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New Orleans Levees and Floodwalls: Hurricane Damage Protection

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Summary

Hurricane Katrina's storm surge breached floodwalls and levees surrounding New Orleans, causing widespread inundation and significant damage and hampering rescue and recovery efforts. Flooding from precipitation and storm surges flowing over levees was anticipated because of the hurricane's intensity; however, structural failure of the floodwalls and consequent flooding were uncertain. The immediate engineering and the underlying causes of the breaches are the subject of speculation, and likely will be the subject of investigations and congressional oversight. The breaches occurred at the *Lake Pontchartrain and Vicinity Project* being constructed by the U.S. Army Corps of Engineers and maintained by local levee districts. Those observers questioning why infrastructure providing a greater level of hurricane protection was not available are countered by those arguing that structural protections carry their own risks. This report will be updated as needed to track significant developments.

Flooding in New Orleans by Hurricane Katrina was predicted, but the extent of the inundation was uncertain. Because of the topography of the city — much of it below sea-level and lacking natural drainage — precipitation often causes local flooding which is controlled by a network of canals and pumps. Flooding as the result of overtopping of levees and floodwalls was predicted for a storm stronger than a fast-moving Category 3 hurricane; that is, it was expected that some water would flow over the levees and floodwalls based on Katrina's forecasted strength. Although the city did not receive Katrina's strongest force head-on, the levee and floodwall infrastructure's capability to protect the city was exceeded.

Failure (often called a breach) of levees and floodwalls reportedly was a contingency not central to emergency planning and response.[1] Four breaches along three New Orleans canals occurred as the result of Katrina. Failure is an inherent risk of any flood control structure, and can result in catastrophic damage. Breaches represent a structural failure,

[1] S. Shane and E. Lipton, "Government Saw Flood Risk but Not Levee Failure," *The New York Times*, Sept. 2. 2005.

which is distinct from overtopping of levees and floodwalls which happens when their design is exceeded. The causes of the multiple breaches in New Orleans are the subject of speculation, and likely will be the subject of investigations and congressional interest.

This report focuses on the city's levee and floodwall infrastructure; it does not cover emergency planning, mitigation, response, and recovery efforts or other parts of the nation affected by Hurricane Katrina. This report is divided into three sections. The first provides a primer on the levee and floodwall system surrounding New Orleans, with particular attention to the federal projects and the challenges of protecting the city. The second section focuses on the floodwalls where the breaches occurred: the *Lake Pontchartrain and Vicinity Project*. The third section discusses providing coastal Louisiana with Category 4 and 5 hurricane protection.

New Orleans Storm and Flood Damage Reduction Infrastructure

New Orleans faces flooding threats from the Mississippi River, coastal storms, and intense precipitation; the system of levees and floodwalls around the city is designed to provide a certain level of protection from these threats.[2] The complimentary system of pumps and canals is designed to remove water trapped in the city. The storm damage reduction infrastructure around New Orleans consists of levees and floodwalls, and represents a combination of federal and local investments and responsibilities. Levees are broad, earthen structures, while floodwalls are concrete and steel walls, built atop a levee or in place of a levee. Floodwalls are often used in urban areas because they require less land than levees. The floodwalls in New Orleans generally are 6 to 10 feet tall and a foot wide at the top and two feet wide at the base, and they stand on earthen foundations.

Federal Projects. Most of the nation's flood and storm damage reduction infrastructure is maintained by local governments and local levee districts; some of the infrastructure is locally built, while other projects are built by the federal government. The principal federal agency responsible for constructing flood, storm, and shore protection infrastructure is the U.S. Army Corps of Engineers (Corps).[3]

Congress has authorized the Corps to construct five hurricane protection projects for coastal Louisiana; the two most relevant to New Orleans are the *Lake Pontchartrain and Vicinity Hurricane Protection Project* and the *West Bank and Vicinity Hurricane Protection Project*. In 1999, the House Committee on Transportation and Infrastructure authorized, via a Committee Resolution, a *Hurricane Protection Louisiana* study to investigate providing Category 4 and 5 hurricane protection for coastal Louisiana that would encompass all five of the previously-authorized projects.[4] Congress also

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[2] For a map of this system produced by the *New Orleans Times-Picayune*, see [http://www.nola.com/hurricane/popup/nolalevees_jpg.html], visited on Sept. 6, 2005.

[3] For more on the Corps' water resources activities, see CRS Report RS20866, *The Civil Works Program of the Army Corps of Engineers: A Primer*, by Nicole T. Carter and Betsy A. Cody.

[4] Storm Categories are based on the Saffir-Simpson Hurricane Scale of 1-5, with Category 4 storms having 131-155 mile per hour (mph) winds and a 13- to 18-foot storm surge and Category 5 storms having winds exceeding 155 mph and surges above 18 feet.

authorized the *Southeast Louisiana Urban Flood Control Project* for pumping and canal improvements for Orleans, Jefferson, and St. Tammany parishes.

In addition, Congress has authorized a study of restoring and protecting coastal Louisiana's wetlands, which can buffer surges produced by some storms. Significant acreage of coastal Louisiana's wetlands have been converted to open water. This conversion is the result of many factors; some are human-induced, while others are natural processes. The most commonly cited human factors are (a) existing flood control and navigation improvements of the Mississippi River, which have reduced the natural processes of sediment nourishment of the coast, and (b) wetlands fragmentation and erosion from the oil and gas production infrastructure along Louisiana's coast, including the construction of numerous canals. The pending House and Senate versions of a Water Resources Development Act (WRDA) of 2005 (H.R. 2864 and S. 728) would authorize an initial $1.1 billion in efforts to restore these wetlands. For more information on coastal Louisiana wetlands loss and restoration, see CRS Report RL32673, *Coastal Louisiana: Attempting to Restore an Ecosystem*, by Jeffrey Zinn. For more information on WRDA legislation, see CRS Issue Brief IB10133, *Water Resources Development Act (WRDA): Army Corps of Engineers Authorization Issues in the 109th Congress*, coordinated by Nicole T. Carter.

Challenge of New Orleans Hurricane Protection. Protecting New Orleans has been an increasingly difficult task. First, the city has become increasingly vulnerable. Land in the city has subsided; barrier islands and wetlands buffering coastal Louisiana have been disappearing; and sea levels have risen. These factors have contributed to speculation that the existing storm damage protection infrastructure was not providing Category 3 protection. According to the project justification sheet included in the Administration's Corps FY2006 budget request, "the project was initially designed in the 1960s, and a reanalysis was performed for part of the project in the mid-1980s. Continuing coastal land loss and settlement of land in the project may have impacted the ability of the project to withstand the design storm."[5] Second, the greater New Orleans metropolitan area has been experiencing population and rapid economic growth resulting in greater numbers of people and more infrastructure and investments exposed to storm threats. The challenge of protecting New Orleans could become even greater. According to some scientists, higher sea surface temperatures may result in increased hurricane intensity.[6] Climate change concerns and other factors have raised questions about whether both estimates of the likelihood of hurricanes of various strengths and past decisions based on these estimates need to be re-evaluated.

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[5] U.S. Army Corps of Engineers, *Fiscal Year 2006, Mississippi Valley Division,* visited Sept. 3, 2005, available at [http://www.usace.army.mil/inet/functions/cw/cecwb/just_states06/mvd.pdf].

[6] For example, see Intergovernmental Panel on Climate Change, *Climate Change 2001: Working Group II: Impacts, Adaptation and Vulnerability*, visited on Sept. 3, 2005, available at [http://www.grida.no/climate/ipcc_tar/wg2/029.htm], or T.R. Knutson and R.E. Tuleya, "Impact of CO2-Induced Warming on Simulated Hurricane Intensity and Precipitation: Sensitivity to the Choice of Climate Model and Convective Parameterization," *Journal of Climate*, 15 Sept. 2004, 17 (18), available at [http://www.gfdl.noaa.gov/reference/bibliography/2004/tk0401.pdf].

Lake Pontchartrain and Vicinity Project

Breaches and Flooding. Some parts of New Orleans were flooded by Hurricane Katrina's precipitation and overtopping of levees, but the major source of flood waters appears to have been the floodwall breaches of the Lake Pontchartrain and Vicinity Project. The immediate and underlying causes of these breaches are the subject of much speculation, ranging from poor or exceeded design, to faulty construction, to poor maintenance, to slow construction due to limited Corps appropriations.

According to the Corps,[7] the breaches were at floodwalls along three canals. The 17th Street Canal breach was at a levee-floodwall combination; the breach reached 450 feet in length. According to the Corps, "it's believed that the force of the water overtopped the floodwall and scoured the structure from behind and then moved the levee wall horizontally." The Industrial Canal floodwall had two breaches — a 100-foot breach, and a 500-foot breach. The London Street floodwall had a 300-foot breach. The Corps continues to work on repairing the breaches. The Corps noted that other levees and floodwalls were being monitored for potential failure. One reason to fear additional failures is that levees and floodwalls are not designed for extended retention of water, but are instead designed for short-term storm events.

Removing flood waters from the city presents multiple challenges. First, repair of the 17th Street Canal is important because the canal is the main route for moving water out of the city once pumps are running. Second, most of the city's pumping facilities are not operational. Estimates for removing flood waters range from 36 days to more than 2 months. The city's saturated soil may delay subsequent rebuilding.

Project History and Appropriations. The Lake Pontchartrain and Vicinity Project was authorized by Congress originally in the Flood Control Act of 1965, with subsequent modifications in other legislation. The project, which remains under construction, is intended to reduce hurricane damages from surges entering Lake Pontchartrain from Lake Borgne through natural tidal passes. The total cost for the Lake Pontchartrain and Vicinity project is $738 million, with the federal responsibility $528 million. Federal allocations reached $458 million (87% of the federal responsibility) with the amount appropriated for FY2005. A Corps project fact sheet stated that the project's FY2005 appropriations would be "insufficient to fund new construction contracts," and that the Corps had the capability to use $20 million.[8] The fact sheet also stated:

> In Orleans Parish, two major pump stations are threatened by hurricane storm surges. Major contracts need to be awarded to provide fronting protection for them. Also, several levees have settled and need to be raised to provide the design protection. The current funding shortfalls in fiscal year 2005 and fiscal year 2006 will prevent the Corps from addressing these pressing needs.

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[7] This Sept. 1, 2005 document is available at [http://www.mvd.usace.army.mil/hurricane/news/11_pm_1_sept_corps_response_to_katrina_recovery_efforts.doc], visited on Sept. 3, 2005.

[8] U.S. Army Corps of Engineers, *Project Fact Sheet, Lake Pontchartrain, LA. and Vicinity Hurricane Protection Project* (May 23, 2005) available at [http://www.mvn.usace.army.mil/pao/response/HURPROJ.asp?prj=lkpon1], visited Sept. 3, 2005.

Funding for the Lake Pontchartrain project has declined from 1996 through 2005. During that period, the Clinton and Bush Administrations requested $58 million for the project; Congress appropriated approximately $70 million more than requested. A funding trend for the Corps' two other New Orleans projects, however, is less evident. The funding history for the Lake Pontchartrain hurricane protection, West Bank hurricane protection, and Southeast Louisiana Urban Flood Control projects and for the total Corps civil works program is provided in **Table 1**. Although the Corps civil works appropriations have increased in the last decade, competition for funds among projects has been tight, with many projects that historically received appropriations not being included in recent budget requests. Federal investments in water resources infrastructure remains considerably lower than levels of the 1950s and 1960s,[9] and the Corps has warned of problems associated with aging infrastructure and a backlog of construction activities. (For more information on Corps appropriations, see CRS Report RL32852, *Energy and Water Development FY2006 Appropriations*, coordinated by Carl E. Behrens.)

Table 1. Requests and Appropriations for Selected New Orleans Projects and Corps Civil Works

Fiscal Year	Lake Pontchartrain (in thousands)		West Bank and Vicinity (in thousands)		Southeast Louisiana (in thousands)		*Total Corps Civil Works (in billions)*	
	Req.	**App.**	**Req.**	**App.**	**Req.**	**App.**	***Req.***	***App.***
2005	3,937	5,719	37,000	30,000	30,000	36,500	*4.12*	*4.71*
2004	3,000	5,500	35,000	28,500	16,500	34,400	*4.19*	*4.57*
2003	4,900	7,000	5,000	9,000	20,083	50,000	*4.29*	*4.63*
2002	7,500	14,250	12,000	12,500	51,908	60,000	*3.90*	*4.49*
2001	3,100	10,000	8,065	8,065	47,260	69,000	*4.06*	*4.54*
2000	11,887	16,887	7,000	15,070	47,066	47,066	*3.91*	*4.14*
1999	5,676	16,000	3,936	7,000	15,278	75,000	*3.24*	*3.96*
1998	6,448	22,920	2,385	2,385	6,440	47,000	*3.70*	*4.06*
1997	4,025	17,025	0	1,500	10,000	17,500	*3.29*	*3.50*
1996	7,848	13,348	NA	NA	0	2,000	*3.34*	*3.20*

Source: Compiled by CRS from Energy and Water Appropriations conference reports.

Category 4 and 5 Protection

In August 2002, the Corps completed a reconnaissance study of whether to strengthen coastal Louisiana's hurricane damage reduction projects, including the New Orleans projects, to protect against Category 4 and 5 storms. If implemented, coastal Louisiana would have the only Category 5 protection system in the country. The next step

[9] For example, annual appropriations for the Corps' construction account fell from a $4 billion average in the mid-1960s (in 1999 dollars) to a $1.5 billion average for 1996 through 2005.

in the Corps' project development process is a feasibility study.[10] The feasibility study for this project was estimated to cost $8 million and take at least five years; construction would take another 10 to 20 years and $2.5 billion.[11] A congressionally-added FY2005 appropriation of $100,000 for the feasibility study was to be used for completing a project management plan and executing the cost share agreement with the local sponsor of the study. The study was not included in the President's FY2006 request. According to a Corps document, $500,000 for FY2006 is required to initiate work on the feasibility study.[12] The House report (H.Rept. 109-86) for the pending Energy and Water Development Appropriations Act for FY2006 (H.R. 2419) did not include funds for this study; the Senate report (S.Rept. 109-84) included $250,000.

As part of a feasibility study, the Corps analyzes the national benefits and costs of a storm damage reduction project. How these evaluations are performed and the costs and benefits that are included has long been debated. For example, structures in New Orleans area generally were not built to withstand Category 5 winds; therefore, providing Category 5 protection from storm surges will not protect the city and its structures from a Category 5 hurricane's winds and other threats. These analyses also take into account the likelihood of various storm events happening.

Hurricane Katrina has resulted in some questioning why a Category 4 or 5 hurricane storm damage system was not already in place for New Orleans, and whether it should be part of the rebuilding effort. Others are supporting more emphasis on restoration of coastal wetlands to improve storm damage protection. Others are raising concerns about the extent of rebuilding that should take place considering the city's hurricane and flooding vulnerability. They are concerned that higher levees and floodwalls may provide a false sense of security and continued risk of catastrophic failure. Decisions on what type and level of hurricane protection to provide New Orleans and other coastal areas in the future, as well as factors contributing to Katrina's damages (Category 3 infrastructure, and levee and floodwall construction, maintenance, and appropriations) likely will be the subject of congressional oversight.

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[10] For information on the Corps project development process, see CRS Report RL32064, *Army Corps of Engineers Water Resources Activities: Authorization and Appropriations*, by Nicole T. Carter and H. Steven Hughes.

[11] U.S. Army Corps of Engineers, New Orleans District, *Riverside, September-October 2004*, visited on Sept. 3, 2005, available at [http://www.mvn.usace.army.mil/pao/Riverside/Sept-Oct_04_Riv.pdf]; and A.C. Revkin, and C. Drew, "Engineers' warnings and pleas for money went unheeded,"*The New York Times*, Sept. 2, 2005.

[12] The March 2005 fact sheet, visited on Sept. 3, 2005, is available at [http://www.mvn.usace.army.mil/pd/Funding_Programs/Current/GI_HurrProt_FY06.pdf].