

**OVERSEEING THE ONGOING REBUILDING AND  
RESTORATION EFFORTS OF HURRICANE AND  
FLOOD PROTECTION BY THE ARMY CORPS  
OF ENGINEERS**

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**HEARING**

BEFORE THE

**COMMITTEE ON  
ENVIRONMENT AND PUBLIC WORKS  
UNITED STATES SENATE**

ONE HUNDRED NINTH CONGRESS

SECOND SESSION

APRIL 18, 2006—NEW ORLEANS, LA

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CANE AND FLOOD PROTECTION BY THE  
ARMY CORPS OF ENGINEERS**

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TUESDAY, APRIL 18, 2006

U.S. SENATE,  
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,  
*New Orleans, LA*

The committee met, pursuant to notice, at 10 o'clock a.m., Louisiana Supreme Court, Supreme Court Chambers, 400 Royal Street, New Orleans, LA, 70130, Hon. David Vitter presiding.

Present: Senator Vitter, Senator Landrieu, and Representative Jefferson.

**OPENING STATEMENT OF HON. DAVID VITTER, U.S. SENATOR  
FROM THE STATE OF LOUISIANA**

Senator VITTER. Good morning. I want to thank all of you for being here.

I thought this field hearing of the Senate Committee, which has oversight and responsibility over the U.S. Army Corps of Engineers, was very important, particularly as we are approaching the next hurricane season, which starts in early June. Clearly, since Katrina and Rita, all of us at the Federal level have had our hands full in terms of emergency levee and other hurricane protection work. Constant oversight and communication with the corps has been a very important part of this. So this hearing is a continuation of that ongoing communication and oversight.

Katrina was an enormously devastating and significant event, as everyone knows. It was the largest natural disaster in the Nation's history, unparalleled in so many ways. In addition, it truly was a man-made disaster, because major catastrophic flooding in New Orleans also occurred because of levee breaches that were related to serious design flaws.

I think that last point is particularly important as we move forward. We have to move forward to correct those mistakes through proper design, engineering and oversight. But we also need to do it in a very quick, expedited way, knowing that the next hurricane season is right around the corner. So again, that's what this hearing is all about.

We have several panels, and I am going to run through the outline of the hearing briefly, then we will get to our first panel. Panel one of three panels is composed of representatives of the U.S. Army Corps of Engineers, in particular, the Assistant Secretary, civilian

leader of the corps, and Dan Hitchings, the Director of Task Force HOPE, which is all of the emergency levee and related work following Hurricane Katrina. We will hear from them and have dialog and questions about the progress and the status of that ongoing work.

Panel two is comprised of four representatives from impacted areas, folks in the immediate area of southeast Louisiana, who serve in various capacities, who live in all of these impacted areas. I will introduce them individually when we get to that panel. And panel three is composed of outside, independent engineering and environmental experts. Personally, I think one of the most important lessons of Katrina, particularly as it relates to levee work and the Corps of Engineers, is that we all need to come together and bring whatever outside, independent expertise is possible to bear on this ongoing work in an efficient way. Too often, in my opinion, the corps has been insulated and isolated in terms of some of their processes and work. And this independent expertise is crucial in order to build consensus and get things done right.

I believe it is being built into the process in at least an informal way with regard to various studies that have been going on since Katrina. And there are many, many different studies. Secretary Rumsfeld authorized the American Society of Civil Engineers to convene an external review panel to provide independent oversight.

In addition, there is the IPET, which is the direct study authorized by the Army and by the DOD. Then there are many other outside, independent groups, environmental and engineering groups, that have done oversight, unofficial oversight, if you will, and brought their expertise to bear.

As we move on, I believe it is essential to systematize that outside, independent expertise, to make sure it is built into the process and organized in an ongoing way. And panel three will represent three significant outside and independent experts to talk about how we move forward in that way.

With that overview, let's start with our first panel. This first panel is the Corps of Engineers, specifically the Honorable John Paul Woodley, Jr., Assistant Secretary of the Army for Civil Works, the civilian leader of the U.S. Army Corps of Engineers; and Mr. Daniel Hitchings, Director of Task Force HOPE, and the Regional Business Director for the Mississippi Valley Division, the leader of the immediate emergency work going on, particularly in southeast Louisiana.

I thank you both for being here. I know you have already submitted full written statements for the record that will be included in the record, the entire written statement. I would ask for purposes of this hearing that you summarize those 5 minute speeches, then we will proceed to questions and discussions.

Secretary Woodley.

[The prepared statement of Senator Vitter follows:]

STATEMENT OF HON. DAVID VITTER, U.S. SENATOR FROM THE STATE OF LOUISIANA

Good Morning. Thank you all for coming this morning for this very important Senate Environment and Public Works Committee field hearing to oversee the ongoing rebuilding and restoration efforts of hurricane and flood protection by the Army Corps of Engineers' in preparation for next hurricane season and also examine developing a comprehensive approach to hurricane protection in Louisiana.

I am holding this hearing today as a member of the Senate Environment and Public Works Committee because the next hurricane season that begins on June 1st is only 44 days away and Louisianans are relying on adequate, if not stronger, hurricane protection to be in place.

Just 7½ months ago, Louisiana and the other Gulf States experienced the most destructive natural disaster in our Nation's history when Hurricane Katrina struck the Gulf Coast. Only a few weeks later, Hurricane Rita further devastated Louisiana. Tragically, Hurricane Katrina left over 1,100 people dead with thousands more still missing. Thousands of Louisianans lost their homes, their jobs, their communities, and sadly too many lost their lives or the lives of loved ones.

In addition to the millions displaced and hundreds of thousands unemployed as a result of Hurricane Katrina, virtually every American has been impacted and still feels the repercussions of this extraordinary disaster through paying higher prices for energy bills and gas at the pump. Hurricane Katrina represents one of the first times in history where a major metropolitan area was evacuated and its economic activity virtually ceased. We must make sure this devastation absolutely never happens again and that is why I am holding this hearing today to ensure progress has been made with the restoration and rebuilding of hurricane protection so we are ready for this hurricane season.

The issue that makes this event even more extraordinary—more unique—is that it was not entirely a natural disaster. The major destruction during Hurricane Katrina was man-made. Our Federal levees failed and others were simply too low and not built up to standard. Both of these man-made failures could have been prevented. We can not afford for these fatal failures to happen again. This is why I have already introduced several pieces of legislation to help get us where we need to be by June 1st for the next hurricane season.

I recently introduced the "Louisiana Emergency Needs Corps of Engineers Authorization Act," which would give the Corps of Engineers the full Congressional authorization it needs now to begin construction on projects such as installing permanent pumping stations that will ensure stronger hurricane protection for south Louisiana.

Congress has been very helpful in quickly approving emergency legislation needed to address the urgent needs of Louisiana. Now, additional urgent action is needed. In many cases, the problems are not a result of money or technological hurdles. The Corps of Engineers has informed us where the weak areas and design flaws are located and what needs to be improved. We know the solution. The problem is authority. We are unable to implement the fix because of technical changes to the law. That is it. That is the single issue preventing improvements to problems affecting less than 5 percent of our hurricane protection system. You are only as strong as your weakest link and Congress can fix this weak link.

We were unprepared for Hurricane Katrina at the local, State and Federal level. There is no question. Now, we better understand the weaknesses. We know the solutions. Our Nation can not afford to be unprepared again.

Congress needs to move forward now and pass legislation before this next hurricane season begins so the Corps of Engineers has the full Congressional authority it needs to rebuild our levees. I believe the corps needs that are included in the Supplemental Appropriations bill are crucial to moving forward with stronger hurricane protection that is needed now.

The Corps of Engineers has been working hard to restore and rebuild hurricane protection in Louisiana. Today, we will hear an update on the Corps of Engineers' progress from both Assistant Secretary of the Army for Civil Works—the Honorable John Paul Woodley, Jr. and Mr. Daniel Hitchings who served as Director of the Task Force Hope after Hurricane Katrina struck.

The Corps of Engineers' also commissioned the Interagency Performance Evaluation Task Force (IPET) to obtain the facts by collecting, analyzing, testing and modeling data and information on the performance of the New Orleans hurricane protection system during Hurricane Katrina. I look forward to hearing from Dr. Lewis Link, the Director of IPET, who is here today to provide an update on IPET's findings.

In addition to IPET, there are several ongoing independent investigations examining and analyzing the ongoing restoration of hurricane protection. Defense Secretary Donald Rumsfeld authorized the American Society of Civil Engineers (ASCE) to convene an external review panel to provide independent oversight and conduct continuing expert review of the work performed by IPET. I look forward to hearing from Mr. Thomas Jackson who is a member of the External Review Panel.

IPET and ASCE's external review panel are made up of independent panels of national experts drawn from the public, private sectors and academia. I believe having independent experts are valuable to have involved throughout the corps process and

play an important role during the restoration and rebuilding of hurricane protection in South Louisiana. I recently introduced the 'Louisiana Hurricane and Flood Protection Council Act' that calls for a Council of independent experts who would work with the corps throughout the process from design to construction. The Council would also take a comprehensive approach to corps projects and determine ways to integrate projects that would allow for more efficiency, be more cost effective and save taxpayers money and also ensure projects are implemented in a timely manner.

Today, we will also hear from locals who will share their perspective on impacts from Hurricane Katrina and Hurricane Rita and why it is very important for hurricane protection to be restored by this next hurricane season for their communities, businesses and neighbors to return home to New Orleans and the surrounding parishes. Restoration of hurricane and flood protection that incorporates better, smarter designs is a key factor for Louisianans and businesses when deciding whether or not to return to the Greater New Orleans area. Louisianans who want to return home are looking for certainty that a stronger, more advanced levee system is in place before they rebuild their lives in the same area again. Thank you and I look forward to hearing from the witnesses.

**STATEMENT OF THE HON. JOHN PAUL WOODLEY, JR., ASSISTANT SECRETARY OF THE ARMY FOR CIVIL WORKS, UNITED STATES ARMY CORPS OF ENGINEERS**

Mr. WOODLEY. Thank you, Senator. I want to express my appreciation and that of the Administration for your leadership in holding this very important hearing, and in the oversight and wisdom that you have been providing, both before this incident and since, as we work to foster the reconstruction of the civil works in and around Southeast Louisiana, and the recovery of this area and its economy.

I am very honored to be here to testify before the committee in preparation for the next hurricane season. I am joined today, as you stated, by Mr. Dan Hitchings, Director of the Corps of Engineers Task Force HOPE. We also have Dr. Lewis E. Link, the Project Director for the Interagency Performance Evaluation Task Force, who will appear on a later panel.

The corps is on schedule to repair the damaged levees and flood walls to their pre-storm condition by June 1st, the beginning of the hurricane season in 2006. Last year, I enlisted the National Academies of Science and Engineering to assemble a multi-disciplinary panel to assist in the forensic investigation of the performance of corps' projects during Hurricane Katrina. The Chief of Engineers, at the same time, established an Interagency Performance Evaluation Task Force, known as the IPET, to provide credible and objective scientific and engineering facts to answer questions about the performance of the New Orleans hurricane and flood protection system. As you mentioned, Senator, the American Society of Civil Engineers provided external peer review of IPET activities through an external review panel.

The corps is immediately acting to incorporate findings of all these studies into both its interim repair and the long-term planning for future work. A draft performance evaluation report for the IPET is scheduled for June 1, 2006. The National Academies Committee on New Orleans Regional Hurricane Projects will perform independent review of the final draft IPET and ASCE final reports. I expect to receive the National Academies report in September 2006. The final IPET report will be released shortly thereafter, and

I have asked the National Academies to review and provide comments on the final IPET report.

At the same time, on a parallel path with IPET and National Academies studies, Congress authorized and appropriated funds for a 2-year, \$20 million Louisiana Coastal Protection and Restoration Project Analysis and Design, to identify options for increasing the level of hurricane storm protection for New Orleans and coastal Louisiana. The interim report is due in June 2006, and the final report recommendations and alternatives due at the end of 2007.

Immediately after the hurricane, President Bush committed to helping New Orleans rebuild, reconstruction of its hurricane protection system. In supplemental appropriations to date, Congress and the President have provided \$2.08 billion to repair and restore the levee system to its designed height.

In February of this year, I submitted a proposal for a supplemental appropriation to strengthen and improve the hurricane protection for greater New Orleans. The repairs and rebuilding activities that are now underway will make the flood control and personal protection system better than it was immediately prior to Hurricane Katrina. The additional measures that I proposed in February will result in a system significantly better and stronger than before. These measures are estimated to cost \$1.46 billion, and have yet to be authorized and funded. If appropriated in 2006, these measures can be completed in 2010.

In the weeks since my February recommendation, new information has been developed that has caused us to recommend additional modifications to the system, first, because of the findings of the IPET, and second because new post-Katrina weather data informs us that the statistically determined 100-year storm is a more powerful storm than the storm for which the existing hurricane protection system was designed. We are working now to provide additional information to allow Congress to consider the options for providing that 100-year level of protection.

Thank you, Senator, for this opportunity. I would certainly be delighted to respond now and later to all your questions and concerns.

Senator VITTER. Thank you, Mr. Secretary.

We also have, as I mentioned, Dan Hitchings, Director of Task Force HOPE.

**STATEMENT OF DANIEL H. HITCHINGS, P.E., REGIONAL BUSINESS DIRECTOR, MISSISSIPPI VALLEY DIVISION, U.S. ARMY CORPS OF ENGINEERS**

Mr. HITCHINGS. Thank you, Senator Vitter, for the opportunity to testify before the committee today. My written testimony today provides a summary of the hurricane protection system and authorized and funded work that is ongoing to reestablish a hurricane protection system before the start of the next summer's hurricane season.

We are engaged in a number of activities, starting first with the repair. The Corps of Engineers is well on its way to accomplishing the initial goal of repairing the damaged portions of the protection system and is committed to completing the reconstruction by 1 June. All work is currently on schedule. There is no indication that we are going to have any difficulty in restoring the protection by

that period of time. Extensive onsite investigation and sampling and laboratory testing is performed to ensure only quality materials are being used.

The second element that we have going on relates to restoration of undamaged and subsided areas. The corps continues to conduct both surface and subsurface investigations of the remaining undamaged portion of the system in the New Orleans area to determine exactly what needs to be done to strengthen those. As Secretary Woodley referred to the IPET findings, we recently became aware of a situation where we now question the integrity of the floodwall system. So we have to do further investigation to ensure that that is capable of performing as designed and in any place that it is not, to take action to ensure that it does have the ability to meet its design intent.

So essentially what we are doing will result in a full restoration of the hurricane protection system to its authorized levels. We also are funded to complete the unconstructed portions of authorized projects. That primarily is in the West Bank and Vicinity project, also in the Lake Pontchartrain and Vicinity project, mostly in the St. Charles Parish area. At the end of all of that work, the entire system will be constructed as authorized, to its authorized level.

This concludes my statement. I have some additional graphics to support any questions you may ask. And I am ready to take those questions. Thank you.

Senator VITTER. Thank you very much, Dan. We will get on to discussion and questions.

Secretary Woodley, as you know, recently General Carl Strock, Chief of Engineers with the corps, testified before a Senate Committee to the effect that the breaches in the levees of the outflow canals were due largely to design flaws under the responsibility of the Corps of Engineers. Do you disagree with his testimony on that point in any way?

Mr. WOODLEY. No, sir, I do not. I think that I would reserve any further comment on my part until receipt and review of the independently reviewed investigation that is intended to fully answer that question. But based on what I know today, I know of no reason to differ with the testimony provided by General Strock.

Senator VITTER. Based on that, would you agree that that places on the Federal Government, and specifically the corps, a rather extraordinary responsibility in terms of response, given that that means that perhaps 70 percent of the catastrophic flooding in New Orleans was essentially man-made, not an act of nature?

Mr. WOODLEY. Actually, Senator, I think that our responsibility for response is the same under either condition. Our responsibility for response is great and enormous, regardless of whether the works performed as designed or whether they did not perform as design.

Senator VITTER. I guess I am particularly thinking of something that may be outside the Corps of Engineers' purview, which is compensating for uninsured losses of homes that suffered from catastrophic flooding because of the design failure. It seems to me there might be a different responsibility there, if it were an act of God versus a mistake, essentially, of the Federal Government. That is the distinction I am drawing.

So again, the question is, would you agree that General Strock's testimony on the design failures at issue places on the Federal Government broadly perhaps an extraordinary responsibility?

Mr. WOODLEY. I would say the responsibility is essentially the same, regardless. The responsibility is great and grave. The precise nature of it and the course it should take is a matter for the gravest deliberation by the Administration and by Congress. I know that our response in the Corps of Engineers has been very substantial, and been, I believe, reflects that sense of responsibility.

Senator VITTER. As you know, the next hurricane season is quickly approaching. It starts in early June. How would you describe to residents in the area the levee and hurricane protection system that we will have by that time, as compared to what it was the day before Hurricane Katrina?

Mr. WOODLEY. I believe that I would describe it as better and more capable of withstanding and protecting against catastrophic flooding than the system that we had prior to Hurricane Katrina. I would also say that an event the size of Hurricane Katrina would result in a certain amount of flooding within the city and that a storm of that size should be a matter of grave concern and should be detected on a path that would take it in or near the city.

Senator VITTER. With regard to the protection we will have by early June, what would the corps' expectation be if Katrina were replayed exactly as it happened, specifically with regard to levee breaches? Clearly there was overtopping. I assume there would still be overtopping if Katrina were replayed this hurricane season. But specifically with regard to breaches, which of course was the biggest problem and caused the most damage, what would the corps' expectation be of how the system would withstand an exact repeat of Hurricane Katrina?

Mr. WOODLEY. Senator, without modeling the event, and I believe it's fair to say that we have not modeled it, I can only respond in a very general way. We believe that many of the works in place would be overtopped. So there would be flooding resulting from that overtopping.

We believe, however, that the system that we are placing in place along the shore of Lake Pontchartrain, in which we are closing the outfall valves with gated closure structures where the canals enter Lake Pontchartrain, removes much of the vulnerability to breach in that area. We believe that we would like to, we are recommending improvements in armoring that are not going to be in place as of 1 June that would give additional protection to some of the more vulnerable places in the levees where, for instance, utilities cross the levees or railroads cross the levees, or navigation structures cross the levees. So we will have a better system in place, but I believe it is fair to say that we will not have a system in place to prevent flooding in all cases if a storm the size of Katrina were to strike New Orleans or its vicinity.

Senator VITTER. Dan, let me ask the same question of you with regard to a repeat of Katrina, specifically on the issue of breaches. It might be useful, I don't want to suggest an answer, but if it's useful to distinguish between different areas east of the Industrial

Canal, west of the Industrial Canal, anything like that, please do so. What would be your response?

Mr. HITCHINGS. My response is in full agreement with what Mr. Woodley described here. If I could put a map up of, map No. 3, to help illustrate some of these areas more specifically, and highlight what we have done to prevent the type of breaching that occurred in those areas.

This is a map that shows the overall area of Orleans Parish, including these areas here in the lower 9th Ward, St. Bernard Parish, then Plaquemines Parish, continuing in these two areas. We experienced breaching on the canals as a result, not of overtopping, but of a failure of a mechanism that supported those structures in that particular area. We also experienced flooding and breaches along the west side of the Industrial Canal.

The corrective actions we have taken, as Mr. Woodley described, closing off those canals, will prevent surge from entering the canals. We do not anticipate that we will have any breaches in those areas as a result of that.

On the Industrial Canal west bank, we have also taken corrective action, one, by repairing all the breaches, and what we put back in there is a stronger structure than it was. But on those unbreached portions, where it scoured behind them significantly, we are putting in scour protection to prevent the undermining of those structures should they be overtopped again.

Along the St. Bernard levee portion, along the MRGO, those damaged portions are being reconstructed, significantly better than they were before. The materials that we are using are entirely glazed, and they are much stronger and more resistant to erosion. Overtopping of those would in fact result in some scouring. In the absence of their erosion protection, any armoring, we do not anticipate that it would result in breaching, just in some scouring of those areas. That's also true for the New Orleans East area that was damaged in here.

We did have overtopping all along the levees in New Orleans East. And again, that would occur, but we do not anticipate any breaches.

Plaquemines Parish, very similar. All the breaches that were in that area, we did reconstruct all those using better, more high quality materials than before. Significant overtopping in Plaquemines Parish occurred during the storm, but again, we do not anticipate that we would have any breaches.

The resultant flooding is an important point to recognize. Preliminary calculations that are being refined at this point indicate that surge that came out of the Industrial Canal area, perhaps even without the breaches, still would have resulted in significant flooding in this portion of Orleans Parish. The East Bank, New Orleans East area and St. Bernard Parish and Plaquemines Parish will also experience the significant flooding levels.

Senator VITTER. If I could interrupt for a second, and you are welcome to finish your response in a minute. But something you just said confused me, talking about surge around the outflow canals. It is my understanding that those levee walls were never overtopped.

Mr. HITCHINGS. That is correct.

Senator VITTER. So if they hadn't breached, there may have been rain water backed up. Is that what you are talking about?

Mr. HITCHINGS. No, I am talking about the fact that along the west side of the Industrial Canal—

Senator VITTER. Oh, that was overtopped.

Mr. HITCHINGS [continuing]. Those flood walls were significantly overtopped, by as much as 2 feet, for a period of up to 6 hours. The volume of water that came into there was significant. We are in the process now of actually doing refined calculations to show what would have happened had there been no breaches. Certainly as we get that information available, we will share it with you and the public as well.

But it is important to recognize that a repeat of Katrina doesn't mean that those areas, even if we had no breaches, would have the flooding; it's very important for everyone to understand.

Senator VITTER. But as I understand it, correct me if I am wrong, you are basically saying, yes, overtopping, no to breaches.

Mr. HITCHINGS. That is correct.

Senator VITTER. In terms of the type of flooding you would have, I assume you would agree, that is a huge difference between flooding, perhaps as we had in East Jefferson, which was significant, particularly if it is your home, but it was not 12 feet of water or 9 feet of water.

Mr. HITCHINGS. Yes. Even if the volume of water ended up being the same, the character of the flooding, probably most dramatically shown in the Lower 9th Ward area, where houses were swept off their foundations, and literally blocks of houses destroyed, overtopping may not have caused that kind of devastation. The phrase has been used, characterizing that as a catastrophic damage. You would still have significant damage from the flooding, just from the water rising, but you would not expect to see the same type of damage as you described.

Senator VITTER. On the levees, on the west side of the Industrial Canal, what will the height be on June 1st, compared to the height the day before Katrina?

Mr. HITCHINGS. Well, those areas that were damaged will be restored to approximately 15 feet. Some of the areas were as low as 12½ feet. Those undamaged portions will be the same height that they were the day before Katrina.

Senator VITTER. I thought your present work included heightening of undamaged sections of the levee system.

Mr. HITCHINGS. Yes, it does, but not by the 1st of June.

Senator VITTER. When will that work be accomplished by?

Mr. HITCHINGS. Well, there are two parts to that question. We are restoring all of the levees and floodwalls in these areas. That will be done September 2007. Particularly in the Industrial Canal area, we have two choices for how to address that problem. The first choice is to raise those existing floodwalls. In most cases, that would require complete replacement of those, and we would, since they have to be at a higher height, we would most likely replace them with T walls. Now, that is an option that is perfectly technically viable to accomplish, at a cost estimated at around \$400 million.

What we have proposed, and have presented before Congress, would be to put a floodgate at Seabrook to isolate that area from Lake Pontchartrain, and then also a floodgate here just above the confluence of GIWW and the MRGO that would again isolate this area. That is a slightly less costly solution, but it is a much better technical solution, because it eliminates the flood threat in those areas, by preventing surge from entering.

The disadvantage is that work will take longer to complete and could take as long as 2010.

Senator VITTER. Secretary Woodley, one of the things we have been talking about, including here today, is oversight, suggestions, input by outside independent experts. Report three of the IPET, commissioned by the Secretary of Defense, will be released only by June, and the final report is due in the fall after the hurricane season.

Clearly, there is an issue of how you balance doing things thoroughly and doing things timely. What are your views on that balance, No. 1? No. 2, what are your views on incorporating, on an on-going and institutionalized basis, the thoughts and input and suggestions of outside independent experts?

Mr. WOODLEY. Senator, that is something that the corps is very open to and is very interested in having that outside, external, independent review of our formulation procedures and of our design procedures. I think that our experience with that has been very good.

In the IPET process, we are doing this in a very continual way. It is not a question of one report being done and then that report being reviewed. We are having interim reviews by the independent groups having them work very closely and provide their ideas and input to the IPET as that work proceeds. Dr. Link will discuss that in greater detail when he testifies in a subsequent panel. I think we are having a very good experience with that, and I believe that it would be something that ought to be incorporated in our procedures going forward.

Senator VITTER. So you have no objection to the basic concept of institutionalizing outside, independent expert suggestions and review?

Mr. WOODLEY. No objection whatsoever. I think that it should be, it has to be carefully designed so that it does not unreasonably take up time and become overly expensive. I believe that that type of concern is fully capable of being met.

Senator VITTER. Do you have any specific reactions, pro or con, to my particular bill in that regard, in how my particular bill goes about designing such a system of institutionalizing outside, independent expertise?

Mr. WOODLEY. I don't have the details where I can go into it with you right now, Senator. But I believe that your proposal is a very constructive one and certainly one that we within the Administration are looking at very carefully.

Senator VITTER. OK. I have asked for some time now various folks in the Administration for some specific input or reaction to the legislation. When could I expect that?

Mr. WOODLEY. I didn't realize that we had that due to you, Senator. So I will get on it and get it back to you as soon as possible. By the end of the month, would that be acceptable?

Senator VITTER. OK.

We are joined by Congressman Jefferson, and I welcome him and turn to him for any questions he might have, and then I will have some wrap-up questions.

Mr. JEFFERSON. Thank you, Senator Vitter. I thank you for holding this hearing.

I want to ask one question to follow up on what you were asking, with respect to the outside investigations or look-sees or whatever. Is there any substantial disagreement, or let me ask it a different way. Is there now full agreement? If there isn't, then you might tell me where there are areas of disagreement between the work that the corps has done to review its own work along the levees before Katrina and after, and the work of the outside, various outside agencies. Are there disagreements now between you and them, or is there now a coming-together about what happened?

Mr. WOODLEY. I would have to ask Dr. Link to discuss exactly what his interactions have been with the other groups. I don't know that we have in hand the reports from the other groups that would allow us to make precise comparisons between them. I do know that the IPET work, I believe, that Dr. Link will say, has made some very important discoveries and will give us a very sound understanding of what the performance of the works were in the event.

You have to remember that the event was extremely complex. What is true of one section of the works is not necessarily true of another section. So you have to be very careful when you describe what took place and how the different types of structures responded to the forces that they were exposed to. So given that, there might be one area or another where there is not full agreement.

My impression though is that at the end of the day, the scientists and engineers will come together with a strong consensus on what took place and a new understanding of the kind of engineering and design that needs to be accomplished in order to provide flood damage reduction structures in which the public will have full confidence.

Mr. JEFFERSON. I remember starting out there seemed to be wide disagreements between the corps and the outside groups. Are you saying that that has narrowed over time and you expect it to narrow even more, to the point where there will be agreement?

Mr. WOODLEY. Yes, sir. Let me say that I think the wide disagreements appear to have been more of a matter of perception than reality. I think the apparent discrepancies were based on describing, one group describing what took place at one portion of the event and another one focusing on what happened at another portion of the event. They were not necessarily at odds, but they appeared to be, because the full explanation was not understood by both sides.

Mr. JEFFERSON. When do you think you might have a veto point where you can make these comparisons and let us know exactly

what happened there, based on what your work involved and what the work of the outside entities involved?

Mr. WOODLEY. We will have a final draft report from the IPET. The leader of that group is here and will testify later today, Dr. Link. That report will be on the 1st of June and it will still be subject to a review process, but it won't be private. It will be fully available. It will still be subject to a review, external, independent review process by the National Academy of Science and Engineering. So we will hold it, it will be open for that. I believe that based upon the process that we have, that on the 1st of June we will have a product in which we will have considerable confidence.

Mr. JEFFERSON. OK, let me ask you one other thing. Although the answer to the question that Senator Vitter asked about when the raising of the levees will be completed and other sections, other than the ones that were damaged in Katrina, destroyed in Katrina, and the outside is—what did you say, 2010?

Mr. HITCHINGS. It will be 2010 before all improvements—

Mr. JEFFERSON. Yes, before then. With that being the case, obviously all this won't happen in 2010 at one time. Along the way, you will be getting things done. How have you prioritized how you will get the work done along the stretch of things that will be done between now and 2010?

Mr. HITCHINGS. That is a very good question. In fact, there really is no prioritization to it. All the work will be done nearly concurrently, subject to authority and funding. Right now we have funding available to begin work on the raising and completing of those projects, and for getting those scheduled. Some of them will start sooner than others, because in some cases, we have all of the engineering completed, plans and specs ready, we can go out with a contract very quickly. Other ones will take a little bit more time to do some subsurface investigation and get the science ready.

So that is the only difference you will see in scheduling, because we are planning to do all the work concurrently, very much like the repair work is going at the present time. We have 59 contractors engaged in the repair work. We expect similar type of work on the restoration.

Mr. JEFFERSON. The repair work is being driven by the June 1st date and the need to fix the breaches. But the rest of it you are going to have to be able to plan out. The procedures are based on authorization and appropriation and all that. I mean, somehow or the other, in the Congress, we are going to be driven by your recommendation as to what should be authorized first or appropriated for first, and that sort of thing. So you operate on this cost benefit ratio all the time.

I am just trying to figure, well, that will drive how you prioritize what part of the levee you start on, and based on what the costs and benefits are to the outcomes. I know you can't carry all that at the same time along the same way. It has to be started somewhere and end somewhere. I am just trying to figure out what your considerations are, if you have any.

Mr. HITCHINGS. Again, I will just state, as I had before, we plan to start every area that we have funding for—

Mr. JEFFERSON. At the same time?

Mr. HITCHINGS. At the same time, as quickly as we can. As I said, some of them will lag others, because some require more engineering. Those portions, those six elements of additional improvements that are subject to authorization and funding, the request that the Administration made was for authorization and funding of those completed. If that occurs, then we will start work on those just as quickly as that money is available. Again, we will work on all of those concurrently.

Mr. JEFFERSON. So you aren't going to be concerned about how much the loss might be here or there, you're simply just going to work on the, if one levee just covers open area and another deals with a large population and huge property at risk, you won't make a determination prioritized based on that?

Mr. HITCHINGS. Well, we haven't had to, because we haven't been resource constrained, either by money or contractors and resources. If we were faced with that, either because of money or that there are not enough contractors to start all the work at the same time, we would engage in a dialog with State and local authorities to identify which of the areas we should start first and which ones to apply the money to.

But up until this point, and this is unique in my career in working with the Corps of Engineers, we have not been resource constrained.

Mr. JEFFERSON. Well, not only are you not resource constrained in terms of money, but with respect to the capabilities of the people to do the work, there's enough folks out there to get that done, too, within your organization and outside?

Mr. HITCHINGS. Absolutely. We are reaching out not only to the 35,000 people we have as the resources of the corps available, as well as the private sector, and they are very heavily engaged in this. So other than the time it takes to do some things, there really isn't any constraint on getting it done.

Mr. JEFFERSON. Thank you.

Senator VITTER. Thank you, Congressman.

Let me go back for some wrap-up questions. One issue that has gotten a lot of attention since the storm, and on which I think there is a lot of consensus, is the importance of armoring the levees to make them stronger, so that even if they are overtopped, they don't breach. The corps has proposed doing selective armoring, and I am concerned about how selective it is going to be. That is why I got another \$130 million added in the Senate bill to beef up the amount of armoring we can do.

What armoring is being currently planned? What will be done by early June.

Mr. HITCHINGS. The armoring basically consists of a couple of components. I am going to ask to put up another chart, chart 11. It wasn't intended for this purpose, but it will allow us to see those areas that we are looking at.

The first area is transitions. Transitions are any place where we are going from earthen levee to some other type of structure. That is everywhere. It is Plaquemines Parish, it is Orleans Parish. As you know, there are flood walls that go to levees and there are road crossings and railroad crossings and flood gates and all of these

things. Every time there is a connection of those, we have found weaknesses, just based on the experience.

So we are in fact going ahead and armoring and strengthening those at this time. We are looking then to the undamaged areas and doing the same thing, so we don't experience that.

The other portion of the armoring, just so it shows on this map, is the longest MRGO levee where we sustained the worst damage. Then also here in New Orleans East, all along the GIWW. So we are proposing to armor these places, because these are the areas that not only sustained the most damage as a result of Katrina, but would be expected to sustain more damage in the future, because of the Gulf surge and wave effect that hit this, and the overtopping. We have an investigation underway with leading scientists to help us to find exactly what type of armoring would be best suited for this situation. But those are the areas.

So basically, it is all the transitions, no matter where they are in the project. Then this section of levee going here that has Gulf exposure and this section of levee here that has Gulf exposure.

Senator VITTER. Isn't it fair to say that with few exceptions, armoring the entire system, if done in a technically proper way, would significantly strengthen the protection offered, because it would guard against breaches?

Mr. HITCHINGS. It certainly would improve the performance of those, if they were exposed to the type of attack that would cause that. But we experienced significant overtopping, for example, along the GIWW to Barataria and virtually no breaches in that. The water came over nearly at the same height there as it did other places. But because of the character of the overtopping, it did not tear those levees up.

So while you certainly could strengthen the levees everywhere by armoring, in many cases you wouldn't really get much of a return on that investment, because the levees wouldn't be threatened by the overtopping itself.

Senator VITTER. Another specific issue I am very concerned about is the pumping capacity in the outflow canals, once these temporary gates are installed. The idea is to put temporary gates where the three outflow canals in Orleans Parish meet Lake Pontchartrain, and to close those gates if a large storm is approaching.

But of course, that means that you cannot remove rain water from the city without having pumps to go over the gates. And so having enough pumping capacity to go over the gates is important, unless you want to get flooded from rainwater during the storm.

As I understand it, the pumping, the temporary pumping capacity planned in this scenario for the 17th Street Canal in particular is well under the capacity, at least on paper, in the city on that same canal. What is being done to increase that pumping capacity in time for the next hurricane season?

Mr. HITCHINGS. Thanks for asking that question. If I could have charts 17 and 18 on the board. Basically, chart 17 will show what the structures are that we are proposing, and then also on chart 18, will give you an overview of the progress on what the plan is.

Chart 17, basically these numbers here represent the current percentage complete on those closure structures and pumping capacity. So we're 25 percent on the canal for 17th Street, 32 percent

in Orleans and 24 percent complete here. This graphic gives you some idea of what the concept is for these closure structures. We would have a temporary gated structure across the canal that would normally be open. And only in the event of an anticipated storm surge would that be closed. And then these temporary pumps would be engaged once the gates are closed, to allow the pumping to continue up in there and then discharge the water downstream of that.

As you noted, the current schedule for that results in a significantly deficient pumping capacity. Over here on this chart, it says on June 1 we expect to have 1,000 cubic feet per second of capacity installed. By the end of June, basically in July, I believe that says 2,800 CFS that we expect to have at that location. And we are evaluating concepts so that we can make a decision on how best to match the capacity of these pump stations. Right now the concepts that we are looking at would allow us to have, by the end of September, 6,200 CFS, which essentially matches the flow capacity of that upstream pump station during high surge times.

So we are looking at this proposal right now. We have been coordinating with the Orleans Parish Sewer and Water Board and also Jefferson Parish to come up with a concept to met the pumping demand of the outflow canal to protect the integrity of the structure in the most cost-effective way. So we're targeting to have 6,200 CFS available here by 30 September, 2,200 on Orleans and then 4,300 on London Avenue Canal. I noted that September 30 is well into the hurricane season, but that is as quickly as those pumps can be produced in those locations.

Senator VITTER. You read my mind. Clearly 30 September is well into the season. Why can't some other capacity like truly temporary pumps, that you have designed, at least in the picture, is what most people would call a permanent looking construction, why can't some other truly temporary pumps be used to get that capacity up for the entirety of the season?

Mr. HITCHINGS. Well, we are looking at every option available to provide that pumping capacity. There are no other systems, no other temporary pumping capacity that we can identify that is going to allow us to do that. We have been working with the local businesses, looking at different concepts of barge thrusters, for example, as a way of moving the water out of those canals. We just haven't come up with anything that is technically feasible.

Senator VITTER. Well, for instance, right after Katrina, in the weeks after Katrina, when the city had to be dewatered, there were truly temporary pumps brought in, and within days they were pumping major amounts of water out of the city. So why couldn't something like that be used or be on standby to increase this capacity for the beginning of the hurricane season?

Mr. HITCHINGS. And that is possible to do that. However, I will note that at the peak of our unwatering effort, we had 160 temporary pumps operating. The total capacity of those 160 pumps was 1,000 cubic feet per second. So while it looked like a lot of water, compared to the capacity of what these existing pump stations and what these temporary pumps are going to be, it is much, much larger. I am not sure that those temporary pumps would have much of a significant impact.

Senator VITTER. So with regard to this problem, what is the status of the plan in conjunction with Jefferson Parish and other local sponsors to capture some significant amount of water before it even gets to the 17th Street Canal, in particular, in the Metarie Playground, the Metarie Country Club area?

Mr. HITCHINGS. Jefferson Parish was working on this, moving forward with it. And we have looked at opportunities to use that as part of an integrated solution that provides the most cost-effective portion. And we are making recommendations to our headquarters this week to look at that.

At the present time, it looks like we can more cost-effectively accomplish this pumping that we need to by putting all of the pumps at the outfall canals. This increment, while it is effective and does accomplish it, is more expensive per cubic foot per second than putting pumps up in this location.

Senator VITTER. But it could be done before September 30th?

Mr. HITCHINGS. It is my understanding that they are working on that right now.

Senator VITTER. Is the corps supporting that work, including through funding?

Mr. HITCHINGS. We certainly don't object to them doing the work.

Senator VITTER. That wasn't my question.

Mr. HITCHINGS. I know that.

Senator VITTER. Is the corps paying for that work to any extent?

Mr. HITCHINGS. We have not made a decision on that at this point, whether or not we would recommend paying for that work.

Senator VITTER. Is the corps considering paying for that work?

Mr. HITCHINGS. That is being proposed as an alternative in the recommendation that we sent forward, although not part of the most cost-effective solution.

Senator VITTER. Well, again, let me just repeat the concern of timing, which is obviously significant with the next hurricane season starting.

Final question. There has been ongoing discussion and disagreement about what the corps has authorization to do right now and what it doesn't have authorization to do. What are the main categories of work that you have planned that we are talking about between now and 2010, the main, big categories that you do not believe you have current authorization to do?

Mr. WOODLEY. Senator, we believe that we have authorization to accomplish all the work that was included in the last supplemental appropriation. I believe that we do not consider ourselves to have authorization at the present time to do any other work.

Senator VITTER. And what are the main categories of that other work that you are asking for authorization for?

Mr. WOODLEY. That includes the permanent pump stations, the armoring of the levees, the things that—

Senator VITTER. Is that pretty much the list thus far?

Mr. HITCHINGS. That is the list that is the \$1.46 billion that is in the proposal that has been submitted to Congress by the Administration. Those are the six elements in that at the current recommended funding levels.

Senator VITTER. Now, on that list is selective armoring. I am confused. Surely you think you have authorization for that now. No?

Mr. HITCHINGS. No, we do not.

Senator VITTER. You don't have authorization for selective armor?

Mr. HITCHINGS. That is correct.

Senator VITTER. Well, this is a continuation of our debate. But let me just point out that as you know, in December, Congress passed significant legislation including what is in my opinion extremely broad authorization language. It allows for "the repair or restoration of any flood control work threatened or destroyed by flood, including the strengthening, raising, extending or other modification thereof as may be necessary in the direction of the Chief of Engineers."

Why doesn't that cover selective armoring?

Mr. HITCHINGS. I am not sure that I am in a position that I could answer that. We certainly could research it, and Mr. Woodley may have some comments.

Mr. WOODLEY. Senator, I agree that is very broad language. But I think that we have, we are seeking the explicit authorization for the particular work that we are proposing. The very general language like that certainly can be used in some cases, but as you know, we generally have a strong preference for very specific authorizations from Congress before we undertake work.

Senator VITTER. Well, let me just point out that these are extraordinary circumstances, and it is an emergency situation with the next hurricane season right around the corner. So I would suggest that preferences aren't as important as getting the work done quickly and correctly. Again, this is extremely broad language.

And I really think the corps is just kicking the can down the road on some of these issues to say that it doesn't have present authorization. I don't know why armoring isn't strengthening. I don't know why even the permanent pump stations isn't a modification of the present system that is necessary in the discretion of the Chief of Engineers. I don't know why any of these things aren't covered by this authorization language.

All right. Congressman Jefferson, any final questions?

Mr. JEFFERSON. Well, just back to, you asked an authorization question with respect to the money that was in the supplemental in December. With respect to the most recent discussions about the \$4.1 billion, that is a matter that you need authorization for, is it not?

Mr. WOODLEY. Yes, sir.

Mr. JEFFERSON. We have been told that if a request simply is made from the White House, as opposed to the Congress having to act on a request, that that would be sufficient to, for FEMA to have authority to do what it needs to do with respect to issuing the ultimate maps. Is that your understanding of what needs to be done, or does there need to be a specific authorization from the Congress to do that?

Mr. WOODLEY. Under FEMA's regulations, the commitment on the part of the Administration is sufficient to allow their regulatory action to proceed with respect to the base flood elevations. I would say that certainly if the Congress explicitly rejected that at some point then the FEMA may have to reconsider that. But I think that is an unlikely eventuality.

Mr. JEFFERSON. But absent a specific rejection, are you saying there is no authorization by the Congress needed, all that needs to be done is a request from the White House and things can move continually from there?

Mr. WOODLEY. With respect to the regulatory requirements for establishment of base flood elevations, yes, sir, that is correct.

Mr. JEFFERSON. Is it your Agency's province to urge the White House to make this recommendation to the Congress?

Mr. WOODLEY. Yes, sir. We work with the Administration—

Mr. JEFFERSON. Have you done so?

Mr. WOODLEY [continuing]. To make these recommendations to bring them forward. We certainly are working—

Mr. JEFFERSON. But you haven't done so yet?

Mr. WOODLEY. We will be doing so very soon.

Mr. JEFFERSON. How soon do you think?

Mr. WOODLEY. Very soon. I don't know exactly what the timing is on it.

Mr. JEFFERSON. Weeks?

Mr. WOODLEY. I would expect to see it very soon.

Mr. JEFFERSON. That would mean weeks, I guess, then?

Mr. WOODLEY. It may be a matter of weeks, yes, sir.

Mr. JEFFERSON. We have heard Mr. Powell say that he has gotten assurances that if his grandchildren were to live behind these levees, they would be secure, they needn't worry about the levees ever breaching, they could worry about a little overtopping here and there that could be handled by the pumps, if we get them in place. But do you feel the same way that he feels about this? Because what we are trying to do here is give our people assurances that they can come back and feel it is safe to live in relative security, recognizing that there is always some danger of overtopping. But with respect to breaching, we can tell our people, can we not, that they can come back and rebuild without fear of these areas breaching again?

Mr. WOODLEY. If the work requested is authorized and appropriated and completed, then we will have a system in place that is designed to, although it may experience overtopping in a major event, catastrophic event, that it would be designed not to experience catastrophic flooding as a result of breaches. So the answer to your question is yes.

Mr. JEFFERSON. Now, when you say catastrophic event, are you talking about a category what storm?

Mr. WOODLEY. I am talking about any storm that produced a storm surge that was higher than the elevation of the storm damage reduction works themselves, so that it put water from, either from the Gulf or from Lake Pontchartrain, over the top of the works.

Mr. JEFFERSON. We have talked so much about these categories, though, just to have the public have an understanding, would it be a Category 3 or Category 4 storm? Are we talking about that we could expect no breaching from that?

Mr. WOODLEY. A Category 3 storm, depending on its characteristics, how quickly it moved and what direction it came from, could very well produce very high storm surges. A Category 5 storm, depending on its direction and its speed, could possibly not produce

such high storm surges. So we will, our plan is to, once we have a design in place and we understand the nature of the works that are in place, what we would undertake to do would be to model it using our modeling capabilities, model a variety of storms against these works. Then at that point we would be in a position to answer that question in terms of what type of storms, what characteristics would speed, wind speed, barometric pressure and all those things would we expect to see overtopping. As of today, I cannot answer your question.

Mr. JEFFERSON. OK. I was going to ask one last thing, with respect to the coastal erosion issues. When we talk about hurricane protection, we are talking about a hurricane protection system. Are you recommending, apart from what we were talking about with the levees and the drainage pumps, a total system-wide approach to this that will include wetlands restoration, coastal restoration, that sort of thing?

Mr. WOODLEY. Absolutely. We have asked to jump start that, in the last request, with a \$100 million appropriation that would allow us to immediately begin work on those elements of the LCA, or Louisiana Coastal Area plan, which has been recommended by the Chief of Engineers, and I believe transmitted to Congress, that would have the greatest likelihood in producing wetlands benefits that would intercept storm surges from the direction of the Gulf of Mexico.

Mr. JEFFERSON. Thank you.

Senator VITTER. Thank you both very much. We are going to move on to our second and third panels. But I really encourage you all to stay for that discussion and that testimony. Thank you for being here.

Mr. WOODLEY. Senator, we will. I apologize, but I do have a conference call with OMB at noon, local time, if I may be excused at that time. But I am delighted to, and certainly intend to stay until I absolutely have to go.

Senator VITTER. Sure. Thank you.

Now we will invite our second panel up. I will be introducing them as they come forward to the witness panel.

This panel again is focused on folks in local affected areas, their perspective and their input. We have William Clifford Smith, who is a Louisiana member of the Mississippi River Commission, and is a civil engineer from Houma, LA. We have the Honorable Benny Rousselle, President of Plaquemines Parish, and the Honorable Timothy Kerner, Mayor of the Town of Jean Lafitte, in Jefferson Parish, LA. We also have Mark Drennen, President and CEO of Greater New Orleans, Inc., a leading business economic development organization.

Welcome to you all. We will go in that order with 5 minutes each, and then we will have questions and discussion.

Mr. SMITH.

**STATEMENT OF THE HON. WILLIAM CLIFFORD SMITH, MEMBER, MISSISSIPPI RIVER COMMISSION, CIVIL WORKS, U.S. ARMY CORPS OF ENGINEERS**

Mr. SMITH. Thank you, Senator.

Good morning, Senator and staff and Congressman Jefferson. Thank you for holding this hearing. I am very pleased that you want to investigate a comprehensive approach to hurricane protection. But I am frustrated and confused. I am here to tell you that a comprehensive approach is not only desirable, but is necessary for the survival of our coast and its economy, community and culture. A proactive approach to avoiding the type of destruction and devastation experienced through Hurricanes Katrina and Rita is long overdue.

We in Terrebonne Parish have been working on such an approach for our region for over 15 years. The obsolete and frustrating authorization, appropriation and permitting process that has evolved in this country represents almost insurmountable barriers. Fifteen years ago, in conjunction with the State of Louisiana and the Corps of Engineers, we began to develop a hurricane protection system for Terrebonne Parish. We completed a feasibility study in 2002, which cost over \$10 million, of which 50 percent was paid by local interest. It was approved by the Chief of Engineers. This project, known as Morganza to the Gulf Hurricane Protection Plan, has a positive cost benefit ratio and has been waiting on congressional authorization since 2002.

The local citizens have been taxing themselves for the last 4 years to raise the local share with the State in the event that a Federal project is ever authorized and funded. As a matter of fact, with local and State funds and no Federal help, we have just begun building a \$17 million segment of this project in accordance with the feasibility report and with the hopes of ultimately receiving credit on a Federal project. The project, when totally completed, would provide Category 3 protection for approximately 200,000 citizens in Terrebonne and Lafourche Parishes, and approximately \$8 billion worth of public and private infrastructure.

I know that I am blessed, because the worst natural disaster to hit America, Hurricane Katrina, was to the east of where I live. Even though the wind blew out of the north at 100 miles an hour, we received minimum damage and inconvenience. Within 30 days, Hurricane Rita hit southwest Louisiana and the wind blew 40 miles an hour out of the south. We had more water in my parish than I have ever seen. Thankfully, my home, my business, my investment had minimum damages, so again, I was blessed.

Because we live so close to the disaster area, especially New Orleans gas operations in the Gulf of Mexico that were devastated by Katrina and Rita, my community's economy is the most prosperous that I have observed. All of this is because the oil and gas companies are doing everything possible to get back in production, because of demand and prices for their product. I have, as a civil engineer and land surveyor, who has lived near the water in this coastal area all my life, I see my coastline washing away into the Gulf of Mexico. I believe if a storm of 100 miles an hour winds hits my community from the south, there could be there 10 to 15 feet of water in the vicinity of Houma.

During my lifetime, over 400,000 acres of land have been lost between my community and the Gulf of Mexico. This buffer that protected my community from hurricanes for over 200 years is erod-

ing. One of the most productive estuary areas in the world is being lost as I speak to you.

I tell everyone in my community to go look at Chalmette and St. Bernard Parish. Chalmette is about 20 miles further inland from the Gulf than my community of Houma, as shown on the attached sketch. I believe that it is a matter of time before my community experiences the fate of Chalmette and St. Bernard Parish.

As horrible as the hurricanes were last year, one good thing that resulted is the recognition that the wetlands and estuary areas, in and of themselves, significantly provide hurricane protection that must be restored and rebuilt. This is surely the case, particularly in my area, because our wetlands have historically protected not only my parish, but much of LaFourche, St. Charles, Jefferson and Orleans, in addition to being the most productive estuaries on earth.

I believe as a civilian member of the Mississippi River Commission, this restoration of our wetlands can be accomplished by managing the resources of the Mississippi River and its tributaries. The survival of our area depends upon you. Please authorize and fund the Morganza to the Gulf Protection Project and the Louisiana Coastal Area Project for the restoration of the national, great coastal area.

Thank you for your time.

Senator VITTER. Thank you, Mr. Smith.

President Rousselle.

**STATEMENT OF BENNY ROUSSELLE, PRESIDENT,  
PLAQUEMINES PARISH GOVERNMENT**

Mr. ROUSSELLE. Thank you, Mr. Chairman, members of the committee.

I represent the people of Plaquemines Parish, a relatively small community located on the Gulf Coast of Louisiana, south of New Orleans.

Plaquemines Parish is small in size and population, yet it provides multi-million dollar revenues for North America. The Parish's oil, gas and fishery industries provide an economic impact that not only Louisiana enjoys, but for the entire United States. The Naval Air Station's Joint Reserve Base, representing all five branches of the U.S. Armed Forces and the U.S. Coast Guard, is located in Plaquemines Parish.

Two prominent scientific research centers are located in Plaquemines Parish as well. Tulane University's F. Edward Hebert Research Center focuses on environmental, biological and medical research activities. The Louisiana State University's Citrus Research Station obtains produce research data on citrus specimens and small fruit.

Plaquemines Parish is also the home of the Conoco Phillips Alliance Refinery, one of the last grassroots refineries built in the United States. The refinery processes crude oil and receives domestic crude oil by pipeline and international crudes via the Louisiana Offshore Oil Port. Approximately 600 employees and contractors operate and maintain the refinery. The refinery started operations in 1971, and remains one of the country's most efficient and modern refineries.

The Chevron Oronite Oak Point Plant in Plaquemines Parish is one of the largest and most advanced producers of high-quality blended fuel and lubricant additives in the world. The plant occupies 100 acres in the Parish and has more than 410 employees. More than 30 unique additive components and intermediates are manufactured at the plant and more than 300 packages are blended at the site for customer requirements.

Southeast Louisiana is a major oil and gas producing region, with an energy industry that accounts for \$93 billion in revenue to the Louisiana economy and the employment of more than 62,000 people. In 2001, Plaquemines Parish produced more than 21 million barrels of crude oil from the more than 23,000 wells, more than any other parish in the State. In addition, Plaquemines Parish also produced more than 146 million cubic feet of natural gas.

The mouth of the Mississippi River is in Plaquemines Parish. Through this gateway to the Mississippi River Valley passes 92 percent of the Nation's agricultural exports, as well as coal, petroleum products, iron and steel, rubber and chemicals. The mouth of the Mississippi River is served by five ports, including the ports of Plaquemines, St. Bernard, New Orleans, South Louisiana and Baton Rouge. These ports handle a significant portion of the Nation's cargo. In fact, annual U.S. tonnage reports consistently rank the Port of South Louisiana first in tonnage shipped, while the Ports of New Orleans and Baton Rouge rank fourth and sixth. The ports also serve as America's cargo gateway to Latin America, and with potentially opening of the Seapoint facility, they are expected to become critical to our trade.

The Parish of Plaquemines jutting out into the Gulf of Mexico was the first to be hit by Hurricane Katrina. Just a few short weeks afterwards, it received the backlash of Hurricane Rita. In both instances, Plaquemines Parish was inundated by waters that flooded and washed away practically all businesses, homes and structures on the east bank and southernmost points of the Parish. Our only protection was levees, both Federal and non-Federal, that suffered tremendous soil loss, and in some instances, collapsed.

Unlike other parishes that need levee protection in some areas of their parish, Plaquemines is bordered by levees on all sides. We rely heavily on our levees year-round for daily protection. We have been dependent on the Corps of Engineers to provide us with protection for our Federal levees. However, Plaquemines Parish has allocated substantial local dollars for Federal and non-Federal levees. This does not include the time and labor spent by employees to maintain both the Federal and non-Federal levees. In order to provide adequate levee protection in Plaquemines Parish, we must get all our levees funded under a Federal system.

However, levee systems are not and cannot be the lone solution. There must be a move to restore America's wetlands. They are an important part of our economy, our culture and our environment. Louisiana boasts the Nation's largest shrimp fishery and second largest commercial fishing industry, only second to Alaska. Some of the largest commercial fishing ports in the country are in the Southeast Louisiana corridor. Fishermen working out of these ports land between 350 million and 495 million pounds of saltwater fish

each year and about 22 million pounds of freshwater fish, the largest freshwater harvest in the Nation.

The wetlands surrounding Plaquemines Parish are the spawning ground and nurseries for much of the Nation's most desirable seafood: shrimp, oysters, crab, catfish and red drum. Without wetlands protection and restoration, Louisiana's seafood industry and the Nation's seafood populations are vulnerable.

Parts of Plaquemines Parish are designed as essential habitat for brown shrimp, white shrimp and red drum by the Gulf of Mexico Fishery Management Council. America's wetlands also provide natural flood control, natural hurricane protection and natural filtration systems to protect water quality. In fact, America's wetlands located in Louisiana have been called the hardest working, the most productive and the greatest wetlands on earth.

But these wetlands are disappearing at the rate of 40 square miles a year. That is 80 percent of the Nation's total coastal wetland loss occurring in the Nation's most important and productive wetlands. Without protection, these wetlands are not only vulnerable, they are gone.

The southern portion of Plaquemines Parish and its east bank population now stands at 10 percent pre-Katrina numbers. Our residents and businesses are waiting for adequate levee protection and coastal restoration. Plaquemines Parish is not a heavily populated area. Louisiana in general is not a heavily populated State. But consider this: these small numbers of people make up nearly 100 percent of the workers in the Nation's second largest seafood industry and comprise the work force of one of the Nation's most important oil and gas-producing regions. They service three of the Nation's busiest ports and form a unique and priceless part of America's cultural heritage.

Today I am asking that you invest in the maintenance of all levee systems in Plaquemines Parish. I am also asking you to invest and dedicate funding to our wetlands and nature's hurricane protection system.

We respectfully request that you don't turn your back on the levees and the vanishing wetlands of our Parish and State. These levees and wetlands present a priceless opportunity to act locally to reap enormous global benefits. Without protection, we are all vulnerable.

Senator VITTER. Thank you, Mr. Rousselle.  
Mayor Kerner.

**STATEMENT OF TIMOTHY P. KERNER, MAYOR, TOWN OF JEAN LAFITTE AND VICE PRESIDENT, WEST JEFFERSON LEVEE DISTRICT, JEFFERSON PARISH, LA**

Mayor KERNER. Good morning. My name is Timothy Kerner, Mayor of the Town of Jean Lafitte and Vice President of the West Jefferson Levee District. I am here to speak on behalf of the citizens of Jefferson Parish.

Hurricane Katrina made landfall on August 29, 2005, causing tremendous flooding damage over large portions of southeastern Louisiana. The event focused great attention on its impact upon the flood protection systems throughout the area.

However, Hurricane Katrina was not the only catastrophe to hit southeastern Louisiana. In late September of 2005, Hurricane Rita, while on a path to making landfall near the Louisiana/Texas border, brought catastrophic tidal inundation to the communities of Crown Point, Lafitte and Barataria as it passed south of Jefferson Parish, Louisiana.

The flooding overtopped and in some instances destroyed existing levee systems that heretofore had provided a limited level of protection in these areas. Because of the extent of damage, the rehabilitation of these levee systems is beyond the financial capability of the West Jefferson Levee District. As such, we are requesting your review of and subsequent approval for funding the repair of those damaged levee systems and for the construction of new levees as may be needed to protect the citizens of lower Jefferson Parish.

We understand that the repair and construction of levee systems, both Federal and non-Federal, located in other communities in and around the New Orleans metropolitan area that were damaged or destroyed by Hurricane Katrina have been included in congressional appropriations to the U.S. Army Corps of Engineers. In earlier supplemental appropriation legislation, the non-Federal levees located in the Parishes of St. Bernard and Plaquemines were addressed, and we understand that in the most recent supplemental appropriation bills that was just passed by the Senate Committee, the non-Federal levee in the Terrebonne Parish has also been addressed. Unfortunately, the non-Federal levees in Lafitte, Crown Point and Barataria were not addressed.

Currently we have the following projects in the continuing authority program, Section 205 with the Corps of Engineers: Crown Point, Rosethorn, Lafitte, Fisher School Basin, Paillet, and Boose Bayou. All these projects are authorized by the Federal Government. In each project, the corps is limited to spending \$7 million per project, with a 65 percent Federal and a 35 percent non-Federal match. We are requesting legislation to increase the Federal funding to \$50 million per project, because the cost will far exceed the \$7 million limit. We are also asking for a reduction in the non-Federal cost share to 10 percent.

We are also asking to change our non-Federal levels to Federal levees to waiver the cost to benefit ratio for the following projects: Lower Lafitte, Lower Barataria, Jones Point, Lower and Upper Highway 45 Evacuation Routes. Although the locations will protect homes, they will more importantly provide evacuation routes.

In closing, the Town of Jean Lafitte's 1990 census shows a 45.5 percent growth, in 2000, a 57.5 percent growth. This area has a long history of providing goods and services for the country. Barataria Bay is one of the largest shellfish producing areas in the State of Louisiana. We provide the rest of the country with fish, crab, oysters, shrimp and crawfish. We also have hundreds of active wells that help fuel automobiles and heat homes and many other things.

But we are also paying the price, because those canals cut by the oil companies allow the floodwaters to devastate our community time and time again. We also are a buffer zone for the 250,000 people that live on the West Bank of Jefferson Parish. And Senator, my family was elected in my area in 1880. It is not just a job for

me. I love the people I represent, and I want to do the best job I possibly can.

Right now, I am venting out the insides of homes, I have crews doing that, I have other people that are coming in and finishing the insides of homes and putting roofs on people's houses that can't afford. We also in some cases are building homes for people that can't afford it. I am doing the best I can with what I need to provide for those people's living protection. I am asking you today to please, please help me and consider my community. Thank you.

Senator VITTER. Thank you, Mr. Mayor, for all your work.

Mr. DRENNEN.

**STATEMENT OF MARK C. DRENNEN, PRESIDENT AND CEO,  
GREATER NEW ORLEANS, INC.**

Mr. DRENNEN. Senator Vitter, Congressman Jefferson, thank you very much for this opportunity.

As you both know, GNO, Inc. is a regional economic development agency with a mission to grow the economy. It started 2½ years ago. Certainly our mission remains the same, but our goals and tactics have changed, like everybody's.

What I want to share with you today is how fragile the economy in our region is right now and how critical it is that the levee protection be successful. I am concerned about a couple comments I heard this morning already in response to some of your questions. The very clear language, Senator Vitter, that you added to the Federal law authorizing what seems to, I think anybody that heard you, authorizing the armoring of the levees, and there seems to be a lack of clarity in the corps as to whether or not that gives them the authority to do what needs to be done.

I am concerned about comments about no priorities, when certainly with my background, we could never count on all the money being there, so we had to set priorities. The comments about no modeling, in response to Senator Vitter, one of your questions. I am hoping I misunderstood or lack understanding, but some of those responses concern me.

We appreciate very much what you have done in getting money for our levees, getting money for housing. That was important, the GO Zone legislation. We are going to be asking you for some modifications to the GO Zone legislation, because it is a great economic tool for us. However, we are concerned in the devastated areas that the timeframes may not allow us to utilize some of that low interest money. We are going to be, again, suggesting some extensions of times to use that as our economy comes back.

We know in our region over 80 percent of the large businesses are back. That is good news. We know that bank deposits are up significantly. That is good news. But what it means is people are holding on to their insurance money until they get some clarity as to what they can and can't do with it. We know that we have seen some important government reforms. I think those are going to happen even more so in this session. Some of the colleges are reopened. That is all great news.

However, there are a lot of things out there that are not healthy, and a breach in a levee is going to cause us severe problems that

we may not come back from. I am absolutely confident that over the next 10 years, we will be a better region if the levees hold.

But let me talk about some of the fragility out there, if that is the correct word. The tourists and conventioners have not come back. They will not come back unless we as a State are able to utilize a lot of the CDBG money to market ourselves nationally. Because the national marketing with \$10 million, \$15 million is not going to be enough, and we are going to have to get \$100 million.

The money that we have asked for in CDBG money that has not come through yet for grants for small businesses is extremely important, not only in the tourism industry, but in a lot of other small businesses. We modeled our request after what happened at New York City. They were very successful in bringing back their economy because they had CDBG money for infrastructure, they had it for economic development. The amount after we spend money on housing that we are going to have is not nearly enough to recover. So tourism, convention business are not back and will not be back unless we can put significant money into it.

Our private hospitals in the region are losing money every time an uninsured patient walks in their door. Normally, as a business, you want people to come in. East Jeff, West Jeff, Oshner, are suffering, losing money every month because they are not getting reimbursed by the State for 100 percent of the costs of the people we used to take care of in the charity hospitals. And all the labor that has come in uninsured, they are not getting reimbursed for. They are having serious problems.

There is an insurance crisis that I think we are all beginning to wake up to. In some parts of the region, you can't get insurance. Other parts, the insurance costs are going to make it very difficult to come back, for people to invest. Another very fragile area is going to be the utility costs. If Entergy New Orleans isn't able to latch onto some CDBG money, like was again done in New York City, they are going to have to increase rates that again, are so much that it is going to make the recovery of our economy very difficult.

We don't even talk about the infrastructure damage. Think about the sewerage and water board here and the damage that has been done underground, the utility structure, the roads. The list goes on and on. We are going to have to get money for infrastructure investments, again, like New York City did. MRGO, we are going to shut down MRGO, how are we going to move all those businesses. We can't, for the hundreds of millions that have been invested there, there has to be a solution to that.

Loans that are being proposed for businesses are good for some businesses, low interest loans. But most businesses have already, small and medium, have already extended their personal credit cards, second mortgages on their house, and just borrowing more money to get out of their problems is not going to be sufficient. We are going to have to get some grant money for businesses that have very clear business plans and have a good chance of survival to help them get through this.

Now, what is the solution to all this? It is what Senator Vitter, Congressman Jefferson, your predecessors have been talking about for years. And that is, we as a region, as a State, want to take care

of ourselves. And we could do that if we could get 50 percent of the royalty payments of offshore oil and gas production. That would give us sufficient money to borrow money to immediately invest in all these things that we have been talking about. Other than that, we are going to have to continue to go to Washington asking for more CDBG money to repair our basic infrastructures that are so necessary for the recovery of the economy in this region.

Again, thank you.

Senator VITTER. Thank you very much.

Now we will get to questions and discussions.

Mr. Smith, I am glad you focused on the Lafourche-Terrebonne area. Because my great concern, like yours, is that that area, we are talking about Greater New Orleans. And a major protection system, which in some ways is inadequate, and yet we move to Lafourche and Terrebonne, we are talking about little or no protection system whatsoever. So if a storm comparable to Katrina or a lot less went 50 miles west, there would be clearly devastation there, as you outlined.

That is why the Morganza to the Gulf project, as you mentioned, is so important. That is why I introduced a bill to fast track that, included it within the WRDA bill which we are trying to move. The entire project included about \$40 million to funds in the Senate emergency appropriations bill for Terrebonne in particular.

Would you talk about the importance of that project, and in particular, an analysis of that cost, which is significant, but what the cost might be of a Katrina that hits Lafourche and Terrebonne head on in terms of FEMA response and everything else?

Mr. SMITH. Well, Senator, of course for us, a storm that would be west, that would hit the coast west of us would be absolutely devastating. Again, there were 400,000 acres of land between where I live in Houma, LA and the Gulf of Mexico when I was born that is not there today. And historically, that was our hurricane protection. And that has gone away because of coastal erosion, subsidence, saltwater intrusion and what have you.

So therefore, we are proposing, and have been proposing for over 15 years, this hurricane protection levee system that encompasses about 72 miles in length. But it would protect not only the inhabited areas primarily in Terrebonne Parish, but also it would protect a vast area of wetlands that is deteriorating as we speak. Again, that is about 120,000 people living in Terrebonne today, and about \$8 billion worth of infrastructure, both public and private infrastructure, in the community. Again, as Plaquemines and the other coastal areas, we are a big producing area of seafood. And of course, oil and gas activities.

So of course, a storm that would devastate our area, similar to what Katrina did primarily to St. Bernard, Plaquemines, and particularly Chalmette, Louisiana, would be absolutely devastating. Even in Rita, we had 10,000 homes flooded in Terrebonne and Lower Terrebonne Parish. We probably have about 40,000 homes in Terrebonne Parish. Again, a storm to the west would probably devastate and flood that entire area.

Again, remember, we are 65 miles, Houma is 65 miles southwest of New Orleans, approximately 30 miles north of the Gulf of Mexico. And I tell everybody, about two or three inches above the

water. And the water is rising. We are also getting closer to the Gulf as every day goes by.

It is kind of mind boggling, though, that we live above sea level. Generally the people in Terrebonne and Lafourche Parish live above sea level, not below sea level, like the majority of the metropolitan areas of New Orleans. But we live very close to the Gulf of Mexico. I see every day on my way to my office, and I actually live a little north of Houma, I see the tidal flow every day in the natural bayous and streams in the area.

So it is just a matter of time, very frankly, although we have all these wonderful programs proposed, all these wonderful projects, and we try to be in the process of authorization and funding, I think it is just a matter of time that we are going to have a disaster if we don't do some major protection.

Senator VITTER. Thank you.

President Rousselle and Mayor Kerner, I know one of several big issues for both of you are converting non-Federal levees in your areas to Federal ones. The corps has proposed some of that, particularly on the West Bank of Plaquemines. It did not propose doing it in other areas, including on the East Bank of Plaquemines, including in areas that directly impact you, Mayor.

I disagree with that. I have proposed and actually included in the Senate legislation conversion of virtually all of that to Federal levees. Could both of you talk about the importance of that work to the protection of your citizens?

Mr. ROUSSELLE. Thank you, Senator Vitter. I want to thank you for including that in there.

The problem that we have is that we have ring levees completely around us. If you do not include those local levees and those privately owned levees in the Federal system, you have a hole in the system. And in our case, for instance, on the West Bank, the water would come in and inundate the hurricane evacuation route, leaving our parish cut in half. And to us, the Administration hopefully will write that letter requesting that that funding be accessed, if it is indeed appropriated through the entire process. Right now, I understand that the \$60 million is hard money and that the balance is not there unless the Administration requests it.

But it is like having a hole in the system without putting all of those levees in. Currently we are on hold right now, we are working on those locally owned levees on the East Bank. The corps is in the process of issuing a contract to put them up to pre-Katrina standards. But that is as far as that goes, and I don't think it will take a whole lot more to bring them up to a Federal standard. But we are really on hold right now. We are participating with stockpiling mud, dirt, but the project, I have received a letter from the corps to tell us not to do any more work on them until they can issue the contract.

So it is imperative that we include these systems, these levees. For instance, the refinery. The refinery is just now getting back up to capacity. That refinery had several feet of water in it, because it is not protected by a Federal levee. So we are hoping that these Federal levee issues will go away and be included.

Senator VITTER. Thank you. Mayor.

Mayor Kerner. There are so many reasons. It would allow us to receive Federal funding, it would take the cost to benefit ratio out of the picture, because in some of my areas, they will never meet the cost to benefit ratio. And the same thing President Rousselle said, in my area, I have Lower Goose Bayou that would have a ring levee system, then further down in Lafitte, no, it wouldn't have one. Goose Bayou North, no levee system. And in the town of Jean Lafitte, a levee system. The middle of the town of Jean Lafitte, no levee system. The [inaudible] area in the town, a levee system. Baratavia, a levee system. Lower Baratavia, no levee system. Crown Point, on the east end, a levee system. Right up at the West End, no levee system.

So what you have is maybe five ring levees and another five areas with no levee system, no evacuation routes. You would have one area dry and another area would be flooded.

So I would love to—Mr. Rousselle just sent me a note on Donaldsonville to the Gulf. Yes, that would actually help my area. It would, the levee from Donaldsonville to Plaquemines Parish and it would catch the Town of Jean Lafitte and also Crown Point, and we are trying to get it to go a little further south to catch the Lower Baratavia.

But back to the non-Federal levees, it would mean everything in the world to my area, because like Mr. Rousselle said, you would have a completed levee system, one levee system and not a couple of ring levees that would be left out when other places would be flooded, you wouldn't have evacuation routes.

Senator VITTER. Thanks.

Mark, you mentioned, a number of crucial business issues, but I want to focus, since this hearing is about levees and flood protection, related issues on that. To generalize what would you say the level of confidence of the business community is in our ongoing hurricane and flood protection work?

Mr. DRENNEN. Senator, I would say it was high enough that most of the major businesses decided to come back. Again, the number that I have seen from some bankers is over 80 percent of the large businesses are here and others are coming back. So I think there is a good enough level of confidence that they made those decisions.

The point I was trying to make is a lot of that is very fragile, and they won't come back a second time. So we absolutely have to get the levees right.

Senator VITTER. Apart from 50 percent royalty sharing, which would be a huge breakthrough, what in your mind are important benchmarks which we need to meet over time to retain and grow that confidence level?

Mr. DRENNEN. Just as it relates to levees?

Senator VITTER. Yes.

Mr. DRENNEN. I think if the business community believes that the planning is underway for Category 5 protection and that we have a source of money to implement Coastal 2050 and to begin to restore the wetlands that that is enough to give them confidence.

Senator VITTER. I thank you.

Congressman

Mr. Jefferson. Thank you. I will just limit my questions to Mr. Drennen. I think Senator Vitter covered the other issues with the officials and with Mr. Smith.

You mentioned the GO Zone legislation and the time line issues. I was very much involved with that, as you know. And I am very interested to know what specific things you would like to see us do to address the time line questions. We have had some recommendations from you. But are you able to speak to that today, or would you rather submit that at a later time?

Mr. DRENNEN. I can speak to one, because we have talked about it fairly substantially. I would like to submit the others to you in writing. We still have a request out to our colleagues to put a comprehensive list together.

But the big one we know of is that a lot of the investment that can take place with the \$7.9 billion in low interest loans will be taking place in areas of the State that were not devastated by the hurricanes, because they are up and able and ready to make application and begin building. You saw the First Aid Bond Commission meeting, where all the projects were in Baton Rouge. We all love Baton Rouge and that is our capital, but we need that money down in this region.

Right now, the State has set aside half of the money, \$4 billion, to be used in the most heavily damaged regions. And that is good news. Is that enough? We have no idea at this point, because there aren't applications being made in our region. And we don't think they are going to be made until we are able to get further along recovery.

So the request is going to be to extend the GO Zone legislation to 2010 in the most heavily devastated areas, again because we are a few years behind the other parts of the State.

Mr. JEFFERSON. Is there a need to tailor this, to make this relief more targeted? You seem to be suggesting that we didn't target it well enough.

Mr. DRENNEN. Well, we don't know yet how much demand there is going to be. My answer to you would be, the State of Louisiana needs these low interest loans. It is good for the whole State. It is certainly good for the 31 parishes that are impacted by it.

But if it turns out \$4 billion is not enough in the severely devastated region, then we have made a mistake. But again, we don't have enough feeling yet to know whether or not \$4 billion is going to be enough. And we don't know when the applications are going to start being made.

Mr. JEFFERSON. How confident do you think the business community is, or anyone is, with respect to the guidelines that have just been issued by FEMA and the corps with respect to rebuilding?

Mr. DRENNEN. There is still a lot of confusion as to exactly what it means. There is still a lot of confusion out there as to how you are going to bring back whole neighborhoods. There are a lot of people in the business community that are still looking at the Baker bill to see how it might be tailored to make it more locally oriented.

The biggest concern we hear is where you have whole neighborhoods that are devastated. How is the State of Louisiana, the LRA,

going to go about redeveloping whole communities, when what is involved is the basic infrastructure of those communities, from roads to sewer lines to utility poles? Who is going to have the money to come in and raise it, raise the ground? How are you going to keep from having one house raised four feet and another one two feet, and the four foot house flooding the two foot house?

So again, there is still a lot of confusion and unanswered questions as we speak today.

Mr. JEFFERSON. You mentioned in just one part of your testimony with respect to the insurance issues and local government financing, can you give me a little better feel for what we are facing with respect to insurance questions out there with the business people?

Mr. DRENNEN. Yes. We have talked, for example, and Benny Rousselle will probably know this better than I, but there are some areas in his parish where they don't have utility lines and may not be getting them. How do you get an ice house, where the fishermen are, without utilities? So we have heard stories about in some areas you can't get insurance at all. In other areas, the costs that are being quoted are so high that nobody could afford to get coverage.

Mr. JEFFERSON. With respect to the Federal responsibility, what do you think we could do or should do with respect to these issues?

Mr. DRENNEN. That is a tough question. Because I don't—whether this is a State solution or a Federal solution, I am not an expert on it yet. I know at every meeting I have been in the last month, it is becoming more and more of an issue, as people see the levees issue begin to solidify, the housing begin to solidify, now they are beginning to find out how difficult it is to get insurance.

So at our level, we are going to be meeting with Jim Donlan soon, to talk about what ideas he has. But again, if insurance costs are too high to be competitive, then it is going to be very difficult for our economy to come back.

Senator VITTER. OK, thank you, Congressman.

We are joined by Senator Landrieu. I want to welcome her and thank her for being here. She has asked that her comments be given during the third panel, so I will excuse you all and thank you all very much for being here.

As the third panel comes up, I will begin to introduce them. And again, this panel is focused on outside independent engineer and environmental expertise and how we institutionalize that with this very important, ongoing Corps of Engineers work.

We have on the third panel Dr. Lewis E. Link, Director of the Interagency Performance Evaluation Task Force established by the Secretary of Defense; Mr. Thomas Jackson, Member of the American Society of Civil Engineers External Review panel, and a former president of the society; and Mr. Carlton Dufrechou, Executive Director of the Lake Pontchartrain Basin Foundation, a leading environmental group in Louisiana.

Welcome to all of you. As with the previous panels, we will invite 5 minutes of testimony, and of course, your entire written testimony will be submitted and made a part of the written record. Then after your 5 minutes each, we will have questions and discussion.

Dr. LINK.

**STATEMENT OF LEWIS E. LINK, PH.D., DIRECTOR,  
INTERAGENCY PERFORMANCE EVALUATION TASK FORCE**

Mr. LINK. Thank you, sir.

Senator Vitter, Senator Landrieu, it is a pleasure to be here. I am Ed Link, I am on the faculty of the University of Maryland in the Department of Civil and Environmental Engineering. And as you stated, the Project Director for IPET.

IPET is an accumulation of expertise, about 150 people from government, State and Federal, academia and industry, who have basically dropped what they were doing prior to Katrina and devoted themselves to this very, very important task. That task is to discover the facts about the behavior of the flood protection system during Katrina and to use those facts to build back a more resistant, more capable system. I am very delighted to represent those people today in this testimony.

One of the unique parts of the IPET activity has been the participation of the peer review process with the American Society of Civil Engineers and the National Research Council. I can't tell you how valuable it has been, and you spoke, Senator, earlier about independent review. The ability to have a team of experts from ASCE looking over our shoulder continuously, and giving us advice and guidelines on how to best solve these very complex problems has been a very positive component of the success that we have had in understanding what really happened during the storm.

I would like to highlight a few things that we have learned. And first of all, all that we are learning is going in several places simultaneously. First, it is going to Task Force Guardian. And in fact, there are 20 people from Task Force Guardian embedded in the IPET Task Force. It gives us a direct connection to critical knowledge that we need, and also a direct connection back to the folks that are involved in designing and constructing the repairs and reconstitution of protection.

Second, we are providing information to the public. We have a public web site that right now has over 3,900 documents on it, including the reports of all of our analysis and the fundamental data that has been used in those analyses. And third, we are providing information to the corps and other interested individuals with regard to future policy and practice in engineering. And that is a role I think that the American Society of Civil Engineers and the National Academies Committee will play in being able to interpret what we have been able to determine from our analysis and provide some really good insights on how we can be better engineers in the future, how we can consider some of these complex situations more effectively.

Some of the things that have been I think most important in our inputs to Task Force Guardian is, first, establishing a new reference system for the Southeast Louisiana area. As you are well aware, the geology of this area makes it very vulnerable to differential settlement and differential subsidence. We were able to accelerate work of NOAA and the corps to create that new reference and to establish the exact elevations of all the critical con-

trol structures, so that now we do know exactly how far below authorized levels these structures are.

We have also been able to determine the failure mechanisms for the breaches. And through understanding those mechanisms, to provide insight to the assessment of the non-damaged areas of the levees and floodwalls, to assisting and understanding what needs to be done for those sections to guarantee their vitality during the next hurricane season.

In addition to that, we are correlating the losses that occurred from Katrina to the flooding exposure and developing a risk and reliability analysis that will allow you to look at the relative vulnerability of, within a given parish or between parishes, after the repairs are made, what the risk level will be at that time. That information will be very useful for examining future alternatives.

I want to thank you for the opportunity to be here and I would be very pleased to answer any questions that you have.

Senator VITTER. Thank you, Doctor. Thanks for all your work and to colleagues' work.

Mr. JACKSON.

**STATEMENT OF THOMAS L. JACKSON, P.E., F. ASCE, D. WRE,  
PAST PRESIDENT, AMERICAN SOCIETY OF CIVIL ENGINEERS  
AND SENIOR VICE PRESIDENT, DMJM HARRIS (RET.)**

Mr. JACKSON. Thank you, Senator Vitter, Senator Landrieu.

Good morning. My name is Tom Jackson and I am pleased to appear before you today on behalf of the American Society of Civil Engineers as you examine the current status of the reconstruction of the New Orleans levees. I am a past president of the ASCE and currently serve on ASCE's external review panel, or ERP. I might add parenthetically I am also a lifelong resident of New Orleans and Jefferson Parish. So I am very familiar with this area and the problems in storm protection that we have had over the years.

The role of ERP, which is composed of 14 specialists who possess a range of technical expertise, is to provide an objective, independent technical review of the work being performed by the U.S. Army Corps of Engineers Interagency Performance Evaluation Task Force, or IPET, on the flood control levees in the New Orleans area following Hurricane Katrina.

As engineers, our paramount concern is for the safety, health and welfare of the public. I would like to repeat that, because it is very important. As engineers, our paramount responsibility is for the safety, health and protection of the public. Today there appear to be a number of key lessons learned, which must be taken into account by Task Force Guardian in any analysis that looks to develop a system that will protect this area from a Category 4 or 5 hurricane.

While the ERP's immediate attention is focused on three main areas of potential lessons learned, first we are concerned about an apparent aggressive design approach which may not have been warranted for a water holding structure of this importance. It appears that at nearly every step of the way, the envelope was pushed. Let me explain.

The target factor of safety was apparently 1.3 for design, which may be on the low side for structures whose facilities and failures

were capable of causing death and widespread destruction. Against this backdrop, quite optimistic soil strengths were selected despite one, the fact that the local geology suggested that conditions would be highly variable, even over relatively short distances. For example, for the 17th Street Canal failures, variation in soil strengths led to factors of safety about 20 to 30 percent higher just north or just south of the failure zone.

No. 2, the fact that the soil conditions and strengths were taken from widely spaced borings that were concentrated along the center line of the levees. No. 3, the fact that soil strengths in the back yards were not adjusted to account for the reduction in overburdened pressures.

In addition, the forces on the wall did not apparently include the possibility that full hydrostatic loads could develop through the formation of a simple gap on the flood side of the wall, moving away from the canal embankment, as water in the canal rose above normal levees. Second, there may have been problems associated with handoffs during the design process, or interfaces between key players in the design. For example, were potential limitations in soil strength clearly communicated between the geotechnical team and the floodwall design team? Were concerns about hydrostatic loading on the wall clearly communicated and considered?

Third, how was the corps' quality assurance/quality control process followed during the design? For a structure of this importance, techniques such as independent peer review or use of border consultants had been used, would the performance have been different?

These concerns merit an in-depth assessment to document the lessons and to provide for ways to move forward and incorporate these lessons learned. The ERP will continue to be looking into these matters. The ERP is currently in the midst of a detailed review of IPET Report Number Two. On March 23, 2006, we delivered a letter to General Strock, Chief of Engineers, which noted several key concerns that the ERP has identified at this stage of its performance evaluation.

Based on our current findings, the ERP recommends the following actions to be undertaken with urgency for levees and floodwalls, and in New Orleans and perhaps elsewhere in the Nation. A, all I-walls should be reevaluated for current design loading assuming a water-filled gap along the flood side of the wall. B, all levees underlain by soft soil should be reevaluated for current design loadings accounting for reduced sheer strength of soil in areas at or beyond the toe of the levee.

C, all levees and floodwalls should be reevaluated to identify those areas where the questionable degree of conservatism inherent in the design process and those sections of concern reanalyzed for current design loadings employing an appropriate degree of conservatism. D, a risk-based approach toward defining the design hurricane conditions is needed. We advise the corps to proceed as quickly as possible toward redefining standard project hurricane using principles and practices similar to those used in establishing the potential catastrophic natural disasters such as earthquakes and other flooding. E, external peer review is an important component of design practice for all critical life-safety structures. We rec-

ommend that the steps described above receive external peer review throughout the design process.

In closing, the ERP will continue evaluating IPET's Report Number Two and will issue its own report in the coming weeks. We note that in a letter to ERP dated April 7th, General Strock expressed the corps' gratitude for the ERP's insightful comments and recommendations, and states that the corps is looking forward to receiving ERP's review comments following.

Thank you.

Senator VITTER. Thank you, Mr. Jackson.

Mr. DUFRECHOU.

**STATEMENT OF CARLTON DUFRECHOU, EXECUTIVE  
DIRECTOR, LAKE PONTCHARTRAIN BASIN FOUNDATION**

Mr. DUFRECHOU. Senator Vitter, Senator Landrieu, it is good to see you both. And to some of the prior speakers, on behalf of Pontchartrain Basin Foundation and everyone in Southeast Louisiana, thank you for your efforts to secure royalties from the oil and gas operations in the Gulf to try to preserve our entire region.

It is an honor for me as an engineer by education to be seated with Dr. Link and Mr. Jackson this morning. As I was preparing my statement, I was trying to be as brief as possible, and I remembered a quote, I believe it was by Professor Einstein some time ago, and I am paraphrasing it, that today's problems cannot be solved with yesterday's thinking.

While I certainly and the Pontchartrain Basin Foundation supports all of the work currently underway by the Corps of Engineers to strengthen our levee system, levees alone won't work. Katrina was not a direct hit on the metropolitan area, it missed us. And yet the impacts were horrific. The corps Civil Works process that we have in the United States, unfortunately, in the past has been myopic. Hurricane protection works were considered by themselves.

And the first line of defense for our region, Senator Vitter and Senator Landrieu, as you both have said repeatedly, has been our coast. And our coast unfortunately has all but been forgotten about until very, very recently. We applaud the work of the agencies to restore the levees. I would like the record to show that I have the utmost respect for all the workers with the Corps of Engineers, they are some of the finest, most dedicated people I have ever met.

However, I believe that the Corps Civil Works process we have right now is limiting. It does not include the big picture. While certainly we need stronger and better levees, the best protection we can hope for in the future is the same degree of protection that we have right now, in the near term, levees that will protect us from a Category 2 or 3 storm. That is not sufficient. That will mean, as Mr. Drennen addressed earlier about the economic impacts to our area, everyone in this region, and by far they are the best of the best that are back, that are trying to bring the metropolitan region back, they are all going to be prepared to evacuate of once or twice a year, whenever a Category 3 storm is near our coast. That is going to be an added economic burden, not only to the businesses, but to everyone who is here.

I guess where I am going with this, Senators, is that while certainly the LCA is a good first step, it is not enough. Hurricane pro-

tection for the future has to include the coast as an integral part. Further than that, we have to get beyond doing navigation works, transportation works, hurricane protection and coastal works independently. They all have to be integrated, in our opinion.

The highest priority must be hurricane protection works. It has to supersede everything else. Here, in the Pontchartrain Basin, until half a century ago, we had a substantial coast. In 1965, Hurricane Betsy, a Category 3 storm, hit the area. While 40 years later, Katrina, was a larger storm and more powerful storm in the Gulf, once Katrina reached the latitude of New Orleans, it was basically a Category 3 hurricane like Betsy. During Hurricane Betsy, I was 9 years old. We had 5-to 6-foot levees on the lake front. My folks and I lived on Bellaire Drive. There was no floodwall behind our house then to protect us from the adjacent 17th Street Canal. There was only a little mound of a levee. But those levees held during Betsy. Some other areas of the city, St. Bernard Parish, unfortunately, the 9th Ward were flooded, many believe because of the Mississippi River Gulf Outlet, which not coincidentally, was completed that same year.

To be comprehensive, we have to look at the big picture. We have to consider channels, like the Mississippi River Gulf Outlet. While Many people believe the MRGO caused flooding in Hurricane Betsy, I am here to tell you today, what the MRGO did more than that was it completely altered the hydrology and ecology of our coast for the long term. It more than anything else has acted as a cancer, progressively eating away at our coastal wetlands for the last half century. And it is still causing damages today. It is a clear and present danger. And as long as channels like the MRGO are there, we can build levees higher and higher and stronger and stronger, but the coast will continue to vanish and the Gulf continue to encroach on us, and we will always be at risk.

Senators we need your guidance and help. Right now, the Corps of Engineers is in a quandary. They have a congressionally authorized channel to maintain—the Mississippi River Gulf Outlet, and we are also asking them to restore our coast and help us with hurricane protection. They have two sets of orders. About the only thing they can do is try to rebuild the levees to the status quo to stay within their box. We have to expand their box, and we certainly need gentlemen like Dr. Lewis and Mr. Jackson and others that have been here this morning, to assist.

Please, in the near term, consider de-authorization of the Mississippi River Gulf Outlet to help to prevent the catastrophes that we have had, that we have experienced recently. Beyond that, make decisions based on the big picture. Integrate coastal restoration and hurricane protection efforts. The Corps of Engineers is a unique entity. They can do magnificent work. But we have to change their box. We have to expand it.

Thank you for the opportunity to speak with you this morning. Senator VITTER. Thank you very much.

We will follow up with questions and discussion.

Dr. LINK AND MR. JACKSON, your committee's work has been very important post-Katrina, in this very crucial stage. What are your thoughts about how we institutionalize that type of outside, inde-

pendent peer review and input on an ongoing basis in terms of this work in Louisiana and perhaps more work more generally?

Mr. JACKSON. Senator, I would say that the Federal law has to determine those projects where peer review must take place. I would think that the corps should, beyond that, look at individual projects that they may want to do, even beyond whatever the Federal law requires.

I have done work, design work for the Corps of Engineers in Vicksburg and the New Orleans District, and I understand the corps thinking pretty well. However, I understand it a lot better today, considering the last several months, than I ever did.

The corps as an institution is a very powerful group. They employ extremely valuable scientists and engineers to both determine what needs to be done and to determine how to do it. However, the corps as an institution, and I would say that it falls into the category of many large institutions, it is bound up within its own rules. As you talked earlier about authorization the corps' interpretation, I think, of authorization that has gone on over the years has been a very, very extremely tight rein on what the corps should do.

As a matter of fact, I made comments to the corps that perhaps the engineers, the professional design engineers within the corps sometimes need to stand up and say, that won't adequately protect the public, and I won't participate. That is a very drastic step for a person in an organization that has the U.S. Army in front of them. During wartime, they are shot.

However, I believe that we need to get to a point where those engineers have the support of an external group, on important issues where life and extensive property result. We have in ERP been constant in our push of the IPET. They have done very wonderful work. And you saw today a lot of discussion about peer review. You saw today a lot of discussion about most of the issues that we in ERP, probably not as an original thought. But the power of an external organization to be able to say these kinds of things, and for people like yourselves to listen, is something that we must incorporate in future work by the corps and other Federal agencies.

Senator VITTER. Dr. Link?

Mr. LINK. Yes, sir, thank you. I think there are several key aspects to this. The independent peer review does exist in the engineering profession, of course. I think we can certainly take advantage of expanding on what is already there in the way of doing consulting boards and independent panels. One of the things that I have learned, especially in this experience with the Task Force, is the power of partnering.

I think we have created a unique kind of relationship between the Task Force and the panel of experts in ASCE that has allowed us to interact continuously. It is not that the typical or traditional, where the Task Force does something and then hands it off for an independent review that is disassociated with the Task Force. We are actually learning from each other as we go along, and yet maintaining that very critical external position that the panel has.

But there is a lot of power in partnering. And I think we should try to figure out a way to factor that in, so that it is not two groups sitting on two sides of a wall. The diversity of ideas and the rich-

ness of the analysis that results from bringing those people together in a unique way, I think, is very, very powerful.

Senator VITTER. Let me just say I would endorse that idea, too. Also for an additional reason, besides everything you mentioned, is the last thing we need to come out of this is for the normal corps process to take even longer than it does now. The typical corps projects is 11, 13 years before you put a shovel in the ground. So the last thing we need is a method of peer review that just adds years onto that rather than shortening that process. And your general notion of partnering avoids having the corps do 5 years of work and then have peer review out of the blue that finds major disagreements with it.

Mr. LINK. Yes, sir, I think you are right on. It is very critical to have the interaction from the first step, not when the plan is complete, but in the formulation of the plan. It is a much, much more productive environment.

Both the ASCE panel and the National Research Council panel have told the Task Force that we can't get our job done in the time allotted. But in fact we are. And it is primarily because of the partnering and the acceleration, the ability to not do the traditional step by step process, but by doing the partnering process.

Senator VITTER. And Carlton, a related question. I completely agree with your comments about using a more integrated approach, that we don't have these separate smokestacks labeled maritime, environmental, levee protection. It all needs to relate.

How do we institutionalize that more integrate approach?

Mr. DUFRECHOU. Senator, it is going to be a challenge. It won't happen overnight. I think it is going to take some courageous leadership from you, Senator Vitter, and Senator Landrieu, to put the direction out there that, guys, enough is enough. We can't have it the way we used to have it any more. Not only is the time line too long, but we have to have the big picture in everything we do down here.

And certainly, Dr. Link and Mr. Jackson are excellent assistants to make this process work. There are many organizations throughout the area, the Coalition to Restore Coastal Louisiana, Pontchartrain Basin Foundation, Barataria-Terrebonne National Estuarine Program, who have independent plans that they know are already prepared on the coast. Certainly we have it for Pontchartrain. We know the ten coastal elements that, once we get those back, we will have sustainable coasts again which will act as the buffers for storm surges.

I would suggest to you, sir, that the leadership has to come from you. As much as we can help at the local level, and the public is certainly behind you with this, the Corps of Engineers is, well, it is an entity like no other in the world that can do a variety of work. It is also a dinosaur. And gentleman, I don't mean that in a derogatory fashion. But the process, unfortunately, it has become process driven all too often instead of outcome driven.

I guess if there is one thing I can leave with you, it is, we have to be outcome driven. And the outcome for us is not Category 3 protection, but it is long-term sustainable hurricane protection for decades to come.

Senator VITTER. I have taken a stab at this idea in proposed legislation of a corps council, merging the corps with outside, independent environmental and engineering experts. If my office hasn't already, we are going to get the three of you and others a copy of that bill. I would invite very active and aggressive critique and input in terms of that legislation.

Mr. DUFRECHOU. Senator, if I might add, we did get an opportunity to look at that with David Dawes in your local office. It is a tremendous first step. It is exactly where we need to go. And that could be the catalyst for the change that we need.

Senator VITTER. I would invite all of you and your colleagues to offer whatever critique, changes, input you think are appropriate. I would love to see those.

Senator Landrieu.

Senator LANDRIEU. Thank you. And let me thank you, Senator Vitter, for putting all these excellent panels together, and for your continued focus through your efforts on the EPW Committee to tackle not just one, but several very complicated issues to move us forward.

I am pleased to have co-sponsored Senator Vitter's legislation, and our offices have worked very closely as we try to get as much input as we can to forge ahead. It is going to be a tough issue to put before Congress. But we are determined to do that, and to force to consider an alternative way, since we represent the State and the region that has been the unfortunate beneficiary of the status quo. We need to see some changes.

Let me ask you, Mr. Jackson, if you would elaborate a minute, I think I agree with what you were saying about the corps' inability sometimes to hit the mark on their authorizations. But could you elaborate a little bit more about what you said to make sure that I am hearing, you said sometimes it is hard for the corps to meet their total authorizations, or sometimes it is hard for them to—I don't know what word you used.

Mr. JACKSON. I think where I was going with the comment is that, and my wife is the lawyer, so I guess that allows me to talk about lawyers. So excuse me, Senator Vitter.

Senator LANDRIEU. Go ahead.

[Laughter.]

Mr. JACKSON. I think sometimes that the corps is a large Agency with a lot of Federal oversight. And it appears to me that they tend to have a habit of getting buried into the exact meaning of a congressional request to authorize projects. I think Senator Vitter's questions earlier today relative to armoring the levees and whether or not the corps had authorization, is a perfect example.

I had an experience with the corps many years ago when we were designing the pumping stations along the lake front in Jefferson Parish. And the New Orleans District Corps had taken the position that their authorization for hurricane protection went to either side of the pumping stations, and they had no responsibility for storm protection across the pumping stations. And of course, we were looking for them to accept their responsibility to help in the funding for those very expensive stations.

At that time, we approached Congress to try to more clearly define that authorization, and the New Orleans District re-inter-

preted their authorization. And then, without any additional congressional action, and assumed responsibility.

I think that is counterproductive to the goals of what the corps is trying to do for this community. While they have done many, many great things, and continue to do so, I think it is counterproductive, if you will, for the corps to get tied up in wording that I don't believe that you as Senators of the U.S. Congress intend in the request. I am sure that all these controls are built in so that the corps won't start spending money in areas that the Congress has not approved. So there has to be some line of balance. I agree with Senator Vitter's comments earlier that these are different times. And to try to split hairs, if you will, on wording in a bill as to whether or not there is authorization, and put things on hold, is not good for the people of this community.

Senator LANDRIEU. Thank you.

Let me change course and just ask you, I know you have done a lot of work with the National Organization of Civil Engineers. That particular organization, several years before Katrina and Rita, had been very critical and issued a report, I am not sure if the title was "A Nation At Risk", that was maybe our education report. But something similar to that, in terms of the lack of overall investment from the Federal Government in civil works, generally.

Mr. JACKSON. Yes.

Senator LANDRIEU. Could you comment as to if that is the position of the organization today, the National Association, that the lack of investments is causing our Nation to be extremely vulnerable in certain areas and could you elaborate on that particular finding?

Mr. JACKSON. Yes, Senator. ASCE, as I think both of you know, puts out a report card on the Nation's infrastructure every 3 years, and they update it on an annual basis. It is a very simple thing to understand, you either get an A or an F or somewhere in between.

So we do this on a national basis. It is not something that ASCE dreams up on their own. The information basically comes from Federal organizations, such as the corps, the Federal Highway Administration and other Federal agencies, which address what the needs are versus what is being done.

We also encourage all of our State sections and branches to do local report cards on the Nation's infrastructure. The grades that ASCE has been giving to the Nation's infrastructure are in the range of Cs and Ds. As a matter of fact, there have been a lot of comments by individuals looking at it that you would be very ashamed to bring such a report card home to Mom and Dad.

So there needs to be significant investment in the Nation's infrastructure in the future. We have ignored the needs over the years. I know it is expensive, and I know it takes not only a commitment of the U.S. Congress, it takes a commitment of every individual in this country. However, like the transmission repairman says on TV, you pay me now or you pay me later.

Senator LANDRIEU. The last report I looked at actually I thought had a D or a D- for civil works overall. Do you remember what the percentage relative to the GDP over time or any kind of data that you could leave, if not, you could submit it to the record, in terms

of the trend of investments. Has it decreased 100 percent over 2 decades or 200 percent? Or has it just remained flat for the last 40 years? How do you all talk about it when you are trying to describe it to the country?

Mr. JACKSON. Yes, Senator, I would be very happy to have that information provided for your office and also for Senator Vitter, rather than me trying to recall. I remembered things a lot better 25 or 30 years ago than I do today.

[The referenced information can be found on page 105.]

Senator LANDRIEU. Thank you. If you would submit that for the record, because I think for the conversation at hand, it is a crucial set of data that we need for the country to realize that it is a short-changing of funding over time that has been a very insidious pattern of underfunding that has resulted in this kind of disaster.

Let me, if I could, direct a question to Dr. Link. You talked about risk and vulnerability. We are in the position now of defending, of course, a great city and a great region, and the two of us try to do our best at it each day since this has happened. But it has not gone without notice. Today, in the front page of either the Times or the Post was a discussion about the marking of the 100th anniversary of the San Francisco earthquake. There was a small group of survivors that of course were quite young children, some infants when that occurred 100 years ago. It was interesting, there are few survivors still.

Does your organization do an assessment of other communities that are so positioned? You know, our colleagues continue to say, well, why are you building below sea level? We are trying to explain that we came here to run the greatest port system in North America. But why did they build San Francisco on a fault line, even after 1906? They rebuilt it after it completely collapsed. Why are we building Phoenix in the middle of a desert? Why are we developing communities in Utah that have no access to fresh water and continue to grow, L.A. being one? Why do we do that? And if we are, why does it make New Orleans either less or better?

In terms of our commitment to build on this particular piece of land, do you have an assessment of the vulnerabilities of other major communities, ranking them? Are we at the top of the list, in the middle of the list? Are we that much different from others relative to the threats that they may be in line for?

Mr. LINK. Senator Landrieu, I think your questions are very important, I wish I had the list. I think we should ask Tom to come up with a report card on that. But we have been basically taking the risk and reliability concepts that were developed for earthquake analysis, and specifically used by the Federal agencies for dam safety. We have been trying to apply them to the more complicated area of hurricane protection. Particularly in the complex situation here in New Orleans.

It is interesting, about a week ago, I gave a keynote address in California to a number of consulting engineering companies. Some of them had the feeling that New Orleans was protected better than they are in the central valley and on the delta. Of course, I explained that that wasn't the case.

But there is a lot of misperception about risk. What we are trying to do here is identify relative levels of vulnerability, depending

on where you are and one of the unique things that will come out of our work is basically an understanding of potential flooding and potential losses as a function of zip code, not for all of Plaquemines Parish or not for a lumped analysis of Orleans Parish, but for every zip code in every census block.

So the possibility of a failure of a particular reach or a particular section of structure can be correlated to the probability of flooding and the probability of different kinds of losses. That is pretty unique. I don't know of any other area where that has been done before. But I think New Orleans is the prototype for that type of an analysis or for that kind of a product to give decisionmakers a richer set of information to understand what is causing the vulnerability.

If I am building in a particular location or I want to develop that location and I have a certain risk of flooding and losses, what is causing that? This product will allow you to understand the primary causes of vulnerability and to examine alternative ways of buying down that risk. I don't know of any product like that in any other community. I think from this perspective, that this is a new application of risk.

Senator LANDRIEU. Senator Vitter has been generous in the time, but I will just follow up with this one comment. I think that exercise is going to be very helpful, and I most certainly don't mind us being the prototype or the model. Clearly, the Nation, and international attention, is focused right here.

But I don't want it to be presented in a way that we are the only model. Because I keep saying that this is a national challenge. It is a challenge to New Orleans and south Louisiana, but we are not the only community challenged. There are rural areas, there are urban areas that have great challenges, whether it is earthquakes or fires or floods or tsunamis or hurricanes coming closer to very highly populated areas like New York from the Atlantic.

This country had better get about the business of getting our systems in much better place to deal with it, both preventing it and dealing with it once these natural disasters do occur. There is no way to prevent them, but there is a much better way to deal with it.

Mr. Dufrechou, I have a question for you, but I will submit it for the record, and I thank Senator Vitter for his generosity.

Mr. DUFRECHOU. Thank you, Senator.

Senator VITTER. A final question. Mr. Jackson, you listed several very specific findings or lessons learned of your peer review work, your association's peer review work. Dr. Link, you all have come up with similar findings. How would the two of you grade the corps in its incorporation of those very specific findings and lessons learned into the corps' present ongoing work in the area?

Mr. JACKSON. Our observation is that the corps has already effected several and has plans to effect the remainder. So our evaluation of the corps' response is an absolute A.

Mr. LINK. I feel the same way. We have had multiple meetings with the Task Force Guardian and the New Orleans District folks. We literally have people from the Task Force here every week working together, taking the lessons learned and applying them, even before we put them on the web page, as soon as we have dis-

covered something. We are here working it with the District and it is being applied.

So for the people from outside the corps on the Task Force, this has been really very gratifying to see this work being used right away.

Senator VITTER. Thank you all very much. I want to thank all the witnesses. I want to also thank everyone who has attended. We have many leaders here today. I want to recognize Sandy Rosenthal, who is the leader of Levees.org, an organization formed after Hurricane Katrina to ensure better, stronger and smarter hurricane protection for the greater New Orleans area. I know Senator Landrieu and I both support all of those goals of the organization.

I also want to thank the Louisiana Supreme Court for hosting us today. We have Justice Kimble with us and want to thank the entire Court for their gracious role in hosting us in this fine building.

I also want to thank the entire Senate Committee on Environment and Public Works. We have several staffers who came down from Washington to be with us today to work on this hearing on both the majority and minority side. They have taken a very active role in this corps and related oversight. So I want to thank the entire committee and the committee staff.

With that, the hearing is adjourned.

[Whereupon, at 12:32 p.m., the committee was adjourned.]

[Additional statements submitted for the record follow:]

STATEMENT OF HON. JOHN PAUL WOODLEY, JR., ASSISTANT SECRETARY OF THE ARMY FOR CIVIL WORKS, U.S. ARMY CORPS OF ENGINEERS

#### INTRODUCTION

Mr. Chairman and distinguished members of the committee, I am John Paul Woodley, Jr., Assistant Secretary of the Army (Civil Works). I am honored to testify before your committee today on the preparation for next hurricane season in Louisiana. I am joined today by Mr. Dan Hitchings, Director of the Corps of Engineers' Task Force Hope.

My testimony today will update the Committee on rebuilding and restoration of hurricane and flood protection system by the Army Corps of Engineers. I will provide an update on measures to strengthen the system that the Administration and Congress are working to authorize and fund; on measures required to certify and further enhance the system to the standard for a 100-year storm; and on analyses being conducted for a greater levels of protection for southern Louisiana. Mr. Hitchings will provide a summary of the damage to the hurricane protection system and describe authorized and funded efforts now underway to re-establish an intact hurricane protection system before the start of this summer's hurricane season.

The damage to the hurricane protection system by Hurricane Katrina was calamitous. Sixty percent (169 of 350 miles) of the earthen levees and concrete floodwall systems and 87 percent (66 of 76) of the existing pump stations were damaged. The Corps is on schedule to repair the damaged levees and floodwalls to their pre-storm condition by June 1, the beginning of the hurricane season.

#### MEASURES TO STRENGTHEN THE SYSTEM

I believe it is important for the Committee and the public to fully understand the efforts we are making to gain the information needed to inform prudent decisions for hurricane protection for New Orleans and the Louisiana coastal areas. Following landfall of Hurricane Katrina on 29 August 2005, Secretary of Defense, Donald H. Rumsfeld, directed the Secretary of the Army, Dr. Francis J. Harvey, to convene an independent panel of national experts under the direction of the National Academies to evaluate the performance of hurricane protection systems in New Orleans and the surrounding areas. I directed the National Academies to assemble a multidisciplinary (e.g., engineering, atmospheric sciences, etc.) panel drawn from the public and private sectors and academia. The purpose of the panel is to assist the office of the Assistant Secretary for Civil Works (ASA (CW)) in conducting a forensic in-

investigation of the performance of U.S. Army Corps of Engineers (USACE) projects during Hurricane Katrina.

The Chief of the U.S. Army Corps of Engineers formally established the Inter-agency Performance Evaluation Task Force (IPET) on October 10, 2005, to provide credible and objective scientific and engineering facts to answer questions about the performance of the New Orleans hurricane and flood protection system during Hurricane Katrina. The IPET is examining and providing forensic analysis on the performance of the entire storm damage reduction system in New Orleans, helping us to understand the failures that occurred, to understand other components of the system that may have been degraded in their capacity to protect against future storms, and to understand where the system performed successfully. The IPET is developing information on risk and reliability of the system as it will be after the corps completes the repairs. The corps is immediately acting to incorporate findings into both its interim repair and its long term work.

The American Society of Civil Engineers is providing external peer review of IPET activities—referred to as the External Review Report (ERP). Both the corps IPET and the ASCE ERP teams are comprised of some of the Nation's most highly regarded engineers and scientists from Government (Federal, State, and local agencies), academia and private industry. These experts are using some of the most advanced scientific and engineering methods and tools in their comprehensive study.

The National Academies Committee on New Orleans Regional Hurricane Projects is performing an independent review of the IPET and ASCE reports and will issue separate findings and recommendations to me. The findings of the National Academies panel will be subject to peer review process before being released under the imprimatur of the National Academies of Science.

The IPET product will include four reports. IPET Report 1, publicly released on 10 Jan 2006, provided the strategy for implementing their performance evaluation and provided interim status. IPET Report 2, released in March, provided a progress report on implementation with interim results. IPET Report 3, scheduled for June 1, 2006, will be a final draft report on the performance evaluation of the hurricane protection system. Following a review by both the ASCE ERP and the National Academies, a final report will be released in the fall of 2006.

The IPET Reports are reviewed by the ASCE External Review Panel and the National Academies Committee. All comments pertaining to IPET will be addressed in future IPET reports. National Academies review comments on IPET reports are provided directly to the Department of the Army. ASCE review comments on IPET reports are provided to LTG Carl Strock, Chief of Engineers.

The National Academies review of the IPET work will produce several reports. A preliminary letter report was issued February 21, 2006, to ASA (CW) providing an assessment of IPET Report 1. An interim report will be issued near the midpoint of their study (tentatively 1 June 2006) with the comprehensive report evaluating the final draft IPET and ERP reports scheduled to be released tentatively in September 2006. The National Academies review of the final IPET report will be prepared about 90 days after the final IPET report is released.

At the same time, on a parallel path with the IPET and National Academies studies, Congress authorized and appropriated funds for a 2-year, \$20 million Louisiana Coastal Protection and Restoration Project (LACPR) analysis and design to identify options for increasing the level of hurricane storm protection for New Orleans and coastal Louisiana. Planning and organization for this study is now underway. It will incorporate all information developed by other studies. As directed, the corps is preparing an interim report due in June 2006, with a final report of recommendations and alternatives due December 30, 2007. We trust that the State will fully comply with the statutory conditions that will enable this study to proceed to completion.

The LACPR study has been referred to as the "Category 5" study, but I caution the committee and the public about the use of such terminology and measures when making decisions about the kinds and size of structures to build for storm protection. Storm category classifications, which are based on sustained wind velocities, are general categorizations best used to inform the general public about the expected level of destructiveness associated with a storm so that individuals and officials can make decisions about how to protect themselves and their property, such as whether or not to evacuate. Storm protection levees and similar structures are now designed to specific storm surge and wave criteria based on the modeled effects of a statistically-selected "design storm." While sustained wind velocity is one measure that has an effect on surge and wave heights, many other factors are critically important, as well. These include storm characteristics such as forward speed, radius, barometric pressure, tidal factors, the bottom depth in front of levees, and more. A storm of Category 5 wind velocity characteristics could well be less destructive to a storm protection system than would a storm with Category 3 wind velocity

if those other factors were unfavorable. The Louisiana Coastal Protection and Restoration Project will incorporate all these factors to study the means to provide a higher level of protection.

Immediately after the hurricane, the Administration committed to helping New Orleans rebuild, and to the reconstruction of its hurricane protection system. In supplemental appropriations to date, Congress and the President have provided \$2.08 Billion to repair and restore the levee system to its design height.

In February, I wrote the Congress with a proposal for a fourth supplemental funding to construct measures that would strengthen and improve the hurricane protection for greater New Orleans. Such measures include additional structural protections that would address the main causes of the catastrophic flooding during Hurricane Katrina, as well as measures to begin to restore the coastal wetlands that help to protect New Orleans from hurricane-generated storm surge. While the repairs and rebuilding activities that are now underway will make the flood control and hurricane protection system better than it was immediately prior to Hurricane Katrina, the additional measures that I proposed in February will result in a system significantly better and stronger than it ever has been before. The proposal includes:

- Construct state-of-the-art pump stations and floodgates at the outfall ends of three drainage canals (17th Street, Orleans Avenue, and London Avenue) to reduce exposure of the interior of the city to surge from Lake Pontchartrain. Closing the lakefront of the outfall canals will prevent a storm surge from entering the canals when the gates are closed while still allowing interior drainage waters to be pumped into Lake Pontchartrain.

- Strengthen protection along the Inner Harbor Navigation Canal (IHNC) through two navigable closure structures at to-be-determined locations on the Industrial Canal at Seabrook near Lake Pontchartrain and west of the intersection of the Gulf Intracoastal Waterway (GIWW) and the Mississippi River Gulf Outlet (MRGO). Placing navigable gated structures on the Industrial Canal at Seabrook and west of the intersection of the GIWW and MRGO will allow ship traffic to move freely when open, but would protect the IHNC from major storm events when closed. There are about 20 miles of floodwall that will be isolated by the permanent pump stations and the navigable gates at Seabrook and GIWW.

- Storm-proof authorized pump stations in Jefferson and Orleans Parishes. Storm-proofing pump stations will allow them to function through the fiercest storms by hardening them, raising critical equipment and providing emergency power and fuel systems.

- Armor critical elements of the hurricane protection system. The corps will selectively armor critical elements in the system such as transitions from levees to walls and from levees or walls to structures, penetrations, crossings, and the like, and also some levee segments that are most exposed to surge. Armoring levees means strengthening them—applying materials to make levees resistant to wave-wash and scour that can occur during overtopping;

- Incorporate a non-Federal levee on the West Bank of the Mississippi River in Plaquemines Parish into the existing Federal levee system to protect an evacuation route. The incorporation of non-Federal levees will allow the corps to improve them to the same standard heights and design as other area Federal Hurricane Protection levees in Plaquemines Parish and offer increased protection for both residents and state Highway 23, a major hurricane evacuation route.

- Reduce the impact of storm surge in areas east of the city by reversing wetland losses in areas affected by navigation channels, oil and gas channels or other channels and modifying the Caernarvon Freshwater Diversion structure or its operation. When the main surge arrives, the basins can then hold more floodwater, thus reducing the high water and potential flooding. Restoring coastal ecosystems, such as barrier islands and marshlands increases the natural lines of defense against hurricane-induced storm surge.

These measures, estimated to cost \$1.46 billion are yet to be authorized and funded. If funds are appropriated in FY2006, these measures can be completed in 2010.

MEASURES REQUIRED TO CERTIFY AND FURTHER ENHANCE THE SYSTEM TO THE  
STANDARD FOR A 100-YEAR FLOOD

In the weeks since my February recommendation, new information has been developed that has caused us to recommend additional modifications to the system. The new recommendations are primarily the result of two new pieces of information. First, the IPET study informs us that any I-walls in the system need to be carefully examined and in many cases may need to be replaced. Second, new, post-Katrina weather data developed by the National Weather Service informs us that the statis-

tically-determined "100-year" storm is a more powerful storm than the storm for which the existing hurricane protection system was designed.

On April 12, 2006, Federal Coordinator for Gulf Coast Rebuilding Donald Powell, along with U.S. Army Corps of Engineers Commander Lt. Gen. Carl Strock, FEMA Director of Mitigation and Administrator of the National Flood Insurance Program (NFIP) David Maurstad, and FEMA Deputy Director for Gulf Coast Recovery Gil Jamieson, announced the release of advisory flood data for New Orleans and the majority of the surrounding area. The flood advisories will inform residents how to reduce or mitigate flood risks as they begin reconstruction, and will provide guidance to communities for better and stronger rebuilding. The Louisiana Recovery Authority (LRA) has stated that for residents to be eligible for its State Homeowner Assistance plan, all reconstruction work must meet or exceed the latest available FEMA advisory base flood elevations and meet the legal requirements of the State Uniform Construction Code. FEMA has previously stated that these advisories must be used for any rebuilding projects using certain FEMA grant dollars, meaning that the FEMA advisories apply to both public infrastructure projects as well as mitigation requirements.

The flood advisories are based on the assumption that the rebuilt hurricane protection system will be sufficient to withstand the newly established 100-year storm, which is a requirement of FEMA's National Flood Insurance Program. Since the Corps is not able to certify the existing and authorized levee design heights for the new more powerful 100-year storm, the levees will have to be raised in many areas to meet the new standard. The Administration is discussing with Congress the timing of a formal request for additional authorization and funding to certify and further enhance the majority of the levee system.

The estimated additional cost to raise and enhance the entire New Orleans area levee system, including Plaquemines Parish, enough to provide 100-year protection is estimated at \$4.1 billion, in addition to the \$1.46 billion I recommended in February. The additional work for certification of the system includes raising levee heights, in some cases as much as 7 feet, and to upgrade or replace the remaining existing I-walls with T-walls. We plan to begin working with Congress immediately to provide \$2.5 billion to address improvements in all of the New Orleans system except for lower Plaquemines. The \$2.5 billion will provide 100-year protection to about 98 percent of the population in the New Orleans area. Providing similar protection to the area of lower Plaquemines, which was home to 2 percent of the area's population, is estimated to cost a total of \$1.6 billion. Before committing to that funding request, the Administration is awaiting the results of the corps' further analysis that will provide additional insight into the technical challenges of protecting such a narrow strip of land; whether certifying the levees there exacerbates an already challenging environmental situation (i.e., sinking and wetlands erosion); and whether such improvements would be economically justified.

#### ANALYSES INTO A GREATER LEVEL OF PROTECTION FOR SOUTHERN LOUISIANA

Longer term, as I previously mentioned, the corps is identifying and analyzing the options for higher levels of protection. The preliminary report of the Louisiana Coastal Protection and Restoration Project is scheduled to be completed in June of this year and a final report will be completed in December 2007, as provided for in law.

#### CLOSING

Mr. Chairman, the rebuilding and redesign of the greater New Orleans hurricane protection system is one of the most ambitious civil works projects ever undertaken and I applaud the efforts of the men and women of the Corps of Engineers, many of whom were personally impacted by the hurricanes that devastated the Gulf Coast. The commitment and selfless service that they are demonstrating by meeting our June first goal is a testament to the dedication of this organization. The amount of work underway is immense. It would ordinarily take years to do what we are doing in months. Work is being accelerated and compressed without jeopardizing the science, the engineering or the best construction practices.

This concludes my statement. Again, I appreciate the opportunity to testify today. I would be pleased to answer any questions you may have.

RESPONSES BY JOHN PAUL WOODLEY JR., TO ADDITIONAL QUESTIONS FROM  
SENATOR JEFFORDS

*Question 1.* During the hearing, Congressman Jefferson asked several questions regarding the level of agreement between the Interagency Performance Evaluation Team (IPET) and the work of outside groups regarding the failure modes of the levees and floodwalls during Katrina. You responded that it was perception, not reality that there were wide disagreements, and that you would be able to respond more thoroughly after the June 1 IPET report was completed. Can you describe the level of agreement between the IPET and other groups regarding the failure modes of the levees and if there are disagreements, what they are, and how the corps intends to use each theory in its repair, design, and reconstruction of the hurricane protection system?

Response. From September 2005 to 1 June 2006, USACE conducted investigations of the failure modes, integrated those lessons learned into new designs, and placed approximately \$800 million of new walls and levees to close the breaches before the next hurricane season. As part of that effort, about 20 members of Task Force Guardian (TFG), the team who performed the design and construction, participated in the IPET studies. As lessons were learned and independently reviewed by the American Society of Civil Engineers, External Review Team, TFG integrated those lessons into the plans and specifications used to reconstruct the walls and levees. These lessons were finalized in design guidance in April 2006 which is being used to raise the levee system to the authorized level of protection by September 2007.

Starting in January 2006, IPET posted its findings on a public website, <https://ipet.wes.army.mil>, requested similar information from the other teams, and had members of the other teams visit the construction placement. The IPET received information from the National Science Foundation (NSF) sponsored Independent Levee Investigation Team (ILIT) in late May 2006 shortly before the completion of the 1 June construction deadline when the team posted its draft report at [http://www.ce.berkeley.edu/?new Orleans/](http://www.ce.berkeley.edu/?new%20Orleans/).

The ILIT report was not complete, and the appendices remain incomplete where IPET expects to find the detailed analyses. Based on the draft findings, there are divergent opinions as to the specific failure modes in the foundation soils. One issue that remains unclear is the level of independent technical review performed on the ILIT report that validates their findings. IPET plans to thoroughly review their final report, offer commentary, and seek discussions on any issues that need clarification.

Also in May 2006, IPET received from the National Institute of Science and Technology (NIST), Technical Note 1476 posted at [http://www.nist.gov/public affairs/releases/hurricane report060906.htm](http://www.nist.gov/public%20affairs/releases/hurricane%20report060906.htm). The IPET reviewed the NIST report and agreed with their findings, however; their work was based on observations and had limited technical analysis.

*Question 2.* On Page 30 and 31 of the transcript, there is a series of questions and answers regarding the FEMA flood maps. Can you describe the current status of the FEMA advisories? Specifically, what do the advisories that have been issued require homeowners to do as structures are rebuilt? What is the relationship between the level of protection required to meet a 1- in 100-year storm as defined by the FEMA flood map process and the level of protection provided by the hurricane protection system as it stands today, June 9, 2006, and as it will stand after improvements and modifications scheduled to occur between now and 2010 are fully implemented?

Response. Questions regarding FEMA advisories and FEMA policy and regulations are best addressed by FEMA officials. However, under current FEMA requirements, levees, floodwalls and appurtenant structures must be of sufficient height and strength to withstand the storm surge and waves associated with a 1- in 100-year storm without overtopping or failing. The current system is inadequate with respect to both height and strength. The height deficiencies are the result of three factors: (1) A better understanding of the frequency of storm surge and waves heights. This is a product of both the introduction of new data and improved modeling technology; (2) Subsidence, or the general settling of the ground in Southeast Louisiana; (3) More stringent criteria for wave overtopping. The original design permitted some overtopping by wave wash.

The strength deficiencies are primarily the result of the extensive use of I-wall type floodwalls. During Katrina, floodwalls of this type failed in three locations. An evaluation by the Independent Performance Evaluation Task Force indicates that the failure was the result of a mechanism not taken into account in the design. As a result, the integrity of approximately 36 miles of floodwall is suspect.

Once the improvements and modifications scheduled to occur between now and 2012 are fully implemented, the system, with the exception of levees in lower Plaquemines Parish, will meet all of the FEMA requirements.

*Question 3.* What is the role of natural wetlands and coastal restoration in your vision for the long-term hurricane protection system in Southern Louisiana?

Response. An integrated system of natural wetlands and coastal restoration, strong structural barriers and levees, and non-structural features provides multiple lines of defense to protect lives and property. Coastal ecological features form the outer line of defense against storm waves. Barrier island systems absorb waves from approaching storms and help limit the amount of water that enters estuaries in advance of tropical systems. Back-barrier marshes and coastal fringe wetlands act as tidal and wave buffers protecting inland features. Upper estuary forested systems provide further protection through wind and surge reduction. Forested ridges formed on old river and bayou banks also provide wave and wind reduction during storm events. The lessons of Hurricane Katrina show the dangers of depending upon a single line of levee defenses located adjacent to densely populated areas. A better system approach would involve fighting storm surges on the outer fringe of populated areas with structural measures fronted by natural coastal protection features. There is growing consensus among scientists involved with Louisiana coastal protection and restoration that future hurricane protection projects for New Orleans and the Louisiana coast must include plans to sustain or enhance the wetland-dominated landscapes that surround the area. Although these landscapes are widely recognized for their great value to the Nation for the natural resources and ecosystem services they provide, these wetlands also function to provide some level of protection from hurricane wave action and storm surge.

*Question 4.* During the hearing, there was an extensive discussion regarding the degree to which the Army Corps of Engineers has authorization for selective armoring throughout the system. An unidentified piece of legislative language was quoted and an interpretation of that language was sought. Can you please provide a summary of your interpretation of the language discussed at the hearing, and your analysis of the degree to which the Army Corps can armor levees without additional authorization?

Response. With funding and authority provided in the 4th Emergency Supplemental, no additional authority for armoring levees in the existing system is currently needed. The \$170 million provided for selective armoring will be directed where the system is most vulnerable. These include areas with low-crest elevations, areas with weak or erodible levee soils, and transitions between levees with floodwalls.

*Question 5.* During the hearing, you stated "the corps is open to and is very interested in having outside, external, independent review of our formulation procedures and four design procedures. I think that our experience with that has been very good." Further, you stated that you would have no objection whatsoever to institutionalizing independent review. How would you propose institutionalizing independent peer review?

Response. This would be a several step process. With its publication in May 2005 of EC 1105-2-408 on Peer Review of Decision Documents, the corps has actually instituted peer review. The EC established within the corps several types of review. First, independent technical review, or ITR, will be conducted outside of the home district responsible for the feasibility study and would be performed or managed by the appropriate technical center of expertise. ITR is a critical examination by a qualified person or team that was not involved in the day-to-day technical work that supports the decision document. The corps has established six centers to manage ITR based on project purpose and located at its Division offices as follows:

- Inland Navigation (LRD)
- Deep Draft Navigation (SAD)
- Flood Damage Reduction (SPD)
- Hurricane and Storm Damage Reduction (NAD)
- Ecosystem Restoration (MVD)
- Water Management and Reallocation (SWD)

External review has been added to the corps existing review process in special cases where the risk and magnitude of the proposed project are such that a critical examination by a qualified person or team outside of the corps and not involved in the day-to-day production of a technical product is necessary. External review will similarly be added in cases where information is based on novel methods, presents complex challenges for interpretation, contains precedent-setting methods or models, or presents conclusions that are likely to affect policy decisions that have a significant impact. External review may be conducted at the discretion of the Chief of En-

gineers on any project he deems needs outside experts to review the technical aspects of a particular study.

With respect to independent review, that is, review conducted by a panel of experts completely outside or disassociated from the Corps of Engineers, we support the general concepts as set forth in S. 728. Independent review in this case would be arranged with, for example, the National Academies of Science or a similar entity to provide expert review of scientific or technical information that could be associated with corps studies. However, until Congress provides the appropriate authority, we have no ability to fund such review on a 100 percent Federal basis.

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STATEMENT OF DANIEL H. HITCHINGS, P.E., REGIONAL BUSINESS DIRECTOR,  
MISSISSIPPI VALLEY DIVISION, U.S. ARMY CORPS OF ENGINEERS

INTRODUCTION

Mr. Chairman and distinguished members of the Committee, I am Mr. Daniel Hitchings, Regional Business Director for the Mississippi Valley Division, U. S. Army Corps of Engineers. I am honored to be testifying before your Committee today, on the preparation for next hurricane season in Louisiana. I am joined today by the Honorable John Paul Woodley, Jr., Assistant Secretary of the Army (Civil Works). My testimony today will provide a summary of the damage to the hurricane protection system and authorized and funded efforts ongoing to re-establish an imperforate hurricane protection system before the start of this summer's hurricane season.

The damage to the hurricane protection system by Hurricane Katrina was calamitous. Sixty percent (169 of 350 miles) of the earthen levees and concrete floodwall systems and 87 percent (66 of 76) of the existing pump stations were damaged. We are on schedule to repair the damaged levees and floodwalls to their pre-storm condition by June 1, the beginning of the hurricane season.

*Orleans Parish*

The flood and hurricane protection system in Orleans Parish is divided into a western portion and eastern portion commonly referred to as Orleans East Bank and New Orleans East respectively.

The Orleans East Bank portion consists of the Lake Pontchartrain Lakefront from the 17th St. Canal to the Inner Harbor Navigation Channel (IHNC) and then along the western bank of the IHNC to the Mississippi River. Within the Orleans East Bank boundaries of the Parish there are 26.2 miles of levees and floodwalls, 13 pump stations, and 15 roadway floodgates. Significant damage occurred to 3.1 miles of levees and floodwalls and to all 13 pump stations. Specifically, the damages to the levees and floodwalls included:

- 455 foot breach in the east side I-wall along 17th St. Canal;
- Breaches on both the east side (425 feet) and west side (720 feet) I-wall along London Ave. Canal;
- Two breaches on the west side of the IHNC both in the vicinity of France Road and Benefit Street; and
- Intermittent minor scour along the other portions of the levee and floodwall protection

The New Orleans East portion is bounded by the east bank of the IHNC, Lake Pontchartrain shoreline between the IHNC and Southpoint, the eastern boundary of the Bayou Sauvage National Wildlife Preserve, and the north and south banks of the Gulf Intracoastal Waterway (GIWW). Within the New Orleans East boundaries of the Parish there are 49.4 miles of exterior levees and floodwalls, 9 miles of interior levees, 9 pump stations, and 7 Floodgates. Significant damage occurred to 7.6 miles of exterior levees and floodwalls, 4 floodgates, and all 9 pump stations. Specifically, the damages to the levees and floodwalls included:

- 12,750 feet of levee breach along the north bank of the GIWW between Michoud Canal and the CSX Railroad;
- A floodwall breach at Pump Station 15 (800 feet) near the Maxent Levee;
- A floodwall breach at the Air Products Hydrogen Plant near the Michoud Canal (300 feet);
- Floodgate floodwall and adjacent levee damage at the CSX railroad crossing;
- 2,000 feet of floodwall damage along the north bank of the GIWW between the IHNC and Paris Road;
- Two breaches in the east side of the IHNC both located in the lower 9th ward neighborhood;

- Damage to 4 floodgates, floodwall, and minor levee damages from Bienvenue Control Structure to GIWW lock; and
- Intermittent minor scour along the other portions of the levee and floodwall protection

#### *St. Bernard Parish*

The St. Bernard Parish hurricane protection system includes the levee/floodwall extending from the Bayou Bienvenue Control Structure, continuing along the Mississippi River Gulf Outlet (MRGO) southeastly, then turns generally to the west, where it ties into the Mississippi River Levee at Caernarvon. There is a total of 25 miles of levees in the Parish. Eight miles of hurricane protection levees were damaged. The most severely damaged levees are along the reach adjacent to the MRGO extending from the Bayou Bienvenue Control Structure to Verret. There was also scour on the Verret to Caernarvon levee and damage to the Bayou Dupre Control Structure, the Bayou Bienvenue Control Structure, and the Creedmore Structure.

#### *Plaquemines Parish*

The Plaquemines Parish Basin includes long, narrow strips of protected land on both sides of the Mississippi River between New Orleans and the Gulf of Mexico. The Mississippi River Levees (MRL) protect the Parish from floods coming down the river; protection from hurricane-induced tidal surges is achieved by the New Orleans to Venice (NOV) hurricane protection system. The NOV is a system of levees on the gulf side of the protected lands and additional berms and floodwalls on top of the MRL along the river. The distance between the gulf-side levees (back levees), and the MRL is less than a mile in most places. Altogether the Plaquemines Parish MRL and NOV systems include 162 miles of levee and 7 miles of floodwall. There are fifteen non-federal pump stations for interior drainage. All of the levees in Plaquemines Parish sustained damage from Hurricanes Katrina and Rita. There was considerable crown and slope scour along the total length. The MRL slope pavement sustained damage from the hundreds of ships and barges that crashed upon it. There were also several distinct locations of severe damage, coinciding with pipeline crossings through the levee and with some floodwall sections. Five of the 6 miles of NOV floodwall along the Mississippi River was damaged beyond repair. There were major breaches at sheet pile wing walls at two pump stations in the back levee. A major breach occurred at the Shell pipeline crossing near Nairn and the West Pointe a la Hache pipeline crossing was severely damaged. Wind and water damage from Katrina and Rita severely impacted nearly every structure within the east bank area of protection and on the west bank below Myrtle Grove (50 miles above Venice).

#### AUTHORIZED AND FUNDED EFFORTS

Repair: The Corps of Engineers is well on its way to accomplishing the initial goal of repairing the damaged portions of the hurricane protection system by the start of the next hurricane season. The Corps has awarded 59 reconstruction contracts and is committed to completing the \$798 million reconstruction of the hurricane protection system to pre-Katrina levels by June 1. Information gained through an Interagency Performance Evaluation Task Force (IPET) and various independent review panels is informing decisions on the repair of the existing authorized structures, including the replacement of damaged I-walls with L- or T-walls or with levee enlargements. The flood walls that failed are being replaced with new designs that use deeper sheet piles and are anchored with H-piles driven up to 80 feet into the ground. Only soil that meets the specifications is being used to rebuild the levees. Extensive on-site inspections, sampling and laboratory testing is performed to ensure only quality materials are being used. High quality clay soils from as far away as Mississippi are being brought in to ensure the levees are better and stronger.

#### *Lake Pontchartrain and Vicinity Project*

In Orleans East Bank, 17 separate construction projects have been completed or are underway to repair the damaged areas and to restore flood protection to pre-hurricane Katrina conditions. These projects represent an estimated \$182.3 million in construction contracts. Work on the breaches is proceeding as scheduled. An analysis by the IPET has shown that the 17th Street canal levees and floodwalls will not perform reliably without major reconstruction and strengthening. Better protection at all three outfall canals will be provided by closing off the mouths of interior drainage canals at Lake Pontchartrain and replacing damaged I-walls with T-walls. The outfall canal closure plan includes installation of temporary gates and pumps by June, until a more permanent solution is authorized, funded and can be constructed. The temporary gates can be opened and closed to protect the canals from

storm-induced surges from Lake Pontchartrain. During most storm events, the gates will remain open and the existing pumps will be operated as intended to evacuate rainwater. The corps is working with local officials to optimize pumping capability when the gates are closed. The schedule for the temporary structures is very compressed. Contractors are using innovative construction techniques to deliver. Work along the Industrial Canal in Orleans Parish is progressing on schedule.

In New Orleans East, 13 separate construction projects have been completed or are underway. These projects represent an estimated \$66.8 million in construction contracts. Repairs for most of the structures in the area are on schedule. There is a delay in the floodwall repairs at Pump Station No. 15, but materials have been delivered and work is progressing. Modifications to the Citrus Back Levee are slightly delayed, but the contractor has an excellent history of meeting its schedule. Modifications to the floodgate at the CSX (L&N) Tracks are slightly delayed due to negotiations with the railroad. These negotiations have now been completed and a revised schedule is being developed.

In St. Bernard Basin, which includes St. Bernard Parish and the Lower 9th Ward of Orleans Parish, 9 separate construction projects have been completed or are underway. These projects represent an estimated \$69.3 million in construction contracts. Levee repairs are all on schedule. Work on both control structures is slightly behind schedule, but the schedule is being managed and the projects will be completed on time.

*New Orleans to Venice*

For the New Orleans to Venice project located in Plaquemines Parish, 20 separate construction projects have been completed or are underway. These projects represent an estimated \$114.5 million in construction contracts. Half of these projects have been completed, including all of the MRL repairs. Recent completion of the Port Sulphur to Fort Jackson MRL repairs has provided full access for levee four enlargement projects that were previously delayed. These are areas where the New Orleans to Venice Hurricane Protection Project consists of additional berms and floodwalls on top of the MRL levees.

*Restoration of undamaged and subsided areas; Completion of un-constructed portions of authorized projects*

The corps continues to conduct both surface and subsurface inspections of the remaining 181 miles of the New Orleans-area levee system that was not visibly damaged by last year's hurricanes, and is thoroughly inspecting all of the I-walls that were not damaged. By September 2007, the Corps plans to restore undamaged but subsided areas of the hurricane protection system to its authorized elevation. They will also complete un-constructed yet authorized portions of the New Orleans to Venice, West Bank and Vicinity, Lake Pontchartrain and Vicinity, Grand Isle, and Larose to Golden Meadow hurricane protection projects and the Southeast Louisiana interior flood damage reduction project.

In addition, we are re-assessing the reliability of all of the floodwalls in the system based on the findings of the IPET. These findings identified a failure mechanism that was not taken into account during design. If the proposed improvements that were described by

Statement of Daniel H. Hitchings, PE, Regional Business Director, Mississippi Valley Division, U.S. Army Corps of Engineers

Mr. Woodley in his testimony are implemented, the length of floodwalls in the system will be reduced by about 20 miles. However, there are 36 miles of floodwalls that will remain in the system. Reevaluation may reveal that replacement or reinforcement of all or part of this length may be necessary.

This concludes my statement. Again, I appreciate the opportunity to testify today. I would be pleased to answer any questions you may have.

RESPONSES BY DANIEL H. HITCHINGS TO ADDITIONAL QUESTIONS FROM  
SENATOR JEFFERDS

*Question 1a.* Can you describe the condition of the levees in New Orleans in terms of tree growth prior to Hurricane Katrina?

Response. Prior to Katrina, the great majority of Federal levees in the New Orleans area were free of trees within the levee footprint. However, there were some reaches of the hurricane protection system where trees were located in, or immediately adjacent to, the levees. This was particularly evident along the levees and floodwalls located on the outfall canals in New Orleans where the Federal hurricane protection project was implemented on top of local levees in densely populated corridors with limited rights-of-way.

Corps policy prohibits tree growth that adversely affects the integrity of levees and floodwalls. However, corps guidance and national environmental policy also recognizes the esthetic and environmental value of trees and requires that acquisition of rights-of-way and the clearance of trees be kept to the minimum necessary for implementation of the project. Our post-Katrina review has identified inconsistent application of these policies, a problem that we are now addressing.

*Question 1b.* What impact would a large root ball inside of a levee/floodwall have on the stability of the system?

Response. Trees located on, or adjacent to, a levee or floodwall pose risks to the integrity of the system by providing a pathway for water to work its way into the levees. An overturned tree within the vicinity of project features could lead to instability of the flood protection by removing large amounts of soil from the levee as well as opening the way for a sliding failure or piping of water. In addition, large overturned trees could fall on and damage floodwalls.

*Question 1c.* Were there any reports of tree removals in the time period immediately preceding Hurricane Katrina?

Response. We are not aware of any such reports. However, it should be noted that the corps relies upon the local levee districts for operation and maintenance oversight of the project.

*Question 1d.* What would the normal corps process be should such a report be received?

Response. Our procedure would be to consult with the local project sponsor who has primary responsibility for operation and maintenance of the project to determine what actions, if any, were needed to address tree removals.

*Question 2.* Can you describe the Army Corps protocols for tree removal, including which trees are cut down, which trees are removed by the roots and how levee stability is insured when a large root ball is removed?

Response. In the interest of repair and rehabilitation of the Lake Pontchartrain, Louisiana, and Vicinity, Hurricane Protection project, we have developed a two-phase approach to the removal of trees that endanger our floodwalls and levees. During the first phase, only trees within the levee section or immediately adjacent to floodwalls will be cut. These trees will be cut 4½ feet above the ground with the tree stumps and roots to be removed after the current hurricane season has ended. The resulting holes will be backfilled with clay material and compacted to ensure the integrity of the levee.

The second phase of the tree removal program will broaden the tree removal zone. We are currently reviewing our criteria for root-free and woody vegetation-free zones adjacent to levees and floodwalls. Changes in the criteria may result in the need to acquire additional rights-of-way.

*Question 3.* Do you anticipate large numbers of levee reconstruction projects after tree removal in New Orleans is completed?

Response. As described in response to question No. 2, the portions of levee sections that are impacted by the removal of trees will be immediately repaired to restore their structural integrity. We have developed initial estimates of trees requiring removal in phase I but are still developing estimates for the extent of tree removal and needed repairs for phase 2.

*Question 4.* Can you clarify your understanding of why splash guards were not included in the original design of the New Orleans levee system at some or all locations?

Response. The flood protection project was designed to protect against a certain storm event. Consideration was not given to protecting the project features against larger storms.

*Question 5.* Can you describe what actions would need to be taken if a levee is armored today, and, in the future, it is determined that a levee raise would be necessary?

Response. If the product selected to armor can be salvaged, it would. We have not completed our construction, economic, and reuse analyses on these products. ERDC recently completed Phase I of a two phase report. Phase I provided an initial evaluation of armoring and protection alternatives that are appropriate. Phase II will be initiated in July 2006 and will expand the range of alternatives and will engage manufacturers and eminent engineers and scientists.

*Question 6.* What is the role of natural wetlands and coastal restoration in your vision for the long-term hurricane protection system in southern Louisiana?

Response. Coastal wetlands are an integral part of a viable coast that serves multiple purposes. One of the primary benefits of a viable, sustainable coast is that it provides the first line of defense against hurricane storm surges. Coastal restoration

features contribute to the overall hurricane protection system by providing storm surge reduction, levee protection buffers, wind shields, and long term operations and maintenance cost reductions.

STATEMENT OF HON. WILLIAM CLIFFORD SMITH, MEMBER, MISSISSIPPI RIVER  
COMMISSION, CIVIL WORKS, U.S. ARMY CORPS OF ENGINEERS

Good morning Senators and staff. Thank you for holding this hearing.

When I read the official notice for this meeting, I understand that its purpose is to oversee the ongoing rebuilding and restoration efforts of hurricane and flood protection by the Corps of Engineers in preparation for the 2006 hurricane season in Louisiana and to examine taking a comprehensive approach to hurricane protection.

Since you are overseeing the ongoing rebuilding and restoration efforts of hurricane and flood protection by the Corps of Engineers in preparation for next years hurricane season in Louisiana", I am here to respectfully inform you that there is no effort being expended to protect the approximately 150,000 citizens and the Nation's economic engine in Terrebonne Parish, which suffered greater flooding from Hurricane Rita than it has ever suffered in my lifetime of 71 years. Over ten thousand homes were flooded by Rita, which made landfall approximately one hundred and fifty miles to the west of Terrebonne.

I am very pleased that you want to investigate a "comprehensive approach to hurricane protection", but I am frustrated and confused. I am here to tell you that a comprehensive approach is not only desirable, but is necessary for the survival of our coast and its economy, communities and culture. A pro-active approach to avoiding the type of destruction and devastation experienced through Hurricanes Katrina and Rita is long overdue.

We, in Terrebonne Parish, have been working on just such an approach for our region for over 15 years (that's right...15 YEARS). The obsolete and frustrating authorization, appropriating and N.E.P.A. permitting processes that have evolved in this country, and the timing issues that are associated with them, present almost insurmountable barriers to resolving the complicated problems associated with implementing any comprehensive hurricane protection system.

Fifteen years ago, in conjunction with the State of Louisiana and the Corps of Engineers, we began to develop a hurricane protection system for Terrebonne Parish. The State, our local Government, and the Corps of Engineers, completed a feasibility study in 2002 which cost over \$10 million, of which 50 percent was paid by local interests. It was approved by the Chief of Engineers. This project, known as the Morganza to the Gulf Hurricane Protection Plan, has a positive cost benefit ratio, but has been waiting for Congressional authorization since 2002. As you all know, no Water Resource Development Act (W.R.D.A.) has passed the Congress since 2000, and this project has been in every proposed version since that time.

The local citizens have been taxing themselves for the last four years to raise the local share with the state in the event that a federal project is ever authorized and funded. As a matter of fact, with local and state funds and no Federal help we have just begun building a \$17 million segment of the project in accordance with the feasibility report and with the hope of ultimately receiving credit on a Federal project. This project will provide Category 3 protection for approximately 200,000 citizens in Terrebonne and Lafourche Parishes and approximately \$8 billion of public and private infrastructure, if and when it is ever built...and if we don't completely wash away before we get assistance from the Federal Government.

During the past 6 months, when someone asks me how I am doing, I tell them I am confused. I know that I am blessed because the greatest natural disaster to hit America, Hurricane Katrina, was to the east of where I live. Even though the wind blew out of the north at 100 MPH, we received minimal damage and inconvenience, being without electricity for only 5 days. Within 30 days, Hurricane Rita hit southwest Louisiana, and the wind blew 40 MPH out of the south; we had more water in my parish than I have ever seen. Thankfully, my home and my business and investments had minimal damage so, again, I was blessed.

Because we live so close to the disaster areas, especially the oil and gas operations in the Gulf of Mexico that were devastated by Katrina and Rita, my community's economy is the most prosperous that I have ever observed. A year ago, I would have told you that Terrebonne Parish was benefiting from an economic boom second to none. Now, the economy is a spike on what we had. We have less than a 4 percent unemployment rate, a 10 percent increase in population over the last 10 years, and at least a 15 percent increase in population over the last 6 months. We have a sales tax increase of over 15 percent per year, with over a 30 percent increase being reflected over the last six months. All of this is because the oil and gas companies are doing everything possible to get back in production because of the demand and

prices for their products. We are blessed to be benefiting from circumstances not under our control.

However, as a Civil Engineer and Land Surveyor who has lived near the water in this coastal area all my life, I am depressed because I see my coastline washing away into the Gulf of Mexico. I believe if a storm of 100 MPH wind hit my community from the south, there could be 10 to 15 feet of water in the vicinity of Houma. During my lifetime, over 400,000 acres of land have been lost between my community and the Gulf of Mexico. The buffer that protected my community from hurricanes for over 200 years is eroding. One of the most productive estuary areas in the world is being lost as I speak to you. It has been documented that 25 square miles of coastal Louisiana is being destroyed by erosion, subsidence, or sea level rise each and every year. The estimate is that we lost 100 to 125 square miles of the Louisiana coast during Hurricanes Rita and Katrina. This depresses me, and it should depress you.

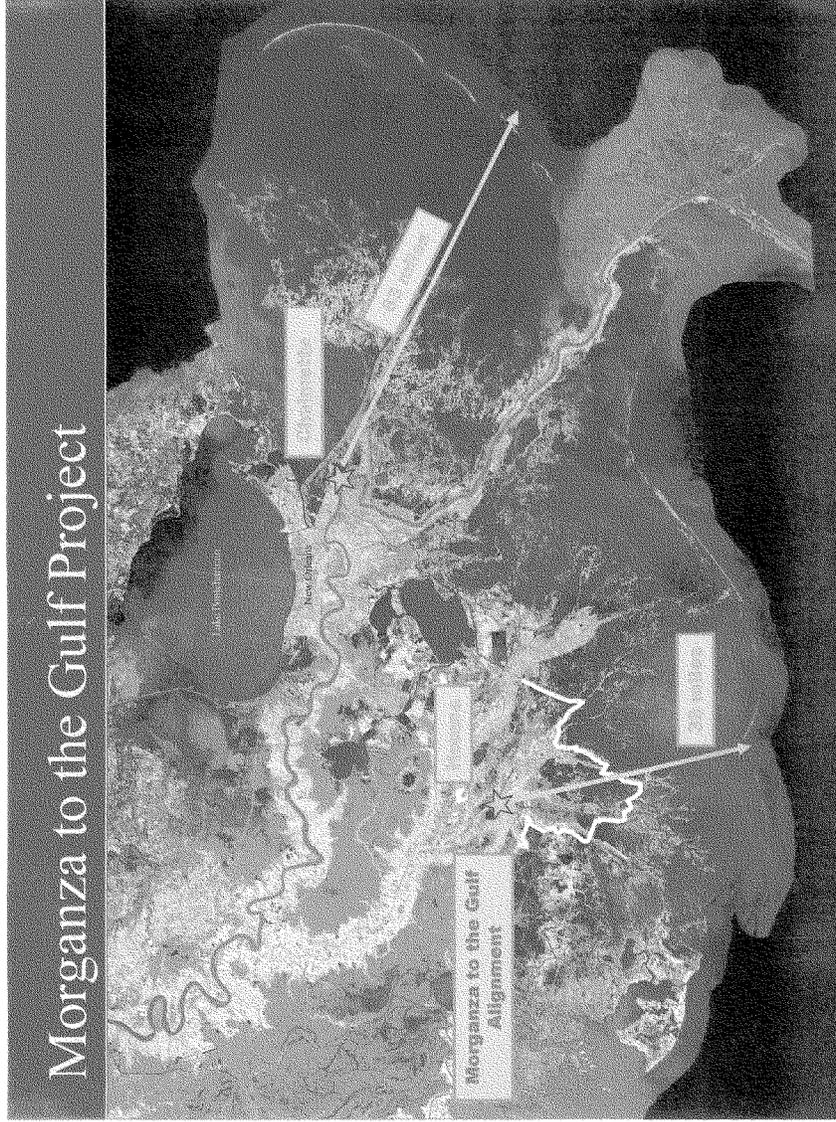
I tell everyone in my community to go look at Chalmette and St. Bernard Parish. Chalmette is about 20 miles further inland from the Gulf than my community of Houma, as shown on the attached sketch. Chalmette had two levees protecting them, and they both were overtopped. In my community, we have none. I believe it is just a matter of time before my community experiences the fate of Chalmette and St. Bernard Parish.

I also am depressed when I hear all the effort and discussion in the New Orleans area and vicinity concerning protection from a Category 3 or Category 5 hurricane. Where I live, we have a Category 0 protection. Over the years my parish used local funds to construct drainage and tidal protection levees and pump stations to handle our deteriorating drainage problems caused by coastal erosion and 60 inches of annual rainfall. The levees protected areas that were flooded many times by previous hurricanes and tropical events, but they were destroyed by Rita. Again, using local funds, we are frantically attempting to rebuild some of our levees and drainage systems before the June 1st hurricane season. It is depressing because what we are building is not hurricane protection.

As drastically as we need this project and as horrible as the hurricanes were last year, one good thing that resulted is the recognition that the wetlands and estuary area are, in and of themselves, significant hurricane protection systems that must be restored and rebuilt. This is surely the case, particularly in my area, because our wetlands have historically protected not only my parish but much of Lafourche, St. Charles, Jefferson, and Orleans, in addition to being the most productive estuary on earth. I believe, as a civilian member of the Mississippi River Commission, this restoration of our wetlands can be accomplished by managing the resources of the Mississippi River and its tributaries so that the fresh water, silt, and nutrients of the river can be utilized under controlled conditions to re-establish the wetlands.

The survival of our area depends upon you. Please authorize and fund the Morganza to the Gulf Hurricane Protection Project and the Louisiana Coastal Area Project for the restoration of the nation's great coastal area.

Thank you for your time.



## STATEMENT OF BENNY ROUSSELLE, PRESIDENT, PLAQUEMINES PARISH GOVERNMENT

Thank you, Chairman and Members of the Committee.

I am Benny Rousselle and I represent the people of Plaquemines Parish, a relatively small community located on the Gulf Coast of Louisiana, south of New Orleans.

Plaquemines Parish is small in size and population, yet it provides multi-million dollar revenues for North America. The parish's oil, gas and fishery industries provide an economic impact for not only Louisiana but for the entire United States. The Naval Air Station—Joint Reserve Base, representing all five branches of the U.S. Armed Forces and the U.S. Coast Guard is located in Plaquemines Parish.

Two prominent scientific research centers are located in Plaquemines Parish. Tulane University's F. Edward Hebert Research Center focuses on environmental, biological and medical research activities. The Louisiana State University's Citrus Research Station obtains produce research data on citrus, vegetables and small fruit.

Plaquemines Parish is also the home of the Conoco Phillips Alliance Refinery, one of the last grassroots refineries built in the United States. The refinery processes crude oil and receives domestic crude oil by pipeline and international crudes via the Louisiana Offshore Oil Port. Approximately 600 employees and contractors operate and maintain the refinery. The refinery started operations in 1971 and remains one of the country's most efficient and modern refineries.

The Chevron Oronite Oak Point Plant in Plaquemines Parish is one of the largest and most advanced producers of high-quality blended fuel and lubricant additives in the world. The plant occupies 100 acres in the parish and has more than 410 employees. More than 30 unique additive components and intermediates are manufactured at the plant and more than 300 packages are blended at the site for customer requirements.

Southeast Louisiana is a major oil and gas-producing region, with an energy industry that accounts for \$93 billion in revenue to the Louisiana economy and the employment of more than 62,000 people. In 2001, Plaquemines Parish produced more than 21 million barrels of crude oil from more than 23,000 wells,—more than any other parish in the State. In addition, Plaquemines Parish also produced more than 146 million cubic feet of natural gas.

The mouth of the Mississippi River is in Plaquemines Parish. Through this gateway to the Mississippi River Valley passes 92 percent of the Nation's agricultural exports, as well as coal, petroleum products, iron and steel, rubber and chemicals.

The mouth of the Mississippi River is served by five ports—including the Ports of Plaquemines, St. Bernard, New Orleans, South Louisiana and Baton Rouge. These ports handle a significant portion of the Nation's cargo. In fact, annual U.S. tonnage reports consistently rank the Port of South Louisiana FIRST in tonnage shipped, while the ports of New Orleans and Baton Rouge rank fourth and sixth. The ports also serve as America's cargo gateway to Latin America and, with the potential opening of the Seapoint facility, they are expected to become critical to our trade with China.

The parish of Plaquemines jutting out into the Gulf of Mexico was the first to be hit by Hurricane Katrina. Just a few short weeks afterward it received the backlash of Hurricane Rita. In both instances, Plaquemines Parish was inundated by waters that flooded and washed away practically all businesses, homes and structures on the east bank and southernmost points. Our only protection was levees, both Federal and non-Federal, that suffered tremendous soil loss and in some instances, collapsed.

Unlike other parishes that need levee protection in some areas of their parish, Plaquemines is bordered by levees on all sides. We rely heavily on our levees year round for daily protection. We have been dependent on the Corps of Engineers to provide us with protection for our Federal levees. However, Plaquemines Parish has allotted substantial local dollars for Federal and non-Federal levees. This does not include the time and labor spent by employees to maintain both the federal and non-Federal levees. In order to provide adequate levee protection of Plaquemines Parish we must have all of our levees funded under a Federal system.

However, levee systems are not and cannot be the lone solution. There must be a move to restore America's wetlands. They are an important part of our economy, our culture and our environment.

Louisiana boasts the Nation's largest shrimp fishery and second-largest commercial fishing industry (second only to Alaska). Some of the largest commercial fishing ports in the country are in the Southeast Louisiana corridor. Fishermen working out of these ports land between 350 million and 495 million pounds of saltwater fish

each year and about 22 million pounds of freshwater fish the largest freshwater harvest in the Nation.

The wetlands surrounding Plaquemines Parish are the spawning grounds and nurseries for much of the Nation's most desirable seafood: shrimp, oysters, crab, catfish and red drum. Without wetlands protection and restoration, the Louisiana seafood industry and the Nation's seafood populations are vulnerable.

Parts of Plaquemines Parish are designated as essential habitat for brown shrimp, white shrimp, and red drum by the Gulf of Mexico fishery Management Council. America's wetlands also provide natural flood control, natural hurricane protection and natural filtration systems to protect water quality. In fact, America's wetlands located in Louisiana have been called "the hardest-working," "the most productive" and "the greatest wetlands on earth." But these wetlands are disappearing at the rate of 40 square miles a year. That's 80 percent of the Nation's total coastal wetland loss occurring in the Nation's most important and productive wetlands. Without protection, these wetlands are not only vulnerable. . . they're gone.

The southern portion of Plaquemines Parish and its east bank population now stands at 10 percent pre-Katrina numbers. Our residents and businesses are waiting for adequate levee protection and coastal restoration. Plaquemines Parish is not a heavily populated area. Louisiana, in general, is not a heavily populated State. But consider this: these small numbers of people make up nearly 100 percent of the workers in the Nation's second-largest seafood industry. And comprise the workforce of one of the Nation's most important oil and gas-producing regions. They service three of the nation's busiest ports and form a unique and priceless part of America's cultural heritage.

Today I am asking that you invest in the maintenance of all levee systems in Plaquemines Parish. I am also asking you to invest and dedicate funding to our wetlands and nature's hurricane protection system.

We respectfully request that you don't turn your back on the levees and the vanishing wetlands of our parish and State. These levees and wetlands present a priceless opportunity to act locally to reap enormous global benefits. Without protection, we're all vulnerable.

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RESPONSE BY BENNY ROUSSELLE TO AN ADDITIONAL QUESTION FROM  
SENATOR JEFFORDS

*Question.* I understand that the corps had plans to meet with you and others in Plaquemines Parish to determine what some options might be for a hurricane protection system that could involve concepts such as maximum protection for population and economic centers coupled with a protected hurricane evaluation route. Can you provide an update on what discussions have occurred, and what your opinion is of the concept I described here for hurricane protection in Plaquemines Parish?

*Response.* I have met with the corps on two separate occasions. I am currently waiting for a third meeting to learn what their final recommendation will be. I agree that we need a comprehensive plan that combines restoration of the barrier islands and maximum levee protection to best serve our area.

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STATEMENT OF TIMOTHY P. KERNER, MAYOR, TOWN OF JEAN LAFITTE AND VICE  
PRESIDENT, WEST JEFFERSON LEVEE DISTRICT, JEFFERSON PARISH, LA

Good morning, my name is Timothy Kerner, Mayor of the Town of Jean Lafitte and Vice-President of the West Jefferson Levee District. I am here to speak on behalf of the citizens of Jefferson Parish.

Hurricane Katrina made landfall on August 29, 2005 causing tremendous flooding damage over large portions of southeastern Louisiana. The event focused great attention on its impact upon the flood protection systems throughout the area.

However, Hurricane Katrina was not the only catastrophe to hit southeastern Louisiana. In late September of 2005, Hurricane Rita while on a path to making landfall near the Louisiana/Texas border brought catastrophic tidal inundation to the communities of Crown Point, Lafitte, and Barataria as it passed south of Jefferson Parish, LA.

The flooding overtopped and in some instances destroyed existing levee systems that heretofore had provided a limited level of flood protection in these areas. Because of the extent of damage, the rehabilitation of these levee systems is beyond the financial capability of the West Jefferson Levee District. As such, we are requesting your review of and subsequent approval for funding the repair of those

damaged levee systems and for the construction of new levees as may be needed to protect the citizens of lower Jefferson Parish.

We understand that the repair and construction of levee systems, both Federal and non-Federal, located in other communities in and around the New Orleans metropolitan area that were damaged or destroyed by Hurricane Katrina have been included in Congressional appropriations to the U.S. Army Corps of Engineers. In earlier supplemental appropriation legislation the non-Federal levees located in the parishes of St. Bernard and Plaquemines were addressed, and we understand that in the most recent supplemental appropriations bill that just passed the Senate Committee, non-Federal levees in Terrebonne Parish have also been addressed. Unfortunately, damage to non-Federal levees in Jefferson Parish from Hurricane Rita have not been addressed leaving to local governmental entities, with limited resources, the sole responsibility for these levees.

Prior to the recent area-wide devastation caused by the passages of Hurricane Katrina and Hurricane Rita, some efforts on the Federal level had been initiated. After being contacted for assistance by Jefferson Parish officials, the West Jefferson Levee District, and the Mayor of the Town of Jean Lafitte, Louisiana, the U.S. Army Corps of Engineers, as part of their Continuing Authorities Program, was already in the process of addressing tidal flood protection at several of the Crown Point, Lafitte, and Barataria sites.

In each case the corps is limited to spending a maximum of \$7 million per project with a 65 percent Federal and 35 percent non-Federal cost share requirement. As each of the below listed projects will far exceed that limit, we are requesting legislation to increase the Federal funding limit and to reduce the non-Federal cost share percentage.

Existing studies:

- (1) Crown Point Basin Flood Protection
- (2) Rosethorn Basin Flood Protection
- (3) Lafitte, Fisher School Basin Flood Protection
- (4) Paillet Basin Flood Protection
- (5) Goose Bayou Basin Flood Protection

New and requested construction:

Recent events demonstrated that completion of the above mentioned projects would have prevented serious flooding in the areas that would have been served by the projects. However, evacuation was stopped due to high water across the roadway between the project locations. As such, we are requesting that projects be authorized sufficient to connect the proposed construction sites. To assure construction of the roadway evacuation routes, the cost to benefit ratio of 1:1 must be waived for the following projects.

- (6) Lower Lafitte Basin Flood Protection
- (7) Lower Barataria Basin
- (8) Jones Point Basin
- (9) Lower Highway 45 Evacuation Route
- (10) Upper Highway 45 Evacuation Route

To assure sufficient action, legislation authorizing a larger Federal participation must be enacted by the Congress. To assist in that process we have included suggested language as an attachment to my testimony.

Unfortunately, even the sites included in the Federal studies and authorized construction projects do not qualify under Federal legislation enacted for recovery from Hurricane Katrina.

For this reason we are looking to the U.S. Congress for assistance in the repair of damaged levees and for assistance in funding the construction of new levees needed to provide safe corridors of evacuation when needed to protect our citizens in future flooding events such as recently experienced from Hurricanes Katrina and Rita.

As Mayor of the Town of Jean Lafitte I am critically interested in providing flood protection for all of the citizens living and working in the communities of Lafitte, Barataria, and Crown Point; but, I am also Vice-President of the West Jefferson Levee District so I am also concerned that those citizens living and working within the project boundaries of the West Bank Hurricane Protection Project receive the maximum flood protection benefit of this project.

When first authorized by congress in 1986 we were told by the U.S. Army Corps of Engineers that this project would provide flood protection against the Standard Project Hurricane, generally assumed to be a level of flood protection against a storm that might occur once in 300 to 500 years. Recent news releases have advised that the West Bank Project after constructed to its authorized elevation will not even provide flood protection to the 100 year level. To say that we were shocked by that information would be an understatement.

At this time, the 250,000 citizens of the west bank of Jefferson Parish, Algiers in Orleans Parish, and Belle Chasse, in Plaquemines Parish who are all relying on this project do not even receive the benefit of a completed system. Approximately 20 miles of a total project length of 64 miles has not yet been constructed. While we have been advised that the corps now has funding sufficient to accelerate completion of the project, we are told, that won't happen for at least 2 years. Even when finished, based on the new information, the project will still not provide the level of flood protection originally promised and authorized.

The third supplemental appropriation legislation recently passed by Congress provided funding sufficient to accelerate the completion of the project no later than September 2007. That legislation mandated 100 percent of the cost of that construction to be borne by the U.S. Army Corps of Engineers. Unfortunately, we are told by the corps that the legislation mandated that they assume all land acquisition duties, previously the responsibility of the non-Federal sponsor. As such, we are concerned, based upon our interaction with the Corps since Hurricane Katrina, that the corps' procedures will significantly delay the start of project construction.

The solution to that problem is for the West Jefferson Levee District to continue to provide the land acquisition services. However, we are told by the corps that legislation is required to direct the corps to allow the non-Federal sponsor to continue its land acquisition activities and to authorize it to reimburse the non-Federal sponsor (West Jefferson Levee District) for the cost of this responsibility.

A press release by the corps recently advised that the West Bank project, although authorized by Congress to be constructed to the level of the Standard Project Hurricane (300- to 500-year frequency) did not now meet the new FEMA criterion for the 100-year frequency storm.

Additional language, and funding, will be required directing the corps to construct the project sufficient to provide at least the FEMA 100-year flood protection, or better.

Since its construction, the corps has continually been responsible for the operation and maintenance of the levees adjacent to the Algiers Canal, of the Gulf Intra-coastal Water Way. The agreement for hurricane protection for the West Bank required non-Federal interests to assume the operation and maintenance responsibility for these levees after they were raised 2-feet. This requirement is onerous and should be eliminated. Language was put into previous WRDA legislation to handle this problem, but after the bill was passed by Congress, the corps took the position that the language was flawed and therefore unenforceable.

In closing, let me finish by saying that the people of south Louisiana in general, and in particular Jefferson Parish, have a long history of providing many of the goods and services needed by the rest of our country. We have worked hard to provide much of the seafood, including fish, oysters, shrimp, and crawfish that is enjoyed by many throughout this great country. Our people toil, and our infrastructure supports the oil industry that helps fuel the automobiles, heat the homes, and power the industry that the rest of the country has come to rely on for their comfort and livelihood. The rivers, bayous, and channels that cut through our communities and allow the commerce of the country to flow smoothly to the many ports and locations throughout the nation, also bring the flood waters that have so devastated our homes and have given us great concern for the future.

#### LEGISLATION NEEDED FOR THE WEST BANK HURRICANE PROTECTION PROJECT

1. Amend Section 328 of the Water Resource and Development Act of 1999 By striking "operation and maintenance" and inserting "operation, maintenance, repair, replacement and rehabilitation"; and By striking "Algiers Channel" and inserting "Algiers Lock and Canal Project Levees, including any enlargements, additions or structural improvements constructed upon the said Algiers Lock and Canal Project Levees as part of the West Bank and Vicinity, New Orleans, LA, Hurricane Protection Project."

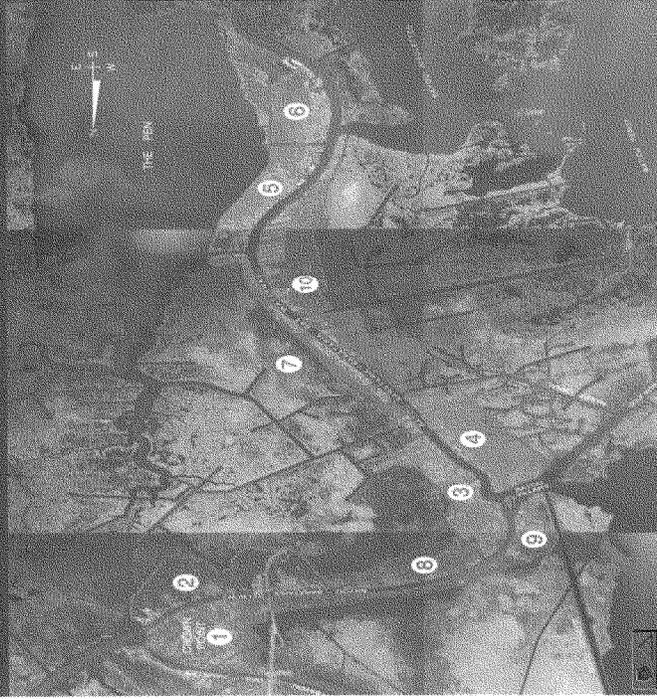
2. Legislation is required to direct the corps to allow the non-Federal sponsor to continue its land acquisition activities and to reimburse the non-Federal sponsor (West Jefferson Levee District) for the cost of this responsibility.

3. Additional language, and funding, will be required directing the Corps to construct the project sufficient to meet at least the FEMA 100-year flood declaration, or better.



# TIDAL FLOOD CONTROL PROTECTION

## LAFITTE AREA



1. CROWN POINT BASIN
2. ROSETHORN BASIN
3. FISHER BASIN
4. PAILET BASIN
5. GOOSE BAYOU BASIN
6. LOWER LAFITTE BASIN
7. EVACUATION AREA
8. EVACUATION AREA
9. JONES POINT BASIN
10. LOWER BARATARIA BASIN

STATEMENT OF MARK C. DRENNEN, PRESIDENT AND CEO, GREATER  
NEW ORLEANS, INC.

In October 2005, the Southeast Louisiana Business Coalition, a group of business leaders from GNO, Inc., Downtown Development District, Jefferson Chamber of Commerce, New Orleans Chamber of Commerce, River Region Chamber of Commerce, Slidell Chamber of Commerce, St. Bernard Chamber of Commerce, West St. Tammany Chamber of Commerce, U.S. Chamber of Commerce and Louis Armstrong International Airport, all representing thousands of small, medium and large employers from the hardest hit areas of the New Orleans region united for three primary purposes:

- to educate congress and Federal agencies as to the vital pre-Katrina national economic impact of the Southeast Louisiana region
- to alert congress and Federal agencies about the severity of the devastation to the regional economy
- to propose a post-Katrina congressional relief package.

Critical to our message were some startling facts and figures.

To date:

- 80,000 businesses have been disrupted by the hurricane and are in severe risk of failure.
- 438,000 new claims for unemployment have been filed since Hurricane Katrina.
- The State of Louisiana anticipates \$1 Billion in lost revenue for Fiscal Year 2005/06.
- 200,000 homes have been substantially damaged.
- basic infrastructure necessary for economic recovery, including schools, hospitals, colleges and roads have been severely damaged or destroyed.
- Tax bases for governmental operations have been lost.

The Southeast Louisiana Business Coalition representing businesses from a variety of sectors, such as banking, law, information technology and telecommunications, and engineering requested critically needed help through appropriations requests, an economic stimulus package and a call for a federally appointed figure to direct recovery efforts.

Appropriations requests include:

- (Our top regional priority)—essential infrastructure help on an aggressive schedule to rebuild the levees to real Category 3 strength to provide disaster mitigation, structural stability, and psychological reassurance for businesses and residents to return to the area.

In addition, we respectfully request long term funding to implement plans developed by the Corp of Engineers and other experts to protect the area from a Category 5 hurricane.

- (Our second regional priority)—the allocation of 25 percent to 50 percent of revenues derived from Louisiana offshore mineral production to implement our already developed coastal restoration plan. A significant contributor to the devastation caused by Katrina was the previous loss of much of our coastal wetlands, which are also vital to the national economy.

- a grant program to provide vital immediate cash for businesses, similar to the recovery grants provided to Manhattan businesses, by Congress, following the September 11th disaster.

- low interest loan programs for commercial and residential development similar to the post 9-11 plan for Manhattan.

- funding to repair damages to key infrastructure for our ports, the airport and highways.

- a comprehensive economic stimulus package authorizing various tax relief measures and incentives, including a combination of:

- Relocation Tax Credits and Employment Credits targeted at stimulating business re-entry into the market at pre-Katrina employment levels

- Accelerated Depreciation and Tax Exempt Bonds to provide an incentive for increased capital projects

- Personal Tax Relief and Tax Credits for those in the affected region in order to entice back individuals, business owners and corporate managers.

The Southeast Louisiana Business Coalition recommended that the President and Congress create a single regional board to be directed by a person of national prominence to coordinate the recovery and rebuilding efforts in Southeast Louisiana. The group believes that relief coordination must occur at the federal, state and local levels in order to maximize resources, execute effective planning, and expedite implementation for post-Katrina recovery.

We fully understand that Louisiana must take every action possible to help itself. With this in mind, our local Governments are proceeding with the development of action plans for recovery of their respective areas. Parish presidents and mayors are including business leaders in their recovery plans. Outside expertise from national groups such as the International Economic Development Council (IEDC), the U.S. Chamber of Commerce and American Institute of Architects (AIA) are actively involved. Governor Blanco convened special session of the Louisiana legislature to address budget issues and State incentive programs as well as convened the Louisiana Recovery Authority to coordinate the State efforts.

We have convened a regional housing task force group to devise short and long-term solutions to this severe problem. Without housing for our citizens, we will be unable to provide a workforce to re-open our businesses. As recommendations are developed, we will share them with Congress.

Almost eight (8) months have passed since the hurricane and some progress has been achieved. Congress has provided significant funding for levees and housing; Don Powell has been appointed; the GO Zone legislation is an important tool for future investment.

Our major remaining problems are the following: housing for our workers with action slowed by funding shortages and FEMA flood control maps; lack of a trained workforce; escalating insurance costs or no insurance; local governments financial hardships leading to an inability to provide basic services; and lack of funding for economic development and infrastructure like provided to NYC.

In conclusion, time is of the essence for our successful recovery. We request your thoughtful consideration of our proposed solutions. With the temporary assistance of the citizens of the United States, we will be successful.

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STATEMENT OF LEWIS E. LINK, PH.D., DIRECTOR, INTERAGENCY PERFORMANCE  
EVALUATION TASK FORCE

Mr. Chairman and distinguished members of the committee, I am Dr. Lewis E. Link, Senior Research Engineer in the Department of Civil and Environmental Engineering, University of Maryland and Project Director, Interagency Performance Evaluation Task Force. It is with great respect and appreciation that I submit this testimony concerning the activities of the Interagency Performance Evaluation Task Force, IPET. The IPET was commissioned by the Chief of the U.S. Army Corps of Engineers shortly after Hurricane Katrina devastated southeast Louisiana and southern Mississippi. The task force was charged to determine the facts concerning the performance of the southeast Louisiana hurricane protection system during Katrina, to report those facts to the public and to quickly facilitate the integration of these facts into the repair and reconstitution of the hurricane protection system.

To accomplish this mission, the IPET has assembled a broad array of national experts from federal and state agencies, academia and industry. More than 150 recognized experts from over 50 organizations comprise the IPET teams. Leadership is provided from within and external to the Corps of Engineers for each major task area. The American Society of Civil Engineers External Review Panel is providing direct peer review of IPET activities as we proceed. Also, the National Research Council Committee on New Orleans Regional Hurricane Protection Projects is providing strategic oversight and independent review of IPET work as well as information from other sources studying Katrina.

IPET information and analysis is provided to the public through a public web site (<https://IPET.wes.army.mil>) that currently provides over 3,900 documents and reports on the New Orleans Hurricane Protection System and the IPET work. This web site is also used to solicit feedback and input from the public on IPET documents and for information needed such as eye-witness accounts of when specific breaching events occurred. IPET Report 1, Performance Evaluation Plan and Interim Status, posted on the web site on January 10, 2006, provides a detailed scope of work and plan for the IPET activities. IPET Report 2, Performance Evaluation Status and Interim Results, posted on the web site on March 10, 2006, provides the most recent documentation of the IPET analyses and the emerging results. The IPET final draft report, Report 3, Performance Evaluation of the New Orleans and Vicinity Hurricane Protection System, is scheduled to be available as a final draft on June 1, 2006. Following a review of this final draft report by both the ASCE ERP and the National Academies, a final IPET report will be released in the fall of 2006.

The IPET effort has been directly tied to the efforts of Task Force Guardian, the Corps team managing the rapid repairs of the protection system, and other Corps elements. Over 20 individuals from Task Force Guardian and the New Orleans District participate in the various IPET teams, providing direct access to critical knowl-

edge and information needed for the IPET analysis. This coordination also provides a direct pipeline to transfer emerging IPET results and lessons learned immediately into the design and construction of repairs to the Hurricane Protection System. The last section of this written testimony includes a summary of the types of products IPET has provided to Task Force Guardian. It is critical that these lessons learned are incorporated immediately into the design and construction process as they are established to ensure we have the optimum repair designs to address IPET identified problems. The IPET lessons learned are also being provided to the Corps to provide a basis for future design and construction to recover the system to authorized protection levels and to complete the authorized Hurricane Protection System. The IPET results and methods will also provide a basis for Corps Headquarters efforts to review and renew engineering policy and practice as well as providing a new level of capabilities for studying future alternative protection measures for New Orleans and the vicinity. IPET results will ultimately help provide better and stronger designs for future protection projects in Louisiana and possibly other protection systems nation wide.

The following paragraphs describe the IPET efforts ongoing to answer the major questions that comprise the mission of the task force.

1. Geodetic Datum: The complex geology of southeast Louisiana provides the additional challenge of variable and relatively rapid subsidence. To accomplish the IPET analysis, it was essential to have an up-to-date geodetic and water level reference system to accurately measure the vertical elevations of all significant structures relative to local mean sea level. IPET accelerated the efforts of the Corps and National Geodetic Survey to update the local and regional reference datum using Global Positioning System, or GPS, technology. IPET also established the accurate elevations of the levees, floodwalls, pumping stations and other relevant structures to support the performance analysis. This provided an accurate reference system for all entities working on the analysis and reconstruction of the hurricane protection system. It also provided an accurate definition of the heights of the protection system structures at the time of Katrina. These revised and accurate elevations will aid future work to achieve the original authorized levels of protection or to any new levels prescribed by future policy or congressional authorizations. They will also be used by the construction industry and others in southern Louisiana for projects that rely on correct elevations relative to the local water surface.

2. Hurricane Protection System Characterization: The Hurricane Protection System is comprised of over 350 miles of levees and floodwalls. To understand the system's performance, it is necessary to understand the design criteria, the design assumptions and the "as built" characteristics of the individual structures. To accomplish this, the IPET has done a systematic examination of the documents concerning design and construction of the system to include the Standard Project Hurricane definition, the translation of the Standard Project Hurricane into surge and wave levels to develop design elevations, the fundamental design of the structures and the intent of the designers and the character of the structures as built. These results are the fundamental inputs to the performance analysis. With the exception of some systematic differences in elevations due to broad misinterpretations of local mean sea level, to date, this comprehensive review and analysis has not found any significant disparities between the fundamental designs and the as-built character of the system.

3. Storm Analysis: Katrina was a very large storm, generating perhaps the largest storm surge measured for the North American Continent and the largest waves on our continental coast measured by a NOAA buoy, approximately 55 feet. This created a hydrodynamic environment that was in some cases significantly greater than the Hurricane Protection System was designed to handle. This was particularly the case for the areas along the Mississippi River Gulf Outlet and the levees in Plaquemines Parish. The water elevations within the Inner Harbor Navigation Canal also exceeded the design levels. Coupled with the fact that many of these areas had actual levee elevations below authorized/design levels, resulted in significant overtopping of levees in these locations. Of particular significance was the fact that the waves striking the MRGO and Plaquemines levees had wave periods of up to three times the design criteria, essentially representing ocean waves, leading to much more wave run up and much more destructive force than anticipated by the original design. The IPET simulations of Katrina surge and wave levels were run on some of our Nation's most powerful supercomputers are some of the most advanced modeling efforts in engineering. These simulations resulted in a high resolution definition of the surge water levels and wave environments experienced by each section of levee or floodwall as a function of time. IPET coupled these data with the definition of the times of the breaching events, which allow determination of the specific water levels and wave forces that the individual structures experienced dur-

ing the breaching process. One of the primary lessons learned here was the need for very accurate wind information and very high resolution computer grids for accurately modeling the storm and the resulting surge and wave conditions in the vicinity of the actual structures. High water marks were used as the primary calibration for these modeling efforts.

4. Performance Analysis: The IPET performance analysis uses a combination of approaches to achieve an understanding of the most likely breaching mechanisms for the individual breach sites. The approaches include detailed field investigations, finite element or other computer simulations, conventional seepage or stability analysis, and physical modeling, both in centrifuges and a 1:50-scale hydraulic model of the 17th Street Canal. The performance analysis of the 17th Street Canal breach, as reported in IPET Report 2, provides an example of the level of detail and analysis methods used. Additional finite element analysis has been accomplished for the 17th Street site that will be released in the near future. The detailed definition of the breaching mechanism is necessary to determine the appropriate repair and reconstruction needed to make these sections more resilient in the future and to determine how to assess the integrity of similar structures that were not severely damaged by Katrina. Similar analyses are being completed for the London Avenue and Inner Harbor Navigation Canal breach sites. A separate analysis is ongoing to understand the performance of the levee sections along MRGO and Plaquemines Parish, focusing on the surge and wave levels experienced, the degree of scour and erosion experienced, the character of the materials in the levee and their placement and the true elevation of each section. These results will be documented and reported within the next month. The breaching mechanisms, and the understanding of why other similar sections did not fail, are vitally important. This information is being directly input in the assessment of the remaining sections of the Hurricane Protection System and to define the probability of different levels of performance of different component structures for the IPET risk and reliability analysis.

5. Consequences: The amount of flooding resulting from the overtopping and breaching of the system during Katrina is being modeled for each drainage area. This capability, along with the characterization of the performance of the pumping stations, provides an ability to examine other scenarios. An example of such a scenario is the extent of flooding if there had been no catastrophic breaching in the system. The losses experienced during and as a result of Katrina are being characterized on a zip code and census block basis. Economic (domestic and commercial), environmental, life and safety and historical/social losses are being characterized. This information will allow correlation of consequences to physical performance. The life and safety and economic losses are also being incorporated into the IPET risk and reliability assessment. The completed consequence products will be released in the IPET final report on June 1.

6. Risk and Reliability: A risk and reliability assessment is being accomplished to provide a system-wide examination of the relative vulnerability of the various drainage basins (polders or parishes) to flooding and losses, given the condition and character of the components of the hurricane protection system on June 1. This work incorporates both stage—frequency and stage—damage relationships that offer the opportunity to examine risk individually at the zip code or census block level or consolidated up to sub basins, basins or polders, parish or system-wide levels. It also allows examination of the impact of changing the character of the protection for a given reach, providing a means to examine how alternative approaches to protection can reduce risk. The risk information for Katrina and for the repaired system as of June 1, 2006, will be provided for the East Bank Polders in the IPET final report.

The vast bulk of the IPET analyses are expected to be completed on time and reported by June 1, 2006. The final draft of Report 3 will remain subject to revision until the final comments of the ASCE External Review Panel around July and the NRC Committee on New Orleans Regional Hurricane Protection Projects are received in September and incorporated into the report.

I appreciate the opportunity to provide this information and pledge the continued dedication of the IPET efforts to the objective analysis of the performance of the hurricane protection system. We are all working toward the common goal of applying lessons learned to the repair, reconstruction and improvement of hurricane protection in New Orleans and southeast Louisiana.

SUMMARY OF IPET PRODUCTS/SUPPORT PROVIDED TO TASK FORCE GUARDIAN AND TASK FORCE HOPE AS OF 17 APRIL 2006

a. Data Repository—25 October 2005. The IPET Data Repository was established as an entry point for collecting information pertaining to the New Orleans and

Southeast Louisiana Hurricane Protection Projects that needs to be validated as factual. This repository supports both the IPET and TFH/TFG efforts by providing a database where information can be reviewed for accuracy and quality prior to posting the information on the IPET public website.

b. Establishment of the IPET Public Website—2 November 2005. The IPET public website was established as a way to be fully transparent in effectively sharing factual information pertaining to the New Orleans and Southeast Louisiana Hurricane Protection Projects. The website provides a way to proactively communicate information that might otherwise require the public and TFG to process Freedom of Information Acts.

c. Establishment of On-Line Team Workspace using Groove—22 September 2005. To enable IPET, ERP, and members of TFH/TFG with on-line workspaces to communicate and share information virtually, Groove software and technical support was provided by IPET. Through these virtual workspaces information can be effectively and efficiently shared. Groove is a primary tool used to bring the IPET, ERP, and TFH/TFG teams together in sharing knowledge and information required to accomplish their missions.

d. Integration of the IPET Public Website and the TFH/TFG Electronic Bid Solicitation Websites—15 November 2005. As a way to more effectively enable public benefit from the historic and performance-related information on the IPET public website and the reconstruction plans and specifications on the TFH/TFG electronic bid solicitation website, electronic linkage was provided to facilitate integration of the two sites.

e. “Summary of Field Observations Relevant to Flood Protection in New Orleans, LA”—5 December 2005. This IPET review provided Task Force Guardian with a simple statement of concurrence or non-concurrence from the IPET floodwall and levee sub team and additional relevant discussion for each of the major findings in the ASCE/NSF report’s chapter eight, “Summary of Observations and Findings.” The additional discussion relates to the analysis being conducted by the IPET or others that would assist in applying the ASCE/NSF findings to the reconstruction of hurricane protection in New Orleans.

f. “Preliminary Wave and Water Level Results for Hurricane Katrina”—23 November 2005. This IPET report to TFH/TFG included observations from the IPET surge and wave sub team from a field trip and overflight of New Orleans and Southeast Louisiana.

g. “Summary of IPET Numerical Model of Hurricane Katrina Surge and Wave Plans, Approach and Methods”—19 December 2005. This PowerPoint presentation by the IPET surge and wave sub team provided TFH/TFG with an update on wave and water level results for Hurricane Katrina. Wave and water level results from fast-track simulations of upper Category 3 type storms on various storm tracks and a Standard Project Hurricane event were also provided.

h. Review of Proposal to Float In and Sink a Barge to Close Canals by June 2006—28 December 2005. The proposal included the use of existing large ship tunnel thrusters mounted on a barge with huge pumping capacities. Review determined that the closure plan does not have enough pumping capacity to match existing pumps during a hurricane. The impact of barges on levee and floodwall integrity was also examined in depth.

i. Technical Support to TFG on the Analysis and Design of the Reconstruction Plans and Specifications for the Breaches—Continuous Support as Needed. Technical support continues to be provided to TFG on an as needed basis. As a minimum, monthly face-to-face meetings take place in New Orleans. This support includes geotechnical and structural consultations. These discussions also include reviews of plans and specifications for reconstruction features such as T-walls, L-walls, I-walls, levees, and foundation investigations.

j. Evaluation of Existing and As-Built Conditions at Canals—On-going. This evaluation includes concrete and steel material properties for reinforcement and sheet piles on the I-walls, as-built length of sheet piles, surveys, and foundation material properties and boring logs.

k. Life-cycle Documentation of the Hurricane Protection System—On-going. This documentation includes a review of the design, construction, and operation and maintenance of the hurricane system.

l. Verification of Current and Reconstructed Floodwall Elevations—November 2005. Established a tidal gage in November 2005 at the 17th Street Canal to monitor current sea level relationships to the newest NAVD88 datum epoch (2004.65). Verified floodwall elevations on Lakefront outfall canals and IHNC relative to this latest tidal and vertical epoch.

m. LIDAR Ground Truthing—On-going. Currently performing ground-truthing surveys throughout the region to calibrate various LIDAR-based elevation models used by Task Force Guardian.

n. Densification of Control Benchmarks—31 December 2005. IPET has established approximately 75 vertical benchmarks throughout the region. These control points are being used for Task Force Guardian construction activities.

o. Establishment of GIS Team—2 February 2006. The “GIS Team” was established to maximize the effectiveness and efficiency of the GIS resources within IPET, Task Force Guardian, Task Force Hope, and the New Orleans District. The GIS Team consists of members from each of the four teams and provides a way to integrate efforts and share information pertaining to the HPS. The GIS Team will also provide for a way to assure a smooth transition of IPET generated GIS information to the New Orleans District upon disbanding of IPET once its performance evaluation is completed. Significant IPET data sets shared with TFG in January and February 2006 include the digital elevation models, vertical datum survey data, geotechnical data, and photographs.

p. Insight into probable cause of breaching at 17th Street Canal—Continuous ending March 2006. Information was shared with TFG on the probable cause of breaching at the 17th Street Canal. Recommendations were provided on considering the formation of a gap at the base of cantilever I-walls and shear strength variations between the centerline and inboard toe of levees used in combination with I-walls.

q. Storm Surge and Wave analysis results for Katrina and historical storms—December 2005. Information pertaining to modeled Katrina storm surge and wave heights and periods for various locations along the HPS was provided to TFG. In addition, modeled surge and wave results from other historical storms were also provided.

r. Review comments on canal closure structures—December 2005 and January 2006. IPET review comments for the outfall canal closure structures were provided to aid in development of high quality P&S for the closure structures.

s. Provided comments in IPET Report 2 regarding comparison of Hurricane Katrina wave and period conditions with design values—March 2006. Design wave conditions, particularly wave period, should be re-evaluated for the east-facing levees in east Orleans, St. Bernard and Plaquemines Parishes.

t. Closure Structures Modeling—January-February 2006. IPET members at MVN performed modeling analysis of the closure structures on 17th Street, Orleans and London Ave Canals.

u. MRGO White Paper—March 2006. Input on analysis of MRGO effect on storm propagation into metropolitan New Orleans and vicinity.

v. Criteria for Assessment of I-Walls—March 2006 and ongoing-IPET members met with TFG to examine the results of performance analysis to date on 17th Street and London Avenue Canals. Criteria were developed to assess the integrity of the remaining sections of I-walls that were not severely damaged during Katrina. These criteria are currently being used to determine the condition of non-damaged areas and to develop approaches to increase the resilience of these sections as necessary to increase protection for the next hurricane season.

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RESPONSES BY LEWIS E. LINK TO ADDITIONAL QUESTIONS FROM  
SENATOR JEFFORDS

*Question 1.* I have attached testimony provided to the Senate Homeland Security and Government Affairs Committee in 2005 regarding the potential causes of levee failures.

[The referenced testimony can be found on page 96.]

Can you describe how your findings in the IPET report differ from these findings, what data you used to draw your conclusions, and the main reasons why you reached the conclusions presented in the IPET report? Please provide any documents for the record that you believe are pertinent to the answer to this question.

Response.

FINDINGS

The referenced testimony (November 2005 to Senate Homeland Security and Government Affairs Committee concerning Katrina) reflects, with the exception of a few observations noted below, reasonable conclusions given the level of information available at the time. This statement is in reference to the written submissions only. It is important to note that this testimony was based on observations without the benefit of analysis. As such, many of the stipulations are general in nature, but lack the specific facts and depth of understanding necessary for effecting repairs or re-

constitution of protection. That was the driving force for the initiation of the more in-depth analyses that the IPET and others pursued following the initial data gathering phase that this testimony represents. Those statements made during the testimony that are based on more complete information are inaccurate as follows:

LSU-Comment about prior pushing, pulling, and pushing sheet piles at 17th Street Canal greatly weakening the soils: There is no evidence that this activity had any influence on soil strength.

LSU-Comment about potential of a lateral flow of water under the piling from the canal contributed to the failure at 17th Street: There was no evidence of lateral water flow under the sheet pile. The clay soils under the sheet pile do not support water flow.

LSU-Comment about levee wall segments adjacent to breach were not interlocked and a number seemingly sheared off their piling foundation: The floodwall interlocks were designed as water stops, not structural elements. They, in fact, performed beyond expectations with regard to separation. We found little or no evidence of the floodwalls shearing off the sheet piles. Numerous segments of wall and sheet pile were recovered at the breach sites and none demonstrated this behavior.

LSU-Statement about "highly organic soil was used to create the levee embankment": The levee embankment was constructed of clay materials of reasonable quality. The clay embankment of the levee was constructed on a peat layer that underlies the region.

LSU-Statement that sheet pile at 17th Street Canal should have been driven 60 feet below sea level: There is no basis for this statement. The clay soils at the site prevented under seepage which would have been the major reason for deeper sheet piles. Deeper sheet piles may have helped at the London Avenue breach sites which were built in sand.

LSU-Comment concerning London Avenue Canal west breach stating that sheet piling on east side of breach were driven 26 feet and only 11.4 feet on west side: More accurate sheet pile measurements have been made and documented in the IPET report. The speculation of sheet piles being shorter than the specified by the design was shown to be false when a number of the sheet piles were pulled to confirm their measurements. All depths were in accordance with design specifications.

IPET analyses were accomplished by a task force of experts from 25 Universities, 23 private sector firms, and Government agencies. All IPET plans, processes and results were reviewed as they were developed by the American society of Civil Engineers External Review Panel, providing confidence in immediately putting findings and lessons learned to work in the repair and reconstitution of hurricane protection in New Orleans. As such, the IPET results have been reviewed and applied as they were developed and are essentially already in the ground in the repairs accomplished and imbedded in the processes being used to recover and complete the system and examine higher levels of protection.

The following are more specific facts based on the in-depth IPET analyses and validated by the ASCE External Review Panel. These facts are documented in IPET Draft Final Report available as of 1 June at <https://ipet.wes.army.mil>.

#### *Hurricane Protection System*

Rapid and variable subsidence caused significant loss of intended levels of protection, in some locations greater than 2 feet.

A mis-interpretation of the relationship between local mean sea level and the geodetic datum resulted in some structures being constructed below (at times between 1 to 2 feet) the design elevations.

With the exception of the structures constructed below design elevations due to mis-interpretation of the local datum, the structures were built largely as designed. Levees built with hydraulic fill were intended to use that material with a clay cap layer to provide erosion protection. The levees were not designed to withstand significant overtopping. All sheet piles sampled were driven to specified depths. All structural materials sampled were within specifications.

Design methodologies used were typical for the time and local practice, as was the data used for the design. The designs were not conservative enough to deal with the unknown or unanticipated conditions and mechanisms.

No changes to the original designs were made to accommodate re-definition of the hazard (1979) or discovery of datum changes (1984).

The piecemeal design and construction of the protection system over a period of decades, yet unfinished, resulted in inconsistent levels of protection and prevented the composite of the hurricane protection structures and measures from performing as a system.

### *Storm*

Hurricane Katrina generated the largest storm surge measured in North America, which along with a severe wave environment, overwhelmed structures to the east and southeast of New Orleans.

Katrina created the largest waves (55 feet) measured by a NOAA Buoy in the Gulf.

The storm surge level varied considerably by location. The largest surge was experienced along the levees of St. Bernard and Plaquemines Parishes and the lowest along the south shore of Lake Pontchartrain.

In many instances the combination of surge and waves far exceeded the design criteria for the structures.

Wave heights, with a few exceptions, were comparable in amplitude to design assumptions. Wave periods, however, along the east side were about three times longer than that assumed for the designs. These long period waves dramatically increased wave run up and the duration of overtopping.

Overtopping waves created high velocity water flow down the back sides of the levees creating large potential for erosion. Erosion potential on the back (protected) sides of the levees greatly exceeded that on the front (water facing) sides.

Surge and wave conditions in the IHNC exceeded design levels.

Surge and wave conditions within the drainage canals did not reach design levels.

### *Performance*

Of the 50 major breaches, 46 were the result of overtopping and subsequent erosion of the levee itself, or the materials behind the floodwall causing instability and breaching.

Structure elevations, lower than design intent due to subsidence, incompleteness of the protection system and in some cases mis-interpretation of the local datum, added to the extent and impact of overtopping and breaching.

Breaches in the levees primarily occurred due to erosion induced by the high velocities of waves overtopping the levees in areas with relatively thin clay caps over erodible (typically hydraulic fill) materials. Flow velocities were three times greater on the back sides of the levees than on the front (water facing) side. Erosion potential is directly proportional to velocity to the third power making the probability of erosion 27 times greater on the back (protected) side of the levee than on the front.

There was little or no evidence of systemic erosion or breaching of levees from the water (front) side.

Many levee sections that were built of erosion resistant materials were overtopped and did not breach.

Four of the breaches occurred because of foundation failures, all involving I-walls and the deflection of the wall which compromised the stability of the levee floodwall structure leading to failure. These structures failed before water reached their design limits. The failure mechanism was not considered in the original design.

A number of I-walls along the IHNC failed as a result of overtopping and erosion of soil materials behind them which reduced their stability. The overtopping in these areas was increased by the loss of protected elevation by subsidence.

Transition areas from one type structure to another or between areas with different heights created weak spots and were prone to failure.

The MRGO channel had little impact on the water levels experienced within the IHNC from Katrina.

### *Flooding*

Flooding from Katrina covered almost 80 percent of New Orleans and vicinity.

For Orleans and St. Bernard Parishes, approximately two-thirds of the flood volume entered the protected area through breaches. The remaining one-third was due to combination of rainfall and overtopping.

Overall, breaching was the source of approximately half the total volume of flooding.

Pump stations, due to their inoperability during the storm, contributed little to the reduction in flooding. Their inoperability after the storm considerably lengthened the time required for dewatering.

Residential areas experienced the majority of the flooding.

### *Consequences*

The most serious consequence of Katrina was the high number of fatalities, most associated with residential areas.

While a large number of people were able to evacuate, the groups least likely to be able to do so on their own, the poor, elderly and disabled, were hardest hit.

Approximately half of the direct property losses, excluding public infrastructure, can be associated with flooding from levee and floodwall breaches.

Katrina caused over \$20 billion in direct property damages, residential areas experienced 78 percent of the total. There was an additional \$6 to \$7 billion in losses to public infrastructure.

Combined with the displacement of population, workforce and businesses, the impacts to infrastructure and affiliated public services will contribute to a slowed recovery.

The flooding caused a breakdown in New Orleans' social structure, a loss of cultural heritage, and dramatically altered the physical, economic, political, social and psychological character of the area.

#### *Risk*

The risk analysis is currently being reviewed and will be provided soon through the IPET website. This information will define the relative vulnerability of areas to future flooding and the sources of that vulnerability. It will also provide a system-wide analytical platform for assessing alternative approaches to providing higher levels of protection to the New Orleans area. The risk methodology and related information bases are being transitioned to be a component of the Louisiana Coastal Protection and Restoration Study.

#### DATA AND RATIONALE

The data used to reach these findings are extensive and comprehensive. They have been organized and managed through an extensive information management effort that has acquired, evaluated, validated and maintained the information to ensure IPET analyses were using quality inputs. This repository was also the resource used to provide information for the IPET public web site which currently comprises well over 4,300 documents. Much of the data used in the analyses came from a wide variety of sources but none as significant as the extensive records of the corps New Orleans District and other Government offices. These data were used to drive models and analyses that generated new information that were input to the analyses for determining findings and lessons learned. The most advanced analytical methods and tools were used in the analyses, including the DOD's most sophisticated super computers, the largest centrifuge in the world and the most capable hydrodynamic computer codes. It was common to take multiple and independent approaches to determine critical information such as the failure modes of the breach sites. Extensive field observations were commonly compared to detailed computer model results, physical modeling and experiments to ensure that the mechanisms identified were confirmed by multiple approaches. In addition, similar analyses were accomplished by separate groups to provide two perspectives on the results. This was the case for both the centrifuge and numerical stability analyses of floodwall performance. The redundancy in analysis was essential in that the results, following peer review by ASCE, were being directly applied to the repairs of the damaged sections of the hurricane protection system and to the evaluation of the undamaged sections to ensure their integrity for the coming hurricane season. I submit to the committee (CD attached), for incorporation into the record, the IPET Draft Final Report as documentation of the full details of the data and methods used to achieve and validate the IPET findings.

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STATEMENT OF THOMAS L. JACKSON, P.E., F.ASCE, D. WRE, PAST PRESIDENT, AMERICAN SOCIETY OF CIVIL ENGINEERS AND SENIOR VICE PRESIDENT, DMJM HARRIS (RET.)

Good morning. My name is Thomas Jackson, and I am pleased to appear before you today to testify on behalf of the American Society of Civil Engineers<sup>1</sup> (ASCE) as you examine the current status of the reconstruction of New Orleans' levees.

Mr. Chairman and members of the subcommittee:

I am a past president of ASCE and currently serve on ASCE's External Review Panel, or ERP. The role of the ERP—which is composed of 14 specialists who possess a range of technical expertise—is to provide an objective, independent technical review of the Internal Performance Evaluation Team's activities which is carrying

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<sup>1</sup>ASCE, founded in 1852, is the country's oldest national civil engineering organization. It represents more than 139,000 civil engineers in private practice, government, industry, and academia who are dedicated to the advancement of the science and profession of civil engineering. ASCE is a 501(c) (3) non-profit educational and professional society.

out an assessment of the performance of the flood-control levees in New Orleans following Hurricane Katrina.<sup>2</sup>

As engineers, our paramount concern is for the safety, health, and welfare of the public. We have learned a great deal from the tragedy of New Orleans, lessons that we hope will allow us to prevent future loss of life and property in Louisiana and elsewhere. We support federal, state, and local agency efforts to ensure that all infrastructure systems are (1) robust, i.e., strong enough and reliable enough to do the job; (2) contain

redundant systems to prevent total system failure; and (3) are resilient enough to allow them to be quickly repaired when the inevitable failures within large, interdependent systems do occur.

Let me begin by saying that the lines of communication between the IPET and the ERP are functioning extremely well, and a good working relationship has been established. Since November, the ERP has provided the IPET with hundreds of comments, questions, and suggestions on a continuing basis. The IPET has considered all of the ERP's comments and most have already been incorporated into the IPET's work plan. We thank the IPET for its commitment to making good use of an independent review panel on a real-time basis to identify needed course corrections to ensure that the outcome is a robust, credible, and defensible performance evaluation.

The ERP is currently in the midst of its detailed review of IPET Report 2. This review follows on two-and-one-half days of meetings with IPET at the Engineer Research and Development Center in Vicksburg a little over a month ago. On March 23, 2006 we delivered a letter to General Strock, Chief of Engineers which noted several key concerns that the ERP has identified at this stage of the performance evaluation.

In general, the ERP finds that Report 2 represents an important, technically sound body of work. We are favorably impressed with many aspects of the studies that have been made, including the piecing together of information to present a clear picture of the physical events during Hurricane Katrina. We generally concur with the technical data, methods of analysis, and technical findings presented in Report 2. The ERP notes that particularly good progress has been made in several key areas including:

1. Defining the storm characteristics.
2. Hydraulic modeling of storms.
3. Linkage of eyewitness accounts, data, and computer modeling results.
4. Definition of a datum and vertical elevation adjustments relative to local mean sea level.
5. Investigation of failure mechanisms at the 17th Street Canal.

Two key factors identified by IPET apparently played major roles in the 17th Street Canal failure:

1 The formation of a gap between the sheetpile wall and the canal-side embankment as the water in the canal rose, which enabled development of full hydrostatic pressure against the wall. The formation of this water-filled gap was apparently not considered in design.

2 The presence of low-strength clay in the backyards on the protected side of the floodwall. Strengths used in design were apparently obtained from samples taken near the centerline of the levee, which had the benefit of significantly more overburden pressure than the clay layer in the backyards.

The ERP is looking forward to seeing the results of additional analyses, which are planned for the 17th Street Canal, including finite element modeling and additional centrifuge testing. The ERP is particularly encouraged by one of the key outcomes to date of the analysis of the failure at the 17th Street Canal—that is the development of a rational, analytical process that will enable a more reliable evaluation of the stability of other reaches of floodwall, particularly those that may show no outward signs of distress following Katrina and Rita. Clearly, the importance of hydrostatic loading and the need to adjust the strength of the clay to account for the effect of overburden pressure will be crucial to gaining confidence in the ability of other reaches of floodwall to withstand the loads that we saw during Katrina.

<sup>2</sup>Hurricane Katrina was a catastrophic storm that made landfall in the Gulf Coast near the Louisiana and Mississippi border with wind speeds near 150 mph. Flooding, not high winds, was the principal cause of damage in New Orleans following the failure of numerous levees in and around the city. For an analysis of the hurricane and its impact on the levee system in New Orleans, see THE AMERICAN SOCIETY OF CIVIL ENGINEERS AND THE NATIONAL SCIENCE FOUNDATION, PRELIMINARY REPORT ON THE PERFORMANCE OF THE NEW ORLEANS LEVEE SYSTEMS IN HURRICANE KATRINA ON AUGUST 29, 2005 (Nov. 2, 2005) at <http://www.asce.org/files/pdf/katrina/teamdatareport1121.pdf>.

Since the recent meeting in Vicksburg, the ERP has taken the opportunity to review IPET Report 2 in greater detail. At this time, there appear to be a number of key lessons learned, which must be taken into account by Task Force Guardian, and in any analysis that looks to develop a system that will be able to withstand Category 4 or 5 hurricanes in the future. The ERP's immediate attention is focused on three main areas of potential lessons learned.

First, we are concerned about an apparent aggressive design approach, which may not have been warranted for a water-holding structure of this importance. It appears that at nearly every step of the way, the envelope was pushed. Let me explain. The target factor of safety was apparently 1.3 for design, which may be on the low side for structures whose failures were capable of causing death and widespread destruction. Against this backdrop, quite optimistic soil strengths were selected despite:

1. The fact that the local geology suggested that conditions would be highly variable, even over relatively short distances. For example, the analysis of the 17th Street Canal failure suggests that natural variations in soils strengths lead to factors of safety about 20-30 percent higher just north and south of the failure zone.
2. The fact that soil conditions and strengths were taken from widely spaced borings that were concentrated along the centerline of the levees.
3. The fact that soil strengths in the backyards were not adjusted to account for the reduction in overburden pressures.

In addition, the forces on the wall did not apparently include the possibility that full hydrostatic loads could develop through the formation of a simple gap caused by the wall moving away from canal-side embankment as the water in the canal rose above normal levels.

Second, there may have been problems associated with handoffs during the design process, or at interfaces between key players in the design. For example, were potential limitations in soil strength clearly communicated between the geotechnical team and the floodwall design team? Were concerns about hydrostatic loading on the wall clearly communicated and considered? How would the system have performed if the sheetpiles had been driven to greater depths?

Third, how was the corps' quality assurance/quality control process followed during design? If, for a structure of this importance, techniques such as independent peer review or use of a Board of Consultants had been used, would the performance been different?

These concerns merit in-depth assessment to document lessons learned and to provide for ways to move forward that incorporate those lessons learned. The ERP will be looking into these matters.

In our review of IPET Report 1, the ERP commented on four critical areas that may go beyond IPET's scope. The ERP is pleased that the Corps is making progress on two these issues. First, the organizational complexities and lack of centralized, comprehensive management at the local, state, and federal levels are apparently being addressed. Second, issues associated with treating the hurricane protection facilities as a complex and interdependent system are also apparently being addressed. For example, closing off the three drainage canals and moving the pump stations to Lake Pontchartrain is a step in the right direction. The 17th Street Canal failure analysis certainly strengthens case for doing so.

The ERP is concerned that there has been apparently little progress on two other issues. First is protection from overtopping. The breaches were catastrophic, and some overtopping is far better than overtopping with breaching. The hurricane protection system needs to be resilient in a way that overtopping could occur without causing catastrophic failure.

Second, the ERP remains concerned about the way the system was conceived and developed. For example, how were life safety and risk factored into the design methodology, such as selection of the factor of safety? It appears that for the 17th Street Canal failure section, decisions made at several stages of the design process were played too close to the margins. By this I mean that assumptions and decisions were apparently not as conservative as they should have been, particularly given the grave consequences of the levee failure. In the end, the design did not adequately account for the uncertainties and variabilities inherent in such a complex system.

In summary, there are important lessons to be learned for flood protection systems in New Orleans and perhaps other cities and states. There are at least six key lessons to date:

1. Design methodology and selection of factors of safety for critical structures—what is the appropriate value for levees in the future?
2. Selection of soil strengths and accounting for variability.
3. The importance of water and considerations of hydrostatic loading.

4. Selection of sheetpile depths.
5. The need for clear communications at handoffs and interfaces.
6. QA/QC procedures and peer review.

Based on the findings discussed above, the ERP recommends the following actions be undertaken, with urgency, for levees and floodwalls in New Orleans and perhaps elsewhere in the Nation:

A. All I-walls should be re-evaluated for current design loadings assuming a water-filled gap along the flood side of the wall.

B. All levees underlain by soft soils should be reevaluated for current design loadings accounting for reduced shear strength of soil in areas at or beyond the toe of the levee.

C. All levees and floodwalls should be reevaluated to identify those areas with a questionable degree of conservatism inherent in the design process, and those sections of concern reanalyzed for current design loadings employing an appropriate degree of conservatism.

D. A risk-based approach toward defining the design hurricane conditions is needed. We advise the Corps to proceed as quickly as possible toward redefining the standard project hurricane using principles and practices similar to those used in establishing design criteria for other infrequent but potentially catastrophic natural disasters such as earthquakes and floods.

E. External peer review is an important component of design practice for all critical life-safety structures. We recommend that the steps described above receive external peer review throughout the design process.

In closing the ERP will continue evaluating IPET's Report 2, and will issue its own report in the coming weeks.. Thank you, Mr. Chairman. That concludes my testimony. I would be pleased to answer any questions that you may have.

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STATEMENT OF CARLTON DUFRECHOU, EXECUTIVE DIRECTOR, LAKE PONTCHARTRAIN  
BASIN FOUNDATION

Mr. Chairman, Senator Vitter, members of the Senate Environment and Public Works Committee, I am Carlton Dufrechou, the Executive Director of the Lake Pontchartrain Basin Foundation (LPBF). On behalf of the Pontchartrain Basin Foundation and the citizens of south east Louisiana, thank you for the opportunity to speak with you about sustainable hurricane protection for our region.

The LPBF is a private, non-profit organization created by the Louisiana State Legislature in 1989, to coordinate the restoration and preservation of the water quality and habitats of the 10,000 square mile Pontchartrain Basin. Our primary role is to act as a spokesperson for Basin citizens and as a catalyst to develop and initiate restoration programs and activities.

Personally, I am a native of New Orleans. My education is in engineering. Earlier in my career, I worked with the Corps of Engineers (COE) as a planner and project manager. Since 1992, I have been with the Lake Pontchartrain Basin Foundation.

Some events and dates like September 11, 2001, are etched in our lives. One of those for me is Hurricane Betsy and 1965. In 1965, I was 9 years old. We lived on Bellaire Drive, just a few blocks from what 40 years later would become the infamous breach of the 17th Street Canal floodwall. In 1965, the floodwall did not exist. Only a small levee, one barely above my height then, paralleling the canal, protected our home. Our lakefront levees were not much higher. Betsy left me with many memories. I recall how, as the storm approached my father and uncle, an architect and engineer respectively, discussed the possibility of the levees being overtopped and flooding. I remember how we left our home and went to ride out the storm with my godfather who lived in an older and higher section of the city. I recall the darkness and howling winds and rains as we huddled in the center hallway that night. I remember the next morning when my dad returned from checking on our house and said that we could go home—that the levees had held in our neighborhood. I remember learning that others were not as fortunate—that much of St. Bernard and the 9th Ward had flooded—that the destruction and losses were tremendous.

Over the next decades, to prevent a reoccurrence of Betsy's devastation, levees are raised and floodwalls are built. Some were raised as high as 17 feet on the lakefront. This became the hurricane protection system for metro New Orleans.

For the next 40 years, almost to the day, it seemed to work.

Then another event like September 11 or the death of President Kennedy was etched in our lives-Hurricane Katrina. It directly impacted one million plus and indirectly impacted the economy of America.

Although while in the Gulf, Katrina was a geographically larger and more powerful storm than Betsy, much about the two storms was alike. Both crossed just east of New Orleans and both were Category 3 hurricanes as they passed the latitude of the city. But Katrina's devastation was orders of magnitude greater than Betsy. There was one other very significant difference-our coast. Forty years ago it was still strong.

Louisiana's coast has always been the New Orleans region's first line of defense against hurricanes. In recent years, we've recognized that more. Unfortunately, almost 40 years ago when our present hurricane protection system was designed, many did not.

For our region to be sustainable, hurricane protection for the future must change. A major hurdle will be changing the way our agencies operate. Navigation and transportation projects have traditionally been developed and implemented independently from hurricane protection and coastal restoration. The result of this independent project development has been tragic for our region. The most conspicuous example in the Pontchartrain Basin is the Mississippi River Gulf Outlet (MRGO). This deep draft navigation channel has drastically altered our coast. It cut a channel 40 miles long perpendicular to the coast breaching our natural lines of defense against hurricanes. The MRGO was completed in 1965, the same year as Hurricane Betsy. Many attribute flooding from Betsy to the MRGO. The MRGO did more. It changed the coastal hydrology and ecology. These changes acted like a cancer, progressively eating away at coastal wetlands. After 40 years of coastal disintegration, it is no coincidence that the impacts of Katrina were horrific to our region. The MRGO must go.

Yet, our lead hurricane protection agency, the COE, is unable to act. The MRGO is a federally authorized project that Congress has directed the COE to maintain for deep draft ship operations. They have their orders and their hands are tied. Congress can change those orders by deauthorizing the MRGO. The MRGO is a clear and present danger to our region. Please deauthorize it immediately.

We must consider the big picture for all future hurricane protection. We need stronger levees and floodwalls but they are not enough. Coastal restoration, our first line of defense, must be integrated into hurricane protection. Recognizing this, the Multiple Lines of Defense Strategy was developed. In the simplest terms, this strategy shows how natural features of our coast like barrier islands, marshes, and ridges compliment engineered features like levees to protect the greater New Orleans region from hurricanes. Applying this strategy, 10 coastal restoration project areas were identified. These are the 10 Pontchartrain Coastal Lines of Defense (attached). They include restoring the Chandeleur barrier islands, maintaining marsh land bridges, restoring natural ridges like Bayou La Loutre, reintroductions of Mississippi River water, and others. Our goal is to mimic nature by restoring the plumbing of the coast. The outcome is a self-sustaining coast. The total cost is \$1 billion. The investment is significant but it will secure the future of our region and secure continued economic benefits to America for perpetuity.

We know what to do and we have the expertise. Stronger levees plus a stronger coast will provide the hurricane protection we desperately needed.

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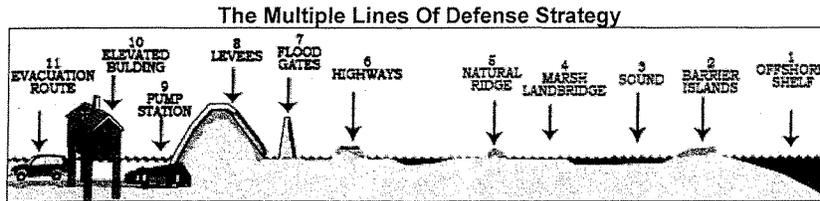
RESPONSE BY CARLTON DUFRECHOU TO AN ADDITIONAL QUESTION FROM  
SENATOR JEFFORDS

*Question.* In your written testimony, you discussed briefly the Multiple Lines of Defense Strategy and the 10 coastal restoration projects that are part of that strategy. Can you elaborate on each of these projects and how their implementation would provide additional hurricane protection?

Response.

## Pontchartrain Coastal Lines of Defense Program

The coast has always been our first line of defense against hurricanes for southeast Louisiana. Recognizing this, the Lake Pontchartrain Basin Foundation (LPBF) developed the Multiple Lines of Defense strategy. In the simplest terms, this strategy shows how natural features of our coast (like barrier islands, marshes, and ridges) compliment manmade features (like levees) to protect the Greater New Orleans area from hurricanes.



Applying this strategy, the LPBF reviewed the 100 plus project proposals to improve the sustainability of forests, swamps, marshes, and barrier islands described in the Comprehensive Habitat Management Plan for the Pontchartrain Basin. The result was the identification of 10 coastal restoration project areas that provide the dual benefits of preserving coastal habitats while simultaneously enhancing hurricane protection for our region. These 10 projects are the Pontchartrain Coastal Lines of Defense.

### Pontchartrain Coastal Lines of Defense Projects



**STRONGER COAST + STRONGER LEVEES = BETTER HURRICANE PROTECTION** The Pontchartrain Coastal Lines of Defense consist of 10 priority projects that should strengthen our coast by restoring habitats to a self sustaining condition. These plus improved levees will provide the hurricane protection desperately needed for our communities to be sustainable. The coast is our first line of defense.

### Pontchartrain Coastal Lines of Defense Projects

#### 1. Maintain the Lake Borgne Landbridge

Where: Maintain the MRGO-Borgne Land Bridge

What: Extensive Rock armoring, local marsh creation, Intermediate marsh

Who: US Army Corps of Engineers, EPA, LSU Hurricane Center, St. Bernard Parish, DNR, Lake Pontchartrain Basin Foundation

Estimated Cost: \$80,000,000

Performance Goals

Flood Protection: Wetland buffer to St. Bernard levees and minimize encroachment of Lake Borgne into the MRGO

Habitat Restoration: Typical intermediate marsh nursery and fringe marsh benefiting recreational and commercial fishing

#### 2. Restore the Bayou la Loutre Ridge (includes constriction of MRGO to GIWW dimensions)

Where: Restore the Bayou la Loutre Ridge

What: Constrict MRGO channel (GIWW dimensions), rebuild and re-forest natural ridge, natural ridge and intermediate marsh

Who: US Army Corps of Engineers, LSU SRC, LSU Hurricane Center, St. Bernard Parish, The Nature Conservancy, DNR, Lake Pontchartrain Basin Foundation

Estimated Cost: \$200,000,000

Performance Goals

Flood Protection: Impede northward movement of storm surges and reduce surge water elevation north of Bayou la Loutre ridge with soil foundation and ridge forest

Habitat Restoration: Restore the natural ridge and hydrologic barrier between the Borgne-Biloxi estuary and the Caernarvon-Terre aux Boeufs estuary, restore the Natural levee ridge habitat of oak, black willow providing refuge of indigenous ridge species

#### 3. Restore the Chandeleur Barrier Islands

Where: Chandeleur Island Restoration

What: Beach nourishment with sand and shell, saline habitat

Who: US Fish & Wildlife Service, National Marine Fisheries Service, USACE (Mobile District), Minerals Management Service, US Geological Survey (Tampa Bay Office), St. Bernard Parish, Pontchartrain Institute for Environmental Sciences, DNR, MS Dept. of Marine Resources, Lake Pontchartrain Basin Foundation

Cost: LPBF Request \$150,000,000 (Due to Hurricane Katrina this may be insufficient)

Performance Goals

Flood Protection: Reduce wave heights and wave energy entering Chandeleur Sound (fair weather and storm generated) and impacting the Biloxi Marsh, reduce storm surge elevations east of barrier islands

Habitat Restoration: Barrier Island dune and lagoon habitats, Saline marsh, bird rookery, recreational and commercial fishing, maintain benefits of National Wildlife Refuge

#### 4. Construct the Jefferson Parish fringe marsh buffer

Where: Jefferson Parish Shoreline Restoration and Protection

What: Rock armoring, marsh creation, SAV habitat, reef balls, Intermediate marsh

Who: National Marine Fisheries Service, US Army Corps of Engineers, LSU Ag Center, LSU - SRC, Jefferson Parish, DNR, Lake Pontchartrain Basin Foundation

Cost: LPBF request \$62,500,000

Performance Goals

Flood Protection: Wetland buffer to levees in East Jefferson Parish by reducing risk of levee failure and reducing shoreline or berm erosion lake ward of the levee

Habitat Restoration: Establish intermediate, fringe marsh providing critical marsh nursery, recreational fishing, birding and other outdoor activities

### **5. Construct the Violet Reintroduction to maintain target salinity in LA and MS**

Where: Mississippi R. Reintroduction at Violet, LA

What: Reintroduce Mississippi R. water to achieve habitat goals of baseline, reestablish cypress forest, Swamp, intermediate to saline marsh

Who: National Marine Fisheries Service, EPA, MS Dept. of Marine Resources, St. Bernard Parish, DNR, Lake Pontchartrain Basin Foundation

Cost: LPBF request \$135,000,000

#### **Performance Goals**

Flood Protection: maintain salinity targets to develop a denser and more mature wetland forest east of Chalmette to buffer to St. Bernard levees, and to enhance oyster growth in the outer Biloxi marsh to maintain marsh reduce surge into Mississippi Sound and Lake Borgne

Habitat Restoration: Reduce salinity intrusion into swamp or fresh marsh habitat, increase primary and secondary productivity including commercial species such as shrimp, blue crab and oysters. Typical

intermediate marsh nursery and fringe marsh benefiting recreational and commercial fishing

### **6. Maintain and restore the Biloxi Marsh Landbridge and reefs - South**

Where: Biloxi Marsh Landbridge (south)

What: Salinity management, Oyster reef propagation (reef balls, etc.), rock armoring, marsh creation, terracing, brackish to saline

Who: US Fish and Wildlife Service, Natural Resource Conservation Service - Lead agency, St. Bernard Parish, LSU SC&E, LSU Ag Center, LA Dept. of Wildlife & Fisheries, DNR, MS Dept. of Marine Resources, Lake Pontchartrain Basin Foundation

Cost: LPBF request \$60,000,000

#### **Performance Goals**

Flood Protection: Maintain integrity of the marsh landbridge and natural ridges preventing Bay Boudreaux developing into a tidal pass or merging into Chandeleur sound which would increase storm surges in Mississippi Sound and Lake Borgne

Habitat Restoration: Preserve and restore brackish marsh including robust oyster beds throughout the outer Biloxi marsh. Develop oyster barrier reefs within the or along the Fishing Smack Bay

### **7. Maintain and restore Breton Landbridge with Caernarvon and marsh creation**

Where: Maintain and Restore the Breton Landbridge

What: marsh creation (Sediment trap), land building (diversions), reefs, Intermediate to brackish marsh

Who: US Army Corps of Engineers, Natural Resource Conservation Service, US Fish and Wildlife Service, Caernarvon Inter-Agency Advisory Committee, Plaquemines Parish, St. Bernard Parish, LSU SC&E, DNR, Lake Pontchartrain Basin Foundation

Cost: LPBF request \$40,000,000 (Due to Hurricane Katrina this may be insufficient)

#### **Performance Goals**

Flood Protection: Wetland buffer to levees in St. Bernard and Plaquemines Parish by reducing storm surge height and energy

Habitat Restoration: Typical intermediate to brackish marsh nursery benefiting recreational and commercial fishing

### **8. Maintain critical marsh shorelines and ridges of the East Orleans Landbridge**

Where: East Orleans Corridor Landbridge

What: conservation, local rock armoring, marsh creation for critical areas of shoreline, Intermediate marsh

Who: US Army Corps of Engineers, LSU SRC, LSU Hurricane Center, UNO – Social Sciences, Orleans Parish, St. Tammany Parish, DNR, Lake Pontchartrain Basin Foundation

Cost: LPBF request \$87,500,000

#### **Performance Goals**

Flood Protection: reduce storm surges into Lake St. Catherine and Lake Pontchartrain by maintaining or enhancing landbridge elements of marsh and Pine Island natural ridges  
 Habitat Restoration: Typical intermediate marsh nursery benefiting recreational and commercial fishing, Maintain natural ridge habitat of the Pine Island ridges

**9. Maintain and restore Biloxi Marsh Landbridge and barrier reefs -North**

Where: Biloxi Marsh Landbridges (north)

What: Salinity management, Oyster reef propagation (reef balls, etc.), rock armoring, marsh creation, terracing, brackish to saline

Who: Natural Resource Conservation Service, US Fish and Wildlife Service, St. Bernard Parish, LSU SC&E, LSU Ag Center, LA Dept. of Wildlife & Fisheries, DNR –Coastal Restoration Division, MS Dept. of Marine Resources, Lake Pontchartrain Basin Foundation

Cost: LPBF request \$60,000,000

Performance Goals

Flood Protection: Maintain integrity of the marsh landbridge preventing Bay Boudreaux developing into a tidal pass and merging into Mississippi Sound which would increase storm surges in Mississippi Sound and

Lake Borgne

Habitat Restoration: Preserve and restore brackish marsh including robust oyster beds throughout the outer Biloxi marsh. Develop oyster barrier reefs within Mississippi Sound shoreline of the Biloxi marsh

**10. Maintain and enhance the Maurepas Landbridge with Maurepas Reintroduction**

Where: Maurepas Landbridge & Maurepas Reintroduction

What: conservation, River reintroductions, hydrologic restoration, marsh creation, swamp & fresh marsh

Who: EPA, Southeastern Louisiana University, Tangipahoa Parish, St. John the Baptist Parish, LA DWF, DNR, DNR – Coastal Management Division, Lake Pontchartrain Basin Foundation

Cost: LPBF request \$50,000,000 for conservation L. Pont. rim, LCA request \$80,000,000

Performance Goals

Flood Protection: Reduce storm surges into Lake Maurepas and adjacent shoreline regions by maintaining or enhancing landbridge elements of swamp and fresh marsh

Habitat Restoration: Develop mature swamp and swamp canopy by increasing primary productivity. Increase productivity of fresh marsh. Enhance recreational and commercial fishing.

Increase detrital export into Lake Pontchartrain

## STATEMENT OF SANDY ROSENTHAL, FOUNDER, LEVEES.ORG

I am Sandy Rosenthal the Founder of Levees.Org. We are a non-partisan grass-roots group formed in 2005 after Hurricanes Katrina and Rita. We have over 3,200 members and our website has hosted over 22,000 unique visitors. We say the destruction that the citizens of New Orleans and southern Louisiana suffered was due to disastrous design and planning mistakes by the U.S. Army Corps of Engineers. We hold the corps accountable for what is inarguably the worse engineering disaster in American history.

The IPET interim reports, ERP letter in response to IPET Interim Report No. 2 and the NSF interim reports have all pointed to improper engineering by the USACOE which led to the breach at the 17th Street Canal at surge levels well below design heights. We expect similar findings to emerge as regards the two breaches at the London Ave Canal floodwall and the many breaches of the IHNC floodwalls.

However, the problems with the USACOA and the Federal process of funding and building flood protection run much deeper than the technicality of engineering errors.

The USACOE:

- Designed to the wrong storm. The Standard Project Hurricane (SPH) was supposed to be the most severe storm reasonably characteristic of the region. In 1965 the USACOA chose a 100 mph storm. By 1972 the National Weather Service had informed the corps that new data showed this standard was insufficient. The corps did nothing.

- Used the wrong safety margin. The 1.3 safety margin is not appropriate for structures protecting the lives and property of a major city. The corps should have easily known this.

- Used the wrong cost-benefit analysis. No value was given to life. Little value has given to protecting developed property. This is not how to protect thousands of lives and tens of billions of exposed property.

- Failed to account for overtopping. This issue was obvious and is considered a basic issue in flood protection. Now, post-Katrina, the corps has made and urgent request for funds to protect the levees and floodwalls from scouring due to overtopping. But, where was the urgency these past 40 years?

- Never finished the IHNC West floodwall. This floodwall was essential to the protection of the City of New Orleans west of the IHNC. It is incredible that 6 miles of critical floodwall was not completed in 40 years. It is probable that the failure to complete the IHNC floodwall protection doomed the City even if no breaches had occurred. The corps will say they were not fully funded to complete this project. Such an excuse is utter nonsense. The USACOA understood the importance of this project and should have been screening for full funding.

As citizens of Louisiana, we have no faith in the USACOE. The corps confuses "authorization" and "funding" with mission. They have no sense of urgency. And, it has become obvious that they engineer to the money available rather than to the reasonable engineering standards that are required to protect lives and property.

There are four keys to reforming the USACOE and to providing adequate flood protection for the citizens of Southeast Louisiana.

1. The corps must have a clearly defined mission. That mission should be flood protection for the lives and property of Louisiana's citizens.

2. The Corps must have a clear sense of urgency.

3. All corps work must be subject to Peer Review. This review must be concurrent to prevent unnecessary delays. It must also be objective and challenging, not a comfortable relationship.

4. A dedicated source of annual funding must be established. We suggest Louisiana's flood protection should be funded from the royalties on the State's onshore and offshore oil and gas production. This way, citizens' safety is not subject to annual congressional budgetary review.

Thank you for accepting our testimony on behalf of the citizens of Louisiana.

*Hurricane Katrina: Performance of the Flood Control System*

**Testimony of  
Raymond B. Seed, Ph.D.  
Professor of Civil and Environmental Engineering  
University of California at Berkeley  
On behalf of the  
NSF-Sponsored Levee Investigation Team  
Before the Committee on Homeland Security and Government Affairs  
U.S. Senate  
November 2, 2005**

Madam Chairman and Members of the Committee:

Good morning. My name is Raymond Seed, and I am pleased to be asked to appear before you today to testify on behalf of the Levee Investigation Team sponsored by the U.S. National Science Foundation.

A large number of leading national and international experts with a tremendous amount of forensic experience in sorting through major disasters have worked very hard this past month, and I am pleased to be able to present you with the first copy of the preliminary report of the findings of the combined ASCE and NSF-sponsored field investigation teams.

I am very grateful for their tremendous efforts in getting this material ready for you today.

**I. Katrina and the Flood Control System**

Our hearts go out to the many who have lost everything, even in some cases their lives, in this catastrophic event. Our teams have had considerable previous experience in many other disasters, including numerous major earthquakes around the world, the recent Indian Ocean tsunami, floods and levee failures, the space shuttle Challenger disaster, and more. But we were not prepared for the level and scope of the devastation that we witnessed when we were in New Orleans.

It must be the intent of our work that something like this not be allowed to happen again.

With that in mind, and in our hearts, I must make it clear that we know a great deal about what happened, and in many cases why, and that it is my intent today to speak as openly as possible. Our team, to a man and to a woman, feel that the people of the New Orleans region, and the Nation, and our governments at all levels, need and deserve nothing less. Important decisions are being made that will affect people's lives for years to come. We recognize the importance of providing the best possible informed information, responsibly studied and professionally and thoughtfully synthesized, that we can at this early juncture. Better and more

complete information will continue to evolve over the coming year, but that will be too late for many ongoing decisions being made right now, today.

Our preliminary report represents a consensus document, and it presents the initial observations and findings that we were able to agree to release with all the team members and organizations involved. If you will ask, I will do my best to answer questions well beyond the scope of our initial Preliminary Report.

## II. Why Did the Levees and Floodwalls Fail?

This is a map of the central New Orleans region, prepared initially by the U.S. Army Corps of Engineers and then modified to reflect additional findings of our investigation teams. It shows the locations of many of the levee breaches that occurred, and serves as a good base map for our discussions today. Not shown on this map are the additional flood protection levee systems that extend down the lower reaches on the Mississippi River, providing a narrow additional protected corridor down to the Gulf.

The storm surges produced by Hurricane Katrina resulted in numerous breaches, and consequent flooding of approximately 75 percent of the metropolitan areas of New Orleans. Most of the levee and floodwall failures were caused by overtopping, as the storm surge rose over the tops of the levees and their floodwalls and produced erosion that subsequently led to failures and breaches.

Overtopping was most severe at the east end of the flood protection system, as the waters of Lake Borgne were driven west producing a storm surge on the order of 18 to 25 feet that massively overtopped levees immediately to the west of this lake. This photo shows one piece of a six mile section of levees at the northeast corner of the MRGO channel that were massively overtopped and eroded by this storm surge, which then sent floodwaters racing towards St. Bernard Parish. There is virtually nothing left of these levees along some parts of this stretch.

A very severe storm surge also occurred farther to the south, along the lower reaches of the Mississippi River, and significant overtopping produced additional breaches in this region as well. This photo shows homes that were carried across the narrow protected corridor in southern Plaquemines Parish by a breach on the west levee, and then thrown astride the crest of the Mississippi Riverfront levee.

Overtopping was lesser in magnitude along the Inner Harbor Navigation Channel and along the western portion of the MRGO channel, but the consequences of this overtopping were again severe. This overtopping again produced erosion and caused numerous additional levee failures. This photo shows the well known breach at the west end of the Ninth Ward. We spent some time figuring out the answer to the chicken and the egg question, and it is our preliminary opinion that the infamous large barge was drawn in through a breach that was already open.

Most of the failures in this central New Orleans area were the result of overtopping, and one of the common failure modes was simply water cascading over concrete floodwalls and then carving sharply etched trenches at the back sides of these walls. This reduced the lateral support at the back sides of the walls, and left them vulnerable to the high water forces on their outboard faces.

Another repeated mode of failure and distress throughout this central region were problems at "transition" sections where two different levee and/or wall systems joined together. There is a need to better coordinate these connections, and their details.

Farther to the west, in the East Bank Canal District, three levee failures occurred along the banks of the 17th Street and London Avenue Canals, and these failures occurred at water levels below the tops of the floodwalls lining these canals. These three levee failures were likely caused by failures in the foundation soils underlying the levees, and a fourth "distressed" levee/floodwall segment on the London Avenue Canal shows signs of having neared the occurrence of a similar failure prior to the water levels having receded. This photo shows the north breach at the London Canal. The section directly across the canal, on the east bank, was very seriously distressed and also requires remediation before it can safely hold high waters again.

### III. The Road Forward

Major repair and rehabilitation efforts are underway to prepare the New Orleans flood protection system for future high water events. The next hurricane season will begin in June of 2006. Preparing the levees for the next hurricane season, however, should also include a review of how the system performed during Hurricane Katrina, so that key lessons can be learned and then used to improve the performance of the system.

Based on our observations, a number of initial comments are warranted concerning the rebuilding and rehabilitation of the levee system.

Although it is somewhat customary to expect levee failures when overtopping occurs, the performance of many of the levees and floodwalls could have been significantly improved, and some of the failures likely prevented, with relatively inexpensive modifications of the levee and floodwall system details. The addition of overtopping erosion protection at the landside toes of the floodwalls through the provision of rip-rap, concrete splash slabs, or even paving of the ground surface at the inboard faces of the levee crest floodwalls might have been effective in reducing this erosion, and might have prevented some of the failures observed.

As the New Orleans regional flood protection system is now being repaired and rebuilt, it would appear advantageous to plan crest heights in a systematic and deliberate way, so that if and when overtopping does occur, it occurs preferentially at the desired locations along any given section of levee/floodwall frontage. Similarly, the transitions between disparate levee/floodwall sections (e.g.: transitions between earthen levees, sheetpiles, and/or concrete wall sections) should be more robustly designed and constructed so that these transitions do not represent locations of potential weakness in otherwise contiguous perimeter flood protection system.

Areas in which piping erosion occurred, including reported instances of piping along the MRGO frontage, suggest that there are areas of foundation that were weakened to a state worse than "pre-Katrina" conditions. Similarly, there may be additional sections like the west bank across from the North breach on the east side of the London Avenue Canal that were distressed (but did not fully breach) and are in need of remedial work. It is important to remember to

check, and to repair as necessary, levee sections that may have been damaged but that did not fail as part of the current repair operations.

Levees are "series" systems, where the failure of one component (one levee segment) means failure of the whole system. They have less redundancy than many other engineered systems. And the consequences of failure are high. The failure of at least several levees at less than their design water height in this hurricane warrants an overall review of the design of the system.

In the short-term, as interim levee repairs continue, consideration should be given to retaining the use of sheetpiles placed against the bridges at the north ends of the 17<sup>th</sup> Street and London Avenue canals to control storm and tidal surges. Until the levees in these canals are more fully repaired or more permanent canal surge check structures are emplaced, having the ability to rapidly prevent storm surges down these canals is still needed.

The USACE, like other public agencies, commonly uses Independent Boards of Consultants to review the adequacy of the design and construction (and remediation) of major dams. The levee system in New Orleans actually protects more life and property than almost any major dam in the United States. We recommend that the Corps should retain an Independent Board of Consultants to review the adequacy of the interim and permanent levee repairs being carried out in the aftermath of Hurricane Katrina.

The U.S. Army Corps of Engineers are stretched very thin right now, trying to respond and effect emergency and interim repairs in the wake of this catastrophe. It must be the job of the Federal government, and oversight committees such as this one, to ensure that they have the resources and technical capabilities to get their job done safely and well. The Corps have responsibility for many potentially high hazard dams and levee systems, and we must be able to have high confidence in their ability to perform these vital tasks.

The ASCE and NSF-sponsored levee assessment team(s) have already been instrumental in providing insights and recommendations for mitigating potentially serious deficiencies in the temporary/emergency repairs at a number of breached sections. It is anticipated that additional important lessons will be learned in the months ahead as these investigations continue, and that some of these lessons are also likely to be useful in moving forward with the ongoing repair and long-term rebuilding of the New Orleans regional flood protection systems. Such lessons will continue to be passed along as quickly as practicable.

As much of the population is currently being permitted to re-occupy portions of the New Orleans area, doing everything possible to ensure the safety of these people and their neighborhoods must continue to be the highest priority.

This concludes my testimony. Thank you.

**Paul F. Mlakar, Ph.D., P.E.  
Senior Research Scientist  
US Army Research and Development Center**

**Testimony Before the  
Committee on Homeland Security and Governmental Affairs  
United States Senate**

**Hearing on  
Hurricane Katrina: Why did the Levees Fail?**

**November 2, 2005**

**Madame Chair and Members of the Committee****Introduction**

I am Dr. Paul F. Mlakar, Senior Research Scientist at the US Army Engineer Research and Development Center (ERDC) in Vicksburg, Mississippi, which is a component of the US Army Corps of Engineers (the Corps). I have spent most of my professional career spanning four decades in the Corps studying the response of structures to extreme loadings. This has included the performance of the Murrah Building in the Oklahoma City bombing and the performance of the Pentagon in the 9/11 crash. I am a Registered Professional Engineer, a Fellow of the American Society of Civil Engineers, and received their Forensic Engineering Award in 2003.

As some of you know, the ERDC conducts research and development to enable the Corps to better perform its military and civil missions in service to the Nation. We employ some 2548 people in seven laboratories located in four states. This staff is recognized nationally and internationally for its expertise in civil engineering and related disciplines. Our facilities include a number of unique devices that allow us to conduct analyses and experiments on the leading edge of technology.

I am pleased to appear today on behalf of the ERDC and the Corps to provide information as requested in your letter of invitation dated 27 October 2005. The Congressional interest in the performance of the storm damage reduction infrastructure in Hurricane Katrina is much appreciated and shared by the Corps. While we do not yet have the answers to all of the questions, we welcome this opportunity to share our progress with you.

The Corps takes its responsibility for the safety and well-being of the Nation's citizens very seriously. In the case of the New Orleans area, we are determined to learn what failed, how it failed, why it failed, and to recommend ways to reduce the risk of failure in the future.

On September 22, 2005, the Corps asked me to lead in the collection of data for the study of the storm damage reduction infrastructure affected by Hurricane Katrina. On September 26, 2005, I deployed to New Orleans on the heels of Hurricane Rita and have spent most of the intervening time in the region. At various times I have been joined by some thirty colleagues from the Corps. Our priority has been on the breaches in the metropolitan area that caused the greatest devastation, i.e. the 17<sup>th</sup> Street Canal, the London Canal, and the Inner Harbor Navigation Canal.

We have been diligently recording the damages and measuring the post-Katrina conditions. We have examined physical evidence to establish the maximum water elevations at various locations. To establish the timeline of events, we have conducted detailed interviews with about 70 people who sat out the storm. To establish the soil properties, we have pushed a state of the art instrumented cone to a depth of 80 feet at 56 locations. We further collected samples of the soil at depth in 10 locations. We have also electronically scanned 63 out of 235 boxes of documents dealing with the design, construction, and maintenance of the projects involved.

As we deployed, the American Society of Civil Engineers and a University of California team sponsored by the National Science Foundation approached the Corps about similar studies of infrastructure performance they were undertaking in hopes of applying lessons learned to the levee systems in California. In the spirit of openness and full transparency, we invited these teams to join us beginning on September 29, 2005 for inspections of the projects involved. On September 30, 2005, we learned that the State of Louisiana would soon establish its own study team and we invited the researchers from the Louisiana State University Hurricane Research Center to join us in advance of this official establishment. The Corps gratefully acknowledges the assistance provided by these teams in the collection of the data.

Over the next eight months, an Interagency Performance Evaluation Team commissioned by the Chief of Engineers will examine and analyze these data, and rationally test various hypotheses about the behavior of the infrastructure. The work currently planned will include the following tasks:

- Geodetic Reference Datum
- Storm Surge and Wave Modeling
- Hydrodynamic Forces
- Floodwall and Levee Performance
- Pumping Station Performance
- Interior Drainage/Flooding Modeling
- Consequence Analysis
- Risk and Reliability Assessment

We will seek the collaboration of other agencies and academia as we proceed with this factual study.

The final results will include conclusions as to the causes of the failures and recommendations for the future design and construction of such infrastructure nationwide. These results will be independently reviewed by the American Society of Civil Engineers and, at the request of the Secretary of Defense, the National Academies/National Research Council will independently review the results as well. Our scheduled completion date is July 1, 2006. In the meantime, our interim results are being shared with our colleagues in the Corps responsible for the repair of the storm damage reduction system in New Orleans and will be taken into consideration in the design and repair of the existing levees and floodwalls.

In response to your specific questions we are able to offer the following responses at this time:

**Why did the levees fail?**

There is no single answer to this question as there were multiple breaches of levees and floodwalls at a number of locations and the exact failure mechanism of each is likely to be different. The answer to this will follow from a thorough analysis of the data we are now collecting. In some cases, e.g. the Inner Harbor Navigation Canal, we have observed evidence of overtopping that may have played a role. In other cases, e.g. the 17<sup>th</sup> Street Canal, we have observed evidence of massive soil movement that could have been a factor in how these levees

failed. There is a need for considerable analysis to answer this question. Until we can compare the evidence to an understanding of the hydrodynamic environment that resulted from the storm, the forces generated by the resulting surge and waves, how those forces were applied to individual structures and how the structures, given their design intent and capacities, should respond to those forces, we will only be speculating as to why they failed.

**What was the physical process that caused these failures?**

The physical processes that caused the breaches will be determined from the comprehensive analysis of the data that we are collecting. What we have to date is evidence of what happened; we can see the final result of the structural behavior, but we cannot yet determine why. That will require more understanding of the design intent of each structure, its condition prior to the storm, the forces to which it was subjected (static and dynamic) and the ability to at least simulate how the structure would respond to those forces. This is the objective of our current interagency analysis efforts.

**What role did human error play in these failures?**

Through a thorough analysis of the data that we are collecting, we will explore whether human error played any role in the performance of the infrastructure.

**Have we found any errors in the design or construction of these systems?**

We have not yet determined whether the failures were caused by errors in the design or construction of these systems, or by some other means. Our analysis will help establish the cause. We are examining the ability of the structures as designed to deal with the forces applied by the storm. Those forces in some cases may have been well beyond the design capacity. In other cases, the structure may not have performed as expected and we will determine why. Until we can relate the performance to the forces, with accepted engineering analysis, we are not comfortable speculating on the adequacy of a design.

**What can these failures and the efforts to repair them tell us about the level of protection the remaining flood and hurricane protection systems provide to residents of New Orleans and the surrounding parishes?**

The results of our study will provide a better indication of the extent to which the remaining system can be expected to reduce the risk of future storm damage. We will be examining and providing analysis on the performance of the entire storm damage reduction system, to understand the failures that occurred, to understand other components of the system that may have been degraded in their capacity to protect against future storms and to understand where the system performed successfully. We will be developing information on risk and reliability of the system as it will be after we complete repairs.

In conclusion, I want to caution against reaching conclusions to your very important questions before appropriate analysis is accomplished. Speculation concerning observed damage is one thing, but we are not yet in a position to understand why that damage occurred. I hope that my

testimony illustrates the Corps' past and continuing commitment to the pursuit and use of sound science and engineering principles in the execution of our civil works missions.

On behalf of the Corps, thank you for allowing me the opportunity to present this testimony today.

**FAILURE OF LEVEE SYSTEMS SURROUNDING GREATER NEW ORLEANS  
DURING HURRICANE KATRINA.- PRELIMINARY ASSESSMENT**

Committee on Homeland Security and Governmental Affairs - U.S. Senate

Written Testimony, Ivor Ll. van Heerden, Ph.D.  
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2<sup>nd</sup> November 2005

Abstract

Hurricane Katrina made landfall in Louisiana at 6:10 am on Monday 29<sup>th</sup> of August, 2005. After the storm 85 % of greater New Orleans was flooded, and about 1000 persons had lost their lives and approximately 100,000 families were homeless, being mostly families that had heeded the evacuation orders. The hurricane protection system that all residents of New Orleans depended upon; their security from surge floods; had failed catastrophically with over twenty breachings or breaks.

The flooding of New Orleans represents two separate flooding events, distinct in time, space and intensity. In eastern New Orleans levee failure accompanied a surge overtopping event, flooding surrounding communities; in western New Orleans catastrophic levee failure caused the flooding. Preliminary findings by the State of Louisiana Forensic Data Gathering Team are that in the case of the 17<sup>th</sup> Street Canal, London Ave Canal and the Industrial Canal, levee collapse and flood breaching reflected unstable soil conditions and a lack of foundation support and water percolation seals, given the soft, porous and highly organic nature of the soils. In the case of the Industrial Canal, levee overtopping may have hastened the structure's collapse.

ADCIRC Storm Surge Modeling

The Hurricane Public Health Research Center at LSU has developed an operational version of the ADCIRC storm surge model that has been in use since 2002 in support of hurricane emergencies. Basically, we take an official advisory from the National Hurricane Center and then convert that meteorological data via a super computer and the necessary numerical computational code into a graphic that represents the expected surge for that particular advisory. Each surge model run takes 5-7 hours to complete from the time of the National Hurricane Center advisory is posted on the Internet till the time we put our output on the Internet ([www.hurricane.lsu.edu/floodprediction/](http://www.hurricane.lsu.edu/floodprediction/)). Our output is sent to a large listserv consisting of emergency management officials from Federal, State, and local government, NGO's and the media. The same product is sent to the Louisiana State University (LSU) staff at the State Emergency Operations Center (EOC) in Baton Rouge where all officials are briefed on the latest surge model outputs. At 10:00

pm on Saturday 28<sup>th</sup> August 2005, 32 hours before landfall, we put out an email and warned that New Orleans would flood as the surge would overtop the levee system especially in Orleans East and St Bernard Parish. We warned that we expected levee erosion. We also reminded the emergency managers assembled at the State EOC that during Hurricane Betsy (1965) the Industrial Canal had been breached and that if we lost levees the flooding would be far more severe than the model depicted.

The ADCIRC model is an ideal forensic tool as it allows us to hindcast the actual surge conditions for any hurricane at any point in the study area and can generate a hydrograph – a graph of how the water level changed with time during the surge event.

#### Nature of the Surge Event

The surge due to Hurricane Katrina consisted of two distinct flooding events, separated in time, space and intensity. East of the track the surge of 15-18 feet above sea level reflected that caused by the winds of a Category three or four storm (120 mph). West of the eye and especially over Lake Pontchartrain the maximum surge was 10-11 feet and winds those of a Category 1 storm (72-76 mph). The surge on the east side rose much quicker and peaked before that on Lake Pontchartrain. We have been collecting data from stopped hand dial clocks in order to determine just when each levee section failed. While the 'stopped clock' data is still preliminary we will present some of the times.

#### General "I" Wall Levee Design

The "I" wall levees consist of linked steel pilings approximately 18 inches wide hammered into the ground to a set depth and then a concrete wall (monolith) is built over the upper few feet of the steel pilings. Reinforcing bars are passed through holes in the sheet piling and then cemented into the monolith structure. At least one contractor complained the structure was not stable due to the soft soils.

#### The 17<sup>th</sup> Street Canal Breachings

The original canal was dredged in the 1890's and the material excavated from the canal placed along the banks. The "I" walls that failed were built in the early 1990's. At the time of construction the original sheet piling was driven down into the ground. Shortly thereafter, because off an approaching storm, the pilings were all pulled out back up to their original elevations. Once the storm threat was over the pilings were then pushed back into the soft soil. These actions of push, pull, and then push greatly weakened the soils. Based on the design memorandum that we found in the files of the Louisiana Department of Transportation and Development, the pilings at the breach extended to a depth of 10 feet below sea level. At or around the time the pilings were being resunk the canal was dredged to a depth of 18.5 feet below sea level. Thus there was a linear depth of 8.5 feet of canal that was not "blocked" by sheet piling allowing the potential of a lateral flow of water under the pilings from the canal. According to local residents, their back yards adjacent to the canal were at times quite wet even when there had been no rains, suggestive of a canal seep, i.e. water making its way from the canal via seeps into their yards – a sign of trouble to come?.

The 17<sup>th</sup> Street breach occurred at approximately 10:15 am on the 29<sup>th</sup> August, 2005, one hour after the peak of the surge when the water level was about 9 feet above sea level. During Katrina a 200 foot section of the levee slid sideways 35 feet in a classical example of a lateral slide failure – a pressure burst. Adjacent to this slide the levee wall segments, that were not interlocked, were flattened by the flow, a number seemingly shearing off their piling foundations. A lateral slide of this nature with some rotation of the levee wall segments during the slide occurs because of foundation failure. A 200 linear foot length of levee slide is indicative of catastrophic structural failure. The backyards of residents adjacent to the levee were heaved up and a former flat terrain was now made up of hummocky dunes – homes, cars and buildings were all heaved up into strange skewed juncture positions by the ‘bull dozing’ of the levee slide.

The levee at the breach was built on top of a highly organic marsh and peat with soft clays – a very porous and weak medium. This highly organic soil was used to create the levee embankment when the canal was originally excavated. A sand layer is present 30 feet below the surface. Once this former swamp was drained for development, the organic matter in these originally flooded soils would have decomposed rather rapidly due to exposure to the air (oxygen) and would have lost some of their strength as well as becoming more porous. Potential conduits for water percolation from the canal between the bottom of the pilings and the canal floor, under pressure of the Katrina surge, would have been via the porous and weak soil embankment; the peat old marsh layer; and even the deeper lying sands. Our preliminary finding is that this canal levee “T” wall design in these very weak soils and substratum, was an accident waiting to happen. At the very least the sheet piling should have been sunk to 60 feet below sea level.

#### London Ave (West) Filmore Breach

The “T” wall design of the levee at this breaching is basically the same as that at the 17<sup>th</sup> Street Canal site. The steel pilings appear to have extended to about 11.4 feet below sea level. Once again the canal floor was substantially deeper than the piling being 18-19 feet below sea level. The levee breach is a smaller version of what happened on the 17<sup>th</sup> Street Canal, there was a lateral slide of the levee embankment and “T” wall and a heave of the back yards of local residents adjacent to the heave. The wall segments on either side of the slide collapsed downwards with the flow. Because the underlying substrate consisted predominately of old beach sands, an enormous amount of sand was carried by the flood into the subdivision at the breach.

The levee at the breach was built on top of a highly organic marsh and peat – a very porous and weak medium. This highly organic soil is believed to have been used to create the levee embankment when the canal was originally excavated. A 50 foot thick sand layer is present 10 feet below the surface. These sands are very porous. Once this former swamp was drained for development, the originally flooded organic soils would have decomposed rather rapidly due to exposure to the air (oxygen) and would have lost some of their strength as well as becoming more porous. The sand layer appears to have been exposed on the floor of the canal after it was dredged around 1990. Potential conduits for water percolation from the canal between the bottom of the pilings and the canal floor, under pressure of the Katrina surge, would have been via the porous and weak soil

embankment; the peat old marsh layer; and especially the deeper lying sands. Sand boils and even blowouts through the substrate under the sheetpile will explain most of the sand in the adjacent residents' back yards. Our preliminary finding is that this canal levee "T" wall design in these very weak soils and substratum, was an accident waiting to happen. At the very least the sheet piling should have been sunk to 80 feet below sea level.

The east bank levee of the London Ave canal at Filmore is bowed, tilted back and cracked in a number of places. There is evidence of sand boils, heaves, and other signs of soil instability. The question could be asked why the walls did not fail at this point? It appears that the sheet piling was sunk to a depth of 26 feet on the east side of the canal at Filmore as against the 11.4 feet where the west breach occurred. This relative difference in sheet piling depth may indicate why the east side at Filmore did not fail, but nevertheless even sheet piling to a depth of 26 feet below sea level was not sufficient.

#### London Ave (East) Mirabeau Breach

The "T" wall design of the levee at this breaching is basically the same as that at the 17<sup>th</sup> Street canal breaching. The steel pilings appear to have extended to about 26 feet below sea level. The levee breach is similar to that of Filmore except the extent of any heave is unknown. Because the underlying substrate consisted predominately of old beach sands, an enormous amount of sand was carried by the flood into the subdivision at the breach.

The levee at the breach was built on top of a highly organic marsh and peat – a very porous and weak medium. This highly organic soil is believed to have been used to create the levee embankment when the canal was originally excavated. A 50 foot thick sand layer, very porous, is present 10 feet below the surface. Once this former swamp was drained for development, the originally flooded organic soils would have decomposed rather rapidly due to exposure to the air (oxygen) and would have lost some of their strength as well as becoming more porous. The sand layer appears to have been exposed on the floor of the canal after it was dredged around 1990. The main conduit for water percolation from the canal under these 26 foot deep pilings, due to the pressure of the Katrina surge, would have been via the beach sands. The walls segments all sag and dip down towards the center of the breach. Those in the center appear to have collapsed outwards. The sagging and dropping (lowering) of the wall segments as one approaches the center of the breach suggests that there was a blowout due to water under pressure escaping from the canal below and under the pilings using the porous sand layer as the pathway. The blowout and subsequent loss of sand substrate would create a void that the wall segments would then collapse into and in this way the structural integrity of the "T" wall segments was destroyed. The huge amounts of clean white sand to be found in the subdivision adjacent to the breach attest to this failure mode. So even though the sheet piling was deeper than at the Filmore West breach, it was still not deep enough. Thus it can be considered that the bowed and tipping wall segments, with sand boils and small heaves on the east bank opposite from the Filmore breach, are indicate of an earlier stage of the Mirabeau breach. If it had not failed at Mirabeau it would have failed at Filmore on the east side. Again this explains most of the sand in the adjacent residents' back yards.

Our preliminary finding is that this canal levee "T" wall design in these very weak soils and substratum, was an accident waiting to happen. At the very least the sheet piling should have been sunk to 80 feet below sea level.

#### Industrial Canal Breachings

The "T" wall design of the levee at this breaching is basically the same as that at the 17<sup>th</sup> Street canal breaching. The steel pilings appear to have extended to about 10 feet below sea level. The canal is much deeper than 10 feet below sea level. There are two major breachings on the Industrial Canal south of its junction with the Gulf Intra Coastal Waterway. The breachings appear to have occurred before the peak of the surge when the water level was at the top of the levee wall (7:15 am).

On first inspection, because of the scour trench (generally 3x4 feet) behind the levee wall (landward side), one can assume that the failure was due to the scour trench excavating its way down to the base on the pilings and then the whole system failed catastrophically due to the pressure of the water. However, if one inspects the wall segments between the two breachings, the scour trench seems to be fairly uniform in size but one sees that the levee wall has two areas with very distinct bows and the walls are tilted backwards - features similar to the London canal on its east side at Filmore. Inspection of the soil embankment on the canal side of these bowed sections reveals that the soil is highly cracked, that long wide sections of soil have slipped down about 12 - 18 inches and there is evidence of 'down percolation holes'. These are scour-like structures created when the water under pressure moves down the cracks and eventually finds its way under the piling and starts to scour a passageway leading to sand boils which then sets the stage for a failure.

The levee at the breaches was built on top of a 10-foot thick highly organic marsh and peat with very soft clays - a very porous and weak medium. This highly organic very soft clay soil is what was used to create the levee embankment when the canal was originally excavated. A layer of very soft to soft clays with silt and sand lenses is present 15 feet below the surface. Once this former swamp was drained for development, the originally flooded organic soils would have decomposed rather rapidly due to exposure to the air (oxygen) and would have lost some of their strength as well as becoming more porous. Potential conduits for water percolation from the canal between the bottom of the pilings and the canal floor, under pressure of the Katrina surge, would have been via the porous and weak soil embankment; the peat old marsh layer; and even the deeper lying clays with porous sand and silt lenses. The down percolation holes created due to the tilting of the walls under pressure of the surge would also have weakened the levee system. It is very important to note that the soil borings all indicate very soft or soft clays, not ideal foundation material.

While the ADCIRC data indicate the failure of these Industrial canal levees occurred at the time overtopping had just started to occur; overtopping would have helped to weaken the soil embankment behind the levees. Just why the levees failed exactly where they did is still a question to be answered, but the failure of the Industrial Canal levees is indicative that this canal levee "T" wall design in these very weak soils and substratum,

was an accident waiting to happen. At the very least the sheet piling should have been sunk to 70 feet below sea level.

#### Conclusions

While Hurricane Katrina was a major hurricane, our preliminary findings are that failure of the 17<sup>th</sup> Street and London Ave canal levees was due to a design that did not account for the very weak nature of the soils. The design criteria of these levees was not exceeded. The design also did not take into account the very high porosity and permeability of these soils. It was a geotechnical engineering failure.

The same conclusion can be made for the Industrial Canal levees that failed during Katrina, although surge overtopping no doubt enhanced their collapse.

Most of the flooding of New Orleans was due to man's follies. Society owes those who lost their lives, and the approximately 100,000 families who lost all, an apology and needs to step up to the plate and rebuild their homes, and compensate for their lost means of employment. New Orleans is one of our nations jeweled cities. Not to have given the residents the security of proper levees is inexcusable.

**Ivor van Heerden**

Ivor van Heerden has been deputy director of the Louisiana State University Hurricane Center since 1999 and director of the Center for the Study of Public Health Impacts of Hurricanes, a Louisiana Board of Regents Health Excellence Fund Center, since 2001. A native of South Africa, he received his undergraduate degree in geology from the University of Natal in South Africa, and a masters and doctorate in Marine Sciences from Louisiana State University (LSU). Ivor has been involved in natural disaster research projects in various parts of the world and played a key part in the dissemination of information on the impacts of Katrina during the emergency. Presently he is leading the State of Louisiana's official forensic data gathering team as concerns the failure of the levees in New Orleans and the consequences for those who lost their homes.



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***Hurricane Katrina: Why Did the Levees Fail?***

**Testimony of**

**Peter Nicholson, Ph.D., P.E.**

**Associate Professor of Civil and Environmental Engineering and  
Graduate Program Chair**

**University of Hawaii**

**On behalf of the**

**AMERICAN SOCIETY OF CIVIL ENGINEERS**

**Before the**

**Committee on Homeland Security and Governmental Affairs**

**U.S. Senate**

**November 2, 2005**

*Hurricane Katrina: Why Did the Levees Fail?*

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Mr. Chairman and Members of the Committee:

Good morning. My name is Peter G. Nicholson, and I am pleased to appear before you today to testify on behalf of the American Society of Civil Engineers<sup>1</sup> (ASCE) as you examine the effect of Hurricane Katrina on the infrastructure of coastal Louisiana, particularly the levee system that protects the city of New Orleans.

I am a member of ASCE and the chair of the ASCE Geo-Institute's Committee on Embankments, Dams and Slopes. I was asked by ASCE to assemble an independent team of experts to travel to New Orleans to collect data and make observations to be used to assess the performance of the flood control levees.

As engineers, our paramount concern is for the safety, health and welfare of the public. We believe there is a tremendous opportunity to learn from the tragedy of New Orleans to prevent future loss of life and property.

The purpose of our site visit was to make observations and gather information about the failure of the levees, including that data that would be lost ("perishable data") during the process of levee repair and the passage of time. This included evidence such as high water marks and indicators of overtopping, and evidence of any foundation movement or failure.

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<sup>1</sup> ASCE, founded in 1852, is the country's oldest national civil engineering organization. It represents more than 139,000 civil engineers in private practice, government, industry, and academia who are dedicated to the advancement of the science and profession of civil engineering. ASCE carried out Building Performance Assessments of the World Trade Center, the Pentagon and the Murrah Federal Building, and its technical assessments following earthquakes, hurricanes, and other natural disasters. The New Orleans levee technical group includes representatives appointed by the ASCE Geo-Institute and ASCE Coasts, Oceans, Ports, and Rivers Institute. ASCE is a 501(c) (3) non-profit educational and professional society.

One of the goals of the assessment team was to gather data in an attempt to determine why certain sections of the levee system failed and why others did not. These determinations may help to answer the question of whether the failures were caused by localized conditions or whether surviving sections of the system may be only marginally better prepared to withstand the type of loads that were generated by this event.

Following the first week in the field gathering data, we presented a press release on October 7, 2005, describing our initial observations concerning the performance of the levee system during and after Hurricane Katrina. We believe that our joint team knows, at least in principal, how the levees in New Orleans failed; the exact details await further analyses.

#### **I. ASCE New Orleans Levee Assessment Team**

The team assembled consisted of professional engineers from ASCE with a range of geotechnical engineering expertise in the study, safety and inspection of dams and levees. While in New Orleans and the surrounding areas, we examined levee failures as well as distressed and intact portions of the levee system between September 29 and October 15.

Our levee team was joined by another ASCE team of coastal engineers, including two colleagues from the Netherlands and Japan, both countries challenged by their geography to design against natural disasters from the sea, and another team primarily from the University of California, Berkeley, under the auspices of the National Science Foundation. Our three teams were joined by a U.S. Army Corps of Engineers' Engineering Research and Development Center (ERDC) team, led by Dr. Paul Mlakar. We would like to thank Dr. Mlakar and the ERDC team for their logistical support.

#### **II. Observations by Sites and Areas**

What we found in the field was very different than what we had expected, given what we had seen in the media reports. Rather than a few breaches through the floodwalls in the city caused largely by overtopping, we found literally dozens of breaches throughout the many miles of levee system. A number of different failure mechanisms were observed, including scour erosion caused by overtopping, seepage, soil failure, and piping.<sup>2</sup> As geotechnical engineers, we were particularly interested to find that many of the levee problems involved significant soil-related issues.

##### **A. 17th Street Canal**

At the 17th Street Canal breach, we observed intact soil blocks that had experienced large translation and heave. This movement would be consistent with a failure either of

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<sup>2</sup> Piping, sometimes referred to as internal erosion, is a channel caused by the flow of water through a dam or embankment. It may increase rapidly and cause catastrophic failure of the embankment.

the soil embankment or the foundation soils beneath. There was no evidence of overtopping at this site. While we cannot yet determine conclusively the cause of the breach itself, this type of soil failure may well have been a significant contributing factor. Further investigation, together with analyses and review of the design and construction documents, should be of tremendous assistance in ultimately making these kinds of determinations.

#### **B. London Avenue Canal – North**

At the north breach on the London Avenue Canal, we observed a large displaced soil mass, which had been heaved nearly vertically over six feet, apparently indicating the toe of a rotational-type soil failure. Again, there was no evidence of overtopping at this site. Field inspection also showed a large amount of sandy soil deposited in the neighborhood landward of the breach, which is believed to be material from the foundation beneath the embankment together with material scoured from the canal bottom. This is consistent with the soil profiles provided to us which showed sand in the subsurface near this location. Under high water pressure, the flow through this type of material can be significant, which is known to cause internal stability problems.

#### **C. London Avenue Canal – North, Across from Breach**

Of particular interest was the levee section almost directly across from the north breach on the London Avenue Canal, where we observed a floodwall and underlying embankment that was in severe distress.

This site provided an excellent case study demonstrating multiple, concurrent failure mechanisms. It was observed that this section of floodwall was distressed to the point that it appeared that it might have been approaching failure when the water loading was relieved as the other breaches occurred. The wall was badly out of alignment and tilting landward; as a result of the tilt, there were gaps between the wall and the supporting soil on the canal or waterside. Also observed were evidence of soil movement, seepage and piping, as indicated by a series of sinkholes near the crest, together with "boils"<sup>3</sup> and heave at or near the inboard toe<sup>4</sup> of the embankment.

#### **D. London Avenue Canal – South**

To the south was another breach on the London Avenue Canal. That breach had apparently cut so deeply that huge volumes of sandy material had been scoured from the canal bottom and then deposited up to five feet deep extending hundreds of feet into the neighborhood. Very little evidence remained to be gathered at this site and the causes and mechanisms of the breach may never be known. It was, however, again

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<sup>3</sup> A boil (or "blow") is a flow of soil, usually in the form of fine sand or silt, into the bottom of an excavation. The flow is forced in by water or water and air under pressure. It may increase rapidly and cause catastrophic failure.

The toe is the base of the slope (in the case of dam or levee) on the side away from the water.

demonstrated by high water marks that the floodwall most likely was not overtopped at this location.

#### **E. Outside New Orleans**

It is important that the impact of the levee breaches outside of the city of New Orleans not be overlooked. Many sections of the system were severely tested by overtopping from a direct onslaught of the storm surge. Many portions of these levees were breached and/or severely distressed, causing severe flooding and, in many cases, complete destruction of thousands of neighborhood homes. Some of the levee sections were nearly obliterated and were observed to have been constructed of highly erodable materials.

### **III. Hurricane Katrina: Why Did the Levees Fail?**

#### **A. The Levee Failures**

Hurricane Katrina was a catastrophic storm that made landfall in the Gulf Coast near the Louisiana and Mississippi border with wind speeds near 150 mph. But the damage in New Orleans due to the high winds and rain paled in comparison to the devastation resulting from the flooding.

The hurricane produced a storm surge that varied considerably depending on location, including the combined effects of orientation, geography, and topography with respect to the forces of the passing storm. Hydraulic modeling of the surge, verified by the most part by our own field observations of high water marks, show that essentially two significantly different levels of storm surge impacted the levee system.

As the storm passed to the east of New Orleans, the counterclockwise "swirl" of the storm generated a large surge from the Gulf of Mexico and Lake Bourne that impacted the eastern facing coastal areas of the New Orleans area and lower Mississippi delta. The surge was then concentrated into the channels of the Mississippi River Gulf Outlet (MRGO) that fed into the Inner Harbor Navigational Channel (IHNC). The funneling of the surge in these channels resulting in widespread overtopping of the levees.

In contrast, a somewhat separate surge that originated in Lake Pontchartrain was generated in part by the flow in from the Gulf of Mexico but also from the north winds across the lake. As shown by the models and field evidence, this surge, which impacted the lakefront and three canals within the central part of the city, was notably less severe. Field data indicated that the surge levels from the lake did not reach the elevation of the lakefront levees and was well below the top height of the floodwalls bordering the interior canals where three notable breaches occurred.

Where the storm surge was most severe, causing massive overtopping, the levees experienced a range of damage from complete obliteration to intact with no signs of distress. Much of the difference in the degree of damage can be attributed to the types

of levees and the materials used in their construction. The majority of the most heavily damaged and/or destroyed earthen levees that we inspected were constructed of sand or "shell fill" which was easily eroded.

At some of these locations the earthen embankments were simply gone. Those with embedded sheetpiles fared only marginally better and were often breached as well. Further inland, in the western portion of the MRGO and along the Inner Harbor Navigation Canal, the degree of overtopping was less severe but again resulted in a number of breaches. Many of these breaches occurred through I-wall structures that were severely scoured on the landside as a result of overtopping. These scour trenches undermined the support of the levee floodwalls and reduced the ability of the walls to withstand the forces of the water on their outer surfaces. Localized concentrations of overtopping water flow or possible localized weaker soils may have been responsible for why certain portions of the system were breached while others remained intact.

Another commonly observed problem was the frequent presence of "transitions" between different sections of the levees. There were a number of different types of these transitions that appeared to have caused problems, including inconsistent crest heights, change in levee type (I-wall vs. T-wall), change in material (concrete, steel sheetpile, earth), and transitions where certain rights-of-way resulted in penetrations of the flood control system.

Where levees were overtopped, the weaker material at the point of transition (i.e., earth to concrete, sheetpile to concrete, earth to sheetpile) would be more susceptible to failure. Many of the problems we observed appeared to have been related to transition details and were often exacerbated by inconsistent crest heights, particularly where the weaker material had the lower height. Many of these transitions were found at sections where infrastructure elements designed and maintained by multiple authorities, and their multiple protection elements, came together, and the weakest (or lowest) segment or element controlled the overall performance.

Finally, three major breaches, and at least one significantly distressed levee-floodwall section, were investigated at sites along the 17th Street and London Avenue canals which, as explained before, were clearly not overtopped.

Obvious soil failures within the embankment or foundation soils at or below the bases of the earthen levees had occurred at two of the breaches. At the distressed section, seepage and piping were evident. These types of soil instabilities appear likely to have been responsible for failure of these wall systems.

Evidence of piping erosion at one these sites serves to illustrate the severity of the underseepage at high water stages. Another possibility that also needs to be investigated, however, is the potential presence of a weak soil unit (either within the

lower embankment, or in the underlying foundation soils) with sufficiently low shear strength that it may have failed.

Additional studies will need to be performed at these breached and distressed locations to better determine embankment and foundation soil conditions, and appropriate seepage flow and shear strength characteristics, so that the mechanisms that led to the observed failures at these sites can be conclusively determined.

#### **B. Recommendations**

Preparing the levees for the next hurricane season should include a review of how the system performed during Hurricane Katrina, so that key lessons can be learned to improve the performance of the system. Based on our observations, a number of initial comments are warranted concerning the rebuilding and rehabilitation of the levee system.

While levee failures may be expected when overtopping occurs, the performance of many of the levees and floodwalls may have been significantly improved, and some of the failures likely prevented, with relatively inexpensive modifications of the levee and floodwall system.

The following specific points need to be dealt with in New Orleans:

- The levees need additional overtopping protection at the inboard sides of the floodwalls to minimize erosion.

Crest heights of the levees need to be planned in a systematic and deliberate way, so that if and when overtopping does occur, it occurs preferentially at the desired locations along any given section of levee's floodwall frontage where the walls are more robust or designed to better resist overtopping.

Transitions should be improved so that they do not represent locations of potential weakness in otherwise contiguous perimeter flood protection systems.

In addition, larger issues should be addressed as well.

- ASCE believes that Congress should enact a National Levee Inspection and Safety Program modeled on the successful National Dam Safety Program. The levee program should include a national inventory of levees, particularly those that protect large, heavily populated urban areas.
- ASCE supports the efforts to reduce coastal land loss in the Louisiana coastal area, an area that has been named America's Wetland because of its national importance. ASCE urges continued support of the existing program for Louisiana

coastal wetlands, funded by the Coastal Wetlands Planning, Prevention, and Protection Act (CWPPPA). ASCE also supports the ongoing effort to implement the comprehensive Louisiana Coastal Area (LCA) Program, which will further reduce land loss and provide additional preservation.

- We must discourage new development in the floodplain unless there is a pressing need for it and adequate protection can be provided. Population centers must be given a higher level of protection than most now have.
- We must use all the tools available to reduce damages. This means use of not only structural means such as levees, floodwalls, and dams, but also non-structural approaches such as flood resistant design, voluntary relocation of homes and businesses, revitalization of wetlands for storage, and use of natural barriers such as the Louisiana wetlands.
- Congress needs to consider seriously whether to establish a more stringent national flood control policy that emphasizes the need to protect human life from a 500-year flood.<sup>5</sup>

The American Society of Civil Engineers (ASCE) believes Congress should establish an independent advisory panel to envision the future of the Gulf Coast and to recommend ways to begin the rebuilding of the areas that were devastated by Hurricane Katrina on August 29. The panel should consist of technical experts from a number of disciplines who would provide an objective review of all design and construction issues relating to the reconstruction of the areas covered by the President's major disaster declarations for Louisiana, Mississippi, and Alabama. The unpaid body would cooperate with and advise all federal, state, and local agencies involved in the reconstruction effort in the affected region.

As we see it, the Advisory Group charter would:

Work as the primary advisor to all state and local governments on the rebuilding of the region, with the primary goal of helping hundreds of thousands of present and future residents of the areas to enjoy a secure and prosperous future.  
Consist of experts from engineering, architecture, urban planning, and other design and construction-related fields.

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<sup>5</sup> A 500-year-flood is so big and rare that it will normally happen only once every 500 years. That doesn't mean that a 500-year-flood can't happen the year after a 500-year-flood. Every flood season has exactly the same chance—one in 500—of producing a 500-year-flood, even in area that experienced a 500-year-flood the season before. In other words, it is the flood that has a 0.2 percent chance of occurring every year. A 100-year flood, on the other hand, is used by the National Flood Insurance Program as the standard for floodplain management and to determine the need for flood insurance. A 100-year flood is based on a one percent chance of a flood's occurring in a given year.

Develop recommendations that would include strategies to minimize the impact of future storm events and other natural hazards.

Provide expert advice on the design and construction of the region's damaged public facilities, including port and harbor installations; lifelines; wastewater and drinking-water plants; airports and airfields; waste-management and disposal facilities; mass transit and public transportation services; roads, bridges, and tunnels; public buildings; and other key infrastructure.

Ensure that the reconstruction efforts take into account the latest technologies in the prevention and mitigation of future harm to public and private buildings from severe windstorms and floods.

Serve as link to federal agencies working in support of the reconstruction effort. Function in an advisory capacity only, having no authority to mandate particular design, construction, or environmental solutions.

#### **IV. Conclusion**

Other potentially important lessons will be learned in the months ahead, and that some of these are also likely to be useful in moving forward with the ongoing repair and long-term rebuilding of the New Orleans regional flood protection systems.

As much of the population is currently being permitted to re-occupy portions of the New Orleans area, doing everything possible to ensure the safety of these people and their neighborhoods must continue to be the highest priority.

Mr. Chairman, this concludes my testimony this morning. I would be pleased to answer any questions you may have.



### Southeast Louisiana Hurricane Protection System



US Army Corps  
of Engineers

- **Repair:**
  - Return pre-Katrina protection to hurricane-damaged components by 1 June 2006
- **Restore:**
  - Restore undamaged levees/floodwalls to originally authorized heights by 1 Sep 2007
  - Correct Floodwall Deficiencies
- **Complete:**
  - Accelerated completion of unconstructed portions of authorized projects by Sep 2007
- **Improve:**
  - Make improvements to optimize the performance of the existing system
- **Certify:**
  - Raise system to provide 100 year level of protection by 2010
- **Evaluate Higher Levels of Protection:**
  - Louisiana Coastal Protection and Restoration Report - preliminary report due June 2006, final December 2007

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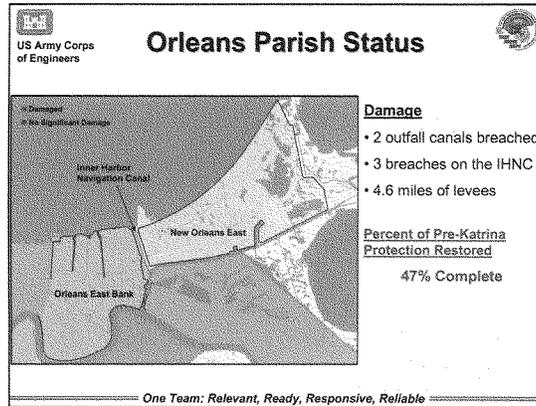
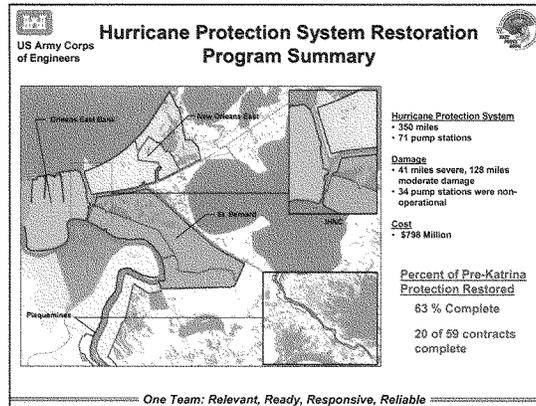
### New Orleans and Vicinity Hurricane Protection System Emergency Supplemental Funding to Date (\$M)

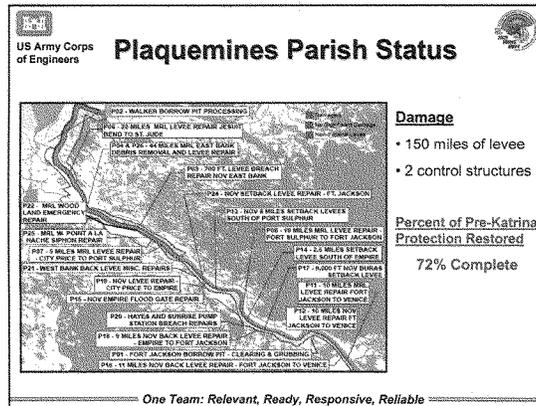
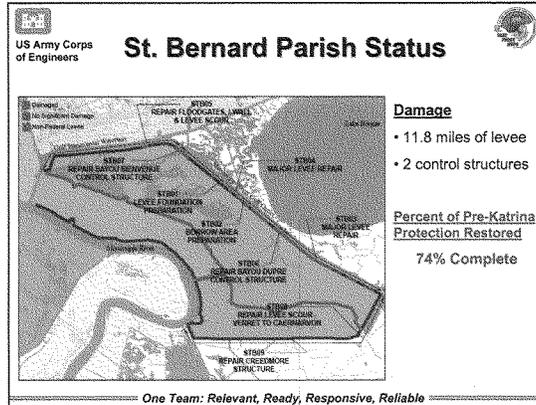


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of Engineers

Component	Funded
Repair Existing System and Rebuild to Design Height	\$1,332
Complete Authorized System	
New Orleans to Venice (Hurricane Protection)	\$ 33
West Bank and Vicinity (Hurricane Protection)	\$147
Lake Pontchartrain and Vicinity (Hurricane Protection)	\$120
Southeast Louisiana Interior Flood Damage Reduction	\$225
Grand Isle (Hurricane Protection)	\$ 15
Lafosse to Golden Meadow (Hurricane Protection)	\$ 4
TOTAL	\$2,077 M

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### Southeast Louisiana Hurricane Protection



US Army Corps  
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**ADDITIONAL IMPROVEMENTS**

The Bush Administration on Feb. 16 asked Congress to support an additional \$1.46 billion in new funding for improvements to southeast Louisiana's hurricane protection system. If approved, the proposal would pay for:

• Permanent pumps and closures for New Orleans' three outfall canals.	<b>\$530 million</b>
• Two navigable closures that would prevent hurricane surge from entering the Industrial Canal area.	<b>\$350 million</b>
• Storm-proofing existing interior drainage pump stations in Jefferson and Orleans Parishes.	<b>\$250 million</b>
• Selective armoring for critical portions of the New Orleans levee system.	<b>\$170 million</b>
• Incorporation of Plaquemines Parish west bank, non-federal levees into the federal levee system.	<b>\$60 million</b>
• Restoration of critical areas of coastal wetlands and ecosystems needed to improve long-term hurricane and storm protection.	<b>\$100 million</b>

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### Southeast Louisiana Hurricane Protection System



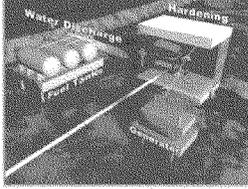
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Pending Supplemental Request



**Permanent Pumps & Closures**

**\$530,000,000**



**Storm-Proofing Pump Stations**

**\$250,000,000**

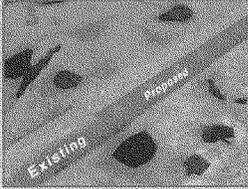
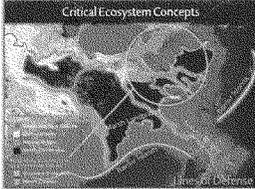
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### Southeast Louisiana Hurricane Protection System

Pending Supplemental Request

Critical Ecosystem Concepts



**Wetlands and Ecosystem Restoration**  
\$100,000,000

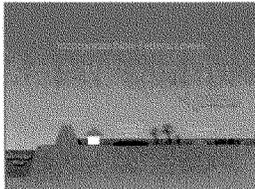
**Selective Armoring**  
\$170,000,000

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### Southeast Louisiana Hurricane Protection System

Pending Supplemental Request



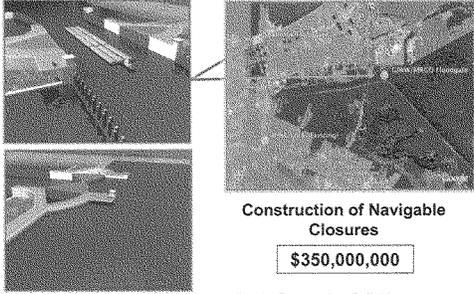
**Incorporation of non-federal levees in Plaquemines**  
\$215,000,000

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### Southeast Louisiana Hurricane Protection System

Pending Supplemental Request



**Construction of Navigable Closures**

**\$350,000,000**

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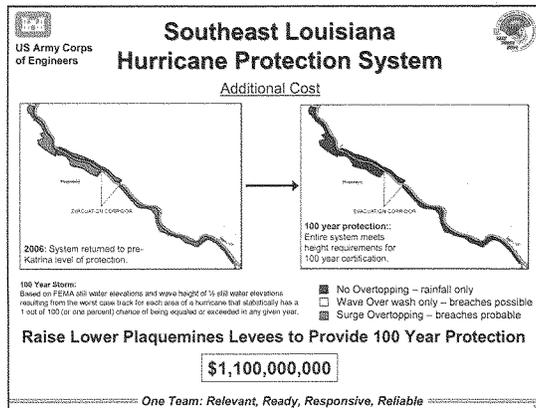
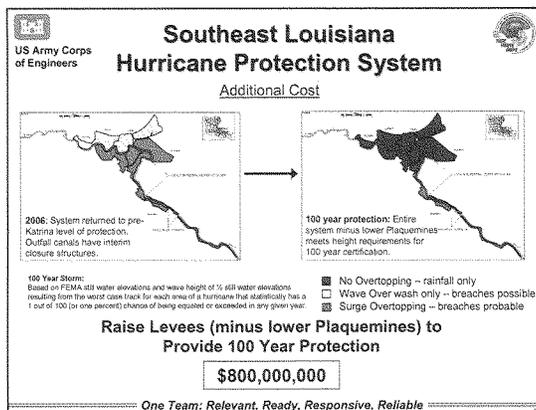
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### Estimated Cost to Provide Protection to Base Flood Elevation (Billions)

Previously Appropriated Funds	\$2.08	
Pending Supplemental Request	\$1.46	
<b>Total Funds Provided/Requested</b>	<b>\$3.54</b>	
Additional Cost for New Orleans Metro Area and Belle Chase		
• Floodwalls	\$1.6*	} <b>\$2.5</b>
• 100-year Protection	\$0.8	
• Non-Federal Levees (West Bank of Plaquemines)	\$0.2	
Additional Costs for Lower Plaquemines Parish		
• T-Walls	\$0.5	} <b>\$1.6</b>
• 100-Year Protection	\$1.1	
<b>Total Additional Costs</b>	<b>\$4.10</b>	

\* Assume 36 miles of floodwall replacement per IPET analysis

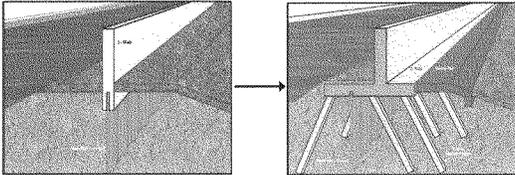
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**Southeast Louisiana Hurricane Protection System**

US Army Corps of Engineers

Additional Cost



**Worst Case Scenario:**  
Replace all 36 miles of floodwalls per IPET Analysis

\$500,000,000 for Lower Plaquemines
\$1,600,000,000 for Remaining HPS
<b>Total: \$2,100,000,000</b>

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**Levee Certification**

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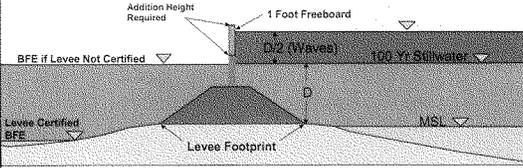
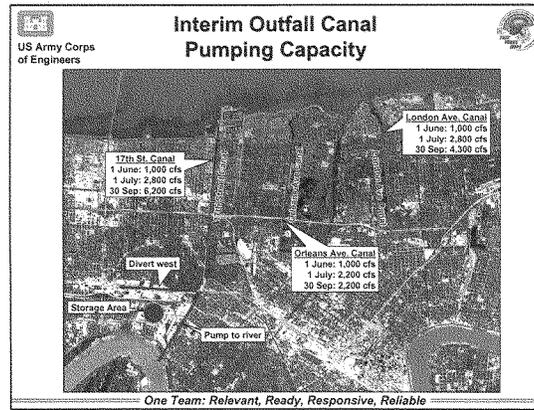
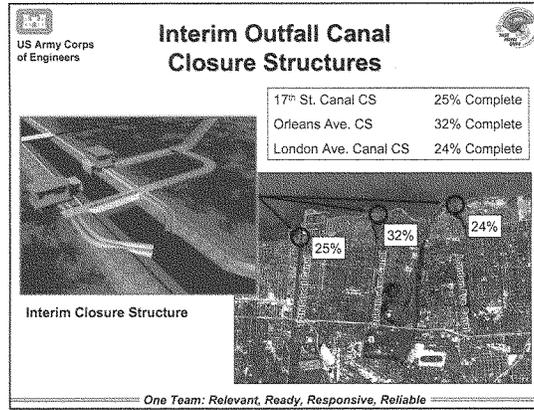


Diagram illustrating Levee Certification. Key features include:

- 1 Foot Freeboard
- D/2 (Waves)
- 100 Yr Stillwater
- MSL (Mean Sea Level)
- Levee Footprint
- Levee Certified BFE (Base Flood Elevation)
- BFE if Levee Not Certified
- Addition Height Required

as of 3/30/06

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## LA Coastal Protection and Restoration

**US Army Corps of Engineers**

**Congressional Direction Summary:**

- Analysis and design exclusive of normal policy considerations of:
  - Category 5 equivalent comprehensive hurricane protection
  - Full range of measures for flood control, coastal restoration, and hurricane protection
- Coordinate with State of Louisiana and its agencies as non-Fed sponsor
- Preliminary Report to Congress: \$8 M effort and Due June 2006
- Final Technical Report: \$12 M effort and Due December 2007
- Submit reports on component areas for authorization as practicable

**Status:**

- PDT Received USACE-CPRA guidance
- Formed USACE-CPRA Pgm/PM/PDT
- Held public scoping meetings to solicit planning input
- Held expert workshops to identify technical challenges and solution approaches
- Performed planning and technical analyses leading up to plan formulation
  - Drafting Preliminary Technical Report (PTR)
  - Formalizing plan for formulation process for Final Technical Report (FTR)
  - Finalizing PMP for FTR - Integrated LACPR and LCA PMT Meetings

Source: Act, 2006 (P.L. 109-148), and Department of Defense Appropriations Act, 2006 (P.L. 109-148), Chapter 2




## La Coastal Area Ecosystem Restoration

**US Army Corps of Engineers**

**CHIEF'S RECOMMENDATION - NEAR TERM PLAN**

<b>Programmatic Authorization</b>	
• Critical Restoration Features	\$828,300,000
• Science & Technology Program	\$100,000,000
• Demonstration Projects	\$95,000,000
• Beneficial Use of Dredged Material	\$100,000,000
<b>Total First Cost Features &amp; Programs Authorization Request</b>	<b>\$1,123,300,000</b>
<b>Related Investigations</b>	
• Investigations of Features Recommended for Authorization	\$31,000,000
• Investigations of Features for Future Authorization	\$39,000,000
• Investigations of Modification of Existing Projects	\$10,000,000
• Investigations of Demonstration Projects	\$5,000,000
• Investigations of Other Large Scale Concepts	\$60,000,000
<b>Total First Cost Related Investigations</b>	<b>\$145,000,000</b>
Features Anticipated for Future Authorization	\$728,200,000
<b>Total First Cost of Projects Authorized in Future</b>	<b>\$728,200,000</b>
<b>Total First Cost LCA Program</b>	<b>\$1,996,500,000</b>

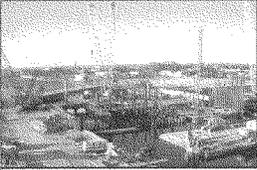
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**Current Project  
Progress Photos**

  
Claiborne Ave to Florida Ave Floodwall

  
Landside Levee Enlargement

  
17<sup>th</sup> St. Canal Closure Structure

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