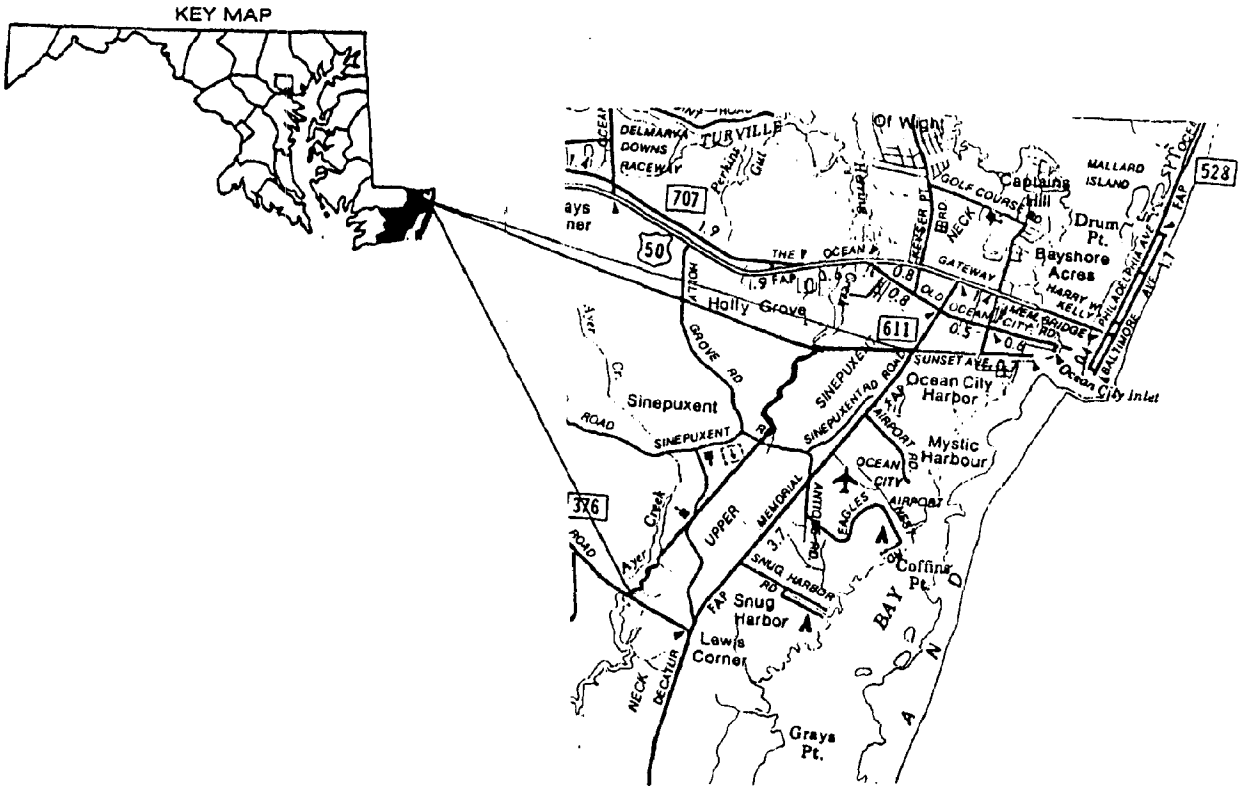
LEWIS ROAD / MD 611
DRAINAGE STUDY

Worcester County, Maryland



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FUNDING FOR THE

LEWIS ROAD/MD 611 DRAINAGE STUDY

WAS MADE POSSIBLE BY

THE COASTAL RESOURCES DIVISION, MARYLAND DEPARTMENT OF NATURAL RESOURCES THROUGH A GRANT PROVIDED BY THE COASTAL ZONE MANAGEMENT ACT OF 1972 AS ADMINISTERED BY THE OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

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LEWIS ROAD/MD ROUTE 611 DRAINAGE STUDY

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SUMMARY

The Lewis Road/MD 611 study area is south of Route U.S. 50 and bound on the east by Route MD 611, on the south by MD 376, on the west by Ayer Creek and on the north by the lands of Historic Railroads, Inc.. The area is approximately 1302 acres of which 931 acres are wood land and 371 acres are open land. Approximately 77 percent of the land is poorly drained.

This study was undertaken to inventory existing drainage and stormwater problems in the study area and to evaluate impacts of development on existing drainage systems. Due to the proximity of Ocean City and based on rapid development patterns within the area, it is projected that this area could be fully developed by the year of 2005. Fully developed is defined in this report as 48 percent impervious surface area. The Worcester County Stormwater Management Code states that any development would have to store the difference between the 2 year pre condition and the 10 year post condition storm runoff. This would require 72 acre feet of storage either on site or off site. The facilities could be shared by multiple developments. The existing drainage channels have deteriorated over the years due to age and lack of maintenance. To correct this problem, it is recommended that the watersheds organize Public Drainage Associations (P.D.A.s) or Public Watershed Associations (P.W.A.s). By using either association, the owners will have a maintenance plan developed with assistance from the U.S. Department of Agriculture and the Maryland Department of Agriculture.

At present, the Ocean City Airport is limited as to the type of aircraft landing at the facility. Predicted population growth and airport usage may dictate airport expansion, namely, runway length. Runway expansion would require

acquisition of additional land, relocation of MD 611 and land use zoning to protect the public as well as the airport. Consideration should be given to total relocation of the airport and use existing area for recreation, Ocean City services or a multi-purpose complex.

Sewage disposal is of major concern with developing areas and extremely important in this study area with soils that are not adapted for this use. Several alternative on-site systems are discussed in this report, but a central water and sewage disposal system should be given strong consideration.

INTRODUCTION

PURPOSE OF STUDY

The purpose of this drainage study is to assess existing drainage problems and the impact of existing and future development on the Lewis Road/MD Rt. 611 area watershed. Data assembled and recommendations presented in study are for the expressed purpose of formulating regulations or policy measures to assist in land use decisions.

AUTHORITY FOR STUDY

Worcester County Commissioners

FUNDING FOR STUDY

Funding for the Lewis Road/MD Rt 611 drainage study was made possible by the Coastal Resource Division, Maryland Department of Natural Resources through a grant provided by the Coastal Zone Management Act of 1972 as administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration.

NATURE OF STUDY

This study reviews water and related land resources to meet present and future needs of the area. It suggests certain alternatives for achieving orderly and beneficial utilization, development and conservation of these resources. Specific evaluations were made for flooding, wetlands, drainage, soils, airport area and waste disposal.

DESCRIPTION OF THE DRAINAGE STUDY AREA

PHYSICAL DATA

The Lewis Road/MD Rt 611 drainage area is bound on the north by the lands of Historic Railroads, Inc.; on the east by MD Rt. 611; on the south by MD Rt. 376; and on the west by Ayer Creek, approximately 5000 feet, and then in a northerly direction to Herring Creek at Historic Railroad, Inc. (See Map No. 1, Map Pocket).

The total drainage area is approximately 1302 acres in which 931 acres are wood land and 371 acres open land. Open land being defined as crop land, house lots, and idle land.

Soils in the study area are of coastal plain origin and approximately 77 percent are poorly drained. The open land soils being used for agricultural purposes are suitable when managed. Other intended purposes such as commercial, etc are discussed later in this report.

Precipitation averages about 43 inches annually and is fairly evenly distributed through the year with a maximum expected in August and a minimum in October or February. Heavy rains during the colder half of the year are usually from low pressure systems moving north or north easterly along the coast. In summer, heavy rains occur mostly in thunderstorms, tropical storms or hurricanes. Thunderstorms occur on an average of 30 days a year with 77 percent of these from May through August. Tropical storms or hurricanes affect the area about once a year, usually between July and November. Many of these cause minor damage through heavy rainfall, strong winds and high tide. Average annual temperature is about 58 degrees F. February has the lowest monthly average at 39 degrees F. And July has the highest at 78 degrees F.

The major water use in the study area is for domestic purposes and a small number of commercial establishments. At present, most of their needs are satisfied by individual wells.

LAND USE

In the study area, approximately 931 acres are wood land and 371 acres are open land. The open land consists of 250 acres being cultivated and 121 acres being home steads, commercial use or idle. Of the total of 1302 acres, approximately 23 percent is non-hydric soils and approximately 77 percent is hydric soils.

With development of most of the land on the island of Ocean City in the past two decades, West Ocean City is rapidly developing to accommodate the overflow. The area between U.S. Rt. 50 and Sunset Avenue is experiencing rapid growth which includes service and supply oriented businesses along with residential (condos). East of the study area and MD Rt. 611, there is the residential development of Mystic Harbor, Ocean City Airport facility, Eagles Nest Mobile Home Park and Campground, Eagles Landing Golfcourse (Town of Ocean City), Frontiertown, Snug Harbor, Assateaque Point Campground Subdivision and The Landings (in planning). On the west side of MD Rt. 611 and in the study area, there is a multi sales/service area, South Point Tennis Club, Real Estate Office, two produce stands, trailer court, service station and Berlin Fire Company building and numerous single-family residences. It appears that some expansion is directed in a southerly direction. The pressures of growth may necessitate that the study area be considered as a potential multi-purpose growth area. The Worcester County Comprehensive Development Plan identifies the study area as suburban residential, which is moderate-density residential, suburban commercial, cluster developments

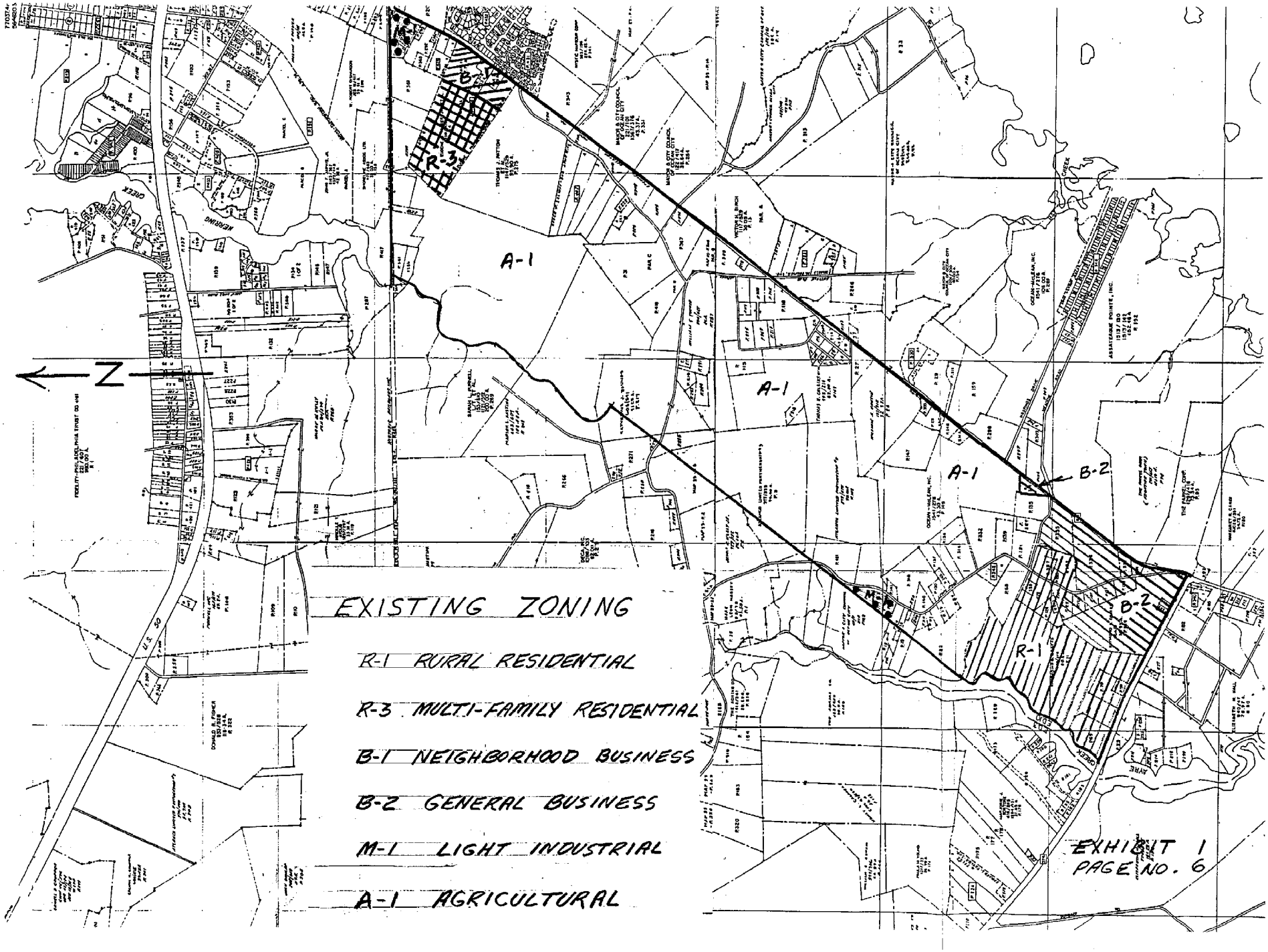
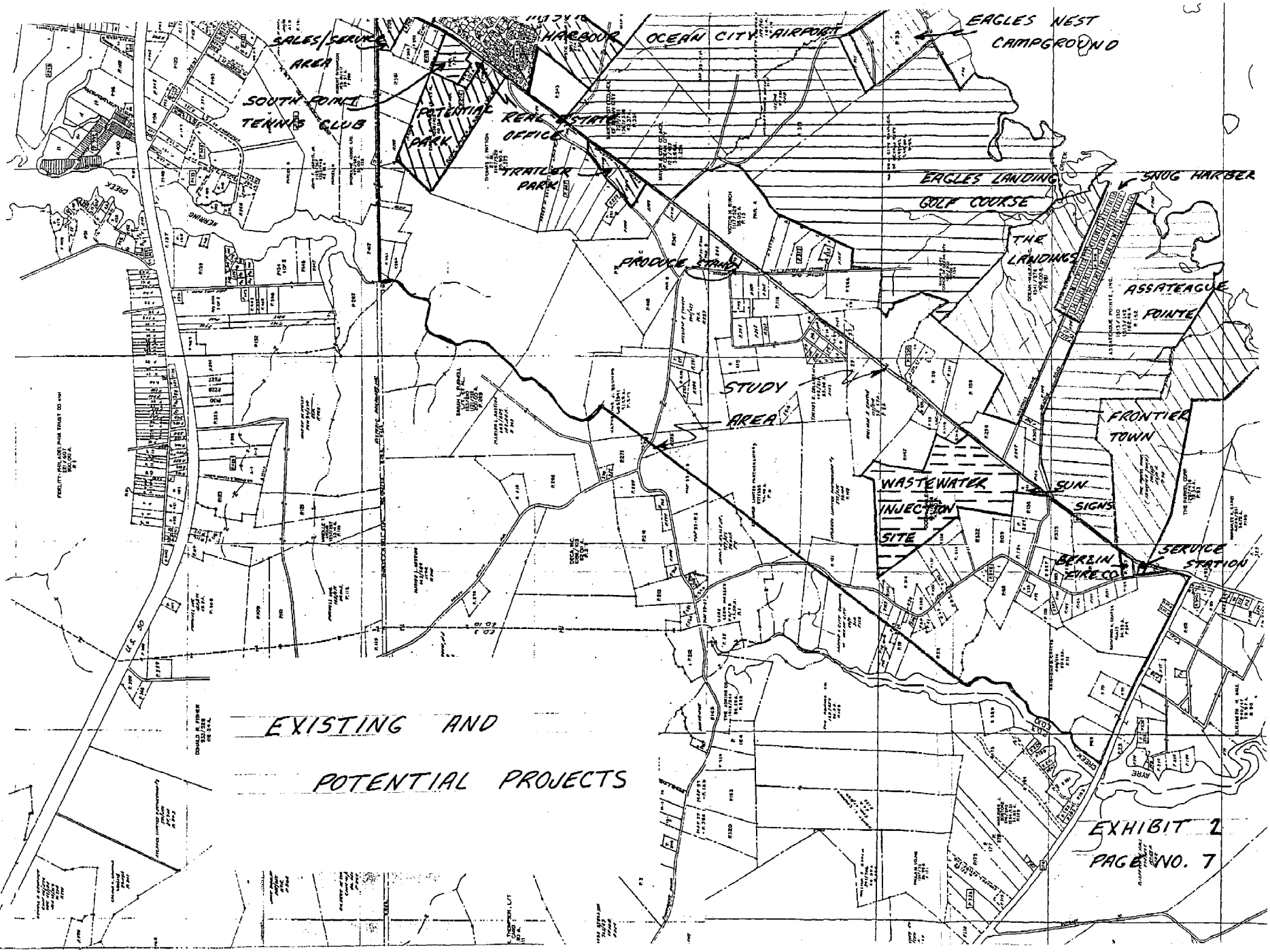


EXHIBIT 1
PAGE NO. 6



EXISTING AND POTENTIAL PROJECTS

EXHIBIT 2
PAGE NO. 7

(Exhibit 1, Page 6 is the Existing Zoning Map and Exhibit 2, Page 7 is the Proposed Land Use Map.)

AQUATIC RESOURCES

The aquatic systems directly affected by the study area are Sinepuxent Bay, Ayer Creek and Herring Creek which indirectly affect tributaries and bodies of water downstream. Some fish that inhabit these creeks are brown bullhead, banded killifish, golden shiner, bluegill, white perch, mullet, carp, needlefish, american eel, anchovy and bluefish (information obtained from report made by Allen Wesche, Natural Resource biologist of the Department of Natural Resources Tidewater Fisheries Administration).

WILDLIFE RESOURCES

Primary terrestrial habitat is the edges of the woodlands. The major forest association in the area is sweet gum - red maple and oak - pine. The wildlife species associated with this habitat include whitetail deer, gray squirrel, cotton tail rabbits, quail, raccoons, opossum, various song birds and small mammals, such as, field moles, shrews, starnose moles and chipmunks.

WETLAND RESOURCES

Several areas are designated as wetlands on the N.W.I. and Md. D.N.R. wetland maps. These areas are shown on Map No. 1, (Map Pocket). Wetlands Map No. 1 was defined by use of the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (dated January, 1991 by F&WS, SCS, EPA and ACE) as areas which possess hydric soils, hydrophytic vegetation and wetland hydrology (saturated condition). Presently there is a legislative mandate for "No net loss"

of non-tidal wetlands. Mitigation of any wetlands lost is necessary in replacement ratios in the range of 1:1 to 3:1. (acreage replacement to acreage lost). Certain enhancement activities such as rehabilitation of stream channels, wildlife ponds, man made wetlands (reverse berms on ditches and flood stage weirs), may be considered as wetland mitigation. The wetlands identified in this area are classified, according to Cowardin nomenclature, as palustrine forested, broad-leaved deciduous, temporarily flooded and palestine, scrub/shrub, deciduous, seasonally well drained.

CULTURAL RESOURCES

With respect to archaeology, there appears to be no historic sites within the study area, except for two historic cemeteries (Exhibit 3, Page 10). However, given the size of the study parcel and the presence of substantial water resources (Ayer Creek, Herring Creek, and marsh), much of this land has a high potential for containing archaeological sites. This assessment is based on the environmental settings of known archaeological sites in other parts of the Delmarva Peninsula. Particularly sensitive areas for prehistoric and historic archaeological settlements would be knolls or sections of relatively higher elevation adjacent to water. Prehistoric/historic Site 18W0151 and historic Site 18W0122 are located in these settings within a 2 mile radius of the study area. Archaeological resources might also be found along older roads in the study area.

It is recommended that an archaeological reconnaissance survey be conducted of the study area to identify its archaeological resources and determine their eligibility for the National Register of Historic Places. The survey should be conducted by a qualified professional archaeologist and conducted in accordance with the "Guidelines for Archaeological Investigations in Maryland" (McNamara,

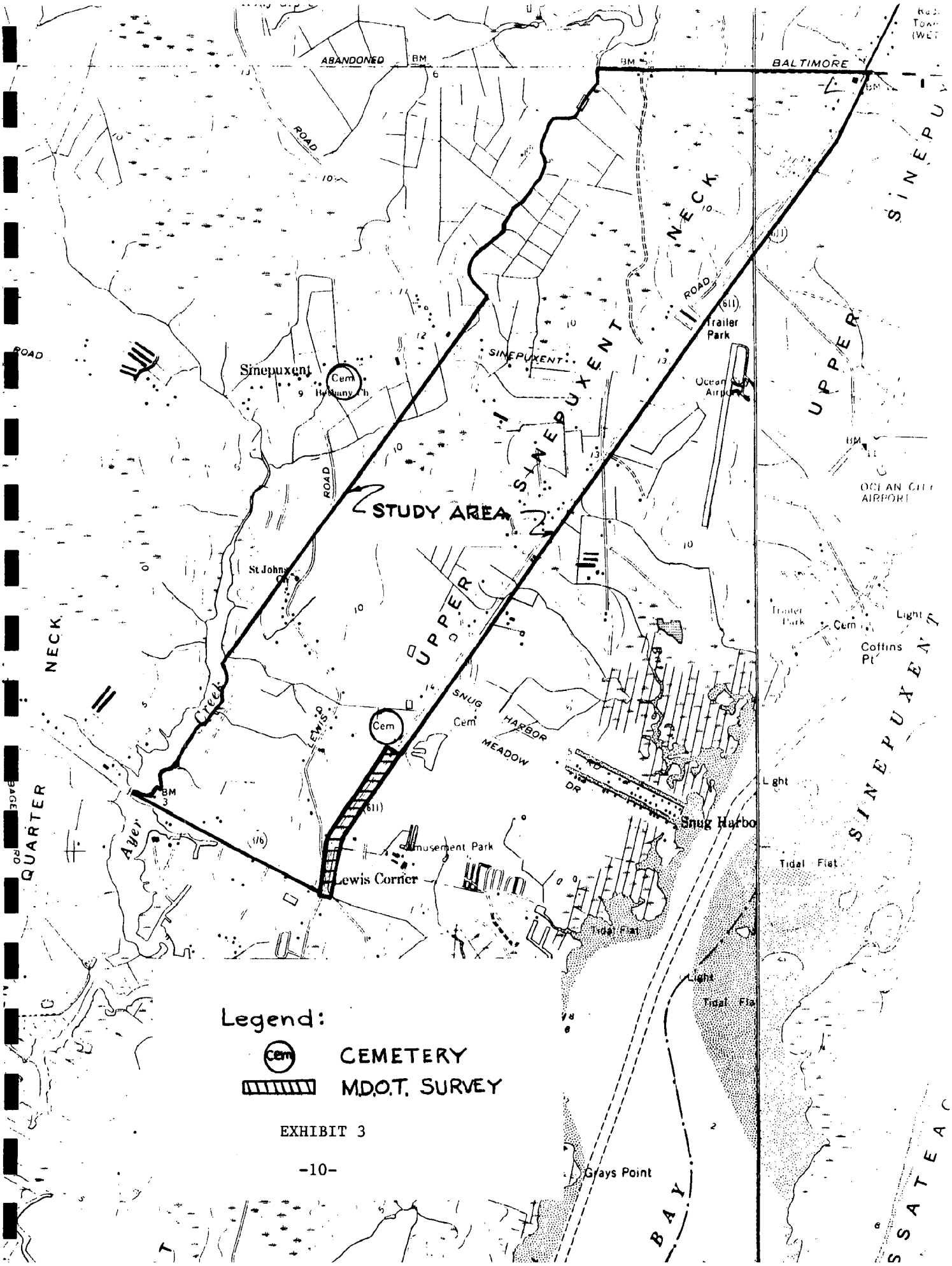

ABANDONED
BALTIMORE
ROAD
SINEPUXENT
NECK
UPPER
Trailer Park
Ocean City Airport
OCEAN CITY AIRPORT
Sinepuxent
Cem
Bethany Ch
STUDY AREA
St Johns Ch
Trailer Park
Cem
Light
Coffins Pt
SNUG HARBOR
MEADOW
DR
Cem
Cem
Light
Snug Harbo
Amusement Park
Lewis Corner
Tidal Flat
Tidal Flat
Light
Tidal Flat
Grays Point
BAY
QUARTER
NECK
Ayer
Creek
Legend:
CEMETERY
M.D.O.T. SURVEY

EXHIBIT 3

1981). No survey would be necessary for the 0.5 mile long segment of Route 611 at the southeastern end of the study area (Exhibit 3, Page 10); a survey of this land was conducted by Wesler et al. in 1981 for the Maryland Department of Transportation. If significant sites are located within the study area, Worcester County would be encouraged to preserve them in place, or to recover the important archaeological data prior to any disturbance.

If the study area entails any involvement from a federal agency (including funding, permits, or licenses), it would be subject to review under Section 106 of the National Historic Preservation Act of 1966, as amended. This historic preservation law requires that the involved governmental agency consider the effects of the proposed project on significant cultural resources.

ENDANGERED AND THREATENED PLANTS AND ANIMALS

No federal or state threatened or endangered plant or wildlife species have been identified in the watershed except for the transitory use by Bald Eagles.

SOILS

The soils in the study area are composed of the Fallingston, Fort Mott, Lakeland, Leon, Mattapex, Othello, Pocomoke, Portsmouth, Sassafras and Woodstown series. Exhibit 4, Page 13 and Exhibit 4a, Page 14 groups soils as hydric or non-hydric and lists soil map symbol, soil name and hydrologic soil group. Exhibit 5, Page 15 is a description of each hydrologic soil group.

The Fallingston, Leon, Othello, Pocomoke and Portsmouth are considered poorly drained soils and occur in wooded, lowland areas and pockets throughout the study area. These soils have high water tables which severely limit their usage.

The Woodstown, Sassafras, Fort Mott and Mattapex soils are moderately-well to well drained. Seasonable high water table in Woodstown and Mattapex soils create moderate limitations for farming and most non-agricultural uses. Sassafras and Fort Mott soils have lower water tables which present no apparent problem. The Lakeland soils consist of fairly level, deep, excessively drained sandy soils with some limitations on certain proposed uses, such as drain fields or lagoons.

Exhibit 6, Pages 16-17, Estimated Engineering Properties of Soils; Exhibit 7, Page 18-19, Soil Limitations For Selected Uses; Exhibit 8, Page 20-22, Estimated Engineering Interpretations; Exhibit 9, Page 23-25, Soil Limitations For Specified Recreational Uses indicate properties of the soils and the influence of those properties or problems related to development of these soils.

Approximately seventy-seven percent of the study area is classified as hydric soils as defined by the Food Security Act of 1985. Highly erodible soils represents 0.3 percent and prime farm land represents 10.7 percent of the site.

The following is a chart showing hydric and non-hydric soils by present and proposed land use:

ZONING	TOTAL ACRES	ACREAGE OF HYDRIC SOIL	ACREAGE OF NON-HYDRIC SOIL
R-1	108	30	78
B-2	81	54	27
M-1	9	4	5
B-1	20	8	12
R-3	42	39	3
Agriculture	958	804	154
Proposed Parks	41	37	4
Proposed Waste Disposal	43	34	9
TOTAL	1302	1010	292

It is notable that approximately 77 percent of soils in the study area are hydric and changes in land use which increases impervious area will likely compound the already existing wetness.

SOILS

FROM WORCESTER COUNTY SOIL SURVEY

MAP SYMBOL	MAPPING UNIT	HYDROLOGIC SOIL GROUP
	HYDRIC SOILS	
Fa	Fallsington Sandy Loam	D
Fg	Fallsington Loam	D
Ls	Leon Loamy Sand	D
Ot	Othello Silt Loam	D
Pk	Pocomoke Sandy Loam	D
Pm	Pocomoke Loam	D
Pt	Portsmouth Silt Loam	D
	NON-HYDRIC SOILS	
FmB	Fort Mott Loamy Sand, 2 - 5 percent slopes	B
LmB	Lakeland Loamy Sand, Clayey Substratum, 0 - 5 percent slopes	A
MoA	Mattapex Fine Sandy Loam, 0 - 2 percent slopes	C
MpA	Mattapex Loam, 0 - 2 percent slopes	C
SaA	Sassafras Sandy Loam, 0 - 2 percent slopes	B
SaB2	Sassafras Sandy loam, 2 - 5 percent slopes, moderately eroded	B
WdA	Woodstown Sandy Loam, 0 - 2 percent slopes	C
WdB	Woodstown Sandy Loam, 2 - 5 percent slopes	C
WoA	Woodstown Loam, 0 - 2 percent slopes	C
WoB	Woodstown Loam, 2 - 5 percent slopes	C

Exhibit 4

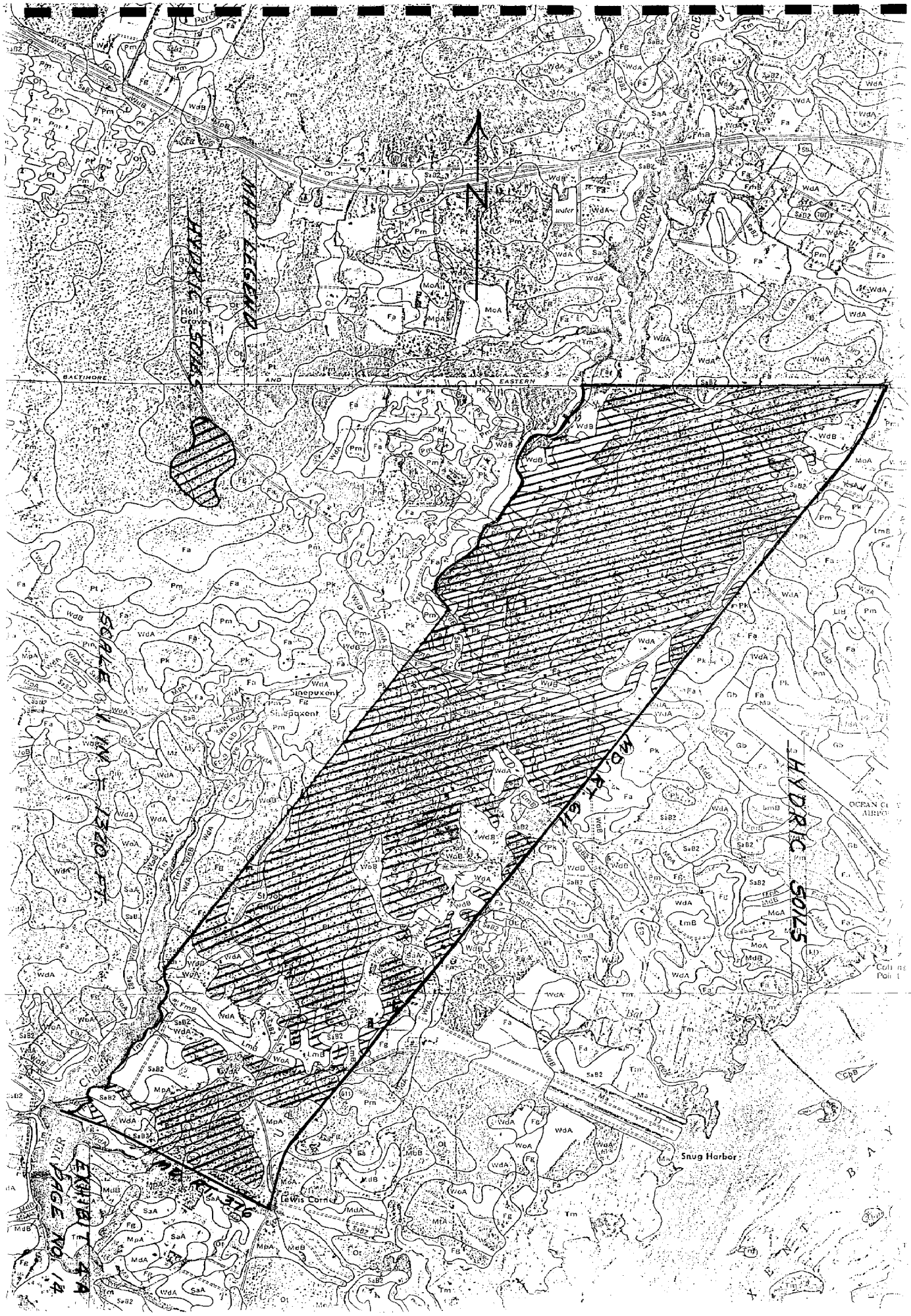


EXHIBIT 4A
PAGE NO. 14

HYDROLOGIC SOIL GROUPS

INTRODUCTION

Each soil is placed into one of four groups according to the rate of surface infiltration of water when the entire soil is thoroughly wetted. Infiltration under thoroughly wetted conditions is correlated positively with internal transmission of water, and thus negatively with runoff potential. Infiltration and transmission of water is not the same as permeability. For instance, a rapidly permeable soil, such as Plummer, will have a very slow infiltration and transmission rate when thoroughly wetted because of a stagnant water table. Descriptions of the different hydrologic soil groups are as follows:

Group A --- Soils having high infiltration rates even when thoroughly wetted, consisting chiefly of deep, well to excessively drained sands and/or gravels. These soils have a high rate of water transmission and would result in a low runoff potential.

Group B --- Soils having moderate infiltration rates when thoroughly wetted, consisting chiefly of moderately-well to well-drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission and a moderate runoff potential.

Group C --- Soils having a slow infiltration rate when thoroughly wetted, consisting chiefly of (1) soils with a layer that impedes the downward movement of water, or (2) soils with moderately fine to fine texture and a slow infiltration rate. These soils have a slow rate of water transmission and a high runoff potential.

Group D --- Soils having very slow infiltration rates when thoroughly wetted, consisting chiefly of (1) clay soils with a high swelling potential, (2) soils with a high permanent water table, (3) soils with claypan or clay layer near the surface, and (4) shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission and a very high runoff potential.

Exhibit 5

SOILS

ESTIMATED ENGINEERING PROPERTIES OF THE SOILS

FROM WORCESTER COUNTY SOIL SURVEY

SOIL NAME AND MAP SYMBOL	DEPTH TO SEASONAL HIGH WATER TABLE	DEPTH FROM SURFACE	UNIFIED	RANGE IN PERMEABILITY	RANGE IN AVAILABLE MOISTURE CAPACITY
		HYDRIC SOILS			
Fallinsgton: Fa, Fg	0	0-12	SM,ML or SM-SC	2.0-6.3	0.02-0.18
		12-28	SM,SC or ML	0.63-2.0	0.18-0.24
		28-55	SP,SM or SC	0.63-6.3	0.06-0.10
Leon: Ls	1/2 - 1-1/2	0-17	SM or SP-SM	>6.3	0.06-0.08
		17-38	SP-SM	0.63-6.3	<0.06
		38-70	SP	>6.3	<0.06
Othello: Ot	0	0-09	ML or ML-CL	0.20-2.0	0.18-0.27
		9-25	CL or ML-CL	0.20-0.63	0.18-0.24
		25-31	SM	0.63-2.0	0.12-0.18
		31-42	SP-SM or SM	0.63-6.3	0.06-0.12
Pocomoke: Pk, Pm	0	0-20	SM,ML or ML-CL	0.63-2.0	0.12-0.24
		20-34	SM,SC or ML-CL	0.63-2.0	0.12-0.18
		34-40	SP-SM or SM	2.00-6.3	0.06-0.12
		40-53	SP or SP-SM	>2.0	<0.06
Portsmouth: Pt	0	0-12	SM-SC or ML	0.20-2.0	0.18-0.24
		12-35	SC,CL or ML-CL	0.63-2.0	0.18-0.24
		35-80	SM or SC	2.00-6.3	0.06-0.12

Exhibit 6

SOILS

ESTIMATED ENGINEERING PROPERTIES OF THE SOILS (CONT)

FROM WORCESTER COUNTY SOIL SURVEY

SOIL NAME AND MAP SYMBOL	DEPTH TO SEASONAL HIGH WATER TABLE	DEPTH FROM SURFACE	UNIFIED	RANGE IN PERMEABILITY	RANGE IN AVAILABLE MOISTURE CAPACITY
		NON-HYDRIC SOILS			
Fort Mott: FmB	5+	0-24	SM	2.0-6.3	0.06-0.18
		12-28	SM or SC	0.63-2.0	0.12-0.18
		37-50	SP or SP-SM	>6.3	<0.06
Lakeland: LmB	5+	0-66	SP,SP-SM or SM	6.3	0.06-0.08
		66-80	SM	0.20-2.0	0.12-0.18
* Mattapex: MoA, MpA	1 1/2-2 1/2	0-16	ML or ML-CL	0.20-2.0	0.18-0.27
		16-39	CL or ML-CL	0.20-0.63	0.18-0.24
		39-55	SP-SM,SM or SM-SC	0.63-6.3	0.06-0.18
Sassafras: SaA, SaB2	5+	0-13	SM or ML	2.00-6.3	0.12-0.18
		13-33	SM-SC,SC or CL	0.63-2.0	0.18-0.24
		33-50	SP-SM or SM	2.00-6.3	<0.06
* Woodstown: WdA, WdB, WoA, WoB	1 1/2-2 1/2	0-12	SM or ML	0.63-2.0	0.12-0.24
		12-30	SM-SC,ML or CL	0.63-2.0	0.12-0.24
		30-64	SM,SC, SP-SM or SM-SC	0.63-2.0	0.12-0.18
		64-75	SM or SP-SM	2.0-6.3	0.06-0.08

* Units potentially contain small inclusions of soils on the National Hydric Soil List.

Exhibit 6

SOILS

SOIL LIMITATIONS FOR SELECTED USE

FROM WORCESTER COUNTY SOIL SURVEY

SOIL SERIES AND MAP SYMBOL	SEWAGE DISPOSAL: SEPTIC TANK FILTER FIELDS (EFFLUENT DISPOSAL ON SITE)	SEWAGE DISPOSAL: LAGOONS	HOMES WITH BASEMENTS (THREE STORIES OR LESS)
HYDRIC SOILS			
Fallsington: Fa, Fg	Severe: high water table	Moderate: moderate permeability	Severe: high water table
Leon: Ls	Severe: high water table	Severe: moderate to moderately rapid permeability	Severe: high water table
Othello: Ot	Severe: high water table; moderately slow permeability	Slight	Severe: high water table
Pocomoke: Pk, Pm	Severe: high water table	Moderate: moderate permeability	Severe: high water table
Portsmouth: Pt	Severe: high water table; moderate to moderately slow permeability	Moderate: moderate to moderately slow permeability	Severe: high water table

Exhibit 7

SOILS

ESTIMATED ENGINEERING PROPERTIES OF THE SOILS (CONT)

FROM WORCESTER COUNTY SOIL SURVEY

SOIL SERIES AND MAP SYMBOL	SEWAGE DISPOSAL: SEPTIC TANK FILTER FIELDS (EFFLUENT DISPOSAL ON SITE)	SEWAGE DISPOSAL: LAGOONS	HOMES WITH BASEMENTS (THREE STORIES OR LESS)
	NON-HYDRIC SOILS		
Fort Mott: FmB	Slight	Moderate: moderate permeability; slope	Slight
* Lakeland: LmB	Slight	Severe: rapid permeability	Slight
Mattapex:			
MoA, MpA	Severe: moderately slow permeability	Slight	Moderate: seasonal high water table
Sassafras:			
SaA	Slight	Moderate: moderate permeability	Slight
SaB2	Slight	Moderate: moderate permeability; slope	Slight
Woodstown:			
WdA	Moderate: seasonal high water table	Moderate: moderate permeability	Moderate: seasonal high water table
WdB	Moderate: seasonal high water table	Moderate: moderate permeability; slope	Moderate: seasonal high water table
WoA	Moderate: seasonal high water table	Moderate: moderate permeability	Moderate: seasonal high water table
WoB	Moderate: seasonal high water table	Moderate: moderate permeability;	Moderate: seasonal high water table

* Possibility of polluting nearby wells, springs, ponds, or other water areas

Exhibit 7

SOILS

ESTIMATED ENGINEERING INTERPRETATIONS

FROM WORCESTER COUNTY SOIL SURVEY

SOIL SERIES AND MAP SYMBOLS	SOIL FEATURES THAT AFFECT ENGINEERING PRACTICES FOR: PIPELINE LOCATION	HIGHWAY LOCATION	SITES FOR PONDS OR RESERVOIRS	DRAINAGE SYSTEMS
	HYDRIC SOILS			
Fallsington: Fa, Fg	Water table at or near subface; fair to good stability	Water table at or near subface; fair to good stability; severe frost action	Moderate seepage in subsoil; high seepage in substratum; high fluctuating water table	Moderate permeability; moderately erodible
Leon: Ls	Seasonal water table at depth of 1/2 - 1 1/2 feet; poor stability	Seasonal water table at depth of 1/2 - 1 1/2 feet; poor stability; severe frost action	High to very high seepage; high fluctuating water table	Moderate to moderately rapid permeability; hazard of ditchbank eaving
Othello: Ot	Water table at or near subface; poor stability	Water table at or near subface; poor stability; severe frost action	Low seepage in subsoil; high seepage in substratum; high fluctuating water table	Moderately slow permeability; highly erodible
Pocomoke: Pk. Pm	Water table at or near subface; fair stability	Water table at or near subface; fair stability; severe frost action	Moderate seepage in subsoil; high seepage in substratum; high water table	Moderate permeability; moderately erodible

Exhibit 8

SOILS

ESTIMATED ENGINEERING INTERPRETATIONS (CONT)

FROM WORCESTER COUNTY SOIL SURVEY

SOIL SERIES AND MAP SYMBOLS	SOIL FEATURES THAT AFFECT ENGINEERING PRACTICES FOR: PIPELINE LOCATION	HIGHWAY LOCATION	SITES FOR PONDS OR RESERVOIRS	DRAINAGE SYSTEMS
Portsmouth: Pt	Water table at or near subface; poor stability	Water table at or near subface; poor stability; severe frost action	Low seepage in subsoil; high seepage in substratum; high water table	Moderate to moderately slow permeability; highly erodible
NON-HYDRIC SOILS				
Fort Mott: FmB	Seasonal water table at depth of more than 5 feet; fair stability	Fair stability; slight frost action	Moderate seepage in subsoil; high seepage in subsratum; high fluctuating water table	Moderate permeability; moderaely erodible
Lakeland: LmB	Seasonal water table at depth of more than 5 feet; fair stability	Fair stability; loose material; slight frost action	High to excessive seepage; water table at a depth of more than 5 feet	Excessively drained
Mattapex: MoA, MpB	Water table at depth of 1 - 2 1/2 feet; fair stability	Water table at depth of 1 - 2 1/2 feet; fair stability; severe frost action	Low seepage in subsoil; high seepage in substratum; moderately high fluctuating water table	Moderately slow permeability; highly erodible

Exhibit 8

SOILS

ESTIMATED ENGINEERING INTERPRETATIONS (CONT)

FROM WORCESTER COUNTY SOIL SURVEY

SOIL SERIES AND MAP SYMBOLS		SOIL FEATURES THAT AFFECT ENGINEERING PRACTICES FOR: PIPELINE LOCATION	HIGHWAY LOCATION	SITES FOR PONDS OR RESERVOIRS	DRAINAGE SYSTEMS
Sassafras:	SaA, SaB2	Water table at depth of more than 5 feet; good stability	Good stability; moderate frost action	Moderate seepage in subsoil; high seepage in substratum; Water table at depth of more than 5 feet	Well drained
Woodstown:	WdA, WdB, WoA, WoB	Water table at depth of 1 1/2-2 1/2 feet; good stability	Water table at depth of 1 1/2-2 1/2 feet; good stability; severe frost action	Moderate seepage in subsoil; high seepage in substratum; fluctuating water table at depth of 1 1/2-2 1/2 feet	Moderate permeability; moderately erodible

Exhibit 8

SOILS

SOIL LIMITATIONS FOR SPECIFIED RECREATIONAL USES

FROM WORCESTER COUNTY SOIL SURVEY

SOIL SERIES AND MAP SYMBOLS	CAMPSITES (INTENSIVE USE)	ATHLETIC FIELDS AND OTHER INTENSIVE PLAY AREAS	PARKS AND EXTENSIVE PLAY AND PICNIC AREAS	LAWNS AND FAIRWAYS	PATHS AND TRAILS
		HYDRIC SOILS			
Fallsington: Fa, Fg	Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table
Leon: Ls	Severe: high water table	Severe: high water table	Moderate: high water table; loose loamy sand surface layer	Severe: loose loamy sand surface layer	Moderate: high water table; loose loamy sand surface layer
Othello: Ot	Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table
Pocomoke: Pk, Pm	Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table
Portsmouth: Pt	Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table	Severe: high water table

Exhibit 9

SOILS

SOIL LIMITATIONS FOR SPECIFIED RECREATIONAL USES (CONT)

FROM WORCESTER COUNTY SOIL SURVEY

SOIL SERIES AND MAP SYMBOLS	CAMPSITES (INTENSIVE USE)	ATHLETIC FIELDS AND OTHER INTENSIVE PLAY AREAS	PARKS AND EXTENSIVE PLAY AND PICNIC AREAS	LAWNS AND FAIRWAYS	PATHS AND TRAILS
		NON-HYDRIC SOILS			
Fort Mott:					
FmB	Slight	Moderate: slope	Slight	Moderate: loamy sand surface layer	Moderate: loamy sand surface layer
Lakeland:					
LmB	Moderate: deep loose loamy sand	Moderate: deep loose loamy sand; slope	Moderate: deep loose sand	Moderate: deep loose loamy sand	Moderate: deep loose loamy sand
Mattapex:					
MoA, MpA	Moderate: high water table; moderately slow permeability	Moderate: high water table; moderately slow permeability	Slight	Slight	Slight
Sassafras:					
SaA	Slight	Slight	Slight	Moderate: sandy laom surface layer	Slight

Exhibit 9

SOILS

SOIL LIMITATIONS FOR SPECIFIED RECREATIONAL USES (CONT)

FROM WORCESTER COUNTY SOIL SURVEY

SOIL SERIES AND MAP SYMBOLS	CAMPSITES (INTENSIVE USE)	ATHLETIC FIELDS AND OTHER INTENSIVE PLAY AREAS	PARKS AND EXTENSIVE PLAY AND PICNIC AREAS	LAWNS AND FAIRWAYS	PATHS AND TRAILS
Woodstown:					
WdA	Moderate: high water table	Moderate: high water table	Slight	Moderate: sandy loam surface layer	Slight
WdB	Moderate: high water table	Moderate: high water table	Slight	Moderate: sandy loam surface layer	Slight
WoA	Moderate: high water table	Moderate: high water table	Slight	Slight	Slight
WoB	Moderate: high water table	Moderate: high water table; slope	Slight	Slight	Slight

Exhibit 9

DRAINAGE

EXISTING DRAINAGE PROBLEMS

The major drainage problems in this study area are excess floodwater and inadequate outlets to convey the waters to major streams or bays. The channels for the most part have become ineffective due to lack of maintenance. The following is a breakdown in estimated percent of the channel ages in the watershed:

YEAR CHANNEL ESTABLISHED	AGE OF CHANNEL	PERCENT
1986-1991	0 - 5 Years	8
1981-1985	6 - 10 Years	6
1976-1980	11 - 15 Years	6
1971-1975	16 - 20 Years	24
1966-1970	21 - 25 Years	12
Before 1965	26 Years and Older	44

This information was obtained from records in the Worcester Soil Conservation office, knowledge of local people and age of wooded growth on the channel slopes. In this area a channel will need a cleanout in about 12-15 years if maintained properly. Poor maintenance can result in cleanout every 4-6 years.

There were 13 sites evaluated throughout this study area for depth, bottom width, top width and roughness factors for existing channels. These sites are refered to as cross sections in this report. The existing county road ditches averaged 1.3 feet in depth, 1.3 feet bottom width and a top width of 2.9 feet. The channel on Rt. 611 and Rt. 376 averaged 1.8 feet in depth, 2.0 feet bottom width and a top width of 10.0 feet. The individual farm channels averaged 1.6 feet in depth, 3.0 feet bottom width and a top width of 5.5 feet. With the above capabilities and low velocities, 84% of the channels will not handle the 2 year storm.

FLOODWATER DAMAGE

Flooding in the watershed results from out of bank flow near the channels and inundation of large areas due to accumulation of surface water. Broad areas of the flat lands are inundated since existing channels are inadequate to convey the floodwater. (Heavy crop losses from this type of flooding can be expected about one year in five. The flooding accompanies local thunderstorms and occasional tropical storms occurring most frequently after crops have been established, resulting in heavy damages).

Road flood damages occur at points where roads cross the channels. Road fill is washed away at pipes. Damages to road shoulders and in some cases to the roadbed itself occur at times of flood. Some of the local roads have flooded as many as 4 to 5 times a year. A flooded road creates a safety hazard and endangers human life.

PROBLEMS RELATED TO WATER MANAGEMENT

Seasonal high water tables affect the problem area cropland and forest land. Landowners and operators have not been able to establish effective on-farm drainage measures due to inadequate outlet channels. Poor drainage conditions have prevented farmers from meeting desired planting and harvest schedules and from taking advantage of modern farming methods. Total crop losses are sustained in low areas where ponding is experienced for extended periods. Weed control is a problem in areas where wet soil conditions prevent proper cultivation. Shallow root development caused by high spring water tables contributes to drought problems in the summer when the water table recedes. The use of cover and green manure crops is limited by the rise of the water table in the fall. This high fall water table affects crop harvest by preventing access to the fields with

heavy harvest machinery. Wet soil conditions also pose problems during timber harvest.

The combination of floodwater damage and inadequate drainage causes reduced crop yields, limits crop diversification, increases crop production costs, limits the use and effectiveness of lime and fertilizer and retards the economic growth of the area.

EROSION DAMAGE

Due to the flat topography, gully and sheet erosion are minor in the watershed. Some slight wind erosion occurs seasonally on the few acres of well drained soils in the watershed. Although erosion and the accompanying sediment productions are slight, even small amounts of sediment are significant when they are deposited in farm ditches and outlet channels with limited capacities.

SEDIMENT DAMAGES

Sediment damages are not extensive in the watershed. Some localized sedimentation does occur and it complicates drainage and floodwater runoff by reducing transmission capacity at culverts and pipes and by building bars behind fallen trees and debris. In the intermittent streams, these sediment deposits are quickly vegetated. Roadway shoulders and present ditch banks are the primary sediment source areas and are most productive during periods of intense rainfall and runoff.

DRAINAGE PROBLEMS

The following is a brief summary on 17 individual sub-watershed areas under existing conditions and the impact of fully developed conditions. Fully developed

is being defined as an area with approximately 48 percent impervious surface area. General sub-watershed area delineations are shown on Exhibit 10, Page 35.

SUB-AREA NO. 1 (DRAINS EASTERLY UNDER RT. 611)

This sub-watershed consists of 15 acres of which 13 acres are clear and 2 acres are wooded. This area has about 40 percent moderately well drained soils and 60 percent very poorly drained soils. The existing channels are in fair condition and will flood with a rainfall of 3.6 inches in 24 hours if fully developed and no drainage improvements are installed. This area would require 2700 LF of channel improvements to solve it's drainage problems.

SUB-AREA NO. 2 (DRAINS WESTERLY TO HERRING CREEK)

This sub-watershed consists of 212 acres of which 24 acres are clear and 188 acres are wooded. This area has about 1 percent well drained soils, 2 percent moderately-well drained soils and 97 percent of poorly drained soils. The existing channels are in fair to good condition. The channels will carry the 2 year storm which is 3.6 inches in 24 hours. It is recommended that maintenance such as mowing or herbicides be done once a year to control wooded vegetation. Some of the channel vegetation was sparse and should be re-vegetated during the period of September 1st to November 1st or March 15th to May 15th. The channels may require cleaning the bottom every 10-12 years. During this cleanout, care should be given as to not disturb the side slopes.

SUB-AREA NO. 3 (DRAINS EASTERLY UNDER RT. 611)

This sub-watershed consists of 68 acres of which 9 acres are clear and 59 acres are wooded. This area consists of about 3 percent moderately well drained

soils and 97 percent of poorly drained soils. The existing channels are in fair condition along Rt. 611. Roadside channels along Sinepuxent Road are in poor condition and will flood with a rainfall of 1.5 inches in 24 hours under existing land use. However, if fully developed will flood with a rainfall of 1.2 inches in 24 hours. To improve this drainage, outlets would have to be constructed to Rt.611. With the improved outlets roadside, channelization could be done on both sides of Sinepuxent Road.

SUB-AREA NO. 4 (DRAINS NORTHERLY TO HERRING CREEK)

This sub-watershed consists of 344 acres of which 121 acres are clear and 223 acres are wooded. About 1 percent of this area is well drained, 1 percent moderately well drained, and 98 percent poorly drained soils. The existing outlet channels are fair to poor. Sinepuxent Road will flood on 3.0 inches of rainfall in a 24 hours. This area if fully developed would require intensive drainage to handle the increased runoff. According to the local U.S.D.A., Soil Conservation Office, this area was surveyed for a public drainage association. It is recommended that this area be organized as a public watershed association to improve the drainage for agriculture and county roads.

SUB-AREA NO. 5 (DRAINS EASTERLY UNDER RT. 611)

This sub-watershed consists of 10 acres land that is all cleared. About 20 percent of the area is moderately well drained and 80 percent poorly drained. The existing drainage system is poor. Rt. 611 channels need a cleanout and some of the farm ditches could use some maintenance. This area will flood with 2.6 inches of rainfall in 24 hours and if fully developed will flood with 1.6 inches in 24

hours. This is one area where improved drainage is a must. Some outlet improvement east of Rt. 611 is needed to remedy the problem.

SUB-AREA NO. 6 (DRAINS EASTERLY UNDER RT. 611)

This sub-watershed consists of 107 acres of which 50 acres are clear and 57 acres of woods. About 22 percent of the area is moderately well drained and 78 percent poorly drained. This area needs drainage improvements for Rt. 611 and 47 acres of agriculture land. This land will flood with 1.9 inches of rainfall in 24 hours and if fully developed will flood with 1.5 inches in 24 hours. With any development, drainage is a must. To achieve a good drainage system, channel improvement would have to include channels east of Rt. 611.

SUB-AREA NO. 7 (DRAINS WESTERLY TO AYER CREEK)

This sub-watershed consists of 108 acres of which 18 acres is clear and 90 acres wooded. About 2 percent of the area is well drained, 4 percent moderately well drained and 94 percent poorly drained. The lower 2000 feet of this watershed has a good channel that needs some wooded growth management. To achieve drainage to the upper reaches would be costly due to about 4000 LF of woodland to go through.

SUB-AREA NO. 8 (DRAINS WESTERLY TO AYER CREEK)

This sub-watershed consists of 58 acres of which 3 acres are clear and 55 acres are woodland. This area has 14 percent moderately well drained soils and 86 percent poorly drained soils. The 3 acres of cleared land are residential areas. The lands adjacent to Lewis Road are moderately well drained and has seventeen

homes. To achieve roadside drainage an outlet must be improved on private lands for about 1100 L.F.

SUB-AREA NO. 9 (DRAINS WESTERLY TO AYER CREEK)

This sub-watershed consists of 80 acres of which 4 acres is clear and 76 acres are wooded. This area has 6 percent moderately well drained soils and 94 percent poorly drained soils. The roadside channels are in poor condition and cannot be improved unless an outlet is improved for 1000 LF through private lands to Ayer Creek. Lewis Road will flood on a 2.2 inch rainfall in 24 hours now and fully developed will flood on a 1.4 inch rainfall in 24 hours. This county road will flood 4 - 5 times a year.

SUB-AREA NO. 10 (DRAINS WESTERLY TO AYER CREEK)

This sub-watershed consists of 121 acres of which 52 acres are clear and 69 acres are wooded. This area has 11 percent well drained soils, 30 percent moderately well drained soils, and 59 percent poorly drained soils. Maryland Rt. 611 needs an outlet constructed for about 4000 L.F. to relieve about 2.0 feet of tailwater. This drainage area is presently being organized into a public watershed association. According to local authorities there is a lot of interest among landowners. Once the outlet ditch is constructed the county roads division can clean their roadside channels. At present Lewis Road will flood with a 2.6 inch rainfall in 24 hours and if fully developed would flood with a 2.2 inch rainfall in 24 hours. This sub-watershed should be considered as a high priority watershed for drainage improvement.

SUB-AREA NO. 11 (DRAINS WESTERLY TO AYER CREEK)

This sub-watershed consists of 56 acres of which 30 acres are clear and 26 acres are wooded. This area has 3 percent well drained, 18 percent moderately well drained, and 79 percent poorly drained soils. There is one main channel to improve that is about 2000 L.F. and this would provide Lewis Road with an outlet. The County Road Division could then improve road side drainage.

SUB-AREA NO. 12 (DRAINS EASTERLY UNDER RT. 611)

This area consists of only 3 acres of woodlands that are poorly drained. The only drainage problem to be solved is water on the west side of Rt. 611. Channel improvements may extend about 500 feet east of Rt. 611 to relieve water along Rt. 611.

SUB-AREA NO. 13 (DRAINS WESTERLY TO AYER CREEK)

This watershed consists of 11 acres of which 8 acres are clear and 3 acres are wooded. The soils are as follows: 36 percent well drained, 36 percent moderately well drained, and 28 percent poorly drained. This area consists of one main ditch which is 1000 feet in length and drains agriculture lands only.

SUB-AREA NO. 14 (DRAINS WESTERLY TO AYER CREEK)

This watershed consists of 11 acres of which 8 acres are clear and 3 acres are wooded. The soils are as follows: 27 percent well drained, 55 percent moderately well drained, and 18% poorly drained. The only channel in this watershed is adjacent to Rt. 376 and is 900 feet in length.

SUB-AREA NO. 15 (DRAINS WESTERLY TO AYER CREEK)

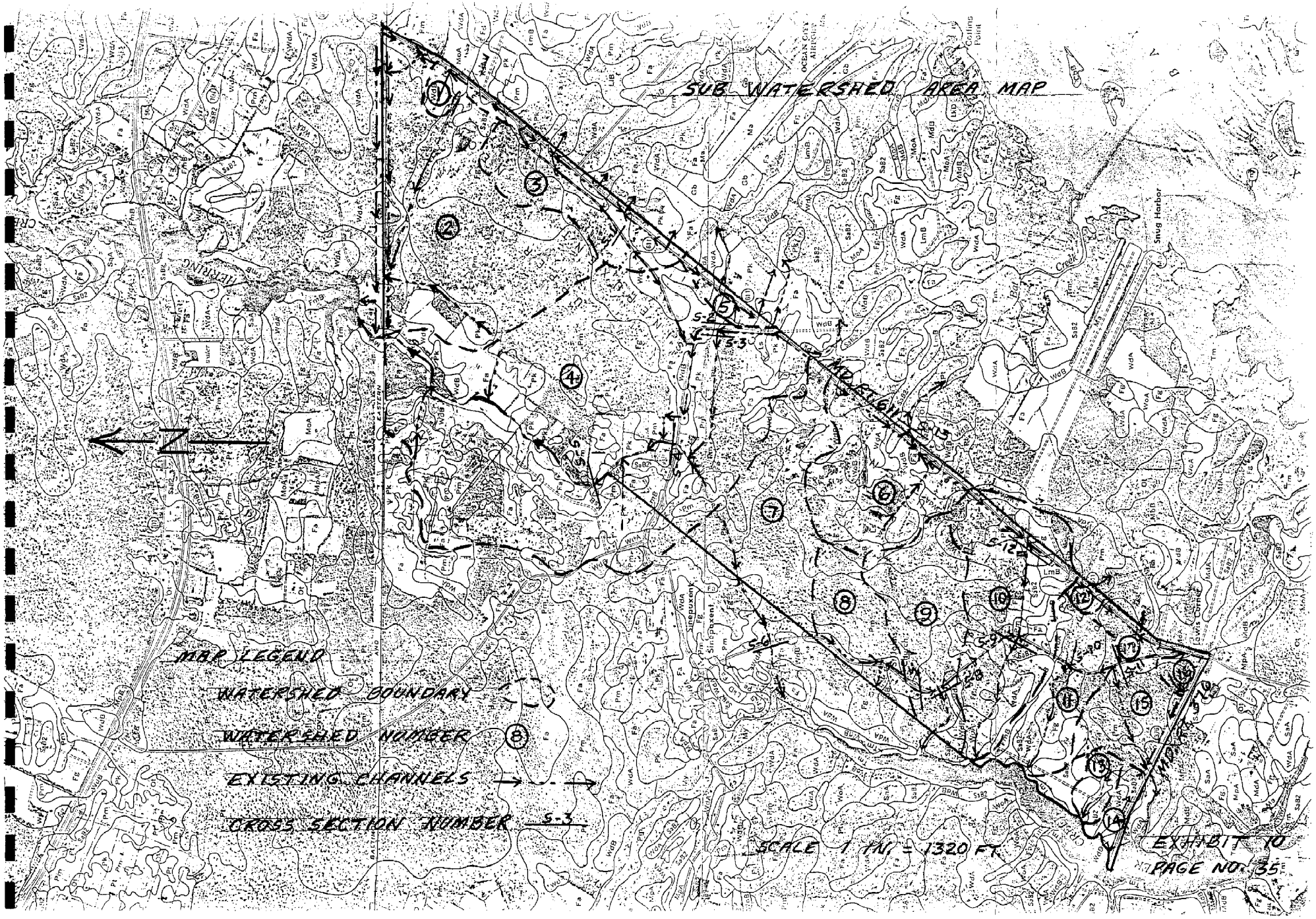
This sub-watershed consists of 52 acres of which 2 acres are clear and 50 acres are wooded. About 15 percent of the area is moderately well drained and 85% poorly drained. The roadside channels adjacent to Lewis Road needs improvement. However, to achieve this an outlet through 1800 feet of woodland would have to be constructed to Rt. 376. Many environmental concerns would have to be addressed before any construction is done.

SUB-AREA NO. 16 (DRAINS SOUTHERLY AND EASTERLY TO RT. 611)

This sub-watershed consists of 15 acres of which 1 acre is clear and 14 acres are wooded. About 7 percent of the area is moderately well drained, 46.5 percent somewhat poorly drained, and 46.5 percent poorly drained. This area drains to Rt. 611 and Rt. 376. Most of the channel improvements would be state and county opening roadside channels. This is an area with high possibility of development.

SUB-AREA NO. 17 (DRAINS EASTERLY TO RT. 611)

This sub-watershed consists of 13 acres of which is all wooded. This area is 100 percent poorly drained. The major need for drainage improvements are adjacent to Rt. 611 which is state maintenance responsibility. In order to get good drainage, the outlet east of Rt. 611 may have to be improved about 800 feet. This area is being developed now and will continue to be developed thus increasing the frequency of flooding.


SUB WATERSHED AREA MAP
MAP LEGEND
WATERSHED BOUNDARY
WATERSHED NUMBER 8
EXISTING CHANNELS
CROSS SECTION NUMBER S-3
SCALE 1 IN. = 1320 FT.
EXHIBIT 10
PAGE NO. 35
N
Snug Harbor
Bat Creek
Collins Point
OCEAN CITY AIRPORT
Sinepuxent
S-2
S-3
S-6
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S-10
S-11
S-12
S-13
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STREAM CLASSIFICATIONS

Streams can be classified in four flow regimes:

1. Perennial - flow occurs at all times except during periods of extreme drought
2. Ephemeral - flow occurs only during and within 14 days following storm periods
3. Intermittent - flow occurs between the limits of 1 and 2 above
4. Standing water - water is impounded by blocked ditches or pools

All of the streams within this study area would be classified as ephemeral.

CHEMICAL WATER QUALITY

Factors affecting Chemical water quality of a stream is as follows:

1. Atmosphere additions and exchanges
2. Rain water, dissolved salts and gases
3. Physical and chemical soil properties
4. The hydrology and amount of contact with the soil and associated soil constituents
5. The vegetation
6. Organic productivity of the stream
7. The tremendous diversity of man's activities
8. Terrestrial, avian, amphibious, and aquatic animal population

Surface water quality not only varies during the course of a year but will vary from stream to stream. Channels being constructed have been compared to natural streams and there were some differences. These water quality concerns should be addressed during project formulation.

GEOLOGICAL INVESTIGATION

There were several test holes put down by hand auger to determine hydric soils and channel stability. The investigation revealed that if channels were designed at depths of 2.0 to 4.0 feet there would be no problem with channel stability. Soils indicate several good sites for detention ponds and a few sites for infiltration ponds. Infiltration ponds could be located in Sassafras and Lakeland soils and detention ponds in the remainder soils within the study area. The Unified Soil Classification System was used to determine engineering properties. The soils were predominately sand (74 percent), 20 percent silts and 6 percent clays. There were a few borings in the center of existing channels to determine depth of sediment loads. Depths of sediment ranged from 1.5 to 2.0 feet and based on wooded growth of the channel the rate of sedimentation was approximately 1.0 inches/year.

ENGINEERING

At the beginning of this project several days were spent in the field evaluating the drainage systems. Information obtained included channel size, roughness factors, sub drainage areas, flow patterns, future channel needs, and existing channel conditions. With this data drainage areas were drafted and measured on aerial photos with the channel locations. Using TR-55 we calculated runoff on the 2 year and 100 year storm events for Worcester County. Water surface profiles were computed using existing land use and fully developed lands for the 2 year and 100 year storm events. With this data, rainfall amounts which would flood specific sites were calculated on existing land use and future development. It is noted that some sites would flood with less than 2.0 inches of rainfall in 24 hours. There were 17 sub watersheds analyzed individually and the

entire 1302 acres was analyzed in its entirety. Each sub-watershed has been written up as well as a composite for the entire study area. Exhibit 16, Page 46, reveals the amount of drainage needs, the estimated cost, and the responsible party for the improvements.

DRAINAGE SOLUTIONS

With 80 percent of the channels 16 years or older there is a great need to improve the drainage. To be able to improve drainage, it is recommended that areas with 2 or more beneficiaries, that depend on their downstream neighbor for an outlet, organize a Public Drainage Association (P.D.A.) or a Public Watershed Association (P.W.A.). A P.D.A. has only drainage as an objective, whereas, a P.W.A. has many objectives, such as drainage, wildlife development, stormwater management and other conservation practices. These associations tax individuals according to benefitted acreage. Once channel construction has been completed, a maintenance tax can be assessed to maintain the channel, as needed, to prolong the life of the channel. Good maintenance will more than double the life of the channel. In this study area there are 17 sub watersheds at present. Due to the flat topography some of the watersheds may possibly be combined. This can be done by increasing the channel depth in order to extend the design grade.

The drainage in this study area falls into three categories as to responsibilities for improvement. Exhibit 16, Page 46, breaks these down by sub watersheds to responsible parties.

The following criteria is recommended for design of channels for agricultural drainage:

1. Design on 2 year storm
2. Have 1.0 feet of freeboard above hydraulic gradient
3. Average depth of 3.0 feet
4. Average bottom width of 3.0 feet

5. Side slopes = 1:1
6. Control velocities to 2.50 feet/sec. or less
7. Control pipe velocities to 2.50 feet/sec.
8. 10 feet grassed filter strips
9. Sediment traps designed to handle 1.7 tons per acre. They should be located at beginning of construction point and locations near pipes. These traps can be restored and used as stormwater management ponds.

By designing these channels 3.0 feet in depth, this will enable the channels to convey the sub surface waters as well surface waters.

The following design criteria is recommended for channels in housing, commercial, and light industrial developments:

1. Design on a 2 year storm
2. Average depth 1.5 feet
3. Design either "V" ditches or parabolic
4. Control velocities to 2.5 feet/sec. or less
5. Control pipe velocities to 2.5 feet/sec.
6. 10 feet grassed filter strips
7. Detention ponds to store the difference between 2 pre and 10 post runoff
8. Minimum top width = 12.0 feet

This type of channel will convey the surface water safely and would be easily maintained. These channels if constructed to specifications can be manicured by grading and mowing and blend into yards, etc.

For all types of drainage, it is recommended that TR-55 published by the U.S.D.A., Soil Conservation Service, be used. The designer can use the Delmarva Runoff Charts for Design Q.

To avoid delays in the installation, it is recommended that the local landowners, Soil Conservation Service, and the University of Maryland Extension Service meet with county, state and federal regulatory agencies to review the projects. This should be done during the early planning stage. There are several wetland areas involved and mitigation for their losses, protection and/or enhancement can be planned and agreed upon. There are several trade offs possible

including ponds, wetland development, wildlife seeding and shade on one side of channel to cool waters. Wetlands should be protected or enhanced in all areas if possible. In areas where wetlands are present it is recommended that a by-pass channel be constructed if topography and soils would not present a problem in channel stability. If this is not possible, another alternative would be to divert the flows to another outlet. If neither of these were feasible and there was no other route but to go through wetlands, then the reversed berm on each side of the channel would greatly reduce wetland damages and if flat could increase the wetland area at some locations. Structures with flash board risers to raise water elevations can be installed downstream of the wetland to control the water levels. Again, it will take team work and planning to protect the natural resources in this study area.

STUDY AREA WITHOUT IMPROVED DRAINAGE SYSTEMS

CROSS SECT. NO.	SUB AREA NO.	D.A. ACRES	CONTROL ELEVATION FIELD	CONTROL ELEVATION ROAD	NON-DEVELOPED RCN	NON-DEVELOPED 2 YR RUNOFF IN.	NON-DEVELOPED 100 YR RUNOFF IN.	NON-DEVELOPED 2 YR ELEV.	NON-DEVELOPED 100 YR ELEV.	FULLY DEVELOPED RCN	FULLY DEVELOPED 2 YR RUNOFF IN.	FULLY DEVELOPED 100 YR RUNOFF IN.	FULLY DEVELOPED 2 YR ELEV.	FULLY DEVELOPED 100 YR ELEV.
1	3	68		10.0	78	1.58	5.49	10.6	11.4	87	2.27	6.55	10.8	11.5
2	5	10		10.5	8	2.35	6.66	10.0	10.6	87	2.27	6.55	10.0	10.6
3	4	20		10.7	81	1.79	5.95	10.4	11.2	87	2.27	6.55	10.5	11.3
4	4	140		9.8	81	1.79	5.95	9.8	10.4	87	2.27	6.55	9.9	10.6
5	4	344	5.4		81	1.79	5.95	6.0	7.0	87	2.27	6.55	6.2	7.2
6	7	108		5.2	78	1.58	5.49	4.2	5.8	87	2.27	6.55	4.5	6.0
7	9	10		6.5	77	1.50	5.36	6.9	7.8	87	2.27	6.55	7.1	7.9
8	9	60		6.5	77	1.50	5.36	6.9	7.8	87	2.27	6.55	7.1	7.9
9	10	56		11.0	78	1.58	5.49	11.3	11.7	87	2.27	6.55	11.4	11.8
10	11	18		9.8	80	1.72	5.72	10.0	10.6	87	2.27	6.55	10.1	10.7
11	15	18		10.2	76	1.43	5.25	10.0	10.7	87	2.27	6.55	10.3	11.0
12	10	15	13.0		78	1.58	5.49	13.1	13.6	87	2.27	6.55	13.3	13.7
13	6	107	10.2		81	1.79	5.95	10.7	11.7	87	2.27	6.55	10.8	11.9

Exhibit 11

RAINFALL AMOUNT IN 24 HOURS WHICH WILL CAUSE FLOODING
(UNDEVELOPED) WITH EXISTING DRAINAGE

* CROSS SECT. NO.	SUB AREA NO.	RCN	CONTROL ELEV.	RAINFALL 24 HOURS (INCHES)	RUNOFF 24 HOURS (INCHES)
1	3	78	10.0	1.5	0.23
2	5	88	10.5	3.8	2.54
3	4	81	10.7	3.8	1.95
4	4	81	9.8	3.6	1.79
5	4	81	5.4	2.3	0.80
6	7	78	5.2	4.0	1.89
7	9	77	6.5	2.2	0.50
8	9	77	6.5	2.2	0.50
9	10	78	11.0	2.6	0.86
10	11	80	9.8	3.4	1.56
11	15	76	10.2	3.5	1.36
12	10	78	13.0	3.4	1.43
13	6	81	10.2	1.9	0.50

* Cross-sections are shown on Exhibit 10, Page 35

Exhibit 12

RAINFALL AMOUNT IN 24 HOURS WHICH WILL CAUSE FLOODING
(FULLY DEVELOPED) WITH EXISTING DRAINAGE

CROSS SECT. NO.	SUB AREA NO.	RCN	CONTROL ELEV.	RAINFALL 24 HOURS (INCHES)	RUNOFF 24 HOURS (INCHES)
1	3	87	10.0	1.2	0.34
2	5	87	10.5	3.8	2.45
3	4	87	10.7	3.8	2.45
4	4	87	9.8	3.0	1.74
5	4	87	5.4	1.6	0.61
6	7	87	5.2	3.9	2.55
7	9	87	6.5	1.4	0.47
8	9	87	6.5	1.4	0.47
9	10	87	11.0	2.2	1.06
10	11	87	9.8	3.2	1.92
11	15	87	10.2	3.4	2.09
12	10	87	13.0	2.7	1.47
13	6	87	10.2	1.5	0.54

Exhibit 13

FULLY DEVELOPED Q (CFS)

CROSS SECT. NO.	SUB AREA NO.	RCN	10 YR 24 HR RAINFALL (INCHES)	10 YR 24 HR RUNOFF (INCHES)	10 YR Q (CFS)	BANKFULL Q (CFS)
1	3	87	5.6	4.13	12.2	15.7
2	5	87	5.6	4.13	2.3	20.3
3	4	87	5.6	4.13	4.2	15.7
4	4	87	5.6	4.13	21.8	40.3
5	4	87	5.6	4.13	46.0	44.8
6	7	87	5.6	4.13	17.5	18.2
7	9	87	5.6	4.13	2.3	12.8
8	9	87	5.6	4.13	10.6	12.8
9	10	87	5.6	4.13	10.0	28.6
10	11	87	5.6	4.13	4.2	28.6
11	15	87	5.6	4.13	4.2	20.3
12	10	87	5.6	4.13	3.3	12.8
13	6	87	5.6	4.13	17.3	18.2

Exhibit 14

RECOMMENDED CHANNEL DESIGN CRITERIA

FREEBOARD = 1.0 FT
HYDRAULIC DEPTH (D) = 2.0 FT

BOTTOM WIDTH (B) = 3.0 FT
SIDE SLOPE (S:S) = 1:1

AREA = 10.0 FT. RADIUS = 1.16 FT. N = .040

$$\text{VELOCITY (V)} = \frac{1.486}{N} R^{2/3} S^{1/2}$$

CROSS SECT. NO.	SUB AREA NO.	Q C.F.S.	SLOPE FT/FT	VEL. FT/SEC	Q = AV	BANK FULL Q C.F.S.
1	3	6.4	0.0003	0.81	8.1	15.7
2	5	1.6	0.0005	1.05	10.5	20.3
3	4	2.3	0.0003	0.81	8.1	15.7
4	4	12.2	0.0020	1.84	18.4	40.3
* 5	4	25.7	0.0003	0.97	26.2	44.8
6	7	9.1	0.0004	0.94	9.4	18.2
7	9	1.2	0.0002	0.58	5.8	12.8
8	9	5.3	0.0002	0.58	5.8	12.8
9	10	5.4	0.0010	1.48	14.8	28.6
10	11	2.3	0.0010	1.48	14.8	28.6
11	15	2.0	0.0005	1.05	10.5	20.3
12	10	1.7	0.0002	0.58	5.8	12.8
13	6	9.8	0.0004	0.94	9.4	18.2

* CHANGE BOTTOM WIDTH TO 6.0 FT. AND HYDRAULIC DEPTH TO 3.0 FT. AREA WOULD BE 27.00 FT. AND RADIUS 1.86 FT.

NOTE: BANK FULL WOULD INCREASE THE CHANNEL CAPACITY BY 94%

Exhibit 15

CHANNEL IMPROVEMENT NEEDS

SUB DRAINAGE AREA	PRIVATE L.F.	PRIVATE COST	COUNTY L.F.	COUNTY COST	STATE L.F.	STATE COST
1	700	$1,960.00	300	$600.00	1,700	$3,400.00
2	5,200	14,560.00	-	-	900	1,800.00
3	2,000	5,600.00	6,200	12,400.00	3,300	6,600.00
4	17,800	49,840.00	10,800	21,600.00	700	1,400.00
5	800	2,240.00	-	-	1,900	3,800.00
6	3,600	10,080.00	-	-	3,000	6,000.00
7	3,000	8,400.00	800	1,600.00	-	
8	1,000	2,800.00	1,900	3,800.00	-	
9	2,200	6,160.00	2,800	5,600.00	-	
10	4,400	12,320.00	4,000	8,000.00	2,200	4,400.00
11	2,100	5,880.00	3,400	6,800.00	-	
12	-	-	-	-	600	1,200.00
13	1,000	2,800.00	-	-	-	
14	-	-	-	-	900	1,800.00
15	1,800	5,040.00	1,200	2,400.00	-	
16	-	-	600	1,200.00	2,800	5,600.00
17	-	-	-	-	1,200	2,400.00
TOTALS	45,600	$127,680.00	32,000	$64,000.00	19,200	$38,400.00

NOTE: PRIVATE CONSTRUCTION COST = $ 2.80 PER L.F.
COUNTY AND STATE COST = $ 2.00 PER L.F.

Exhibit 16

OTHER AREAS OF CONCERN

AQUIFERS

Ground water is used for all domestic, industrial, and public water supplies in the county. The wells furnishing these demands are less than 400 feet deep for the most part and are finished in unconsolidated coastal plain deposits that are of miocene age or younger. In researching 16 wells the following data was collected:

Name of Aquifer	Number	Range in Depth (Ft)
Pleistocene	12	11.0 to 95.0
Pocomoke	1	180
Manokin	3	240.0 to 275.0

The above three aquifers were the only ones that are being used for water supplies in this study area.

SEWAGE DISPOSAL

General

Sewage disposal is a definite problem not only in this study area but throughout the county. This study area has approximately 77 percent hydric soils (1010 acres). With the hydric soils and poor drainage systems with high water tables this area has a definite environmental problem. As the growth increases, the sewage problem is going to escalate. This is especially true in this study area where the demand in the future will consist of commercial and increased residential development, recreation facilities, and possible motels. With the high percentage of hydric soils, this area is unsuitable for development on septic

tank disposal systems alone. In order to address this problem we have researched other alternatives for sewage disposal systems that are being used in the coastal plains.

Bermed Infiltration Ponds

A bermed infiltration pond is an excavation approximately eight to ten feet deep with no less than 10,000 square feet in surface area. The excavation exposes a water bearing substratum overlain by an impermeable soil. Part of the excavated material is placed around the pond perimeter to form a berm (Figure 1, Page 53). The water from the substratum rises and falls in the pond with seasonal fluctuations in the water table. Septic tank effluent is discharged near the bottom of the pond for disposal. The biological organisms in the pond complete the treatment process and the water moves into the surficial groundwater surrounding the pond or evaporates. The purpose of the design is to overcome site limitations that prohibit the use of conventional trench or sand lined trench on-site sewage disposal systems in areas of the Coastal Plain. These systems can only be used where upper and lower confining units isolate non-potable shallow saturated sands.

Bermed infiltration ponds can be used only in the following soils that are in this study area; they are Mattapex and Othello. They have proven to be very effective in Dorchester County and are approved by the Maryland Department of the Environment. These ponds are constructed when underground sewer systems will not function in heavy clay and silt soils with high water tables. The water quality in the ponds will be able to sustain fish. However, there are some site criteria issued by the Maryland Department of the Environment that must be met. They are as follows:

1. Minimum lot size is 4.0 acres
2. A bermed pond must be at least 300 feet from another bermed pond
3. Land slopes shall be less than 2 percent
4. 150 feet from any well
5. 150 feet from surface water
6. 100 feet from property line
7. 50 feet from building foundations

Design Criteria

1. Interior side slopes = 1:1
2. Pond depth shall be a minimum of 8.0 feet and expose a permeable substratum as much as practical (minimum of 2.0 feet)
3. Berm shall be a minimum of 20 feet wide, 1.5 feet in height and be constructed with silts and clays. Interior side slopes shall be 6:1 and exterior a minimum of 4:1.
4. The berm must be stabilized and seeded within 14 days of construction. No trees are permitted in the berm.
5. Signs warning of deep water and waste disposal should be posted and be clearly visible from all four directions.

Soils - Profile Description

Upper confining A & B horizons with a minimum thickness of 36 inches and textures of silt loam, silty clay, silty clay loam, clay loam or clay underlain by saturated fine sandy soils with a minimum thickness of 24 inches and a lower confining layer at least 60 inches in thickness.

Size Requirements

NUMBER OF HOUSING UNITS	SURFACE AREA SQ. FT.	BIP RESERVED AREA INCLUDES BIP SQ. FT.
1 or 2	10,000	20,000
3	14,000	28,000
4	18,000	36,000
5	22,000	44,000
6	25,500	51,000
7	29,000	58,000
8	32,500	65,000
9	36,000	72,000
10	39,500	79,000

Cost Of Bermed Infiltration Ponds

According to Dorchester County Officials, the ponds cost between $ 14,000 and $ 16,000 for the average home site.

Summary Of Findings

Although these bermed infiltration ponds are expensive, they can be used in areas not suited for septic drain fields. They have been tested for leaching and the maximum distance that nitrates have been detected is 150 feet. Attached are the following drawings:

Figure 1 - A bermed infiltration pond design sheet with cross sections

Figure 2 - A typical four compartment septic tank

Figure 3 - A typical buried intermittent filter system

Figure 4 - A typical bermed infiltration pond concept

Sand Mound System

This study area is located in management area "A" which is the most restrictive area in Worcester County for on-site sewage disposal. This system will work only in soils where seasonal high water is 24 inches or greater below the surface. The only soils in this watershed where you could use the sand mound system are sassafras or the deep woodstown soils. This system requires a septic tank, a pumping station, and a sand mound consisting of stone and sands. The waste is pumped onto the stone and then filters through 24 inches of sand to the ground surface then into the ground that is 24 inches above seasonal high water table giving the site 4.0 feet of filtering before entering the ground water. This system varies in cost from $ 9,000 to $ 15,000.

Conventional Gravity Trench

Underground septic systems with septic tank, distribution boxes, and stone lined trenches with 4 inch perforated plastic pipe are limited for effective use in the following soils: Fallsington, Leon, Mattapex, Othello, Pocomoke and Portsmouth. Soils with slight to moderate limitations are: Fort Mott, Lakeland, Sassafras and Woodstown. Some Woodstown may be classified as moderate to severe. The construction of channels 3.0 feet in depth would relieve some problems with a high water table in Woodstown and Fallsington and they may pass a perk test. The cost on a system of this type varies from $ 2,500 to $ 4,000 depending on design capacity.

Injection System

There is a proposal to use this type system on parcel 149, Map No. 33, in the southeast section of this study area. The system is designed for 242 housing units with 300 Gal./Day of wastewater for each unit. This is a total of 72,600 Gal./Day. for the system. Proposed is installing 6 - 72" x 34' pipes into the ground. The average elevation is 8.0 feet M.S.L., thus the pipes would be installed at elevation - 24 feet M.S.L. In researching some 16 private wells in the area, we found wells from 11.0 feet to 275 feet in depth. This may cause water contamination in the more shallow wells. The jury is still out on this type of disposal system.

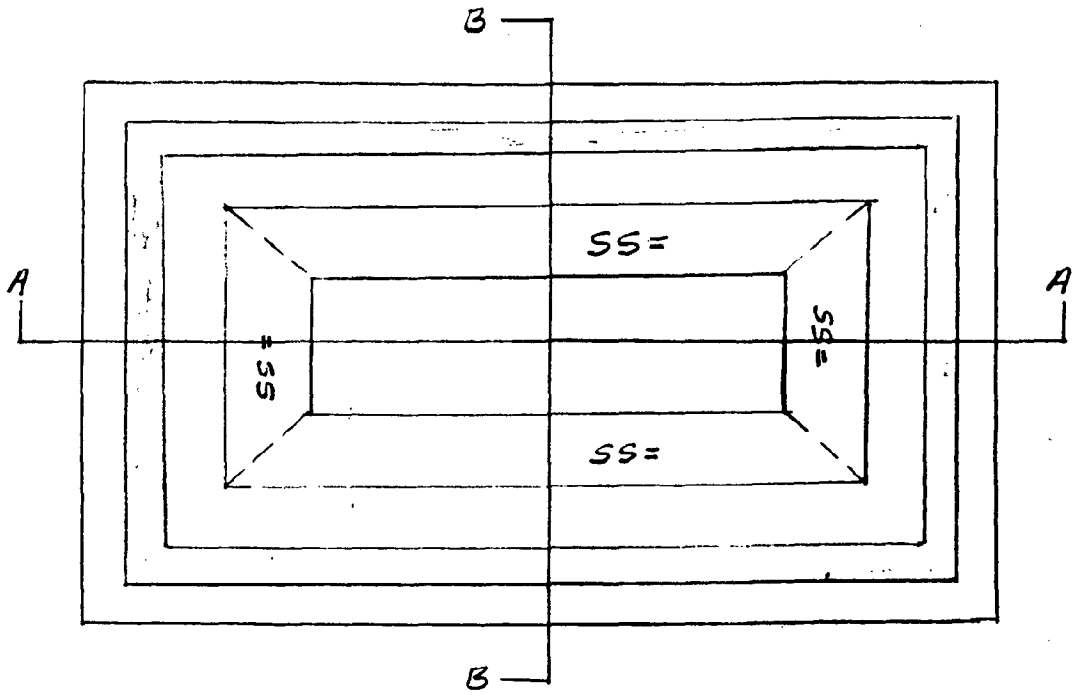
Central Water And Sewage System

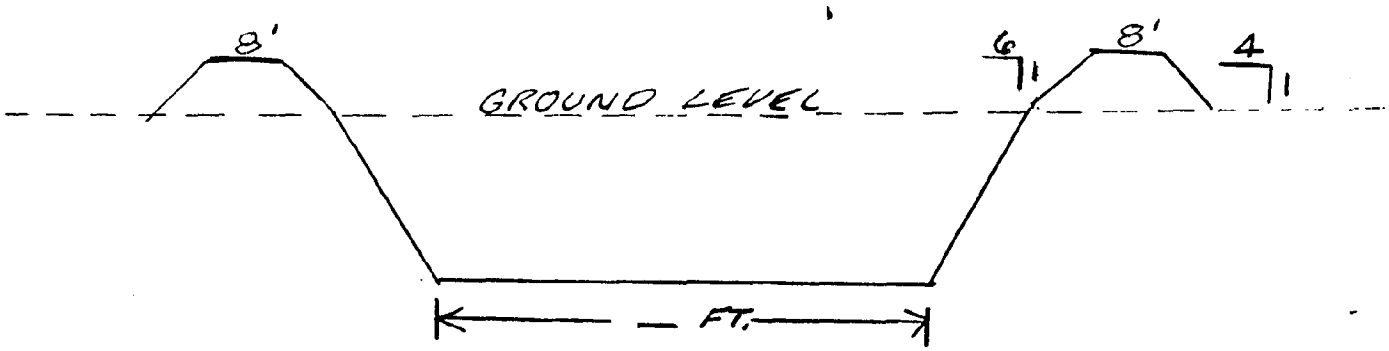
This system can be used in this study area where much of the land is unsuitable for development with on-site septic disposal. It can be a public central water and sewer service or a private system installed by the developer.

This determination can be made by Worcester County officials based on economics and projected land use. However, there are some principals that should govern this type of system and they are as follows:

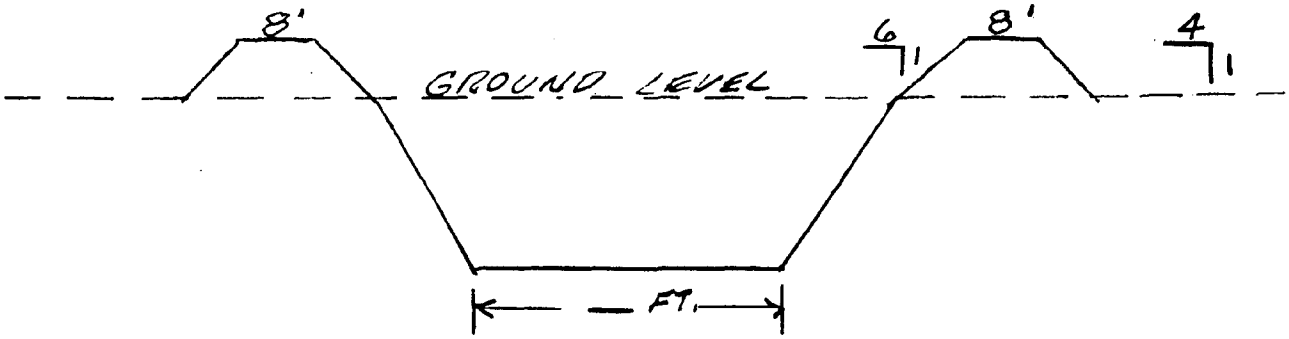
1. Service to be provided when other systems due to soil limitations will not function
2. To correct an existing public health hazard or environmental threat
3. Used to accommodate high density growth areas only
4. Serve only areas that would support the system with little help from county tax money

BERMED INFILTRATION POND DESIGN



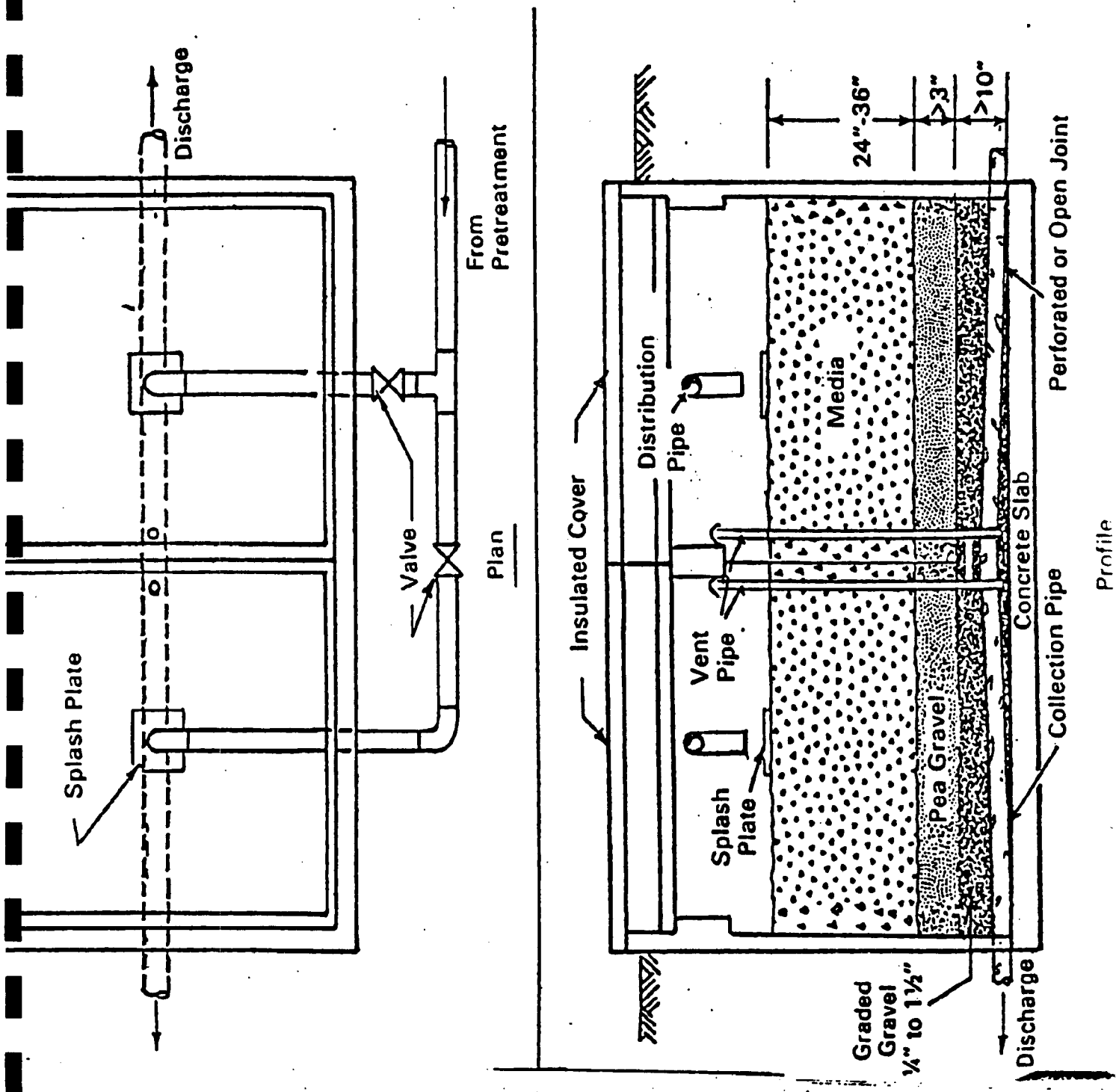


SECTION A-A



SECTION B-B

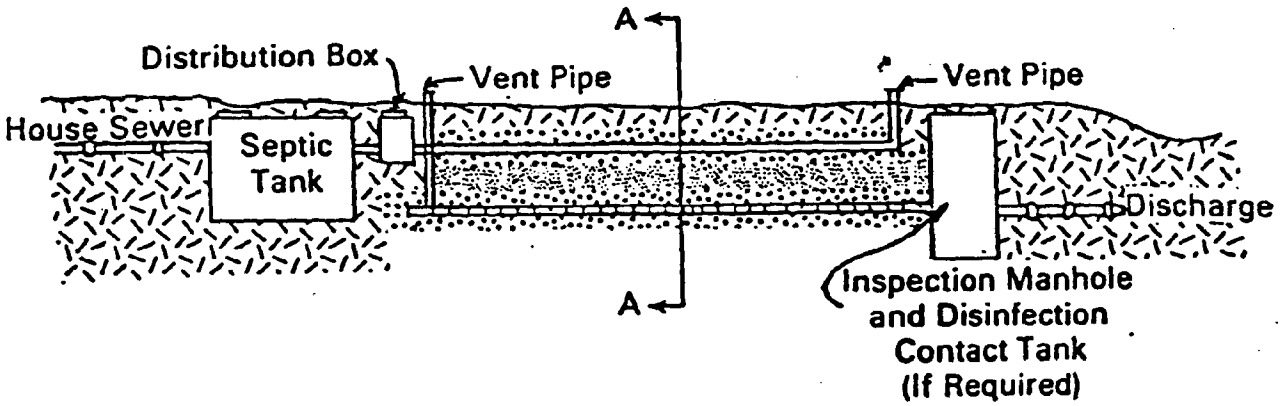
FIGURE 1
PAGE NO. 53



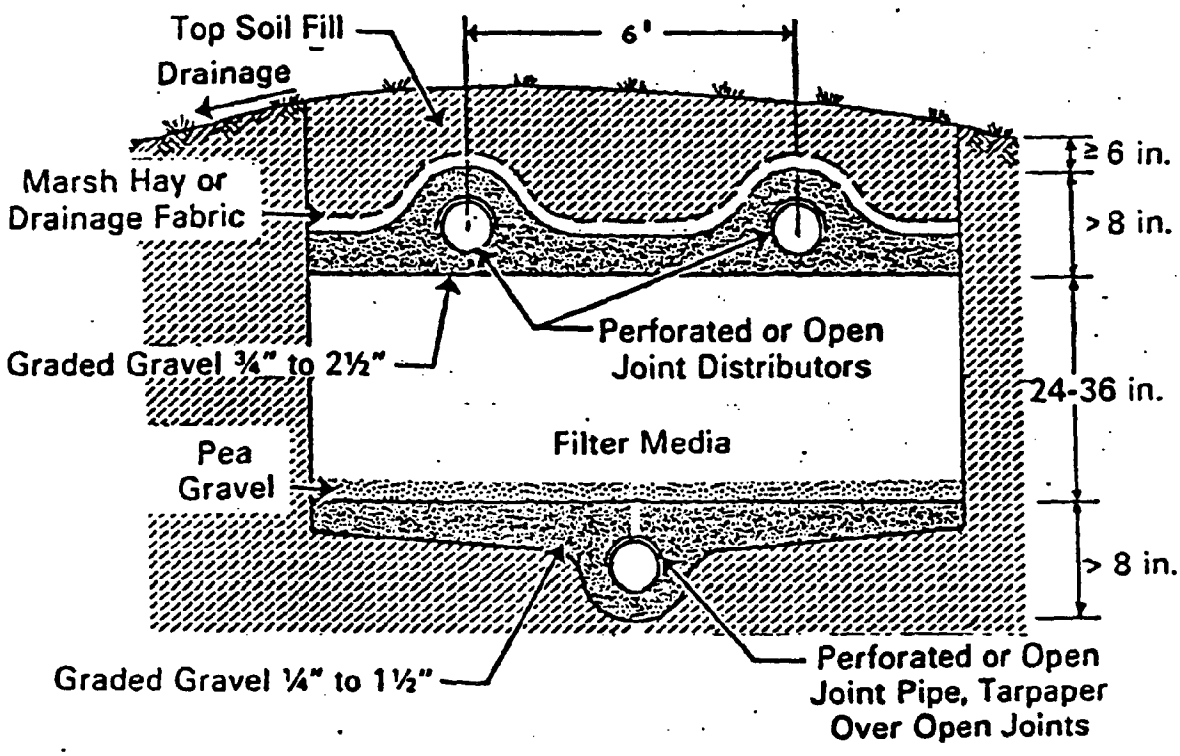
TYPICAL FOUR-COMPARTMENT SEPTIC TANK

FIGURE 2
PAGE NO. 54

TYPICAL BURIED INTERMITTENT FILTER INSTALLATION

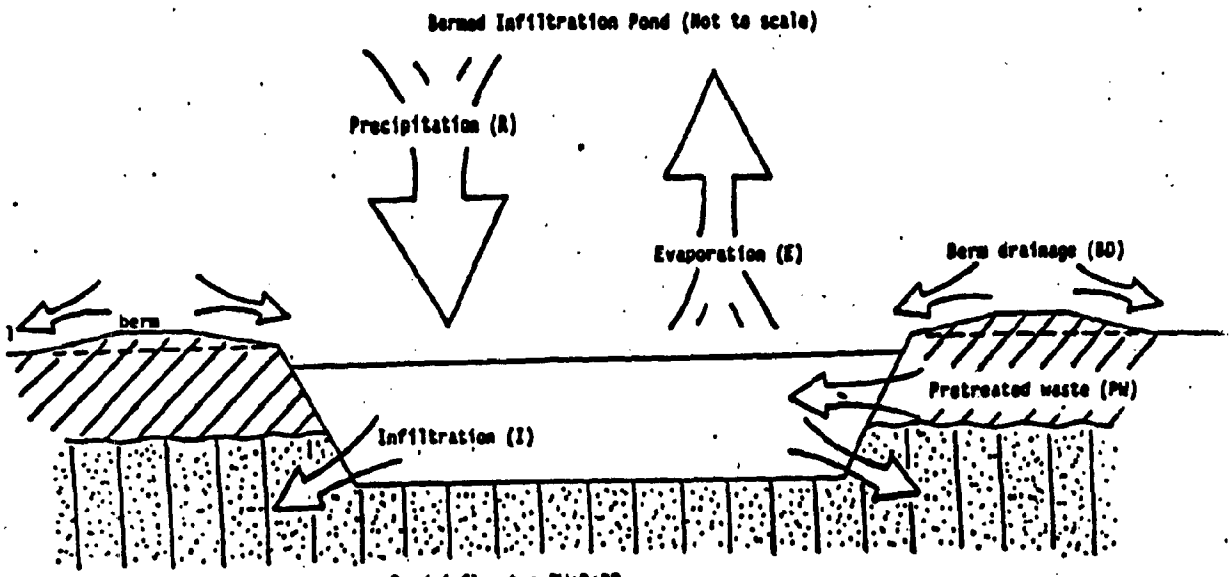


Profile



Section A-A

FIGURE 3
PAGE NO. 55



Pond influent = PW+R+BD
Pond effluent = E+I
Hydraulic balance = (PW+R+BD)-(E+I)
ΔI = (PW+R+BD)-E

The bermed infiltration pond concept involves pretreating the household wastes prior to disposal in the pond. Large volumes of water enter the pond from precipitation, surface drainage from the inside of the berm and the pretreated wastewater: Water leaves the pond by evaporation and infiltration.

FIGURE 4
PAGE NO. 56

STORM WATER MANAGEMENT

The achievement of water quality protection in urbanizing watersheds is heavily dependent upon the systematic implementation of effective, basin-wide Storm Water Management (SWM) controls. The benefits derived include groundwater recharge, low stream flow augmentation, water quality enhancement and reduction in the total runoff volume. Each of the benefits help negate the adverse environmental impacts resulting from development and land use change. Infiltration practices include the following:

1. Infiltration Basin
2. Infiltration Trench
3. Dry Well
4. Vegetated Swales with Check Dams
5. Vegetated Filter
6. Wetlands
7. Artificial Wetlands
8. Detention Basin
9. Combination Underground Detention Chamber and Recharge Facility
10. Stormwater Treatment System Using Peat-Sand Filters
11. Retention Basin

Infiltration practices are dependent upon the soils profile and the location of the seasonal groundwater table. The soils table (Exhibit 6, Pages 16-17) gives approximate values for the water table and permeability. This information could be used to evaluate applicable use on a specific site.

Storm water detention and retention structures are the most used practice in Worcester County. Exhibit 17, Page 60 is a summary of detention storage required for the entire study area. Approximately 72 acre-feet of storage would be required if the area is fully developed. Since each of the seventeen drainage areas have separate outlets and topography does not lend to combining drainage areas (except certain areas along MD 611), total development or partial development should consider the entire area within the sub-drainage area so that

stormwater management facilities can be strategically located for maximum effectiveness. Infiltration Trenches and Combination Underground Detention Chambers and Recharge Facilities have been used where applicable. Although infiltration systems are being used, these systems in a highly urbanized setting have a relatively short life span.

A draft paper, "Peat-Sand Filters, A Proposed Stormwater Management practice for Urbanized Areas", prepared by John Galli, Department of Environmental Programs, Metropolitan Washington Council of Governments and prepared for the Coordinated Anacostia Retrofit Program and D.C. Department of Public Works, indicates that this type of system has merit for controlling runoff.

The man made-soil infiltration system combines peat, sand and a grass cover crop to achieve high overall pollutant removal efficiency within a single, relatively compact unit. In addition, the system also features a small wet pool for pre-treating stormwater runoff. The general compactness and relative freedom of the proposed system from common site constraints (such as high water table, poor soils, etc.) make it a candidate for many end of pipe applications.

This type of system may lend itself to commercial residential development, such as a neighborhood service center could transport storm water through storm sewer to the management facility and eventually to receiving waters through improved drainage systems. Exhibit 18, Page 61 is a schematic of the system from the draft paper (Galli).

The development of stormwater management policy is difficult because of the many problems associated with surface runoff in urbanizing areas. These problems are related to both the quantity and quality of stormwater runoff that requires multi-objective design policies to mitigate adverse impacts. Increased flooding magnitudes become more evident because the volume and rate of runoff exceed the

natural carrying capacity of the stream channel, which cannot adjust to the sudden impact of urban development.

It is suggested that Worcester County maintain the current progress in Storm Water Management Programs and continue to investigate new approaches as they become available.

STORM WATER STORAGE REQUIREMENTS

The Worcester County stormwater code, Title 2, Land Resources, Subtitle 1, stormwater management; states the following: If there is not an outlet with the capacity to handle a 25 year storm which is 6.4 inches of rainfall in 24 hours the developer or owner has to store the difference of the 2 year pre and the 10 year post development runoff. The storage facility is more effective if located near the outlet or downstream section of the development. Once constructed they must be properly maintained to retain their design capacity. Our intensive field evaluation and hydraulic analysis of the area indicates that there are no channels that will convey the 25 year storm. The following table shows the storage required for 17 sub watersheds if fully developed.

DETENTION BASIN STORAGE SUMMARY

SUB WATERSHED NUMBER	DRAINAGE AREA SQUARE MILE	2 YEAR Q CFS PRE	10 YEAR Q CFS POST	REQUIRED STORAGE AC. FT
1	.023	1.9	3.3	0.70
2	.330	15.9	30.6	12.11
3	.110	6.4	12.2	4.04
4	.540	25.7	46.0	18.71
5	.016	1.6	2.3	0.32
6	.167	9.7	17.3	5.42
7	.169	9.1	17.5	6.21
8	.090	5.0	10.4	3.63
9	.125	6.7	13.6	4.91
10	.189	10.0	19.2	6.94
11	.088	5.5	10.2	2.93
12	.005	0.5	0.9	0.19
13	.017	1.4	2.6	0.58
14	.017	1.4	2.6	0.58
15	.080	4.6	9.4	3.22
16	.023	1.6	3.3	0.97
17	.020	1.2	3.0	1.05

Exhibit 17

PEAT - SAND FILTERS

(NO SCALE)

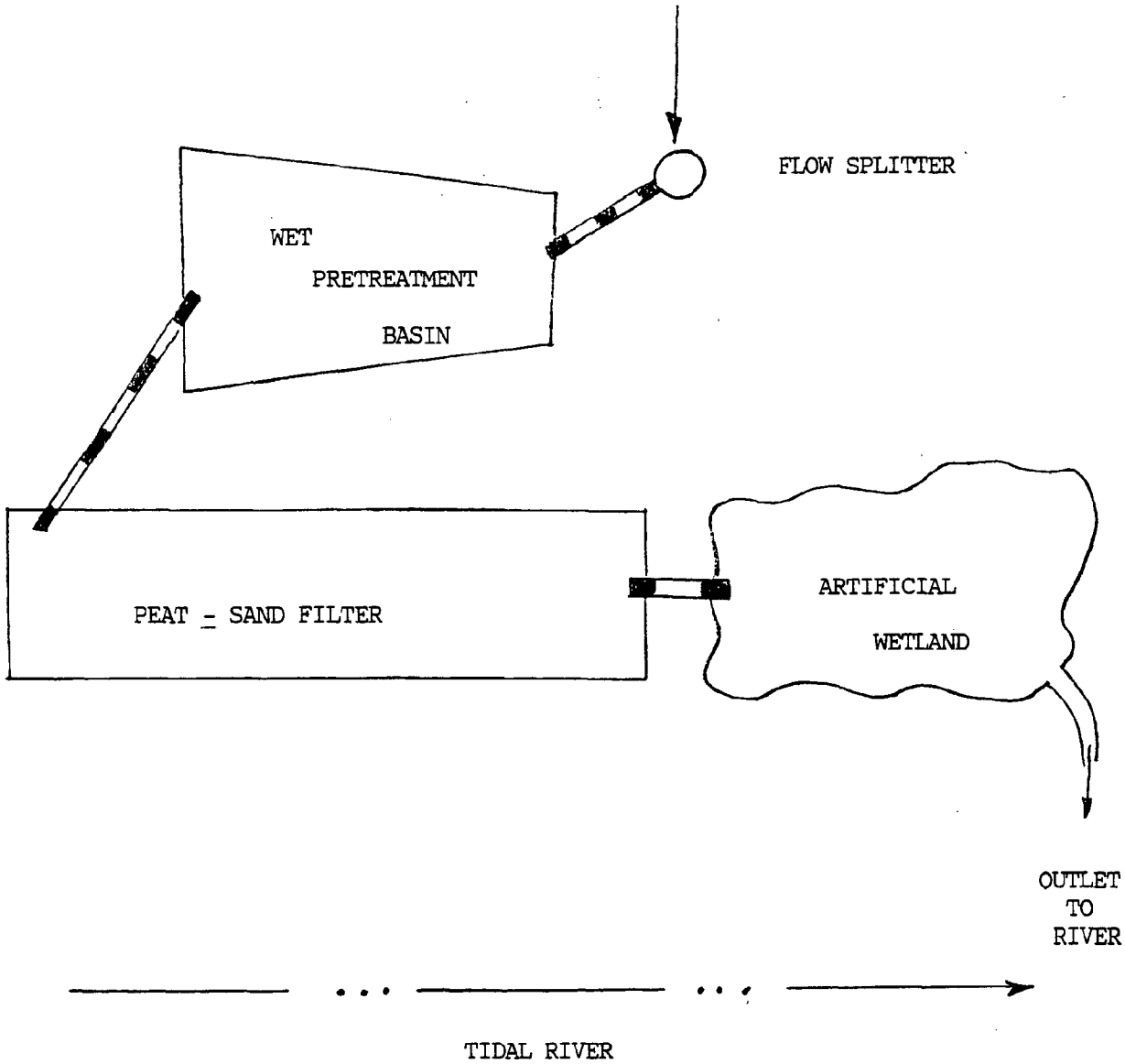


Exhibit 18

RECREATION

Parcel 274, Tax Map No. 26, Robert J. Taylor, et al. has been proposed by the owner as a private county recreational park. Approximately 90 percent of the land area is Fallingston (Fg), Pocomoke Loam (Pm) and Pocomoke Sandy Loam (Pk). The Worcester County Soil Survey, Soil Limitation for Specified Recreational Uses shows that these soils have severe limitations because of the high water table. An adequate drainage system combined with water management and ecological improvements to offset environmental damage may qualify the site for the intended use. This parcel contains 39.67 acres of wooded land.

The planned recreation area with Pocomoke and Fallsington soils, associated with seasonal high water tables at the surface, limits the use for athletic fields such as soccer and softball without intensive drainage. The ideal drainage system would be accomplished by improving an outlet channel and installing sub-surface drainage (4 inch plastic tile). The spacing for the tile would be 70 feet or 627 L.F. / acre. An estimated cost of $ 500.00 / acre for tile plus $ 5,500 for the outlet channel would be $ 25,575 or $ 637 / acre.

Suggestive alternatives are:

1. Wildlife and nature trails for educational purposes with picnic areas.

2. Water theme park such as Wild World Water and Amusement Park located in Largo, Maryland.

3. A chip and putt lighted nine hole golf course. The operator would furnish one club and one putter. This is a fast growing sport for family entertainment.

OCEAN CITY MUNICIPAL AIRPORT

Introduction

The initial Master Plan for Ocean City Airport was developed in 1958 by Airways Engineering Corporation. A new Master Plan was prepared by Greiner Engineering Sciences, Inc. in 1977. A revised Master Plan Update was completed in December, 1987 by Greiner Engineering Mid-Atlantic, Inc. The purpose of the Master Plan Update was to revise the airport layout plan in accordance with existing improvements and for development based on projections of future needs.

The 1987 update indicates that Ocean City has experienced substantial growth in year-round population and that this trend should continue as the economic base increases. Ocean City is also attempting to stabilize the seasonal fluctuations of the tourism market by aggressive newspaper, radio and TV advertisements along with direct mailings and special events during the off-season. Special cut rate incentives and weekend package deals are being promoted to increase off-season visitors. It has been estimated that twenty-eight golf courses will be located in the approximate area by the year 2000. The construction of these golf courses in the immediate area of Ocean City could also increase the tourism population during the off season. Continued progress toward attracting a more stabilized tourist population may increase airport usage, therefore; necessitating airport expansion.

Future Expansion

The Master Plan Update states that with the existing and projected future demand for turbojet operations, the ultimate would be that both runways be extended to accommodate these aircraft. For extensions of these runways more land would be required, the relocation of MD 611 may be required and an extended

approach slope would be necessary. Another option would be the total relocation of the airport complex and devote the complex to other compatible uses. The 1987 Master Plan Update recommends that the improvement on runway 14-32 be in a westerly direction and on runway 1-19 be in a southerly direction. The southerly direction of runway 1-19 is complicated by the construction of Eagles Landing Golf Course which may dictate an extension in a northerly direction, if wetlands crieria can be mitigated.

It is inherent that the airport maintain existing operation and/or expand its size and level of operations to satisfy existing and future aviation demands and that persons who live, work or own property near the airport may enjoy a maximum amount of freedom from noise or other adverse impacts. The U.S. Department of Transportation, Federal Aviation Administration Circular AC 150/5050-6, Airport Land Use Compatibility Planning provides generalized guidance for compatible land use planning in the vicinity of both new and existing airports.

The circular identifies the primary planning inputs as noise quality (LUG) zones (Exhibit 19, Page 68), noise sensitivity criteria (LUG Chart I, Exhibit 20, Page 69, and Chart II, Exhibit 21, Page 70), existing land use patterns and the direction and rate of change in these patterns (unconstrained future land use patterns). Other inputs to the planning process normally required, include land suitability analysis (i.e. slope analysis, drainage and flooding, soils and bearing, vegetation and fauna, environmental analysis, cultural or historic sites, etc.); water and sanitary sewer availability; thoroughfares and access; existing zoning; existing easements and restrictive covenants, total acres of need for each major land use category for future years; and the interrelationships of each use. Protection of runway approaches from interference by high objects or buildings, smoke, glare, bird hazards, electromagnetic radiation, and concentrations of

people is also an essential aspect of the compatibility schemes. Many uses having high noise tolerance can create interferences, as an example, sanitary landfills, solid waste dumps, and certain kinds of agricultural operations, while unaffected by noise, tend to attract large numbers of feeding birds and can be safety hazards to airport operations. Commercial and industrial districts may also create potential safety hazards (glare, smoke, etc.) unless adequate protection is included in the plan. Additional detail is contained in AC 150/5190-4, A Model Zoning Ordinance to Limit Heights of Objects Around Airports, and AC 150/5200-3, Bird Hazards to Aircraft.

Most land uses are considered compatible with noise levels less than 65 day-night average sound level (LdN) contour. The immediate area around the Ocean City Airport may be affected by this level but also safety of aircraft and residents within the operational area is of equal importance.

The land use planning overall goal should achieve an acceptable balance between the needs and tolerances of both the airport and its neighbors. This would require that both entities be open and flexible, recognizing that some changes to present courses of action may be essential to promote public safety and economics of the area. Planning criteria may encourage Worcester County government to incorporate land use and development controls.

Land Use And Development Controls

Land use and development controls can be used to protect the impact areas from encroachment. A number of different controls are normally available to local governments and/or to airport sponsors to prevent such intrusions. The controls which are generally most useful for achieving airport compatibility - zoning, easements, and land purchase - will be discussed here. Other controls having

either less or special applicability include building codes (noise insulation requirements), health and housing codes, programming of public capital improvements, and cooperation of financial institutions.

a. Zoning. The most common and useful land use control is zoning. Zoning is an exercise of the police powers of state and local governments which designates the uses permitted on each parcel of land. It normally consists of a zoning ordinance which delineates the various use districts and includes a zoning map based upon the land use element of the community's comprehensive plan (the airport-land use compatibility plan should be a part of the comprehensive plan). The primary advantage of zoning is that it can promote compatibility while leaving the land in private ownership, on the tax rolls, and economically productive. At the same time it is subject to change and must be continually monitored if it is to remain a viable compatibility tool.

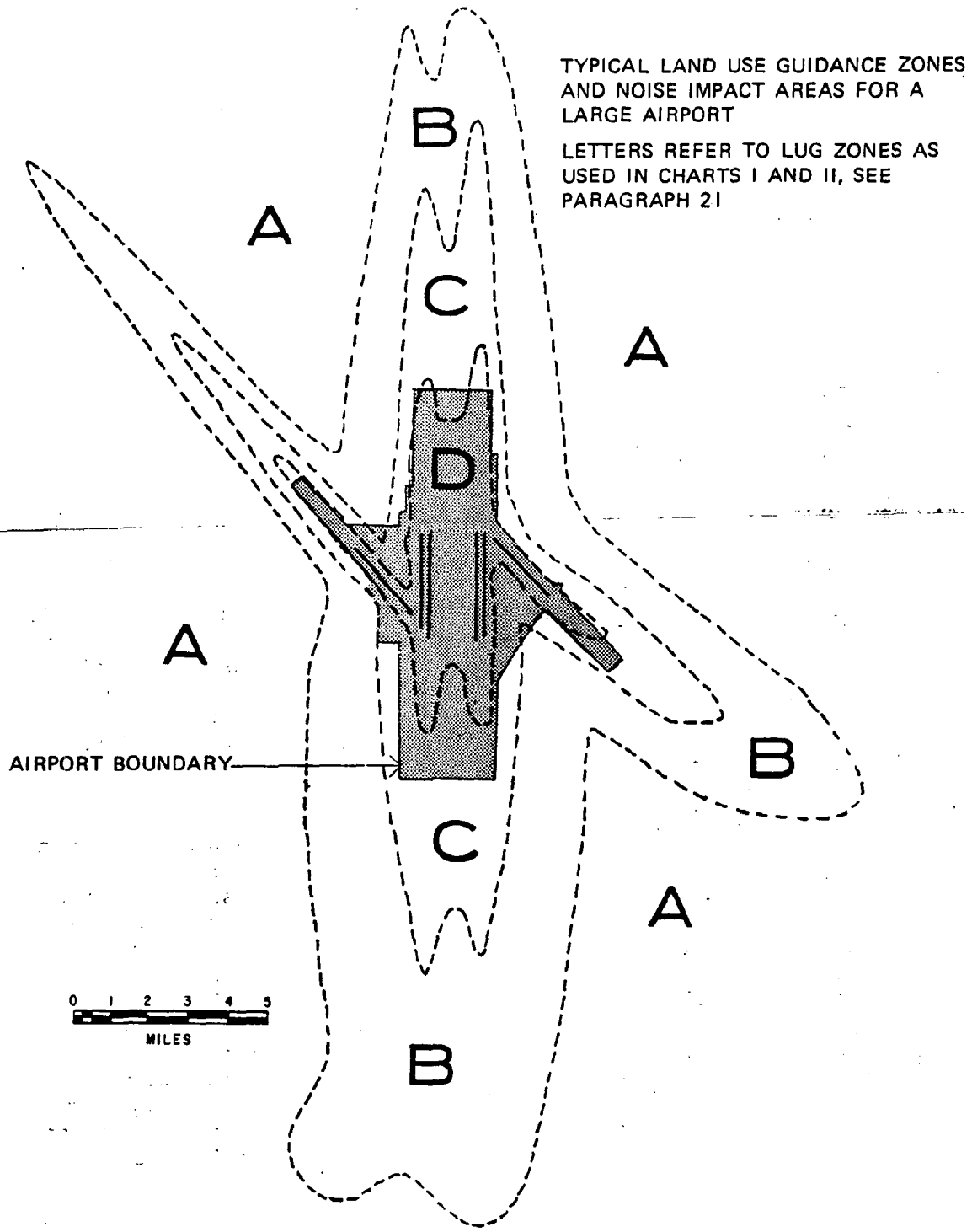
b. Easements. Easements may be used as an effective and permanent form of land use control. In many instances, they may be better for airport compatibility purposes than zoning. Easements are permanent, with title held by the purchaser until sold or released, and work equally well inside or outside zoning jurisdictions. They are directly enforceable by the holder through civil courts and may often be acquired for a fraction of the cost of the land value. Also of consideration is that the land is left free for full development with compatible uses.

c. Transfer of Development Rights (TDR). TDR involves separate ownership and use of the various "rights" associated with a parcel of real estate.

Under the TDR concept, some of the property's development rights are transferred to a remote location where they may be used to intensify allowable development.

d. Land Purchase. Purchase of land in fee simple is the most positive of all forms of land use control. It is also usually the most expensive. However, when combined with either resale for compatible uses or retention and use for a compatible public purpose, the net cost may be effectively reduced significantly. As a preventative measure, purchase should usually be limited to critical locations or to hard core cases where other solutions are not workable.

It is recommended that the use of zoning around the airport and its environment should be considered for airport safety as well as public safety. Zoning must consider the total needs of the area with the specific needs of the airport. It appears that the primary need for the airport is the area directly under the approach slopes, namely; west and north toward MD 611 which includes residential, woods, utility, and highway obstructions (Exhibit 20, Page 69 and Exhibit 21, Page 70; Obstruction). With these types of obstruction special zoning considering height of structures, type of structures, density and type of activity should be regulated. The limits of zoning regulation should at least encompass the area under the recommended FAA approach slope. Map No. 2, (Map Pocket) shows area under approach slope on aerial photo of an approach slope configuration. Configuration is determined by existing obstructions but putting limits on future obstruction. Other obstacles may need to be overcome by the purchase of land, by the transfer of development rights or by obtaining easements. This will take cooperation between land owner, county government and owners of the airport (Ocean City).



AIRPORT NOISE PATTERNS

EXHIBIT 19

LAND USE GUIDANCE CHART I: AIRPORT NOISE INTERPOLATION

LAND USE GUIDANCE ZONES (LUG)	NOISE EXPOSURE CLASS	INPUTS: AIRCRAFT NOISE ESTIMATING METHODOLOGIES				HUD NOISE ASSESSMENT GUIDELINES	SUGGESTED NOISE CONTROLS
		L_{dn} DAY-NIGHT AVG. SOUND LEVEL	NEF NOISE EXPOSURE FORECAST	CNR COMPOSITE NOISE RATING	CNEL COMMUNITY NOISE EQUIVALENT LEVEL		
A	MINIMAL EXPOSURE	0 TO 55	0 TO 20	0 TO 90	0 TO 55	"CLEARLY ACCEPTABLE"	NORMALLY REQUIRES NO SPECIAL CONSIDERATIONS
B	MODERATE EXPOSURE	55 TO 65	20 TO 30	90 TO 100	55 TO 65	"NORMALLY ACCEPTABLE"	LAND USE CONTROLS SHOULD BE CONSIDERED
C	SIGNIFICANT EXPOSURE	65 TO 75	30 TO 40	100 TO 115	65 TO 75	"NORMALLY UNACCEPTABLE"	NOISE EASEMENTS, LAND USE, AND OTHER COMPATIBILITY CONTROLS RECOMMENDED
D	SEVERE EXPOSURE	75 & HIGHER	40 & HIGHER	115 & HIGHER	75 & HIGHER	"CLEARLY UNACCEPTABLE"	CONTAINMENT WITHIN AIRPORT BOUNDARY OR USE OF POSITIVE COMPATIBILITY CONTROLS RECOMMENDED

EXHIBIT 20

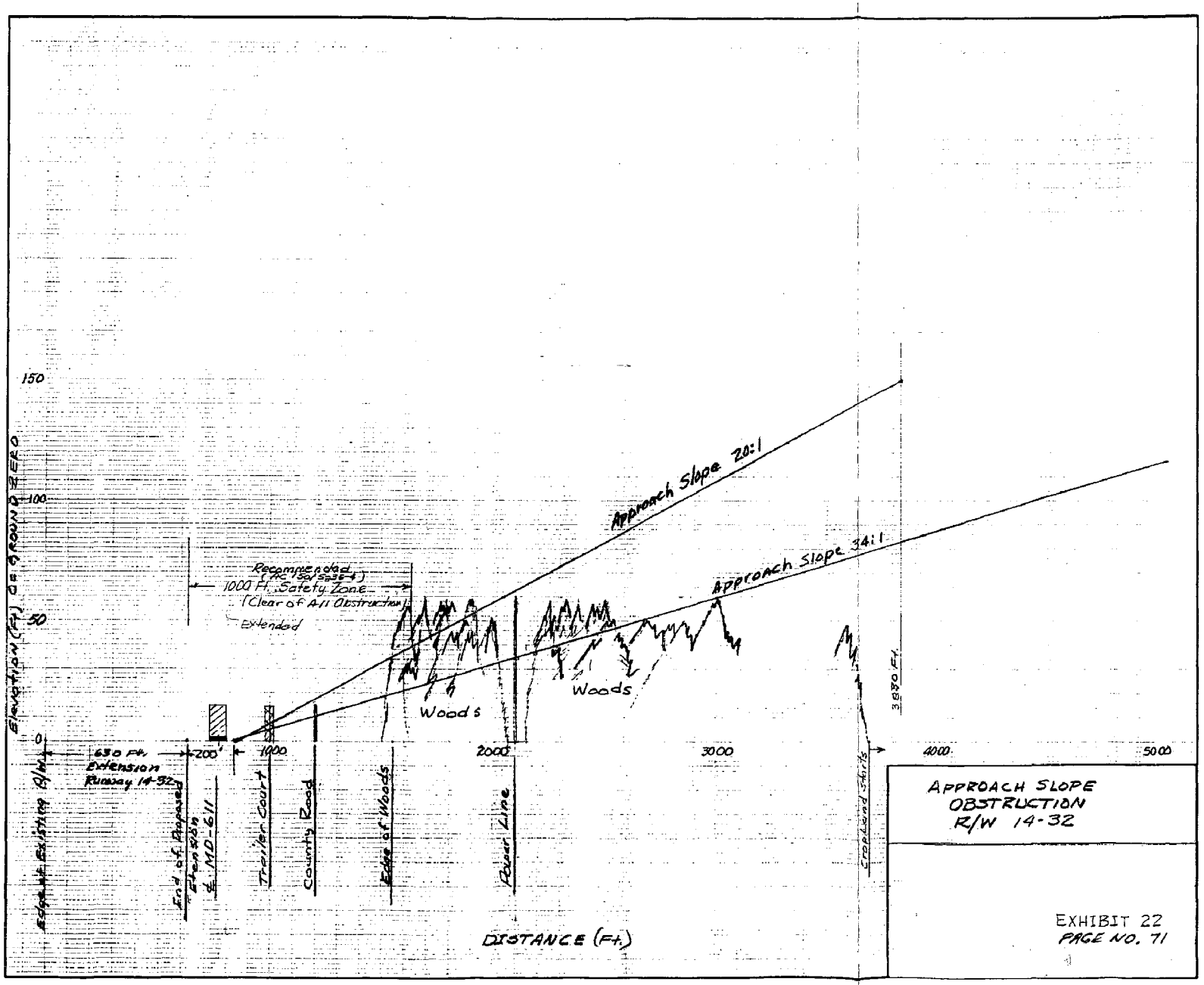
LAND USE GUIDANCE CHART II: LAND USE NOISE SENSITIVITY INTERPOLATION

LAND USE		LUG ZONE[1]		LAND USE		LUG ZONE[1]		LAND USE		LUG ZONE[1]	
SLUCM NO.	NAME	SUG-GESTED	STUDY	SLUCM NO.	NAME	SUG-GESTED	STUDY	SLUCM NO.	NAME	SUG-GESTED	STUDY
10	Residential.	A-B		30	Manufacturing (continued).[2]			60	Services.[4]		
11	Household units.			31	Rubber and miscellaneous plastic products—manufacturing.	C-D		61	Finance, insurance, and real estate services.	B	
11,11	Single units—detached.	A		32	Stone, clay, and glass products—manufacturing.	C-D		62	Personal services.	B	
11,12	Single units—semiattached.	A						63	Business services.	B	
11,13	Single units—attached row.	B		33	Primary metal industries.	D		64	Repair services.	C	
				34	Fabricated metal products—manufacturing.	D		65	Professional services.	B-C	
11,21	Two units—side-by-side.	A						66	Contract construction services.	C	
11,22	Two units—one above the other.	A		35	Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks—manufacturing.	B		67	Governmental services.	B	
								68	Educational services.	A-B	
11,31	Apartments—walk up.	B						69	Miscellaneous services.	A-C	
11,32	Apartments—elevator.	B-C									
				39	Miscellaneous manufacturing.	C-D		70	Cultural, entertainment, and recreational.		
12	Group quarters.	A-B									
13	Residential hotels.	B		40	Transportation, communication, and utilities.						
14	Mobile home parks or courts.	A						71	Cultural activities and nature exhibitions.	A	
15	Transient lodgings.	C									
19	Other residential.	A-C		41	Railroad, rapid rail transit, and street railway transportation.	D		72	Public assembly.	A	
								73	Amusements.	C	
20	Manufacturing.[2]	C-D		42	Motor vehicle transportation.	D		74	Recreational activities.[5]	B-C	
				43	Aircraft transportation.	D		75	Resorts and group camps.	A	
				44	Marine craft transportation.	D		76	Parks.	A-C	
21	Food and kindred products—manufacturing.	C-D		45	Highway and street right-of-way.	D					
				46	Automobile parking.	D		79	Other cultural, entertainment, and recreational.[5]	A-B	
22	Textile mill products—manufacturing.	C-D		47	Communication.	A-D					
23	Apparel and other finished products made from fabrics, leather, and similar materials—manufacturing.	C-D		48	Utilities.	D					
				49	Other transportation, communication, and utilities.	A-D		80	Resource production and extraction.		
24	Lumber and wood products (except furniture)—manufacturing.	C-D						81	Agriculture.	C-D	
								82	Agricultural related activities.	C-D	
25	Furniture and fixtures—manufacturing.	C-D		50	Trade.[4]			83	Forestry activities and related services.	D	
								84	Fishing activities and related services.	D	
26	Paper and allied products—manufacturing.	C-D		51	Wholesale trade.	C-D		85	Mining activities and related services.	D	
				52	Retail trade—building materials, hardware, and farm equipment.	C		89	Other resource production and extraction.	C-D	
27	Printing, publishing, and allied industries.	C-D									
				53	Retail trade—general merchandise.	C					
28	Chemicals and allied products—manufacturing.	C-D		54	Retail trade—food.	C		90	Undeveloped land and water areas.		
				55	Retail trade—automotive, marine craft, aircraft, and accessories.	C					
29	Petroleum refining and related industries[3]	C-D						91	Undeveloped and unused land area (excluding noncommercial forest development).	D	
				56	Retail trade—apparel and accessories.	C					
				57	Retail trade—furniture, home furnishings, and equipment.	C					
								92	Noncommercial forest development.	D	
				59	Retail trade—eating and drinking.	C-D		93	Water areas.	A-D	
					Other retail trade.			94	Vacant floor area.	A-D	
								95	Under construction.	A-D	
								99	Other undeveloped land and water areas.	A-D	

1. REFER TO LAND USE GUIDANCE CHART I, PAGE 12.
2. ZONE "C" SUGGESTED MAXIMUM EXCEPT WHERE EXCEEDED BY SELF GENERATED NOISE.
3. ZONE "D" FOR NOISE PURPOSES; OBSERVE NORMAL HAZARD PRECAUTIONS.
4. IF ACTIVITY IS NOT IN SUBSTANTIAL, AIR-CONDITIONED BUILDING, GO TO NEXT HIGHER ZONE.
5. REQUIREMENTS LIKELY TO VARY — INDIVIDUAL APPRAISAL RECOMMENDED.

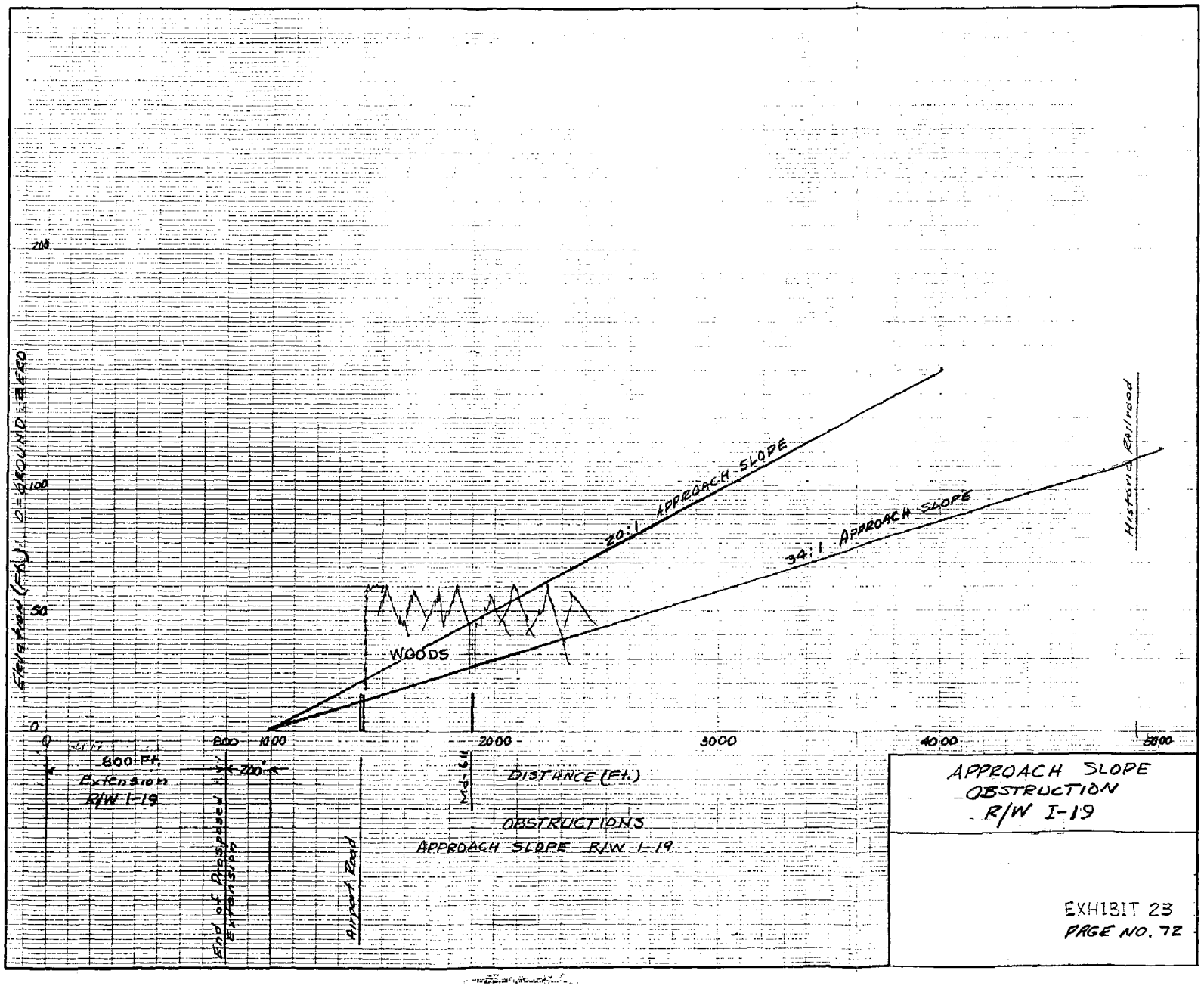
SLUCM: STANDARD LAND USE CODING MANUAL, SEE PARAGRAPH 21

EXHIBIT 21



APPROACH SLOPE
OBSTRUCTION
R/W 14-32

EXHIBIT 22
PAGE NO. 71



APPROACH SLOPE
OBSTRUCTION
R/W I-19

EXHIBIT 23
PAGE NO. 72

UTILITIES, ROADS, SERVICES

Maryland Route 611 and South Point Road serves as a highway artery from South Point to U. S. Route 50 with Maryland Route 376 intersection at Lewis Corner. Anticipated population growth both year round and seasonal, which increases the demand for housing and associated services, will place new demands on this highway. The Maryland State Highway needs inventory targets Maryland Route 611 for improvement. The Worcester County Comprehensive Plan identifies the study area as Suburban Residential (Moderate-density residential, suburban commercial, cluster developments). Airport runway extension would require relocation of Maryland Route 611 in the immediate area. Any assumption that predicts moderate to intense future development in the study area will require modifications to traffic patterns. Worcester County planning can suggest that any improvements to the highway incorporate future drainage plans to insure for adequate drainage.

Associated with this highway are such things as telephone and television cable, water systems, sewer systems and drainage systems. High water tables hinder and increase cost of installation of such service. The Worcester County Comprehensive Plan recognizes future development of West Ocean City and the traffic conflicts that may occur. The county should work very closely with the state to minimize problems related to through and turning traffic movements within this area.

FUNDING AND TECHNICAL ASSISTANCE RESOURCES

The possible program resources that may assist include the following:

- Farmers Home Administration --- Assistance for sewers and water - small community (as of October 1, 1991, this authority will be turned over to Rural Development Administration (RDA).
- Department of Housing and Community Development
  - DHCD's infrastructure Loan Program -- This program will loan money at a favorable interest rate to Worcester County for any number of infrastructure related improvements (water and sewer, roads, etc.)
  - DHCD's Community development Block Grant Program is a possible source of funds, albeit a long shot because of program restrictions and county priorities. The program must benefit 51 percent low and moderate income citizens and the funds must be spent in a timely manner.
- Department of Environment
  - Water Quality Revolving Loan fund - The payback for this loan fund is keyed to user affordability.
  - State Water Pollution Cost Share Program
  - Special Projects Program

OWNERSHIP OF PROPERTY IN STUDY AREA
(MAP 3, MAP POCKET)

NUMBER	PARCEL	OWNERS' NAME	OWNERS' ADDRESS	ACRES
		TAX MAP 33		
1	P71	Coates, Raymond D.	P.O. Box 366 Berlin, MD 21811	90.22
2	P70	Hastings, Russell L.	11719 Assateaque Road Berlin, MD 21811	4.39
3	P59	Bunting, Gerald W.	11725 Assateaque Road Berlin, MD 21811	1.18
4	P309	Coates, Raymond D.	P.O. Box 366 Berlin, MD 21811	34.93
5	P243	Coates, Raymond D.	P.O. Box 366 Berlin, MD 21811	0.45
6	P244	Coates, Raymond D.	P.O. Box 366 Berlin, MD 21811	20,000 S.F.
7	P93	Parkel Corp.	P.O. Box 691 Berlin, MD 21811	73.30
8	P101	Gordon, Charles H.	6407 Heritage Road Berlin, MD 21811	33,628 S.F.
9	P337	Berlin Vol. Fire Co., Inc.	214 North Main Street Berlin, MD 21811	1.45
10	P129	Coates, Raymond D.	P.O. Box 366 Berlin, MD 21811	2.00
11	P131	Byrd, C. Ames	200 Market Street Pocomoke, MD 21851	6.49
12	P127	White Company, Inc.	Rt 3, Box 352 Berlin, MD 21811	2.00
13	P126	Weinstein, Morris	P.O. Box 6021 Baltimore, MD 21231	2.00
14	P125	Purnell, Major Showell	Rt 2, Box 303 Berlin, MD 21811	2.00

15	P124	Fuller, Edith	Rt 2, Box 347 Berlin, MD 21811	2.00
16	P207	Purnell, Gary	Rt 2, Box 300 Berlin, MD 21811	25,571 S.F.
17	P128	White Company, Inc.	Rt 3, Box 352 Berlin, MD 21811	1.00
18	P72	Pitts, Iola P.	P.O. Box 294 Berlin, MD 21811	7.62
19	P283	Massadur, Clementine S.	8544 Lewis Road Berlin, MD 21811	1.00
20	P327	Taylor, Robert	Rt. 2, Box 306 Berlin, MD 21811	1.63
21	P132	Massdin, Thomas	R-1 Douglasville, PA 19518	6.49
22	P336	Parker, Jr., Eugene R.	P.O. Box 307 Ocean City, MD 21842	15.20
23	P335	Parkel Corp.	P.O. Box 691 Berlin, MD 21811	8.90
24	P341	Lane, David R.	3613 Ocean Pines Berlin, MD 21811	1.74
25	P135	Fooks, Levin	8555 Stephen Decatur Hwy Berlin, MD 21811	5.94
26	P229	Duffy, Larry E.	P.O. Box 353 Berlin, MD 21811	2.49
27	P134	Henry, Milford	Rt 4, Box 175 Berlin, MD 21811	4.50
28	P68	Davis, William F.	Rt 2, Box 307 Berlin, MD 21811	7.80
29	P139	Fassett, George A., Heirs	6822 Eastridge Road Baltimore, MD 21207	7.00
30	P149	Ocean-McLean, Inc.	C/O Jon Utley McLean, VA 22101	43.30
31	P332	Purnell, Owens F.	Rt 2, Box 454 Berlin, MD 21811	5.00

32	P342	Unknown		
33	P342	Unknown		
34	P22	Henry, Clifton O.	Rt 2, Box 314 Berlin, MD 21811	25.00
35	P24	Purnell, Gary C.	Rt 2, Box 300 Berlin, MD 21811	2.00
36	P23	Reed, Jr., Gary A.	P.O. Box 2116 Ocean City, MD 21842	1.04
38	P21	Purnell, Leon	8747 Lewis Road Berlin, MD 21811	1.00
39	P20	Purnell, Willie E.	40 Rodney Tingle Berlin, MD 21811	1.00
40	P19	Histed, Ara M.	1869 Red Lion Road Baer, DE 19701	4.49
41	P204	Davis, Rosetta	Rt 2, Box 318 Berlin, MD 21811	0.43
42	P230	Shockley, William D.	11211 Assateaque Road Berlin, MD 21811	0.18
43	P18	Showell, Ann M.	P.O. Box 190 Ocean City, MD 21842	1.00
44	P17	Showell, Ann M.	P.O. Box 190 Ocean City, MD 21842	1.00
45	P16	Showell, Ann M.	P.O. Box 190 Ocean City, MD 21842	0.75
46	P15	Showell, Ann M.	P.O. Box 190 Ocean City, MD 21842	1.50
47	P123	St. Johns M.E. Church	RFD Berlin, MD 21811	1.00
48	P122	Ocean City	P.O. Box 158 Ocean City, MD 21842	31.00
49	P1	Massey, Isaac L	Rt 2, Box 331 Berlin, MD 21811	47.50

50	P141	Purnell, Ruby L.	Rt 2, Box 321A Berlin, MD 21811	1.25
51	P318	Purnell, Franklin	C/O Catherine Wise Berlin, MD 21811	10.00
52	P140	Henry, Clifton O.	Rt 2, Box 314 Berlin, MD 21811	1.95
53	P130	Shockley, Betty M.	Rt 2, Box 177A Berlin, MD 21811	1.99
54	P285	Derrickson, Russell S.	8740 Lewis Road Berlin, MD 21811	1.00
55	P137	Fooks, Lambert	8541 Libertytown Road Berlin, MD 21811	5.00
56	P138	Rounds, Violet	8743 Stephen Decautur Hwy Berlin, MD 21811	6.87
57	P316	Owens, Laree P.	1426 Wistar Drive Wyncote, PA 19095	5.00
58	SHA	Unknown		
59	P148	Rety, Frank S.	Rt 2, Box 449 Berlin, MD 21811	2.16
60	P25	Smith, Stanford L.	8760 Stephen Decatur Hwy Berlin, MD 21811	2.91
61	P333	Smith, Stanford L.	Rt 2, Box 381 Berlin, MD 21811	1.00
62	P147	Purnell, Hollis L.	Rt 2, Box 384 Berlin, MD 21811	9.00
64	P26	Eastin, William S.	3517 Endman Avenue Baltimore, MD 21213	52.57
65	P121	Owens, Laree P. And Others	1426 Wistak Drive Wyncote, PA 19095	10.00
66	P142	ATLANCO Limited Partnership #3	Box 747 Bolling Green, VA 22427	50.00
67	P3	ATLANCO Limited Partnership #3	Box 747 Bolling Green, VA 22427	94.00

68	P143	Collins, Thomas H., ETAL	9300 A 1A Suite 201 Vero Beach, FL 32963	63.00
69	P210	Purnell, Venson P.	12026 Sinepuxent Road Berlin, MD 21811	2.00
70	P117	Smith, Charles O.	1762 Belle Court Millersville, MD 21108	0.55
71	P146	Robertson, Charles A.	Rt 2, Box 374 Berlin, MD 21811	25,524 S.F.
72	P145	Robertson, Charles A.	Rt 2, Box 374 Berlin, MD 21811	0.51
73	P7	Marfori, Ramon P.	109 Clark Street Salisbury, MD 21801	0.42
74	P4	Griffin, Reginald	8915 Stephen Decatur Hwy Berlin, MD 21811	2.07
75	P5	Luthardt, Charles J.	1824 Superior Avenue Baltimore, MD 21227	0.32
78	P6	Ingraham, Frank B.	111 Brenner Drive Newark, DE 19713	0.64
79	P8	Griffin, Reginald	8915 Stephen Decatur Hwy Berlin, MD 21811	0.85
80	P9	Clubb, Lillian B.	8915 Stephen Decatur Hwy Berlin, MD 21811	0.28
81	P10	Steen, Jr., Rudolph	929 Lombardee Circle Glen Burnie, MD 21061	0.78
82	P144	Truitt, W. Bond	202 W. Federal Street Snow Hill, MD 21863	0.58
83	P11	Taylor, Preston D.	Rt 2, Box 372 Berlin, MD 21811	1.55
84	P213	Anderson, Kenneth P.	246 Indian knoll Road Ocean City, MD 21842	0.96
85	P263	Exter, Gerald A.	Rt 2, Box 375 Berlin, MD 21811	2.60
86	P295	Charles, Paul T.	P.O. Box 1229 Ocean City, MD 21842	2.59
87	P115	Unknown		

88	P119	Cutler, Howard H.	316-C Franklin Place Plainfield, NJ 07060	1.00
89	P118	Eunice Elliott Hudson For Life	9017 Stephen Decatur Hwy Berlin, MD 21811	14.17
90	P205	Elliott, William B.	Rt 2, Box 452 Berlin, MD 21811	2.36
91	P300	Collins, Thomas H.	9300 A1A Suite 201 Vero Beach, FL 32963	2.63
98	P308	Birch, Victor H.	12217 Sinepuxent Road Berlin, MD 21811	11.95
145	P339	Tariq, Sheikh M.	P.O. Box 702 Berlin, MD 21811	1.00
146	P278	Peters, George	503 Lark Drive Newark, DE 19711	0.64
147	P27	Griffin, Reginald I.	8915 Stephen Decatur Hwy Berlin, MD 21811	3.49

TAX MAP 26

93	P257	Turner, William C.	125 8th Street Pocomoke, MD 21851	26.00
94	P284	Davis, John W.	11805 Sinepuxent Road Berlin, MD 21811	2.00
95	P283	Davis, John W.	11805 Sinepuxent Road Berlin, MD 21811	1.00
96	P218	Davis, Theodore E.	Box 255, Cedar Lane Fruitland, MD 21826	2.00
97	P391	Northam, Mildred K.	P.O. Box 7 Ocean City, MD 21842	2.18
99	P367	Birch, Victor H.	12217 Sinepuxent Road Berlin, MD 21811	8.50
100	P374	Rigas, Christopher J.	P.O. Box 801 Berryville, VA 22611	0.89
101	P418 Par D	Birch, Victor H.	12217 Sinepuxent Road Berlin, MD 21811	11.73

102	P31 Par C	Birch, Victor H.	12217 Sinepuxent Road Berlin, MD 21811	22.48
103	P268	Hastings, Marion L.	219 Broad Street Berlin, MD 21811	108.00
104	P220	Meneley, Wendel W.	P.O. Box 1356 Ocean City, MD 21842	4.00
105	P339	Holland, Robert L.	9209 Stephen Decatur Hwy Berlin, MD 21811	4.46
106	P221	Dennis, John H.	Rt 2, Box 353 Berlin, MD 21811	1.53
107	P222	Henry, Samuel S.	Rt 2, Box 354 Berlin, MD 21811	1.00
108	P407-1	Sherwanick, Lawrence	7878 Howard Road Baltimore, MD 21222	5.78
109	P407-2	Hargley, Arden H.	Rt 2, Box 361 Berlin, MD 21811	6.00
110	P407-3	Hydock, Mary P.	128 S. Franklin Street Allentown, PA 18102	6.00
111	P407-4	Neeley, Marion	Rt 2, Box 363 Berlin, MD 21811	6.60
112	P407-5	Spennenweber, Harry J.	8153 Orchard Point Road Pasedena, MD 21122	6.80
113	P348	Sapperstein, Mark C.	P.O. Box 21525 Baltimore, MD 21208	3.10
114	P349	Sapperstein, Mark C.	P.O. Box 21525 Baltimore, MD 21208	2.69
115	P340	Potts, Bernard	3206 Medfield Road Baltimore, MD 21208	1.67
116	P211	Lyons, Edward P.	2909 Edgewater Drive Edgewater, MD 21037	2.62
117	P275	Patton, Thomas J.	P.O. Box 578 Berlin, MD 21811	9.59
118	P269	Purnell, Sarah L., L/T, Etal	P.O. Box 120 Ocean City, MD 21842	200.00
119	P382	Falzone, Edward	R-1019 Taylor Ave Scranton, PA 18510	0.92

120	P286	Falzone, Salvatore P.	P.O. Box 22 Dunmore, PA 18512	2.40
121	P381	Falzone, Joseph	211 Elizabeth Street Dunmore, PA 18512	2.36
122	P417	Evans, Emil C.	9639 Stephen Decatur Hwy Berlin, MD 21811	21.70
123	P273	Evans, Emil C.	9639 Stephen Decatur Hwy Berlin, MD 21811	1.00
124	P135	Shoreline Associates	C/O Herbert O'Connor Towson, MD 21204	32.00
125	P289	Chesapeake Enter.,Inc.	P.O. Box 18525 Baltimore, MD 21240	10.34
126	P288	Disharoon, W. Robert	6953 Gunning Club Lane Newark, MD 21841	39.90
127	P361	Schrawder, Lawrence O.	Harbor Road Ocean City, MD 21842	10.00
128	P274 Par 3A	Taylor, Robert J., Etal	4473 Que Street Washington, D.C. 20007	39.67
129	P274 Par 2	Whitlock, Lawrence T.	Rt 2, Box 239 Berlin, MD 21811	1.31
130	P274 Par 3-B	Parker, Eugene R., Jr.	P.O. Box 307 Ocean City, MD 21842	1.84
131	P274 Par 1-A	Parker, Eugene R., Jr.	P.O. Box 307 Ocean City, MD 21842	5.66
132	P274 Par 2-A	South Point Indoor Club	9529 Stephen Decatur Hwy Ocean City, MD 21842	
132	P424 Par 1	Taylor, Howard L.	P.O. Box 164 Ocean City, MD 21842	0.98
133	P424 Par 2	Birch, Paul	P.O. Box 117 Secretary, MD 21664	0.95
134	P424 Par 3	Birch, Louis N.	P.O. Box 164 Ocean City, MD 21842	2.73
135	P291	Schrowder, Lawrence O.	Harbor Road Ocean City, MD 21842	0.31
136	P292	Collins, Kathryne L.	9601 Stephen Decatur Hwy Berlin, MD 21811	2.41

137	P290	Cassidy, John T.	612 Twin Tree Road Salisbury, MD 21801	42.00
138	P208	Pagliewani, Louie	P.O. Box 1150 Ocean City, MD 21842	6.02
139	P358	Unknown		
140	P69	Fisher, Philip E.	11635 Assateaque Road Berlin, MD 21811	7.33
141	P365	Wood, Dean	4632 Deer Spring Road Braddock Heights, MD 21714	1.00
142	P219	Snell, Andrew	Rt 2, Box 349 Berlin, MD 21811	1.02
143	P217	Bounds, Katherine J.	Rt 2, Box 333 Berlin, MD 21811	91.25
144	P285	Hastings, Marion L.	219 Broad Street Berlin, MD 21811	6.00

OWNERSHIP OF PROPERTY IN STUDY AREA

NUMBER	PARCEL	OWNERS' NAME
84	P213	Anderson, Kenneth P.
66	P142	ATLANCO Limited Partnership #3
67	P3	ATLANCO Limited Partnership #3
9	P337	Berlin Vol. Fire Co., Inc.
134	P424, Par 3	Birch, Louis N.
133	P424, Par 2	Birch, Paul
98	P308	Birch, Victor H.
102	P31, Par C	Birch, Victor H.
99	P367	Birch, Victor H.
101	P418, Par D	Birch, Victor H.
143	P217	Bounds, Katherine J.
3	P59	Bunting, Gerald W.
11	P131	Byrd, C. Ames
137	P290	Cassidy, John T.
86	P295	Charles, Paul T.
125	P289	Chesapeake Enter.,Inc.
80	P9	Clubb, Lillian B.
10	P129	Coates, Raymond D.
5	P243	Coates, Raymond D.
6	P244	Coates, Raymond D.
4	P309	Coates, Raymond D.
1	P71	Coates, Raymond D.
136	P292	Collins, Kathryne L.
91	P300	Collins, Thomas H.
68	P143	Collins, Thomas H., Etal
88	P119	Cutler, Howard H.
95	P283	Davis, John W.
94	P284	Davis, John W.
41	P204	Davis, Rosetta
96	P218	Davis, Theodore E.
28	P68	Davis, William F.
106	P221	Dennis, John H.
54	P285	Derrickson, Russell S.
126	P288	Disharoon, W. Robert
26	P229	Duffy, Larry E.
64	P26	Eastin, William S.
90	P205	Elliott, William B.
89	P118	Eunice Elliott Hudson For Life
123	P273	Evans, Emil C.
122	P417	Evans, Emil C.
85	P263	Exter, Gerald A.
119	P382	Falzone, Edward
121	P381	Falzone, Joseph
120	P286	Falzone, Salvatore P.

29	P139	Fassett, George A., Heirs
140	P69	Fisher, Philip E.
55	P137	Fooks, Lambert
25	P135	Fooks, Levin
15	P124	Fuller, Edith
8	P101	Gordon, Charles H.
74	P4	Griffin, Reginald
79	P8	Griffin, Reginald
147	P27	Griffin, Reginald I.
109	P407-2	Hargley, Arden H.
103	P268	Hastings, Marion L.
144	P285	Hastings, Marion L.
2	P70	Hastings, Russell L.
52	P140	Henry, Clifton O.
34	P22	Henry, Clifton O.
27	P134	Henry, Milford
107	P222	Henry, Samuel S.
40	P19	Histed, Ara M.
105	P339	Holland, Robert L.
110	P407-3	Hydock, Mary P.
78	P6	Ingraham, Frank B.
24	P341	Lane, David R.
75	P5	Luthardt, Charles J.
116	P211	Lyons, Edward P.
73	P7	Marfori, Ramon P.
19	P283	Massadur, Clementine S.
21	P132	Massdin, Thomas
49	P1	Massey, Isaac L
104	P220	Meneley, Wendel W.
111	P407-4	Neeley, Marion
97	P391	Northam, Mildred K.
48	P122	Ocean City
30	P149	Ocean-McLean, Inc.
57	P316	Owens, Laree P.
65	P121	Owens, Laree P. And Others
138	P208	Pagliewani, Louie
23	P335	Parkel Corp.
7	P93	Parkel Corp.
131	P274, Par 1A	Parker, Eugene R., Jr.
130	P274, Par 3B	Parker, Eugene R., Jr.
22	P336	Parker, Jr., Eugene R.
117	P275	Patton, Thomas J.
146	P278	Peters, George
18	P72	Pitts, Iola P.
115	P340	Potts, Bernard
51	P318	Purnell, Franklin
16	P207	Purnell, Gary
35	P24	Purnell, Gary C.
62	P147	Purnell, Hollis L.
38	P21	Purnell, Leon
14	P125	Purnell, Major Showell
31	P332	Purnell, Owens F.
50	P141	Purnell, Ruby L.

118	P269	Purnell, Sarah L., L/T, Etal
69	P210	Purnell, Venson P.
39	P20	Purnell, Willie E.
36	P23	Reed, Jr., Gary A.
59	P148	Rety, Frank S.
100	P374	Rigas, Christopher J.
72	P145	Robertson, Charles A.
71	P146	Robertson, Charles A.
56	P138	Rounds, Violet
113	P348	Sapperstein, Mark C.
114	P349	Sapperstein, Mark C.
127	P361	Schrawder, Lawrence O.
135	P291	Schrowder, Lawrence O.
108	P407-1	Sherwanick, Lawrence
53	P130	Shockley, Betty M.
42	P230	Shockley, William D.
124	P135	Shoreline Associates
46	P15	Showell, Ann M.
45	P16	Showell, Ann M.
44	P17	Showell, Ann M.
43	P18	Showell, Ann M.
70	P117	Smith, Charles O.
60	P25	Smith, Stanford L.
61	P333	Smith, Stanford L.
142	P219	Snell, Andrew
132	P274, Par 2A	South Point Indoor Club
112	P407-5	Spennenweber, Harry J.
81	P10	Steen, Jr., Rudolph
47	P123	St. Johns M.E. Church
145	P339	Tariq, Sheikh M.
132	P424, Par 1	Taylor, Howard L.
83	P11	Taylor, Preston D.
20	P327	Taylor, Robert
128	P274, Par 3A	Taylor, Robert J., Etal
82	P144	Truitt, W. Bond
93	P257	Turner, William C.
87	P115	Unknown
33	P342	Unknown
32	P342	Unknown
139	P358	Unknown
58	SHA	Unknown
13	P126	Weinstein, Morris
12	P127	White Company, Inc.
17	P128	White Company, Inc.
129	P274, Par 2	Whitlock, Lawrence T.
141	P365	Wood, Dean

OWNERSHIP OF PROPERTY IN OCEAN CITY AIRPORT AREA

NUMBER	PARCE	OWNERS' NAME	OWNERS' ADDRESS	ACRES
		TAX MAP 33		
1	P26	Eastin, William S.	3517 Erdman Avenue Baltimore, MD 21213	51.40
2	P37	Cadden, Alfred H.	1742 Johnson Street Baltimore, MD 21230	0.88
3	P153	Pierce, Sr., David H.	Rt 2, Box 505 Berlin, MD 21811	1.53
4	P28	Assateaque Mobile Sport Fish Sherman Association	P.O. Box 149 Berlin, MD 21811	9.62
5	P266	Purnell, Owens F.	Rt 2, Box 454 Berlin, MD 21811	8.19
6	P32 P154	Ocean City	P.O. Box 158 Ocean City, MD 21842	245.00 40.00
7	P118	Eunice Elliott Hudson For Life	9017 Stephen Decatur Hwy Berlin, MD 21811	14.17
8	P155	Bennett, Leroy	533 N Potomac Street Baltimore, MD 21205	3.10
9	P325	Hose, Jr., Charles	Rt 9, Box 152 York, PA 17402	1.01
10	P322D	Adams, Evelyn M.	1354 Williams Road York, PA 17402	4.15
11	P322C	Deem, Sr., Michael J.	12249 Eagles Nest Road Berlin, MD 21811	5.00
12	P322B	Neighoff, Charles V.	1911 Guy Way Baltimore, MD 21222	4.68
13	P322A	Aldinger, Charles S.	485 Pinehurst Road York, PA 17402	4.06
14	P13	Birch, Victor H.	12217 Sinepuxent Road Berlin, MD 21811	35.03
15	P113	Ocean City	P.O. Box 158 Ocean City, MD 21842	50.97

16	P315	Bayridge Marina, Inc.	Rt 2, Box 480 Berlin, MD 21811	41.95
17	P33	Eagles Nest, Inc.	12612 Eagles Nest Drive Berlin, MD 21811	23.90
18	P36	Dondero, Charles A.	P.O. Box 309 Ocean City, MD 21842	3.40
19	P32	Ocean City	P.O. Box 158 Ocean City, MD 21842	245.00
21	P3	Atlanco Limited Ptnrshp	Box 747 Bolling Green, VA 22427	94.00
22	P235	Bayridge Marina, Inc.	Rt 2, Box 480 Berlin, MD 21811	4.70
		TAX MAP 34		
23	P1	Batson, David R.	4208 Glenridge Street Kensington, MD 20795	7.30
24	P5	Unknown		
25	P14	Ocean City	P.O. Box 158 Ocean City, MD 21842	182.00
		TAX MAP 26		
26	P254	Ocean City	P.O. Box 158 Ocean City, MD 21842	38.64
27	P243	Hageman, Ruth M.	1835 Phelps Place, NW Washington, DC 20008	15.39
28	P341	Mystic Harbor Corp.	C/O Douglas Buttner Baltimore, MD 21203	226.20
30	P331	Ocean City	P.O. Box 158 Ocean City, MD 21842	43.37
		TAX MAP 27		
29	P442	Rt 611, Ltd. Ptnrshp	C/O Robert Taylor Washington, DC 20007	100.00

OWNERSHIP OF PROPERTY IN OCEAN CITY AIRPORT AREA

NUMBER	PARCEL	OWNERS' NAME
10	P322D	Adams, Evelyn M.
13	P322A	Aldinger, Charles S.
4	P28	Assateaque Mobile Sport Fish Sherman Association
21	P3	Atlanco Limited Partnership #3
23	P1	Batson, David R.
22	P235	Bayridge Marina, Inc.
16	P315	Bayridge Marina, Inc.
8	P155	Bennett, Leroy
14	P13	Birch, Victor H.
2	P37	Cadden, Alfred H.
11	P322C	Deem, Sr., Michael J.
18	P36	Dondero, Charles A.
17	P33	Eagles Nest, Inc.
1	P26	Eastin, William S.
7	P118	Eunice Elliott Hudson For Life
27	P243	Hageman, Ruth M.
9	P325	Hose, Jr., Charles
28	P341	Mystic Harbor Corp.
12	P322B	Neighoff, Charles V.
15	P113	Ocean City
25	P14	Ocean City
26	P254	Ocean City
19	P32	Ocean City
6	P32, P154	Ocean City
30	P331	Ocean City
3	P153	Pierce, Sr., David H.
5	P266	Purnell, Owens F.
29	P442	Rt 611, Ltd. Ptnrshp
24	P5	Unknown

RECOMMENDATIONS/CONCLUSIONS FOR CONSIDERATION

1. Land use changes should be limited until adequate stormwater conveyance system is provided, including water quality protection.

2. Rezoning should be according to specific land capabilities with areas, too wet or without adequate drainage being zoned conservation (Partial rezoning out as a concept).

3. P.D.A. or P.W.A. could be used to solve drainage and stormwater management problems.

4. Easements for waterways and stormwater facilities must be acquired including maintenance agreements.

5. Airport expansion plans need to be clearly outlined and zoning used to protect the public as well as the airport. A total relocation of airport may be the best possible solution. Soils and wetlands must be taken into consideration. A joint Ocean City County Study should be initiated.

6. Sewage disposal is of major concern on soils (77 percent Hydric) with severe limitations. If plans are to develop these sites, a central water and sewage disposal system should be a priority. Cost of installation could be applied to the tax base of properties affected.

7. Existing drainage is poor and unsuitable for any further development without modification to improve the surface water conveyance system and installation of stormwater storage facilities.

8. County should limit development due to the environmentally sensitive soils (77 percent Hydric) and the high value of the area to the county recreational atmosphere.

9. The rural characteristic of this sensitive watershed will be beneficial to maintain to preserve the attraction of the nearby state and federal parks.

10. Development for the region will be more cost effective if sewage disposal is directed to existing waste water treatment facilities of West Ocean City and Berlin.

11. The low lying areas will be more economically cost effective preserved in its relatively rural nature. A basis for the existing recreational resources and for expansion of future recreational tourism dictates consideration of maintenance of the Ayer Creek Shoreline in agriculture and conservation.

12. If development is permitted without improvement of outlets, 100 percent on site stormwater storage with very slow release rates should be considered.

13. Channels designed to convey a given storm event will degrade if an approved maintenance plan is not implemented. Channels should be inspected once a year and required maintenance performed to maintain the design capacity. Land easements should be provided by the developer and maintenance cost borne by the developer.

14. A new instrument of legal responsibility for maintenance needs to be used. P.D.A. and P.W.A. are good vehicles to solve problems and perform maintenance, however, these organizations can be disbanded whenever the members decide it may be in their best interest to do so. It may be necessary to record with property deeds of the beneficiaries this legal responsibility for maintenance when man made modification of outlets is performed.

15. On site sewage disposal could impact existing shallow wells. Proposed sewage systems should assess impacts and identify responsibility for contamination where it may be induced.

16. If this study area was fully developed, 72 acre feet of storage would be required. Less than five percent of soils are suitable for infiltration thus storage on the other soils would have to be provided above the high water table and released at a 2 year pre storm event.

17. Worcester County may need to adopt a stormwater management policy that will remove pollutants in an economical and environmental sound way. In order to achieve this goal, incentives such as tax breaks may be considered.

LISTING OF ABBREVIATIONS

ABBREVIATION	TERMINOLOGY
D.A.	Drainage Area
AC. FT.	Acre Feet
C.F.S.	Cubic Feet Per Second
V	Velocity
Ft./Sec.	Feet Per Second
SS	Side Slopes
RCN	Runoff Curve Number
Pre	Previous Condition
Post	Future Condition
MSL	Mean Sea Level
Sq. Ft.	Square Feet
N	Roughness Factor
D	Hydraulic Depth
B	Bottom Width
R	Hydraulic Radius
WP	Wetted Perimeter
P.D.A.	Public Drainage Association
P.W.A.	Public Watershed Association
Qr	Required C.F.S.
Qd	Designed C.F.S.
AV	Area Times Velocity
TR-55	Technical Release Number 55
Q	Runoff in C.F.S.
L.F.	Linear Feet
BIP	Bermed Infiltration Pond
Freeboard	Difference Between Designed High Water And a Control Point
Kd	Conveyance Method = $\frac{Q}{S\ 1/2}$
S	Slope in Ft./Ft.
S 1/2	1/2 is the Power of the Slope

ACKNOWLEDGEMENTS

U. S. Department of Agriculture, Soil Conservation Service

Worcester County Drainage Committee

Maryland Department of Agriculture, Worcester County

Worcester Soil Conservation District

Worcester County Roads Department

Worcester County Planning and Zoning

Worcester County Park and Recreation Department

Worcester County Health Department

Maryland State Highway Administration, Worcester County

Federal Aviation Administration, Salisbury Airport

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