pipe	352	ft	$160	$56,320
Pumps	1	set of 3	$65,730	$65,730
Pump House and Accessories	1	ea	$77,880	$77,880
Total Implementation Costs				$223,930
LERRD (estimated permanent flood easement cost)	24,4474	sq.ft.	$1	$244,474
Contingency (15%)				$33,590
Engineering and Design (20%)				$44,786
Supervision and Administration (7.5%)				$16,795
Mobilization (6%)				$13,436
O&M (1%)				$2,239
Total Project Cost				$577,010
Equivalent Annual Project Cost				$28,607

(FY 2010 Price Level, FDR 4.125%)

The preliminary benefit to cost ratio, based on this cost estimate is 3.7, therefore a more detailed analysis of the design requirements for implementation of this project and the resulting costs were developed as discussed in Appendix D (Civil Design) and Appendix F (Cost Engineering). The estimated costs resulting from this analysis are shown in **Table 78**, below. The resulting benefit to cost ratio is 1.3, therefore the measure was kept for further analysis.

Table 78 – Golf Road Connector at Lake Mary Anne Site Evaluation Costs

Easement Area (ac)	Constr. Duration (months)	First Cost	Lands & Damages	S&A	IDC	Total Costs	Annual O&M	Eq. Annual Costs
2.8	6	$790,000	$147,900	$198,000	$10,200	$1,146,100	$24,000	$81,000

(FY 2010 Price Level, FDR 4.125%)

Evaluation Decision: Keep

FPME01: Belleau Lake Expansion

This measure was also analyzed by IDNR in their September 2009 Study. Belleau Lake, south of Rand Road and west of Interstate 294, currently retains flood flows during a 10% annual chance of exceedance flood event. In this measure, the lake would be expanded by lowering the bottom contours and expanding the footprint. The resulting in-line lake elevation would be lowered from 626.2 feet to 622.0 feet, the downstream channel invert. Outflow from the lake would be controlled by the conveyance capacity of the creek downstream of the lake. Steep side slopes, exposed along the western edge of the lake by the decrease in water elevation, would be graded at 3:1 for safety and stability. The newly configured lake would be capable of providing up to 75 acre-feet of additional flood storage capacity at the 1% annual chance of exceedance flood event. **Table 79** presents the calculated reduction in damages resulting from implementation of this project. **Table 80** shows the estimated costs. The resulting benefit to cost ratio is 0.1, therefore the site eliminated from further analysis.

Table 79 – Belleau Lake Expansion Damage Reduction

Equivalent Annual Damages Reduced by Category							Total Equivalent Annual Damages Reduced
APT	VEH	COM	IND	PUB	RES	TRAFFIC	
$0	$0	$0	$0	$2,000	$1000	$0	$3,000

(FY 2010 Price Level, FDR 4.125%)

Table 80 – Belleau Lake Expansion Cost Estimate

Item	Quantity	Unit	Unit Cost	Total Cost
24" Reinforced Concrete Pipe	10	ft	$50	$500
Seeding/Mulching/Fertilizing	3	acres	$2,000	$6,000
Excavation	50683	cy	$11	$557,513
Total Implementation Costs				$564,013
LERRD (estimated right-of-way cost)	207094	sq. ft.	$0	$0
Contingency (15%)				$84,602
Engineering and Design (20%)				$112,803
Supervision and Administration (7.5%)				$42,301
Mobilization (6%)				$33,841
O&M (1%)				$5,640
Total Project Cost				$837,559
Equivalent Annual Project Cost				$41,524

(FY 2010 Price Level, FDR 4.125%)

Evaluation Decision: Eliminate

Willow-Higgins Creek

WHME01: Modification of Touhy Avenue Reservoir
As discussed in Appendix A (Hydrology & Hydraulics), the reservoir was modeled with expanded capacity. The model resulted in an insignificant change in water surface profile and therefore no further analysis was conducted.

Evaluation Decision: Eliminate

Silver Creek

SCCI01: Channel Improvements North of North Avenue
Silver Creek is underground in this section of the channel. To improve flow, installation of an additional culvert section was investigated. The improved channel was modeled as discussed in Appendix A (Hydrology & Hydraulics). Reductions in damages calculated by HEC-FDA with the modeled improvements are shown in **Table 81**. A cost estimate was developed for the site as discussed in Appendix F (Cost Engineering) and resulted in the calculated equivalent annual costs shown in **Table 82**. Lands and damages were calculated as for other sites, at $52,835 per acre. Supervision and administration were calculated as 25% of the first cost.

Table 81 – Silver Creek Channel Improvement North of North Avenue Damage Reduction

Equivalent Annual Damages Reduced by Category							Total Equivalent Annual Damages Reduced
APT	VEH	COM	IND	PUB	RES	TRAFFIC	
$1000	$7,000	$196,000	$213,000	$1000	$770,000	$439,000	$1,628,000

(FY 2010 Price Level, FDR 4.125%)

Table 82 – Channel Improvement North of North Avenue Cost Estimate

Easement Area (ac)	Constr. Duration (months)	First Cost	Lands & Damages	S&A	IDC	Total Costs	Annual O&M	Eq. Annual Costs
0	5	$2,338,000	$0	$585,000	$21,000	$2,944,000	$3,000	$149,000

(FY 2010 Price Level, FDR 4.125%)

The benefit to cost ratio from this initial analysis is 10.5. However, after this initial evaluation, an analysis of routing changes resulting from the additional culvert was conducted as described in Appendix A (Hydrology & Hydraulics). The increased flow resulted in increased flood elevations downstream of the culvert and no feasible mitigation measures were identifed. This measure was therefore eliminated from further consideration.

Evaluation Decision: Eliminate

<u>SCCI02: Channel Improvements between North Wolf Road & Lee Street</u>
This portion of the channel extends for over 1,000 feet underneath railroad tracks. Based on the length of the channel under the tracks, it was determined that this measure would not be implementable.

Evaluation Decision: Eliminate

<u>SCME01: Modification of Structure 106</u>
Examination of the existing reservoir using aerials indicated that expansion of the reservoir by further excavation while maintaining the existing side slopes would only result in 10 acre feet of additional storage. An alternative expansion scenario was also identified in which the reservoir would be expanded by installing vertical sheet pile walls and eliminating the need for sloped sides, although it was determined that due to the use of sheet pile, the costs would be too high to warrant further investigation.

Evaluation Decision: Eliminate

<u>SCME02: Modification of Structure 102</u>
The existing reservoir was modeled with a 119 acre foot expansion, based on available area, as discussed in Appendix A (Hydrology & Hydraulics). Using the new profiles, damage reductions were calculated by HEC-FDA as shown in **Table 83**. A design and cost estimate were developed for the site as discussed in Appendix D (Civil Design) and Appendix F (Cost Engineering) and resulted in the calculated equivalent annual costs shown in **Table 84**. Lands and damages were calculated as for other sites, at $52,835 per acre. Supervision and administration were calculated as 25% of the first cost. The resulting benefit to cost ratio is 0.2. Therefore, the expansion was eliminated from further consideration.

Table 83 – Structure 102 Modification Damage Reduction

Equivalent Annual Damages Reduced by Category							Total Equivalent Annual Damages Reduced
APT	VEH	COM	IND	PUB	RES	TRAFFIC	
$1,025	$437	$5,369	$1,994	$0	$93,548	$34,469	$136,840

(FY 2010 Price Level, FDR 4.125%)

Table 84 – Structure 102 Expansion Cost Estimate

Easement Area (ac)	Constr. Duration (months)	First Cost	Lands & Damages	S&A	IDC	Total Costs	Annual O&M	Eq. Annual Costs
12.1	16	$7,287,000	$639,300	$1,822,000	$265,800	$10,014,100	$165,000	$661,000

(FY 2010 Price Level, FDR 4.125%)

Evaluation Decision: Eliminate

SCOT01: Addison Creek/Silver Creek Interbasin Flow
Urbanization in the Silver Creek and Addison Creek watersheds has led to the possibility of interbasin flow from the Addison Creek watershed to the Silver Creek watershed. Although this potentially increases flooding in Silver Creek, analysis of steps to alleviate the effects of the interbasin flow are beyond the scope of this study.

Evaluation Decision: Eliminate

Des Plaines River

DPOT01: Reevaluation of Salt Creek Diversion
Preliminary analysis of this option by MWRDGC indicated that any changes to the Salt Creek Diversion would have impacts along Salt Creek in Brookfield. Based on this assessment, the measure was eliminated from further analysis.

Evaluation Decision: Eliminate

DPOT02: Modification of Des Plaines River Riparian Greenway
To improve flow conditions in the mainstem, modification of the riparian greenway was investigated. An initial evaluation of this measure consisted of modifying the hydraulic model of the river, as discussed in Appendix A (Hydrology & Hydraulics). The modifications to the model represented tree trimming along 30 miles of the channel. **Table 85** presents the resulting reduction in damages.

Table 85 – Modification of Greenway Damage Reduction

Equivalent Annual Damages Reduced by Category							Total Equivalent Annual Damages Reduced
APT	VEH	COM	IND	PUB	RES	TRAFFIC	
$86,000	$2,000	$1,239,000	$112,000	$61,000	$343,000	$3,391,000	$5,233,000

(FY 2010 Price Level, FDR 4.125%)

As discussed in Appendix F (Cost Engineering), the estimated cost for trimming trees along the channel and chipping and disposing of the debris is $2,083,000. The trimming would be repeated every five years to maintain the cleared conditions. Maintenance trimming is estimated to cost $1,509,000. These costs, annualized over the 50 year period of analysis, result in an equivalent annual cost of $379,800. The resulting BCR for this measure is 13.8.

While these initial results were very positive, concerns about whether the project would be implementable were raised. The measure was reformulated to look in more detail at potential for flow improvements and available land. In this iteration, lands in the two-year floodplain owned by either LCFPD or FPDCC were evaluated. Implementation would consist of clearing the two-year floodplain of trees and planting grasses and shrubs in their place.

Reaches of the greenway downstream of large damage areas were identified as presented in **Table 86** below. The tree clearing was modeled as discussed in Appendix A (Hydrology & Hydraulics). The reduction in damages resulting from each reach is presented in **Table 87**. The hydraulic modeling for this refined analysis was performed in the revised model used in the last added analysis as discussed in Section 3.5 of Volume 2 as the reformulation of this measure was conducted after the need to update the without project conditions was identified.

Preliminary cost estimates for each reach were developed as discussed in Appendix F (Cost Engineering). Lands and damages were calculated, as for other sites, at $52,835 per acre. Supervision and Administration costs were calculated as 25% of the first cost. O&M costs were calculated assuming that invasive species control and periodic prescribed burns would be required. Invasive species control was assumed to occur monthly during the growing season for the first five years and subsequently twice per year. Prescribed burns would be conducted every five years. The total implementation costs and O&M costs were annualized of the 50 year period of analysis. **Table 88** presents the estimated equivalent annual costs for each reach.

Table 86 – Riparian Greenway Modification Reaches

Reach ID	River Miles	Area (ac)	Municipalities	County
DPOT02-A	50.21-52.91	209	River Forest, Melrose Park, Maywood	Cook
DPOT02-B	51.04-56.88	250	River Grove, Chicago	Cook
DPOT02-C	69.70-76.4	419	Mt. Prospect, Glenview, Wheeling, Prospect Heights	Cook/Lake
DPOT02-D	76.40-78.82	181	River Woods, Buffalo Grove, Lincolnshire	Lake
DPOT02-E	91.67-97.11	379	Waukegan, Gurnee	Lake

Table 87 – Riparian Greenway Modification Screening Reduction in Damages

Reach ID	APT	AUTO	COM	IND	PUB	RES	TRAFFIC	Total Equiv. Annual Damages Reduced
DPOT02-A	$43,000	$1,000	$444,000	$122,000	$0	$148,000	$1,629,000	$2,385,000
DPOT02-B	$85,000	$1,000	$1,723,000	$347,000	$4,000	$276,000	$4,056,000	$6,493,000
DPOT02-C	$52,000	$1,000	$603,000	$262,000	$40,000	$206,000	$4,423,000	$5,587,000
DPOT02-D	$0	$1,000	$20,000	$7,000	$35,000	$120,000	$467,000	$650,000
DPOT02-E	$1,000	$1,000	$84,000	$0	$135,000	$23,000	$1,910,000	$2,154,000

(FY 2010 Price Level, FDR 4.125%)

Table 88 – Riparian Greenway Modification Screening Cost Estimates

Reach ID	Constr. Duration (mos)	First Cost	Lands & Damges	S&A	IDC	Total Costs	Annual O&M	Eq. Annual Costs
DPOT02-A	6	$9,886,000	$11,043,000	$2,471,000	$210,000	$23,610,000	$124,000	$1,295,000
DPOT02-B	6	$11,825,000	$13,209,000	$2,956,000	$251,000	$28,241,000	$149,000	$1,549,000
DPOT02-C	6	$11,997,000	$13,420,000	$2,999,000	$255,000	$28,672,000	$150,000	$1,571,000
DPOT02-D	6	$8,561,000	$9,563,000	$2,140,000	$182,000	$20,447,000	$108,000	$1,121,000
DPOT02-E	6	$17,927,000	$20,024,000	$4,482,000	$381,000	$42,814,000	$226,000	$2,348,000

(FY 2010 Price Level, FDR 4.125%)

Table 89 presents the evaluation results for each reach. As shown in the table, reaches D and E had negative net benefits and were eliminated from further consideration. Reaches A, B and C, however, had positive net benefits. Further analysis of these reaches, however, showed that, as formulated, the modifications would increase stages downstream.

Table 89 – Riparian Greenway Modification Screening Results

Reach	Total Equivalent Annual Damages Reduced	Equivalent Annual Costs	Net Benefits	BCR
DPOT02-A	$2,385,000	$1,295,000	$1,090,000	1.8
DPOT02-B	$6,493,000	$1,549,000	$4,944,000	4.2
DPOT02-C	$5,587,000	$1,571,000	$4,016,000	3.6
DPOT02-D	$650,000	$1,121,000	($471,000)	0.6
DPOT02-E	$2,154,000	$2,348,000	($194,000)	0.9

(FY 2010 Price Level, FDR 4.125%)

The conditions of the greenway were assessed in the fall of 2010. The assessment results indicate that much of the area is a high functioning floodplain forest with mature canopy trees and lush herbaceous understory. The very rare and significant flatwoods community type was also present in small areas. In areas that had undergone recent human activities (e.g., mowing or clearing of canopy), the current conditions were degraded with thick stands of invasive shrub species such as European Buckthorn. Overall, the greenway included natural resources that are considered to be significant and important to the local and regional ecosystems.

A brief look at the species composition of the area revealed high native plant species richness and coverage. In degraded areas, the plant species composition was less rich and included many non-native and invasive species. However, the structure of the community is ideal floodplain forest with large tall canopy trees, a small amount of shrub layer coverage, and a lush and diverse herbaceous layer. The shrub and herbaceous layers were negatively impacted and of lower structural integrity only in degraded areas. Since most of the assessment area is considered to be a significant natural resource, removal of the structural components (e.g., all woody species) of the system would result in significant negative impacts. These impacts, if not avoided, have to be minimized and/or mitigated for.

As a multi-purpose study, measures evaluated for flood risk management potential must meet not only objectives and constraints related to this purpose, but also overall study objectives and constraints. One overall objective is to preserve existing natural resources and a constraint is that measures must avoid adverse impacts to existing ecosystem integrity. Implementation of this measure would result in direct impacts to the structural integrity of a significant natural resource and impact the function of this riparian corridor as a conduit for species movement and connectivity of the riparian zone to the surrounding uplands. Therefore, this measure was eliminated from further consideration.

Evaluation Decision: Eliminate

DPOT03: Optimize Reservoir Operations
This measure would involve watershed-wide coordination of operations at floodwater storage sites to ensure efficient operations of the existing sites. Existing major reservoirs in the watershed are listed below in **Table 90**.

Table 90 – Structures Included in Reservoir Optimization Screening Analysis

Reservoir	Watershed	Location	Maintained by
Jack B. Williams Reservoir (Structure 106)	Silver Creek	Grand & Mannheim	Franklin Park
Silver Creek Reservoir (Structure 102)	Silver Creek	Irving Park & Mannheim	MWRDGC
Willow-Higgins Reservoir (Structure 140)	Willow-Higgins Creek	Touhy & Mount Prospect	MWRDGC
White Pine Ditch Reservoir	Buffalo-Wheeling Creek	Dundee & Buffalo Grove Rd	Buffalo Grove
Heritage Park Reservoir	Buffalo-Wheeling Creek	Wolf & Dundee	Wheeling Park District & Wheeling
Wilke-Kirchoff Reservoir	Weller Creek	Arlington Heights	Arlington Heights
Mt. Prospect Reservoir	Weller Creek	Central & Northwest Hwy	Mt. Prospect & Arlington Heights
Buffalo Creek Reservoir	Buffalo-Wheeling Creek	Lake-Cook Road	LCFPD, Buffalo Grove, MWRDGC
Lake Arlington Reservoir	McDonald Creek	Palatine & Windsor	Arlington Heights

Implementation of this measure would not require a significant Federal investment. Instead, the municipalities and local agencies operating the reservoirs would create a plan for communication and coordination during flood events that require operation of the facilities. This measure, therefore was not kept for further analysis in this study, but will instead be recommended for implementation by the operators of the listed reservoirs.

Evaluation Decision: Recommend for implementation by local agencies

DPBM01: BNSF Railroad Bridge Pier Extension
IDNR investigated several flood risk management alternatives in this area (see Attachment 1: Groveland Avenue Limited Strategic Study, October 2009). Of the alternatives involving the BNSF Railroad Bridge crossing the Des Plaines River in this area, extension of the piers was shown to have the greatest impact on the water surface profile. In this measure, the piers on the railroad bridge would be extended and curved both upstream and downstream to provide a flow transition across the bridge piers. The extensions change the effective width of the piers from 33 feet to 6.5 feet and the effective width of the bridge from 219 feet to 265 feet. Additionally, earth excavation would be required both upstream and downstream of the extension to allow for effective conveyance of flows through the bridge. Using the water surface profile developed by IDNR, HEC-FDA calculated the reduction in damages shown in **Table 91**.

A site design and cost estimate were developed for the site as discussed in Appendix D (Civil Design) and Appendix F (Cost Engineering) and resulted in the calculated equivalent annual costs shown in **Table 92**. Lands and damages were calculated as for other sites, at $52,835 per acre. Supervision and Administration costs were calculated as 25% of the first cost.

Although this measure has positive net benefits, several considerations led to the conclusion that this measure would not be implementable. The hydraulic investigation did not include reaches outside of the immediate Riverside area. Because the project reduces local flood stages by increasing channel conveyance, downstream areas outside of the study area are likely to experience increased flooding. Even though this was not specifically analyzed, induced downstream flooding is likely, requiring extensive mitigation through compensatory storage or easements. Additionally, the owner of the bridge, Burlington Northern Santa Fe Railroad, indicated that they were not interested in participating in any projects that require modifications to the existing bridge structure. This measure was therefore eliminated from further analysis.

Table 91 – BNSF Railroad Bridge Pier Extension Damage Reduction

Equivalent Annual Damages Reduced by Category							Total Equivalent Annual Damages Reduced
APT	VEH	COM	IND	PUB	RES	TRAFFIC	
$199,397	$1,059	$18,700	$11,300	$114,990	$141,060	$776,400	$1,262,900

(FY 2010 Price Level, FDR 4.125%)

Table 92 – BNSF Railroad Bridge Pier Extension Costs

Easement Area (ac)	Constr. Duration (months)	First Cost	Lands & Damages	S&A	IDC	Total Costs	Annual O&M	Eq. Annual Costs
0.6	6	$2,255,000	$52,800	$564,000	$25,800	$2,897,600	$39,000	$183,000

(FY 2010 Price Level, FDR 4.125%)

Evaluation Decision: Eliminate

DPBM02: Forest Avenue Bridge Realignment

The effect of this measure on the water surface profile was analyzed by IDNR. Preliminary analysis showed that realignment of the bridge piers did not significantly affect the water surface profile, and IDNR did not include this measure in their Groveland Avenue Limited Strategic Study. Based on this analysis, this measure was eliminated from further analysis.

Evaluation Decision: Eliminate

Table 93 – Summary of Structure Modification Site Evaluation

ID	Watershed	County	State	Total	Eliminated	Kept
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	3	3	0
WL	Weller Creek	Cook	IL	1	1	0
FP	Farmer-Prairie Creek	Cook	IL	2	1	1
WH	Willow-Higgins Creek	Cook/Dupage	IL	1	1	0
SC	Silver Creek	Cook/Dupage	IL	5	5	0
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	5	5	0
			TOTAL	17	16	1

3.5 – Non-Structural Site Evaluation

A large number of sites were identified for possible implementation of non-structural measures. Because this information can only be evaluated at a detailed level according to site specific information, site evaluations were not conducted for each of the structures retained in the screening. During the preconstruction engineering and design (PED) phase, a more detailed investigation will be conducted.

SECTION 4 –FLOOD RISK MANAGEMENT PLAN FORMULATION

4.1 Updates to Without Project Conditions and and Benefit Cost Analysis

Additional detailed evalulation for each of the retained sites was conducted to ensure that all relevant design and cost information was considered and net benefits had been maximized. At this stage, the without project conditions were reviewed to ensure that they present the most reasonable approximation of watershed baseline and expected future conditions. In addition, the discount rate used in the benefit and cost calculations was updated to 3.75% for the current fiscal year (FY13) and price levels were updated to October 2012 price levels.

Changes to the without project conditions included revised modeling for the Van Patten Woods lateral storage area and removal of the North Fork Mill Creek Dam Modification. The Van Patten Woods modeling was recently updated for the Phase I design analysis to reflect design modifications. The Lake County Forest Preserve District is in the process of permitting the notching for the North Fork Mill Creek Dam for ecosystem restoration. With implementation of this notching, there will no longer be an opportunity to increase floodwater storage by modifying the dam. The dam is modeled as in place for baseline conditions and notched in future conditions.

The sites retained for further evaluation include: BCRS02, ACRS08, DPLV01, DPLV09, DPBM04, and FPCI01. For all sites, estimated real estate costs were also updated to reflect site specific analyses conducted as discussed in Appendix I (Real Estate).Opportunties for optimizing the sites were investigated as discussed below:

ACRS08 and BCRS02: Previous hydrologic and hydraulic modeling for thes reservoirs had focused on the tributaries. Because the majority of benefits for these features are on the mainstem, the modeling was revised to optimize the impacts of the structures on mainstem flooding. Benefits for ACRS08 increased, as shown in Table 94; however, benefits for BCRS02 decreased. The reduction in BCRS02 benefits resulted from updates to the hydrologic modeling that refined the sub-basin delineation for the site. As a result of the updated modeling, BCRS02 was eliminated from consideration.

DPLV01, DPLV04, and DPLV05: Benefits associated with reduced administration costs for the flood insurance program resulting from removal of structures from the floodplain were added to the project benefits.

DPLV09: Benefits associated with reduced administration costs for the flood insurance program resulting from removal of structures from the floodplain were added to the project benefits. In addition, an estimate of prevented emergency flood fighting costs was developed, as the high risk of flooding in this community has led to significant public investment in flood fighting, as discussed in Appendix E (Economic Analysis).

Opportunities to include recreation features at this site were also investigated, consisting of a trail along the floodwall alignment connecting to the existing Des Plaines River Trail system. This trail would provide access to the trail system for communities on the west bank of the river and a shorter trail "loop" for use by residents looking for a shorter hike, walk, or bike ride. A discussion of the analysis used to determine the recreation benefits, annualized costs, and net benefits can be found in Appendix E (Economic Analysis).

Updated benefits and costs for each individually justified site are presented in the tables below. The sites are arranged from highest net benefits to lowest. This ranking was used to begin the last added analysis, as discussed in the following section. Additionally, a "Plan" is designated for each site according to which flood risk management plan they may be included in, as discussed in the main report.

Table 94 – First Added Benefits ($1,000)

Site	Flodd Damages Reduced by Category							Total Damage Reduced	FIA Savings	Flood Fighting	Recreation	Total Benefits
	APT	AUTO	COM	IND	PUB	RES	TRAFFIC					
DPBM04	$0	$0	$0	$0	$0	$0	$4,280	$4,280				$4,280
DPLV04	$35	$0	$81	-$6	-$5	$140	$1,899	$2,144	$35			$2,179
DPLV09	$315	$46	$176	-$5	$12	$694	$829	$2,068	$155	$60	$187	$2,470
DPLV05	$42	$0	-$12	$127	-$2	-$17	$1,453	$1,591	$38			$1,629
ACRS08	$25	$1	$48	$18	$9	$102	$1,089	$1,290				$1,290
DPLV01	$331	$0	$0	$0	$0	$87	$0	$418	$23			$441
FPCI01	$0	$0	$0	$0	$0	$107	$0	$107				$107
BCRS02	$6	$0	$12	$7	$1	$32	$374	$433				$433

(FY 2013 Price Level, FDR 3.75%)

Table 95 – First Added Costs ($1,000)

Site	Constr. Duration (months)	Site area (acres)	All costs shown in $1,000							
			First Cost	Lands and Damges	PED	S&A	IDC	Total Costs	Annual O&M	Eq. Annual Costs
BCRS02	12	111	$9,169	$1,235	$917	$1,375	$217	$12,913	$104	$680
L22	6	112	$2,920	$1,120	$292	$438	$37	$4,807	$1	$215
ACRS08	12	93	$9,108	$5,185	$911	$1,366	$283	$16,853	$68	$819
DPLV01	12	2	$4,190	$435	$419	$629	$97	$5,769	$18	$275
DPLV09	29	22	$15,849	$1,500	$1,585	$2,377	$943	$22,254	$52	$1,044
DPLV05	24	42	$7,118	$498	$712	$1,068	$340	$9,735	$56	$490
DPLV04	24	109	$7,877	$1,110	$788	$1,182	$396	$11,352	$51	$557
DPBM04	18	9	$11,898	$23	$1,190	$1,785	$395	$15,291	$54	$736
FPCI01	6	3	$754	$88	$75	$113	$8	$1,038	$24	$70

(FY 2013 Price Level, FDR 3.75%)

Table 96 – First Added Benefit Cost Analysis ($1,000)

Site	Description	Mitigation	Total Benefits[1,2]	Annual Costs[1]	Net Benefits	BCR
DPBM04	First Ave Bridge Modification		$4,280	$736	$3,545	5.8
DPLV04	Belmont-Irving Park Levee		$2,179	$557	$1,622	3.9
DPLV09	Touhy-Miner Levee		$2,470	$1,044	$1,426	2.4
DPLV05	Fullerton-Grand Levee		$1,629	$490	$1,139	3.3
ACRS08	Aptakisic Creek Reservoir		$1,290	$819	$471	1.6
DPLV01	Groveland Avenue Levee		$441	$275	$166	1.6
FPCI01	Lake Mary Anne Pump Station		$107	$70	$37	1.5
BCRS02	Bull Creek Reservoir	L22	$433	$895	-$462	0.5

[1] Benefits and costs are annualized over a 50 year period of analysis, using a 3.75% discount rate.
[2] Additional benefit categories include Flood Insurance Administration Cost Savings for structures removed from the floodplain, reductions in flood fighting costs, and recreation benefits.

(FY 2013 Price Level, FDR 3.75%)

Screened non-structural sites were also separated according to policy compliance. Sites in portions of the watesrshed that do not meet the 800 cfs requirement would be part of the Full Plan; all remaining sites would be NED sites.

4.2 Mitigation for Levee Induced Damages

As discussed in Section 3.2, the hydraulic model showed that construction of DPLV04, DPLV05, and DPLV09 would result in increased stages outside of the proposed levee reaches. Each levee is individually justified even when accounting for the induced damages, however, additional analysis was conducted to identify and evaluate mitigation alternatives.

Because these levees are relatively close to each other along the mainstem, they were modeled together to ensure that the impacts were fully accounted for, as discussed in Appendix A (H&H Analysis). The combined levees had compounded impacts resulting in more significant stage increases and induced damages, as shown in **Table 97**.

Table 97 – Levee Induced Damages

	DPLV04	DPLV05	DPLV09	Combined Levees
Flood Protection Benefits	$2,350	$1,932	$2,575	$6,875
Induced Flood Damages	($206)	($213)	($491)	($2,853)
Total Economic Benefits	$2,144	$1,719	$2,084	$4,005

(FY 2013 Price Level, FDR 3.75%)

A detailed discussion of the formulation methodology and the sites considered can be found in the main report. DPRS04 and WLRS04 were retained as potenetial compensatory storage sites. The cost this alternative is presented in **Table 98**, below. Thet total cost presented in the table is less than the induced damages, $2,853,000, and is therefore economically justified. Additionally, a detailed hydraulic and economic analysis showed that the benefits of the proposed reservoirs would exceed the costs, as shown in This combination of sites was retained for inclusion in the last added analysis.

Table 98 – Compensatory Storage Evaluation

Site	Costs ($1,000)							
	First Cost	PED	CM	Lands and Damages	IDC	Total Costs	Annual O&M	Eqiv. Annual Costs
DPRS04	$10,229	$1,534	$716	$312	$11	$12,802	$59	$604
WLRS04	$12,985	$1,948	$909	$700	$24	$16,566	$56	$715
					Total Equivalent Annual Cost			$1,560

(FY 2014 Price Level, FDR 3.5%)

Table 99 – Compensatory Storage Project Individual Benefits and Costs

Project	Flood Damage Reduced	Recreation Benefits	Total Benefits	Annual Costs	Net Benefits
DPRS04	$498,000	$150,000	$648,000	$604,000	$44,000
WLRS04	$981,000	$0	$981,000	$715,000	$266,000

(FY 2014 Price Level, FDR 3.5%)

4.3 Last Added Analysis

The screened and evaluated sites shown to be individually justified were further evaluated using a "last added" analysis. Through the screening and evaluation process, each site has been individually justified and optimized with respect to without project conditions. The last added analysis will evaluate measures in combination with each other ensuring that each site added to the plan is justified as an increment of the formulated plan.

Since the benefits of implementation of these measures are interdependent, this analysis will ensure that benefits are not claimed by two projects in the same plan. The site with the highest net benefits is the starting point, using the with-project hydraulic and economic models of that site as the formulated plan. The remaining projects are then each added to the plan, and benefit to cost ratios and net benefits are calculated for each combination. An increase in net benefits indicates that the new element is incrementally justified within the plan. The combination with the highest net benefits becomes the new baseline plan.

The remaining sites are then added to the hydraulic and economic model of the new formulated plan to determine the next site to be included in the plan. The analysis is repeated until either all sites have been added or there are no combinations of the remaining sites with the formulated plan that result in increased net benefits.

As detailed in the preceeding sections, various sites are individually justified and retained for further analysis. Levess 04, 05, and 09 are dependant on implementation of WLRS04 and DPRS04 for mitigation of induced damages; these sites were therefore included together in the formulation. The measures, ranked by net benefits (highest to lowest), are shown in Table 96. FPCI01 is included in the sites retained, however the modeled project showed no impacts on the mainstem: all benefits from this site are on the Farmer-Prairie Creek tributary.

Table 100 – Sites Considered in Last Added Analysis

Site	Description	Plan[1]	Total Benefits[2,3]	Annual Costs[2]	Net Benefit	BCR
DPLV04	Fullerton-Grand Levee	NED	$2,186	$864	$1,322	2.5
DPLV05	Belmont-Irving Park Levee	NED	$1,762	$789	$973	2.2
DPRS04	Fullerton Woods Reservoir	NED	$648	$604	$44	1.1
DPLV09	Touhy-Miner Levee	NED	$2,488	$1,176	$1,312	2.1
WLRS04	Semrow Driving Range Reservoir	NED	$981	$715	$265	1.4
--	Policy Compliant Non-Structural	NED	$2,831	$1,835	$996	1.5
DPLV01	Groveland Avenue Levee	CAP	$441	$264	$177	1.7
DPBM04[4]	First Ave Bridge Modification	Comp	$4,258	$656	$3,602	6.5
FPCI01[4]	Lake Mary Anne Pump Station	Comp	$107	$85	$22	1.3
--	Non-policy compliant Non-Structural	Comp	$270	$157	$113	1.7

[1] HQUSACE has directed the District to prepare a plan that includes all individually justified sites, a plan that includes all policy compliant plans that could not be implemented under the continuing authorities program (CAP), and sites for implementation under CAP. Full, NED, or CAP is shown to indicate which plan they would fall within.
[2] Benefits and costs are annualized over a 50 year period of analysis, using a 3.5% discount rate.
[3] Additional benefit categories include Flood Insurance Administration Cost Savings for structures removed from the floodplain, reductions in flood fighting costs, and recreation benefits.

(FY 2014 Price Level, FDR 3.5%)

A summary of the formulated plans is presented in Table 4.27. The mainstem levee and reservoir system increments were added to the plan first. The policy compliant non-structural projects were then added to the plan, followed by the CAP project, DPLV01, and the non-policy compliant projects. The analysis showed that net benefits continued to increase and that all sites remain justified in combination with each other.

For the Full Plan, the highest ranking site is DPBM04. Implementation of this site in combination with the remaining sites was modeled to determine the combined project benefits. The resulting benefits were then compared to the costs of implementing each pair of projects. The benefits, costs, and net benefits are presented in **Table 101**. The evaluation of policy compliant non-structural measures is presented in **Table 102** and **Table 103**. A summary of the evaluation of all non-structural measures is presented in **Table 104** and **Table 105**. A similar procedure was conducted for policy compliant sites that would be included in the NED or CAP Plan.

Table 101 – Last Added Analysis ($1,000)

Round	Plan Components	Total Benefits	Total Costs	Cumulative Net Benefits	Incremental Net Benefits
1	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee	$4,688	$2,257	$2,431	--
2	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner levee	$7,755	$3,998	$3,757	$1,326
3	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner levee Policy Compliant Non-structural	$10,084	$5,754	$4,330	$573
4	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner levee Policy Compliant Non-structural DPLV01 - Groveland Ave Levee	$10,524	$6,018	$4,506	$176
5	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner levee Policy Compliant Non-structural DPLV01 - Groveland Ave Levee DPBM04 - First Ave Bridge Modification	$14,777	$6,674	$8,103	$3,773
6	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner levee Policy Compliant Non-structural DPLV01 - Groveland Ave Levee DPBM04 - First Ave Bridge Modification Non-policy Compliant Non-structural	$15,009	$6,831	$8,178	$75
7	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner levee Policy Compliant Non-structural DPLV01 - Groveland Ave Levee DPBM04 - First Ave Bridge Modification Non-policy Compliant Non-structural FPCI01 - Lake Mary Anne Pump Station	$15,116	$6,916	$8,200	$22

Table 102 – Incremental Non-Structural Analysis – NED Plan

County	Community	Structures in Community	Total Structures	% Structures in Community	Benefits ($1,000)	Project Costs ($1,000)	Annual Costs ($1,000)	Net Benefits ($1,000)
Cook	Des Plaines	137	96	69%	$211.7	$9,297.2	$392.9	($181.2)
	Des Plaines FW[1]	79	79	100%	$848.3	$19,104.2	$815.5	$32.9
	Elmwood Park	54	48	89%	$100.1	$5,835.0	$248.6	($148.5)
	Maywood	2	2	100%	$0.6	$24.3	$0.8	($0.2)
	Prospect Heights	9	9	100%	$26.4	$1,332.2	$56.4	($30.0)
	River Forest	22	14	64%	$40.3	$1,627.7	$69.4	($29.1)
	River Grove	6	1	17%	$1.2	$106.1	$4.5	($3.3)
	Riverside	7	5	71%	$32.2	$978.7	$41.6	($9.4)
	Rosemont	2	2	100%	$295.0	$576.6	$24.6	$270.5
	Schiller Park	0	0	0%	$0.0	$0.0	$0.0	$0.0
	Wheeling	150	111	50%	$172.6	$3,781.6	$159.5	$13.1
	Wheeling Township	23	21	91%	$134.2	$1,336.0	$55.8	$78.4
Lake	Gurnee	48	39	81%	$797.5	$4,100.6	$160.5	$637.0
	Libertyville	28	21	75%	$15.5	$9,484.8	$403.9	($388.4)
	Lincolnshire	40	38	95%	$63.0	$1,175.2	$48.9	$14.1
	Long Grove	2	2	100%	$16.4	$322.0	$13.7	$2.7
	Mettawa	2	2	100%	$3.0	$656.9	$28.0	($25.0)
	Riverwoods	49	45	92%	$169.3	$3,548.2	$150.4	$18.9
	Libertyville Township	80	63	79%	$135.7	$11,382.4	$481.4	($345.7)
	Newport Township	3	2	67%	$1.3	$196.4	$8.3	($7.0)
	Vernon Township	46	40	87%	$161.1	$2,634.5	$107.7	$53.4
	Warren Township	1	1	100%	$1.1	$64.9	$2.8	($1.6)
Kenosha	Pleasant Prairie	5	5	31%	$36.0	$1,307.2	$55.7	($19.7)
	Bristol	2	2	17%	$3.0	$511.1	$21.8	($18.8)

[1] The Des Plaines FW group was evaluated as a buyout area with implementation of recreation features on the vacated lands.
(FY 2014 Price Level, FDR 3.5%)

Table 103 – Summary of NED Plan Incrementally Justified Non-Structural Measures

County	Elevation	Dry Floodproof	Wet Floodproof	Fill Bsmt	Ring Levee	Buyout	Total Structures	Benefits ($1,000)	Project Costs ($1,000)	Annual Costs ($1,000)	Net Benefits ($1,000)
Cook	79	15	24	9	5	81	213	$1,269	$30,128	$1,189,000	$80
Lake	80	18	21	12	19	14	164	$1,060	$15,079	$567,000	$493
Kenosha	0	0	0	0	0	0	0	$0	$0	$0	$0
Total	159	33	45	21	24	95	377	$2,657	$45,207	$1,537	$573

(FY 2014 Price Level, FDR 3.5%)

Table 104 – Incremental Non-Structural Analysis – Full Plan

County	Community	Structures in Community	WOP Damages ($1,000)	Total Structures	% Structures in Community	Benefits ($1,000)	Project Costs ($1,000)	Annual Costs ($1,000)	Net Benefits ($1,000)
Cook	Buffalo Grove	34	$23.9	31	91%	$22.1	$438.9	$18.7	$3.4
	Des Plaines	140	$259.1	99	71%	$231.8	$10,275.6	$434.6	($202.8)
	Des Plaines FW[1]	79	$679.3	79	100%	$848.3	$19,104.2	$815.5	$32.9
	Elmwood Park	54	$104.5	48	89%	$100.1	$5,835.0	$248.6	($148.5)
	Franklin Park	98	$77.3	38	39%	$26.8	$2,667.3	$113.6	($86.8)
	Leyden Township	21	$90.7	16	76%	$78.1	$816.0	$34.7	$43.4
	Maine Township	34	$60.5	32	94%	$60.0	$2,312.7	$98.5	($38.5)
	Maywood	2	$0.6	2	100%	$0.6	$24.3	$0.8	($0.2)
	Melrose Park	16	$7.3	15	94%	$7.0	$466.1	$18.7	($11.8)
	Park Ridge	5	$1.4	3	60%	$0.6	$92.3	$3.8	($3.2)
	Prospect Heights	9	$26.4	9	100%	$26.4	$1,332.2	$56.4	($30.0)
	River Forest	22	$56.6	14	64%	$40.3	$1,627.7	$69.4	($29.1)
	River Grove	6	$4.1	1	17%	$1.2	$106.1	$4.5	($3.3)
	Riverside	7	$33.6	5	71%	$32.2	$978.7	$41.6	($9.4)
	Rosemont	2	$295.0	2	100%	$295.0	$576.6	$24.6	$270.5
	Schiller Park	0	$0.0	0	0%	$0.0	$0.0	$0.0	$0.0
	Wheeling	221	$287.3	166	75%	$231.3	$4,903.1	$207.3	$24.0
	Wheeling Township	23	$135.2	21	91%	$134.2	$1,336.0	$55.8	$78.4
Lake	Gurnee	48	$957.5	39	81%	$797.5	$4,100.6	$160.5	$637.0
	Libertyville	28	$57.6	21	75%	$15.5	$9,484.8	$403.9	($388.4)
	Lincolnshire	40	$63.4	38	95%	$63.0	$1,175.2	$48.9	$14.1
	Long Grove	2	$16.4	2	100%	$16.4	$322.0	$13.7	$2.7
	Mettawa	2	$3.0	2	100%	$3.0	$656.9	$28.0	($25.0)
	Riverwoods	49	$172.0	45	92%	$169.3	$3,548.2	$150.4	$18.9
	Libertyville Township	80	$147.4	63	79%	$135.7	$11,382.4	$481.4	($345.7)
	Newport Township	3	$1.7	2	67%	$1.3	$196.4	$8.3	($7.0)
	Vernon Township	46	$166.7	40	87%	$161.1	$2,634.5	$107.7	$53.4
	Warren Township	1	$1.1	1	100%	$1.1	$64.9	$2.8	($1.6)
Kenosha	Pleasant Prairie	16	$81.3	16	100%	$81.3	$2,369.2	$100.8	($19.6)
	Salem	6	$52.1	6	100%	$52.1	$774.6	$32.9	$19.2
	Bristol	12	$44.9	12	100%	$44.9	$1,715.2	$73.0	($28.1)
	Somers	1	$59.3	1	100%	$59.3	$330.2	$14.1	$45.2
	Paddock Lake	23	$85.1	23	100%	$85.1	$2,874.3	$122.4	($37.3)

[1] The Des Plaines FW group was evaluated as a buyout area with implementation of recreation features on the vacated lands.
(FY 2014 Price Level, FDR 3. 5%)

Table 105 – Summary of Incrementally Justified Non-Structural Measures (Full Plan)

County	Elevation	Dry Floodproof	Wet Floodproof	Fill Bsmt	Ring Levee	Buyout	Total Structures	Benefits ($1,000)	Project Costs ($1,000)	Annual Costs ($1,000)	Net Benefits ($1,000)
Cook	92	1	1	4	2	2	102	$137	$3,056	$114	$23
Lake	0	0	0	0	0	0	0	$0	$0	$0	$0
Kenosha	1	0	3	0	0	3	7	$95	$1,170	$44	$52
Total	93	1	4	4	2	5	109	$232	$4,227	$157	$75

(FY 2014 Price Level, FDR 3.5%)

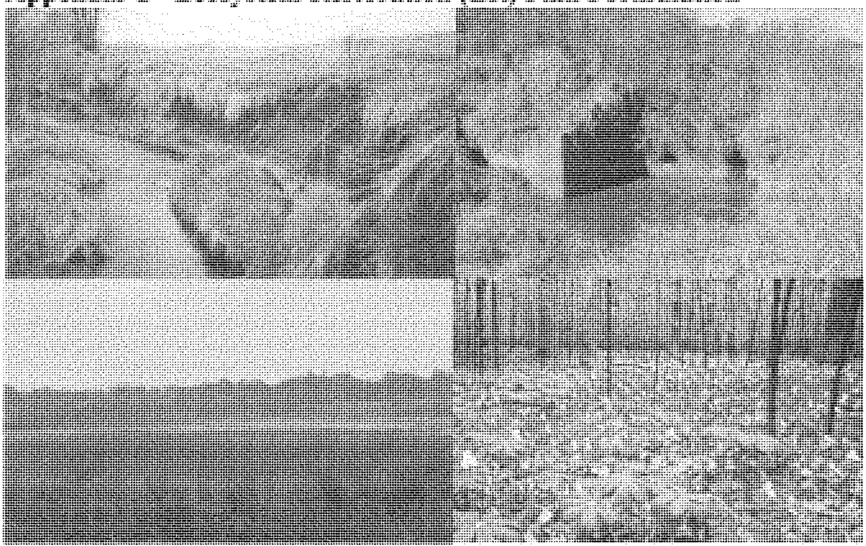
ACRONYMS AND ABBREVIATIONS

BCR	Benefit to Cost Ratio
CUP	Chicago Underflow Plan
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FPDCC	Forest Preserve District of Cook County
GIS	Geographic Information System
H&H	Hydrology & Hydraulics
HEC-FDA	Hydrologic Engineering Center – Flood Damage Analysis
IDNR	Illinois Department of Natural Resources
IDOT	Illinois Department of Transportation
IEMA	Illinois Emergency Management Agency
LCFPD	Lake County Forest Preserve District
LIDAR	Light Detection and Ranging
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
NED	National Economic Development
NIPC	Northern Illinois Planning Council
O&M	Operation & Maintenance
S&A	Supervision & Administration
SEWRPC	Southeastern Wisconsin Regional Planning Council
T&E	Threatened and Endangered
VISTA	Visual Interactive System for Transportation Algorithms

Upper Des Plaines River and Tributaries, Illinois and Wisconsin

Integrated Feasibility Report and Environmental Assessment

Appendix C –Ecosystem Restoration (ER) Plan Formulation



March 2014

US Army Corps of Engineers®
Chicago District

APPENDIX C
Upper Des Plaines River Feasibility Study
Ecosystem Restoration Plan Formulation

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SECTION 1 – INVENTORY AND FORECASTING

Threatened & Endangered Species List

Table 1 – T&E plant species occurring within or adjacent to (1 mile) the study area.

Common Name	Scientific Name	IL	WI	Habitat	County Occurrence
American cranberry	Vaccinium macrocarpon	SE *		Bogs	Lake, Cook, Racine
American dog violet	Viola conspersa	ST *		Mesic forests, flatwoods	Lake, Cook, Kenosha, Racine
American larch	Larix laricina	ST		Bogs, forested fens	Lake, Kenosha, Racine
American slough grass	Beckmannia syzigachne	SE		Wet prairies	Lake, Cook
Beaked rush	Rhynchospora alba	SE		Bogs, fens	Lake, Cook, Kenosha, Racine
Beaked sedge	Carex rostrata	ST *		Sedge meadows, bogs	Lake
Black-seeded rice grass	Oryzopsis racemosa	SE *		Mesic forests	Lake, Cook
Bog bedstraw	Galium labradoricum	ST *		Bogs, fens, sedge meadows	Lake, Kenosha
Bulrush	Scirpus hattorianus	SE *		Open wetlands	Lake
Common bog arrow grass	Triglochin maritimum	SE *		Fens, pannes, cal. seeps	Lake, Cook, Kenosha, Racine
Cord root sedge	Carex chordorrhiza	SE		Bogs	Lake
Crawe's sedge	Carex crawei	ST		Fens, sand prairies, swales	Lake, Cook, Kenosha, Racine
Crawford's oval sedge	Carex crawfordii	SE		Marsh	Lake
Downy Solomon's seal	Polygonatum pubescens	ST *		Mesic forests	Lake, Cook, Kenosha, Racine
Downy willow herb	Epilobium strictum	ST *		Mesic forest, flatwoods, bogs, fens	Lake, Kenosha
Dwarf raspberry	Rubus pubescens	ST *		Mesic forests, flatwoods, bogs, fens	Lake, Cook, Kenosha, Racine
Earleaved foxglove	Tomanthera auriculata	ST		Mesic prairie, savannas	Lake, Cook, Racine
Fern pondweed	Potamogeton robbinsii	SE *		Lakes, ponds, streams	Lake, Cook, Kenosha
Golden sedge	Carex aurea	SE		Fens	Lake, Cook, Racine
Grass-leaved pondweed	Potamogeton gramineus	SE *		Lakes, ponds, streams	Lake, Cook, Kenosha
Hairy white violet	Viola incognita	ST *		Flatwoods, forested fens, mesic forests	Lake, Cook
Little green sedge	Carex viridula	SE *		Springs, marl flats, cal. floating mats	Lake, Cook, Kenosha, Racine
Marsh speedwell	Veronica scutellata	ST *		Marshes, graminoid fens	Lake, Cook, Racine
Millet grass	Milium effusum	ST *		Openings in northern forests	Cook, Racine
Mountain blue-eyed grass	Sisyrinchium montanum	SE *		Mesic prairies	Lake, Cook
Northern cranesbill	Geranium bicknellii	SE *		Dry forest openings, disturbed areas	Lake, Racine
Northern grape fern	Botrychium matricariifolium	SE		Mesic forests, sand savannas, successional habitats	Lake, Cook, Kenosha
Pale vetchling	Lathyrus ochroleucus	ST *		Savannas, ravines	Lake, Cook, Racine
Prairie Indian plantain	Cacalia tuberosa		ST *	Wet prairies, wet sand prairies	Lake, Cook, Kenosha, Racine
Prairie white-fringed orchid	Platanthera leucophaea	SE,FT *	SE,FT *	Mesic / wet prairie	Lake, Cook, Kenosha, Racine
Prairie sedge	Carex prasina	ST *		Mesic upland forests	Lake, Cook, Kenosha, Racine
Purple milkweed	Asclepias purpurascens		SE *	Prairies, edge of woodland	Lake, Cook, Kenosha, Racine
Purple fringed orchid	Platanthera psycodes	SE *		Flatwood openings, mesic sand prairies	Lake, Racine
Queen-of-the-prairie	Filipendula rubra	ST *		Prairies, fens	Cook
Round-leaved sundew	Drosera rotundifolia	SE		Bogs	Lake, Cook, Kenosha, Racine
Seaside crowfoot	Ranunculus cymbalaria	SE		Saline/brackish shores	Lake, Cook, Kenosha, Racine
Slender bog arrow grass	Triglochin palustris	SE *		Fens, pannes, cal. seeps	Lake, Cook, Kenosha, Racine
Small sundrops	Oenothera perennis	SE *		Gravel prairie, mesic prairie, old field	Lake, Cook, Kenosha, Racine
Sullivant's milkweed	Asclepias sullivantii		ST *	Mesic prairies	Cook, Kenosha, Racine
Swollen sedge	Carex intumescens	SE		Forested wetlands	Cook, Racine
Tuckerman's sedge	Carex tuckermanii	SE *		Flatwoods, swamp forests	Lake, Racine
White lady's-slipper orchid	Cypripedium candidum	SE *		Wet-mesic prairies, fens	Lake, Cook, Kenosha, Racine
White-stemmed pondweed	Potamogeton praelongus	SE		Cold deep lakes	Lake, Cook, Kenosha, Racine
Wild quinine	Parthenium integrifolium		ST *	Prairies	Lake, Cook, Kenosha, Racine

* Indicates within study area. SE = State Endangered, ST = State Threatened, FE = Federally Endangered, FT = Federally Threatened.

Table 2 – T&E animal species occurring within or adjacent to (1 mile) the study area.

Common Name	Scientific Name	IL	WI	Habitat	County Occurance
Birds					
Pied-billed grebe	*Podilymbus podiceps*	ST *		Lakes, ponds, riverine, wetland	Lake and Cook
Double-crested cormorant	*Phalarocorax auritus*	ST *		Lakes, ponds, riverine, wetland	Cook
American bittern	*Botaurus lentiginosus*	SE *		Wetland	Lake and Cook
Least bittern	*Ixbrychus exilis*	SE *		Wetland	Lake and Cook
Great egret	*Ardea albus*	ST *	ST *	Wetland	Cook, Kenosha and Racine
Snowy egret	*Egretta thula*	SE *		Wetland	Cook
Little blue heron	*Egretta caerulea*	SE *		Lakes, ponds, riverine, wetland	Cook
Black-crowned night-heron	*Nycticorax nycticorax*	SE *		Forested swamp and wetland	Lake and Cook
Yellow-crowned night-heron	*Nycticorax violaceus*	ST *		Forested swamp	Cook
Osprey	*Pandion haliaetus*	SE *	ST	Lakes, ponds, riverine	Cook
Bald eagle	*Haliaeetus leucocephalus*	SE *, FT	ST *, FT	Lakes, ponds, riverine	Cook, Kenosha and Racine
Northern harrier	*Circus cyaneus*	SE *		Wetland, grassland, crops	Cook
Sharp-shinned hawk	*Accipiter striatus*	SE *		Upland/mesic forest, shrubland, residential areas, forested swamp savannah	Cook
Red-shouldered hawk	*Buteo lineatus*	SE *		Forested swamp	Lake and Cook
Swainson's hawk	*Buteo swainsoni*	SE		Upland/mesic forest, grassland, savannah	Kane
Peregrine falcon	*Falco peregrinus*	SE *, FE		All	Lake and Cook
Yellow rail	*Coturnicops noveboracensis*	SE *		Grassland, wetland	Cook
King rail	*Rallus elegans*	ST *		Grassland, wetland	Lake and Cook
Commen moorhen	*Gallinula chloropus*	ST *		Wetland	Lake and Cook
Sandhill crane	*Grus canadensis*	SE *		Wetland, grassland, crops	Lake
Upland sandpiper	*Bartramia longicauda*	SE *		Grassland	Lake and Cook
Wilson' s phalarope	*Phalaropus tricolor*	SE *		Lakes, ponds, riverine, wetland	Lake and Cook
Common tern	*Sterna hirundo*	SE *	SE *	Lakes, ponds, riverine, wetland	Lake
Forster's tern	*Sterna forsteri*	SE *	SE *	Lakes, ponds, riverine, wetland	Lake and Cook
Black tern	*Chilidonias niger*	SE *		Lakes, ponds, riverine, wetland	Lake and Cook
Barn owl	*Tyto alba*	SE *		Crops, grassland, residential areas, savannah	Cook
Long-eared owl	*Asio otus*	SE *		Upland/mesic forest, shrubland	Lake and Cook
Short-eared owl	*Asio flammeus*	SE *		Grassland	Lake and Cook
Brown creeper	*Certhia americana*	ST *		Forested swamp, upland/mesic forest, residential areas	Lake
Bewick's wren	*Thryomanes bewickii*	SE *		Residential areas, shrubland	Cook
Veery	*Catharus fuscescens*	ST *		Forested swamp, upland/mesic forest, residential areas, savannah	Lake and Cook
Loggerhead shrike	*Lanius ludovicianus*	ST *	SE *	Grassland, shrubland, crops	Lake, Cook, Kenosha, Racine
Henslow's sparrow	*Ammodramus henslowii*	SE *		Grassland	Lake and Cook
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	SE *		Wetland	Lake and Cook
Piping plover	*Charadrius melodus*		SE	Rivers, wetland	
Acadian flycatcher	*Empidonax virescens*		ST *	Forest	Kenosha
Cerulean warbler	*Dendroica cerulea*		ST *	Forest	Kenosha

* Indicates within study area. SE = State Endangered, ST = State Threatened, FD = Federally Endangered, FT = Federally Threatened.

Table 2 – T&E animal species occurring within or adjacent to (1 mile) the study area (Continued).

Reptiles					
Kirtland's water snake	*Clonophis kirtlandii*	ST *		Forest, wetland, prairie and savannah, lakes, ponds, impoundmants	Lake and Cook
Eastern Massasauga	*Sistrurus catenatus*	SE *	SE *	Forest, wetland, prairie and savannah	Lake and Cook, Kenosha
Blanding's turtle	*Emydonidea blandingi*		ST *	Wetland	Kenosha and Racine
Amphibians					
Blanchard's cricket frog	*Acrid crepitans blanchardi*		SE	Ponds and streams	Grant, Lafayette
Insects					
Swamp metalmark	*Calephelis mutica*	SE *		Wetland	Lake and Cook
Hoary elfin	*Incisalia polia*	SE *		Forest and savannah	Lake
Melissa blue	*Lycaeides melissa*	FE		Prairie, savannah, cultural	Lake and Cook
Ottoe skipper	*Hesperia ottoe*	ST *		Prairie	Lake and Cook
Hine's Emerald dragonfly	*Somatochlora hineana*	SE		Wetland	Lake and Cook
Fish					
ironcolor shiner	*Notropis chalybaeus*	ST *		Creeks and small rivers	Cook
blackchin shiner	*Notropis heterodon*	ST *		Standing water	Lake and Cook
blacknose shiner	*Notropis heterolepis*	SE *		Creeks and small rivers	Lake and Cook
Iowa darter	*Etheostoma exile*	SE *		Headwaters and creeks	Lake and Cook
redfin shiner	*Lythrurus umbratilis*		ST *	Streams	Kenosha and Racine
Mussels					
Slippershell mussel	*Alasmidonta viridis*	SE *		Headwaters, creesk and small rivers	Cook
Elephant ear	*Elliptio crassidens*	ST *		Medium rivers	Cook
Spike	*Elliptio dilatata*	ST		Small and medium rivers	Kane
Rainbow	*Villosa iris*	SE *		Small and medium rivers	Cook

SECTION 2 – PLAN FORMULATION AND EVALUATION

2.1 – Planning Level Cost Details

The following cost estimate assumptions were developed by the Chicago District cost estimating section (TS-DC), with aid from the Planning Section (PM-PL-E). Spreadsheets used to develop annualized costs are archived electronically in the District project files:

- Cost 01 Unit Bid Prices.xls
- Cost 02 Cost Estimate Work Sheet.xls
- Cost 03 Annualization.xls

General: Based quantities for a 60 acre site to distribute overhead costs accordingly. Assumed typical project duration will be 12 months. 10% profit is included for the prime contractor. There is only one sub-contractor used in the estimate for drain tile removal. Depending on the contracting mechanism for these jobs, it may be reasonable to adjust to account for an earthwork contractor as a sub or a prime with a landscape contractor as the stub. There is a running 25% contingency. Escalation has been accounted for to year 2019. Fuel rates are currently shown as $4.00 for unleaded gasoline, and $4.25 for diesel fuel (on-road) and $4.00 for diesel fuel (off-road).

Labor Rates: Labor rates were derived from the following: Service Contract Wage Determination 03-0288 (Rev. -9) dated 02 June 2009 – for Forestry and Land Management Services. Because some of the work is demolition, and earthwork, it is reasonable to use wage rates for construction, as these are in keeping with current market conditions. Therefore, the Davis-Bacon Wage Rates were used for heavy landscaping. General Decision Number IL080020 dated 24 July 2009.

Selective Tree Clearing / Site Clearing: Includes clearing of trees and brush, chipping and hauling costs. Our estimate for clearing an acre is currently $5462.51 with the contractor's overhead costs; however, we have roughly 24% escalation mark-up for the year 2019, and a running contingency which bring the cost to $11,013.85 per acre. The hauling includes loading and dumping and is currently $9.01 per cubic yard of material. With the escalation and contingency, this rises to $18.16 per cubic yard. All of this is included in the unit price per acre of clearing.

Tree Clearing: Assumed dense area where 6" trees are spaced at 1 per 100 sf. Approx. 10' o.c. Assumed a crew can clear one acre in 24 hours. Density of trees used is comparable to our current construction contract for Orland Tract. This density is used solely for the purpose of developing a unit bid price per acre for tree clearing. Crew production is modified to allow time for marking trees for removal. Added hauling costs for disposal of chips as this is a conservative cost.

Brush Clearing: Assumed dense brush and adjusted productivity to approximately 1 acre can be cleared in 8 hours. Added hauling and disposal costs to this item to be conservative.

Understory Clearing: Assumed each acre produces approx 400 cy of debris. This is based on 100 trees per acre. Adjusted production rate to an effort of 4 hours to clear 1 ac.

Drain Tile Disablement: Assumed drain tile removal contractor will demolish pipe and leave debris in place. No disposal costs are included with this item. Survey hours for located and marking drain tiles have been included for this effort. Updated production rate which includes a crew of 4 laborers and assumes it will take them approximately 2 hours to survey one acre. No additional costs were included for plans or electronic files for this effort. The crew's hourly labor rate is $191.72 without markups. Anticipated quantity is 7500' per acre.

Ditch Filling: Assumed a cross sectional area of 64 sf. Based on a trapezoidal ditch with 4' flat bottom, 3:1 side slopes and a 4' depth. A 5 mile haul of costs to truck in borrow for this effort is included. Additional contingencies may need to be added if we do not locate the anticipated borrow site. May need to adjust soil from borrow to more specific requirements of soil.

Ditch Plugging: Made same assumptions as ditch filling. Updated quantities as needed to increase the ditch plug to fill the channel for a length of 12' as suggested.

Remove Soil Compaction (Top 2-feet): Assumed a small decompaction roller will be used – trailed behind a low pressure tractor – similar to a compaction roller. Assumed the roller will be no larger than 3' wide. If areas require larger equipment – costs will need to be adjusted accordingly.

Grading to Increase Floodplain: Assumed grading would be an average of 4' depth. In some places, grading might be less than 4' or more. 4' is used only as a means to identify the quantity of material being moved on site. We have updated the grading items, clearing items to include off-site disposal costs.

Dam Removal: Developed a crew for concrete demolition for small dam removal. Developed production rate to 1 hour per cubic yard of removal. Assumed a 20 mile haul distance for the debris removal. No dumping fees/ unique waste fees are included. Stabilization of the area after dam removal can include a number of items from seeding, erosion control mats, grading, etc. There are separate unit bid items for these efforts.

Stream Remeandering: Developed a crew for earthwork grading to be used for this effort. Assumed the crew could effectively grade approximately 2 linear feet of stream per hour. Did not include any costs associated with dewatering or coffer dams, temporary water diversion structures. Assumed no off site disposal of materials that are excavated. Costs are based on regrading excavated material on site (fill in the old channel).

Cobble Riffles: Used information from current contract for Eugene Fields Estimate. Estimated depth of key excavation to be approx 4'. Assumed that backfill of trench with aggregate was 1' and coarse aggregate and stone mix to make up the remaining 3'. Assumed a haul distance of 20 miles.

Woody Debris: Includes cost of removing approx 3 trees to accumulate 1 cy of debris. Assumed contractor could place 5 cy of debris per hour. This task is placing woody debris instream for habitat, not removing woody debris from the stream.

Temporary Erosion Control: We have included a linear foot estimate of silt fence for temporary erosion control; this is typically placed in the contractor's overheads as it will be an item most likely included in the contractor's mobilization costs. We have added a per unit price for erosion control matting. Riprap is not an acceptable material for stream restoration; however, field stone or riverine cobbles would be used in sites where the stream cannot be allowed to move around in its floodplain.

Plantings: Developed a planting crew in which everything in the estimated planting list is planted by hand. Used a production rate of ¼ acre per hour. The application areas will be defined by a restoration specialist. The seed list is native species and will be detailed by a restoration specialist.

Prescribed Burns: Because the production rate of this effort is largely site specific, assumptions were made to err on the conservative side. Sites could be small and confined which would reduce productivity and require more effort and time. Current crew for prescribed burns consists of the following: 3 laborers and 1 light equipment operator, torch and water supply. Costs for trucking water in have not been added. Rate includes a burn crew of 4 people. Production rate has been updated to coincide with the $400/ac guidance. This results in a production rate of 0.6 ac per hour and an hourly rate of approximately $252/hr with contractor's markups only.

Invasive Species Removal – Physical: Physical removal of invasive species includes mowing only. Production rate is 0.5 ac/hour.

Invasive Species Removal – Herbicide: Current crew consists of 1 outside laborer and sprayer. Assumed one crew can cover 1 acre in 4 hours.

Erosion Control Matting: Included unit bid price for placing and removal of temporary erosion control matting. Separating this item from the rest of the estimate makes it easy to apply to the task where it will be needed.

Silt Fence: Included unit bid price for placing and removal of temporary silt fence. Separating this item from the rest of the estimate makes it easy to apply to the task where it will be needed.

2.2 – Riverine Analysis & Benefits

The following riverine Habitat Unit analysis was developed by the Chicago District Planning Section (PM-PL-E) and the E-Team. Spreadsheets used to develop annualized costs are archived electronically in the District project files:

- Riverine AAHUs.xls

The future without project condition was determined to be the current condition present. Data from a 30 year period show that stream conditions have not changed much in terms of biological integrity and habitat quality. If no restoration activities were to occur, these streams would be roughly in the same condition in 50-years based on reasonable foresight. It is known that the Hofmann, Fairbanks, Armitage, Dan Wright, Ryerson and Rasmussen Lake dams will be removed in the future without project conditions. These actions will improve certain reaches of river, but the five remaining dams still fragment the lower system from the upper system. These actions were considered in the future without and with conditions for those sites that would benefit. It was assumed there would be improvement in riverine habitat and an increase is species richness since free flowing hydraulics and fish passage would then be possible. These dams are scheduled to be removed by 2013. There have been no significant riverine restoration projects in the past nor are any reasonably foreseen within the 50-year period of analysis with the exception of the dam removal mentioned above.

R5 – R1 plus remeander stream and/or in-stream habitat (increase HSI benefits to 75% of total potential). Riverine benefits assume that the riparian zone will never be 100% restored. No dam removal would preclude certain fish from recolonizing, thusly reducing the potential for maximum increase in IBI.

R6 – R2 plus remeander stream and/or in-stream habitat (increase HSI benefits to 80% of total potential). Riverine benefits assume that the riparian zone will never be 100% restored, but slightly improved over Alt 5. No dam removal would preclude certain fish from recolonizing, thusly reducing the potential for maximum increase in IBI.

R7 – R3 plus remeander stream and/or in-stream habitat (increase HSI benefits to 85% of total potential). Riverine benefits assume that the riparian zone will never be 100% restored, but slightly improved over R6. No dam removal would preclude certain fish from recolonizing, thusly reducing the potential for maximum increase in IBI.

R8 – R4 plus remeander stream and/or in-stream habitat (increase HSI benefits to 80% of total potential). Riverine benefits assume that the riparian zone will be 85% restored, thusly maximizing benefits under this category. No dam removal would preclude certain fish from recolonizing, thusly reducing the potential for maximum increase in IBI.

R9 – R7 plus dam removal (increase HSI benefits to 95% of total potential). Riverine benefits assume that the riparian zone will be restored to 100% of its potential. Dam removal would increase the IBI portion of the HSI by through allowing for certain species of fish to recolonize from the lower portions of the Des Plaines River.

Excel Table Headers

Site # - The code for the site where riverine restoration is possible or needed.

Type – There are two types of riverine restoration being prescribed. RIF is solely the installation of riffles and woody debris for in stream habitat where degraded streams are already freely meandering. RM is remeandering a channelized stream and includes riffles and woody debris as well.

FWO Length – This is the length of the stream in the future without project condition.

FWO Q Units – This conversion from feet to units that are comparable to acres. The rational was that 100 feet of stream is worth 1 acre of habitat. The equation is FWO stream length / 100 feet = FWO Q Units.

CC/FWO HSI – The future without project conditions were assumed to be the same as the current conditions since this watershed has been impaired for so long. This calculation is based on the IBI and QHEI normalized scores. The equation is (IBI/60 + QHIE/100)/2 = CC/FWO HSI score.

FWO AAHUs – The future without project average annual habitat units is CC/FWO HSI x FWO Q Units.

FW Length – This is the length of the stream if it were to be remeandered under one of the alternatives. A typical stream meandering project would lengthen the stream channel by 25%. The equation is (FWO Length x .25) + FWO Length.

FW Q Units – This conversion from feet to units that are comparable to acres. The rational was that 100 feet of stream is worth 1 acre of habitat. The equation is FW stream length / 100 feet = FW Q Units.

AA HSI – This is the average annual HSI score over a 50-year period of analysis. It was estimated that it would take remeandering projects 15-years to achieve maximum benefits and riffle projects 30-years.

AAHUs – This is the Average Annual Habitat Units - HSI (Quality) x the FW Q Units (Quantity).

Net AAHUs – This is the net Average Annual Habitat Units that is calculated by the Future With AAHUs minus the Future Without AAHUs.

2.3 – Cost Effectiveness & Incremental Cost Analysis

Table 3 – Rural Total Alternative Planning Level Construction Costs Summary

Sites	Alt1	Alt2	Alt3	Alt4	Alt5	Alt6	Alt7	Alt8	Alt9
K01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K02	$1,229,384	$10,947,078	$13,103,329	$13,103,329	$1,741,913	$11,459,607	$11,033,132	$11,459,607	$11,484,281
K03	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K04	$407,706	$2,639,061	$3,136,772	$3,136,772	$407,706	$2,634,889	$2,575,640	$2,639,062	$2,639,062
K05	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K06	$1,020,278	$15,745,125	$19,019,483	$19,150,632	$2,753,614	$16,678,461	$16,235,379	$16,817,610	$16,842,284
K07	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K08	$36,375	$2,721,141	$3,626,732	$3,646,214	$99,917	$2,784,683	$3,003,727	$2,809,957	$2,834,631
K09	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K10	$1,273,505	$9,802,209	$12,074,438	$12,141,053	$5,072,672	$13,601,376	$13,381,321	$13,669,335	$13,694,009
K11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K12	$2,180,156	$25,090,941	$30,901,752	$30,901,752	$2,180,156	$28,177,428	$24,929,085	$25,090,344	$25,090,344
K13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K14	$1,012,699	$4,042,917	$4,873,290	$4,873,290	$1,600,228	$4,984,582	$4,667,065	$4,630,446	$4,655,120
K15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K16	$36,801	$1,571,053	$1,948,489	$1,948,489	$36,801	$1,863,043	$1,539,845	$1,571,053	$1,571,053
K17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K18	$4,620,983	$24,079,079	$31,445,279	$31,573,435	$921,161	$24,879,087	$22,201,040	$20,559,308	$20,583,982
K19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K20	$8,418	$1,342,944	$2,017,602	$2,010,078	$241,474	$1,821,806	$1,808,054	$1,576,000	$1,600,674
K21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K22	$713,214	$7,464,870	$9,570,980	$9,563,911	$1,200,344	$9,020,630	$8,246,420	$7,952,001	$7,976,674
K23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K24	$271,636	$1,826,518	$2,306,398	$2,302,314	$271,636	$2,456,631	$1,934,631	$1,826,518	$1,826,518
K25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K26	$286,568	$3,475,401	$4,234,966	$4,234,966	$286,568	$3,840,223	$3,421,412	$3,475,401	$3,475,401
K27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K28	$236,753	$2,844,400	$3,502,192	$3,502,192	$236,753	$3,230,052	$2,841,087	$2,844,400	$2,844,400
K29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K30	$956,816	$14,436,958	$18,473,496	$18,612,364	$1,537,177	$17,111,054	$15,215,786	$15,160,716	$15,185,390
K31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K32	$919,525	$4,602,931	$5,458,284	$5,458,284	$1,213,127	$5,352,067	$4,665,106	$4,916,533	$4,941,207
K33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K34	$1,901,889	$10,758,656	$13,784,593	$13,738,920	$2,343,126	$12,408,629	$11,558,229	$11,176,587	$11,201,261
K35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K36	$3,138,236	$25,974,008	$31,528,869	$31,437,254	$3,248,808	$29,362,962	$25,460,061	$25,992,965	$26,017,639
K37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K38	$292,751	$5,517,494	$7,097,790	$7,097,790	$292,751	$6,155,065	$6,142,929	$5,517,457	$5,517,457
K40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K41	$1,765,735	$10,458,363	$13,081,814	$13,945,357	$2,120,374	$11,973,341	$19,812,393	$10,917,021	$10,941,695
K42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K43	$648,096	$5,915,996	$7,239,267	$7,139,267	$648,096	$6,962,173	$6,374,129	$5,925,996	$5,925,996
K44	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K45	$2,503,704	$17,723,109	$23,664,258	$23,721,407	$3,174,243	$20,904,322	$28,973,012	$18,501,163	$18,525,837

Table 3 – Rural Total Alternative Planning Level Construction Costs Summary (Continued).

Sites	Alt1	Alt2	Alt3	Alt4	Alt5	Alt6	Alt7	Alt8	Alt9
K46	$865,291	$12,505,179	$15,886,409	$15,886,409	$865,291	$14,293,694	$13,831,239	$12,504,179	$11,586,179
K47	$1,925,261	$24,766,364	$31,654,985	$31,740,421	$2,389,804	$29,601,100	$28,122,440	$25,336,841	$25,361,515
K48	$1,353,018	$12,114,545	$14,631,851	$14,631,426	$1,353,018	$13,351,760	$12,758,372	$12,114,545	$12,114,545
K49	$907,842	$7,834,020	$9,446,223	$9,446,223	$881,167	$8,536,321	$8,192,924	$7,808,145	$7,808,145
K50	$1,215,004	$12,520,024	$15,126,748	$15,113,053	$1,702,628	$14,800,232	$13,750,869	$13,121,053	$13,145,756
K51	$203,364	$3,226,274	$3,938,967	$3,938,967	$203,364	$3,860,833	$3,469,783	$3,226,274	$3,226,274
K52	$257,075	$3,953,745	$4,880,192	$4,880,192	$257,075	$4,178,058	$4,266,250	$3,953,741	$3,953,741
K53	$1,382,655	$8,797,479	$10,640,042	$10,678,273	$1,666,042	$10,267,099	$22,422,031	$9,119,099	$9,143,773
K54	$1,576,359	$19,161,545	$24,127,589	$24,153,960	$1,976,359	$21,966,532	$31,518,355	$19,193,099	$19,193,099
K55	$413,313	$4,012,013	$5,058,140	$5,058,140	$413,313	$4,411,085	$4,418,852	$4,012,013	$4,012,013
K56	$1,244,767	$8,213,574	$10,361,814	$10,313,445	$1,749,786	$9,630,264	$19,342,707	$8,799,307	$8,814,381
K57	$2,753,321	$20,322,407	$24,556,346	$24,556,346	$2,753,321	$22,408,543	$35,966,780	$20,322,409	$20,322,409
K58	$1,164,358	$11,582,525	$13,981,440	$13,981,440	$1,164,358	$12,679,960	$12,264,769	$11,582,525	$11,582,525
K59	$4,333,980	$34,615,160	$43,937,092	$43,936,721	$4,333,982	$38,293,014	$73,116,139	$34,617,263	$34,617,263
K60	$1,159,508	$13,179,379	$15,832,902	$15,627,543	$1,159,508	$15,041,228	$18,913,117	$12,974,023	$12,974,023
K61	$5,486,863	$26,277,943	$33,020,004	$33,141,976	$5,928,648	$29,920,162	$69,786,085	$26,864,661	$26,889,335
K62	$3,217,617	$15,454,884	$19,521,146	$19,501,643	$3,618,872	$17,019,349	$44,122,788	$16,126,629	$16,160,313
K63	$1,898,451	$16,922,082	$20,388,435	$20,390,624	$1,898,451	$18,703,262	$17,784,949	$16,934,130	$16,934,130
K64	$3,850,427	$20,229,575	$26,013,351	$25,900,672	$3,362,387	$23,018,918	$21,240,847	$20,608,217	$20,704,891
K65	$9,097	$1,521,438	$1,869,901	$1,879,545	$86,201	$2,309,131	$1,754,892	$1,608,298	$1,632,972
L31	$5,415	$10,476,771	$14,469,351	$14,836,446	$5,415	$11,952,738	$12,352,312	$10,504,846	$10,504,846
L33	$1,582,387	$23,204,074	$29,086,388	$29,372,258	$1,582,387	$26,152,627	$25,433,972	$23,488,946	$23,488,946
L34	$22,721	$4,905,706	$5,867,830	$5,867,820	$22,721	$5,173,497	$4,915,982	$4,905,706	$4,905,706
L35	$140,390	$2,883,644	$3,620,674	$3,710,433	$140,390	$3,308,028	$3,095,271	$2,973,403	$2,973,403
L36	$663,546	$14,292,133	$17,775,650	$17,898,580	$663,546	$16,677,851	$15,582,442	$14,505,859	$14,530,644
L37	$737,351	$9,178,436	$11,496,316	$11,580,806	$737,351	$10,180,768	$10,010,758	$9,263,929	$9,263,929
L38	$386,641	$11,094,597	$14,744,490	$14,911,768	$834,916	$12,713,873	$13,078,960	$11,590,572	$11,615,246
L39	$818,769	$9,665,398	$12,048,042	$12,048,042	$1,154,717	$11,099,240	$10,783,930	$10,001,346	$10,026,020
L40	$181,404	$2,782,051	$3,501,490	$3,574,789	$570,827	$3,614,243	$3,424,849	$3,244,884	$3,269,568
L41	$851,125	$10,014,674	$12,622,013	$12,680,682	$1,494,957	$12,009,641	$11,304,409	$10,600,895	$10,625,569
L42	$251,615	$2,477,901	$3,081,013	$3,158,240	$461,734	$3,042,348	$2,928,615	$2,704,309	$2,728,983
L43	$1,266,382	$19,673,619	$25,276,378	$25,275,517	$1,266,382	$21,984,984	$21,818,467	$19,673,619	$19,673,619
L45	$290,211	$2,486,510	$3,043,562	$3,043,562	$290,211	$2,762,580	$2,648,941	$2,486,510	$2,486,510
L46	$444,441	$3,904,285	$4,832,631	$4,887,439	$701,858	$4,621,769	$4,463,586	$4,216,508	$4,241,182
L47	$993,774	$11,576,099	$14,867,646	$14,913,965	$1,256,424	$13,715,704	$13,215,659	$11,912,354	$11,937,028
R01	$1,313,120	$11,313,598	$13,800,388	$13,800,388	$1,611,914	$13,139,868	$21,858,756	$11,612,392	$11,637,066
R02	$1,106,823	$5,317,669	$6,325,310	$6,325,310	$1,106,823	$5,811,115	$16,561,365	$5,317,669	$5,317,669
R03	$2,082,211	$12,421,609	$15,243,612	$15,243,612	$2,903,604	$14,086,898	$26,766,642	$12,843,002	$12,867,676
R04	$1,687,583	$11,577,877	$14,384,212	$14,375,624	$2,174,398	$13,734,686	$30,232,251	$12,143,149	$12,167,823
R05	$1,190,581	$4,875,718	$6,291,380	$6,282,361	$1,529,701	$5,724,990	$19,176,921	$5,254,703	$5,279,377
R06	$726,494	$7,478,150	$8,986,976	$8,986,976	$879,894	$8,439,950	$7,803,022	$7,420,652	$7,420,652

Table 4 – Urban Total Alternative Planning Level Construction Costs Summary

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C02	$2,340,098	$2,401,647	$2,234,412	$2,309,453	$3,891,790	$3,891,790	$2,234,412	$3,891,790	$3,891,790
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C04	$1,145,689	$1,145,689	$1,145,689	$1,156,165	$1,511,030	$1,511,030	$1,145,689	$1,511,030	$1,511,016
C05	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C07	$2,488,725	$2,548,464	$2,333,648	$2,401,393	$3,349,897	$3,349,897	$2,356,230	$3,351,843	$3,353,843
C08	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C09	$9,453,744	$9,474,569	$8,123,699	$8,440,421	$11,848,592	$11,848,592	$8,250,649	$11,878,311	$11,878,311
C10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C11	$6,258,798	$6,983,079	$5,633,969	$5,771,120	$8,149,733	$8,149,733	$5,633,763	$8,154,438	$8,154,438
C12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C13	$327,167	$327,167	$327,167	$346,109	$493,107	$493,107	$327,167	$493,107	$493,107
C14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C15	$11,211,612	$9,645,298	$8,711,629	$8,554,964	$13,047,533	$13,047,533	$8,637,899	$12,338,978	$12,330,978
C16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C17	$2,514,512	$2,516,873	$2,163,497	$2,227,889	$2,923,330	$2,923,330	$2,192,826	$2,930,285	$2,930,285
C18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L01	$1,239,122	$1,571,683	$1,343,173	$1,262,531	$1,932,565	$2,023,880	$1,582,344	$2,258,531	$2,382,636
L02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L03	$5,567,686	$5,567,686	$5,567,686	$5,667,632	$7,691,243	$7,533,798	$5,567,686	$7,698,243	$7,691,243
L04	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L05	$7,147,316	$7,147,316	$7,147,316	$7,276,386	$10,551,721	$10,486,382	$7,147,156	$10,551,721	$10,551,721
L06	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L07	$1,082,845	$1,082,845	$1,082,845	$1,132,564	$1,782,715	$1,782,715	$1,082,845	$1,782,715	$1,782,715
L08	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L09	$5,635,547	$5,635,547	$5,549,068	$5,734,317	$7,547,538	$7,446,965	$5,603,986	$7,568,769	$7,580,593
L10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L11	$2,822,367	$2,822,367	$2,703,163	$2,861,534	$4,229,881	$4,229,881	$2,767,187	$4,249,763	$4,249,763
L12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L13	$5,319,487	$5,319,487	$5,319,487	$5,538,998	$7,915,221	$7,891,446	$5,319,487	$7,915,221	$7,915,221
L14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L15	$1,076,039	$1,076,039	$1,076,039	$1,084,090	$1,374,287	$1,312,838	$1,076,030	$1,374,287	$1,374,287
L16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L17	$1,164,389	$1,164,389	$1,164,389	$1,177,230	$1,503,166	$1,411,847	$1,164,389	$1,503,166	$1,503,166
L18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L19	$18,338,907	$18,729,459	$18,551,017	$18,796,699	$25,979,643	$25,146,543	$18,697,290	$25,414,320	$24,272,864
L20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L21	$3,683,028	$3,683,028	$3,683,028	$3,858,044	$5,314,884	$5,216,083	$3,683,820	$5,314,884	$5,314,884
L22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L23	$8,180,923	$8,756,088	$8,508,159	$8,957,483	$12,837,488	$13,049,334	$8,729,571	$12,869,829	$13,130,707
L24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L25	$3,235,478	$3,235,478	$3,066,455	$3,248,223	$4,532,764	$4,577,943	$3,124,934	$4,546,915	$4,635,516
L26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L27	$3,163,687	$3,163,687	$3,163,687	$3,213,348	$4,062,525	$3,837,175	$3,163,687	$4,062,525	$4,062,525
L28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L29	$9,040,562	$9,040,562	$9,016,255	$9,334,198	$11,632,418	$12,060,093	$9,122,336	$11,647,574	$12,221,176
L30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L31	$4,744,327	$4,744,327	$4,744,327	$4,896,880	$6,703,046	$6,561,339	$4,744,327	$6,703,046	$6,703,046
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 5 – Rural Net Average Annual Habitat Units Summary.

Site	Acres	R1	R2	R3	R4	R5	R6	R7	R8	R9
K01	159	148	129	199	199	148	129	199	199	199
K02	664	355	738	689	689	392	779	735	731	743
K03	324	187	260	249	249	187	260	249	249	249
K04	154	48	130	204	204	48	130	204	204	204
K05	1,067	899	1,089	1,011	1,011	899	1,089	1,011	1,011	1,011
K06	978	826	1,022	927	1,132	865	1,069	982	1,179	1,201
K07	368	297	459	429	537	327	495	470	573	590
K08	176	(60)	(19)	(70)	10	17	20	23	20	28
K09	627	984	942	1,009	1,056	1,028	992	1,066	1,106	1,124
K10	605	756	861	809	913	786	894	846	946	957
K11	304	320	366	348	429	343	392	377	455	464
K12	1,542	1,260	1,481	1,381	1,381	1,260	1,481	1,381	1,381	1,381
K13	64	29	31	30	30	29	31	30	30	30
K14	210	202	231	219	219	232	265	256	253	264
K15	409	207	206	286	286	218	218	299	298	302
K16	105	71	91	88	88	71	91	88	88	88
K17	155	176	195	179	179	176	195	179	179	179
K18	1,463	316	464	226	682	341	492	258	711	722
K19	461	430	495	479	479	430	495	479	479	479
K20	114	81	85	260	85	89	94	270	94	96
K21	158	106	131	123	123	115	140	134	133	136
K22	470	290	361	355	355	321	395	392	389	398
K23	1,785	1,052	1,090	1,122	1,161	1,121	1,169	1,210	1,240	1,268
K24	96	46	59	25	25	46	59	25	25	25
K25	632	222	121	218	218	222	121	218	218	218
K26	209	87	121	86	86	87	121	86	86	86
K27	1,064	389	737	846	1,061	399	749	860	1,073	1,079
K28	170	119	142	138	138	119	142	138	138	138
K29	415	381	248	434	480	385	253	439	485	488
K30	995	600	702	673	943	619	725	699	966	977
K31	626	603	709	586	586	603	709	586	586	586
K32	287	256	300	285	285	280	327	314	311	318
K33	2,134	1,226	2,148	2,051	2,445	1,352	2,287	2,202	2,584	2,621
K34	686	898	1,004	942	1,011	922	1,031	971	1,038	1,046
K35	923	769	807	753	753	769	807	753	753	753
K36	1,589	1,790	2,075	1,913	2,118	1,809	2,096	1,936	2,139	2,146
K37	363	315	322	182	182	315	322	182	182	182
K38	387	328	392	367	367	328	392	367	367	367
K40	504	355	434	171	171	355	434	171	171	171
K41	689	850	1,250	933	1,067	884	1,286	972	1,103	1,112
K42	721	520	584	452	452	520	584	452	452	452
K43	350	287	348	331	331	287	348	331	331	331
K44	2,363	1,107	1,444	1,358	1,719	1,131	1,471	1,388	1,746	1,755
K45	1,183	1,394	1,579	1,497	1,673	1,449	1,639	1,562	1,733	1,748

Table 5 – Rural Net Average Annual Habitat Units Summary (Continued).

Site	Acres	R1	R2	R3	R4	R5	R6	R7	R8	R9
K46	832	513	585	213	213	513	585	213	213	213
K47	1,619	1,956	2,144	1,696	2,249	2,017	2,211	1,768	2,315	2,332
K48	762	586	717	678	678	586	717	678	678	678
K49	552	438	280	455	455	438	280	455	455	455
K50	786	605	739	710	756	630	767	740	783	792
K51	190	101	128	124	124	101	128	124	124	124
K52	249	223	257	249	249	223	257	249	249	249
K53	522	464	532	504	565	483	552	526	584	589
K54	1,272	1,144	1,129	1,109	1,221	1,144	1,129	1,109	1,221	1,221
K55	263	336	429	326	326	336	429	326	326	326
K56	515	697	676	689	777	715	697	714	799	809
K57	1,221	1,104	1,313	1,237	1,237	1,104	1,313	1,237	1,237	1,237
K58	695	568	408	661	661	568	408	661	661	661
K59	2,147	2,028	2,022	2,051	2,243	2,028	2,022	2,051	2,243	2,243
K60	824	317	744	609	375	317	744	609	375	375
K61	1,608	1,870	2,111	1,998	2,199	1,933	2,181	2,074	2,269	2,287
K62	949	1,073	1,191	1,138	1,234	1,119	1,243	1,196	1,286	1,303
K63	1,054	739	941	1,002	1,008	739	941	1,002	1,008	1,008
K64	1,328	1,557	1,796	1,677	1,830	1,598	1,841	1,727	1,875	1,890
K65	78	25	33	32	105	30	40	40	112	115
L31	907	1,068	1,097	681	1,263	1,068	1,097	681	1,263	1,263
L33	1,481	531	1,475	746	1,767	531	1,475	746	1,767	1,767
L34	317	519	251	236	236	519	251	236	236	236
L35	213	321	337	306	293	321	337	306	293	293
L36	951	969	1,078	1,000	1,148	984	1,095	1,017	1,165	1,168
L37	601	669	761	687	837	669	761	687	837	837
L38	838	149	536	572	313	207	603	647	379	406
L39	648	687	786	742	742	716	817	775	772	779
L40	189	286	312	234	251	300	329	253	267	276
L41	673	620	704	659	1,233	655	742	700	1,272	1,281
L42	147	100	124	142	142	105	130	149	149	152
L43	1,401	1,376	1,513	1,454	1,454	1,376	1,513	1,454	1,454	1,454
L45	160	204	250	215	215	204	250	215	215	215
L46	254	277	315	302	248	285	324	312	257	261
L47	779	861	943	877	1,053	876	961	897	1,071	1,078
R01	698	404	644	564	564	421	663	586	584	590
R02	295	331	323	377	377	331	323	377	377	377
R03	754	1,029	1,139	1,063	1,063	1,038	1,148	1,074	1,073	1,076
R04	723	889	668	534	686	912	694	563	713	722
R05	297	281	51	304	156	296	68	324	173	181
R06	464	360	130	438	438	360	130	438	438	438

Table 6 – Urban Net Average Annual Habitat Units Summary.

Site	Acres	U1	U2	U3	U4	U5	U6	U7	U8	U9
C01	529	172	172	172	245	287	287	172	287	287
C02	327	0	1	(35)	15	16	16	314	392	392
C03	536	0	0	393	87	100	100	393	486	486
C04	93	53	53	53	50	61	61	53	61	61
C05	315	191	191	191	194	164	164	191	164	164
C07	233	208	222	212	212	181	181	172	212	212
C08	52	55	68	68	72	82	82	68	82	82
C09	815	591	593	532	560	688	688	721	925	925
C10	89	151	158	158	153	181	181	158	181	181
C11	511	340	355	354	365	452	452	390	488	488
C12	555	53	54	53	212	171	171	515	666	666
C13	31	(2)	(2)	(2)	6	7	7	(2)	7	7
C14	30	16	16	16	19	20	20	16	20	20
C15	1,007	719	816	726	753	1,306	1,306	882	1,494	1,494
C16	365	195	195	153	153	201	201	256	329	329
C17	161	71	72	71	77	98	98	115	153	153
C18	55	13	13	13	16	20	20	13	20	20
L01	219	103	390	69	84	100	100	261	261	261
L02	530	199	199	227	248	305	305	408	437	437
L03	492	420	420	420	434	504	504	420	504	504
L05	323	181	181	181	198	202	202	197	234	234
L06	859	601	601	444	602	595	595	732	717	717
L09	410	315	315	321	195	422	422	366	422	422
L10	551	108	108	155	179	116	116	254	231	231
L11	289	148	148	88	123	111	111	200	271	271
L12	167	207	207	207	208	245	245	207	245	245
L13	521	416	416	416	436	518	518	416	518	518
L14	250	54	54	54	73	81	81	54	81	81
L15	76	79	79	79	81	91	91	79	91	91
L16	88	86	86	86	64	97	97	86	97	97
L17	89	70	70	70	73	81	81	70	81	81
L18	337	292	292	296	178	318	318	296	371	371
L19	1,210	1,373	1,386	1,223	1,260	1,428	1,428	1,465	1,713	1,713
L20	99	100	100	100	106	120	120	100	120	120
L21	340	145	145	145	165	184	184	145	184	184
L22	759	422	422	422	456	514	514	422	514	514
L23	846	573	622	362	328	530	530	726	959	959
L24	615	344	344	344	408	416	416	344	416	416
L25	272	168	168	129	41	181	181	225	294	294
L26	205	93	93	66	69	100	100	112	160	160
L27	230	215	215	215	226	253	253	215	253	253
L28	1,064	610	610	357	446	574	574	500	744	744
L29	730	323	323	120	219	325	325	118	322	322
L30	323	194	194	194	221	254	254	194	254	254
L32	378	355	355	355	384	437	437	355	437	437
L44	380	510	510	471	479	575	575	595	652	652

SECTION 3 – HEP AND HGM DOCUMENTATION

ERDC/EL TR-SWWRP-09-X

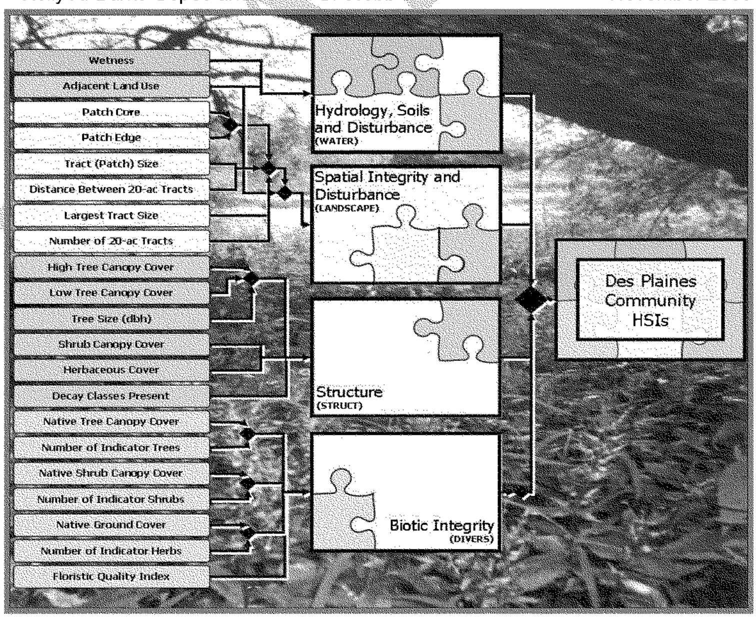
US Army Corps of Engineers®
Engineer Research and Development Center

Community Models for the Upper Des Plaines River Watershed, Illinois and Wisconsin

Model Documentation
Draft Report

Kelly A. Burks-Copes and Antisa C. Webb

November 2009



Environmental Laboratory

System-Wide Water Resources Program
Habitat Based Ecological Response Models

ERDC/EL TR-SWWRP-09-X
October 2009

Community Models for the Upper Des Plaines River Watershed, Illinois and Wisconsin

Model Documentation

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Abstract: Over the last decade, the Upper Des Plaines River Watershed (located in northeastern Illinois, Lake and Cook Counties, and southeastern Wisconsin) has experienced significant flooding owing to the limited channel capacity of the main stem Des Plaines River and its numerous tributaries. The anthropogenic pressures have led to significant degradation of the system's unique ecosystems – namely tall grass prairies, graminoid-dominated savannas, and wooded flats/riparian forests along the Upper Des Plaines main stem and its associated tributaries. In response, the US Army Corps of Engineers (USACE) has undertaken several studies to evaluate reasonable solutions to the problem found along 85 miles of the main stem and its associated tributaries in both Illinois and Wisconsin. As part of the process, a multi-agency, multi-disciplinary evaluation team was established to formulate alternatives that would address several critical problems including the reduction of existing flood damage, the prevention of future damage, and the protection/restoration of environmental integrity. In 2001, the team chose to use the Habitat Evaluation Procedures (HEP) methodology to capture ecosystem response in the prairie, savanna, and woodland ecosystems across the watershed. Between 2001 and 2008, this team designed, calibrated, and applied a series of community-based index models for these ecosystems using field and spatial data gathered from 85 individual reference sample sites scattered across the watershed. These models contained 25 parameters combined into various predictive community functional components (i.e., Hydrology, Spatial Integrity, Structure, and Biotic Integrity) capable of capturing the changes to ecosystem integrity in response to changes in land and water management activities proposed by the study. The intent of this document is to provide the scientific basis upon which these models were developed, and describe the 7-year long process the team undertook to complete this effort. Although some results are presented here to demonstrate and verify the veracity of the models' calibration and subsequent outputs, readers interested in the application of these models on the Upper Des Plaines studies should direct their inquiries to the Chicago District.

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Preface

This report provides the documentation of newly developed community models [based on the Habitat Evaluation Procedures (HEP)] for the Upper Des Plaines River Watershed in the vicinity of Chicago, Illinois.

The work described herein was conducted at the request of the U.S. Army Engineer District, Chicago, Illinois. This report was prepared by Ms. Antisa C. Webb, Ms. Kelly A. Burks-Copes, U.S. Army Engineer Research and Development Center (ERDC), Environmental Laboratory (EL), Vicksburg, Mississippi, and Mr. Seth W. Jones, U.S. Army Engineer District, Galveston, Texas. At the time of this report, Ms. Webb and Ms. Burks-Copes were ecologists in the Ecological Resources Branch. Mr. Jones was an ecologist in the Planning and Environmental Branch.

Many people contributed to the overall success of the production of the model documentation. The authors wish to thank the following people for their hard work and persistence during the intensive months over which the project was assessed: Ms. Jennifer Emerson (Bowhead Information Technology Services), Ms. Brook Herman (Chicago District), and Mr. Joe Hmieleski (Lake County Stormwater Management Commission). We also thank XYZ for their comprehensive review of the report.

This report was prepared under the general supervision of Ms. Antisa C. Webb, Chief, Ecological Resources Branch and Dr. Edmond Russo, Chief, Ecosystem Evaluation and Engineering Division. At the time of publication of this report, Dr. Beth Fleming was Director of EL.

This report should be cited as follows:

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1 Introduction

Over the last decade, the Upper Des Plaines River Watershed (located in northeastern Illinois, Lake and Cook Counties, and southeastern Wisconsin) has experienced significant flooding owing to the limited channel capacity of the main stem Des Plaines River and its numerous tributaries. The anthropogenic pressures have led to significant degradation of the system's unique ecosystems – namely tall grass prairies, graminoid-dominated savannas, and wooded flats/riparian forests along the Upper Des Plaines main stem and its associated tributaries. What follows is a description of these critical natural resources, and a discussion of the threats they face in light of increasing urban encroachment, significant alterations of hydroregime, and ever increasing competition from non-native populations.

Study Background

In 1999, the U.S. Army Corps of Engineers (USACE) District in Chicago, Illinois (District) was authorized by Section 419 of the Water Resources Development Act of 1999 to conduct the study on the Upper Des Plaines River and its associated tributaries in both Illinois and Wisconsin to determine the feasibility of improvements in the interests of flood damage reduction, environmental restoration and protection, water quality, recreation, and related purposes (USACE 2001). In conducting the study (referred to throughout the remainder of this report as the Upper Des Plains Multi-Purpose Phase II Feasibility Study or DPII), the District was directed to "not exclude from consideration and evaluation flood damage reduction measures based on restrictive policies regarding the frequency of flooding, the drainage area, and the amount of runoff." The Phase II study therefore has three primary objectives:

1. Further reduction of main stem flooding
2. Reduction of tributary flooding; and
3. Environmental restoration of degraded ecosystems within the basin.

Secondary objectives include improving water quality and enhancing recreational opportunities throughout the basin. The study will consider sites located within tributary watersheds and along the main stem for both

Flood Damage Reduction (FDR) and Ecosystem Restoration (ER) potential. The affects of FDR sites within tributary watersheds on main stem flooding will also be evaluated. Shortly thereafter, the District developed a Project Management Plan (PMP) recommending a cost-shared feasibility study with the Illinois Department of Natural Resources (IDNR), Lake County Storm Water Management Commission (LCSMC), Southeastern Wisconsin Regional Planning Commission (SEWRPC), Cook, Lake and Kenosha Counties (USACE 2001).

The key to a sustainable watershed will be a comprehensive flood control plan that will balance water storage and environmentally sensitive designs (possibly in the form of nonstructural solutions) (IDNR 2001b). In the development of alternative plans, the Upper Des Plaines River and Tributaries Sponsors and Stakeholders Alliance recommended the Corps use a combined environmental-flood damage reduction approach to plan formulation that addressed these issues in a holistic, multi-purpose and comprehensive manner (IDNR 2001b). The general approach was to design and implement projects to reduce flood damages and at the same time improve the overall quality of an ecosystem degraded over the years by farming and development.

Ecosystems are hierarchical and can be viewed as nested sets of open systems in which the physical, chemical, and biological processes form interactive subsystems each at different scales. Ecosystems can be microscopic in size or can be as large as the biosphere. Thus, ecosystem restoration efforts can be directed at different sized ecosystems within the nested set, spanning multiple counties, states, watersheds, or encapsulating smaller complexes of habitat within these larger-scaled entities (as is the case of the Upper Des Plaines Watershed).

Purpose of the Models

Planning, management, and policy decisions require information on the status, condition and trends of these complex ecosystems and their components at various scales (e.g. local, regional, watershed and system levels) to make reasonable and informed decisions about the planning management and conservation of sensitive or valued resources. One well accepted solution has been to develop index models that assess ecosystems at varying scales. By definition, index models are comprehensive, multi-scale, grounded in natural history, relevant and helpful, able to integrate terrestrial and aquatic environments, flexible and measurable (Andreasen et al. 2003). Determining the value of diverse biological resources in this study required a method that captured the complex biotic patterns of the landscape, rather than merely focusing on a single species habitat or suitability requirements within the study area In effect, the DPII study team made the decision to assess ecosystem benefits using a series of community-based (functional) models.

Ecosystem functions are defined here as a series of processes that take place within an ecosystem. These include the storage of water, transformation of nutrients, growth of living matter, and diversity of plants, and they have value for the community itself, for surrounding ecosystems, and for people. Functions can be grouped broadly as habitat, hydrologic, water quality, and spatial integrity although these distinctions are somewhat arbitrary and simplistic. For example, the value of a wetland for recreation (hunting, fishing, bird watching) is a product of all the processes that work together to create and maintain the ecosystem. Not all communities perform all functions nor do they perform all functions equally well. The location and size of a community may determine what functions it will perform. For example, the geographic location may determine its habitat functions, and the location of community within a watershed may determine its hydrologic or water-quality functional capacity. Many factors determine how well a community will perform these functions: climatic conditions, quantity and quality of water entering the system, and disturbances or alteration within the community or the surrounding landscape. Disturbances may be the result of natural conditions, such as an extended drought, or human activities, such as land clearing, dredging, or the introduction of invasive species.

The purpose of this modeling effort was to broadly capture existing, (baseline) conditions of the communities, and compare changes that would occur to the resources present given different project scenarios or alternatives under the standard USACE planning paradigm (USACE 2000). The models were used to facilitate plan formulation based upon project benefits. The purpose of the models was not to exhaustively capture the full range of all chemical, physical, and biological characteristics of the project area, but to provide tools for making comparisons between potential plans in order to select plans with the highest benefits. Planning decisions for the feasibility study were therefore made based on the results of the model applied using a planning level approach to the well received and respected Habitat Evaluation Procedures (HEP) (USFWS 1980a-c) and Hydrogeomorphic Assessment of Wetlands (HGM) (Ainslie et al. 1999; Brinson 1993) frameworks.

Contribution to the Planning Effort

These methodologies (HEP, HGM, etc.) help to characterize the baseline conditions (in a quantitative manner) of the numerous ecological resources throughout the watershed. The methods assisted the study team in the projection of change to fundamental ecosystem processes[1] (without which, ecosystem restoration itself could not happen), as the multi-purpose alternatives were proposed. The study team designed the HEP/HGM assessments to evaluate the future changes both in quantity (acres) and quality (community habitat suitability and/or functional capacity) of aquatic, wetland and terrestrial ecosystems simultaneously. Outputs were calculated in terms of annualized changes anticipated over the life of the project.

Early in the evaluation process, an interagency Ecosystem Assessment Team (E-Team) was convened. Scientists from the U.S. Army Engineer Research and Development Center, Environmental Laboratory (ERDC) facilitated the efforts. Representatives from the District, IDNR, U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (USEPA), LCSMC, SEWRPC, Cook, Lake and Kenosha Counties actively participated in the assessment process. The remainder of this document focuses on the Habitat Suitability Index (HSI) models developed by the E-Team for the DPII study.

Planning Model Certification

As an aside, the USACE Planning Models Improvement Program (PMIP) was established to review, improve, and validate analytical tools and models for USACE Civil Works business programs. In May of 2005, the PMIP developed Engineering Circular (EC) 1105-2-407, Planning Models Improvement Program: Model Certification (USACE 2005). This EC

[1] There are four fundamental ecosystem processes – water cycling, mineral cycling, solar energy flow, and community dynamics (aka succession).

requires the use of certified models for all planning activities. It tasks the Planning Centers of Expertise to evaluate the technical soundness of all planning models based on theory and computational correctness. EC 1105-2-407 defines planning models as,

> *" . . any models and analytical tools that planners use to define water resources management problems and opportunities, to formulate potential alternatives to address the problems and take advantage of the opportunities, to evaluate potential effects of alternatives and to support decision-making."*

Clearly, the community based HSI models and the functional assessment (HGM-based) models (and their associated input/output spreadsheets) developed for the study must be certified, and the Chicago District has initiated this activity. Information necessary to address model certification is outlined in Table 2 of the EC 1105-2-407 (pages 9-11). To assist the reviewers in the certification effort for these models, the authors have developed an appendix to crosswalk the EC checklist requirements and this report (*Appendix C*).

For purposes of model certification, it is important to note that these models must be formally certified, but the methodologies under which they are applied (i.e., HEP and HGM) do not require certification as it is considered part of the application process. HEP in particular has been specifically addressed in the EC:

> *"The Habitat Evaluation Procedures (HEP) is an established approach to assessment of natural resources, developed by the US Fish and Wildlife Service in conjunction with other agencies. The HEP approach has been well documented and is approved for use in Corps projects as an assessment framework that combines resource quality and quantity over time, and is appropriate throughout the United States" (refer to Attachment 3, page 22, of the EC).*

The authors used the newly developed **Habitat Evaluation and Assessment Tools (HEAT)** (Burks-Copes et al. 2008) to automate the calculation of habitat units for the study. This software is not a "shortcut" to HEP or HGM modeling, or a model in and of itself, but rather a series of computer-based programming modules that accept the input of mathematical details and data comprising the index models, and through their applications in the HEP or the HGM processes, calculates the outputs in responses to parameterized alternative conditions. The **HEAT** software contains two separate programming modules – one used for HEP applications referred to as the **EXpert Habitat Evaluation Procedures** (**EXHEP**) module, and a second used in HGM applications referred to as the **EXpert Hydrogeomorphic Approach to Wetland Assessments** (**EXHGM**) modules. Both the **EXHEP and EXHGM** modules were employed to calculate outputs for the study. The developers of the **HEAT** tool (including both the **EXHEP** and **EXHGM** modules themselves) are pursuing certification through a separate initiative, and hope to have this tool through the process in the next year barring unforeseen financial and institutional problems.

Report Objectives

This document describes the development of community-based HSI models for three community habitat types (Prairie, Savannas, and Woodlands) located within the Upper Des Plaines River watershed. The objectives of this report are to:

4. Characterize the Upper Des Plaines River watershed, within the study area, in southeastern Wisconsin and northeastern Illinois;
5. Characterize the three habitat communities used in the HEP evaluation and their applicable cover types;
6. Present the relationships of habitat maintenance components for each of the community models; and
7. Define and justify the selection of assessment variables and their associated curve calibrations used to characterize the components of each community model.
8. Provide critical information to reviewers to facilitate the certification of these index models.

Report Structure

This report is organized in the following manner. *Chapter 1* provides the background, objectives, and organization of the document. *Chapter 2* provides a brief overview of HEP, the method in which the model will be applied, including the procedures recommended for development and application of the HSI models. *Chapter 3* discusses the evolution of the community models in terms of conceptual development, offers critical insight into the characterization of each community, provides details regarding the key functional components in each model (and their mathematical representations), and then concludes with the construction and testing of the models over the last two years. *Chapter 4* offers insight into the model calibration approach as it applies to all the models described herein, and offers descriptions of the assessment variables used to characterize the communities including definitions, rationale for selection, and specific sampling guidelines. Several appendices are attached to this document. *Appendix A* is a list of acronyms used throughout this document. *Appendix B* is a glossary of commonly used terms regarding HSI models and the HEP evaluation. *Appendix C* offers a crosswalk between the standard requirements and information necessary to certify these models and this report. *Appendix D* contains a point of contact for the formal minutes documenting the decisions made during the initial model development workshops and offers a complete list of E-Team participants. *Appendix E* provides initial model review forms. *Appendix F* documents the review comments provided by the District and the workshop participants as the planning study proceeds through review. Finally, *Appendix G* provides individual index curves for the variables used in the models.

2 HEP Overview

The HEP Process

The HEP methodology is an environmental accounting process developed to appraise habitat suitability for fish and wildlife species in the face of potential change (USFWS 1980 a-c). Designed to predict the response of habitat parameters in a quantifiable fashion, HEP is an objective, reliable, and well-documented process used nationwide to generate environmental outputs for all levels of proposed projects and monitoring operations in the natural resources arena. When applied correctly, HEP provides an impartial look at environmental effects, and delivers measurable products to the user for comparative analysis.

In HEP, a Suitability Index (SI) is a mathematical relationship that reflects a species' or community's sensitivity to a change in a limiting factor (i.e., variable) within the habitat type. These suitability relationships are depicted using scatter plots and bar charts (i.e., suitability curves). The SI value (Y-axis) ranges from 0.0 to 1.0, where an SI = 0.0 represents a variable that is extremely limiting, and an SI = 1.0 represents a variable in abundance (not limiting) for the species or community. In HEP, an HSI model is a quantitative estimate of habitat conditions for an evaluation species or community HSI models combine the SIs of measurable variables into a formula depicting the limiting characteristics of the site for the species/community on a scale of 0.0 (unsuitable) to 1.0 (optimal).

Statement of Limitations

The HEP methodology can provide a rational, supportable, focused, and traceable evaluation of habitat functionality. However, the user must understand the basic HEP tenets as defined in supporting literature (USFWS 1980a-c) prior to attempting application of the methodology. Outcomes derived under HEP are dependent on the user's ability to predict future conditions and the reliability of resource data used. The user should understand that HEP is not a carrying capacity model and cannot comprehensively predict future species and species population sizes. Furthermore, HEP is not designed to compare across evaluation elements (e.g. compare prairie habitat to forest habitat). The user should not expect

HEP to provide the only predictive environmental response to project development scenarios, and should understand the limitations of the methodology's response to predictive evaluations prior to its application.[1]

HSI Models in HEP

Users can select several indicator species to evaluate overall site fitness. In the HEP process, species are often selected on the basis of their ecological, recreational, spiritual, or economic value. In other instances, species are chosen for their representative value (i.e., one species can "represent" a group or guild of species which have similar habitat requirements). Most of these species can, in turn, be described using single or multiple habitat models and a single HSI mathematical formula. In some studies, several cover types are included in an HSI model to accurately reflect the complex interdependencies critical to the species' or community's existence. Regardless of the number of cover types incorporated within an HSI model, any HSI model based on the existence of a single life requisite requirement (e.g. food, water, cover or reproduction), uses a single formula to describe the relationship between quality and carrying capacity for the site.

Some species are insufficiently examined using the simplistic approach. In these instances, a more detailed model can emphasize critical life requisites, increase limiting factor sensitivity, and improve the predictive power of the analysis. Multiple habitats and formulas are often necessary to calculate the habitat suitability of these more comprehensive HSI models. The second type of HSI model is used to capture the juxtaposition of habitats, essential dependencies, and performance requirements such as reproduction, roosting needs, escape cover demands, or winter cover that describe the sensitivity of a species or community. Multiple formula models require more extensive processing to evaluate habitat conditions

Habitat Units in HEP

HSI models can be tailored to a particular situation or application and adapted to meet the level of effort desired by the user. Thus, a single model

[1] Additional support for the HEP methodology has been provided in *Appendix C, 2 Technical Quality, a. Theory.*

(or a series of inter-related models) can be adapted to reflect a site's response to a particular design at any scale (e.g., species, community, ecosystem, regional, or global dimensions). Several agencies and organizations have adapted the basic HEP methodology for their specific needs in this manner (Inglis et al. 2006, Gillenwater et al. 2006, and Ahmadi-Nedushan et al. 2006). HEP combines both the habitat quality (HSI) and quantity of a site (measured in acres) to generate a measure of change referred to as Habitat Units (HUs). Once the HSI and habitat quantities have been determined, the HU values can be mathematically derived with the following equation: HU = HSI x Area (acres). Under the HEP methodology, one HU is equivalent to one acre of optimal habitat for a given species or community.

Capturing Changes Over Time in HEP Applications

In studies spanning several years, Target Years (TYs) must be identified early in the process. Target Years are units of time measurement used in HEP that allow users to anticipate and direct significant changes (in area or quality) within the project (or site). As a rule, the baseline TY is always TY = 0, where the baseline year is defined as a point in time before proposed changes would be implemented. As a second rule, there must always be a TY = 1 and a TY = X_2. TY1 is the first year land- and water-use conditions are expected to deviate from baseline conditions TYX_2 designates the ending target year. A new target year must be assigned for each year the user intends to develop or evaluate change within the site or project. The habitat conditions (quality and quantity) described for each TY are the expected conditions at the end of that year. It is important to maintain the same target years in both the environmental and economic analyses, and between the baseline and future analyses. In studies focused on the long-term effects, HUs generated for indicator species are estimated for several TYs to reflect the life of the project. In such analyses, future habitat conditions can be estimated for both the without-project (e.g., No Action Plan) and with-project conditions. Projected long-term effects of the project are reported in terms of Average Annual Habitat Units (AAHUs) values Based on the AAHU outcomes, alternative designs can be formulated and trade-off analyses can be simulated to promote environmental optimization.

Developing Index Models for HEP

Based on the USFWS's Ecological Service Manual (ESM) series on HEP (USFWS 1980 a-c), there are 12 steps involved in the application of HEP when assessing an environmental project:

1. Build a multi-disciplinary E-Team;
2. Define the project;
3. Map the site's cover types (CTs);
4. Select, modify and/or create index model(s);
5. Conduct field sampling;
6. Perform data management and statistical analyses;
7. Calculate baseline conditions;
8. Set goals and objectives, and define project life and TYs;
9. Generate Without-project (WOP) conditions and calculate outputs;
10. Generate With-project (WP) conditions and calculate outputs;
11. Perform trade-offs; and
12. Report the results of the analyses.

However, this document only addresses the development of the model used in the HEP process for this study. For further detail on each of the 12 steps, contact Brook Herman in the Chicago District (contact information can be found in *Appendix D*) to obtain a copy of the ecosystem assessment report for the study.

Steps in Model Development

Community assessment was identified as a priority for the District's upcoming feasibility study. However, few HSI community models were published and available for application. ERDC-EL proposed a strategy to the District to develop community models for the MRGBER study. The strategy entailed five steps:

1. Compile all available information that could be used to characterize the communities of concern.
2. Convene an expert panel in a workshop setting to examine this material and generate a list of significant resources and common characteristics (land cover classes, topography, hydrology, physical processes) of the system that could be

combined in a meaningful manner to "model" the communities. In the workshop, it was important to outline study goals and objectives and then identify the desired model endpoints (e.g., outputs of the model). It was also critical for the participants to identify the limiting factors present in the project area relative to the model endpoints and habitat requirements .The outcome of the workshop was a series of mathematical formulas that were identified as functional components (e.g., Hydrology, Vegetative Structure, Diversity, Connectivity, Disturbance, etc.) which were comprised of variables that were:

a. biologically, ecologically, or functionally meaningful for the subject,
b. easily measured or estimated,
c. able to have scores assigned for past and future conditions,
d. related to an action that could be taken or a change expected to occur,
e. were influenced by planning and management actions, and
f. independent from other variables in each model.

3. Develop both a field and a spatial data collection protocol (using Geographic Information Systems or GIS) and in turn, use these strategies to collect all necessary data and apply these data to the model in both the "reference" setting and on the proposed project area
4. Present the model results to an E-Team and revise/recalibrate the model based on their experiences, any additional and relevant regional data, and application directives.
5. Submit the model to both internal ERDC/District/E-Team review and then request review from the initial expert panel that participated in the original workshop, as well as solicit review from independent regional experts who were not included in the model development and application process.

Model Review Process

The process described below is currently being implemented to assure that quality control was an integral part of model development and document production. Three independent reviews of the model(s) and the subsequent application of the model(s) for this study will be undertaken in support of the model development process for the study. First, an in-house Laboratory-based Technical Review (LTR) will be conducted to ensure that:

1. The concepts, assumptions, features, methods, analyses, and details were appropriate and fully coordinated;
2. An appropriate range of feasible alternatives were evaluated;
3. Problems, opportunities, and issues were defined and scoped;
4. Analytic methods used were environmentally sound, appropriate, reasonable, fall within policy guidelines, and yielded reliable results;
5. Any deviations from policy and guidance were identified, documented, and approved;
6. The products met laboratory standards based on format and presentation; and
7. The products met the customer's needs and expectations.

To assure fair and impartial review of the products, members of the Laboratory-based Technical Review Team (LTRT) will be chosen on the basis of expertise and seniority in the laboratory chain of command. No LTRT member will be directly associated with the development or application of the model(s) for this study, thereby assuring independent technical review. Review comments will be submitted to the Laboratory-based Project Delivery Team (LPDT) in written format. Two technology transfer forms will be completed to document the formal internal laboratory review process (see *Appendix E*)

Simultaneously, a second review will be undertaken by the E-Team and District representatives and written comments will be proffered back to the LPDT using the review form and checklist attached in *Appendix E*. This review will focus primarily on accuracy of content and compatibility with the ongoing District documentation. It is important to note that the District will be responsible for incorporating the ERDC-EL documents into their integrated feasibility study reports and documents.

A third, and final external Expert Technical Review (ETR) focused on the veracity of the model built for the study will be performed at the request of the laboratory's principal investigator. This third review team will be asked to review the validity of the model's basic premises, identifying any critical errors in model assumptions and providing any support documentation from their areas of expertise supporting the model's concepts. This third team (referred to as the Expert Technical Review Team or ETRT) will be comprised of regional experts (including university professors and local scientists with specific community knowledge of the local hydrology, ecology and geology), not directly associated with either the laboratory or District proposed project. Timing of this review will be dependent on the application's schedule, but will likely occur towards the end of the study's planning and evaluation process.[1]

Technical Review Guidelines

Technical review guidelines for the laboratory's internal quality control and LTR processes have been described above. A general summary is as follows:

1. Coordination with the customer;
2. Compliance with applicable laws, policies, and regulations;
3. Integration of multiagency input;
4. Milestone determination and attainment;
5. Document reviews and comment incorporation;
6. Technical review strategy sessions; and
7. Certification of Quality Control Plan acceptance.

[1] *Appendix F* documents the comments received by reviewers and ERDC-EL's response to these comments.

3 Community-based HSI Modeling

As described earlier in *Chapter 2* of this report, index models quantify the effects of change in a given ecosystem setting and can be used to account for restoration gains under the HEP assessment paradigm. This chapter describes the relevant ecological communities found along the Upper Des Plaines river and its tributaries as it runs from Wisconsin down into Illinois, and describes the process by which the E-Team developed and tested a small number of community-based HSI models for the purpose of assessing the efficacy of proposed alternatives for the current feasibility study. A general description of the variables and their relationships to one another are described for the model as well. The goal of this chapter therefore is to characterize the E-Team's effort to capture the general character of the relevant ecosystems using a traditional HEP-based index model-based approach.

Model Development Workshops

A series of ten workshops were held over the course of seven years (2001-2008) to develop the models and characterize baseline conditions of the study area prior to plan formulation and alternative assessment for the ecosystem restoration study. Three separate community-based index models were developed under this paradigm (Forest, Savanna, and Prairie). Several federal state and local agencies, as well as local and regional experts from the stakeholders' organizations, and private consultants, participated in the model workshops.[1] In the first workshop, the E-Team was briefed on the project scope and opportunities by the District planners. Land and water management activities (e.g., hydrologic alterations, urban development and agricultural production) were identified as the system's key anthropogenic drivers. The stressors (i.e., physical, chemical and biological changes to system structure and function) were identified and grouped into five categories: 1) hydrologic alteration, 2) geomorphic and topographic alteration, 3) climate change, 4) urban encroachment and agricultural use, and 5) exotic species

[1]A list of E-Team participants can be found in *Appendix D*.

introductions. Each stressor altered ecosystem integrity[1] within a water, soils, habitat and/or landscape context. For example, hydrologic alterations to the channel have caused changes not only in flooding frequency and duration, but have altered ecosystem function and structure across the basin. Urban encroachment has exacerbated these problems by reducing infiltration, increasing storm water runoff, and increasing disturbance regimes system-wide. These changes have ultimately led to opportunities for exotic species invasions reducing spatial complexity on a landscape scale. The direct and indirect effects of these alternations are as obvious as they are numerous – reduced hydrologic pulsing, reduced sediment transport, fragmentation, and loss of biodiversity.

Coupling Conceptual Modeling and Index Modeling

Conceptual models are proving to be an innovative approach to organize communicate, and facilitate analysis of natural resources at the landscape scale (Harwell et al. 1999, Turner et al. 2001, Henderson and O'Neil 2004, Davis et al. 2005, Ogden et al 2005, Watzin et al. 2005, Alvarez-Rogel et al. 2006). By definition a conceptual model is a representation of relationships among natural forces, factors, and human activities believed to impact, influence or lead to an interim or final ecological condition (Harwell et al. 1999, Henderson and O'Neil 2004). In most instances these models are presented as qualitative or descriptive narratives and illustrated by influence diagrams that depict the causal relationships among natural forces and human activities that produce changes in systems (Harwell et al. 1999, Turner et al. 2001, Ogden et al. 1005, Alvarez-Rogel et al. 2006). No doubt, conceptual models provide a forum in which individuals of multiple disciplines representing various agencies and outside interests can efficiently and effectively characterize the system and predict its response to potential alternatives in a descriptive manner. In theory and practice, conceptual models have proved an invaluable tool to focus stakeholders on developing ecosystem restoration goals given recognized drivers and stressors. These in turn are translated into

[1] We prescribe to the Society of Ecological Restoration's (2001) definition of ***ecosystem integrity*** here, which has been defined as "the state or condition of an ecosystem that displays the biodiversity characteristic of the reference, such as species composition and community structure, and is fully capable of sustaining normal ecosystem functioning."

essential ecosystem characteristics that can be established as targets for modeling activities.

For purposes of this effort, a systematic framework was developed that coupled the traditional USACE planning process with an index modeling approach derived from a sound conceptual understanding of ecological principles and ecological risk assessment that characterized ecosystem integrity across spatial and temporal scales, organizational hierarchy, and ecosystem types, yet adapted to the project's specific environmental goals. Ideally, the development of conceptual models involves a close linkage with community-index modeling, and produces quantitative assessment of systematic ecological responses to planning scenarios (Figure 1).

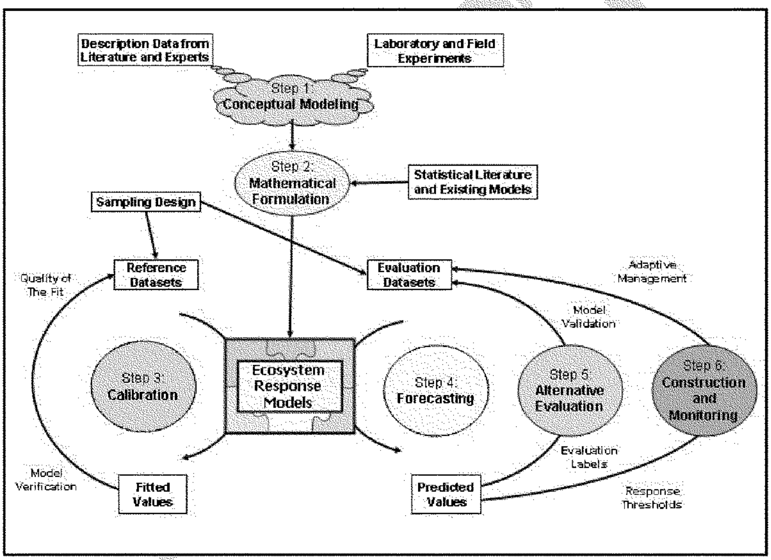

Figure 1. Overview of the successive steps (1-6) of the community-based index model building and application process for ecosystem restoration, where two data sets (one for calibration and one for alternative evaluations) are used (adapted from Guisan and Zimmerman 2000).[1]

[1] It is important to note here that the same models used to evaluate alternatives should be used in the future to monitor the restored ecosystem and generate response thresholds to trigger adaptive management under the indicated feedback mechanism. As such, the District can use the models developed early-on in the process to adaptively manage the system over the long-term.

Under this modeling paradigm, conceptual modeling led to the choice of an appropriate scale for conducting the analysis and to the selection of ecologically meaningful explanatory variables for the subsequent environmental (index) modeling efforts. These models were calibrated using reference-based conditions and modified when the application dictated a necessary change.

As a first step in the index model development process, ERDC-EL developed a conceptual model to illustrate the relationships between these system-wide drivers and stressors and tried to highlight the ecosystem responses to these pressures across the entire watershed (Figure 2).

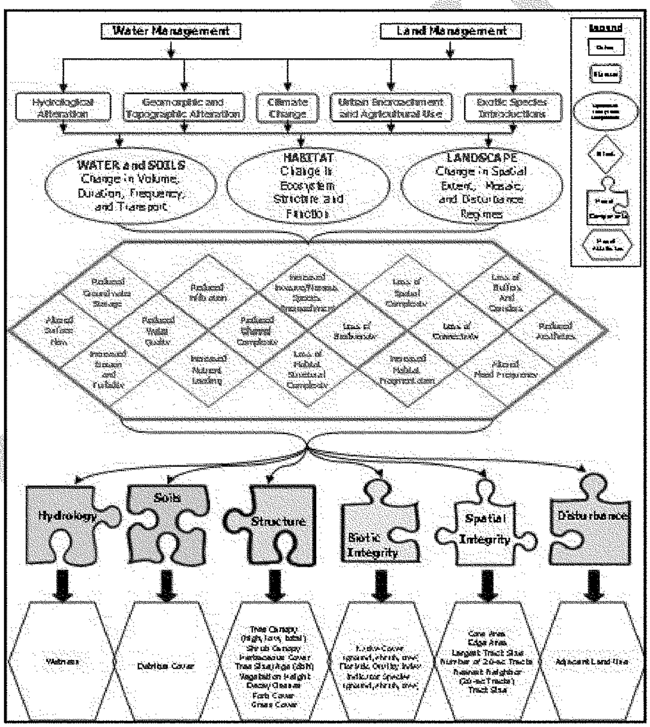

Figure 2. A conceptual model for the Upper Des Plaines Watershed.

Conceptually speaking, the "Significant Ecosystem Components" (water, soils, habitat, and landscape) were characterized by parameters responsive to project design. These parameters or variables (hydroperiod, vegetative cover, disturbance, etc.) were grouped in a meaningful manner to quantify the functionality of the community in the face of change based on expert opinion and scientific literature. The effort to combine the variables in mathematical algorithms could then be viewed as community index modeling under the HEP paradigm. For purposes of organization, the community based index models were constructed from combinations of components – an analogy used was one of puzzle building. The individual model components were represented as "pieces" of the ecosystem puzzle, that when combined captured the essence of the system's functionality (Figure 3).

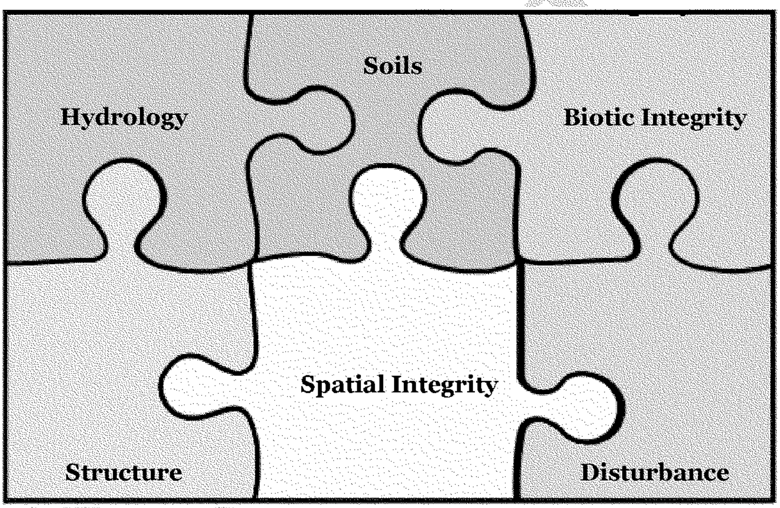

Figure 3. Within the conceptual modeling building framework, the various model components (color-coded for organization purposes) are pieced together to capture the essence of community functionality using the ecosystem puzzle analogy.

Vegetation communities in the area ranged from riparian forests, shrublands, savannahs, meadows, open marshes and the river itself. Out of this effort, three draft models arose: one for the watershed's woodlands (including flatwoods and the riparian zone), one for the system's savannas, and a final model for the watersheds wet/dry prairie complexes. Subsequent refinement of these models led to the identification of contributing ecosystem components, and a description of associated variables (with suggested sampling protocols) that can be used to measure ecosystem restoration benefits. The accuracy and utility of the proposed models were "tested" (e.g., verified) with specific field and planning exercises on the District's ongoing ecosystem restoration feasibility study. The application led ERDC-EL to modify the models several times over the course of the study to accommodate broader planning specifications. A general description of the system's reference domain and the unique ecosystems therein follows.

Characterization of the Upper Des Plaines River Watershed

General Description

Northeastern Illinois has been described as the historic crossroads between America's East and West. Established as a natural portage between the Great Lakes and the Mississippi valley, this region served as the pivotal link in the nation's water, rail, and aviation networks. The central city, Chicago, is the economic and cultural capital of the Midwest. The metropolitan area is home to over eight million people. Public services are provided by six county governments, 272 cities and villages, and nearly 1,000 schools, park, and other special-purpose districts (Northeastern Illinois Planning Commission 2006). The population of this region has increased rapidly since the 1940s, and between 1990 and 2000, local population growth exceeded 40 percent (Figure 4) (Stumpf, Hansel, and Barnhardt 2006). A further increase is anticipated for some areas over the next 20 years (Northeastern Illinois Planning Commission 2006).

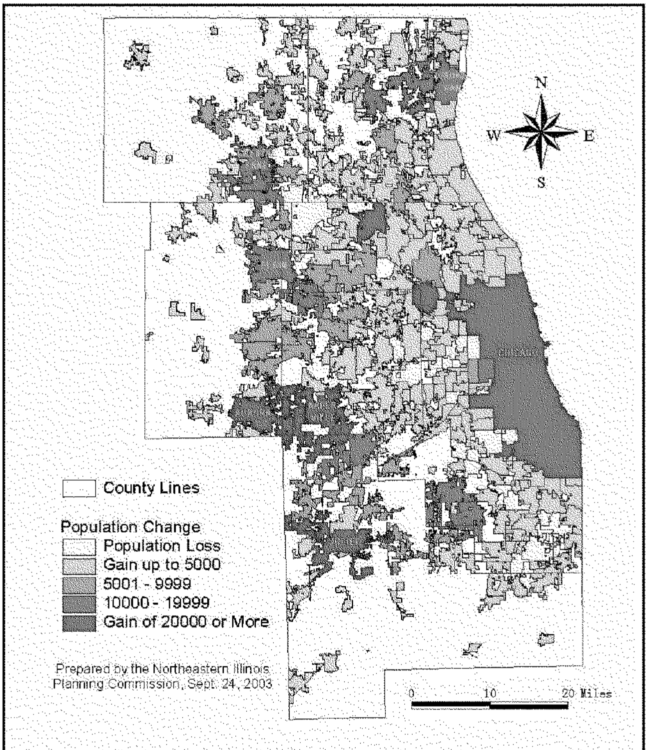

Figure 4. Population change by municipality in Northeastern Illinois between 1990 and 2000.[1]

The Des Plaines River watershed is still predominantly rural, but its proximity to the greater Kenosha, Milwaukee, and Racine urban areas subject it to advanced urbanization pressures. The public preference for low-density residential development (as indicated by the findings of attitudinal surveys conducted by SEWRPC in 1963, 1972, and 1991) and the diffusion of urban development outward from the older urban centers resulted in high rates of population growth in areas immediately adjacent to cities such as Kenosha, Milwaukee, and Racine (SEWRPC 2003).

1 Map taken from the Northeastern Illinois Planning Commission website at http://www.nipc.org/region/#snapshots. Data retrieved March 2006.

The region encompasses 3,749 square miles of land and water. Nearly 40 percent of the land was still in agricultural production in 1990. Natural assets include 75 miles of Lake Michigan shoreline (over half of it in public ownership); 280 square miles of forest preserves, parks, and other open space (including irreplaceable areas of undisturbed prairie and oak savanna); 138 square miles of wetlands; and extensive river, stream and lake resources (Northeastern Illinois Planning Commission 2006).

The Des Plaines River originates near Racine, Wisconsin and enters Illinois two miles northeast of Rosecranes in Lake County. The river flows 97 miles south before it joins with the Kankakee River to form the Illinois River (IDNR 1998b). The Upper Des Plaines basin drains approximately 480 square miles spanning central Lake County, north-central Cook County, and the northeastern portion of DuPage County (IDNR 1998b). Three hundred forty-six square miles of the basin is in the state of Illinois, and encompasses a diversity of land cover and land uses. No other natural Illinois river runs through such an urbanized watershed and still has so many natural features intact (Figure 5).

Figure 5. The upper Des Plaines River flowing through this highly urbanized watershed still retains its wilderness legacy in remnant pockets.

Visitors who described the area in 1840 reported that the land cover in the Upper Des Plaines basin consisted of 40 percent prairie and 60 percent forest and savanna (Krohe 1998). Scientists estimate that about a quarter of the basin was once wetlands of one type or another. West of the river, a complex landscape dominated by small lakes formed when the glacial ice melted. This landscape existed for more than 10,000 years between the times the great ice sheets stopped shaping the land to when the Euro-American settlers influence began to reshape the landscape (Krohe 1998).

Today, approximately 18 percent of the basin has been characterized as "wooded" and is made up of areas primarily in and along the forest preserves. Non-forested wetlands in the form of marshes and wet meadows cover only 3.5 percent of the surface. Most of the lakes have been drained. Fewer than 167 pothole lakes survive in the Illinois northern reaches of the basin (Krohe 1998). Losses of pre-settlement habitat in the Upper Des Plaines basin are less severe than in the state as a whole. Currently, natural areas consisting of nearly 2,300 acres survive. Today, only 18 acres of high quality prairie remain of the nearly 90,000 acres of prairie thought to have been present in 1840 (Krohe 1998).

Due to air quality regulations implemented in the 1970's to protect public health, air pollutants have been drastically reduced (Krohe 1998). Pollution of surface water has also been reduced, but less dramatically. Water quality is declining in many of the area lakes, and their suitability for more demanding uses such as water supply and recreation could be impaired. According to the Illinois Environmental Protection Agency, the overall water quality can only be considered as fair (Krohe 1998). While the reaches of the Upper Des Plaines River are too small for navigation, they do function as a sewer for the basin especially when stormwater overwhelms treatment plants. In addition, surface water quality is often compromised by hard-to-regulate non-point sources including soils washing from fields and building sites, de-icing salts washing in from roads, and phosphorous discharging into the system from lawns and croplands (Krohe 1998).

Fragmentation directly attributed to the construction of roads, agricultural practices, and urban sprawl is dividing once intact habitats into small "islands." Such splintered tracts are often too small for larger species to roam, resulting in their emigration, while making other populations more vulnerable to disease and genetic stress from in-breeding (Krohe 1998). Fires, which are required for prairie and savanna regeneration, have been reduced to small controlled burns within preserves, resulting in the conversion of savanna to dense woodlands (Krohe 1998). Exotic plants and animals have been introduced into the basin, often with unintended ecological effects such as finding a major advantage over native species when competing for habitat, often choking out the native species and unbalancing the native community (Chicago Region Biodiversity Council 1999). Seventy percent of the vascular plants species in the basin are not native to the area. Approximately 30 introduced plant species have adapted so well to the disturbed ecosystems that they have become pests (e.g. garlic mustard, reed canary grass, and Kentucky bluegrass) (Krohe 1998) (Figure 6).

Figure 6. Field of garlic mustard, an invasive plant that disrupts natural systems.[1]

The economic base of the basin is diverse and growing. As the density of business in the region has increased, a supporting infrastructure of experts has also increased, doubling the number of jobs in Lake County, IL since 1970 (Krohe 1998). This trend, along with a long-standing shift of the state's population to northeast Illinois, has resulted in Lake County's population quadrupling (Krohe 1998).

Reference Domain

The reference domain decided by the District and the E-Team for these models is defined as the Upper Des Plaines River watershed, which spans the southeast corner of Wisconsin and northeastern portions of Illinois. The decision was based on time and funding limits of the initial study. The watershed covers five counties: Racine and Kenosha Counties in Wisconsin; and Lake, Cook, and DuPage Counties in Illinois (Figure 7). The Upper Des Plaines Watershed encompasses approximately 308,899 acres with 41 percent (129,410 acres) found in Lake County alone (Figure 8). Cook and Kenosha Counties contribute another 29 and 26 percent respectively (88,356 and 78,910 acres). The remaining four percent is

[1] Photo courtesy of the Liberty Prairie Conservancy, found on the UDPREP website: www.upperdesplainesriver.org/resources.htm. Data retrieved November 2005.

divided across Racine and DuPage Counties (6,850 and 5,372 acres respectively).

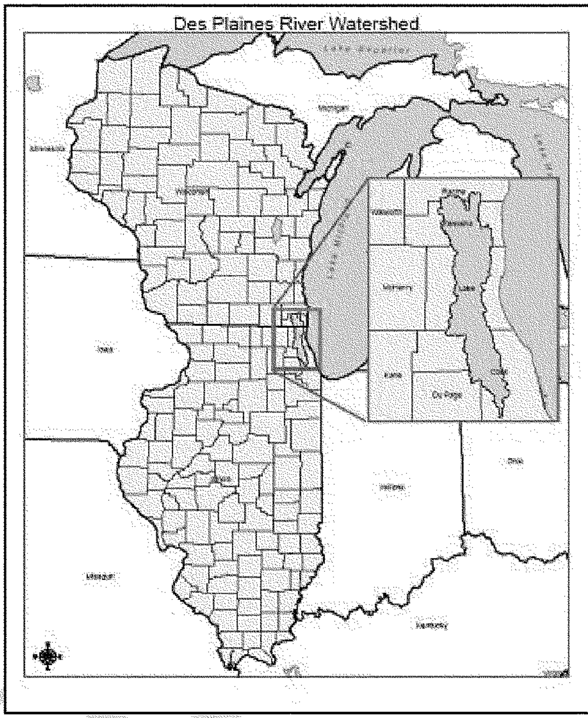

Figure 7. Location of Upper Des Plaines River Watershed in Wisconsin and Illinois.

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Figure 8. Distribution of acreages across the five counties in the Upper Des Plaines Watershed.

Climatic Characterization

The climate of the Upper Des Plaines basin is typically continental and is supported by its changeable weather and the wide range of temperature extremes. However, this climate is moderated by the region's close proximity to Lake Michigan. Temperatures range from average lows in the teens to 20°s F in the winter to average highs in the 80°s F in the summer (IDNR 1998b). Based on the latest 30-yr average first occurrence of freezing temperatures in the fall is October 15, and the average last occurrence of freezing temperatures in the spring is May 1 (IDNR 1998b).

Mean annual precipitation in the area is 34.20 inches (Figure 9) (IDNR 1998b). Rainfall is normally heaviest during the growing season and lightest in midwinter. The months with the most snowfall are November through April. Heavy snowfalls rarely exceed 12 inches (IDNR 1998b).

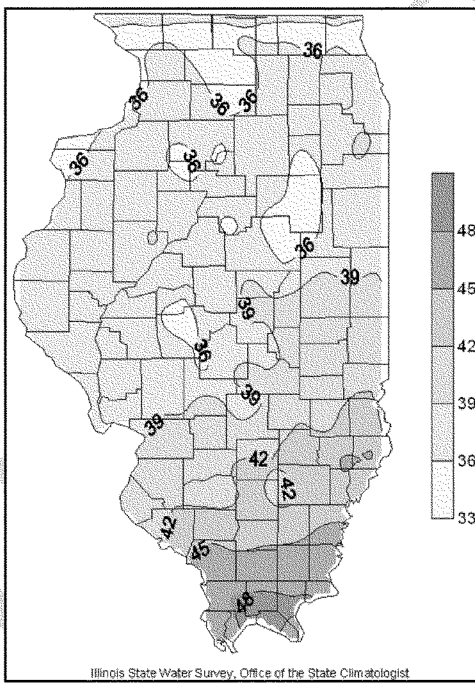

Figure 9. Mean annual precipitation (inches) across the state of Illinois from 1971-2000.[1]

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[1] Map used with permission from Illinois State Water Survey (2005). *"What are the Dimensions of Water Availability in Illinois?"* found on the website at http://www.sws.uiuc.edu/docs/wsfaq/. Data retrieved November 2005.

Geomorphic Characterization

The geology of the region plays a key role in where flora and fauna prefer to grow, where streams flow, and where urban centers thrive. Ice was the key architect of the reference domain's landscape. Major land contouring began about 26,000 years ago and ended about 13,000 years ago when the glaciers receded from the Chicago region for the last time (Sullivan 2001). The Ice Age (i.e., Pleistocene) saw four major ice advances in eastern North America. The first occurred about 500,000 years ago. The last advance (the Wisconsin stage) began about 70,000 years ago. At one time, the Wisconsin ice spread as far as Shelbyville, Illinois (200 miles south of Chicago). The current landscape reveals the complex series of ice movements that occurred during the later years of the Wisconsin glacial episode. The glaciers that covered the region were as much as a quarter of a mile thick. In central North America, the ice followed river valleys, and over the course of the Pleistocene, scoured those valleys into the deep, broad basins that now hold the Great Lakes (Figure 10).

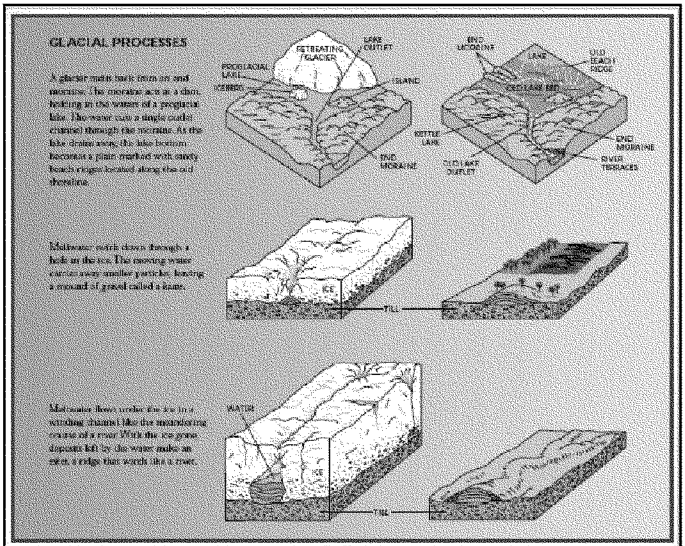

Figure 10. The glaciation process in the reference domain.[1]

The landscape of the Chicago region recorded five major advances of the ice out of the Lake Michigan basin alternating with periods when the ice retreated to the basin. The glacial constructions covered the bedrock foundation from 320 to 505 million years ago (Paleozoic era) (IDNR 1998a). The bedrock surface is a complex of buried valleys, lowlands, and uplands, where the buried valleys contain coarse-grained sediments that form important productive aquifers (Horberg 1945). These valleys were probably formed by a regional drainage network that existed prior to continental glaciers (IDNR 1998a). In the Chicago region, the most common type of bedrock was a magnesium-rich limestone called dolomite that was originally deposited on reefs set in shallow seas during the Silurian period about 400 million years ago. A layering process of glacial deposition best describes the geological history of the Chicago region (Figure 11).

[1] Diagram taken from Sullivan (2001). *An Atlas of Biodiversity.* Chicago Wilderness, 66 pp.

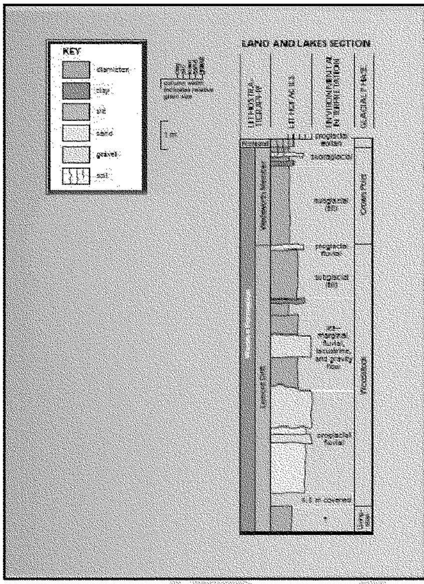

Figure 11. Layers illustrate the predominant geology within the reference domain.[1]

From the bottom up, sorted sands and gravels left by meltwater flowed from distant ice fronts. As the ice moved closer, unsorted diamicton was mixed with sorted gravel. As the ice covered the area, unsorted till was deposited. Rapid melting left material carried on the top of the glacier along the surface. As the ice retreated, wind (eolian) scattered dust over the earlier deposits. In general, the surface features were comprised of material deposited by the glaciers or by the lakes that appeared as the glaciers melted. In some places, these deposits were nearly 400 feet thick.

Deposits of glacial origin generally range from less than 100 feet to 200 feet thick or more. The thickest drift exists in the northern half of the area and thins southward (IDNR 1998a). The land surface of the area is composed of several closely grouped end moraines (Figure 12) that generally run north to south and roughly parallel the western shoreline of Lake Michigan. The moraines were formed at the margin of the glacial ice

[1] Diagram taken from Sullivan (2001). *An Atlas of Biodiversity.* Chicago Wilderness, 66 pp.

as it stood for several hundred years before melting back into the Lake Michigan basin and beyond. They are composed of till and indicate that the glacial margin pulsated back and forth several times while the ice was active (IDNR 1998a).

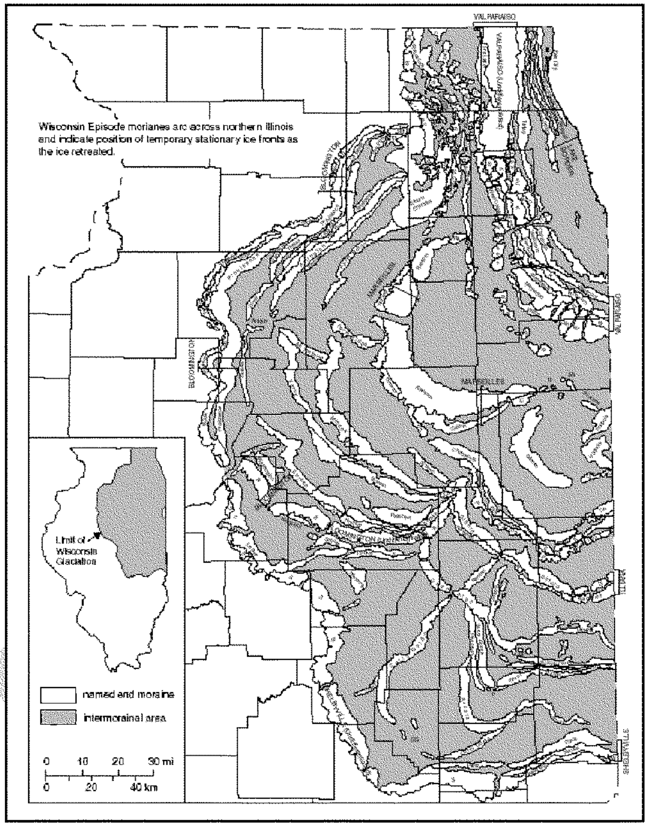

Figure 12. End moraines of the Wisconsin Glacial Episode (map scale equals 1:500,000).[1]

The glacial sediments found in the area today can generally be grouped into three categories: (1) an uppermost clayey till of the Wadsworth

[1] Map used with permission from Illinois State Geological Survey, found in Willman, H. B. and Frye; J. C. (1970). Pleistocene Stratigraphy of Illinois; Illinois State Geological Survey Bulletin 94, plate 1.

Formation from the Wedron Group, (2) underlying the Wadsworth, a silty gravelly till of the Lemont Formation from the Wedron Group, and (3) in western Lake County, under the Lemont, a reddish-gray silty till of the Tiskilwa Formation (Hansel and Johnson 1986). All three layers of glacial drift are thicker to the west and become thinner to the east.

As shown in Figure 13, the surficial unit over most of the Upper Des Plaines watershed is the clayey till of the Wadsworth Formation. Outwash of the Henry Formation from the Mason Group occurs primarily along the length of the Des Plaines River (IDNR 1998a). The river probably established its present valley while the ice margin stood immediately to the east, and the sand and gravel outwash was deposited in the valley that served as the melt-water outlet. Small areas near the Wisconsin border have lake sediments of the Equality Formation, and modern stream alluvium (Cahokia Formation) occurs along the streams (IDNR 1998a).

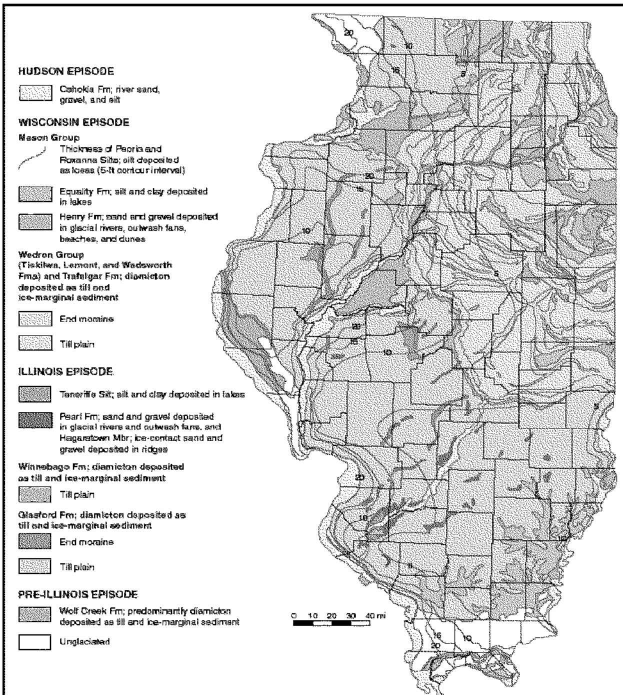

Figure 13. Quaternary deposits found in Illinois (map scale equals 1:500,000).[1]

Soil development in the area was strongly influenced by geologic, topographic, and biologic differences that created habitats conducive to the development and survival of various natural communities. Along the Des Plaines River in southwestern Cook and western Will Counties, bedrock was exposed in large enough quantities to support flora and fauna. Here, unique communities of plants and animals reside today on soils only a few inches thick deposited on the underlying bedrock. Over the course of centuries, topography, drainage, climate, and vegetation shaped these raw materials into the soils we see today (Figure 14).

[1] Map used with permission from Illinois State Geological Survey, found in Lineback; J. A. 1979. *Quaternary Deposits of Illinois*; Illinois State Geological Survey.

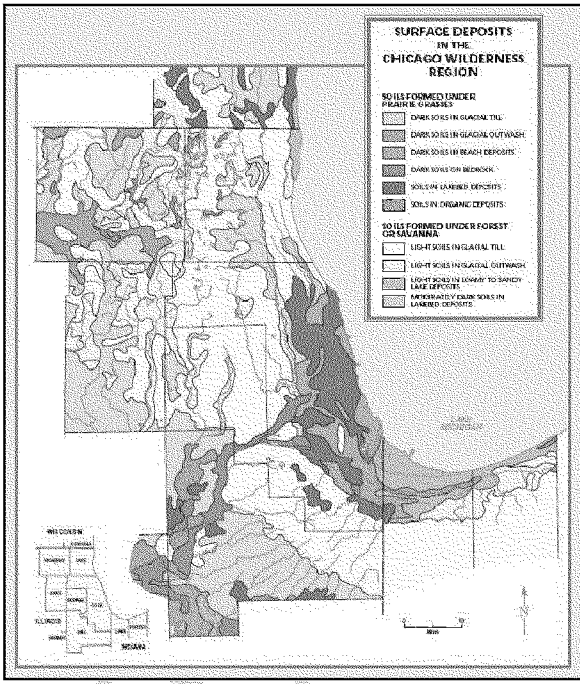

Figure 14. Surface depositing in the reference domain.[1]

Differences in the frequency, rate, and magnitude of surficial geologic processes have created many combinations of slope, angle, length, and orientation which in turn have influenced local drainage patterns, erosion, and sedimentation processes. Modifications by human activities have caused significant changes to the frequency, rate, and magnitude of surficial processes that directly affect localized communities (IDNR 1998a).

The age and physical characteristics of the geologic materials underlying the thin layer of loess blanketing the landscape has played an important role in soil development as well. The northern portion of the basin has greater amounts of wetlands with poorly drained soils than the southern

[1] Map taken from Sullivan (2001). *An Atlas of Biodiversity*. Chicago Wilderness, 66 pp.

portion (IDNR 1998a). The recency of glacial activity that deposited these materials has contributed to the lack of an extensive surface water stream network. Many of the soils in these wetland areas are slowly permeable, experience seasonally high water tables, are susceptible to shrink-swell due to clay plasticity, and are only marginally suitable as construction foundation materials (IDNR 1998a).

The basin is predominantly comprised of morainal features commonly associated with active ice glaciation and demonstrating limited erosional change (IDNR 1998a). The landscape can generally be characterized as uplands and lowlands (Figure 15). Much of the land in the basin is considered uplands, including the extensive regions of higher ground and end moraines. The lowlands occur mostly along stream valleys, floodplains, and areas occupied by sediments deposited by former lakes (IDNR 1998a).

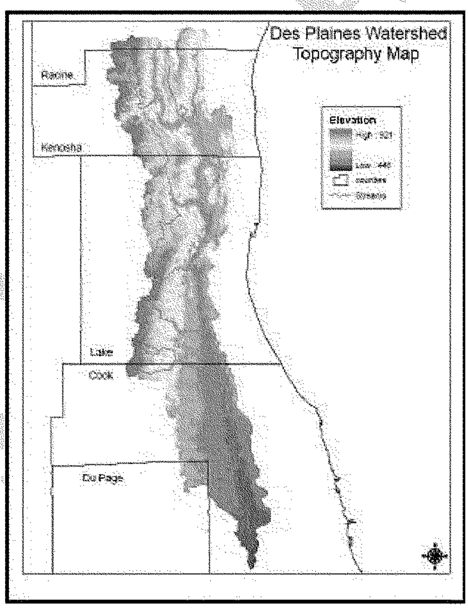

Figure 15. Topography of the Des Plaines Watershed.

The nature of the soils within the Des Plaines River watershed has been determined primarily by the interaction between the parent glacial deposits covering the Region and topography, climate, plants, animals, and time. Within each soil profile, the effects of these soil-forming factors are reflected in the transformation of soil material in place, chemical removal of soil components by leaching or physical removal by wind or water erosion, additions by chemical precipitation or by physical deposition, and transfer of some soil components from one part of the soil profile to another (SEWRPC 2003). The STATSGO database (USDA 1994) lists fifteen soils associations in the reference domain (Figure 16).

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Figure 16. Soils in the reference domain.

The most widespread are the Morley-Markham-Ashkum (32 percent of the total area), Urbanland-Markham-Ashkum (14 percent), Varna-Elliott-Ashkum (13 percent), Elliott-Ashkum-Varna (10 percent), and Drummer-Plano-Elburn (six percent) (USDA 1994).

These soil associations fall predominantly into two soil orders: Mollisols and Alfisols, with scattered occurrences of Entisols and Inceptisols on floodplains and sandy outwash areas and along stepper, eroded uplands (IDNR 1998a). The two types can be differentiated by the accumulation of organic matter in the upper soil horizon. By definition, mollisols have a darker soil color and develop under prairie grassland vegetation, and are considered more fertile (Figure 17).

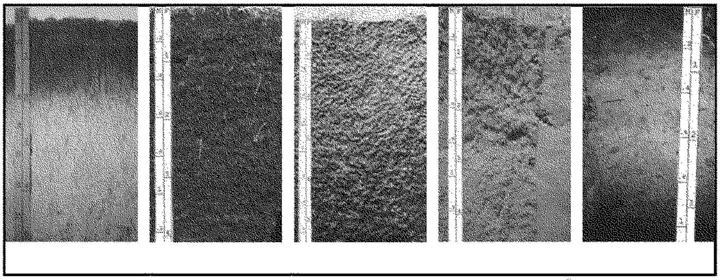

Figure 17. Illustration of soil characteristics.[1]

Alfisols are not as organically rich, have thinner upper soil horizons, and develop under deciduous forest vegetation. Entisols and Inceptisols have minimal soil horizons and occupy small but significant areas because they help created niche communities (IDNR 1998a). The depressional, hummocky areas within the irregularly shaped hills of the region are often site of thick accumulations of peat and muck at various stages of decomposition (e.g., Histosols). These soils are associated with wetlands and are very susceptible to the degradation by oxidation if they are drained. They commonly form under unique hydrologic conditions conducive to hydrophytic vegetation (IDNR 1998a).

Slow permeability and erosion potential are two major problems faced by land owners in this area. The hummocky, uneven landscape prevalent throughout the area, combined with the relatively fine-textured sediments, makes high water tables, frequent flooding, and sedimentation a problem in low-lying areas. Sixty percent of the area is covered by soils developed in silty clay and silty clay loam-textured till, which is generally slowly permeable and subject to considerable wetness (IDNR 1998a). Soil erosion becomes a major concern where slopes greater than five percent occur. Where slope angles increase around moraines and drainages, erosion increases significantly (IDNR 1998a). The steeper slopes adjoining the floodplains are often susceptible to severe soil erosion through sheetwash and the development of gully networks. Uncontrolled erosion and sedimentation can seriously damage in-channel and streambank ecology

[1] Photos courtesy of Iowa State University and the Natural Soils Survey Center, found on the soil order website. http://www.riverdell.k12.nj.us/staff/molnar/picturesoilscomplete.htm. Data retrieved March 2006.

by altering water tables, channel capacity, and channel geometry (IDNR 1998a).

Hydrologic Characterization

Water resources are an essential component of any ecosystem because they provide different types of habitats for aquatic and terrestrial biota. In addition to their natural functions, they serve as sources of water supply for domestic, industrial, and agricultural use. There are more than 500 miles of rivers and streams in the Upper Des Plaines basin (IDNR 1998b). The Des Plaines River drains in a generally southeasterly direction across the Wisconsin-Illinois border beyond Chicago proper (SEWRPC 2003). The river then travels southerly to its confluence with the Kankakee River, where the two rivers join to form the Illinois River (Figure 18).

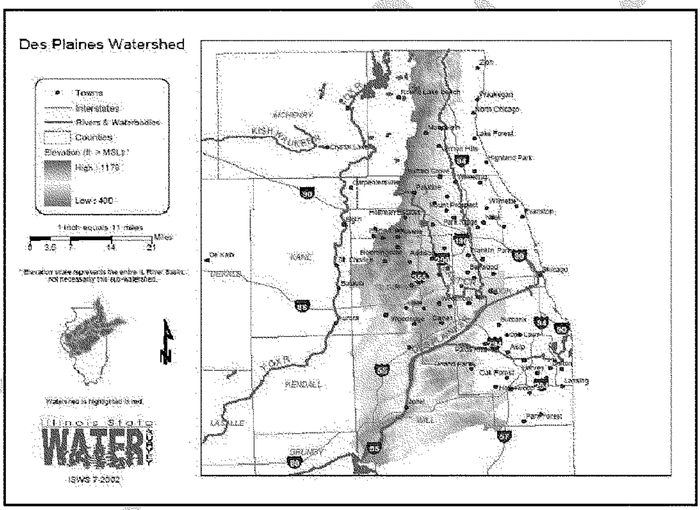

Figure 18. Des Plaines River watershed surface hydrology.[1]

The watershed is bounded on the north by the Fox and Root River watersheds, on the west by the Fox River watershed, and on the east by the Pike River watershed and areas directly tributary to Lake Michigan. The

[1] Map used with permission from Illinois State Water Survey (2006), found on the website at http://www.sws.uiuc.edu. Data retrieved March 2006.

river itself is 67 miles long and flows through 33 municipalities. This study expands the area of concern from the main stem in Illinois to include the entire Upper Des Plaines watershed, 15 tributaries and their subwatersheds in Illinois and Wisconsin (Figure 19). Historically, the Des Plaines River system was a narrow elongated depression within the late Wisconsinan Age glacial drift (Pepoon 1927). The Upper Des Plaines River, from the confluence of Salt Creek northward, was very shallow and about 30 feet wide with banks of terraced alluvium and covered with hydrophytic vegetation (Pepoon 1927).

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Figure 19. Upper Des Plaines River subwatersheds.

The characteristics of the surface drainage of the Upper Des Plaines River watershed are diverse with respect to channel cross-sectional shape, channel slope, degree of stream sinuosity, and floodland shape and width. The heterogeneous character of the surface drainage system is due partly to the natural effects of glaciation superimposed on the bedrock, and partly to the extensive channel modifications and other results of urbanization that are evident throughout the watershed. The quantity and quality of water at a particular location within the Des Plaines watershed can vary greatly with time. Average streamflow varies greatly from year to year. Over the 57 years of record, the annual flows have ranged from one inch in the drought of 1940, to a high of almost 25 inches in 1993 (IDNR 1998b). The long-term average flow in the basin is approximately 9.4 inches per year. These variations may occur rapidly or slowly and may occur in the atmosphere, on the land, in the surface waters, or in the groundwater of the watershed. Moreover, these variations may involve water in all its states—solid, liquid, and vapor (SEWRPC 2003) (Figure 20).

Figure 20. Example of Upper Des Plaines River Watershed surface hydrology.[1]

Precipitation is the primary source of all water in the Des Plaines River watershed. Part of the precipitation runs directly off the land surface into stream channels and is ultimately discharged from the watershed; part is temporarily retained in snow packs, ponds, and depressions in the soil or on vegetation, and is subsequently transpired or evaporated; while the remainder is retained in the soil or passed through the soil into a zone of saturation or groundwater reservoir. Some water is retained in the groundwater system; but in the absence of groundwater development, much eventually returns to the surface through conveyance in agricultural drain tile systems or as seepage or spring discharge into ponds and surface channels. This discharge constitutes the entire natural flow of surface streams in the Des Plaines River watershed during extended periods of dry weather (SEWRPC 2003) (Figure 21).

With the exception of the groundwater in the deep sandstone aquifer underlying the watershed, all of the water on the land surface and

[1] Photo courtesy of Jeff Lin, ERDC-EL.

underlying the Des Plaines River basin generally remains an active part of the hydrologic system.

Figure 21. Example of Upper Des Plaines River Watershed tributary surface hydrology (2002 photo of Mill Creek).[1]

Groundwater originates as precipitation that filters into the ground. As precipitation infiltrates the soil, the most recent glacial aquifers (surficial aquifers) are recharged. Water can flow downward to recharge bedrock aquifers in areas where the surficial aquifers directly overlie the shallow-bedrock aquifers (Arnold, et al. 1999). The permeability of the soil and surficial deposits partially determines the rate of infiltration.

In the deep aquifer, water is held in storage beneath the nearly impermeable water-tight Maquoketa shale formation and is, therefore, taken into the hydrologic cycle in only a very limited way. Since the recharge area of the deep aquifer lies entirely west of the Des Plaines River watershed, artificial movement through wells and minor amounts of leakage through the shale beds provide the only connection between this water and the surface water and shallow groundwater resources of the watershed (SEWRPC 2003) (Figure 22).

[1] Photo courtesy of Lake County Storm Water Management Commission.

Figure 22. Example of Upper Des Plaines River Watershed surface hydrology (2002 photo at the Druce Lake site).

As the water infiltrates the soil, it begins to change chemically due to reactions with air in the soil and with earth materials through which it flows. Contamination is generally the result of human-induced chemical changes and not naturally occurring processes. Much of the contamination of Illinois' groundwater is localized (IDNR 1998b). On a watershed scale, groundwater has not been degraded with respect to Iron, Total Dissolved Solids, Sulfate, Nitrate, Chloride, or Calcium Carbonate (hardness) (IDNR 1998b).

Vegetative Characterization

An ecosystem's vegetation at any given time is determined by a variety of factors, including climate, topography, soils, proximity to bedrock, drainage, occurrence of fire, and human activities. Because of the temporal and spatial variability of these factors and the sensitivity of different forms of vegetation to these factors, the system's character is one of dynamic, changing juxtapositions (i.e., a fluid mosaic). Of particular concern for this effort, is the state of the vegetative communities within the model domain (Figure 23).

Figure 23. At stake - the dwindling forest, savanna and prairie communities (2002 photos taken by the field data collection team at various locations across the watershed).

The pre-settlement vegetation in Illinois generally can be described as prairie and forest (Figure 24). Early surveys described native vegetation east of the Des Plaines River as mostly savanna with local pockets of prairie including wet prairie and marsh (IDNR 1998c). Forest communities were present along the east border of the river. West of the river was a complex of savanna, prairie, marsh and small lakes (IDNR 1998c). Savannas were spatially dynamic and their total area and distribution varied on pre-settlement landscape depending on several factors including local conditions of climate, and fire frequency and intensity (Taft 1997). Fire is generally considered to have been a major ecological factor in maintenance of tall-grass prairie, savanna, and open woodland vegetation in the Midwest (Anderson 1990).

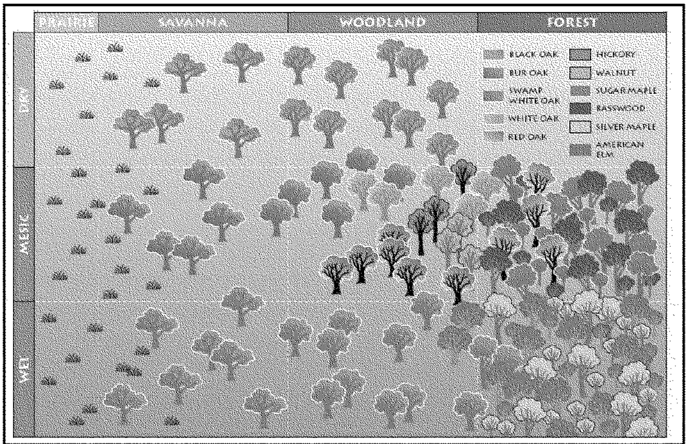

Figure 24. Pre-settlement communities of the region, separated by soil moisture and density of canopy cover.[1]

To fully quantify the habitat conditions for this area, it is useful to divide the project into manageable sections and quantify these in terms of acres per habitat type. This process, referred to as "cover typing," allows the user to define the differences between vegetative "types" (e.g., forest, shrublands, wet/dry meadows, etc.), hydrology and soils characteristics, and clearly delineate these distinctions on a map. The final classification system, based primarily upon dominant vegetation cover, captures "natural" settings and common landuse practices in a specific and orderly fashion that accommodates USACE's plan formulation process.

To facilitate model development, a series of 33 unique landuse/land cover types (i.e., cover types or CTs) were identified based on a classification system developed by the Chicago Region Biodiversity Council (1999, page 32 and Appendix 1) with input from the E-Team on indicator species and underlying soil conditions (Table 1).

[1] Figure taken from Sullivan (2001). *An Atlas of Biodiversity.* Chicago Wilderness, 66pp.

Table 1. Cover types identified and mapped for the reference domain.

No.	Code	Description
1	AGCROPLAND	Agricultural Croplands
2	BOGSFENS	Forested Bogs and Fens (Calcareous Floating Mat Fens, Forested Fens and
3	DETENTION	Other Man-made Lakes (Detention Ponds, Borrow Pits, etc.)
4	FORFLPLWET	Wet-mesic and Wet Floodplain Forests
5	FORNFLATS	Northern Flatwood Forests
6	FORUPLWET	Wet-mesic Upland Forests and Wet-Mesic Woodlands
7	LAKEARTIFC	Naturalized Man-made Lakes
8	LAKEGLACL	Glacial Flowthrough and Kettle Lakes
9	MARSHBASIN	Basin Marshes
10	MARSHSTRMS	Streamside Marshes
11	MEADOW	Sedge Meadows
12	NEWFORFLAT*	Newly Developed Northern Flatwood Forests
13	NEWFORFWET*	Newly Developed Wet-mesic and Wet Floodplain Forests
14	NEWFORUWET*	Newly Developed Wet-mesic Upland Forests
15	NEWLAKEART*	Newly Developed Naturalized Man-made Lakes
16	NEWMARSHBS*	Newly Developed Basin Marshes
17	NEWMARSHSS*	Newly Developed Streamside Marshes
18	NEWMEADOW*	Newly Developed Sedge Meadows
19	NEWPRARDRY*	Newly Developed Dry and Mesic Fine-textured-soil Prairies
20	NEWPRARWET*	Newly Developed Wet Fine-textured-soil Prairies
21	NEWSAVDRY*	Newly Developed Dry-mesic and Mesic Fine-textured-soil Savannas
22	NEWSAVWET*	Newly Developed Wet-mesic Fine-textured-soil Savannas
23	NEWSTREAMS*	Newly Developed Streams
24	NEWWOODLND*	Newly Developed Dry-mesic and Mesic Woodlands
25	PARKS	Parks and Open Spaces
26	PASTURES	Pastures, Haylands and Urban Fields
27	PRAIRIEDRY	Dry and Mesic Fine-textured-soil Prairies
28	PRAIRIEWET	Wet Fine-textured-soil Prairies
29	SAVANNADRY	Dry-mesic and Mesic Fine-textured-soil Savannas
30	SAVANNAWET	Wet-mesic Fine-textured-soil Savannas
31	STREAMS	Streams
32	URBAN	Urban Lands (Residential, Commercial, and Roads)
33	WOODLNDDRY	Dry-mesic and Mesic Woodlands

*Cover types identified as "NEW" refer to newly developed areas proposed in conjunction with construction of proposed alternatives.

These existing cover types were subsequently mapped using GIS (and ground-truthed during the 2002-2003 field seasons) (Figure 25).

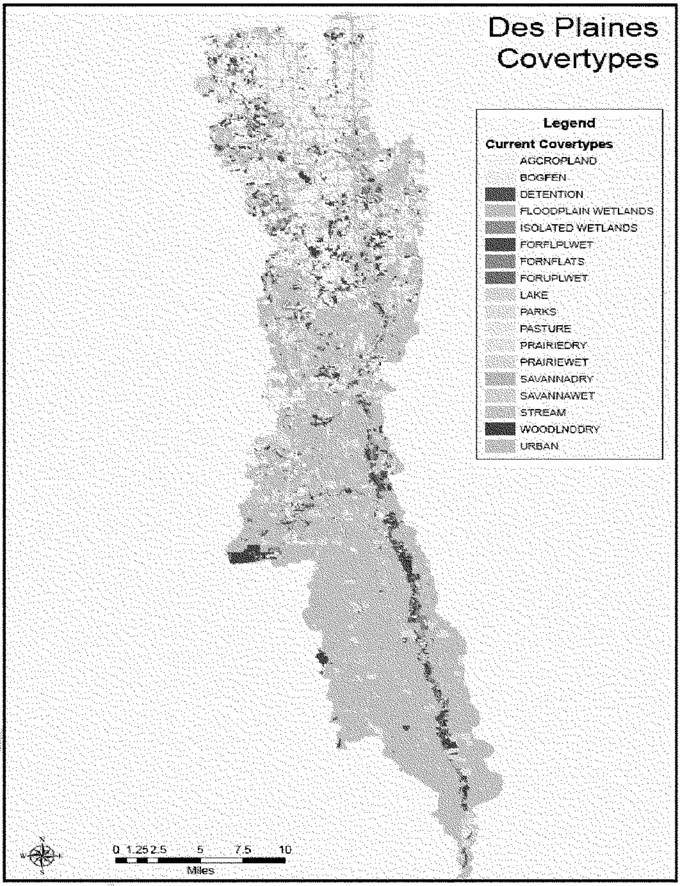

Figure 25. Cover type map for the reference domain.

Generally speaking, current land cover is dominated by urban land uses, including agriculture cropland and pastures (approximately 85 percent). The southern half of the watershed includes part of the Chicago metropolitan area. The majority of the forested areas (approximately 8 percent, including upland and floodplain) are concentrated on the slopes and along the Des Plaines River main stem and tributaries. Grasslands (approximately 2 percent) present in the landscape include fields, rights-of-way and remnant prairies. They are concentrated in the northern half of Lake County and are virtually absent from Cook County. Non-forested wetlands (including marshes, wet meadows, and bogs) have declined dramatically only accounting for approximately 3.5 percent of the landscape. Remaining wetlands are concentrated along the Des Plaines River and scattered throughout Lake County, particularly west of the river. Open water accounts for the remaining 1.5 percent and occur in the lakes of the watershed.

Community Characterizations

Prairie Community Characterization

By definition, the prairie community in the Upper Des Plaines watershed can be characterized as grasslands that have developed on flat lands in areas commonly subjected to long periods without rainfall (Figure 26).

Figure 26. Classic example of the prairie community in the Upper Des Plaines Watershed (photo taken at the Zoo Area in August 2002).

The drought periods may be regular seasonal occurrences, or they may occur only in some years, like those in the Midwest. Short-grass prairies found in the West have less than 20 inches of precipitation a year. With increasing precipitation, the grasses and other plants grow taller. From central Nebraska east, tall grass prairies dominate the landscape (Sullivan 2001). In the presence of fire, prairie communities thrive, however, in its absence, prairies are invaded by trees and shrubs, which kill prairie plants with shade. Another ecological concern is the loss of habitat to cropland or urban lands, resulting in tall grass prairies surviving as small, scattered fragments. Exotic species invasion is a third ecological problem. Native plant seeds are not able to reach and spread to new ground as fast as imported exotic plant species. The most common exotic species in Illinois prairies are Hungarian brome grass (*Bromus inermis*) and Queen Anne's lace (*Daucus carota*) (Sullivan 2001).

Approximately 350 plant species grow on the prairies of Illinois, Indiana, and Wisconsin (Sullivan 2001). These plants grow in communities, each having their own unique mix of species. The two most important factors for determining communities are soil texture and soil moisture. Prairies on wet soils can contain plants commonly found in wetland communities such as sedge meadows and fens. Prairies on sandy soils often contain plants common in the drier lands to the west. Four classes of prairies are recognized in Illinois: Tall grass prairies; Sand prairies along Lake Michigan; Gravel hill prairies (including loess and glacial drift) on top of kames; and Shrub prairies (IDNR 1998c). The primary prairie community of concern for this modeling effort is the tall grass prairie community. Covertypes were determined based on soil moisture regime (dry, mesic and wet) (Sullivan 2001, IDNR 1998c) (Table 2).

Table 2. Prairie communities modeled under this effort.

Prairie Communities Soil Texture Class	Soil Moisture Subclass	Dominant Species	Cover Type Code
Tall Grass Prairies (fine textured soils)	Dry	*Andropogon scoparius* *Carex bicknellii* *Stipa spartea*	PRAIRIEDRY NEWPRARDRY
	Mesic	*Andropogon gerardi* *Sorghastrum nutnas* *Sporobolus heterolepis*	
	Wet	*Calamagrosits canadensis* *Carex pellita* *Carex sartwellii* *Spartina pectinata*	PRAIRIEWET NEWPRARWET

Savanna Community Characterization

By definition, savannas in the watershed are described as wooded communities with graminoid groundcover. Savanna trees have broad crowns - an indication that they grew in locations where they had enough space to expand. Savannas often have soils that are transitional between forest and prairie. These communities can be characterized as forested communities with average tree canopy cover ranging from 10 to 50 percent (Chicago Region Biodiversity Council 1999) (Figure 27).

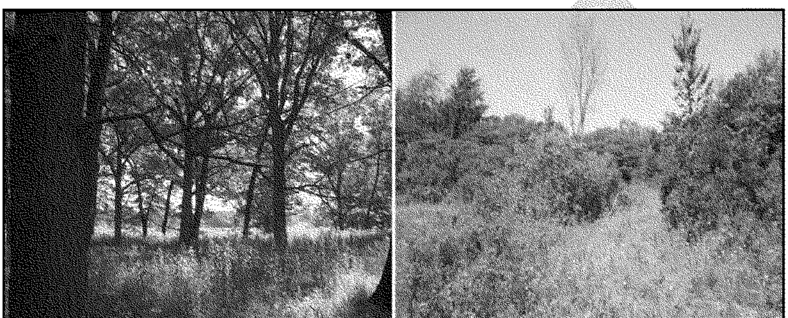

Figure 27. Classic examples of the savanna community in the Upper Des Plaines Watershed (photos taken in Wadsworth Savanna area in August 2002).

Soil texture and soil moisture serve as characteristics that determine classes and subclasses of savannas according to Chicago Region Biodiversity Council's classification system (1999). The primary savanna communities of concern for this modeling effort were those communities occupying fine-textured soil found on till plains and lowlands. Covertypes were determined based on soil moisture regime (dry-mesic, mesic, and wet-mesic) (Table 3).

Table 3. Savanna communities modeled under this effort.

Savanna Communities	Soil Texture Class	Soil Moisture Subclass	Dominant Species	Cover Type Code
Savannas	Fine-textured soils	Dry-Mesic	Quercus macrocarpa Quercus velutina Juglans nigra Quercus alba Quercus coccinea	NEWSAVDRY SAVANNADRY
		Mesic	Quercus macrocarpa Quercus velutina Quercus alba	
		Wet-Mesic	Quercus macrocarpa Quercus bicolor Quercus coccinea	NEWSAVWET SAVANNAWET

According to the Chicago Region Biodiversity Council (1999), the dry-mesic communities have soil moisture levels analogous to dry-mesic upland forest. Mesic savannas are often found at the base of morainal ridges and are commonly dominated by bur oaks (*Quercus macrocarpa*). Wet-mesic savannas can have standing water present in spring and early summer, but by autumn, the ground is dry enough to allow a fire to burn through the groves. These wetter communities are often associated with northern flatwoods.

Woodlands Community Characterization

For the purpose of this modeling effort, "woodlands" refer to all forested communities dominated by trees with an average canopy cover greater than 50 percent.[1] These communities are predominantly associated with loamy/gravel soils (Chicago Region Biodiversity Council 1999).[2] These areas typically have multi-layered structure with canopy, sub-canopy, shrub, and herbaceous layers (Chicago Region Biodiversity Council 1999). They are shaped by the frequency and duration of flooding, nutrient and

[1] Developers Note: Originally, the E-Team intended to develop a separate "flatwoods" model to capture the unique character of these vegetative stands. However the results of the sampling effort, the cover type mapping effort, and the vegetative characterization protocol described in the Chicago Region Biodiversity Council's report led the team to combine both the floodplain and flatwood stands into a single "woodlands" community model.

[2] Flatwoods are unique in that they are a product of specialized soil conditions (permeable/slowly permeable soils) that are influenced by groundwater at or near the surface on level or nearly level topography.

sediment deposition, and the permeability of the soil (Chicago Region Biodiversity Council 1999) (Figure 28).

Figure 28. Classic examples of the woodland community in the Upper Des Plaines Watershed. From left to right, examples of upland forest, dry woodlands, floodplain forests and flatwoods (photos taken between 2002 and 2003).

Three major characteristics are used to classify the primary woodland communities of concern for this modeling effort: density of canopy cover, topography and/or flooding preference, and wetness (or soil moisture). Covertypes were determined based on the combination of these three characteristics (Table 4).

Table 4. Woodland communities modeled under this effort.

Canopy Cover	Topography/ Flooding	Soil Moisture Subclass	Dominant Species	Cover Type Code
Forests (80-100%)	Microtopographic Variation Present but Regular Flooding Absent	Wet-Mesic	*Acer saccharum* *Quercus rubra* *Juglans nigra* *Ulmus americana*	FORUPLWET NEWFORUWET
	Microtopographic Variation Present and Regular Flooding Present	Wet-Mesic	(No clear dominants) Characteristic species include: *Acer nugundo* *Acer saccharinum* *Celtis occindentalis* *Juglans nigra* *Ulmus americana* *Ulmus rubra*	FORFLPLWET NEWFORFWET
		Wet	*Acer saccharinum* *Populus deltoides* *Salix nigra*	
Flatwoods (50-80%)	Level/Nearly Level Impermeable/Slowly Permeable Soils	NA	*Quercus bicolor* *Ulmus americana* *Fraxinus nigra*	FORNFLATS NEWFORFLAT
Woodlands (50-80%)	Situated on Well Drained Soils and/or the Tops of South-facing slopes of Moraines	Dry-Mesic	*Quercus alba* *Quercus rubra* *Quercus macrocarpa* *Fraxinus americana*	NEWWOODLND WOODLNDDRY
		Mesic	*Quercus alba* *Quercus rubra* *Acer nigrum*	
		Wet-Mesic	*Quercus bicolor* *Salix nigra* *Fraxinus pennsylvanica* *Quercus macrocarpa* *Quercus coccinea*	FORUPLWET NEWFORUWET

Basic Model Components

A generic modeling approach was used to capture the functionality of the three communities of concern. In essence the E-Team chose to focus on targeting four primary modeling components, namely:

1. Hydrology,
2. Spatial Integrity,
3. Structure, and
4. Biotic Integrity.

The following sections describe the underlying principles governing the selection of these critical functional components and provide customized flow-diagrams to indicate how they were combined to develop a HEP-compatible index model for the application.

Functional Component #1: Hydrology (WATER)

Ecosystems possess natural hydrologic patterns that provide water for organisms and physical structure for wildlife habitats. This hydrologic regime serves as the vehicle for transfer of abiotic and biotic materials through the system. Water is essential as sustenance for organisms, and is a driving force for physical changes to the environment (USEPA 1999). It serves to transport energy, nutrients and species themselves. The watershed's communities are heavily influenced by pulses of water infiltrating their boundaries throughout the year. As such, the degree of pulsing or "wetness" and the adjacent land use conditions were thought to dictate the ecosystem's ability to support terrestrial and aquatic inhabitants as well as support the diverse plant communities indicative of health in the region (Figure 29).

Figure 29. Hydrology dictates the functionality of the three communities. From left to right, examples of wet prairie, wet savanna, and floodplain forest (photos taken between 2002 and 2003).

Functional Component #2: Spatial Integrity (LANDSCAPE)

At the landscape level, natural ecosystems have a characteristic pattern and connectivity of habitat patches. The number of and the juxtaposition of these patches supports the movement of species and the transfer of materials (energy and nutrients) among habitats (USEPA 1999). Forest, prairie and savanna ecosystems all have characteristic patterns of habitat patches, and at a larger landscape level, these patterns can be viewed as a mosaic of interrelated and connected ecosystems. To adequately characterize ecosystem functions, one must capture both the system's "place" in the landscape, as well as identify key corridors and the processes that "shape" the system (i.e., habitat fragmentation) (Figure 30).

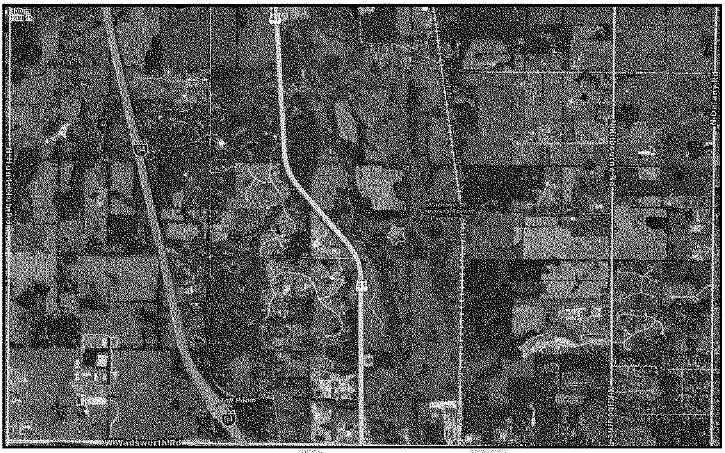

Figure 30. Fragmentation and urban encroachment are common problems for the remnant communities situated along the Upper Des Plaines and its tributaries (Wadsworth Prairie in Illinois – photo taken from Mapquest).

Therefore, landscape-level characteristics (i.e., patch size, core size, edge size, and distribution as well as the levels of disturbance immediately adjacent to the systems) were thought to dictate whether flora and fauna find the ecosystem serviceable. In general, high levels of disturbance perturb sensitive species and reduce the system's ecological integrity.

Functional Component #3: Structure (STRUCT)

Ecosystems possess a natural complexity of physical features that provide a greater variety of niches and more intricate interactions among species (USEPA 1999). Local structural complexity increases with more snags in forests, more woody debris in streams, and more layers and perches in the ecosystems. The communities' physical characteristics and structures within the system dictate the habitat suitability of a system to support animal populations and guilds as well. The emphasis of the model was to capture the system's ability to provide physical space for its numerous terrestrial and aquatic inhabitants to meet key life requisite requirements (e.g., breeding, feeding and cover) (Figure 31).

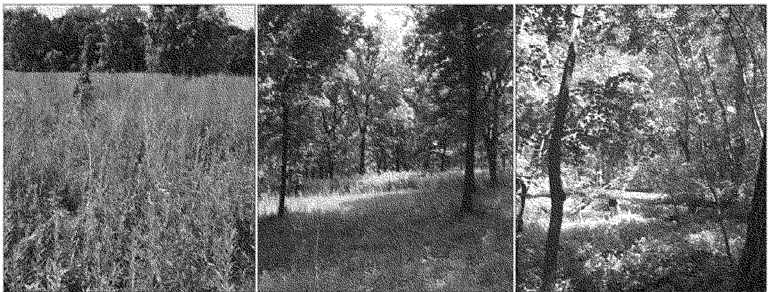

Figure 31. Structural complexity offers niche diversification to resident wildlife in the Upper Des Plaines communities. From left to right, examples of prairie, savanna, and woodlands (photos taken between 2002 and 2003).

Functional Component #4: Biotic Integrity (DIVERS)

The antagonistic and symbiotic interactions among organisms are some of the most important factors influencing the structure of natural ecosystems. Because these interactions have evolved over long periods of time, the deletion of species from or the addition of species to an ecosystem can dramatically alter its composition, structure and function. Biotic interactions are particularly important in maintaining community structure and ecosystem functions, and are described as "keystone" interactions in the literature (USEPA 1999). Interactions between organisms are a major determinant of the distribution and abundance of species in a community. In the case of the current assessment, the vegetative species compositions of living plant biomass within the communities dictated the ecological integrity of the ecosystems and suggest whether the communities could support animal populations and guilds. The emphasis of the models was therefore placed upon the dynamics of the plant community as revealed by the vegetative diversity and community structure of the habitats (Figure 32).

Figure 32. Biotic diversity offers numerous benefits to resident wildlife in the communities of the Upper Des Plaines watershed. From left to right, examples of prairie, savanna, and woodlands (photos taken between 2002 and 2003).

Model Flow Diagrams

Flow diagrams best illustrate each model's final design that culminated from the workshop and initial application efforts (Figure 33).

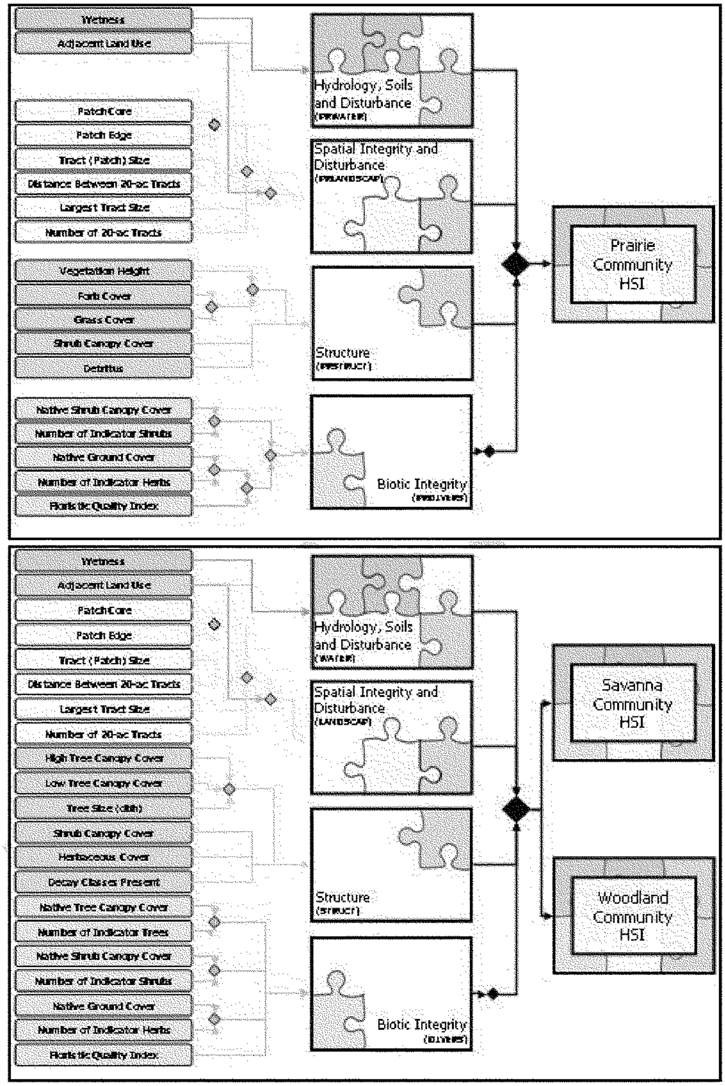

Figure 33. Flow diagrams depicting combinations of model components and variables to form the community index models for the reference domain (Upper Des Plaines Watershed). From top to bottom the Prairie, Savanna and Woodland models are depicted. Note that the Savanna and Woodland models are identical in relationships and differ only in calibration of the individual variables. Also note that the differences between prairie and the forested models hinge on the characterization of the Structure and Biotic Integrity Components.

Variables in these models were selected as indicators of ecosystem functionality, and have been color coded in the figure to correlate their use in specific model components (i.e., purple = hydrologic parameters, orange = soil characteristics, etc.). Thus, the E-Team opted to combine the model components described above (i.e., ***Hydrology***, ***Spatial Integrity***, ***Structure***, and ***Biotic Integrity***) in a meaningful manner mathematically to characterize the existing conditions found in the watershed, and to capture the effects of change under proposed design scenarios (refer to the section below). The rationale for including variables in these models is presented in greater detail in Chapter 5.

Model Formulas

After successfully diagramming the relationships between model components and the variables therein, the E-Team was asked to use their extensive natural resources expertise to translate these flow diagrams into mathematical algorithms that would capture the functional capacity of each community in a quantifiable manner. It is important to note that this process was iterative and adaptive. Over the course of several years, the E-Team tested both the accuracy of the models to predict the suitability of known reference-based conditions as well as test their utility in distinguishing amongst proposed restoration initiatives (contact the District POC, Brook Herman, for details regarding ongoing applications using these models on the Des Plaines River). Table 5 and Table 6 contain the final model algorithms for the three communities (i.e., Prairies, Savannas, and Woodlands).

Table 5. Index formulas for the Des Plaines prairie community index model.

Model Component	Variable Code	CT Code	Formulas
PRDIVERS	INDEXFQI	NEWPRARDRY NEWPRARWET PRAIRIEDRY PRAIRIEWET	$\dfrac{2 \times \left(\dfrac{V_{INDEXFQI} + \sqrt{V_{NUMINDGRND} \times V_{CANATGRND}}}{2}\right) + \sqrt{V_{NUMINDSHRB} \times V_{CANATSHRUB}}}{3}$
	NUMINDGRND		
	CANATGRND		
	NUMINDSHRB		
	CANATSHRUB		
PRSTRUCT	HTVEG		$\dfrac{\sqrt{V_{HTVEG} \times \left(\dfrac{V_{CANFORBS} + V_{CANGRASS}}{2}\right)} + V_{CANSHRUB} + V_{DETRITUS}}{3}$
	CANFORBS		
	CANGRASS		
	CANSHRUB		
	DETRITUS		
PRWATER	WETNESS		$\sqrt{V_{WETNESS} \times V_{TYPADJLAND}}$
	TYPADJLAND		
PRLANDSCAP	AREACORE		$\left[\dfrac{\dfrac{\sqrt{V_{AREACORE} \times V_{AREAEDGE}} + V_{SIZETRACT}}{2} + \dfrac{V_{DIST20TRAC} + V_{SIZELGTRAC} + V_{NUM20TRAC}}{3}}{2}\right] \times V_{TYPADJLAND}$
	AREAEDGE		
	SIZETRACT		
	DIST20TRAC		
	SIZELGTRAC		
	NUM20TRAC		
	TYPADJLAND		
Overall Habitat Suitability Index (HSI):			$\dfrac{2 \times \left(LRSI_{PRDIVERS}\right) + LRSI_{PRSTRUCT} + LRSI_{PRWATER} + LRSI_{PRLANDSCAP}}{5}$

Table 6. Index formulas for the Des Plaines savanna and woodland community index models

Model Component	Variable Code	CT Code	Formulas
DIVERS	NUMINDTREE CANATREE CANATSHRUB NUMINDSHRB NUMINDGRND CANATGRND INDEXFQI	NEWSAVDRY NEWSAVWET SAVANNADRY SAVANNAWET	$\frac{\sqrt{V_{NUMINDTREE} \times V_{CANATREE}} + \sqrt{V_{NUMINDSHRB} \times V_{CANATSHRUB}} + \sqrt{V_{NUMINDGRND} \times V_{CANATGRND}} + V_{INDEXFQI}}{4}$
STRUCT	CANHITREE CANLOWTREE DBHTREE CANSHRUB CANHERB NUMDECAY		$\frac{\left(\frac{V_{CANHITREE} + V_{CANLOWTREE} + V_{DBHTREE}}{3}\right) + V_{CANSHRUB} + V_{CANHERB} + V_{NUMDECAY}}{4}$
WATER	WETNESS TYPADJLAND		$\sqrt{V_{WETNESS} \times V_{TYPADJLAND}}$
LANDSCAP	AREACORE AREAEDGE SIZETRACT DIST20TRAC SIZELGTRAC NUM20TRAC TYPADJLAND		$\left[\frac{\frac{\sqrt{V_{AREACORE} \times V_{AREAEDGE}} + V_{SIZETRACT}}{2} + \frac{V_{DIST20TRAC} + V_{SIZELGTRAC} + V_{NUM20TRAC}}{3}}{2}\right] \times V_{TYPADJLAND}$
Overall Habitat Suitability Index (HSI):			$\frac{2 \times \left(LRSI_{DIVERS}\right) + LRSI_{STRUCT} + LRSI_{WATER} + LRSI_{LANDSCAP}}{5}$

It is important to note that the community-based models developed herein do not subscribe to the "limiting-factor" species-based modeling paradigm of the past, but rather attempt to capture each community's integrity based on a series of component indicators (i.e., ***Hydrology***, ***Spatial Integrity***, ***Structure***, and ***Biotic Integrity***) that together characterize the functioning of the system. This new function-based approach does not rely on a geometric mean, but rather takes into account the compensatory nature of the system's components. In other words, a degraded woodland might be considered "unsuitable" for a given species, but could potentially have value for others, and therefore would still be considered "functional" (although minimally so). Thus, the hydrological connection to a woodland could be altered (possibly through channelization or tiling), and would therefore score very low (<0.2) on the Hydrology Component of the model, yet still retain some functionality – it could might still provide structure or niches for disturbance-tolerant species. This approach is not new, but is a common strategy for habitat suitability modeling in the scientific literature of late (Brook and Bowman 2006 and references therein, Schluter et al. 2006; Store and Jokimaki 2003; Store and Kangas 2001; Ruger et al. 2005).

4 Sampling and HSI Model Calibration Protocols

This chapter describes the variables employed within the three community index models (i.e., prairie, savanna and woodlands). In an effort to support the future use of these models, we have included detailed sampling protocols, as well as rationale for the incorporation of each variable into the models, and offer scientific literature to support their inclusion therein. In order to use these parameters within a traditional HEP context, each variable must be normalized or scaled on a 0 to 1 range. Here we describe the normalization process in some detail, and have also included *Appendix G* at the end of this report to fully document the final index curves.

HSI Model Variables Selection Rationale

As mentioned previously, ERDC-EL used a systematic, scientifically-based, statistical protocol to develop and calibrate the community models for the study using an iterative approach that involved the selection of reference sites from across the watershed and a sampling scheme that obtained numbers to assure model precision. Below, the variables associated with the community models (and justifications for their inclusion in the models) have been provided in tabular format (Table 7).

Table 7. Variables and rationales for association in the Upper Des Plaines Watershed community index models.

Code	Variable Description	Definition and Rationale
AREACORE	Percent of the Area That is Core	A tract or patch (synonymous for purposes of this report) of community habitat can be divided into a center "core" area and an outer "edge" area. For this study, the edge area was defined as a 100-m band inside the perimeter of the community patch based upon a Tech Note developed for the Ecosystem Management and Restoration Research Program by Fischer and Fischenich (2000). The community core is defined as the area within the outer ring or band of edge area. The core represents the area with lower probability of being impacted by surrounding disturbed habitats or anthropogenic affects of urban encroachment. AREACORE is the percent of the total patch area that is core. Fragmentation of remnant habitats is of key concern in the Upper Des Plaines Watershed. Simple geometry dictates that small fragments have more edge in relation to their area than large fragments, and that the less like a circle the fragment is the greater is its perimeter. The consequences of decreased core and increased edge include: (1) the change in physical conditions (organisms near the edge are subjected to more wind, less moisture, and greater temperature extremes) and (2) invasion by species from the surrounding habitat (e.g., competitors such as weeks and predators) (USEPA 1999). Population declines of interior-dependant species (e.g., migratory songbirds) have been attributed to loss of core area and increases in edge (Wilcove et al. 1986; Paton 1994). This variable has been included to quantify the existing size of core in the ecosystems, and direct future design of habitats to meet a minimum core size to support interior-dependant species needs.
AREAEDGE	Percent of the Area That is Edge	A tract or patch (synonymous for purposes of this report) of community habitat can be divided into a center "core" area and an outer "edge" area. For this study, the edge area was defined as a 100-m band inside the perimeter of the community patch and represents the area most likely impacted by surrounding disturbed habitats or anthropogenic affects of urban encroachment (refer to AREACORE for Fischer and Fischenich 2000 citation). Smaller patches have a greater percent edge than larger patches. Edges are artifacts of man-modified landscapes which are permanent, yet dynamic, and are highly associated with the universal impacts of urbanization in forested and grassland regions (Ranney, Bruner and Levenson 1981). It has been conclusively shown that there is a selective effect on tree composition and forest island dynamics when edges are created (Ranney, Bruner and Levenson 1981). Edges have high cover densities (Schreiber et al. 1976, Johnson et al. 1979) and represent convergence of contrasting habitats (Odum 1959; States 1976). A higher percent of edge area is a good indicator that increased habitat fragmentation has occurred leaving smaller isolated biogeographical "islands" (refer to rationale provided in AREACORE above). As these islands become smaller, edges species replace interior species and den them potential sites for establishment which can lead to extirpation of interior-dependent species. The creation of edges will lead to a regression from mature, mesic conditions to dryer, pioneer conditions in the interior (Ranney, Bruner and Levenson 1981). Forest edges generate microclimatic gradients which result in a physical environment that differs from both open fields and interior forests. As such, many species of wildlife are attracted to edges where two or more of these habitats adjoin (Herkert et al. 1997). Edge is a line value, but must be visualized as a condition (i.e., edge is a zone) (Giles 1978). This variable has been included to quantify the amount of edge in relation to the site's size, and will capture the benefits of having some edge, but it has also been included to quantify the negative effects of urbanization and habitat fragmentation in the DPII ecosystems today. This variable can also be used to direct future design of habitats just as AREACORE will be used in the scenarios outlined above.

(Continued)

Table 7. (Continued).

Code	Variable Description	Definition and Rationale
CANATGRND	Percent of the Ground Vegetation Canopy Cover Comprised of Native Species	The percent of the ground vegetation cover that is comprised of native species is an indicator of the species composition and diversity of the community. Ecosystems in the reference domain are known to harbor rare species and assemblages of concern. Reference conditions (i.e., pristine, undisturbed areas) are likely to have conservative plants (i.e., plants with high mean C values) (Matthews et al., 2005; Swink and Wilhelm 1979, 1994). As such, we can assume that the presence of diverse vegetation (particularly native species endemic to the region) indicates a high level of wetland functionality. Extracted from the FQI analysis completed at each site, this variable was included to capture the "nativeness" of the ground cover at each site - serving as a de facto indicator of ecosystem function and health.
CANATSHRUB	Percent of the Shrub Canopy Cover Comprised of Native Species	The percent of the shrub cover that is comprised of native species is an indicator of the species composition and diversity of the community. Just as CANATGRND captures "nativeness" of herbaceous ground cover, this variable captures "nativeness" of the shrub covers at each site - serving as a de facto indicator of ecosystem function and health. The assumption is the same. The presence of diverse vegetation (particularly native species endemic to the region) indicates a high level of wetland functionality. This variable was derived from the FQI analysis and was included to capture the "nativeness" of the ground cover at each site - serving as a de facto indicator of ecosystem function and health.
CANATREE	Percent of the Tree Canopy Cover Comprised of Native Species	The percent of the tree cover that is comprised of native species is an indicator of the species composition and diversity of the community. Just as CANATGRND and CANATSHRUB captures "nativeness" of herbaceous ground covers, this variable captures "nativeness" of the tree canopy cover at each site - serving as a de facto indicator of ecosystem function and health. The assumption is the same. The presence of diverse vegetation (particularly native species endemic to the region) indicates a high level of wetland functionality. This variable was derived from the FQI analysis and was included to capture the "nativeness" of the ground cover at each site - serving as a de facto indicator of ecosystem function and health.
CANFORBS	Percent Forb Canopy Cover	This variable characterizes the percentage of the herbaceous vegetation cover that is comprised of forb (native flowering herbaceous plants) species as part of the community's herbaceous composition and structure. High-quality communities are characterized as multi-layered herbaceous ecosystems comprised primarily of grass and forbs plant species. Many grassland bird species prefer areas containing low to moderate forb cover that provides essential habitat components including perches for songbirds and above-ground nesting substrates for many species (Kahl, R.B et al. 1985). In other words, a community dominated by forbs does not provide an optimum setting. Therefore, this variable was included as a limiting factor – indicating a certain desirable level of heterogeneity in the herbaceous cover (i.e., a balance of both forbs and grasses in the community is optimum).
CANGRASS	Percent Grass Canopy Cover (Graminoid)	This variable characterizes the percentage of the herbaceous vegetation cover that is comprised of grass (graminoid) species, including sedges and rushes, as part of the community's herbaceous composition and structure. Just as CANFORBS was added to the model to capture the heterogeneity of the site, optimum conditions suggest a balance of both forbs and grasses is preferable for the community ecosystems in the area. This variable was included to characterize the existing percentage of the herbaceous vegetation cover that is comprised of grass in a community setting. Grassland birds have a varying preference for nesting habitat requirements. However, there is a suite of grassland birds including the eastern meadowlark, that prefer nesting territories characterized by predominantly grass cover with some presence of forb cover, and relatively little to no bare ground (Swanson 1996).
		(Continued)

Table 7. (Continued).

Code	Variable Description	Definition and Rationale
CANHERB	Percent Herbaceous Canopy Cover	This variable characterizes the percentage of the vegetation cover that is comprised of herbaceous species as part of the community's species composition and structure. Herbaceous canopy cover is an important determinant of infiltration rate and interrill erosion (Thurow et al. 1986, 1988). Changes in plant community composition and the distribution of species can influence (positively or negatively) the ability of a site to capture and store precipitation (Pellant et al 2000). The amount and distribution of vegetative cover is one of the most important contributors to site stability relative to the site potential; therefore, it is a direct indication of site susceptibility to accelerated wind or water erosion (Smith and Wischmeier 1962, Morgan 1986, Benkobi et al. 1993, Blackburn et al. 1994, Pierson et al. 1994, Gutierrez and Hernandez 1996, Cerda 1999). Each species is adapted to a range of intensity and duration of sunlight. Many of the native species of the region are adapted to the full sunlight of savannas or the scattered shade of open woodlands (Chicago Region Biodiversity Council 1999). Others are adapted to the heavier shade of closed forests. These various patterns of sunlight were maintained primarily by the forces of climate, fire, and browsing. It should be noted that lack of fire in forested and savanna communities can lead to shrub encroachment and tree canopy closure – causing overshading and limiting the growth in the understory and herbaceous layers. The availability of sunlight at various levels within terrestrial communities and in aquatic communities is a powerful factor in their survival and is a key consideration in protection and restoration (Chicago Region Biodiversity Council 1999). This variable has been included in the forest and savanna models as a de facto measure of erosion, light penetration and canopy patchiness – high herbaceous canopy indicates high levels of sunlight penetrating the upper canopies, and little or no tree and shrub canopy in the upper layers. This variable can also be used to capture the positive effects of proposed management designs such as shrub/sapling removal by mechanisms such as controlled burns.
CANHITREE	Percent High Tree Canopy Cover	This variable characterizes the highest layer in the overstory canopy. Trees are defined as 5-cm (2-in) dbh and 5.5-m (18-ft) tall. "High" refers to those trees in the overstory greater than 9.1-m (30-ft) tall. High structural complexity promotes diversity in ecosystems. Species rarely occupy area – they occupy three-dimensional space (Giles 1978). The abundance of vegetative structure greatly influences the abundance and diversity of animals in both wetland and terrestrial ecosystems - complex habitats accommodate more species because they create more ways for species to survive (Norse 1990). Furthermore, studies indicate that physical structure may prevent generalist forages from fully exploiting resources and thus promote the coexistence of more species (Werner 1984). In particular, vertical stratification diversification of forests and savannas produces stratification of light and temperature, as well as providing intricate spaces for shelter and food sources for species. Thus, structural complexity plays a critical role in the presence of microclimate, food abundance, and cover that affect organism fitness (Cody 1985). Three distinct layers can be described in any system: groundcover (refer to CANHERB above), understory (i.e., mid-canopy) and overstory (i.e., upper canopy). The presence of each layer offers a niche for community associations. High levels of overstory canopy cover are likely to reduce sunlight in the layers below – shading out the vegetation beneath, and reducing the niches in the system. This variable was added to characterize the highest layer in the system (i.e., tree canopy cover exceeding 30 feet).

(Continued)

Table 7. (Continued).

Code	Variable Description	Definition and Rationale
CANLOWTREE	Percent Lower Tree Canopy Cover	This variable characterizes the lower layer in the overstory canopy. Trees are defined as 5-cm (2-in) dbh and 5.5-m (18-ft) tall. "Low" refers to those trees in the overstory less than 9.1-m (30-ft) tall. Refer to CANHITREE above for rationale. Again, this variable was added to capture one of the higher layers in the system (i.e., tree canopy cover less than 30 feet in height). This variable was added to capture the successional level of the system (i.e., high levels of low tree canopy indicate high levels of recruitment and indicate a potential for future shading of the layers below).
CANSHRUB	Percent Shrub Canopy Cover	This variable characterizes the percentage of the vegetation cover that is comprised of shrub species as part of the community's species composition and structure. Varying intensities and frequencies of natural fires contributed to the rich mosaic of the landscape. Virtually all of the regional landscape was influenced by fire to some extent and burned at least occasionally (Chicago Region Biodiversity Council 1999). Fire suppression following settlement has greatly reduced the extent of fire-dependent communities and the former rich variety of habitats. Prairies and savannas have mostly disappeared, even from protected areas, while the surviving woodlands tend to be choked with shrubby brush and fire-intolerant trees, both native and exotic. The simplified and homogenized landscape offers little of the complex habitat needed by a wide variety of plants and animals native to the area. In the region's forests, secondary effects from fire suppression and invasion by "weedy" species include shading out of the ground flora and erosion where soil is exposed. In prairie ecosystems, this variable represents the potential succession of prairie to savanna and ultimately forest. Studies of Midwestern prairie sites show a higher rate of nest predation and parasitism affecting birds that were nesting closer to woody vegetation than those birds nesting far from woody vegetation (Herkert, et al. 1993; Johnson and Temple 1990), and thus, a shrubby prairie is likely to have less productivity for grass-based species. This variable has been included as a de facto measure of succession of grasslands to savannas and forests, and will be used to quantify the effects of proposed management strategies that maintain grasslands with techniques such as controlled burning and mowing.
DBHTREE	Average dbh of Trees	The size of trees (in terms of average diameter at breast height (dbh)) is an indicator of the age and structural composition of the community. The age of forests (and savannas) is an important ecological characteristic because the variety of tree heights and the diversity of plant species generally increase with forest age (Gustafson and Crow 1994). This diversity contributes to the quality of forests as habitat for many organisms. Both managed and unmanaged forests consist of a mosaic of patches of various tree species and ages. The size and arrangement of these patches have important ecological effects for both plant communities and wildlife habitat. This variable was included to capture the "age" of the forests and savannas, and to capture proposed designs that alternated plantings of seedlings, saplings and poles.

(Continued)

Table 7. (Continued).

Code	Variable Description	Definition and Rationale
DETRITUS	Percent of the Ground Covered By Detritus in Wet Systems or Litter in Dry Systems (%)	Detritus in wet systems and litter in dry systems contribute to the natural complexity of physical features that provides for a greater variety of niches and more intricate interactions among species, affecting a wide range of ecological processes from predator-prey interactions to energy transfer among ecosystems. The natural process of decomposition is critical ecosystem health and the recycling of nutrients and energy that sustains life. Ecosystems with more three-dimensional structure have more species because they create more ways for species to survive (USEPA 1999). The structural complexity provided by detritus/litter also plays a critical role in the presence of the micro-climate, food abundance, and cover that affect organism fitness (Cody 1985) accommodating more species and more ways for those species to survive (Norse 1990). Soil microbes consume wastes and the remains of dead plants and animals, rendering their potential toxins and human pathogens harmless, while recycling their constituent materials into forms usable by plants (USEPA 1999). As with other processes that characterize ecosystems, the ability to assimilate wastes and provide clean air, water, and soil has evolved to suit the conditions of the environment over time. Natural systems have finite capacities for assimilating wastes and detoxifying contaminants. Excessive inputs of wastes, the removal of critical species, or the alteration of other ecological process (i.e., hydrology) can disrupt the purification process and degrade the ecosystem. Wetlands operate through a series of interdependent physical, chemical, and biological mechanisms that include sedimentation, adsorption, precipitation and dissolution, filtration, biochemical interactions, volatilization and aerosol formation, and infiltration to assimilate and recycle waste materials – this capacity may be exceeded by anthropogenic inputs depending on system-specific conditions (USEPA 1999). Plant rooting patterns, litter production and associated decomposition processes, basal area and spatial distribution can all affect infiltration and/or runoff (Pellant et al 2000). This variable has been added to capture the erosion potential and nutrient recycling capacity of the ecosystems (and their associated soil microbes), and monitor the effects of the proposed designs on the functional capacity of the systems to consume and remove wastes.

(Continued)

Table 7. (Continued).

Code	Variable Description	Definition and Rationale
DIST20TRAC	Average Distance to All 20-acre Tracts of Similar Cover Within 5 Miles of the Tract (m)	This variable characterizes the degree of habitat fragmentation across all of the remaining community within the watershed. Too often, ecologists perceive habitats as lone entities, when in reality they are interacting, functional components of the landscape (Noss 1991). Landscape connectivity, therefore, involves the linkage of habitats, species, communities and ecological processes at multiple spatial and temporal scales (Noss 1991). Many of the most significant human effects on biodiversity involve changes in the connectivity of habitat (Noss 1991). Human activities can reduce connectivity by creating artificial barriers to species dispersal, leading to isolated populations that become vulnerable to extinction due to reduced access to resources, genetic deterioration, increased susceptibility to environmental catastrophes and demographic accidents, and other problems (Harris 1984; Soule 1987). Connectivity of the landscape mosaic is absolutely necessary for species to survive (Noss 1991). Disturbances periodically make portions of the landscape uninhabitable. Corridors fulfill a “fire escape” function b permitting animals to flee disturbance. Corridors also aid in recolonization of the recovering site by plants and animals. Habitat patches that are isolated from similar habitat patches by great distances or inhospitable terrain are likely to have fewer species than less isolated patches because relatively few individuals of a given species will immigrate into the isolated patch, and fewer mobile species will visit isolated patches because it is inefficient to do so (Hunter 1996). The size of habitat patches has important implications for ecological integrity [i.e., system wholeness, including presence of all appropriate elements and occurrence of all processes at appropriate rates (Angermeier and Karr 1994)] (USEPA 1999) (refer to SIZETRACT below for further rationale on specie-area relationships). Small habitat patches (e.g., habitat islands) have fewer species than large patches (Hunter 1996). Studies have clearly demonstrated that larger non-isolated regions have not only more species in total (i.e., higher gamma diversity), but also more species per habitat (higher alpha diversity) than smaller and insular areas (Rosenzweig 1995). This variable has been included to capture not only the connectivity of the habitats in the region, but also to capture a minimum size “islands” in the landscape – indicating species “source” availability. This variable has direct implications on management – designs must be geared to provide 20 acre habitat patches within five-miles of similar habitat to have an effect on ecosystem health.
HTVEG	Average Height of the Herbaceous Vegetation(cm)	The average height (cm) of herbaceous vegetation characterizes the composition and structure of a community patch/tract. Variations in vegetation height support different groups of community birds. Some community birds will use the elevated grass and forb stems of tallgrass prairie as perches and the ground canopy as cover for nesting. Rodents, small birds, reptiles and amphibians also use the tall grasses for cover from birds of prey (Sullivan, J. 2001). A range of short, medium and tall herbaceous vegetation heights is preferable as characteristic prairie bird species prefer different vegetation heights depending on the species (Herkert, J.R. et al. 1993). Swanson's (1996) literature review found that a height of cover at 204 grassland bird nest sites in Illinois averaged 38 cm and ranged from 5-79 cm; with 67 percent of all nests found in cover 25-50 cm tall. This variable was included to capture the relative suitability of the current and proposed grassland habitats to provide suitable perching conditions for bird species.

(Continued)

Table 7. (Continued).

Code	Variable Description	Definition and Rationale
INDEXFQI	Floristic Quality Index (FQI)	The Floristic Quality Index (FQI) is a tool used to provide a numerical value for a natural area evaluation based on plant species present. This variable characterizes the species composition and diversity of the community. For the purposes of this model, adventives are included in the FQI score. Adventive species are species native to North America but growing outside of their natural range due to the human-caused breakdown of natural barriers to dispersal or its escape and survival after being introduced (Delaware Natural Heritage Program 2001). Originally developed by Swink and Wilhelm (1979 and 1994), FQI can replace very subjective measures of quality, such as "high" or "low", with a still somewhat subjective, but more dispassionate, quantitative and uniform set of measures. These measures allow for comparison of the floristic quality among many sites and for tracking changes at the same site over time. The approach assumed that a vast proportion of the modern landscape was severely degraded and fragmented, and as such, the remaining remnants had varying degrees of floristic integrity. The methodology was based upon the assumption that native flora displayed varying degrees of: 1) tolerance to disturbance, and 2) fidelity to specific habitat integrity. Under this approach, the floristic quality of an area was determined based on the presence and proportion of conservative native plant species. The basic tool of the method was a checklist of all the plant species known from the Chicago region. Each native species on the checklist was given a "Coefficient of Conservatism" (C) ranging from zero to ten (Swink and Wilhelm 1979; 1994).
NUM20TRAC	Average Number of 20-Acre Tracts of Similar Cover Within 5 miles of the Tract (m)	The average numbers of similar tracts or patches that are close enough to a given tract or patch of similar cover type provides opportunities for consolidation or connectivity of similar patch types within the watershed. Refer to DIST20TRAC above for rationale. Larger numbers of habitat patches located closer to one another helps to minimize isolation due to adverse impacts and fragmentation (Hunter 1996). Similar to DIST20TRAC, this variable has been included to capture the connectivity and size of the habitats in the region. This variable has direct implications on management - designs must be geared to provide numerous 20 acre habitat patches within five-miles of similar habitat to have an effect on ecosystem health. This variable will also help identify remnant habitat patches suitable for combining into larger areas, providing enhanced functionality for area sensitive species and increased genetic variability, contributing to recovery goals that include restoring ecosystems so that they sustain viable populations of all native area-limited species and formerly common species (Chicago Region Biodiversity Council 1999).
NUMDECAY	Number of Decay Classes Present	The level of decay is an indicator of the age and structural composition of the community. Dead trees are one of the most important contributors to increased structural complexity in forests (Maser et al. 1988). Coarse wood debris creates new microhabitats and influences hydrology and nutrient cycling as well (USEPA 1999). When a tree falls, the canopy is opened and additional light is admitted to the forest floor. The opening creates opportunities for new plants to become established. Fallen trees and branches suspended across other trees create elevated relief and structural complexity. The surface of the forest floor is roughed by fallen tree stems, their tipped rootballs, and the pits left after their uprooting. Fallen trees and branches provide a substantial reservoir of soil organic matter and essential nutrients increasing the chemical diversity of the forest. This variable was added to the models to capture the structural complexity of the forested ecosystems, and can be used as an indicator of forest maturity and biogeochemical processing .

(Continued)

Table 7. (Continued).

Code	Variable Description	Definition and Rationale
NUMINDGRND	Ground Vegetation Diversity - Number of Species with "C" Value >5	Indicator species are those species that offer a signal of the biological condition of an ecosystem. Indicator species within the herbaceous ground cover serve to characterize the species composition and diversity within the community. The assessment of ecosystem integrity based on a single index will be insufficient to account for all relevant aspects (Herman, et al. 2001). The FQI or mean C when reported alone can be misleading (Herman, et al. 2001). Species richness (number of species) by itself can also be an insensitive indicator of habitat quality since it is possible for a degraded site to support a similar or greater umber of taxa than an intact, high quality site. Six measures of biological integrity for wetlands have been suggested by Keddy et al. 1993. These include species diversity, indicator guilds, exotic species, rare species, plant biomass, and amphibian biomass. Keddy et al. (1993) views diversity as an essential indicator of integrity, but also recommends assessing guild diversity. This variable has been included to capture the number of "native" species present at the site in an attempt to capture several of these key measures, namely species diversity (richness and evenness), presence specifically of "indicators," and presence of these species tied to a specific community or guild (namely ground vegetation) - the assumption being that higher numbers of indicator species present signifies ecosystem health and integrity.
NUMINDSHRB	Shrub Vegetation Diversity -Number of Species with "C" Value >5	Indicator species within the shrub cover serve to characterize the species composition and diversity within the community. Refer to NUMINDGRND rationale above. This variable has been included to capture the number of "native" species at the site in an attempt to capture several of these key measures, namely species diversity (richness and evenness), presence specifically of "indicators," and presence of these species tied to a specific community or guild (namely shrubs) - the assumption being that higher numbers of indicator species present signifies ecosystem health and integrity.
NUMINDTREE	Tree Vegetation Diversity - Number of Species with "C" Value >5	Indicator species within the overstory tree canopy cover serve to characterize the species composition and diversity within the community. Rationale for variable selection. Refer to NUMINDGRND rationale above. This variable has been included to capture the number of "native" species at the site in an attempt to capture several of these key measures, namely species diversity (richness and eveness), presence specifically of "indicators," and presence of these species tied to a specific community or guild (namely trees) - the assumption being that higher numbers of indicator species present signifies ecosystem health and integrity.
SIZELGTRAC	Size of the Largest Tract of Similar Cover Within a 5-mile Radius	The largest tract (in acres) of similar cover within a five-mile radius of a given patch or tract characterizes landscape mosaic of community patches within the watershed. Larger tracts/patches of habitat containing larger populations of targeted species have better functionality and suitability than smaller tracts/patches of habitat with small numbers of species (USEPA 1999). Larger patch fragments have a higher core to edge ratio. Some benefits of larger patches are a greater variety of environments, niches and species (Hunter 1996), and the ability to support larger numbers of species that are less susceptible to genetic deterioration and extinction (Harris 1984, Soule 1987). The greater the distance between larger and smaller patches, the more inefficient it becomes for mobile species to visit the smaller patches, affecting the number and diversity of species (Hunter 1996). Viable populations of prairie reptiles and amphibians need at least 200 acres to maintain most of the species. A goal for prairie restoration is to create prairie tracts of 500-1000 acres to ensure breeding populations and give mobile species opportunities to re-colonize nearby functioning prairie patches (Chicago Region Biodiversity Council 1999). This variable has been included to capture the maximum remnant prairies, forests or savannas found in the DPII region today, and to indicate that these large islands are likely to be chopped up into smaller pieces in the future as urban encroachment overcomes relictual settings.

(Continued)

Table 7. (Continued).

Code	Variable Description	Definition and Rationale
SIZETRACT	Tract Size	The size (acres) of a community tract or patch characterizes the landscape mosaic of community patches within the watershed. The size of habitat patches has important implications for ecological integrity (USEPA 1999). Fragmentation of habitats has been implicated in the decline of biological diversity and the ability of ecosystems to recover fro disturbances (Flather et al. 1992). Large patches have more species because they provide a greater number and variety of niches. Large patches are more likely to have both common and rare species, while small patches are more likely to have only common species (i.e., area-sensitive species will be excluded in smaller patches) (Hunter 1996). Small habitat patches (e.g., habitat islands) have fewer species than large patches, and are more susceptible to extinction. Area-sensitive species that cannot maintain populations in limited areas of otherwise high quality habitat will avoid patches purely on the basis of size (USEPA 1999). Species with small home ranges, such as songbirds, may also avoid small fragments if they prefer the interior of large habitat patches (Robbins, et al. 1989) or select patches large enough to support other members of their species (Stamps 1991). This variable was included to characterize both the patch size of the various habitats as well as to capture the future urbanization threat to these ecosystems if preventative measures are not taken in the recommended plans.
TYPADJLAND	Identification of Adjacent Landuse Practices	Lands adjacent to a given community tract/patch are classified according to their predominant landuse including: pristine, uninhabited areas, parks, pasturelands, utility rights-of-way and railroads, dirt and gravel roads/oil and gas fields, agricultural croplands, residential/golf courses , paved roads/highways, and commercial/industrial. Ecosystems do not exist in a steady-state; they are dynamic, each possessing a characteristic composition structure and function that have adapted to natural disturbances over long periods of time. At the landscape level, natural disturbances destroy patches of vegetation and restart plant succession. Human activities (both onsite and offsite) that deviate from these patterns affect individual species (and through biotic interactions many other species and ecological processes) by direct exploitation, habitat elimination, and modification of ecological processes (USEPA 1999). By changing the access of species to their food, shelter, and reproduction, human activities initiate a cascade of biotic interactions that can affect entire ecosystems (USEPA 1999). Impervious surfaces prevent infiltration and direct water away from subsurface pathways to overland flow, increasing the flashiness of streams. Urbanization and suburbanization commonly exceed the threshold of approximately 10 to 20 percent impermeable surface that is known to cause rapid runoff throughout the watershed (Center for Watershed Protection 1994). In heavily urbanized watershed, stream channelization and large amount of impervious surface result in rapid changes in flow, particularly during storm events. These artificially high runoff events increase flood frequency (Beven 1986), cause bank erosion and channel widening (Hammer 1972), and reduce baseflow during dry periods. Agricultural practices also greatly affect hydrologic patterns (USEPA 1999). Clearing forest and prairie environments generally decreases interception of rainfall by natural plant cover and reduces soil infiltration resulting in increased overland flow, channel incision, floodplain isolation, and headward erosion of stream channels (Prestegaard 1988). Draining and channelizing wetlands directs flow more quickly downstream, increasing the size and frequency of floods, and reducing baseflow (USEPA 1999). Such activities can actually increase the magnitude of extreme floods by decreasing upstream storage capacity and accelerating water delivery. Human activities, such as land clearing and erosion, can cause the loss of nutrients (e.g., phosphorus), disrupt natural cycling of nutrients, and limit ecosystem productivity (USEPA 1999). At the same time, agriculture and industry can discharge excessive amounts of nutrients (e.g., nitrogen) into natural ecosystems and drastically change their trophic structure, and degrade water quality. This variable was added to the models to capture the effects of human activities immediately outside of the habitat area, and can be used as an indication of urban pressures on the remaining relictual ecosystems in the future.

(Continued)

Table 7. (Concluded).

Code	Variable Description	Definition and Rationale
WETNESS	Native Mean Wetness With Adventives	This variable is the Coefficient of Wetness, including adventive species, obtained from the results of the FQI analysis for each community site. The Wetness with adventives score is based on the local plant wetness designation (e.g., Obligate, Facultative-wet, Facultative, Facultative-Upland and Upland). The plant wetness designations are from the (Swink and Wilhlem 1994), which primarily use the wetness designations from (Reed 1988), except in a few cases where Swink and Wilhelm assigned a designation if one was lacking in the national list, or they strongly disagreed with the designation given in the national list. Ecosystems possess natural hydrologic patterns that provide water for organisms and physical structure for habitats. Wetlands in particular depend on constant or recurrent shallow inundation or saturation at or near the surface of the substrate (National Research Council 1995). A proper hydrologic regime is necessary to maintain desirable plant communities - prolonged saturation can lead to anaerobic soil conditions and a general decline of these ecosystems (Lin 2006). This variable is used in the model to capture the hydrologic regime of the ecosystem, and can be indicative or a return of hydrology to the site through the breaking of tiles.

A Reference-Based Approach to Model Calibration

Reference sites in this instance refer to multiple sites in a defined geographic area (the reference domain) that have been selected to represent specific types of ecosystems (i.e., prairies, savannas, and woodlands).[1] Reference sites have been most commonly described as natural settings – lacking human disturbances (Hughes 1994, Bailey et al. 2004a, Chessman and Royal 2004, Intergovernmental Task Force on Water Quality Monitoring 2005). Reference-based conditions were therefore expected to exhibit a range of physical, chemical, and biological values. When reference sites have been characterized as undisturbed ecosystems, conditions were expected to emulate the spatial and temporal variability that commonly occur in natural ecosystems (Swanson et al. 1993; Morgan et al. 1994; White and Walker 1997; Landres et al. 1999). When reference sites included altered or disturbed ecosystems (as is the case in most urban-based ecosystem restoration efforts), the reference conditions exhibited a wider range of values that reflect both natural variability and variability due to human activities. In these instances, optimal conditions or "virtual" references have been established using a variety of techniques including literature values, historical data, paleoecological data, and expert opinion [Society for Ecological Restoration International (SERI) 2004; Ecological Restoration Institute 2008]. Regardless of how reference conditions have been established, ecosystem evaluations have used a reference-based approach as a template for model development, planning, and alternative analysis.

Various types of reference-based approaches have been developed for a variety of ecosystems including streams (Barbour et al. 1999, Karr and Chu 1999, Bailey et al. 2004b), large rivers (Angradi 2006, Flotemersch et al. 2006), wetlands (Smith et al. 1995, Brinson and Rheinhardt 1996, Smith 2001, USEPA 2002), grasslands (Prober et al. 2002), forests (Fule et al. 1997, Moore et al. 1999, Tinker et al. 2003, Ecological Restoration Institute 2008), tidal marshes/estuaries (Findlay et al. 2002, Merkey

[1] The information herein was taken from a workshop held at ERDC-EL in the summer of 2008 under the Ecosystem Management and Restoration Research Program's Environmental Benefits Analysis initiative. In that workshop, a draft manuscript was circulated to the participants for review and comment. Here we provide excerpts from that paper, and inject local knowledge of the watershed's reference conditions where relevant.

2003), and coral reefs (Jameson 1998). Reference-based approaches have also been used to evaluate ecosystems in a landscape or watershed context (Warne et al. 2000, Andreasen et al. 2001, Reindardt et al. 2007, Wardrop et al. 2007, Whigham et al. 2007, Smith 2008).

Reference Site Selection Strategy

Choosing the relevant reference conditions in a region is a matter of judgment (Andreasen et al. 2001). In some instances, the natural state might be reconstructed from historic records or based on scientific knowledge such as reconstruction of potential vegetation. ERDC-EL assisted the District in locating a series of sample sites across the entire study area that were considered both reference standard (optimal) or degraded (sub-optimal) that represented the range of conditions existing within the reference domain.

Early in the process ERDC discussed the selection of reference sites with the District for the community models. Here we synopsize the directives given to the District:

A. Definitions

1) ***Reference*** sites serve several purposes in HEP. First, they function as the physical representation of the communities from the region that can be observed and measured repeatedly. Second, they make it possible to establish the range of variability exhibited by the measures of the model variables, which make it possible for calibration of variables and indices. Third, they serve as a template for restoration by providing design specifications.

2) ***Reference standard*** areas are those optimum conditions in the region that are then used to establish the highest standard of comparison for calibrating assessment model variables and indices. In HEP, the least altered areas in the least altered landscapes are selected as *reference standard* wetlands. This is based on the assumption that these areas sustain the highest level of function across the suite of habitats within the community that are inherent to the system.

B. General Selection Strategy

1) ***Conduct field reconnaissance*** to screen potential candidate reference sites. The objective is to identify sites that represent the range of conditions that exist in the reference area from highly altered sites in highly altered landscapes to unaltered (pristine) sites in unaltered landscapes.

2) ***Determine the number*** of reference sites to be included. A variety of factors influence the number of reference sites to be included in the process. Large projects will require more reference sites. Reference areas with a wide variety of alteration scenarios will require more sites. Detail of resolution to detect the types of impacts that typically affect riparian areas in the region is another factor. Lastly, the ideal number of sites dictated by the foregoing considerations must be balanced against the realities of budgets, time and personnel.

C. Criteria for Defining Reference Conditions

1) Must be politically palatable and reasonable;

2) Must include a large number of sites from the region;

3) Must represent important aspects of pre-historical conditions;

4) May use minimal disturbance as the surrogate for pre-historical conditions, given the difficulty of establishing pre-historical conditions;

5) Must be uniform across political boundaries and bureaucracies (e.g., Federal, State, and local); and

6) When the areas have experienced extensive alteration, it may be possible to reconstruct a reference standard area using historical accounts and photography.

Desired Reference Standard Conditions

Reference site characterization and model calibration for this study included gathering data on water quality, hydrology, substrate conditions, flora, and fauna, and to the greatest extent possible, identifications of underlying stressors in the region. In particular, land-use activities, physical habitat alterations, and native species were identified. In addition to the physical and chemical characteristics of the study area, land ownership and regulatory jurisdictions played an important role in determining impacts/mitigation and opportunities for restoration. Some of this information was geographically-based and was assessed using documented protocols in an ArcGIS environment. Based on this inventory and reconnaissance effort (completed by the District in early 2002), the reference standard conditions for the Des Plaines communities were characterized in the following manner:

Hydrology – Hydrological characteristics (pulse conditions and patterns) were not altered by human disturbances that caused changes in hydroregime (flood frequency, duration, or magnitude) or sediment transport. Flood pulsing and overland flow mimicked the climatic/natural regime. Vegetation was present to resist flow downstream, and together with topographic relief and subsurface water flow, they promoted surface water storage. The flood prone area was undisturbed by humans. Surface hydraulic connections existed between the bankfull channel and the flood prone area. Surface water ponded for more than one day in these areas. The depth of saturated sediment was near the surface of the wetlands. Groundwater and the managed water supply was appropriate to establish and maintain a diverse cover type.

Biogeochemical - A range of vegetation types and sediment combined with suitable topographic relief to support detention of particulates. Sufficient water flow through the riparian zone (surface and subsurface) was evident as well as substrates with enough silt to adsorb elements, promote propagule recruitment, and supply organic materials. In addition, presence of organic mater indicated nutrient cycling occurring within the ecosystems.

Spatial Configuration – Spatially-explicit landscape characteristics within the ecosystems associated with patch geometry and distribution were optimized. Landscape simplification was absent – a mosaic or heterogeneic suite of habitat types was present sufficient in both size and numbers to promote both core area stability and edge diffusion (a blurring of the edge contrast). Habitat connectivity was evident and supported the persistence of both plant and animal populations. Distances between high quality patches was minimized, and a mixture of age classes were present within a reasonable distance of one another to promote niche diversification and offer escape routes during stochastic disturbances. Land adjacent to the reference areas was undeveloped and unperturbed by human disturbances such as agricultural activities.

Biotic Integrity and Structure - An abundance of native trees, shrubs, and herbaceous vegetation was readily apparent. Invasive plant species were absent. Guild representatives (i.e., indicators) included a wide variety of growth forms (trees, shrubs, vines, grasses, forbs, algae, and lichens). Plant vertical configuration and foliage profile (canopy cover) presented a variety of vertical layers. Vegetation provided vertical and horizontal connectivity the length of the system. All age classes of trees (seedlings, saplings, and trees) were represented in the woodland and savanna communities. Biotic legacies from preceding communities, propagules from adjacent stands, ecosystem structuring processes and the generation of spatial heterogeneic complexes combined to produce both overall compositional diversity and patch diversity (habitat breadth).

Reference Site Selection

Once the inventory and reconnaissance was completed, the E-Team used the strategy outlined above to filter and screen the potential sites down to a manageable number. To assure adequate sampling size, the District was asked to locate at least three sites per cover type spanning the range of reference conditions and representing the relative variation found across the system (described earlier in the reference-based section above). Again, an attempt was made to evenly distribute these sites across the entire watershed. To reduce data collection variability, a single three-person sampling team (a recorder and two data collectors) was used to collect all field data. To the greatest extent possible, underlying stressors in the region were described in the notes section of the field data collection sheets. In particular, land-use activities, physical habitat alterations, and indicator species were described in detail. Their goal was to identify, prioritize, and then select sites across the study area that were considered either "high (H)," "medium (M)," or "low quality (L)" based on expert opinion (Table 8).

Table 8. DPII Reference Sites.

County	Site #	Site Name	Site Quality	County	Site #	Site Name	Site Quality
Dry and Mesic Fine-textured-soil Prairies (PRAIRIEDRY)				Wet Fine-textured-soil Prairies (PRAIRIEWET)			
Cook	1	Camp Pine	H	Cook	3	Oakton College	H
Cook	95	Port Wine	H	Cook	9	Zoo Area	H
Cook	4	River Trail	H	Kenosha	34	Bain Station RR Prairie	H
Lake	44	Old School	H	Lake	50	Van Patton Woods	H
Lake	51	Wadsworth Savanna	H	Lake	51	Wadsworth Savanna	H
Lake	68	Independence Grove	M	Cook	95	Port Wine	M
Lake	54	Wright Woods	M	Lake	96	Newport Township	M
Kenosha	101	Site #11	L	Lake	54	Wright Woods	M
Lake	35	Almond Marsh	L	Kenosha	32	Kilbourn Road Ditch	L
Lake	96	Newport Township	L	Kenosha	24	Merkt's Woods	L
Lake	47	Ryerson	L	Kenosha	101	Site #11	L
				Lake	52	Waukegan Savanna	L

(Continued)

Table 8. (Continued).

County	Site #	Site Name	Site Quality	County	Site #	Site Name	Site Quality
Dry-mesic and Mesic Fine-textured-soil Savannas (SAVANNADRY)				Wet-mesic Fine-textured-soil Savannas (SAVANNAWET)			
Lake	35	Almond Marsh	H	Cook	95	Port Wine	H
Lake	68	Independence Grove	H	Kenosha	16	Des Plaines Complex (aka Des Plaines River Dry Woods aka Pleasant RR Prairie)	H
Cook	7	Willow Sanders	M	Lake	51	Wadsworth Savanna	M
Kenosha	16	Des Plaines Complex (aka Des Plaines River Dry Woods aka Pleasant RR Prairie)	M	Kenosha	32	Kilbourn Road Ditch	L
Lake	46	Rollins Savanna	M				
Kenosha	100	Des Plaines River Wetlands	L				
Kenosha	103	Paris Prairie Remnant	L				
Kenosha	30	Schneider Road Marsh	L				
Racine	105	Site #9	L				

(Continued)

Table 8. (Continued).

County	Site #	Site Name	Site Quality	County	Site #	Site Name	Site Quality
Wet-mesic and Wet Floodplain Forests (FORFLPLWET)				**Northern Flatwood Forests (FORNFLATS)**			
Cook	6	Thatcher	H	Lake	37	Elm Road Woods	H
Cook	9	Zoo Area	H	Lake	47	Ryerson	H
Lake	42	MacArthur	H	Lake	54	Wright Woods	H
Lake	47	Ryerson	H	Cook	1	Camp Pine	M
Lake	53	Wetland Demonstration Project	H	Cook	3	Oakton College	M
Cook	1	Camp Pine	M	Lake	42	MacArthur	M
Cook	3	Oakton College	M	Cook	4	River Trail	L
Cook	95	Port Wine	M	Cook	7	Willow Sanders	L
Cook	4	River Trail	M	Lake	68	Independence Grove	L
Kenosha	100	Des Plaines River Wetlands	M	Lake	44	Old School	L
Lake	51	Wadsworth Savanna	M	**Wet-mesic Upland Forests and Wet-Mesic Woodlands (FORUPLWET)**			
Lake	54	Wright Woods	M	Lake	38	Ethel's Woods	H
Cook	7	Willow Sanders	L	Lake	97	Old Mill	H
Kenosha	16	Des Plaines Complex (aka Des Plaines River - Dry Woods aka Pleasant RR Prairie)	L	Lake	68	Independence Grove	M
Kenosha	24	Merkt's Woods	L	Lake	42	MacArthur	M
				Cook	7	Willow Sanders	L

(Continued)

Table 8. (Concluded).

County	Site #	Site Name	Site Quality	County	Site #	Site Name	Site Quality
Dry-mesic and Mesic Woodlands (WOODLNDDRY)							
Kenosha	17	Friendship Lake	H	Cook	2	Dam #4	L
Lake	35	Almond Marsh	H	Cook	3	Oakton College	L
Lake	42	MacArthur	H	Cook	95	Port Wine	L
Lake	47	Ryerson	H	Cook	4	River Trail	L
Lake	50	Van Patton Woods	H	Cook	7	Willow Sanders	L
Lake	51	Wadsworth Savanna	H	Kenosha	102	McDermott's Potholes	L
Cook	9	Zoo Area	M	Kenosha	24	Merkt's Woods	L
Lake	68	Independence Grove	M	Lake	38	Ethel's Woods	L
Lake	46	Rollins Savanna	M	Lake	52	Waukegan Savanna	L
Cook	1	Camp Pine	M				

These initial rankings were based upon the consensus of the "on-the-ground" resource managers that had actual knowledge of each site's level of disturbance, species composition, land ownership, and the presence or absence of hydrologic alterations. An attempt was made to evenly distribute the site selection across the three primary counties (i.e., Lake, Cook, Kenosha, and to a small extent Racine). All told, **85** sites were considered either reference standard (optimal) or sub-optimal and were chosen to represent the range of conditions existing within the reference domain (Figure 34).

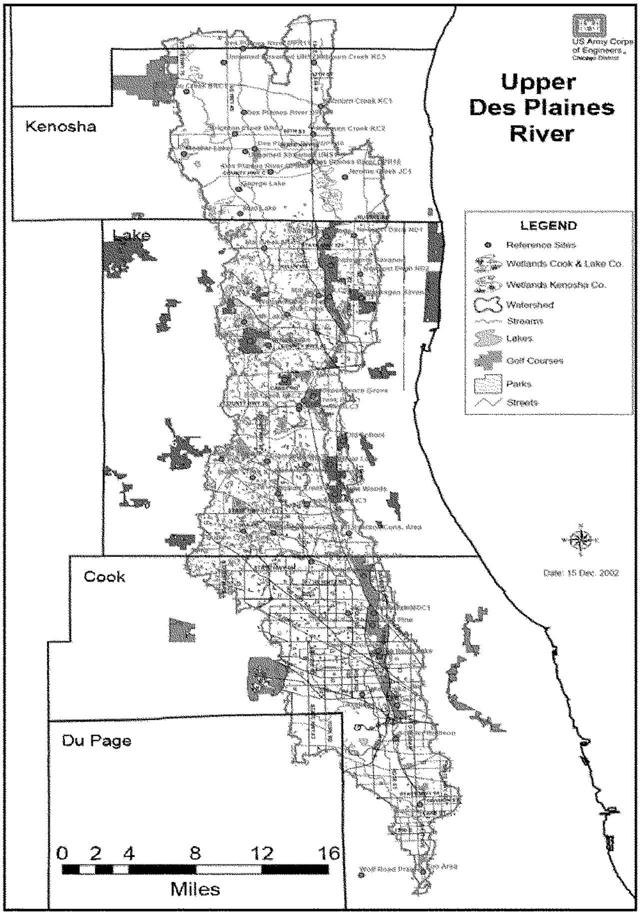

Figure 34. Des Plaines Watershed reference sites used to calibrate the community index models.

Field Data Collection

Table 9 below identifies the sampling techniques used to measure the individual model variables in the 2003-2004 field efforts.

Table 9. Field sampling protocols summarized for the variables associated with the Upper Des Plaines Watershed community index models.

Code	Variable Description	Sampling Methodology and Data Management	Cover Type Applicability
CANATGRND	Percent of the Ground Vegetation Canopy Cover Comprised of Native Species	FQI data were sampled every 10 meters along a 100 m linear transect for a total of three transects per cover type. Using the results of the FQI analysis report, determine from the "Physiognomy" section the percent of the ground vegetation species encountered that were native.	ALL
CANATSHRUB	Percent of the Shrub Canopy Cover Comprised of Native Species	FQI data were sampled every 10 meters along a 100 m linear transect for a total of three transects per cover type. Using the results of the FQI analysis report, determine from the "Physiognomy" section the percent of the shrub species encountered that were native.	ALL
CANATREE	Percent of the Tree Canopy Cover Comprised of Native Species	FQI data were sampled every 10 meters along a 100 m linear transect for a total of three transects per cover type. Using the results of the FQI analysis report, determine from the "Physiognomy" section the percent of the tree species encountered that were native.	SAVANNADRY SAVANNAWET FORFLPLWET FORNFLATS FORUPLWET WOODLNDDRY
CANFORBS	Percent Forb Canopy Cover	Using a 1-m^2 quadrat along a linear 100-m transect, stop every 10-meters and record the estimated percent of the herbaceous vegetation cover that is comprised of forb species.	PRAIRIEDRY PRAIRIEWET
CANGRASS	Percent Grass Canopy Cover (Graminoid)	Using a 1-m^2 quadrat along a linear 100-m transect, stop every 10-meters and record the estimated percent of the herbaceous vegetation cover that is comprised of grass species.	PRAIRIEDRY PRAIRIEWET
CANHERB	Percent Herbaceous Canopy Cover	Using a 100 - m transect, stop every 10 - m, use 1 - m2 quadrat, record herbaceous canopy cover.	SAVANNADRY SAVANNAWET FORFLPLWET FORNFLATS FORUPLWET WOODLNDDRY
CANHITREE	Percent High Tree Canopy Cover	Using a 1-m^2 quadrat along a linear 100-m transect, stop every 10-meters and record the estimated percent of the canopy cover of trees taller than 9.1-m (30-ft) in the overstory canopy.	SAVANNADRY SAVANNAWET FORFLPLWET FORNFLATS FORUPLWET WOODLNDDRY

(Continued)

Table 9. (Continued).

Code	Variable Description	Sampling Methodology and Data Management	Cover Type Applicability
CANLOWTREE	Percent Lower Tree Canopy Cover	Using a 1-m^2 quadrat along a linear 100-m transect, stop every 10-meters and record the estimated percent of the canopy cover of trees less than 9.1-m (30-ft) tall in the overstory canopy.	SAVANNADRY SAVANNAWET FORFLPLWET FORNFLATS FORUPLWET WOODLNDDRY
CANSHRUB	Percent Shrub Canopy Cover	Using a 1-m^2 quadrat along a linear 100-m transect, stop every 10-meters and record the estimated percent of the canopy cover that is shrub.	ALL
DBHTREE	Average dbh of Trees	Using a belt transect, record tree species and measure all trees > 5.5m (18ft) in height and > 5cm (2in) dbh.	SAVANNADRY SAVANNAWET FORFLPLWET FORNFLATS FORUPLWET WOODLNDDRY
DETRITUS	Percent of the Ground Covered By Detritus in Wet Systems or Litter in Dry Systems (%)	Using a 100-m transect, stop every 10-m and use a 1-m^2 quadrat to record percent of the ground that is covered by detritus in wet systems and litter in dry systems.	PRAIRIEDRY PRAIRIEWET
HTVEG	Average Height of the Herbaceous Vegetation(cm)	Using a 100-m transect, stop every 10-m, measure height of herbaceous vegetation from the center of each quadrant within a one square-meter quadrat.	PRAIRIEDRY PRAIRIEWET
INDEXFQI	Floristic Quality Index (FQI)	FQI data were sampled every 10 meters along a 100 m linear transect for a total of three transects per cover type. Using a one-quarter square meter quadrat survey and evaluate prairie tracts.	ALL
NUMDECAY	Number of Decay Classes Present	Using a belt transect, record which of the five stages of woody decay is present: 1 = Logs recently fallen, bark attached, leaves and fine twigs present, no fungi present. 2 = Logs with loose bark, no leaves and fine twigs present, fungi may be present. 3 = Logs without bark, few stubs of branches present, 4 = Logs without bark or branches, heartwood in advanced state of decay, fungi may be present. 5 = Logs decayed into ground, fungi may be present.	SAVANNADRY SAVANNAWET FORFLPLWET FORNFLATS FORUPLWET WOODLNDDRY

(Continued)

Table 9. (Concluded).

Code	Variable Description	Sampling Methodology and Data Management	Cover Type Applicability
NUMINDGRND	Ground Vegetation Diversity - Number of Species with "C" Value >5	FQI data were sampled every 10 meters along a 100 m linear transect for a total of three transects per cover type. Using the results of the "C" value assessment in the FQI analysis, determine the number of ground vegetation species present with a "C" value greater than five.	ALL
NUMINDSHRB	Shrub Vegetation Diversity –Number of Species with "C" Value >5	FQI data were sampled every 10 meters along a 100 m linear transect for a total of three transects per cover type. Using the results of the "C" value assessment in the FQI analysis, determine the number of shrub species present with a "C" value greater than five.	ALL
NUMINDTREE	Tree Vegetation Diversity - Number of Species with "C" Value >5	Using the results of the "C" value assessment in the floristic quality index analysis, report out the number of tree species present with a "C" value greater than five.	SAVANNADRY SAVANNAWET FORFLPLWET FORNFLATS FORUPLWET WOODLNDDRY
WETNESS	Native Mean Wetness With Adventives	FQI data were sampled every 10 meters along a 100 m linear transect for a total of three transects per cover type. Using the results of the FQI analysis, determine the native mean wetness with adventives. Each species found at the site is assigned a category (e.g., Obligate, Facultative-wet, Facultative, Facultative-Upland and Upland) based on the National Wetland Indicator Categories, and these categories in turn are assigned a value ranging from -5 to +5 (Upland) (Reed 1988, Swink and Wilhlem 1994). Positive (+) values indicate a dry condition and negative (-) values indicate a wet condition. For HEP, the values were converted to a positive integer scale, with –5 equal to 0 and +5 equal to 10.	ALL

A standardized approach was developed to collect all field data. Using a somewhat subjective protocol (taking random numbers of footsteps in a random direction into each reference site) each linear transect (100-m) was laid out, and samples were taken every 10 meters, resulting in 10 replications per transect (Figure 35).

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Figure 35. Field sampling protocols for the community models developed for the Des Plaines River Watershed.

A minimum of three transects (300-m) or 30 replications were measured and recorded per cover type (recommended sample size) to reduce variability and standard deviation in the data. A three-person sampling team was used to collect the field data collection (a recorder and two data collectors). The data recorder stood at the center point of the sample plot and recorded the data from fellow sampling team members. Estimates of ground cover were made using visual estimates and quadrats that provided a reference grid for calibration. This practice was "tested" several times at the beginning of each site visit to "train" the team to estimate similarly. Overhead canopies were estimated using optic tubes (Figure 36).

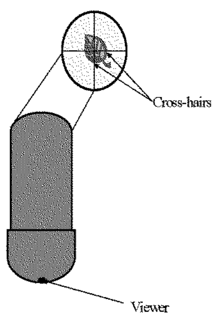

Figure 36. The optic tubes used to measure overhead canopy for the study were made of PVC tubing with cross-hair wires inserted into one end. The field team member placed the other end to their eye and determined if the intersection of the two wires was directly over the object (i.e., the tree leaves) being estimated. If so, then a "hit" or "+" was recorded on the data sheet. If not, then a "miss" or "-" was recorded instead. To insure better accuracy, we recommended that multiple random points were measured within the sample area. One note: it was important to hold the optic tube at a 90-degree angle to what was being measured (i.e., perpendicular to the ground) to obtain an accurate measure.

Although there is a well documented FQI inventory method, the E-Team chose to employ a more simplified approach that complimented the protocols employed to gather the other vegetative cover parameters. A grid system was used to divide the quadrats into 4 quadrants of equal size (one quarter each of the original size) to measure the FQI and related parameters (i.e., wetness, native indicators and ground covers). The idea was that the smaller sections were easier to estimate than the entire 1-m quadrat. The data were sampled every 10 meters along a 100 m linear transect. Vegetative height data were measured at the center of all 4 quadrants within the one square meter quadrat. Table 10 summarizes the number of sites, transects and sample points taken per cover type for the calibration efforts.

Table 10. Sample Sizes Used to Calibrate the Upper Des Plaines community models.

Cover Type	Lake		Cook		Kenosha and Racine	
	Sites	Points	Sites	Points	Sites	Points
PRAIRIEDRY	7	210	3	90	1	30
PRAIRIEWET	5	150	3	90	4	120
SAVANNADRY	3	90	1	30	5	150
SAVANNAWET	1	30	1	30	2	60
FORFLFLWET	5	150	7	210	3	90
FORFFLATS	6	180	4	120	0	0
FORUPLWET	4	120	1	30	0	0
WOODLNDDRY	9	270	7	210	3	90
Prairie Model	12	360	6	180	5	150
Savanna Model	4	120	2	60	7	210
Woodland Model	24	720	19	570	6	180
OVERALL TOTALS	40	1,200	27	810	18	540

Spatially Explicit Data Collection

Error! Reference source not found. below identifies the sampling techniques used to measure the individual variables in the 2006-2007 GIS analyses.

Table 11. GIS sampling protocols summarized for the variables associated with the Upper Des Plaines Watershed community index models.

Code	Variable Description	Sampling Methodology and Data Management	Cover Type Applicability
AREACORE	Percent of the Area That is Core	Using GIS and aerial photography determine the total patch size in acres (ac) and the percent of area that is edge (AREAEDGE) by delineating patch perimeter, measure inward 100m and determine acreage within this band. Divide this number by SIZETRACT of the polygon. Do this for each polygon of like cover within the site. The average AREAEDGE for each site is then subtracted from the total patch size (100%) to get the percent of area that is core (AREACORE).	ALL
AREAEDGE	Percent of the Area That is Edge	Using GIS and aerial photography determine the total patch size in acres (ac) and then delineate the patch perimeter, by measuring inward 100m. Next, calculate area of this 100-m edge band and divide by the area of the total patch size to determine percent area that is edge.	ALL
DIST20TRAC	Average Distance to All 20-acre Tracts of Similar Cover Within 5 Miles of the Tract (m)	On a tributary basis, using GIS and aerial imagery delineate community patches then determine the average distance between 20-acre patches of similar habitat within a 5 mile radius inside the project boundary along the tributary (m).	ALL
NUM20TRAC	Average Number of 20-Acre Tracts of Similar Cover Within 5 miles of the Tract (m)	On a tributary basis, using GIS and aerial imagery delineate community patches then determine the average number of 20-acre (or greater) community habitat patches of similar cover within a 5 mile radius inside the project boundary along the tributary.	ALL
SIZELGTRAC	Size of the Largest Tract of Similar Cover Within a 5-mile Radius	On a tributary basis, using GIS and aerial imagery, measure the size of the largest patch of habitat within a 5-mile radius from a given patch of similar cover inside the project boundary along the tributary (ac).	ALL
SIZETRACT	Tract Size	On a cover type-by-cover type basis, using GIS and aerial imagery, determine the average patch size of polygons within the site of similar cover type for a given community tract/patch.	ALL
TYPADJLAND	Identification of Adjacent Landuse Practices	On a site-by-site basis, using GIS and aerial imagery, draw a 200-m band around the outside of the site's boundary and identify the predominant land use category. Classify the landuse practice as one of the following categories: 0 = No Data, SI = 0 1 = Pristine, Uninhabited Areas, SI = 1.0 2 = Parks 3 = Pasturelands 4 = Utility Rights-of-way and Rail Roads 5 = Dirt & Gravel roads, Oil and Gas Fields 6 = Agricultural Croplands 7 = Residential and Golf Courses 8 = Paved Roads, Highways 9 = Commercial/Industrial	ALL

Landscape variables were measured based on both onsite reconnaissance, interpretation of maps and aerial photos, and GIS data layers. Landscape variable data were developed by the District GIS specialist, whom provided ERDC-EL with the following protocols:[1]

(1) Extract Cook Co site data from HEPsites shapefile to create Cook_HEP_Sites.
(2) Add Site_Ac field to attribute table and remove other fields.
(3) Add ERDC_No field and copy ERDC numbers to table.
(4) Select data from CookCo cover types that intersects CookCoHEP to create CookCoSelect.
(5) Union CookCoSelect with CookCoHEP to get HEPSites names and acreages. Create CookCoUNION file.
(6) Calculate acreage of plots using x-tools in CookCoUNION.
(7) Review data and remove plots <.25 acres.
(8) Create 100m buffer inside CookCoPATCH save as CookCoBUFFER.
(9) Calculate acreage for CookCoBUFFER.
(10) Join CookCoBuffer to CookCoUNION using FID field.
(11) Export joined dataset to create CookCoPATCH.
(12) Add fields for SIZEPATCH, AREAEDGE TO CookCoPATCH.
(13) Calculate variables for SIZEPATCH and AREAEDGE.
(14) Add TYPADJLAND field to CookCoHEP draw 200m buffer outside and look at adjacent land use and populate data.
(15) Create CookCoPOINT file and generate 30 random points within each site. (I use Hawth's Analysis Tools extension). Add DISTADJLAN field to CookCoPOINT and measure distance to the predominant landuse category. (I tried to automate this but was not successful).
(16) Export attribute tables from CookCoPOINT, CookCoPATCH, and CookCoSite to MS Excel.

HSI Statistical Analysis and Curve Calibrations

The reference condition described earlier defined the measurement scale and the state toward which the E-Team desired to move the system. In the case of the Upper Des Plaines Watershed, the reference-based approach employed "reference standard ecosystems" to establish optimal conditions (HSI = 1.0) that served as benchmarks or standards of comparison for the existing and future conditions. Locating "degraded" reference sites was essential to calibrating the model. These "degraded" reference conditions

[1] Please direct questions regarding these GIS protocols to Mr. J.D. Ennis in the Chicago District.

represented the other end of the measurement scale and represented the ecological systems that were clearly degraded and socially unacceptable (HSI – 0.0). We refer to this process as "calibration," which we define here loosely as the use of known (reference) data on the observed relationship between a dependent variable and an independent variable to make estimates of other values of the independent variable from new observations of the dependent variable.

To calibrate the models, we used the average values across the watershed and their associated standard deviations to generate a curve for each variable in each model. We calculated these statistics on both a "cover type-by-cover type" basis, as well as at the broader county and watershed scales. To develop curves for each variable, ERDC used a straightforward assignment process. The watershed mean was assigned a **0.75** SI value in every case. The standard deviation of the mean was added to the average, and this total was assigned a **1.0** SI on the curve (Figure 37).

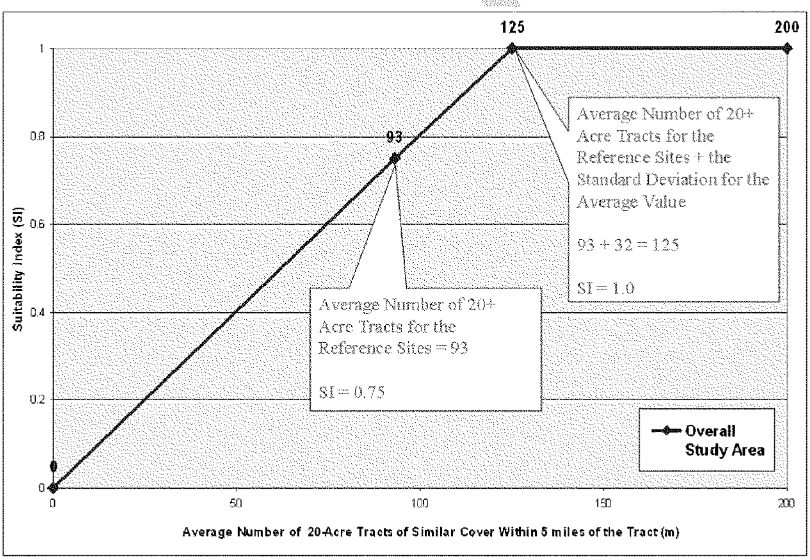

Figure 37. Example of curve calibration method using the watershed mean and its standard deviation.

In some instances, the E-Team made the decision to calibrate the curve on the basis of cover type distinctions. For example, the E-Team reviewed the individual cover type means and made the decision that each cover type had a unique floristic character, and therefore, they developed individual SI curves for each cover type's FQI data (Figure 38).

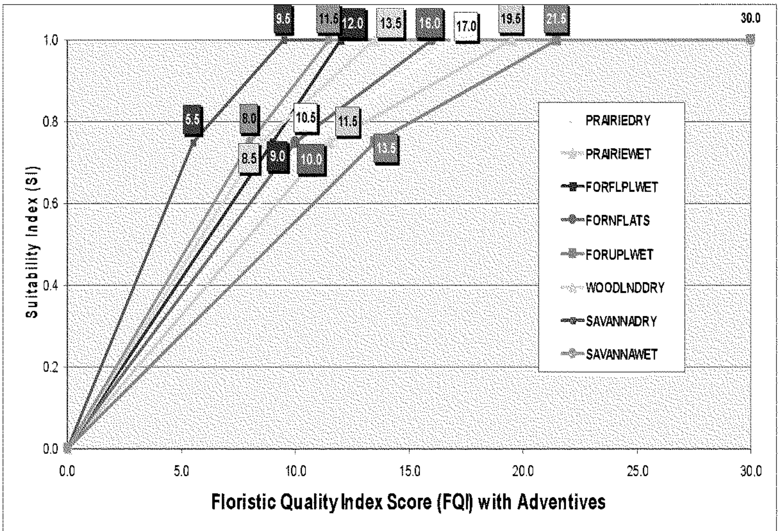

Figure 38. The model calibration approach was flexible enough to encourage and incorporate professional expertise into the methodology. Here, the reference data support the separation of cover types based on mean data. Wet prairies and upland wet forests have significantly higher FQI scores that do those communities with less hydrologic connectivity. As a result, the HSI model was calibrated to capture this unique condition of each ecosystems.

Ultimately, the curves developed for the watershed were the result of an iterative process where the E-Team directed ERDC-EL to gradually modify the curves to better reflect reality as they perceived it "in-the-field." ERDC-EL made a conscious effort to fully document these changes, and curves that have been altered from the means and standard deviations as a result of "expert judgment" are presented as "red" curves in the graphs and supporting text (Figure 39).

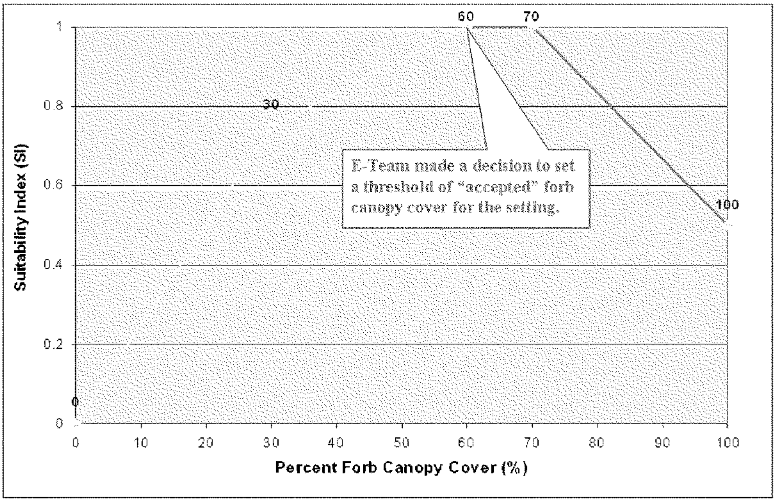

Figure 39. Example of curve calibration method using a combination of watershed means, standard deviations and expert opinion.

To review the final curves for the Upper Des Plaines community models, refer to *Appendix G*.

Model Results

The results of the baseline HEP assessment for the reference sites are summarized below. HSIs capture the quality of the acreage within the reach. Units (i.e., HUs) take this quality and apply it to the governing area through multiplication (Quality X Quantity = Units). Both HSIs and HUs are reported for each site and model. Interpretations of these findings can be generalized in the following manner (Table 12).

Table 12. Interpretation of HSI scores resulting from HEP assessments.

HSI Score	Interpretation
0.0	Not-suitable - the community does not perform to a measurable level and will not recover through natural processes
Above 0.0 to 0.19	Extremely low or very poor functionality (i.e., habitat suitability) - the community functionality can be measured, but it cannot be recovered through natural processes
0.2 to 0 .29	Low or poor functionality
0.3 to 0.39	Fair to moderately low functionality
0.4 to 0 .49	Moderate functionality
0.5 to 0.59	Moderately high functionality
0.6 to .79	High or good functionality
0.8 to0.99	Very high or excellent functionality
1.0	Optimum functionality - the community performs functions at the highest level - the same level as reference standard settings

In most instances, the individual community HSI scores fell in the mid-range of values (~0.5) indicating only a moderate level of functionality in the study area (Table 13, Figure 40 and Figure 41). The highest functioning site was the Friendship Lake Marsh in Kenosha County, Wisconsin (Weighted HSI = 0.79).The highest producing site in terms of Habitat Units (HUs) was the Willow Sanders in Cook County, Illinois (Total HUs = 412). This was to be expected – as it contains significant amounts of habitat acres (acres = 783).

Table 13. Baseline results for the Upper Des Plaines Watershed reference sites verification analysis.

County	ERDC Site Code	Site Name	PRAIRIES			SAVANNAS			WOODLANDS		
			HSIs	Acres	HUs	HSIs	Acres	HUs	HSIs	Acres	HUs
Cook	1	Camp Pine	0.63	34	22				0.51	575	292
	2	Dam #4							0.52	33	17
	3	Oakton College	0.77	3	2				0.52	72	37
	4	River Trail	0.59	10	6				0.52	422	221
	6	Thatcher							0.43	190	82
	7	Willow Sanders				0.25	26	7	0.54	757	405
	9	Zoo Area	0.53	5	3				0.53	107	57
	95	Port Wine	0.59	24	14	0.64	51	33	0.46	293	133

(Continued)

Table 13. (Concluded).

County	ERDC Site Code	Site Name	PRAIRIES			SAVANNAS			WOODLANDS		
			HSIs	Acres	HUs	HSIs	Acres	HUs	HSIs	Acres	HUs
Kenosha	16	DPR Complex				0.49	94	46	0.44	166	73
	17	Friendship Lake Marsh							0.79	31	24
	20	Hooker Lake and Marsh							0.03	1	0
	24	Merkt's Woods	0.38	106	40				0.53	36	19
	30	Schneider Road Marsh				0.59	5	3			
	32	Kilbourn Road Ditch	0.54	25	13	0.57	2	1			
	34	Bain Station RR Prairie	0.63	7	4						
	100	Des Plaines River Wetlands				0.52	13	7	0.50	71	35
	101	Site #11	0.60	65	39						
	102	McDermott's Potholes							0.60	5	3
	103	Paris Prairie Remnant				0.41	1	0			
Lake	35	Almond Marsh	0.51	30	15	0.66	32	21	0.52	243	125
	37	Elm Road Woods							0.68	11	7
	38	Ethel's Woods/Rasmussen Lake							0.53	216	114
	42	Mac Arthur Woods							0.60	419	252
	44	Old School							0.44	5	2
	46	Rollins Savanna				0.61	117	72	0.66	50	33
	47	Ryerson Woods	0.37	3	1				0.60	432	261
	50	Van Patton Woods	0.62	212	130				0.73	25	18
	51	Wadsworth Savanna	0.69	71	49	0.70	3	2	0.66	257	170
	52	Waukegan Savanna	0.35	34	12				0.57	34	19
	53	Wetland Demo Project							0.48	216	104
	54	Wright Woods	0.66	45	30				0.60	181	109
	68	Independence Grove	0.67	23	15	0.69	26	18	0.62	102	63
	96	Newport Township	0.61	62	38						
	97	Old Mill				0.69	72	50	0.69	101	70
Racine	105	Site #9				0.56	2	1			

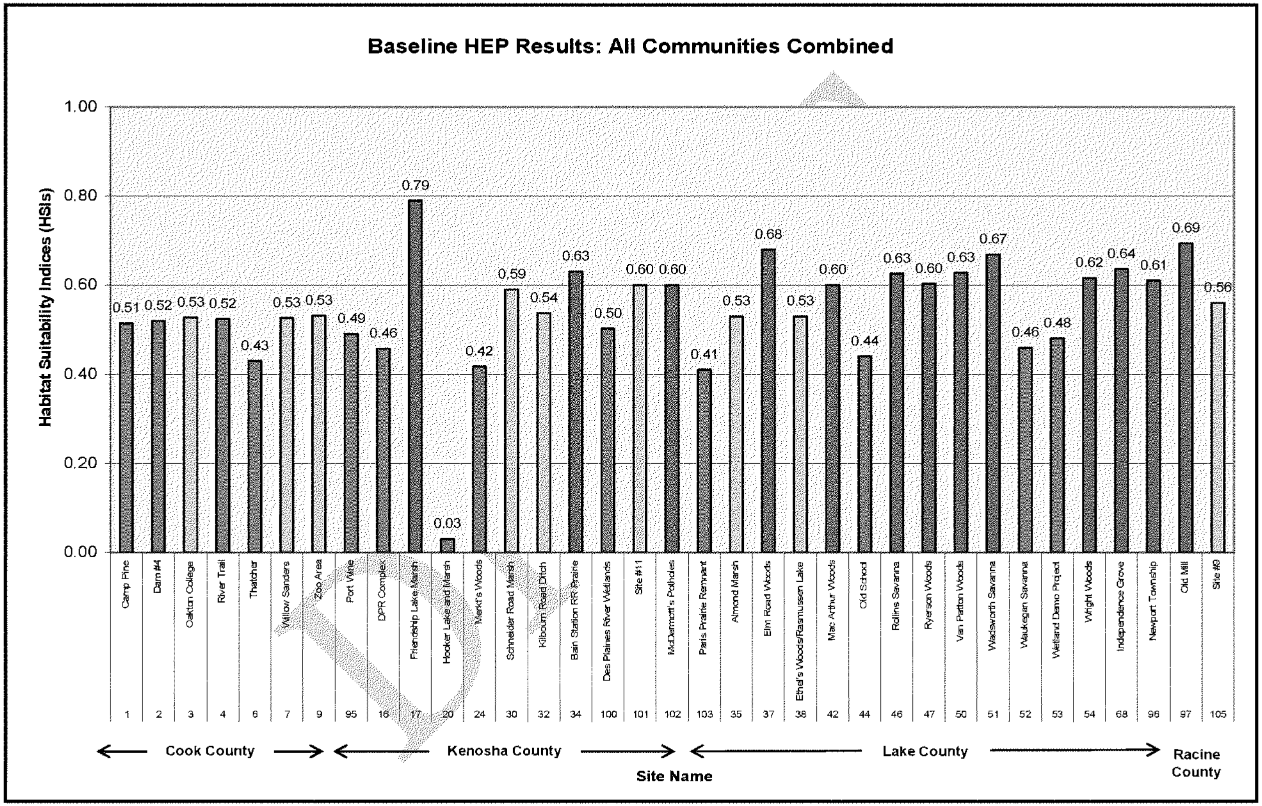

Figure 40. Baseline graphical results (weighted HSIs) for the Upper Des Plaines communities.

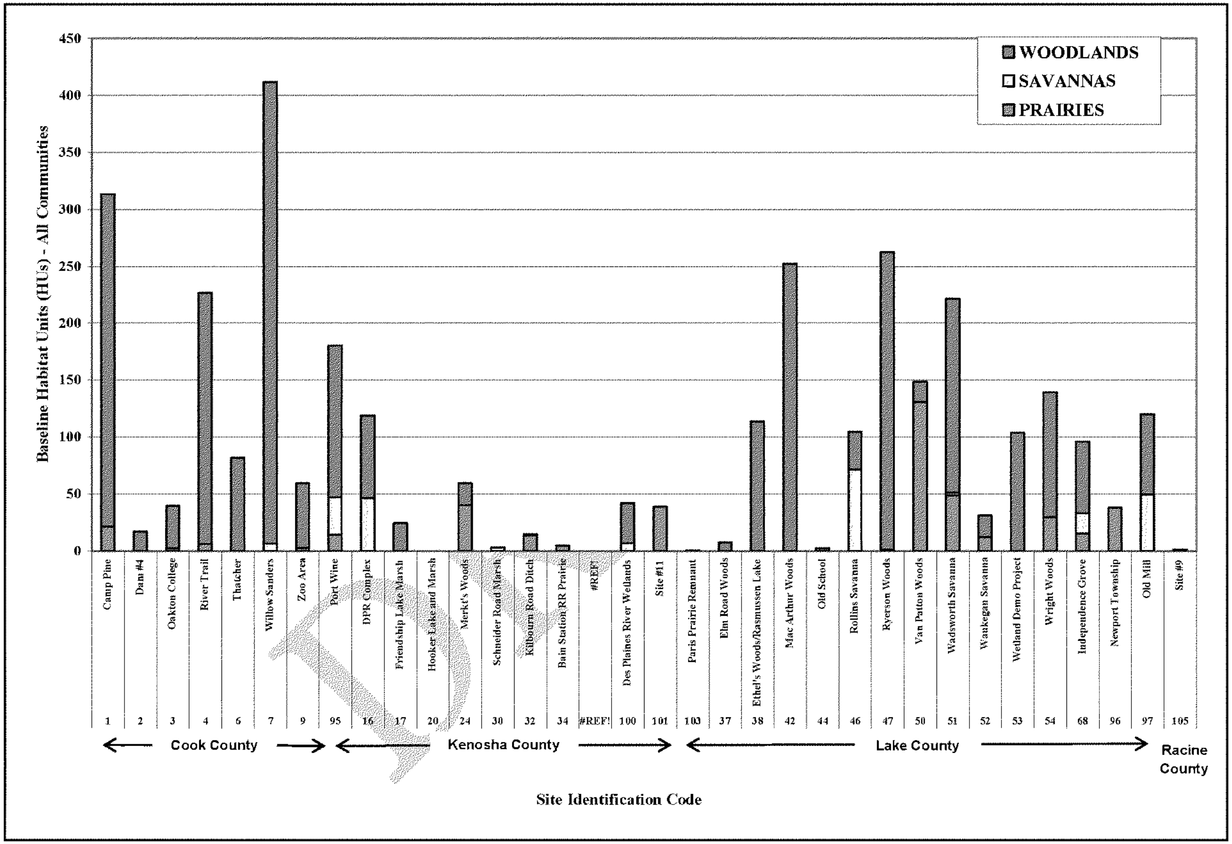

Figure 41. Baseline graphical results (bundled HUs) for the Upper Des Plaines communities.

Model Verification

The first test of the model was to assess the various references sites (both optimal and sub-optimal) with the formulas and curves and determine whether the model "relating to reality" with respect to the E-Team's expectations. We consider this step to be model verification:

> ***Verification*** *(aka Confirmation) is the comparison of the model output to data from well-known, published test cases to confirm that the algorithms and computer code accurately represent system dynamics.* [1]

For purposes of this effort, *verification* asks whether the model is responding as they experts believe it should. Sites deemed to be highly functional wetlands according to experts, should produce high HSI scores. Sites deemed dysfunctional (by the experts) should produce low HSI scores. Again, the model calibration effort described above was an iterative process, and as such, changes to the model's curves and algorithms were made in an attempt to bring these results into closer alignment. Admittedly, this process was somewhat subjective. But the experts working on the models were the best in the region. Below, we provide both the E-Team's expectation of reference site condition (i.e., **High**, **Medium**, or **Low**) (Table 14).

1 Personal communication regarding American Society of Civil Engineers' definitions with Dr. John Nestler, ERDC-EL, August 2009

Table 14. Correlations between the HEP runs at the reference sites and the expert's opinions as their functionality.

			Results of the HEP Runs			Expert Opinion		
			PRAIRIES	SAVANNAS	WOODLANDS	PRAIRIES	SAVANNAS	WOODLANDS
County	ERDC Site Code	Site Name	HSIs	HSIs	HSIs	HSIs	HSIs	HSIs
Cook	1	Camp Pine	High		Low	High		Medium
	2	Dam #4			Low			Low
	3	Oakton College	High		Medium	High		Medium
	4	River Trail	Medium		Medium	High		Low
	6	Thatcher			Low			High
	7	Willow Sanders		Low	Medium		Medium	Low
	9	Zoo Area	Low		Medium	High		Low
	95	Port Wine	Medium	Medium	Low	High	Medium	Medium
Kenosha	16	DPR Complex		Low	Low		High	Medium
	17	Friendship Lake Marsh			High			High
	20	Hooker Lake and Marsh			Low			
	24	Merkt's Woods	Low		Medium	Low		Low
	30	Schneider Road Marsh		Medium			Low	
	32	Kilbourn Road Ditch	Low	Medium		Low	Low	
	34	Bain Station RR Prairie	High			High		
	100	Des Plaines River Wetlands		Low	Low		Low	Medium
	101	Site #11	Medium			Low		
	102	McDermott's Potholes			Medium			Low
	103	Paris Prairie Remnant		Low			Low	

(Continued)

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County	ERDC Site Code	Site Name	Results of the HEP Runs: PRAIRIES HSIs	Results of the HEP Runs: SAVANNAS HSIs	Results of the HEP Runs: WOODLANDS HSIs	Expert Opinion: PRAIRIES HSIs	Expert Opinion: SAVANNAS HSIs	Expert Opinion: WOODLANDS HSIs
Lake	35	Almond Marsh	Low	High	Low	Low	High	High
	37	Elm Road Woods			High			High
	38	Ethel's Woods/Rasmussen Lake			Medium			Medium
	42	Mac Arthur Woods			Medium			High
	44	Old School			Low			Low
	46	Rollins Savanna		Medium	High		Medium	Medium
	47	Ryerson Woods	Low		High	Low		High
	50	Van Patton Woods	High		High	High		High
	51	Wadsworth Savanna	High	High	High	High	High	High
	52	Waukegan Savanna	Low		Medium	Low		Low
	53	Wetland Demo Project			Low			High
	54	Wright Woods	High		High	Medium		High
	68	Independence Grove	High	High	High	Medium	High	Medium
	96	Newport Township	Medium			Medium		
	97	Old Mill		High	High			High
Racine	105	Site #9		Low			Low	

As a simple test of the veracity of the models and the expert's opinions of the reference site conditions was performed using a correlation analysis. (Figure 42).

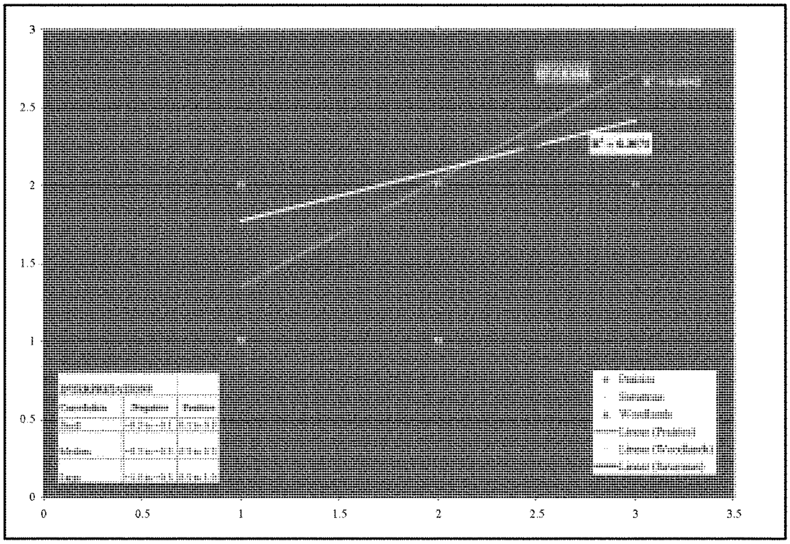

Figure 42. A Pearson's correlation of expert team's opinion of site functionality and the HEP results indicate that they are positively related to some degree.

The most common measure of correlation is the Pearson Product Moment Correlation (aka Pearson's correlation).[1] The Pearson correlation values range from +1 to -1. A rule-of-thumb interpretation of the Pearson's correlation is found in the corner of **Error! Reference source not found.** above. Based on this analysis, we can demonstrate that the Prairie Community Model is strongly correlated to expert opinion regarding site conditions, and therefore can be said to pass the test of "verification" (Pearson correlation value = 0.67). The remaining models did not score as significantly correlated (i.e., Savanna = 0.55 and Woodlands = 0.32), but they still demonstrated a positive correlation albeit moderate to small

[1] Background information was retrieved from http://en.wikipedia.org/wiki/Pearson_product-moment_correlation_coefficient and http://davidmlane.com/hyperstat/A34739.html (SEPTEMBER 2008).

according to the interpretive graph. Because the area is suffering from severe alterations of the natural hydrologic regime, there are no sites within the reference domain functioning at these expected optimal levels, the E-Team felt it was still reasonable to assume that these models offered a solid, scientifically driven means to characterizing conditions and assessing alternative plans. So for now, the E-Team has agreed that the reference sites were functioning at a reasonable level of expectation and as such the model calibrations were deemed acceptable.

Model Validation

To date the Upper Des Plaines community index models have not been validated. We define model validation here as:

Validation *is accomplished by establishing an objective yet independent line of evidence that the model specifications conform to the user's needs and intended use(s). The validation process questions whether the model is an accurate representation of the system based on independent data not used to develop the model in the first place. Validation can encompass all of the information that can be verified, as well as all of the things that cannot -- i.e., all of the information that the model designers might never have anticipated the user might want or expect the product to do.* [1]

For purposes of this effort, *validation* refers to independent data collections (bird surveys, water quality surveys, etc.) that can be compared to the model outcomes to determine whether the model is capturing the essence of the ecosystem's functionality.

As independent measures of function for the models herein, we propose three options or directions to consider in future opportunities for research arise:

1. A few "relevant" HSI Blue Book (species) models could be used to assess the baseline conditions of the area comparing their outputs to the community models' outputs. As these are already "approved" for use under the USACE model certification program, their outputs

[1] Personal communication regarding American Society of Civil Engineers' definitions with Dr. John Nestler, ERDC-EL, August 2009

should provide relevant cross-validation. However, as most of the HSI Blue Books lack validation, this approach may not be appropriate either. And again, as the Blue Book models are designed to measure only limiting "life requisites" of these key species, they might not be inclusive enough to capture community function and processes.

2. An extremely expensive and time consuming approach could be undertaken to assess biodiversity (both species richness and diversity) in an attempt to identify an "independent measure of function." However, to validate the communities modeled herein, a majority of the faunal groups present would need to be surveyed (mammals, birds, fish, reptiles, amphibians, plants, and possibly even insects). This in turn leads to the question, if we had time and funds to do this level of inventory, why use models at all?
3. Alternatively, validation of the models could potentially be accomplished by assessing patch dynamics using transition model at a landscape scale (Acevedo et al. 1995). Again, this would be validating models with models which might not be considered a true validation exercise.

5 Summary and Conclusions

The implications of this report's findings herein are rather straightforward. First, the results support the conceptual premise surrounding the HSI models and indicate their representative capabilities. In other words, scientific literature characterizing the state of the Upper Des Plaines Watershed ecosystems along the main stem and its tributaries point to an overall decline in ecosystem integrity (i.e., health, biodiversity, stability, sustainability, naturalness, wildness, and beauty) – a finding these models can now verify and quantify (we found less than optimal HSI results at all references sites). Furthermore, the results indicate an opportunity to redress ongoing losses. There is great potential to restore sustainable communities therein, offering a significant positive return on investment to both the stakeholders and the federal government.

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Appendix A: Notation

A-Team	HGM Assessment Team
AAFCU	Average Annual Functional Capacity Unit
AAHU	Average Annual Habitat Unit
C	Coefficient of Conservatism
CAR	Fish and Wildlife Coordination Act Report
CT	Cover Type
CT HSI	Cover Type Habitat Suitability Index
District	Chicago District
DPII	Upper Des Plaines Multi-Purpose Phase II Feasibility Study
EC	Engineering Circular
EIS	Environmental Impact Statement
ER	Ecosystem Restoration
EOA	Equivalent Optimum Area
ERDC	U.S. Army Engineer Research and Development Center
ERDC-EL	ERDC Environmental Laboratory
ESM	Ecological Service Manual
E-Team	Ecosystem Assessment Team
ETR	Expert Technical Review
ETRT	Expert Technical Review Team
EXHEP	EXpert Habitat Evaluation Procedures Software
EXHGM	EXpert Hydrogeomorphic Wetland Assessment Software
FCI	Functional Capacity Index
FCSA	Feasibility Cost Sharing Agreement
FCU	Functional Capacity Unit
FDR	Flood Damage Reduction
FEMA	Federal Emergency Management Agency
FQA	Floristic Quality Assessment
FQI	Floristic Quality Index
GIS	Geographic Information System
HEAT	Habitat Evaluation and Assessment Tools
HEP	Habitat Evaluation Procedures

HGM	Hydrogeomorphic Assessment of Wetlands
HSI	Habitat Suitability Index
HU	Habitat Unit
IBI	Index of Biotic Integrity
ICA	Incremental Cost Analysis
IDNR	Illinois Department of Natural Resources
ILEPA	Illinois Environmental Protection Agency
INHS	Illinois Natural History Survey
ITRT	Independent Technical Review Team
LCSMC	Lake County Stormwater Management Commission
LRSI	Life Requisite Suitability Index
LPDT	Laboratory-based Project Delivery Team
LTR	Laboratory-based Technical Review
LTRT	Laboratory-based Technical Review Team
NEPA	National Environmental Policy Act
NED Plan	National Economic Development Plan
NER Plan	National Ecosystem Restoration Plan
NRCS	Natural Resources Conservation Service
PDT	Project Delivery Team
PMIP	USACE Planning Models Improvement Program
PMP	Project Management Plan
PWAA	Partial Wetland Assessment Area
QHEI	Qualitative Habitat Evaluation Index
RA	Relative Area
RVI	Relative Value Index
SERI	Society for Ecological Restoration International
SEWRPC	Southeastern Wisconsin Regional Planning Commission
SI	Suitability Index
TY	Target Year
UDPREP	Upper Des Plaines River Ecosystem Partnership
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VSI	Variable Subindex
WOP	Without-project Condition

WP	With-project Condition

Appendix B: Glossary of Terms

Activity

The smallest component of a management measure that is typically a nonstructural, ongoing (continuing or periodic) action in USACE planning studies (Robinson, Hansen, and Orth 1995).

Alternative (aka Alternative Plan, Plan, or Solution)

An alternative can be composed of numerous management measures that in turn are comprised of multiple features or activities. Alternatives are mutually exclusive, but management measures may or may not be combinable with other management measures or alternatives (Robinson, Hansen, and Orth 1995).

In HEP analyses, this is the "With-project" condition commonly used in restoration studies. Some examples of Alternatives include:

Alternative 1: Plant food plots, increase wetland acreage by 10 percent, install 10 goose nest boxes, and build a fence around the entire site.

Alternative 2: Build a dam, inundate 10 acres of riparian corridor, build 50 miles of supporting levee, and remove all wetlands in the levee zone.

Alternative (cont)

Alternative 3: Reduce the grazing activities on the site by 50 percent, replant grasslands (10 acres), install a passive irrigation system, build 10 escape cover stands, use 5 miles of willow fascines along the stream bank for stabilization purposes.

Assessment Model

A simple mathematical tool that defines the relationship between ecosystem/landscape scale variables and either functional capacity of a wetland or suitability of habitat for species and communities. Habitat Suitability Indices are examples of assessment models that the HEAT software can be used to assess impacts/benefits of alternatives.

Average Annual Habitat Units (AAHUs)

A quantitative result of annualizing Habitat Unit (HU) gains or losses across all years in the period of analysis.

AAHUs = Cumulative HUs ÷ Number of years in the life of the project, where:

Cumulative HUs =

$$\sum (T_2 - T_1)[\{((A_1 H_1 + A_2 H_2) / 3)\} + \{((A_2 H_1 + A_1 H_2) / 6)\}]$$

and where:

T_1 = First Target Year time interval
T_2 = Second Target Year time interval
A_1 = Area of available wetland assessment area at beginning of T_1
2 = Area of available wetland assessment area at end of T_2
H_1 = HSI at beginning of T_1
H_2 = HSI at end of T_2.

Baseline Condition (aka Existing Conditions)	The point in time before proposed changes are implemented in habitat assessment and planning analyses. Baseline is synonymous with Target Year (TY = 0).
Blue Book	In the past, the USFWS was responsible for publishing documents identifying and describing HSI models for numerous species across the nation. Referred to as "Blue Books" in the field, due primarily to the light blue tint of their covers, these references fully illustrate and define habitat relationships and limiting factor criteria for individual species nationwide. Blue Books provide: HSI Models, life history characteristics, SI curves, methods of variable collection, and referential material that can be used in the application of the HSI model in the field. For copies of Blue Books, or a list of available Blue Books, contact your local USFWS office.
Calibration	The use of known (reference) data on the observed relationship between a dependent variable and an independent variable to make estimates of other values of the independent variable from new observations of the dependent variable.
Combined NED/NER Plan (Combined Plan)	Plans that produce both types of benefits such that no alternative plan or scale has a higher excess of NED plus NER benefits over total project costs (USACE 2003).

Cover Type (CT) Homogenous zones of similar vegetative species, geographic similarities and physical conditions that make the area unique. In general, cover types are defined on the basis of species recognition and dependence.

Ecosystem A biotic community, together with its physical environment, considered as an integrated unit. Implied within this definition is the concept of a structural and functional whole, unified through life processes. Ecosystems are hierarchical, and can be viewed as nested sets of open systems in which physical, chemical and biological processes form interactive subsystems. Some ecosystems are microscopic, and the largest comprises the biosphere. Ecosystem restoration can be directed at different-sized ecosystems within the nested set, and many encompass multi-states, more localized watersheds or a smaller complex of aquatic habitat.

Ecosystem Function

Ecosystem functions are the dynamic attributes of ecosystems, including interactions among organisms and interactions between organisms and their environment (SERI 2001). Some restoration ecologists limit the use of the term "ecosystem functions" to those dynamic attributes which most directly affect metabolism, principally the sequestering and transformation of energy, nutrients, and moisture. Examples are carbon fixation by photosynthesis, trophic interactions, decomposition, and mineral nutrient cycling. When ecosystem functions are strictly defined in this manner, other dynamic attributes are distinguished as "ecosystem processes" such as substrate stabilization, microclimatic control, differentiation of habitat for specialized species, pollination and seed dispersal. Functioning at larger spatial scales is generally conceived in more general terms, such as the long-term retention of nutrients and moisture and overall ecosystem sustainability.

Ecosystem Integrity

The state or condition of an ecosystem that displays the biodiversity characteristic of the reference, such as species composition and community structure, and is fully capable of sustaining normal ecosystem functioning (SERI 2001). These characteristics are often defined in terms such as health, biodiversity, stability, sustainability, naturalness, wildness, and beauty.

Ecosystem Assessment Team (E-Team) An interdisciplinary group of regional and local scientists responsible for determining significant resources, identification of reference sites, construction of assessment models, definition of reference standards, and calibration of assessment models. In some instances the E-Team is also referred to as the Environmental Assessment Team or simply the Assessment Team.

Equivalent Optimal Area (EOA) The concept of equivalent optimal area (EOA) is used in HEP applications where the composition of the landscape, in relation to providing life requisite habitat, is an important consideration. An EOA is used to weight the value of the LRSI score to compensate for this inter-relationship. For example, for optimal wood duck habitat conditions, at least 20 percent of an area should be composed of cover types providing brood-cover habitat (a life requisite). If an area has less than 20 percent in this habitat, the suitability is adjusted downward.

Existing Condition Also referred to as the baseline condition, the existing condition is the point in time before proposed changes, and is designated as Target Year (TY = 0) in the analysis.

Feature A feature is the smallest component of a management measure that is typically a structural element requiring construction in USACE planning studies (Robinson, Hansen, and Orth 1995).

Field Data This information is collected on various parameters (i.e., variables) in the field, and from aerial photos, following defined, well-documented methodology in typical HEP applications. An example is the measurement of percent herbaceous cover, over ten quadrats, within a cover type. The values recorded are each considered "field data." Means of variables are applied to derive suitability indices and/or functional capacity indices.

Goal A goal is defined as the end or final purpose. Goals provide the reason for a study rather than a reason to formulate alternative plans in USACE planning studies (Yoe and Orth 1996).

Guild A group of functionally similar species with comparable habitat requirements whose members interact strongly with one another, but weakly with the remainder of the community. Often a species HSI model is selected to represent changes (impacts) to a guild.

Habitat Assessment The process by which the suitability of a site to provide habitat for a community or species is measured. This approach measures habitat suitability using an assessment model to determine an HSI.

Habitat Suitability Index Model (HSI)	A quantitative estimate of suitability habitat for a site. The ideal goal of an HSI model is to quantify and produce an index that reflects functional capacity at the site. The results of an HSI analysis can be quantified on the basis of a standard 0-1.0 scale, where 0.00 represents low functional capacity for the wetland, and 1.0 represents high functional capacity for the wetland. An HSI model can be defined in words, or mathematical equations, that clearly describe the rules and assumptions necessary to combine functional capacity indices in a meaningful manner for the wetland.
Habitat Suitability Index Model (HSI) (cont)	For example: $HSI = (SI\ V_1 * SI\ V_2) / 4$, where: SI V_1 is the Variable Subindex for variable 1; SI V_2 is the SI for variable 2

Habitat Unit (HU) A quantitative environmental assessment value, considered the biological currency in HEP. Habitat Units (HUs) are calculated by multiplying the area of available habitat (quantity) by the quality of the habitat for each species or community. Quality is determined by measuring limiting factors for the species (or community), and is represented by values derived from Habitat Suitability Indices (HSIs).

HU = AREA (acres) X HSI.

Changes in HUs represent potential impacts or improvements of proposed actions.

Life Requisite Suitability Index (LRSI) A mathematical equation that reflects a species' or community's sensitivity to a change in a limiting life requisite component within the habitat type in HEP applications. LRSIs are depicted using scatter plots and bar charts (i.e., life requisite suitability curves). The LRSI value (Y axis) ranges on a scale from 0.0 to 1.0, where an LRSI = 0.0 means the factor is extremely limiting and an LRSI = 1.0 means the factor is in abundance (not limiting) in most instances.

Limiting Factor A variable whose presence/absence directly restrains the existence of a species or community in a habitat in HEP applications. A deficiency of the limiting factor can reduce the quality of the habitat for the species or community, while an abundance of the limiting factor can indicate an optimum quality of habitat for the same species or community.

Locally Preferred Plan (LPP) The name frequently given to a plan that is preferred by the non-Federal sponsor over the National Economic Development (NED) plan (USACE 2000).

Management Measure The components of a plan that may or may not be separable actions that can be taken to affect environmental variables and produce environmental outputs. A management measure is typically made up of one or more features or activities at a particular site in USACE Planning studies (Robinson, Hansen, and Orth 1995).

Measure The act of physically sampling variables such as height, distance, percent, etc., and the methodology followed to gather variable information in HEP applications (i.e., see "Sampling Method" below).

Multiple Formula Model (MM) (aka Life Requisite Model)

In HEP applications, there are two types of HSI models, the Single Formula Model (SM) (refer to the definition below) and the Multiple Formula Model (MM). In this case a multiple formula model is, as one would expect, a model that uses more than one formula to assess the suitability of the habitat for a species or a community. If a species/community is limited by the existence of more than one life requisite (food, cover, water, etc.), and the quality of the site is dependent on a minimal level of each life requisite, then the model is considered an MM model. In order to calculate the HSI for any MM, one must derive the value of a Life Requisite Suitability Index (LRSI) (see definition below) for each life requisite in the model – a process requiring the user to calculate multiple LRSI formulas. This Multiple Formula processing has led to the name "Multiple Formula Model" in HEP.

Multi-Criteria Decision Analysis (MCDA)

The study of methods and procedures by which concerns about multiple conflicting criteria can be formally incorporated into the management planning process", as defined by the International Society on Multiple Criteria Decision Making (http://www.terry.uga.edu/mcdm/ MAY 2008).

MCDA is also referred as Multi-Criteria Decision Making (MCDM), Multi-Dimensions Decision-Making (MDDM), and Multi-Attributes Decision Making (MADM)

National Economic Development (NED) Plan	For all project purposes except ecosystem restoration, the alternative plan that reasonably maximizes net economics benefits consistent with protecting the Nation's environment, the NED plan, shall be selected. The Assistant Secretary of the Army for Civil Works (ASACW) may grant an exception when there are overriding reasons for selecting another plan based upon other Federal, State, local and international concerns (USACE 2000).
National Ecosystem Restoration (NER) Plan	For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected. The selected plan must be shown to be cost effective and justified to achieve the desired level of output. This plan shall be identified as the National Ecosystem Restoration (NER) Plan. (USACE 2000).
No Action Plan (aka No Action Alternative or Without-project Condition)	Also referred to as the Without-project condition, the No Action Plan describes the project area's future if there is no Federal action taken to solve the problem(s) at hand. Every alternative is compared to the same Without-project condition (Yoe and Orth 1996).

Objective	A statement of the intended purposes of the planning process; it is a statement of what an alternative plan should try to achieve. More specific than goals, a set of objectives will effectively constitute the mission statement of the Federal/non-Federal planning partnership. A planning objective is developed to capture the desired changes between the without- and With-project conditions that when developed correctly identify effect, subject, location, timing, and duration (Yoe and Orth 1996).
Plan (aka Alternative, Alternative Plan, or Solution)	A set of one or more management measures functioning together to address one or more planning objectives (Yoe and Orth 1996). Plans are evaluated at the site level with HEP or other assessment techniques and cost analyses in restoration studies (Robinson, Hansen, and Orth 1995).
Program	Combinations of recommended plans from different sites make up a program. Where the recommended plan at each such site within a program is measured in the same units, a cost analyses can be applied in a programmatic evaluation (Robinson, Hansen, and Orth 1995).
Project Area	The area that encompasses all activities related to an ongoing or proposed project.
Project Manager	Any biologist, economist, hydrologist, engineer, decision- maker, resource project manager, planner, environmental resource specialist, limnologist, etc., who is responsible for managing a study, program, or facility.

Reference Domain The geographic area from which reference communities or wetland are selected in HEP applications. A reference domain may, or may not, include the entire geographic area in which a community or wetland occurs.

Reference Ecosystems All the sites that encompass the variability of all conditions within the region in HEP applications. Reference ecosystems are used to establish the range of conditions for construction and calibration of HSIs and establish reference standards.

Reference Standard Ecosystems The ecosystems that represent the highest level of habitat suitability or function found within the region for a given species or community in HEP applications.

Relative Area (RA) The relative area is a mathematical process used to "weight" the various applicable cover types on the basis of quantity in HEP applications. To derive the relative area of a model's CTs, the following equation can be utilized:

$$\text{Relative Area} = \frac{\text{Acres of Cover Type}}{\text{Total Applicable Area}}$$

where:

Acres of Cover Type = only those acres assigned to the cover type of interest within the site
Total Applicable Area = the sum of the acres associated with the model at the site.

Relative Preferences	The rank of ecosystem services in order of importance. Relative preferences for various services are much easier to determine than differences in dollar measures of service values. Although less common than dollar measures of value, individual and community indices of ranked preferences can be used to aggregate service values and compare plans using a single measure (King et al. 2000).
Risk	The volatility of potential outcomes. In the case of ecosystem values, the important risk factors are those that affect the possibility of service flow disruptions and the reversibility of service flow disruptions. These are associated with controllable and uncontrollable on-site risk factors (e.g., invasive plants, overuse, or restoration failure) and landscape risk factors (e.g., changes in adjacent land uses, water diversions) (King et al. 2000).

Sampling Method The protocol followed to collect and gather field data in HEP and HGM applications. It is important to document the relevant criteria limiting the collection methodology. For example, the time of data collection, the type of techniques used, and the details of gathering this data should be documented as much as possible. An example of a sampling method would be:

Between March and April, run five random 50-m transects through the relevant cover types. Every 10-m along the transect, place a 10-m² quadrat on the right side of the transect tape and record the percent herbaceous cover within the quadrat. Average the results per transect.

Scale In some geographical methodologies, the scale is the defined size of the image in terms of miles per inch, feet per inch, or pixels per acres. Scale can also refer to different "sizes" of plans (Yoe and Orth 1996) or variations of a management measure in cost analyses. Scales are mutually exclusive, and therefore a plan or alternative may only contain one scale of a given management measure (Robinson, Hansen, and Orth 1995).

Single Formula Model (SM) In habitat assessments, there are two potential types of models selected to assess change at a site – the Single Formula Model and the Multiple Formula Model (refer to the definition above). In this instance, an HSI model is based on the existence of a single life requisite requirement, and a single formula is used to depict the relationship between quality and carrying capacity for the site.

Site The location upon which the project manager will take action, evaluate alternatives and focus cost analysis (Robinson, Hansen, and Orth 1995).

Solutions (aka Alternative, Alternative Plan, or Plan) A solution is a way to achieve all or part of one or more planning objectives (Yoe and Orth 1996). In cost analysis, this is the alternative (see definition above).

Spreadsheet A type of computer file or page that allows the organization of data (alpha-numeric information) in a tabular format. Spreadsheets are often used to complete accounting/economic exercises.

Suitability Index (SI) A mathematical equation that reflects a species' or community's sensitivity to a change in a limiting factor (i.e., variable) within the habitat type in HEP applications. These indices are depicted using scatter plots and bar charts (i.e., suitability curves). The SI value (Y-axis) ranges on a scale from 0.0 to 1.0, where an SI = 0.0 means the factor is extremely limiting, and an SI = 1.0 means the factor is in abundance (not limiting) for the species/community (in most instances).

Target Year (TY) A unit of time measurement used in HEP that allows the project manager to anticipate and direct significant changes (in area or quality) within the project (or site). As a rule, the baseline TY is always TY = 0, where the baseline year is defined as a point in time before proposed changes would be implemented. As a second rule, there must always be a TY = 1, and a TY = X_2. TY_1 is the first year land- and water-use conditions are expected to deviate from baseline conditions. TY_{X2} designates the ending target year. A new target year must be assigned for each year the project manager intends to develop or evaluate change within the site or project. The habitat conditions (quality and quantity) described for each TY are the expected conditions at the end of that year. It is important to maintain the same target years in both the environmental and economic analyses.

Trade-Offs(TOs) Used to adjust the model outputs by considering human values. There are no right or proper answers, only acceptable ones. If trade-offs are used, outputs are no longer directly related to optimum habitat or wetland function (Robinson, Hansen, and Orth 1995).

Validation Establishing by objective yet independent evidence that the model specifications conform to the user's needs and intended use(s). The validation process questions whether the model is an accurate representation of the system based on independent data not used to develop the model in the first place. Validation can encompass all of the information that can be verified, as well as all of the things that cannot -- i.e., all of the information that the model designers might never have anticipated the user might want or expect the product to do.

For purposes of this effort, *validation* refers to independent data collections (bird surveys, water quality surveys, etc.) that can be compared to the model outcomes to determine whether the model is capturing the essence of the ecosystem's functionality.

Variable A measurable parameter that can be quantitatively described, with some degree of repeatability, using standard field sampling and mapping techniques. Often, the variable is a limiting factor for a wetland's functional capacity used in the development of SI curves and measured in the field (or from aerial photos) by personnel, to fulfill the requirements of field data collection in an HEP application. Some examples of variables include: height of grass, percent canopy cover, distance to water, number of snags, and average annual water temperature.

Verification	Model verification refers to a process by which the development team confirms by examination and/or provision of objective evidence that specified requirements of the model have been fulfilled with the intention of assuring that the model performs (or behaves) as it was intended. Sites deemed to be highly functional wetlands according to experts, should produce high HSI scores. Sites deemed dysfunctional (by the experts) should produce low HSI scores.
Without-project Condition(WOP) (aka No Action Plan or No Action Alternative)	Often confused with the terms "Baseline Condition" and "Existing Condition," the Without-Project Condition is the expected condition of the site without implementation of an alternative over the life of the project, and is also referred to as the "No Action Plan" in traditional planning studies (Yoe and Orth 1996; USACE 2000).
With-project Condition (WP)	In planning studies, this term is used to characterize the condition of the site after an alternative is implemented (Yoe and Orth 1996; USACE 2000).

Appendix C: Model Certification Crosswalk

Information necessary to address model certification under EC 1105-2-407 is presented in *Table 2* of the *USACE Protocols for Certification of Planning Models* report (USACE 2007, pages 9-11)[1]. In an effort to streamline certification for the Bosque Riparian community-based (HSI) index model and the Spatial Heterogeneity Index (SHI) model, the authors have provided a table to crosswalk the EC requirements and the information contained in this report (Table C - 1).

Table C - 1. Crosswalk between EC 1105-2-407 model certification requirements and information contained in this report.

Cover Sheet		
	a.	**Model Name(s):** a. Community Models (Prairies, Savannas and Woodlands) for the Upper Des Plaines River Watershed, Illinois and Wisconsin
	b.	**Functional Area:** Ecosystem Restoration; Impact Assessment /Mitigation
	c.	**Model Proponent:** Chicago District
	d.	**Model Developers** ERDC-EL and Chicago District (with support from interagency and stakeholder participants)
1. Background		
	a.	**Purpose of Model:** These models were developed in an effort to quantify the value of diverse biological resources in this study area with the intent of capturing complex biotic patterns of the landscape. Refer to *Chapter 1*, "Purpose of the Models" for more detail.
	b.	**Model Description and Depiction:** The models were rendered in HEP-compatible formats Model components were comprised of combinations of relevant parameters to characterize the hydrology, soils, biotic integrity, structure, spatial complexity, and disturbance regimes of the Upper Des Plaines Watershed located in northeastern Illinois, Lake and Cook Counties, and southeastern Wisconsin. Model components (and their underlying variables) were normalized (scaled from 0.0 to 1.0) as required by traditional HEP procedures. Both flow charts ("ecosystem puzzles") and mathematical algorithms were used to depict the models herein. Refer to *Chapter 3* (*Basic Model Components, Model Flow Diagrams and Model Formulas*), and *Chapter 4* (*Model Concept* and *Steps 1-5)* for details relating to the individual model components and format.
	c.	**Contribution to Planning Effort** These models helped to characterize the baseline conditions (in a quantitative manner) of the unique and significant ecological resources along the Upper Des Plaines River and its associated tributaries as they flowed through

[1] http://www.usace.army.mil/cw/cecw-cp/models/protocols_cert_7-02-07.pdf

		northeastern Illinois, Lake and Cook Counties, and southeastern Wisconsin. When applied within the HEP assessment paradigm, the study team will be able to evaluate and compare the benefits of proposed ecosystem restoration initiatives, impacts due to flood risk management measures, offsets proposed in mitigation measures.
	d.	**Description of Input Data:** Both field and spatially-explicit (GIS) data are necessary to calculate the outputs. Refer to *Chapters 3* and *4* for a list of variables and appropriate sampling protocols and statistical data management activities.
	e.	**Description of Output Data:** Habitat Suitability Indices are generated on a normalized scale of 0-1 in compliance with the traditional HEP paradigm. Within a standard HEP application, these indices can be multiplied by area to produce Habitat Units (HUs) and can be assessed over time under both With- and Without-project scenarios to generate Average Annual Habitat Units (AAHUs) (Refer to *Chapter 2 HEP Overview*).
	f.	**Statement on the capabilities and limitations of the model:** These models have been verified using reference data and conditions in the Upper Des Plaines Watershed. They can be used to assess baseline conditions as well as assess both a No Action condition and proposed alternative designs in either an Impact/Mitigation study or within an Ecosystem Restoration context. These models should not be applied outside of the watershed without review and recalibration.
	g.	**Description of model development process including documentation on testing conducted (Alpha and Beta tests):** A series of workshops were convened and experts contributed to the development of both the conceptual framework and the final index models presented here. The models were calibrated using reference data from across the model domain (Upper Des Plaines Watershed – refer to *Chapter 3* (*Reference Domain*). Internal (ERDC-EL) peer review has commenced, and the authors are considering the development of several peer-reviewed journal articles for publication. *Chapter 2* discusses the internal/external peer review process standard for ERDC-EL publications and model building efforts. *Chapter 3* discusses the model building process. *Chapter 4* addresses the model calibration process as well as the alpha/beta tests of the model to quantify baseline conditions for the study area.
2. Technical Quality		
	a.	**Theory:** In theory, the quantification of ecosystem function in these communities can be obtained by using indicators of ecosystem integrity and applying these in the well documented, and accepted HEP-based framework. The U.S. Fish and Wildlife Service (USFWS) published quantifiable procedures in 1980 to assess planning initiatives as they relate to change of fish and wildlife habitats (USFWS 1980a,b,and c). These procedures, referred to collectively as Habitat Evaluation Procedures and known widely as HEP, use a habitat-based approach to assess ecosystems and provide a mechanism for quantifying changes in habitat quality and quantity over time under proposed alternative scenarios. Habitat Suitability Indices (HSIs) are simple mathematical algorithms that generate a unitless index derived as a function of one or more environmental variables that characterize or typify the site conditions (i.e., vegetative cover and composition, hydrologic regime, disturbance, etc.) and are deployed in the HEP framework to quantify the outcomes of restoration or impact scenarios. These tools have been applied many times over the course of the last 30 years (Williams 1988, VanHorne and Wiens 1991, Brooks 1997, Brown et al. 2000, Store and Jokimaki 2003, Shifley et al. 2006, Van der Lee et al. 2006). Virtually all attempts to use HSI models have been heavily criticized, and many criticisms are well deserved. In most instances, these criticisms have focused on the lack of: (a) identification of the appropriate context (spatial and temporal) for the model parameters, (b) a conceptual framework for what the model is indicating, (c) integration of science and values, and (d) validation of the models (Kapustka 2005, Barry et al. 2006, Hirzel et al. 2006, Inglis et al. 2006, Ray and Burgman 2006, Van der Lee et al. 2006). A

fundamental problem with these approaches continues to be the inability to link species presence or relative abundance with significant aspects of habitat quality (VanHorne and Wiens 1991) such as productivity.

Despite such criticisms, HSI models have played an important role in the characterization of ecosystem conditions nationwide. They represent a logical and relatively straightforward process for assessing change to fish and wildlife habitat (Williams 1988, VanHorne and Wiens 1991, Brooks 1997, Brown et al. 2000, Kapustka 2005). The controlled and economical means of accounting for habitat conditions makes HEP a decision-support process that is superior to techniques that rely heavily upon professional judgment and superficial surveys (Williams 1988, Kapustka 2005). They have proven to be invaluable tools in the development and evaluation of restoration alternatives (Williams 1988, Brown et al. 2000, Store and Kangas 2001, Kapustka 2003, Store and Jokimaki 2003, Gillenwater et al. 2006, Schluter et al. 2006, Shifley et al. 2006), managing refuges and nature preserves (Brown et al. 2000, Ortigosa et al. 2000, Store and Kangas 2001, Felix et al. 2004, Ray and Burgman 2006, Van der Lee et al. 2006) and others), and mitigating the effects of human activities on wildlife species (Burgman et al. 2001, NRC 2001, Van Lonkhuyzen et al. 2004). These modeling approaches emphasize usability. Efforts are made during model development to ensure that they are biologically valid and operationally robust. Most HSI models are constructed largely as working versions rather than as final, definitive models (VanHorne and Wiens 1991). Simplicity is implicitly valued over comprehensiveness, perhaps because the models need to be useful to field managers with little training or experience in this arena. The model structure is therefore simple, and the functions incorporated in the models are relatively easy to understand. The functions included in models are often based on published and unpublished information that indicates they are responsive to species density through direct or indirect effects on life requisites. The general approach of HSI modeling is valid, in that the suitability of habitat to a species is likely to exhibit strong thresholds below which the habitat is usually unsuitable and above which further changes in habitat features make little difference. And as such, most HSI models should be seen as quantitative expressions of the best understanding of the relations between easily measured environmental variables and habitat quality. Habitat suitability models then, are a compromise between ecological realism and limited data and time (Radeloff et al. 1999, Vospernik et al. 2007).

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	b.	**Description of system being represented by the model:** The Upper Des Plaines prairie, savanna and woodland ecosystems have been modeled here. *Chapter 3* offers community (ecosystem) characterizations garnered from peer reviewed literature and gray literature generated by federal/local resource management agencies.
	c.	**Analytical requirements and assumptions:** Adequate sample sizes (30+ per variable) must be obtained to assure some level of precision (reduction of uncertainty). It is assumed that the user will adopt and follow the suggested sampling protocols detailed herein. Follow-on data management (calculation of means per variable) is straightforward and should not be difficult to emulate.

	d.	**Conformance with Corps policies and procedures:** As indicated in the PMIP, HEP is an accepted and approved approach to quantifying benefits/impacts for these types of studies (Refer to Chapter 1 *Planning Model Certification*). The protocol described herein is being fully vetted through the ERDC review process, and participants in the workshops, as well as external reviewers have been included in the process (Refer to Chapter 2 – *Model Review Process*). Outputs conform to USACE policies and procedures.
	e.	**Identification of formulas used in the model and proof that the computations are appropriate and done correctly:** Formulas can be found in Chapter 3. All spreadsheets used to organize data and the datafiles used to calculate outputs can be obtained from the District upon request (contact Brook Herman – see Appendix D for contact information). ERDC-EL performed QA/QC on all spreadsheet and datafile operations and can describe these to the reviewers upon request.
3. System Quality		
	a.	**Description and rationale for selection of supporting software tool/programming language and hardware platform:** The **HEAT** software is a fully vetted software package currently undergoing model certification. The models described here are not software per se (Refer to Chapter 1 – *Planning Model Certification*), and as such do not contain any programming. ArcMap, ArcToolbox, and Spatial Analyst are all commercially developed off-the-shelf software programs readily available to the user base.
	b.	**Proof that the programming was done correctly:** NA
	c.	**Description of process used to test and validate model:** Verification of the models can be found in Chapter 4 – *Model Verification*.
	d.	**Discussion of the ability to import data into other software analysis tools (interoperability issue):** NA
4. Usability		
	a.	**Availability of input data necessary to support the model:** All data (presented in spreadsheet and database format) can be obtained from the District upon request (contact Brook Herman – see Appendix D for contact information).
	b.	**Formatting of output in an understandable manner:** Outputs of the model are standard indices (HSI) - compatible with traditional HEP applications (scaled 0-1).
	c.	**Usefulness of results to support project analysis:** Model results have been successfully utilized in plan formulation and alternative comparison analyses for the Upper Des Plaines study.
	d.	**Ability to export results into project management documentation:** All outputs are MS Office-compatible and easily imported into MS Word and MS PowerPoint for documentation and distribution.
	e.	**Training availability:** **HEAT** software training was been provided to the Chicago District and the stakeholders/partners engaged in the Upper Des Plaines E-Team in 2004. The current District POC (Brook Herman) received additional training at ERDC in 2008. ERDC-EL also provides model building workshops at the local, regional and national level through PROSPECT and/or on a reimbursable basis. The District was also required to perform 1/3 of all calculations and 1/3 of all spreadsheet management activities to assure successful technology transfer ("ownership") of the models and the evaluations thereafter.
	f.	**Users documentation availability and whether it is user friendly and complete:** This document serves as the model "manual."

		There is a draft manual for the **HEAT** software currently undergoing certification (Burks-Copes et al. 2008). And there are Ecological Service Manuals (ESMs) to support HEP applications (USFWS 1980a-c).
	g.	**Technical support availability:** ERDC-EL provides technical support on all products upon request and on a reimbursable basis.
	h.	**Software/hardware platform availability to all or most users:** The models are provided in both MS Word and MS Excel format and in **HEAT** datafiles to all study participants (including contractors and stakeholders). All data (presented in spreadsheet and database format) can be obtained from the District upon request (contact Brook Herman – see *Appendix D* for contact information). The GIS data utilized herein is available upon request from the Albuquerque District.
	i.	**Accessibility of the model:** The model is accessible now, and will be posted on the System-wide Water Resources Program's (SWWRP) Water Resources Depot website upon completion of ERDC-EL technical review (https://swwrp.usace.army.mil/DesktopDefault.aspx).
	j.	**Transparency of model and how it allows for easy verification of calculations and outputs:** The mathematical operations in the models are clearly documented herein and can be easily transferred into any spreadsheet program for verification (a step ERDC-EL uses to QA/QC every model development activity). The outputs are scaled from 0-1 (1 = optimal functionality and 0 = not functioning). An interpretative table has been provided in *Chapter 4* to assist the user in conclusions.
	k.	**Accessibility (where is model physically located?:** Both the Chicago District and ERDC-EL will maintain separate and relatively permanent copies of all model information (NTE 7 years). The models will also be posted on the SWWRP website.

Appendix D: E-Team Participants

As described in the main report, a series of workshops were used to facilitate the development of the community-based index models compatible with the HEP application paradigm for the current feasibility study. Formal minutes were developed for each workshop and can be provided upon request from the Chicago District (contact Brook Herman – refer to contact information below). Several federal state and local agencies, as well as local and regional experts from the stakeholder organizations, and private consultants, participated in the model workshops. A complete list of participants can be found in Table D - 1 below. It is important to note that attrition over the course of the study led to many changes in this original roster. We have attempted to include both the names of original participants as well as replacements and additions here as well.

Table D - 1. Model development workshop(s) participants.

E-Team Members	Agency	Phone	Email Address
Wayne Vanderploeg	Cook County Forest Preserve District	(847) 798-9745	wvanderploueg@ameritech.net
Mike Miller	Illinois Department of Natural Resources	(217) 333-7093	miller@isgs.uiuc.edu
Steve Pescitelli	Illinois Department of Natural Resources	(630) 553-0164	spescitelli@dnrmail.state.il.us
Pat Malone	Illinois Department of Natural Resources	(217) 785-5500	pmalone@dnrmail.state.il.us
Arlan Juhl	Illinois Department of Natural Resources	(217) 782-4636	ajuhl@dnrmail.state.il.us
Rick Gosch	Illinois Department of Natural Resources	(217) 782-4636	rgosch@dnrmail.state.il.us
Jim Anderson	Lake County Forest Preserve District	(847) 968-3282	janderson@co.lake.il.us
Joe Hmieleski	Lake County Stormwater Management Commission	(847) 918-5273	jhmieleski@co.lake.il.us
Tom Slawski	Southeastern Wisconsin Regional Planning Commission	(262) 547-6721	tslawski@sewrpc.org
Ingrid West	Upper Des Plaines River Ecosystem Partnership	(630) 559-2047	westmri@hotmail.com
Brook Herman	USACE - Chicago District	(312) 846-5559	brook.d.herman@usace.army.mil
Frank Veraldi	USACE - Chicago District	(312) 846-5589	Frank.M.Veraldi@usace.army.mil

(Continued)

Table D - 1 (Concluded).

E-Team Members	Agency	Phone	Email Address
Gene Flemings	USACE - Chicago District	(312) 353-6320	Eugene.J.Flemming@usace.army.mil
J.D. Ennis	USACE - Chicago District	(312) 353-6400 ext.2002	John.D.Ennis@usace.army.mil
Jean Sellar	USACE - Chicago District	(312) 846-5588	Jean.A.Sellar@usace.army.mil
Keith Ryder	USACE - Chicago District	(312) 353-6400 ext. 2020	Keith.G.Ryder@usace.army.mil
Kim Fisher	USACE - Chicago District	(312) 353-6400 ext. 3126	Kimberly.J.Fisher@usace.army.mil
Pat Lawlor	USACE - Chicago District	(312) 353-6400 ext. 2007	Patricia.A.Lawlor@usace.army.mil
Shamel Abou-EL-Seoud	USACE - Chicago District	(312) 353-6400 ext. 3009	Shamel.Abou-el-Seod@usace.army.mil
Suzanne Davis	USACE - Chicago District	(312) 846-5580	susanne.j.davis@usace.army.mil
Dave Brandt	USDA-NRCS	(815) 338-0099 ext.111	dave.brandt@il.usda.gov
David Misek	USDA-NRCS	(847) 223-1056	davis.mesik@il.usda.gov
Tom Glatzel	USEPA: Region 5	(312) 886-6678	glatzel.thomas@epa.gov
Jeff Mengler	USFWS (Chicago Illinois Field Office)	(847) 381-2253 x 226	jeffrey_mengler@fws.gov
John Rogner	USFWS (Chicago Illinois Field Office)	(847) 381-2253 ext. 212	john_rogner@fws.gov
Mike Redmer	USFWS (Chicago Illinois Field Office)	(847) 381-2253	mike_redmer@fws.gov
Jeff Heath	formerly with USACE - Chicago District		
Mike Fisher	formerly with USACE - Chicago District		
Bill White	formerly with IDNR-OWR		

Appendix E: Model Review Forms

LPDT HSI Model Document Checklist

I. **Chapter 1 Introduction**
- ❑ Purpose of the Models
- ❑ Contribution to the Planning Effort
- ❑ Planning Model Certification
- ❑ Report Objectives
- ❑ Report Structure

II. **Chapter 2 HEP Overview**
- ❑ The HEP Process
  - ❍ Statement of Limitations
  - ❍ HSI models in HEP
  - ❍ Habitat units in HEP
  - ❍ Capturing changes over time in HEP applications
- ❑ Developing HSI Models
  - ❍ Steps in Model Development
  - ❍ Model Review Process

III. **Chapter 3: Community-based Index Model(s)**
- a. Model Development Workshops
- b. Coupling Conceptual Models and Index Models
- c. Community Characterization
  - i. General Description
  - ii. Reference Domain
  - iii. Climate Characterization
  - iv. Vegetative Characterization
  - v. Hydrologic Characterization
  - vi. Geomorphic Characterization
- d. Model Components
- e. Model Flow Diagram
- f. Reference-Based Modeling Approach
- g. Model Formulas

IV. **Chapter 4: Model Sampling and Calibration Protocols**
- ❑ Model Variable Selection Rationale
- ❑ Field Sampling Scheme and Transect Layouts
- ❑ Spatially Explicit Parameters and Analysis Protocols
- ❑ Hydrologic Data
- ❑ Statistical Analysis and Curve Calibrations

- ❑ Model Verification – Baseline Results

V. Summary and Conclusions

VI. References

Additional Contents:

- ❑ Appendix A - Notations (aka Acronyms)
- ❑ Appendix B - Glossary
- ❑ Appendix C - Model Certification Crosswalk
- ❑ Appendix D - E-Team Participants
- ❑ Appendix E - Model Review Forms
- ❑ Appendix F - Model Comments and Responses
- ❑ Appendix G – Community Index Curves

Certificate of Product Check

This certifies that adequate review was provided by all appropriate disciplines to verify the following:

1. Correct application of methods
2. Adequacy of basic data and assumptions
3. Completeness of documentation
4. Compliance with guidance, standards, regulations, and laws
5. Correct study approach

____

Kelly A. Burks-Copes Date
Principal Investigator
Environmental Laboratory
U.S. Army Engineer Research and Development Center
Vicksburg, MS

Table E - 1.Internal ERDC-EL Technology Transfer Review Form.

TECHNOLOGY TRANSFER STATUS SHEET

INSTRUCTIONS
The author(s) of a document based on ERDC-EL research and written for publication or presentation should attach one copy of this sheet to the document when the first draft is prepared. Documents include reports, abstracts, journal articles, and selected proposals and progress reports. The sheet will remain with the most recent draft of the document.

JOB NUMBERS:

a. WORD PROCESSING SECTION ______________________________
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2. TITLE	3. AUTHOR(S)
4. PRESENTATION (Conference Name & Date)	5. PUBLICATION (TR, IR, MP, Journal Name, etc.)
6. SPONSOR OR PROGRAM WORK UNIT	7. DATE REQUIRED BY SPONSOR

8. DATE DRAFT COMPLETED BY AUTHOR(S) AND AREADY FOR SECURITY OR TECHNICAL REVIEW

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a. THIS DOCUMENT HAS BEEN REVIEWED FOR SECURITY CLASSIFICATION FOLLOWING GUIDELINES SPECIFIED IN AR 380-5, DEPARTMENT OF THE ARMY INFORMAITON SECURITY PROGRAM, AND FOUND TO BE:

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CLASSIFICATION WAS BASED ON THE ______________________________
SECURITY CLASSIFICATION GUIDE DATED ______________________________

10. AUTHOR	11. DATE
12. GROUP/DIVISION CHIEF	13. DATE

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DATE TO REVIEWER DATE RETURN REQUESTED DATE RETURNED TECHNICAL REVIEWER

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DATE TO REVIEWER DATE RETURN REQUESTED DATE RETURNED TECHNICAL REVIEWER

____ ACCEPTABLE W/MINOR REVISIONS ____ ACCEPTABLE W/MAJOR REVISIONS ____ UNACCEPTABLE

c. ________________ ________________ ________________ ________________
DATE TO REVIEWER DATE RETURN REQUESTED DATE RETURNED TECHNICAL REVIEWER

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NOTE: RETURN TO AUTHOR WHEN TECHNICAL REVIEW IS COMPELTED.

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Table E - 1. (Concluded).

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Table E - 2. Security Clearance Form for ERDC-EL Reports

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INSTRUCTIONS FOR SUBMISSION OF MATERIAL FOR CLEARANCE (ENG Form 4239-R) 1. An original and two copies of papers or material on civil works functions or other non-military matters requiring HQUSACE approval, will be forwarded to reach HQUSACE at least 15 days before clearance is required. Including any maps, pictures and drawings, etc., referred to in the text. 2. Technical papers containing unpublished data and information obtained by the author in connection with his/her official duties will contain the following acknowledgement when released for publication outside the US Army Corps of Engineers. The acknowledgement will identify the research program which provided resources for the paper, the agency directing the program and a statement that publication is by permission of the Chief of Engineers. The tests described and the resulting data presented herein, unless otherwise noted, were obtained from research conducted under the _______________ of (Program) the United States Army Corps of Engineers by the _____________________. Permission was granted by (Agency) the Chief of Engineers to publish this information. 3. When manuscripts are submitted for publication in THE MILITARY ENGINEER, a brief biographical sketch (100 to 150 words) of the author is required, indicating his/her background in the subject matter.

Table E - 3. External Technical Review Form for Assessment Reports and Model Documentation

		Type: Review	Page XX of XX	
Review Comments		Concept Final: Other:	Date:	
Project: Location:		Review Focus: Model Content Name: Organization:		
Comment Number	Drawing/ Number	Page/ Space	COMMENT	ACTION

Appendix F: Model Comments and Responses

The DPII models were reviewed internally at ERDC-EL and externally by the E-Team. Comments were received from March to December of 2006. E-Team comments are provided below as well as ERDC-EL responses (Table F - 1). Changes were made accordingly.

Table F - 1. Review comments and responses.

Review Comments

Project: Upper Des Plaines River and its Tributaries Ecosystem Restoration Study

Review Focus: Model Documentation – Completeness, Scientific Basis (Editorial comments accepted as well)

Reviewer	Page/ Para	Chapter Comments	Reviewer Verbiage	Response
LRC District	General	General	1.1. Consider changing the name from HSI models to habitat quality index models: The label (Habitat Suitability Index) that was given to the models and the way in which they were derived do not agree in terms of previously agreed upon definitions. Although there was a definition given in the appendices as to the treatment of the HSI for the purposes of this report, the definition itself is vague and does nothing to truly illuminate the purpose behind the original use of the HSI.	ERDC does not concur. HSI is the term applied to index based models used in HEP. Since HEP was the method used, we prefer to keep the HEP terminology. We can clarify in sections describing HSI models and their development (Ch 2 and Glossary) that we are referring to community based approach instead of the species based. Resolution: District Agreed to response.
LRC District	General	General	1.2 Whenever the word community is used, please be specific as to what kind of community is being referred to.	Concur and will be corrected.
LRC District	Page 1/para 2	Chapter 1 - Background	In general the paragraph suggests that the UDPII study is mainly concerned with flood damage reduction and secondarily improvement of ecosystem quality. Consider rewording the paragraph to emphasize that the UDP II project is multi-purpose and will treat both objectives equally and that flood damage reduction is not considered more important over ecological restoration.	Concur and corrected in the 12-12-06 revised version. . . . District provided ERDC with correct verbiage from their Feasibility Report
LRC District	Page 2/para 2	Chapter 1 – Contribution to the Planning Effort - These methodologies help to characterize the baseline conditions (in a quantitative manner) of the numerous ecological resources throughout the watershed.	Please identify which methodologies were used for continuity of report.	The methods are identified in the last sentence of the previous paragraph and again later in this paragraph. ERDC will consider changing first sentence of paragraph to repeat the methods by name (HEP and HGM).

(Continued)

Table F - 1. (Continued).

Reviewer	Page/ Para	Chapter Comments	Reviewer Verbiage	Response
LRC District	Page 2/para 2	Chapter 1 – Contribution to the Planning Effort – The methods assisted the study team in the projection of change to fundamental ecosystem processes (without which, ecosystem restoration itself could not happen), as the multi-purpose alternatives were proposed.	Please clarify what fundamental ecosystem processes are for the purposes of this report. It seems this descriptive language is referring to the output of the models such as the Habitat Units.	ERDC will provide examples of "fundamental ecosystem processes" in this sentence.
LRC District	Pg 2/para 3 and others	Chapter 1 – Contribution to the Planning Effort -	Please explain what functional carrying capacity is referring to.	Nothing in para 3 refers to "functional carrying capacity". However in para 2, "functional capacity" is mentioned in reference to HGM. It is in no way related to carrying capacity. Recommend we refer to HGM citations and Jeff Lin's HGM model report. No further action necessary
LRC District	Pg 3	Chapter 1 - Report Objectives	Consider adding to the report objectives number 4, a discussion on the development and underlying assumptions of the models and the implications of these models, which would tie in the evolution of the HSI models to the plant community quality index for the purpose of obtaining the objectives of the study team. A suggestion, an appropriate place for this discussion would be in chapter 2.	Four (4) objectives are currently reported in the 12-12-06 revised version. The fourth objective captures the rationale, curve break points and assumptions associated with each variable. District Concurs, no further action required.
LRC District	Pg 5	Chapter 2 – In general	Consider adding the basic tenant that ecological models should be used to augment and not supplant the expertise of resource specialists with site specific knowledge; such that the models help support planning decisions and are not counter to expert knowledge.	Agreed, ecological models support planning decisions. However, under the current Corps panning paradigm, expert opinion is insufficient to justify the recommended plan selection, and therefore, PDTs are forced to make decisions based on a combination of computational models and expert opinion. District Concurs, no further action required.

(Continued)

Table F - 1. (Continued).

Reviewer	Page/ Para	Chapter Comments	Reviewer Verbiage	Response
LRC District	Pg 6/para 1	Chapter 2 – HSI models in HEP	Please provide examples of the studies where several cover types were included in an HSI model. Perhaps include where these studies took place and what kind of habitat types were included or provide a reference to these studies.	USFWS Ecological Services Manual (ESM 103) for HSI Model documentation requires that models be associated with specific cover types. ERDC will add references for 3 USFWS HSI Blue book citations to support this statement.
LRC District	Pg 6/para 1	Chapter 2 – HSI models in HEP - … any HSI model based on the existence of a single life requisite requirement uses a single formula to describe the relationship between quality and carrying capacity for the site.	Carrying capacity is used, please refer to previous comment.	HSI models used in HEP do not represent carrying capacity. ERDC will change the words "carry capacity" to "habitat suitability".
LRC District	Pg 6/para 3	Chapter 2 – HSI models in HEP	Please tie in how the concept of the Equivalent Optimum Area (EOA) is related to how the models in this report were developed.	This information was included for general information regarding the fundamentals for developing HSI models as cited by USFWS ESM 103. It does not pertain directly to UDPII models . . . ERDC will remove this discussion from the report.
LRC District	Pg 7/para 1	Chapter 2 – Habitat Units in HEP - Thus, a single model (or a series of inter-related models) can be adapted to reflect a site's response to a particular design at any scale	Please clarify the intended meaning of the word design in the sentence referring to how the models may be modified to be used at different scales. Is design related to the objectives of the potential users of the model?	Design refers to alternative plans or measures being evaluated. ERDC will clarify in final version
LRC District	Pg 7/para 1	Chapter 2 – Habitat Units in HEP - Several agencies and organizations have adapted the basic HEP methodology for their specific needs in this manner.	Please provide examples of the agencies and organizations that have used or are currently using the HSI models. Maybe provide an example of their adaptations and how their actions helped attain their goals.	ERDC will add a reference citation that reviewed HSI models in use (i.e., Inglis, G. J., H. Hurren, et al. (2006), Gillenwater, D., T. Granata, et al. (2006), and Ahmadi-Nedushan, B., A. St-Hilaire, et al. (2006).

(Continued)

Table F - 1. (Continued).

Reviewer	Page/ Para	Chapter Comments	Reviewer Verbiage	Response
LRC District	Pg 7/para 2 (Pg 8/ para 1)	Chapter 2 – Steps in Model Development	Define community assessment, refer to previous comment on definition of community.	Community assessment is not mentioned until pg 8, steps in Model development in the 12-12-06 revised version. Assuming that is the reference ERDC will reiterate the definition of community
LRC District	Pg 7 (Pg 8)	Chapter 2 – Steps in Model Development	Please provide a detailed explanation as to the process in which the decision was reached to develop community based models to appropriately meet the objectives for the upcoming feasibility study, especially in light of the fact that no previous peer-reviewed studies of this nature have been published. Please provide a more in depth discussion on the appropriateness of these models and their development for the obtainment of the study team's goals and objectives. A clearly delineated discussion on the underlying assumptions of the models is missing from this chapter as well.	Although this discussion is relevant, ERDC does not agree that it belongs in this Chapter. The District can address the DPII goals and objectives in their Assessment Report, and ERDC will include a paragraph (provided by the District) in Chapter 1 of this report as part of the introduction to model selection.
LRC District	General	Chapter 3-	4.1. Consider summarizing the bulk of information into 2-3 pages with references to more detailed information on specific sections, especially pages 13-32.	ERDC will review the chapter and consider condensing and summarizing where appropriate, however, characteristics and description of model and reference domain are required in ERDC model documentation reports.
LRC District	General	Chapter 3	4.2. Generally, many pages seem to be rather short on information, meaning almost half the page or more is without narrative, tables or figures. To ensure continuity of the report and ease of reading consider reformatting for a more seamless read and less abbreviated pages, which should unify sections and facilitate better understanding of the report.	ERDC Will review formatting, and reduce size of images where appropriate, however, ERDC report style must be followed.
LRC District	Pg 14 (Fig. 1)	Chapter 3 - General Description	4.3. Page 14, Figure 1, please be cautious of using maps from other sources which do not explicitly delineate the study area. If the use of these maps is expressing an important point, please overlay the boundaries of the study area to facilitate understanding of the information presented in the map relative to the study area.	ERDC will try to include inset of 5 county boundary of study area when possible on all maps from other sources

(Continued)

Table F - 1. (Continued).

Reviewer	Page/ Para	Chapter Comments	Reviewer Verbiage	Response
LRC District	Pg. 18 (Fig 5)	Chapter 3 - Reference Domain	4.4. Page 18, Figure 5, please be cautious of the use of pie charts when graphically representing information. Typically, the use of a bar graph is preferable to pie charts in ecology based reports and presentations.	The chart of cover type composition is visually descriptive in its current presentation format.
LRC District	Pg. 34 (Fig 21)	Chapter 3 - Ecology	4.5. Page 34, Figure 21, please incorporate a short list of cover types and their associated acronyms to facilitate understanding of this figure.	ERDC will review figure and add table of cover type descriptions and acronyms
LRC District	Pg. 35 (Tab. 1)	Chapter 3 - Ecology	4.6. Page 35, Table 1, consider placing all tables consisting of lists of species in the appendix. This would facilitate the ease of assimilating the contents of the report and would allow the reader to look up those lists if that information was desired.	ERDC will review and consider
LRC District	Pg. 38 (Tab. 2)	Chapter 3– Prairie Communities	4.7. Page 38, Table 2, consider abbreviating the community tables to the community types that occur in the study area. Although it is interesting information, it could leave the wrong impression with the reader. For example, sand, gravel and dolomite prairies are not considered a part of the current or past diversity of the study area.	ERDC will review and consider
LRC District	Pg. 44-58	Chapter 3 – Regional Wildlife	4.8 Pages 44-58, regional wildlife, again, please consider a very short summary of this section. Please refer to comment 4.1.	ERDC will review and consider condensing and summarizing this section
LRC District	Pg. 58-60 (Tab. 5 & 6)	Chapter 3 - Threatened and Endangered Species	4.9 Pages 58-60 and tables 5 and 6. Please consider including information on Wisconsin state threatened and endangered species. Also, please refer to comment 4.6.	Rather than add to the considerable size of this document, ERDC will instead refer to the District's Planning documentation for presentation of this material. Delete T& E section from Chapter 3.
LRC District	Pg. 61-74	Chapter 3 - Threats to the Upper Des Plaines River Watershed	4.10. Pages 61-74. In general, the information presented in this section is another reiteration of previously published information; please consider condensing to a summary form (1-2 pages) for reasons discussed in previous comments.	ERDC will review and consider condensing and summarizing this section
LRC District	Pg. 61-62	Chapter 3 - Threats to the Upper Des Plaines River Watershed	4.11. Pages 61-62. The list of natural processes located in the UDP study area does not seem to be related or tied to further explanations in the narrative. Also, this list seems a bit general because these same non-specific terms could be applied to almost any natural system. Consider removing.	ERDC will review and determine whether to better explain or remove

(Continued)

Table F - 1. (Continued).

Reviewer	Page/ Para	Chapter Comments	Reviewer Verbiage	Response
LRC District	Pg. 70-72 (Fig. 53-56)	Chapter 3 - Insects	4.12 Figures 53-56. Consider revising or leaving out of final draft. The titles help to interpret what the selected photos are depicting; however, a better method would be to explicitly delineate natural vs. human altered areas on each photo.	ERDC will review and consider
LRC District	General	Chapter 4 -	5.1 In general, for the prairie model, the 19 variables measured for each area deemed prairie and assigned a score based on the SI curves seems extremely high based on the assumed accuracy and predictive power of the model.	Variable selection, incorporation and calibration (i.e., sensitivity) were directed by experts chosen by the District and stakeholders.
LRC District	General	Chapter 4 - Descriptions of Components	5.2. In general, the descriptions of the components (e.g. diversity, structure, etc.) seem to be the actual assumptions underlying the prairie community model, if this is so, please consider labeling them as such.	Assumption is that the functionality of Prairies can be characterized by quantifying the relationships between model components and fundamental ecosystem processes. Therefore, ERDC will not be changing this section to characterize model components descriptions as assumptions, rather, ERDC will include the above assumption in the opening paragraph of this section.
LRC District	Pg. 75, para. 2	Chapter 4 - Applicable Cover Type Habitats	5.3. Page 75, paragraph 2, for continuity please explain how the differences in vegetative cover types were defined.	Concur. ERDC will add to the cover type descriptions
LRC District	Pg. 93	Chapter 4 - Percent of Area that is Core (AREACORE)	5.4. Page 93, please provide some more detail on how the 100 meters was chosen or derived as the specific area defined as edge. Although, there are references cited from specific studies, what was their specific area they believed was edge and was the 100 meters somehow an average of those studies?	Variable selection, incorporation and calibration (i.e., sensitivity) were directed by experts chosen by the District and stakeholders. Please refer to specific studies cited for more details.
LRC District	Pg. 96	Chapter 4 -	5.5. Page 96, please reconsider the use of the term canopy in the description of the variable which measures the percentage of cover of ground vegetation. The label is confusing as to how ground vegetation can also be described as canopy.	Variable selection, incorporation and calibration (i.e., sensitivity) were directed by experts chosen by the District and stakeholders.
LRC District	Pg. 96	Chapter 4 -	5.6. Page 96, paragraph 4, please reword first sentence.	Concur

(Continued)

Table F - 1. (Continued).

Reviewer	Page/ Para	Chapter Comments	Reviewer Verbiage	Response
LRC District	Pg. 98	Chapter 4 -	5.7. Page 98, please refer to comment 5.5.	Variable selection, incorporation and calibration (i.e., sensitivity) were directed by experts chosen by the District and stakeholders.
LRC District	Pg. 99	Chapter 4 -	5.8. Page 99, please refer to comment 5.5.	Variable selection, incorporation and calibration (i.e., sensitivity) were directed by experts chosen by the District and stakeholders.
LRC District	Pg. 105	Chapter 4 – Definition term	5.9. Page 105, please be aware of the fact the FQI is a weighted average and that using the FQI to calculate another number by way of a mathematical formula, averaging the FQI and other measured variables, is in effect taking an average of an average, which is not considered valid.	Variable selection, incorporation and calibration (i.e., sensitivity) were directed by experts chosen by the District and stakeholders.
LRC District	General	Chapter 4 – Indicator Species	5.10. In general, please consider changing the label of indicator species to conservative species whenever a variable is defined as measuring the number of species with a coefficient of conservatism (C) value of five or greater.	Variable selection, incorporation and calibration (i.e., sensitivity) were directed by experts chosen by the District and stakeholders.
LRC District	Pg. 117, para. 4	Chapter 5 - Savanna Components and Relationships	6.1. Page 117, paragraph 1, the savanna model is referred to as prairie.	Concur – will correct
LRC District	General	Chapter 5 – (number of Variables)	6.2 Please refer to comment 5.1 as to the reasoning behind the number of variables chosen for the model.	Variable selection, incorporation and calibration (i.e., sensitivity) were directed by experts chosen by the District and stakeholders.
LRC District	General	Chapter 5 – (description of components)	6.3. Please refer to comment 5.2 as to the descriptions of the components	Will review and consider
LRC District	Pg. 117, para. 2	Chapter 5 - Applicable Cover Type Habitats	6.4. Page 117, paragraph 2, for continuity please explain how the differences in vegetative cover types were defined.	Concur. Will add to the cover type descriptions
LRC District	Pg. 136	Chapter 5	6.5. Page 136, please refer to comment 5.4. as to more detail on how the 100 meters was chosen for edge comparison.	Variable selection, incorporation and calibration (i.e., sensitivity) were directed by experts chosen by the District and stakeholders. Please refer to specific studies cited for more details.

(Continued)

Table F - 1. (Continued).

Reviewer	Page/ Para	Chapter Comments	Reviewer Verbiage	Response
LRC District	Pg. 138	Chapter 5	6.6. Page 138, please refer to comment 5.5.	Variable selection, incorporation and calibration (i.e., sensitivity) were directed by experts chosen by the District and stakeholders.
LRC District	Pg. 139, para. 3	Chapter 5 - Suitability Index.	6.7. Page 139, paragraph 3, please reword first sentence.	Concur
LRC District	Pg. 142	Chapter 5	6.8. Page 142, please refer to comment 5.5.	Variable selection, incorporation and calibration (i.e., sensitivity) were directed by experts chosen by the District and stakeholders.
LRC District	Pg. 149	Chapter 5	6.9. Page 149, please refer to comment 5.9. be aware of the fact the FQI is a weighted average.	Variable selection, incorporation and calibration (i.e., sensitivity) were directed by experts chosen by the District and stakeholders.
LRC District	Pg. 156	Chapter 5 – Fig. 7	6.10. Page 156, consider reformatting Figure 107 to a larger size, it is a little hard to read in its present condition.	Concur – all variable curve figures will be the same size
LRC District	General	Chapter 5	6.11. In general, please refer to comment 5.10	Will review and consider changing label of indicator to conservative
LRC District	Pg. 136, para. 1	Chapter 6 – Woodland Components and Relationships	7.1. Page 163, paragraph 1, the woodland model is referred to as prairie.	Concur – will correct
LRC District	General	Chapter 6 – Number of Variables	7.2. Please refer to comment 5.1 as to the reasoning behind the number of variables chosen for the model.	Variable selection, incorporation and calibration (i.e., sensitivity) were directed by experts chosen by the District and stakeholders.
LRC District	General	Chapter 6 – Components	7.3. Please refer to comment 5.2 as to the descriptions of the Components	ERDC will review and consider
LRC District	Pg. 163, para. 2	Chapter 6 – Applicable Cover Type Habitats	7.4. Page 163, paragraph 2, for continuity please explain how the differences in vegetative cover types were defined.	Concur. ERDC will add to the cover type descriptions

(Continued)

Table F - 1. (Continued).

Reviewer	Page/ Para	Chapter Comments	Reviewer Verbiage	Response
LRC District	General	Chapter 6 – Canopy term	7.5 In general, please reconsider the use of the term canopy in the description of variables which measure the percentage of cover of herbaceous ground vegetation. Please refer to comment 5.5.	Variable selection, incorporation and calibration (i.e., sensitivity) were directed by experts chosen by the District and stakeholders.
LRC District	Pg. 186, para. 3	Chapter 6 – Suitability Index.	7.6. Page 186, paragraph 3, please reword first sentence.	Concur
LRC District	General	Chapter 6	7.7. Please refer to comment 5.9.	Concur – all variable curve figures will be the same size
LRC District	General	Chapter 6	7.8. In general, please refer to comment 5.10.	Will review and consider changing label of indicator to conservative
Lake Cnty Stormwater Mgmnt District	Pg. 1, para 2	Chapter 1 – Background	Replace last sentence with: "The general approach was to design and implement projects to reduce flood damages and at the same time improving the overall quality of an ecosystem degraded over the years by farming and development."	ERDC will review and consider
Lake Cnty Stormwater Mgmnt District	Pg. 1, para 3	Chapter 1 – Background	End of sentence 1, insert: "each at different scales."	Concur.
Lake Cnty Stormwater Mgmnt District	Pg 1, para 3	Chapter 1 - Background	Sentence 2, delete: "It is important to note that by definition"; Capitalize: Ecosystems	ERDC will review and consider
Lake Cnty Stormwater Mgmnt District	Pg. 2, para 1	Chapter 1 – Background	Sentence 1, delete: "We must recognize that"; Capitalize: Planning	ERDC will review and consider

(Continued)

Table F - 1. (Continued).

Reviewer	Page/ Para	Chapter Comments	Reviewer Verbiage	Response
Lake Cnty Stormwater Mgmnt District	Pg. 2, para 1	Chapter 1 – Background	Delete: "Scientists often become mired in the details about what exactly should be measured, what spatial scale should be studied, how frequently measurements should be taken, and how much data should be accumulated before recommendations are presented to decision makers. Those ecologists who are more oriented to problem solving (e.g., USACE planners, resource managers, etc.) point out that every detail of an ecosystem does not have to be understood in order to make reasonably intelligent decisions about the planning management and conservation of sensitive or valued resources."	ERDC will review and consider
Lake Cnty Stormwater Mgmnt District	Pg. 2, para 2	Chapter 1 – Background	Delete: "Obviously,"; Capitalize: Determining	Concur
Lake Cnty Stormwater Mgmnt District	Pg 2, para 3	Chapter 1 – Background	Sentence 2, delete: "And with their tried-and-true structure,"; Capitalize: These	Concur
Lake Cnty Stormwater Mgmnt District	Pg 2, para 3	Chapter 1 – Background	Beginning of sentence 3, insert: "We designed"; Delete: "were designed"	Concur – if ERDC editors agree
Lake Cnty Stormwater Mgmnt District	Pg 2, para 3	Chapter 1 – Background	Beginning of last sentence, insert: "We calculated"; Delete: "were calculated"	Concur – if ERDC editors agree
Lake Cnty Stormwater Mgmnt District	Pg 2, para 4	Chapter 1 – Background	Sentence 1, insert: "we convened" an interagency; Delete "was convened"	Concur – if ERDC editors agree

(Continued)

Table F - 1. (Continued).

Reviewer	Page/ Para	Chapter Comments	Reviewer Verbiage	Response
Lake Cnty Stormwater Mgmnt District	Pg. 11, para 1	Chapter 3 – General Description	Sentence 2, delete: "has" served as	Concur – if ERDC editors agree
Lake Cnty Stormwater Mgmnt District	Pg. 13, Fig. 2	Chapter 3 – General Description	Figure 2, This picture is not good - too fuzy	Will review and consider replacing it with better resolution image, if we can acquire one.
Lake Cnty Stormwater Mgmnt District	Pg. 13, para 1	Chapter 3 – Reference Domain	Why was this region chosen - I mean, just the Upper Des Plaines Watershed? Why didnt we look at other stretches of this watershed? What causes the upper part of the watershed to stand out from the other portions of the shed?	First, the reference domain boundary was based on the HGM determination (which was based on geomorphic classification) and we wanted the HEP models to emulate the same boundary. Second, was a scoping issue for the project . ERDC will review this section and consider adding more detail for justification.
Lake Cnty Stormwater Mgmnt District	Pg. 17, para 1	Chapter 3 - Geology	Sentence 3, delete "construction" began about 26,000 years ago	Concur
Lake Cnty Stormwater Mgmnt District	Pg. 39, 40, 46, 47, 50, 65, 66, Tables 2, 3, 4, 5, 6, 7, 8	Chapter 3	Columns being cut off!	ERDC editors will correct all formatting issues
Lake Cnty Stormwater Mgmnt District	Pg. 66, para 1 list	Chapter 3 - Threats to the upper Des Plaines River Watershed	It might be better to group all of the "water" parameters together, then "soil", then the others	ERDC will review and consider
Lake Cnty Stormwater Mgmnt District	Pg. 89, 91, 96, Tables 10, 11, 12	Chapter 4	Columns being clipped	ERDC editors will correct all formatting issues

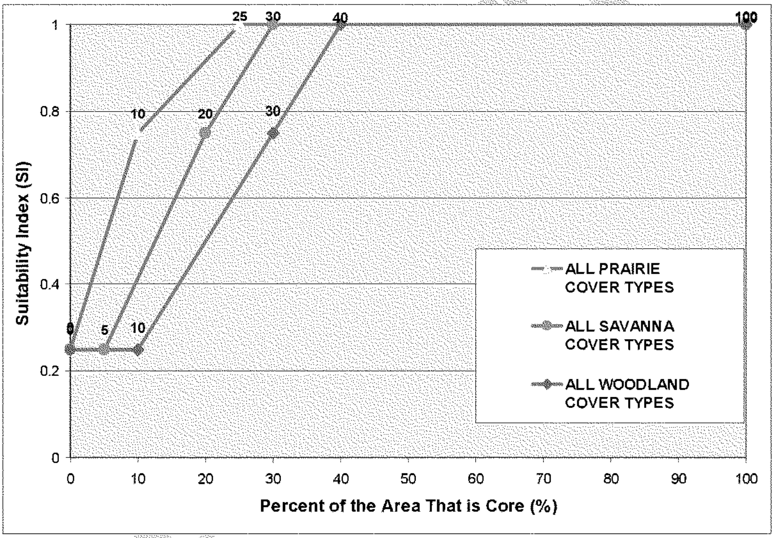
(Continued)

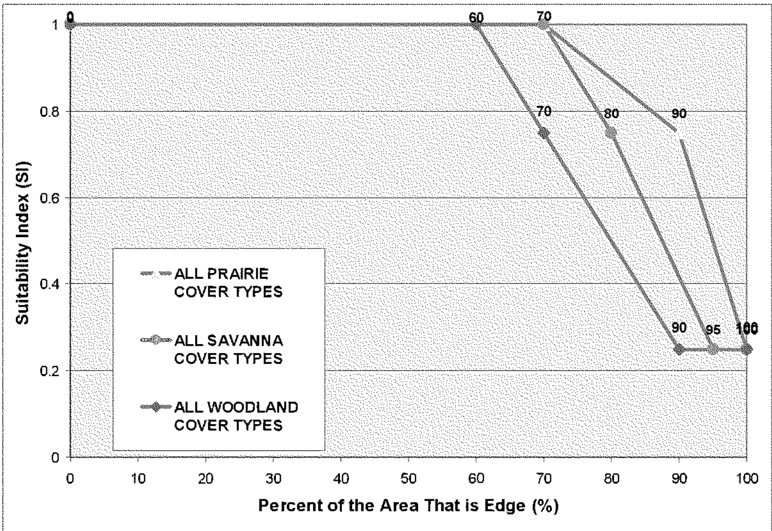
Table F - 1. (Continued).

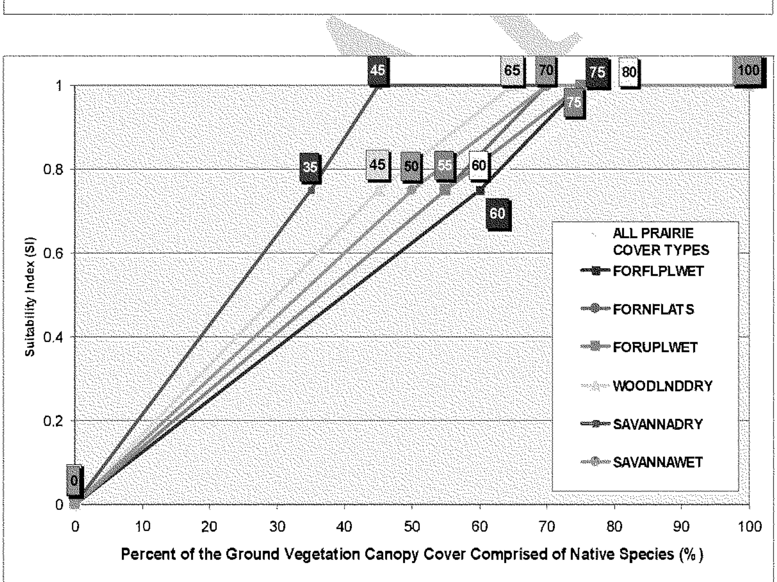
Reviewer	Page/ Para	Chapter Comments	Reviewer Verbiage	Response
Lake Cnty Stormwater Mgmnt District	Pg. 131, 132, Tables 14, 15	Chapter 5 - Model Calibration – Reference Sites	Columns being clipped	ERDC editors will correct all formatting issues
Lake Cnty Stormwater Mgmnt District	Pg. 176, 178, 184, Tables 18, 19, 20	Chapter 6	Columns being clipped	ERDC editors will correct all formatting issues

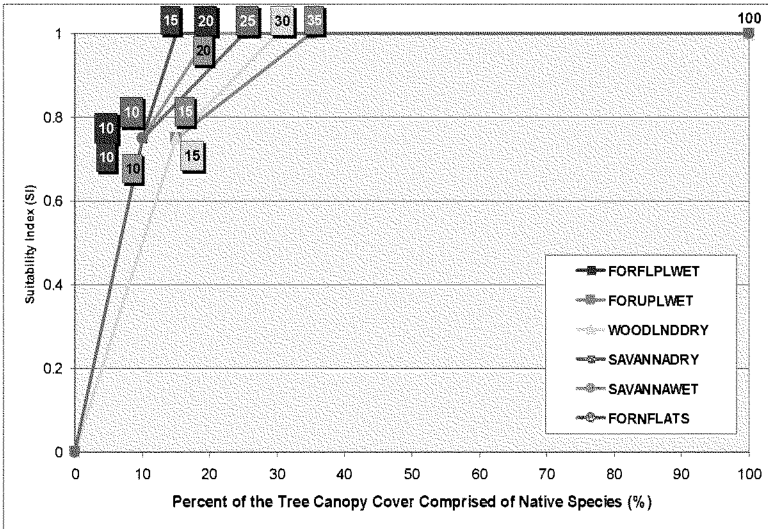
Appendix G:
HSI Curves for the Community Index Models

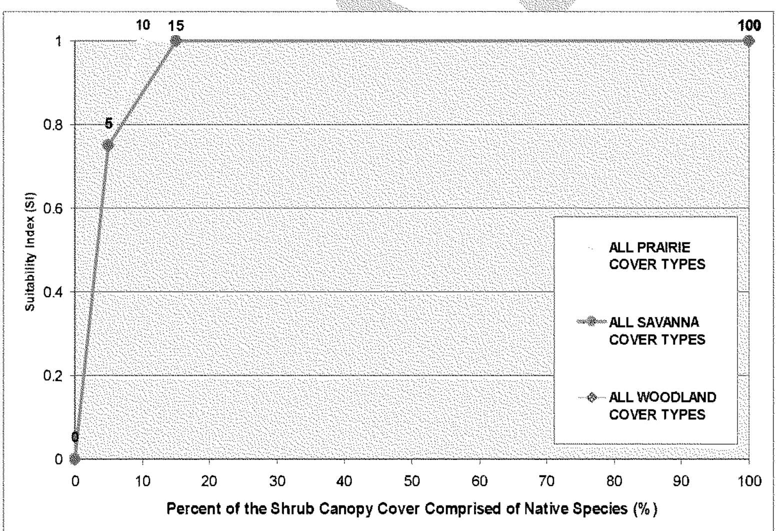
The following curves were developed by the E-Team to measure ecosystem function in the Des Plaines communities found along the Upper Des Plaines River and its various tributaries running through Wisconsin south through Illinios. Note that curves displayed in red indicate a consensus decision by the E-Team to modify the curve from the original field/GIS data collected.

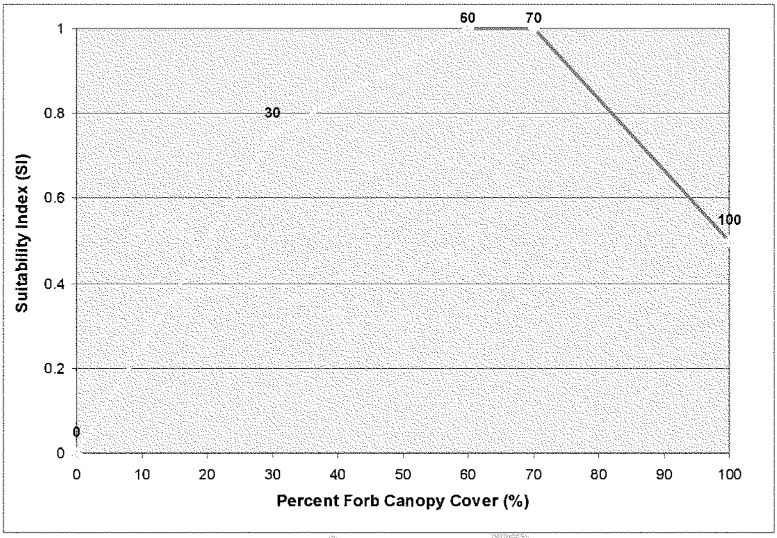


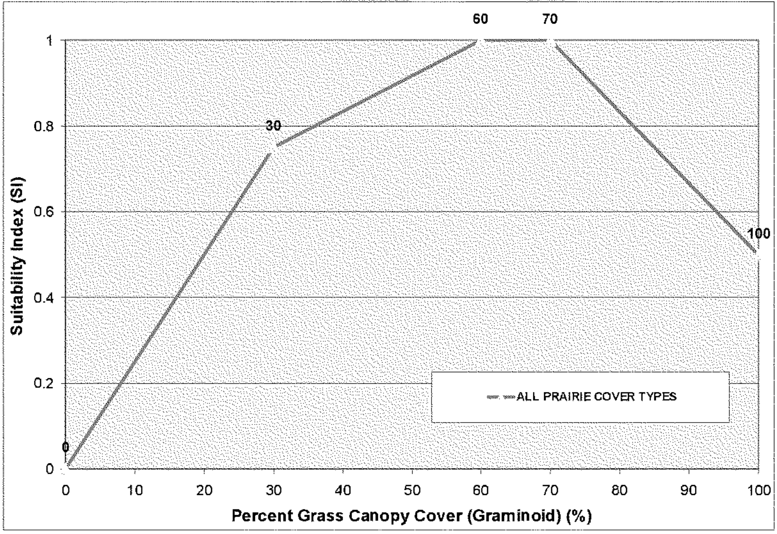

Suitability Index (SI)
Percent of the Area That is Edge (%)
ALL PRAIRIE COVER TYPES
ALL SAVANNA COVER TYPES
ALL WOODLAND COVER TYPES

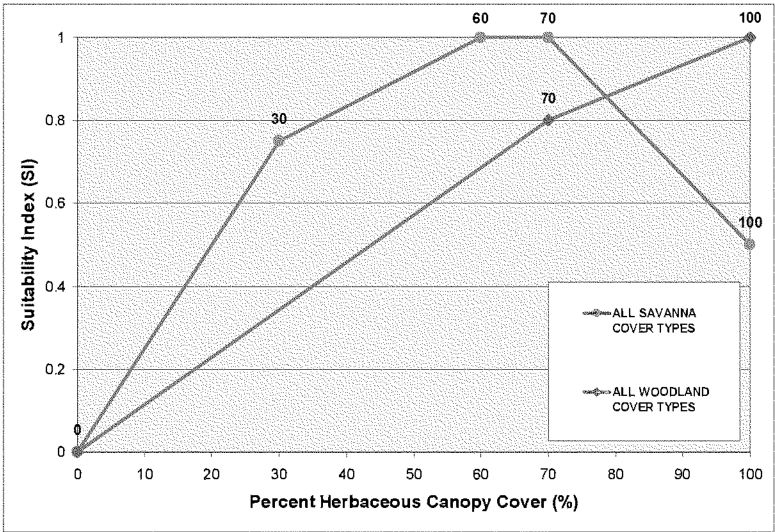

Suitability Index (SI)
Percent of the Ground Vegetation Canopy Cover Comprised of Native Species (%)
ALL PRAIRIE COVER TYPES
FORFLPLWET
FORNFLATS
FORUPLWET
WOODLNDDRY
SAVANNADRY
SAVANNAWET

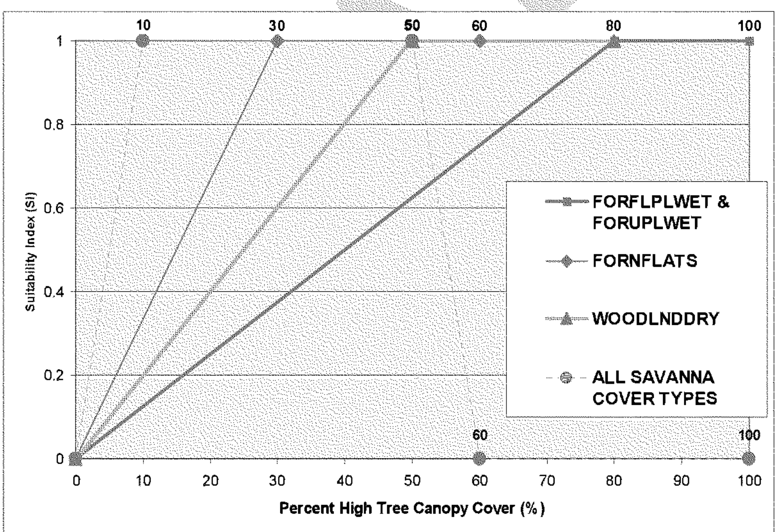

Suitability Index (SI)
Percent of the Tree Canopy Cover Comprised of Native Species (%)
FORFLPLWET
FORUPLWET
WOODLNDDRY
SAVANNADRY
SAVANNAWET
FORNFLATS

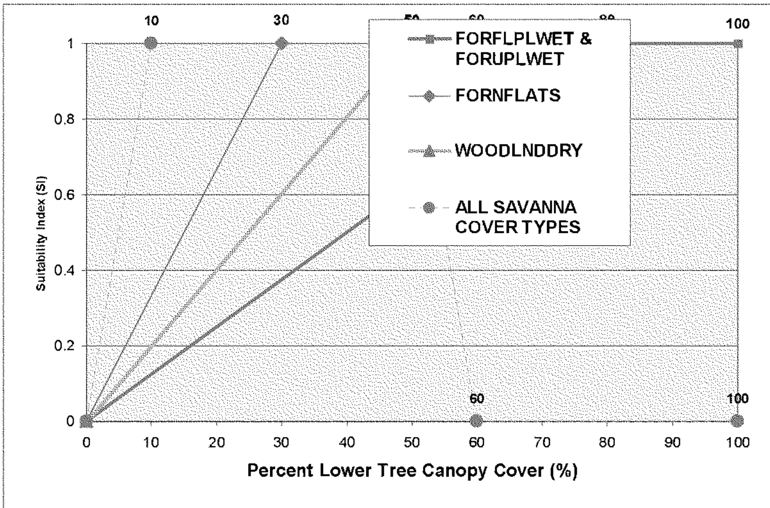

Suitability Index (SI)
Percent of the Shrub Canopy Cover Comprised of Native Species (%)
ALL PRAIRIE COVER TYPES
ALL SAVANNA COVER TYPES
ALL WOODLAND COVER TYPES

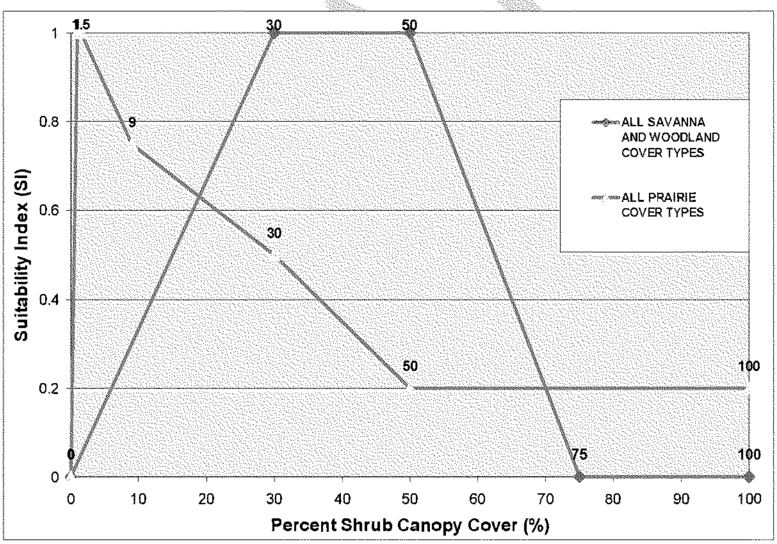

60
70
30
100
0
Suitability Index (SI)
Percent Forb Canopy Cover (%)

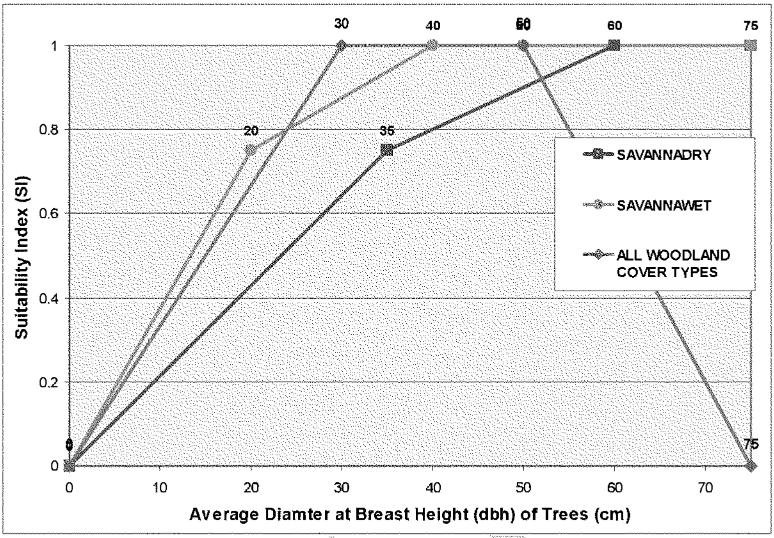

60
70
30
100
0
Suitability Index (SI)
ALL PRAIRIE COVER TYPES
Percent Grass Canopy Cover (Graminoid) (%)

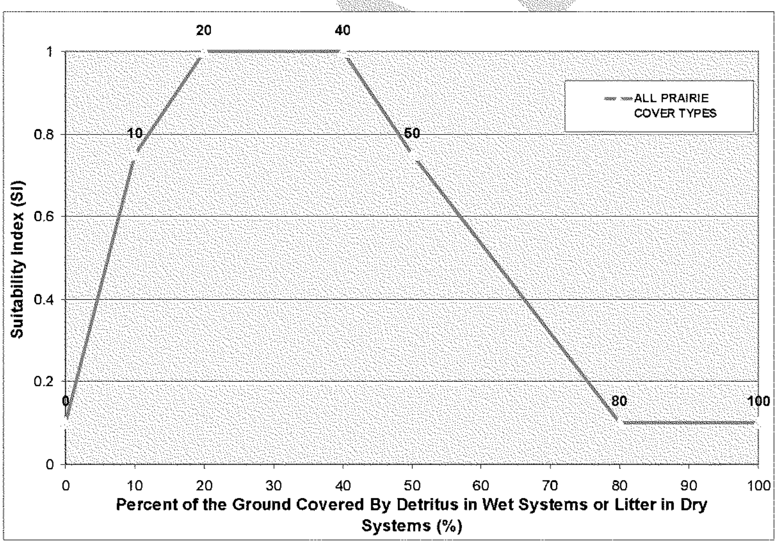

Suitability Index (SI)
Percent Herbaceous Canopy Cover (%)
ALL SAVANNA COVER TYPES
ALL WOODLAND COVER TYPES
0
30
60
70
70
100
100

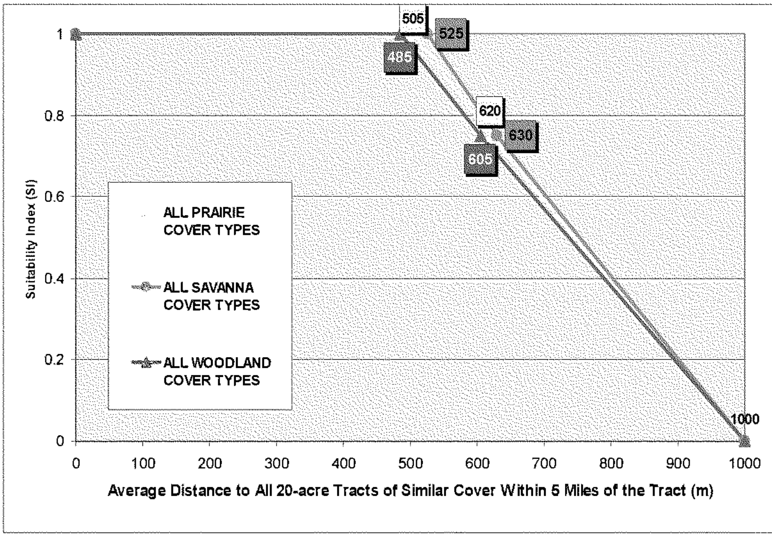

Suitability Index (SI)
Percent High Tree Canopy Cover (%)
FORFLPLWET & FORUPLWET
FORNFLATS
WOODLNDDRY
ALL SAVANNA COVER TYPES
10
30
50
60
80
100
60
100

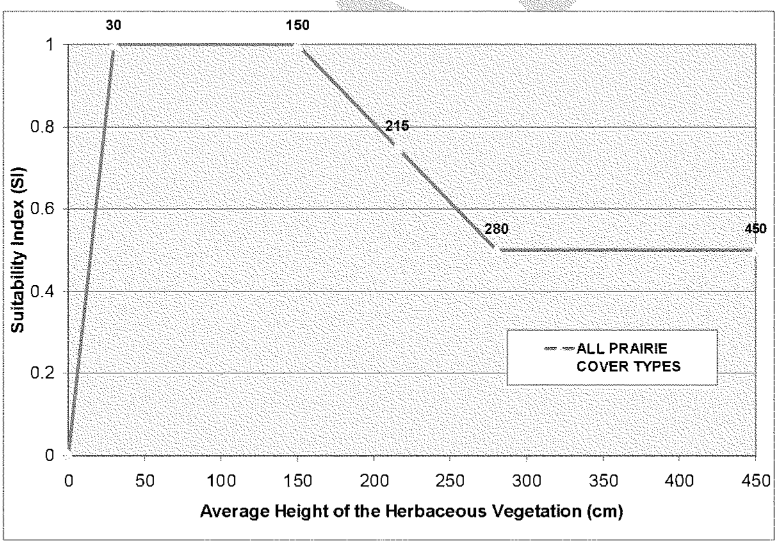

FORFLPLWET & FORUPLWET
FORNFLATS
WOODLNDDRY
ALL SAVANNA COVER TYPES
Suitability Index (SI)
Percent Lower Tree Canopy Cover (%)
10
30
100
60
100

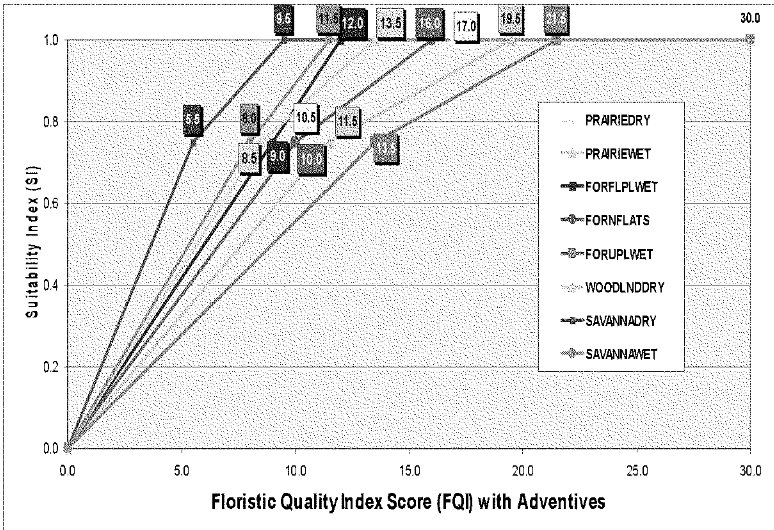

ALL SAVANNA AND WOODLAND COVER TYPES
ALL PRAIRIE COVER TYPES
Suitability Index (SI)
Percent Shrub Canopy Cover (%)
1.5
30
50
9
30
50
100
0
75
100


SAVANNADRY
SAVANNAWET
ALL WOODLAND COVER TYPES
Suitability Index (SI)
Average Diamter at Breast Height (dbh) of Trees (cm)

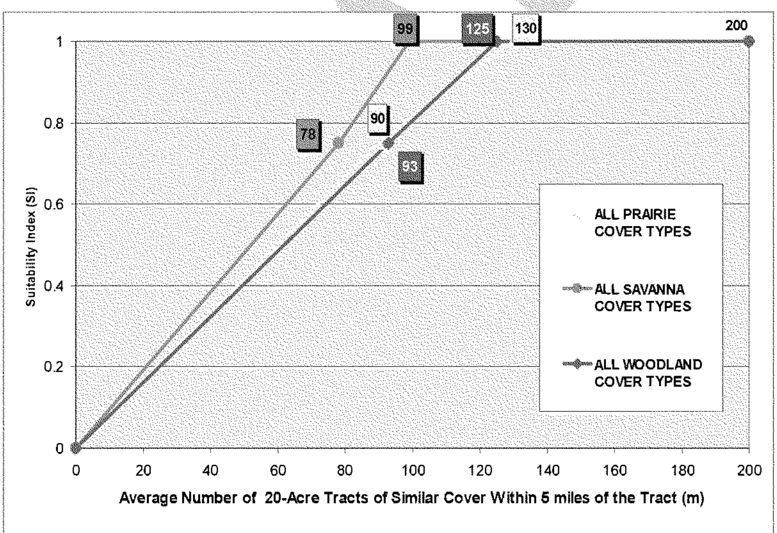

ALL PRAIRIE COVER TYPES
Suitability Index (SI)
Percent of the Ground Covered By Detritus in Wet Systems or Litter in Dry Systems (%)


505
525
485
620
630
605
1000
1
0.8
0.6
0.4
0.2
0
Suitability Index (SI)
ALL PRAIRIE COVER TYPES
ALL SAVANNA COVER TYPES
ALL WOODLAND COVER TYPES
0
100
200
300
400
500
600
700
800
900
1000
Average Distance to All 20-acre Tracts of Similar Cover Within 5 Miles of the Tract (m)

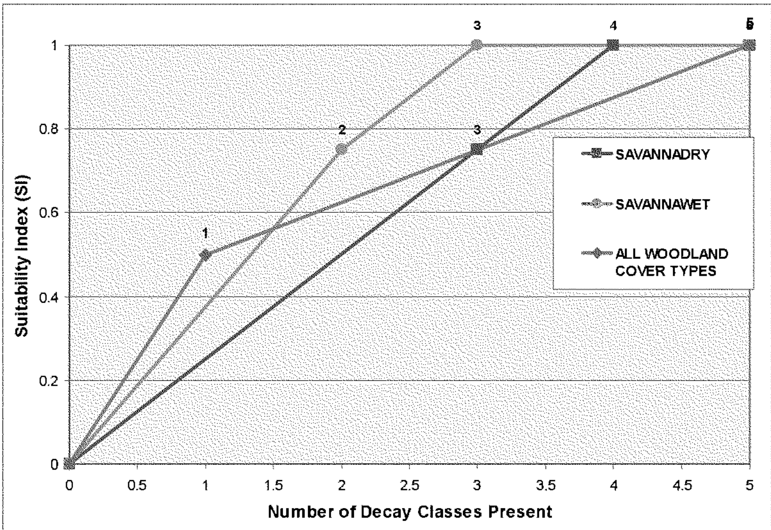

30
150
215
280
450
1
0.8
0.6
0.4
0.2
0
Suitability Index (SI)
ALL PRAIRIE COVER TYPES
0
50
100
150
200
250
300
350
400
450
Average Height of the Herbaceous Vegetation (cm)

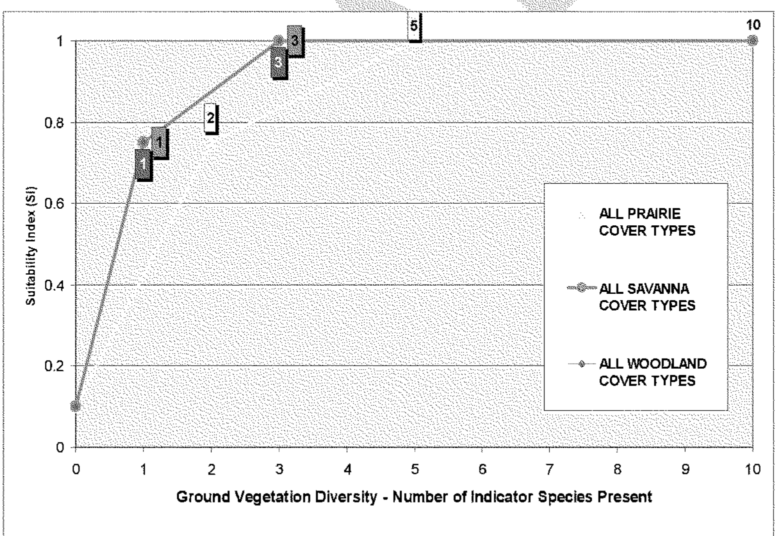


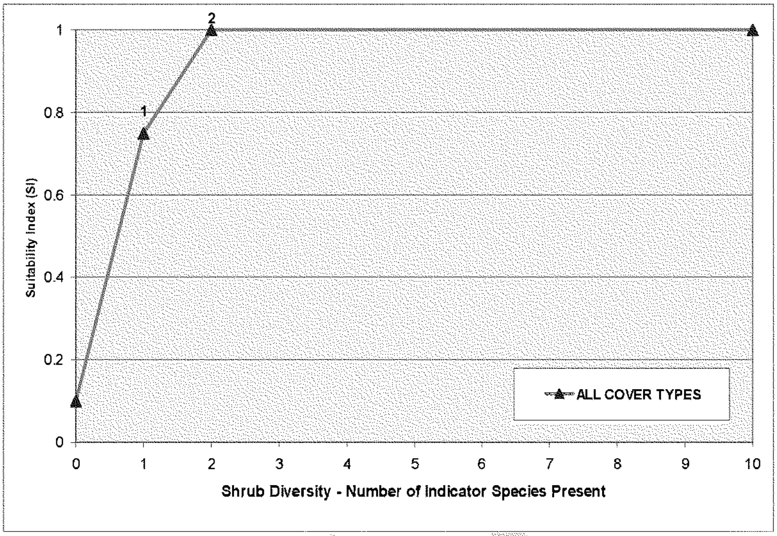
9.5
11.5
12.0
13.5
16.0
17.0
19.5
21.5
30.0
5.5
8.0
10.5
11.5
8.5
9.0
10.0
13.5
1.0
0.8
0.6
0.4
0.2
0.0
Suitability Index (SI)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
Floristic Quality Index Score (FQI) with Adventives
PRAIRIEDRY
PRAIRIEWET
FORFLPLWET
FORNFLATS
FORUPLWET
WOODLNDDRY
SAVANNADRY
SAVANNAWET

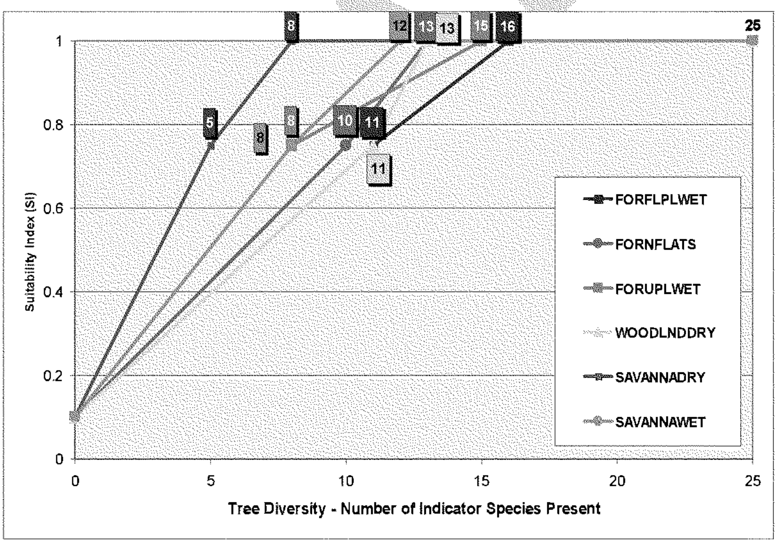


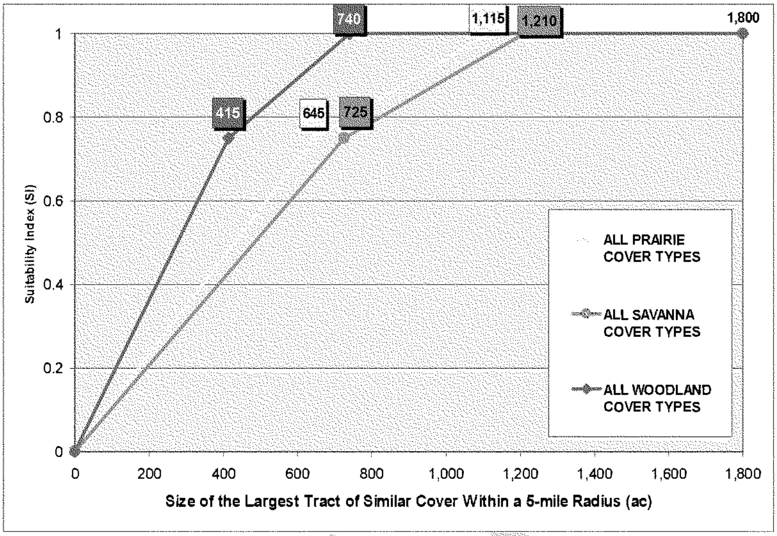
99
125
130
200
78
90
93
1
0.8
0.6
0.4
0.2
0
Suitability Index (SI)
0
20
40
60
80
100
120
140
160
180
200
Average Number of 20-Acre Tracts of Similar Cover Within 5 miles of the Tract (m)
ALL PRAIRIE COVER TYPES
ALL SAVANNA COVER TYPES
ALL WOODLAND COVER TYPES

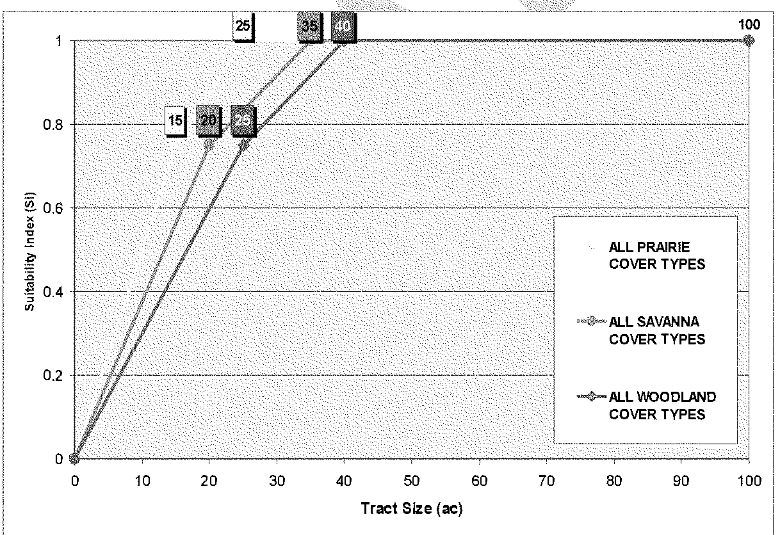

Suitability Index (SI)
Number of Decay Classes Present
SAVANNADRY
SAVANNAWET
ALL WOODLAND COVER TYPES

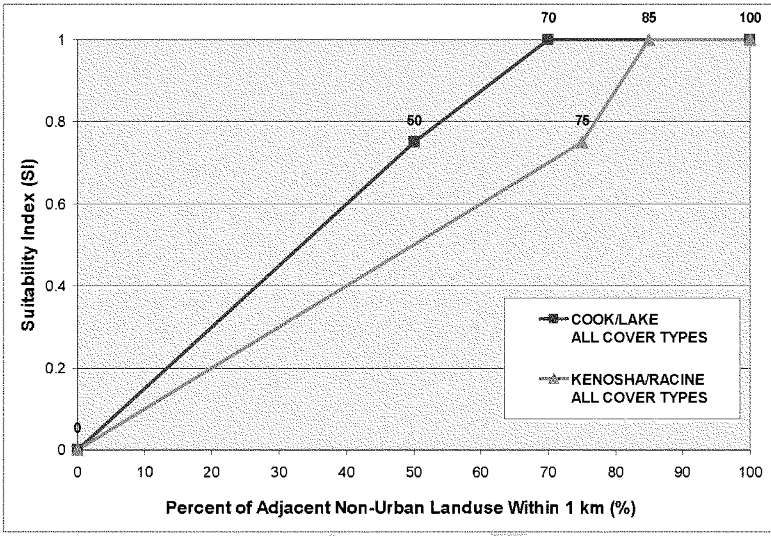

Suitability Index (SI)
Ground Vegetation Diversity - Number of Indicator Species Present
ALL PRAIRIE COVER TYPES
ALL SAVANNA COVER TYPES
ALL WOODLAND COVER TYPES

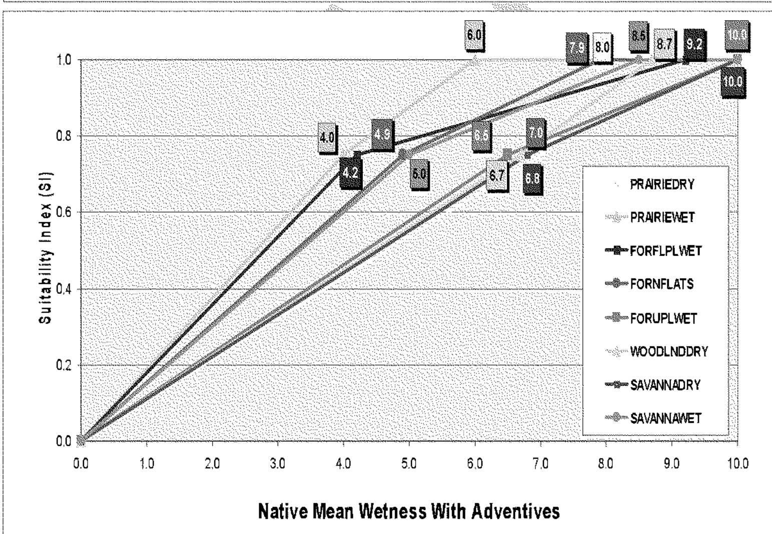

Suitability Index (SI)
Shrub Diversity - Number of Indicator Species Present
ALL COVER TYPES


Suitability Index (SI)
Tree Diversity - Number of Indicator Species Present
FORFLPLWET
FORNFLATS
FORUPLWET
WOODLNDDRY
SAVANNADRY
SAVANNAWET


740
1,115
1,210
1,800
415
645
725
Suitability Index (SI)
1
0.8
0.6
0.4
0.2
0
0 200 400 600 800 1,000 1,200 1,400 1,600 1,800
Size of the Largest Tract of Similar Cover Within a 5-mile Radius (ac)
ALL PRAIRIE COVER TYPES
ALL SAVANNA COVER TYPES
ALL WOODLAND COVER TYPES


25
35
40
100
15
20
25
Suitability Index (SI)
1
0.8
0.6
0.4
0.2
0
0 10 20 30 40 50 60 70 80 90 100
Tract Size (ac)
ALL PRAIRIE COVER TYPES
ALL SAVANNA COVER TYPES
ALL WOODLAND COVER TYPES


Suitability Index (SI)
Percent of Adjacent Non-Urban Landuse Within 1 km (%)
0
50
70
75
85
100
COOK/LAKE
ALL COVER TYPES
KENOSHA/RACINE
ALL COVER TYPES


Suitability Index (SI)
Native Mean Wetness With Adventives
4.0
4.2
4.9
5.0
6.0
6.5
6.7
6.8
7.0
7.9
8.0
8.5
8.7
9.2
10.0
10.0
PRAIRIEDRY
PRAIRIEWET
FORFLPLWET
FORNFLATS
FORUPLWET
WOODLNDDRY
SAVANNADRY
SAVANNAWET

Appendix H: Species List for Upper Des Plaines Watershed

The following list of species was developed by the Chicago District in an effort to characterize the communities modeled herein. Please direct questions regarding the content of this table to the District's POC (Brook Herman - see *Appendix D* for contact information) (click here to view attached file).

ERDC/EL TR-06-4

Environmental Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

Wetlands Research Program

A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Depressional Wetlands in the Upper Des Plaines River Basin

Jeff P. Lin

May 2006

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Jeff P. Lin

Environmental Laboratory
U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Final report

Prepared for U.S. Army Corps of Engineers
Washington, DC 20314-1000

ABSTRACT:
This Regional Guidebook characterizes the wetlands in the Upper Des Plaines River Basin using the hydrogeomorphic (HGM) approach. The HGM approach is a collection of concepts and methods used to develop functional indices to assess the capacity of a particular wetland to perform functions relative to similar wetlands in a region. Specifically, this report describes the rationale that was used to select functions for two subclasses of herbaceous freshwater depressions, the Isolated Depression subclass and the Floodplain Depression subclass. The report also describes the process used to select model variables and metrics and to develop assessment models. Data from reference wetlands are provided and used to calibrate model variables and assessment models. Protocols for applying functional indices to the assessment of wetland functions are provided.

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Preface

This report was prepared by Jeff P. Lin, EL, Wetlands and Coastal Ecology Branch. The author wishes to acknowledge the efforts of the following people, without whom this document would not have been possible: Kate Bliss, Jaimee Hammit, Jean Sellar, Kim Fisher, Greg Moore, Mike Machalek, all from USACE Chicago District, Kristen Schultheis, Norris & Associates, John Tandarich, Hey & Associates, and Joe Hmieleski, Lake County Stormwater Management Commission, all assisted with the collection of field data. Jim Anderson, Lake County Forest Service, assisted greatly with the identification of reference sites in Lake County, IL. J.D. Ennis, Chicago District, readily provided many of the necessary GIS layers and aerial photography. Jim Anderson, Joe Hmieleksi, Jean Sellar, Barb Kleiss, EL, Jeff Mengler, U.S. Fish and Wildlife Service, Mike Miller, Illinois State Geological Survey, and Dave Brandt, USDA, all contributed to the creation and conceptual development of these models. Chris Noble, EL, and Tom Roberts, Tennessee Tech University, provided review of the initial draft of the Guidebook. Additional review was also provided by Tom Slawski, Southeastern Wisconsin Regional Planning Commission, Jim Anderson, Joe Hmieleski, and Jeff Mengler.

This report was completed under funding from the USACE Chicago District. This work took place under the general supervision of Dr. Morris Mauney, Jr., Chief, Wetlands and Coastal Ecology Branch; Dr. David J. Tazik, Chief, Ecosystem Evaluation and Engineering Division; and Dr. Edwin A. Theriot, Director, EL.

COL James R. Rowan was Commander and Executive Director of ERDC. Dr. James R. Houston was Director.

1 Introduction

Background

The Hydrogeomorphic (HGM) Approach is a collection of concepts and methods for developing functional indices and subsequently using them to assess the capacity of a wetland to perform functions relative to similar wetlands in a region. The approach was initially designed to be used in the context of the Clean Water Act Section 404 Regulatory Program permit review sequence to consider alternatives, minimize impacts, assess unavoidable project impacts, determine mitigation requirements, and monitor the success of mitigation projects. However, a variety of other potential applications for the approach have been identified, including determining minimal effects under the Food Security Act, designing mitigation project impacts, and managing wetlands.

On 16 August 1996, a National Action Plan to Implement the Hydrogeomorphic Approach (NAP) was published (*Federal Register* 1997). The NAP was developed cooperatively by a National Interagency Implementation Team consisting of the U.S. Army Corps of Engineers (USACE), U.S. Environmental Protection Agency (USEPA), National Resources Conservation Service (NRCS), Federal Highways Administration (FHWA), and U.S. Fish and Wildlife Service (USFWS). Publication of the NAP was designed to outline a strategy and promote the development of Regional Guidebooks for assessing the functions of regional wetland subclasses using the HGM Approach; to solicit the cooperation and participation of Federal, state, and local agencies, academia, and the private sector in this effort; and to update the status of Regional Guidebook development.

The sequence of tasks necessary to develop a Regional Guidebook outlined in the NAP was used to develop this Regional Guidebook (see the section, "Development Phase"). An initial workshop was held in Libertyville, IL, in January 2003. The workshop was attended by hydrologists, geologists, soil scientists, wildlife biologists, and plant ecologists primarily from local, state, and federal government agencies with extensive knowledge of local wetland ecosystem. Based on the results of the workshop, two regional wetland subclasses were defined and characterized, a reference domain was defined, wetland functions were selected, model variables were identified, and conceptual assessment models were developed. Subsequently, field and GIS based work was conducted to collect data from reference wetlands. Field data were collected during July and

August, 2003. Data from 64 reference sites (Appendix B) were then used to revise and calibrate the conceptual assessment models.

Objectives

The objectives of this Regional Guidebook are to (a) characterize the wetlands in the Upper Des Plaines River Basin, (b) provide the rationale used to select functions for the Isolated Depression and Floodplain Depression Subclasses, (c) provide the rationale used to select model variables and metrics, (d) provide the rationale used to develop assessment models, (e) provide data from reference wetlands and document their use in calibrating model variables and assessment models, and (f) outline the necessary protocols for applying the functional indices to the assessment of wetland functions.

Scope

This guidebook is organized in the following manner. Chapter 1 provides the background, objectives, and organization of the guidebook. Chapter 2 provides a brief overview of the major components of the HGM Approach and the development and application phases required to implement the approach. Chapter 3 characterizes the wetlands in the Upper Des Plaines River Basin in terms of geographical extent, climate, geomorphic setting, hydrology, vegetation, soils, and other factors that influence wetland function. Chapter 4 discusses each of the wetland functions, model variables, and function indices. This discussion includes a definition of the function; a quantitative, independent measure of the function for validation; a description of the wetland ecosystem and landscape characteristics that influence the function; a definition and description of model variables used to represent these characteristics in the assessment model; a discussion of the assessment model used to derive the functional index; and an explanation of the rationale used to calibrate the index with reference wetland data. Chapter 5 outlines the steps of the assessment protocol for identifying and conducting a functional assessment of Isolated Depression and Floodplain Depression Wetlands in the Upper Des Plaines River Basin, and includes field and GIS data forms. Appendix A presents a Glossary. Appendix B contains the data collected at reference sites. Appendix C explains the use of Functional Capacity Units. Appendix D summarizes the functions, assessment models, and variables used in the models.

While it is possible to assess the functions of Depressional Wetlands in the Upper Des Plaines River Basin using only the information contained in Chapters 4 and 5, it is suggested that potential users familiarize themselves with the information in Chapters 2 and 3 prior to conducting an assessment.

2 Overview of the Hydrogeomorphic Approach

As indicated in Chapter 1, the HGM Approach is a collection of concepts and methods for developing functional indices and subsequently using them to assess the capacity of a wetland to perform functions relative to similar wetlands in a region. The HGM Approach includes four integral components: (a) the HGM classification, (b) reference wetlands, (c) assessment models/functional indices, and (d) assessment protocols. During the development phase of the HGM Approach, these four components are integrated in a Regional Guidebook for assessing the functions of a regional wetland subclass. Subsequently, during the application phase, end users, following the assessment protocols outlined in the Regional Guidebook, assess the functional capacity of selected wetlands. Each of the components of the HGM Approach and the development and application phases are discussed in this chapter. More extensive discussions can be found in Brinson (1993, 1995a,b); Brinson et al. (1995, 1996, 1998); Hauer and Smith (1998); Smith (2001); Smith and Wakeley (2001); Smith et al. (1995); and Wakeley and Smith (2001).

Hydrogeomorphic Classification

Wetland ecosystems share a number of features, including relatively long periods of inundation or saturation, hydrophytic vegetation, and hydric soils. In spite of these common attributes, wetlands occur under a wide range of climatic, geologic, and physiographic situations and exhibit a wide variety of physical, chemical, and biological characteristics and processes (Cowardin et al. 1979; Ferren et al. 1996a,b,c; Mitsch and Gosselink 2000; Semeniuk 1987). The variability of wetlands makes it challenging to develop assessment methods that are both accurate (i.e., sensitive to significant changes in function) and practical (i.e., can be completed in the relative short time available for conducting assessments). Existing "generic" methods designed to assess multiple wetland types throughout the United States are relatively rapid, but lack the resolution necessary to detect significant changes in function. However, one way to achieve an appropriate level of resolution within the available time frame is to reduce the level of variability exhibited by the wetlands being considered (Smith et al. 1995).

The HGM Classification was developed specifically to accomplish this task (Brinson 1993). It identifies groups of wetlands that function similarly using three criteria that fundamentally influence how wetlands function: geomorphic setting, water source, and hydrodynamics. Geomorphic setting refers to the landform and position of the wetland in the landscape. Water source refers to the primary water source in the wetland, such as precipitation, overbank floodwater, or groundwater. Hydrodynamics refers to the level of energy and the direction that water moves in the wetland. Based on these three classification criteria, any number of "functional" wetland groups can be identified at different spatial or temporal scales. For example, at a continental scale, Brinson (1993) identified five hydrogeomorphic wetland classes. These were later expanded to the seven classes described in Table 1 (Smith et al. 1995). In many cases, the level of variability in wetlands encompassed by a continental scale hydrogeomorphic class is still too great to allow development of assessment models that can be rapidly applied while being sensitive enough to detect changes in function at a level of resolution appropriate to the 404 review process. For example, at a continental geographic scale the depression class includes wetland ecosystems in different regions as diverse as vernal pools in California (Zedler 1987), prairie potholes in North and South Dakota (Hubbard 1988, Kantrud et al. 1989), playa lakes in the high plains of Texas (Bolen et al. 1989), kettles in New England, and cypress domes in Florida (Ewel 1984, Kurz and Wagner 1953).

To reduce both inter- and intraregional variability, the three classification criteria are applied at a smaller, regional geographic scale to identify regional wetland subclasses. In many parts of the country, existing wetland classifications can serve as a starting point for identifying these regional subclasses (Ferren et al. 1996a,b,c; Golet and Larson 1974; Stewart and Kantrud 1971; Wharton et al. 1982). Regional subclasses, like the continental classes, are distinguished on the basis of geomorphic setting, water source, and hydrodynamics. In addition, certain ecosystem or landscape characteristics may also be useful for distinguishing regional subclasses in certain regions. For example, depressional subclasses might be based on water source (i.e., groundwater versus surface water), or the degree of connection between the wetland and other surface waters (i.e., the flow of surface water in or out of the depression through defined channels). Tidal fringe subclasses might be based on salinity gradients (Shafer and Yozzo 1998). Slope subclasses might be based on the degree of slope, landscape position, the source of water (i.e., throughflow versus groundwater), or other factors. Riverine subclasses might be based on water source, position in the watershed, stream order, watershed size, channel gradient, or floodplain width. Examples of potential regional subclasses are shown in Table 2, Smith et al. (1995), and Rheinhardt et al. (1997).

Regional Guidebooks include a thorough characterization of the regional wetland subclass in terms of its geomorphic setting, water sources, hydrodynamics, vegetation, soil, and other features that were taken into consideration during the classification process.

Table 1
Hydrogeomorphic Wetland Classes at the Continental Scale

HGM Wetland Class	Definition
Depression	Depression wetlands occur in topographic depressions (i.e., elevation contours) that allow the accumulation of surface water. Depression wetlands may have any combination of inlets and outlets or lack them completely. Potential water sources are precipitation, overland flow, streams, or groundwater/interflow from adjacent uplands. The predominant direction of flow is from the higher elevations toward the center of the depression. The predominant hydrodynamics are vertical fluctuations that range from diurnal to seasonal. Depression wetlands may lose water through evapotranspiration, intermittent or perennial outlets, or recharge to groundwater. Prairie potholes, playa lakes, vernal pools, and cypress domes are common examples of depressional wetlands.
Tidal Fringe	Tidal fringe wetlands occur along coasts and estuaries and are under the influence of sea level. They intergrade landward with riverine wetlands where tidal current diminishes and riverflow becomes the dominant water source. Additional water sources may be groundwater discharge and precipitation. The interface between the tidal fringe and riverine classes is where bidirectional flows from tides dominate over unidirectional flows controlled by floodplain slope of riverine wetlands. Because tidal fringe wetlands frequently flood and water table elevations are controlled mainly by sea surface elevation, tidal fringe wetlands seldom dry for significant periods. Tidal fringe wetlands lose water by tidal exchange, by overland flow to tidal creek channels, and by evapotranspiration. Organic matter normally accumulates in higher elevation marsh areas where flooding is less frequent and the wetlands are isolated from shoreline wave erosion by intervening areas of low marsh. *Spartina alterniflora* salt marshes are a common example of tidal fringe wetlands.
Lacustrine Fringe	Lacustrine fringe wetlands are adjacent to lakes where the water elevation of the lake maintains the water table in the wetland. In some cases, these wetlands consist of a floating mat attached to land. Additional sources of water are precipitation and groundwater discharge, the latter dominating where lacustrine fringe wetlands intergrade with uplands or slope uplands. Surface water flow is bidirectional, usually controlled by water-level fluctuations resulting from wind or seiche. Lacustrine wetlands lose water by flow returning to the lake after flooding and evaporation. Organic matter may accumulate in areas sufficiently protected from shoreline wave erosion. Unimpounded marshes bordering the Great Lakes are an example of lacustrine fringe wetlands.
Slope	Slope wetlands are found in association with the discharge of groundwater to the land surface or sites with saturated overflow with no channel formation. They normally occur on sloping land ranging from slight to steep. The predominant source of water is groundwater or interflow discharging at the land surface. Precipitation is often a secondary contributing source of water. Hydrodynamics are dominated by downslope unidirectional water flow. Slope wetlands can occur in nearly flat landscapes if groundwater discharge is a dominant source to the wetland surface. Slope wetlands lose water primarily by saturated subsurface flows and by evapotranspiration. Slope wetlands may develop channels, but the channels serve only to convey water away from the slope wetland. Slope wetlands are distinguished from depressional wetlands by the lack of a topographic depression and the predominance of the groundwater/interflow water source. Fens are a common example of slope wetlands.
Mineral Soil Flats	Mineral soil flats are most common on interfluves, extensive relic lake bottoms, or large floodplain terraces where the main source of water is precipitation. They receive virtually no groundwater discharge, which distinguishes them from depressions and slopes. Dominant hydrodynamics are vertical fluctuations. Mineral soil flats lose water by evapotranspiration, overland flow, and seepage to underlying groundwater. They are distinguished from flat upland areas by their poor vertical drainage due to impermeable layers (e.g., hardpans), slow lateral drainage, and low hydraulic gradients. Mineral soil flats that accumulate peat can eventually become organic soil flats. They typically occur in relatively humid climates. Pine flatwoods with hydric soils are an example of mineral soil flat wetlands.
Organic Soil Flats	Organic soil flats, or extensive peatlands, differ from mineral soil flats in part because their elevation and topography are controlled by vertical accretion of organic matter. They occur commonly on flat interfluves, but may also be located where depressions have become filled with peat to form a relatively large flat surface. Water source is dominated by precipitation, while water loss is by overland flow and seepage to underlying groundwater. They occur in relatively humid climates. Raised bogs share many of these characteristics but may be considered a separate class because of the convex upward form and distinct edaphic conditions for plants. Portions of the Everglades and northern Minnesota peatlands are examples of organic soil flat wetlands.
Riverine	Riverine wetlands occur in floodplains and riparian corridors in association with stream channels. Dominant water sources are overbank flow from the channel or subsurface hydraulic connections between the stream channel and wetlands. Additional sources may be interflow, overland flow from adjacent uplands, tributary inflow, and precipitation. When overbank flow occurs, surface flows down the floodplain may dominate hydrodynamics. In headwaters, riverine wetlands often intergrade with slope, depressional, poorly drained flats, or uplands as the channel (bed) and bank disappear. Perennial flow is not required. Riverine wetlands lose surface water via the return of floodwater to the channel after flooding and through surface flow to the channel during rainfall events. They lose subsurface water by discharge to the channel, movement to deeper groundwater (for losing streams), and evaporation. Peat may accumulate in off-channel depressions (oxbows) that have become isolated from riverine processes and subjected to long periods of saturation from groundwater sources. Bottomland hardwoods on floodplains are an example of riverine wetlands.

Table 2
Potential Regional Wetland Subclasses in Relation to Geomorphic Setting, Dominant Water Source, and Hydrodynamics

Geomorphic Setting Source	Dominant Water	Dominant Hydrodynamics	Potential Regional Wetland Subclasses	
			Eastern USA	Western USA/Alaska
Depression	Groundwater or interflow	Vertical	Prairie potholes, marshes, Carolina bays	California vernal pools
Fringe (tidal)	Ocean	Bidirectional, horizontal	Chesapeake Bay and Gulf of Mexico tidal marshes	San Francisco Bay marshes
Fringe (lacustrine)	Lake	Bidirectional, horizontal	Great Lakes marshes	Flathead Lake marshes
Slope	Groundwater	Unidirectional, horizontal	Fens	Avalanche chutes
Flat (mineral soil)	Precipitation	Vertical	Wet pine flatwoods	Large playas
Flat (organic soil)	Precipitation	Vertical	Peat bogs, portions of Everglades	Peatlands over permafrost
Riverine	Overbank flow from channels	Unidirectional, horizontal	Bottomland hardwood forest	Riparian wetlands

Reference Wetlands

Reference wetlands are wetland sites selected to represent the range of variability that occurs in a regional wetland subclass as a result of natural processes and disturbance (e.g., succession, channel migration, fire, erosion, and sedimentation) as well as cultural alteration. The reference domain is the geographic area occupied by the reference wetlands (Smith et al. 1995). Ideally, the geographic extent of the reference domain will mirror the geographic area encompassed by the regional wetland subclass; however, this is not always possible because of time and resource constraints.

Reference wetlands serve several purposes. First, they establish a basis for defining what constitutes a characteristic and sustainable level of function across the suite of functions selected for a regional wetland subclass. Second, they establish the range and variability of conditions exhibited by model variables and provide the data necessary for calibrating model variables and assessment models. Finally, they provide a concrete physical representation of wetland ecosystems that can be observed and measured.

Reference standard wetlands are the subset of reference wetlands that perform the suite of functions selected for the regional subclass at a level that is characteristic in the least altered wetland sites in the least altered landscapes. Table 3 outlines the terms used by the HGM Approach in the context of reference wetlands.

Table 3
Reference Wetland Terms and Definitions

Term	Definition
Reference domain	The geographic area from which reference wetlands representing the regional wetland subclass are selected (Smith et al. 1995).
Reference wetlands	A group of wetlands that encompass the known range of variability in the regional wetland subclass resulting from natural processes and disturbance and from human alterations.
Reference standard wetlands	The subset of reference wetlands that perform a representative suite of functions at a level that is both sustainable and characteristic of the least human altered wetland sites in the least human altered landscapes. By definition, the functional capacity index for all functions in reference standard wetlands is assigned a 1.0.
Reference standard wetland variable condition	The range of conditions exhibited by model variables in reference standard wetlands. By definition, reference standard conditions receive a variable subindex score of 1.0.
Site potential (mitigation project context)	The highest level of function possible, given local constraints of disturbance history, land use, or other factors. Site potential may be less than or equal to the levels of function in reference standard wetlands of the regional wetland subclass.
Project target (mitigation project context)	The level of function identified or negotiated for a restoration or creation project.
Project standards (mitigation context)	Performance criteria and/or specifications used to guide the restoration or creation activities toward the project target. Project standards should specify reasonable contingency measures if the project is not being achieved.

Assessment Models and Functional Indices

In the HGM Approach, an assessment model is a simple representation of a function performed by a wetland ecosystem. It defines the relationship between one or more characteristics or processes of the wetland ecosystem. Functional capacity is simply the ability of a wetland to perform a function compared to the level of performance in reference standard wetlands.

Model variables represent the characteristics of the wetland ecosystem and surrounding landscape that influence the capacity of a wetland ecosystem to perform a function. Model variables are ecological quantities that consist of five components (Schneider 1994): (a) a name, (b) a symbol, (c) a measure of the variable and procedural statements for quantifying or qualifying the measure directly or calculating it from other measures, (d) a set of variables (i.e., numbers, categories, or numerical estimates (Leibowitz and Hyman 1997)) that are generated by applying the procedural statement, and (e) units on the appropriate measurement scale. Table 4 provides several examples.

Table 4
Components of a Model Variable

Name (Symbol)	Measure / Procedural Statement	Resulting Values	Units (Scale)
Substrate Disturbance ($V_{DISTURB}$)	The alteration of the soils by activities such as addition of fill material, soil oxidation, rock plowing, or removal of sediment.	present absent	unitless (nominal scale)
Presence of Ditches (V_{DITCH})	The presence of ditches within a certain distance of the wetland	1.0 0.8 0.3	unitless (interval scale)
Cover of Woody Vegetation (V_{WOODY})	The average percent aerial cover of leaves and stems of shrubs and trees (> 1 m).	0 to >100	percent

Model variables occur in a variety of states or conditions in reference wetlands. The state or condition of the variable is denoted by the value of the measure of the variable. For example, percent herbaceous groundcover, the measure of the percent cover of herbaceous vegetation, could be large or small. Based on its condition (i.e., value of the metric), model variables are assigned a variable subindex. When the condition of a variable is within the range of conditions exhibited by reference standard wetlands, a variable subindex of 1.0 is assigned. As the condition deflects from the reference standard condition (i.e., the range of conditions within which the variable occurs in reference standard wetlands), the variable subindex is assigned based on the defined relationship between model variable condition and functional capacity. As the condition of a variable deviates from the conditions exhibited in reference standard wetlands, it receives a progressively lower subindex, reflecting its decreasing contribution to functional capacity. In some cases, the variable subindex drops to zero. For example, when the percent cover of herbaceous groundcover is 40 percent or greater, the subindex for percent herbaceous groundcover is 1.0. As the percent cover falls below 40 percent, the variable subindex score decreases on a linear scale to zero.

Model variables are combined in an assessment model to produce a Functional Capacity Index (FCI) that ranges from 0.0 to 1.0. The FCI is a measure of the functional capacity of a wetland relative to reference standard wetlands in the reference domain. Wetlands with an FCI of 1.0 perform the function at a level characteristic of reference standard wetlands. As the FCI decreases, it indicates that the capacity of the wetland to perform the function is less than that of reference standard wetlands.

Assessment protocol

The final component of the HGM Approach is the assessment protocol. The assessment protocol is a series of tasks, along with specific instructions, that allow the end user to assess the functions of a particular wetland area using the functional indices in the Regional Guidebook. The first task is characterization, which involves describing the wetland ecosystem and the surrounding landscape, describing the proposed project and its potential impacts, and identifying the wetland areas to be assessed. The second task is collecting the data for model variables. The final task is analysis, which involves calculation of functional indices.

Development phase

The Development Phase of the HGM Approach is ideally carried out by an interdisciplinary team of experts known as the "Assessment Team," or "A-Team." The product of the Development Phase is a Regional Guidebook for assessing the functions of a specific regional wetland subclass (Figure 1). In developing a Regional Guidebook, the A-Team will complete the following major tasks. After organization and training, the first task of the A-Team is to classify the wetlands within the region of interest into regional wetland subclasses using the principles and criteria of the HGM Classification (Brinson 1993; Smith et al. 1995). Next, focusing on the specific regional wetland subclasses selected, the A-Team develops an ecological characterization or functional profile of the subclass. The A-Team then identifies the important wetland functions, conceptualizes assessment models, identifies model variables to represent the characteristics and processes that influence each function, and defines metrics for quantifying model variables. Next, reference wetlands are identified to represent the range of variability exhibited by the regional subclass. Field data are then collected from the reference wetlands and used to calibrate model variables and verify the conceptual assessment models. Finally, the A-Team develops the assessment protocols necessary for regulators, managers, consultants, and other end users to apply the indices to the assessment of wetland functions. The following list provides the detailed steps involved in this general sequence:

Task 1: Organize the A-Team.
  A. Identify A-Team members.
  B. Train A-Team in the HGM approach.

Task 2: Select and Characterize Regional Wetland Subclasses.
  A. Identify/prioritize wetland subclasses.
  B. Select regional wetland subclasses and define reference domain.
  C. Initiate literature review.
  D. Develop preliminary characterization of regional wetland subclasses.

Task 3: Select Model Variables and Metrics and Construct Conceptual Assessment Models.
  A. Review existing assessment models.
  B. Identify model variables and metrics.
  C. Define initial relationship between model variables and functional capacity.
  D. Construct conceptual assessment models for deriving FCIs.
  E. Complete Precalibrated Draft Regional Guidebook (PDRG).

Task 4: Conduct Peer Review of PDRG.
  A. Distribute PDRG to peer reviewers.
  B. Conduct interdisciplinary, interagency workshop of PDRG.
  C. Revise PDRG to reflect peer review recommendations.

D. Distribute revised PDRG to peer reviewers for comment.
E. Incorporate final comments from peer reviewers on revisions into PDRG.

Task 5: Identify and Collect Data from Reference Wetlands.
A. Identify reference wetland field sites.
B. Collect data from reference wetland field sites.
C. Analyze reference wetland data.

Task 6: Calibrate and Field Test Assessment Models.
A. Calibrate model variables using reference wetland data.
B. Verify and validate (optional) assessment models.
C. Field test assessment models for repeatability and accuracy.
D. Revise PDRG based on calibration, verification, validation (optional), and field testing results into a Calibrated Draft Regional Guidebook (CDRG).

Task 7: Conduct Peer Review and Field Test of CDRG.
A. Distribute CDRG to peer reviewers.
B. Field test CDRG.
C. Revise CDRG to reflect peer review and field test recommendations.
D. Distribute CDRG to peer reviewers for final comment on revisions.
E. Incorporate peer reviewers' final comments on revisions.
F. Publish Operational Draft Regional Guidebook (ODRG).

Task 8: Technology Transfer.
A. Train end users in the use of the ODRG.
B. Provide continuing technical assistance to end users of the ODRG.

Application phase

The Application Phase involves two steps. The first is using the assessment protocols outlined in the Regional Guidebook to carry out the following tasks (Figure 1).

a. Define assessment objectives.

b. Characterize the project site.

c. Screen for red flags.

d. Define the Wetland Assessment Area.

e. Collect field data.

f. Analyze field data.

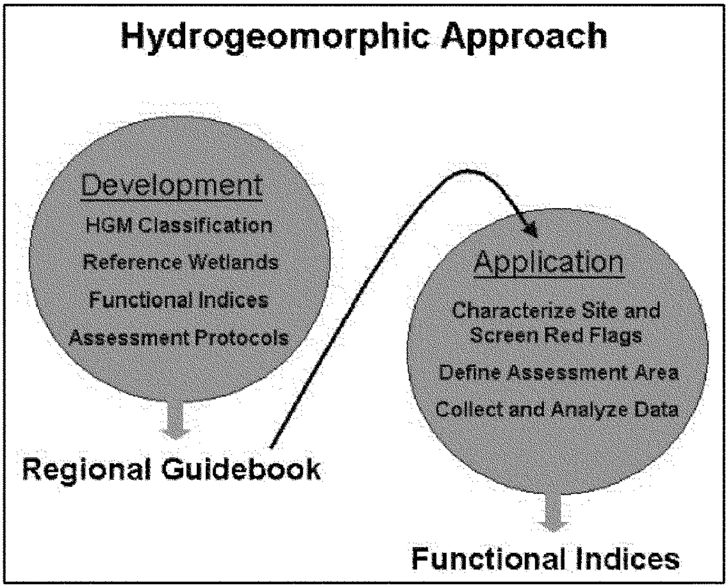

Figure 1. Development and application phases of the HGM Approach

The second step involves applying the results of the assessment, the FCI, to the appropriate decision-making process. Although the HGM approach was originally conceived for use in a regulatory context as part of Section 404 of the Clean Water Act, it has a variety of other potential applications as well. For instance, The HGM assessment model for the Upper Des Plaines River Basin was developed primarily for use in ecosystem restoration, done in an overall planning context.

There are several ways in which HGM models can be applied as part of an overall planning framework. For instance, in analysis of alternative plans, the HGM approach can be used to measure variable impacts to existing wetlands, or locating and evaluating potential wetlands restoration sites. Because the HGM approach produces a numerical value as a measure of various wetland functions, these numbers can be used to quantify and compare impacts and benefits to wetlands due to various alternative proposed plans and actions. These comparisons can be made through the calculation of Functional Capacity Units (see Appendix C), which take into account the number of wetland acres being affected.

3 Characterization of Regional Wetland Subclasses in the Upper Des Plaines River Basin

This Regional Guidebook was developed to assess the functions of two subclasses of herbaceous freshwater depressions in the Upper Des Plaines River Basin: Isolated Depressional and Floodplain Depressional Wetlands. However, this chapter will also address the classification of other subclasses that are found in the basin.

The chapter begins with a general description of the Upper Des Plaines Basin reference domain, and then provides an overview of various physical and biological characteristics of the reference domain. It concludes with descriptions of the HGM wetland classes and regional wetland subclasses that occur in the reference domain, and guidelines for recognizing them with a combination of field observation and geographical information system (GIS) layers.

Reference Domain

The reference domain for this guidebook is the Upper Des Plaines River (UDPR) watershed, which encompasses the 13 northernmost subbasins of the Des Plaines River watershed in northeastern Illinois and southeastern Wisconsin (Figure 2). The UPDR consists of the portion of the Des Plaines River upstream of its confluence with Salt Creek near the city of Brookfield, IL, to where the river originates in the southernmost portion of Racine County, Wisconsin, near the town of Union Grove. The UDPR watershed covers approximately 479 square miles (1,241 square kilometers), of which 346 square miles (896 square kilometers) are in Lake County, north-central Cook County, and the northeastern portion of Du Page County, Illinois, and 133 square miles (344 square kilometers) in Kenosha County and the southernmost portion of Racine County in Wisconsin. At most, it spans approximately 10 miles (16 km) in an east-west direction. The watershed contains about 570 miles (917 km) of perennial streams and rivers, including the Des Plaines River and its major tributaries — Jerome Creek, Kilbourn Ditch, Dutch Gap Canal, and Brighton Creek in

Wisconsin, and Willow, Weller, Buffalo, Indian, Mill, and North Mill Creeks in Illinois.

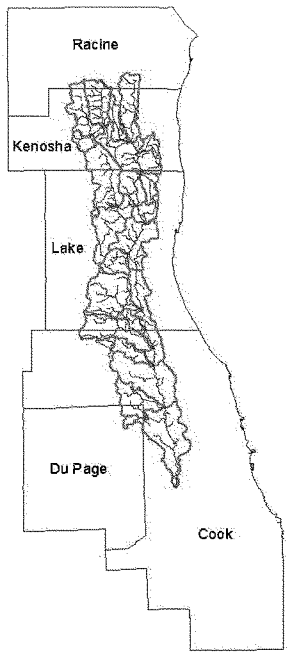

Figure 2. Upper Des Plaines Watershed

Environment and Resources of the Upper Des Plaines River Basin

The following subsections review major concepts that have bearing on the classification and functions of wetlands in the modern landscape of the Upper Des Plaines River Basin. Unless otherwise noted, the information presented here is derived primarily from the Critical Trends Assessment Program (CTAP) Upper Des Plaines River Area Assessment reports (IDNR 1998) and the Southeastern Wisconsin Regional Planning Commission's "Comprehensive Plan for the Des Plaines River Watershed" (SEWRPC 2003).

Physiography and climate

About 72 percent of the Upper Des Plaines Basin in Illinois occurs within the Wheaton Morainal Country physiographic divisions, with the remainder occurring in the heavily urbanized Chicago Lake Plain physiographic division, which encompasses the southeastern portion of the basin. Elevation in the entire basin ranges from 600 ft (183 m) to 891 ft (272 m) above sea level, and a majority of the land has a less than 2 percent slope, creating a relatively broad floodplain. The Chicago Lake Plain area was the floor of glacial Lake Chicago. The topography of this area generally is very flat, with low, gently sloping ridges (Willman 1971) and thus is far more uniform than that of the Wheaton Morainal Country.

The hummocky topographic features seen in the Wheaton Morainal Country were formed by the discontinuous deposition of glacial till superimposed on bedrock during the most recent (Wisconsin) glacial period. Generally ranging from 100 to 300 ft, these glacial deposits (unconsolidated sand, silt, clay, gravel, and boulders) left by stagnant and melting ice piles led to the formation of many depressional areas and subsequent lakes and marshes.

The climate of the Upper Des Plaines River basin is humid continental, with a wide range of temperature extremes, although this is tempered somewhat by the region's proximity to Lake Michigan. Temperature and precipitation are relatively uniform across the basin, although Cook County has slightly higher mean annual temperatures and precipitation levels than Lake and Kenosha Counties. From 1961 to 1990, mean temperatures at Chicago O'Hare International Airport in Cook County ranged from -6.1°C (21.0°F) in January to 22.8°C (73.0°F) in July, with an annual mean temperature of 9.4°C (48.9°F). In that same period, mean temperatures at Waukegan in northern Lake County ranged from -7.0°C (19.4°F) in January to 21.7°C (71.1°F) in July, with an annual mean temperature of 8.2°C (46.8°F). Mean temperatures measured at Union Grove, WI (the northernmost point of the watershed), are nearly identical to those measured in Waukegan.

Rainfall in the Upper Des Plaines River Basin is highest during June through September and lowest during January and February (where precipitation is primarily from sleet and snowfall). Mean annual rainfall from 1961 to 1990 was 35.8 in. (91.0 cm) at O'Hare and 34.2 in. (86.9 cm) at Waukegan. From 1945 to 1933, mean annual rainfall was 32.7 in. (83.0 cm) at Antioch, Wisconsin.

Stream flow and groundwater hydrology

Streams in the basin exhibit a consistent seasonal flow cycle, with high flows in the spring months and low flows common in the summer and fall. A substantial portion (approximately 25 percent in the main stem river) of this flow originates from wastewater treatment plants. The basin is subject to significant and damaging flooding due to a lack of channel capacity in the Des Plaines River and its tributaries and urban encroachment into the floodplain. The area has had, on average, one significant flood every 4 years. Major floods in 1986 and 1987 caused over $100 million in damages to surrounding communities (USACE

2001). Flooding on the main stem is most common in the spring, and flooding on the tributaries is most common in the summer.

Groundwater in the basin is stored in a complex system of glacial drift, Silurian shallow dolomite (shallow bedrock), and deep sandstone aquifers (deep bedrock), with vertical distributions ranging from near surface to around 1,700 ft in depth (Larsen 1973). The principal sources of water in the shallow aquifers are percolation from precipitation and infiltration from surface streams. Much of this groundwater eventually discharges to lower lying lakes and wetlands, and provides the base flow of surface streams (Sheaffer and Zeizel 1966).

Geology and geomorphology

The landscape of the Upper Des Plaines River Basin has been shaped primarily by glacial scouring and deposits that occurred 25,000 to 14,000 years ago during the Wisconsinan glaciation, the last major advance of the ice age. These deposits consisted primarily of till and outwash, as well as more minor deposits of lacustrine sediments and organic-rich debris. The glacial deposits were then overlaid by windblown silt, known as loess. Collectively, these deposits control, in part, land use, ecosystem development, and landscape processes in the basin.

The most prominent topographic features of the area are a series of north-south running moraines (ridges) that range from 1 to 3 miles wide and tens of miles long and were formed by the deposition of glacial till. Between these moraines are relatively flat lowland areas from which the drainage system of the basin developed. Also among the ridges are numerous undrained depressions, which create either small lakes or wetlands that formed in saturated organic soils (Larsen 1973).

The geology of the basin changes measurably from west to east. The moraines are hummockier at the western edge of the basin, indicating that glacial ice tended to stagnate and pile up in that area. Furthermore, in terms of grain size, the composition of the till is much more heterogeneous in this area, and the glacial drift layers are thicker as well.

Soils

In the Upper Des Plaines River Basin there is a wide variation in the characteristics of parent materials in which soils have developed, although a majority developed in silty clay and silty clay loam textured till. The northern part of the basin has a greater amount of wetlands and poorly drained soils than the southern part. For instance, large sections in the north are of the Morley-Markham-Ashkum soil association, and contain many poorly drained depressions. The more productive soils, particularly the Drummer series, are also found in the north on flatter portions of the till plain. In contrast, the southern portion of the basin has been heavily urbanized, and few natural surfaces remain.

Soils in the basin are primarily of the Alfisols and Mollisols soil orders, although there are also pockets of Entisols and Inceptisols, generally on floodplains and along steeper, eroded uplands. Common mineral soils found in wetlands in the basin include those in the Sawmill, Peotone, and Ashkum soil series. Additionally, many wetland depressional areas contain Histosols, with deep layers of muck and peat (primarily of the Houghton and Muskego soil series).

Vegetation communities

The *Upper Des Plaines River Area Assessment*, Volume 3 (1998) report lists 16 natural terrestrial community types (adapted from White and Madany 1978) that either occur, or are believe to have formerly occurred, in the basin. These 16 types fall under the more general forest, prairie, and wetland community categories. Four wetland community types are described below. Of the four, the sedge meadow, wet prairie, and marsh communities are relevant to the isolated and floodplain depressions HGM models that are presented in this guidebook.

Northern Flatwoods. Northern flatwoods occur on poorly drained sites in the Valparaiso morainic system. These wetlands are seasonally wet, and water is often retained in microdepressions during the wet periods. The canopy is dominated by various white oak species, while the ground cover species include a wide variety of *Carex* sedges. There are approximately 85 acres of high quality northern flatwoods remaining in the Upper Des Plaines River Basin.

Sedge Meadow. The sedge meadow is dominated by the mound forming hummock sedge (*Carex stricta*). This wetland type can occur either on mineral or organic soils, and is saturated, although not inundated, for most of the year. Sedge meadows are often found within other community types, such as wet prairie, marshes, and shrub swamps.

Wet Prairie. Wet prairies are found on poorly drained and slowly permeable soils. Wet prairie vegetation is characterized by prairie cord grass (*Spartina pectinata*), and a variety of sedges and forbs, and shrubs.

Marsh. Marshes are dominated by herbaceous vegetation, consisting largely of cattails (*Typha spp.*). They have either organic or mineral soils, and water at or near the surface during most of the growing season.

Fauna

The Upper Des Plaines watershed supports a wide range of fauna, including an estimated 43 mammal species, 16 amphibian species, 23 reptile species, and 270 bird species. In general, the greatest threat to these species is suburban/urban growth and the subsequent loss of habitat. Exotic faunal species are much less of a problem in the area than exotic and invasive plant species. Many of the faunal species (especially among birds and reptiles) found in wetlands will also utilize some other terrestrial or aquatic habitat during their life cycle.

Birds. Wetlands represent the most significant avian habitat in the region. The Deer Lake/Redwing slough complex, in particular, provides habitat for a wide variety of birds, including several state threatened and endangered species. Wetland habitats in the area are also used as stop-over sites by a number of migrating bird species.

Mammals. Common mammal species that utilize wetlands in the region include beavers (*Castor Canadensis*), muskrats (*Ondatra zibethicus*), minks (*Mustela vison*), red fox (*Vulpes vulpes*), white-tailed deer (*Odocoileus virginianus*), raccoons (*Procyon lotor*), and various shrew species. No known threatened or endangered mammal species are found in the area.

Amphibians and Reptiles. Typical amphibian species found in the wetlands in the region are the green frog (*Rana clamitans melanota*) and northern leopard frog (*Rana pipiens*); these frog species tend to be numerous in marsh areas. Typical reptiles are the painted turtle (*Chrysemys picta*), snapping turtle (*Chelydra serpentina serpentina*), and common garter snake (*Thamnophis sirtalis sirtalis*). The state threatened Kirtland's water snake (*Clonophis kirtlandii*) and state endangered massasauga snake (*Sistrurus catenatus*) both rely on wetland habitats, and prefer wet prairie areas with abundant ground cover.

Alterations to environmental conditions

Changes in Land use. In 1820, based on a Government Land Office survey done at the time, the land cover of the Upper Des Plaines River Basin was approximately 40 percent prairie and 60 percent forest and savanna. The presettlement historical coverage of wetlands in the basin (extrapolated from hydric soil acreage in Lake County) is estimated to have been 26 percent of the total area (57,600 acres). Since that time, the biological landscape of the basin has been drastically altered by human activity. Many historical wetlands have been tiled and drained to make use for agriculture, and large parts of the basin have become heavily urbanized. The construction and creation of agricultural fields, buildings, and roads have also fragmented once contiguous forest, wetland, and prairie habitats. More recently, urban development has replaced agricultural land, and now dominates large portions of the landscape (Figure 3).

By recent estimates, a majority (57 percent) of Upper Des Plaines River Basin land cover in Illinois is of the urban/built up class. Another 16 percent is upland forest, 11 percent is cropland, and 6 percent of the basin is classified as wetland (forested and non-forested). On the other hand, a majority of the Wisconsin portion of the watershed is in cropland (68 percent), while only about 12 percent is classified as urban, about 8 percent as wetland, and about 6 percent as woodland.

Invasive and Exotic Species. A major problem and threat to the natural diversity of ecosystems in the watershed has been the influx and diffusion of invasive and exotic plant species. Major causes of the proliferation of invasive species are altered flooding regimes and increased siltation. Many marshes have been completely overtaken by reed canary grass (*Phalaris arundinacea*), and dense stands of cattails (*Typha spp.*) have become nearly ubiquitous in these systems as well. Other introduced or invasive plant species posing problems in wetlands include common and glossy buckthorn (*Rhamnus cathartica* and

Rhamnus frangula), purple loosestrife (*Lythrum salicaria*), bittersweet nightshade (*Solanum dulcamara*), and common reed (*Phragmites australis*).

Figure 3. Aerial photos of the Rollins Savanna area, Lake County, taken in 2001 (on the left) and 1939 (on the right)

Description of Regional Wetland Subclasses

The following descriptions of wetland HGM classes and subclasses in the Upper Des Plaines River basin is not meant to encompass every type of wetland found in the region, but includes those types that were encountered during field reconnaissance and data collection in the area, and does comprise the majority of wetland subclasses to be found in the basin. Each subclass listed below would require its own separate assessment model. HGM functional assessment models have been created so far for the Isolated Depression and Floodplain Depression subclasses, and as such, more detail is provided in the description of these two subclasses.

The dichotomous key in Figure 4 can be used as a quick guide for distinguishing among the various subclasses that are described below.

1. Wetland is located in topographic depression	Go To #2
2. Wetland is wholly or the majority is outside of the mapped 10-year floodplain	Isolated Depression
2. Wetland is wholly or the majority is inside of the mapped 10-year floodplain	Floodplain Depression
1. Wetland is not located in topographic depression	Go To #2
2. Wetland is within mapped 2-year floodplain	Go To #3
3. Wetland is associated with a lake	Lacustrine Fringe
3. Wetland is associated with a stream or river	Go To #4
4. Wetland has ≤ 30% tree or shrub cover	Herbaceous Riverine
4. Wetland has > 30% tree or shrub cover	Forested Riverine
2. Wetland is outside of mapped 2-year floodplain	Flat

Figure 4. Dichotomous key to various HGM subclasses in the Upper Des Plaines River Basin

Depressions

In the Upper Des Plaines River Basin, the Depressions HGM class has been subdivided into several subclasses based on the presence of outlets and location within the floodplain. Generally speaking, depressional wetlands occur in topographic depressions that allow the accumulation of surface water. For the purposes of this HGM model, a depression is defined as having a minimum depth of 2 ft in at least part of the wetland. A 2-ft depth is used because of the availability of digital 2-ft elevation contour lines in the watershed. These contour lines can be used when applying the model to determine whether or not a site can be classified as a depression.

Historically, many undrained depressions of various sizes were formed in the basin from glacial movement and activity. These depressions were able to store water from precipitation and stream flooding (for those located in the floodplain), providing natural flood protection benefits in the watershed. However, subsequent human activity has led to the draining and filling of many of these. These changes are in part responsible for reducing the ability of the watershed to absorb major flooding events.

Currently, the depression class accounts for the majority of wetlands in the watershed (IDNR 1998). Their relative number, combined with their ecological and flood attenuation benefits, and their potential for restoration are the reasons that the A-Team decided to focus on this wetland type for the Guidebook.

Isolated Depressions. In the Upper Des Plaines Basin, wetlands are classified as isolated if they are located outside of the mapped 10-year floodplain (Figure 5). Their hydrology is driven by direct precipitation and associated runoff, with additional subsurface flow under certain geologic settings. It should be noted that the classification of wetlands as *isolated* in this document does not have any use or bearing on jurisdictional and regulatory determinations.

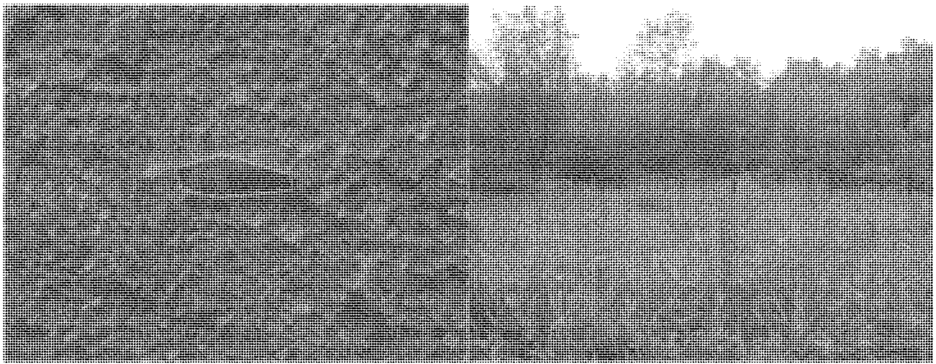

Figure 5. Aerial and ground views of an isolated depression located in Deer Grove Forest Preserve, Cook County, IL

Isolated depressions can have one or more surface outlets, or no outlets at all. These outlets can be a natural channel (such as a headwater stream), or manmade, as in the case of ditches and tiles. If there is no defined outlet, water can still leave the depression if it reaches a level higher than the depth of the wetland.

These depressions are mostly herbaceous systems, defined as having ≤ 30 percent tree/shrub cover (Cowardin et al. 1979). They consist primarily of low marsh or sedge meadow communities, or both. Plants commonly found in these systems include river bulrush (*Scirpis fluviatilis*) and smartweeds (*Polygnum spp.*) in the low marsh areas, and *Carex stricta* and *Carex lacustris* in the sedge meadow areas. Cattails (*Typha spp.*) are ubiquitous in both community types, although they tend to, along with reed canary grass (*Phalaris arundicae*), be far denser in the more disturbed areas.

Floodplain Depressions. Floodplain depressions are distinguished from isolated depressions in that they are located within the mapped 10-year floodplain. The 10-year floodplain is used as a boundary for two primary reasons, one functional and one utilitarian. The functional reason for use of the 10-year floodplain is that for wetlands within this area floodwater will play a periodic role in the site's hydrologic regime, but is not the dominant hydrologic influence in the wetland. The utilitarian reason is that a floodplain map is necessary for wetland classification, and in the UDPR basin (due to its geomorphology), the 10-year floodplain is similar to the more readily obtainable 100-year FEMA floodplain. Because of their location within the floodplain, these sites are able to export materials downstream, and also have the capacity to mitigate flooding in upland areas. Like isolated depressions, floodplain depressions are also primarily herbaceous systems. They will commonly have marsh vegetation communities that are dominated by *Typha spp.* In general, the floodplain systems tend to be less vegetatively diverse than their isolated counterparts (Figure 6).

Figure 6. Aerial and ground views of a floodplain depression located in Deer Grove Forest Preserve, Cook County, IL

Riverine

Riverine wetlands in the Upper Des Plaines Basin are wetlands not located within a topographic depression, but located within the mapped 10-year floodplain of the Des Plaines River and its tributaries. The primary water source for these sites is flooding from the adjacent river or stream. Additional water sources are precipitation and runoff from adjacent upland areas. Both forested and herbaceous Riverine wetlands are found in the reference domain (Figures 7 and 8).

Figure 7. Aerial and ground views of a forested Riverine wetland located in Deer Grove Forest Preserve, Cook County, IL

Figure 8. Aerial and ground views of an herbaceous Riverine wetland located in Kenosha County, WI

Lacustrine Fringe

Lacustrine Fringe wetlands are adjacent to lakes and are subject to regular (less than every 10 years) flooding from the lake. In the reference domain, these wetlands generally consist of dense stands of *Typha spp* (Figure 9).

Figure 9. Aerial and ground views of an herbaceous Lacustrine Fringe wetland located in Lake County, IL

Flats

In the reference domain, flats HGM class occurs primarily as the forested Northern Flatwoods community. Detailed information concerning the Northern Flatwoods community can be found in Anderson (1998).

4 Wetland Functions and Assessment Models

Overview

The following functions are performed by both Isolated Depressions and Floodplain Depressions in the Upper Des Plaines River Basin:

a. Maintain Characteristic Hydrologic Regime.

b. Maintain Characteristic Biogeochemical Processes.

c. Maintain Characteristic Plant Communities.

d. Maintain Characteristic Fauna.

e. Export Organic Carbon.[1]

This chapter begins with a description of all the variables used in the Isolated Depression and Floodplain Depression models. Each variable description includes what functions the variable is used in, the justification for using the variable, and the variable subindex scaling.

The following sequence is then used to present and discuss each of these functions:

a. Definition: defines the function and identifies an independent quantitative measure that can be used to validate the functional index.

b. Rationale for selecting the function: provides the rationale for why a function was selected and discusses onsite and offsite effects that may occur as a result of lost functional capacity.

c. Characteristics and processes that influence the function: describes the characteristics and processes of the wetland and the surrounding landscape that influence the function and lay the groundwork for the description of model variables.

[1] This function is performed by Floodplain Depressions and not Closed Isolated Depressions.

d. Description of model variables: defines and discusses model variables and describes how each model variable is measured.

e. Functional Capacity Index: describes the assessment model from which the FCI is derived and discusses how model variables interact to influence functional capacity.

Variables

General note on variable scaling

Variables are scaled either categorically or continuously. Variables are scaled categorically if they either (a) measured the presence or absence of features (V_{ALT} for example), or (b) owing to the outlined assessment methodology, where several variables are "visually estimated" (V_{CAT} for instance), the variable cannot be measured precisely, but instead can be more accurately placed in certain range of values. For variables that are measured continuously, a linear scaling was used based on best professional judgment and the lack of references or evidence to justify any alternative non-linear scaling.

V_{ALT} and $V_{ALT\text{-}OEX}$: Presence of hydrologic alteration

V_{ALT} variable is used in the Maintain Characteristic Hydrologic Regime and Maintain Characteristic Plant Communities functions. $V_{ALT\text{-}OEX}$ is used in the Export Organic Carbon (for Floodplain Depressions) function.

V_{ALT} is defined as the presence of artificial drainages such as tiles or ditches in or within 50 m of the wetland, and in the case of Floodplain Depressions, the presence of any modifications to or within 50 m the contributing stream channel (such as straightening and maintained channelization or the presence of levees and berms, see Table 6). All of these alterations will directly affect the hydrology of the wetland, either by increasing drainage or changing the flooding regime. Although ditch number, depth, and location, and soil texture of the site all factor into the effect ditches will have on the wetland, this variable only measures the presence or absence of any ditches, as it assumed that any functioning ditch will have at least some impact on the hydrology of the wetland. A subindex score of 0.5 is assigned for the presence of ditches as an "average" value, recognizing that most ditches will have more or less impact on the function.

The variable subindex scaling of V_{ALT} for Isolated Depressions is given in Table 5.

Table 5
Subindex Scaling for V_{ALT} in Isolated Depressions and Site Alteration Portion of V_{ALT} for Floodplain Depressions

Type of Alteration to Wetland	Subindex
No alterations	1.0
Functioning ditch(es) within 50 m	0.5
Functioning tiles	0.2
Functioning ditch(es) and tiles	0.0

In Floodplain Depressions, alterations to the adjacent stream channel need to be considered as well. For the Maintain Characteristic Hydrologic Regime and Maintain Characteristic Plant Communities functions, the subindex score in Floodplain Depressions is determined by averaging the subindex score from the site alteration portion (Table 5) with the subindex score from the stream alteration portion (Table 6), so V_{ALT} = [(site alteration SI) + (stream alteration SI)]/2.

For the Export Organic Carbon function, only alterations to the stream channel are considered relevant, so for that function $V_{ALT\text{-}OEX}$ is used instead of V_{ALT}. $V_{ALT\text{-}OEX}$ is identical to the stream alteration portion of V_{ALT} (Table 6).

The variable subindex scaling of $V_{ALT\text{-}OEX}$ (stream alteration portion of V_{ALT}) for Floodplain Depressions is given in Table 6.

Table 6
Subindex Scaling of $V_{ALT\text{-}OEX}$ (Stream Alteration Portion of V_{ALT}) for Floodplain Depressions

Type of Alteration to Stream	Subindex
No alterations/impact (Figure 10)	1.0
Moderate impact (Figure 11). a) Presence of artificial levees, spoil piles, roads, etc. along stream reach, and/or stream has been moderately downcut, channelized, excavated and/or straightened. Generally, alterations have not been maintained and some of the natural stream morphology has returned.	0.5
Severe impact (Figure 12). a) Presence of artificial levees, spoil piles, roads, etc. along stream reach, and/or stream has been severely downcut, channelized, excavated, and/or straightened. Alterations are being maintained and the natural stream morphology is not apparent.	0.1

Figure 10. Example of unimpacted stream reach. Stream is naturally meandering and point bars are evident. No evidence of spoil piles, etc., along streambank

Figure 11. Example of stream reach that has been moderately impacted. Stream appears to have had past alteration, as the streambanks are sharply defined and show evidence of having old spoil piles. However, the stream does maintain a meander and any alterations do not appear to be recent or maintained

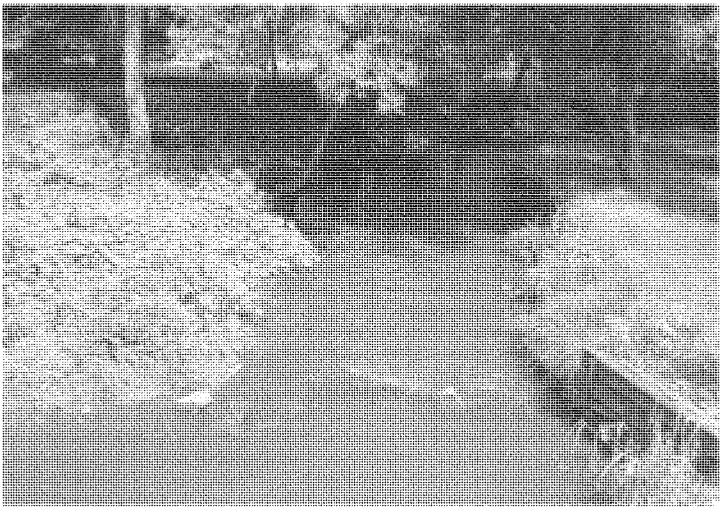

Figure 12. Example of stream reach that has been severely impacted. Channel has been straightened and makes unnatural 90-deg turns. Streambanks show sharp, straight downward cuts along the edge, and water is flowing at an unnatural velocity. Evidence of spoil pile along the streambank

V_{BUFFER}: Wetland buffer

This variable is used in the Maintain Characteristic Biogeochemical Processes and Maintain Characteristic Fauna functions.

This variable is defined as the percentage of the wetland perimeter that can be classified as buffer (forest, unmowed grassland, other undeveloped habitat $\geq$ 30 m in width). Buffers can limit the amount of human encroachment and disturbance into the site, provide important additional terrestrial habitat for wildlife (Semlitsch and Bodie 2003), and limit silt, nutrient, and contaminant loading into the wetland (Lowrance et al. 1984). Buffers 30- to 60-m wide are generally acknowledged as being sufficient to effectively protect water resources (e.g., Lee and Samuel 1976, Phillips 1989, Davies and Nelson 1994). Buffers of 30 m were also considered as providing adequate protection for 77 percent of wetland dependent species (of all taxa) in Massachusetts (Boyd 2001).

Percentage of wetland perimeter buffered ranged from 3 to 100 percent in Floodplain Depressions, and 0 to 100 percent in Isolated Depressions. The subindex score increases linearly from 0.0 to 1.0 as the percent buffered increases from 0 to 100 percent.

The variable subindex curve of V_{BUFFER} for Isolated Depressions and Floodplain Depressions is given in Figure 13.

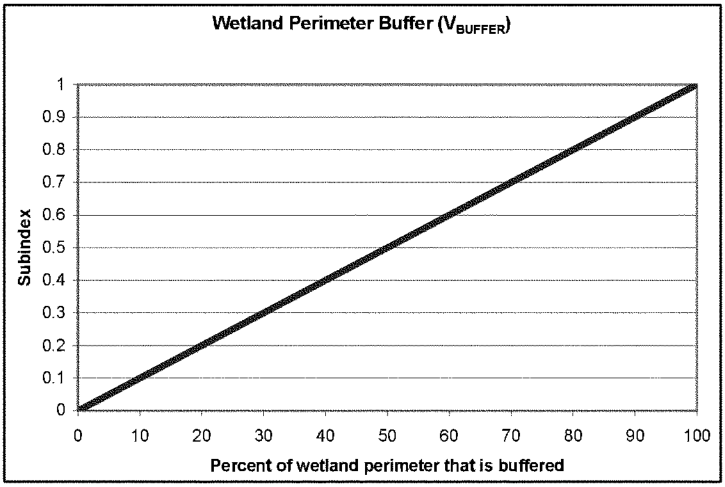

Figure 13. Relationship between percent buffer and subindex score

The equation used to calculate the V_{BUFFER} subindex score is:

$$V_{BUFFER} = 0.01\ (\%\ Buffer)$$

V_c: Native mean c ($\bar{c}$) score

Variable is used in Maintain Characteristic Plant Communities function.

This variable is the native $\bar{c}$ value derived from a site inventory Floristic Quality Assessment (FQA) (Swink and Wilhelm 1994) of the assessment area. In an FQA, each plant is assigned a C value, called the "coefficient of conservatism." The $\bar{c}$ value (from 0-10) is a measure of a species' fidelity to a specific natural community or communities. Practically, it can be used as an indicator of site disturbance, in that plants with high C values are usually found only in natural undisturbed areas, while plants with low C values can populate highly disturbed areas.

Native $\bar{c}$ is the mean C of all native plants found at the site. For example, a site with the following species: *Ambrosia trifida* (C = 0), *Carex stricta* (C = 5), *Pilea pumila* (C = 5), and *Agrostis alba* (C = *), would have a native mean C of (0+5+5)/3, or 3.3. Because *Agrostis alba* is classified as an adventive species, it does not have a C value and therefore is not included in the calculation.

Reference floodplain depressions had native $\bar{c}$ values from 2.5 to 4.9; with reference standard sites generally having scores ≥ 4.2. Isolated Depressions had $\bar{c}$ values from 0.8 to 5.6; with reference standard sites generally having scores ≥ 5.0.

The variable subindex curve of V_c for Isolated Depressions is given in Figure 14. The scaling of the curve is based on a combination of the reference data and best professional judgment.

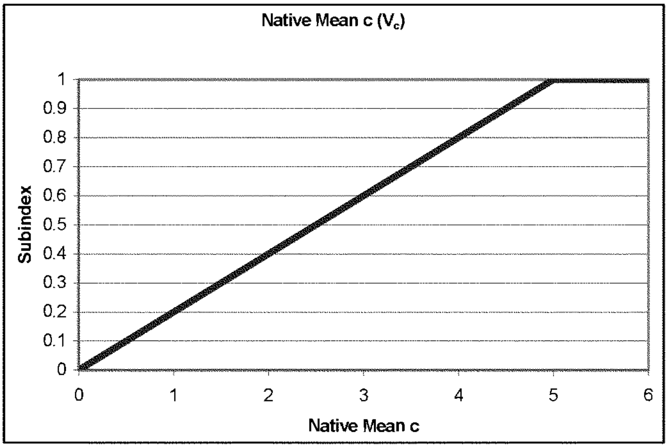

Figure 14. Relationship between native mean c score and subindex in Isolated Depressions

The equations used to calculate the V_c subindex score for Isolated Depressions are: $\overline{c} < 5.0, V_c = 0.20(\overline{c})$ and $\overline{c} \geq 5.0, V_c = 1.0$.

The variable subindex curve of V_c for Floodplain Depressions is given in Figure 15.

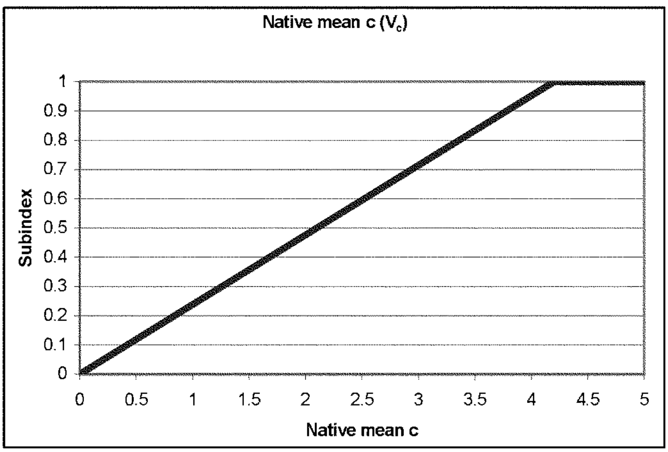

Figure 15. Relationship between native mean $\overline{c}$ score and subindex in Floodplain Depressions

The equations used to calculate the V_c subindex score are:
$\bar{c} < 4.2, V_c = 0.238(\bar{c})$ and $\bar{c} \geq 4.2, V_c = 1.0$.

V_{CAT}: Percent cover of *Typha spp.*

Variable is used in Maintain Characteristic Plant Communities function.

This variable is defined as the percentage of the assessment area that is covered by broadleaf cattail (*Typha latifolia*), narrowleaf cattail (*Typha angustifolia*), and their hybrid species (*Typha* X *glauca*). The possibly exotic *Typha angustifolia* and the *Typha* X *glauca* hybrid tend to be more aggressive than the native *Typha latifolia* and can eventually dominate a site, precluding the growth and establishment of other species (Galatowitsch et al. 1999). Because the three *Typha* species are not always easily distinguished by a quick visual glance, and all three often grow together in dense stands, this variable does not distinguish between the different species.

This variable is also used in the model to distinguish between sites with similar FQI and $\bar{c}$ scores. Many sites will have their plant diversity concentrated in a small sedge meadow boundary surrounding a much larger cattail marsh area. This structure is less desirable than a wetland where the plant diversity is distributed across the entire site. However, because the inventory FQA does not take into account species densities, these two sites may have similar FQI and $\bar{c}$ scores.

The variable is scaled identically for Isolated and Floodplains Depression, and the subindex is determined categorically, based on ranges of cattail cover. Reference standard sites had cattail cover of less than 20 percent.

The variable subindex scaling of V_{CAT} for Isolated Depressions and Floodplain Depressions is given in Table 7.

Table 7
Subindex Scaling of *Typha spp.* Cover

Typha spp. Percent Cover	Subindex
0-20	1.0
21-50	0.75
51-80	0.50
81-100	0.25

V_{CATCH}: Ratio of wetland area to catchment area

Variable is used in the Maintain Characteristic Hydrologic Regime function.

This variable is the ratio of the wetland containing the assessment area to the area of its surrounding catchment, and is a measure of the relative amount of run-off the wetland is receiving and storing. A more appropriate measure would be the ratio of wetland volume to catchment area; however, as detailed depth data are not readily available for the entire watershed, estimating wetland volumes is not feasible.

Isolated Depression reference sites had ratios ranging from 0.05 to 0.82, with reference standard sites ranging from 0.02 to 0.16. Floodplain Depression reference sites had ratios ranging from 0.01 to 1.15, with reference standard sites ranging from 0.04 to 0.33. Sites may have changes in catchment size from historical conditions that resulted from the building of elevated roads or railroad tracks, which block normal overland flow, resulting in a larger ratio. Conversely, effective catchment size can be enlarged through the building of ditch and irrigation networks, which will result in a smaller ratio.

Ratios higher than the reference standard range would indicate that the depressional wetland is not receiving the amount of water necessary to maintain a hydroperiod characteristic of reference standard sites. Furthermore, at a certain point the depressional wetland would not be receiving enough water to sustain hydrophytic vegetation and saturated soils. Therefore, as the ratio increases above the reference standard range, the subindex score decreases linearly to 0.0. Similarly, the subindex score linearly decreases when the ratio is below the reference standard range, but only to 0.5, as even at the lower ratios the depressional wetland would still be receiving enough water to support basic characteristics of the wetland.

The variable subindex curve of V_{CATCH} for Isolated Depressions is given in Figure 16.

The equations used to calculate the V_{CATCH} subindex score for Isolated Depressions are:

Ratio(R) < 0.02, $V_{CATCH} = 25R + 0.5$
$0.02 \leq R \leq 0.16$, $V_{CATCH} = 1.0$
$0.16 < R < 1.0$, $V_{CATCH} = -1.19R + 1.19$
$R \geq 1.0$, $V_{CATCH} = 0.0$

The variable subindex curve of V_{CATCH} for Floodplain Depressions is given in Figure 17.

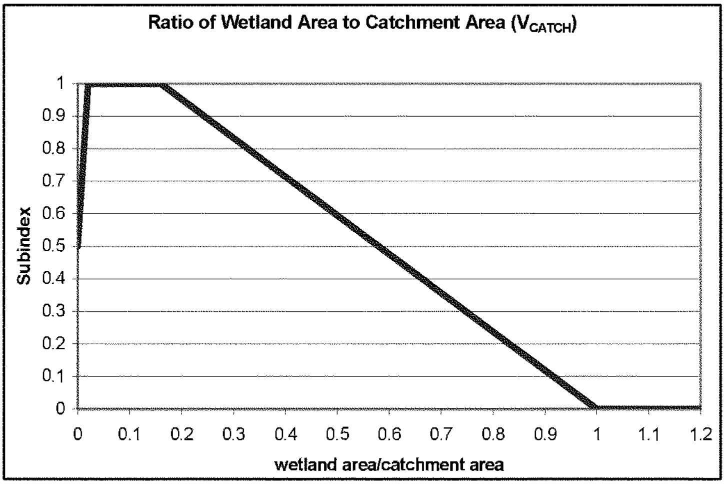

Figure 16. Relationship between wetland/catchment area ratio and subindex score in Isolated Depressions

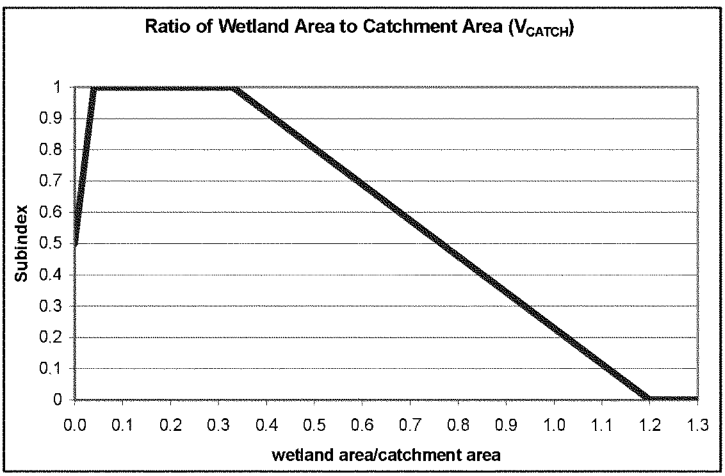

Figure 17. Relationship between wetland/catchment area ratio and subindex score in Floodplain Depressions

The equations used to calculate the V_{CATCH} subindex score for Floodplain Depressions are:

Ratio(R) < 0.04, $V_{CATCH} = 12.5(R) + 0.5$
$0.04 \leq R \leq 0.33$, $V_{CATCH} = 1.0$

$0.33 < R < 1.2$, $V_{CATCH} = -1.149(R) + 1.379$
$R \geq 1.2$, $V_{CATCH} = 0.0$

V_{FQI}: Native Floristic Quality Index

This variable is used in the Maintain Characteristic Plant Communities function.

This variable is the native Floristic Quality Index (FQI) score derived from a site inventory FQA of the assessment area. The FQI can be used as a measure of intrinsic plant biodiversity at the site.

Native FQI = $\bar{c}\sqrt{n}$, where n is the number of native species found at the site and $\bar{c}$ is the native mean C score (see V_C description). For example, a site with the following species: *Ambrosia trifida* (C = 0), *Carex stricta* (C = 5), *Pilea pumila* (C = 5), and *Agrostis alba* (C = *), would have an FQI of $3.33\sqrt{3}$, or 5.8. Because *Agrostis alba* is classified as an adventive species it is not included in the calculation.

In reference Isolated Depressions, native FQI scores ranged from 4.5 to 38.1. In reference Floodplain Depressions, native FQI scores ranged from 5.2 to 42.4.

The variable subindex curve of V_{FQI} for Isolated Depressions is given in Figure 18. The scaling of the curve is based on a combination of the reference data and best professional judgment.

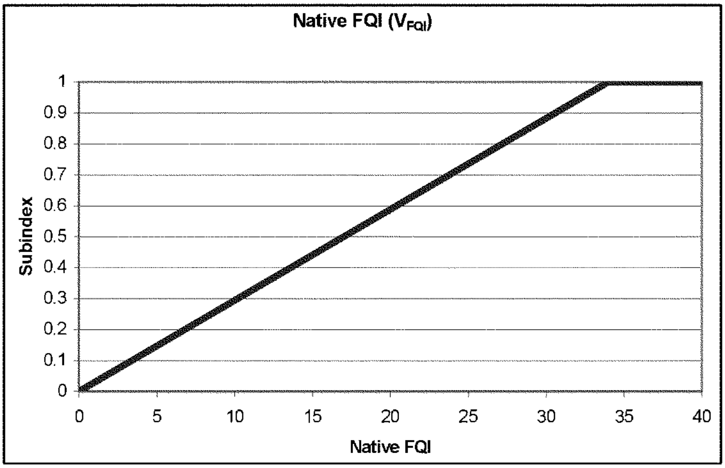

Figure 18. Relationship between native FQI and subindex in Isolated Depressions

The equations used to calculate the V_{FQI} subindex score for Isolated Depressions are:

$FQI < 34, V_{FQI} = 0.0294(FQI)$
$FQI \geq 34, V_{FQI} = 1.0$

The variable subindex curve of V_{FQI} for Floodplain Depressions is given in Figure 19.

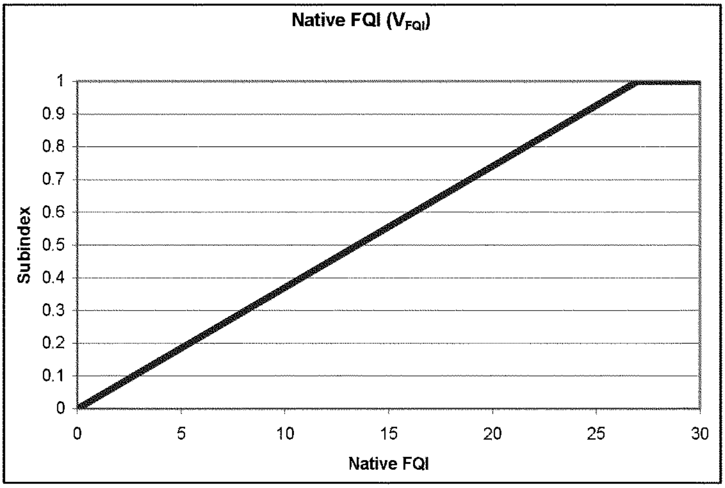

Figure 19. Relationship between FQI and subindex in Floodplain Depressions

The equations used to calculate the V_{FQI} subindex score for Floodplain Depressions are:

$FQI < 27, V_{FQI} = 0.03704(FQI)$
$FQI \geq 27, V_{FQI} = 1.0$

V_{GVC}: Ground vegetation cover

This variable is used in the Maintain Characteristic Hydrologic Regime, Maintain Characteristic Biogeochemical Processes, Maintain Characteristic Fauna, and Export Organic Carbon (for Floodplain Depressions) functions.

This variable is defined as the percentage of the assessment area that is covered with herbaceous and woody-vine vegetation. The amount of ground vegetation cover serves as a measure of plant biomass available for evapotranspiration, and is also an indicator of primary productivity and vegetative structure in the assessment area. Ground vegetation cover at reference sites ranged from 60 to >95 percent, although most reference sites and all reference standard sites contained ground vegetation cover >95 percent. Sites with less ground vegetation cover were either recently restored or planted, formerly forested sites (with current tree cover around 30 percent), or had stunted growth of herbaceous plants.

The subindex score decreases linearly from 1.0 to 0.0 as ground vegetation cover in the assessment area decreases from 100 to 0 percent.

The variable subindex curve of V_{GVC} for both Isolated and Floodplain depressions is given in Figure 20.

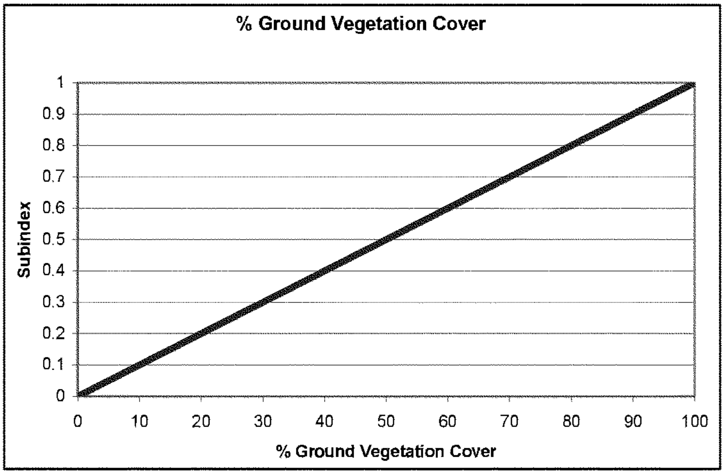

Figure 20. Relationship between ground vegetation cover and subindex score

The equation used to calculate the subindex score for V_{GVC} is:

$V_{GVC} = 0.01\ (\%\ GVC)$

V_{INV}: Invasive species cover

Variable is used in Maintain Characteristic Plant Communities and Maintain Characteristic Fauna functions.

This variable is defined as the percentage of the assessment area that is covered by invasive species, excluding *Typha spp.* In the reference domain, the most common invasive species encountered was reed canary grass (*Phalaris arundinacea*), and this variable can usually be scored by looking for the percent cover of this one particular species. *P. arundinacea* has the advantage of being highly productive in flooded areas but also very drought resistant (Rice and Pinkerton 1993). Other invasive species that may cover a significant portion of the wetland include common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), and giant ragweed (*Ambrosia trifida*).

Invasive species generally spread into wetlands that have been disturbed by anthropogenic activity. These species spread aggressively in the wetland, replacing and preventing the establishment of indigenous vegetation (Galatowitsch et al. 1999). Based on personal observation in highly disturbed depressional wetlands in the reference domain, invasive species (*P. arundinacea* in particular) can come to dominate a site, accounting for over 95 percent of the ground vegetation cover in the wetland (Figure 21). The negative effect of *P. arundinacea* on the plant community has been further demonstrated in a study where wet meadow sites with *P. arundinacea* had roughly two-thirds of the species richness of plots without *P. arundinacea*, and sites with both *P. arundinacea* and hydrologic disturbance had roughly one-third of the species richness of sites without *P. arundinacea* (Kercher et al. 2004).

In reference to Isolated Depressions, invasive species percent cover ranged from <5 to 90 percent, in Floodplain Depressions, percent cover ranged from 7.5 to 95 percent. Reference standard sites in both classes generally contained < 10 percent invasive species cover. The variable is scaled identically for Isolated and Floodplains Depression, based on the reference data and best professional judgment. The subindex is determined categorically, based on ranges of invasive species cover.

Figure 21. Floodplain Depression located in Cook County, IL, that is almost completely covered by reed canary grass (*Phalaris arundinacea*)

The variable subindex scaling for V_{INV} in Isolated and Floodplain Depressions is given in Table 8.

Table 8
Subindex Scaling for Invasive Species Cover in Isolated and Floodplain Depressions

Invasive Species Percent Cover	Subindex
0-10	1.0
11-25	0.8
26-50	0.6
51-80	0.3
81-94	0.1
95-100	0

$V_{LANDUSE}$: Land use within 300 m

Variable is used in Maintain Characteristic Fauna function.

This variable is defined as the overall land use (LU) within 300 m of the assessment area. The surrounding LU can affect how organisms move within and between wetlands, and also accounts for the amount of available terrestrial habitat around the wetland. A 300-m distance was used based on a literature review by Semlitsch and Bodie (2003). They reported that 289 m was the mean maximum distance (distance radiating from the outer edge of the wetland) of core terrestrial habitat that was utilized by various groups of amphibians and reptiles (with a range of 218 m for salamanders and 368 m for frogs).

The overall LU score is derived by dividing a 300-m buffer around the assessment area into grids, and assigning each grid one of three general LU categories — urban, agricultural, and forest/grassland/wetland. Each category is assigned an individual score: urban = 5, agriculture = 3, and forest/grassland/wetland = 1, using the logic that urban areas are generally more detrimental to wildlife than agricultural areas, and to be consistent with the scoring scheme used in the V_{LUC} variable. The overall LU score is average score of the individual grids.

In reference sites, 300-m LU scores ranged from 1.04 to 3.97 in Isolated Depressions, and from 1.42 to 3.66 in Floodplain Depressions. In order to reflect the realistic possibility that future land-use changes can achieve variable scores outside the range of what was found in reference sites, the subindex curves allow for the entire range of possible scores (1.00 to 5.00) for this variable. In Isolated Depressions, the subindex score decreases linearly from 1.0 to 0.0 as the catchment LU score increases from 1.00. In Floodplain Depressions, the subindex score decreases linearly from 1.0 to 0.0 as the 300-m LU score increases from 1.50, because reference standard Floodplain Depressions tended to have higher 300-m LU scores than Isolated Depressions.

The variable subindex curve of $V_{LANDUSE}$ for Isolated Depressions is given in Figure 22.

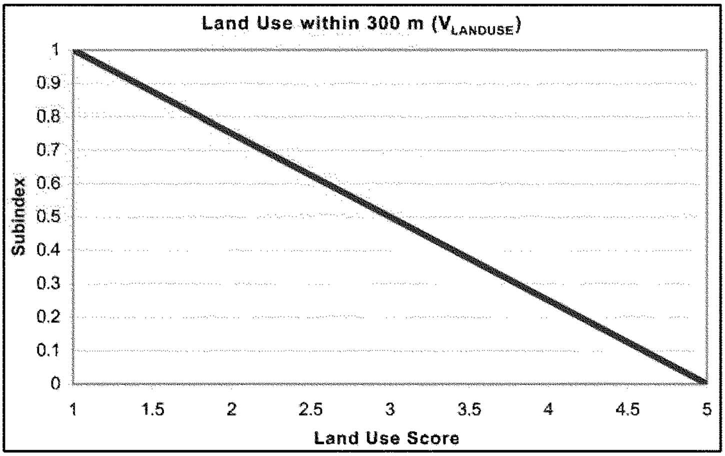

Figure 22. Relationship between land-use score and subindex in Isolated Depressions

The equation used to calculate the subindex score for $V_{LANDUSE}$ in Isolated Depressions is:

$$V_{LANDUSE} = -0.25(300m\ LU\ Score) + 1.25$$

The variable subindex curve of $V_{LANDUSE}$ for Floodplain Depressions is given in Figure 23.

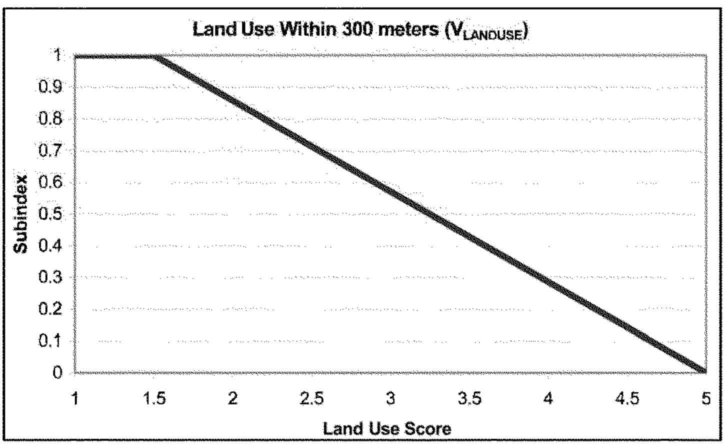

Figure 23. Relationship between land-use score and subindex in Floodplain Depressions

The equations used to calculate the subindex score for $V_{LANDUSE}$ in Floodplain Depressions are:

Land use Score (LU) ≤ 1.5, V_{LUC} = 1.0
LU > 1.5, V_{LUC} = -0.2857(Catchment LU Score) + 1.4286

V_{LUC}: Land use of the catchment area

Variable is used in the Maintain Characteristic Hydrologic Regime, Maintain Characteristic Biogeochemical Processes, and Maintain Characteristic Plant Community functions.

This variable is the overall LU score of the wetland's catchment. Land-use changes (e.g., urbanization) in the catchment can have a dramatic impact on both the hydrologic regime of wetlands (Euliss and Mushet 1996, Azous and Horner 2001, Bhaduri et al. 1997) and nutrient loading into those wetlands.

The overall LU score is derived by dividing the catchment area into grids, and assigning each grid one of three general LU categories — urban, agricultural, and forested/grassland/wetland. Each category is assigned an individual score: urban = 5, agriculture = 3, and forest/grassland/wetland = 1. The overall LU score is average score of the individual grids. The values (1,3,5) are based on "national average" export coefficients for nitrogen and phosphorus as reported in Rast and Lee (1977), where urban watersheds on average exported 5.8 times as much, and rural/agricultural watersheds exported on average 3.3 times as much combined total phosphorus and total nitrogen than forested watersheds. Additionally, having more impermeable surfaces and the subsequent increase in runoff, urban LU will have more of an impact on hydrology than rural/agriculture LU. The LU scores can obviously be more finely tuned than the "rougher" estimates used here, as different sub-categories within the urban and rural/agriculture classifications will have different effects on runoff and nutrient loading. However, finer estimates would require an additional level of detail and accuracy that is not currently available in the LU maps that cover the entire reference domain.

In reference sites, catchment LU scores ranged from 1.00 to 4.27 in Isolated Depressions, and from 1.11 to 4.15 in Floodplain Depressions. In order to reflect the realistic possibility that future land-use changes can achieve variable scores outside the range of what was found in reference sites, the subindex curves allow for the entire range of possible scores (1.00 to 5.00) for this variable. In Isolated Depressions, the subindex score decreases linearly from 1.0 to 0.0 as the catchment LU score increases from 1.00. In Floodplain Depressions, the subindex score decreases linearly from 1.0 to 0.0 as the catchment LU score increases from 1.50, as reference standard Floodplain Depressions tended to have higher catchment LU scores than Isolated Depressions.

The variable subindex curve of V_{LUC} for Isolated Depressions is given in Figure 24.

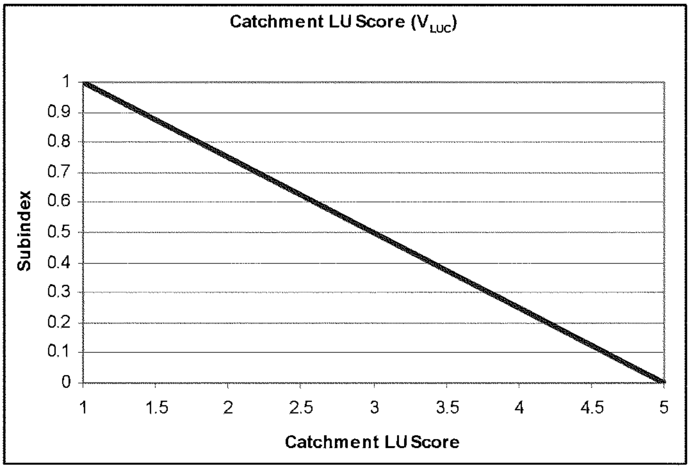

Figure 24. Relationship between catchment land-use score and subindex score in Isolated Depressions

The equation used to calculate the subindex score for V_{LUC} for Isolated Depressions is:

V_{LUC} = -0.25(Catchment LU Score) + 1.25

The variable subindex curve of V_{LUC} for Floodplain Depressions is given in Figure 25.

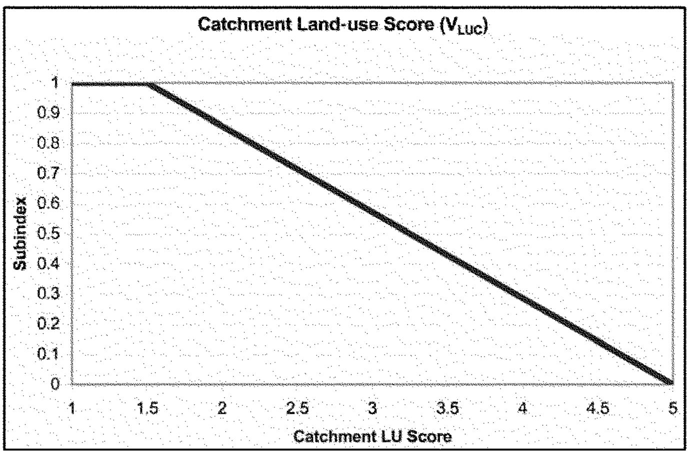

Figure 25. Relationship between catchment land-use score and subindex score in Floodplain Depressions

The equations used to calculate the subindex score for V_{LUC} for Floodplain Depressions are:

Catchment LU Score (LU) $\leq$ 1.5, V_{LUC} = 1.0
LU > 1.5, V_{LUC} = -0.2857(Catchment LU Score) + 1.4286

V_{NAT}: Percent of plant species that are native

Variable is used in Maintain Characteristic Plant Communities and Maintain Characteristic Fauna functions.

This variable is defined as the percent of total plant species counted at the site that are considered native in the FQA database. Some exotic species have the ability to out-compete native species, and having a high percentage of non-native species at the site can alter the natural ecosystem structure of the wetland, as well as serving as an indicator of unnatural levels of disturbance. Additionally, many faunal populations depend on native plants for food, cover, or nesting (Weller 1981).

In reference Isolated Depression sites, this variable ranged from 65 to 96 percent, with reference standard sites having more than 95 percent native species. In Floodplain Depressions, this variable ranged from 70 to 99 percent in isolated depressions, with reference standard sites having more than 90 percent native species.

The equations used to calculate the V_{NAT} subindex score for Isolated Depressions and Floodplain Depressions are:

% Native species (NS) < 65, V_{NAT} = .001538(NS)
65 $\leq$ NS< 90, V_{NAT} = 0.036(NS) – 2.24
IF $\geq$ 90, V_{INV} = 1.0

The variable subindex curve of V_{NAT} for Isolated Depressions is given in Figure 26.

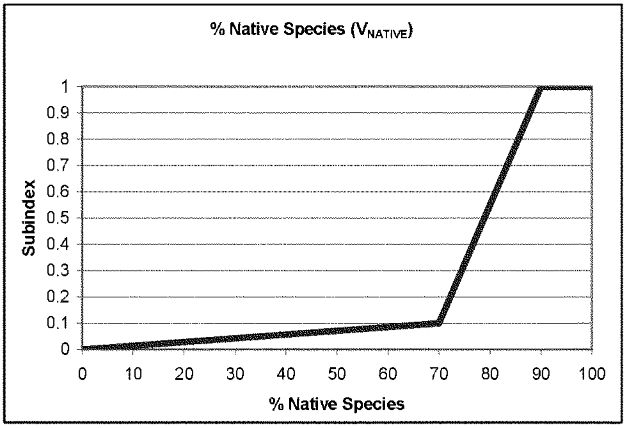

Figure 26. Relationship between native species percentage and subindex in Isolated Depressions

V_{OHOR}: Thickness of surface 'O' horizon

Variable is used in Maintain Characteristic Biogeochemical Processes and Export Organic Carbon (for Floodplain Depressions) functions.

This variable is defined as the thickness, in inches, of the 'O' horizon in the first 32 in. (80 cm) of the soil profile. It does not include 'O' horizons that are buried in the soil profile (beneath an A, B, C, or any mineral horizon or layer), because these below surface horizons are not as readily available for export or biological activity. The 'O' horizon is defined as a horizon containing greater than 20 percent by weight organic soil materials (Schoeneberger et al. 2002). The organic matter may range anywhere from partially to highly decomposed material.

Soil organic carbon is a source of and a sink for plant nutrients, aids infiltration, improves soil structure, promotes water retention, absorbs both anthropogenic and natural toxic substances, and is an energy source for heterotrophic organisms (Juregensen et al. 1989, Mitsch and Gosselink 2000, Craft 2001). This variable also serves as an indicator that nutrients in vegetative organic material are being recycled.

This variable is scaled differently, depending on whether the predominant soil type in the assessment area is mineral or organic. An organic soil (histosol) is defined as having 16 in. (40 cm) or more of the upper 32 in. (80 cm) as organic soil material (USDA, NRCS 2002). In the reference domain, organic soils, especially near the surface, will often be of a "mucky" texture. In reference Floodplain Depressions with mineral soils, average depth of surface 'O' horizons ranged from 0 to 6.5 in. (16.5 cm), and the average depth of surface 'O' horizons for organic soils ranged from 27.5 in. (69.9 cm) to 55 in. (139.7 cm, the maximum depth of the sample core). In Isolated Depressions, average depth of surface 'O' horizons in mineral soils ranged from 0 to 11.5 in. (29.2 cm), and average depth of surface 'O' horizons in organic soils ranged from 0 to 55 in. (139.7 cm).

The subindex curves are identical for Isolated and Floodplain Depressions if the soil is organic, with the subindex score decreasing linearly from 1.0 to 0 as the depth of the 'O' horizon decreases from 32 to 0 in. (80 to 1 cm). The subindex curves are scaled differently for the two subclasses if the soil is mineral, because Isolated Depressions with mineral soils tended to have deeper 'O' horizons in the Floodplain Depressions with mineral soils. In Isolated Depressions, the subindex score decreases linearly from 1.0 to 0 as the depth of the 'O' horizon decreases from 6 to 0 in. (15.2 to 0 cm). In Floodplain Depressions the subindex score decreases linearly from 1.0 to 0 as the depth of the 'O' horizon decreases from 3 to 0 in.

The variable subindex curves of V_{OHOR} for Isolated Depressions and Floodplain Depressions are given in Figures 27, 28, and 29.

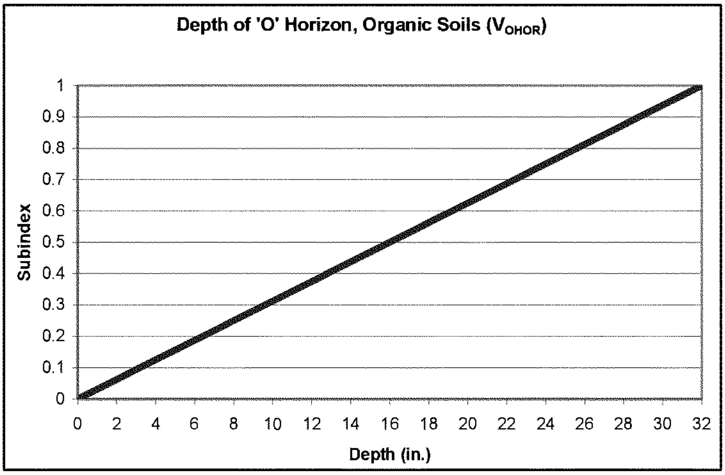

Figure 27. Relationship between 'O' horizon depth and subindex score in organic soils in Isolated Depressions and Floodplain Depressions

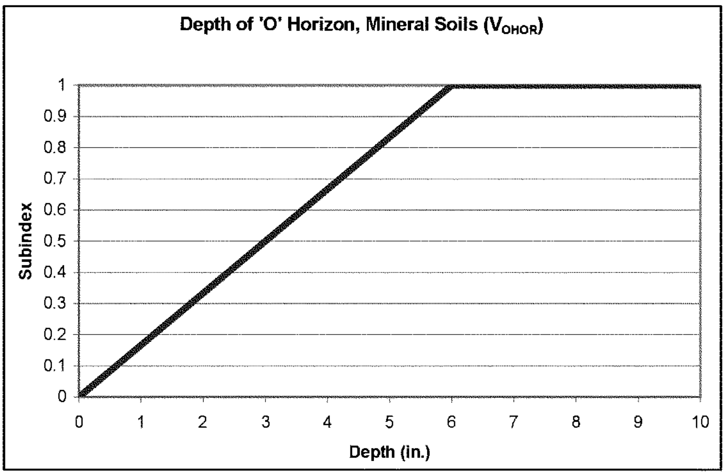

Figure 28. Relationship between 'O' horizon depth and subindex score in mineral soils in Isolated Depressions

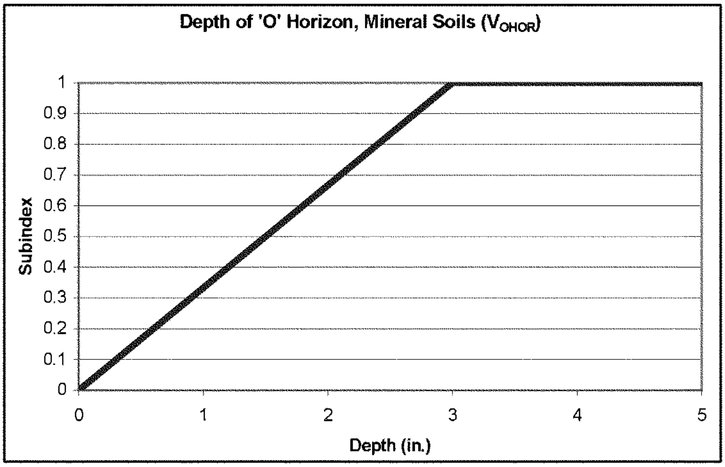

Figure 29. Relationship between 'O' horizon depth and subindex score in mineral soils in Floodplain Depressions

The equation used to calculate the V_{OHOR} subindex score for organic soils in Isolated Depressions and Floodplain Depressions is:

$V_{OHOR} = 0.03125(O)$

The equations used to calculate the V_{OHOR} subindex score for mineral soils in Isolated Depressions are:

Depth of O horizon $(O) \geq 6$, $V_{OHOR} = 1.0$
$O < 6$, $V_{OHOR} = 0.1667(O)$

The equations used to calculate the V_{OHOR} subindex score for mineral soils in Floodplain Depressions are:

Depth of O horizon $(O) \geq 3$, $V_{OHOR} = 1.0$
$O < 3$, $V_{OHOR} = 0.333(O)$

V_{SOIL}: Soil structure

Variable is used in the Maintain Characteristic Hydrologic Regimes and Maintain Characteristic Biogeochemical Processes functions.

This variable measures the percentage of the first 12 in. (30 cm) of the soil profile that is either a plow layer (an Ap horizon, which generally indicates past agricultural activity at the site), or has a "platy" or "massive" structure. It is used to assess anthropogenic impact to the natural near-surface properties of the soil.

Each soil has a naturally occurring arrangement of soil particles into distinct aggregates or shapes. At reference standard sites, soils are of primarily granular or subangular blocky shape. However, the natural aggregates can be altered or destroyed by disturbance. Soil compaction, for instance, can join aggregates and create a 'massive' or a 'platy" structure, which results in decreases in pore size, water filled pore space, and soil temperature. These changes affect the activity of soil organisms by decreasing the rate of decomposition of soil organic matter and the subsequent release of nutrients. (USDA, NRCS 1996).

In both Isolated and Floodplain Depressions, the subindex score decreases linearly from 1.0 to 0 as the percentage of soil altered increases from 0 to 100 percent.

The variable subindex curve of V_{SOIL} for both Isolated Depressions and Floodplain Depressions is given in Figure 30.

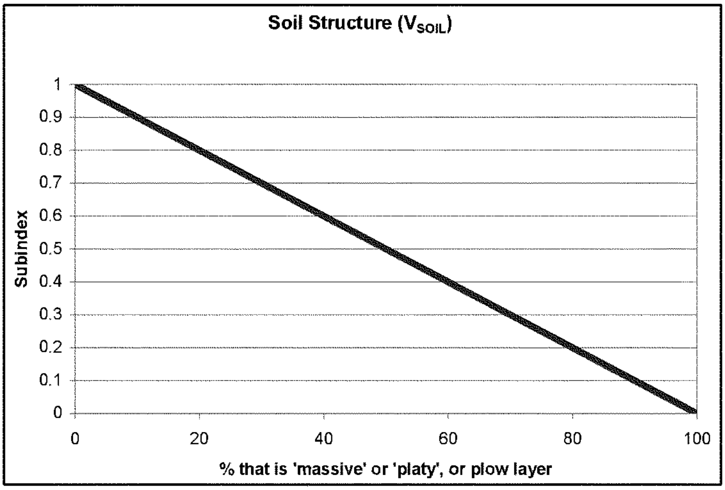

Figure 30. Relationship between soil structure and subindex score

The equation used to calculate the V_{SOIL} subindex score is:

$V_{SOIL} = -0.01(SOIL) + 1.0$

Alternate method of scaling V_{SOIL}. If the people applying this model in the field do not have the ability to readily discern a plow layer or the structure of the soil, this variable may be alternately scored using Table 9, which requires knowledge of any soil disturbance in the assessment area. Recognizing that alterations to the native soil may vary in their level of impact, an "average" subindex score of 0.4 is assigned if any alteration at all is known to have occurred in the past 20 years. If plowing or compaction has occurred between 20 and 50 years ago, it is presumed that the native soil properties have partially returned to what they were prior to the alteration, and a subindex score of 0.7 is assigned. At greater than 50 years, it is assumed that the native soil properties have fully returned to what they were prior to alteration, and there is no decrease in subindex score. These values and time periods are based on best professional judgment.

Table 9
Subindex Scaling for V_{SOIL} (Alternate Method) for Isolated and Floodplain Depressions

Soil Structure/Alteration	Subindex
No known alterations to native soil, or plowing or compaction occurred > 50 years ago	1.0
Native soils have been plowed or compacted within the past 20-50 years	0.7
Native soils have been buried with fill, or plowed or compacted within the past 20 years	0.4

V_{TSSC}: Tree-shrub-sapling percent cover

Variable is used in Maintain Characteristic Fauna function.

This variable is defined as the percent cover of living trees, shrubs, and saplings (all woody vegetation ≥ 4.5 ft (1.4 m) tall) in the assessment area. It partly accounts for the vegetative structure for wildlife habitat at the site. By definition, isolated depressions are non-forested (≤ 30 percent cover of trees/shrubs/saplings), although most sites contained at least a few trees and shrubs, especially near the edge of the wetland. Reference standard sites all had tree-shrub-sapling percent coverage of less than 10 percent. A larger percentage of tree-shrub-sapling percent coverage in these herbaceous wetlands is generally attributable to the encroachment of invasive species, such as common buckthorn (*Rhamnus cathartica*) and glossy buckthorn (*Rhamnus frangula*). Therefore, the subindex score decreases as the tree-shrub-sapling coverage increase above 10 percent. This variable is scored categorically using percent cover ranges.

The variable subindex scaling of V_{SNAG} for Isolated Depressions and Floodplain Depressions is given in Table 10.

Table 10
Subindex Scoring of V_{TSSC}

Tree-Shrub-Sapling % Cover	Subindex
0-10 percent	1.0
11-20 percent	0.7
21-30 percent	0.3

V_W: Plant wetness (W) score

Variable is used in the Maintain Characteristic Hydrologic Regime function.

This variable is the W/adventives (coefficient of wetness, including adventive species) score obtained from a site inventory Floristic Quality Assessment of the assessment area. The W/adventives score is the average plant wetness (W) value for all plants in the assessment area. The W value is a number assigned to each plant based on its wetness designation (OBL = -5, FACW+ = -4, FACW = -3, FACW- = -2, FAC+ = -1, FAC = 0, FAC- = 1, FACU+ = 2, FACU = 3, FACU- = 4, UPL = 5). The plant wetness designations are from the 'Plants of the Chicago Region' book (Swink and Wilhlem 1994), which primarily uses the wetness designations from the 'National List of Plant Species that Occur in Wetlands' (Reed 1988), except in a few cases where Swink and Wilhelm assigned a designation if one was lacking in the national list, or they strongly disagreed with the designation given in the national list. Isolated Depression reference sites had W/adventive scores ranging from -0.7 to -3.8, with reference standard sites having scores ranging from -2.4 to -3.8. Deviation from the lower end (-2.4) of the range would suggest that the hydrology of the site is such that it has become too "dry" and would not support a reference standard plant community. A score > 0.0 would suggest that the site is no longer a wetland.

This variable is not used for Floodplain Depressions because in those sites the variable did not distinguish reference standard sites from other sites. In Isolated Depressions the subindex score decreases linearly from 1.0 to 0.2 (the 0.2 value was set based on the best professional judgment of the A-team) as the W/adventives score goes from -2.4 to 0. If the W/adventives score is >0.0, then the subindex is 0.0.

The variable subindex curve of V_W for Isolated Depressions is given in Figure 31.

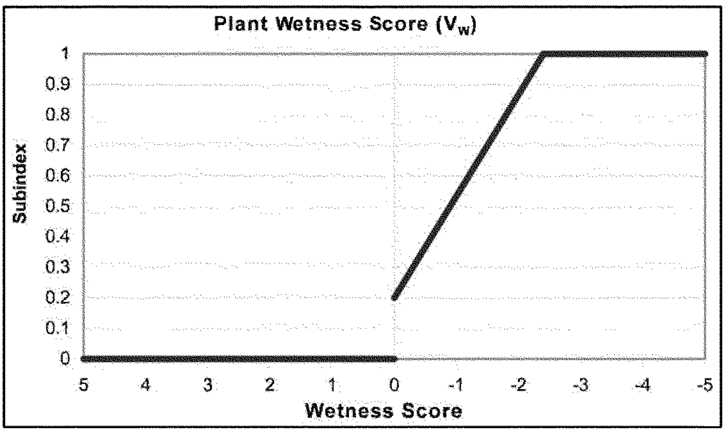

Figure 31. Relationship between W/adventives score and subindex score in Isolated Depressions

The equations used to calculate the V_W subindex score are as follows:

W/adventives > 0, $V_W = 0.0$
-2.4 < W/adventives ≤ 0 , $V_W = -.3333(W/adventives) + 0.2$
W/adventives ≤ -2.4, $V_W = 1.0$

V_{W500}: Wetlands within 500 m

Variable is used in Maintain Characteristic Fauna function.

This variable is a weighted measure of the number of wetlands located within 500 m of the assessment area. Each wetland within 500 m is multiplied by a factor from 1 to 3 based on its distance from the assessment area. The 'wetlands within 500 m score' is the sum of all the weighted values. More weight is given to wetlands that are closer to the assessment area, under the logic that a) closer wetlands will be more accessible to species with a limited dispersal range, and b) the less distance required for travel, the less chance deadly hazards will be encountered. Road traffic, for instance, can be a barrier to effective dispersal by amphibians (Fahrig et al. 1995). The 500-m dispersal range and the weighting system used here were selected based on the best professional judgment of the author and the A-team.

This variable is important at a landscape level (although it is more relevant for mammals, amphibians, and reptiles, than it is for birds), especially within the context of a mosaic of small wetlands (Gibbs 1993). It approximates both the density and proximity of wetlands in an area, and measures the ability of a meta-populations of animals to move from one wetland to another, thus increasing their viability.

In reference Isolated Depressions, scores ranged from 3.5 to 27.5. In reference Floodplain Depressions, scores ranged from 6 to 34. The scaling of the curve is based on the reference data and best professional judgment of the author.

The variable subindex curve of V_{W500} for Isolated Depressions is given in Figure 32.

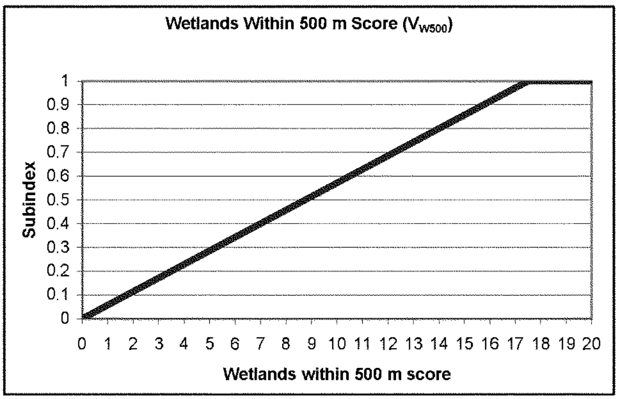

Figure 32. Relationship between wetlands within 500m score and subindex in Isolated Depressions

The equations used to calculate the V_{W500} subindex score for Isolated Depressions are:

W500 score ≥ 17.5, $V_{W500} = 1.0$
W500 score < 17.5, $V_{W500} = 0.05714(W500)$

The variable subindex curve of V_{W500} for Floodplain Depressions is given in Figure 33.

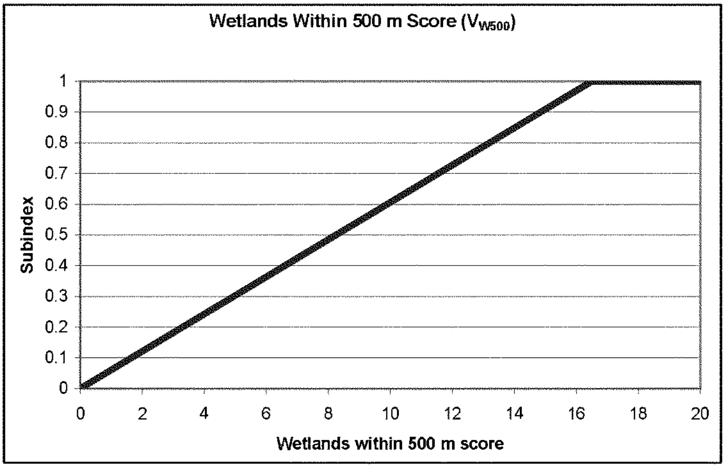

Figure 33. Relationship between wetlands within 500-m score and subindex in Floodplain Depressions

The equations used to calculate the V_{W500} subindex score for Floodplain Depressions are:

W500 score ≥ 16.5, $V_{W500} = 1.0$
W500 score < 16.5, $V_{W500} = 0.0606(W500)$

Functions

Functional Capacity Indices are, by definition, a measure of the function on a "per unit" basis, meaning that the size of the wetland is generally not taken into consideration when determining functional scores. For instance, with the "Maintain Characteristic Fauna" function, although wetland tract size is obviously correlated to available wetland wildlife habitat (10 acres of wetland provides more habitat than a similarly functioning 1 acre wetland), acre for acre the function is performed at the same level. Wetland size can be addressed through the use of Functional Capacity Units (FCUs), which are merely the size of the wetland multiplied by the individual functional capacity index. The use of FCUs is discussed in more detail in Appendix C.

Function 1: Maintain characteristic hydrologic regime

Definition. This function is defined as the capacity of a depressional wetland to maintain and exhibit variations in the depth and duration of surface and below-surface water levels, as well as the volume and frequency and timing of water inputs and outputs, similar to that found in reference standard conditions. In isolated depressions, this function occurs largely through the long- and short-term storage and movement of water received through runoff and direct precipitation, and in some systems, groundwater inputs. Floodplain depressions also have floodwater as another potential hydrologic input. Water can be lost from the system through evapotranspiration, groundwater recharge, or drainage through a natural or artificial outlet.

The function is modeled here by assessing direct and indirect evidence that the hydrologic regime has been modified. An independent measure of this function would be to use wells for long-term monitoring of the water table, and comparing hydrograph results between impacted and reference standard wetlands.

Rationale for selecting function. Maintenance of a characteristic hydrologic regime is integral to the performance of all other functions. For instance, the wetland must store water for a sufficient enough period of time to maintain other wetland characteristics (e.g., hydric soils and hydrophytic vegetation).

Prolonged saturation leads to anaerobic soil conditions, which is critical for the occurrence of several biogeochemical processes (such as the cycling of various elements, compounds, and nutrients) that are highly dependent on the oxygen concentrations and redox capacity of the soil (Mausbauch and Richardson 1994). A proper hydrologic regime is also necessary for the maintenance of a desirable plant community, and the creation of suitable faunal habitat.

Characteristics and processes that influence the function. In isolated depressions, the primary source of hydrology is direct precipitation into the wetland and associated runoff from the wetland catchment. In floodplain depressions, the primary sources of hydrology are direct precipitation into the wetland and associated runoff from the wetland catchment, as well as flooding from an associated stream channel. However, the extent and importance of stream flooding will vary among sites, depending on the nature of adjacent streams. For both subclasses, the hydrology of the wetland will generally be driven by the intensity, duration, areal extent, and frequency of precipitation events. Depending on its location in the watershed, groundwater may also play a substantial role in the hydrology of the depression. In the reference domain, precipitation during the late spring/summer/early fall period (April through September) is often associated with short thunderstorms (1 to 2 hr) and on a month-to-month basis is on average about twice as high then during the rest of the year (October through March), where precipitation is generally longer in duration but less intense (IDNR 1998).

The ability of the wetland to store surface and subsurface water is affected by a variety of natural and anthropogenic processes and activities. Climate and landscape scale geomorphic features are largely natural factors that influence the wetland's hydrology. On-site characteristics that directly affect this function include the relative size and volume of the wetland, soil sorption capabilities, and the amount of biomass present for evapotranspiration. Catchment characteristics can have a pronounced effect on hydrology (Brooks et al. 1991), and changes to the size or LU of the catchment will affect the timing and volume of runoff received in the wetland. Changes in LU (the removal of perennially vegetated areas in particular) can also increase erosional sediment loads into depressional wetlands, thereby decreasing their volume and reducing their water storage capacity and flood attenuation benefits (Ludden et al. 1983). Storage of water will also be affected by hydrologic modifications such as ditches or drainage tiles on or near the site, porosity of the soil, and, in the case of floodplain depressions, modifications to the stream channel that can either increase or decrease flooding to the site.

Ground vegetation cover can be used as an indicator of relative rates of evapotranspiration at both types of depressions. The presence of herbaceous vegetation can greatly increase evapotranspiration at a site. Broadleaf cattail (*Typha latifolia*), for instance, can in some cases have double or triple the evapotranspiration rate of an unvegetated area (Towler et al. 2004, Allen et al. 1997). Ground vegetation cover can also be used as an indicator that hydrologic alterations have occurred; sparse or stunted herbaceous vegetation at a site would suggest the hydrology is not able to support the vegetation. Similarly, the 'W' score (see the V_W variable) obtained from a Floristic Quality Assessment (Swink and Wilhelm 1994) is another possible vegetative indicator of the hydrologic condition of the wetland.

Functional Capacity Index. The model for assessing the Maintain Characteristic Hydrology function includes the following assessment variables:

- Variables used for Isolated Depressions:
  V_{ALT}: Presence of hydrologic alteration
  V_{CATCH}: Ratio of wetland area to catchment area
  V_{GVC}: Ground vegetation cover
  V_{LUC}: Land use of the catchment area
  V_{SOIL}: Soil structure
  V_W: FQA W/adventives score

- Variables used for Floodplain Depressions:
  V_{ALT}: Presence of hydrologic alteration
  V_{CATCH}: Ratio of wetland area to catchment area
  V_{GVC}: Ground vegetation cover
  V_{LUC}: Landuse of the catchment area
  V_{SOIL}: Soil structure

The forms of the assessment models are as follows:

a. For Isolated Depressions:

$$FCI = \frac{\left[\frac{\frac{(V_{GVC} + V_{SOIL} + V_{W})}{3} + V_{CATCH}}{2} + V_{ALT} + V_{LUC} \right]}{3}$$

The equation for this function measures direct (V_{ALT} and V_{LUC}) and indirect (V_W) indicators of change to the site hydrology, as well as relative storage capacity (V_{CATCH}, V_{SOIL}) and biomass (V_{GVC}) available for transpiration. More weight is given to V_{CATCH}, and the most weight is given to V_{ALT} and V_{LUC}, because, based on best professional judgment, those variables would presumably have a greater effect on site hydrology than the other three. Arithmetic means are used in the function, so the FCI would only equal 0.0 if all variable subindex scores equaled 0.0.

b. For Floodplain Depressions:

$$FCI = \frac{\left[\frac{\frac{(V_{GVC} + V_{SOIL})}{2} + V_{CATCH}}{2} + V_{ALT} + V_{LUC} \right]}{3}$$

The structure and logic of the model for this function in Floodplain Depressions are similar to the Isolated Depressions model, except V_W is not used.

Function 2: Maintain characteristic biogeochemical processes

Definition. This function is defined as the capacity of a wetland to maintain the rate, magnitude, and timing of various biogeochemical processes similar to that of reference standard conditions. These processes include the cycling of various nutrients and elements, organic matter accumulation and decomposition, and short- and long-term sequestration of inorganic and organic constituents. Directly and quantitatively measuring one or more of these processes, such as denitrification rates, net annual primary productivity, or annual rates of organic matter decomposition, can independently validate this function.

Rationale for selecting function. Biogeochemical processes are vital for determining and maintaining the nature of the wetland ecosystem. Nutrient cycling supports the development, growth, and subsequent decay and decomposition of the local plant community (Bormann and Likens 1970), which in turn provides habitat and energy sources for the animal community (Crow and MacDonald 1978). Nutrient cycling is a fundamental process performed by all ecosystems, but tends to be accomplished at particularly high rates in many wetland systems (Mitsch and Gosselink 2000).

This function also encompasses the removal and either storage or transformation of organic and inorganic elements and compounds (nitrogen, phosphorus, and various heavy metals, for example) from hydrologic inflows, which depressional wetlands are especially suited to do because of their location in the landscape (Crumpton and Baker 1993). The removal of elements and compounds has the value of providing water quality benefits by preventing or slowing the export of these contaminants from the wetland through groundwater or surface water and reducing pollution into a receiving lake, stream, or aquifer.

Characteristics and processes that influence the function. The ability of the wetland to perform this function depends upon the transfer of elements and materials between trophic levels within the wetland, rates of decomposition, and the movement of materials in and out of the wetland. These activities depend on a variety of biotic and abiotic processes. Biotic processes control the cycling and storage of nutrients among four major compartments: (a) the soil, (b) primary producers, such as vascular and nonvascular plants, (c) consumers, such as animals and bacteria, and (d) dead organic matter, such as litter and detritus. Decomposition and primary productivity rates will also depend on the hydrologic regime at the site. The removal and retention of elements and compounds from incoming water sources is affected by abiotic processes, such as the rate of water input and retention time, and the adsorption of materials to soil particles, and the actual amount of elements and compounds being delivered into the wetland. Also, the types and quantity of elements and compounds coming into the wetland will depend on the LU of its catchment, and the presence of any vegetative buffers. Wetlands, as the ecotone between terrestrial and aquatic environments (Naiman et al. 1989), are particularly subject to anthropogenic change that can affect material transport from the watershed or catchment into the wetland. Therefore, any changes to the natural soils, hydrology, vegetation, or LU surrounding the wetland can greatly impact the performance of this function.

This function is assessed by assuming that if material inputs, soil characteristics, and living and dead plant biomass in the wetland are similar to that of reference standard wetlands, then the biogeochemical processes will be occurring similarly as well.

Functional Capacity Index. The model for assessing the Maintain Characteristic Biogeochemical Processes function includes the following assessment variables:

V_{BUFFER}: Wetland buffer
V_{GVC}: Ground vegetation cover
V_{LUC}: Land use of catchment area
V_{OHOR}: Thickness of surface 'O' horizon
V_{SOIL}: Soil structure

The assessment model for this function is identical for Isolated Depressions and Floodplain Depressions. The form of the assessment model is:

$$FCI = \frac{\left[\frac{\left(V_{OHOR} + V_{GVC} + V_{BUFFER}\right)}{3} + V_{SOIL} + V_{LUC}\right]}{3}$$

The FCI for this function is calculated based on three general components: The first (V_{OHOR} and V_{GVC}) measure the amount of living and dead biomass at the site. The second (V_{SOIL}) measures disturbance to the soil and the subsequent effects on decomposition rates and nutrient storage, and the third (V_{LUC}, V_{BUFFER}) is a measure of inputs into the wetland. More weight is given to the V_{SOIL} and V_{LUC} variables because changes to these variables will likely have a greater impact on the amount and type of nutrients entering the wetland, as well as the length of time that the nutrients are stored for the processes of biogeochemistry to take place than the other three variables. Arithmetic means are used in the function so all variable subindex scores would have to equal 0.0 for the FCI to equal 0.0.

Function 3. Export organic carbon

Definition. This function is defined as the capacity of the wetland to export dissolved and particulate organic carbon produced in the wetland, which can be important for various ecological processes in downstream aquatic systems. The function is only applicable to the Floodplain Depressions subclass and not the Isolated Depressions subclass. An independent quantitative measure of this function is mass of carbon exported per unit area per unit time ($[g/m^2]/yr$).

Rationale for selecting function. The high productivity of wetlands connected to streams and rivers make them important sources of dissolved and particulate organic carbon for aquatic food webs and biogeochemical processes in downstream aquatic habitats (Vannote et al. 1980, Elwood et al. 1983, Sedell et al. 1989). Dissolved organic carbon is a significant source of energy for the microbes that form the base of the detrital food web in aquatic ecosystems, and possibly an energy source for shredders and filter-feeding organisms (Vannote et al. 1980).

Characteristics and processes that influence the function. Connected floodplain wetlands are able to export relatively high rates of organic carbon because of several factors, including: (a) the large amount of organic matter in the litter and soil layers that come into contact with surface water, (b) relatively long periods of inundation and, consequently, contact between surface water and organic matter, thus allowing for significant leaching, (c) the ability of the labile carbon fraction to be rapidly leached from organic matter when exposed to water, and (d) the ability of floodwater and precipitation runoff to transport dissolved and particulate organic carbon from the floodplain to the stream channel.

Performance of this function requires two general components: the production of organic carbon on site, and a mechanism for mobilizing and exporting it. Although the primary export mechanism (< 10-year flooding) is similar among floodplain depressions, the capability of the site to export carbon can be affected by alterations to the site hydrology.

Functional Capacity Index. The model for assessing the Maintain Characteristic Hydrology function includes the following assessment variables:

$V_{ALT-OEX}$: Presence of hydrologic alteration (stream portion)
V_{GVC}: Ground vegetation cover
V_{OHOR}: Thickness of surface 'O' horizon

The form of the assessment model is:

$$FCI = \frac{(V_{GVC} + V_{OHOR})}{2} \times V_{ALT-OEX}$$

The FCI for this function measures the relative amount of living and dead biomass (V_{GVC} and V_{OHOR}) available for export, and hydrologic alterations ($V_{ALT-OEX}$) that can affect the flooding regime and, therefore, the ability of the site to export carbon. The two components are multiplied as organic carbon export cannot occur without both the carbon source and the export mechanism. Therefore, either component is equal to 0.0, the FCI will also equal 0.0.

Function 4: Maintain characteristic plant communities

Definition. This function is defined as the capacity of a wetland to provide the environment necessary for a characteristic plant community to develop and be maintained. In assessing this function, one must consider both the extant plant community as an indication of current conditions and the physical factors that determine whether or not a characteristic plant community is likely to be maintained in the future. A potential independent measure of this function would be to use direct or indirect ordination methods based on vegetation composition and abundance, as well as other environmental factors.

Rationale for selecting function. This function is important not only for the intrinsic value of the plant community, but also because the plant community influences other wetland processes, such as productivity and biogeochemical cycling, as well as providing habitat and food for wildlife communities.

Characteristics and processes that influence the function. A variety of physical and biological factors influence the ability of depressional wetlands to maintain characteristic plant communities. Fundamentally, the nature of the plant community will largely be influenced and maintained by the local hydrology (Goslee et al. 1997, Godwin et al. 2003). However, in recent history, anthropogenic alterations in and surrounding wetlands have greatly impacted depressional wetlands and their plant communities. Urbanization, conversion of natural lands to agriculture, and associated hydrologic manipulations have led to increased sedimentation, nutrient loading, and changes in the hydrologic regime in many wetlands. One of the major consequences of these changes is the aggressive establishment of non-native and invasive plant species (Kercher and Zedler

2004a). Once established, these species are often difficult to remove, and can prevent the growth of a more diverse plant community and possibly alter other fundamental ecological properties of an area, such as plant productivity and nutrient cycling (Mack et al. 2000). Wetlands, owing to their landscape sink position where disturbances, moisture, and nutrients all accumulate, are perhaps especially susceptible to invasions by single species that become monotypes (Zedler and Kercher 2004). Indeed, it is now typical for depressional wetlands in the Upper Des Plaines Basin to consist primarily of thick, near monotypic stands of cattails (*Typha spp.*) or reed canary grass (*Phalaris arundinacea*). Both of these species can thrive and are competitive dominants under a variety of hydrologic regimes, especially under high nutrient conditions (Kercher and Zedler 2004b).

To assess this function, both current vegetation compositions as well as environmental factors that can influence vegetation composition are evaluated.

Functional Capacity Index. The model for assessing the Maintain Characteristic Plant Communities function includes the following assessment variables:

V_{ALT}: Presence of hydrologic alteration
V_C: Native mean c score
V_{CAT}: Cover of *Typha spp.*
V_{FQI}: Native FQI score
V_{INV}: Invasive species cover (excluding *Typha spp.*)
V_{LUC}: Land use of the catchment area
V_{NAT}: Percent of plant species that are native

The assessment model for this function is identical for Isolated Depressions and Floodplain Depressions. The form of the assessment model is:

$$FCI = \left\{ \frac{\left(\frac{V_{NAT} + V_{FQI} + V_C}{3}\right) + \sqrt{(V_{INV} \times V_{CAT}) \times \left(\frac{V_{ALT} + V_{LUC}}{2}\right)}}{2} \right\}$$

The mathematical expression of the model has three general components. The first component (V_{NAT}, V_{FQI}, V_C) describes the composition of the extant plant community. The second and third components address the ability of that current community to either be maintained (if desirable) or improved. The second component measures the extent of various invasive plant species (V_{INV} and V_{CAT}) in the wetland, which can inhibit the establishment of a desirable native plant community. These two variables are multiplied to reflect the overriding effect of the V_{INV} variable on the V_{CAT} variable, i.e., having a high V_{CAT} subindex score (low *Typha* cover) does not benefit the function if the reason for low *Typha spp.* cover is that the site is completely covered with *Phalaris arundinacea*. V_{INV} and V_{CAT} are weighted heavily in this function, because they reflect both the nature of the current plant community and the capacity of that community to be positively altered. The third component (V_{ALT} and V_{LUC}) represents other on- and near-site environmental factors that, through a variety of factors, can influence the establishment and maintenance of the plant community. The geometric mean of these two components is used so that if either component is equal to 0.0, then the entire "maintain/improve" portion of the function would equal 0.0. However, for the entire function to equal 0.0, all variables in the function would have to equal 0.0.

Function 5: Maintain characteristic fauna

Definition. This function is defined as the capacity of a wetland to support and maintain a characteristic diversity and abundance of wildlife species that utilize wetlands during some part of their life cycles. This function includes maintaining habitat within the wetland and the surrounding area, as well as connectivity among wetlands within the landscape. Various existing animal inventory methods can be used as an independent measure of this function.

Rationale for selecting function. A variety of vertebrate and invertebrate species utilize wetlands during some or all of their life cycle. High performance of this function indicates that the wetland remains suitable for these wildlife species to utilize for refuge, habitat, and breeding.

Characteristics and processes that influence the function. The use of wetland depressions by wildlife is influenced by a variety of spatial, temporal, and structural factors. One of the most important factors within the wetland influencing wildlife is the structure and composition of the plant community (van der Valk 1989, Weller 1987). The plant community can be suitable, to various degrees, for food, shelter, nesting, breeding, and foraging, depending on the complexity and composition of the vegetation. Also, an increase in plant diversity and habitat patchiness (having multiple areas of different vegetation types with sharp boundaries) will generally lead to a greater diversity of wildlife species utilizing the wetland. However, the spread of invasive plant species in the wetland can displace desirable native plants and animals. Areas taken over by reed canarygrass (*Phalaris arundinacea*), for instance, may be of little use to wildlife (Hoffman and Kearns 1997).

Hydrology is also a major factor influencing the quality of the wildlife habitat, both in its effect on the plant community, and in providing the seasonal inundation and ponded areas necessary for the breeding and survival of several species of insects and amphibians (Johnson 1987).

Landscape factors will also influence usage by wildlife, although the landscape factors addressed in this function pertain more towards the viability of mammals, amphibians, and reptiles then they do towards birds. Because of urbanization and conversion to agriculture, most natural areas have become fragmented and as a consequence many wetlands exist in isolated patches. The adverse effects of fragmentation have been well documented for birds (Askins et al. 1987, Kilgo et al. 1997), reptiles and amphibians (Semlitsch 1998, Semlitsch and Jensen 2001), and to a lesser extent, mammals (Nilon 1986, VanDruff and Rowse 1986, Nilon and VanDruff 1987).

Because of the fragmented landscape, wetland density and proximity to nearest neighbors are important determinants of the success of metapopulations, where organisms live in multiple populations that are occasionally connected through migration from one wetland to another (Gibbs 1993). For instance, many species of reptiles and amphibians will move overland to seek out wetlands with more favorable conditions when their current habitat has deteriorated (Beebee 1996). Successful movement of individuals and facilitation of metapopulations is more likely in areas that contain a high number of wetlands that are relatively close to one another. The presence of wildlife corridors, which can provide safety from predators and anthropogenic hazards, are also important for the movement of individuals between wetlands and from upland environments. Also, having other natural areas surrounding the wetland can provide essential core terrestrial habitat for many species (Semlitsch and Bodie 2003).

Besides reducing natural wildlife corridors and adjacent habitat, urban and agricultural LU can also have other negative effects on fauna. Certain amphibians and reptiles are particularly susceptible to changes in food sources brought about as a result of urbanization. For example, populations of the western fox snake (*Elaphe vulpine vulpine*) and eastern milk snake (*Lampropltis triangulum tiangulum*) are likely to be reduced over time because of the potential reduction of the species of rodent upon which they prey (SEWRPC 2003). Other amphibians and reptiles are highly sensitive to agricultural pesticides and herbicides. Ingestion of toads that have incidentally been sprayed by these chemicals, for instance, can prove fatal to hognose snakes (*Heterodon platirhinos*) (SEWRPC 2003).

Functional Capacity Index. The model for assessing the Maintain Characteristic Faunal Habitat function includes the following assessment variables:

V_{ALT}: Presence of hydrologic alteration
V_{BUFFER}: Percentage of wetland perimeter that is buffered
V_{GVC}: Ground vegetation cover
V_{INV}: Invasive species cover (excluding *Typha spp.*)
$V_{LANDUSE}$: Land use within 300 m of site
V_{NAT}: Percent of plant species that are native
V_{TSSC}: Tree-shrub-sapling % cover
V_{W500}: Wetlands within 500-m score

The form of the assessment model is as follows:

$$FCI = \frac{\sqrt{V_{INV} \times \frac{\left(V_{NAT} + V_{ALT} \frac{(V_{GVC} + V_{TSSC})}{2}\right)}{3}} + \frac{(V_{W500} + V_{BUFFER} + V_{LANDUSE})}{3}}{2}$$

The mathematical expression of this model measures two general components necessary for performance of the function. The first component (V_{INV}, V_{TSSC}, V_{GVC}, V_{NAT}, and V_{ALT}) measures habitat quality inside the wetland, i.e., the structural and aerial distribution and composition of living and dead standing vegetation in the assessment area, and the potential for periodic inundation. V_{INV}

is given the most weight, and is multiplied with the average of the other variables, as a site that is completely covered with invasive species would have little wildlife value (Hoffman and Kearns 1997). Although hydrology is an important factor, V_{ALT} is not given more weight because hydrologic changes would potentially also be reflected in some of the other variables in this component.

The second component (V_{BUFFER}, V_{W500}, and $V_{LANDUSE}$) measures landscape factors that can influence the function. The FCI is equal to the arithmetic mean of both components. Even if the wetland itself is currently poor wildlife habitat, if it is restored, the improved habitat and fauna will be more sustainable if the surrounding landscape factors are optimal. Therefore, both components would have to equal 0.0 for the FCI to equal 0.0.

5 Assessment Protocol

Introduction

Previous chapters of this Regional Guidebook provide background information on the HGM Approach, and document the variables and models used to assess the functions of Herbaceous Isolated Depression and Herbaceous Floodplain Depression wetlands. This chapter outlines a protocol for collecting and analyzing the data necessary to assess the functional capacity of a wetland in the context of a 404 permit review process or similar assessment scenario.

The typical assessment scenario is a comparison of pre-project and post-project conditions in the wetland. In practical terms, this translates into an assessment of the functional capacity of the WAA under both pre-project and post-project conditions and the subsequent determination of how FCIs have changed as a result of the project. Data for the pre-project assessment are collected under existing conditions at the project site, while data for the post-project assessment are normally based on the conditions that are expected to exist following proposed project impacts. A skeptical, conservative, and well-documented approach is required in defining post-project conditions. This recommendation is based on the often-observed lack of similarity between predicted or engineered post-project conditions and actual post-project conditions. This chapter discusses each of the tasks required to complete an assessment of depressional wetlands:

a. Define assessment objectives.

b. Characterize the project site.

c. Screen for red flags.

d. Define the Wetland Assessment Area.

e. Collect field and GIS data.

f. Analyze field and GIS data.

g. Apply assessment results.

Define Assessment Objectives

Begin the assessment process by unambiguously identifying its purpose. This can be as simple as stating, "The purpose of this assessment is to determine how the proposed project will impact wetland functions." Other potential objectives could be as follows:

a. Compare several wetlands as part of an alternatives analysis.

b. Identify specific actions that can be taken to minimize project impacts.

c. Document baseline conditions at the wetland site.

d. Determine mitigation requirements.

e. Determine mitigation success.

f. Determine the effects of a wetland management technique.

Characterize the Project Area

Characterizing the project area involves describing the project area in terms of climate, surficial geology, geomorphic setting, surface and groundwater hydrology, vegetation, soils, land use, proposed impacts, and any other characteristics and processes that have the potential to influence how wetlands at the project area perform functions. The characterization should be written, and accompanied by maps and figures that show project area boundaries, jurisdictional wetlands, WAA (discussed later in this chapter), proposed impacts, roads, ditches, buildings, streams, soil types, plant communities, threatened or endangered species habitat, and other important features. Some information sources that will be useful in characterizing a project area are aerial photographs, topographic maps, available wetlands maps, and county soil surveys.

Screen for Red Flags

Red flags are features within or in the vicinity of the project area to which special recognition or protection has been assigned on the basis of objective criteria (Table 11). Many red flag features, such as those based on national criteria or programs, are similar from region to region. Other red flag features are based on regional or local criteria. Obviously, not all of the red flag features listed in Table 11 will be applicable to the Upper Des Plaines reference domain. Screening for red flag features represents a proactive attempt to determine if the wetlands or other natural resources in and around the project area require special consideration or attention that may preempt or postpone an assessment of wetland function. If a red flag feature exists, the assessment of wetland functions may not be necessary if the project is unlikely to occur as a result of the red flag feature. For example, if a proposed project has the potential to impact a threatened or endangered species or habitat, an assessment of wetland functions may be unnecessary because the project may be denied or modified strictly on the basis of the impacts to threatened or endangered species or habitat.

Table 11
Red Flag Features and Respective Program/Agency Authority

Red Flag Features	Authority[1]
Native lands and areas protected under the American Indian Religious Freedom Act	A
Hazardous wastes sites identified under CERCLA or RCRA	I
Areas protected by a Coastal Zone Management Plan	E
Areas providing Critical Habitat for Species of Special Concern	B, C, F
Areas covered under the Farmland Protection Act	K
Floodplains, floodways, or floodprone areas	J
Areas with structures/artifacts of historic or archeological significance	G
Areas protected under the Land and Water Conservation Fund Act	K
Areas protected by the Marine Protection Research and Sanctuaries Act	B, D
National wildlife refuges and special management areas	C
Areas identified in the North American Waterfowl Management Plan	C, F
Areas identified as significant under the RAMSAR treaty	H
Areas supporting rare or unique plant communities	C,H
Areas designated as Sole Source Groundwater Aquifers	I, L
Areas protected by the Safe Drinking Water Act	I, L
City, County, State, and National Parks	D, F, H, L
Areas supporting threatened or endangered species	B, C, F, H, I
Areas with unique geological features	H
Areas protected by the Wild and Scenic Rivers Act or Wilderness Act	D

[1]Program Authority/Agency
A = Bureau of Indian Affairs
B = National Marines Fisheries Service
C = U.S. Fish and Wildlife Service
D = National Park Service
E = State Coastal Zone Office
F = State Departments of Natural Resources, Fish and Game, etc.
G = State Historic Preservation Office
H = State Natural Heritage Offices
I = U.S. Environmental Protection Agency
J = Federal Emergency Management Administration
K = National Resource Conservation Service
L = Local Government Agencies

Define the Wetland Assessment Area

The WAA is an area of wetland within a project area that belongs to a single regional wetland subclass, and is relatively homogeneous with respect to the site-specific criteria used to assess wetland functions (i.e., hydrologic regime, vegetation structure, topography, soils, successional stage, etc.). In many project areas, there will be just one WAA representing a single wetland subclass, as illustrated in Figure 35. However, as the size and heterogeneity of the project area increase, it is more likely that it will be necessary to define and assess multiple WAAs or Partial Wetland Assessment Areas (PWAAs) within a project area.

At least three situations necessitate defining and assessing multiple PWAAs within a project area.

The first situation exists when widely separated wetland patches of the same regional subclass occur in the project area (Figure 34). The second situation exists when more than one regional wetland subclass occurs within a project area (Figure 35). The third situation exists when a physically contiguous wetland area of the same regional subclass exhibits spatial heterogeneity with respect to hydrology, vegetation, soils, disturbance history, or other factors that translate into a significantly different value for one or more of the site-specific variable measures. These differences may be a result of natural variability (e.g., zonation on large river floodplains) or cultural alteration (e.g., logging, surface mining, hydrologic alterations) (Figure 36). Designate each of these areas as a separate PWAA and conduct a separate assessment on each area.

There are elements of subjectivity and practicality in determining what constitutes a significant difference in portions of the WAA. Field experience with the regional wetland subclass under consideration should provide the sense of the range of variability that typically occurs, and the common sense necessary to make reasonable decisions about defining multiple PWAAs. Splitting an area into many PWAAs in a project area based on relatively minor differences resulting from natural variability should not be used as a basis for dividing a contiguous wetland into multiple PWAAs. However, zonation caused by different hydrologic regimes or disturbances caused by rare and destructive natural events (i.e., hurricanes) should be used as a basis for defining PWAAs.

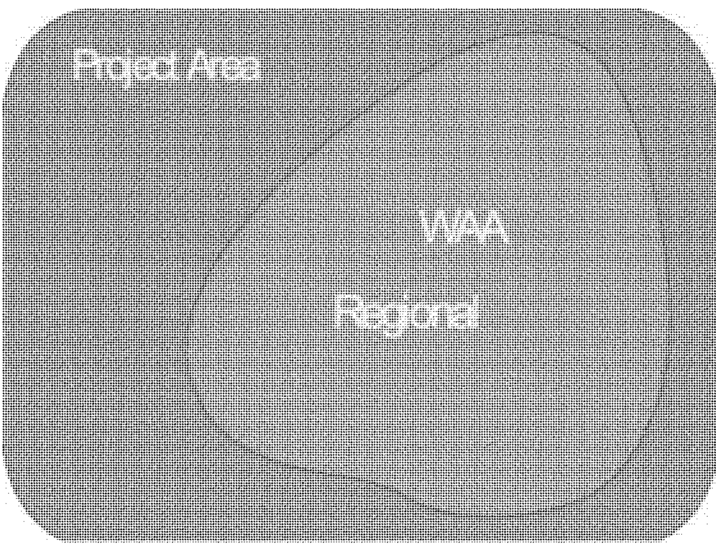

Figure 34. A single WAA within a project area

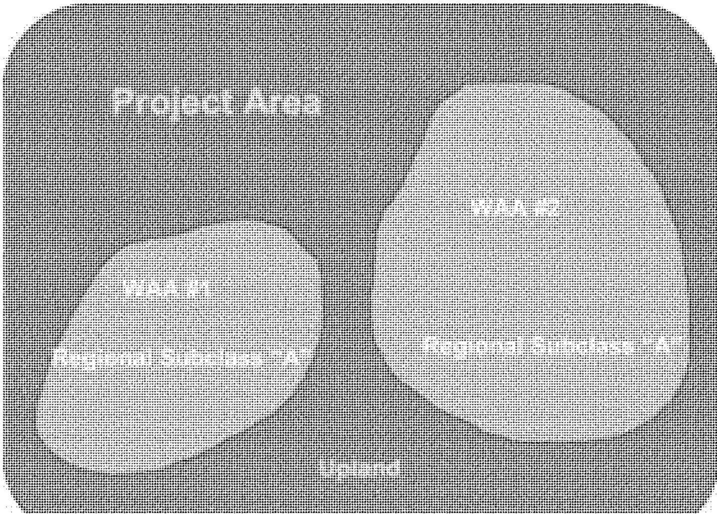

Figure 35. Spatially separated WAAs from the same regional wetland subclass within a project area

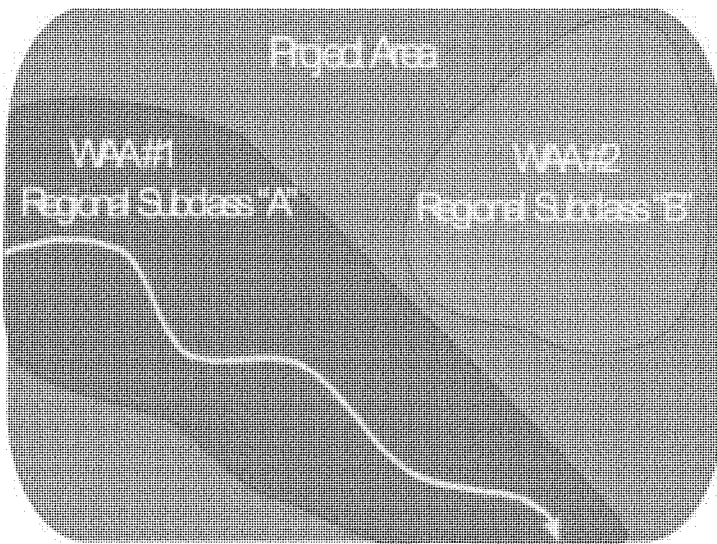

Figure 36. More than one regional subclass within a project area

Determine Subclass

The dichotomous key (Figure 4) provided in Chapter 3 can be used as a guide for determining wetland subclass. Determination of subclass can largely be done prior to the site visit with the use of various digital or hard copy maps. The first task is to determine whether or not the assessment area is located in a topographic depression. For the purposes of this model, a depression is defined as a wetland that is a minimum of 2 ft deep in at least some areas. Using a digital map and 2-ft contour lines, this would mean that there is at least one contour line drawn inside the wetland that is lower than all contour lines that form the edge of the wetland (see Figure 37 for an example). A 10-year flood coverage is essential for determining whether or not a site is considered a "floodplain" or "isolated" depression. If a 10-year coverage is not available for an area, the FEMA 100-year map can be used instead; because of the geomorphology of the reference domain, the 10- and 100-year floodplains are fairly similar.

Collect Field and GIS Data

Calculating the variable subindex scores used to assess functions in this guidebook requires a combination of field data collection and Geographical Information System (GIS) data collection and analysis. This section provides details on the methodology used to collect these data. In the case of GIS based data collection, although step by step instructions are provided for determining variable scores, the methodology assumes that the assessor has a working familiarity with ESRI's ArcView 3.x ® GIS software, on which the instructions are based. The same operations can also be performed using ESRI's ArcGIS 8.x and 9.x software, although the steps may differ slightly from what is presented here.

Field data

Although a single individual can collect the necessary field data, it is suggested that the field crew consist of at least two people. Besides safety and time considerations, the advantage of having two people is that they can concur on the visual estimate of variables requiring a percent cover range. At least one person on the field crew should, at minimum, be able to identify common sedge meadow and marsh plant species. One person in the field crew should also have the ability to identify and distinguish soil horizons.

The following equipment is recommended for the collection of field data:

a. Plant identification keys.

b. Soil probe/sharpshooter shovel.

c. Soil survey.

d. Meter stick.

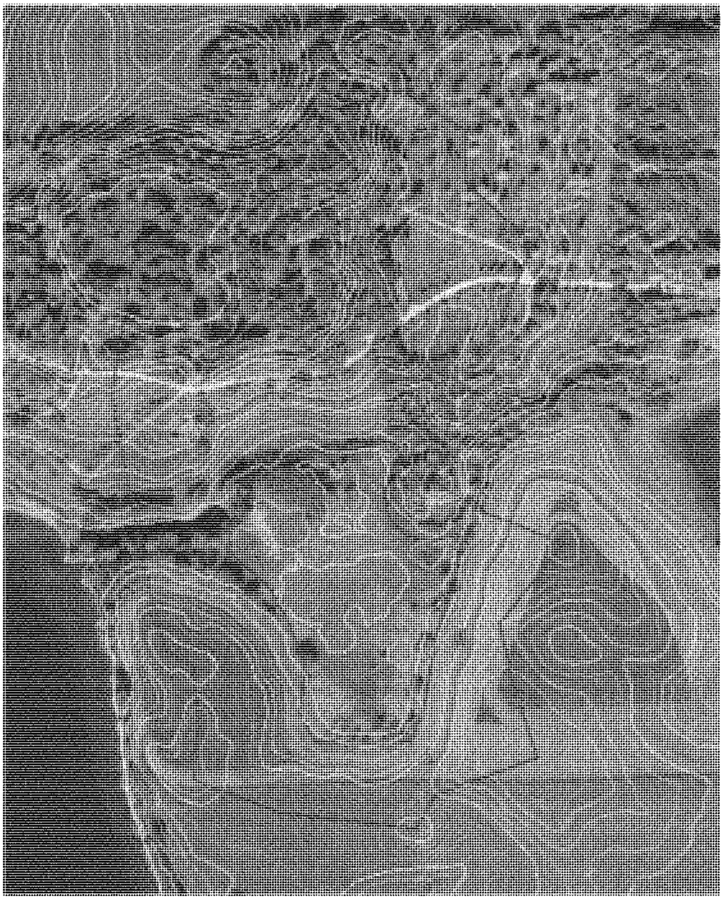

Figure 37. Example of wetland catchment drawn using 2-ft contour lines

Many of the field-collected data are visually estimated during a walk-through of the WAA, rather than through the use of data plots or transects. Because of the nature of many of these sites (which often have high levels of standing water), using plots or transects would often be either too time consuming, or physically impractical.

Several of these field data can also be measured using recent high-resolution aerial photography, but field reconnaissance of the site should also be done to confirm that no major changes have occurred to the site since the photograph was taken.

For smaller WAAs (< 25 acres), it is recommended that the samplers walk around the entire perimeter of the site, as well as, if feasible, walking at least one random transect across the site. For larger WAAs, the sampler should traverse selected areas, until they are confident that they have observed representative areas of the entire WAA. Field sampling of the entire assessment area should usually take no longer than 2 hr.

Soil data require the collection of at least three soil cores at each assessment area. More cores may be required if there is large variability in the soil types within the assessment area. Use the following steps to collect soil data (used for the V_{OHOR} and V_{SOIL} variables):

a. Use digital or hard copy soil survey maps to determine the dominant (> 50 percent aerial coverage) mapped soil type in the assessment area. Determine if the dominant soil type mapped is mineral or organic.

b. Select a minimum of three representative points within the boundaries of the dominant mapped soil type in which to collect soil cores. Representative areas can be selected when on site, generally by choosing areas that contain the dominant vegetative community of the assessment area. Cores should be taken up to 32 in. (81.3 cm) in depth, or to the end of the surface 'O' horizon, whichever comes first. The cores should also be of the same type (organic or mineral). Organic soils are defined as soils with at least 16 in. (40.6 cm) of organic material in the first 32 in. (81.3 cm) of the profile.

c. Measure the thickness of the organic material at the surface and average the thickness from the three cores to obtain a final depth of 'O' horizon measurement.

d. Using the same soil cores, determine how much of the first 12 in. (30 cm) has been plowed, or is of massive or platy structure (see instructions for V_{SOIL}).
or
Based on previous knowledge of the assessment area, note if it has been buried, plowed, or compacted, and when the alteration occurred (< 20 years ago, between 20-50 years ago, or > 50 years ago).

Data collected in the field are entered into Data Form 1 (Figure 38).

GIS data

The following data layers are necessary to collect the GIS-based data:

a. Land use coverages.

b. Contour line coverage.

c. Digital aerial photos.

If digital contour line maps or aerial photos are not available, USGS topographic maps can be used instead, although their use is less desirable and generally will not be as accurate for calculating variable scores.

DATA FORM 1: HGM FIELD DATA COLLECTION SHEET

Site [ ] Date [ ] **Type:** Isolated Floodplain

GENERAL FIELD DATA Assessment Team [ ]

Ground Vegetation Cover (%) (Visual Estimate): OR [ ]

GVC (%) by plot: Plot 1____2____3____4____5____6____7____8____9____10____11____12____AVG____

Tree-Shrub-Sapling Cover (Circle One): 0-10% 11-20% 21-30%

Invasive Speceis Cover (Circle One): 0-5% 6-20% 21-50% 51-80% 81-94% 95-100%

Typha spp. Cover (Circle One): 0-20% 21-50% 51-80% 81-100%

Hydrologic Alteration (Circle if Observed):
- Ditch(es) within 50 meters of site
- Alterations to stream channel: None Moderate Severe N/A
- Tiles/evidence of tiling

FQA DATA

Native FQI Score [ ]

Native mean c score [ ]

W/adventives score [ ]

Native Species (%) [ ]

SOIL DATA

Dominant Soil Type of Assessment Area (Circle One): Mineral Organic

PLOT 1	PLOT 2	PLOT 3
"O" Horizon Depth (in.) [ ]	"O" Horizon Depth (in.) [ ]	"O" Horizon Depth (in.) [ ]
Massive or Platy Structure or Plow Layer (in.) [ ]	Massive or Platy Structure or Plow Layer (in.) [ ]	Massive or Platy Structure or Plow Layer (in.) [ ]

Figure 38. Field Data Sheet

Several variables in this model are designed to be collected using ESRI ArcView® software. The instructions provided for calculating each of these variables are for those using ArcView® 3.x, although the instructions will also largely be applicable for those using ArcView® 8.x/9x. The detail of the instructions assumes that the user has working knowledge of ArcView® 3.x, and the ability to edit and process polygons using the program.

The two essential polygons that must be created by the user are:

a. The wetland boundary.

b. The wetland's catchment.

Creating the polygon of the wetland boundary will require either a digital aerial photo (preferred method), or a digital topographic map. Using the "Create Polygon" feature in ArcView, digitize the entire wetland area, using the aerial photo or map as a guide. In lieu of digitizing the wetland boundaries, pre-existing polygons from a wetlands map (NWI, etc.) can be used, although, depending on the source, these may be less accurate.

The catchment can be drawn using digital contour lines as a guide (see Figure 37 for an example). The catchment does not include the wetland itself. The easiest way to create the catchment area is to draw the entire catchment polygon (including the wetland), then use the Geoprocessing "Erase" feature to erase the wetland area from it. What is left is defined henceforth as the catchment area.

To actually delineate the catchment, use these steps:

a. Identify the high points surrounding the wetland.

b. Draw a line connecting all the high points. This line should run as perpendicular to the contour lines as possible.

c. The wetland may be receiving additional drainage (from urban storm sewers, for instance) from outside the catchment area. If this is the case, the additional area needs to be included in the catchment area.

d. The real catchment may also be smaller, owing to the presence of elevated roads within the natural catchment. If these roads do not have drainage culverts, then the roads should be considered part of the boundary of the catchment.

Calculation of two of the variables requires use of the XTools extension for ArcView® 3.x, which has the ability to calculate the area and perimeter of polygons. XTools can be downloaded for free at this website: *http://arcscripts.esri.com/details.asp?dbid=11526.*

GIS data are recorded in Data Form 3 (Figure 39).

DATA FORM 2: HGM GIS DATA COLLECTION SHEET

Site [ ] Date [ ] Assessment Team [ ]

Wetland Area (ha): [ ]
Catchment Area (ha): [ ]
Wetland Area/Catchment Area ratio: [ ]

Catchment Landuse Score [ ]
300 m Landuse Score [ ]
Wetland Perimeter That is Buffered (percent) [ ]

Wetlands within 500 meters Assessment Area

Distance (m)	Number	Multiplier
0-100		3
101-200		2.5
201-300		2
301-400		1.5
401-500		1

Total Score: [ ]

Figure 39. GIS Data Sheet

Procedures for Measuring Assessment Variables

For each variable, it is indicated whether the data are collected primarily in the field or using GIS.

V_{ALT}: Presence of hydrologic alteration (field data)

Based on the site walk through or aerial photos, look for the presence of ditches in or within 50 m adjacent to the assessment area. With very large sites, aerial photos may need to be relied on, although smaller ditches may not appear on aerial photos. The presence of tiles is harder to determine; the indicator used here is that if a site has recently been taken out of agricultural production (and tiles have not been removed), it is assumed that the site has been tiled. Local knowledge may also be useful in determining whether a site has been tiled. For stream alteration (in the case of Floodplain Depressions), determine if no impact, moderate impact, or severe impact has occurred, using the criteria in Table 12. Also, see Figures 10, 11, and 12 in Chapter 4 for examples of these levels of impact.

Table 12
Descriptions of Impact Levels to Stream

Level of Impact	Description
No alterations/impact	No artificial levees, spoil piles, roads, etc. along the stream reach. Stream has not been downcut, channelized, or straightened.
Moderate impact	(a) Presence of artificial levees, spoil piles, roads, etc., along stream reach, and/or stream has been moderately downcut, channelized, and/or straightened. Generally, alterations have not been maintained and some of the natural stream morphology has returned. *and/or* (b) Knowledge that flooding frequency has been somewhat reduced from natural conditions, but is still < 10 years.
Severe impact	(a) Presence of artificial levees, spoil piles, roads, etc., along stream reach, and/or stream has been severely downcut/channelized, and/or straightened. Alterations are being maintained and the natural stream morphology is not apparent. *and/or* (b) Knowledge that flooding frequency has greatly reduced from natural conditions, and is > 10 years.

V_{BUFFER}: Wetland buffer (GIS data)

The files needed to calculate this variable are:

a. Wetland area shapefile.

b. Aerial photo, or topographic map, or county land-use file.

Use the following steps to calculate this variable score:

a. Use XTools to determine the length of the wetland perimeter.

b. Using the ArcView "Measuring" tool, manually determine the length of the wetland perimeter that is surrounded by buffer (using the aerial photo, topo map, or land-use coverage as a guide). Buffer is defined as any natural area (forest, wetland, grassland, etc.) ≥ 30 m in width.

c. Divide the buffered perimeter by the total wetland perimeter, and multiply by 100. This value is the raw V_{BUFFER} score, which is used to calculate the V_{BUFFER} subindex score.

V_{CAT}: Cover of *Typha spp.* (field data)

Based on the site walk through, visually estimate the percentage of the assessment area covered by *Typha spp.* Record the estimate as one of the following cover categories: 0-20 percent, 21-50 percent, 51-80 percent, 81-100 percent.

V_{CATCH}: Ratio of wetland area to catchment area (GIS data and field data)

The files needed to calculate this variable score are:

a. Wetland area shapefile.

b. Catchment area shapefile.

Use the following steps to calculate this variable score.

a. Use XTools to calculate the areas (unit not important) of the wetland area and its corresponding catchment area.

b. Divide wetland area by catchment area. This ratio is the raw V_{CATCH} score, which is then used to calculate the V_{CATCH} subindex score.

It is possible that the actual catchment area is either larger or smaller than the measured catchment area. There are two situations where the catchment size should be checked in the field:

a. There are urban areas adjacent to the measured catchment. In this case, it is possible that storm water is being diverted from the urban area into the wetland. If this is the case, then the extent of the urban area needs to be added to the catchment. The existence of storm drains from the adjacent areas should be verified in the field.

b. There are elevated roads in the catchment that do not have drainage culverts. If there are no culverts, then the road becomes part of the catchment boundary. The presence of culverts in these roads should be verified in the field.

V_{GVC}: Ground vegetation cover (GIS data or field data)

Based on the site walk through, visually estimate and record the percentage of the assessment area (not including open water areas) covered by living herbaceous plants. Most sites in the reference domain had ground vegetation cover of 95 to 100 percent, which is easy to visually estimate. If ground vegetation is lower than this, however, it is suggested that the percent cover is estimated in a minimum of 12 randomly placed 1-m^2 plots (the plots can be placed around the area the soil cores are taken). The percent ground vegetation cover of the assessment area is the average percent cover from the 12 plots. If aerial photography is available, this variable can also be estimated using the photo, although the field visit should be used to confirm that cover has not changed significantly from the photo.

V_{INV}: Invasive species % cover (field data)

Based on the site walk through, visually estimate the percentage range of the assessment area (not including open water areas) covered by invasive species, excluding any *Typha spp.* The percentage ranges used are 0-5, 6-20, 21-50, 51-80, 81-94, and 95-100 percent for isolated depressions, and 0-10, 11-25, 26-50, 51-80, 81-94, and 95-100 percent for floodplain depressions.

The most common invasive species in the reference domain is *Phalaris arundinacea* (reed canary grass), so this variable can often be scored by looking for percent cover of *P. arundinacea*. Other invasive species that will occasionally be found in abundance (enough to contribute meaningfully to a percent cover estimate) are *Phragmites australis* (common reed), *Lythrum salicaria* (purple loosestrife), and *Ambrosia trifida* (giant ragweed).

$V_{LANDUSE}$: Land use within 300 m of site
V_{LUC}: Land use of the catchment area (GIS data)

Calculation of the V_{LUC} and $V_{LANDUSE}$ variables requires use of the Spatial Analyst extension for ArcView® 3.x and a land-use file in GRID (raster) format. The land use then needs to be reclassified so that:

a. Urban (includes commercial, industrial, and all residential densities) = 5.

b. Agriculture (includes all farmland and pasture) = 3.

c. Natural (includes forest, grasslands, and wetlands) = 1.

If first converting from a shapefile to GRID, a cell size of 10 m^2 or less is recommended.

The files needed to calculate the $V_{LANDUSE}$ variable score are:

a. Wetland area shapefile.

b. Land-use GRID file.

Use the following steps to calculate the $V_{LANDUSE}$ variable score:

a. Use the "Create Buffers" feature to create a 300-m buffer around the wetland area shapefile.

b. Make sure the Spatial Analyst extension has been opened. Make the new buffer shapefile active, then go to "Summarize Zones" under the "Analysis" menu.

c. When asked, "Pick theme containing variable to summarize," select the land-use grid file. A table of various statistics will then be displayed.

d. The "Mean" statistic is the raw $V_{LANDUSE}$ score, which is used to calculate the $V_{LANDUSE}$ subindex score.

The files needed to calculate the V_{LUC} variable score are:

a. Catchment area shapefile.

b. Land-use GRID file.

Use the following steps to calculate the V_{LUC} variable score:

a. Make sure the Spatial Analyst extension has been opened. Make the catchment area shapefile active, then go to "Summarize Zones" under the "Analysis" menu.

b. When asked, "Pick theme containing variable to summarize," select the land-use grid file. A table of various statistics will then be displayed.

c. The "Mean" statistic is the raw V_{LUC} score, which is used to calculate the V_{LUC} subindex score.

V_{OHOR}: Depth of 'O' horizon (field data)

Measure and average the depth of the 'O' horizon for all three soil cores. See the V_{OHOR} variable in Chapter 4 for more information on the 'O' horizon.

V_{SOIL}: Soil structure (field data)

For each core, determine the total depth of any layer that is either (a) a plow layer (Ap horizon) or (b) "massive" or "platy" in structure (Figure 40) in the first 12 in. of soil. Calculation example:

Layer	Depth (in.)	Structure
Ap	0-5	Granular
A1	5-11	Platy
A2	11-12	Granular

For the above profile, a total of 11 of the first 12 in. is either a plow layer and of 'platy' structure — so 11/12 = 92 percent.

V_{TSSC}: Tree-shrub-sapling vegetation percent cover (GIS/field data)

Based on the site walkthrough, visually estimate the percentage of the assessment area covered by living trees, shrubs, and saplings. Trees-shrubs-saplings are defined as all woody vegetation ≥ 4.5 ft (1.4 m) tall. Record the estimate as one of the following cover categories: 0-10 percent, 11-20 percent, 21-30 percent. This variable can also be estimated using aerial photography.

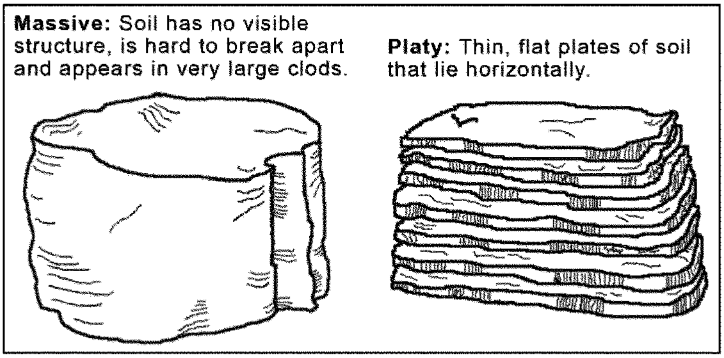

Figure 40. "Massive" and "Platy" soil structures

V_W, V_C, V_{FQI}, V_{NAT}: W/adventives score, native mean c, native FQI, percent of species that are native (field data)

All four of these variables are obtained from a site inventory Floristic Quality Assessment (FQA), based on a single visit (optimally during June through August). A site inventory FQA entails a walk through of the assessment area and making a record of every plant species that is seen. Each plant species is recorded once. It is suggested that the inventory is done using a time-meander search (Goff et al. 1982), using 15-min intervals, with a maximum search time of 2 hr (searches done during reference data collection were limited to 2 hr.) The survey ends when less than 10 percent (from the preceding interval) new species are found in the subsequent 10-min interval. For example:

a. In the first 15-min interval, 10 species are identified.

b. In the second 15-min period, 8 new species are identified (53 percent additional species, so the search continues).

c. In the third 15-min interval, 4 new species are identified (50 percent additional species from the previous interval, so the search continues).

d. In the fourth 15-min interval, no new species are identified. The search ends.

Calculation of W/adventives, native mean C, and native FQI requires either the FQA software with the Chicago Plant Database (both available from Conservation Research Institute/Conservation Design forum — *http://www.cdfinc.com/CRI/FQA%20Order%20Form%202004.pdf*) or either a printed copy of the Chicago Plant Database or the *Plants of the Chicago Region* book (Swink and Wilhelm 1994), in which case the variables can be calculated manually. V_{NAT} is calculated by dividing the number of native species from the total number of species, using the native/non-native designations from the FQA Chicago database.

V_{W500}: Wetlands within 500 m (GIS data)

The files needed to calculate this variable score are:

a. Polygon of wetland assessment area.

b. Wetlands map.

Use the following steps to calculate this variable score.

a. Use the "Buffer" tool to create a 500-m buffer, divided into 100-m segment bands, around the project area.

b. Count the number of wetlands ≥0.25 acre that are contained within each band. If a wetland spans across multiple bands, count it as belonging to the band it is in closest to the project area. The 0.25-acre minimum is used to eliminate small patches of misclassified areas in the land-use grids.

c. Multiply the number of wetlands in each band by the following:

- Band 1, (0-100 m) × 3.0
- Band 2, (101-200 m) × 2.5
- Band 3, (201-300 m) × 2.0
- Band 4, (301-400 m) × 1.5
- Band 5, (401-500 m) × 1.0

d. Add together the scores from all bands. This is the raw V_{W500} score, which is then used to calculate the V_{W500} subindex score.

Apply Assessment Results

Once the assessment and analysis phases are complete, the results can be used to (a) compare the same WAA at different points in time, (b) compare different WAAs at the same point in time, (c) compare different alternatives to a project, or (d) compare different HGM classes or subclasses as per Smith et al. (1995).

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Appendix A
Glossary

Abiotic: Not biological.

Assessment model: A simple model that defines the relationship between ecosystem and landscape scale variables and functional capacity of a wetland. The model is developed and calibrated using reference wetlands from a reference domain.

Assessment objective: The reason an assessment of wetland functions is being conducted. Assessment objectives normally fall into one of three categories: documenting existing conditions, comparing different wetlands at the same point in time (e.g., alternatives analysis), and comparing the same wetland at different points in time (e.g., impact analysis or mitigation success).

Assessment team (A-Team): An interdisciplinary group of regional and local scientists responsible for classification of wetlands within a region, identification of reference wetlands, construction of assessment models, definition of reference standards, and calibration of assessment models.

Biotic: Of or pertaining to life; biological.

Direct impacts: Project impacts that result from direct physical alteration of a wetland, such as the placement of dredge or fill.

Direct measure: A quantitative measure of an assessment model variable.

Functional assessment: The process by which the capacity of a wetland to perform a function is measured. This approach measures capacity using an assessment model to determine a Functional Capacity Index.

Functional capacity: The rate or magnitude at which a wetland ecosystem performs a function. Functional capacity is dictated by characteristics of the wetland ecosystem and the surrounding landscape, and interaction between the two.

Functional Capacity Index (FCI): An index of the capacity of a wetland to perform a function relative to other wetlands in a regional wetland subclass. Functional Capacity Indices are by definition scaled from 0.0 to 1.0. An index of 1.0 indicates the wetland is performing a function at the highest sustainable functional capacity, the level equivalent to a wetland under reference standard conditions in a reference domain. An index of 0.0 indicates the wetland does not perform the function at a measurable level, and will not recover the capacity to perform the function through natural processes.

Glacial outwash: Sand and gravel that have been "washed out" from the ice in meltwater streams along the margin of a glacier.

Glacial till: Accumulations of unsorted, unstratified mixtures of clay, silt, sand, gravel, and boulders, leftover from glacial movements.

Highest sustainable functional capacity: The level of functional capacity achieved across the suite of functions by a wetland under reference standard conditions in a reference domain. This approach assumes that the highest sustainable functional capacity is achieved when a wetland ecosystem and the surrounding area are undisturbed.

Hydrogeomorphic wetland class: The highest level in the hydrogeomorphic wetland classification. There are five basic hydrogeomorphic wetland classes: depression, riverine, slope, fringe, and flat.

Hydrogeomorphic unit: Hydrogeomorphic units are areas within a wetland assessment area that are relatively homogeneous with respect to ecosystem scale characteristics such as microtopography, soil type, vegetative communities, or other factors that influence function. Hydrogeomorphic units may be the result of natural or anthropogenic processes. See **Partial wetland assessment area.**

Hydroperiod: The annual duration of flooding (in days per year) at a specific point in a wetland.

Indicator: Indicators are observable characteristics that correspond to identifiable variable conditions in a wetland or the surrounding landscape.

Indirect measure: A qualitative measure of an assessment model variable that corresponds to an identifiable variable condition.

Indirect impacts: Impacts resulting from a project that occur concurrently or at some time in the future, away from the point of direct impact. For example, indirect impacts of a project on wildlife can result from an increase in the level of activity in adjacent, newly developed areas, even though the wetland is not physically altered by direct impacts.

Invasive species: Generally exotic species without natural controls that out compete native species.

Jurisdictional wetland: Areas that meet the soil, vegetation, and hydrologic criteria described in the "Corps of Engineers Wetlands Delineation Manual" (Environmental Laboratory 1987) or its successor.

Loess: Windblown silt of late glacial and post-glacial age.

Mitigation: Restoration or creation of a wetland to replace functional capacity that is lost as a result of project impacts.

Mitigation plan: A plan for replacing lost functional capacity resulting from project impacts.

Mitigation wetland: A restored or created wetland that serves to replace functional capacity lost as a result of project impacts.

Model variable: A characteristic of the wetland ecosystem or surrounding landscape that influences the capacity of a wetland ecosystem to perform a function.

Organic matter: Plant and animal residue in the soil in various stages of decomposition.

Organic soil material: Soil material that is saturated with water for long periods or artificially drained and, excluding live roots, has an organic carbon content of 18 percent or more with 60 percent or more clay, or 12 percent or more organic carbon with 0 percent clay. Soils with an intermediate amount of clay have an intermediate amount of organic carbon. If the soil is never saturated for more than a few days, it contains 20 percent or more organic carbon.

Organic soils (Histosol): A soil of which more than half of the upper 80 cm (32 in.) is organic or if organic soil material of any thickness rests on rock or on fragmental material having interstices filled with organic material.

Oxidation: The loss of one or more electrons by an ion or molecule.

Partial wetland assessment area (PWAA): A portion of a Wetland Assessment Area (WAA) that is identified a priori, or while applying the assessment procedure, because it is relatively homogeneous and different from the rest of the WAA with respect to one or more model variables. The difference may occur naturally or as a result of anthropogenic disturbance. See **Hydrogeomorphic unit.**

Project alternative(s): Different ways in which a given project can be done. Alternatives may vary in terms of project location, design, method of construction, amount of fill required, and other ways.

Project area: The area that encompasses all activities related to an ongoing or proposed project.

Project target: The level of functioning identified for a restoration or creation project. Conditions specified for the functioning are used to judge whether a project reaches the target and is developing toward site capacity.

Red flag features: Features of a wetland or the surrounding landscape to which special recognition or protection is assigned on the basis of objective criteria. The recognition or protection may occur at a Federal, state, regional, or local level and may be official or unofficial.

Reference domain: All wetlands within a defined geographic area that belong to a single regional wetland subclass.

Reference standards: Conditions exhibited by a group of reference wetlands that correspond to the highest level of functioning (highest sustainable capacity) across the suite of functions of the regional wetland subclass. By definition, highest levels of functioning are assigned an index of 1.0.

Reference wetlands: Wetland sites that encompass the variability of a regional wetland subclass in a reference domain. Reference wetlands are used to establish the range of conditions for construction and calibration of functional indices and to establish reference standards.

Region: A geographic area that is relatively homogeneous with respect to large-scale factors such as climate and geology that may influence how wetlands function.

Regional wetland subclass: Regional hydrogeomorphic wetland classes that can be identified based on landscape and ecosystem scale factors. There may be more than one regional wetland subclass for each of the hydrogeomorphic wetland classes that occur in a region, or there may be only one.

Site potential: The highest level of functioning possible, given local constraints of disturbance history, land use, or other factors. Site capacity may be equal to or less than levels of functioning established by reference standards for the reference domain, and it may be equal to or less than the functional capacity of a wetland ecosystem.

Soil surface: The soil surface is the top of the mineral soil; or, for soils with an "O" horizon, the soil surface is the top of the part of the "O" horizon that is at least slightly decomposed. Fresh leaf or needle fall that has not undergone observable decomposition is excluded from soil.

Value of wetland function: The relative importance of wetland function or functions to an individual or group.

Variable: An attribute or characteristic of a wetland ecosystem or the surrounding landscape that influences the capacity of the wetland to perform a function.

Variable condition: The condition of a variable as determined through quantitative or qualitative measure.

Variable index: A measure of how an assessment model variable in a wetland compares to the reference standards of a regional wetland subclass in a reference domain.

Wetland: See **Wetland ecosystems**.

Wetland ecosystems: In 404: "areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (Corps Regulation 33 CFR 328.3 and EPA Regulations 40 CFR 230.3). In a more general sense, wetland ecosystems are three-dimensional segments of the natural world where the presence of water at or near the surface creates conditions leading to the development of redoximorphic soil conditions, and the presence of a flora and fauna adapted to the permanently or periodically flooded or saturated conditions.

Wetland assessment area (WAA): The wetland area to which results of an assessment are applied.

Wetland functions: The normal activities or actions that occur in wetland ecosystems, or simply, the things that wetlands do. Wetland functions result directly from the characteristics of a wetland ecosystem and the surrounding landscape, and their interaction.

Wetland restoration: The process of restoring wetland function in a degraded wetland. Restoration is typically done as mitigation.

Appendix B
Reference Data

Site ID	Type	County	Rating[1]	Depth of surface "O" Horizon, in.	Mineral or Organic Soil?	Stream Alteration	Site Alteration(s)
CF1	Flood	Cook	2	15	both	severe	none observed
CI15	Flood	Cook	3	0	both	N/O	none observed
LF4	Flood	Lake	1	11.5	both	moderate	none observed
LF6	Flood	Lake	3.5	12	both	moderate	culverts
LI4	Flood	Lake	3.5	10.8	both	N/O	none observed
CF2	Flood	Cook	2	0	mineral	none	culvert
CF4	Flood	Cook	1.5	0	mineral	moderate	none observed
CF5	Flood	Cook	1.5	0	mineral	N/O	none observed
CF9	Flood	Cook	4.5	4	mineral	none	none observed
CI5	Flood	Cook	2	0	mineral	N/O	culvert
LF3h	Flood	Lake	4.5	3.8	mineral	none	adjacent ditch
LF3m	Flood	Lake	4	8	mineral	none	none observed
LF7h	Flood	Lake	3.5	6.5	mineral	N/O	none observed
LF11	Flood	Lake	3	1	mineral	moderate	none observed
LF12	Flood	Lake	2.5	0	mineral	moderate	none observed
LF15	Flood	Lake	4	3.3	mineral	moderate	none observed
LF16	Flood	Lake	3	0	mineral	none	none observed
LI5	Flood	Lake	2.5	3	mineral	N/O	beaver activity, culverts
CF6	Flood	Cook	4	55	organic	N/O	none observed
KF9	Flood	Kenosha	2.5	28	organic	N/O	none observed
KF12	Flood	Kenosha	2.5	33.5	organic	moderate	natural dam
KF25	Flood	Kenosha	2	27.5	organic	moderate	none observed
KF31	Flood	Kenosha	3	N/A	organic	N/O	cattle
LF5	Flood	Lake	3	55	organic	none	none observed
LF7m	Flood	Lake	2.5	37.5	organic	N/O	none observed
LF10	Flood	Lake	3.5	27	organic	none	ditch along road

[1] This was the rating initially assigned to the site based on the field visit.

Site ID	FQI (native)	Mean c (native)	W/Adventives	% Non Native Species	% GVC	% TSSC	% INV
CF1	13.3	3.1	-1.9	21	>95	<5	50
CI15	20.7	3.7	-3.4	14	>95	<5	20
LF4	5.2	3	-3.6	25	>95	<5	90
LF6	23.1	4.4	-3.3	11	>95	<5	40
LI4	19.8	3.5	-3.3	13	>95	<5	40
CF2	13.4	2.5	-2.1	15	>95	<5	25
CF4	13.2	3	-0.8	30	>95	<5	95
CF5	17.7	4.1	-3.9	14	>95	<5	60
CF9	27	4.2	-1.9	18	>95	<5	12.5
CI5	10.9	2.6	-2.3	26	>95	<5	30
LF3h	42.4	4.9	-2.8	1	> 95	<5	55
LF3m	28	4.1	-3.5	8	> 95	<5	35
LF7h	30.6	4.2	-2.9	12	>95	<5	7.5
LF11	19.6	3.3	-3.1	10	80	30	25
LF12	17.7	3.1	-1.2	16	65	30	30
LF15	32.6	5	-1.2	4	>95	7.5	25
LF16	16.8	3.2	-3	10	>95	10	10
LI5	15.8	3	-2.4	29	80	10	50
CF6	24.2	4.1	-3.5	15	>95	10	30
KF9	15.4	3.1	-2.3	11	90	<5	10
KF12	21.4	3.8	-2.2	11	>95	<5	10
KF25	12.7	3	-2.3	18	100	<5	95
KF31	17.4	3.9	-3.4	20	>95	<5	15
LF5	21.2	4.2	-3.7	7	>95	5	10
LF7m	25	4	-3.4	13	>95	<5	7.5
LF10	20.9	3.6	-2.6	19	>95	<5	80

Site ID	% Cattail	Snags	Wetland Area/ Catchment Ratio	Wetlands Within 500 m Score	Catchment LU Score	300 m Buffer LU Score	% of Wetland Perimeter that is Buffered
CF1	51-80	no	0.51	12.0	3.18	3.66	83
CI15	51-80	no	0.28	12.5	2.79	1.93	100
LF4	0-20	no	0.38	12.0	2.95	2.73	78
LF6	51-80	no	0.12	5.5	3.20	3.00	66
LI4	81-100	no	0.24	4.0	2.98	2.69	59
CF2	51-80	no	0.34	6.0	2.82	3.62	100
CF4	0-20	no	0.05	14.0	1.20	1.50	100
CF5	21-50	no	0.08	15.0	1.65	2.30	75
CF9	0-20	no	0.20	16.5	1.57	2.19	100
CI5	81-100	no	0.05	9.5	1.58	1.42	93
LF3h	51-80	no	1.04	32.5	2.32	2.12	80
LF3m	0-20	no	1.04	32.5	2.32	2.12	80
LF7h	81-100	no	0.39	14.5	3.19	2.46	16
LF11	81-100	yes	0.16	10.5	3.41	2.82	93
LF12	0-20	no	0.34	6.0	3.08	3.02	96
LF15	0-20	no	0.34	14.5	1.71	1.98	100
LF16	81-100	no	0.01	11.5	4.15	3.20	100
LI5	51-80	yes	0.15	34.0	3.72	3.70	3
CF6	51-80	no	0.32	6.0	1.72	1.67	100
KF9	81-100	no	0.02	6.0	3.10	3.06	62
KF12	81-100	no	0.53	17.0	2.29	2.39	89
KF25	0-20	no	0.23	12.0	2.55	2.38	39
KF31	81-100	no	0.25	17.5	2.63	2.41	95
LF5	0-20	no	0.54	9.0	1.31	1.84	92
LF7m	81-100	no	0.39	14.5	3.19	2.46	16
LF10	0-20	no	1.15	11.5	3.36	2.88	86

Site ID	Type	County	Rating[1]	Depth of surface "O" Horizon, in.	Mineral or Organic soil?	Site Alteration(s)
CI2	Isolated	Cook	1	0	both	none observed
CI6	Isolated	Cook	3.5	0	both	ditch
KI27	Isolated	Kenosha	3.5	13.5	both	none observed
KI34	Isolated	Kenosha	4	5	both	none observed
KI36	Isolated	Kenosha	3	30.3	both	culvert
LI11	Isolated	Lake	3.5	39.8	both	none observed
LI16	Isolated	Lake	4.5	10	both	none observed
CI8	Isolated	Cook	2	2	mineral	none observed
CI11	Isolated	Cook	4	0	mineral	none observed
CI14	Isolated	Cook	3	0	mineral	none observed
CI16	Isolated	Cook	4	1.5	mineral	none observed
CI17	Isolated	Cook	2	1.5	mineral	culvert
KI24	Isolated	Kenosha	4	2.5	mineral	culvert
KI50	Isolated	Kenosha	3	8	mineral	none observed
LF8	Isolated	Lake	1.5	0	mineral	plowed/tiled
LF13	Isolated	Lake	2.5	6.3	mineral	boardwalk
LI1	Isolated	Lake	1	4	mineral	dirt road
LI3	Isolated	Lake	1	0	mineral	site no longer wetland
LI7	Isolated	Lake	3.5	6.3	mineral	ditch along road
LI14	Isolated	Lake	3.5	0	mineral	none observed
LI15	Isolated	Lake	4	6.8	mineral	none observed
LI21	Isolated	Lake	3.5	11.5	mineral	none observed
LI22	Isolated	Lake	4	8.3	mineral	none observed
LI26	Isolated	Lake	4.5	2	mineral	none observed
CI1	Isolated	Cook	3	55	organic	none observed
CI4	Isolated	Cook	1.5	0	organic	none observed
CI10	Isolated	Cook	4	28.5	organic	none observed
CI12	Isolated	Cook	5	55	organic	none observed
KF1	Isolated	Kenosha	4	14.3	organic	none observed
KI21	Isolated	Kenosha	2	55	organic	none observed
KI37	Isolated	Kenosha	3.5	32	organic	none observed
KI40	Isolated	Kenosha	2	55	organic	none observed
KI42	Isolated	Kenosha	2.5	12.5	organic	none observed
LI2	Isolated	Lake	2	55	organic	old drain tile, site planted
LI12	Isolated	Lake	2.5	55	organic	old drain tile, site planted
LI25	Isolated	Lake	3.5	55	organic	none observed
LI27	Isolated	Lake	2.5	19.3	organic	none observed
LI28	Isolated	Lake	2.5	24.7	organic	none observed

[1]This was the rating initially assigned to the site based on the field visit.

Site ID	FQI (native)	Mean c (native)	W/Adventives	% Non Native Species	% GVC	% TSSC	% INV
CI2	4.5	1.7	-0.7	13	>95	<5	95
CI6	21.7	3.4	-2.2	16	>95	10	5
KI27	18.1	3.3	-1.7	20	>95	<5	20
KI34	22.6	3.4	-1.0	15	>95	<5	10
KI36	22.7	3.6	-3.2	17	>95	<5	7.5
LI11	14.1	3	-1.5	33	>95	<5	25
LI16	24.4	4.6	-2.6	15	>95	<5	7.5
CI8	9.8	2.8	-1.9	29	>95	<5	10
CI11	19.5	4.3	-3.8	15	>95	10	17.5
CI14	19.2	3.8	-3.3	7	>95	<5	50
CI16	21	3.8	-2.2	16	>95	<5	5
CI17	14.2	3.8	-2.2	13	10	20	5
KI24	18	3.3	-2.1	19	>95	20	20
KI50	18.8	3.7	-2.4	28	>95	<5	7.5
LF8	10.3	2.7	-1.1	35	>95	<5	55
LF13	20.6	3.9	-2.7	13	>95	<5	75
LI1	8.8	2.4	-1.7	26	>95	0	90
LI3	1.5	0.8	2.3	56	>95	<5	5
LI7	28.2	4.4	-2.4	19	>95	30	10
LI14	23.3	3.8	-3.2	10	70	30	30
LI15	20.1	3.6	-0.9	23	>95	<5	7.5
LI21	23.4	4.4	-3.8	7	>95	<5	10
LI22	24.1	3.7	-1.9	7	>95	<5	7.5
LI26	21	4	-2.4	13	>95	<5	7.5
CI1	17.9	3.9	-2	25	>95	7.5	17.5
CI4	10.4	3	-2.5	25	60	<5	22.5
CI10	25.8	5	-3.8	13	>95	7.5	7.5
CI12	38.1	5.6	-3.8	4	>95	10	5
KF1	23.8	3.6	-3.4	20	>95	<5	5
KI21	14.3	3	-1.3	19	>95	<5	7.5
KI37	25.4	4.4	-3.2	11	>95	<5	30
KI40	22.3	4.1	-1.6	15	>95	<5	25
KI42	25.4	4.4	-2.9	6	>95	<5	80
LI2	15.3	3.3	-2.1	16	85	<5	40
LI12	24.1	3.8	-1.8	18	80	<5	20
LI25	34.5	5.1	-3.6	10	>95	10	25
LI27	16.4	3.1	-2.3	18	>95	<5	7.5
LI28	23	4.1	-2.3	24	>95	<5	10

Site ID	% Cattail	Snags	Wetland Area/ Catchment Ratio	Wetlands Within 500 m Score	Catchment LU Score	300 m Buffer LU Score	% of Wetland Perimeter that is Buffered
CI2	0-20	no	0.14	4.0	1.92	1.97	100
CI6	51-80	no	0.03	1.0	1.13	2.66	84
KI27	81-100	no	0.29	27.5	2.98	2.83	18
KI34	21-50	no	0.19	20.0	3.23	3.12	0
KI36	81-100	no	0.58	12.0	2.76	2.75	75
LI11	81-100	no	0.23	18.0	4.27	3.97	68
LI16	81-100	yes	0.38	22.0	2.16	1.95	91
CI8	81-100	yes	0.34	5.0	2.28	1.98	92
CI11	0-20	no	0.06	9.0	1.82	1.69	100
CI14	0-20	no	0.05	14.0	1.13	1.91	100
CI16	0-20	no	0.10	4.5	1.25	1.08	100
CI17	0-20	no	0.16	3.5	1.29	1.63	100
KI24	0-20	no	0.05	12.5	2.88	3.16	0
KI50	51-80	yes	0.39	4.5	4.03	3.79	0
LF8	0-20	no	0.09	10.0	2.94	2.69	15
LF13	0-20	no	0.24	13.5	2.16	2.02	87
LI1	0-20	no	0.07	14.5	3.61	3.99	0
LI3	0-20	no	0.07	20.0	3.23	3.05	0
LI7	0-20	yes	0.37	2.0	1.13	1.93	81
LI14	0-20	yes	0.02	9.0	2.02	1.23	81
LI15	21-50	yes	0.24	17.0	2.06	2.36	100
LI21	0-20	no	0.08	23.5	1.00	1.79	100
LI22	21-50	no	0.11	26.0	1.49	1.81	90
LI26	0-20	no	0.1	13.5	1.63	1.64	100
CI1	0-20	no	0.09	15.0	1.11	1.38	100
CI4	0-20	yes	0.12	7.0	2.75	1.76	100
CI10	0-20	no	0.02	6.5	1.00	1.22	100
CI12	0-20	yes	0.16	17.5	1.00	1.04	100
KF1	81-100	no	0.11	4.5	2.95	2.38	61
KI21	81-100	no	0.09	11.5	3.66	2.96	17
KI37	21-50	no	0.22	2.0	2.67	2.98	66
KI40	81-100	no	0.82	5.5	3.52	3.79	24
KI42	0-20	no	0.02	21.0	2.17	1.76	100
LI2	0-20	yes	0.21	16.5	3.02	3.18	100
LI12	0-20	yes	0.28	19.5	3.19	3.32	100
LI25	21-50	no	0.38	12.0	1.66	2.29	80
LI27	81-100	no	0.82	16.5	3.06	3.20	31
LI28	81-100	no	0.28	9.5	3.35	3.36	44

Appendix C
Functional Capacity Units[1]

In the 404 Regulatory Program, the primary application of FCI is to compare different wetland areas, such as project alternatives, or pre- or post-project condition. However, comparing two wetland areas on the basis of a functional capacity index alone can lead to erroneous conclusions. For example, consider the following scenario. A new highway is being planned, and there are two alternative routes under consideration. The first route will impact 5 acres of wetland with an FCI of 0.8 for a particular wetland function. The second route will impact 25 acres of wetland, also with an FCI of 0.8 for the same function. In comparing the two alternatives based on functional capacity, it would be correct to say that on a per unit area basis there was no difference between the alternatives. However, when incorporating the size of each wetland area into the comparison, a conclusion of no difference would be erroneous. The comparison of the two alternatives, based on the functional capacity index and size of wetland, would lead to a more appropriate conclusion that the first alternative is the least damaging to the selected wetland function.

The functional capacity indices resulting from the assessment phase can be applied in a variety of ways during the application phase using *functional capacity units (FCUs).* Functional capacity units provide a measure of the ability of a wetland area to perform a function, and are calculated by multiplying a functional capacity index by the area of wetland the FCI represents. For example:

$$FCU = FCI \times \text{size of wetland area}$$

where:

FCU = Functional capacity units for wetland area

FCI = Functional capacity index for wetland area

Once the functional capacity of a wetland area is expressed in terms of FCUs, a number of the comparison necessary in the 404 permit review process can be made. For example:

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[1] The following is adapted from an article written by R. Daniel Smith in the USACE Wetlands Research Program Bulletin, Volume 4, No. 3, October 1994.

a. Comparing the same wetland area at different points in time (e.g., pre- or post-project conditions).

b. Comparing WAAs in the same hydrogeomorphic wetland class at the same point in time.

c. Comparing WAAs in different hydrogeomorphic wetland classes at the same point in time.

Appendix D Summary of Variables and Functional Capacity Indices

All Variables Used

V_{ALT}: Presence of hydrologic alteration
$V_{ALT\text{-}OEX}$: Presence of hydrologic alteration (stream portion)
V_{BUFFER}: Wetland buffer
V_{C}: Native mean c score
V_{CAT}: Cover of *Typha spp.*
V_{CATCH}: Ratio of wetland area to catchment area
V_{FQI}: Native FQI score
V_{GVC}: Ground vegetation cover
V_{INV}: Invasive species cover (excluding *Typha spp.*)
$V_{LANDUSE}$: Land use within 300 m of site
V_{LUC}: Land use of the catchment area
V_{NAT}: Percent of plant species that are native
V_{OHOR}: Thickness of surface "O" horizon
V_{SOIL}: Soil structure
V_{TSSC}: Tree-shrub-sapling percent cover
V_{W}: Plant wetness score
V_{W500}: Wetlands within 500 m score

Functional Capacity Indices

Maintain characteristic hydrologic regime

a. Isolated Depressions:

$$FCI = \frac{\left[\frac{\frac{(V_{GVC} + V_{SOIL} + V_{W})}{3} + V_{CATCH}}{2} + V_{ALT} + V_{LUC}\right]}{3}$$

b. Floodplain Depressions:

$$FCI = \frac{\left[\frac{\frac{(V_{GVC} + V_{SOIL})}{2} + V_{CATCH}}{2} + V_{ALT} + V_{LUC} \right]}{3}$$

Maintain characteristic biogeochemical processes

Isolated and Floodplain Depressions

$$FCI = \frac{\left[\frac{\left(V_{OHOR} + V_{GVC} + V_{BUFFER}\right)}{3} + V_{SOIL} + V_{LUC} \right]}{3}$$

Export organic carbon

Floodplain Depressions

$$FCI = \frac{\left(V_{GVC} + V_{OHOR}\right)}{2} \times V_{ALT-OEX}$$

Maintain characteristic plant communities

Isolated and Floodplain Depressions

$$FCI = \left\{ \frac{\left(\frac{V_{NAT} + V_{FQI} + V_{C}}{3} \right) + \sqrt{\left(V_{INV} \times V_{CAT}\right) \times \left(\frac{V_{ALT} + V_{LUC}}{2} \right)}}{2} \right\}$$

Maintain characteristic fauna

a. *Isolated and Floodplain Depressions:*

$$FCI = \frac{\sqrt{V_{INV} \times \frac{\left(V_{NAT} + V_{ALT} \frac{\left(V_{GVC} + V_{TSSC} \right)}{2} \right)}{3}} + \frac{\left(V_{W500} + V_{BUFFER} + V_{LANDUSE} \right)}{3}}{2}$$

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14. ABSTRACT

This Regional Guidebook characterizes the wetlands in the Upper Des Plaines River Basin using the hydrogeomorphic (HGM) approach. The HGM approach is a collection of concepts and methods used to develop functional indices to assess the capacity of a particular wetland to perform functions relative to similar wetlands in a region. Specifically, this report describes the rationale that was used to select functions for two subclasses of herbaceous freshwater depressions, the Isolated Depression subclass and the Floodplain Depression subclass. The report also describes the process used to select model variables and metrics and to develop assessment models. Data from reference wetlands are provided and used to calibrate model variables and assessment models. Protocols for applying functional indices to the assessment of wetland functions are provided.

15. SUBJECT TERMS

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Des Plaines River	HGM	Wetland
	Hydrogeomorphic approach	

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A Survey of Riverine Fish Assemblages and Habitat of the Upper Des Plaines River System

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Abstract – Fish community and habitat surveys were conducted in the upper Des Plaines River system to determine current status of fish species distribution, to assess overall stream quality and to evaluate the potential for ecosystem restoration. During the period from 2002 to 2004, forty-nine sites upstream of Salt Creek in Illinois and the entire watershed in Wisconsin were surveyed for fish species richness, biological integrity and riverine habitat. Forty-three native species of fishes were found, twenty-three less than the reconstructed pre-settlement fish assemblage. One species not native to the upper Des Plaines River system and four species not native to the North American continent were also present. The Index of Biotic Integrity (IBI) developed by Illinois EPA was utilized to assess biological integrity. IBI scores ranged from 0 to 44, with most in the range classified as "limited aquatic resource". Although some of the stations in the upper watershed received higher IBI scores, overall scores were similar in the agricultural areas of Wisconsin and the urbanized areas in Illinois. The Qualitative Habitat Evaluation Procedure (QHEI) developed by the Ohio EPA was utilized to assess riverine habitat quality. The average QHEI score of 44 classifies the upper Des Plaines River system as a "moderate aquatic resource" in terms of riverine habitat. Fish and habitat survey results suggest Newport Ditch, Kilbourn Road Ditch, Brighton Creek, Bull Creek, Center Creek and the upper reaches of the Des Plaines River subwatersheds as high restoration priorities. Riverine restoration should include reestablishment of hydrology & hydraulics, stream channel morphology, channel complexity and native riparian plant communities. Any restoration effort should consider the impact of fish migration barriers and include plans to restore connectivity through dam removal or addition of fish passage, particularly at the Hofmann Dam, a major barrier to restoration in the upper watershed.

Introduction

Stream degradation and reduction of biotic integrity are widespread problems in watersheds throughout the country, both in agricultural and urban areas. In addition to effects resulting from land use practices, sources of stream degradation include water quality limitations, channel modifications, and fragmentation due to dams and other migration barriers. In many cases, combinations of factors contribute to degraded conditions. Moreover, interaction between known stressors and natural stream characteristics, such as soil types, landform, and other features may affect the level of degradation and potential for restoration for certain stream types.

In recent years there has been an emphasis on an ecosystem or watershed-based approach to stream restoration. A key component in setting restoration priorities is identification of primary limiting factors. Although the sources of degradation may be multi-factorial, baseline information on biotic communities, combined with information on physical conditions can help direct restoration expenditures in a logical manner. For example, extensive habitat restoration in a water quality limited system is not effective use of limited financial resources. Similarly, habitat or water quality restoration in a fragmented system lacking quality recruitment sources may not result in restoration of biotic integrity.

The upper Des Plaines River system is highly degraded, resultant from a variety of landscape-scale impacts, including substantial and widespread water quality impacts due to urbanization and agricultural practices. The presence of 13 mainstem dams and a many tributary barriers have also led to a highly fragmented condition. Although some recent survey information is available for the upper Des Plaines River, a comprehensive basin-wide study including areas in Illinois and Wisconsin is not currently available. With the increased interests in restoration, and flood mitigation directed towards this and other large urban river basins by Federal, State, and local agencies, basic physical and biological information is crucial to directing restoration activities and priorities. Large-scale studies of severely degraded river systems are generally limited, even though they are extremely useful in identifying factors affecting fish community structure and species distribution in large.

In this study we provide baseline information on the upper Des Plaines River system in Illinois and Wisconsin for both fish communities and physical habitat conditions. Survey data were also used to characterize stream quality using both biotic and abiotic indices. The primary factors affecting fish species distribution and community structure are evaluated in the context of historic data and current recruitment sources. Finally, we attempt to provide a framework to guide restoration priorities in this and other large, degraded watersheds.

Study Area

This study included the mainstem of the Des Plaines River and all tributary streams above the Salt Creek confluence, which includes Kenosha and Racine counties in Wisconsin and Lake and Cook counties in Illinois (Map 1). The upper Des Plaines River watershed is approximately 135 square miles in Wisconsin and 350 square miles in Illinois. Historically, the Des Plaines River system was a narrow elongated depression within the late Wisconsinan Age glacial drift (Pepoon 1927). The upper Des Plaines River, from the confluence of Salt Creek northward, was very shallow and about 30 feet wide with banks of terraced alluvium and covered with hydrophytic vegetation (Pepoon 1927). As European settlement increased, the watershed began to be stripped of natural plant communities, initially due to agricultural practices. Landuse in many areas of the watershed were gradually converted to urban and suburban use dominated by rooftops, pavement and other impervious surfaces. Streams became more entrenched and began to exhibit signs of an altered hydrology with increased peak flows and reduced base flows. As of 1990, land use in the Wisconsin portion of the watershed consisted of 68.3% agriculture, 14.7% natural landscape, and 11.8 % urban (SEWRPC 2003). Land use in the Illinois portion of the watershed consists of 57.4% urban, 23% natural landscape, and 19.6% agriculture (ILDNR 1998). Table 1 shows subwatershed size and landuse. These landscape-scale changes in land-use, and subsequent hydrologic and hydraulic alterations, have led to decreased habitat quality, degraded water quality and reduced species richness.

Methods

Fish Collections

Forty-nine sampling sites (Map 1 & Table 2) were selected to provide adequate spatial distribution for determining stream quality within each subwatershed of the upper Des Plaines River system; twenty-nine wadable tributary sites were surveyed for stream fishes using a backpack electro-fishing unit. All habitats within the designated reach were sampled thoroughly by one shocking unit and up to three individuals for netting fish. For tributary streams, collection effort was thus standardized by setting station length at 15 times the mean stream width (Smogor 2002).

A total of 20 non-wadable sites were sampled on the mainstem Des Plaines River using a boat mounted electro-fishing unit. A distance of 15 times the mean stream width for these larger streams would be

Map 1: Study are watersheds, survey sites and dams

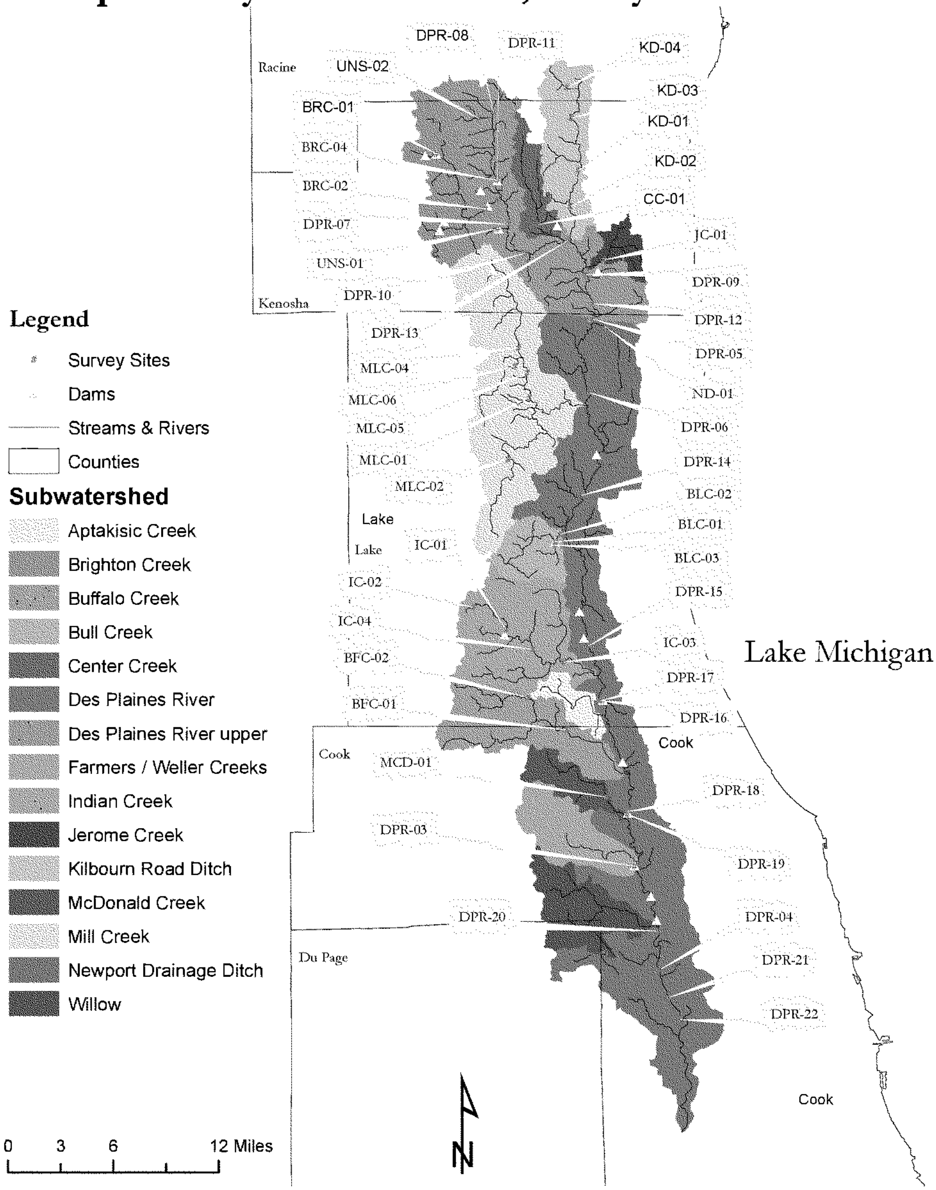

Table 1 – Survey site localities for the upper Des Plaines River system

Subwatershed	Acres	Square Miles	Landuse acres Natural	Landuse acres Urban	Landuse acres Agriculture	Landuse % Natural	Landuse % Urban	Landuse % Agriculture
Aptakisic Creek	4,102	6.4	785	3,170	147	19%	77%	4%
Brighton Creek	17,684	28	6,022	3,803	7,859	34%	22%	44%
Buffalo Creek	19,242	30.1	4,592	14,197	453	24%	74%	2%
Bull Creek	7,621	11.9	2,301	4,087	1,233	30%	54%	16%
Center Creek	6,593	10.3	743	783	5,067	11%	12%	77%
Des Plaines River	95,169	148.7	30,422	59,454	5,293	32%	62%	6%
Des Plaines River upper	34,348	53.7	9,530	7,529	17,289	28%	22%	50%
Farmers & Weller Creeks	12,148	19.0	4,355	11,313	0	36%	93%	0%
Indian Creek	26,952	42.1	9,113	15,233	2,606	34%	57%	10%
Jerome Creek	3,784	5.9	900	1,745	1,138	24%	46%	30%
Kilbourn Road Ditch	15,127	23.6	2,004	3,376	9,747	13%	22%	64%
McDonald Creek	6,475	10.1	688	5,787	0	11%	89%	0%
Mill Creek	41,956	65.6	12,831	13,887	15,238	31%	33%	36%
Newport Drainage Ditch	5,255	8.2	1,130	1,932	2,194	21%	37%	42%
Willow Creek	13,660	21.3	1,408	12,245	7	10%	90%	0%
Upper Des Plaines Basin	310,117	485	86,825	158,540	68,271	28%	51%	22%

Table 2 – Survey site localities for the upper Des Plaines River system

Subwatershed	Area mi sq	Site #	Stream	ST	Cnty	Locality
Kilbourn Road Ditch	23.6	KD-01	Kilbourn Road Ditch	WI	Kenosha	Hwy 50
		KD-02	Kilbourn Road Ditch	WI	Kenosha	Hwy K
		KD-03	Kilbourn Road Ditch	WI	Kenosha	Hwy A
		KD-04	Kilbourn Road Ditch	WI	Racine	Braun Rd.
Center Creek	10.3	CC-01	Center Creek	WI	Kenosha	Hwy 50
Brighton Creek	20.4	BRC-01	Brighton Creek	WI	Kenosha	Hwy X
		BRC-02	Brighton Creek	WI	Kenosha	Reach between Hwy K @ Rt. 45
		BRC-04	Brighton Creek	WI	Kenosha	Pleasant Landfill
Jerome Creek	5.9	JC-01	Jerome Creek	WI	Kenosha	Hwy H, just north of 95th St.
Des Plaines River upper	53.7	DPR-10	Des Plaines River	WI	Kenosha	Hwy MB
		DPR-11	Des Plaines River	WI	Kenosha	Hwy N
		DPR-12	Des Plaines River	WI	Kenosha	Hwy ML
		DPR-13	Des Plaines River	WI	Kenosha	At 120th Ave adjacent to I-94
		UNS-01	Unnamed stream	WI	Kenosha	Hwy D .5 miles NE of Bristol
		UNS-02	Unnamed stream	WI	Kenosha	Hwy 45
Des Plaines River	149.5	DPR-03	Des Plaines River	IL	Cook	Dempster Dam Downstream
		DPR-04	Des Plaines River	IL	Cook	Irving Park Rd.
		DPR-05	Des Plaines River	IL	Lake	Russell Rd.
		DPR-06	Des Plaines River	IL	Lake	Wadsworth Rd.
		DPR-07	Des Plaines River	WI	Kenosha	Hwy 50
		DPR-08	Des Plaines River	WI	Kenosha	Hwy KR; in Dragway
		DPR-09	Des Plaines River	WI	Kenosha	Lake View Parkway
		DPR-14	Des Plaines River	IL	Lake	Belvidere Rd.
		DPR-15	Des Plaines River	IL	Lake	Dan Wright Woods, 1.5 mi. DS Rt 60
		DPR-16	Des Plaines River	IL	Lake	Ryerson Woods Dam Upstream
		DPR-17	Des Plaines River	IL	Lake	Ryerson Woods Dam Downstream
		DPR-18	Des Plaines River	IL	Cook	Dam #2 Woods, Upstream, Foundry Road
		DPR-19	Des Plaines River	IL	Cook	Dam #2 Woods, Downstream, Foundry Road
		DPR-20	Des Plaines River	IL	Cook	I 294 Bridge
		DPR-21	Des Plaines River	IL	Cook	Grand Ave.
		DPR-22	Des Plaines River	IL	Cook	Armitage Ave. Dam Upstream
Newport	8.2	ND-01	Newport Ditch	IL	Lake	Kilbourn Rd.
Mill Creek	65.6	MLC-01	Mill Creek	IL	Lake	Milburn Rd. just W of school
		MLC-02	Mill Creek	IL	Lake	Rollins Savanna below dam
		MLC-03	Mill Creek	IL	Lake	Rollins Savanna above dam
		MLC-04	N.B. Mill Creek	IL	Lake	Ethel's Woods above Rasmussen Lake
		MLC-05	N.B. Mill Creek	IL	Lake	Ethel's Woods below Rasmussen Lake
		MLC-06	Hastings Creek	IL	Lake	
Bull Creek	11.9	BLC-01	Bull Creek	IL	Lake	Peterson Rd.
		BLC-02	Bull Creek	IL	Lake	Hwy 21
		BLC-03	Bull Creek	IL	Lake	Cass Park just south of Rt. 137
Indiana Creek	42.1	IC-01	Indian Creek	IL	Lake	Seneca Dr.
		IC-02	Killdeer Creek	IL	Lake	Tandy Park at McHenry Rd.
		IC-03	Indian Creek	IL	Lake	Prairie View Park (R&R) & Port Clinton Rd.
		IC-04	Indian Creek	IL	Lake	Parallel to Rt. 83 and Endwood Dr.
Buffalo Creek	30.1	BFC-01	Buffalo Creek	IL	Cook	Route 83 and Buffalo Grove Rd.
		BFC-02	Buffalo Creek	IL	Lake	Coffin Rd. @ Long Grove
McDondald Creek	10.1	MDC-01	McDonald Creek	IL	Cook	McDonald Rd.

impractical to sample in a reasonable time frame, therefore each location was sampled for one hour of boat electro-fishing, covering all visible habitat types at each given site. Two individuals situated at the bow of the boat used lightweight dip nets to collect as many fish as possible.

All small fishes, under 150 mm, were immediately preserved in a 10% formalin solution for enumeration and identification in the laboratory. Fishes over 150 mm were identified in the field and released, with the exception of voucher specimens. At minimum, one individual of each species collected at each station was documented by photograph or preservation. All preserved specimens reside in the Field Museum of Natural History and Southern Illinois University fish collections.

Index of Biotic Integrity

The Index of Biotic Integrity (IBI) employs fish assemblage as the indicator of biological form and function. Fish are not only a highly visible part of the aquatic resource, but they are quite sensitive to the surrounding water and habitat quality. This does not suggest that the use of other organisms is insufficient or inappropriate (Simon 1991). The ambient condition of the upper Des Plaines River system was evaluated using the IBI (Karr 1981; Karr et. al. 1986; Simon 1991; Smogor 2002). This method makes use of a systematic process to set quantitative criteria that enables the measurement of riverine stream quality. This index employs ten parameters or "metrics" based on structural and functional components of the fish assemblage. Structural components include diversity, taxonomic guilds, and abundance. Functional components include feeding or trophic guilds, reproductive behavior, tolerance to adverse environmental stressors, and individual stresses (Simon 1991; Smogor 2002). These metrics are calibrated to for differences in stream size and geographic region. The following ten metrics may each receive a score 0 to 6, based on comparison to unaltered reference sites, with a total IBI score ranging from 0 to 60 (Smogor 2002):

1) Number of native fish species
2) Number of native Catostomid species
3) Number of native Centrarchid species
4) Number of native intolerant species
5) Number of native Cyprinid species
6) Number of native benthic insectivore species
7) Proportion of individuals as specialist benthic insectivores
8) Proportion of individuals as generalist feeders
9) Proportion of individuals as obligate course-mineral substrate spawners and intolerant
10) Proportion of tolerant species

Qualitative Habitat Evaluation Index

The Qualitative Habitat Evaluation Index (QHEI), developed by the Ohio EPA (Rankin 1989), was employed to assess the habitat quality of the upper Des Plaines River system. The QHEI consists of eight sections with a maximum total of 100 points:

1) Characterization of substrate types and the effects of siltation
2) Characterization of in-stream cover
3) Characterization of channel morphology
4) Characterization of the riparian zone and bank erosion
5) Assessment of the pool / glide & riffle / run
6) Gradient
7) Shade
8) Channel incision

One raw data sheet consisting of one to five transects was completed for each site. The sites were assessed from a river right descending perspective. The transects were dependent and based on the area sampled for fishes and began some distance up or downstream from evident bridge disturbance to the stream; however, the impacts from these structures should be taken into consideration when implementing restoration measures since this study recommends remedies to anthropogenic disturbance to stream morphology and function. A variable of impoundment was added to the QHEI for this particular study under the channel morphology section to give weight to stream connectivity. If backwater effects from a downstream structure impacted the stream section, a score of zero was received, if the stream section was free flowing, a score of nine was received. Other impacts of dams were indirectly reflected in stream morphology and function parameter. See Attachment 1 for QHEI scoring guide.

Subwatershed Quality Ranking

A ranking system was implemented to determine priority for riverine restoration sites for each subwatershed. This ranking system is based upon the five categorical descriptions of the IBI and QHEI (Table 3). For example, the survey sites that resemble least disturbed conditions, and therefore the best available, would fall under rank five, Unique Aquatic Resource. Survey sites that have been extremely degraded and have lost practically all ecological function would fall under rank 1 (Imperiled Aquatic Resource). The rank for each subwatershed was determined by averaging the IBI and QHEI scores of survey sites within a basin; then averaging the individual mean IBI and QHEI rank numbers. This process integrates biological integrity and habitat quality scores into a single combined ranking for an individual subwatershed. Rank numbers may fall in between two descriptions (↨), and therefore have characteristics of both descriptors. Sites that have major disparity between the quality of habitat and the quality of the fish assemblage may be attributed to prevention of fish migration by dams or poor water quality, thus habitat would not be the limiting factor at the site.

Table 3 - Combined Riverine Ranking Scheme

IBI	QHEI	Rank	Descriptions
51 - 60	80 - 100	5	Unique Aquatic Resource
		4.5	↨
41 - 50	60 - 79	4	Highly Valued Resource
		3.5	↨
31 - 40	40 - 59	3	Moderate Aquatic Resource
		2.5	↨
21 - 30	20 - 39	2	Limited Aquatic Resource
		1.5	↨
0 - 20	0 - 19	1	Imperiled Aquatic Resource

Results

Fishes

A total of 43 native fish species were collected in the upper Des Plaines River system during 2002-2004. In addition to *Cyprinus carpio* (common carp) and *Carassius auratus* (goldfish), two other non-native species were collected, *Barbonymus schwanenfeldii* (tinfoil barb), and *Pterogloplichthys disjunctivis* (sailfin catfish). Also collected was *Lepomis microlophus* (redear sunfish), which are native to Illinois, but does not naturally occur in the Des Plaines River system. Species distribution by collection site is shown in Table 4. The most frequently occurring species within the upper Des Plaines River system are all considered tolerant species; 88% *Lepomis cyanellus* (green sunfish), 83% *Lepomis macrochirus* (bluegill), 69% *Pimephales notatus* (bluntnose minnow), 69% *Catostomus commersonii* (white sucker), 65% *Micropterus salmoides* (largemouth bass), and 63% *Fundulus notatus* (blackstripe topminnow). Table 5 shows the percent occurrence of all species collected for this study.

The only abundant non-native species was common carp with a 42% occurrence rate. Based on the observed distribution in this study, common carp appear to occupy larger streams and rivers as adults and

Table 4 - Fish distribution by site within the upper Des Plaines River system.

* State Threatened, ^non-native

Family	Species	Common Name	BFC-01	BFC-02	BLC-01	BLC-02	BLC-03	BRC-01	BRC-02	BRC-04	CC-01	DPR-03	DPR-04	DPR-05
Amiidae	*Amia calva*	bowfin												
Clupeidae	*Dorosoma cepedianum*	gizzard shad									X			
Cyprinidae	*Cyprinus carpio*^	common carp	X									X	X	X
	Carassius auratus^	goldfish											X	X
	Notemigonus crysoleucas	golden shiner	X				X		X					
	Semotilus atromaculatus	creek chub		X	X	X	X	X	X	X	X		X	
	Nocomis biguttatus	hornyhead chub				X			X	X		X	X	
	Cyprinella spiloptera	spotfin shiner							X	X		X	X	X
	Luxilus chrysocephalus	striped shiner							X	X				
	Lythrurus umbratilis	redfin shiner												
	Pimephales notatus	bluntnose minnow	X	X			X		X	X	X	X	X	X
	Pimephales promelas	fathead minnow		X					X		X	X	X	
	Notropis dorsalis	bigmouth shiner									X		X	
	*Notropis heterodon**	blackchin shiner												
	Notropis stramineus	sand shiner										X	X	X
	Notropis volucellus	mimic shiner												
	Campostoma anomalum	central stoneroller				X			X	X	X			X
	Rhinichthys atratulus	blacknose dace												
	Barbonymus schwanenfeldii^	tinfoil barb												
Catostomidae	*Catostomus commersonii*	white sucker	X	X	X	X	X		X	X	X	X	X	X
	Minytrema melanops	spotted sucker							X	X		X		X
Ictaluridae	*Ictalurus punctatus*	channel cat										X		X
	Ameiurus natalis	yellow bullhead	X	X					X			X		X
	Ameiurus melas	black bullhead	X	X					X					X
	Noturus flavus	stonecat										X		
	Noturus gyrinus	tadpole madtom							X					
Loricaridae	*Pterogloplichthys disjunctivis*^	sailfin catfish										X		
Umbridae	*Umbra limi*	central mudminnow			X		X	X	X	X	X			
Esocidae	*Esox americanus*	grass pickerel												
	Esox lucius	northern pike							X			X		
Aphredodaridae	*Aphredodarus sayanus*	pirate perch							X	X				
Gasterosteidae	*Culaea inconstans*	brook stickleback												
Fundulidae	*Fundulus notatus*	blackstripe topminnow							X	X	X	X	X	X
Moronidae	*Morone mississippiensis*	yellow bass												
Centrarchidae	*Ambloplites rupestris*	rockbass										X		
	Pomoxis nigromaculatus	black crappie										X	X	X
	Micropterus salmoides	largemouth bass	X			X		X		X	X	X		X
	Micropterus dolomieu	smallmouth bass												
	Lepomis humilis	orangespotted sunfish										X	X	X
	Lepomis macrochirus	bluegill	X	X		X	X	X	X	X		X	X	X
	Lepomis microlophus^	redear sunfish												
	Lepomis cyanellus	green sunfish	X	X	X	X		X	X	X	X	X		X
	Lepomis gibbosus	pumpkinseed						X	X	X		X		X
Perciadae	*Perca flavescens*	yellow perch										X		
	Etheostoma exile	Iowa darter												
	Etheostoma flabellare	fantail darter				X								
	Etheostoma nigrum	Johnny darter							X	X	X	X	X	X
	Percina maculata	blackside darter				X			X	X	X	X		X
	Species Richness		9	8	4	9	6	6	22	17	13	24	15	20
	IBI		14	10	11	37	15	15	44	37	24	31	24	32
	QHEI		47	54	76	48	84	33	58	59	45	34	36	35

Table 4 - Fish distribution by site within the upper Des Plaines River system.

* State Threatened, ^non-native

Family	Species	Common Name	DPR-06	DPR-07	DPR-08	DPR-09	DPR-10	DPR-11	DPR-12	DPR-13	DPR-14	DPR-15	DPR-16	DPR-17
Amiidae	*Amia calva*	bowfin												
Clupeidae	*Dorosoma cepedianum*	gizzard shad							X	X		X	X	
Cyprinidae	*Cyprinus carpio*^	common carp		X	X	X							X	X
	Carassius auratus^	goldfish												
	Notemigonus crysoleucas	golden shiner	X	X							X			X
	Semotilus atromaculatus	creek chub		X	X			X			X			X
	Nocomis biguttatus	hornyhead chub		X							X			X
	Cyprinella spiloptera	spotfin shiner		X	X	X	X				X	X	X	
	Luxilus chrysocephalus	striped shiner			X									
	Lythrurus umbratilis	redfin shiner												
	Pimephales notatus	bluntnose minnow	X	X	X		X				X	X	X	X
	Pimephales promelas	fathead minnow			X		X							X
	Notropis dorsalis	bigmouth shiner			X									
	*Notropis heterodon**	blackchin shiner									X			
	Notropis stramineus	sand shiner			X	X					X	X	X	X
	Notropis volucellus	mimic shiner												
	Campostoma anomalum	central stoneroller		X	X			X						
	Rhinichthys atratulus	blacknose dace			X			X						
	Barbonymus schwanenfeldii^	tinfoil barb												
Catostomidae	*Catostomus commersonii*	white sucker	X	X	X			X			X	X		
	Minytrema melanops	spotted sucker	X	X			X				X	X	X	
Ictaluridae	*Ictalurus punctatus*	channel cat												
	Ameiurus natalis	yellow bullhead				X	X							X
	Ameiurus melas	black bullhead		X			X		X	X				
	Noturus flavus	stonecat												X
	Noturus gyrinus	tadpole madtom		X										
Loricaridae	*Pterogloplichthys disjunctivis*^	sailfin catfish												
Umbridae	*Umbra limi*	central mudminnow		X	X	X								
Esocidae	*Esox americanus*	grass pickerel	X											
	Esox lucius	northern pike		X							X			
Aphredodaridae	*Aphredodarus sayanus*	pirate perch			X									
Gasterosteidae	*Culaea inconstans*	brook stickleback												
Fundulidae	*Fundulus notatus*	blackstripe topminnow	X	X	X	X			X	X	X	X	X	X
Moronidae	*Morone mississippiensis*	yellow bass												
Centrarchidae	*Ambloplites rupestris*	rockbass									X			X
	Pomoxis nigromaculatus	black crappie	X	X			X		X	X	X		X	X
	Micropterus salmoides	largemouth bass	X	X		X	X	X	X	X	X	X	X	X
	Micropterus dolomieu	smallmouth bass												
	Lepomis humilis	orangespotted sunfish	X		X						X		X	X
	Lepomis macrochirus	bluegill	X	X		X	X	X	X	X	X	X	X	X
	Lepomis microlophus^	redear sunfish	X											
	Lepomis cyanellus	green sunfish		X	X	X	X	X	X	X	X	X	X	X
	Lepomis gibbosus	pumpkinseed	X		X	X	X		X	X				X
Perciadae	*Perca flavescens*	yellow perch												
	Etheostoma exile	Iowa darter			X									
	Etheostoma flabellare	fantail darter												
	Etheostoma nigrum	Johnny darter	X	X	X	X	X	X				X	X	X
	Percina maculata	blackside darter		X	X				X	X		X		
	Species Richness		13	20	20	11	12	8	9	9	17	12	13	18
	IBI		30	34	34	23	24	25	22	21	34	28	25	25
	QHEI		36	33	67	51	41	20	49	46	32	51	23	48

Table 4 - Fish distribution by site within the upper Des Plaines River system.

* State Threatened, ^non-native

Family	Species	Common Name	DPR-18	DPR-19	DPR-20	DPR-21	DPR-22	IC-01	IC-02	IC-03	IC-04	JC-01	KD-01	KD-02
Amiidae	*Amia calva*	bowfin												
Clupeidae	*Dorosoma cepedianum*	gizzard shad			X									
Cyprinidae	*Cyprinus carpio*^	common carp	X	X	X		X		X	X				X
	Carassius auratus^	goldfish			X									
	Notemigonus crysoleucas	golden shiner								X				
	Semotilus atromaculatus	creek chub		X				X					X	X
	Nocomis biguttatus	hornyhead chub		X		X							X	X
	Cyprinella spiloptera	spotfin shiner		X	X	X	X							X
	Luxilus chrysocephalus	striped shiner												X
	Lythrurus umbratilis	redfin shiner												
	Pimephales notatus	bluntnose minnow		X	X	X	X	X		X	X		X	X
	Pimephales promelas	fathead minnow		X		X							X	X
	Notropis dorsalis	bigmouth shiner						X						
	*Notropis heterodon**	blackchin shiner												
	Notropis stramineus	sand shiner		X	X	X								
	Notropis volucellus	mimic shiner		X										
	Campostoma anomalum	central stoneroller											X	X
	Rhinichthys atratulus	blacknose dace												
	Barbonymus schwanenfeldii^	tinfoil barb		X										
Catostomidae	*Catostomus commersonii*	white sucker	X	X	X	X	X	X		X	X		X	X
	Minytrema melanops	spotted sucker	X	X	X	X	X							
Ictaluridae	*Ictalurus punctatus*	channel cat		X	X									
	Ameiurus natalis	yellow bullhead		X						X	X			
	Ameiurus melas	black bullhead							X	X	X			X
	Noturus flavus	stonecat												
	Noturus gyrinus	tadpole madtom		X										
Loricaridae	*Pterogloplichthys disjunctivis*^	sailfin catfish												
Umbridae	*Umbra limi*	central mudminnow									X	X	X	X
Esocidae	*Esox americanus*	grass pickerel												
	Esox lucius	northern pike		X										
Aphredodaridae	*Aphredodarus sayanus*	pirate perch										X	X	X
Gasterosteidae	*Culaea inconstans*	brook stickleback											X	
Fundulidae	*Fundulus notatus*	blackstripe topminnow	X	X	X	X	X				X	X	X	X
Moronidae	*Morone mississippiensis*	yellow bass												
Centrarchidae	*Ambloplites rupestris*	rockbass		X	X	X								
	Pomoxis nigromaculatus	black crappie		X	X									
	Micropterus salmoides	largemouth bass	X	X					X	X	X			X
	Micropterus dolomieu	smallmouth bass												
	Lepomis humilis	orangespotted sunfish		X	X									
	Lepomis macrochirus	bluegill	X	X	X	X		X	X	X	X		X	
	Lepomis microlophus^	redear sunfish								X				
	Lepomis cyanellus	green sunfish		X	X	X	X	X	X		X	X	X	X
	Lepomis gibbosus	pumpkinseed		X									X	
Perciadae	*Perca flavescens*	yellow perch												
	Etheostoma exile	Iowa darter												
	Etheostoma flabellare	fantail darter												
	Etheostoma nigrum	Johnny darter		X		X		X					X	X
	Percina maculata	blackside darter			X	X	X				X			
	Species Richness		6	24	16	13	8	7	5	9	10	4	14	16
	IBI		32	31	25	26	27	15	10	33	19	11	29	42
	QHEI		21	53	28	26	19	50	48	26	44	45	35	59

Table 4 - Fish distribution by site within the upper Des Plaines River system.

* State Threatened, ^non-native

Family	Species	Common Name	KD-03	KD-04	MDC-01	MLC-01	MLC-02	MLC-03	MLC-04	MLC-05	MLC-06	ND-01	UNS-01	UNS-02
Amiidae	*Amia calva*	bowfin					X	X						
Clupeidae	*Dorosoma cepedianum*	gizzard shad												
Cyprinidae	*Cyprinus carpio*^	common carp	X			X			X	X				
	Carassius auratus^	goldfish												
	Notemigonus crysoleucas	golden shiner		X			X	X					X	
	Semotilus atromaculatus	creek chub		X	X					X		X	X	X
	Nocomis biguttatus	hornyhead chub	X							X		X		
	Cyprinella spiloptera	spotfin shiner										X		
	Luxilus chrysocephalus	striped shiner												X
	Lythrurus umbratilis	redfin shiner										X		
	Pimephales notatus	bluntnose minnow	X	X	X	X				X		X		X
	Pimephales promelas	fathead minnow	X	X		X								
	Notropis dorsalis	bigmouth shiner		X										X
	*Notropis heterodon**	blackchin shiner												
	Notropis stramineus	sand shiner												
	Notropis volucellus	mimic shiner												
	Campostoma anomalum	central stoneroller												X
	Rhinichthys atratulus	blacknose dace												
	Barbonymus schwanenfeldii^	tinfoil barb												
Catostomidae	*Catostomus commersonii*	white sucker	X	X	X	X							X	X
	Minytrema melanops	spotted sucker	X											
Ictaluridae	*Ictalurus punctatus*	channel cat				X				X				
	Ameiurus natalis	yellow bullhead	X		X		X	X	X	X				
	Ameiurus melas	black bullhead	X	X		X	X		X			X		
	Noturus flavus	stonecat												
	Noturus gyrinus	tadpole madtom					X			X				
Loricaridae	*Pterogloplichthys disjunctivis*^	sailfin catfish												
Umbridae	*Umbra limi*	central mudminnow	X	X		X	X					X		
Esocidae	*Esox americanus*	grass pickerel												
	Esox lucius	northern pike						X				X		
Aphredodaridae	*Aphredodarus sayanus*	pirate perch	X	X								X		
Gasterosteidae	*Culaea inconstans*	brook stickleback		X										
Fundulidae	*Fundulus notatus*	blackstripe topminnow	X	X		X			X			X		
Moronidae	*Morone mississippiensis*	yellow bass					X							
Centrarchidae	*Ambloplites rupestris*	rockbass												
	Pomoxis nigromaculatus	black crappie				X	X	X	X	X				
	Micropterus salmoides	largemouth bass	X	X	X	X	X			X		X		
	Micropterus dolomieu	smallmouth bass					X							
	Lepomis humilis	orangespotted sunfish				X			X	X				
	Lepomis macrochirus	bluegill		X	X	X	X	X	X	X	X	X		X
	Lepomis microlophus^	redear sunfish												
	Lepomis cyanellus	green sunfish	X	X	X	X	X	X	X	X		X	X	X
	Lepomis gibbosus	pumpkinseed					X		X	X	X	X	X	
Perciadae	*Perca flavescens*	yellow perch				X	X	X						
	Etheostoma exile	Iowa darter												
	Etheostoma flabellare	fantail darter												
	Etheostoma nigrum	Johnny darter	X	X			X					X		X
	Percina maculata	blackside darter	X									X		
	Species Richness		15	15	7	14	15	8	9	13	2	16	5	9
	IBI		27	31	14	23	23	15	14	25	0	39	16	31
	QHEI		54	36	48	63	52	31	26	68	29	64	42	63

Table 5 - Species occurrence depicted by number of sites and % of total sites.

Species	# of sites	% occurrence	Common name
Lepomis cyanellus	42	88%	green sunfish
Lepomis macrochirus	40	83%	bluegill
Pimephales notatus	33	69%	bluntnose minnow
Catostomus commersonii	33	69%	white sucker
Micropterus salmoides	31	65%	largemouth bass
Fundulus notatus	30	63%	blackstripe topminnow
Etheostoma nigrum	25	52%	Johnny darter
Semotilus atromaculatus	24	50%	creek chub
Cyprinus carpio	20	42%	common carp
Lepomis gibbosus	20	42%	pumpkinseed
Cyprinella spiloptera	18	38%	spotfin shiner
Ameiurus melas	18	38%	black bullhead
Umbra limi	18	38%	central mudminnow
Pomoxis nigromaculatus	18	38%	black crappie
Ameiurus natalis	17	35%	yellow bullhead
Percina maculata	17	35%	blackside darter
Minytrema melanops	16	33%	spotted sucker
Nocomis bigutattus	15	31%	hornyhead chub
Pimephales promelas	15	31%	fathead minnow
Lepomis humilis	13	27%	orangespotted sunfish
Notemigonus crysoleucas	12	25%	golden shiner
Notropis stramineus	12	25%	sand shiner
Campostoma anomalum	11	23%	central stoneroller
Aphredodarus sayanus	9	19%	pirate perch
Esox lucius	7	15%	northern pike
Dorosoma cepedianum	6	13%	gizzard shad
Notropis dorsalis	6	13%	bigmouth shiner
Ictalurus punctatus	6	13%	channel catfish
Ambloplites rupestris	6	13%	rockbass
Luxilus chrysocephalus	5	10%	striped shiner
Noturus gyrinus	5	10%	tadpole madtom
Perca flavescens	4	8%	yellow perch
Carassius auratus	3	6%	goldfish
Amia calva	2	4%	bowfin
Rhinichthys atratulus	2	4%	blacknose dace
Noturus flavus	2	4%	stonecat
Culaea inconstans	2	4%	brook stickleback
Lepomis microlophus	2	4%	redear sunfish
Lythrurus umbratilis	1	2%	redfin shiner
Notropis heterodon	1	2%	blackchin shiner
Notropis volucellus	1	2%	mimic shiner
Barbonymus schwanenfeldii	1	2%	tinfoil barb
Pterogloplichthys disjunctivis	1	2%	sailfin catfish
Esox americanus	1	2%	grass pickerel
Morone mississippiensis	1	2%	yellow bass
Micropterus dolomieu	1	2%	smallmouth bass
Etheostoma exile	1	2%	Iowa darter
Etheostoma flabellare	1	2%	fantail darter

the pools of smaller streams during juvenile stages. Common carp were typically lower in abundance at stations with a higher habitat quality rating. Goldfish were only collected at two sites on the mainstem, (6% occurrence rate). One sailfin catfish was collected in the tailrace of the Dempster Avenue Dam (DPR-03) and one tinfoil barb was collected just downstream of Dam No. 2 (DPR-19) in Cook County. The sailfin catfish is native to South American rivers and the tinfoil barb native to Southeast Asian rivers. These two individuals were obvious releases from household aquariums and would probably not survive a Midwestern winter due to their tropical climate requirements. A redear sunfish was collected at Wadsworth Road (DPR-06). This fish is native to the southern third of Illinois, but can now be found in Northern regions as a result of stocking.

Native, but rare species recorded from the basin include *Amia calva* (bowfin), *Rhinichthys meleagris* (blacknose shiner), *Noturus flavus* (stonecat), *Culaea inconstans* (brook stickleback), *Notropis heterodon* (blackchin shiner), *Notropis volucellus* (mimic shiner), *Esox americanus* (grass pickerel), *Morone mississippiensis* (yellow bass), *Micropterus dolomieu* (smallmouth bass), *Etheostoma exile* (Iowa darter) and *Etheostoma flabellare* (fantail darter). These species occurred at only one or two sites and may represent relicts of previous wider distribution within the upper Des Plaines River system.

Bluegill, largemouth bass, *Ameiurus* sp. (bullheads), and *Pomoxis nigromaculatus* (black crappie) were the most commonly occurring sport fish present in the survey; however, most individuals were smaller than normal harvestable size, thus angling opportunities for these species are somewhat limited. Although *Esox lucius* (northern pike) and *Ictalurus punctatus* (channel catfish) were less abundant, individuals of larger sizes were present at some locations. Other sport fish such as *Ambloplites rupestris* (rockbass), *Micropterus dolomieu* (smallmouth bass), *Morone mississippiensis* (yellow bass) and *Perca flavescens* (yellow perch) were either too rare in abundance or attain insufficient size to be considered a productive fishery.

Index of Biotic Integrity

Of 48 sites assessed in the upper Des Plaines River system, 4% were classified as Highly Valued Resources, 27% Moderate Resources, 40% Limited Resources, and 29% Imperiled Resources. There were no sites classified as a Unique Aquatic Resource, the highest quality rating. Table 6 shows the scores for individual IBI metrics including the basin means for each metric. The highly degraded nature of the basin was indicated by several of the individual IBI metrics, most notably "number of intolerant species", which had a basin average of 1.0 out of a possible 6. Low basin means for all trophic metrics indicate lack of normal ecosystem function regarding stream food sources. Low gradient habitat conditions may account in part for lower scores for sucker species, which typically prefer riffle and run habitat; however, only two sucker species were collected in the entire basin, which included a number of higher gradient stations. Low gradient conditions were also indicated by the low metric mean for course mineral substrate spawners whereas some higher gradient locations yielded higher scores for this metric (Table 6). Low gradient conditions may have favored pool species such and sunfish as indicated by the higher mean scores for this sunfish species metric.

Qualitative Habitat Evaluation Index

Based on the Qualitative Habitat Evaluation Index there were two sites, both on Bull Creek (BLC-03 and BLC-01), which were classified as a Unique Aquatic Resource. These sites had excellent habitat and stream morphology although bank erosion and down cutting may indicate potential hydraulic problems. Five sites in the upper Des Plaines basin (10%) were classified as a Highly Valued Resource, 22 sites (46%) were classified as a Moderate Aquatic Resource, 17 sites (35%) were classified as Limited Aquatic Resource and 2 sites (4%) were classified as an Imperiled Aquatic Resource. Table 7 shows individual metric and total QHEI scores for the upper Des Plaines River system. The average QHEI score of 44 classifies the upper Des Plaines River system as a "moderate aquatic resource".

Table 6 - Individual IBI metric scores and basin averages for the Des Plaines River system

Subwatershed	Site #	# of native fish sp.	# of native sucker sp.	# of native sunfish sp.	# of native intolerant sp.	# of native minnow sp.	# of native benthic invertivore sp.	Prop.(%) of indiv. as specialist benthic invertivores	Prop.(%) of indiv. as generalist feeders	Prop.(%) of indiv. as obligate course-mineral substrate spawners and intolerant	Prop.(%) of tolerant sp.	IBI Total Score
Kilbourn Road Ditch	KD-01	5	3	6	2	4	2	2	3	1	1	29
	KD-02	5	2	5	2	5	3	6	6	5	3	42
	KD-03	4	4	4	3	2	2	0	4	1	3	27
	KD-04	5	2	6	0	5	2	1	5	1	4	31
Center Creek	CC-01	4	2	5	0	4	3	0	2	2	2	24
Des Plaines River upper	DPR-10	3	2	6	2	2	1	x	x	x	1	24
	DPR-11	2	2	6	0	3	2	1	3	4	2	25
	DPR-12	2	0	4	0	0	1	1	6	2	6	22
	DPR-13	2	0	6	0	0	1	x	x	x	6	21
	UNS-01	1	2	5	0	2	0	x	x	x	1	16
	UNS-02	3	2	5	0	4	2	2	5	5	3	31
Des Plaines River	DPR-03	5	2	6	2	4	2	1	4	1	4	31
	DPR-04	3	1	3	1	5	1	2	3	1	4	24
	DPR-05	4	3	6	1	3	2	2	5	1	5	32
	DPR-06	3	2	6	1	3	1	2	6	1	5	30
	DPR-07	5	4	6	3	4	3	2	3	1	3	34
	DPR-08	6	2	6	2	6	4	1	3	1	3	34
	DPR-09	2	0	5	0	2	1	x	x	x	6	23
	DPR-14	4	2	6	3	5	0	0	6	2	6	34
	DPR-15	2	3	5	1	2	2	1	3	3	6	28
	DPR-16	2	1	5	1	2	1	1	6	1	5	25
	DPR-17	4	0	6	1	4	1	1	2	1	5	25
	DPR-18	6	3	2	2	1	0	0	6	6	6	32
	DPR-19	5	2	6	2	5	2	1	2	1	5	31
	DPR-20	3	2	4	1	3	1	1	6	1	3	25
	DPR-21	3	2	3	2	4	2	1	4	1	4	26
	DPR-22	1	2	1	1	2	2	6	6	6	5	27
Brighton Creek	BRC-01	2	0	6	0	1	0	0	4	0	2	15
	BRC-02	6	2	6	3	6	4	2	6	4	5	44
	BRC-04	5	4	6	3	4	2	2	4	5	2	37
Jerome Creek	JC-01	1	0	3	0	0	0	x	x	x	4	11
Newport	ND-01	5	0	6	2	4	3	6	6	1	6	39
Mill Creek	MLC-01	4	2	6	0	2	2	1	2	1	3	23
	MLC-02	4	0	6	2	1	2	0	2	0	6	23
	MLC-03	2	0	5	0	1	0	0	1	0	6	15
	MLC-04	2	0	6	0	0	0	0	2	0	4	14
	MLC-05	3	0	6	2	2	1	0	6	0	5	25
	MLC-06	0	0	0	0	0	0	0	0	0	0	0
Bull Creek	BLC-01	1	2	3	0	1	0	x	x	x	1	11
	BLC-02	3	2	6	2	3	3	6	6	2	4	37
	BLC-03	2	2	3	0	3	0	x	x	x	1	15
Indiana Creek	IC-01	1	2	4	0	2	1	3	1	0	1	15
	IC-02	1	0	6	0	0	0	0	0	0	3	10
	IC-03	4	2	5	1	4	2	1	6	5	3	33
	IC-04	3	2	6	0	1	1	0	1	1	4	19
Buffalo Creek	BFC-01	2	2	5	0	2	0	0	1	0	2	14
	BFC-02	2	2	4	0	2	0	0	0	0	0	10
McDondald Creek	MDC-01	2	2	6	0	2	0	0	2	0	0	14
DPR Basin Ave		3.1	1.6	5.0	1.0	2.6	1.4	1.4	3.6	1.7	3.5	24.5

x indicates not enough fish to calculate metric

Table 7 - Individual QHEI metric scores and basin averages for the Des Plaines River system

Subwatershed	Site #	SUBSTRATE	INSTRM COVER	CHAN MORPH	RIPARIAN ZONE	POOL RIFFLE	GSI	TOTAL SCORE
Kilbourn Road Ditch	KD-01	5	5	11	5	4	5	35
	KD-02	25	4	11	6	9	4	60
	KD-03	20	3	12	3	11	3	51
	KD-04	11	4	0	5	2	3	25
Center Creek	CC-01	17	5	4	4	10	5	45
Des Plaines River upper	DPR-10	9	2	14	10	3	3	41
	DPR-11	0	2	8	4	3	4	21
	DPR-12	14	2	11	10	6	7	50
	DPR-13	10	3	12	9	3	6	43
	UNS-01	8	5	1	3	7	6	30
	UNS-02	22	5	14	4	9	8	62
Des Plaines River	DPR-03	2	4	12	4	8	4	34
	DPR-04	3	4	12	5	8	4	36
	DPR-05	0	2	14	9	3	7	35
	DPR-06	0	2	14	10	3	7	36
	DPR-07	4	3	11	4	7	4	33
	DPR-08	13	9	17	7	14	6	67
	DPR-09	6	8	18	8	7	4	51
	DPR-14	0	3	14	8	3	7	35
	DPR-15	7	6	13	9	5	6	46
	DPR-16	0	3	2	7	5	5	22
	DPR-17	5	3	13	7	14	5	47
	DPR-18	0	4	2	6	3	5	20
	DPR-19	7	7	13	6	14	5	52
	DPR-20	3	1	10	4	6	3	27
	DPR-21	3	2	11	2	4	3	25
	DPR-22	0	2	2	8	3	5	20
Brighton Creek	BRC-01	13	7	2	6	1	4	33
	BRC-02	15	7	13	8	9	6	58
	BRC-04	21	6	11	6	11	4	59
Jerome Creek	JC-01	14	4	10	5	7	5	44
Newport	ND-01	16	8	18	5	10	7	63
Mill Creek	MLC-01	20	7	14	7	7	8	62
	MLC-02	9	4	15	8	3	4	43
	MLC-03	4	4	5	8	1	4	26
	MLC-04	4	5	2	5	3	6	25
	MLC-05	17	12	14	7	15	3	68
	MLC-06	9	2	1	7	7	2	28
Bull Creek	BLC-01	18	13	19	7	13	7	76
	BLC-02	9	6	14	8	6	6	48
	BLC-03	17	17	17	9	15	8	84
Indiana Creek	IC-01	11	8	11	5	6	6	47
	IC-02	18	5	13	2	6	4	47
	IC-03	10	5	1	2	4	3	25
	IC-04	7	3	15	10	5	7	47
Buffalo Creek	BFC-01	9	8	12	4	11	4	47
	BFC-02	11	15	11	5	6	6	54
McDondald Creek	MDC-01	18	5	13	2	6	4	47
DPR Basin Ave		10	5	11	6	7	5	43

Work in Progress

Relationship between Biotic Integrity (IBI) and habitat quality (QHEI)

Since habitat is an important factor influencing fish community structure and biotic integrity, IBI and QHEI should be positively correlated; however, no correlation between the IBI and QHEI scores at individual stations in the Upper Des Plaines system (Figure 1) was evident; however, using mean IBI and QHEI for each subwatershed did indicate a positive relationship between the indices (Figure 2).

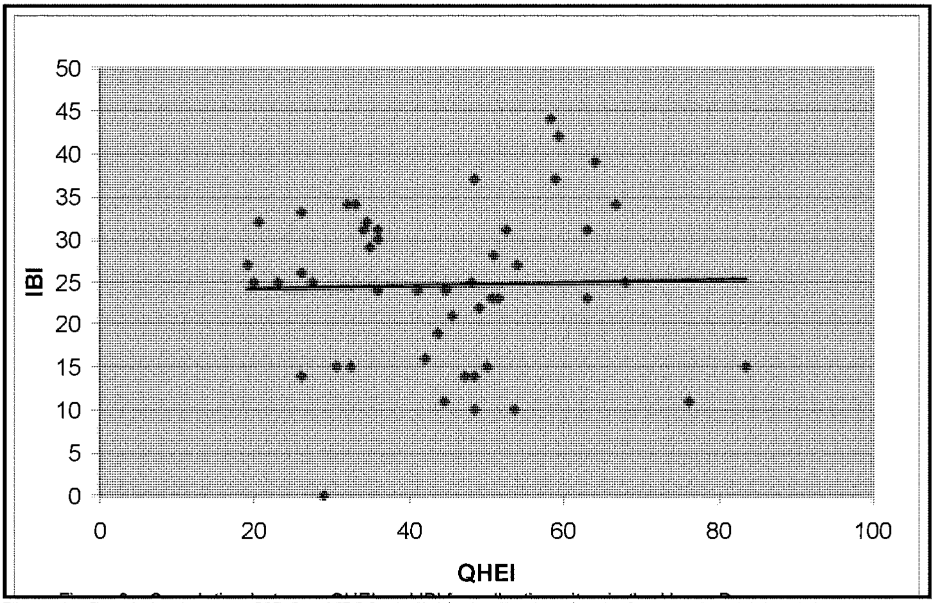

Figure 1 - Correlation between QHEI and IBI for individual collection sites in the upper Des Plaines River system.

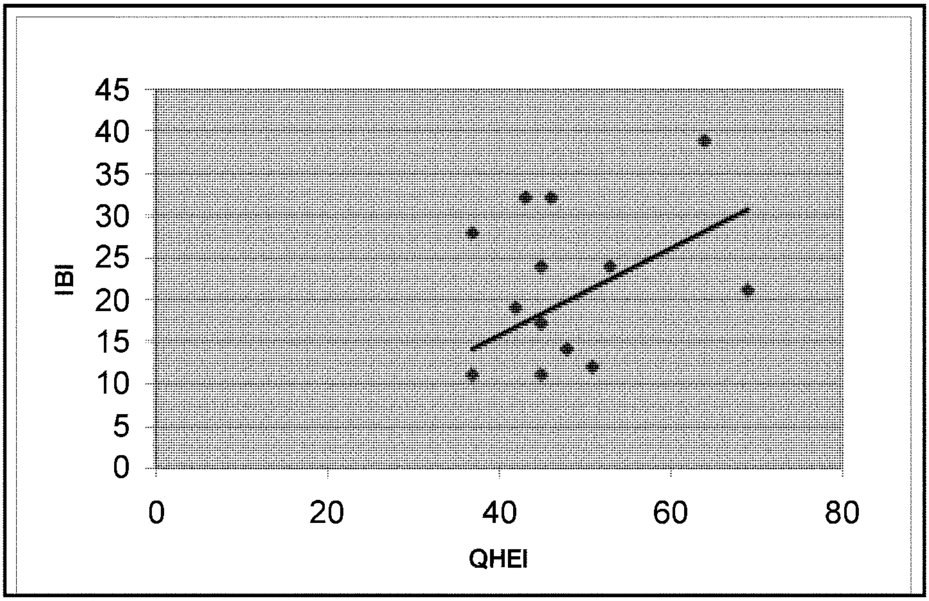

Figure 2 - Correlation between mean IBI and QHEI for each subwatershed in the upper Des Plaines River system.

Subwatershed Quality Ranking

In order to provide a framework to guide restoration in the upper Des Plaines River system, results from fish and habitat rating were combined (Table 8). The means for both IBI and QHEI were ranked to develop an overall quality ranking for each subwatershed. This analysis could be used for setting restoration priorities and also provide insights regarding appropriate restoration practices

Newport Ditch had the highest overall quality ranking with and overall score of 3.5. Kilbourn Road Ditch, Brighton Creek, Bull Creek, Center Creek and the upper portions of the Des Plaines River were also among the top ranking subwatersheds. The extent of degradation in the Upper Des Plaines River system is reflected in the relative low quality of even the highest-ranking streams. Habitat within the Newport Ditch subwatershed is only of moderate quality and may be a limiting factor. Higher IBI scores in this subwatershed indicate potential for a biological response to any restoration efforts. Kilbourn Road and Brighton subwatersheds may also be habitat limited, and the restoration of habitat may also result in improvement in biotic integrity. IBI scores in "moderate" range in these subwatersheds indicate at least some level of normally functioning fish assemblages, in contrast to the Silver, Prairie, Willow Creek and other basin subwatersheds, which are highly degraded, containing only the most tolerant species. Bull Creek, on the other hand has higher quality habitat available but low IBI scores indicating possible water quality problems or some other factors such as altered stream hydrology, which may limit food production.

Discussion

Fishes

In general, pre-settlement species richness of the upper Des Plaines River system, about 66 species, was naturally less rich than the lower system, about 80 species. This was likely due to the fact that much of the upper system ran dry in some years and that the lower system was characterized as a high gradient,

Table 8 - Prioritization of subwatershed riverine restoration based on riverine biological integrity and habitat qualtiy.

RANK	Subwatershed	# of native fish sp.	# of native sucker sp.	# of native sunfish sp.	# of native intolerant sp.	# of native minnow sp.	# of native benthic invertivore sp.	Prop.(%) of indiv. as specialist benthic invertivores	Prop.(%) of indiv. as generalist feeders	Prop.(%) of indiv. as obligate course-mineral substrate spawners and intolerant	Prop.(%) of tolerant sp.	**IBI Score**	SUBSTRATE	INSTRM COVER	CHAN MORPH	RIPARIAN ZONE	POOL RIFFLE	GSI	**QHEI Score**
3.5	Newport Drainage Ditch	5.0	0.0	6.0	2.0	4.0	3.0	6.0	6.0	1.0	6.0	**39**	16	8	18	5	10	7	**63**
3.0	Brighton Creek	4.3	2.0	6.0	2.0	3.7	2.0	1.3	4.7	3.0	3.0	**32**	16	7	9	7	7	5	**50**
3.0	Bull Creek	2.0	2.0	4.0	0.7	2.3	1.0	6.0	6.0	2.0	2.0	**21**	15	12	17	8	12	7	**69**
3.0	Kilbourn Road Ditch	4.8	2.8	5.3	1.8	4.0	2.3	2.3	4.5	2.0	2.8	**32**	15	4	9	5	7	4	**43**
2.5	Des Plaines River upper	2.2	1.3	5.3	0.3	1.8	1.2	1.3	4.7	3.7	3.2	**23**	11	3	10	7	5	6	**41**
2.5	Center Creek	4.0	2.0	5.0	0.0	4.0	3.0	0.0	2.0	2.0	2.0	**24**	17	5	4	4	10	5	**45**
2.0	Aptakisic Creek	2.0	2.0	4.5	0.0	2.0	0.0	0.0	0.5	0.0	1.0	**12**	10	12	12	4	8	5	**50**
2.0	Buffalo Creek	2.0	2.0	4.5	0.0	2.0	0.0	0.0	0.5	0.0	1.0	**12**	10	12	12	4	8	5	**50**
2.0	Des Plaines River	3.6	1.9	4.8	1.5	3.4	1.6	1.5	4.3	1.9	4.7	**29**	3	4	11	6	7	5	**36**
2.0	Farmers & Weller Creeks	2.0	2.0	6.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	**14**	18	5	13	2	6	4	**47**
2.0	Indian Creek	2.3	1.5	5.3	0.3	1.8	1.0	1.0	2.0	1.5	2.8	**19**	11	5	10	5	5	5	**41**
2.0	Jerome Creek	1.0	0.0	3.0	0.0	0.0	0.0	x	x	x	4.0	**11**	14	4	10	5	7	5	**44**
2.0	McDonald Creek	2.0	2.0	6.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	**14**	18	5	13	2	6	4	**47**
2.0	Mill Creek	2.5	0.3	4.8	0.7	1.0	0.8	0.2	2.2	0.2	4.0	**17**	10	6	8	7	6	5	**42**
2.0	Willow Creek	2.0	2.0	6.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	**14**	18	5	13	2	6	4	**47**
2.4	DP Basin Averages	2.8	1.6	5.1	0.6	2.4	1.1	1.4	3.1	1.2	2.4	21	13.4	6.4	11.2	4.8	7.2	4.9	48

large river that was much more productive due to the greater diversity of microhabitats before the major lock and dam structures were created (Forbes & Richardson 1920). These projections cannot sincerely be made from data that is anecdotal in nature (i.e. reports with no voucher specimens), but can be from historic observations that include preserved specimens. The pre-settlement upper system fish assemblage would likely be characterized as those species that inhabit low gradient streams with gravel, sand, muck and detritus as the primary substrates. Aquatic vegetation was very important to this system, which included vast side stream and basin marshes. Exact species richness and species composition before the 1980s is nearly impossible to reckon due to lack of documentation of collection sites with preserved specimens; however, a rough estimate of species richness based on historic and recent specimens would be about 66 native species. Table 9 shows the reconstructed upper Des Plaines River system pre-settlement fish assemblage using historic specimens from the Milwaukee Public Museum, Illinois Natural History Survey, Field Museum of Natural History, University of Michigan and Southern Illinois University collections.

Base on recent surveys (SEWRPC 2003, ILDNR 2004, USACE 2002 –2004) and independent collections (museum records), there are 15 species that once occurred in the upper Des Plaines River system that are now considered as extirpated (Table 9). Certain extirpated species would be regained through dam removal and habitat restoration, which include *Cyprinella lutrensis* (red shiner), *Ictiobus bubalus* (smallmouth buffalo), *Hypentelium nigricans* (northern hogsucker), *Lepomis megalotis* (longear sunfish), and *Percina caprodes* (logperch). These large river fishes would easily recolonize if the Hofmann Dam was removed because they occur within a 20-mile span downstream of this major fish barrier in similar water quality and habitat conditions. It would not be so easy, however, for species that occupy smaller streams and require excellent water quality to independently recolonize, such as *Hybopsis amnis* (pallid shiner), *Campostoma oligolepis* (largescale stoneroller), *Notropis heterolepis* (blackchin shiner), *Notropis rubellus* (rosyface shiner), *Notropis texanus* (weed shiner), *Phoxinus erythrogaster* (redbelly dace), *Erimyzon sucetta* (lake chubsucker), *Etheostoma caeruleum* (rainbow darter), and *Etheostoma microperca* (least darter). Vast improvements in water quality and riverine habitat restoration of subwatersheds are needed before reintroduction plans for these species could even be considered. One species that is more problematic to regain is *Anguilla rostrata* (American eel). This fish is catadromous, which means it must travel to the Gulf of Mexico to spawn, then young would return. There are far more barriers than the Hofmann Dam to remove to successfully restore eel populations within the upper Illinois River system.

Riverine surveys from 2002 through 2004 documented 43 native species and 5 non-native species. Two non-native species, sailfin catfish and tinfoil barb are considered as single incident individuals resultant from local aquaria release. These two species do not occur in reproducing populations within the upper Des Plaines River system and would have probably not survived the cold-water conditions of winter; therefore, concern for potential ecological impacts is not warranted. The redear sunfish has been intentionally introduced all over the US for recreational fishery supplement and control of nuisance snail populations. The specimen collected in the mainstem Des Plaines River most likely originated from this stocking effort. It is possible that the abundance of this fish may increase and displace native sunfishes; however, current abundance is quite low and with habitat restoration and the termination of stocking within the upper Des Plaines River systems, this species should not become a nuisance. Goldfish currently occupies sections of the Des Plaines Rive proper. This fish is locally abundant in medium to large streams and is frequently associated with sluggish water and vegetation. This species has not incurred major ecology impacts to the Des Plaines River system, nor are any minor impacts well documented. Although this species will probably always be present in reproducing populations within the upper Des Plaines River system, restoration efforts should not be impacted by their presence. The major species of concern when restoring aquatic habitat and species richness, however, is the common carp. The habits and abundance of this fish, in any riverine system, apply major pressure to aquatic vegetation, water quality, benthic invertebrate populations and native fishes themselves. Any riverine reaches that undertake restoration should sincerely consider the removal or abundance control of this species to achieve maximum ecological output.

Table 9 - Pre-settlemet fish assemblage of the upper Des Plaines River system and current status

Common name	Species	Status	Common name	Species	Status
bowfin	*Amia calva*	rare	channel catfish	*Ictalurus punctatus*	common
American eel	*Anguilla rostrata*	extirpated	black bullhead	*Ameiurus melas*	common
gizzard shad	*Dorosoma cepedianum*	common	yellow bullhead	*Ameiurus natalis*	common
golden shiner	*Notemigonus crysoleucas*	common	stonecat	*Noturus flavus*	rare
creek chub	*Semotilus atromaculatus*	common	tadpole madtom	*Noturus gyrinus*	common
hornyhead chub	*Nocomis biguttatus*	common	central mudminnow	*Umbra limi*	common
pallid shiner	*Hybopsis amnis*	extirpated	grass pickerel	*Esox americanus*	common
blacknose dace	*Rhinichthys meleagris*	rare	northern pike	*Esox lucius*	common
bluntnose minnow	*Pimephales notatus*	common	pirate perch	*Aphredoderus sayanus*	rare
fathead minnow	*Pimephales promelas*	common	brook silverside	*Labidesthes sicculus*	rare
red shiner	*Cyprinella lutrensis*	extirpated	blackstripe topminnow	*Fundulus notatus*	common
spotfin shiner	*Cyprinella spiloptera*	common	brook stickleback	*Culaea inconstans*	common
central stoneroller	*Campostoma anomalum*	common	yellow bass	*Morone mississippiensis*	rare
largescale stoneroller	*Campostoma oligolepis*	extirpated	smallmouth bass	*Micropterus dolomieu*	rare
stiped shiner	*Luxilus chrysocephalus*	common	largemouth bass	*Micropterus salmoides*	common
common shiner	*Luxilus cornutus*	common	white crappie	*Pomoxis annularis*	rare
redfin shiner	*Lythrurus umbratilis*	rare	black crappie	*Pomoxis nigromaculatus*	common
emerald shiner	*Notropis atherinoides*	common	rockbass	*Ambloplites rupestris*	common
bigmouth shiner	*Notropis dorsalis*	common	bluegill	*Lepomis macrochirus*	common
blackchin shiner	*Notropis heterodon*	rare	longear sunfish	*Lepomis megalotis*	extirpated
blacknose shiner	*Notropis heterolepis*	extirpated	green sunfish	*Lepomis cyanellus*	common
spottail shiner	*Notropis hudsonius*	rare	pumkinseed	*Lepomis gibbosus*	common
roseyface shiner	*Notropis rubellus*	extirpated	warmouth	*Lepomis gulosus*	rare
sand shiner	*Notropis stramineus*	common	orangespotted sunfish	*Lepomis humilis*	common
weed shiner	*Notropis texanus*	extirpated	yellow perch	*Perca flavescens*	common
mimic shiner	*Notropis volucellus*	rare	rainbow darter	*Etheostoma caeruleum*	extirpated
southern redbelly dace	*Phoxinus erythrogaster*	extirpated	Iowa darter	*Etheostoma exile*	rare
smallmouth buffalo	*Ictiobus bubalus*	extirpated	fantail darter	*Etheostoma flabellare*	rare
white sucker	*Catostomus commersonii*	common	least darter	*Etheostoma microperca*	extirpated
northern hogsucker	*Hypentelium nigricans*	extirpated	Johnny darter	*Etheostoma nigrum*	common
creek chubsucker	*Erimyzon oblongus*	rare	logperch	*Percina caprodes*	extirpated
lake chubsucker	*Erimyzon sucetta*	extirpated	blackside darter	*Percina maculata*	common
spotted sucker	*Minytrema melanops*	common	freshwater drum	*Aplodinotus grunniens*	rare

Riverine Quality

Riverine structure and function of the upper Des Plaines River watershed are severely impacted based on observations and data from this survey and past surveys (SERPC 2003) as well. Almost 100% of the river and stream miles have been modified or manipulated in some fashion. Low gradient streams are easily degraded through unnatural sediment deposition and water quality change. It is evident that the aforementioned problems, stemming from land uses of agriculture, residential and industry, have caused changes in riverine structure and function and decreased overall aquatic species richness. To further compound the effects of land use change, direct impacts to channel morphology, instream habitat complexity, side stream vegetation, and hydraulic regimes have completely compromised the pre-settlement riverine ecology of the upper Des Plaines River system. The construction of dams has prevented the recolonization of fishes and has disallowed genetic flow between fish populations.

Potential for Riverine Restoration

The subwatersheds that have significant species richness, biological integrity and habitat quality remaining were identified in the Results section (Table 8). The top five watersheds on the list (Newport Ditch, Kilbourn Road Ditch, Brighton Creek, Center Creek, and the upper portions of the Des Plaines River) are prime targets because they have the potential to fully restore functioning riverine processes, which in turn will allow for support of a significant percentage of pre-settlement faunal and floral assemblages; Bull Creek does not have sufficient space to restore riverine function, but does have the potential for increased species richness. Although the Des Plaines River mainstem does not fall out as a high priority, it does not mean the 13 dams along the mainstem should not be removed. Barriers to fish passage have existed in the upper Des Plaines River system since the early 1800s. The major barrier was constructed in 1950 at Riverside, which is called the Hofmann Dam, but at this same location, a series of dams have been ever present since 1826. The restoration of priority subwatersheds along with the imperative of "dam removal or bypass" on the mainstem should significantly increase biotic integrity and species richness throughout the upper Des Plaines River system. Restoration efforts should focus on restoring riverine connectivity, channel morphology, hydrology & hydraulics, and riparian zones based on geomorphology and soils of the given areas.

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Attachment 1 - QHEI scoring guide

SUBSTRATE	
POOL \ RIFFLE	
Bedrock	**2 (if present)**
Boulder	**3 (if present)**
Cobble	**3 (if present)**
Gravel	**3 (if present)**
Sand	**3 (if present)**
Hardpan	**3 (if present)**
Muck	**1 (if present)**
Detritus	**2 (if present)**
Silt	**0 (if present)**
Artificial	**0 (if present)**
SUB ORIGIN	
SILT	(H)heavy = **-2**], (M)moderate = **- 1**] (L)low = **0**], (F)free = **1**
EMBEDDEDNESS	(E)extensive = **- 1**], (M)moderate = **0** , (N)normal = **1**
# SUBS	4 or more = **2**; 3 or less = **0**
INSTRM COVER	[< 75% = **11**]; [75 - 50% = 7]; [50 - 25% = **3**]; > 25= **1**
UND BANKS	**1 (if present)**
OVR VEG	**1 (if present)**
ROOT MAT	**1 (if present)**
ROOT WAD	**1 (if present)**
DEEP POOL	**1 (if present)**
BOULDERS	**1 (if present)**
OXBOW BCKWTRS	**1 (if present)**
AQ MACROPHYT	**1 (if present)**
LOGS WOOD	**1 (if present)**
CHAN MORPH	
SINUOSITY	H(high) = **3**, (M)moderate = **2**, (L)low = **1**, (N)none = **0**
DEVELOPMENT	(E)excellent = **3**, (G)good = **2**, (F)fair = **1**, (P)poor = **0**
CHANNELIZATION	(N)none = **3**, (RD)recovered = **2**, (RG)recovering = **1**, (NR)no recovery = **0**
STABILITY	(H)high = **2**, (M)moderate = **1**, (L)low = **0**
IMPOUNDED	YES = **0**; NO = **9**
STRM WIDTH	No Score
RIPARIAN ZONE	
WIDTH L BANK	(W)wide = **2**, (M)moderate = **1.5**, (N)narrow = **1**, (VN)very narrow = **.5**, (0)none = **0**
WIDTH R BANK	(W)wide = **2**, (M)moderate = **1.5**, (N)narrow = **1**, (VN)very narrow = **.5**, (0)none = **0**
QUALITY L BANK	N(natural = **2**); O(oldfield = **1.5**); A(agric, pasture, rec = **1**) ; U(urban = **0**)
QUALITY R BANK	N(natural = **2**); O(oldfield = **1.5**); A(agric, pasture, rec = **1**) ; U(urban = **0**)
BANK EROSION	(N)none = **2**; (M)moderate = **1**; (H)heavy = **0**
POOL RIFFLE	
POOL DEPTH (4)	> 36" = **4**; 36" = 24" = **2**; 24" - 12" = **1**; >12" = **0**
RIFFLE DEPTH (3)	> 5" = **3**; 5" - 3" = **2**; > 3" = **1;** no riffle = **0**
RUN DEPTH (3)	> 20" = **3**; 20" - 10" = **2**; > 10" = **0**
MORPHOLOGY (2)	(**2**)pool width > riffle width; (**1**) pool width = riffle width; (**0**)pool width < riffle width
VELOCITY (3)	(eddies, fast, mod) = each get **1**, torrential, interstitial, intermittent = each **-1**
RIFFLE STAB (3)	Stable (cobble, boulder) = **3**; Mod (large gravel) = **2**; unstable (fine gravel, sand = **1**); no riffle = **0**
RIFF EMBEDD (2)	(N)none = **2**, (L)low = **1**, (E)extensive = **0**
GRADIENT (3)	(TH)too high = **2**; (H)high = **3**; (M)medium = **2**; (L)low = **1**
SHADE (3)	> 50% = **3**; 50 - 25% = **2**; >25% = **1**
INCISION (4)	H(high) = **0**; (L)low = **2**; (N)none = **4**

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[Article]

Effects of Tributary Spatial Position, Urbanization, and Multiple Low-Head Dams on Warmwater Fish Community Structure in a Midwestern Stream

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Abstract.—A survey of stream fish communities was conducted in the upper Des Plaines River watershed in Illinois and Wisconsin to determine the distribution of fish species and to evaluate the effects of tributary spatial position, urbanization, and multiple low-head dams on fish species diversity and species composition. Forty-eight sites upstream of Salt Creek in Illinois to the headwaters in Wisconsin were surveyed between 2002 and 2004. We found that fish species diversity decreased as agricultural land was replaced by urban land. In addition, tributary position within the drainage network caused significant differences in fish species diversity; specifically, we found significantly less fish species diversity in main-stem tributary streams located lower in the drainage network than in similarly sized streams located in the headwaters of the drainage area. Fish species composition, determined by multivariate principal components analysis, also showed significant differences among stream position within the drainage network. Increases in urbanization did not have a significant effect on fish species diversity within undammed tributary sites, but it did have a strong influence on fish species composition. Hence, as urbanization increased in these undammed tributaries, the fish species composition changed from coolwater–riverine specialist to warmwater–riverine generalist assemblages. In contrast, for tributary streams with low-head dams, the presence of dams had a greater effect on fish species composition than urbanization. In addition, the presence of multiple low-head dams on the main stem had a cumulative detrimental effect on fish species diversity, which decreased along an upstream-to-downstream gradient. Consequently, it is important to consider tributary spatial position within the drainage network, the amount of urbanization, and the number and locations of dams when characterizing the structure of warmwater fish communities, especially in relation to the development of restoration plans in highly urbanized or urbanizing watersheds.

Previous studies in the Midwest and Great Lakes region have demonstrated that both agricultural and urban land uses are major determinants of fish community integrity (Wang et al. 1997, 2000; Stewart et al. 2001; Fitzpatrick et al. 2001, 2004). These studies identified important relationships between biotic integrity and changing land use—in particular, the conversion of agricultural land to urban land and the effects of this conversion on the associated aquatic communities. However, the causes of decrease in biological integrity associated with urbanization seem to be complex both spatially and temporally and are still not well understood (Adolphson et al. 2002; Fitzpatrick et al. 2004).

Although the exact mechanisms by which urban land uses affect fish communities remain elusive, historical localized differences in land cover development, point and nonpoint source pollution, hydrologic and hydraulic modification, storm water and wastewater treatment practices, and the presence of fish barriers may be the key to understanding a stream fish community's response to urbanization (Wang et al. 2000; Fitzpatrick et al. 2004). For example, Osborne and Wiley (1992) found that the spatial position of tributaries within the

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drainage network significantly influences the structure of fish communities inhabiting warmwater streams and that frequency of disturbance and emigration–colonization dynamics are important mechanisms affecting the structure of stream fish communities in watersheds dominated by agricultural land use. Fitzpatrick et al. (2004) also determined that proximity to a source of recolonizing species and lack of physical barriers that impede migration are probably major determinants of the integrity of existing and potential fish communities in urban stream systems. Low-head dams in particular have been identified as being influential on the composition of aquatic communities (Watters 1996; Santucci et al. 2005; Guenther and Spacie 2006). Additionally, dams are often associated with urbanization, and these two factors may have synergistic negative effects on the aquatic community.

Dams, including low-head dams, act to fragment rivers and disrupt the natural patterns of connectivity, which results in the degradation of stream biota, both upstream and downstream of the impoundment (Ward and Stanford 1983; Porto et al. 1999; Gillette et al. 2005). Localized impacts of low-head dams have been determined to affect spatial and temporal patterns of fish assemblage structure, habitat, and water quality in river systems (Erman 1973; Tiemann et al. 2004; Gillette et al. 2005). Fish assemblages directly upstream of low-head dam impoundments are generally characterized by species from lentic, deeper, slow-flowing habitats. Conversely, assemblages immediately downstream from such impoundments are characterized by species typically associated with shallow, fast-flowing habitats (Tiemann et al. 2004; Gillette et al. 2005). Over larger scales, low-head dams can significantly influence the structure and abundance of upstream fish communities in tributary streams well beyond the actual impounded areas (Guenther and Spacie 2006), thus demonstrating how riverine species primarily adapted to fast-flowing waters can become completely extirpated from entire reaches upstream (Winston et al. 1991). Understanding the potential cumulative impacts of low-head dams and the need to address this fragmentation to restore or rehabilitate sustainable fisheries has come to the forefront in riverine ecology and management (Kanehl et al. 1997; Helfrich et al. 1999; Santucci et al. 2005).

Although many studies have examined the effects of changes in land use or the presence of dams on fish communities independently, to the best of our knowledge no studies have investigated both of these factors within the same study. Specifically, we hypothesize that tributary position and fragmentation caused by dams are as important as urban land development in determining fish community diversity and structure in urban or urbanizing watersheds. Therefore, our objectives were to investigate the effects of tributary spatial position, urbanization, and multiple low-head dams on the diversity and composition of the fish community present in the upper Des Plaines River watershed in Illinois and Wisconsin.

Study Area

The Des Plaines River originates in Racine and Kenosha counties in Wisconsin and flows southward through central Lake County and north-central Cook County to the northeastern portion of Du Page County in Illinois. The upper Des Plaines River watershed covers part of the Chicago metropolitan area, one of the largest urban areas of the United States. Because the areas surrounding this urban community contain productive farmland, this is an appropriate watershed to examine the effects of the gradient of agricultural to urban land use (Adolphson et al. 2002). The river flows about 156 km south before its confluence with the Kankakee River to form the Illinois River. The study area, which we call the upper Des Plaines River watershed, includes the main stem of the Des Plaines River and all tributaries upstream of the Hofmann Dam, which occupy portions of Kenosha and Racine counties in Wisconsin and Lake and Cook counties in Illinois. The upper Des Plaines River watershed is approximately 345 km^2 in Wisconsin and 900 km^2 in Illinois, giving a total watershed size of about 1,245 km^2 (see Figure 1).

Historically, the Des Plaines River system was a narrow, elongated depression within the late Wisconsinan Stage glacial drift (Pepoon 1927). The upper Des Plaines River, upstream of the Hofmann Dam northward, was very shallow and about 9 m wide with banks of terraced alluvium and covered with hydrophytic vegetation (Pepoon 1927). As European settlement increased, the natural terrestrial plant communities of this watershed were affected by physical removal and hydrological alterations for agricultural production. Many portions of the watershed were then subsequently converted to urban and industrial use as part of the greater Chicago metropolitan region. Dam construction, dredging, and channelization in Lake and Cook counties have significantly altered the physical, hydraulic, and hydrologic characteristics of this river system (ILDNR 1998). Dams have existed in the upper Des Plaines River system since the early 1800s. All dams were run-of-river, low-head structures, consisting of 10 main-stem dams and 7 tributary dams (Figure 2), ranging from about 0.3 m to 3.7 m in height.

As of 1990, land use in the Wisconsin portion of the watershed was about 12% urban, 68% agriculture, and 20% natural landscape (e.g., wetlands, woodlands, and

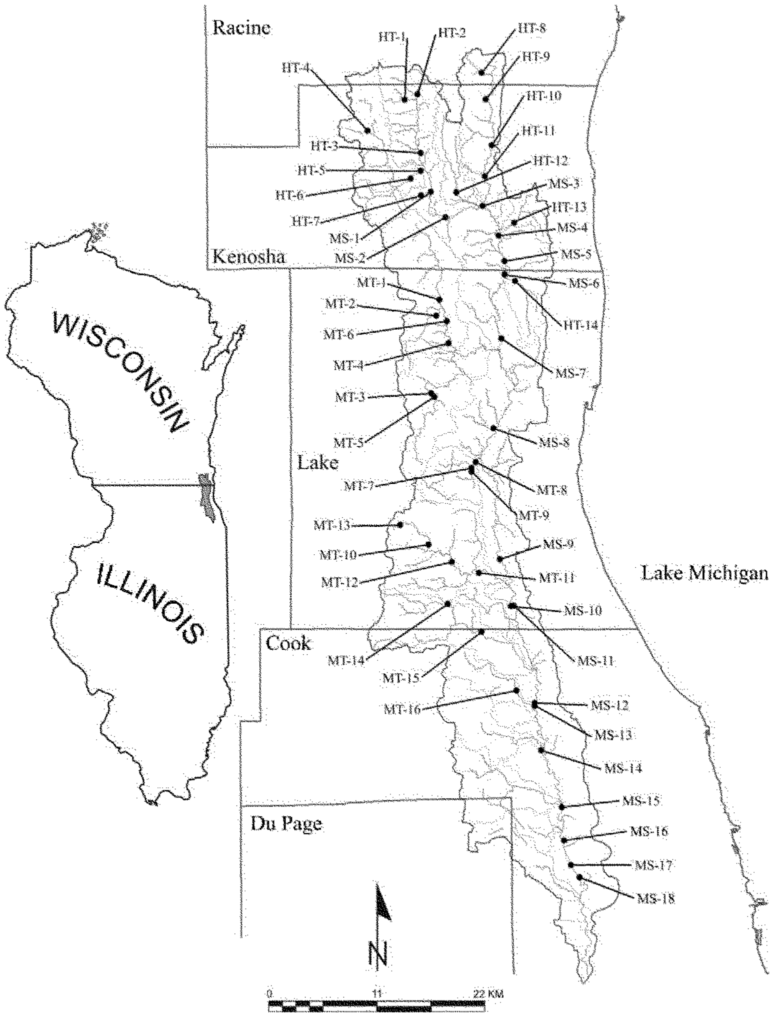

FIGURE 1.—Locations of the study area and the 48 sample sites in the upper Des Plaines River watershed.

other open lands; SEWRPC 2003). Land use in the Illinois portion of the watershed was about 57% urban, 20% agriculture, and 23% natural landscape (ILDNR 1998). The watershed land uses grade from largely agricultural in the headwaters to almost fully urban at the Hofmann Dam. The major tributaries, for the most part, also exhibit a similar gradation in land use. These landscape-scale changes and the concomitant hydrologic and hydraulic alterations have led to degraded habitat; poor water quality; reduced biological integrity, species richness, and ecosystem productivity; and extensive flood damage to manmade structures (ILDNR 1998).

The Des Plaines River is a generally shallow, warmwater, low-gradient stream system. Mean annual flow at the outlet of our study area has ranged from about 10 to 21 m^3/s according to records from 1944 through 2004. From 1944 to 2004, mean daily minimum flow was about 1.0 m^3/s and mean daily maximum flow was 97 m^3/s. Mean daily minimum and maximum flows of 9.2 and 26.1 m^3/s, respectively, were recorded during the sampling period from 2002 to 2004, which indicates that flows were within the normal ranges observed during the 60-year period of record for this system.

Methods

We sampled all of the tributary streams within this portion of the watershed that contained adequate perennial discharge to support a fishery. Exact sampling locations within a particular tributary or in the main stem depended on our ability to obtain permission and to safely access and survey the body of water. The 48 sampling sites we selected in streams throughout the upper Des Plaines River watershed were separated into three treatment groups according to their relative position within the drainage network, based on the methods of Osborne and Wiley (1992). These treatment groups were called headwater tributary (HT), main-stem tributary (MT), and main stem (MS). Fourteen HT sites were located in the upper portion of the drainage basin network, 16 MT sites were located in the middle to lower portion of the drainage, and 18 MS sites were located on the main stem of the upper Des Plaines River.

The spatial analysis for this study utilized the ESRI ArcGIS 9.1 and ArcView 3.2 software, run on a Windows XP platform. The streams coverage in this study was based on U.S. Geological Survey (USGS) stream shape files digitized from USGS 24 min quad maps; to attain a higher accuracy, however, certain streams were redigitized on the basis of 2002 aerial photographs. All riverine survey sites were digitized and georeferenced in ArcView 3.2 based on locality data recorded in the field. Subwatersheds were initially based on USGS gauges, and then were subdivided by the area above each riverine survey site in which land uses and areas were calculated. Generalized land use coverage of the entire upper Des Plaines River watershed was created by the U.S. Army Corps of Engineers Chicago District, which was hand-digitized from 2004 color aerial photography. This land use coverage was then clipped to the subwatersheds created from the riverine survey sites.

Fish surveys in wadable stream segments were conducted during daylight hours with a pulsed-DC backpack electrofishing unit powered by a single generator. The power supplied to the water was sufficient to stun and capture fish. In the wadable portions, we standardized the fish collection effort by sampling a reach that was 15 times the mean stream width, using a single pass moving upstream in a zigzag pattern to ensure full coverage of all available habitats, including woody debris, undercut banks, riffles, runs,

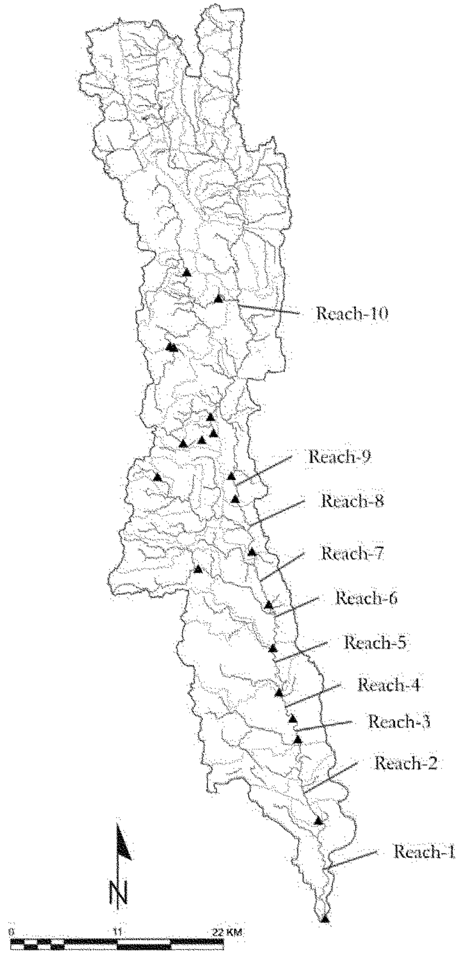

FIGURE 2.—Locations of the dams and associated stream reaches in the upper Des Plaines River watershed.

and deeper pools (Lyons 1996; Waite and Carpenter 2000; Smogor 2002). All stunned fish were collected with a 6.25-mm-mesh dip net and processed on-site immediately after that survey was completed. Small fish ($\leq$150 mm total length) were immediately preserved in a 10% formalin solution for enumeration and identification in the laboratory. Fish over 150 mm were identified in the field and released, except for voucher specimens. Minimally, one individual of each species collected at each station was documented by either photography or preservation. All preserved specimens reside in either the Field Museum of Natural

History in Chicago, Illinois, or Southern Illinois University fish collections in Carbondale. All fish collected at a site were used to calculate abundance in terms of the number of fish per hour per species. The numbers of fish of each species at each site were used to calculate Shannon diversity index values (Krebs 1989) and in subsequent principal components analysis (PCA) to characterize the composition of fish species.

Fish in the nonwadable portions of Des Plaines River main-stem stream sites were sampled according to Illinois Department of Natural Resources collection protocols using a boat-mounted, three-phase, AC electrofishing unit. The power supplied to the water was sufficient to stun and capture fish. All stunned fish were collected with a 6.25-mm-mesh dip net and placed in a 200-L holding tank that was supplied with pure oxygen. Boat electrofishing runs were conducted during daylight hours, beginning at the upstream edge of each station and generally proceeding downstream for 30 min along each bank of the river (total time = 1 h/station). Efforts were made to thoroughly sample all available habitats, including woody debris, undercut banks, riffles, runs, and deeper pools; these efforts often required circling and reversing in an upstream direction. We worked to proportionally sample both lentic and lotic reaches where possible; however, lentic conditions largely dominated the main-stem sites because of the presence of the dams. Fish were processed as summarized above after each 30-min run and released downstream, outside of the sampling area.

Surveys were conducted in the summer months between 2002 and 2004 during base flow conditions. Regardless of the size or depth of the sampling site, width was measured to the nearest 0.3 m. Additionally, to linearize relationships, we $\log_e(x + 1)$ transformed fish abundance data before analysis (Gauch 1982).

Sites MS-9 through MS-18 (Figure 1) were not wadable and thus necessitated the use of a boat-mounted electrofishing unit. These sites were located in the furthest downstream areas on the main stem of the Des Plaines River. Although there are known gear efficiency differences between backpack and boat-mounted electrofishing units, we found that the backpack electrofishing sites MS-1 through MS-8 versus the boat electrofishing sites shared 27 of the same fish species or 75% of the total of 36 species collected by both gear types. Five fish species—redfin pickerel *Esox americanus*, blackchin shiner *Notropis heterodon*, central stoneroller *Campostoma anomalum*, black bullhead *Ameiurus melas*, and central mudminnow *Umbra limi*—were collected with the backpack electrofisher only. Four other species—the mimic shiner *Notropis volucellus*, stonecat *Noturus flavus*, bigmouth shiner *Notropis dorsalis*, and yellow perch *Perca flavescens*—were collected with the boat electrofisher only. However, four of these nine species (two from each collection gear type) were so rare that they were not included within the fish species composition analysis below. The redfin pickerel, blackchin shiner, and mimic shiner were each found at one site and the stonecat was found at two sites within the entire watershed. Overall, our findings indicated that the potential bias between these gear types was minimal in this study, and we felt confident in combining these sites into a single main-stem treatment group for subsequent analyses.

All statistical analyses were performed in SYSTAT (SYSTAT 2002), and a P-value of 0.05 was used to determine significance. Differences in watershed size and stream width were tested separately by using an analysis of variance (ANOVA) with stream type (i.e., HT, MT, or MS) as the main effect. Differences in fish species diversity at sampling stations were tested with backwards-stepping general linear models (GLMs). In these analyses, the stream type, the log-transformed number of individuals of each species caught (to account for the potential confounding effect of sample size on species diversity), and the interaction between these two main effects were initially entered into the model (i.e., fish species diversity = constant + stream type + log[total abundance] + [stream type × log{total abundance}]). The backwards-stepping procedure then removed nonsignificant terms from the analysis and performed another analysis using the remaining independent variables. After stepping, if the interaction term was found to be significant, a completely estimated ANOVA was run, using all three terms included in the model (Sokal and Rohlf 1995). Because none of the interaction terms were significant (see Results below), we considered the ANOVA provided by the backwards-stepping GLM to be the final and best model (Sokal and Rohlf 1995). Differences in species diversity attributable to stream position (i.e., station treatment) were determined by direct post hoc testing.

Principal components analysis was used to identify patterns in fish species composition. We used PCA because it is an objective multivariate technique that does not require subjective weights or endpoints (Gauch 1982) and works well with continuous data (James and McCulloch 1990). Principal components analysis is sensitive to, and may be biased by, nonlinear trends in species' abundances along environmental gradients; however, the watershed analyzed in this study was well within the native range of each species (Forbes and Richardson 1920; Becker 1983), rendering correction for geographic effects unnecessary (Hinch et al. 1994).

Principal components analysis was conducted using the standardized abundance for each species at each sample site. Because rare species have disruptive effects on multivariate analyses, only species occurring in greater than 5% of the sample sites were included in the analysis (Gauch 1982). We used only the first two principal components in this study to characterize fish species composition because they represented ecologically meaningful combinations or associations of fish species abundances (Gauch 1982). To determine whether or not the fish communities found in each stream type differed from one another, we tested for the effects of stream type on both of the principal components (PC-1 and PC-2) separately, using an ANOVA. The first principal component (PC-1) is indicative of fish species diversity, and the second (PC-2) distinguishes coolwater–specialist riverine fish species from warmwater–generalist species.

We assessed the effects of urban land use and stream type on fish species diversity and composition. However, because of the potential confounding effects of watershed and stream size differences and dams, we did not use the MS sites in this analysis. Similarly, only the HT and MT sites without dams were included. Fish species diversity and fish-based principal component scores as described in the model above were used in their own analysis of covariance (ANCOVA) with stream type (i.e., HT versus MT) as the main effect and the arcsine-transformed percent of urban land use as the covariate (i.e., dependent variable = constant + stream type + arcsine{urban land} + [stream type × arcsine{urban land}]). A backwards-stepping GLM yielded the final and best model.

We assessed the effects of dams and urban land use on fish species composition in the MT sites only. To accomplish this, we designated the sites on tributary reaches that were separated from the main stem of the Des Plaines River by a dam as "fragmented" and the sites on tributaries that were not separated by dams as "connected"(only MT sites contained reaches that were fragmented from the main stem, which is why HT sites were not used in this analysis). Fish-species-based principal component scores as described in the model above were used in their own ANCOVAs with connection type (i.e., fragmented versus connected) as the main effect and the arcsine-transformed percent of urban land use (SEWRPC 2003; ILDNR 1998) as the covariate (i.e., dependent variable = constant + stream type + arcsine{urban land} + [stream type × arcsine{urban land}]). As in the previous ANCOVA, backwards-stepping GLM yielded the final and best model output (Sokal and Rohlf 1995).

Finally, to assess whether or not the effects of dams on the MS sites were cumulative, we analyzed the changes in fish species diversity and fish-species-based principal component scores among reaches separated by dams by linear regression (Santucci et al. 2005). The areas between the dams on the MS sites were assigned the reach numbers shown in Figure 2 before analysis. The main-stem reaches of the Des Plaines River are numbered in increasing order from downstream to upstream (representing a linear gradient).

Results

Fish Species Inventory and Community Composition

A total of 48 species were collected in the upper Des Plaines River: 43 native and 5 nonnative species. The list of species and percent occurrence among each of the treatment groups for all sampling sites combined are compiled in Table 1. The most frequently occurring species (found in more than 60% of the total sample sites within the upper Des Plaines River system) included the green sunfish, bluegill, bluntnose minnow, white sucker, largemouth bass, and blackstripe topminnow.

Comparison among treatment groups indicated that green sunfish, bluegill, bluntnose minnow, and white sucker were the only species found in high proportions in each stream type. These were the only species found with occurrences greater than 60% within the MT streams. In addition to these four species, the HT sites also were dominated by creek chub, johnny darter, central mudminnow, bluntnose minnow, blackstripe topminnow, and pirate perch. Like the HT sites, the MS sites also contained high proportions of blackstripe topminnow and johnny darter species. In contrast to the HT sites, the MS sites also were dominated by largemouth bass, spotfin shiner, black crappie, spotted sucker, and common carp.

Native, but relatively rare, species recorded from the basin include the bowfin, western blacknose dace *Rhinichthys obtusus*, stonecat, brook stickleback, blackchin shiner, mimic shiner, redfin pickerel, yellow bass, smallmouth bass, Iowa darter, and fantail darter.

Our analyses of fish community diversity revealed that the sampling locations in MS sites had the greatest number of fish species (mean = 14) and the highest Shannon diversity scores (mean = 2.02; Table 2). The HT sites also had relatively high numbers of species and fish species diversity scores (means = 13 and 1.92, respectively; Table 2). The MT sites featured both the fewest number of species (mean = 9) and lowest fish species diversity scores (mean = 1.38; Table 2).

The PCA performed on fish diversity and community composition used the abundance data for 33 of the 48 fish species found at our sampling stations, as only

TABLE 1.—Species caught, number of sites at which they were found, and percent occurrence by stream type in the upper Des Plaines River watershed.

Species	Number of sites	Percent occurrence: Headwater tributaries	Main-stem tributaries	Main stem
Rock bass *Ambloplites rupestris*	6	0.0	0.0	33.3
Black bullhead *Ameiurus melas*	18	35.7	50.0	27.8
Yellow bullhead *Ameiurus natalis*	17	14.3	56.3	33.3
Bowfin *Amia calva*	2	0.0	12.5	0.0
Pirate perch *Aphredoderus sayanus*	9	64.3	0.0	0.0
Central stoneroller *Campostoma anomalum*	11	57.1	12.5	11.1
Goldfish *Carassius auratus*	3	0.0	0.0	16.7
White sucker *Catostomus commersonii*	33	78.6	62.5	66.7
Brook stickleback *Culaea inconstans*	2	14.3	0.0	0.0
Spotfin shiner *Cyprinella spiloptera*	18	35.7	6.3	77.8
Common carp *Cyprinus carpio*	20	21.4	31.3	61.1
Gizzard shad *Dorosoma cepedianum*	6	7.1	0.0	27.8
Red fin pickerel *Esox americanus*	1	0.0	0.0	5.6
Northern pike *Esox lucius*	7	14.3	6.3	22.2
Iowa darter *Etheostoma exile*	1	7.1	0.0	0.0
Fantail darter *Etheostoma flabellare*	1	0.0	6.3	0.0
Johnny darter *Etheostoma nigrum*	25	78.6	25.0	66.7
Blackstripe topminnow *Fundulus notatus*	30	71.4	31.3	94.4
Channel catfish *Ictalurus punctatus*	6	0.0	18.8	22.2
Green sunfish *Lepomis cyanellus*	42	100.0	87.5	83.3
Pumpkinseed *Lepomis gibbosus*	20	50.0	37.5	50.0
Orangespotted sunfish *Lepomis humilis*	13	7.1	18.8	50.0
Bluegill *Lepomis macrochirus*	40	57.1	93.8	88.9
Redear sunfish *Lepomis microlophus*	2	0.0	0.0	11.1
Common shiner *Luxilus cornutus*	5	35.7	12.5	0.0
Redfin shiner *Lythrurus umbratilis*	1	7.1	0.0	0.0
Smallmouth bass *Micropterus dolomieu*	1	0.0	6.3	0.0
Largemouth bass *Micropterus salmoides*	31	57.1	50.0	77.8
Spotted sucker *Minytrema melanops*	16	21.4	0.0	72.2
Yellow bass *Morone mississippiensis*	1	0.0	6.3	0.0
Hornyhead chub *Nocomis biguttatus*	15	42.9	18.8	38.9
Golden shiner *Notemigonus crysoleucas*	12	21.4	25.0	22.2
Bigmouth shiner *Notropis dorsalis*	6	28.6	6.3	5.6
Blackchin shiner *Notropis heterodon*	1	0.0	0.0	5.6
Sand shiner *Notropis stramineus*	12	7.1	12.5	55.6
Mimic shiner *Notropis volucellus*	1	0.0	0.0	5.6
Stonecat *Noturus flavus*	2	0.0	0.0	11.1
Tadpole madtom *Noturus gyrinus*	5	7.1	12.5	11.1
Yellow perch *Perca flavescens*	4	0.0	18.8	5.6
Blackside darter *Percina maculata*	17	42.9	12.5	50.0
Bluntnose minnow *Pimephales notatus*	33	71.4	62.5	77.8
Fathead minnow *Pimephales promelas*	15	50.0	18.8	33.3
Black crappie *Pomoxis nigromaculatus*	18	0.0	31.3	72.2
Western blacknose dace *Rhinichthys obtusus*	2	14.3	0.0	0.0
Creek chub *Semotilus atromaculatus*	24	85.7	50.0	27.8
Central mudminnow *Umbra limi*	18	78.6	31.3	11.1

these 33 were abundant enough (i.e., occurring at more than 5% of the sample sites) for use in the PCA. In the resulting analysis, the first two principal components of species abundance data accounted for 32% of the total variance explained (Table 3). Because principal components beyond the first two explained a much lower amount of the total variance and were not readily interpretable, we pursued no further analysis involving these components.

The first principal component (PC-1) accounted for 17% of the variation and was positively associated with fishes typically found at sampling sites with the highest diversity of species; indeed, PC-1 has a significant positive relationship with fish species diversity scores (Pearson's product-moment correlation; $r = 0.59$, Bonferroni adjusted $P = 0.0001$). The second axis (PC-2) accounted for 16% of the variation in fish abundance and distinguished sites featuring strictly warmwater fishes (e.g., black crappie, largemouth bass, bluegill, rockbass, spotfin shiner) from sites with eurythermal fishes, which can occur in both coldwater and warmwater stream communities (e.g., creek chub, central stoneroller, central mudminnow, common shiner; Table 3). For example, 7 of the 10 fish species

TABLE 2.—Number of species, total number of fish caught, and fish species diversity (Shannon) index scores at sample sites in the upper Des Plaines River watershed.

Stream type	Site and mean	Number of species	Total number of fish	Shannon Index
Headwater tributary	HT-1	9	125	1.40
	HT-2	20	195	2.22
	HT-3	8	274	1.81
	HT-4	6	97	1.51
	HT-5	17	222	2.23
	HT-6	22	219	2.55
	HT-7	5	15	1.34
	HT-8	15	103	2.09
	HT-9	15	98	2.36
	HT-10	16	118	2.36
	HT-11	14	227	1.85
	HT-12	13	328	1.87
	HT-13	4	11	1.29
	HT-14	16	206	1.98
	Mean	13	160	1.92
Main-stem tributary	MT-1	9	64	1.56
	MT-2	2	2	0.69
	MT-3	8	272	0.33
	MT-4	14	180	1.80
	MT-5	15	454	0.83
	MT-6	13	228	1.46
	MT-7	4	28	0.90
	MT-8	14	44	2.37
	MT-9	6	41	1.50
	MT-10	7	97	1.25
	MT-11	5	55	1.06
	MT-12	18	221	2.03
	MT-13	10	65	1.52
	MT-14	9	229	1.89
	MT-15	8	55	1.63
	MT-16	7	108	1.22
	Mean	9	134	1.38
Main stem	MS-1	20	136	2.56
	MS-2	12	18	2.35
	MS-3	9	16	2.05
	MS-4	11	19	2.23
	MS-5	9	16	2.05
	MS-6	20	517	1.90
	MS-7	14	58	2.33
	MS-8	17	166	2.10
	MS-9	12	62	2.03
	MS-10	13	125	2.02
	MS-11	19	194	1.96
	MS-12	6	25	1.26
	MS-13	23	374	1.94
	MS-14	23	275	2.21
	MS-15	16	66	2.01
	MS-16	15	82	1.77
	MS-17	13	173	1.74
	MS-18	8	16	1.96
	Mean	14	130	2.02

TABLE 3.—Factor loadings of principal components (PC-1 and PC-2) derived from fish species abundance data in the upper Des Plaines River watershed.

Species	PC-1	Species	PC-2
Spotfin shiner	0.72	Black crappie	0.69
Bluntnose minnow	0.71	Largemouth bass	0.54
Blackstripe topminnow	0.70	Bluegill	0.52
Sand shiner	0.63	Rock bass	0.45
Blackside darter	0.61	Spotfin shiner	0.44
Hornyhead chub	0.61	Orangespotted sunfish	0.43
Channel catfish	0.58	Yellow perch	0.43
Johnny darter	0.55	Sand shiner	0.43
Northern pike	0.54	Channel catfish	0.42
Rock bass	0.54	Yellow bullhead	0.41
White sucker	0.51	Common carp	0.32
Green sunfish	0.48	Spotted sucker	0.27
Spotted sucker	0.44	Northern pike	0.21
Fathead minnow	0.39	Golden shiner	0.19
Common carp	0.38	Goldfish	0.17
Tadpole madtom	0.36	Pumpkinseed	0.07
Common shiner	0.34	Gizzard shad	0.07
Orangespotted sunfish	0.33	Tadpole madtom	0.06
Central stoneroller	0.29	Black bullhead	0.03
Central mudminnow	0.26	Bluntnose minnow	0.02
Pirate perch	0.25	Blackstripe topminnow	−0.09
Goldfish	0.19	Green sunfish	−0.21
Black crappie	0.18	Hornyhead chub	−0.29
Pumpkinseed	0.13	Blackside darter	−0.32
Largemouth bass	0.11	Fathead minnow	−0.34
Bigmouth shiner	0.06	Johnny darter	−0.35
Black bullhead	0.04	Bigmouth shiner	−0.43
Creek chub	0.02	White sucker	−0.45
Bluegill	−0.02	Pirate perch	−0.48
Yellow bullhead	−0.02	Common shiner	−0.50
Yellow perch	−0.04	Central mudminnow	−0.55
Gizzard shad	−0.10	Central stoneroller	−0.65
Golden shiner	−0.12	Creek chub	−0.72

with the lowest negative component loadings shown in Table 3 are considered "secondary coolwater" species or eurythermal species likely to be encountered in Wisconsin coldwater streams (Lyons 1996). This axis also distinguishes riverine specialist species (i.e., generally found in lotic environments) from generalist species (i.e., commonly found in both lentic and lotic environments); 7 out of the 11 fish species with the lowest negative component loadings were riverine specialists: creek chub, central stoneroller, common shiner, bigmouth shiner, Johnny darter, blackside darter, and hornyhead chub (Smith 1979; Becker 1983; Guenther and Spacie 2006). Six other riverine specialist species were found within the study area (fantail darter, brook stickleback, blacknose dace, redfin shiner, smallmouth bass, and stonecat) but not in high enough abundance to be included in the PCA.

Fish species composition within the upper Des Plaines River watershed is influenced by position within the drainage network. In Figure 3, the polygons that group sampling sites by their respective position types within the drainage network point out similarities and differences in fish species composition for MS and HT sites, as well as a unique, "overlapping" composition of fish species in MT sites. Because both MS and HT sites have more diverse fish communities, they are both positive with respect to PC-1, but because the MS and HT sites host typical warmwater–generalist and coolwater–specialist fish communities, respectively, they are distinctly separated along PC-2. In contrast to both the MS and HT sites, the MT sites have low fish species diversity and so are negative with respect to PC-1; because the MT sites lack a distinct species composition, they span both the positive and negative portions of the PC-2 axis.

These patterns in fish species composition were further substantiated by the results of an ANOVA, which demonstrated that stream position significantly influenced the fish species composition expressed as both PC-1 ($P = 0.012$; multiple $R^2 = 0.18$; $F = 4.920$; df = 2, 45) and PC-2 ($P = 0.0001$; multiple $R^2 = 0.59$; $F = 32.686$; df = 2, 45). In the post hoc tests of PC-1 fish species composition, the compositions contained in the MS sites were significantly different from those in the MT sites (Tukey's multiple comparison test; $P = 0.013$). No significant differences in fish species composition were found between the MS and HT sites (Tukey's multiple comparison test; $P = 0.878$) or between the MT and HT sites (Tukey's multiple comparison test; $P = 0.062$). For PC-2 fish species composition, fish species compositions found the HT sites were significantly different from those in both the MS (Tukey's multiple comparison test; $P = 0.0001$) and MT sites (Tukey's multiple comparison test; $P = 0.0001$). No significant differences in fish species composition were found between MS sites and MT sites (Tukey's multiple comparison test; $P = 0.104$), which further supports the idea that these communities have many of the same species in common.

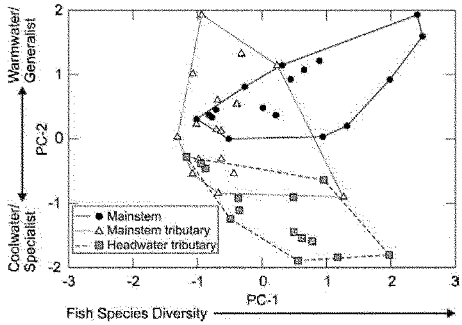

FIGURE 3.—Bivariate plots of principal components (PC) 1 and 2 generated from fish abundance data. The sites are grouped by stream type.

Influence of Stream Position and Urbanization

An ANCOVA of fish species diversity scores with respect to stream type (HT, MT, and MS) using log-transformed total numbers of individuals as a covariate was conducted for all 48 sites and showed that the position of the sampling site within the drainage area had a significant influence on fish species diversity ($P = 0.0001$; multiple $R^2 = 0.34$; $F = 11.445$; df = 2, 45). No significant influence was found with respect to the number of individuals captured at a given site. Among treatment categories, fish species diversity was significantly greater at both the MS and HT sites (Tukey's multiple comparison test; $P = 0.0001$ and 0.002, respectively) than at the MT sites. Fish species diversity was not significantly different between the MS and the HT sites (Tukey's multiple comparison test; $P = 0.754$). Furthermore, this diversity does not seem to be attributable to a difference in size between the two types of tributary sites. Separate ANOVAs of the log-transformed watershed acres and stream width indicated that watershed size ($P = 0.0001$; multiple $R^2 = 0.760$; $F = 71.068$; df = 2, 45) and stream width ($P = 0.0001$; multiple $R^2 = 0.760$; $F = 71.111$; df = 2, 45) are significantly greater in the MS than in the HT and MT sites. However, post hoc analyses found no significant differences in watershed size (Tukey's multiple comparison test; $P = 0.640$) or width (Tukey's multiple comparison test; $P = 0.070$) between the HT versus MT sites. Mean watershed size for HT sites was 28.4 km^2 (SD = 24.8 km^2) and 36.3 km^2 (SD = 27.8 km^2) for MT sites. Mean stream width for HT sites was 2.9 m (SD = 0.8 m) and 4.5 m (SD = 1.7 m) for MT sites. Mean watershed size for MS sites was 789.9 km^2 (SD = 524.7 km^2) and mean stream width was 21.2 m (SD = 10.4 m).

An ANCOVA of Shannon diversity scores with respect to tributary stream type (HT versus MT) using the arcsine-transformed percentage of urban land present in the watershed as a covariate was conducted for the 22 sites not fragmented by dams; these 22 sites were restricted to those HT and MT sites having greater than approximately 20% urban land cover. While there was a significant negative correlation between the percent urban land use and fish species diversity scores in the watershed as a whole, as noted above fish species diversity did not differ between the HT and MT sites; also, urbanization was not found to be a significant influence in this subset of the sample sites ($P = 0.053$; multiple $R^2 = 0.17$; $F = 4.222$; df = 1, 20).

In addition to performing analyses of diversity, we investigated the effect of percent urban land use on fish species composition. While there was a significant relationship to composition measured as PC-2 ($P = 0.0001$; multiple $R^2 = 0.59$; $F = 29.127$; df = 1, 20), the percentage of urban land present in the watershed had no effect on PC-1 ($P = 0.085$; multiple $R^2 = 0.14$; $F = 3.283$; df = 1, 20; Figure 4). The HT and MT sites did not affect fish species composition in PC-1 or PC-2, and no significant interaction was found between these unfragmented tributary sites and percent urbanization. Thus, although urban land use does not have a significant effect on fish species diversity (e.g., PC-1

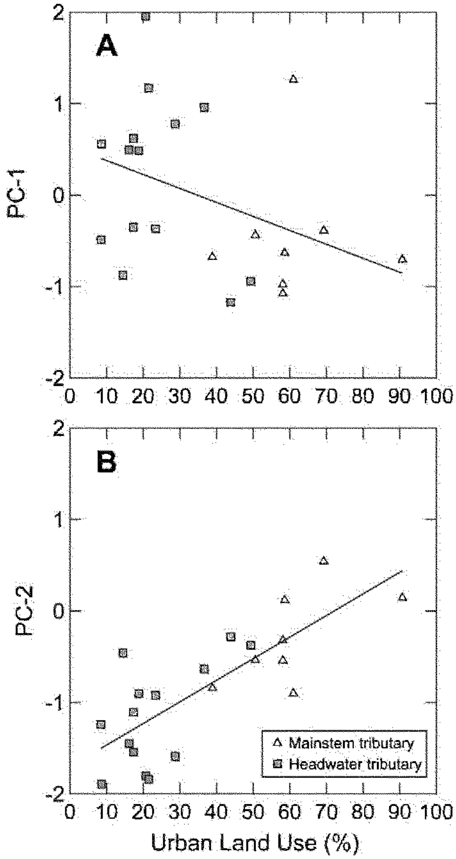

FIGURE 4.—Bivariate plots of (A) principal component (PC) 1 and (B) principal component 2 versus the percentage of urban land among headwater and main-stem tributary sites in the upper Des Plaines River watershed. The lines represent linear regressions.

in Figure 4), it does influence the warmwater–generalist and coolwater–specialist fish species structure (e.g., PC-2 in Figure 4).

Influence of Dams and Urbanization

We assessed the potential effects of dams and urbanization in this study for 16 MT sites. Seventeen dams were located on the main stem and tributaries of the upper Des Plaines River watershed (Figure 2). The lengths of the dammed reaches located on the main stem generally ranged from about 2 to more than 16 km, reach number 10 being the longest. Three of the MT reaches were fragmented by dam structures.

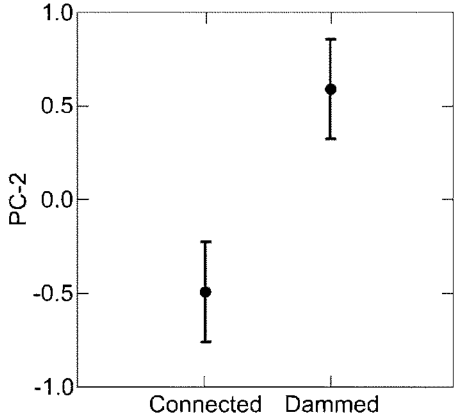

FIGURE 5.—Plots (means ± SDs) of principal component 2 (PC-2) at connected and dammed main-stem tributary sites in the upper Des Plaines River watershed.

An ANCOVA of Shannon diversity scores with respect to connection type (dammed versus undammed) with arcsine-transformed percentage of urban land present in the watershed as a covariate showed that fish species diversity was not influenced by connection type or urbanization ($P > 0.05$; multiple $R^2 = 0.07$; df = 1, 13). Similarly, an ANCOVA of PC-1 also was found to not be affected by dams or urbanization ($P > 0.05$; multiple $R^2 = 0.07$; df = 1, 13). Conversely, an ANOVA of PC-2 demonstrates that, after accounting for the effect of urbanization, only fragmentation by dams significantly explained the differences in fish species composition ($P = 0.012$; multiple $R^2 = 0.54$; $F = 8.585$; df = 1, 13). Sites fragmented by dams were dominated by warmwater–generalist fish assemblages, whereas sites connected to the main stem of the Des Plaines River had higher proportions of coolwater–specialist fishes (Figure 5). Thus, fragmentation of MT sites by dams appears to be an important factor influencing fish species structure, even in this highly urbanized portion of the study area.

Fish species diversity decreases among dam reaches along an upstream-to-downstream gradient among the MS sites (Figure 6; $P = 0.044$; multiple $R^2 = 0.231$). This shows that the most diverse fish community is found in the longest and most upstream reach, which also is connected to the most tributaries (reach 10). Importantly, the stream width of the MS sites generally increases from about 8 to 40 m from upstream to downstream. In contrast, we found no linear relationship among reach and fish species composition in either PC-1 ($P = 0.326$; multiple $R^2 = 0.060$) or PC-2 ($P = 0.926$; multiple $R^2 = 0.001$). This pattern of loss in

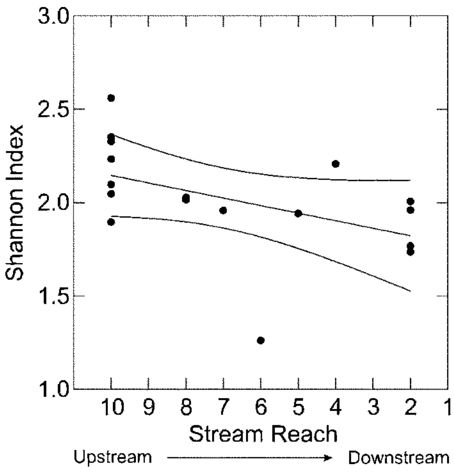

FIGURE 6.—Bivariate plot of fish species diversity (Shannon) index scores among stream reaches separated by dams located on the main stem of the upper Des Plaines River. The lines represent the linear regression and 95% confidence intervals.

fish species diversity seems to reflect the influence of multiple dams and provides evidence that these effects were cumulative.

Discussion

Our findings indicate that both urbanization and dams have a synergistic detrimental effect on the Des Plaines River, negatively impacting fish species diversity and composition. Our analyses demonstrate that stream fish communities within this watershed are negatively affected by increased urbanization and its associated degradation of water quality. Furthermore, superimposed on this urban/urbanizing landscape are multiple dams on the main stem and tributaries of this system that negatively affect fish communities by restricting fish passage, thus eliminating the possibility of recolonization and recruitment from downstream to upstream on the main stem of the Des Plaines River as well as disrupting dispersal and the connectivity of tributary streams to the main stem of the river. The effects of multiple dams in this system were found to be cumulative, which suggests that any restoration efforts on this system would not be effective without incorporating a targeted strategy to reconnect these fragmented streams through dam removal or some equivalent natural fishway (Katopodis et al. 2001).

The upper Des Plaines River watershed is typical of many upper Midwestern watersheds, in that human activities have changed the surrounding lands from forest or prairie to agricultural fields or cities. Such a shift in land use patterns causes concomitant changes to the stream environment, including an increase in impervious surface area and changes in water quality, hydrology and hydraulics, and reduction or fragmentation of riparian stream buffers. Furthermore, such changes have effects on fish community structure (Klein 1979; Richards et al. 1996; Roth et al. 1996; Wang et al. 1997, 2000, 2001; Helms et al. 2005; Morgan and Cushman 2005). Our study also corroborates the commonly found pattern that high proportions of urban land are associated with decreased fish species diversity. Almost all of our study sites were located in watersheds with more than 10% urban land use, a level known to be associated with a significant loss in fish species abundance and diversity, especially in this region of the U.S. (Ruhl 1995; Dreher 1997; Wang et al. 2000; Fitzpatrick et al. 2004; Harris et al. 2005).

This loss in diversity is probably related to the degradation of water quality and habitat loss associated with urbanization (ILDNR 1998; Arnold et al. 1999). For example, there are limited riparian buffers along the Des Plaines River and associated tributaries in the urbanized areas of this system, and the loss of riparian buffers is known to have a significant negative impact on fish communities (Roth et al. 1996; Wang et al. 1997; Stewart et al. 2001). Furthermore, increased urbanization within the Des Plaines River watershed is associated with decreased water and sediment quality as a result of increased point and nonpoint sources of phosphorus and nitrate; increased proportion of wastewater compounds, including detergents, insecticides, polycyclic aromatic hydrocarbons (PAHs), and flame retardants; elevated chloride concentrations; and increased sediment concentrations of arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc (Harris et al. 2005). Therefore, we think it very likely that the fish communities within the Des Plaines River watershed are responding to the reduction in water quality associated with increased urbanization in this watershed.

The high level of variability in fish species diversity in the upper Des Plaines River watershed seems to depend on position within the drainage network in this system. Specifically, the MS and HT streams contain more diverse fish communities than do the MT streams. Also, the MT sites contained the lowest mean number of species compared with the MS and HT sites. These results agree with Osborne and Wiley (1992) and Cumming (2004), who demonstrated that fish species richness in tributary streams is highly dependent on position within the stream drainage network. Whereas Osborne and Wiley (1992) and Cumming (2004) generally found that fish species richness increased with the downstream position within a watershed (i.e., with increasing D-link number; Osborne and Wiley 1992), our results indicated that fish species richness was greatest in the upstream reaches of the watershed. This finding reflects the historic development of this watershed, which was centered on the lower reaches of the system, leaving the upstream reaches relatively less disturbed by human activities.

Because the HT and MT sites are similar in watershed size and stream width, we expected that these tributaries would have similar fish species compositions and differ from the MS sites in this respect. However, on the basis of fish species composition, the MT sites were more similar to the MS sites than to the HT sites, indicating a possible linkage between the MT sites located lower in the drainage network and the MS sites of the Des Plaines River. Although the abundance and diversity of fish in the MT sites are low, these sites contain a subset of the same fish species as the MS sites. This finding further underlines the importance of stream location within the drainage network as a factor influencing fish community structure.

Although the percentage of urban land use within the HT and MT streams did not significantly influence fish species diversity, it did influence fish species composition as measured by PC-2. Although the HT sites have a different species composition than the MT sites, the two areas seemed to respond similarly to the proportion of urban land. This suggests to us that as urbanization increases within these watersheds the resulting changes in fish communities take the form not of changes in species diversity but in changes from coolwater–specialist fish assemblages to warmwater–generalist fish assemblages. The HT and MT sites overlap at about 40% to 50% urban land use, the levels at which transitions in community composition typically occur in the Des Plaines River (Harris et al. 2005).

This shift in fish community composition may indicate hydrological changes associated with urbanization, such as more frequent and larger floods during wet periods and reduced base flows during dry periods (Wang et al. 2000). Discharge in the upper Des Plaines River watershed was more variable at HT sites than at MS sites (ILDNR 1998; SEWRPC 2003). In contrast, statistical trend analyses by ILDNR (1998) confirmed that there have been sizable increases in low flows throughout our MT and MS sites, primarily due to a combination of regional increases in precipitation, treated wastewater effluent discharges, and activities such as lawn watering and other additions of water to the storm sewer system during dry periods.

Approximately 25% of the water that flows in the upper Des Plaines River originates from wastewater treatment plants; this source accounts for about 50% and 95% of the river's flow during medium- and low-flow periods, respectively (ILDNR 1998). Although Tiemann et al. (2004) suggested that urbanization and industry cause decreased flows as the result of water intake during periods of drought, both the larger river MS sites and MT sites historically have been, and remain, more stable than HT sites during critical low-flow periods, even as urbanization and population levels have increased in these areas. Such increased stability in flow conditions has been associated with increased species richness (Horwitz 1978; Osborne and Wiley 1992). Also, the much larger volumes and more stable flows in the MS sites of the Des Plaines River provide potential refuge areas for fish during low-flow periods and could aid subsequent recolonizations of MT sites (Osborne and Wiley 1992). Accordingly, we expected that both the MS and MT sites would contain a higher number and greater diversity of fish species than the ephemeral HT areas; however, we found the opposite trend. This difference in species diversity between HT and MT sites, combined with a dominance of coolwater–specialist assemblages in the HT sites versus warmwater–generalist assemblages in the MT sites, suggests that that these differences could be related to the fragmentation by dams within this study area.

Guenther and Spacie (2006) demonstrated that fish assemblages upstream of impoundments created by low-head dams had much higher generalist species richness and abundance than assemblages in unfragmented tributary streams. Our findings confirmed this trend: dammed MT sites contained a significantly different fish assemblage, one dominated by warmwater–generalist species, whereas undammed MT sites contained higher proportions of coolwater–specialist fish species. In addition, the HT sites, which were not fragmented by dams, were much less affected by dams on the main stem of the Des Plaines River (i.e., physically separated by more stream distance) than were the MT sites. The HT sites contained the highest proportion and greatest number of riverine specialist species in comparison with MT or MS stream sites, which also is consistent with previous research (Taylor et al. 2001; Guenther and Spacie 2006).

The establishment of the major lock-and-dam structures in the upper portion of the Illinois River (just downstream of our study area) is hypothesized to have significantly contributed to the loss in aquatic diversity through habitat loss and fragmentation (Forbes and Richardson 1920). Retzer (2005) calculated a loss of 30% of the native fish community

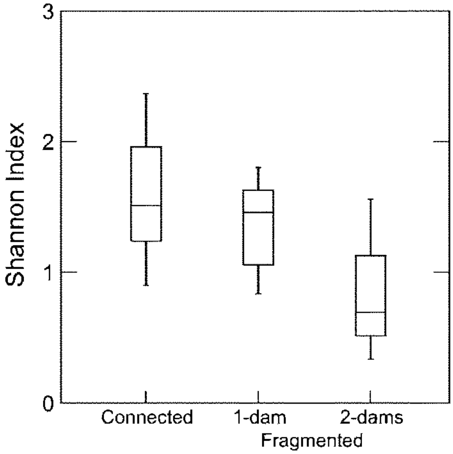

FIGURE 7.—Box plots of fish species diversity (Shannon) index scores among main-stem tributary sites in the upper Des Plaines River watershed. The tributary sites were disaggregated into connected (not dammed) sites and sites fragmented by one or two low-head dams. The box plot shows the median (horizontal line), the range (ends of the whiskers), and the upper 75th and lower 25th percentiles (edges of the box) of the data in each group.

throughout the entire Des Plaines River watershed from 1879–1905 to 1990. Although the exact species richness and community structure are difficult to determine using available records, comparisons of historical fish collections from the upper Des Plaines River with the current fish community results suggests a loss of 15 species and an overall decrease in fish community diversity throughout the watershed from presettlement to present times. Twelve of the 15 species extirpated from this watershed were riverine specialists: American eel *Anguilla rostrata*, pallid shiner *Hybopsis amnis*, red shiner *Cyprinella lutrensis*, largescale stoneroller *Campostoma oligolepis*, roseyface shiner *Notropis rubellus*, weed shiner *N. texanus*, southern redbelly dace *Phoxinus erythrogaster*, smallmouth buffalo *Ictiobus bubalus*, northern hog sucker *Hypentelium nigricans*, longear sunfish *Lepomis megalotis*, rainbow darter *Etheostoma caeruleum*, and logperch *Percina caprodes*. The loss of these species is consistent with previous findings that overall species richness is reduced in fragmented streams (Winston et al. 1991; Porto et al. 1999; Herbert and Gelwick 2003; Tiemann et al. 2004).

This shift from riverine specialists to generalists is probably related to the shift to primarily lentic habitats (Erman 1973; Winston et al. 1991; Falke and Gido 2005; Santucci et al. 2005; Guenther and Spacie 2006). Such lentic conditions are unsuitable to riverine specialists and generally prevent these species from colonizing neighboring tributaries fragmented by backwater areas upstream of low-head dams (Guenther and Spacie 2006). In contrast, generalist species, particularly large piscivorous species, such as the largemouth bass that were predominant in MS sites, are capable of colonizing both the reservoir conditions upstream of low-head dams and the nearby tributaries connected to these reservoirs (Winston et al. 1991). Perhaps more significantly, low-head dams influence the fish and macroinvertebrate communities, as well as habitat, in ways similar to larger dams (Tiemann et al. 2004). Low-head dams limit habitat on stream systems by restricting access to available habitats, which has led to changes in fish community structure (Porto et al. 1999). Thus, it is not surprising that the removal of a low-head dam on the Milwaukee River (Milwaukee, Wisconsin), for example, reestablished fish passage and contributed to the recovery of the reach above the former dam site, which responded by improvements in habitat and fish biotic integrity (IBI) scores (Kanehl et al. 1997).

In contrast to previous studies, which found no significant cumulative effect of multiple dams on fish IBI scores (Santucci et al. 2005) or species richness (Tiemann et al. 2004), our study found that the series of 10 low-head dams led to a gradual alteration of fish species diversity in the upper Des Plaines River watershed in an upstream-to-downstream gradient. Fish species diversity did not increase with stream size, although the patterns in fish assemblages appeared to be influenced by these impoundments—contrary to the tendency for fish species richness, community diversity, and biomass to increase with increasing stream size (Schlosser 1987). In addition, the high number of dams on the main stem limits access to tributaries that would otherwise be accessible; this may also be contributing to an overall reduction in species diversity downstream. Most of the reaches on the main stem were connected to at least one tributary, but reach 10 was connected to the highest number of tributaries. Specifically, these dams are most probably affecting fish species diversity by acting as barriers to movement necessary for growth, survival, or reproduction (Helfrich et al. 1999; Tiemann et al. 2004; Gillette et al. 2005; Santucci et al. 2005).

Low-head dams in upstream tributaries may also be altering fish assemblage structure via the disruption of dispersal and connectivity to the main stem of the Des Plaines River, which may have contributed to our observation that fish species diversity was lower at the MT sites than at the MS and HT sites (Santucci et al. 2005; Guenther and Spacie 2006). A comparison of fish species diversity between connected (i.e., not dammed and also connected to the main channel) and fragmented reaches indicates an inverse relationship between the number of dams on a tributary and fish species diversity; fish species diversity scores decrease as the number of dams increases (Figure 7). Thus, fragmentation of fish communities by dams on tributary streams may also be cumulative, the fragmentation increasing as more dams are added. This fragmentation, combined with the degraded water-quality conditions caused by urbanization, is probably contributing to the loss in fish species diversity. This also may explain why the tributary sites separated by dams contained the least diverse fish communities and were generally dominated by species tolerant to pollution.

Management Implications

Clearly, sampling fish communities in a limited number of headwater tributaries, main-stem tributaries, or main-stem segments may be inadequate in highly fragmented watersheds. Extrapolation of limited sampling results could lead to either under- or overreporting of fish diversity and fish community condition. The presence of dams, which increases the likelihood of local extirpation and loss of diversity, should thus be a consideration in the formulation of sampling programs and experimental design.

Within the upper Des Plaines River study area (upstream of Hoffman Dam), for example, selective dam removal or the installation of a fishway or passage structure at only a few sites would probably allow localized improvements in the fish species diversity (see Kanehl et al. 1997). However, this selective removal would provide relatively limited improvement in fish species richness for the system as a whole, given the degraded nature of the fish communities currently present and the cumulative effects of the remaining dam structures, especially in the lower reaches of the study area.

Restoration within the main-stem sites of the upper Des Plaines River must rely on reconnection to more species-rich areas of the watershed, such as the upper reaches of the study areas (e.g., reach 10; Figure 2), which in this study had more abundant and diverse fish communities. Surveys conducted downstream of our study area (Pescitelli and Rung 1998, 2005) have also found higher diversity, many species (including sport fishes) exhibiting truncated distribution patterns (Santucci et al. 2005). Reconnection to both upstream and downstream recruitment sources should be high priorities for restoration in the upper Des Plaines River, coupled with efforts to remove dams or provide fish passage throughout the entire main stem and main-stem tributaries.

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Attachment ER-001: Supporting Documentation for Complete Hydrologic Restoration

Agriculture and urban development has had a major influence on the physical structure of stream, wetland and their buffering plant communities, inclusive of the processes that created and sustained them. This has allowed invasive and nonnative species to colonize these altered areas. There is also a negative feedback loop in most wetland and stream areas where altered hydrology and lack of fire has induced the riparian structure (plant) to fail, in turn causing the system to unravel, which feeds back to more altered hydrology and hydraulics. The following discussion illustrates the intrinsic hydrologic problems that are driven by man's alteration of the water cycle, inclusive of hydrology altering invasive plant species, and why drier buffering communities to streams and wetlands are of utmost importance.

Vast areas of tile-drained hydric soils and channelized stream reaches have severely reduced the extent of the riverine hyporheic zone and have severed them from their floodplain (Warmer et al. 2009; Lacoursiere and Vought 2010). One of the most significant impacts drain tiles have on a landscape is drastically reducing nutrient-retention capabilities of a stream and its riparian zone by swiftly transporting both subsurface and surface waters directly to and quickly through the stream (Lacoursiere and Vought 2010). Naturally, waters would flow through the hyphoreic zone and over the active floodplain, thusly being relieved of its nutrient load and assimilated into the soils for plant uptake; however, the altered state allows greater quantities of nutrients (Warmer et al. 2009) to reach downstream wetlands and water bodies. Higher nutrient levels likely have a significant negative effect on native vegetation by altering soil chemistry and the balance of competition between species (Horswill et al. 2008; Bobbink et al. 1998). Reed canary grass (*Phalaris arundinacea*), cattail (*Typha spp.*), and other invasive plants have been shown to be reliant on nutrient-rich conditions which increase their frequency and biomass (Perry et al. 2004; Kercher and Zedler 2004; Blumenthal et al. 2003; Wetzel and Van Der Valk 1998; Morghan 1999). As an agriculturally influenced watershed with other ongoing anthropogenic inputs of nutrients, the upper Des Plaines River has likely experienced a relief of nutrients as a limiting resource for invasive species, thus allowing for their increase in abundance and dominance (Wedin & Tilman 1996; Rickey, et al. 2004). Compounded with a considerable amount of organic carbon stripping from soils (Warmer et al. 2009; Royer and David 2005) and suppressed processes of stream migration/meandering and fire, this condition allows for native species to be outcompeted and have their establishment suppressed, which ultimately results in species richness declines.

Woody vegetation comprised of opportunistic and invasive shrubs and trees, as well as dense stands of invasive herbaceous plants have significantly changed the structure and vegetative composition of the sites selected for the NER Plan. This has resulted in the significant disruption of natural water levels through increased evapotranspiration. Evapotranspiration is one of the most important output fluxes in wetlands and plant communities, in many cases accounting for up to 100% of annual water losses (Frank & Inouye 1994; Souch et al. 1998). A study by Paul K. Doss (1993) within northwest Indiana found that the hydrologic regime of wetlands is predominantly controlled by evapotranspiration of wetland flora as well as the evapotranspiration of upland phreatophytic vegetation. It was found that significant shifts in hydrologic regimes as well as ground water depletion during daylight hours were controlled by the evapotranspirative demands of wetland and nearby upland vegetation (Doss 1993).

Dense monotypic stands of invasive hydrophytes and woody invasion of riparian and buffering upland soils are significant disruptors to the hydrologic regimes of the site's wetlands. A change in a plant community's species composition and structure drive changes in water balances (Sun et al. 2008). Woody vegetation alters water availability by intercepting precipitation, increasing infiltration via stemflow and root channels, and/or transpiring water that would otherwise reach the soil and recharge groundwater (Huxman et al. 2005; Farley et al. 2005). When compared to open water evaporation, cattail (*Typha latifolia*) evapotranspiration was shown to be 0.6 to 2.1 times greater than other native wetland vegetation (Brezny et al. 1973).

A site at the Indiana Dunes National Lakeshore, with similar conditions of invasive cattail and common reed encroachment on remnant wetland vegetation, has been shown to exhibit higher evapotranspiration rates when compared to an undisturbed site (Souch et al. 1998). With increasingly higher evapotranspirative demands as invasive and woody species become more dominant, the altered temperature fluctuations within the water and sediment of the upper Des Plaines River watershed may be driving the ecology of its wetlands just as these water/sediment temperatures drive the solubility of dissolved oxygen, nutrient cycles, the metabolism and respiration of living organisms, and microbial biomass and activities (McCulley et al. 2004; Souch et al. 1998).

The above detailed scientific discussion basically says that hydrology is not separated into distinct parts that can be restored independently. Complete success of an ecosystem restoration site is fully dependent on the sum of all its parts and ignoring the fact that "drier" plant communities have dramatic affects on the hydrology as a whole is a primary causative of project failure. The achievement of stream and wetland benefits require addressing all of the components possible that are currently adversely affecting this sites water elevations and cycles, or hydrology. The amounts of nonnative phreatophytic vegetation that have invaded the NER Plan sites is very extensive and they continue to keep the ground water table below levels in which former wetland areas would not return without the removal of these species. Prime example of this is the Calumet Prairie Section 506 that is nearing the end of construction. This former wet sand prairie was altered enough to allow cottonwoods, peach leaf willows and several other species to colonize and subsequently drop the water table elevation enough to preclude the sustenance of native hydrophytes. Shortly after the removal of these trees and shrubs, native hydrophytes now dominate again, including the rare adder's tongue fern.

The following documents also provide support for restoring all components of the NER Plan's sites.

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The Effect of Forest Structure on Amphibian Abundance and Diversity in the Chicago Region

Victoria A. Nuzzo and Kenneth S. Mierzwa

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Lake County Forest Preserve District
Forest Preserve District of Will County

March 19, 2000

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SUMMARY

Amphibian populations are under increasing threat in the Chicago region due to habitat loss and habitat degradation. The impacts of habitat loss are self-evident and well documented. The impacts of habitat degradation are less clear. In the Chicago Region the majority of forests have been degraded (altered from their natural pre-settlement condition) by grazing, logging, and fire exclusion, and excessive deer herbivory. We investigated whether amphibian abundance and diversity was related to the condition of upland forests adjacent to breeding ponds. We monitored vegetation composition and amphibian abundance in April and June, 1999, in six high quality (Grade B) forests and six low quality (Grade C and D) forests adjacent to ponds in Lake County (eight sites) and Will County (four sites), Illinois.

A total of 205 amphibians of six species were recorded at all sites in drift fences (65 trap-nights at each site, total 780 trap-nights). The six high quality forests supported higher amphibian species richness and diversity than the six low quality forests, and nonsignificantly higher numbers of amphibians. Down wood was significantly more abundant in the higher quality forests, which had more and larger logs, especially well-decayed logs, than the lower quality forests. Overstory tree density was lower in the high quality forests, due to the lower abundance of trees in smaller size classes. Cover and species diversity of herbaceous vegetation was similar in both high and low quality forests. When forests were grouped on the basis of amphibian abundance (six 'better' habitat sites vs six 'poorer' habitat sites) percent cover of herbaceous vegetation in both April and June was significantly higher in sites with greater numbers of amphibians.

Multiple linear regression indicated that 1) amphibian abundance was higher in sites with higher cover of herbaceous vegetation in June, and 2) the presence of water was an important determinant of amphibian abundance. Amphibian abundance was most closely related to the length of time that ponds retained water (ponds with later dry dates permit a greater percentage of larvae to achieve metamorphosis), and the number of ponds within 0.5 km. These results indicate that hydrology is the dominant force driving amphibian populations in upland forests in the Chicago Region, and forest structure is important only when hydrology is suitable. By implication, amphibian populations in sites with suitable hydrology (clustered ponds, one or more that retain water through mid-July) and unsuitable structure (low herbaceous cover in June) may benefit if the vegetational structure is managed. We propose two ways to test this premise. First, expand the current study to include multiple ponds within several sites, over several years. Second, actively manage half of the adjacent upland forests for increased groundlayer vegetation, and monitor the response of the amphibian community to these changes.

Specific site management strategies supported by the results of this study include removal of drain tiles and filling of ditches; restoration or creation of additional wetlands which hold water well into the summer but dry in at least some years; management for increased leaf litter in spring and increased herbaceous vegetation in summer; and understory thinning through removal of exotic or weedy shrubs and saplings, and judicious use of prescribed fire. Pending the outcome of current research on fire effects, we encourage either very early spring or late fall burns (when few amphibians are surface active), and either a conservative fire-return interval or use of multiple burn units around the best amphibian breeding wetlands.

INTRODUCTION

Researchers interested in assessing interactions between amphibians and upland habitat have focused on areas characterized by distinct differences, comparing old growth forests to recently logged forest stands (Ash, 1997; Welsh and Lind 1991, 1995; Petranka et al. 1993; Pearman, 1997), undeveloped sites to developed sites (Delis et al. 1996, Dodd 1996, Means et al. 1996), disparate habitat types (Jones 1988), or sites subjected to different logging treatments (Renken, 1997). No studies have investigated the impact of gradual habitat degradation on amphibian abundance and species richness, nor the relationship between forest quality and amphibian abundance and diversity.

The majority of upland forests in the Chicago Region have been moderately to severely degraded by urban development (fragmentation), land use activities (fire suppression, grazing, logging), white-tailed deer herbivory, and invasion of non-indigenous species (Bowles et al. 1998). Few of the forests in the Chicago region retain high natural quality, yet upland forest provides critical habitat for at least six local amphibian species (Mierzwa 1998; Phillips et al. 1999). Many amphibians are non-migratory or short distance migrants (Phillips and Sexton 1989; Madison 1997) and have small home ranges (Kleeberger and Werner 1983). Habitat-restricted species, such as *Ambystoma maculatum* and *Rana sylvatica* are likely more impacted by habitat degradation than habitat generalist species, such as *Bufo americanus* and *Rana catesbeiana*.

This study was an investigation of the relationship between forest structure (and, by implication, natural quality) and amphibian diversity and abundance in the Chicago Region. Specific research questions were: 1) Is there a significant difference in abundance or diversity of amphibians in high vs low natural quality forests?; and 2) If so, what factors are associated with higher amphibian abundance or diversity? Adult pond-breeding salamanders spend the majority of the year in upland habitat, in underground refuges (Semlitsch 1998) with occasional intervals of surface movement and foraging (Madison and Farrand 1997). We therefore also investigated whether the 'natural quality' of the upland forests affected salamander survival, specifically, were adult salamander numbers higher in high quality forests than low quality forests adjacent to breeding ponds. We hypothesized that high quality natural sites would support more species, and higher abundance, of amphibians than low quality sites. Further, we hypothesized that high quality sites would be more likely to support "habitat restricted" species, and low quality sites would support "habitat generalist" species. This information is critical for the long-term preservation of amphibians within the Chicago region, where many forest species survive in relatively isolated populations within existing preserves.

METHODS

Study sites were selected that: 1) consisted of a minimum of 40 ha of contiguous wooded habitat in public ownership; 2) contained one or more known or probable amphibian breeding ponds, defined as ephemeral ponds at least 10cm deep and 20m diameter in spring 1999. Plots were located at least 50m from an edge, defined as a road, trail, housing development or field, and at least 500m from any other study site (*Ambystoma maculatum* travels a mean of 125m between upland and breeding habitats, and 95% remain within 164m of the breeding pond; Semlitsch 1998); and 3) could be paired on the basis of assumed natural quality (INAI grade A or B vs INAI Grade C or D) with another study site that a) had a similar sized pond with similar vegetation and canopy cover, b) had a similar upland forest community type, and c) was located in the same forested tract or in a nearby forested tract. Twelve sites were located that met these criteria. Eight were in Lake County, 30 miles north of Chicago, and four were in Will County, 30 miles south of Chicago (Figure 1 and Table 1). Within each county, sites were paired on the basis of pond size and vegetative structure, and apparent natural quality of the adjacent upland forest of similar size, soil, hydrology, and aspect. All forests were located within the Northeastern Morainal Division (Schwegman, 1973) to minimize biogeographic variation in the potential species assemblage.

"Natural quality" is a qualitative assessment of the perceived similarity of a natural community to the presettlement condition, based on visual evidence of past impacts. While used extensively throughout Illinois and other states, "natural quality" lacks a quantitative basis that would substantiate the qualitative assignments, and that would allow comparisons between sites with similar or dissimilar assigned grades. While most experienced natural area biologists agree on the assignment of sites to very high or very low natural quality, there is a large grey area for sites between these two extremes.

We initially intended to sample mesic upland forests adjacent to ponds of similar size and structure, with the forests differing primarily in natural quality; very high (rich herbaceous understory, oldgrowth overstory) and very low (bare understory or an understory dominated by nonindigenous vegetation, and young or highly disturbed overstory). We failed to locate any Grade A mesic forests adjacent to suitable ponds, and used

Illinois Natural Areas Inventory (INAI) natural quality grades. Summarized from White (1978).

Grade A: Relatively stable or undisturbed communities; for example, old growth, ungrazed forest.

Grade B: Late successional or lightly disturbed communities; recently lightly disturbed, or moderately to heavily disturbed in the past but recovered significantly. For example, old-growth forest selectively logged or moderately grazed, and subsequently recovered.

Grade C: Mid-successional or moderately to heavily disturbed communities; for example, a heavily grazed old-growth forest, or a young to mature second-growth forest.

Grade D: Early successional or severely disturbed communities; for example, a recently clearcut forest, or a mature second-growth but severely grazed forest.

Figure 1. Sample Plot Locations

Grade B forests as our "high quality" sites. We found only one pair of sites that met the selection criteria (Ryerson 5 and Lake-Cook). Consequently, we expanded the selection criteria to include dry-mesic, mesic, and wet-mesic forests, and also a range in 'low' natural quality (Grade C and Grade D). Thus, within pairs there was a distinct difference in natural quality, with one plot obviously more degraded than the other, but among all plots this distinction was less evident, and the plots formed a gradient of both natural quality and community type. Establishing study site criteria in the office helps focus the search for suitable sites, but locating sites that meet these criteria is often difficult, with the result that site selection criteria must often be expanded to allow a minimum number of replicate study sites (Petranka 1994).

Table 1. Sample Plot Coordinates

Plot Name	County	Latitude	Longitude	UTM E	UTM N
MacArthur	Lake	42 14 42	087 55 54	423084	4677406
Daniel Wright	Lake	42 12 50	087 55 22	423826	4673943
Elm North	Lake	42 13 00	087 54 52	424529	4674216
Elm South	Lake	42 12 55	087 54 44	424711	4673964
Ryerson North	Lake	42 10 50	087 54 27	424991	4670295
Ryerson South	Lake	42 10 20	087 54 17	425280	4669339
Ryerson 5	Lake	42 10 35	087 54 21	425187	4669773
Lake-Cook	Lake	42 09 06	087 54 05	425480	4667096
Plum West	Will	41 27 02	087 33 44	453131	4588934
Plum East	Will	41 27 10	087 33 27	453448	4589126
Thorn 19	Will	41 27 43	087 40 58	442977	4590262
Thorn 13	Will	41 27 29	087 40 52	443170	4589840

Within each site a single 0.25ha (50m x 50m) plot was located, with the plot center approximately 25m from the edge of the pond. We initially intended to establish 1ha plots, but found that most ponds were located less than 100m from an edge or disturbance. In the Chicago region virtually all large forested tracts that contain ephemeral/flatwoods ponds are publicly owned, and the majority have trail systems that traverse the entire tract, leaving few areas sufficiently isolated from trails and edges to meet the site selection criteria. Therefore, plot size was reduced.

We chose to conduct high intensity sampling (both amphibians and vegetation) in a relatively low number of plots (n=12), given the tradeoffs between number of replicates, plot size, and sampling effort (Hairston 1989 in Petranka 1994), and the difficulty in locating suitable study sites.

Data Collection, Amphibians and reptiles — Amphibians and reptiles were sampled with drift fences and time-constrained visual encounter surveys (Heyer et al., 1994; Sutherland, 1996), with drift fences installed at least one week prior to sampling activities. A single drift fence array was installed at the center of each sample plot, oriented parallel to and approximately 25m distant from the pond. Drift fences were constructed of aluminum flashing, 30m long and 50cm high, embedded several cm into the substrate. The array included two funnel traps constructed from cylinders of aluminum window screening and plastic funnels, one placed at each end of the drift fence, and two 5l buckets buried flush with the substrate surface at the center of the fence, one placed on each side of the fence. Drift fences were checked at one to two day intervals over a three week period in spring (April 24 to May 18 1999) when early breeding amphibian species were leaving ponds and later breeding species were arriving, and a four week period in summer (June 22 to July 25 1999) when immature amphibians were leaving the ponds. Spring drift fence sampling was timed to coincide with the movement of early breeding species away from the ponds. This typically results in fewer captures than during the earlier in-migration period. However, post-breeding animals are presumably moving more slowly and spending time foraging, and thus give a better representation of terrestrial habitat use.

All captured animals were identified to species and released away from the fence in the direction of original movement to minimize chances of recapture. Because most movement is directional, either toward or away from the pond (Dodd and Cade 1998), we assumed that placement of the animal on the opposite side of and several meters from the drift fence was sufficient to prevent the same animals from being recaptured. Results are reported as catch per trap night, with a trap night being the equivalent of a 24 hour period of sampling with each 30m long drift fence. When drift fences were not in use funnel traps were removed and buckets covered.

Time constrained visual encounter surveys were conducted at each site within 48 hours of rainfall by two trained observers on four visits between April 16 and June 1, 1999. Search area centered on the drift fence and covered the entire plot on each visit. Each round of sampling was conducted by the same individual(s) at all plots, to minimize bias. The observers turned logs and other cover objects, and observed animals under cover or active and in the open (Welsh and Lind, 1991; Churchwell and Mierzwa, 1998). Results are reported as catch per person hour.

Data Collection, Vegetation — Structure and composition of each forest was recorded within the 0.25ha (50m x 50m) plot centered on the drift fence array, using a systematic sampling design (Elzinga et al 1998). Five parallel 50m transects were established along a baseline parallel to and 25m distant from the drift fence, and more or less following the pond edge; thus, transects bisected the drift fence and extended from pond edge 50m into the forest. The first transect was randomly located within the first 10m interval along the baseline, and the remaining transects were systematically located at 10m intervals. Groundlayer data were recorded in 25 permanent $1m^2$ quadrats, five per transect; the first quadrat was randomly positioned within the first 10m of transect, and the remaining four quadrats were then systematically located at ten meter intervals. Groundlayer data consisted of presence and estimated cover (within 13 cover classes) of all vascular species <1m tall, and of exposed soil, wood, and leaf litter.

Shrub and tree data were recorded in 13 circular $100m^2$ (5.78m radius) quadrats centered on alternate groundlayer quadrats. Density was recorded by species for all woody plants >1m tall and $\leq$10cm dbh in three size classes; <1-2m tall; >2m tall and <5cm dbh; and 5-9.9cm dbh, and density and diameter at breast height were recorded by species for all trees ($\geq$ 10 cm dbh). Groundlayer data were recorded in both April and June as we anticipated seasonal changes, while shrub and tree data were recorded only in April.

Abiotic features were recorded within the $1m^2$ quadrats. Litter depth, canopy cover, and vegetation "thickness" were recorded in April and June. Litter depth was measured to the nearest cm at four points/quadrat. Canopy cover was measured at 0.3m above ground level using a concave densiometer. Vegetation thickness was measured by recording number of $30cm^2$ (6cm x 5cm) squares obscured by vegetation (observed from 4m distant at a height of 1.5m above ground), on a board 0.30m x 2.0m, in four vertical layers; 0-.25m, >.25-.50m, >.50-1.0m and >1.0-2.0m above ground (100 squares/vertical meter, maximum 200 squares total). Diameter of all stumps and down logs ≥10cm in diameter were recorded to the nearest cm, and assigned to one of five 'decay classes' (Maser et al. 1979: 1= newly fallen tree with intact bark, branches and trees; 2=sagging slightly, with intact bark, some branches, and no twigs; 3=sagging near ground, with sloughing bark and no large branches; 4=completely on ground with little or no bark, and punky wood; 5= well decayed, with soft powdery wood and invasion of roots and seedlings). Because we were interested in measuring actual available habitat/shelter, we recorded only that portion of down logs that was actually on or within 3cm of the ground surface.

Data collection, wetland — Surface area of the pond was measured in the field and from aerial photographs. Depth was recorded at 5m intervals beginning at the pond edge and extending across the pond, along three transects parallel to vegetation transects and at right angles to the center of the drift array.

Data collection, landscape -- Features potentially affecting amphibian and reptile metapopulations were measured from one inch = 400 foot black and white aerial photographs, supplemented with coarser scale color infrared photos for most sites. The number of known or potential amphibian breeding wetlands within 0.5km was noted; this distance was chosen based on the greatest documented dispersal distance for juvenile blue-spotted salamanders in the Chicago Region (Mierzwa and Beltz, 1999). Also measured was the distance to the nearest known or probable breeding wetland, and the distance to the nearest forest edge.

Data Analysis: Amphibian data consisted of a single value/site, and therefore we used the mean value (average among quadrats at each site) for each environmental variable in all statistical tests. Because sites formed a gradient of natural quality and community type, we used stepwise multiple regression (using drift fence data) to determine if specific habitat features of the upland forests were associated with higher amphibian abundance and diversity. Variables for each regression were selected with the Best Subset Regression procedure. We used two-tailed t-tests to determine if 'high' quality sites collectively differed significantly from 'low' quality sites in amphibian abundance and diversity, and biotic and abiotic variables. We used paired t-tests to determine if plot pairs had similar between-plot differences in amphibian abundance and diversity, and biotic and abiotic variables.

Plots were ranked for amphibian habitat quality using total drift fence data (spring and summer combined). Two methods were used; the first ranked sites from high to low on the basis of total drift fence abundance, combining salamanders, toads, and frogs. The second method independently ranked sites from high to low for salamanders (two relatively specialized forest habitat species), toads (one habitat generalist), and frogs (three species, two usually associated with herbaceous vegetation and one with woodland habitat), and then summed the three ranks. Both methods produced similar rankings of sites. The six sites with the highest abundance of amphibians were classified as 'good' habitat and the remaining six sites as 'poor' habitat. Two-tailed t-tests were then used to test for significant differences between the 'good' and 'poor' amphibian sites. Considering toads (Bufonidae) and frogs (Hylidae and Ranidae) separately is a somewhat artificial split in a taxonomic sense; however it does take into consideration the presumed physiological and behavioral adaptations of toads for an existence in relatively xeric conditions.

All data were tested for homogeneity of variance, then tested for significant differences using parametric (t-tests) or non-parametric (Kruskal-Wallis) tests as appropriate. Statistical analysis was conducted with Statistix (Analytical Software 1996). Reptile data are presented in tables butwere not included in statistical analysis as the project focused on amphibian use of upland forests. Detrended correspondence analysis was conducted on groundlayer and overstory data to determine if stands clustered on the basis of natural quality or amphibian abundance and diversity, and to assess which variables were most closely associated with a) natural quality and b) amphibian richness and density. Multivariate analysis was conducted with PC-ORD (McCune 1993).

RESULTS

A total of 205 amphibians of six species were recorded at all sites in drift fences (65 trap-nights at each site, total 780 trap-nights; Table 2). The highest abundance and diversity were recorded at Elm North, where 42 salamanders, nine toads, and 14 frogs were captured. The lowest abundance was recorded at Lake-Cook, where no amphibians were captured during the study period. Most amphibians were recorded during the spring capture period; 80% of salamanders, 41% of toads, and 92% of frogs.

Time constrained visual encounter surveys resulted in a total of 74 captures at all sites (2.5 hours/ site; Table 2). Ninety-six percent of captures were of one species, *Ambystoma laterale*. Single individuals were captured of *Pseudacris triseriata*, *Rana pipiens*, and *Thamnophis sirtalis*.

Multiple linear regression indicated that just seven of the tested variables explained most of the differences in amphibian abundance (Table 3). Three of these variables reflected vegetation structure; percent cover of herbaceous vegetation in June, percent cover of leaf litter in April, and horizontal vegetation thickness in April, while four of the variables reflected the presence of water; average pond depth, pond drydate, number of ponds within 0.5km, and distance to the nearest pond. Pond drydate was positively and significantly correlated with both pond depth and pond number ($p<0.01$). The former correlation is expected, as deeper ponds tend to retain water longer, but the latter correlation is likely an anomaly dependent on two sites (Thorn 13 and Thorn 19) that retained water throughout the study period, and were also near a large number of other ponds. When these two sites were omitted, no correlation was detected between pond number and dry date ($p=0.62$), while the correlation between pond depth and drydate remained strong ($p<0.01$). Therefore, only pond drydate was used in multiple regressions, when both drydate and pond number were identified by the best subset regression procedure.

Salamanders, primarily *Ambystoma laterale* and some *Ambystoma maculatum*, were recorded at 11 of the 12 sites (no amphibians were recorded at the 12th site) and were the dominant amphibian group at seven sites. Eighty percent of salamanders were captured in April. Salamander abundance was significantly and positively related to pond depth and cover of herbaceous vegetation in June (Figures 2a and 2b). Together, these two factors accounted for 64% of the variation in total salamander abundance, and 67% of the variation in April salamander abundance. In June, salamander abundance increased significantly as a function of pond drydate (Figure 2c).

Toads (*Bufo americanus*) were recorded at nine sites and were the dominant amphibians at three sites. Toads were more abundant in June (0.81/trap-night) than in April (0.54/trap-night). Toad abundance in June was positively related to pond drydate (Figure 3a), but toad abundance in April was unrelated to any of the tested variables. Total toad abundance (April and June combined) was significantly related only to horizontal vegetation thickness in April; toad abundance increased as vegetation thickness decreased (Figure 3b).

Frogs (*Pseudacris crucifer*, *Pseudacris triseriata*, *Rana pipiens*) were recorded at seven sites and were the dominant amphibian group at one site. Frogs were slightly more abundant in April (1.06/ trap night) than in June (0.81/trap night). Frog abundance in both April and June was consistently and significantly positively associated with herbaceous cover in June (Figure 4a). Frog abundance in April was also significantly and positively associated with reduced distance to the nearest pond (Figure 4b).

Total drift fence data reflected the interaction of the three amphibian groups. Pond depth and cover of leaf litter in April accounted for 68% of the variation in capture rate throughout the study period (Figures 5a and 5b). Leaf litter cover in April was also a primary influence on amphibian species richness (see below). In April, drift fence capture was significantly and positively related to both herbaceous cover in June and pond depth (Figures 6a and 6b). In June, total drift fence capture increased significantly with increased pond drydate (Figure 6c).

The number of amphibian species at any given site was very strongly related to just four variables; cover of leaf litter in April, and cover of herbaceous vegetation in June, and distance to the nearest pond and pond drydate. Together, these four factors explained 97% of the variation in species richness. Amphibian species diversity (H'), a measure of the relative number of species and evenness of species distributions among all sites (Brower et al. 1990), was strongly related to cover of leaf litter in April, and the distance to the nearest pond.

As a group, the six 'good' amphibian sites had significantly more groundlayer vegetation in April and in June than the six 'poor' amphibian sites (18.2% and 64.8% vs 10.5% and 43.5% in April and June, respectively), and significantly more down wood in lower decay classes (670 dm^3 vs 118 dm^3, respectively; Table 3). No other significant differences were detected between the two groups of sites.

As a group, the six 'high' natural quality sites had significantly higher amphibian species richness and nonsignificantly higher H' diversity than the six 'low' quality sites (Table 3). Drift fence capture rates of all amphibians were two to three times higher in the six 'high' quality sites, but these differences were not significant. Both high and low quality sites had statistically similar cover of herbaceous vegetation, species richness, vegetation thickness, and canopy cover, in both April and June. The 'high' quality sites had significantly more (43.7 vs 14.5) and larger (1323 dm^3 vs 88 dm^3)

logs, greater volume of well-decayed logs (3888 dm^3 vs 890 dm^3), and deeper leaf litter in June, than the 'low' quality sites. Tree density was nonsignificantly greater in the 'low' quality sites (3569/ha) than in the 'high' quality sites (2365/ha) although basal area was similar. This indicates that the 'high' quality sites had fewer but larger trees while the 'low' quality sites had numerous smaller trees. The presence of large trees was one of the characteristics used to define 'high' natural quality. The 'low quality' sites had nonsignificantly more alien or nonindigenous trees (26% vs 7%), than the high quality sites. The 'low' quality sites also had nonsignificantly more shrubs (4234/ha vs 1785/ha) and a higher percent of nonindigenous shrubs (5% vs 17%). The presence of nonindigenous trees and shrubs was one of the characteristics used to define 'high' and 'low' natural quality.
Paired t-tests indicated that within each pair of plots, the 'high' quality site had significantly more leaf litter cover and lower tree canopy cover in April, and deeper and more leaf litter cover and less exposed soil in June, and more down wood, than the 'low' quality site (Table 4). Nonindigenous shrubs were significantly denser in the 'low' quality site of each pair, as would be expected, as the abundance of nonindigenous shrubs was one of the characteristics used to define 'low' natural quality.

Decorana of groundlayer vegetation in both April and June separated the Will County sites from the Lake County sites along the first axis, and grouped plots within preserves along the second axis (Figure 7a). Decorana of overstory trees separated the 'high' quality sites from the 'low' quality sites along the first and second axes (Figure 7b). No correlations were detected between amphibian abundance or diversity and forest composition.

DISCUSSION

Amphibian abundance was strongly influenced by the presence of water. Sites with deeper ponds that dried later in the summer supported more amphibians (especially salamanders and toads) than shallow ponds that dried early in the summer. Sites that were located near other ponds also supported significantly more salamanders and toads. Interestingly, frog (but not salamander or toad) abundance was significantly related to the distance to the nearest pond; frog abundance in April increased as the distance to other ponds decreased. Neither the size of the pond (surface area in square meters) nor the distance to the forest edge was associated with any of the amphibian measures.

The importance of water to amphibian abundance was not unexpected, as all amphibians encountered in this study are pond-breeders. The relationship between upland forest vegetation and amphibians was surprisingly simplistic; sites with greater herbaceous cover in June supported more amphibians (especially salamanders and frogs) than sites with less herbaceous cover. While salamanders have long been associated with abundance of down wood (Welsh and Lind 1995, Dupuis et al, 1995), we found no relationship between salamanders and the number of logs, the area of log contact, the amount of down wood, or the abundance of well decayed wood.

The number and diversity of amphibian species were also closely correlated with June herbaceous cover and pond drydate, and with two additional features; cover of leaf litter in April, and distance to the nearest pond. Sites with $\leq$80% leaf cover supported zero to one species, while sites with >90%

leaf cover supported four to five species. Potentially, leaf cover provided protection from predation and desiccation. Ash (1997) suggested that leaf litter provided an important foraging habitat for plethodontid salamanders in the Blue Ridge Mountains, and that changes in leaf litter characteristics could affect both moisture and food availability. A study by deMaynadier and Hunter (1998) determined that litter cover was an important habitat feature for amphibians in general. Sites located near (<200m) another potential breeding pond supported an average of 3.8 amphibian species, while sites located far (>400m) from a potential breeding pond averaged just 1.5 species. Both spotted and blue-spotted salamanders adults tend to remain near the breeding pond, but some individuals migrate between ponds (Semlitsch 1998). This migration allows both genetic and demographic exchange among established populations (Gill 1978, Berven and Grudzien 1990) and to colonization of new (or former) breeding sites (Laan and Verboom 1990). Several studies have documented an increased risk of amphibian extinction at isolated ponds (Sjogren-Gulve and Ray 1996; Sjogren-Gulve 1994). In general an assemblage of amphibians, or any other taxa, is more likely to persist over the long term when it is a component of a functioning metapopulation (Hanski 1997).

In this study, salamander abundance was strongly and positively associated with the number of nearby potential breeding ponds, as also found with other amphibians (Vos and Stumpel 1995). A single-year study cannot document source-sink relationships (Pulliam 1997), but we suggest that long-term viability of salamander populations requires presence of several breeding ponds within a site. In the Chicago Region, forested sites with breeding ponds are often isolated by streets and urban development, and salamanders can rarely if ever migrate between these sites (deMaynadier and Hunter 2000, Gibbs 1998). Consequently, migration between breeding ponds is frequently restricted to within-sites.

The length of time that the ephemeral ponds retained water was closely associated with abundance of salamanders and toads in June. This relationship reflected the presence of juveniles emerging from ponds that held water longer. The four sites that dried before June 28 had no recruitment; five sites that dried in the first week of July had low recruitment, and two of the three sites that retained water past July 10 had high recruitment. These results indicate that (in the Chicago Region, at least) some percentage of *Ambystoma maculatum* can develop from egg to juvenile in approximately 130 days. The actual percentage of larvae that emerge prior to mid July is likely low, as a minimum of 154 days is needed for just 10% of Pennsylvania *A. maculatum* larvae to achieve metamorphosis (Rowe and Dunson 1995).

At four ponds which dried on or before June 28 (Ryerson 5, Lake-Cook, Plum West, Plum East) only one juvenile amphibian, a *Pseudacris triseriata*, was captured. This species is typically the first to achieve metamorphosis in Chicago region ponds. Assuming that this dry date is typical, it is unlikely that juvenile recruitment of most amphibian species occurs at these four locations except perhaps in exceptionally wet years. Most adult amphibians inhabiting terrestrial habitat at these sites are almost certainly immigrants from nearby ponds. At Lake-Cook, which is isolated from other ponds by roads and residential development, the combination of an early drying pond and lack of available movement corridors has apparently resulted in complete amphibian extirpation. No amphibians were caught at that site in drift fences, time-constrained visual encounter surveys, or seining of the pond. No calling frogs were heard, and no egg masses were noted. Amphibians were known historically from the immediate vicinity (Field Museum of Natural History collection, and Richard A. Edgren Jr.; KSM personal communication, March 3, 2000).

Five ponds dried between July 2 and July 6 (Dan Wright, Elm South, Ryerson South, Ryerson North, and MacArthur). Low numbers of juvenile *Ambystoma laterale* were captured at the first three ponds. No juveniles were observed at the other two ponds, and none of the five ponds had captures of more than one species of juvenile amphibian. When juvenile *A. laterale* were captured, they made up a relatively high percentage of total captures for that species (30-40%) because the number of adult captures was also low. Unpredictable annual variation in juvenile survival at these ponds may limit the size of the adult population.

One pond (Elm North) dried on July 16. Juveniles of three species of amphibians were captured (*Ambystoma laterale*, *Bufo americanus*, *Pseudacris crucifer*) and a fourth (*Rana pipiens*) was observed in the dry pond basin but not captured. Juveniles were more abundant than at earlier drying ponds, but made up only 16.8% of total observations because adult amphibians were more common here than at any other site. The forest adjacent to this pond also had the highest amount of June herbaceous cover (81%).

Two ponds (Thorn 19 and Thorn 13) did not dry in 1999 and are believed to be permanent most years. At Thorn 19 juveniles made up 48.6% of the captures for three species (*Ambystoma laterale*, *Ambystoma maculatum*, and *Bufo americanus*). At Thorn 13 only toad juveniles were captured, and few amphibians of any age class were observed. These disparate results are difficult to interpret, because predator-prey relationships and competitive dynamics are likely very different in permanent ponds relative to the ephemeral ponds at most sites. Larval survival or growth rates could differ in the two ponds. Alternatively, the lower amount of herbaceous cover in June at Thorn 13 could result in higher predation on juveniles, increased desiccation, or an inability to move far enough from the pond to encounter drift fences.

In the Chicago Region, amphibians must contend with multiple impacts; habitat loss as well as habitat isolation due to roads and urban development, and historic and ongoing hydrological alteration. At the beginning of this study we assumed that all ponds were essentially 'undisturbed', based on visual assessment and general site history. We found during the course of this study that three of the 12 sites had anthropogenic alteration; the area surrounding the MacArthur pond had been drained many years prior, isolating the pond hydrologically from other ponds; the pond at Plum West was drained by a ravine that had been 'straightened' at a prior date and subsequently eroded back into the pond margin; and the pond at Lake-Cook on at least one occasion appeared to receive storm runoff from the right-of-way of a heavily trafficked four-lane highway, with the associated contaminants (we did not assess water quality in the ponds). We noted shallow ditches or tiles near other ponds, including two at Ryerson Woods, which did not directly drain the ponds but may have influenced runoff rates. It has also been suggested that reduced herbaceous vegetation contributes to more rapid runoff and a lowered water table (Swink and Wilhelm, 1994), although we did not document this relationship in this study.

Our study documented surface water conditions at 12 ponds in a year with a wet early spring and a dry late spring and summer. Longer-term conditions are more complex: We noted in February/

March 2000 that at least two of the 12 ponds (MacArthur and Lake-Cook) were still dry. Ponds in areas with high clay content soils, including Ryerson North and Ryerson 5, held snowmelt and had sufficient water on March 8, 2000 to support calling *Pseudacris triseriata* and *Pseudacris crucifer*. It would be useful to investigate the effect of pond hydroperiod on amphibians with a multi-year hydrology study addressing relative degree of groundwater and surface water influence on each pond, permeability of underlying soils, and influence of historic drainage.

Assessing amphibian abundance at different seasons (April and June) provides insight into temporal responses to habitat features. There was little correlation between the abundance of amphibians in April, based on drift fence data, and their abundance in June, and all three species groups (salamanders , toad, and frogs) were associated with different features in April and June. Because these animals occupy the sites on a year round basis, using data from a single season or a single species group may provide a one-sided assessment of the suitability of an upland site to support amphibians. Collecting data over multiple years would allow a better assessment of the long-term usefulness of any particular site.

We found no relationship between drift fence sampling and time constrained visual encounter surveys. Drift fences are effective for sampling nocturnal and fossorial species such as salamanders of the genus *Ambystoma* and many frogs, but are less effective with large active species able to climb over the fence. Visual encounter surveys will often encounter these more active species, although in our study 96% of the

captures were of *Ambystoma laterale*. Used in combination, these two methods can provide an accurate survey of the fauna at a given location (Heyer et al., 1994; Karns, 1987).

When we grouped sites on the basis of higher vs lower amphibian abundance, we found that sites with more amphibians had significantly more herbaceous vegetation in both April and June than sites with few amphibians. (18% vs 11% in April, and 65% vs 44% in June). We were unable to find significant differences in terms of down wood, overstory cover or composition, herbaceous species richness or other site characteristics that could explain the differences in observed amphibian abundance. While other studies have found strong correlations between upland habitat structure and salamander abundance, many of these studies assessed sites with substantial macroscale differences, such as logged vs unlogged (Renken 1997, Petranka et al. 1993), different community types (Beauregard and Leclair 1988), or moisture gradients. In this study, we investigated sites that were similar on a macroscale (all were upland forests adjacent to flatwoods ponds in the Chicago Region) but differed substantially on a microscale. Thus, it is not unexpected that our results differ from those of previous studies. Alternatively, it may imply that other unmeasured variables are important to salamander density, or that salamanders are surviving in vestigial habitats. Adult salamanders are long-lived, and gradual change in habitat may have delayed impacts on salamander density, in contrast to rapid change such as logging. Without longterm data to determine trends (increased or decreased density over time at each site) it is difficult to determine factors responsible for different amphibian abundances in these forests adjacent to flatwoods ponds.

We were interested in whether the quality of the upland forest community was related to amphibian abundance and diversity. We predicted that 'high' quality sites would support more individuals and more species than 'low' quality sites. Amphibian species richness and diversity were both significantly higher in 'high' quality forests than in 'low' quality forests, supporting the second part of our hypothesis. The first part of the hypothesis was not supported: Although the six 'high' quality sites (INAI Grade B) supported more than twice the number of salamanders, frogs, and toads than the six 'low' quality sites (INAI Grade C and D), these differences were not significant (Table 4).

Rather than two distinct groups of 'high' and 'low' natural quality in the same community type, our 12 study sites formed a gradient in natural quality within three community types. We believe this is an artifact of the low number of sites (12) and the inherent variability between natural communities and along the quality gradient, resulting in considerable noise in the data set. This problem could be addressed in future by including a much larger number of sites.

Sites varied substantially in vegetation structure and composition. This heterogeneity may have obscured any relationship between natural quality and amphibian abundance. Sites also varied in natural quality. While the two Grade D sites (Lake-Cook and Thorn13) supported the fewest amphibians, and two of the Grade B sites (Elm North and Thorn 19) supported the most amphibians, the remaining eight sites did not follow a consistent pattern. Three Grade C sites (Daniel Wright, Plum East, and Ryerson South) supported more amphibians than their paired Grade B sites. When only salamanders were considered, two of the Grade C sites (Daniel Wright and Ryerson South) still supported more animals than their paired Grade B sites. We conclude that the suite of characteristics used to determine natural quality are not necessarily the features that characterize suitable upland habitat for amphibians in general and salamanders in particular, although there may be substantial overlap.

Natural quality is an arbitrary and qualitative assessment of site degradation. Sites with a history of logging, grazing, fire exclusion, alien species invasion, etc., are deemed to have lower natural quality (less resemblance to presettlement conditions) than sites without these impacts. While this concept intuitively holds true, no studies have been conducted to document and substantiate this assumption. Basic parameters such as tree density, basal area, and groundlayer species richness, are insufficient measures of natural quality. Likely, a combination of factors, including abundance of species considered 'conservative' vs 'disturbance-adapted', density of trees in a range of size classes, age since disturbance, and degree of disturbance (including both direct anthropogenic disturbance, such as logging and grazing, and indirect anthropogenic disturbance such as excessive white tailed deer herbivory and localized lowering of the water table) will be necessary to verify the validity of the natural quality assessment.

This study was preliminary, looking only at 12 sites. Each preserve had several ponds to select from, and within forested tracts monitored ponds were selected more or less at random. Selecting different ponds would have produced different results; we suggest increasing the number of study sites, and monitoring multiple ponds within a forest to obtain insight into the actual relationships between ponds, upland forest, and amphibian abundance and diversity. In March 2000 (after this study was concluded) we established drift fences at an additional four ponds at MacArthur. Capture rates for a single night (March 8) ranged from none at the 1999 pond to 75 individuals at a pond just 400m north. The 1999 pond was dry on March 8 2000, and the adjacent upland forest had very little herbaceous vegetation. The new pond had shallow water, and part of the adjacent flatwoods forest was densely vegetated. Based on this study, and the additional drift fence work in MacArthur, we conclude that 1) There is substantial variation in salamander and amphibian abundance among the ponds within individual sites. 2) This variation is related to the length of time that an individual pond holds water and the number of nearby ponds, which in turn is affected by site-wide hydrologic conditions. Hydrology is likely the primary limiting factor for Chicago Region amphibians; 3) This variation is also related to the abundance of groundlayer vegetation in the adjacent forest. We suggest that forest vegetation structure is a limiting factor, but only IF a site is sufficiently large and with several ponds to allow between-pond migration, and IF some of those ponds hold water long enough to allow larvae to achieve metamorphosis.

It may be possible to test the relationship between upland forest structure and amphibian success. Elm North, with the highest amphibian abundance of the 12 sites, was the only actively managed site; understory saplings were removed and the site had been prescribed burned in prior years. Other researchers have assessed amphibian response to natural area management activities, including shrub removal and prescribed burning, and documented a positive response for at least some species (Mierzwa, 1997; Palis, 1994; Kirkland et al., 1996). We suggest that similar management be conducted on Elm South, and the abundance of amphibians and community structure be monitored over time in both sites. If the relative abundance of amphibians in Elm South increases with management, then the characteristics of the managed sites may be assumed to provide better upland forest habitat. Conducting this same study in two or more sites (we suggest MacArthur Woods and Thorn Creek) would provide replication and permit a broader application of results.

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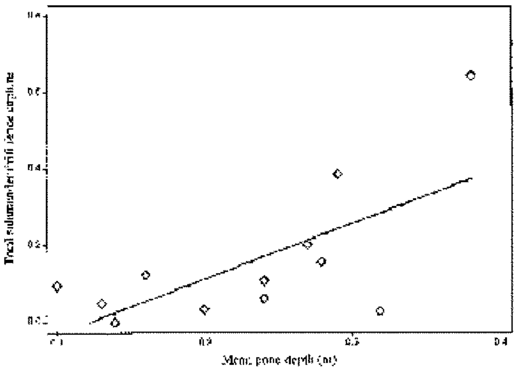

Figure 2a. Salamander abundance relative to pond depth.

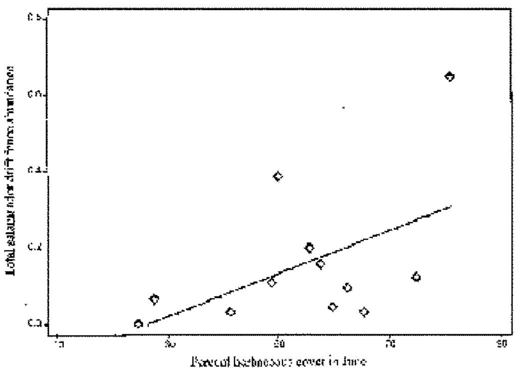

Figure 2b. Salamander abundance relative to herbaceous vegetation.

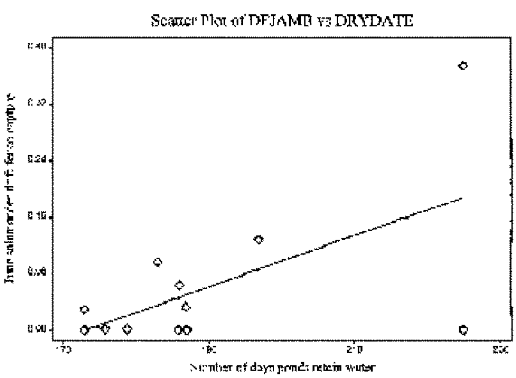

Figure 2c. Salamander abundance relative
to pond drydate.

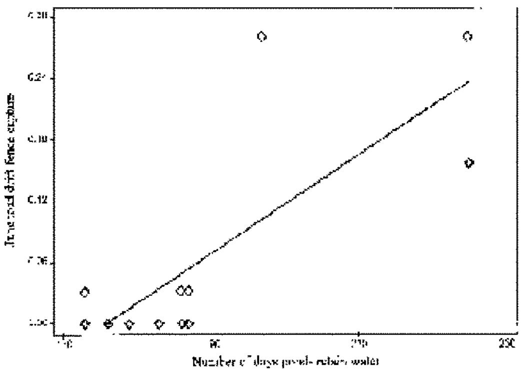

Figure 3a. Toad abundance relative to pond drydate.

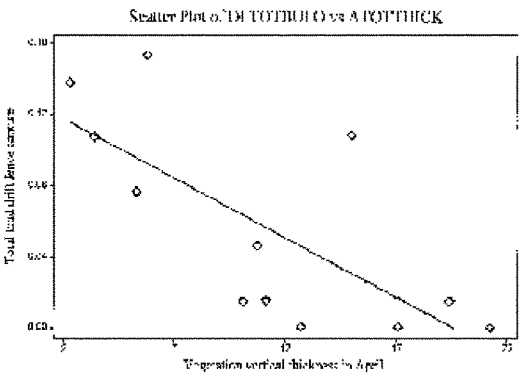

Figure 3b. Toad abundance relative to
vegetation vertical thickness in April.

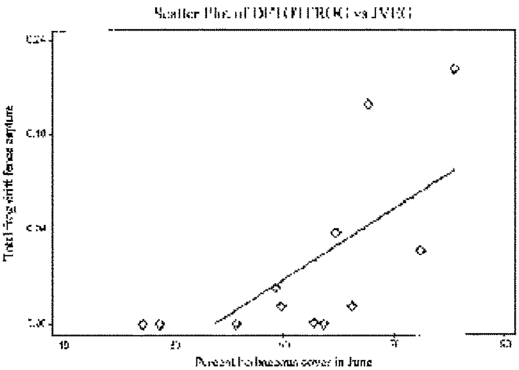

Figure 4a. Frog abundance relative to
herbaceous cover in June.

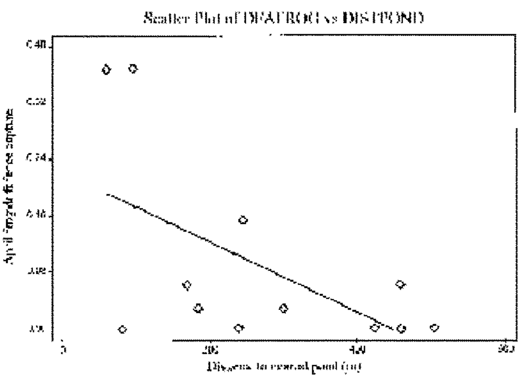

Figure 4b. Frog abundance relative to
distance to nearest pond.

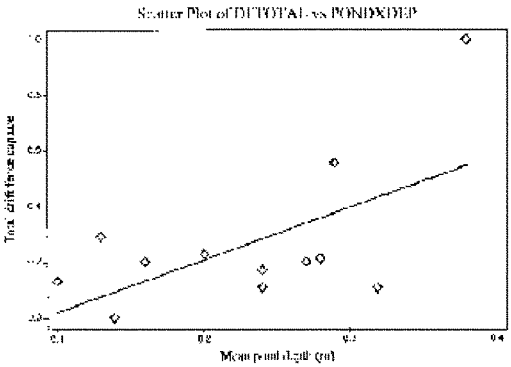

Figure 5a. Total amphibian abundance relative to mean pond depth.

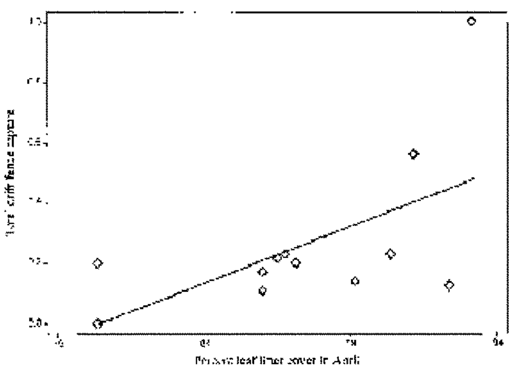

Figure 5b. Total amphibian abundance relative to leaf litter cover in April.

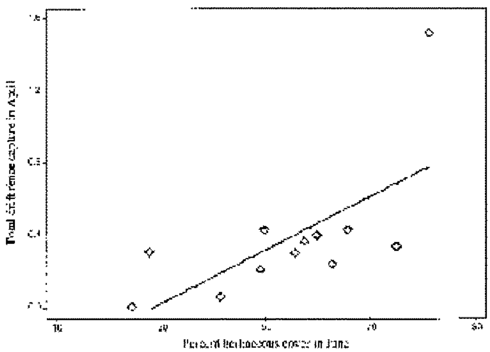

Figure 6a. Total drift fence captures in April relative to herbaceous cover in June.

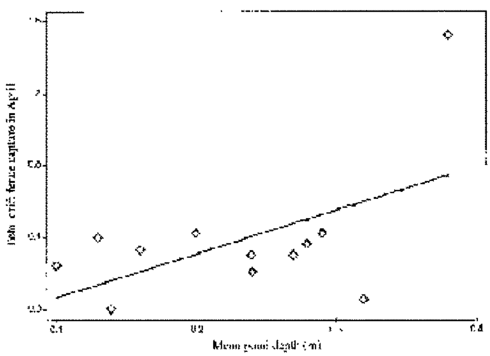

Figure 6b. Total drift fence captures in April
relative to mean pond depth.

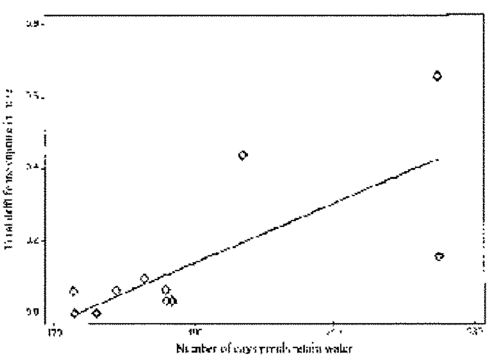

Figure 6c. Total drift fence captures in June
relative to pond drydate.

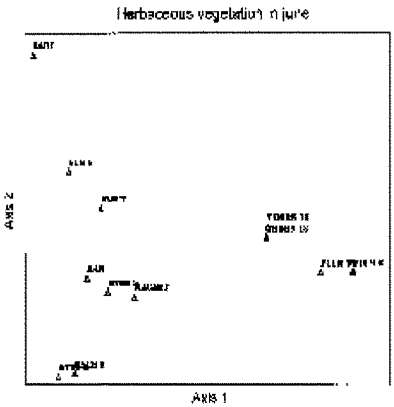

Figure 7a. Decorana of groundlayer vegetation.

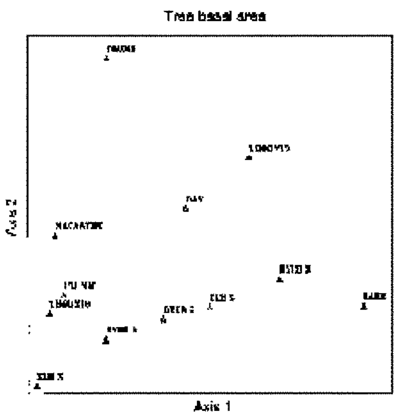

Figure 7b. Decorana of overstory trees.

Appendix A. Common and Scientific Names of Amphibians and Reptiles Observed During This Study. Nomenclature follows Collins, J. T., Standard common and current scientific names of amphibians and reptiles. Society for the Study of Amphibians and Reptiles Herpetological Circular

Amphibians

Blue-spotted salamander	*Ambystoma laterale*
Spotted salamander	*Ambystoma maculatum*
American toad	*Bufo americanus*
Gray treefog	*Hyla versicolor*
Spring peeper	*Pseudacris crucifer*
Western chorus frog	*Pseudacris triseriata*
Green frog	*Rana clamitans*
Northern leopard frog	*Rana pipiens*

Reptiles

Brown snake	*Storeria dekayi*
Common garter snake	*Thamnophis radix*

http://www.riverwoods-il.net/Government/municipal.html

Chapter 6
WOODLAND PROTECTION

9-6-1: TITLE:

This chapter shall be known, cited and referred to as the *RIVERWOODS WOODLAND PROTECTION ORDINANCE.* (Ord. 05-2-2, 2-1-2005)

9-6-2: FINDINGS OF THE BOARD OF TRUSTEES:

A. The plan commission of the village of Riverwoods on June 3, 2004, conducted a public hearing on the question of adopting a zoning text amendment under the Riverwoods zoning ordinance for the purpose of protecting woodlands, and submitted its report to the board of trustees recommending that a woodland protection ordinance be considered to protect woodland areas in the village.

B. The board of trustees conducted a public hearing and town meeting on December 7, 2004, and received testimony from Mr. Charles Stewart, President, Urban Forest Management, Inc., who has served as village forester since 1976; Dr. George Ware, Ph.D., Dendrologist Emeritus at the Morton Arboretum; Mr. Steve Swanson, director of the Kennecott Grove National Historic Area in Glenview, Illinois; Mr. Mark O'Leary, M.S., senior ecologist with Applied Ecological Services, Inc., an ecological consulting, contracting and restoration firm; and Mr. Patrick Glenn, P.E., with Gewalt Hamilton Associates, Inc. ("GHA"), the engineering firm that serves as village engineer. At such town meeting, GHA presented its report entitled "Report On Woodland/Turfgrass Hydrology, Using NRCC TR-55 Hydrological Methods", dated December 2004, prepared by GHA (the "GHA Report").

C. The urban forest research unit of the USDA forest service, Northeastem Research Station in Syracuse, New York, was established in 1978, to investigate the effects of urban forests and their management on human health and environmental quality, and it has developed the urban forest effects (UFORE) model, which model is used to quantify the following:

1. Urban forest structure by land use type (e.g., species composition, tree density, tree health, leaf area, leaf and tree biomass, species diversity, etc.);

2. Hourly amount of pollution removed by the urban forest, and its associated percent air quality improvement throughout a year. Pollution removal is calculated for ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide and particulate matter (<10 microns);

3. Hourly urban forest volatile organic compound emissions and the relative impact of tree species on net ozone and carbon monoxide formation throughout the year;

4. Total carbon stored and net carbon annually sequestered by the urban forest;

5. Effects of trees on building energy use and consequent effects on carbon dioxide emissions from power plants;

6. Compensatory value of the forest, as well as the value of air pollution removal and carbon storage and sequestration;

7. Tree pollen allergenicity index;

8. Potential impact of gypsy moth and Asian longhorned beetle infestation;

9. Tree transpiration.

The urban forest research unit of the USDA forest service, Northeastern Research Station in Syracuse, New York, has modeled numerous cities in the United States and published its results quantifying the direct, favorable ecological and financial benefits of maintaining urban forests.

D. After reviewing the expert testimony and reports presented to the board of trustees and the published research available to quantify the economic benefits of urban forests, the board of trustees adopts the following findings as the basis for adoption of this chapter and intends that this chapter be interpreted in the light of such findings:

1. Approximately ninety percent (90%) of the areas within the village's R-1, R-2 and R-3 single-family residential zoning districts (excluding subdivisions developed as planned unit developments) are located within the mixed hardwood forest and woodland landscape that is the characteristic natural ecological system in the village.

2. In the village's woodland ecosystem, the canopy, understory and ground plane (herbaceous) levels each have characteristic species. Characteristic ground plane plants include trillium, wild geranium, grasses, sedges and native vines such as Virginia creeper. Characteristic species in the understory level (referred to be common names) include ironwood, blue beech, hawthorn, eastern redbud and smaller trees and shrubs. The canopy level is dominated by the following species and their cultivars: red maple, sugar maple, silver maple, black cherry, hickory, elm, hackberry, eastem cottonwood and

oak species. Additional canopy trees can include American basswood, ash, black locust, northern catalpa, pine, walnut, and willow trees.

3. The natural woodland ecology in the village is modified and pressured by human activity and development, the presence of deer herds, in particular, and other wildlife and insect populations, and the proliferation of nonnative, invasive species, such as buckthorn and garlic mustard. Human activity in the form of replacing native understory and ground plane plants with turfgrass is also a negative factor in the maintenance of healthy woodlands because each of the three (3) native components of the woodlands - the upperstory, understory and ground plane - is necessary for the continued regeneration of native trees and plants.

4. Since 1976, the village's woodlands have diminished in quantity and in the quality of the plant community as a result of the pressure factors that are described above. As a result, the village's woodlands have become more fragmented and have suffered a loss in the ability to regenerate the more desirable species of trees and plants of the native landscape.

5. For the natural woodland ecology in the village to remain self-sustaining, it is necessary to take steps to reduce the further loss and fragmentation of woodland areas resulting from human activity in order that the woodland trees and plants can more readily resist the pressure factors resulting from nonhuman factors.

6. The village should continue to monitor the work of the Lake County forest preserve district in maintaining the deer population at a level that can be supported by the environment; the village should continue to work with other governmental units to minimize and control infestations of gypsy moth, Asian longhorned beetles and similar pests; and the village should continue to support woodland restoration by educational efforts and by providing assistance to residents seeking to eliminate nonnative, invasive species from their properties. The actions referred to in this section should be coordinated with the provisions in this chapter regulating the removal of protected woodlands to establish the best possible conditions for the health of the woodlands.

7. The woodlands in the village, as demonstrated in the "GHA Report", significantly reduce the volume and rate of storm water runoff produced under various land use conditions in the village in comparison to the volume and rate of storm water runoff in turfgrass lawn areas. The "GHA Report" is incorporated in this chapter as if fully set forth herein. Lessening the removal of herbaceous plants and understory trees and the substitution of turfgrass in place thereof will reduce storm water runoff and lessen the severity of local flooding in the village.

8. The maintenance of a healthy woodland environment in the village provides the following benefits: shade and cooling; control of erosion; filtering of water pollutants from storm water; recharging of aquifers used by residents for drinking water; replenishment of the ground water table; maintenance of flows into wetlands and streams; cleansing of air of pollutants; mitigation of global warming by absorbing greenhouse gases; and promotion of a biologically diverse community of microorganisms, plants and animals, protecting some species from extinction while preserving genetic diversity. The urban forest effects (UFORE) model developed by the urban forest research unit of the USDA forest service, Northeastern Research Station in Syracuse, New York, has been used to quantify the dollar benefits of urban forests, and such models indicate that there is a significant quantifiable benefit from woodlands in respect of the benefits described above, and such findings demonstrate that the village's urban forest cover produces significant quantifiable benefits.

9. The regulations proposed in this chapter, in the severest case of applicability, nevertheless will allow for a building envelope which is sufficient for the construction of a main dwelling and multiple combinations of accessory uses (such as a tennis court and swimming pool and an accessory

building) that, in size and extent, would be comparable to intensely developed, existing residential properties in the village except in the degree to which woodlands have been removed. The protection of woodlands will promote higher property values for woodland areas in the village. The regulations proposed in this chapter will not unreasonably restrict development nor constitute an arbitrary and capricious exercise of municipal powers.

10. The preservation of woodland areas in the village will provide many essential benefits to the community as a whole, as described in the foregoing subsections, and, accordingly, the adoption of a long term policy of preserving woodland areas is necessary to safeguard, protect and promote the health, safety and welfare of the current and future inhabitants of the village and surrounding areas. (Ord. 05-2-2, 2-1-2005)

9-6-3: AUTHORITY:

This chapter is adopted under authority vested in the village under the provisions of the Illinois municipal code, including 65 Illinois Compiled Statutes 5/11-12-4, 5/11-12-5, 5/11-12-6, 5/11-13-1, 5/11-14-1, 5/11-20-4, 5/11-30-2, and 5/11-125-1. (Ord. 05-2-2, 2-1-2005)

9-6-4: DEFINITIONS:

For purposes of this chapter: The terms "tree", "protected tree", "highly desirable tree", "diameter breast height" and "village forester" shall have the meanings given in the Riverwoods tree preservation ordinance, as amended (title 5 of this code); the terms "building", "structure", "accessory building or structure", "deck", "patio", "playhouse" and "lot" shall have the meanings given in section 9-2-3 of this title. Other terms used in this chapter are defined below. All defined terms used in this chapter include the singular as well as plural forms of such terms.

EFFECTIVE DATE: The original effective date of this chapter is February 1, 2005.

NOXIOUS SPECIES: Undesirable, nonnative tree and plant species such as Acer negundo (Box Elder), Rhamnus cathartica (common buckthorn), Rhamnus fragula (smooth buckthorn), Ailanthus altissima (tree of heaven), Elaeagnus angustifolia (Russian olive), Elaeagnus umbellate (autumn olive), Populas alba (white poplar), Ulmus pumila (Siberian elm), Alliaria petiolata (garlic mustard) and similar species that displace and compete with native plants and harm natural associations among native plants in the Riverwoods woodland plant community.

PROTECTED WOODLAND: A contiguous area, containing a stand of deciduous trees whose total combined canopy covers an area of ten thousand (10,000) square feet or more, and more generally consisting of the canopy, understory and ground plane elements characteristic of the Riverwoods woodland plant community. A protected woodland as herein defined shall be deemed to exist notwithstanding that: a) its boundaries traverse across lot lines of different owners, b) there is an uneven distribution of canopy, understory or ground plane elements within the area, and c) there is a significant presence of noxious species which have degraded the Riverwoods woodland plant community.

REMOVE OR REMOVAL: The physical detachment or elimination of, or the effective detachment or elimination of, one or more elements of the canopy, understory or ground plane (herbaceous) levels in protected woodland, through damage, cutting of major vegetation to the ground, complete extraction, killing by spraying or application of herbicides, root cutting or other material disturbance, or by improving, building upon or covering the protected woodland with, for example, any of the following items, so that the protected woodland no longer remains in a natural condition suitable for the continued propagation of the protected woodland: buildings; accessory buildings or structures, including swimming pools and tennis courts, decks, parking areas, including all paved areas used for parking or access to those areas, drives, aisles, sidewalks and loading areas; patios; any graveled, paved or hard surfaced area; any turfgrass (such as Kentucky bluegrass, fine fescue, perennial ryegrass, bentgrass roughstalk, bluegrass, tall fescue). Without limitation of the foregoing, "remove" or "removal" does not include the pruning of protected trees in accordance with national pruning standards.

RIVERWOODS WOODLAND PLANT COMMUNITY: The native tree and plant species indigenous to the village's woodland ecosystem. The village's woodland ecosystem consists of the canopy, understory and ground plane (herbaceous) levels, each of which has characteristic species and which coexists in an interrelated plant community as a climax forest (or would coexist as persistent layers in the potential natural vegetation but for the presence of one or more harmful factors). Characteristic ground plane plants include trillium, wild geranium, grasses, sedges and native vines such as Virginia creeper. Characteristic species in the understory level include Capinus caroliniana (blue beech), Ostrya virginiana (ironwood), Crataegus spp. (hawthorn), Cercis canadensis (eastern redbud) and smaller trees and shrubs. The canopy level is dominated by the following species and their cultivars: Acer rubrum (red maple), Acer saccharum (sugar maple), Acer saccharinum (silver maple), Prunus serotina (black cherry), Carya spp. (hickory species), Ulmus spp. (elm species), Celtis occidentalis (hackberry), Populus deltoides (eastern cottonwood) and Quercus spp. (oak species). Additional canopy trees include Tilia americana (American basswood), Fraxinus spp. (ash), Robinia pseudoacacia (black locust), Catalpa speciosa (northern catalpa), Juglans spp. (walnut) and trees of the pine genus (Pinus) and of the willow family (Salix). (Ord. 05-2-2, 2-1-2005)

9-6-5: PURPOSE:

The purpose of this chapter is to preserve woodland areas within the village by regulating and limiting the removal of protected woodlands in order to safeguard the benefits of the Riverwoods woodland plant community for this and succeeding generations. (Ord. 05-2-2, 2-1-2005)

9-6-6: REGULATION OF REMOVAL OF PROTECTED WOODLAND:

A. With respect to any residential lot in the village (other than a lot governed by subsection B of this section), it shall be unlawful for any person to cause or permit any removal of more than thirty percent (30%) of the protected woodland existing on such lot as of the effective date, except that if such lot has never been improved with a single-family dwelling (that is, if such lot exists in a native, undisturbed state), then it shall be unlawful for any person to cause or permit any removal of more than forty percent (40%) of the protected woodland existing on such lot as of the effective date. For purposes of determining the amount of protected woodland on any lot, the woodland areas located in any unpaved portion of any street or street easement shall be counted.

B. If, as of the effective date, any residential lot (vacant or improved) exists which may be further subdivided in accordance with the requirements of this title and which consists of sixty percent (60%) or more of protected woodland, then at least sixty percent (60%) of the area of the lot as a whole shall continue to be maintained as protected woodland regardless of whether any subsequent subdivision or development of the lot occurs. The allocation of protected woodland that must be maintained on each resulting lot shall be specified at the time of subdivision, to ensure compliance with the requirements of this subsection, by means of a restriction in the plat of subdivision or enforceable deed covenant which is approved and enforceable by the village. It shall be unlawful for any person to cause or permit the removal of protected woodland from any lot in violation of this subsection. (Ord. 05-2-2, 2-1-2005)

9-6-7: DELINEATION OF PROTECTED WOODLAND:

When any application for site development permit is made under title 8 of this code, the applicant shall delineate the protected woodland, if any, located on such applicant's lot. The following criteria shall be used in judging compliance with this section:

A. The Riverwoods woodland plant community consists of a plant association of canopy trees, understory trees and shrubs, and woody and herbaceous ground plane plants. It does not include grass lawns, impervious surfaces, or other manmade surfaces such as a horse corral.

B. Protected woodland shall be delineated on a lot by identifying the point where the woodland plant community meets grass lawns, impervious surfaces, or other manmade surfaces.

C. The woodland delineation flags shall be placed along the edge of the woodland at a point that defines the critical root zone of the largest canopy tree or understory tree that is in the protected woodland and within thirty feet (30') of the woodland edge.

D. Woodland delineation flags shall be placed as close together as necessary to define the protected woodland, but no farther apart than fifty feet (50').

E. If large canopy trees or understory trees (for this purpose, meaning trees with a diameter breast height of 12 inches or more) are not present within thirty feet (30') along the outer edge of the protected woodland, the woodland delineation flags shall be placed a minimum of ten feet (10') from the edge of the woodland plant community.

The woodland edge that is delineated on the lot shall be reviewed by the village forester, who shall either reject or approve the proposed delineation or approve the delineation with modifications. The delineation, as approved by the village forester, shall be located in the field by a surveyor or engineer and the surveyed location shall be shown on the site plan. No site development permit shall be issued to any person if the proposed development would result in a violation of section 9-6-6 of this chapter. In determining the amount of protected woodland on any lot, an owner may document any additions to the woodland areas located on such owner's lot after the effective date if the owner shall submit a reforestation plan with the village. Such plan shall contain such detail with respect to the cessation of turfgrass cultivation, the removal of other material disturbing the natural surface of the area, the minimum area to be impacted and the adoption of natural landscaping management techniques as shall be specified by the village forester. The amount of protected woodland on such owner's lot as of the effective date shall not be deemed to include the woodland areas established on such owner's lot after the effective date as a result of the implementation of such reforestation plan. (Ord. 05-2-2, 2-1-2005)

9-6-8: CONFLICT WITH OTHER ZONING PROVISIONS:

Where conflict results between the regulations of this chapter and the provisions of the zoning districts in which any lot is located, the regulations of this chapter shall control. (Ord. 05-2-2, 2-1-2005)

9-6-9: PENALTIES:

Whoever violates any of the provisions of this chapter shall be punished by a fine of up to seven hundred fifty dollars ($750.00) for each such violation, and a separate and distinct violation shall be deemed to have occurred for each day that such violation exists. In addition to any fine permitted or required to be imposed hereunder, the village may seek injunctive relief to prevent an actual or threatened violation of this chapter, and may also seek mandatory injunctive relief to require the owner of the lot in question to bring such lot into compliance with this chapter by removing any buildings, structures, landscaping or improvements such owner constructed or installed in violation of this chapter and/or by requiring such owner to prepare and implement a tree reforestation plan to reestablish woodlands on such lot to the extent required in this chapter, the corporate authorities finding that the village and the health, safety and welfare of its residents will be irreparably harmed by the failure to observe the maximum covered area allowances set forth herein, and that the imposition of a fine alone is an inadequate remedy for such violations. (Ord. 05-2-2, 2-1-2005)

REPORT ON WOODLAND/TURFGRASS HYDROLOGY

Using NRCS TR-55 Hydrological Methods

Prepared for:
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December, 2004

GHA Project Number 9770.001

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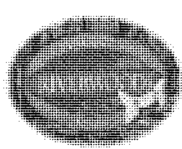


REPORT ON WOODLAND/TURFGRASS HYDROLOGY
USING NRCS TR-55 HYDROLOGICAL METHODS

CONTENTS

1) EXECUTIVE SUMMARY

The United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) has developed analytical hydrologic methods to predict and quantify the volume and rate of stormwater runoff produced under various land use conditions. This report is uses these techniques to examine the hydrologic characteristics of woodland and turfgrass lawn areas.

2) INTRODUCTION AND BACKGROUND

In 1975, the USDA Soil Conservation Service (now the NRCS) published Technical Reference 55 (TR-55), *Urban Hydrology for Small Watersheds* in an effort to provide a reliable method of quantifying stormwater runoff rates and volumes. The NRCS has since updated this publication, most recently in 1999. The techniques described in TR-55 are now in widespread use by engineers for the design of stormwater management facilities.

3) METHODOLOGY

Modeling of stormwater runoff using TR-55 analysis is based on three general parameters:

Rainfall Data

Engineers classify rainstorms by two general features: duration and return frequency. *Duration* is simply the time from the beginning to the end of precipitation, usually expressed in minutes, hours, or days. *Return frequency* is a measure of the intensity of the storm. Naturally, less intense storms occur more frequently than large, heavy storms. Return frequency is often expressed in terms of years, e.g. a "10-year storm" or a "100-year storm".

This convention for expression of return frequency can lead to some confusion. A "100-year storm" is a rainfall event during a specified length of time, that has a one percent (one in one hundred) chance of being equaled or exceeded in any given year. Similarly, a "10-year storm" has a 10% (ten in one hundred) chance of occurring in any year.

Technically, the return frequency is expressed in terms of "percent chance exceedence", e.g. as a "1% chance exceedence event" or a "10% chance exceedence event". Nonetheless, the more common "year" convention is used for this report.

In order to judge the hydrologic responses over a variety of rainfall conditions, the TR-55 watershed prepared for this analysis simulated 28 different rainfall events. Specifically, 1-, 2-, 5-, 10-, 25, 50-, and 100-year storms were each modeled at 3, 12, 24, and 48 hour durations. All rainfall data used was taken from Appendix I of the Lake County Watershed Development Ordinance, attached as Exhibit A.

Storage

The TR-55 methods allow for the simulation of stormwater storage in ponds, lakes, and other localized depressions with the potential to store stormwater runoff. For the "generic" models prepared for this report, all watersheds were assumed to have no storage.

It should be noted, however, that storage potential is, in fact, a likely factor when comparing woodland and lawn hydrology. It is not uncommon for wooded areas to contain small, poorly drained areas which trap runoff and infiltrate it into the ground. While such "pockets" are often unnoticed or not considered objectionable in woodland areas, they are generally considered a nuisance in lawn areas, and are generally filled or otherwise drained as part of establishing a lawn. Unfortunately, the hydrologic methods available do not present a reliable technique for estimating this potential, small-scale storage capacity.

Hydrologic Factors

The third set of parameters involved in TR-55 modeling are the general hydrologic parameters of the watershed, including the watershed area and shape, the land use, the amount of impervious cover, the ground slope and capacity of the underlying soil to absorb water. In a TR-55 analysis, the land use/cover, and soil parameters are combined to produce a composite *curve number* for use in the numeric modeling.

TR-55 distinguishes soils into four *hydrologic soil groups*. 'A' soils have high infiltration rates and readily absorb water, reducing the amount of runoff; "B", "C", soils have moderate and low infiltration rates, respectively, and "D" soils have very low infiltration rates and high runoff potential.

As indicated on the Generalized Soil Map attached as Exhibit B, the Village of Riverwoods is underlain largely with 'D' soils to the north and east and with 'B' soils to the south and west.

In order to account for the predominate soil types in the Village, four sets of hydrologic parameters were compared for this report:

- 2 acres of woodland with 'B' soils,
- 2 acres of turfgrass with 'B' soils,
- 2 acres of woodland with 'D' soils, and
- 2 acres of turfgrass with 'D' soils,

Using these land use characteristics and the hydrologic soil groups, the curve number for each set of parameters was taken from Table 2-2a and 2-2b of the TR-55 manual, attached as Exhibit C.

4) RESULTS

The model results are tabulated as follows (for purposes of comparison with typical units, one acre-foot is approximately 326,000 gallons, and one cubic foot per second (cfs) is approximately 450 gallons per minute):

Return Interval (Years)	Woodland Runoff Volume (Acre-feet)	Lawn Runoff Volume (Acre-feet)	% Increase	Woodland Peak Discharge (CFS)	Lawn Peak Discharge (CFS)	% Increase
1	*	0.001	N/A	*	0.02	N/A
2	*	0.006	N/A	0.01	0.05	400%
5	0.006	0.019	217%	0.05	0.12	240%
10	0.013	0.032	146%	0.10	0.21	110%
25	0.034	0.063	85%	0.23	0.42	83%
50	0.059	0.097	64%	0.39	0.67	72%
100	0.099	0.149	51%	0.67	1.09	63%

* Volume or rate below numerical threshold of model

Table 1: 3-hour event, 'B' Soils

Return Interval (Years)	Woodland Runoff Volume (Acre-feet)	Lawn Runoff Volume (Acre-feet)	% Increase	Woodland Peak Discharge (CFS)	Lawn Peak Discharge (CFS)	% Increase
1	0.035	0.048	37%	0.23	0.34	48%
2	0.057	0.073	28%	0.40	0.54	35%
5	0.091	0.113	24%	0.68	0.87	28%
10	0.121	0.146	21%	0.94	1.15	22%
25	0.183	0.213	16%	1.46	1.73	18%
50	0.241	0.275	14%	1.95	2.25	15%
100	0.323	0.362	12%	2.63	2.99	14%

Table 2: 3-hour event, 'D' Soils

Return Interval (Years)	Woodland Runoff Volume (Acre-feet)	Lawn Runoff Volume (Acre-feet)	% Increase	Woodland Peak Discharge (CFS)	Lawn Peak Discharge (CFS)	% Increase
1	0.005	0.017	240%	0.01	0.04	300%
2	0.012	0.030	150%	0.03	0.07	133%
5	0.031	0.058	87%	0.08	0.15	88%
10	0.051	0.087	71%	0.13	0.24	85%
25	0.097	0.147	52%	0.26	0.43	65%
50	0.146	0.207	42%	0.42	0.62	48%
100	0.221	0.297	34%	0.66	0.89	35%

Table 3: 12-hour event, 'B' Soils

Return Interval (Years)	Woodland Runoff Volume (Acre-feet)	Lawn Runoff Volume (Acre-feet)	% Increase	Woodland Peak Discharge (CFS)	Lawn Peak Discharge (CFS)	% Increase
	0.088	0.108	23%	0.26	0.32	23%
	0.117	0.141	21%	0.35	0.42	20%
	0.174	0.203	17%	0.52	0.6	15%
	0.224	0.257	15%	0.66	0.75	14%
	0.319	0.358	12%	0.94	1.04	11%
	0.408	0.452	11%	1.18	1.29	9%
	0.531	0.579	9%	1.52	1.63	7%

Table 4: 12-hour event, 'D' Soils

Return Interval (Years)	Woodland Runoff Volume (Acre-feet)	Lawn Runoff Volume (Acre-feet)	% Increase	Woodland Peak Discharge (CFS)	Lawn Peak Discharge (CFS)	% Increase
1	0.010	0.026	160%	0.020	0.050	150%
2	0.024	0.049	104%	0.050	0.100	100%
5	0.052	0.088	69%	0.110	0.190	73%
10	0.080	0.125	56%	0.170	0.270	59%
25	0.143	0.204	43%	0.310	0.430	39%
50	0.207	0.280	35%	0.440	0.570	30%
100	0.302	0.391	29%	0.630	0.780	24%

Table 5: 24-hour event, 'B' Soils

Return Interval (Years)	Woodland Runoff Volume (Acre-feet)	Lawn Runoff Volume (Acre-feet)	% Increase	Woodland Peak Discharge (CFS)	Lawn Peak Discharge (CFS)	% Increase
1	0.108	0.131	21%	0.220	0.260	18%
2	0.156	0.184	18%	0.320	0.360	13%
5	0.226	0.260	15%	0.440	0.490	11%
10	0.286	0.324	13%	0.550	0.600	9%
25	0.403	0.446	11%	0.740	0.800	8%
50	0.508	0.556	9%	0.910	0.970	7%
100	0.653	0.706	8%	1.150	1.200	4%

Table 6: 24-hour event, 'D' Soils

Return Interval (Years)	Woodland Runoff Volume (Acre-feet)	Lawn Runoff Volume (Acre-feet)	% Increase	Woodland Peak Discharge (CFS)	Lawn Peak Discharge (CFS)	% Increase
1	0.015	0.035	133%	0.030	0.050	67%
2	0.033	0.062	88%	0.050	0.090	80%
5	0.067	0.108	61%	0.100	0.140	40%
10	0.101	0.152	50%	0.140	0.190	36%
25	0.174	0.241	39%	0.220	0.280	27%
50	0.247	0.328	33%	0.290	0.360	24%
100	0.356	0.453	27%	0.400	0.470	18%

Table 7: 48-hour event, 'B' Soils

Return Interval (Years)	Woodland Runoff Volume (Acre-feet)	Lawn Runoff Volume (Acre-feet)	% Increase	Woodland Peak Discharge (CFS)	Lawn Peak Discharge (CFS)	% Increase
1	0.128	0.153	20%	0.140	0.160	14%
2	0.181	0.211	17%	0.190	0.210	11%
5	0.260	0.295	13%	0.260	0.280	8%
10	0.327	0.367	12%	0.320	0.340	6%
25	0.455	0.501	10%	0.420	0.450	7%
50	0.571	0.621	9%	0.520	0.540	4%
100	0.731	0.785	7%	0.640	0.670	5%

Table 8: 48-hour event, 'D' Soils

6) CONCLUSIONS

The model results indicate that the quantity and rate of stormwater runoff from lawn areas is greater than that produced by woodland areas. The difference is most pronounced for low-intensity, short-duration storms, and gradually diminishes with increasing duration and intensity. For long-duration, very heavy storms, the difference is negligible between the two land uses. Also, the increase in runoff from lawn areas is less pronounced over 'D' (very low permeability) soils than over 'B' (moderate permeability) soils.

From a qualitative standpoint, these results make sense. During short, gentle rainstorms, the middle and upper story of a woodland area tend to intercept rain before it reaches the ground. However, this capacity for storage is limited, and as the storm duration and/or intensity increase, the attenuation effect is decreased.

Furthermore, in areas of low-permeability soils, it is reasonable to expect that the hydrologic effects of land cover would be less influential; if the ground cannot absorb water, it makes little difference what is on the surface.

Although stormwater issues are generally focused on flooding following extreme rain events, it is important not to overlook the effects of more frequent rains. Generally speaking, people are willing to accept some non-damaging flooding after unusually heavy rains; the majority of drainage complaints in the Village of Riverwoods involve nuisance issues related to slow or poor drainage following common rainfall events. So while the development of wooded areas to residential lawns may have little effect on damaging flooding, the potential exists for adverse impact on drainage in general.

APPENDIX I

Rainfall Depth-Duration Frequency Tables for Lake County
Rainfall is in inches

Duration	1 year	2 year	5 year	10 year	25 year	50 year	100 year	*Mult. factor
5 min	0.28	0.34	0.41	0.47	0.57	0.66	0.78	0.12
10 min	0.49	0.59	0.71	0.81	1.00	1.16	1.37	0.21
15 min	0.63	0.76	0.92	1.05	1.28	1.49	1.76	0.27
30 min	0.87	1.04	1.26	1.44	1.76	2.04	2.41	0.37
1 hour	1.10	1.32	1.60	1.82	2.23	2.59	3.06	0.47
2 hour	1.36	1.62	1.97	2.25	2.76	3.19	3.77	0.58
3 hour	1.50	1.79	2.18	2.48	3.04	3.52	4.16	0.64
6 hour	1.76	2.10	2.55	2.91	3.56	4.13	4.88	0.75
12 hour	2.04	2.44	2.96	3.38	4.13	4.79	5.66	0.87
18 hour	2.21	2.63	3.20	3.65	4.47	5.17	6.11	0.94
24 hour	2.35	2.80	3.40	3.88	4.75	5.50	6.50	1.00
48 hour	2.54	3.02	3.67	4.19	5.13	5.94	7.02	1.08
72 hour	2.73	3.25	3.94	4.50	5.51	6.38	7.54	1.16
120 hour	3.25	3.93	4.91	5.70	6.93	8.04	9.96	**6 county
240 hour	4.12	4.95	6.04	6.89	8.18	9.38	11.14	**6 county

References: *IDNR / OWR Floodplain Map Revision Manual March 1996 Bulletin 70 1988*

<u>*Multiplication Factor</u> - Average ratios of X-hour/24-hour rainfall for Illinois, 1989 Bulletin 70.
<u>**6 County</u> - A multiplicative factor is not available for these storm events. Therefore, the 6-county Bulletin 70 data is used for regulatory studies.

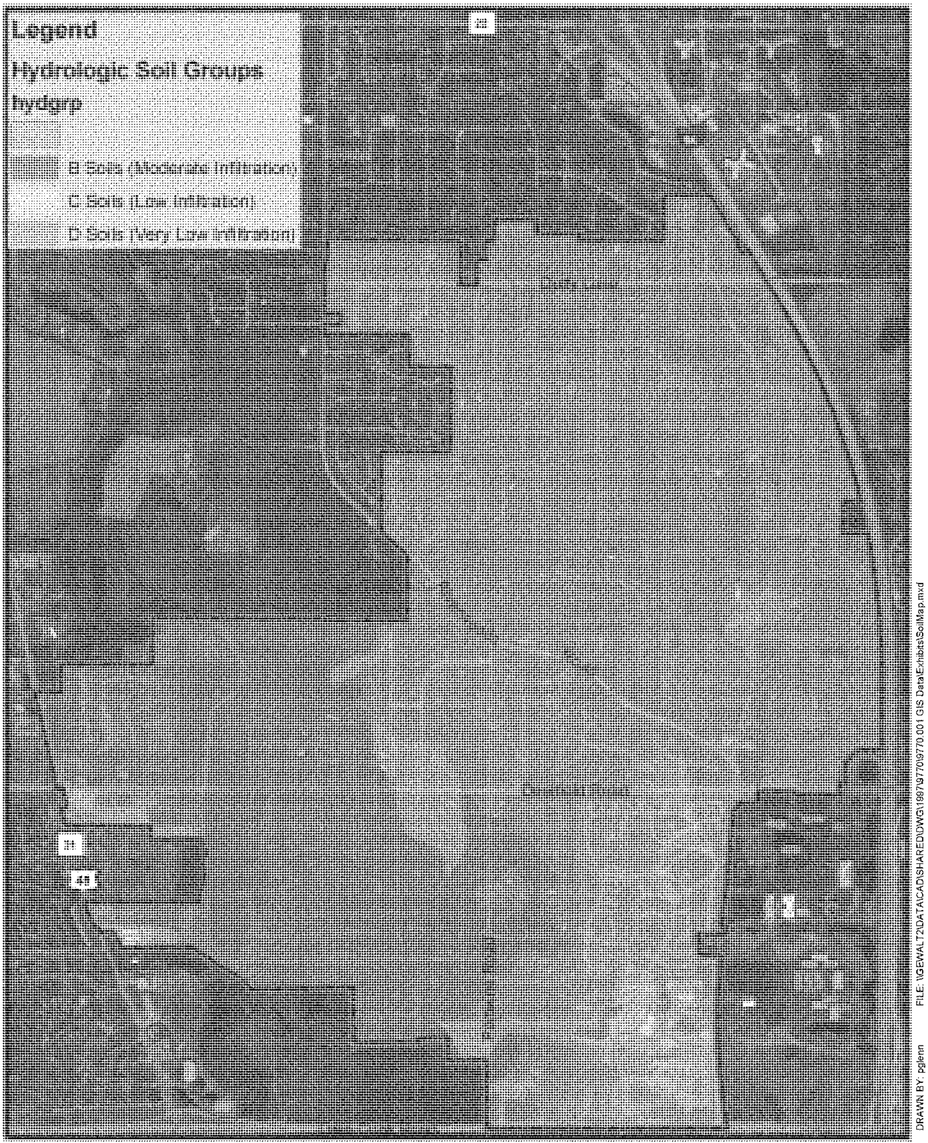
HUFF RAINFALL DISTRIBUTIONS

The Huff quartiles represent the typical rainfall distribution for 4 different storm duration ranges. The First quartile applies to storms less than or equal to 6 hours long. Second is for storms greater than 6 hours and less than or equal to 12 while the third Huff quartile is for storms greater than 12 hours and less than or eqnal to 24 hours. Fourth quartile storms apply to storm durations greater than 24 hours.

HUFF QUARTILE DISTRIBUTIONS												
CUMUL.	AREA < 10 SM				AREA > 10 & AREA < 50				AREA > 50 & AREA < 400			
STORM	HUFF QUARTILE				HUFF QUARTILE				HUFF QUARTILE			
PERCENT	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
05	16	03	03	02	12	03	02	02	08	02	02	02
10	33	08	06	05	25	06	05	04	17	04	04	03
15	43	12	09	08	38	10	08	07	34	08	07	05
20	52	16	12	10	51	14	12	09	50	12	10	07
25	60	22	15	13	62	21	14	11	63	21	12	09
30	66	29	19	16	69	30	17	13	71	31	14	10
35	71	39	23	19	74	40	20	15	76	42	16	12
40	75	51	27	22	78	52	23	18	80	53	19	14
45	79	62	32	25	81	63	27	21	83	64	22	16
50	82	70	38	28	84	72	33	24	86	73	29	19
55	84	76	45	32	86	78	42	27	88	80	39	21
60	86	81	57	35	88	83	55	30	90	86	54	25
65	88	85	70	39	90	87	69	34	92	89	68	29
70	90	88	79	45	92	90	79	40	93	92	79	35
75	92	91	85	51	94	92	86	47	95	94	87	43
80	94	93	89	59	95	94	91	57	96	96	92	54
85	96	95	92	72	96	96	94	74	97	97	95	75
90	97	97	95	84	97	97	96	88	98	98	97	92
95	98	98	97	92	98	98	98	95	99	99	99	97

References: *Floyd A. Huff and James R. Angel, 1989 "Frequency Distributions and Hydroclimatic Characteristics of Heavy Rainstorms in Illinois', Illinois State Water Survey, Bulletin 70.*

Exhibit A



Sources: United Sates Geological Survey
Natural Resources Conservation Service
Lake County

N

Photo Date April, 2002

Riverwoods General Soil Map

Exhibit B

GEWALT HAMILTON
ASSOCIATES, INC.

DATE: 12/3/2004
GHA Project No. 9770.001

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.
2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Exhibit C

Table 2-2c Runoff curve numbers for other agricultural lands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4]	48	65	73
Woods—grass combination (orchard or tree farm). [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.
2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.
3 *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.
4 Actual curve number is less than 30; use CN = 30 for runoff computations.
5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.
6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Exhibit C

HYDROLOGIC MODEL INPUT/OUTPUT

3-HOUR STORM 1,5,10,25,50, AND 100-YEAR RETURN INTERVALS

Job File: G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Rain Dir: G:\1997\9770\Riverwoods Misc\HYDROLOGY\

=========================
JOB TITLE
=========================

Project Date: 12/3/2004
Project Engineer: Patrick Glenn
Project Title: Riverwoods Woodland Hydrology Sample Calculations
Project Comments:
Calculations prepared to examine the hydrologic differences
between turfgrass and wooded areas.

Table of Contents

Table of Contents (continued)

Table of Contents (continued)

Type.... Master Network Summary   Page 1.01
Name.... Watershed
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

MASTER DESIGN STORM SUMMARY

Network Storm Collection: Lake County 3-ho

Return Event	Total Depth in	Rainfall Type	RNF ID
1	1.5000	Synthetic Curve	0-10 1stQ 50%
2	1.7900	Synthetic Curve	0-10 1stQ 50%
5	2.1800	Synthetic Curve	0-10 1stQ 50%
10	2.4800	Synthetic Curve	0-10 1stQ 50%
25	3.0400	Synthetic Curve	0-10 1stQ 50%
50	3.5200	Synthetic Curve	0-10 1stQ 50%
100	4.1600	Synthetic Curve	0-10 1stQ 50%

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
LAWN - B	AREA	1	.001		3.0400	.02		
LAWN - B	AREA	2	.006		2.4800	.05		
LAWN - B	AREA	5	.019		1.4600	.12		
LAWN - B	AREA	10	.032		1.4200	.21		
LAWN - B	AREA	25	.063		1.0800	.42		
LAWN - B	AREA	50	.097		.9600	.67		
LAWN - B	AREA	100	.149		.9000	1.09		
LAWN - D	AREA	1	.048		.9200	.34		
LAWN - D	AREA	2	.073		.8400	.54		
LAWN - D	AREA	5	.113		.8200	.87		
LAWN - D	AREA	10	.146		.8000	1.15		
LAWN - D	AREA	25	.213		.8000	1.73		
LAWN - D	AREA	50	.275		.7600	2.25		
LAWN - D	AREA	100	.362		.7400	2.99		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
*OUTFALL	JCT	1	.084		.9800	.57		
*OUTFALL	JCT	2	.137		.8800	.95		
*OUTFALL	JCT	5	.228		.8600	1.57		
*OUTFALL	JCT	10	.312		.8600	2.17		
*OUTFALL	JCT	25	.494		.8400	3.55		
*OUTFALL	JCT	50	.672		.8400	5.00		
*OUTFALL	JCT	100	.934		.8200	7.17		
WOODED LOT - B	AREA	1	.000		.0200	.00		
WOODED LOT - B	AREA	2	.000		3.0600	.01		
WOODED LOT - B	AREA	5	.006		2.5600	.05		
WOODED LOT - B	AREA	10	.013		2.5600	.10		
WOODED LOT - B	AREA	25	.034		1.4000	.23		
WOODED LOT - B	AREA	50	.059		1.4000	.39		
WOODED LOT - B	AREA	100	.099		1.0400	.67		
WOODED LOT - D	AREA	1	.035		1.0400	.23		
WOODED LOT - D	AREA	2	.057		.9000	.40		
WOODED LOT - D	AREA	5	.091		.8400	.68		
WOODED LOT - D	AREA	10	.121		.8400	.94		
WOODED LOT - D	AREA	25	.183		.8000	1.46		
WOODED LOT - D	AREA	50	.241		.8000	1.95		
WOODED LOT - D	AREA	100	.323		.7600	2.63		

```
Type.... Design Storms                                         Page 2.01
Name.... Lake County 3-ho

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Title... Project Date: 12/3/2004
         Project Engineer: Patrick Glenn
            Project Title: Riverwoods Woodland Hydrology
         Sample Calculations
         Project Comments:
         Calculations prepared to examine the hydrologic
         differences between turfgrass and wooded areas.

                DESIGN STORMS SUMMARY

 Design Storm File,ID =              Lake County 3-ho


 Storm Tag Name      = 1
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 1stQ 50%
 Storm Frequency     = 1 yr
 Total Rainfall Depth= 1.5000 in
 Duration Multiplier =  3
 Resulting Duration  = 3.0000 hrs
 Resulting Start Time= .0000 hrs  Step= .1500 hrs  End= 3.0000 hrs


 Storm Tag Name      =      2
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 1stQ 50%
 Storm Frequency     = 2 yr
 Total Rainfall Depth= 1.7900 in
 Duration Multiplier =  3
 Resulting Duration  = 3.0000 hrs
 Resulting Start Time= .0000 hrs  Step= .1500 hrs  End= 3.0000 hrs


 Storm Tag Name      =      5
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 1stQ 50%
 Storm Frequency     = 5 yr
 Total Rainfall Depth= 2.1800 in
 Duration Multiplier =  3
 Resulting Duration  = 3.0000 hrs
 Resulting Start Time= .0000 hrs  Step= .1500 hrs  End= 3.0000 hrs


 Storm Tag Name      =     10
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 1stQ 50%
 Storm Frequency     = 10 yr
 Total Rainfall Depth= 2.4800 in
 Duration Multiplier =  3
 Resulting Duration  = 3.0000 hrs
 Resulting Start Time= .0000 hrs  Step= .1500 hrs  End= 3.0000 hrs
```

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Title... Project Date: 12/3/2004
Project Engineer: Patrick Glenn
Project Title: Riverwoods Woodland Hydrology
Sample Calculations
Project Comments:
Calculations prepared to examine the hydrologic
differences between turfgrass and wooded areas.

DESIGN STORMS SUMMARY

Design Storm File,ID = Lake County 3-ho

Storm Tag Name = 25

Data Type, File, ID = Synthetic Storm 0-10 1stQ 50%
Storm Frequency = 25 yr
Total Rainfall Depth= 3.0400 in
Duration Multiplier = 3
Resulting Duration = 3.0000 hrs
Resulting Start Time= .0000 hrs Step= .1500 hrs End= 3.0000 hrs

Storm Tag Name = 50

Data Type, File, ID = Synthetic Storm 0-10 1stQ 50%
Storm Frequency = 50 yr
Total Rainfall Depth= 3.5200 in
Duration Multiplier = 3
Resulting Duration = 3.0000 hrs
Resulting Start Time= .0000 hrs Step= .1500 hrs End= 3.0000 hrs

Storm Tag Name = 100

Data Type, File, ID = Synthetic Storm 0-10 1stQ 50%
Storm Frequency = 100 yr
Total Rainfall Depth= 4.1600 in
Duration Multiplier = 3
Resulting Duration = 3.0000 hrs
Resulting Start Time= .0000 hrs Step= .1500 hrs End= 3.0000 hrs

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::


------------------------------------------------------------------------

Segment #1:  Tc: User Defined

                                         Segment #1 Time:      .2500 hrs
------------------------------------------------------------------------

                                                ========================
                                                 Total Tc:     .2500 hrs
                                                ========================
```

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: User Defined

Segment #1 Time: .2500 hrs

========================
Total Tc: .2500 hrs
========================

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: User Defined

Segment #1 Time: .2500 hrs

========================
Total Tc: .2500 hrs
========================

Type.... Tc Calcs Page 3.04
Name.... WOODED LOT - D

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: User Defined

Segment #1 Time: .2500 hrs

=========================
Total Tc: .2500 hrs
=========================

Type.... Runoff CN-Area
Name.... LAWN - B

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	61	2.000			61.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			61.00 (61)

Type.... Runoff CN-Area
Name.... LAWN - D

Page 4.02

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	80	2.000			80.00

COMPOSITE AREA & WEIGHTED CN ---> 2.000 80.00 (80)

Type.... Runoff CN-Area
Name.... WOODED LOT - B

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Woods - good	55	2.000			55.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			55.00 (55)

Type.... Runoff CN-Area Page 4.04
Name.... WOODED LOT - D

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Woods - good	77	2.000			77.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			77.00 (77)

```
Type.... Unit Hyd. Summary                                  Page 5.01
Name.... LAWN - B          Tag:      1                   Event: 1 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:      1

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 1 year storm
              Duration      = 3.0000 hrs      Rain Depth = 1.5000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 1
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   3.0667 hrs
              Computed Peak Flow             =      .02 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =   3.0600 hrs
              Peak Flow, Interpolated Output =      .02 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:LAWN - B
                           CN    =   61
                           Area =        2.000 acres
                           S     =   6.3934 in
                           0.2S =    1.2787 in

                            Cumulative Runoff
                           -------------------
                                    .0074 in
                                     .001 ac-ft

              HYG Volume...            .001 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.02
Name.... LAWN - B           Tag:      2                     Event: 2 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:      2

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 2 year storm
              Duration      = 3.0000 hrs      Rain Depth = 1.7900 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 2
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   2.6000 hrs
              Computed Peak Flow             =      .05 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =   2.6000 hrs
              Peak Flow, Interpolated Output =      .05 cfs
              ============================================

                           DRAINAGE AREA
                        -------------------
                        ID:LAWN - B
                        CN   =   61
                        Area =        2.000 acres
                        S    =   6.3934 in
                        0.2S =   1.2787 in

                         Cumulative Runoff
                        -------------------
                                 .0379 in
                                  .006 ac-ft

              HYG Volume...            .006 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.03
Name.... LAWN - B           Tag:      5                  Event: 5 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:      5

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 3.0000 hrs      Rain Depth = 2.1800 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   1.4667 hrs
              Computed Peak Flow             =      .12 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =   1.4800 hrs
              Peak Flow, Interpolated Output =      .12 cfs
              ============================================

                            DRAINAGE AREA
                            -------------------
                            ID:LAWN - B
                            CN    =   61
                            Area =        2.000 acres
                            S     =   6.3934 in
                            0.2S =   1.2787 in

                             Cumulative Runoff
                            -------------------
                                     .1114 in
                                      .019 ac-ft

              HYG Volume...           .019 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.04
Name.... LAWN - B            Tag:     10                   Event: 10 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:     10

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 10 year storm
              Duration      = 3.0000 hrs      Rain Depth = 2.4800 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 10
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   1.4333 hrs
              Computed Peak Flow             =      .22 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =   1.4400 hrs
              Peak Flow, Interpolated Output =      .22 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:LAWN - B
                           CN    =   61
                           Area =        2.000 acres
                           S     =   6.3934 in
                           0.2S =   1.2787 in

                            Cumulative Runoff
                           -------------------
                                    .1900 in
                                     .032 ac-ft

              HYG Volume...           .032 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.05
Name.... LAWN - B           Tag:     25                  Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:     25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration      = 3.0000 hrs      Rain Depth = 3.0400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 25
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   1.1000 hrs
              Computed Peak Flow             =      .42 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =   1.1000 hrs
              Peak Flow, Interpolated Output =      .42 cfs
              ============================================

                              DRAINAGE AREA
                            -------------------
                            ID:LAWN - B
                            CN    =   61
                            Area =        2.000 acres
                            S     =   6.3934 in
                            0.2S =    1.2787 in

                             Cumulative Runoff
                            -------------------
                                     .3804 in
                                      .063 ac-ft

              HYG Volume...            .063 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                   Page 5.06
Name.... LAWN - B            Tag:     50                  Event: 50 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%    Tag:     50

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 50 year storm
              Duration      = 3.0000 hrs      Rain Depth = 3.5200 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 50
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   1.0000 hrs
              Computed Peak Flow             =      .67 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =   1.0000 hrs
              Peak Flow, Interpolated Output =      .67 cfs
              ============================================

                             DRAINAGE AREA
                            -------------------
                            ID:LAWN - B
                            CN   =   61
                            Area =        2.000 acres
                            S    =   6.3934 in
                            0.2S =   1.2787 in

                             Cumulative Runoff
                            -------------------
                                     .5818 in
                                      .097 ac-ft

              HYG Volume...           .097 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =  1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.07
Name.... LAWN - B            Tag:    100                  Event: 100 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:    100

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 100 year storm
              Duration      = 3.0000 hrs      Rain Depth = 4.1600 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 100
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =    .9000 hrs
              Computed Peak Flow             =     1.09 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =    .9000 hrs
              Peak Flow, Interpolated Output =     1.09 cfs
              ============================================

                            DRAINAGE AREA
                          -------------------
                          ID:LAWN - B
                          CN    =   61
                          Area =        2.000 acres
                          S     =   6.3934 in
                          0.2S =   1.2787 in

                           Cumulative Runoff
                          -------------------
                                   .8951 in
                                    .149 ac-ft

              HYG Volume...            .149 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.08
Name.... LAWN - D           Tag:      1                     Event: 1 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:      1

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 1 year storm
              Duration      = 3.0000 hrs      Rain Depth = 1.5000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 1
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =    .9667 hrs
              Computed Peak Flow             =      .34 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =    .9600 hrs
              Peak Flow, Interpolated Output =      .34 cfs
              ============================================

                             DRAINAGE AREA
                          -------------------
                          ID:LAWN - D
                          CN   =   80
                          Area =        2.000 acres
                          S    =   2.5000 in
                          0.2S =    .5000 in

                           Cumulative Runoff
                          -------------------
                                   .2857 in
                                    .048 ac-ft

              HYG Volume...           .048 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =  1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.09
Name.... LAWN - D           Tag:      2                    Event: 2 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:      2

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 2 year storm
              Duration      = 3.0000 hrs      Rain Depth = 1.7900 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 2
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =    .8667 hrs
              Computed Peak Flow             =      .55 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =    .8800 hrs
              Peak Flow, Interpolated Output =      .55 cfs
              ============================================

                             DRAINAGE AREA
                            -------------------
                            ID:LAWN - D
                            CN    =   80
                            Area =        2.000 acres
                            S     =   2.5000 in
                            0.2S =     .5000 in

                             Cumulative Runoff
                            -------------------
                                     .4391 in
                                      .073 ac-ft

              HYG Volume...           .073 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.10
Name.... LAWN - D           Tag:      5                    Event: 5 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:      5

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 3.0000 hrs      Rain Depth = 2.1800 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =    .8333 hrs
              Computed Peak Flow             =      .88 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =    .8400 hrs
              Peak Flow, Interpolated Output =      .88 cfs
              ============================================

                           DRAINAGE AREA
                         -------------------
                         ID:LAWN - D
                         CN    =   80
                         Area =        2.000 acres
                         S     =   2.5000 in
                         0.2S =     .5000 in

                          Cumulative Runoff
                         -------------------
                                  .6752 in
                                   .113 ac-ft

              HYG Volume...            .113 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.11
Name.... LAWN - D          Tag:     10                    Event: 10 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:     10

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 10 year storm
              Duration      = 3.0000 hrs      Rain Depth = 2.4800 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 10
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =    .8333 hrs
              Computed Peak Flow             =     1.16 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =    .8200 hrs
              Peak Flow, Interpolated Output =     1.16 cfs
              ============================================

                             DRAINAGE AREA
                            -------------------
                            ID:LAWN - D
                            CN    =   80
                            Area  =        2.000 acres
                            S     =   2.5000 in
                            0.2S  =    .5000 in

                             Cumulative Runoff
                            -------------------
                                     .8751 in
                                      .146 ac-ft

              HYG Volume...           .146 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.12
Name.... LAWN - D          Tag:     25                   Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:     25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration      = 3.0000 hrs      Rain Depth = 3.0400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 25
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =    .8000 hrs
              Computed Peak Flow             =     1.73 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =    .8000 hrs
              Peak Flow, Interpolated Output =     1.73 cfs
              ============================================

                            DRAINAGE AREA
                           -------------------
                           ID:LAWN - D
                           CN   =   80
                           Area =       2.000 acres
                           S    =   2.5000 in
                           0.2S =    .5000 in

                            Cumulative Runoff
                           -------------------
                                   1.2801 in
                                     .213 ac-ft

              HYG Volume...            .213 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 50 year storm
Duration       = 3.0000 hrs      Rain Depth = 3.5200 in
Rain Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 1stQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir        = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - LAWN - D 50
Tc             = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 80

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =    .7667 hrs
Computed Peak Flow             =     2.25 cfs

Time Increment for HYG File    =    .0200 hrs
Peak Time, Interpolated Output =    .7800 hrs
Peak Flow, Interpolated Output =     2.25 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:LAWN - D
              CN    =   80
              Area =        2.000 acres
              S     =   2.5000 in
              0.2S =    .5000 in

               Cumulative Runoff
              -------------------
                      1.6522 in
                        .275 ac-ft

HYG Volume...           .275 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration      = 3.0000 hrs      Rain Depth = 4.1600 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 1stQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - LAWN - D 100
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 80

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =    .7333 hrs
Computed Peak Flow             =     2.99 cfs

Time Increment for HYG File    =    .0200 hrs
Peak Time, Interpolated Output =    .7400 hrs
Peak Flow, Interpolated Output =     2.99 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:LAWN - D
              CN   =   80
              Area =        2.000 acres
              S    =   2.5000 in
              0.2S =    .5000 in

               Cumulative Runoff
              -------------------
                      2.1746 in
                        .362 ac-ft

HYG Volume...             .362 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =  1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 1 year storm
Duration      = 3.0000 hrs      Rain Depth = 1.5000 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 1stQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - WOODED LOT - B 1
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 55

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =    .0000 hrs
Computed Peak Flow             =      .00 cfs

Time Increment for HYG File    =    .0200 hrs
Peak Time, Interpolated Output =    .0000 hrs
Peak Flow, Interpolated Output =      .00 cfs
============================================

              DRAINAGE AREA
              -------------------
              ID:WOODED LOT - B
              CN    =   55
              Area =        2.000 acres
              S     =   8.1818 in
              0.2S =   1.6364 in

               Cumulative Runoff
              -------------------
                       .0000 in
                        .000 ac-ft

HYG Volume...           .000 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 2 year storm
Duration      = 3.0000 hrs      Rain Depth = 1.7900 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 1stQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - WOODED LOT - B 2
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 55

============================================
Computational Time Increment    =   .03333 hrs
Computed Peak Time              =   3.0667 hrs
Computed Peak Flow              =      .01 cfs

Time Increment for HYG File     =    .0200 hrs
Peak Time, Interpolated Output =   3.0600 hrs
Peak Flow, Interpolated Output =      .01 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:WOODED LOT - B
              CN   =   55
              Area =        2.000 acres
              S    =   8.1818 in
              0.2S =   1.6364 in

               Cumulative Runoff
              -------------------
                       .0028 in
                        .000 ac-ft

HYG Volume...           .000 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                   Page 5.17
Name.... WOODED LOT - B     Tag:      5                    Event: 5 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:      5

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 3.0000 hrs      Rain Depth = 2.1800 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   2.6000 hrs
              Computed Peak Flow             =      .05 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =   2.6000 hrs
              Peak Flow, Interpolated Output =      .05 cfs
              ============================================

                            DRAINAGE AREA
                         -------------------
                         ID:WOODED LOT - B
                         CN   =   55
                         Area =        2.000 acres
                         S    =   8.1818 in
                         0.2S =   1.6364 in

                          Cumulative Runoff
                         -------------------
                                  .0339 in
                                   .006 ac-ft

              HYG Volume...            .006 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                      Page 5.18
Name.... WOODED LOT - B     Tag:     10                     Event: 10 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:     10

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 10 year storm
              Duration      = 3.0000 hrs      Rain Depth = 2.4800 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 10
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   2.5667 hrs
              Computed Peak Flow             =      .10 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =   2.5800 hrs
              Peak Flow, Interpolated Output =      .10 cfs
              ============================================

                            DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - B
                            CN    =   55
                            Area =        2.000 acres
                            S     =   8.1818 in
                            0.2S =   1.6364 in

                             Cumulative Runoff
                            -------------------
                                     .0789 in
                                      .013 ac-ft

              HYG Volume...           .013 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.19
Name.... WOODED LOT - B      Tag:      25                 Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:      25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration      = 3.0000 hrs      Rain Depth = 3.0400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 25
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment  =   .03333 hrs
              Computed Peak Time            =   1.4333 hrs
              Computed Peak Flow            =      .23 cfs

              Time Increment for HYG File   =    .0200 hrs
              Peak Time, Interpolated Output =  1.4400 hrs
              Peak Flow, Interpolated Output =     .23 cfs
              ============================================

                           DRAINAGE AREA
                        -------------------
                        ID:WOODED LOT - B
                        CN   =   55
                        Area =       2.000 acres
                        S    =   8.1818 in
                        0.2S =   1.6364 in

                         Cumulative Runoff
                        -------------------
                                 .2055 in
                                  .034 ac-ft

              HYG Volume...           .034 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.20
Name.... WOODED LOT - B      Tag:     50                   Event: 50 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:     50

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 50 year storm
              Duration      = 3.0000 hrs      Rain Depth = 3.5200 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 50
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   1.4000 hrs
              Computed Peak Flow             =      .39 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =   1.4000 hrs
              Peak Flow, Interpolated Output =      .39 cfs
              ============================================

                            DRAINAGE AREA
                          -------------------
                          ID:WOODED LOT - B
                          CN   =   55
                          Area =        2.000 acres
                          S    =   8.1818 in
                          0.2S =   1.6364 in

                           Cumulative Runoff
                          -------------------
                                   .3525 in
                                    .059 ac-ft

              HYG Volume...            .059 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 100 year storm
              Duration      = 3.0000 hrs      Rain Depth = 4.1600 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 100
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   1.1000 hrs
              Computed Peak Flow             =      .67 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =   1.1000 hrs
              Peak Flow, Interpolated Output =      .67 cfs
              ============================================

                               DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - B
                            CN    =   55
                            Area =        2.000 acres
                            S     =   8.1818 in
                            0.2S =   1.6364 in

                             Cumulative Runoff
                            -------------------
                                     .5949 in
                                      .099 ac-ft

              HYG Volume...            .099 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.22
Name.... WOODED LOT - D     Tag:      1                    Event: 1 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:      1

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 1 year storm
              Duration      = 3.0000 hrs      Rain Depth = 1.5000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 1
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   1.1000 hrs
              Computed Peak Flow             =      .24 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =   1.1000 hrs
              Peak Flow, Interpolated Output =      .24 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - D
                           CN    =   77
                           Area =        2.000 acres
                           S    =   2.9870 in
                           0.2S =    .5974 in

                            Cumulative Runoff
                           -------------------
                                    .2095 in
                                     .035 ac-ft

              HYG Volume...            .035 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 2 year storm
              Duration      = 3.0000 hrs       Rain Depth = 1.7900 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 2
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =    .9667 hrs
              Computed Peak Flow             =      .40 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =    .9600 hrs
              Peak Flow, Interpolated Output =      .40 cfs
              ============================================

                              DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - D
                            CN    =   77
                            Area =        2.000 acres
                            S     =   2.9870 in
                            0.2S =     .5974 in

                             Cumulative Runoff
                            -------------------
                                     .3403 in
                                      .057 ac-ft

              HYG Volume...            .057 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.24
Name.... WOODED LOT - D     Tag:      5                     Event: 5 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:      5

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 3.0000 hrs      Rain Depth = 2.1800 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =    .8667 hrs
              Computed Peak Flow             =      .69 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =    .8600 hrs
              Peak Flow, Interpolated Output =      .69 cfs
              ============================================

                               DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - D
                            CN    =   77
                            Area =        2.000 acres
                            S     =   2.9870 in
                            0.2S =     .5974 in

                             Cumulative Runoff
                            -------------------
                                     .5481 in
                                      .091 ac-ft

              HYG Volume...           .091 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                   Page 5.25
Name.... WOODED LOT - D      Tag:      10                 Event: 10 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:      10

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 10 year storm
              Duration      = 3.0000 hrs      Rain Depth = 2.4800 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 10
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =    .8333 hrs
              Computed Peak Flow             =      .94 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =    .8400 hrs
              Peak Flow, Interpolated Output =      .94 cfs
              ============================================

                             DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - D
                            CN    =   77
                            Area =       2.000 acres
                            S    =   2.9870 in
                            0.2S =    .5974 in

                             Cumulative Runoff
                            -------------------
                                     .7278 in
                                      .121 ac-ft

              HYG Volume...           .121 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.26
Name.... WOODED LOT - D     Tag:     25                 Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:     25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration      = 3.0000 hrs      Rain Depth = 3.0400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 25
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =    .8333 hrs
              Computed Peak Flow             =     1.46 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =    .8200 hrs
              Peak Flow, Interpolated Output =     1.46 cfs
              ============================================

                                 DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - D
                            CN    =   77
                            Area =        2.000 acres
                            S     =   2.9870 in
                            0.2S =     .5974 in

                             Cumulative Runoff
                            -------------------
                                    1.0988 in
                                      .183 ac-ft

              HYG Volume...           .183 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =  1.6698 (solved from K =   .7491)

              Unit peak,          qp =    9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                   Page 5.27
Name.... WOODED LOT - D      Tag:     50                 Event: 50 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:     50

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 50 year storm
              Duration      = 3.0000 hrs      Rain Depth = 3.5200 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 50
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =    .8000 hrs
              Computed Peak Flow             =     1.95 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =    .8000 hrs
              Peak Flow, Interpolated Output =     1.95 cfs
              ============================================

                            DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - D
                           CN    =   77
                           Area =       2.000 acres
                           S     =   2.9870 in
                           0.2S =     .5974 in

                            Cumulative Runoff
                           -------------------
                                   1.4454 in
                                     .241 ac-ft

              HYG Volume...            .241 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.28
Name.... WOODED LOT - D     Tag:    100                  Event: 100 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 1stQ 50%   Tag:    100

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 100 year storm
              Duration      = 3.0000 hrs      Rain Depth = 4.1600 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 1stQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 100
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =    .7667 hrs
              Computed Peak Flow             =     2.64 cfs

              Time Increment for HYG File    =    .0200 hrs
              Peak Time, Interpolated Output =    .7800 hrs
              Peak Flow, Interpolated Output =     2.64 cfs
              ============================================

                            DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - D
                           CN    =   77
                           Area =        2.000 acres
                           S     =   2.9870 in
                           0.2S =     .5974 in

                            Cumulative Runoff
                           -------------------
                                   1.9378 in
                                     .323 ac-ft

              HYG Volume...            .323 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

HYDROLOGIC MODEL INPUT/OUTPUT

12-HOUR STORM 1,5,10,25,50, AND 100-YEAR RETURN INTERVALS

Job File: G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Rain Dir: G:\1997\9770\Riverwoods Misc\HYDROLOGY\

=========================
JOB TITLE
=========================

Project Date: 12/3/2004
Project Engineer: Patrick Glenn
Project Title: Riverwoods Woodland Hydrology Sample Calculations
Project Comments:
Calculations prepared to examine the hydrologic differences
between turfgrass and wooded areas.

Table of Contents

Table of Contents (continued)

Table of Contents (continued)

Type.... Master Network Summary Page 1.01
Name.... Watershed
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

MASTER DESIGN STORM SUMMARY

Network Storm Collection: Lake County 12-h

Return Event	Total Depth in	Rainfall Type	RNF ID
1	2.1400	Synthetic Curve	0-10 2ndQ 50%
2	2.4400	Synthetic Curve	0-10 2ndQ 50%
5	2.9600	Synthetic Curve	0-10 2ndQ 50%
10	3.3800	Synthetic Curve	0-10 2ndQ 50%
25	4.1300	Synthetic Curve	0-10 2ndQ 50%
50	4.7900	Synthetic Curve	0-10 2ndQ 50%
100	5.6600	Synthetic Curve	0-10 2ndQ 50%

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
LAWN - B	AREA	1	.017		7.0500	.04		
LAWN - B	AREA	2	.030		6.0500	.07		
LAWN - B	AREA	5	.058		6.0000	.15		
LAWN - B	AREA	10	.087		5.4500	.24		
LAWN - B	AREA	25	.147		5.4500	.43		
LAWN - B	AREA	50	.207		5.4500	.62		
LAWN - B	AREA	100	.297		5.4500	.89		
LAWN - D	AREA	1	.108		5.4000	.32		
LAWN - D	AREA	2	.141		5.4000	.42		
LAWN - D	AREA	5	.203		5.4000	.60		
LAWN - D	AREA	10	.257		5.4000	.75		
LAWN - D	AREA	25	.358		5.4000	1.04		
LAWN - D	AREA	50	.452		5.4000	1.29		
LAWN - D	AREA	100	.579		4.8500	1.63		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
*OUTFALL	JCT	1	.218		5.4500	.59		
*OUTFALL	JCT	2	.300		5.4500	.82		
*OUTFALL	JCT	5	.466		5.4500	1.30		
*OUTFALL	JCT	10	.618		5.4500	1.76		
*OUTFALL	JCT	25	.921		5.4500	2.66		
*OUTFALL	JCT	50	1.213		5.4500	3.50		
*OUTFALL	JCT	100	1.628		5.4000	4.68		
WOODED LOT - B	AREA	1	.005		8.9000	.01		
WOODED LOT - B	AREA	2	.012		7.7500	.03		
WOODED LOT - B	AREA	5	.031		7.1500	.08		
WOODED LOT - B	AREA	10	.051		6.0000	.13		
WOODED LOT - B	AREA	25	.097		5.4500	.26		
WOODED LOT - B	AREA	50	.146		5.4500	.42		
WOODED LOT - B	AREA	100	.221		5.4500	.66		
WOODED LOT - D	AREA	1	.088		5.4000	.26		
WOODED LOT - D	AREA	2	.117		5.4000	.35		
WOODED LOT - D	AREA	5	.174		5.4000	.52		
WOODED LOT - D	AREA	10	.224		5.4000	.66		
WOODED LOT - D	AREA	25	.319		5.4000	.94		
WOODED LOT - D	AREA	50	.408		5.4000	1.18		
WOODED LOT - D	AREA	100	.531		5.4000	1.52		

```
Type.... Design Storms                                          Page 2.01
Name.... Lake County 12-h

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Title... Project Date: 12/3/2004
         Project Engineer: Patrick Glenn
            Project Title: Riverwoods Woodland Hydrology
         Sample Calculations
         Project Comments:
         Calculations prepared to examine the hydrologic
         differences between turfgrass and wooded areas.

                DESIGN STORMS SUMMARY

 Design Storm File,ID =              Lake County 12-h


 Storm Tag Name      = 1
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 2ndQ 50%
 Storm Frequency     = 1 yr
 Total Rainfall Depth= 2.1400 in
 Duration Multiplier =  12
 Resulting Duration  = 12.0000 hrs
 Resulting Start Time= .0000 hrs  Step= .6000 hrs  End= 12.0000 hrs


 Storm Tag Name      =      2
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 2ndQ 50%
 Storm Frequency     = 2 yr
 Total Rainfall Depth= 2.4400 in
 Duration Multiplier =  12
 Resulting Duration  = 12.0000 hrs
 Resulting Start Time= .0000 hrs  Step= .6000 hrs  End= 12.0000 hrs


 Storm Tag Name      =      5
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 2ndQ 50%
 Storm Frequency     = 5 yr
 Total Rainfall Depth= 2.9600 in
 Duration Multiplier =  12
 Resulting Duration  = 12.0000 hrs
 Resulting Start Time= .0000 hrs  Step= .6000 hrs  End= 12.0000 hrs


 Storm Tag Name      =     10
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 2ndQ 50%
 Storm Frequency     = 10 yr
 Total Rainfall Depth= 3.3800 in
 Duration Multiplier =  12
 Resulting Duration  = 12.0000 hrs
 Resulting Start Time= .0000 hrs  Step= .6000 hrs  End= 12.0000 hrs
```

```
Type.... Design Storms                                              Page 2.02
Name.... Lake County 12-h

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Title... Project Date: 12/3/2004
         Project Engineer: Patrick Glenn
            Project Title: Riverwoods Woodland Hydrology
         Sample Calculations
         Project Comments:
         Calculations prepared to examine the hydrologic
         differences between turfgrass and wooded areas.

                DESIGN STORMS SUMMARY

 Design Storm File,ID =               Lake County 12-h


 Storm Tag Name       =     25
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 2ndQ 50%
 Storm Frequency     = 25 yr
 Total Rainfall Depth= 4.1300 in
 Duration Multiplier =  12
 Resulting Duration  = 12.0000 hrs
 Resulting Start Time= .0000 hrs  Step= .6000 hrs  End= 12.0000 hrs


 Storm Tag Name       =     50
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 2ndQ 50%
 Storm Frequency     = 50 yr
 Total Rainfall Depth= 4.7900 in
 Duration Multiplier =  12
 Resulting Duration  = 12.0000 hrs
 Resulting Start Time= .0000 hrs  Step= .6000 hrs  End= 12.0000 hrs


 Storm Tag Name       =    100
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 2ndQ 50%
 Storm Frequency     = 100 yr
 Total Rainfall Depth= 5.6600 in
 Duration Multiplier =  12
 Resulting Duration  = 12.0000 hrs
 Resulting Start Time= .0000 hrs  Step= .6000 hrs  End= 12.0000 hrs
```

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::


------------------------------------------------------------------------

Segment #1:  Tc: User Defined

                                         Segment #1 Time:      .2500 hrs
------------------------------------------------------------------------

                                                =========================
                                                 Total Tc:     .2500 hrs
                                                =========================
```

TIME OF CONCENTRATION CALCULATOR

Segment #1: Tc: User Defined

Segment #1 Time: .2500 hrs

Total Tc: .2500 hrs

Type.... Tc Calcs Page 3.03
Name.... WOODED LOT - B

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

TIME OF CONCENTRATION CALCULATOR

Segment #1: Tc: User Defined

Segment #1 Time: .2500 hrs

Total Tc: .2500 hrs

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::


------------------------------------------------------------------------

Segment #1:  Tc: User Defined

                                   Segment #1 Time:      .2500 hrs
------------------------------------------------------------------------

                                         =========================
                                          Total Tc:      .2500 hrs
                                         =========================
```

Type.... Runoff CN-Area Page 4.01
Name.... LAWN - B

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	61	2.000			61.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			61.00 (61)

Type.... Runoff CN-Area
Name.... LAWN - D

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	80	2.000			80.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			80.00 (80)

Type.... Runoff CN-Area   Page 4.03
Name.... WOODED LOT - B

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Woods - good	55	2.000			55.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			55.00 (55)

Type.... Runoff CN-Area Page 4.04
Name.... WOODED LOT - D

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Woods - good	77	2.000			77.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			77.00 (77)

```
Type.... Unit Hyd. Summary                                  Page 5.01
Name.... LAWN - B            Tag:      1                  Event: 1 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%   Tag:      1

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 1 year storm
              Duration      = 12.0000 hrs     Rain Depth = 2.1400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 1
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   7.2667 hrs
              Computed Peak Flow             =      .04 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   7.2500 hrs
              Peak Flow, Interpolated Output =      .04 cfs
              ============================================

                             DRAINAGE AREA
                            -------------------
                            ID:LAWN - B
                            CN    =   61
                            Area =         2.000 acres
                            S     =   6.3934 in
                            0.2S =   1.2787 in

                             Cumulative Runoff
                            -------------------
                                     .1023 in
                                      .017 ac-ft

              HYG Volume...           .017 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                 Page 5.02
Name.... LAWN - B            Tag:      2                 Event: 2 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%   Tag:      2

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 2 year storm
              Duration      = 12.0000 hrs     Rain Depth = 2.4400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 2
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   7.2333 hrs
              Computed Peak Flow             =      .07 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   7.2500 hrs
              Peak Flow, Interpolated Output =      .07 cfs
              ============================================

                               DRAINAGE AREA
                            -------------------
                            ID:LAWN - B
                            CN    =   61
                            Area =        2.000 acres
                            S     =   6.3934 in
                            0.2S =   1.2787 in

                             Cumulative Runoff
                            -------------------
                                     .1785 in
                                      .030 ac-ft

              HYG Volume...            .030 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 5 year storm
Duration       = 12.0000 hrs     Rain Depth = 2.9600 in
Rain Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 2ndQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir        = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - LAWN - B 5
Tc             = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 61

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =   6.0667 hrs
Computed Peak Flow             =      .15 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =   6.0500 hrs
Peak Flow, Interpolated Output =      .15 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:LAWN - B
              CN    =   61
              Area =        2.000 acres
              S     =   6.3934 in
              0.2S =   1.2787 in

               Cumulative Runoff
              -------------------
                       .3501 in
                        .058 ac-ft

HYG Volume...           .058 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =    9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                   Page 5.04
Name.... LAWN - B            Tag:     10                  Event: 10 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%   Tag:     10

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 10 year storm
              Duration      = 12.0000 hrs     Rain Depth = 3.3800 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 10
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4667 hrs
              Computed Peak Flow             =      .24 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4500 hrs
              Peak Flow, Interpolated Output =      .24 cfs
              ============================================

                               DRAINAGE AREA
                            -------------------
                            ID:LAWN - B
                            CN    =   61
                            Area =        2.000 acres
                            S     =   6.3934 in
                            0.2S =   1.2787 in

                             Cumulative Runoff
                            -------------------
                                     .5198 in
                                      .087 ac-ft

              HYG Volume...            .087 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 year storm
Duration      = 12.0000 hrs     Rain Depth = 4.1300 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 2ndQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - LAWN - B 25
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 61

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =   5.4667 hrs
Computed Peak Flow             =      .43 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =   5.4500 hrs
Peak Flow, Interpolated Output =      .43 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:LAWN - B
              CN   =   61
              Area =        2.000 acres
              S    =   6.3934 in
              0.2S =   1.2787 in

               Cumulative Runoff
              -------------------
                       .8794 in
                        .147 ac-ft

HYG Volume...           .147 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 50 year storm
              Duration      = 12.0000 hrs     Rain Depth = 4.7900 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 50
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4333 hrs
              Computed Peak Flow             =      .62 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4500 hrs
              Peak Flow, Interpolated Output =      .62 cfs
              ============================================

                               DRAINAGE AREA
                            -------------------
                            ID:LAWN - B
                            CN    =   61
                            Area =        2.000 acres
                            S     =   6.3934 in
                            0.2S =   1.2787 in

                             Cumulative Runoff
                            -------------------
                                    1.2448 in
                                      .207 ac-ft

              HYG Volume...            .207 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.07
Name.... LAWN - B           Tag:    100                  Event: 100 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%    Tag:    100

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 100 year storm
              Duration      = 12.0000 hrs     Rain Depth = 5.6600 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 100
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4333 hrs
              Computed Peak Flow             =      .89 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4500 hrs
              Peak Flow, Interpolated Output =      .89 cfs
              ============================================

                            DRAINAGE AREA
                           -------------------
                           ID:LAWN - B
                           CN    =   61
                           Area =        2.000 acres
                           S     =   6.3934 in
                           0.2S =   1.2787 in

                            Cumulative Runoff
                           -------------------
                                   1.7816 in
                                     .297 ac-ft

              HYG Volume...            .297 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.08
Name.... LAWN - D            Tag:      1                    Event: 1 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%   Tag:      1

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 1 year storm
              Duration      = 12.0000 hrs     Rain Depth = 2.1400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 1
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4333 hrs
              Computed Peak Flow             =      .32 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4500 hrs
              Peak Flow, Interpolated Output =      .32 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:LAWN - D
                           CN   =   80
                           Area =        2.000 acres
                           S    =   2.5000 in
                           0.2S =    .5000 in

                            Cumulative Runoff
                           -------------------
                                    .6497 in
                                     .108 ac-ft

              HYG Volume...           .108 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 2 year storm
Duration      = 12.0000 hrs     Rain Depth = 2.4400 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 2ndQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - LAWN - D 2
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 80

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =   5.4333 hrs
Computed Peak Flow             =      .42 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =   5.4500 hrs
Peak Flow, Interpolated Output =      .42 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:LAWN - D
              CN   =   80
              Area =       2.000 acres
              S    =   2.5000 in
              0.2S =    .5000 in

               Cumulative Runoff
              -------------------
                       .8477 in
                        .141 ac-ft

HYG Volume...           .141 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.10
Name.... LAWN - D            Tag:       5                   Event: 5 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%    Tag:      5

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 12.0000 hrs     Rain Depth = 2.9600 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4333 hrs
              Computed Peak Flow             =      .60 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4500 hrs
              Peak Flow, Interpolated Output =      .60 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:LAWN - D
                           CN   =   80
                           Area =       2.000 acres
                           S    =   2.5000 in
                           0.2S =    .5000 in

                            Cumulative Runoff
                           -------------------
                                   1.2201 in
                                     .203 ac-ft

              HYG Volume...           .203 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.11
Name.... LAWN - D           Tag:     10                   Event: 10 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%   Tag:     10

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 10 year storm
              Duration      = 12.0000 hrs     Rain Depth = 3.3800 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 10
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4333 hrs
              Computed Peak Flow             =      .76 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4000 hrs
              Peak Flow, Interpolated Output =      .75 cfs
              ============================================

                           DRAINAGE AREA
                        -------------------
                        ID:LAWN - D
                        CN   =   80
                        Area =        2.000 acres
                        S    =   2.5000 in
                        0.2S =    .5000 in

                         Cumulative Runoff
                        -------------------
                                1.5417 in
                                  .257 ac-ft

              HYG Volume...           .257 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.12
Name.... LAWN - D           Tag:     25                    Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%   Tag:     25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration      = 12.0000 hrs     Rain Depth = 4.1300 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 25
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4333 hrs
              Computed Peak Flow             =     1.04 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4000 hrs
              Peak Flow, Interpolated Output =     1.04 cfs
              ============================================

                             DRAINAGE AREA
                            -------------------
                            ID:LAWN - D
                            CN    =   80
                            Area =        2.000 acres
                            S     =   2.5000 in
                            0.2S =     .5000 in

                             Cumulative Runoff
                            -------------------
                                    2.1496 in
                                      .358 ac-ft

              HYG Volume...             .358 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.13
Name.... LAWN - D            Tag:     50                 Event: 50 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%   Tag:     50

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 50 year storm
              Duration      = 12.0000 hrs     Rain Depth = 4.7900 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 50
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4333 hrs
              Computed Peak Flow             =     1.29 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4000 hrs
              Peak Flow, Interpolated Output =     1.29 cfs
              ============================================

                               DRAINAGE AREA
                            -------------------
                            ID:LAWN - D
                            CN    =   80
                            Area =        2.000 acres
                            S     =   2.5000 in
                            0.2S =     .5000 in

                             Cumulative Runoff
                            -------------------
                                    2.7105 in
                                      .452 ac-ft

              HYG Volume...           .452 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                      Page 5.14
Name.... LAWN - D            Tag:    100                   Event: 100 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%   Tag:    100

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 100 year storm
              Duration      = 12.0000 hrs     Rain Depth = 5.6600 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 100
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   4.8667 hrs
              Computed Peak Flow             =     1.64 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   4.8500 hrs
              Peak Flow, Interpolated Output =     1.63 cfs
              ============================================

                             DRAINAGE AREA
                            -------------------
                            ID:LAWN - D
                            CN    =   80
                            Area =        2.000 acres
                            S     =   2.5000 in
                            0.2S =     .5000 in

                             Cumulative Runoff
                            -------------------
                                    3.4759 in
                                      .579 ac-ft

              HYG Volume...            .579 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.15
Name.... WOODED LOT - B     Tag:      1                      Event: 1 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%   Tag:      1

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 1 year storm
              Duration      = 12.0000 hrs     Rain Depth = 2.1400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 1
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  12.0000 hrs
              Computed Peak Flow             =      .02 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  12.0000 hrs
              Peak Flow, Interpolated Output =      .02 cfs
              ============================================

                           DRAINAGE AREA
                        -------------------
                        ID:WOODED LOT - B
                        CN    =   55
                        Area =        2.000 acres
                        S     =   8.1818 in
                        0.2S =   1.6364 in

                         Cumulative Runoff
                        -------------------
                                 .0292 in
                                  .005 ac-ft

              HYG Volume...           .005 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =  1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                   Page 5.16
Name.... WOODED LOT - B      Tag:       2                  Event: 2 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%    Tag:      2

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 2 year storm
              Duration      = 12.0000 hrs     Rain Depth = 2.4400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 2
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   9.0333 hrs
              Computed Peak Flow             =      .03 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   7.8500 hrs
              Peak Flow, Interpolated Output =      .03 cfs
              ============================================

                           DRAINAGE AREA
                         -------------------
                         ID:WOODED LOT - B
                         CN    =   55
                         Area =        2.000 acres
                         S     =   8.1818 in
                         0.2S =    1.6364 in

                          Cumulative Runoff
                         -------------------
                                  .0719 in
                                   .012 ac-ft

              HYG Volume...           .012 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.17
Name.... WOODED LOT - B     Tag:      5                     Event: 5 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%   Tag:      5

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 12.0000 hrs     Rain Depth = 2.9600 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   7.2333 hrs
              Computed Peak Flow             =      .08 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   7.2500 hrs
              Peak Flow, Interpolated Output =      .08 cfs
              ============================================

                            DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - B
                           CN    =   55
                           Area =        2.000 acres
                           S     =   8.1818 in
                           0.2S =    1.6364 in

                            Cumulative Runoff
                           -------------------
                                     .1843 in
                                      .031 ac-ft

              HYG Volume...           .031 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.18
Name.... WOODED LOT - B      Tag:      10                  Event: 10 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%   Tag:      10

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 10 year storm
              Duration      = 12.0000 hrs     Rain Depth = 3.3800 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 10
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   6.0667 hrs
              Computed Peak Flow             =      .13 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   6.0500 hrs
              Peak Flow, Interpolated Output =      .13 cfs
              ============================================

                               DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - B
                            CN    =    55
                            Area =        2.000 acres
                            S     =    8.1818 in
                            0.2S =    1.6364 in

                             Cumulative Runoff
                            -------------------
                                     .3063 in
                                      .051 ac-ft

              HYG Volume...           .051 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                   Page 5.19
Name.... WOODED LOT - B     Tag:     25                   Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%   Tag:     25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration      = 12.0000 hrs     Rain Depth = 4.1300 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 25
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4667 hrs
              Computed Peak Flow             =      .26 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.5000 hrs
              Peak Flow, Interpolated Output =      .26 cfs
              ============================================

                            DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - B
                            CN    =   55
                            Area =        2.000 acres
                            S     =   8.1818 in
                            0.2S =   1.6364 in

                             Cumulative Runoff
                            -------------------
                                     .5825 in
                                      .097 ac-ft

              HYG Volume...            .097 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 50 year storm
              Duration      = 12.0000 hrs     Rain Depth = 4.7900 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 50
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4667 hrs
              Computed Peak Flow             =      .42 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4500 hrs
              Peak Flow, Interpolated Output =      .42 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - B
                           CN    =   55
                           Area =        2.000 acres
                           S    =   8.1818 in
                           0.2S =   1.6364 in

                            Cumulative Runoff
                           -------------------
                                    .8774 in
                                     .146 ac-ft

              HYG Volume...           .146 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration      = 12.0000 hrs     Rain Depth = 5.6600 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 2ndQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - WOODED LOT - B 100
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 55

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =   5.4667 hrs
Computed Peak Flow             =      .66 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =   5.4500 hrs
Peak Flow, Interpolated Output =      .66 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:WOODED LOT - B
              CN   =   55
              Area =        2.000 acres
              S    =   8.1818 in
              0.2S =   1.6364 in

               Cumulative Runoff
              -------------------
                      1.3264 in
                        .221 ac-ft

HYG Volume...           .221 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.22
Name.... WOODED LOT - D      Tag:       1                   Event: 1 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%    Tag:      1

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 1 year storm
              Duration      = 12.0000 hrs     Rain Depth = 2.1400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 1
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4667 hrs
              Computed Peak Flow             =      .26 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4500 hrs
              Peak Flow, Interpolated Output =      .26 cfs
              ============================================

                           DRAINAGE AREA
                          -------------------
                          ID:WOODED LOT - D
                          CN    =   77
                          Area =        2.000 acres
                          S     =   2.9870 in
                          0.2S =     .5974 in

                           Cumulative Runoff
                          -------------------
                                   .5253 in
                                    .088 ac-ft

              HYG Volume...            .088 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                   Page 5.23
Name.... WOODED LOT - D      Tag:       2                  Event: 2 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%    Tag:       2

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 2 year storm
              Duration      = 12.0000 hrs     Rain Depth = 2.4400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 2
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4333 hrs
              Computed Peak Flow             =      .35 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4500 hrs
              Peak Flow, Interpolated Output =      .35 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - D
                           CN    =   77
                           Area =        2.000 acres
                           S     =   2.9870 in
                           0.2S =    .5974 in

                            Cumulative Runoff
                           -------------------
                                   .7030 in
                                    .117 ac-ft

              HYG Volume...            .117 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.24
Name.... WOODED LOT - D      Tag:      5                    Event: 5 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%   Tag:      5

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 12.0000 hrs     Rain Depth = 2.9600 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4333 hrs
              Computed Peak Flow             =      .52 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4500 hrs
              Peak Flow, Interpolated Output =      .52 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - D
                           CN    =   77
                           Area =        2.000 acres
                           S     =   2.9870 in
                           0.2S =     .5974 in

                            Cumulative Runoff
                           -------------------
                                   1.0434 in
                                     .174 ac-ft

              HYG Volume...           .174 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 10 year storm
Duration      = 12.0000 hrs     Rain Depth = 3.3800 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 2ndQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - WOODED LOT - D 10
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 77

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =   5.4333 hrs
Computed Peak Flow             =      .67 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =   5.4500 hrs
Peak Flow, Interpolated Output =      .66 cfs
============================================

               DRAINAGE AREA
              -------------------
              ID:WOODED LOT - D
              CN    =   77
              Area =        2.000 acres
              S    =   2.9870 in
              0.2S =    .5974 in

               Cumulative Runoff
              -------------------
                      1.3420 in
                        .224 ac-ft

HYG Volume...            .224 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.26
Name.... WOODED LOT - D      Tag:      25                 Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%    Tag:      25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration       = 12.0000 hrs     Rain Depth = 4.1300 in
              Rain Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir        = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 25
              Tc             = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4333 hrs
              Computed Peak Flow             =      .94 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4000 hrs
              Peak Flow, Interpolated Output =      .94 cfs
              ============================================

                            DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - D
                           CN    =   77
                           Area =        2.000 acres
                           S     =   2.9870 in
                           0.2S =    .5974 in

                            Cumulative Runoff
                           -------------------
                                   1.9141 in
                                     .319 ac-ft

              HYG Volume...             .319 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.27
Name.... WOODED LOT - D     Tag:     50                   Event: 50 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 2ndQ 50%   Tag:     50

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 50 year storm
              Duration       = 12.0000 hrs     Rain Depth = 4.7900 in
              Rain Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir        = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 50
              Tc             = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4333 hrs
              Computed Peak Flow             =     1.18 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4000 hrs
              Peak Flow, Interpolated Output =     1.18 cfs
              ============================================

                           DRAINAGE AREA
                         -------------------
                         ID:WOODED LOT - D
                         CN    =   77
                         Area =        2.000 acres
                         S     =   2.9870 in
                         0.2S =     .5974 in

                          Cumulative Runoff
                         -------------------
                                 2.4483 in
                                   .408 ac-ft

              HYG Volume...            .408 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

              Unit peak,           qp =     9.06 cfs
              Unit peak time       Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,     Tb =   .83333 hrs
```

```
              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 100 year storm
              Duration      = 12.0000 hrs     Rain Depth = 5.6600 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 2ndQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 100
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =   5.4333 hrs
              Computed Peak Flow             =     1.52 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =   5.4000 hrs
              Peak Flow, Interpolated Output =     1.52 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - D
                           CN    =   77
                           Area =        2.000 acres
                           S    =   2.9870 in
                           0.2S =    .5974 in

                            Cumulative Runoff
                           -------------------
                                   3.1840 in
                                     .531 ac-ft

              HYG Volume...            .531 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

HYDROLOGIC MODEL INPUT/OUTPUT

24-HOUR STORM 1,5,10,25,50, AND 100-YEAR RETURN INTERVALS

Job File: G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Rain Dir: G:\1997\9770\Riverwoods Misc\HYDROLOGY\

==========================
JOB TITLE
==========================

Project Date: 12/3/2004
Project Engineer: Patrick Glenn
Project Title: Riverwoods Woodland Hydrology Sample Calculations
Project Comments:
Calculations prepared to examine the hydrologic differences
between turfgrass and wooded areas.

Table of Contents

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Table of Contents (continued)

Type.... Master Network Summary Page 1.01
Name.... Watershed
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

MASTER DESIGN STORM SUMMARY

Network Storm Collection: Lake County 24-h

Return Event	Total Depth in	Rainfall Type	RNF ID
1	2.3500	Synthetic Curve	0-10 3rdQ 50%
2	2.8000	Synthetic Curve	0-10 3rdQ 50%
5	3.4000	Synthetic Curve	0-10 3rdQ 50%
10	3.8800	Synthetic Curve	0-10 3rdQ 50%
25	4.7500	Synthetic Curve	0-10 3rdQ 50%
50	5.5000	Synthetic Curve	0-10 3rdQ 50%
100	6.5000	Synthetic Curve	0-10 3rdQ 50%

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
LAWN - B	AREA	1	.026		16.8000	.05		
LAWN - B	AREA	2	.049		15.6500	.10		
LAWN - B	AREA	5	.088		15.6500	.19		
LAWN - B	AREA	10	.125		15.6000	.27		
LAWN - B	AREA	25	.204		15.6000	.43		
LAWN - B	AREA	50	.280		15.6000	.57		
LAWN - B	AREA	100	.391		15.6000	.78		
LAWN - D	AREA	1	.131		15.5500	.26		
LAWN - D	AREA	2	.184		15.6000	.36		
LAWN - D	AREA	5	.260		15.6000	.49		
LAWN - D	AREA	10	.324		15.5500	.60		
LAWN - D	AREA	25	.446		15.6000	.80		
LAWN - D	AREA	50	.556		15.5500	.97		
LAWN - D	AREA	100	.706		15.6000	1.20		

Type.... Master Network Summary Page 1.02
Name.... Watershed
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
*OUTFALL	JCT	1	.274		15.6000	.54		
*OUTFALL	JCT	2	.412		15.6000	.82		
*OUTFALL	JCT	5	.626		15.6000	1.23		
*OUTFALL	JCT	10	.816		15.6000	1.59		
*OUTFALL	JCT	25	1.195		15.6000	2.28		
*OUTFALL	JCT	50	1.550		15.6000	2.90		
*OUTFALL	JCT	100	2.053		15.6000	3.76		
WOODED LOT - B	AREA	1	.010		16.8000	.02		
WOODED LOT - B	AREA	2	.024		16.7500	.05		
WOODED LOT - B	AREA	5	.052		15.6000	.11		
WOODED LOT - B	AREA	10	.080		15.6000	.17		
WOODED LOT - B	AREA	25	.143		15.6000	.31		
WOODED LOT - B	AREA	50	.207		15.6000	.44		
WOODED LOT - B	AREA	100	.302		15.6000	.63		
WOODED LOT - D	AREA	1	.108		15.6000	.22		
WOODED LOT - D	AREA	2	.156		15.6000	.32		
WOODED LOT - D	AREA	5	.226		15.5500	.44		
WOODED LOT - D	AREA	10	.286		15.5500	.55		
WOODED LOT - D	AREA	25	.403		15.6000	.74		
WOODED LOT - D	AREA	50	.508		15.5500	.91		
WOODED LOT - D	AREA	100	.653		15.6000	1.15		

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Title... Project Date: 12/3/2004
Project Engineer: Patrick Glenn
Project Title: Riverwoods Woodland Hydrology
Sample Calculations
Project Comments:
Calculations prepared to examine the hydrologic
differences between turfgrass and wooded areas.

DESIGN STORMS SUMMARY

Design Storm File,ID = Lake County 24-h

```
Storm Tag Name      = 1
------------------------------------------------------------------------
Data Type, File, ID = Synthetic Storm    0-10 3rdQ 50%
Storm Frequency     = 1 yr
Total Rainfall Depth= 2.3500 in
Duration Multiplier =  24
Resulting Duration  = 24.0000 hrs
Resulting Start Time= .0000 hrs  Step= 1.2000 hrs  End= 24.0000 hrs


Storm Tag Name      =      2
------------------------------------------------------------------------
Data Type, File, ID = Synthetic Storm    0-10 3rdQ 50%
Storm Frequency     = 2 yr
Total Rainfall Depth= 2.8000 in
Duration Multiplier =  24
Resulting Duration  = 24.0000 hrs
Resulting Start Time= .0000 hrs  Step= 1.2000 hrs  End= 24.0000 hrs


Storm Tag Name      =      5
------------------------------------------------------------------------
Data Type, File, ID = Synthetic Storm    0-10 3rdQ 50%
Storm Frequency     = 5 yr
Total Rainfall Depth= 3.4000 in
Duration Multiplier =  24
Resulting Duration  = 24.0000 hrs
Resulting Start Time= .0000 hrs  Step= 1.2000 hrs  End= 24.0000 hrs


Storm Tag Name      =     10
------------------------------------------------------------------------
Data Type, File, ID = Synthetic Storm    0-10 3rdQ 50%
Storm Frequency     = 10 yr
Total Rainfall Depth= 3.8800 in
Duration Multiplier =  24
Resulting Duration  = 24.0000 hrs
Resulting Start Time= .0000 hrs  Step= 1.2000 hrs  End= 24.0000 hrs
```

Type.... Design Storms
Name.... Lake County 24-h

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Title... Project Date: 12/3/2004
Project Engineer: Patrick Glenn
Project Title: Riverwoods Woodland Hydrology
Sample Calculations
Project Comments:
Calculations prepared to examine the hydrologic
differences between turfgrass and wooded areas.

DESIGN STORMS SUMMARY

Design Storm File,ID = Lake County 24-h

Storm Tag Name = 25

Data Type, File, ID = Synthetic Storm 0-10 3rdQ 50%
Storm Frequency = 25 yr
Total Rainfall Depth= 4.7500 in
Duration Multiplier = 24
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= 1.2000 hrs End= 24.0000 hrs

Storm Tag Name = 50

Data Type, File, ID = Synthetic Storm 0-10 3rdQ 50%
Storm Frequency = 50 yr
Total Rainfall Depth= 5.5000 in
Duration Multiplier = 24
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= 1.2000 hrs End= 24.0000 hrs

Storm Tag Name = 100

Data Type, File, ID = Synthetic Storm 0-10 3rdQ 50%
Storm Frequency = 100 yr
Total Rainfall Depth= 6.5000 in
Duration Multiplier = 24
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= 1.2000 hrs End= 24.0000 hrs

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

::

TIME OF CONCENTRATION CALCULATOR

::

Segment #1: Tc: User Defined

Segment #1 Time: .2500 hrs

=========================

Total Tc: .2500 hrs

=========================

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: User Defined

Segment #1 Time: .2500 hrs

=========================
Total Tc: .2500 hrs
=========================

::

TIME OF CONCENTRATION CALCULATOR

::

Segment #1: Tc: User Defined

Segment #1 Time: .2500 hrs

=========================

Total Tc: .2500 hrs

=========================

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

::

TIME OF CONCENTRATION CALCULATOR

::

Segment #1: Tc: User Defined

Segment #1 Time: .2500 hrs

=========================

Total Tc: .2500 hrs

=========================

Type.... Runoff CN-Area   Page 4.01
Name.... LAWN - B

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	61	2.000			61.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			61.00 (61)

::

Type.... Runoff CN-Area   Page 4.02
Name.... LAWN - D

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	80	2.000			80.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			80.00 (80)

Type.... Runoff CN-Area
Name.... WOODED LOT - B

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Woods - good	55	2.000			55.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			55.00 (55)

Type.... Runoff CN-Area   Page 4.04
Name.... WOODED LOT - D

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Woods - good	77	2.000			77.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			77.00 (77)

```
Type.... Unit Hyd. Summary                                   Page 5.01
Name.... LAWN - B             Tag:      1                  Event: 1 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%    Tag:      1

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 1 year storm
              Duration      = 24.0000 hrs     Rain Depth = 2.3500 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 1
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  16.8333 hrs
              Computed Peak Flow             =      .05 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  16.8500 hrs
              Peak Flow, Interpolated Output =      .05 cfs
              ============================================

                                 DRAINAGE AREA
                           -------------------
                           ID:LAWN - B
                           CN    =   61
                           Area =        2.000 acres
                           S     =   6.3934 in
                           0.2S =    1.2787 in

                            Cumulative Runoff
                           -------------------
                                    .1538 in
                                     .026 ac-ft

              HYG Volume...           .026 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                        Page 5.02
Name.... LAWN - B            Tag:      2                        Event: 2 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:      2

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 2 year storm
              Duration      = 24.0000 hrs     Rain Depth = 2.8000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 2
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6333 hrs
              Computed Peak Flow             =      .10 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6500 hrs
              Peak Flow, Interpolated Output =      .10 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:LAWN - B
                           CN    =   61
                           Area =        2.000 acres
                           S    =   6.3934 in
                           0.2S =   1.2787 in

                            Cumulative Runoff
                           -------------------
                                    .2924 in
                                     .049 ac-ft

              HYG Volume...          .049 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                Page 5.03
Name.... LAWN - B          Tag:      5                  Event: 5 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:      5

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 24.0000 hrs     Rain Depth = 3.4000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6333 hrs
              Computed Peak Flow             =      .19 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6500 hrs
              Peak Flow, Interpolated Output =      .19 cfs
              ============================================

                            DRAINAGE AREA
                            -------------------
                            ID:LAWN - B
                            CN   =   61
                            Area =        2.000 acres
                            S    =   6.3934 in
                            0.2S =   1.2787 in

                             Cumulative Runoff
                            -------------------
                                     .5285 in
                                      .088 ac-ft

              HYG Volume...           .088 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 10 year storm
Duration       = 24.0000 hrs     Rain Depth = 3.8800 in
Rain Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 3rdQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir        = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - LAWN - B 10
Tc             = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 61

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =  15.6333 hrs
Computed Peak Flow             =      .27 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  15.6000 hrs
Peak Flow, Interpolated Output =      .27 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:LAWN - B
              CN    =   61
              Area =        2.000 acres
              S     =   6.3934 in
              0.2S =   1.2787 in

               Cumulative Runoff
              -------------------
                       .7523 in
                        .125 ac-ft

HYG Volume...           .125 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.05
Name.... LAWN - B           Tag:     25                 Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:     25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration      = 24.0000 hrs     Rain Depth = 4.7500 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 25
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6333 hrs
              Computed Peak Flow             =      .43 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6000 hrs
              Peak Flow, Interpolated Output =      .43 cfs
              ============================================

                            DRAINAGE AREA
                            -------------------
                            ID:LAWN - B
                            CN    =   61
                            Area =        2.000 acres
                            S     =   6.3934 in
                            0.2S =   1.2787 in

                             Cumulative Runoff
                            -------------------
                                    1.2215 in
                                      .204 ac-ft

              HYG Volume...           .204 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 50 year storm
Duration      = 24.0000 hrs     Rain Depth = 5.5000 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 3rdQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - LAWN - B 50
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 61

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =  15.6333 hrs
Computed Peak Flow             =      .57 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  15.6000 hrs
Peak Flow, Interpolated Output =      .57 cfs
============================================

              DRAINAGE AREA
            -------------------
            ID:LAWN - B
            CN   =   61
            Area =        2.000 acres
            S    =   6.3934 in
            0.2S =   1.2787 in

             Cumulative Runoff
            -------------------
                    1.6787 in
                      .280 ac-ft

HYG Volume...           .280 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.07
Name.... LAWN - B           Tag:    100                   Event: 100 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:    100

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 100 year storm
              Duration      = 24.0000 hrs     Rain Depth = 6.5000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 100
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6000 hrs
              Computed Peak Flow             =      .78 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6000 hrs
              Peak Flow, Interpolated Output =      .78 cfs
              ============================================

                           DRAINAGE AREA
                        -------------------
                        ID:LAWN - B
                        CN   =   61
                        Area =        2.000 acres
                        S    =   6.3934 in
                        0.2S =   1.2787 in

                         Cumulative Runoff
                        -------------------
                                2.3472 in
                                  .391 ac-ft

              HYG Volume...           .391 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.08
Name.... LAWN - D           Tag:      1                    Event: 1 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:      1

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 1 year storm
              Duration      = 24.0000 hrs     Rain Depth = 2.3500 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 1
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6000 hrs
              Computed Peak Flow             =      .27 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6000 hrs
              Peak Flow, Interpolated Output =      .27 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:LAWN - D
                           CN    =   80
                           Area =        2.000 acres
                           S     =   2.5000 in
                           0.2S =    .5000 in

                            Cumulative Runoff
                           -------------------
                                    .7868 in
                                     .131 ac-ft

              HYG Volume...            .131 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.09
Name.... LAWN - D            Tag:      2                     Event: 2 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:      2

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 2 year storm
              Duration      = 24.0000 hrs     Rain Depth = 2.8000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 2
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6000 hrs
              Computed Peak Flow             =      .36 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6000 hrs
              Peak Flow, Interpolated Output =      .36 cfs
              ============================================

                            DRAINAGE AREA
                        -------------------
                        ID:LAWN - D
                        CN    =   80
                        Area =        2.000 acres
                        S     =   2.5000 in
                        0.2S =     .5000 in

                         Cumulative Runoff
                        -------------------
                                1.1021 in
                                  .184 ac-ft

              HYG Volume...            .184 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.10
Name.... LAWN - D            Tag:      5                   Event: 5 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:      5

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 24.0000 hrs     Rain Depth = 3.4000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6000 hrs
              Computed Peak Flow             =      .49 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6000 hrs
              Peak Flow, Interpolated Output =      .49 cfs
              ============================================

                               DRAINAGE AREA
                            -------------------
                            ID:LAWN - D
                            CN    =   80
                            Area =        2.000 acres
                            S    =   2.5000 in
                            0.2S =    .5000 in

                             Cumulative Runoff
                            -------------------
                                    1.5574 in
                                      .260 ac-ft

              HYG Volume...            .260 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 10 year storm
Duration      = 24.0000 hrs     Rain Depth = 3.8800 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 3rdQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - LAWN - D 10
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 80

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =  15.6000 hrs
Computed Peak Flow             =      .60 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  15.6000 hrs
Peak Flow, Interpolated Output =      .60 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:LAWN - D
              CN    =   80
              Area =        2.000 acres
              S    =   2.5000 in
              0.2S =    .5000 in

               Cumulative Runoff
              -------------------
                      1.9429 in
                        .324 ac-ft

HYG Volume...           .324 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.12
Name.... LAWN - D            Tag:     25                 Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:     25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration      = 24.0000 hrs     Rain Depth = 4.7500 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 25
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6000 hrs
              Computed Peak Flow             =      .80 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6000 hrs
              Peak Flow, Interpolated Output =      .80 cfs
              ============================================

                             DRAINAGE AREA
                            -------------------
                            ID:LAWN - D
                            CN   =   80
                            Area =        2.000 acres
                            S    =   2.5000 in
                            0.2S =    .5000 in

                             Cumulative Runoff
                            -------------------
                                    2.6759 in
                                      .446 ac-ft

              HYG Volume...           .446 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 50 year storm
Duration       = 24.0000 hrs     Rain Depth = 5.5000 in
Rain Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 3rdQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir        = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - LAWN - D 50
Tc             = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 80

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =  15.6000 hrs
Computed Peak Flow             =      .97 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  15.6000 hrs
Peak Flow, Interpolated Output =      .97 cfs
============================================

              DRAINAGE AREA
            -------------------
            ID:LAWN - D
            CN    =   80
            Area =        2.000 acres
            S     =   2.5000 in
            0.2S =    .5000 in

             Cumulative Runoff
            -------------------
                    3.3333 in
                      .556 ac-ft

HYG Volume...            .556 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration      = 24.0000 hrs     Rain Depth = 6.5000 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 3rdQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - LAWN - D 100
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 80

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =  15.6000 hrs
Computed Peak Flow             =     1.20 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  15.6000 hrs
Peak Flow, Interpolated Output =     1.20 cfs
============================================

              DRAINAGE AREA
              -------------------
              ID:LAWN - D
              CN    =   80
              Area =        2.000 acres
              S    =   2.5000 in
              0.2S =    .5000 in

               Cumulative Runoff
              -------------------
                      4.2353 in
                        .706 ac-ft

HYG Volume...             .706 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                     Page 5.15
Name.... WOODED LOT - B      Tag:      1                     Event: 1 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:      1

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 1 year storm
              Duration      = 24.0000 hrs     Rain Depth = 2.3500 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 1
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  18.0333 hrs
              Computed Peak Flow             =      .02 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  18.0500 hrs
              Peak Flow, Interpolated Output =      .02 cfs
              ============================================

                               DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - B
                            CN   =   55
                            Area =       2.000 acres
                            S    =   8.1818 in
                            0.2S =   1.6364 in

                             Cumulative Runoff
                            -------------------
                                     .0573 in
                                      .010 ac-ft

              HYG Volume...           .010 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.16
Name.... WOODED LOT - B     Tag:      2                     Event: 2 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:      2

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 2 year storm
              Duration      = 24.0000 hrs     Rain Depth = 2.8000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 2
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  16.8333 hrs
              Computed Peak Flow             =      .05 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  16.8500 hrs
              Peak Flow, Interpolated Output =      .05 cfs
              ============================================

                               DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - B
                            CN   =   55
                            Area =       2.000 acres
                            S    =   8.1818 in
                            0.2S =   1.6364 in

                             Cumulative Runoff
                            -------------------
                                     .1449 in
                                      .024 ac-ft

              HYG Volume...           .024 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.17
Name.... WOODED LOT - B      Tag:       5                   Event: 5 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%    Tag:      5

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 24.0000 hrs     Rain Depth = 3.4000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6667 hrs
              Computed Peak Flow             =      .11 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6500 hrs
              Peak Flow, Interpolated Output =      .11 cfs
              ============================================

                           DRAINAGE AREA
                        -------------------
                        ID:WOODED LOT - B
                        CN    =   55
                        Area =        2.000 acres
                        S     =   8.1818 in
                        0.2S =    1.6364 in

                         Cumulative Runoff
                        -------------------
                                 .3127 in
                                  .052 ac-ft

              HYG Volume...           .052 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.18
Name.... WOODED LOT - B     Tag:     10                   Event: 10 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:     10

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 10 year storm
              Duration      = 24.0000 hrs     Rain Depth = 3.8800 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 10
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6333 hrs
              Computed Peak Flow             =      .18 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6500 hrs
              Peak Flow, Interpolated Output =      .17 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - B
                           CN    =   55
                           Area =        2.000 acres
                           S     =   8.1818 in
                           0.2S =   1.6364 in

                            Cumulative Runoff
                           -------------------
                                    .4828 in
                                     .080 ac-ft

              HYG Volume...            .080 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.19
Name.... WOODED LOT - B      Tag:      25                  Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:      25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration      = 24.0000 hrs     Rain Depth = 4.7500 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 25
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6333 hrs
              Computed Peak Flow             =      .31 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6000 hrs
              Peak Flow, Interpolated Output =      .31 cfs
              ============================================

                                 DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - B
                            CN    =   55
                            Area =        2.000 acres
                            S     =   8.1818 in
                            0.2S =    1.6364 in

                             Cumulative Runoff
                            -------------------
                                     .8583 in
                                      .143 ac-ft

              HYG Volume...            .143 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.20
Name.... WOODED LOT - B     Tag:     50                 Event: 50 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:     50

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 50 year storm
              Duration      = 24.0000 hrs     Rain Depth = 5.5000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 50
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6333 hrs
              Computed Peak Flow             =      .44 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6000 hrs
              Peak Flow, Interpolated Output =      .44 cfs
              ============================================

                             DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - B
                            CN    =   55
                            Area =        2.000 acres
                            S     =   8.1818 in
                            0.2S =   1.6364 in

                             Cumulative Runoff
                            -------------------
                                    1.2393 in
                                      .207 ac-ft

              HYG Volume...           .207 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.21
Name.... WOODED LOT - B      Tag:    100                 Event: 100 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:    100

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 100 year storm
              Duration      = 24.0000 hrs     Rain Depth = 6.5000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 100
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6333 hrs
              Computed Peak Flow             =      .63 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6000 hrs
              Peak Flow, Interpolated Output =      .63 cfs
              ============================================

                            DRAINAGE AREA
                          -------------------
                          ID:WOODED LOT - B
                          CN    =   55
                          Area =        2.000 acres
                          S     =   8.1818 in
                          0.2S =   1.6364 in

                           Cumulative Runoff
                          -------------------
                                  1.8133 in
                                    .302 ac-ft

              HYG Volume...            .302 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

              Unit peak,           qp =     9.06 cfs
              Unit peak time       Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,     Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 1 year storm
Duration      = 24.0000 hrs     Rain Depth = 2.3500 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 3rdQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - WOODED LOT - D 1
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 77

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =  15.6333 hrs
Computed Peak Flow             =      .22 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  15.6000 hrs
Peak Flow, Interpolated Output =      .22 cfs
============================================

                DRAINAGE AREA
              -------------------
              ID:WOODED LOT - D
              CN    =   77
              Area =        2.000 acres
              S     =   2.9870 in
              0.2S =    .5974 in

               Cumulative Runoff
              -------------------
                       .6481 in
                        .108 ac-ft

HYG Volume...           .108 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.23
Name.... WOODED LOT - D      Tag:      2                   Event: 2 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%    Tag:      2

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 2 year storm
              Duration      = 24.0000 hrs     Rain Depth = 2.8000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 2
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6000 hrs
              Computed Peak Flow             =      .32 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6000 hrs
              Peak Flow, Interpolated Output =      .32 cfs
              ============================================

                            DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - D
                           CN    =    77
                           Area =        2.000 acres
                           S     =   2.9870 in
                           0.2S =     .5974 in

                            Cumulative Runoff
                           -------------------
                                    .9348 in
                                     .156 ac-ft

              HYG Volume...           .156 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                              Page 5.24
Name.... WOODED LOT - D     Tag:      5               Event: 5 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:      5

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 24.0000 hrs     Rain Depth = 3.4000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6000 hrs
              Computed Peak Flow             =      .44 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6000 hrs
              Peak Flow, Interpolated Output =      .44 cfs
              ============================================

                            DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - D
                           CN    =   77
                           Area =        2.000 acres
                           S    =   2.9870 in
                           0.2S =    .5974 in

                            Cumulative Runoff
                           -------------------
                                   1.3567 in
                                     .226 ac-ft

              HYG Volume...           .226 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.25
Name.... WOODED LOT - D      Tag:      10                 Event: 10 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%    Tag:      10

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 10 year storm
              Duration      = 24.0000 hrs     Rain Depth = 3.8800 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 10
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6000 hrs
              Computed Peak Flow             =      .55 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6000 hrs
              Peak Flow, Interpolated Output =      .55 cfs
              ============================================

                              DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - D
                            CN   =   77
                            Area =       2.000 acres
                            S    =   2.9870 in
                            0.2S =    .5974 in

                             Cumulative Runoff
                            -------------------
                                    1.7187 in
                                      .286 ac-ft

              HYG Volume...           .286 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                   Page 5.26
Name.... WOODED LOT - D     Tag:     25                  Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:     25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration      = 24.0000 hrs     Rain Depth = 4.7500 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 25
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6000 hrs
              Computed Peak Flow             =      .74 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6000 hrs
              Peak Flow, Interpolated Output =      .74 cfs
              ============================================

                               DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - D
                            CN   =   77
                            Area =        2.000 acres
                            S    =   2.9870 in
                            0.2S =    .5974 in

                             Cumulative Runoff
                            -------------------
                                    2.4153 in
                                      .403 ac-ft

              HYG Volume...           .403 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.27
Name.... WOODED LOT - D      Tag:     50                  Event: 50 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 3rdQ 50%   Tag:     50

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 50 year storm
              Duration      = 24.0000 hrs     Rain Depth = 5.5000 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 3rdQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 50
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  15.6000 hrs
              Computed Peak Flow             =      .92 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  15.6000 hrs
              Peak Flow, Interpolated Output =      .92 cfs
              ============================================

                               DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - D
                            CN    =   77
                            Area =         2.000 acres
                            S     =   2.9870 in
                            0.2S =     .5974 in

                             Cumulative Runoff
                            -------------------
                                    3.0465 in
                                      .508 ac-ft

              HYG Volume...            .508 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration      = 24.0000 hrs     Rain Depth = 6.5000 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 3rdQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - WOODED LOT - D 100
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 77

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =  15.6000 hrs
Computed Peak Flow             =     1.15 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  15.6000 hrs
Peak Flow, Interpolated Output =     1.15 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:WOODED LOT - D
              CN   =   77
              Area =        2.000 acres
              S    =   2.9870 in
              0.2S =    .5974 in

               Cumulative Runoff
              -------------------
                      3.9193 in
                        .653 ac-ft

HYG Volume...           .653 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =  1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

HYDROLOGIC MODEL INPUT/OUTPUT

48-HOUR STORM 1,5,10,25,50, AND 100-YEAR RETURN INTERVALS

```
Job File: G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Rain Dir: G:\1997\9770\Riverwoods Misc\HYDROLOGY\

                    ==========================
                            JOB TITLE
                    ==========================

   Project Date: 12/3/2004
   Project Engineer: Patrick Glenn
      Project Title: Riverwoods Woodland Hydrology Sample Calculations
   Project Comments:
   Calculations prepared to examine the hydrologic differences
   between turfgrass and wooded areas.
```

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Table of Contents (continued)

Type.... Master Network Summary Page 1.01
Name.... Watershed
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

MASTER DESIGN STORM SUMMARY

Network Storm Collection: Lake County - 48

Return Event	Total Depth in	Rainfall Type	RNF ID
1	2.5400	Synthetic Curve	0-10 4thQ 50%
2	3.0200	Synthetic Curve	0-10 4thQ 50%
5	3.6700	Synthetic Curve	0-10 4thQ 50%
10	4.1900	Synthetic Curve	0-10 4thQ 50%
25	5.1300	Synthetic Curve	0-10 4thQ 50%
50	5.9400	Synthetic Curve	0-10 4thQ 50%
100	7.0200	Synthetic Curve	0-10 4thQ 50%

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
LAWN - B	AREA	1	.035		42.9000	.05		
LAWN - B	AREA	2	.062		43.0500	.09		
LAWN - B	AREA	5	.108		43.2000	.14		
LAWN - B	AREA	10	.152		43.0000	.19		
LAWN - B	AREA	25	.241		43.1000	.28		
LAWN - B	AREA	50	.328		43.1500	.36		
LAWN - B	AREA	100	.453		43.2000	.47		
LAWN - D	AREA	1	.153		42.8500	.16		
LAWN - D	AREA	2	.211		43.2000	.21		
LAWN - D	AREA	5	.295		40.7500	.28		
LAWN - D	AREA	10	.367		40.7500	.34		
LAWN - D	AREA	25	.501		40.6500	.45		
LAWN - D	AREA	50	.621		40.7500	.54		
LAWN - D	AREA	100	.785		40.7500	.67		

Type.... Master Network Summary   Page 1.02
Name.... Watershed
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
*OUTFALL	JCT	1	.330		43.1500	.39		
*OUTFALL	JCT	2	.487		43.1500	.55		
*OUTFALL	JCT	5	.731		43.1500	.78		
*OUTFALL	JCT	10	.947		43.1500	.98		
*OUTFALL	JCT	25	1.372		43.2000	1.34		
*OUTFALL	JCT	50	1.767		40.8000	1.68		
*OUTFALL	JCT	100	2.325		40.8000	2.15		
WOODED LOT - B	AREA	1	.015		47.0500	.03		
WOODED LOT - B	AREA	2	.033		42.9500	.05		
WOODED LOT - B	AREA	5	.067		42.9500	.10		
WOODED LOT - B	AREA	10	.101		43.1500	.14		
WOODED LOT - B	AREA	25	.174		43.1000	.22		
WOODED LOT - B	AREA	50	.247		43.2000	.29		
WOODED LOT - B	AREA	100	.356		43.0500	.40		
WOODED LOT - D	AREA	1	.128		42.9000	.14		
WOODED LOT - D	AREA	2	.181		42.8500	.19		
WOODED LOT - D	AREA	5	.260		40.8000	.26		
WOODED LOT - D	AREA	10	.327		40.8000	.32		
WOODED LOT - D	AREA	25	.455		40.7000	.42		
WOODED LOT - D	AREA	50	.571		40.7500	.52		
WOODED LOT - D	AREA	100	.731		40.7000	.64		

```
Type.... Design Storms                                       Page 2.01
Name.... Lake County - 48

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Title... Project Date: 12/3/2004
         Project Engineer: Patrick Glenn
            Project Title: Riverwoods Woodland Hydrology
         Sample Calculations
         Project Comments:
         Calculations prepared to examine the hydrologic
         differences between turfgrass and wooded areas.

                DESIGN STORMS SUMMARY

 Design Storm File,ID =              Lake County - 48


 Storm Tag Name      = 1
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 4thQ 50%
 Storm Frequency     = 1 yr
 Total Rainfall Depth= 2.5400 in
 Duration Multiplier =  48
 Resulting Duration  = 48.0000 hrs
 Resulting Start Time= .0000 hrs  Step= 2.4000 hrs  End= 48.0000 hrs


 Storm Tag Name      =     2
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 4thQ 50%
 Storm Frequency     = 2 yr
 Total Rainfall Depth= 3.0200 in
 Duration Multiplier =  48
 Resulting Duration  = 48.0000 hrs
 Resulting Start Time= .0000 hrs  Step= 2.4000 hrs  End= 48.0000 hrs


 Storm Tag Name      =     5
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 4thQ 50%
 Storm Frequency     = 5 yr
 Total Rainfall Depth= 3.6700 in
 Duration Multiplier =  48
 Resulting Duration  = 48.0000 hrs
 Resulting Start Time= .0000 hrs  Step= 2.4000 hrs  End= 48.0000 hrs


 Storm Tag Name      =    10
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 4thQ 50%
 Storm Frequency     = 10 yr
 Total Rainfall Depth= 4.1900 in
 Duration Multiplier =  48
 Resulting Duration  = 48.0000 hrs
 Resulting Start Time= .0000 hrs  Step= 2.4000 hrs  End= 48.0000 hrs
```

```
Type.... Design Storms                                              Page 2.02
Name.... Lake County - 48

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Title... Project Date: 12/3/2004
         Project Engineer: Patrick Glenn
            Project Title: Riverwoods Woodland Hydrology
         Sample Calculations
         Project Comments:
         Calculations prepared to examine the hydrologic
         differences between turfgrass and wooded areas.

                DESIGN STORMS SUMMARY

 Design Storm File,ID =              Lake County - 48


 Storm Tag Name      =     25
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 4thQ 50%
 Storm Frequency     = 25 yr
 Total Rainfall Depth= 5.1300 in
 Duration Multiplier =  48
 Resulting Duration  = 48.0000 hrs
 Resulting Start Time= .0000 hrs  Step= 2.4000 hrs  End= 48.0000 hrs


 Storm Tag Name      =     50
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 4thQ 50%
 Storm Frequency     = 50 yr
 Total Rainfall Depth= 5.9400 in
 Duration Multiplier =  48
 Resulting Duration  = 48.0000 hrs
 Resulting Start Time= .0000 hrs  Step= 2.4000 hrs  End= 48.0000 hrs


 Storm Tag Name      =    100
 ----------------------------------------------------------------------
 Data Type, File, ID = Synthetic Storm    0-10 4thQ 50%
 Storm Frequency     = 100 yr
 Total Rainfall Depth= 7.0200 in
 Duration Multiplier =  48
 Resulting Duration  = 48.0000 hrs
 Resulting Start Time= .0000 hrs  Step= 2.4000 hrs  End= 48.0000 hrs
```

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

::

TIME OF CONCENTRATION CALCULATOR

::

Segment #1: Tc: User Defined

Segment #1 Time: .2500 hrs

=========================

Total Tc: .2500 hrs

=========================

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

TIME OF CONCENTRATION CALCULATOR

Segment #1: Tc: User Defined

Segment #1 Time: .2500 hrs

Total Tc: .2500 hrs

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: User Defined

Segment #1 Time: .2500 hrs

=========================
Total Tc: .2500 hrs
=========================

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

::

TIME OF CONCENTRATION CALCULATOR

::

Segment #1: Tc: User Defined

Segment #1 Time: .2500 hrs

=========================

Total Tc: .2500 hrs

=========================

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	61	2.000			61.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			61.00 (61)

::

Type.... Runoff CN-Area
Name.... LAWN - D

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Open space (Lawns,parks etc.) - Goo	80	2.000			80.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			80.00 (80)

Type.... Runoff CN-Area
Name.... WOODED LOT - B

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Woods - good	55	2.000			55.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			55.00 (55)

Type.... Runoff CN-Area
Name.... WOODED LOT - D

File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Woods - good	77	2.000			77.00
COMPOSITE AREA & WEIGHTED CN --->		2.000			77.00 (77)

```
Type.... Unit Hyd. Summary                                     Page 5.01
Name.... LAWN - B            Tag:      1                   Event: 1 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:      1

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 1 year storm
              Duration      = 48.0000 hrs     Rain Depth = 2.5400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 1
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .06 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .06 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:LAWN - B
                           CN   =   61
                           Area =        2.000 acres
                           S    =   6.3934 in
                           0.2S =   1.2787 in

                            Cumulative Runoff
                           -------------------
                                   .2078 in
                                    .035 ac-ft

              HYG Volume...           .035 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =  1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.02
Name.... LAWN - B           Tag:      2                     Event: 2 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:      2

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 2 year storm
              Duration      = 48.0000 hrs     Rain Depth = 3.0200 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 2
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .09 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .09 cfs
              ============================================

                              DRAINAGE AREA
                            -------------------
                            ID:LAWN - B
                            CN    =   61
                            Area =        2.000 acres
                            S     =   6.3934 in
                            0.2S =   1.2787 in

                             Cumulative Runoff
                            -------------------
                                     .3727 in
                                      .062 ac-ft

              HYG Volume...            .062 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.03
Name.... LAWN - B            Tag:      5                    Event: 5 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:      5

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 48.0000 hrs     Rain Depth = 3.6700 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .14 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .14 cfs
              ============================================

                             DRAINAGE AREA
                          -------------------
                          ID:LAWN - B
                          CN    =   61
                          Area =        2.000 acres
                          S     =   6.3934 in
                          0.2S =   1.2787 in

                           Cumulative Runoff
                          -------------------
                                   .6509 in
                                    .108 ac-ft

              HYG Volume...           .108 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                   Page 5.04
Name.... LAWN - B           Tag:     10                  Event: 10 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:     10

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 10 year storm
              Duration      = 48.0000 hrs     Rain Depth = 4.1900 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 10
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .19 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .19 cfs
              ============================================

                             DRAINAGE AREA
                            -------------------
                            ID:LAWN - B
                            CN    =   61
                            Area =       2.000 acres
                            S     =   6.3934 in
                            0.2S =    1.2787 in

                             Cumulative Runoff
                            -------------------
                                     .9109 in
                                      .152 ac-ft

              HYG Volume...           .152 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.05
Name.... LAWN - B          Tag:     25                    Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:     25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration      = 48.0000 hrs     Rain Depth = 5.1300 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 25
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .28 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .28 cfs
              ============================================

                          DRAINAGE AREA
                        -------------------
                        ID:LAWN - B
                        CN   =   61
                        Area =        2.000 acres
                        S    =   6.3934 in
                        0.2S =   1.2787 in

                         Cumulative Runoff
                        -------------------
                                1.4478 in
                                  .241 ac-ft

              HYG Volume...            .241 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,         qp =     9.06 cfs
              Unit peak time     Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                   Page 5.06
Name.... LAWN - B           Tag:     50                  Event: 50 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:     50

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 50 year storm
              Duration      = 48.0000 hrs     Rain Depth = 5.9400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 50
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .36 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .36 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:LAWN - B
                           CN    =   61
                           Area =        2.000 acres
                           S     =   6.3934 in
                           0.2S =    1.2787 in

                            Cumulative Runoff
                           -------------------
                                   1.9655 in
                                     .328 ac-ft

              HYG Volume...            .328 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                     Page 5.07
Name.... LAWN - B           Tag:    100                  Event: 100 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:    100

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 100 year storm
              Duration      = 48.0000 hrs     Rain Depth = 7.0200 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - B 100
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 61

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .47 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .47 cfs
              ============================================

                            DRAINAGE AREA
                           -------------------
                           ID:LAWN - B
                           CN    =   61
                           Area =        2.000 acres
                           S    =   6.3934 in
                           0.2S =   1.2787 in

                            Cumulative Runoff
                           -------------------
                                   2.7164 in
                                     .453 ac-ft

              HYG Volume...            .453 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.08
Name.... LAWN - D            Tag:      1                 Event: 1 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:      1

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 1 year storm
              Duration      = 48.0000 hrs     Rain Depth = 2.5400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 1
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .16 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .16 cfs
              ============================================

                             DRAINAGE AREA
                           --------------------
                           ID:LAWN - D
                           CN    =   80
                           Area =       2.000 acres
                           S     =   2.5000 in
                           0.2S =     .5000 in

                            Cumulative Runoff
                           --------------------
                                    .9167 in
                                     .153 ac-ft

              HYG Volume...            .153 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 2 year storm
Duration      = 48.0000 hrs     Rain Depth = 3.0200 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 4thQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - LAWN - D 2
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 80

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =  43.2000 hrs
Computed Peak Flow             =      .21 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  43.1996 hrs
Peak Flow, Interpolated Output =      .21 cfs
============================================

              DRAINAGE AREA
            -------------------
            ID:LAWN - D
            CN   =   80
            Area =        2.000 acres
            S    =   2.5000 in
            0.2S =    .5000 in

             Cumulative Runoff
            -------------------
                    1.2650 in
                      .211 ac-ft

HYG Volume...           .211 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.10
Name.... LAWN - D           Tag:      5                 Event: 5 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:      5

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 48.0000 hrs     Rain Depth = 3.6700 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  40.8333 hrs
              Computed Peak Flow             =      .28 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  40.7997 hrs
              Peak Flow, Interpolated Output =      .28 cfs
              ============================================

                           DRAINAGE AREA
                          -------------------
                          ID:LAWN - D
                          CN    =   80
                          Area  =       2.000 acres
                          S     =   2.5000 in
                          0.2S  =    .5000 in

                           Cumulative Runoff
                          -------------------
                                  1.7723 in
                                    .295 ac-ft

              HYG Volume...           .295 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.11
Name.... LAWN - D             Tag:     10                   Event: 10 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:     10

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 10 year storm
              Duration      = 48.0000 hrs     Rain Depth = 4.1900 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 10
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  40.8000 hrs
              Computed Peak Flow             =      .34 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  40.7997 hrs
              Peak Flow, Interpolated Output =      .34 cfs
              ============================================

                            DRAINAGE AREA
                         -------------------
                         ID:LAWN - D
                         CN    =   80
                         Area =        2.000 acres
                         S     =   2.5000 in
                         0.2S =     .5000 in

                          Cumulative Runoff
                         -------------------
                                 2.1997 in
                                   .367 ac-ft

              HYG Volume...            .367 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.12
Name.... LAWN - D          Tag:     25                     Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:     25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration      = 48.0000 hrs     Rain Depth = 5.1300 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 25
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  40.8000 hrs
              Computed Peak Flow             =      .45 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  40.7997 hrs
              Peak Flow, Interpolated Output =      .45 cfs
              ============================================

                             DRAINAGE AREA
                            -------------------
                            ID:LAWN - D
                            CN    =   80
                            Area =        2.000 acres
                            S     =   2.5000 in
                            0.2S =     .5000 in

                             Cumulative Runoff
                            -------------------
                                    3.0066 in
                                      .501 ac-ft

              HYG Volume...           .501 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                Page 5.13
Name.... LAWN - D           Tag:     50                Event: 50 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:     50

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 50 year storm
              Duration      = 48.0000 hrs     Rain Depth = 5.9400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - LAWN - D 50
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 80

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  40.8000 hrs
              Computed Peak Flow             =      .54 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  40.7997 hrs
              Peak Flow, Interpolated Output =      .54 cfs
              ============================================

                             DRAINAGE AREA
                            -------------------
                            ID:LAWN - D
                            CN   =   80
                            Area =        2.000 acres
                            S    =   2.5000 in
                            0.2S =    .5000 in

                             Cumulative Runoff
                            -------------------
                                    3.7272 in
                                      .621 ac-ft

              HYG Volume...           .621 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration      = 48.0000 hrs     Rain Depth = 7.0200 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 4thQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - LAWN - D 100
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 80

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =  40.8000 hrs
Computed Peak Flow             =      .67 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  40.7997 hrs
Peak Flow, Interpolated Output =      .67 cfs
============================================

              DRAINAGE AREA
             -------------------
             ID:LAWN - D
             CN   =   80
             Area =        2.000 acres
             S    =   2.5000 in
             0.2S =    .5000 in

              Cumulative Runoff
             -------------------
                     4.7129 in
                       .785 ac-ft

HYG Volume...            .785 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: LAWN - D)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 1 year storm
Duration      = 48.0000 hrs     Rain Depth = 2.5400 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 4thQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - WOODED LOT - B 1
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 55

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =  48.0000 hrs
Computed Peak Flow             =      .03 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  47.9996 hrs
Peak Flow, Interpolated Output =      .03 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:WOODED LOT - B
              CN   =   55
              Area =        2.000 acres
              S    =   8.1818 in
              0.2S =   1.6364 in

               Cumulative Runoff
              -------------------
                       .0899 in
                        .015 ac-ft

HYG Volume...           .015 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 2 year storm
Duration       = 48.0000 hrs     Rain Depth = 3.0200 in
Rain Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 4thQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir        = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - WOODED LOT - B 2
Tc             = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 55

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =  43.2000 hrs
Computed Peak Flow             =      .06 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  43.1996 hrs
Peak Flow, Interpolated Output =      .06 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:WOODED LOT - B
              CN    =   55
              Area =        2.000 acres
              S     =   8.1818 in
              0.2S =   1.6364 in

               Cumulative Runoff
              -------------------
                       .2001 in
                        .033 ac-ft

HYG Volume...            .033 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.17
Name.... WOODED LOT - B      Tag:       5                  Event: 5 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%    Tag:       5

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 48.0000 hrs     Rain Depth = 3.6700 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .10 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .10 cfs
              ============================================

                            DRAINAGE AREA
                         -------------------
                         ID:WOODED LOT - B
                         CN    =   55
                         Area =        2.000 acres
                         S     =   8.1818 in
                         0.2S =   1.6364 in

                          Cumulative Runoff
                         -------------------
                                  .4048 in
                                   .067 ac-ft

              HYG Volume...            .067 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.18
Name.... WOODED LOT - B      Tag:     10                  Event: 10 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:     10

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 10 year storm
              Duration      = 48.0000 hrs     Rain Depth = 4.1900 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 10
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .14 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .14 cfs
              ============================================

                                 DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - B
                            CN    =   55
                            Area =        2.000 acres
                            S     =   8.1818 in
                            0.2S =   1.6364 in

                             Cumulative Runoff
                            -------------------
                                     .6074 in
                                      .101 ac-ft

              HYG Volume...           .101 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                  Page 5.19
Name.... WOODED LOT - B      Tag:      25                Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:      25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration       = 48.0000 hrs     Rain Depth = 5.1300 in
              Rain Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir        = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 25
              Tc             = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .22 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .22 cfs
              ============================================

                            DRAINAGE AREA
                          -------------------
                          ID:WOODED LOT - B
                          CN    =   55
                          Area =        2.000 acres
                          S     =   8.1818 in
                          0.2S =   1.6364 in

                           Cumulative Runoff
                          -------------------
                                 1.0454 in
                                   .174 ac-ft

              HYG Volume...            .174 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 50 year storm
Duration      = 48.0000 hrs     Rain Depth = 5.9400 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 4thQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - WOODED LOT - B 50
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 55

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =  43.2000 hrs
Computed Peak Flow             =      .29 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  43.1996 hrs
Peak Flow, Interpolated Output =      .29 cfs
============================================

                DRAINAGE AREA
              -------------------
              ID:WOODED LOT - B
              CN    =   55
              Area =        2.000 acres
              S     =   8.1818 in
              0.2S =    1.6364 in

               Cumulative Runoff
              -------------------
                      1.4834 in
                        .247 ac-ft

HYG Volume...           .247 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.21
Name.... WOODED LOT - B      Tag:    100                  Event: 100 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%    Tag:    100

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 100 year storm
              Duration      = 48.0000 hrs     Rain Depth = 7.0200 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - B 100
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 55

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .40 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .40 cfs
              ============================================

                            DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - B
                           CN   =   55
                           Area =        2.000 acres
                           S    =   8.1818 in
                           0.2S =   1.6364 in

                            Cumulative Runoff
                           -------------------
                                   2.1366 in
                                     .356 ac-ft

              HYG Volume...           .356 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - B)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                   Page 5.22
Name.... WOODED LOT - D      Tag:       1                  Event: 1 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%    Tag:      1

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 1 year storm
              Duration      = 48.0000 hrs     Rain Depth = 2.5400 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 1
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .14 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .14 cfs
              ============================================

                             DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - D
                           CN    =   77
                           Area  =        2.000 acres
                           S     =   2.9870 in
                           0.2S  =    .5974 in

                            Cumulative Runoff
                           -------------------
                                    .7655 in
                                     .128 ac-ft

              HYG Volume...            .128 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                Page 5.23
Name.... WOODED LOT - D      Tag:      2                 Event: 2 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%    Tag:      2

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 2 year storm
              Duration      = 48.0000 hrs     Rain Depth = 3.0200 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 2
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .19 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .19 cfs
              ============================================

                            DRAINAGE AREA
                           -------------------
                           ID:WOODED LOT - D
                           CN    =   77
                           Area =        2.000 acres
                           S    =   2.9870 in
                           0.2S =    .5974 in

                            Cumulative Runoff
                           -------------------
                                   1.0849 in
                                     .181 ac-ft

              HYG Volume...            .181 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,           qp =     9.06 cfs
              Unit peak time       Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,     Tb =   .83333 hrs
```

```
              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 5 year storm
              Duration      = 48.0000 hrs     Rain Depth = 3.6700 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 5
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  43.2000 hrs
              Computed Peak Flow             =      .26 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  43.1996 hrs
              Peak Flow, Interpolated Output =      .26 cfs
              ============================================

                            DRAINAGE AREA
                          -------------------
                          ID:WOODED LOT - D
                          CN    =   77
                          Area =        2.000 acres
                          S    =   2.9870 in
                          0.2S =    .5974 in

                           Cumulative Runoff
                          -------------------
                                  1.5580 in
                                    .260 ac-ft

              HYG Volume...            .260 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 10 year storm
Duration      = 48.0000 hrs     Rain Depth = 4.1900 in
Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 4thQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - WOODED LOT - D 10
Tc            = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 77

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =  40.8333 hrs
Computed Peak Flow             =      .32 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  40.7997 hrs
Peak Flow, Interpolated Output =      .32 cfs
============================================

                  DRAINAGE AREA
              -------------------
              ID:WOODED LOT - D
              CN    =   77
              Area =        2.000 acres
              S     =   2.9870 in
              0.2S =     .5974 in

               Cumulative Runoff
              -------------------
                      1.9616 in
                        .327 ac-ft

HYG Volume...           .327 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
Type.... Unit Hyd. Summary                                    Page 5.26
Name.... WOODED LOT - D     Tag:     25                   Event: 25 yr
File.... G:\1997\9770\Riverwoods Misc\HYDROLOGY\HYDROLOGY_SAMPLES.PPW
Storm... 0-10 4thQ 50%   Tag:     25

              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 25 year storm
              Duration      = 48.0000 hrs     Rain Depth = 5.1300 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 25
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres  Runoff CN= 77

              ============================================
              Computational Time Increment   =    .03333 hrs
              Computed Peak Time             =   40.8000 hrs
              Computed Peak Flow             =       .42 cfs

              Time Increment for HYG File    =     .0500 hrs
              Peak Time, Interpolated Output =   40.7997 hrs
              Peak Flow, Interpolated Output =       .42 cfs
              ============================================

                             DRAINAGE AREA
                            -------------------
                            ID:WOODED LOT - D
                            CN    =   77
                            Area =       2.000 acres
                            S     =   2.9870 in
                            0.2S =     .5974 in

                             Cumulative Runoff
                            -------------------
                                    2.7321 in
                                      .455 ac-ft

              HYG Volume...            .455 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =    .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =    .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 50 year storm
Duration       = 48.0000 hrs     Rain Depth = 5.9400 in
Rain Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
Rain File -ID =  - 0-10 4thQ 50%
Unit Hyd Type = Default Curvilinear
HYG Dir        = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
HYG File - ID =  - WOODED LOT - D 50
Tc             = .2500 hrs
Drainage Area = 2.000 acres  Runoff CN= 77

============================================
Computational Time Increment   =   .03333 hrs
Computed Peak Time             =  40.8000 hrs
Computed Peak Flow             =      .52 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  40.7997 hrs
Peak Flow, Interpolated Output =      .52 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:WOODED LOT - D
              CN    =    77
              Area =        2.000 acres
              S     =   2.9870 in
              0.2S =     .5974 in

               Cumulative Runoff
              -------------------
                      3.4267 in
                        .571 ac-ft

HYG Volume...             .571 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =     9.06 cfs
Unit peak time      Tp =   .16667 hrs
Unit receding limb, Tr =   .66667 hrs
Total unit time,    Tb =   .83333 hrs
```

```
              SCS UNIT HYDROGRAPH METHOD

              STORM EVENT: 100 year storm
              Duration      = 48.0000 hrs      Rain Depth = 7.0200 in
              Rain Dir      = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              Rain File -ID =  - 0-10 4thQ 50%
              Unit Hyd Type = Default Curvilinear
              HYG Dir       = G:\1997\9770\Riverwoods Misc\HYDROLOGY\
              HYG File - ID =  - WOODED LOT - D 100
              Tc            = .2500 hrs
              Drainage Area = 2.000 acres   Runoff CN= 77

              ============================================
              Computational Time Increment   =   .03333 hrs
              Computed Peak Time             =  40.8000 hrs
              Computed Peak Flow             =      .64 cfs

              Time Increment for HYG File    =    .0500 hrs
              Peak Time, Interpolated Output =  40.7997 hrs
              Peak Flow, Interpolated Output =      .64 cfs
              ============================================

                          DRAINAGE AREA
                        -------------------
                        ID:WOODED LOT - D
                        CN    =   77
                        Area =        2.000 acres
                        S     =   2.9870 in
                        0.2S =     .5974 in

                         Cumulative Runoff
                        -------------------
                                4.3838 in
                                  .731 ac-ft

              HYG Volume...            .731 ac-ft (area under HYG curve)

              ***** SCS UNIT HYDROGRAPH PARAMETERS *****

              Time Concentration, Tc =   .25000 hrs (ID: WOODED LOT - D)
              Computational Incr, Tm =   .03333 hrs = 0.20000 Tp

              Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
              K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
              Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

              Unit peak,          qp =     9.06 cfs
              Unit peak time      Tp =   .16667 hrs
              Unit receding limb, Tr =   .66667 hrs
              Total unit time,    Tb =   .83333 hrs
```

Upper Des Plaines River and Tributaries, Illinois and Wisconsin Integrated Feasibility Report and Environmental Assessment

Appendix D – Civil Design

March 2014

US Army Corps
of Engineers
Chicago District

TABLE OF CONTENT

UPPER DES PLAINES RIVER
ILLINOIS & WISCONSIN WATERSHEDS
FEASIBILITY STUDY

APPENDIX D
CIVIL DESIGN ANALYSIS

INTRODUCTION

GENERAL

1. The purpose of this report is to present the engineering analysis for the formation of Phase II FEASIBILITY STUDY plans. This study is a continuation and extension of the phase I Upper Des Plaines River Feasibility Study that was approved November 1999. The phase I study focused primarily on flooding problems along the main stem of the Des Plaines River (upstream of its confluence with Salt Creek), and recommended implementation of six projects to reduce main stem flooding. Study recommendations were authorized in the Water Resources Development Act of 1999 (P.L. 106-53). The phase I study was preceded by a Reconnaissance study that was completed in 1989. The phase II study has three primary objectives: further reduction of main stem flooding; reduction of tributary flooding; and environmental restoration of degraded ecosystems within the basin. Secondary objectives include improving water quality and enhancing recreational opportunities throughout the basin. The study will consider sites located within tributary watersheds and along the main stem for both Flood Damage Reduction (FDR) and Ecosystem Restoration (ER) potential. The affects of FDR sites within tributary watersheds on main stem flooding will also be evaluated.

PURPOSE AND SCOPE

2. The purpose of this section is to: 1) describe design criteria, engineering methods, procedures, and assumptions that were used for layout and perform preliminary design analysis of the alternatives; 2) present the methods used and calculations developed for earthwork quantities 3) present the requirements for the real estate needed; 4) present

criteria and requirements for utility interferences; and 5) discuss the engineering design analysis requirements for the next phase of the project.

PREVIOUS INVESTIGATIONS

3. See paragraph 1.1.5 and Plate 10 of Feasibility Main Report.

EXISTING SURVEY DATA

4. Local GIS data was used for the design of the levees, floodwalls, reservoirs, road raises, other measures, and dam removals and represents conditions existing at that time. The GIS data used includes 2-ft contours, real estate parcels, streets and highways, streams and water bodies. The GIS data was provided by Tele Atlas North America, Northeastern Illinois Planning Commission, IDOT Bureau of Information Processing, and Lake County GIS/Mapping Division.

5. GIS Data Disclaimer: While the United States Army Corps of Engineers, Chicago District (hereinafter referred to USACE) has made a reasonable effort to insure the accuracy of the maps and associated data, it should be explicitly noted that USACE makes no warranty, representation or guarantee, either express or implied, as to the content, sequence, accuracy, timeliness or completeness of any of the data provided herein. The USACE, its officers, agents, employees, or servants shall assume no liability of any nature for any errors, omissions, or inaccuracies in the information provided regardless of how caused. The USACE, its officers, agents, employees or servants shall assume no liability for any decisions made or actions taken or not taken by the user of the maps and associated data in reliance upon any information or data furnished here. By using these maps and associated data the user does so entirely at their own risk and explicitly acknowledges that he/she is aware of and agrees to be bound by this disclaimer and agrees not to present any claim or demand of any nature against the USACE, its officers, agents, employees or servants in any forum whatsoever for any damages of any nature whatsoever that may result from or may be caused in any way by the use of the maps and associated data.

6. The horizontal coordinates referenced the Illinois State Plane Coordinate System, East Zone, North American Datum of 1983 (NAD83) U.S. feet. The elevations used for the reservoir

weirs and levee crests all reference North American Vertical Datum (NAVD) 88 in U.S. feet.

7. Baseline utility information is available for the conceptual design of the reservoirs, levees/floodwalls, other measures, and dam removals for this feasibility study. Preliminary utility coordination with utility companies was performed to identify existing utilities in significant conflict with the proposed features. This information was used to amend features to minimize utility conflicts. A detailed survey of all existing utilities within and adjacent to the project site will be required during the design phase for each individual site.

SECTION 1 - RESERVOIRS

RESERVOIR SITE SELECTIONS

8. One hundred forty sites were identified as potential locations for proposed reservoirs. Refer to the Main Report for more information on the initial site selection details. Idealized Reservoir Analyses (Attachment D-1) were performed for the second phase reservoir selections to reduce the alternatives from the one hundred forty sites and to determine optimal reservoir locations. The optimum locations minimized area and costs while maximizing storage.

9. The Idealize Reservoir Assumptions:

a. Levee and reservoir side slope is 1(V): 3(H).
b. Reservoir footprint/area is rectangular with the length 1.5 times greater than the width.
c. Top of levee is 10-foot wide.
d. The existing terrain is flat.
e. The weir is typically 2 feet below the height of levee and 10 feet wide.
f. The reservoir area is considered as the area within the inner toe of the boundary levee.
g. The reservoir area computed represents half of the site. The surplus excavated material will be stored on the other half of the site.

10. For a reservoir storage volume, reservoir areas were calculated based on the reservoir excavation and levee fill requirements. The reservoir excavation depths and levee fill requirements are combination of levee heights and excavation depths. 25, 50, 100, 200, 400, 800, 1200, and 1600 AC-FT were used for the reservoir storage volume. 6 FT, 8 FT, and 10 FT were used for the levee heights, and 5 FT, 10 FT, and 15 FT were used for the reservoir excavation requirements. The weir height was assumed to be 2 FT below the levee height. The reservoir storage is determined based on the weir height above grade and the excavation depth.

11. For each reservoir storage volume, the reservoir area and excavation and levee fill quantities were computed for the levee heights and reservoir excavation depths combinations. Nine alternatives were developed for each reservoir storage volume, and a total of seventy-two alternatives were computed for all the reservoir storages listed above. Other quantities

computed for each alternative includes: topsoil stripping, seeding area, topsoil placement, and clearing and grubbing area. The cost estimate for each alternative was determined and is documented in Appendix F, Cost. For each reservoir, the relationship between the costs and the reservoir storage areas are shown in Attachment D-1. Refer to the main report, for more information on the secondary site selection process using the Idealize Reservoir Analyses.

12. Based on the Idealize Reservoir, Hydrology and Hydraulic analyses, and other parameters as discussed in the main report, the cost-benefit were computed for the sites and the following sites were selected with B/C ratio greater than 1.0: DPRS04, WLRS04, WHRS01, BCRS02, ACRS03, ACRS08, BWRS31, FDRS01, FDRS03, WHRS06, DPRS07, & DPRS23. The reservoirs are name according to its watershed, i.e., Des Plaines, Bull Creek, Feehanville Ditch, McDonald Creek, Aptakisic Creek, etc.

SITE SUITABILITY (GEOTECHNICAL)

13. Geotechnical review was performed on the selected sites listed above to determine the site suitability for a reservoir based on available geotechnical data. See Attachment D-2. The site suitability was determined by utilizing a surficial geology map of the Chicago area, Natural Resources Conservation Service (NRCS) soil maps, and available subsurface boring data. While geologic maps attempt to delineate areas of similar geologic materials and stratigraphic characteristics, they are open to broad interpretation and were used conservatively for design purposes. Boring logs were or are being performed within each project site, to precisely investigate each site for reservoir suitability. For sites where geotechnical data was available redesign was performed. Refer to appendix G for the Geotechnical Analyses.

14. Proposed sites were ranked as "Good", "Fair", and "Poor" based on the in situ materials found in the area and the likelihood that the materials would mitigate the issues of seepage and stability. In general, areas likely to contain free draining material such as sand or gravel as well as areas that are comprised mostly of unstable deposits of peat, 'muck', or other organic material are less suitable than areas that are more likely to contain finer, more stable sediments (silt, clay, silty clay, etc.). The following

guidelines were used to identify the suitability of each site location:

a. Sand & Gravel - poor for seepage, fair for stability;
b. Silt - fair for seepage, poor for stability;
c. Clay - good for seepage, fair to good for stability;
d. Peat/Muck - fair to poor for seepage, poor for stability

15. The proposed sites ACRS08 and MDRS04 lie within the Wadsworth Member of the Wedron Formation according to the map of surficial geology of the Chicago region. The Wadsworth member is a system of glacial moraines and is described as containing, "Mostly gray clayey and silty clayey till, relatively low in content of pebbles, cobbles, and boulders; contains local lenses of silt; commonly mantled with 1-2 ft. of leached silt (loess) and soil."(Willman and Lineback 1970). Additionally, the surficial soils in these sites have been mapped by the NRCS as containing fine-silty sediments. Due to a higher likelihood of stable, less permeable sediments in these areas, these sites are given a designation of "Good".

16. Sites FDRS01, DPRS23, DPRS15, and DPRS57 lie partially within the Cahokia alluvium which is described as, "Modern floodplain and stream deposits, mostly poorly sorted silt and sand with local deposits of sandy gravel". There are ~50 borings located in the Cahokia alluvium within 200-3000 ft of DPRS23 and FDRS01 that confirm the presence of lenses of fine-coarse sand at varying depths up to ~40 ft and thicknesses of 1-3 ft. The likely existence of coarser sediments may result in potential seepage issues that may result in remedial measurements such as the need for drains and/or cutoff walls. Thus, these proposed sites are given a designation of "Fair". Site specific investigation and analysis would be required to determine the presence and depths of the coarse soil lenses.

17. While BCRS02 lies within the Wedron formation, NRCS soil maps designate this area as being comprised mostly of 'Houghton muck', a soil unit that contains mostly peat and poorly drained organic sediments. This soft soil may lead to slope stability concerns that may require relatively flatter slope or the addition of engineered systems to support the required slopes. Thus, it is also given a designation of "Fair". Site specific investigations and analysis would be required to determine the presence and depths of the soft soil layers.

18. DPRS07 site is located either partially within the Mackinaw member of the Henry formation. The Mackinaw member has been mapped as glacial valley deposits and outwash terraces containing, "Sand and gravel, generally well sorted and evenly bedded." (Willman and Lineback, 1970). NRCS soil maps also classify these areas as containing sandy material. The sand material at the site locations may result in groundwater control issues which may require remedial measurement implementations such as drains, cut-off walls, and/or dewatering pumps. Due to the likely presence of permeable sediments in these proposed sites and the potential issues of seepage they are given a designation of "Poor". Site specific investigations and analysis will be required to identify the presence and depths of sand materials.

PROPOSED RESERVOIRS

General

19. Similar to the Idealized Reservoir, the designed reservoirs will be located within half of the site and the other half of the site will be used to store the excavated material as spoils or as otherwise stated. The reservoir systems include a levee, inlet structures (weir, storm sewer pipe, etc) and an outlet structure (pump station). The reservoirs have side slopes of 1(V):3(H) and vary in depth. The reservoir's surface area will be seeded over 6 inches of topsoil. The storage for each reservoir stated below does not include the volume displaced from the placement of 6 inches of topsoil and seeding. The reservoir is surrounded by a levee-spillway, which contributes to the reservoir storage. The levees have a 10 foot wide crest, or as otherwise stated, with a side slope of 1(V):3(H) and made of impervious material. An inspection trench will be excavated and backfilled with imperious fill along the levee. The trench is assumed to be 5 feet deep and 3 feet wide. Water flows into the reservoir through a concrete weir or storm sewer pipe and pump station. The weirs are reinforced concrete with side slopes of 1(V):3(H) and top elevation below the levee top elevation. The concrete weir is assumed to be 2-foot thick with a minimum of 3-foot key. The river side toe of the weir will be lined with riprap for erosion control and energy dissipation. Pumps will be used to dewater the reservoir. The pumps will be located within a pump station structure. The reservoirs are designed for 25 year to 100 year flood events. Based on existing geotechnical information, some of the

reservoirs will be partially or entirely enclosed with a cut-off wall for seepage control measures. As discussed above, it is assumed that all excavated material from the reservoir will be managed on site or as otherwise stated. Some of the material will be used to build the levee, and the surplus material will be stored on the site as spoil or used for other purposes.

20. The permanent easement includes the levee/reservoir area, pump station, and spoils areas. The permanent easement for the levee/reservoir is located a minimum of 15 feet from the toe of the outer levee, which will be cleared of trees and shrubs and seeded. The permanent and temporary easement (work limits) follows the property boundary lines as possible. When the permanent improvements lie within most of the property area, the entire property will be acquired as permanent easement.

Bull Creek Reservoir 02 (BCRS02)

21. BCRS02 is located in the city of Mundelein in Lake County, Illinois. See Plates D1a and D1b. The site is bounded by Lake Street/US 45 and Metra Railroad on the east, Winchester Rd on the north and residential developments on the west and south. The access to the site is through an undeveloped property on the north-east side of the site. An alternate access to the site can be through US 45 south of USG Dr. Observations from an aerial map indicates that there is an access road that crosses the Metra train tracks. Coordination with Metra Railroad should be performed to determine if this access is practical for heavy construction. Traffic flagman is recommended at the access location(s) of the site.

22. The proposed reservoir is designed for a 25-year to 100-year flood event and has a storage volume of 176.7 AC-FT. The top area of the reservoir is 53 AC, and the bottom area is 47.5 AC. The reservoir is 4 feet deep from the toe of the levee with an approximate bottom elevation of 754 (without topsoil and seeding). Storm water flows into the reservoir through a proposed concrete reinforced pipe with inlet elevation of 758.5. The pipe inlet is connected with a series of proposed ditches, which collect overflows from the west surrounding areas. There are no drainage utilities information provided; therefore, further investigations should be perform to determine the appropriate locations and design of the proposed ditches and proposed drainage

structures connections with the existing structures as needed. In addition, the new sheet flow as a result of the new improvements (reservoir & spoils) should be managed on site. Water flows out of the reservoir through a proposed concrete weir. The weir is 10 feet wide with a top elevation of 758.0. The proposed weir intercepts an existing ditch. It is assumed that the ditch flows through an existing culvert underneath the existing railroad and road (US45). Improvements to the existing ditch may be needed to accommodate the flows from the reservoir. Further investigations are required to confirm the locations and capacities of the existing ditch and culverts.

23. The levee surrounding the reservoir is approximately 7325 feet long with top elevation of 765.0 (without topsoil and seeding). Impervious material excavated for the reservoir will be used as fill for the levee. The surface area of the levee along with the permanent easement area will be seeded over 6 inches of topsoil.

24. The surplus material from the reservoir excavation and levee fill will be stored at the south end of the site. The surplus material is determined to be approximately 280,400 CY. The spoil is approximately 13 feet high with side slopes of 1(V):17(H). The spoil surface area will also be seeded over 6 inches of topsoil.

25. As discussed above, according to the surficial geology map and NRSC soil maps, this site is located within the Wedron formation and consists mostly of Houghton muck, a soil unit that contains mostly peat and poorly drained organic sediments. A cutoff wall was included as part of this reservoir. The location of the cut-off wall is estimated to be along the entire west half of the reservoir perimeter. Site specific investigations and analyses were performed to determine the presence and depths of the soft soil layers. A conservative design of the cutoff was decided upon after this data became available. Refer to appendix G for the Geotechnical Analyses and Site Surficial Geology Deposit and NRCS soil maps.

Construction of this reservoir will impact the existing wetland complex at the site. To mitigate for these impacts, 112 acres of former agricultural land at site L22 will be restored (see Plate D1b).

Aptakisic Creek Reservoir 08 (ACRS08)

26. ACRS08 is located in Lake County just north of Aptakisic Creek, a tributary of the Des Plaines River. See Plate 17. The site is bounded by Brandywyn Lane on the north, Buffalo Grove on the west, Aptakisic Road (HWY 33) on the south and Meridian Way/Prairie Rd on the east. An existing tree-lined ditch crosses the site from Brandywyn Lane to Buffalo Grove Rd. Observations from an aerial map indicates that the entire site is an existing farmland and it is mostly cleared of trees. The access to the site, as shown on Plate 17, is from Aptakisic road. The site can also be access from Brandywyn Lane or Meridian Way. Further investigations should be performed to determine the ideal construction access location(s) where construction traffic will provide little or no disruption to the current traffic conditions and nearby residences. The Average Daily Traffic (ADT) of the intercepting road should also be determined. Traffic flagman is recommended at the access location(s) of the site.

27. The proposed reservoir is designed for a 25-year to 100-year flood event and has a storage volume of 550 AC-FT. The top area of the reservoir is 45.4 AC, and the bottom area is 40 AC. The reservoir is 2 feet deep from the toe of the levee with bottom elevations varying from 678 to 684. The bottom elevation does not consider the reservoir seeding over 6 inches of topsoil. Storm water is pumped into the reservoir from Aptakisic Creek with an inflow rate of 200 cfs. Approximately 870 LF of 60-inch reinforced concrete pipe (RCP) will collect storm water from the creek through the pump station and outlet through two 36-inchRCP to the reservoir. Two, 100 CFS pumps are assumed with an additional pump and 36-inch discharge for redundancy. The pumping duration to fill the reservoir is assumed to be 2 days. After an event, the reservoir will be drained through the proposed sluice gate and by pumping. A sluice gate is located at the existing ground level with an approximate invert elevation of 678.5. The sluice gate will allow above grade water to drain into the existing ditch. Remaining water below grade in the reservoir will be pumped out through the pump station and into the existing ditch. One of the 36-inch RCP pipe and pump can be used to drain the reservoir.

28. From observations on an aerial map, it is assumed that the existing ditch is connected to a storm sewer pipe or culvert at Brandywyn Lane upstream and Buffalo Grove Road at the downstream end of the ditch. The Illinois Streamstats

program shows that the 100-year peak flow rate of the ditch is 207 CFS. The existing ditch will be relocated approximately 150 feet south-west of the current location to accommodate the proposed reservoir. The proposed ditch will have a bottom width of 15 feet, 1(V):3(H) side slopes, minimum height of 3 feet, and slope of 0.17%. Ditches along the perimeter of the reservoir and spoil area will be placed. The ditches will have a typical bottom width of 5 feet, 1(V):3(H) side slopes, and a minimum height of 1 foot. There is no drainage utilities information provided. Therefore, further investigations should be perform to determine the appropriate locations and design of the proposed ditches and proposed drainage structures connections with the existing structures as needed. In addition, the new sheet flow as a result of the new improvements (reservoir & spoils) should be managed on site.

29. The levee surrounding the reservoir is approximately 5,660 feet long with top elevation of 693.0 (without topsoil and seeding). Impervious material excavated for the reservoir will be used as fill for the levee. The surface area of the levee along with the permanent easement area will be seeded over 6 inches of topsoil.

30. The surplus material from the reservoir excavation and levee fill will be stored on the site. The total surplus material is determined to be approximately 96,000 CY. The Spoil fill is approximately 10 feet high with varying side slopes of 1(V):20(H) to 1(V):50(H). The spoil surface area will also be seeded over 6 inches of topsoil. Refer to Plate D13 for the ACRS08 site plan.

31. According to the surficial geology map this site is located within the Wadsworth Member of the Wedron Formation and consists mostly of gray clayey and silty clayey till. Due to a higher likelihood of stable, less permeable fine-silty sediments, a cutoff wall is not needed. Site specific investigations and analyses are required to confirm the soil conditions. Refer to Attachment D-2 for the site Surficial Geology Deposit and NRCS soil maps.

Feehanville Ditch Reservoir 01 (FDRS01)

32. FDRS01 is located between Mt. Prospect and Des Plaines on the west and the city of Glenview on east in Cook County, Illinois. See Plate D2. The site is bounded by I-294 on the east and River Rd. on the west, Lake Rd. on the north and

Central Rd. on the south. The entire site is located on Cook County Forest Preserve property and is heavily forested. In the eastern middle portion of the site, a small pond exists. Along the entire western edge of the site, the Des Plaines River runs.

33. The site is accessible through Central Rd where an existing small gravel truck lane leads to the top of existing spoil pile. A secondary access point further east on Central Rd. could also provide access, but is not preferable because the road leads to a trail center. From the aerial photos, there seems to be a few gravel truck haul paths that could be utilized during excavation of reservoir as a haul road. Traffic flagman is recommended at the access location of the site due to heavy traffic from surrounding suburban area.

34. The proposed reservoir is designed for a 100-year flood event and has a storage volume of 2140.9 AC-FT. The top area of the reservoir is 322 AC, and the bottom area is 312 AC. The reservoir bottom elevation is around 630 FT (without topsoil and seeding). Storm water flows into the reservoir through a proposed concrete reinforced concrete weir with inlet elevation of 637.3. The weir is 305 feet long and is located in a section of the ring levee in the southwest corner of the property. The proposed weir would intercept rising flood waters of the Des Plaines River and spill into the reservoir for storage.

35. Water is pumped out of the reservoir by a proposed pump station and corresponding piping. The pump outfalls onto an existing ditch that empties into Des Plaines River. Improvements to the existing ditch may be needed to accommodate the flows from the reservoir such as riprap or other erosion control features.

36. The levee surrounding the reservoir is approximately 15,727 ft long with top elevation of 640.3 (without topsoil and seeding). Impervious material excavated for the reservoir will be used as fill for the levee. The surface area of the levee along with the permanent easement area will be seeded over 6 inches of topsoil.

37. The surplus material from the reservoir excavation and ring levee fill will be stored at the south end of the site in an extension to existing spoil pile. The surplus material is determined to be approximately 3,166,379 CY. The top of the existing spoil pile elevation is approximately 702. The

extension of this spoil pile would match existing top elevation and gradually project down to existing ground with side slopes of 1(V):20(H). The spoil surface area will also be seeded over 6 inches of topsoil. Refer to plate D2 for the FDRS01 site plan.

38. There is no drainage utilities information provided. Therefore, further investigations should be perform to determine the appropriate locations of the proposed ditches to drain spoil pile and ring levee surrounding reservoir to properly manage the storm water.

39. According to the surficial geology map and NRSC soil map this site is located within the Cahokia alluvium which is described as, 'Modern floodplain and stream deposits, mostly poorly sorted silt and sand with local deposits of sandy gravel'. The likely existence of coarser sediments may result in potential seepage issues that may result in remedial measurements such as the need for drains. Additionally due to the only moderate slope stability and seepage issues, a cutoff wall is recommended along the entire perimeter of the reservoir. Site specific investigations and analyses are required to determine the presence and depths of the soft soil layers. Detailed design of the cutoff wall is also required. Refer to Attachment D-2 for the site Surficial Geology Deposit and NRCS soil maps.

Camp Ground Road Reservoir (DPRS15) - Option 1

40. DPRS15 is located between Park Ridge and Des Plaines in Cook County, Illinois. See Plates D3aand D3b. The site is bounded by I-294 on the east and River Rd. on the west, Algonquin Rd. on the north and Oakton St. on the south. The entire site is located on Cook County Forest Preserve property and is heavily forested. An existing recreational trail runs through the entire site, along the entire western edge of the site the Des Plaines River runs.

41. The site is accessible through Camp Ground Rd where an existing paved 2 lane road leads to the top of proposed reservoir. A secondary built access point further south on Oakton could also provide access, but is not preferable because of the road traffic on this 4 lane road. From the aerial photos, there seems to be little but virgin forest. Traffic flagman is recommended at the access location of the site due to heavy traffic from surrounding suburban area.

42. The proposed reservoir is designed to mitigate for impacts of increased flood stages that construction of DPLV09 would have and has a storage volume of 275.39 AC-FT. See Main Report Section 10. The top area of the reservoir is 24 AC, and the bottom area is 19 AC. The reservoir bottom elevation is around 622.7 FT. Storm water flows into the reservoir through a proposed concrete reinforced concrete box culvert with inlet elevation of 630.7. The culvert cuts across the ring levee in the southwest corner of the property. The proposed culvert would intercept rising flood waters of the Des Plaines River and spill into the reservoir for storage.

43. Water is gravity fed out of the reservoir by a proposed reinforced concrete pipe and corresponding flap gate that empties into Des Plaines River. Improvements to the existing bank may be needed to accommodate the flows from the reservoir such as riprap or other erosion control features.

44. The levee surrounding the reservoir is approximately 4800 ft long with top elevation of 635.6. Impervious material excavated for the reservoir will be used as fill for the levee. The surface area of the levee along with the permanent easement area will be seeded over 6 inches of topsoil.

45. The surplus material from the reservoir excavation and ring levee fill will be stored at the east end of the site in a spoil pile. The surplus material is determined to be approximately 406,377 CY. The top of the proposed spoil pile elevation is approximately 644. The spoil pile would gradually project down from the top elevation to existing ground with side slopes of 1(V):6(H). The spoil surface area will also be seeded over 6 inches of topsoil. Refer to plate D3a for the DPRS15-Option 1 site plan.

46. There is no drainage utilities information provided. Therefore, further investigations should be perform to determine the appropriate locations of the proposed ditches to drain spoil pile and ring levee surrounding reservoir to properly manage the storm water.

47. This site is composed of silty clay. A cutoff wall will not be required. Refer to Attachment D-2 for the site Surficial Geology Deposit and NRCS soil maps.

Camp Ground Road Reservoir (DPRS15) - Option 2

48. The second option for the proposed reservoir will still mitigate for impacts from construction of DPLV09, will be located on the same site as option 1, and has a storage volume of 515.82 acre-feet. See Plate D3b. The area of the reservoir is 55.2 acres, and it covers a majority of the proposed site. The reservoir bottom elevation is around 622.7 FT. Storm water flows into the reservoir through a proposed concrete reinforced box culvert with inlet elevation of 630.7. The culvert cuts across the ring levee in the southwest corner of the property. The proposed culvert would intercept rising flood waters of the Des Plaines River, and spill over into the reservoir for storage.

49. Water is gravity fed out of the reservoir by a proposed reinforced concrete pipe and corresponding flap gate that empties into the Des Plaines River. Improvements to the existing bank may be needed to accommodate the flows from the reservoir such as riprap or other erosion control features.

50. The levee surrounding the reservoir is approximately 6205 FT long with top elevation of 635.6. Impervious material excavated for the reservoir will be used as fill for the levee. The surface area of the levee along with the permanent easement area will be seeded over 6 inches of topsoil.

51. The surplus material from the reservoir excavation and ring levee will be hauled off site to a disposal location. The surplus material is determined to be approximately 1,103,323 CY. Refer to plate D3b for the DPRS15-Option 2 site plan.

Fullerton Woods Reservoir (DPRS04)

52. DPRS04 is located in River Grove in Cook County, Illinois. The site is bounded by River Rd and 5th Ave. on the north, River Rd. on the east, and 5th Ave. on the West. The entire site is located on Cook County Forest Preserve property and is partially forested.

53. The site is accessible from River Rd at the existing paved access path. Traffic flagman is recommended at the access location of the site due to heavy traffic from surrounding suburban area.

54. The proposed reservoir is designed for a 100-year flood event, a storage volume of 150 AC-FT, and flow of 115 CFS. The reservoir includes a three feet freeboard which results in a total storage of 200 AC-FT. The top area of the reservoir is 16.5 AC. The reservoir bottom elevation is 611.5 FT (without topsoil and seeding). Storm water from the Des Plaines River is pumped into the reservoir through a proposed 54″ RCP. After a storm event, water will drain out of the reservoir through the pump station to Des Plaines River by gravity. The pump station will utilize two 100 CFS pumps, which includes one 100 CFS pump for redundancy. The pumping duration to fill the reservoir is 16 hours.

55. The berm surrounding the reservoir is approximately 3641 ft long with top elevation of 635 (without topsoil and seeding). Impervious material excavated for the reservoir will be used as fill for the levee. The surface area of the levee along with the permanent easement area will be seeded over 6 inches of topsoil.

56. It is assumed that the surplus material from the reservoir construction is suitable for impervious fill for the levee construction of Sites DPLV04 and DPLV05. There will be no spoils placed on the site. The surplus material volume is balanced with impervious material needed for the levees construction. Refer to Section 2 for the volume of fill needed for the Levees.

57. Preliminary design and layout of perimeter ditches are shown on the plate to provide drainage for the reservoir berm and surrounding areas. The ditches will drain into existing roads (5^{th} Ave. and River Rd.) storm sewer lines. The road storm sewer lines may need to be resized to accommodate the additional flow and should be further investigated during the design phase. Another option is to drain the ditch to the pump station sump. This option may require additional grading, but should be considered during the design phase.

58. There is an existing 30' wide drop shaft manhole at the south-east area of the proposed reservoir owned by MWRD. As shown on as-built drawings provided by MWRD, there are also existing structures under-grade just south-east of the manhole. The reservoir is not in conflict with these structures and should be protected during construction. MWRD drawings also show a 66" x 82.5" combined sewer located along Des Plaines River Rd. The pipe is located approximately under the reservoir berm and 40 feet below grade. The sewer will

not be impacted by the reservoir construction. However, actual location survey of the pipe should be conducted to verify that there are no conflicts with the proposed berm or pump station. There is a 48" Storm Sewer, a 48" combined sewer, and a 12" sanitary sewer line at the south-east end of the reservoir. This pipe may cross the berm of the reservoir and should be confirmed with a location survey of the pipes and other utilities in the area. Refer to Plate 22 for DPRS04 site plan.

59. Recreation features are proposed as an option for DPRS04 site. A meeting was held between USACE and IDNR to discuss recreation features that can be incorporated into the site. The following recreation and planting features are proposed for the site:

a. Trees: Ten trees per acre are proposed within the proposed island in the reservoir and at the south-east open area of the site. No trees will be placed within 15 feet from the toe of the reservoir berm.
b. Seeding: The island will be seeded to develop a mesic savanna habitat.
c. Trails: Ten feet wide asphalt trails will be placed at the island and top of the reservoir berm. Trail benches and drinking fountains will be placed along the trails.
d. Parking Lot: A parking lot will be placed at the site staging area. The lot will have spaces for 11 vehicles including one handicap space.
e. Permanent Pond: The reservoir will have a permanent pond. The reservoir will not be fully drained after a flood event. The reservoir will be excavated another five feet to create the pond. It is assumed that material excavated will be transported to a storage facility for the Illinois Tollway future use.
f. Picnic Shelter
g. Bathroom Facility

Harry Semrow Driving Range Reservoir (WLRS04)

60. WLRS04 is located in Des Plaines in Cook County, Illinois. This site is an existing golf driving range located at the corner of Golf Rd. and Rand Rd. The entire site is located on Cook County Forest Preserve property and is partially forested.

61. The site is accessible from Rand Rd. at the existing access path. Traffic flagman is recommended at the access location of the site due to heavy traffic from surrounding suburban area.

62. The proposed reservoir is designed for a 100-year flood event, storage volume of 208 AC-FT, and flow of 70 CFS. The reservoir includes a three feet freeboard which results in a total storage of 250 AC-FT. The top area of the reservoir is 14.7 AC. The reservoir bottom elevation varies between 635 and 629 (without topsoil and seeding). Storm water from the Des Plaines River is pumped into the reservoir through proposed 54″ RCPs and ditch. The intake/discharge ditch has a 3 feet wide bottom width, 3H:1V side slopes, and a minimum of 4 feet in depth. After a storm event, water will drain out of the reservoir though the pump station to Des Plaines River by gravity. The pump station will utilize two 70 CFS pumps, which includes one 70 CFS pump for redundancy. The pumping duration to fill the reservoir is 35 hours.

63. The berm surrounding the reservoir is 20 feet wide and is approximately 2921 ft long with top elevation of 652 (without topsoil and seeding). As mentioned above, the site is an existing golf driving range and will be maintained as a golf driving range with the new reservoir. A double-decker golf range is proposed with the reservoir. The upper level of the driving range will be placed on the top of the reservoir berm and the lower level driving range will be place at grade level within the reservoir. The lower level driving range will be protected with corrugated roofing. A preliminary design was developed for the roof structure. The corrugated roof will be supported by two W6 x 15 steel columns spaced 10 feet on center and 35′ long MC6 x 12 beams. The columns will be placed on 2′ x 2′ spread foundation. There is no soil information available for this site. Due to the lightness of the structure, the structure is more susceptible to uplift from wind loads than settlement. However, differential settlement can occur due to differing soil conditions since this is a long structure. Fours stairs and two ADA ramps are assumed for access to the upper level. Structural Impervious material excavated for the reservoir will be used as fill for the levee. The surface area of the levee along with the permanent easement area will be seeded over 6 inches of topsoil.

64. It is assumed that the surplus material from the reservoir construction is suitable for impervious fill for

the levee construction of Site DPLV09. There will be no spoils placed on the site. The surplus material that is not used for the levee will be hauled to a storage site for Illinois Tollway future road construction. Refer to Section 2 for the volume of fill needed for the Levee.

65. Preliminary design and layout of perimeter ditches are shown on the plate to provide drainage for the reservoir berm and surrounding areas. The ditches are shown to drain into the proposed pump station and through the pipe and ditch to the Des Plaines River. However, further investigation should be performed to determine the appropriate locations and designs ditches and drainage structures to maintain storm water on site. Refer to Plate 18 for WLRS04 site plan.

Willow Higgins Reservoir (WHRS01)

66. WHRS01 is located in the city of Rosemont in Cook County, Illinois, adjacent to O'Hare airport. See Plate D14. The site is bounded by I-190 on the south, Mannheim Road and rail tracks on the west, and residential developments on the east and south. The access to the site is off of I-190 to the south. Project vehicles will use the I-190 on ramp for access to and from the construction site. It is assumed trucks will enter the site prior to the toll booth. Trucks will then exit the site loaded with spoil material after the toll booth, and merge onto I-190 traffic. Traffic control will be a high priority at this site, since this on ramp is heavily used and trucks will be using the only available I-Pass lane. Traffic flagmen are recommended at the access location(s) of the site due to high traffic volume. Close coordination with IDOT will be required, including how fees for the tollway will be paid. An existing water main runs across the site, which will need to be relocated prior to construction. A full utility survey will be performed in the design phase to determine all potential utility conflicts.

67. The proposed reservoir is designed for a 1-year to 100-year flood event, a storage volume of 604 AC-FT, and flow of 100 CFS. The footprint of the reservoir is 29.8 acres. The reservoir is 36 feet deep from the interior toe of the levee with a bottom elevation of 627 (without topsoil and seeding). The exterior height of the levee varies from approximately 13 to 25 feet. Storm water is pumped into the reservoir through a proposed concrete reinforced pipe with inlet elevation of 617.6 in Willow Creek. The pipe will extend approximately 350

feet from the creek to the interior of the reservoir. There are no drainage utilities information provided; therefore, further investigations should be perform to determine the final locations of the proposed pipe and pump station. The pump station will have two 100 CFS pumps including one for redundancy. In addition, the new sheet flow as a result of the new improvements should be managed on site. Ditches are proposed along the east and west sides of the reservoir, which will direct the water back to Willow Creek on the north side of the reservoir. The west ditch may tie into an existing stream leading to the creek. Water will flow out of the reservoir through the 48″ inlet pipe, but will be allowed to gravity flow due to the high reservoir elevation. A sluice gate will be placed on the pipe to control the flow.

68. The levee surrounding the reservoir is approximately 3800 feet long with top elevation of 663.0 (without topsoil and seeding). Impervious material excavated for the reservoir will be used as fill for the levee. The surface area of the levee along with the permanent easement area will be seeded over 6 inches of topsoil. The footprint of the reservoir will avoid existing trees as much as possible. It is expected based on the aerial that about 20% of the proposed reservoir and levee area is covered by trees which will need to be cleared.

69. The surplus material from the reservoir excavation and levee fill will be removed from the site, and is proposed to be used as fill material for planned Illinois Tollway projects. Approximately 550,000 CY spoil is anticipated. Additional soil investigations will be necessary to determine how much of that material is suitable for use as fill material. The topography of the current site contains a plateau made up of unknown material which was placed on site when the area was bought out by the FAA. Based on the topography of the site, approximately half of the 550,000 CY spoil is material within this plateau, while the other half is existing site soils which are expected to contain good fill material. Refer to appendix G for the Geotechnical Analyses and Site Surficial Geology Deposit and NRCS soil maps.

VOLUME CALCULATIONS

70. Quantity takeoffs were computed by using Bentley CADD software packages (Microstation and Inroads) and Microsoft Excel. Digital Terrain Models (DTM) were developed using existing topography from GIS. DTMs of the potential reservoirs were also created. By comparing the two DTMs the volume and fill quantities for the reservoirs where determined though Triangle Volumes in Inroads. Triangle Volumes method projects the triangles from an existing surface onto the design Surface and then compute the volume of each of the resultant prismoids for a total volume. These volumes were then used to compute storage volume for the spoils. Cross-sections for the levees and reservoirs were generated in Inroads. The cross-sections were checked for inconsistencies with the proposed reservoir and existing topography DTMs data. In addition, the Average-End Area (AEA) volumes were generated for the levees and reservoirs. The average-end volumes were used to compare the Triangle Volume as a check.

71. The true and planar surface areas for the levees, reservoirs, and spoil areas were also determined in Inroads. The areas were used to compute the seeding areas and topsoil volumes for the reservoir, levee, and spoil. The topsoil soil will be stripped with the areas proposed for the levees (including the 15 feet permanent easements) and reservoir. It is assumed that 1-foot of topsoil will be stripped at these locations.

72. The clearing and grubbing areas were determined in Microstation and included the spoil, levee (including the 15 feet permanent easements) and reservoir areas.

73. The levee trench depth and width were assumed to be 5 feet and 3 feet respectively. The levee trench excavation/fill volume was determine by the multiplying the length of the levee by the assumed width and depth of the trench.

74. The pump station inlet/outlet pipes were assumed to be 54" for all reservoirs. Detailed designs of the pump station, including the inlet/outlet pipes, are required during the Plans and Specification Design Phase. In addition, the flow and pumping duration should be verified.

REAL ESTATE

75. The conceptual real estate requirements, including the utility, permanents and temporary easement (PE & TE), for each site are shown and documented on the Real Estate Maps. The permanent and temporary easements were drawn based on the parcel data provided from GIS. Where the proposed improvements covers most area of a parcel, the entire parcel was considered as permanent easement. The reservoir permanent easement line is located at a minimum of 15 feet from the outer toe of the levee. The pump stations as well as the spoil areas were also considered as permanent easements. The access roads and staging areas where considered as temporary easements.

OPERATION AND MAINTENANCE

76. For the operation and maintenance work for the various projects, historic data from Little Calumet Flood control project was used which included all the major features included in the DPII design. A spreadsheet was created which broke out the individual design projects into separate worksheets. Each worksheet was tailored so that only the appropriate O&M items were included for instance floodwall items were not included in a reservoir project. The individual O&M work was based on quantities from the bid schedule such as square footage of floodwall, length of levee, or number of pump stations.

DEMOLITION

77. Existing features to be demolished are discussed under the project descriptions above.

UTILITY RELOCATIONS

78. Preliminary utility coordination with utility companies was performed to identify existing utilities in significant conflict with the proposed features. This information was used to amend features to minimize utility conflicts. A detailed survey of all existing utilities within and adjacent to the project site will be required during the design phase for each individual site. There are no building relocations required for the projects.

SECTION 2 - LEVEES & FLOODWALLS

GENERAL

79. Five potential sites were considered suitable for a levee/floodwall alignment. The five sites are named DPLV01, DPLV04, DPLV05, DPLV09, and DPLV15. The levee and floodwall alignments were developed utilizing contours, parcels, aerial images, and existing building locations from local GIS data.

80. Several other sites were eliminated from being added to the list of potential sites due to several issues. These issues included having to cross an existing creek, roads, and a railroad with the floodwall/levee alignment and the difficulty of finding high ground to tie the floodwall/levee into for adequate flood protection.

FLOODWALL/LEVEE DESIGN

81. The levees in this study were designed using the following criteria:

a. Side slopes for the levees are 3.0 horizontal to 1.0 vertical.

b. Crest widths for the levees are 10 feet.

c. The top of floodwall and levee crest elevations for each site were determined by the Hydraulics and Hydrology (H&H) Section. The elevations are shown on the plates for each site.

d. The stripping volume included a width that is equal to the footprint of the levee and a depth of one foot.

e. A slit trench was included for all levee segments to explore for unsuitable soils beneath the levee foundation before construction.

f. See Plate D11 attached at the end of this appendix for a typical levee section.

82. The alignments were chosen in consideration of available space and to allow access for maintenance operations and

flood fighting purposes. Most of the sites have either homes or businesses adjacent to the river which required the use of floodwalls. See the Real Estate Requirements section of this appendix for a description of the various easements used.

83. Floodwalls were designed for areas in which there was not enough real estate or physical space available to accommodate a levee. When a floodwall and a levee intersected, the floodwall was assumed to be embedded in the levee section approximately 10 feet. All the floodwalls for each site were designed as I-walls. All the steel sheet pile (SSP) was assumed to be PZ22. A ratio of 3:1 was used to determine the length of the SSP. The ratio is based on the principal that for every one foot of floodwall above the existing ground line then there is three feet of SSP below ground. The wall itself consists of reinforced concrete with a minimum of two foot of SSP embedded at the bottom of the wall below grade. See Plate D11 attached at the end of this appendix for a typical floodwall section. No structural analysis was performed on any of the floodwalls in this study. This analysis will need to be performed in the next phase of this project.

LEVEE CONSTRUCTION IMPERVIOUS FILL SOURCES

84. Impervious fill needed for the levee construction for Site DPLV04, DPLV05, and DPLV09 will be provided from the excess and suitable material excavated for the reservoirs construction. The table below shows the reservoir site(s) that will be used as a borrow source for the levees. Excess and suitable material not used for the levees will be hauled to a storage facility for Illinois Tollway future road construction.

85. It is assumed that the all material excavated is suitable and will be used for the levees or hauled to the Illinois Tollway storage site. Refer to the Geotechnical Appendix for available boring information for the reservoir sites.

86. Illinois Tollway Material Requirements are unknown and should be considered to ensure that excavated materials meet their requirements.

Levee Sites	Reservoir Site/Impervious Fill for Levees (CY)			Total
	DPRS04	WLRS04	WHRS01	
DPLV04	49800			49800
DPLV05	89500			89500
DPLV09		28400		28400
IL Tollway	0	129500	550000	679500
Total	139300	157900	550000	

CLOSURE STRUCTURES

87. Closure structures are required to be installed across roads and driveways to form a continuous line of protection. The locations of the closure structures are shown on the plates for each site. The specific type of closure structure assumed for design purposes was a double leaf swing floodgate to block water across the roadways. All of the closure structures were assumed to have steel sheet pile installed under the road bed to cutoff seepage and a 12 inch thick concrete pad across the road which would tie into the ends of the floodwall.

INTERIOR DRAINAGE FEATURES

88. No interior drainage features were specifically designed for this project. Interior drainage analysis will need to be performed in the next phase of this project. For cost purposes interior drainage was based on similar projects within the watershed.

PROPOSED LEVEES & FLOODWALLS

DPLV01

89. Site DPLV01 project features includes road raises at Park Ln, Groveland Ave., and Lincoln Ave. See Plate 22. The roads will be raised to elevation 618 with total lengths of 1250 feet. A levee was considered along the north side of Park Ln. However, a levee would cross multiple private properties without providing flood protection for those properties. As a result, a road raise design was recommended in lieu of the levee. Park Ave. is currently a two-lane road with diagonal parking on the north side and parallel parking on the south side. The proposed road raise will eliminate the diagonal parking and replace with parallel parking. Any driveways that intersect with the raised roads will also need to be raised

to match the new road elevations. Groveland Ave. and Lincoln Ave. are both two-lane roads. Maintenance of traffic and traffic safety will be required during the road raise construction. Maintenance of traffic could be temporary lanes, detours and re-routing. Maintenance of traffic shall be in accordance with AASHTO and the Highway Capacity Manual. The existing levee along Groveland Ave will be raised from elevation 616 to 618. Sheet pile will be driven into the existing levee to obtain the designed top elevation of 618. The sheet pile wall is approximately 870 feet in length. Steel cap will be placed over the sheet pile. The sheet pile will tie-into the proposed road raise at the north termination. The sheet pile terminates at Forest Ave at the south. A road closure structure at Forest Ave is proposed to tie into the south termination of the sheet pile and the proposed floodwall. A floodwall is proposed south of Forest Ave and along the Des Plaines River. The floodwall top elevation is 618.0 and approximately 699 feet in length. The floodwall will tie into the railroad embankment at the south termination and the proposed road closure structure at the north termination.

There is an existing water line located within and along the existing berm. The water line should be located during the design phase and coordinated with the location of the proposed sheet pile.

Pump stations and gate wells are included in the report and would also be included in final design. These features are intended to mitigate interior drainage issues. Refer to Plate 24 for DPLV01 Site Plan.

DPLV04

90. DPLV04 is located in the city of River Grove in Cook County, Illinois. The site extends from Franklin St./Kennedy St. Railroad to the north and Palmer St. to the South. A levee/floodwall will be placed at the river side of River Rd. and along 5th Ave. on the south end. The levee/floodwall has a top elevation of 628.39 (NAVD 88). The levee and floodwall will have lengths of 3031 feet and 3134 feet respectively. The floodwall between Henrrick Ave. and Fullerton Ave. is in close proximity with the River. Therefore, toe protection will be necessary along the floodwall. A levee will tie-in to high-ground at the railroad on the north end. At the south-end, a levee will tie-in to natural high ground at

Palmer St. The proposed levee between Sta. 55+00 and 59+00 will tie-in to the proposed reservoir (DPRS04) berm. The reservoir berm top elevation is 635, which is 6.6 feet above the top of levee. Two road closure structures are proposed where the levee/floodwall intercepts existing roads. A road raise will be placed at 5th Ave to continue the line of protection. A road raise is recommended over a road closure since the depth from the road to the design elevation is less than two feet at this location. The road raise will allow River Road to be open and functional during a flood event. From aerial maps, there is an existing culvert at the river, just north of Fullerton Ave. and an existing ditch was identified at approximately Sta. 49+00. Further investigation should be completed to determine if a drainage structure is necessary at these locations. A manhole was also located at the river side of River Rd and Herrick Ave. A utility survey is necessary during design phase to mitigate for possible utility conflicts. See Plate 21 for DPLV04 Site Plan.

DPLV05

91. DLPV05 is located in Schiller Park in Cook County, Illinois. The site extends just north of Irving Park Rd. to the north and Franklin St./Kennedy Street, just north of the railroad, at the south end. Levee/floodwall will be built on the river side of River Rd with a top elevation of 629.31 (NAVD 88). The levee and floodwall lengths are 5,150 feet and 3,284 feet respectively. The floodwall length includes raising and strengthening 380 feet of existing retaining wall. Additional retaining wall information is included below. There will be three road closure structures to maintain the line of protection, including a recommended sand bag closure at Belmont Ave. Belmont Ave road elevation at the closure varies from 628.3 at the road edge to 629.7 at the centerline of the road. Thus, only one foot or less exists between the design elevation of 629.31 and the existing grade. Furthermore, the line of protection is located at an existing bridge approach on Belmont and raising Belmont Ave will be costly due to the bridge modifications. The system will terminate into natural high-ground at the north end and at the railroad embankment at the south end. Another tie-in option at the north end is to extend the levee/floodwall further north on River Road to meet high-ground. This option would eliminate one road closure. However, the line of protection will include a bridge and it is not clear if the

bridge is being supported by a retaining wall or by piers. From an aerial map, the parapet wall is not a solid wall. This option can be further investigated as an alternative to a road closure. From aerial views, the existing retaining wall, mentioned above, lies approximately between Sta. 61+20 and Sta. 65+00. The retaining wall supports River Road and is at close proximity to Des Plaines River. The wall will be modified as needed and raised to the design elevation to act as a floodwall. From aerial maps, an existing culvert was identified at approximately Sta. 18+00. Further investigation should be completed to determine if a drainage structure is necessary at this location. See Plate 20 for DPLV05 Site Plan.

DPLV09

92. Site DPLV09 is a levee/floodwall combination from Miner St. to the north, the Illinois Tollway ramp at the south end and located along the west side of the Des Plaines River. The site is located in the City of Des Plaines in Cook County, Illinois. DPLV09 is divided into three segments - Segment 1 (northern segment), Segment 2 (middle segment), and Segment 3 (southern segment). The levees represent a total of 3,250 linear feet with a crest width of 10 feet. The floodwalls are a combined length of 7,938 feet. Road closure structures are needed at Oakton and Algonquin. The floodwall length includes raising 500 feet of existing retaining wall in Segment 1. From aerial maps, the river is at close proximity to River Rd approximately between Sta. 2+00 and Sta. 7+00 (Segment 1), where the road is supported by the retaining wall. The retaining wall will be raised to the design elevation and modified as needed to act as a floodwall. The levee crest and top of floodwall elevations vary and are shown on the plates. Pump Stations, gate wells and closure structures are part of the recommended plan. At the south end (Segment 3), the levee wraps around the ramp to meet high ground at the embankment of the ramp/toll way. Further field investigation is necessary to ensure that the levee tie-in at the ramp/toll way is at the embankment and not the road. See plates 19A, 19B, and 19C for additional site plan details.

From aerial views, an existing culvert was identified at approximately Sta. 13+00 (opposite from Oakwood Ave., Segment 1). The levee will intercept two drainage structures at the toe of the ramp and toll way at Segment 3. Drainage structure(s) at these locations should be further investigated.

DPLV15

93. Site DPLV15 is a levee west of Buckley Rd. and east of the Des Plaines River. The levee has a total length of 2,938 feet with a crest width of 10 feet. The crest of the levee is at elevation 660. A permanent access road is required from Buckley Road to where the levee is located. See plate D7 for additional site plan details.

QUANTITY CALCULATIONS

94. The levee embankment quantity was calculated using a triangulated volume method with software. Using InRoads software, the first step was to create a surface model of the existing ground surface from 2-foot contour data. Then a levee alignment was created with the design elevation assigned to it. From that alignment another surface was created that contained the levee footprint. Using the existing surface model and the design surface model InRoads software can calculate the quantity of material necessary for the levee in cubic yards.

95. The height of exposed concrete floodwall had to be taken as an average for quantity purposes since the elevation of the existing ground varies. Using InRoads software, the first step was to create a surface model of the existing ground surface from 2-foot contour data. Then a floodwall alignment was created with the design elevation assigned to it. Using InRoads, cross sections were cut at 100-foot intervals along the proposed alignment. For each site, the existing ground elevation was measured at five stations along the proposed alignment and an average was taken. This average existing ground elevation and the elevation for the top of floodwall was used to determine the average height of exposed concrete floodwall for each site. Then a 3:1 ratio was used to determine the depth of the steel sheet pile. For quantity purposes it was also assumed PZ22 type steel sheet pile would be used. To calculate the volume of concrete necessary for the floodwall an average cross sectional area was determined and then multiplied by the total length of floodwall. It was also assumed that no topsoil would be needed for floodwall construction since excavation would be minimal.

96. Clearing and grubbing, determined in acreage, was assumed to occur over the entire temporary and permanent easement areas. Stripping is determined in cubic yards as the removal

of one foot of material under the levee footprint. Top soil was assumed to occupy the top six inches of a levee section. Seeding calculations were performed assuming that the entire temporary and permanent easement areas were to be seeded after construction was completed.

BORROW/DISPOSAL AREA

97. Borrow and disposal areas for these sites were assumed to be within a twenty mile radius from the construction site. Borrow and disposal areas will be investigated further during the next phase of this project. Potential borrow locations are listed below:

Lake County Grading Co
32901 North Milwaukee Ave.
Libertyville, IL 60048
847-362-2590

Bluff City Materials, Inc
1245 Gifford Rd.
Elgin, IL 60120

STAGING/STORAGE/ACCESS

98. The temporary easements shown on the plates are assumed to be used as staging, storage, and access areas by the Contractor. Access during construction will be provided from the roads near each levee/floodwall location. All of these features will be further defined during the next phase of this project.

MITIGATION

99. As part of the Environmental Assessment, sites were reviewed to determine whether they would have any significant impacts. For sites with significant impacts that could not be avoided, a mitigation plan was developed. Reservoir site DPRS15 provides floodplain mitigation for DPLV09, C16 provides habitat mitigation for DPRS15, and L22 provides habitat mitigation for BCRS02. See plates D1b and D3c. Also, see Section 9, Environmental Assessment in the Main Report.

REAL ESTATE

100. Permanent Easement. Permanent easement consists of property that is necessary for the project features and access for performing maintenance such as mowing the levees, general inspections, and for flood fighting operations. The amount of property required is 15 feet beyond each toe of the levee and 15 feet beyond each side of the floodwall alignment.

101. Temporary Easement. Temporary easements consist of property that is needed during the construction phase of a levee or a floodwall and may also be used as staging, storage, and access by the Contractor. The amount of property required for the temporary easements for a levee or floodwall is generally 10 feet beyond the permanent easement. However, for all of the sites except DPLV15, there was not enough property to layout the temporary easements as described above due to the close proximity of existing buildings. All of the temporary easements were laid out in open areas near the levee/floodwall sites. It should also be noted that sites DPLV09 and DPLV07 have temporary easement areas on the river side of the levee/floodwall. This should be looked at further in the next phase of the project and possibly consider moving the levee/floodwall closer to the river to allow for the temporary easements to be on the land side of the levee/floodwall.

102. Utility Easement. Preliminary utility coordination was performed with utility companies to identify existing utilities in conflict with the proposed features. Utility easements required for relocations or remediation will be assessed.

OPERATION AND MAINTENANCE

103. For the operation and maintenance work for the various projects, historic data from Little Calumet Flood control project was used which included all the major features included in the DPII design. A spreadsheet was created which broke out the individual design projects into separate worksheets. Each worksheet was tailored so that only the appropriate O&M items were included for instance floodwall items were not included in a reservoir project. The individual O&M work was based on quantities from the bid schedule such as square footage of floodwall, length of levee, or number of pump stations.

DEMOLITION

104. Existing features to be demolished are discussed under the project descriptions above.

UTILITY RELOCATIONS

105. Preliminary utility coordination with utility companies was performed to identify existing utilities in significant conflict with the proposed features. This information was used to amend features to minimize utility conflicts. A detailed survey of all existing utilities within and adjacent to the project site will be required during the design phase for each individual site. There are no building relocations required for the projects.

SECTION 3 - OTHER MEASURES

GENERAL

106. Potential structural flood risk reduction sites where identified and screened through collaboration with the project partners and stakeholders. Refer to the main report for more information on the site developments. Conceptual site plans and quantities where developed for existing reservoir expansions, road raises, and bridge raise modifications, and flow conveyances. The sites are discussed in detail below.

107. The roads and bridges are owned and maintained by the Illinois Department of Transportation (IDOT Therefore, the road and bridge designs should be coordinated with IDOT and follow IDOT standard specifications and design. The road raise elevations for road raise sites were determined based on maximized net benefits calculated using preliminary costs and benefits at each site during the screening step.

108. Since the road and bridge reconstructions are within IDOT ROW, the permanent and temporary easements for the projects are the required areas in addition to IDOT ROW.

Railroad Bridge Pier Extension 01 (DPBM01)

109. DPBM01 is located in the village of Riverside, IL and consists of a skewed railroad bridge that crosses the Des Plaines River between Forest Ave and Ogden Ave. See Plate D4. Currently the pier arrangement impedes natural flow of the river. This project extends and realigns the railroad piers upstream and downstream to provide flow conveyance. This flow improvement will change the piers effective width from 33-feet to the actual 6.5-feet and the effective bridge width from 219-feet to 265-feet in the hydraulic modeling.

110. Additionally river bank side-slope excavation upstream and downstream would be needed to allow for effective conveyance of flows through the bridge. Extending the piers and the excavation would reduce the 100-year flood elevation by 0.74-feet. Refer to Plate D4 for a general layout of this alternative.

111. The permanent easement for DPBM01 includes only the excavation of the river bank to widen the river to improve flow. This bank loss occurs on the northwest, southeast, and southwest corners of the railroad bridge crossing the Des Plaines River.

112. The temporary easement for DPBM01 is located at a minimum of 10 feet from the new bank edge to allow for equipment movement. Additionally a large area is enclosed in the temporary easement on the northeast corner of the bridge to provide for staging and storage. This staging and storage area will provide the site entrance access off the dead end of West Ave. Access to the west bank will be through the river. The work will need to be conducted during typical low water months from May to November.

113. The design assumptions used herein are based on IDNR assessments for the pier extensions. There is no boring data required for the design of the sheet pile pier extension. A conservative assumption of 25 ft deep sheet pile to anchor the pier extension to the river bed was used. A generalized river bed elevation of 596 ft was used based on the surrounding information. In addition, a total of 596 feet was assumed for the pier extension lengths. The extensions will be built at angles to the existing pier and in line with the flow of the river. The height above the water of the pier extension was assumed to be 10 ft and extend 12 ft below water giving the pier extension a total height of 22 ft. Hydraulic analysis is required to determine the effective length of the pier extensions for flow conveyance. In addition boring data are required for the design of the sheet pile.

114. Without a full hydraulic design an assumption of 1:1 side slopes for the river excavation was made for the river banks, although not conservative, the area is not publically accessible so this side slope seemed warranted when compared to existing contours. Additionally, the banks would be seeded/vegetated for stability.

115. There was no drainage utilities information provided; therefore, further investigations should be performed to determine the appropriate locations of storm water features to handle rainfall events during and post construction.

Lake Mary Anne Pump Station (FPCI01)

116. FPCI01 is located in the city of Des Plaines in Cook County, Illinois. See Plate 17. To maintain lower flood stages in Lake Mary Anne, storm water will be pumped out of the lake to Dude Ranch Pond, which is located just south of Lake Mary Anne and across from Golf Rd. According to IDNR Farmer's Prairie Creek Study, there is an existing 12-inch and 18-inch outlet pipes that carries run-off from I-294 Tollway. The pipes are currently inactive and will remain inactive. Therefore, the lake will no longer collect run-off from the Tollway. There are two work areas and staging areas proposed for this project. The work areas are located on each side of Golf Rd.

117. Two-5 CFS pumps are proposed to pump storm water from Lake Mary Anne to Dude Rand Pond through a 12-inch outlet pipe. A 12-inch intake pipe is also proposed. Based on the existing topography, the inlet invert of the intake pipe is 626.0, and the outlet invert of the outlet pipe was determined to be 628.0. Adequate soundings survey of the lake and pond should be performed to properly determine the invert elevations of the proposed intake and outlet pipes. A headwall will be installed at the outlet pipe. Riprap will also be placed for erosion control. The outlet pipe will be installed under Golf rd to Dude Rand Pond. Golf road is a major road and will likely have major utilities crossing, including a 96" interceptor pipe. Therefore, the proposed pipe will be installed under the road by directional jacking to minimize impacts to crossing utilities and traffic. Refer to plate 17 for FPCI01 site plan.

118. There is no existing utilities information. Further investigations are required to confirm and evaluate the impacts to the existing utilities and also determine the appropriate depth of the pipe for directional jacking to minimize existing utility impacts.

Mt. Prospect Reservoir Expansion (WLME01)

119. WLME01 is an existing reservoir located in the village of Mt. Prospect in Cook County and adjacent to Melas Park. See Plate D5. The reservoir bottom elevation and depth are approximately 646 EL. and 24 feet respectively. The reservoir collects storm water from Arlington Heights and Mount Prospect through an 84″ RCP and drop structure. After the storm event, water is pumped out of the reservoir through a 24″ force main and ultimately to Weller Creek. An existing

72″ over-flow pipe is located at the west slope of the reservoir. The over-flow structure is used when the pump station is off-line or when the inflow is greater than the pump station outflow. The over-flow structure collects storm water and transfer the water into the deep tunnel or directly into Weller Creek. An existing low-flow bypass pipe connects the inflow structure to the pump station 24″ force main. The reservoir includes an under-drain pipe system the collects standing water in the reservoir. The pipe system drains water from the reservoir bottom into the collection chamber, which is then pumped out. Mt. Prospect is responsible for the operation of the reservoir inflow and under drain system. The city of Arlington Heights is responsible for the operation of the pump station. Construction access will be from the existing park access at Central Rd. Since the site is an existing park, a traffic control is recommended. The north-east corner of the existing parking lot is proposed for the staging area.

120. The existing reservoir will be expanded horizontally, at the south end of the reservoir, by approximately 370 feet and an additional storage of 156 AC-FT. The expanded reservoir will maintain the bottom elevation of 646 as the existing reservoir. The top of the expanded reservoir has a crest width of 10 feet and the top elevation varies between 670 and 676. 18″ under-drain pipes will be placed at the expanded reservoir to meet with the existing system. It is assumed that the inflow and outflow volume will be the same as the existing. Therefore, no modifications will be made to the inflow and outflow structures.

121. The excavated material from the reservoir will be stored on site at two locations - over the existing spoil (Spoil Area 1) and at the west end of the site (Spoil Area 2). Spoil Area 1 is approximately 14 feet high, which includes the existing spoil height. The side slopes varies from 1(V):6(H) to 1(V):12(H). Spoil Area 2 height varies between 18 to 28 feet and side slopes from 1(V):2.5(H) to 1(V):5(H). Spoil Area 2 displaces the existing trail and volley ball court. The spoil surface area will also be seeded over 6 inches of topsoil. Refer to Plate D5 for the WLME01 site plan.

122. There is no drainage utilities information provided. Therefore, further investigations should be perform to determine the appropriate locations and design of the proposed drainage structures connections with the existing

structures as needed. In addition, the new sheet flow as a result of the new spoil should be managed on site.

Silver Creek Reservoir Expansion (SCME02)

123. SCME02 is an existing reservoir located in the city of Schiller Park in Cook County. See Plate D6. SCME02 contains two reservoirs (east and west reservoirs) that are separated by a 60″ diameter bypass pipe. The bypass pipe conveys flow from Silver Creek. Storm water flows from Silver Creek into the east reservoir through the existing spillway structure. After the storm event, water is pumped out of the reservoir through the existing pump station. The west reservoir includes an under-drain pipe system that serves to collect standing water in the reservoir and feeds the pump station intake structure. Water pumped out of the reservoir discharges into Silver Creek. Storm water flows into the west reservoir from the east reservoir through a 60″ diameter equalizer pipe. The west and east reservoirs are enclosed by 16-foot tall slurry wall with tip elevation of 629.0. There is an existing access ramp to the bottom of the reservoir located at the south-end of the reservoir. The existing access to the site is from Seymour Ave. on the north-east side of the project site.

124. The existing reservoirs will be expanded vertically by deepening the reservoir by 10 feet. As determined from the as-built drawings, the high grade elevation of the bottom reservoir at the west and east reservoir is at approximately 625 and 623 respectively. The new high grade reservoir bottom elevations will be 615 and 613 respectively. The expanded reservoirs will provide a total of approximately 155 AC-FT of storage. The existing under-drain system will be removed and replaced at the new depth. The existing spillway chute will be extended by approximately 35 feet to meet the new grade. The spillway berm, including the erosion control cell grout, will be replaced. The pump station intake structure will also be extended to meet the new grade. The existing equalizer pipe will be filled and abandoned in place and a new 60″ diameter equalizer pipe will be installed.

125. It is assumed that the slurry wall tip is embedded in impermeable layer and no modifications will be made. However, further investigations are required to determine the soil conditions and evaluate the slurry wall, as a result of the improvements.

126. The excavated material from the reservoir will be stored on site. The proposed spoil area is located east of the reservoirs. An existing building on the site was recently demolished and the site is completely cleared. The total excavated material is determined to be approximately 212,000 CY. The spoil height approximately 23 feet with side slopes of 1(V):5(H). The spoil surface area will also be seeded over 6 inches of topsoil. Refer to Plate D6 for the SCME02 site plan.

127. There is no drainage utilities information provided. Therefore, further investigations should be perform to determine the appropriate locations and design of the proposed drainage ditches and proposed drainage structures connections with the existing structures as needed. In addition, the new sheet flow as a result of the new spoil should be managed on site.

First Ave. Bridge Modification and Road Raise 04 (DPBM04)

128. DPBM04 is located in the city of River Grove in Cook County, Illinois. See Plate 23. The bridge to be modified is located on First Ave, over the Des Plaines River. First Ave. is a 4-lane highway with Design Hourly Volume (DHV) of 2501 vph and Average Daily Traffic (ADT) of 25010 vpd. The design speed is 65 MPH. The existing bridge is a concrete bridge with 3.5 feet deep concrete beams and 7.5 inches slab. Due to the high traffic volume, traffic maintenance is required. The bridge reconstruction should be performed in stages, where at least two lanes are opened to traffic. A staging area is proposed at the south end of the project site.

129. IDOT low beam clearance requirements controls for the road raise. The low beam elevation was determined to be 629.07, which is 2-foot above the design high water (500-year, 627.07). As shown on the bridge as-built, the existing low beam elevation is 625.2 (NAVD 88). Therefore, the roadway will be raised by approximately 3.9 feet at the bridge. It is assumed that the proposed bridge type and geometry will be the same as the existing bridge. Therefore, the proposed bridge superstructure will include 3.5 feet beams and 7.5 inches deck. The proposed bridge deck will maintain a 2-lane width of 22-foot with cross-slope of 1.56% and 8-foot shoulders with cross-slope of 2.0%. A longitudinal slope of

1.0% was used for the roadway and a side slopes of 1(V):2(H) was used for the roadway fill. The proposed pavement typical section is also assumed to be the same as existing. The total road raise length, including intersecting roads is 2036 feet. Refer to plate 23 for DPBM04 site plan, profile, and cross-section.

130. There is no existing utilities information. The existing storm drainage lines and inlets should be evaluated and the inlets should be raised accordingly. Traffic signals at the intersection of River Rd and First Ave should also be raised. Further investigations are required to confirm and evaluate the impacts to the existing utilities.

Route 120 Bridge Modification and Road Raise 13 (DPBM13)

131. DPBM13 is located in Park City in Lake County, Illinois. See Plate D9. The bridge to be modified is located on Route 120 (Belvedere Rd), over the Des Plaines River. Route 120 is a 4-lane divided highway with Design Hourly Volume (DHV) of 2501 vph and Average Daily Traffic (ADT) of 19200 vpd. The design speed is 65 MPH. The existing bridge is a concrete bridge with 3.5 feet deep steel beams and 7 inches slab. Due to the high traffic volume, traffic maintenance is required. The bridge reconstruction should be performed in stages, where at least two lanes are opened to traffic. A staging area is proposed at the east end of the project site.

132. IDOT low beam clearance requirements controls for the road raise. The low beam elevation was determined to be 666.45, which is 2-foot above the design high water (500-year, 664.47). As shown on the bridge as-built, the existing low beam elevation is 661.71 (NAVD 88). Therefore, the roadway will be raised by approximately 4.7 feet at the bridge. It is assumed that the proposed bridge type and geometry will be the same as the existing bridge. Therefore, the proposed bridge superstructure will include 3.5 feet beams and 7.5 inches deck. The proposed bridge deck will maintain its existing structure, with one bridge deck in each direction of traffic. Each deck will maintain a 2-lane width of 24-foot with cross-slope of 1.56%, 6-foot interior shoulders, and 10-foot exterior shoulders, each with cross-slope of 2.0%. A longitudinal slope of 1.0% was used for the roadway and a side slopes of 1(V):2(H) was used for the roadway fill. The proposed pavement typical section is also assumed to be the same as existing. The total road raise

length is 1240 feet. Refer to plate D9 for DPBM13 site plan, profile, and cross-section.

133. There is no existing utilities information. The existing storm drainage lines and inlets should be evaluated and the inlets should be raised accordingly. Traffic signals at the intersection of River Rd and First Ave should also be raised. Further investigations are required to confirm and evaluate the impacts to the existing utilities.

Libertyville Marsh (L22)

134. A wetland complex currently exists on the proposed Bull Creek Reservoir site. See Plates D1a and D1b. To mitigate for adverse impacts from the reservoir construction, ecosystem restoration (mitigation) will be implemented at Libertyville marsh, approximately two miles from the reservoir site within the same watershed. The hydrology will be restored on 112 acres of this former agricultural land and native marsh and wet prairie plantings will restore the natural habitat in the project area.

135. Bull Creek Reservoir (BCRS02) requires mitigation. The 112-acre wetland complex, although currently overridden with invasive plant species and secondary growth forest, still provides habitat for marsh and prairie species of insect, amphibian, reptile, bird and mammal and hydrologic functions. The marshes are dominated by cattails Typha spp. and reed canary grass (Phalaris aurndinacea) and the wet prairie by Eurasian cool season grasses and weedy tree species such as buckthorn (Rhamnus cathartica). The current floristic quality based on the coefficient of conservatives, or mean C, for marsh is 1.4 and wet prairie is 1.0.

136. It is typical of mitigation projects to be located as close as possible to the impacted site or within the watershed. Site L22, which was analyzed in the NER plan, is within the Bull Creek watershed and has enough wet prairie and marsh community types to serve as the mitigation site. The site is also in public ownership, with the Lake County Forest Preserve and the Township of Libertyville both owning parcels. Both of these agencies have designated this 760-acre site as protected open space with primary purpose of ecological restoration. There are approximately 214-acres of marsh and 138-acres of wet prairie on this site, which is

more than enough for in-kind mitigation. See plate D1b for the restoration plan at site L22.

VOLUME CALCULATIONS

137. Quantity takeoffs for the sites were computed by using Bentley CADD software packages - Microstation and Inroads as well as Microsoft Excel. Digital Terrain Models (DTM) of the existing topography were developed using existing contours from GIS. DTMs of the proposed road raises were also created. By comparing the two DTMs the fill volume quantities for the road raise where determined though Triangle Volumes in Inroads. Triangle Volumes method projects the triangles from an existing surface onto the design Surface and then compute the volume of each of the resultant prismoids for a total volume. Profiles and cross-sections for the road raises where generated in Inroads. The cross-sections where checked for inconsistencies with the proposed road raise and existing topography DTMs data. Refer to Section 1 for the quantity computations for the reservoir expansions.

138. The true and planar surface areas for the road raise side slopes and pavement where also determined in Inroads. The areas for the road raise side slopes where used to compute the seeding areas and topsoil volumes. The areas for the road raise pavement was used determined the roadway reconstruction quantities.

139. It is assumed that the existing bridge superstructure typical section will be used for the bridge reconstruction. Therefore, the quantities for the bridge modifications were determined from the as-built drawings.

REAL ESTATE

140. The conceptual real estate requirements, including the permanents and temporary easement (PE & TE), for each site are shown and documented on the site plans. The real estate for the road raises and bridge modifications did not consider the areas within IDOT ROW. The permanent and temporary easement where drawn based on the parcel data provided from GIS. The access roads and staging areas where considered as temporary easements.

OPERATION AND MAINTENANCE

141. For the operation and maintenance work for the various projects, historic data from Little Calumet Flood control project was used which included all the major features included in the DPII design. A spreadsheet was created which broke out the individual design projects into separate worksheets. Each worksheet was tailored so that only the appropriate O&M items were included for instance floodwall items were not included in a reservoir project. The individual O&M work was based on quantities from the bid schedule such as square footage of floodwall, length of levee, or number of pump stations.

DEMOLITION

142. Existing features to be demolished are discussed under the project descriptions above.

UTILITY RELOCATIONS

143. Preliminary utility coordination with utility companies was performed to identify existing utilities in significant conflict with the proposed features. This information was used to amend features to minimize utility conflicts. A detailed survey of all existing utilities within and adjacent to the project site will be required during the design phase for each individual site. There are no building relocations required for the projects.

SECTION 4 - DAM REMOVALS

GENERAL

144. Five existing dams on the upper Des Plaines River were considered for complete removal. The five dams are named Dam No. 1, Dam No. 2, Dempster St. Dam, Touhy Dam, and Dam No. 4. See Plates 42 through 46 for the site plans and Plates D10 through D12 for details and typical sections. The five dams are classified as small, run-of-the-river low-head dams that currently serve no functional purpose. Through dam removal, both fish passage and riverine function may be restored, which have benefits of habitat restoration and water quality improvement. The dam removal sites were developed utilizing contours, parcels, aerial images, and existing building locations from local GIS data. Four of the sites are located in heavily wooded areas owned by the Forest Preserve District. The fifth site (Dempster St. Dam) is located in downtown Des Plaines, Illinois. While each site presents challenges, the dams can be physically removed from the river.

REAL ESTATE

145. The conceptual real estate requirements for each site are shown and documented on the site plans. The work limits, access roads, and staging areas shown on the site plans are all considered temporary easements. Since the existing dams are being removed from the river and no other permanent features are being built there is no need for permanent easements. If any existing paved parking lots or roads are used for staging, storage or access; these areas shall be repaired to before project condition or better.

OPERATION AND MAINTENANCE

146. Since the existing dams are being removed from the river and no other permanent features are being built there is no need for operation and maintenance work.

DEMOLITION

147. At each site an existing dam will be demolished and removed from the river. Historical data indicates all five of

the dams are made of reinforced concrete. It is assumed that clearing and grubbing would be performed only in the areas necessary to build temporary access roads and staging areas needed to access the dams and store construction equipment. The access roads and staging areas will be constructed with stone. It is assumed that all five dams will be demolished in-the-wet by driving excavators into the river to perform the work without the use of any type of coffer dam or water diversion structure. Based on previous dam removal experience this is the most practical method of removal. Once demolition of the dam is complete the staging areas and access roads will be removed. If any paved parking lots or roads are used for staging, storage or access; these areas shall be repaired to before project condition or better. Once all construction activities are complete the affected areas will be restored to pre-existing condition by seeding and planting of new trees. Turbidity curtains shall be required downstream from each dam removal site.

UTILITY RELOCATIONS

148. There is no utility information available for the conceptual design of the dam removal sites for this feasibility study. Based on the locations of the dams and the surrounding areas it is unlikely that any existing utilities are present under or adjacent to the dams where the demolition would take place. Detailed survey of all existing utilities within and adjacent to the dam removal sites will be required during the design phase. There are no utility relocations, building relocations, or utility connections required for the dam removal sites at this time.

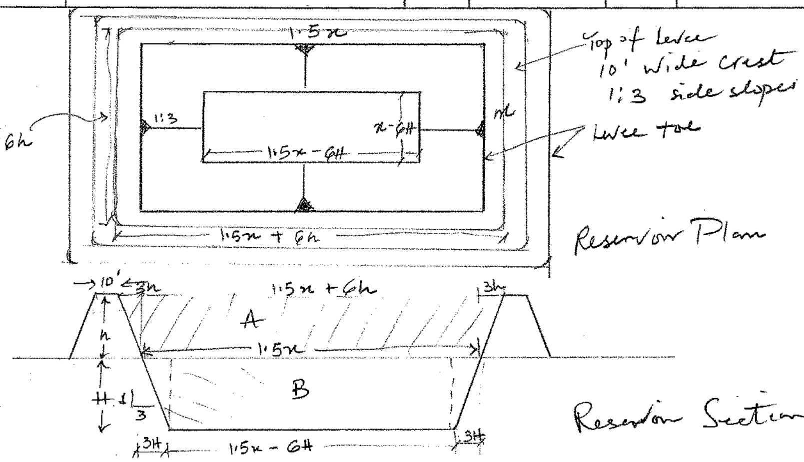
Upper Des Plaines River and Tributaries, Illinois and Wisconsin Integrated Feasibility Report and Environmental Assessment

Appendix D – Civil Design

ATTACHMENT D-1
IDEALIZED RESERVOIR ANALYSES

PROJECT TITLE: DP II	COMPUTED BY: Faye L	DATE: 12/23	SHEET: 1 / 3
STRUCTURE TITLE: Reservior Volume Computations	CHECKED BY:	DATE:	CONTRACT NO:

US Army Corps of Engineers
Chicago District



1) Total Volume = Volume A + Volume B

Volume B: $\left[\dfrac{(1.5x-6H)(x-6H)+(1.5x \times x)}{2}\right] H$

$= \left(\dfrac{1.5x^2 - 9Hx - 6Hx + 36H^2 + 1.5x^2}{2}\right) H$

$= \left(\dfrac{3x^2 - 15Hx + 36H^2}{2}\right) H$

Vol. B $= (x^2 - 5Hx + 12H^2)\dfrac{3H}{2}$

Volume A: $\left[\dfrac{(1.5x \times x) + (1.5x+6h)(x+6h)}{2}\right] h$

$= \left(\dfrac{1.5x^2 + 1.5x^2 + 9hx + 6hx + 36h^2}{2}\right) h$

NCC Form 1272-1 08 Mar 00

US Army Corps of Engineers Chicago District	PROJECT TITLE:	COMPUTED BY:	DATE:	SHEET: 2	3
	STRUCTURE TITLE:	CHECKED BY:	DATE:	CONTRACT NO:	

$$= \frac{(3x^2 + 15hx + 36h^2)h}{2}$$

Vol. A $= (x^2 + 5hx + 12h^2)\frac{3h}{2}$

Total Volume =

$$\frac{3h}{2}(x^2 + 5hx + 12h^2) + \frac{3H}{2}(x^2 - 5Hx + 12H^2)$$

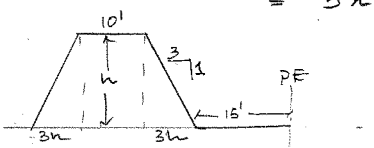
2) Levee Length: Reservoir Perimeter − Weir Length

Assume Weir Length = 10 FT

Levee Length: $2(x + 1.5x) - 10$

$= 5x - 10$

3)



Levee Cross-Sectional Area: $2(3h \times \frac{1}{2} \times h) + (10 \times h)$

$= 3h^2 + 10h$

Levee fill Volume = $(3h^2 + 10h) \times$ Levee Length

Levee Seeding Area: $\left[2\left(\sqrt{9h^2 + h^2}\right) + 10 + 15\right] \times$ Levee Length

$= \left[2\left(\sqrt{10h^2}\right) + 25\right] \times$ Levee Length

NCC Form 1272-1 08 Mar 00

US Army Corps of Engineers Chicago District	PROJECT TITLE:	COMPUTED BY:	DATE:	SHEET: 3	3
	STRUCTURE TITLE:	CHECKED BY:	DATE:	CONTRACT NO:	

4) Clearing and Grubbing Area:

Total length $= 1.5x + 2(6h + 10 + 15)$

$= 1.5x + 12h + 50$

Total Width $= x + 12h + 50$

Area $= (1.5x + 12h + 50)(x + 12h + 50)$

$1.5x^2 + 18xh + 75x + 12xh + 144h^2 + 600h + 50x$

$+ 600h + 2500$

$= 1.5x^2 + 144h^2 + 30xh + 125x + 1200h + 2500$

DPII - FEASIBILITY

IDEALIZE RESERVOIR EXCAVATION AND LEVEE FILL COMPUTATION

Civil Engineer: Faye Leffler
Cost Engineer: Kristin Cipriano
Date: 12/31/2009

			Reservoir Excavation (CY)			Levee Length (FT)			Levee Fill (CY)			Levee Seeding Area (SY)			Topsoil Stripping (CY)		
			H, Reservoir Depth (FT)			H, Reservoir Depth (FT)			H, Reservoir Depth (FT)			H, Reservoir Depth (FT)			Assumed 18"		
No.	Reservoir Storage (AC-FT)	h-2, Weir Height (FT)	5	10	15	5	10	15	5	10	15	5	10	15	5	10	15
1	25	4	20831.4	26289.4	28626.8	1420.4	1196.0	1086.6	8838.2	7442.0	6761.1	9934.7	8365.3	7599.8	4967.3	4182.6	3799.9
2	25	6	16199.2	21683.3	24243.8	1258.5	1095.5	1011.1	12677.8	11036.1	10186.4	10570.6	9201.7	8493.2	5285.3	4600.9	4246.6
3	25	8	12902.9	17994.8	20522.6	1128.5	1006.8	941.3	16717.8	14916.2	13944.6	11064.5	9872.2	9229.1	5532.3	4936.1	4614.6
4	50	4	42584.5	54046.0	59101.4	2009.3	1669.9	1496.9	12502.2	10390.4	9313.8	14053.2	11679.5	10469.2	7026.6	5839.7	5234.6
5	50	6	33644.0	45411.7	51096.7	1791.6	1539.5	1402.5	18048.4	15508.9	14128.6	15048.5	12931.1	11780.2	7524.2	6465.5	5890.1
6	50	8	27324.4	38537.4	44325.1	1619.5	1426.4	1316.5	23993.1	21132.1	19504.3	15879.7	13986.1	12908.7	7939.8	6993.0	6454.4
7	100	4	86474.5	110179.3	120864.5	2841.6	2338.4	2073.2	17681.1	14550.3	12899.8	19874.6	16355.4	14500.1	9937.3	8177.7	7250.1
8	100	6	69055.4	93742.1	105971.0	2544.8	2165.4	1951.4	25636.2	21814.1	19658.7	21375.0	18188.3	16391.1	10687.5	9094.1	8195.6
9	100	8	56809.4	80726.6	93430.7	2312.9	2017.2	1842.0	34264.7	29884.3	27289.0	22677.8	19778.7	18061.0	11338.9	9889.3	9030.5
10	200	4	174796.6	223318.9	245525.1	4018.4	3282.8	2885.5	25003.2	20426.3	17954.4	28105.1	22960.4	20181.8	14052.5	11480.2	10090.9
11	200	6	140614.3	191629.7	217343.0	3609.4	3049.1	2724.6	36361.6	30716.9	27448.3	30317.7	25611.3	22885.9	15158.9	12805.6	11443.0
12	200	8	116683.6	166651.0	193718.1	3292.6	2850.9	2581.5	48778.5	42234.9	38244.4	32283.7	27952.8	25311.7	16141.8	13976.4	12655.9
13	400	4	352207.0	450828.9	496438.8	5682.3	4617.5	4032.5	35356.7	28731.4	25090.9	39743.1	32295.8	28203.7	19871.5	16147.9	14101.9
14	400	6	284772.2	389133.7	442362.5	5114.7	4297.9	3816.0	51525.9	43297.3	38442.5	42961.5	36100.6	32052.7	21480.7	18050.3	16026.4
15	400	8	237708.6	340676.0	397197.8	4677.5	4028.6	3624.8	69295.6	59682.5	53700.1	45862.7	39500.4	35541.0	22931.4	19750.2	17770.5
16	800	4	708111.1	907587.9	1000510.1	8035.4	6504.6	5653.2	49997.9	40473.1	35175.3	56200.6	45494.2	39539.1	28100.3	22747.1	19769.6
17	800	6	574557.9	786582.5	895605.6	7243.2	6063.3	5357.8	72968.9	61081.8	53975.2	60840.3	50929.0	45003.7	30420.1	25464.5	22501.8
18	800	8	481562.3	691796.1	808243.3	6635.6	5693.2	5098.4	98305.0	84343.9	75531.4	65062.3	55822.3	49989.8	32531.2	27911.1	24994.9
19	1200	4	1064623.5	1365322.9	1505839.9	9840.9	7952.4	6896.3	61232.2	49481.7	42910.6	68828.6	55620.4	48234.0	34414.3	27810.2	24117.0
20	1200	6	865169.3	1185401.2	1350644.9	8876.4	7417.6	6540.4	89421.8	74725.9	65888.9	74558.5	62305.3	54937.1	37279.2	31152.7	27468.6
21	1200	8	726428.8	1044638.9	1221578.5	8138.0	6970.2	6228.5	120562.7	103262.9	92274.6	79793.4	68343.7	61071.2	39896.7	34171.8	30535.6
22	1600	4	1421450.8	1823563.0	2011820.6	11363.0	9172.9	7944.2	70703.0	57076.0	49430.8	79474.4	64156.8	55563.2	39737.2	32078.4	27781.6
23	1600	6	1156207.9	1584928.8	1806613.2	10253.2	8559.4	7537.3	103291.9	86227.7	75930.9	86123.2	71895.3	63310.0	43061.6	35947.7	31655.0
24	1600	8	971819.4	1398373.0	1636097.5	9404.5	8046.7	7181.1	139326.1	119210.9	106386.8	92211.8	78898.7	70411.2	46105.9	39449.4	35205.6

Topsoil Placement (CY)			Clearing & Grubbing Area (SY			Total Costs $			uration of Excavation and F			Construction Duration		
Assumed 6"			H, Reservoir Depth (FT)			H, Reservoir Depth (FT)			Days			Months		
5	10	15	5	10	15	5	10	15	5	10	15	5	10	15
827.9	697.1	633.3	24989.8	19525.0	17103.1	$6,165,567	$6,212,640	$6,231,120	41	49	52	6	6	6
880.9	766.8	707.8	23383.6	19482.8	17602.7	$6,107,967	$6,161,834	$6,185,645	38	45	48	6	6	6
922.0	822.7	769.1	22603.6	19707.8	18227.9	$6,305,351	$6,126,610	$6,151,417	36	43	46	6	6	6
1171.1	973.3	872.4	42523.5	31853.3	27004.3	$6,636,216	$7,274,271	$7,173,726	48	96	103	6	8	9
1254.0	1077.6	981.7	38618.9	30942.5	27125.7	$6,635,296	$6,892,092	$6,950,486	71	87	95	7	8	8
1323.3	1165.5	1075.7	36303.8	30532.5	27470.9	$6,514,171	$6,812,271	$6,878,525	66	81	89	7	8	8
1656.2	1363.0	1208.3	75192.4	54338.9	44703.9	$7,795,352	$8,187,703	$8,935,354	92	113	122	8	9	14
1781.3	1515.7	1365.9	66602.6	51561.4	43925.5	$7,529,709	$7,952,089	$8,107,205	80	102	112	8	9	9
1889.8	1648.2	1505.1	61120.6	49753.4	43568.4	$7,236,666	$7,667,420	$7,951,387	74	94	105	7	8	9
2342.1	1913.4	1681.8	137142.1	96255.3	77172.8	$9,688,728	$11,274,494	$11,664,024	113	224	244	9	17	18
2526.5	2134.3	1907.2	119060.7	89568.6	74404.7	$9,762,874	$10,680,875	$11,135,815	155	200	223	14	16	17
2690.3	2329.4	2109.3	107114.1	84793.7	72458.7	$9,280,998	$10,205,047	$10,001,091	139	183	206	13	15	16
3311.9	2691.3	2350.3	256253.0	175779.5	137996.7	$14,159,606	$16,159,405	$16,853,942	222	279	304	17	23	24
3580.1	3008.4	2671.1	219019.4	161030.2	130988.8	$12,909,103	$14,580,105	$16,781,183	188	247	443	16	18	30
3821.9	3291.7	2961.7	193962.8	150086.9	125615.9	$11,565,611	$13,730,969	$15,999,552	166	224	409	15	17	29
4683.4	3791.2	3294.9	487704.7	328742.4	253847.4	$21,738,669	$25,227,605	$27,805,891	293	444	608	23	30	41
5070.0	4244.1	3750.3	411929.3	297526.2	237998.2	$19,446,745	$23,484,795	$25,413,034	294	490	552	23	32	35
5421.9	4651.9	4165.8	360400.3	273919.0	225426.4	$17,783,444	$21,800,634	$23,897,309	257	442	508	22	30	33
5735.7	4635.0	4019.5	715354.0	478288.9	366447.3	$29,379,908	$34,995,912	$37,217,778	437	664	729	30	43	46
6213.2	5192.1	4578.1	600904.1	430414.7	341554.9	$26,365,588	$31,690,160	$34,381,855	365	586	662	27	40	43
6649.4	5695.3	5089.3	522761.5	393961.1	321592.6	$22,461,565	$28,702,525	$32,430,642	317	527	608	21	34	41
6622.9	5346.4	4630.3	941035.3	626067.4	477365.6	$36,487,101	$43,624,439	$47,740,561	498	737	972	33	47	60
7176.9	5991.3	5275.8	787842.2	561436.5	443325.9	$31,358,010	$39,293,116	$43,955,610	414	649	882	29	43	56
7684.3	6574.9	5867.6	683013.0	512042.3	415874.5	$28,585,772	$35,824,626	$40,899,384	503	583	809	32	40	53

Assumptions:

1) Reservoir Excavation =	3H/2*(x^2-5Hx+12H^2)
2) Levee Length =	Reservoir Perimeter - Weir Length
Levee Length =	2*(X + 1.5X) -10
Levee Height =	Weir Height + 2FT
Levee Cross-sectional area =	3*h^2 + 10h
Levee Fill =	Cross-sectional area x Length
Where:	
H =	Reservoir Excavation depth
h =	Levee Height
X =	Shortest side of the reservoir

3) Assumed that the existing terrain is flat. Therefore, excavation and fill quantities are generated on a flat grade.

Inroads Volume Check Report

Using No. 21, Storage Volume = 1200 AC-FT, X = 1396.0, Levee Height = 8, and Reservoir Depth = 10

Inroad Report:
RESERVOIR LENGTH = 1396*1.5 = 2094 FT
RESERVOIR WIDTH = 1396.0 FT
RESERVOIR DEPTH = 10 FT
LEVEE HEIGHT = 8 FT
INROADS STORAGE REPORT = 1199.7 AC-FT
INROADS RESERVOIR EXCAVATION = 28197137.7 CF (1044338.4CY)

DPII - FEASIBILITY
IDEALIZE RESERVOIR AREA COMPUTATIONS PER STORAGE, LEVEE HEIGHT, & RESERVOIR DEPTH

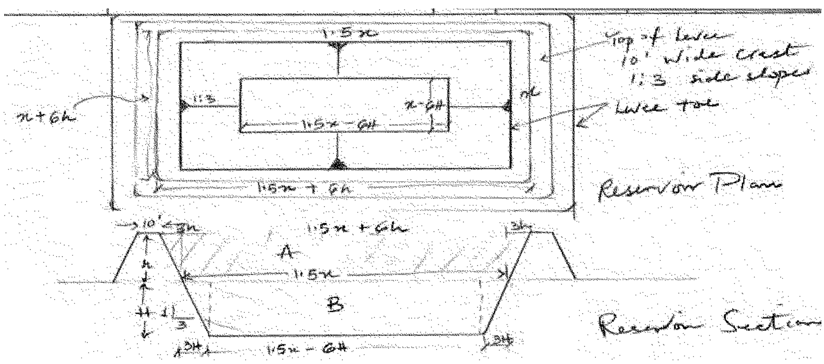
				x (FT)			Reservoir Area (AC)		
				H, Reservoir Depth (FT)			H, Reservoir Depth (FT)		
No.	Reservoir Storage (AC-FT)	Reservoir Storage (CF)	h, Weir Height (FT)	5	10	15	5	10	15
1	25	1089000	4	286.1	241.2	219.3	2.82	2.00	1.66
2	25	1089000	6	253.7	221.1	204.2	2.22	1.68	1.44
3	25	1089000	8	227.7	203.4	190.3	1.79	1.42	1.25
4	50	2178000	4	403.9	336.0	301.4	5.62	3.89	3.13
5	50	2178000	6	360.3	309.9	282.5	4.47	3.31	2.75
6	50	2178000	8	325.9	287.3	265.3	3.66	2.84	2.42
7	100	4356000	4	570.3	469.7	416.6	11.20	7.60	5.98
8	100	4356000	6	511.0	435.1	392.3	8.99	6.52	5.30
9	100	4356000	8	464.6	405.4	370.4	7.43	5.66	4.72
10	200	8712000	4	805.7	658.6	579.1	22.35	14.93	11.55
11	200	8712000	6	723.9	611.8	546.9	18.04	12.89	10.30
12	200	8712000	8	660.5	572.2	518.3	15.02	11.27	9.25
13	400	17424000	4	1138.5	925.5	808.5	44.63	29.50	22.51
14	400	17424000	6	1024.9	861.6	765.2	36.17	25.56	20.16
15	400	17424000	8	937.5	807.7	727.0	30.26	22.47	18.20
16	800	34848000	4	1609.1	1302.9	1132.6	89.16	58.46	44.18
17	800	34848000	6	1450.6	1214.7	1073.6	72.46	50.81	39.69
18	800	34848000	8	1329.1	1140.6	1021.7	60.83	44.80	35.94
19	1200	52272000	4	1970.2	1592.5	1381.3	133.66	87.33	65.70
20	1200	52272000	6	1777.3	1485.5	1310.1	108.77	75.99	59.10
21	1200	52272000	8	1629.6	1396.0	1247.7	91.45	67.11	53.61
22	1600	69696000	4	2274.6	1836.6	1590.8	178.16	116.15	87.15
23	1600	69696000	6	2052.6	1713.9	1509.5	145.09	101.15	78.46
24	1600	69696000	8	1882.9	1611.3	1438.2	122.08	89.41	71.23

Assumptions:

1) Reservoir Volume Equation = 3H/2*(x^2-5Hx+12H^2) + 3h/2*(x^2+5hx+12h^2)
Where:
h = Weir Height
H = Reservoir Depth
x = Shortest side of the reservoir

2) Reservoir Area = x*1.5x

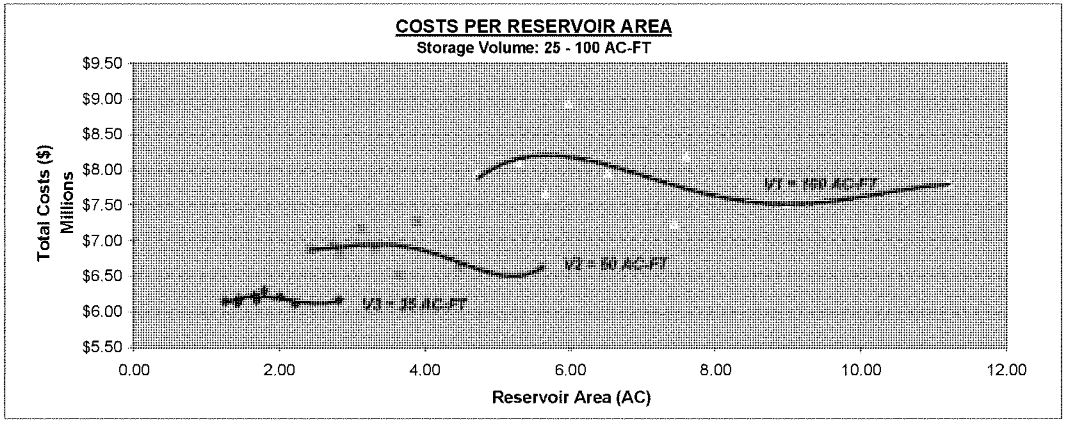
3) The area calculated above represents half the area for each site.
The excavated material will be deposited on the other half of the site.



DPII - FEASIBILITY
IDEALIZE RESERVOIR STORAGE-AREA-COST ANALYSES

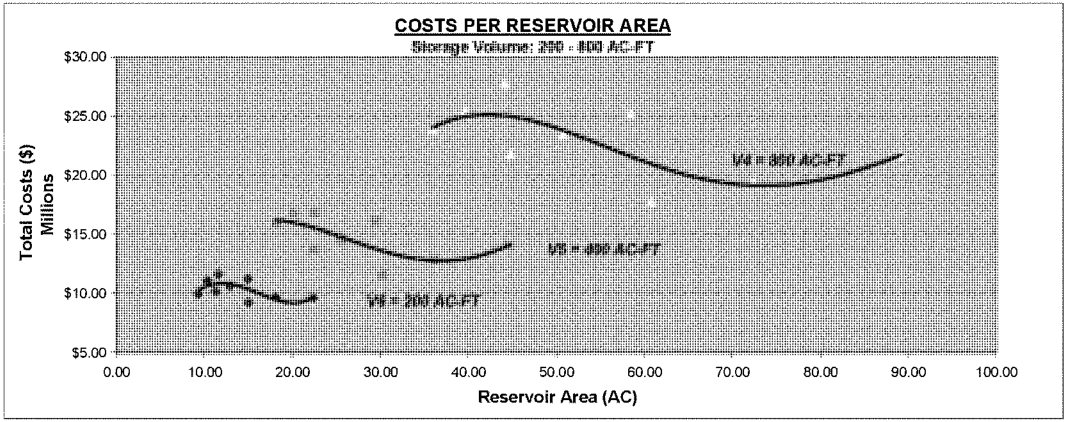
				Reservoir Area (AC)			Total Cost, $		
				H, Reservoir Depth (FT)			H, Reservoir Depth (FT)		
No.	Reservoir Storage (AC-FT)	Reservoir Storage (CF)	h-2, Weir Height (FT)	5	10	15	5	10	15
1	25	1089000	4	2.82	2.00	1.66	$6,165,567.04	$6,212,639.77	$6,231,119.83
2	25	1089000	6	2.22	1.68	1.44	$6,107,967.43	$6,161,834.07	$6,185,644.67
3	25	1089000	8	1.79	1.42	1.25	$6,305,350.91	$6,126,610.13	$6,151,416.59
4	50	2178000	4	5.62	3.89	3.13	$6,636,215.76	$7,274,271.36	$7,173,726.03
5	50	2178000	6	4.47	3.31	2.75	$6,635,296.00	$6,892,091.86	$6,950,485.62
6	50	2178000	8	3.66	2.84	2.42	$6,514,171.46	$6,812,271.30	$6,878,524.92
7	100	4356000	4	11.20	7.60	5.98	$7,795,352.13	$8,187,702.79	$8,935,353.89
8	100	4356000	6	8.99	6.52	5.30	$7,529,708.71	$7,952,088.76	$8,107,205.34
9	100	4356000	8	7.43	5.66	4.72	$7,236,665.54	$7,667,419.65	$7,951,387.45
10	200	8712000	4	22.35	14.93	11.55	$9,688,728.00	$11,274,493.74	$11,664,024.21
11	200	8712000	6	18.04	12.89	10.30	$9,762,873.67	$10,680,874.67	$11,135,815.32
12	200	8712000	8	15.02	11.27	9.25	$9,280,997.91	$10,205,047.02	$10,001,090.59
13	400	17424000	4	44.63	29.50	22.51	$14,159,606.47	$16,159,405.42	$16,853,941.85
14	400	17424000	6	36.17	25.56	20.16	$12,909,102.66	$14,580,104.88	$16,781,183.01
15	400	17424000	8	30.26	22.47	18.20	$11,565,611.19	$13,730,969.03	$15,999,552.10
16	800	34848000	4	89.16	58.46	44.18	$21,738,669.09	$25,227,605.24	$27,805,891.48
17	800	34848000	6	72.46	50.81	39.69	$19,446,744.64	$23,484,795.17	$25,413,033.55
18	800	34848000	8	60.83	44.80	35.94	$17,783,444.25	$21,800,633.94	$23,897,309.28
19	1200	52272000	4	133.66	87.33	65.70	$29,379,908.28	$34,995,911.68	$37,217,777.80
20	1200	52272000	6	108.77	75.99	59.10	$26,365,588.48	$31,690,159.68	$34,381,854.50
21	1200	52272000	8	91.45	67.11	53.61	$22,461,565.23	$28,702,524.76	$32,430,642.12
22	1600	69696000	4	178.16	116.15	87.15	$36,487,101.34	$43,624,438.71	$47,740,561.18
23	1600	69696000	6	145.09	101.15	78.46	$31,358,009.65	$39,293,116.13	$43,955,610.24
24	1600	69696000	8	122.08	89.41	71.23	$28,585,771.96	$35,824,625.51	$40,899,383.88

No.	Volume = 25 AC-FT		Volume = 50 AC-FT		Volume = 100 AC-FT	
	Area (AC)	Total Costs	Area (AC)	Total Costs	Area (AC)	Total Costs
1	2.82	$6,165,567.04	5.62	$6,636,215.76	11.20	$7,795,352.13
2	2.00	$6,212,639.77	3.89	$7,274,271.36	7.60	$8,187,702.79
3	1.66	$6,231,119.83	3.13	$7,173,726.03	5.98	$8,935,353.89
4	2.22	$6,107,967.43	4.47	$6,635,296.00	8.99	$7,529,708.71
5	1.68	$6,161,834.07	3.31	$6,892,091.86	6.52	$7,952,088.76
6	1.44	$6,185,644.67	2.75	$6,950,485.62	5.30	$8,107,205.34
7	1.79	$6,305,350.91	3.66	$6,514,171.46	7.43	$7,236,665.54
8	1.42	$6,126,610.13	2.84	$6,812,271.30	5.66	$7,667,419.65
9	1.25	$6,151,416.59	2.42	$6,878,524.92	4.72	$7,951,387.45



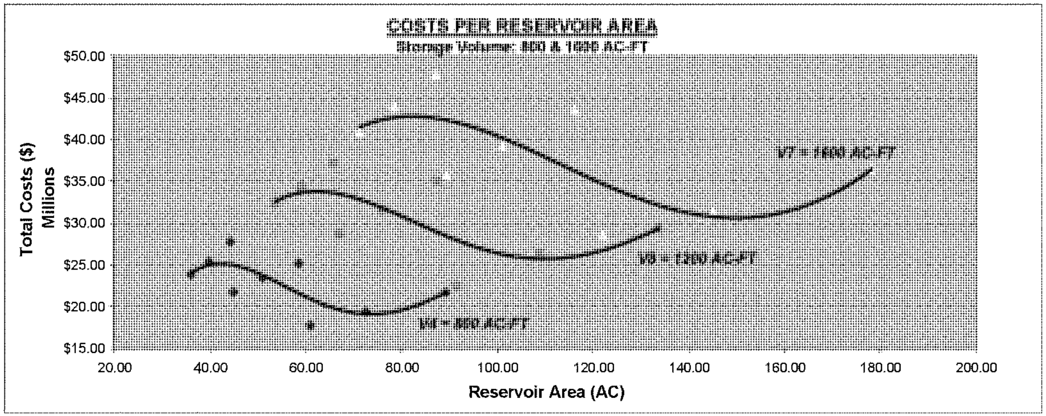
Curve Data:
V1 = Polynomial of the fourth degree, Equation: y = -7120x4 + 246746x3 - 3E+06x2 + 2E+07x - 2E+07
V2 = Polynomial of the fourth degree, Equation: y = 55614x4 - 812235x3 + 4E+06x2 - 9E+06x + 1E+07
V3 = Polynomial of the third degree, Equation: y = 315158x3 - 2E+06x2 + 4E+06x + 4E+06

No.	Volume = 200 AC-FT		Volume = 400 AC-FT		Volume = 800 AC-FT	
	Area (AC)	Total Costs	Area (AC)	Total Costs	Area (AC)	Total Costs
1	22.35	$9,688,728.00	44.63	$14,159,606.47	89.16	$21,738,669.09
2	14.93	$11,274,493.74	29.50	$16,159,405.42	58.46	$25,227,605.24
3	11.55	$11,664,024.21	22.51	$16,853,941.85	44.18	$27,805,891.48
4	18.04	$9,762,873.67	36.17	$12,909,102.66	72.46	$19,446,744.64
5	12.89	$10,680,874.67	25.56	$14,580,104.88	50.81	$23,484,795.17
6	10.30	$11,135,815.32	20.16	$16,781,183.01	39.69	$25,413,033.55
7	15.02	$9,280,997.91	30.26	$11,565,611.19	60.83	$17,783,444.25
8	11.27	$10,205,047.02	22.47	$13,730,969.03	44.80	$21,800,633.94
9	9.25	$10,001,090.59	18.20	$15,999,552.10	35.94	$23,897,309.28



Curve Data:
V4 = Polynomial of the fourth degree, Equation: y = -6.1982x4 + 1821.8x3 - 188661x2 + 8E+06x - 1E+08
V5 = Polynomial of the fourth degree, Equation: y = -15.567x4 + 2607.5x3 - 140492x2 + 3E+06x - 3E+06
V6 = Polynomial of the third degree, Equation: y = 6038x3 - 290324x2 + 4E+06x - 1E+07

No.	Volume = 800 AC-FT		Volume = 1200 AC-FT		Volume = 1600 AC-FT	
	Area (AC)	Total Costs	Area (AC)	Total Costs	Area (AC)	Total Costs
1	89.16	$21,738,669.09	133.66	$29,379,908.28	178.16	$36,487,101.34
2	58.46	$25,227,605.24	87.33	$34,995,911.68	116.15	$43,624,438.71
3	44.18	$27,805,891.48	65.70	$37,217,777.80	87.15	$47,740,561.18
4	72.46	$19,446,744.64	108.77	$26,365,588.48	145.09	$31,358,009.65
5	50.81	$23,484,795.17	75.99	$31,690,159.68	101.15	$39,293,116.13
6	39.69	$25,413,033.55	59.10	$34,381,854.50	78.46	$43,955,610.24
7	60.83	$17,783,444.25	91.45	$22,461,565.23	122.08	$28,585,771.96
8	44.80	$21,800,633.94	67.11	$28,702,524.76	89.41	$35,824,625.51
9	35.94	$23,897,309.28	53.61	$32,430,642.12	71.23	$40,899,383.88



Curve Data:
V7 = Polynomial of the fourth degree, Equation: y = -0.3242x4 + 229.02x3 - 52763x2 + 5E+06x - 1E+08
V8 = Polynomial of the fourth degree, Equation: y = -1.4914x4 + 660.2x3 - 102414x2 + 7E+06x - 1E+08
V4 = Polynomial of the fourth degree, Equation: y = -6.1982x4 + 1821.8x3 - 188661x2 + 8E+06x - 1E+08

Upper Des Plaines River and Tributaries, Illinois and Wisconsin Integrated Feasibility Report and Environmental Assessment

Appendix D – Civil Design

ATTACHMENT D-2
SITE SUITABILITY STUDY – GEOTECHNICAL REVIEW

CELRC-ED-G January 26, 2010
MEMORANDUM FOR RECORD
SUBJECT: Des Plaines II: Site Suitability Study Geotechnical Review

1. TS-DG was asked to assist in determining the site suitability of proposed reservoir sites along the Des Plaines River in Lake and Cook counties, IL, (Figure 1) based on available geologic data.

2. Site suitability was determined by utilizing a surficial geology map of the Chicago area (ISGS, scale 1:250,000) and NRCS soil maps to establish what geologic units or material the proposed reservoir sites lie within as well as available subsurface boring data where available. It should be noted that while geologic maps attempt to delineate areas of similar geologic materials and stratigraphic characteristics they are open to broad interpretation and should be used conservatively for design purposes.

3. Proposed sites were ranked using a three-tiered designation of: 'Good', 'Fair', and 'Poor', based on the in situ materials found in the area and the likelihood that the materials would mitigate the issues of seepage and stability. In general, areas likely to contain free draining material such as sand or gravel as well as areas that are comprised mostly of unstable deposits of peat, 'muck', or other organic material are less suitable than areas that are more likely to contain finer, more stable sediments (silt, clay, silty clay, etc.). The following guidelines were used to identify the suitability of each site location:

    a. Sand & Gravel - poor for seepage, fair for stability;
    b. Silt - fair for seepage, poor for stability;
    c. Clay - good for seepage, fair to good for stability;
    d. Peat/Muck - fair to poor for seepage, poor for stability

4. The proposed sites **AC08, MD04, FD02** (Figure 6), and **SC02** (Figure 8) lie within the Wadsworth Member of the Wedron Formation according to the map of surficial geology of the Chicago region. The Wadsworth member is a system of glacial moraines and is described as containing, 'Mostly gray clayey and silty clayey till, relatively low in content of pebbles, cobbles, and boulders; contains local lenses of silt; commonly mantled with 1-2 ft. of leached silt (loess) and soil.' (Willman and Lineback 1970). Additionally, the surficial soils in these sites have been mapped by the NRCS as containing fine-silty sediments (Figure 7). Due to a higher likelihood of stable, less permeable sediments in these areas, these sites are given a designation of '**Good**'.

5. Sites **FD01, FD03, DP24, DP23** (Figures 6 & 7), and **DPRS57** (Figure 9) lie partially within the Cahokia alluvium which is described as, 'Modern floodplain and stream deposits, mostly poorly sorted silt and sand with local deposits of sandy gravel'. There are ~50 borings located in the Cahokia alluvium within 200-3000 ft of DP23 and FD01 that confirm the presence of lenses of fine-coarse sand at varying depths up to ~40 ft and thicknesses of 1-3 ft. The likely existence of coarser sediments may result in potential seepage issues that may result in remedial measurements such as the need for drains and/or cutoff walls. Thus, these proposed sites are designation as '**Fair**'. Site specific

investigation and analysis would be required to determine the presence and depths of the coarse soil lenses.

6. While **BC02** lies within the Wedron formation (Figure 4), NRCS soil maps designate this area as being comprised mostly of 'Houghton muck', (Figure 5) a soil unit that contains mostly peat and poorly drained organic sediments. This soft soil may lead to slope stability concerns that may require relatively flatter slope or the addition of engineered systems to support the required slopes. Thus, it is also given a designation of '**Fair**'. Site specific investigations and analysis would be required to determine the presence and depths of the soft soil layers.

7. Sites **DP38, DP40, DP41** (Figure 2-3), **DP34** (Figure 4-5), and **AC03** (Figure 6-7) and **DP07** (Figure 8) are located either partially or completely within the Mackinaw member of the Henry formation. The Mackinaw member has been mapped as glacial valley deposits and outwash terraces containing, 'Sand and gravel, generally well sorted and evenly bedded.' (Willman and Lineback, 1970). Additionally, there are 15 borings located 200-3000 ft. from the SE corner of the DP34 site within the mapped Mackinaw member that indicate consistent layers of fine-coarse sand at depth of ~1.5-30 ft. with thicknesses ranging from ~2.5-20 ft. NRCS soil maps also classify these areas as containing sandy material. The sand material at the site locations may result in groundwater control issues which may require remedial measurement implementations such as drains, cut-off walls, and/or dewatering pumps. Due to the likely presence of permeable sediments in these proposed sites and the potential issues of seepage they are designated as '**Poor**'. Site specific investigations and analysis will be required to identify the presence and depths of sand materials.

8. The following table provides a summary of the site suitability findings related to geotechnical considerations for the proposed site locations:

Site Location	**Material**	**Slope Stability**	**Seepage**	**Overall**
AC08	Clay, Silty Clay	Good	Good	Good
MD04	Clay, Silty Clay	Fair to Good	Good	Good
FD02	Clay, Silty Clay	Fair to Good	Good	Good
SC02	Clay, Silty Clay	Fair to Good	Good	Good
BC02	Peat/Muck, Clay, Silt	Poor	Fair to Poor	Fair
FD01	Clay, Silt, Sand, Gravel	Fair	Fair	Fair
FD03	Silt, Sand	Fair	Fair	Fair
DP23	Clay, Silt, Sand, Gravel	Fair	Fair	Fair
DP24	Clay, Silt, Sand, Gravel	Fair	Fair	Fair
DPRS57	Sand, Gravel, Clay, Silt	Fair	Fair	Fair
AC03	Sand, Gravel	Fair to Poor	Poor	Poor
DP07	Mostly Sand, Gravel	Fair to Poor	Poor	Poor
DP34	Mostly Sand, Gravel	Fair to Poor	Poor	Poor
DP38	Silty/Sandy, Gravel	Fair to Poor	Poor	Poor
DP40	Silty/Sandy, Gravel, Peat	Fair to Poor	Poor	Poor
DP41	Silty/Sandy, Gravel, Peat	Fair to Poor	Poor	Poor

Reference:
Willlman, H.B., Lineback, J.A., *Surficial Geology of the Chicago Region*, 1:250,000, Illinois State Geological Survey, 1970.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov. Accessed Jan 12, 2010

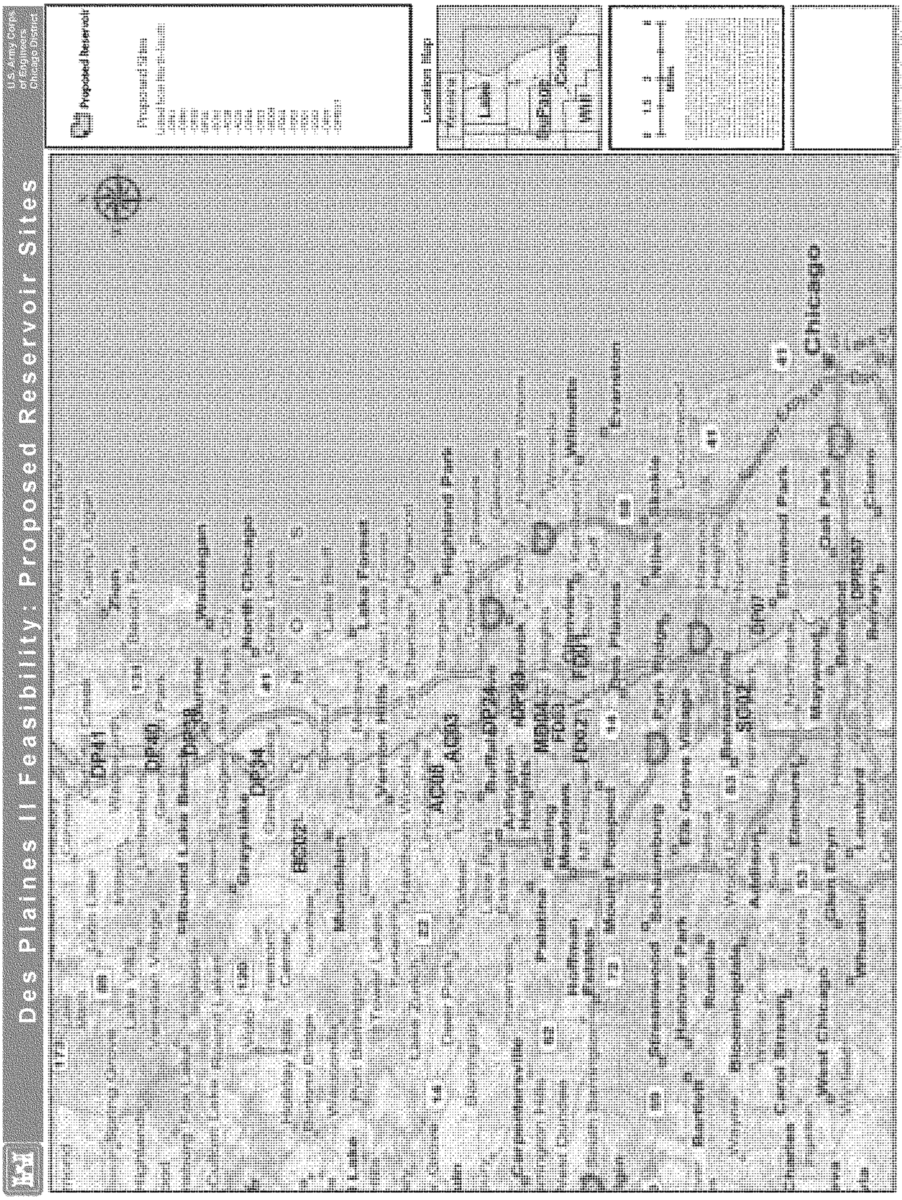


Figure 1: Location Map

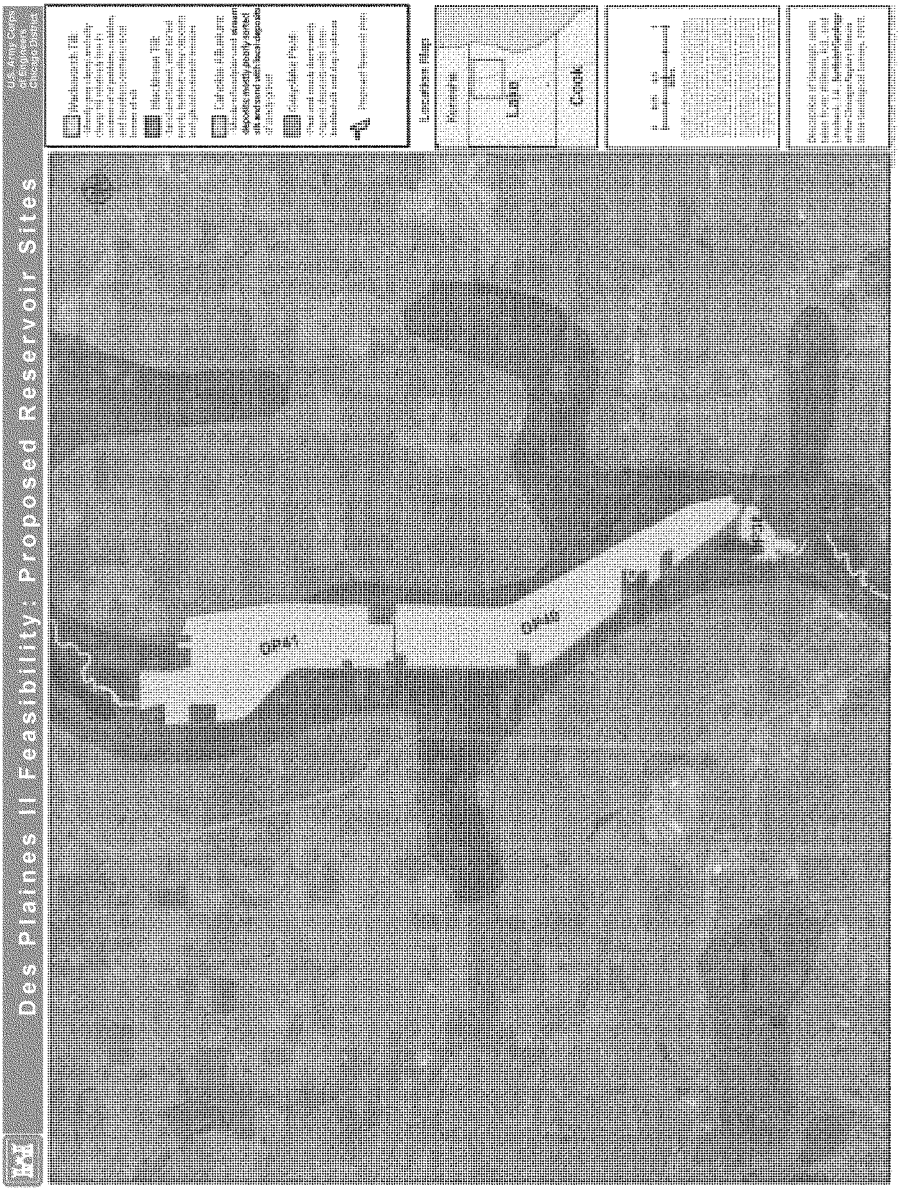


Figure 2: Surficial Geology Deposits

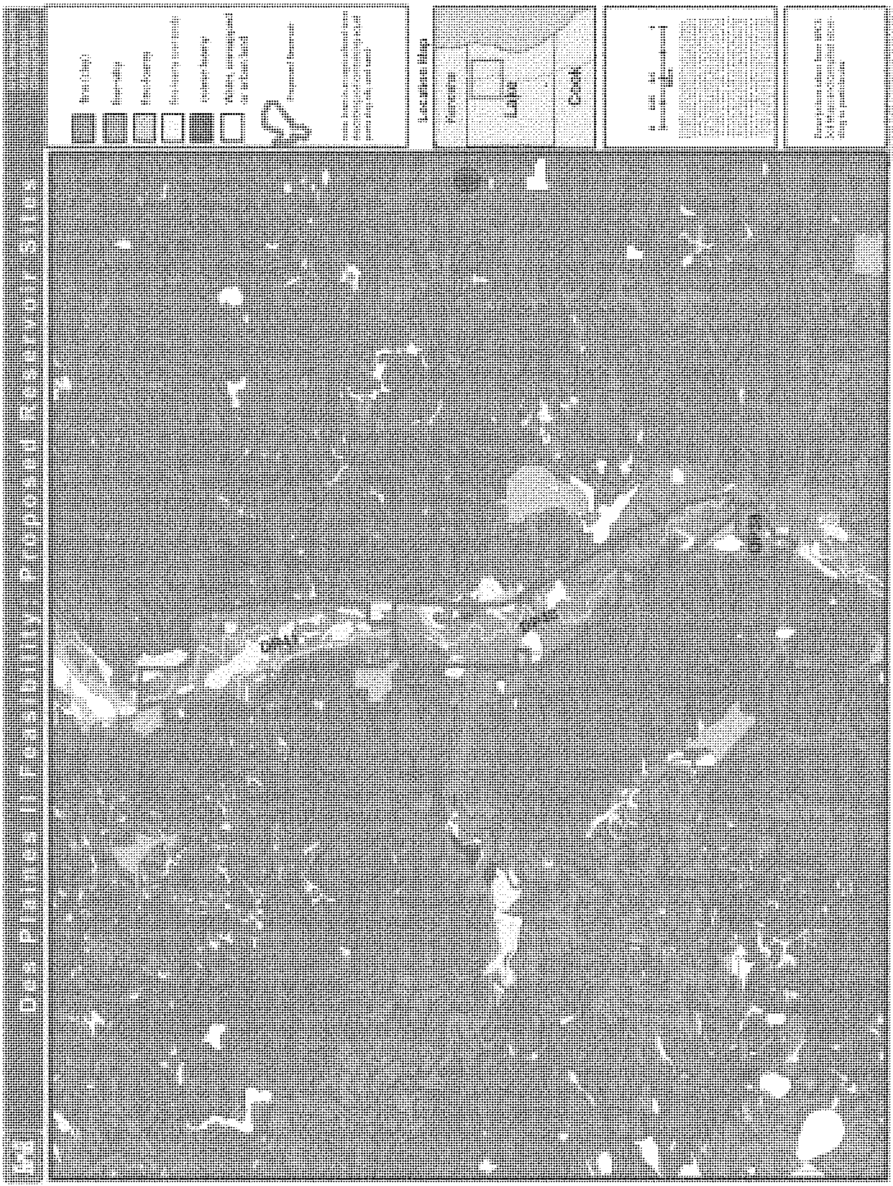


Figure 3: NRCS soil map

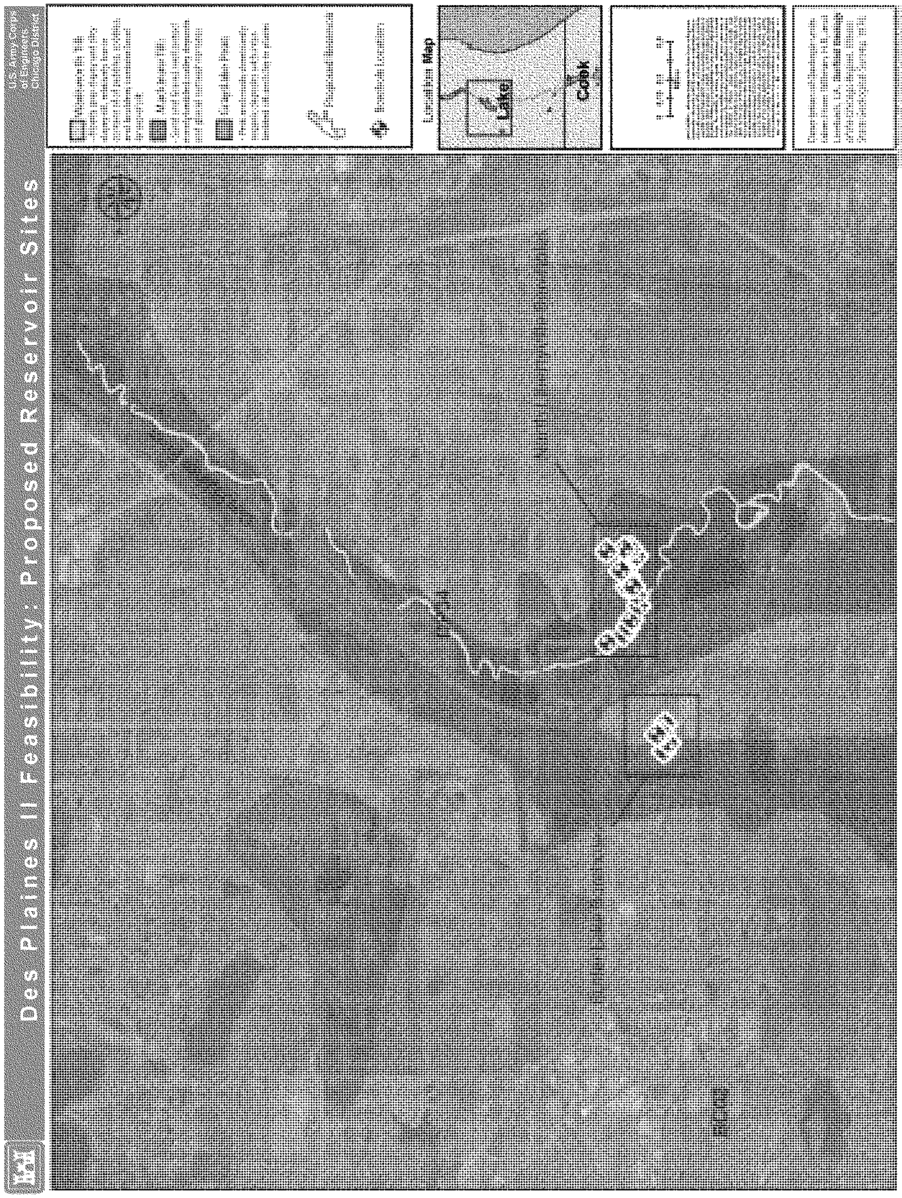


Figure 4: Surficial Geology Deposits

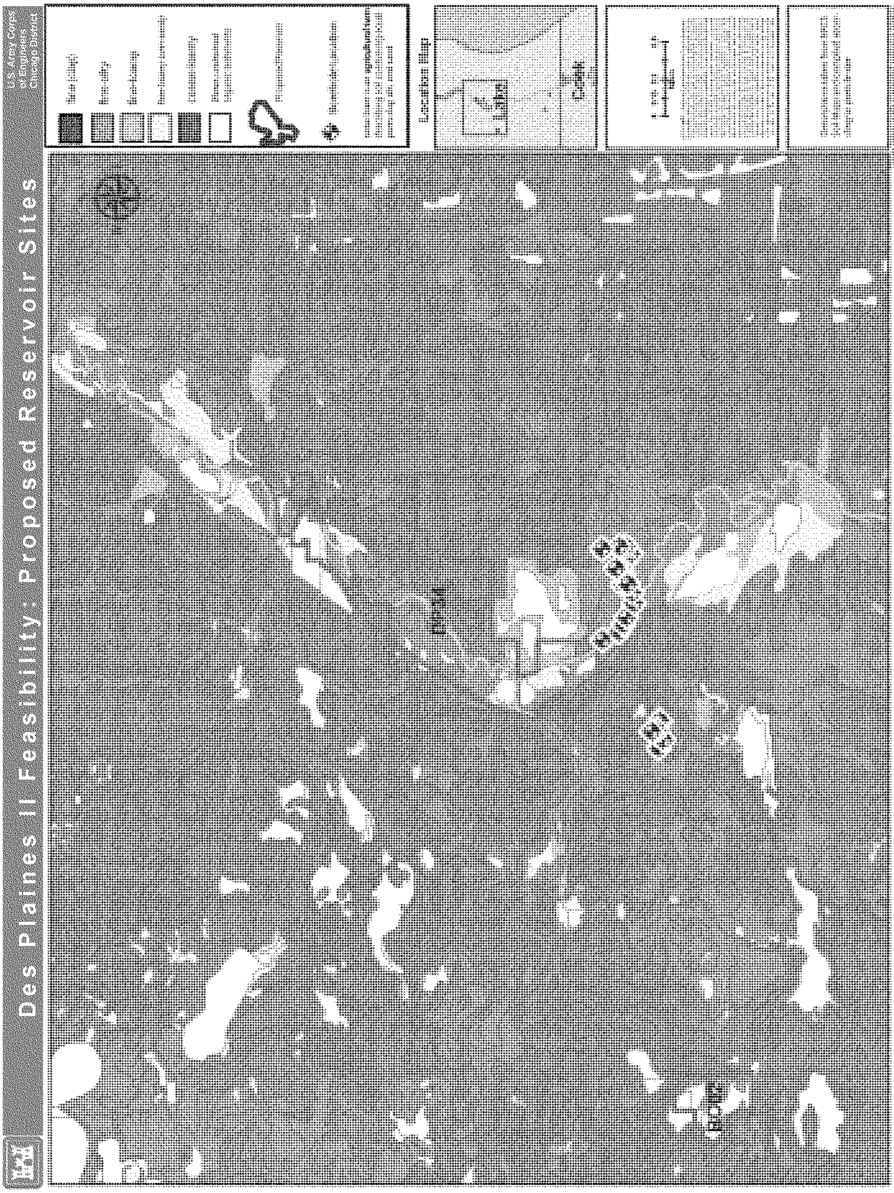


Figure 5: NRCS Soil map

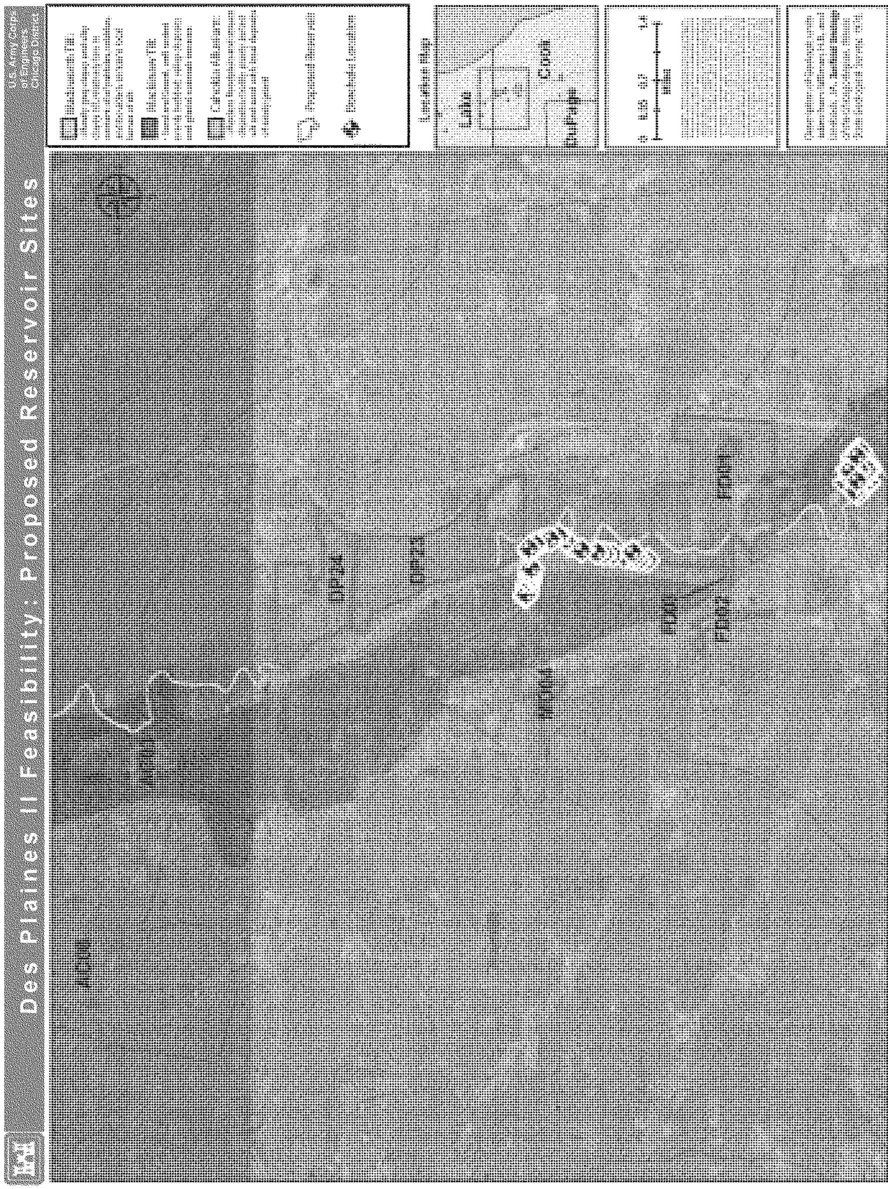


Figure 6: Surficial Geology Deposits

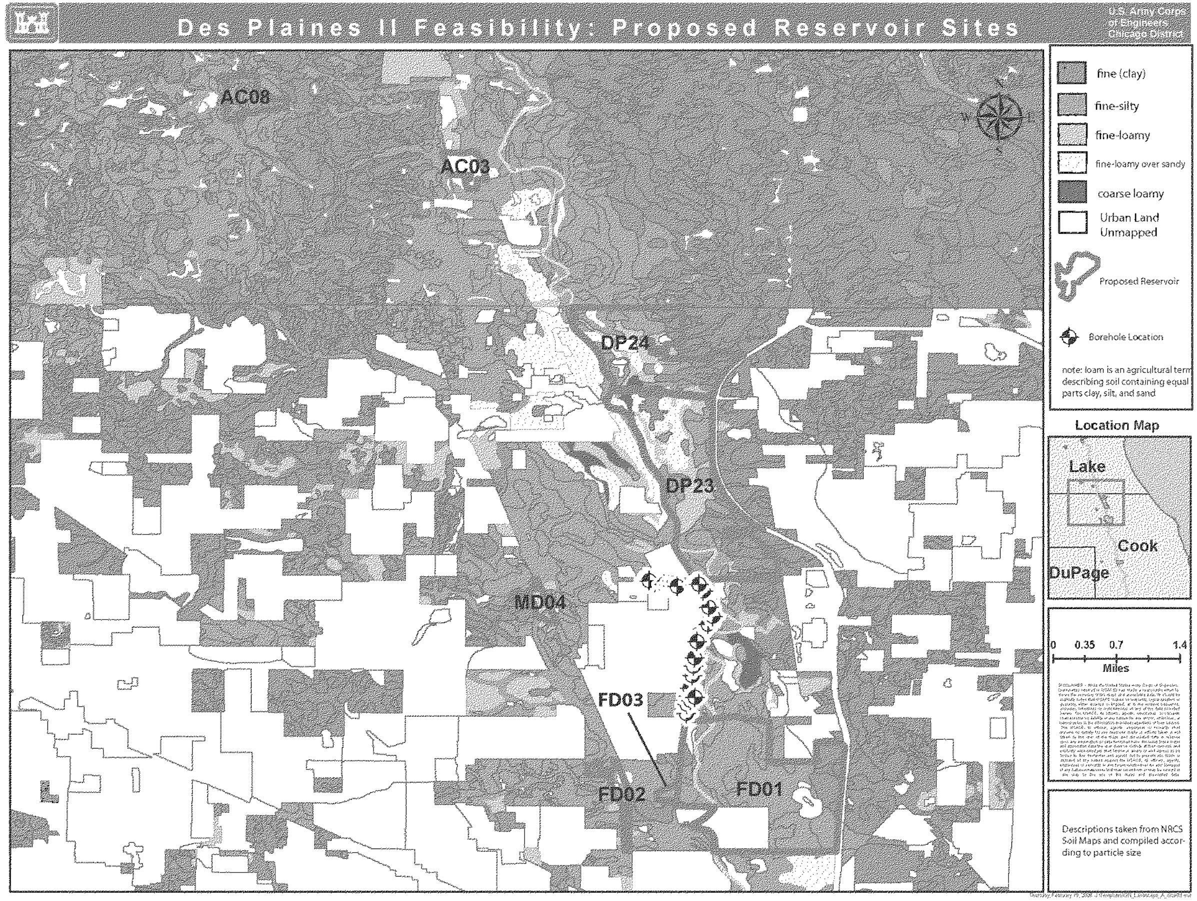


Figure 7: NRCS Soil Map

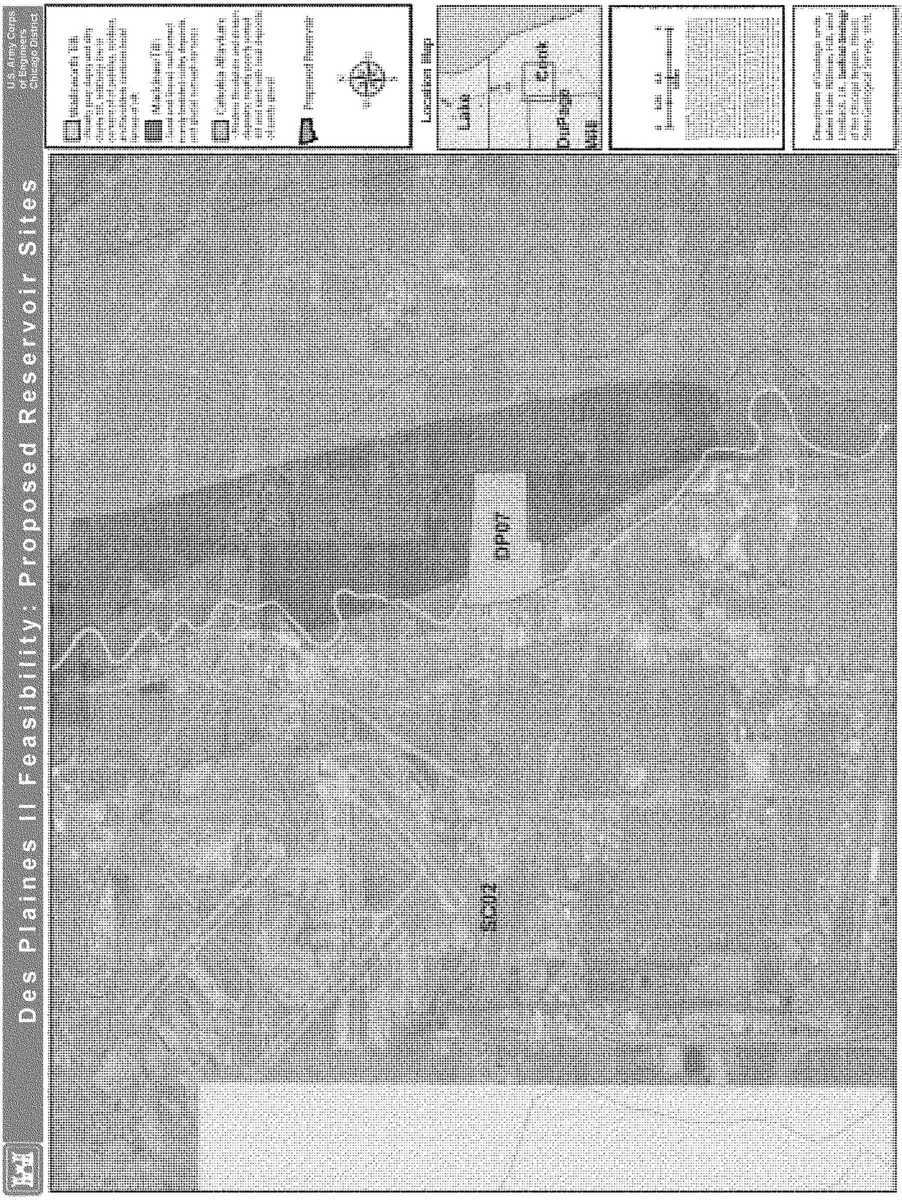


Figure 8: Surficial Geology Deposits

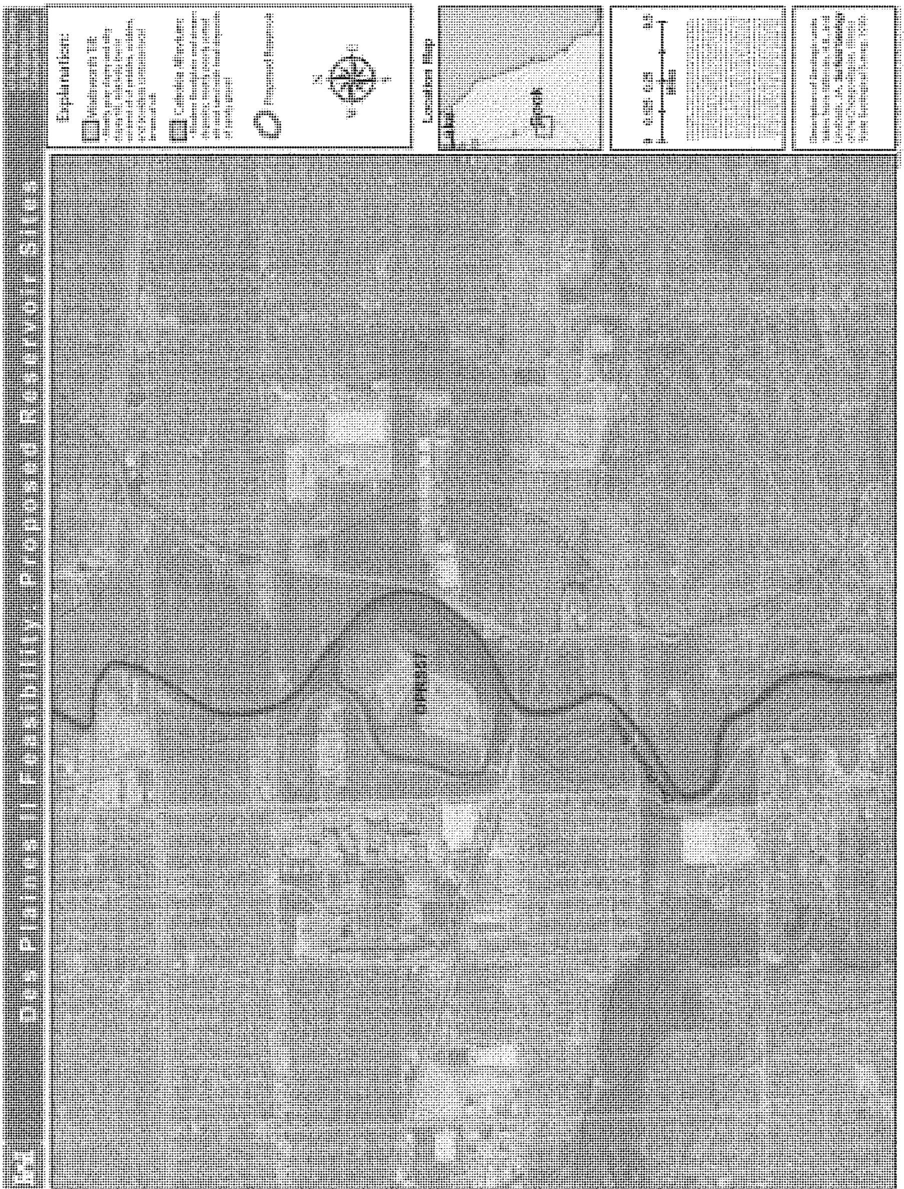
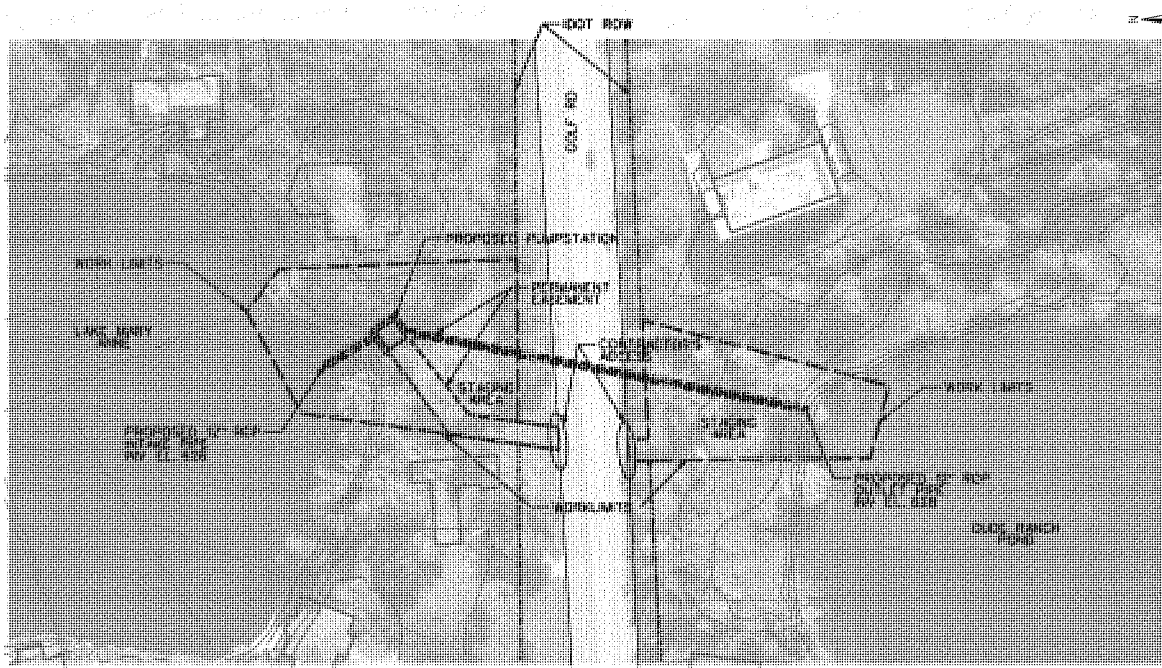


Figure 9: Surficial Geology Deposits

Upper Des Plaines River and Tributaries, Illinois and Wisconsin Integrated Feasibility Report and Environmental Assessment

Appendix D – Civil Design

ATTACHMENT D-3
PLATES



NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME. REFER TO THE CIVIL APPENDIX FOR THE SURVEY DATA SOURCES.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.

4. THE 12" RCP UNDER GOLF RD. WILL BE PLACED BY PIPE JACKING.

80 40 0 80 160

1 INCH = 80 FEET

U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

FPCI01 PUMPSTATION
CONCEPTUAL SITE PLAN
DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
AS SHOWN	MAR 2014	FPCI01_Site Plan.DGN

PLATE 17

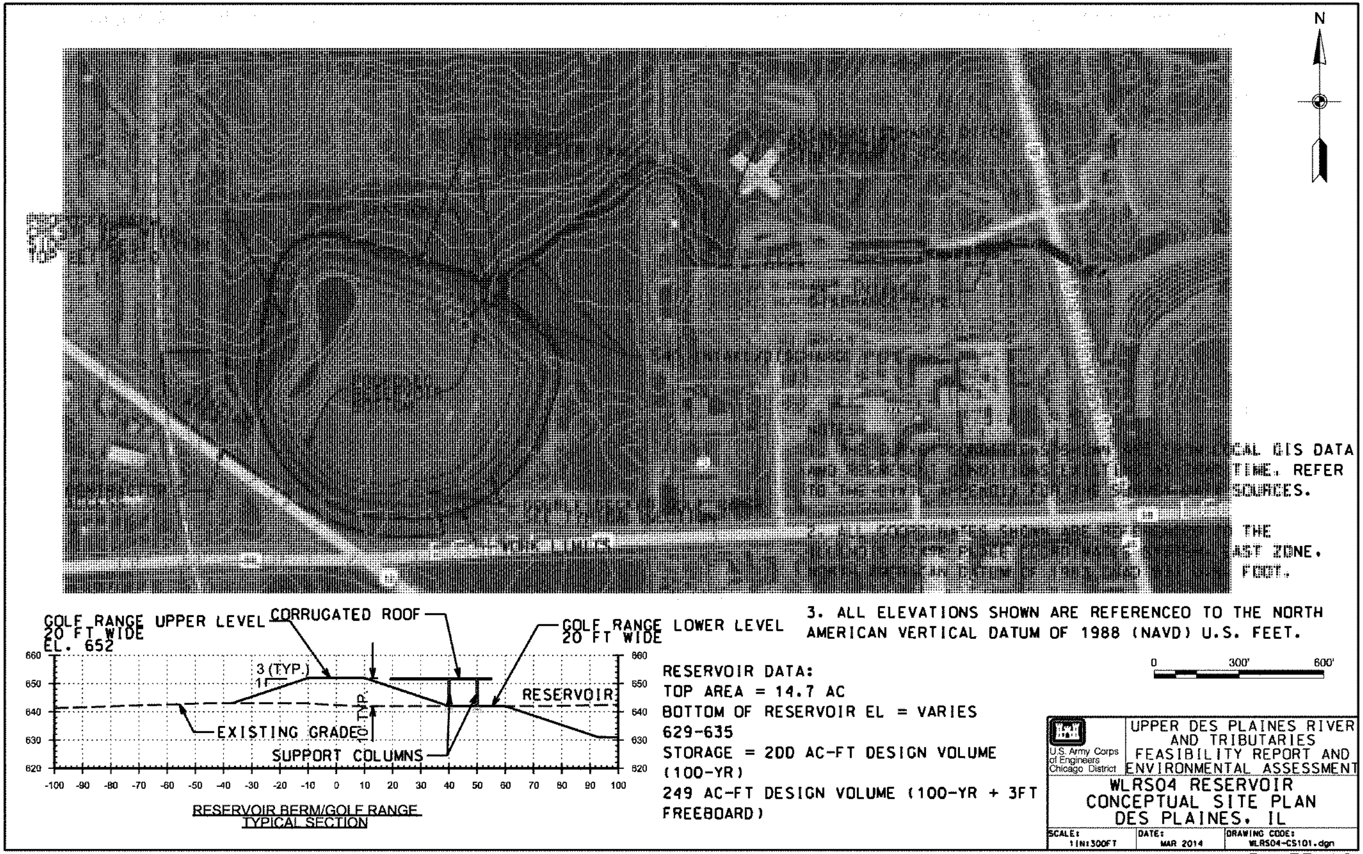

N
...AL GIS DATA
...TIME. REFER
...SOURCES.
... THE
...AST ZONE.
... FOOT.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD) U.S. FEET.
GOLF RANGE UPPER LEVEL 20 FT WIDE EL. 652
CORRUGATED ROOF
GOLF RANGE LOWER LEVEL 20 FT WIDE
3 (TYP.)
1
10' TYP.
RESERVOIR
EXISTING GRADE
SUPPORT COLUMNS
RESERVOIR BERM/GOLF RANGE TYPICAL SECTION
RESERVOIR DATA:
TOP AREA = 14.7 AC
BOTTOM OF RESERVOIR EL = VARIES 629-635
STORAGE = 200 AC-FT DESIGN VOLUME (100-YR)
249 AC-FT DESIGN VOLUME (100-YR + 3FT FREEBOARD)
0 300' 600'
U.S. Army Corps of Engineers Chicago District
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT
WLRS04 RESERVOIR CONCEPTUAL SITE PLAN DES PLAINES, IL
SCALE: 1IN:300FT
DATE: MAR 2014
DRAWING CODE: WLRS04-CS101.dgn

PLATE 18

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD 83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88) U.S. FEET.

4. THE PROPOSED FLOOD WALL LENGTH IS 3020 FEET, WHICH INCLUDES 500 OF RAISING AN EXISTING RETAINING WALL (STA. 2+0D TO 7+00). THE FLOODWALL TOP ELEVATION IS 634.6.

5. ONE ROAD CLOSURE STRUCTURE WILL BE NECESSARY TO COMPLETE THE LINE OF PROTECTION.

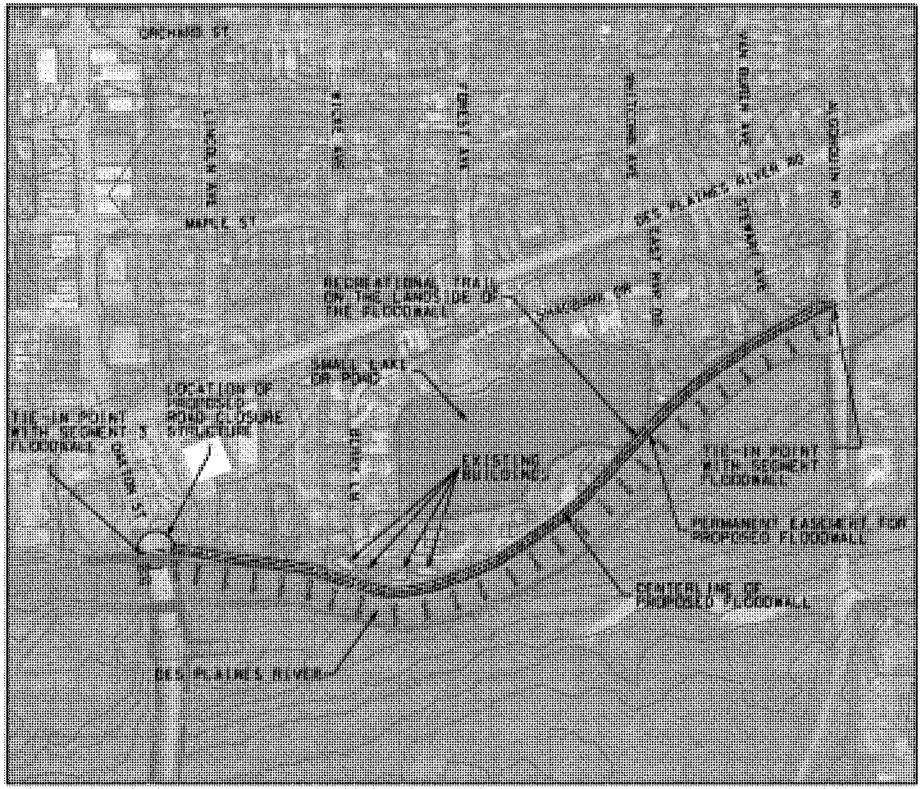
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

DPLV09SEG1 LEVEE
CONCEPTUAL SITE PLAN
DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
AS SHOWN	MAR 2014	DPLV09SEG1-CS101.dgn

PLATE 19A



N

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENTS CONDITIONS EXISTING AT THAT TIME.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM. EAST ZONE. NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
4. THE PROPOSED FLOODWALL IS 2,718 LF WITH AN ELEVATION OF 635.0 FT.
5. ONE ROAD CLOSURE STRUCTURE WILL BE NECESSARY TO COMPLETE THE LINE OF PROTECTION.
6. THIS SEGMENT OF FLOODWALL SHALL HAVE A PAVED RECREATIONAL TRAIL ALONG ITS ENTIRE LENGTH.

0 300' 600'

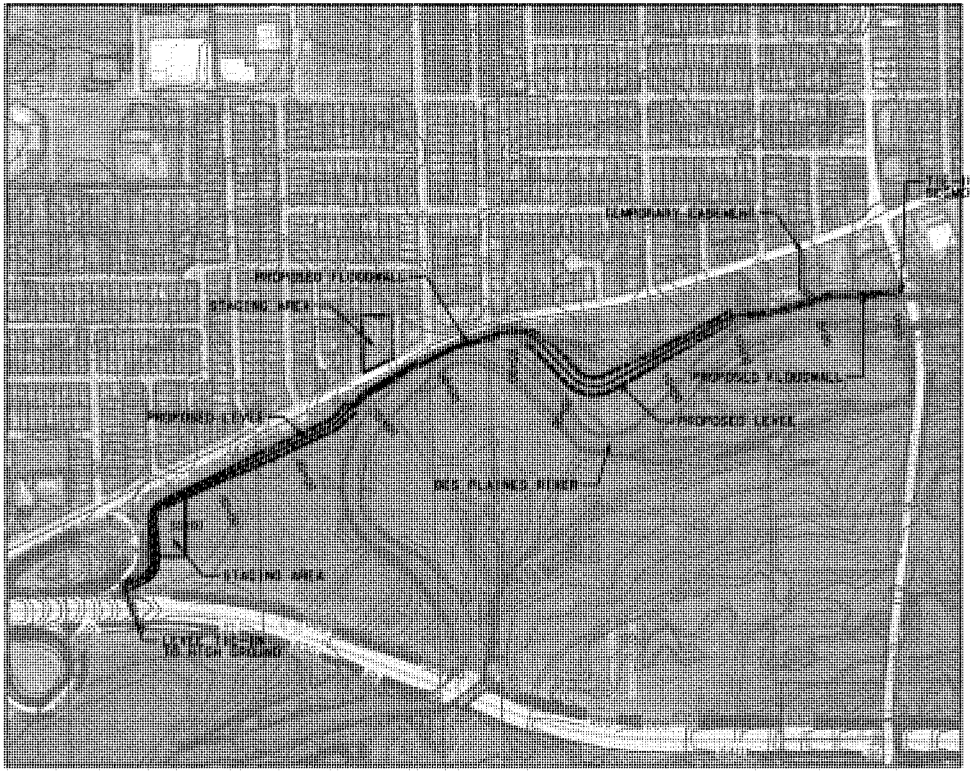
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

DPLV09 - SEGMENT 2
FLOODWALL SITE PLAN
DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
AS-SHOWN	MAR 2014	DPLV09_S2_Siteplan.dgn

PLATE 19B



NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD 83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88) U.S. FEET.

4. THE PROPOSED FLOOD WALL LENGTH IS 2200 FEET, AND LEVEE LENGTH IS 3250 FEET. TOP OF FLOODWALL/LEVEE: STA. 0+00 TO STA. 14+20, EL. 633.7; STA. 14+40 TO STA. 54+50, EL. 633.4.

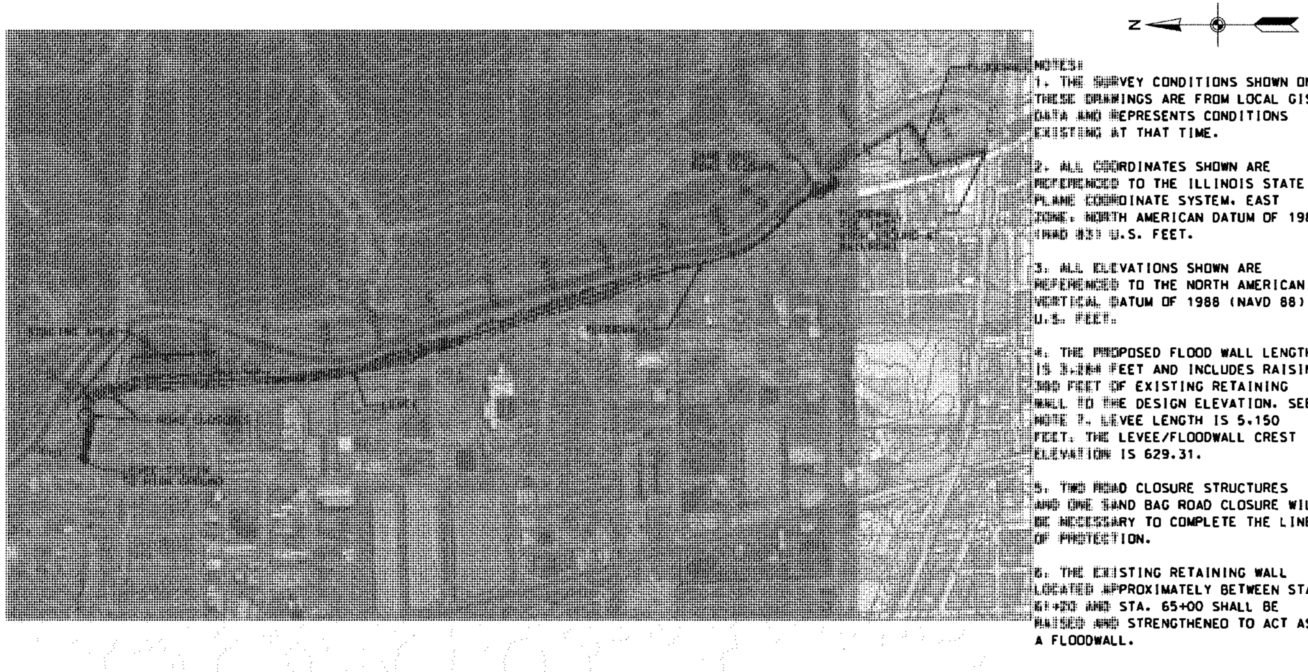
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

DPLV09SEG3 LEVEE
CONCEPTUAL SITE PLAN
DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
AS SHOWN	MAR 2014	DPLV09SEG3-CS101.dgn

PLATE 19C



NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENTS CONDITIONS EXISTING AT THAT TIME.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD 83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88) U.S. FEET.

4. THE PROPOSED FLOOD WALL LENGTH IS [illegible] FEET AND INCLUDES RAISING [illegible] FEET OF EXISTING RETAINING WALL TO THE DESIGN ELEVATION. SEE NOTE [illegible]. LEVEE LENGTH IS 5,150 FEET. THE LEVEE/FLOODWALL CREST ELEVATION IS 629.31.

5. TWO ROAD CLOSURE STRUCTURES AND ONE SAND BAG ROAD CLOSURE WILL BE NECESSARY TO COMPLETE THE LINE OF PROTECTION.

6. THE EXISTING RETAINING WALL LOCATED APPROXIMATELY BETWEEN STA. [illegible] AND STA. 65+00 SHALL BE RAISED AND STRENGTHENED TO ACT AS A FLOODWALL.

0 700' 1400'

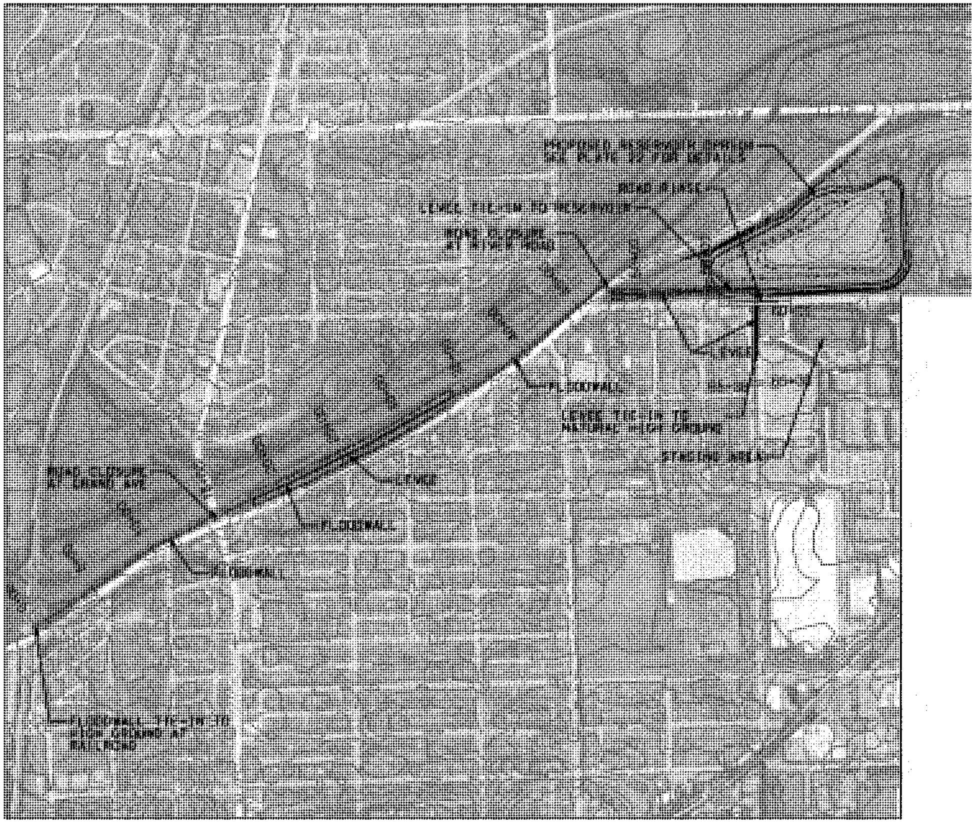
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

OPLV05 LEVEE
CONCEPTUAL SITE PLAN
SCHILLER PARK & FRANKLIN PARK,
COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
AS SHOWN	MAR 2014	OPLV05-CS101.DGN

PLATE 20



PLAN VIEW

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD 83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88) U.S. FEET.

4. THE PROPOSED FLOOD WALL LENGTH IS 3134 FEET AND LEVEE LENGTH IS 3031 FEET. THE FLOODWALL/LEVEE CREST ELEVATION IS 628.39.

5. TWO ROAD CLOSURE STRUCTURES WILL BE NECESSARY TO COMPLETE THE LINE OF PROTECTION. THE ROAD WILL BE RAISED AT 5TH AVE.

6. THE LEVEE AT THE SOUTH END WILL TIE INTO THE PROPOSED RESERVOIR (DPRSO4). SEE PLATE 22 FOR DETAILS OF THE RESERVOIR.

0 600' 1200'

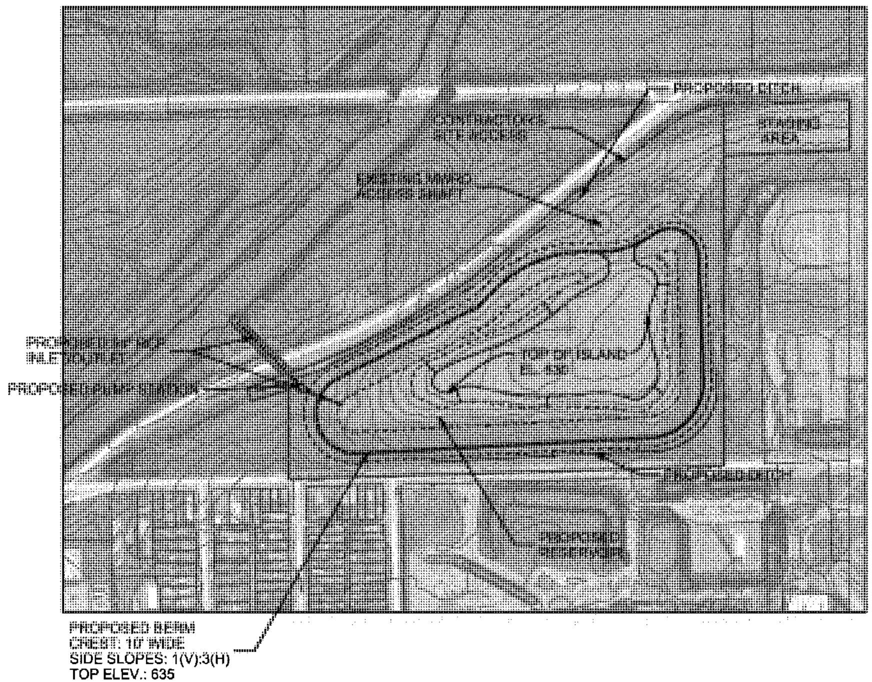
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

DPLV04 LEVEE
CONCEPTUAL SITE PLAN
RIVER GROVE, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
AS SHOWN	MAR 2014	DPLV04-CS101.DGN

PLATE 21



N

RESERVOIR DATA

TOP AREA = 16.5 AC
BOTTOM OF RESERVOIR EL. = 611.5
STORAGE = 150 AC-FT DESIGN VOLUME (100-YR)
200 AC-FT VOLUME (100-YR + 3FT FREEBOARD)

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS AT THAT TIME. REFER TO THE CIVIL APPENDIX FOR THE SURVEY DATA SOURCES.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLAN COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD) US FEET.

4. THE EXISTING MWRD ACCESS SHAFT SHALL BE PROTECTED.

0 300' 600'

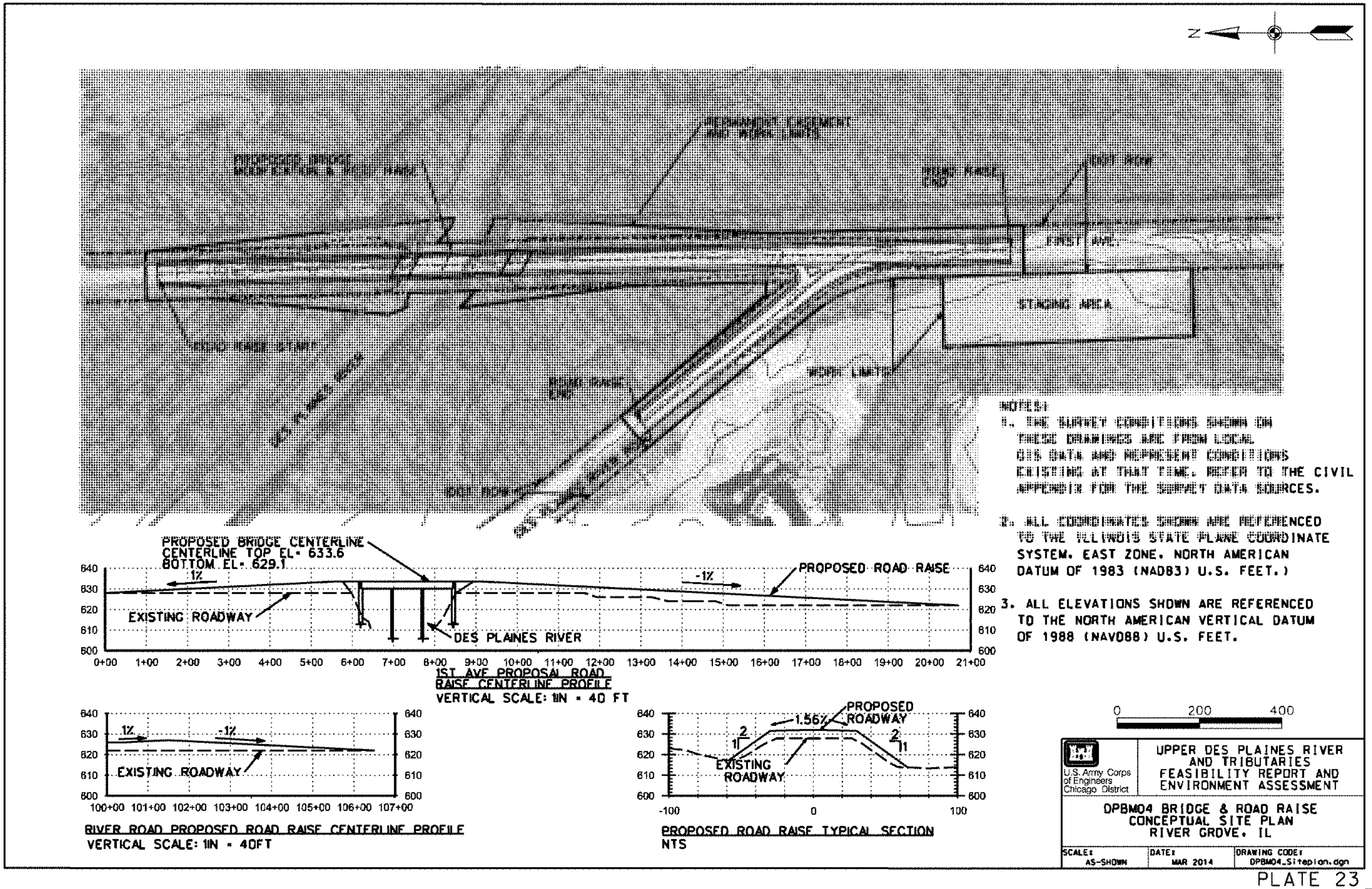
U.S. Army Corps of Engineers Chicago District

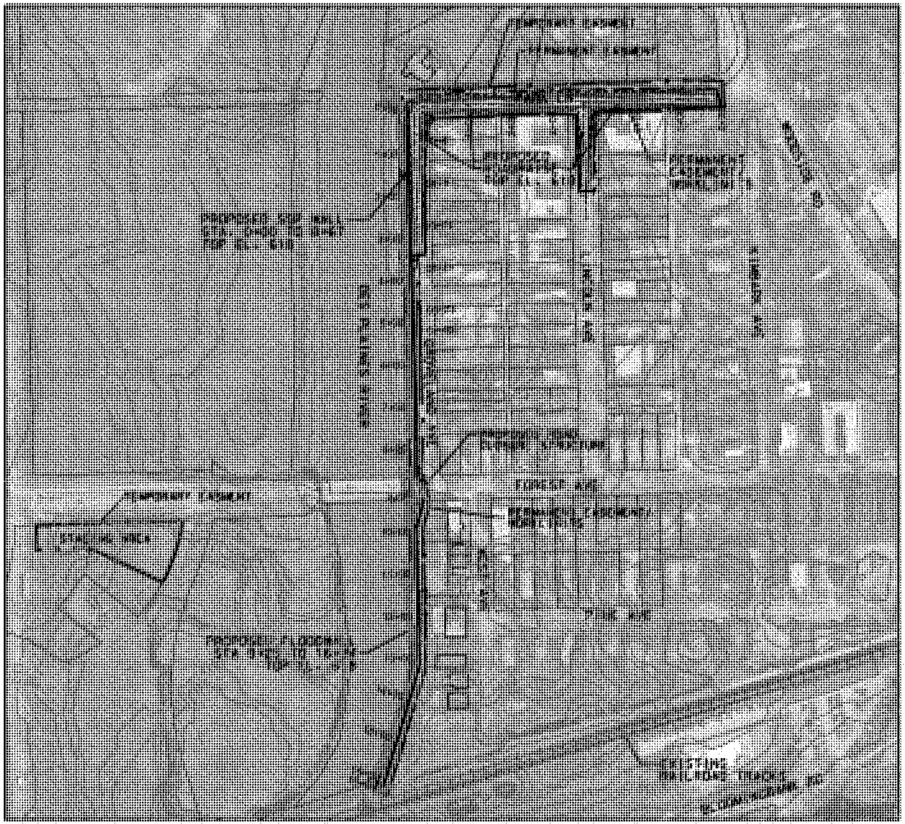
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

DPRS04 RESERVOIR CONCEPTUAL SITE PLAN RIVER GROVE, IL

SCALE:	DATE:	DRAWING CODE:
1" = 300'	MAR 2014	DPRS04_Siteplan.DGN

PLATE 22


N
NOTES:
1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME. REFER TO THE CIVIL APPENDIX FOR THE SURVEY DATA SOURCES.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.)
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
PROPOSED BRIDGE CENTERLINE
CENTERLINE TOP EL= 633.6
BOTTOM EL= 629.1
1%
-1%
PROPOSED ROAD RAISE
EXISTING ROADWAY
DES PLAINES RIVER
1ST AVE PROPOSAL ROAD RAISE CENTERLINE PROFILE
VERTICAL SCALE: 1IN = 40 FT
RIVER ROAD PROPOSED ROAD RAISE CENTERLINE PROFILE
VERTICAL SCALE: 1IN = 40FT
PROPOSED ROADWAY
1.56%
EXISTING ROADWAY
PROPOSED ROAD RAISE TYPICAL SECTION
NTS
0 200 400
U.S. Army Corps of Engineers Chicago District
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT
DPBM04 BRIDGE & ROAD RAISE CONCEPTUAL SITE PLAN RIVER GROVE, IL
SCALE: AS-SHOWN
DATE: MAR 2014
DRAWING CODE: DPBM04_Siteplan.dgn
PLATE 23



NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.

4. STEEL SHEET PILE WILL BE DRIVEN INTO THE EXISTING LEVEE ALONG GROVELAND AVE. TO RAISE THE TOP ELEVATION TO 618. THE LENGTH OF SHEET PILE IS 867 LF.

5. THE PROPOSED FLOODWALL ON THE SOUTH SIDE OF FOREST AVE HAS A LENGTH OF 699 LF AND TOP ELEVATION OF 618.

6. THE PROPOSED ROADRAISE HAS A TOP ELEVATION OF 618 AND SIDE SLOPES OF 1(V):2(H).

7. ONE ROAD CLOSURE STRUCTURE WILL BE REQUIRED AT FOREST AVE TO CONTINUE THE LINE OF FLOOD PROTECTION.

N

200' 100' 0 200'

SCALE: 1'' = 200'-0"

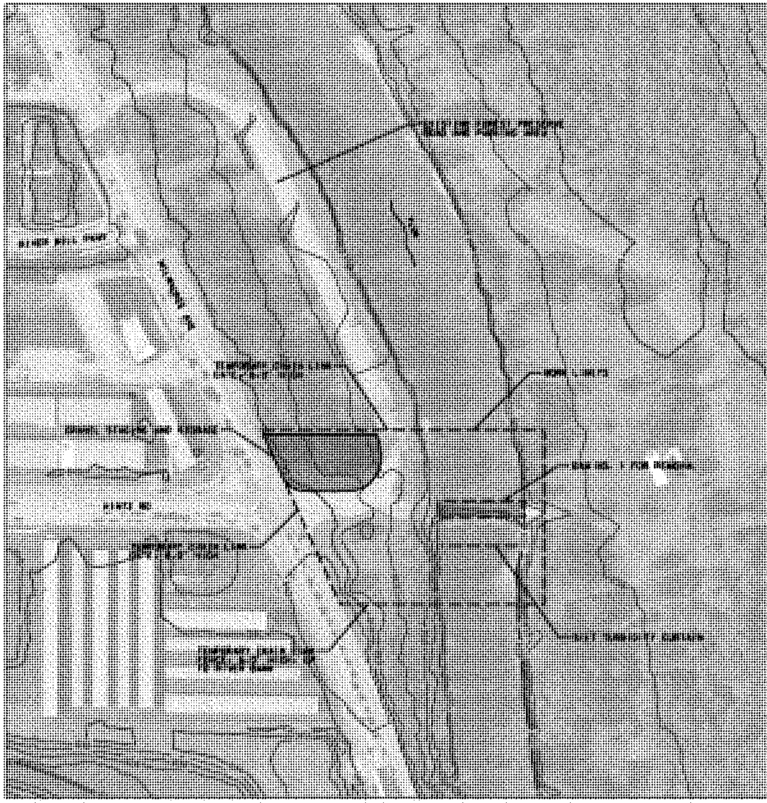
U.S. Army Corps of Engineers Chicago District

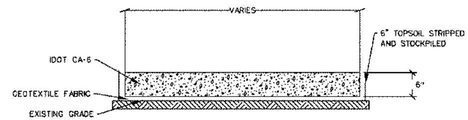
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

DPLV01 FLOODWALL
CONCEPTUAL SITE PLAN
RIVERSIDE , COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
1" = 200'	MAR 2014	DPLV01_Siteplan.dgn

PLATE 24

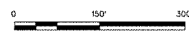




DAM NO. 1 GRAVEL STAGING & STORAGE (TYP)
N.T.S.

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
4. STAGING AND STORAGE AREAS SHALL BE CONSTRUCTED AS SHOWN ON TYPICAL SECTION.
5. ALL GRAVEL AND GEOTEXTILE FABRIC SHALL BE REMOVED AFTER DEMOLITION ACTIVITIES ARE COMPLETED AND PROPERLY DISPOSED.
6. STRIPPED TOPSOIL SHALL BE REPLACED AND THE ACCESS ROAD AND STAGING/STORAGE AREA SHALL BE RESTORED TO PRE-CONSTRUCTION CONDITION.
7. AT A MINIMUM CLEARING AND GRUBBING SHALL TAKE PLACE ON THE AREA COVERED BY THE TEMPORARY GRAVEL ACCESS ROAD AND STAGING/STORAGE AREA TO ALLOW THE CONTRACTOR ACCESS TO THE DAM.



SCALE:1"=150'

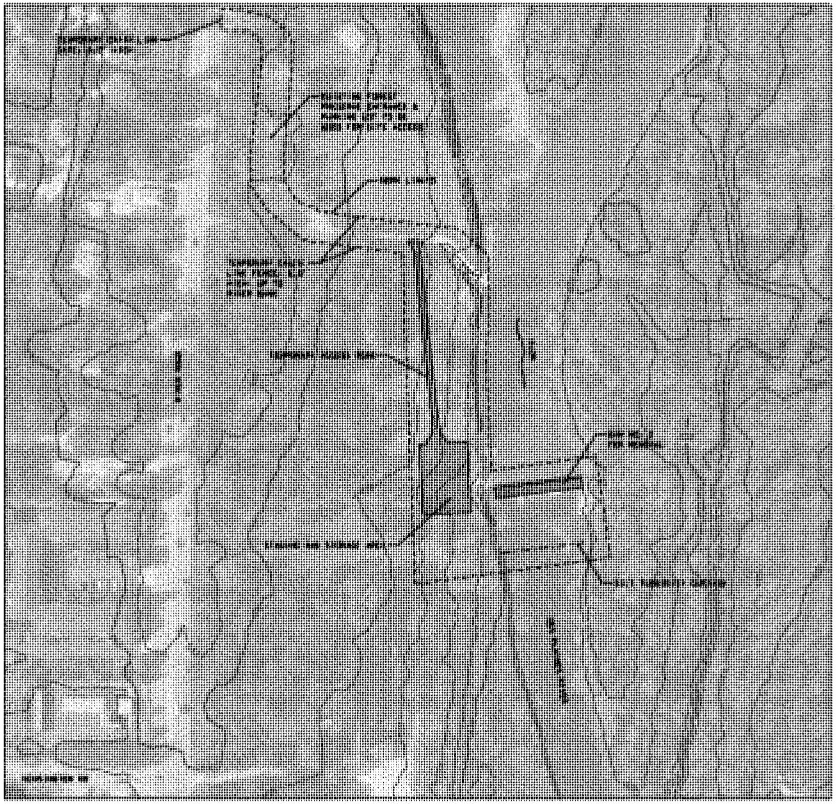
U.S. Army Corps of Engineers Chicago District

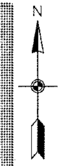
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

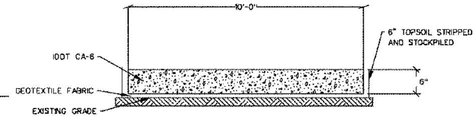
DAM NO. 1 REMOVAL SITE PLAN
WHEELING, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
1" = 150'-0"	MAR 2014	DAM_NO_1_SITE_PLAN.DGN

PLATE 36

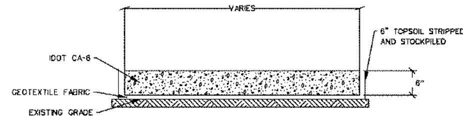






DAM NO. 2 GRAVEL ACCESS ROAD (TYP)

N.T.S.

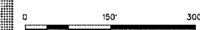


DAM NO. 2 GRAVEL STAGING & STORAGE (TYP)

N.T.S.

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENTS CONDITIONS EXISTING AT THAT TIME.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
4. STAGING AND STORAGE AREAS SHALL BE CONSTRUCTED AS SHOWN ON TYPICAL SECTION
5. ALL GRAVEL AND GEOTEXTILE FABRIC SHALL BE REMOVED AFTER DEMOLITION ACTIVITIES ARE COMPLETED AND PROPERLY DISPOSED.
6. STRIPPED TOPSOIL SHALL BE REPLACED AND THE ACCESS ROAD AND STAGING/STORAGE AREA SHALL BE RESTORED TO PRE-CONSTRUCTION CONDITION.
7. AT A MINIMUM CLEARING AND GRUBBING SHALL TAKE PLACE ON THE AREA COVERED BY THE TEMPORARY GRAVEL ACCESS ROAD AND STAGING/STORAGE AREA TO ALLOW THE CONTRACTOR ACCESS TO THE DAM.



SCALE:1"=150'

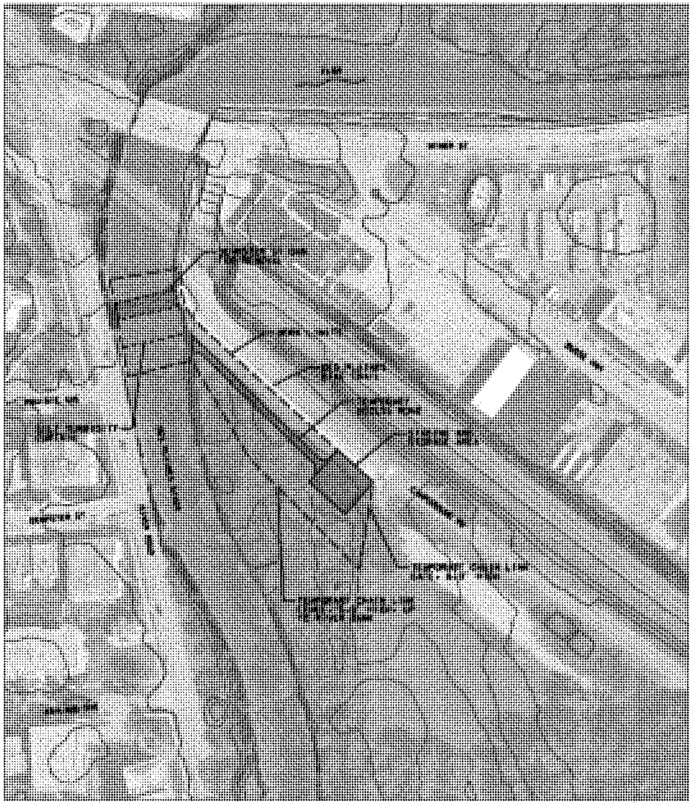
U.S. Army Corps of Engineers Chicago District

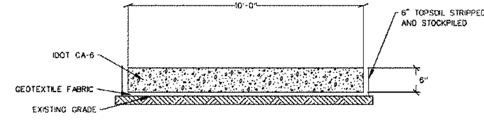
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIROMENTAL ASSESSMENT

DAM NO. 2 REMOVAL SITE PLAN
MOUNT PROSPECT, COOK COUNTY, IL

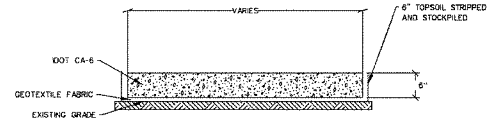
SCALE:	DATE:	DRAWING CODE:
1" = 150'- 0"	MAR 2014	DAM_NO_2_SITE_PLAN.DGN

PLATE 37





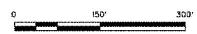
DEMPSTER ST. DAM GRAVEL ACCESS ROAD (TYP)
N.T.S.



DEMPSTER ST. DAM GRAVEL STAGING & STORAGE (TYP)
N.T.S.

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
4. STAGING AND STORAGE AREAS SHALL BE CONSTRUCTED AS SHOWN ON TYPICAL SECTION.
5. ALL GRAVEL AND GEOTEXTILE FABRIC SHALL BE REMOVED AFTER DEMOLITION ACTIVITIES ARE COMPLETED AND PROPERLY DISPOSED.
6. STRIPPED TOPSOIL SHALL BE REPLACED AND THE ACCESS ROAD AND STAGING/STORAGE AREA SHALL BE RESTORED TO PRE-CONSTRUCTION CONDITION.
7. AT A MINIMUM CLEARING AND GRUBBING SHALL TAKE PLACE ON THE AREA COVERED BY THE TEMPORARY GRAVEL ACCESS ROAD AND STAGING/STORAGE AREA TO ALLOW THE CONTRACTOR ACCESS TO THE DAM.



SCALE:1"=150'

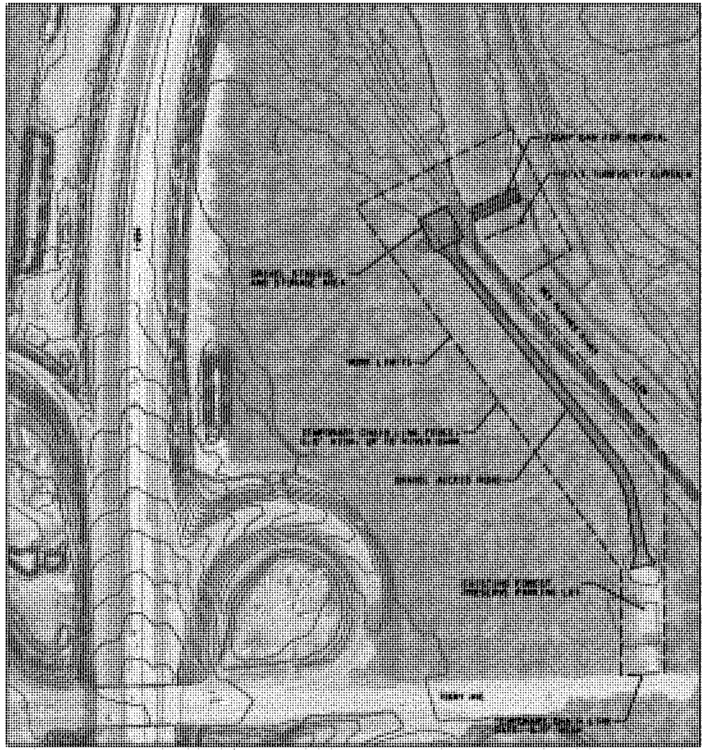
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

DEMPSTER ST. DAM REMOVAL SITE PLAN
DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
1" = 150'- 0"	MAR 2014	DEMPSTER_DAM_SITE_PLAN.DGN

PLATE 38



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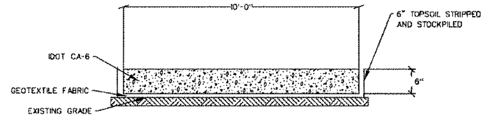
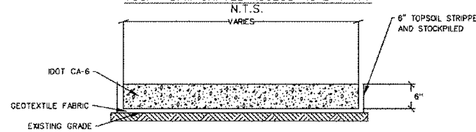


TOUHY DAM GRAVEL ACCESS ROAD (TYP)
N.T.S.



TOUHY DAM GRAVEL STAGING & STORAGE (TYP)
N.T.S.

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
4. STAGING AND STORAGE AREAS SHALL BE CONSTRUCTED AS SHOWN ON TYPICAL SECTION.
5. ALL GRAVEL AND GEOTEXTILE FABRIC SHALL BE REMOVED AFTER DEMOLITION ACTIVITIES ARE COMPLETED AND PROPERLY DISPOSED.
6. STRIPPED TOPSOIL SHALL BE REPLACED AND THE ACCESS ROAD AND STAGING/STORAGE AREA SHALL BE RESTORED TO PRE-CONSTRUCTION CONDITION.
7. AT A MINIMUM CLEARING AND GRUBBING SHALL TAKE PLACE ON THE AREA COVERED BY THE TEMPORARY GRAVEL ACCESS ROAD AND STAGING/STORAGE AREA TO ALLOW THE CONTRACTOR ACCESS TO THE DAM.

0 200' 400'
SCALE:1"=200'

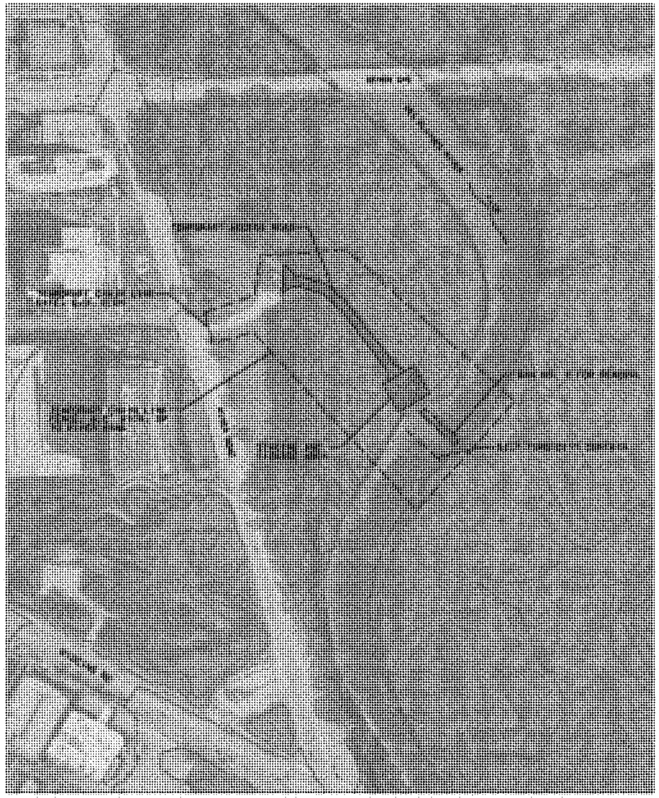
U.S. Army Corps of Engineers Chicago District

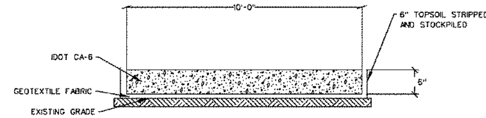
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

TOUHY DAM REMOVAL SITE PLAN
DES PLAINES, COOK COUNTY, IL

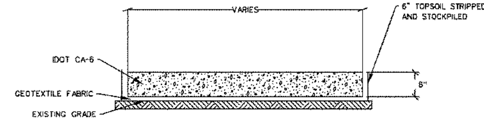
SCALE:	DATE:	DRAWING CODE:
1" = 200'- 0"	MAR 2014	TOUHY_DAM_SITE_PLAN.DGN

PLATE 39





DAM NO. 4 GRAVEL ACCESS ROAD (TYP)
N.T.S.



DAM NO. 4 GRAVEL STAGING & STORAGE (TYP)
N.T.S.

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS EXISTING AT THAT TIME.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
4. STAGING AND STORAGE AREAS SHALL BE CONSTRUCTED AS SHOWN ON TYPICAL SECTION.
5. ALL GRAVEL AND GEOTEXTILE FABRIC SHALL BE REMOVED AFTER DEMOLITION ACTIVITIES ARE COMPLETED AND PROPERLY DISPOSED.
6. STRIPPED TOPSOIL SHALL BE REPLACED AND THE ACCESS ROAD AND STAGING/STORAGE AREA SHALL BE RESTORED TO PRE-CONSTRUCTION CONDITION.
7. AT A MINIMUM CLEARING AND GRUBBING SHALL TAKE PLACE ON THE AREA COVERED BY THE TEMPORARY GRAVEL ACCESS ROAD AND STAGING/STORAGE AREA TO ALLOW THE CONTRACTOR ACCESS TO THE DAM.

0 200' 400'
SCALE:1"=200'

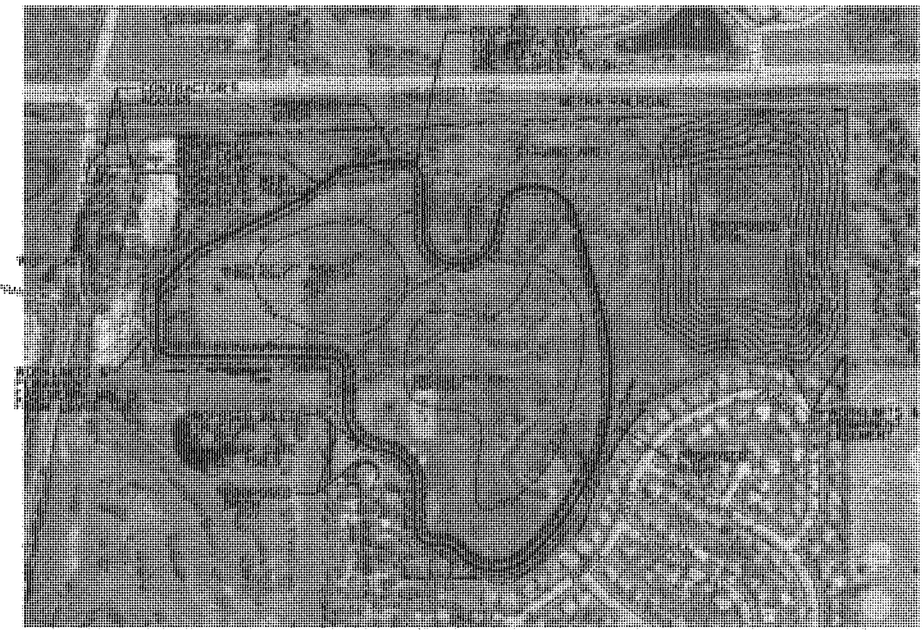
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

DAM NO. 4 REMOVAL SITE PLAN
DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
1" - 200'- 0"	MAR 2014	DAM_NO_4_SITE_PLAN.DGN

PLATE 40



RESERVOIR DATA

TOP AREA = 53 AC
BOTTOM AREA = 47.5 AC
RETENSION STORAGE = 177 AC-FT
DETENSION STORAGE = 166 AC-FT
(OVERFLOW)

OUTFLOW FLOW - 100 CFS

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM A LOCAL GIS DATA AND REPRESENTS CONDITIONS EXISTING AT THAT TIME. REFER TO THE CIVIL APPENDIX FOR THE SURVEY DATA SOURCES.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.)
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
4. PROPOSED SSP CUTOFF WALL WILL BE 20 FT DEEP AND APPROXIMATELY 330 FT LONG.

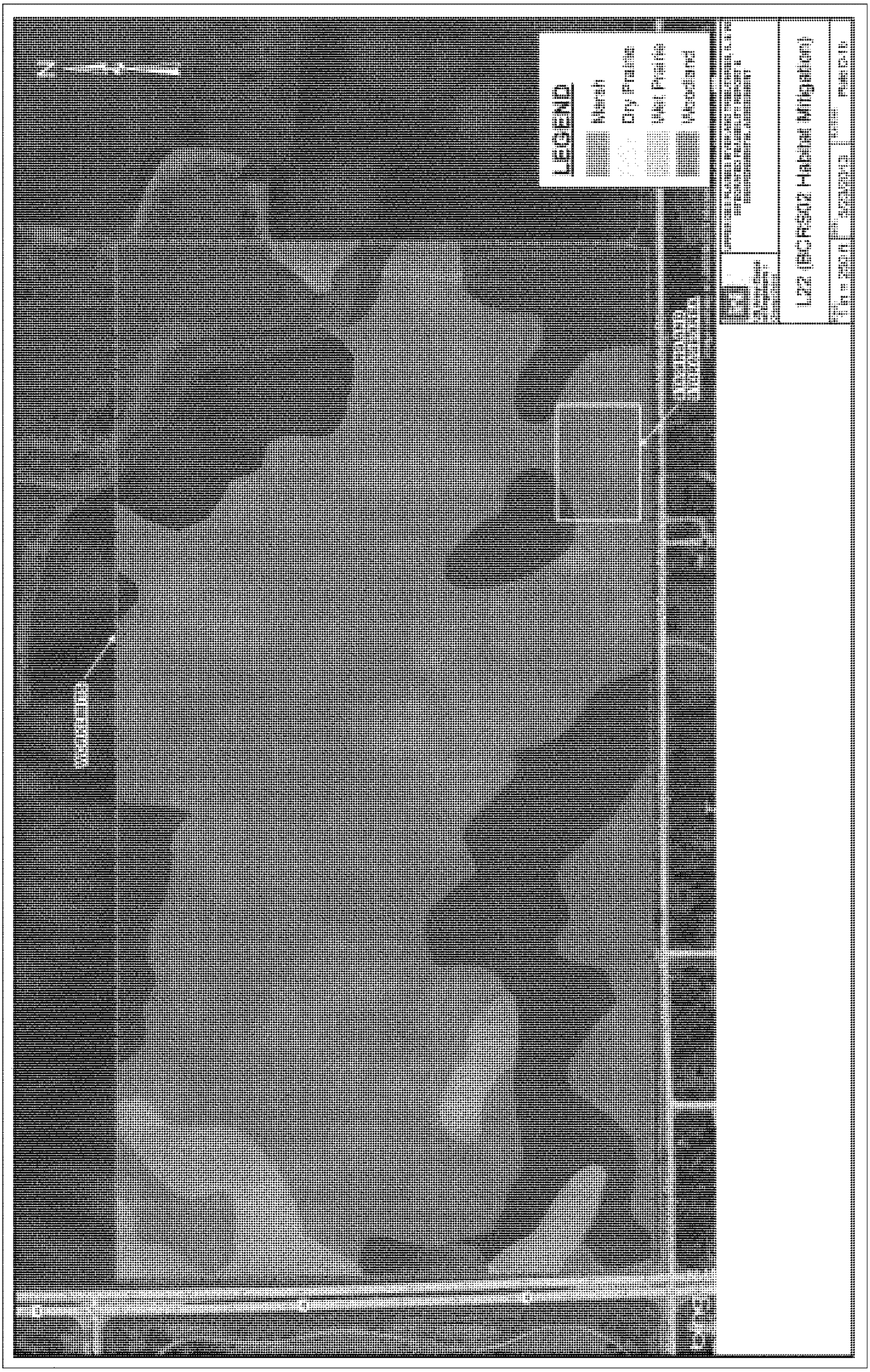
U.S. Army Corps of Engineers Chicago District

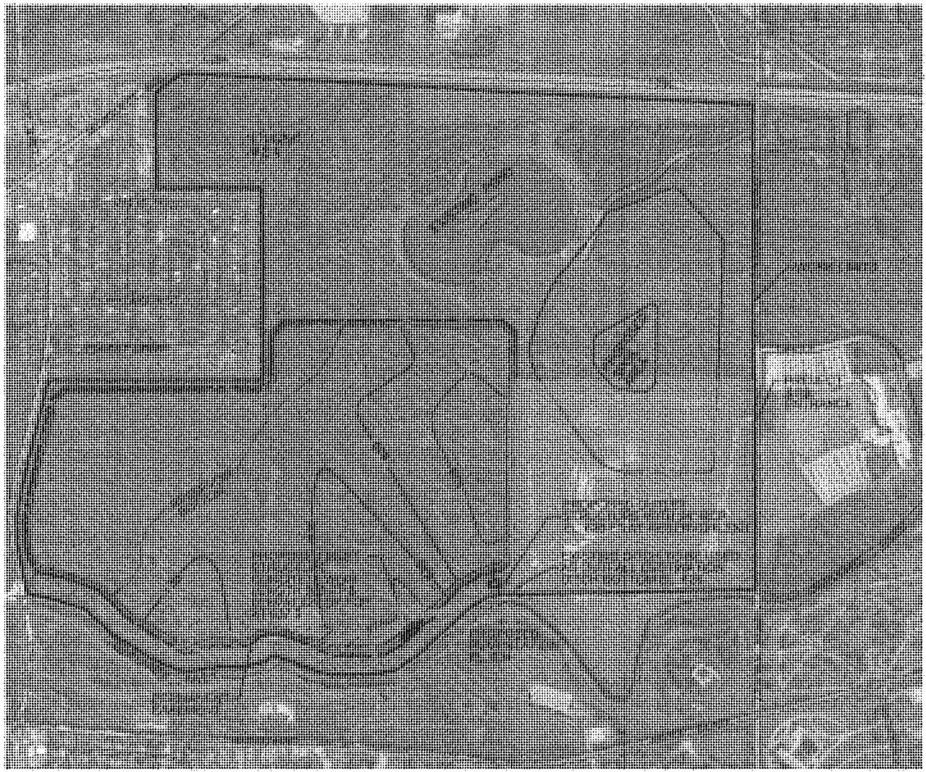
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

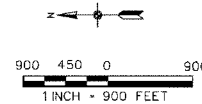
BCRS02 RESERVOIR
CONCEPTUAL SITE PLAN
MUNDELEIN, LAKE COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
1 IN:400FT	MAR 2014	BCRS02_SITE PLAN.DGN

PLATE D-1a


LEGEND
Marsh
Dry Prairie
Wet Prairie
Woodland





RESERVOIR DATA

TOP AREA = 322 AC
BOTTOM AREA = 312 AC
STORAGE = 2140.9 AC-FT
INFLOW = 200 CFS

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM A LOCAL GIS DATA AND REPRESENTS CONDITIONS EXISTING AT THAT TIME. REFER TO THE CIVIL APPENDIX FOR THE SURVEY DATA SOURCE.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.)
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
4. BASED ON THE SURFICIAL GEOLOGY AND NRCS SOIL MAPS, CUTOFF WALL WILL BE PLACED ALONG THE PERIMETER OF THE RESERVOIR. FURTHER INVESTIGATIONS ARE REQUIRED FOR THE LOCATIONS AND DESIGN OF THE CUTOFF WALL.

U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

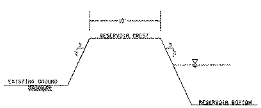
FDRS01 RESERVOIR
CONCEPTUAL SITE PLAN
MT. PROSPECT, COOK CTY, IL

SCALE:	DATE:	DRAWING CODE:
1" = 900'	MAR 2014	FDRS01_Siteplan.dgn

PLATE D-02

ST 1
4-3.5'x1.5' RCP
BOX CULVERTS @ 35 LF EACH
UPSTREAM IE = 630.7 (W)
DOWNSTREAM IE = 629.7 (E)
(PROVIDE CONCRETE DROP
STRUCTURE AT DOWNSTREAM END)

ST 2
350 LF - 30" RCP
UPSTREAM IE = 622.7 (E)
DAYLIGHT PIPE AT RIVER
WITH HEADWALL AND FLAP GATE



TYPICAL RESERVOIR X-SECTION

RESERVOIR STAGE STORAGE

ELEVATION	AREA (acres)	AVERAGE AREA (acres)	STAGE VOLUME (acre-feet)	CUMULATIVE VOLUME (acre-feet)	COMMENT
622.7	19.30			0.00	*Bottom of Reservoir*
		19.348	5.804		
623.0	19.40			5.80	
		19.554	19.554		
624.0	19.71			25.36	
		19.867	19.867		
625.0	20.02			45.23	
		20.181	20.181		
626.0	20.34			65.41	
		20.496	20.496		
627.0	20.65			85.90	
		20.812	20.812		
628.0	20.97			106.71	
		21.130	21.130		
629.0	21.29			127.84	
		21.449	21.449		
630.0	21.61			149.29	
		21.769	21.769		
631.0	21.93			171.06	
		22.091	22.091		
632.0	22.25			193.15	
		22.349	13.409		
632.6	22.45			**206.56**	*100-Yr HWL Elev.*
		22.511	9.004		
633.0	22.58			215.57	
		22.738	22.738		
634.0	22.90			238.30	
		23.063	23.063		
635.0	23.23			261.37	
		23.324	13.995		
635.6	23.42			275.36	*Top of Reservoir 3' Freeboard*

	AC-FT
Req'd Storage Volume =	205
Volume Provided at 100-yr HWL Elev. =	**206.56**
Volume Provided w/ 3' Freeboard =	275.36

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM A LOCAL GIS DATA AND REPRESENTS CONDITIONS EXISTING AT THAT TIME. SURVEY SHOWS 2' CONTOURS.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
4. DRAINAGE SWALE EAST OF RESERVOIR CREATED TO DIVERT OVERLAND RUNOFF FROM SITE HIGH POINT.
5. RESERVOIR FOOTPRINT = 28.1 ACRES
SPOIL PILE FOOTPRING = 11.6 ACRES

N

500' 250' 0 500'

SCALE: 1'' = 500'-0"

U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES
FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

DPRS15 - OPTION 1
COMP STORAGE SITE FOR DPLV09
DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
1" = 500'	SEPTEMBER 2012	DPLV7A_CSS_Siteplan.dgn

PLATE D-03a

RESERVOIR STAGE STORAGE

ELEVATION	AREA (acres)	INCREMENTAL VOLUME (acre feet)	CUMULATIVE VOLUME (acre feet)	COMMENT
622.7			0.00	Bottom of Reservoir
623.7	50.47	50.27	50.27	
624.7	50.88	50.68	100.95	
625.7	51.29	51.09	152.03	
626.7	51.71	51.50	203.53	
627.7	52.12	51.91	255.44	
628.7	52.53	52.33	307.77	
629.7	52.95	52.74	360.51	
630.7	53.37	53.16	413.67	
631.7	53.78	53.57	467.24	
632.6	**54.16**	**48.59**	**515.82**	*100-Yr HWL Elev.*
633.0	54.33	21.70	537.52	
634.0	54.75	54.54	592.06	
635.0	55.17	54.96	647.02	
635.6	55.93	34.08	679.64	Top of Reservoir 3' Freeboard

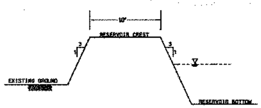
	AC-FT
Volume at 100-Yr HWL Elev	515.82
Max volume with 3 ft freeboard	679.64

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM A LOCAL GIS DATA AND REPRESENTS CONDITIONS EXISTING AT THAT TIME. SURVEY SHOWS 2' CONTOURS.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.
4. DRAINAGE WILL REMAIN AS EXISTING, OFF THE SITE, ALONG THE ROAD AND TO RIVER.
5. RESERVOIR FOOTPRINT = 57.0 ACRES ASSUMED THAT ALL SPOIL WILL BE DISPOSED OF OFFSITE.

ST 1
4-3.5'x1.5' RCP
BOX CULVERTS @ 35 LF EACH
UPSTREAM IE = 630.7 (W)
DOWNSTREAM IE = 629.7 (E)
(PROVIDE CONCRETE DROP STRUCTURE AT DOWNSTREAM END)

ST 2
350 LF - 30" RCP
UPSTREAM IE = 622.7 (E)
DAYLIGHT PIPE AT RIVER
WITH HEADWALL AND FLAP GATE



TYPICAL RESERVOIR X-SECTION

N

500' 250' 0 500'

SCALE: 1'' = 500'-0"

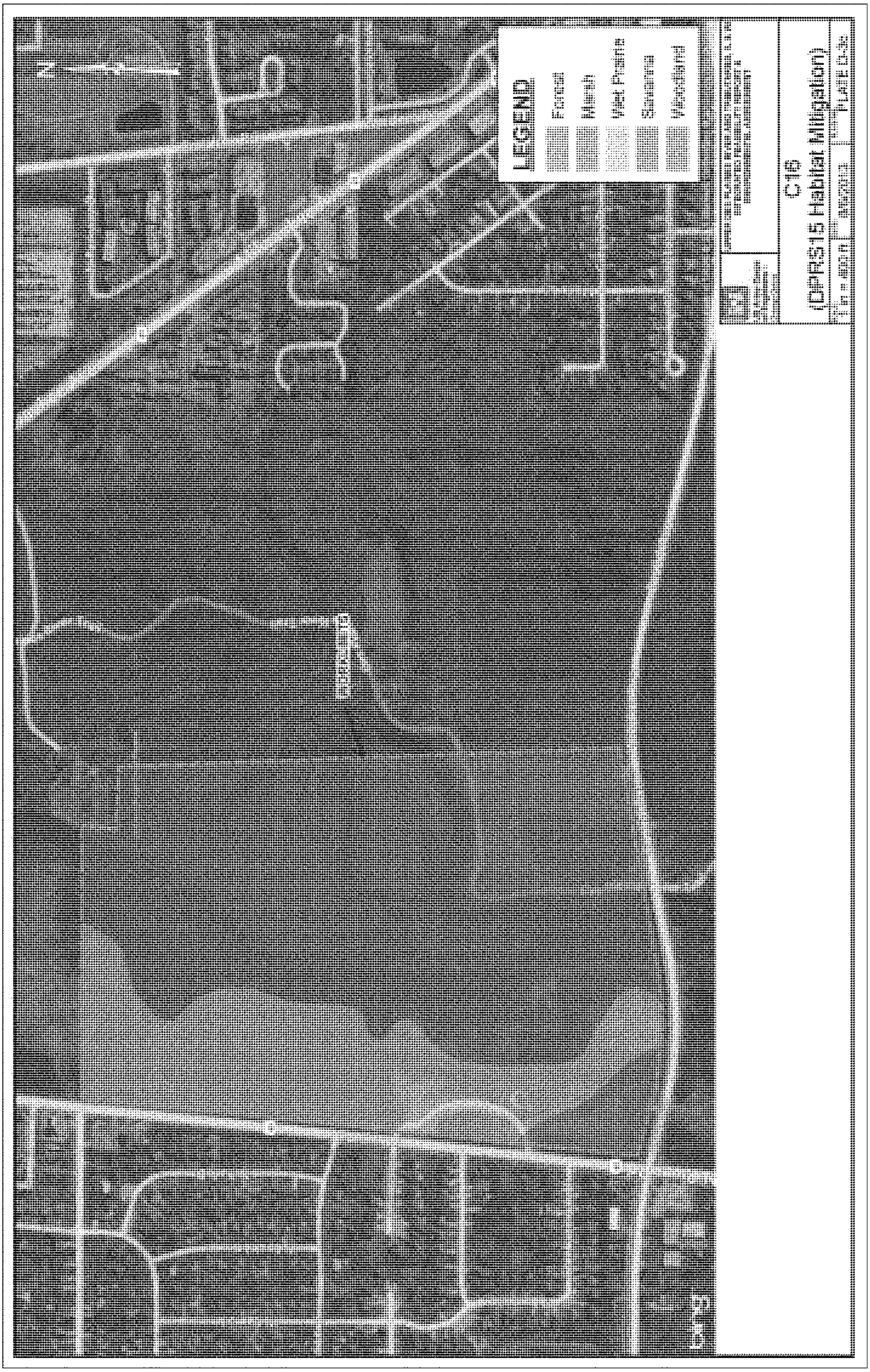
U.S. Army Corps of Engineers Chicago District

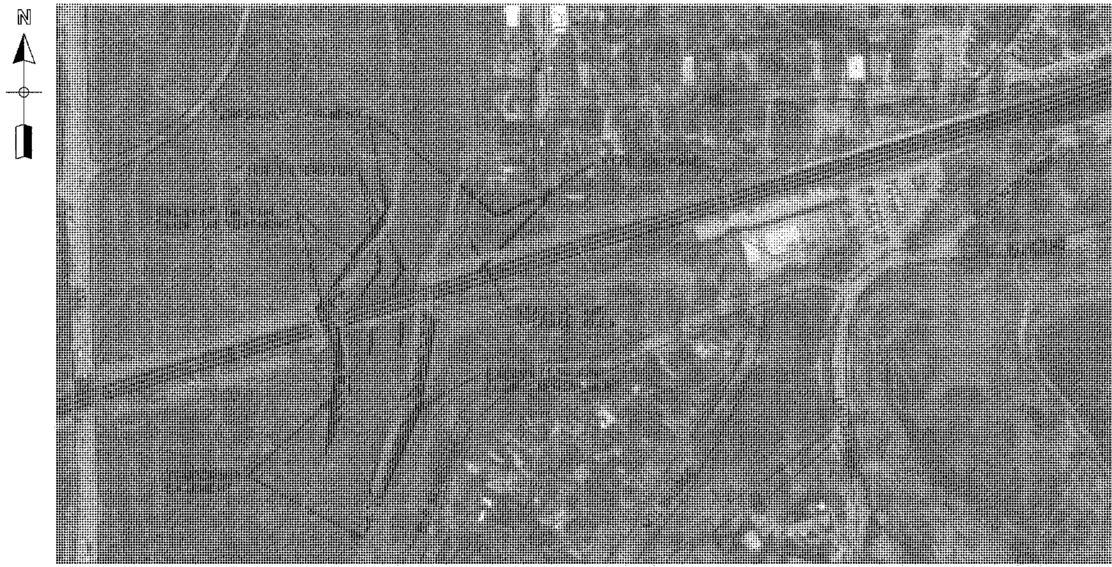
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

DPRS15 - OPTION 2
COMP STORAGE SITE FOR DPLV09
DES PLAINES, COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
1" = 500'	SEPTEMBER 2012	DPLV7A_CSS_Siteplan.dgn

PLATE D-03b


LEGEND
Forest
Marsh
Wet Prairie
Savanna
Woodland
C15
(DPRS15 Habitat Mitigation)



1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM A LOCAL GIS DATA AND REPRESENTS CONDITIONS EXISTING AT THAT TIME

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.

4. LENGTH OF COMBINDED PIERS EXTENSION WOULD TOTAL 264 FT

200' 100' 0 200'

SCALE: 1'' = 200'-0"

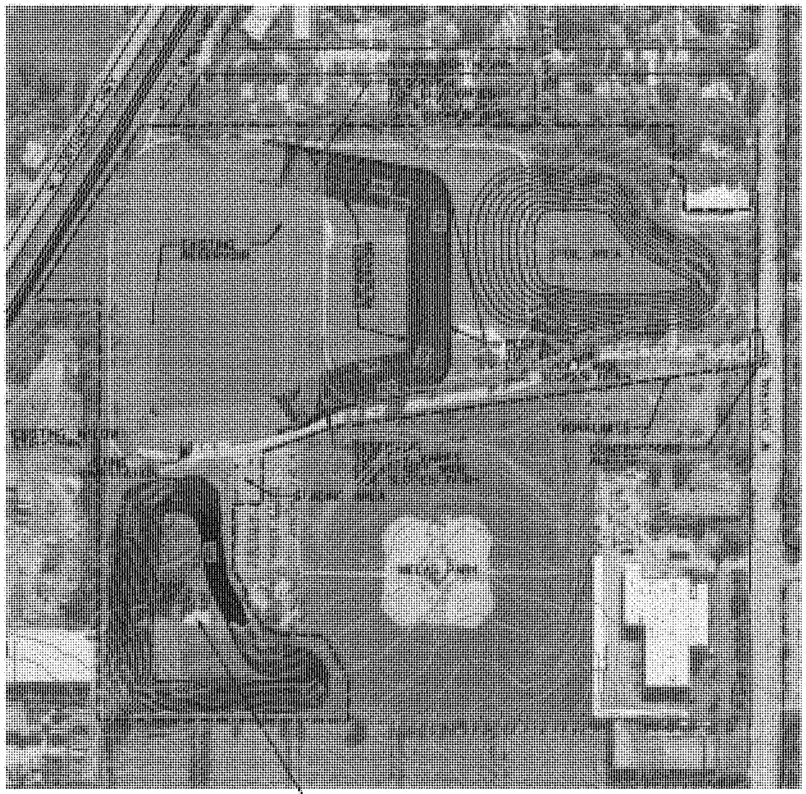
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES
FEASIBILITY REPORT
AND ENVIRONMENT ASSESSMENT

DPBM01 BRIDGE PIER EXTENSION
CONCEPTUAL SITE PLAN
RIVERSIDE , COOK COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
1" = 200'	MAR 2014	DPBM01_Siteplan.dgn

PLATE D-04



250′ 125′ 0 250′

SCALE: 1′′ = 250′-0″

RESERVOIR DATA (EXPANDED AREA)

TOP AREA=	5.89 ACRE
BOTTOM AREA=	2.65 ACRE
STORAGE=	156 AC-FT

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM A LOCAL GIS DATA AND REPRESENTS CONDITIONS EXISTING AT THAT TIME. REFER TO THE CIVIL APPENDIX FOR THE SURVEY DATA SOURCES.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.)
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.

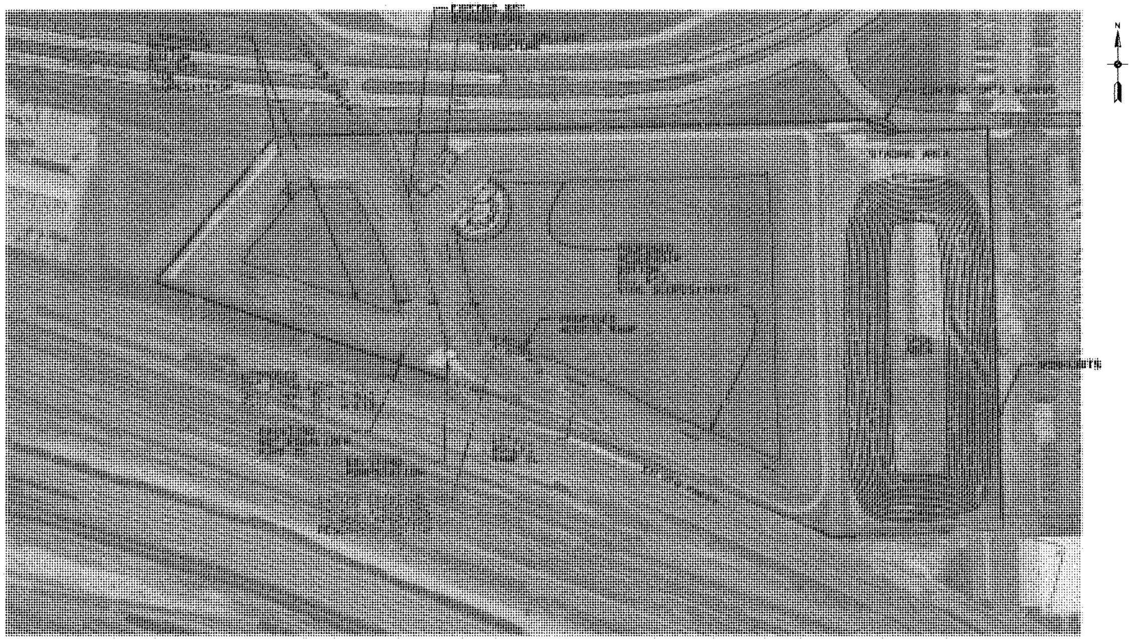
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

WLME01 RESERVOIR EXPANSION CONCEPTUAL SITE PLAN MT PROSPECT, IL

SCALE: 1"=250′ | DATE: MAR 2014 | DRAWING CODE: WLME01_Site Plan.DGN

PLATE D-05



NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM A LOCAL GIS DATA AND REPRESENTS CONDITIONS EXISTING AT THAT TIME. REFER TO THE CIVIL APPENDIX FOR THE SURVEY DATA SOURCES.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.)

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.

250 125 0 250 500

1 INCH = 250 FEET

U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES
FEASIBILITY REPORT
AND ENVIRONMENT ASSESSMENT

SCME02 RESERVOIR EXPANSION
CONCEPTUAL SITE PLAN
FRANKLIN PARK, COOK COUNTY IL

SCALE:	DATE:	DRAWING CODE:
AS SHOWN	MAR 2014	SCME02_Site Plan.DGN

PLATE D-06

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM A LOCAL GIS DATA AND REPRESENTS CONDITIONS EXISTING AT THAT TIME.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.

4. THE PROPOSED LEVEE IS 2,938 LF WITH AN ELEVATION OF 660 FT.

N

250 125 0 250 500

1 INCH = 250 FEET

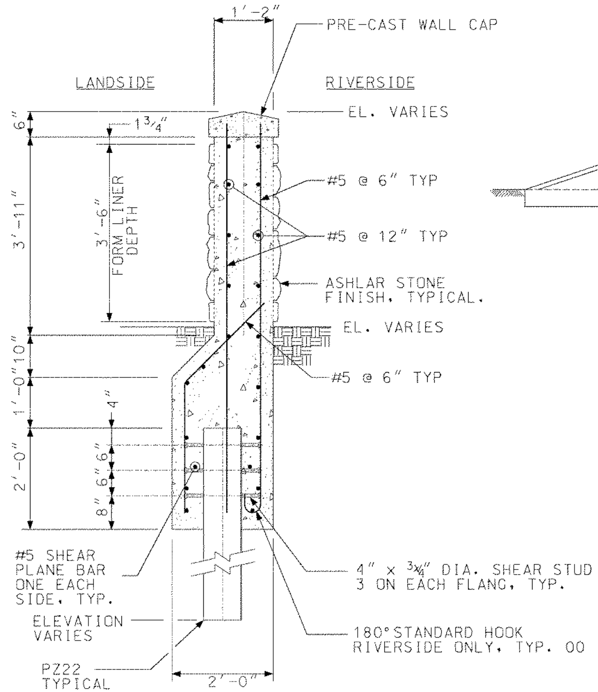
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

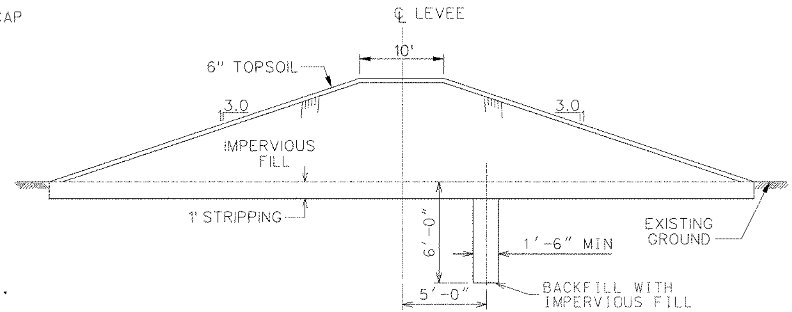
DPLV15 LEVEE
CONCEPTUAL SITE PLAN
HIGHLAND PARK, LAKE COUNTY, IL

SCALE:	DATE:	DRAWING CODE:
1" = 250'	MAR 2014	DPLV15_Siteplan.dgn

PLATE D-07



TYPICAL FLOODWALL SECTION
N.T.S



TYPICAL LEVEE SECTION WITH SLIT TRENCH
N.T.S

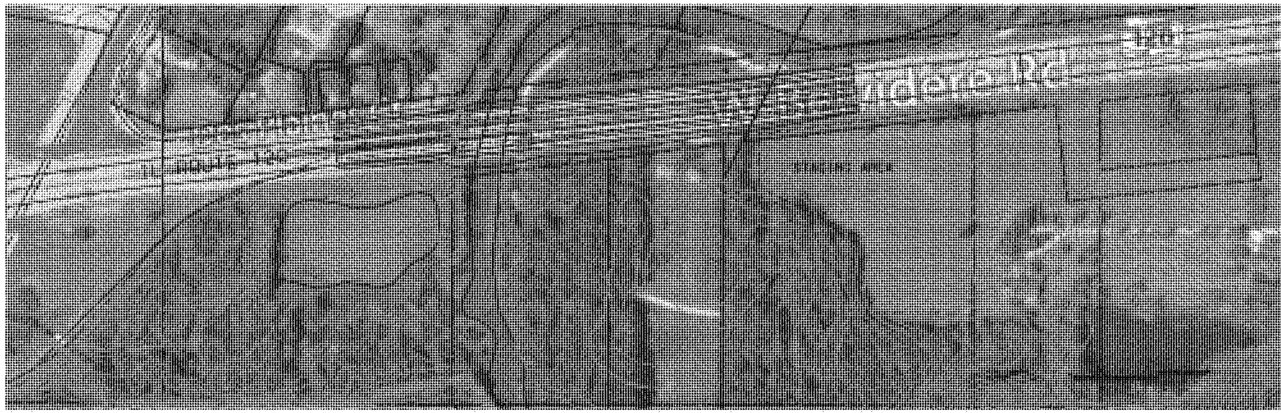
U.S. Army Corps of Engineers Chicago District

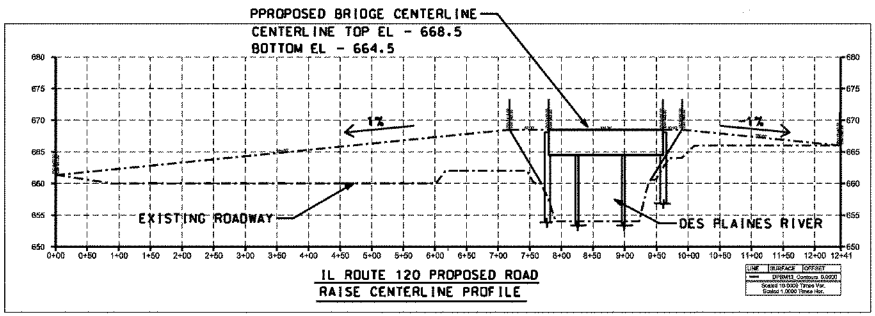
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT VOLUME 2 - NED PLAN

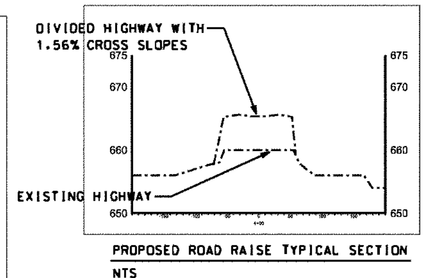
LEVEE & FLOODWALL TYPICAL SECTIONS

SCALE:	DATE:	DRAWING CODE:
AS SHOWN	MAY 2010	Typical_Sections.dgn

PLATE D-08







1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT THE CONDITIONS EXISTING AT THAT TIME. REFER TO THE CIVIL APPENDIX FOR THE SURVEY DATA SOURCES.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINIOS STATE PLAN COORDINATE SYSTEM, EAST ZONE, NORTH AMERIAN DATUM OF 1983 (NAD83) US FEET.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.

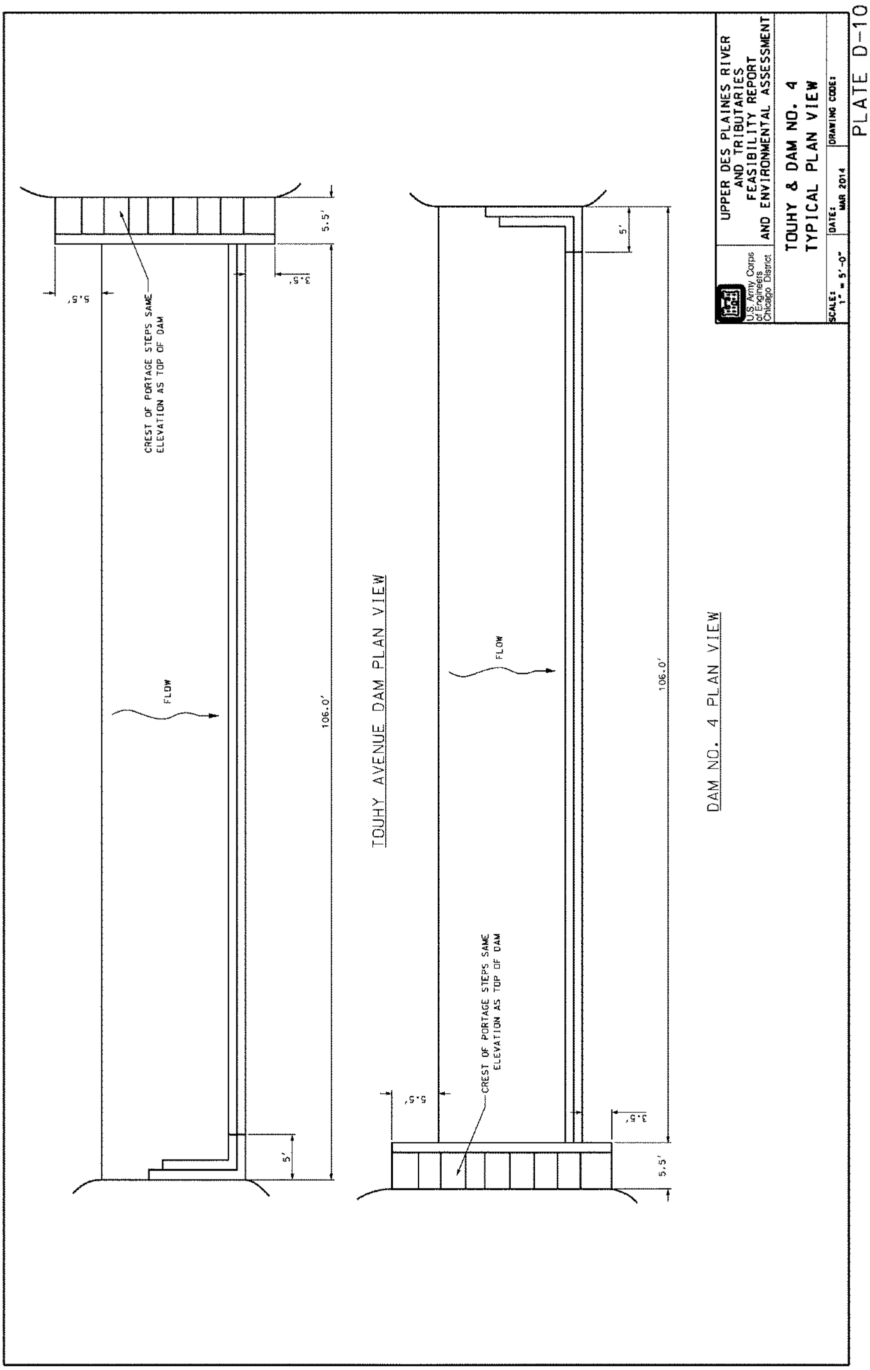
U.S. Army Corps of Engineers Chicago District

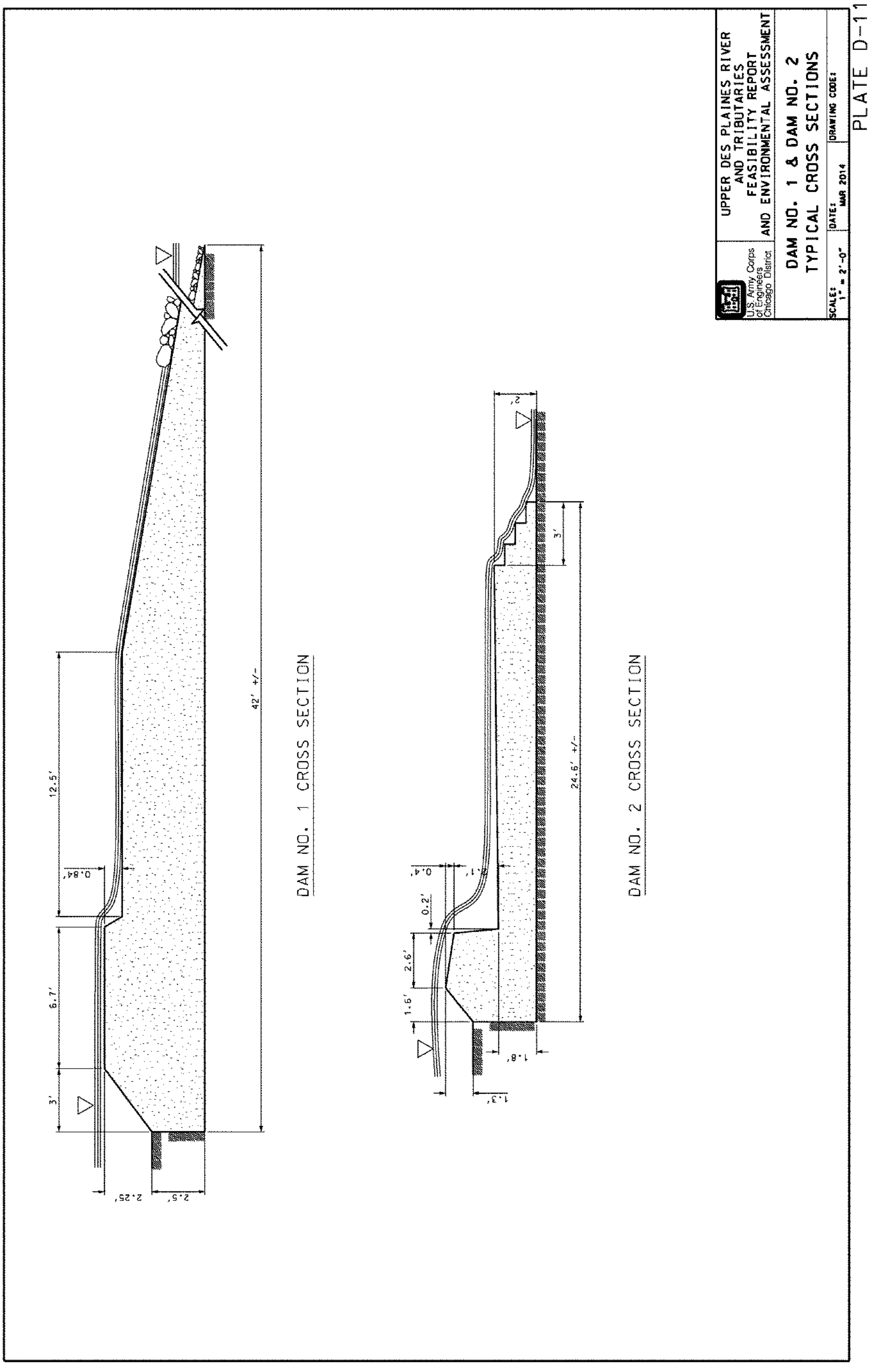
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENT ASSESSMENT

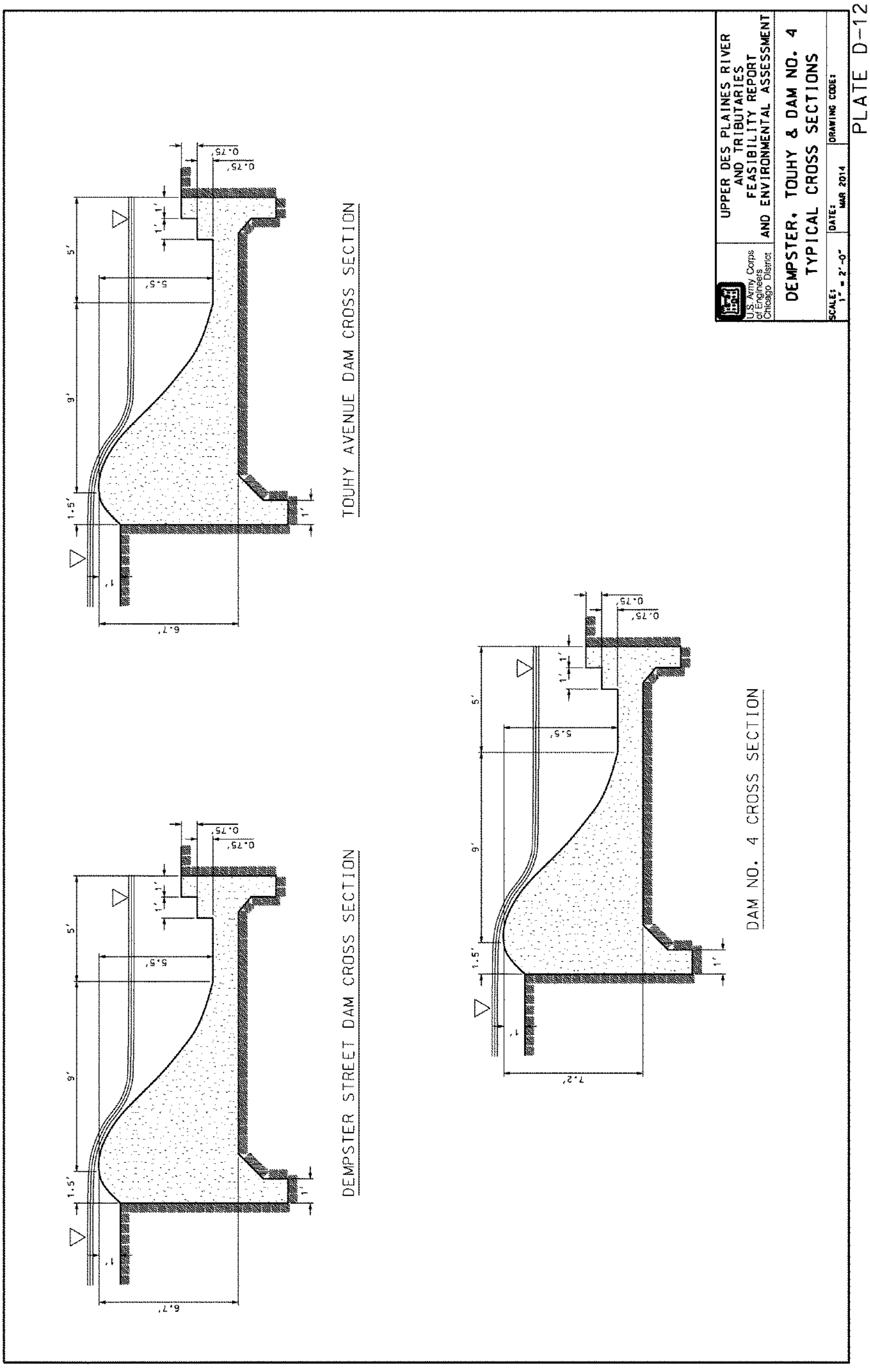
DPBM13 BRIDGE & ROAD RAISE CONCEPTUAL SITE PLAN GURNEE, COOK COUNTY IL

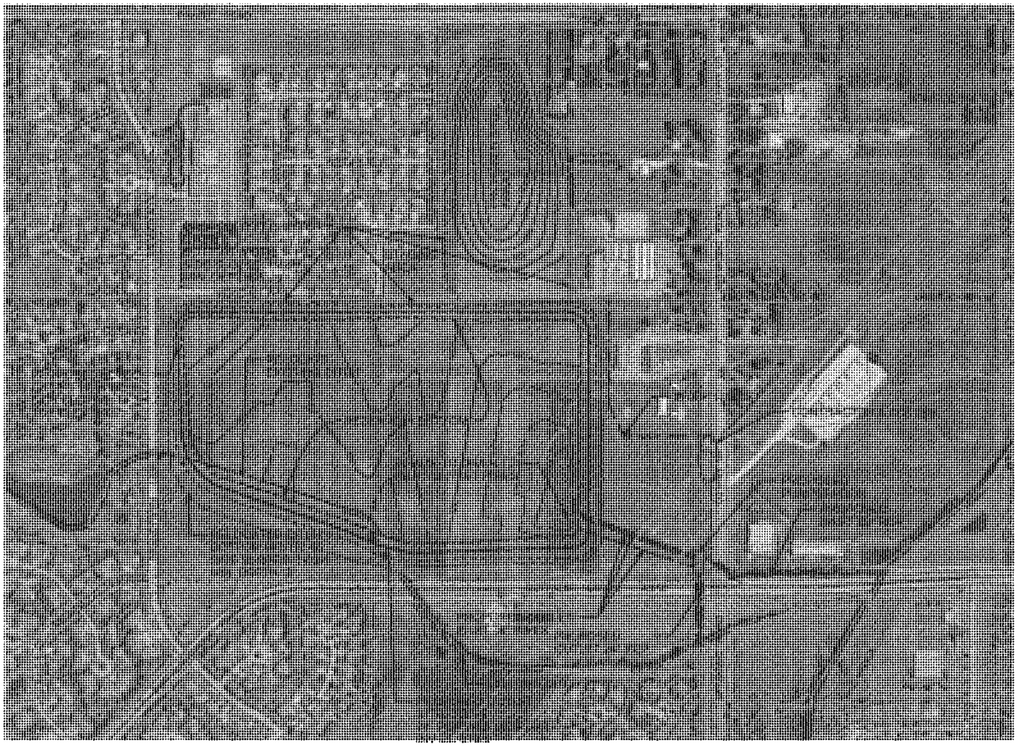
SCALE:	DATE:	DRAWING CODE:
AS-SHOWN	MAR 2014	DPBM13_Siteplan.dgn

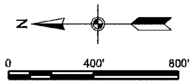
PLATE D-09


UPPER DES PLAINES RIVER
AND TRIBUTARIES
FEASIBILITY REPORT
AND ENVIRONMENTAL ASSESSMENT
U.S. Army Corps
of Engineers
Chicago District
TOUHY & DAM NO. 4
TYPICAL PLAN VIEW
SCALE: 1" = 5'-0"
DATE: MAR 2014
DRAWING CODE:
PLATE D-10
TOUHY AVENUE DAM PLAN VIEW
CREST OF PORTAGE STEPS SAME ELEVATION AS TOP OF DAM
FLOW
106.0'
5.5'
3.5'
5'
DAM NO. 4 PLAN VIEW
CREST OF PORTAGE STEPS SAME ELEVATION AS TOP OF DAM
FLOW
106.0'
5.5'
3.5'
5'


UPPER DES PLAINES RIVER
AND TRIBUTARIES
FEASIBILITY REPORT
AND ENVIRONMENTAL ASSESSMENT
U.S. Army Corps
of Engineers
Chicago District
DAM NO. 1 & DAM NO. 2
TYPICAL CROSS SECTIONS
SCALE: 1" = 2'-0"
DATE: MAR 2014
DRAWING CODE:
PLATE D-11
DAM NO. 1 CROSS SECTION
42' +/-
12.5'
0.84'
6.7'
3'
2.25'
2.5'
DAM NO. 2 CROSS SECTION
2'
3'
24.6' +/-
0.4'
0.2'
2.1'
2.6'
1.6'
1.8'
1.3'


TOUHY AVENUE DAM CROSS SECTION
DEMPSTER STREET DAM CROSS SECTION
DAM NO. 4 CROSS SECTION
5'
9'
1.5'
5.5'
6.7'
7.2'
0.75'
1'
U.S. Army Corps of Engineers Chicago District
UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT
DEMPSTER, TOUHY & DAM NO. 4 TYPICAL CROSS SECTIONS
SCALE: 1" = 2'-0"
DATE: MAR 2014
DRAWING CODE:
PLATE D-12





RESERVOIR DATA

TOP AREA = 45.4 AC
BOTTOM AREA = 40 AC
STORAGE = 550 AC-FT
INFLOW = 200 CFS

NOTES:

1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM A LOCAL GIS DATA AND REPRESENTS CONDITIONS EXISTING AT THAT TIME. REFER TO THE CIVIL APPENDIX FOR THE SURVEY DATA SOURCES.

2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FEET.)

3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FEET.

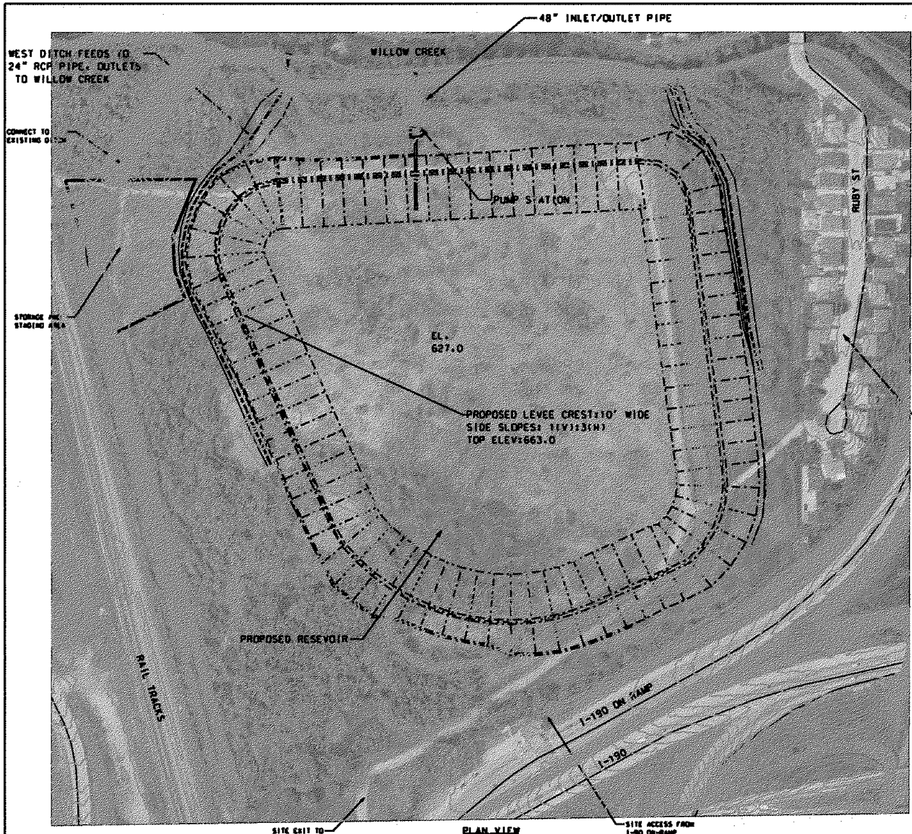
U.S. Army Corps of Engineers Chicago District

UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

ACRS08 RESERVOIR CONCEPTUAL SITE PLAN BUFFALO GROVE, IL

SCALE:	DATE:	DRAWING CODE:
1IN:400FT	MAR 2014	ACRS08-C-101.DGN

PLATE D-13

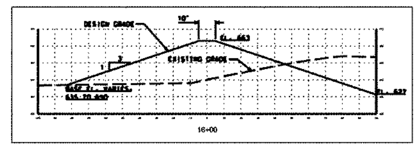


PLAN VIEW

RESERVOIR DATA

TOP OF LEVEE EL. = 663.0
BOTTOM OF RESERVOIR EL. = 627.0
FOOTPRINT = 29.8 ACRES
STORAGE VOLUME= 604 ACRE-FEET
3 FEET FREEBOARD

NOTES:
1. THE SURVEY CONDITIONS SHOWN ON THESE DRAWINGS ARE FROM LOCAL GIS DATA AND REPRESENT CONDITIONS AT THAT TIME. REFER TO THE CIVIL APPENDIX FOR THE SURVEY DATA SOURCES.
2. ALL COORDINATES SHOWN ARE REFERENCED TO THE ILLINOIS STATE PLANE COORDINATE SYSTEM, EAST ZONE AND NORTH AMERICAN DATUM OF 1983 (NAD83) U.S. FOOT.
3. ALL ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) U.S. FOOT.
4. ASSUMED THAT ALL EXCESS CUT MATERIAL WILL BE TRANSPORTED OFF SITE FOR USE BY IDOT.



TYPICAL CROSS SECTION
N.T.S.

0 200' 400'

U.S. Army Corps of Engineers Chicago District	UPPER DES PLAINES RIVER AND TRIBUTARIES FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

WHRS01 RESERVOIR
CONCEPTUAL SITE PLAN

SCALE:	DATE:	DRAWING CODE:
1"=200'	MAR 2014	WHRS01-CS101.dgn

PLATE D-14

Upper Des Plaines River and Tributaries, Illinois and Wisconsin
Integrated Feasibility Report and Environmental Assessment

Appendix D – Civil Design

ATTACHMENT D-4
QUANTITY TAKE-OFF COMPUTATIONS

US Army Corps of Engineers Chicago District	PROJECT TITLE: Site ACRS08 Reservoir	COMPUTED BY: FAYE LEFFLER	DATE: 8/1/2013
	COMPUTATION TITLE: QUANTITY COMPUTATIONS	CHECKED BY: ADAM TENNANT	DATE:

Bid Item 0001 - Mobilization and Demobilization

See Cost Appendix and MII report for mobilization and demobilization assumptions.

Bid Item 0002 - Temporary Field Office, Project and Safety Signs

See Cost Appendix and MII report for Temporary Field Office, Project and Safety Signs

Bid Item 0003 - Clearing and Grubbing Area

The clearing and grubbing areas will include the Reservoir, Ditch, and Spoil Areas.
The permanent easement (work limits) area is a minimum of 15 feet from the toe of the levee.

Location	(1)Area (AC)
Reservoir	50.02777319
Ditch	3.4
Spoil Area	11.1
Total Area =	64.5

(2)Clearing and Grubbing Area =	6.4 AC

(1)Area calculated from microstation
(2)There are no trees within most of the area. Assumed 10% of the total area will be cleared

Bid Item 0004 - Topsoil Stripping

Assumptions: Topsoil will be stripped within the levee footprint, 15 FT permanent
Adjacent areas will be stripped to get more topsoil needed for seeding
12" Topsoil will be stripped.

Required Topsoil Volume

Levee Seeding =		7841.22037	CY
Spoil Areas =		8936.19259	CY
Reservoir =		32903.3093	CY
Ditch =		2829.47593	CY
Total =		52510.1981	CY

*The levee seeding area is determined by subtracting the Inroad Surface Area reports of the reservior base from the entire reservoir (levee + reservoir). Refer to the ACRS08 Inroads Report. The levee topsoil volume was determined my multipling the levee surface area by 6" of topsoil.
*The spoil, reservoir, and ditch areas were determined by the Inroads Surface Area report of the areas - Refer to the ACRS08 Inroads Report. The topsoil volume was determined by multipling the area by 6" of top soil.

(1) Available Topsoil Volume

Levee Footprint=		14984.4926	CY
Ditch =		5480.11111	CY
Levee Footptint +Ditch =		20464.6037	CY
Adjacent Areas =		32045.5944	CY

(1) Topsoil will be available on site to be reused. There will be no import.

Total Stripping Topsoil Vol =	52510.1981 CY

Bid Item 0005 - Reservoir/Levee Excavation & Fill Volume

Item 0005AA and 0005AB

The Reservoir/Levee excavation and fill quantities were determined using Inroads Triangle Volume Report - See ACRS08 Inroads Report.

Original Surface: ACRS08_topo
Design Surface: ACRS08 Reservoir
Cut Factor: 1
Fill Factor: 1

Cut:	4851469.2	cu ft
Fill:	2513781.9	cu ft
Net:	2337687.3	cu ft

Cut:	179684	cu yd
Fill:	93103	cu yd
Net:	86581	cu yd

Total Cut Volume =	179684 CY
Total Fill Volume =	93103 CY

Item 0005AC - Levee Trench Excavation/Fill

Levee Trench

Assumptions:	Width =	3	FT
	Depth =	5	FT
Length of Levee =		5658.35	FT
Trench Fill & Excavation Volume =		3143.52778	CY

Length of levee was determined from the levee centerline alignment in inroads. The trench fill and excavation volume was determined by multipling the trench width, depth, and length of levee.

Item 0005 AD - Levee Seeding Area

	Topsoil Stripping		Seeding Area	
Location	Planar Area (SF)	Topsoil Stripping (CY)[1]	True Area (SF)	Topsoil Vol. (CY)[2]
Levee Footprint	404581.3	14984.4926	423425.9	7841.22
Ditch Area	147963	5480.11111	152791.7	2829.476
Total =	552544.3	20464.6037	576217.6	10670.7

Seeding Area =	13.2281359	AC
Topsoil Volume =	10670.6963	CY

[1]Use 12 inches for the topsoil stripping depth

[2]Use 6" for topsoil placement

*Topsoil stripping is determined using the planar (2D) area of the levee footprint and ditch areas, assuming the areas are flat.

*The seeding area for the levee and ditch areas were determined by the Inroads Surface Area report of the areas - Refer to the ACRS08 Inroads Report. The topsoil volume was determined by multipling the area by 6" of top soil.

Bid Item 0005 AE - Reservoir Seeding

Reservoir Area =	1776778.7	SF
	40.7892264	AC

Topsoil Vol =	32903.3093	CY

The seeding area for the reservoir was determined by the Inroads Surface Area report of the area - Refer to the ACRS08 Inroads Report. The topsoil volume was determined by multipling the area by 6" of top soil.

Bid Item 0006 - Spoil Construction

Spoil Approximate Height = 10 FT

Spoil Side Slopes = 1(V): 15(H)

[1]Spoil from Reservior Grading =		86581	CY
Spoil from Ditches Grading =		9366.30	
		95947.30	CY

Available Spoil Fill =		101802.6	CY

Seeding Surface Area =		482554.4	SF
		11.1	AC

[2]Topsoil =		241277.2	CF
		8936.19259	CY

[(1)]Spoil Fill = Reservoir Excavated Vol - Levee Fill Vol
[(2)]Assumed 6" Topsoil
*Available Spoil Fill is the spoil fill capacity. Therefore the proposed spoil grading plan has enough capacity to contain the excess materials from grading.
*The seeding area for the spoil were determined by the Inroads Surface Area report of the area - Refer to the ACRS08 Inroads Report. The topsoil volume was determined by multipling the area by 6" of top soil.

Bid Item 0007 - Pumpstation

Required Flow = 200 CFS
Pumps = three, 100 CFS pumps
Per VE recommendations, two 100 CFS pumps will be utilitized plus one 100 CFS pump for redundancy.

Bid Item 0008 - Storm Drainage Structures

Inlet Pumpstation

Flow =		200	cfs
Pumping Days =		2	Days
60" Inlet RCP =		876.2107	LF
Three 36" Outlet RCP =		1734	LF

The pumpstation flow and pumping duration data were provided by H&H. See H&H appendix.
The lengths of pipes were determined using the length measure tool in microstation.

Outlet Pumpstation
Two of the three 36" RCP at the reservior will be used pump water from the reservior back into the river
Water will discharge back into the river through the 60" RCP and an additional 24" RCP.

24" Inlet RCP =		330	LF

Other Storm Sewers

24" Oulet RCP with sluice gate	150	LF

Total 60" RCP =		**876.2107**	**LF**
Total 36" RCP =		**1734**	**LF**
Total 24" RCP =		**480**	**LF**

Bid Item 0009 Ditch Grading

Assumptions for Ditch at Spoil Areas:

Width =	5	FT
Average Depth =	1.5	FT
Side Slope	1(V):3(H)	

Excavation Volume:

Length =	2397.9943	FT
Cross-sectional Area =	10.875	SF
Excavation/Grading Volume =	965.858815	CY

The excavation volume for the ditches surrounding the spoil area was determined by multipling the length of the ditch with cross-sectional area of the ditch using the assumptions provided above. The length of the ditch was determine in microstation.

Total Ditch Excavation and Fill:

Ditch	Excavation (CY)	Fill (CY)
Main Ditch	2808.9	92.2
Ditch A	3767.6	0
Ditch B	3224.1	342
Spoil Area Ditch	965.8588153	0
Total	10766.45882	434.2

The main ditch, Ditch A and B excavation and fill volumes were determined using Inroads Triangle Volume report - see ACRS08 Inroads report

Total Ditch Grading =	10332.2588 CY

*The ditch grading volume was determined by subtracting the fill volume from the excavation volume.
*The ditch footprint is within the PE easement. Therefore, the topsoil and seeding is accounted for under Topsoil Striping and Levee Seeding respectively.

	PROJECT TITLE: Site ACRS08 Reservoir	COMPUTED BY: FAYE LEFFLER	DATE: 8/1/2013
US Army Corps of Engineers® Chicago District	COMPUTATION TITLE: INROADS REPORT	CHECKED BY: ADAM TENNANT	DATE:

Triangle Volume Report for Reservoir (Reservoir Cut and Levee Fill)

Original Surface:	ACRS08_topo
Description:	
Preference:	Default
Type:	Existing
Design Surface:	ACRS08 Reservior_alignment3
	Created from roadway
Description:	designer
Preference:	Default
Type:	Design
Cut Factor:	1
Fill Factor:	1

Cut:	4851469.2	cu ft
Fill:	2513781.9	cu ft
Net:	2337687.3	cu ft
Cut:	179684	cu yd
Fill:	93103	cu yd
Net:	86581	cu yd

Ditch Excavation and Fill Volume

Main Ditch (Existing Ditch Relocation)

Original Surface:	ACRS08_topo
Description:	
Preference:	Default
Type:	Existing
Design Surface:	ACRS08 Main Ditch
	Created from roadway
Description:	designer
Preference:	Default
Type:	Design
Cut Factor:	1
Fill Factor:	1

Cut:	75839.5	cu ft
Fill:	2489	cu ft
Net:	73350.6	cu ft
Cut:	2808.9	cu yd
Fill:	92.2	cu yd
Net:	2716.7	cu yd

Reservoir Ditch A

Original Surface: ACRS08_topo
Description:
Preference: Default
Type: Existing
Design Surface: Ditch A
Created from roadway
Description: designer
Preference: Default
Type: Design
Cut Factor: 1
Fill Factor: 1

Cut:	101725.2	cu ft
Fill:	0.2	cu ft
Net:	101725	cu ft
Cut:	3767.6	cu yd
Fill:	0	cu yd
Net:	3767.6	cu yd

Reservoir Ditch B

Original Surface: ACRS08_topo
Description:
Preference: Default
Type: Existing
Design Surface: Ditch B
Created from roadway
Description: designer
Preference: Default
Type: Design
Cut Factor: 1
Fill Factor: 1

Cut:	87049.4	cu ft
Fill:	9235.1	cu ft
Net:	77814.3	cu ft
Cut:	3224.1	cu yd
Fill:	342	cu yd
Net:	2882	cu yd

Spoil Construction

Triangle Volume Report for Spoil Fill

Original Surface:	ACRS08_topo
Design Surface:	ACRS08_spoil1
Cut Factor:	1
Fill Factor:	1

Cut:	174.2	cu ft
Fill:	2748668.9	cu ft
Net:	-2748494.7	cu ft
Cut:	6.5	cu yd
Fill:	101802.6	cu yd
Net:	-101796.1	cu yd

Reservoir Storage report:

Elevation	Incremental Volume CF	Cumulative Volume CF	Acre-Feet AC-FT	Surface Area SF
684.00	7439208.8	7439208.8	170.8	1739897.3
686.00	3568250.6	11007459.4	252.7	1817338.5
688.00	3695607.8	14703067.2	337.5	1864355.3
690.00	3761962.7	18465029.9	423.9	1897644.6
692.00	3828764.7	22293794.6	511.8	1931157.3
693.00	1939572.7	24233367.3	556.3	1947997.5

Surface Area Reports

Surface Area Report for Spoil

Spoil Area 2

Surface:	ACRS08_spoil1
Fence Mode:	Ignore

True Area:	482554.4	sq ft
Planar Area:	481688.3	sq ft

Surface Area Report for Reservior and Levee

Surface: ACRS08 Reservior_alignment 3
Fence Mode: Ignore

True Area: sq ft	2200204.6	SF
Planar Area: sq ft	2179209.8	SF

Surface Area Report for Reservoir Only

Surface: ACRS08 Reservoir_alignment 3
Fence Mode: Inside

True Area:	1776778.7	sq ft
Planar Area:	1774628.5	sq ft

Surface Area Report for Levee

Levee Surface True Area =		423425.9	SF
Levee Planar Area =		404581.3	SF

Surface Area Report for Main Ditch

Surface: ACRS08 Main Ditch
Fence Mode: Ignore

True Area: sq ft	42744.7	SF
Planar Area: sq ft	41477.1	SF

Surface Area Report for Reservoir Ditch A

Surface: Ditch A
Fence Mode: Ignore

True Area: sq ft	39176	SF
Planar Area: sq ft	37491.6	SF

Surface Area Report for Reservoir Ditch B

Surface: Ditch B
Fence Mode: Ignore

True Area: sq ft	70871	SF
Planar Area: sq ft	68994.3	SF

BCRS02 QUANTITIES COMPUTATIONS

Prepared by:	Faye Leffler
Checked by:	Laura Vanden Berg
Date Prepared:	Sep-10
Date Checked:	Oct-12

Item 000X - Clearing and Grubbing 60.57 AC

Assumptions: Area includes the reservoir, levee and PE Area

Total Area =

Item 000X - Reservoir Excavation Volume

Inroads Triangle Volume Report			
Original Surface:	BCRS02_topo		
Design Surface:	BCRS02_reservoi	cu ft	
Cut Factor:	1	cu ft	
Fill Factor:	1	cu ft	
Cut:	612548.8	cu yd	
Fill:	5509.3	cu yd	
Net:	607039.5	cu yd	
Cut:	22687		22482.9 CY
Fill:	204		
Net:	22482.9		

Total Cut Volume =

Item 000X - Levee Fill Volume

Inroads Triangle Volume Report			
Original Surface:	BCRS02_topo		
Design Surface:	BCRS02_levee	cu ft	
Cut Factor:	1	cu ft	
Fill Factor:	1	cu ft	
Cut:	5294.1	cu yd	
Fill:	1345686	cu yd	
Net:	-1340391.8	cu yd	
Cut:	196.1		49840.2 CY
Fill:	49840.2		
Net:	-49644.1		

Fill Volume =
Stripped Volume =

		3 FT		
Item 000X Levee Trench Fill		5 FT		
		7324.733 FT		
Levee Trench		4069.29611 CY		
Assumptions:	Width =			
	Depth =			
Length of Levee =				
Trench Fill/Excavation Volume =				
Check:	Volume Report for both Reservoir and Levee			
	Original Surface:	BCRS02_topo	Levee Fill =	-204 CY
	Design Surface:	BCRS02_reservoir	Reservoir Cut=	22883.1
	Cut Factor:	1		
	Fill Factor:	1		
	Cut:	617845 cu ft		
	Fill:	1355800.6 cu ft		
	Net:	-737955.6 cu ft		
	Cut:	22883.1 cu yd		
	Fill:	50214.8 cu yd		
	Net:	-27331.7 cu yd		
Item 000X - Topsoil Stripping				
Assumptions:	Topsoil will be stri	349322.5 SF		
	Adjacent areas wil	135652.191 SF		
	12" Topsoil will be	484974.691 SF		
		233092 SF		
Levee Planar Area =				
PE Area =		718066.691 SF		
Levee + PE Area =				
Adjacent Areas =		26595.0626 CY		
Total Stripping Area =				
Topsoil Stripping Volume =				
		150 LF		
Item 000X - 18" RCP		5		
Assumptions:	Length of pipe =	750 LF		
No of pipes =				
Total Length of Pipe =				

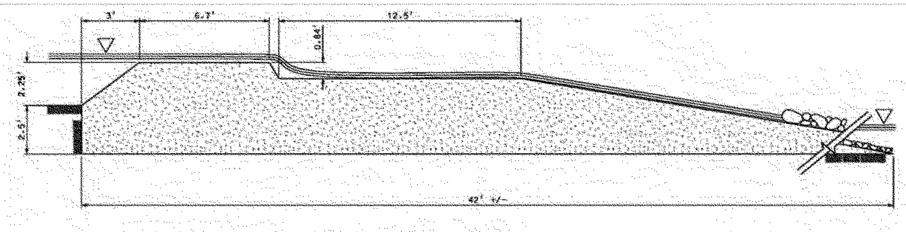
Item 000X - Seeding Area

Assumptions:	Seeded area inclu	364296.1	SF
	6" Topsoil will be p	135652.191	SF
		499948.291	SF
<u>Levee</u>		11.4772335	AC
Levee Surface Area =		9258.30168	CY
PE Area =			
Total Levee Seeding Area =			
		218118.4	SF
Topsoil Volume for Levee =		5.00730946	AC
		4039.22963	CY
<u>Spoil</u>			
Total Spoil Seeding Area =		718066.691	SF
Topsoil Volume for Spoil =			
		CY	
Total seeding area =			

Item 000X - Spoil Construction

Spoil Fill = 22482.9

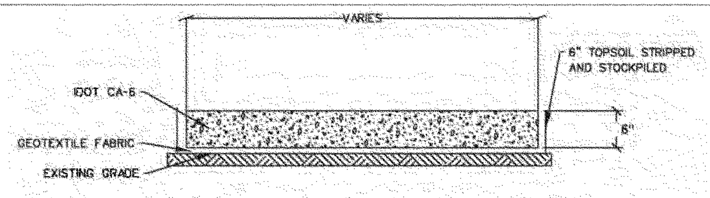
US Army Corps of Engineers Chicago District	PROJECT TITLE: **DP II - Feasibility Study**	COMPUTED BY: **MWC**	DATE: **10/24/11**	SHEET: 1 of 2
	COMPUTATION TITLE: **Quantities for Dam No. 1 Removal**	CHECKED BY: **AK**	DATE: **10/24/11**	



DAM NO. 1 CROSS SECTION

- Width of the dam across the river is 127 ft
- Dam is made of reinforced concrete
- Total volume of concrete = (135.7 sq. ft)(127 ft)(1 CY/27 cu. Ft) = 638.3 CY

- The clearing and grubbing area is based on the staging/storage area layout and a small amount of clearing needed at the river bank to provide access into the river.
- The area for the access road and staging/storage area was measured in the site layout drawing file, Dam_No_1_Site_Plan_2D.dgn, stored in ProjectWise
- Clearing and grubbing area = 0.40 acres
- Landscape restoration is equal to the acres for clearing and grubbing = 0.40 acres
- Sediment removal is approx. 50 CY. The assumption was made that less sediment is present than at previously surveyed dams on the river such as Armitage dam.



DAM NO. 1 GRAVEL STAGING & STORAGE (TYP)
N.T.S.

- Stripping 6" of topsoil from the staging/storage area:

  = (17,569.9 sq. ft)(0.5 ft)(1 CY/27 cu. Ft) = 325.4 CY
- Unit weight of IDOT CA-6 stone is approx. 130 lb/cu. Ft
- IDOT CA-6 stone needed for temp. access road and staging/storage area

  = (17,569.9 sq. ft)(0.5 ft)(130 lb/cu. Ft)(1 ton/2,000 lb) = 571.0 tons

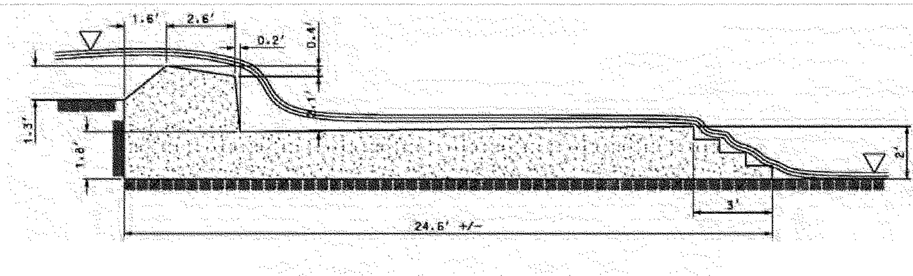
LRC Form 1272-1, October 1999

	PROJECT TITLE:	COMPUTED BY:	DATE:	SHEET:
US Army Corps of Engineers® Chicago District	**DPII - Feasibility Study**	**MWC**	**10/24/11**	2 of 2
	COMPUTATION TITLE:	CHECKED BY:	DATE:	
	Quantities for Dam No. 1 Removal	**AK**	**10/24/11**	

- Geotextile fabric for staging/storage area:

  = (17,569.9 sq. ft)(1 sq. ft/9 SY) = 1,952.2 SY
- Total temporary chain link fencing, 6 ft high = 756 ft
- The temporary fencing was measured along the work limits up to the approx. river edge seen in the aerial photo. 20 ft was deducted from the total fencing to allow for two gates at the site entrances.
- Two temporary 10 ft wide, 6 ft high gates at the site entrances are required.

US Army Corps of Engineers® Chicago District	PROJECT TITLE: **DP II - Feasibility Study**	COMPUTED BY: **MWC**	DATE: **10/20/11**	SHEET: 1 of 2
	COMPUTATION TITLE: **Quantities for Dam No. 2 Removal**	CHECKED BY: **AK**	DATE: **10/20/11**	



DAM NO. 2 CROSS SECTION

- Width of the dam across the river is 151 ft
- Dam is made of reinforced concrete
- Cross Sectional Area by Segments:

  (2.0 ft)(21.6 ft) = 43.2 sq. ft

  (0.5)(3.0 ft)(2.0 ft) = 3.0 sq. ft

  (1.2 ft)(4.4 ft) = 5.28 sq. ft

  (0.5)(1.6 ft)(1.3 ft) = 1.04 sq. ft

  (0.9 ft)(2.6 ft) = 2.34 sq. ft

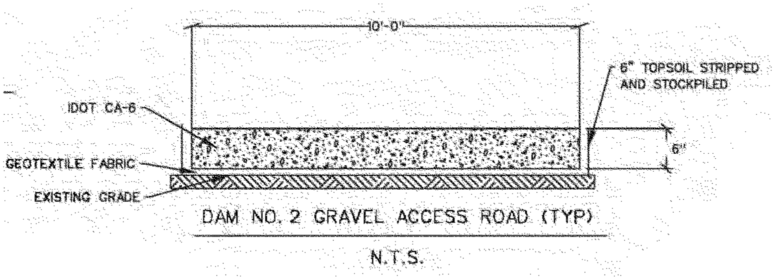
  (0.5)(2.6 ft)(0.4 ft) = 0.52 sq. ft
- Total Concrete volume for the dam:

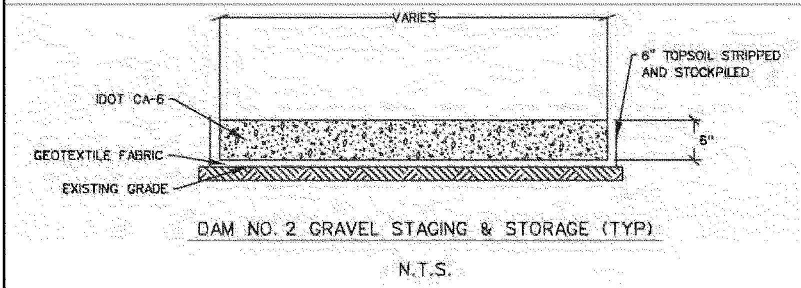
  = (43.2 sq. ft + 3.0 sq. ft + 5.28 sq. ft + 1.04 sq. ft + 2.34 sq. ft + 0.52 sq. ft)(151 ft)(1 CY/27 cu. Ft) = 309.7 CY

- The clearing and grubbing area is based on the temporary access road and staging/storage area layout.
- The area for the access road and staging/storage area was measured in the site layout drawing file, Dam_No_2_Site_Plan_2D.dgn, stored in ProjectWise
- Clearing and grubbing area = 0.34 acres
- Landscape restoration is equal to the acres for clearing and grubbing = 0.34 acres
- Sediment removal is approx. 50 CY. The assumption was made that less sediment is present than at previously surveyed dams on the river such as Armitage dam.

LRC Form 1272-1, October 1999

	PROJECT TITLE:	COMPUTED BY:	DATE:	SHEET:
US Army Corps of Engineers® Chicago District	**DPII - Feasibility Study**	**MWC**	**10/20/11**	2 of 2
	COMPUTATION TITLE: **Quantities for Dam No. 2 Removal**	CHECKED BY: **AK**	DATE: **10/20/11**	





- Stripping 6" of topsoil from the temp. access road and staging/storage area

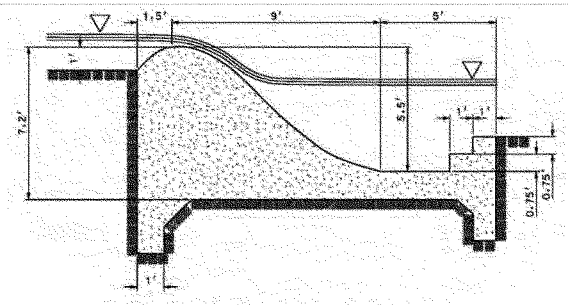
  = (14,734.8 sq. ft)(0.5 ft)(1 CY/27 cu. Ft) = 272.9 CY
- Unit weight of IDOT CA-6 stone is approx. 130 lb/cu. Ft
- IDOT CA-6 stone needed for temp. access road and staging/storage area

  = (14,734.8 sq. ft)(0.5 ft)(130 lb/cu. Ft)(1 ton/2,000 lb) = 478.9 tons
- Geotextile fabric for staging/storage area:

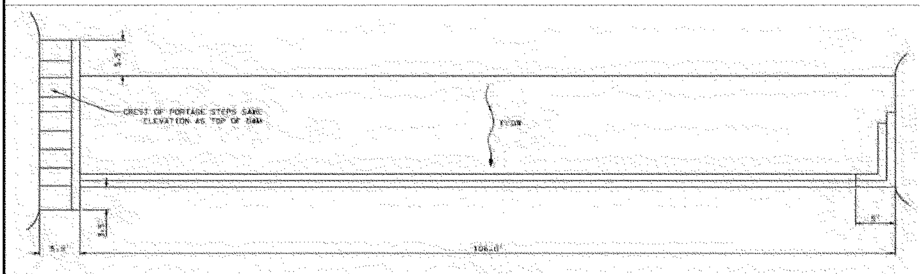
  = (125 ft)(85 ft)(1 sq. ft/9 SY) = 1,181 SY
- Geotextile fabric for temporary access road:

  = (4,110 sq. ft)(1 sq. ft/9 SY) = 457 SY
- Total temporary chain link fencing, 6 ft high = 2,231 ft
- The temporary fencing was measured along the work limits up to the approx. river edge seen in the aerial photo. 10 ft was deducted from the total fencing to allow for the gate at the site entrance
- One temporary 10 ft wide, 6 ft high gate at site entrance required

US Army Corps of Engineers® Chicago District	PROJECT TITLE: **DP II - Feasibility Study**	COMPUTED BY: **MWC**	DATE: **10/21/11**	SHEET: 1 of 2
	COMPUTATION TITLE: **Quantities for Dam No 4 Removal**	CHECKED BY: **AK**	DATE: **10/21/11**	



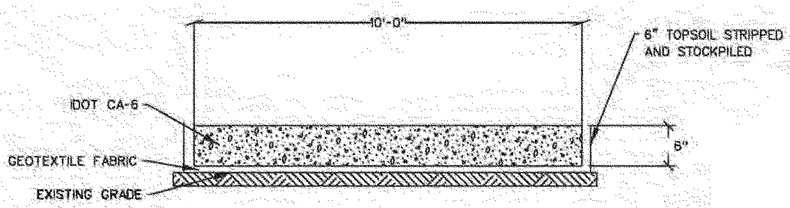
DAM NO. 4 CROSS SECTION



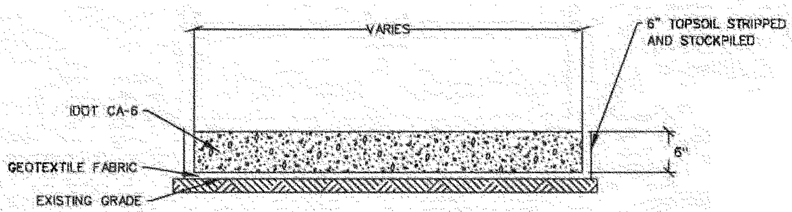
DAM NO. 4 PLAN VIEW

- The clearing and grubbing area is based on the temporary access road and staging/storage area layout.
- The area for the access road and staging/storage area was measured in the site layout drawing file, Dam_No_4_Site_Plan_2D.dgn, stored in ProjectWise
- Clearing and grubbing area = 15,905.4 sq. ft = 0.4 acres
- Landscape restoration is equal to the acres for clearing and grubbing = 0.4 acres
- Sediment removal is approx. 50 CY. The assumption was made that less sediment is present than at previously surveyed dams on the river such as Armitage dam.
- Total temporary chain link fencing, 6 ft high = 1,453 ft
- The temporary fencing was measured along the work limits up to the approx. river edge seen in the aerial photo. 10 ft was deducted from the total fencing to allow for the gate at the site entrance
- One temporary 10 ft wide, 6 ft high gate at site entrance required

US Army Corps of Engineers® Chicago District	PROJECT TITLE: **DPII - Feasibility Study**	COMPUTED BY: **MWC**	DATE: **10/21/11**	SHEET: 2 of 2
	COMPUTATION TITLE: **Quantities for Dam No 4 Removal**	CHECKED BY: **AK**	DATE: **10/21/11**	



DAM NO. 4 GRAVEL ACCESS ROAD (TYP)
N.T.S.

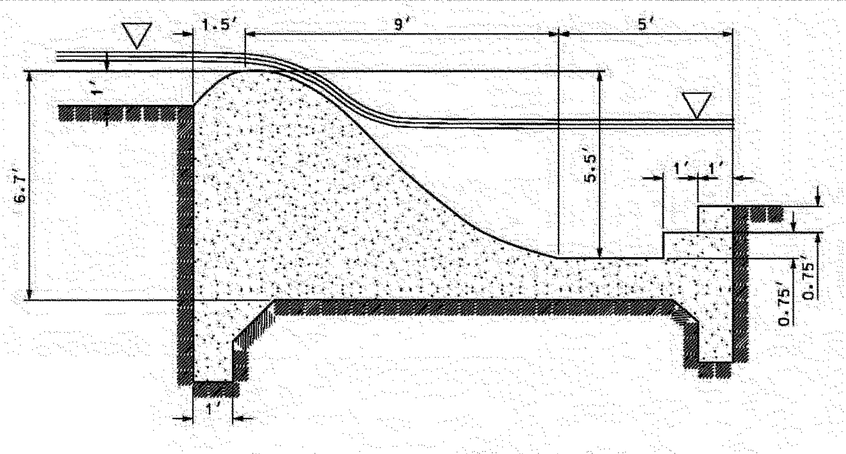


DAM NO. 4 GRAVEL STAGING & STORAGE (TYP)
N.T.S.

- Stripping 6" of topsoil from the temp. access road and staging/storage area
  = (15,905.4 sq. ft)(0.5 ft)(1 CY/27 cu. Ft) = 294.5 CY
- Unit weight of IDOT CA-6 stone is approx. 130 lb/cu. Ft
- IDOT CA-6 stone needed for temp. access road and staging/storage area
  = (15,905.4 sq. ft)(0.5 ft)(130 lb/cu. Ft)(1 ton/2,000 lb) = 516.9 tons
- Geotextile fabric for staging/storage area:
  = (76 ft)(85 ft)(1 sq. ft/9 SY) = 717.8 SY
- Geotextile fabric for temporary access road:
  = (9,416.3 sq. ft)(1 sq. ft/9 SY) = 1,046.3 SY
- Dam is made of reinforced concrete
- Dam concrete volume = (58.2 sq. ft)(106.0 ft)(1 CY/27 cu. Ft) = 228.5 CY
- Take 25% of the dam volume for the wing walls and stairs = 57.1 CY
- Total Concrete volume for the dam = (228.5 CY + 57.1 CY) = 285.6 CY

LRC Form 1272-1, October 1999

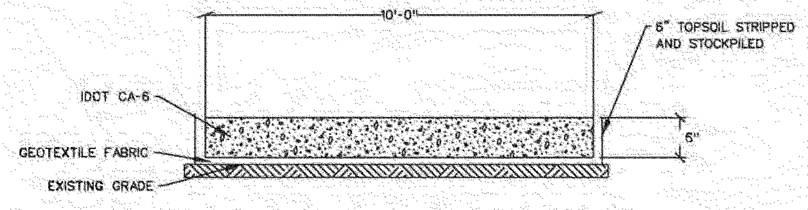
US Army Corps of Engineers® Chicago District	PROJECT TITLE: DP II - Feasibility Study	COMPUTED BY: MWC	DATE: 10/21/11	SHEET: 1 of 2
	COMPUTATION TITLE: Quantities for Dempster St Dam Removal	CHECKED BY: AK	DATE: 10/24/11	



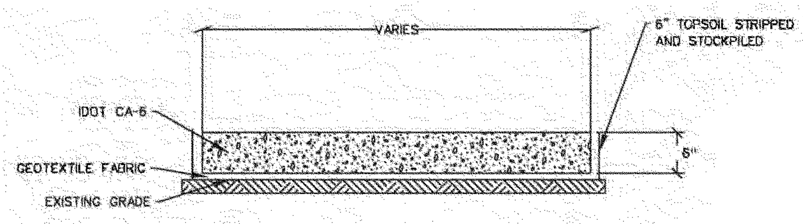
DEMPSTER STREET DAM CROSS SECTION

- The clearing and grubbing area is based on the temporary access road and staging/storage area layout.
- The area for the access road and staging/storage area was measured in the site layout drawing file, Dempster_Dam_Site_Plan_2D.dgn, stored in ProjectWise
- Clearing and grubbing area = 10,741.4 sq. ft = 0.25 acres
- Landscape restoration is equal to the acres for clearing and grubbing = 0.25 acres
- Sediment removal is approx. 50 CY. The assumption was made that less sediment is present than at previously surveyed dams on the river such as Armitage dam.
- Total temporary chain link fencing, 6 ft high = 1,152 ft
- The temporary fencing was measured along the work limits up to the approx. river edge seen in the aerial photo. 10 ft was deducted from the total fencing to allow for the gate at the site entrance
- One temporary 10 ft wide, 6 ft high gate at site entrance required

	PROJECT TITLE:	COMPUTED BY:	DATE:	SHEET:
US Army Corps of Engineers® Chicago District	**DPII - Feasibility Study**	**MWC**	**10/21/11**	2 of 2
	COMPUTATION TITLE: **Quantities for Dempster St Dam Removal**	CHECKED BY: **AK**	DATE: **10/24/11**	



DEMPSTER ST. DAM GRAVEL ACCESS ROAD (TYP)
N.T.S.



DEMPSTER ST. DAM GRAVEL STAGING & STORAGE (TYP)
N.T.S.

- Stripping 6" of topsoil from the temp. access road and staging/storage area
  = (10,741.4 sq. ft)(0.5 ft)(1 CY/27 cu. Ft) = 198.9 CY
- Unit weight of IDOT CA-6 stone is approx. 130 lb/cu. Ft
- IDOT CA-6 stone needed for temp. access road and staging/storage area
  = (10,741.4 sq. ft)(0.5 ft)(130 lb/cu. Ft)(1 ton/2,000 lb) = 349.1 tons
- Geotextile fabric for staging/storage area:
  = (6,473.8 sq. ft) (1 sq. ft/9 SY) = 719.3 SY
- Geotextile fabric for temporary access road:
  = (4,267.6 sq. ft)(1 sq. ft/9 SY) = 474.2 SY
- Dam is made of reinforced concrete
- Dam concrete volume = (58.2 sq. ft)(102.0 ft)(1 CY/27 cu. Ft) = 219.9 CY
- Take 25% of the dam volume for the wing walls and stairs = 55.0 CY
- Total Concrete volume for the dam = (219.9 CY + 55.0 CY) = 274.9 CY

LRC Form 1272-1, October 1999

US Army Corps of Engineers Chicago District	PROJECT TITLE: **DP II - Feasibility Study**	COMPUTED BY: **AGT**	DATE: **4/06/10**	SHEET: 1 of 1
	COMPUTATION TITLE: **Quantities for Site DPBM01**	CHECKED BY: **LCV**	DATE: **10/5/12**	

Total pier extension length= 266.4 ft

Length was based on IDNR plate no backup

or reasoning provided.

Sheet Pile Height = 25 ft

Based on conservative assumption from

TS-DG

Clear and Grub Area = 79,109 SF

Measure from microstation

Excavation for Flow Improvement =

(5108 SF +3922 SF+17081 SF)*depth (22 ft)

574442 CF → 21,275 CY/2 BASED ON 1:1 SLOPES

For calculation purposes assume a river bed elevation of 596.0 ft at the base of pier extension. Assumption 25 ft deep sheet pile depth to anchor pier extension.

Assumption pier extension is 10 ft above water and 12 ft below water. For a total pier extension height of 22 ft.

Sq ft of SSP = (25 ft)(266.4 ft)=6,160 S.F.

Concrete Volume: width of wall = 1.17 ft

Total height of wall = 22 ft

Volume=[(1.17')(22')(266.4')]/27= 254 CY

Perm. Easement Area = 26,111 SF land lost to river enlargement = .6 ACRES

Temp Easement Area = 52,998 SF =

LRC Form 1272-1, October 1999

DPBM04 QUANTITIES COMPUTATIONS

Prepared by: Laura Vanden Berg
Checked by: Matt Cunningham
Date Prepared: Oct-12
Date Checked: Nov-12

Item 0003 - Clearing & Grubbing

[1]Worklimits =	538311.9	SF
Clearing & Grubbing Area =	284604.8393	SF
	6.533628083	AC

Item 0004 & 0005 - Roadway Reconstruction

Number of Lanes =	4	
Lane width =	11	FT
Shoulder Width =	8	FT

Roadway Reconstruction Lengths

Location	[1]Length (FT)
North of Bridge 1st Ave	384
South of Bridge 1st Ave	2349.44
River Rd	865.7
Bridge	352.56
Total Length	3951.7

Total Roadway reconstruction length =	3599.14	LF/lane
	0.681655303	mi/Lane
Bridge Reconstruction Length =	352.56	LF/Lane
	0.066772727	mi/Lane
Roadway & Shoulder Area =	234630.1	SF
Bridge (including Approches) Area =	19076.9607	SF

Item 0006 - Seeding Area

Side Slope Fill Area =	93168.8	SF
Work Area =	203916.4393	SF
Total Area =	6.820138643	AC

Item 0007 - Roadraise Fill Volume

Inroads Triangle Volume Report

Original Surface:	DPBM04_topo
Design Surface:	Prop_Roadway
Cut Factor:	0
Fill Factor:	1

Cut:	4133.5	cu ft
Fill:	1189302.6	cu ft
Net:	-1185169	cu ft

Cut:	153.1	cu yd
Fill:	44048.3	cu yd
Net:	-43895.2	cu yd

Total Fill Volume =	44048.3	CY

(1) Lengths and area measurement performed in microstation using the measure tool.

DPBM13 QUANTITIES COMPUTATIONS

Prepared by:	Laura Vanden Berg
Checked by:	Matt Cunningham
Date Prepared:	Apr-12
Date Checked:	Oct-12

Existing Roadway Removal & Demolition

Item	Depth (ft)	Area (SF)	Volume (CY)
PCC Pavement & Bituminous Surface	1	103233.7	3823.5
Bridge Deck	0.58	14040	303.3
Bridge steel beams	3.5		0.0

Parapet Wall & Guardrail removal	472	LF
Curb Removal	4960	LF

Item 0004 & 0005 - Roadway Reconstruction

Roadway Reconstruction Lengths

Location	[1]Length (FT)
Route 120 west of bridge	718
Route 120 east of bridge	250
Bridge length	272
Total Length	1240

Item 0006 - Seeding Area

Side Slope & Median Fill Area =	60678.2	SF
Total Area =	1.39	AC

Item 0007 - Roadraise Fill Volume

Inroads Triangle Volume Report

Original Surface:	DPBM13_topo
Design Surface:	DPBM13_ProRoad_Route120
Cut Factor:	1
Fill Factor:	1

Cut:	1000	cu ft
Fill:	538356.5	cu ft
Net:	-537356.5	cu ft

Cut:	37	cu yd
Fill:	19939.2	cu yd
Net:	-19902.1	cu yd

Total Fill Volume =	19939.2	CY

Roadway Reconstruction

Material	Depth (ft)	Area (SF)	Volume (CY)
1.5" Bituminous Concrete Surface	0.125	103233.7	477.9
11.5" Bituminous Concrete Binder Mixture	1	103233.7	3823.5
12" Sub Base Granular Fill	1	103233.7	3823.5

Concrete Curb & Gutter Replacement

Total Length = 4960 LF

Bridge Modifications

Bridge Raise Height =	2.73	FT		
	Thickness (FT)	Area (SF)	Volume (CY)	Weight (lbs)
Concrete Slab	0.583333333	14040	303.3333333	
Steel beams				38700

Extend Abutments & Pier Walls: Wall Length = 63 FT

DPLV01 QUANTITIES COMPUTATIONS

Prepared by: Faye Leffler
Date: Jan-11
Checked by: Laura Vanden Berg
Date: Oct-12

Total Length and Area of Roadraise

Location	Length (LF)	Area (SF)
Park Ln & Groveland Ave	1046.2	31983.7
Lincoln Ave	200.0	3483.9
Total	1246.2	35467.6

Existing Roadway Removal & Demolition

Roadway Stripping	Depth (ft)	Area (SF)	Volume (CY)
Bituminous Surface Course	0.25	35458.5	328.3
PCC Base Course	0.75	35458.5	985.0

Curb Removal	2492	LF

Clearing and Grubbing

Location	Area (SF)
At SSP wall	20859.0
At Floodwall	22698.1

Total =	43557	SF
	1.0	AC

Road Raise Fill

Triangle Volume Report for Road Raise Fill

Original Surface: DPLV01_topo
Design Surface: DPLV01_Roadraise
Cut Factor: 1
Fill Factor: 1

Cut:	0.1	cu ft
Fill:	133625.3	cu ft
Net:	-133625.2	cu ft

Cut:	0	cu yd
Fill:	4949.1	cu yd
Net:	-4949.1	cu yd

Total Fill Volume = 4949.1 CY

Roadway Reconstruction

Material	Depth (ft)	Area (SF)	Volume (CY)
Bituminous Surface Course	0.25	35467.6	328.4
PCC Base Course	0.75	35467.6	985.2
Sub Base Granular Fill	0.5	35467.6	656.8

Used same typical section as existing

Seeding

Roadraise Side Slope Area =	13277.1	SF
Seeding at SSP wall vicinity	20859.0	SF
Seeding at floodwall vicinity	22698.1	SF
Total	1.305	AC

Topsoil = 1052.485 CY

Concrete Curb & Gutter Replacement

Total Length = 2492 LF

Sheet Pile Wall at Groveland Ave

Sta. 0+00 to 8+67

Length of Sheet Pile =	867	LF
Depth of Sheet Pile =	20	FT
SSP Area =	17340	SF
SSP Cap Length =	867	LF

Floodwall

Sta. 9+05 to 16+24

Length of Floodwall =	719	LF
Depth of SSP =	20	FT
Depth of Concrete wall =	8	FT
SSP Area =	14380	SF
Concrete wall Area =	5752	SF
Concrete wall thickness =	1.167	FT
Concrete volume =	248.6	CY

US Army Corps of Engineers Chicago District	PROJECT TITLE: DPII - Site DPLV09 Segment 1	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: QUANTITY COMPUTATIONS	CHECKED BY: ROBERT VANOER	DATE:

Bid Item 0001 - Mobilization and Demobilization

See Cost Appendix and MII estimates for mobilization and demolization assumptions.

Bid Item 0002 - Maintenance of Traffic

See Cost Appendix and MII estimates for Maintenance of Traffic assumptions

Bid Item 0003 - Clearing and Grubbing

The clearing and grubbing areas will include the worklimits (permanent easement) and staging areas (temporary easement).
The permanent easement (worklimit area) is 15 feet from the centerline of the floodwall.
The areas were computed in microstation.

Location	Area (AC)
Work Limits (Permanent Easement Area)	2.1
Staging Area	1

Total Clearing and Grubbing Area =	3.1	AC

Bid Item 0004 - Floodwall

Floodwall	Floodwall Length (FT)	*Concrete Height (FT)	**SSP Height (FT)	Concrete Width (FT)	Concrete Volume (CY)	*SSP Area (SF)
Sta. 0+00 to 0+80	80	10.4	25.2	1.167	35.960889	2176
Sta. 0+80 to 2+00	120	17	45	1.167	88.173333	5640
Sta. 2+00 to 7+00	500	3.6	0	1.167	77.8	0
Sta. 7+00 to 10+80	380	9.9	23.7	1.167	162.602	9766
Sta. 10+80 to 15+80	500	17.2	45.6	1.167	371.71111	23800
Sta. 15+80 to 26+80	1100	10.5	25.5	1.167	499.21667	30250
Sta. 26+80 to 30+20	340	14.6	37.8	1.167	214.55511	13532
Total	3020				1450.0191	85164

Total Concrete Volume (CY) =	1450.0	CY
Total SSP Area (SF) =	85164	SF

The floodwall top elevation is 634.6
The concrete height is relative to the existing grade and varies along the alignment and height was determined from the alignment profile.
*Concrete height includes the 2ft concrete embeddment. SSP area includes the 2 feet embeddment into the concrete.
**assumed 3 SSP to 1 concrete ratio

US Army Corps of Engineers® Chicago District	**PROJECT TITLE:** DPII - Site DPLV09 Segment 1	**COMPUTED BY:** FAYE LEFFLER	**DATE:** 6/11/2013
	COMPUTATION TITLE: QUANTITY COMPUTATIONS	**CHECKED BY:** ROBERT VANOER	**DATE:**

Bid Item 0005 - Road Closures

One road closure at Algonquin Rd, 4-lane road, length = 44 FT
Assumed each lane is 11 feet.

Bid Item 0006 - Retaining Wall Modifications

An existing retaining wall is supporting River Rd between Sta 2+00 and Sta. 7+00. The retaining wall will be raised to the design elevation and also act as a floodwall.

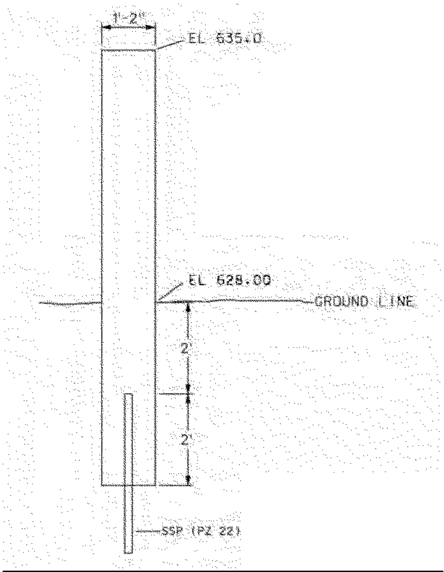
Approx. length of retaining wall =	500	LF
Assume wall is 3 feet above existing grade (628), top of wall EL =	631	EL
Levee/Floodwall Design EL =	634.6	EL
Existing retaining wall raise height =	3.6	FT

Bid Item 0007 - Interior Drainage

Interior drainage was not evaluated for the DPII study and will be evaluated during the PED phase.
From aerial views, there is an existing culvert at approx. Sta 13+00 (opposite from Oakwood Ave). There are also multiple outlets that discharges into the river.

The cost estimate for Interior Drainage was determined using Libertyville Estate levee/floodwall project.
The costs were developed using cost per linear foot of floodwall protection.
Total Length of Floodwall = 3020 FT

US Army Corps of Engineers® Chicago District	PROJECT TITLE: **DP II - Feasibility Study**	COMPUTED BY: **MWC**	DATE: **11/21/12**	SHEET: 1 of 1
	COMPUTATION TITLE: **Quantities for DPLV09 Segment 2**	CHECKED BY: **LCV**	DATE: **11/29/12**	



Average Ground Elevation = 628

<u>Ground Elevation</u>

<u>Sta</u>	<u>EL</u>
4+00	624
10+00	630
16+00	629
20+00	632
25+00	625
Average	628

Total Alignment length = 2,818 ft

Oakton St Closure Width = 100 ft

Floodwall length = 2,818 - 100

= 2,718 ft

SSP: 3 to 1 Ratio

7.0 ft of exposed concrete wall

(7.0)(3) = 21.0' deep

Sq. ft of SSP = (21.0)(2718) = <u>57,078 Sq. ft</u>

Concrete Volume : width of wall = 1'-2" = 1.17'

Total height of wall = 11.0'

Area = (11.0)(1.17) = 12.87 sq. ft

Volume = (12.87)(2718)(1/27) = <u>1,296 CY</u>

LRC Form 1272-1, October 1999

US Army Corps of Engineers® Chicago District	PROJECT TITLE: DP II - Feasibility Study	COMPUTED BY: MWC	DATE: 11/21/12	SHEET: 2 of 2
	COMPUTATION TITLE: Quantities for DPLV09 Segment 2	CHECKED BY: LCV	DATE: 11/29/12	

Recreational Trail:

Assumptions:

- 2,718 ft of trail
- Trail is on the landside of the floodwall
- Trail is placed 1 ft from the face of the floodwall
- Trail is 9 ft wide
- Geotextile fabric placed within excavated footprint of trail
- 6" of CA-7 stone placed and compacted for the base
- 3" of bituminous binder course
- 1.5" of bituminous surface course

Geotextile fabric needed:

= (10.75')(2718')(1 SY/9 SF) = 3,247 SY

Volume of CA-7 Stone Needed:

= (0.5')(9.0')(2,718')(1 CY/27 CF) = 453 CY

Area of Bituminous Binder Course (3" thickness):

= (9.0')(2,718')(1 SY/9 SF) = 2,718 SY

Area of Bituminous Surface Course (1.5" thickness):

= (9.0')(2,718')(1 SY/9 SF) = 2,718 SY

	PROJECT TITLE:	COMPUTED BY:	DATE:
US Army Corps of Engineers Chicago District	DPII - Site DPLV09 Segment 3	FAYE LEFFLER	6/11/2013
	COMPUTATION TITLE:	CHECKED BY:	DATE:
	QUANTITY COMPUTATIONS	ROBERT VANOER	

Bid Item 0001 - Mobilization and Demobilization

See Cost Appendix and MII estimates for mobilization and demolization assumptions.

Bid Item 0002 - Maintenance of Traffic

See Cost Appendix and MII estimates for Maintenance of Traffic assumptions

Bid Item 0003 - Clearing and Grubbing

The clearing and grubbing areas will include the worklimits (permanent easement) and staging areas (temporary easement).
The permanent easement (work limits) area is 15 feet from the toe of the levee or centerline line of the floodwall.
The areas were computed in microstation.

Location	Area (AC)
Work Limits (Permanent Easement Area)	4.3
Staging Area	2.4

Total Clearing and Grubbing Area =	6.7	AC

Bid Item 0004 - Floodwall

Floodwall	Floodwall Length (FT)	*Concrete Height (FT)	**SSP Height (FT)	Concrete Width (FT)	Concrete Volume (CY)	SSP Area (SF)
Sta. 0+00 to 2+25	225	6.4	13.2	1.167	62.24	3420
Sta. 2+25 to 11+95	970	12.5	31.5	1.167	524.06944	32495
Sta. 23+67 to 25+30	163	13.4	34.2	1.167	94.405978	5900.6
Sta. 25+30 to 30+75	545	17.3	45.9	1.167	407.52072	26105.5
Sta. 30+75 to 34+22	347	11.3	27.9	1.167	169.47866	10375.3
Total	2250				1257.7148	78296.4

Total Concrete Volume (CY) =	1257.7	CY
Total SSP Area (SF) =	78296.4	SF

The levee/floodwall top elevation: Sta 0+00 to 16+00, EL 633.7; Sta. 16+00 to 53+97, EL 633.4
The concrete height is relative to the existing grade and varies along the alignment and height was determined from the alignment profile.
*Concrete height includes the 2ft concrete embeddment. SSP area includes the 2 feet embeddment into the concrete.
**assumed 3 SSP to 1 concrete ratio

US Army Corps of Engineers Chicago District	PROJECT TITLE: DPII - Site DPLV09 Segment 3	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: QUANTITY COMPUTATIONS	CHECKED BY: ROBERT VANOER	DATE:

Bid Item 0005 - Levee

Stripping

The base of the levee will be stripped 1ft deep.
The base of the levee was determined by multipling the true area of the levee perimeter by 1ft.
The levee perimeter was developed from the levee surface inroads. The surface area was then computed in inroads using the levee perimeter and the existing grade surface.
The area provided in the table below was developed from an inroads surface area report (see earthwork computations).

Levee	Area (SF)	Depth (1FT)	Volume (CY)
Levee1	16020.6	1	593.3555556
Levee2	28751.8	1	1064.881481
Total			1658.237037

Imprevious Fill

The imprevious fill (levee fill) was computed using average end-area method in Inroads with cross-section cuts every 100 ft (see earthwork computations).
The levee is 10-feet wide at the top with 1(V):3(H) side slopes.
The total imprevious fill includes the volume of the levee fill and stripping.

Levee	Levee Volume (CY)	Strip Volume (CY)	Total
Levee1	1482.3	593.3555556	2075.655556
Levee2	3382.3	1064.881481	4447.181481
Total			6522.837037

Bid Item 0006 - Interior Drainage

Interior drainage was not evaluated for the DPII study and will be evaluated during the PED phase.
From aerial views, multiple outlets were observed that discharges into the river.

The cost estimate for Interior Drainage was determined using Libertyville Estate levee/floodwall project.
The costs were developed using cost per linear foot of floodwall protection.

Total Length of Floodwall =	2250	FT
Total Length of Levee =	3197	FT

US Army Corps of Engineers, Chicago District	PROJECT TITLE: DPII - Site DPLV09 Segment 3	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: Earthwork Inroads Report	CHECKED BY: ROBERT VANOER	DATE:

Impervious Fill

oss Section Set Name: Levee 2
Alignment Name: Floodwall/Levee
Input Grid Factor: 1

Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities								Added Quantities						Mass Ordinate
	Cut				Fill				Cut			Fill			
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Factor	Volume	Adjusted	Factor	Volume	Adjusted	
34+00.00	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0
35+00.00	1	0	0	0	1	212	392.7	392.7	1	0	0	1	0	0	-392.7
36+00.00	1	0	0	0	1	78.7	538.4	538.4	1	0	0	1	0	0	-931.1
37+00.00	1	0	0	0	1	72.2	279.5	279.5	1	0	0	1	0	0	-1210.6
38+00.00	1	0	0	0	1	71.8	266.7	266.7	1	0	0	1	0	0	-1477.3
39+00.00	1	0	0	0	1	71.3	265	265	1	0	0	1	0	0	-1742.3
40+00.00	1	0	0	0	1	72.2	265.8	265.8	1	0	0	1	0	0	-2008.1
41+00.00	1	0	0	0	1	72.2	267.5	267.5	1	0	0	1	0	0	-2275.6
42+00.00	1	0	0	0	1	66.6	257.2	257.2	1	0	0	1	0	0	-2532.7
43+00.00	1	0	0	0	1	41.2	199.8	199.8	1	0	0	1	0	0	-2732.5
44+00.00	1	0	0	0	1	18.9	111.3	111.3	1	0	0	1	0	0	-2843.8
45+00.00	1	0	0	0	1	15.2	63.2	63.2	1	0	0	1	0	0	-2907
46+00.00	1	0	0	0	1	15.2	56.4	56.4	1	0	0	1	0	0	-2963.4
47+00.00	1	0	0	0	1	15.2	56.4	56.4	1	0	0	1	0	0	-3019.8
48+00.00	1	0	0	0	1	1.8	31.5	31.5	1	0	0	1	0	0	-3051.3
49+00.00	1	0	0	0	1	4.7	12	12	1	0	0	1	0	0	-3063.3
50+00.00	1	0	0	0	1	15.2	36.9	36.9	1	0	0	1	0	0	-3100.2
51+00.00	1	0	0	0	1	15.2	56.4	56.4	1	0	0	1	0	0	-3156.6
52+00.00	1	0	0	0	1	15.2	56.4	56.4	1	0	0	1	0	0	-3213
53+00.00	1	0	0	0	1	38.1	98.8	98.8	1	0	0	1	0	0	-3311.8
53+97.35	1	4.7	8.5	8.5	1	0.9	70.5	70.5	1	0	0	1	0	0	-3373.8
Grand Total:			8.5	8.5			**3382.3**	**3382.3**		0	0		0	0	

oss Section Set Name: Levee 1
Alignment Name: Floodwall/Levee
Input Grid Factor: 1

Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities								Added Quantities						Mass Ordinate
	Cut				Fill				Cut			Fill			
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Factor	Volume	Adjusted	Factor	Volume	Adjusted	
12+00.00	1	0	0	0	1	56.2	0	0	1	0	0	1	0	0	0
13+00.00	1	0	0	0	1	38	174.6	174.6	1	0	0	1	0	0	-174.6
14+00.00	1	0	0	0	1	32	129.7	129.7	1	0	0	1	0	0	-304.2
15+00.00	1	0	0	0	1	43.5	139.7	139.7	1	0	0	1	0	0	-443.9
16+00.00	1	0	0	0	1	45.6	164.8	164.8	1	0	0	1	0	0	-608.7
17+00.00	1	0	0	0	1	30.3	140.4	140.4	1	0	0	1	0	0	-749.1
18+00.00	1	0	0	0	1	17.8	88.9	88.9	1	0	0	1	0	0	-838.1
19+00.00	1	0	0	0	1	15.2	61.1	61.1	1	0	0	1	0	0	-899.1
20+00.00	1	0	0	0	1	26.2	76.6	76.6	1	0	0	1	0	0	-975.8
21+00.00	1	0	0	0	1	41.2	124.8	124.8	1	0	0	1	0	0	-1100.5
22+00.00	1	0	0	0	1	41.2	152.7	152.7	1	0	0	1	0	0	-1253.2
23+00.00	1	0	0	0	1	41.2	152.7	152.7	1	0	0	1	0	0	-1405.9
24+00.00	1	0	0	0	1	0	76.3	76.3	1	0	0	1	0	0	-1482.3
Grand Total:			0	0			**1482.3**	**1482.3**		0	0		0	0	

US Army Corps of Engineers. Chicago District	PROJECT TITLE: DPII - Site DPLV09 Segment 3	COMPUTED BY: FAYE LEFFLER	DATE: 8/11/2013
	COMPUTATION TITLE: Earthwork Inroads Report	CHECKED BY: ROBERT VANDER	DATE:

US Army Corps of Engineers® Chicago District	PROJECT TITLE: DPII - Site DPLV09 Segment 3	COMPUTED BY: FAYE LEFFLER	DATE: 8/11/2013
	COMPUTATION TITLE: Earthwork Inroads Report	CHECKED BY: ROBERT VANOER	DATE:

Stripping Surface Area

Surface Area Report for Levee 1

Surface: DPLV09 Existing Topo
Fence Mode: Inside

True Area: sq ft	16020.6	SF
Planar Area: sq ft	16019.6	SF

Surface Area Report for Levee 2

Surface: DPLV09 Existing Topo
Fence Mode: Inside

True Area: sq ft	28751.8	SF
Planar Area: sq ft	28681.2	SF

DPRS15-Option 1 QUANTITIES COMPUTATIONS

Prepared by: Damian Allen
Date Prepared: Jan-12
Checked by: Laura Vanden Berg
Date Checked: Oct-12

Item 0003 - Clearing and Grubbing Area

Location	Area (AC)
Work Limts Area =	93.16
Reservoir Area	28.6
Staging Area	0.7
Spoil Area	12.3

Total Clearing and Grubbing Area = 41.6 AC

1. The clearing areas includes the reservoir, spoil, and staging area.
2. Entire site area contains trees.

Item 0004 - Topsoil Stripping

Topsoil Strip Volume
Reservoir Area = 45697.99 CY

1. 12" Topsoil will be stripped within the reservoir footprint.
2. Adjacent areas will be stripped to get more topsoil needed for seeding.

Item 0005AA & AB - Reservoir Excavation/Fill Volume

Inroads Triangle Volume Report
Original Surface: DPLV7A_Topo
Design Surface: DPLV7A_Resvr
Cut Factor: 1
Fill Factor: 1

Reservoir Clay Cut:	457285.4	CY
Topsoil Strip:	45697.99	CY
Total Clay Cut =	411587.41	CY
Reservoir Fill:	5210	CY

1. Total Clay Cut = Clay Cut - Topsoil Strip
2. Clay Cut includes reservoir and drainage swale.
3. Total Fill =

Bid Item 005AC & AD Reservoir Respread/Seeding

Reservoir Area =	1245065	SF
	28.58	AC
Topsoil Respread =	23056.76	CY

1. Topsoil respread = 6"

Item 0006 - Spoil Placement

Approximate height = 12 FT
Side Slopes = 1(V):4(H)

Total Spoil Fill =		406377.41	CY
Spoil Seeding Area =		1204305.4	SF
		27.65	AC
Topsoil Respread =		602152.7	CF
		22301.95	CY

1. Total Spoil Fill = Inroads Fill Vol. - Spoil Tsoil Respread Vol.
2. Topsoil respread = 6"

Item 0007- Storm Drain Structures

Length of 30" RCP = 350 LF
Riprap = 1.85 CY

1. Pipe measured in microstation
2. Riprap placed at upstream/downstream invert of 30" outfall pipe.
3. Riprap assumes 1' deep x 5'x5' area.

Item 0009/00010 - Excess Material Haul-Off

Topsoil Strip Volume
Unused Clay = 0.00 CY
Unused Topsoil = 339.28 CY

1. Unused Clay = Total Reservoir Cut - Reservoir Fill - Spoil Fill
2. Unused Topsoil = Reservoir Tsoil Strip - Reservoir Tsoil Respread - Spoil Tsoil Respread

DPRS15 QUANTITIES COMPUTATIONS

Prepared by: Laura Vanden Berg
Date: 9/25/2012
Checked by: Matt Cunningham
Date: 10/17/2012

Item 0003 - Clearing and Grubbing Area

Location	Area (AC)
Work Limts Area =	93.16
Reservoir Area	55.2
Staging Area	0.7
Spoil Area	0.0

Total Clearing and Grubbing Area = 55.9 AC

1. The clearing areas includes the reservoir, spoil, and staging area.
2. Entire site area contains trees.

Item 0004 - Topsoil Stripping

Topsoil Strip Volume
Reservoir Area = 92365.33 CY

1. 12" Topsoil will be stripped within the reservoir footprint.
2. Adjacent areas will be stripped to get more topsoil needed for seeding.

Item 0005AA & AB - Reservoir Excavation/Fill Volume

Inroads Triangle Volume Report
Original Surface: DPLV7A_Topo
Design Surface: DPLV7A_Resvr
Cut Factor: 1
Fill Factor: 1

Reservoir Clay Cut:	1198770.9	CY
Topsoil Strip:	92365.33	CY
Total Clay Cut =	1106405.57	CY
Reservoir Fill:	3083	CY

1. Total Clay Cut = Clay Cut - Topsoil Strip
2. Clay Cut includes reservoir and drainage swale.
3. Total Fill =

Bid Item 005AC & AD Reservoir Respread/Seeding

Reservoir Area =	2507525.6 57.56	SF AC
Topsoil Respread =	46435.66	CY

1. Topsoil respread = 6"

Item 0009/00010 - Excess Material Haul-Off

Topsoil Strip Volume

Unused Clay =	1103322.57 CY
Unused Topsoil =	45929.67 CY

1. Unused Clay = Total Reservoir Cut - Reservoir Fill
2. Unused Topsoil = Reservoir Tsoil Strip - Reservoir Tsoil Respread

FDRS01 QUANTITIES COMPUTATIONS

Prepared by:	Adam Tennant	
Checked by:	Brian Kootstra	Laura Vanden Berg
Date:	Jan-10	Oct-12

Item 0003 - Clearing and Grubbing Area

Assumptions: Area includes the PE Area and spoil area

Location	Area (AC)
RES	335.3
Spoil Area	113.3
Total Area =	448.6

(1)Area calculated from Inroads
There areas are dense with trees

Item 0005 - Reservoir Excavation

Cut: 3234682.4 CY

(1)The total cut volume includes the cut volume for the levee.

Item 0007 AA - Levee Fill Volume

Inroads Triangle Volume Report for Levee Fill

Original Surface:	DPRS24_topo
Design Surface:	DPRS24_Levee
Cut Factor:	1
Fill Factor:	1

Cut:	3234682.4	cu yd
Fill:	68303.4	cu yd
Net:	3166379	cu yd

Fill Volume =		68303.4	CY

At a small portion of the levee alignment, the top of levee elevation is lower than the existing grade . Therefore, there are cut volumes in the levee volume report. The cut volume is considered under the reservoir excavation volume.

Item 0007 AB - Levee Trench Fill

Levee Trench

Assumptions:	Width =	3	FT
	Depth =	5	FT
Length of Levee =		15502.3	FT
Trench Fill/Excavation Volume =		8612.38889	CY

Item 0008 - Spoil Construction

(1)Spoil Fill Required =		3166379	CY
		1962.64	AC-FT
Available Spoil Fill =		3205682	CY
Spoil Seeding Area =		113.3	AC
		4936554.4	SF
(2)Topsoil =		2468277.2	CF
		91417.6741	CY

(1)Spoil Fill = Reservoir Excavated Vol - Levee Fill Vol
The trench fill volume in not include with the spoil volume, becauce the trench excavated material balances with the trench fill material from the reservoir excavated volume.

(2)Assumed 6" Topsoil

Item 0007 AD - Levee Seeding Area

	Topsoil Stripping		Seeding Area	
Location	Planar Area (SF)	Topsoil Stripping (CY)(1)	True Area (SF)	Topsoil Vol. (CY)(3)
Levee Footprint	545550.60	20205.5778	545550.60	10102.79
PE Area(2)	235707.52	8729.908	235707.52	4364.954
Total =	781258.116	28935.4858	781258.12	14467.74

Levee Seeding Area =	17.9352185	AC

(1)Use 12inches for the topsoil stripping depth
(2)Area between the PE line and Levee outer toe. Area determined in microstation
(3)Use 6" for topsoil placement

Item 0006 - Topsoil Stripping

Assumptions: Topsoil will be stripped within the levee footprint and the 15 FT permanent easement (PE) area.
Adjacent areas will be stripped to get more topsoil needed for seeding
12" Topsoil will be stripped.

Required Topsoil Volume

Levee Seeding =		14467.7429	CY
Spoil Areas =		91417.6741	CY
Total =		105885.417	CY

Available Topsoil Volume

Levee Footprint=		20205.5778	CY
PE Area =		8729.908	CY
Levee Footptint + PE =		28935.4858	CY
Adjacent Areas =		76949.9312	CY
Total Stripping Topsoil Vol =		105885.417	CY

Item 0009 - Pump Station.

Pumpstation

Flow =		?200	cfs
Pumping Days =		?2	Days
36" Inlet RCP =		252	LF
36" Outlet RCP =		83	LF
		335	LF

Item 0011AA - 24" RCP

24" Inlet RCP 347 LF

Item 0004 Concrete Spillway

Weir Length =		305	FT
Weir Top EL =		637.3	FT
Weir Ext Toe EL =		627	FT
Weir Int Toe EL =		628	FT
x-Area =		82	SF
concrete volume=		926.296296	CY

Item 0004 Concrete Spillway

Weir Length =	305	FT
Weir Width =	40	FT
Weir Top EL =	642.7	

FPCI01 QUANTITIES COMPUTATIONS

Prepared by:	Faye Leffler
Checked by:	Laura Vanden Berg
Date prepared:	Apr-10
Date checked	Oct-12

Clearing and Grubbing

North Area to be cleared =	27127.16	SF
South Area to be cleared =	20550.87	SF
Total Area =	47678.03	SF
	1.094537	AC

Earthwork

Triangle Volume Report for Pumpstation and pipe structures excavation

Original Surface:	FPCI01_topo
Design Surface:	FPCI01_Pipe_Excavation
Cut Factor:	1
Fill Factor:	1

Cut:	40282.7	cu ft
Fill:	0	cu ft
Net:	40282.6	cu ft
Cut:	1492	cu yd
Fill:	0	cu yd
Net:	1491.9	cu yd

Total Cut Volume =	1492 CY

Restoration Seeding

Excavated Area =	10603	SF
Pumpstation Area =	400	SF
Seeding Area =	10203	SF
	0.234229	AC

Storm Sewers

Pumpstation Intake Pipe Length (12" RCP) =	60	LF
Pumpstation 12" RCP outlet pipe (w/o pipe jacking) =	255	LF
Pumpstation 12" RCP outlet pipe (with pipe jacking) =	120	LF

Erosion Control

Riprap Area = 350 SF

Pumpstation

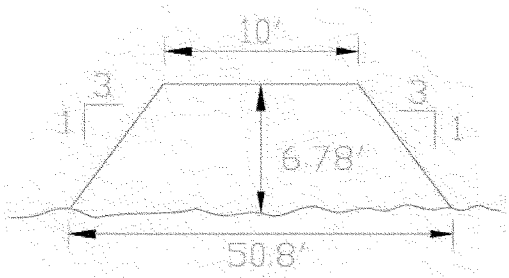
*Pumps = Two - 5 cfs pumps

*Pump design provided by IDNR

US Army Corps of Engineers® Chicago District	PROJECT TITLE: DP II - Feasibility Study	COMPUTED BY: MWC	DATE: 8/30/11	SHEET: 1 of 1
	COMPUTATION TITLE: Quantities for Site DPLV15	CHECKED BY: LCV	DATE: 10/4/12	

DPLV15

Levee Segment is 2,938 LF. Average height of the levee is 6.78 ft.



- Stripping 1ft of mat'l : [(50.8ft)(1ft)(2,938ft)]/27 = 5,528 CY
- Clay Needed for the Levee: 21,911 CY (from InRoads)
- Slit Trench: [(5 ft)(1.5 ft)(2,938 ft)]/27 = 816 CY
- 6" topsoil needed : [(53ft)(0.5ft)(2,938ft)]/27 = 2,884 CY
- Total clay needed: (21,911) + (5,528) - (2,884) + (816) = 25,371 CY

Permanent Easement Area = 6.8 acres

Temporary Easement Area = 2.2 acres

Total seeding = (6.8) + (2.2) = 9 acres

LRC Form 1272-1, October 1999

SCME02 QUANTITIES COMPUTATIONS

Prepared by: Faye Leffler
Checked by: Laura Vanden Berg
Prepared Date: Apr-10
Checked Date: Oct-12

Demolition		
Items to be demolished		
Strip exising erosion cell grout at spillway, Area =	17987	SF
Demolition Spillway Inlet/headwall		
Remove 6" existing perforated underdrain pipe =	4400	LF
Remove 6" existing solid underdrain pipe =	1600	LF
Remove 12" existing solid underdrain pipe =	500	LF
Remove existing manholes and inlets		
Remove existng pumpstation intake inlet structure		

Reservoir Excavation Volume

Inroads Triangle Volume Report for East and West Reservoir Excavation
Original Surface: SCME02_topo
Design Surface: SCME02_PropReservoir
Cut Factor: 1
Fill Factor: 1

Cut:	5715824.2	cu ft
Fill:	2479.8	cu ft
Net:	5713344.5	cu ft
Cut:	211697.2	cu yd
Fill:	91.8	cu yd
Net:	211605.4	cu yd

Total Cut Volume =	211697.2 CY

Bid Item 0017 Reservoir Seeding

Reservoir Area =	722573.4	SF
	16.588	AC
Topsoil Vol =	13380.99	CY

Utility Modifications		
Existing Equalizer Pipe		
Fill Exising 60" equalizer pipe, Total length =	183	FT
Fill Volume =	133.0139	CY
Pumpstation Intake Pipe		
Extend intake pipe =	33	FT

Access Roadway		
Realigned Access Road Horizontal Length =	150	FT
Longitudinal Slope =	10	%
True Legnth =	150.7481	FT
Access Road Width =	16	FT
Roadway Area =	2411.97	SF

Modify Existing Spillway		
Extend Chute Spillway =	33	FT
Erosion Cell Grout =	18699.9	SF
Filter Fabric =	18699.9	SF

Equilizer Pipe

New Pipe Length = 240 FT

Item 0008 - Spoil Construction

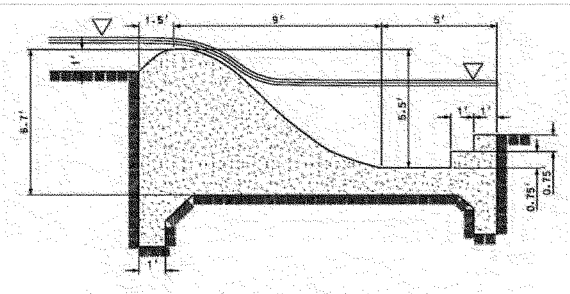
Spoil Height = 23 FT

Side Slopes = 1(V):5(H)

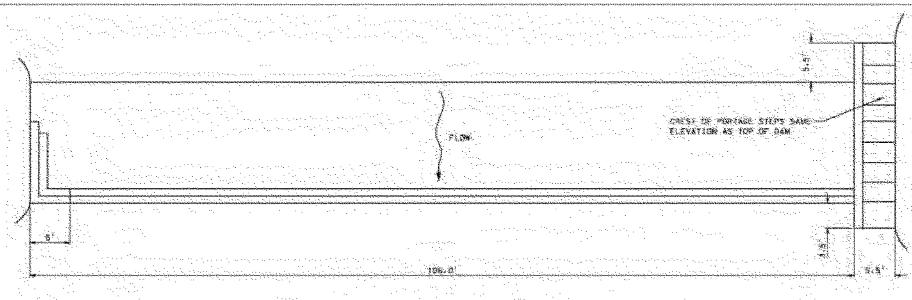
Spoil Fill Required =		211697.2	CY
		131.22	AC-FT
Available Spoil Fill #1 =		206542.8	CY
Spoil Seeding Area =		384983.9	SF
		8.8	AC
[1]Topsoil =		192492	CF
		7129.331	CY

[1]Assumed 6" Topsoil

US Army Corps of Engineers® Chicago District	PROJECT TITLE: DP II - Feasibility Study	COMPUTED BY: MWC	DATE: 10/20/11	SHEET: 1 of 2
	COMPUTATION TITLE: Quantities for Touhy Dam Removal	CHECKED BY: AK	DATE: 10/21/11	



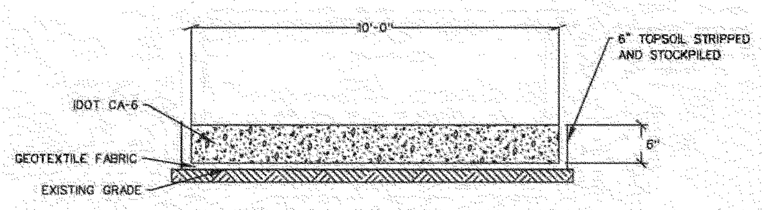
TOUHY AVENUE DAM CROSS SECTION



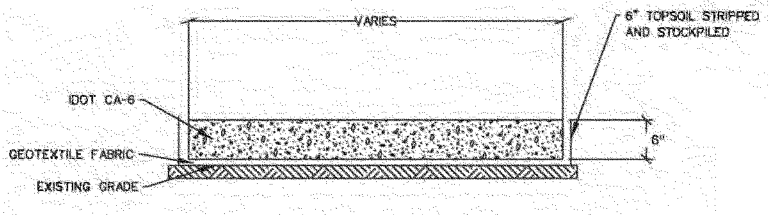
TOUHY AVENUE DAM PLAN VIEW

- The clearing and grubbing area is based on the temporary access road and staging/storage area layout.
- The area for the access road and staging/storage area was measured in the site layout drawing file, Touhy_Dam_Site_Plan_2D.dgn, stored in ProjectWise
- Clearing and grubbing area = 30,060.6 sq. ft = 0.7 acres
- Landscape restoration is equal to the acres for clearing and grubbing = 0.7 acres
- Sediment removal is approx. 50 CY. The assumption was made that less sediment is present than at previously surveyed dams on the river such as Armitage dam.
- Total temporary chain link fencing, 6 ft high = 2,181 ft
- The temporary fencing was measured along the work limits up to the approx. river edge seen in the aerial photo. 10 ft was deducted from the total fencing to allow for the gate at the site entrance
- One temporary 10 ft wide, 6 ft high gate at site entrance required

US Army Corps of Engineers® Chicago District	PROJECT TITLE: **DPII - Feasibility Study**	COMPUTED BY: **MWC**	DATE: **10/20/11**	SHEET: 2 of 2
	COMPUTATION TITLE: **Quantities for Touhy Dam Removal**	CHECKED BY: **AK**	DATE: **10/21/11**	



TOUHY DAM GRAVEL ACCESS ROAD (TYP)
N.T.S.



TOUHY DAM GRAVEL STAGING & STORAGE (TYP)
N.T.S.

- Stripping 6" of topsoil from the temp. access road and staging/storage area
  = (30,060.6 sq. ft)(0.5 ft)(1 CY/27 cu. Ft) = 556.7 CY
- Unit weight of IDOT CA-6 stone is approx. 130 lb/cu. Ft
- IDOT CA-6 stone needed for temp. access road and staging/storage area
  = (30,060.6 sq. ft)(0.5 ft)(130 lb/cu. Ft)(1 ton/2,000 lb) = 977.0 tons
- Geotextile fabric for staging/storage area:
  = (75 ft)(85 ft)(1 sq. ft/9 SY) = 708.3 SY
- Geotextile fabric for temporary access road:
  = (23,710.8 sq. ft)(1 sq. ft/9 SY) = 2,634.5 SY
- Dam is made of reinforced concrete
- Dam concrete volume = (58.2 sq. ft)(106.0 ft)(1 CY/27 cu. Ft) = 228.5 CY
- Take 25% of the dam volume for the wing walls and stairs = 57.1 CY
- Total Concrete volume for the dam = (228.5 CY + 57.1 CY) = 285.6 CY

LRC Form 1272-1, October 1999

WLME01 QUANTITIES COMPUTATIONS

Prepared by: Faye Leffler
Checked by: Laura Vanden Berg
Prepared Date: Apr-10
Checked Date: Oct-12

Demolition

Items to be demolished
Existing Pedestrian Bridge = 150 LF

Item 0003 - Clearing and Grubbing Area

Location	Area (AC)
Spoil Area 1	0.0
*Spoil Area 2	7.0
Total Area =	7.0

*Clearing and Grubbing Area = 3.5 AC

*Approximately half of the site at Spoil area 2 contains trees. Assume 50% of the site will be cleared.

Item 0004 - Reservoir Expansion Excavation Volume

Inroads Triangle Volume Report
Original Surface: WLME01_topo
Design Surface: WLME01_ReservoirExpansion
Cut Factor: 1
Fill Factor: 1

Cut:	7020614.7	cu ft
Fill:	178895.4	cu ft
Net:	6841719.3	cu ft

Cut:	260022.8	cu yd
Fill:	6625.8	cu yd
Net:	253397	cu yd

Total Cut Volume = 253397 CY

Items 0007 AA, 0007 AB and 0007 AC - Spoil Construction			
Spoil #1 Approximate Height =		14 FT	
Spoil #1 Side Slopes =		Varies from 1(V):6(H) to 1(V):12(H)	
Spoil #2 Approximate Height =		Varies from 18 to 28 feet	
Spoil #2 Side Slopes =		Varies from 1(V):2.5(H) to 1(V):5(H)	
Spoil Fill Required =		253397	CY
		157.06	AC-FT
Available Spoil Fill #1 =		89321.8	CY
Available Spoil Fill #2 =		160194.2	CY
Total =		249516	CY
Seeding Area #1 =		296583.5	SF
Seeding Area #2 =		311234.4	SF
Total =		607817.9	SF
		14.0	AC
[(1)]Topsoil =		303908.95	CF
		11255.887	CY

[(1)]Assumed 6" Topsoil

Item 0005 - Topsoil Stripping

Assumptions: Topsoil will be stripped within the reservoir expanded area and spoil areas.
Topsoil willl be imported, if more topsoil is needed.
6" Topsoil will be stripped.

Required Topsoil Volume

Spoil Areas =		11255.887	CY
Reservoir =		8105.32037	CY
Total =		19361.2074	CY

Available Topsoil Volume

Spoil Area 1 =		5455.6537	CY
Spoil Area 2 =		5643.30741	CY
Expanded Reservoir Area =		7713.90185	CY
Available Topsoil Total =		18812.863	CY
Import Topsoil =		548.344444	CY
Total =		19361.2074	CY

Total Stripping Topsoil Vol =		19361.2074	CY

Bid Item 0011 Reservoir Seeding

Reservoir Area =	437687.3	SF
	10.0479178	AC

Topsoil Vol =	8105.32037	CY

Item 0010 - Storm Drainage Structures

18" Underdrain Storm System	1800	LF

US Army Corps of Engineers, Chicago District	PROJECT TITLE: DPII - Site DPLV04	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: QUANTITY COMPUTATIONS	CHECKED BY: ROBERT VANOER	DATE:

Bid Item 0001 - Mobilization and Demobilization

See Cost Appendix and MII estimates for mobilization and demolization assumptions.

Bid Item 0002 - Maintenance of Traffic

See Cost Appendix and MII estimates for Maintenance of Traffic assumptions

Bid Item 0003 - Clearing and Grubbing

The clearing and grubbing areas will include the worklimits (permanent easement) and staging areas (temporary easement).
The permanent easement (work limits) area is 15 feet from the toe of the levee or centerline line of the floodwall.
The areas were computed in microstation.

Location	Area (AC)
Work Limits (Permanent Easement Area)	6.8
Staging Area	4.6

Total Clearing and Grubbing Area =	11.4	AC

Bid Irem 0004 - Floodwall

Floodwall	Floodwall Length (FT)	*Concrete Height (FT)	**SSP Height (FT)	Concrete Width (FT)	Concrete Volume (CY)	SSP Area (SF)
Sta. 6+20 to 14+70	850	15.4	40.2	1.167	565.77889	35870
Sta. 34+00 to 47+40	1340	17.2	45.6	1.167	996.18578	63784
Total	2190				1561.9647	99654

Total Concrete Volume (CY) =	1562.0	CY
Total SSP Area (SF) =	99654	SF

The levee/floodwall top elevation: EL 628.39
The concrete height is relative to the existing grade and varies along the alignment and height was determined from the alignment profile.
*Concrete height includes the 2ft concrete embeddment. SSP area includes the 2 feet embeddment into the concrete.
**assumed 3 SSP to 1 concrete ratio

Bid Item 0005 - Road Closures

Road closure at W. Grand Ave, 4-lane road plus one turning lane, length =	55	FT
Road closure at River Rd, 4-lane road plus 8 ft wide median =	52	FT

Assumed each lane is 11 feet.

US Army Corps of Engineers, Chicago District	PROJECT TITLE: DPII - Site DPLV04	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: QUANTITY COMPUTATIONS	CHECKED BY: ROBERT VANOER	DATE:

Bid Item 0006 - Levee

Stripping

The base of the levee will be stripped 1ft deep.
The base of the levee was determined by multipling the true area of the levee perimeter by 1ft.
The levee perimeter was developed from the levee surface inroads. The surface area was then computed in inroads using the levee perimeter and the existing grade surface.
The area provided in the table below was developed from an inroads surface area report (see earthwork computations).

Levee	Area (SF)	Depth (1FT)	Volume (CY)
Levee1	10830.3	1	401.1222222
Levee2	49324.4	1	1826.82963
Levee3	17382.7	1	643.8037037
Levee4	3428.6	1	126.9851852
Total			2998.740741

Impervious Fill

The impervious fill (levee fill) was computed using average end-area method in Inroads with cross-section cuts every 100 ft (see earthwork computations).
The levee is 10-feet wide at the top with 1(V):3(H) side slopes.
The total impervious fill includes the volume of the levee fill and stripping.

Levee	Levee Volume (CY)	Strip Volume (CY)	Total
Levee1	2083.9	401.1222222	2485.022222
Levee2	16851.9	1826.82963	18678.72963
Levee3	2629.4	643.8037037	3273.203704
Levee4	76.7	126.9851852	203.6851852
Total			24640.64074

Bid Item 0007 - Road Raise at 5th Ave.

Existing Conditions:
Assumptions: 4-lane road, 11 feet wide lane, no shoulders
Total Width of Road: 44 feet

Design Parameters

Road raise elevation at levee =	628.39	
Longitudinal slope =	1%	
Cross slope =	1.50%	
Side Slopes =	1(V):2(H)	
Number of Lanes =	4	
Lane Width =	11	FT
No Shoulders		

Road Reconstruction

Road Reconstruction includes removal of existing roadway and curbs.
Assumed existing roadway depth is 1 foot. The surface area of the existing road is also the proposed road surface area and determined in inroads (see earthwork computation).

Roadway Demo	Depth (ft)	Area (SF)	Volume (CY)
Bituminous Surface Course & PCC Base Course	1	16409.7	607.8

Road Reconstruction	Depth (ft)	Area (SF)	Volume (CY)
PCC Base Course	0.8125	16409.7	493.8
Sub Base Granular Fill	0.5	16409.7	303.9

Assumed portland cement concrete pavement will be placed:

Road Fill

The road fill was computed using average end-area method in Inroads with cross-section cuts every 50 ft (see earthwork computations).

Road Fill =	583.9 CY

US Army Corps of Engineers Chicago District	PROJECT TITLE: DPII - Site DPLV04	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: QUANTITY COMPUTATIONS	CHECKED BY: ROBERT VANOER	DATE:

Bid Item 0007 - Interior Drainage

Interior drainage was not evaluated for the DPII study and will be evaluated during the PED phase.
From aerial views, multiple outlets were observed that discharges into the river.

The cost estimate for Interior Drainage was determined using Libertyville Estate levee/floodwall project.
The costs were developed using cost per linear foot of floodwall protection.

Total Length of Floodwall =	2190	FT
Total Length of Levee =	4240	FT

US Army Corps of Engineers, Chicago District	PROJECT TITLE: DPII - Site DPLV04	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: EARTHWORK INROADS REPORT	CHECKED BY: ROBERT VANOER	DATE:

Impervious Fill

›ss Section Set Name: Levee 1
Alignment Name: Levee/Floodwall
Input Grid Factor: 1

Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities								Added Quantities						Mass Ordinate
	Cut				Fill				Cut			Fill			
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Factor	Volume	Adjusted	Factor	Volume	Adjusted	
0+00.00	1	6.1	0	0	1	0	0	0	1	0	0	1	0	0	0
1+00.00	1	0	11.3	11.3	1	53.4	98.8	98.8	1	0	0	1	0	0	-87.5
2+00.00	1	0	0	0	1	232	528.4	528.4	1	0	0	1	0	0	-615.9
3+00.00	1	0	0	0	1	72.3	563.5	563.5	1	0	0	1	0	0	-1179.3
4+00.00	1	0	0	0	1	59.9	244.9	244.9	1	0	0	1	0	0	-1424.2
5+00.00	1	0	0	0	1	67.3	235.7	235.7	1	0	0	1	0	0	-1659.9
6+00.00	1	0	0	0	1	77.8	268.7	268.7	1	0	0	1	0	0	-1928.6
7+00.00	1	0	0	0	1	0	144	144	1	0	0	1	0	0	-2072.6
Grand Total:			11.3	11.3			**2083.9**	**2083.9**		0	0		0	0	

›ss Section Set Name: Levee 2
Alignment Name: Levee/Floodwall
Input Grid Factor: 1

Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities								Added Quantities						Mass Ordinate
	Cut				Fill				Cut			Fill			
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Factor	Volume	Adjusted	Factor	Volume	Adjusted	
15+00.00	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0
16+00.00	1	0	0	0	1	168.2	311.5	311.5	1	0	0	1	0	0	-311.5
17+00.00	1	0	0	0	1	185.5	655.1	655.1	1	0	0	1	0	0	-966.6
18+00.00	1	0	0	0	1	256	817.6	817.6	1	0	0	1	0	0	-1784.2
19+00.00	1	0	0	0	1	220.9	883.2	883.2	1	0	0	1	0	0	-2667.4
20+00.00	1	0	0	0	1	244.6	862.1	862.1	1	0	0	1	0	0	-3529.5
21+00.00	1	0	0	0	1	266.4	946.2	946.2	1	0	0	1	0	0	-4475.7
22+00.00	1	0	0	0	1	273.5	999.7	999.7	1	0	0	1	0	0	-5475.4
23+00.00	1	0	0	0	1	277.9	1021.1	1021.1	1	0	0	1	0	0	-6496.5
24+00.00	1	0	0	0	1	292.9	1057	1057	1	0	0	1	0	0	-7553.6
25+00.00	1	0	0	0	1	253.2	1011.3	1011.3	1	0	0	1	0	0	-8564.9
26+00.00	1	0	0	0	1	220.9	878.1	878.1	1	0	0	1	0	0	-9442.9
27+00.00	1	0	0	0	1	218.1	812.9	812.9	1	0	0	1	0	0	-10255.9
28+00.00	1	0	0	0	1	244.1	855.8	855.8	1	0	0	1	0	0	-11111.7
29+00.00	1	0	0	0	1	252.4	919.4	919.4	1	0	0	1	0	0	-12031.1
30+00.00	1	0	0	0	1	261.7	952.1	952.1	1	0	0	1	0	0	-12983.2
31+00.00	1	0	0	0	1	259.5	965.2	965.2	1	0	0	1	0	0	-13948.4
32+00.00	1	0	0	0	1	264.9	971	971	1	0	0	1	0	0	-14919.4
33+00.00	1	0.1	0.1	0.1	1	269.8	990.1	990.1	1	0	0	1	0	0	-15909.3
34+00.00	1	0	0.1	0.1	1	239.1	942.4	942.4	1	0	0	1	0	0	-16851.6
Grand Total:			0.3	0.3			**16851.9**	**16851.9**		0	0		0	0	

US Army Corps of Engineers, Chicago District	PROJECT TITLE: DPII - Site DPLV04	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: EARTHWORK INROADS REPORT	CHECKED BY: ROBERT VANDER	DATE:

ss Section Set Name: Levee 3
Alignment Name: Levee/Floodwall
Input Grid Factor: 1

Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities – Cut Factor	Cut Area	Cut Volume	Cut Adjusted	Fill Factor	Fill Area	Fill Volume	Fill Adjusted	Added Quantities – Cut Factor	Cut Volume	Cut Adjusted	Fill Factor	Fill Volume	Fill Adjusted	Mass Ordinate
48+00.00	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0
49+00.00	1	0	0	0	1	193.4	358.1	358.1	1	0	0	1	0	0	-358.1
50+00.00	1	0	0	0	1	89.4	523.7	523.7	1	0	0	1	0	0	-881.8
51+00.00	1	0	0	0	1	77	308.2	308.2	1	0	0	1	0	0	-1190
52+00.00	1	0	0	0	1	60	253.7	253.7	1	0	0	1	0	0	-1443.6
53+00.00	1	0	0	0	1	55.9	214.7	214.7	1	0	0	1	0	0	-1658.3
54+00.00	1	0	0.1	0.1	1	42.7	182.7	182.7	1	0	0	1	0	0	-1841
55+00.00	1	0	0.1	0.1	1	59.9	190.1	190.1	1	0	0	1	0	0	-2031
56+00.00	1	0	0	0	1	56	214.7	214.7	1	0	0	1	0	0	-2245.7
57+00.00	1	8.9	12.8	12.8	1	33.1	164.9	164.9	1	0	0	1	0	0	-2397.8
58+00.00	1	7.3	26.3	26.3	1	33.4	123.1	123.1	1	0	0	1	0	0	-2494.6
59+00.00	1	11.9	35.6	35.6	1	15.1	89.9	89.9	1	0	0	1	0	0	-2548.9
59+20.00	1	0	4.4	4.4	1	0	5.6	5.6	1	0	0	1	0	0	-2550.1
Grand Total:			79.3	79.3			**2629.4**	**2629.4**		0	0		0	0	

ss Section Set Name: Levee 4
Alignment Name: Levee/Floodwall
Input Grid Factor: 1

Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities – Cut Factor	Cut Area	Cut Volume	Cut Adjusted	Fill Factor	Fill Area	Fill Volume	Fill Adjusted	Added Quantities – Cut Factor	Cut Volume	Cut Adjusted	Fill Factor	Fill Volume	Fill Adjusted	Mass Ordinate
58+80.00	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0
59+00.00	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0
60+00.00	1	0	0	0	1	4	7.4	7.4	1	0	0	1	0	0	-7.4
61+00.00	1	0	0	0	1	9.2	24.4	24.4	1	0	0	1	0	0	-31.8
62+00.00	1	0	0	0	1	4	24.4	24.4	1	0	0	1	0	0	-56.2
63+00.00	1	0	0	0	1	3.5	14	14	1	0	0	1	0	0	-70.2
64+00.00	1	4.7	8.7	8.7	1	0	6.6	6.6	1	0	0	1	0	0	-68
Grand Total:			8.7	8.7			**76.7**	**76.7**		0	0		0	0	

US Army Corps of Engineers, Chicago District	PROJECT TITLE: DPII - Site DPLV04	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: EARTHWORK INROADS REPORT	CHECKED BY: ROBERT VANDER	DATE:

Stripping

Surface Area Report for Levee 1

Surface: DPLV04_1ft_Contours
Fence Mode: Inside

True Area:	10830.3	SF
Planar Area:	10770.8	SF

Surface Area Report for Levee 2

Surface: DPLV04_1ft_Contours
Fence Mode: Inside

True Area: sq ft	49324.4	SF
Planar Area: sq ft	49061.7	SF

Surface Area Report for Levee 3

Surface: DPLV04_1ft_Contours
Fence Mode: Inside

True Area: sq ft	17382.7	SF
Planar Area: sq ft	17340.9	SF

Surface Area Report for Levee 4

Surface: DPLV04_1ft_Contours
Fence Mode: Inside

True Area: sq ft	3428.6	SF
Planar Area: sq ft	3427.5	SF

Roadraise Fill

ss Section Set Name: 5thAve_roadEdge
Alignment Name: 5thAve_roadEdge
Input Grid Factor: 1

Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities								Added Quantities						Mass Ordinate
	Cut				Fill				Cut			Fill			
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Factor	Volume	Adjusted	Factor	Volume	Adjusted	
4+50.00	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0
4+84.08	1	0.2	0.1	0.1	1	19.9	12.6	12.6	1	0	0	1	0	0	-12.5
5+00.00	1	0	0	0	1	25.9	13.5	13.5	1	0	0	1	0	0	-25.9
5+50.00	1	0	0	0	1	36.1	57.5	57.5	1	0	0	1	0	0	-83.4
6+00.00	1	0	0	0	1	50.3	80.1	80.1	1	0	0	1	0	0	-163.5
6+50.00	1	0	0	0	1	70.4	111.8	111.8	1	0	0	1	0	0	-275.2
6+50.79	1	0	0	0	1	70.3	2.1	2.1	1	0	0	1	0	0	-277.3
6+90.79	1	0	0	0	1	68	102.5	102.5	1	0	0	1	0	0	-379.8
7+00.00	1	0	0	0	1	66.1	22.9	22.9	1	0	0	1	0	0	-402.6
7+50.00	1	0	0	0	1	44.5	102.4	102.4	1	0	0	1	0	0	-505
8+00.00	1	0	0	0	1	20.7	60.4	60.4	1	0	0	1	0	0	-565.4
8+37.54	1	0.4	0.3	0.3	1	4.3	17.3	17.3	1	0	0	1	0	0	-582.5
8+50.00	1	0	0.1	0.1	1	0	1	1	1	0	0	1	0	0	-583.3
Grand Total:			0.5	0.5			**583.9**	**583.9**		0	0		0	0	

US Army Corps of Engineers. Chicago District	PROJECT TITLE: DPII - Site DPLV04	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: EARTHWORK INROADS REPORT	CHECKED BY: ROBERT VANDER	DATE:

Roadraise Surface Area

Surface Area Report for proposed road raise surface

Surface: 5th Ave RoadRaise
Fence Mode: Inside

True Area: sq ft	16409.7	SF
Planar Area: sq ft	16156.7	SF

US Army Corps of Engineers. Chicago District	PROJECT TITLE: DPII - Site DPLV05 (Alignment 3)	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: QUANTITY COMPUTATIONS	CHECKED BY: ROBERT VANOER	DATE:

Bid Item 0001 - Mobilization and Demobilization

See Cost Appendix and MII estimates for mobilization and demolization assumptions.

Bid Item 0002 - Maintenance of Traffic

See Cost Appendix and MII estimates for Maintenance of Traffic assumptions

Bid Item 0003 - Clearing and Grubbing

The clearing and grubbing areas will include the worklimits (permanent easement) and staging areas (temporary easement).
The permanent easement (work limits) area is 15 feet from the toe of the levee or centerline line of the floodwall.
The areas were computed in microstation.

Location	Area (AC)
Work Limits (Permanent Easement Area)	8.2
Staging Area	5.6

Total Clearing and Grubbing Area =	13.8	AC

Bid Item 0004 - Floodwall

Floodwall	Floodwall Length (FT)	*Concrete Height (FT)	**SSP Height (FT)	Concrete Width (FT)	Concrete Volume (CY)	SSP Area (SF)
Sta. 53+73 to 55+41	168	16.3	42.9	1.167	118.35973	7543.2
Sta. 55+41 to 55+64	23	20.3	54.9	1.167	20.180456	1308.7
Sta. 55+64 to 60+23	459	17.3	45.9	1.167	343.2147	21986.1
Sta. 60+23 to 60+64	41	19.3	51.9	1.167	34.201744	2209.9
Sta. 60+64 to 61+68	104	16.2	42.6	1.167	72.8208	4638.4
Sta. 61+68 to 62+22	54	11.2	27.6	1.167	26.1408	1598.4
Sta. 68+70 to 73+50	480	3.3	3.9	1.167	68.464	2832
Sta. 73+50 to 77+88	438	3	3	1.167	56.794	2190
Sta. 78+34 to 78+49	15	2.5	1.5	1.167	1.6208333	52.5
Total	1782				741.79707	44359.2

Total Concrete Volume (CY) =	741.8	CY
Total SSP Area (SF) =	44359.2	SF

The levee/floodwall top elevation: EL 629.31
The concrete height is relative to the existing grade and varies along the alignment and height was determined from the alignment profile.
*Concrete height includes the 2ft concrete embeddment. SSP area includes the 2 feet embeddment into the concrete.
**assumed 3 SSP to 1 concrete ratio

	PROJECT TITLE: DPII - Site DPLV05 (Alignment 3)	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
US Army Corps of Engineers. Chicago District	COMPUTATION TITLE: QUANTITY COMPUTATIONS	CHECKED BY: ROBERT VANOER	DATE:

Bid Item 0005 - Road Closures

Road closure at Irving Park Rd, 4-lane road plus one turning lane, length =	55	FT
Road closure at River Rd, 4-lane road, Length =	44	FT
Road closure at River Rd, 4-lane road plus one turning lane, Length =	55	FT

Assumed each lane is 11 feet.

Bid Item 0006 - Levee

Stripping

The base of the levee will be stripped 1ft deep.
The base of the levee was determined by multipling the true area of the levee perimeter by 1ft.
The levee perimeter was developed from the levee surface inroads. The surface area was then computed in inroads using the levee perimeter and the existing grade surface.
The area provided in the table below was developed from an inroads surface area report (see earthwork computations).

Levee	Area (SF)	Depth (1FT)	Volume (CY)
Levee1	4504.8	1	166.8444444
Levee2	3898.3	1	144.3814815
Levee3	101714.1	1	3767.188889
Levee4	4583.7	1	169.7666667
Total			4248.181481

Imprevious Fill

The imprevious fill (levee fill) was computed using average end-area method in Inroads with cross-section cuts every 100 ft (see earthwork computations).
The levee is 10-feet wide at the top with 1(V):3(H) side slopes.
The total imprevious fill includes the volume of the levee fill and stripping.

Levee	Levee Volume (CY)	Strip Volume (CY)	Total
Levee1	182.3	166.8444444	349.1444444
Levee2	732.2	144.3814815	876.5814815
Levee3	28694.5	3767.188889	32461.68889
Levee4	115.8	169.7666667	285.5666667
Total			33972.98148

Bid Item 0007 - Interior Drainage

Interior drainage was not evaluated for the DPII study and will be evaluated during the PED phase.
From aerial views, multiple outlets were observed that discharges into the river.

The cost estimate for Interior Drainage was determined using Libertyville Estate levee/floodwall project.
The costs were developed using cost per linear foot of floodwall protection.

Total Length of Floodwall =	1782	FT
Total Length of Levee =	5576	FT

Bid Item 0008 - Retaining Wall Modifications

An existing retaining wall is supporting River Rd between Sta 62+22 and Sta. 63+44. The retaining wall will be raised to the design elevation and also act as a floodwall.

Approx. length of retaining wall =	122	LF
Assume wall is 3 feet above existing grade (623), top of wall EL =	626	EL
Levee/Floodwall Design EL =	629.31	EL
Existing retaining wall raise height =	3.31	FT

US Army Corps of Engineers, Chicago District	PROJECT TITLE: DPII - Site DPLV05 (Alignment 3)	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: Earthwork Inroads Report	CHECKED BY: ROBERT VANOER	DATE:

Impervious Fill

Levee 3
oss Section Set Name: Levee/Floodwall Alignment 3
Alignment Name: Levee/Floodwall Alignment 3
Input Grid Factor: 1 **Note:** All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities								Added Quantities						Mass Ordinate
	Cut				Fill				Cut			Fill			
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Factor	Volume	Adjusted	Factor	Volume	Adjusted	
8+20.00	1	0	0	0	1	54.1	0	0	1	0	0	1	0	0	0
9+00.00	1	0	0	0	1	138.8	285.8	285.8	1	0	0	1	0	0	-285.8
10+00.00	1	0	0	0	1	117.3	474.3	474.3	1	0	0	1	0	0	-760.1
11+00.00	1	0	0	0	1	167.7	527.7	527.7	1	0	0	1	0	0	-1287.8
12+00.00	1	0	0	0	1	202.2	685	685	1	0	0	1	0	0	-1972.7
13+00.00	1	0	0	0	1	213.2	769.3	769.3	1	0	0	1	0	0	-2742
14+00.00	1	0	0	0	1	218.5	795.8	795.8	1	0	0	1	0	0	-3537.8
15+00.00	1	0	0	0	1	204.6	779.8	779.8	1	0	0	1	0	0	-4317.6
16+00.00	1	0	0	0	1	212.2	771.8	771.8	1	0	0	1	0	0	-5089.4
17+00.00	1	0	0	0	1	204.4	771.5	771.5	1	0	0	1	0	0	-5860.9
18+00.00	1	0	0	0	1	232.7	809.6	809.6	1	0	0	1	0	0	-6670.5
19+00.00	1	0	0	0	1	360.4	1098.4	1098.4	1	0	0	1	0	0	-7768.8
20+00.00	1	0	0	0	1	147.7	940.8	940.8	1	0	0	1	0	0	-8709.7
21+00.00	1	0	0	0	1	97.9	454.8	454.8	1	0	0	1	0	0	-9164.4
22+00.00	1	0	0	0	1	62.4	296.8	296.8	1	0	0	1	0	0	-9461.2
23+00.00	1	0	0	0	1	70.7	246.4	246.4	1	0	0	1	0	0	-9707.7
24+00.00	1	0	0	0	1	70.7	261.9	261.9	1	0	0	1	0	0	-9969.6
25+00.00	1	0	0	0	1	88	293.9	293.9	1	0	0	1	0	0	-10263.5
26+00.00	1	0	0	0	1	106.5	360.2	360.2	1	0	0	1	0	0	-10623.7
27+00.00	1	0	0	0	1	100.7	383.7	383.7	1	0	0	1	0	0	-11007.4
28+00.00	1	0	0	0	1	111.7	393.4	393.4	1	0	0	1	0	0	-11400.8
29+00.00	1	0	0	0	1	103.4	398.3	398.3	1	0	0	1	0	0	-11799.1
30+00.00	1	0	0	0	1	107.4	390.3	390.3	1	0	0	1	0	0	-12189.4
31+00.00	1	0	0	0	1	112.2	406.6	406.6	1	0	0	1	0	0	-12596
32+00.00	1	0	0	0	1	110.2	411.8	411.8	1	0	0	1	0	0	-13007.7
33+00.00	1	0	0	0	1	313.1	783.8	783.8	1	0	0	1	0	0	-13791.5
34+00.00	1	0	0	0	1	93.6	753.1	753.1	1	0	0	1	0	0	-14544.6
35+00.00	1	0	0	0	1	75	312.2	312.2	1	0	0	1	0	0	-14856.8
36+00.00	1	0	0	0	1	75.7	279.1	279.1	1	0	0	1	0	0	-15135.9
37+00.00	1	0	0	0	1	64.9	260.4	260.4	1	0	0	1	0	0	-15396.3
38+00.00	1	0	0	0	1	71.3	252.2	252.2	1	0	0	1	0	0	-15648.5
39+00.00	1	0	0	0	1	167.4	442.1	442.1	1	0	0	1	0	0	-16090.6
40+00.00	1	0	0	0	1	355.4	968.3	968.3	1	0	0	1	0	0	-17058.9
41+00.00	1	0	0	0	1	169.9	972.9	972.9	1	0	0	1	0	0	-18031.8
42+00.00	1	0	0	0	1	213.5	710	710	1	0	0	1	0	0	-18741.8
43+00.00	1	0	0	0	1	217.3	797.7	797.7	1	0	0	1	0	0	-19539.5
44+00.00	1	0	0	0	1	216.8	803.9	803.9	1	0	0	1	0	0	-20343.4
45+00.00	1	0	0	0	1	214.2	798.1	798.1	1	0	0	1	0	0	-21141.5
46+00.00	1	0	0	0	1	242.4	845.5	845.5	1	0	0	1	0	0	-21986.9
47+00.00	1	0	0	0	1	243.2	899.2	899.2	1	0	0	1	0	0	-22886.1
48+00.00	1	0	0	0	1	228.1	872.8	872.8	1	0	0	1	0	0	-23758.9
49+00.00	1	0	0	0	1	263.3	910	910	1	0	0	1	0	0	-24668.9
50+00.00	1	0	0	0	1	219	893.2	893.2	1	0	0	1	0	0	-25562.1
51+00.00	1	0	0	0	1	227.8	827.4	827.4	1	0	0	1	0	0	-26389.5
52+00.00	1	0	0	0	1	221.2	831.5	831.5	1	0	0	1	0	0	-27221
53+00.00	1	0	0	0	1	220.4	817.8	817.8	1	0	0	1	0	0	-28038.8
53+72.86	1	0	0	0	1	265.5	655.7	655.7	1	0	0	1	0	0	-28694.5
Grand Total:			0	0			**28694.5**	**28694.5**		0	0		0	0	

US Army Corps of Engineers, Chicago District	PROJECT TITLE: DPII - Site DPLV05 (Alignment 3)	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: Earthwork Inroads Report	CHECKED BY: ROBERT VANOER	DATE:

Levee 4
oss Section Set Name: Levee/Floodwall Alignment 3_1
Alignment Name: Levee/Floodwall Alignment 3
Input Grid Factor: 1
Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities								Added Quantities						Mass
	Cut				Fill				Cut			Fill			
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Factor	Volume	Adjusted	Factor	Volume	Adjusted	Ordinate
64+00.00	1	0	0	0	1	37.8	0	0	1	0	0	1	0	0	0
65+00.00	1	0	0	0	1	9.2	87	87	1	0	0	1	0	0	-87
66+00.00	1	0	0	0	1	3.2	22.9	22.9	1	0	0	1	0	0	-110
67+00.00	1	6.9	12.8	12.8	1	0	5.9	5.9	1	0	0	1	0	0	-103
68+00.00	1	6.9	25.6	25.6	1	0	0	0	1	0	0	1	0	0	-77.5
68+43.17	1	3.3	8.1	8.1	1	0	0	0	1	0	0	1	0	0	-69.3
Grand Total:			46.5	46.5			**115.8**	**115.8**		0	0		0	0	

Levee 1
oss Section Set Name: Levee/Floodwall Alignment 3_2
Alignment Name: Levee/Floodwall Alignment 3
Input Grid Factor: 1
Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities								Added Quantities						Mass
	Cut				Fill				Cut			Fill			
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Factor	Volume	Adjusted	Factor	Volume	Adjusted	Ordinate
0+00.00	1	4.1	0	0	1	0	0	0	1	0	0	1	0	0	0
1+00.00	1	0	7.6	7.6	1	12.1	22.4	22.4	1	0	0	1	0	0	-14.8
2+00.00	1	0	0	0	1	14.3	48.8	48.8	1	0	0	1	0	0	-63.6
3+00.00	1	0	0	0	1	26.4	75.4	75.4	1	0	0	1	0	0	-139
Grand Total:			7.6	7.6			**146.5**	**146.5**		0	0		0	0	

Stripping Surface Area

Surface Area Report for Levee 3

Surface: DPLVxx_1ft_Contours
Fence Mode: Inside

True Area: sq ft	101714.1	SF
Planar Area: sq ft	101347.6	SF

Surface Area Report for Levee 4

Surface: DPLVxx_1ft_Contours
Fence Mode: Inside

True Area: sq ft	4583.7	SF
Planar Area: sq ft	4580.3	SF

	PROJECT TITLE:	COMPUTED BY:	DATE:
US Army Corps of Engineers Chicago District	PROJECT TITLE: DPII - Site DPLV02	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: QUANTITY COMPUTATIONS	CHECKED BY: ROBERT VANOER	DATE:

Bid Item 0001 - Mobilization and Demobilization

See Cost Appendix and MII estimates for mobilization and demolization assumptions.

Bid Item 0002 - Maintenance of Traffic

See Cost Appendix and MII estimates for Maintenance of Traffic assumptions

Bid Item 0003 - Clearing and Grubbing

The clearing and grubbing areas will include the worklimits (permanent easement) and staging areas (temporary easement).
The permanent easement (work limits) area is 15 feet from the toe of the levee or centerline line of the floodwall.
The areas were computed in microstation.

Location	Area (AC)
Work Limits (Permanent Easement Area)	4
Staging Area	2.2

Total Clearing and Grubbing Area =	6.2	AC

Bid Item 0004 - Road Closures

Road closure at Lake St., 4-lane road, length = 44 FT
Assumed each lane is 11 feet.

Bid Item 0005 - Levee

Stripping
The base of the levee will be stripped 1ft deep.
The base of the levee was determined by multipling the true area of the levee perimeter by 1ft.
The levee perimeter was developed from the levee surface inroads. The surface area was then computed in inroads using the levee perimeter and the existing grade surface.
The area provided in the table below was developed from an inroads surface area report (see earthwork computations).

Levee	Area (SF)	Depth (1FT)	Volume (CY)
Levee1	84636.6	1	3134.688889
Total			3134.688889

Imprevious Fill
The imprevious fill (levee fill) was computed using average end-area method in inroads with cross-section cuts every 100 ft (see earthwork computations).
The levee is 10-feet wide at the top with 1(V):3(H) side slopes.
The total imprevious fill includes the volume of the levee fill and stripping.

Levee	Levee Volume (CY)	Strip Volume (CY)	Total
Levee1	9280.2	3134.688889	12414.88889
Total			12414.88889

Bid Item 0006 - Interior Drainage

Interior drainage was not evaluated for the DPII study and will be evaluated during the PED phase.
From aerial views, multiple outlets were observed that discharges into the river.

The cost estimate for Interior Drainage was determined using Libertyville Estate levee/floodwall project.
The costs were developed using cost per linear foot of floodwall protection.
Total Length of Levee = 2329 FT

US Army Corps of Engineers, Chicago District	PROJECT TITLE: DPII - Site DPLV02	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: EARTHWORK INROADS REPORT	CHECKED BY: ROBERT VANOER	DATE:

Impervious Fill

ss Section Set Name: DPLV02-Leve ver 2
Alignment Name:
Input Grid Factor: 1

Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities – Cut				Station Quantities – Fill				Added Quantities – Cut			Added Quantities – Fill			Mass
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Factor	Volume	Adjusted	Factor	Volume	Adjusted	Ordinate
0+00.00	1	3.1	0	0	1	0.1	0	0	1	0	0	1	0	0	0
1+00.00	1	0	5.7	5.7	1	48.3	89.7	89.7	1	0	0	1	0	0	-84
2+00.00	1	0	0	0	1	48.4	179.1	179.1	1	0	0	1	0	0	-263.1
3+00.00	1	0	0	0	1	64.7	209.3	209.3	1	0	0	1	0	0	-472.4
4+00.00	1	0	0	0	1	77.8	263.7	263.7	1	0	0	1	0	0	-736.1
5+00.00	1	0	0	0	1	105.8	339.9	339.9	1	0	0	1	0	0	-1076
6+00.00	1	0	0	0	1	102.4	385.5	385.5	1	0	0	1	0	0	-1461.5
7+00.00	1	0	0	0	1	109.3	392	392	1	0	0	1	0	0	-1853.6
8+00.00	1	0	0	0	1	106.9	400.3	400.3	1	0	0	1	0	0	-2253.9
9+00.00	1	0	0	0	1	91.5	367.4	367.4	1	0	0	1	0	0	-2621.3
10+00.00	1	0	0	0	1	71.1	301.2	301.2	1	0	0	1	0	0	-2922.5
11+00.00	1	0	0	0	1	54.7	233.1	233.1	1	0	0	1	0	0	-3155.5
12+00.00	1	0	0	0	1	47.1	188.7	188.7	1	0	0	1	0	0	-3344.2
13+00.00	1	0	0	0	1	42.7	166.4	166.4	1	0	0	1	0	0	-3510.6
14+00.00	1	0	0	0	1	61.4	192.8	192.8	1	0	0	1	0	0	-3703.4
15+00.00	1	0	0	0	1	100.3	299.5	299.5	1	0	0	1	0	0	-4002.9
16+00.00	1	0	0	0	1	35.7	252	252	1	0	0	1	0	0	-4254.9
17+00.00	1	0	0	0	1	374	758.8	758.8	1	0	0	1	0	0	-5013.7
18+00.00	1	0	0	0	1	559.6	1729	1729	1	0	0	1	0	0	-6742.8
19+00.00	1	0	0	0	1	28.5	1089.1	1089.1	1	0	0	1	0	0	-7831.8
20+00.00	1	5.3	9.9	9.9	1	0	52.7	52.7	1	0	0	1	0	0	-7874.6
21+00.00	1	0	9.9	9.9	1	164.6	304.8	304.8	1	0	0	1	0	0	-8169.5
22+00.00	1	0.9	1.6	1.6	1	88	467.7	467.7	1	0	0	1	0	0	-8635.6
23+00.00	1	1.1	3.6	3.6	1	122.7	390.2	390.2	1	0	0	1	0	0	-9022.2
24+00.00	1	12.1	24.4	24.4	1	0	227.3	227.3	1	0	0	1	0	0	-9225.1
24+29.35	1	10.1	12	12	1	0	0	0	1	0	0	1	0	0	-9213
Grand Total:			67.2	67.2			**9280.2**	**9280.2**		0	0		0	0	

Stripping

Surface Area Report for Levee Perimeter

Surface: DPLV02_1ft_Contours
Fence Mode: Inside

True Area: sq ft	84636.6	SF
Planar Area: sq ft	83599.6	SF

	PROJECT TITLE: DPII - Site DPLV11	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
US Army Corps of Engineers Chicago District	COMPUTATION TITLE: QUANTITY COMPUTATIONS	CHECKED BY: ROBERT VANOER	DATE:

Bid Item 0001 - Mobilization and Demobilization

See Cost Appendix and MII estimates for mobilization and demolization assumptions.

Bid Item 0002 - Maintenance of Traffic

See Cost Appendix and MII estimates for Maintenance of Traffic assumptions

Bid Item 0003 - Clearing and Grubbing

The clearing and grubbing areas will include the worklimits (permanent easement) and staging areas (temporary easement).
The permanent easement (work limits) area is 15 feet from the toe of the levee or centerline line of the floodwall.
The areas were computed in microstation.

Location	Area (AC)
Work Limits (Permanent Easement Area)	6
Staging Area	3

Total Clearing and Grubbing Area =	9	AC

Bid Item 0004 - Floodwall

Floodwall	Floodwall Length (FT)	*Concrete Height (FT)	**SSP Height (FT)	Concrete Width (FT)	Concrete Volume (CY)	*SSP Area (SF)
Sta. 0+00 to 10+50	1050	17	45	1.167	771.51667	49350
Sta. 10+50 to 17+00	650	11.4	28.2	1.167	320.27667	19630
Sta. 25+00 to 37+20	1220	19.2	51.6	1.167	1012.4373	65392
Sta. 38+00 to 47+00	900	19.2	51.6	1.167	746.88	48240
Sta. 62+50 to 66+30	350	19.2	51.6	1.167	290.45333	18760
Sta. 66+30 to 68+00	170	5.16	9.48	1.167	37.914533	1951.6
Sta. 69+20 to 72+00	280	5.16	9.48	1.167	62.447467	3214.4
Total	4620				3241.926	206538

Total Concrete Volume (CY) =	3241.9	CY
Total SSP Area (SF) =	206538	SF

The levee/floodwall top elevation: EL 637.16
The concrete height is relative to the existing grade and varies along the alignment and height was determined from the alignment profile.
*Concrete height includes the 2ft concrete embeddment. SSP area includes the 2 feet embeddment into the concrete.
**assumed 3 SSP to 1 concrete ratio

Bid Item 0005 - Road Closures

Road closure at Rand Rd, 4-lane road, length =	44	FT
Road closure at River Rd, 4-lane road plus one turning lane, Length =	55	FT

Assumed each lane is 11 feet.

Bid Item 0006 - Pumpstation

Weller creek crosses the line of protection at the south end of the project site. A pumpstation will be placed at this location.
The pumpstation is assumed to be of similar capacity with Farmer Prairie Creek Pumpstation for cost estimating.

US Army Corps of Engineers. Chicago District	**PROJECT TITLE:** DPII - Site DPLV11	**COMPUTED BY:** FAYE LEFFLER	**DATE:** 6/11/2013
	COMPUTATION TITLE: QUANTITY COMPUTATIONS	**CHECKED BY:** ROBERT VANOER	**DATE:**

Bid Item 0007 - Levee

Stripping

The base of the levee will be stripped 1ft deep.
The base of the levee was determined by multipling the true area of the levee perimeter by 1ft.
The levee perimeter was developed from the levee surface inroads. The surface area was then computed in inroads using the levee perimeter and the existing grade surface.
The area provided in the table below was developed from an inroads surface area report (see earthwork computations).

Levee	Area (SF)	Depth (1FT)	Volume (CY)
Levee1	42573.5	1	1576.796296
Levee2	136947.6	1	5072.133333
Total			6648.92963

Imprevious Fill

The imprevious fill (levee fill) was computed using average end-area method in Inroads with cross-section cuts every 100 ft (see earthwork computations).
The levee is 10-feet wide at the top with 1(V):3(H) side slopes.
The total imprevious fill includes the volume of the levee fill and stripping.

Levee	Levee Volume (CY)	Strip Volume (CY)	Total
Levee1	6472.3	1576.796296	8049.096296
Levee2	38309.7	5072.133333	43381.83333
Total			51430.92963

US Army Corps of Engineers. Chicago District	PROJECT TITLE: DPII - Site DPLV11	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: Earthwork Inroads Report	CHECKED BY: ROBERT VANOER	DATE:

Impervious Fill

ɔss Section Set Name: Levee2
Alignment Name: Levee/Floodwall
Input Grid Factor: 1

Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities – Cut Factor	Cut Area	Cut Volume	Cut Adjusted	Fill Factor	Fill Area	Fill Volume	Fill Adjusted	Added Quantities – Cut Factor	Cut Volume	Cut Adjusted	Fill Factor	Fill Volume	Fill Adjusted	Mass Ordinate
47+00.00	1	0	0	0	1	465.8	0	0	1	0	0	1	0	0	0
48+00.00	1	0.1	0.2	0.2	1	485.3	1761.2	1761.2	1	0	0	1	0	0	-1761.1
49+00.00	1	0	0.2	0.2	1	529	1878.3	1878.3	1	0	0	1	0	0	-3639.2
50+00.00	1	0	0	0	1	521.9	1946.1	1946.1	1	0	0	1	0	0	-5585.3
51+00.00	1	0	0	0	1	527.2	1942.7	1942.7	1	0	0	1	0	0	-7527.9
52+00.00	1	0.9	1.7	1.7	1	502.6	1907	1907	1	0	0	1	0	0	-9433.2
53+00.00	1	11.5	23.1	23.1	1	485.5	1829.8	1829.8	1	0	0	1	0	0	-11239.9
54+00.00	1	9.5	39	39	1	528.9	1878.5	1878.5	1	0	0	1	0	0	-13079.5
55+00.00	1	1.9	21.1	21.1	1	567	2029.3	2029.3	1	0	0	1	0	0	-15087.7
56+00.00	1	0	3.5	3.5	1	659.9	2271.9	2271.9	1	0	0	1	0	0	-17356.1
57+00.00	1	17.5	32.4	32.4	1	689.1	2498	2498	1	0	0	1	0	0	-19821.8
58+00.00	1	29.9	67.7	67.7	1	831.6	2816.1	2816.1	1	0	0	1	0	0	-22550.2
59+00.00	1	0	55.3	55.3	1	933.3	3268.4	3268.4	1	0	0	1	0	0	-25763.3
60+00.00	1	0	0	0	1	1034.6	3644.3	3644.3	1	0	0	1	0	0	-29407.5
61+00.00	1	1.4	2.6	2.6	1	841.1	3473.6	3473.6	1	0	0	1	0	0	-32878.6
62+00.00	1	0.4	3.4	3.4	1	989.5	3353	3353	1	0	0	1	0	0	-36228.2
62+50.00	1	0	0.4	0.4	1	986.8	1811.3	1811.3	1	0	0	1	0	0	-38039.1
Grand Total:			270.5	270.5			**38309.7**	**38309.7**		0	0		0	0	

ɔss Section Set Name: Levee1
Alignment Name: Levee/Floodwall
Input Grid Factor: 1

Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities – Cut Factor	Cut Area	Cut Volume	Cut Adjusted	Fill Factor	Fill Area	Fill Volume	Fill Adjusted	Added Quantities – Cut Factor	Cut Volume	Cut Adjusted	Fill Factor	Fill Volume	Fill Adjusted	Mass Ordinate
17+00.00	1	0	0	0	1	139.1	0	0	1	0	0	1	0	0	0
18+00.00	1	0	0	0	1	172.3	576.5	576.5	1	0	0	1	0	0	-576.5
19+00.00	1	0	0	0	1	182.3	656.5	656.5	1	0	0	1	0	0	-1233
20+00.00	1	0.3	0.6	0.6	1	220	745	745	1	0	0	1	0	0	-1977.5
21+00.00	1	0	0.6	0.6	1	225.4	824.9	824.9	1	0	0	1	0	0	-2801.8
22+00.00	1	0	0	0	1	225.4	834.9	834.9	1	0	0	1	0	0	-3636.7
23+00.00	1	0	0	0	1	225.4	834.9	834.9	1	0	0	1	0	0	-4471.5
24+00.00	1	2.1	3.9	3.9	1	268.1	910.1	910.1	1	0	0	1	0	0	-5377.7
25+00.00	1	0	3.9	3.9	1	322.2	1089.5	1089.5	1	0	0	1	0	0	-6463.3
Grand Total:			9	9			**6472.3**	**6472.3**		0	0		0	0	

US Army Corps of Engineers Chicago District	PROJECT TITLE: DPII - Site DPLV11	COMPUTED BY: FAYE LEFFLER	DATE: 6/11/2013
	COMPUTATION TITLE: Earthwork Inroads Report	CHECKED BY: ROBERT VANOER	DATE:

Stripping Surface Area

Surface Area Report for Levee 1

Surface: DPLV11 Existing Topo
Fence Mode: Inside

True Area:	42573.5	SF
Planar Area:	42509.3	SF

Surface Area Report for Levee 2

Surface: DPLV11 Existing Topo
Fence Mode: Inside

True Area: sq ft	136947.6	SF
Planar Area: sq ft	136881.3	SF

Upper Des Plaines River and Tributaries
Integrated Feasibility Report and Environmental Assessment

Appendix E – Economic Analysis

May 2014

US Army Corps
of Engineers®
Chicago District

May 2014

Upper Des Plaines River and Tributaries
Illinois & Wisconsin
Integrated Feasibility Report and Environmental Assessment

Appendix E – Economic Analysis

May 2014

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UPPER DES PLAINES RIVER FEASIBLITY PHASE II STUDY

APPENDIX E – ECONOMICS

CHAPTER 1 – DEMOGRAPHICS

The major portion of the project study area lies within the Chicago metropolitan area and has moderate to high housing values and income levels, a diverse ethnic demographic composition, and contains good recreational facilities. Current and projected population data for 43 primary communities located within the study area is shown in Table 1.2. The five largest communities affected by overbank flooding as of 2010 are Arlington Heights (75,101), Des Plaines (58,364), Mount Prospect (54,167), Park Ridge (37,480), and Gurnee (31,295).The most densely populated areas are located in Cook County. Municipalities that lie in or intersect the watershed have a total estimated 2010 population of approximately 500,000. Municipalities in Lake County that lie in or intersect the watershed have an estimated 2010 population of approximately 350,000. Municipalities in Kenosha and Racine Counties that lie in or intersect the watershed have an estimated 2010 population of over 100,000. However, recent population growth has been greatest in Kenosha and Racine Counties (11.4%) as compared to Lake County (3.2%) and Cook County (-1.3%) from 2000 to 2010. These trends are projected to continue to at least 2020.

Median housing values and household incomes for the project study area were moderate to high. In Kenosha and Racine Counties, these values ranged from $108,000 (Kenosha) to $159,800 (Pleasant Prairie) for housing and $41,902 (Kenosha) to $62,856 (Pleasant Prairie) for median household income. For Lake County, these values ranged from $118,200 (Waukegan) to $823,300 (Mettawa) for housing and $42,335 (Waukegan) to $158,990 (Riverwoods) for median household income. For Cook County the median housing values ranged from $105,400 (Maywood) to $386,600 (River Forest) and median household income from $40,050 (River Grove) to $89,284 (River Forest).

Much of the land adjacent to the upper Des Plaines River in Illinois is owned by the Lake and Cook County Forest Preserve Districts. These lands are maintained principally as plant and wildlife preserves. As such they provide major aesthetic, picnicking, hiking, and other recreational opportunities to communities within the project area. Adjacent lands along the many tributaries to the Des Plaines River have varied land uses including recreational, residential, commercial and agricultural areas.

State	County	Municipality	2000 Population[1]	2010 Population[2]	% Change 2000-2010	2020 Population[3]	% Change 2010-2020
WI	Racine	Union Grove Village	4,322	4,915	13.72%	5,410	25.17%
	Kenosha	Kenosha City	90,352	99,218	9.81%	106,837	18.25%
		Paddock Lake Village	3,012	2,992	-0.66%	3,708	23.11%
		Pleasant Prairie Village	16,136	19,719	22.21%	20,215	25.28%
IL	Lake	Gurnee Village	28,834	31,295	8.54%	33,472	16.09%
		Hawthorn Woods Village	6,002	7,663	27.67%	12,635	110.51%
		Libertyville Village	20,742	20,315	-2.06%	21,293	2.66%
		Lincolnshire Village	6,108	7,275	19.11%	9,004	47.41%
		Long Grove Village	6,735	8,043	19.42%	9,476	40.70%
		Mettawa Village	367	547	49.05%	1,073	192.37%
		Mundelein Village	30,935	31,064	0.42%	33,062	6.88%
		Old Mill Creek Village	251	178	-29.08%	3,575	1324.30%
		Riverwoods Village	3,843	3,660	-4.76%	3,935	2.39%
		Vernon Hills Village	20,120	25,113	24.82%	23,312	15.86%
		Wadsworth Village	3,083	3,815	23.74%	5,730	85.86%
		Waukegan City	87,901	89,078	1.34%	91,110	3.65%
	Cook/Lake	Arlington Heights Village	76,031	75,101	-1.22%	80,304	5.62%
		Barrington Village	10,168	10,327	1.56%	10,342	1.71%
		Buffalo Grove Village	42,909	41,496	-3.29%	44,475	3.65%
		Deer Park Village	3,102	3,200	3.16%	3,598	15.99%
		Deerfield Village	18,420	18,225	-1.06%	19,734	7.13%
		Wheeling Village	34,496	37,648	9.14%	39,376	14.15%
	Cook	Bellwood Village	20,535	19,071	-7.13%	21,064	2.58%
		Des Plaines City	58,720	58,364	-0.61%	59,802	1.84%
		Elmwood Park Village	25,405	24,883	-2.05%	25,854	1.77%
		Forest Park Village	15,688	14,167	-9.70%	15,720	0.20%
		Franklin Park Village	19,434	18,333	-5.67%	19,860	2.19%
		Lyons Village	10,255	10,729	4.62%	10,777	5.09%
		Maywood Village	26,987	24,090	-10.73%	26,122	-3.21%
		Melrose Park Village	23,171	25,411	9.67%	22,486	-2.96%
		Mount Prospect Village	56,265	54,167	-3.73%	57,454	2.11%
		Niles Village	30,068	29,803	-0.88%	31,943	6.24%
		Norridge Village	14,582	14,572	-0.07%	14,450	-0.91%
		North Riverside Village	6,688	6,672	-0.24%	7,014	4.87%
		Northlake City	11,878	12,323	3.75%	11,260	-5.20%
		Park Ridge City	37,775	37,480	-0.78%	37,005	-2.04%
		Prospect Heights City	17,081	16,256	-4.83%	16,426	-3.83%
		River Forest Village	11,635	11,172	-3.98%	11,632	-0.03%
		River Grove Village	10,668	10,227	-4.13%	10,838	1.59%
		Riverside Village	8,895	8,875	-0.22%	9,190	3.32%
		Rosemont Village	4,224	4,202	-0.52%	4,111	-2.68%
		Schiller Park Village	11,850	11,793	-0.48%	11,669	-1.53%
		Stone Park Village	5,127	4,946	-3.53%	4,611	-10.06%
WI	Racine & Kenosha County Totals		113,822	126,844	11.44%	136,170	19.63%
IL	Lake County Totals		344,029	354,970	3.18%	382,798	11.27%
	Cook County Totals		482,949	476,609	-1.31%	491,996	1.87%

1 - U.S. Census Bureau 2000
2 - https://www.census.gov/popest/data/cities/totals/2011/index.html
3 - Northeastern Illinois Planning Commission endorsed 2030 forecasts interpolated down to 2020 and Southeastern Wisconsin Regional Planning Commission endorsed 2020 forecasts

Table 1.2 – Population Trends in Upper Des Plaines River Watershed Communities

CHAPTER 2 – ECONOMIC METHODS

A primary objective in conducting an economic assessment for flood damage reduction studies is to determine equivalent annual damages (EAD) along river reaches in the study area, taking into account all possible flood scenarios. This EAD value can be used compare changes in the damage resulting from various alternative plans over the study period. These estimates take into account all possible storm events that might occur, from very frequent to very infrequent and use interrelated hydrologic, hydraulic, geotechnical and economic information in the analysis. Specifically, EAD is determined by combining baseline and future condition discharge-frequency, stage-discharge (or stage-frequency), and stage-damage functions and integrating the resulting damage-frequency function. This value is then annualized over the study's period of analysis at the current federal discount rate. Uncertainties are present for each of these functions and are factored into the computations.

Although this Phase II Study is related to the Phase I Study, there are major differences between the two. The Phase II study has added ecosystem restoration as a main objective. Additionally, the Phase II Study will look at damages along the tributaries in addition to a reevaluation of the mainstem Des Plaines River. Also, Federal (Corps) planning guidance and computer analysis tools continue to evolve and the current analyses conducted reflect these changes.

The two major flood damage assessment models to be used in this Phase II study evaluations are the Corps of Engineers Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) and the Visual Interactive System for Transportation Algorithms (VISTA) for transportation impacts. The analysis of transportation impacts was substantially improved from the spreadsheet model used in the Phase I Study by incorporating a state of the art dynamic computer simulation model of traffic flows. Geographic Information Systems (GIS) were also used in the economic analysis for this study. Using GIS, structure inventories within the floodplain and information from public records on parcel improvements were relied upon where physical structure inventories are lacking.

2.1 Summary of Previous Analyses

The Phase I Study was approved in November 1999. This study focused primarily on flooding problems along the mainstem of the Upper Des Plaines River and authorized the implementation of six projects to reduce main stem flooding. A Limited Reevaluation Report (LRR) updating costs and benefits associated with Phase I projects was completed and approved in June 2007. The LRR provided current estimates of project benefits, construction costs, real estate requirement values, and economic justification for the authorized project.

The Phase I Study formulated and evaluated several potential sites for Flood Risk Management (FRM) that were either not implementable due to land availability issues or did not result in positive net benefits. Project benefits were evaluated only on the mainstem of the upper Des Plaines River and showed that the creation of additional flood storage is critical to reducing damages along the mainstem upper Des Plaines

River. This Phase II Study builds on the data collected for the Phase I Study in considering FRM sites located within tributary watersheds and along the mainstem.

The economic analysis of the Phase I Study indicated a need to not only focus on traditional structural damages but also on damages associated with the flood-induced delays in the study area transportation network. Table 2.1 shows a breakdown of equivalent annual benefits associated with the six authorized projects as calculated for the 2007 LRR (Oct 2006 price levels, 4.875%). Benefits associated with structures (residential, apartments, commercial, industrial and public categories) account for about half of the total and those associated with transportation (flood induced delays, road repair, and repair induced delays) account for the remainder.

Damage Category	Annual Benefits	Percent of Total
Residential	$ 1,209,000	13%
Apartment and Townhomes	$ 2,019, 000	22%
Commercial, Industrial, Public	$ 1,286,000	14%
Road Repair Cost	$ 548,000	6%
Flood Induced Road Delays	$ 1,330,000	14%
Delays Due to Road Repair	$ 2,515,000	27%
Emergency and Floodfighting Costs	$ 270,000	3%
FIA Cost Reduction	$ 25,000	0.3%
Total Annual Benefits	$ 9,203,000	100%

(Oct 2006 Price Levels at a Federal Discount Rate of 4.875%)

Table 2.1 – Phase I Study 2007 LRR Annualized Benefits by Damage Category October

2.2 HEC-FDA Model Development

Economic flood damages to structures were calculated using the Corps of Engineers Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) computer program. Over the course of the study, the model was updated. Results reported in this economic appendix were generated by version 1.2.5.a. HEC-FDA is designed to use risk-based analysis methods for flood risk management studies. Risk and uncertainty input to the model were developed as outlined in Corps Engineering Manual (EM) 1110-2-1419 (Hydrologic Engineering Requirements for Flood Damage Reduction Studies) and EM 1110-2-1619 (Risk-Based Analysis for Flood Damage Reduction Studies) and Engineering Regulation (ER) 1105-2-101 (Planning – Risk Analysis for Flood Damage Reduction Studies). Development of Hydrologic and Hydraulic data was developed jointly by the Chicago District and the study partners. Details of this data development are provided in the hydrology and hydraulics appendix. The following section documents development of structure inventory and economic data used in the HEC-FDA models.

2.2.1 Scope of Study and Data Sets

Prior to the development of any modeling, the scope of the project was developed along with an inventory of existing data and needs for new data. The scope of the modeling defines the spatial and temporal limits of the study. The spatial limit was defined by determining the locations of structures within known floodplain limits. The study is limited to 15 tributary models and the Des Plaines River mainstem. Individual HEC-FDA models were developed for each basin in Illinois. Basins in Wisconsin were modeled separately. The temporal limit was defined according to the baseline and future conditions selected in the hydrologic and hydraulic (H&H) models. At the time the H&H models were being developed, 2002 to 2005, the base year was set to year 2010 to correspond to the probable completion of all Phase I Study authorized projects. Most likely future conditions were set to 2020 based on availability of projected land use data.

The scope of spatial data required was determined through an analysis the 0.01 (1/100) annual exceedance probability (AEP) floodplain as delineated by FEMA's GIS Q3 or DFIRM data. Since the FEMA Q3 and DFIRM data were developed as a tool for the National Flood Insurance Program and not for the intended purpose of this study, a 250 ft buffer was added to acquire outlier structures during the inventory process. In theory this should capture any structures included in the 0.002 (1/500) AEP floodplain.

Economic data for this study are comprised of two types of information: 1. identification and cataloging of potentially damaged goods and services; 2. creating and relating engineering data in order to monetize damages to those goods and services.

The first task was to collect and identify the goods and services that could be damaged. Collectively these have been differentiated as structural damages or transportation damages. This differentiation is based on the method of identifying the goods and services affected by flooding and the method used to relate monetary damages to river stages. Table 2.2 presents the damage categories used in this study. Six of the seven categories of damages have been grouped as structural damages. Structural damages relate to some fixed item or property that is damaged by flood waters.

Type	Damage Category	Description
STRUCTURAL	APT	Multi-unit residential structures
	COM	Commercial structures
	IND	Industrial structures
	PUB	Tax-exempt structures in public ownership
	RES	Single-family residential structures
	AUTO	Parked or abandoned vehicles
TRANSPORTATION	TRAFFIC	Flood induced traffic delay and detour damages

Table 2.2 – HEC-FDA Damage Categories

Two categories used in the Phase I Study were eliminated from consideration: road repairs, and transportation delays due to road repairs. As will be discussed in Section 2.2.3, several transportation agencies within the study area revealed that monetary damages for these categories would be minimal as they are of short duration and occur at low annual exceedance probabilities.

2.2.2 Engineering Data

Structure Elevation Inventory

Developing the structure inventory was a multiple step process. The first step was to identify potentially flooded structures, and determine the first floor elevation and low water entry point. Then a depreciated replacement value and a depth-damage function were determined for each structure, as discussed in Section 2.2.3.

Structure data from prior studies conducted by USACE and study partners were used wherever possible. Indentified structures that were not a part of existing data sets were surveyed by a land survey crew. This crew obtained the first floor elevation, low water entry elevation, and the lowest adjacent ground elevation for each structure. New structure surveys utilized the new survey datum of NAVD, while the prior structure data was on NGVD datum. The datum used for structure datasets in the HEC-FDA models for each tributary and the mainstem was selected to correspond with the datum used by the hydraulic model, with conversions between the datum conducted where appropriate.

If a structure was found subsequent to the elevation survey or would be damaged by only the 0.002 (1/500) AEP event and was not captured within the 250 foot buffer, the required elevation data were obtained from available LiDAR (Light Detection And Ranging) data. LiDAR data collected for this study has a vertical accuracy of approximately 1 foot +/- 1 foot. This degree of accuracy provides a relative estimate of the ground elevation at the structure. LiDAR data is reported with a degree of accuracy for the horizontal and vertical directions for the entire map. This degree of accuracy is not meant to apply specifically to every point on the map but as an overall degree of accuracy of all points sampled. Raw LiDAR data includes structures; a "bare earth" LiDAR model is developed by post-processing the raw data to remove trees and structures. A generalization of the relationship between the LiDAR surface relative to a structure's first floor, lowest adjacent ground elevation, and the lowest point of entry elevation was developed based on an analysis of the structure survey data, sorted by HEC-FDA occupancy code. The details and results of this analysis are included in Attachment 5.

Stationing and Bank Parameterization

In order to populate the basic structure inventory parameters for stationing and bank designation, the study used GIS to obtain this information from parcel location. GIS was also used to determine assumed vehicle locations with respect to the structures they are associated with and flooded road crossing locations. To create this information a stream alignment was created for each of the models in GIS. Points were created that best represented a parcel, flooded crossing, or vehicle damage area. Using the Linear Referencing method in the ESRI toolbox, a station number was allocated to each of the potentially damaged entities. Stationing was checked and bank designations were assigned by hand in GIS.

2.2.3 Economic Data

Structure Damages

Two methods were utilized to determine the value of structures in Illinois: residential structure valuations were determined through a random sample of tax assessor data, non-residential structure valuations were determined by directly surveying each of those structures. The parcel population for the structure inventory valuation study was created by extracting parcels predominately in the floodplain. Non-residential structures were extracted from this subset to arrive at the residential parcel population for this study. A random sample of 10 percent of all residential structures was created and provided to the contractor, URS Corporation, along with a list of all non-residential structures for individual analysis. Structure valuation was conducted with the USACE GeoFIT program which integrates GIS and Microsoft Access software to compile the data necessary to compute a depreciated replacement value via the Marshall and Swift (M&S) method. Once all the data is loaded into GeoFIT, the depreciated replacement values are generated by the M&S Valuation Service software (Residential computations were based on September 2008 and Non-residential computations were based on October 2008 values).

Assessment values for all residential structures in the study area were determined from each county's tax assessment database. Tax assessments are comprised of land and improvement values for each parcel. Since flooding only affects the structure on a property, the depreciated replacement value of the structure is required. Only the assessed improvement values were utilized. Assessed land values are not included in the depreciated replacement values. Assessments in Cook County (2004 data) are calculated at 16% of the fair market value of the property. Lake County assessments (2005 Data) are at 33.3% of the fair market value.

URS developed depreciated replacement values for 232 structures in Cook County and 151 structures in Lake County. Using these random samples from each county, a relationship between the depreciated replacement value and the respective county's land improvement assessment was created. This index was then used for the remainder of the residential inventory rather than estimating depreciated replacement values for each property separately. The median value of this index (Improvement Assessed Value/Depreciated Replacement Value) for the 232 random residential properties evaluated in Cook County is 6.57 or 15.2%. Therefore the depreciated replacement value for residential units in Cook County is 6.57 times the county's assessed land improvement value. The median value of the index for the depreciated replacement value to the assessed land improvement value in Lake County is 1.92 or 52%. It should be noted that these indices are inclusive of the assessment percentage to fair market value utilized by each county. Attachment 1 of this appendix contains a detailed report of the study conducted by URS. There is a slight deviation in the values reported by URS due to the removal of outlier data points. The averaging of the data is sensitive to the extreme outlier data points and professional judgment was used to make that determination.

HEC-FDA also requires the creation of a monetary damage relationship for goods and services relative to flood stages/frequencies. This relationship is expressed as a depth-damage curve, either as a percent of the structure's value or as a "direct dollar" damage. A depth damage curve is a relationship between the estimated damages of an item and the associated flood depth on or at that item. Each structure is assigned two depth damage functions, one for the structure itself and the other for its contents. Generic depth-damage curves for both non-residential and residential structures were applied to a majority of the structures in the study area. Those not fitting the generic depth-damages curves were assigned direct depth-damage curves. Monetary impacts were calculated as a percentage of the depreciated replacement values of these structures using the appropriate damage function.

The two sets of generic depth-damage functions that were used in the economic analysis of this study were for residential structures as outlined in EGM 04-01, Generic Depth-Damage Relationships for Residential Structures with Basements, and draft non-residential as developed by IWR-USACE and FEMA (Solicitation of Expert Opinion Depth-Damage Function Calculations for the Benefit Cost Analysis Tool, DRAFT, October 2008). Content values associated with residential depth-damage functions were developed as outlined in EGM 04-01. Content values associated with non-residential depth-damage functions were developed by IWR concurrent with the development of the non-residential depth damage curves. The non-residential curves, developed by expert elicitation, account for the potential variability in contents.

Structures classified as requiring their own depth-damage function were individually surveyed by URS. A typical example of a structure not fitting a non-residential generic depth-damage curve is a large manufacturing facility or hospital complex. These structures had the necessary depth-damage relationships developed through an approved Office of Management and Budget (OMB) survey. This survey was conducted as part of the structure value survey conducted by URS, as detailed in Attachment 1.

Depth-damage functions are assigned according to Occupancy Type. All occupancy types and categories used for the purpose of estimating damages in this Study are presented in Table 2.3.

Category	Occupancy Type ID	Occupancy Description
Apartment	APT_P	Apartment/Condo (pre-engineered)
	APT_E	Apartment/Condo (engineered)
Commercial	CLOTH_E	Clothing Store (engineered)
	CLOTH_P	Clothing Store (pre-engineered)
	CONV_E	Convenience Store (engineered)
	CONV_P	Convenience Store (pre-engineered)
	ELEC_E	Electronics Retailer (engineered)
	ELEC_P	Electronics Retailer (pre-engineered)
	FFR_E	Fast Food Restaurant (engineered)
	FFR_P	Fast Food Restaurant (pre-engineered)
	FURN_E	Furniture Store (engineered)
	FURN_P	Furniture Store (pre-engineered)

	GROC_E	Grocery Store (engineered)
	GROC_P	Grocery Store (pre-engineered)
	HOSP_E	Hospital (engineered)
	HOSP_P	Hospital (pre-engineered)
	HTL_E	Hotel (engineered)
	HTL_P	Hotel (pre-engineered)
	MED_E	Medical Office (engineered)
	MED_P	Medical Office (pre-engineered)
	OFF_E	Office Building - One Story (engineered)
	OFF_P	Office Building - One Story (pre-engineered)
	REST_E	Restaurant (engineered)
	REST_P	Restaurant (pre-engineered)
	SERV_E	Service Related Business (engineered)
	SERV_P	Service Related Business (pre-engineered)
Industrial	LT_E	Light Manufacturing (engineered)
	LT_P	Light Manufacturing (pre-engineered)
	WH_E	Warehouse (engineered)
	WH_P	Warehouse (pre-engineered)
	WHR_E	Warehouse Refrigerated (engineered)
	WHR_P	Warehouse Refrigerated (pre-engineered)
Public	CF_E	Correctional Facility (engineered)
	CF_P	Correctional Facility (pre-engineered)
	PS_E	Protective Services (engineered)
	PS_P	Protective Services (pre-engineered)
	REC_E	Recreational (engineered)
	REC_P	Recreational (pre-engineered)
	RF_E	Religious (engineered)
	RF_P	Religious (pre-engineered)
	SCH_E	School (engineered)
	SCH_P	School (pre-engineered)
Residential	1SNB	One Story No Basement
	1SWB	One Story With Basement
	2SNB	Two Story No Basement
	2SWB	Two Story With Basement
	BLNB	Bi-Level No Basement
	BLWB	Bi-Level With Basement
	TLNB	Tri-Level No Basement
	TLWB	Tri-Level With Basement

Table 2.3 – Occupancy types used in study

Modifications to the generic depth damage functions in EGM 04-01 were made to adjust for inconsistencies in certain depth-damage functions as discussed below. Attachment 2 contains graphs, illustrations, and tables for each of residential and nonresidential depth-damage relationships.

- The content depth-damage curve for the one story with basement shows damage at eight (8) feet below the first floor while the structure depth-damage reports zero damage. The content depth-damage curve, for a two or more story structure with basement, has no damage at eight (8) feet below the first floor. However, that same structure reports structural damage, see the structure depth-damage curve, at eight (8) feet below the first floor. Oddly enough, the structure damage at seven and eight feet below the first floor, for a two or more story structure with basement, report the same level of damage 1.7%. The correction in this instance was to zero out the damages on both sets of depth-damages, structure and content, at eight (8) feet below the first floor.

- The Chicago region has a classification for split level in the Cook County Assessors structure codes, however, the generic split level depth-damage functions do not correspond to the construction of typical buildings classified as split level in the region. Two more specific classifications were created, the Bi-Level and Tri-Level. A Bi-Level structure with basement uses the one story with basement depth-damage function with a vertical offset of four (4) feet, therefore damages would not begin until four (4) feet below the first floor. For the Bi-Level function, zero relates to the front door elevation. Bi-Level structure without basement utilize the two or more story with no basement depth-damage function with a vertical offset of four feet, therefore damages would begin at six (6) feet below the first floor. Tri-Level with Basement utilizes the Split Level with Basement depth-damage function with a correction to the seven (7) and eight (8) foot values of the structure damage percentages. The values are zeroed-out for eight (8) feet below first floor and seven (7) feet below first floor were set to the same values as the two or more stories with basement with a mean damage of 1.7% and a 2.7% standard deviation. Tri-Level with no basement used the Split Level with no basement with a vertical offset of four (4) feet; therefore zero percent damage would be at six (6) feet below the first floor.

The Southeastern Wisconsin Regional Planning Commission (SEWRPC) conducted and concluded an assessment of Wisconsin portion of the study area in June of 2003. There are very few potentially damaged structures in Wisconsin, less than 100 in all of Kenosha County. The June 2003 study evaluated structural and non-structural FRM measures, and found that structural measures were not justified in the Wisconsin portion of the watershed.

This independent assessment did not follow the hydrologic and hydraulic methods used in the Illinois portion of the study. Thus the engineering data was not compatible for use with the HEC-FDA program. The economic assessment in Wisconsin used hard copy data provided to USACE from SEWRPC and used a spreadsheet for calculations rather than HEC-FDA. The inventory of structures in Wisconsin was developed from this spreadsheet. For these structures, the 2009 RS Means Cost Estimating Manual was used to determine the depreciated replacement value based on the information provided. Each structure was reassigned to appropriate generic structure classifications in order to use the depth-damage functions discussed above.

Damages attributed to these structures were delineated by SEWRPC and provided to USACE as depths of flooding above first floor for 2, 5, 25, 50, and 100 year events. To determine the depths of flooding for 1, 10, and 500 year flood events the existing data was fitted to a Log Pearson Type III distribution and the additional data was extrapolated from this function.

Vehicle Damages

Vehicle damages were grouped as a structural damage because while they are not inherently fixed to any one location (i.e. transitory) they are a fixed entity, because they are parked or abandoned during a flood event. In accordance with EGM 09-04, Generic Depth-Damage Relationships for Vehicles, vehicles per residential household were determined using U.S. Census data. A distribution of vehicle types was determined using data from the Illinois Secretary of State website combined with data provided in EGM 09-04. The distribution was then applied to the residential structure inventory. Vehicle values were determined for each type of vehicle (Sedans, Sports Car, SUVs, Mini-Vans and Pickups) at three different value levels: Salvage (assumed to be $2,000), Used (Manheim Used Vehicle Value Index $11,899 in 2008), and New (determined from pricing at Edmunds.com). A triangular probability distribution of the three value levels was applied to create a specific value for each vehicle instance. To account for the fact that per zip code, the reported number of vehicles per household reported by the U.S. Census is not in fact a whole number, such as 2, but rather a number such as 1.74, after all the data has been compiled; a random 26%, in this case, of the instances of a second vehicle would be removed from the data set. Vehicle damage accounts for those vehicles abandoned during the evacuation of the subject area. To account for the 88.1% of vehicles that will be moved out of the flood damage area (as specified in EGM 09-04), after all the data had been compiled a random 88.1% of the vehicle instances were removed from the data set. The depth damage curves specified in Table 3 of EGM 09-04 were used, and are shown in Table 2.4 below.

In Wisconsin, there were few residential structures with which to associate vehicles. Given the assumed evacuation of 88.1% of these vehicles during a flood event, the amount of vehicle damages incurred during a flood event would be very small. As a result, vehicle counts, and therefore vehicle damages, were not calculated for watersheds in Wisconsin.

PERCENT DAMAGE TO VEHICLES										
DEPTH ABOVE GROUND (ft)	SEDANS		PICKUPS		SUVs		SPORTS CAR		MINI VANS	
	% DAMAGE	STANDARD DEVIATION	% DAMAGE	STANDARD DEVIATION	% DAMAGE	STANDARD DEVIATION	% DAMAGE	STANDARD DEVIATION	% DAMAGE	STANDARD DEVIATION
0.5	7.60%	2.42%	5.20%	3.02%	0.00%	11.28%	1.40%	19.22%	0.00%	9.11%
1	28.00%	1.84%	20.30%	2.53%	13.80%	8.76%	29.20%	16.81%	17.80%	6.82%
2	46.20%	1.51%	34.40%	2.33%	30.60%	6.67%	52.80%	13.17%	38.30%	5.33%
3	62.20%	1.45%	47.50%	2.38%	45.80%	5.24%	72.20%	8.47%	56.80%	4.88%
4	76.00%	1.57%	59.60%	2.57%	59.40%	4.78%	87.40%	3.61%	73.30%	5.34%
5	87.60%	1.74%	70.70%	2.81%	71.40%	5.36%	98.40%	6.12%	87.80%	6.23%
6	97.00%	1.92%	80.80%	3.04%	81.80%	6.61%	100.00%	13.80%	100.00%	7.20%
7	100.00%	2.06%	89.90%	3.21%	90.60%	8.17%	100.00%	13.80%	100.00%	7.20%
8	100.00%	2.06%	98.00%	3.32%	97.80%	9.88%	100.00%	13.80%	100.00%	7.20%
9	100.00%	2.06%	100.00%	3.36%	100.00%	11.70%	100.00%	13.80%	100.00%	7.20%
10	100.00%	2.06%	100.00%	3.36%	100.00%	11.70%	100.00%	13.80%	100.00%	7.20%

Table 2.4 – Vehicle Depth-Damage Relationship

Transportation Damages

The concept of transportation damages is not new to USACE studies. Typical methodology is laid out in Section VII of Institute for Water Resources (IWR) Report 88-R-2, National Economic Development Procedure Manual – Urban Flood Damages. VISTA's ascription of dynamic network damages to specific damage location, however, is new.

Vehicles were broken into two categories for the purpose of this analysis, passenger and commercial vehicles. Damages associated with distance and delays were calculated separately for each category of vehicle as discussed below. Monetary output for the distance value associated with transportation damages was computed using a spreadsheet that detailed the operating cost of automobiles and trucks on a per mile basis[1]. This worksheet examines the cost associated with fuel, maintenance, tires, repairs, and depreciation.

Factors associated with these categories are the costs associated with the percentage of vehicles that are operated on highways, in the city, and under severe congestion as well as the additional cost associated with the condition of the pavement. It was assumed that 50% of the drivers were on Highway and 50% were on city roads. Congestion does not factor into the calculation. Road conditions were assumed to be well managed. A value of 26 cents per mile for passenger vehicles and 65.5 cents per-mile for commercial trucks was determined using an average cost of gas of $2.30 and diesel of $2.17. These average costs were developed by averaging the real price of fuel over 80 years, the period for which data was available. The above pricing was updated to current price levels by indexing from the 2008 Price Level to a 2009 Price Level using the Bureau of Labor Statistics Transportation Consumer Price Index data (CUURA207SAT, CUUSA207SAT) for the Chicago-Gary-Kenosha region.

A sensitivity analysis was conducted to evaluate uncertainty associated with volatile fuel prices. The average cost of fuel from 2000 to 2010 is $3.00 per gallon for gasoline and $2.83 per gallon for diesel. The impact of this increase on total expected annual damages is an increase of less than 1%. The sensitivity of the economic analysis to this parameter, therefore, is low. The time value associated with delays and detours has a much larger influence on the results that the cost of fuel, only associated with detours.

Although it is likely that, during a flood event, some trips will be deferred or demurred, a literature review by the VISTA team found that consistent and comprehensive data on this phenomenon is not available. A discussion of the studies reviewed can be found in Section 3.3.6 of Attachment 3. As a result, trips postponed or canceled during a flood event were not included in the analysis.

For passenger vehicles, monetary output for the time value associated with transportation delays was computed using Table D-4: Value of Time Saved by Trip

[1] Barnes, Gary and Langworthy, Peter. The Per-Mile Costs of Operating Automobiles and Trucks. Minnesota Department of Transportation. 2003.

Length and Purpose in ER 1105-2-100, Planning Guidance Notebook. Determination of the value of time saved was taken from the before-tax family income for trips in the study area. The 2006-2008 American Community Survey Profile for Chicago's primary metropolitan statistical area (inclusive of Cook, Dekalb, DuPage, Grundy, Kane, Kendall, Lake, McHenry, and Will Counties) shows a median family income of $73,760 in 2008 dollars. Table 2.6 provides the calculations based in Table D-4. The total value of work time saved per vehicle is multiplied by the number of adults per vehicle. The 2004 report by the US Department of Transportation entitled Summary of Travel Trends – 2001 Nation Household Travel Survey reported 1.14 persons per vehicle.

For commercial vehicles, monetary output for the time value associated with delays was calculated as shown in Table 2.7. For this category, since all trips are assumed to be for work purposes, all trips are given the same weight and the rates are not adjusted according to time grouping.

Since this methodology only produces a gross damage value for the entire network it has limited use in plan formulation. A method is needed to ascribe the overall network damages to pertinent damage sites within the network. The System Impacts-Based Aggregation (SIBA) method was selected, as documented in Attachment 3. The ascription allows USACE to create a direct depth-damage relationship for impacted road crossings.

During the development of the road direct depth-damage relationships, it was noticed that damages at some road crossings exhibited a decrease in damage estimates with increasing annual exceedance probability. The standard approach in the HEC-FDA modeling environment allocates a spatially fixed good or service to a point along a flooding source, e.g. house or a parked car, whose damages are independent from all other goods or services. As the flood wave passes this point, the stages/ discharges increase for decreasing frequency of a flood event. This produces an increasing damage relationship as the severity of the flooding increases independent of any other house or parked car. The relationship of increased damages to decreased frequency should be monotonic, i.e. the damages consistently do not decrease with decreasing frequency.

The traffic model developed for this study is a dynamic network analysis that allows investigators the ability to see system impacts of decisions at the scale of an individual driver or road segment. For example, the VISTA model can answer the question, "What is the impact to the transportation network if Golf Road is closed for two days?" Once the investigation broadens to multiple impacts to the system network, however, a problem arises as to how to ascribe the model results back to individual crossings. In the prior example, only Golf Road was closed for two days. If First Avenue is also closed for three days, the impacts change. The first scenario, in which only Golf Road is closed, showed that closing this road for two days increased vehicle travel by two miles and delays by 35 minutes. The second scenario, in which both Golf Road and First Avenue are closed, increased vehicle travel by four miles and delays by 45 minutes. Due to the proximity of these roads and the interdependence of travel on them, ascribing damages to Golf Road and First Avenue individually becomes complicated. Unfortunately, superposition does not apply, and the relationship of increasing damages to decreasing frequency is sometimes non-monotonic.

Value of Time Saved 2009PL unless otherwise noted
2003 Mean Household Income[1] $73,670
Index 2003 Mean Household Income to 2009PL[2] $76,446
Hourly Rate (2080 Hours per annum) $36.75

	Value of Time Saved Adjusted to Hourly Basis	Value of Time Saved Adjusted to Hourly Basis	Occupancy Rate[3]	Value of Time Saved Adjusted to Hourly and Occupancy
	$/Hour	% of Hourly Family Income		Value per Vehicle per Hour
Low Time Savings				
0-5 minutes				
Work trips	2.35	6.40%	**1.14**	2.68
Social/Recreation Trips	0.48	1.30%	**1.00**	0.48
Other Trips	0.04	0.10%	**1.00**	0.04
Medium				
6-15 minutes				
Work trips	11.83	32.20%	1.14	13.49
Social/Recreation Trips	8.49	23.10%	1.00	8.49
Other Trips	5.33	14.50%	1.00	5.33
High Time Savings				
Over 15 minutes				
Work trips	19.77	53.80%	1.14	22.54
Social/Recreation Trips	22.05	60.00%	1.00	22.05
Other Trips	23.71	64.50%	1.00	23.71
Vacation				
All Time Savings	27.60	75.10%	1.00	27.60

Weight Categories	**Values**
Work	**0.25**
Social/Rec	**0.22**
Other	**0.53**

Adjusted Rate per Category per Time Grouping

0-5 minutes	0.79
6-15 Minutes	8.07
>15 minutes	23.05

Table 2.6 – Passenger Vehicle Value of Time Saved by Trip Length and Purpose

[1] American Community Survey Profile 2006-2008, Table S1901
[2] Bureau of Labor Statistics CPI for Chicago-Gary-Kenosha region
[3] Per ER 1105-2-100, work trips are evaluated on a per person basis while social, recreation, and other trips are on a per vehicle basis.

Occupation (SOC code)	Employment (1)	Employment percent relative standard error (3)	Hourly mean wage	Annual mean wage	Wage percent relative standard error (3)	Hourly Wage Percentile					Annual Wage Percentile (2)				
						10th	25th	Median	75th	90th	10th	25th	Median	75th	90th
Truck Drivers, Heavy and Tractor-Trailer (533032)	44480	8.3	$21.41	$44,540	2	$14.68	$16.95	$20.72	$25.28	$29.13	$30,540	$35,260	$43,090	$52,580	$60,590
Truck Drivers, Light or Delivery Services (533033)	25160	4.6	$15.56	$32,370	2.1	$8.25	$10.62	$14.33	$19.33	$25.73	$17,150	$22,090	$29,800	$40,210	$53,510

(1) Estimates for detailed occupations do not sum to the totals because the totals include occupations not shown separately. Estimates do not include self-employed workers.
(2) Annual wages have been calculated by multiplying the hourly mean wage by 2,080 hours; where an hourly mean wage is not published, the annual wage has been directly calculated from the reported survey data.
(3) The relative standard error (RSE) is a measure of the reliability of a survey statistic. The smaller the relative standard error, the more precise the estimate.

SOC code: Standard Occupational Classification code -- see http://www.bls.gov/soc/home.htm

Data extracted on March 23, 2009

USACE Weighted Average	
Heavy Trucks (64%)[1]	$ 13.23
Light Trucks (36%)[1]	$ 5.18
Average Truck Time Value	$ 18.41
Index 2007PL to 2008PL	$ 19.10

Table 2.7 – Commercial Vehicle Value of Time Saved

[1] Chicago Area Transportation Study (Northern Illinois Planning Council (NIPC), now Chicago Metropolitan Agency for Planning (CMAP)), 2007.

One could view this, in economic terms, by examining firms in a market competing for a fix amount of resources. Let the firms in the market place represent the roads and the fixed resource is the vehicles on those roads. On any particular day there is a fixed amount of resources for use by all firms. If any one firm gains in its resources then another firms must lose in resources so that there are a fixed number of resources. Each day firms can gain and lose share of the limited resources. This is analogous to the VISTA model which has a set number of vehicles in their model, or in this analogy, resources. Each simulation of the VISTA model represents one of the eight hydrological frequencies or in our analogy a comparative day. Comparing individual damaged locations within the VISTA model can be equated to comparing firms in a market acquiring a limited resource. In the context of the analogy above this would be a gain by Buyer A at the expense of Buyer B. Since the market is gaining all the time, then the losses by Buyer B have to be such that the system still gains overall. Let's look at it in terms of market share per day. On day 1, the market has 10 units of which Buyer A has 10%, Buyer B has 50%, and Buyer C has 40%. On day 2, the market increase by 10 units to 20 total units. The percentage each Buyer has in this market is unchanged. On day 3, the market increase by 5 units to a total of 25 units. Buyer A gained in market share by 20% to a total of 30% whereas Buyer B and Buyer C decrease by 10% each.

Since the entire market on Day 3 can utilize only 25 units, but the percentage shared by each Buyer changed, the total market is monotonic but the individual buyers are not.

	Day 1	Day 2	Day 3
Buyer A	1	2	7.5
Buyer B	5	10	10
Buyer C	4	8	7.5
Total	10	20	25

Table 2.8 – Non-Monotonic Example

In HEC-FDA damages relative to flood stages must be increasing monotonic functions. Due to the complexity of the VISTA model, specific sites within the transportation network have non-monotonic depth-damage curves. The outcome of this relationship is that some tributary models for the study would realize negative damages at that location during certain frequencies in the HEC-FDA model. Examination of the road network at specific locations shows that congestion during specific hydrologic events can bottle neck traffic in one location, creating improved traffic conditions at nearby intersections.

The proposed resolution to this problem is to force the curves into a monotonically increasing relationship through a conservative reduction in damages. The process resolves the problem area by trimming the monetary damages in the frequency prior to the trough in the curve, as shown in figure 2.1. The loss in damages due to this method amount to only a 0.05% decrease in expected annual benefits.

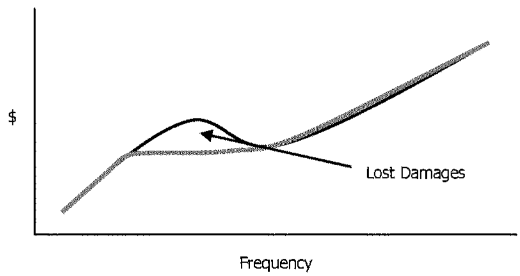

Figure 2.1 – Fitting VISTA results to meet the requirements for HEC-FDA

Physical Damages to Roads

Originally, a process was developed to monetize both physical damages to roads and the delay associated with those damages. Delays and additional mileage incurred during road repairs could be calculated from a modification of the VISTA depth-damage curves, assuming that cleanup and repairs would shut the road down for a single 24 hour period.

An estimate of physical damages to roads was developed by surveying representatives of the local transportation departments impacted by this study. The results of the survey are shown in Table 2.9. As shown in the survey results, the local transportation experts do not feel that costs associated with damages to roads caused by floods are very high and that the majority of damages are associated with debris cleanup. Given that most of the clean up would be scheduled to occur during periods of low traffic volume, including these delays in the planning process would not result in a large increase to the calculated damages. Due to the low value of these physical damages and associated delays, it was decided to not include these categories in the analysis.

Period of analysis and discount rate

Computation of Equivalent Annual Damages, which accounts for changes during the period of analysis, was performed using the current federal discount rate of 3.75% (EGM 13-01 for FY2013) and a period of analysis of 50 years (2010 through 2059). Formulation was conducted using the discount rate current at the time, but final results are reported using the current rate.

Monetary changes between the expected annual damages associated with the "base" year and the "most likely future" conditions were due to the projected changes in population, represented as increased urbanization runoff in the hydrologic model, and projected increase in transportation delays, represented by the increased lost time as a function of monetary loss.

The Upper Des Plaines River and Tributary Study was authorized in WRDA 1999 and at the time the "base" year was set as 2010. The forecasted land use data used to determine the increase urbanization runoff was provided by the Chicago Metropolitan Agency for Planning (CMAP), formerly the Northeast Illinois Planning Commission (NIPC). The 2020 regional planning document was a long range forecast in the late 1990's.

Within the hydrologic model, curve number (CN) values were typically increased to account for the expected increase in impervious area associated with urbanization. In general, differences in H&H conditions between the base year and future year were not substantial in Cook County since the area is already well developed. Greater differences were noticed in the surrounding, less developed counties. A more detailed discussion of H&H model development can be found within Appendix A. Within the transportation model, a future conditions scenario was developed using the expected 2020 transportation network and 2020 transportation demand data developed by CMAP. A more detailed discussion of transportation model development can be found in Appendix E, Attachment 3.

Normally the "most likely future" is 25 to 30 years from the base year. In this particular case there was not sufficient forecast information available to create the necessary hydrologic input data. During the development of the transportation delay study the 2020 future was already established. As with any forecast beyond a few years there is a balance that must be struck between the availability of the data and the expertise of the modeler.

Questions	Respondents					
	IDOT	Cook[1]	Lake	Kenosha	AVG	STD
1. Monitor Roadways for flooding/safety impacts and alert public agencies affected by an event						
Estimated Costs (annual)	$75,000	**$6,480**	$5,000	$3,000	$22,370	$35,116
Or Labor (annual man-days)	150	**15**	10	6	45.25	70
2. Installation and removal of detour signs and road barricades						
Estimated Costs (per flooded roadway)	$1,000	**$585**	$250	$1,000	$709	$314
Or Labor (per flooded roadway)	2	**1.5**	0.5	2	1.50	1
3. Flood Protection and other operation provided during a flood event (includes installation, operation, removal, and disposal)						
a. Sandbagging						
Material Estimated Costs (per instance)	$0	**$11,349**	$0	$0	$2,837	$5,675
And Labor (per instance)	0	*12.7*	0	0	3.18	6
b. Pumping						
Material Estimated Costs (per instance)	$0	**$2,393**	0 (NR)	$0	$798	$1,382
And Labor (per instance)	0	*14.2*	2	0	4.05	7
4. Post flood event roadway clean-up						
a. Street and Gutter Sweeping						
Estimated Costs (per flooded roadway)	$2,500	**$1,000**	$0	$100	$900	$1,158
Or Labor (per flooded roadway)	5	2	0	0.2	1.80	2
b. Cleaning of Drainage Structures						
Estimated Costs (per structure)	$1,000	**$398.56**	$0	$100	$375	$450
Or Labor (per structure)	2	0.75	0	0.2	0.74	1
5. Additional Maintenance activities for scour critical bridges and culverts following a flood event						
a. Inspection costs						
Estimated Costs (per structure)	$1,000	**$170**	$500	$0	$418	$440
Or Labor (per structure)	2	0.3	1	0	0.83	1
b. Scour protection measures						
Estimated Costs (material per structure)	$0	**$3,400**	$0	$0	$850	$1,700
And Labor (per structure)	0	NR	0	0	0.00	0
c. Debris removal on piers/abutments						
Estimated Costs (material per structure)	NR	NR	NR	$0	0.00	0
And Labor (per structure)	10	NR	2	0	4.00	5
6. Roadway repairs following a flood event						
a. Shoulder restoration						
Estimated Costs (material per instance)	$1,000	**NR**	NR	$100	$550	$636
And Labor (per structure)	20	NR	5	1	8.67	10
b. Average condition that trigger shoulder erosion						
Depth (ft)	0.5	NR	NR	0.5	0.50	0
And Velocity (ft/s)	NR	NR	NR	NR		
7. Addressing claims for vehicles trapped in flooded underpasses or otherwise damaged by flood waters						
Estimated Costs (per instance)	$5,000	**NR**	$0	$0	$1,667	$2,887
Or Labor (per instance)	10	NR	0	0	3.33	6

(2008 Price Level)

Table 2.9 – Survey of Costs Stemming from Flood Damages to Roads

[1] Bolded values provided on survey form, italicized values estimated assuming a labor rate of $500 per man- day.

2.3 – RISK AND UNCERTAINTY

Flood risk management involves defining the probability an area will be flooded resulting in undesirable consequences, and identifying the plan most likely to minimize those consequences. Since risk inherently involves the chance of occurrence, uncertainties associated with the risk analysis are quantified and taken into account. As laid out by Corps regulation ER 1105-2-101, Risk Analysis for Flood Damage Reduction Studies, risk and uncertainty are intrinsic in water resources planning and design. All estimated values in project planning and design are inaccurate to various degrees. With advances in statistical hydrology and the availability of computerized analysis tools, such as the Corps of Engineers Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) model, it is now possible to improve the evaluation of uncertainties in hydrologic, hydraulic, geotechnical and economic aspects of calculations. Through this risk analysis, and with careful communication of the results, the stakeholders can be better informed about what to expect from flood damage reduction projects and their residual risks.

The determination of equivalent annual damages for a flood risk management study must take into account the complex relationships between and uncertainties in key hydrologic, hydraulic, geotechnical, and economic information:

- Hydrologic - The discharge-frequency function describes the probability a given flood will occur. Variables with uncertainties accounted for in the analysis include gage records that are often short or do not exist, precipitation-runoff computational methods that are not precisely known, and imprecise knowledge of the effectiveness of flow regulating structures. Using graphical probability functions, HEC-FDA calculates error bands based upon the input frequency-discharge curve and the equivalent gage period of record.

- Hydraulic - The stage-discharge function describes the water surface elevation for a given flow rate. Uncertainties arise from the use of simplified models to describe complex hydraulic relationships, including simplified geometric data, effects of hydraulic structures, and errors in estimates of slopes and roughness factors. HEC-FDA calculates error bands to the stage-discharge curve based upon a provided error distribution.

- Geotechnical - The geotechnical levee failure function describes levee failure probabilities in relation to channel and protected area water stages. Uncertainties include geotechnical parameters such as soil and permeability values used in the analysis, mathematical simplifications in analysis models, the frequency and magnitude of physical changes or failure events, and the uncertainty of unseen features such as rodent burrows, cracks within the levee, or other defects. Although geotechnical uncertainties are present, the current version of HEC-FDA does not assign error bands around levee failure functions.

- Economic - The stage-damage function describes the amount of damage that may occur for a given flood elevation. Uncertainties include depth/damage relationships, structure and content values, structure locations, first floor elevations, flood duration, flood warning time and the response of floodplain inhabitants.

These four inter-related functions make up the conceptual risk approach utilized by the Corps on all flood risk management projects, as illustrated in Figure 2.2. HEC-FDA performs a Monte Carlo simulation of discharge-probability, stage-discharge, and stage-damage relationships, incorporating their associated uncertainties, to compute a damage-probability function. Expected annual damages, an estimate of annual damages for a given condition and year of analysis are calculated by integrating the damage-probability function. HEC-FDA uses a Monte Carlo routine to perform numerous (over 30,000) model realizations by randomly selecting values within the specified uncertainty limits for each function.

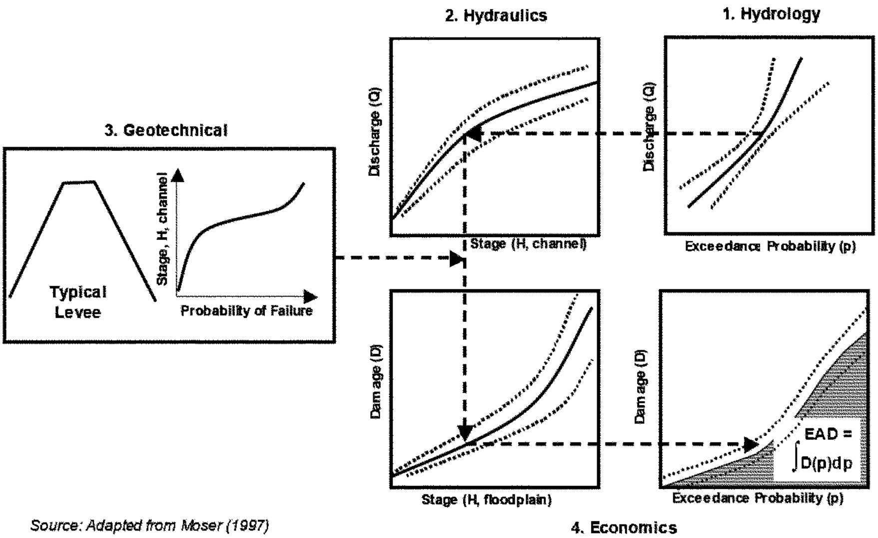

Figure 2.2 – Conceptual Risk Approach for Estimating Flood Damages

Identification and classification of the types of uncertainties in the risk and uncertainty analysis method is the key to both quantifying its impact and understanding its implications to the model results. The majority of the model uncertainty can be classified as *natural variability,* resulting from factors such as chance (e.g. flood-frequency curves). Uncertainty derived from measurement limitations or human error is classified as *knowledge uncertainty.*

Natural variability in a hydrologic system is typically quantified by the discharge-frequency relationship. The HEC-FDA methods provided to quantify this relationship are contained in the Graphical Method and the Analytical Method. Due to the complexity of the study and the need to work in both an effective and efficient way, the Graphical Method was selected over the more rigorous Analytical Method.

Knowledge uncertainty is a major factor in this study. Issues of uncertainty in measurements are commonly experienced. For example, prior to the invention of digital thermometers most oral thermometers got pretty accurate readings using a graduated scale showing tenth of degrees. Currently, many digital thermometers are available that read to the hundredth decimal place, a very accurate measurement. Whether that reading is the same after multiple measurements, however, is a matter of the instrument's precision.

As a more complex example of knowledge uncertainty, engineering hydrology at the watershed scale has limitations based on knowledge and ability to measure at what is sometimes referred to as the "hillslope scale." At this small scale, variations within the system can be included in a detailed model. Most regional hydrology models, however, translate observation and experience of a natural system into an empirical relationship. This relationship creates an output that mimics the system being analyzed. The various input parameters can be measured very accurately and precisely yet, due to gaps in our knowledge of the system, fail to perfectly mimic the modeled system. This study uses a regional model due to the size of the system we are studying. Uncertainty in each of the two types of data sources for the economic analysis, *engineering data* and *economic data*, will be addressed separately. Knowledge uncertainties in this study's engineering data include flood stage variability due to assignment of a Manning's n value and structure elevations.

Manning's n Value Uncertainties

Uncertainty in stage is a function of many parameters including uncertainty in cross-sectional geometry, uncertainty in discharge, and uncertainty in the Manning's n-value. EM 1110-2-1619 provides information on minimal standard deviation of error in stage as function of cross section accuracy and reliability of the Manning's n-value. The geomorphology of the region and the urbanization of the area around the Des Plaines River gave the study team pause as to the whether the EM 1110-2-1619 Table 5-2 method was applicable.

The study assumes that variability in stages is greatly attributed to the ability of the engineer to assign an appropriate Manning's n value. To capture this error, the Manning's n-value of the modeled channel was allowed to vary randomly from the original value by 15% at each cross-section. Stage was then simulated using USACE's HEC-RAS (River Analysis System) model. Three HEC-RAS simulations, the minimum sample required to calculate a standard deviation, were performed and a standard deviation of the stage at each frequency was calculated for each cross-section.

Parameterization of the HEC-FDA model's HygEng data set, discharge and stage uncertainty, utilized a DOS program called WSPRetrieve created by the USACE Hydrologic Engineering Center. This program allows use of HEC-FDA's Graphical Method for the Exceedance Probability Function and sets a global standard deviation value for stage error in water surface profiles. The probability distribution for this global assignment defaults to a normal distribution for stage error, assumed to be constant for the entire model for all reaches and all water surface profiles. The global assignment feature for the "Set Stage Error" has limitations.

To create a single stage error for the entire model, eight calculated stage standard deviations were aggregated at each cross-section. To capture the maximum error at each particular cross-section the maximum value was selected to represent the stage error for that cross-section. A single stage error value was then generated by taking the averaging stage errors over all cross sections for each particular model. Table 2.10 summarizes the stage errors calculated and applied in each HEC-FDA model. Variation in stage deviation between watersheds is likely due to the complex hydraulics of the system. These calculated stage errors represent as the degree of uncertainty in the calculated profiles for each watershed through perturbation of the Manning's n-value. The low uncertainty shown in Table 2-10 only narrows the potential range of monetary damages relative to the potential values from EM 1110-2-1619.

Watershed	Standard Deviation (ft)
Newport Drainage Ditch	0.07
Mill Creek	0.15
Bull Creek	0.09
Indian Creek	0.15
Buffalo-Wheeling Creek	0.09
McDonald Creek	0.15
Weller Creek	0.14
Farmer-Prairie Creek	0.07
Willow-Higgins Creek	0.09
Silver Creek	0.09
Des Plaines River	0.09

Table 2.10 – Stage Uncertainty tabulation

Structure Elevation Uncertainties

Structure elevation data were taken from field survey and LiDAR data. Survey data were taken from four sources: the Phase I Study, Illinois Department of Natural Resources surveys, a survey conducted by Dynasty Group on behalf of MWRDGC, and surveys conducted by SEWRPC. The majority of the structure elevation information was obtained via field survey thus achieving a higher degree of certainty in the elevation data. Since not all structures need this level of certainty and in some cases there is diminishing return on the time and money invested in such a costly field survey, LiDAR data were used to determine elevations for some structures. LiDAR data was used for structures outside the 1/100 AEP but within the 1/500 AEP floodplain. Since LiDAR only provides an estimate of the ground elevation, the study needed to derive information about a structure's first floor elevation and lowest entry point. Typical relationships between LiDAR ground elevation data and first floor elevations were developed using the field surveyed data. Field survey data was grouped by occupancy code and analyzed for correlations between the ground elevation and the first floor and low entry elevation.

Economic Uncertainties - Structural

The majority of the structural economic uncertainty was predefined by others (EGM 04-01, Residential Generic Depth-Damage Functions, and Non Residential Generic Depth Damage Functions). Non-residential facilities not capable of being classified in generic terms were individually surveyed. For these structures, uncertainty in the damage estimates was reported by the respondent of the survey in terms of Low, Most Likely, and High values.

Economic Uncertainties - Transportation

Uncertainty for the damages due to flood induced delays and detours are based on travel time offset. The concept of travel time offset can be visualized as the effect that road closures have on the daily traffic cycle. A rainfall event could occur during any period of the day. To capture the degree of uncertainty associated with the timing of rainfall events and consequent road closures to diurnal traffic congestion, model runs were prepared that shifted the start of the flooding duration at set increments within a 24 hour period: 0 (No Offset), 3, 8, 13, and 18 hours. Using this method VISTA was able to gage the degree of model sensitivity relative to the starting of road closure and the daily traffic congestion patterns in the network. Attachment 3 provides a detailed explanation of the methods, theory, and results. The conclusion of the VISTA study is that while there is variability in the results due to travel time offset the "no-offset" scenario results should be utilized for economic damage calculation. A triangular distribution was used in HEC-FDA and the maximum and minimum uncertainty damage values were calculated by taking a percentage of the reported damages, as shown in Table 2.11.

Annual Chance of Exceedance (Frequency)	% Uncertainty
99% (1 yr)	0.41%
50% (2 yr)	0.41%
20% (5 yr)	0.41%
10% (10 yr)	0.41%
4% (25 yr)	7.78%
2% (50 yr)	6.60%
1% (100 yr)	18.44%
0.2% (500 yr)	9.59%

Table 2.11 – Uncertainty range for Transportation Depth-Damage Curves

An analysis of the effect of storm start time and duration was conducted for transportation delays in order to determine the critical storm duration. A 24-hour storm was compared with a 10-day storm and showed very little difference in impacts to the transportation network. The analysis was expanded by varying the start time of the storm over a 24 hour period. In comparing the impacts on delays and detours resulting from this variation, the 24-hour storm showed a greater impact on the transportation network than the 10-day storm. The 24-hour storm was therefore selected as the critical duration for the VISTA model. Further discussion of this analysis can be found in Attachment 3.

CHAPTER 3 – WITHOUT PROJECT CONDITIONS

3.1 Existing Flood Damage Reduction Structures

The without-project condition of the upper Des Plaines River watershed is the basis for comparing the alternative plans. In forecasting these conditions, an effort is made to describe foreseeable changes to the most important aspects of the study area over the life of a project. This forecasting is based on an assessment of the existing conditions, previous trends, and predicted trends within the study area. The without-project condition describes the future conditions that will exist if no action is taken. The without-project conditions for the Phase II study include the implementation of the six flood damage reduction projects authorized by the Phase I study. Even though some of these projects have not been implemented, their effects on existing conditions are included as baseline for this analysis. The effects of Phase I reservoir projects were captured within the hydrologic modeling while the effects of the Phase I levee projects were captured within the HEC-FDA model. Along reaches protected by levees, the beginning depth damage values were modified to reflect the top elevation of the levees.

3.2 Updates to Without Project Condition

During the course of the study, the need for revisions to the mainstem without project condition model inputs was identified. Further discussion of the revisions can be found in Chapter 4 of the Main Report. The without project condition damages reported here reflect the most current modeling.

The first revision came about as a result of a technical review within the USACE. The work produced by the Project Delivery Team (PDT) underwent Agency Technical Review (ATR) at key points in the study process. During the review immediately prior to finalization of the NED plan, a need for revisions to the estimated value of time delays incurred as a result of flooded road crossings was identified. The revision resulted in a decrease in calculated damages and a parallel decrease in project benefits. Transportation damages were indexed to 0.83 of the originally calculated values. An additional revision was made to the hydraulic model of the mainstem Des Plaines River in Illinois, as discussed in Chapter 4 of the Main Report.

The data presented here is the most current without project condition data and includes all updates and revisions. However, due to the scale and complexity of the study, both the H&H and economic analyses that had been accomplished at the time these revisions were identified had required a considerable investment of time. Screening data for reservoirs presented in Chapter 4 of the Main Report and Appendix B use older data. However, as the updates consistently showed a decrease in damages and benefits, no previously eliminated projects would be reincorporated by repeating the screening analysis. The PDT therefore determined that the existing screening level analysis for reservoirs is appropriate.

3.3 Potentially Damaged Structures

Table 3.1 through Table 3.29 show a breakdown by damage category of the number of structures included in the analysis and the number of structures in that inventory at risk of flood damage. The number of structures presented in these tables includes all damaged structures, including those damaged below the first floor elevation. Geographically, the Des Plaines River Watershed runs predominately north to south. Urbanization of the Chicagoland area has typically been in a northwestern and southwestern direction. Sub-watersheds in the southern portion of the Des Plaines River watershed are more urbanized and show a greater number of structures at risk of flood damage than watersheds in the northern portion of the study area.

For structures in Wisconsin, presented in Tables 3.1 through 3.7, the data provided by SEWRPC showed no change between baseline and future conditions, therefore, the number of potentially damaged structures does not change between the two scenarios. For these watersheds, a single table for baseline and future conditions is presented.

Tables 3.8 through 3.29 were created from data provided by HEC-FDA's FDA_StrucDetail.OUT (herein referred to as StrucDetail) and FDA_SdErrors.OUT files (herein referred to as SdErrors). StrucDetail contains estimates for damages to structures at each modeled flood event. Structures that would not be damaged under conditions in which uncertainty would apply can be identified by the fact that they are present in the StrucDetail file, but are not damaged in any of the modeled floods. Tables 3.2 through 3.23 show the number of structures damaged at each of the eight frequencies analyzed, as computed from the StrucDetail file. The SdErrors file reports the number of structures removed by FDA. The difference between the total structure count and the total structures removed is the number of structures damaged with uncertainty applied, as discussed in Section 2.3, presented as "Potentially Damaged Structures." The difference between the number of potentially damaged structures and the number of structures damaged at the 0.2% annual chance of exceedance flood (the most inclusive flood event) is the number of structures identified by uncertainty. By way of example, Table 3.8 shows only one of the inventoried structures damaged at the 500 year event. Four additional structures, however, were identified by varying the uncertain parameters in the model, therefore a total of five structures in the watershed could be potentially damaged due to uncertainty.

Structures not included in the count of structures at risk of flood damage were determined to be "out of the floodplain" by HEC-FDA its aggregate stage-damage computations. CPD-72, HEC-FDA Flood Damage Reduction Analysis User's Manual provides a detailed breakdown on how the model determines which structures are selected as being "out of the floodplain". As HEC-FDA makes the determination of whether a structure is in or out of the floodplain, the model checks, based on uncertainty, if a structure has the potential for being damaged at the upper and lower uncertainty bounds. If a structure is flagged as "in the floodplain" based on this check, it is analyzed.

Tables 3.30 through 3.32 provide summaries of the inventoried and potentially damaged structures for the entire watershed.

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
RES	1SNB	One Story No Basement	12		1	1	6	9	10	12	12		12
	1SWB	One Story With Basement	12		2	2	11	12	12	12	12		12
	2SNB	Two Story No Basement	3				1	2	2	3	3		3
	2SWB	Two Story With Basement	1					1	1	1	1		1
	BLNB	Bi-Level No Basement	1				1	1	1	1	1		1
	BLWB	Bi-Level With Basement	5				3	4	5	5	5		5
	TLNB	Tri-Level No Basement											0
	TLWB	Tri-Level With Basement											0
	RES_D	Direct Depth Damage Data											0
	TOTAL RES		34	0	3	3	22	29	31	34	34	0	34
	Total		34	0	3	3	22	29	31	34	34	0	34

Table 3.1 – Brighton Creek Potentially Damaged Structures

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
RES	1SNB	One Story No Basement	4				2	4	4	4	4		4
	2SNB	Two Story No Basement	1				1	1	1	1	1		1
	2SWB	Two Story With Basement	2				2	2	2	2	2		2
	BLWB	Bi-Level With Basement	1		1	1	1	1	1	1	1		1
	RES_D	Direct Depth Damage Data	2				1	1	2	2	2		2
	TOTAL RES		10	0	1	1	7	9	10	10	10	0	10
	Total		10	0	1	1	7	9	10	10	10	0	10

Table 3.2 – Dutch Gap Canal Potentially Damaged Structures

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
RES	1SWB	One Story With Basement	1					1	1	1	1		1
	TOTAL RES		1	0	0	0	0	1	1	1	1	0	1
	Total		1	0	0	0	0	1	1	1	1	0	1

Table 3.3 – Center Creek Potentially Damaged Structures

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
RES	1SWB	One Story With Basement	1		1	1	1	1	1	1	1		1
	RES_D	Direct Depth Damage Data	1					1	1	1	1		1
	TOTAL RES		2	0	1	1	1	2	2	2	2	0	2
	Total		2	0	1	1	1	2	2	2	2	0	2

Table 3.4 – Kilbourn Road Ditch Potentially Damaged Structures

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
RES	1SNB	One Story No Basement	6				1	3	4	6	6		6
	1SWB	One Story With Basement	2		1	1	1	2	2	2	2		2
	2SNB	Two Story No Basement	1							1	1		1
	BLWB	Bi-Level With Basement	1		1	1	1	1	1	1	1		1
	TOTAL RES		10	0	2	2	3	6	7	10	10	0	10
	Total		10	0	2	2	3	6	7	10	10	0	10

Table 3.5 – Jerome Creek Potentially Damaged Structures

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
RES	1SWB	One Story With Basement	4		1	1	1	2	3	4	4		4
	BLWB	Bi-Level With Basement	1							1	1		1
	RES_D	Direct Depth Damage Data	3					2	2	3	3		3
	TOTAL RES		8	0	1	1	1	4	5	8	8	0	8
TRAFFIC		Direct Depth Damage Data[1]	18									18	18
	Total		26	0	1	1	1	4	5	8	8	18	26

[1]This count includes all inventoried crossings in Wisconsin

Table 3.6 – Des Plaines River Mainstem (WI) Potentially Damaged Structures

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
IND	WH_P	Warehouse (pre-engineered)	1										0
	TOTAL IND		1	0	0	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	4									1	1
	1SWB	One Story With Basement	16										0
	2SNB	Two Story No Basement	1										0
	2SWB	Two Story With Basement	1										0
	BLNB	Bi-Level No Basement	2										0
	BLWB	Bi-Level With Basement	2										0
	TLNB	Tri-Level No Basement	1							1	1		1
	TLWB	Tri-Level With Basement	2										0
	TOTAL RES		29	0	0	0	0	0	0	1	1	1	2
AUTO	SEDAN	Sedan style	4										0
	SPORTS	Sport Cars	1										0
	PICKUPS	Pickup Trucks	2									1	1
	TOTAL AUTO		7	0	0	0	0	0	0	0	0	1	1
TRAFFIC		Direct Depth Damage Data	4									2	2
	Total		41	0	0	0	0	0	0	1	1	4	5

Table 3.7 – Newport Drainage Ditch Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
IND	WH_P	Warehouse (pre-engineered)	1										0
	TOTAL IND		1	0	0	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	4									1	1
	1SWB	One Story With Basement	16										0
	2SNB	Two Story No Basement	1										0
	2SWB	Two Story With Basement	1										0
	BLNB	Bi-Level No Basement	2										0
	BLWB	Bi-Level With Basement	2										0
	TLNB	Tri-Level No Basement	1							1	1		1
	TLWB	Tri-Level With Basement	2										0
	TOTAL RES		29	0	0	0	0	0	0	1	1	1	2
AUTO	SEDAN	Sedan style	4										0
	SPORTS	Sport Cars	1										0
	PICKUPS	Pickup Trucks	2									1	1
	TOTAL AUTO		7	0	0	0	0	0	0	0	0	1	1
TRAFFIC		Direct Depth Damage Data	4									2	2
	Total		41	0	0	0	0	0	0	1	1	4	5

Table 3.8 – Newport Drainage Ditch Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	8									1	1
		TOTAL APT	8	0	0	0	0	0	0	0	0	1	1
COM	CLOTH_E	Clothing Store (engineered)	1								1		1
	CONV_E	Convenience Store (engineered)	1								1		1
	ELEC_P	Electronics Retailer (pre-engineered)	1										0
	FFR_E	Fast Food Restaurant (engineered)	2										0
	FURN_E	Furniture Store (engineered)	1										0
	FURN_P	Furniture Store (pre-engineered)	1								1		1
	MED_E	Medical Office (engineered)	2										0
	OFF_E	Office Building - One Story (engineered)	10								4	1	5
	REST_P	Restaurant (pre-engineered)	1										0
	SERV_E	Service Related Business (engineered)	5								2		2
	COM_D	Direct Depth Damage Data	3									1	1
		TOTAL COM	28	0	0	0	0	0	0	0	9	2	11
IND	LT_E	Light Manufacturing (engineered)	3								2		2
	LT_P	Light Manufacturing (pre-engineered)	2								1		1
	WH_P	Warehouse (pre-engineered)	4					2	3	3	4		4
	IND_D	Direct Depth Damage Data	1									1	1
		TOTAL IND	10	0	0	0	0	2	3	3	7	1	8
PUB	REC_E	Recreational (engineered)	1										0
	RF_E	Religious (engineered)	1										0
	SCH_E	School (engineered)	2								2		2
	PUB_D	Direct Depth Damage Data	1										0
		TOTAL PUB	5	0	0	0	0	0	0	0	2	0	2
RES	1SNB	One Story No Basement	107					2	2	2	6	1	7
	1SWB	One Story With Basement	70			1	1	2	2	2	4	3	7
	2SNB	Two Story No Basement	56										0
	2SWB	Two Story With Basement	174							1	3	3	6
	BLNB	Bi-Level No Basement	6										0
	BLWB	Bi-Level With Basement	8									1	1
	TLNB	Tri-Level No Basement	41										0
	TLWB	Tri-Level With Basement	34						1	1	1		1
		TOTAL RES	496	0	0	1	1	4	5	6	14	8	22
AUTO	SEDAN	Sedan style	76					1	1	1	3		3
	SPORTS	Sport Cars	5										0
	MINI	Mini Vans	4										0
	SUV	Sports Utility Vehicles	11										0
	PICKUPS	Pickup Trucks	8										0
		TOTAL AUTO	104	0	0	0	0	1	1	1	3	0	3
TRAFFIC		Direct Depth Damage Data	13									6	6
	Total		664	0	0	1	1	7	9	10	35	18	53

Table 3.9 – Mill Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	8									1	1
	TOTAL APT		8	0	0	0	0	0	0	0	0	1	1
COM	CLOTH_E	Clothing Store (engineered)	1								1		1
	CONV_E	Convenience Store (engineered)	1								1		1
	ELEC_P	Electronics Retailer (pre-engineered)	1										0
	FFR_E	Fast Food Restaurant (engineered)	2										0
	FURN_E	Furniture Store (engineered)	1										0
	FURN_P	Furniture Store (pre-engineered)	1								1		1
	MED_E	Medical Office (engineered)	2										0
	OFF_E	Office Building - One Story (engineered)	10								4	1	5
	REST_P	Restaurant (pre-engineered)	1										0
	SERV_E	Service Related Business (engineered)	5								2		2
	SERV_P	Service Related Business (pre-engineered)	0										0
	COM_D	Direct Depth Damage Data	3									1	1
	TOTAL COM		28	0	0	0	0	0	0	0	9	2	11
IND	LT_E	Light Manufacturing (engineered)	3							1	2		2
	LT_P	Light Manufacturing (pre-engineered)	2								1		1
	WH_P	Warehouse (pre-engineered)	4				1	3	3	3	4		4
	IND_D	Direct Depth Damage Data	1									1	1
	TOTAL IND		10	0	0	0	1	3	3	4	7	1	8
PUB	REC_E	Recreational (engineered)	1										0
	RF_E	Religious (engineered)	1										0
	SCH_E	School (engineered)	2							1	2		2
	PUB_D	Direct Depth Damage Data	1										0
	TOTAL PUB		5	0	0	0	0	0	0	1	2	0	2
RES	1SNB	One Story No Basement	107				1	2	2	2	7		7
	1SWB	One Story With Basement	70			1	1	2	2	2	4	3	7
	2SNB	Two Story No Basement	56										0
	2SWB	Two Story With Basement	174							1	4	2	6
	BLNB	Bi-Level No Basement	6										0
	BLWB	Bi-Level With Basement	8									1	1
	TLNB	Tri-Level No Basement	41										0
	TLWB	Tri-Level With Basement	34					1	1	1	1		1
	TOTAL RES		496	0	0	1	2	5	5	6	16	6	22
AUTO	SEDAN	Sedan style	76				1	1	1	1	3		3
	SPORTS	Sport Cars	5										0
	MINI	Mini Vans	4										0
	SUV	Sports Utility Vehicles	11										0
	PICKUPS	Pickup Trucks	8										0
	TOTAL AUTO		104	0	0	0	1	1	1	1	3	0	3
TRAFFIC		Direct Depth Damage Data	13									7	7
	Total		664	0	0	1	4	9	9	12	37	17	54

Table 3.10 – Mill Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
COM	ELEC_E	Electronics Retailer (engineered)	2										0
	FFR_E	Fast Food Restaurant (engineered)	1									1	1
	MED_E	Medical Office (engineered)	1										0
	TOTAL COM		4	0	0	0	0	0	0	0	0	1	1
PUB	REC_E	Recreational (engineered)	1							1	1		1
	SCH_E	School (engineered)	1					1	1	1	1		1
	TOTAL PUB		2	0	0	0	0	1	1	2	2	0	2
RES	1SNB	One Story No Basement	2				1	1	2	2	2		2
	1SWB	One Story With Basement	16					1	1	6	9	5	14
	2SNB	Two Story No Basement	1						1	1	1		1
	2SWB	Two Story With Basement	46					1	9	18	20	1	21
	BLNB	Bi-Level No Basement	1								1		1
	TLNB	Tri-Level No Basement	1										0
	TLWB	Tri-Level With Basement	2					2	2	2	2		2
	RES_D	Direct Depth Damage Data	0										0
	TOTAL RES		69	0	0	0	1	5	15	29	35	6	41
AUTO	SEDAN	Sedan style	13							3	4	1	5
	MINI	Mini Vans	1										0
	SUV	Sports Utility Vehicles	1										0
	PICKUPS	Pickup Trucks	1										0
	TOTAL AUTO		16	0	0	0	0	0	0	3	4	1	5
TRAFFIC		Direct Depth Damage Data	4									2	2
	Total		95	0	0	0	1	6	16	34	41	10	51

Table 3.11 – Bull Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
COM	ELEC_E	Electronics Retailer (engineered)	2										0
	FFR_E	Fast Food Restaurant (engineered)	1									1	1
	MED_E	Medical Office (engineered)	1										0
	TOTAL COM		4	0	0	0	0	0	0	0	0	1	1
PUB	REC_E	Recreational (engineered)	1							1	1		1
	SCH_E	School (engineered)	1					1	1	1	1		1
	TOTAL PUB		2	0	0	0	0	1	1	2	2	0	2
RES	1SNB	One Story No Basement	2				1	2	2	2	2		2
	1SWB	One Story With Basement	16					1	1	6	9	5	14
	2SNB	Two Story No Basement	1							1	1		1
	2SWB	Two Story With Basement	46					1	10	19	20	1	21
	BLNB	Bi-Level No Basement	1									1	1
	TLNB	Tri-Level No Basement	1										0
	TLWB	Tri-Level With Basement	2				1	2	2	2	2		2
	TOTAL RES		69	0	0	0	2	6	15	30	34	7	41
AUTO	SEDAN	Sedan style	13							3	4	1	5
	MINI	Mini Vans	1										0
	SUV	Sports Utility Vehicles	1										0
	PICKUPS	Pickup Trucks	1										0
	TOTAL AUTO		16	0	0	0	0	0	0	3	4	1	5
TRAFFIC		Direct Depth Damage Data	4									2	2
	Total		95	0	0	0	2	7	16	35	40	11	51

Table 3.12 – Bull Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	1										0
	TOTAL APT		1	0	0	0	0	0	0	0	0	0	0
COM	OFF_E	Office Building - One Story (engineered)	2								1	1	2
	SERV_E	Service Related Business (engineered)	2								1		1
	TOTAL COM		4	0	0	0	0	0	0	0	2	1	3
IND	WH_E	Warehouse (engineered)	1										0
	TOTAL IND		1	0	0	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	1										0
	1SWB	One Story With Basement	10						1	1	3		3
	2SNB	Two Story No Basement	12										0
	2SWB	Two Story With Basement	113		1	1	2	3	6	8	32	13	45
	BLW8	Bi-Level With Basement	1										0
	TLW8	Tri-Level With Basement	1								1		1
	TOTAL RES		138	0	1	1	2	3	7	9	36	13	49
AUTO	SEDAN	Sedan style	16								1	2	3
	SPORTS	Sport Cars	1										0
	MINI	Mini Vans	5										0
	SUV	Sports Utility Vehicles	6									1	1
	PICKUPS	Pickup Trucks	3										0
	TOTAL AUTO		31	0	0	0	0	0	0	0	1	3	4
TRAFFIC		Direct Depth Damage Data	6									3	3
	Total		181	0	1	1	2	3	7	9	39	20	59

Table 3.13 – Indian Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	1										0
		TOTAL APT	1	0	0	0	0	0	0	0	0	0	0
COM	OFF_E	Office Building - One Story (engineered)	2								1	1	2
	SERV_E	Service Related Business (engineered)	2								1		1
		TOTAL COM	4	0	0	0	0	0	0	0	2	1	3
IND	WH_E	Warehouse (engineered)	1										0
		TOTAL IND	1	0	0	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	1										0
	1SWB	One Story With Basement	10						1	1	3		3
	2SNB	Two Story No Basement	12										0
	2SWB	Two Story With Basement	113		1	1	2	3	6	8	32	13	45
	BLWB	Bi-Level With Basement	1										0
	TLWB	Tri-Level With Basement	1								1		1
		TOTAL RES	138	0	1	1	2	3	7	9	36	13	49
AUTO	SEDAN	Sedan style	16								1	2	3
	SPORTS	Sport Cars	1										0
	MINI	Mini Vans	5										0
	SUV	Sports Utility Vehicles	6									1	1
	PICKUPS	Pickup Trucks	3										0
		TOTAL AUTO	31	0	0	0	0	0	0	0	1	3	4
TRAFFIC		Direct Depth Damage Data	6									3	3
	Total		181	0	1	1	2	3	7	9	39	20	59

Table 3.14 – Indian Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	37								20	5	25
	APT_D	Direct Depth Damage Data	0										0
	TOTAL APT		37	0	0	0	0	0	0	0	20	5	25
COM	CLOTH_E	Clothing Store (engineered)	8								2		2
	CONV_E	Convenience Store (engineered)	2										0
	ELEC_E	Electronics Retailer (engineered)	1										0
	FFR_E	Fast Food Restaurant (engineered)	6								1		1
	FURN_E	Furniture Store (engineered)	1									1	1
	FURN_P	Furniture Store (pre-engineered)	1										0
	GROC_E	Grocery Store (engineered)	1										0
	MED_E	Medical Office (engineered)	1								1		1
	OFF_E	Office Building - One Story (engineered)	49					2	3	3	9	1	10
	REST_E	Restaurant (engineered)	4										0
	REST_P	Restaurant (pre-engineered)	1								1		1
	SERV_E	Service Related 8usiness (engineered)	4							1	3		3
	COM_D	Direct Depth Damage Data	1									1	1
	TOTAL COM		80	0	0	0	0	2	3	4	17	3	20
IND	LT_E	Light Manufacturing (engineered)	25								2	1	3
	LT_P	Light Manufacturing (pre-engineered)	1							1	1		1
	WH_E	Warehouse (engineered)	4							1	2	1	3
	WH_P	Warehouse (pre-engineered)	1								1		1
	TOTAL IND		31	0	0	0	0	0	0	2	6	2	8
PUB	REC_E	Recreational (engineered)	1										0
	RF_E	Religious (engineered)	3										0
	SCH_E	School (engineered)	2										0
	TOTAL PUB		6	0	0	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	414				1	10	20	88	342	19	361
	1SWB	One Story With Basement	270						11	22	140	13	153
	2SNB	Two Story No Basement	236					4	14	39	136	31	167
	2SWB	Two Story With Basement	104							2	13	3	16
	BLNB	Bi-Level No Basement	2										0
	TLNB	Tri-Level No Basement	44				1	3	7	11	27	3	30
	TLWB	Tri-Level With Basement	19								4	3	7
	TOTAL RES		1089	0	0	0	2	17	52	162	662	72	734
AUTO	SEDAN	Sedan style	140				1	3	6	12	75	10	85
	SPORTS	Sport Cars	19							3	13	1	14
	MINI	Mini Vans	15							1	3	1	4
	SUV	Sports Utility Vehicles	20							1	4	5	9
	PICKUPS	Pickup Trucks	17							1	6	1	7
	TOTAL AUTO		211	0	0	0	1	3	6	18	101	18	119
TRAFFIC		Direct Depth Damage Data	13									7	7
	Total		1467	0	0	0	3	22	61	186	806	107	913

Table 3.15 – Buffalo-Wheeling Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	37								20	5	25
	TOTAL APT		37	0	0	0	0	0	0	0	20	5	25
COM	CLOTH_E	Clothing Store (engineered)	8								2		2
	CONV_E	Convenience Store (engineered)	2										0
	ELEC_E	Electronics Retailer (engineered)	1										0
	FFR_E	Fast Food Restaurant (engineered)	6								1		1
	FURN_E	Furniture Store (engineered)	1									1	1
	FURN_P	Furniture Store (pre-engineered)	1										0
	GROC_E	Grocery Store (engineered)	1										0
	MED_E	Medical Office (engineered)	1								1		1
	OFF_E	Office Building - One Story (engineered)	49					2	3	3	9	1	10
	REST_E	Restaurant (engineered)	4										0
	REST_P	Restaurant (pre-engineered)	1								1		1
	SERV_E	Service Related Business (engineered)	4							1	3		3
	COM_D	Direct Depth Damage Data	1										0
	TOTAL COM		80	0	0	0	0	2	3	4	17	2	19
IND	LT_E	Light Manufacturing (engineered)	25							2	2	1	3
	LT_P	Light Manufacturing (pre-engineered)	1							1	1		1
	WH_E	Warehouse (engineered)	4							1	2	1	3
	WH_P	Warehouse (pre-engineered)	1								1		1
	TOTAL IND		31	0	0	0	0	0	0	4	6	2	8
PUB	REC_E	Recreational (engineered)	1										0
	RF_E	Religious (engineered)	3										0
	SCH_E	School (engineered)	2										0
	TOTAL PUB		6	0	0	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	414				1	11	23	119	344	17	361
	1SWB	One Story With Basement	270						11	29	140	13	153
	2SNB	Two Story No Basement	236					4	16	47	139	30	169
	2SWB	Two Story With Basement	104							2	13	3	16
	BLNB	Bi-Level No Basement	2										0
	TLNB	Tri-Level No Basement	44				1	3	7	11	27	3	30
	TLWB	Tri-Level With Basement	19								4	3	7
	TOTAL RES		1089	0	0	0	2	18	57	208	667	69	736
AUTO	SEDAN	Sedan style	140				1	3	6	15	76	9	85
	SPORTS	Sport Cars	19							3	13	1	14
	MINI	Mini Vans	15							1	3	1	4
	SUV	Sports Utility Vehicles	20							2	5	4	9
	PICKUPS	Pickup Trucks	17							1	6	1	7
	TOTAL AUTO		211	0	0	0	1	3	6	22	103	16	119
TRAFFIC		Direct Depth Damage Data	13									7	7
	Total		1467	0	0	0	3	23	66	238	813	101	914

Table 3.16 – Buffalo-Wheeling Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
COM	CONV_E	Convenience Store (engineered)	1										0
		TOTAL COM	1	0	0	0	0	0	0	0	0	0	0
IND	LT_E	Light Manufacturing (engineered)	4										0
	IND_D	Direct Depth Damage Data	0										0
		TOTAL IND	4	0	0	0	0	0	0	0	0	0	0
PUB	RF_E	Religious (engineered)	1										0
		TOTAL PUB	1	0	0	0	0	0	0	0	0	0	0
RES	1SWB	One Story With Basement	80									9	9
	2SWB	Two Story With Basement	64								1	4	5
	TLWB	Tri-Level With Basement	35								1	2	3
		TOTAL RES	179	0	0	0	0	0	0	0	2	15	17
AUTO	SEDAN	Sedan style	26										0
	SPORTS	Sport Cars	2										0
	MINI	Mini Vans	2										0
	SUV	Sports Utility Vehicles	3										0
	PICKUPS	Pickup Trucks	2										0
		TOTAL AUTO	35	0	0	0	0	0	0	0	0	0	0
TRAFFIC		Direct Depth Damage Data	2										0
	Total		222	0	0	0	0	0	0	0	2	15	17

Table 3.17 – McDonald Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
COM	CONV_E	Convenience Store (engineered)	1										0
		TOTAL COM	1	0	0	0	0	0	0	0	0	0	0
IND	LT_E	Light Manufacturing (engineered)	4										0
		TOTAL IND	4	0	0	0	0	0	0	0	0	0	0
PUB	RF_E	Religious (engineered)	1										0
		TOTAL PUB	1	0	0	0	0	0	0	0	0	0	0
RES	1SWB	One Story With Basement	80									9	9
	2SWB	Two Story With Basement	64								1	4	5
	TLWB	Tri-Level With Basement	35								1	2	3
		TOTAL RES	179	0	0	0	0	0	0	0	2	15	17
AUTO	SEDAN	Sedan style	26										0
	SPORTS	Sport Cars	2										0
	MINI	Mini Vans	2										0
	SUV	Sports Utility Vehicles	3										0
	PICKUPS	Pickup Trucks	2										0
		TOTAL AUTO	35	0	0	0	0	0	0	0	0	0	0
TRAFFIC		Direct Depth Damage Data	2										0
	Total		222	0	0	0	0	0	0	0	2	15	17

Table 3.18 – McDonald Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
COM	COM_D	Direct Depth Damage Data	1									1	1
	TOTAL COM		1	0	0	0	0	0	0	0	0	1	1
IND	LT_E	Light Manufacturing (engineered)	1									1	1
	TOTAL IND		1	0	0	0	0	0	0	0	0	1	1
RES	1SWB	One Story With Basement	210	1	1	1	1	1	1	12	136	28	164
	2SWB	Two Story With Basement	117						1	10	65	22	87
	BLWB	Bi-Level With Basement	6								6		6
	TLWB	Tri-Level With Basement	80							2	62	9	71
	TOTAL RES		413	1	1	1	1	1	2	24	269	59	328
AUTO	SEDAN	Sedan style	56							1	17	21	38
	SPORTS	Sport Cars	8								3		3
	MINI	Mini Vans	4								3		3
	SUV	Sports Utility Vehicles	5								2	1	3
	PICKUPS	Pickup Trucks	5								2	2	4
	TOTAL AUTO		78	0	0	0	0	0	0	1	27	24	51
TRAFFIC		Direct Depth Damage Data	2									2	2
	Total		495	1	1	1	1	1	2	25	296	87	383

Table 3.19 – Weller Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
COM	COM_D	Direct Depth Damage Data	1									1	1
	TOTAL COM		1	0	0	0	0	0	0	0	0	1	1
IND	LT_E	Light Manufacturing (engineered)	1										0
	TOTAL IND		1	0	0	0	0	0	0	0	0	0	0
RES	1SWB	One Story With Basement	210	1	1	1	1	1	1	48	140	25	165
	2SWB	Two Story With Basement	117						1	30	70	7	77
	BLWB	Bi-Level With Basement	6								6		6
	TLWB	Tri-Level With Basement	80							6	63	8	71
	TOTAL RES		413	1	1	1	1	1	2	84	279	40	319
AUTO	SEDAN	Sedan style	56						1	1	21	18	39
	SPORTS	Sport Cars	8								3	1	4
	MINI	Mini Vans	4								3		3
	SUV	Sports Utility Vehicles	5								2	1	3
	PICKUPS	Pickup Trucks	5								3	1	4
	TOTAL AUTO		78	0	0	0	0	0	1	1	32	21	53
TRAFFIC		Direct Depth Damage Data	2										0
	Total		495	1	1	1	1	1	3	85	311	62	373

Table 3.20 – Weller Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	78							1	1	7	8
		TOTAL APT	78	0	0	0	0	0	0	1	1	7	8
COM	CLOTH_E	Clothing Store (engineered)	1										0
	CLOTH_P	Clothing Store (pre-engineered)	5							1	1		1
	CONV_E	Convenience Store (engineered)	5										0
	ELEC_E	Electronics Retailer (engineered)	3										0
	FFR_E	Fast Food Restaurant (engineered)	2										0
	FURN_E	Furniture Store (engineered)	1										0
	GROC_E	Grocery Store (engineered)	1										0
	HOSP_E	Hospital (engineered)	2										0
	MED_E	Medical Office (engineered)	5					1	1	1	1	1	2
	OFF_E	Office Building - One Story (engineered)	16									1	1
	REST_E	Restaurant (engineered)	7										0
	REST_P	Restaurant (pre-engineered)	1										0
	SERV_E	Service Related Business (engineered)	12									2	2
	COM_D	Direct Depth Damage Data	7									1	1
		TOTAL COM	68	0	0	0	0	1	1	2	2	5	7
IND	LT_E	Light Manufacturing (engineered)	1										0
		TOTAL IND	1	0	0	0	0	0	0	0	0	0	0
PUB	REC_E	Recreational (engineered)	1										0
	RF_E	Religious (engineered)	5						1	1	1		1
	SCH_E	School (engineered)	3										0
		TOTAL PUB	9	0	0	0	0	0	1	1	1	0	1
RES	1SNB	One Story No Basement	113							2	2	5	7
	1SWB	One Story With Basement	154		1	2	2	4	4	5	5	2	7
	2SNB	Two Story No Basement	86					1	1	5	5	16	21
	2SWB	Two Story With Basement	456				5	14	24	35	41	95	136
	BLNB	Bi-Level No Basement	1										0
	TLNB	Tri-Level No Basement	1										0
	TLWB	Tri-Level With Basement	53							1	1	2	3
		TOTAL RES	864	0	1	2	7	19	29	48	54	120	174
AUTO	SEDAN	Sedan style	115									15	15
	SPORTS	Sport Cars	11									2	2
	MINI	Mini Vans	12										0
	SUV	Sports Utility Vehicles	12										0
	PICKUPS	Pickup Trucks	7									1	1
		TOTAL AUTO	157	0	0	0	0	0	0	0	0	18	18
TRAFFIC		Direct Depth Damage Data	6									1	1
	Total		1183	0	1	2	7	20	31	52	58	151	209

Table 3.21 – Farmer-Prairie Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	78							1	1	7	8
	TOTAL APT		78	0	0	0	0	0	0	1	1	7	8
COM	CLOTH_E	Clothing Store (engineered)	1										0
	CLOTH_P	Clothing Store (pre-engineered)	5							1	1		1
	CONV_E	Convenience Store (engineered)	5										0
	ELEC_E	Electronics Retailer (engineered)	3										0
	FFR_E	Fast Food Restaurant (engineered)	2										0
	FURN_E	Furniture Store (engineered)	1										0
	GROC_E	Grocery Store (engineered)	1										0
	HOSP_E	Hospital (engineered)	2										0
	MED_E	Medical Office (engineered)	5					1	1	1	1	1	2
	OFF_E	Office Building - One Story (engineered)	16									1	1
	REST_E	Restaurant (engineered)	7										0
	REST_P	Restaurant (pre-engineered)	1										0
	SERV_E	Service Related Business (engineered)	12									2	2
	COM_D	Direct Depth Damage Data	7									1	1
	TOTAL COM		68	0	0	0	0	1	1	2	2	5	7
IND	LT_E	Light Manufacturing (engineered)	1										0
	TOTAL IND		1	0	0	0	0	0	0	0	0	0	0
PUB	REC_E	Recreational (engineered)	1										0
	RF_E	Religious (engineered)	5						1	1	1		1
	SCH_E	School (engineered)	3										0
	TOTAL PUB		9	0	0	0	0	0	1	1	1	0	1
RES	1SNB	One Story No Basement	113							2	2	5	7
	1SWB	One Story With Basement	154		1	2	2	4	4	5	5	2	7
	2SNB	Two Story No Basement	86					1	1	5	5	16	21
	2SWB	Two Story With Basement	456				5	14	24	35	41	95	136
	BLNB	Bi-Level No Basement	1										0
	TLNB	Tri-Level No Basement	1										0
	TLWB	Tri-Level With Basement	53							1	1	2	3
	TOTAL RES		864	0	1	2	7	19	29	48	54	120	174
AUTO	SEDAN	Sedan style	115									15	15
	SPORTS	Sport Cars	11									2	2
	MINI	Mini Vans	12										0
	SUV	Sports Utility Vehicles	12										0
	PICKUPS	Pickup Trucks	7									1	1
	TOTAL AUTO		157	0	0	0	0	0	0	0	0	18	18
TRAFFIC		Direct Depth Damage Data	6									1	1
	Total		1183	0	1	2	7	20	31	52	58	151	209

Table 3.22 – Farmer-Prairie Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	32									3	3
APT	TOTAL APT		32	0	0	0	0	0	0	0	0	3	3
COM	FFR_E	Fast Food Restaurant (engineered)	1										0
COM	HTL_E	Hotel (engineered)	1								1		1
COM	OFF_E	Office Building - One Story (engineered)	5								3	1	4
COM	OFF_P	Office Building - One Story (pre-engineered)	1								1		1
COM	REST_E	Restaurant (engineered)	2										0
COM	COM_D	Direct Depth Damage Data	6									1	1
COM	TOTAL COM		16	0	0	0	0	0	0	0	5	2	7
IND	WH_P	Warehouse (pre-engineered)	1										0
IND	IND_D	Direct Depth Damage Data	2										0
IND	TOTAL IND		3	0	0	0	0	0	0	0	0	0	0
PUB	REC_E	Recreational (engineered)	2										0
PUB	TOTAL PUB		2	0	0	0	0	0	0	0	0	0	0
RES	1SWB	One Story With Basement	67								6	3	9
RES	2SWB	Two Story With Basement	12										0
RES	TLWB	Tri-Level With Basement	21								1	1	2
RES	TOTAL RES		100	0	0	0	0	0	0	0	7	4	11
AUTO	SEDAN	Sedan style	11										0
AUTO	SPORTS	Sport Cars	1										0
AUTO	MINI	Mini Vans	2										0
AUTO	SUV	Sports Utility Vehicles	2										0
AUTO	PICKUPS	Pickup Trucks	2										0
AUTO	TOTAL AUTO		18	0	0	0	0	0	0	0	0	0	0
TRAFFIC		Direct Depth Damage Data	7									5	5
	Total		178	0	0	0	0	0	0	0	12	14	26

Table 3.23 – Willow-Higgins Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	32								3	10	13
	TOTAL APT		32	0	0	0	0	0	0	0	3	10	13
COM	FFR_E	Fast Food Restaurant (engineered)	1									1	1
	HTL_E	Hotel (engineered)	1								1		1
	OFF_E	Office Building - One Story (engineered)	5								5		5
	OFF_P	Office Building - One Story (pre-engineered)	1								1		1
	REST_E	Restaurant (engineered)	2									1	1
	COM_D	Direct Depth Damage Data	6									2	2
	TOTAL COM		16	0	0	0	0	0	0	0	7	4	11
IND	WH_P	Warehouse (pre-engineered)	1								1		1
	IND_D	Direct Depth Damage Data	2										0
	TOTAL IND		3	0	0	0	0	0	0	0	1	0	1
PUB	REC_E	Recreational (engineered)	2									1	1
	TOTAL PUB		2	0	0	0	0	0	0	0	0	1	1
RES	1SWB	One Story With Basement	67								9	12	21
	2SWB	Two Story With Basement	12								2		2
	TLWB	Tri-Level With Basement	21								2	2	4
	TOTAL RES		100	0	0	0	0	0	0	0	13	14	27
AUTO	SEDAN	Sedan style	11										0
	SPORTS	Sport Cars	1										0
	MINI	Mini Vans	2										0
	SUV	Sports Utility Vehicles	2										0
	PICKUPS	Pickup Trucks	2										0
	TOTAL AUTO		18	0	0	0	0	0	0	0	0	0	0
TRAFFIC		Direct Depth Damage Data	7									7	7
	Total		178	0	0	0	0	0	0	0	24	36	60

Table 3.24 – Willow-Higgins Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Frequency								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	6						3	4	4		4
		TOTAL APT	6	0	0	0	0	0	3	4	4	0	4
COM	CONV_E	Convenience Store (engineered)	2				1	1	1	2	2		2
	ELEC_E	Electronics Retailer (engineered)	1					1	1	1	1		1
	FFR_E	Fast Food Restaurant (engineered)	3								1	2	3
	HOSP_E	Hospital (engineered)	1					1	1	1	1		1
	MED_E	Medical Office (engineered)	4						1	1	2		2
	OFF_E	Office Building - One Story (engineered)	32		1	1	1	2	9	12	19	5	24
	REST_E	Restaurant (engineered)	4						3	3	4		4
	SERV_E	Service Related Business (engineered)	6		1	1	1	1	3	4	4		4
	COM_D	Direct Depth Damage Data	4									4	4
		TOTAL COM	57	0	2	2	3	6	19	24	34	11	45
IND	LT_E	Light Manufacturing (engineered)	7						3	5	6		6
	LT_P	Light Manufacturing (pre-engineered)	1							1	1		1
	WH_P	Warehouse (pre-engineered)	1										0
	IND_D	Direct Depth Damage Data	10									7	7
		TOTAL IND	19	0	0	0	0	0	3	6	7	7	14
PUB	REC_E	Recreational (engineered)	3								1	1	2
	RF_E	Religious (engineered)	1							1	1		1
		TOTAL PUB	4	0	0	0	0	0	0	1	2	1	3
RES	1SNB	One Story No Basement	260	5	8	23	42	88	143	168	202	25	227
	1SWB	One Story With Basement	589	1	4	12	27	86	195	297	345	46	391
	2SNB	Two Story No Basement	17			4	6	6	11	12	14		14
	2SWB	Two Story With Basement	92					29	62	74	74	7	81
	BLNB	Bi-Level No Basement	1					1	1	1	1		1
	BLWB	Bi-Level With Basement	8						1	3	5		5
	TLWB	Tri-Level With Basement	37			2	3	14	16	18	19	2	21
		TOTAL RES	1004	6	12	41	78	224	429	573	660	80	740
AUTO	SEDAN	Sedan style	153		1	2	5	8	18	37	62	19	81
	SPORTS	Sport Cars	10					2	2	3	3	1	4
	MINI	Mini Vans	11						1	2	4	1	5
	SUV	Soprts Utility Vehicles	9						1	1	1	1	2
	PICKUPS	Pickup Trucks	10					3	3	4	5		5
		TOTAL AUTO	193	0	1	2	5	13	25	47	75	22	97
TRAFFIC		Direct Depth Damage Data	7									7	7
	Total		1290	6	15	45	86	243	479	655	782	128	910

Table 3.25 – Silver Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Frequency								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	6					1	4	4	4		4
		TOTAL APT	6	0	0	0	0	1	4	4	4	0	4
COM	CONV_E	Convenience Store (engineered)	2				1	1	1	2	2		2
	ELEC_E	Electronics Retailer (engineered)	1					1	1	1	1		1
	FFR_E	Fast Food Restaurant (engineered)	3							1	3		3
	HOSP_E	Hospital (engineered)	1					1	1	1	1		1
	MED_E	Medical Office (engineered)	4						1	2	3	1	4
	OFF_E	Office Building - One Story (engineered)	32		1	1	1	2	11	19	22	7	29
	REST_E	Restaurant (engineered)	4					2	3	4	4		4
	SERV_E	Service Related Business (engineered)	6		1	1	1	1	3	4	4	2	6
	COM_D	Direct Depth Damage Data	4										0
		TOTAL COM	57	0	2	2	3	8	21	34	40	10	50
IND	LT_E	Light Manufacturing (engineered)	7					1	4	6	6		6
	LT_P	Light Manufacturing (pre-engineered)	1							1	1		1
	WH_P	Warehouse (pre-engineered)	1								1		1
	IND_D	Direct Depth Damage Data	10										0
		TOTAL IND	19	0	0	0	0	1	4	7	8	0	8
PUB	REC_E	Recreational (engineered)	3							1	2		2
	RF_E	Religious (engineered)	1								1		1
		TOTAL PUB	4	0	0	0	0	0	0	1	3	0	3
RES	1SNB	One Story No Basement	260	5	8	8	8	8	8	8	8	8	16
	1SWB	One Story With Basement	589	1	4	12	28	118	243	326	405	156	561
	2SNB	Two Story No Basement	17			4	6	8	12	14	14		14
	2SWB	Two Story With Basement	92					31	70	74	81	9	90
	BLNB	Bi-Level No Basement	1					1	1	1	1		1
	BLWB	Bi-Level With Basement	8					1	3	5	5		5
	TLWB	Tri-Level With Basement	37			2	3	14	16	20	19	8	27
		TOTAL RES	1004	6	12	26	45	181	353	448	533	181	714
AUTO	SEDAN	Sedan style	153		1	2	5	10	22	55	98	36	134
	SPORTS	Sport Cars	10					2	3	3	4	5	9
	MINI	Mini Vans	11						1	3	5	6	11
	SUV	Soprts Utility Vehicles	9						1	1	3	1	4
	PICKUPS	Pickup Trucks	10					3	4	5	5	3	8
		TOTAL AUTO	193	0	1	2	5	15	31	67	115	51	166
TRAFFIC		Direct Depth Damage Data	7									7	7
	Total		1290	6	15	30	53	206	413	561	703	249	952

Table 3.26 – Silver Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Frequency								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	288		3	14	34	54	78	92	147	115	262
		TOTAL APT	288	0	3	14	34	54	78	92	147	115	262
COM	CLOTH_E	Clothing Store (engineered)	1							1	1		1
	CONV_E	Convenience Store (engineered)	6			1	1	2	2	3	4	2	6
	ELEC_E	Electronics Retailer (engineered)	4					1	1	1	3	1	4
	FFR_E	Fast Food Restaurant (engineered)	16			3	4	6	7	8	10	6	16
	FURN_E	Furniture Store (engineered)	2				1	1	1	1	1	1	2
	HOSP_E	Hospital (engineered)	7			3	3	3	3	3	3	3	6
	HTL_E	Hotel (engineered)	9						2	4	6	3	9
	MED_E	Medical Office (engineered)	7					3	4	4	5		5
	OFF_E	Office Building - One Story (engineered)	87		1	9	25	39	51	63	78	8	86
	REST_E	Restaurant (engineered)	24		1	2	7	10	11	13	23		23
	SERV_E	Service Related Business (engineered)	57			6	12	22	32	36	48	3	51
		TOTAL COM	220	0	2	24	53	87	114	137	182	27	209
IND	LT_E	Light Manufacturing (engineered)	70			1	2	9	19	28	54	11	65
	LT_P	Light Manufacturing (pre-engineered)	1							1	1		1
	WH_E	Warehouse (engineered)	19			1	2	5	7	9	13	5	18
	WH_P	Warehouse (pre-engineered)	5					1	2	2	2	2	4
	WHR_E	Warehouse Refrigerated (engineered)	1						1	1	1		1
		TOTAL IND	96	0	0	2	4	15	29	41	71	18	89
PUB	PS_E	Protective Services (engineered)	4						1	1	1	2	3
	REC_E	Recreational (engineered)	11			1	2	2	4	6	7	4	11
	RF_E	Religious (engineered)	8			3	3	4	4	4	6	1	7
	SCH_E	School (engineered)	9		1	1	1	2	2	5	7		7
		TOTAL PUB	32	0	1	5	6	8	11	16	21	7	28
RES	1SNB	One Story No Basement	288	4	33	99	132	184	208	219	241	23	264
	1SWB	One Story With Basement	1,722	2	13	67	135	313	517	644	1,060	405	1,465
	2SNB	Two Story No Basement	240		4	12	17	60	87	109	139	79	218
	2SWB	Two Story With Basement	638	1	4	37	60	104	166	218	351	182	533
	BLWB	Bi-Level With Basement	32			2	3	6	18	18	20	6	26
	TLNB	Tri-Level No Basement	26			1	2	5	9	12	14	10	24
	TLWB	Tri-Level With Basement	274		2	17	31	54	85	107	146	105	251
		TOTAL RES	3,220	7	56	235	380	726	1,090	1,327	1,971	810	2,781
AUTO	SEDAN	Sedan style	451	1	7	20	27	53	74	91	167	89	256
	SPORTS	Sport Cars	53	1	1	2	2	6	8	11	18	12	30
	MINI	Mini Vans	41				1	2	4	5	8	11	19
	SUV	Soprts Utility Vehicles	41			2	3	4	6	7	13	9	22
	PICKUPS	Pickup Trucks	41		1	2	3	4	6	11	15	8	23
		TOTAL AUTO	627	2	9	26	36	69	98	125	221	129	350
TRAFFIC		Direct Depth Damage Data	44									44	44
	Total		4,527	9	71	306	513	959	1,420	1,738	2,613	1,150	3,763

Table 3.27 – Des Plaines Mainstem (IL) Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Frequency								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	288		4	19	39	66	84	101	164	99	263
	TOTAL APT		288	0	4	19	39	66	84	101	164	99	263
COM	CLOTH_E	Clothing Store (engineered)	1							1	1		1
	CONV_E	Convenience Store (engineered)	6			1	2	2	2	4	4	2	6
	ELEC_E	Electronics Retailer (engineered)	4				1	1	1	3	3	1	4
	FFR_E	Fast Food Restaurant	16			3	5	7	8	10	13	3	16
	FURN_E	Furniture Store (engineered)	2			1	1	1	1	1	2		2
	HOSP_E	Hospital (engineered)	7			3	3	3	3	3	3	4	7
	HTL_E	Hotel (engineered)	9					2	2	4	6	3	9
	MED_E	Medical Office (engineered)	7					4	4	4	5		5
	OFF_E	Office Building - One Story	87		1	12	29	42	55	67	81	5	86
	REST_E	Restaurant (engineered)	24		1	4	7	10	12	17	23		23
	SERV_E	Service Related Business	57		1	7	17	24	35	42	50	1	51
	TOTAL COM		220	0	3	31	65	96	123	156	191	19	210
IND	LT_E	Light Manufacturing	70			1	3	14	25	31	61	5	66
	LT_P	Light Manufacturing (pre-	1							1	1		1
	WH_E	Warehouse (engineered)	19			1	3	5	7	10	13	5	18
	WH_P	Warehouse (pre-engineered)	5					2	2	2	3	1	4
	WHR_E	Warehouse Refrigerated	1					1	1	1	1		1
	TOTAL IND		96	0	0	2	6	22	35	45	79	11	90
PUB	PS_E	Protective Services (engineered)	4						1	1	1	2	3
	REC_E	Recreational (engineered)	11			1	2	2	5	6	7	4	11
	RF_E	Religious (engineered)	8		1	3	3	4	4	4	6	1	7
	SCH_E	School (engineered)	9		1	1	2	2	4	5	7		7
	TOTAL PUB		32	0	2	5	7	8	14	16	21	7	28
RES	1SNB	One Story No Basement	288	7	46	112	146	196	213	220	255	10	265
	1SWB	One Story With Basement	1,722	2	18	83	175	384	567	698	1,158	309	1,467
	2SNB	Two Story No Basement	240		4	13	25	75	94	117	182	36	218
	2SWB	Two Story With Basement	638	1	5	41	69	119	182	246	408	129	537
	BLWB	Bi-Level With Basement	32			2	3	11	18	18	20	6	26
	TLNB	Tri-Level No Basement	26			1	3	7	9	12	20	4	24
	TLWB	Tri-Level With Basement	274		2	22	35	64	93	110	192	60	252
	TOTAL RES		3,220	10	75	274	456	856	1,176	1,421	2,235	554	2,789
AUTO	SEDAN	Sedan style	451	1	9	24	37	59	80	101	189	69	258
	SPORTS	Sport Cars	53	1	2	2	3	6	9	13	21	9	30
	MINI	Mini Vans	41				2	3	5	6	15	6	21
	SUV	Soprts Utility Vehicles	41			2	3	5	6	7	14	10	24
	PICKUPS	Pickup Trucks	41		1	3	3	4	9	13	18	5	23
	TOTAL AUTO		627	2	12	31	48	77	109	140	257	99	356
TRAFFIC		Direct Depth Damage Data	44									44	44
	Total		4,527	12	96	362	621	1,125	1,541	1,879	2,947	833	3,780

Table 3.28 – Des Plaines Mainstem (IL) Potentially Damaged Structures – 2020 Conditions

Watershed	APT	COM	IND	PUB	RES	AUTO	TRAFFIC	TOTAL
Brighton Creek	0	0	0	0	34	0	0	34
Dutch Gap Canal	0	0	0	0	10	0	0	10
Center Creek	0	0	0	0	1	0	0	1
Kilbourn Road Ditch	0	0	0	0	2	0	0	2
Jerome Creek	0	0	0	0	10	0	0	10
Des Plaines River Mainstem (WI)	0	0	0	0	8	0	18	26
Newport Ditch	0	0	1	0	29	7	4	41
Mill Creek	8	28	10	5	496	104	13	664
Bull Creek	0	4	0	2	69	16	4	95
Indian Creek	1	4	1	0	138	31	6	181
Buffalo-Wheeling Creek	37	80	31	6	1,089	211	13	1,467
McDonald Creek	0	1	4	1	179	35	2	222
Weller Creek	0	1	1	0	413	78	2	495
Farmer-Prairie Creek	78	68	1	9	864	157	6	1,183
Willow-Higgins Creek	32	16	3	2	100	18	7	178
Silver Creek	6	57	19	4	1,004	193	7	1,290
Des Plaines River Mainstem (IL)	288	220	96	32	3,220	627	44	4,527
TOTAL	450	479	167	61	7,666	1,477	126	10,426

Table 3.29 – Summary of Structures in Inventory

Watershed	APT	COM	IND	PUB	RES	AUTO	TRAFFIC	TOTAL
Brighton Creek	0	0	0	0	34	0	0	34
Dutch Gap Canal	0	0	0	0	10	0	0	10
Center Creek	0	0	0	0	1	0	0	1
Kilbourn Road Ditch	0	0	0	0	2	0	0	2
Jerome Creek	0	0	0	0	10	0	0	10
Des Plaines River Mainstem (WI)	0	0	0	0	8	0	18	26
Newport Ditch	0	0	0	0	2	1	2	5
Mill Creek	1	11	8	2	22	3	6	53
Bull Creek	0	1	0	2	41	5	2	51
Indian Creek	0	3	0	0	49	4	3	59
Buffalo-Wheeling Creek	25	20	8	0	734	119	7	913
McDonald Creek	0	0	0	0	17	0	0	17
Weller Creek	0	1	1	0	328	51	2	383
Farmer-Prairie Creek	8	7	0	1	174	18	1	209
Willow-Higgins Creek	3	7	0	0	11	0	5	26
Silver Creek	4	45	14	3	740	97	7	910
Des Plaines River Mainstem (IL)	262	209	89	28	2,781	350	44	3,763
TOTAL	303	304	120	36	4,964	648	97	6,472

Table 3.30 – Summary of 2010 Condition Potentially Damaged Structures

Watershed	APT	COM	IND	PUB	RES	AUTO	TRAFFIC	TOTAL
Brighton Creek	0	0	0	0	34	0	0	34
Dutch Gap Canal	0	0	0	0	10	0	0	10
Center Creek	0	0	0	0	1	0	0	1
Kilbourn Road Ditch	0	0	0	0	2	0	0	2
Jerome Creek	0	0	0	0	10	0	0	10
Des Plaines River Mainstem (WI)	0	0	0	0	8	0	18	26
Newport Ditch	0	0	0	0	2	1	2	5
Mill Creek	1	11	8	2	22	3	7	54
Bull Creek	0	1	0	2	41	5	2	51
Indian Creek	0	3	0	0	49	4	3	59
Buffalo-Wheeling Creek	25	19	8	0	736	119	7	914
McDonald Creek	0	0	0	0	17	0	0	17
Weller Creek	0	1	0	0	319	53	2	375
Farmer-Prairie Creek	8	7	0	1	174	18	1	209
Willow-Higgins Creek	13	11	1	1	27	0	7	60
Silver Creek	4	50	8	3	714	166	7	952
Des Plaines River Mainstem (IL)	263	210	90	28	2,789	356	44	3,780
TOTAL	314	313	115	37	4,955	725	100	6,559

Table 3.31 – Summary of 2020 Condition Potentially Damaged Structures

The location of damage in buildings can provide information about impacts to the structure from flooding. Using first floor and flood elevation data, the number of structures damaged only below the first floor elevation for each modeled flood event was tabulated. Since the data is only shows the number of structures with impacts below the first floor the count of structures at lower frequencies will not be additive. If a structure is flooded due to a low water entry point below the first floor the frequency at which that occurs with register a count for that structure. The table will continue to register this count at each frequency until the flood depth hits the first flood. When a flood depth reaches or surpass the structure's first floor the count will drop off the tabulation. This summary is shown in Table 3.32 through Table 3.59.

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SNB	One Story No Basement	12		1	1	6	9	10	12	12
	1SWB	One Story With Basement	12		2	2	11	12	12	12	12
	2SNB	Two Story No Basement	3				1	2	2	3	3
	2SWB	Two Story With Basement	1					1	1	1	1
	BLNB	Bi-Level No Basement	1				1	1	1	1	1
	BLWB	Bi-Level With Basement	5				3	4	5	5	5
	TOTAL RES		34	0	3	3	22	29	31	34	34
	Total		34	0	3	3	22	29	31	34	34

Table 3.32 – Brighton Creek Structures Damaged Below FFE

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SNB	One Story No Basement	4				2	4	4	4	4
	2SNB	Two Story No Basement	1				1	1	1	1	1
	2SWB	Two Story With Basement	2				2	2	2	2	2
	BLWB	Bi-Level With Basement	1		1	1	1	1	1	1	1
	RES_D	Direct Depth Damage Data	2				1	1	2	2	2
	TOTAL RES		10	0	1	1	7	9	10	10	10
	Total		10	0	1	1	7	9	10	10	10

Table 3.33 – Dutch Gap Canal Structures Damaged Below FFE

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SWB	One Story With Basement	1					1	1	1	1
	TOTAL RES		1	0	0	0	0	1	1	1	1
	Total		1	0	0	0	0	1	1	1	1

Table 3.34 – Center Creek Structures Damaged Below FFE

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SWB	One Story With Basement	1		1	1	1	1	1	1	1
	RES_D	Direct Depth Damage Data	1					1	1	1	1
	TOTAL RES		2	0	1	1	1	2	2	2	2
	Total		2	0	1	1	1	2	2	2	2

Table 3.35 – Kilbourn Road Ditch Structures Damaged Below FFE

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SNB	One Story No Basement	6				1	3	4	6	6
	1SWB	One Story With Basement	2		1	1	1	2	2	2	2
	2SNB	Two Story No Basement	1							1	1
	BLWB	Bi-Level With Basement	1		1	1	1	1	1	1	1
	TOTAL RES		10	0	2	2	3	6	7	10	10
	Total		10	0	2	2	3	6	7	10	10

Table 3.36 – Jerome Creek Structures Damaged Below FFE

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SWB	One Story With Basement	4		1	1	1	2	3	4	4
	BLWB	Bi-Level With Basement	1							1	1
	RES_D	Direct Depth Damage Data	3					2	2	3	3
	TOTAL RES		8	0	1	1	1	4	5	8	8
	Total		8	0	1	1	1	4	5	8	8

Table 3.37 – Des Plaines River Mainstem (WI) Structures Damaged Below FFE

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	TLNB	Tri-Level No Basement	1							1	
	TOTAL RES		1	0	0	0	0	0	0	1	0
	Total		1	0	0	0	0	0	0	1	0

Table 3.38 – Newport Drainage Ditch Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	TLNB	Tri-Level No Basement	1							1	
	TOTAL RES		1	0	0	0	0	0	0	1	0
	Total		1	0	0	0	0	0	0	1	0

Table 3.39 – Newport Drainage Ditch Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
COM	CLOTH_E	Clothing Store (engineered)	1								
	CONV_E	Convenience Store (engineered)	1								
	FURN_P	Furniture Store (pre-engineered)	1								1
	OFF_E	Office Building - One Story (engineered)	4								
	SERV_E	Service Related Business (engineered)	2								
	TOTAL COM		9	0	0	0	0	0	0	0	1
IND	LT_E	Light Manufacturing (engineered)	2								
	LT_P	Light Manufacturing (pre-engineered)	1								
	WH_P	Warehouse (pre-engineered)	4								
	TOTAL IND		7	0	0	0	0	0	0	0	0
PUB	SCH_E	School (engineered)	2								
	TOTAL PUB		2	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	6								4
	1SWB	One Story With Basement	4					1	1	1	2
	2SWB	Two Story With Basement	3							1	2
	TLWB	Tri-Level With Basement	1						1	1	1
	TOTAL RES		14					1	2	3	9
	Total		32	0	0	0	0	1	2	3	10

Table 3.40 – Mill Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
COM	CLOTH_E	Clothing Store (engineered)	1								
	CONV_E	Convenience Store (engineered)	1								
	FURN_P	Furniture Store (pre-engineered)	1								1
	OFF_E	Office Building - One Story (engineered)	4								
	SERV_E	Service Related Business (engineered)	2								
		TOTAL COM	9	0	0	0	0	0	0	0	1
IND	LT_E	Light Manufacturing (engineered)	2								
	LT_P	Light Manufacturing (pre-engineered)	1								
	WH_P	Warehouse (pre-engineered)	4								
		TOTAL IND	7	0	0	0	0	0	0	0	0
PUB	SCH_E	School (engineered)	2								
		TOTAL PUB	2	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	7								4
	1SWB	One Story With Basement	4					1	1	1	2
	2SWB	Two Story With Basement	4							1	3
	TLWB	Tri-Level With Basement	1					1	1	1	1
		TOTAL RES	16					2	2	3	10
	Total		34	0	0	0	0	2	2	3	11

Table 3.41 – Mill Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
PUB	REC_E	Recreational (engineered)	1								
	SCH_E	School (engineered)	1								
		TOTAL PUB	2	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	2				1				
	1SWB	One Story With Basement	9					1		3	3
	2SNB	Two Story No Basement	1								
	2SWB	Two Story With Basement	20					1	6	3	3
	BLNB	Bi-Level No Basement	1								1
	TLWB	Tri-Level With Basement	2					2	1	1	1
		TOTAL RES	35	0	0	0	1	4	7	7	8
	Total		37	0	0	0	1	4	7	7	8

Table 3.42 – Bull Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
PUB	REC_E	Recreational (engineered)	1								
	SCH_E	School (engineered)	1								
	TOTAL PUB		2	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	2				1				
	1SWB	One Story With Basement	9					1		3	3
	2SNB	Two Story No Basement	1								
	2SWB	Two Story With Basement	20					1	6	3	3
	TLWB	Tri-Level With Basement	2				1	2	1	1	1
	TOTAL RES		34	0	0	0	2	4	7	7	7
	Total		36	0	0	0	2	4	7	7	7

Table 3.43 – Bull Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
COM	OFF_E	Office Building - One Story (engineered)	1								
	SERV_E	Service Related Business (engineered)	1								1
	TOTAL COM		2	0	0	0	0	0	0	0	1
RES	1SWB	One Story With Basement	3						1	1	2
	2SWB	Two Story With Basement	32		1	1	2	3	6	8	28
	TLWB	Tri-Level With Basement	1								
	TOTAL RES		36	0	1	1	2	3	7	9	30
	Total		38	0	1	1	2	3	7	9	31

Table 3.44 – Indian Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
COM	OFF_E	Office Building - One Story (engineered)	1								
	SERV_E	Service Related Business (engineered)	1								1
	TOTAL COM		2	0	0	0	0	0	0	0	1
RES	1SWB	One Story With Basement	3						1	1	2
	2SWB	Two Story With Basement	32		1	1	2	3	6	8	28
	TLWB	Tri-Level With Basement	1								
	TOTAL RES		36	0	1	1	2	3	7	9	30
	Total		38	0	1	1	2	3	7	9	31

Table 3.45 – Indian Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	20								
	TOTAL APT		20	0	0	0	0	0	0	0	0
COM	CLOTH_E	Clothing Store (engineered)	1								
	FFR_E	Fast Food Restaurant (engineered)	1								
	OFF_E	Office Building - One Story (engineered)	8								1
	REST_P	Restaurant (pre-engineered)	1								
	SERV_E	Service Related Business (engineered)	2								
	TOTAL COM		13	0	0	0	0	0	0	0	1
IND	LT_E	Light Manufacturing (engineered)	2								
	LT_P	Light Manufacturing (pre-engineered)	1								
	WH_E	Warehouse (engineered)	2								
	WH_P	Warehouse (pre-engineered)	1								
	TOTAL IND		6	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	341				1	10	17	51	41
	1SWB	One Story With Basement	140						9	18	70
	2SNB	Two Story No Basement	136					1	1	5	13
	2SWB	Two Story With Basement	10							2	5
	TLNB	Tri-Level No Basement	27					1			
	TLWB	Tri-Level With Basement	4								4
	TOTAL RES		658	0	0	0	1	12	27	76	133
	Total		697	0	0	0	1	12	27	76	134

Table 3.46 – Buffalo-Wheeling Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	20								
	TOTAL APT		20	0	0	0	0	0	0	0	0
COM	CLOTH_E	Clothing Store (engineered)	1								
	FFR_E	Fast Food Restaurant (engineered)	1								
	OFF_E	Office Building - One Story (engineered)	8								1
	REST_P	Restaurant (pre-engineered)	1								
	SERV_E	Service Related Business (engineered)	2								
	TOTAL COM		13	0	0	0	0	0	0	0	1
IND	LT_E	Light Manufacturing (engineered)	2								
	LT_P	Light Manufacturing (pre-engineered)	1								
	WH_E	Warehouse (engineered)	2								
	WH_P	Warehouse (pre-engineered)	1								
	TOTAL IND		6	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	343				1	11	20	65	40
	1SWB	One Story With Basement	140						9	25	70
	2SNB	Two Story No Basement	139					1	3	6	12
	2SWB	Two Story With Basement	10							2	5
	TLNB	Tri-Level No Basement	27					1			
	TLWB	Tri-Level With Basement	4								4
	TOTAL RES		663	0	0	0	1	13	32	98	131
	Total		702	0	0	0	1	13	32	98	132

Table 3.47 – Buffalo-Wheeling Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	2SWB	Two Story With Basement	1								1
	TLWB	Tri-Level With Basement	1								1
	TOTAL RES		2	0	0	0	0	0	0	0	2
	Total		2	0	0	0	0	0	0	0	2

Table 3.48 – McDonald Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	2SWB	Two Story With Basement	1								1
	TLWB	Tri-Level With Basement	1								1
	TOTAL RES		2	0	0	0	0	0	0	0	2
	Total		2	0	0	0	0	0	0	0	2

Table 3.49 – McDonald Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SWB	One Story With Basement	136							10	64
	2SWB	Two Story With Basement	65						1	9	31
	BLWB	Bi-Level With Basement	6								6
	TLWB	Tri-Level With Basement	62							2	10
	TOTAL RES		269	0	0	0	0	0	1	21	111
	Total		269	0	0	0	0	0	1	21	111

Table 3.50 – Weller Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SWB	One Story With Basement	140							45	61
	2SWB	Two Story With Basement	70							28	31
	BLWB	Bi-Level With Basement	6								6
	TLWB	Tri-Level With Basement	63							6	7
	TOTAL RES		279	0	0	0	0	0	0	79	105
	Total		279	0	0	0	0	0	0	79	105

Table 3.51 – Weller Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	1								
		TOTAL APT	1	0	0	0	0	0	0	0	0
COM	CLOTH_P	Clothing Store (pre-engineered)	1								
	MED_E	Medical Office (engineered)	1								
		TOTAL COM	2	0	0	0	0	0	0	0	0
PUB	RF_E	Religious (engineered)	1								
		TOTAL PUB	1	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	2							1	1
	1SWB	One Story With Basement	5		1	1	1	3	3	3	3
	2SNB	Two Story No Basement	5					1	1	3	3
	2SWB	Two Story With Basement	41				5	14	24	32	33
	TLWB	Tri-Level With Basement	1								
		TOTAL RES	54	0	1	1	6	18	28	39	40
	Total		58	0	1	1	6	18	28	39	40

Table 3.52 – Farmer-Prairie Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	1								
		TOTAL APT	1	0	0	0	0	0	0	0	0
COM	CLOTH_P	Clothing Store (pre-engineered)	1								
	MED_E	Medical Office (engineered)	1								
		TOTAL COM	2	0	0	0	0	0	0	0	0
PUB	RF_E	Religious (engineered)	1								
		TOTAL PUB	1	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	2							1	1
	1SWB	One Story With Basement	5		1	1	1	3	3	3	3
	2SNB	Two Story No Basement	5					1	1	3	3
	2SWB	Two Story With Basement	41				5	14	24	32	33
	TLWB	Tri-Level With Basement	1								
		TOTAL RES	54	0	1	1	6	18	28	39	40
	Total		58	0	1	1	6	18	28	39	40

Table 3.53 – Farmer-Prairie Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
COM	HTL_E	Hotel (engineered)	1								
	OFF_E	Office Building - One Story (engineered)	1								
	OFF_P	Office Building - One Story (pre-engineered)	1								
	TOTAL COM		5	0	0	0	0	0	0	0	0
RES	1SWB	One Story With Basement	6							1	1
	TLWB	Tri-Level With Basement	1							1	1
	TOTAL RES		7	0	0	0	0	0	0	2	2
	Total		12	0	0	0	0	0	0	2	2

Table 3.54 – Willow-Higgins Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	3								
	TOTAL APT		3	0	0	0	0	0	0	0	0
COM	HTL_E	Hotel (engineered)	1								
	OFF_E	Office Building - One Story (engineered)	5								1
	OFF_P	Office Building - One Story (pre-engineered)	1								
	TOTAL COM		7	0	0	0	0	0	0	0	1
IND	WH_P	Warehouse (pre-engineered)	1								
	TOTAL IND		1	0	0	0	0	0	0	0	0
RES	1SWB	One Story With Basement	9								8
	2SWB	Two Story With Basement	2								2
	TLWB	Tri-Level With Basement	2								1
	TOTAL RES		13	0	0	0	0	0	0	0	11
	Total		24	0	0	0	0	0	0	0	12

Table 3.55 – Willow-Higgins Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	3								
	TOTAL APT		3	0	0	0	0	0	0	0	0
COM	CONV_E	Convenience Store (engineered)	1								
	ELEC_E	Electronics Retailer (engineered)	1								
	HOSP_E	Hospital (engineered)	1								
	MED_E	Medical Office (engineered)	1								
	OFF_E	Office Building - One Story (engineered)	9						1	1	3
	REST_E	Restaurant (engineered)	3								
	SERV_E	Service Related Business (engineered)	4								
	TOTAL COM		20	0	0	0	0	0	1	1	3
IND	LT_E	Light Manufacturing (engineered)	2								
	TOTAL IND		2	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	139	4	6	18	30	43	53	45	44
	1SWB	One Story With Basement	182	1	4	8	14	30	73	97	131
	2SNB	Two Story No Basement	10			3	4	2	4	1	2
	2SWB	Two Story With Basement	53					10	29	35	53
	BLNB	Bi-Level No Basement	1							1	1
	BLWB	Bi-Level With Basement	2						1	2	2
	TLWB	Tri-Level With Basement	18			1	3	4	9	10	9
	TOTAL RES		405	5	10	30	51	89	169	191	242
	Total		430	5	10	30	51	89	170	192	245

Table 3.56 – Silver Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	3								
	TOTAL APT		3	0	0	0	0	0	0	0	0
COM	CONV_E	Convenience Store (engineered)	1								
	ELEC_E	Electronics Retailer (engineered)	1								
	HOSP_E	Hospital (engineered)	1								
	MED_E	Medical Office (engineered)	1								
	OFF_E	Office Building - One Story (engineered)	9						1	1	3
	REST_E	Restaurant (engineered)	3								
	SERV_E	Service Related Business (engineered)	4								
	TOTAL COM		20	0	0	0	0	0	1	1	3
IND	LT_E	Light Manufacturing (engineered)	2								
	TOTAL IND		2	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	139	4	6	18	30	42	53	45	44
	1SWB	One Story With Basement	182	1	4	8	14	31	72	97	131
	2SNB	Two Story No Basement	10			3	4	2	4	1	2
	2SWB	Two Story With Basement	53					10	29	35	53
	BLNB	Bi-Level No Basement	1						1	1	1
	BLWB	Bi-Level With Basement	2						1	1	2
	TLWB	Tri-Level With Basement	18			1	3	4	9	10	8
	TOTAL RES		405	5	10	30	51	89	169	191	241
	Total		430	5	10	30	51	89	170	192	244

Table 3.57 – Silver Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	123								
	TOTAL APT		123	0	0	0	0	0	0	0	0
COM	CLOTH_E	Clothing Store (engineered)	1								
	CONV_E	Convenience Store (engineered)	4								
	ELEC_E	Electronics Retailer (engineered)	3								
	FFR_E	Fast Food Restaurant (engineered)	9								
	FURN_E	Furniture Store (engineered)	1								
	HOSP_E	Hospital (engineered)	3								
	HTL_E	Hotel (engineered)	5								
	MED_E	Medical Office (engineered)	4								
	OFF_E	Office Building - One Story (engineered)	64								
	REST_E	Restaurant (engineered)	18								
	SERV_E	Service Related Business (engineered)	43								
	TOTAL COM		155	0	0	0	0	0	0	0	0
IND	LT_E	Light Manufacturing (engineered)	39								
	LT_P	Light Manufacturing (pre-engineered)	1								
	WH_E	Warehouse (engineered)	12								
	WH_P	Warehouse (pre-engineered)	2								
	WHR_E	Warehouse Refrigerated (engineered)	1								
	TOTAL IND		55	0	0	0	0	0	0	0	0
PUB	PS_E	Protective Services (engineered)	1								
	REC_E	Recreational (engineered)	5								
	RF_E	Religious (engineered)	5								
	SCH_E	School (engineered)	5								
	TOTAL PUB		16	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	217			2	13	13	15	13	5
	1SWB	One Story With Basement	742		2	12	49	138	240	363	482
	2SNB	Two Story No Basement	120					2	9	8	13
	2SWB	Two Story With Basement	267		3	14	33	53	72	108	178
	BLWB	Bi-Level With Basement	18				2	6	7	3	0
	TLNB	Tri-Level No Basement	14			1	0	3	3	2	2
	TLWB	Tri-Level With Basement	116			5	8	17	25	35	51
	TOTAL RES		1494	0	5	34	105	232	371	532	731
	Total		1843	0	5	34	105	232	371	532	731

Table 3.58 – Des Plaines River Mainstem (IL) Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	129								
	TOTAL APT		129	0	0	0	0	0	0	0	0
COM	CLOTH_E	Clothing Store (engineered)	1								
	CONV_E	Convenience Store (engineered)	4								
	ELEC_E	Electronics Retailer (engineered)	3								
	FFR_E	Fast Food Restaurant (engineered)	9								
	FURN_E	Furniture Store (engineered)	1								
	HOSP_E	Hospital (engineered)	3								
	HTL_E	Hotel (engineered)	6								
	MED_E	Medical Office (engineered)	4								
	OFF_E	Office Building - One Story (engineered)	72						1	1	1
	REST_E	Restaurant (engineered)	18								
	SERV_E	Service Related Business (engineered)	44								
	TOTAL COM		165	0	0	0	0	0	1	1	1
IND	LT_E	Light Manufacturing (engineered)	46								
	LT_P	Light Manufacturing (pre-engineered)	1								
	WH_E	Warehouse (engineered)	12								
	WH_P	Warehouse (pre-engineered)	2								
	WHR_E	Warehouse Refrigerated (engineered)	1								
	TOTAL IND		62	0	0	0	0	0	0	0	0
PUB	PS_E	Protective Services (engineered)	1								
	REC_E	Recreational (engineered)	6								
	RF_E	Religious (engineered)	5								
	SCH_E	School (engineered)	5								
	TOTAL PUB		17	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	218			3	16	12	16	9	3
	1SWB	One Story With Basement	805		2	26	67	176	274	389	509
	2SNB	Two Story No Basement	122					5	10	12	11
	2SWB	Two Story With Basement	286		4	16	39	53	86	123	189
	BLWB	Bi-Level With Basement	18				2	5	3	2	0
	TLNB	Tri-Level No Basement	14			1		3	2	2	2
	TLWB	Tri-Level With Basement	121			7	11	20	27	39	48
	TOTAL RES		1584	0	0	6	53	135	274	418	576
	Total		1957	0	6	53	135	274	418	577	763

Table 3.59 – Des Plaines River Mainstem (IL) Structures Damaged Below FFE 2020

3.4 Transportation Damages

As discussed in Section 2.2, the transportation damage category consists of the cost of traffic delays due to flooded road crossings. The number of crossings inventoried and assigned depth-damage functions, as well as the number potentially damaged by HEC-FDA simulations in 2010 and 2020 scenarios are included in Tables 3.1 through 3.28. Simulation of flood induced delays and detours were obtained from the VISTA transportation modeling. For each scenario and flood frequency, VISTA calculated the cumulative effect of the road closure to the network in terms of additional miles traveled by each vehicle and the additional time it takes each vehicle to get to its destination.

Throughout this report 2010 has been the assumed baseline year. This assumption is based on the implementation of the Des Plaines River Phase I projects within the hydrologic and hydraulic modeling. At the time the transportation model was developed, the most current data available was for 2006. Thus data used in the baseline conditions of the transportation model is from this year.

Transportation damage locations were identified by overlaying the Chicago Metropolitan Agency for Planning (CMAP) network on top of the stream/floodplain network for this study. Illinois road closure data was developed from HEC-RAS rating curves and HEC-1 hydrograph data. This dataset provided the depth and duration of flooding for the baseline and future condition scenarios. SEWRPC provided similar flooded road crossing information for sites in Wisconsin. Using this data, USACE calculated the duration of closure for each of the identified roads (see Appendix A – Hydrology & Hydraulics Appendix for more details). The identified roads represent the main arteries for the study area. Once the without project data had been created and calibrated, the contractor created scenario runs for each of the annual exceedance probabilities (1, 1/2, 1/5, 1/10, 1/25, 1/50, 1/100, and 1/500) using 2006 traffic demand and future traffic demands in 2020. VISTA a cumulative effect of the road closure to the network from these scenarios in terms of additional miles traveled by each vehicle and the additional time it takes each vehicle to get from its origination to its destination.

From each scenario and flood frequency, VISTA calculated the cumulative effect of the road closures to the network in terms of additional miles traveled by each vehicle and the additional time it takes each vehicle to get from its origin to its destination. Table 3.60 details the computed time delay output for the baseline and future conditions. Table 3.61 details the computed distance delay output. These values were monetized as discussed in Section 2.2.3. This section also provides some insight as to why damages decrease for the 1% flood event. As a result of the dynamic nature of the traffic model's response to the spatial distribution and temporal duration of road closures the overall transportation network had improved time savings over the fifty year event. This is counter intuitive for the typical flood risk management analysis where river stages increase with decreasing frequency of the event. Under the typical study the damages are static structures that do not move. Damages for a transportation study need to account for decisions made by drives that are moving about the watershed.

Modeled baseline conditions without flooding were calibrated to existing conditions using Chicago Metropolitan Agency for Planning (CMAP) data. The modeled delays were reviewed by the Transportation sub-committee of the Project Delivery Team to verify that the projected distribution of delays and detours corresponds with actual impacts experienced in the watershed during past flood events.

Future conditions were modeled using projected demand data and planned changes to the area roadway network. Modeled future conditions, however, resulted in extreme estimates of delays and resulting damages: initial damage calculations totaled as much as eight times the baseline damages. A revision of assumptions such as improved driver knowledge of the network did not yield more reasonable results. The modelers noted that the high total delays resulted from a small number of vehicles experiencing extremely long delays, as much as 12 or 13 hours. As these extreme delays would generally not be tolerated by drivers, the resolution identified by the modelers was to truncate vehicle delays to exclude these unrealistic results. The truncation procedure is detailed in the May 2011 modeling report. Future mainstem transportation damages calculated in HEC-FDA using these revised total delays are approximately 33% greater than the baseline damages.

However, due to uncertainty in the assumptions used to generate the future condition model and the challenges associated with verifying and calibrating the resulting delays and damages at individual roads, a simplified relationship was developed. Damages in the future condition were related to the depth damage functions developed for the baseline condition by adding 10% to the baseline condition damages used to calculate depth damage functions. This index of 10% corresponds to the projected traffic demand increase 2006 to the 2020 projected by CMAP.

This 10% in damages by depth over the baseline conditions does not translate directly to a 10% increase in transportation damages in the future. Changes in future condition flood stages are also part of the future condition modeled in HEC-FDA. This approach accounts for expected impacts to the road network resulting from projected increases in flood stages due to urbanization within the study area, while maintaining reviewed relationships between high volume roadways and delays resulting from flood-induced road closures.

Upper Des Plaines River Watershed - With Floods
Vehicle Distribution by Delay Bracket - System Wide Results

		Time Savings						No Change	Time Delays					
		> 15 minutes		5 to 15 minutes		0 to 5 minutes		0 min	0 to 5 minutes		5 to 15 minutes		> 15 minutes	
Flood Event	Vehicle Type	Vehicle Count	Average Minutes	Vehicle Count	Average Minutes	Vehicle Count	Average Minutes	Vehicle Count	Vehicle Count	Average Minutes	Vehicle Count	Average Minutes	Vehicle Count	Average Minutes
1-year	Passenger Car	30,441	29.9	37,644	8.9	230,926	0.6	23,838,870	257,038	0.7	27,528	8.8	19,288	49.7
	Commercial Truck	1,164	26.6	1,521	8.5	19,351	0.5	2,153,969	24,932	0.5	876	8.6	367	48.8
2-year	Passenger Car	69,988	29.7	76,332	9.0	569,105	0.6	55,468,736	712,544	0.9	74,691	9.0	59,319	134.8
	Commercial Truck	2,734	26.5	3,500	8.5	49,130	0.5	5,010,509	68,390	0.6	2,667	9.0	1,490	114.3
5-year	Passenger Car	126,272	31.0	116,133	9.1	1,085,869	0.6	94,227,783	1,754,402	1.4	233,719	9.0	222,762	200.5
	Commercial Truck	5,552	29.3	6,391	8.7	91,769	0.5	8,484,067	189,265	1.4	17,212	8.5	14,464	143.4
10-year	Passenger Car	142,328	31.1	130,087	9.1	1,461,321	0.6	116,956,428	2,700,635	1.5	415,593	8.9	402,283	282.0
	Commercial Truck	6,508	29.4	7,739	8.7	118,756	0.5	10,533,476	279,165	1.5	35,649	8.5	29,607	187.8
25-year	Passenger Car	185,267	31.3	162,869	9.1	1,865,867	0.6	147,123,936	3,845,779	1.7	691,473	8.6	922,464	220.2
	Commercial Truck	8,821	30.2	10,095	8.8	152,336	0.5	13,263,505	397,335	1.7	58,061	8.3	56,987	179.2
50-year	Passenger Car	199,776	31.6	163,452	9.2	2,079,013	0.6	160,829,268	4,617,895	1.7	955,034	8.4	2,247,707	215.6
	Commercial Truck	9,415	30.9	10,780	8.8	168,808	0.5	14,550,806	473,693	1.7	87,885	8.3	113,873	179.0
100-year	Passenger Car	194,501	31.8	156,960	9.1	2,091,251	0.6	158,259,939	4,837,327	1.7	1,067,781	8.3	4,484,386	319.5
	Commercial Truck	9,115	31.1	10,570	8.8	171,338	0.5	14,407,332	502,489	1.7	98,497	8.2	215,919	347.3
500-year	Passenger Car	232,932	30.7	221,171	9.0	2,408,623	0.6	184,332,381	5,854,986	1.8	1,436,924	8.3	9,194,108	364.7
	Commercial Truck	10,813	30.5	13,130	8.7	205,061	0.5	16,947,204	615,151	1.8	134,591	8.1	425,550	406.8

Table 3.60 – VISTA Time Delay – Baseline Conditions

Upper Des Plaines River Watershed **Additional Vehicle Miles Traveled - System Wide Results**									
	Without Floods		With Floods		Difference				
Flood Event	Passenger Cars Miles	Commercial Trucks Miles	Passenger Cars Miles	Commercial Trucks Miles	Passenger Cars Miles	Commercial Trucks Miles	Passenger Cars Percent	Commercial Trucks Percent	Flood Duration Days
1-year	163,431,932	16,012,936	163,395,811	16,013,054	-36,121	118	-0.022%	0.001%	3
2-year	381,341,174	37,363,517	381,234,568	37,365,141	-106,606	1,625	-0.028%	0.004%	7
5-year	653,727,727	64,051,743	653,900,984	64,115,456	173,257	63,713	0.027%	0.099%	12
10-year	817,159,659	80,064,679	817,427,830	80,196,586	268,171	131,907	0.033%	0.165%	15
25-year	1,035,068,902	101,415,260	1,035,921,985	101,642,381	853,084	227,121	0.082%	0.224%	19
50-year	1,144,023,523	112,090,551	1,143,404,044	112,387,335	-619,479	296,784	-0.054%	0.265%	21
100-year	1,144,023,523	112,090,551	1,126,154,896	111,177,715	-17,868,627	-912,836	-1.562%	-0.814%	21
500-year	1,361,932,765	133,441,132	1,314,272,575	131,014,269	-47,660,190	-2,426,863	-3.499%	-1.819%	25

Table 3.61 – VISTA Distance Delay – Baseline Conditions

3.5 Equivalent Annual Damages

ER 1105-2-100, Section 3.3.c provides the framework by which flood damage reduction is evaluated. The NED evaluation process requires the determination of existing and future, if the available, flood damages. Average annual damages for future damages must be discounted to the base year, reported as equivalent annual damages herein.

Tables 3.62 and Table 3.63 were created from output generated from the USACE HEC-FDA model. For all tributaries the analysis was conducted using a discount rate of 3.75% and converted to the current FY13. The index used to convert from FY10 to FY13 is 1.06 for the structural features and 0.95 for the transportation features.

Most data collection occurred during 2008 and used price levels current at that time. A price level update was conducted using the Engineering News Record Economic Construction Cost Index for Chicago on the valuation of the structure and the valuation of transportation (using the "All Items" category).

Attachment 4 provides a GIS-based presentation of the damages in each watershed. Equivalent annual damages are broken down by damage reach and category. Maps in this attachment depict the relative degree of damage, by size of the symbol, and location within the FEMA designated Special Flood Hazard Area. Attachment 6 provides additional details, showing damages in each watershed by reach.

Watershed	Equivalent Annual Damages ($1,000)		
	STRUCTURAL	TRANSPORTATION	TOTAL
Brighton Creek	$145	$0	$145
Dutch Gap Canal	$33	$0	$33
Center Creek	$4	$0	$4
Kilbourn Road Ditch	$45	$0	$45
Jerome Creek	$32	$0	$32
Des Plaines River Mainstem (WI)	$45	$187	$232
Newport Ditch	$0	$0	$0
Mill Creek	$179	$82	$261
Bull Creek	$117	$17	$135
Indian Creek	$36	$51	$87
Buffalo-Wheeling Creek	$344	$8	$351
McDonald Creek	$0	$0	$0
Weller Creek	$139	$3	$142
Farmer-Prairie Creek	$140	$4	$144
Willow-Higgins Creek	$21	$22	$43
Silver Creek	$881	$229	$1,110
Des Plaines River Mainstem (IL)	$7,396	$42,093	$49,489
TOTAL	$9,556	$42,696	$52,253

(FY2014 Price Level, 3.5% Federal Discount Rate)

Table 3.62 – Watershed Equivalent Annual Damages by Damage Type

Watershed	Equivalent Annual Damages ($1,000)							
	APT	AUTO	COM	IND	PUB	RES	TRAFFIC	TOTAL
Brighton Creek						$145		$145
Dutch Gap Canal						$33		$33
Center Creek						$4		$4
Kilbourn Road Ditch						$45		$45
Jerome Creek						$32		$32
Des Plaines River Mainstem (WI)						$45	$187	$232
Newport Ditch								$0
Mill Creek			$11	$16	$119	$33	$82	$261
Bull Creek					$40	$77	$17	$135
Indian Creek						$36	$51	$87
Buffalo-Wheeling Creek	$12	$6	$30	$9		$287	$8	$351
McDonald Creek								$0
Weller Creek		$1				$138	$3	$142
Farmer-Prairie Creek			$2		$14	$124	$4	$144
Willow-Higgins Creek			$19			$2	$22	$43
Silver Creek	$1	$3	$53	$2		$822	$229	$1,110
Des Plaines River Mainstem (IL)	$872	$95	$1,435	$355	$1,546	$3,093	$42,093	$49,489
TOTAL	$885	$105	$1,550	$382	$1,719	$4,915	$42,696	$52,253

(FY2014 Price Level, 3.5% Federal Discount Rate)

Table 3.63 – Watershed Without Project Equivalent Annual Damages by Damage Categories

CHAPTER 4 – FLOOD RISK MANAGEMENT PLAN FORMULATION

Plan formulation is an iterative process that involves cycling through the formulation, evaluation, and comparison steps of the planning process to develop a reasonable range of alternative plans, thus narrowing those plans to a final array for plan selection and design and implementation. Evaluating with and without-project conditions for each alternative is necessary to establish plan benefits. Flood damage reduction plans are evaluated based on monetary-based contributions to the nation's economy or National Economic Development (NED) account.

As detailed in the main report, due to policy considerations, three flood risk management plans, listed below, were developed for this study. Each plan maximizes net benefits.

1. *Comprehensive Plan:* A plan that fully responds to the study authority and includes all economically justified, environmentally acceptable separable features evaluated during the course of the study.
2. *CAP Plan:* All policy compliant, economically justified, environmentally acceptable separable features of such scope that they could reasonably be implemented under the Continuing Authorities Program (CAP).
3. *NED Plan:* All policy compliant, economically justified, environmentally acceptable separable features of such scope that they could not be implemented under CAP.

The main report and Appendix B: Flood Risk Management Plan Formulation detail the plan formulation process including the procedures for screening and evaluating the many initially identified alternatives and the process for formulating the tentatively selected plans. Benefits were modeled in HEC-FDA as reductions in flood damages resulting from changes to the water surface profile or construction of barriers to flooding.

For non-structural measures, a modified procedure was used. To efficiently capture the impacts at individual structures that would result from the non-structural measures, the FDA_StrucDetail.OUT output file was used to compute the expected annual damages at individual structures. The resulting benefits would therefore be the reduction in flood damages at the individual structures. The benefits and costs were aggregated within communities to determine whether the measures were justified for the group of structures as a whole.

4.1 Flood Risk Management Plans

Each alternative project will provide some level of damage reduction, however; only a project that dyields positive net benefits is considered a justified project. The net benefit criterion requires that the project not only reduce damages, but the project provides more monetary benefits than the cost to construct. Many projects will provide a higher degree of protection (less residual annual damages), but with a correspondingly higher degree of cost to implement and maintain when compared to the benefits the project provides.

After each project has been studied as a stand-alone project, those projects which have positive net benefits are then analyzed for effectiveness as a group of projects, the last added analysis. Last added analysis demonstrates the economic effectiveness of projects that have hydrologic and hydraulic connectivity. Projects that have hydrologic and hydraulic connectivity have the potential to steal damage reduction benefits and residual damages from each other as each project is added to the project study. The project(s) with the highest net benefits are used as a comparison plan and net benefits are calculated with each individually justified element added to that plan. If there is an increase in net benefits, the combinations are justified. The combination resulting in the highest net benefits becomes the new comparison plan, and new net benefit calculations are performed with each remaining individually justified project added to that new plan. This process continues until either all elements are added or the addition of new elements to the plan results in a decrease in net benefits.

A discussion of the last added analysis procedure and results can be found in Appendix B (NED Plan Formulation). The Plans resulting from the last added analysis are summarized in Table 4.1.

Plan	Sites	Benefits ($1,000)	Costs ($1,000)	Net Benefits ($1,000)	BCR
Comprehensive	DPBM04 + DPLV04 + DPLV05 + DPLV09 + ACRS08 + DPLV01 + FPCI01 + non-structural measures (15 communities)	$15,124	$7,127	$7,998	2.1
NED	ACRS08 + DPLV04 + DPLV05 + DPLV09 + ACRS08 + non-structural measures (10 communities)	$10,123	$5,897	$4,226	1.7
CAP	DPLV01	$441	$274	$166	1.6

Includes adjustments in Flood Insurance Administration Costs, Flood Fighting Prevented, and Recreation Benefits (see Section 4.2)
Benefits (FY2014 Price Level, 3.5% Federal Discount Rate)

Table 4.1 – Flood Risk Management Plan Benefits, Costs, and Net Benefits

4.2 Additional Flood Risk Management Benefits and Costs

Flood Warning and Response

The majority of the watershed's residual damages are located along the Des Plaines River; therefore, a revision of the Des Plaines River Phase I Flood Warning and Response plan will be forthcoming.

Adjustments in Flood Insurance Administration Costs

The Flood Insurance Administration (FIA) expends significant time and effort administering each flood insurance policy under the National Flood Insurance Program (NFIP). The estimated average annual cost of this time and effort is $192 (per USACE Economic Guidance Memo 06-04). For the economic analysis, this estimate is used to calculate a decrease in aggregate NFIP administrative expenditures for each with-project alternative where structures are removed from the floodplain. Structures in the floodplain are assumed to be covered by a flood insurance policy.

Removal of structures from floodplain from implementation of sites DPLV09 and DPLV01 as well as non-structural sites were identified. The cost savings in flood insurance administration costs for the structures protected by each measure will be added to the benefits for that project. As shown in Table 4.2, DPLV09 removes 991 structures, DPLV01 removes 122, and several additional sites are removed through the implementation of non-structural measures.

Flood Risk Management Project	Structures Removed from FEMA designated Special Flood Hazard Area	Annual Flood Insurance Expenditures Reduced[6] ($1,000)
Levee 9	807	$155
Levee 5	200	$38
Levee 4	182	$35
Levee 1	122	$23
Elevation (policy compliant)	218	$42
Dry Floodproofing (policy compliant)	81	$16
Ring Levee (policy compliant)	37	$7
Elevation (non-policy compliant)	76	$15
Dry Floodproofing (non-policy compliant)	4	$1
Ring Levee (non-policy compliant)	16	$3
Comprehensive Plan Total	1,545	$297
CAP Total	122	$23
NED Total	1,327	$255

Table 4.2 – Structures Removed from Floodplain by Proposed FRM Projects

[6] EGM 06-04 (Fiscal Year 2006) was the last reported value from FEMA. Price level of this document was assumed to be 2006.

Floodfighting

There are additional costs borne by local municipalities associated with flood events that are not included in the structural and transportation damage category estimates presented thus far. Additional costs incurred during flood emergencies include flood fighting, debris removal, evacuation, temporary housing, medical supplies, food, clothing and reoccupation. Reliably estimating these costs is difficult given the scale of this study.

Available data from recent flood events – August 2007 (FEMA-1722-DR-IL) and September 2008 (FEMA-1800-DR-IL) – was reviewed to determine whether a relationship between depth of flooding and floodfighting costs could be established. $3.8 million and $4.4 million were provided to state and local agencies as reimbursements for floodfighting measures during the respective events. These data, however, only include a portion of the communities within the watershed and do not provide a clear relationship between flood probability and costs.

Rather than develop a watershed-wide relationship between floodfighting and particular flood events, projects such as levees were evaluated to determine whether implementation would reduce these costs in a particular community. At the section of the Des Plaines River that will be protected by DPLV09, the community of Des Plaines has spent a significant amount of money on floodfighting. Due to uncertainty in the flood warning system and the severity of potential flood damages, emergency flood protection measures are mobilized for most events. In August 2007, a 20% chance event at the Des Plaines gage, the community claimed $1,283,000 for emergency flood protection and debris removal. In September 2008, a 10% chance event at the Des Plaines gage, the community claimed approximately $1,133,000. These costs were therefore used a baseline for flood protection costs in the community that would be mobilized during flood events starting with the 10% chance event. The percentage of this total corresponding to the portion of the community along the riverbank that would be protected by the levee, approximately one third, was used as the baseline of reduced floodfighting costs. This cost was annualized over the period of analysis, to determine the average annual benefits. The total annualized reduction in flood fighting costs associated with DPLV09 is $60,000.

Recreation Benefits

Recreation features were included as separable elements at three sites: DPLV09, DPRS04, and the Des Plaines Floodway/Big Bend Drive Area. An economic analysis of these features is below:

<u>DPLV09</u>

The potential to enhance the recreational experience along the Des Plaines River is analyzed for its economic feasibility. At site DPLV09, a recreation trail connecting to the existing Des Plaines River trail is included in the proposed site design. Benefits for this trail are calculated as described in ER 1105-2-100 (Planning Guidance Notebook),

Appendix E, Section VII and points and values are attributed as required by EGM 14-03 (Unit Day Values for Recreation for Fiscal Year 2014).

The proposed recreation trail is located in the City of Des Plaines located on the west side of the Des Plaines River between Miner Street and Oakton Avenue. The existing Des Plaines River Trail runs along the eastern side of the Des Plaines River. Access to the established Des Plaines River Trail is at Miner Street, Algonquin Road, and Oakton Road. Residents can currently access the Des Plaines River Trail via these routes and sidewalks along Des Plaines River Road. The City of Des Plaines notes the safety concerns about residents crossing Des Plaines River Road at this location on their website: "In addition, the safety of the Algonquin and Oakton crossings were improved with additional signage, striping and proposed pedestrian actuated flashing beacons (Oakton)."[7]

The proposed design would include a pedestrian footpath along the eastern side of the Des Plaines River Road between Ashland Road and Oakton Road. The footpath would be wider and set back from the roadway, providing a safer and scenic recreation trail with access to the 50 miles of trails along the Des Plaines River that extend from River Forest in Illinois to the Wisconsin border.

Criteria	
1. Is a regional model available?	No
2. If "No", do uses affected involve specialized recreation activities?	No
3. If "No", do expected annual visits affected exceed 750,000?	No
4. Do specific annual Federal recreation costs exceed $1,000,000 (FY82 price levels)?	No
5. If "No", then use UDV's for evaluating recreation benefits resulting from the proposed Project.	

Table 4.3 Criteria for selecting an appropriate recreation evaluation procedure

Evaluation criteria for the selection of recreation benefit evaluation methods and evaluation procedures are provided in ER 1105-2-100. Table 4.3 provides the steps used in the selection of the Unit Day Valuation method for the computation of NED benefits for the project.

Federal interest for participating in this proposed recreation plan was evaluated based upon ER 1105-2-100 and Economic Guidance Memorandum 13-03 (UDV method). This method is appropriate given the above referenced Guidelines. The UDV method assigns point values (convertible to dollar values) for recreational facility attributes including recreation experience, availability, carrying capacity, accessibility, and environmental/aesthetic quality.

Determination of Unit Day Values. Unit day value points are determined for both the existing Without Project and the proposed With Project conditions. Because of the activities possible at the proposed trail facilities, estimation of UDVs was determined for general recreational activities. Activities will include walking, running, biking, in-line

[7] http://www.desplaines.org/index.aspx?nid=224 (accessed on May 8th, 2013)

skating, and other general activities. The UDV increases were based upon the comparison of General Recreation Criteria (EGM 13-03) in the existing condition versus the improved With Project condition, as follows. Table 4.4 displays the UDV points assigned to each category for the Without Project and the proposed With Project conditions.

Recreation Experience. The City of Des Plaines currently has west bank pedestrian sidewalk with access to the Des Plaines River Trail along Miner Street, Algonquin Road, and Oakton Road. This pedestrian system does not provide a sufficient and safe venue for general activities and provides limited walking, biking, running, and in-line skating along a narrow path next to a busy two lane road. The proposed recreational feature would enhance the general recreation activity on the east side of Des Plaines River Road. These activities will be enjoyed in an aesthetically improved river walk destination as opposed to the current residential pedestrian sidewalk along a busy road.

Availability of Opportunity. The facility quality of recreational activities available in the Without and With-Project condition can be found within a half hour of the proposed project.

Carrying Capacity. In the without project condition the trail system offers adequate facilities to conduct general recreation activities. The proposed trail along the west bank of the river will provide optimum facilities with which to conduct a variety of high-quality general recreational activities. The new trail segment will be a significant upgrade from the existing conditions due to the re-routed location on the riverbank and protected from road traffic.

Accessibility. The proposed recreation feature will not affect accessibility to the trail.

Environmental. Users of the proposed recreation facility with a river setting will experience a greatly improved esthetic quality and vastly safer recreational path compared to the without project condition of a trail adjacent to Des Plaines River Road.

Unit Day Values (UDVs) were assigned using the point values shown in Table 4.4. The total point value corresponds to a UDV of $5.47 for the without project and $8.17 for the recreation trail. To determine the annual benefits, the UDV is multiplied by the expected number of users annually. The current usage of the public sidewalk, between Ashland Road and Oakton, to access the Des Plaines River Trail was determined by the population within approximately a half mile of the proposed site. There are approximately 500 residential structures within this distance. A conservative assumption is that residents within this distance are willing to visit the Des Plaines River Trail; crossing at Miner, Algonquin, or Oakton; at least once a year. The without project annual benefits are $2,735.

Since the proposed site is located on the eastern bank of the Des Plaines River, visitors from the existing Des Plaines River recreational trail, located along the western bank of the river, would have to divert from the trail to access this site. The amenities are such that it would draw walkers, joggers, and bikers to divert from the main trail. The proposed asphalt trail would provide a loop for local trail users and access to the trail system along the eastern bank of the river.

UDV Categories	Without Project	Levee 9 Recreation Feature
Recreation Experience	6	7
Availability of Opportunity	3	3
Carrying Capacity	5	13
Accessibility	7	17
Environmental	5	10
Total	26	50
Conversion of Points to $ Value	$5.47	$8.17

(FY2014 PL)

Table 4.3 – Estimated UDV Points for Recreation Trail at site DPLV09

User counts for a section of trail along the Des Plaines in the nearby community of Wheeling were used as a basis for the estimated number of users. Based on these counts, average use during cold weather months is approximately 200 visitors per week while average use during warm weather months, average usage increases to around 600 visitors per week. The cold and warm weather usage rates combine for an annual use of about 22,000 visitors per year. For 22,000 users with a value of $8.17 each, the total annual benefits are $179,740.

	Without Project	With Project
Annual Users	500	22,000
Unit Day Value	$5.47	$8.17
Annual Benefits	$3,000	$180,000
Incremental Difference		$177,000
Project Cost Estimate		$143,000
Interest During Construction Total First Cost Annualized First Cost Annualized OMRR&R		$6,000 $149,000 $6,000 $1,000
Total Annualized Cost		$7,000
BCR		24.1
Net Benefits		$170,000

Note: All costs and benefits are rounded to neared $1,000.
(FY2014 Price Level and 3.75% Discount Rate)

Table 4.4 – DPLV09 Annual Cost and Benefit Analysis

Construction and Operation & Maintenance cost are detailed in the Civil and Cost Engineering appendix and are at October 2013 (FY14) price levels. A discount rate of 3.5% was applied to the total first cost and amortized over a period of 50 year project life. The potential recreation feature has a healthy benefit to cost ratio of 24.1 and net benefits of $169,657.

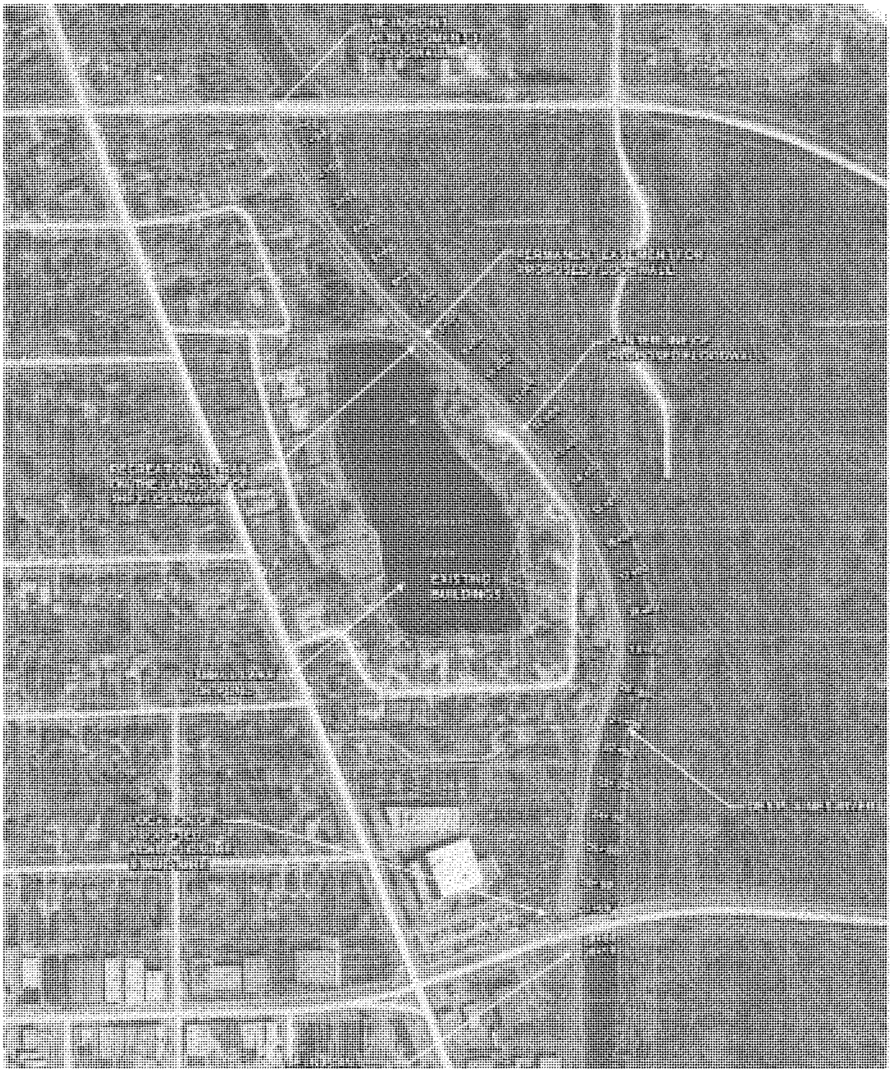

Figure 4.1 – Levee 9 Recreation Trail

DPRS04

At site DPRS04, no recreation facilities are currently in existence. Therefore, any recreational facilities developed at this site would be new rather than a modification of existing features. However, UDV is calculated for both the existing Without Project and proposed With Project conditions. Table 4.5 exhibits the UDV points assigned to each category for both conditions. The proposed features for the With Project condition include the following:

- Landscaped site to include grasses and trees
- Picnic shelter
- Asphalt trails
- Water feature with aeration fountain
- Restroom facility
- Drinking fountains

Recreation Experience. There are presently no recreation facilities at the DPRS04 site. The proposed features include a landscaped site with a picnic shelter, trail with benches, parking lot, and restroom. The proposed features would allow for several general recreational activities, such as picnicking, walking, running, and cycling. It is expected that users would engage in some or all of these activities when visiting the site.

Availability of Opportunity. The facility quality of recreational activities available in the Without and With Project condition can be found within a half hour of the proposed project.

Carrying Capacity. In the Without Project condition there are not adequate facilities to conduct general recreation activities. The proposed trail around the perimeter of the reservoir will provide optimum facilities with which to conduct a variety of high-quality general recreational activities.

Accessibility. The existing site (Without Project condition) has limited access by any means to the site or within the site. The With Project condition will allow for good access to the site – to include good roads to and within the site.

Environmental. The Without Project condition has low esthetic factors. However, the With Project condition would provide a recreational site with grasses and trees that would provide high esthetic quality. There are no anticipated factors that would lower this quality.

User Day Values (UDVs) were assigned using the point values shown in Table 4.5. The total point value corresponds to a UDV of $4.06 for the Without Project and $7.06 for the With Project condition. Annual benefits were determined by utilization of the UDV, which is multiplied by the expected number of users annually. Since there is currently no access to the site, the site has no current users. Therefore, a conservative assumption is that the Without Project condition annual benefits (the product of UDV and expected number of users) is $0.

UDV Categories	Without Project	DPRS04 Recreation Features
Recreation Experience	0	5
Availability of Opportunity	3	3
Carrying Capacity	0	9
Accessibility	0	11
Environmental	0	11
Total	3	39
Conversion of Points to $ Value	$4.06	$7.06

(FY2014 PL)
Table 4.5 – Estimated UDV Points for Recreation Features at DPRS04

User counts for a section of Des Plaines River Trail in the community of Wheeling were used as a basis for the estimated number of users. Based on these counts, average use during cold weather months is approximately 200 visitors per week while during warm weather months average use increases to approximately 600 visitors per week. The cold and warm weather usage rates combine for an annual use of about 22,000 visitors per year. For 22,000 users with a value of $7.06 each, the total annual benefits are $155,320.

	Without Project	With Project
Annual Users	0	22,000
Unit Day Value	$4.06	$7.06
Annual Benefits	$0	$155,000
Incremental Difference		$155,000
Project Cost Estimate		$567,000
Interest During Construction		$9,000
Total First Cost		$576,000
Annualized First Cost		$25,000
Annualized OMRR&R		$5,000
Total Annualized Cost		$30,000
BCR		5.3
Net Benefits		$126,000

Note: All costs and benefits are rounded to neared $1,000.
(FY2014 Price Level and 3.5% Discount Rate)
Table 4.6 – DPRS04 Annual Cost and Benefit Analysis

Construction and Operation & Maintenance cost are detailed in the Civil and Cost Engineering appendix and are at October 2013 (FY14) price levels. A discount rate of 3.5% was applied to the total first cost and amortized over a period of 50 year project life. The potential recreation feature has a benefit to cost ratio of 5.3 and net benefits of $125,761.

Des Plaines Floodway/Big Bend Drive Area

At the Des Plaines Floodway/Big Bend Drive Area, no recreation facilities are currently in existence. Therefore, any recreational facilities developed at this site would be new rather than a modification of existing features. However, UDV is calculated for both the existing and proposed With Project conditions. Table 4.7 exhibits the UDV points assigned to each category for both conditions. The proposed features for the With Project condition include approximately 4,000 feet of asphalt trail connecting to existing roads and the Des Plaines River trail network on the opposite bank.

Recreation Experience. There are presently no recreation facilities at the DPRS04 site. The proposed features include a naturalized site with paved trails allowing for use by walkers, hikers, cyclists, and runners. The proposed features would allow for several general recreational activities, as listed above.

Availability of Opportunity. The facility quality of recreational activities available in the Without and With Project condition can be found within a half hour of the proposed project.

Carrying Capacity. In the Without Project condition there are not adequate facilities to conduct general recreation activities. The proposed trail around the site will provide optimum facilities with which to conduct a variety of high-quality general recreational activities.

Accessibility. The existing site (Without Project condition) consists of private properties and therefore has little or no access available to the public. The With Project condition will allow for good access to the site – to include good roads to and within the site.

Environmental. The Without Project condition has low aesthetic factors, consisting of private homes. The With Project condition would provide a recreational site with exceptional aesthetic qualities: the site would be vegetated with grasses and trees and provide view of and access to the Des Plaines River. There are no anticipated factors that would lower this quality.

User Day Values (UDVs) were assigned using the point values shown in Table 4.7. The total point value corresponds to a UDV of $4.06 for the Without Project and $7.78 for the With Project condition. Annual benefits were determined by utilization of the UDV, which is multiplied by the expected number of users annually. Since there is currently no access to the site, the site has no current users. Therefore, a conservative assumption is that the Without Project condition annual benefits (the product of UDV and expected number of users) is $0.

UDV Categories	Without Project	Des Plaines Floodway/Big Bend Drive Area Recreation Feature
Recreation Experience	0	5
Availability of Opportunity	3	3
Carrying Capacity	0	9
Accessibility	0	11
Environmental	0	18
Total	3	46
Conversion of Points to $ Value	$4.06	$7.78

(FY2014 PL)

Table 4.7 – Estimated UDV Points for Recreation Features at Des Plaines Floodway/Big Bend Drive Area

User counts for a section of trail along the Des Plaines in the nearby community of Wheeling were used as a basis for the estimated number of users. Based on these counts, average use during cold weather months is approximately 200 visitors per week while during warm weather months, average use increases to around 600 visitors per week. The cold and warm weather usage rates combine for an annual use of about 22,000 visitors per year. For 22,000 users with a value of $7.78 each, the total annual benefits are $171,160.

	Without Project	With Project
Annual Users	0	22,000
Unit Day Value	$4.06	$7.78
Annual Benefits	$0	$171,000
Incremental Difference		$171,000
Project Cost Estimate		$277,000
Interest During Construction		$4,000
Total First Cost		$281,000
Annualized First Cost		$12,000
Annualized OMRR&R		$1,000
Total Annualized Cost		$13,000
BCR		13.2
Net Benefits		$158,000

Note: All costs and benefits are rounded to neared $1,000.
(FY2014 Price Level and 3.5% Discount Rate)

Table 4.8 – Des Plaines Floodway/Big Bend Drive Area Annual Cost and Benefit Analysis

Construction and Operation & Maintenance cost are detailed in the Civil and Cost Engineering appendix and are at October 2013 (FY14) price levels. A discount rate of 3.5% was applied to the total first cost and amortized over a period of 50 year project life. The potential recreation feature has a benefit to cost ratio of 13.2 and net benefits of $158,162.

4.3 Residual Annual Damages

With implementation of the Flood Risk Management Plans, residual risk of flood damages exists throughout the watershed. Several tributaries did will not experience any reduction in flood risk. The tables below present the EAD calculated both with and without project for the mainstem as well as tributaries where a reduced flood risk would result from plan implementation. As shown in the tables, implementation of the plan reduces the risk of damages, but over the period of analysis, flood damages are still expected to occur in the watershed. Tables 4.9 through 4.17 show expected residual damages for after implementation of the Full, NED, and CAP plans.

Damage Category	EAD ($1,000)		Benefits ($1,000)	% Change
	Without Project	With Project		
APT	$872	$77	$795	91%
AUTO	$95	$48	$47	50%
COM	$1,435	$491	$945	66%
IND	$355	$92	$263	74%
PUB	$1,546	$901	$644	42%
RES	$3,093	$871	$2,222	72%
TRAFFIC	$42,093	$32,322	$9,771	23%
Total	$49,489	$34,800	$14,688	30%

(FY2014 Price Level and 3.5% Discount Rate)

Table 4.9 – Des Plaines Mainstem Residual Damages – Comprehensive Plan

Damage Category	EAD ($1,000)		Benefits ($1,000)	% Change
	Without Project	With Project		
APT	$12	$12	$0	0%
AUTO	$6	$6	$0	0%
COM	$30	$27	$3	12%
IND	$9	$7	$2	17%
PUB				
RES	$287	$132	$155	54%
TRAFFIC	$8	$8	$0	0%
Total	$351	$191	$160	46%

(FY2014 Price Level and 3.5% Discount Rate)

Table 4.10 – Buffalo-Wheeling Creek Residual Damages – Comprehensive Plan

Damage Category	EAD ($1,000)		Benefits ($1,000)	% Change
	Without Project	With Project		
APT				
AUTO				
COM	$2	$2	$0	0%
IND				
PUB	$14	$14	$0	0%
RES	$124	$17	$107	86%
TRAFFIC	$4	$4	$0	0%
Total	$144	$37	$107	74%

(FY2014 Price Level and 3.5% Discount Rate)

Table 4.11 – Farmer-Prairie Creek Residual Damages – Comprehensive Plan

Damage Category	EAD ($1,000)		Benefits ($1,000)	% Change
	Without Project	With Project		
APT	$1	$1	$0	0%
AUTO	$3	$3	$0	0%
COM	$53	$23	$30	57%
IND	$2	$2	$0	0%
PUB				
RES	$822	$774	$48	6%
TRAFFIC	$229	$229	$0	0%
Total	$1,110	$1,032	$78	7%

(FY2014 Price Level and 3.5% Discount Rate)

Table 4.12 – Silver Creek Residual Damages – Comprehensive Plan

Damage Category	EAD ($1,000)		Benefits ($1,000)	% Change
	Without Project	With Project		
APT				
AUTO				
COM				
IND				
PUB				
RES	$45	$2	$43	95%
TRAFFIC				
Total	$45	$2	$43	95%

(FY2014 Price Level and 3.5% Discount Rate)

Table 4.13 – Kilbourn Road Ditch Residual Damages – Comprehensive Plan

Damage Category	EAD ($1,000)		Benefits ($1,000)	% Change
	Without Project	With Project		
APT				
AUTO				
COM				
IND				
PUB				
RES	$145	$86	$59	41%
TRAFFIC				
Total	$145	$86	$59	41%

(FY2014 Price Level and 3.5% Discount Rate)

Table 4.14 – Kilbourn Road Ditch Residual Damages – Comprehensive Plan

Damage Category	EAD ($1,000)		Benefits ($1,000)	% Change
	Without Project	With Project		
APT	$872	$408	$464	53%
AUTO	$95	$48	$47	50%
COM	$1,435	$491	$945	66%
IND	$355	$92	$263	74%
PUB	$1,546	$902	$644	42%
RES	$3,093	$958	$2,135	69%
TRAFFIC	$42,093	$36,655	$5,439	13%
Total	$49,489	$39,551	$9,938	20%

(FY2014 Price Level and 3.5% Discount Rate)

Table 4.15 – Des Plaines Mainstem Residual Damages – NED Plan

Damage Category	EAD ($1,000)		Benefits ($1,000)	% Change
	Without Project	With Project		
APT	$12	$12	$0	0%
AUTO	$6	$6	$0	0%
COM	$30	$27	$3	12%
IND	$9	$7	$2	17%
PUB				
RES	$287	$213	$74	26%
TRAFFIC	$8	$8	$0	0%
Total	$351	$272	$79	23%

(FY2014 Price Level and 3.5% Discount Rate)

Table 4.16 – Buffalo-Wheeling Creek Residual Damages – NED Plan

Damage Category	EAD ($1,000)		Benefits ($1,000)	% Reduction
	Without Project	With Project		
APT	$872	$541	$331	38%
AUTO	$95	$95	$0	100%
COM	$1,435	$1,435	$0	100%
IND	$355	$355	$0	100%
PUB	$1,546	$1,546	$0	100%
RES	$3,093	$3,006	$87	3%
TRAFFIC	$42,093	$42,093	$0	100%
Total	$49,489	$49,071	$418	1%

(FY2014 Price Level and 3.5% Discount Rate)

Table 4.17 – Des Plaines Mainstem Residual Damages – CAP Plan

4.4 Plan Performance

A detailed explanation of evaluation procedure of the alternative measures is provided in the Flood Risk Management Plan Formulation Appendix and Hydrologic and Hydraulic Analysis Appendices. HEC-FDA runs were used to determine the equivalent annual benefits of each plan.

4.5 Flood Risk Management Plan Uncertainty

As discussed throughout this Appendix, uncertainty is incorporated in the calculations performed by HEC-FDA. Each plan has an associated range of likely reductions in damages. The totals presented throughout this report represent the most likely reductions in damages based on the without and with project assumptions used to model the watershed. The table below presents a range of expected values, incorporating these uncertainties.

Plan Name	Plan Description	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
		Total Without Project	Total With Project	Damage Reduced	0.75	0.5	0.25
Comp	DPBM04 + DPLV01 + DPLV04 + DPLV05 + DPLV09 + WLRS04 + DPRS04 + FPCI01	$49,489	$37,898	$11,591	$7,549	$10,796	$14,759
NED	DPLV04 + DPLV05 + DPLV09 + WLRS04 + DPRS04	$49,489	$41,966	$7,523	$4,650	$6,937	$9,738
CAP	DPLV01	$49,489	$49,071	$418	$323	$406	$502

(FY2014 Price Level and 3.5% Discount Rate)

Table 4.18 –Damage Reduction Benefit Uncertainty

CHAPTER 5 – NED/NER COMBINED PLAN SELECTION

The Corps Environmental Operating Principles (EOPs) strive to achieve environmental sustainability by seeking balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another. This Phase II study builds upon these principles by the formulation of plans that serve both flood damage reduction and ecosystem restoration purposes. Corps Planning Guidance promotes the formulation of combined plans that serve economic and environmental purposes whenever possible. Unfortunately, a specific procedure for formulating and evaluating combined NED/NER plans does not exist and are currently under development. Without specific guidance available, the study team has developed the following methodology for use in this Phase II study.

5.1 Tradeoff Analysis

There are three major formulation options when developing plans with elements that serve NED and NER purposes. The options depend on whether elements within the plan are physically or functionally interdependent versus independent. Combined NED/NER plans that have interdependent elements either share the same physical location or functions. Interdependent elements can sometimes negatively impact each other or compete for the same resources. In those cases, the outputs from the elements that impact each other or are in competition for benefits with each other must be traded off. Trade offs are not necessary for outputs from those elements that do not impact or even benefit each other. Plans that have independent elements are formulated separately into individual NED and NER plans. The third formulation option involves adding limited ecosystem restoration features to a NED plan that are not claimed for NER contributions. These limited ecosystem restoration features are added to reduce impacts and/or enhance the ecological output of a structural measure otherwise devoid of environmental characteristics. Below is a summary of the three formulation options:

a. Physically and/or functionally *interdependent* (combined NED/NER plan)
    - Without trade-offs (no impacts on each other)
    - With trade-offs (impacts on or competition with each other)
b. Physically and functionally *independent* (separate NED and NER plans)
c. Addition of limited ecosystem restoration features to NED plan

In order to formulate a combined NED/NER plan, single purpose NED and NER plans must be formulated and evaluated separately in order to form the basis for a trade-off analysis if needed and to ensure the plan that maximized net economic and environmental outputs is identified. The respective NED and NER plans are determined to be the most efficient, effective, complete and acceptable plans. Combined NED/NER plans result in the "best" recommended plan so that no alternative plan or scale has higher NED benefits plus NER benefits over total project costs. This plan shall attempt to maximize the sum of net NED and NER benefits and to offer the best balance between two Federal objectives. Recommendations for multipurpose projects are based on a combination of NED benefit-cost analysis and NER benefits analysis, including cost effectiveness and incremental cost analysis, performed using the Institute for Water Resources (IWR) Planning Suite.

According to ER 1105-2-100, when formulating plans that have interdependent elements where there is competition for resources, meaning more of one output (say, NER) can only be obtained by accepting less of another (say, NED), a trade-off analysis is required. Tradeoffs between NED outputs and NER outputs are permissible and should be made as long as the value of what is gained exceeds its implementation cost plus the value of what is foregone. In other words, it is acceptable to trade NED benefits in favor of NER outputs as long as the incremental value of the NER outputs exceeds the sum of NED benefits foregone plus incremental costs. Since the unit of measure is different between NED and NER accounts, a method is needed to normalize the units in order to compare benefits and perform tradeoffs where necessary. Corps guidance dictates the use of the Separable Cost-Remaining Benefit Method (SC-RB) for obtaining an equitable distribution of the costs of a multipurpose project among the purposes served. Incremental costs equal added cost necessary to realize added environmental outputs less reduced cost permitted by reduced NED outputs. Trades of one output for another shall be made until it is not possible to make further trades improving the total project. Naturally the potential trades go in both directions, more NER output for less NED output and more NED output for less NER output. This is a formulation-evaluation process by which the optimal combined NED/NER Plan is developed.

The study team has developed the following process for formulating, evaluating, and comparing multipurpose plans. Essentially single purpose plans are initially formulated and evaluated by identifying and screening potential sites, developing and screening management measures for each site, and formulating and analyzing alternatives from screened measures. The goal of these steps is to identify individual NED and NER plans that can then be compared to determine interdependency and the need for determining tradeoffs. If tradeoffs are not required, the Combined NED/NER Plan consists of the individual NED and NER plans. If a tradeoff analysis is necessary, the Combined NED/NER Plan is determined by the process described in the previous paragraph. A flowchart describing this process is shown in Figure 5.1 below.

One the single purpose NED and NER plans were selected the plans were compared and it was determined that they are not interdependent. Therefore, a tradeoff analysis was not required and the combined plan is simply a combination of all elements of both the NED and NER plans.

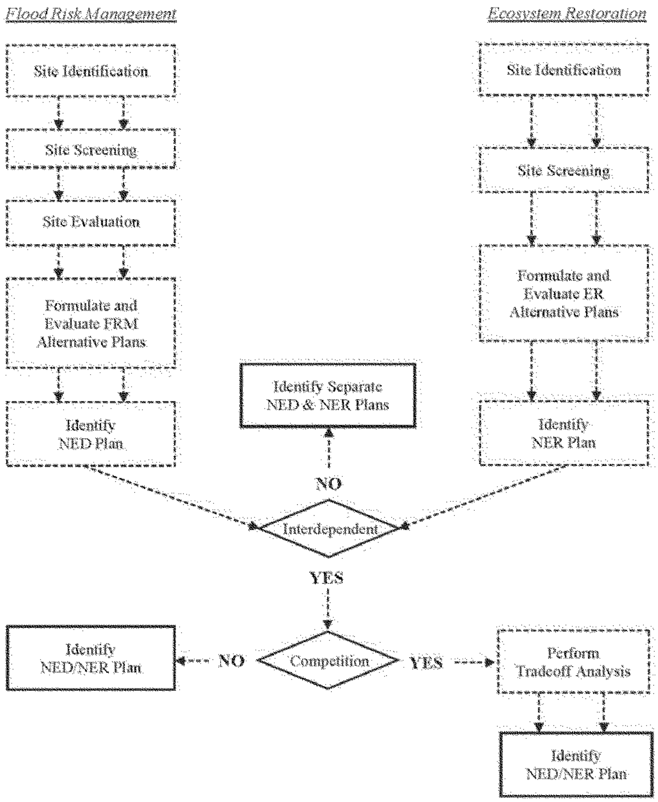

Figure 5.1 – Plan Formulation Process for Determining Combined NED/NER Plan

5.2 Cost Allocation

Costs for each element of the combined plan are allocating according to that site's purpose. As there are no multi-purpose sites, there is no distribution of costs between purposes within any one site.

CHAPTER 6 – ECONOMIC UPDATE PROCEDURES

Plans for economic updates are required under ER 1105-2-100 (Appendix D). Update procedures are not intended to revisit the procedural aspects of the economic analysis. Instead the procedure will resample the baseline economic data to provide an update to the data used in the benefit cost analysis performed during plan formulation.

Three major areas of update will occur during a limited re-evaluation of the economics: Structure Valuation, Automobile Counts and Cost, and Transportation monetization. The recent volatility in the housing markets would indicate the prudent course of action is to resample after a period of 3-5 years. A representative and random sample of ten percent of the structures will provide sufficient statistical data to develop a new index between the county assessor's valuation and an independent depreciated replacement value calculated using GeoFIT/MEANS valuation. Updates to the automobile valuation will follow the most recent EGM. Finally, the monetization for mileage and time will be updated to reflect current valuation.

Depending on when the economic update occurs, projects will be in various stages of design and construction. Any preliminary engineering and design (PED) costs expended at that time will be sunk costs and will not be included in the calculation of the updated benefit-to-cost ratio.

In 2012 a depreciation valuation check of the commercial, industrial, and public structures was conducted.

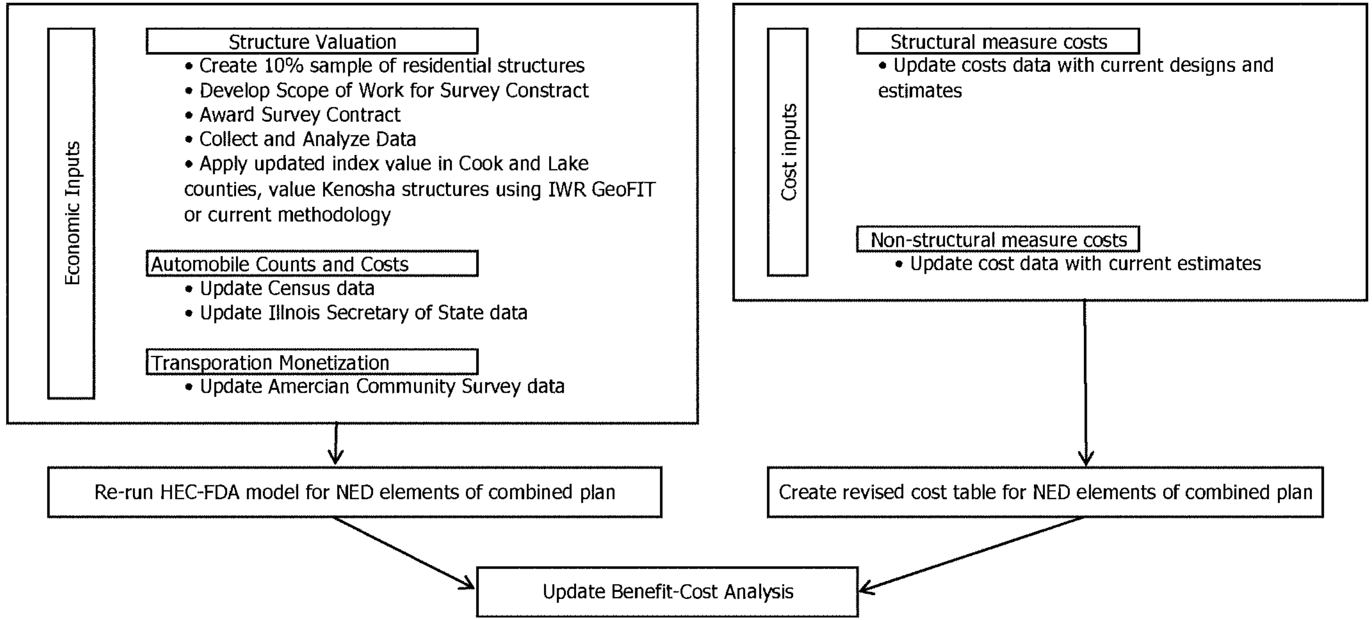

Figure 6.1 – Economic Update Procedure

GLOSSARY OF TERMS

Annual Exceedance Probability (AEP) – The probability that a flood event will be exceeded in any given year considering the full range of possible annual floods.

Digital Flood Insurance Rate Maps (DFIRM) – A FIRM that has been prepared as a digital product, which may involve converting an existing manually produced FIRM to digital format, or creating a product from new digital data sources using a GIS environment. The DFIRM product allows for the creation of interactive, multi-hazard digital maps. Linkages are built into an associated database to allow users options to access the engineering backup material used to develop the DFIRM, such as hydrologic and hydraulic models, flood profiles, data tables, Digital Elevation Models, and structure-specific data, such as digital elevation certificates and digital photographs of bridges and culverts.

Expected Annual Damages – The statistical average amount of damages expected from flooding for an "average" year as calculated for either baseline or future condition.

Equivalent Annual Damages – The discounted damage value associated with present worth of the future without-or-with project condition over the analysis period (project life) considering changes in hydrology, hydraulics, and flood damage conditions over the life of the project.

Flood Insurance Rate Maps (FIRM) - The insurance and floodplain management map produced by FEMA that identifies, based on detailed or approximate analyses, the areas subject to flooding during a 1-percent-annual-chance flood event in a community. Flood Insurance risk zones, which are used to compute actuarial flood insurance rates, also are shown. In areas studied by detailed analyses, the FIRM shows base flood elevations to reflect the elevations of the 1-percent-annual-chance flood. For many communities, when detailed analyses are performed, the FIRM also may show areas inundated by 0.2-percent-annual-chance flood and regulatory floodway areas.

GeoFIT - A tool developed to answer one of the most costly, time consuming and error-prone aspects of flood damage analysis: the process of building field inventory and valuation process. The software is designed to automate the business process of inventory collection and valuation of structures for individual flood damage feasibility studies. Each study carried out with this application will use unique sets of data that must be loaded onto personal computers hosting a GeoFIT installation. The data will vary in size, geographic location, spatial coordinates and attribution. But the basic required data layers will be identical in structure for every study conducted with the GeoFIT application.

HEC-FDA - Corps of Engineers Hydrologic Engineering Center's Flood Damage Analysis - provides the capability to perform an integrated hydrologic engineering and economic analysis during the formulation and evaluation of flood risk management plans. HEC-FDA is designed to assist U.S. Army Corps of Engineers (USACE) study members in using risk analysis procedures for formulating and evaluating flood risk management measures

(EM 1110-2-1619, ER 1105-2-101). Also, HEC-FDA will assist USACE staff in analyzing the economics of flood risk management projects. The software, 1) stores hydrologic and economic data necessary for an analysis, 2) provides tools to visualize data and results, 3) computes expected annual damage (EAD) and equivalent annual damages, 4) computes annual exceedance probability (AEP) and conditional non-exceedance probability as required for levee certification, and, 5) implements the risk analysis procedures described in EM 1110-2-1619

National Economic Development (NED) – National Economic Development is the Federal objective of water and related land resources project planning as detailed in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies 10 March 1983. A plan recommending Federal action is to be the alternative plan with the greatest net economic benefit consistent with protecting the Nation's environment.

National Ecosystem Restoration (NER) – Ecosystem restoration is one of the primary missions of the US Army Corps of Engineers Civil Works program. Contributions to national ecosystem restoration are increases in the net quantity and/or quality of desired ecosystem resources.

Q3 – Early GIS version of the FEMA Flood Insurance Rate Maps

RS Means - A division of Reed Business Information that has tabulated and publishes manuals which provides information to private and public sector to aid in construction estimates and projections for their project costs. It is a data standard for pricing in government work in addition to Marshall and Swift.

ACRONYMS AND ABBREVIATIONS

AEP	Annual Exceedance Probability
CCHD	Cook County Highway Department
CMAP	Chicago Metropolitan Agency for Planning
DFIRM	Digital Flood Insurance Rate Map
EAD	Equivalent Annual Damages
EGM	Economic Guidance Memorandum
EM	Engineering Manual
EOP	Environmental Operating Principles
ER	Engineering Regulation
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FPDCC	Forest Preserve District of Cook County
FRM	Flood Risk Management
GIS	Geographic Information Systems
HEC-FDA	Hydrologic Engineering Center – Flood Damage Analysis
HEC-RAS	Hydrologic Engineering Center – River Analysis System
H&H	Hydrology and Hydraulics
IDNR	Illinois Department of Natural Resources
IWR-USACE	USACE Institute for Water Resources
LCFPD	Forest Preserve District Lake County
LCSMC	Lake County Stormwater Management Commission
LiDAR	Light Detection and Ranging
LRR	Limited Reevaluation Report
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
NED	National Economic Development
NER	National Ecosystem Restoration
NIPC	Northern Illinois Planning Council
OMB	Office of Management and Budget
PDT	Project Delivery Team
SC-RB	Separable Cost – Remaining Benefit
SEWRPC	Southeastern Wisconsin Regional Planning Commission
SIBA	System Impacts-Based Aggregation
USFWS	U.S. Fish and Wildlife Service
USACE	U.S. Army Corps of Engineers
VISTA	Visual Interactive System for Transportation Algorithms

Upper Des Plaines River and Tributaries
Integrated Feasibility Report and Environmental Assessment
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APPENDIX F

COST ENGINEERING

Upper Des Plaines River and Tributaries
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APPENDIX F: COST ENGINEERING

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1 Project Scope

Included in this appendix are the detailed cost estimates for this feasibility level report on the Des Plaines River watershed. The estimates reflect the current feasibility level design. These civil works projects include flood and storm damage reduction projects additionally ecosystem restoration projects are included. The civil works projects primarily include the construction of reservoirs, levees, floodwalls, and channel improvements. The ecosystem projects primarily include invasive species removal, riffle placement, and plantings.

2 Cost Methodology

2.1 General

The feasibility cost estimate for the preferred plan has been prepared using MCACES 2nd Generation MII Version 4.1. The preparation of the cost estimate is in accordance with guidelines and policies included in: "ER 1110-1-1300 - Cost Engineering Policy and General Requirements"; "ER 1110-2-1302 - Civil Works Cost Engineering,"; "EI 01D010, Construction Cost Estimates"; EM 1110-1-8, Construction Equipment Ownership and Operating Expense Schedule, Region II, ; and "EM 1110-2-1304, Civil Works Construction Cost Index System (CWCCIS),"; "ETL 1110-2-573, Construction Cost Estimating Guide for Civil Works," The estimate was completed using the latest guidance from OCE concerning implementation of the Civil Works Breakdown Structure (CWBS) and Chart of Accounts. MII estimate software was used to apply unique crews to detailed work items and obtaining material and supply quotes from prospective vendors/contractors where possible for significant cost items.

Project cost estimates were prepared as though the Government were a prudent and well-equipped contractor estimating the project. This methodology is present throughout all the construction cost estimates. The estimates are developed in as much detail as can be assumed based on the best information available at this time.

Input for the cost estimate was obtained primarily from the Project Delivery Team (PDT) consisting of the US Army Corps of Engineers Chicago District (USACE LRC) and the various local sponsors.

The estimates adhere to the civil works work breakdown structure and were internally verified for quality control addressing cost, schedule and risk issues as practical. Record of assumptions, methodologies, concerns, and unknowns are maintained within the MII folder level for each estimate.

Project definition characteristics to include physical properties of the project site, functional purpose of the project and methods of construction were considered when developing the estimates.

The cost estimates for all portions of the estimate were based on the current price level for November 2013. No temporal escalation factors are applied to the construction costs in the MII estimates this was be applied at the TPCS level per the agreed upon implementation schedule .

2.2 **Direct Costs**

Direct costs are based on anticipated equipment, labor and materials necessary to construct this project. Direct costs have been calculated independent of the contractor assigned to perform the tasks. Following formulation of the direct cost, a determination is made as to whether the work would be performed by the prime contractor or a subcontractor.

2.2.1 *Quantities*

The estimate is based on detailed quantity take-offs prepared from the drawings as used as the basis of the estimate and augmented by spot checks performed by re-taking-off the original drawings. The civil designer has prepared bid schedules for all projects. Additional factors were applied to the quantities to take into account the shrink and swell factors the below table documents these.

CONVERSION FACTORS			
	CONVERT TO		
ORGINAL	BCY	LCY	ECY
BCY	1	1.3	0.9
LCY	0.769	1	0.692
ECY	1.11	1.45	1

2.2.2 *Labor and Equipment*

The equipment rates came directly from Construction Equipment Ownership and Operating Expense Schedule, Region II. These labor rates are Davis Bacon compliant and obtained from the department of labor and include all appropriate contractor markups (PTI, WCI, overhead, and profit).

2.2.3 *Vendor Quotes*

Vendor quotes have been acquired and documented for the key material prices associated with significant features of work. These key material item are steel sheet piles, clearing of trees, and seed .

2.2.4 *Crews*

Project specific crews have been developed for use in estimating the direct costs for items and also estimated by using job quotes or historical cost information. Crew members consist of selected components of labor classifications and equipment pieces assembled to perform specific tasks. Productivity has been assigned to each crew reflective of the expected output per unit of measure for the specific activities listed in the cost estimate.

2.2.5 *Work Schedules/Overtime*

The estimate assumes a 5 day/week 8 hr/day standard work schedule to conservatively estimate time to complete project.

2.2.6 *Sales Tax*
Sales tax for the state of Illinois and Wisconsin are not applied to bare material costs in the MII estimate due to the fact that waiver are obtained for civil works construction in both states .

2.3 **Additional Details**

1. The structure of the cost estimate is planned that all tasks are logical and in accordance with appropriate plan of construction and understanding of the project scope. A unit cost for each task is developed in an effort to increase the accuracy of the estimate and includes consideration given to site specific conditions as they pertain to constructability, bidability, and operability issues. Lump sum unit cost and unit pricing is used only to report items with limited or no design specified. The assumptions for these allowances are documented in the estimates and are based on experience and consultation with project teammates. As design scope evolves in PED phase, it is anticipated that these lump sum costs will be better defined.

2. The NED proposed project features are comprised largely of earthwork components and steel sheet pile. To compute accurate earthwork quantities, the district obtained recent contour data from topographic mapping at two-foot intervals from the proposed project locations. This mapping was used for determining proposed project features, computing earthwork quantities, and developing cross sections of proposed features.

3. Unit prices for these features and lump sum costs for structures were developed using historical estimating crews verified from prior use within district or from the MII Costbook database. Bid Abstracts maintained within the Chicago District Cost Engineering branch were used as additional support for development of unit prices. Additionally local DOT bid records were relied upon for checking accuracy of unit prices from estimate.

4. The unit prices for the features in the estimates are prepared based on calculated quantities for individual construction tasks. Each task is then priced as accurately as possible in MII based on up to date labor, materials, and equipment.

5. The estimated costs developed for these projects are fair and reasonable to a well-equipped contractor and include overhead costs and profit. Actual crew sizes, equipment and production rates that contractors have achieved previously on similar types of projects were implied in developing the unit costs for the work items that appear in these estimates.

6. The project scope of each site defined the type of equipment to be used, and the production rate suited to economical performance of work for the project. This methodology also influenced the project schedule.

7. For the operation and maintenance cost for the various projects historic data from Little Calumet Flood control project was used which included all the major features included in the DPII design. A spreadsheet was created which broke out the individual design projects into separate worksheets. Each worksheet was tailored so that only the

appropriate O&M items were included for instance floodwall items were not included in a reservoir project. The individual O&M estimate were based on quantities from the bid schedule provided by the civil designer such as square footage of floodwall, length of levee, or number of pump stations. These historic costs were updated to reflect the current cost at time the actual project estimate.

8. Along with flood control features and ecosystem restoration work the feasibility project recommends non-structural flood risk management measures to be implemented at individual structures throughout the watershed. The evaluated measures for individual structures were: elevating, dry floodproofing, wet floodproofing, and construction of a ring levee. Implementation costs were developed on a parametric level that then could be applied on an individual structure based on readily available county property tax databases measurements and descriptions.

   Elevation was considered for residential structures usually in the range of two to five feet. Wet floodproofing was considered for both residential and non-residential structures. Dry floodproofing was considered for both residential and non-residential structures. A levee encircling the structure was considered for non-residential structures where other options were not feasible, especially large high damage structures such as hospitals. The maximum feasible height for these ring levees was four feet.

   The individual work items for each measure includes items like electrical and plumbing reconnection, permits, excavation, wall construction, membrane placement and etc.

9. Utility relocations and adjustments have been estimated outside of the estimates due their responsibility falling to the local sponsor. At this time, site specific utility information is known and features have been modified to avoid major utility corridors, a 5% allowance for any adjustments is included. The nature of the existing utilities introduces risk and potential cost increase that may be mitigated or refined with further investigation and design. This cost is included in the real estate assessment of the feasibility study and is reflected within the TPCS.

10. Each project requires clearing and grubbing to different degrees. Based on existing site aerial photographs the assumptions for level of effort were accomplished dense forestation requires a more intensive clearing. It is assumed that each project will require cutting and chipping of trees. This unit price of this item is always checked with the most recent bid abstract as this item is usually included at some level for all construction projects additionally vendor quotes for this work were obtained.

11. Each site has been selected based on various factors to include hydraulic considerations, civil design considerations, and economic factors, and etc. Site access and easement acquisition considerations are on-going. It is assumed that access can be obtained relatively easily at no excessive costs to construction.

Real Estate coordination may take additional resources due to existing land use. Some of the proposed sites reside close to existing railroad facilities and will require coordination to obtain temporary easements for construction.

Real estate acquisition presents a high risk due to proposed land use as well. Historical knowledge of various local stakeholders input and concerns introduce a potential risk for cost increases. There are potential mitigation costs for each site based on local stakeholder agreements for items such as clearing and grubbing. All these risk were covered in CSRA.

12. Care was taken for site with earthwork portions; the estimates capture placing and compacting the spoils materials on site. The quantity estimates for excavation are derived from Microstation In-Roads software and topographic data. This includes quantities of excavation for the reservoir, topsoil stripping and the levee inspection trench.

    The equipment and crew chosen for the excavation of the sites is based primarily on the size of the site and the amount of material excavated and placed. For smaller sites a hydraulic excavator with a 2 CY bucket is being used to excavate the material. For larger sites self propelled scrapers were chosen as these sites can accommodate larger equipment and various crews onsite simultaneously. For these larger sites, off-highway hauling trucks are also required to move the material from the excavation site to the spoil location. Off-highway haulers are acceptable as the spoil site is on the same real estate as the excavation site.

13. Each reservoir site assumes that suitable and cohesive clay material specified for the berm and levee construction can be excavated on site. The uncertain nature of the existing materials and probable resolution introduces significant risk to each of these sites.

    It is also assumed that each site is free of contaminated soils and groundwater. These items have been researched for this report, however, if found to have either of these issues could magnify the cost of construction considerably.

    For the feasibility study of Des Plaines II proposed projects, existing site use, utility locations, and geotechnical investigations will be paramount in mitigating both construction and design risks for the proposed sites.

14. WLRS04 reservoir is assumed to remain dry and will not hold a normal pool elevation during non-flood events. Therefore, costs for seeding the berm, levee and reservoir bottom are included. Seeding was chosen as a less expensive alternative to placing sod. It is assumed that hydroseeding is the most appropriate method of applying seed to these large areas.

15. All reservoir estimates include costs for a 'proposed' pump station to be included on site. At this time design has not commenced on the design of the pump stations. Flow rates as

they relate to hydraulic and hydrology requirements are known to be in the range of 200 cfs, however, required pump capacities and operation is not known. Individual construction and task items included in these estimates are derived from a pump station on a similar reservoir project in the region. The costs of mechanical, electrical and structural components of the pump station were researched for similar projects. While the unknown design of the pump station suggests that potential risks exist within the estimates, the assumptions used to develop the pump station costs is considered conservative. For each of the alternatives in undeveloped areas, an additional allowance is included to account for the probable cost to procure electrical supply to the pump station. Additional site inspection and hydraulic requirements will help refine the design of the pump station and further refine cost during PED.

16. All reservoir estimates include possible storm drainage structures needed to fill the reservoir or discharge to adjacent waterways. Based on the best information available at this time, feasible size and length of pipes, headwalls, gates, and other appurtenances are included in the estimates. In particular, for reservoirs, the unknown design of the operational function of the pump station, unknown water surface profiles of the discharge waterway, and theoretical elevation of the pool of the reservoir make it difficult to fully capture the risks associated with the drainage features still left to be fully designed. When refined, the drainage structures could pose a significant cost primarily with increase in materials.

2.4 Indirect Costs

Overhead costs for the estimates were calculated based on historical information for similar projects within the Chicago District. The Job Office Overheads were based on a percentage supplied to us by the Cost DX. These items primarily include field administration and offices, as well as quality control personnel, surveying, and government submittal costs.

2.4.1 *Prime Contractor*

The construction contracts are planned to be let by Chicago District's contracting arm. A simplified conservative approach to markups of the prime contractor was taken of 10% JOOH, 10% HOOH, and 8% profit.

2.4.2 *Bond*

Bond added as 1.5% as a contractor markup for the prime contractor applied as a running percentage to prime's own work and sub contractor work.

2.4.3 *Subcontractors*

The estimates included several subcontractors to complete the work these included landscaping, pile driving, site utility, concrete, and earth work. A conservative approach to markups of the subcontractor was taken of 10% HOOH, and 8% profit.

2.5 Project Feature Accounts

The Des Plaines River and Tributaries Integrated Feasibility estimate was prepared and organized according to the Civil Works Breakdown Structure (CWBS). As such, the estimate includes the following feature accounts: (11) levees & floodwalls, (03) reservoirs, (06) fish & wildlife facilities, (19) buildings, grounds & utilities, (14) recreation facilities, (08) roads, railroads & bridges and (02) relocations

2.5.1 *(30) Planning, Engineering, and Design*

The work covered under this account includes project management, project planning, preliminary design, final design, preparation of plans, preparation of specifications, engineering during construction, advertisement, opening of bids, and contract award. The cost for this account is estimated as 15% of the construction contract value for non-ecosystem projects and 10% for ecosystem projects.

2.5.2 *(31) Supervision and Administration*

The work covered under this account includes contract supervision, contract administration, construction administration, technical management activities, and District office supervision and administration costs. The cost for this account is estimated as 7% of the construction contract value for non-ecosystem projects and 6% for ecosystem projects.

2.6 **Risk-Based Contingency Development**

Although the project scope is reasonably well defined for each site, the design is still at a feasibility level. At this level of design, the lack of information on each site presents risks in many features of the proposed projects. The entire DPII project at his point was broken into part at the bequest of headquarters due to budgeting process. The five categories are NED, NER, CAP 205, CAP 206, and Non-Policy Compliant all of which had separate contingencies developed.

The NED & NER groupings had overall detailed Cost and Schedule Risk Analysis (CSRA) which was performed on the entire plan through a certified CSRA team. The remaining CAP 205, CAP 206, and Non-Policy Compliant groupings had Abbreviated Risk Analysis (ARA) to determine contingencies.

Internal factors affecting risk include availability of real estate, possible mitigation, scope creep, design issues, quantities, site access, and stakeholder input. External factors affecting risk include the escalation of fuel and materials additionally bidding climate. An overall contingency of 37.5% was determined from CSRA process and for the NED portion a contingency of 26.9%. CAP 205, CAP 206, and Non-Policy Compliant all of which had separate contingencies developed from (ARA) had percentages of 35.5%, 30%, and 30% respectively.

2.7 **Project Implementation Schedule**

The total project schedule was developed from the current project implementation schedule developed by the PDT and managed by the Project Manager and expanding the construction schedule based on the significant construction activities and durations from the MII cost estimate. The construction schedule calendars include major holidays and non-work weather days.

The estimated time to construct each project varies. In general, the construction duration of each project was determined based on the production rates of the largest and most significant features of the project. A project construction schedule was developed using Microsoft Project to substantiate the construction duration assumptions. Often a disconnect with the probable durations is noticed when compared to MII durations that normally don't take into account multiples of the same crew working on one task. MII durations normally work on assumption of one crew completing all the work in one task item, which can lead to large unrealistic durations. In this case as a correction the production rates were multiplied by a whole number to reflect more than one crew working, thus task durations were reduced to a realistic amount.

2.8 FULLY FUNDED COST ESTIMATE

The fully funded cost estimate including inflation to the mid-point of construction is $387 million as shown in the Total Project Cost Summary. The fully funded table distributes the base level cost estimate across the appropriate years according to the schedule. Each feature account is inflated to the mid-point of expenditure activity using CWCCIS factors. These inflated feature account totals are summed to yield a total fully funded project cost.

3 Risk Analysis Development

3.1 Cost and Schedule Risk Analyis Development

A Cost and Schedule Risk Analysis (CSRA) was performed on this project to more accurately identify risk and potential impacts to the project. This analysis required participation by entire PDT to identify the 80% confidence level project cost and contingencies.

3.2 Risk Results

See Attachment A

3.3 Risk register

See Attachment A

4 DETAILED MII REPORTS

4.1.1 *MII Cost Estimate Report – Definition of Terms*

Bare Costs
Bare costs are defined as project costs that have no markups included. Bare cost excludes direct cost markups for productivity, overtime, and any tax adjustments, along with payroll, taxes and insurance (PTI), contractor markups, special markups, or owner cost markups.

Direct Costs
Direct costs are defined as bare costs which are marked up for productivity adjustments, overtime, taxes and/or other miscellaneous adjustments.

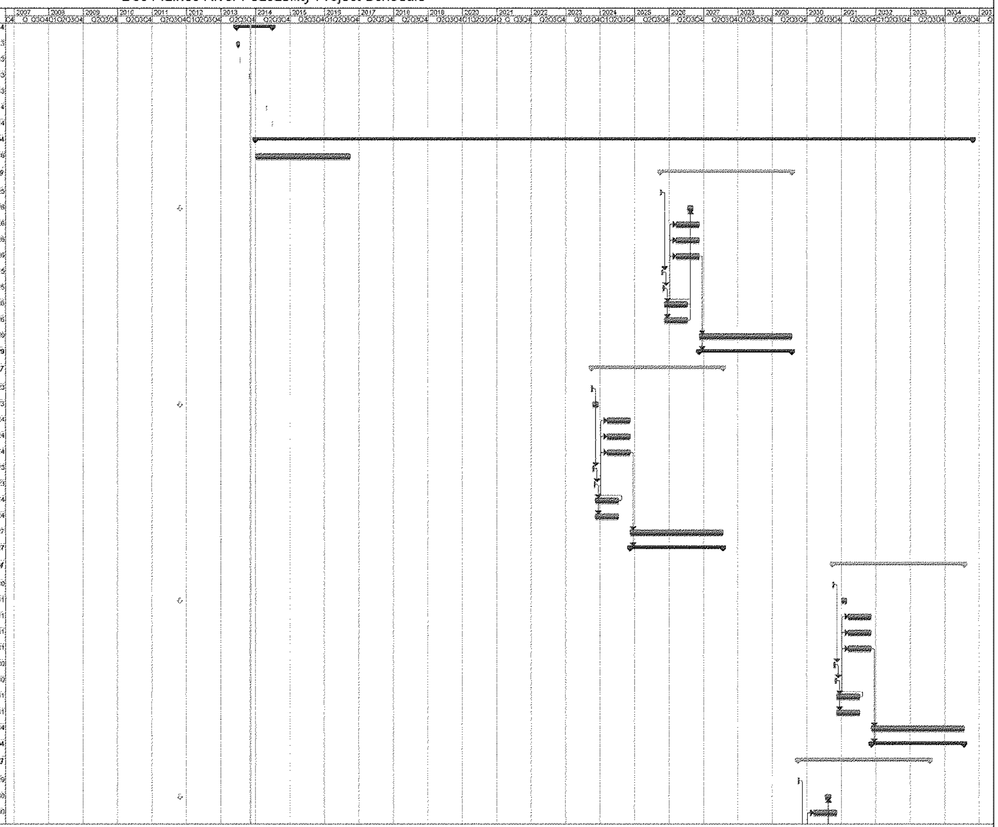
Cost to Prime
Cost to prime is defined as direct costs with markups applied for PTI and any allowances such as small tools for the subcontractor work. The subcontractor markup for job office overhead (JOOH), home office overhead (HOOM), profit, bond and excise tax and/or any miscellaneous adjustment is also included. This is in effect the cost to the performing contractor. Any special markups are included in this cost but are not passed on to the owner's markup cost. Therefore, the special markups are not compounded but are treated as an additional cost.

Contract Cost (Cost To Owner)
Contract Cost (sometimes referred to as "cost to owner") takes the cost to prime and then adds to that the cost for the contractor's PTI as well as any allowance, such as small tools, for the contractor's work. Then the contractor's own markups for JOOH, HOOM, profit, bond, and excise tax and/or any miscellaneous adjustments are included. Any special markups are included in the cost but are not passed on to the owner's markup cost. Therefore, the special markups are not compounded but are treated as an additional cost.

Project Cost
The project cost takes the contract cost and then adds any escalation, contingencies, SIOH (supervision, inspection and overhead) and/or any miscellaneous owner costs. It should be noted that escalation factors are applied in TPCS and not using escalation functions in the MII cost estimating software.

Des Plaines River Feasability Project Schedule

ID	Task Name	Duration	Start	Finish
1	**Remaining Feasability**	**271 days?**	**Mon 6/17/13**	**Mon 6/30/14**
2	Public Review Star	23 days	Mon 6/17/13	Wed 7/17/13
3	CSRA	1 day?	Thu 7/25/13	Thu 7/25/13
4	Submit Final Feasibility Report to MSC	1 day	Thu 10/31/13	Thu 10/31/13
5	DE Transmittal Letter to H	1 day	Tue 12/31/13	Tue 12/31/13
6	Civil Works Review Board	1 day	Wed 4/30/14	Wed 4/30/14
7	Chief's Report Final	1 day	Mon 6/30/14	Mon 6/30/14
8	**PED Milestones**	**5432 days?**	**Thu 1/2/14**	**Fri 10/27/34**
9	Start PED	717 days?	Thu 1/2/14	Fri 9/30/16
10	***C15***	***998 days***	***Wed 10/1/25***	***Fri 7/27/29***
1	MOBILIZATION/DEMOBILIZATION	10 days	Wed 10/1/25	Tue 10/14/25
2	BANK GRADING 20:1	176 days	Wed 7/15/26	Sat 9/12/26
3	SWALE GRADING	176 days	Mon 3/16/26	Mon 11/16/26
4	COBBLE RIFFLES	176 days	Mon 3/16/26	Mon 11/16/26
5	FILL DITCH	176 days	Mon 3/16/26	Mon 11/16/26
6	DRAIN TILE SURVEY	10 days	Wed 10/15/25	Tue 10/28/25
7	DRAIN TILE VALVES	10 days	Wed 10/29/25	Tue 11/11/25
8	TREE & UNDERSTORY THINNING	176 days	Wed 11/12/25	Wed 7/15/26
9	TREE REMOVAL	176 days	Wed 11/12/25	Wed 7/15/26
10	HERBACEOUS MANAGEMENT	704 days	Tue 11/17/26	Fri 7/27/29
11	**NATIVE PLANT ESTABLISHMENT**	**704 days**	**Tue 11/17/26**	**Fri 7/27/29**
11	***C08***	***998 days***	***Mon 10/2/23***	***Wed 7/28/27***
1	MOBILIZATION/DEMOBILIZATION	10 days	Mon 10/2/23	Fri 10/13/23
2	BANK GRADING 20:1	176 days	Sun 10/15/23	Wed 12/13/23
3	SWALE GRADING	176 days	Thu 3/14/24	Thu 11/14/24
4	COBBLE RIFFLES	176 days	Thu 3/14/24	Thu 11/14/24
5	FILL DITCH	176 days	Thu 3/14/24	Thu 11/14/24
6	DRAIN TILE SURVEY	10 days	Mon 10/16/23	Fri 10/27/23
7	DRAIN TILE VALVES	10 days	Mon 10/30/23	Fri 11/10/23
8	TREE & UNDERSTORY THINNING	176 days	Mon 11/13/23	Mon 7/15/24
9	TREE REMOVAL	176 days	Mon 11/13/23	Mon 7/15/24
10	HERBACEOUS MANAGEMENT	704 days	Fri 11/15/24	Wed 7/28/27
11	**NATIVE PLANT ESTABLISHMENT**	**704 days**	**Fri 11/15/24**	**Wed 7/28/27**
12	***K09***	***998 days***	***Tue 10/1/30***	***Thu 7/27/34***
1	MOBILIZATION/DEMOBILIZATION	10 days	Tue 10/1/30	Mon 10/14/30
2	BANK GRADING 20:1	176 days	Wed 1/1/31	Sat 3/1/31
3	SWALE GRADING	176 days	Fri 3/14/31	Fri 11/14/31
4	COBBLE RIFFLES	176 days	Fri 3/14/31	Fri 11/14/31
5	FILL DITCH	176 days	Fri 3/14/31	Fri 11/14/31
6	DRAIN TILE SURVEY	10 days	Tue 10/15/30	Mon 10/28/30
7	DRAIN TILE VALVES	10 days	Tue 10/29/30	Mon 11/11/30
8	TREE & UNDERSTORY THINNING	176 days	Tue 11/12/30	Tue 7/15/31
9	TREE REMOVAL	176 days	Tue 11/12/30	Tue 7/15/31
10	HERBACEOUS MANAGEMENT	704 days	Mon 11/17/31	Thu 7/27/34
11	**NATIVE PLANT ESTABLISHMENT**	**704 days**	**Mon 11/17/31**	**Thu 7/27/34**
13	***K33***	***998 days***	***Mon 10/1/29***	***Wed 7/27/33***
1	MOBILIZATION/DEMOBILIZATION	10 days	Mon 10/1/29	Fri 10/12/29
2	BANK GRADING 20:1	176 days	Mon 7/15/30	Thu 9/12/30
3	SWALE GRADING	176 days	Thu 3/14/30	Thu 11/14/30



U.S. Army Corps of Engineers - Chicago District

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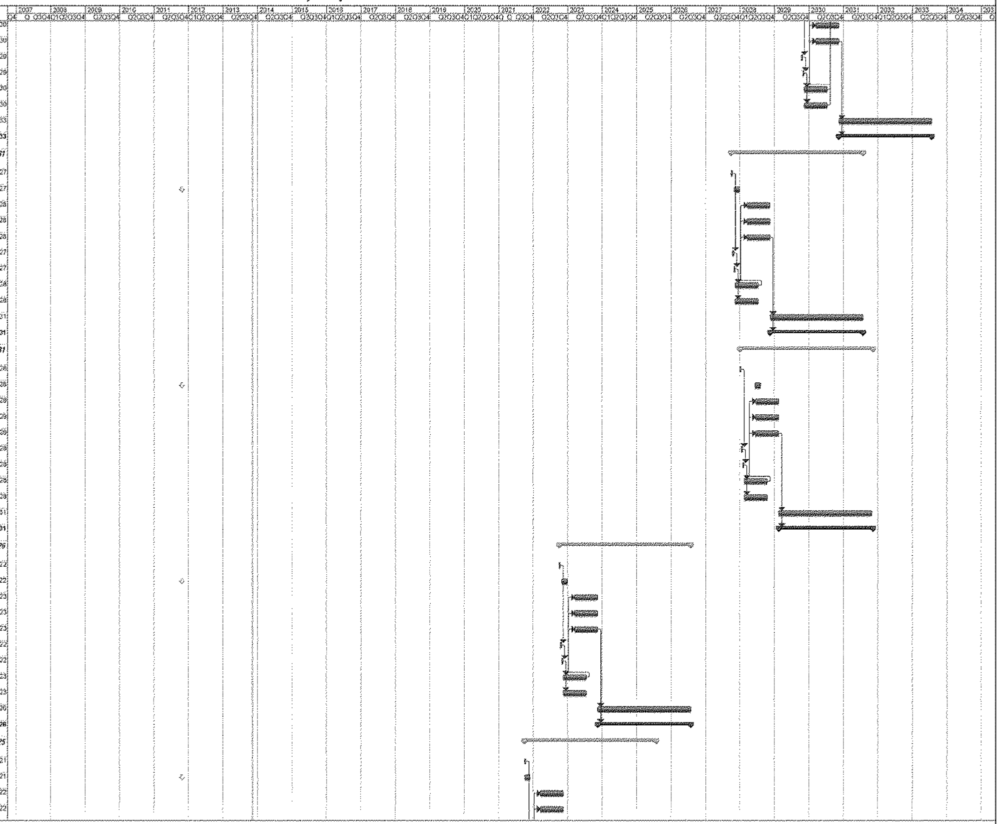
Des Plaines River Feasability Project Schedule

ID	Task Name	Duration	Start	Finish
4	COBBLE RIFFLES	176 days	Thu 3/14/30	Thu 11/14/30
5	FILL DITCH	176 days	Thu 3/14/30	Thu 11/14/30
6	DRAIN TILE SURVEY	10 days	Mon 10/15/29	Fri 10/26/29
7	DRAIN TILE VALVES	10 days	Mon 10/29/29	Fri 11/9/29
8	TREE & UNDERSTORY THINNING	176 days	Mon 11/12/29	Mon 7/15/30
9	TREE REMOVAL	176 days	Mon 11/12/29	Mon 7/15/30
10	HERBACEOUS MANAGEMENT	704 days	Fri 11/15/30	Wed 7/27/33
11	**NATIVE PLANT ESTABLISHMENT**	**704 days**	**Fri 11/15/30**	**Wed 7/27/33**
14	***K41***	***998 days***	***Fri 10/1/27***	***Tue 7/29/31***
1	MOBILIZATION/DEMOBILIZATION	10 days	Fri 10/1/27	Thu 10/14/27
2	BANK GRADING 20:1	176 days	Mon 11/1/27	Thu 12/30/27
3	SWALE GRADING	176 days	Wed 3/15/28	Wed 11/15/28
4	COBBLE RIFFLES	176 days	Wed 3/15/28	Wed 11/15/28
5	FILL DITCH	176 days	Wed 3/15/28	Wed 11/15/28
6	DRAIN TILE SURVEY	10 days	Fri 10/15/27	Thu 10/28/27
7	DRAIN TILE VALVES	10 days	Fri 10/29/27	Thu 11/11/27
8	TREE & UNDERSTORY THINNING	176 days	Fri 11/12/27	Fri 7/14/28
9	TREE REMOVAL	176 days	Fri 11/12/27	Fri 7/14/28
10	HERBACEOUS MANAGEMENT	704 days	Thu 11/16/28	Tue 7/29/31
11	**NATIVE PLANT ESTABLISHMENT**	**704 days**	**Thu 11/16/28**	**Tue 7/29/31**
15	***K47***	***1008 days***	***Mon 1/3/28***	***Wed 11/12/31***
1	MOBILIZATION/DEMOBILIZATION	10 days	Mon 1/3/28	Fri 1/14/28
2	BANK GRADING 20:1	176 days	Sun 6/11/28	Wed 8/9/28
3	SWALE GRADING	176 days	Thu 6/15/28	Thu 2/15/29
4	COBBLE RIFFLES	176 days	Thu 6/15/28	Thu 2/15/29
5	FILL DITCH	176 days	Thu 6/15/28	Thu 2/15/29
6	DRAIN TILE SURVEY	10 days	Mon 1/17/28	Fri 1/28/28
7	DRAIN TILE VALVES	10 days	Mon 1/31/28	Fri 2/11/28
8	TREE & UNDERSTORY THINNING	176 days	Mon 2/14/28	Mon 10/16/28
9	TREE REMOVAL	176 days	Mon 2/14/28	Mon 10/16/28
10	HERBACEOUS MANAGEMENT	704 days	Fri 2/16/29	Wed 10/29/31
11	**NATIVE PLANT ESTABLISHMENT**	**714 days**	**Fri 2/16/29**	**Wed 11/12/31**
16	***L05***	***998 days***	***Mon 10/3/22***	***Wed 7/29/26***
1	MOBILIZATION/DEMOBILIZATION	10 days	Mon 10/3/22	Fri 10/14/22
2	BANK GRADING 20:1	176 days	Sun 10/30/22	Wed 12/28/22
3	SWALE GRADING	176 days	Thu 3/16/23	Thu 11/16/23
4	COBBLE RIFFLES	176 days	Thu 3/16/23	Thu 11/16/23
5	FILL DITCH	176 days	Thu 3/16/23	Thu 11/16/23
6	DRAIN TILE SURVEY	10 days	Mon 10/17/22	Fri 10/28/22
7	DRAIN TILE VALVES	10 days	Mon 10/31/22	Fri 11/11/22
8	TREE & UNDERSTORY THINNING	176 days	Mon 11/14/22	Mon 7/17/23
9	TREE REMOVAL	176 days	Mon 11/14/22	Mon 7/17/23
10	HERBACEOUS MANAGEMENT	704 days	Fri 11/17/23	Wed 7/29/26
11	**NATIVE PLANT ESTABLISHMENT**	**704 days**	**Fri 11/17/23**	**Wed 7/29/26**
17	***L31***	***998 days***	***Fri 10/1/21***	***Tue 7/29/25***
1	MOBILIZATION/DEMOBILIZATION	10 days	Fri 10/1/21	Thu 10/14/21
2	BANK GRADING 20:1	176 days	Sun 10/3/21	Wed 12/1/21
3	SWALE GRADING	176 days	Wed 3/16/22	Wed 11/16/22
4	COBBLE RIFFLES	176 days	Wed 3/16/22	Wed 11/16/22



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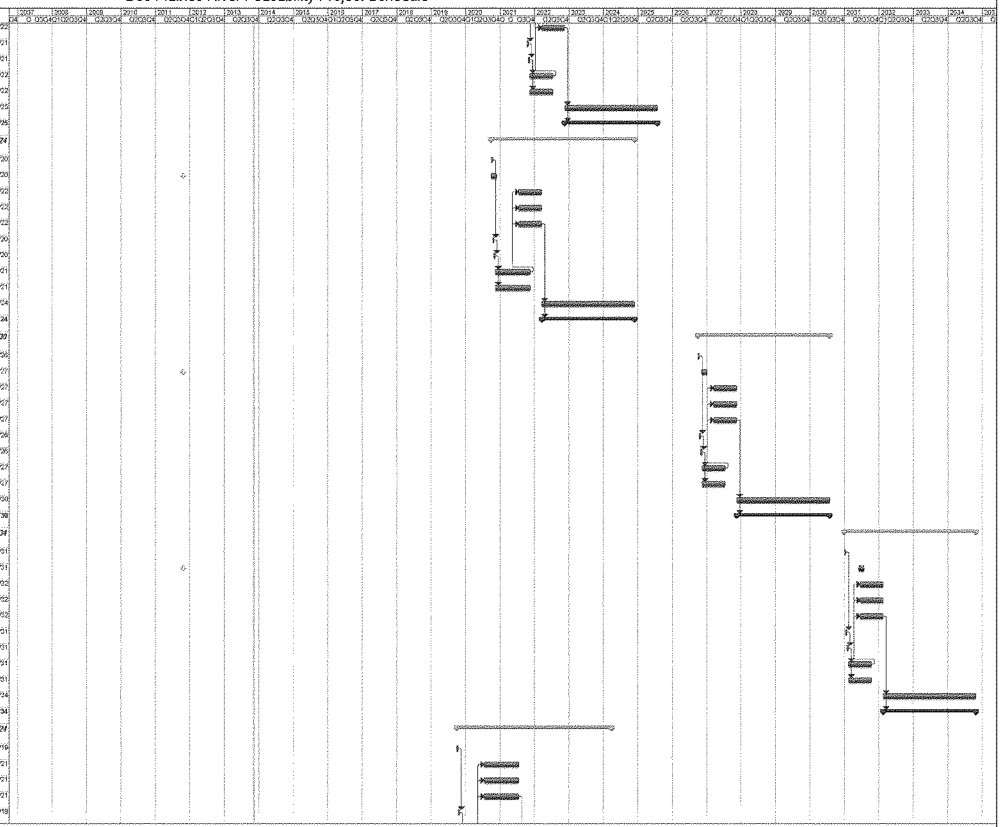
Des Plaines River Feasability Project Schedule

ID	Task Name	Duration	Start	Finish
5	FILL DITCH	176 days	Wed 3/16/22	Wed 11/16/22
6	DRAIN TILE SURVEY	10 days	Fri 10/15/21	Thu 10/28/21
7	DRAIN TILE VALVES	10 days	Fri 10/29/21	Thu 11/11/21
8	TREE & UNDERSTORY THINNING	176 days	Fri 11/12/21	Fri 7/15/22
9	TREE REMOVAL	176 days	Fri 11/12/21	Fri 7/15/22
10	HERBACEOUS MANAGEMENT	704 days	Thu 11/17/22	Tue 7/29/25
11	**NATIVE PLANT ESTABLISHMENT**	**704 days**	**Thu 11/17/22**	**Tue 7/29/25**
18	***L33***	***1001 days***	***Sun 9/27/20***	***Thu 11/28/24***
1	MOBILIZATION/DEMOBILIZATION	10 days	Thu 10/1/20	Wed 10/14/20
2	BANK GRADING 20:1	176 days	Sun 9/27/20	Wed 11/25/20
3	SWALE GRADING	176 days	Fri 7/16/21	Fri 3/18/22
4	COBBLE RIFFLES	176 days	Fri 7/16/21	Fri 3/18/22
5	FILL DITCH	176 days	Fri 7/16/21	Fri 3/18/22
6	DRAIN TILE SURVEY	10 days	Thu 10/15/20	Wed 10/28/20
7	DRAIN TILE VALVES	10 days	Thu 10/29/20	Wed 11/11/20
8	TREE & UNDERSTORY THINNING	176 days	Thu 11/12/20	Tue 11/16/21
9	TREE REMOVAL	176 days	Thu 11/12/20	Tue 11/16/21
10	HERBACEOUS MANAGEMENT	704 days	Mon 3/21/22	Thu 11/28/24
11	**NATIVE PLANT ESTABLISHMENT**	**704 days**	**Mon 3/21/22**	**Thu 11/28/24**
19	***L41***	***998 days***	***Thu 10/1/26***	***Mon 7/29/30***
1	MOBILIZATION/DEMOBILIZATION	10 days	Thu 10/1/26	Wed 10/14/26
2	BANK GRADING 20:1	176 days	Sun 11/8/26	Wed 1/6/27
3	SWALE GRADING	176 days	Tue 3/16/27	Tue 11/16/27
4	COBBLE RIFFLES	176 days	Tue 3/16/27	Tue 11/16/27
5	FILL DITCH	176 days	Tue 3/16/27	Tue 11/16/27
6	DRAIN TILE SURVEY	10 days	Thu 10/15/26	Wed 10/28/26
7	DRAIN TILE VALVES	10 days	Thu 10/29/26	Wed 11/11/26
8	TREE & UNDERSTORY THINNING	176 days	Thu 11/12/26	Thu 7/15/27
9	TREE REMOVAL	176 days	Thu 11/12/26	Thu 7/15/27
10	HERBACEOUS MANAGEMENT	704 days	Wed 11/17/27	Mon 7/29/30
11	**NATIVE PLANT ESTABLISHMENT**	**704 days**	**Wed 11/17/27**	**Mon 7/29/30**
20	***R04***	***998 days***	***Wed 1/1/31***	***Fri 10/27/34***
1	MOBILIZATION/DEMOBILIZATION	10 days	Wed 1/1/31	Tue 1/14/31
2	BANK GRADING 20:1	176 days	Sun 6/1/31	Wed 7/30/31
3	SWALE GRADING	176 days	Mon 6/16/31	Mon 2/16/32
4	COBBLE RIFFLES	176 days	Mon 6/16/31	Mon 2/16/32
5	FILL DITCH	176 days	Mon 6/16/31	Mon 2/16/32
6	DRAIN TILE SURVEY	10 days	Wed 1/15/31	Tue 1/28/31
7	DRAIN TILE VALVES	10 days	Wed 1/29/31	Tue 2/11/31
8	TREE & UNDERSTORY THINNING	176 days	Wed 2/12/31	Wed 10/15/31
9	TREE REMOVAL	176 days	Wed 2/12/31	Wed 10/15/31
10	HERBACEOUS MANAGEMENT	704 days	Tue 2/17/32	Fri 10/27/34
11	**NATIVE PLANT ESTABLISHMENT**	**704 days**	**Tue 2/17/32**	**Fri 10/27/34**
21	***L39***	***998 days***	***Tue 10/1/19***	***Fri 3/29/24***
1	MOBILIZATION/DEMOBILIZATION	10 days	Tue 10/1/19	Mon 10/14/19
2	SWALE GRADING	176 days	Wed 7/15/20	Mon 7/19/21
3	COBBLE RIFFLES	176 days	Wed 7/15/20	Mon 7/19/21
4	FILL DITCH	176 days	Wed 7/15/20	Mon 7/19/21
5	DRAIN TILE SURVEY	10 days	Tue 10/15/19	Mon 10/28/19



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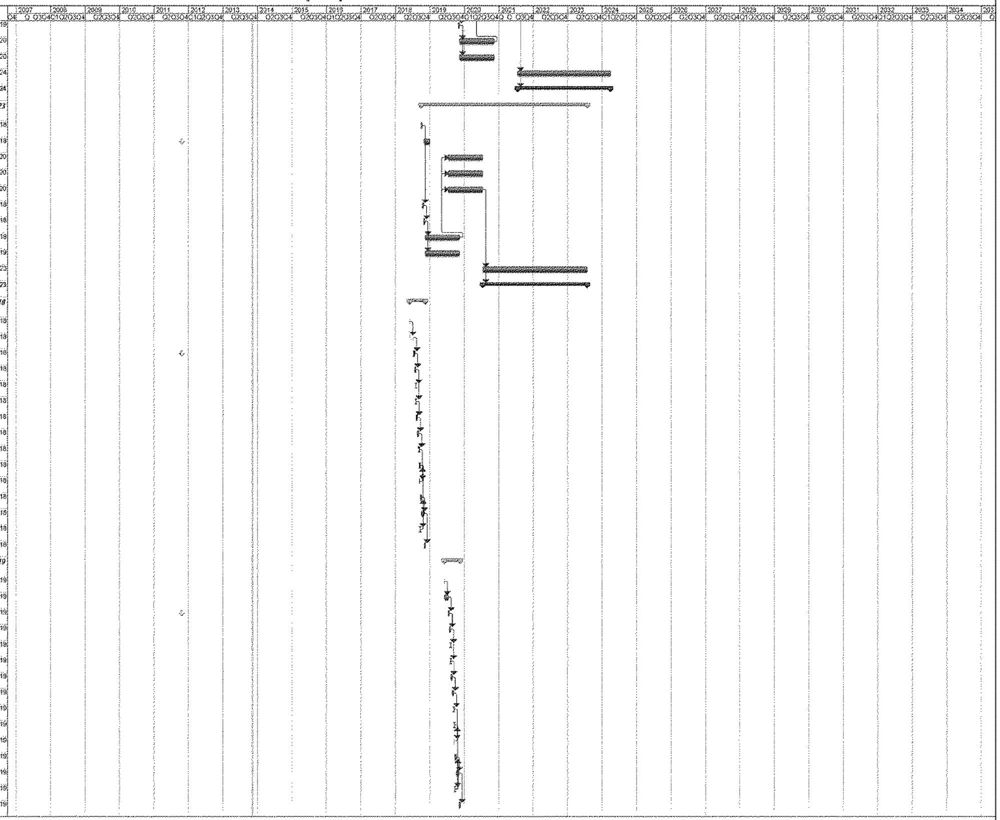
Des Plaines River Feasability Project Schedule

ID	Task Name	Duration	Start	Finish
6	DRAIN TILE VALVES	10 days	Tue 10/29/19	Mon 11/11/19
7	TREE & UNDERSTORY THINNING	176 days	Tue 11/12/19	Fri 11/13/20
8	TREE REMOVAL	176 days	Tue 11/12/19	Fri 11/13/20
9	HERBACEOUS MANAGEMENT	704 days	Tue 7/20/21	Fri 3/29/24
10	**NATIVE PLANT ESTABLISHMENT**	**704 days**	**Tue 7/20/21**	**Fri 3/29/24**
22	***1.43***	***998 days***	***Mon 10/1/18***	***Fri 7/28/23***
1	MOBILIZATION/DEMOBILIZATION	10 days	Mon 10/1/18	Fri 10/12/18
2	BANK GRADING 20:1	176 days	Thu 11/1/18	Sun 12/30/18
3	SWALE GRADING	176 days	Fri 7/12/19	Wed 7/15/20
4	COBBLE RIFFLES	176 days	Fri 7/12/19	Wed 7/15/20
5	FILL DITCH	176 days	Fri 7/12/19	Wed 7/15/20
6	DRAIN TILE SURVEY	10 days	Mon 10/15/18	Fri 10/26/18
7	DRAIN TILE VALVES	10 days	Mon 10/29/18	Fri 11/9/18
8	TREE & UNDERSTORY THINNING	176 days	Mon 11/12/18	Tue 11/12/19
9	TREE REMOVAL	176 days	Mon 11/12/18	Tue 11/12/19
10	HERBACEOUS MANAGEMENT	704 days	Thu 7/16/20	Fri 7/28/23
11	**NATIVE PLANT ESTABLISHMENT**	**704 days**	**Thu 7/16/20**	**Fri 7/28/23**
23	***DAM NO. 1 REMOVAL***	***120 days***	***Fri 6/1/18***	***Thu 11/15/18***
1	NOTICE TO PROCEED	1 day	Fri 6/1/18	Fri 6/1/18
2	PREPARE PRECONSTRUCTION SUBMITTALS	30 days	Mon 6/4/18	Fri 7/13/18
3	REVIEW PRECONSTRUCTION SUBMITTALS	30 days	Fri 7/13/18	Mon 7/23/18
4	MOBILIZATION/DEMOBILIZATION	10 days	Tue 7/24/18	Mon 8/6/18
5	TEMPORARY FIELD OFFICE AND PROJECT SIGNS	2 days	Tue 8/7/18	Wed 8/8/18
6	TRAFFIC CONTROL AND SIGNAGE	2 days	Tue 8/7/18	Wed 8/8/18
7	CLEARING AND GRUBBING	10 days	Thu 8/9/18	Wed 8/22/18
8	STRIPPING & RESPREADING TOPSOIL	10 days	Thu 8/23/18	Wed 9/5/18
9	IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	5 days	Thu 9/6/18	Wed 9/12/18
10	SILT TURBIDITY CURTAIN	3 days	Fri 9/14/18	Tue 9/18/18
11	SEDIMENT SURVEYING	1 day	Thu 9/13/18	Thu 9/13/18
12	SEDIMENT REMOVAL	10 days	Fri 9/21/18	Thu 10/4/18
13	DEMOLITION AND REMOVAL OF DAM NO. 1	20 days	Fri 10/5/18	Thu 11/1/18
14	TEMPORARY FENCING & GATES	2 days	Wed 9/19/18	Thu 9/20/18
15	LANDSCAPE RESTORATION	10 days	Fri 11/2/18	Thu 11/15/18
24	***DAM NO. 2 REMOVAL***	***122 days***	***Mon 6/3/19***	***Tue 11/19/19***
1	NOTICE TO PROCEED	1 day	Mon 6/3/19	Mon 6/3/19
2	PREPARE PRECONSTRUCTION SUBMITTALS	30 days	Tue 6/4/19	Mon 7/15/19
3	REVIEW PRECONSTRUCTION SUBMITTALS	30 days	Mon 7/15/19	Thu 7/25/19
4	MOBILIZATION/DEMOBILIZATION	10 days	Fri 7/26/19	Thu 8/8/19
5	TEMPORARY FIELD OFFICE AND PROJECT SIGNS	2 days	Fri 8/9/19	Mon 8/12/19
6	TRAFFIC CONTROL AND SIGNAGE	2 days	Fri 8/9/19	Mon 8/12/19
7	CLEARING AND GRUBBING	10 days	Tue 8/13/19	Mon 8/26/19
8	STRIPPING & RESPREADING TOPSOIL	10 days	Tue 8/27/19	Mon 9/9/19
9	IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	5 days	Tue 9/10/19	Mon 9/16/19
10	SILT TURBIDITY CURTAIN	3 days	Wed 9/18/19	Fri 9/20/19
11	SEDIMENT SURVEYING	1 day	Tue 9/17/19	Tue 9/17/19
12	SEDIMENT REMOVAL	10 days	Wed 9/25/19	Tue 10/8/19
13	DEMOLITION AND REMOVAL OF DAM NO. 2	20 days	Wed 10/9/19	Tue 11/5/19
14	TEMPORARY FENCING & GATES	2 days	Mon 9/23/19	Tue 9/24/19
15	LANDSCAPE RESTORATION	10 days	Wed 11/6/19	Tue 11/19/19



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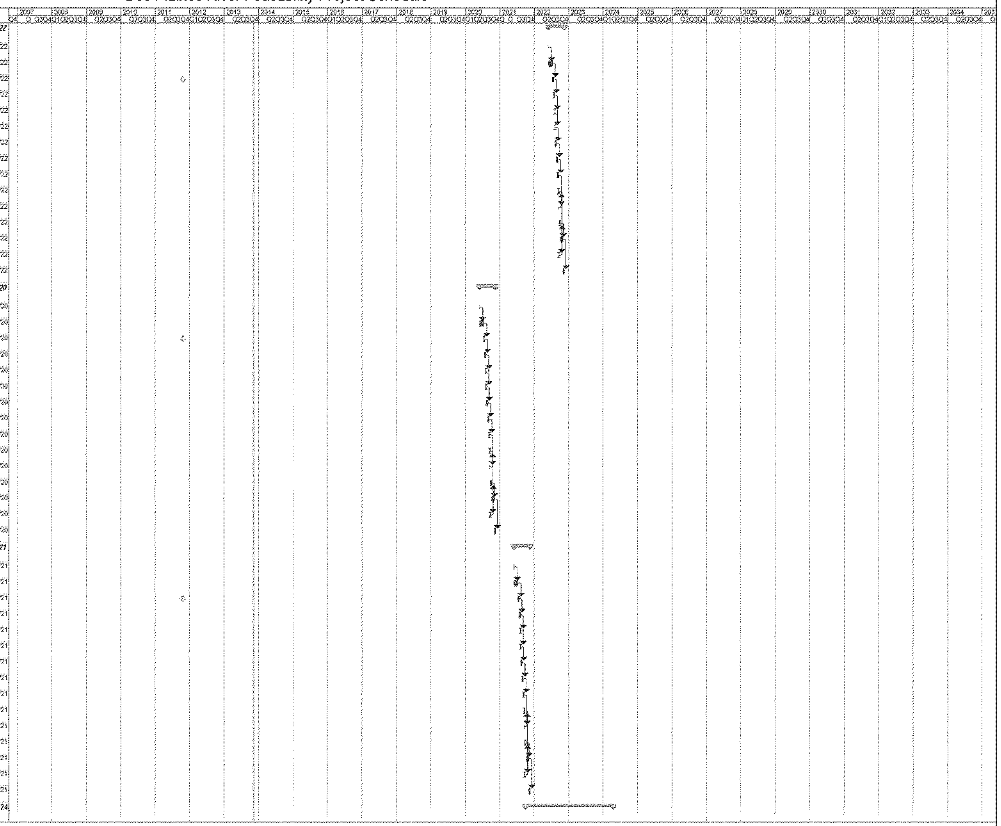
ID	Task Name	Duration	Start	Finish
25	***DAM NO. 4 REMOVAL***	***121 days***	***Wed 6/1/22***	***Wed 11/16/22***
1	NOTICE TO PROCEED	1 day	Wed 6/1/22	Wed 6/1/22
2	PREPARE PRECONSTRUCTION SUBMITTALS	30 days	Thu 6/2/22	Wed 7/13/22
3	REVIEW PRECONSTRUCTION SUBMITTALS	30 days	Wed 7/13/22	Sat 7/23/22
4	MOBILIZATION/DEMOBILIZATION	10 days	Mon 7/25/22	Fri 8/5/22
5	TEMPORARY FIELD OFFICE AND PROJECT SIGNS	2 days	Mon 8/8/22	Tue 8/9/22
6	TRAFFIC CONTROL AND SIGNAGE	2 days	Mon 8/8/22	Tue 8/9/22
7	CLEARING AND GRUBBING	10 days	Wed 8/10/22	Tue 8/23/22
8	STRIPPING & RESPREADING TOPSOIL	10 days	Wed 8/24/22	Tue 9/6/22
9	IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	5 days	Wed 9/7/22	Tue 9/13/22
10	SILT TURBIDITY CURTAIN	3 days	Thu 9/15/22	Mon 9/19/22
11	SEDIMENT SURVEYING	1 day	Wed 9/14/22	Wed 9/14/22
12	SEDIMENT REMOVAL	10 days	Thu 9/22/22	Wed 10/5/22
13	DEMOLITION AND REMOVAL OF DAM NO. 2	20 days	Thu 10/6/22	Wed 11/2/22
14	TEMPORARY FENCING & GATES	2 days	Tue 9/20/22	Wed 9/21/22
15	LANDSCAPE RESTORATION	10 days	Thu 11/3/22	Wed 11/16/22
26	***DEMPSTER DAM REMOVAL***	***122 days***	***Mon 6/1/20***	***Tue 11/17/20***
1	NOTICE TO PROCEED	1 day	Mon 6/1/20	Mon 6/1/20
2	PREPARE PRECONSTRUCTION SUBMITTALS	30 days	Tue 6/2/20	Mon 7/13/20
3	REVIEW PRECONSTRUCTION SUBMITTALS	30 days	Mon 7/13/20	Thu 7/23/20
4	MOBILIZATION/DEMOBILIZATION	10 days	Fri 7/24/20	Thu 8/6/20
5	TEMPORARY FIELD OFFICE AND PROJECT SIGNS	2 days	Fri 8/7/20	Mon 8/10/20
6	TRAFFIC CONTROL AND SIGNAGE	2 days	Fri 8/7/20	Mon 8/10/20
7	CLEARING AND GRUBBING	10 days	Tue 8/11/20	Mon 8/24/20
8	STRIPPING & RESPREADING TOPSOIL	10 days	Tue 8/25/20	Mon 9/7/20
9	IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	5 days	Tue 9/8/20	Mon 9/14/20
10	SILT TURBIDITY CURTAIN	3 days	Wed 9/16/20	Fri 9/18/20
11	SEDIMENT SURVEYING	1 day	Tue 9/15/20	Tue 9/15/20
12	SEDIMENT REMOVAL	10 days	Wed 9/23/20	Tue 10/6/20
13	DEMOLITION AND REMOVAL OF DAM NO. 2	20 days	Wed 10/7/20	Tue 11/3/20
14	TEMPORARY FENCING & GATES	2 days	Mon 9/21/20	Tue 9/22/20
15	LANDSCAPE RESTORATION	10 days	Wed 11/4/20	Tue 11/17/20
27	***TOUHY DAM REMOVAL***	***122 days***	***Tue 6/1/21***	***Wed 11/17/21***
1	NOTICE TO PROCEED	1 day	Tue 6/1/21	Tue 6/1/21
2	PREPARE PRECONSTRUCTION SUBMITTALS	30 days	Wed 6/2/21	Tue 7/13/21
3	REVIEW PRECONSTRUCTION SUBMITTALS	30 days	Tue 7/13/21	Fri 7/23/21
4	MOBILIZATION/DEMOBILIZATION	10 days	Mon 7/26/21	Fri 8/6/21
5	TEMPORARY FIELD OFFICE AND PROJECT SIGNS	2 days	Mon 8/9/21	Tue 8/10/21
6	TRAFFIC CONTROL AND SIGNAGE	2 days	Mon 8/9/21	Tue 8/10/21
7	CLEARING AND GRUBBING	10 days	Wed 8/11/21	Tue 8/24/21
8	STRIPPING & RESPREADING TOPSOIL	10 days	Wed 8/25/21	Tue 9/7/21
9	IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	5 days	Wed 9/8/21	Tue 9/14/21
10	SILT TURBIDITY CURTAIN	3 days	Thu 9/16/21	Mon 9/20/21
11	SEDIMENT SURVEYING	1 day	Wed 9/15/21	Wed 9/15/21
12	SEDIMENT REMOVAL	10 days	Thu 9/23/21	Wed 10/6/21
13	DEMOLITION AND REMOVAL OF TOUHY AVE DAM	20 days	Thu 10/7/21	Wed 11/3/21
14	TEMPORARY FENCING & GATES	2 days	Tue 9/21/21	Wed 9/22/21
15	LANDSCAPE RESTORATION	10 days	Thu 11/4/21	Wed 11/17/21
28	***DPLV09***	665 days	Fri 10/1/21	Thu 4/18/24



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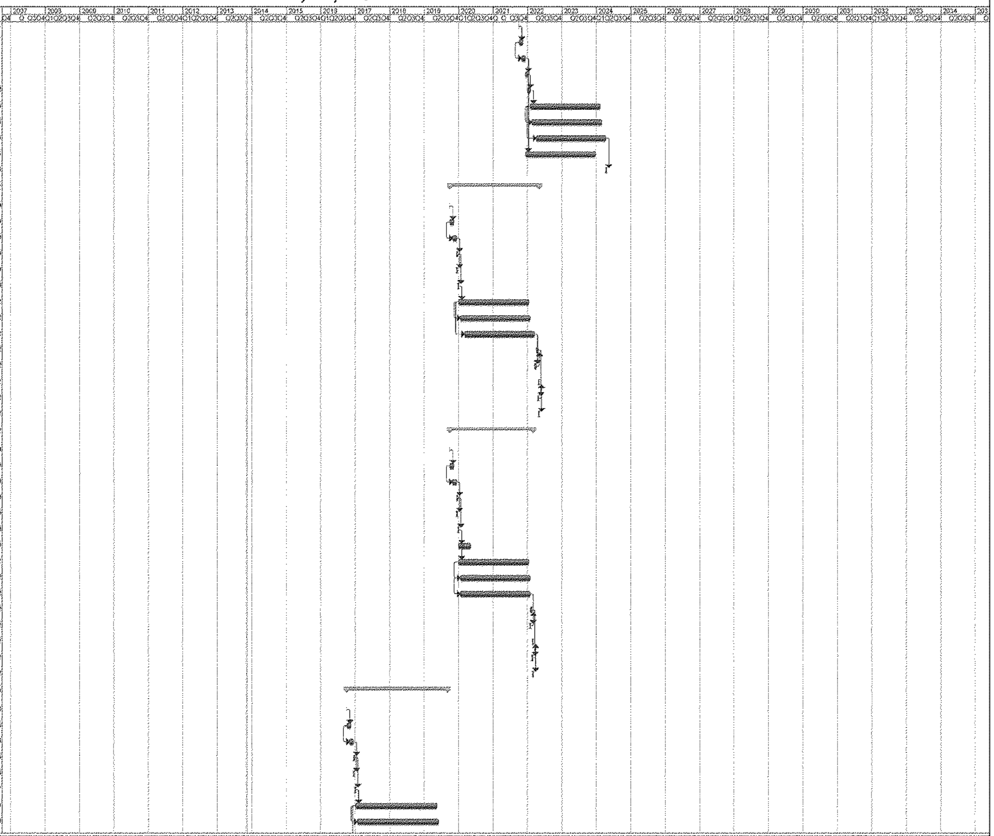
ID	Task Name	Duration	Start	Finish
1	NOTICE TO PROCEED	1 day	Fri 10/1/21	Fri 10/1/21
2	PREPARE PECONSTRUCTION SUBMITTAL	30 days	Mon 10/4/21	Fri 11/12/21
3	REVIEW PRECONSTRUCTION SUBMITTAL	30 days	Mon 11/1/21	Fri 12/10/21
4	MOBILIZATION	14 days	Mon 12/13/21	Thu 12/30/21
5	CLEARING AND GRUBBING	22 days	Fri 12/31/21	Mon 1/31/22
6	FLOODWALL	528 days	Tue 2/1/22	Thu 2/8/24
7	LEVEE	528 days	Thu 2/17/22	Mon 2/26/24
8	INTERIOR DRAINAGE	528 days	Tue 4/5/22	Thu 4/11/24
9	UTILITY RELOCATION	528 days	Mon 12/13/21	Wed 12/20/23
10	SEEDING	5 days	Fri 4/12/24	Thu 4/18/24
29	***DPLV05***	**678 days**	**Tue 10/1/19**	**Thu 5/5/22**
1	Notice to Proceed	1 day	Tue 10/1/19	Tue 10/1/19
2	Prepare Peconstruction Submittals	30 days	Wed 10/2/19	Tue 11/12/19
3	Review Preconstruction Submittals	30 days	Wed 10/30/19	Tue 12/10/19
4	Mobilization	10 days	Wed 12/11/19	Tue 12/24/19
5	Set-Up of Temporary Construction Facilities	5 days	Wed 12/11/19	Tue 12/17/19
6	Clearing and Grubbing	7.5 days	Wed 12/25/19	Fri 1/3/20
7	Construct Sheetpile Wall	528 days	Fri 1/3/20	Wed 1/12/22
8	Construct Concrete Wall	528 days	Tue 1/21/20	Fri 1/28/22
9	Place and Compact Impervious Fill	528 days	Fri 3/6/20	Wed 3/16/22
10	Seeding of Levee	12.5 days	Tue 4/5/22	Thu 4/21/22
11	Place Topsoil	14 days	Wed 3/16/22	Tue 4/5/22
12	Demobilization	4 days	Fri 4/29/22	Wed 5/4/22
13	Site Cleanup & Restoration	5 days	Fri 4/22/22	Thu 4/28/22
14	Job Completion/As-Builts	5 days	Fri 4/29/22	Thu 5/5/22
30	***DPLV04***	**633 days**	**Tue 10/1/19**	**Thu 3/3/22**
1	Notice to Proceed	1 day	Tue 10/1/19	Tue 10/1/19
2	Prepare Peconstruction Submittals	30 days	Wed 10/2/19	Tue 11/12/19
3	Review Preconstruction Submittals	30 days	Wed 10/30/19	Tue 12/10/19
4	Mobilization	10 days	Wed 12/11/19	Tue 12/24/19
5	Set-Up of Temporary Construction Facilities	5 days	Wed 12/11/19	Tue 12/17/19
6	Clearing and Grubbing	7.5 days	Wed 12/25/19	Fri 1/3/20
7	5th Ave Road Raise	88 days	Fri 1/3/20	Wed 5/6/20
8	Construct Sheetpile Wall	528 days	Fri 1/3/20	Wed 1/12/22
9	Construct Concrete Wall	528 days	Tue 1/21/20	Fri 1/28/22
10	Place and Compact Impervious Fill	528 days	Tue 1/21/20	Fri 1/28/22
11	Seeding of Levee	12.5 days	Tue 2/1/22	Thu 2/17/22
12	Place Topsoil	2 days	Fri 1/28/22	Tue 2/1/22
13	Demobilization	4 days	Fri 2/25/22	Wed 3/2/22
14	Site Cleanup & Restoration	5 days	Fri 2/18/22	Thu 2/24/22
15	Job Completion/As-Builts	5 days	Fri 2/25/22	Thu 3/3/22
31	***DPLV01***	**678 days**	**Mon 10/3/16**	**Thu 9/5/19**
1	Notice to Proceed	1 day	Mon 10/3/16	Mon 10/3/16
2	Prepare Peconstruction Submittals	30 days	Tue 10/4/16	Mon 11/14/16
3	Review Preconstruction Submittals	30 days	Tue 11/1/16	Mon 12/12/16
4	Mobilization	10 days	Tue 12/13/16	Mon 12/26/16
5	Set-Up of Temporary Construction Facilities	5 days	Tue 12/13/16	Mon 12/19/16
6	Clearing and Grubbing	7.5 days	Tue 12/27/16	Thu 1/5/17
7	Construct Sheetpile Wall	528 days	Thu 1/5/17	Wed 5/15/19
8	Construct Concrete Wall	528 days	Mon 1/23/17	Fri 5/31/19

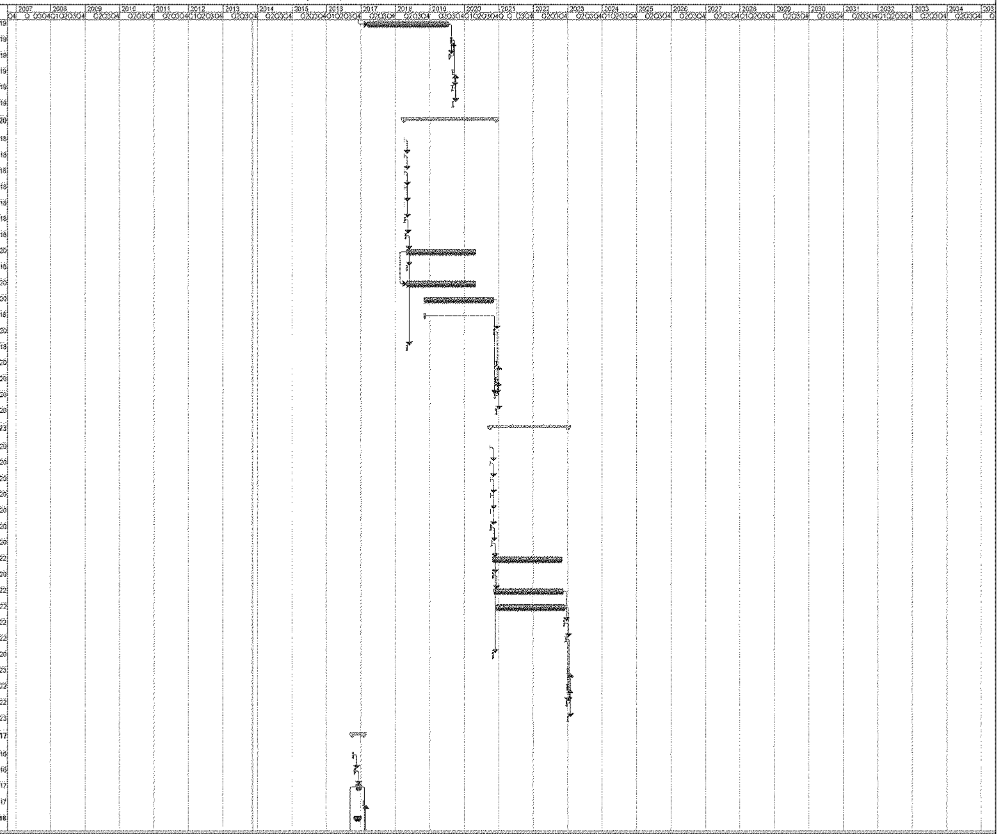


U.S. Army Corps of Engineers - Chicago District

Project schedule DPII.mpp
Wed 11/6/13

Des Plaines River Feasability Project Schedule

ID	Task Name	Duration	Start	Finish
9	Place and Compact Impervious Fill	520 days	Thu 3/9/17	Wed 7/17/19
10	Seeding of Levee	12.5 days	Tue 8/6/19	Thu 8/22/19
11	Place Topsoil	14 days	Wed 7/17/19	Tue 8/6/19
12	Demobilization	4 days	Fri 8/30/19	Wed 9/4/19
13	Site Cleanup & Restoration	5 days	Fri 8/23/19	Thu 8/29/19
14	Job Completion/As-Builts	5 days	Fri 8/30/19	Thu 9/5/19
32	***DPRS04***	**701 days**	**Mon 4/2/18**	**Mon 12/7/20**
1	Notice to Proceed	1 day	Mon 4/2/18	Mon 4/2/18
2	Prepare Preconstruction Submittals	1 day	Tue 4/3/18	Tue 4/3/18
3	Review Preconstruction Submittals	1 day	Wed 4/4/18	Wed 4/4/18
4	Mobilization	1 day	Thu 4/5/18	Thu 4/5/18
5	Set-Up of Temporary Construction Facilities	1 day	Thu 4/5/18	Thu 4/5/18
6	Clearing and Grubbing	5 days	Fri 4/6/18	Thu 4/12/18
7	Strip and Stockpile Topsoil	8 days	Fri 4/13/18	Tue 4/24/18
8	Reservoir Excavation and Stockpiling	528 days	Wed 4/25/18	Fri 5/1/20
9	Levee Inspection Trench Excavation	10 days	Wed 4/25/18	Tue 5/8/18
10	Construct Levee Embankment	528 days	Wed 4/25/18	Fri 5/1/20
11	Spread and Compact Spoil Embankment	528 days	Thu 11/1/18	Mon 11/9/20
12	Respread Topsoil for Levee Embankment	10 days	Thu 11/1/18	Wed 11/14/18
13	Respread Topsoil for Spoil Embankment	5 days	Tue 11/10/20	Mon 11/16/20
14	Install Drainage Structures	10 days	Wed 4/25/18	Tue 5/8/18
15	Demobilization	4 days	Tue 12/1/20	Fri 12/4/20
16	Site Cleanup & Restoration	5 days	Tue 11/24/20	Mon 11/30/20
17	Seeding of Levee & Spoil Embankments	5 days	Tue 11/17/20	Mon 11/23/20
18	Job Completion/As-Builts	5 days	Tue 12/1/20	Mon 12/7/20
33	***WLRS04***	**591 days**	**Thu 10/1/20**	**Thu 1/5/23**
1	Notice to Proceed	1 day	Thu 10/1/20	Thu 10/1/20
2	Prepare Preconstruction Submittals	1 day	Fri 10/2/20	Fri 10/2/20
3	Review Preconstruction Submittals	1 day	Mon 10/5/20	Mon 10/5/20
4	Mobilization	1 day	Tue 10/6/20	Tue 10/6/20
5	Set-Up of Temporary Construction Facilities	1 day	Tue 10/6/20	Tue 10/6/20
6	Clearing and Grubbing	5 days	Wed 10/7/20	Tue 10/13/20
7	Strip and Stockpile Topsoil	8 days	Wed 10/14/20	Fri 10/23/20
8	Reservoir Excavation and Stockpiling	528 days	Mon 10/26/20	Wed 11/2/22
9	Levee Inspection Trench Excavation	10 days	Mon 10/26/20	Fri 11/6/20
10	Construct Levee Embankment	528 days	Mon 11/9/20	Wed 11/16/22
11	Spread and Compact Spoil Embankment	528 days	Tue 12/1/20	Thu 12/8/22
12	Respread Topsoil for Levee Embankment	10 days	Thu 11/17/22	Wed 11/30/22
13	Respread Topsoil for Spoil Embankment	5 days	Fri 12/9/22	Thu 12/15/22
14	Install Drainage Structures	10 days	Mon 10/26/20	Fri 11/6/20
15	Demobilization	4 days	Fri 12/30/22	Wed 1/4/23
16	Site Cleanup & Restoration	5 days	Fri 12/23/22	Thu 12/29/22
17	Seeding of Levee & Spoil Embankments	5 days	Fri 12/16/22	Thu 12/22/22
18	Job Completion/As-Builts	5 days	Fri 12/30/22	Thu 1/5/23
34	***FPCI01***	**85 days**	**Mon 10/3/16**	**Fri 1/27/17**
1	MOBILIZATION	10 days	Mon 10/3/16	Fri 10/14/16
2	CLEAR AND GRUB	15 days	Mon 10/17/16	Fri 11/4/16
3	TRENCH EXCAVATION FOR STRUCTURE	44 days	Mon 11/7/16	Thu 1/5/17
4	SEEDING	5 days	Mon 1/23/17	Fri 1/27/17
5	**STORM DRAIN STRUCTURES**	**18 days**	**Mon 11/14/16**	**Wed 12/7/16**

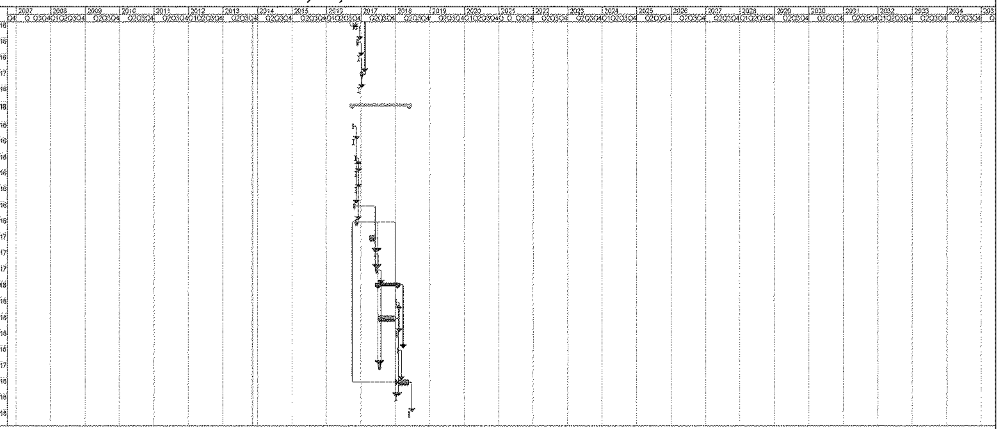


Project schedule DPII.mpp
Wed 11/6/13

U.S. Army Corps of Engineers - Chicago District

Des Plaines River Feasability Project Schedule

ID	Task Name	Duration	Start	Finish
6	12 RCP COLLECTOR	3 days	Mon 11/14/16	Wed 11/16/16
7	PIPE JACKING	12 days	Thu 11/17/16	Fri 12/2/16
8	12 HEADWALL	3 days	Mon 12/5/16	Wed 12/7/16
9	PUMPSTATION	20 days	Mon 12/26/16	Fri 1/20/17
10	RIPRAP	2 days	Thu 12/8/16	Fri 12/9/16
35	***DPBM04***	**431 days**	**Mon 10/3/16**	**Mon 5/28/18**
1	Mobilization	7 days	Mon 10/3/16	Tue 10/11/16
2	Temporary Fence	2 days	Wed 10/12/16	Thu 10/13/16
3	Temporary Gravel	3 days	Wed 11/2/16	Fri 11/4/16
4	Crane Setup	2 days	Mon 11/7/16	Tue 11/8/16
5	Marine Mobilization	2 days	Mon 11/7/16	Tue 11/8/16
6	Clearing and Grubbing	15 days	Wed 10/12/16	Tue 11/1/16
7	Pavement removal	20 days	Wed 11/2/16	Tue 11/29/16
8	New Pavement	42 days	Mon 4/3/17	Tue 5/30/17
9	Pavement Marking	2 days	Wed 5/31/17	Thu 6/1/17
10	Bridge Demolition	20 days	Fri 6/2/17	Thu 6/29/17
11	**New Bridge**	**147 days**	**Fri 6/30/17**	**Mon 1/22/18**
12	Precast Concrete Beams Beams	5 days	Tue 1/2/18	Mon 1/8/18
13	New Abutments/Piers	132 days	Fri 6/30/17	Mon 1/1/18
14	Concrete Deck/Parapet	10 days	Tue 1/9/18	Mon 1/22/18
15	Seeding	7 days	Tue 1/23/18	Wed 1/31/18
16	Road Raise Fill	22 days	Fri 6/30/17	Mon 7/31/17
17	Maintenance of Traffic	79 days	Thu 2/1/18	Tue 5/22/18
18	Rem/Replace Concrete C&G	5 days	Tue 1/2/18	Mon 1/8/18
19	Raise Traffic Signal	4 days	Wed 5/23/18	Mon 5/28/18



U.S. Army Corps of Engineers - Chicago District

Project schedule DPII.mpp
Wed 11/6/13

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW CERTIFICATION STATEMENT

For Project No. 114268
LRC - Upper Des Plaines River & Tributaries, IL & WI
Feasibility Study

The Upper Des Plains River and Tributaries, IL & WI Feasibility Study, as presented by the Chicago District, has undergone a successful Cost Agency Technical Review (Cost ATR) of remaining costs, performed by the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies. This certification signifies the cost products meet the quality standards as prescribed in ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

As of May 1, 2014, the Cost MCX certifies the estimated total project cost:

	FY14 Budget	Fully Funded
NED	$ 140,827,000	$ 159,108,000
NER	$ 158,365,000	$ 195,251,000
NED/NER Plan Subtotal	**$ 299,192,000**	**$ 354,359,000**
CAP 205	$ 5,832,000	$ 6,248,000
CAP 206	$ 3,258,000	$ 3,790,000
CAP Plan Subtotal	**$ 9,090,000**	**$ 10,038,000**
Non-Policy Compliant	$ 20,645,000	$ 22,631,000
Comprehensive Plan TOTAL	**$ 328,927,000**	**$ 387,028,000**

Note: Account 01 – Lands and Damages baseline cost and corresponding contingency have been provided by Real Estate. Cost ATR did not review or evaluate these costs. It remains the responsibility of the District to correctly reflect these cost values within the Final Report and to implement effective project management controls and implementation procedures including risk management throughout the life of the project.

®

Kim C. Callan, PE, CCE, PM
Chief, Cost Engineering MCX
Walla Walla District

**** TOTAL PROJECT COST SUMMARY ****

Printed:5/1/2014
Page 1 of 5

PROJECT: NED DPII FEASIBILITY STUDY
PROJECT NO: 114268
LOCATION: Northeast Illinois

DISTRICT: LRC Chicago District
POC: CHIEF, COST ENGINEERING, John Groboski
PREPARED: 4/18/2014

This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis) Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				TOTAL PROJECT COST (FULLY FUNDED)				
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Spent Thru: 1-Oct-13 ($K) K	L	COST ($K) M	CNTG ($K) N	FULL ($K) O
02	RELOCATIONS	$2,660	$998	37.5%	$3,658	0.0%	$2,660	$998	$3,658	$0		$3,008	$1,128	$4,136
03	RESERVOIRS	$15,494	$5,810	37.5%	$21,304	0.0%	$15,494	$5,810	$21,304	$0		$17,679	$6,630	$24,309
11	LEVEES & FLOODWALLS	$36,623	$13,734	37.5%	$50,357	0.0%	$36,623	$13,734	$50,357	$0		$41,648	$15,618	$57,267
14	RECREATION FACILITIES	$837	$314	37.5%	$1,151	0.0%	$837	$314	$1,151	$0		$947	$355	$1,302
19	BUILDINGS, GROUNDS & UTILITIES	$11,369	$4,263	37.5%	$15,632	0.0%	$11,369	$4,263	$15,632	$0		$13,506	$5,065	$18,570
	CONSTRUCTION ESTIMATE TOTALS:	$66,983	$25,119		$92,102	0.0%	$66,983	$25,119	$92,102	$0		$76,788	$28,795	$105,583
01	LANDS AND DAMAGES	$25,649	$2,812	11.0%	$28,461	0.0%	$25,649	$2,812	$28,461	$0		$27,680	$3,039	$30,719
30	PLANNING, ENGINEERING & DESIGN	$10,051	$3,769	37.5%	$13,820	0.0%	$10,051	$3,769	$13,820	$0		$11,152	$4,182	$15,334
31	CONSTRUCTION MANAGEMENT	$4,687	$1,758	37.5%	$6,445	0.0%	$4,687	$1,758	$6,445	$0		$5,434	$2,038	$7,472
	PROJECT COST TOTALS:	$107,370	$33,457	31.2%	$140,827		$107,370	$33,457	$140,827	$0		$121,054	$38,054	$159,108

Mandatory by Regulation — CHIEF, COST ENGINEERING, John Groboski

Mandatory by Regulation — PROJECT MANAGER, Jeff Zuercher

Mandatory by Regulation — CHIEF, REAL ESTATE, Vic Kotwicki

CHIEF, PLANNING, Sue Davis

CHIEF, ENGINEERING, Joe Schmidt

CHIEF, OPERATIONS, Steve.E.Hungness

CHIEF, CONSTRUCTION, Shamel Abou-El-Seoud

CHIEF, CONTRACTING, Regina Blair

CHIEF, PM-PB, Sherri Barham

CHIEF, DPM, Linda Sorn

ESTIMATED FEDERAL COST SHARE: 65% **$103,420**
ESTIMATED NON-FEDERAL COST SHARE: 35% **$55,688**

ESTIMATED TOTAL PROJECT COST: $159,108

Filename: 1-2014April2_DPII NED TPCS GSC-JGN.xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: NED DPII FEASIBILITY STUDY
LOCATION: Northeast Illinois
This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

DISTRICT: LRC Chicago District
POC: CHIEF, COST ENGINEERING, John Groboski
PREPARED: 4/18/2014

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 4/18/2014 Effective Price Level: 10/1/2013				Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	ESC (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
	PHASE 5													
11	LEVEES & FLOODWALLS	$14,416	$5,406	37.5%	$19,822	0.0%	$14,416	$5,406	$19,822	2022Q1	16.5%	$16,789	$6,296	$23,086
11	LEVEES & FLOODWALLS	$10,524	$3,947	37.5%	$14,471	0.0%	$10,524	$3,947	$14,471	2020Q1	11.9%	$11,781	$4,418	$16,199
11	LEVEES & FLOODWALLS	$11,683	$4,381	37.5%	$16,064	0.0%	$11,683	$4,381	$16,064	2020Q1	11.9%	$13,078	$4,904	$17,983
	CONSTRUCTION ESTIMATE TOTALS:	$36,623	$13,734	37.5%	$50,357		$36,623	$13,734	$50,357			$41,648	$15,618	$57,267
01	LANDS AND DAMAGES	$1,233	$370	30.0%	$1,603	0.0%	$1,233	$370	$1,603	2019Q1	9.7%	$1,353	$406	$1,759
01	LANDS AND DAMAGES	$304	$30	10.0%	$334	0.0%	$304	$30	$334	2018Q1	7.6%	$327	$33	$360
01	LANDS AND DAMAGES	$235	$24	10.0%	$259	0.0%	$235	$24	$259	2018Q1	7.6%	$253	$25	$278
30	PLANNING, ENGINEERING & DESIGN													
1.5%	Project Management	$549	$206	37.5%	$755	0.0%	$549	$206	$755	2017Q3	11.9%	$614	$230	$845
1.0%	Planning & Environmental Compliance	$366	$137	37.5%	$503	0.0%	$366	$137	$503	2017Q3	11.9%	$410	$154	$563
6.0%	Engineering & Design	$2,197	$824	37.5%	$3,021	0.0%	$2,197	$824	$3,021	2017Q3	11.9%	$2,458	$922	$3,380
0.3%	Reviews, ATRs, IEPRs, VE	$92	$35	37.5%	$127	0.0%	$92	$35	$127	2017Q3	11.9%	$103	$39	$142
0.3%	Life Cycle Updates (cost, schedule, risks)	$92	$35	37.5%	$127	0.0%	$92	$35	$127	2017Q3	11.9%	$103	$39	$142
1.0%	Contracting & Reprographics	$366	$137	37.5%	$503	0.0%	$366	$137	$503	2017Q3	11.9%	$410	$154	$563
3.0%	Engineering During Construction	$1,099	$412	37.5%	$1,511	0.0%	$1,099	$412	$1,511	2019Q3	20.9%	$1,328	$498	$1,826
1.0%	Planning During Construction	$366	$137	37.5%	$503	0.0%	$366	$137	$503	2019Q3	20.9%	$442	$166	$608
1.0%	Project Operations	$366	$137	37.5%	$503	0.0%	$366	$137	$503	2017Q3	11.9%	$410	$154	$563
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$1,465	$549	37.5%	$2,014	0.0%	$1,465	$549	$2,014	2019Q3	20.9%	$1,771	$664	$2,434
1.5%	Project Operation:	$549	$206	37.5%	$755	0.0%	$549	$206	$755	2019Q3	20.9%	$663	$249	$912
1.5%	Project Management	$549	$206	37.5%	$755	0.0%	$549	$200	$755	2019Q3	20.9%	$603	$249	$912
	CONTRACT COST TOTALS:	$46,451	$17,178		$63,629		$46,451	$17,178	$63,629			$52,957	$19,598	$72,554

Filename: 1-2014April2_DPII NED TPCS GSC-JGN.xlsx
TPCS

Printed:5/1/2014
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**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: NED DPII FEASIBILITY STUDY
LOCATION: Northeast Illinois
This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

DISTRICT: LRC Chicago District PREPARED: 4/18/2014
POC: CHIEF, COST ENGINEERING, John Groboski

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 4/18/2014 Effective Price Level: 10/1/2013				Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	ESC (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	PHASE 6													
03	RESERVOIRS	$6,519	$2,445	37.5%	$8,964	0.0%	$6,519	$2,445	$8,964	2019Q3	10.9%	$7,226	$2,710	$9,936
03	RESERVOIRS	$8,975	$3,366	37.5%	$12,341	0.0%	$8,975	$3,366	$12,341	2022Q1	16.5%	$10,453	$3,920	$14,372
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$15,494	$5,810	37.5%	$21,304		$15,494	$5,810	$21,304			$17,679	$6,630	$24,309
01	LANDS AND DAMAGES	$284	$28	10.0%	$312	0.0%	$284	$28	$312	2016Q1	7.6%	$306	$31	$336
01	LANDS AND DAMAGES	$636	$64	10.0%	$700	0.0%	$636	$64	$700	2022Q1	16.5%	$741	$74	$815
30	PLANNING, ENGINEERING & DESIGN													
1.5%	Project Management	$232	$87	37.5%	$319	0.0%	$232	$87	$319	2016Q1	14.1%	$265	$99	$364
1.0%	Planning & Environmental Compliance	$155	$58	37.5%	$213	0.0%	$155	$58	$213	2018Q1	14.1%	$177	$66	$243
6.0%	Engineering & Design	$930	$349	37.5%	$1,279	0.0%	$930	$349	$1,279	2018Q1	14.1%	$1,061	$398	$1,458
0.3%	Reviews, ATRs, IEPRs, VE	$39	$15	37.5%	$54	0.0%	$39	$15	$54	2018Q1	14.1%	$44	$17	$61
0.3%	Life Cycle Updates (cost, schedule, risks)	$39	$15	37.5%	$54	0.0%	$39	$15	$54	2018Q1	14.1%	$44	$17	$61
1.0%	Contracting & Reprographics	$155	$58	37.5%	$213	0.0%	$155	$58	$213	2018Q1	14.1%	$177	$66	$243
3.0%	Engineering During Construction	$465	$174	37.5%	$639	0.0%	$465	$174	$639	2020Q3	25.7%	$584	$219	$803
1.0%	Planning During Construction	$155	$58	37.5%	$213	0.0%	$155	$58	$213	2020Q3	25.7%	$195	$73	$268
1.0%	Project Operations	$155	$58	37.5%	$213	0.0%	$155	$58	$213	2018Q1	14.1%	$177	$66	$243
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$620	$233	37.5%	$853	0.0%	$620	$233	$853	2020Q3	25.7%	$779	$292	$1,071
1.5%	Project Operation:	$232	$87	37.5%	$319	0.0%	$232	$87	$319	2020Q3	25.7%	$292	$109	$401
1.5%	Project Management	$232	$87	37.5%	$319	0.0%	$232	$87	$319					
	CONTRACT COST TOTALS:	$19,823	$7,181		$27,004		$19,823	$7,181	$27,004			$22,520	$8,157	$30,677

Filename: 1-2014April2_DPII NED TPCS GSC-JGN.xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: NED DPII FEASIBILITY STUDY
LOCATION: Northeast Illinois
This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

DISTRICT: LRC Chicago District
POC: CHIEF, COST ENGINEERING, John Groboski
PREPARED: 4/18/2014

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 4/18/2014 Effective Price Level: 10/1/2013				Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	ESC (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	PHASE 7													
14	RECREATION FACILITIES	$107	$40	37.5%	$147	0.0%	$107	$40	$147	2022Q1	16.5%	$125	$47	$171
19	BUILDINGS, GROUNDS & UTILITIES	$5,862	$2,198	37.5%	$8,060	0.0%	$5,862	$2,198	$8,060	2023Q1	18.8%	$6,964	$2,611	$9,575
19	BUILDINGS, GROUNDS & UTILITIES	$5,507	$2,065	37.5%	$7,572	0.0%	$5,507	$2,065	$7,572	2023Q1	18.8%	$6,542	$2,453	$8,995
14	RECREATION FACILITIES	$566	$212	37.5%	$778	0.0%	$566	$212	$778	2019Q3	10.8%	$627	$235	$863
14	RECREATION FACILITIES	$0	$0	37.5%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
14	RECREATION FACILITIES	$164	$62	37.5%	$226	0.0%	$164	$62	$226	2023Q1	18.8%	$195	$73	$268
	CONSTRUCTION ESTIMATE TOTALS:	$12,206	$4,577	37.5%	$16,783		$12,206	$4,577	$16,783			$14,453	$5,420	$19,872
01	LANDS AND DAMAGES	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	$4,566	$457	10.0%	$5,023	0.0%	$4,566	$457	$5,023	2018Q1	7.6%	$4,913	$491	$5,404
01	LANDS AND DAMAGES	$18,391	$1,839	10.0%	$20,230	0.0%	$18,391	$1,839	$20,230	2018Q1	7.6%	$19,788	$1,979	$21,767
30	PLANNING, ENGINEERING & DESIGN													
1.5%	Project Management	$183	$69	37.5%	$252	0.0%	$183	$69	$252	2018Q3	16.3%	$213	$80	$293
1.0%	Planning & Environmental Compliance	$122	$46	37.5%	$168	0.0%	$122	$46	$168	2018Q3	16.3%	$142	$53	$195
6.0%	Engineering & Design	$732	$275	37.5%	$1,007	0.0%	$732	$275	$1,007	2018Q3	16.3%	$851	$319	$1,170
0.3%	Reviews, ATRs, IEPRs, VE	$31	$12	37.5%	$43	0.0%	$31	$12	$43	2018Q3	16.3%	$36	$14	$50
0.3%	Life Cycle Updates (cost, schedule, risks)	$31	$12	37.5%	$43	0.0%	$31	$12	$43	2018Q3	16.3%	$36	$14	$50
1.0%	Contracting & Reprographics	$122	$46	37.5%	$168	0.0%	$122	$46	$168	2018Q3	16.3%	$142	$53	$195
3.0%	Engineering During Construction	$366	$137	37.5%	$503	0.0%	$366	$137	$503	2019Q3	20.9%	$442	$166	$608
1.0%	Planning During Construction	$122	$46	37.5%	$168	0.0%	$122	$46	$168	2019Q3	20.9%	$147	$55	$203
1.0%	Project Operations	$122	$46	37.5%	$168	0.0%	$122	$46	$168	2018Q3	16.3%	$142	$53	$195
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$488	$183	37.5%	$671	0.0%	$488	$183	$671	2019Q3	20.9%	$590	$221	$811
1.5%	Project Operation:	$183	$69	37.5%	$252	0.0%	$183	$69	$252	2019Q3	20.9%	$221	$83	$304
1.5%	Project Management	$183	$69	37.5%	$252	0.0%	$183	$69	$252	2019Q3	20.9%	$221	$83	$304
	CONTRACT COST TOTALS:	$37,848	$7,880		$45,728		$37,848	$7,880	$45,728			$42,337	$9,084	**$51,420**

Filename: 1-2014April2_DPII NED TPCS GSC-JGN.xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: NED DPII FEASIBILITY STUDY
LOCATION: Northeast Illinois
This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

DISTRICT: LRC Chicago District PREPARED: 4/18/2014
POC: CHIEF, COST ENGINEERING, John Groboski

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 4/18/2014 Effective Price Level: 10/1/2013				Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	ESC (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
	PHASE 8													
02	RELOCATIONS	$2,660	$998	37.5%	$ 3,658	0.0%	$2,660	$998	$3,658	2020Q3	13.1%	$3,008	$1,128	$4,136
08	ROADS, RAILROADS & BRIDGES	$0	$0	0.0%	$ -	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
19	BUILDINGS, GROUNDS & UTILITIES	$0	$0	0.0%	$ -	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
19	BUILDINGS, GROUNDS & UTILITIES	$0	$0	0.0%	$ -	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$2,660	$998	37.5%	3,658		$2,660	$998	$3,658			$3,008	$1,128	$4,136
01	LANDS AND DAMAGES	$0	$0	0.0%	$ -	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	$0	$0	0.0%	$ -	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	$0	$0	0.0%	$ -	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	$0	$0	0.0%	$ -	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
1.5%	Project Management	$40	$15	37.5%	55	0.0%	$40	$15	$55	2019Q3	20.9%	$48	$18	$66
1.0%	Planning & Environmental Compliance	$27	$10	37.5%	37	0.0%	$27	$10	$37	2019Q3	20.9%	$33	$12	$45
6.0%	Engineering & Design	$160	$60	37.5%	220	0.0%	$160	$60	$220	2019Q3	20.9%	$193	$73	$266
0.3%	Reviews, ATRs, IEPRs, VE	$7	$3	37.5%	10	0.0%	$7	$3	$10	2019Q3	20.9%	$8	$3	$12
0.3%	Life Cycle Updates (cost, schedule, risks)	$7	$3	37.5%	$10	0.0%	$7	$3	$10	2019Q3	20.9%	$8	$3	$12
1.0%	Contracting & Reprographics	$27	$10	37.5%	37	0.0%	$27	$10	$37	2019Q3	20.9%	$33	$12	$45
3.0%	Engineering During Construction	$80	$30	37.5%	110	0.0%	$80	$30	$110	2020Q3	25.7%	$101	$38	$138
1.0%	Planning During Construction	$27	$10	37.5%	37	0.0%	$27	$10	$37	2020Q3	25.7%	$34	$13	$47
1.0%	Project Operations	$27	$10	37.5%	37	0.0%	$27	$10	$37	2019Q3	20.9%	$33	$12	$45
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$106	$40	37.5%	146	0.0%	$106	$40	$146	2020Q3	25.7%	$133	$50	$183
1.5%	Project Operation:	$40	$15	37.5%	55	0.0%	$40	$15	$55	2020Q3	25.7%	$50	$19	$69
1.5%	Project Management	$40	$15	37.5%	55	0.0%	$40	$15	$55	2020Q3	25.7%	$50	$19	$69
	CONTRACT COST TOTALS:	$3,248	$1,218		4,466		$3,248	$1,218	$4,466			$3,732	$1,400	$5,132

**** TOTAL PROJECT COST SUMMARY ****

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PROJECT: NER Des Plaines II FEASIBILITY STUDY
PROJECT NO: 114268
LOCATION: Northeast Illinois

DISTRICT: LRC Chicago District
POC: CHIEF, COST ENGINEERING, John Groboski
PREPARED: 4/18/2014

This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis) Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				TOTAL PROJECT COST (FULLY FUNDED)				
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Spent Thru: 1-Oct-13 ($K) K	L	COST ($K) M	CNTG ($K) N	FULL ($K) O
06	FISH & WILDLIFE FACILITIES	$63,906	$17,191	26.9%	$81,097	0.0%	$63,906	$17,191	$81,097	$0	-	$79,420	$21,364	$100,784
	CONSTRUCTION ESTIMATE TOTALS:	$63,906	$17,191		$81,097	0.0%	$63,906	$17,191	$81,097	$0		$79,420	$21,364	$100,784
01	LANDS AND DAMAGES	$56,266	$8,035	14.3%	$64,301	0.0%	$56,266	$8,035	$64,301	$0		$66,470	$9,605	$76,075
30	PLANNING, ENGINEERING & DESIGN	$6,387	$1,718	26.9%	$8,105	0.0%	$6,387	$1,718	$8,105	$0		$8,762	$2,357	$11,119
31	CONSTRUCTION MANAGEMENT	$3,832	$1,031	26.9%	$4,863	0.0%	$3,832	$1,031	$4,863	$0		$5,731	$1,542	$7,273
	PROJECT COST TOTALS:	$130,391	$27,974	21.5%	$158,365		$130,391	$27,974	$158,365	$0		$160,383	$34,868	$195,251

Mandatory by Regulation	CHIEF, COST ENGINEERING, John Groboski
Mandatory by Regulation	PROJECT MANAGER, Jeff Zuercher
Mandatory by Regulation	CHIEF, REAL ESTATE, Vic Kotwicki
	CHIEF, PLANNING, Sue Davis
	CHIEF, ENGINEERING, Joe Schmidt
	CHIEF, OPERATIONS, Steve.E.Hungness
	CHIEF, CONSTRUCTION, Shamel Abou-El-Seoud
	CHIEF, CONTRACTING, Regina Blair
	CHIEF, PM-PB, Sherri Barham
	CHIEF, DPM, Linda Sorn

ESTIMATED FEDERAL COST SHARE:	65%	$126,913
ESTIMATED NON-FEDERAL COST SHARE:	35%	$68,338
ESTIMATED TOTAL PROJECT COST:		**$195,251**

Filename: 2-2014April2_DPII NER TPCS GSC-JGN.xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: NER Des Plaines II FEASIBILITY STUDY
LOCATION: Northeast Illinois
This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

DISTRICT: LRC Chicago District PREPARED: 4/18/2014
POC: CHIEF, COST ENGINEERING, John Groboski

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 10/15/2013 Effective Price Level: 10/1/2013				Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13								
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	RISK BASED CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	ESC (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
	PHASE 1 or CONTRACT 1													
06	FISH & WILDLIFE FACILITIES	$15,164	$4,079	26.9%	$19,243	0.0%	$15,164	$4,079	$19,243	2028Q2	31.8%	$19,989	$5,377	$25,366
06	FISH & WILDLIFE FACILITIES	$6,569	$1,767	26.9%	$8,336	0.0%	$6,569 $0	$1,767	$8,336	2027Q3	29.9%	$8,532	$2,295	$10,827
	CONSTRUCTION ESTIMATE TOTALS:	$21,733	$5,846	26.9%	$27,579		$21,733	$5,846	$27,579			$28,521	$7,672	$36,193
01	LANDS AND DAMAGES	$16,690	$3,338	20.0%	$20,028	0.0%	$16,690	$3,338	$20,028	2025Q1	23.6%	$20,628	$4,126	$24,753
01	LANDS AND DAMAGES	$7,390	$1,478	20.0%	$8,868	0.0%	$7,390	$1,478	$8,868	2024Q1	21.2%	$8,954	$1,791	$10,745
30	PLANNING, ENGINEERING & DESIGN													
1.5%	Project Management	$326	$88	26.9%	$414	0.0%	$326	$88	$414	2025Q1	50.3%	$490	$132	$622
1.0%	Planning & Environmental Compliance	$217	$58	26.9%	$275	0.0%	$217	$58	$275	2025Q1	50.3%	$326	$88	$414
2.0%	Engineering & Design	$435	$117	26.9%	$552	0.0%	$435	$117	$552	2025Q1	50.3%	$654	$176	$830
0.3%	Reviews, ATRs, IEPRs, VE	$54	$15	26.9%	$69	0.0%	$54	$15	$69	2025Q1	50.3%	$81	$22	$103
0.3%	Life Cycle Updates (cost, schedule, risks)	$54	$15	26.9%	$69	0.0%	$54	$15	$69	2025Q1	50.3%	$81	$22	$103
1.0%	Contracting & Reprographics	$217	$58	26.9%	$275	0.0%	$217	$58	$275	2025Q1	50.3%	$326	$88	$414
2.0%	Engineering During Construction	$435	$117	26.9%	$552	0.0%	$435	$117	$552	2028Q1	70.8%	$743	$200	$943
1.0%	Planning During Construction	$217	$58	26.9%	$275	0.0%	$217	$58	$275	2028Q1	70.8%	$371	$100	$470
1.0%	Project Operations	$217	$58	26.9%	$275	0.0%	$217	$58	$275	2025Q1	50.3%	$326	$88	$414
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$869	$234	26.9%	$1,103	0.0%	$869	$234	$1,103	2028Q1	70.8%	$1,484	$399	$1,883
1.0%	Project Operation:	$217	$58	26.9%	$275	0.0%	$217	$58	$275	2028Q1	70.8%	$371	$100	$470
1.0%	Project Management	$217	$58	26.9%	$275	0.0%	$217	$58	$275	2028Q1	70.8%	$371	$100	$470
	CONTRACT COST TOTALS:	$49,288	$11,597		$60,885		$49,288	$11,597	$60,885			$63,727	$15,101	$78,828

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: NER Des Plaines II FEASIBILITY STUDY
LOCATION: Northeast Illinois
This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

DISTRICT: LRC Chicago District
POC: CHIEF, COST ENGINEERING, John Grabowski
PREPARED: 4/18/2014

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: / Effective Price Level:			10/15/2013 / 10/1/2013	Program Year (Budget EC): / Effective Price Level Date:			2014 / 1 OCT 13					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 2 or CONTRACT 2													
06	FISH & WILDLIFE FACILITIES	$12,020	$3,233	26.9%	$15,253	0.0%	$12,020	$3,233	$15,253	2021Q2	14.8%	$13,794	$3,710	$17,504
06	FISH & WILDLIFE FACILITIES	$4,801	$1,291	26.9%	$6,092	0.0%	$4,801	$1,291	$6,092	2022Q2	17.1%	$5,620	$1,512	$7,131
06	FISH & WILDLIFE FACILITIES	$8,509	$2,289	26.9%	$10,798	0.0%	$8,509	$2,289	$10,798	2024Q2	21.8%	$10,362	$2,787	$13,150
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$25,330	$6,814	26.9%	$32,144		$25,330	$6,814	$32,144			$29,776	$8,010	$37,785
01	LANDS AND DAMAGES	$10,895	$1,090	10.0%	$11,985	0.0%	$10,895	$1,090	$11,985	2018Q2	8.1%	$11,782	$1,178	$12,960
01	LANDS AND DAMAGES	$2,874	$287	10.0%	$3,161	0.0%	$2,874	$287	$3,161	2019Q3	10.9%	$3,186	$319	$3,505
01	LANDS AND DAMAGES	$4,581	$458	10.0%	$5,039	0.0%	$4,581	$458	$5,039	2021Q3	15.3%	$5,283	$528	$5,812
30	PLANNING, ENGINEERING & DESIGN													
1.5%	Project Management	$380	$102	26.9%	$482	0.0%	$380	$102	$482	2019Q1	18.5%	$450	$121	$572
1.0%	Planning & Environmental Compliance	$253	$68	26.9%	$321	0.0%	$253	$68	$321	2019Q1	18.5%	$300	$81	$381
2.0%	Engineering & Design	$507	$136	26.9%	$643	0.0%	$507	$136	$643	2019Q1	18.5%	$601	$162	$763
0.3%	Reviews, ATRs, IEPRs, VE	$63	$17	26.9%	$80	0.0%	$63	$17	$80	2019Q1	18.5%	$75	$20	$95
0.3%	Life Cycle Updates (cost, schedule, risks)	$63	$17	26.9%	$80	0.0%	$63	$17	$80	2019Q1	18.5%	$75	$20	$95
1.0%	Contracting & Reprographics	$253	$68	26.9%	$321	0.0%	$253	$68	$321	2019Q1	18.5%	$300	$81	$381
2.0%	Engineering During Construction	$507	$136	26.9%	$643	0.0%	$507	$136	$643	2023Q1	38.6%	$703	$189	$892
1.0%	Planning During Construction	$253	$68	26.9%	$321	0.0%	$253	$68	$321	2023Q1	38.6%	$351	$94	$445
1.0%	Project Operations	$253	$68	26.9%	$321	0.0%	$253	$68	$321	2019Q1	18.5%	$300	$81	$381
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$1,013	$272	26.9%	$1,285	0.0%	$1,013	$272	$1,285	2023Q1	38.6%	$1,404	$378	$1,782
1.0%	Project Operation:	$253	$68	26.9%	$321	0.0%	$253	$68	$321	2023Q1	38.6%	$351	$94	$445
1.0%	Project Management	$253	$68	26.9%	$321	0.0%	$253	$68	$321	2023Q1	38.6%	$351	$94	$445
	CONTRACT COST TOTALS:	$47,731	$9,738		$57,469		$47,731	$9,738	$57,469			$55,286	$11,450	$66,736

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: NER Des Plaines II FEASIBILITY STUDY
LOCATION: Northeast Illinois
This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

DISTRICT: LRC Chicago District PREPARED: 4/18/2014
POC: CHIEF, COST ENGINEERING, John Groboski

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 10/15/2013 Effective Price Level: 10/1/2013				Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13								
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	ESC (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
	PHASE 3 or CONTRACT 3													
06	FISH & WILDLIFE FACILITIES	$8,704	$2,341	26.9%	$11,045	0.0%	$8,704	$2,341	$11,045	2025Q2	24.2%	$10,812	$2,908	$13,720
06	FISH & WILDLIFE FACILITIES	$8,139	$2,189	26.9%	$10,328	0.0%	$8,139	$2,189	$10,328	2026Q2	26.7%	$10,312	$2,774	$13,086
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$16,843	$4,531	26.9%	$21,374		$16,843	$4,531	$21,374			$21,124	$5,682	$26,806
01	LANDS AND DAMAGES	$6,263	$626	10.0%	$6,889	0.0%	$6,263	$626	$6,889	2022Q3	17.6%	$7,368	$737	$8,104
01	LANDS AND DAMAGES	$7,573	$757	10.0%	$8,330	0.0%	$7,573	$757	$8,330	2024Q3	22.4%	$9,269	$927	$10,196
30	PLANNING, ENGINEERING & DESIGN													
1.5%	Project Management	$253	$68	26.9%	$321	0.0%	$253	$68	$321	2021Q1	28.1%	$324	$87	$411
1.0%	Planning & Environmental Compliance	$168	$45	26.9%	$213	0.0%	$168	$45	$213	2021Q1	28.1%	$215	$58	$273
2.0%	Engineering & Design	$337	$91	26.9%	$428	0.0%	$337	$91	$428	2021Q1	28.1%	$432	$116	$548
0.3%	Reviews, ATRs, IEPRs, VE	$42	$11	26.9%	$53	0.0%	$42	$11	$53	2021Q1	28.1%	$54	$14	$68
0.3%	Life Cycle Updates (cost, schedule, risks)	$42	$11	26.9%	$53	0.0%	$42	$11	$53	2021Q1	28.1%	$54	$14	$68
1.0%	Contracting & Reprographics	$168	$45	26.9%	$213	0.0%	$168	$45	$213	2021Q1	28.1%	$215	$58	$273
2.0%	Engineering During Construction	$337	$91	26.9%	$428	0.0%	$337	$91	$428	2023Q1	38.6%	$467	$126	$593
1.0%	Planning During Construction	$168	$45	26.9%	$213	0.0%	$168	$45	$213	2023Q1	38.6%	$233	$63	$296
1.0%	Project Operations	$168	$45	26.9%	$213	0.0%	$168	$45	$213	2021Q1	28.1%	$215	$58	$273
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$674	$181	26.9%	$856	0.0%	$674	$181	$855	2023Q1	38.6%	$934	$251	$1,186
1.0%	Project Operation:	$168	$45	26.9%	$213	0.0%	$168	$45	$213	2023Q1	38.6%	$233	$63	$296
1.0%	Project Management	$168	$45	26.9%	$213	0.0%	$168	$45	$213	2023Q1	38.6%	$233	$63	$296
	CONTRACT COST TOTALS:	$33,372	$6,639		$40,011		$33,372	$6,639	$40,011			$41,370	$8,317	$49,687

**** TOTAL PROJECT COST SUMMARY ****

Printed:4/23/2014
Page 1 of 2

PROJECT: CAP 205 Des Plaines II FEASIBILITY STUDY
PROJECT NO: 114268
LOCATION: Northeast Illinois

DISTRICT: LRC Chicago District
POC: CHIEF, COST ENGINEERING, John Groboski
PREPARED: 4/18/2014

This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis) Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				TOTAL PROJECT COST (FULLY FUNDED)				
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Spent Thru: 1-Oct-13 ($K) K	L	COST ($K) M	CNTG ($K) N	FULL ($K) O
02	RELOCATIONS	$157	$56	35.5%	$213	0.0%	$157	$56	$213			$176	$82	$238
11	LEVEES & FLOODWALLS	$3,134	$1,113	35.5%	$4,247	0.0%	$3,134	$1,113	$4,247	$0		$3,306	$1,174	$4,480
	CONSTRUCTION ESTIMATE TOTALS:	$3,291	$1,168		$4,459	0.0%	$3,291	$1,168	$4,459	$0		$3,482	$1,236	$4,718
01	LANDS AND DAMAGES	$435	$44	10.0%	$479	0.0%	$435	$44	$479	$0		$446	$45	$490
30	PLANNING, ENGINEERING & DESIGN	$493	$122	24.7%	$615	0.0%	$493	$122	$615	$0		$563	$139	$703
31	CONSTRUCTION MANAGEMENT	$230	$49	21.4%	$279	0.0%	$230	$49	$279	$0		$278	$60	$338
	PROJECT COST TOTALS:	$4,449	$1,383	31.1%	$5,832		$4,449	$1,383	$5,832	$0		$4,769	$1,479	$6,248

Signature	Title
Mandatory by Regulation	CHIEF, COST ENGINEERING, John Groboski
Mandatory by Regulation	PROJECT MANAGER, Jeff Zuercher
Mandatory by Regulation	CHIEF, REAL ESTATE, Vic Kotwicki
	CHIEF, PLANNING, Sue Davis
	CHIEF, ENGINEERING, Joe Schmidt
	CHIEF, OPERATIONS, Steve.E.Hungness
	CHIEF, CONSTRUCTION, Shamel Abou-El-Seoud
	CHIEF, CONTRACTING, Regina Blair
	CHIEF, PM-PB, Sherrie Barham
	CHIEF, DPM, Linda Sorn

ESTIMATED FEDERAL COST SHARE: 65% **$4,061**
ESTIMATED NON-FEDERAL COST SHARE: 35% **$2,187**

ESTIMATED TOTAL PROJECT COST: $6,248

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: CAP 205 Des Plaines II FEASIBILITY STUDY
LOCATION: Northeast Illinois
This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

DISTRICT: LRC Chicago District PREPARED: 4/18/2014
POC: CHIEF, COST ENGINEERING, John Groboski

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			4/18/2014	Program Year (Budget EC):			2014	FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level:			10/1/2013	Effective Price Level Date:			1 OCT 13					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 5													
02	RELOCATIONS	$157	$56	35.5%	$213	0.0%	$157	$56	$213	2020Q1	11.9%	$176	$62	$238
11	LEVEES & FLOODWALLS	$3,134	$1,113	35.5%	$4,247	0.0%	$3,134	$1,113	$4,247	2017Q1	5.5%	$3,306	$1,174	$4,480
	CONSTRUCTION ESTIMATE TOTALS:	$3,291	$1,168	35.5%	$4,459		$3,291	$1,168	$4,459			$3,482	$1,236	$4,718
01	LANDS AND DAMAGES	$435	$44	10.0%	$479	0.0%	$435	$44	$479	2015Q3	2.5%	$446	$45	$490
30	PLANNING, ENGINEERING & DESIGN													
1.5%	Project Management	$49	$12	24.7%	$61	0.0%	$49	$12	$61	2017Q3	11.9%	$55	$14	$68
1.0%	Planning & Environmental Compliance	$33	$8	24.7%	$41	0.0%	$33	$8	$41	2017Q3	11.8%	$37	$9	$46
6.0%	Engineering & Design	$197	$49	24.7%	$246	0.0%	$197	$49	$246	2017Q3	11.9%	$220	$55	$275
0.3%	Reviews, ATRs, IEPRs, VE	$8	$2	24.7%	$10	0.0%	$8	$2	$10	2017Q3	11.9%	$9	$2	$11
0.3%	Life Cycle Updates (cost, schedule, risks)	$8	$2	24.7%	$10	0.0%	$8	$2	$10	2017Q3	11.9%	$9	$2	$11
1.0%	Contracting & Reprographics	$33	$8	24.7%	$41	0.0%	$33	$8	$41	2017Q3	11.9%	$37	$9	$46
3.0%	Engineering During Construction	$99	$24	24.7%	$123	0.0%	$99	$24	$123	2019Q3	20.9%	$120	$30	$149
1.0%	Planning During Construction	$33	$8	24.7%	$41	0.0%	$33	$8	$41	2019Q3	20.9%	$40	$10	$50
1.0%	Project Operations	$33	$8	24.7%	$41	0.0%	$33	$8	$41	2017Q3	11.9%	$37	$9	$46
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$132	$28	21.4%	$160	0.0%	$132	$28	$160	2019Q3	20.9%	$160	$34	$194
1.5%	Project Operation:	$49	$10	21.4%	$59	0.0%	$49	$10	$59	2019Q3	20.9%	$59	$13	$72
1.5%	Project Management	$49	$10	21.4%	$59	0.0%	$49	$10	$59	2019Q3	20.9%	$59	$13	$72
	CONTRACT COST TOTALS:	$4,449	$1,393		$5,832		$4,449	$1,383	$5,832			$4,769	$1,479	$6,248

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: Des Plaines II CAP NER FEASIBILITY STUDY
PROJECT NO: 114268
LOCATION: Northeast Illinois

DISTRICT: LRC Chicago District PREPARED: 4/21/2014
POC: CHIEF, COST ENGINEERING, John Groboski

This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
						Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				Spent Thru: 1-Oct-13				
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	($K) K	L	COST ($K) M	CNTG ($K) N	FULL ($K) O
06	FISH & WILDLIFE FACILITIES	$2,176	$653	30.0%	$2,829	0.0%	$2,176	$653	$2,829	$0		$2,484	$745	$3,230
	CONSTRUCTION ESTIMATE TOTALS:	$2,176	$653		$2,829	0.0%	$2,176	$653	$2,829	$0		$2,484	$745	$3,230
01	LANDS AND DAMAGES	$35	$4	10.0%	$39	0.0%	$35	$4	$39	$0		$39	$4	$43
30	PLANNING, ENGINEERING & DESIGN	$219	$29	13.4%	$248	0.0%	$219	$29	$248	$0		$285	$38	$324
31	CONSTRUCTION MANAGEMENT	$131	$12	8.8%	$143	0.0%	$131	$12	$143	$0		$177	$16	$193
	PROJECT COST TOTALS:	$2,561	$697	27.2%	$3,258		$2,561	$697	$3,258	$0		$2,986	$803	$3,790

Mandatory by Regulation ______ CHIEF, COST ENGINEERING, John Groboski

Mandatory by Regulation ______ PROJECT MANAGER, Jeff Zuercher

Mandatory by Regulation ______ CHIEF, REAL ESTATE, Vic Kotwicki

______ CHIEF, PLANNING, Sue Davis

______ CHIEF, ENGINEERING, Joe Schmidt

______ CHIEF, OPERATIONS, Steve.E.Hungness

______ CHIEF, CONSTRUCTION, Shamel Abou-El-Seoud

______ CHIEF, CONTRACTING, Regina Blair

______ CHIEF, PM-PB, Michael C Padilla

______ CHIEF, DPM, Linda Sorn

ESTIMATED FEDERAL COST SHARE: 65% **$2,463**
ESTIMATED NON-FEDERAL COST SHARE: 35% **$1,326**

ESTIMATED TOTAL PROJECT COST: $3,790

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Des Plaines II CAP NER FEASIBILITY STUDY
LOCATION: Northeast Illinois
This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

DISTRICT: LRC Chicago District PREPARED: 4/21/2014
POC: CHIEF, COST ENGINEERING, John Grdboski

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: / Effective Price Level:			21-Apr-14 / 1-Oct-13	Program Year (Budget EC): / Effective Price Level Date:			2014 / 1 OCT 13					
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	ESC (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
	PHASE 3 or CONTRACT 3													
06	FISH & WILDLIFE FACILITIES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	$448	$134	30.00%	$582	0.0%	$448	$134	$582	2019Q1	9.7%	$492	$147	$639
06	FISH & WILDLIFE FACILITIES	$453	$136	30.00%	$589	0.0%	$453	$136	$589	2020Q1	11.9%	$507	$152	$659
06	FISH & WILDLIFE FACILITIES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$901	$270	30%	$1,171		$901	$270	$1,171			$999	$300	$1,298
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
01	LANDS AND DAMAGES	$7	$1	10.0%	$8	0.0%	$7	$1	$8	2017Q1	5.5%	$7	$1	$8
01	LANDS AND DAMAGES	$7	$1	10.0%	$8	0.0%	$7	$1	$8	2018Q1	7.6%	$8	$1	$8
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
1.5%	Project Management	$14	$2	13.4%	$16	0.0%	$14	$2	$16	2021Q1	28.1%	$18	$2	$20
1.0%	Planning & Environmental Compliance	$9	$1	13.4%	$10	0.0%	$9	$1	$10	2021Q1	28.1%	$12	$2	$13
2.0%	Engineering & Design	$18	$2	13.4%	$20	0.0%	$18	$2	$20	2021Q1	28.1%	$23	$3	$26
0.3%	Reviews, ATRs, IEPRs, VE	$2	$0	13.4%	$2	0.0%	$2	$0	$2	2021Q1	28.1%	$3	$0	$3
0.3%	Life Cycle Updates (cost, schedule, risks)	$2	$0	13.4%	$2	0.0%	$2	$0	$2	2021Q1	28.1%	$3	$0	$3
1.0%	Contracting & Reprographics	$9	$1	13.4%	$10	0.0%	$9	$1	$10	2021Q1	28.1%	$12	$2	$13
2.0%	Engineering During Construction	$18	$2	13.4%	$20	0.0%	$18	$2	$20	2023Q1	38.6%	$25	$3	$28
1.0%	Planning During Construction	$9	$1	13.4%	$10	0.0%	$9	$1	$10	2023Q1	38.6%	$12	$2	$14
1.0%	Project Operations	$9	$1	13.4%	$10	0.0%	$9	$1	$10	2021Q1	28.1%	$12	$2	$13
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$36	$3	8.9%	$39	0.0%	$36	$3	$39	2023Q1	38.6%	$50	$4	$54
1.0%	Project Operation:	$9	$1	8.9%	$10	0.0%	$9	$1	$10	2023Q1	38.6%	$12	$1	$14
1.0%	Project Management	$9	$1	8.9%	$10	0.0%	$9	$1	$10	2023Q1	38.6%	$12	$1	$14
	CONTRACT COST TOTALS:	$1,059	$289		$1,348		$1,059	$289	$1,348			$1,207	$324	$1,530

**** TOTAL PROJECT COST SUMMARY ****

Printed:4/24/2014
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**** CONTRACT COST SUMMARY ****

PROJECT: Des Plaines II CAP NER FEASIBILITY STUDY
LOCATION: Northeast Illinois
This Estimate reflects the scope and schedule in report: Integrated Feasibility Report and Environmental Assessment

DISTRICT: LRC Chicago District PREPARED: 4/21/2014
POC: CHIEF, COST ENGINEERING, John Groboski

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 21-Apr-14 Effective Price Level: 1-Oct-13				Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	PHASE 4													
06	FISH & WILDLIFE FACILITIES	$386	$116	30.00%	$502	0.0%	$386	$116	$502	2021Q1	14.2%	$441	$132	$573
06	FISH & WILDLIFE FACILITIES	$479	$144	30.00%	$623	0.0%	$479	$144	$623	2022Q1	16.5%	$558	$167	$725
06	FISH & WILDLIFE FACILITIES	$410	$123	30.00%	$533	0.0%	$410	$123	$533	2023Q1	18.8%	$487	$146	$633
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$1,275	$383	30%	$1,658		$1,275	$383	$1,658			$1,486	$446	$1,931
01	LANDS AND DAMAGES	$7	$1	10.0%	$8	0.0%	$7	$1	$8	2020Q1	11.9%	$8	$1	$9
01	LANDS AND DAMAGES	$7	$1	10.0%	$8	0.0%	$7	$1	$8	2021Q1	14.2%	$8	$1	$9
01	LANDS AND DAMAGES	$7	$1	10.0%	$8	0.0%	$7	$1	$8	2023Q1	18.8%	$8	$1	$9
30	PLANNING, ENGINEERING & DESIGN													
1.5%	Project Management	$19	$3	13.4%	$22	0.0%	$19	$3	$22	2021Q1	28.1%	$24	$3	$28
1.0%	Planning & Environmental Compliance	$13	$2	13.4%	$15	0.0%	$13	$2	$15	2021Q1	28.1%	$17	$2	$19
2.0%	Engineering & Design	$26	$3	13.4%	$29	0.0%	$26	$3	$29	2021Q1	28.1%	$33	$4	$38
0.3%	Reviews, ATRs, IEPRs, VE	$3	$0	13.4%	$3	0.0%	$3	$0	$3	2021Q1	28.1%	$4	$1	$4
0.3%	Life Cycle Updates (cost, schedule, risks)	$3	$0	13.4%	$3	0.0%	$3	$0	$3	2021Q1	28.1%	$4	$1	$4
1.0%	Contracting & Reprographics	$13	$2	13.4%	$15	0.0%	$13	$2	$15	2021Q1	28.1%	$17	$2	$19
2.0%	Engineering During Construction	$26	$3	13.4%	$29	0.0%	$26	$3	$29	2022Q1	33.3%	$35	$5	$39
1.0%	Planning During Construction	$13	$2	13.4%	$15	0.0%	$13	$2	$15	2022Q1	33.3%	$17	$2	$20
1.0%	Project Operations	$13	$2	13.4%	$15	0.0%	$13	$2	$15	2021Q1	28.1%	$17	$2	$19
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$51	$5	8.9%	$56	0.0%	$51	$5	$56	2022Q1	33.3%	$68	$6	$74
1.0%	Project Operation:	$13	$1	8.9%	$14	0.0%	$13	$1	$14	2022Q1	33.3%	$17	$2	$19
1.0%	Project Management	$13	$1	8.9%	$14	0.0%	$13	$1	$14	2022Q1	33.3%	$17	$2	$19
	CONTRACT COST TOTALS:	$1,502	$409		$1,911		$1,502	$409	$1,911			$1,780	$480	$2,259

Filename: 4-2014April2_DPII CAP NER TPCS JGN.xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

Printed:4/24/2014
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PROJECT: PNC Des Plaines II FEASIBILITY STUDY
PROJECT NO: 114268
LOCATION: Northeast Illinois

DISTRICT: LRC Chicago District
POC: CHIEF, COST ENGINEERING, John Groboski
PREPARED: 4/22/2014

This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis) Program Year (Budget EC): 2014; Effective Price Level Date: 1 OCT 13				TOTAL PROJECT COST (FULLY FUNDED)				
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Spent Thru: 1-Oct-13 ($K) K	L	COST ($K) M	CNTG ($K) N	FULL ($K) O
02	RELOCATIONS	$376	$113	30.0%	$489	0.0%	$376	$113	$489	$0		$387	$119	$516
03	RESERVOIRS	$727	$218	30.0%	$945	0.0%	$727	$218	$945	$0		$767	$230	$997
08	ROADS, RAILROADS & BRIDGES	$9,433	$2,830	30.0%	$12,263	0.0%	$9,433	$2,830	$12,263	$0		$9,950	$2,986	$12,936
19	BUILDINGS, GROUNDS & UTILITIES	$1,716	$422	24.6%	$2,138	0.0%	$1,716	$422	$2,138	$0		$2,039	$501	$2,540
	CONSTRUCTION ESTIMATE TOTALS:	$12,252	$3,583	29.2%	$15,835	0.0%	$12,252	$3,583	$15,835	$0		$13,152	$3,836	$16,988
01	LANDS AND DAMAGES	$1,623	$162	10.0%	$1,785	0.0%	$1,623	$162	$1,785	$0		$1,742	$174	$1,916
30	PLANNING, ENGINEERING & DESIGN	$1,841	$249	13.5%	$2,090	0.0%	$1,841	$249	$2,090	$0		$2,248	$304	$2,552
31	CONSTRUCTION MANAGEMENT	$858	$77	9.0%	$935	0.0%	$858	$77	$935	$0		$1,078	$97	$1,175
	PROJECT COST TOTALS:	$16,574	$4,071	24.6%	$20,645		$16,574	$4,071	$20,645	$0		$18,221	$4,410	$22,631

Mandatory by Regulation CHIEF, COST ENGINEERING, John Groboski

Mandatory by Regulation PROJECT MANAGER, Jeff Zuercher

Mandatory by Regulation CHIEF, REAL ESTATE, Vic Kotwicki

CHIEF, PLANNING, Sue Davis

CHIEF, ENGINEERING, Joe Schmidt

CHIEF, OPERATIONS, Steve.E.Hungness

CHIEF, CONSTRUCTION, Shamel Abou-El-Seoud

CHIEF, CONTRACTING, Regina Blair

CHIEF, PM-PB, Sherrie Barham

CHIEF, DPM, Linda Sorn

ESTIMATED FEDERAL COST SHARE:	65%	$0
ESTIMATED NON-FEDERAL COST SHARE:	35%	$0
NON-COMPLIANT PLAN (Local Sponser)	100%	$22,631
ESTIMATED TOTAL PROJECT COST:		$22,631

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TPCS

**** TOTAL PROJECT COST SUMMARY ****

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**** CONTRACT COST SUMMARY ****

PROJECT: PNC Des Plaines II FEASIBILITY STUDY
LOCATION: Northeast Illinois
This Estimate reflects the scope and schedule in report; Integrated Feasibility Report and Environmental Assessment

DISTRICT: LRC Chicago District PREPARED: 4/22/2014
POC: CHIEF, COST ENGINEERING, John Graboski

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 4/22/2014 Effective Price Level: 10/1/2013				Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	ESC (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
	PHASE 8													
02	RELOCATIONS	$376	$113	30.0%	$489	0.0%	$376	$113	$489	2017Q1	5.6%	$397	$119	$516
03	RESERVOIRS	$727	$218	30.0%	$945	0.0%	$727	$218	$945	2017Q1	5.5%	$767	$230	$997
08	ROADS, RAILROADS & BRIDGES	$9,433	$2,830	30.0%	$12,263	0.0%	$9,433	$2,830	$12,263	2017Q1	5.5%	$9,950	$2,985	$12,936
19	BUILDINGS, GROUNDS & UTILITIES	$1,653	$407	24.6%	$2,060	0.0%	$1,653	$407	$2,060	2023Q1	18.8%	$1,964	$483	$2,447
19	BUILDINGS, GROUNDS & UTILITIES	$63	$15	24.6%	$78	0.0%	$63	$15	$78	2023Q1	18.8%	$75	$18	$93
	CONSTRUCTION ESTIMATE TOTALS:	$12,252	$3,583	29%	15,835		$12,252	$3,583	$15,835			$13,152	$3,836	$16,988
01	LANDS AND DAMAGES	$88	$9	10.0%	$97	0.0%	$88	$9	$97	2016Q1	3.5%	$91	$9	$100
01	LANDS AND DAMAGES	$23	$2	10.0%	$25	0.0%	$23	$2	$25	2016Q1	3.5%	$24	$2	$26
01	LANDS AND DAMAGES	$535	$54	10.0%	$589	0.0%	$535	$54	$589	2018Q1	7.6%	$576	$58	$633
01	LANDS AND DAMAGES	$977	$98	10.0%	$1,075	0.0%	$977	$98	$1,075	2018Q1	7.6%	$1,051	$105	$1,156
30	PLANNING, ENGINEERING & DESIGN													
1.5%	Project Management	$184	$25	13.5%	$209	0.0%	$184	$25	$209	2019Q3	20.9%	$222	$30	$252
1.0%	Planning & Environmental Compliance	$123	$17	13.5%	$140	0.0%	$123	$17	$140	2019Q3	20.9%	$149	$20	$169
6.0%	Engineering & Design	$735	$99	13.5%	$834	0.0%	$735	$99	$834	2019Q3	20.9%	$888	$120	$1,008
0.3%	Reviews, ATRs, IEPRs, VE	$31	$4	13.5%	$35	0.0%	$31	$4	$35	2019Q3	20.9%	$37	$5	$43
0.3%	Life Cycle Updates (cost, schedule, risks)	$31	$4	13.5%	$35	0.0%	$31	$4	$35	2019Q3	20.9%	$37	$5	$43
1.0%	Contracting & Reprographics	$123	$17	13.5%	$140	0.0%	$123	$17	$140	2019Q3	20.9%	$149	$20	$169
3.0%	Engineering During Construction	$368	$50	13.5%	$418	0.0%	$368	$50	$418	2020Q3	25.7%	$462	$62	$525
1.0%	Planning During Construction	$123	$17	13.5%	$140	0.0%	$123	$17	$140	2020Q3	25.7%	$155	$21	$175
1.0%	Project Operations	$123	$17	13.5%	$140	0.0%	$123	$17	$140	2019Q3	20.9%	$149	$20	$169
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$490	$44	9.0%	$534	0.0%	$490	$44	$534	2020Q3	25.7%	$616	$55	$671
1.5%	Project Operation:	$184	$17	9.0%	$201	0.0%	$184	$17	$201	2020Q3	25.7%	$231	$21	$252
1.5%	Project Management	$184	$17	9.0%	$201	0.0%	$184	$17	$201	2020Q3	25.7%	$231	$21	$252
	CONTRACT COST TOTALS:	$16,574	$4,071		$20,645		$16,574	$4,071	$20,645			$18,221	$4,410	$22,631

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TPCS

Estimated by USACE LRC
Designed by USACE LRC
Prepared by Adam Tennant
Preparation Date 10/9/2013
Effective Date of Pricing 10/9/2013
Estimated Construction Time Days

Description	ContractCost	ProjectCost
Project Cost Summary Report	145,868,091	145,868,091
1. NED	66,982,140	66,982,140
ALL DPLV09	15,246,396	15,246,396
WBS02	724,000	724,000
WBS11	14,415,696	14,415,696
WBS14	106,700	106,700
ALL DPLV04	12,267,669	12,267,669
WBS02	585,000	585,000
WBS11	11,682,669	11,682,669
ALL DPLV05	11,053,021	11,053,021
WBS02	529,000	529,000
WBS11	10,524,021	10,524,021
ALL DPRS04	7,439,061	7,439,061
WBS02	354,000	354,000
WBS03	6,518,597	6,518,597
WBS14	566,463	566,463
ALL WLRS04	9,442,705	9,442,705
WBS02	468,000	468,000
WBS03	8,974,705	8,974,705
ALL NON-STRUCTURAL	11,533,289	11,533,289
WBS19 NON-STRUCTURAL LAKE	5,862,000	5,862,000
ALL NON-STRUCTURAL COOK	5,671,289	5,671,289
2. NER	63,905,577	63,905,577
WBS06 K-47	15,163,701	15,163,701
0001 MOBILIZATION/DEMOBILIZATION	441,661	441,661
0002 STREAM REMEANDER	135,607	135,607
0003 FILL DITCH	100,998	100,998
0004 DRAIN TILE SURVEY	271,992	271,992
0005 DRAIN TILE VALVES	218,565	218,565
0006 TREE & UNDERSTORY THINNING	761,492	761,492
0007 TREE REMOVAL	1,197,308	1,197,308
0008 HERBACEOUS MANAGEMENT	1,906,933	1,906,933
0009 NATIVE PLANT ESTABLISHMENT	10,129,145	10,129,145
WBS06 K-41	6,569,275	6,569,275
0001 MOBILIZATION/DEMOBILIZATION	191,338	191,338
0002 STREAM REMEANDER	154,281	154,281
0004 DRAIN TILE SURVEY	115,752	115,752
0005 DRAIN TILE VALVES	93,015	93,015
0007 TREE REMOVAL	1,197,308	1,197,308
0008 HERBACEOUS MANAGEMENT	610,219	610,219
0009 NATIVE PLANT ESTABLISHMENT	4,207,363	4,207,363
WBS06 L-43	12,019,909	12,019,909

Description	ContractCost	ProjectCost
0001 MOBILIZATION/DEMOBILIZATION	350,094	350,094
0004 DRAIN TILE SURVEY	149,856	149,856
0005 DRAIN TILE VALVES	120,420	120,420
0006 TREE & UNDERSTORY THINNING	102,335	102,335
0007 TREE REMOVAL	312,743	312,743
0008 HERBACEOUS MANAGEMENT	3,203,648	3,203,648
0009 NATIVE PLANT ESTABLISHMENT	7,780,814	7,780,814
WBS06 L-39	4,801,213	4,801,213
0001 MOBILIZATION/DEMOBILIZATION	139,841	139,841
0002 STREAM REMEANDER	67,968	67,968
0003 FILL DITCH	24,239	24,239
0004 DRAIN TILE SURVEY	66,024	66,024
0005 DRAIN TILE VALVES	53,055	53,055
0006 TREE & UNDERSTORY THINNING	505,655	505,655
0008 HERBACEOUS MANAGEMENT	1,642,505	1,642,505
0009 NATIVE PLANT ESTABLISHMENT	2,301,925	2,301,925
WBS06 L-31	8,508,587	8,508,587
0001 MOBILIZATION/DEMOBILIZATION	247,823	247,823
0004 DRAIN TILE SURVEY	79,800	79,800
0005 DRAIN TILE VALVES	64,125	64,125
0006 TREE & UNDERSTORY THINNING	1,553,083	1,553,083
0007 TREE REMOVAL	71,552	71,552
0008 HERBACEOUS MANAGEMENT	2,580,717	2,580,717
0009 NATIVE PLANT ESTABLISHMENT	3,911,487	3,911,487
WBS06 C-09	8,704,184	8,704,184
0001 MOBILIZATION/DEMOBILIZATION	253,520	253,520
0002 STREAM REMEANDER	0	0
0003 FILL DITCH	0	0
0004 DRAIN TILE SURVEY	136,248	136,248
0005 DRAIN TILE VALVES	109,485	109,485
0006 TREE & UNDERSTORY THINNING	993,251	993,251
0007 TREE REMOVAL	2,284,902	2,284,902
0009 NATIVE PLANT ESTABLISHMENT	4,926,779	4,926,779
WBS06 C-15	8,138,707	8,138,707
0001 MOBILIZATION/DEMOBILIZATION	237,050	237,050
0004 DRAIN TILE SURVEY	112,560	112,560
0005 DRAIN TILE VALVES	90,450	90,450
0006 TREE & UNDERSTORY THINNING	1,191,901	1,191,901
0007 TREE REMOVAL	2,041,624	2,041,624
0008 HERBACEOUS MANAGEMENT	457,664	457,664
0009 NATIVE PLANT ESTABLISHMENT	4,007,458	4,007,458
3. CAP-NED	553,483	553,483

Description	ContractCost	ProjectCost
ALL DPLV01	553,483	553,483
WBS11	553,483	553,483
4. CAP-506	2,175,111	2,175,111
WBS06 Dam #1 Removal	447,639	447,639
1 MOBILIZATION/DEMOBILIZATION	13,150	13,150
2 TEMPORARY FIELD OFFICE AND PROJECT SIGNS	59,307	59,307
3 TRAFFIC CONTROL AND SIGNAGE	50,943	50,943
4 CLEARING AND GRUBBING	6,841	6,841
5 STRIPPING & RESPREADING TOPSOIL	9,841	9,841
6 IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	44,268	44,268
7 SILT TURBIDITY CURTAIN	10,303	10,303
8 SEDIMENT SURVEYING	15,331	15,331
9 SEDIMENT REMOVAL	13,583	13,583
10 DEMOLITION AND REMOVAL OF DAM NO. 1	187,735	187,735
11 TEMPORARY FENCING & GATES	15,091	15,091
12 LANDSCAPE RESTORATION	8,245	8,245
13 PERFORMANCE AND PAYMENT BOND	13,000	13,000
WBS06 Dam #2 Removal	453,175	453,175
1 MOBILIZATION/DEMOBILIZATION	13,199	13,199
2 TEMPORARY FIELD OFFICE AND PROJECT SIGNS	59,307	59,307
3 TRAFFIC CONTROL AND SIGNAGE	50,943	50,943
4 CLEARING AND GRUBBING	6,841	6,841
5 STRIPPING & RESPREADING TOPSOIL	8,619	8,619
6 IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	45,750	45,750
7 SILT TURBIDITY CURTAIN	10,303	10,303
8 SEDIMENT SURVEYING	15,331	15,331
9 SEDIMENT REMOVAL	13,583	13,583
10 DEMOLITION AND REMOVAL OF DAM NO. 2	174,975	174,975
11 TEMPORARY FENCING & GATES	33,078	33,078
12 LANDSCAPE RESTORATION	8,245	8,245
13 PERFORMANCE AND PAYMENT BOND	13,000	13,000
WBS06 Dempster Ave Dam Removal	385,513	385,513
1 MOBILIZATION/DEMOBILIZATION	11,229	11,229
2 TEMPORARY FIELD OFFICE AND PROJECT SIGNS	59,307	59,307
3 TRAFFIC CONTROL AND SIGNAGE	50,943	50,943
4 CLEARING AND GRUBBING	6,841	6,841
5 STRIPPING & RESPREADING TOPSOIL	6,913	6,913
6 IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	30,769	30,769
7 SILT TURBIDITY CURTAIN	10,303	10,303
8 SEDIMENT SURVEYING	15,331	15,331
9 SEDIMENT REMOVAL	13,583	13,583
10 DEMOLITION AND REMOVAL OF DEMPSTER DAM	137,220	137,220

Description	ContractCost	ProjectCost
11 TEMPORARY FENCING & GATES	21,827	21,827
12 LANDSCAPE RESTORATION	8,245	8,245
13 PERFORMANCE AND PAYMENT BOND	13,000	13,000
WBS06 Touhy Ave Dam Removal	478,921	478,921
1 MOBILIZATION/DEMOBILIZATION	14,000	14,000
2 TEMPORARY FIELD OFFICE AND PROJECT SIGNS	59,307	59,307
3 TRAFFIC CONTROL AND SIGNAGE	50,943	50,943
4 CLEARING AND GRUBBING	13,682	13,682
5 STRIPPING & RESPREADING TOPSOIL	17,492	17,492
6 IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	84,343	84,343
7 SILT TURBIDITY CURTAIN	10,303	10,303
8 SEDIMENT SURVEYING	15,331	15,331
9 SEDIMENT REMOVAL	13,583	13,583
10 DEMOLITION AND REMOVAL OF TOUHY DAM	138,747	138,747
11 TEMPORARY FENCING & GATES	39,331	39,331
12 LANDSCAPE RESTORATION	8,859	8,859
13 PERFORMANCE AND PAYMENT BOND	13,000	13,000
WBS06 Dam #4 Removal	409,863	409,863
1 MOBILIZATION/DEMOBILIZATION	12,000	12,000
2 TEMPORARY FIELD OFFICE AND PROJECT SIGNS	59,307	59,307
3 TRAFFIC CONTROL AND SIGNAGE	50,943	50,943
4 CLEARING AND GRUBBING	6,841	6,841
5 STRIPPING & RESPREADING TOPSOIL	9,126	9,126
6 IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	44,875	44,875
7 SILT TURBIDITY CURTAIN	10,303	10,303
8 SEDIMENT SURVEYING	15,331	15,331
9 SEDIMENT REMOVAL	13,583	13,583
10 DEMOLITION AND REMOVAL OF DAM NO. 4	138,747	138,747
11 TEMPORARY FENCING & GATES	26,947	26,947
12 LANDSCAPE RESTORATION	8,859	8,859
13 PERFORMANCE AND PAYMENT BOND	13,000	13,000
5. POLICY NON COMPLIANT	12,251,779	12,251,779
ALL DPBM04	9,773,114	9,773,114
WBS02	340,000	340,000
WBS08	9,433,114	9,433,114
ALL FPCI01	762,665	762,665
WBS02	36,000	36,000
WBS03	726,665	726,665
ALL NON-STRUCTURAL	1,716,000	1,716,000
WBS19 NON-STRUCTURAL KENOSHA	63,000	63,000
WBS19 NON-STRUCTURAL COOK	1,653,000	1,653,000

Description	Contractor	DirectCost	SubCMU	CostToPrime	PrimeCMU	ContractCost
Contract Cost Summary Report		115,431,599	8,236,406	100,878,904	22,200,086	145,868,091
1. NED	PR Prime Contractor	53,807,811	5,928,482	43,006,360	7,245,847	66,982,140
ALL DPLV09	PR Prime Contractor	11,558,508	1,631,853	12,046,486	2,056,035	15,246,396
ALL DPLV04	PR Prime Contractor	9,320,207	1,248,487	9,643,422	1,698,976	12,267,669
ALL DPLV05	PR Prime Contractor	8,358,303	1,260,524	8,783,302	1,434,193	11,053,021
ALL DPRS04	PR Prime Contractor	5,834,491	739,480	5,233,110	865,089	7,439,061
ALL WLRS04	PR Prime Contractor	7,240,438	1,048,137	7,173,176	1,154,130	9,442,705
ALL NON-STRUCTURAL	PR Prime Contractor	11,495,864	0	126,864	37,425	11,533,289
2. NER	PR Prime Contractor	49,678,546	1,635,506	47,771,378	12,591,526	63,905,577
WBS06 K-47	PR Prime Contractor	11,837,321	289,950	11,195,053	3,036,431	15,163,701
WBS06 K-41	PR Prime Contractor	5,111,946	178,506	4,890,347	1,278,823	6,569,275
WBS06 L-43	PR Prime Contractor	9,419,166	13,516	8,812,312	2,587,228	12,019,909
WBS06 L-39	PR Prime Contractor	3,743,482	78,960	3,563,522	978,771	4,801,213
WBS06 L-31	PR Prime Contractor	6,597,076	214,568	6,419,895	1,696,944	8,508,587
WBS06 C-09	PR Prime Contractor	6,708,993	432,950	6,642,690	1,562,242	8,704,184
WBS06 C-15	PR Prime Contractor	6,260,563	427,056	6,247,559	1,451,088	8,138,707
3. CAP-NED		418,110	31,892	450,002	103,481	553,483
ALL DPLV01	PR Prime Contractor	418,110	31,892	450,002	103,481	553,483
4. CAP-506	PR Prime Contractor	1,693,049	54,462	1,618,932	427,601	2,175,111
WBS06 Dam #1 Removal	PR Prime Contractor	348,703	10,029	332,582	88,907	447,639
WBS06 Dam #2 Removal	PR Prime Contractor	352,979	10,063	336,843	90,133	453,175
WBS06 Dempster Ave Dam Removal	PR Prime Contractor	300,923	7,860	284,554	76,730	385,513
WBS06 Touhy Ave Dam Removal	PR Prime Contractor	371,193	16,413	360,606	91,315	478,921
WBS06 Dam #4 Removal	PR Prime Contractor	319,251	10,096	304,347	80,516	409,863
5. POLICY NON COMPLIANT		9,834,083	586,066	8,032,233	1,831,631	12,251,779
ALL DPBM04		7,516,374	585,230	7,486,853	1,671,511	9,773,114
ALL FPCI01	PR Prime Contractor	601,709	836	545,380	160,120	762,665
ALL NON-STRUCTURAL	PR Prime Contractor	1,716,000	0	0	0	1,716,000

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
Project Direct Costs Report		46,834,816	7,017,057	27,564,348	6,775,090	27,240,289	115,431,599
1. NED	PR Prime Contractor	14,930,006	5,048,832	13,601,096	2,526,981	17,700,896	53,807,811
ALL DPLV09	PR Prime Contractor	3,409,237	730,956	4,927,570	515,565	1,975,179	11,558,508
WBS02		0	0	0	0	724,000	724,000
WBS11	PR Prime Contractor	3,393,733	726,557	4,869,184	515,565	1,251,179	10,756,219
1 MOBILZATION AND DEMOBILIZATION		0	0	0	0	419,875	419,875
2 MAINTENANCE OF TRAFFIC	PR Prime Contractor	59,566	0	0	0	0	59,566
3 CLEARING AND GRUBBING	LN Landscaping Contractor	18,160	16,732	0	0	0	34,892
4 FLOODWALL	PR Prime Contractor	2,881,233	538,502	4,853,035	51,652	0	8,324,423
0004AA CONCRETE	CO Concrete Contractor	1,281,320	62,334	1,165,619	11,636	0	2,520,909
0004AB PZ-22	PD Pile Driving Contractor (Land)	1,599,914	476,167	3,687,416	40,016	0	5,803,514
5 ROAD CLOSURE STRUCTURE	PR Prime Contractor	0	0	0	457,913	0	457,913
6 RETAINING WALL MODIFICATIONS	CO Concrete Contractor	109,555	6,074	13,729	6,000	0	135,357
traffic control	CO Concrete Contractor	5,957	0	0	6,000	0	11,957
7 INTERIOR DRAINAGE	PR Prime Contractor	0	0	0	0	831,304	831,304
8 LEVEE	EA Earthwork	325,218	165,250	2,420	0	0	492,888
0006AA STRIPPING	EA Earthwork	26,127	14,341	0	0	0	40,469
0006B IMPERVIOUS FILL	EA Earthwork	269,550	142,893	0	0	0	412,443
0005AC EXCAVATION FOR SLIT TRENCH	EA Earthwork	33,812	6,899	0	0	0	40,711
0009AA SEEDING	EA Earthwork	15,738	440	2,420	0	0	18,598
0009AB TOPSOIL	EA Earthwork	13,803	7,577	0	0	0	21,380
WBS14	PR Prime Contractor	15,504	4,399	58,386	0	0	78,289
TRAIL FOR DPLV09	LN Landscaping Contractor	15,504	4,399	58,386	0	0	78,289
GEOTEXTILE FABRIC	LN Landscaping Contractor	5,753	141	5,682	0	0	11,576
CRUSHED AGGREGATE, CA-7	LN Landscaping Contractor	1,923	1,505	10,031	0	0	13,459
BITUMINOUS BINDER COURSE, 3" THICKNESS	LN Landscaping Contractor	4,920	1,865	27,452	0	0	34,238
BITUMINOUS SURFACE COURSE, 1.5" THICKNESS	LN Landscaping Contractor	2,908	887	15,221	0	0	19,016
ALL DPLV04	PR Prime Contractor	3,282,125	679,891	3,540,270	435,445	1,382,475	9,320,207
WBS02		0	0	0	0	585,000	585,000
WBS11	PR Prime Contractor	3,282,125	679,891	3,540,270	435,445	797,475	8,735,207
1 MOBILZATION AND DEMOBILIZATION		0	0	0	0	340,272	340,272
2 MAINTENANCE OF TRAFFIC	PR Prime Contractor	11,913	0	0	0	0	11,913
3 CLEARING AND GRUBBING	PR Prime Contractor	37,093	6,877	0	0	0	43,970
4 FLOODWALL	CO Concrete Contractor	2,412,734	314,617	2,892,970	434,845	0	6,055,166

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
0004AA CONCRETE	CO Concrete Contractor	1,453,691	33,784	724,478	4,600	0	2,216,553
0004AB STEEL SHEET PILING, PZ-22	PD Pile Driving Contractor (Land)	959,042	280,833	2,168,493	51,377	0	3,459,745
0004AC ROAD CLOSURE STRUCTURE	CO Concrete Contractor	0	0	0	378,868	0	378,868
5 LEVEE	EA Earthwork	542,936	290,568	47,370	0	0	880,873
0006AA STRIPPING	EA Earthwork	34,015	18,671	0	0	0	52,685
0006B IMPERVIOUS FILL	EA Earthwork	475,436	261,716	44,950	0	0	782,102
0005AC EXCAVATION FOR SLIT TRENCH	EA Earthwork	33,812	6,899	0	0	0	40,711
0009AA LEVEE SEEDING	EA Earthwork	15,738	440	2,420	0	0	18,598
0009AB TOPSOIL	EA Earthwork	17,747	9,741	0	0	0	27,488
6 5TH AVE ROAD RAISE	PR Prime Contractor	277,450	67,829	599,930	600	11,138	956,946
0007AA ROAD RECONSTRUCTION	PR Prime Contractor	276,723	67,669	586,130	600	11,138	942,260
BITUMINOUS SURFACE COURSE	PR Prime Contractor	11,998	2,267	55,110	600	0	69,974
Pavement Marking	PR Prime Contractor	0	0	0	600	0	600
PCC BASE COURSE	PR Prime Contractor	48,405	14,383	502,826	0	0	565,614
Sewer Work	PR Prime Contractor	3,362	293	1,376	0	0	5,031
SUB BASE GRANULAR FILL	PR Prime Contractor	3,069	2,142	28,194	0	0	33,405
ROAD DEMO	PR Prime Contractor	213,251	48,878	0	0	11,138	273,267
Hauling & Disposal Cost	PR Prime Contractor	13,592	12,393	0	0	11,138	37,123
0007AB ROAD FILL	PR Prime Contractor	726	160	13,800	0	0	14,686
7 INTERIOR DRAINAGE	PR Prime Contractor	0	0	0	0	446,066	446,066
ALL DPLV05	PR Prime Contractor	3,153,741	814,327	2,759,792	286,963	1,343,480	8,358,303
WBS02		0	0	0	0	529,000	529,000
WBS11	PR Prime Contractor	3,153,741	814,327	2,759,792	286,963	814,480	7,829,303
1 MOBILZATION AND DEMOBILIZATION		0	0	0	0	306,525	306,525
2 MAINTENANCE OF TRAFFIC	PR Prime Contractor	11,913	0	0	0	0	11,913
3 CLEARING AND GRUBBING	PR Prime Contractor	0	0	0	0	70,000	70,000
4 FLOODWALL	CO Concrete Contractor	2,151,072	308,591	2,749,096	280,963	0	5,489,723
4AA CONCRETE	CO Concrete Contractor	1,201,787	31,436	600,969	4,400	0	1,838,592
4AB STEEL SHEET PILING, PZ-22	PD Pile Driving Contractor (Land)	944,698	277,136	2,140,647	47,607	0	3,410,087
4AC ROAD CLOSURE STRUCTURE	CO Concrete Contractor	0	0	0	228,956	0	228,956
4AD ROAD CLOSURE (SANDBAG)	CO Concrete Contractor	4,588	19	7,480	0	0	12,087
5 LEVEE	EA Earthwork	873,236	498,834	6,050	0	0	1,378,120
5AA STRIPPING	EA Earthwork	62,607	34,365	0	0	0	96,972
5AB IMPERVIOUS FILL	EA Earthwork	743,634	429,005	0	0	0	1,172,639
5AC LEVEE SEEDING	EA Earthwork	4,388	1,099	6,050	0	0	11,537
5AD SEEDING TOPSOIL	EA Earthwork	62,607	34,365	0	0	0	96,972
6 INTERIOR DRAINAGE	PR Prime Contractor	0	0	0	0	437,955	437,955
7 RETAINING WALL MODIFICATIONS	CO Concrete Contractor	117,519	6,902	4,646	6,000	0	135,067
traffic control	CO Concrete Contractor	5,957	0	0	6,000	0	11,957
ALL DPRS04	PR Prime Contractor	2,002,369	1,075,036	1,160,720	852,504	743,862	5,834,491

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
WBS02		0	0	0	0	354,000	354,000
WBS03	PR Prime Contractor	1,898,674	986,748	983,931	822,504	364,862	5,056,718
1 MOB & DEMOB		0	0	0	0	189,862	189,862
2 TEMP. FIELD OFF. P. & S. SIGNS	PR Prime Contractor	17,441	1,392	17,406	33,200	0	69,439
0001 Project, Safety and Warning Signs	PR Prime Contractor	1,431	233	1,236	0	0	2,899
Project Sign	PR Prime Contractor	431	72	876	0	0	1,379
Safety Sign	PR Prime Contractor	1,000	161	360	0	0	1,521
0002 Field Office	PR Prime Contractor	16,010	1,160	16,170	33,200	0	66,540
SetUp & Disconnect	PR Prime Contractor	10,134	1,160	2,370	4,000	0	17,663
Maintenance, Office Supplies and Utilities	PR Prime Contractor	5,877	0	13,800	29,200	0	48,877
3 CLEARING AND GRUBBING	PR Prime Contractor	39,862	11,612	0	0	25,000	76,474
4 TOPSOIL	EA Earthwork	82,375	45,216	0	0	0	127,591
5 RESERVOIR CONSTRUCTION	EA Earthwork	1,060,615	882,707	40,600	0	0	1,983,921
AA RESERVOIR EXCAVATION	EA Earthwork	838,027	798,462	0	0	0	1,636,489
DPLV04 DUMP	EA Earthwork	199,257	104,210	0	0	0	303,467
Loading into trucks	EA Earthwork	62,039	15,415	0	0	0	77,453
Hauling & Disposal Cost	EA Earthwork	137,218	88,796	0	0	0	226,014
DPLV05 DUMP	EA Earthwork	369,572	194,708	0	0	0	564,280
Loading into trucks	EA Earthwork	111,495	27,703	0	0	0	139,198
Hauling & Disposal Cost	EA Earthwork	258,076	167,005	0	0	0	425,082
AB IMPERVIOUS LEVEE FILL	EA Earthwork	173,477	52,338	0	0	0	225,815
AC LEVEE TRENCH EXCAVATION/FILL	EA Earthwork	12,162	4,212	0	0	0	16,374
AD LEVEE SEEDING	EA Earthwork	10,408	6,849	21,267	0	0	38,524
AE RESERVOIR SEEDING	EA Earthwork	9,462	6,226	19,333	0	0	35,021
AC SEEDING TOPSOIL	EA Earthwork	17,079	14,620	0	0	0	31,698
6 PUMPSTATION	SU Site Utility Contractor	434,080	34,257	858,076	784,360	150,000	2,260,773
Mechanical	SU Site Utility Contractor	13,562	2,480	32,400	772,000	0	820,442
Pumps, Discharge, Piping and Valves	SU Site Utility Contractor	0	0	0	772,000	0	772,000
Sluice Gates	SU Site Utility Contractor	6,138	1,183	32,400	0	0	39,721
Flap Gates	SU Site Utility Contractor	7,424	1,297	0	0	0	8,721
Plenum & PVC Piping	SU Site Utility Contractor	0	0	0	0	0	0
Electrical	SU Site Utility Contractor	29,035	1,320	269,510	0	150,000	449,865
Electrical Work and Pump Controller	SU Site Utility Contractor	18,922	524	113,525	0	0	132,970
Diesel Generator - Back Up	SU Site Utility	10,113	797	155,985	0	0	166,895

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
	Contractor						
	SU Site Utility						
ComEd Supply for Electric	Contractor	0	0	0	0	150,000	150,000
	SU Site Utility						
Structural	Contractor	389,351	30,456	556,166	12,360	0	988,333
07AC Metalwork Fabrication, Machine Work & Misc.	SU Site Utility						
Metal	Contractor	6,426	830	10,166	0	0	17,422
	SU Site Utility						
Concrete Work	Contractor	376,955	28,101	546,000	0	0	951,057
	SU Site Utility						
07AA Reinforced Concrete Structure and Misc. Metal	Contractor	376,955	28,101	546,000	0	0	951,057
	SU Site Utility						
Grading	Contractor	5,969	1,525	0	12,360	0	19,854
	SU Site Utility						
Painting of Hydraulic Structure	Contractor	2,133	0	0	0	0	2,133
	SU Site Utility						
7 STORM DRAINAGE STRUCTURES	Contractor	53,965	10,614	67,849	4,944	0	137,371
	SU Site Utility						
AA 54" RCP	Contractor	41,686	9,614	63,726	0	0	115,025
	SU Site Utility						
AB HEADWALL 54" DIA	Contractor	10,442	598	2,025	4,944	0	18,010
	SU Site Utility						
AC CATCH BASIN	Contractor	1,837	402	2,098	0	0	4,337
8 DITCH GRADING	EA Earthwork	665	950	0	0	0	1,614
9 MAINTENANCE OF TRAFFIC	PR Prime Contractor	209,672	0	0	0	0	209,672
WBS14	PR Prime Contractor	103,696	88,288	176,789	30,000	25,000	423,773
	LN Landscaping						
REC FEATURES FOR DPRS04 (Bid Item 12)	Contractor	103,696	88,288	176,789	30,000	25,000	423,773
PLANTING MESIC/DRY SAVANNA	PR Prime Contractor	13,920	943	14,955	0	0	29,819
	LN Landscaping						
TREES	Contractor	14,032	3,277	13,000	0	0	30,309
	LN Landscaping						
TRAIL	Contractor	31,465	9,118	126,844	0	0	167,428
	LN Landscaping						
AA GEOTEXTILE FABRIC	Contractor	10,631	261	10,500	0	0	21,392
	LN Landscaping						
AB CRUSHED AGGREGATE, CA-7	Contractor	3,553	2,781	22,144	0	0	28,478
	LN Landscaping						
AC BITUMINOUS BINDER COURSE, 3" THICKNESS	Contractor	10,862	4,118	60,600	0	0	75,580
AD BITUMINOUS SURFACE COURSE, 1.5"	LN Landscaping						
THICKNESS	Contractor	6,420	1,959	33,600	0	0	41,979
PARKING LOT	LN Landscaping	3,432	1,111	8,440	0	0	12,984

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
	Contractor						
EXTRAS	LN Landscaping Contractor	3,022	0	13,550	0	25,000	41,572
ADDITIONAL EXCAVATION	LN Landscaping Contractor	37,823	73,838	0	0	0	111,661
BATHROOM	LN Landscaping Contractor	0	0	0	30,000	0	30,000
ALL WLRS04	PR Prime Contractor	3,056,382	1,741,869	1,118,784	436,504	886,899	7,240,438
WBS02		0	0	0	0	468,000	468,000
WBS03	PR Prime Contractor	3,056,382	1,741,869	1,118,784	436,504	418,899	6,772,438
1 MOBILIZATION/DEMOBILIZATION		0	0	0	0	261,399	261,399
2 TEMPORARY FIELD OFFICE, PROJECT & SAFETY SIGNS	PR Prime Contractor	17,441	1,392	17,406	33,200	0	69,439
0001 Project, Safety and Warning Signs	PR Prime Contractor	1,431	233	1,236	0	0	2,899
Project Sign	PR Prime Contractor	431	72	876	0	0	1,379
Safety Sign	PR Prime Contractor	1,000	161	360	0	0	1,521
0002 Field Office	PR Prime Contractor	16,010	1,160	16,170	33,200	0	66,540
SetUp & Disconnect	PR Prime Contractor	10,134	1,160	2,370	4,000	0	17,663
Maintenance, Office Supplies and Utilities	PR Prime Contractor	5,877	0	13,800	29,200	0	48,877
3 CLEARING AND GRUBBING	PR Prime Contractor	11,959	3,484	0	0	7,500	22,942
4 TOPSOIL STRIPPING	EA Earthwork	78,382	43,024	0	0	0	121,406
5 RESERVOIR CONSTRUCTION	EA Earthwork	2,157,736	1,622,044	36,733	0	0	3,816,513
AA RESERVOIR EXCAVATION	EA Earthwork	300,470	557,574	0	0	0	858,044
AB IMPERVIOUS LEVEE FILL	EA Earthwork	199,498	60,188	0	0	0	259,687
AC MATERIAL HAUL TO IL TOLLWAY	EA Earthwork	1,197,982	727,419	0	0	0	1,925,401
Loading into trucks	EA Earthwork	119,940	29,801	0	0	0	149,741
Hauling & Disposal Cost	EA Earthwork	1,078,042	697,618	0	0	0	1,775,660
AD MATERIAL HAUL TO DPLV09	EA Earthwork	122,333	66,582	0	0	0	188,916
Loading into trucks	EA Earthwork	31,560	7,842	0	0	0	39,402
Hauling & Disposal Cost	EA Earthwork	90,773	58,741	0	0	0	149,514
AE LEVEE TRENCH EXCAVATION/FILL	EA Earthwork	9,845	3,410	0	0	0	13,255
AF LEVEE SEEDING	EA Earthwork	6,623	4,358	13,533	0	0	24,515
AG RESERVOIR SEEDING	EA Earthwork	11,355	7,471	23,200	0	0	42,026
AH SEEDING TOPSOIL	EA Earthwork	16,164	13,837	0	0	0	30,000
AX MATERIAL HAUL TO DPLV05	EA Earthwork	293,465	181,204	0	0	0	474,669
Loading into trucks	EA Earthwork	21,827	5,423	0	0	0	27,250
Hauling & Disposal Cost	EA Earthwork	271,638	175,781	0	0	0	447,419
6 INLET PUMPSTATION	SU Site Utility Contractor	434,080	34,257	858,076	398,360	150,000	1,874,773
Mechanical	SU Site Utility Contractor	13,562	2,480	32,400	386,000	0	434,442
Pumps, Discharge, Piping and Valves	SU Site Utility	0	0	0	386,000	0	386,000

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
	Contractor						
	SU Site Utility						
Sluice Gates	Contractor	6,138	1,183	32,400	0	0	39,721
	SU Site Utility						
Flap Gates	Contractor	7,424	1,297	0	0	0	8,721
	SU Site Utility						
Plenum & PVC Piping	Contractor	0	0	0	0	0	0
	SU Site Utility						
Electrical	Contractor	29,035	1,320	269,510	0	150,000	449,865
	SU Site Utility						
Electrical Work and Pump Controller	Contractor	18,922	524	113,525	0	0	132,970
	SU Site Utility						
Diesel Generator - Back Up	Contractor	10,113	797	155,985	0	0	166,895
	SU Site Utility						
ComEd Supply for Electric	Contractor	0	0	0	0	150,000	150,000
	SU Site Utility						
Structural	Contractor	389,351	30,456	556,166	12,360	0	988,333
07AC Metalwork Fabrication, Machine Work & Misc.	SU Site Utility						
Metal	Contractor	6,426	830	10,166	0	0	17,422
	SU Site Utility						
Concrete Work	Contractor	376,955	28,101	546,000	0	0	951,057
	SU Site Utility						
07AA Reinforced Concrete Structure and Misc. Metal	Contractor	376,955	28,101	546,000	0	0	951,057
	SU Site Utility						
Grading	Contractor	5,969	1,525	0	12,360	0	19,854
	SU Site Utility						
Painting of Hydraulic Structure	Contractor	2,133	0	0	0	0	2,133
	SU Site Utility						
7 STORM DRAINAGE STRUCTURES	Contractor	142,267	30,744	206,569	4,944	0	384,524
	SU Site Utility						
AA 54" RCP	Contractor	128,021	29,557	196,860	0	0	354,438
	SU Site Utility						
AB HEADWALL 54" DIA	Contractor	10,442	598	2,025	4,944	0	18,010
	SU Site Utility						
AC CONCRETE DROP STRUCTURE	Contractor	3,804	588	7,684	0	0	12,076
9 DITCH GRADING	EA Earthwork	4,846	6,924	0	0	0	11,769
11 MAINTENANCE OF TRAFFIC	PR Prime Contractor	209,672	0	0	0	0	209,672
ALL NON-STRUCTURAL	PR Prime Contractor	26,151	6,754	93,959	0	11,369,000	11,495,864
WBS19 NON-STRUCTURAL LAKE		0	0	0	0	5,862,000	5,862,000
ALL NON-STRUCTURAL COOK		26,151	6,754	93,959	0	5,507,000	5,633,864
WBS14 TRAIL FOR BUY OUT AREAS	PR Prime Contractor	26,151	6,754	93,959	0	0	126,864
GEOTEXTILE FABRIC	PR Prime Contractor	8,825	193	7,778	0	0	16,796

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
CRUSHED AGGREGATE, CA-7	PR Prime Contractor	2,951	2,060	16,403	0	0	21,414
BITUMINOUS BINDER COURSE, 3" THICKNESS	PR Prime Contractor	9,040	3,050	44,889	0	0	56,979
BITUMINOUS SURFACE COURSE, 1.5" THICKNESS	PR Prime Contractor	5,335	1,451	24,889	0	0	31,676
WBS19 NON-STRUCTURAL COOK		0	0	0	0	5,507,000	5,507,000
2. NER	PR Prime Contractor	29,106,309	1,531,726	10,272,337	1,681,347	7,086,827	49,678,546
WBS06 K-47	PR Prime Contractor	6,655,096	418,864	2,952,642	490,557	1,320,161	11,837,321
0001 MOBILIZATION/DEMOBILIZATION		0	0	0	0	441,661	441,661
0002 STREAM REMEANDER	EA Earthwork	51,379	48,120	0	0	0	99,499
0002AA BANK GRADING 20:1	EA Earthwork	50,484	46,841	0	0	0	97,325
0002AB DITCH PLUGS	EA Earthwork	895	1,279	0	0	0	2,174
0003 FILL DITCH	EA Earthwork	43,180	30,925	0	0	0	74,105
0004 DRAIN TILE SURVEY		0	0	0	271,992	0	271,992
0005 DRAIN TILE VALVES		0	0	0	218,565	0	218,565
0006 TREE & UNDERSTORY THINNING	LN Landscaping Contractor	537,914	20,816	0	0	0	558,729
0007 TREE REMOVAL	LN Landscaping Contractor	0	0	0	0	878,500	878,500
0008 HERBACEOUS MANAGEMENT	PR Prime Contractor	1,352,672	2,580	117,284	0	0	1,472,535
0009 NATIVE PLANT ESTABLISHMENT	PR Prime Contractor	4,669,952	316,423	2,835,359	0	0	7,821,734
0009AB BASIN MARSH	PR Prime Contractor	1,579,098	106,994	1,046,066	0	0	2,732,158
0009AC SIDE STREAM MARSH	PR Prime Contractor	292,039	19,787	165,883	0	0	477,709
0009AE WET PRAIRIE	PR Prime Contractor	716,322	48,535	560,379	0	0	1,325,236
0009AF MESIC/DRY PRAIRIE	PR Prime Contractor	154,575	10,473	69,926	0	0	234,974
0009AG WET SAVANNA	PR Prime Contractor	218,957	14,836	124,192	0	0	357,985
0009AH MESIC/DRY SAVANNA	PR Prime Contractor	240,127	16,270	257,978	0	0	514,376
0009AJ WET FOREST	PR Prime Contractor	9,221	629	2,979	0	0	12,828
0009AK FLAT WOODS	PR Prime Contractor	201,266	13,637	95,932	0	0	310,835
0009AL OPEN WOODLAND	PR Prime Contractor	1,258,348	85,261	512,024	0	0	1,855,633
WBS06 K-41	PR Prime Contractor	2,486,025	182,076	1,165,240	208,767	1,069,838	5,111,946
0001 MOBILIZATION/DEMOBILIZATION		0	0	0	0	191,338	191,338
0002 STREAM REMEANDER	EA Earthwork	55,879	45,921	11,400	0	0	113,200
0002AA BANK GRADING 20:1	EA Earthwork	45,650	42,356	0	0	0	88,007
0002AB COBBLE RIFFLES	EA Earthwork	10,229	3,564	11,400	0	0	25,194
0004 DRAIN TILE SURVEY		0	0	0	115,752	0	115,752
0005 DRAIN TILE VALVES		0	0	0	93,015	0	93,015
0007 TREE REMOVAL	LN Landscaping Contractor	0	0	0	0	878,500	878,500
0008 HERBACEOUS MANAGEMENT	PR Prime Contractor	432,855	826	37,531	0	0	471,211
0009 NATIVE PLANT ESTABLISHMENT	PR Prime Contractor	1,997,291	135,329	1,116,309	0	0	3,248,929
0009AB BASIN MARSH	PR Prime Contractor	234,907	15,916	155,613	0	0	406,437
0009AC SIDE STREAM MARSH	PR Prime Contractor	377,011	25,545	214,149	0	0	616,705

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
0009AE WET PRAIRIE	PR Prime Contractor	6,090	413	4,764	0	0	11,267
0009AF MESIC/DRY PRAIRIE	PR Prime Contractor	129,924	8,803	58,774	0	0	197,502
0009AG WET SAVANNA	PR Prime Contractor	189,086	12,812	107,249	0	0	309,147
0009AH MESIC/DRY SAVANNA	PR Prime Contractor	171,685	11,633	184,448	0	0	367,766
0009AJ WET FOREST	PR Prime Contractor	21,751	1,474	7,407	0	0	30,631
0009AK FLAT WOODS	PR Prime Contractor	447,194	30,300	213,151	0	0	690,644
0009AL OPEN WOODLAND	PR Prime Contractor	419,643	28,433	170,753	0	0	618,829
WBS06 L-43	PR Prime Contractor	6,172,058	269,734	2,115,505	270,276	591,594	9,419,166
0001 MOBILIZATION/DEMOBILIZATION		0	0	0	0	350,094	350,094
0004 DRAIN TILE SURVEY		0	0	0	149,856	0	149,856
0005 DRAIN TILE VALVES		0	0	0	120,420	0	120,420
0006 TREE & UNDERSTORY THINNING	LN Landscaping Contractor	72,289	2,797	0	0	0	75,086
0007 TREE REMOVAL	PR Prime Contractor	0	0	0	0	241,500	241,500
0008 HERBACEOUS MANAGEMENT	PR Prime Contractor	2,272,489	4,334	197,036	0	0	2,473,860
0009 NATIVE PLANT ESTABLISHMENT	PR Prime Contractor	3,827,280	262,602	1,918,468	0	0	6,008,351
0009AB BASIN MARSH	PR Prime Contractor	812,605	55,059	538,306	0	0	1,405,970
0009AD WET MEADOW	PR Prime Contractor	431,567	32,521	19,896	0	0	483,983
0009AE WET PRAIRIE	PR Prime Contractor	252,888	17,135	197,834	0	0	467,857
0009AH MESIC/DRY SAVANNA	PR Prime Contractor	325,970	22,087	350,202	0	0	698,259
0009AJ WET FOREST	PR Prime Contractor	64,382	4,362	21,924	0	0	90,668
0009AK FLAT WOODS	PR Prime Contractor	13,920	943	6,635	0	0	21,499
0009AL OPEN WOODLAND	PR Prime Contractor	1,925,949	130,495	783,671	0	0	2,840,115
WBS06 L-39	PR Prime Contractor	2,689,086	120,137	675,338	119,079	139,841	3,743,482
0001 MOBILIZATION/DEMOBILIZATION		0	0	0	0	139,841	139,841
0002 STREAM REMEANDER	EA Earthwork	24,449	19,721	5,700	0	0	49,870
0002AA BANK GRADING 20:1	EA Earthwork	19,334	17,939	0	0	0	37,273
0002AC COBBLE RIFFLES	EA Earthwork	5,115	1,782	5,700	0	0	12,597
0003 FILL DITCH	EA Earthwork	10,363	7,422	0	0	0	17,785
0004 DRAIN TILE SURVEY		0	0	0	66,024	0	66,024
0005 DRAIN TILE VALVES		0	0	0	53,055	0	53,055
0006 TREE & UNDERSTORY THINNING	LN Landscaping Contractor	357,192	13,822	0	0	0	371,014
0008 HERBACEOUS MANAGEMENT	PR Prime Contractor	1,165,101	2,222	101,020	0	0	1,268,344
0009 NATIVE PLANT ESTABLISHMENT	PR Prime Contractor	1,131,981	76,949	568,618	0	0	1,777,548
0009AB BASIN MARSH	PR Prime Contractor	233,457	15,818	154,653	0	0	403,928
0009AD WET MEADOW	PR Prime Contractor	40,968	3,026	7,805	0	0	51,799
0009AE WET PRAIRIE	PR Prime Contractor	140,654	9,530	110,034	0	0	260,218
0009AF MESIC/DRY PRAIRIE	PR Prime Contractor	97,153	6,583	43,950	0	0	147,685
0009AL OPEN WOODLAND	PR Prime Contractor	619,749	41,992	252,177	0	0	913,917
WBS06 L-31	PR Prime Contractor	4,716,405	167,481	1,268,941	143,925	300,323	6,597,076

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
0001 MOBILIZATION/DEMOBILIZATION		0	0	0	0	247,823	247,823
0004 DRAIN TILE SURVEY		0	0	0	79,800	0	79,800
0005 DRAIN TILE VALVES		0	0	0	64,125	0	64,125
0006 TREE & UNDERSTORY THINNING	LN Landscaping Contractor	1,097,089	42,454	0	0	0	1,139,543
0007 TREE REMOVAL	LN Landscaping Contractor	0	0	0	0	52,500	52,500
0008 HERBACEOUS MANAGEMENT	PR Prime Contractor	1,830,616	3,492	158,724	0	0	1,992,831
0009 NATIVE PLANT ESTABLISHMENT	PR Prime Contractor	1,788,701	121,535	1,110,218	0	0	3,020,454
0009AB BASIN MARSH	PR Prime Contractor	1,159,165	78,541	767,884	0	0	2,005,590
0009AD WET MEADOW	PR Prime Contractor	52,418	3,891	8,159	0	0	64,468
0009AE WET PRAIRIE	PR Prime Contractor	34,511	2,338	26,998	0	0	63,847
0009AF MESIC/DRY PRAIRIE	PR Prime Contractor	75,692	5,129	34,241	0	0	115,062
0009AH MESIC/DRY SAVANNA	PR Prime Contractor	146,744	9,943	157,653	0	0	314,341
0009AI FOREST FLOODPLAIN	PR Prime Contractor	13,340	904	4,543	0	0	18,787
0009AJ WET FOREST	PR Prime Contractor	212,576	14,403	72,387	0	0	299,367
0009AL OPEN WOODLAND	PR Prime Contractor	94,253	6,386	38,352	0	0	138,991
WBS06 C-09	PR Prime Contractor	2,986,653	183,800	1,362,787	245,733	1,930,020	6,708,993
0001 MOBILIZATION/DEMOBILIZATION		0	0	0	0	253,520	253,520
0002 STREAM REMEANDER	EA Earthwork	0	0	0	0	0	0
0002AA BANK GRADING 20:1	EA Earthwork	0	0	0	0	0	0
0002AB COBBLE RIFFLES	EA Earthwork	0	0	0	0	0	0
0003 FILL DITCH	EA Earthwork	0	0	0	0	0	0
0004 DRAIN TILE SURVEY		0	0	0	136,248	0	136,248
0005 DRAIN TILE VALVES		0	0	0	109,485	0	109,485
0006 TREE & UNDERSTORY THINNING	LN Landscaping Contractor	701,626	27,151	0	0	0	728,777
0007 TREE REMOVAL	LN Landscaping Contractor	0	0	0	0	1,676,500	1,676,500
0009 NATIVE PLANT ESTABLISHMENT	PR Prime Contractor	2,285,026	156,649	1,362,787	0	0	3,804,462
0009AB BASIN MARSH	PR Prime Contractor	74,822	5,070	49,566	0	0	129,458
0009AC SIDE STREAM MARSH	PR Prime Contractor	462,854	31,361	262,909	0	0	757,124
0009AD WET MEADOW	PR Prime Contractor	243,944	18,353	14,088	0	0	276,385
0009AE WET PRAIRIE	PR Prime Contractor	298,709	20,239	233,680	0	0	552,629
0009AF MESIC/DRY PRAIRIE	PR Prime Contractor	271,158	18,373	122,665	0	0	412,196
0009AG WET SAVANNA	PR Prime Contractor	30,451	2,063	17,272	0	0	49,786
0009AH MESIC/DRY SAVANNA	PR Prime Contractor	477,355	32,344	512,841	0	0	1,022,539
0009AI FOREST FLOODPLAIN	PR Prime Contractor	0	0	0	0	0	0
0009AJ WET FOREST	PR Prime Contractor	353,521	23,953	120,382	0	0	497,856
0009AL OPEN WOODLAND	PR Prime Contractor	72,212	4,893	29,383	0	0	106,488
WBS06 C-15	PR Prime Contractor	3,400,985	189,634	731,885	203,010	1,735,050	6,260,563

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
0001 MOBILIZATION/DEMOBILIZATION		0	0	0	0	237,050	237,050
0004 DRAIN TILE SURVEY		0	0	0	112,560	0	112,560
0005 DRAIN TILE VALVES		0	0	0	90,450	0	90,450
0006 TREE & UNDERSTORY THINNING	LN Landscaping Contractor	841,952	32,581	0	0	0	874,533
0007 TREE REMOVAL	LN Landscaping Contractor	0	0	0	0	1,498,000	1,498,000
0008 HERBACEOUS MANAGEMENT	PR Prime Contractor	324,641	619	28,148	0	0	353,409
0009 NATIVE PLANT ESTABLISHMENT	PR Prime Contractor	2,234,392	156,433	703,737	0	0	3,094,562
0009AB BASIN MARSH	PR Prime Contractor	143,554	9,727	95,097	0	0	248,378
0009AD WET MEADOW	PR Prime Contractor	833,356	62,860	32,333	0	0	928,549
0009AE WET PRAIRIE	PR Prime Contractor	104,693	7,094	81,902	0	0	193,688
0009AG WET SAVANNA	PR Prime Contractor	238,971	14,836	139,984	0	0	393,790
0009AH MESIC/DRY SAVANNA	PR Prime Contractor	49,882	3,380	53,590	0	0	106,851
0009AJ WET FOREST	PR Prime Contractor	763,883	51,758	260,121	0	0	1,075,762
0009AL OPEN WOODLAND	PR Prime Contractor	100,053	6,779	40,712	0	0	147,544
3. CAP-NED		57,185	8,980	351,344	600	0	418,110
ALL DPLV01	PR Prime Contractor	57,185	8,980	351,344	600	0	418,110
WBS11	PR Prime Contractor	57,185	8,980	351,344	600	0	418,110
5 ROAD RAISE SATISFACTORY FILL	EA Earthwork	1,679	1,563	106,404	0	0	109,645
6 ROADWAY RECONSTRUCTION	PR Prime Contractor	24,983	7,417	207,935	600	0	240,934
0006AA BITUMINOUS SURFACE COURSE	PR Prime Contractor	3,361	635	15,437	600	0	20,033
Pavement Marking	PR Prime Contractor	0	0	0	600	0	600
0006AB PCC BASE COURSE	PR Prime Contractor	18,552	4,640	164,303	0	0	187,496
Sewer Work	PR Prime Contractor	3,362	293	1,376	0	0	5,031
0006AC SUB BASE GRANULAR FILL	PR Prime Contractor	3,069	2,142	28,194	0	0	33,405
7 CONCRETE CURB & GUTTER	CO Concrete Contractor	30,524	0	37,006	0	0	67,530
4. CAP-506	PR Prime Contractor	909,159	195,838	333,000	213,852	41,200	1,693,049
WBS06 Dam #1 Removal	PR Prime Contractor	193,651	47,675	57,309	41,868	8,200	348,703
1 MOBILIZATION/DEMOBILIZATION		0	0	0	13,150	0	13,150
2 TEMPORARY FIELD OFFICE AND PROJECT SIGNS	PR Prime Contractor	17,438	1,313	17,571	9,475	0	45,797
Project, Safety and Warning Signs	PR Prime Contractor	931	152	1,056	0	0	2,139
Project Sign	PR Prime Contractor	431	72	876	0	0	1,379
Safety Sign	PR Prime Contractor	500	80	180	0	0	760
Field Office	PR Prime Contractor	16,507	1,161	16,515	9,475	0	43,658
SetUp & Disconnect	PR Prime Contractor	16,507	1,161	16,290	4,000	0	37,958
Maintenance, Office Supplies and Utilities	PR Prime Contractor	0	0	225	5,475	0	5,700
3 TRAFFIC CONTROL AND SIGNAGE	PR Prime Contractor	36,134	34	2,920	250	0	39,338
4 CLEARING AND GRUBBING	PR Prime Contractor	3,848	1,035	0	200	200	5,283
5 STRIPPING & RESPREADING TOPSOIL	LN Landscaping Contractor	2,748	3,311	1,161	0	0	7,221

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
6 IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	EA Earthwork	17,560	1,614	13,306	0	0	32,481
7 SILT TURBIDITY CURTAIN	PR Prime Contractor	1,296	111	6,050	500	0	7,956
8 SEDIMENT SURVEYING	PR Prime Contractor	8,935	1,946	0	958	0	11,839
9 SEDIMENT REMOVAL	EA Earthwork	943	730	253	8,041	0	9,966
10 DEMOLITION AND REMOVAL OF DAM NO. 1	PR Prime Contractor	95,082	37,178	8,416	4,294	0	144,969
Wet Demo - Middle Section	PR Prime Contractor	92,304	35,853	0	0	0	128,156
Rip Rap for Scour Trench	PR Prime Contractor	2,778	1,325	8,416	4,294	0	16,813
11 TEMPORARY FENCING & GATES	PR Prime Contractor	7,000	180	4,473	0	0	11,653
12 LANDSCAPE RESTORATION	LN Landscaping Contractor	2,668	223	3,159	0	0	6,050
13 PERFORMANCE AND PAYMENT BOND		0	0	0	5,000	8,000	13,000
WBS06 Dam #2 Removal	PR Prime Contractor	177,741	38,010	80,625	48,403	8,200	352,979
1 MOBILIZATION/DEMOBILIZATION		0	0	0	13,199	0	13,199
2 TEMPORARY FIELD OFFICE AND PROJECT SIGNS	PR Prime Contractor	17,438	1,313	17,571	9,475	0	45,797
Project, Safety and Warning Signs	PR Prime Contractor	931	152	1,056	0	0	2,139
Project Sign	PR Prime Contractor	431	72	876	0	0	1,379
Safety Sign	PR Prime Contractor	500	80	180	0	0	760
Field Office	PR Prime Contractor	16,507	1,161	16,515	9,475	0	43,658
SetUp & Disconnect	PR Prime Contractor	16,507	1,161	16,290	4,000	0	37,958
Maintenance, Office Supplies and Utilities	PR Prime Contractor	0	0	225	5,475	0	5,700
3 TRAFFIC CONTROL AND SIGNAGE	PR Prime Contractor	36,134	34	2,920	250	0	39,338
4 CLEARING AND GRUBBING	PR Prime Contractor	3,848	1,035	0	200	200	5,283
5 STRIPPING & RESPREADING TOPSOIL	LN Landscaping Contractor	2,390	2,773	1,161	0	0	6,324
6 IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	EA Earthwork	15,933	1,544	16,091	0	0	33,568
7 SILT TURBIDITY CURTAIN	PR Prime Contractor	1,296	111	6,050	500	0	7,956
8 SEDIMENT SURVEYING	PR Prime Contractor	8,935	1,946	0	958	0	11,839
9 SEDIMENT REMOVAL	EA Earthwork	943	730	253	8,041	0	9,966
10 DEMOLITION AND REMOVAL OF DAM NO. 2	PR Prime Contractor	75,084	28,121	21,130	10,780	0	135,116
Wet Demo - Middle Section	PR Prime Contractor	68,107	24,792	0	0	0	92,899
Rip Rap for Scour Trench	PR Prime Contractor	6,978	3,329	21,130	10,780	0	42,217
11 TEMPORARY FENCING & GATES	PR Prime Contractor	13,073	180	12,290	0	0	25,543
12 LANDSCAPE RESTORATION	LN Landscaping Contractor	2,668	223	3,159	0	0	6,050
13 PERFORMANCE AND PAYMENT BOND		0	0	0	5,000	8,000	13,000
WBS06 Dempster Ave Dam Removal	PR Prime Contractor	163,757	33,918	55,102	39,947	8,200	300,923
1 MOBILIZATION/DEMOBILIZATION		0	0	0	11,229	0	11,229
2 TEMPORARY FIELD OFFICE AND PROJECT SIGNS	PR Prime Contractor	17,438	1,313	17,571	9,475	0	45,797
Project, Safety and Warning Signs	PR Prime Contractor	931	152	1,056	0	0	2,139

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
Project Sign	PR Prime Contractor	431	72	876	0	0	1,379
Safety Sign	PR Prime Contractor	500	80	180	0	0	760
Field Office	PR Prime Contractor	16,507	1,161	16,515	9,475	0	43,658
SetUp & Disconnect	PR Prime Contractor	16,507	1,161	16,290	4,000	0	37,958
Maintenance, Office Supplies and Utilities	PR Prime Contractor	0	0	225	5,475	0	5,700
3 TRAFFIC CONTROL AND SIGNAGE	PR Prime Contractor	36,134	34	2,920	250	0	39,338
4 CLEARING AND GRUBBING	PR Prime Contractor	3,848	1,035	0	200	200	5,283
5 STRIPPING & RESPREADING TOPSOIL	LN Landscaping Contractor	1,890	2,021	1,161	0	0	5,073
6 IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	EA Earthwork	12,192	1,384	9,000	0	0	22,576
7 SILT TURBIDITY CURTAIN	PR Prime Contractor	1,296	111	6,050	500	0	7,956
8 SEDIMENT SURVEYING	PR Prime Contractor	8,935	1,946	0	958	0	11,839
9 SEDIMENT REMOVAL	EA Earthwork	943	730	253	8,041	0	9,966
10 DEMOLITION AND REMOVAL OF DEMPSTER DAM	PR Prime Contractor	68,311	24,941	8,416	4,294	0	105,962
Wet Demo - Middle Section	PR Prime Contractor	65,533	23,616	0	0	0	89,148
Rip Rap for Scour Trench	PR Prime Contractor	2,778	1,325	8,416	4,294	0	16,813
11 TEMPORARY FENCING & GATES	PR Prime Contractor	10,103	180	6,572	0	0	16,855
12 LANDSCAPE RESTORATION	LN Landscaping Contractor	2,668	223	3,159	0	0	6,050
13 PERFORMANCE AND PAYMENT BOND		0	0	0	5,000	8,000	13,000
WBS06 Touhy Ave Dam Removal	PR Prime Contractor	200,764	40,732	78,379	42,918	8,400	371,193
1 MOBILIZATION/DEMOBILIZATION		0	0	0	14,000	0	14,000
2 TEMPORARY FIELD OFFICE AND PROJECT SIGNS	PR Prime Contractor	17,438	1,313	17,571	9,475	0	45,797
Project, Safety and Warning Signs	PR Prime Contractor	931	152	1,056	0	0	2,139
Project Sign	PR Prime Contractor	431	72	876	0	0	1,379
Safety Sign	PR Prime Contractor	500	80	180	0	0	760
Field Office	PR Prime Contractor	16,507	1,161	16,515	9,475	0	43,658
SetUp & Disconnect	PR Prime Contractor	16,507	1,161	16,290	4,000	0	37,958
Maintenance, Office Supplies and Utilities	PR Prime Contractor	0	0	225	5,475	0	5,700
3 TRAFFIC CONTROL AND SIGNAGE	PR Prime Contractor	36,134	34	2,920	250	0	39,338
4 CLEARING AND GRUBBING	PR Prime Contractor	7,696	2,070	0	400	400	10,566
5 STRIPPING & RESPREADING TOPSOIL	LN Landscaping Contractor	4,854	5,657	2,323	0	0	12,834
6 IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	EA Earthwork	33,453	3,157	25,275	0	0	61,885
7 SILT TURBIDITY CURTAIN	PR Prime Contractor	1,296	111	6,050	500	0	7,956
8 SEDIMENT SURVEYING	PR Prime Contractor	8,935	1,946	0	958	0	11,839
9 SEDIMENT REMOVAL	EA Earthwork	943	730	253	8,041	0	9,966
10 DEMOLITION AND REMOVAL OF TOUHY DAM	PR Prime Contractor	69,120	25,311	8,416	4,294	0	107,140
Wet Demo - Middle Section	PR Prime Contractor	66,342	23,986	0	0	0	90,327

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
Rip Rap for Scour Trench	PR Prime Contractor	2,778	1,325	8,416	4,294	0	16,813
11 TEMPORARY FENCING & GATES	PR Prime Contractor	18,166	180	12,025	0	0	30,371
12 LANDSCAPE RESTORATION	LN Landscaping Contractor	2,731	223	3,546	0	0	6,500
13 PERFORMANCE AND PAYMENT BOND		0	0	0	5,000	8,000	13,000
WBS06 Dam #4 Removal	PR Prime Contractor	173,246	35,503	61,584	40,718	8,200	319,251
1 MOBILIZATION/DEMOBILIZATION		0	0	0	12,000	0	12,000
2 TEMPORARY FIELD OFFICE AND PROJECT SIGNS	PR Prime Contractor	17,438	1,313	17,571	9,475	0	45,797
Project, Safety and Warning Signs	PR Prime Contractor	931	152	1,056	0	0	2,139
Project Sign	PR Prime Contractor	431	72	876	0	0	1,379
Safety Sign	PR Prime Contractor	500	80	180	0	0	760
Field Office	PR Prime Contractor	16,507	1,161	16,515	9,475	0	43,658
SetUp & Disconnect	PR Prime Contractor	16,507	1,161	16,290	4,000	0	37,958
Maintenance, Office Supplies and Utilities	PR Prime Contractor	0	0	225	5,475	0	5,700
3 TRAFFIC CONTROL AND SIGNAGE	PR Prime Contractor	36,134	34	2,920	250	0	39,338
4 CLEARING AND GRUBBING	PR Prime Contractor	3,848	1,035	0	200	200	5,283
5 STRIPPING & RESPREADING TOPSOIL	LN Landscaping Contractor	2,539	2,996	1,161	0	0	6,696
6 IDOT CA-6 FOR ACCESS ROAD & STAGING / STORAGE AREA	EA Earthwork	17,802	1,625	13,500	0	0	32,926
7 SILT TURBIDITY CURTAIN	PR Prime Contractor	1,296	111	6,050	500	0	7,956
8 SEDIMENT SURVEYING	PR Prime Contractor	8,935	1,946	0	958	0	11,839
9 SEDIMENT REMOVAL	EA Earthwork	943	730	253	8,041	0	9,966
10 DEMOLITION AND REMOVAL OF DAM NO. 4	PR Prime Contractor	69,120	25,311	8,416	4,294	0	107,140
Wet Demo - Middle Section	PR Prime Contractor	66,342	23,986	0	0	0	90,327
Rip Rap for Scour Trench	PR Prime Contractor	2,778	1,325	8,416	4,294	0	16,813
11 TEMPORARY FENCING & GATES	PR Prime Contractor	12,462	180	8,167	0	0	20,809
12 LANDSCAPE RESTORATION	LN Landscaping Contractor	2,731	223	3,546	0	0	6,500
13 PERFORMANCE AND PAYMENT BOND		0	0	0	5,000	8,000	13,000
5. POLICY NON COMPLIANT		1,832,157	231,680	3,006,571	2,352,310	2,411,365	9,834,083
ALL DPBM04		1,586,135	187,344	2,799,783	2,328,360	614,751	7,516,374
WBS02		0	0	0	0	340,000	340,000
WBS08		1,586,135	187,344	2,799,783	2,328,360	274,751	7,176,374
1 MOBILIZATION AND DEMOBILZATION		0	0	0	0	274,751	274,751
2 TEMPORARY FIELD OFFICE, PROJ SIGNS	PR Prime Contractor	1,920	0	26,860	0	0	28,780
3 CLEARING AND GRUBBING	LN Landscaping Contractor	49,397	12,055	0	7,000	0	68,452
4 ROADWAY RECONSTRUCTION	EA Earthwork	657,210	66,843	1,595,179	313,983	0	2,633,216
PAVEMENT REMOVAL	EA Earthwork	93,426	32,987	0	43,450	0	169,863

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
NEW PAVEMENT	EA Earthwork	563,785	33,855	1,595,179	259,733	0	2,452,553
PAVEMENT MARKING	EA Earthwork	0	0	0	10,800	0	10,800
5 BRIDGE RECONSTRUCTION	PR Prime Contractor	661,969	98,637	639,289	2,000,177	0	3,400,071
DEMOLITION	PR Prime Contractor	21,994	12,489	0	448,830	0	483,313
Bridge Deck/Pier Removal	PR Prime Contractor	21,994	12,489	0	448,830	0	483,313
NEW BRIDGE	PR Prime Contractor	639,975	86,148	639,289	1,551,347	0	2,916,758
Precast Concrete Beams Beams	PR Prime Contractor	0	0	0	567,000	0	567,000
New Abutments/Piers	PR Prime Contractor	639,975	86,148	639,289	0	0	1,365,411
Temp Cofferdams	PR Prime Contractor	118,134	32,972	110,760	0	0	261,867
Footings	PR Prime Contractor	21,953	69	31,329	0	0	53,351
Piers/Cap	PR Prime Contractor	196,487	13,676	89,100	0	0	299,263
Piling HP12x53	PR Prime Contractor	106,915	25,753	319,000	0	0	451,667
Abutments	PR Prime Contractor	196,487	13,676	89,100	0	0	299,263
Concrete Deck/Parapet	PR Prime Contractor	0	0	0	984,347	0	984,347
6 SEEDING	LN Landscaping Contractor	26,175	769	4,235	0	0	31,179
7 ROAD RAISE FILL	EA Earthwork	7,937	7,392	503,100	0	0	518,429
8 MAINTENANCE OF TRAFFIC	PR Prime Contractor	181,527	1,648	31,120	7,200	0	221,495
ALL FPC101	PR Prime Contractor	246,022	44,336	206,787	23,950	80,614	601,709
WBS02		0	0	0	0	36,000	36,000
WBS03	PR Prime Contractor	246,022	44,336	206,787	23,950	44,614	565,709
1 MOB & DEMOB		0	0	0	0	21,165	21,165
2 TEMP. FIELD OFF. P. & S. SIGNS	PR Prime Contractor	13,053	1,392	12,421	14,950	0	41,817
0001 Project, Safety and Warning Signs	PR Prime Contractor	2,920	233	2,366	0	0	5,519
Project Sign	PR Prime Contractor	431	72	876	0	0	1,379
Safety Sign	PR Prime Contractor	569	89	300	0	0	958
Warning Signs	PR Prime Contractor	1,920	72	1,190	0	0	3,182
0002 Field Office	PR Prime Contractor	10,134	1,160	10,055	14,950	0	36,298
SetUp & Disconnect	PR Prime Contractor	10,134	1,160	2,370	4,000	0	17,663
Maintenance, Office Supplies and Utilities	PR Prime Contractor	0	0	7,685	10,950	0	18,635
3 CLEARING AND GRUBING	PR Prime Contractor	8,123	1,506	0	0	0	9,630
4 EARTHWORK - TRENCH EXCAVATION FOR STRUCTURES	PR Prime Contractor	36,918	28,702	0	0	23,079	88,699
Loading into trucks	PR Prime Contractor	1,978	462	0	0	0	2,440
Hauling & Disposal Cost	PR Prime Contractor	28,166	25,681	0	0	23,079	76,926
5 SEEDING	LN Landscaping Contractor	180	125	387	0	0	691
6 STORM DRAIN STRUCTURES	PR Prime Contractor	70,465	10,882	12,615	9,000	0	102,962
0006AA 12" RCP	PR Prime Contractor	7,817	400	3,701	0	0	11,919
0006AB PIPE JACKING	PR Prime Contractor	61,383	10,473	8,760	9,000	0	89,616
0006AC 12" HEADWALL	PR Prime Contractor	1,264	9	154	0	0	1,428
7 PUMPSTATION	PR Prime Contractor	107,932	625	161,346	0	0	269,903

Description	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
0007AA REINF. CONC. STR. & MISC. METAL	PR Prime Contractor	45,389	264	21,952	0	0	67,606
0007AC METALWORK FABRICATION, MACHINE WORK & MISC. METAL	PR Prime Contractor	4,367	295	5,494	0	0	10,156
0007AD ELEC. WK & PUMP CONTROLIER	PR Prime Contractor	32,340	0	62,595	0	0	94,935
0007AE PAINTING OF HYDRAULIC STRUCTURE	PR Prime Contractor	1,474	0	0	0	0	1,474
8 RIPRAP	LN Landscaping Contractor	2,868	317	768	0	0	3,954
9 MAINTENANCE OF TRAFFIC	PR Prime Contractor	6,483	786	19,250	0	370	26,889
ALL NON-STRUCTURAL	PR Prime Contractor	0	0	0	0	1,716,000	1,716,000
WBS19 NON-STRUCTURAL KENOSHA		0	0	0	0	63,000	63,000
WBS19 NON-STRUCTURAL COOK		0	0	0	0	1,653,000	1,653,000

US Army Corps
of Engineers®

Upper Des Plaines River and Tributaries, Illinois and Wisconsin

Cost and Schedule Risk Analysis Report for the Integrated Feasibility Report and Environmental Assessment

Prepared for:

U.S. Army Corps of Engineers,
Chicago District

Prepared by:

U.S. Army Corps of Engineers
Chicago District

Date: May 9, 2014

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APPENDIX

EXECUTIVE SUMMARY

Report Purpose:
Under the auspices of the US Army Corps of Engineers (USACE), Chicago District, this report presents the results of a cost and schedule risk analysis (CSRA) for the Upper Des Plaines River and Tributaries, Integrated Feasibility Report and Environmental Assessment. In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a formal risk analysis study was conducted by the Chicago District for the identification of project risks and needed cost and schedule contingencies necessary to support completion of the project.

The work is currently in the feasibility stage and will be shared with the civil works review board shortly. The project was broken into .The CSRA focused on all aspects of the future work. A large portion of the project costs are in real estate (approximately 29%). Real estate risks were considered by others and were not a part of the CSRA. As a result of this, the value of real estate was not included in the contingency calculations. Of the remainder, Fish and Wildlife facilities, mostly comprised of eco-restoration projects, compose approximately 50% of the project cost. The remainder of the costs is in Reservoirs, Roads, Railroads & Bridges, Levees and Floodwalls and Recreational Facilities. Planning, Engineering and Design (PED) costs are estimated as 15% of the construction contract excluding the Lands and Damages value for non-ecosystem projects and 10% for ecosystem projects. Construction Management costs
for this account is estimated as 7% of the construction contract value for non-ecosystem projects and 6% for ecosystem projects..

The bulk of the risks are overwhelmingly in preliminary design, early concept estimate, scope, and time value of money. External factors affecting risk include the escalation of fuel and materials additionally bidding climate. An overall contingency of 37.5% was determined from CSRA process and for the NED portion a contingency of 26.9%.
CAP 205, CAP 206, and Non-Policy Compliant all of which had separate contingencies developed from (ARA) had percentages of 35.5%, 30%, and 30% respectively.
The result is a recommended 42.8% contingency to support completion of the project. The various percentages equates to an approximate $66 million on the estimated $387 million project costs and represents the District's recommended contingency with a theoretical 80% chance of successful execution.

Background:
The Upper Des Plaines River watershed originates Racine and Kenosha counties of southeastern Wisconsin. The watershed then extends south into Illinois through Lake County and then Cook County, where it converges with the Salt Creek watershed near Riverside, Illinois. The Des Plaines River then flows southwest on to its confluence with the Kankakee River, where the two rivers combine to form the Illinois River. The project area includes the entire drainage area upstream of the confluence with Salt Creek, including 12 major tributaries to the river. The Upper Des Plaines watershed covers approximately 484 square miles, an area that spans approximately 60 miles from north to south and 8 miles from east to west. The Upper Des Plaines River travels over 69 miles before its confluence with Salt Creek. Tributaries within the project area include about 330 miles of perennial and intermittent streams. Communities along the Upper Des Plaines River and its tributaries have experienced major flooding resulting in hundreds of millions of dollars in damages over the past several decades.

Project Scope:

This project has two primary purposes: further reduction of flooding along the mainstem and tributaries, and environmental restoration of degraded ecosystems within the basin. Secondary purposes are improving water quality and enhancing recreational opportunities throughout the basin. The project will consider multiple sites located within tributary watersheds and along the mainstem for both Flood Risk Management (FRM) and Ecosystem Restoration (ER) potential. The effects of FRM sites within tributary watersheds on mainstem flooding will also be evaluated. For more information see the

Integrated Feasibility Report and Environmental Assessment. Scope of work is based on funding assumptions. They are the Continuing Authorities Plan (CAP), the Policy Compliant Plan (PCP), and the Full Plan. This CSRA is based on scope contained in the Full Plan, which contains the widest (more costly) scope. Major project features include levees, floodwalls, reservoirs and eco-restoration at multiple sites.

Risk Analysis Results:

The entire DPII project at his point was broken into parts at the bequest of headquarters due to budgeting process. The five categories are NED, NER, CAP 205, CAP 206, and Non-Policy Compliant all of which had separate contingencies developed. The NED & NER groupings had overall detailed Cost and Schedule Risk Analysis (CSRA) which was performed on the entire plan through a certified CSRA team. The remaining CAP 205, CAP 206, and Non-Policy Compliant groupings had Abbreviated Risk Analysis (ARA) to determine contingencies.

A Cost and Schedule Risk Analysis (CSRA) was performed on 07/25/13 on this project to identify the 80% confidence level contingencies for the project. Members involved in the meeting consisted of individuals of different disciplines within USACE and members of the local sponsor(s). The contingencies considered both cost and schedule; the schedule risks then being converted to an additional cost risk.

An overall contingency of 37.5% was determined from CSRA process and for the NED portion a contingency of 26.9%. CAP 205, CAP 206, and Non-Policy Compliant all of which had separate contingencies developed from (ARA) had percentages of 35.5%, 30%, and 30% respectively. The resulting percentages were then applied to the project activities. Real estate contingencies were developed by the CELRB Real Estate office and not included in this analysis. The following results were observed:

Construction Results	Contingency Amount	Contingency %
NED Construction	$28,383,679	35.01%
NED Project Schedule	$2,041,710	2.52%
NED Combined Cost & Schedule	$30,425,390	37.53%
NER Construction	$17,035,124	22.96%
NER Project Schedule	$2,902,920	3.91%
NER Combined Cost & Schedule	$19,938,044	26.87%
ARA CAP 205	$1,383,446	23.71%
ARA CAP 206	$699,738	21.47%
ARA Non Policy Compliant	$4,180,135	20.37%

High Risk Items, Cost:

The following were high risk items affecting cost. The complete risk register can be viewed in Appendix A.

- **Risk TL-1, Design is Preliminary:**
  Discussion - Technical information is still not complete. For example the reservoir may need a cutoff wall that is not currently accounted for in the project cost (lacking full geotechnical information). Costs may escalate due to lack of design.

- **Risk EST-1, Early Concept Estimate:**
  Discussion – This estimate is highly correlated with TL-1. As design lacks detail, estimates must contain generalizations until design is defined further. Many features have limited scope definition.
- **Risk PPM-1, Scope Not Clearly Defined:**
  Discussion – Direction and timing of the project may be unclear. There is a possibility of scope creep. Local sponsor/partner participation and federal commitment has yet to be determined.

- **Risk EST-8, Time Value of Money:**
  Discussion – The project spans decades. Many different escalation factors can be used to adjust for the time value of money. Selecting the correct escalation factor can make a large difference in the overall project cost. CWCCIS is the most likely factor that will be used and may not be conservative enough to cover these costs.

High Risk Items, Schedule:

The following items were high risk items affecting the project schedule. The complete risk register can be viewed in Appendix A.

- **Risk EST-1, Early Concept Estimate:**
  Discussion – This estimate is highly correlated with TL-1. As design lacks detail, estimates must contain generalizations until design is defined further. Many features have limited scope definition.

- **Risk TL-7, Induced Flooding:**
  Discussion - Analysis currently shows that we are not raising flood stages to a level that constitutes a taking from a Federal perspective. This makes the projects difficult to support for local sponsors due to increased costs (100%

non-fed costs). If modeling is incorrect, or if local sponsors are forced to deal with the insignificant impacts, additional costs may be incurred. We would need to identify flowage easements where flooding could occur or site additional compensatory storage at local sponsor cost.

- **Risk PPM-4, Changes in Staff:**
  Discussion - With a project completion of 2036, staff turnover is expected both at USACE and with the Local Sponsor(s). Steps can be taken to minimize the impacts through proper documentation and knowledge transfer.

Mitigation Recommendations:
A positive outcome of the CSRA was a thorough discussion of the risks and their mitigation measures. PDT members worked through each risk item and how the risks would affect the overall project. Some of the risks could be partially or completely mitigated through additional engineering and design efforts. Those that could not were addressed so that their affects could be minimized. Some of the risks could not be mitigated such as adverse weather and funding issues.

Major recommendations are as follows for high risk items:
TL-1 – Design is Preliminary, PPM-1 – Scope Not Clearly Defined & EST-1 – Early Concept Estimate: All three of these risks are related (and correlated in the CSRA). Further develop and refine design and site selection. These sites need to be discussed with partners for design finalization. Other recommendations were discussed within the CSRA meeting and design team members were called into the meetings at different times to discuss priorities.

Total Project Cost Summary:
The following table portrays the full costs of the project features based on the anticipated contracts. Costs are in thousands of dollars. The 34.6% contingency is based on an 80% confidence level, as per USACE Civil Works guidance.

NED Baseline Cost Estimate	$81,080,000		
Confidence Level	Contingency ($)	Contingency (%)	Total
50%	$26,174,646	32.28%	$107,254,64
80%	**$30,425,390**	**37.53%**	**$111,505,390**
95%	$34,368,340	42.39%	$115,448,340
NER Baseline Cost Estimate	**$74,188,577**		
Confidence Level	Contingency ($)	Contingency (%)	Total
50%	$15,888,245	21.42%	$90,076,822
80%	**$19,938,044**	**26.87%**	$94,126,621
95%	$23,952,758	32.29%	$98,141,335

Table 1: Results from Two Cost and Schedule Risk Analysis

	Abbreviated Risk Analysis		
Classification	Contingency ($)	Contingency (%)	Total
ARA CAP 205	$1,383,446	23.71%	$5,833,075
ARA CAP 206	$699,738	21.47%	$3,257,850
ARA Non Policy Compliant	$4,180,135	20.37%	$20,514,914

Table 2: Results from Three Abbreviated Risk Analysis

1. PURPOSE

This Cost and Schedule Risk Analysis (CSRA) is for Upper Des Plaines River and Tributaries, Integrated Feasibility Report and Environmental Assessment. The project's primary missions are floodwater reduction and eco-restoration. The project is currently in the feasibility level of development. Major project features include levees, floodwalls, reservoirs and eco-restoration at multiple sites.

The purpose for this CSRA is to analyze different risk components in the project and their affects on cost and schedule. The outcome is a contingency calculation at the recommended confidence level for both cost and schedule that are measured in terms of dollars and Years, respectively. The most common and recommended contingency has been established at 80 percent confidence.

2. BACKGROUND

The Upper Des Plaines River watershed originates in Racine and Kenosha counties of southeastern Wisconsin. The watershed then extends south into Illinois through Lake County and then Cook County, where it converges with the Salt Creek watershed near Riverside, Illinois. The Des Plaines River then flows southwest on to its confluence with the Kankakee River, where the two rivers combine to form the Illinois River. The study area for this Study includes the entire drainage area upstream of the confluence with Salt Creek, including 12 major tributaries to the river. The Upper Des Plaines watershed covers approximately 484 square miles, an area that spans approximately 60 miles from north to south and 8 miles from east to west. The Upper Des Plaines River travels over 69 miles before its confluence with Salt Creek. Tributaries within the study area include about 330 miles of perennial and intermittent streams.

Development in the watershed coincided with the development of the Chicago metropolitan area. Although the southern portion of the watershed in and around Chicago is more urbanized than the northern portion of Lake County in Illinois and Kenosha and Racine Counties in Wisconsin, land use changes have impacted the entire study area. Only 9% of the current land use remains as natural open space. Communities along the Upper Des Plaines River and its tributaries have experienced major flooding resulting in hundreds of millions of dollars in damages over the past several decades.

3. REPORT SCOPE

The scope of the risk analysis report is to calculate and present the cost and schedule contingencies at the 80 percent confidence level using the risk analysis processes as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for both cost and schedule risks for all project features. The study and presentation can include or exclude consideration for operation and maintenance or life cycle costs, depending upon the program or decision document intended for funding.

4. USACE RISK ANALYSIS PROCESS

The risk analysis process follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering Directory of Expertise for Civil Works (Cost Engineering DX). The risk analysis process reflected within the risk analysis report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. The risk analysis results are intended to serve several functions, one being the establishment of reasonable contingencies reflective of an 80 percent confidence level to successfully accomplish the project work within that established contingency amount. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as provide tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, cost and schedule risk analyses should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting, and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, the risk analysis is performed to meet the requirements and recommendations of the following documents and sources:

ER 1110-2-1150, Engineering and Design for Civil Works Projects.

ER 1110-2-1302, Civil Works Cost Engineering.

ETL 1110-2-573, Construction Cost Estimating Guide for Civil Works.

Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering DX.

Memorandum from Major General Don T. Riley (U.S. Army Director of Civil Works), dated July 3, 2007.

Engineering and Construction Bulletin issued by James C. Dalton, P.E. (Chief, Engineering and Construction, Directorate of Civil Works), dated September 10, 2007.

5. METHODOLOGY/PROCESS

A CSRA meeting was held in the CESAJ office on 7/25/13. Participants include the following members. Note that the meetings included key sponsor participants:

Organization	Title
CELRC-TS-DC	Cost Engineer
CELRC-PM-PL-F	Chief, Economic Formulation and Analysis Section
CELRC-PM-PM	Project Manager
CELRC-TS-DC	Cost Engineer
CELRC-TS-D-HH	Hydraulics Engineer
CELRC-TS-D-C	Chief, Cost and Civil Engineering
CELRE-RE	Real Estate Specialist
CELRC-TS-D-HE	Environmental Engineering
CELRC-TS-C-C	Construction-Operations
CELRC-RE	Real Estate Specialist
CELRC-TS-D-C	Civil Engineer
CELRC-TS-D-T	Structural Engineer
IDNR-OWR	Chief, Engineering Studies Section
IDNR-OWR	Director, Office of Water Resources
LCSMC	Regulatory Engineer Supervisor
LCSMC	Executive Director
Kenosha County	Director, Division of Planning Operations
CELRC-PM-PL-F	Lead Planner

CELRC – US Army Corps of Engineers, Chicago District
CELRE – US Army Corps of Engineers, Detroit District
IDNR-OWR – Illinois Department of Natural Resources, Office of Water Resources
LCSMC – Lake County Stormwater Management Commission

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve any desired level of cost confidence. A parallel process is also used to determine the probability of various project schedule duration outcomes and quantify the required schedule contingency (float) needed in the schedule to achieve any desired level of schedule confidence.

In simple terms, contingency is an amount added to an estimate (cost or schedule) to allow for items, conditions, or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should ba applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost Engineering DX guidance for cost and schedule risk analysis generally focuses on the 80-percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk adverse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes. Because Crystal Ball is an Excel add-in, the schedules for each option are recreated in an Excel format from their native format. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results would be provided in section 7.

5.1 Identify and Assess Risk Factors

Identifying the risk factors via the PDT are considered a qualitative process that results in establishing a risk register that serves as the document for the further study using the Crystal Ball risk software. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

Checklists or historical databases of common risk factors are sometimes used to facilitate risk factor identification. However, key risk factors are often unique to a project and not readily derivable from historical information. Therefore, input from the entire PDT is obtained using creative processes such as brainstorming or other facilitated risk assessment meetings. In practice, a combination of professional judgment from the PDT and empirical data from similar projects is desirable and is considered.

A Formal PDT meeting was held in CELRC on 7/25/13 for the purposes of identifying and assessing risk factors. Discussions also included the Illinois Department of Natural Resources – Office of Water Resources, Lake County Stormwater Management Commission and Kenosha County. The initial formal meeting focused primarily on risk factor identification using brainstorming techniques, but also included some facilitated discussions based on risk factors common to projects of similar scope and geographic location. Subsequent meetings focused primarily on risk factor assessment and quantification. Additionally, numerous conference calls and informal meetings were conducted throughout the risk analysis process on an as-needed basis to further facilitate risk factor identification, market analysis, and risk assessment.

5.2 Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans are analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts are quantified using probability distributions (density functions), because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involves multiple project team disciplines and functions. However, the quantification process relies more extensively on collaboration between cost engineering, designers, and risk analysis team members with lesser inputs from other functions and disciplines.

The following is an example of the PDT quantifying risk factor impacts by using an iterative, consensus-building approach to estimate the elements of each risk factor:

- Maximum possible value for the risk factor.
- Minimum possible value for the risk factor.
- Most likely value (the statistical mode), if applicable.
- Nature of the probability density function used to approximate risk factor uncertainty.
- Mathematical correlations between risk factors.
- Affected cost estimate and schedule elements.

Risk discussions focused on the various project features as presented within the USACE Civil Works Work Breakdown Structure for cost accounting purposes. It was recognized that the various features carry differing degrees of risk as related to cost, schedule, design complexity, and design progress. It was also understood that features were in various phases of design and construction, varying risks further. The example features under study are presented in Table 3:

01	LANDS AND DAMAGES*
02	RELOCATIONS*
03	RESERVOIRS
06	FISH & WILDLIFE FACILITIES
11	LEVEES & FLOODWALLS
14	RECREATION FACILITIES
19	BUILDINGS, GROUNDS & UTILITIES
30	PLANNING, ENGINEERING & DESIGN
31	CONSTRUCTION MANAGEMENT

* Indicates features not considered in this CSRA

Table 3. Work Breakdown Structure by Feature

The resulting product from the PDT discussions is captured within a risk register as presented in section 7 for both cost and schedule risk concerns. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions are meant to support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

5.3 Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. *Monte Carlo* simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the base cost estimate. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by *Monte Carlo* simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

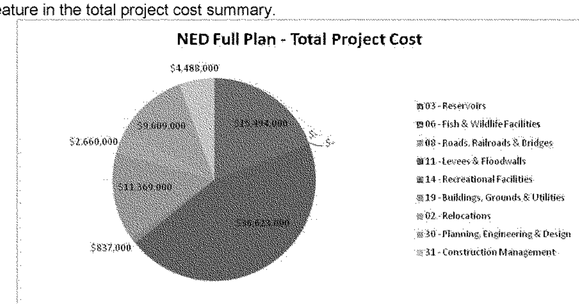
For schedule contingency analysis, the option schedule contingency is calculated as the difference between the P80 option duration forecast and the base schedule duration. These contingencies are then used to calculate the time value of money impact of project delays that are included in the presentation of total cost contingency in section 6. The resulting time value of money, or added risk escalation, is then added into the contingency amount to reflect the USACE standard for presenting the "total project cost" for the fully funded project amount.

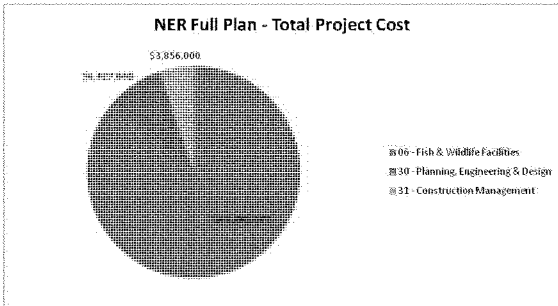
Schedule contingency is analyzed only on the basis of each option and not allocated to specific tasks. Based on Cost Engineering DX guidance, only critical path and near critical path tasks are considered to be uncertain for the purposes of contingency analysis.

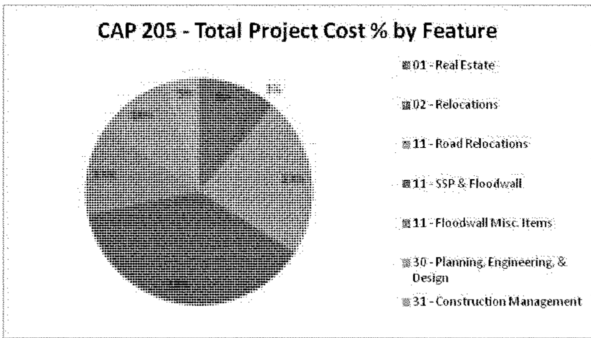
6. KEY CONSIDERATIONS AND ASSUMPTIONS

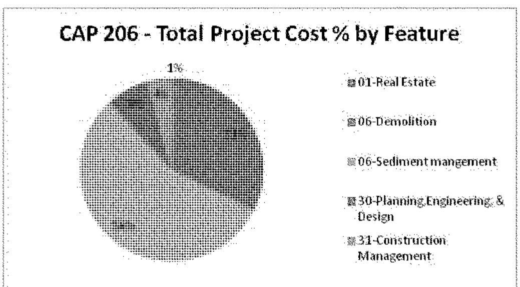
Key assumptions include the following:

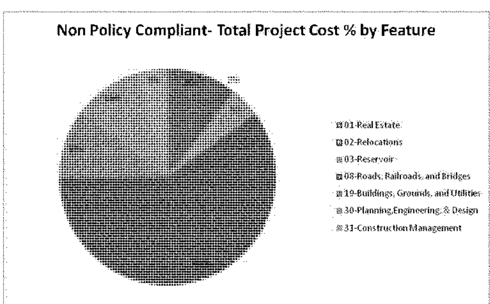
- Remaining project features will be awarded as multiple projects.
- The project schedule is presented in the main report.
- The project is currently at the feasibility level of design.
- Real Estate is not included in the CSRA. Contingencies for real estate were prepared by others.
- Relocations are calculated as a percentage of construction costs, as recommended by the Real Estate Specialist. As so, they were not included in the computations for the CSRA. Contingencies computed by the CSRA were added to this feature in the total project cost summary.











- The remaining components are at the feasibility level of design. The design PDT believes that many features will change as H&H modeling is completed.
- Life Cycle costs have not been included in this cost estimate.
- Funding is 65% federal, 35% non-federal & 100% non-compliant (non-compliant work will be done entirely by the local sponsor).

7. RISK ANALYSIS RESULTS

7.1 Risk Register

Risk is unforeseen or unknown factors that can affect a project's cost or schedule. Time and money have a direct relationship due to the time value of money. A risk register is a tool commonly used in project planning and risk analysis and serves as the basis for the risk studies and Crystal Ball risk models. The risk register describes risks in terms of cost and schedule. A summary risk register that includes typical risk events studied (high and moderate levels) is presented in this section. The risk register reflects the results of risk factor identification and assessment, risk factor quantification, and contingency analysis. A more detailed risk register is provided in Appendix A. The detailed risk registers of Appendix A include low level and unrated risks, as well as additional information regarding the specific nature and impacts of each risk.
It is important to note that a risk register can be an effective tool for managing and communicating identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls.
- Communicating risk management issues.
- Providing a mechanism for eliciting risk analysis feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

A correlation is a dependency that exists between two risks and may be direct or indirect. An indirect correlation is one in which large values of one risk are associated with small values of the other. Indirect correlations have correlation coefficients between 0 and -1. A direct correlation is one in which large values of one risk are associated with large values of the other. Direct correlations have correlation coefficients between 0 and 1. Correlations were identified in this analysis.

The risk register identifies thirty one different risks that are either moderate or high risks. An abridged version of the risk register is presented below.

Risk No.	Risk/Opportunity Event	Project Cost Risk Level*	Project Schedule Risk Level*
Internal Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)			
PROJECT & PROGRAM MGMT			
PPM-1	Scope Definition	HIGH	LOW
PPM-4	Changes In Staff	MODERATE	HIGH
PPM-6	National Funding Priorities	HIGH	MODERATE
PPM-8	FPDCC Support	LOW	HIGH
CONTRACT ACQUISITION RISKS			
CA-1	Acquisition Strategy	HIGH	MODERATE
CA-3	Multiple Separate Contracts	MODERATE	LOW
CA-4	Non-Structural Acquisitions	MODERATE	LOW
TECHNICAL RISKS			
TL-1	Design is Preliminary	HIGH	MODERATE
TL-2	Surveys Preliminary (Flood Risk Management)	HIGH	LOW
TL-3	Geotechnical	HIGH	MODERATE
TL-7	Induced Flooding	HIGH	HIGH
TL-8	Spoil Disposal Coordination	HIGH	HIGH
TL-9	Reservoir Connecting Channel	MODERATE	LOW
LANDS AND DAMAGES RISKS			
RISKS	INCLUDED ELSEWHERE	INCLUDED	RISK
REGULATORY AND ENVIRONMENTAL RISKS			
RE-4	Permitting	LOW	MODERATE
RE-6	Monitoring Ecosystem Restoration	MODERATE	LOW
CONSTRUCTION RISKS			
CON-5	Differing Site Conditions	MODERATE	MODERATE
CON-6	Site Constraints	LOW	MODERATE
CON-8	User Requests	MODERATE	MODERATE
CON-9	Traffic Control	LOW	MODERATE
CON-10	Railroad Involvement	LOW	MODERATE
CON-11	DOT Involvement	MODERATE	MODERATE
ESTIMATE AND SCHEDULE RISKS			

EST-1	Early Concept Project	HIGH	HIGH
EST-4	Quantity Assumptions on Preliminary Concepts	HIGH	LOW
EST-5	Crews and Productivity	MODERATE	LOW
EST-8	Time Value of Money	MODERATE	LOW
EST-9	Driving Range Cost	MODERATE	LOW

EXTERNAL RISKS			
EXT-5	Non-Structural Acquisitions	MODERATE	LOW

7.2 Cost Risk Analysis - Cost Contingency Results

The project Cost Contingency at the 80% confidence level is 29.24%. This level was established by analyzing the different cost risk factors that affect the project. Cost risks that were specific to individual project features were discussed in detail. For example, risk EST-9, "Driving Costs Range" references risks associated with the replacement of a golf driving range which is a specific feature. Other risks apply to the entire project such as CON-8, "User Requests" which would affect all remaining features. Cost contingencies can be either positive or negative. The cost sensitivity chart shows relative cost contingency of individual risks. The sum of all the risks would be 100% of the cost contingency. See the cost sensitivity chart below:

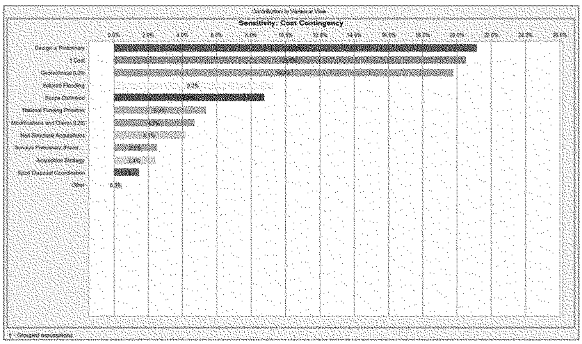


Figure: Sensitivity Chart for NED Cost Risk

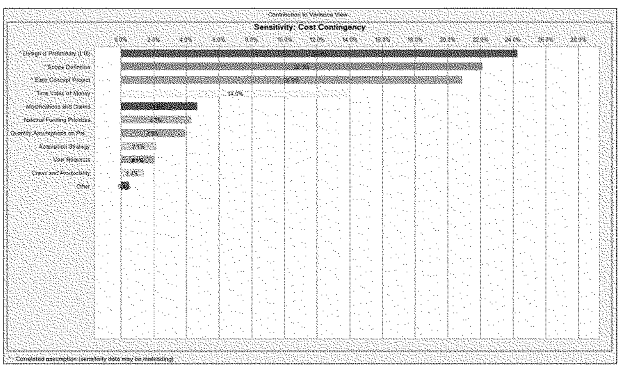


Figure: Sensitivity Chart for NER Cost Risk

Schedule Contingency Results

The project Schedule Contingency at the 80% confidence level is 27.54%. This level was established by analyzing the different schedule risk factors that affect the project. The risk sensitivity chart shows relative schedule contingency of individual risks. The sum of all the risks would be 100% of the risk contingency. See the schedule risk sensitivity chart below:

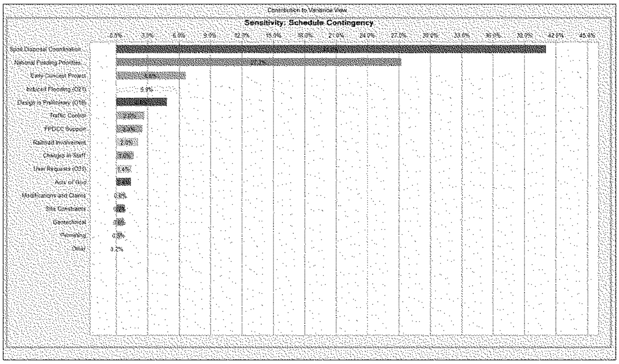


Figure: Sensitivity Chart for NED Cost Risk Schedule Risk Analysis

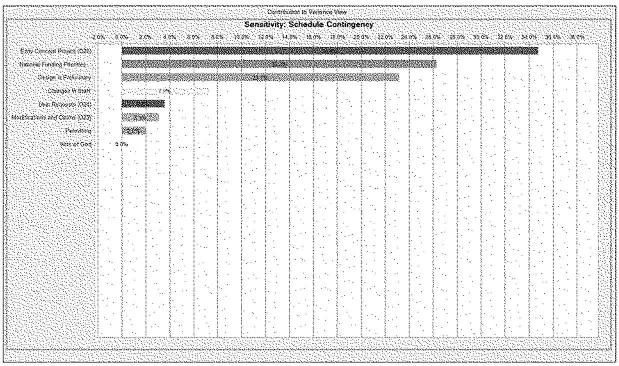


Figure: Sensitivity Chart for NER Cost Risk Schedule Risk Analysis

7.3 Combined Cost and Schedule Contingency Results

The combined cost and schedule risk results are presented below. These exclude real estate risks. The contingency below represent a combination of cost and schedule and includes the time value of money. The amount at the 80% confidence level is shown below.

Portion	Confidence Level	Contingency ($)	Contingency (YR)	Contingency (%)
NED	80%	$30,425,390	2.9 YRS	37.53%
NER	80%	$19,938,044	2.4 YRS	26.87%

Costs are indicative of amounts to be added all features.

8. MAJOR FINDINGS/OBSERVATIONS

8.1 Risk Analysis Results

A Cost and Schedule Risk Analysis (CSRA) was performed on 7/25/13 on this project to identify the 80% confidence level contingencies for the remaining construction activities. The contingencies considered both cost and schedule; the schedule risks then being converted to an additional cost risk. The resulting 37.53% and 26.87% for NED and NER portions respectively was applied to the remaining project activities such as Design and Construction Management. Real Estate contingencies were provided by the Real Estate Specialist and were not a part of the CSRA. Further, Relocations were calculated as a percentage of the construction costs, at the request of the Real Estate Specialist and were not considered in the CSRA. Please note that actual contingency carried in the TPCS will be greater than the following numbers as the contingency for construction was added to the relocations costs. The following results were observed:

Construction Results	Contingency Amount	Contingency %
NED Construction	$28,383,67	35.01%
NED Project Schedule	$2,041,710	2.52%
NED Combined Cost & Schedule	$30,425,390	37.53%

NER Construction	$17,035,124	22.96%
NER Project Schedule	$2,902,920	3.91%
NER Combined Cost & Schedule	$19,938,044	26.87%

8.2 Real Estate Risks

As previously stated, Real Estate risks and relocations were considered outside the scope of this CSRA. The following statement for real estate risks was provided by the Real Estate Specialist, "The real estate contingency, also known as incremental costs, have been developed through the appraisal process. Two separate incremental cost percentages have been developed for real estate. First, all NED sites and NER sites in Cook County and Lake County have concluded a 10% contingency based on unknown improvements being affected and unknown economic remnants. NER sites owned by the potential non-Federal sponsors and easements through public and unimproved land have less risk of excessive costs. Two exceptions to this conclusion have been made, both for the large acreage ecosystem restoration sites K47 and K41. Both are large acreages, existing farms, multiple ownerships, and carry higher acquisition risks. An incremental cost of 20% has been concluded for both sites based on the possibility of negotiation latitude above estimated market value and potential for excessive condemnation costs."

8.3 High Cost Risk Items

The following were high risk items affecting cost. The complete risk register can be viewed in Appendix A.

- **Risk PPM-1, Scope Not Clearly Defined:**
  Discussion – Direction and timing of the project may be unclear. There is a possibility of scope creep. Local sponsor/partner participation and federal commitment has yet to be determined. This risk was correlated with TL-1 and EST-1.

- **Risk PPM-6, Competing National Funding Priorities:**
  Discussion - Projects within the study may or may not take precedence; outside projects may draw resources away from or towards this project.

- **Risk CA-1, Undefined Acquisition Strategy:**
  Discussion – There are multiple elements to the plan and it is uncertain which type of contracting mechanism will be most beneficial. We don't know who (which Government agency-Full Plan) will take the lead on each of the elements.

- **Risk TL-1, Design is Preliminary:**
  Discussion - Technical information is still not complete. For example the reservoir may need a cutoff wall that is not currently accounted for in the project cost (lacking full geotechnical information). Costs may escalate due to lack of design. This risk was correlated with PPM-1 and EST-1.

- **Risk TL-2, Surveys Preliminary (Flood Risk Management):**
  Discussion – Additional Survey information is needed to complete the design. This is not unusual for feasibility report and can be refined in PED.

- **Risk TL-3, Geotechnical:**
  Discussion – Construction and design of levees and floodwalls may be impacted. Unsuitable materials may need to be removed and replaced with suitable fill. If unsuitable materials are found, redesign will be required or in the worst case the entire project may be not feasible.

- **Risk TL-7, Induced Flooding:**
  Discussion – Analysis currently shows that we are not raising flood stages to a level that constitutes a taking from a Federal perspective. This makes the projects difficult to support for local sponsors due to increased costs (100% non-fed costs). If modeling is incorrect, or if local sponsors are forced to deal with the insignificant impacts, additional costs may be incurred. We would need to identify flowage easements where flooding could occur or site additional compensatory storage at local sponsor cost.

- **Risk TL-8, Spoil Disposal Coordination:**
  Discussion – Spoil disposal costs are one of the largest factors in stormwater disposal facility costs. USACE has assumed that a portion of the spoils will be accepted by the local Tollway Authority to be used on their projects. This requires timing and coordination between the two organizations. If the schedules do not mesh properly, construction costs will increase as USACE will need to locate another (probably more costly) disposal method.

- **Risk EST-1, Early Concept Estimate:**
  Discussion – This estimate is highly correlated with TL-1. As design lacks detail, estimates must contain generalizations until design is defined further. Many features have limited scope definition. This risk was correlated with PPM-1 and TL-1.

- **Risk EST-4, Quantity Assumptions on Preliminary Concepts:**
  Discussion – DPII quantities have had a significant amount of development time, which has resulted in high quality documentation. Though the documents approach the quality of PED documentation the investigations that they are based on are only exploratory. (i.e. topographic data) Design changes probably will cause changes in quantities.

8.4 Moderate Cost Risk Items

The following were moderate risk items affecting cost.

- **Risk PPM-4, Changes in Staff:**
  Discussion – With a project completion of 2036, staff turnover is expected and steps can be taken to minimize the impacts through proper documentation and knowledge transfer.

- **Risk CA-3, Multiple Separate Contracts:**
  Discussion – As the number of contracts increase, inefficiencies increase, and greater procurement costs, take more time, and cost more money. Based on locations of projects there may be areas where efficiencies can be gained by combining projects.

- **Risk CA-4, Non-Structural Acquisitions:**
  Discussion – Current State Law does not allow the current Local Sponsor to implement flood reduction measures to Private Properties. A new Local Sponsor will need to be found, but they also may need to develop a method to implement these FRM's to accomplish project goals.

- **Risk TL-9, Reservoir Connecting Channel:**
  Discussion – Uncertainties exist over how the connection will be made. Multiple properties will be traversed to get from the reservoir to the river. There may be disputes over means, methods and real estate. Unforeseen utility conflicts can exist.

- **Risk RE-6, Monitoring Ecosystem Restoration:**
  Discussion – Project is still in feasibility level of development. Ecological success parameters and decision matrices are not yet fully developed.

- **Risk CON-5, Differing Site Conditions:**
  Discussion – Differing site conditions is the largest cause of contract modifications.

- **Risk CON-8, User Requests:**
  Discussion – User requests are typically for structures and facilities that will be eventually taken over by the local sponsor. These concepts can change as design/development moves forward. Cost and time growth occurs as a result of these changes.

- **Risk CON-11, DOT Involvement:**
  Discussion – Site WLRS04 will require spoils to be disposed of off site. Quantities will be large and require construction of access roads off heavily trafficked roadways. State and local DOT's may not support additional construction traffic generated as a result of construction activities which will affect local traffic conditions.

- **Risk EST-5, Crews and Productivity:**
  Discussion – This risk has been partially mitigated by adjusting productivity to bring unit prices in line with similar bid abstract items. Additional geotechnical information will also allow for better adjustments to rates.

- **Risk EST-8, Time Value of Money:**
  Discussion – Many different escalation factors can be used to adjust for the time value of money. Selecting the correct escalaiton factor can make a large difference in the overall project cost. CWCCIS is the most likely factor that will be used and may not be conservative enough to cover these costs.

- **Risk EST-9, Driving Range Cost:**
  Discussion – Scope and cost for this feature are preliminary. As the project becomes better defined, costs are anticipated to change. Local sponsor input will also likely drive scope change.

- **Risk EXT-5, Non-Structural Acquisitions:**
  Discussion – Individual properties may or may not opt to participate in the flood reduction measures. Exact mechanism for implementation will need to be developed and may impact the number of homeowners that are interested in participation.

8.5 High Schedule Risk Items

The following items were high risk items affecting the project schedule. The complete risk register can be viewed in Appendix A.

- **Risk PPM-4, Changes in Staff:**
  Discussion – With a project completion of 2036, staff turnover is expected and steps can be taken to minimize the impacts through proper documentation and knowledge transfer.

- **Risk PPM-8, Forest Preserve District of Cook County Support:**
  Discussion – Site DPRS04 is locally known as Fullerton Woods in River Grove, IL. Site WLRS04 is locally known as the Harry Semrow Driving Range and Miniature Golf Course. Both properties are owned by the FPDCC. Their mission may be in conflict with USACE mission for this project. They may not support all aspects of the project (land use, tree removal and others)

- **Risk TL-7, Induced Flooding:**
  Discussion – Analysis currently shows that we are not raising flood stages to a level that constitutes a taking from a Federal perspective. This makes the projects difficult to support for local sponsors due to increased costs (100% non-fed costs). If modeling is incorrect, or if local sponsors are forced to deal with the insignificant impacts, additional costs may be incurred. We would need to identify flowage easements where flooding could occur or site additional compensatory storage at local sponsor cost.

- **Risk TL-8, Spoil Disposal Coordination:**
  Discussion – Spoil disposal costs are one of the largest factors in stormwater disposal facility costs. USACE has assumed that a portion of the spoils will be accepted by the local Tollway Authority to be used on their projects. This requires timing and coordination between the two organizations. If the schedules do not mesh properly, construction costs will increase as USACE will need to locate another (probably more costly) disposal method.

- **Risk EST-1, Early Concept Estimate:**
  Discussion – This estimate is highly correlated with TL-1. As design lacks detail, estimates must contain generalizations until design is defined further. Many features have limited scope definition.

8.6 Moderate Schedule Risk Items

The following items were moderate risk items affecting the project schedule. The complete risk register can be viewed in Appendix A.

- **Risk PPM-6, Competing National Funding Priorities:**
  Discussion - Projects within the study may or may not take precedence; outside projects may draw resources away from or towards this project.

- **Risk CA-1, Undefined Acquisition Strategy:**
  Discussion – There are multiple elements to the plan and it is uncertain which type of contracting mechanism will be most beneficial. We don't know who (which Government agency-Full Plan) will take the lead on each of the elements.

- **Risk TL-1, Design is Preliminary:**
  Discussion – Technical information is still not complete. For example the reservoir may need a cutoff wall that is not currently accounted for in the project cost (lacking full geotechnical information). Costs may escalate.

- **Risk TL-3, Geotechnical:**
  Discussion – Construction and design of levees and floodwalls may be impacted. Unsuitable materials may need to be removed and replaced with suitable fill. If unsuitable materials are found, redesign will be required or in the worst case the entire project may be not feasible.

- **Risk RE-4, Permitting:**
  Discussion – Failure of USACE to obtain permits will delay the project. They always take longer than expected.

- **Risk CON-5, Differing Site Conditions:**
  Discussion – Differing site conditions is the largest cause of contract modifications.

- **Risk CON-6, Site Constraints:**
  Discussion – Equipment access, distances to staging areas, lost productivity are all factors. This only applies to the FRM sites.

- **Risk CON-8, User Requests:**
  Discussion – User requests are typically for structures and facilities that will be eventually taken over by the local sponsor. These concepts can change as design/development moves forward. Cost and time growth occurs as a result of these changes.

- **Risk CON-9, Traffic Control:**
  Discussion – Construction along major roadways will require extensive traffic control to ensure the safety of the project. As demographics change, the measures may need to be increased. Additionally, local entities may impose time and noise restrictions.

- **Risk CON-10, Railroad Involvement:**
  Discussion – FRM structures tie into railroad structures in more than one location. We are connecting with their embankment and this will require extensive negotiations to execute the needed plan.

- **Risk CON-11, DOT Involvement:**
  Discussion – Site WLRS04 will require spoils to be disposed of off site. Quantities will be large and require construction of access roads off heavily trafficked roadways. State and local DOT's may not support additional construction traffic generated as a result of construction activities which will affect local traffic conditions.

8.7 Major Findings

For the remaining construction activities, the CSRA suggests a resulting 37.53% and 26.87% for NED and NER portions respectively contingency at the 80% confidence level, exclusive of real estate contingencies. These project contingencies include base cost plus cost and schedule (exclusive of real estate contingencies). Real estate contingencies were derived by others and were not a part of this CSRA.

9. MITIGATION RECOMMENDATIONS

A positive outcome of the CSRA was a thorough discussion of the risks and their mitigation measures. PDT members worked through each risk item and how the risks would affect the overall project. Most all of the risks could be partially or completely mitigated through additional engineering and design efforts. Those that could not were addressed so that their affects could be minimized. For example, PPM-6, Competing National Funding Priorities, was brought to the design team and the Project Manager developed a mitigation and contingency plan. Funding and human resource, real estate and many other factors were discussed at length to derive an acceptable level of risk contingency for both cost and schedule. Some of the risks have a similar root which required more focus from the design team. H&H analysis completion is critical to many of the risk components. Additional emphasis was placed on completion of this aspect of the design. Note that risks PPM-1, TL-1 and EST-1 were correlated (statistically linked) as they were similar in nature.

Recommendations are as follows for high risk items:

- TL-1, Design is Preliminary: Begin design work. This will partially mitigate many risks.
- PPM-1, Scope Not Clearly Defined: Similar to TL-1.
- EST-1, Early Concept Estimate: Similar to TL-1
- EST-8, Time Value of Money: Recommend updating total project cost annually (as required by USACE regulations) to monitor and adjust for escalation.
- TL-7, Induced Flooding: Modeling must be performed before and after implementation as well as field observations to ensure the accuracy of the model.
- PPM-4, Changes in Staff: Steps can be taken to minimize the impacts through proper documentation and knowledge transfer.

Other recommendations were discussed within the CSRA meeting and design team members were called into the meetings at different times to discuss priorities.

APPENDIX A

DETAILED RISK REGISTERS FOR ARA

(CAP 205) Upper DesPlaines River & Tributaries
Feasibility (Recommended Plan)
Abbreviated Risk Analysis

Meeting Date: 25-Jul-13

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	3	4	5
Possible	0	1	2	3	4
Unlikely	0	0	1	2	3

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope Growth							
						Max Potential Cost Growth	75%
PS-1	Relocations	• Investigations sufficient to support design assumptions?	• Design confidence? • Potential for scope growth, added features and quantities? • Investigations sufficient to support design assumptions?	Scope Demolition, Changes in Staff, National Funding Priorities and Forest Preserve District Support are likely to cause changes to the estimate. Scope Definition is still at the feasability level. Changes in Staff can cause changes in project focus, this project has a relatively low benefit/cost ratio giving it a lower funding priority	Likely	Marginal	2
PS-2	Road Relocations	• Design confidence?	• Potential for scope growth, added features and quantities? • Design confidence?	Scope Demolition, Changes in Staff, National Funding Priorities and Forest Preserve District Support are likely to cause changes to the estimate. Scope Definition is still at the feasability level. Changes in Staff can cause changes in project focus, this project has a relatively low benefit/cost ratio giving it a lower funding priority	Likely	Marginal	2
PS-3	SSP & Floodwall	• Water care and diversion fully understood, planned?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	Floodwall is based on previous designs. Costs were parametric based on previous designs	Likely	Marginal	2
PS-4	Floodwall Misc. Items	• Project accomplish intent?	• Potential for scope growth, added features and quantities? • Project accomplish intent?	Misc items include Road Closure structure, landscaping, traffic control and interior drainage. These costs were based on previous designs.	Likely	Marginal	2
PS-12	Remaining Construction Items			No remaining construction items exist as project is not currently under construction. All future construction items are considered in this risk register.	Unlikely	Negligible	0
PS-13	Planning, Engineering, & Design	• Potential for scope growth, added features and quantities?	• Potential for scope growth, added features and quantities?	Scope growth will cause increases in PED costs. More design time will be required by the PDT.	Likely	Marginal	2
PS-14	Construction Management	• Potential for scope growth, added features and quantities?	• Potential for scope growth, added features and quantities?	Scope growth will cause increases in CM costs. More time will be required for site visits	Likely	Marginal	2
Acquisition Strategy							
						Max Potential Cost Growth	30%
AS-1	Relocations	• 8a or small business likely?	• Contracting plan firmly established? • 8a or small business likely?	Contracting plan is not established. There are multiple elements to each plan and it is uncertain who and which mechanism will be utilized. The potential also exists for each plan to be broken out into multiple contracts over time. It is unlikely that relocations will be broken out from the construction contracts unless utilities are required to relocate components of their infrastructure	Possible	Marginal	1
AS-2	Road Relocations	• 8a or small business likely?	• Contracting plan firmly established? • 8a or small business likely?	Contracting plan is not established. There are multiple elements to each plan and it is uncertain who and which mechanism will be utilized. The potential also exists for each plan to be broken out into multiple contracts over time. As the number of contracts increases, inefficiencies increase and project costs increase.	Likely	Marginal	2
AS-3	SSP & Floodwall	• 8a or small business likely?	• Contracting plan firmly established? • 8a or small business likely?	Contracting plan is not established. There are multiple elements to each plan and it is uncertain who and which mechanism will be utilized. As the number of contracts increases, inefficiencies increase and project costs increase. The SSP and floodwall may be broken out	Likely	Marginal	2
AS-4	Floodwall Misc. Items	• 8a or small business likely?	• Contracting plan firmly established? • 8a or small business likely?	Contracting plan is not established. There are multiple elements to each plan and it is uncertain who and which mechanism will be utilized. As the number of contracts increases, inefficiencies increase and project costs increase. These items are more likely to be broken out into separate contracts	Likely	Marginal	2
AS-12	Remaining Construction Items			No remaining construction items exist as project is not currently under construction. All future construction items are considered in this risk register.	Unlikely	Negligible	0
AS-13	Planning, Engineering, & Design	• Contracting plan firmly established?	• 8a or small business likely? • Contracting plan firmly established?	PED costs will increase as the number of contracts increase. More contracts will require more (separate) reviews. More design time will be required by the PDT.	Likely	Marginal	2
AS-14	Construction Management	• Contracting plan firmly established?	• 8a or small business likely? • Contracting plan firmly established?	CM costs will increase as the number of contracts increase. More time will be required for site visits. There will be more documentation by the field. The PMs and contracting officers will have to track more projects.	Likely	Marginal	2

Construction Elements							
						Max Potential Cost Growth	**25%**
CE-1	Relocations			Relocations are calculated as a percentage of construction costs. Scope is not yet defined. Risks are covered under project scope growth.	Unlikely	Negligible	0
CE-2	Road Relocations	• Potential for construction modification and claims?	• Potential for construction modification and claims?	Differing site conditions is the largest cause of contract modifications.	Very LIKELY	Marginal	3
CE-3	SSP & Floodwall	• Special mobilization?	• Potential for construction modification and claims? • Potential for construction modification and claims? • Special mobilization?	Differing site conditions is the largest cause of contract modifications. Mobilization for SSP is different from other types.	Very LIKELY	Marginal	3
CE-4	Floodwall Misc. Items		• Potential for construction modification and claims?	Differing site conditions is the largest cause of contract modifications.	Very LIKELY	Marginal	3
CE-12	Remaining Construction Items			No remaining construction items exist as project is not currently under construction. All future construction items are considered in this risk register.	Unlikely	Negligible	0
CE-13	Planning, Engineering, & Design	• Potential for construction modification and claims?	• Potential for construction modification and claims?	MCDS will increase PED costs.	Very LIKELY	Marginal	3
CE-14	Construction Management	• Potential for construction modification and claims?	• Potential for construction modification and claims?	Mods will increase CM costs slightly. More paperwork and negotiations will be required.	Very LIKELY	Marginal	3
Quantities for Current Scope							
						Max Potential Cost Growth	**20%**
Q-1	Relocations	• Level of confidence based on design and assumptions?	• Level of confidence based on design and assumptions?	Technical information is still not complete. Surveys are not complete. Additional design work may cause increases to costs. Utility relocation costs for lack of design are similar to PS-1	Possible	Negligible	0
Q-2	Road Relocations	• Sufficient investigations to develop quantities?	• Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities?	Technical information is still not complete. Surveys are not complete. Additional design work may cause increases to costs. If assumptions are not correct costs can escalate. Road raise includes borrow fill. Quantities are likely to change as the design gets refined causing changes in costs.	Likely	Critical	4
Q-3	SSP & Floodwall	• Sufficient investigations to develop quantities?	• Level of confidence based on design and assumptions? • Appropriate methods applied to calculate quantities? • Sufficient investigations to develop quantities?	Technical information is still not complete. Surveys are not complete. Additional design work may cause increases to costs. If assumptions are not correct costs can escalate. Sheet pile wall may be at wrong depth or other design assumptions may be invalid. Pile depth has a large affect on cost.	Likely	Critical	4
Q-4	Floodwall Misc. Items	• Sufficient investigations to develop quantities?	• Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities?	Technical information is still not complete. Surveys are not complete. Additional design work may cause increases to costs. If assumptions are not correct costs can escalate.	Likely	Critical	4
Q-12	Remaining Construction Items			No remaining construction items exist as project is not currently under construction. All future construction items are considered in this risk register.	Unlikely	Negligible	0
Q-13	Planning, Engineering, & Design	• Level of confidence based on design and assumptions?	• Level of confidence based on design and assumptions?	PED costs can escalate if current design assumptions are incorrect.	Possible	Significant	2
Q-14	Construction Management			CM costs are not likely to increase unless scope growth occurs. This risk is covered in PS-14.	Unlikely	Negligible	0

Cost Estimate Assumptions

						Max Potential Cost Growth	35%
CT-1	Relocations	• Assumptions related to prime and subcontractor markups/assignments?	• Assumptions related to prime and subcontractor markups/assignments?	Prime and subcontractor markups are a function of contract acquisition planning and are considered in another risk item	Unlikely	Negligible	0
CT-2	Road Relocations	• Assumptions related to prime and subcontractor markups/assignments?	• Assumptions related to prime and subcontractor markups/assignments?	Prime and subcontractor markups are a function of contract acquisition planning and are considered in another risk item	Unlikely	Negligible	0
CT-3	SSP & Floodwall	• Reliability and number of key quotes?	• Reliability and number of key quotes?	Estimate is based on past costs	Very LIKELY	Negligible	2
CT-4	Floodwall Misc. Items	• Assumptions related to prime and subcontractor markups/assignments?	• Assumptions related to prime and subcontractor markups/assignments?	Prime and subcontractor markups are a function of contract acquisition planning and are considered in another risk item.	Unlikely	Negligible	0
CT-12	Remaining Construction Items			No remaining construction items exist as project is not currently under construction. All future construction items are considered in this risk register.	Unlikely	Negligible	0
CT-13	Planning, Engineering, & Design	• Assumptions related to prime and subcontractor markups/assignments?	• Assumptions related to prime and subcontractor markups/assignments?	Prime and subcontractor markups are a function of contract acquisition planning and are considered in another risk item	Unlikely	Negligible	0
CT-14	Construction Management	• Assumptions related to prime and subcontractor markups/assignments?	• Assumptions related to prime and subcontractor markups/assignments?	Prime and subcontractor markups are a function of contract acquisition planning and are considered in another risk item	Unlikely	Negligible	0

External Project Risks

						Max Potential Cost Growth	40%
EX-1	Relocations	• Potential for severe adverse weather?	• Potential for severe adverse weather?	Severe weather is convered in the specifications. The contractor is allowed delays due to adverse weather conditions. PDT did not believe that weather delays would be a factor.	Unlikely	Negligible	0
EX-2	Road Relocations	• Unanticipated inflations in fuel, key materials?	• Potential for severe adverse weather? • Unanticipated inflations in fuel, key materials?	Severe weather is convered in the specifications. The contractor is allowed delays due to adverse weather conditions. PDT did not believe that weather delays would be a factor.	Unlikely	Negligible	0
EX-3	SSP & Floodwall	• Unanticipated inflations in fuel, key materials?	• Unanticipated inflations in fuel, key materials?	Concrete and steel have seen large changes is price over the past five years.	Likely	Marginal	2
EX-4	Floodwall Misc. Items	• Potential for severe adverse weather?	• Potential for severe adverse weather?	Severe weather is convered in the specifications. The contractor is allowed delays due to adverse weather conditions. PDT did not believe that weather delays would be a factor.	Unlikely	Negligible	0
EX-12	Remaining Construction Items	• Potential for severe adverse weather?	• Potential for severe adverse weather?	No remaining construction items exist as project is not currently under construction. All future construction items are considered in this risk register.	Unlikely	Negligible	0
EX-13	Planning, Engineering, & Design	• Potential for severe adverse weather?	• Potential for severe adverse weather?	Severe weather is convered in the specifications. The contractor is allowed delays due to adverse weather conditions. PDT did not believe that weather delays would be a factor.	Unlikely	Negligible	0
EX-14	Construction Management	• Potential for severe adverse weather?	• Potential for severe adverse weather?	Severe weather is convered in the specifications. The contractor is allowed delays due to adverse weather conditions. PDT did not believe that weather delays would be a factor.	Unlikely	Negligible	0

(CAP 206) Upper DesPlaines River & Tributaries, Illinois and Wisconsin Feasibility Study, Feasibility Level Estimate
Feasibility (Recommended Plan)
Abbreviated Risk Analysis

Meeting Date: 25-Jul-13

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	3	4	5
Possible	0	1	2	3	4
Unlikely	0	0	1	2	3

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope Growth							
						Max Potential Cost Growth	75%
PS-1	Demolition	• Design confidence?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Design confidence?	Direction and timing of project may be unclear. Possibility of scope creep (go beyond original intent of dam removal). Key players in the PDT may pursue other opportunities and the base knowledge may be lost. With a project completion multiple years away, staff turnover is expected and steps can be taken to minimize the impacts through proper documentation and knowledge transfer.	Likely	Marginal	2
PS-2	Sediment mangement/remaining activites	• Design confidence?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Design confidence?	Technical information is still not complete. For example the reservoir may need a cutoff wall that is not currently accounted for in the project cost(lacking full geotechnical information). Costs may escalate. Relocations of existing utilities may not be fully represented in the current design.	Likely	Marginal	2
PS-12	Remaining Construction Items	• Potential for scope growth, added features and quantities?	NA	NA	Unlikely	Negligible	0
PS-13	Planning, Engineering, & Design	• Design confidence?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Design confidence?	401 certification, floodway permits are required. Failure of USACE to obtain permits will delay the project. They always take longer than expected. Additional Scope would increase the need for more PED, but that is not anticipated. Scope creep is possible but the chances of this creep making an impact is marginal	Possible	Marginal	1
PS-14	Construction Management	• Design confidence?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Design confidence?	If scope creep is not controlled the need for construction management would increase. LRC has policy in place to keep these costs under control and also to accurately estimate them in the beginning stages of the project. The scope of this project is defined well. Unlikely occurrence with marginal impact.	Unlikely	Marginal	0
Acquisition Strategy							
						Max Potential Cost Growth	30%
AS-1	Demolition	• Limited bid competition anticipated?	• 8a or small business likely? • Limited bid competition anticipated?	Some contracting mechanisms take more/less time and cost more/less money than others. There are multiple elements to the plan and it is uncertain which type of contracting mechanism will be most beneficial. We don't know who (which Government agency-Full Plan) will take the lead on each of the elements.	Likely	Marginal	2
AS-2	Sediment mangement/remaining activites	• Limited bid competition anticipated?	• 8a or small business likely? • Limited bid competition anticipated?	Some contracting mechanisms take more/less time and cost more/less money than others. There are multiple elements to the plan and it is uncertain which type of contracting mechanism will be most beneficial. We don't know who (which Government agency-Full Plan) will take the lead on each of the elements.	Likely	Marginal	2
AS-12	Remaining Construction Items	• Limited bid competition anticipated?	NA	NA	Unlikely	Negligible	0
AS-13	Planning, Engineering, & Design	• Limited bid competition anticipated?	• 8a or small business likely? • Limited bid competition anticipated?	Some contracting mechanisms take more/less time and cost more/less money than others. There are multiple elements to the plan and it is uncertain which type of contracting mechanism will be most beneficial. We don't know who (which Government agency-Full Plan) will take the lead on each of the elements.	Likely	Marginal	2
AS-14	Construction Management	• High-risk acquisition limits competition, design/build?	• 8a or small business likely? • High-risk acquisition limits competition, design/build?	Some contracting mechanisms take more/less time and cost more/less money than others. There are multiple elements to the plan and it is uncertain which type of contracting mechanism will be most beneficial. We don't know who (which Government agency-Full Plan) will take the lead on each of the elements.	Likely	Marginal	2

Construction Elements

						Max Potential Cost Growth	25%
CE-1	Demolition	• Unique construction methods?	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Unique construction methods?	The desired channel morphology may be impacted or not produce the anticipated ecological benefits. Potential down stream impacts can occur. Due to working in a river locations of the debris, and what size equipment can be brought into the river the contractor may have to handle the debris a few times before its actually out of the river and in a dump truck. Assume likely and have a marginal impact	Likely	Marginal	2
CE-2	Sediment mangement/remaining activites	• Unique construction methods?	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Unique construction methods?	There is excessive soil erosion due to timing of the plant material installation. The desired channel morphology may be impacted or not produce the anticipated ecological benefits. Potential down stream impacts can occur.	Likely	Marginal	2
CE-12	Remaining Construction items	• Unique construction methods?	NA	NA	Unlikely	Negligible	0
CE-13	Planning, Engineering, & Design	• Unique construction methods?	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Unique construction methods?	This is a pretty straight forward project with removing dams. The demolition and restoration work is not complex. The rest of the design should go smoothly and just consist of addressing review comments and tightening up the plans and specs. Assume unlikely and negligible	Unlikely	Negligible	0
CE-14	Construction Management	• Unique construction methods?	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Unique construction methods?	This is a pretty straight forward project with removing dams. The demolition and restoration work is not complex. There are quite a few contractors in the area that do both types of work so the likely hood of a lot of mods or claims is low. Assume unlikely and negligible.	Unlikely	Negligible	0

Quantities for Current Scope

						Max Potential Cost Growth	20%
Q-1	Demolition	• Possibility for increased quantities due to loss, waste, or subsidence?	• Level of confidence based on design and assumptions? • Possibility for increased quantities due to loss, waste, or subsidence?	Critical quantities provided as design progress in PED phase could have fluctuations larger than 10%. Dam demo quantities have had a significant amount of development time, which has resulted in high quality documentation. Though the documents approach the quality of PED documentation the investigations that they are based on are only exploratory. (i.e. topographic data) Design changes probably will cause changes in quantities.	Possible	Significant	2
Q-2	Sediment mangement/remaining activites	• Possibility for increased quantities due to loss, waste, or subsidence?	• Level of confidence based on design and assumptions? • Possibility for increased quantities due to loss, waste, or subsidence?	Critical quantities provided as design progress in PED phase could have fluctuations larger than 10%. Dam demo quantities have had a significant amount of development time, which has resulted in high quality documentation. Though the documents approach the quality of PED documentation the investigations that they are based on are only exploratory. (i.e. topographic data) Design changes probably will cause changes in quantities.	Possible	Significant	2
Q-12	Remaining Construction items	• Possibility for increased quantities due to loss, waste, or subsidence?	NA	NA	Unlikely	Negligible	0
Q-13	Planning, Engineering, & Design	• Possibility for increased quantities due to loss, waste, or subsidence?	• Level of confidence based on design and assumptions? • Possibility for increased quantities due to loss, waste, or subsidence?	The LRC designers and planners have a lot of experience with dam removal and restoration work. PDT has high confidence in the design. Assume unlikely with negligible impact	Unlikely	Negligible	0
Q-14	Construction Management	• Possibility for increased quantities due to loss, waste, or subsidence?	• Level of confidence based on design and assumptions? • Possibility for increased quantities due to loss, waste, or subsidence?	PDT has worked on these types of projects with the field and incorporated their "lessons learned" feedback on quantities and units of measure. PDT has a high confidence level that the construction management portion of this job will go well. Multiple quality control placed on product. Assume unlikely with negligible impact.	Unlikely	Negligible	0

Specialty Fabrication or Equipment

						Max Potential Cost Growth	75%
FE-1	Demolition	• Unusual parts, material or equipment manufactured or installed?	NA	NA	Unlikely	Negligible	0
FE-2	Sediment mangement/remaining activites	• Unusual parts, material or equipment manufactured or installed?	NA	NA	Unlikely	Negligible	0
FE-12	Remaining Construction Items	• Unusual parts, material or equipment manufactured or installed?	NA	NA	Unlikely	Negligible	0
FE-13	Planning, Engineering, & Design	• Unusual parts, material or equipment manufactured or installed?	NA	NA	Unlikely	Negligible	0
FE-14	Construction Management	• Unusual parts, material or equipment manufactured or installed?	NA	NA	Unlikely	Negligible	0

Cost Estimate Assumptions

						Max Potential Cost Growth	35%
CT-1	Demolition	• Site accessibility, transport delays, congestion?	• Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	The project scope is currently in a constant state of change. Features are being added and removed. Many features have limited scope definition. This process may cause cost details to inadvertently be added or removed.	Unlikely	Critical	2
CT-2	Sediment mangement/remaining activites	• Reliability and number of key quotes?	• Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	The PDT has taken a conservative approach by using previously constructed/estimated items as a filler until full design is available in PED. Question do remain though that potential assumptions are not conservative enough.	Unlikely	Critical	2
CT-12	Remaining Construction Items	• Reliability and number of key quotes?	NA	NA	Unlikely	Negligible	0
CT-13	Planning, Engineering, & Design	• Reliability and number of key quotes?	• Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	NA	Unlikely	Negligible	0
CT-14	Construction Management	• Reliability and number of key quotes?	• Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	NA	Unlikely	Negligible	0

External Project Risks

						Max Potential Cost Growth	40%
EX-1	Demolition	• Political influences, lack of support, obstacles?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles?	PDT feels confident that time delays will have minimal impact to the overall schedule. Dam removal may generate political opposition and highly motivated proponents and opponents	Unlikely	Critical	2
EX-2	Sediment mangement/remaining activites	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles?	PDT feels confident that time delays will have minimal impact to the overall schedule. Dam removal may generate political opposition and highly motivated proponents and opponents	Unlikely	Critical	2
EX-12	Remaining Construction Items	• Potential for severe adverse weather?	NA	NA	Unlikely	Negligible	0
EX-13	Planning, Engineering, & Design	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles?	High concerns. Several local sponsor on board and wants to do the project the way they desire and the District is having trouble controlling all parties to agree on scope. Although they currently all agree on preferred plan. Assume likely with negligible impacts due to tweaking and would likely only push features around	Likely	Negligible	1
EX-14	Construction Management	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles?	No concerns. The length of the contract should mitigate most risks. Assume unlikely with negligible impacts.	Unlikely	Negligible	0

(Non Policy Compliant) Upper DesPlaines River & Tributaries, Illinois and Wisconsin Feasibility Study, Feasibility Level Estimate
Feasibility (Recommended Plan)
Abbreviated Risk Analysis

Meeting Date: 25-Jul-13

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	3	4	5
Possible	0	1	2	3	4
Unlikely	0	0	1	2	3

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope Growth							
						Max Potential Cost Growth	75%
PS-1	Relocations	• Design confidence?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Design confidence?	Utilities may need to be relocated or upgraded. Roads may need to be relocated , power upgrades, utility relocations all require additional time and $$. There may be unidentified utilities.	Likely	Marginal	2
PS-2	FPC01	• Design confidence?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Design confidence?	Technical information is still not complete. For example this reservoir will need full design of pumpstations that costs may escalate if assumptions were incorrect.	Likely	Marginal	2
PS-3	DPBM04	• Potential for scope growth, added features and quantities?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Design confidence?	Working with local DOT can be tricky. The current design is not a full structural and transportation design. The scope of the major cost item will be driven by the DOT and not USACE. possible cost increases that would be significant.	Possible	Significant	2
PS-4	Non-Structural Measures	• Potential for scope growth, added features and quantities?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Design confidence?	The scope and plans have been constantly changing. It is possible that PED will be different than the current design. This is definitely a possibility, but the more likely result is that items will not be built at all. Some of these switches may also be cheaper off-setting some of the higher priced additions.	Possible	Marginal	1
PS-12	Remaining Construction Items	• Potential for scope growth, added features and quantities?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Design confidence?	NA	Unlikely	Negligible	0
PS-13	Planning, Engineering, & Design	• Design confidence?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Design confidence?	permits will delay the project. They always take longer than expected Additional Scope would increase the need for more PED, but that is not anticipated. Scope creep is possible but the chances of this creep making an impact is marginal	Possible	Marginal	1
PS-14	Construction Management	• Design confidence?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Design confidence?	If scope creep is not controlled the need for construction management would increase. LRC has policy in place to keep these costs under control and also to accurately estimate them in the beginning stages of the project. The scope of this project is defined well. Unlikely occurrence with marginal impact.	Unlikely	Marginal	0
Acquisition Strategy							
						Max Potential Cost Growth	30%
AS-1	Relocations	• Limited bid competition anticipated?	• 8a or small business likely? • Limited bid competition anticipated?	Some contracting mechanisms take more/less time and cost more/less money than others. There are multiple elements to the plan and it is uncertain which type of contracting mechanism will be most beneficial. We don't know who (which Government agency-Full Plan) will take the lead on each of the elements	Likely	Marginal	2
AS-2	FPC01	• Limited bid competition anticipated?	• 8a or small business likely? • Limited bid competition anticipated?	Some contracting mechanisms take more/less time and cost more/less money than others. There are multiple elements to the plan and it is uncertain which type of contracting mechanism will be most beneficial. We don't know who (which Government agency-Full Plan) will take the lead on each of the elements.	Likely	Marginal	2
AS-3	DPBM04	• Contracting plan firmly established?	• 8a or small business likely? • Limited bid competition anticipated?	Some contracting mechanisms take more/less time and cost more/less money than others. There are multiple elements to the plan and it is uncertain which type of contracting mechanism will be most beneficial. We don't know who (which Government agency-Full Plan) will take the lead on each of the elements.	Likely	Marginal	2
AS-4	Non-Structural Measures	• Contracting plan firmly established?	• 8a or small business likely? • Limited bid competition anticipated?	Some contracting mechanisms take more/less time and cost more/less money than others. There are multiple elements to the plan and it is uncertain which type of contracting mechanism will be most beneficial. We don't know who (which Government agency-Full Plan) will take the lead on each of the elements.	Likely	Marginal	2
AS-12	Remaining Construction Items	• Limited bid competition anticipated?	NA	NA	Unlikely	Negligible	0
AS-13	Planning, Engineering, & Design	• Limited bid competition anticipated?	• 8a or small business likely? • Limited bid competition anticipated?	Some contracting mechanisms take more/less time and cost more/less money than others. There are multiple elements to the plan and it is uncertain which type of contracting mechanism will be most beneficial. We don't know who (which Government agency-Full Plan) will take the lead on each of the elements.	Likely	Marginal	2
AS-14	Construction Management	• High-risk acquisition limits competition, design/build?	• 8a or small business likely? • High-risk acquisition limits competition, design/build?	Some contracting mechanisms take more/less time and cost more/less money than others. There are multiple elements to the plan and it is uncertain which type of contracting mechanism will be most beneficial. We don't know who (which Government agency-Full Plan) will take the lead on each of the elements.	Likely	Marginal	2

Construction Elements

						Max Potential Cost Growth	25%
CE-1	Relocations	• Unique construction methods?	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Unique construction methods?	There may be unidentified utilities. Non-Structural flood control work will be impacted the greatest. Utility relocations all require additional time and $$. This work is small in scope since it is mainly concerning residential items but could add up if it occurs over a large percentage of sites	Likely	Marginal	2
CE-2	FPCI01	• Unique construction methods?	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Unique construction methods?	Contractor finds something different than what is indicated. Differing site conditions is the largest cause of contract modifications.Traffic control measures and permits may be different or increase over time from planning to construction. Construction along major roadways will require extensive traffic control to ensure the safety of the project. As demographics change, the measures may need to be increased. Additionally, local entities may impose time and noise restrictions.	Likely	Marginal	2
CE-3	DPBM04	• Potential for construction modification and claims?	• Special equipment or subcontractors needed? • Potential for construction modification and claims?	Working with local DOT can be tricky. The current design is not a full structural and transportation design. The scope of the major cost item will be driven by the DOT and not USACE, possible cost increases that would be significant be driven by specialized design.	Possible	Significant	2
CE-4	Non-Structural Measures	• Potential for construction modification and claims?	• Potential for construction modification and claims?	HTRW investigations have not been done for non structural site most are residential so this should not be an issue. However, additional investigations will be done as the design progresses. The impact associated with HTRW on these sites could eventually add up. Currently, we are trying to avoid these risks, but it may be difficult to avoid all impacts.	Likely	Marginal	2
CE-12	Remaining Construction Items	• Unique construction methods?	NA	NA	Unlikely	Negligible	0
CE-13	Planning, Engineering, & Design	• Unique construction methods?	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Unique construction methods?	NA	Unlikely	Negligible	0
CE-14	Construction Management	• Unique construction methods?	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Unique construction methods?	NA	Unlikely	Negligible	0

Quantities for Current Scope

						Max Potential Cost Growth	20%
Q-1	Relocations	• Possibility for increased quantities due to loss, waste, or subsidence?	• Level of confidence based on design and assumptions? • Possibility for increased quantities due to loss, waste, or subsidence?	Critical quantities provided as design progress in PED phase could have fluctuations larger than 10% DPII quantities have had a significant amount of development time, which has resulted in high quality documentation. Though the documents approach the quality of PED documentation the investigations that they are based on are only exploratory. (i.e. topographic data) Design changes probably will cause changes in quantities.	Possible	Significant	2
Q-2	FPCI01	• Possibility for increased quantities due to loss, waste, or subsidence?	• Level of confidence based on design and assumptions? • Possibility for increased quantities due to loss, waste, or subsidence?	Critical quantities provided as design progress in PED phase could have fluctuations larger than 10% DPII quantities have had a significant amount of development time, which has resulted in high quality documentation. Though the documents approach the quality of PED documentation the investigations that they are based on are only exploratory. (i.e. topographic data) Design changes probably will cause changes in quantities.	Possible	Significant	2
Q-3	DPBM04	• Level of confidence based on design and assumptions?	• Level of confidence based on design and assumptions? • Possibility for increased quantities due to loss, waste, or subsidence?	fluctuations larger than 10% DPII quantities have had a significant amount of development time, which has resulted in high quality documentation. Though the documents approach the quality of PED documentation the investigations that they are based on are only exploratory. (i.e. topographic data) Design changes probably will cause changes in quantities.	Possible	Significant	2
Q-4	Non-Structural Measures	• Level of confidence based on design and assumptions?	• Level of confidence based on design and assumptions? • Possibility for increased quantities due to loss, waste, or subsidence?	fluctuations larger than 10% DPII quantities have had a significant amount of development time, which has resulted in high quality documentation. Though the documents approach the quality of PED documentation the investigations that they are based on are only exploratory. (i.e. topographic data) Design changes probably will cause changes in quantities.	Possible	Significant	2
Q-12	Remaining Construction Items	• Possibility for increased quantities due to loss, waste, or subsidence?	NA	NA	Unlikely	Negligible	0
Q-13	Planning, Engineering, & Design	• Possibility for increased quantities due to loss, waste, or subsidence?	• Level of confidence based on design and assumptions? • Possibility for increased quantities due to loss, waste, or subsidence?	The LRC designers and planners have a lot of experience with all types of work included. PDT has high confidence in the design with the exception of the bridge work. Assume unlikely with marginal impact.	Unlikely	Marginal	0
Q-14	Construction Management	• Possibility for increased quantities due to loss, waste, or subsidence?	• Level of confidence based on design and assumptions? • Possibility for increased quantities due to loss, waste, or subsidence?	PDT has worked on these types of projects with the field and incorporated their "lessons learned" feedback on quantities and units of measure. PDT has a high confidence level that the construction management portion of this job will go well. Multiple quality control placed on product. Assume unlikely with negligible impact.	Unlikely	Negligible	0

Specialty Fabrication or Equipment

						Max Potential Cost Growth	75%
FE-1	Relocations	• Unusual parts, material or equipment manufactured or installed?	NA	NA	Unlikely	Negligible	0
FE-2	FPC01	• Unusual parts, material or equipment manufactured or installed?	NA	NA	Unlikely	Negligible	0
FE-3	OPBM04	• Unusual parts, material or equipment manufactured or installed?	NA	NA	Unlikely	Negligible	0
FE-4	Non-Structural Measures	• Unusual parts, material or equipment manufactured or installed?	NA	NA	Unlikely	Negligible	0
FE-12	Remaining Construction Items	• Unusual parts, material or equipment manufactured or installed?	NA	NA	Unlikely	Negligible	0
FE-13	Planning, Engineering, & Design	• Unusual parts, material or equipment manufactured or installed?	NA	NA	Unlikely	Negligible	0
FE-14	Construction Management	• Unusual parts, material or equipment manufactured or installed?	NA	NA	Unlikely	Negligible	0

Cost Estimate Assumptions

						Max Potential Cost Growth	35%
CT-1	Relocations	• Lack confidence on critical cost items?	• Lack confidence on critical cost items?	The project scope is currently in a constant state of change. Features are being added and removed. Many features have limited scope definition. This process may cause cost details to inadvertently be added or removed such as utility relocations.	Unlikely	Critical	2
CT-2	FPC01	• Lack confidence on critical cost items?	• Site accessibility, transport delays, congestion? • Lack confidence on critical cost items?	The PDT has taken a conservative approach by using previously constructed/estimated items for estimate. Until full design is available in PED. Question do remain though that potential assumptions are not conservative enough. The scope and plans have been constantly changing. It is possible that PED will be different than the current design. This is definitely a possibility, but the more likely result is that items will not be built. This access to this specific feature is tight and could be problematic in terms of traffic control due to the road that intersect project site.	Unlikely	Critical	2
CT-3	OPBM04	• Reliability and number of key quotes?	• Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	It is possible that PED will be different than the current design. This will likely result is that items will not be built at all or specific features will be swapped out for more costly bridge features. Some of these switches may also be cheaper off-setting some of the higher priced additions.	Likely	Marginal	2
CT-4	Non-Structural Measures	• Assumptions regarding crew, productivity, overtime?	• Site accessibility, transport delays, congestion? • Assumptions regarding crew, productivity, overtime?	Restricted staging, storage and workspaces may cause construction issues. Equipment access, distances to staging areas, lost productivity are all factors. These issues are likely with negligible	Likely	Negligible	1
CT-12	Remaining Construction Items	• Reliability and number of key quotes?	NA	NA	Unlikely	Negligible	0
CT-13	Planning, Engineering, & Design	• Reliability and number of key quotes?	• Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	NA	Unlikely	Negligible	0
CT-14	Construction Management	• Reliability and number of key quotes?	• Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	NA	Unlikely	Negligible	0

External Project Risks

						Max Potential Cost Growth	40%
EX-1	Relocations	• Political influences, lack of support, obstacles?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles?	Lightning, tornados, etc. Contractors are required to carry builders risk insurance to cover the costs. Time is typically the only modification offered PDT feels confident that time delays will have minimal impact to the overall schedule	Unlikely	Critical	2
EX-2	FPC01	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles?	Lightning, tornados, etc. Contractors are required to carry builders risk insurance to cover the costs. Time is typically the only modification offered PDT feels confident that time delays will have minimal impact to the overall schedule	Unlikely	Critical	2
EX-3	DPBM04	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles?	insurance to cover the costs. Time is typically the only modification offered PDT feels confident that time delays will have minimal impact to the overall schedule	Unlikely	Critical	2
EX-4	Non-Structural Measures	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles?	insurance to cover the costs. Time is typically the only modification offered PDT feels confident that time delays will have minimal impact to the overall schedule	Unlikely	Critical	2
EX-12	Remaining Construction Items	• Potential for severe adverse weather?	NA	NA	Unlikely	Negligible	0
EX-13	Planning, Engineering, & Design	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles?	High concerns. Several local sponsor on board and wants to do the project the way they desire and the District is having trouble controlling all parties to agree on scope. Although they currently all agree on preferred plan. Assume likely with negligible impacts due to tweaking and would likely only push features around	Likely	Negligible	1
EX-14	Construction Management	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles?	No concerns. The length of the contract should mitigate most risks. Assume unlikely with negligible impacts.	Unlikely	Negligible	0

FOR CONTINUATION OF HOUSE DOCUMENT 114-105

UPPER DES PLAINES RIVER AND TRIBUTARIES, ILLINOIS AND WISCONSIN: INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

SEE PART 2