MORGANZA TO THE GULF OF MEXICO, LOUISIANA, POST-AUTHORIZATION CHANGE REPORT (PAC)

ECONOMIC APPENDIX OUTLINE

PART 1: BACKGROUND INFORMATION

INTRODUCTION

General. This appendix presents an economic evaluation of the two storm surge risk reduction alternatives being considered for the Morganza to the Gulf of Mexico, Louisiana evaluation area, which includes portions of two parishes in the state of Louisiana. It was prepared in accordance with Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, and ER 1105-2-101, Planning Guidance, Risk Analysis for Flood Damage Reduction Studies. The National Economic Development Procedures Manual for Flood Risk Management and Coastal Storm Risk Management, prepared by the Water Resources Support Center, Institute for Water Resources, was also used as a reference, along with the Users Manual for the Hydrologic Engineering Center Flood Damage Analysis Model.

The economic appendix consists of a description of the methodology used to determine National Economic Development (NED) damages and benefits under existing and future conditions, projects costs, net benefits, and benefit-to-cost ratios. The evaluation reports benefits and costs at October 2011 price level. The proposed alternatives were evaluated by comparing estimated equivalent annual benefits that would accrue to the study area with estimated average annual project costs. Benefits were converted to equivalent annual values by use of the current FY 2012 Federal discount rate of 3.75 percent and a period of analysis of 50 years. The year in which significant benefits will accrue as a result of project construction is 2026 for the 0.03 annual exceedance probability (AEP) storm surge risk reduction system alternative and 2035 for the 0.01 AEP alternative. The alternatives in the remainder of the appendix will be referred to as the 3% AEP alternative and the 1% AEP alternative. The year 2035 was chosen as the base year for each of the alternatives as the basis for plan comparison.

In addition to the NED account, two other project accounts have been used to evaluate the project alternatives: Regional Economic Development (RED) and Other Social Effects (OSE). Each of these accounts will be discussed in separate appendices.

NED Benefit Categories Considered. The NED procedure manuals for coastal and urban areas recognize four primary categories of benefits for flood risk management measures: inundation reduction, intensification, location, and employment benefits. The majority of the benefits attributable to a project alternative generally result from the reduction of actual or potential damages caused by inundation. Inundation reduction, which is the only category of NED benefits addressed in this evaluation, includes the reduction of physical damages to structures, contents, and vehicles, avoidance of structure-raising costs, emergency cost reduction, agricultural benefits, water supply benefits, and safe harbor benefits.

Physical Flood Damage Reduction. Physical flood damage reduction benefits include the decrease in potential damages to residential and commercial structures, their contents, and the privately owned vehicles associated with these structures. Inundation reduction benefits were considered under both existing and future conditions. Projections of the future development expected to place in the study area during the period of analysis were included as part of the future condition analysis.

Since partial storm surge risk reduction will be provided before the base year of each project alternative, inundation reduction benefits for residential and commercial structures, their contents, and vehicles can be achieved during construction. The benefits during construction were computed by comparing the expected without-project damages to the with-project damages receiving partial risk reduction. The benefits during construction begin in the year 2024 for both of the alternatives.

Office of Management and Budget (OMB) survey forms were used to collect information on the value and placement of contents in the 24 industrial facilities located in the study area. The information from these surveys was used to develop the physical flood damage and benefits for these industrial properties. Additional information regarding the use of the OBM approved forms can be found in the final report dated May 2009 entitled *Morganza to the Gulf Post Authorization Change Report: Residential and Nonresidential Structure Inventory and Nonresidential Surveys*.

Avoidance of Structure-Raising Costs. Typically, property owners in areas that incur repetitive flooding have three options for reducing their flood risk: raise their structures in place, floodproof/retrofit their structures, or relocate to other areas. For purposes of this evaluation, only structure-raising measures were considered. The avoidance of structure-raising costs for all residential and non-residential structures that would otherwise incur repetitive flooding is considered a benefit attributable to the project alternative.

Emergency Cost Reduction Benefits. Emergency costs are those costs incurred by the community during and immediately following a major storm. They include the costs of emergency measures, such as evacuation and reoccupation activities conducted by local governments and homeowners, repair of streets, highways, and railroad tracks, and the subsequent cleanup and restoration of private, commercial, and public properties. In this evaluation, only the emergency cost reduction benefits associated with debris removal and cleanup and the reduction of damages to major and secondary highways and streets were considered.

Agricultural Benefits. NED agricultural benefits are defined as the increase in the value of the agricultural output of the area and the decrease in the cost of maintaining a given level of output attributable to a project alternative. These benefits include reductions in production costs and in associated costs, the reduction in damage costs from floods, erosion, sedimentation, inadequate drainage, or inadequate water supply, the value of increased production of crops, and the economic efficiency of increasing the production of crops in the project area.

Agricultural benefits have not been quantified and are not included in this appendix. However, the average annual agricultural acres inundated under without-project and with-project conditions have been provided for each of the project alternatives.

Municipal Water Supply Benefits. The NED benefits from municipal water supply are defined as the willingness of a community to pay for an increase in the value of goods and services attributable to the water supply. In most cases, the marginal cost of supplying water is used to calculate the willingness of the consumers to pay for the additional water supply. However, because the marginal cost was not determined in this study, the water supply benefits were measured by comparing the reduction in the cost of treating water for municipal usage during periods of high salinity that is attributable to each of the project alternatives.

Safe Harbor Benefits for Large Recreational and Commercial Boat Fleets. The project alternatives reduce the risk of physical damage to large recreational and commercial boat fleet boats from the storm surges associated with minor storms, tropical storms, and hurricanes. The reduction in damages to large vessels and the reduction in the cost of moving the vessels to safer areas are considered benefits attributable to the project alternatives. However, only the reduction in travel costs was considered in this evaluation.

Regional Economic Development. The RED account has been addressed in a separate appendix to evaluate the project alternatives. If the economic activity lost in the flooded region can be transferred to another area or region in the national economy, then these losses are not included in the NED account. However, the impacts on the employment, income, and output of the non-Federal or regional economy are considered part of the RED account. The input-output macroeconomic model RECONS was used to address the impacts of the construction spending associated with each of the project alternatives on the regional economy.

Other Social Effects. The OSE account has been addressed in a separate appendix to evaluate the project alternatives. OSE focuses on the health and safety impacts that each of the project alternatives has on the local population. Also, Environmental Justice (EJ) issues were investigated as part of the Environmental Impact Statement.

DESCRIPTION OF THE STUDY AREA

Geographic Location. The study area, which is located in coastal Louisiana approximately 60 miles southwest of the city of New Orleans, includes all of Terrebonne Parish and the portion of Lafourche Parish to the south and west of Bayou Lafourche.

Communities located within the study area include the city of Houma, the towns of Chauvin, Dulac, and Montegut in southern Terrebonne Parish, the towns of Donner and Gibson in western Terrebonne Parish, and the towns of Gray and Schriever in northern Terrebonne Parish. Also included are the towns of Raceland, Lockport, and Pointe aux Chenes in Lafourche Parish and the portion of the city of Thibodaux south of Bayou Lafourche. The Gulf Intracoastal Waterway (GIWW) passes through the northern part of the study area in an east-west direction, and the Houma Navigation Channel (HNC) extends due south from Houma to the Gulf of Mexico. The southern extent of the study area is the alignment for the proposed hurricane protection structure that would cross the southern part of Terrebonne Parish in an east-west direction. The Morganza evaluation area was divided into 276 unique hydrologic reaches to enable an economic analysis of the project alternatives through the use of the HEC-FDA certified model. However, an inventory of residential and non-residential structures was only assembled in the 264 study area reaches that could be impacted by storm surges under the without-project condition.

Land Use. The total number of acres of developed, agricultural, and undeveloped land in Terrebonne Parish and the portion of Lafourche Parish included in the study area as of the year 2009 is shown in Table 1. The portions of Lafourche Parish north and east of Bayou Lafourche were not included in the analysis.

As shown in the table, approximately 10 percent of the total acres in the study area are currently developed. Since there are approximately 76,000 acres of agricultural land and 2,100 acres of shrub land and grassland available for future development, there is sufficient land available to accommodate the projected residential and non-residential development through the year 2085 without impacting the wetlands in the area.

SOCIOECONOMIC SETTING

Population and Number of Households. Table 2 displays the population in each of the parishes for the years 1970, 1980, 1990, 2000, and 2010 (study year), as well as projections for the year 2035 and the year 2085, the two years that engineering inputs were modeled and used to calculate damages and benefits. Population projections are based on the Moody's County Forecast Database, which has population projections to the year 2038. Moody's projections were extended by New Orleans District from the year 2038 to the year 2085 based on the growth rate forecasted by Moody's for the years 2018 through 2038. The slow, steady growth rate projected by Moody's during this 20-year period was consistent with the growth predicted by parish planning officials.

As shown in Table 2, both Lafourche and Terrebonne Parishes experienced a steady increase in population between 1970 and 2010. According to U.S. Census data, the population of Lafourche Parish increased from 89,974 in 2000 to 96,318 in 2010, a growth of 6,344 residents over the ten-year period. During the same period, the population of Terrebonne Parish increased from 104,503 to 111,860, an increase of 7,357 residents. The population in both parishes is projected to maintain this steady increase in population growth, with Lafourche Parish expected to have approximately 97,900 residents in 2035 and approximately 104,200 residents in the year 2085. Terrebonne Parish is expected to experience even more growth with an estimated population of approximately 120,900 in 2035 and 142,800 in 2085. Approximately 218,800 residents are projected to reside in the two-parish area in 2035, while approximately 247,000 residents are projected for the year 2085.

Table 3 displays the estimated population of the two parishes located within the inventoried portion of the study area for the year 2010 and the projected population for the years 2035 and 2085. The 2010 estimates are based on an inventory of residential and non-residential properties assembled in 2009 by field survey teams. The number of inventoried residential structures was then multiplied by 2.9, the average number of persons per household in the study area in 2010. In 2010, there were approximately 28,800 people residing in the inventoried structures in Lafourche Parish and approximately 104,900 people in Terrebonne Parish for a total of 133,700 residents. The projected population for the years 2035 and 2085 was based on the 2010 proportion of the total population residing within the inventoried area. The projected population for the years 2035 and 2085 for each parish was then multiplied by these proportions to determine the projected population for each parish. The population of Lafourche Parish is projected to total approximately 29,300 in 2035 and about 31,200 in 2085. In Terrebonne Parish, the population in this area is expected to total approximately 113,200 in 2035 and 133,800 in 2085.

Table 4 shows the total number of households in each parish for the years 1970, 1980, 1990, 2000, and 2010 and projections for the years 2035 and 2085. The projected number of households was based on the Moody’s County Forecast Database and extended from the year 2038 to the year 2085 by New Orleans District based on the a growth rate forecasted by Moody’s for the years 2018 through 2038.

The total number of households in Lafourche and Terrebonne Parishes experienced a steady increase between 1970 and 2010, which paralleled the growth in population. This increase, which was commensurate with the population growth experienced by the entire Gulf Coast region during the same period, can be attributed to increases in oil and gas exploration in the Gulf of Mexico and technological advancements in the industry. Similar to the projected population growth in the two-parish area, the number of households is expected to continue increasing through the year 2085. Lafourche Parish is projected to have approximately 36,300 households in the year 2035, while Terrebonne Parish is projected to have about 43,400 households. By the year 2085, the number of households in Lafourche Parish is expected to reach approximately 38,100, while the number in

Terrebonne Parish is expected to reach to approximately 50,400. In total, the two parishes are projected to have approximately 88,600 households in the year 2085.

Income. Table 5 shows the per capita personal income levels for each parish for the years 1990, 2000, 2005, 2008, and 2009, the year with the latest available data.

As shown in the table, both parishes experienced a steady increase in per capita income between 1990 and 2008. The growth in per capita income during this time reflects the increased oil and gas exploration and production activities in the Gulf of Mexico and the improvement in the economy of the state. It also reflects the improvement in the national economy that occurred from the late 1990s through the year 2008.

Between 2008 and 2009, however, both parishes experienced a slight decline in per capita income, which is likely a result of the global economic recession experienced during this time. The decline is slightly lower than the decline in per capita income seen in the state of Louisiana, which decreased from a per capita income of $38,142 in 2008 to $37,632 in 2009.

Employment. Table 6 shows the total nonfarm employment by parish for the years 1970, 1980, 1990, 2000, 2010, and projections for the years 2035 and 2085. The employment projections were based on the Moody's County Forecast Database and extended from the year 2038 to the year 2085 by New Orleans District based on the growth rate forecasted by Moody's for the years 2018 through 2038.

Employment trends in the area have historically moved with the demand for oil and gas resources. The unemployment rate in Terrebonne and Lafourche parishes averaged approximately three percent prior to the end of 2008. The Houma-Thibodaux Metropolitan Statistical Area (MSA) continues to lead the state in jobs created and has one of the lowest unemployment rates in the state.

While the oil and gas industry pays the highest wages of all of the sectors of the economy, the services industry employs the largest number of residents. The retail sector is the second largest employer followed by government and other public agencies. The oil and gas sector in Terrebonne Parish employs slightly over 5,000 residents.

In addition to the oil and gas industry, there are three other sectors of the economy that are important to the region: commercial navigation, fisheries, and agriculture. The GIWW, the Houma Navigation Canal, and Bayou Lafourche provide key navigational channels for the energy sector. The coastal region provides a fertile spawning ground for fisheries including shrimp, crabs, oysters, and finfish. Finally, the area grows and processes sugarcane.

Future Trends. In all portions of the study area, growth is highly dependent upon the major employment sectors. In addition, the growth in manufacturing is another major sector dependent upon the shipbuilding industry adjacent to Bayou Lafourche and the Houma Navigation Canal. The cyclical nature of the oil and gas industry has caused temporary fluctuations in the local economy since 1970. However, the overall level of growth in the population, income, and employment of the region has shown a steady increase. During the 1990s and early 2000s, technological advancements were made in the offshore oil exploration industry, such as 3D seismic drilling, which spurred exploration activity. Also during this decade, a regional cancer treatment facility was opened in the city of Houma.

The area was significantly impacted by the 2010 Deepwater Horizon British Petroleum oil spill and the decision by the Federal government to suspend the issuance of new deepwater drilling permits while safety standards were reassessed. Even though the first deep-water drilling permit since the oil spill was issued in March 2011, the area has not yet returned to the level of economic activity that it experienced prior to the oil spill and the resulting ban on drilling. According to data released by the Louisiana Department of Natural Resources at the end of 2011, there are currently 35 rigs in operation, the highest rig count off the Louisiana coast since the oil spill. The weekly rig count prior to the oil spill averaged 42 rigs. This appears to be a positive sign that the area is beginning to recover, albeit at a slow pace.

While the long term impact of the oil spill to the study area is unknown, there are other positive developments occurring in the area. During the past two decades, improvements were made in the transportation network including the opening of Interstate 310, which facilitates travel between the cities of Houma and New Orleans. The proposed I-49 highway will provide an efficient traffic route between the cities of New Orleans and Lafayette, although funding has not yet been obtained for its construction. This project may lead to increased development in the northern portion of the study area near the town of Gray in Terrebonne Parish. A proposed highway that will connect Louisiana Highway 3127 to the cities of Thibodaux and Houma could also facilitate growth in the study area.

Compliance with Policy Guidance Letter (PGL) 25 and Executive Order 11988. Given the recent growth trends, it is reasonable to assume that development will continue to occur in the study area with or without the storm surge risk reduction system, and will not conflict with PGL 25 and EO 11988, which state that the primary objective of a flood risk reduction project is to protect existing development, rather than to make undeveloped land available for more valuable uses. With the project in place, future development may shift from the northern portions of the study area to the southern portion of the study area south of Houma. However, the overall growth rate is anticipated to be the same with or without the project in place. Thus, the project will not induce development, but would rather reduce the risk of the population being displaced after a major storm event.

RECENT FLOOD HISTORY

Tropical Flood Events. While Lafourche and Terrebonne parishes have periodically experienced localized flooding from excessive rainfall events, the primary cause of the flood events that have taken place in the two-parish study area has been the tidal surges from hurricanes and tropical storms. During the past 25 years, coastal Louisiana was impacted by eight major tropical events: Hurricane Juan (1985), Hurricane Andrew (1992), Tropical Storm Isidore and Hurricane Lili (2002), Hurricanes Katrina and Rita (2005), and Hurricanes Gustav and Ike (2008). While none of these storms tracked directly through the study area, the tidal surges associated with these storm events inundated structures and resulted in billions of dollars in damages to coastal Louisiana.

Table 7 provides a summary of the total FEMA flood claims paid to all Louisiana policyholders as a result of these tropical events. The table includes the number of paid losses, the total amount paid, and the average amount paid on each loss. The total and average paid losses have been converted to reflect 2011 price levels. The table only includes losses that were covered by flood insurance.

The following is a summary of each of the eight major tropical events and their effects on the two-parish area and coastal Louisiana.

Hurricane Juan. Hurricane Juan caused extensive flooding throughout southern Louisiana due to its prolonged 5-day movement back and forth along the Louisiana coast. Rainfall totals in the area ranged from 5 inches to almost 17 inches. The storm was responsible for storm surges of 5 to 8 feet and tides of 3 to 6 above normal. According to FEMA officials, the estimated value of the residential and commercial damage and public assistance throughout coastal Louisiana totaled $112.5 million.

Over 800 homes were inundated in the coastal portion of Terrebonne Parish south of the city of Houma. Scattered pockets of flooding were also reported in the portions of Terrebonne and Lafourche Parishes north of Houma. Approximately 40 percent of the homes in the coastal areas of Lafourche Parish, including Pointe aux Chenes, were also inundated by the high tides.

Agricultural damages from the storm totaled $175 million, with 24 percent of these damages occurring in the two-parish study area. The soybean crop suffered over half of the agricultural damage, while the sugar cane crop incurred 20 percent of the damage. Excessive rains and storm surge oversaturated the fields and caused a reduction in crop yields. The saturated fields also made it easier for the winds to topple over the cane stalks.

Hurricane Andrew. On August 26, 1992, Hurricane Andrew made landfall in St. Mary Parish, 80 miles west of Morgan City. FEMA reported that over 2,000 flood claims were filed as a result of the storm in Louisiana. These claims had a total value of over $25 million. Over 90 percent of this flood damage occurred in the Terrebonne Parish communities south of Houma, where up to six feet of water was reported. Only minor flooding in the back parts of subdivisions was reported in the city of Houma and in the areas north of the city. The unleveed portion of Lafourche Parish along its border with Terrebonne Parish, which includes the community of Pointe aux Chenes, also incurred extensive flood damage. However, most of the agricultural damage in the area occurred as the result of wind damage to the sugar cane crop.

Tropical Storm Isidore and Hurricane Lili. On October 3, 2002, one week after Tropical Storm Isidore affected the southeastern and south central coastal areas of Louisiana, Hurricane Lili made landfall on the western edge of Vermilion Bay south of the cities of Abbeville and New Iberia as a weak Category 2 hurricane. The high winds caused tidal flooding in the communities east of the eye of the storm. The ridge communities in Terrebonne Parish south of the city of Houma, including Cocodrie, Dulac, Isle de Jean Charles, and Montegut, and the community of Pointe aux Chenes in Lafourche Parish were affected by tidal flooding. The only community south of Houma that did not flood was Chauvin.

Insured flood losses from Tropical Storm Isidore and Hurricane Lili totaled nearly $600 million. Approximately $105 million of insured losses were related to Tropical Storm Isidore, while Hurricane Lili caused $471 million of insured losses. According to windshield surveys conducted by the American Red Cross, approximately 10,000 residential structures were damaged by winds and storm surges of the two storms. These surveys included both insured and uninsured structures. Tropical Storm Isidore caused damage to 2,905 structures, while Hurricane Lili caused damage to 7,356 structures.

In a revised report released in mid-November by the Louisiana State University Agricultural Center (LSU AgCenter), the estimated agricultural damages caused by Tropical Storm Isidore and Hurricane Lili totaled $454.3 million. This estimate also includes the agricultural damages caused by the continuation of rain during the month of October, which delayed the harvesting of crops. The excessive rains and storm surge flooded the agricultural fields and increased the harvest costs.

The wind and waves of Tropical Storm Isidore and Hurricane Lili caused extensive beach erosion in the barrier islands of Louisiana. These islands protect the Louisiana coastline from storm surges and provide a natural habitat for many species of wildlife. The barrier islands west of the mouth of the Mississippi River that were affected by the two storm events include the Isles Dernieres (Whiskey Bayou, Raccoon Island, Trinity Island, and East Island), Timbalier Island, East Timbalier Island, Elmer Island, and Grand Terre. Grand Isle incurred extensive damage along its eastern beach. Three small islands east of the mouth of the Mississippi River, Grand Gosier Island, Curlew Island, and Chandeleur Island, incurred extensive damage and beach erosion. A monetary value has not been determined for these environmental damages.

Hurricane Katrina. On August 29, 2005, Hurricane Katrina made landfall near the town of Buras in Plaquemines Parish about 50 miles east of coastal Lafourche and Terrebonne parishes. While it entered as a category 3 storm with winds in excess of 120 mile per hour. However, its storm surge of approximately 30 feet was more characteristic of a Category 5 hurricane. The majority of the damages from Hurricane Katrina occurred outside of the Morganza study area. However, if the hurricane had taken a more westerly track, the Houma area could have experienced the same magnitude of flooding as the city of New Orleans.

According to the Department of Health and Hospitals, approximately 1,400 deaths were reported following Hurricane Katrina. Approximately 1.3 million residents were displaced immediately following the storm, and 900,000 residents remained displaced as of October 5, 2005. According to the Louisiana Recovery Authority, two years after the storm, approximately 210,000 FEMA applicants still had out-of state mailing addresses, while 230,000 FEMA applicants had an in-state mailing address in a different zip code.

The storm caused more than $40.6 billion of insured losses to the homes, businesses, and vehicles in six states. Approximately two thirds of these losses, or $25.3 billion, occurred in Louisiana based on data obtained from the Insurance Information Institute. According to the LRA, approximately 150,000 housing units were damaged, and according to the Department of Environmental Quality, 350,000 vehicles, and 60,000 fishing and recreational vessels were damaged.

The storm surge from Hurricane Katrina inundated marshes and farmland throughout the coastal area including Terrebonne and Lafourche parishes. According to the LSU AgCenter, agricultural losses totaled approximately $825 million. The agricultural resources impacted by the storm include sugarcane, cotton, rice, soybeans, timber, pecans, citrus, and livestock. The losses to aquaculture (crawfish, alligators, and turtles), fisheries (shrimp, oysters, and menhaden), and wildlife and recreational resources totaled approximately $175 million.

Hurricane Rita. The hurricane made landfall along the Texas-Louisiana border on September 24, 2005, as a Category 3 storm with winds in excess of 120 miles per hour. As the hurricane passed south of the study area, its high winds pushed water north into coastal Lafourche and Terrebonne parishes. A storm surge of approximately 15 - 20 feet affected Coastal Louisiana from Terrebonne Parish to the Texas border. With estimated insured losses of approximately $3 billion, Hurricane Rita became one of the most costly natural disasters in U.S. history.

Approximately 2,000 square miles of farmland and marshes throughout the coastal area were inundated. According to the LSU AgCenter, agricultural losses totaled approximately $490 million. The agricultural resources impacted by the storm include sugarcane, cotton, rice, soybeans, timber, pecans, citrus, and livestock. The losses to aquaculture (crawfish, alligators, and turtles), fisheries (shrimp, oysters, and menhaden), and wildlife and recreational resources totaled approximately $100 million.

Hurricanes Gustav and Ike. On September 1, 2008, almost exactly three years after Hurricane Katrina, Hurricane Gustav made landfall near Cocodrie in Terrebonne Parish as a strong Category 2 hurricane. It followed a northwest path into central Louisiana, and most of the damages caused by the storm resulted from its high winds and heavy rain. Coastal flooding occurred in the low lying areas of Jefferson and Lafourche Parishes and the coastal areas of Terrebonne Parish south of the City of Houma.

Nearly 2 million residents of South Louisiana evacuated in the days before Gustav made landfall. Louisiana officials reported that emergency spending totaled approximately $500 million, which included $210 million for state agencies, $48 million for deploying the National Guard, $13.5 million for general evacuation shelters, $3 million for special-needs medical shelters, $6.1 million for transporting the medical needy, $21 million for costs of contraflow and evacuation from coastal communities and other areas, $20 million in special generators to open ice plants, pharmacies and service stations throughout the impacted areas, $5 million for state-purchased fuel, $19.7 million for ready-to-eat meals, $5.3 million for ice, and $2.5 million for water supplies. The State Department of Transportation estimated that it cost approximately $50 million to remove 1.5 million cubic yards of debris, and approximately $20 million to repair draw bridges.

Almost two weeks later, on September 12 and 13, the Louisiana coastal region incurred additional flood damages as Hurricane Ike moved along the Louisiana coast. According to estimates from the state officials, approximately 12,000 homes and businesses were flooded by the two storms. Approximately 2,500 buildings in Terrebonne Parish south of the City of Houma incurred flood damages from Hurricane Ike.

The LSU AgCenter estimated that potential lost revenues and damages to the infrastructure of the agriculture, forestry, and fisheries industries in Louisiana resulting from the two hurricanes totaled approximately $959 million. The storm surge primarily affected the cattle, rice, soybeans, and sugarcane.

FEMA Flood Claims. While Lafourche and Terrebonne parishes have periodically experienced localized flooding from excessive rainfall events, the primary cause of the flood events that have taken place in the two-parish study area has been the tidal surges from hurricanes and tropical storms. The total FEMA flood claims for the two parishes in the Morganza to the Gulf evaluation area that were paid between 1978 and September 2011 are summarized in Table 8. The table includes only those claims that were covered by flood insurance. Figure 1 shows the location of the repetitive loss properties that have had two or more FEMA flood claims during any 10-year period between 1978 and 2010.

SCOPE OF THE STUDY

Problem Description. The study area is characterized by low, flat terrain with ridges surrounding the waterways. The terrain has made the area highly susceptible to flooding from the tidal surges of hurricanes and tropical storms. The apparent subsidence, or relative sea level rise, that has been taking place in the Morganza study area, is expected to magnify the flooding problems in the future. While the Terrebonne Levee and Conservation District is currently maintaining a system of forced drainage levees, pump stations, and flood control structures for Terrebonne Parish, an adequate overall storm surge risk reduction system is not currently available for the entire study area.

Project Alternatives. As part of the 2002 Morganza to the Gulf, Louisiana Feasibility Report, a project alignment was selected and later authorized to provide storm surge risk reduction for portions of Terrebonne and Lafourche parishes. The authorized alignment was designed to contain the pre-Katrina surge elevations associated with the 1% (100-year) annual exceedance probability (AEP) storm surge risk reduction system, and the costs were provided in 2002 price levels. Since that time, the hydrology, project design criteria, and implementation costs have changed. A Revised Project Cost Estimate (RPCE) report was developed in 2008 using post-Katrina design criteria and water surface profiles for the 1% (100-year) AEP storm surge risk reduction system. A second alternative under consideration, the 3% (approximately 35-year) AEP storm surge risk reduction system, applies pre-Katrina design criteria and authorized levee height elevations to the authorized alignment. This alignment involves the construction of new earthen levees that would run parallel to Louisiana Highway 57 south of Lake Boudreaux and north of the Falgout Canal and would connect to existing forced drainage levees. The levees will be used in conjunction with flood risk management and environmental structures and would minimize the adverse impacts to the environment, local interests, navigation, and industry. Finally, construction of a lock structure on the Houma Navigation Canal (HNC) south of Bayou Grand Caillou has been included as part of the system. Figure 2 shows the location of the study area reaches and the project alignment. The study area reaches are also shown in the 11x17 maps attached to the main report.

PART 2: ECONOMIC AND ENGINEERING INPUTS TO THE HEC-FDA MODEL

HEC-FDA MODEL

Model Overview. The Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) Version 1.2.5a Corps-certified model was used to calculate the damages and benefits for the Morganza evaluation. The economic and engineering inputs necessary for the model to calculate damages for existing conditions (2010), the first year of partial storm surge risk reduction (2024), the project base year (2035), and the final year in the period of analysis (2085) are described in this section of the report. The economic inputs include structure inventory, future development, contents-to-structure value ratios, vehicles, first floor elevations, and depth-damage relationships. The engineering inputs include ground elevations, exterior and interior relationships, local levee performance, and Federal levee performance. A separate HEC-FDA model was executed for the industrial structures in the study area for the years 2024, 2035, and 2085.

The uncertainty surrounding each of the economic and engineering variables was also entered into the model. Either a normal probability distribution, with a mean value and a standard deviation, or a triangular probability distribution, with a most likely, a maximum and a minimum value, was entered into the model to quantify the uncertainty associated with the key economic variables. A normal probability distribution was entered into the model to quantify the uncertainty surrounding the ground elevations. The number of years that stages were recorded at a given gage was entered for each study area reach to quantify the hydrologic uncertainty or error surrounding the stage-probability relationships. The uncertainty associated with the levee performance was quantified using the levee features section of the model, which related the elevation of exterior storm surges to the probability of levee failure.

ECONOMIC INPUTS TO THE HEC-FDA MODEL

Structure Inventory. Field surveys were conducted in 2009 to develop a residential and non-residential structure inventory for the economic analysis. The areas to be inventoried had been selected in 2008 based on estimates of surge elevations for this area developed as part of the Louisiana Coastal Protection and Restoration (LACPR) evaluation.
Since the ground elevations in the northern portions of the evaluation area near Bayou Lafourche, including the towns of Gray and Schriever in Terrebonne Parish and the

southern portion of the city of Thibodaux in Lafourche Parish, and in the western portions of the study area near Donner and Gibson in Terrebonne Parish, were determined to be above these storm surge estimates, the structures in these areas were not included in the inventory.

Based on the structural information collected during the field surveys, the Marshall and Swift Valuation Service was used to calculate a depreciated replacement cost for all residential and non-residential structures in the study area reaches. The inventoried structures were classified as one of 14 structure types: residential one-story with slab or pier foundation, residential two-story with slab or pier foundation, mobile home, eating and recreation, grocery and gas station, multi-family residence, professional building, public and semi-public building, repairs and home use establishment, retail and personal services building, and warehouse, and contractor services building. The inventory also included 24 industrial structures that were inventoried using OMB approved interview forms. Table 9 shows the number of structures by structure category and the total number of vehicles associated with the residential structures for existing conditions (2010) for each study area reach or HEC-FDA model station number. The value of the land was not included in the analysis.

Future Development Inventory. Projections were made of the future residential and non-residential development to take place in the Morganza study area under without-project conditions. Based on historical economic trends, a total of 7,320 residential and 1,319 non-residential structures were placed on the undeveloped land within the study area reaches as part of the structure inventory for the year 2035. An additional 16,332 residential and 4,661 non-residential structures were added to the inventory for the year 2010 to obtain the structure inventory for the year 2085.

The development projected to occur in each study area reach between the year 2010 and the year 2035 was placed at an elevation equal to the stage associated with the without-project one percent annual chance exceedance (1% ACE) (100-year) event, unless the ground elevation was higher. The projected development occurring after the year 2035 was placed at an elevation equal to the stage associated with the without-project 1% ACE (100-year) event for the year 2085, unless the ground elevation was higher. The values for the projected residential and non-residential structures were assigned using the average value calculated for each structure category based on the 2010 existing development.

Table 10 shows the number of structures in each structure category and the average depreciated replacement values for (2010) existing conditions. Table 11 shows the projected number of structures in each structure category for the future years 2035 and 2085, respectively. The value of the land was not included in the analysis.

Residential and Non-Residential Content-to-Structure Value Ratios. On-site interviews were conducted with the owners of a sample of ten structures from each of the three residential content categories (30 residential structures) and each of the eight non-residential content categories (80 non-residential structures). A CSVR was computed for each residential and non-residential structure in the sample based on the total depreciated content value developed from the surveys. An average CSVR for each of the five residential structure categories and nine commercial structure classifications was calculated as the average of the individual structure CSVRs.

Since only a limited number of field surveys were conducted for each of the residential and non-residential content categories, statistical bootstrapping was performed to address the potential error in estimating the mean and standard deviation CSVR values. Statistical bootstrapping is a method that uses re-sampling with replacement to improve the estimate of a population statistic when the sample size is insufficient for straightforward statistical inference. The bootstrapping method has the effect of increasing the sample size. Thus, bootstrapping provides a way to account for the distortions caused by the specific sample that may not be fully representative of the population.

With use of the @Risk software, a simulation using 100,000 iterations was executed for each content category. Within each iteration, a new ten-observation sample with replacement, called a bootstrap sample, was taken from the original sample of ten observations. Each observation within the original sample was given a uniform probability or chance of being selected as each one of the ten values within the bootstrap sample. The @Risk spreadsheet calculated a mean value and a standard deviation for each of the bootstrap samples, and then calculated a mean value for all of the bootstrap means and mean value of all the standard deviations.

Table 12 shows the CSVRs and standard deviations for each of the residential and non-residential structure categories derived using the statistical bootstrapping technique. The CSVRs and standard deviations were used in the HEC-FDA model along with the depth-damage relationships to calculate flood damages for residential and non-residential structures. A unique CSVR was developed for each of the 24 industrial structures in the study area based on the content values provided by the owners of the properties using OMB approved interview forms.

Vehicle Inventory. Based on 2000 Census block group data for the evaluation area, it was determined that there are an average of 1.64 vehicles associated with each household (owner occupied housing or rental unit). According to the Southeast Louisiana Evacuation Behavioral Report published in 2006 following Hurricanes Katrina and Rita, approximately 70 percent of privately owned vehicles are used for evacuation during storm events. The remaining 30 percent of the privately owned vehicles remain parked at the residences and are subject to flood damages. Using the Manheim Used Vehicle Value Index, which is based on over 4 million annual automobile transactions adjusted to reflect retail replacement value, each vehicle was assigned an average value of $12,879. Since only those vehicles not used for evacuation can be included in the damage calculations, an adjusted average vehicle value of $6,336 ($12,879 x 1.64 x .30) was assigned to each individual residential structure record in the HEC-FDA model. The adjusted vehicle value was adjusted upward by 3.7 percent using the Manheim index from 2010 to 2011 to reflect an October 2011 price level. If an individual structure had more than one housing unit, then the adjusted vehicle value was assigned to each housing unit in a residential or multi-family structure category.

First Floor Elevations and Elevation of Vehicles. Topographical data obtained from the Light Detection and Ranging (LIDAR) digital elevation model (DEM) using the NAVD88 (2004.65 epoch) were used to determine ground elevations. Field survey teams estimated the height of each residential and non-residential structure above the ground using hand levels. The ground elevation was added to the height of the foundation of the structure above the ground in order to determine the first floor elevation of the structure. Vehicles were assigned to the ground elevation of the adjacent residential structures.

Depth-Damage Relationships. Site-specific saltwater, long duration (approximately one week) depth-damage relationships, developed by a panel of building and construction experts for the Morganza evaluation, were used in the economic analysis. These curves indicate the percentage of the total structure value that would be damaged at various depths of flooding. Damage percentages were determined for each one-half foot increment from one-half foot below first floor elevation to two feet above first floor, and for each one-foot increment from 2 feet to 15 feet above first floor elevation. The panel of experts developed depth-damage relationships for five residential structure categories and for three commercial structure categories. Depth-damage relationships were also developed for three residential content categories and eight commercial content categories. A unique depth-damage relationship was developed for the contents of each of the 24 industrial structures in the study area based on information provided by the owners of the properties using OMB approved interview forms.

The depth-damage relationships for vehicles were developed based on interviews with the owners of automobile dealerships that had experienced flood damages and were used to calculate flood damages to vehicles at the various levels of flooding.

Table 13 shows the residential and non-residential depth-damage relationships developed for structures, contents, and vehicles. More specific data regarding the depth-damage relationships can be found in the final report dated May 1997 entitled *Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVRs) in Support of the Lower Atchafalaya and Morganza to the Gulf, Louisiana, Feasibility Study*.

Uncertainty Surrounding the Economic Inputs. The uncertainty surrounding the four key economic variables was quantified and entered into the HEC-FDA model. These economic variables included structure values, contents-to-structure value ratios, first floor elevations, and depth-damage relationships. The HEC-FDA model used the uncertainty surrounding these variables to estimate the uncertainty surrounding the stage-damage relationships developed for each study area reach.

Structure and Vehicle Values. In order to quantify the uncertainty surrounding the values calculated for the residential and non-residential structure inventory, several survey teams valued an identical set of structures from various evaluation areas in the Gulf Coast region. The structure values calculated by each of the teams during windshield surveys were used to develop a mean value and a standard deviation for each structure in the sample. The standard deviation was then expressed as a percentage of the mean value for that structure. The average standard deviation as a percentage of the mean for the sampled structures was then used to represent the uncertainty surrounding the structure value for all the inventoried residential and non-residential structures. The average standard deviation, which was expressed as a percentage of the mean structure value, totaled 12.15 percent for residential structures and 14.28 percent for non-residential structures.

The uncertainty surrounding the values assigned to the vehicles in the inventory was determined using a triangular probability distribution function. The Manheim vehicle value, adjusted for number of vehicles per household and for the evacuation of vehicles prior to a storm event, was used as the most likely value. The average value of a new vehicle before taxes, license, and shipping charges was used as the maximum value, while the average 10-year depreciation value of a vehicle was used as the minimum value.

Content-to-Structure Value Ratios. On-site interviews were conducted with the owners of a sample of ten structures from each of the three residential content categories (30 residential structures) and each of the eight non-residential content categories (80 non-residential structures). A CSVR was computed for each residential and non-residential structure in the sample based on the total depreciated content value developed from these interviews. A probability distribution function derived using the statistical bootstrapping method was then used to describe the distribution of these observations around the expected mean value. The mean and standard deviation values for each residential and non-residential category were entered into the HEC-FDA model. The model used a normal probability density function to describe the uncertainty surrounding the CSVR for each content category. The expected values and standard deviations are shown for each of the three residential categories and the eight non-residential categories in the final report dated May 1997 entitled *Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVRs) in Support of the Lower Atchafalaya and Morganza to the Gulf, Louisiana Feasibility Study*. Since the CSVRs for the 24 industrial structures in the study area were based on information provided by the property owners, there was no uncertainty surrounding these ratios.

First Floor Elevations. The topographical data used to estimate the first floor elevations assigned to the structure inventory contain two sources of uncertainty. The first source of uncertainty arises from the use of the 2009 LIDAR data, and the second source of uncertainty arises from the use of hand levels to determine the structure foundation heights above ground elevation. The error implicit in using LIDAR data to estimate the ground elevation of each of the inventoried structures is normally distributed with a mean of zero and a standard deviation of 0.219 feet. These statistics were calculated based on comparing 2,241 engineering survey points or spot elevations to the elevations determined using the 2009 LIDAR data throughout the evaluation area. According to the Hydrologic Engineering Center training manual, the uncertainty implicit in estimating foundation heights using hand levels from within 50 feet of the structure is normally distributed with a mean of zero and a standard deviation of 0.3 feet at the 95 percent level of confidence.

Based on the error surrounding the LIDAR data and the error arising from the use hand levels, the total uncertainty was estimated for each structure category at the 90 percent level of confidence. The two standard deviations (LIDAR and hand levels) were squared and then totaled. The square root of this total, 0.297 feet, represents the uncertainty surrounding the first floor elevations assigned to the structures located in the Morganza evaluation area.

Depth-Damage Relationships. A triangular probability density function was used to determine the uncertainty surrounding the damage percentage associated with each depth of flooding. A minimum, maximum and most likely damage estimate was provided by a panel of experts for each depth of flooding. The specific range of values regarding probability distributions for the depth-damage curves can be found in the final report dated May 1997 entitled *Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVRs) in Support of the Lower Atchafalaya and Morganza to the Gulf, Louisiana, Feasibility Study*.

The owners of the 24 industrial properties provided a minimum, maximum, and most likely content damage estimate for each depth of flooding using OBM approved survey forms. Copies of the OBM survey forms used to develop the depth-damage relationships can be found in the final report dated May 2009 entitled *Morganza to the Gulf Post Authorization Change Report: Residential and Nonresidential Structure Inventory and Nonresidential Surveys*.

ENGINEERING INPUTS TO THE HEC-FDA MODEL

Ground Elevations. Geospatial Engineering acquired elevation data for the Morganza study area in 2009. The LIDAR data were processed and used to create a digital elevation model (DEM) with a five-foot by five-foot horizontal grid resolution. The DEM used NAVD88 2004.65 vertical datum to determine the ground elevations for each of the residential and non-residential structures in the evaluation area.

Stage-Probability Relationships. Stage-probability relationships were provided for the existing (2010) without-project condition, and for the first year of partial storm surge reduction (2024), the base year of the project (2035), and the final year in the period of analysis (2085) under both without-project and with-project conditions for each of the 276 study area. Water surface profiles were provided for eight annual chance exceedance (ACE) events: 99% (1-year), 20% (5-year), 10% (10-year), 4% (25-year), 2% (50-year), 1% (100-year), 0.5% (200-year), and 0.2% (500-year). The water surface profiles were based only on storm surge and did not incorporate heavy rainfall events.

The 99% ACE (1-year) event, 20% ACE (5-year) event, and 10% ACE (10-year) event water surface profiles for the year 2010 were based on gage data. For each of these ACE events, the water surface profiles for the years 2024, 2035, and 2085 were determined by adding relative sea level rise to the gage data. The water surface profiles for the 2% ACE (50-year) event through the 0.2% ACE (500-year) event were based on results from the ADCIRC model. The 4% ACE (25-year) event stages were determined by interpolation between the 10% ACE (10-year) event stages and the 2% ACE (50-year) event stages.

In cases where an analysis of the hydrology indicated that the surge elevation for a particular probability storm event would not impact a study area reach, the stages for that event were assigned using an elevation lower than the minimum ground elevation in that study area reach. This was done to ensure that flood damages due to storm surge would not be reported for these areas. The minimum ground elevations were referenced to the LIDAR data for the Morganza evaluation.

Non-Federal and Federal Levee Performance. Local levee systems provide flood risk reduction under existing conditions (2010) for over 29,000 residential and non-residential structures located within 78 of the study area reaches. A set of fragility curves, which relates specific stages in NAVD 88 (2004.65 epoch) on the exterior side of the levee to four probabilities of levee failure (zero percent, ten percent, forty-five percent, and ninety-five percent), were developed for each of the local levee systems under the without-project condition. It was assumed that there was a zero percent probability of failure at the 2-foot stage for all local levees.

The fragility curves developed for each of the local levee systems considered multiple failure modes including the slope of the levee, seepage, wave heights, overtopping, and erodability. The failure of an existing non-Federal levee typically occurs when the structural integrity of the levee is compromised by the storm surge. However, geotechnical failure analyses conducted in the evaluation area determined that there is only a one to three percent probability of failure at the top of the levee due to stability issues. Thus, overtopping and erodability were used to develop the non-Federal levee fragility curves.

The fragility curves for the non-Federal levee system were entered into the HEC-FDA model for each study area reach containing a non-Federal levee in order to assess the performance of the non-Federal levee system. Table 14 shows the non-Federal levee fragility curves and the top of levee elevation developed for each of the study area reaches containing a levee.

Federal levees will provide flood risk reduction under future conditions for approximately 52,000 residential and non-residential structures located within 233 of the study area reaches. Each of the study area reaches was assigned to one of the ten major Federal levee reaches (A, B, and E through L) based on the location of the reach and the path of the storm surge should the Federal levee fail. Fragility curves were not developed for the Federal levee system. Only a top of the Federal levee elevation was entered into the HEC-FDA model for each of the study area reaches. The top of the levee elevation in this analysis does not represent the actual height of the Federal levee; rather, it represents the still water stage elevation at which the levee is assumed to fail. At this stage, which is below the actual top of the levee, waves will overtop the Federal levee at a rate of 2.0 cubic feet per second (cfs). Table 15 shows the top of Federal levee still water stage or elevation for each of the major levee reaches for each of the project alternatives.

When existing non-Federal or Federal levees are included in the analysis, an exterior-interior stage relationship must be considered in the analysis. The exterior-interior stage relationship defines the relationship between the water surface, or stage, outside of the levee and the stage within the floodplain behind the levee. Under the with-project conditions, exterior and interior stage relationships were provided for each study area reach. In the event of a Federal levee failure, the interior surge elevation changes as the distance from the levee increases. Thus, a unique interior surge elevation curve was provided for each interior study area reach under with-project conditions. Under the without-project condition, an exterior-interior stage relationship was not provided for each study area reach. In the event of a non-Federal levee failure, the elevation of the surges within the reach is the same on both sides of the levee regardless of the distance from the levee.

Figures 2-1 and 2-2 in the main report provide a conceptual depiction of how the engineering inputs are used in the HEC-FDA model.

Uncertainty Surrounding the Engineering Inputs. The uncertainty surrounding three key engineering parameters was quantified and entered into the HEC-FDA model. These engineering variables included ground elevations, stage-probability curves, and performance of the non-Federal and Federal levees. The HEC-FDA model used the uncertainty surrounding these variables to estimate the uncertainty surrounding the elevation of the storm surges for each study area reach.

Ground Elevations. An engineering survey was conducted to estimate the uncertainty surrounding the use of the 2009 LIDAR data to estimate ground elevations in urbanized areas. The LIDAR data were compared to 2,241 spot elevations, or engineering survey points, throughout the urbanized portions of the evaluation area. The uncertainty surrounding these data was found to be normally distributed with a mean of zero and a standard deviation of 0.219 feet. (A combination of the uncertainty surrounding the ground elevations and the foundation height of a residential and non-residential structure was discussed in the first floor elevation uncertainty section of this report.)

Stage-Probability Relationships. A 50-year equivalent record length was used to quantify the uncertainty surrounding the stage-probability relationships for each study area reach. Based on this equivalent record length, the HEC-FDA model calculated the confidence limits surrounding the stage-probability functions.

Levee Performance. The uncertainty surrounding the performance of the non-Federal levees was based on the fragility curves entered for each study area reach. The Federal levees are assumed to fail with certainty once the surge stage reaches the top of the levee height assigned to each study area reach.

PART 3: NATIONAL ECONOMIC DEVELOPMENT (NED) FLOOD DAMAGE AND BENEFIT CALCULATIONS

NED FLOOD DAMAGE AND BENEFIT CALCULATIONS FOR STRUCTURES, CONTENTS, AND VEHICLES

HEC-FDA Model Calculations. The HEC-FDA model was utilized to evaluate flood damages using risk-based analysis. Damages were reported at the index location for each of the 264 study area reaches for which a structure inventory had been conducted. A range of possible values, with a maximum and a minimum value for each economic variable (first floor elevation, structure and content values, and depth-damage relationships), was entered into the HEC-FDA model to calculate the uncertainty or error surrounding the elevation-damage, or stage-damage, relationships. The model also used the number of years that stages were recorded at a given gage to determine the hydrologic uncertainty surrounding the stage-probability relationships. Fragility curves for the non-Federal levees and top of levee elevations and exterior/interior stage relationships for Federal levees were entered into the levee features section of the model.

The possible occurrences of each variable were derived through the use of Monte Carlo simulation, which used randomly selected numbers to simulate the values of the selected variables from within the established ranges and distributions. For each variable, a sampling technique was used to select from within the range of possible values. With each sample, or iteration, a different value was selected. The number of iterations performed affects the simulation execution time and the quality and accuracy of the results. This process was conducted simultaneously for each economic and hydrologic variable. The resulting mean value and probability distributions formed a comprehensive picture of all possible outcomes.

Stage-Damage Relationships with Uncertainty. The HEC-FDA model used the economic inputs to generate a stage-damage relationship for each structure category in each study area reach under existing (2010) and future (2024, 2035, and 2085) conditions. The possible occurrences of each economic variable were derived through the use of Monte Carlo simulation. A total of 1,000 iterations were executed by the model for the Morganza evaluation. The sum of all sampled values was divided by the number of samples to yield the expected value for a specific simulation. A mean and standard deviation was automatically calculated for the damages at each stage.

Stage-Probability Relationships with Uncertainty. The HEC-FDA model used an equivalent record length (50 years) for each study area reach to generate a stage-probability relationship with uncertainty for the without-project and the with-project alternatives under existing (2010) and future (2024, 2035, and 2085) conditions through the use of graphical analysis. The model used the eight stage-probability events together with the equivalent record length to define the full range of the stage-probability or stage-probability functions by interpolating between the data points. Confidence bands surrounding the stages for each of the probability events were also provided.

Without-Project Expected Annual Damages. The model used Monte Carlo simulation to sample from the stage-probability curve with uncertainty. For each of the iterations within the simulation, stages were simultaneously selected for the entire range of probability events. For the study area reaches without a non-Federal levee system, the Monte Carlo simulation then selects a corresponding damage value for each of the stages from the stage-damage relationships with uncertainty. For the study area reaches with a non-Federal levee system, the Monte Carlo simulation also selects a failure probability from the fragility curve developed for the non-Federal levee. If the selected stages from the stage-probability curve are below the height of the non-Federal levee, then the fragility curve is used to determine if there is levee failure. If the levee fails, then a damage estimate is sampled from the stage-damage relationship. However, if the levee does not fail, then zero damages will be selected for that iteration. If the selected stages are equal to or above the height of the non-Federal levee and the levee fails, then the Monte Carlo simulation will select a damage value from the stage-damage relationship with uncertainty for that iteration. In general, the top of the non-Federal levee elevations were set at an elevation between the stages associated with the 10% ACE (10-year) event and the 4% ACE (25-year) event. There are no exterior-interior stage probability relationships under the without-project conditions.

The sum of all damage values divided by the number of iterations run by the model yielded the expected value, or mean damage value, with confidence bands for each probability event. The probability-damage relationships are integrated by weighting the damages corresponding to each magnitude of flooding (stage) by the percentage chance of exceedance (probability). From these weighted damages, the model determined the expected annual damages (EAD) with confidence bands (uncertainty). For the without-project alternative, the expected annual damages (EAD) were totaled for each study area reach to obtain the total without-project EAD under existing (2010) and future (2024, 2035, and 2085) conditions.

Adjusted Without-Project Expected Annual Damages. The without-project expected annual damages calculated as part of the economic analysis do not consider the behavior of property owners whose structures have incurred repetitive flood losses. The HEC-FDA model implicitly assumes that all damaged assets will be restored to their prior market value completely and instantaneously after each storm event. However, property owners could also opt to have their structures raised in place, floodproof and/or retrofit their structures, relocate within the floodplain, or permanently evacuate from the study area. The course of action selected by an individual property owner following repetitive flood losses depends upon many factors, including the degree of aversion to future anticipated flood risk by that property owner.

As shown in Table 16, unadjusted without-project expected annual damages increase approximately 184 percent between 2010 and 2085. Approximately 6 percent of this percentage increase is attributable to future development, while the remaining 178 percent is attributable to the projected rise in relative sea level. A breakdown of expected annual damages revealed that there were a significant number of structures with damage exposure from relatively frequent events. Table 17 shows that approximately 7,500 residential and non-residential structures incur flood damages from a 10% ACE (10-year) storm event in the year 2035, and Table 18 shows that approximately 1,700 residential structures would incur damages greater than or equal to 50 percent of the structural value at the 10% ACE (10-year) event. Given the number of structures at risk from frequent flooding, the magnitude of these damages, and the increased frequency which residential and non-residential structures would be exposed to flooding, adjustments to the implicit assumptions of the HEC-FDA model were deemed necessary.

Historical Response to Flood Events. The Morganza study area experienced numerous flood events during the past several decades. Historical data show that the post-flood response of property owners to the flood events prior to 2005 did not result in significant outmigration from the study area. Data from the 2000 Census show that approximately 65 percent of residents in the Lafourche and Terrebonne Parishes lived in the same housing unit as they had in 1995. This percentage ranged from a high of 81 percent in Dulac (southern portion of the study area) to a low of 54 percent in Thibodaux (northern portion of the study area). In comparison, the national percentage of the population residing in the same house in 2000 as in 1995 was 54 percent.

According to local officials, residents in low-lying communities began relocating to areas in the northern parts of the study area after Hurricanes Katrina and Rita impacted the area in 2005. Reasons for this intra-parish shift were a combination of weariness on the part of residents of having to deal with repeat flooding and the more stringent requirements to obtain permits for rebuilding after homes were damaged. In order to rebuild, residents had to incur the cost of building to higher elevations. The ability to secure insurance at a reasonable price was also cited as a reason for the exodus.

The rate of retreat from the southern communities slowed around 2008 after Hurricane Ike impacted the area due to federal assistance, as well as the construction of local levees, which reduced damages to the area. In addition, the two parishes have also implemented elevation programs designed to raise the structures in flood-prone areas. The elevation costs have been offset by state and Federal funding and, in the case of properties with flood insurance, supplemental support in the form of FEMA Increased Cost of Compliance Grants. These programs have made structure elevation more affordable for residents.

Local officials also stated that residents prefer to remain due to the culture of the residents and the economy of the area. The economy of Terrebonne Parish is closely tied to its abundant natural resources, and many of the residents in the small communities outside of Houma are shrimpers, oystermen, crabbers, fishermen, and trappers. In Lafourche Parish, the economy is strongly tied to the production and distribution of natural gas and oil, commercial fishing, and sugar cane.

Historical data show that recent flood events have not resulted in significant outmigration from the study area, and the post-flood response of property owners in the past has been consistent with the HEC-FDA assumption that the structure inventory will remain in place throughout the period of analysis. Although the HEC-FDA certified model is a probability-based, and not an event-driven, model, the assumption that structures will be completely and immediately repaired, is rarely the case for major flood events. While it may require considerable time (months to years) to fully complete repairs, past population trends nevertheless indicate that residents and the structures in which they live have not been permanently removed from the study area. However, the manner in which property owners have responded in the past may or may not be representative of how they will respond in the future to more repetitive and more severe flood events. The more frequent and damaging that flood events become due to sea level rise, the less time property owners have to repair damaged structures prior to the next flood. Thus, adjustments were made to the 2024, 2035, and 2085 structure inventories to account for the projected rise in relative sea level.

Structure Inventory Adjustments. The adjustments were made to the structure inventory before executing the HEC-FDA model to more accurately reflect the most likely future without-project and with-project conditions. For the 2024 residential structure inventory, all properties with a first floor elevation less than or equal to the 2010 10% ACE (10-year) water surface elevation exterior to the non-Federal levee, if it exists, within each study area reach were raised to the 2010 1% ACE (100-year) plus 2 feet to account for the sea level rise projected to occur during the period of analysis. This would also ensure that the structures would not be raised more than once during the period of analysis. For the 2035 residential structure inventory, all properties with a first floor elevation less than or equal to the 2024 10% ACE (10-year) water surface elevation exterior to the non-Federal levee were raised to the 2010 1% ACE (100-year) plus 2 feet. For the 2085 residential structure inventory, all properties with a first floor elevation less than or equal to the 2035 10% ACE (10-year) water surface elevation exterior to the non-Federal levee were raised to the 2010 1% ACE (100-year) plus 2 feet.

The non-residential structure inventory was also adjusted for repetitive flooding based on the 10% ACE (10-year) water surface elevation exterior to the non-Federal levee. If the total value of the structures in a non-residential structure category (except warehouses) was greater than or equal to 15 percent of the total value within a study area reach, then all of the structures in that category were raised based on the same criteria used for the residential structure inventory. If the total value was less than 15 percent, then the structures in that non-residential structure category were not adjusted for repetitive flooding due to their limited exposure. Warehouses were assumed to remain at their initial first floor elevation throughout the period of analysis. These structures would be difficult to elevate given the size and nature of their operations. Floodproofing measures were also not considered the most likely course of action for the owners of warehouses and other non-residential properties since these measures were deemed problematic and difficult to identify for storm surge flooding events.

The adjustments to the residential and non-residential structure inventory were made using the module feature of the HEC-FDA model. The adjusted first-floor elevations were used for the without-project inventory for the years 2024, 2035, and 2085 and for the 2024 with-project structure inventory. A separate module was created for the with-project structure inventories for the years 2035 and 2085. Since partial risk reduction will be provided by each of the project alternatives beginning in the year 2024, the first-floor elevations in these years were not adjusted under with-project conditions. It should be noted that the structures that were elevated between the years 2010 and 2024 are the only structures that were adjusted during the period of analysis under the with-project conditions.

Rationale for the Adjustments. The adjustments made to the 2024, 2035, and 2085 structure inventory were designed to account for the future behavior of property owners whose structures incur repetitive flooding. Beyond the dollar damage and disruptions associated with a flood event, a variety of considerations influence individual property owner rebuild decisions. Significant among these considerations are FEMA requirements for participation in the flood insurance program and the local permitting rules adopted by communities.

FEMA rules require that a structure located within the 1% ACE (100-year) receiving 50 percent or more structural damage from an individual flood event must elevate if it is to be rebuilt/repaired at the original location. Additionally, FEMA has requirements in place to address repetitively damaged properties. FEMA defines a repetitive flood loss property as one that incurs flood damages greater than $1,000 two or more times during a

10-year period. FEMA defines a severe repetitively flooded property as one that incurs flood damage two or more times during a ten-year period with the cumulative value of these damages exceeding the value of the structure, or one that has four claims exceeding a specifically defined amount over the same period. Thus, to be compliant with FEMA rules, severely repetitively flooded properties experiencing such damages would have to be elevated to the 1% ACE (100-year) event level. Property owners could also choose to implement an equivalent mitigation measure or face a significant increase in flood insurance premiums. Finally, the parish could enforce its own elevation requirements for properties in the high-risk flood zones that are severely damaged or are identified as repetitive flood properties, even if the owners are not National Flood Insurance Program policy holders.

As shown in Tables 17 and 18 there is a significant increase in the number of structures incurring flood damages between the 10% ACE (10-year) event and the 4% ACE (25-year) event. The inundation profiles displayed in Tables 17 and 18, along with the probabilities of repetitive flood events for individual structures, provide the basis for identifying a range of structure elevation values to be considered as the decision rule for making an adjustment the structure inventory. Evaluating repetitive flooding probabilities reveals that structures with first flood elevations at or below the 10% ACE (10-year) event have approximately a 26 percent change of being inundated two or more times over a 10-year period. For structures with first floor elevations at or below the 6.7% ACE (15-year) event and 4% ACE (25-year) event, the corresponding inundation chances fall to 14 percent and 6 percent, respectively. Note that selection of a 10-year period for computing multiple flood event probabilities should not be viewed as a definitive value for purposes of this investigation. The value of computing repetitive flooding probabilities is to provide insight regarding the decision rule for making an adjustment the structure inventory. Selection of alternative period lengths would result in different likelihoods of structures experiencing multiple flood events, but the basic relationship of probabilities across ACE events would not change. Ultimately, the adopted decision rule for structure inventory adjustment was based on the distribution of structures across ACE events, FEMA rules for rebuilding, and the expectation that the higher frequency of repetitive flooding associated with being located at the 10% ACE (10-year) event could strongly motivate property owners to take actions to reduce their exposure to flood risk and constitute the most accurate description of the most likely future.

As previously described, the structure inventory was adjusted for repetitive flooding based on the 10% ACE (10-year) water surface elevation exterior to the non-Federal levee. While non-Federal levees provide risk reduction up to the elevation associated with the 6.7% ACE (15-year) event to 5% ACE (20-year) event for approximately 60 percent of the structure inventory, these levees were not considered in this evaluation. However, as long as the non-Federal levees do not fail, structures located in the 6.7% ACE to 5% ACE (15-year to 20-year) floodplain are provided some level of risk reduction above the 10% ACE (10-year) event. This fact contributes to the rationale for using the first floor structure elevations associated with the 10% ACE (10-year) event as the adjustment point for the structure inventory.

Regarding the rationale for timing of the structure inventory adjustments, the following should be noted. Because residents are neither likely to anticipate the increase in relative sea level that is projected to occur between the years 2010 and 2024 nor take proactive mitigation measures in response, the 2024 structure inventory was adjusted based on the 10% ACE (10-year) event for the year 2010. Similarly, the 2035 structure inventory was adjusted based on the 10% ACE (10-year) event for the year 2024, and the 2085 structure inventory was adjusted based on the 10% ACE (10-year) event for the year 2035.

With-Project Expected Annual Damages. The with-project stage probability curves with uncertainty relate the stages on the exterior of the Federal levee system to each probability event. An exterior-interior stage relationship was also entered into the HEC-FDA model for each study area reach. The exterior-interior stage curve relates the stages on the outside of the Federal levee system to the stages on the inside of the Federal levee system for each study area reach. For the Morganza evaluation, the exterior stages were set equal to the water surface profiles from the with-project stage probability relationships for each reach, and the interior stages were set equal to the water surface profiles from the without-project stage-probability relationships. Additionally, since fragility curves were not developed for the Federal levee system, a top of the levee elevation was assigned and entered into the model for each study area reach. This elevation is below the actual top of the levee elevation to account for wave action above the still water stages. At stages below the top of the levee elevation, there is a 100 percent chance that the Federal levee will not fail. At stages equal to or greater than the top of the levee elevation, there is a 100 percent chance that the levee will fail.

The HEC-FDA model used Monte Carlo simulation to sample from the with-project stage-probability relationships with uncertainty for each iteration run by the model. The exterior stage randomly selected by the model was then compared to the top of the Federal levee elevation for each study area reach. If the exterior stage was below the top of the levee elevation, a zero damage value was assigned to that exterior stage. If the exterior stage selected by the model was equal to or above the height of the Federal levee, the related interior stage was used to calculate the damages from the stage-damage relationships with uncertainty. In this case, the with-project interior damages would be equal to the without-project damages for that probability event.

The sum of all damage values divided by the number of iterations run by the model yielded the expected value, or mean damage value, with confidence bands for each probability event. The probability-damage relationships were integrated by weighting the damages corresponding to each magnitude of flooding (stage) by the percentage chance of exceedance (probability). From these weighted damages, the model determined the expected annual damages (EAD) with confidence bands (uncertainty). For the with-project alternative, the expected annual damages (EAD) were totaled for each study area reach to obtain the total with-project EAD under existing (2010) and future (2024, 2035, and 2085) conditions.

Damages resulting from waves overtopping Federal levees were not calculated in this draft of the analysis. Since the top of levee elevations specified in the HEC-FDA model are less than the design top of the Federal levee, wave action above the still water stage has been incorporated into levee performance. Also, the study area reaches south of the city of Houma contain marshland that function as storage area for any excess storm surges attributable to residual wave overtopping. The exclusion of the potential damages from overtopping are not expected to be significant and does not affect plan formulation.

The performance of non-Federal levees was also not included in the calculation of with-project damages for study area reaches that are inside the Federal levee system. If the storm surge overtops the Federal levees, then it is expected that it will also overtop the non-Federal levees. The HEC-FDA model currently does not have the capability to analyze the performance of two levees simultaneously. The exclusion of non-Federal levee performance under the with-project conditions is not considered to have a significant impact on with-project damages.

For those reaches exterior to the Federal levee, the same process was used to calculate damages as was discussed under the without-project conditions. If a non-Federal levee was present in the reach, then a non-Federal levee fragility curve was used along with the with-project stage-damage relationships with uncertainty to calculate damages. If a non-Federal levee was not present in the reach, then the with-project stage-probability curves were used along with the stage-damage relationships with uncertainty to calculate damages. The with-project stages for the exterior reaches could be higher than the without-project stages for a range of probability events. The Federal levee reduces the impact of the storm surge on the interior reaches, but it elevates the stages and induces damages in all exterior reaches.

Induced Damages. The twelve study area reaches located below the proposed Federal levee system incur higher stages for various ACE storm events with the project in place for the years 2024, 2035, and 2085. The HEC-FDA model station numbers associated with these reaches are 163, 169, 175, 235, 256, 316, 340, 490, 496, 508, 604, and 631. Since these reaches experience induced damages as a direct result of the project alternatives, all of the properties in the impacted reaches, which includes 1,010 residential and non-residential structures, would be acquired and the approximately 2,500 residents would be relocated to areas outside the 100-year floodplain. The with-project induced damages, which included damages to residential and non-residential structures, their contents, and vehicles, as well as the debris removal and cleanup costs and damages to streets and highways, were removed for each of these reaches from the total damages for each of the project alternatives. The use of modules was utilized in the HEC-FDA model to remove the induced damages in the affected study area reaches. The cost of the property acquisition totaled $305 million including $249 million for residential structures and $56 million for non-residential structures. The property acquisition and relocation costs were added to the total project costs for the 3% AEP alternative and the 1% AEP alternative. A map of the impacted reaches and a more detailed discussion of the acquisition option can be found in the main report of this evaluation.

Expected Annual Inundation Reduction Benefits. The HEC-FDA model compared the without-project damages with uncertainty to the with-project damages with uncertainty to calculate the expected, benefits with uncertainty for each of the project alternatives. Benefits were calculated for the first year of partial risk reduction (2024), the project base year (2035), and future conditions (2085). Table 19 shows the expected annual without-project damages, with-project damages, and benefits for the years 2024, 2035, and 2085 for the residential and non-residential structures. The tables also show the expected annual benefits at the 25, 50, and 75 percentiles. These percentiles reflect the percentage chance that the benefits will be greater than or equal to the indicated amount.

Benefits During Construction. Construction of both the 3% AEP and 1% AEP alternatives is expected to begin in the year 2014. A closed system with all of the control structures and with at least the first levee lift in place, depending on the levee reach, is scheduled to be completed by the year 2024 for the 3% AEP alternative. A closed system with all control structures and with the first and a significant number of second levee lifts in place is scheduled to be completed by the year 2024 for the 1% AEP alternative. The construction of the 3% AEP storm damage risk reduction system is scheduled to achieve the full design elevation and full project performance in the year 2026, while the construction of the 1% AEP storm risk reduction systems is scheduled to achieve the full design elevation and full project performance in the year 2035. Completion of the initial lift of levee reaches, along with control structures, will provide partial risk reduction for the entire evaluation area. For both the 3% AEP and the 1% AEP alternatives, benefits during construction would accrue for the period 2024 to 2034. The base year for both alternatives has been designated as 2035.

Engineering inputs, which include without-project and with-project water surface profiles, fragility curves for non-Federal levees, top of Federal levee elevation and exterior-interior stage relationships for each study area reach, were developed for the year 2024. The engineering and economic inputs incorporating uncertainty were used in the HEC-FDA model to calculate the without-project and with-project damages for the two project alternatives during the period of construction. The interim benefits that begin in the year 2024 after the completion of the initial lift of levee reaches, associated locks, and floodgates were computed by comparing the expected annual without-project damages to the with-project damages for each of the alternatives. The annual without and with-project damages were adjusted so that the benefits for each of the alternatives could remain constant through 2035, the base year, for each of the alternatives.

The benefits during construction were compounded forward to the base year, totaled, and then amortized over the 50-year period of analysis using the Federal discount rate of 3.75 percent. The calculation of the benefits during construction claimed for the 3% and 1% AEP alternatives is shown in Tables 20 and 21, respectively.

Equivalent Annual Damages and Benefits. Damages and benefits for each of the years during the period of analysis were computed by linear interpolation between 2024 and 2084 for both the 3% AEP and the 1% AEP alternative. The FY 2012 Federal interest rate of 3.75 percent was used to compound the stream of expected annual damages and benefits before the project base year and to discount the stream of expected annual damages and benefits occurring after the base year to calculate the total present value of the damages and benefits over the period of analysis. The present value of the expected annual damages and benefits was then amortized over the period of analysis using the Federal discount rate to calculate the equivalent annual benefits. Tables 20 and 21 show the calculation of equivalent annual damages and benefits for each of the project alternatives.

Table 22 shows the equivalent annual residential and non-residential without-project damages, with-project damages, and benefits for each project alternative. Table 23 shows the equivalent annual without-project damages, with-project damages, and benefits for each project alternative for the 24 industrial properties. The tables also show the equivalent annual benefits at the 25, 50, and 75 percentiles. These percentiles reflect the percentage chance that the benefits will be greater than or equal to the indicated values.

OTHER NED BENEFIT CATEGORIES

General. In addition to the physical damages to structures, contents, and vehicles, there are five other categories of NED benefits that are attributable to the Morganza alternatives: avoidance of structure-raising costs, emergency cost reductions, agricultural benefits, safe harbor of large commercial and recreational boat fleets, and municipal water supply benefits. These benefit categories account for less than 10 percent of the total benefits associated with the project alternatives.

Avoidance of Structure-Raising Costs. Typically, property owners in areas that incur repetitive flooding have three options for reducing their flood risk: raise their structures in place, floodproof/retrofit their structures, or relocate to other areas. For purposes of this evaluation, only structure-raising measures were considered to represent the most likely response under future without-project conditions. The avoidance of structure-raising costs by owners of residential and non-residential structures that could incur repetitive flooding and the temporary relocation of the residents can be considered benefits attributable to the project alternatives.

As shown in Table 24, there were 3,092 structures in the evaluation area that have the potential for repetitive flood losses and were elevated during the period of analysis. The cost per square foot to elevate these structures was based on data obtained during interviews conducted by Corps personnel in 2008 with representatives of three shoring firms in the Metropolitan New Orleans area that specialize in the elevation of structures. An average elevation cost per square foot was derived for each one-foot increment from the original elevation of the structure for slab and pier foundation 1-story and 2-story residential structures and mobile homes. The cost of elevating a 1-story slab foundation residential structure was used for all non-residential structures. These costs were updated to October 2011 price levels using Civil Works Construction Costs Index (CWCCIS). Table 25 shows the costs per square foot of elevating each structure type for each one-foot increment of elevation up to 13 feet.

The total cost for the temporary relocation of residents during the two-month elevation process includes lodging, the labor costs associated moving personal property into and out of a POD, and the storage of these contents. The average furnished apartment rental in the Houma area was determined to be $1,200 per month based on advertised rental properties. The average POD rental, which includes pick-up and delivery, was determined to be $700 for the two-month period. The average labor cost for moving personal property into and out of the POD was determined to be $650 based on the quote from the POD company. The temporary relocation cost using October 2011 price levels totaled $3,750 for each elevated structure.

The elevation cost per square foot, based on the type of structure, number of stories, foundation type, and the number of feet elevated, was multiplied by the square footage of the footprint of each raised structure obtained from the structure inventory collected in 2009 for the evaluation area. The temporary relocation cost per structure was added to the elevation cost to derive the total structure raising cost. Table 26 shows the number of structures elevated, the average height that the structures were elevated, the total cost of elevating these structures, and the average elevation cost per structure.

The total cost of raising 703 structures between the years 2010 and 2024 was calculated to be approximately $108.3 million. The average elevation cost per year during this period was $7.2 million. The cost of raising 464 structures between the years 2025 and 2035 totaled approximately $94.9 million with an average cost per year of $8.6 million, and the cost of raising 1,855 structures between the years 2036 and 2085 totaled $238.2 million with an average cost per year of $4.8 million. The present value of these annual average costs was totaled and then amortized over the period of analysis (2024 through 2084) using the current Federal discount rate of 3.75 percent.

Emergency Cost Reduction. The NED costs associated with each of the emergency activities conducted by the public and private sectors before, during, and after storm events, and infrastructure damage to roads and utilities were estimated based on data obtained during interviews with professionals who are familiar with emergency activities and infrastructure inundation impacts. More than 100 organizations and over 150 individuals were contacted as part of the interview process, and responses were obtained from 39 experts. The interviews were conducted between December 2009 and March 2010. The information compiled as part of the interview process was used to develop depth-emergency cost and depth-infrastructure damage relationships for the Morganza evaluation area. The results can be found in the final report dated March 2012 entitled, *Development of Depth-Emergency Costs and Infrastructure Damage Relationships for Selected South Louisiana Parishes*.

The emergency costs in the report were divided into six groups: evacuation activities (evacuation, subsistence, and reoccupation), debris removal and cleanup, public utilities, infrastructure, public services patronized, and public services produced. The public utilities group was divided into five subcategories: natural gas, electricity, telecommunications, sewage and wastewater treatment, and water supply. The infrastructure group was divided into seven subcategories: streets and highways, bridges, railroads, ports, airports, land-based pipelines, and petroleum wells. The public services patronized group was divided into six subcategories: education, libraries, indoor recreation facilities, medical, eldercare, and daycare. The public services produced group was divided into five subcategories: police, fire, incarceration, judicial, and government administrative.

The damage relationships for each subcategory were generated for two flood event scenarios, along with three depths of flooding for each scenario: freshwater short duration (less than two days) and saltwater long duration (two days or more), and flooding depths of 2 feet, 5 feet, and 12 feet. However, only the saltwater long duration depth-damage relationships were applied in this analysis. The flooding event was assumed to affect a typical area occupied by 3,800 households or 10,000 residents. An individual questionnaire was developed for each of the emergency cost groups and subcategories. The experts were asked to provide a minimum, most likely, and maximum estimate for a variety of parameters required to compute the costs/damages for each of the subcategories. The experts were instructed that the range between the minimum and maximum values was not expected to represent absolute minimum and maximum values, but rather the 90th percentile of the possible outcomes.

The responses from the experts for each estimated parameter were combined and averaged to generate aggregated minimum, most likely, and maximum values. These aggregated values were used to specify a triangular probability distribution. The triangular distributions were used as inputs in an @Risk (Version 5) spreadsheet constructed to produce a distribution of results representing the cost/damage for the subcategory. The distribution fitting feature of @Risk was used to identify the probability distribution functional form that best fit the output of the @Risk spreadsheet based on the Chi-Squared statistic. In all cases the normal distribution was found to represent the best fit. (In identifying the best fit functional form, the normal and triangular distributions were considered.) Consideration was limited to these two because the ultimate use of this information was input as depth-damage functions into HEC-FDA, which is limited to these two functional forms.

The mean dollar damages at each of the three depths of flooding were converted to a percentage of the total cost/damage estimate at the 12 feet depth of flooding. In addition to the three estimated depth of flooding points, a zero damage point was also specified at 1.9 feet of flooding. (This forced damage to begin at 2 feet of flooding.) Once expressed as a percentage, mean values the four depth of flooding data points are structured in the conventional manner that is employed with HEC-FDA. The standard deviation at each depth of flooding was handled in a similar manner as the mean value, with each of the dollar value standard deviations expressed as a percentage of the mean cost/damage dollar value at 12 feet.

The cost/damage depth-damage relationships were entered into the HEC-FDA model, along with information about the structures and infrastructure obtained from an inventory compiled for the study area, including structure type, study area reach, and foundation height, and the engineering inputs (stage-probability relationships and levee fragility curves) to determine the emergency cost reduction benefits attributable to each of the project alternatives. The cost/damage value at 12 feet of flooding was used as the emergency cost or infrastructure value for each "structure inventory" record in the HEC-FDA model.

For this evaluation, only the debris removal and cleanup of the residential and non-residential structures, and the physical damages to streets and highways were quantified and included in the net benefit analysis for the project alternatives. The evacuation, subsistence, and reoccupation costs and the police and fire department relocation costs were quantified, but were not included in the net benefit analysis. These emergency cost categories were quantified in the March 2012 report. The depth-damage results can be found in Chapter 6 of the March 2012 report. The responses to the questionnaires can be found in Attachment 2 of the report.

Debris Removal and Cleanup. Immediately after the floodwaters from a tropical event subside, the public and private sectors of the flooded community must begin the cleanup process. The first activities that typically take place include the removal of debris from roads and yards. The streets must be made accessible for use by emergency vehicles and for residents to return to their homes. Most of this type of debris is either vegetative or sediment debris left after the floodwaters subside. While these categories of debris could be a significant part of the cleanup process, they are not addressed in this analysis. This analysis has included the collection, processing, and proper disposal of the debris material from the inside of the inundated structures, which varies according to residential or non-residential occupancy type of the structure. This type of debris includes content-related debris, white goods, electronics, and hazardous waste (paints, oil, household chemicals, poisons, etc.). Hazardous debris must be properly disposed of so as to minimize the existing and future threats to human health and the environment.

Interviews were conducted with four experts in the fields of debris collection, processing, and disposal. The questionnaires used in the interview process were designed to elicit information from the experts regarding the cost of each stage of the debris cleanup process by structure occupancy type. The experts were asked to provide a minimum, most likely, and maximum estimate for the cleanup costs associated with the 2 feet, 5 feet, and 12 feet depths of flooding. A prototypical structure size in square feet was used for each of the five residential occupancy categories and for each of the eight non-residential occupancy categories. The experts were asked to estimate the percentage of the total cleanup caused by floodwater and to exclude any cleanup that was required by high winds.

The total amount of content-related debris estimated for each structure occupancy type was expressed in cubic yards per structure. The white goods were expressed in units per structure, and the electronics and hazardous materials were expressed in pounds of debris per structure. A minimum, most likely, and maximum cost estimate was provided for the collecting and processing of each cubic yard of content-related debris, each white goods unit, and each pound of electronics and hazardous waste for the saltwater long duration flood scenario. A minimum, most likely, and maximum cost estimate was also provided for the removal, hauling away, and disposal of the debris. The minimum, most likely, and maximum estimates from each expert were converted into aggregated values (as previously described) for each structure occupancy type and were entered into the @Risk spreadsheet as triangular distributions. Fitting of the @Risk spreadsheet output to a probability distribution functional form and conversion of the probability distribution information into HEC-FDA depth-damage input was accomplished as previously described. The mean debris removal and cleanup costs and the standard deviations for each of the three depths of flooding are shown by structure occupancy type in Table 27.

The cost/depth-damage relationships for each structure occupancy category were converted to percentages and entered into the HEC-FDA model, along with the debris and cleanup structure records (cost/damage value at 12 feet of flooding was used as the emergency cost or infrastructure value) and engineering inputs (stage-probability relationships and levee fragility curves) to calculate the expected annual without-project and with-project debris removal and cleanup costs for the years 2024, 2035, and 2085. The expected annual costs were converted to equivalent annual values using the current Federal discount rate of 3.75 percent and a 50-year period of analysis. Since the costs were initially expressed in 2010 price levels, the equivalent annual without-project and with-project values were updated to October 2011 price levels and are shown in Table 28. It should be noted that the adjusted structure inventory for repetitive flooding was used to calculate the reduction in debris removal and cleanup costs.

*Damages to Infrastructure***.** The reduction of potential flood damages to the infrastructure (streets and highways, bridges, railroads, ports, airports, land-based pipelines, and petroleum wells) in an evaluation area can form a significant category of benefits attributable to a project alternative. For purposes of this analysis, only the damages to streets and highways were considered. Streets are defined as roadways with two lanes with relatively lower volumes of traffic and access, while major and secondary highways are defined as roadways with four lanes with relatively higher volumes of traffic and access.

GIS data were used to determine the number of miles of streets and highways in each of the study area reaches in the Morganza evaluation area. Within each study area reach, a grid was used to create individual HEC-FDA structure records. Each structure record was equal to one 1,000 feet x 1,000 feet grid unit. The NAVTEQ, Inc. database was then used to obtain the number of miles of streets and highways within each grid unit. A mean ground elevation was assigned to the grids based on LIDAR data.

Interviews were conducted with an expert in street and highway construction to determine the cost of repairing each mile of roadway. Costs were provided for three roadway components. The components of streets include street surface, street base, and street curb, while the components of major and secondary highways include road surface, road base, and road shoulder. A minimum, most likely, and maximum replacement value per mile, which included materials and labor, was assigned to each component. The expert was then asked to provide an estimate of the depreciation that has taken place in each roadway based on the age of the roadway. The value of each mile of roadway component was discounted by the estimated depreciation percentage. Finally, the expert was asked to estimate the percentage of the road components that would be damaged at the 2-feet, 5-feet, and 12-feet depths of flooding.

The damage to the streets and highways per mile was calculated by multiplying the cost of the materials and labor to replace each infrastructural component by the inverse of the depreciation percentage by the percentage damage to each component. The minimum, most likely, and maximum damages for each roadway component were used to develop a range of values for the total cost of the infrastructural damages for each mile of roadway. The triangular probability distributions were input to the @Risk model, and the probability distribution fitting feature was used to find the distribution that best fit the output. The normal distribution was found to fit the infrastructural damage outputs better than the triangular distribution. The mean value for the damages per mile and standard deviations for each of the three depths of flooding are shown for major and secondary highways and streets in Table 29.

The depth-damage relationships for major and secondary highways and streets were converted to percentages and entered into the HEC-FDA model, along with the major and secondary highways and streets structure records (damage value at 12 feet of flooding was used as the infrastructure value) and engineering inputs (stage-probability relationships and levee fragility curves) to calculate the expected annual without-project and with-project major and secondary highways and streets for the years 2024, 2035, and 2085. The expected annual costs were converted to equivalent annual values using the current Federal discount rate of 3.75 percent and a 50-year period of analysis. Since the costs were initially expressed in 2010 price levels, the equivalent annual without-project and with-project values were updated to October 2011 price levels and are shown in Table 30.

Agricultural Benefits. An economic analysis of the agricultural lands in the study area was conducted to determine the number of acres impacted in the study area. The

National Agricultural Statistical Service (NASS) geo-spatial information system for the year 2010 data were used to identify the agricultural land and crop distribution in each of the study area reaches. Agricultural activity was found in 35 of the Morganza study area reaches. The relationships for the without-project (2010, 2035, and 2085) conditions and for the with-project alternatives (2035 and 2085) conditions were used with the top of levee elevation for the non-Federal and Federal levees to determine the average annual flooded acres. Table 31 shows the average annual flooded agricultural acres by study area reach under the without-project conditions for the years 2010, 2035, and 2085 and under the with-project alternatives conditions for the years 2035 and 2085. Even if a high estimate of the net revenue generated by an average annual acre was used in the analysis, the total agricultural benefits would only equal approximately one percent of the total inundation reduction benefits to structures, contents, and vehicles for each of the project alternatives. Thus, estimates of agricultural benefits were not included in the net benefit computations.

Safe Harbor Benefits for Boat Fleets. In addition to the HNC, five bayous located in the coastal portion of the study area are used as navigational routes to and from the Gulf of Mexico: Bayous DuLarge, Grand Caillou, Petit Caillou, Terrebonne, and Pointe aux Chenes. Large commercial and recreational vessels dock along these waterways because of the proximity to the Gulf of Mexico and other fishing grounds, but these vessels must be moved upstream to safer harbors during tropical events. Storm surges could cause physical damages to moored vessels by tossing them into adjacent vessels or docks, pushing debris into the vessels, or washing them up on land. Since the project alternatives would reduce the impact that storm surges have on the waterways, vessels would not have to be moved to sheltered locations. The reduction in physical damages to the large commercial and recreational boat fleet and the reduction in the costs of moving these vessels inland to safer waterways are considered benefits attributable to the project. However, the physical damages were not quantified in this analysis.

According to data obtained from the Louisiana Department of Wildlife and Fisheries (LDWF) and the U.S. Coast Guard (USCG), there were 1,574 motorized vessels greater than 25 feet in length registered in Terrebonne Parish in 2009. These vessels were grouped into five categories: 949 were classified as commercial fishing vessels, 361 were classified as recreational boats, 140 were classified as oil and gas crew boats, 33 were used as commercial passenger vessels, and 91 were designated as other commercial vessels. Vessels less than 26 feet in length were not included in the analysis because they are typically removed from the water in advance of an approaching storm and would not benefit from the construction of the project.

Projections for the Motorized Vessel Fleet. The number of vessels in the commercial fishing and recreational fleets was projected for the years 2024, 2035, and 2085. The projections were based on both historic trends in boat registrations and economic growth patterns, and they were made for median, high growth, and low growth scenarios. The number of oil and gas related vessels was not projected because the project alternatives would not have an impact on these vessels. According to industry representatives, oil and gas related vessels are used to evacuate crewmen from offshore oil rigs prior to tropical events, and these vessels typically leave for other ports outside of the evaluation area. The number of vessels in the commercial passenger fleet and the other vessel fleet was projected to remain constant throughout the evaluation period. Projections for the commercial fishing, recreational vessel, and commercial passenger fleets were obtained from the draft report entitled *Economic Benefits of Protecting the Large Recreational and Commercial Boat Fleets* dated March 2012.

Commercial Fishing Vessels. The commercial fishing fleet consists primarily of shrimp boats, but it also includes vessels used to harvest oysters and finfish. The number of commercial fishing vessels registered with the LDWF has been declining since the late 1990s due to an industry trend toward larger, but fewer, vessels. While the number of vessels less than 26 feet in length decreased 18.5 percent from 1,115 in 1999 to 909 in 2008, the number of vessels in the 40 to 65 feet range increased over 400 percent from 46 in 1998 to 236 in 2008. The overall number of registered commercial fishing vessels decreased 10.8 percent from 1,757 in 1997 to 1,568 in 2008, which is an average annual decline of 0.44 percent.

The projections for the commercial fishing fleet were based on the annual brown and white shrimp catch for the state of Louisiana during the 13-year period 1997 through 2009. During this period, Terrebonne Parish contributed approximately 30 percent of the total shrimp catch in the state. The Terrebonne shrimp catch totaled 25.9 million pounds in 2009 and averaged 32.9 million pounds annually between 1997 and 2009. The average catch size for the 13-year period was used as the median value in the projections. The low estimate of 21.5 million pounds was calculated by subtracting two standard deviations from the median value. The high estimate of 44.3 million pounds was calculated by adding two standard deviations to the median value.

Historical trends were used to determine the percentage of the total shrimp catch caught by vessels in each of the size categories. The percentage caught by the smaller crafts was projected to decrease through the year 2040, while the percentage caught by the larger crafts was projected to increase through the year 2040. After the year 2040, these percentages were projected to remain constant. Table 32 shows the percentage of the total shrimp catch caught by each vessel size for the years 2009, 2024, 2035, and 2085.

The 2002 LDWF report was used to calculate the median catch for each vessel size. Table 33 displays the median shrimp catch for each vessel size.

The projected number of vessels in each size category for the low, median, and high growth scenarios in the years 2024, 2035, and 2085 is shown in Table 34. These numbers are based on the annual shrimp catch, the percentage of the total catch by vessel size, and the median catch for each vessel size. As an example, the projected number of vessels over 65 feet in length for the high scenario in the year 2024 was calculated by multiplying 44.3 million pounds (the high estimate of the total shrimp catch) by 15.9 percent (the percentage of the total catch for vessels over 60 feet in length from Table 32). This product was then divided by 69,050 (the median shrimp catch for vessels over 60 feet in length from Table 33) to estimate that there will be 102 vessels over 60 feet in length in the year 2024 under the high growth scenario.

Recreational Vessels. The large recreational vessel fleet experienced an average annual growth rate of 2.0 percent between 1999 and 2009 and an average annual growth rate of 2.9 percent between 2002 and 2009. This growth can be attributed to population growth and rising median income. Table 35 shows the annual growth in the number of recreational vessels by vessel size for the years 1999 to 2009 and 2002 to 2009.

In the median forecast, the average 10-year annual growth rate was extended through the year 2040, and a slower growth rate was used for the period between 2040 and 2085. In the low growth estimate, the size of the recreational vessel fleet is projected to remain constant during the year 2085. In the high growth estimate, the size of the recreational vessel fleet is based on the 2002 through 2009 growth rate. Table 36 shows the forecasted growth rates by vessel size for the median and high growth scenarios. Table 37 shows the projected number of recreational vessels for the years 2024, 2035, and 2085 under the low growth, median, and high growth scenarios.

Commercial Passenger Vessels. The commercial passenger fleet consists of charter fishing vessels that are similar to recreational vessels but with a different type of ownership. While commercial passenger fleet in Terrebonne Parish declined 2.9 percent annually from 68 vessels in 1997 to 56 vessels in 2003, the fleet increased 5.9 percent annually from 56 vessels in 2004 to 79 vessels in 2009. Overall, the number of commercial passenger vessels grew at an average annual growth rate of 1.2 percent. Due to the fluctuations in the number of vessels during the 13-year period, the median commercial passenger fleet was projected to remain constant at 33 vessels for the years 2024, 2035, and 2085. Of this total, 21 vessels were between 26 feet and 40 feet in length, 9 vessels were between 40 feet and 65 feet in length, and 3 vessels were over 65 feet in length. The low estimate is based on an annual decrease of 1.0 percent through the year 2040 and an annual decrease of 0.5 percent from the year 2040 through the year 2085. The high estimate is based on a 1.0 percent annual increase through the year 2040 and a 0.5 percent annual increase from the year 2040 through the year 2085. The projected number of commercial passenger vessels for the years 2024, 2035, and 2085 for the low growth, median, and high growth scenarios is shown in Table 38.

Evacuation Travel Distances. The homeports of the motorized vessel fleet under the without-project condition were determined based on interviews with experts in the Terrebonne Parish maritime industry. As shown in Table 39, 60 percent of the vessels dock along Bayous Petit Caillou and Grand Caillou, and 30 percent dock along Bayous DuLarge and Terrebonne. The remaining 10 percent dock along the HNC and Bayou Pointe aux Chenes. The homeport of 78 percent of the vessels is located above the project alternatives, while the homeport of 22 percent of the vessels is located below the project alternatives.

The distribution of the vessel fleet along the six waterways was used to estimate the average number of nautical miles that a vessel would travel to evacuate from storms more intense than the 10% ACE (10-year) event. Under the without-project condition, all vessels would have to travel north of their homeport to seek shelter during tropical events. Under the with-project conditions, only the vessels with homeports below the proposed alternatives would have to evacuate to safer locations. The weighted average number of nautical miles each vessel would have to travel in advance of an approaching storm event was determined to be 10.94 nautical miles under without-project conditions and 1.14 nautical miles with the proposed alternatives in place. The distances traveled to flee an approaching storm under without and with-project conditions are shown in Table 40. The total distances traveled to flee approaching storms were calculated under the without-project and the with-project conditions by multiplying the number of vessels in each vessel type and size category by the weighted average travel distances.

Travel Costs per Nautical Mile. The cost per nautical mile by vessel size category for commercial fishing, recreational/commercial passenger (charter fishing), and other commercial vessels was estimated using fuel and crew costs. The average speed and fuel consumption for each size category by vessel type was determined based on the characteristics of used vessels available for sale on the websites www.MaritimeSales.com and www.YachtWorld.com. The cost of diesel fuel was based on the 3-year average of Gulf Coast monthly fuel costs during the period March 2009 through February 2012 from the U.S. Energy Information Agency (EIA). Crew costs were estimated at $15 per hour for crew members and $20 per hour for captains. Crew sizes varied by vessel type and size, with larger vessels requiring more manpower. Table 40 show the calculation of the travel costs per nautical mile for the commercial fishing vessels, recreational/commercial passenger vessels, and other vessels by size category.

Travel costs were calculated using October 2011 price levels for the without-project and the with-project conditions by multiplying the projected number of vessels in the fleet by the weighted average travel distance from by the average operating cost per nautical mile. Table 41 shows the without-project and with-project total vessel travel costs for each vessel size for the low growth, median, and high growth scenarios for the years 2024, 2035, and 2085. The difference between the without-project travel costs and the travel costs with the project alternatives in place is considered the travel cost reduction benefit attributable to the project alternatives.

Expected Annual Travel Costs Reduction. The without-project and with-project travel costs were integrated by weighting the travel costs by the percentage chance of exceedance (probability) for those ACE events equal to and more intense than the 10% ACE (10-year) event. From these weighted travel costs, the expected annual travel costs were calculated for the without-project and with-project conditions for the low growth, median, and high growth scenarios for the years 2024, 2035, and 2085. The difference between the without-project and the with-project expected annual travel costs is considered the benefit attributable to the project alternatives. The expected annual travel costs reductions are shown in Table 43.

Expected Annual Physical Damage Reduction for the Vessel Fleet. A depth-damage curve relating the height of the storm surge above normal sea level at one-foot increments to the percentage of the vessel damaged was developed for the vessel fleet as part of the draft report entitled *Economic Benefits of Protecting the Large Recreational and Commercial Boat Fleets* dated March 2012. The damage percentages were based on data collected in the Louisiana coastal region following Hurricanes Katrina and Rita. However, because sufficient documentation supporting the development of the depth-damage relationships was not available, physical damages to the vessel fleet were not calculated used in the net benefit analysis for the Morganza PAC Report.

Municipal Water Supply Benefits. The Terrebonne Water District Number 1 is responsible for supplying drinking water to the residents of Terrebonne Parish. The city of Houma and the town of Grand Caillou are served by a water treatment facility located at the confluence of the Houma Navigation Canal (HNC) and the Gulf Intracoastal Waterway (GIWW), which draws water from the GIWW. The remainder of Terrebonne Parish is served by the water treatment facility in Schriever that draws water from Bayou Lafourche. The Schriever plant is also periodically used to supplement the Houma water supply. Under existing conditions, above normal salinity levels occur each year during late summer and early fall in the GIWW, which impacts the Houma Water Treatment Plant (HWTP), and in the portion of Bayou Lafourche located between the Company Canal in Lafourche Parish and the GIWW, which impacts the Schriever Water Treatment Plant (SWTP). The HNC has been identified as the major conduit for the intrusion of saltwater from the Gulf of Mexico. During periods of high salinity levels, the HWTP and the SWTP must obtain water from the Bayou Black Reservoir in order to meet their municipal water supply demands.

Water for Lafourche Parish is provided by five water treatment facilities located along Bayou Lafourche. The Lockport facility, which is located on Bayou Lafourche downstream from the Company Canal, is the only plant in Lafourche Parish to have reported excessive salinity levels. Since the Lockport water treatment facility has no alternative water sources, the plant typically treats the saltwater and then sends out advisories to the residents of the area.

Average Annual Number of Days of High Salinity. Since the HNC was constructed in 1961, chloride concentrations at the Houma Water Treatment Plant (HWTP) have exceeded the State standard of 250 parts per million (ppm) an average of 37 days per year with a standard deviation of 25.6 days. The number of days of high salinity ranged from a high of 109 days in 1999 to a low of zero days in 1961, 1989, and 1993. The @Risk program was used to determine that a Gamma probability distribution would best fit these data for the period between 1961 through 2011. The Gamma probability distribution was then used to predict the number of days of high salinity for each year in the period of analysis (2012 through 2084). The expected value for the number of days of high salinity during the period is 31.2 days per year, not accounting for rising sea level. The distribution was truncated so as not to generate values below zero days of high salinity.

Construction of the lock-gate complex on the HNC, which is projected to be completed in the year 2019, will reduce the amount of saltwater intrusion into the evaluation area. The number of days with salinity greater than 250 ppm with the project in place depends on how the HNC and Bayou Grand Caillou navigational and environmental structures are operated. A system-wide salinity model was used by Engineering to assess the salinity at 78 locations throughout the project area. However, for purposes of this analysis, only the three locations closest to the HWTP were used to determine the reductions in salinity. Salinity levels were simulated in the model to compare the reduction in salinity levels under the without-project and with-project conditions for year 2004. Under the without-project condition, there were 53 days of salinity greater than 250 ppm. With the HNC floodgate closed and all other environmental and navigational structures open, the number of days of high salinity was reduced to 40 days, which is a decrease of 23.91 percent. With the HNC lock and the other structures open, the number of days was only reduced to 49 days. With the HNC lock open and all environmental structures closed, the number of days was only reduced to 50 days. For this analysis, the most likely operation is for the HNC gate to be closed and the other structures to be open.

Additional Costs Associated with High Salinity Levels. The expected annual number of days for each of the years in the period of analysis was then multiplied by the increase in chemical costs per million gallons (MG) per day using water from Bayou Black instead of the GIWW. Based on information provided by HWTP, the incremental treatment cost is $84.79 per MG. The incremental cost was then multiplied by the average number of gallons treated per day of 4.056 MG based on data from FY 2008-09 to determine the average daily increase in treatment cost. The average daily treatment cost was calculated to be $343.94. This cost was then multiplied by the average number of days of high salinity for each year to determine the average annual cost under the without-project conditions. The average daily treatment cost under the with-project conditions was determined by reducing the without-project cost by 23.91 percent beginning in the year 2019.

Additionally, granular activated carbon (GAC) must be added to water obtained from Bayou Black because the high level of total organic carbon (TOC) in the water decreases the life of the GAC in the water supply. The cost of each GAC treatment was estimated by the SWTP to be $275,000. Without the project in place, the GAC would need to be replaced every 3 years and with the project in place, the GAC would need to be replaced every 4 years. The reduction in the number of years in the GAC replacement cycle generates a cost savings during the period of analysis (2019 through 2084).

The project alternative would reduce the costs associated with the operation of the four gates located along Bayou Black (Water Proof Pump Station, Minors, Hanson, and Elliot Jones) to prevent saltwater intrusion. The power usage under the without-project condition costs $330 per year, while the power usage with the project in place costs $251 per year. The reduced power usage leads to an estimated cost savings of $79 per year.

The gates would no longer need to be refurbished every 20 years at a cost of $135,000 and replaced every 40 years at a cost of $1 million. Thus, the project would create a cost savings of $2.27 million during the period of analysis. Finally, the Water Proof Pump Station would no longer need to be refurbished every 20 years at a cost of $135,000 and replaced every 40 years at a cost of $500,000. This would create a cost savings of $1,270,000 during the period of analysis (2019 through 2084).

Annualized Cost Savings. Table 44 shows the projected annual increase in the cost of supplying water that results from increased salinity under the without-project and with-project conditions in October 2011 price levels. The difference between the two total costs is the total cost savings attributable to the project alternative. The total cost savings were annualized over the period of analysis using the current Federal discount rate of 3.75 percent to determine the average annual cost savings or benefits associated with the project alternative.

PART 4: LIFE CYCLE COSTS OF THE PROJECT ALTERNATIVES

CONSTRUCTION OF THE PROJECT ALTERNATIVES

Construction Schedule. Construction of each of the project alternatives is scheduled to begin in the year 2014 and will continue through the year 2070 for the 3% AEP alternative and through the year 2071 for the 1% AEP alternative. The authorized levee alignment for each of the alternatives will be constructed utilizing the existing non-Federal levee systems throughout the area whenever possible and will be constructed in phases due to the relatively poor foundation conditions and the absence of quality burrow material. The 3% AEP alternative requires one or two levee lifts, depending on the levee reach, to achieve the design elevation by the year 2026. Two additional levee lifts are scheduled after the year 2026 to maintain the design elevation. The 1% AEP alternative requires two or three levee lifts, depending on the levee reach, to achieve the design elevation by the year 2035. Three additional levee lifts are scheduled after the year 2035 to maintain the design elevation. The first levee lifts will be overbuilt and allowed to settle for several years before the later levee lifts are added. The later lifts will account for the relative sea-level rise and subsidence that is projected to occur throughout the period of analysis. The life cycle costs also include the construction of sector gates and a lock structure on the Houma Navigation Canal and the major periodic rehabilitation cost of these navigation structures.

Average Annual Costs. Life cycle cost estimates were provided for both the 3% AEP and the 1% AEP alternatives in October 2011 price levels. The first costs, along with the schedule of expenditures, were used to determine the interest during construction and gross investment cost at the end of the installation period (2035 for the 3% AEP alternative and the 1% AEP alternative). The current Federal discount rate of 3.75 percent was used to discount the costs to the base year and then amortize the costs over the 50-year period of analysis. After the average annual construction costs were calculated, the annual operations and maintenance costs were added.

Tables 45 and 46 provide the life cycle costs for each of the project alternatives, the average annual construction costs, the annual operation and maintenance costs, and the total average annual costs.

PART 5: RESULTS OF THE ECONOMIC ANALYSIS

NET BENEFIT ANALYSIS

Calculation of Net Benefits. The expected annual benefits attributable to each of the project alternatives for each of the benefit categories were converted to an equivalent time frame by using the current Federal discount rate of 3.75 percent. The base year for this conversion is the year 2035 for the 3% AEP alternative and the 1% AEP alternative. The equivalent annual benefits were then compared to the average annual costs to develop a benefit-to-cost ratio for each alternative. The net benefits for each alternative were calculated by subtracting the average annual costs from the equivalent annual benefits. The net benefits were used to determine the economic justification of each of the project alternatives.

Comparison of Net Benefits for the Project Alternatives. Tables 47 and 48 summarize the equivalent annual damages and benefits, total annual costs, benefit-to-cost ratio, and equivalent annual net benefits for the 3% AEP and the 1% AEP alternatives. Tables 49 and 50 show the net benefits for the project alternatives using only the existing condition (2010) structure inventory for the 3% and 1% AEP alternatives.

Sensitivity Analysis. The purpose of this sensitivity analysis was to investigate the impact that a change in depth-damage relationships from an adjacent area would have on the net benefits and benefit-to-cost ratios of the 3% AEP alternative and the 1% AEP alternative. The saltwater long-duration depth-damage relationships developed by a panel of experts as part of the Donaldsonville to the Gulf evaluation were applied to the residential and non-residential structures, contents, and vehicles in the Morganza evaluation area. The depth-damage relationships developed for the Donaldsonville evaluation are shown in Table 51. The net benefits and benefit-to-cost ratios calculated for the two project alternatives using the Donaldsonville to the Gulf depth-damage relationships are shown in Tables 52 and 53.

Update to 2012 Price Level. The damages, benefits, and costs values were updated to a 2012 price level and are shown in Table 54 for the 3% AEP alternative and Table 55 for the 1% AEP alternative. The following indexes were used to update the benefit categories and cost values from 2011 to 2012: the Construction Index developed by the Bureau of Labor Statistics was used for residential and non-residential benefit categories, including the industrial benefit category, and the avoided structure-raising costs category; the National Highway Construction Cost Index was used for the highway and streets benefit categories; the Remediation Services Index developed by the Bureau of Labor Statistics was used for the debris removal and cleanup benefit category; the Diesel Fuel Price Index developed by the Energy Information Administration was used for boat fleets benefit category, and the Composite Civil Works Construction Cost Index System was used for the project costs.

RISK ANALYSIS AND PROJECT PERFORMANCE

Benefit Exceedance Probability Relationship. The HEC-FDA model used the uncertainty surrounding the economic and engineering inputs to generate results that can be used to assess the performance of the two project alternatives. A spreadsheet was developed using the expected annual damage and benefit results from the HEC-FDA model to calculate the equivalent annual without-project and with-project damages and the damages reduced for each of the project alternatives. Table 56 shows the equivalent annual benefits at the 75, 50, and 25 percentiles. These percentiles reflect the percentage chance that the benefits will be greater than or equal to the indicated values. A trend function was applied to estimate the forecasted damage reduction above the 75 percentile for each of the project alternatives. The benefit exceedance probability relationship for each of the project alternatives can be compared to the point estimate of the average annual costs for each of the project alternatives. The table and graphs for each of the project alternatives shows the percent chance that the benefit-to-cost ratio will be greater than one and the net benefits will be positive.

Residual Risk. Residual risk is the flood risk that remains in the floodplain after a proposed flood risk management alternative is implemented. It includes the consequence of capacity exceedance as well as consideration of project performance. Table 57 shows the number of structures damaged and the structural damages in dollars under the without-project conditions for each of the eight ACE events, the residual damages in dollars under the with-project conditions for the 2% ACE (50-year),1% ACE (100-year), 0.5% ACE (200-year), and 0.2% ACE (500-year) events, and the percentage of the total number of structures including automobiles, residential structures, commercial structures, and mobile homes damaged by each of the four ACE events for the year 2035. All three ACE events exceed the design of the 3% AEP alternative, while only the 0.5 % ACE (200-year) event and 0.2% ACE (500-year) event exceeds the design of the 1% AEP (100-year) alternative. The residual damages in each of these cases are higher than the without-project damages because structures below the 10% ACE (10-year) event are elevated to above the 1% ACE (100-year) event to account for the response of residents to repetitive flood losses beginning in the year 2024. Finally, the table shows the minimum and maximum flood depths under the without-project conditions, which assumes that the non-Federal levees will fail, for each of the four ACE events.

Table 58 shows the number and the percentage of the total structures in the study area that would be inundated at three-foot increments of flooding at the under the without project conditions in the year 2035. The residual damages with the proposed Federal alternatives would be higher due to structures being elevated under the without-project condition to account for the response of residents to repetitive flooding, but not elevated with the project alternatives in place. For example, 19 percent of the structures would not be inundated, 12 percent of the structures would receive between 0 and 3 feet of flooding, and approximately 36 percent would have a depth of flooding between 3 and 6 feet above the first floor elevation.

AEP by Reach for the Years of Analysis. The results from the HEC-FDA model were also used to calculate the long-term annual exceedance probability (AEP) and the conditional non-exceedance probability, or assurance, for various probability storm events. The model provided a target stage to assess project performance for each study area reach under both existing (2010) and future (2024, 2035, and 2085) without-project and with-project conditions. For study area reaches without Federal or non-Federal levees, the target stage was set by default at the elevation where the model calculated five percent residual damages for the 1% ACE (100-year) event. For levees without geotechnical failure, which includes the Federal levees in the Morganza analysis, the target stage was set equal to the assigned top of the Federal levee elevation. For levees with geotechnical failure, which includes the non-Federal levees in the Morganza analysis, the target stage was computed based on the joint probability of annual exceedance and probability of geotechnical failure.

The model calculated a target stage AEP with a median and expected value that reflected the likelihood that the target stages will be exceeded in a given year. The median value was calculated using point estimates, while the expected value was calculated using

Monte Carlo simulation. The results also show the long-term risk or the probability of a target stage being exceeded over 10-year, 30-year, and 50-year periods. Finally, the model results show the conditional non-exceedance probability or the likelihood that a target stage will not be exceeded by the 10% ACE (10 year), the 4% ACE (25-year), the 2% ACE (50-year), the 1% ACE (100-year), the 0.4% ACE (250-year), and the 0.2% ACE (500-year) events.

Table 59 displays the project performance results for four high damage study area reaches, 11BW79, 11BW5, 1-5, and BL89, which correspond to HEC-FDA model station numbers 64, 58, 82, and 298, under existing (2010) and future (2024, 2035, and 2085) without-project and with-project conditions. Study area reaches 11BW79 an 11BW5 are both located in the northern portion of the city of Houma, study area reach 1-5 is located south and east of the city of Houma, and study area reach BL89 is north and east of the city of Houma and south of Bayou Lafourche. The location of these four high damage study area reaches can be found on the 11 x 17 maps containing the study area reaches in the main report. The project performance information for the remaining 260 study area reaches follows the same logic and format, but is not displayed in the table.

As an example, the target stage for study area reach 11BW79 under existing and future without project conditions shown in the table is based on the joint probability of an annual exceedance event and geotechnical failure since there is a non-Federal levee with geotechnical failure entered into the model. The target stages for the 3% AEP and 1% AEP are shown as the assigned top of Federal levee elevation since geotechnical failure was not entered into the model. Using the year 2035 as an example, the median AEP is 0.1196 (without risk), and the expected AEP is 0.1190 (with risk) and the return interval is 8.4 years under without-project conditions. The median and expected AEP for the 3% AEP alternative is 0.0237 and 0.0256 with a return interval of 39.1 years, respectively. The median and expected AEP for the 1% AEP alternative is 0.004 and 0.072, respectively.

The long term risk is the likelihood that the target stage will be exceeded during a multi-year time window (10, 25, or 50 years). The long term risk of the target stage being exceeded is 71.8 percent for a 10-year period, 95.8 percent for a 30-year period, and 99.8 percent for a 50-year period under without project conditions for 2035. For the 3% AEP alternative, the long term risk of the target stage being exceeded is 22.9 percent for a 10-year period, 47.7 percent for a 30-year period, and 72.7 percent for a 50-year period. For the 1% AEP alternative, the long term risk of the target stage being exceeded is 7.0 percent for a 10-year period, 16.5 percent for a 30-year period, and 30.3 percent for a 50-year period. The output also shows the assurance or conditional non-exceedance for various probability events. This is the likelihood that a target stage will not be exceeded by a specified event. For this reach, there is a 79.6 percent chance that the stage associated with the 10% ACE (10-year) event will not exceed the target stage, 17.4 percent for the 4% ACE (25-year), 5.0 percent for the 2% ACE (50-year), 2.1 percent for the 1% ACE (100-year), 1.1 percent for the 0.4% (250-year), and 0.007 percent for the 0.2% (500-year) under without project conditions. For the 3% AEP alternative, there is a 99.8-percent for the 10% ACE (10-year), 79.6 percent for the 4% ACE (25-year), 41.3

percent for the 2% ACE (50-year), 20.9 percent for the 1% (100-year), 11.1 percent for the 0.4% ACE (250-year), and 6.3 percent for the 0.2% ACE (500-year). For the 1% AEP alternative, there is a 99.9 percent for the 10% ACE (10-year), 99.8 percent for the 4% ACE (25-year), 91.6 percent for the 2% ACE (50-year), 71.5 percent for the 1% ACE (100-year), 49.8 percent for the 0.4% ACE (250-year), and 33.1 percent for the 0.2% ACE (500-year) events.

Figure 1

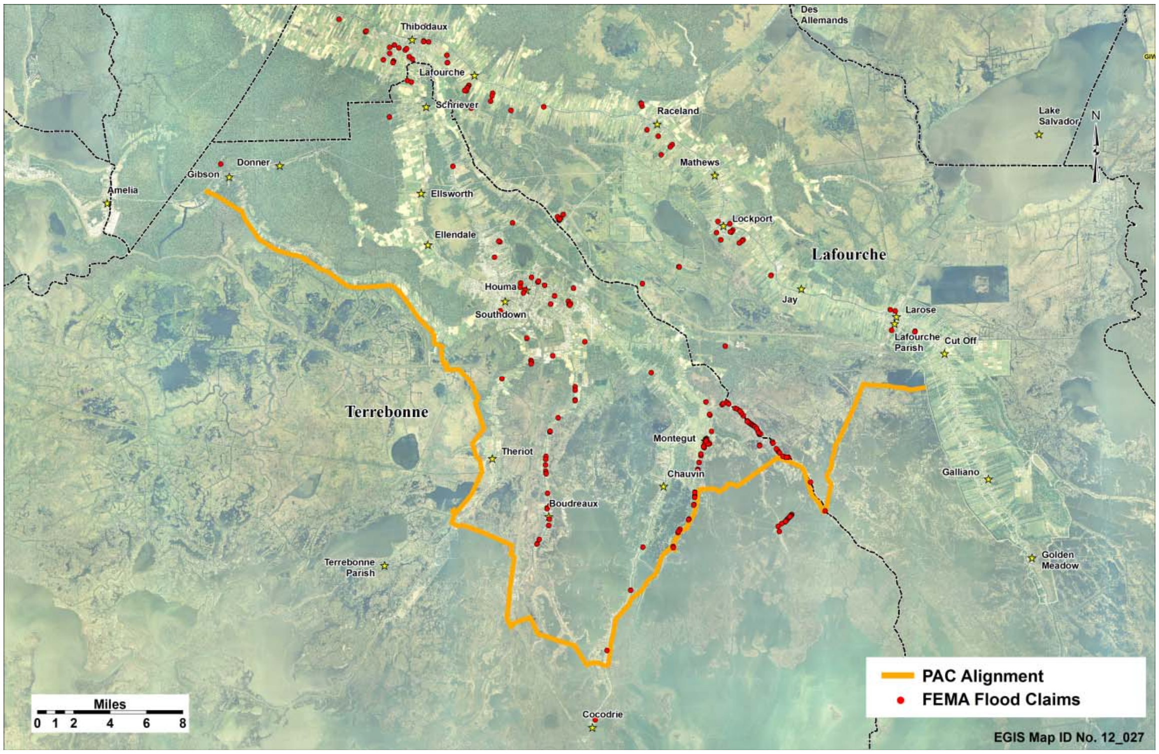


Figure 1. FEMA Repetitive Loss Properties – 1978-2010

Figure 2

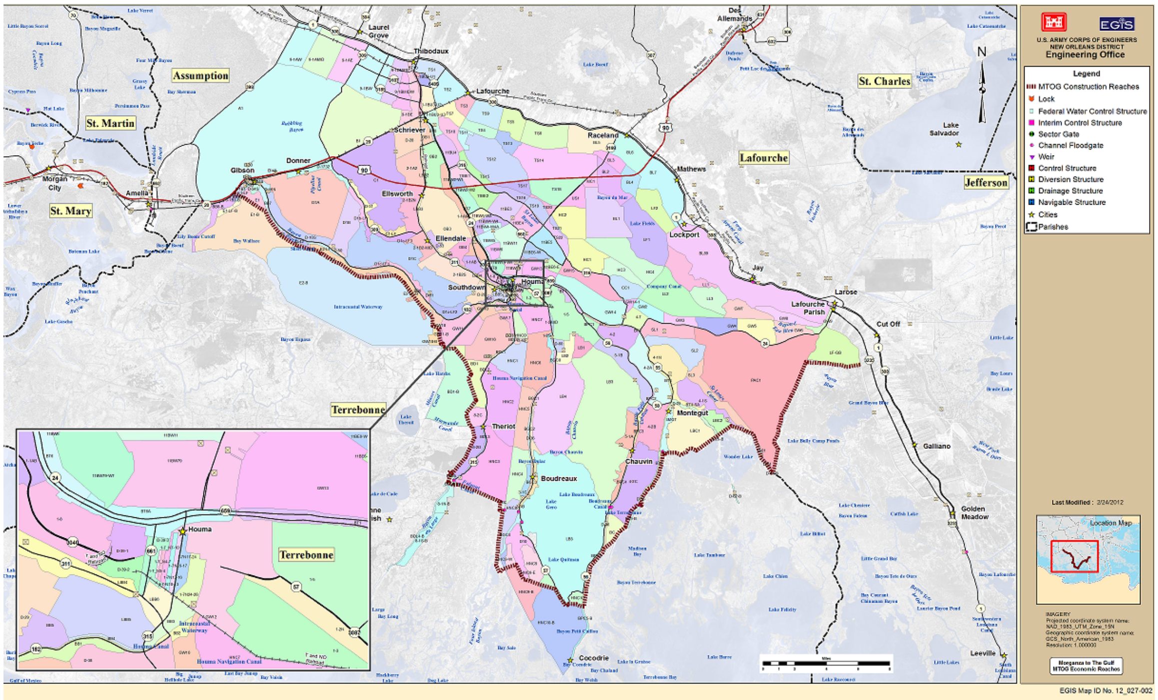


Figure 2. Study Area Reaches and Authorized Alignment

Table of Tables	
Title	Table Number

Table 1
Land Use in the Study Area
(2009)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Land Class Name	Acres	Percentage of Total
Developed land	38,798	8.7
Agricultural Land		
Pasture/Hay	46,544	10.5
Sugarcane	20,681	4.6
Fallow/Idle Cropland	8,606	1.9
Soybeans	425	0.1
Rice	1	0.0
Subtotal	76,257	17.1
Undeveloped Land		
Barren/Wetlands	289,737	65.1
Shrubland	1,758	0.4
Grasslands	347	0.1
Forests	41	0.1
Open Space	1,486	0.3
Subtotal	293,369	65.9
Open Water	36,487	8.2
Total	444,911	100.0

Source: National Agricultural Statistical Service

Table 2
Historical and Projected Parish Population
(1,000s)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Parish	1970	1980	1990	2000	2010	2035	2085
Lafourche	69.1	83.5	85.8	90.0	96.3	97.9	104.2
Terrebonne	76.2	95.1	97.0	104.5	112.0	120.9	142.8
Total	145.2	178.6	182.9	194.4	208.3	218.8	247.0

Source: U.S. Census data, Moody's County Forecast Database, and discussions with parish planning officials.

Table 3
Existing Condition and Projected Population
within Inventoried Study Area
(1,000s)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Parish	2010	2035	2085
Lafourche	28.8	29.3	31.2
Terrebonne	104.9	113.2	133.8
Total	133.7	142.5	165.0

Source: Moody's County Forecast Database and discussions with parish planning officials.

Table 4
Number of Households by Parish
(1,000s)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Parish	1970	1980	1990	2000	2010	2035	2085
Lafourche	18.0	25.7	28.8	32.1	33.7	36.3	38.1
Terrebonne	19.6	29.5	31.9	36.0	38.2	43.4	50.4
Total	37.6	55.2	60.7	68.1	71.9	79.7	88.5

Source: U.S. Census data, Moody's County Forecast Database, and discussions with parish planning officials.

Table 5
Per Capita Income
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Parish	1990	2000	2005	2008	2009
Lafourche	$ 13,070	$ 23,039	$ 30,422	$ 42,613	$ 42,205
Terrebonne	$ 13,218	$ 20,991	$ 28,037	$ 39,772	$ 39,049

Source: Bureau of Economic Analysis

Table 6
Total Non-Farm Employment
(1,000s)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Parish	1970	1980	1990	2000	2010	2035	2085
Lafourche	15.1	24.4	22.1	30.4	37.5	40.7	44.2
Terrebonne	24.6	42.4	35.8	47.3	58.9	67.3	81.3
Total	39.7	66.8	57.9	77.7	96.4	108.0	125.5

Source: Based on Moody's County Forecast Database and discussions with parish planning officials.

Table 7
FEMA Flood Claims in Louisiana
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Event	Year	Number of Paid Claims	Total Amount Paid (1,000s)	Average Amount Paid (1,000s)
Tropical Storm Juan	Oct-85	6,187	$ 189,842	$ 30.7
Hurricane Andrew	Aug-92	5,589	$ 270,791	$ 48.5
Tropical Storm Isadore	Sep-02	8,441	$ 141,869	$ 16.8
Hurricane Lili	Oct-02	2,563	$ 46,049	$ 18.0
Hurricane Katrina	Aug-05	167,099	$ 18,556,254	$ 111.0
Hurricane Rita	Sep-05	9,507	$ 539,086	$ 56.7
Hurricane Gustav	Sep-08	4,524	$ 115,250	$ 25.5
Hurricane Ike	Sep-08	46,137	$ 2,712,969	$ 58.8

Source: Federal Emergency Management Agency (FEMA)
Note: Total amount paid and average amount paid have been updated to the Oct 2011 price level using the CPI for all urban consumers.

Table 8
FEMA Flood Claims by Parish
1978-2011
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Parish	Number of Policies September 2011	Number of Claims
Lafourche	14,222	5,066
Terrebonne	20,044	12,780

Source: FEMA

Table 9
Number of Structures per Reach in the Existing Condition
(2010)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Reach Name	HEC-FDA Station Number	Residential	Mobile Home	Non-Residential	Vehicle	Total
1-1AB	1	36	81	120	237	474
1-1AN	4	1,090	415	217	1,925	3,647
11BE1	7	2	199	-	201	402
11BE2	10	159	37	14	217	427
11BE3	13	234	346	35	877	1,492
11BE4	16	163	109	67	272	611
11BE5	19	69	104	44	433	650
11BE6-E	22	-	1	2	1	4
11BE6-W	25	1	125	24	126	276
1-1BU3-U1	28	-	-	-	-	-
1-1BU3-U2	31	-	-	-	-	-
1-1BU3-U3	34	-	-	-	-	-
11BU4	37	-	-	-	-	-
11BW11	40	89	41	38	130	298
11BW2-W1	43	63	19	1	88	171
11BW2-W2	46	368	143	10	772	1,293
11BW4-W3	49	9	12	4	30	55
11BW4-W4	52	658	86	29	1,198	1,971
11BW4-W4A	55	230	3	12	329	574
11BW5	58	1,565	1	54	4,721	6,341
11BW6	61	672	8	81	3,108	3,869
11BW79	64	1,567	35	89	1,996	3,687
11BW79-W7	67	767	67	120	1,916	2,870
1-2MID	70	-	-	62	-	62
1-2N	73	209	34	89	308	640
1-2S	76	-	-	27	-	27
1-3	79	1,003	84	51	1,347	2,485
1-5	82	2,395	315	358	2,710	5,778
1-7_N3-4	85	16	-	2	28	46
1-7_N4-7	88	35	-	3	76	114
1-7_N7-10	91	68	-	3	80	151
1-7-N10-13	94	87	3	7	104	201
1-7N13-16	97	38	4	33	49	124
1-7N16-17	100	-	-	2	-	2

Table 9 (Cont.)
Number of Structures per Reach in the Existing Condition
(2010)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Reach Name	HEC-FDA Station Number	Residential	Mobile Home	Non-Residential	Vehicle	Total
1-7N17-24	103	43	1	36	56	136
1-7N24-28	106	217	4	22	296	539
1-8	109	336	44	221	710	1,311
2-1A2	112	-	-	-	-	-
2-1B2-MID	115	6	1	2	7	16
2-1B2N	118	37	2	6	39	84
2-1B2S	121	1,032	19	218	1,211	2,480
3-1B	124	250	31	19	281	581
3-1C	127	72	19	6	91	188
4-1N	130	169	35	12	204	420
4-1S	133	162	88	10	250	510
4-2	136	449	99	10	548	1,106
4-2A	139	323	289	23	612	1,247
4-2B	142	114	112	11	226	463
4-2C	145	98	30	5	128	261
4-7	148	195	29	15	224	463
4MGT	151	192	74	8	315	589
5-1A	154	858	188	40	1,364	2,450
5-1B	157	496	105	37	601	1,239
6-1B1	160	3	-	2	3	8
6-1B1-B	163	2	1	-	3	6
8-1N	166	15	5	3	20	43
8-1N-B	169	39	12	1	51	103
8-1S-B	175	122	42	10	164	338
8-2C	178	-	-	2	-	2
8-2D	181	51	23	3	74	151
9-1AE	184	-	2	-	2	4
9-1AMID	187	-	-	-	-	-
9-1AW	190	-	1	-	1	2
9-1BE	193	4	1	2	5	12
9-1BMIDE	196	1	2	2	3	8
9-1BMIDW	199	-	-	-	-	-
9-1BW	202	3	22	1	25	51
A1	205	29	21	20	50	120
B1	208	12	11	2	23	48
BB1	211	141	1	8	267	417
BB2	214	4	-	10	4	18
BB3	217	16	3	49	39	107

Table 9 (Cont.)
Number of Structures per Reach in the Existing Condition
(2010)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Reach Name	HEC-FDA Station Number	Residential	Mobile Home	Non-Residential	Vehicle	Total
BB4	220	6	-	-	6	12
BB5	223	388	-	2	388	778
BB6	226	8	5	3	13	29
BB7	229	120	101	43	221	485
BB8-B	235	-	6	47	21	74
BD1	238	54	18	4	72	148
BDL0	241	14	51	1	65	131
BDL1	244	21	7	5	28	61
BDL2	247	4	-	-	4	8
BDL3	250	82	27	5	109	223
BDL4	253	65	-	3	65	133
BDL4-B	256	53	15	11	68	147
BDL5	259	35	10	19	45	109
BGC0	262	21	76	9	97	203
BGC1	265	23	7	2	30	62
BGC2	268	24	11	3	35	73
BGC3	271	132	49	26	181	388
BGC4	274	49	31	41	80	201
BL1	277	1	10	7	11	29
BL2	280	132	15	35	147	329
BL3	283	66	13	24	79	182
BL4	286	58	33	21	91	203
BL5	289	379	197	125	576	1,277
BL6	292	1,382	397	140	1,839	3,758
BL7	295	1,465	146	225	2,322	4,158
BL89	298	1,897	523	239	3,758	6,417
BPC1	301	339	12	2	351	704
BPC2	304	54	35	7	89	185
BPC3	307	112	58	13	170	353
BPC4	310	55	21	18	76	170
BPC5	313	250	34	9	284	577
BPC5-B	316	198	23	39	221	481
BT1	319	485	45	118	592	1,240
BT10	322	-	-	-	-	-
BT2	325	107	27	3	134	271
BT3	328	17	3	6	20	46
BT4	331	97	68	15	165	345
BT4-SA	334	55	6	3	61	125
BT5	337	10	-	4	10	24
BT5-B	340	10	-	-	10	20
BT6	343	395	25	239	792	1,451

Table 9 (Cont.)
Number of Structures per Reach in the Existing Condition
(2010)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Reach Name	HEC-FDA Station Number	Residential	Mobile Home	Non-Residential	Vehicle	Total
BT6A	346	275	62	162	419	918
BT7	349	146	58	69	381	654
BT8	352	16	7	22	23	68
BT9	355	-	-	-	-	-
C1	358	22	9	5	31	67
C1-LF	361	7	1	2	8	18
CC1	364	50	67	7	117	241
D-01	367	21	11	-	32	64
D-06	370	25	9	1	34	69
D10	373	28	12	4	40	84
D-16N	376	37	30	7	67	141
D-16S	379	147	119	8	266	540
D-1732	382	119	86	13	205	423
D1A	385	-	-	-	-	-
D1B	388	-	-	-	-	-
D1b-LF	391	2	1	4	3	10
D1C	394	12	9	10	21	52
D1c-LF1	397	180	108	29	404	721
D1c-LF2	400	150	65	20	215	450
D1c-LF3	403	5	1	4	6	16
D-25	406	116	29	24	154	323
D-25-B	409	-	-	-	-	-
D-26	412	47	2	2	49	100
D-28	415	20	20	4	40	84
D-29	418	1,391	-	50	1,471	2,912
D-30	421	32	2	1	34	69
D-31	424	12	6	3	18	39
D-34N	427	16	-	5	16	37
D-34S	430	4	1	2	5	12
D-35	433	7	-	2	7	16
D-36	436	133	99	6	232	470
D-37	439	62	-	-	62	124
D-38	442	273	-	22	734	1,029
D-39-1	445	300	14	30	314	658
D-39-2	448	66	1	22	274	363
D-39-3	451	184	3	70	329	586
D-42	454	24	29	3	53	109
D-43	457	152	50	12	202	416
D-44	460	3	71	6	94	174
D-45	463	4	-	-	4	8
D-48	466	8	3	-	11	22

Table 9 (Cont.)
Number of Structures per Reach in the Existing Condition
(2010)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Reach Name	HEC-FDA Station Number	Residential	Mobile Home	Non-Residential	Vehicle	Total
D-49	469	-	5	-	5	10
D-50	472	30	34	5	142	211
D-51	475	47	1	2	48	98
D-53	478	84	-	5	84	173
D-56	481	65	11	5	76	157
D-60	484	-	370	2	370	742
D-61	487	44	28	1	72	145
D-61-B	490	6	-	-	6	12
D-62-B	496	58	4	2	62	126
D-64	499	93	-	-	93	186
E1	502	2	18	14	20	54
E1-LF	505	-	1	-	1	2
E1-LF-B	508	-	-	8	-	8
E2	511	-	-	1	-	1
E2-B	514	-	-	4	-	4
E2-LF	517	133	72	75	205	485
E2-LF-B	520	-	-	-	-	-
FC	523	-	-	1	-	1
GW10	526	434	4	35	474	947
GW11	529	54	-	14	54	122
GW12	532	977	48	147	2,276	3,448
GW13	535	288	478	64	776	1,606
GW14	538	817	37	114	2,673	3,641
GW14-1	541	32	13	12	45	102
GW15	544	129	145	22	274	570
GW16	547	28	64	7	92	191
GW17	550	-	-	13	-	13
GW18	553	44	-	1	44	89
GW18-B	556	-	1	-	1	2
GW2	559	21	8	1	29	59
GW3	562	21	24	12	45	102
GW4	565	-	4	1	4	9
GW5	568	-	4	-	4	8
GW6	571	-	10	-	10	20
GW7	574	-	4	-	4	8
GW8	577	-	2	-	2	4
GW9	580	24	7	16	31	78
HC1	583	100	120	19	220	459
HC2	586	-	-	2	-	2
HC3	589	28	50	9	78	165
HC4	592	7	-	3	7	17

Table 9 (Cont.)
Number of Structures per Reach in the Existing Condition
(2010)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Reach Name	HEC-FDA Station Number	Residential	Mobile Home	Non-Residential	Vehicle	Total
HNC0	595	2	3	75	5	85
HNC1	598	25	10	10	35	80
HNC10	601	14	3	1	17	35
HNC10-B	604	89	26	9	115	239
HNC2	607	129	55	22	184	390
HNC3	610	58	36	13	94	201
HNC4	613	27	8	1	35	71
HNC5	616	60	110	5	170	345
HNC6	619	-	9	51	9	69
HNC7	622	33	9	253	42	337
HNC8	625	60	3	13	63	139
HNC9	628	-	-	-	-	-
HNC9-B	631	142	29	7	171	349
HNC9-E	634	6	9	-	15	30
HNC9-W	637	7	4	6	11	28
LB1	640	-	-	-	-	-
LB2	643	9	15	7	24	55
LB3	646	-	-	3	-	3
LB4	649	31	264	17	295	607
LB5	652	30	19	12	49	110
LBB2	655	3	-	2	3	8
LBB3	658	51	9	7	60	127
LBB4	661	99	3	139	105	346
LBB5	664	610	-	28	610	1,248
LBB6	667	88	-	35	88	211
LBC1	670	-	-	2	-	2
LBC2	673	-	-	3	-	3
LF1	676	24	-	11	24	59
LF2	679	13	1	4	14	32
LF-GB	682	-	5	9	5	19
LL1	685	3	-	-	3	6
LL2	688	-	-	-	-	-
LL3	691	-	1	-	1	2
MC1	694	-	-	-	-	-
OB1	697	-	-	-	-	-
OB2	700	40	74	5	114	233
OB3	703	18	12	10	150	190
OB4	706	55	-	2	55	112
PAC1	709	3	2	7	5	17
SL1	712	54	55	10	109	228
SL2	715	20	-	2	20	42

Table 9 (Cont.)
Number of Structures per Reach in the Existing Condition
(2010)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Reach Name	HEC-FDA Station Number	Residential	Mobile Home	Non-Residential	Vehicle	Total
SL3	718	140	54	8	194	396
TS1	721	-	-	-	-	-
TS10	724	-	-	-	-	-
TS11	727	77	-	18	77	172
TS12	730	19	25	23	44	111
TS13	733	13	6	4	19	42
TS14	736	-	3	-	3	6
TS15	739	-	-	-	-	-
TS16	742	123	177	5	300	605
TS17	745	30	8	2	38	78
TS18	748	12	-	-	12	24
TS19	751	401	195	31	750	1,377
TS2	754	-	-	-	-	-
TS20	757	1	-	-	1	2
TS21	760	-	-	-	-	-
TS22	763	228	205	46	433	912
TS3	766	-	-	-	-	-
TS4	769	37	3	14	40	94
TS5	772	82	57	39	139	317
TS6	775	226	48	56	274	604
TS7	778	-	-	-	-	-
TS9	781	80	57	20	137	294
US1	784	-	-	2	-	2
GW11-B	787	-	-	-	-	-
E1-B	790	-	-	-	-	-
BB7-B	793	-	-	-	-	-
BD1-B	796	-	-	-	-	-
BC	799	-	-	-	-	-
Total		36,681	9,858	6,227	64,365	117,131

Note: Industrial Structures were modeled as a separate category and therefore are not included in the above structure inventory.

Table 10
Residential and Non-Residential Structure Inventory
Existing Conditions (2010)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Structure Category	Number	Average Depreciated Replacement Value
Residential		
One-Story Slab	21,693	$ 168,000
One-Story Pier	12,717	$ 92,000
Two-Story Slab	1,656	$ 232,000
Two-Story Pier	615	$ 148,000
Mobile Home	9,858	$ 10,000
Total Residential	**46,539**	
Non-Residential		
Eating and Recreation	297	$ 348,000
Professional	1,167	$ 555,000
Public and Semi-Public	642	$ 813,000
Repair and Home Use	148	$ 175,000
Retail and Personal Services	586	$ 572,000
Warehouse	2,932	$ 181,000
Grocery and Gas Station	146	$ 359,000
Multi-Family Occupancy	309	$ 431,000
Industrial	24	$ 1,854,000
Total Non-Residential	**6,251**	

Source: Based on *Morganza to the Gulf Post Authorization Change Report: Residential and Non-residential Structure Inventory and Nonresidential Surveys Final Report* dated May 2009

Table 11
Number of Projected Residential and Non-Residential Structures
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Future Conditions (2010-2035)	
Structure Category	Number
Residential	
One-Story Slab	3,522
One-Story Pier	1,924
Two-Story Slab	204
Two-Story Pier	91
Mobile Home	1,579
Total Residential	**7,320**
Non-Residential	
Eating and Recreation	137
Professional	286
Public and Semi-Public	92
Repair and Home Use	32
Retail and Personal Services	122
Warehouse	620
Grocery and Gas Station	30
Multi-Family Occupancy	0
Industrial	0
Total Non-Residential	**1,319**
Future Conditions (2035-2085)	
Structure Category	Number
Residential	
One-Story Slab	4,344
One-Story Pier	2,328
Two-Story Slab	263
Two-Story Pier	111
Mobile Home	1,866
Total Residential	**8,912**
Non-Residential	
Eating and Recreation	537
Professional	484
Public and Semi-Public	91
Repair and Home Use	66
Retail and Personal Services	251
Warehouse	1,850
Grocery and Gas Station	63
Multi-Family Occupancy	0
Industrial	0
Total Non-Residential	**3,342**

Source: Based on *Projections of Future Development and Land Usage Morganza to the Gulf Feasibility Evaluation Final Report* dated February 2011

Table 12

Content-to-Structure Value Ratios (CSVRs) and Standard Deviations (SDs)
by Structure Category
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Structure Category		(CSVR, SD)
Residential	One-story	(0.72, 0.23)
	Two-story	(0.51, 0.28)
	Mobile home	(1.42, 0.65)
Non-Residential	Eating and Recreation	(3.19, 4.06)
	Groceries and Gas Stations	(1.31, 0.98)
	Professional Buildings	(0.76, 0.71)
	Public and Semi-Public Buildings	(0.84, 1.06)
	Multi-Family Buildings	(0.24, 0.13)
	Repair and Home Use	(2.33, 1.96)
	Retail and Personal Services	(1.40, 1.08)
	Warehouses and Contractor Services	(2.93, 3.56)

Table 13
Depth-Damage Relationships for Structures, Contents and Vehicles
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Occupancy Type	Category Name	Damage Type	Parameter																				
1STY-PIER	Residential		Stage	-1.1	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
		Structure	Mean %	0.0	1.1	12.2	15.2	49.4	50.1	66.7	70.2	71.2	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5
			Lower %	0.0	1.0	11.9	13.7	44.4	45.1	60.0	63.2	64.1	87.7	87.7	87.7	87.7	87.7	87.7	87.7	87.7	87.7	87.7	87.7
			Upper %	0.0	1.7	18.3	22.8	74.0	75.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		Contents	Mean %	0.0	0.0	0.0	0.0	95.0	95.0	95.0	95.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0
			Lower %	0.0	0.0	0.0	0.0	90.0	90.0	95.0	95.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0
			Upper %	0.0	0.0	0.0	0.0	98.0	98.0	98.0	98.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1STY-SLAB	Residential		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	1.1	1.1	23.3	23.3	37.2	41.9	45.3	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0
			Lower %	0.0	1.0	1.0	21.0	21.0	35.5	37.7	40.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8
			Upper %	0.0	1.7	1.7	35.0	35.0	55.9	62.9	68.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		Contents	Mean %	0.0	0.0	0.0	0.0	95.0	95.0	95.0	95.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0
			Lower %	0.0	0.0	0.0	0.0	90.0	90.0	95.0	95.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0
			Upper %	0.0	0.0	0.0	0.0	98.0	98.0	98.0	98.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Struct	N		0.3		N		12.2		N	71.0	24.0			-901.0						
2STY-PIER	Residential		Stage	-1.1	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
		Structure	Mean %	0.0	1.4	2.2	6.4	19.0	19.0	31.9	32.6	33.3	93.4	93.4	93.4	93.4	93.4	93.4	93.6	93.6	93.6	93.6	93.6
			Lower %	0.0	1.2	2.0	5.8	17.1	17.1	28.7	29.3	30.0	84.0	84.0	84.0	84.0	84.0	84.0	84.0	84.0	84.0	84.0	84.0
			Upper %	0.0	2.1	3.3	9.6	28.5	28.5	47.9	48.9	49.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		Contents	Mean %	0.0	0.0	0.0	0.0	69.6	74.7	74.7	78.5	79.9	83.2	83.2	83.2	83.2	83.2	83.2	97.5	97.8	98.5	98.5	98.5
			Lower %	0.0	0.0	0.0	0.0	66.2	70.9	70.9	74.6	75.9	79.0	79.0	79.0	79.0	79.0	79.0	92.6	92.9	93.6	93.6	93.6
			Upper %	0.0	0.0	0.0	0.0	73.1	78.4	78.4	82.5	83.9	87.3	87.3	87.3	87.3	87.3	87.3	100.0	100.0	100.0	100.0	100.0
2STY-SLAB	Residential		Stage	-1.1	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
		Structure	Mean %	0.0	1.2	1.2	16.1	16.1	26.1	27.1	28.5	80.0	80.0	80.0	80.0	80.0	80.0	80.3	80.3	80.3	83.2	83.2	83.2
			Lower %	0.0	1.1	1.1	14.5	14.5	23.5	24.4	25.7	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0
			Upper %	0.0	1.8	1.8	24.2	24.2	39.1	40.7	42.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	0.0	0.0	69.6	74.7	74.7	78.5	79.9	83.2	83.2	83.2	83.2	83.2	83.2	97.5	97.8	98.5	98.5	98.5
			Lower %	0.0	0.0	0.0	0.0	66.2	70.9	70.9	74.6	75.9	79.0	79.0	79.0	79.0	79.0	79.0	92.6	92.9	93.6	93.6	93.6
			Upper %	0.0	0.0	0.0	0.0	73.1	78.4	78.4	82.5	83.9	87.3	87.3	87.3	87.3	87.3	87.3	100.0	100.0	100.0	100.0	100.0
AUTO	AUTO		Stage	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
		Structure	Mean %	0.0	0.0	3.7	13.0	46.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Lower %	0.0	0.0	2.3	12.0	44.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Upper %	0.0	0.0	4.7	15.0	45.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 13 (Cont)
Depth-Damage Relationships for Structures, Contents and Vehicles
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Occupancy Type	Category Name	Damage Type	Parameter																				
EAT	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	6.6	19.8	19.8	24.5	24.5	29.6	34.7	37.9	37.9	37.9	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3
			Lower %	0.0	0.0	6.2	18.4	18.4	22.8	22.8	26.6	31.2	34.1	34.1	34.1	57.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0
			Upper %	0.0	0.0	7.6	22.8	22.8	28.2	28.2	37.0	43.4	47.4	47.4	47.4	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2
		Contents	Mean %	0.0	0.0	0.0	41.2	45.6	73.3	74.8	92.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Lower %	0.0	0.0	0.0	39.2	43.3	69.6	71.1	87.8	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0
			Upper %	0.0	0.0	0.0	51.5	57.0	91.6	93.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
GROC	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	6.6	19.8	19.8	24.5	24.5	29.6	34.7	37.9	37.9	37.9	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3
			Lower %	0.0	0.0	6.2	18.4	18.4	22.8	22.8	26.6	31.2	34.1	34.1	34.1	57.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0
			Upper %	0.0	0.0	7.6	22.8	22.8	28.2	28.2	37.0	43.4	47.4	47.4	47.4	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2
		Contents	Mean %	0.0	0.0	0.0	99.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Lower %	0.0	0.0	0.0	94.1	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0
			Upper %	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MOBHOM	MOBHOME		Stage	-1.1	-1.0	-0.5	0.0	0.5	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	6.4	7.3	9.9	43.4	44.7	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6
			Lower %	0.0	6.1	6.9	9.4	41.2	42.5	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7
			Upper %	0.0	8.6	9.8	13.4	58.6	60.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		Contents	Mean %	0.0	0.0	0.0	95.0	96.0	97.0	98.0	99.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Lower %	0.0	0.0	0.0	90.0	92.0	94.0	96.0	98.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Upper %	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MULT	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	6.6	19.8	19.8	24.5	24.5	29.6	34.7	37.9	37.9	37.9	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3
			Lower %	0.0	0.0	6.2	18.4	18.4	22.8	22.8	26.6	31.2	34.1	34.1	34.1	57.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0
			Upper %	0.0	0.0	7.6	22.8	22.8	28.2	28.2	37.0	43.4	47.4	47.4	47.4	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2
		Contents	Mean %	0.0	0.0	0.0	20.1	26.2	33.5	42.4	49.8	51.7	51.7	51.7	51.7	51.7	51.7	71.8	85.2	100.0	100.0	100.0	100.0
			Lower %	0.0	0.0	0.0	15.8	22.4	31.2	40.5	46.6	50.3	50.3	50.3	50.3	50.3	50.3	56.4	79.6	93.5	97.1	97.1	97.1
			Upper %	0.0	0.0	0.0	22.2	28.7	35.2	46.2	51.4	53.0	53.1	54.6	54.6	54.6	54.6	79.3	89.5	100.0	100.0	100.0	100.0
PROF	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	6.6	19.8	19.8	24.5	24.5	29.6	34.7	37.9	37.9	37.9	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3
			Lower %	0.0	0.0	6.2	18.4	18.4	22.8	22.8	26.6	31.2	34.1	34.1	34.1	57.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0
			Upper %	0.0	0.0	7.6	22.8	22.8	28.2	28.2	37.0	43.4	47.4	47.4	47.4	79.2	79.2	79.2	79.2	79.2	79.2	79.2	79.2
		Contents	Mean %	0.0	0.0	0.0	35.0	43.3	56.7	63.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Lower %	0.0	0.0	0.0	30.0	37.1	48.6	54.8	85.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Upper %	0.0	0.0	0.0	50.0	61.8	81.0	91.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 13 (Cont)
Depth-Damage Relationships for Structures, Contents and Vehicles
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

PUBL	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	1.1	22.3	23.7	25.8	32.7	34.4	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	80.5	80.5	80.5	80.5
			Lower %	0.0	0.0	1.1	20.8	22.1	24.0	29.5	31.0	71.2	71.2	71.2	71.2	71.2	71.2	71.2	71.2	72.4	72.4	72.4	72.4
			Upper %	0.0	0.0	1.3	25.7	27.3	29.7	39.3	43.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		Contents	Mean %	0.0	0.0	0.0	80.0	85.0	85.7	86.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Lower %	0.0	0.0	0.0	60.0	63.8	64.3	65.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
			Upper %	0.0	0.0	0.0	88.0	93.5	94.2	95.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
REPA	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	1.1	22.3	23.7	25.8	32.7	34.4	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	80.5	80.5	80.5	80.5
			Lower %	0.0	0.0	1.1	20.8	22.1	24.0	29.5	31.0	71.2	71.2	71.2	71.2	71.2	71.2	71.2	71.2	72.4	72.4	72.4	72.4
			Upper %	0.0	0.0	1.3	25.7	27.3	29.7	39.3	43.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		Contents	Mean %	0.0	0.0	0.0	33.3	34.3	34.3	69.2	70.6	72.1	80.6	83.7	83.7	83.7	83.7	83.7	83.7	83.7	83.7	83.7	83.7
			Lower %	0.0	0.0	0.0	31.7	32.6	32.6	65.7	67.1	68.5	76.6	79.6	79.6	79.6	79.6	79.6	79.6	79.6	79.6	79.6	79.6
			Upper %	0.0	0.0	0.0	41.7	42.9	42.9	86.5	88.3	90.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
RETA	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	1.1	22.3	23.7	25.8	32.7	34.4	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	80.5	80.5	80.5	80.5
			Lower %	0.0	0.0	1.1	20.8	22.1	24.0	29.5	31.0	71.2	71.2	71.2	71.2	71.2	71.2	71.2	71.2	72.4	72.4	72.4	72.4
			Upper %	0.0	0.0	1.3	25.7	27.3	29.7	39.3	43.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	0.0	36.6	60.5	60.5	75.4	85.1	94.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Lower %	0.0	0.0	0.0	34.8	57.5	57.5	71.6	80.8	89.7	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0
			Upper %	0.0	0.0	0.0	45.7	75.7	75.7	94.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
WARE	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	1.1	22.3	23.7	25.8	32.7	34.4	79.1	79.1	79.1	79.1	79.1	79.1	79.1	79.1	80.5	80.5	80.5	80.5
			Lower %	0.0	0.0	1.1	20.8	22.1	24.0	29.5	31.0	71.2	71.2	71.2	71.2	71.2	71.2	71.2	71.2	72.4	72.4	72.4	72.4
			Upper %	0.0	0.0	1.3	25.7	27.3	29.7	39.3	43.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	0.0	17.6	22.1	22.1	29.2	34.0	42.8	50.8	58.7	66.7	74.6	79.7	79.7	79.7	79.7	79.7	79.7	79.7
			Lower %	0.0	0.0	0.0	16.8	21.0	21.0	27.8	32.3	40.7	48.3	55.8	63.4	70.9	75.7	75.7	75.7	75.7	75.7	75.7	75.7
			Upper %	0.0	0.0	0.0	22.0	27.7	27.7	36.6	42.5	53.6	63.5	73.4	83.4	93.3	99.6	99.6	99.6	99.6	99.6	99.6	99.6

Source: Based on *Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVRs) in Support of the Lower Atchafalaya and Morganza to the Gulf, Louisiana, Feasibility Study Final Report* dated May 1997

Table 14
Non-Federal Levee Fragility Curve
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

		Stage (ft.) associated w/Probability of Failure				Top of Levee (ft.)
Reach Name	Station	0%	10%	45%	95%	
1-1AB	1	2.0	3.8	4.4	4.7	5.0
1-1AN	4	2.0	3.8	4.4	4.7	5.0
11BE4	16	2.0	4.5	5.3	5.6	6.0
11BE5	19	2.0	3.0	3.5	3.7	4.0
11BE6-W	25	2.0	4.5	5.3	5.6	6.0
11BW11	40	2.0	2.3	2.6	2.8	3.0
11BW5	58	2.0	4.1	4.8	5.1	5.5
11BW6	61	2.0	4.1	4.8	5.1	5.5
11BW79	64	2.0	4.5	5.3	5.6	6.0
11BW79-W7	67	2.0	4.1	4.8	5.1	5.5
1-2S	76	2.0	3.0	3.5	3.7	4.0
1-3	79	2.0	4.9	5.7	6.0	6.5
1-5	82	2.0	2.3	2.6	2.8	3.0
1-7_N3-4	85	2.0	4.1	4.8	5.1	5.5
1-7_N4-7	88	2.0	4.1	4.8	5.1	5.5
1-7_N7-10	91	2.0	4.1	4.8	5.1	5.5
1-7-N10-13	94	2.0	4.1	4.8	5.1	5.5
1-7N13-16	97	2.0	4.1	4.8	5.1	5.5
1-7N16-17	100	2.0	4.1	4.8	5.1	5.5
1-7N17-24	103	2.0	4.1	4.8	5.1	5.5
1-7N24-28	106	2.0	4.1	4.8	5.1	5.5
3-1B	124	2.0	7.1	8.4	8.8	9.5
3-1C	127	2.0	4.5	5.3	5.6	6.0
4-1N	130	2.0	3.0	3.5	3.7	4.0
4-1S	133	2.0	5.3	6.2	6.5	7.0
4-2	136	2.0	3.0	3.5	3.7	4.0
4-2A	139	2.0	4.5	5.3	5.6	6.0
4-2B	142	2.0	4.5	5.3	5.6	6.0
4-2C	145	2.0	4.5	5.3	5.6	6.0
4-7	148	2.0	4.5	5.3	5.6	6.0
4MGT	151	2.0	4.5	5.3	5.6	6.0
5-1A	154	2.0	4.5	5.3	5.6	6.0
5-1B	157	2.0	4.5	5.3	5.6	6.0
6-1B1	160	2.0	4.5	5.3	5.6	6.0
6-1B1-B	163	2.0	4.5	5.3	5.6	6.0
8-1N	166	2.0	3.0	3.5	3.7	4.0

Table 14 (Cont.)
Non-Federal Levee Fragility Curve
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

		Stage (ft.) associated w/Probability of Failure				Top of Levee
Reach Name	Station	0%	10%	45%	95%	(ft.)
8-1N-B	169.0	2.0	3.0	3.5	3.7	4.0
8-1S-B	175.0	2.0	3.0	3.5	3.7	4.0
8-2C	178.0	2.0	4.5	5.3	5.6	6.0
8-2D	181.0	2.0	4.5	5.3	5.6	6.0
9-1AE	184.0	2.0	6.0	7.0	7.4	8.0
9-1AMID	187.0	2.0	6.0	7.0	7.4	8.0
9-1AW	190.0	2.0	6.0	7.0	7.4	8.0
9-1BMIDE	196.0	2.0	6.0	7.0	7.4	8.0
9-1BMIDW	199.0	2.0	6.0	7.0	7.4	8.0
9-1BW	202.0	2.0	6.0	7.0	7.4	8.0
BL2	280.0	2.0	4.5	5.3	5.6	6.0
BL3	283.0	2.0	4.5	5.3	5.6	6.0
BL4	286.0	2.0	3.8	4.4	4.7	5.0
BL5	289.0	2.0	3.8	4.4	4.7	5.0
BL6	292.0	2.0	3.8	4.4	4.7	5.0
BL7	295.0	2.0	4.5	5.3	5.6	6.0
BL89	298.0	2.0	3.8	4.4	4.7	5.0
BPC3	307.0	2.0	4.5	5.3	5.6	6.0
BPC4	310.0	2.0	4.5	5.3	5.6	6.0
BT4	331.0	2.0	4.5	5.3	5.6	6.0
BT4-SA	334.0	2.0	5.3	6.2	6.5	7.0
D-01	367.0	2.0	7.5	8.8	9.3	10.0
D10	373.0	2.0	4.5	5.3	5.6	6.0
D-16S	379.0	2.0	3.0	3.5	3.7	4.0
D-25	406.0	2.0	5.3	6.2	6.5	7.0
D-29	418.0	2.0	4.9	5.7	6.0	6.5
D-30	421.0	2.0	3.0	3.5	3.7	4.0
D-36	436.0	2.0	7.1	8.4	8.8	9.5
D-48	466.0	2.0	3.0	3.5	3.7	4.0
D-53	478.0	2.0	3.8	4.4	4.7	5.0
D-56	481.0	2.0	4.5	5.3	5.6	6.0
D-60	484.0	2.0	4.5	5.3	5.6	6.0
D-61	487.0	2.0	4.5	5.3	5.6	6.0
D-61-B	490.0	2.0	4.5	5.3	5.6	6.0
D-62-B	496.0	2.0	4.5	5.3	5.6	6.0
D-64	499.0	2.0	3.8	4.4	4.7	5.0
E2-LF	517.0	2.0	4.0	4.7	5.0	5.4
E2-LF-B	520.0	2.0	4.0	4.7	5.0	5.4
LBC1	670.0	2.0	4.5	5.3	5.6	6.0
LBC2	673.0	2.0	4.5	5.3	5.6	6.0
PAC1	709.0	2.0	7.5	8.8	9.3	10.0
SL3	718.0	2.0	7.5	8.8	9.3	10.0

Table 15

Still Water Stage Associated with Federal Levee Failure by Levee Reach

Morganza to the Gulf of Mexico, LA

Post-Authorization Change Report

Federal Levee Reach	Levee Failure Still Water Stage (ft.)					
	2024		2035		2085	
	3% AEP	1% AEP	3% AEP	1% AEP	3% AEP	1% AEP
A	9.4	13.6	10.5	15.9	11.2	18.3
B	11.1	15.5	10.8	16.5	11.5	17.7
E	13.2	13.3	14.2	19.8	13.5	20.8
F	13.0	13.2	13.3	20.6	13.5	20.8
G	12.9	14.5	13.1	19.5	13.6	19.6
H	14.8	17.2	16.2	20.5	15.8	21.8
I	14.9	18.2	15.1	20.5	15.8	21.8
J	15.3	18.5	15.5	20.9	15.8	21.8
K	14.0	17.8	15.1	21.0	14.4	21.8
L	14.7	17.3	15.1	20.3	14.4	21.8

Note: The Federal levee heights associated with failure of the 3% AEP do not uniformally rise across the selected years due to the estimated settlement that occurs relative to the levee lift schedule.

Table 16
Expected Annual Damages (1,000's)
Structures, Contents, and Vehicles
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Analysis Year	Unadjusted Without-Project Damages	Percent Increase from 2010
2010	$ 515,000	
2024	$ 591,000	15
2035	$ 726,000	41
2085	$ 1,462,000	184

Note: Without-project damages before adjusting the structure inventories for repetitive flood losses after the year 2010.

Table 17
Number of Structures Receiving Damages By Probability Event in 2035
Residential, Commercial, and Mobile Homes
Unadjusted Without-Project Condition
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Annual Chance Exceedance Event (ACE)	Residential	Non-Residential	Mobile Home	Total
0.99 (1 yr)	1,114	371	211	1,696
0.20 (5 yr)	1,905	586	400	2,891
0.10 (10 yr)	5,240	1,117	1,178	7,535
0.04 (25 yr)	26,442	3,848	6,603	36,893
0.02 (50 yr)	35,072	6,054	9,185	50,311
0.01 (100 yr)	41,801	7,562	11,252	60,615
0.005 (200 yr)	42,147	7,591	11,428	61,166
0.002 (500 yr)	42,356	7,594	11,437	61,387

Note: The table reflects the number of structures damaged by ACE event before adjustments were made to the structure inventory for repetitive flooding. In contrast, Table 55 shows the number of structures damaged by ACE event in Table 55 after the adjustments have been made for repetitive flooding. It should be noted that this table uses damages below their first floor elevation as a criteria for being damaged by an ACE event.

Table 18

Number of Structures Receiving 50% or Greater Damages By Probability Event in 2035

Residential and Mobile Homes

Without-Project Condition

Morganza to the Gulf of Mexico, LA

Post-Authorization Change Report

Annual Chance Exceedance (ACE) Event	Residential Structures Receiving Greater Than 50% Damage
0.99 (1 yr)	95
0.20 (5 yr)	341
0.10 (10 yr)	1,702
0.04 (25 yr)	17,316
0.02 (50 yr)	30,830
0.01 (100 yr)	34,045
0.005 (200 yr)	40,692
0.002 (500 yr)	41,460

Notes: Calculations do not include performance of non-Federal levees.

Calculations include mobile homes.

Calculations are based on 50% damage to structure value not including damage to contents.

Records containing multiple structures were only counted once.

Table 19

Expected Annual Damages and Benefits (1000's)

Morganza to the Gulf of Mexico, LA

Post-Authorization Change Report

2010						
	Expected Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
Plan Name	Total Without-Project	Total With-Project	Damages Reduced	0.75	0.50	0.25
Without	$ 448,347	$ -	$ -	$ -	$ -	$ -
2024						
	Expected Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
Plan Name	Total Without-Project	Total With-Project	Damages Reduced	0.75	0.50	0.25
Without	$ 494,858	$ 494,858	$ -	$ -	$ -	$ -
Alt 3%	$ 494,858	$ 278,146	$ 216,712	$ 168,561	$ 223,760	$ 272,228
Alt 1%	$ 494,858	$ 145,647	$ 349,211	$ 247,849	$ 368,043	$ 454,104
2035						
	Expected Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
Plan Name	Total Without-Project	Total With-Project	Damages Reduced	0.75	0.50	0.25
Without	$ 589,520	$ 589,520	$ -	$ -	$ -	$ -
Alt 3%	$ 589,520	$ 310,599	$ 278,920	$ 186,728	$ 279,399	$ 367,643
Alt 1%	$ 589,520	$ 102,896	$ 486,623	$ 289,293	$ 490,945	$ 667,940
2085						
	Expected Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
Plan Name	Total Without-Project	Total With-Project	Damages Reduced	0.75	0.50	0.25
Without	$ 1,050,905	$ 105,905	$ -	$ -	$ -	$ -
Alt 3%	$ 1,050,905	$ 512,436	$ 538,469	$ 420,920	$ 544,770	$ 659,740
Alt 1%	$ 1,050,905	$ 134,785	$ 916,120	$ 628,945	$ 914,694	$ 1,192,751

Note : Damage values based on HEC-FDA model executions for structures, their contents, and vehicles only.

Table 20
3% AEP Calculation of Equivalent Annual Damages and Benefits (1000's)
Base Year 2035
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

					Present Value (PV) Expected Annual Damages/Benefits		
Year	Years from Base Year	PV Factor	Expected Annual Without-Project Damages	Expected Annual With-Project Damages	Expected Annual Without- Project Damages	Expected Annual With-Project Damages	Expected Annual Benefits
2010-12	-22	2.370	$ 448,347	-	-	-	
2013	-21	2.279	-	-	-	-	
2014	-20	2.191	-	-	-	-	
2015	-19	2.107	-	-	-	-	
2016	-18	2.026	-	-	-	-	
2017	-17	1.948	-	-	-	-	
2018	-16	1.873	-	-	-	-	
2019	-15	1.801	-	-	-	-	
2020	-14	1.732	-	-	-	-	
2021	-13	1.665	-	-	-	-	
2022	-12	1.601	-	-	-	-	
2023	-11	1.539	-	-	-	-	
2024	-10	1.480	$ 494,858	$ 278,146	$ 715,091	$ 401,933	$ 313,158
2025	-9	1.423	$ 503,372	$ 286,661	$ 701,104	$ 399,265	$ 301,839
2026	-8	1.369	$ 511,887	$ 233,967	$ 687,193	$ 314,094	$ 373,100
2027	-7	1.316	$ 520,402	$ 242,481	$ 673,373	$ 313,758	$ 359,614
2028	-6	1.265	$ 528,917	$ 250,996	$ 659,653	$ 313,037	$ 346,616
2029	-5	1.217	$ 537,431	$ 259,511	$ 646,046	$ 311,958	$ 334,088
2030	-4	1.170	$ 545,946	$ 268,026	$ 632,560	$ 310,548	$ 322,012
2031	-3	1.125	$ 554,461	$ 276,540	$ 619,206	$ 308,832	$ 310,373
2032	-2	1.082	$ 562,975	$ 285,055	$ 605,990	$ 306,835	$ 299,155
2033	-1	1.040	$ 571,490	$ 293,570	$ 592,921	$ 304,579	$ 288,342
2034	0	1.000	$ 580,005	$ 302,084	$ 580,005	$ 302,084	$ 277,920
2035	1	0.962	$ 588,520	$ 310,599	$ 567,248	$ 299,373	$ 267,875
2036	2	0.925	$ 597,767	$ 314,636	$ 555,336	$ 292,302	$ 263,034
2037	3	0.889	$ 607,015	$ 318,673	$ 543,544	$ 285,352	$ 258,193
2038	4	0.855	$ 616,263	$ 322,709	$ 531,880	$ 278,522	$ 253,358
2039	5	0.822	$ 625,510	$ 326,746	$ 520,348	$ 271,813	$ 248,535
2040	6	0.790	$ 634,758	$ 330,783	$ 508,955	$ 265,225	$ 243,730
2041	7	0.760	$ 644,006	$ 334,820	$ 497,706	$ 258,758	$ 238,948
2042	8	0.731	$ 653,254	$ 338,856	$ 486,605	$ 252,412	$ 234,193
2043	9	0.703	$ 662,501	$ 342,893	$ 475,657	$ 246,187	$ 229,469
2044	10	0.676	$ 671,749	$ 346,930	$ 464,864	$ 240,083	$ 224,781
2045	11	0.650	$ 680,997	$ 350,967	$ 454,230	$ 234,097	$ 220,133
2046	12	0.625	$ 690,244	$ 355,003	$ 443,757	$ 228,231	$ 215,526
2047	13	0.601	$ 699,492	$ 359,040	$ 433,448	$ 222,483	$ 210,965
2048	14	0.577	$ 708,740	$ 363,077	$ 423,305	$ 216,853	$ 206,452
2049	15	0.555	$ 717,988	$ 367,114	$ 413,328	$ 211,339	$ 201,990
2050	16	0.534	$ 727,235	$ 371,150	$ 403,520	$ 205,940	$ 197,580
2051	17	0.513	$ 736,483	$ 375,187	$ 393,881	$ 200,655	$ 193,226
2052	18	0.494	$ 745,731	$ 379,224	$ 384,411	$ 195,483	$ 188,928

Table 20 (Cont.)
3% AEP Calculation of Equivalent Annual Damages and Benefits (1000's)
Base Year 2035
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

					Present Value (PV) Expected Annual Damages/Benefits		
Year	Years from Base Year	PV Factor	Expected Annual Without-Project Damages	Expected Annual With-Project Damages	Expected Annual Without-Project Damages	Expected Annual With-Project Damages	Expected Annual Benefits
2053	19	0.475	$ 754,978	$ 383,260	$ 375,112	$ 190,423	$ 184,688
2054	20	0.456	$ 764,226	$ 387,297	$ 365,982	$ 185,474	$ 180,508
2055	21	0.439	$ 773,474	$ 391,334	$ 357,022	$ 180,633	$ 176,389
2056	22	0.422	$ 782,722	$ 395,371	$ 348,232	$ 175,900	$ 172,332
2057	23	0.406	$ 791,969	$ 399,407	$ 339,611	$ 171,273	$ 168,338
2058	24	0.390	$ 801,217	$ 403,444	$ 331,158	$ 166,751	$ 164,407
2059	25	0.375	$ 810,465	$ 407,481	$ 322,873	$ 162,332	$ 160,541
2060	26	0.361	$ 819,712	$ 411,518	$ 314,754	$ 158,015	$ 156,739
2061	27	0.347	$ 828,960	$ 415,554	$ 306,800	$ 153,797	$ 153,002
2062	28	0.333	$ 838,208	$ 419,591	$ 299,009	$ 149,678	$ 149,331
2063	29	0.321	$ 847,456	$ 423,628	$ 291,381	$ 145,656	$ 145,725
2064	30	0.308	$ 856,703	$ 427,665	$ 283,914	$ 141,729	$ 142,185
2065	31	0.296	$ 865,951	$ 431,701	$ 276,606	$ 137,896	$ 138,710
2066	32	0.285	$ 875,199	$ 435,738	$ 269,456	$ 134,155	$ 135,301
2067	33	0.274	$ 884,446	$ 439,775	$ 262,461	$ 130,504	$ 131,957
2068	34	0.264	$ 893,694	$ 443,812	$ 255,619	$ 126,941	$ 128,678
2069	35	0.253	$ 902,942	$ 447,848	$ 248,929	$ 123,466	$ 125,463
2070	36	0.244	$ 912,190	$ 451,885	$ 242,389	$ 120,076	$ 122,313
2071	37	0.234	$ 921,437	$ 455,922	$ 235,997	$ 116,770	$ 119,227
2072	38	0.225	$ 930,685	$ 459,959	$ 229,750	$ 113,546	$ 116,204
2073	39	0.217	$ 939,933	$ 463,995	$ 223,646	$ 110,402	$ 113,244
2074	40	0.208	$ 949,180	$ 468,032	$ 217,683	$ 107,337	$ 110,346
2075	41	0.200	$ 958,428	$ 472,069	$ 211,859	$ 104,350	$ 107,509
2076	42	0.193	$ 967,676	$ 476,106	$ 206,172	$ 101,438	$ 104,733
2077	43	0.185	$ 976,924	$ 480,142	$ 200,619	$ 98,601	$ 102,018
2078	44	0.178	$ 986,171	$ 484,179	$ 195,198	$ 95,836	$ 99,362
2079	45	0.171	$ 995,419	$ 488,216	$ 189,907	$ 93,142	$ 96,765
2080	46	0.165	$ 1,004,667	$ 492,252	$ 184,743	$ 90,518	$ 94,225
2081	47	0.158	$ 1,013,914	$ 496,289	$ 179,705	$ 87,962	$ 91,743
2082	48	0.152	$ 1,023,162	$ 500,326	$ 174,790	$ 85,472	$ 89,318
2083	49	0.146	$ 1,032,410	$ 504,363	$ 169,995	$ 83,047	$ 86,947
2084	50	0.141	$ 1,041,658	$ 508,399	$ 165,318	$ 80,686	$ 84,632

	W/O	With	Benefit
Amortization Factor	0.04457	0.04457	0.04457
Equivalent Annual (2024-2084)	1,064,961	540,054	524,907
Equivalent Annual (2035-2084)	747,898	380,170	367,728
Equivalent Annual (2024-2034)	317,063	159,884	157,178

Note: Present value and amortization factors are based on the fiscal year 2012 Federal discount rate of 3.75 percent.

	3 % AEP
Partial Performance begins in:	2024
Full Performance begins in:	2035
Base Year	2035

Table 21
1% AEP Calculation of Equivalent Annual Damages and Benefits (1000's)
Base Year 2035
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

					Present Value (PV) Expected Annual Damages/Benefits		
Year	Years from Base Year	PV Factor	Expected Annual Without- Project Damages	Expected Annual With-Project Damages	Expected Annual Without-Project Damages	Expected Annual With-Project Damages	Expected Annual Benefits
2010-12	-22	2.370	$ 448,347	-	-	-	-
2013	-21	2.279	-	-	-	-	-
2014	-20	2.191	-	-	-	-	-
2015	-19	2.107	-	-	-	-	-
2016	-18	2.026	-	-	-	-	-
2017	-17	1.948	-	-	-	-	-
2018	-16	1.873	-	-	-	-	-
2019	-15	1.801	-	-	-	-	-
2020	-14	1.732	-	-	-	-	-
2021	-13	1.665	-	-	-	-	-
2022	-12	1.601	-	-	-	-	-
2023	-11	1.539	-	-	-	-	-
2024	-10	1.480	$ 494,858	$ 145,647	$ 715,091	$ 210,466	$ 504,625
2025	-9	1.423	$ 503,372	$ 154,162	$ 701,104	$ 214,719	$ 486,385
2026	-8	1.369	$ 511,887	$ 162,676	$ 687,193	$ 218,388	$ 468,805
2027	-7	1.316	$ 520,402	$ 171,191	$ 673,373	$ 221,512	$ 451,860
2028	-6	1.265	$ 528,917	$ 179,706	$ 659,653	$ 224,125	$ 435,528
2029	-5	1.217	$ 537,431	$ 188,221	$ 646,046	$ 226,260	$ 419,786
2030	-4	1.170	$ 545,946	$ 196,735	$ 632,560	$ 227,947	$ 404,613
2031	-3	1.125	$ 554,461	$ 205,250	$ 619,206	$ 229,217	$ 389,988
2032	-2	1.082	$ 562,975	$ 213,765	$ 605,990	$ 230,098	$ 375,893
2033	-1	1.040	$ 571,490	$ 222,279	$ 592,921	$ 230,615	$ 362,306
2034	0	1.000	$ 580,005	$ 230,794	$ 580,005	$ 230,794	$ 349,211
2035	1	0.962	$ 588,520	$ 102,896	$ 567,248	$ 99,177	$ 468,071
2036	2	0.925	$ 597,767	$ 103,534	$ 555,336	$ 96,185	$ 459,151
2037	3	0.889	$ 607,015	$ 104,172	$ 543,544	$ 93,279	$ 450,265
2038	4	0.855	$ 616,263	$ 104,810	$ 531,880	$ 90,458	$ 441,421
2039	5	0.822	$ 625,510	$ 105,447	$ 520,348	$ 87,719	$ 432,629
2040	6	0.790	$ 634,758	$ 106,085	$ 508,955	$ 85,060	$ 423,895
2041	7	0.760	$ 644,006	$ 106,723	$ 497,706	$ 82,478	$ 415,228
2042	8	0.731	$ 653,254	$ 107,361	$ 486,605	$ 79,972	$ 406,633
2043	9	0.703	$ 662,501	$ 107,998	$ 475,657	$ 77,540	$ 398,117
2044	10	0.676	$ 671,749	$ 108,636	$ 464,864	$ 75,178	$ 389,686
2045	11	0.650	$ 680,997	$ 109,274	$ 454,230	$ 72,887	$ 381,343
2046	12	0.625	$ 690,244	$ 109,912	$ 443,757	$ 70,662	$ 373,095
2047	13	0.601	$ 699,492	$ 110,550	$ 433,448	$ 68,503	$ 364,945
2048	14	0.577	$ 708,740	$ 111,187	$ 423,305	$ 66,408	$ 356,897
2049	15	0.555	$ 717,988	$ 111,825	$ 413,328	$ 64,375	$ 348,953
2050	16	0.534	$ 727,235	$ 112,463	$ 403,520	$ 62,402	$ 341,118
2051	17	0.513	$ 736,483	$ 113,101	$ 393,881	$ 60,488	$ 333,393
2052	18	0.494	$ 745,731	$ 113,738	$ 384,411	$ 58,630	$ 325,781
2053	19	0.475	$ 754,978	$ 114,376	$ 375,112	$ 56,828	$ 318,284
2054	20	0.456	$ 764,226	$ 115,014	$ 365,982	$ 55,079	$ 310,903
2055	21	0.439	$ 773,474	$ 115,652	$ 357,022	$ 53,383	$ 303,639
2056	22	0.422	$ 782,722	$ 116,290	$ 348,232	$ 51,737	$ 296,495
2057	23	0.406	$ 791,969	$ 116,927	$ 339,611	$ 50,141	$ 289,470
2058	24	0.390	$ 801,217	$ 117,565	$ 331,158	$ 48,592	$ 282,566
2059	25	0.375	$ 810,465	$ 118,203	$ 322,873	$ 47,090	$ 275,783
2060	26	0.361	$ 819,712	$ 118,841	$ 314,754	$ 45,633	$ 269,121
2061	27	0.347	$ 828,960	$ 119,478	$ 306,800	$ 44,219	$ 262,580
2062	28	0.333	$ 838,208	$ 120,116	$ 299,009	$ 42,848	$ 256,161
2063	29	0.321	$ 847,456	$ 120,754	$ 291,381	$ 41,519	$ 249,862

Table 21 (Cont.)
1% AEP Calculation of Equivalent Annual Damages and Benefits (1000's)
Base Year 2035
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

					Present Value (PV) Expected Annual Damages/Benefits		
Year	Years from Base Year	PV Factor	Expected Annual Without- Project Damages	Expected Annual With-Project Damages	Expected Annual Without-Project Damages	Expected Annual With-Project Damages	Expected Annual Benefits
2064	30	0.308	$ 856,703	$ 121,392	$ 283,914	$ 40,230	$ 243,685
2065	31	0.296	$ 865,951	$ 122,030	$ 276,606	$ 38,979	$ 237,627
2066	32	0.285	$ 875,199	$ 122,667	$ 269,456	$ 37,767	$ 231,689
2067	33	0.274	$ 884,446	$ 123,305	$ 262,461	$ 36,591	$ 225,870
2068	34	0.264	$ 893,694	$ 123,943	$ 255,619	$ 35,451	$ 220,168
2069	35	0.253	$ 902,942	$ 124,581	$ 248,929	$ 34,345	$ 214,584
2070	36	0.244	$ 912,190	$ 125,218	$ 242,389	$ 33,273	$ 209,116
2071	37	0.234	$ 921,437	$ 125,856	$ 235,997	$ 32,234	$ 203,763
2072	38	0.225	$ 930,685	$ 126,494	$ 229,750	$ 31,226	$ 198,523
2073	39	0.217	$ 939,933	$ 127,132	$ 223,646	$ 30,249	$ 193,396
2074	40	0.208	$ 949,180	$ 127,770	$ 217,683	$ 29,302	$ 188,381
2075	41	0.200	$ 958,428	$ 128,407	$ 211,859	$ 28,384	$ 183,475
2076	42	0.193	$ 967,676	$ 129,045	$ 206,172	$ 27,494	$ 178,678
2077	43	0.185	$ 976,924	$ 129,683	$ 200,619	$ 26,631	$ 173,988
2078	44	0.178	$ 986,171	$ 130,321	$ 195,198	$ 25,795	$ 169,403
2079	45	0.171	$ 995,419	$ 130,958	$ 189,907	$ 24,984	$ 164,923
2080	46	0.165	$ 1,004,667	$ 131,596	$ 184,743	$ 24,199	$ 160,545
2081	47	0.158	$ 1,013,914	$ 132,234	$ 179,705	$ 23,437	$ 156,268
2082	48	0.152	$ 1,023,162	$ 132,872	$ 174,790	$ 22,699	$ 152,091
2083	49	0.146	$ 1,032,410	$ 133,510	$ 169,995	$ 21,983	$ 148,011
2084	50	0.141	$ 1,041,658	$ 134,147	$ 165,318	$ 21,290	$ 144,028

	W/O	With	Benefit
Amortization Factor	0.04457	0.04457	0.04457
Equivalent Annual (2024-2084)	1,064,961	223,725	841,236
Equivalent Annual (2035-2084)	747,898	113,888	634,010
Equivalent Annual (2024-2034)	317,063	109,837	207,226

Note: Present value and amortization factors are based on the fiscal year 2012 Federal discount rate of 3.75 percen

	1% AEP
Partial Performance begins in:	2024
Full Performance begins in:	2035
Base Year	2035

Table 22

Equivalent Annual Damages and Benefits to Residential and Non-Residential Categories (1000's)

(2024-2085)

Morganza to the Gulf of Mexico, LA

Post-Authorization Change Report

	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
Plan Name	Without-Project	With-Project	Damages Reduced	0.75	0.50	0.25
Alt 3%	$ 1,064,961	$ 540,054	$ 524,907	$ 372,017	$ 517,556	$ 653,715
Alt 1%	$ 1,064,961	$ 223,725	$ 841,236	$ 563,801	$ 886,123	$ 1,171,750

Note: Expected annual damages for structures, their contents, and vehicles were calculated for the years 2024, 2035, and 2085 and converted to equivalent annual values.

Table 23

Equivalent Annual Damages and Benefits for Industrial Properties Category (1000's)

(2024-2085)

Morganza to the Gulf of Mexico, LA

Post-Authorization Change Report

	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
Plan Name	Without-Project	With-Project	Damages Reduced	0.75	0.50	0.25
Alt 3%	$ 24,252	$ 9,566	$ 14,686	$ 6,315	$ 15,670	$ 20,406
Alt 1%	$ 24,252	$ 3,695	$ 20,557	$ 14,322	$ 21,939	$ 28,564

Note: Expected annual damages for industrial properties for the years 2024, 2035, and 2085, were converted to equivalent annual values.

Table 24
Number of Structures Elevated by Analysis Year
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Analysis Year	Residential	Non-Residential
2024	707	66
2035	417	47
2085	1,789	66
Total	2,913	179

Table 25
Structure-Raising Costs
(Dollars per Square Foot in 2011 price level)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Ft. Raised	1-Sty Slab	2-Sty Slab	1-Sty Pier	2-Sty Pier	Mobile Home
1.0	74.52	82.62	65.88	72.90	36.72
2.0	74.52	82.62	65.88	72.90	36.72
3.0	76.14	84.24	68.58	75.60	36.72
4.0	78.84	89.64	68.58	75.60	36.72
5.0	78.84	89.64	68.58	75.60	44.82
6.0	80.46	91.26	70.20	77.22	44.82
7.0	80.46	91.26	70.20	77.22	44.82
8.0	83.16	93.96	71.82	78.84	44.82
9.0	83.16	93.96	71.82	78.84	44.82
10.0	83.16	93.96	71.82	78.84	44.82
11.0	83.16	93.96	71.82	78.84	44.82
12.0	83.16	93.96	71.82	78.84	44.82
13.0	85.86	99.36	73.44	80.46	44.82

Source: Based on interviews with three major shoring companies in the Metropolitan New Orleans area
Note: Temporary Relocation costs equal to $3,750 were also applied to the elevated structures.

Table 26
Structure-Raising Costs Avoided
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Time Period	Total No. of Structures	Average No. of Feet Raised	Total Cost (in Millions)	Average Cost (in Thousands)
2010 to 2024	773	11	$ 108	$ 140
2025 to 2035	464	12	$ 95	$ 205
2036 to 2085	1855	11	$ 238	$ 128

Table 27
Depth-Damage Relationships for Debris Removal and Cleanup Cost
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Occupancy Type	Parameter	Stage in Feet				
1STY-PIER	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 4,957	$ 5,354	$ 5,828
	Standard Deviation	$ -	$ -	$ 817	$ 831	$ 854
1STY-SLAB	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 4,956	$ 5,353	$ 5,748
	Standard Deviation	$ -	$ -	$ 816	$ 830	$ 840
2STY-PIER	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 4,957	$ 5,353	$ 5,828
	Standard Deviation	$ -	$ -	$ 817	$ 830	$ 851
2STY-SLAB	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 6,262	$ 6,870	$ 7,610
	Standard Deviation	$ -	$ -	$ 855	$ 881	$ 916
EAT	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 33,060	$ 33,645	$ 34,451
	Standard Deviation	$ -	$ -	$ 7,740	$ 7,744	$ 7,748
GROC	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 34,736	$ 35,483	$ 36,481
	Standard Deviation	$ -	$ -	$ 7,757	$ 7,756	$ 7,766
MOBHOM	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 4,822	$ 5,252	$ 5,860
	Standard Deviation	$ -	$ -	$ 814	$ 823	$ 860
MULT	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 7,955	$ 8,581	$ 10,277
	Standard Deviation	$ -	$ -	$ 685	$ 738	$ 997
PROF	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 33,799	$ 34,294	$ 35,643
	Standard Deviation	$ -	$ -	$ 7,742	$ 7,745	$ 7,762
PUBL	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 33,799	$ 34,294	$ 35,643
	Standard Deviation	$ -	$ -	$ 7,742	$ 7,746	$ 7,763
REPA	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 35,141	$ 35,889	$ 36,886
	Standard Deviation	$ -	$ -	$ 7,757	$ 7,758	$ 7,768
RETA	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 33,585	$ 34,080	$ 35,429
	Standard Deviation	$ -	$ -	$ 7,741	$ 7,745	$ 7,762
WARE	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 48,057	$ 54,939	$ 63,208
	Standard Deviation	$ -	$ -	$ 8,283	$ 8,541	$ 8,929

Source: Based on *Development of Depth-Emergency Costs and Infrastructure Damage Relationships for Selected South Louisiana Parishes Final Report dated March 2012*

Table 28

Equivalent Annual Damages and Benefits for Debris Category (1000's)

(2024-2085)

Morganza to the Gulf of Mexico, LA

Post-Authorization Change Report

	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
Plan Name	Without-Project	With-Project	Damages Reduced	0.75	0.50	0.25
Alt 3%	$ 36,905	$ 17,908	$ 18,997	$ 14,108	$ 18,460	$ 23,377
Alt 1%	$ 36,905	$ 7,878	$ 29,027	$ 19,960	$ 30,217	$ 39,392

Note: Expected annual damages for the years 2024, 2035, and 2085 were converted to equivalent annual values.

Table 29

Depth-Damage Relationships for Major & Secondary Highways and Streets

Morganza to the Gulf of Mexico, LA

Post-Authorization Change Report

Occupancy Type	Parameter	Stage in Feet				
STREETS	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 88,262	$ 162,965	$ 246,059
	Standard Deviation	$ -	$ -	$ 22,441	$ 27,017	$ 37,795
HIGHWAY	Stage	0.0	1.9	2.0	5.0	12.0
	Percentage of Structure Damage	$ -	$ -	$ 158,070	$ 483,837	$ 669,393

Source: Based on *Development of Depth-Emergency Costs and Infrastructure Damage Relationships for Selected South Louisiana Parishes Final Report dated March 2012*

Table 30
Equivalent Annual Damages and Benefits for Major & Secondary Highways and Streets (1000's)
(2024-2085)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values		
Plan Name	Without-Project	With-Project	Damages Reduced	0.75	0.50	0.25
Alt 3%	$ 31,476	$ 14,326	$ 17,151	$ 10,291	$ 15,779	$ 19,895
Alt 1%	$ 31,476	$ 8,088	$ 23,389	$ 14,570	$ 21,645	$ 27,838

Note: Expected annual damages for the years 2024, 2035, and 2085 were converted to equivalent annual values.

Table 31
Average Annual Agricultural Acres Impacted
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Study Area Reaches		2010	2035					2085				
		Without-Project	Without-Project	With 35 Yr	With 100 Yr	Benefits 35 Yr	Benefits 100 Yr	Without-Project	With 35 Yr	With 100 Yr	Benefits 35 Yr	Benefits 100 Yr
		Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
1	1-5	77	138	5	0	133	138	317	10	2	307	314
2	2-1A2	19	23	10	1	13	22	23	10	1	13	22
3	2-1B2N	53	61	30	4	31	57	68	31	4	38	65
4	4-7	11	17	1	0	16	17	47	1	0	46	47
5	9-1AE	10	10	10	10	0	0	20	20	20	0	0
6	9-1AMID	18	18	18	18	0	0	36	36	36	0	0
7	9-1AW	9	9	9	9	0	0	18	18	18	0	0
8	9-1BE	2	2	0	0	2	2	3	0	0	3	3
9	9-1BMIDE	0	0	0	0	0	0	1	1	1	0	0
10	9-1BMIDW	3	3	3	3	0	0	5	5	5	0	0
11	9-1BW	10	11	11	11	0	0	21	21	21	0	0
12	BL5	13	15	8	1	8	14	35	8	1	27	34
13	BL6	1	2	0	0	2	2	6	1	0	5	6
14	BL7	7	9	2	0	7	9	46	3	0	43	46
15	BL89	14	22	4	1	18	21	75	8	1	67	74
16	C1-LF	27	27	12	1	15	26	31	12	1	20	30
17	D1b-LF	16	16	7	1	9	15	16	7	1	9	15
18	D1c-LF2	19	25	10	1	15	24	86	10	1	76	85
19	D1c-LF3	38	57	17	2	40	55	297	17	2	280	295
20	D-28	18	20	9	1	11	19	21	10	1	11	20
21	D-31	12	12	5	1	7	11	12	5	1	7	11
22	E2-LF	82	138	14	2	124	136	323	14	2	309	322
23	GW14	8	8	2	0	6	8	19	4	0	15	18
24	GW16	8	10	2	0	8	10	20	2	0	18	20
25	GW2	36	68	2	1	66	67	139	5	1	134	139
26	HNC6	16	24	1	0	23	24	43	2	0	41	43
27	SL2	28	40	5	1	35	39	172	10	1	162	171
28	TS1	1	1	1	0	0	1	1	1	0	0	1
29	TS10	8	11	8	1	3	10	18	8	1	10	17
30	TS11	0	0	0	0	0	0	0	0	0	0	0
31	TS2	3	3	3	1	0	2	6	6	1	0	4
32	TS3	1	3	1	0	2	3	3	1	0	2	3
33	TS5	9	10	6	1	4	9	12	6	1	6	12
34	TS6	9	10	6	1	4	9	15	6	1	9	15
35	TS7	5	7	5	1	2	6	10	5	1	5	9
36	TS9	16	19	10	1	9	18	23	11	1	13	22
Total		**607**	**849**	**236**	**75**	**613**	**774**	**1989**	**312**	**128**	**1677**	**1861**

Note: Agricultural acres in the eastern Federal levee tie-in areas north of Bayou Lafourche are not included in the table.

Table 32
Percent of Total Catch Caught by Vessel Size Category
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Length	2009	2024	2035	2085
Total <26'	7.2%	6.5%	5.9%	5.7%
26' to < 40'	23.2%	20.9%	19.3%	18.5%
40' to < 65'	55.2%	56.7%	57.8%	58.3%
65' and over	14.4%	15.9%	17.0%	17.5%

Source: *Economic Benefits of Protecting the Large Recreational and Commercial Boat Fleets Final Report* dated April 2012

Table 33
Median Catch by Vessel Size
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Length	Median Catch (lbs)
≤20'	3,000
21' to ≤ 40'	20,300
41' to ≤ 60'	47,653
60' and over	69,050

Source: *Economic Benefits of Protecting the Large Recreational and Commercial Boat Fleets Final Report* dated April 2012

Table 34
Commercial Fishing Vessel Forecast
(2024-2085)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

	Low			Median			High		
	2024	2035	2085	2024	2035	2085	2024	2035	2085
26' to < 40'	222	204	196	339	313	300	457	421	404
40' to < 65'	256	261	263	391	399	402	527	537	542
65' and over	50	53	55	76	81	83	102	109	112
Total >=26	527	518	514	807	793	786	1,086	1,067	1,059

Source: *Economic Benefits of Protecting the Large Recreational and Commercial Boat Fleets Final Report* dated April 2012

Table 35
Recreational Fleet Historical Growth Rates
(1999-2009)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Vessel Size	Annual Growth	
	1999-2009	2002-2009
26' to < 40'	1.8%	2.5%
40' to < 65'	3.2%	5.2%
65' and over	5.0%	7.1%
Total ≥26	2.0%	2.9%

Source: *Economic Benefits of Protecting the Large Recreational and Commercial Boat Fleets Final Report* dated April 2012

Table 36
Recreational Fleet Growth Rates
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Vessel Size	Median		High	
	To 2040	To 2085	To 2040	To 2085
26' to < 40'	1.0%	0.5%	2.0%	0.7%
40' to < 65'	2.5%	1.0%	4.0%	1.3%
65' and over	3.0%	1.5%	6.0%	2.0%

Source: *Economic Benefits of Protecting the Large Recreational and Commercial Boat Fleets Final Report* dated April 2012

Table 37
Number of Recreational Vessel Forecast
(2024-2085)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

	Low			Median			High		
	2024	2035	2085	2024	2035	2085	2024	2035	2085
26' to < 40'	283	283	283	329	367	482	381	474	716
40' to < 65'	67	67	67	97	127	225	121	186	404
65' and over	11	11	11	17	24	54	26	50	163
Total >=26	361	361	361	443	518	761	528	709	1,283

Source: *Economic Benefits of Protecting the Large Recreational and Commercial Boat Fleets Final Report* dated April 2012

Table 38
Commercial Passenger Vessel Forecast
(2024-2085)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

	Low			Median			High		
	2024	2035	2085	2024	2035	2085	2024	2035	2085
26' to < 40'	18	16	11	21	21	21	24	26	33
40' to < 65'	8	7	5	9	9	9	10	12	17
65' and over	3	2	2	3	3	3	3	4	5
Total >=26	28	25	18	33	33	33	37	42	55

Source: *Economic Benefits of Protecting the Large Recreational and Commercial Boat Fleets Final Report* dated April 2012

Table 39
Distribution of Vessel Fleets
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Waterway	Percentage of Vessel Fleet	Below Project Alignment	Above Project Alignment
Houma Navigation Channel	5%	2%	3%
Bayou Petit Caillou	30%	5%	25%
Bayou Grand Caillou	30%	0%	30%
Bayou Dularge	15%	12%	3%
Bayou Terrebonne	15%	1%	14%
Bayou Pointe aux Chene	5%	2%	3%
Total	100%	**22%**	**78%**

Source: *Economic Benefits of Protecting the Large Recreational and Commercial Boat Fleets Final Report* dated April 2012

Table 40
Distance to Refuge Without- & With-Project
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

	Without-Project				
	Percent Below	Nautical Miles	Percent Above	Distance	Weighted Average
Houma Navigation Channel	2%	15.0	3%	0.0	0.30
Bayou Petit Caillou	5%	20.0	25%	15.0	4.75
Bayou Grand Caillou	0%	0.0	30%	10.0	3.00
Bayou Dularge	12%	8.0	3%	2.0	1.02
Bayou Terrebonne	1%	15.0	14%	12.0	1.83
Bayou Pointe aux Chene	2%	1.0	3%	0.5	0.04
Total	**22%**		**78%**		**10.94**
	With-Project				
	Percent Below	Nautical Miles	Percent Above	Distance	Weighted Average
Houma Navigation Channel	2%	10.0	3%	0.0	0.20
Bayou Petit Caillou	5%	8.0	25%	0.0	0.40
Bayou Grand Caillou	0%	0.0	30%	0.0	0.00
Bayou Dularge	12%	4.0	3%	0.0	0.48
Bayou Terrebonne	1%	5.0	14%	0.0	0.05
Bayou Pointe aux Chene	2%	0.5	3%	0.0	0.01
Total	**22%**		**78%**		**1.14**

Source: *Economic Benefits of Protecting the Large Recreational and Commercial Boat Fleets Final Report* dated April 2012

Table 41
Travel Cost by Vessel Type and Size
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Recreation & Commercial Passenger							
Vessel Size	Speed (knots)	Hourly Fuel Consumption	Cost of Diesel (gal)	Hourly Fuel Cost	Hourly Cost of Crew	Hourly Operating Cost	Cost per Nautical Mile
26' to < 40'	23	25	$ 3.13	$ 78.25	$ 20.00	$ 98.25	$ 4.27
40' to < 65'	18	25	$ 3.13	$ 79.29	$ 35.00	$ 114.29	$ 6.35
65' and over	11	16	$ 3.13	$ 50.08	$ 50.00	$ 100.08	$ 9.10
Commercial Fishing							
Vessel Size	Speed (knots)	Hourly Fuel Consumption	Cost of Diesel (gal)	Hourly Fuel Cost	Hourly Cost of Crew	Hourly Operating Cost	Cost per Nautical Mile
26' to < 40'	8	6	$ 3.13	$ 18.78	$ 35.00	$ 53.78	$ 6.72
40' to < 65'	10	8	$ 3.13	$ 25.04	$ 50.00	$ 75.04	$ 7.50
65' and over	10	16	$ 3.13	$ 50.08	$ 65.00	$ 115.08	$ 11.51
Other Vessels							
Vessel Size	Speed (knots)	Hourly Fuel Consumption	Cost of Diesel (gal)	Hourly Fuel Cost	Hourly Cost of Crew	Hourly Operating Cost	Cost per Nautical Mile
26' to < 40'	8	10	$ 3.13	$ 31.30	$ 50.00	$ 81.30	$ 10.16
40' to < 65'	10	16	$ 3.13	$ 50.08	$ 65.00	$ 115.08	$ 11.51
65' and over	12	20	$ 3.13	$ 62.60	$ 80.00	$ 142.60	$ 11.88

Source: *Economic Benefits of Protecting the Large Recreational and Commercial Boat Fleets Final Report dated April 2012*

Table 42
Total Travel Cost by Vessel Size
(2024-2085)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Without-Project									
	Low Forecast			Median Forecast			High Forecast		
Vessel Size	2024	2035	2085	2024	2035	2085	2024	2035	2085
26' to < 40'	30,804	29,426	28,609	41,715	41,524	46,032	52,942	54,718	65,151
40' to < 65'	29,704	30,054	30,122	42,998	45,724	52,818	55,835	61,333	77,224
65' and over	15,259	15,663	15,803	19,217	20,532	23,818	23,491	26,775	38,564
Total	75,767	75,143	74,534	103,930	107,780	122,668	132,268	142,826	180,940
With-Project									
	Low Forecast			Median Forecast			High Forecast		
Vessel Size	2024	2035	2085	2024	2035	2085	2024	2035	2085
26' to < 40'	3,211	3,068	2,983	4,349	4,329	4,799	5,519	5,705	6,792
40' to < 65'	3,097	3,133	3,140	4,483	4,767	5,506	5,821	6,394	8,051
65' and over	1,591	1,633	1,647	2,003	2,140	2,483	2,449	2,791	4,020
Total	7,899	7,834	7,770	10,835	11,236	12,788	13,789	14,890	18,863
Benefits									
	Low Forecast			Median Forecast			High Forecast		
Vessel Size	2024	2035	2085	2024	2035	2085	2024	2035	2085
26' to < 40'	27,593	26,359	25,626	37,366	37,195	41,233	47,423	49,014	58,359
40' to < 65'	26,607	26,921	26,982	38,515	40,957	47,312	50,014	54,939	69,174
65' and over	13,668	14,030	14,155	17,213	18,391	21,335	21,042	23,983	34,544
Total	67,868	67,309	66,763	93,095	96,544	109,880	118,478	127,936	162,076

Source: *Economic Benefits of Protecting the Large Recreational and Commercial Boat Fleets Final Report* dated April 2012

Table 43
Expected Annual Travel Cost and Benefits
(2024-2085)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

	Low Forecast			Median Forecast			High Forecast		
	2024	2035	2085	2024	2035	2085	2024	2035	2085
Without-Project Costs	11,214	11,121	11,031	15,382	15,951	18,155	19,576	21,138	26,779
With-Project Costs	1,169	1,159	1,150	1,604	1,663	1,893	2,041	2,204	2,792
Benefits	10,045	9,962	9,881	13,778	14,288	16,262	17,535	18,934	23,987

Source: *Economic Benefits of Protecting the Large Recreational and Commercial Boat Fleets Final Report* dated April 2012

Table 44
Additional Costs Associated with High Salinity Levels
Morganza to the Gulf
Post-Authorization Change Report

Without-Project Year	Chemicals Costs	Treatment Costs	Operation Costs	Refurbish Costs	Replacement Costs	TOTAL
2012	$10,744	$275,000	$330			$286,074
2013	$10,744		$330			$11,074
2014	$10,744		$330			$11,074
2015	$10,744	$275,000	$330			$286,074
2016	$10,744		$330			$11,074
2017	$10,744		$330			$11,074
2018	$10,744	$275,000	$330			$286,074
2019	$10,744		$330			$11,074
2020	$10,744		$330	$1,000,000	$500,000	$1,511,074
2021	$10,744	$275,000	$330			$286,074
2022	$10,744		$330			$11,074
2023	$10,744		$330			$11,074
2024	$10,744	$275,000	$330			$286,074
2025	$10,744		$330			$11,074
2026	$10,744		$330			$11,074
2027	$10,744	$275,000	$330			$286,074
2028	$10,744		$330			$11,074
2029	$10,744		$330			$11,074
2030	$10,744	$275,000	$330			$286,074
2031	$10,744		$330			$11,074
2032	$10,744		$330			$11,074
2033	$10,744	$275,000	$330			$286,074
2034	$10,744		$330			$11,074
2035	$10,744		$330			$11,074
2036	$10,744	$275,000	$330			$286,074
2037	$10,744		$330			$11,074
2038	$10,744		$330			$11,074
2039	$10,744	$275,000	$330			$286,074
2040	$10,744		$330	$135,000	$135,000	$281,074
2041	$10,744		$330			$11,074
2042	$10,744	$275,000	$330			$286,074
2043	$10,744		$330			$11,074
2044	$10,744		$330			$11,074
2045	$10,744	$275,000	$330			$286,074
2046	$10,744		$330			$11,074
2047	$10,744		$330			$11,074
2048	$10,744	$275,000	$330			$286,074
2049	$10,744		$330			$11,074
2050	$10,744		$330			$11,074
2051	$10,744	$275,000	$330			$286,074
2052	$10,744		$330			$11,074
2053	$10,744		$330			$11,074
2054	$10,744	$275,000	$330			$286,074
2055	$10,744		$330			$11,074
2056	$10,744		$330			$11,074
2057	$10,744	$275,000	$330			$286,074
2058	$10,744		$330			$11,074
2059	$10,744		$330			$11,074
2060	$10,744	$275,000	$330	$1,000,000	$500,000	$1,786,074
2061	$10,744		$330			$11,074
2062	$10,744		$330			$11,074
2063	$10,744	$275,000	$330			$286,074
2064	$10,744		$330			$11,074
2065	$10,744		$330			$11,074
2066	$10,744	$275,000	$330			$286,074
2067	$10,744		$330			$11,074
2068	$10,744		$330			$11,074
2069	$10,744	$275,000	$330			$286,074
2070	$10,744		$330			$11,074
2071	$10,744		$330			$11,074
2072	$10,744	$275,000	$330			$286,074
2073	$10,744		$330			$11,074
2074	$10,744		$330			$11,074
2075	$10,744	$275,000	$330			$286,074
2076	$10,744		$330			$11,074
2077	$10,744		$330			$11,074
2078	$10,744	$275,000	$330			$286,074
2079	$10,744		$330			$11,074
2080	$10,744		$330	$135,000	$135,000	$281,074
2081	$10,744	$275,000	$330			$286,074
2082	$10,744		$330			$11,074
2083	$10,744		$330			$11,074
2084	$10,744	$275,000	$330			$286,074

With-Project 1% and 3% AEP Alternatives Year	Chemicals Costs	Treatment Costs	Operation Costs	Refurbish Costs	Replacement Costs	TOTAL
2012	$10,744	$275,000	$330			$286,074
2013	$10,744		$330			$11,074
2014	$10,744		$330			$11,074
2015	$10,744	$275,000	$330			$286,074
2016	$10,744		$330			$11,074
2017	$10,744		$330			$11,074
2018	$10,744	$275,000	$330			$286,074
2019	$8,175		$251			$8,426
2020	$8,175		$251			$8,426
2021	$8,175		$251			$8,426
2022	$8,175	$275,000	$251			$283,426
2023	$8,175		$251			$8,426
2024	$8,175		$251			$8,426
2025	$8,175		$251			$8,426
2026	$8,175	$275,000	$251			$283,426
2027	$8,175		$251			$8,426
2028	$8,175		$251			$8,426
2029	$8,175		$251			$8,426
2030	$8,175	$275,000	$251			$283,426
2031	$8,175		$251			$8,426
2032	$8,175		$251			$8,426
2033	$8,175		$251			$8,426
2034	$8,175	$275,000	$251			$283,426
2035	$8,175		$251			$8,426
2036	$8,175		$251			$8,426
2037	$8,175		$251			$8,426
2038	$8,175	$275,000	$251			$283,426
2039	$8,175		$251			$8,426
2040	$8,175		$251			$8,426
2041	$8,175		$251			$8,426
2042	$8,175	$275,000	$251			$283,426
2043	$8,175		$251			$8,426
2044	$8,175		$251			$8,426
2045	$8,175		$251			$8,426
2046	$8,175	$275,000	$251			$283,426
2047	$8,175		$251			$8,426
2048	$8,175		$251			$8,426
2049	$8,175		$251			$8,426
2050	$8,175	$275,000	$251			$283,426
2051	$8,175		$251			$8,426
2052	$8,175		$251			$8,426
2053	$8,175		$251			$8,426
2054	$8,175	$275,000	$251			$283,426
2055	$8,175		$251			$8,426
2056	$8,175		$251			$8,426
2057	$8,175		$251			$8,426
2058	$8,175	$275,000	$251			$283,426
2059	$8,175		$251			$8,426
2060	$8,175		$251			$8,426
2061	$8,175		$251			$8,426
2062	$8,175	$275,000	$251			$283,426
2063	$8,175		$251			$8,426
2064	$8,175		$251			$8,426
2065	$8,175		$251			$8,426
2066	$8,175	$275,000	$251			$283,426
2067	$8,175		$251			$8,426
2068	$8,175		$251			$8,426
2069	$8,175		$251			$8,426
2070	$8,175	$275,000	$251			$283,426
2071	$8,175		$251			$8,426
2072	$8,175		$251			$8,426
2073	$8,175		$251			$8,426
2074	$8,175	$275,000	$251			$283,426
2075	$8,175		$251			$8,426
2076	$8,175		$251			$8,426
2077	$8,175		$251			$8,426
2078	$8,175	$275,000	$251			$283,426
2079	$8,175		$251			$8,426
2080	$8,175		$251			$8,426
2081	$8,175		$251			$8,426
2082	$8,175	$275,000	$251			$283,426
2083	$8,175		$251			$8,426
2084	$8,175		$251			$8,426

Source: Based on schedule of water supply costs provided by Houma Water Treatment Plant
Note: The expected value for the annual number of days of high salinity during the period, 2012 to 2084, is 31.2 days.

Table 45
3% AEP Total Annual Costs
(2011 Price Level; 3.75% Discount Rate)
Morganza to the Gulf
Post-Authorization Change Report
($ Millions)

Year	Years from Base Year	Expenditures	Present Value Factor	Present Value of Expenditures
2010	-24		2.419	0
2011	-23		2.332	0
2012	-22	$0	2.248	0
2013	-21	$0	2.166	0
2014	-20	$14	2.088	30
2015	-19	$695	2.013	1,398
2016	-18	$625	1.940	1,213
2017	-17	$716	1.870	1,339
2018	-16	$708	1.802	1,276
2019	-15	$398	1.737	691
2020	-14	$355	1.674	595
2021	-13	$587	1.614	947
2022	-12	$557	1.555	866
2023	-11	$328	1.499	491
2024	-10	$102	1.445	147
2025	-9	$35	1.393	48
2026	-8	$20	1.342	27
2027	-7	$0	1.294	0
2028	-6	$0	1.247	0
2029	-5	$0	1.202	0
2030	-4	$10	1.159	12
2031	-3	$8	1.117	9
2032	-2	$8	1.076	8
2033	-1	$106	1.038	110
2034	0	$106	1.000	106
2035	1	$213	0.964	205
2036	2	$34	0.929	32
2037	3	$13	0.895	12
2038	4	$13	0.863	11
2039	5	$0	0.832	0
2040	6	$32	0.802	25
2041	7	$21	0.773	16
2042	8	$14	0.745	10
2043	9	$14	0.718	10
2044	10	$0	0.692	0
2045	11	$20	0.667	14
2046	12	$10	0.643	7

Table 45 (Cont.)
3% AEP Total Annual Costs
(2011 Price Level; 3.75% Discount Rate)
Morganza to the Gulf
Post-Authorization Change Report
($ Millions)

Year	Years from Base Year	Expenditures	Present Value Factor	Present Value of Expenditures
2047	13	$0	0.620	0
2048	14	$0	0.597	0
2049	15	$0	0.576	0
2050	16	$25	0.555	14
2051	17	$8	0.535	4
2052	18	$0	0.515	0
2053	19	$17	0.497	8
2054	20	$17	0.479	8
2055	21	$0	0.462	0
2056	22	$0	0.445	0
2057	23	$0	0.429	0
2058	24	$0	0.413	0
2059	25	$0	0.398	0
2060	26	$0	0.384	0
2061	27	$0	0.370	0
2062	28	$0	0.357	0
2063	29	$0	0.344	0
2064	30	$0	0.331	0
2065	31	$11	0.319	4
2066	32	$0	0.308	0
2067	33	$0	0.297	0
2068	34	$0	0.286	0
2069	35	$0	0.276	0
2070	36	$35	0.266	9
2071	37	$0	0.256	0
2072	38	$0	0.247	0
2073	39	$15	0.238	3
2074	40	$15	0.229	3
2075	41		0.221	0
Discount Rate (%)	3.75			
Amortization Factor	0.04457			
Annual Implementation Costs				$ 432.8
Operations and Maintenance Cost				$ 5.5
Total Annual Costs ($Millions)				$ 438.3

*Project costs include acquistion costs of structures in 12 study area reaches receiving induced damages south of the proposed alternatives.

Table 46
1% AEP Total Annual Costs
(2011 Price Level; 3.75% Discount Rate)
Morganza to the Gulf
Post-Authorization Change Report
($ Millions)

Year	Period of Analysis	Construction Cost	PV Factor	PV Construction Cost
2010	-24		2.419	0
2011	-23		2.332	0
2012	-22	$0	2.248	0
2013	-21	$0	2.166	0
2014	-20	$22	2.088	46
2015	-19	$822	2.013	1,653
2016	-18	$728	1.940	1,412
2017	-17	$893	1.870	1,670
2018	-16	$958	1.802	1,727
2019	-15	$663	1.737	1,151
2020	-14	$445	1.674	744
2021	-13	$773	1.614	1,248
2022	-12	$836	1.555	1,301
2023	-11	$723	1.499	1,084
2024	-10	$605	1.445	874
2025	-9	$405	1.393	565
2026	-8	$231	1.342	310
2027	-7	$185	1.294	240
2028	-6	$162	1.247	202
2029	-5	$188	1.202	226
2030	-4	$185	1.159	214
2031	-3	$115	1.117	129
2032	-2	$21	1.076	22
2033	-1	$142	1.038	147
2034	0	$192	1.000	192
2035	1	$261	0.964	252
2036	2	$63	0.929	59
2037	3	$22	0.895	20
2038	4	$22	0.863	19
2039	5	$22	0.832	18
2040	6	$22	0.802	18
2041	7	$0	0.773	0
2042	8	$0	0.745	0
2043	9	$0	0.718	0
2044	10	$0	0.692	0
2045	11	$99	0.667	66
2046	12	$52	0.643	34

Table 46 (Cont.)
1% AEP Total Annual Costs
(2011 Price Level; 3.75% Discount Rate)
Morganza to the Gulf
Post-Authorization Change Report
($ Millions)

Year	Period of Analysis	Construction Cost	PV Factor	PV Construction Cost
2047	13	$9	0.620	6
2048	14	$9	0.597	6
2049	15	$0	0.576	0
2050	16	$13	0.555	7
2051	17	$29	0.535	16
2052	18	$16	0.515	8
2053	19	$0	0.497	0
2054	20	$0	0.479	0
2055	21	$47	0.462	22
2056	22	$47	0.445	21
2057	23	$0	0.429	0
2058	24	$0	0.413	0
2059	25	$0	0.398	0
2060	26	$21	0.384	8
2061	27	$5	0.370	2
2062	28	$19	0.357	7
2063	29	$19	0.344	7
2064	30	$0	0.331	0
2065	31	$0	0.319	0
2066	32	$0	0.308	0
2067	33	$0	0.297	0
2068	34	$0	0.286	0
2069	35	$0	0.276	0
2070	36	$27	0.266	7
2071	37	$27	0.256	7
2072	38	$0	0.247	0
2073	39	$0	0.238	0
2074	40	$14	0.229	3
2075	41	$14	0.221	3
		$ 10,177.2		$ 15,772.4
Discount Rate (%)	3.75			
Amortization Factor	0.04457			
Annual Implementation Costs				$ 703.0
Operations and Maintenance Cost				$ 7.3
Total Annual Costs ($Millions)				$ 710.3

*Project costs include acquistion costs of structures in 12 study area reaches receiving induced damages south of the proposed alternatives.

Table 47
3% Annual Exceedance Probability Alternative
(2011 Price Level; 3.75% Discount Rate)
Total Equivalent Annual Net Benefits
Morganza to the Gulf
Post-Authorization Change Report
($ Millions)

Item	Equiv Annual W/O Project Damages (2035-2084)	Equiv Annual With-Project Damages (2035-2084)	Equiv Annual Benefits (2035-2084)	Equiv Annual Benefits During Construction (2024-2034)	Total Equiv Annual Benefits	
Damage Category						
Residential & Commercial - Structure/Content/Vehicles	$ 747.9	$ 380.2	$ 367.7	$ 157.2	$ 524.9	
Industrial - Structure/Contents	$ 16.5	$ 6.4	$ 10.1	$ 4.4	$ 14.5	
Highways	$ 6.6	$ 4.2	$ 2.3	$ 1.1	$ 3.4	
Streets	$ 15.5	$ 5.6	$ 9.9	$ 3.7	$ 13.6	
Debris Removal & Cleanup	$ 25.7	$ 12.6	$ 13.1	$ 5.9	$ 19.0	
Water Supply	$ 0.1	$ 0.1	$ 0.1	$ 0.1	$ 0.2	
Boat Fleets	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	
Avoided Structure-Raising Costs	$ 4.9	$ -	$ 4.9	$ 5.3	$ 10.3	
Total	$ 817.3	$ 409.1	$ 408.2	$ 177.6	$ 585.9	
First Costs						$ 5,902
Interest During Construction						$ 3,937
Annual Operation & Maintenance Costs						$ 6
Total Annual Costs						$ 438
B/C Ratio						1.34
Equivalent Annual Net Benefits - 2035 Base Year						$ 148

Table 48
1% Annual Exceedance Probability Alternative
(2011 Price Level; 3.75% Discount Rate)
Total Equivalent Annual Net Benefits
Morganza to the Gulf
Post-Authorization Change Report
($ Millions)

Item	Equiv Annual W/O Project Damages (2035-2084)	Equiv Annual With-Project Damages (2035-2084)	Equiv Annual Benefits (2035-2084)	Equiv Annual Benefits During Construction (2024-2034)	Total Equiv Annual Benefits	
Damage Category						
Residential & Commercial - Structure/Content/Vehicles	$ 747.9	$ 113.9	$ 634.0	$ 207.2	$ 841.2	
Industrial - Structure/Contents	$ 16.5	$ 1.3	$ 15.2	$ 5.1	$ 20.3	
Highways	$ 6.6	$ 2.3	$ 4.3	$ 1.5	$ 5.7	
Streets	$ 15.5	$ 2.3	$ 13.3	$ 4.2	$ 17.4	
Debris Removal & Cleanup	$ 25.7	$ 4.0	$ 21.7	$ 7.3	$ 29.0	
Water Supply	$ 0.1	$ 0.1	$ 0.1	$ 0.1	$ 0.2	
Boat Fleets	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	
Avoided Structure-Raising Costs	$ 4.9	$ -	$ 4.9	$ 5.3	$ 10.3	
Total	$ 817.3	$ 123.8	$ 693.5	$ 230.8	$ 924.3	
First Costs						$ 10,177
Interest During Construction						$ 5,864
Annual Operation & Maintenance Costs						$ 7
Total Annual Costs						$ 710
B/C Ratio						1.30
Equivalent Annual Net Benefits Base Year 2035						$ 214

Table 49
3% Annual Exceedance Probability Alternative - Without Future Development
(2011 Price Level; 3.75% Discount Rate)
Total Equivalent Annual Net Benefits
Morganza to the Gulf
Post-Authorization Change Report
($ Millions)

Item	Equiv Annual W/O Project Damages (2035-2084)	Equiv Annual With-Project Damages (2035-2084)	Equiv Annual Benefits (2035-2084)	Equiv Annual Benefits During Construction (2024-2034)	Total Equiv Annual Benefits	
Damage Category						
Residential & Commercial - Structure/Content/Vehicles	$ 727.2	$ 362.0	$ 365.3	$ 155.4	$ 520.7	
Industrial - Structure/Contents	$ 16.5	$ 6.4	$ 10.1	$ 4.4	$ 14.5	
Highways	$ 6.6	$ 4.2	$ 2.3	$ 1.1	$ 3.4	
Streets	$ 15.5	$ 5.6	$ 9.9	$ 3.7	$ 13.6	
Debris Removal & Cleanup	$ 24.2	$ 11.2	$ 13.1	$ 5.8	$ 18.9	
Water Supply	$ 0.1	$ 0.1	$ 0.1	$ 0.1	$ 0.2	
Boat Fleets	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	
Avoided Structure-Raising Costs	$ 4.9	$ -	$ 4.9	$ 5.3	$ 10.3	
Total	$ 795.1	$ 389.4	$ 405.7	$ 175.8	$ 581.5	
First Costs						$ 5,902
Interest During Construction						$ 3,937
Annual Operation & Maintenance Costs						$ 6
Total Annual Costs						$ 438
B/C Ratio						1.33
Equivalent Annual Net Benefits - 2035 Base Year						$ 143

Table 50
1% Annual Exceedance Probability Alternative - Without Future Development
(2011 Price Level; 3.75% Discount Rate)
Total Equivalent Annual Net Benefits
Morganza to the Gulf
Post-Authorization Change Report
($ Millions)

Item	Equiv Annual W/O Project Damages (2035-2084)	Equiv Annual With-Project Damages (2035-2084)	Equiv Annual Benefits (2035-2084)	Equiv Annual Benefits During Construction (2024-2034)	Total Equiv Annual Benefits	
Damage Category						
Residential & Commercial - Structure/Content/Vehicles	$ 747.9	$ 113.9	$ 634.0	$ 207.2	$ 841.2	
Industrial - Structure/Contents	$ 16.5	$ 1.3	$ 15.2	$ 5.1	$ 20.3	
Highways	$ 6.6	$ 2.3	$ 4.3	$ 1.5	$ 5.7	
Streets	$ 15.5	$ 2.3	$ 13.3	$ 4.2	$ 17.4	
Debris Removal & Cleanup	$ 25.7	$ 4.0	$ 21.7	$ 7.3	$ 29.0	
Water Supply	$ 0.1	$ 0.1	$ 0.1	$ 0.1	$ 0.2	
Boat Fleets	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	
Avoided Structure-Raising Costs	$ 4.9	$ -	$ 4.9	$ 5.3	$ 10.3	
Total	$ 795.1	$ 112.0	$ 683.1	$ 230.8	$ 913.9	
First Costs						$ 10,177
Interest During Construction						$ 5,864
Annual Operation & Maintenance Costs						$ 7
Total Annual Costs						$ 710
B/C Ratio						1.29
Equivalent Annual Net Benefits Base Year 2035						$ 204

Table 51
Donaldsonville to the Gulf, LA Depth-Damage Relationships for Structures, Contents and Vehicles
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Occupancy Type	Category Name	Damage Type	Parameter																				
1STY-PIER	Residential		Stage	-1.1	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
		Structure	Mean %	0.0	1.7	2.7	27.6	47.1	54.1	56.4	58.7	63.8	72.2	77.4	79.9	80.3	84.4	87.9	88.6	88.9	89.0	89.3	89.4
			Lower %	0.0	0.0	0.9	3.5	16.0	45.1	47.8	48.4	53.3	61.8	64.3	66.7	69.2	72.2	76.2	76.2	76.2	76.2	76.2	76.2
			Upper %	0.0	3.6	4.0	41.9	50.4	64.5	65.2	69.3	73.2	78.0	92.5	98.2	98.2	102.3	107.9	107.9	108.2	108.2	109.2	109.2
			Stage	-1.1	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
		Contents	Mean %	0.0	0.0	0.0	35.0	46.8	48.4	50.3	56.7	67.5	76.3	80.9	88.1	88.4	89.1	89.1	89.1	89.1	89.1	89.1	89.1
			Lower %	0.0	0.0	0.0	27.5	39.9	45.2	48.0	53.0	65.6	74.1	78.5	85.5	85.7	86.4	86.5	86.5	86.5	86.5	86.5	86.5
			Upper %	0.0	0.0	0.0	38.6	50.9	51.2	54.9	59.1	69.5	80.6	85.4	92.9	93.2	93.9	94.0	94.0	94.0	94.0	94.0	94.0
1STY-SLAB	Residential		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	1.0	9.8	31.1	37.7	41.4	44.6	50.0	62.3	67.0	69.4	69.8	74.9	80.7	81.4	81.5	81.5	82.0	82.0	82.0
			Lower %	0.0	0.0	2.8	11.1	28.5	30.9	32.3	41.7	54.5	55.1	56.0	59.0	66.3	70.6	70.6	70.6	70.6	70.6	70.6	70.6
			Upper %	0.0	6.0	41.4	46.6	50.9	50.9	55.8	58.1	77.1	77.1	81.5	81.5	90.3	93.9	97.4	97.4	97.4	97.4	97.4	97.4
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	0.0	35.0	46.8	48.4	50.3	56.7	67.5	76.3	80.9	88.1	88.4	89.1	89.1	89.1	89.1	89.1	89.1	89.1
			Lower %	0.0	0.0	0.0	27.5	39.9	45.2	48.0	53.0	65.6	74.1	78.5	85.5	85.7	86.4	86.5	86.5	86.5	86.5	86.5	86.5
			Upper %	0.0	0.0	0.0	38.6	50.9	51.2	54.9	59.1	69.5	80.6	85.4	92.9	93.2	93.9	94.0	94.0	94.0	94.0	94.0	94.0
2STY-PIER	Residential		Stage	-1.1	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
		Structure	Mean %	0.0	1.5	2.4	8.3	23.1	28.7	31.5	34.2	35.8	43.3	46.5	47.4	47.7	50.1	63.6	65.6	67.0	69.3	72.1	73.3
			Lower %	0.0	0.0	0.4	0.4	10.8	20.5	27.7	28.0	28.2	32.0	37.8	40.1	40.1	40.1	52.5	56.7	59.5	60.4	63.3	65.0
			Upper %	0.0	3.4	5.6	31.6	36.3	37.6	37.8	47.0	47.3	58.7	58.7	59.3	59.3	61.2	75.7	76.9	80.7	80.8	85.6	91.9
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.7	21.3	24.8	30.7	34.6	37.7	45.6	50.5	56.7	60.6	61.6	62.3	68.1	68.1	72.0	74.0	75.8	77.0	77.2
			Lower %	0.0	0.0	19.6	22.9	29.7	33.5	36.5	44.2	49.0	54.0	58.7	59.7	60.4	66.0	66.0	69.7	71.7	73.4	74.6	74.8
			Upper %	0.0	1.5	22.1	25.8	31.6	35.6	38.8	46.9	53.9	59.3	64.7	65.7	66.4	72.7	72.7	76.7	78.9	80.8	82.1	82.3
2STY-SLAB	Residential		Stage	-1.1	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
		Structure	Mean %	0.0	0.0	0.0	5.9	19.1	25.3	26.0	30.1	32.1	43.0	46.9	47.5	47.6	52.0	61.9	64.3	65.7	67.6	69.6	69.6
			Lower %	0.0	0.0	0.0	0.0	5.8	17.2	18.1	22.6	25.4	26.6	37.0	37.0	37.0	40.4	55.0	57.6	57.6	60.0	60.4	60.4
			Upper %	0.0	0.0	0.0	34.0	38.3	40.5	40.8	48.3	48.3	65.2	65.2	67.3	67.3	73.0	74.1	75.2	75.2	75.2	75.2	75.2
			Stage	-1.0	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
		Contents	Mean %	0.0	0.0	0.7	21.3	24.8	30.7	34.6	37.7	45.6	50.5	56.7	60.6	61.6	62.3	68.1	68.1	72.0	74.0	75.8	77.0
			Lower %	0.0	0.0	0.0	19.6	22.9	29.7	33.5	36.5	44.2	49.0	54.0	58.7	59.7	60.4	66.0	66.0	69.7	71.7	73.4	74.6
			Upper %	0.0	0.0	1.5	22.1	25.8	31.6	35.6	38.8	46.9	53.9	59.3	64.7	65.7	66.4	72.7	72.7	76.7	78.9	80.8	82.1
AUTO	AUTO		Stage	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
		Structure	Mean %	0.0	0.0	8.0	19.0	27.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Lower %	0.0	0.0	4.0	13.0	18.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Upper %	0.0	0.0	10.0	20.0	30.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 51 (cont)
Donaldsonville to the Gulf, LA Depth-Damage Relationships for Structures, Contents and Vehicles
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Occupancy Type	Category Name	Damage Type	Parameter																				
EAT	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.6	0.6	14.3	18.6	21.4	23.5	26.2	30.9	31.3	33.0	34.6	43.6	51.0	54.1	56.8	60.1	60.4	61.6	61.8
			Lower %	0.0	0.0	0.0	4.0	13.3	15.7	16.1	20.2	23.6	24.0	24.0	24.0	32.6	39.1	46.3	46.9	49.8	50.1	51.4	51.4
			Upper %	0.0	1.5	1.6	21.8	23.0	31.7	33.4	35.2	39.5	39.5	49.3	54.8	61.5	68.0	68.0	68.7	69.9	69.9	70.9	70.9
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	0.0	31.2	34.3	60.3	65.0	84.0	91.0	93.4	93.4	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1
			Lower %	0.0	0.0	0.0	28.1	30.9	54.2	58.5	75.6	81.9	84.1	84.1	86.5	86.5	86.5	86.5	86.5	86.5	86.5	86.5	86.5
			Upper %	0.0	0.0	0.0	39.0	42.9	75.4	81.2	89.9	95.8	97.8	97.8	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3
GROC	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.6	0.6	14.3	18.6	21.4	23.5	26.2	30.9	31.3	33.0	34.6	43.6	51.0	54.1	56.8	60.1	60.4	61.6	61.8
			Lower %	0.0	0.0	0.0	4.0	13.3	15.7	16.1	20.2	23.6	24.0	24.0	24.0	32.6	39.1	46.3	46.9	49.8	50.1	51.4	51.4
			Upper %	0.0	1.5	1.6	21.8	23.0	31.7	33.4	35.2	39.5	39.5	49.3	54.8	61.5	68.0	68.0	68.7	69.9	69.9	70.9	70.9
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	85.7	87.3	87.5	88.1	89.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Lower %	0.0	0.0	71.2	78.6	78.7	79.3	80.7	58.9	89.9	89.9	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
			Upper %	0.0	0.0	92.7	94.9	95.7	96.1	97.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MOBHOM	MOBHOME		Stage	-1.1	-1.0	-0.5	0.0	0.5	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	10.3	12.3	34.5	62.3	64.1	68.9	71.6	74.7	79.8	80.4	81.7	94.0	94.3	95.4	95.4	95.4	95.4	95.4	95.4
			Lower %	0.0	0.0	0.0	9.6	41.1	47.0	53.3	56.9	58.5	71.0	71.0	71.0	80.9	84.6	84.6	84.6	84.6	84.6	84.6	84.6
			Upper %	0.0	15.4	19.1	55.2	68.2	69.9	74.7	77.8	83.9	84.6	84.6	88.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	0.0	0.1	15.0	30.1	45.6	58.8	69.2	78.3	82.4	84.3	84.4	84.4	84.4	84.4	84.4	84.4	84.4	84.4
			Lower %	0.0	0.0	0.0	0.0	14.5	29.1	44.2	57.0	67.1	75.9	79.8	81.7	81.7	81.7	81.7	81.7	81.7	81.7	81.7	81.7
			Upper %	0.0	0.0	0.0	0.1	15.4	30.9	46.9	62.8	73.9	83.6	87.9	89.9	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
MULT	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	0.0	28.1	32.8	35.2	37.9	39.7	47.2	49.7	52.0	54.6	61.7	64.9	67.8	68.0	70.3	70.4	70.6	70.9
			Lower %	0.0	0.0	0.0	9.2	22.6	28.2	29.1	30.4	43.4	43.7	47.2	47.9	53.3	53.3	60.2	60.3	64.5	64.5	64.5	64.5
			Upper %	0.0	0.0	0.0	38.5	45.7	49.9	51.9	52.6	54.0	58.9	59.1	71.6	78.1	78.3	78.6	78.8	79.0	79.2	79.5	79.7
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	0.0	15.2	19.9	22.4	27.7	44.5	48.9	48.9	48.9	48.9	48.9	48.9	64.1	71.3	93.4	97.8	97.8	97.8
			Lower %	0.0	0.0	0.0	12.0	17.0	21.0	28.4	41.6	47.5	47.5	47.5	47.5	47.5	47.5	50.5	66.6	87.4	95.1	95.1	95.1
			Upper %	0.0	0.0	0.0	16.9	21.8	23.6	30.2	46.0	50.1	50.2	51.6	51.6	51.6	51.6	70.9	75.0	96.5	100.0	100.0	100.0
PROF	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	4.1	16.6	18.9	21.2	24.5	27.1	35.4	36.3	36.9	38.0	41.9	51.4	52.9	54.2	54.7	54.8	55.4	55.5
			Lower %	0.0	0.0	0.2	5.3	11.1	15.3	18.7	22.7	27.4	28.0	28.0	28.0	40.1	40.3	46.3	46.3	46.3	46.3	46.3	46.3
			Upper %	0.0	0.0	23.1	25.2	26.2	26.2	36.2	36.6	53.9	53.9	54.4	56.5	65.9	65.9	65.9	65.9	66.3	66.3	69.4	69.4
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	0.0	26.0	31.2	34.8	38.2	67.6	86.9	86.9	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0
			Lower %	0.0	0.0	0.0	23.4	28.0	31.3	34.4	60.9	78.3	78.3	89.2	89.2	89.2	89.2	89.2	89.2	89.2	89.2	89.2	89.2
			Upper %	0.0	0.0	0.0	32.5	38.9	43.4	47.7	84.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 51 (cont)
Donaldsonville to the Gulf, LA Depth-Damage Relationships for Structures, Contents and Vehicles
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

PUBL	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.6	0.6	14.3	18.6	21.4	23.5	26.2	30.9	31.3	33.0	34.6	43.6	51.0	54.1	56.8	60.1	60.4	61.6	61.8
			Lower %	0.0	0.0	0.0	4.0	13.3	15.7	16.1	20.2	23.6	24.0	24.0	24.0	32.6	39.1	46.3	46.9	49.8	50.1	51.4	51.4
			Upper %	0.0	1.5	1.6	21.8	23.0	31.7	33.4	35.2	39.5	39.5	49.3	54.8	61.5	68.0	68.0	68.7	69.9	69.9	70.9	70.9
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	0.0	8.6	11.7	13.6	16.6	90.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
			Lower %	0.0	0.0	0.0	6.5	8.8	10.2	12.4	67.6	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
			Upper %	0.0	0.0	0.0	9.5	12.8	15.0	18.2	92.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
REPA	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	0.0	28.1	32.8	35.2	37.9	39.7	47.2	49.7	52.0	54.6	61.7	64.9	67.8	68.0	70.3	70.4	70.6	70.9
			Lower %	0.0	0.0	0.0	9.2	22.6	28.2	29.1	30.4	43.4	43.7	47.2	47.9	53.3	53.3	60.2	60.3	64.5	64.5	64.5	64.5
			Upper %	0.0	0.0	0.0	38.5	45.7	49.9	51.9	52.6	54.0	58.9	59.1	71.6	78.1	78.3	78.6	78.8	79.0	79.2	79.5	79.7
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	0.0	32.9	33.7	33.7	63.9	66.0	68.0	73.0	76.4	76.4	76.4	76.4	76.4	76.4	76.4	76.4	76.4	76.4
			Lower %	0.0	0.0	0.0	29.7	30.3	30.3	57.5	59.4	61.2	65.8	68.7	68.7	68.7	68.7	68.7	68.7	68.7	68.7	68.7	68.7
			Upper %	0.0	0.0	0.0	41.2	42.1	42.1	79.8	82.5	85.0	91.3	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5
RETA	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.6	0.6	14.3	18.6	21.4	23.5	26.2	30.9	31.3	33.0	34.6	43.6	51.0	54.1	56.8	60.1	60.4	61.6	61.8
			Lower %	0.0	0.0	0.0	4.0	13.3	15.7	16.1	20.2	23.6	24.0	24.0	24.0	32.6	39.1	46.3	46.9	49.8	50.1	51.4	51.4
			Upper %	0.0	1.5	1.6	21.8	23.0	31.7	33.4	35.2	39.5	39.5	49.3	54.8	61.5	68.0	68.0	68.7	69.9	69.9	70.9	70.9
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	0.0	55.0	66.0	77.0	88.0	89.9	91.9	93.8	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6
			Lower %	0.0	0.0	0.0	49.4	59.4	69.1	79.2	81.0	82.6	84.4	89.7	89.7	89.7	89.7	89.8	89.8	89.8	89.8	89.8	89.8
			Upper %	0.0	0.0	0.0	63.1	75.8	88.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
WARE	COM		Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Structure	Mean %	0.0	0.0	0.0	28.1	32.8	35.2	37.9	39.7	47.2	49.7	52.0	54.6	61.7	64.9	67.8	68.0	70.3	70.4	70.6	70.9
			Lower %	0.0	0.0	0.0	9.2	22.6	28.2	29.1	30.4	43.4	43.7	47.2	47.9	53.3	53.3	60.2	60.3	64.5	64.5	64.5	64.5
			Upper %	0.0	0.0	0.0	38.5	45.7	49.9	51.9	52.6	54.0	58.9	59.1	71.6	78.1	78.3	78.6	78.8	79.0	79.2	79.5	79.7
			Stage	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
		Contents	Mean %	0.0	0.0	0.0	15.6	19.4	19.4	26.8	34.1	41.6	49.0	56.5	63.9	71.4	75.2	75.2	75.2	75.2	75.2	75.2	75.2
			Lower %	0.0	0.0	0.0	14.1	17.5	17.5	24.1	30.6	37.4	44.1	50.9	57.6	64.2	67.6	67.6	67.6	67.6	67.6	67.6	67.6
			Upper %	0.0	0.0	0.0	19.6	24.4	24.4	33.5	42.7	51.9	61.2	70.6	79.9	89.1	93.9	93.9	93.9	93.9	93.9	93.9	93.9

Source: *Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVRs) in Support of the Donaldsonville to the Gulf, Louisiana, Feasibility Study Final Report dated March 2006*
Note: Long duration, saltwater depth-damage relationships were used for the sensitivity analysis

Table 52

3% Annual Exceedance Probability Alternative Using Donaldsonville to the Gulf Depth-Damage Relationships

(2011 Price Level; 3.75% Discount Rate)

Total Equivalent Annual Net Benefits

Sensitivity Analysis

Morganza to the Gulf

Post-Authorization Change Report

($ Millions)

Item	Equiv Annual W/O Project Damages (2035-2084)	Equiv Annual With-Project Damages (2035-2084)	Equiv Annual Benefits (2035-2084)	Equiv Annual Benefits During Construction (2024-2034)	Total Equiv Annual Benefits	
Damage Category						
Residential & Commercial - Structure/Content/Vehicles	$ 615.2	$ 319.0	$ 296.3	$ 126.4	$ 422.6	
Industrial - Structure/Contents	$ 16.5	$ 6.4	$ 10.1	$ 4.4	$ 14.5	
Highways	$ 6.6	$ 4.2	$ 2.3	$ 1.1	$ 3.4	
Streets	$ 15.5	$ 5.6	$ 9.9	$ 3.7	$ 13.6	
Debris Removal & Cleanup	$ 25.7	$ 12.6	$ 13.1	$ 5.9	$ 19.0	
Water Supply	$ 0.1	$ 0.1	$ 0.1	$ 0.1	$ 0.2	
Boat Fleets	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	
Avoided Structure-Raising Costs	$ 4.9	$ -	$ 4.9	$ 5.3	$ 10.3	
Total	$ 684.6	$ 347.9	$ 336.7	$ 146.8	$ 483.6	
First Costs						$ 5,902
Interest During Construction						$ 3,937
Annual Operation & Maintenance Costs						$ 6
Total Annual Costs						$ 438
B/C Ratio						1.10
Equivalent Annual Net Benefits - 2035 Base Year						$ 45

Table 53
1% Annual Exceedance Probability Alternative Using Donaldsonville to the Gulf Depth-Damage Relationships
(2011 Price Level; 3.75% Discount Rate)
Total Equivalent Annual Net Benefits
Sensitivity Analysis
Morganza to the Gulf
Post-Authorization Change Report
($ Millions)

Item	Equiv Annual W/O Project Damages (2035-2084)	Equiv Annual With-Project Damages (2035-2084)	Equiv Annual Benefits (2035-2084)	Equiv Annual Benefits During Construction (2024-2034)	Total Equiv Annual Benefits	
Damage Category						
Residential & Commercial - Structure/Content/Vehicles	$ 615.2	$ 98.5	$ 516.7	$ 166.1	$ 682.8	
Industrial - Structure/Contents	$ 16.5	$ 1.3	$ 15.2	$ 5.1	$ 20.3	
Highways	$ 6.6	$ 2.3	$ 4.3	$ 1.5	$ 5.7	
Streets	$ 15.5	$ 2.3	$ 13.3	$ 4.2	$ 17.4	
Debris Removal & Cleanup	$ 25.7	$ 4.0	$ 21.7	$ 7.3	$ 29.0	
Water Supply	$ 0.1	$ 0.1	$ 0.1	$ 0.1	$ 0.2	
Boat Fleets	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	
Avoided Structure-Raising Costs	$ 4.9	$ -	$ 4.9	$ 5.3	$ 10.3	
Total	$ 684.6	$ 108.4	$ 576.2	$ 189.6	$ 765.8	
First Costs						$ 10,177
Interest During Construction						$ 5,864
Annual Operation & Maintenance Costs						$ 7
Total Annual Costs						$ 710
B/C Ratio						1.08
Equivalent Annual Net Benefits Base Year 2035						$ 55

Table 54
3% Annual Exceedance Probability Alternative
(2012 Price Level; 3.75% Discount Rate)
Total Equivalent Annual Net Benefits
Morganza to the Gulf
Post-Authorization Change Report
($ Millions)

Item	Equiv Annual W/O Project Damages (2035-2084)	Equiv Annual With-Project Damages (2035-2084)	Equiv Annual Benefits (2035-2084)	Equiv Annual Benefits During Construction (2024-2034)	Total Equiv Annual Benefits	
Damage Category						
Residential & Commercial - Structure/Content/Vehicles	$ 761.4	$ 387.0	$ 374.3	$ 160.0	$ 534.4	
Industrial - Structure/Contents	$ 16.8	$ 6.5	$ 10.3	$ 4.5	$ 14.8	
Highways	$ 6.9	$ 4.5	$ 2.5	$ 1.1	$ 3.6	
Streets	$ 16.5	$ 6.0	$ 10.5	$ 3.9	$ 14.4	
Debris Removal & Cleanup	$ 26.2	$ 12.8	$ 13.3	$ 6.0	$ 19.3	
Water Supply	$ 0.1	$ 0.1	$ 0.1	$ 0.1	$ 0.2	
Boat Fleets	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	
Avoided Structure-Raising Costs	$ 5.0	$ -	$ 5.0	$ 5.4	$ 10.4	
Total	$ 832.9	$ 416.8	$ 416.1	$ 181.0	$ 597.1	
First Costs						$ 5,961
Interest During Construction						$ 3,976
Annual Operation & Maintenance Costs						$ 6
Total Annual Costs						$ 443
B/C Ratio						1.35
Equivalent Annual Net Benefits - 2035 Base Year						$ 154

Note: The following indexes were used to update the benefit categories and cost values from 2011 to 2012: the Construction Index developed by the Bureau of Labor Statistics was used for residential and non-residential benefit categories, including the industrial benefit category, and the avoided structure-raising costs category; the National Highway Construction Cost Index was used for the highway and streets benefit categories; the Remediation Services Index developed by the Bureau of Labor Statistics was used for the debris removal and cleanup benefit category; the Diesel Fuel Price Index developed by the Energy Information Administration was used for boat fleets benefit category, and the Composite Civil Works Construction Cost Index System was used for the project costs.

Table 55
1% Annual Exceedance Probability Alternative
(2012 Price Level; 3.75% Discount Rate)
Total Equivalent Annual Net Benefits
Morganza to the Gulf
Post-Authorization Change Report
($ Millions)

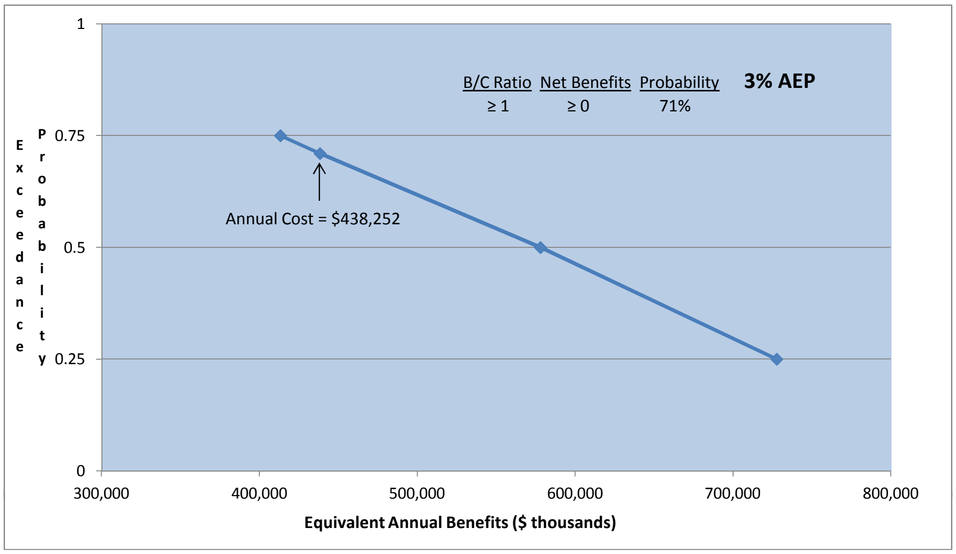
Item	Equiv Annual W/O Project Damages (2035-2084)	Equiv Annual With-Project Damages (2035-2084)	Equiv Annual Benefits (2035-2084)	Equiv Annual Benefits During Construction (2024-2034)	Total Equiv Annual Benefits	
Damage Category						
Residential & Commercial - Structure/Content/Vehicles	$ 761.4	$ 115.9	$ 645.4	$ 211.0	$ 856.4	
Industrial - Structure/Contents	$ 16.8	$ 1.3	$ 15.5	$ 5.2	$ 20.7	
Highways	$ 6.9	$ 2.4	$ 4.5	$ 1.6	$ 6.1	
Streets	$ 16.5	$ 2.4	$ 14.1	$ 4.4	$ 18.5	
Debris Removal & Cleanup	$ 26.2	$ 4.1	$ 22.1	$ 7.4	$ 29.5	
Water Supply	$ 0.1	$ 0.1	$ 0.1	$ 0.1	$ 0.2	
Boat Fleets	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	
Avoided Structure-Raising Costs	$ 5.0	$ -	$ 5.0	$ 5.4	$ 10.4	
Total	$ 832.9	$ 126.2	$ 706.7	$ 235.1	$ 941.8	
First Costs						$ 10,279
Interest During Construction						$ 5,922
Annual Operation & Maintenance Costs						$ 7
Total Annual Costs						$ 717
B/C Ratio						1.31
Equivalent Annual Net Benefits Base Year 2035						$ 224

Note: The following indexes were used to update the benefit categories and cost values from 2011 to 2012: the Construction Index developed by the Bureau of Labor Statistics was used for residential and non-residential benefit categories, including the industrial benefit category, and the avoided structure-raising costs category; the National Highway Construction Cost Index was used for the highway and streets benefit categories; the Remediation Services Index developed by the Bureau of Labor Statistics was used for the debris removal and cleanup benefit category; the Diesel Fuel Price Index developed by the Energy Information Administration was used for boat fleets benefit category, and the Composite Civil Works Construction Cost Index System was used for the project costs.

Table 56
Equivalent Annual Damages and Benefits (1000's)
(2024-2085)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

	Equivalent Annual Damage			Probability Damage Reduced Exceeds Indicated Values (Forecasted)					
Plan Name	Total Without Project	Total With Project	Damages Reduced	1.00	0.75	0.71	0.69	0.50	0.25
Alt 3%	$ 1,167,498	581,641	585,856	$ 257,130	$ 413,212	$ 438,252	$ 451,556	$ 577,946	$ 727,617
Alt 1%	$ 1,167,498	$ 243,226	$ 924,272	$ 291,970	$ 623,134	$ 681,273	$ 710,342	$ 970,405	$ 1,288,282

Notes 1: A trend function was applied to estimate the forecasted damaged reduced values above 0.75.
2: Highlighted values represent the equivalent annual cost (1,000s) of each alternative.
3: The 3% AEP has a 71 percent chance of having postivite net benefits.
4: The 1% AEP has a 69 percent chance of having postivite net benefits.



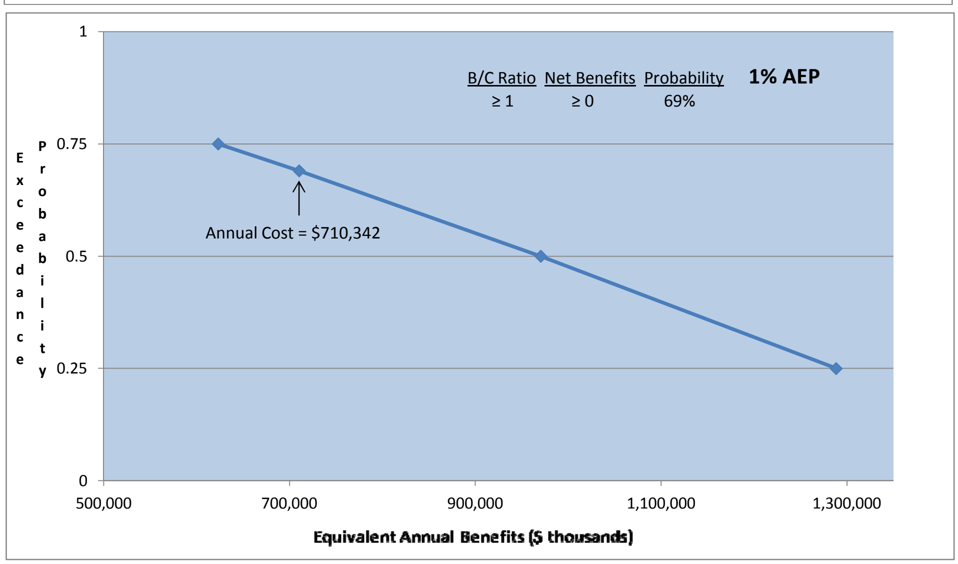


Table 57
Residual Risk for Total Study Area in 2035
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

ACE	Without Project: Number of Structures Damaged assuming Non-Federal Levees Fail (No Autos)	Without Project: Damages assuming Non-Federal Levees Fail ($1,000s)	3% Alt: Residual Damages assuming Federal Levees do not Fail ($1,000s)	1% Alt: Residual Damages assuming Federal Levees do not Fail ($1,000s)
0.99	260	$ 15,434	$ -	$ -
0.20	1,120	$ 31,139	$ -	$ -
0.10	5,585	$ 261,238	$ -	$ -
0.04	34,943	$ 4,255,591	$ -	$ -
0.02	48,362	$ 9,749,459	$ 11,821,867	$ -
0.01	58,836	$ 12,055,838	$ 14,569,446	$ -
0.005	61,166	$ 14,678,678	$ 15,586,386	$ 15,586,386
0.002	61,387	$ 15,774,471	$ 15,832,630	$ 15,832,630

Note: It should be noted that the residual risk will be higher with the project alternatives in place relative to the without-project conditions since structures below the 10% ACE (10-year) event are elevated above the 1% ACE (100-year) event to account for the response of residents to repetitive flood loss. Also, the residual damages under with-project conditions are higher since the structure detail output file produced by the HEC-FDA model uses the exterior water surface profiles to the Federal levee to show damages under with-project conditions and interior water surface profiles to the non-Federal levee to show damages under without project conditions.

Source: HEC-FDA model Structure Detail output file for the year 2035.

Table 58
Total Study Area Depth of Flooding for the 1% ACE (100-year) Event in 2035
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Depth of Flooding in Feet	*Number of Structures**	*Percentage by Bin*
0	11,679	19.00%
3	7,384	12.02%
6	21,980	35.77%
9	18,396	29.94%
12	1,827	2.97%
>12	187	0.30%
Total Number of Structures		61,453
Total Number of Structures that have a depth of flooding >0		49,773

* No Automobiles

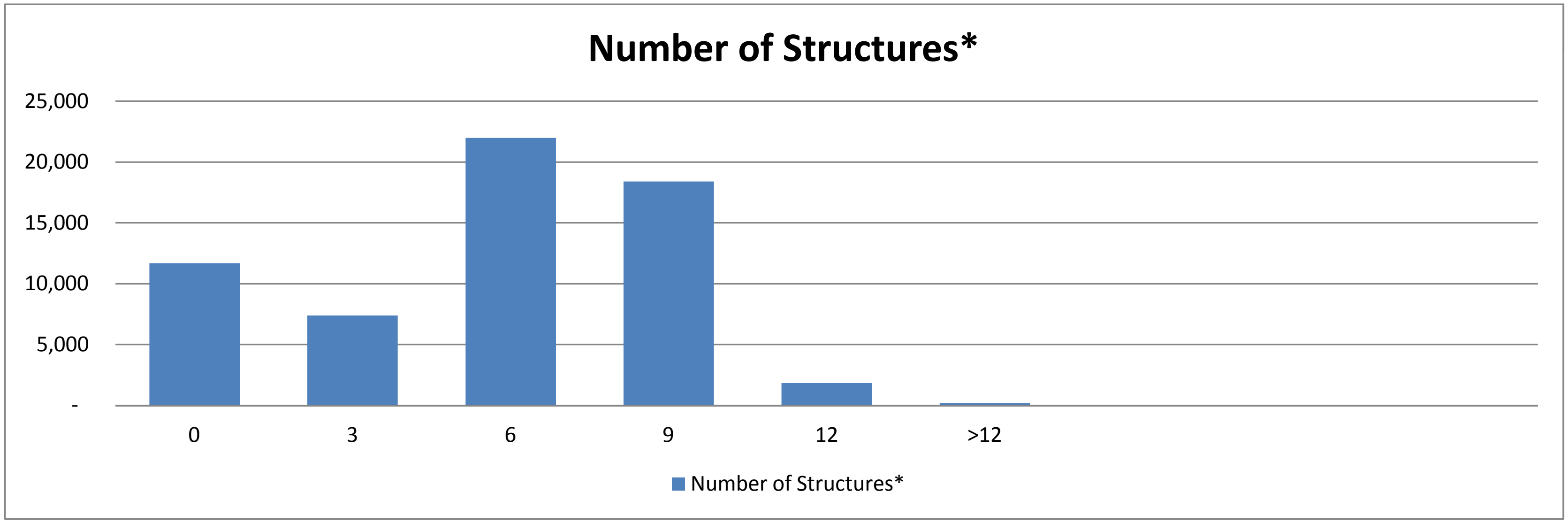


Table 59
Levee Performance Annual Exceedance Probability
(2010-2085)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Study Area Reach 11BW79 Station 64												
2010												
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
Without	Levee	0.1068	0.1054	0.6719	0.9647	0.9962	0.8864	0.2528	0.0864	0.0441	0.0233	0.0153
2024												
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
Without	Levee	0.1147	0.1136	0.7005	0.9731	0.9976	0.8423	0.2053	0.0637	0.0292	0.0150	0.0098
3%	9.4	0.0254	0.0271	0.2399	0.5609	0.7463	0.9998	0.7857	0.3715	0.1786	0.0953	0.0509
1%	13.6	0.0072	0.0104	0.0997	0.2702	0.4084	0.9998	0.9915	0.8250	0.5631	0.3645	0.2204
2035												
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
Without	Levee	0.1196	0.1190	0.7184	0.9579	0.9982	0.7955	0.1743	0.0492	0.0206	0.0106	0.0066
3%	10.5	0.0237	0.0256	0.2287	0.4776	0.7269	0.9997	0.7959	0.4132	0.2097	0.1107	0.0628
1%	15.9	0.0040	0.0072	0.0697	0.1654	0.3034	0.9997	0.9976	0.9156	0.7153	0.4977	0.3305
2085												
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
Without	Levee	0.2231	0.2193	0.9159	0.9994	1.0000	0.3740	0.0564	0.0195	0.0104	0.0054	0.0042
3%	11.2	0.0307	0.0330	0.2849	0.6343	0.8130	0.9994	0.6656	0.2913	0.1279	0.0546	0.0310
1%	18.3	0.0033	0.0052	0.0505	0.1441	0.2284	0.9998	0.9998	0.9764	0.8291	0.5569	0.3822

Note: Non-Federal Levee has 7 foot top of levee elevation under without-project conditions.

Table 59 (Cont.)
Levee Performance Annual Exceedance Probability
(2010-2085)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Study Area Reach 11BW5 Station 58													
2010													
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events						
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
Without	Levee	0.0663	0.0683	0.5072	0.8803	0.9709	0.8226	0.2587	0.0509	0.0245	0.0129	0.0084
2024													
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events						
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
Without	Levee	0.0842	0.0827	0.5782	0.9249	0.9866	0.7681	0.1777	0.0423	0.0191	0.0096	0.0060
3%	9.4	0.0253	0.0269	0.2389	0.5591	0.7446	0.9997	0.7993	0.3681	0.1727	0.0890	0.0455
1%	13.6	0.0072	0.0103	0.0987	0.2679	0.4053	0.9997	0.9930	0.8309	0.5654	0.3608	0.2132
2035													
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events						
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
Without	Levee	0.1191	0.1200	0.7214	0.9590	0.9983	0.7131	0.1369	0.0351	0.0137	0.0067	0.0039
3%	10.5	0.0237	0.0256	0.2286	0.4774	0.7269	0.9997	0.7959	0.4132	0.2097	0.1107	0.0628
1%	15.9	0.0040	0.0072	0.0696	0.1650	0.3029	0.9997	0.9976	0.9156	0.7153	0.4977	0.3305
2085													
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events						
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
Without	Levee	0.3564	0.3460	0.9857	1.0000	1.0000	0.2489	0.0384	0.0128	0.0062	0.0029	0.0031
3%	11.2	0.0307	0.0327	0.2832	0.6317	0.8108	0.9993	0.6693	0.2954	0.1304	0.0566	0.0327
1%	18.3	0.0033	0.0052	0.0505	0.1441	0.2284	0.9998	0.9998	0.9764	0.8291	0.5569	0.3822

Note: Non-Federal Levee has 5.5 foot top of levee elevation under without-project conditions.

Table 59 (Cont.)
Levee Performance Annual Exceedance Probability
(2010-2085)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Study Area Reach 1-5 Station 82													
2010													
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events						
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020	
Without	Levee	0.1863	0.1786	0.8602	0.9973	0.9999	0.3185	0.0524	0.0145	0.0089	0.0051	0.0036	
2024													
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events						
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020	
Without	Levee	0.4063	0.3854	0.9923	1.0000	1.0000	0.1626	0.0259	0.0106	0.0054	0.0028	0.0020	
3%	14.8	0.0159	0.0184	0.1693	0.2890	0.4336	0.9997	0.9851	0.8042	0.5544	0.3133	0.1978	
1%	17.2	0.0026	0.0048	0.0467	0.1336	0.2126	0.9998	0.9997	0.9712	0.8476	0.6097	0.4355	
2035													
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events						
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020	
Without	Levee	0.7554	0.7538	1.0000	1.0000	1.0000	0.0025	0.0052	0.0007	0.0027	0.0014	0.0001	
3%	16.2	0.0074	0.0101	0.9690	0.2250	0.3993	0.9997	0.9919	0.8486	0.5902	0.3356	0.2126	
1%	20.5	0.0015	0.0031	0.0302	0.0737	0.1419	0.9998	0.9998	0.9941	0.9310	0.7404	0.5635	
2085													
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events						
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020	
Without	Levee	0.0904	0.0939	0.6270	0.9481	0.9928	0.6308	0.1048	0.0340	0.0166	0.0092	0.0059	
3%	15.8	0.0159	0.0184	0.1693	0.4267	0.6044	0.9996	0.9277	0.6095	0.3093	0.1442	0.0843	
1%	21.8	0.0023	0.0040	0.0394	0.1136	0.1820	0.9998	0.9997	0.9909	0.8875	0.6450	0.4635	

Note: Non-Federal Levee has 3.0 foot top of levee elevation under without-project conditions.

Table 59 (Cont.)
Levee Performance Annual Exceedance Probability
(2010-2085)
Morganza to the Gulf of Mexico, LA
Post-Authorization Change Report

Study Area Reach BL89 Station 298												
2010												
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
Without	Levee	0.0529	0.0545	0.4289	0.8137	0.9392	0.9978	0.1924	0.0384	0.0107	0.0000	0.0000
2024												
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
Without	Levee	0.0691	0.0717	0.5247	0.8926	0.9757	0.8180	0.1383	0.0415	0.0177	0.0060	0.0027
3%	14.7	0.0111	0.0135	0.1270	0.3347	0.4929	0.9997	0.9778	0.7508	0.4534	0.2328	0.1417
1%	17.3	0.0050	0.0074	0.0714	0.1992	0.3095	0.9997	0.9989	0.9330	0.7091	0.4313	0.2776
2035												
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
Without	Levee	0.0899	0.0866	0.5956	0.8960	0.9892	0.5336	0.2005	0.0509	0.0111	0.0017	0.0000
3%	15.1	0.0130	0.0154	0.1436	0.3213	0.5394	0.9996	0.9623	0.6913	0.3948	0.2002	0.1234
1%	20.3	0.0027	0.0046	0.0453	0.1094	0.2068	0.9997	0.9997	0.9821	0.8542	0.6016	0.4254
2085												
Plan Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
		Median	Expected	10	30	50	0.1000	0.0400	0.0200	0.0100	0.0040	0.0020
Without	Levee	0.2475	0.2358	0.9324	0.9997	1.0000	0.1590	0.0275	0.0027	0.0000	0.0000	0.0000
3%	14.4	0.0250	0.0272	0.2411	0.5630	0.7483	0.9996	0.7727	0.3886	0.1808	0.0857	0.0529
1%	21.8	0.0031	0.0052	0.0509	0.1450	0.2298	0.9998	0.9997	0.9738	0.8181	0.5638	0.4026

Note: Non-Federal Levee has 5.0 foot top of levee elevation under without-project conditions.

Regional Economic Development Appendix
Morganza to the Gulf of Mexico, La

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Definitions

Gross Regional Product: total economic activity in the study area during the model year as measured by either production value of final goods and services (final demand) or income generation to factors of production (value added).

Employment: average annual jobs, both full and part time, not full time equivalents.

Labor Income: all forms of employment income, including employee compensation (wages and benefits) and proprietor income.

Output: represents the value of industry production, includes both value added and intermediate goods purchased in the economy.

Direct Effects: the response (change in employment, income, output, or gross regional product) for a given industry to a change in its final demand.

Indirect Effects: the impacts caused by industries purchasing from other industries in response to final demand changes, a multiplier effect.

Induced Effects: the impacts on all local industries caused by the expenditures of new household income generated by the direct and indirect effects of final demand changes, a multiplier effect.

Background:

The Morganza to the Gulf of Mexico hurricane risk reduction system is located in the parishes of Terrebonne and Lafourche. The project is being constructed in response to reoccurring hurricane storm damage and is designed to prevent the loss of life, to reduce flood damages, to reduce negative impacts on navigation, and to prevent the destruction of wetlands. This flood risk reduction system would encompass an estimated 120,000 people.

Construction Alternatives:

For this analysis two construction alternatives are being examined: One alternative has a levee height that reduces flood risk up to the 1% annual exceedance probability (AEP) flood event; the other alternative has a levee height that reduces flood risk up to the 3% AEP flood event. This 3% AEP alternative was originally the 1% AEP alternative according to the pre-Katrina requirements for levee construction.

Study Area

The study area of Morganza to the Gulf consists of 20 parishes that were selected by the RECONS project team based on the labor market, commuter-shed, and population centers serving the project location (see table 1). According to RECONS' 2009 data, the population of the study area is 2,199,734. The number of households is 816,005. Total personal income is $90,517,000,000. The employment rate in the study area is 91%. The other region identified is the rest of Louisiana and consists of every other parish except for the ones in the study area.[1]

Methodology:

This Regional Economic Development (RED) analysis employs input-output economic analysis, which measures the interdependence among industries and workers in an economy. This analysis uses a matrix representation of a region's economy to predict the effect of changes in one industry on others. The greater the interdependence among industry sectors, the larger the multiplier effect on the economy. Changes to government spending drive the input-output model to project new levels of sales (output), value added (GRP), employment, and income for each industry.

The specific input-output model used in this analysis is RECONS (Regional Economic System). This model was developed by the Institute for Water Resources (IWR), Michigan State University, and the Louis Berger Group. RECONS uses industry multipliers derived from the commercial input-output model IMPLAN to estimate the effects that spending on USACE projects has on a regional economy. The model is linear and static, showing relationships and impacts at a certain fixed point in time. Spending impacts are composed of three different effects: direct, indirect, and induced.

Direct effects represent the impacts the new federal expenditures have on industries which directly support the new project. Labor and construction materials can be considered direct components

[1] These metrics are current as of 2009, the year of the data used in the model.

to the project. Indirect effects represent changes to secondary industries that support the direct industries. Induced effects are changes in consumer spending patterns caused by the change in employment and income within the industries affected by the direct and induced effects. The additional income workers receive via a project may be spent on clothing, groceries, dining out, and other items in the regional area.

The inputs for the RECONS model are expenditures that are entered by work activity or industry sector, each with its own unique production function.   For construction, the following work activities were identified: construction and major repairs of floodwalls, construction and major repair of earthen levees, construction activities for ecosystem and habitat restoration, lock or dam gate fabrication and installation, and lock construction of on-site features. For preconstruction, engineering, and design (PE&D), sector 369 engineering services was selected. For Supervision and administration (S&A), sector 386, business support services was selected. For pipeline relocation, sector 39 repair and maintenance construction activities was selected. And for environmental mitigation, the work activity remediation activities and services was selected.[2] The baseline data used by RECONS to represent the regional economy of Louisiana are annual averages from the Bureau of the Census, the Bureau of Labor Statistics, and the Bureau of Economic Analysis for the year 2009. The model results are expressed in 2011 dollars.

Assumptions

Input-output analysis rests on the following assumptions. The production functions of industries have constant returns to scale, so if output is to increase, inputs will increase in the same proportion. Industries face no supply constraints; they have access to all the materials they can use. Industries have a fixed commodity input structure; they will not substitute any commodities or services used in the production of output in response to price changes. Industries produce their commodities in fixed proportions, so an industry will not increase production of a commodity without increasing production in every other commodity it produces. Furthermore, it is assumed that industries use the same technology to produce all of its commodities. Finally, since the model is static, it is assumed that the economic conditions of 2009, the year of the socio-economic data in the RECONS model database, will prevail during the years of the construction process.

Column Descriptions for Tables 1 and 2

"Total Construction Stimulus" is the sum of all inputs including construction, preconstruction, engineering, and design (PED), supervision and administration (S&A), utility relocation, and environmental mitigation. "Output" is the sum total of transactions that take place as a result of the construction project, including both value added and intermediate goods purchased in the economy. "Labor Income" includes all forms of employment income, including employee compensation (wages and benefits) and proprietor income. "Gross Regional Product (GRP)" is the value-added output of the study regions. This metric captures all final goods and services produced in the study areas because of

[2] Real Estate transactions are considered a transfer of an asset resulting in no multiplier effects, and, therefore, are not included in this RED analysis.

the project's existence. It is different from output in the sense that one dollar of a final good or service may have multiple transactions associated with it. "Employment" is the estimated worker-years of labor required to build the project.

Results

For the 3% AEP alternative, the construction stimulus of $5,897,000,000 would generate 85,000 worker-years of labor, $4,239,000,000 in labor income, $8,839,000,000 in output, and $5,802,000,000 in Gross Regional Product (see table 2). For the 1% AEP alternative, the construction stimulus of $9,819,915,000 would generate 155,000 worker-years of labor, $7,654,000,000 in labor income, $15,254,000,000 in output, and $10,243,000,000 in Gross Regional Product (see table 2).

In the remaining parishes for the 3% AEP alternative, the construction stimulus of $5,897,000,000 would generate 1,600 worker-years of labor, $40,000,000 in labor income, $151,000,000 in output, and $61,000,000 in Gross Regional Product. For the 1% AEP alternative, the construction stimulus of $9,819,915,000 would generate 3,300 worker-years of labor, $83,000,000 in labor income, $303,000,000 in output, and $124,000,000 in Gross Regional Product (see table 2). The annual regional impacts of constructing the hurricane risk reduction system will accrue to the impact areas in amounts proportional to the level of spending for each year of construction.

For both alternatives, the secondary effects, the combined indirect and induced multiplier effects, account for 45% of the total output, about 35% of employment, about 33% of labor income, and 41% of gross regional product in the project area. The study area captures about 85% of the direct spending on the project. The remaining 15% of spending leaks out of the study area (see table 3).

Summary

The construction of the Morganza to the Gulf of Mexico levee system would yield significant increases in employment and gross regional product not only to the parishes of Terrebonne and Lafourche, but to Metro New Orleans and beyond. The 3% annual exceedance probability alternative would generate an estimated $5.8 billion in gross regional product and 85,000 worker-years of labor annually during the construction of the levee system. The 1% annual exceedance probability alternative would generate an estimated $10.2 billion in gross regional product and 155,000 worker-years of labor.

Table 1
Study Area Summary
Morganza to the Gulf of Mexico, La

Parish	Area (sq. mi)	Population	Households	Total Personal Income (in millions)
Ascension	303	104,702	37,280	$3,916
Assumption	365	23,632	8,552	$799
East Baton Rouge	469	429,211	166,068	$18,149
East Feliciana	456	21,057	6,827	$695
Iberville	653	32,987	10,770	$1,035
Jefferson	496	439,261	169,681	$19,446
Lafourche	1,177	93,768	33,790	$3,954
Livingston	703	122,404	43,929	$3,848
Orleans	349	326,968	124,294	$15,261
Plaquemines	1,041	27,039	9,364	$895
Pointe Coupee	591	23,137	8,750	$784
St Bernard	488	29,365	11,218	$1,224
St Charles	410	53,810	18,475	$1,969
St Helena	410	10,582	4,004	$336
St James	258	22,227	7,460	$689
St John The Baptist	348	48,996	16,546	$1,618
St Tammany	1,110	240,775	87,796	$10,406
Terrebonne	1,480	111,202	38,980	$4,268
West Baton Rouge	205	23,108	8,375	$805
West Feliciana	426	15,503	3,846	$421
Total	**11,737**	**2,199,734**	**816,005**	**$90,517**

Source: RECONS Database (2009)

Table 2
Summary of Regional Economic Impacts
Morganza to the Gulf of Mexico, La
(Dollars are in Thousands)

Project Area

Alternative	Construction Stimulus	Employment	Labor Income	Output	Gross Regional Product
3% AEP	$5,897,800	85,000	$4,239,000	$8,839,000	$5,802,000
1% AEP	$9,819,915	155,000	7,654,000	15,254,000	10,243,000

The Remaining Parishes in LA

Alternative	Construction Stimulus	Employment	Labor Income	Output	Gross Regional Product
3% AEP	$5,897,800	1,600	$40,000	$151,000	$61,000
1% AEP	$9,819,915	3,300	83,000	303,000	124,000

Notes:
1. October 2011 Price level
2. Construction Stimulus reflects costs estimates as of October 25, 2012.

Table 3
Direct and Secondary Effects of Expenditures
Morganza to the Gulf PAC
(Dollars are in 000s)

Project Area
3% AEP Alternative

Effects	Gross Regional Product	Output	Labor Income	Employment
Direct	3,411,000	4,892,000	2,828,000	55,000
Secondary	2,391,000	3,947,000	1,411,000	30,000
Total	5,802,000	8,839,000	4,239,000	85,000

1% AEP Alternative

Effects	Gross Regional Product	Output	Labor Income	Employment
Direct	6,090,000	8,394,000	5,212,000	103,000
Secondary	4,153,000	6,859,000	2,442,000	52,000
Total	10,243,000	15,253,000	7,654,000	155,000

The Remaining Parishes
3% AEP Alternative

Effects	Gross Regional Product	Output	Labor Income	Employment
Direct	3,429,000	6,913,000	2,599,000	50
Secondary	58,000	146,000	38,000	1,600
Total	3,487,000	7,059,000	2,637,000	1,650

1% AEP Alternative

Effects	Gross Regional Product	Output	Labor Income	Employment
Direct	5,000	10,000	4,000	70
Secondary	119,000	293,000	79,000	3,000
Total	124,000	303,000	83,000	3,070

Note: The secondary effects include the indirect and induced multiplier effects.

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OTHER SOCIAL EFFECTS APPENDIX

I. INTRODUCTION

This appendix presents a socioeconomic evaluation of the alternatives being considered for storm surge risk reduction for the Morganza to the Gulf evaluation area, which includes portions of two parishes in the state of Louisiana. It was prepared in accordance with Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, ER 1105-2-101, Planning Guidance, Risk Analysis for Flood Damage Reduction Studies, and Engineering Circular (EC) 1105-2-409.

Purpose

The purpose of this appendix is to describe the Other Social Effects (OSE) account of the Morganza to the Gulf of Mexico Post-Authorization Change (PAC) Hurricane Protection Project. The OSE account considers the potential social ramifications of Corps actions so that decision makers and stakeholders are able to evaluate the social implications of each alternative and choose an alternative that will be judged as complete, effective, and fair.

Study Area

The Morganza to the Gulf PAC study area is located in coastal Louisiana approximately 60 miles southwest of the city of New Orleans and includes all of Terrebonne Parish and the portion of Lafourche Parish to the south and west of Bayou Lafourche. Communities located within the study area include the city of Houma, the towns of Chauvin, Dulac, and Montegut in southern Terrebonne Parish, the towns of Donner and Gibson in western Terrebonne Parish, and the towns of Gray and Schriever in northern Terrebonne Parish. Also included are the towns of Raceland, Lockport, and Pointe aux Chenes in Lafourche Parish and the portion of the city of Thibodaux south of Bayou Lafourche. Both parishes have historically suffered extensive hurricane and tropical storm damage due to insufficient flood control features. The impact of preparing for, mitigating, and recovering from these damages has placed a significant physical and emotional burden on individuals and has been devastating for communities. The goals of the proposed project are to provide protection to residents within the study area from the damaging effects of storm surges while also protecting and preserving the fragile and rapidly deteriorating coastal wetlands.

Overview of Other Social Effects

While federal water resources planning guidance has long called for an examination of the social effects associated with USACE water resources planning projects, the tendency has historically been to discount the social impacts of Corps projects during the planning process and focus instead on the economic analysis (USACE, 2008). EC 1105-2-409, however, states that “all Corps planning studies will evaluate, display and compare the full range of alternative plans’ effects across all four Principles and Guidelines’ accounts (National Economic Development

(NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE)" (USACE, 2008 pg. 4).

The OSE account ensures that adequate attention is paid to the beneficial and adverse social effects of Corps' projects during the planning process. This appendix follows the guidance set forth by the USACE Institute for Water Resources (IWR) in the *Handbook on Applying "Other Social Effects" Factors in Corps of Engineers Water Resources Planning* (USACE, 2008). The handbook describes the procedures for analyzing and using OSE criteria in the planning process and identifies social factors that affect individual and group definitions of satisfaction and well-being.

Organization of Appendix

The OSE appendix is organized as follows:

- Section 1 provides an introduction to OSE.
- Section 2 provides a description of the existing and future without-project socioeconomic characteristics and other social factors of the study area.
- Section 3 provides an OSE analysis of the project alternatives.

II. OTHER SOCIAL EFFECTS STUDY AREA CHARACTERISTICS

This section provides a description of the existing and future without-project socioeconomic characteristics and other social factors of the study area.

Socioeconomic Characteristics of the Study Area

In this section, socioeconomic data for Lafourche and Terrebonne Parishes are presented in order to provide a context from which to evaluate the potential social impacts of the proposed project.

Population and Households.

Population characteristics such as size and change constitute important areas of consideration in that they determine consumption patterns, land use activities, and future development patterns. Table 1 displays the population in each of the parishes for the years 1970, 1980, 1990, 2000, and 2010 (study year), as well as projections for the year 2035 and the year 2085, the two years that were modeled by Hydraulics and Hydrology Branch (H&H) and used to calculate damages and benefits. Population projections are based on Moody's County Forecast Database which has population projections to the year 2038. Moody's projections were extended by the New Orleans District from the year 2038 to the year 2085 based on the growth rate forecasted by Moody's for the years 2018 through 2038. The slow, steady growth rate projected by Moody's during this 20-year period was consistent with the growth predicted by parish planning officials.

As shown in Table 1, both Lafourche and Terrebonne Parishes have experienced a steady increase in population between 1970 and 2010. According to U.S. Census data, the population of Lafourche Parish was 89,974 in 2000 and 96,318 in 2010, an increase of 6,344 residents over the ten-year period. During the same period, the population of Terrebonne Parish increased from 104,503 to 111,860, an increase of 7,357 residents. The population in both parishes is projected to maintain this steady increase in population growth, with Lafourche Parish expected to have roughly 97,900 residents in 2035 and approximately 104,200 residents in the year 2085. Terrebonne Parish is expected to experience even more growth with an estimated population of roughly 120,900 in 2035 and 142,800 in 2085. Approximately 218,800 residents are projected to reside in the two-parish area in 2035, while approximately 247,000 residents are projected for the year 2085.

Table 2 shows the number of households in each parish in 1970, 1980, 1990, 2000, and 2010 and projections for the years 2035 and 2085. The projected number of households was based on Moody's County Forecast Database and extended from the year 2038 to 2085 by the New Orleans District based on the growth rate forecasted by Moody's for the years 2018 through 2038.

The total number of households in Lafourche and Terrebonne Parishes experienced a steady increase between 1970 and 2010, which paralleled the growth in population. This increase, which was commensurate with the population growth experienced by the entire Gulf Coast region during the same period, can be attributed to increases in oil and gas exploration in the Gulf of Mexico and technological advancements in the industry. Similar to the projected population growth in the two-parish area, the number of households is expected to continue increasing through the year 2085. Lafourche Parish is projected to have approximately 36,300 households in the year 2035, while Terrebonne Parish is projected to have about 43,400 households. By the year 2085, the number of households in Lafourche Parish is expected to reach approximately 38,100, while the number in Terrebonne Parish is expected to reach to approximately 50,400. In total, the two parishes are projected to have approximately 88,600 households in the year 2085.

Employment.

Table 3 shows the total nonfarm employment by parish for the years 1970, 1980, 1990, 2000, 2010, and projections for the years 2035 and 2085. The employment projections were based on the Moody's County Forecast Database and extended from the year 2038 to the year 2085 by New Orleans District based on the growth rate forecasted by Moody's for the years 2018 through 2038.

Employment trends in the area have historically moved with the demand for oil and gas resources. The unemployment rate in Terrebonne and Lafourche parishes averaged approximately three percent prior to the end of 2008. The Houma-Thibodaux Metropolitan

Statistical Area (MSA) continues to lead the state in jobs created and has one of the lowest unemployment rates in the state.

While the oil and gas industry pays the highest wages of all of the sectors of the economy, the services industry employs the largest number of residents. The retail sector is the second largest employer followed by government and other public agencies. The oil and gas sector in Terrebonne Parish employs slightly over 5,000 residents.

In addition to the oil and gas industry, there are three other sectors of the economy that are important to the region: energy, fisheries, and agriculture. The GIWW, the Houma Navigation Canal, and Bayou Lafourche provide key navigational channels for the energy sector. The coastal region provides a fertile spawning ground for fisheries including shrimp, crabs, oysters, and finfish. Finally, the area grows and processes sugarcane that is used both domestically and abroad.

Social Profile of the Study Area

This section provides a baseline profile of the social characteristics of the study area. Data for the social profile were obtained from a variety of sources including 2010 U.S. Census records, the 2006-2010 U.S. Census Bureau's American Community Survey (ACS) estimates[1], ESRI data, and aerial photography. The baseline characteristics are considered the existing and future-without project conditions.

Health and Safety

Severe flood events threaten the health and safety of residents living within the study area. Loss of life, injury, and post flood health hazards may occur in the event of catastrophic flooding. For example, while the study area was not directly impacted by Hurricane Katrina, the Louisiana Recovery Authority estimated (as of November 2006) that 1,464 fatalities occurred associated with Hurricane Katrina with 135 more residents declared missing. Hurricanes Gustov and Ike were less costly in terms of lives lost, but still claimed 98 deaths. When facilities that provide critical care or emergency services are impacted by flood events, residents are at an even greater risk for experiencing negative health outcomes. Both Hurricanes Katrina and Rita reduced the previous availability of health facilities and services and required additional fire and police protection. During Gustov and Ike, some police stations were required to relocate because of flooding. In addition to the damages of Katrina and Rita to hospitals, police stations, and fire stations, many employees providing related services lost their homes reducing the staff needed to operate health and safety services. As many as 30 hospitals were initially closed following the hurricanes with as many as 141 damaged at various levels of impact.

[1] The U.S. Census Bureau is now only providing population and housing characteristics in the decennial censuses. Other social characteristics (e.g., low-income) will now be provided in the U.S. Census Bureau's American Community Survey (ACS). The ACS provides estimates of social characteristics based on data collected over five years. The 2006-2010 estimates represent the average characteristics over the 5-year period of time.

The number of medical facilities, police stations, and fire stations located within the study area were obtained using 2010 ESRI data (latest year available).

Medical Care Facilities

There are two hospitals, two nursing homes, and three health care service facilities within the portion of Lafourche Parish included in the study area, and 15 medical care facilities (e.g., hospitals, medical centers, home health care services, and nursing homes) in Terrebonne Parish.

Police Stations

Lafourche Parish has seven police stations/sheriff’s offices and a juvenile justice facility located within the study area and Terrebonne Parish has four police stations/sheriff’s offices, according to ESRI data.

Fire Stations

There are 23 fire stations located within the study area—five in Lafourche Parish and 18 in Terrebonne Parish.

Social Connectedness

The degree to which communities are able to instill a shared sense of belonging and purpose among residents is in large part determined by the communities' civic infrastructure. The presence of social institutions such as libraries, places of worship, and schools provide residents an opportunity for civic participation and engagement which allows residents to come together and work toward a common goal. The number of libraries, places of worship, and schools located within the study area were obtained using 2010 ESRI data (latest year available).

Civic Infrastructure

According to ESRI data, the portion of Lafourche Parish included in the study area has one library, 7 places of worship, and 16 schools. ESRI data also show that there are 6 libraries, 34 places of worship, and 45 schools located within the study area in Terrebonne Parish.

Leisure and Recreation

Having personal leisure time available and having access to recreational areas contributes to residents’ quality of life and is therefore an important aspect of well-being. The number of recreational areas within the study area was obtained using 2010 ESRI data (latest year available).

Recreational Areas

Lafourche Parish has four recreational areas located within the study area—the Sugarland Country Club, Acadia Park, Bayou Country Club, and Peltier Municipal Park. Terrebonne Parish has four also: Southern Oaks Golf Club, Ellendale Country Club, Gray Park, and Colonial Acres Golf Course.

Additionally, recreational fishing and hunting are very important to the area. The high quality of the recreational fishery, especially an abundance of red fish and trout, has made this an important leisure time activity for residents. Inland saltwater fish species, crabs, and shrimp are also available in the more brackish water. Game species hunted in the area include waterfowl, deer, rabbit, squirrels, rail, gallinule, and snipe.

Social Vulnerability/Resiliency

The devastation left behind after Hurricane Katrina brought attention to the salience of the related concepts of social vulnerability and resiliency when evaluating water resources projects (USACE, 2008). Social vulnerability is a characteristic of groups or communities that limits or prevents their ability to withstand adverse impacts from hazards to which they are exposed. Resiliency, in turn, refers to the ability of groups or communities to cope with and recover from adverse events. The factors that contribute to vulnerability often reduce the ability of groups or communities to recover from a disaster; therefore, more socially vulnerable groups or communities are typically less resilient.

Several factors have been shown to contribute to an area's vulnerability/resiliency, including poverty, racial/ethnic composition, educational attainment, and proportion of the population over the age of 65.

Poverty Rate

High poverty rates negatively impact the social welfare of residents and undermine the community's ability to assist residents in times of need. The 2006-2010[2] U.S. Census data indicate that 15.6 percent of the population of Lafourche and 17.4 percent of the population in Terrebonne Parish fell below the poverty line. In contrast, 18.1 percent of the population in the state of Louisiana and 13.8 percent in the nation overall fell below the poverty line during the same period.

Racial / Ethnic Composition

Race/ethnicity continues to play an important role in the everyday lives of Americans. Unequal access to social resources and language barriers may affect preparing for and recovering from flood events for certain groups. Table 4 shows the racial and ethnic characteristics of Lafourche and Terrebonne Parishes, according to the 2010 U.S. Census. In both parishes, the majority of the population is non-Hispanic white (78.0% in Lafourche Parish and 68.6% in Terrebonne Parish), followed by non-Hispanic black (13.2% in Lafourche Parish and 18.8% in Terrebonne Parish). The Hispanic population in both parishes is roughly 4.0 percent.

[2] As stated previously, the 2006-2010 estimates represent the average characteristics over the 5-year period of time.

Additionally, approximately 230 members of the Biloxi-Chitimacha tribe are located in Isle de Jean Charles which is in the southern portion of Terrebonne Parish.

Educational Attainment

Educational attainment also has important implications for the social vulnerability/resiliency of communities. More educated individuals have less difficulty accessing information and navigating the sometimes complex process of recovery after flood events (e.g., obtaining government assistance, insurance claims, etc.) According to 2006-2010 ACS data, the percentage of the population age 25 and older in Lafourche Parish with a high school diploma is 72.1 percent and 14.3 percent has a bachelor's degree or higher. Similarly, 73.0 percent of the population 25 and older in Terrebonne Parish has a high school diploma and 13.0 percent has a bachelor's degree or higher. These figures are lower than the state of Louisiana (81.0% has a high school diploma and 20.9% has a bachelor's degree or higher) and the nation overall (85.0% and 27.9%, respectively).

Age

Age is another important factor to consider when examining the social vulnerability/resiliency of a community. For example, elderly residents may have special needs or mobility issues and require more social resources before, during, and after flood events. According to 2010 U.S. Census data, the proportion aged 65 and older in Lafourche Parish is 12.5 percent and 11.2 percent in Terrebonne Parish. The state of Louisiana and the nation overall have roughly the same proportion of the population over the age of 65 (12.3% and 13.0%, respectively).

Social Vulnerability Index

The Hazards and Vulnerability Research Institute at the University of South Carolina created an index that compares the social vulnerability of U.S. counties/parishes to environmental hazards. The variables included in the index are based on previous research which has found that certain characteristics (e.g., poverty, racial/ethnic composition, educational attainment, and proportion over the age of 65) contribute to a community's vulnerability when exposed to hazards. According to the IWR OSE handbook (USACE, 2008), the Social Vulnerability Index (SoVI®)[3] is a valuable tool that can be used in the planning process to identify areas that are socially vulnerable and whose residents may be less able to withstand adverse impacts from hazards.

The SoVI® was computed as a comparative measure of social vulnerability for all counties/parishes in the U.S., with higher scores indicating more social vulnerability than lower scores. Lafourche Parish has a SoVI® 2005-09 score of -1.20 (0.29 national percentile) and Terrebonne Parish has a SoVI® 2005-09 score of -1.08 (0.31 national percentile). Stated another way, Lafourche and Terrebonne Parishes are less socially vulnerable than roughly 70 percent of counties/parishes in the U.S. In comparison, Orleans Parish—notorious for its enduring levels of

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[3] More information on the methodology and data used to calculate the SoVI® can be found here: http://webra.cas.sc.edu/hvri/products/sovi.aspx

high poverty—has a SoVI® 2005-09 score of 2.06 with only 18 percent of counties/parishes in the nation ranked more socially vulnerable.

The study area's social vulnerability, however, is expected to increase over time if subsidence and sea level rise continue to occur, and the population in the study area increases as it is projected to do. The absolute number of socially vulnerable people (e.g., low-income, minority, less-educated, and over the age of 65) at risk for flood events will increase. This, in turn, may lead to an increased burden placed on local, state, and federal agencies to ensure that these socially vulnerable populations have access to resources before, during, and after flood events.

III. OTHER SOCIAL EFFECTS EVALUATION OF ALTERNATIVES

Social Implications of the Alternatives

This section provides an OSE analysis of the project alternatives. The evaluation is based on the differential impact that each alternative is expected to have on the socioeconomic characteristics and other social factors of the study area presented in the previous section.

The analysis was conducted based on without-project overflow and depth-of-flooding data provided by Engineering Division. The data were provided for the years 2035 and 2085 for 2% annual chance exceedance (ACE) events (50-year), 1% ACE events (100-year), and for 0.2% ACE events (500-year). Figures 1-3 show the estimated depth of inundation during 2%, 1%, and 0.2% ACE events for the year 2085.

The data do not take into account the performance of local levees. As a result, impacts to population, housing, medical facilities, etc. are overstated. Local levee systems provide flood risk reduction under existing conditions (2010) for over 25,000 residential and non-residential structures. Local levees are expected to provide flood risk reduction between a 10% ACE event (10-year) and 7% ACE event (15-year), on average.

Performance of the federal levee for the 1% AEP Alternative would reduce risk for elevations up to approximately the stages associated with the 1% ACE event (100-year) or slightly above. This is again assuming that the levee doesn't fail at an elevation below the design elevation of the Federal levee.

Performance of the federal levee for the 3% Annual Exceedance Probability (AEP) Alternative would reduce risk for elevations up to approximately the stages associated with the 3% ACE event (35-year)—assuming that the levee doesn't fail at an elevation below the design elevation of the Federal levee. Therefore, for the purposes of this analysis, it is assumed that the 3% AEP Alternative would fail when exposed to 2% ACE events (50-year) and for less frequent events.

Tables 5 and 6 present the results of the impacts to population and housing, medical/emergency facilities, civic infrastructure, and recreational areas under the No Action Alternative, the 1% AEP Alternative, and the 3% AEP Alternative based on these without-project overflow and depth-of-flooding data. The impacted population and housing figures are based only on without-project overflow data and not depth-of-flooding data. Therefore, impacts due to flooding could range from minimal to extensive. Medical/emergency facilities, civic infrastructure, and recreational areas are considered impacted if depth-of-flooding data show two feet or more of flooding in the facility location.

Again, it is important to note that the reduced risk associated with the 1% AEP Alternative and the 3% AEP Alternative are based on without-project depth-of-flooding data and the assumption that the 1% AEP Alternative will provide flood risk reduction for 1% (and more frequent) ACE events and the 3% AEP Alternative will provide flood risk reduction for 3% (and more frequent) ACE events.

Population and Housing

No Action Alternative

As shown in Table 5, if the population and housing units increase at the rate projected by Moody's, a 0.2% ACE event in 2035 would impact 206,700 residents/71,300 housing units; a 1% ACE event would impact 181,500 individuals/62,600 housing units; and a 2% ACE event would impact 180,200 residents/62,100 housing units.

Table 6 shows that in 2085, a 0.2% ACE event would impact 242,400 residents/83,600 housing units; a 1% ACE event would impact 217,200 individuals/74,900 housing units; and a 2% ACE event would impact 215,900 residents/74,500 housing units.

The No Action Alternative would not provide risk reduction to the residents living within the study area which would increase over time due to sea level rise. A catastrophic flood would result in severe negative impacts to residents and cause significant damage to residential structures. Additionally, residents in these communities would not be able to benefit from discounted flood insurance premiums offered by the National Flood Insurance Program (NFIP) should the flood rate insurance maps be updated to reflect increases in flood risk over time due to sea level rise.

1% AEP Storm Surge Risk Reduction System Alternative

As shown in Tables 5 and 6, if no action is taken by USACE, approximately 181,500 individuals/62,600 housing units would be impacted by a 1% ACE event in 2035 and 217,200 residents/74,900 housing units in 2085.

Under the 1% AEP Alternative, these residents and housing units would be at a reduced risk for adverse impacts as a result of 1% (and more frequent) ACE events. Additionally, many residents in these communities would be able to benefit from discounted flood insurance premiums offered by the NFIP (should the flood rate insurance maps be updated to reflect increases in flood risk over time due to sea level rise).

It’s also important to note that approximately 840 residential structures (roughly 2,500 people) are located outside of the project alignment and would not benefit from this alternative. This includes approximately 230 members of the Biloxi-Chitimacha tribe who are located in Isle de Jean Charles which is outside of the southern boundary of the project alignment in Terrebonne Parish.

3% AEP Storm Surge Risk Reduction System Alternative

Under the 3% AEP alternative, residents and housing units would be at a reduced risk for adverse impacts as a result of 3% (and more frequent) ACE events. However, if a 2% or less frequent ACE event occurs, these residents and housing units would not experience any reduction in risk. Additionally, residents in these communities would not be able to benefit from discounted flood insurance premiums offered by the NFIP (again, if the flood rate insurance maps are updated to reflect increases in flood risk over time due to sea level rise).

As with the 1% AEP Alternative, approximately 840 residential structures (roughly 2,500 people) are located outside of the project alignment and would not benefit from this alternative. This includes approximately 230 members of the Biloxi-Chitimacha tribe who are located in Isle de Jean Charles which is outside of the southern boundary of the project alignment in Terrebonne Parish.

Health and Safety

No Action Alternative

As stated previously, the study area includes 22 medical care facilities (e.g., hospitals, medical centers, home health care services, and nursing homes). As shown in Table 5, under the No Action Alternative, a 0.2% ACE event in 2035 would impact 20 medical facilities, 12 police stations/sheriff's offices/juvenile justice facility, and 22 fire stations; a 1% ACE event would impact 16 medical facilities, 6 police stations/sheriff's offices/juvenile justice facility, and 18 fire stations; and a 2% ACE event would impact 13 medical facilities, 4 police stations/sheriff's offices/juvenile justice facility, and 17 fire stations.

Table 6 shows that in 2085, a 0.2% ACE event would impact 20 medical facilities, 12 police stations/sheriff's offices/juvenile justice facility, and 22 fire stations; a 1% ACE event would impact 18 medical facilities, 8 police stations/sheriff's offices/juvenile justice facility, and 19 fire stations; and a 2% ACE event would impact 16 medical facilities, 5 police stations/sheriff's offices/juvenile justice facility, and 17 fire stations.

While evacuation for severe weather events in the Morganza study area is typically high due to mandatory evacuation orders by state authorities, flood events threaten the health and safety of those residents who remain in the area. The potential for loss of life and injuries during flood events for those remain, and the risks of post flood health hazards attributable to such widespread flooding, are greater under the No Action Alternative as compared to the project alternatives. Residents are at an even greater risk for experiencing negative health outcomes when facilities that provide critical care or emergency services are impacted by flood events. The No Action Alternative has a higher potential for reducing the availability of health facilities and services and requiring additional fire and police protection than the project alternatives.

1% AEP Storm Surge Risk Reduction System Alternative

As shown in Table 5, the 1% AEP Alternative would provide reduced risk during 1% ACE events (100-year) to 16 medical care facilities, 6 police stations/sheriff's offices, and 18 fire stations that without-project depth-of-flooding data show would experience two feet or more of flooding in 2035. Table 6 shows that by the year 2085, the number of medical facilities experiencing reduced risk under this alternative would increase to 18, police stations/sheriff's offices would increase to 8, and fire stations would increase to 19.

The 1% AEP would result in the greatest potential for reduced risk to the health and safety of residents living within the Morganza study area.

3% AEP Storm Surge Risk Reduction System Alternative

The 3% AEP Alternative would provide reduced risk during 3% (and more frequent) ACE events to medical care facilities, police stations/sheriff's offices, and fire stations located in the study area. However, if a 2% (or less frequent) ACE event occurs, these facilities would not experience any reduction in risk.

The 3% AEP would result in reduced risk to the health and safety of residents living within the study area during 3% (and more frequent) ACE events. However, residents would remain at risk for experiencing negative health outcomes during less frequent events.

Social Connectedness

No Action Alternative

As stated previously, the study area includes 7 libraries, 41 places of worship, and 61 schools. Table 5 shows that under the No Action Alternative, a 0.2% ACE event (500-year) would impact all 7 libraries, 40 places of worship, and 56 schools in 2035. Table 5 also shows that under the No Action Alternative, a 1% ACE event (100-year) would impact 6 libraries, 36 places of worship, and 43 schools, and a 2% ACE event (50-year) would impact 5 libraries, 34 places of worship, and 38 schools.

Table 6 shows that in 2085, 0.2% ACE event would remain similar to that of 2035, while a 1% ACE event would impact 7 libraries, 39 places of worship, and 56 schools, and a 2% ACE event would impact 6 libraries, 35 places of worship, and 43 schools.

1 % AEP Storm Surge Risk Reduction System Alternative

As shown in Table 5, the 1% AEP Alternative would provide reduced risk during 1% ACE events (100-year) to 6 libraries, 36 places of worship, and 43 schools that without-project depth-of-flooding data show would experience two feet or more of flooding in 2035. Table 6 shows that by the year 2085, the number of libraries experiencing reduced risk under this alternative would increase to 7, places of worship would increase to 39, and schools would increase to 56.

3 % AEP Storm Surge Risk Reduction System Alternative

The 3% AEP Alternative would provide reduced risk during 3% (and more frequent) ACE events to libraries, places of worship, and schools located in the study area. However, if a 2% (or less frequent) ACE event occurs, these facilities would not experience any reduction in risk.

Leisure and Recreation

No Action Alternative

Tables 5 and 6 show that under the No Action Alternative, a 0.2% ACE event (500-year) would impact all 8 recreational areas located within the study area under without-project conditions in the years 2035 and 2085, a 1% ACE event would impact 5 in the years 2035 and 2085, and a 3% ACE event would impact 4 in the years 2035 and 2085.

1 % AEP Storm Surge Risk Reduction System Alternative

As shown in Tables 5 and 6, the 1% AEP Alternative would provide reduced risk during 1% ACE events to 5 recreational areas in the years 2035 and 2085.

3 % AEP Storm Surge Risk Reduction System Alternative

The 3% AEP Alternative would provide reduced risk during 3% (and more frequent) ACE events to recreational areas located in the study area. However, if a 2% (or less frequent) ACE event occurs, these areas would not experience any reduction in risk.

Social Vulnerability and Resiliency

No Action Alternative

As stated previously, social vulnerability in the area is expected to increase over time as the absolute number of socially vulnerable people (e.g., low-income, minority, less-educated, and over the age of 65) at risk for flood events increases should subsidence, sea level rise, and population growth occur to levels expected. Under the No Action Alternative, the area would remain vulnerable to flooding, and long term resiliency would be hampered by the continued local efforts necessary to prepare for, and react to, flood events.

1% AEP Storm Surge Risk Reduction System Alternative

Under the 1% AEP Alternative, the study area would experience flood risk reduction for 1% (and more frequent) ACE events. The level of social vulnerability expected in the study area in the year 2085 would be reduced under this alternative as compared to the No Action Alternative, and thus, the study area's potential for long-term growth and sustainability would be enhanced.

3% AEP Storm Surge Risk Reduction System Alternative

Under the 3% AEP Alternative, the study area would experience flood risk reduction for 3% (and more frequent) ACE events. The social vulnerability of the study area would be reduced under this alternative as compared to the No Action Alternative, and thus, the study area's potential for long-term growth and sustainability would be enhanced. However, the study area would remain vulnerable to less frequent/more damaging events.

Summary of Alternative Analysis

The Morganza to the Gulf PAC study examined three alternatives—the No Action Alternative, the 1% AEP Alternative, and the 3% AEP Alternative. The OSE analysis evaluated the differential impact that each alternative is expected to have on the socioeconomic characteristics and other social factors of the study area. After first providing a description of the existing and future without-project socioeconomic characteristics and other social factors of the study area, an analysis of the impacts to population and housing, medical/emergency facilities, civic infrastructure, and recreational areas under the three alternatives was conducted. The analysis was conducted based on without-project overflow and depth-of-flooding data for the years 2035 and 2085. Results show significant differences between the alternatives with important implications for the overall social well-being of the study area.

The No Action Alternative would not reduce the risk associated with hurricane and tropical storm damage to residents of the Morganza study area. Therefore, there is a high potential for extensive hurricane and tropical storm damage to continue occurring in the area. The apparent subsidence, or relative sea level rise, that has been taking place in the Morganza to the Gulf area, coupled with the anticipated population growth, is expected to magnify the flooding problems in the future. As a result, subsequent flooding events could cause even more damage to housing units, public facilities, and commercial structures than has previously been experienced. Under this alternative, residents would remain at a higher risk for adverse health impacts such as loss of life and injury, as well as post flood health hazards. The area would remain vulnerable to flooding, and long term resiliency would be hampered by the continued local efforts necessary to prepare for, and react to, flood events.

The 1% AEP would result in the greatest potential for reduced flooding in the Morganza study area. This alternative would reduce the risks associated with damages to housing units, public facilities, and commercial structures for 1% (and more frequent) ACE events as well as provide increased protection to the health and safety of residents living within the study area. The area's social vulnerability would be reduced under this alternative, and thus, the potential for long-term growth and sustainability would be enhanced. Also, under this alternative, the area would be at a reduced risk of incurring the costs associated with clean-up, debris removal, and building and infrastructure repair as a result of flood events.

The 3% AEP would also reduce the risk of flooding in the Morganza study area. However, this alternative would only provide risk reduction for 3% (and more frequent) ACE events. The area would still face risks associated with less frequent (more damaging) events.

References

U.S. Army Corps of Engineers. 2008. Handbook on Applying “other Social Effects” Factors in Corps of Engineers Water Resources Planning.

U.S. Bureau of the Census, 2010. U.S. Census of Population and Housing, SF1 and SF3 datatables. http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed January 10th, 2012.

U.S. Bureau of the Census, 2006-2010 American Community Survey. http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed February 10th, 2012.

Figures

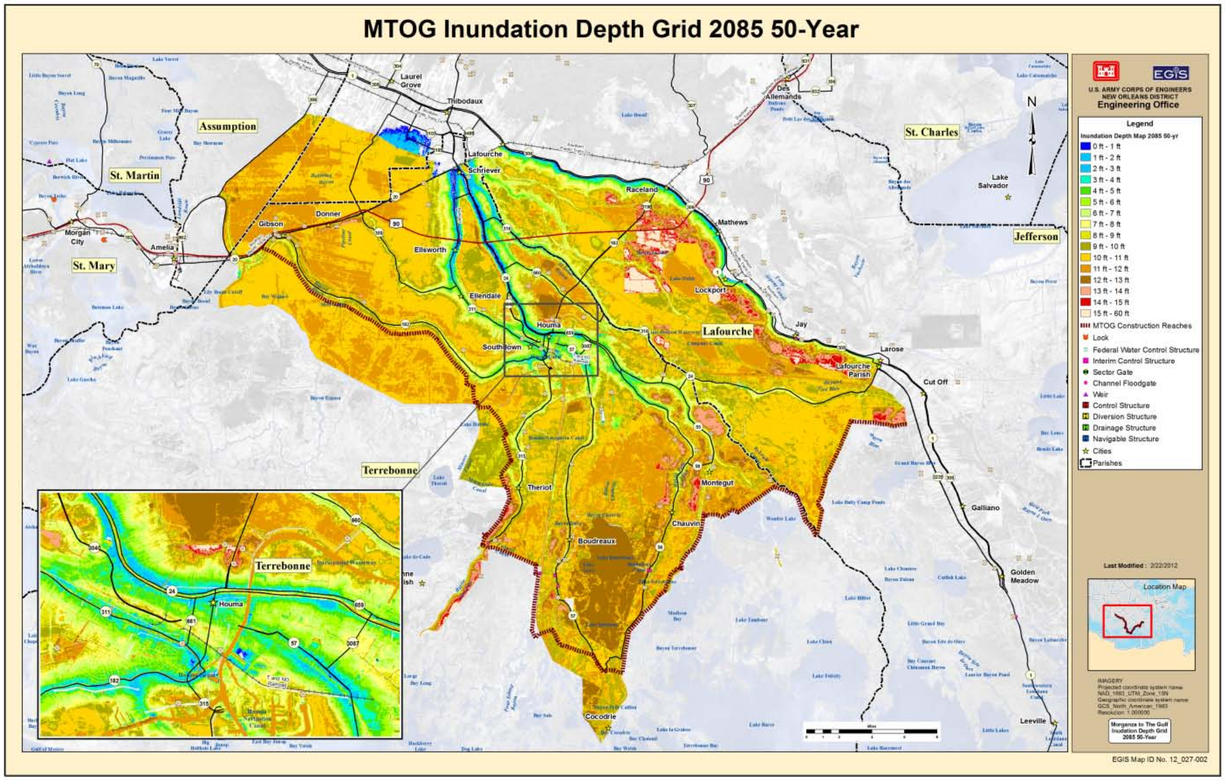

Figure 1. Morganza Study Area Estimated Inundation for 2% ACE Event (50-Year) in 2085

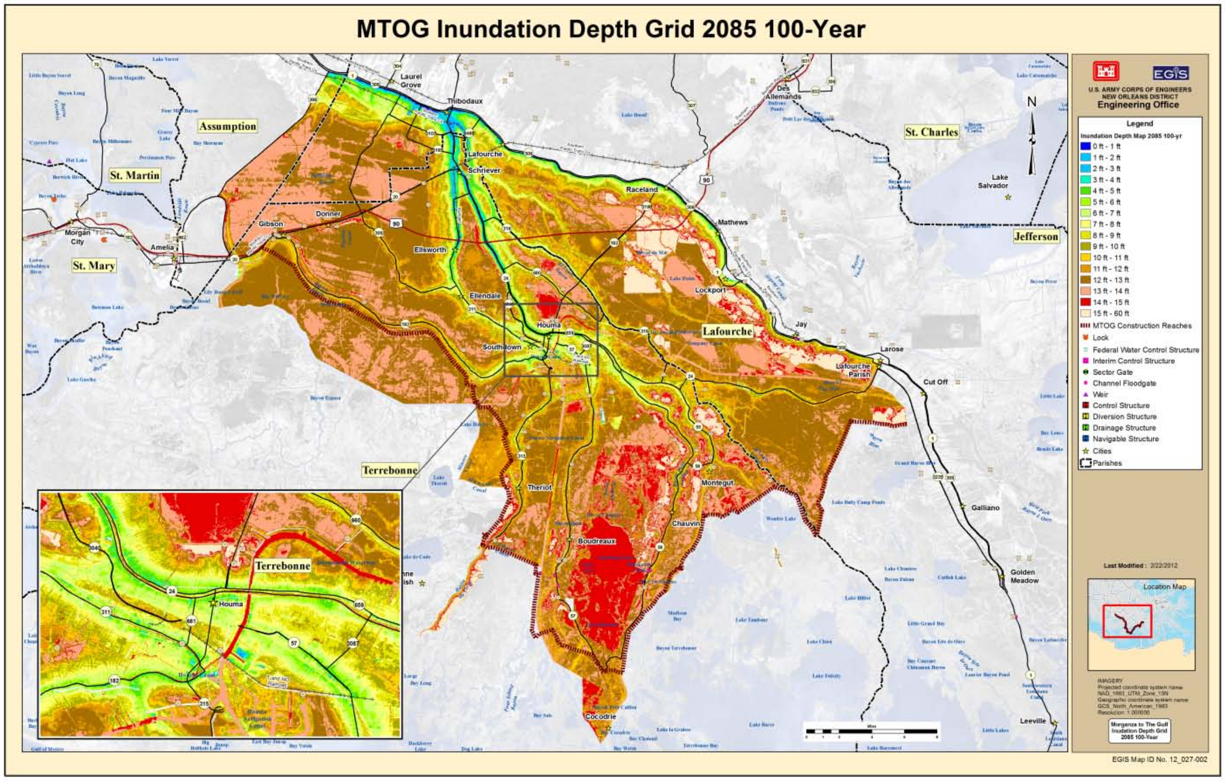

Figure 2. Morganza Study Area Estimated Inundation for 1% ACE Event (100-Year) in 2085

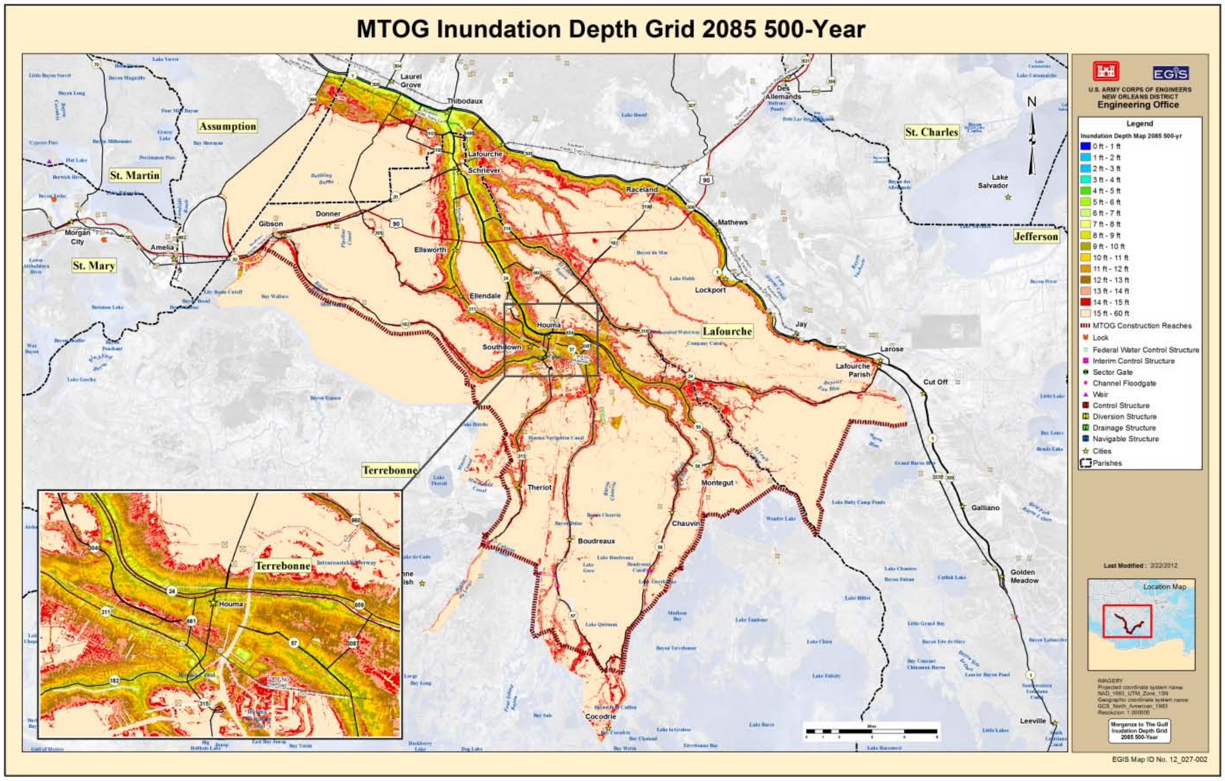

Figure 3. Morganza Study Area Estimated Inundation for 0.2% ACE Event (500-Year) in 2085

Table 1
Historical and Projected Parish Population (1,000s)
2010
Morganza to the Gulf of Mexico, La.
Post-Authorization Change Report

Parish	1970	1980	1990	2000	2010	2035	2085
Lafourche	69.1	83.5	85.8	90	96.3	97.9	104.2
Terrebonne	76.2	95.1	97	104.5	112.0	120.9	142.8
Total	145.2	178.6	182.9	194.4	208.3	218.8	247.0

Source: U.S. Census data, Moody's Country Forecast Database, and discussions with local officials.

Table 2
Number of Households by Parish (1,000s)
2010
Morganza to the Gulf of Mexico, La.
Post-Authorization Change Report

Parish	1970	1980	1990	2000	2010	2035	2085
Lafourche	18.0	25.7	28.8	32.1	33.7	36.3	38.1
Terrebonne	19.6	29.5	31.9	36.0	38.2	43.4	50.4
Total	37.6	55.2	60.7	68.1	71.9	79.7	88.5

Source: U.S. Census data, Moody's Country Forecast Database, and discussions with local officials.

Table 3
Total Nonfarm Employment (1,000s)
2010
Morganza to the Gulf of Mexico, La.
Post-Authorization Change Report

Parish	1970	1980	1990	2000	2010	2035	2085
Lafourche	15.1	24.4	22.1	30.4	37.5	40.7	44.2
Terrebonne	24.6	42.4	35.8	47.3	58.9	67.3	81.3
Total	39.7	66.8	57.9	77.7	96.4	108.0	125.5

Source: Based on Moody's Forecast and discussions with local officials

Table 4
Race and Ethnic Composition Morganza to the Gulf PAC
2010
Morganza to the Gulf of Mexico, La.
Post-Authorization Change Report

	Lafourche Parish		Terrebonne Parish	
	Number	%	Number	%
Total	96,318		111,860	
Hispanic	3,647	3.8	4,421	4
Non-Hispanic	92,671	96.2	107,439	96
White alone	75,080	78	76,789	68.6
Black or African American alone	12,679	13.2	21,046	18.8
American Indian and Alaska Native alone	2,623	2.7	6,226	5.6
Asian alone	707	0.7	1,127	1
Native Hawaiian and Other Pacific Islander alone	26	0	40	0
Some Other Race alone	62	0.1	93	0.1
Two or More Races	1,494	1.6	2,118	1.9

Source: 2010 U.S. Census

Table 5
Evaluation of Alternatives
2035
Morganza to the Gulf of Mexico, La.
Post-Authorization Change Report

	No Action Alternative			1% AEP Alternative			3% AEP Alternative		
	50	100	500	50	100	500	50	100	500
Population and Housing									
Population	180.2	181.5	206.7	0	0	206.7	180.2	181.5	206.7
Housing Units	62.1	62.6	71.3	0	0	71.3	62.1	62.6	71.3
Social Factor									
Health and Safety									
Medical Facilities	13	16	20	0	0	20	13	16	20
Police Stations	4	6	12	0	0	12	4	6	12
Fire Stations	17	18	22	0	0	22	17	18	22
Social Connectedness									
Libraries	5	6	7	0	0	7	5	6	7
Places of Worship	34	36	40	0	0	40	34	36	40
Schools	38	43	56	0	0	56	38	43	56
Leisure and Recreation									
Recreational Areas	4	5	8	0	0	8	4	5	8

Source: U.S. Census data, Moody's Country Forecast Database, ESRI data.
Based on without-project overflow and depth-of-flooding data provided by Engineering Division
Population/housing figures are based on without-project overflow data and not depth-of-flooding data.
Facilities are considered impacted if depth-of-flooding data show two feet or more of flooding.

Table 6
Evaluation of Alternatives
2085
Morganza to the Gulf of Mexico, La.
Post-Authorization Change Report

	No Action Alternative			1% AEP Alternative			3% AEP Alternative		
	50	100	500	50	100	500	50	100	500
Population and Housing									
Population	215.9	217.2	242.4	0	0	242.4	215.9	217.2	242.4
Housing Units	74.5	74.9	83.6	0	0	83.6	74.5	74.9	83.6
Social Factor									
Health and Safety									
Medical Facilities	16	18	20	0	0	20	16	18	20
Police Stations	5	8	12	0	0	12	5	8	12
Fire Stations	17	19	22	0	0	22	17	19	22
Social Connectedness									
Libraries	6	7	7	0	0	7	6	7	7
Places of Worship	35	39	40	0	0	40	35	40	40
Schools	43	56	56	0	0	56	43	56	56
Leisure and Recreation									
Recreational Areas	4	5	8	0	0	8	4	5	8

Source: U.S. Census data, Moody's Country Forecast Database, ESRI data.
Based on without-project overflow and depth-of-flooding data provided by Engineering Division
Population/housing figures are based on without-project overflow data and not depth-of-flooding data.
Facilities are considered impacted if depth-of-flooding data show two feet or more of flooding.