2019

Lake Pontchartrain and Vicinity GRR Economics – Appendix J

U.S. Army Corps of Engineers,
New Orleans District

Non-Federal Sponsor: Coastal Protection and Restoration Authority Board

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1 INTRODUCTION

This appendix presents an economic evaluation of the hurricane and storm damage risk reduction alternatives for the Lake Pontchartrain and Vicinity Feasibility Study. 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, prepared by the Water Resources Support Center, Institute for Water Resources, was also used as a reference, along with the User's Manual for the Hydrologic Engineering Center Flood Damage Analysis Model (HEC-FDA). The Life Safety analysis will be addressed in its own appendix.

1.1 STUDY AREA

The Lake Pontchartrain and Vicinity study area comprises much of the greater New Orleans area. The delineated sub-basins are St. Charles, Jefferson East Bank, Orleans East Bank, New Orleans East, and the Chalmette Loop. In Figure 1, the sub-basins within the LPV study area are outlined in red. See the Socioeconomics section of the EIS for an overview of the socioeconomic variables in the study area.

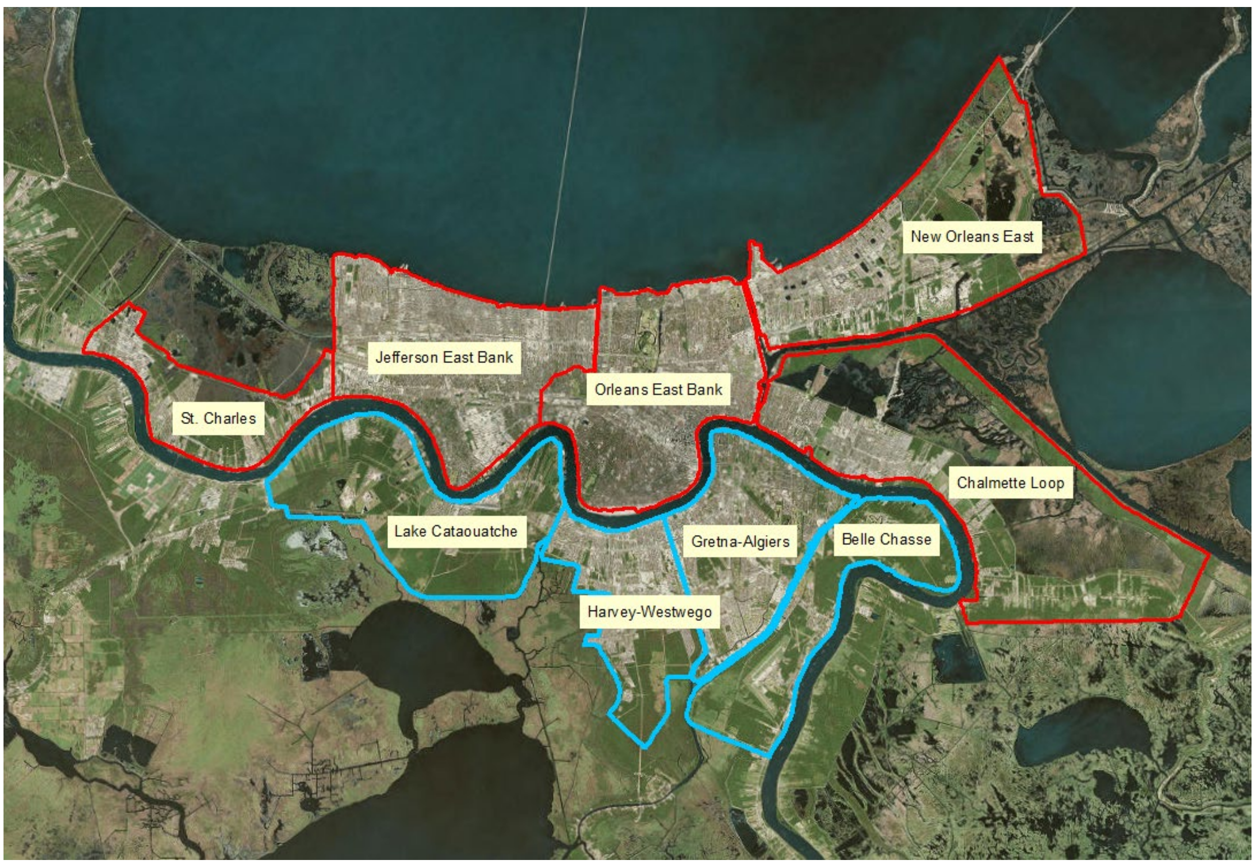

Figure 1. Study Area

1.2 MAJOR TROPICAL EVENTS

While the planning area has periodically experienced localized flooding from excessive rainfall events and has experienced two major floods from the Mississippi River in 1927 and 1973, the primary cause of the flood events that have taken place in South Louisiana has been the tidal surges from hurricanes and tropical storms.

Hurricane Juan caused extensive flooding throughout southern Louisiana due to its prolonged 5-day movement back and forth along the Louisiana coast in October 1985. The majority of the flood damage occurred in the Lincolnshire and Westminster subdivisions located on the west bank of Jefferson Parish. Rainfall totals in the area ranged from five inches to almost 17 inches. The storm was responsible for storm surges of five to eight feet and tides of three to six above normal. According to FEMA officials, the estimated value of the residential and commercial damage and public assistance totaled $112.5 million.

The most significant storm event to affect the Metropolitan New Orleans Area since Hurricane Betsy in 1965 was Hurricane Katrina. Hurricane Katrina made landfall on August 29, 2005, near the town of Buras in Plaquemines Parish as a 0.25% AEP storm with winds in excess of 120 miles per hour and a storm surge of approximately 30 feet. After tracking across the southeastern Louisiana coastline, it made a second landfall near the town of Waveland on the Mississippi Gulf Coast. The surge from Lake Pontchartrain pushed water into the three major outflow canals (London Avenue, Orleans, and 17th Street) of the city of New Orleans, which overwhelmed their adjacent floodwalls. The surge from Lake Borgne overwhelmed the levees protecting St. Bernard Parish, New Orleans East, and the Lower Ninth Ward. Many portions of the metropolitan area were submerged in more than 6 feet of water for more than 3 weeks. Area pump stations were left inoperable or inaccessible, which caused the dewatering process to take approximately 53 days. According to the Department of Health and Hospitals (DHH), approximately 1,400 deaths were reported following Hurricane Katrina. Approximately 1.3 million residents were displaced immediately following the storm. 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 (DEQ), 350,000 vehicles, and 60,000 fishing and recreational vessels were damaged.

2 ALTERNATIVES

The final array of alternatives consists of two system-wide levee lift alternatives. One alternative lifts the current levee elevation to the future 1% AEP event. The other alternative lifts the current levee elevation to the future .5% AEP event. For more detailed descriptions and maps of the structural alignments refer to the main report. Tables 4 and 5 below display the equivalent annual damages reduced and the residual damages by reach for the 1% and .5% alternative respectively.

2.1 ECONOMIC MODEL

The HEC-FDA program version 1.4.2 was utilized to evaluate flood damages using risk-based methods. This program is used to quantify the uncertainty in discharge-exceedance probability, stage-discharge, and stage-damage functions and assimilates it into the economic and engineering performance analyses of alternatives. Monte Carlo simulation is used to compute the expected value of damage while explicitly accounting for the uncertainty in economic and hydraulic parameters used to determine flood inundation damages. The analysis considers a range of possible values for each economic variable used to calculate the elevation- or stage-damage curves, and for each hydrologic/hydraulic variable used to calculate the stage-frequency curves. It also considers a probability distribution for the likely occurrence of any given outcome within the specified range. The key economic inputs for the analysis are the structure inventory, depth-damage functions, content-to-structure value ratios, and the associated quantified risk and uncertainty parameters associated with these inputs.

2.2 STRUCTURE INVENTORY

The structure inventory used for this study is the National Structure Inventory (NSI) version 2. This updated version of the inventory uses Zillow data, ESRI map layer data, and CoreLogic data to improve structure placement over the previous version of the NSI. RS Means was used to calculate the depreciated replacement value of structures. An extensive survey was conducted to estimate foundation heights for different sectors within the Metro New Orleans area. Furthermore, the foundation heights of the inventory were updated using data from a traffic zone survey that was conducted for the Metro New Orleans data. This structure inventory does not include future development. Structure counts by reach along with the total structure and content value are shown in Table 1. Structure counts by occupancy types are shown in Table 2.

Table 1
Lake Pontchartrain and Vicinity
Structure Counts and Value by Reach

Reach	Structure Count	Total Value
CL	19,598	7,802,961,000
JEB	86,639	48,018,373,000
NOE	23,959	11,612,588,000
OEB	93,052	63,381,560,000
SC	10,104	4,704,841,000
Total	233,352	135,520,323,000

Table 2 Lake Pontchartrain and Vicinity Structure Counts by Occupancy Type NSI 2019	
Residential	
One-Story Slab	73,761
One-Story Pier	67,339
Two-Story Slab	26,600
Two-Story Pier	23,478
Mobile Home	3,420
Total Residential	194,598
Non-Residential	
Eating and Recreation	3,718
Professional	12,065
Public and Semi-Public	3,293
Repair and Home Use	4,211
Retail and Personal Services	7,666
Warehouse	5,016
Multi-Family Occupancy	2,795
Total Non-Residential	38,764

2.3 STRUCTURE VALUE UNCERTAINTY

The uncertainty surrounding the residential structure values was based on the depreciation percentage applied to the average replacement cost per square foot calculated from the four exterior wall types. A triangular probability distribution was used to represent the uncertainty surrounding the residential structure values in each occupancy category. The most-likely depreciated value was based on the average construction class and a 20 percent depreciation rate (consistent with an observed age of a 20-year old structure in average condition), the minimum value was based on the economy construction class and a 45 percent depreciation rate (consistent with an observed age of a 30-year old structure in poor condition), and the maximum value was based on the luxury construction class and a 7 percent depreciation rate (consistent with an observed age of a 10-year old structure in good condition). These values were then converted to a percentage of the most-likely value with the most-likely value equal to 100 percent of the average value for each occupancy category and the economy and luxury class values equal to a percentage of these values. The triangular probability distributions were entered into the HEC-FDA model to represent the uncertainty surrounding the structure values in each residential occupancy category.

The uncertainty surrounding the non-residential structure values was based on the depreciation percentage applied to the average replacement cost per square foot calculated from the six exterior wall types. A triangular probability distribution based on the depreciation percentage associated with an observed age (determined using the professional judgment of personnel familiar with the study area) and the type of frame structure was used to represent the uncertainty surrounding the non-residential structure values in each occupancy category. The most-likely depreciated value was based on the depreciation percentage (25 percent) assigned to structures with an observed age of 20 years for masonry and wood construction, the minimum depreciated value was based on the depreciation percentage (40 percent) assigned to structures with an observed age of 30 years for framed construction, and the maximum depreciated value was based on the on the depreciation percentage (8 percent) assigned to structures with an observed age of 10 years for masonry on masonry or steel construction. These values were then converted to a percentage of the most-likely value with the most-likely value being equal to 100 percent and the minimum and maximum values equal to percentages of the most-likely value. The triangular probability distributions were entered into the HEC-FDA model to represent the uncertainty surrounding the structure values for each non-residential occupancy category.

2.4 COMPLIANCE WITH POLICY GUIDANCE LETTER (PGL) AND EXECUTIVE ORDER 11988

Figure 2 shows that a predominance of the developable land is already developed. Based off the land use information as well as forecasted population trends (Figure 3), it is expected that development will continue to occur in urbanized areas within the study area with or without the hurricane and storm damage risk reduction measures in place and will not conflict with PGL 25 and EO 11988. Additionally, since a 1% risk reduction project currently exists it is anticipated that the overall growth rate will remain the same with or without the proposed project in place. Thus, the proposed project will not induce development, but would rather reduce the risk of the population being displaced after a major storm event.

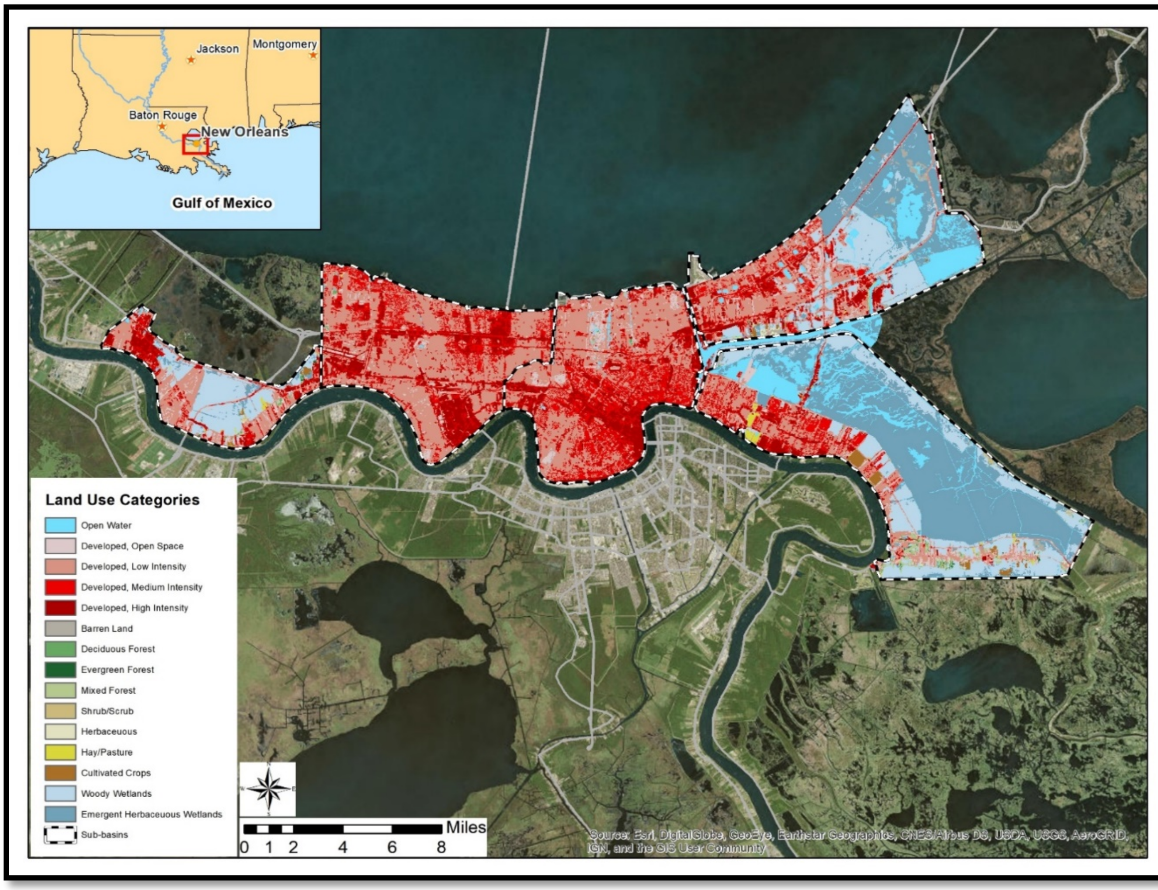

Figure 2. Existing Land Use

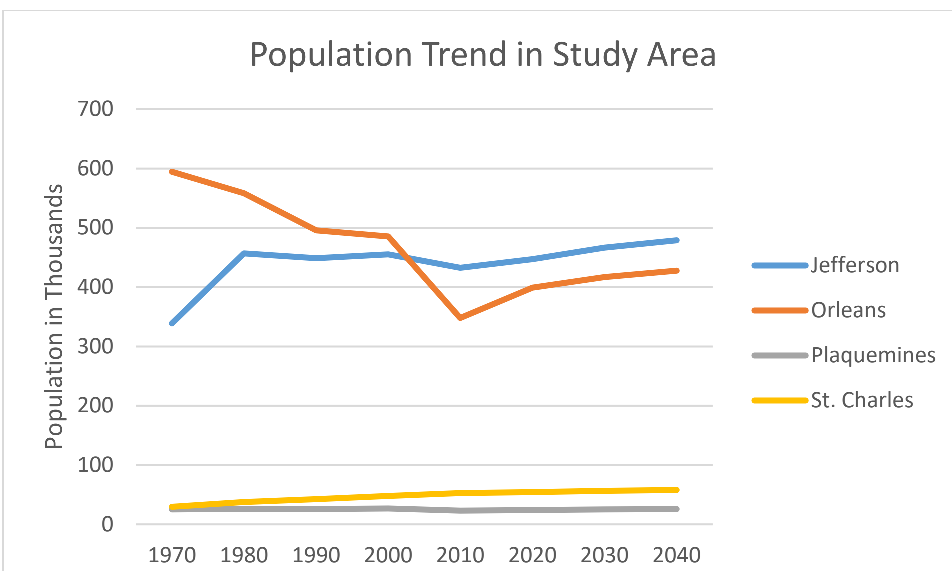

Figure 3. Population Trends

2.5 DEPTH-DAMAGE RELATIONSHIPS AND CONTENT-TO-STRUCTURE VALUE RATIO

Depth-damage relationships define the relationship between the depth of flooding and the percent of damage at varying depths that occurs to structures and contents. These mathematical functions are used to quantify the flood damages to a given structure. The content-to-structure value ratio (CSVR) is expressed as a ratio of two values: the depreciated replacement cost of contents and the depreciated replacement cost of the structure. One method to derive these relationships is the "Expert Opinion" method described in the *Handbook of Forecasting Techniques, IWR Contract Report 75-7, December 1975* and *Handbook of Forecasting Techniques, Part II, Description of 31 Techniques, Supplement to IWR Contract Report 75-7, August 1977.* A panel of experts was convened to develop site-specific depth-damage relationships and CSVRS for feasibility studies associated with Jefferson and Orleans Parishes. Professionals in the fields of residential and non-residential construction, general contractors, insurance claims adjusters with experience in flood damage, and a certified restoration expert were selected to sit on the panel. The panel was tasked with developing an array of residential and non-residential structure and content types. Residential structure types were divided into one-story on pier, one-story on slab, two-story on pier, two-story on slab and mobile homes. Non-residential structure types were categorized as metal-frame walls, masonry bearing walls, and wood or steel frame walls. Residential contents were evaluated as one-story, two-story, or mobile home. Non-residential content categories included the following types: eating and recreation, groceries and gas stations, multi-family residences, repair and home use, retail and personal services, professional businesses, public and semi-public, and warehouse and contractor services. The results of this panel were published in the report *Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-To-Structure Value Ratios (CSVRS) In Support Of the Jefferson and Orleans Flood Control Feasibility Studies, June 1996 Final Report*. Table 3 displays the content-to-structure value ratios and their respective standard deviations used for both LPV and WBV.

Table 3 **Content-to-Structure Value Ratios (CSVRs) and Standard Deviations (SDs)**		
Structure Category		(CSVR,SD)
Residential	One-story	(0.69, 0.37)
	Two-story	(0.67, 0.35)
	Mobile home	(1.14, 0.79)
Non-Residential	Eating and Recreation	(1.70, 2.93)
	Groceries and Gas Stations	(1.34, 0.78)
	Professional Buildings	(0.54, 0.54)
	Public and Semi-Public Buildings	(0.55, 0.80)
	Multi-Family Buildings	(0.28, 0.17)
	Repair and Home Use	(2.36, 2.95)
	Retail and Personal Services	(1.19, 1.05)
	Warehouses and Contractor Services	(2.07. 3.25)

2.6 VEHICLE INVENTORY AND VALUES

Based on 2010 Census information for the New Orleans Metropolitan area, there are an average of 2.0 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. According to Edmunds.Com, the average value of a used car was $18,800 as of 2nd quarter 2015. The Manheim Used Vehicle Value Index was used to adjust the average value to reflect FY 2019 price levels. According to the Manheim index, the average value of a used car increased 8.0 percent to $20,000 between the years 2015 and 2019. Since only those vehicles not used for evacuation can be included in the damage calculations, an adjusted average vehicle value of $12,000 ($20,000 x 2.0 x 0.30) was assigned to each individual residential automobile structure record in the HEC-FDA model. If an individual structure contained more than one housing unit, then the adjusted vehicle value was assigned to each housing unit in a residential or multi-family structure category. Only vehicles associated with residential structures were included in the analysis. Vehicles associated with non-residential properties were not included in the evaluation. Finally, every apartment building was assumed to contain 50 units so every apartment building has $600,000 as the average value for vehicles (50 units x $10.6 thousand).

2.6.1 VEHICLE VALUE UNCERTAINTY

The uncertainty surrounding the values assigned to the vehicles in the inventory was determined using a triangular probability distribution function. The average value of a used car, $18,600, was used as the most-likely value. The average value of a new vehicle, $34,000, before taxes, license, and shipping charges was used as the maximum value, while the average 10-year depreciation value of a vehicle, $3,000 was used as the minimum value. The percentages were developed for the most-likely, minimum, and the maximum values with the most-likely equal to 100 percent, and the minimum and the maximum values as percentages of the most-likely value (minimum=25%, most-likely=100%, maximum=183%). These percentages were entered into the HEC-FDA model as a triangular probability distribution to represent the uncertainty surrounding the vehicle value for both residential and non-residential vehicles.

2.7 FIRST FLOOR ELEVATIONS

Topographical data based on NAVD 88 vertical datum was used to assign ground elevations to structures and vehicles in the study area. The assignment of ground elevations and the placement of structures were based on a digital elevation model (DEM) with a fifteen foot by fifteen foot grid resolution developed by the United States Geological Survey (USGS). The ground elevation was added to the height of the foundation of the structure above the ground in order to obtain the first floor elevation of each structure in the study area. Vehicles were assigned to the ground elevation of the adjacent residential structures.

2.7.1 UNCERTAINTY SURROUNDING ELEVATIONS

There are two sources of uncertainty surrounding the first floor elevations: the use of the LiDAR data for the ground elevations and the methodology used to determine the structure foundation heights above ground elevation. The error surrounding the LiDAR data was determined to be plus or minus 0.5895 feet at the 95 percent level of confidence. This uncertainty was normally distributed with a mean of zero and a standard deviation of 0.3 feet.

The uncertainty surrounding the foundation heights for the residential structure categories and commercial structures was estimated by calculating the standard deviations surrounding the sampled mean values. An overall weighted average standard deviation for all of the sampled structures was computed for each residential and non-residential structure category and for all of the residential and non-residential structures, regardless of structure category.

Uncertainty can only be applied to structure occupancies in the HEC-FDA model. In order to develop a standard deviation for each structure occupancy, first, the structures in each residential category had to be grouped into the structure occupancies; second, a mean foundation height value was calculated for the structures within the structure occupancy; third, the standard deviation as a percentage of the mean foundation height value for all the sampled residential structures was calculated and that percentage was applied to the mean foundation value of the residential and non-residential occupancies; fourth, the calculated standard deviation for each structure occupancy was entered into the HEC-FDA model.

2.7.2 STAGE-DAMAGE RELATIONSHIPS WITH UNCERTAINTY

The HEC-FDA model used the economic and engineering inputs to generate a stage-damage relationship for each structure category in each study area reach under 2023 and 2073 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 LPV 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.

2.7.3 STAGE-PROBABILITY RELATIONSHIPS WITH UNCERTAINTY

The HEC-FDA model used an equivalent record length of 50 years for each study area reach to generate a stage-probability relationship with uncertainty through the use of graphical analysis. The model used the eight stage-probability events (1, 0.1, .04, .02, .01, .005, .002, .001) 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. 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. False levees were used to control for damages occurring below the stages where inundation begins.

2.8 EXPECTED ANNUAL AND EQUIVALENT 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. 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 EAD were totaled for each study area reach to obtain the total without-project EAD under 2023 and 2073 conditions. The model uses the discount rate to discount the future damages and benefits occurring in 2073 back to the base year of 2023. Table 4 shows the without-project expected annual damages by reach for 2023 and 2073 respectively along with the without-project equivalent annual damages. Table 5 shows the damages by probability event for 2023 and 2073. Table 6 shows the damages by damage category for 2023 and 2073. The increase in damages from 2023 to 2073 is due to a combination of intermediate relative sea-level rise and the subsidence of the existing levee system.

Table 4
Lake Pontchartrain and Vicinity
Expected and Equivalent Annual Without-Project Damages
FY 19 Price Level; FY 20 Discount Rate
$1,000s

Sub-basin	Expected Annual Damages 2023	Expected Annual Damages 2073	Equivalent Annual Damages 2023-2073
Chalmette Loop	6,199	12,684	8,665
Jefferson East Bank	67,037	243,978	134,333
New Orleans East	8,564	38,964	20,126
Orleans East Bank	9,520	137,109	58,046
Saint Charles	6,842	19,910	11,812
Total	98,162	452,646	232,982

Table 5
Lake Pontchartrain and Vicinity
Damages by year and probability event
$1,000s

AEP	Damages 2023	Damages 2073
1	0	0
0.1	0	0
0.04	0	0
0.02	0	0
0.01	109,933	1,335,165
0.05	1,336,526	35,885,831
0.002	18,080,420	81,901,980
0.001	36,549,710	99,531,020

Table 6
Lake Pontchartrain and Vicinity
Damages by Damage Category and Reach
$1,000s

2023					
Reach	Auto	Commercial	Mobile Homes	Residential	Total
CL	270	2,607	64	3,257	6,199
JEB	1,984	37,901	617	26,535	67,037
NOE	398	2,870	179	5,117	8,564
OEB	279	4,907	155	4,179	9,520
SC	254	3,330	86	3,172	6,842
Total	3,186	51,615	1,102	42,259	98,162
2073					
Reach	Auto	Commercial	Mobile Homes	Residential	Total
CL	543	5,410	135	6,596	12,684
JEB	6,736	145,370	2,137	89,735	243,978
NOE	1,633	14,646	697	21,989	38,964
OEB	3,587	72,132	2,793	58,597	137,109
SC	744	8,588	174	10,404	19,910
Total	13,243	246,146	5,936	187,321	452,646

Table 7
Lake Pontchartrain and Vicinity
Equivalent Annual Damages Reduced-1% Alternative 2
FY 19 Price Level; FY 20 Discount Rate
$1,000s

Sub-Basin	Without Project	Residual Damages	Damages Reduced
Chalmette Loop	8,665	1,873	6,792
Jefferson East Bank	134,333	20,055	114,278
New Orleans East	20,126	2,209	17,918
Orleans East Bank	58,046	5,624	52,422
Saint Charles	11,812	136.144736	11,676
Total	232,983	29,896	203,086

Table 8
Lake Pontchartrain and Vicinity
Equivalent Annual Damages Reduced-.5% Alternative 3
FY 19 Price Level; FY 20 Discount Rate
$1,000s

Sub-Basin	Without Project	Residual Damages	Damages Reduced
Chalmette Loop	8,665	832	7,833
Jefferson East Bank	134,333	19,568	114,765
New Orleans East	20,126	734	19,392
Orleans East Bank	58,046	4,389	53,657
Saint Charles	11,812	51	11,761
Total	232,983	25,574	207,408

2.9 AVERAGE ANNUAL COSTS

The initial construction cost (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 (2023). The FY 2020 Federal discount rate of 2.75 percent was used to discount the costs to the base year and then amortize the costs over the 50-year period of analysis. The operations, maintenance, relocations, rehabilitation, and repair (OMRR&R) costs for each alternative was discounted to present value and annualized using the Federal discount rate of 2.75 percent for 50 years. Tables 7 and 9 provide the life cycle costs for each of the project components, the average annual construction costs, the annual operation and maintenance costs, and the total average annual costs for each of the alternatives.

Table 9
Life Cycle Cost Schedule-Construction and OMRR&R
1% AEP Alternative 2
(2019 Price Level; FY 20 Discount Rate)
Lake Pontchartrain and Vicinity

Year	Years from Base Year	Expenditures	Present Value Factor	Present Value of Expenditures
2021	1	$120,100,385	1.0415	$125,084,551
2022	0	$256,090,168	1.0137	$259,598,603
2023	-1	$23,955,790	0.9865	$23,632,387
2024	-2	$113,729,676	0.9601	$109,191,862
2025	-3	$23,955,790	0.9344	$22,384,290
2026	-4	$23,955,790	0.9094	$21,785,396
2027	-5	$23,955,790	0.8851	$21,203,270
2028	-6	$23,955,790	0.8614	$20,635,518
2029	-7	$23,955,790	0.8383	$20,082,139
2030	-8	$23,955,790	0.8159	$19,545,529
2031	-9	$23,955,790	0.7941	$19,023,293
2032	-10	$113,729,676	0.7728	$87,890,294
2033	-11	$23,955,790	0.7521	$18,017,150
2034	-12	$23,955,790	0.732	$17,535,638
2035	-13	$23,955,790	0.7124	$17,066,105
2036	-14	$23,955,790	0.6933	$16,608,549
2037	-15	$23,955,790	0.6748	$16,165,367
2038	-16	$23,955,790	0.6567	$15,731,767
2039	-17	$400,146,343	0.6391	$255,733,528

2040	-18	$311,885,448	0.622	$193,992,749
2041	-19	$23,955,790	0.6054	$14,502,835
2042	-20	$23,955,790	0.5892	$14,114,752
2043	-21	$23,955,790	0.5734	$13,736,250
2044	-22	$23,955,790	0.5581	$13,369,726
2045	-23	$23,955,790	0.5431	$13,010,390
2046	-24	$23,955,790	0.5286	$12,663,031
2047	-25	$23,955,790	0.5145	$12,325,254
2048	-26	$113,729,676	0.5007	$56,944,449
2049	-27	$23,955,790	0.4873	$11,673,657
2050	-28	$23,955,790	0.4742	$11,359,836
2051	-29	$538,184,408	0.4615	$248,372,104
2052	-30	$23,955,790	0.4492	$10,760,941
2053	-31	$311,885,448	0.4372	$136,356,318
2054	-32	$23,955,790	0.4255	$10,193,189
2055	-33	$23,955,790	0.4141	$9,920,093
2056	-34	$23,955,790	0.403	$9,654,183
2057	-35	$23,955,790	0.3922	$9,395,461
2058	-36	$23,955,790	0.3817	$9,143,925
2059	-37	$23,955,790	0.3715	$8,899,576
2060	-38	$232,090,325	0.3616	$83,914,767
2061	-39	$23,955,790	0.3519	$8,430,043
2062	-40	$23,955,790	0.3425	$8,204,858
2063	-41	$269,241,282	0.3333	$89,738,2336
2064	-42	$23,955,790	0.3244	$7,771,258
2065	-43	$57,828,066	0.3157	$18,256,221
2066	-44	$23,955,790	0.3072	$7,359,219
2067	-45	$23,955,790	0.299	$7,162,781
2068	-46	$23,955,790	0.291	$6,971,135
2069	-47	$23,955,790	0.2832	$6,784,280

2070	-48	$23,955,790	0.2757	$6,604,611
2071	-49	$23,955,790	0.2683	$6,427,338
2072	-50	$23,955,790	0.2611	$6,254,857
		$3,796,872,508		$2,201,807,572

Interest Rate (%)	2.75
Amortization Factor	0.03704
Average Annual Costs	$57,274,100
Average Annual O&M Costs	$24,282,900
Total Average Annual Costs	$81,557,000

Table 10
Life Cycle Cost Schedule-Construction and OMRR&R
0.5% AEP Alternative 3
(2019 Price Level; FY 20 Discount Rate)
Lake Pontchartrain and Vicinity

Year	Years from Base Year	Expenditures	Present Value Factor	Present Value of Expenditures
2021	1	$131,407,301	1.0415	$136,864,949
2022	0	$280,199,917	1.0137	$284,026,536
2023	-1	$26,351,369	0.9865	$25,996,344
2024	-2	$124,577,066	0.9601	$119,609,412
2025	-3	$26,351,369	0.9344	$24,623,433
2026	-4	$26,351,369	0.9094	$23,964,412
2027	-5	$26,351,369	0.8851	$23,323,029
2028	-6	$26,351,369	0.8614	$22,698,811
2029	-7	$26,351,369	0.8383	$22,091,301
2030	-8	$26,351,369	0.8159	$21,500,049
2031	-9	$26,351,369	0.7941	$20,924,622
2032	-10	$124,577,066	0.7728	$96,274,375

2033	-11	$26,351,369	0.7521	$19,819,558
2034	-12	$26,351,369	0.732	$19,289,107
2035	-13	$26,351,369	0.7124	$18,772,854
2036	-14	$26,351,369	0.6933	$18,270,417
2037	-15	$26,351,369	0.6748	$17,781,428
2038	-16	$26,351,369	0.6567	$17,305,526
2039	-17	$437,958,587	0.6391	$279,919,299
2040	-18	$341,388,322	0.622	$212,357,022
2041	-19	$26,351,369	0.6054	$15,952,888
2042	-20	$26,351,369	0.5892	$15,525,925
2043	-21	$26,351,369	0.5734	$15,110,389
2044	-22	$26,351,369	0.5581	$14,705,975
2045	-23	$26,351,369	0.5431	$14,312,385
2046	-24	$26,351,369	0.5286	$13,929,328
2047	-25	$26,351,369	0.5145	$13,556,524
2048	-26	$124,577,066	0.5007	$62,373,688
2049	-27	$26,351,369	0.4873	$12,840,581
2050	-28	$26,351,369	0.4742	$12,496,916
2051	-29	$588,992,321	0.4615	$271,848,826
2052	-30	$26,351,369	0.4492	$11,836,933
2053	-31	$341,388,322	0.4372	$149,246,044
2054	-32	$26,351,369	0.4255	$11,211,805
2055	-33	$26,351,369	0.4141	$10,911,732
2056	-34	$26,351,369	0.403	$10,619,690
2057	-35	$26,351,369	0.3922	$10,335,465
2058	-36	$26,351,369	0.3817	$10,058,847
2059	-37	$26,351,369	0.3715	$9,789,632
2060	-38	$255,871,181	0.3616	$92,512,992
2061	-39	$26,351,369	0.3519	$9,272,625
2062	-40	$26,351,369	0.3425	$9,024,453

2063	-41	$296,503,322	0.3333	$98,824,682
2064	-42	$26,351,369	0.3244	$8,547,856
2065	-43	$65,202,218	0.3157	$20,584,227
2066	-44	$26,351,369	0.3072	$8,096,430
2067	-45	$26,351,369	0.299	$7,879,737
2068	-46	$26,351,369	0.291	$7,668,844
2069	-47	$26,351,369	0.2832	$7,463,595
2070	-48	$26,351,369	0.2757	$7,263,839
2071	-49	$26,351,369	0.2683	$7,069,430
2072	-50	$26,351,369	0.2611	$6,880,224
		$4,166,697,450		$2,414,739,508
Interest Rate (%)	2.75			
Amortization Factor	0.03704			
Average Annual Costs	$62,733,000			
Average Annual O&M Costs	$26,711,200			
Total Average Annual Costs	$89,444,200			

2.10 NONSTRUCTURAL ASSESSMENT

An equivalent annual damage value was calculated for each structure in the inventory for both LPV and WBV using intermediate output files from the HEC-FDA model. This EAD per structure was then compared against the average annualized cost of applying a non-structural measure (house raising and dry floodproofing) for the Southwest Coastal study in order to determine the approximate number of structures that would be economically justified. Using this methodology, for the LPV study, approximately 1,600 structures would be economically justified. This total is 0.7% of the total structure inventory and 1% of the subset of structures damaged from inundation. Eight smaller economically justified aggregations of structures were identified, roughly corresponding to a city block; no large economically justified aggregations of structures were identified.

2.11 NET BENEFITS

The net benefits for the alternatives were calculated by subtracting the average annual costs from the equivalent annual benefits. The net benefits were used to determine the economic justification of the project alternatives. Table 11 summarizes the equivalent annual damages and benefits, total first costs, average annual cost, benefit-to-cost ratio, and equivalent annual net benefits for each project alternative. Both alternatives are economically justified, meaning their benefit-to-cost ratio is a least 1. Of the two alternatives, Alternative 2 has the highest net benefits. Since alternative 2 is the plan that maximizes net benefits, it is the National Economic Development (NED) Plan.

Table 11
Lake Pontchartrain and Vicinity
Summary of Results
FY 19 Price Level
FY 20 Discount Rate: 2.75%

Alternative	Alt 2 (1%)	Alt 3 (0.5%)
Project First Cost	$2,599,083,000	$2,849,129,000
Interest During Construction	$8,492,601	$9,284,268
Total Investment Cost	$2,607,575,601	$2,858,413,268
AA Investment Costs	$57,274,100	$62,733,000
AA O&M Costs	$24,282,900	$26,711,200
Total AA Costs	$81,557,000	$89,444,200
Without Project EAD	$232,983,000	$232,983,000
EAD Reduced Benefits	$203,086,000	$207,408,000
Net Benefits	$121,529,000	$117,963,800
B/C Ratio	2.5	2.3

2.11.1 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 project alternatives. Table 12 shows the expected 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. 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 indicates the percent chance that the expected annual benefits will exceed the expected annual costs therefore the benefit cost ratio is greater than one and the net benefits are positive.

Table 12
Risk Analysis
Probability that Expected Annual Benefits Exceed Annual Costs
Lake Pontchartrain and Vicinity
FY 2019 Price Level; FY 2020 Discount Rate
$1,000s

		Probability that Damages Reduced exceed indicated values				
Plan Name	Equivalent Annual Damages Reduced	0.75	0.5	0.25	Average Annual Costs	Probability Benefits Exceed Costs
Alt 2 (1% AEP)	203,086	20,358	66,786	310,411	81,557	0.5>X>0.25
Alt 3 (0.5% AEP)	207,408	37,285	83,912	319,223	89,444	0.5>X>0.25