US Army Corps
of Engineers
Mobile District

June 2009

Mississippi Coastal Improvements Program (MsCIP) Hancock, Harrison, and Jackson Counties, Mississippi

Comprehensive Plan and Integrated Programmatic Environmental Impact Statement

Volume 3 - Appendix B: Economics



FOREWORD

This document is one of a number of technical appendices to the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan and Integrated Feasibility Report and Environmental Impact Statement.

The Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan Integrated Feasibility Report and Environmental Impact Statement provides systems-based solutions and recommendations that address: hurricane and storm damage reduction, ecosystem restoration and fish and wildlife preservation, reduction of damaging saltwater intrusion, and reduction of coastal erosion. The recommendations contained in the Main Report/EIS also provide measures that aid in: greater coastal environmental and societal resiliency, regional economic re-development, and measures to reduce long-term risk to the public and property, as a consequence of hurricanes and coastal storms. The recommendations cover a comprehensive package of projects and activities that treat the environment, wildlife, and people, as an integrated system that requires a multi-tiered and phased approach to recovery and risk reduction, irrespective of implementation authority or agency.



The MsCIP Study Area

The purpose of the Comprehensive Plan Report is to present, to the Congress of the United States, the second of two packages of recommendations (i.e., the first being the "interim" recommendations funded in May 2007, and this "final" response, as directed by the Congress), directed at recovery of vital water and related land resources damaged by the hurricanes of 2005, and development of recommendations for long-term risk reduction and community and environmental resiliency, within the three-county, approximately 70 mile-long coastal zone, including Mississippi Sound and its barrier islands, of the State of Mississippi.

This appendix, the Main Report/EIS, and all other appendices and supporting documentation, were subject to Independent Technical Review (ITR) and an External Peer Review (EPR). Both review processes will have been conducted in accordance with the Corps "Peer Review of Decision Documents" process, has been reviewed by Corps staff outside the originating office, conducted by a Regional and national team of experts in the field, and coordinated by the National Center of Expertise in Hurricane and Storm Damage Protection, North Atlantic Division, U.S. Army Corps of Engineers.

The report presents background on the counties that comprise the Mississippi coastline most severely impacted by the Hurricanes of 2005, their pre-hurricane conditions, a summary of the effects of the 2005 hurricane season, problem areas identified by stakeholders and residents of the study area, a summary of the approach used in analyzing problems and developing recommendations directed at assisting the people of the State of Mississippi in recovery, recommended actions and projects that would assist in the recovery of the physical and human environments, and identification of further studies and immediate actions most needed in a comprehensive plan of improvements for developing a truly resilient future for coastal Mississippi.

This appendix contains detailed technical information used in the analysis of existing and future without-project conditions, in the development of problem-solving measures, and in the analysis, evaluation, comparison, screening, and selection of alternative plans, currently presented as recommendations contained in the Main Report/EIS.

Each appendix functions as a complete technical document, but is meant to support one particular aspect of the feasibility study process. However, because of the complexity of the plan formulation process used in this planning study, the information contained herein should not be used without parallel consideration and integration of all other appendices, and the Main Report/EIS that summarizes all findings and recommendations.

The intent of the economic appendix is to outline the economic evaluation conducted for the Mississippi Coastal Improvements Programs (MsCIP) Comprehensive Plan. This appendix will display the National Economic Development (NED) benefits, Regional Economic Development (RED) benefits, Environmental Quality (EQ) benefits, Other Social Effects (OSE), and costs that were evaluated for the various Comprehensive Plan measures. The intent of this appendix is to demonstrate the cost effectiveness of measures. recommendations of cost effective plans are outlined in the MsCIP Main Report, and are based on the data from this appendix, other technical appendices, and the results of the Risk Informed Decision Framework (RIDF) evaluations.

Contents

CHAPTER I. DEFINING THE STUDY AREA 1
1.3.1 Planning Zones 1
1.3.2 Planning Units 2
1.3.3 Planning Sub-Units 2

CHAPTER II. OVERVIEW OF ECONOMIC METHODOLOGY 7

CHAPTER III. MODELING EFFORTS 10
3.1 Corps of Engineers Flood Inventory Tool (CEFIT) 10
3.1.1 Program Overview 10
3.1.2 Extent of Use 11
3.1.3 Uncertainty 11
3.2 Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) 11
3.2.1 Program Overview 11
3.2.2 Depth Damage Relationships 13
3.2.3 Extent of Use 14
3.2.4 Uncertainty 14
3.3 Beach-FX 14
3.3.1 Program Overview 14
3.3.2 Depth Damage Functions 15
3.3.3 Extent of Use 15
3.3.4 Uncertainty 15
3.4 Institute for Water Resources (IWR) Planning Suite 16
3.4.1 Program Overview 16
3.4.2 Extent of Use 17
3.4.3 Uncertainty 17
3.5 Economic Impact Forecasting Systems (EIFS) 18
3.5.1 Program Overview 18
3.5.2 Extent of Use 18
3.5.3 Uncertainty 19

CHAPTER IV. DATA COLLECTION METHODOLOGY 20
4.1 Damage Categories 21
4.2 Occupancy Types 21
4.3 First Floor Elevations 29
4.4 Structure Values 30
4.4.1 Residential Structure Values 30
4.5 Content Values 35

CHAPTER V. INVENTORY AND FORECASTING CONDITIONS 40
5.1 Historic Conditions 40
5.1.1 Impacts of Hurricane Camille 40
5.1.2 Historic (Pre-Hurricane) Population Trends 41
5.1.3 Historic (Pre-Hurricane Katrina) Environmental Setting 42
5.2 Existing (Post-Hurricane Katrina) Conditions 43
5.2.1 Impacts from Hurricane Katrina 43
5.2.2 Existing Structure Conditions 44

5.2.3 Existing (Post-Hurricane Katrina) Socio-economic Conditions 52
5.2.4 Existing (Post-Hurricane Katrina) Environmental Setting 60
5.3 Future Without-Project Conditions 61
5.3.1 Period of Analysis 61
5.3.2 Assumptions 62
5.3.3 Scenario Testing 64
5.3.4 Future Without-Project Surge Risk 70
5.3.5 Summary of Future Without-Project Damages 74
5.3.6 Impacts of Redevelopment Scenarios on Equivalent Annual Without-Project Damages 83
5.3.7 Impacts of Relative Sea Level Rise on Equivalent Annual Without-Project Damages 86

CHAPTER VI. DEVELOPMENT AND EVALUATION OF MEASURES 90
6.1 Overview of Benefits and Cost Evaluation 90
6.1.1 Calculation of National Economic Development Benefits 90
6.1.2 Calculation of Costs 91
6.1.3 Calculation of Regional Economic Development Benefits 93
6.2 Evaluation of Barrier Island Measures 94
6.2.1 General Description 94
6.2.2 List of Measures 104
6.2.3 With-Project Conditions 107
6.2.4 Summary of Costs 108
6.2.5 Regional Economic Development (EIFS Model) 108
6.2.6 Summary of Costs and Benefits 109
6.3 Evaluation of Beach and Dune Construction Measures 110
6.3.1 Planning Unit One 110
6.3.2 Panning Unit Two 121
6.3.3 Planning Unit Three 133
6.4 Seawall and Elevated Roadway Area Measures 143
6.4.1 General 143
6.4.2 Historic (Pre-Hurricane Katrina) Conditions 143
6.4.3 Opportunities 147
6.4.4 Assumptions 147
6.4.5 Measures 147
6.4.6 National Economic Development (NED) 148
6.4.7 Environmental Quality (EQ) 150
6.4.8 Summary of Costs 152
6.4.9 Regional Economic Development (RED) 152
6.5 Evaluation of Pearlington Area Measures 154
6.5.1 General 154
6.5.2 Opportunities 155
6.5.3 Assumptions 155
6.5.4 Measures 155
6.5.5 National Economic Development (NED) 156
6.5.6 Environmental Quality (EQ) 164
6.5.7 Summary of Costs 165
6.5.8 Regional Economic Development (RED) 165
6.6 Admiral Island Ecosystem Restoration Measures 167
6.6.1 Formulation of Alternatives 167

6.6.2 Comparison of Alternatives 173
6.6.3 Regional Economic Development (RED) Benefits 176
6.7 Evaluation of Turkey Creek Ecosystem Restoration Measures 177
6.7.1 Formulation of Alternatives 177
6.7.2 Comparison of Alternatives 183
6.7.3 Regional Economic Development Benefits 185
6.8 Evaluation of Ocean Springs Area Measures 187
6.8.1 General 187
6.8.2 Opportunities 188
6.8.3 Assumptions 188
6.8.4 Measures 188
6.8.5 National Economic Development (NED) 189
6.8.6 Environmental Quality (EQ) 197
6.8.7 Summary of Costs 198
6.8.8 Regional Economic Development (RED) 199
6.9 Evaluation of Gautier Area Measures 200
6.9.1 General 200
6.9.2 Opportunities 200
6.9.3 Assumptions 200
6.9.4 Measures 201
6.9.5 National Economic Development (NED) 202
6.9.6 Environmental Quality (EQ) 210
6.9.7 Summary of Costs 211
6.9.8 Regional Economic Development (RED) 212
6.10 Evaluation of Gulf Park Estates Area Measures 213
6.10.1 General 213
6.10.2 Opportunities 213
6.10.3 Assumptions 213
6.10.4 Measures 215
6.10.5 National Economic Development (NED) 216
6.10.6 Environmental Quality (EQ) 225
6.10.7 Summary of Costs 225
6.10.8 Regional Economic Development (RED) 226
6.11 Evaluation of Belle Fontaine Area Measures 228
6.11.1 General 228
6.11.2 Opportunities 229
6.11.3 Assumptions 229
6.11.4 Measures 229
6.11.5 National Economic Development (NED) 231
6.11.6 Environmental Quality (EQ) 238
6.11.7 Summary of Costs 239
6.11.8 Regional Economic Development (RED) 240
6.12 Evaluation of Pascagoula - Moss Point Area Measures 242
6.12.1 General 242
6.12.2 Opportunities 242
6.12.3 Assumptions 243
6.12.4 Measures 244
6.12.5 National Economic Development (NED) 246

6.12.6 Environmental Quality (EQ) 258
6.12.7 Summary of Costs 259
6.12.8 Regional Economic Development (RED) 260
6.13 Evaluation of Bayou Cumbest Area Ecosystem Restoration Measures 263
6.13.1 Environmental Quality (EQ) 264
6.13.4 Regional Economic Development (RED) 272
6.14 Dantzler Area Ecosystem Restoration Measures 273
6.14.1 Formulation of Measures 273
6.14.2 Comparison of Measures 279
6.14.3 Regional Economic Development (RED) Benefits 281
6.14.4 Summary Explanation of the EIFS Model Output 282
6.15 Franklin Ecosystem Restoration Measures 283
6.15.1 Formulation of Alternatives 283
6.15.2 Comparison of Alternatives 288
6.15.3 Regional Economic Development (RED) Benefits 290
6.16 Evaluation of Inland Barrier and Surge Barrier Flood Damage Reduction Measures 292
6.16.1 General 292
6.16.2 Historic (Pre-Hurricane Katrina) Conditions 292
6.16.3 Opportunities 295
6.16.4 Assumptions 295
6.16.5 Measures 295
6.16.6 National Economic Development (NED) 298
6.16.7 Environmental Quality (EQ) 303
6.16.8 Summary of Costs 305
6.16.9 Regional Economic Development (RED) 306
6.17 Evaluation of Coast Wide Nonstructural Flood Damage Reduction Measures 306
6.17.1 General 306
6.17.2 Opportunities 306
6.17.3 Assumptions 311
6.17.4 Types of Nonstructural Measures 311
6.17.5 Historic Conditions 311
6.17.6 Existing Conditions 312
6.17.7 Without-Project Conditions 313
6.17.8 Equivalent Annual Damages Reduced and Residual Damages 318
6.17.9. Summary of Damages 323
6.17.10 Summary of Costs 324
6.17.11 Alternative Land Use 325
6.17.12 Other Social and Economic Benefits 325
6.17.13 Summary of Regional Economic Development Benefits 325
6.18 Forrest Heights Levee, City of Gulfport, Harrison County 327
6.18.1 General 327
6.18.2 Location 327
6.18.3 Assumptions 328
6.18.4 Existing Conditions 328
6.18.5 Without-Project Conditions 329
6.18.6 List of Measures 333
6.18.7 With-Project Conditions 337
6.18.8 Summary of Costs 337

6.18.9 Regional Economic Development (RED) Benefits Socioeconomic Impacts using the Economic Impact Forecast System 338

CHAPTER VII. SENSITIVITY ANALYSIS 340
7.1 Period of Analysis Sensitivity 340
7.1.1 Effects of the Period of Analysis on Damages 340
7.1.2 Effects of the Time Value of Money 347
7.2 First Floor Elevation Uncertainty Sensitivity 348

CHAPTER VIII. RECOMMENDED PLAN FEATURES 352

ADDENDUM A – HEC-FDA DEPTH DAMAGE FUNCTIONS 354

CHAPTER A-I. OVERVIEW 354
A-1.1 Selection of Depth-Damage Relationships 354
A-1.2 Uncertainty 355
A-1.3 Residential Damage Relationships 355
A-1.4 Commercial Damage Relationships 365

ADDENDUM B – EXPERT ELICITATION ABSTRACT 390

COASTAL STORM DAMAGE RELATIONSHIPS BASED ON EXPERT OPINION ELICITATION 390

CHAPTER B-I. ABSTRACT 391

CHAPTER B-II. INTRODUCTION 391
B-2.1 Program Overview 391
B-2.3 Needs and Existing Storm Damage Information 392
B-2.4 Use of Expert Opinions 392
B-2.5 Recent USACE Expert-Opinion Elicitation Studies 393
B-2.6 Residential Damage Due to Coastal Storms 393

CHAPTER B-III. PARTICIPANTS 394
B-3.1 Requirements 394
B-3.2 Participants 394

CHAPTER B-IV. WORKSHOP RESULTS 395
B-4.1 Straw man Coastal Storm Damage Framework 395
B-4.2 Revised Framework 396
B-4.2.1 Inundation Damage 396
B-4.2.2 Waves Damage 397
B-4.2.3 Wave Run-up Damage 397
B-4.2.4 Erosion Damage 397
B-4.2.5 Combining Damages 398
B-4.2.6 Coastlines with of Bluffs 399
B-4.2.7 Long-term and Short-term Needs / Next Steps 399

CHAPTER B-V. REFERENCES 399

CHAPTER B-VI. DAMAGE RELATIONSHIP DETAILS 401

ADDENDUM C – PARKING AND ACCESS 406

CHAPTER C-I. USER FEES, PUBLIC ACCESS AND PARKING 406

C-1.1 Parking 406
C-1.2 Access 414
C-1.3 User Fees 414
C-1.4 Conclusion 415

Figures

The MsCIP Study Area i
Figure 1. MsCIP Planning Zones 3
Figure 2. Overview of 3 planning units 54 planning sub-units 4
Figure 3. Overview of Economic Methodology 5
Figure 4. Example of the extent of Hurricane Katrina Surge Damage – Planning Unit One 8
Figure 1-1. Congressionally authorized study area 1
Figure 1-2. Planning Zones 2
Figure 1-3. Planning Units 3
Figure 1-4. Overview of 54 planning sub-units 3
Figure 1-5. Sub-units for Planning Unit One 4
Figure 1-6. Sub-units for Planning Unit Two 5
Figure 1-7. Sub units for Planning Unit Three 6
Figure 2-1. Overview of Economic Methodology 8
Figure 3.2-1. Illustration of transformation for traditional equivalent annual damage computation 13
Figure 3.3-1. Data used for Beach-FX Program 15
Figure 4-1. Overview of Economic Data Collection Methodology 21
Figure 4.2-1. Example of a residential brick - slab on grade structure 22
Figure 4.2-2. Example of a residential masonry - slab on grade structure 23
Figure 4.2-3. Example of a residential wood – slab on grade structure 23
Figure 4.2-4. Example of a Wood Frame on Slab Residential Structure 24
Figure 4.2-5. Example of a mobile home residence 24
Figure 4.2-6. Example of a Mobile Home Residence 25
Figure 4.2-7. Example of Mobile Home Residence 25
Figure 4.2-8. Example of a residential wood on piles structure 26
Figure 4.2-9. Example of residential wood on piles structure 26
Figure 4.2-10. Example of Masonry on Piles Residential Structure 27
Figure 4.2-11. Example of two-story masonry on slab 27
Figure 4.2-12. Example of a Church (Municipal Category) 28
Figure 4.2-13. Example of a Commercial Services Building 28
Figure 4.2-14. Example of a Municipal Fire Station 29
Figure 5.2-1. Hurricane Katrina Path and Extent of Hurricane Katrina Surge in Planning Units One, Two, and Three 44
Figure 5.2-2. Example of Structure Damage in Planning Unit One 45
Figure 5.2-3. Structure Damage in Planning Unit One 46
Figure 5.2-4. Katrina Surge Damage in Planning Unit One 46
Figure 5.2-5. Surge Damage in Bay St. Louis – Planning Unit One 47
Figure 5.2-6. Surge Damage in Biloxi Area – Planning Unit Two 48
Figure 5.2-7. Surge Damage in Biloxi Area – Planning Unit Two 48
Figure 5.2-8. Surge Damage in Planning Unit Two 49

Figure 5.2-9. Pascagoula Beach Boulevard Pre-Hurricane Katrina – Planning Unit Three 49
Figure 5.2-10. Pascagoula Beach Boulevard Post-Hurricane Katrina – Planning Unit Three 50
Figure 5.2-11. Pascagoula Beach Boulevard Pre-Hurricane Katrina – Planning Unit Three 50
Figure 5.2-12. Pascagoula Beach Boulevard Post-Hurricane Katrina – Planning Unit Three 51
Figure 5.2-13. Pascagoula Yacht Club Pre-Hurricane Katrina – Planning Unit Three 51
Figure 5.2-14. Pascagoula Yacht Club Post-Hurricane Katrina – Planning Unit Three 52
Figure 5.2-15. 2006 Mississippi Population Density 54
Figure 5.2-16. Non-Seasonally Adjusted Unemployment Rates for Mississippi and Hancock County 57
Figure 5.2-17. Non-Seasonally Adjusted Unemployment Rates for Mississippi and Harrison County 57
Figure 5.2-18. Non-Seasonally Adjusted Unemployment Rates for Mississippi and Jackson County 58
Figure 5.3-1. Period of Analysis used for Flood Damage Reduction and Hurricane and Storm Damage Prevention 61
Figure 5.3-2. Maximum Probable Intensity Footprint for the Without Project Condition 71
Figure 5.3-3. Population within the Future Without-Project Maximum Probable Intensity Surge Footprint 72
Figure 5.3-4. Risk Zones within the Maximum Probable Intensity Area 73
Figure 5.3-5. Without-Project Equivalent Damages by Future Scenario 75
Figure 5.3-6. Impacts of Residential Compared to Mixed Redevelopment for Expected Relative Sea Level 84
Figure 5.3-7. Impacts of Residential Compared to Mixed Redevelopment for Expected Relative Sea Level Rise 85
Figure 5.3-8. Impacts of Residential Compared to Commercial Redevelopment for High Relative Sea Level Rise 86
Figure 5.3-9. Impacts of 2.0-feet of relative sea level rise on a residential redevelopment 87
Figure 5.3-10. Impacts of 3.4-feet of relative sea level rise on a residential redevelopment 88
Figure 5.3-11. Impacts of 2.0-feet of relative sea level rise on a mixed redevelopment 89
Figure 5.3-12. Impacts of 2.0-feet of relative sea level rise on a mixed redevelopment 89
Figure 6.1-1. Linear Interpretation of Equivalent annual damages 91
Figure 6.2.1-1. Location of the Mississippi Barrier Island 95
Figure 6.2.1-2. Photo of the south beach at Horn Island. Pre-existing dunes have been destroyed by numerous hurricanes over the last several years 98
Figure 6.3-1. Project Sites for LOD2 in Planning Unit One 111
Figure 6.3-2. Project Limits for Line of Defense 2 in Planning Unit One 111
Figure 6.3-3. Typical Cross Section for Measures A through H 113
Figure 6.3.2-1. Project Sites for LOD2 in Panning Unit 2 121
Figure 6.3.2-2. Eastern Project Limits for Line of Defense 2 in Panning Unit 2 122
Figure 6.3.2-3. Western Project Limits for Line of Defense 2 in Panning Unit 2 122
Figure 6.3.2-4. Typical Cross Section for Measures A through H 124
Figure 6.3.2-5. Typical Cross Section for Measures I and J 125
Figure 6.3.2-6. Typical Cross Section for Measure K 126
Figure 6.3.3-1. Project Sites for Beach and Dune Placement in Planning Unit Three 133
Figure 6.3.3-2. Typical Cross Section for Measures A through H 135
Figure 6.3.3-3. Typical cross section for Measures I and J 136
Figure 6.3.3-4. Typical cross section for measure K 137
Figure 6.4-1. Planning Zones – Impacted area is the coastal zone 145
Figure 6.4-2. Planning sub-units in Coastal Area for Planning Unit One, Two, and Three 146
Figure 6.5-1. Pearlington Area – Planning Sub-unit Six 154
Figure 6.5-2. Display of Potential Measures for the Pearlington Area (Planning Sub-Unit Six) 156
Figure 6.5-3 Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Pearlington Area 159

Figure 6.5-4 Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Pearlington Area – Includes an adjustment for relative sea level rise 160
Figure 6.5-5 Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Pearlington Area 161
Figure 6.5-6 Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Pearlington Area – Includes an adjustment for relative sea level rise 162
Figure 6.6-1. Location of the Admiral Island Restoration Area 168
Figure 6.6-2 Admiral Island restoration site 170
Figure 6.6-3 Display of Cost Effective Alternatives for the Admiral Island Area 175
Figure 6.7-1. Location of Turkey Creek Restoration area in Planning Unit Two 178
Figure 6.7-2. Turkey Creek Restoration Site 180
Figure 6.7-3. Display of Cost Effective Alternatives for the Turkey Creek Area 185
Figure 6.8-1. Ocean Springs Area – Planning Sub-unit 22 187
Figure 6.8-2. Display of Potential Measures for the Ocean Springs Area (Planning Sub-Unit 22) .. 189
Figure 6.8-3. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Ocean Springs Area 192
Figure 6.8-4. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Ocean Springs Area – Includes an adjustment for relative sea level rise 193
Figure 6.8-5 Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Ocean Springs Area 194
Figure 6.8-6 Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Ocean Springs Area – Includes an adjustment for relative sea level rise 195
Figure 6.9-1. Gautier Area – Planning Sub-unit 30 201
Figure 6.9-2. Display of Potential Measures for the Gautier Area (Planning Sub-Unit 30) 203
Figure 6.9-3. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Gautier Area 205
Figure 6.9-4. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Gautier Area – Includes an adjustment for relative sea level rise 206
Figure 6.9-5. Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Gautier Area 207
Figure 6.9-6. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Gautier Area – Includes an adjustment for relative sea level rise 208
Figure 6.10-1. Gulf Park Estates Area – Planning sub-unit 26 214
Figure 6.10-2. Display of Potential Measures for the Gulf Park Estates Area (Planning Sub-Unit 26) 216
Figure 6.10-3. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Gulf Park Estates Area 219
Figure 6.10-4. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Gulf Park Estates Area – Includes an adjustment for relative sea level rise. 220
Figure 6.10-5. Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Gulf Park Estates Area 221
Figure 6.10-6. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Gulf Park Estates Area – Includes an adjustment for relative sea level rise. 222
Figure 6.11-1. Belle Fontaine Area – Planning Sub-unit 27 228
Figure 6.11-2. Display of Potential Measures for the Belle Fontaine Area (Planning Sub-unit 27).. 230
Figure 6.11-3. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Belle Fontaine Area 233
Figure 6.11-4. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Belle Fontaine Area – Includes an adjustment for relative sea level rise 234
Figure 6.11-5. Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Belle Fontaine Area 235
Figure 6.11-6. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Belle Fontaine Area – Includes an adjustment for relative sea level rise 236

Figure 6.12-1. Pascagoula - Moss Point Area – Planning Sub-units 51 and 52 243
Figure 6.12-2. Display of Potential Measures for the Pascagoula-Moss Point Area (Planning Sub-units 51 and 52) 245
Figure 6.12-3. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Planning Sub-unit 51 248
Figure 6.12-4. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Planning Sub-unit 52 249
Figure 6.12-5. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Planning Sub-unit 51 – Includes an adjustment for relative sea level rise 250
Figure 6.12-6. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Planning Sub-unit 52 – Includes an adjustment for relative sea level rise 251
Figure 6.12-7. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Planning Sub-unit 51 252
Figure 6.12-8. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Planning Sub-unit 52 253
Figure 6.12-9. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Planning Sub-unit 51 – Includes an adjustment for high relative sea level rise 254
Figure 6.12-10. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Planning Sub-unit 52 – Includes an adjustment for high relative sea level rise 255
Figure 6.13-1 Bayou Cumbest Area, Planning Unit Three, Planning Sub-Unit fifty-three 263
Figure 6.13-2 Bayou Cumbest restoration site 266
Figure 6.13-3 Cost Effective Measures for Bayou Cumbest Area 271
Figure 6.14-2. Dantzler Restoration Site 277
Figure 6.14-3. Display of Cost Effective Alternatives for the Dantzler Area 281
Figure 6.15-1. Franklin Creek Restoration Area. 284
Figure 6.15-2. Franklin Creek Restoration Site 286
Figure 6.15-3. Display of Cost Effective Alternatives for the Franklin Creek Area 290
Figure 6.16-1. Planning Zones – Impacted area is the inland zone 293
Figure 6.16-2 Planning sub-units in Inland Area for Planning Units One, Two, and Three 294
Figure 6.16-3. Footprints for the Inland Barrier Levees Alignments 299
Figure 6.17-1. Hurricane Katrina Path and Extent of Hurricane Katrina Surge in Planning Units One, Two, and Three 312
Figure 6.17-2. Nonstructural ABFE measure footprint 319
Figure 6.17-3. Nonstructural ABFE measure for planning unit one – Hancock County 320
Figure 6.17-4. Nonstructural ABFE measure for Planning Unit Two – Harrison County 321
Figure 6.17-5. Nonstructural ABFE Measure for Planning Unit Three – Jackson County 322
Figure 6.18-1. Forrest Heights Ring Levee Location 328
Figure 6.18-2. Hurricane Katrina Inundation and High Water, Forrest Heights 329
Figure 6.18-3. Computed Discharge-Frequency Curve, Turkey Creek at Ohio Avenue 331
Figure 6.18-4. Computed Rating Curve, Turkey Creek at Ohio Avenue. 333
Figure 6.18-5. 17-ft Elevation Levee Alignment with Culvert and Pump/Detention Basin Locations 334
Figure 6.18-6. Channel Clearing and Snagging Limits 335
Figure 6.18-7. Crown Scour from Hurricane Katrina at Mississippi River Gulf Outlet (MRGO) Levee in St. Bernard Parish, New Orleans, LA 336
Figure 6.18-8. Typical Levee Overtopping Section 336
Figure 7.1-1. Calculation of Equivalent annual damages 340
Figure A-1. Residential One-Story Structure Damage Relationship 357
Figure A-2. Residential One-Story Content Damage Relationship 358
Figure A-3. Residential Two-Story Structure Damage Relationship 360
Figure A-4. Residential Two-Story Content Damage Relationship 361

Figure A-5. Mobile Home Structure Damage Relationship 363
Figure A-6. Mobile Home Content Damage Relationship 364
Figure A-7. Eating and Recreation Structure Damage Relationship 366
Figure A-8. Eating and Recreation Content Damage Relationship 367
Figure A-9. Grocery Store and Gas Station Structure Damage Relationship 369
Figure A-10. Grocery Store and Gas Station Content Damage Relationship 370
Figure A-11. Municipal Structure Damage Relationship 372
Figure A-12. Municipal Content Damage Relationship 373
Figure A-13. Retail and Personal Services Structure Damage Relationship 375
Figure A-14. Retail and Personal Services Content Damage Relationship 376
Figure A-15. Multi-Family Structure Damage Relationship 378
Figure A-16. Multi-Family Content Damage Relationship 379
Figure A-17. Professional Businesses Structure Damage Relationship 381
Figure A-18. Professional Businesses Content Damage Relationship 382
Figure A-19. Commercial Repair and Home Use Structure Damage Relationship 384
Figure A-20. Commercial Repair and Home Use Damage Relationship 385
Figure A-21. Warehouse and Contractor Services Structure Damage Relationships 387
Figure A-22. Warehouse and Contractor Services Structure Damage Relationships 388
Figure B-1. Inundation Wood Frame without Piles (no enclosure) 401
Figure B-2. Inundation Wood Frame with Piles (full enclosure) 402
Figure B-3. Inundation Wood Frame with Piles (no enclosure) 402
Figure B-4. Inundation Concrete and Masonry without Piles 403
Figure B-5. Waves – Structure not on Piles 403
Figure B-6. Waves – Structure on Piles (no enclosure) 404
Figure B-7. Waves – Structure on Piles (full enclosure) 404
Figure B-8. Erosion – Pile Foundation 405
Figure B-9. Erosion – Shallow Foundation 405
Figure C1-1. Hancock County Map 410
Figure C1-2. Harrison County Map 411
Figure C1-3. Jackson County Map 412
Figure C1-4. Hancock County Parking Lot 413
Figure C1-5. Example of Harrison County Parking Lot. 413
Figure C1-6. Example Jackson County Parking Lot. 414

Tables

Table 1. Select Hurricane Camille Statistics 6
Table 2. Damage to Structures Caused by Hurricane Camille Surge. 6
Table 3. 1950-2000 Population Levels and Growth (in thousands) 7
Table 4. Structures Damaged 50% or More by Planning Unit and by Category 7
Table 5. 2000-2005 Estimates of Population Levels and Growth 8
Table 6. Overview of Future Scenarios 9
Table 7. Future Without-Project Scenarios One, Three, and Five Inventory Parcels by Planning Unit and by Structure Category 10
Table 8. Future Without-Project Scenarios Two, Four, and Six Inventory Parcels by Planning Unit and by Structure Category 10
Table 9. Structure and Content Values by Category and Planning Unit 10
Table 10. Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario 10
Table 11. Summaries of Benefits and Costs for Measures Recommended for Implementation[1] 12
Table 4-1. Structure Damage Categories and Occupancy Types 22
Table 4-2. Depreciated Replacement Factors by Occupancy Type Used for Residential Structures that Suffered Moderate to No Damage (Less than 50%) from Hurricane Katrina ... 31

Table 4-3. Depreciated Replacement Cost Values for Residential Structures Used for Residential Structures that Suffered Significant Damage (50% or more) from Hurricane Katrina 32
Table 4-4. Depreciated Replacement Factors by Occupancy Type Used for Residential Structures that Suffered Moderate to No Damage (Less than 50%) from Hurricane Katrina 32
Table 4-5. Depreciated Replacement Cost Values for Residential Structures Used for Residential Structures that Suffered Significant Damage (50% or more) from Hurricane Katrina 33
Table 4-6. Depreciated Replacement Factors by Occupancy Type 35
Table 4-7. Depreciated Replacement Factors by Occupancy Type 36
Table 4-8. Depreciated Replacement Factors by Occupancy Type 37
Table 4-9. Depreciated Replacement Factors by Occupancy Type 39
Table 5-1. Select Hurricane Camille Statistics. 40
Table 5-2. Damage to Residential Structures Caused by Hurricane Camille Surge. 41
Table 5-3. Damage to Commercial Structures Caused by Hurricane Camille Surge. 41
Table 5-4. 1950-2000 Population Levels and Growth (in thousands) 42
Table 5-5. Structures Damaged 50% or More by Planning Unit and by Category 45
Table 5-6. 2000-2005 Estimates of Population Levels and Growth 53
Table 5-7. 2006 Estimated Population Levels 53
Table 5-8. 2000-2004 Urban Growth and Distribution 54
Table 5-9. 2000 Population Racial Distribution 55
Table 5-10. 2002 Employment Distribution by Major Sector 56
Table 5-11. January 2005 – January 2007 Unemployment Rates (%) 58
Table 5-12. 2004 Median Income and Poverty Levels 60
Table 5-13. Assumptions of Structure Redevelopment by Year 63
Table 5-14. Overview of Future Scenarios 65
Table 5-15. Futures Without-Project Scenarios One, Three, and Five Inventory Parcels by Planning Unit and by Structure Category 66
Table 5-16. Futures Without Project Scenarios One, Three, and Five Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation 66
Table 5-17. Futures Without-Project Scenarios One, Three, and Five Inventory Structure and Content Values by Category and Planning Unit 67
Table 5-18. Futures Without-Project Scenarios Two, Four, and Six Inventory Parcels by Planning Unit and by Structure Category 68
Table 5-19. Futures Without-Project Scenarios Two, Four, and Six Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation 68
Table 5-20. Futures Two, Four, and Six Inventory Structure and Content Values by Category and Planning Unit 69
Table 5-21. Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario 74
Table 5-22. Equivalent Annual Without-Project Damages by Planning Sub-Unit and Future Scenario[1] 75
Table 5-23. Total Structure and Content Value for Selected Planning Sub-Units 78
Table 5-24. Stage Damage by Event for Future Scenario One, Planning Unit One, Planning Sub-Unit Two 79
Table 5-25. Stage Damage by Event for Future Scenario One, Planning Unit One, Planning Sub-Unit Five 79
Table 5-26. Stage Damage by Event for Future Scenario One, Planning Unit One, Planning Sub-Unit Six 80
Table 5-27. Stage Damage by Event for Future Scenario One, Planning Unit Two, Planning Sub-Unit Eight 80
Table 5-28. Stage Damage by Event for Future Scenario One, Planning Unit Two, Planning Sub-Unit Twelve 81

Table 5-29. Stage Damage by Event for Future Scenario One, Planning Unit Two, Planning Sub-Unit Eighteen 81
Table 5-30. Stage Damage by Event for Future Scenario One, Planning Unit Two, Planning Sub-Unit Nineteen 82
Table 5-31. Stage Damage by Event for Planning Unit Three, Planning Sub-Unit Twenty-One 82
Table 5-32. Stage Damage by Event for Future Without-Project Scenario One, Planning Unit Three, Planning Sub-Unit Fifty-Two 83
Table 5-33. Comparison of Residential Redevelopment vs. Mixed Redevelopment for Expected Relative Sea Level Rise 84
Table 5-34. Comparison of Residential Redevelopment vs. Mixed Redevelopment for Expected Relative Sea Level Rise 84
Table 5-35 Comparison of Residential Redevelopment vs. Mixed Redevelopment for Expected Relative Sea Level Rise 85
Table 5-36. Impacts of Relative Sea Level Rise on Futures One, Three, and Five 87
Table 5-37. Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario 88
Table 6.2-1. Historic Landings and Value of All Fisheries from Mississippi Sound 95
Table 6.2-2. Structures Damaged 50% or More by Planning Unit and by Category 97
Table 6.2-3. Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario 99
Table 6.2-4. Increase in Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario due to Further Degradation of the Barrier Islands 100
Table 6.2-5. Loss of Shrimp, Oysters, and other Species Due to Hurricane Katrina 101
Table 6.2-6. Annual Ship Island Visitation 101
Table 6.2-7. Guidelines for Assigning Points for General Recreation 103
Table 6.2-8. Point Value of Recreational Use 103
Table 6.2-9. Point Value of Recreational Use 104
Table 6.2-10. NED Benefits by Measures 107
Table 6.2-11. EQ Benefits by Measures 107
Table 6.2-12. Total Average Annual Costs by Measure 108
Table 6.2-13. EIFS Model Inputs for Barrier Island Measures 108
Table 6.2-14. EIFS Model Outputs for Barrier Island Measures 109
Table 6.2-15. Summary Benefits and Costs by Measures 109
Table 6.3-1. Summary of Beach and Dune Costs by Measure for Planning Unit One 115
Table 6.3-2. Outputs and Costs by Measure 117
Table 6.3-3. List of Efficient Measures 117
Table 6.3-4. List of Effective Measures 118
Table 6.3-5. List of Cost Effective Measures for Planning Unit One 118
Table 6.3-6. EIFS Model Implementation Inputs for LOD2 119
Table 6.3-7. EIFS Model Implementation Outputs for LOD2 119
Table 6.3-8. EIFS Model Operation and Maintenance Cost Inputs for LOD2 119
Table 6.3-9. EIFS Model Operation and Maintenance Cost Outputs for LOD2 120
Table 6.3-10. List of Cost Effective Measures Carried Forward for Further Consideration Planning Unit One 120
Table 6.3.2-1. Summary of Beach and Dune Costs by Measure for Planning Unit Two 128
Table 6.3.2-2. Outputs and Costs by Measure 129
Table 6.3.2-3. List of Efficient Measures 129
Table 6.3.2-4. List of Effective Measures 130
Table 6.3.2-5. List of Cost Effective Measures for Planning Unit Two 130
Table 6.3.2-6. EIFS Model Implementation Cost Inputs for LOD2 131
Table 6.3.2-7. EIFS Model Implementation Cost Outputs for LOD2 131
Table 6.3.2-8. EIFS Model Operation and Maintenance Cost Inputs for LOD2 131
Table 6.3.2-9. EIFS Model Operation and Maintenance Cost Outputs for LOD2 132
Table 6.3.2-10. List of Measures Carried Forward for Further Evaluation in Planning Unit Two Planning Unit Two 132

Table 6.3.3-1. Summary of Beach and Dune Costs by Measure for Planning Unit Three 138
Table 6.3.3-2. Outputs and Costs by Increments by Measure 139
Table 6.3.3-3. List of Economically Efficient Measures for Planning Unit Three 140
Table 6.3.3-4. List of Economically Effective Measures for Planning Unit Three 141
Table 6.3.3-5. List of Cost Effective Measures for Planning Unit Three 141
Table 6.3.3-6. EIFS Model Implementation Inputs for LOD2 142
Table 6.3.3-7. EIFS Model Implementation Outputs for LOD2 142
Table 6.3.3-8. EIFS Model Operation and Maintenance Cost Inputs for LOD2 142
Table 6.3.3-9. EIFS Model Operation and Maintenance Cost Outputs for LOD2 142
Table 6.3.3-10. List of Measures Carried Forward for Further Evaluation in Planning Unit Three .. 143
Table 6.4-1. Pre-Hurricane Katrina Economic Asset Characteristics for the Impacted Seawall and Roadway Areas 144
Table 6.4-2. Destroyed Structures by Category and Planning Unit 147
Table 6.4-3. Equivalent Annual Damage Reduction by Future Scenario 150
Table 6.4-4. Residual Damages by Measure and by Future Scenario 150
Table 6.4-5. Wetland Acres Impacted by Jackson County Seawall 151
Table 6.4-6. Wetland Acres Impacted by Hancock and Harrison Seawall 151
Table 6.4-7. Summary of Costs by Measure for Seawall and Elevated Roadway Area 152
Table 6.4-8. EIFS Model Implementation Costs Inputs for the Seawall and Elevated Area 152
Table 6.4-9. EIFS Model Implementation Costs Outputs for the Seawall and Elevated Area 153
Table 6.4-10. EIFS Model O&M Costs Inputs for the Seawall and Elevated Area 153
Table 6.4-11. EIFS Model O&M Costs Outputs for the Seawall and Elevated Area 153
Table 6.5-1. Pre-Hurricane Katrina Estimate of Structures for the Pearlington Area Planning Sub-unit Six 154
Table 6.5-2. Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years 157
Table 6.5-3. Summary of Damages by Potential Measure and Applicable Future Scenario 164
Table 6.5-4. Wetland acres impacted by elevation 20' Pearlington ring levee 164
Table 6.5-5. Wetland acres impacted by elevation 30' Pearlington ring levee 165
Table 6.5-6. Summary of Costs by Measure for the Pearlington Area 165
Table 6.5-8. EIFS Model Construction Costs Outputs for the Pearlington Area 166
Table 6.5-9. EIFS Model O&M Costs Inputs for the Pearlington Area 166
Table 6.5-10. EIFS Model O&M Costs Outputs for the Pearlington Area 167
Table 6.6-1. Ecosystem Restoration Management Measures 169
Table 6.6-2. Ecosystem Restoration Alternatives 171
Table 6.6-3. Summary of Benefits 172
Table 6.6-4. Summary of Costs by Measure for Admiral Island Area 173
Table 6.6-5. All Alternatives: AAC and AAFU for Admiral Island 174
Table 6.6-6. Elimination of Economically Ineffective Alternatives 174
Table 6.6-7. Cost Effective Alternatives 175
Table 6.6-8. EIFS Model Implementation Inputs for Admiral Island Ecosystem 176
Table 6.6-9. EIFS Model Implementation Outputs for Admiral Island Ecosystem 176
Table 6.6-10. EIFS Model O&M Inputs for Admiral Island Ecosystem 176
Table 6.6-11. EIFS Model O&M Outputs for Admiral Island Ecosystem 177
Table 6.7-1. Ecosystem Restoration Management Measures 178
Table 6.7-2. Ecosystem Restoration Alternatives 180
Table 6.7-3. Summary of Benefits 181
Table 6.7-4. Summary of Costs by Measure for Turkey Creek 183
Table 6.7-5. All Alternatives: AAC and AAFU 183
Table 6.7-6. All Alternatives Arrayed by Increasing Output 184
Table 6.7-7. Elimination of Economically Ineffective Alternatives 184
Table 6.7-8. Cost Effective Alternatives for the Turkey Creek Area 185
Table 6.7-9. EIFS Model Implementation Inputs for Turkey Creek Ecosystem 186

Table 6.7-10. EIFS Model Implementation Outputs for Turkey Creek Ecosystem 186
Table 6.7-11. EIFS Model O&M Inputs for Turkey Creek Ecosystem 186
Table 6.7-12. EIFS Model O&M Outputs for Turkey Creek Ecosystem..... 186
Table 6.8-1. Pre-Hurricane Katrina Estimate of Structures for the Ocean Springs Area Planning Sub-unit 22..... 188
Table 6.8-2. Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years 190
Table 6.8-3. Summary of Damages by Potential Measure and by Applicable Future Scenario 197
Table 6.8-4. Wetland acres impacted by elevation 20' Ocean Springs ring levee..... 198
Table 6.8-5. Wetland acres impacted by elevation 30' Ocean Springs ring levee..... 198
Table 6.8-6. Summary of Costs by Measure for the Ocean Springs Area..... 198
Table 6.8-7. EIFS Model Implementation Costs Inputs for the Ocean Springs Area..... 199
Table 6.8-8. EIFS Model Implementation Costs Outputs for the Ocean Springs Area 199
Table 6.8-9. EIFS Model O&M Cost Inputs for the Ocean Springs Area..... 199
Table 6.8-10. EIFS Model O&M Cost Outputs for the Ocean Springs Area 200
Table 6.9-1. Pre-Hurricane Katrina Estimate of Structures for the Gautier Area (Planning Sub-unit 30)..... 201
Table 6.9-2. Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years 204
Table 6.9-3. Summary of Damages by Potential Measure and by Applicable Future Scenario 210
Table 6.9-4. 211
Wetland acres impacted by elevation 20' Gautier ring levee. 211
Table 6.9-5. 211
Wetland acres impacted by elevation 30' Gautier ring levee. 211
Table 6.9-6. Summary of Costs by Measure for the Gautier Area..... 211
Table 6.9-7. EIFS Model Construction Costs Inputs for the Gautier Area 212
Table 6.9-8. EIFS Model Construction Costs Outputs for the Gautier Area 212
Table 6.9-9. EIFS Model O&M Cost Inputs for the Gautier Area..... 212
Table 6.9-10. EIFS Model O&M Cost Outputs for the Gautier Area 213
Table 6.10-1. Pre-Hurricane Katrina Estimate of Structures for the Gulf Park Estates Area Planning Sub-unit 26..... 214
Table 6.10-2. Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years 218
Table 6.10-3. Summary of Damages by Potential Measure and by Applicable Future Scenario 224
Table 6.10-4. Wetland Acres Impacted by Elevation 20' Gulf Park Estates Ring Levee 225
Table 6.10-5. Wetland Acres Impacted by Elevation 30' Gulf Park Estates Ring Levee. 225
Table 6.10-6. Summary of Costs by Measure for Gulf Park Estates Area 226
Table 6.10-7. EIFS Model Implementation Cost Inputs for the Gulf Park Estates Area 227
Table 6.10-8. EIFS Model Implementation Cost Outputs for the Gulf Park Estates Area..... 227
Table 6.10-9. EIFS Model O&M Cost Inputs for the Gulf Park Estates Area..... 227
Table 6.10-10. EIFS Model O&M Cost Outputs for the Gulf Park Estates Area 227
Table 6.11-1. Pre-Hurricane Katrina Estimate of Structures for the Belle Fontaine Area Planning Sub-unit 27..... 228
Table 6.11-2. Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years 232
Table 6.11-3. Summary of Damages by Measure..... 238
Table 6.11-4. Wetland Acres Impacted by Elevation 20' Belle Fontaine Ring Levee A..... 239
Table 6.11-5. Wetland Acres Impacted by Elevation 30' Belle Fontaine Ring Levee B..... 239
Table 6.11-6. Summary of Costs by Measure for the Belle Fontaine Area 239
Table 6.11-7. EIFS Model Construction Costs Inputs for the Belle Fontaine Area 240
Table 6.11-8. EIFS Model Construction Costs Outputs for the Belle Fontaine Area 241
Table 6.11-9. EIFS Model O&M Cost Inputs for the Belle Fontaine Area (Planning Sub-unit 27) ... 241

Table 6.11-10. EIFS Model O&M Cost Outputs for the Belle Fontaine Area (Planning Sub-unit 27) 242
Table 6.12-1. Pre-Hurricane Katrina Estimate of Structures for the Pascagoula-Moss Point Area Planning Sub-units 51 and 52 243
Table 6.12-2. Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years 247
Table 6.12-3. Summary of Damages by Measure 258
Table 6.12-4. Wetland Acres Impacted by Elevation 20' Pascagoula/Moss Point Ring Levee A 259
Table 6.12-5. Wetland Acres Impacted by Elevation 30' Pascagoula/Moss Point Ring Levee B 259
Table 6.12-6. Summary of Costs by Measure for the Pascagoula-Moss Point Area 259
Table 6.12-7. EIFS Model Implementation Cost Inputs for the Pascagoula/Moss Point Area 260
Table 6.12-8. EIFS Model Implementation Cost Inputs for the Pascagoula/Moss Point Area 260
Table 6.12-9. EIFS Model Implementation Cost Outputs for the Pascagoula/Moss Point Area 261
Table 6.12-10. EIFS Model Implementation Cost Outputs for the Pascagoula/Moss Point Area 261
Table 6.12-11. EIFS Model Operation and Maintenance Cost Inputs for the Pascagoula/Moss Point Area 261
Table 6.12-12. EIFS Model Operation and Maintenance Cost Inputs for the Pascagoula/Moss Point Area 262
Table 6.12-13. EIFS Model Operation and Maintenance Cost Outputs for the Pascagoula/Moss Point Area 262
Table 6.12-14. EIFS Model Operation and Maintenance Cost Outputs for the Pascagoula/Moss Point Area 262
Table 6.13-1. Ecosystem Restoration Management Measures 265
Table 6.13-2. Ecosystem Restoration Measures 267
Table 6.13-3. Summary of Benefits 268
Table 6.13-4. Summary of Costs by Measure for Bayou Cumbest 269
Table 6.13-5. All Measures: Average Annual Costs and Average Annual Functional Units 269
Table 6.13-6. Elimination of Economically Ineffective Measures 270
Table 6.13-7. Cost Effective Measures for Bayou Cumbest 271
Table 6.13-8. EIFS Model Implementation Cost Inputs for Bayou Cumbest Ecosystem 272
Table 6.13-9. EIFS Model Implementation Cost Outputs for Bayou Cumbest Ecosystem 272
Table 6.13-10. EIFS Model O&M Cost Inputs for Bayou Cumbest Ecosystem 272
Table 6.13-11. EIFS Model O&M Cost Outputs for Bayou Cumbest Ecosystem 273
Table 6.14-1. Ecosystem Restoration Management Measures 275
Table 6.14-2. Ecosystem Restoration Measures 276
Table 6.14-3. Summary of Benefits 278
Table 6.14-4. Summary of Costs by Measure for Dantzler Area 279
Table 6.14-5. All Measures: AAC and AAFU 279
Table 6.14-6. All Measures Arrayed by Increasing Output 280
Table 6.14-7. Elimination of Economically Ineffective Measures 280
Table 6.14-8. Cost Effective Measures for Dantzler Area 281
Table 6.14-9. EIFS Model Implementation Inputs for the Dantzler Ecosystem 282
Table 6.14-10. EIFS Model Implementation Outputs for the Dantzler Ecosystem 282
Table 6.14-11. EIFS Model O&M Inputs for the Dantzler Ecosystem 282
Table 6.14-12. EIFS Model O&M Outputs for the Dantzler Ecosystem 283
Table 6.15-1 Ecosystem Restoration Management Measures 284
Table 6.15-2. Ecosystem Restoration Alternatives 286
Table 6.15-3. Summary of Benefits 287
Table 6.15-4. Summary of Costs by Measure for Franklin Creek 288
Table 6.15-5. All Alternatives: AAC and AAFU 288
Table 6.15-6. All Alternatives Arrayed by Increasing Output 289
Table 6.15-7. Elimination of Economically Ineffective Alternatives 289
Table 6.15-8. Cost Effective Alternatives for Franklin Creek Area 289

Table 6.15-9. EIFS Model Implementation Inputs for Franklin Creek Ecosystem 290
Table 6.15-10. EIFS Model Implementation Outputs for Franklin Creek Ecosystem..... 291
Table 6.15-11. EIFS Model O&M Inputs for Franklin Creek Ecosystem..... 291
Table 6.15-12. EIFS Model O&M Outputs for Franklin Creek Ecosystem..... 291
Table 6.16-1. Pre-Hurricane Katrina Estimate of Structures for Inland Zone Area..... 292
Table 6.16-2. Destroyed Structures by Category and Planning Unit..... 295
Table 6.16-3. Equivalent Annual Damage Reduction by Future Scenario 302
Table 6.16-4. Residual Damage by Measure and by Future Scenario..... 303
Table 6.16-5. Wetland Acres Impacted by Inland Barrier A, elevation 20.0-feet NAVD88 304
Table 6.16-6. Wetland Acres Impacted by Inland Barrier B, elevation 30.0-feet NAVD88 304
Table 6.16-7. Wetland Acres Impacted by Inland Barrier C, elevation 40.0-feet NAVD88 305
Table 6.16-8. Summary of Costs by Measure for the Inland Barrier Area..... 305
Table 6.16-9. EIFS Model Implementation Cost Inputs for the Inland Barrier Area..... 307
Table 6.16-10. EIFS Model Implementation Cost Inputs for the Inland Barrier Area..... 307
Table 6.16-11. EIFS Model Implementation Cost Outputs for the Inland Barrier Area 308
Table 6.16-12. EIFS Model Implementation Cost Outputs for the Inland Barrier Area 308
Table 6.16-13. EIFS Model Operation and Maintenance Cost Inputs for the Inland Barrier Area ... 309
Table 6.16-14. EIFS Model Operation and Maintenance Cost Inputs for the Inland Barrier Area ... 309
Table 6.16-15. EIFS Model Operation and Maintenance Cost Outputs for the Inland Barrier Area 310
Table 6.16-16. EIFS Model Operation and Maintenance Cost Outputs for the Inland Barrier Area 310
Table 6.17-1. Structures Damaged 50% or More by Planning Unit and by Category..... 312
Table 6.17-2. Overview of Future Scenarios..... 313
Table 6.17-3. Futures Without-Project Scenarios Three and Five Inventory Parcels by Planning Unit and by Structure Category..... 314
Table 6.17-4. Futures Without Project Scenarios Three and Five Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation..... 314
Table 6.17-5. Futures Without-Project Scenarios Three and Five Inventory Structure and Content Values by Category and Planning Unit..... 315
Table 6.17-6. Futures Without-Project Scenarios Four and Six Inventory Parcels by Planning Unit and by Structure Category..... 316
Table 6.17-7. Futures Without-Project Scenarios Four and Six Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation 316
Table 6.17-8. Future Without-Project Scenarios Four and Six Inventory Structure and Content Values by Category and Planning Unit 317
Table 6.17-9. Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario..... 318
Table 6.17-10. Summary of Damages by Potential Measure for Future Scenarios Three and Five 323
Table 6.17-11. Summary of Damages by Potential Measure for Future Scenarios Four and Six ... 324
Table 6.17-12. Summary of Costs by Nonstructural Measure..... 324
Table 6.17-13. EIFS Model Construction Costs Inputs for the Nonstructural Measures 326
Table 6.17-14. EIFS Model Construction Costs Outputs for the Nonstructural Measures..... 326
Table 6.17-15. EIFS Model O&M Costs Inputs for the Nonstructural Measures 326
Table 6.17-16. EIFS Model O&M Costs Outputs for the Nonstructural Measures..... 327
Table 6.18-1. Surge Stage-Probability and Uncertainty 330
Table 6.18-2. Turkey Creek Flood Stages At Ohio Avenue, Harrison County FIS. 330
Table 6.18-3. Discharge-Frequency, Turkey Creek at Ohio Avenue..... 332
Table 6.18-4. Without-Project Damages for the Forrest Heights Area by Future Scenario 333
Table 6.18-5. Summary of Equivalent Annual Damages Reduced 337
Table 6.18-6. Summary of Equivalent Annual Residual Damages..... 337
Table 6.18-7. Summary of Costs by Measure for Forrest Heights 337

Table 6.18-8. EIFS Model Implementation Inputs for the Forrest Heights Area 338
Table 6.18-9. EIFS Model Implementation Outputs for the Forrest Heights Area 338
Table 6.18-10. EIFS Model O&M Inputs for the Forrest Heights Area 338
Table 6.18-11. EIFS Model O&M Outputs for the Forrest Heights Area 339
Table 7.1-1. Overview of Future Scenarios 341
Table 7.1-2. Details of Future Without-Project Scenarios One, Three, and Five 100-Year and 50-Year Periods of Analysis 342
Table 7.1-3. Equivalent Annual Damage Reduction Comparison of 50-Year Compared to 100-Year Future Without-Project Scenario One Pearlington and Gautier Area Measures 343
Table 7.1-4. Equivalent Annual Residual Damage Comparison of 50-Year Compared to 100-Year Future Without-Project Scenario One Pearlington and Gautier Area Measures 343
Table 7.1-5. Equivalent Annual Without-Project Damage Comparison of 50-Year Compared to 100-Year Future Without-Project Scenarios Three and Five Pearlington and Gautier Area Measures 344
Table 7.1-6. Equivalent Annual Damage Reduction Comparison of 50-Year Compared to 100-Year Future Without-Project Scenario Three Pearlington and Gautier Area Measures 345
Table 7.1-7. Equivalent Annual Damage Reduction Comparison of 50-Year Compared to 100-Year Future Without-Project Scenario Five Pearlington and Gautier Area Measures 345
Table 7.1-8. Equivalent Annual Residual Damage Comparison of 50-Year Compared to 100-Year Future Without-Project Three Pearlington and Gautier Area Measures 346
Table 7.1-9. Equivalent Annual Residual Damage Comparison of 50-Year Compared to 100-Year Future Without-Project Five Pearlington and Gautier Area Measures 346
Table 7.1-10. Average Annual Implementation Cost Comparison of 50-Year Compared to 100-Year Pearlington and Gautier Area Measures 348
Table 7.2-1. First Floor Uncertainty Sensitivity on Equivalent Annual Without-Project Damages Pearlington and Gautier Area Measures 349
Table 7.2-2. First Floor Uncertainty Sensitivity on Equivalent annual damages Reduced Future Without Project Scenario One Pearlington and Gautier Area Measures 350
Table 7.2-3. First Floor Uncertainty Sensitivity on Equivalent annual damages Reduced Future Without Project Scenario Three Pearlington and Gautier Area Measures 350
Table 7.2-4. First Floor Uncertainty Sensitivity on Equivalent annual damages Reduced Future Without Project Scenario Five Pearlington and Gautier Area Measures 351
Table 8-1. Summaries of Benefits and Costs for Measures Recommended for Implementation[1] 353
Table A1-1. Residential One-Story Damage Relationship 356
Table A1-2. Residential Two-Story Damage Relationship 359
Table A1-3. Residential Mobile Home Damage Relationship 362
Table A1-4. Commercial Eating and Recreation Damage Relationship 365
Table A1-5. Commercial Grocery and Gas Station Damage Relationship 368
Table A1-6. Municipal Damage Relationship 371
Table A1-7. Retail and Personal Services Damage Relationship 374
Table A1-8. Multi-Family Damage Relationship 377
Table A1-9. Professional Businesses Damage Relationship 380
Table A1-10. Commercial Repair and Home Damage Relationship 383
Table A1-11. Warehouse and Contractor Services Damage Relationship 386
Table C1-1. Hancock County Parking 407
Table C1-2. Harrison County Parking 407
Table C1-3. Jackson County Parking 409

LIST OF ACRONYMS

AAFU – Average Annual Functional Units

ABFE – Advisory Base Flood Elevation

BFE – Base Flood Elevation

CEFIT – Corps of Engineers Flood Inventory Tool

EAD – Equivalent Annual Damages

EIFS – Economic Impact Forecast System

EGM – Economic Guidance Memorandum

EM – Engineering Manual

EQ – Environmental Quality

ER – Engineering Regulation

ERDC – Engineer Research and Development Center

FEMA – Federal Emergency Management Agency

FHI – Functional Habitat Unit

HEC-FDA – Hydrologic Engineering Centers - Flood Damage Analysis

IWR – Institute for Water Resources

LaCPR – Louisiana Coastal Protection and Restoration

MEMA – Mississippi Emergency Management Agency

MPI – Maximum Probable Intensity

MsCIP – Mississippi Coastal Improvements Program

NAVD88 – North American Vertical Datum 1988

NED – National Economic Development Benefits

NFIP –National Flood Insurance Program

OSE – Other Social Effects

P&G – Planning and Guidance

RED – Regional Economic Development

ROM Costs – Rough Order Magnitude Costs

USACE – US Army Corps of Engineers

EXECUTIVE SUMMARY

General

The intent of the economic appendix is to outline the economic evaluation conducted for the Mississippi Coastal Improvements Programs (MsCIP) Comprehensive Plan. This appendix will display the National Economic Development (NED) benefits, Regional Economic Development (RED) benefits, Environmental Quality (EQ) benefits, Other Social Effects (OSE), and costs that were evaluated for the various Comprehensive Plan measures. The intent of this appendix is to demonstrate the cost effectiveness of measures. Plan features of cost effective plans are outlined in the MsCIP Main Report, and are based on the data from this appendix, other technical appendices, and the results of the Risk Informed Decision Framework (RIDF) evaluations.

Authorizing Language

The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: ***"For an additional amount for "investigations" to expedite studies of flood and storm damage reduction related to the consequences of hurricanes in the Gulf of Mexico and Atlantic Ocean in 2005, $37,300,000 to remain available until expended: Provided, that using $10,000,000 of the funds provided, the Secretary shall conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes at full Federal expense; Provided further, that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits; Provided further, that interim plan features for near term improvements shall be provided within 6 months of enactment of this act with final plan features within 24 months of this enactment."***

The requirements laid out in this authorizing language are unique in their direction that the study team use neither incremental cost-benefit analysis nor maximization of net national economic development (NED) benefits in the selection of plan features. This provided a unique opportunity, but also the requirement that the team very carefully describe the plan formulation and selection process developed for this study effort.

Study Purpose and Scope

The purpose of the comprehensive study is to present the second of two packages of recommended plan features, the "final" response requested by Congress, directed at recovery of vital water and related land resources damaged by the hurricanes of 2005 within the three-county coastal region of the State of Mississippi. The report presents background on the three coastal counties that comprise the Mississippi coastline most severely impacted by the Hurricanes of 2005, their pre-hurricane conditions, a summary of the effects of the 2005 hurricane season, problem areas identified by stakeholders and residents of the study area, a summary of the approach used in analyzing problems and developing plan features directed at assisting the people of the State of Mississippi in recovery, recommended actions and projects that would assist in the recovery of the physical and

human environments, and identification of further studies and immediate actions most needed in a comprehensive plan of improvements for coastal Mississippi.

Study Area

Delineation of the study area is critical for the evaluation of benefits and for their aggregation to determine the economic value of proposed measures. The over all study area for this analysis is the three coastal Mississippi counties; Hancock, Harrison, and Jackson from west to east respectively. The area was further delineated into planning zones, planning units, and planning sub-units.

The first delineation in the hierarchy of segregating the study area was the creation of four planning zones, as shown below in figure 1. The planning zones span the width of Mississippi from state line to state line, and run from south to north. The four zones have been titled the Off-shore Zone, the Coastal Zone, the Inland Zone, and the Upland Zone from south to north respectively. The Off-shore zone includes all areas south of the Mississippi Sound shoreline. The Coastal Zone includes all areas generally from the shoreline North to the CSX railroad and terminating at the Port Bienville railroad spur in Hancock County and Hwy 52 in Jackson County. The Inland Zone accounts for all areas north of the Coastal Zone to the MPI storm surge limit, and the Upland Zone extends from north of the MPI storm surge limit to the County lines.

For the comprehensive plan, the three coastal counties were divided into three planning units based on watershed boundaries which, coincidentally, align with the county jurisdictions. Planning unit one begins at the western state boundary, or the east bank of the Pearl River, and continue to the midpoint of St. Louis Bay. Planning unit two begins at the midpoint of St. Louis Bay and continues east to the midpoint of Biloxi Bay. Planning unit three extends from the midpoint of Biloxi Bay east to the border of Mississippi and Alabama.

Further delineation of the area required breaking the planning units into fifty-four planning sub-units based on hydrologic characteristics, population centers, and economic considerations of potential measure. For hydraulic considerations, Hurricane Surge Atlas maps were evaluated. These maps were prepared by FEMA and the Corps of Engineers, Mobile District from **SLOSH** (Sea, Lake, and Overland Surges from Hurricanes) programming done by the National Oceanic &Atmospheric Administration (NOAA). Sub-units were delineated so that the maximum storm surge difference between sub-units was approximately two-feet. Planning unit one includes ten sub-units, planning unit two eighteen sub-units, and planning unit three twenty-six sub-units. Figure 2 depicts the 54 planning sub-units.

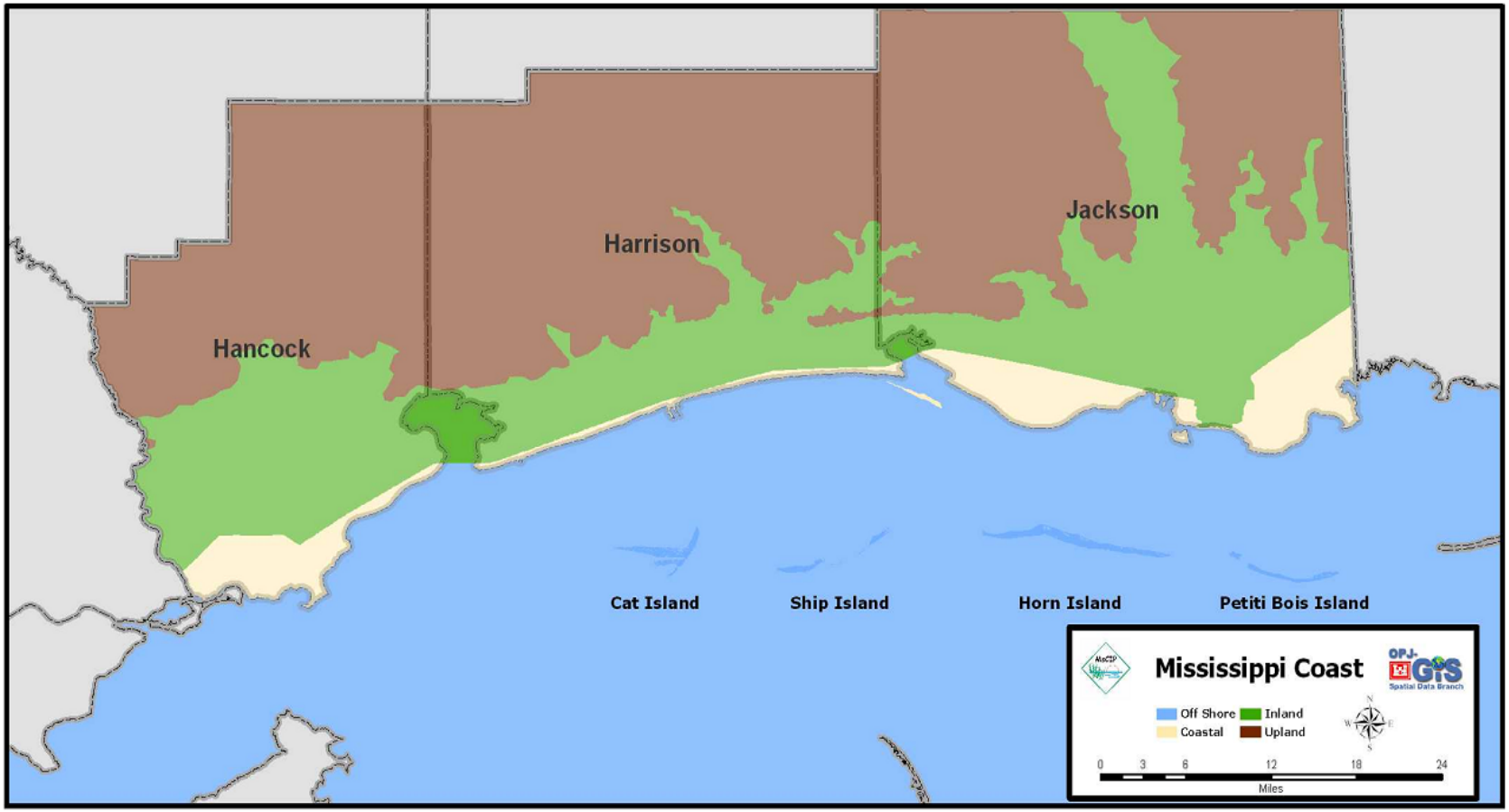


Figure 1. MsCIP Planning Zones

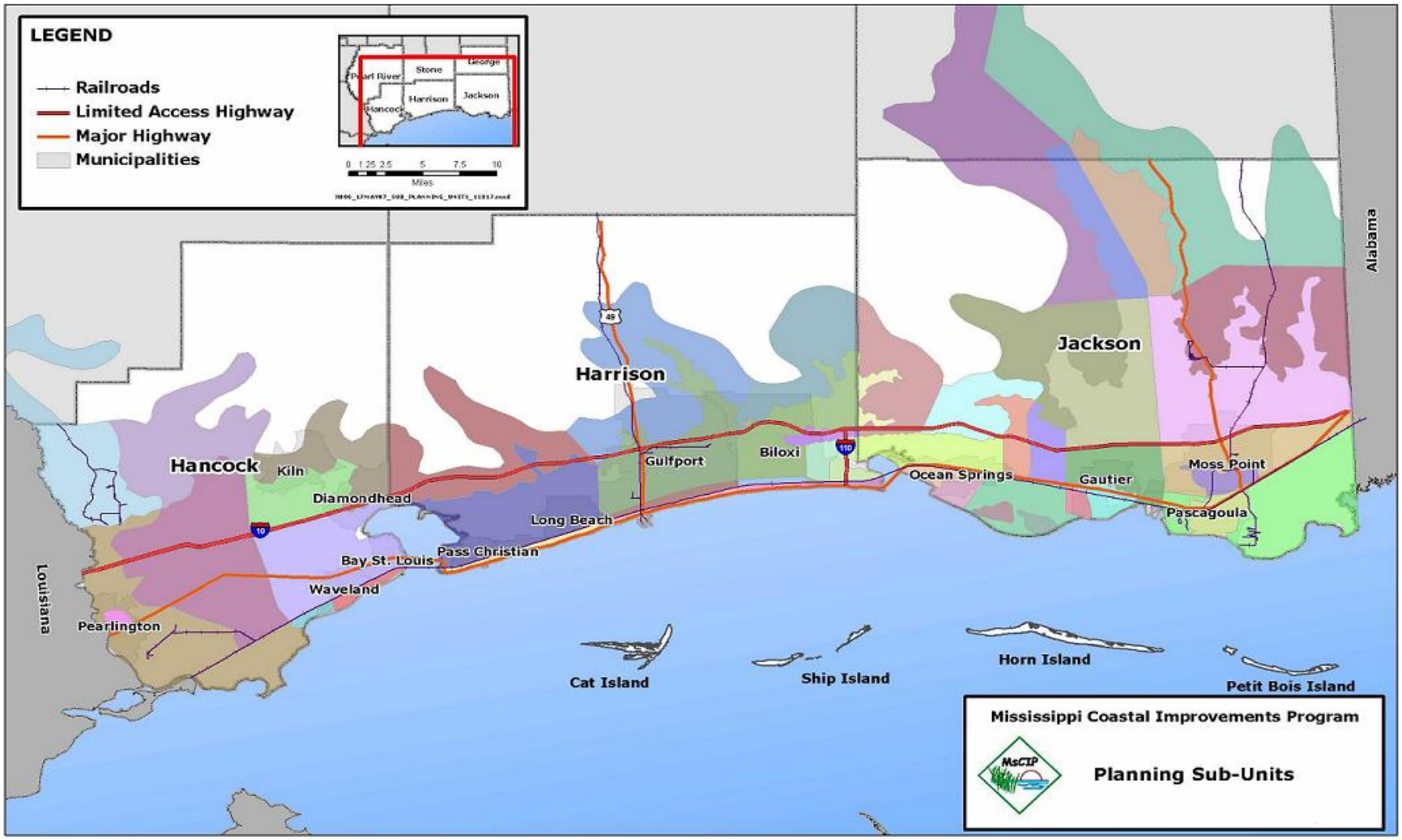


Figure 2. Overview of 3 planning units 54 planning sub-units

Economic Methodology

The economic methodology was developed to seamlessly fit into the six step planning process and current Corps guidance. The six step planning process, as defined by the Engineering Regulation (ER) 1105-2-100; Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (U.S. Water Resources Council 1983), referred to as the P&G, is:

1/ Identify Problems and Opportunities
2/ Inventory and Forecast Conditions
3/ Develop Alternatives
4/ Evaluate Alternatives
5/ Compare Alternatives
6/ Select the Recommended Plan

The Mississippi Gulf Coast is a complex system that is made up of a diverse blend of ecological and human habitats. Given those complexities, a fluid and flexible process was needed to evaluate and aggregate the benefits of potential measures and measures. The process incorporates data collection, forecasting techniques, scenario planning, cost effective evaluation using state of the art modeling techniques, and the communication of both benefits and risks associated with potential measures and measures. Figure 3 outlines the process used for this analysis.

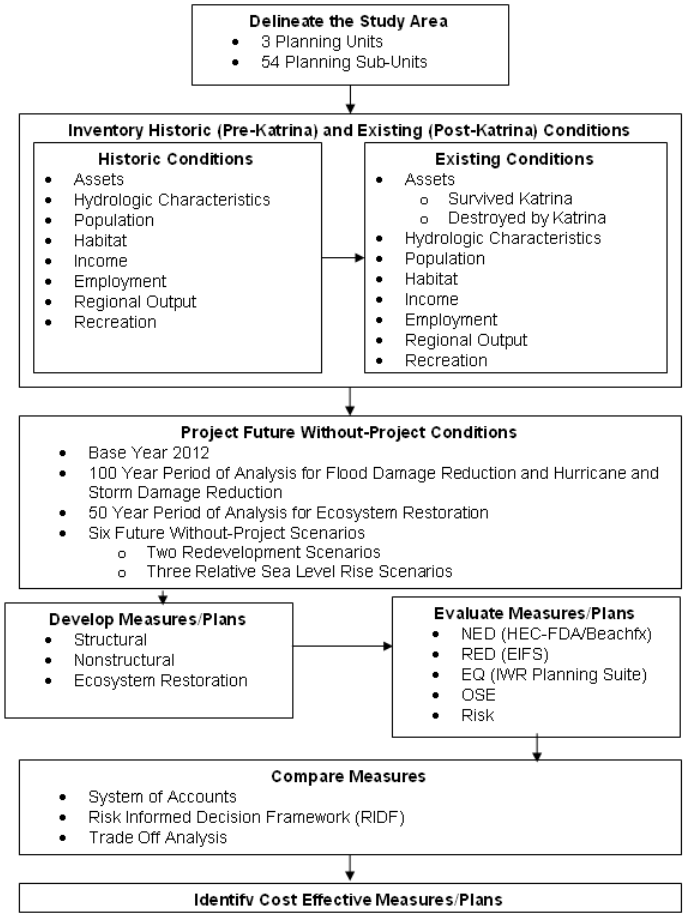


Figure 3. Overview of Economic Methodology

Historic Conditions

The Mississippi Gulf Coast is no stranger to large storm surge events. On August 17, 1969, Hurricane Camille impacted the area in a similar fashion to Hurricane Katrina. Hurricane Camille made landfall at Bay St. Louis, Mississippi only miles way from Hurricane Katrina's landfall path. The total surge area ranged from lower Plaquemines Parish in Louisiana to Perdido Pass, Alabama. Maximum surge from Hurricane Camille on the Mississippi coast ranged from 21.7-feet above m.s.l. in planning unit one, to 24.2-feet above m.s.l. in planning unit two, and 15.8-feet above m.s.l. in planning unit 3.

Damage to the Mississippi Coast from Hurricane Camille was extensive. Federal relief expenditures topped 100 million dollars at 1970 prices, over 600 million dollars when accounted for inflation. The magnitude of this number is astounding considering that many of the relief programs that exist today did not exist for Hurricane Camille. Table 1 shows selected Hurricane Camille damage statistics. Tables 2 and 3 show damage to residential and commercial structures caused by Hurricane Camille surge.

Table 1.
Select Hurricane Camille Statistics.

Camille Statistics	Mississippi	Louisiana	Alabama
Persons Dead	135	9	Unknown
Persons Missing	27	0	Unknown
Families Suffering Loss	63,665	9,442	750
Dwellings Destroyed	3,881	1,771	10
Dwellings with major damage	12,112	1,753	50
Dwellings with minor damage	29,736	3,697	500
Trailers destroyed	406	664	12
Trailers with major damage	325	290	6
Farm buildings destroyed	645	114	5
Farm buildings with major damage	2,002	97	5
Small businesses destroyed or with major damage	569	110	14
Damage to public property	$200,000,000	$10,000,000	$500,000
Damage to private property	$750,000,000	$312,000,000	$7,500,000

1 Source: Report on Hurricane Camille U.S. Army Corps of Engineers – MOBILE DISTRICT

2 These dollars reflect a 1970 price level.

Table 2.
Damage to Structures Caused by Hurricane Camille Surge.

County	Destroyed	Damaged	Total Homes Impacted
Hancock	988	4,217	**5,205**
Harrison	2,608	8,983	**11,591**
Jackson	280	1,289	**1,569**
Total	3,876	14,489	**18,365**

1 Source: Report on Hurricane Camille U.S. Army Corps of Engineers – MOBILE DISTRICT

The 1950-2000 population levels and growth for the U.S., Mississippi, the three-county study area, and each county are presented in Table 3. During this fifty year period, the population of the three-county study area grew by 186.6 percent. This is 5.6 times the Mississippi percentage population

growth of 33.2 percent and 2.2 times the U.S. percentage population growth of 86.0 percent for the same timeframe. The three-county area accounted for 32.7 percent of the nominal population growth for Mississippi from 1950 to 2000.

Table 3.
1950-2000 Population Levels and Growth (in thousands)

	United States	Mississippi	Three-County Study Area	Hancock County	Harrison County	Jackson County
1950	151,326	2,179	127	12	84	31
1960	179,323	2,178	189	14	119	56
1970	203,212	2,217	239	17	134	88
1980	226,546	2,521	301	25	158	118
1990	248,710	2,573	312	32	165	115
2000	281,421	2,903	364	43	190	131
50 Year Nominal Change	130,095	724	237	31	106	100
50 Year Percentage Change	86.0%	33.2%	186.6%	258.3%	126.2%	322.5%

Source: U.S. Census Bureau, 2000 Census

Existing Conditions

On August 29, 2005, Hurricane Katrina made land fall in Hancock County, Mississippi just east of the Pearl River. By virtually all accounts, it was the single largest disaster in U.S. history. Storm surge from Hurricane Katrina was the largest that has ever hit the continental United States. The surge inundated approximately 484 square miles of southern Mississippi. The relief expenditures in Mississippi alone have totaled in the billions of dollars.

The three planning units suffered tremendous devastation from Hurricane Katrina's surge. It is estimated that 32,446 structures were significantly destroyed (at least fifty-percent or more), with another 15,000 to 25,000 suffering moderate to minimal inundation damage. Of the structures sustaining significant destruction, 9,555 were in planning unit one, 16,528, in planning unit two, and 6,363 in planning unit three. Of those significant loss structures, approximately 19,000 claims were paid out by the Federal Emergency Management Agency's (FEMA's) National Flood Insurance Program (NFIP) totally over $2.3 Billion dollars, with the average claim around $137,000. Currently, no accurate data exists for uninsured losses, but estimates also range in the billions of dollars. Table 4 displays the significantly damaged structures by planning unit and by structure category. Figure 4 shows an example of the destruction caused by Hurricane Katrina in the planning unit one.

Table 4.
Structures Damaged 50% or More by Planning Unit and by Category

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Commercial	1,267	1,794	378	**3,439**
Residential	8,099	14,500	5,780	**28,379**
Municipal	127	89	136	**352**
Mobile Home	62	145	69	**276**
Total	**9,555**	**16,528**	**6,363**	**32,446**

Source: U.S. Census Bureau, Population Division



Figure 4. Example of the extent of Hurricane Katrina Surge Damage – Planning Unit One

The 2000-2005 population level and growth estimates for the U.S., Mississippi, the three-county study area, and each county are displayed in Table 5.

Table 5.
2000-2005 Estimates of Population Levels and Growth

	United States	Mississippi	Three-County Study Area	Hancock County	Harrison County	Jackson County
July 1, 2000	282,216,952	2,848,634	364,863	43,283	189,699	131,881
July 1, 2001	285,226,284	2,856,108	366,362	43,944	189,512	132,906
July 1, 2002	288,125,973	2,863,091	367,498	44,607	189,996	132,895
July 1, 2003	290,796,023	2,874,171	367,790	45,166	189,189	133,435
July 1, 2004	293,638,158	2,892,668	372,885	45,821	192,129	134,935
July 1, 2005	296,507,061	2,908,496	375,304	46,546	193,187	135,571
5 Year Nominal Change	14,290,109	59,862	10,441	3,263	3,488	3,690
5 Year Percentage Change	5.06%	2.10%	2.86%	7.54%	1.84%	2.80%

Source: U.S. Census Bureau, Population Division

Future Without-Project Conditions

Forecasting future "without-project" conditions is an important part of the Corps planning process. In order to evaluate the true economic value of potential measures over the project life, a forecast is created based on the historic and existing information, as well as quantitative and qualitative assumptions about what may happen within the study area in the future. In addition to forecasting of future "without-project" conditions, this study also evaluated alternative re-development and relative sea-level rise scenarios. This "Scenario Forecasting" technique was used for the MsCIP Comprehensive Plan in an attempt to capture uncertainty pertaining to these two key variables. For this purpose, six future "without-project" scenarios were developed and are summarized in Table 6.

Table 6.
Overview of Future Scenarios

Future Scenario	Redevelopment Type	Relative Sea Level Rise	Description
Future Scenario 1	Residential	Historical Only	Rebuild structures as existed pre-Hurricane Katrina with no relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 2	Mixed Residential & Commercial	Historical Only	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, no relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 3	Residential	Expected	Rebuild structures as existed pre-Hurricane Katrina with up to 2.4-feet relative sea level rise over the 100-year period of analysis. This future scenario applies to all three planning units.
Future Scenario 4	Mixed Residential & Commercial	Expected	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, an up to 2.4-feet relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 5	Residential	High	Rebuild structures as existed pre-Hurricane Katrina with up to 3.4-feet of relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 6	Mixed Residential & Commercial	High	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, up to3.4-feet of relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.

Future Scenarios One and Two are included only to evaluate the effects of relative sea level rise. These Future scenarios will not be used in the evaluation of potential measures. Futures Three, Four, Five, and Six will be the future scenarios by which potential measures will be evaluated depending on the planning unit.

Structure inventory data was developed for the six future without-project scenarios including structure categories, structure value, content value, and other characteristics, which were input into the HEC-FDA program. Tables 7, 8, and 9 show a summary of select structure characteristics by future without-project scenario and table 10 summarizes the average annual without-project damages by future without-project scenario.

Table 7.
Future Without-Project Scenarios One, Three, and Five Inventory Parcels by Planning Unit and by Structure Category

Structure Categories	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Residential	17,907	49,121	49,688	**116,716**
Mobile Homes	498	2,497	3,553	**6,548**
Commercial	3,255	5,618	4,266	**13,139**
Municipal	653	351	763	**1,767**
Vacant Land	22,843	29,984	29,779	**82,606**
Total	**45,156**	**87,571**	**88,049**	**220,776**

Table 8.
Future Without-Project Scenarios Two, Four, and Six Inventory Parcels by Planning Unit and by Structure Category

Structure Categories	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Residential	17,757	48,636	49,688	**69,942**
Mobile Homes	498	2,497	3,553	**52,687**
Commercial	3,408	6,101	4,266	**13,775**
Municipal	651	381	763	**1,795**
Vacant Land	22,842	29,956	29,779	**82,577**
Total	**45,156**	**87,571**	**88,049**	**220,776**

Table 9.
Structure and Content Values by Category and Planning Unit

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Future Without-Project Scenarios One, Three, and Five Inventory				
Structure Value Subtotal	**$3,370,979,973**	**$9,284,611,429**	**$5,605,921,896**	**$18,261,513,298**
Content Value Subtotal	**$2,565,304,099**	**$7,011,916,003**	**$3,808,364,637**	**$13,385,584,739**
Total	**$5,936,284,072**	**$16,296,527,432**	**$9,414,286,533**	**$31,647,098,037**
Future Without-Project Scenarios Two, Four, and Six Inventory				
Structure Value Subtotal	**$4,234,629,816**	**$8,944,955,778**	**$5,605,921,896**	**$18,785,507,490**
Content Value Subtotal	$4,012,724,707	$7,074,305,948	$3,808,364,637	**$14,895,395,292**
Total	**$8,247,354,523**	**$16,019,261,726**	**$9,414,286,533**	**$33,680,902,782**

Table 10.
Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario

Without-Project Damages	Future 1[2] Damages	Future 2[2] Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Planning Unit One	$198,960,000	$202,060,000	$218,050,000	$222,220,000	$237,310,000	$241,520,000
Planning Unit Two	$91,260,000	$94,680,000	$103,280,000	$107,120,000	$115,470,000	$119,760,000
Planning Unit Three	$88,670,000	$88,670,000	$104,700,000	$104,700,000	$122,420,000	$122,420,000
Total	**$378,890,000**	**$385,410,000**	**$426,030,000**	**$434,040,000**	**$475,200,000**	**$483,700,000**

Damages are rounded to the nearest ten thousand.

Evaluation of Measures and Alternatives

Initial analysis yielded an extensive list of potential measures that were appropriate to a given site or problem area. The sites/problem areas are illustrated in the Main Report. The development of preliminary measures for structural and non-structural damage reduction is discussed in detail in the Engineering Appendix. The development of preliminary measures for ecosystem restoration and saltwater intrusion remediation is discussed in detail in the Environmental Appendix.

Many measures were initially evaluated and screened, based on technical or environmental criteria, and are not discussed here. Those measures that were found to be technically sound for a particular application, and environmentally sound, in regards to potential impacts to environmental resources, were forwarded for evaluation. The development of more detail included preliminary design and cost estimation, coastal, hydrologic and/or hydraulic analysis and design, environmental analysis, and determination of potential damages prevented, residual damages, and other factors. Models used to evaluate the benefits of the measures included the Corps of Engineers Flood Inventory Tool (CEFIT), the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) program, the Beach-FX program, the Institute for Water Resources (IWR) Plan program, and the Economic Impact Forecasting System (EIFS).

Recommended Plan features

The system wide plan features for the MsCIP Comprehensive plan, explained in more detail in the Main Report, have multiple levels. Some of the features will be recommended as work for entities other than the Corps of Engineers, some will be recommended for further construction, and some will be recommended for implementation. The list of measures in this appendix which are recommended for further study include the ring levee and nonstructural measures at the Pearlington, Ocean Springs, Gautier, Gulf Park Estates, Belle Fontaine, and Pascagoula/Moss Point areas, as well as further inquiry into the coast wide 20-foot, 30-foot, and 40-foot elevation nonstructural measures. Among the list of recommended plan features for construction that were analyzed in this appendix include barrier island restoration, beach and dune placement, ecosystem restoration at the Admiral Island, Turkey Creek, Bayou Cumbest, Dantzler, and Franklin Creek areas, the 21-foot elevation levee at the Forrest Heights area, and the acquisition of parcels within high risk areas.

For planning and screening purposes, the analysis in this appendix used a 100-year period of analysis for measures that were determined to be complex in nature such as the barrier island restoration or measures that had a high risk of residual damages due to relative sea level rise such as flood risk management measures. Other measures that were not as complex in nature, such as the beach and dune placement and the ecosystem restoration measures were evaluated at the traditional 50-year period of analysis used in Corps of Engineers studies. In order to show consistency among the plans recommended for construction, those measures that were initially screened at a 100-year period of analysis have been converted to a 50-year period of analysis for costs and benefits and are summarized in table 11. The costs in table 11 represent Rough Order Magnitude (ROM) utilized for screening. Detailed Micro-Computer Aided Cost Estimating System (MCACES) costs can be found in the cost estimating appendix.

Table 11.
Summaries of Benefits and Costs for Measures Recommended for Implementation[1]

	Equivalent annual damages Reduced Future 3 (Annual $)	Recreation (Annual $)	Environmental Impacts	Changes in Sales Volume ($)	Changes in Income ($)	Changes in Employment	Total First Cost with IDC[2] ($)	Average Annual Cost (Annual $)
Barrier Island Restoration	$18,028,000	$466,000	$43,618,000 Fishery Losses Avoided	$798,984,000	$167,850,000	4,920	$551,134,800	$29,608,000
Beach and Dune Placement	Moderate Reduction	N/A	736 Functional Habitat Index (FHI) Score	$33,413,200	$7,307,000	208	$25,192,300	$1,353,000
Acquisition in High Risk Areas	$22,000,000 to $33,000,000	Potential Recreational Opportunities	Potential Restoration Opportunities	$3,238,602,000	$706,330,000	19,452	$459,442,100	$24,682,000
Forrest Heights 21-FT Ring Levee	$89,000	N/A	3.6 Acres Impacted	$30,425,000	$6,440,000	193	$14,482,500	$778,000
Admiral Island Ecosystem Rest.	Increased Surge Storage	N/A	60 Average Annual Functional Units (AAFU)	$49,750,000	$ 11,996,000	301	$22,997,000	$1,235,000
Turkey Creek Ecosystem Rest.	Increased Surge Storage	N/A	1,565 Average Annual Functional Units (AAFU)	$15,237,000	$3,226,000	97	$7,206,300	$387,000
Bayou Cumbest Ecosystem Rest.	Increased Surge Storage	N/A	188 Average Annual Functional Units (AAFU)	$54,073,000	$ 10,546,000	306	$26,917,800	$1,446,000
Dantzler Ecosystem Rest.	Increased Surge Storage	N/A	1,244 Average Annual Functional Units (AAFU)	$ 5,054,000	$ 986,000	29	$2,331,800	$125,000
Franklin Creek Ecosystem	Increased Surge Storage	N/A	516 Average Annual Functional Units (AAFU)	$3,890,000	$ 759,000	22	$1,960,500	$105,000

1/ These measures were analyzed for economic benefits and do not represent the entire recommended plan features for implementation. See the main report for more detail.
2/ Implementation costs are based on ROM cost estimates and an FY 08 price level and do not include escalation. See the engineering appendix for more details on the costs.
3/ Average annual damages reduced and costs are based on a 50-year period of analysis and an FY 08 discount rate of 4.875-percent. Dollar values are rounded to the nearest thousand.

CHAPTER I. DEFINING THE STUDY AREA

This section describes the location and delineation of the study area used in this analysis. Delineation of the study area is critical for the evaluation of benefits and for their aggregation to determine the economic value of proposed measures. The over all study area for this analysis is the three coastal Mississippi counties; Hancock, Harrison, and Jackson from west to east respectively. The area was further delineated into planning zones, planning units, and planning sub-units which are detailed in the following subsections. Figure 1-1 shows the congressionally mandated study area for the Mississippi Coastal Improvements Program.



Figure 1-1. Congressionally authorized study area

1.3.1 Planning Zones

The first delineation in the hierarchy of segregating the study area was the creation of four planning zones. The planning zones span the width of Mississippi from state line to state line, and run from south to north. The four zones have been titled the Off-shore Zone, the Coastal Zone, the Inland Zone, and the Upland Zone from south to north respectively. The Off-shore zone includes all areas south of the Mississippi Sound shoreline. The Coastal Zone includes all areas generally from the shoreline North to the CSX railroad and terminating at the Port Bienville railroad spur in Hancock County and Hwy 52 in Jackson County. The Inland Zone accounts for all areas north of the Coastal Zone to the MPI storm surge limit, and the Upland Zone extends from north of the MPI storm surge limit to the County lines. Figure 1-2 depicts the four planning zones.

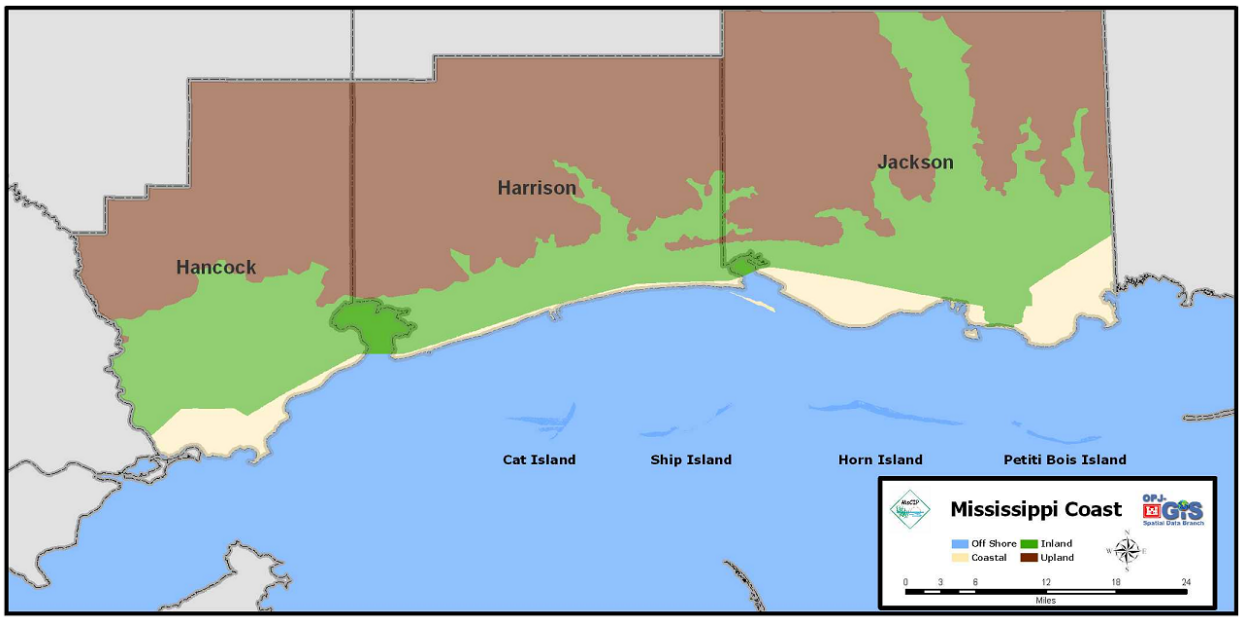


Figure 1-2. Planning Zones

1.3.2 Planning Units

For the comprehensive plan, the three coastal counties were divided into three planning units based on watershed boundaries which, coincidentally, align with the county jurisdictions. Planning unit one begins at the western state boundary, or the east bank of the Pearl River, and continue to the midpoint of St. Louis Bay. Planning unit two begins at the midpoint of St. Louis Bay and continues east to the midpoint of Biloxi Bay. Planning unit three extends from the midpoint of Biloxi Bay east to the border of Mississippi and Alabama. Figure 1-3 shows the planning unit boundaries.

1.3.3 Planning Sub-Units

Further delineation of the area required breaking the planning units into fifty-four planning sub-units based on hydrologic characteristics, population centers, and economic considerations of potential measure. For hydraulic considerations, Hurricane Surge Atlas maps were evaluated. These maps were prepared by FEMA and the Corps of Engineers, Mobile District from **SLOSH** (Sea, Lake, and Overland Surges from Hurricanes) programming done by the National Oceanic &Atmospheric Administration (NOAA). Sub-units were delineated so that the maximum storm surge difference between sub-units was approximately two-feet. Planning unit one includes ten sub-units, planning unit two eighteen sub-units, and planning unit three twenty-six sub-units. Figures 1-4 shows all the sub-units and figures 1-5, 1-6, and 1-7 illustrate the planning units one, two, and three and their sub-units, respectively.

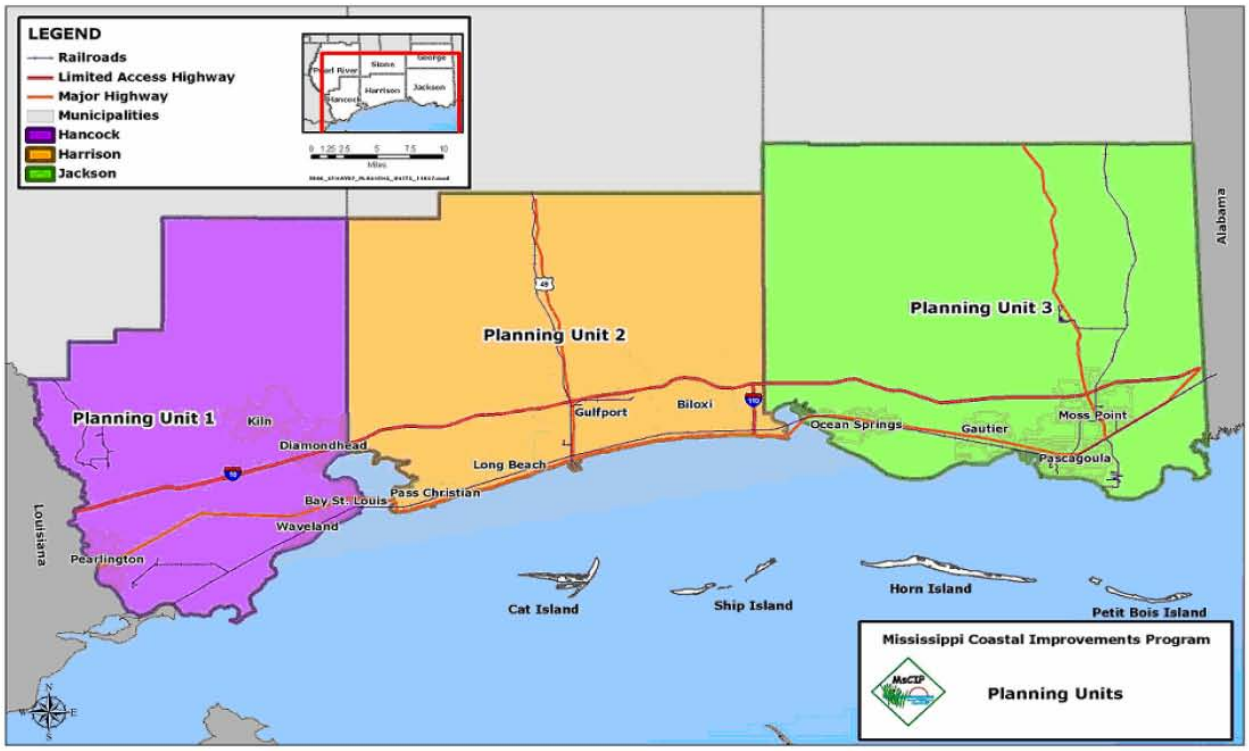


Figure 1-3. Planning Units

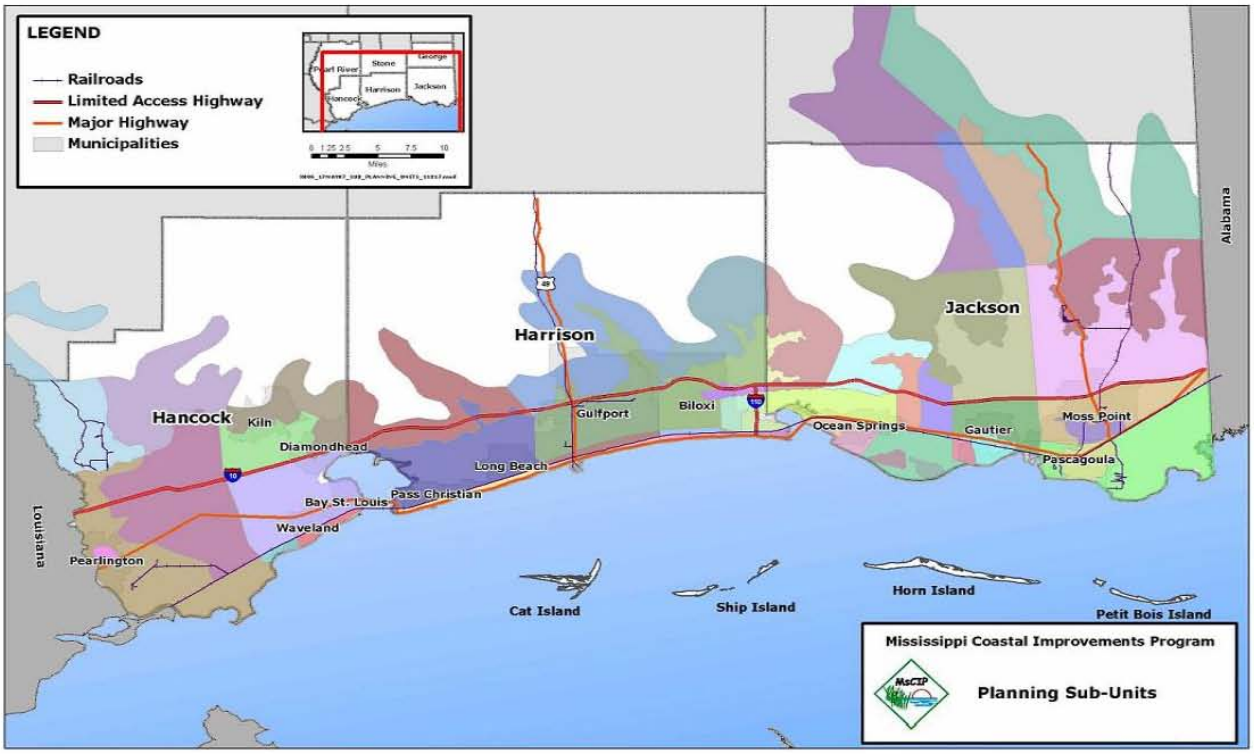


Figure 1-4. Overview of 54 planning sub-units

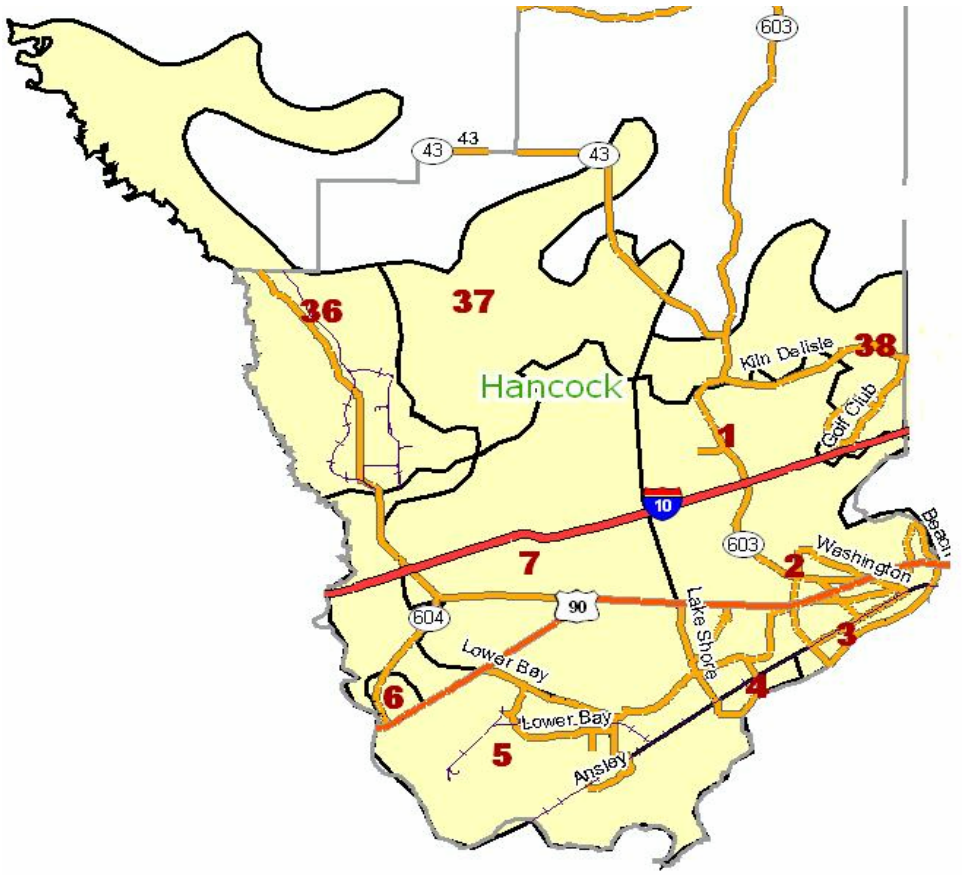


Figure 1-5. Sub-units for Planning Unit One

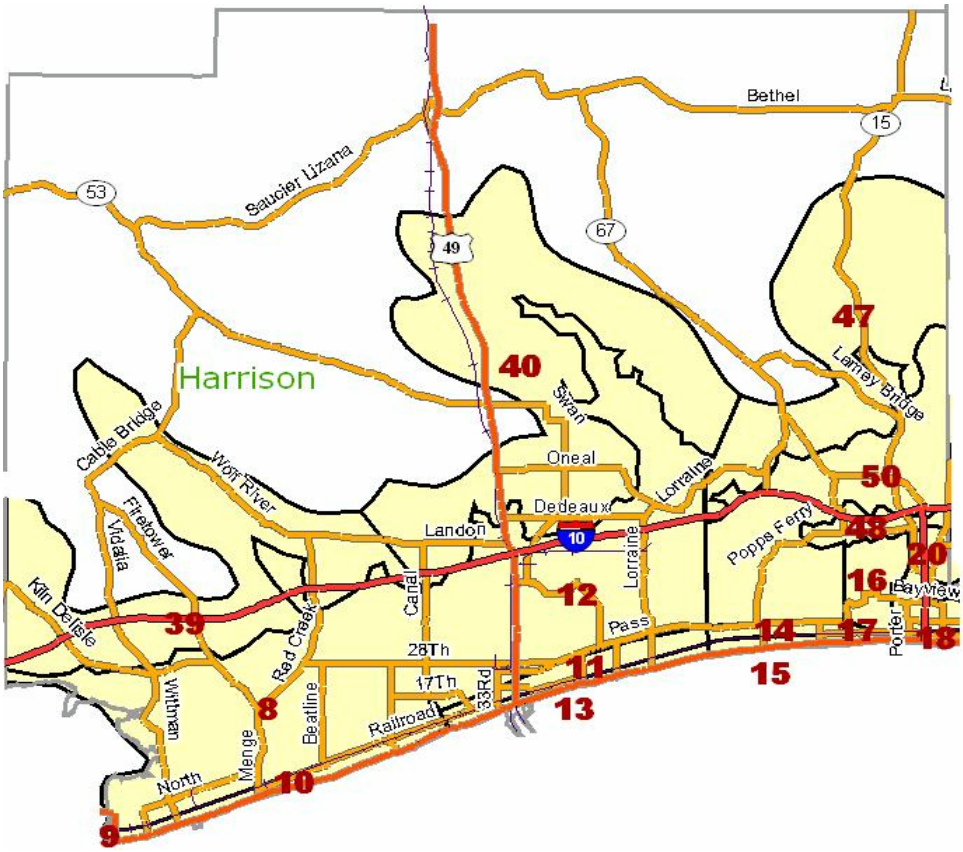


Figure 1-6. Sub-units for Planning Unit Two

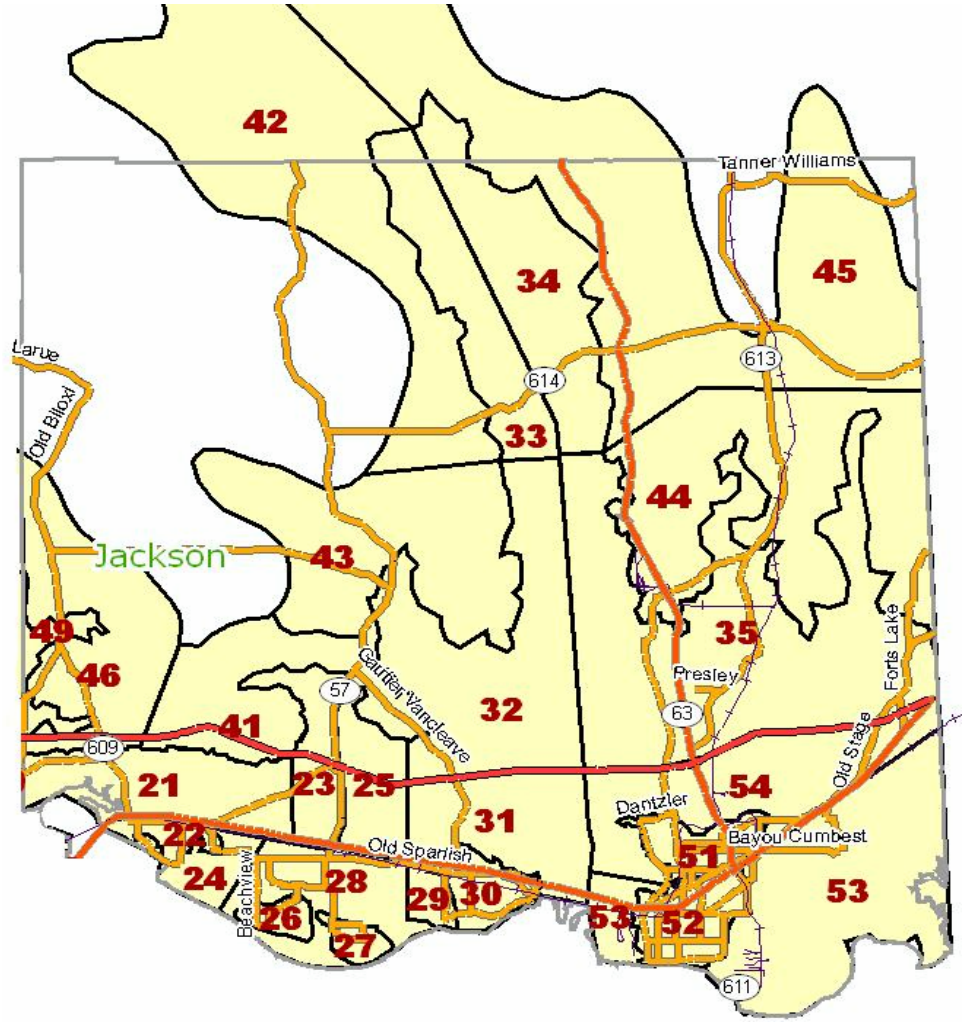


Figure 1-7. Sub units for Planning Unit Three

CHAPTER II. OVERVIEW OF ECONOMIC METHODOLOGY

This section describes the methodology for the evaluation of economic impacts of potential solutions for the Mississippi Gulf Coast under the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Report. It is intended to be an outline of the process used to determine the economic impacts that are fully detailed throughout this appendix and in the main report. The methodology was developed to seamlessly fit into the six step planning process and current Corps guidance. The six step planning process, as defined by the Engineering Regulation (ER) 1105-2-100; Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (U.S. Water Resources Council 1983), referred to as the P&G, is:

1/ Identify Problems and Opportunities
2/ Inventory and Forecast Conditions
3/ Develop Alternatives
4/ Evaluate Alternatives
5/ Compare Alternatives
6/ Select the Recommended Plan

The Mississippi Gulf Coast is a complex system that is made up of a diverse blend of ecological and human habitats. Given those complexities, a fluid and flexible process was needed to evaluate and aggregate the benefits of potential measures and measures. The process incorporates data collection, forecasting techniques, scenario planning, cost effective evaluation using state of the art modeling techniques, and the communication of both benefits and risks associated with potential measures and measures. Figure 2-1 outlines the process used for this analysis.

The first step in the process was to delineate the study area. The overarching study area, as defined by Congress, is the three coastal counties in Mississippi; Hancock, Harrison and Jackson from west to east respectively. For purposes of system wide evaluation and aggregating benefits, the study area was divided into four planning zones, three planning units, and fifty-four sub-planning units. These are described in more detail in the following section.

Once the planning zones, planning units, and planning sub-units were identified, the next step was inventorying the economic, social, and environmental characteristics of the area. Data from Local, State, and Federal government agencies was utilized to determine the Historic (Pre-Hurricane Katrina) Condition, including data from the U.S. Census Bureau, the Federal Emergency Management Agency (FEMA), U.S. Fish and Wildlife, the Mississippi Emergency Management Agency (MEMA), the Mississippi Governor's Recovery Office, County Tax Assessors, previously conducted Corps of Engineers studies conducted in the area, and other valuable data sources. Historic data included economic structures (structures, content, and critical infrastructure), social and regional indicators (population, income, and employment), topographic and hydrologic characteristics, acreage of habitat, and etc.

With the historic data serving as a foundation, the next step was to determine the impacts of surge inundation from Hurricane Katrina. The team developed an inventorying methodology that was a combination of sampling and field verification. Every street within the fifty-four planning sub-units was driven over the course of four months from June to October, 2006, for purposes of determining the existing (Post-Hurricane Katrina) conditions and characteristics of structures. The findings of this work were put into a structure database that included over 200,000 tax parcels, 138,000 of which contained structures. Hydrologic programming was used to evaluate the surge inundation of each

planning sub-unit and a combination of Geographical Information System (GIS) data and ground truthing was used for habitat evaluation.

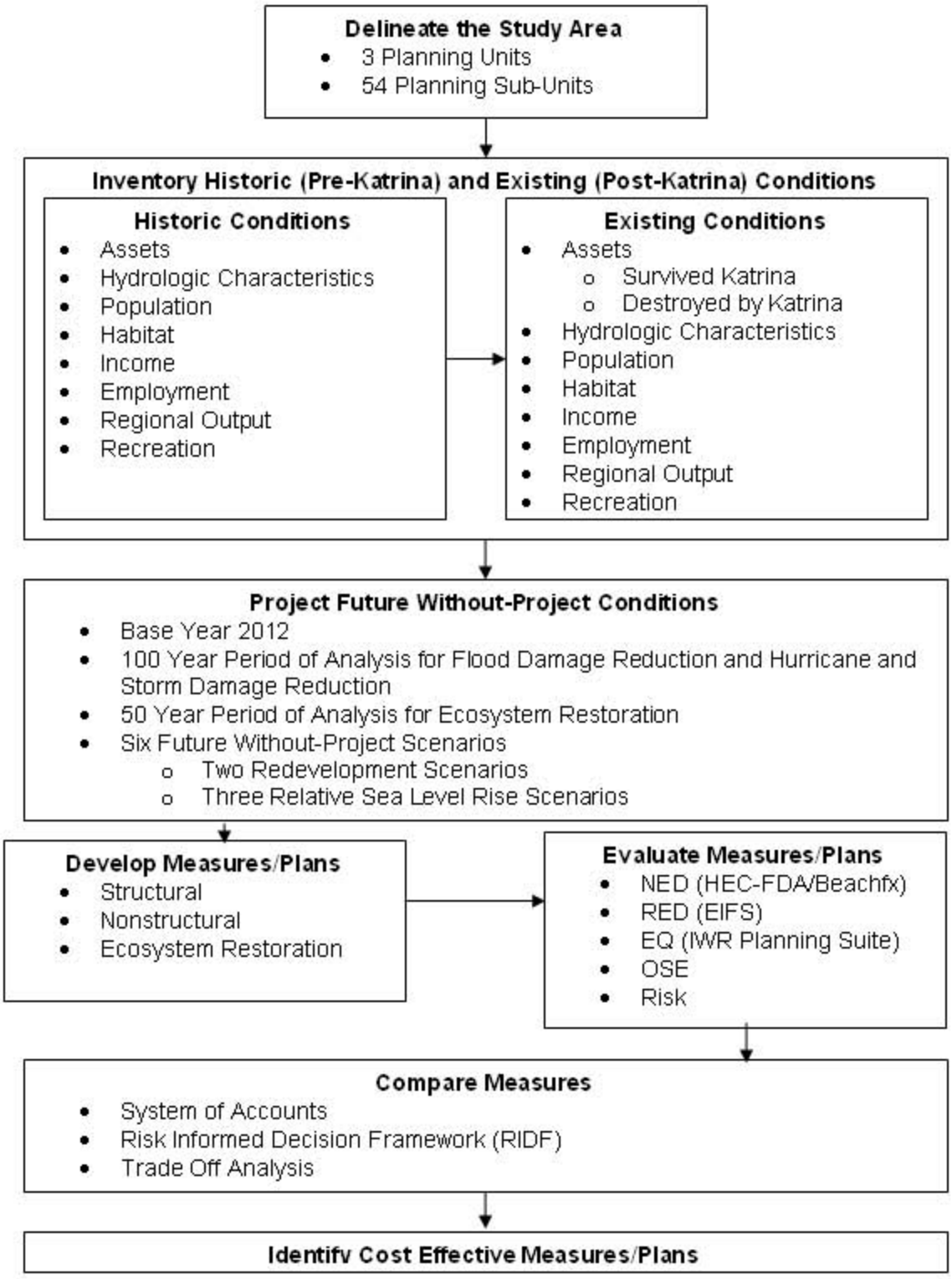


Figure 2-1. Overview of Economic Methodology

Six future without-project scenarios were developed, based on the existing condition characteristics, for the evaluation of future without-project conditions. In order to address sensitivity issues, the six scenarios were initially evaluated over a 100-year period of analysis from the base year 2012 (2012–2111) and using the FY08 federal discount rate of four-and-seven-eighths (4.875) percent. The six future scenarios include two redevelopment scenarios (residential and mixed-residential and commercial) and three relative sea level rise scenarios (existing, moderate, and high relative sea level rise) for a total of six different future scenarios. Scenario one is a residential redevelopment with no relative sea level rise over the 100-year period of analysis, scenario two is a mixed residential and commercial redevelopment with no relative sea level rise, scenario three is a residential redevelopment with a maximum relative sea level rise depending on location of 2.0-feet over the period of analysis, scenario four is a mixed residential and commercial redevelopment and a maximum relative sea level rise of a 2.0-foot, scenario five is a residential redevelopment with a relative sea level rise depending on location of 3.4-feet, and scenario six is a mixed residential and commercial redevelopment with a maximum relative sea level rise depending on location of 3.4-feet. All plans recommended for construction in the Comprehensive Plan were adjusted to a 50-year period of analysis per Corps Policy. The detailed evaluation of these scenarios is outlined below in the Future Without-Project section, and a technical description of the calculation of relative sea level can be found in the engineering appendix.

The next step, identified as step three in the planning process, was to develop measures that relate to the planning objectives for this study, which are detailed in section 2.3 of this document. An measure is something that can be implemented to directly address a problem within the study area. Some examples of measures include levees and acquisitions for flood damage reduction, beach and dune construction for flood damage reduction and ecosystem restoration, excavation and planting of native species for ecosystem restoration. These measures can be stand alone or may be able to be combined like a system.

For the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan Report, multiple measures were developed under structural, nonstructural, and ecosystem restoration categories. The project delivery team applied a screening process based on engineering, environmental, and economic feasibility to narrow the list of viable measures. The full list of measures and how they were screened can be found in the MsCIP Comprehensive Plan Main Report.

The result of the screening was a list of measures that were fully evaluated as compared to the future without-project conditions. These measures were evaluated using the four systems of accounts, outlined in ER 1105-2-100, which include National Economic Development (NED) benefits, Regional Economic Development (RED) benefits, Environmental Quality benefits, and Other Social Effects (OSE). Evaluations of the various metrics that make up these four accounts were conducted using multiple economic programs, expert opinion, and other sources where available. The main economic programs used for the evaluation of measures include the Corps of Engineers Flood Inventory Tool (CEFIT), the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) program, the Beach-FX program, the Institute for Water Resources (IWR) Planning Suite, and the Economic Impact Forecasting System (EIFS). Outputs from these programs were carried forward for the comparison of the measures.

The final two steps of the process include a comparison of measures/plans and the identification of cost effective plans. A comparison of the evaluated measures was conducted using the System of Accounts (SOA) table and the Risk Informed Decision Framework (RIDF) process developed specifically for the MsCIP and LaCPR studies. Detailed descriptions of these two comparison methods and a list of recommended plan features can be found in Chapter Eight of this appendix and in the main report.

CHAPTER III. MODELING EFFORTS

3.1 Corps of Engineers Flood Inventory Tool (CEFIT)

3.1.1 Program Overview

The Corps of Engineers Flood Inventory Tool (CEFIT) program allows users to calculate replacement estimates for a variety of structures and replacement cost of commercial inventory. The CEFIT program is a proprietary program produced by Marshall and Swift in coordination with the Institute for Water Resources (IWR). The program consists of two components: a Residential Estimator component and a Commercial Contents Inventory component. The program allows for user inputs to define the type of structure that is being evaluated and provides outputs based on observed data collected by Marshall & Swift.

- Residential Estimator

The Residential Estimator component is a program that allows the user to calculate replacement cost for a variety of structures. It will calculate the depreciated replacement cost for single family residential, schools, and churches.

It has a variety of inputs that allow for a realistic estimate of depreciated replacement cost. It incorporates the location of the structure (by zip code), age, square footage, quality of construction, exterior wall material, roof type etc. All of these inputs increase the accuracy in gauging a correct estimate. The required inputs are location, age, square footage, quality of construction, and exterior wall material. Residential Estimator allows you to input your own depreciation factor or it allows the user to use program defined depreciated replacement factors based on data collection efforts for the defined area and other inputs.

The outputs for the Residential Estimator include a list of the inputs, total replacement cost of a new structure, depreciation on the structure due to age and quality, and the total depreciated replacement cost for the structure. Age and quality are the most influential factors in determining the amount of depreciation.

- Commercial Contents Inventory (CCI)

The Commercial Contents Inventory component is a program that allows the user to calculate depreciated replacement cost for inventory and equipment for various businesses. This program will calculate the depreciated replacement cost for a variety of business types. There are over 975 industry categories and 12 sales-size groupings.

There are 4 required inputs for CCI. They include: the sic code for primary and secondary operation, projected annual revenue for upcoming year, square footage of occupied building or portion of occupied building, and the number of full and part-time employees. CCI also has an input for the number of production shifts. However, the users manual recommend that the user should leave the production shifts at 1.

CCI has built in checkpoint procedures when it appears that certain inputs are outside the bounds of typical industry experience. When this happens inputs will be highlighted in red. The program also notes that it does not capture the value of leased or rented equipment. The program only captures the value on solely owned property and equipment.

The program recommends, for accurate results, to use current information, search for the closet sic code for the specific business type, use company specific data for optional items, and modify the quality and density level of equipment as appropriate.

The program returns three output values. It returns an inventory replacement value, an industry-norm equipment replacement value, and a company specific equipment replacement value. All of these values are depreciated replacement costs. The accuracy of the company specific depreciated replacement cost depends on the confidence level of input values.

3.1.2 Extent of Use

Where available, data from field interviews was utilized in estimating depreciated replacement cost for structure and content values. This was done by comparing tax data to data that was collected in the field and applying comparison percentages to different structure types. A detailed explanation of this process can be found below in chapter IV.

For those structure types, such as municipal and commercial and industrial structures, the CEFT program was employed for the estimation of depreciated replacement cost of structures and their contents. Specifically, the CEFIT program was used to estimate depreciated replacement cost of public structures and their contents, such as schools and churches, as well as to estimate the value of inventory within commercial and industrial structures. Data used as input for the program came from a variety of sources including field interviews of businesses, available financial statements of publicly traded companies, and existing data from previous Corps of Engineers studies. Outputs from the program were incorporated into the structure database described in detail in a later section of this appendix, and ultimately incorporated as inputs into the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) and Beach-FX programs for evaluation of damages and damages reduced.

3.1.3 Uncertainty

The CEFIT program does not contain a direct mechanism for addressing any uncertainty that exists in the estimation of the program's outputs. Since the output values, which include the depreciated replacement cost of schools and churches and of commercial and industrial structures, of the CEFIT program are an input for the HEC-FDA and Beach-FX programs, uncertainty is addressed within those program frameworks. Both programs allow you to input the uncertainty around the depreciated replacement cost of the structure and inventory values derived by the CEFIT program. The programs account for two standard deviations of uncertainty, or approximately the ninety-five percent confidence level. A detailed description of how the HEC-FDA and Beach-FX programs address uncertainty regarding these and other variables is described below in greater detail.

3.2 Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA)

3.2.1 Program Overview

The Hydrologic Engineering Center's-Flood Damage Analysis (HEC-FDA) program is the standard analytical tool for calculating equivalent annual damages (EAD) from flood inundation. As per the user's manual, the HEC-FDA program "Provides the capability to perform an integrated hydrologic engineering and economic analysis during the formulation and evaluation of flood damage reduction plans. The program follows functional elements of a study involving coordinated study layout and configuration, hydrologic engineering analyses, economic analyses, and plan formulation and

evaluation…the procedures are consistent with federal and Corps of Engineers policy regulations (ER-1105-2-100 and ER 1105-2-101)."

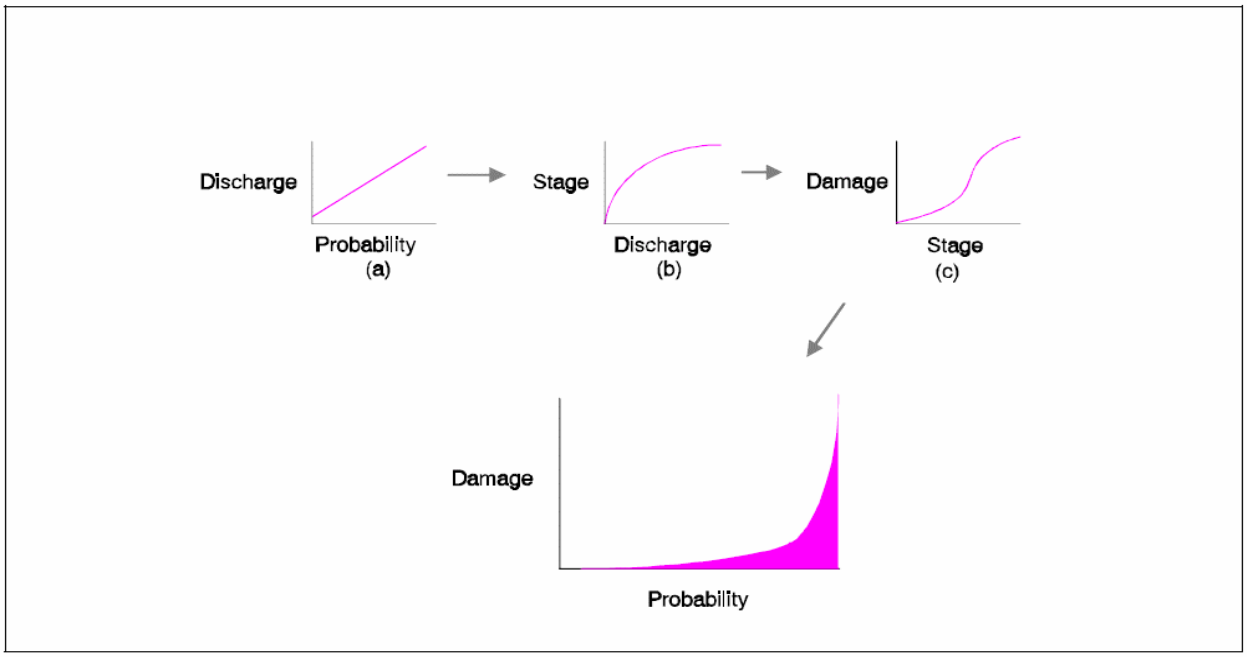
"Both economic flood damage and hydrologic engineering analyses are performed using a consistent study configuration (streams, damage reaches, plans, and analysis years). Two types of evaluations are available: analysis of damage and project performance by analysis year: and equivalent annual damage. Many Output tables and plots are used for reporting results. Computations and display of results are consistent with technical procedures described in EM 1110-2-1619."

The steps for evaluation using HEC-FDA are:

- Define Study Parameters
    - Study Stream(s) – defines the source of the water
    - Analysis Years - defines the base year and most likely future year
    - Survey Year – the year the data was initially collected
    - Update Year - allows for an update of data in the future
- Define Damage Reaches (Planning sub-units)
    - Reach Name – the limits of an area that share hydrologic and economic similarities
    - Beginning and Ending stations – the start and finish points of a reach
    - Index Location – a point between the beginning and ending stations of a reach where the greatest confidence in data is located for that reach (e.g. At a stream gage location)
- Define Plans
    - Existing Condition – typically the defined study area at the point in time the data was collected
    - Without-Project Condition – defines the study area with the assumptions made regarding the hydrologic and economic characteristics expected in the future if nothing were to be done
    - With-Project Conditions – defines each of the potential measures that could be implemented and how it acts (reduces damages) as compared to the without-project condition
- Enter Hydrologic Data
    - Water Surface Profile
    - Stage-Discharge Functions
    - Exceedance-Probability Functions
- Enter Economic Data
    - Structure Inventory Data – compiled database that includes structure characteristics such as location, structure and content value, first floor elevation, etc.
    - Depth Damage Relationships – defined relationships between the depth of water and the damage to each of the structures and their respective contents

- Assign Structure Inventories to Plans – each plan has its own specific structure inventory that is defined specifically for that plan and attributed to that plan
- Compute Aggregated Stage Damage with Uncertainty and Equivalent Annual Damages – this is the first computational step in the HEC-FDA model. It evaluates the damage at the various stages of the stage frequency curves and determines the damages attributed to each of the stage intervals. This step can be computed with or without uncertainty.
- Evaluation of Plans by Analysis Years – evaluates a plan and its performance reaches based on target standards defined for the without project conditions for the study. These standards are based on the residual damages associated with a specific exceedance probability event.
- Equivalent Annual Damage Analysis – computes the equivalent annual damages for each plan based on the pre-defined period of analysis years (e.g. 100-years) and the desired discount rate (e.g. 4.875-percent). Figure 3.2-1 shows the traditional EAD computation process.

EM 1110-2-1619
1 Aug 96



Source: Engineering Manual (EM) 1110-2-1619

Figure 3.2-1. Illustration of transformation for traditional equivalent annual damage computation

3.2.2 Depth Damage Relationships

The depth damage relationships used for the HEC-FDA analysis are based on expert elicitation and observation of damages from flood events. Generic curves for residential one-story and two-story structures and their contents are from *Corps of Engineers Economic Guidance Memorandum (EGM) 01-03, Generic Depth Damage Relationships*. Commercial, municipal, and mobile home structure and content curves are from the July 1997 final Report entitled *Depth-Damaged Relationships for Structures, Contents, and Vehicles and Content-To-Structure Value Ratios (CSVR) in Support of the Lower Atchafalaya Reevaluation and Morganza to the Gulf, Louisiana Feasibility Studies* prepared for New Orleans District Corps of Engineers. Addendum A to this appendix describes the HEC-FDA damage curves in detail.

3.2.3 Extent of Use

For the MsCIP Comprehensive Plan Report, the HEC-FDA model was used to evaluate the without-project flood damages of the study area and the respective damages reduced of various measures in the coastal and inland planning zones. The use of this model for the MsCIP Comprehensive Plan Report is slightly different than the typical riverine application of the model, but it is still an appropriate tool for the evaluation of measures under MsCIP. The Hydrologic Engineering Center (HEC) made several modifications to the model specifically for this study. Both modifications were with respect to the uncertainty bounds around the stage frequency curves and the first floor elevations of structures.

3.2.4 Uncertainty

The HEC-FDA model allows for the quantification of uncertainty pertaining to hydrologic characteristics, such as the exceedance probability functions, and economic characteristics such as first floor elevation, structure value, content value, and depth-damage relationships. Uncertainty regarding these parameters, and their effect on EAD, are captured by using Monte Carlo simulation. Monte Carlo simulation samples the parameters from a range, typically two standard deviations, and incorporates the potential variance in the values that may occur in the real world.

3.3 Beach-FX

3.3.1 Program Overview

Beach-FX is an engineering-economic program that simulates beach response over time, as storms, natural recovery, and management methods alter the beach profile. The model estimates expected structural damages expressed as losses due to flooding, erosion and waves. It is an event-based, data-driven Monte Carlo simulation program. This structure has been used successfully in the past in a large number of U.S. Corps of Engineers (USACE) studies.

The program is an event-driven life-cycle Monte Carlo simulation program. A shore protection project life cycle (e.g. 100-years) is simulated by determining the beach and structure response to a set of storms (the events driving the process). The associated damages are determined for each structure that is programmed. This simulation is repeated for many different sets of storms, and the results averaged. Input data to the program is stored in databases, and, wherever possible, information needed to localize, parameterize, and modify program behavior is also stored as data (data-driven programming).

The program simulates beach response over time as storms, natural recovery, and management methods alter the beach profile. Events of interest (storms, beach nourishment) take place at calculated times. As each event takes place, the program simulates the physical and economic responses associated with that event. Structural damages include losses due to flooding, erosion, and wave impact. Simplified beach profiles, as defined by key data points, are tracked as the beach profile evolves over time.

The program makes use of a Shoreline Response Database (SRD). The SRD is a pre-generated set of beach profile responses to storms, for a range of storms and profiles. The program uses “plausible storms”, based on historic storms, as initiating events. The procedure for developing plausible storms is described in Appendix A. The shoreline modification due to a storm is determined through use of a shoreline response program, in this case SBeach, a cross-shore storm response program developed by the Waterways Experiment Station (WES) of the Corps. The SRD contains information on the input (pre-storm) profile, the storm, and the response (post-storm) profile, for

many combinations of storms and pre-storm profiles. The Monte Carlo simulation program then reads information from the SRD as needed to determine shoreline change following a storm event.

As each storm is processed, the shoreline response is determined, and a post-storm beach configuration is calculated, as well as profiles of maximum water level, wave height, and erosion during the storm. This information is used to determine economic damages, based on empirical curves (damage functions) relating the percentage loss of value of structure and contents to "damage-driving parameters" calculated from the aforementioned profiles and characteristics of the structure. The nature of the data used by the program is shown in Figure 3.3.1.

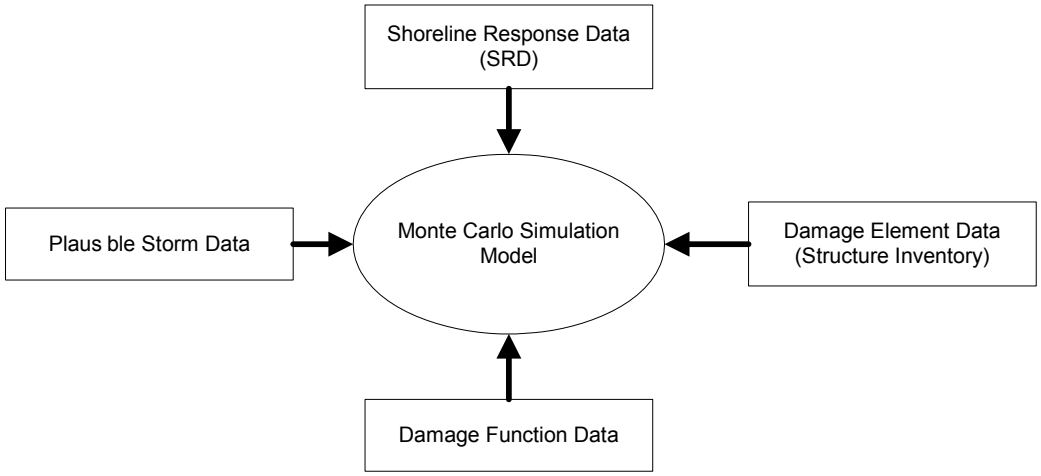


Figure 3.3-1. Data used for Beach-FX Program

3.3.2 Depth Damage Functions

Depth damage functions used within the Beach-FX simulations are based on expert elicitation and are broken into several damage categories. These damage categories include inundation damages, wave's damage, wave run-up (wave set-up) damages, and erosion damages. Addendum B to this appendix is an abstract of how the damage functions were developed and Addendum C describes in detail the damage functions used for Beach-FX.

3.3.3 Extent of Use

For the MsCIP Comprehensive Plan Report, the Beach-FX program was set up to be used to evaluate without-project damages and damages reduced for commercial structures that are physical located south (Gulf Side) of the major roadways in the three planning units. Those structures north of the major roadways in each of the planning units are evaluated using HEC-FDA (see previous section). Each of the beach and dune placement measures, described in detail later in this appendix, were evaluated against two future without-project scenarios: 1/ a future scenario with n expected relative sea level rise of 2.0-feet and 2/ a future scenario with a with an expected relative sea level rise of 3.4-feet. Section 6.2 of this appendix describes the Beach-FX evaluation in greater detail.

3.3.4 Uncertainty

The complexities of the combined engineering-economic problem of risk-based analysis, in which there are uncertainties associated with the physical performance of systems and the economic consequences of that performance, are typically addressed through the use of Monte Carlo

simulation techniques. Monte Carlo simulation is particularly useful for physically based real-world problems, where the results of the simulation can be tested against historical and reasonable behaviors.

Beach-FX uses Monte Carlo simulation to sample variable values within a range in order to capture uncertainty. Variables such as structure value, content and inventory, first floor elevation, and days to rebuild the structure when it is destroyed are given an upper and lower limit, which the simulation selects from each time a lifecycle is run.

3.4 Institute for Water Resources (IWR) Planning Suite

3.4.1 Program Overview

The US Army Corps of Engineers Institute for Water Resources (IWR) has developed IWR-PLAN Decision Support Software to assist with the formulation and comparison of alternative plans. While IWR-PLAN was initially developed to assist with environmental restoration and watershed planning studies, the program can be useful in planning studies addressing a wide variety of problems. IWR-PLAN can assist with plan formulation by combining solutions to planning problems and calculating the additive effects of each combination, or "plan." IWR-PLAN can assist with plan comparison by conducting cost effectiveness and incremental cost analyses, identifying the plans which are the best financial investments and displaying the effects of each on a range of decision variables.

IWR-PLAN builds upon the basic plan formulation and comparison framework of the DOS program ECO-EASY: Cost Effectiveness and Incremental Cost Analyses for Environmental Planning developed within the Corps Evaluation of Environmental Investments Research Program. The IWR-PLAN system transforms ECO-EASY to a Windows95 or Windows NT operating environment while adding new functions. Development of IWR-PLAN has been carried out within the Corps Decision Support Technologies Research Program, conducted at IWR. The Corps of Engineers and the Social Sciences Institute of the Natural Resources Conservation Service cosponsor IWR-PLAN development. To aid new users along the IWR-PLAN learning curve, a checklist of steps for applying the software is included under the section Getting Started.

IWR-PLAN takes user-defined solutions to planning problems and externally-generated estimates of each solution's effects and can formulate all possible combinations of those solutions, considering user-defined relationships between solutions. IWR-PLAN will then identify which combinations are the best financial investments through cost effectiveness and incremental cost analyses. Each combination of solutions is an alternative plan. If alternative plans have already been formulated outside IWR-PLAN, the user can bypass the routine for building combinations and still use IWR-PLAN to assist in identifying which plans are the best investments.

IWR-PLAN includes many new functions. An important one is that IWR-PLAN will keep track of the effects on up to ten user-defined variables. This makes IWR-PLAN a useful tool in watershed scale studies where there are likely to be a wide range of effects under consideration.

Other new functions include the ability to set constraints for all variables, to define derived variables (weighted combinations of other variables), to conduct sensitivity analysis, to examine different scenarios with different assumptions from one set of input data, to make comparisons across different scenarios, to track user defined "plans of interest", to export all IWR-PLAN data with direct links to other software, to view results through a variety of reporting and graphing measures, and to access on-screen help.

IWR-PLAN’s context-sensitive on-screen help system is available on each screen to define terms and explain how to use the screen's functions. This Online help, together with the Getting Started

checklist and accompanying operating instructions, should provide enough information to operate IWR-PLAN successfully. Additional background information is provided by the procedures manual Cost Effectiveness and Incremental Cost Analyses published by IWR in 1995 (IWR Report 95-R-1). This manual is recommended reading - especially for new users without previous ECO-EASY experience. The manual is available by download from the section "Current Reports Online" on IWR's home page.

3.4.2 Extent of Use

IWR Plan was used to conduct a cost effectiveness analysis for each of the measures and alternatives that were formulated for ecosystem restoration (see Chapter VI). The analyses followed the methodologies established in the US Army Corps of Engineers Institute for Water Resources publications, Evaluation of Environmental Investment Procedures Manual, Interim: Cost Effectiveness and Incremental Analyses, May 1995, IWR Report #95-R-1 and Cost Effectiveness Analysis for Environmental Measuring: Nine Easy Steps, October 1994, IWR Report 94-PS-2. The nine steps outline in the cited IWR report have become the standard practice for identifying what are known as “Best Buy” ecosystem restoration measures, or those measures that yield the greatest ‘bang for the buck’ at various levels of output.

The IWR Measure model was developed based on these nine steps and is the preferred Corps of Engineers model for the evaluation for ecosystem restoration measures. For the MsCIP Comprehensive Plan Report, Congressional Authority stated, "…but shall not perform an incremental benefit-cost analysis to identify the recommended project…." Following this authorization, only the first five steps of the nine easy steps, which are bolded below, were used in the IWR Plan evaluation, resulting in the identification of cost effective plans for restoration purposes. The nine steps are:

- Formulation of combinations:
  Step 1 - Display Outputs and Costs
  Step 2 – Identify Combinable Management Measures
  Step 3 – Calculate Outputs and Costs
- Cost Effective Analysis:
  Step 4 – Eliminate Economically Inefficient Solutions
  Step 5 – Eliminate Economically Ineffective Solutions
- Development of Incremental Cost Curve
  Step 6 – Calculate average costs
  Step 7 – Recalculate average costs for additional output
- Incremental Cost Analysis:
  Step 8 – Calculate incremental costs
  Step 9 – Compare successive outputs and incremental costs

3.4.3 Uncertainty

Uncertainty is a factor in any number manipulation program. Cost variability and output variability can be incorporated into the IWR Plan program using sensitivity calculations. Sensitivity can be calculated by using either variable sensitivity or solution sensitivity. A uniform coefficient can be applied to all variables or selected variables.

Variable sensitivity calculates high and low variable values using a uniform coefficient. This creates results for a range for the variable value. Custom sensitivity can be applied.

The high and low values entered for solution sensitivity are uniform coefficients used for computing the high and low values for the selected solution combination. This creates a value range result for that solution.

3.5 Economic Impact Forecasting Systems (EIFS)

3.5.1 Program Overview

The Economic Impact Forecast Systems (EIFS) was originally developed by the U.S. Army Corps of Engineers Construction Engineering Research Laboratory (USACERL) in 1975 to efficiently identify and address the regional economic effects of proposed military actions. EIFS is a web-based program and information system that provides regional economic analyses to planners and analysts. The program was developed to provide socioeconomic impact assessment, necessitated by the passage of the National Environmental Policy Act (NEPA) in 1969, which requires federal agencies to consider the impacts of an action on the "human environment" before decisions are made or an action is taken. This process is intended to help public officials make better decisions that are based on an understanding of environmental consequences and take actions that protect, restore, and enhance the human environment.

The EIFS program draws information from a tailored socioeconomic database for any county (or multi-county area) in the United States, estimating the changes associated with any project proposal, as defined by the user. EIFS database consists of data gathered from economic analyses, including Census of Agriculture, the Bureau of Economic Analysis, and County Business Patterns. The EIFS program requires basic input data regarding the action being studied: the dollar amounts of associated construction, number of military and civilian employees and their average salaries. Once these inputs are ascertained, the local multi-county region of influence (ROI) can be defined. Given the inputs for a particular project proposal, EIFS through a series of algorithm that are based on regional economic theory will assess potential impacts on four elements of a local economy: business volume, employment, personal income, and population. In short the program provides flexibility for the evaluation of measure scenarios and "what if" games at minimal expense.

3.5.2 Extent of Use

The EIFS program was used to evaluate the Regional Economic Development (RED) of proposed measures and plans. The conclusion that EIFS makes is that it predicts resultant changes in total personal income, total employment, and total sales by local businesses, and total population. Once these aggregate changes are predicted, EIFS provides analyses of historical trends in the defined ROI, and uses the Rational Threshold Level (RTV) and Forecast Significance of Impacts (FSI) profiles to develop significance criteria. Comparisons of projected change are then easily compared to the significance thresholds to produce conclusions. If insignificant impacts result, the analysis is complete. If significant impacts are indicated, a more detailed analysis will likely be required. In other words, because a projected change indicates that it would not be within the historic RTV range, it does not necessarily mean that it has a significant impact. It only means that a more detailed analysis is likely required to resolve this issue. The EIFS program, in combination with the RTV, has proven successful in determining socioeconomic impacts. The system meets the criteria for a good assessment program; theoretically sound and defensible, available for public review and scrutiny, and pragmatic in its application.

3.5.3 Uncertainty

The EIFS model incorporates uncertainty by using a Rational Threshold Value (RTV). Once model projections are obtained, the Rational Threshold Value profile allows the user to evaluate the significance of the impacts. This analytical tool reviews the historical trends for the defined region and develops measures of local historical fluctuations in sales volume, income, employment, and population. These evaluations identify the positive and negative changes within which a project can affect the local economy without creating a significant impact. The greatest historical changes define the boundaries that provide a basis for comparing an action's impact on the historical fluctuation in a particular area. Specifically, EIFS sets the boundaries by multiplying the maximum historical deviation of the following variables:

	Increase	**Decrease**
Sales Volume	x%	x%
Income	x%	x%
Employment	x%	x%
Population	x%	x%

The major strengths of the RTV are its specificity to the region under analysis and its basis on actual historical data for the region. The EIFS impact model, in combination with the RTV, has proven successful in addressing perceived socioeconomic impacts. The EIFS model and the RTV technique for measuring the intensity of impacts have been reviewed by economic experts and have been deemed theoretically sound.

CHAPTER IV. DATA COLLECTION METHODOLOGY

This section describes in detail the methodology implemented for the collection of data for the evaluation of National Economic Development (NED) benefits, Regional Economic Development (RED) benefits, Environmental Quality (EQ) benefits, and Other Social Effects (OSE). Data collection is a central element in the overall inventory and evaluation process. Hurricane Katrina hit the Mississippi Gulf Coast on August 29th, 2005 and caused significant damage to the environmental, human, and economic landscape of the area. The effects of this devastating event form the existing conditions for the MsCIP Comprehensive Plan and the basis to which the analysis of potential solutions were conducted and outlined in this appendix.

Due to limited time and the magnitude of the number of structures in the 40-foot NAVD88 surge inundation footprint, a hybrid field verification/sampling technique was developed for purposes of collecting structure data. Structure characteristics are crucial in the evaluation of risk and potential damage from surge events. The main structure data collected for this analysis was 1/ damage category, 2/ structure occupancy type, 3/ first floor elevation, 4/ structure value, 5/ content value, and 6/ whether or not the structure was significantly damaged by Hurricane Katrina. The ability to confidently obtain values for these data variables were the driving force in the development of the field verification methodology.

The first step in the field verification process was to obtain existing data from Local, State, and Federal government agencies as well as credible academic sources. For economic structure data, pre-Hurricane Katrina (2005) tax data for each of the planning units was obtained from Hancock, Harrison, and Jackson Counties, Mississippi. Next, utilizing GIS software, all of the tax parcels that fell within the 40-foot (NAVD-88) surge inundation footprint were identified, creating the maximum extent of parcels that would be identified that would be impacted by a surge analysis. This area is approximately 1,361 square miles or 100 square miles larger than the state of Rhode Island.

Next, a cluster sampling methodology was created and inventoried by driving every street within the inundation area. The sampling methodology was based upon the fact that construction along the Gulf Coast is very similar and that blocks, streets, and or subdivisions could be grouped together. While driving the area, the PDT members determined the grouping sizes based on observations in the field, and then defined typical structure characteristics for the grouping. For example, “A subdivision may be four streets and include approximately fifty structures. The subdivision may have two basic construction types, 1/ residential one-story and 2/ residential two-story, split approximately seventy-percent and thirty-percent respectively. Within the subdivision, the first floor elevation above ground of structures may range from four to six feet. The homes were built in the 1990’s so the construction is generally good in quality. Water was a factor in this area and approximately sixty percent of the homes in this area sustained significant inundation damage (50% or more damaged).” These observations were noted and input into the structure database for this area as the economic characteristics. The process was repeated over the course of six months from June through November, 2006. The end result was a database with economic data for over 200,000 tax parcels within the 40-foot NAVD88 inundation area.

Other sources of existing data were also identified for purposes of evaluating Environmental Quality, Regional Economic Development, and Other Social Effects. Data from Local, State, and Federal government agencies as well as reputable academic sources were utilized for data collection in these areas. The methodology used for the collection of data in this analysis is outline in Figure 4-1.

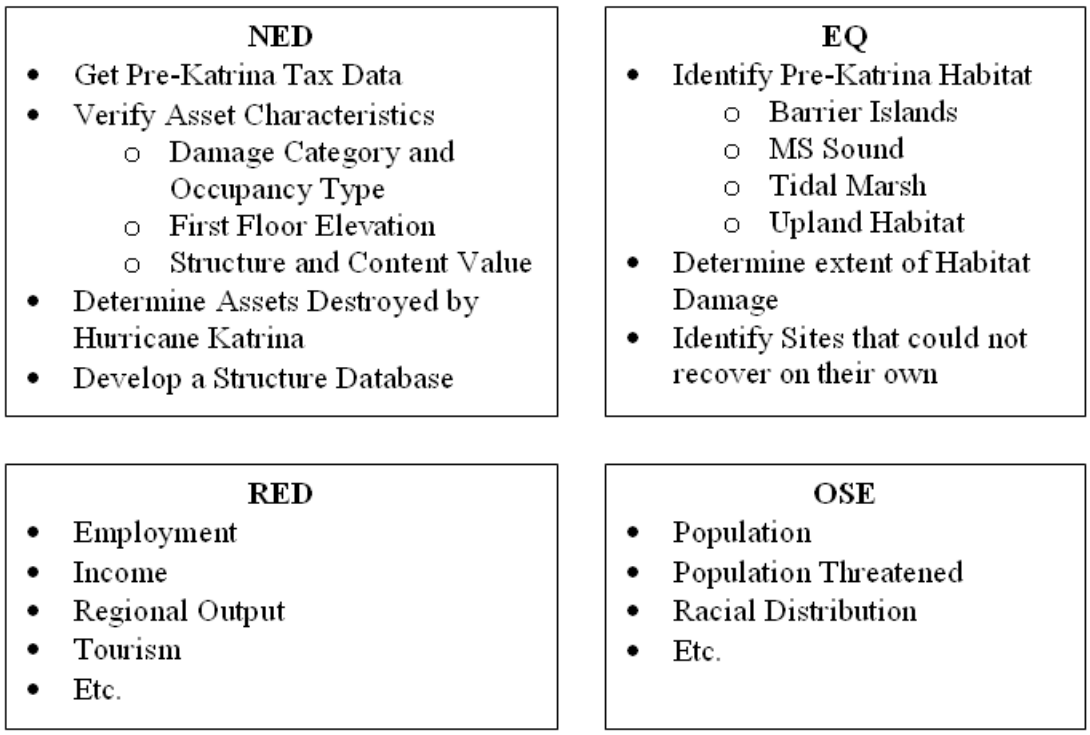


Figure 4-1. Overview of Economic Data Collection Methodology

4.1 Damage Categories

Damage categories are a means of initially categorizing the structures within the study area. This basic category is dictated primarily by general use of the structure. For this report, all structures fall within the categories of residential, commercial, municipal, and mobile home. A combination of tax data and field verification were used to determine the damage category for each structure.

4.2 Occupancy Types

Structures in each damage category were further subcategorized into structure occupancy types. The structure occupancy type allows for the combining of structures that have very similar characteristics such as construction material and depth-damage relationships. The residential damage category includes one-story and two-story single family residences. The commercial category includes: 1/ eating and recreation, 2/ groceries and gas stations, 3/ multi-family residences, 4/ repair and home use, 5/ retail and personal services, 6/ professional business, and 7/ warehouse and contractor services. The municipal category includes those structures which are generally non-taxable structures including federal, state, and local structures as well as churches. The Mobile Home category includes pre-manufactured single family residential housing that is not on a permanently fixed foundation (can be moved with relative ease). Table 4-1 provides a list of structures that fall into the various categories and occupancy types. Figures 4.2-1 through 4.2-14.

Table 4-1.
Structure Damage Categories and Occupancy Types

Damage Category	Occupancy Type	Structure Examples
COMMERCIAL	EAT	Restaurants, bars, and lounges
COMMERCIAL	MULT	Apartments, condos, multi-family
COMMERCIAL	REPA	Auto repair shops
COMMERCIAL	RETA	Retail, Laundromat, barber shop
COMMERCIAL	GROC	Grocery stores and gas stations
COMMERCIAL	WARE	Warehouses, light industry
COMMERCIAL	PROF	Hospitals, medical clinics, lawyer and professional offices
RESIDENTIAL	1-STORY	Single family dwellings with one story construction
RESIDENTIAL	2-STORY	Single family dwellings with two story construction
Mobile Homes	MOBHOME	Mobile Homes and other small metal structures
Municipal	PUBL	Municipal buildings, schools, police and fire stations



Figure 4.2-1. Example of a residential brick - slab on grade structure



Figure 4.2-2. Example of a residential masonry - slab on grade structure



Figure 4.2-3. Example of a residential wood – slab on grade structure



Figure 4.2-4. Example of a Wood Frame on Slab Residential Structure



Figure 4.2-5. Example of a mobile home residence



Figure 4.2-6. Example of a Mobile Home Residence



Figure 4.2-7. Example of Mobile Home Residence



Figure 4.2-8. Example of a residential wood on piles structure



Figure 4.2-9. Example of residential wood on piles structure



Figure 4.2-10. Example of Masonry on Piles Residential Structure



Figure 4.2-11. Example of two-story masonry on slab



Figure 4.2-12. Example of a Church (Municipal Category)



Figure 4.2-13. Example of a Commercial Services Building



Figure 4.2-14. Example of a Municipal Fire Station

4.3 First Floor Elevations

First floor elevations were estimated using a two part approach. The first step was to estimate the ground elevation NAVD88 at the center point of each parcel using LIDAR data and a GIS program. The second part of the process was to estimate the finished floor elevation above the ground for each structure. The entire study area driven and estimates were made of the height above ground for each structure within a group or cluster. For example, “In neighborhood A, all on the structures were slab on grade and therefore the finished floor above ground for all the structures in that neighborhood were assigned a zero value. Thus, all structures in neighborhood A had a first floor elevation equal to the ground elevation.” The sum of the ground elevation plus the finished floor height above ground (ground + finished floor above ground = first floor elevation) was the first floor elevation NAVD88 for a given structure. Those first floor elevations were then attributed to the appropriate structure in the structure database.

Uncertainty pertaining to first floor elevation estimates exist for reasons ranging from human error to software rounding and uncertainty with regards to the precision of LIDAR data collection. Both the HEC-FDA and Beach-FX programs allow for the inclusion of uncertainty with regards to first floor elevation estimates. For this analysis, the field observed uncertainty pertaining to first floor elevations is 3.52-feet at one standard deviation.

Uncertainty was calculated by comparing surveyed first floor elevations to LIDAR plus field estimating technique. This was accomplished by the comparison of 3,000 structures (1,000 in each planning unit), or approximately a two-percent sample. Contractors working for the MOBILE DISTRICT shot accurate first floor elevations for those 3,000 structures and the PDT members compared the contractor values with the LIDAR plus field estimated values to calculate the one-

standard deviation uncertainty. This uncertainty was then used as an input into HEC-FDA and Beach-FX for the calculation of equivalent annual damages.

The 3.52-feet of uncertainty at one standard deviation are a significant uncertainty, and are commensurate of the time and scoping limitations placed on the MsCIP Comprehensive Effort. At approximately $25 per structure to acquire field shot first floor elevations, a cost of approximately $3,250,000 and an estimated time of two-and-a-half years would be needed to acquire the first floor elevation with the traditional confidence level of a feasibility level effort. A complete traditional survey of all of the first floor elevations within the MPI footprint is neither cost effective nor feasible with respect to timing constraints.

Even though the data shows a 3.52-foot uncertainty, it is believed that the first floor elevation data is more accurate than the distribution based on the two-percent sample suggests. Therefore a sensitivity analysis was conducted based on uncertainty used in previously conducted feasibility studies where costs and timing allowed for a complete traditional survey. This sensitivity analysis can be found below in Chapter VII of this appendix.

4.4 Structure Values

This section describes the estimation of structure values used as inputs for the calculation of equivalent annual damages. Typical Corps economic policy is to use an estimate of depreciated replacement cost for the value of a structure. Depreciated replacement cost was used for structures that were not destroyed by Hurricane Katrina, and full depreciated replacement cost was used for those structures that were expected to be rebuilt. The process for estimating depreciated replacement cost of structures was unique for the residential, commercial and industrial, and municipal categories. Where applicable, field observed and tax data was incorporated into the processes described in the following subsections. Where field and tax data gaps existed, Marshall and Swift proprietary software were used to estimate the value of structures.

4.4.1 Residential Structure Values

1) Tax data for all residential structures in the maximum probable intensity (MPI) inundation footprint area was collected from each county tax assessor. A sample for each residential category was provided to Savannah District (SAS) Real Estate Division.

2) Residential categories include:

a. Single family residences (SFR) - were categorized based on construction type (wood/slab, brick/pile, etc.) and floors (1, 2, or 3).

b. Multi-family residences (MFR)[1] - were categorized as town homes, duplexes, or triplexes and apartments were either 1 or 2 stories.

3) SAS Real Estate used Marshall and Swift software to determine the depreciated replacement cost of each residential structure within the sample and provided the estimates to the SAM Economic team.

[1] Multi-family residences (Duplexes, Triplexes, and Town homes) are given the commercial category name for depth damage purposes only, since they damage in a different way from single family residences even though they are still residential for discussion purposes.

Depreciated replacement cost estimates produced by the Marshall and Swift program were calculated using a number of inputs including:

- Square footage
- Number of stories
- Exterior wall materials e.g. masonry or wood
- Foundation
- Quality
- Age of structure

The most important input in determining the depreciated replacement cost of a structure is its age.

4) The Mobile District (SAM) Economic team compared the Marshall and Swift estimates to the pre-Hurricane Katrina tax assessed value of the sample and determined a depreciated replacement cost 'factor' by each category. Table 4-2 describes the depreciated replacement cost factors for the different types of residential structures.

Table 4-2.
Depreciated Replacement Factors by Occupancy Type Used for Residential Structures that Suffered Moderate to No Damage (Less than 50%) from Hurricane Katrina

Category Name	Type	Construction Type	Depreciated Replacement Factor (%)
Residential	Single Family Residence	Wood on Slab	81%
Residential	Single Family Residence	Masonry on Slab	88%
Residential	Single Family Residence	Wood on Piles	84%
Residential	Single Family Residence	Masonry on Piles	98%
Commercial[1]	Duplex	N/A	70%
Commercial[1]	Triplex	N/A	87%
Commercial[1]	Town Homes	N/A	70%
Commercial[1]	Apartments	N/A	100%

1 Multi-family residences (Duplexes, Triplexes, and Town homes) are given the commercial category name for depth damage purposes only, since they damage in a different way from single family residences even though they are still residential for discussion purposes.

5) The depreciated replacement cost factors described in table 4-2 were then applied to all the residential structures in the corresponding category by multiplying that percentage times the tax assessed value for the structure. For example, if the tax value for a single family wood on slab residence was $100,000, then the depreciated replacement value for the structure was $81,000 ($100,0000 x 81% = $81,000).

6) If the structure was sustained significant damage from Hurricane Katrina (50% or more destroyed), full depreciated replacement costs were given to that structure. The CEFIT program was used to determine the depreciated replacement cost of residential structures. The CEFIT model estimates depreciated replacement cost value based on the parameters mentioned above, such as square footage and age of structure. The estimation of depreciated replacement cost values was conducted by taking an average of values produced from a range of values in each parameter. For example, a range of 1,000, 1,250, 1,500, 1,750, 2,000, and 2,500 square feet was used when defining the size; a range of fair-to-good, good, good-to-very good, very good, very-good to excellent

and excellent were used for quality and condition; etc. Table 4-3 shows the averages from the sample range by residential category.

Table 4-3.
Depreciated Replacement Cost Values for Residential Structures Used for Residential Structures that Suffered Significant Damage (50% or more) from Hurricane Katrina

Category Name	Construction Type	Number of Floors	Depreciated Replacement Cost ($)
Residential	Wood	1	$119,400
Residential	Wood	2	$148,702
Residential	Masonry	1	$193,475
Residential	Masonry	2	$176,079

1/ Based on estimates obtained from the CEFIT program.

B. Commercial/Industrial:

1) Commercial structures were categorized by business type (fast food, grocery, restaurant, gas station, motel/hotel, etc).

2) SAS Real Estate used Marshall and Swift Estimator to determine the depreciated replacement cost of a typical structure in each category and provided the estimates to the SAM Economic team which was then applied to all structures in that category. This was compared with the Pre-Katrina tax records and a depreciated replacement cost factor was then found for each business category. The factor percentages for commercial structures were high in comparison with the norm of depreciated replacement costs. This is a result of deflated structure values before Hurricane Katrina and less recent tax data. Table 4-4 shows the depreciated replacement cost factors for various types of commercial structures. They were applied in the same way as the residential factors previously described.

Table 4-4.
Depreciated Replacement Factors by Occupancy Type Used for Residential Structures that Suffered Moderate to No Damage (Less than 50%) from Hurricane Katrina

Category Name	Type	Depreciated Replacement Factor (%)
Commercial	Airline Hanger	79%
Commercial	Bank	79%
Commercial	Casino (Small)	60%
Commercial	Casino (Medium)	88%
Commercial	Casino (Large)	100%
Commercial	Factory (Small)	80%
Commercial	Factory (Medium to Large)	100%
Commercial	Fast Food	92%
Commercial	Gas Station (Small)	83%
Commercial	Gas Station (Medium to Large)	95%
Commercial	Grocery (Small)	54%
Commercial	Grocery (Medium)	78%
Commercial	Grocery (Large)	100%

Table 4-4.
Depreciated Replacement Factors by Occupancy Type
Used for Residential Structures that Suffered Moderate to No Damage
(Less than 50%) from Hurricane Katrina (continued)

Category Name	Type	Depreciated Replacement Factor (%)
Commercial	Small Retail (Sore)	80%
Commercial	Large Retail	95%
Commercial	Hospital (Small)	71%
Commercial	Hospital (Medium to Large)	75%
Commercial	Laundromat	72%
Commercial	Lodge	70%
Commercial	Medical Clinic	80%
Commercial	Meeting Hall	55%
Commercial	Mini-Storage	88%
Commercial	Motel	100%
Commercial	Nursing Home	82%
Commercial	Office (Medical)	90%
Commercial	Quick Lube	94%
Commercial	Restaurant (Local)	80%
Commercial	Restaurant (National Chain)	96%
Commercial	Seafood Factory	100%
Commercial	Strip Mall (Small)	69%
Commercial	Strip Mall (Medium-Large)	100%
Commercial	Theater	100%
Commercial	Warehouse	69%
Commercial	Warehouse	100%

3) If the structure sustained significant damage from Hurricane Katrina (50% or more destroyed), full depreciated replacement costs were given to that structure. SAS Real Estate division estimated full depreciated replacement cost for the same business categories previously mentioned. Those depreciated replacement cost values were applied to the structures that were destroyed by Hurricane Katrina. Table 4-5 shows the depreciated replacement cost for the various commercial structure types.

Table 4-5.
Depreciated Replacement Cost Values for Residential Structures
Used for Residential Structures that Suffered Significant Damage
(50% or more) from Hurricane Katrina

Category Name	Type	Depreciated Replacement ($)
Commercial	Airline Hanger	$23,488
Commercial	Bank	$146,855
Commercial	Casino (Small)	$15,100,912
Commercial	Casino (Medium)	$63,289,595
Commercial	Casino (Large)	$176,994,638
Commercial	Factory (Small)	$454,045

Table 4-5.
Depreciated Replacement Cost Values for Residential Structures Used for Residential Structures that Suffered Significant Damage (50% or more) from Hurricane Katrina (continued)

Category Name	Type	Depreciated Replacement ($)
Commercial	Factory (Medium to Large)	$874,997
Commercial	Fast Food	$225,626
Commercial	Gas Station (Small)	$112,040
Commercial	Gas Station (Medium to Large)	$261,828
Commercial	Grocery (Small)	$580,453
Commercial	Grocery (Medium)	$1,609,533
Commercial	Grocery (Large)	$2,103,448
Commercial	Small Retail (Sore)	$319,779
Commercial	Large Retail	$3,535,050
Commercial	Hospital (Small)	$5,977,498
Commercial	Hospital (Medium to Large)	$8,445,952
Commercial	Laundromat	$72,224
Commercial	Lodge	$129,923
Commercial	Medical Clinic	$1,046,930
Commercial	Meeting Hall	$211,446
Commercial	Mini-Storage	$110,651
Commercial	Motel	$7,482,273
Commercial	Nursing Home	$123,606
Commercial	Office (Medical)	$350,235
Commercial	Quick Lube	$114,692
Commercial	Restaurant (Local)	$80,947
Commercial	Restaurant (National Chain)	$400,306
Commercial	Seafood Factory	$300,608
Commercial	Strip Mall (Small)	$319,779
Commercial	Strip Mall (Medium-Large)	$8,985,291
Commercial	Theater	$2,050,454
Commercial	Warehouse (Small)	$39,474
Commercial	Warehouse (Medium-Large)	$92,224

C. Municipal and Churches (Tax exempt):

1) No tax data existed for Municipal structures/Churches since they are tax exempt, therefore a depreciated cost factor could not be estimated for structures that fell into this category. Marshall and Swift software was used to estimate depreciated replacement cost for these structures.

2) Municipal structures/Churches were categorized as low, medium, and high based on size, number of floors, and other structure characteristics.

3) SAS Real Estate used Marshall and Swift software to determine the depreciated replacement cost of a typical structure in each category and provided the estimates to the SAM Economic team which were then applied to all structures in that category.

Estimates were calculated using a number of inputs including:

- Square footage
- Number of stories
- Exterior wall materials e.g. masonry or wood
- Foundation
- Quality
- Age of structure

The most important input in determining the depreciated replacement cost of a structure was its age. Table 4-6 shows the depreciated replacement costs for the various types of municipal structures.

Table 4-6.
Depreciated Replacement Factors by Occupancy Type

Category Name	Type	Depreciated Replacement Cost ($)
Municipal	Church (Small)	$126,125
Municipal	Church (Medium)	$990,116
Municipal	Church (Large)	$5,612,686
Municipal	Government and School (Small)	$462,712
Municipal	Government and School (Medium)	$523,404
Municipal	Government and School (Large)	$1,537,263

Uncertainty pertaining to structure value was estimated and put into the HEC-FDA and Beach-FX models as part of the process to calculate equivalent annual damages. Previous MOBILE DISTRICT feasibility studies estimated uncertainty of structure values between 10 and 15-percent. Since the nature of the sampling used for the MsCIP study was less rigorous than normal feasibility level efforts, a 25-percent uncertainty was used for structure values.

4.5 Content Values

This section describes the process used to estimate content values for residential, commercial and industrial, and municipal and church structures. Were available, data collected from field interviews was collected and utilized. It was difficult to obtain information about content and inventory during the field inventory process, thus significant data gaps of 'real world' data existed. In order to fill those data gaps, existing data from previous studies, Corps of Engineers Economic Guidance Memorandums (Gem's), and the CEFIT model was used.

A. Residential Content Values:

1) SAM Economic Team uses the Corps of Engineers Flood Inventory Tool (CEFIT) Residential Estimator by Marshall & Swift (in close cooperation with the Institute for Water Resources) to develop an appropriate structure-to-content ratio based on the various categories mentioned for depreciated replacement costs. Since limited data was available for the damage to contents from Katrina and other surge events, the methodology outline in the Corps of Engineer's Civil Works – Planning Guidance, Economic Guidance Memorandum 01-03 dated 12/2004 was adopted for the estimation of residential content values. Table 4-7 shows the content-to-structure ratio by occupancy type for residentially occupied dwellings.

Table 4-7.
Depreciated Replacement Factors by Occupancy Type

Category Name	Type	Construction Type	Content-to-Structure Ratio (%)
Residential[1]	Single Family Residence	Wood on Slab	100%
Residential[1]	Single Family Residence	Masonry on Slab	100%
Residential[1]	Single Family Residence	Wood on Piles	100%
Residential[1]	Single Family Residence	Masonry on Piles	100%
Commercial[2]	Duplex	N/A	23%
Commercial[2]	Triplex	N/A	23%
Commercial[2]	Town Homes	N/A	23%
Commercial[2]	Apartments	N/A	23%

1 Defined by Corps of Engineers EGM 01-03.
2 Multi-family residences (Duplexes, Triplexes, and Town homes) are given the commercial category name for depth damage purposes only, since they damage in a different way from single family residences even though they are still residential for discussion purposes.

B. Commercial/Industrial Inventory and Equipment Values:

1) SAM Economic Team interviewed businesses for inventory and equipment values based on categories of business types (fast food, grocery, restaurant, gas station, motel/hotel, etc.)

2) Where data gaps arose the team used previous studies, the FEMA Hazus MH program, and the Corps of Engineers Flood Inventory Tool (CEFIT) Residential Estimator by Marshall & Swift. The Commercial Contents Inventory Estimator was used to generate theses estimates. The team calculated estimates for a small, medium, and large business in each business category. Business such as large discount retailers e.g. Wal-Mart or home improvement stores like Home Depot had only one estimate each.

Each output generated consists of 4 inputs:

- The Standard Industrial Classification Code (sic code)
- Annual Revenue
- Square Footage
- Number of Employees

The inputs were altered to give realistic estimates for small, medium, and large businesses. The most important determinants in calculating an accurate output were the annual revenue and number of employees in a sample business.

3) The data was used to identify a typical inventory and equipment value by business type that will be applied to that category. Table 4-8 shows the commercial inventory and equipment values by category named and occupancy type.

Table 4-8.
Depreciated Replacement Factors by Occupancy Type

Category Name	Business Type	Annual Revenue ($)	Business Size	Total Estimated Employees	Depreciated Content Value ($)
Commercial	AIRLINE HANGER	$400,000	SMALL	7	**$44,404**
Commercial	AIRLINE HANGER	$1,500,000	MEDIUM	21	**$297,423**
Commercial	AIRLINE HANGER	$4,000,000	LARGE	35	**$722,361**
Commercial	AUTO AUDIO STORE	$600,000	SMALL	12	**$217,741**
Commercial	AUTO MART	$600,000	MEDIUM	7	**$129,626**
Commercial	AUTO REPAIR	$500,000	MEDIUM	9	**$52,223**
Commercial	BANK	$655,860	SMALL	10	**$380,262**
Commercial	BANK	$6,403,250	MEDIUM	50	**$4,021,226**
Commercial	BANK	$15,169,000	LARGE	100	**$15,083,976**
Commercial	BARBER SHOP	$100,000	SMALL	6	**$7,744**
Commercial	BEAUTY SHOP	$200,000	SMALL	10	**$27,744**
Commercial	BOAT REPAIR	$250,000	SMALL	5	**$26,200**
Commercial	BOAT STORAGE	$600,000	MEDIUM	9	**$124,370**
Commercial	BOOK STORE	$300,000	SMALL	6	**$60,080**
Commercial	CABINET MANUFACTURER	$700,000	MEDIUM	11	**$110,100**
Commercial	CARWASH	$750,000	LARGE	15	**$129,720**
Commercial	CHURCH	$209,010	SMALL	6	**$7,360**
Commercial	CHURCH	$639,072	MEDIUM	21	**$97,539**
Commercial	CHURCH	$7,500,000	LARGE	160	**$2,139,728**
Commercial	ELECTRICAL SUPPLY	$800,000	MEDIUM	10	**$169,600**
Commercial	FACTORY	$1,000,000	MEDIUM	13	**$188,100**
Commercial	FACTORY	$13,000,000	LARGE	50	**$6,054,700**
Commercial	FACTORY*	$257,000	SMALL	3	**$80,000**
Commercial	FAST FOOD	$1,600,000	MEDIUM	50	**$206,300**
Commercial	FAST FOOD	$765,840	SMALL	40	**$134,000**
Commercial	FIBERGLASS	$600,000	MEDIUM	7	**$80,000**
Commercial	FLORIST	$300,000	SMALL	7	**$57,861**
Commercial	FUNERAL HOME	$1,500,000	LARGE	24	**$293,113**
Commercial	GARDEN NURSERY	$600,000	MEDIUM	7	**$160,088**
Commercial	GAS STATION	$2,000,000	SMALL	16	**$234,357**
Commercial	GAS STATION	$5,000,000	LARGE	36	**$568,484**
Commercial	GENERAL CONTRACTING	$1,200,000	MEDIUM	6	**$340,548**
Commercial	GROCERY	$750,000	SMALL	15	**$86,600**
Commercial	GROCERY	$2,000,000	MEDIUM	50	**$292,150**
Commercial	GROCERY	$5,000,000	LARGE	90	**$1,397,268**
Commercial	HARDWARE STORE	$600,000	MEDIUM	8	**$168,566**
Commercial	HEALTH CLUB/ GYM	$500,000	MEDIUM	20	**$104,851**
Commercial	HOME DEPOT	$34,473,615	LARGE	220	**$30,925,597**
Commercial	HOSPITAL	$5,000,000	SMALL	125	**$419,680.00**
Commercial	HOSPITAL	$70,000,000	MEDIUM	1,000	**$7,266,392**
Commercial	HOSPITAL	$134,430,900	LARGE	1,700	**$11,820,155**
Commercial	INDUSTRIAL MACHINERY	$1,000,000	MEDIUM	8	**$193,450**
Commercial	INSURANCE/OFFICE	$800,000	MEDIUM	9	**$131,247**
Commercial	JUNIOR COLLEGE	$15,000,000	MEDIUM	321	**$1,817,232**
Commercial	LANDSCAPING	$300,000	SMALL	6	**$60,540**
Commercial	LAUNDROMAT	$200,000	SMALL	7	**$17,811**
Commercial	LAUNDROMAT	$400,000	MEDIUM	15	**$116,577**

Table 4-8.
Depreciated Replacement Factors by Occupancy Type (continued)

Category Name	Business Type	Annual Revenue ($)	Business Size	Total Estimated Employees	Depreciated Content Value ($)
Commercial	LAUNDROMAT	$700,000	LARGE	18	**$231,209**
Commercial	LIQUOR STORE	$600,000	MEDIUM	7	**$110,128**
Commercial	LODGE	$889,000	SMALL	25	**$178,925**
Commercial	LOUNGE	$254,110	SMALL	10	**$93,595**
Commercial	MACHINE FABRICATION	$1,000,000	MEDIUM	17	**$108,400**
Commercial	MARINE CARGO	$1,000,000	SMALL	15	**$268,151**
Commercial	MEDICAL CLINIC	$600,000	SMALL	8	**$47,415**
Commercial	MEDICAL CLINIC	$2,000,000	MEDIUM	27	**$218,292**
Commercial	MEDICAL CLINIC	$4,000,000	LARGE	40	**$329,675**
Commercial	MOTEL	$2,000,000	MEDIUM	45	**$567,267**
Commercial	MOVIE THEATER	$1,500,000	LARGE	50	**$400,000**
Commercial	NURSERY SCHOOL	$300,000	SMALL	17	**$12,795**
Commercial	NURSING HOME	$3,000,000	SMALL	120	**$466,992**
Commercial	NURSING HOME	$7,896,400	MEDIUM	270	**$1,403,893**
Commercial	PAPER MILL	$800,000	MEDIUM	10	**$152,100**
Commercial	PETFOOD MANUFACTURING	$700,000	MEDIUM	11	**$93,900**
Commercial	QUICK LUBE	$1,000,000	LARGE	15	**$325,469**
Commercial	RADIO STATION	$433,815	SMALL	15	**$77,300**
Commercial	RESTAURANT[1]		SMALL		**$250,000**
Commercial	RESTAURANT	$1,370,000	LARGE	70	**$219,141**
Commercial	SCHOOL	$300,000	SMALL	15	**$47,132**
Commercial	SCHOOL	$1,500,000	MEDIUM	35	**$216,118**
Commercial	SCHOOL	$5,000,000	LARGE	155	**$866,136**
Commercial	TIMBER COMPANY	$600,000	SMALL	12	**$256,809**
Commercial	WALMART	$100,000,000	LARGE	350	**$17,904,400**
Commercial	WAREHOUSE	$2,000,000	MEDIUM	20	**$287,708**
Commercial	WAREHOUSE	$4,000,000	LARGE	40	**$729,199**
Commercial	WAREHOUSE	$8,000,000	X-LARGE	80	**$2,546,637**
Commercial	WAREHOUSE/MINI STORAGE	$750,000	SMALL	8	**$69,631**
Commercial	AUTO DEALERSHIP[1]	N/A	N/A	N/A	**$27,375,190**
Commercial	MINI STORAGE[1]	N/A	N/A	N/A	**$8,000**
Commercial	HVAC INSTALL/REPAIR[1]	N/A	N/A	N/A	**$60,000**
Commercial	WOMEN'S APPAREL	$2,000,000	MEDIUM	18	**$580,458**
Commercial	FAST FOOD	$1,600,000	MEDIUM	50	**$206,300**
Commercial	FAST FOOD	$765,840	SMALL	40	**$134,000**
Commercial	DEPARTMENT STORE	$7,000,000	MEDIUM	100	**$969,471**
Commercial	RESTAURANT	$1,370,000	LARGE	70	**$219,141**
Commercial	VIDEO RENTAL	$700,000	MEDIUM	18	**$302,736**
Commercial	BEAUTY SHOP	$300,000	SMALL	18	**$193,247**
Commercial	DRY CLEANERS	$400,000	SMALL	13	**$65,566**
Commercial	DRUG STORE	$2,000,000	MEDIUM	20	**$441,860**
Commercial	STRIP MALL[2]	$16,135,840	MEDIUM	347	**$3,112,779**

1 Denotes real world identified values.
2 Strip Mall includes the rows from women's apparel through drug store.
3 All other values were derived from the Corps of Engineers Flood Inventory Tool (CEFIT) Residential Estimator Program.

C. Municipal/Churches:

1) Existing data from other Corps studies or the FEMA Hazus MH Program was used for municipal and church structures along with the Corps of Engineers Flood Inventory Tool (CEFIT) Residential Estimator by Marshall & Swift. The Commercial Contents Inventory Estimator was used to generate these estimates. Estimates were calculated for small, medium, and large churches and schools.

Each output generated consisted of 4 inputs:

- The Standard Industrial Classification Code (sic code)
- Annual Revenue
- Square Footage
- Number of Employees

The inputs were altered to give realistic estimates for small, medium, and large government buildings, schools, and churches. The most important determinants in calculating an accurate output were the annual revenue and number of employees in a sample school or church. The amount of annual funding was used as a substitute for annual revenue for schools. Both schools and churches have specific sic codes. Table 4-9 shows the content values for the different types of municipal structures.

Table 4-9.
Depreciated Replacement Factors by Occupancy Type

Category Name	Business Type	Annual Revenue ($)	Business Size	Total Estimated Employees	Depreciated Content Value ($)
Municipal	Church (Small)	$209,010	SMALL	6	**$7,360**
Municipal	Church (Medium)	$639,072	MEDIUM	21	**$97,539**
Municipal	Church (Large)	$7,500,000	LARGE	160	**$2,139,728**
Municipal	Government and School (Small)	$300,000	SMALL	15	**$47,132**
Municipal	Government and School (Medium)	$1,500,000	MEDIUM	35	**$216,118**
Municipal	Government and School (Large)	$5,000,000	LARGE	155	**$866,136**

Uncertainty pertaining to content value was estimated and put into the HEC-FDA and Beach-FX models as part of the process to calculate equivalent annual damages. Previous MOBILE DISTRICT feasibility studies estimated uncertainty of structure values between 5 and 15-percent. Since the nature of the sampling used for the MsCIP study was less rigorous than normal feasibility level efforts, a 25-percent uncertainty was used for content values.

CHAPTER V. INVENTORY AND FORECASTING CONDITIONS

This chapter describes the pre-Hurricane Katrina (historic) conditions, post-Hurricane Katrina (existing) conditions and the future without-project conditions for the fifty-four planning sub-units that define the surge inundation footprint up to the 40-foot NAVD88 contour (see figure 1.4.3. above).

5.1 Historic Conditions

5.1.1 Impacts of Hurricane Camille

The Mississippi Gulf Coast is no stranger to large storm surge events. On August 17, 1969, Hurricane Camille impacted the area in a similar fashion to Hurricane Katrina. Hurricane Camille made landfall at Bay St. Louis, Mississippi only miles way from Hurricane Katrina's landfall path. The total surge area ranged from lower Plaquemines Parish in Louisiana to Perdido Pass, Alabama. Maximum surge from Hurricane Camille on the Mississippi coast ranged from 21.7-feet above m.s.l. in planning unit one, to 24.2-feet above m.s.l. in planning unit two, and 15.8-feet above m.s.l. in planning unit 3.

Damage to the Mississippi Coast from Hurricane Camille was extensive. Federal relief expenditures topped 100 million dollars at 1970 prices, over 600 million dollars when accounted for inflation. The magnitude of this number is astounding considering that many of the relief programs that exist today did not exist for Hurricane Camille. Table 5-1 shows selected Hurricane Camille damage statistics. Tables 5-2 and 5-3 show damage to residential and commercial structures caused by Hurricane Camille surge.

Table 5-1.
Select Hurricane Camille Statistics.

Camille Statistics	Mississippi	Louisiana	Alabama
Persons Dead	135	9	Unknown
Persons Missing	27	0	Unknown
Families Suffering Loss	63,665	9,442	750
Dwellings Destroyed	3,881	1,771	10
Dwellings with major damage	12,112	1,753	50
Dwellings with minor damage	29,736	3,697	500
Trailers destroyed	406	664	12
Trailers with major damage	325	290	6
Farm buildings destroyed	645	114	5
Farm buildings with major damage	2,002	97	5
Small businesses destroyed or with major damage	569	110	14
Damage to public property	$200,000,000	$10,000,000	$500,000
Damage to private property	$750,000,000	$312,000,000	$7,500,000

1 Source: Report on Hurricane Camille U.S. Army Corps of Engineers – MOBILE DISTRICT
2 These dollars reflect a 1970 price level.

Table 5-2.
Damage to Residential Structures Caused by Hurricane Camille Surge.

County	Homes Destroyed	Homes Damaged	Total Homes Impacted
Hancock	936	4,067	**5,003**
Harrison	2,347	8,603	**10,950**
Jackson	276	1,232	**1,508**
Total	3,559	13,902	**17,461**

1 Source: Report on Hurricane Camille U.S. Army Corps of Engineers – MOBILE DISTRICT

Table 5-3.
Damage to Commercial Structures Caused by Hurricane Camille Surge.

County	Homes Destroyed	Homes Damaged	Total Homes Impacted
Hancock	52	150	**202**
Harrison	261	380	**641**
Jackson	4	57	**61**
Total	317	587	**904**

1 Source: Report on Hurricane Camille U.S. Army Corps of Engineers – MOBILE DISTRICT

Other damage statistics from Hurricane Camille include (1970 price levels):

- $23.5 million in industrial damages in Mississippi in flooded areas
- $7.8 million in damages to schools in Mississippi in flooded areas
- $3.5 million in damages to Mobile District navigation projects
- $10.1 million in damages to the two VA hospitals in Harrison County and $593,300 aggregate damage to other hospitals in Mississippi in flooded areas
- $5.2 million in damages to highways in Mississippi in flooded areas
- $2.1 million in damages to bridges in Mississippi
- $10.5 million in damages to vehicle in Mississippi in flooded areas
- $4.8 million in damages to Keesler Air Force Base
- Roughly $50 million in damages to Federal Government facilities
- $1.7 million in damages to Non-Federal Government facilities in Mississippi
- $14.7 million in marine damages in Mississippi
- $14.8 million cost of debris removal in flooded areas in Mississippi

5.1.2 Historic (Pre-Hurricane) Population Trends

The 1950-2000 population levels and growth for the U.S., Mississippi, the three-county study area, and each county are presented in Table 5-4. During this fifty year period, the population of the three-county study area grew by 186.6 percent. This is 5.6 times the Mississippi percentage population

growth of 33.2 percent and 2.2 times the U.S. percentage population growth of 86.0 percent for the same timeframe. The three-county area accounted for 32.7 percent of the nominal population growth for Mississippi from 1950 to 2000.

Table 5-4.
1950-2000 Population Levels and Growth (in thousands)

	United States	Mississippi	Three-County Study Area	Hancock County	Harrison County	Jackson County
1950	151,326	2,179	127	12	84	31
1960	179,323	2,178	189	14	119	56
1970	203,212	2,217	239	17	134	88
1980	226,546	2,521	301	25	158	118
1990	248,710	2,573	312	32	165	115
2000	281,421	2,903	364	43	190	131
50 Year Nominal Change	130,095	724	237	31	106	100
50 Year Percentage Change	86.0%	33.2%	186.6%	258.3%	126.2%	322.5%

Source: U.S. Census Bureau, 2000 Census

5.1.3 Historic (Pre-Hurricane Katrina) Environmental Setting

The study area consists of the three coastal counties within the State of Mississippi: Hancock, Harrison, and Jackson counties; and the coastal (offshore) ecosystem including its barrier islands. This area ranges in elevation from sea level to about 30-feet NAVD88. The essentially flat to gently undulating, locally swampy Coastal Lowlands are underlain by alluvial, deltaic, estuarine, and coastal deposits and merge with the fluvial-deltaic plains of the streams of the area. According to the Cowardin et. al., *Classification of Wetlands and Deepwater Habitat of the United States*, there are five major wetland and deepwater systems, four of which are found within Coastal Mississippi. They include marine, estuarine, riverine, and palustrine wetland systems.

Within Coastal Mississippi, the marine system is the area along the Gulf of Mexico front south of the barrier islands. It is comprised of the intertidal beachfront of the barrier islands along the Gulf of Mexico, and subtidal which consists of the unconsolidated sandy water bottoms. The string of barrier islands are comprised of dynamic and diverse habitats and are part of a complex integrated system of beaches, dunes, marshes, bays, tidal flats, and inlets. These barrier islands are located along a littoral drift zone that moves sand westward creating three elongated islands and then to the westward most island (i.e. Cat) where littoral currents are not as well defined. From east to west, the islands are Petit Bois, Horn, Ship, and Cat. Ship Island was breached by prior hurricanes and now is actually two small islands, West Ship Island and East Ship Island, with a shallow sand bar between the two. Since Hurricane Camille in 1969, this breach has existed with varying amounts of natural rebuilding between later storms.

Under current conditions, the islands provide a natural boundary between the water's salinity [~33 parts per thousand (ppt)] of the open Gulf of Mexico and the brackish water found in Mississippi Sound. Salinity in the Sound during low flow periods range from 10 to 30 ppt. Highest salinities occur just south of Pascagoula and Gulfport and the lowest salinities in the Lake Borgne-Pearl River area. Mississippi Sound is a shallow coastal lagoon along northern Gulf of Mexico from Mobile Bay, Alabama, in the east to Lake Borgne, Louisiana, in the west. Circulation is driven by tides modified slightly with the wind. Gulf waters enter the Sound through the deep passes between the barrier islands with the help of tidal forces. This mixing of freshwater runoff and saline waters has created a dynamic estuarine environment. Mississippi Sound receives its major freshwater flow from the

Pascagoula and Pearl Rivers and is critical to the survival of numerous birds, mammals, fish, and other marine organisms of national importance.

Many different habitat types are found in and around the estuarine environment, including shallow open-waters, salt marshes, sandy beaches, mud and sand flats, oyster reefs, river deltas, tidal pools, and submerged aquatic vegetation (SAVs). These diverse ecosystems serve a variety of critical functions necessary to sustain a vital thriving commercial fishing industry of national economic significance. Prior to the hurricane season of 2005, sea grasses were restricted to the northern shores of the barrier islands and small patches throughout the immediate shorelines. These areas are characterized by *Diplanthera Wright* (Shoal grass)*, Cymodocea manatorum* (Manatee grass), *Thalassia testudinum* (Turtle grass), and *Ruppia maritime* (Widgeon grass). Approximately 20,000 acres of SAVs were present in Mississippi Sound prior to 1969; however, in late 1969, Hurricane Camille caused the destruction of the majority of these areas. In 1969, an estimated 13,000 acres of SAVs were documented and as of 1998, only 2,000 acres were documented (Moncrieff 1998).

Prior to the 2005 hurricane season, the majority of the shoreline in Coastal Mississippi consisted of manmade beaches beyond concrete seawalls. A few remaining areas along the shoreline consist of more natural areas, such as expanses of marsh along the western and eastern borders of the state. A natural beach and dune system, located along Belle Fontaine in the central portion of Coastal Mississippi, is the only natural beach remaining and has experienced severe erosion to a point that it is virtually non-existent. The beach of Coastal Mississippi provides a unique habitat for a variety of plants and animals. For example, 75% of migratory waterfowl live in or depend on coastal beaches during their lifespan. Dune vegetation provides nesting areas for several kinds of birds, such as least terns, and animals, such as mole crabs and rodents.

Wet Pine Savannah wetlands found in Coastal Mississippi provide for diverse habitat for a number of plants and animals including many threatened and endangered species found only in these unique habitats. Pine Savannah wetlands are commonly referred to as sponges that provide floodwater retention, groundwater recharge, and water purification. Development stresses were impinging upon these wetland habitats.

Coastal Mississippi supports an array of reptiles, amphibians, birds, and mammals. Reptiles and amphibians found in the area include snakes, turtles, lizards, toads, frogs, salamanders, and crocodilians. Coastal Alabama and Mississippi have a great diversity of reptiles including 23 species of turtles, 10 species of lizards, 39 species of snakes, and the alligator. Eighteen species of salamanders and 22 species of frogs and toads are indigenous to the coastal region.

Overall, the environmental conditions of Coastal Mississippi were already stressed prior to the hurricane season of 2005 and with its onset, many habitats were adversely impacted. However, these stressed conditions in Coastal Mississippi are irreversible with adequate planning and management.

5.2 Existing (Post-Hurricane Katrina) Conditions

5.2.1 Impacts from Hurricane Katrina

On August 29, 2005, Hurricane Katrina made land fall in Hancock County, Mississippi just east of the Pearl River. By virtually all accounts, it was the single largest disaster in U.S. history. Storm surge from Hurricane Katrina was the largest that has ever hit the continental United States. The surge inundated approximately 484 square miles of southern Mississippi. The relief expenditures in

Mississippi alone have totaled in the billions of dollars. Figure 5.2-1 shows the inundation footprint of Hurricane Katrina.



Figure 5.2-1. Hurricane Katrina Path and Extent of Hurricane Katrina Surge in Planning Units One, Two, and Three

5.2.2 Existing Structure Conditions

Data collected as part of the field inventory process was used to create a structure database. The structure database is the compilation of the data collection effort previously described. It includes each of the structure characteristics mentioned above, damage categories, structure occupancy types, first floor elevations, structure value, content value collected. These characteristics were put into the database along with the data collected from the tax assessor to create a structure database. This structure database represents the existing condition of the structures residing within the study area and the basis for the calculation of equivalent annual damages for the existing, future without-project and future with-project conditions using the HEC-FDA and Beach-FX programs. The structure database is intended to be a snap-shot in time of the structures within the study area. The use of this database was essential for the analysis conducted throughout the course of the MsCIP Comprehensive Plan.

The three planning units suffered tremendous devastation from Hurricane Katrina's surge. It is estimated that 32,446 structures were significantly destroyed (at least fifty-percent or more), with another 15,000 to 25,000 suffering moderate to minimal inundation damage. Of the structures sustaining significant destruction, 9,555 were in planning unit one, 16,528, in planning unit two, and 6,363 in planning unit three. Of those significant loss structures, approximately 19,000 claims were paid out by the Federal Emergency Management Agency's (FEMA's) National Flood Insurance Program (NFIP) totally over $2.3 Billion dollars, with the average claim around $137,000. Currently, no accurate data exists for uninsured losses, but estimates range in the billions of dollars. Table 5-5 displays the significantly damaged structures by planning unit and by structure category. Figures 5.2-2 through 5.2-14 show examples of the destruction caused by Hurricane Katrina in the three planning units.

Table 5-5.
Structures Damaged 50% or More by Planning Unit and by Category

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Commercial	1,267	1,794	378	**3,439**
Residential	8,099	14,500	5,780	**28,379**
Municipal	127	89	136	**352**
Mobile Home	62	145	69	**276**
Total	**9,555**	**16,528**	**6,363**	**32,446**

Source: Estimated from field inventory cluster sampling.



Figure 5.2-2. Example of Structure Damage in Planning Unit One



Figure 5.2-3. Structure Damage in Planning Unit One



Figure 5.2-4. Katrina Surge Damage in Planning Unit One



Figure 5.2-5. Surge Damage in Bay St. Louis – Planning Unit One



Figure 5.2-6. Surge Damage in Biloxi Area – Planning Unit Two



Figure 5.2-7. Surge Damage in Biloxi Area – Planning Unit Two



Figure 5.2-8. Surge Damage in Planning Unit Two



Figure 5.2-9. Pascagoula Beach Boulevard Pre-Hurricane Katrina – Planning Unit Three



Figure 5.2-10. Pascagoula Beach Boulevard Post-Hurricane Katrina – Planning Unit Three



Figure 5.2-11. Pascagoula Beach Boulevard Pre-Hurricane Katrina – Planning Unit Three



Figure 5.2-12. Pascagoula Beach Boulevard Post-Hurricane Katrina – Planning Unit Three



Figure 5.2-13. Pascagoula Yacht Club Pre-Hurricane Katrina – Planning Unit Three



Figure 5.2-14. Pascagoula Yacht Club Post-Hurricane Katrina – Planning Unit Three

5.2.3 Existing (Post-Hurricane Katrina) Socio-economic Conditions

This section contains a description of the existing conditions (post-Hurricane Katrina) demographic and economic characteristics of the study area. It also provides analysis of the interrelation of those characteristics. The people who live in the study area and the economic activities in which they are engaged are vital components of the study area. This information provides insight into the study area's socioeconomic characteristics and provides part of the basis for certain facets of the economic impact evaluation study.

5.2.3.1 Demographics (Population)

5.2.3.1.1 Recent Population Trends

The 2000-2005 population level and growth estimates for the U.S., Mississippi, the three-county study area, and each county are displayed in Table 5-6. The July 1, 2000 to July 1, 2005 timeframe is the most recent before Hurricane Katrina made landfall in late August of 2005. During this five year period, the population of the three-county study area grew by 2.86 percent. This is 1.4 times the Mississippi percentage population growth of 2.10 percent and 0.6 times the U.S. percentage population growth of 5.06 percent. The three-county study area accounted for 17.4 percent of the nominal population growth for Mississippi from 2000-2005.

Table 5-6.
2000-2005 Estimates of Population Levels and Growth

	United States	Mississippi	Three-County Study Area	Hancock County	Harrison County	Jackson County
July 1, 2000	282,216,952	2,848,634	364,863	43,283	189,699	131,881
July 1, 2001	285,226,284	2,856,108	366,362	43,944	189,512	132,906
July 1, 2002	288,125,973	2,863,091	367,498	44,607	189,996	132,895
July 1, 2003	290,796,023	2,874,171	367,790	45,166	189,189	133,435
July 1, 2004	293,638,158	2,892,668	372,885	45,821	192,129	134,935
July 1, 2005	296,507,061	2,908,496	375,304	46,546	193,187	135,571
5 Year Nominal Change	14,290,109	59,862	10,441	3,263	3,488	3,690
5 Year Percentage Change	5.06%	2.10%	2.86%	7.54%	1.84%	2.80%

Source: U.S. Census Bureau, Population Division

5.2.3.1.2 Existing Condition (Post-Katrina) Population

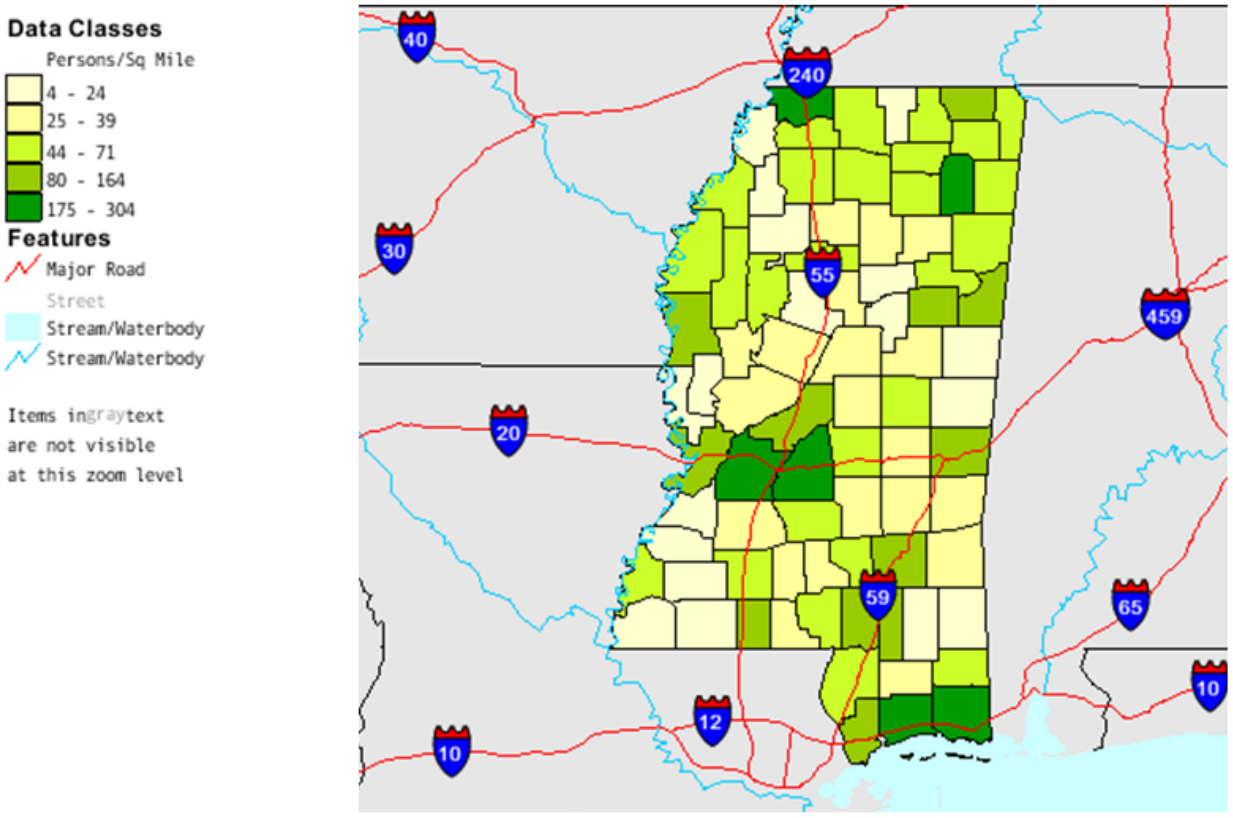
The 2006 population level estimates for the U.S., Mississippi, the three-county study area, and each county are shown in Table 5-7. The table also displays each county's population and the study area's population as a percentage of the populations of the U.S. and Mississippi.

Table 5-7.
2006 Estimated Population Levels

	United States	Mississippi	Three-County Study Area	Hancock County	Harrison County	Jackson County
July 1, 2006 Population Estimate	299,398,484	2,910,540	342,873	40,421	171,875	130,577
Percentage of U.S. Population	100.0%	0.972%	0.115%	0.014%	0.057%	0.040%
Percentage of Mississippi Population		100.0%	11.8%	1.4%	5.9%	4.5%

Source: U.S. Census Bureau, Population Division

Figure 5.2-15 is a map displaying the population densities of counties in Mississippi. As can be seen from the map, the three-county study area is one of the more densely populated areas in Mississippi. It can also be seen that Hancock County has a lower population density than Harrison County or Jackson County.



Source: U.S. Census Bureau

Figure 5.2-15. 2006 Mississippi Population Density

5.2.3.1.3 Urban Growth and Distribution

The 2000-2004 population changes for the U.S., Mississippi, the three-county study area, each county, and major cities within each county are displayed in Table 5-8. The city with the greatest nominal or percentage population growth in the study area from 2000 to 2004 is Gautier with population growth of 5,172 persons or 44.28 percent.

Table 5-8.
2000-2004 Urban Growth and Distribution

	2000	2004	2000-2004 Nominal Change	2000-2004 Percentage Change
United States	281,421,906	293,655,404	12,233,498	4.35%
Mississippi	2,844,658	2,902,966	58,308	2.05%
Three-County Area	363,988	373,762	9,774	2.69%
Hancock County	42,967	45,933	2,966	6.90%
Bay Saint Louis	8,209	8,293	84	1.02%
Waveland	6,674	7,120	446	6.68%
Harrison County	189,601	192,393	2,792	1.47%
Biloxi	50,644	50,115	-529	-1.04%
D'Iberville	7,608	7,757	149	1.96%
Gulfport	71,127	71,850	723	1.02%

Table 5-8.
2000-2004 Urban Growth and Distribution (continued)

	2000	2004	2000-2004 Nominal Change	2000-2004 Percentage Change
Long Beach	17,320	17,258	-62	-0.36%
Pass Christian	6,579	6,758	179	2.72%
Jackson County	131,420	135,436	4,016	3.06%
Gautier	11,681	16,853	5,172	44.28%
Ocean Springs	17,225	17,698	473	2.75%
Pascagoula	26,200	25,865	-335	-1.28%

Source: U.S. Census Bureau, Population Division

5.2.3.1.4 Racial Distribution

Table 5-9 shows the racial distribution for the U.S., Mississippi, each county in the study area, and also includes the racial distribution for the major cities in each county as of 2000.

Table 5-9.
2000 Population Racial Distribution

Table Header	White	Black	Hispanic	Asian	American Indian	Other	Multiple Races
United States	75.1%	12.3%	12.5%	3.6%	0.9%	5.5%	2.4%
Mississippi	61.4%	36.3%	1.4%	0.7%	0.4%	0.5%	0.7%
Hancock County	90.2%	6.8%	1.8%	0.9%	0.6%	0.3%	1.1%
Bay Saint Louis	80.2%	16.6%	1.7%	1.1%	0.4%	0.2%	1.4%
Diamondhead	95.3%	1.8%	2.9%	0.9%	0.4%	0.5%	1.1%
Pearlington	77.6%	20.4%	1.4%	0.1%	0.4%	0.1%	1.4%
Shoreline Park	94.6%	2.0%	1.9%	0.3%	1.0%	0.3%	1.7%
Waveland	85.4%	11.2%	2.0%	1.5%	0.5%	0.5%	0.9%
Harrison County	73.1%	21.1%	2.6%	2.6%	0.5%	0.9%	1.7%
Biloxi	71.4%	19.0%	3.6%	5.1%	0.5%	1.4%	2.4%
D'Iberville	78.2%	11.4%	2.6%	7.0%	0.4%	0.9%	2.1%
Gulfport	62.2%	33.5%	2.6%	1.3%	0.4%	0.5%	1.6%
Long Beach	87.5%	7.4%	2.3%	2.6%	0.4%	0.7%	1.4%
Pass Christian	65.9%	28.2%	1.7%%	3.5%	0.6%	0.6%	1.2%
Jackson County	75.4%	20.9%	2.1%	1.6%	0.3%	0.7%	1.1%
Escatawpa	80.5%	17.6%	0.6%	0.7%	0.3%	0.1%	0.7%
Gautier	68.2%	27.7%	3.2%	1.3%	0.5%	0.9%	1.4%
Moss Point	28.0%	70.6%	1.0%	0.2%	0.2%	0.4%	0.6%
Ocean Springs	87.7%	7.0%	2.5%	2.6%	0.4%	0.7%	1.5%
Pascagoula	67.2%	29.0%	3.9%	1.0%	0.2%	1.7%	1.0%

Source: U.S. Census Bureau, 2000 Census

5.2.3.2 Economy

5.2.3.2.1 Employment Distribution

The 2002 distribution of employment by major sectors for Mississippi, the three-county study area, and each county is shown in Table 5-10. Approximately 5.4% of Mississippi's Professional and Technical employment could be found in Hancock County in 2002. Hancock County is home to the John C. Stennis Space Center. The Stennis Space Center, with over 4,600 employees is NASA's primary center for rocket propulsion testing. Harrison County is a popular vacation destination for its beaches and casinos. Harrison County accounts for 26.9 percent of Mississippi's employment in the arts and 20.0 percent of Mississippi's employment in food and accommodation services. Jackson County features Pascagoula Harbor. In 2004, 66.7 percent of Mississippi's waterborne commerce volume and 1.3 percent of U.S. volume moved through Pascagoula Harbor. Pascagoula Harbor's annual volume increased 44% from 1986 to 2004. Northrop Grumman Ship Systems' Ingalls Operations, with over 10,000 employees, can also be found in Jackson County. Jackson County accounted for 8.8 percent of Mississippi's employment in manufacturing.

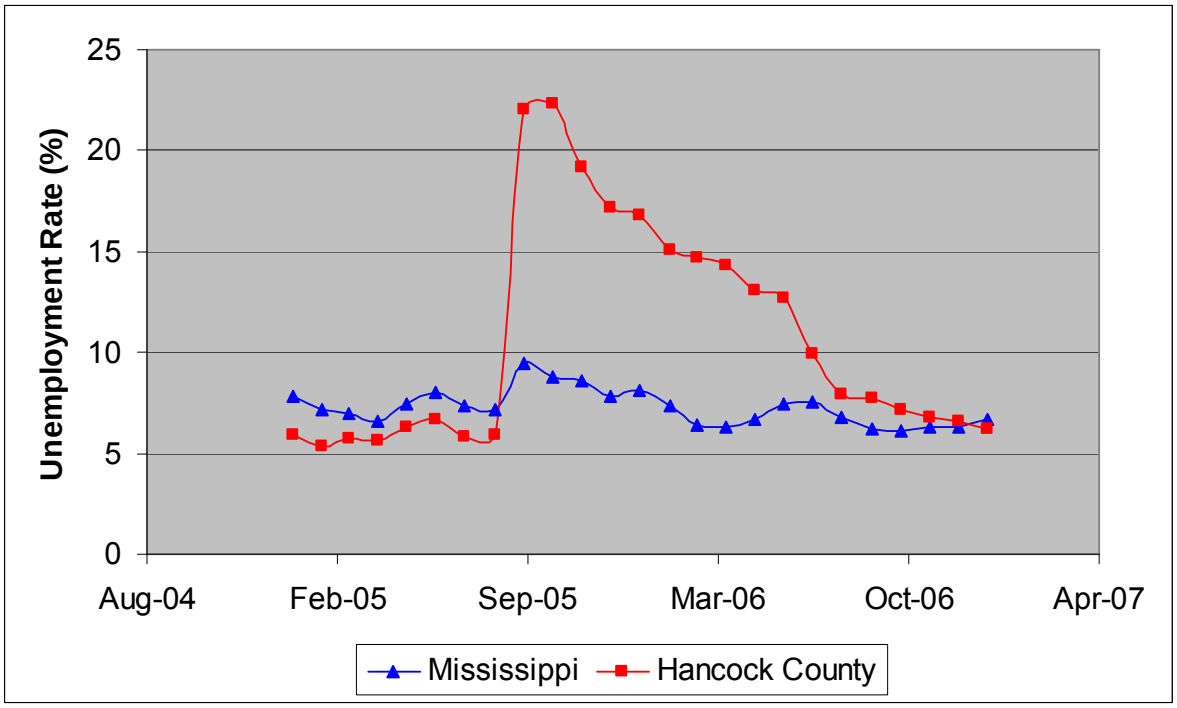
Table 5-10.
2002 Employment Distribution by Major Sector

	Mississippi	Three-County Study Area	Hancock County	Harrison County	Jackson County
Manufacturing	182,822	21,500	1,000	4,500	16,000
Wholesale	35,316	2,963	251	2,112	600
Retail	135,838	18,698	1,586	11,548	5,564
Real Estate	9,665	1,585	131	1,084	370
Professional & Technical	29,023	5,205	1,555	2,050	1,600
Administration	46,115	5,821	1,280	3,211	1,330
Education	1,678	204	20	100	84
Health & Social Care	131,976	17,549	500	12,429	4,620
Arts	9,292	2,700	100	2,500	100
Food & Accommodation	109,405	27,523	2,114	21,822	3,587
Other Services	22,180	3,558	176	2,067	1,315

Source: U.S. Census Bureau, 2002 Economic Census

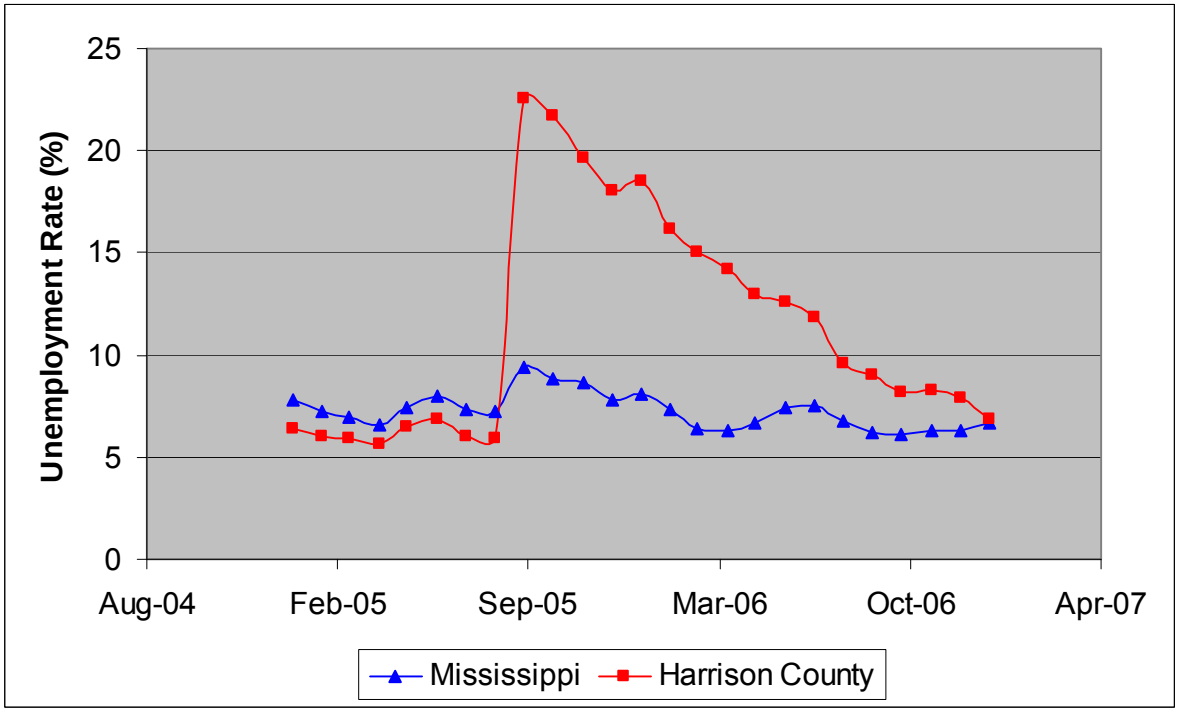
5.2.3.2.2 Unemployment

The non-seasonally adjusted unemployment rates for Mississippi and each county in the study area from January 2005 to January 2007 are displayed graphically in Figures 5.2-16, 5.2-17 and 5.2-18. These same numbers are also displayed in Table 5-11. Unemployment rates within the study area increased dramatically following Hurricane Katrina, but have since recovered to roughly pre-Katrina levels.



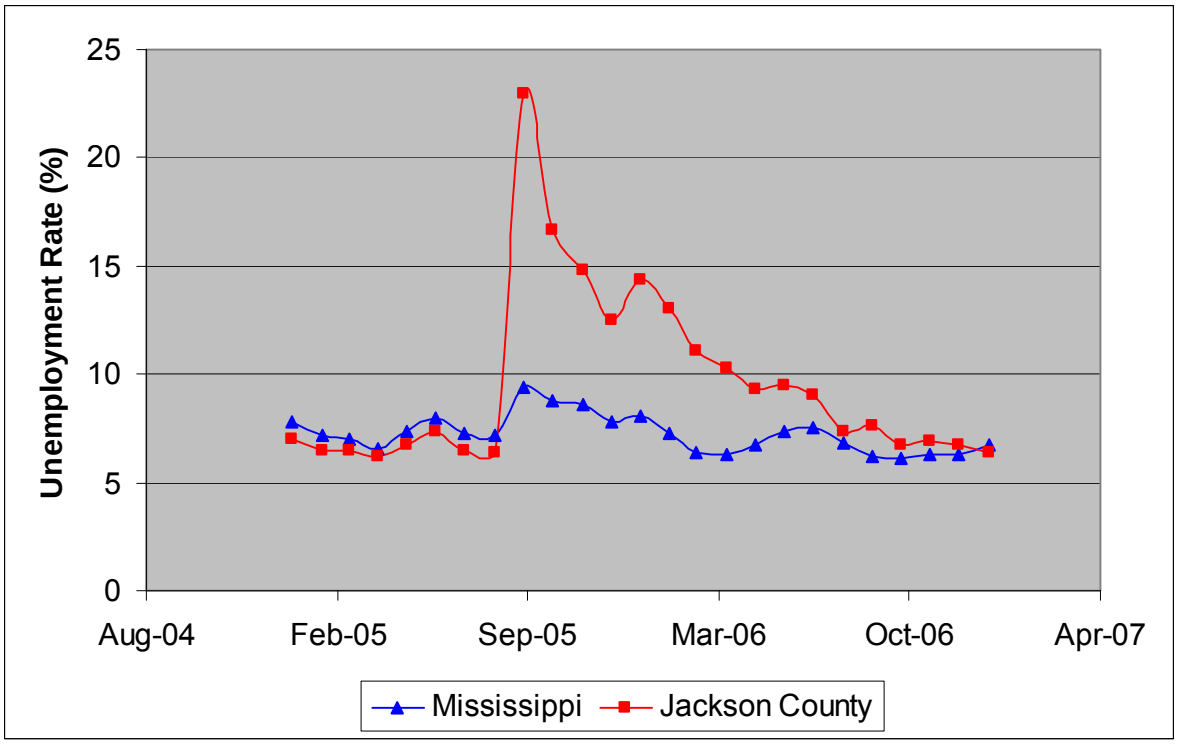
Source: Bureau of Labor Statistics

Figure 5.2-16. Non-Seasonally Adjusted Unemployment Rates for Mississippi and Hancock County



Source: Bureau of Labor Statistics

Figure 5.2-17. Non-Seasonally Adjusted Unemployment Rates for Mississippi and Harrison County



Source: Bureau of Labor Statistics

Figure 5.2-18. Non-Seasonally Adjusted Unemployment Rates for Mississippi and Jackson County

Table 5-11.
January 2005 – January 2007 Unemployment Rates (%)

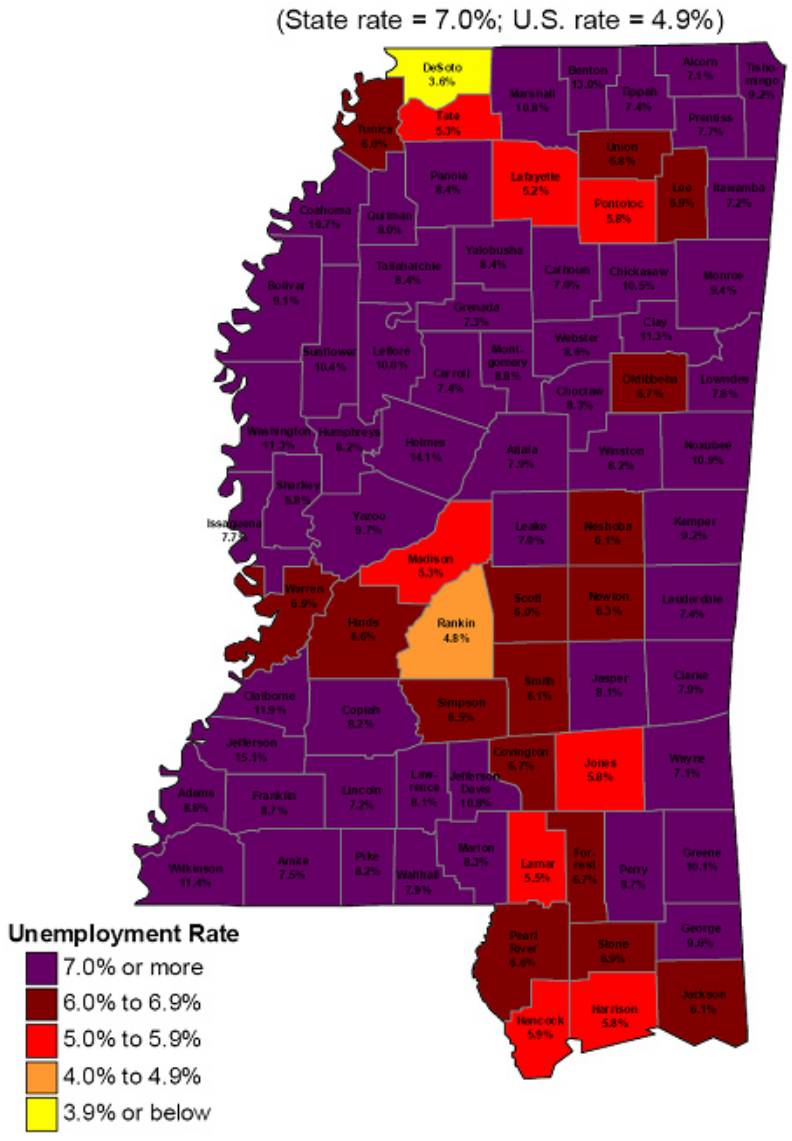
	Mississippi	Hancock County	Harrison County	Jackson County
Jan-05	7.8	5.9	6.4	7.0
Feb-05	7.2	5.3	6.0	6.5
Mar-05	7.0	5.7	5.9	6.5
Apr-05	6.6	5.6	5.6	6.2
May-05	7.4	6.3	6.5	6.7
Jun-05	8.0	6.7	6.9	7.4
Jul-05	7.3	5.8	6.0	6.5
Aug-05	7.2	5.9	5.9	6.4
Sep-05	9.4	22.0	22.6	23.0
Oct-05	8.8	22.3	21.7	16.7
Nov-05	8.6	19.2	19.6	14.8
Dec-05	7.8	17.2	18.0	12.5
Jan-06	8.1	16.8	18.5	14.4
Feb-06	7.3	15.1	16.2	13.0
Mar-06	6.4	14.7	15.0	11.1
Apr-06	6.3	14.3	14.2	10.3
May-06	6.7	13.1	13.0	9.3
Jun-06	7.4	12.7	12.6	9.5
Jul-06	7.5	9.9	11.8	9.0
Aug-06	6.8	7.9	9.6	7.4

Table 5-11.
January 2005 – January 2007 Unemployment Rates (%) (continued)

	Mississippi	Hancock County	Harrison County	Jackson County
Sep-06	6.2	7.7	9.0	7.6
Oct-06	6.1	7.2	8.2	6.7
Nov-06	6.3	6.8	8.3	6.9
Dec-06	6.3	6.6	7.9	6.7
Jan-07	6.7	6.2	6.9	6.4

Source: Bureau of Labor Statistics

Figure 5.2-19 is a map displaying the unemployment rates for Mississippi by county for August, 2005. Before Hurricane Katrina the counties in the study area had unemployment rates lower than the Mississippi unemployment rate.



Source: Bureau of Labor Statistics

Figure 5.2-19. Non-Seasonally Adjusted Unemployment Rates by County for Mississippi

5.2.3.2.3 Income and Poverty

Median income and poverty levels for the U.S., Mississippi and each county in the study area for 2004 are displayed in Table 5-12. Each of the three counties in the study area had a higher median income and a lower poverty rate than that of Mississippi in 2004.

Table 5-12.
2004 Median Income and Poverty Levels

	Median Income	Nominal Poverty	Poverty Rate
United States	$44,334	37,039,804	12.7%
Mississippi	$34,278	549,224	19.3%
Hancock County	$36,285	7,737	16.6%
Harrison County	$35,576	31,809	16.9%
Jackson County	$40,418	20,256	15.0%

Source: U.S. Census Bureau, Small Area Income & Poverty Estimates

5.2.4 Existing (Post-Hurricane Katrina) Environmental Setting

Prior to the storms, Coastal Mississippi had already experienced large population growth over the last few decades. Loss and/or alteration of various habitats types (i.e. barrier islands, submerged aquatic vegetation (SAVs), marsh habitat – freshwater and estuarine, wet pine savannah, etc.) had adverse impacts on both fish and wildlife and also on those habitats upon which they depend. Erosion to the barrier islands could possibly increase salinity; thus, greatly changing ecological habitats that exist, which could lead to saltwater intrusion, increased wave action, and destroying coastal wetlands. Increased salinity within Mississippi Sound would impact shellfish and many other forms of marine life. At the Chandeleur Islands in Louisiana, loss of those island masses allows us to anticipate potential environmental changes. Initial assessments are showing SAVs diminishing, marsh erosion ongoing/accelerating, and wave energy having no natural barrier.

Following Hurricane Katrina, the Commerce Secretary declared a complete fisheries failure due to the extensive devastation to the processing facilities, docks, loss of boats, degradation of habitat, deposition of marine debris, and degraded water quality. Losses to many commercially important fisheries stock, foraging areas, nurseries, and etc. have been felt economically in the region. Increased salinity due to continued degradation of the barrier islands will result in detrimental impacts to the vital economic fisheries industry that the estuarine environment sustains.

Oyster reefs have been seriously impacted by Hurricane Katrina and all reefs in Coastal Mississippi were closed immediately following the storm, with some of them still remaining closed almost 2 years later. There are signs the reefs are beginning some of the healing processes on their own; however, much work will be needed to restore the oyster reefs to their former prime condition. Extensive sampling of the reefs is currently being conducted by the MDMR to provide information needed to plan extensive long-term recovery activities. Initial assessments of the reef conditions are underway but at present, are incomplete. Conditions of the reefs are highly variable. Generally, offshore areas were heavily scoured. Recent very heavy oyster spat set (less than one inch in length) was found in some of these areas with no spat set in other areas. Some light SAVs, marsh grass and drift wood were found. Inshore reefs generally had moderate to very low numbers of live oysters in some areas with other areas revealing no live oysters.

The coastal maritime forests on the barrier islands and also the mainland were almost entirely lost as a result of the storm. Almost 2 years following those events, approximately 90% of this habitat is still lost. Even prior to the storms, but especially after, wet pine savannah wetland habitat has been

under increased developmental pressures due to the extreme and urgent housing need faced by Mississippians as they are trying to rebuild. This habitat is becoming fragmented and with the increased development, fire maintenance is increasingly harder to perform. Due to the nature of the flat coastal plains with little relief, these lands are some of the first to be considered for housing development. These habitats are becoming fragmented causing a loss of wildlife corridors and contiguous expanses of habitat necessary for continued species existence. Coastal Mississippi has lost over half of its wet pine savannahs due to the urbanization throughout the area; thus, creating a threatened ecosystem that in turn is home to many threatened and endangered species. Because of the loss of these habitats, the species dependent upon them are increasingly becoming diminished. As a result of Hurricane Katrina and other storms of 2005, estuarine and freshwater marsh habitats were severely impacted by the debris that landed within its footprints; thus, clogging natural tidal and/or runoff flow. Furthermore, many historical marsh habitats (i.e. Shoreline Park) were noted to have detrimental damage due to its historical filling and development. Following those events, many historical habitats were identified that would benefit Coastal Mississippi upon its conversion back to its natural habitat. In conclusion, the hurricane season of 2005 greatly impacted the environmental setting of Coastal Mississippi.

5.3 Future Without-Project Conditions

5.3.1 Period of Analysis

For sensitivity purposes, the period of analysis used for the MsCIP Comprehensive Plan is a 100-year period, which was then converted to a 50-year period of analysis for those plan elements that would be recommended for construction. The base year used for the MsCIP Comprehensive Plan is the first year of the period of analysis. Typically, the base year is considered to be the first year that full project benefits come online and it is always the year to which benefits and costs of measures are discounted (present-worthed) back to in order to make an even ("apple-to-apples") comparison. The base year for the analysis used for the MsCIP Comprehensive Plan is the year 2012. Figure 5.3-1 depicts the methodology that was used for the 100-year period of analysis. This methodology was also used for the 50-year period of analysis, with the exception of the most likely future being 2061 (50 years), instead of 2111 (100 years).

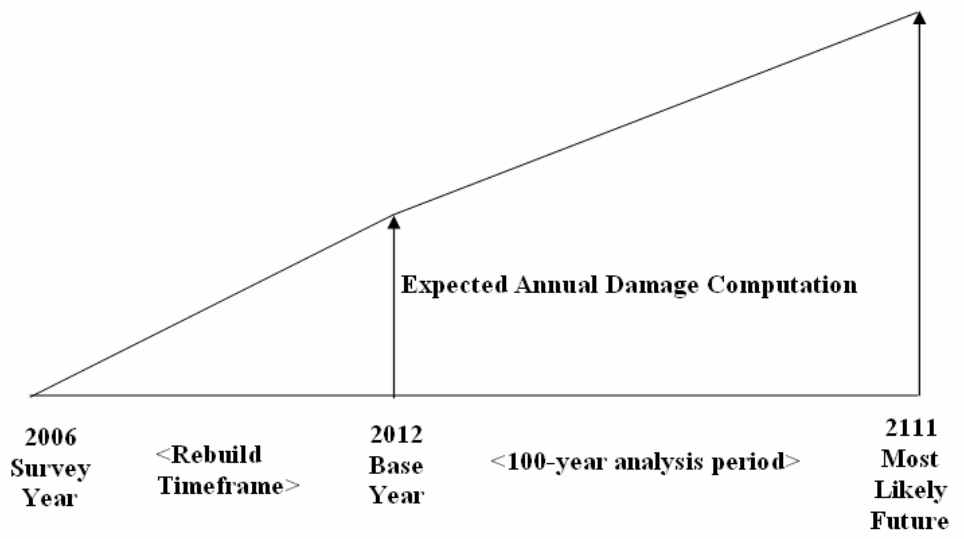


Figure 5.3-1. Period of Analysis used for Flood Damage Reduction and Hurricane and Storm Damage Prevention

5.3.2 Assumptions

The following assumptions were designed to construct the forecast estimate of the of the three county study area. The assumptions were based on discussions with state and local interests, various experts, and past experiences following devastating hurricanes along the northern Gulf Coast such as Hurricanes Camille and Fredrick. Further, these assumptions were based on an existing condition identified by using tax parcel data from the tax assessors of the three coastal counties and by conducting the field inventory to assess the extent of damages and where they occurred. These assumptions drive the future without-project structure inventory that was forecast and evaluated in HEC-FDA along with the hydrodynamic forecast conditions, which can be found in detail in the engineering appendix, to estimate future without-project inundation damages and damages reduced as result of potential measures.

- The base year for which costs and benefits are discounted is 2012.
- The discount rate used for this analysis is the FY-08 discount rate of 4-7/8-percent.
- The period of analysis for screening and sensitivity purposes is 100-years (2012 to 2111), however all measures recommended for construction will be converted back to a 50-year period of analysis (2012 to 2111). A more detailed discussion of this assumption can be found as a sensitivity analysis in chapter VII of this appendix.
- The demands for waterfront and near water living will not decrease in the future as a result of hurricanes (i.e. people will always want to live by the water).
- Only destruction of property occupied prior to Hurricane Katrina will be accounted for in forecasting (i.e. there will be no projection of previously undeveloped land).
- Destruction categories include significant (damaged 50-percent or more and must be completely rebuilt) and moderate to minimal (less than 50-percent rebuilt and can be either repaired or rehabilitated).
- Previously occupied structures that were destroyed as a result of Hurricane Katrina will be redeveloped and the population will return to at least pre-Katrina levels. Redevelopment is defined as the building back of structures that existed before Hurricane Katrina, not development that occurs on land that was undeveloped.
- Full redevelopment of previously occupied structures will occur by the base year 2012.
- Redevelopment of the study area could take the form of residential redevelopment (exactly the way it was pre-Hurricane Katrina) or a mixture of commercial/condominium and residential redevelopment. In addition to redevelopment, it is assumed that relative sea level rise could take the form of base, moderate or high relative sea level rise. The six future scenarios are outlined in the following section.
- Economic cycles such as recessionary and expansionary periods could, and probably will, have an impact on the timing and magnitude of the redevelopment of the coast over the period of analysis, but are not able to be predicted and are not accounted for in the forecast.
- An increase in relative sea level rise will probably occur over the period of analysis.
- Relative sea level rise is not a linear function, meaning that some years may experience more or less than other years. Since the amount of relative sea level rise in any given year is impossible to predict, a linear relationship is used to model relative sea level rise for purposes of forecasting.

- Given the majority of the coast is fronted by man-made seawalls and roadways and the majority of structures are not immediately located by the water like other Gulf Coast and Eastern Seaboard communities, effects of future erosion on human development behavior will be none to minimal.

- Effects of future inundation caused by relative sea level rise could have any where from a minimal to a moderate effect on human development behavior, but those effects are currently difficult or impossible to measure and are not account for in this forecasting effort.

- Communities will adopt and adhere to FEMA guidelines under the National Flood Insurance Program (NFIP).

- FEMA guidelines require minimum heights that the first floor elevation must be built to in order to be included in the National Flood Insurance Program (NFIP). For the purposes of the redevelopment projected in this report, houses that will be rebuilt before the start of 2009 are assumed to be rebuilt to the Pre-Hurricane Katrina Base Flood Elevation (BFE) and those that are rebuilt between 2009 and 2011 will be rebuilt to the Advisory Base Flood Elevation (ABFE) as existed May 2007. The BFE and ABFE estimates vary in range of elevation depending on the planning sub-unit in question. Table 5-13 shows these heights by reach.

- Redevelopment is estimated to occur as follows:

Table 5-13.
Assumptions of Structure Redevelopment by Year

Year	Percent Redeveloped	Elevation of Redevelopment
2005	N/A	Hurricane Katrina Landfall (August 29th)
2006	10%	Pre-Hurricane Katrina Base Flood Elevations
2007	25%	Pre-Hurricane Katrina Base Flood Elevations
2008	40%	Pre-Hurricane Katrina Base Flood Elevations
2009	60%	Advisory Base Flood Elevations
2010	80%	Advisory Base Flood Elevations
2011	100%	Advisory Base Flood Elevations
2012	Full Redevelopment	Base Year

- Depth damage characteristics of structures (the percent of structure damage at various levels of inundation) are assumed and used to define economic damage as a result of inundation.

- The depth damage characteristics of structures vary by construction type and are similar to those in other parts for the Gulf Coast, particularly the New Orleans area. It is also assumed that the duration of surge inundation is approximately 24 hours, which is considered short-term duration. The depth-damage relationships are explained in more detail in Addendums A and B.

- Depreciated replacement cost of structures was used unless a structure was destroyed fifty-percent or more due to surge from Hurricane Katrina. For those structures damaged fifty-percent or more and must be rebuilt, full depreciated replacement cost was used to denote the value in the structure inventory.

5.3.3 Scenario Testing

5.3.3.1 Methodology

Forecasting future scenarios is an important part of the Corps planning process. In order to evaluate the true economic value of potential measures over the project life, a forecast is created based on the historic and existing information, as well as quantitative and qualitative assumptions about what may happen within the study area in the future. One method is to identify the 'most likely' future, or the best guess about what may happen based on observed variables and assumptions of both natural and human behaviors. Another method is to conduct scenario planning, where multiple future scenarios are created in order to evaluate what would happen if observed variables or assumptions do not happen as projected. The purpose of scenario planning is to attempt to answer 'what if' questions that arise when making forecasting assumptions and predictions.

For the Mississippi Coastal Improvements Project, the former method was chosen due to the size, scope, and complexity of the overall analysis. The six future without-project scenarios are displayed in table 5-14 summarizes the six future scenarios.

These six future without-project scenarios were based on existing condition characteristics, patterns of rebuilding following historical hurricanes within the specific area such as Hurricane Camille, patterns of rebuilding in other similar parts of the northern Gulf Coastal area such as Gulf Shores and Orange Beach, AL following Hurricane Fredrick, and potential impacts of relative sea level rise over the period of analysis. Following Hurricane Camille, the Mississippi Gulf Coast not only rebuilt the structures and infrastructure it lost to the devastating storm surge, but saw substantial growth in both residential and commercial infrastructure. However, it did not see a major shift in their proportion, i.e., the ratio of residential and commercial infrastructure did not immediately change as a result of a shift in behavior immediately following the storm. In contrast, the effects of Hurricane Fredrick to the Alabama Gulf Coast Communities of Gulf Shores and Orange Beach saw a fundamental shift of infrastructure from typically residential, to condominium and business structures. These two scenarios form the two rebuilding components of the future without-project scenarios; residential (a rebuild of the coastal area based on what existed prior to Hurricane Katrina) and residential and commercial (a rebuild of what type existed prior to Hurricane Katrina with a shift from residential to commercial along the coast.

The other component of the future without-project scenarios is relative sea level rise, or an estimate of the affect of eustatic sea level rise combined with subsidence. In order to evaluate the effects of this component, a range of relative sea level rise was identified and modeled and the details can be found in the engineering appendix. Three potential relative sea level rise settings were identified; base (historical relative sea level rise with no future projection), moderate (historical relative sea level rise and a future projection of up to 2.4-feet depending on location), and high (historical relative sea level rise and a future projection of up to 3.4-feet depending on location). These three components, coupled with the two redevelopment components, form the six future without-project scenarios used in the evaluation of this study.

As with any attempt to project the future, accuracy is limited by a host of factors such as timing (what if a recession hits), reality not fully matching the assumptions used (what if the redevelopment effort doesn't happen as fast as predicted or what if human behavior shifts in a way that was unforeseen), and on. In other words, any attempt to project the future will include some risk and uncertainty and therefore the intent of making these forecasts is to provide an estimate of what the future could be in order to evaluate the impacts of potential actions, not to say this is exactly what is going to happen.

Table 5-14.
Overview of Future Scenarios

Future Scenario	Redevelopment Type	Relative Sea Level Rise	Description
Future Scenario 1	Residential	Historical Only	Rebuild structures as existed pre-Hurricane Katrina with no relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 2	Mixed Residential & Commercial	Historical Only	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, no relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 3	Residential	Expected (up to 2.4-Feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina with up to 2.4-feet relative sea level rise over the This future scenario applies to all three planning units.
Future Scenario 4	Mixed Residential & Commercial	Expected (up to 2.4-Feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, a up to 2.4-feet relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 5	Residential	High Rate (up to 3.4-feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina with up to 3.4-feet of relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 6	Mixed Residential & Commercial	High Rate (Up to 3.4-feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, up to3.4-feet of relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.

Future Scenarios One and Two are included only to evaluate the effects of relative sea level rise. These Future scenarios will not be used in the evaluation of potential measures. Futures Three, Four, Five, and Six will be the future scenarios by which potential measures will be evaluated depending on the planning unit.

5.3.3.2 Future Scenario 1

Scenario one is the full redevelopment of structures within the study area by the year 2012. Under this scenario, structures will be rebuilt as they were pre-Katrina. For example, if the structure was a residential structure pre-Katrina it will be rebuilt as a residential structure; commercial back to commercial; etc. It includes 220,776 tax parcels as defined by Hancock (planning unit one), Harrison (planning unit two), and Jackson (planning unit three) Counties, Mississippi. Of those parcels, 138,170 are structures including 22,313 are in planning unit one, 57,587 in planning unit two, and 58,270 in planning unit three. In addition to the redevelopment of structures, this scenario accounts for no relative sea level rise over the 100-year period of analysis (2012–2111). Table 5-15 displays the parcels by planning unit, category of structure, and by one-foot elevation contour. Table 5-16 displays the parcels for all three planning units by structure category and by one-foot elevation contour. Table 5-17 displays the value of structures and their contents by category and planning unit. **Note:** This scenario will not be used to evaluate potential measures in Chapter IV of this appendix because it does not adequately account for the effect of relative sea level rise. However, it will be used as a sensitivity analysis to evaluate the effects of the increment between a no relative sea level rise scenario and the expected relative sea level rise scenario.

Table 5-15.
Futures Without-Project Scenarios One, Three, and Five Inventory Parcels by Planning Unit and by Structure Category

Structure Categories	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Residential	17,907	49,121	49,688	**116,716**
Mobile Homes	498	2,497	3,553	**6,548**
Commercial	3,255	5,618	4,266	**13,139**
Municipal	653	351	763	**1,767**
Vacant Land	22,843	29,984	29,779	**82,606**
Total	**45,156**	**87,571**	**88,049**	**220,776**

Table 5-16.
Futures Without Project Scenarios One, Three, and Five Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation

Estimated First Floor Elevation Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	19	1	2	1	**23**
2-foot	115	1	16	4	**136**
3-foot	411	2	42	18	**473**
4-foot	1,015	2	88	34	**1139**
5-foot	2,566	20	143	52	**2,781**
6-foot	3,117	77	196	68	**3,458**
7-foot	3,975	129	270	87	**4,461**
8-foot	5,111	183	350	108	**5,752**
9-foot	6,475	226	463	130	**7,294**
10-foot	8,012	270	576	163	**9,021**
11-foot	10,381	321	730	194	**11,626**
12-foot	14,068	396	1,064	256	**15,784**
13-foot	18,411	507	1,537	352	**20,807**
14-foot	22,416	617	2,128	465	**25,626**
15-foot	31,139	779	3,424	629	**35,971**
16-foot	34,210	878	3,829	692	**39,609**
17-foot	37,925	1,006	4,125	774	**43,830**
18-foot	42,793	1,144	4,771	865	**49,573**
19-foot	47,914	1,368	5,650	942	**55,874**
20-foot	56,895	1,606	7,244	1,089	**66,834**
21-foot	60,673	1,784	7,809	1,154	**71,420**
22-foot	64,417	1,960	8,158	1,221	**75,756**
23-foot	71,143	2,174	8,893	1,293	**83,503**
24-foot	75,711	2,331	9,295	1,345	**88,682**
25-foot	79,957	2,473	9,633	1,392	**93,455**
26-foot	83,944	2,648	9,901	1,428	**97,921**

Table 5-16.
Futures Without Project Scenarios One, Three, and Five Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation (continued)

Estimated First Floor Elevation Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
27-foot	86,948	2,788	10,144	1,463	**101,343**
28-foot	89,743	2,887	10,405	1,487	**104,522**
29-foot	92,130	2,986	10,634	1,502	**107,252**
30-foot	94,042	3,057	10,873	1,521	**109,493**
31-foot	95,586	3,158	11,114	1,535	**111,393**
32-foot	96,621	3,242	11,324	1,545	**112,732**
33-foot	97,531	3,300	11,450	1,555	**113,836**
34-foot	98,165	3,364	11,559	1,572	**114,660**
35-foot	98,669	3,429	11,623	1,584	**115,305**
36-foot	99,075	3,481	11,651	1,590	**115,797**
37-foot	99,498	3,532	11,682	1,598	**116,310**
38-foot	99,952	3,589	11,711	1,600	**116,852**
39-foot	100,478	3,644	11,747	1,605	**117,474**
40-foot	116,716	6,548	13,139	1,767	**138,170**

Table 5-17.
Futures Without-Project Scenarios One, Three, and Five Inventory Structure and Content Values by Category and Planning Unit

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Structure Values				
Residential	$2,415,885,807	$4,449,184,443	$3,200,940,955	**$10,066,011,205**
Mobile Homes	$8,518,174	$48,312,941	$52,053,731	**$108,884,846**
Commercial	$611,355,705	$4,526,104,161	$2,048,940,654	**$7,186,400,520**
Municipal	$335,220,287	$261,009,884	$303,986,556	**$900,216,727**
Structure Value Subtotal	**$3,370,979,973**	**$9,284,611,429**	**$5,605,921,896**	**$18,261,513,298**
Content Values				
Residential	$2,415,885,807	$4,449,184,443	$3,200,940,955	**$10,066,011,205**
Mobile Homes	$12,606,898	71503152.68	77039521.88	**$161,149,573**
Content Values				
Commercial	$1,213,472.28	$2,388,618,644	$428,362,111	**$2,818,194,227**
Municipal	$135,597,922	$102,609,763	$102,022,049	**$340,229,734**
Content Value Subtotal	**$2,565,304,099**	**$7,011,916,003**	**$3,808,364,637**	**$13,385,584,739**
Total	**$5,936,284,072**	**$16,296,527,432**	**$9,414,286,533**	**$31,647,098,037**

5.3.3.3 Future Scenario 2

Scenario two is the full redevelopment of structures within the study area by the year 2012. Under this scenario, structures away from the water front in Planning Units one and two and all of planning unit three will be rebuilt as they were pre-Katrina. For example, if the structure was a residential structure pre-Katrina it will be rebuilt as a residential structure; commercial structures will be rebuilt back to commercial structures; etc. In addition, structures in planning units one and two, structures

along the Mississippi Sound and Back Bay water fronts will be rebuilt as condominiums and casinos. It includes 220,776 tax parcels as defined by Hancock (planning unit one), Harrison (planning unit two), and Jackson (planning unit three) Counties, Mississippi. Of those parcels, 138,199 are structures including 22,314 are in planning unit one, 57,615 in planning unit two, and 58,270 in planning unit three. In addition to the redevelopment of structures, this scenario accounts for no relative sea level rise over the 100-year period of analysis (2012–2111). Table 5-18 displays the parcels by planning unit, category of structure, and by one-foot elevation contour. Table 5-19 displays the parcels for all three planning units by structure category and by one-foot elevation contour. Table 5-20 displays the value of structures and their contents by category and planning unit. **Note:** This scenario will not be used to evaluate potential measures in Chapter IV of this appendix because it does not adequately account for the effect of relative sea level rise. However, it will be used as a sensitivity analysis to evaluate the effects of the increment between a no relative sea level rise scenario and the expected relative sea level rise scenario.

Table 5-18.
Futures Without-Project Scenarios Two, Four, and Six Inventory Parcels by Planning Unit and by Structure Category

Structure Categories	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Residential	17,757	48,636	49,688	**69,942**
Mobile Homes	498	2,497	3,553	**52,687**
Commercial	3,408	6,101	4,266	**13,775**
Municipal	651	381	763	**1,795**
Vacant Land	22,842	29,956	29,779	**82,577**
Total	**45,156**	**87,571**	**88,049**	**220,776**

Table 5-19.
Futures Without-Project Scenarios Two, Four, and Six Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation

Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	19	1	3	1	**24**
2-foot	111	1	17	4	**133**
3-foot	403	2	43	18	**466**
4-foot	1,003	2	89	34	**1,128**
5-foot	2,543	20	144	52	**2,759**
6-foot	3,080	77	197	68	**3,422**
7-foot	3,932	129	271	87	**4,419**
8-foot	5,055	183	351	108	**5,697**
9-foot	6,408	226	464	130	**7,228**
10-foot	7,934	270	577	163	**8,944**
11-foot	10,291	321	730	194	**11,536**
12-foot	13,954	396	1,069	256	**15,675**
13-foot	18,266	507	1,546	352	**20,671**
14-foot	22,220	617	2,147	465	**25,449**
15-foot	30,880	779	3,468	630	**35,757**
16-foot	33,923	878	3,930	692	**39,423**
17-foot	37,611	1,006	4,272	775	**43,664**
18-foot	42,439	1,144	4,949	866	**49,398**

Table 5-19.
Futures Without-Project Scenarios Two, Four, and Six Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation (continued)

Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
19-foot	47,513	1,368	5,840	943	**55,664**
20-foot	56,412	1,606	7,398	1,089	**66,505**
21-foot	60,178	1,784	7,975	1,153	**71,090**
22-foot	63,910	1,960	8,365	1,220	**75,455**
23-foot	70,535	2,174	9,137	1,292	**83,138**
24-foot	75,091	2,331	9,590	1,344	**88,356**
25-foot	79,328	2,473	9,986	1,391	**93,178**
26-foot	83,308	2,648	10,301	1,427	**97,684**
27-foot	86,314	2,788	10,584	1,462	**101,148**
28-foot	89,112	2,887	10,878	1,486	**104,363**
29-foot	91,498	2,986	11,147	1,501	**107,132**
30-foot	93,409	3,057	11,406	1,520	**109,392**
31-foot	94,952	3,158	11,677	1,534	**111,321**
32-foot	95,986	3,242	11,902	1,544	**112,674**
33-foot	96,897	3,300	12,053	1,554	**113,804**
34-foot	97,531	3,364	12,178	1,571	**114,644**
35-foot	98,035	3,429	12,247	1,583	**115,294**
36-foot	98,441	3,481	12,278	1,589	**115,789**
37-foot	98,864	3,532	12,315	1,597	**116,308**
38-foot	99,318	3,589	12,345	1,599	**116,851**
39-foot	99,844	3,644	12,381	1,604	**117,473**
40-foot	116,081	6,548	13,775	1,795	**138,199**

Table 5-20.
Futures Two, Four, and Six Inventory Structure and Content Values by Category and Planning Unit

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Structure Values				
Residential	$2,390,977,748	$4,402,477,082	$3,200,940,955	**$9,994,395,785**
Mobile Homes	$8,518,168	$48,312,740	$52,053,731	**$108,884,639**
Commercial	$1,500,399,292	$4,233,140,761	$2,048,940,654	**$7,782,480,707**
Municipal	$334,734,608	$261,025,195	$303,986,556	**$899,746,359**
Structure Value Subtotal	**$4,234,629,816**	**$8,944,955,778**	**$5,605,921,896**	**$18,785,507,490**
Content Values				
Residential	$2,390,977,748	$4,402,477,082	$3,200,940,955	**$9,994,395,785**
Mobile Homes	$12,606,888.64	$71,502,855.20	$77,039,521.88	**$161,149,266**
Commercial	$1,473,899,310	$2,498,045,931	$428,362,111	**$4,400,307,352**
Municipal	$135,240,760	$102,280,080	$102,022,049	**$339,542,889**
Content Value Subtotal	$4,012,724,707	$7,074,305,948	$3,808,364,637	**$14,895,395,292**
Total	**$8,247,354,523**	**$16,019,261,726**	**$9,414,286,533**	**$33,680,902,782**

5.3.3.4 Future Scenario 3

Scenario three is the full redevelopment of structures within the study area by the year 2012. Under this scenario, structures will be rebuilt as they were pre-Katrina. For example, if the structure was a residential structure pre-Katrina it will be rebuilt as a residential structure; commercial structures will be rebuilt back to commercial structures; etc. Scenario three is the same structure inventory as scenario one with the addition of a relative sea level rise of 2.4-feet over the 100-year period of analysis (2012–2111). The structure inventory, structure values, and content values for future scenario three are described in detail in above section 5.3.3.2. This scenario will be used to evaluate potential measures in Chapter IV of this appendix.

5.3.3.5 Future Scenario 4

Scenario four is the full redevelopment of structures within the study area by the year 2012. Under this scenario, structures away from the water front in Planning Units one and two and all of planning unit three will be rebuilt as they were pre-Katrina. For example, if the structure was a residential structure pre-Katrina it will be rebuilt as a residential structure; commercial back to commercial; etc. In planning units one and two, structures along the Mississippi Sound and Back Bay water fronts will be rebuilt as condominiums and casinos. Basically, Scenario three is the same structure inventory as scenario one with the addition of a relative sea level rise of up to 2.4-feet over the 100-year period of analysis (2012–2111). The structure inventory, structure values, and content values for future scenario three are described in detail in above section 5.3.3.3. This scenario will be used to evaluate potential measures in Chapter IV of this appendix.

5.3.3.6 Future Scenario 5

Scenario five is the same structure inventory as scenario one with the addition of a relative sea level rise of up to 3.4-feet depending over the 100-year period of analysis (2012–2111). The structure inventory, structure values, and content values for future scenario three are described in detail in above section 5.3.3.2. This scenario will be used to evaluate potential measures in Chapter IV of this appendix.

5.3.3.7 Future Scenario 6

Scenario six is the same structure inventory as scenario two with the addition of a relative sea level rise of up to 3.4-feet over the 100-year period of analysis (2012–2111). The structure inventory, structure values, and content values for future scenario three are described in detail in above section 5.3.3.3. This scenario will be used to evaluate potential measures in Chapter IV of this appendix.

5.3.4 Future Without-Project Surge Risk

5.3.4.1 Maximum Probable Intensity (MPI) Event

Computer simulations have predicted[2] how far inland storm surge will extend if the worse-case hurricane or maximum possible intensity (MPI) event hits the Mississippi coast. The extent of the surge from the MPI event is shown in Figure 5.3-2. The maximum water level of the MPI event along the Mississippi coastline was determined to be approximately 30 feet along the entire western half of the state and east of Pascagoula. The landward extent of the inundation indicates the storm surge reaches Interstate 10 for much of the western portion of the state. Lower peaks near Biloxi and Mobile Bay (24-27 feet) may be attributed to the protection afforded by the barrier islands. The line of defense accordingly approximates the 24 to 30 feet. (NAVD '88 datum) contours.

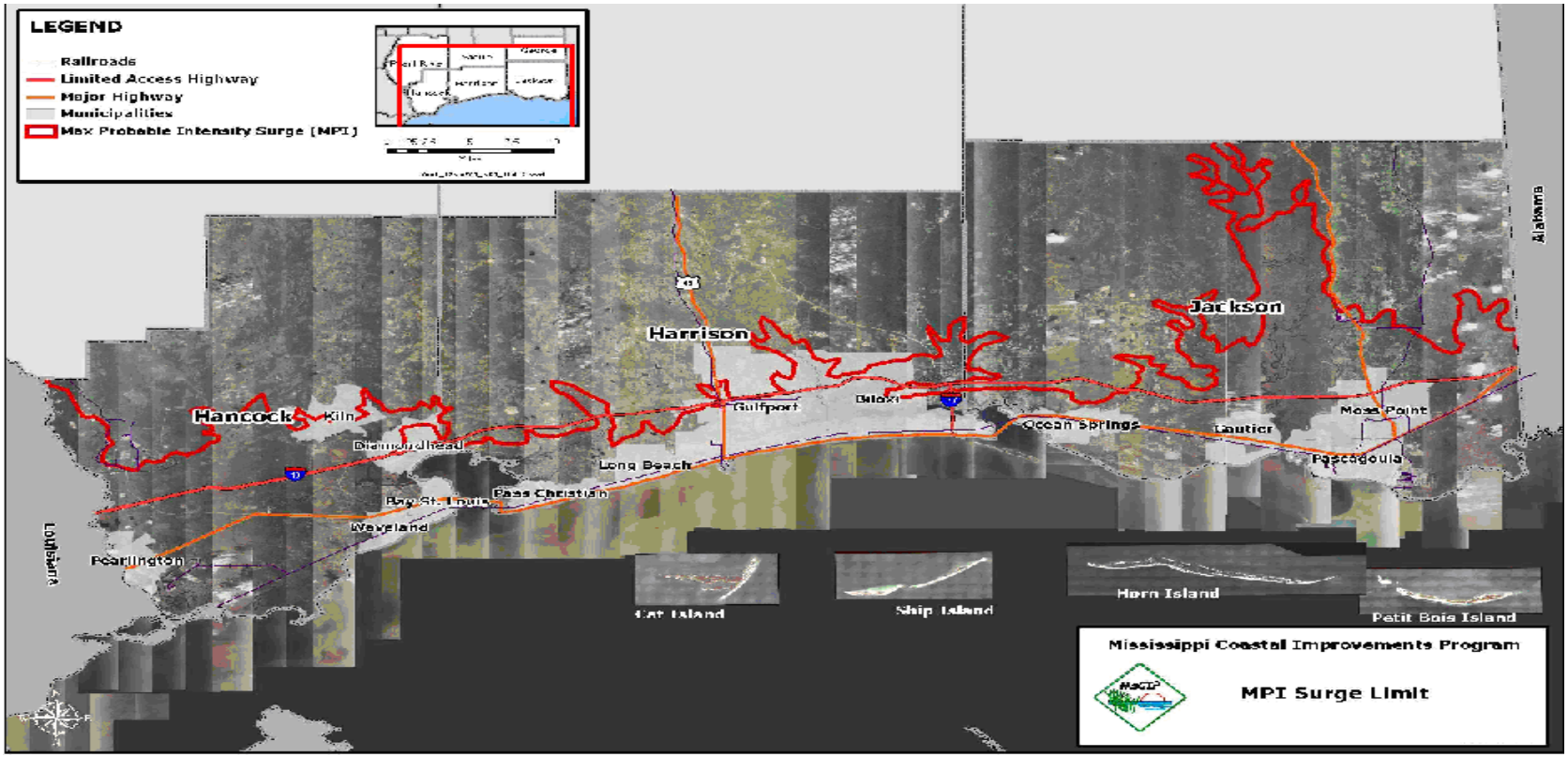


Figure 5.3-2. Maximum Probable Intensity Footprint for the Without Project Condition

[2] Storm surge modeling is described in the MsCIP Comprehensive Plan Engineering Appendix.

Figure 5.3-3 shows the population density of the three planning units within the MPI event footprint.

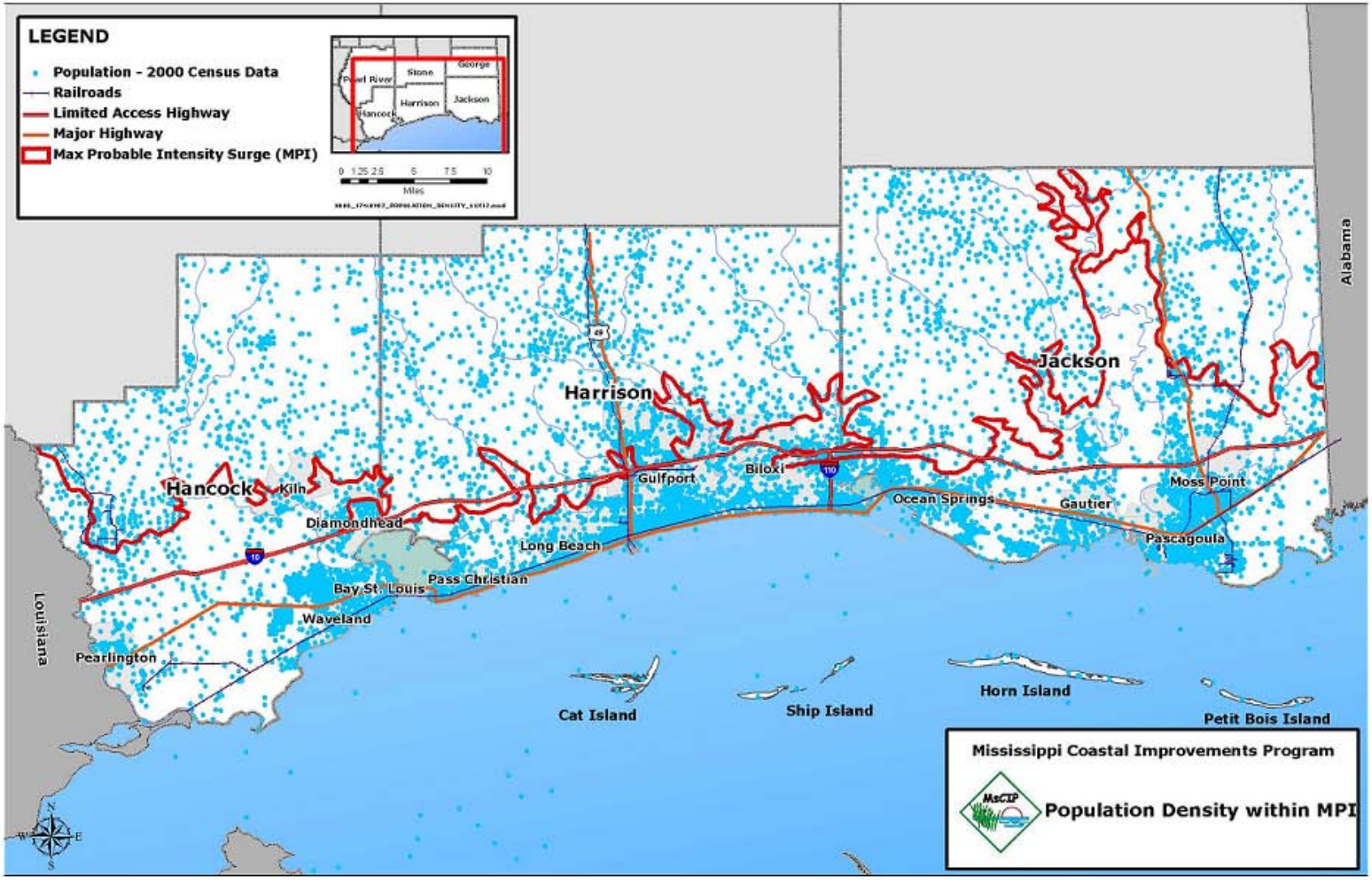


Figure 5.3-3. Population within the Future Without-Project Maximum Probable Intensity Surge Footprint

Figure 5.3-4 shows the various risk zones within the extent of the MPI event.

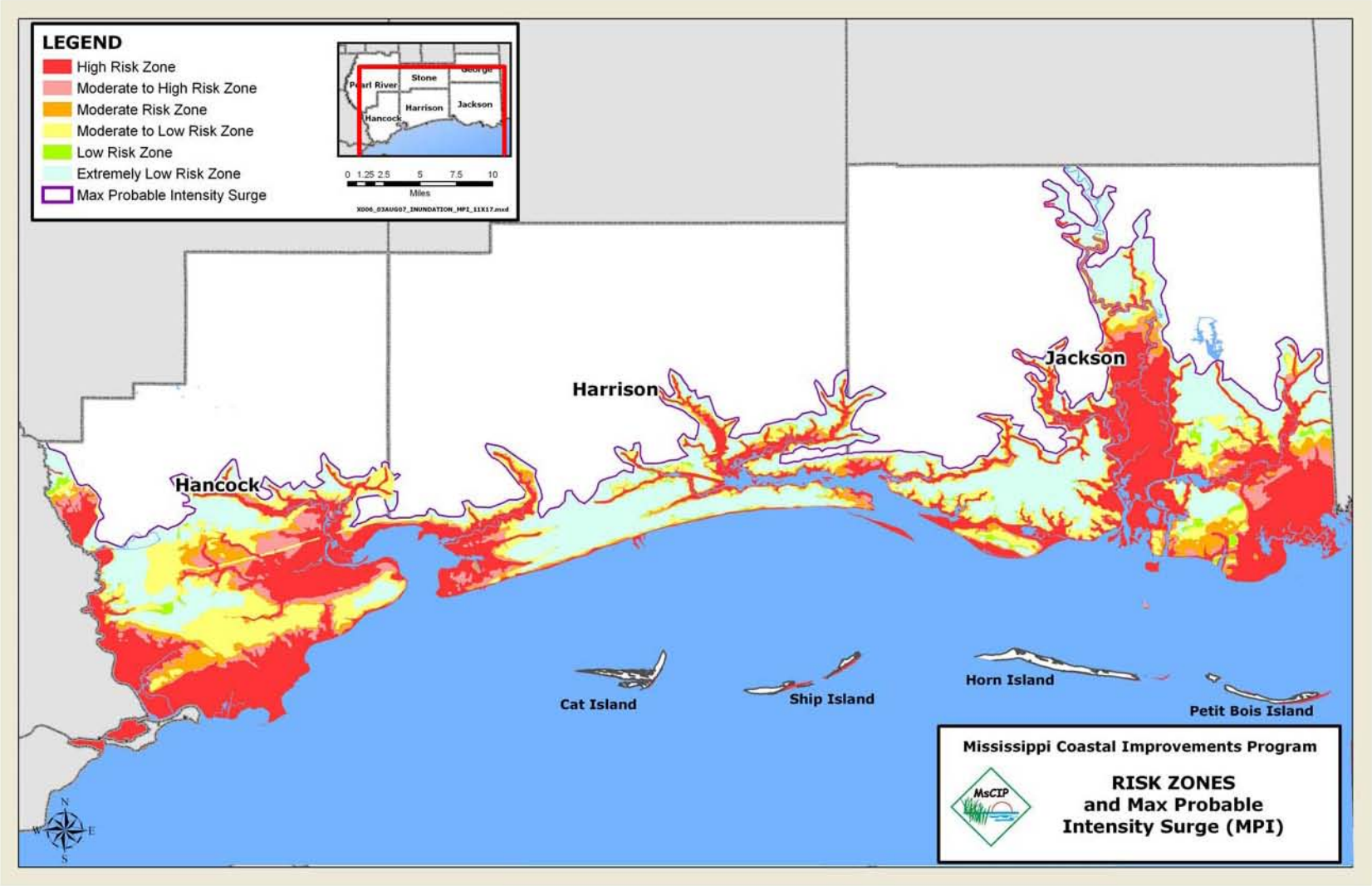


Figure 5.3-4. Risk Zones within the Maximum Probable Intensity Area

5.3.5 Summary of Future Without-Project Damages

This section describes the equivalent annual without-project damages for the entire study area to the 40-foot NAVD88 contour. Future without-project damages for the entire study area were calculated using the HEC-FDA program. Equivalent annual without-project damages were calculated for each of the 54 planning sub-units and each of the six future scenarios. The equivalent annual damages for specific areas, or planning sub-units, will be described in detail in the various sections of Chapter IV of this appendix. Note: The equivalent annual without-project damages calculated at the beach and dune sites will be evaluated on a localized scale using the Beach-FX program. Section 6.2 will describe in detail the equivalent annual without-project damages at the beach and dune sites. The remainder of this section will depict the outputs of the HEC-FDA modeling only.

The results of the without project conditions for all fifty-four planning sub-units in depicted in Table 5-21. The table shows the total equivalent annual without-project damages by planning unit for each of the future scenarios. These values represent the annual damages if no action is taken and if the study area is redeveloped to the levels described in Table 5-14. Figure 5.3-5 shows the without-project damages by future scenario. Table 5-22 shows the expected annual without-project damages by reach and by future scenario.

Table 5-21.
Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario

Without-Project Damages	Future 1[2] Damages	Future 2[2] Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Planning Unit One	$198,960,000	$202,060,000	$218,050,000	$222,220,000	$237,310,000	$241,520,000
Planning Unit Two	$91,260,000	$94,680,000	$103,280,000	$107,120,000	$115,470,000	$119,760,000
Planning Unit Three	$88,670,000	$88,670,000	$104,700,000	$104,700,000	$122,420,000	$122,420,000
Total	**$378,890,000**	**$385,410,000**	**$426,030,000**	**$434,040,000**	**$475,200,000**	**$483,700,000**

Damages are rounded to the nearest ten thousand.
1 Futures Two, Four, and Six do not apply to planning unit three, therefore total damages are the same as future scenarios one, three, and five.
2 Future Scenarios one and two will be used to evaluate the impacts of relative sea level rise only, and will not be discussed in the direct evaluation of potential measures detailed in Chapter IV of this appendix.

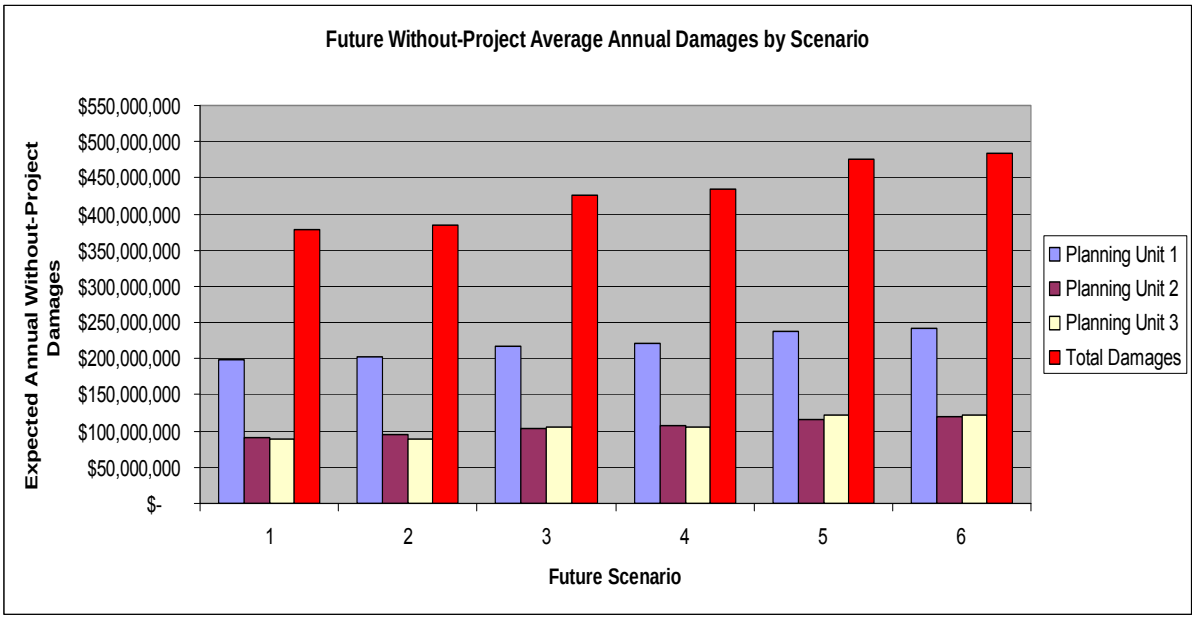


Figure 5.3-5. Without-Project Equivalent Damages by Future Scenario

Table 5-22.
Equivalent Annual Without-Project Damages by Planning Sub-Unit and Future Scenario[1]

Planning Unit and Sub-Unit	Future 1[2] Damages	Future 2[2] Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Unit One-Sub-Unit 1	$7,862,850	$7,863,020	$8,526,510	$8,571,980	$9,274,710	$9,275,260
Unit One-Sub-Unit 2	$137,947,140	$139,624,330	$150,862,640	$153,217,360	$163,864,720	$166,246,250
Unit One-Sub-Unit 3	$4,870,480	$5,842,300	$5,364,560	$6,513,000	$6,057,830	$7,287,670
Unit One-Sub-Unit 4	$2,739,650	$3,194,780	$3,014,870	$3,539,920	$3,308,930	$3,890,880
Unit One-Sub-Unit 5	$14,675,170	$14,677,680	$15,937,700	$16,015,090	$17,296,090	$17,300,110
Unit One-Sub-Unit 6	$11,568,960	$11,569,130	$12,885,400	$12,889,540	$14,205,370	$14,206,350
Unit One-Sub-Unit 7	$5,500,120	$5,500,120	$6,409,900	$6,460,160	$6,963,040	$6,963,380
Unit Two Sub-Unit-8	$14,860,070	$15,736,500	$16,671,180	$17,664,090	$18,732,000	$19,881,850
Unit Two Sub-Unit-9	$197,220	$197,220	$222,210	$222,220	$248,550	$248,550
Unit Two Sub-Unit-10	$5,884,170	$6,415,660	$6,616,080	$7,167,230	$7,464,200	$8,032,430
Unit Two Sub-Unit-11	$634,970	$634,990	$713,540	$713,560	$806,760	$806,790
Unit Two Sub-Unit-12	$14,831,530	$14,832,960	$16,886,630	$16,888,210	$19,298,510	$19,300,230

Table 5-22.
Equivalent Annual Without-Project Damages by Planning Sub-Unit and Future Scenario[1]
(continued)

Planning Unit and Sub-Unit	Future 12 Damages	Future 22 Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Unit Two Sub-Unit-13	$6,342,540	$6,436,620	$6,995,520	$7,104,440	$7,697,760	$7,821,230
Unit Two Sub-Unit-14	$149,990	$150,010	$174,120	$174,150	$206,540	$206,570
Unit Two Sub-Unit-15	$1,238,660	$1,234,760	$1,395,320	$1,391,460	$1,534,500	$1,532,550
Unit Two Sub-Unit-16	$1,241,620	$1,264,200	$1,417,560	$1,443,940	$1,580,110	$1,611,010
Unit Two Sub-Unit-17	$70	$70	$80	$80	$110	$110
Unit Two Sub-Unit-18	$17,649,830	$18,112,300	$20,105,420	$20,632,810	$22,318,530	$22,907,340
Unit Two Sub-Unit-19	$12,176,200	$12,176,200	$13,540,060	$13,540,060	$14,498,660	$14,498,660
Unit Two Sub-Unit-20	$9,104,980	$10,541,140	$10,619,760	$12,251,380	$12,244,150	$14,073,590
Unit Three Sub-Unit-21	$17,569,340	$17,569,340	$20,025,530	$20,025,530	$22,577,840	$22,577,840
Unit Three Sub-Unit-22	$1,719,390	$1,719,390	$1,958,170	$1,958,170	$2,190,200	$2,190,200
Unit Three Sub-Unit-23	$273,410	$ 273,410	$320,000	$320,000	$374,150	$374,150
Unit Three Sub-Unit-24	$3,819,150	$3,819,150	$4,298,090	$4,298,090	$4,705,940	$4,705,940
Unit Three Sub-Unit-25	$3,280	$3,280	$4,360	$4,360	$7,330	$7,330
Unit Three Sub-Unit-26	$5,416,740	$5,416,740	$6,273,270	$6,273,270	$7,010,490	$7,010,490
Unit Three Sub-Unit-27	$2,146,230	$2,146,230	$2,505,530	$2,505,530	$2,949,790	$2,949,790
Unit Three Sub-Unit-28	$5,233,540	$5,233,540	$5,756,790	$5,756,790	$6,165,720	$6,165,720
Unit Three Sub-Unit-29	$1,137,600	$1,137,600	$1,343,400	$1,343,400	$1,535,650	$1,535,650
Unit Three Sub-Unit-30	$4,920,250	$4,920,250	$5,831,120	$5,831,120	$6,701,750	$6,701,750
Unit Three Sub-Unit-31	$5,307,020	$5,307,020	$6,204,150	$6,204,150	$6,954,320	$6,954,320
Unit Three Sub-Unit-32	$2,548,650	$2,548,650	$3,100,610	$3,100,610	$3,660,240	$3,660,240
Unit Three Sub-Unit-33	$310	$310	$420	$420	$710	$710
Unit Three Sub-Unit-34	$11,550	$11,550	$13,440	$13,440	$17,680	$17,680

Table 5-22.
Equivalent Annual Without-Project Damages by Planning Sub-Unit and Future Scenario[1]
(continued)

Planning Unit and Sub-Unit	Future 12 Damages	Future 22 Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Unit Three Sub-Unit-35	$5,400,880	$5,400,880	$6,904,910	$6,904,910	$8,903,510	$8,903,510
Unit One-Sub-Unit 36	$8,908,670	$8,908,670	$9,763,750	$9,663,330	$10,537,160	$10,537,220
Unit One-Sub-Unit 37	$616,980	$616,980	$671,210	$675,150	$731,660	$731,680
Unit One-Sub-Unit 38	$4,267,130	$4,267,280	$4,617,740	$4,677,850	$5,069,830	$5,081,490
Unit Two Sub-Unit-39	$74,950	$74,950	$84,800	$84,800	$96,320	$96,330
Unit Two Sub-Unit-40	$3,780	$3,780	$4,650	$4,650	$5,940	$5,940
Unit Three Sub-Unit-41	$50	$50	$50	$50	$100	$100
Unit Three Sub-Unit-42	$1,040	$1,040	$1,350	$1,350	$2,220	$2,220
Unit Three Sub-Unit-43	$27,680	$27,680	$34,210	$34,210	$44,840	$44,840
Unit Three Sub-Unit-44	$91,160	$91,160	$108,070	$108,070	$132,280	$132,280
Unit Three Sub-Unit-45	$780	$780	$900	$900	$1,300	$1,300
Unit Three Sub-Unit-46	$39,750	$39,750	$44,590	$44,590	$52,110	$52,110
Unit Two Sub-Unit-47	$4,420	$4,420	$5,450	$5,450	$6,530	$6,530
Unit Two Sub-Unit-48	$56,210	$56,310	$65,730	$65,840	$74,870	$74,990
Unit Three Sub-Unit-49	$11,730	$11,730	$13,310	$13,310	$16,180	$16,180
Unit Two Sub-Unit-50	$6,804,480	$6,805,210	$7,764,770	$7,765,580	$8,656,060	$8,656,940
Unit Three Sub-Unit-51	$3,983,600	$3,983,600	$4,878,490	$4,878,490	$5,785,400	$5,785,400
Unit Three Sub-Unit-52	$17,464,120	$17,464,120	$21,199,790	$21,199,790	$27,027,040	$7,027,040
Unit Three Sub-Unit-53	$6,010,820	$6,010,820	$7,133,170	$7,133,170	$7,812,130	$7,812,130
Unit Three Sub-Unit-54	$5,532,370	$5,532,370	$6,744,800	$6,744,800	$7,790,870	$7,790,870
Total	**$378,883,280**	**$385,412,030**	**$426,035,680**	**$434,041,850**	**$475,199,230**	**$483,701,720**

1 Given the magnitude of the future-without project damages depicted in this table, a sensitivity analysis was conducted with regard to multiple criteria including period of analysis and first floor elevation uncertainty. The results of the sensitivity analysis can be found in Chapter VII of this appendix.
2 Future Scenarios one and two will be used to evaluate the impacts of relative sea level rise only, and will not be discussed in the

Table 5-22.
Equivalent Annual Without-Project Damages by Planning Sub-Unit and Future Scenario[1]
(continued)

Planning Unit and Sub-Unit	Future 12 Damages	Future 22 Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages

direct evaluation of potential measures detailed in Chapter IV of this appendix.

5.3.5.1 Future Without-Project Stage-Damage for Selected Reaches

As shown in the previous table, the magnitude of the equivalent annual damages is very large for the six future without-project scenario conditions. Planning sub-units two, five, six, eight, twelve, eighteen, nineteen, twenty-one, and fifty-two each have equivalent annual damages in the tens of millions of dollars. In order to communicate the effects that are being modeled, comparisons of the total present worth of damages by frequency event to the total economic value in the planning sub-units shows the nature of the damages that are being expressed by the HEC-FDA modeling.

This section is intended to dissect those nine planning sub-units for future without-project scenario one. This future scenario was chosen because it is the baseline case upon which the other Future Scenarios were built. It does not include the effects of a different type of redevelopment than what actually existed pre-Hurricane Katrina and it does not include the effects of relative sea level rise. Table 5-23 shows the total economic value input into HEC-FDA for each of these nine reaches.

Table 5-23.
Total Structure and Content Value for Selected Planning Sub-Units

Planning Sub-Unit	Structure Value Thousand $'s	Content Value Thousand $'s	Total Economic Value Thousand $'s
2	$1,359,527.34	$1,969,251.33	$3,328,778.67
5	$313,687.82	$256,492.02	$570,179.84
6	$168,756.85	$154,811.46	$323,568.31
8	$2,995,946.35	$987,316.91	$3,983,263.25
12	$1,174,270.25	$1,594,487.74	$2,768,757.99
18	$706,994.07	$365,494.03	$1,072,488.09
19	$95,273.76	$23,225.26	$118,499.03
21	$1,268,159.01	$761,125.18	$2,029,284.19
52	$909,227.20	$1,641,424.90	$2,550,652.10

Tables 5-24 through 5-32 display the total present worth of the stage damages for the 0.9990 to 0.0010 exceedance probability events. These damages are what the HEC-FDA model uses to calculate equivalent annual damages. Those stage damages are then compared to the total economic value for the reach to show what percentage of damage is expected. In each of the reaches, the 0.0100 to the 0.0010 probability events dominate the damage curve.

Probability and stage expressed in these tables was defined by the MOBILE DISTRICT Engineering Division working in concert with the Engineer Research and Development Center (ERDC). Stage mentioned in the tables is the mean stage for the event; however the HEC-FDA model incorporates uncertainty to two standard deviations, or approximately the 95% confidence level. For more detail about the exceedance probability functions, see the engineering appendix.

Table 5-24.
Stage Damage by Event for Future Scenario One, Planning Unit One, Planning Sub-Unit Two

Total Present Worth Stage Damages							
Exceedance Probability	**Mean Stage[1] (Feet)**	**Residential (Thnds $'s)**	**Commercial (Thnds $'s)**	**Mobile Home (Thnds $'s)**	**Municipal (Thnds $'s)**	**Total (Thnds $'s)**	**Percent Stage Damage to Total Structure and Content Value**
0.9990	2.71	$43,752.65	$6,816.17	$165.43	$913.49	$51,650.45	1.55%
0.2000	6.12	$117,474.39	$30,251.34	$794.75	3,$120.67	$151,647.27	4.56%
0.1000	7.28	$144,237.52	$42,772.81	$1,066.45	$4,059.85	$192,143.91	5.77%
0.0400	10.60	$247,259.36	$113,942.01	$2,158.47	$8,698.01	$372,068.45	11.18%
0.0200	14.50	$382,169.71	$247,948.38	$3,271.80	$16,782.18	$650,186.57	19.53%
0.0100	17.50	$516,672.42	$386,292.25	$4,052.87	$25,211.05	$932,246.09	28.01%
0.0040	20.39	$658,732.22	$531,087.42	$4,762.79	$34,179.58	$1,228,782.40	36.91%
0.0020	22.40	$781,660.37	$655,195.97	$5,278.95	$41,791.58	$1,483,949.27	44.58%
0.0010	24.00	$897,503.25	$766,823.05	$5,680.46	$48,926.85	$1,718,957.61	51.64%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

Table 5-25.
Stage Damage by Event for Future Scenario One, Planning Unit One, Planning Sub-Unit Five

Total Present Worth Stage Damages							
Exceedance Probability	**Mean Stage[1] (Feet)**	**Residential (Thnds $'s)**	**Commercial (Thnds $'s)**	**Mobile Home (Thnds $'s)**	**Municipal (Thnds $'s)**	**Total (Thnds $'s)**	**Percent Stage Damage to Total Structure and Content Value**
0.9990	2.71	$2,831.63	$159.23	$0.37	$3,252.07	$6,246.01	1.10%
0.2000	6.12	$8,546.12	$560.27	$2.54	$6,998.57	$16,113.62	2.83%
0.1000	7.09	$11,167.39	$626.61	$4.12	$8,004.18	$19,809.39	3.47%
0.0400	9.60	$20,645.22	$990.55	$11.89	$10,300.30	$31,957.56	5.60%
0.0200	13.50	$49,121.31	$1,806.15	$103.87	$13,938.97	$64,983.80	11.40%
0.0100	16.00	$77,080.05	$2,724.47	$307.90	$17,026.23	$97,154.65	17.04%
0.0040	18.42	$104,263.11	$3,947.35	$647.18	$20,769.96	$129,646.02	22.74%
0.0020	20.10	$134,148.90	$5,993.35	$1,251.67	$26,311.70	$167,725.72	29.42%
0.0010	21.40	$157,207.12	$7,381.61	$1,651.89	$29,674.20	$195,936.22	34.36%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

Table 5-26.
Stage Damage by Event for Future Scenario One, Planning Unit One, Planning Sub-Unit Six

Total Present Worth Stage Damages							
Exceedance Probability	**Mean Stage[1] (Feet)**	**Residential (Thnds $'s)**	**Commercial (Thnds $'s)**	**Mobile Home (Thnds $'s)**	**Municipal (Thnds $'s)**	**Total (Thnds $'s)**	**Percent Stage Damage to Total Structure and Content Value**
0.9990	2.71	$4,155.33	$0	$0	$0	$4,158.04	1.29%
0.2000	6.12	$13,762.69	$0	$0	$0	$13,768.81	4.26%
0.1000	7.09	$18,088.33	$0	$0	$0	$18,095.42	5.59%
0.0400	9.60	$31,662.57	$7.83	$0.94	$8.61	$31,689.55	9.79%
0.0200	13.50	$56,978.26	$139.11	$14.36	$146.16	$57,291.39	17.71%
0.0100	16.00	$73,714.92	$453.88	$44.47	$449.30	$74,678.57	23.08%
0.0040	18.42	$88,892.40	$1,035.06	$98.80	$1,007.65	$91,052.33	28.14%
0.0020	20.10	$106,163.34	$2,065.55	$190.31	$1,964.42	$110,403.72	34.12%
0.0010	21.40	$115,324.45	$3,683.34	$239.23	$2,475.17	$121,743.59	37.63%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

Table 5-27.
Stage Damage by Event for Future Scenario One, Planning Unit Two, Planning Sub-Unit Eight

Total Present Worth Stage Damages							
Exceedance Probability	**Mean Stage[1] (Feet)**	**Residential (Thnds $'s)**	**Commercial (Thnds $'s)**	**Mobile Home (Thnds $'s)**	**Municipal (Thnds $'s)**	**Total (Thnds $'s)**	**Percent Stage Damage to Total Structure and Content Value**
0.9990	2.71	$2,141.84	$54.64	$44.53	$202.54	$2,446.26	0.06%
0.2000	6.12	$9,323.46	$214.76	$129.53	$707.99	$10,381.86	0.26%
0.1000	7.22	$13,281.91	$289.37	$170.76	$923.10	$14,672.36	0.37%
0.0400	10.30	$33,548.77	$581.58	$319.65	$1,790.40	$36,250.70	0.91%
0.0200	14.10	$88,836.15	$5,206.34	$585.72	$3,347.80	$97,990.11	2.46%
0.0100	17.10	$155,514.48	$26,941.23	$973.69	$4,353.88	$187,800.38	4.71%
0.0040	20.11	$247,538.39	$103,117.93	$1,785.00	$5,143.68	$357,605.11	8.98%
0.0020	22.20	$325,623.37	$216,476.56	$2,744.81	$5,560.92	$550,427.86	13.82%
0.0010	23.80	$392,965.09	$337,060.26	$3,681.36	$5,811.47	$739,541.98	18.57%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

Table 5-28.
Stage Damage by Event for Future Scenario One, Planning Unit Two, Planning Sub-Unit Twelve

Total Present Worth Stage Damages							
Exceedance Probability	**Mean Stage[1] (Feet)**	**Residential (Thnds $'s)**	**Commercial (Thnds $'s)**	**Mobile Home (Thnds $'s)**	**Municipal (Thnds $'s)**	**Total (Thnds $'s)**	**Percent Stage Damage to Total Structure and Content Value**
0.9990	2.71	$1,988.77	$47.46	$3.30	$2,084.47	$4,126.71	0.15%
0.2000	6.12	$8,560.61	$987.48	$27.34	$4,825.86	$14,407.41	0.52%
0.1000	7.06	$12,432.19	$1,831.97	$45.28	$5,619.54	$19,936.04	0.72%
0.0400	8.80	$20,819.74	$4,389.53	$92.88	$6,777.05	$32,088.00	1.16%
0.0200	11.60	$52,597.25	$17,540.91	$306.00	$9,567.96	$80,023.72	2.89%
0.0100	13.70	$88,637.76	$38,709.85	$602.27	$12,242.46	$140,206.04	5.06%
0.0040	15.77	$137,378.09	$74,366.99	$1,064.98	$15,937.42	$228,763.25	8.26%
0.0020	17.20	$180,500.95	$110,520.89	$1,533.91	$19,497.52	$312,070.47	11.27%
0.0010	18.30	$211,794.19	$139,076.04	$1,901.68	$22,109.50	$374,899.71	13.54%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

Table 5-29.
Stage Damage by Event for Future Scenario One, Planning Unit Two, Planning Sub-Unit Eighteen

Total Present Worth Stage Damages							
Exceedance Probability	**Mean Stage[1] (Feet)**	**Residential (Thnds $'s)**	**Commercial (Thnds $'s)**	**Mobile Home (Thnds $'s)**	**Municipal (Thnds $'s)**	**Total (Thnds $'s)**	**Percent Stage Damage to Total Structure and Content Value**
0.9990	1.89	$1,196.85	$814.40	$0.45	$0	$2,013.59	0.19%
0.2000	4.52	$4,134.09	$4,428.21	$2.21	$0.03	$8,566.85	0.80%
0.1000	5.67	$5,769.70	$7,318.97	$3.31	$0.05	$13,097.70	1.22%
0.0400	9.10	$14,765.74	$29,763.69	$12.16	$12.75	$44,563.44	4.16%
0.0200	12.80	$30,337.62	$78,692.33	$25.27	$99.03	$109,167.05	10.18%
0.0100	15.70	$52,765.43	$137,070.85	$36.73	$338.35	$190,227.06	17.74%
0.0040	18.53	$85,274.97	$223,677.63	$49.13	$858.62	$224,603.91	20.94%
0.0020	20.50	$110,187.46	$294,474.00	$56.52	$1,289.90	$406,028.38	37.86%
0.0010	22.30	$128,969.02	$346,487.93	$60.90	$1,649.46	$477,189.61	44.49%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

Table 5-30.
Stage Damage by Event for Future Scenario One, Planning Unit Two, Planning Sub-Unit Nineteen

Total Present Worth Stage Damages							
Exceedance Probability	**Mean Stage[1] (Feet)**	**Residential (Thnds $'s)**	**Commercial (Thnds $'s)**	**Mobile Home (Thnds $'s)**	**Municipal (Thnds $'s)**	**Total (Thnds $'s)**	**Percent Stage Damage to Total Structure and Content Value**
0.9990	1.89	$417.12	$3,064.00	$0	$0	$3,483.01	2.94%
0.2000	4.52	$1,400.28	$9,518.44	$0	$0	$10,923.24	9.22%
0.1000	5.67	$1,913.34	$12,702.56	$0	$0	$14,621.57	12.34%
0.0400	9.00	$4,202.27	$24,542.56	$0	$0	$28,753.83	24.27%
0.0200	12.50	$6,385.52	$32,868.82	$0	$0	$39,266.84	33.14%
0.0100	15.50	$7,651.28	$38,032.17	$0	$0	$45,698.95	38.56%
0.0040	18.33	$8,282.91	$42,794.02	$0	$0	$51,095.26	43.12%
0.0020	20.30	$8,574.57	$48,380.46	$0	$0	$56,975.33	48.08%
0.0010	22.10	$8,733.57	$55,938.36	$0	$0	$64,694.03	54.59%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

Table 5-31.
Stage Damage by Event for Planning Unit Three, Planning Sub-Unit Twenty-One

Total Present Worth Stage Damages							
Exceedance Probability	**Mean Stage[1] (Feet)**	**Residential (Thnds $'s)**	**Commercial (Thnds $'s)**	**Mobile Home (Thnds $'s)**	**Municipal (Thnds $'s)**	**Total (Thnds $'s)**	**Percent Stage Damage to Total Structure and Content Value**
0.9990	1.89	$1,489.63	$1,351.47	$0.02	$69.50	$2,912.51	0.14%
0.2000	4.52	$5,105.26	$5,413.10	$0.20	$297.05	$10,820.13	0.53%
0.1000	5.67	$7,357.69	$8,197.76	$0.35	$440.67	$16,002.14	0.79%
0.0400	9.20	$22,551.01	$27,942.77	$2.85	$1,363.10	$51,868.93	2.56%
0.0200	12.90	$53,793.29	$78,582.18	$19.28	$2,728.38	$135,136.03	6.66%
0.0100	16.00	$104,083.69	$153,498.33	$88.03	$4,735.96	$262,422.01	12.93%
0.0040	18.95	$155,294.94	$211,865.24	$217.60	$7,192.37	$374,589.10	18.46%
0.0020	21.00	$225,520.81	$282,660.42	$457.75	$11,494.07	$520,154.05	25.63%
0.0010	22.90	$278,089.23	$333,611.61	$642.16	$15,032.83	$627,398.73	30.92%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

Table 5-32.
Stage Damage by Event for Future Without-Project Scenario One, Planning Unit Three, Planning Sub-Unit Fifty-Two

Total Present Worth Stage Damages							
Exceedance Probability	**Mean Stage[1] (Feet)**	**Residential (Thnds $'s)**	**Commercial (Thnds $'s)**	**Mobile Home (Thnds $'s)**	**Municipal (Thnds $'s)**	**Total (Thnds $'s)**	**Percent Stage Damage to Total Structure and Content Value**
0.9990	2.06	$3,899.74	$14.64	$0.10	$4.29	$3,920.83	0.15%
0.2000	4.08	$9,646.99	$154.08	$1.32	$38.91	$9,845.38	0.39%
0.1000	6.04	$22,131.53	$973.43	$5.41	$189.83	$23,306.24	0.91%
0.0400	7.70	$38,867.81	$2,450.39	$12.89	$443.27	$41,782.06	1.64%
0.0200	11.20	$116,418.24	$15,160.58	$62.18	$2,329.48	$133,981.68	5.25%
0.0100	13.90	$211,730.44	$40,212.52	$148.06	$5,866.14	$257,971.06	10.11%
0.0040	16.44	$329,875.80	$85,879.90	$264.00	$11,561.68	$427,597.82	16.76%
0.0020	18.20	$425,218.57	$129,392.54	$350.77	$16,688.20	$571,668.28	22.41%
0.0010	19.80	$489,727.78	$159,839.78	$402.18	$20,420.62	$670,410.16	26.28%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

5.3.6 Impacts of Redevelopment Scenarios on Equivalent Annual Without-Project Damages

The two redevelopment scenarios, as previous discussed, are the redevelopment of the area back to the same way it was pre-Hurricane Katrina (residential redevelopment) and a redevelopment of the way the area was pre-Hurricane Katrina with commercial/condominium redevelopment (mixed redevelopment) along the water fronts of planning units one and two. The impacts of different redevelopment and the corresponding relationship to damages is a combination of different structure and content values that would could occupy the same space (five single family residences versus and condominium) and the depth-damage relationship of those different structures. The measurement of impacts from various redevelopment scenarios can be expressed by comparing the residential redevelopment to the mixed redevelopment for a given relative sea level rise scenario, or future scenario one versus future scenario two, future scenario three versus future scenario four, and future scenario five versus future scenario six. Tables 5-33 and figure 5.3-6 show the comparison of future scenario one to future scenario two, table 5-34 and figure 5.3-7 show the comparison of future scenario three to future scenario four, and table 5-35 and figure 5.3-8 compare future scenario five to future scenario six.

Table 5-33.
Comparison of Residential Redevelopment vs. Mixed Redevelopment for Expected Relative Sea Level Rise

Without-Project Damages	Future 1[1] Damages	Future 2[1] Damages	% Change from Future One
Planning Unit One	$198,960,000	$202,060,000	1.56%
Planning Unit Two	$91,260,000	$94,680,000	3.75%
Planning Unit Three	$88,670,000	$88,670,000	0.00%
Total	**$378,890,000**	**$385,410,000**	**1.72%**

Damages are rounded to the nearest ten thousand.
1 Future Scenarios one and two are used here to evaluate the impacts redevelopment only, and will not be discussed in the direct evaluation of potential measures detailed in Chapter IV of this appendix.

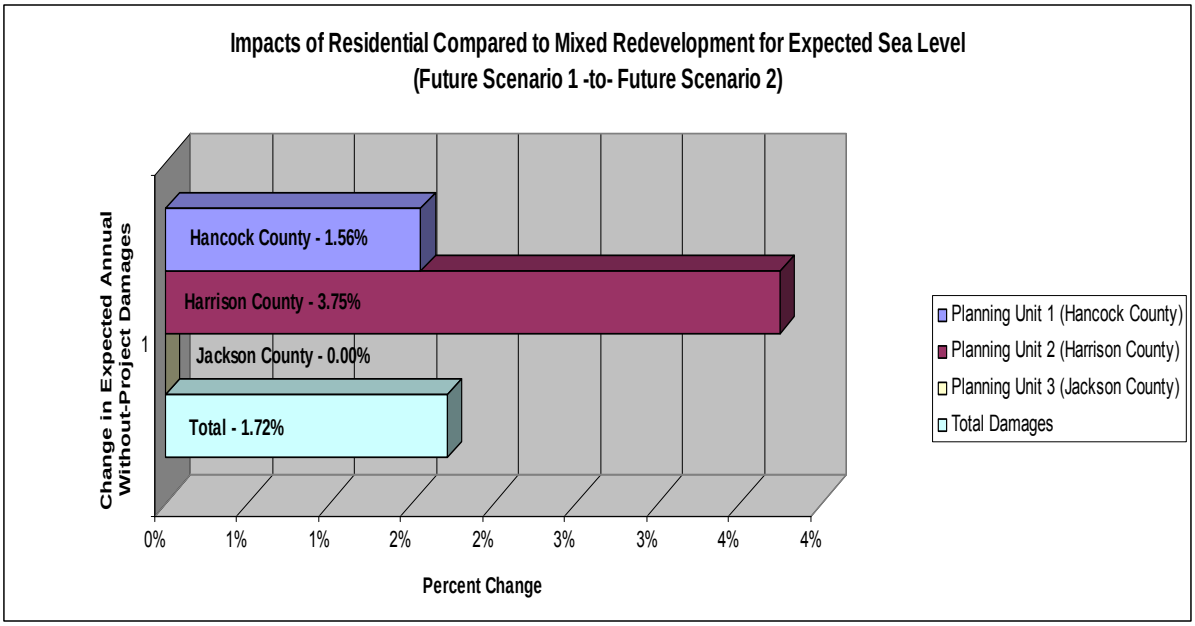


Figure 5.3-6. Impacts of Residential Compared to Mixed Redevelopment for Expected Relative Sea Level

Table 5-34.
Comparison of Residential Redevelopment vs. Mixed Redevelopment for Expected Relative Sea Level Rise

Without-Project Damages	Future 3 Damages	Future 4 Damages	% Change from Future One
Planning Unit One	$ 218,050,000	$ 222,220,000	1.91%
Planning Unit Two	$ 103,280,000	$ 107,120,000	3.72%
Planning Unit Three	$ 104,700,000	$ 104,700,000	0.00%
Total	**$ 426,030,000**	**$ 434,040,000**	**1.88%**

Damages are rounded to the nearest ten thousand.

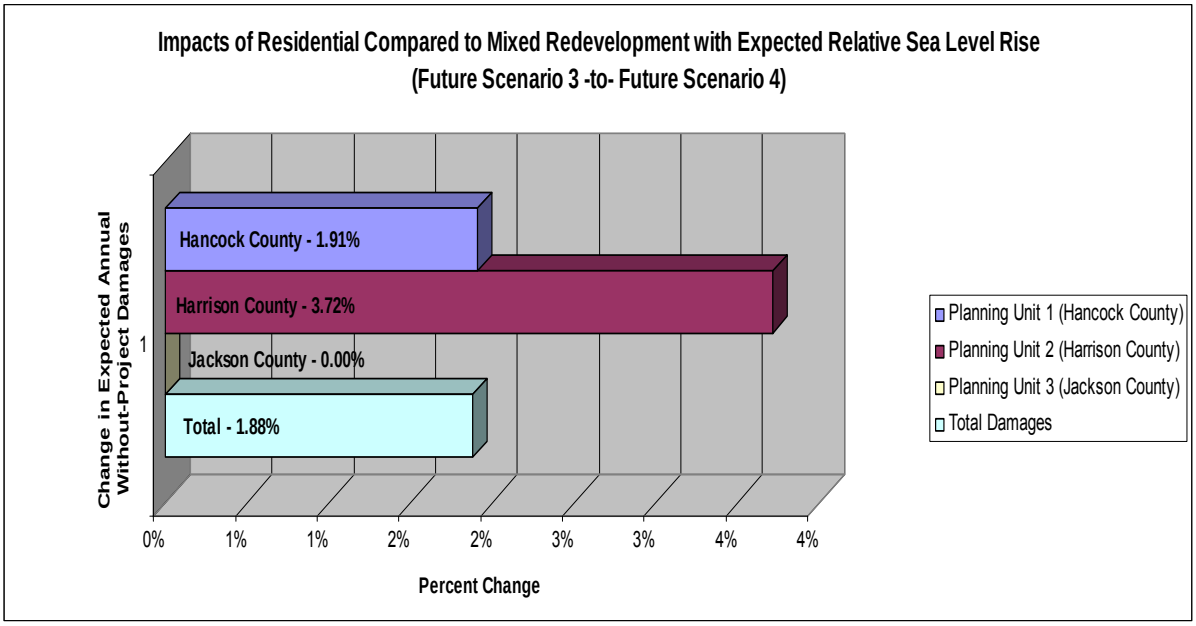


Figure 5.3-7. Impacts of Residential Compared to Mixed Redevelopment for Expected Relative Sea Level Rise

Table 5-35
Comparison of Residential Redevelopment vs. Mixed Redevelopment for Expected Relative Sea Level Rise

Without-Project Damages	Future 4 Damages	Future 6 Damages	% Change from Future One
Planning Unit One	$222,220,000	$241,520,000	1.77%
Planning Unit Two	$107,120,000	$119,760,000	3.72%
Planning Unit Three	$104,700,000	$122,420,000	0.00%
Total	**$434,040,000**	**$483,700,000**	**1.79%**

Damages are rounded to the nearest ten thousand.

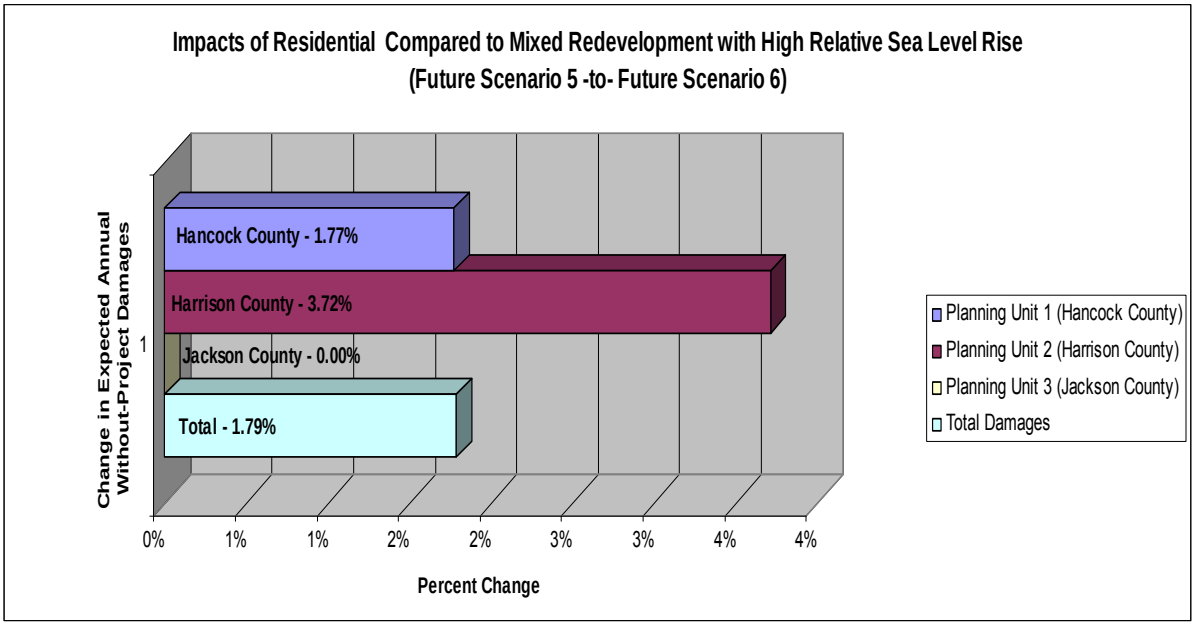


Figure 5.3-8. Impacts of Residential Compared to Commercial Redevelopment for High Relative Sea Level Rise

5.3.7 Impacts of Relative Sea Level Rise on Equivalent Annual Without-Project Damages

The impact of relative sea level rise over the period of analysis is the increase in damages when everything but relative sea level rise remains constant. This can be evaluated by comparing futures one, three and five against each other and futures two, four, and six against each other. The impact of relative sea level rise when compared to futures one, three, and five shows the effects that could be expected if the study area rebuilds exactly the way it was pre-Hurricane Katrina. The impact of relative sea level rise as compared to futures two, four, and six represent what could be expected given the rebuilding of the study area to a mixture of its pre-Hurricane Katrina setting with the shift from a residential coastline in planning units one and two to a commercial and condominium setting.

The increased equivalent annual damages are the direct effect of several phenomenon's' that result from the increased inundation. First, the higher water levels attributed to the expected relative sea level rise (Futures three and four - 2.0-feet) and high sea level rise (Futures five and six - 3.4-feet) would cause more damage to structures and their contents that would already be expected to be impacted under the existing relative sea level scenarios (Futures one and two). The second effect of increased relative sea level rise is that there would be damages to structures and their contents that would not be expected under the existing relative sea level rise scenarios, or completely new damage specifically attributable to the increased relative sea level rise. Table 5-36, figure 5.3-9, and figure 5.3-10 compares the effects of relative sea level rise on futures one, three, and five. Table 5-37, figure 5.3-11, and figure 5.3-12 compares its effects on futures two, four, and six.

Table 5-36.
Impacts of Relative Sea Level Rise on Futures One, Three, and Five

Without-Project Damages	Future 1[2] Damages	Future 3 Damages	% Change from Future One	Future 5 Damages	% Change from Future One
Planning Unit One	$198,960,000	$218,050,000	9.59%	$237,310,000	19.28%
Planning Unit Two	$91,260,000	$103,280,000	13.17%	$115,470,000	26.53%
Planning Unit Three	$88,670,000	$104,700,000	18.08%	$122,420,000	38.06%
Total	**$378,890,000**	**$426,030,000**	**12.44%**	**$475,200,000**	**25.42%**

Damages are rounded to the nearest ten thousand.
1 Future Scenario one is used here to evaluate the impacts of relative sea level rise only, and will not be discussed in the direct evaluation of potential measures detailed in Chapter IV of this appendix.

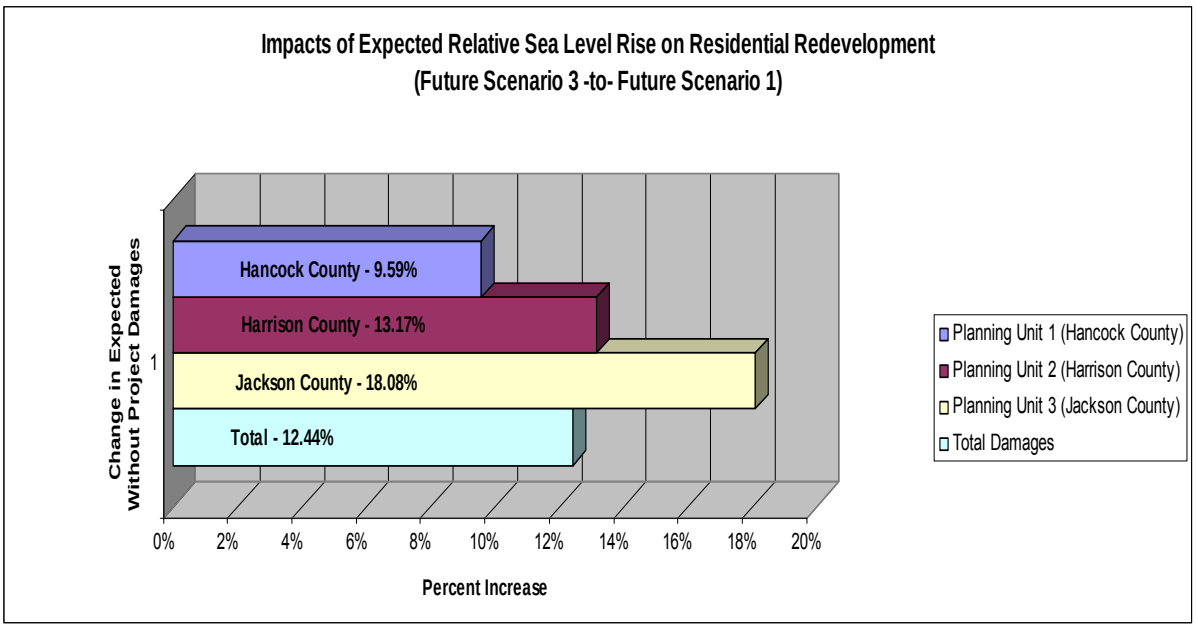


Figure 5.3-9. Impacts of 2.0-feet of relative sea level rise on a residential redevelopment

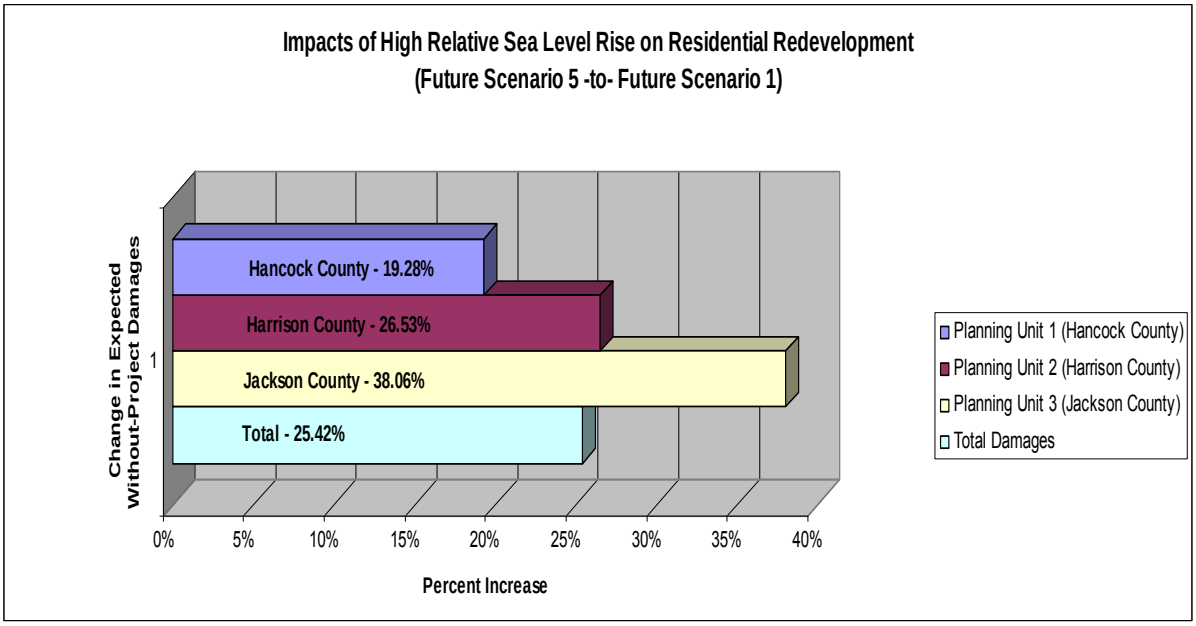


Figure 5.3-10. Impacts of 3.4-feet of relative sea level rise on a residential redevelopment

Table 5-37.
Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario

Without-Project Damages	Future 2[2] Damages	Future 4 Damages	% Change from Future Two	Future 6 Damages	% Change from Future Two
Planning Unit One	$202,060,000	$222,220,000	9.98%	$ 241,520,000	19.53%
Planning Unit Two	$94,680,000	$107,120,000	13.14%	$ 119,760,000	26.49%
Planning Unit Three	$88,670,000	$104,700,000	18.08%	$ 122,420,000	38.06%
Total	**$385,410,000**	**$434,040,000**	**12.62%**	**$ 483,700,000**	**25.50%**

Damages are rounded to the nearest ten thousand.
1 Futures Two, Four, and Six do not apply to planning unit three, therefore total damages are the same as future scenarios one, three, and five for planning unit three.
2 Future Scenario two is used here to evaluate the impacts of relative sea level rise only, and will not be discussed in the direct evaluation of potential measures detailed in Chapter IV of this appendix.

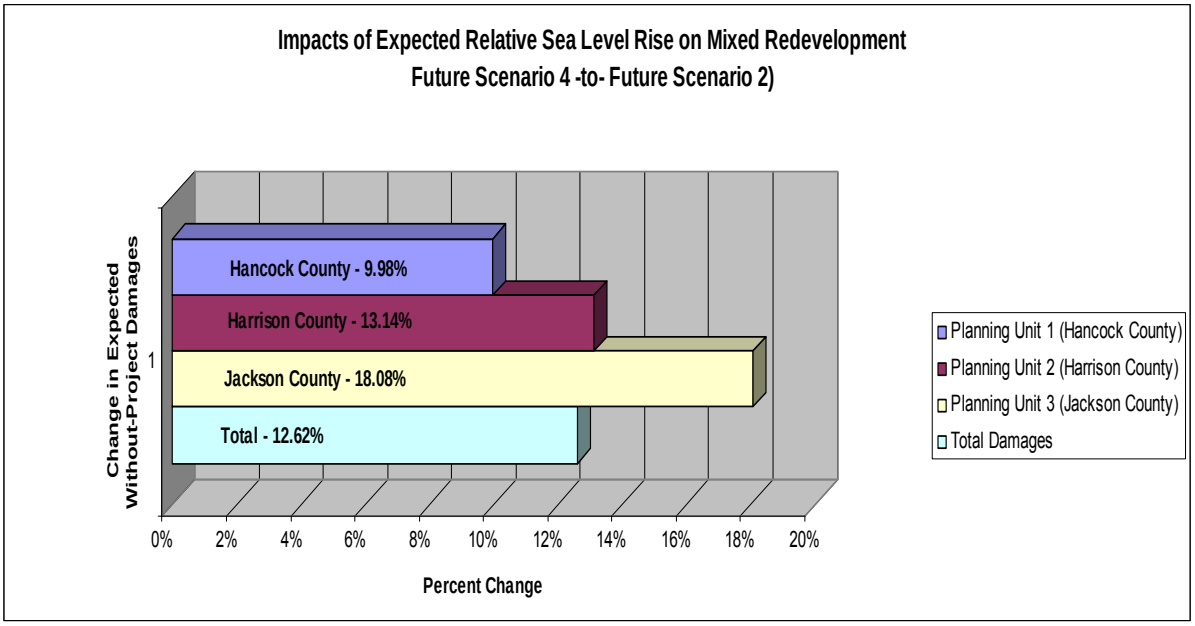


Figure 5.3-11. Impacts of 2.0-feet of relative sea level rise on a mixed redevelopment

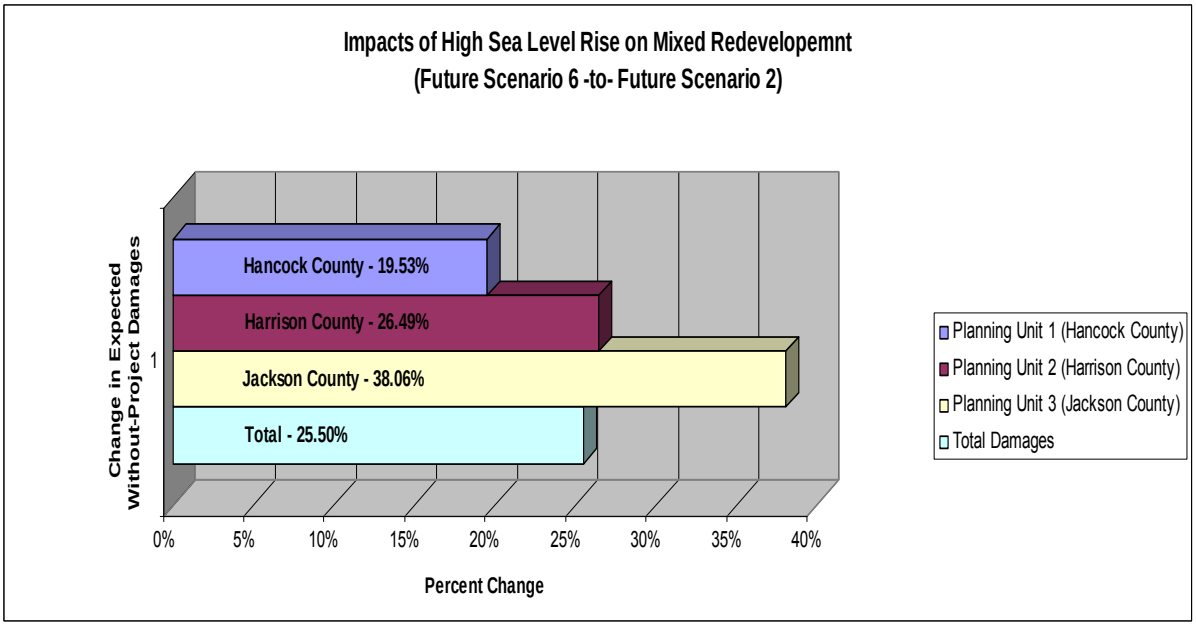


Figure 5.3-12. Impacts of 2.0-feet of relative sea level rise on a mixed redevelopment

CHAPTER VI. DEVELOPMENT AND EVALUATION OF MEASURES

This section describes steps three and four of the Corps six step planning process. These steps are the development of potential measures and the evaluation of those measures as compared to the without project conditions. Initial analysis yielded an extensive list of potential measures that were appropriate to a given site or problem area. The sites/problem areas are illustrated in the Main Report. The development of preliminary measures for structural and non-structural damage reduction is discussed in detail in the Engineering Appendix. The development of preliminary measures for ecosystem restoration and saltwater intrusion remediation is discussed in detail in the Environmental Appendix.

Many measures were initially evaluated and screened, based on technical or environmental criteria, and are not discussed here. Those measures that were found to be technically sound for a particular application, and environmentally sound, in regards to potential impacts to environmental resources, were forwarded for consideration, into the next phase of analysis. Measures forwarded into Round 2 of the evaluation and screening process were developed to a greater level of detail, to allow more detailed comparison, and potential modification for further study. The development of more detail included preliminary design and cost estimation, coastal, hydrologic and/or hydraulic analysis and design, environmental analysis, and determination of potential damages prevented, residual damages, and other factors. This latter process is discussed in more detail in the main report.

6.1 Overview of Benefits and Cost Evaluation

This section describes an overview of the methodology and steps taken in the calculation of benefits and costs. The principles for the overall process are the same no matter the area in question. Since the scope and scale of the comprehensive plan is so extensive, the methodologies utilized will be described here, and then summary tables and paragraphs will be used in the following sections that describe the evaluation of the various measures.

6.1.1 Calculation of National Economic Development Benefits

Except for the Beach and Dune placement measures described in detail in section 6.3, all of the surge inundation reduction benefits for the various measures were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) program. For the analyses in this comprehensive plan, National Economic Development (NED) benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "…***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits…"*** More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

Equivalent annual flood damages for the various measures and alternatives at each area were evaluated and compared to the applicable future without project scenarios previously described in Chapter V. As previously noted, the six future without project scenarios combine various types of relative sea level rise with two types of redevelopment (see section 5.3 for more detail). The HEC-FDA model calculates damages reduced for a base year and a most likely future year and interpolates damages between the two points to determine equivalent annual damages. The model was set up so the exceedance probability function for the base year does not incorporate relative sea level and the function for the most likely future year does include the relative sea level rise adjustment. This allows the model to determine the damages between the two points.

Equivalent annual damages are calculated as:

Equivalent annual damages (EAD) = Present Worth of Total Damages x Capital Recovery Factor

Capital Recovery Factor (CRF) = i / (1-(1+i) ^-n)

Where:

i = interest rate

n = period of analysis

Figure 6.1-1 shows the linear interpretation used by HEC-FDA to calculate equivalent annual damages. The same methodology was used when converting projects recommended for construction to a 50-year period of analysis.

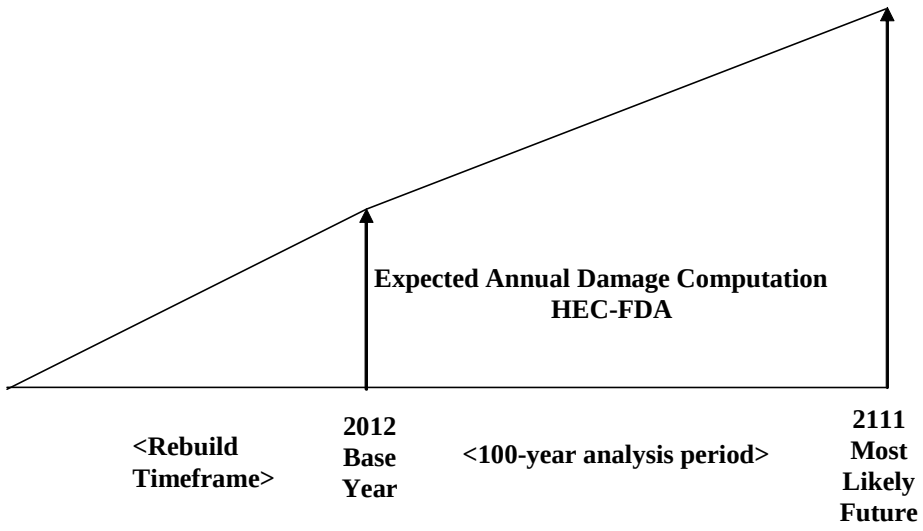


Figure 6.1-1. Linear Interpretation of Equivalent annual damages

6.1.2 Calculation of Costs

This section describes the use of cost estimates in the evaluation of the measures and alternatives. The methodology and application will be described here, and the sections describing the specific measures and alternatives at each site will show summaries of the costs. Detailed line item cost estimates can be found in the MsCIP Comprehensive Plan Cost Appendix.

6.1.2.1 Implementation Costs

Rough Order Magnitude (ROM) implementation costs were developed for each of the different measures and alternatives evaluated at each of the areas. The MOBILE DISTRICT Engineering Division developed the costs for structural measures and the Corps of Engineers Nonstructural Flood proofing Committee (NSFPC) developed the costs for the nonstructural measures. Savannah District Real Estate Division provided the real estate portions of each of the plans. All costs shown are in October 2007 price levels unless otherwise stated. Detailed cost estimates can be found in the cost estimating appendix to the MsCIP Comprehensive Plan Report.

6.1.2.2 Average Annual Implementation Costs

Average annual implementation costs were calculated for each of the measures and alternatives are calculated as:

Average Annual Implementation Cost = (Total Present Worth of Implementation Costs + IDC) x Capital Recovery Factor

Typically, costs are associated to the years they would be expended in should the project be constructed. Those expenditures are then brought back to the same fiscal year (FY) as the benefits in order for a direct and accurate comparison. This methodology was used for all measures and alternatives that will be recommended for construction. For those measures and alternatives that will be recommended for further study, the timing of expenditures have not yet been identified; therefore the total implementation cost act as the total present worth of the implementation costs and will be multiplied by the capital recovery factor to get the average annual implementation cost values.

Interest during construction is an added economic cost because it is the opportunity cost of having construction monies tied up until the measure becomes fully operational. Interest during construction was calculated based on the following formula:

$IDC^3 = \sum$ (Monthly Expenditure x Interest Rate Factor)

Monthly Expenditure = Implementation Cost / D

Interest Rate Factor = $(1+ I_M)$ ^ $(D – M)) - 1$

Where:

I_M = Interest Rate Factor = (Discount Rate / 12)

D = Total Construction Duration

M = Elapsed Time (Months) of Construction

Interest during construction was calculated for all measures and alternatives that will be recommended for construction. Due to the size and scope of the comprehensive effort, at this point in the analysis, the length of construction for many of the measures and alternatives has not been identified; interest during construction was not calculated for all of measures. Further study would be required in order to calculate interest during construction for those measures and alternatives not ready for construction recommendation. The main report details the measures and alternatives and their respective plan features.

[3] IDC was calculated based on Corps of Engineers National Economic Development Procedures Manual--Urban Flood Damage.

6.1.2.3 Operation and Maintenance Costs

Operation and Maintenance (O&M) costs were identified for each of the potential measures and alternatives. O&M costs for the structural solutions are described in the engineering appendix and the cost estimating appendix and are generally two-percent of the contract cost of the structure. O&M costs for the nonstructural measures and alternatives are described in the nonstructural appendix and are mostly based on the up keep of remaining lands associated with acquisition measures. All O&M costs shown for are annual costs and are typically borne by the local sponsor.

6.1.2.4 Total Average Annual Costs

Total average annual costs were calculated for each of the measures and alternative plans. Total average annual costs are the sum of the average annual implementation cost plus annual operation and maintenance cost.

6.1.3 Calculation of Regional Economic Development Benefits

This section describes the methodology and steps used to evaluate the regional economic development impacts attributable to each of the various measures and plans. The Economic Impact Forecasting System (EIFS) model was used in this analysis. Chapter III describes the background EIFS model. The methodology and application will be described here, and the sections describing the specific measures and alternatives at each site will show summaries of the costs.

6.1.3.1 Methodology

Impacts on business, employment, income, and population were evaluated using the Economic Impact Forecast System (EIFS), an economic analysis tool that, given the inputs for a particular project proposal, will asses potential impacts on four indicators of a local economy. EIFS is based on regional economic theory and provides regional economic analyses to planners and analysts. It draws information from a tailored socioeconomic database for any county in the United States. The database items are extracted from: Economic Censuses (wholesale, retail, services, and manufacturers), Census of Agriculture, the Bureau of Economic Analysis (BEA) employment and income time series, the BEA labor time series, and the County Business Patterns (CBP). The entire system-models, tools, and database-is then available to assess potential impacts on four indicators of a local economy: business volume, employment, personal income, and population.

6.1.3.2 EIFS Model Assumptions

EIFS assumes that the infrastructure pre-Katrina is intact, in-place, and functioning as a wholesome economic unit in the region of influence. The fact is that under existing conditions many of the established economic infrastructure is not present but transient. In some cases, rebuilt economic units have moved into fill that deficit to provide the goods and services. The assumption of this analysis assumes that the last or destroyed infrastructure will be rebuilt or replaced in the near-term and will not significantly reduce the impacts and outputs forecasted in this investigation.

6.1.3.3 Summary Explanation of the EIFS Model Inputs and Outputs

6.1.3.3.1 EIFS Model Inputs

The two data sources used as inputs for the EIFS model were the implementation cost and O&M cost for each of the measures and alternatives. Each of the cost inputs used was in present worth dollars, not average annual. Present worth costs were used because it is the actual estimated

amount that will be spent to implement, operate, and maintain the measure or alternative and that is what will drive the regional impacts.

6.1.3.3.2 EIFS Model Outputs

- Change in Sales Volume

Changes in local business activity include direct sales volume and induced volume. Direct sales volume is the change in the dollar value of sales in the retail and wholesale trade sector and receipts in the service sector resulting from local purchases by people as well as construction and procurement expenditures. Induced sales volume is the additional sales activity generated as a result of the direct change in sales.

- Income

Changes in income represent the wage and salary payments made to construction workers and to the resident workforce.

- Employment

Employment changes include both direct and indirect changes, as well as short and long term changes. The direct long-term change in local employment is the increase in employment associated with construction. Subsequent indirect increases in employment are produced by the multiplier effect resulting from increased spending by the additional staff and construction employees.

6.2 Evaluation of Barrier Island Measures

6.2.1 General Description

The coastline of mainland Mississippi is bordered on the south by the Mississippi Sound, a shallow body of water that separates the coast from four barrier islands that lie several miles to the south. These barrier islands are located along a littoral drift zone that moves sand westward creating three elongated islands and then westward toward Cat Island, where littoral currents are not as well defined. Cat Island has a different origin than the other islands and is a remnant of a lobe of the St. Bernard Delta that was created by the Mississippi River. Wave action has created a beach on the eastern side of the island forming a distinctive T-shape. From west to east, the islands are Cat, Ship (now actually two islands, West and East Ship Island), Horn and Petit Bois. The western ends of both Petit Bois and Ship Islands have migrated to maintained navigation channels and the continuing littoral drift of the sand into the channels is causing an artificial termination of the migration. A new island has emerged on the west side of the channel from Petit Bois Island, created from the dredged sand coming from island that is disposed of on the west side of the channel.

6.2.1.1 Location

The barrier islands of Mississippi are located 10 to 15 miles south of the mainland. Currently, there are five islands in the chain that extends for 45 miles west from a point south of the Alabama – Mississippi state line along the coast. Currently, Ship Island exists as two islands separated by a shallow sand bar. It was breached during Hurricane Camille in 1969 and remains today as West and East Ship Island. Two maintained navigation channels pass through the chain of islands. The Gulfport channel passes near the west end of West Ship Island and the Pascagoula channel passes near the end of Petit Bois Island. The present day location of the channels prevents any further westward migration of either island.

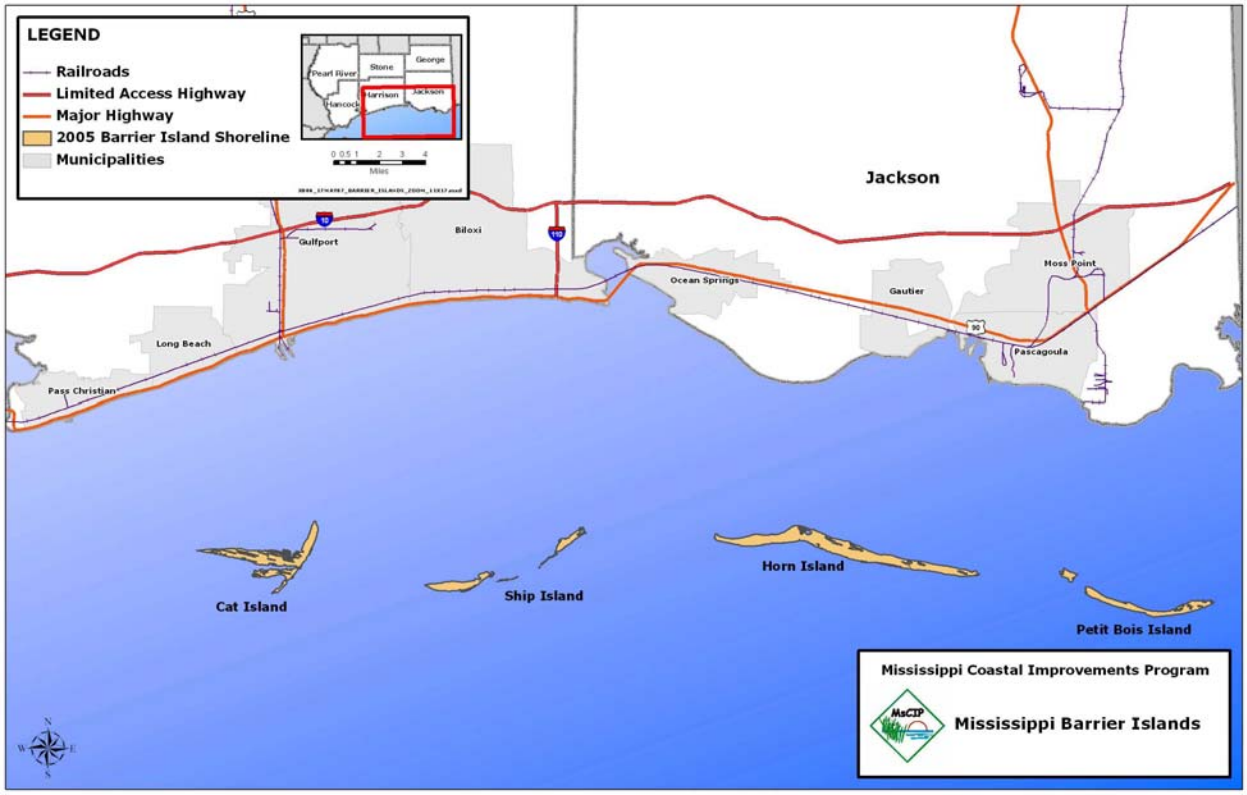


Figure 6.2.1-1. Location of the Mississippi Barrier Island

6.2.1.2 Historic Conditions (Pre-Hurricane Katrina)

6.2.1.2.1 Historic Fisheries

The value of the fisheries that are harvested from the Mississippi Sound has been an integral aspect of the local economy for decades. The industry has seen a significant rise in value since the 1970's, as is shown in table 6.2-1. The table and figure also show the effects of increased salinity on the system.

Table 6.2-1.
Historic Landings and Value of All Fisheries from Mississippi Sound

Year	Metric Tons	Pounds	% Change Pounds Since 1975	Value ($)	% Change Value ($) Since 1975
1975	138,690.7	305,757,600	N/A	$14,347,114	N/A
1976	130,708.7	288,160,500	-3%	$21,008,332	89%
1977	141,972.6	312,992,800	5%	$25,516,974	130%
1978	142,684.9	314,563,068	6%	$25,461,768	129%
1979	151,465.0	333,919,773	12%	$32,199,124	190%
1980	126,493.7	278,868,057	-6%	$24,866,290	124%
1981	95,263.2	210,017,239	-29%	$22,696,940	104%
1982	151,472.3	333,935,723	12%	$34,431,141	210%
1983	174,631.7	384,993,091	29%	$43,993,751	296%

Table 6.2-1.
Historic Landings and Value of All Fisheries from Mississippi Sound (continued)

Year	Metric Tons	Pounds	% Change Pounds Since 1975	Value ($)	% Change Value ($) Since 1975
1984	196,038.3	432,186,113	45%	$43,516,262	292%
1985	199,368.2	439,527,147	48%	$37,992,383	242%
1986	169,477.6	373,630,286	25%	$42,114,062	279%
1987	180,987.9	399,006,020	34%	$44,856,157	304%
1988	133,662.3	294,671,899	-1%	$43,744,133	294%
1989	122,979.5	271,120,626	-9%	$43,488,151	292%
1990	131,213.2	289,272,701	-3%	$39,748,280	258%
1991	97,280.4	214,464,348	-28%	$32,222,731	190%
1992	76,880.8	169,491,372	-43%	$29,986,817	170%
1993	83,485.4	184,051,940	-38%	$30,638,289	176%
1994	99,875.3	220,185,111	-26%	$36,930,906	233%
1995	65,725.1	144,897,569	-51%	$41,704,923	276%
1996	73,703.7	162,487,111	-45%	$35,120,373	216%
1997	81,842.8	180,430,714	-39%	$47,742,072	330%
1998	95,585.2	210,727,081	-29%	$48,402,305	336%
1999	121,378.6	267,591,178	-10%	$48,608,616	338%
2000	98,777.0	217,763,858	-27%	$58,751,487	429%
2001	97,034.6	213,922,401	-28%	$50,632,920	356%
2002	98,869.5	217,967,609	-27%	$47,565,219	328%
2003	96,828.8	213,468,811	-28%	$46,148,637	316%
2004	83,261.5	183,558,261	-38%	$43,618,143	293%

Source: Values were collected from the National Marine Fisheries website - http://www.st.nmfs.gov/st1/commercial/index html

6.2.1.3 Existing Condition (Post-Hurricane Katrina)

6.2.1.3.1 Damage to Structures

The three coastal Mississippi counties suffered tremendous devastation from Hurricane Katrina's surge. It is estimated that 32,446 structures were significantly destroyed (at least fifty-percent or more), with another 15,000 to 25,000 suffering moderate to minimal inundation damage. Of the structures sustaining significant destruction, 9,555 were in planning unit one, 16,528, in planning unit two, and 6,363 in planning unit three. Of those significant loss structures, approximately 19,000 claims were paid out by the Federal Emergency Management Agency's (FEMA's) National Flood Insurance Program (NFIP) totally over $2.3 Billion dollars, with the average claim around $137,000. Currently, no accurate data exists for uninsured losses, but estimates range in the billions of dollars. Table 1 displays the significantly damaged structures by planning unit and by structure category. Table 6.2-2 shows the severely damaged structure by planning unit.

Table 6.2-2.
Structures Damaged 50% or More by Planning Unit and by Category

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Commercial	1,267	1,794	378	3,439
Residential	8,099	14,500	5,780	28,379
Municipal	127	89	136	352
Mobile Home	62	145	69	276
Total	**9,555**	**16,528**	**6,363**	**32,446**

Source: Estimated from field inventory cluster sampling.

6.2.1.3.2 Damage to Barrier Islands

Immediately following Hurricane Katrina, most of the effort was spent protecting human life and securing structures throughout the impacted areas on the mainland; therefore, few assessments of the vegetation impacts exist, especially on the barrier islands. For the barrier island system, most all of the marsh vegetation recovered several months following Hurricane Katrina. The predominant vegetation that has long-term impacts consists of those pines found in the maritime forests. It is estimated that about 75% of these pine species were killed following the hurricane season of 2005, with most that attributable to Hurricane Katrina. The emergent marsh habitat is thriving so well it actually looks as though hurricanes never past through the barrier island system. The sea oats are still found in small patches due to the reduced dune system. Any measure that includes the planting of marsh vegetation will have to consider the current population of nutria that inhabits the islands. These exotic animals from South America can destroy attempts to establish marsh planting and any program should include the control of these rodents.

As is typical of most barrier island systems, the Mississippi islands are an ever-changing and dynamic landscape. Data shows that the islands have lost approximately 20 to 25 percent of their land mass since pre-Camille times. The islands have been heavily influenced by the various hurricanes including even the lower intensity ones. Hurricane George, in 1998, even though a small hurricane, proved to be devastating to the islands due heavy erosion from waves. Many of the higher dunes systems on the islands were destroyed and much of the elevation the islands once had is gone. Most of the islands are now very susceptible to over-wash during storms. Another result of being submerged during Hurricane Katrina was the loss of much of the maritime pine forest that existed on the islands. The trees, mostly now dead from the salt water submergence, played a major role in preventing erosion both from wind and any surges against the islands.



Figure 6.2.1-2. Photo of the south beach at Horn Island. Pre-existing dunes have been destroyed by numerous hurricanes over the last several years

6.2.1.2 Without-Project Condition

6.2.1.2.3 Equivalent annual damages

As previously described in Chapter V, six future without-project scenarios were developed, based on the existing condition characteristics, for the evaluation of future without-project conditions. The six scenarios were evaluated over a 100-year period of analysis from the base year 2012 (2012–2111) and using the FY08 federal discount rate of four-and-seven-eighths (4.875) percent. The six future scenarios include two redevelopment scenarios (residential and mixed-residential and commercial) and three relative sea level rise scenarios (base sea level, expected relative sea level rise, and high relative sea level rise) for a total of six different future scenarios. Scenario one is a residential redevelopment with no relative sea level rise over the 100-year period of analysis, scenario two is a mixed residential and commercial redevelopment with no relative sea level rise, scenario three is a residential redevelopment with an expected relative sea level rise, scenario four is a mixed residential and commercial redevelopment and an expected relative sea level rise, scenario five is a residential redevelopment with a high relative sea level rise, and scenario six is a mixed residential and commercial redevelopment with a high relative sea level rise. Table 6.2-3 shows the equivalent annual damages for the six future without-project scenarios.

Table 6.2-3.
Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario

Without-Project Damages	Future 1[2] Damages	Future 2[2] Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Planning Unit One	$198,960,000	$202,060,000	$218,050,000	$222,220,000	$237,310,000	$241,520,000
Planning Unit Two	$91,260,000	$94,680,000	$103,280,000	$107,120,000	$115,470,000	$119,760,000
Planning Unit Three	$88,670,000	$88,670,000	$104,700,000	$104,700,000	$122,420,000	$122,420,000
Total	**$378,890,000**	**$385,410,000**	**$426,030,000**	**$434,040,000**	**$475,200,000**	**$483,700,000**

Damages are rounded to the nearest ten thousand.
1 Futures Two, Four, and Six do not apply to planning unit three, therefore total damages are the same as future scenarios one, three, and five.
2 Future Scenarios one and two will be used to evaluate the impacts of relative sea level rise only, and will not be discussed in the direct evaluation of potential measures detailed in Chapter IV of this appendix.

These equivalent annual without-project damages are those that would be expected to occur over the period of analysis should the barrier islands remain in their existing state, however, recent data collected by the USGS, and analysis of historical data by the Corps and others, suggests that this may not be the case. The long-term trends exhibited by the Barrier Islands and wetlands of Louisiana, and the coastal areas of Alabama and the panhandle of Florida, suggest that the regional sediment budget of the Northern Gulf of Mexico is not sufficient to restore and/or maintain these areas in their existing condition. Although no one study or investigator has suggested a time frame for the demise of these features, it is increasingly evident that their effectiveness at reducing storm surge and wave energies has been reduced significantly in the last 50 years. This has been exhibited most dramatically after Katrina in reduction of Barrier Island extent [note – look at Bob Morten's report].

Unfortunately, due to severe timing and funding constraints pertaining to the MsCIP Comprehensive Plan and the complexity of modeling various states of the barrier islands, only a sensitivity analysis was conducted to roughly capture the increased inundation risk of the further degradation of the islands. The data from that sensitivity analysis indicates that further loss of the barrier islands could result in as much as ten-feet of additional wave damage to structures and their contents. This loss of surge protection could actually increase the total equivalent annual damages over the project life by as much as an additional eight to nine-percent. Table 6.2-4 displays the anticipated effects of increased damages due to further loss of the barrier islands.

Table 6.2-4.
Increase in Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario due to Further Degradation of the Barrier Islands

Without-Project Damages	Future 1[2] Damages	Future 2[2] Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Planning Unit One with Islands	$198,960,000	$202,060,000	$218,050,000	$222,220,000	$237,310,000	$241,520,000
% Increase without Islands	0%	0%	0%	0%	0%	0%
$ Increase without Islands	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Planning Unit Two with Islands	$91,260,000	$94,680,000	$103,280,000	$107,120,000	$115,470,000	$119,760,000
% Increase without Islands	7%	7%	7%	7%	7%	7%
$ Increase without Islands	**$6,388,200**	**$6,627,600**	**$7,229,600**	**$7,498,400**	**$8,082,900**	**$8,383,200**
Planning Unit Three with Islands	$88,670,000	$88,670,000	$104,700,000	$104,700,000	$122,420,000	$122,420,000
% Increase without Islands	10%	10%	10%	10%	10%	10%
$ Increase without Islands	**$8,670,000**	**$8,670,000**	**$10,470,000**	**$10,470,000**	**$12,242,000**	**$12,242,000**
Total $ Increase without Islands	**$15,058,200**	**$15,297,600**	**$17,699,600**	**$17,968,400**	**$20,324,900**	**$20,625,200**

Damages are rounded to the nearest ten thousand.
1/ Futures Two, Four, and Six do not apply to planning unit three, therefore total damages are the same as future scenarios one, three, and five.
2/ Future Scenarios one and two will be used to evaluate the impacts of relative sea level rise only, and will not be discussed in the direct evaluation of potential measures detailed in Chapter IV of this appendix.

6.2.1.2.3 Loss of Fisheries

Marine resources harvested from the Mississippi Sound are crucial to the economy of the three coastal counties and the state of Mississippi. It is estimated that in 2004, approximately 4,800 jobs and $300 million in gross annual revenue were dependent on fisheries from the sound. Various species harvested include oysters, bluefish, drum sea trout, sea catfish, white and brown shrimp, mullet, and snapper. According to National Marine Fisheries, total landings in 2004, the most accurate pre-Katrina data available, included 83,262 metric tons (183,558,261 pounds) for an estimated landing value of $43,618,143. In 2004, oyster production from the Mississippi Sound accounted for 8-percent of national oyster production and 11-percent of eastern oyster production. Comparison of pre-Katrina and post-Katrina landings provides a sharp comparison of what Mississippi Sound provided the State of Mississippi in terms of economic benefits, and what was lost as a result of the hurricane.

Comparison of the nearest full year (use of 2005 is problematic due to the fact that the hurricanes occurred mid-year) of monetary benefits due to commercial fish and shellfish landings, on either side of the hurricanes of 2005, provides the following insight into losses caused by those hurricanes. Table 6.2-5 shows an example of the devastating impacts of increased salinity in the Mississippi Sound due to Hurricane Katrina. If the islands continue to degrade, a point will be reached where the

salinity would kill the entire oyster and shrimp harvesting and the majority of all other existing fisheries as well. More detail about the devastating impacts of island degradation can be found in the environmental appendix.

Table 6.2-5.
Loss of Shrimp, Oysters, and other Species Due to Hurricane Katrina

Species	2004	2006	Loss
Shrimp	$26,353,576	$11,854,449	$14,499,127
Oysters	$6,073,242	$1,447,132*	$4,626,110
All Species Listed Above	$43,618,143	$21,741,108	$21,877,035

6.2.1.2.4 Loss of Recreation

This section describes the without-project recreation conditions for the barrier islands, which are the continued degradation of the islands and loss of all recreational use as a result of the continued degradation. Typically, recreational uses on the islands include general recreation such as boating, sightseeing, picnicking, swimming, and fishing from banks and boats. Additionally, the western portion of Ship Island, known as West Ship Island, is the home to two historic sites; Fort Massachusetts and the French Warehouse. Ship Island, the second island from the west in figure 6.2.1-1 above, was split into two islands by Hurricane Camille.

Visitors attend West Ship Island by using a commercial company called Ship Island Excursions or privately owned recreation boats. The island and facilities are run by the National Park Service. Table 6.2-6 below shows annual statistics estimated by the Park Service from 1989 through 2006.

Table 6.2-6.
Annual Ship Island Visitation

Year	Annual Visitation	Change from Previous Year (%)
1989	45,386	N/A
1990	54,661	20.436%
1991	49,301	-9.806%
1992	51,623	4.710%
1993	49,432	-4.244%
1994	51,059	3.291%
1995	53,793	5.355%
1996	59,724	11.026%
1997	58,969	-1.264%
1998	59,917	1.608%
1999	65,657	9.580%
2000	66,609	1.450%
2001	63,059	-5.330%
2002	62,720	-0.538%
2003	65,327	4.157%
2004	62,135	-4.886%
2005	41,453	-33.286%
2006	20,340	-50.932%

As the table shows, annual attendance to West Ship Island was relatively stable until the Island was impacted by Hurricane Katrina. Attendance in 2006 plummeted by more than 67-percent from its 2004 pre-Katrina level. The average yearly attendance for the five year period pre-Hurricane Katrina (2000-2004) was 63,970 visitors. Since there is little other data available on the recreational use of the barrier islands, and due to the timing constraints of this study, this number was used to estimate the annual recreational use.

Based on 63,970 annual user days, a unit day value (UDV) analysis was conducted to determine the monetary recreational value of use of the barrier islands. The UDV method relies on expert or informed opinion and judgment to estimate the average willingness to pay of recreational users. Interviews conducted pertaining to the without-project condition relied on expert or informed opinion and judgment to approximate the average willingness to pay of users of West Ship Island.

The guidelines for assigning points to general recreation include five categories:

- The quality of the recreational experience as affected by congestion,
- Availability of substitute areas in terms of travel time,
- Carrying capacity determined by level of facility development,
- Accessibility as affected by road and parking conditions, and
- Environmental quality based on aesthetics.

A resource is then rated on a 100-point scale. The total possible points that can be assigned to each criterion are as follows:

- Recreational Experience – 30,
- Availability of Opportunity – 18,
- Carrying Capacity – 14,
- Accessibility – 18, and
- Environmental - 20.

The conversion of points to dollar values for general recreation is expressed in two activity categories: general recreation and general fishing and hunting. Hence, points are expressed in the same manner. Therefore, for this project, general recreation includes boating, sightseeing, picnicking, swimming, and the visitation of the historical Fort Massachusetts and the French Warehouse. General fishing and hunting includes fishing from banks and boats. Table 6.2-7 summarizes the point value system as defined by EGM 08-02.

Table 6.2-7.
Guidelines for Assigning Points for General Recreation

Criteria	Judgment Factors				
Recreation experience[1] **Total Points: 30**	Two general activities[2]	Several general activities	Several general activities; one high quality value activity[3]	Several general activities; more than one high quality value activity	Numerous high quality value activities; some general activities
Point Value:	0-4	5-10	11-16	17-23	24-30
Availability of opportunity[4] **Total Points: 18**	Several within 1 hr. travel time; a few within 30 min. travel time	Several within 1 hr. travel time; none within 30 min. travel time	One or two within 1 hr. travel time; none within 45 min. travel time	None within 1 hr. travel time	None within 2 hr. travel time
Point Value:	0-3	4-6	7-10	11-14	15-18
Carrying Capacity[5] **Total Points: 14**	Minimum facility for development for public health and safety	Basic facility to conduct activity(ies)	Adequate facilities to conduct without deterioration of the resource or activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative
Point Value:	0-2	3-5	6-8	9-11	12-14
Accessibility **Total Points: 18**	Limited access by any means to site or within site	Fair access, poor quality roads to site; limited access within site	Fair access, fair road to site; fair access, good roads within site	Good access, good roads to site; fair access, good roads within site	Good access, high standard road to site; good access within site
Point Value:	0-3	4-6	7-10	11-14	15-18
Environmental **Total Points: 20**	Low aesthetic factors6 that significantly lower quality[7]	Average aesthetic quality; factors exist that lower quality to minor degree	Above average aesthetic quality; any limiting factors can be reasonably rectified	High aesthetic quality; no factors exist that lower quality	Outstanding aesthetic quality; no factors exist that lower quality
Point Value:	0-2	3-6	7-10	11-15	16-20

Table 6.2-8 shows the average respondent values for the value of recreational use of the barrier islands. Notes from those interviews include overwhelming high aesthetic value, general uses except for the ability to visit the historical Fort Massachusetts and French Warehouse, fair to good accessibility, and adequate to optimum facilities at the site.

Table 6.2-8.
Point Value of Recreational Use

	Recreational Experience	Availability of Opportunity	Carrying Capacity	Accessibility	Environmental	Totals
Average Respondent	10.00	3.00	8.00	10.00	20.00	**51.00**

Table 6.2-9 shows the conversion of points to FY 2008 dollar based on EGM 08-02.

Table 6.2-9.
Point Value of Recreational Use

Point Values	General Recreation Values	General Fishing and Hunting Values	Specialized Fishing and Hunting Values	Specialized Recreation Values other than Fishing and Hunting
0	$3.40	$4.89	$23.81	$13.82
10	$4.04	$5.53	$24.44	$14.67
20	$4.46	$5.95	$24.87	$15.73
30	$5.10	$6.59	$25.51	$17.00
40	$6.38	$7.23	$26.14	$18.07
50	$7.23	$7.86	$28.69	$20.40
60	$7.86	$8.71	$31.24	$22.53
70	$8.29	$9.14	$33.16	$27.21
80	$9.14	$9.78	$35.71	$31.67
90	$9.78	$9.99	$38.26	$36.13
100	$10.20	$10.20	$40.38	$40.38

Table is from EGM 08-02 "Unit Day Values for Recreation, Fiscal Year 2008"

The general recreation score of 51 translates to unit day value of $7.29. The average annual benefits were calculated by multiplying the UDV by the annual visitor occasions. Using the estimated 63,970 annual users and the interpolated $7.29 unit day value, the average annual recreation loss of continuing to allow the islands to degrade is $466,341

6.2.2 List of Measures

Measure A – Restore Island Footprint

The pre-Camille footprint of the islands was obtained from historical records and the amount of area that has been lost to coastal erosion since that time was computed. Without accurate topography of the islands and an assumption was made that some dunes had a top of elevation of 20 feet NAVD88. It should be noted that some of the islands have migrated and any reconstruction would be to increase their footprint at their present location and not move them back to historical locations.

Several approaches to restoration of the islands were considered. This measure will only include new land mass that is being added to the islands by using sand dredged and transported from an off-shore location. The shaping of the sand into beaches, dunes and marsh areas will not affect the existing islands other than that narrow strip of land that will form the boundary between the existing island and the new land mass. This measure can be used in combination with other measures under this line of defense should it be desired to restore habitat on the existing islands.

Restoration of Ship Island to a pre-Camille configuration includes closing the post-Katrina, 3-mile long breach to a 2000-foot width and with elevation 20.0-foot NAVD88 dunes, along with some rebuilding of the other islands to a larger land area. The land mass of each of the islands was estimated in a pre-Hurricane Camille condition using historical aerial photography.

Measure B – Replenish Sand in Littoral Zone, Inland Source

Another consideration to help restore the islands is to supplement the sand in the littoral system. This could be accomplished by adding sand in specific locations based on sediment transport modeling. This would allow the littoral currents to move the sand onto the islands where the natural process of island building could take place. This would not directly affect the present-day islands and would help mitigate any effects of dredging the ship channels that pass through the chain of islands where sand may have been lost from the system.

The construction of inland waterways in Alabama and Mississippi has resulted in continuing maintenance dredging to maintain the channel depths and alignments. Dredging of some of the areas along the river has produced large quantities of sand that have potential use for replenishment of littoral zones such as are found along the Mississippi Barrier Islands. This dredged material, approximately 30 million cubic yards, is now accumulated in disposal areas along the banks of the rivers.

Measure C – Replenish Sand in Select Littoral Zones, Offshore and Inland River Sources

Another consideration to help restore the islands is to supplement the sand into specific areas of the littoral system with sand obtained from both Inland and offshore borrow areas. Like Measure B, this could be accomplished by adding sand in specific locations based on sediment transport modeling. The general locations for this measure were based on islands that have migrated westward to alignments of maintained navigation channels causing an artificial termination of further migration. Placing sand into these locations would allow the littoral currents to move the sand onto the islands where the natural process of island building could take place. While this process would not directly affect the present-day islands, it would help mitigate any effects of dredging the ship channels that pass through the chain of islands where sand may have been lost from the system. The sand that could be used in this measure may come from the same offshore borrow area as Measure A, the St. Bernard Shoals located about 45 miles south of the barrier islands as well as the inland river systems as described in Measure B.

Measure D – Environmental Restoration w/ 2-foot Dune

This measure would involve environmental restoration of the islands consisting of shaping existing sand into low dunes on the beaches with planted vegetation and planting of maritime forests on the existing islands where they were mostly destroyed by Hurricane Katrina.

Despite continual changes that occur, the barrier islands remain to buffer the mainland from storms and provide habitat for the rich, diverse wildlife residing within the area. On the southern portion of the islands, sea oats primarily, which are tolerant of high salt levels, thrive on the dune system which is located behind the beach area. Behind the primary dunes, trees and shrubs, such as short-leaf and long-leaf pines, can be found in the maritime forest. In the island interiors, emergent marshes collect fresh rainwater to help support its inhabitants

A restoration measure with the least impact on the existing post-Katrina islands would be to re-establish the vegetation that was destroyed. This measure could involve restoration of the existing islands through adding sand dunes on the beaches along with planted vegetation (i.e. *Uniola paniculata*), planting of marshes (i.e. *Spartina alterniflora*, *Juncus roemerianus*, and *Spartina patens*) and maritime forests (i.e. *Pinus elliottii Engelm*, *Serenoa repens, Sabal minor*, etc.), and planting sea grasses (i.e. *Diplanthera wrightii, Cymodocea manatorum, Thalassia testudinum*, and *Ruppia maritime*) in the near-shore areas of the islands. Foremost, the vegetation would restore the island's natural setting, which allows for the diverse array of flora and fauna to persist. This plan would not involve adding any land mass to the islands other than the possibility of adding to the dune system. Vegetation would aid in reducing erosion from wind; thus helping in maintaining the stability of the

islands. The vegetation would also aid in preventing erosion in the event that the islands gets overtopped by storm surge in a large hurricane.

Measure E – Environmental Restoration w/ 6-foot Dune

This measure would involve environmental restoration of the islands consisting of adding sand onto the existing beaches in sufficient quantities to construct a dune approximately 6 feet high. The dunes on the beaches would be planted with vegetation along with the planting of maritime forests on the existing islands where they were mostly destroyed by Hurricane Katrina. The sand required to construct a dune of this size would be more than could be removed from the existing beach berm and would come from the same offshore borrow area as the sand used in Measure A. Placement of the sand would require moving the sand from a hopper dredge to a staging area on the beach, then moving the sand to the area of placement along the beach.

Measure F – Environmental Restoration of Sea Grass Beds

This measure would involve environmental restoration of the sea grass beds that have historically existed on the north side of the islands in the Mississippi Sound. Knowledge of submerged aquatic vegetation (SAVs) is limited to reports by Humm (1956) and Humm and Caylor (1957) before the Gulf of Mexico Estuarine Inventory (GMEI) Study (1973). They reported the occurrence of five flowering species known as “seagrasses” and 77 algal species all along the Mississippi barrier islands. Studies carried out by the GMEI personnel revealed that there were about 17,000 acres of SAVs in Mississippi Sound prior to Hurricane Katrina. Information obtained from MDMR indicated that since Hurricane Camille in 1969, 8,800 acres of SAVs have been lost. Using maps from MDMR, fifty percent of the total lost acreage would be replaced throughout the previous range to help restore this valuable habitat under this measure.

Measure G – Restore Ship Island Breach

The most predominate affect of Hurricane Katrina on the Mississippi Barrier Islands was the large increase in size of the breach in Ship Island commonly known as the Camille Cut. The pre-Camille footprint of Ship Island was obtained from historical records. This data showed the area that was breached during Hurricane Camille forming two separate islands. West and East Ship Island has two major historic sites that are in danger from the continuing erosion of the barrier islands. Current studies by the Corps indicate that restoring the two islands to a single island, pre-Camille condition may prevent the rapid erosion of the beaches that is now occurring as well as helping to provide wave erosion on the mainland. Estimates indicated that the total restoration of Ship Island to a single land mass off the Mississippi coast will involve approximately 8 million cubic yards of sand. As happened during Hurricane Camille, the breach was opened during Hurricane Katrina leaving two islands with approximately three miles of open water between the remaining portions. This portion of the island has also been breached during other prior hurricanes and while most of the island has reformed to a low bar over time, it never gained enough sand to form dunes and establish vegetation along this center portion.

Fort Massachusetts is located on the northern shore of West Ship and the French Warehouse is located on the northern shore of East Ship Island. Both of these sites are endangered by on-going erosion of the shoreline with Mississippi Sound. Another site, known as the Quarantine Station, has already been lost to erosion.

Measure H – Comprehensive Measure

This plan is a physical implementation combination of measures C and G.

6.2.3 With-Project Conditions

The benefits attributable to the proposed barrier island measures are those avoided future losses should no action be taken. Implementation of the measures would result in the avoidance of increased surge damages due to amplified wave attack, the preservation of the Mississippi Sound habitat that is vital to both local fisheries and economies, but also a large source of national oyster production, and the continued use of the barrier islands as a recreational resource. Table 6.2-10 shows the estimated NED benefits for each of the barrier island measures and table 6.2-11 shows the EQ benefits by measure. Benefits were quantified where possible and are based on expert elicitation from six interviews conducted with project delivery team members and knowledgeable federal and state agency contacts.

Table 6.2-10.
NED Benefits by Measures

Measures	Future 3 Avoidance of Increased Surge Damage (Annual $)	Future 4 Avoidance of Increased Surge Damage (Annual $)	Future 5 Avoidance of Increased Surge Damage (Annual $)	Future 6 Avoidance of Increased Surge Damage (Annual $)	Avoidance of Recreation Loss (Annual $)
	NED Benefits				
(No Action)	$0	$0	$0	$0	$0
Measure A	$17,699,600	$17,699,600	$17,699,600	$17,699,600	$466,341
Measure B	$10,831,480	$10,844,920	$12,646,145	$12,661,160	$116,585
Measure C	$9,748,332	$9,760,428	$11,381,531	$11,395,044	$116,585
Measure D	$9,206,758	$8,296,364	$9,674,301	$9,685,787	$116,585
Measure E	$9,206,758	$8,296,364	$9,674,301	$9,685,787	$116,585
Measure F	$7,365,406	$6,637,091	$7,739,441	$7,748,630	$116,585
Measure G	$7,229,600	$7,498,400	$8,082,900	$8,383,200	$233,171
Measure H	$17,699,600	$17,699,600	$17,699,600	$17,699,600	$466,341

1/ Estimates are based on expert or informed opinion and judgment to estimate the extent of the losses avoided in each category.

Table 6.2-11.
EQ Benefits by Measures

Measures	Avoidance Fisheries Landings Lost (Annual Pounds)	Avoidance Fisheries Landings Lost (Annual $)
(No Action)	0	$0
Measure A	183,558,261	$43,618,143
Measure B	36711652	$8,723,629
Measure C	27533739	$6,542,721
Measure D	18355826	$4,361,814
Measure E	18355826	$4,361,814
Measure F	9177913	$2,180,907
Measure G	91779131	$21,809,072
Measure H	183,558,261	$43,618,143

1/ Estimates are based on expert or informed opinion and judgment to estimate the extent of the losses avoided in each category.

6.2.4 Summary of Costs

Table 6.2-12 summarizes the rough order magnitude (ROM) costs for potential barrier island measures. IDC was calculated based on a five-year (60 month) construction duration and the FY08 discount rate of 4-7/8-percent. Average annual costs are based on the 4-7/8-percent discount rate and a 100-year period of analysis. There are no estimated direct costs for annual operation and maintenance; however, a maintenance plan does exist and is detailed in the barrier island appendix.

Table 6.2-12.
Total Average Annual Costs by Measure

Measures	Total Implementation Cost ($)[1]	IDC ($)	Total First Cost ($)	Average Annual First Cost ($)	Average Annual O&M Cost ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A	$942,200,000	$119,317,000	$1,061,517,000	$53,431,000	$0	$53,431,000
Measure B	$1,013,800,000	$128,383,000	$1,142,183,000	$57,491,000	$0	$57,491,000
Measure C	$147,400,000	$18,667,000	$166,067,000	$8,359,000	$0	$8,359,000
Measure D	$14,200,000	$1,798,000	$15,998,000	$805,000	$0	$805,000
Measure E	$39,200,000	$4,965,000	$44,165,000	$2,223,000	$0	$2,223,000
Measure F	$264,500,000	$33,495,000	$297,995,000	$14,999,000	$0	$14,999,000
Measure G	$181,400,000	$22,972,000	$204,372,000	$10,287,000	$0	$10,287,000
Measure H	$328,800,000	$41,639,000	$370,439,000	$18,646,000	$0	$18,646,000

1/ Numbers are rounded to the nearest thousand and are based on ROM costs at an FY-08 price level. The cost estimating appendix shows these in more detail, as well as MCACES costs for the tentatively-recommended plan.

6.2.5 Regional Economic Development (EIFS Model)

The purpose of this analysis is to determine the economic impact of the proposed project measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local areas of Jackson County, Harrison County and Hancock County Mississippi. The expenditures for the measures are estimated to be $942,200,000 for Measure A, Restore Island Footprint measure, $1,013,800,000 for Measure B, Replenish Littoral Zone (river sand) measure, $147,700,000 for Measure C, Replenish Littoral Zone (offshore sand) measure, $14,200,000 for Measure D, 2-foot Dune with beach sand measure, $39,200,000 for Measure E, 6-foot Dune with plantings measure, $264,500,000 for the Measure F measure and $181,400,000 for Measure G, Restore Ship Island measure. Tables 6.2-10 and 6.2-11 summarize the EIFS model inputs and outputs for the Barrier Island Measures.

Table 6.2-13.
EIFS Model Inputs for Barrier Island Measures

	Measure A	Measure B	Measure C	Measure D	Measure E	Measure F	Measure G	Measure H
Region of Influence (ROI)	Three Counties	Three Counties	Three Counties	Three Counties	Three Counties	Three Counties	Three Counties	Three Counties
Change in Local Expenditures	$942,200,000	$1,013,800,000	$147,400,000	$14,200,000	$39,200,000	$264,500,000	$181,400,000	$328,800,000

Based of the given inputs the outputs are as followed:

Table 6.2-14.
EIFS Model Outputs for Barrier Island Measures

	Measure A	Measure B	Measure C	Measure D	Measure E	Measure F	Measure G	Measure H
Direct Sales Volume	$942,200,000	$1,013,800,000	$147,400,000	$14,200,000	$39,200,000	$264,500,000	$181,400,000	$328,800,000
Induced Sales Volume	$1,347,346,000	$1,449,734,000	$210,782,000	$20,306,000	$56,056,000	$378,235,000	$259,402,000	$470,184,000
Total Sales Volume	$2,289,546,000	$2,463,534,000	$358,182,000	$34,506,000	$95,256,000	$642,735,000	$440,802,000	$798,984,000
Direct Income	$197,936,200	$212,977,800	$30,965,600	$2,983,118	$8,235,085	$55,565,820	$38,108,280	$69,073,880
Induced Income	$283,048,700	$304,558,200	$44,280,810	$4,265,858	$11,776,170	$79,459,120	$54,494,840	$98,775,650
Total Income	$480,984,900	$517,536,000	$75,246,410	$7,248,976	$20,011,255	$135,024,940	$92,603,120	$167,849,530
Direct Employment	5,802	6,243	908	87	241	1,629	1,117	2,025
Induced Employment	8,297	8,928	1,298	125	345	2,329	1,597	2,895
Total Employment	14,099	15,171	2,206	212	586	3,958	2,714	4,920
Local Population	0	0	0	0	0	0	0	0

6.2.6 Summary of Costs and Benefits

Table 6.2-15 summarizes the costs and benefits for the various Barrier Island measures.

Table 6.2-15.
Summary Benefits and Costs by Measures

	Measure A	Measure B	Measure C	Measure D	Measure E	Measure F	Measure G	Measure H
National Economic Development Benefits								
Future 3 Damages Avoided (Annual $)	$17,699,600	$10,831,480	$9,748,332	$9,206,758	$9,206,758	$7,365,406	$7,229,600	$17,699,600
Future 4 Damages Avoided (Annual $)	$17,699,600	$10,844,920	$9,760,428	$8,296,364	$8,296,364	$6,637,091	$7,498,400	$17,699,600
Future 5 Damages Avoided (Annual $)	$17,699,600	$12,646,145	$11,381,531	$9,674,301	$9,674,301	$7,739,441	$8,082,900	$17,699,600
Future 6 Damages Avoided (Annual $)	$17,699,600	$12,661,160	$11,395,044	$9,685,787	$9,685,787	$7,748,630	$8,383,200	$17,699,600
Recreation Losses Avoided (Annual $)	$466,341	$116,585	$116,585	$116,585	$116,585	$116,585	$233,171	$466,341
Environmental Quality Benefits								
Fishery Losses Avoided ($)	$43,618,143	$8,723,629	$6,542,721	$4,361,814	$4,361,814	$2,180,907	$21,809,072	$43,618,143

Table 6.2-15.
Summary Benefits and Costs by Measures (continued)

	Measure A	Measure B	Measure C	Measure D	Measure E	Measure F	Measure G	Measure H
Regional Economic Development Benefits								
Change in Sales Volume	$2,289,546,000	$2,463,534,000	$358,182,000	$34,506,000	$95,256,000	$642,735,000	$440,802,000	$798,984,000
Change in Income	$480,984,900	$517,536,000	$75,246,410	$7,248,976	$20,011,255	$135,024,940	$92,603,120	$167,849,530
Change in Employment	14,099	15,171	2,206	212	586	3,958	2,714	4,920
Average Annual Costs including IDC								
Average Annual Cost	$53,431,000	$57,491,000	$8,359,000	$805,000	$2,223,000	$14,999,000	$10,287,000	$18,646,000

6.3 Evaluation of Beach and Dune Construction Measures

6.3.1 Planning Unit One

6.3.1.1 Background

The beaches of Hancock County are approximately 9 miles in length, and host one of the Gulf Coast's largest populations of Least Tern, a Federally-listed endangered species, plus a significant number of Piping Plover. The beaches possessed a vegetated dune system (pre-Katrina) that was maintained by local interests and supported a significant ecosystem, in addition to passive recreation usage outside the dune system. This dune system provided not only ecosystem benefits, but some measure of hurricane or storm damage reduction due to its ability to absorb some of the surge and wave energy during those types of events. During Hurricane Katrina, this dune system was almost entirely destroyed by surge and wave action. Almost all ecosystem functions and values were eliminated during this single event. Much of the sand removed is believed to be close off shore in the near shore zone. The MsCIP Interim Chiefs Report recommended that a beach and dune placement project be constructed in planning unit one. The interim project consists of the following: (1) replacing approximately 43,800 cubic yards of lost sand dune material, (2) placing 37,000 linear feet of stabilizing sand fence, and (3) planting 19.3 acres of dune vegetation. Figures 6.3-1 and 6.3-2 show the project location and extent for planning unit one.

6.3.1.1.1 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation
- Preservation of Fish & Wildlife and restoration of their habitats
- Prevention or remediation of erosion
- Other related water resource purposes, such as ecosystem restoration or barrier island restoration

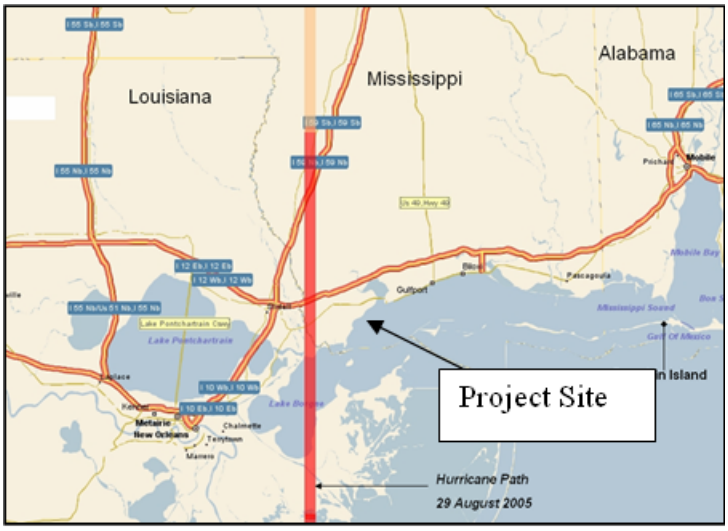


Figure 6.3-1. Project Sites for LOD2 in Planning Unit One

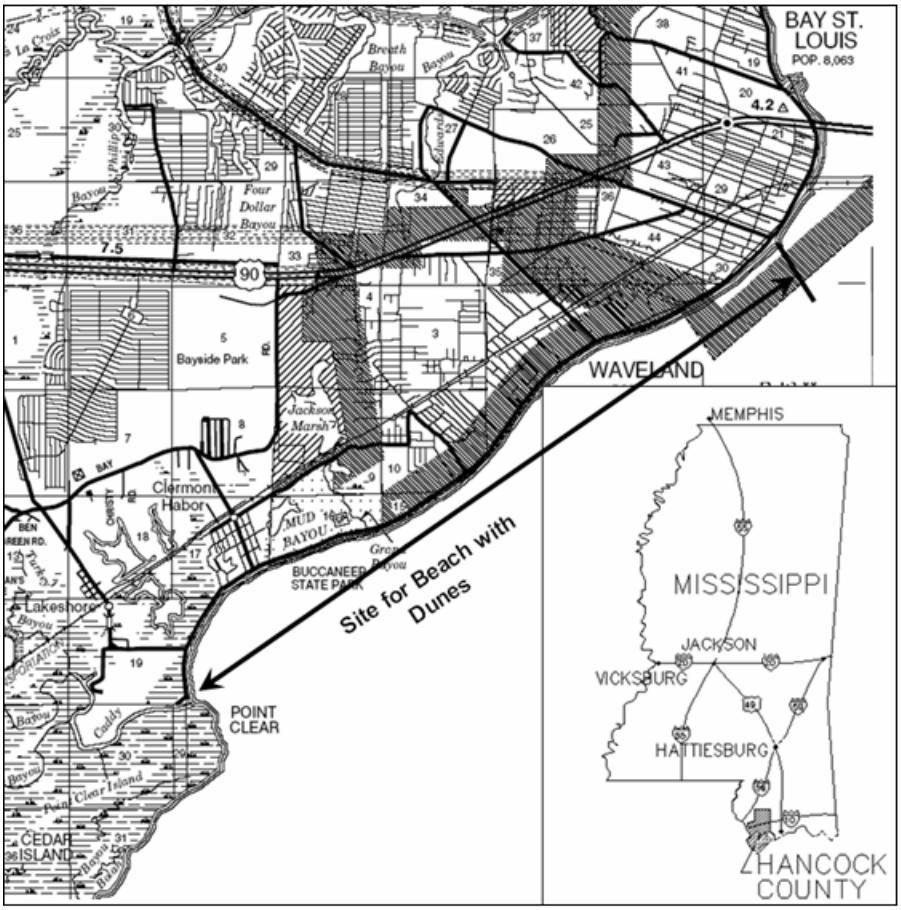


Figure 6.3-2. Project Limits for Line of Defense 2 in Planning Unit One

6.3.1.2 General Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs,
- Price levels are October, 2007 unless otherwise stated,
- A 50-year period of analysis was used to calculate average annual benefits and costs.

6.3.1.3 Measures

Eleven measures were evaluated for enhanced beach protection at the study site. All involve providing a dune and berm to the location. Some of the measures, Measures A through H described below, can not be constructed without the construction of the Seawall and Elevated roadway measure, which is evaluated in great detail later in this appendix. The measures for Line of Defense 2 in planning unit one are as follows:

- Measure A consists of a 10.0 feet NAVD88 dune elevation, 40.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure.
- Measure B consists of an 8.0 feet NAVD88 dune elevation, 50.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure.
- Measure C consists of a 10.0 feet NAVD88 dune elevation, 20.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure.
- Measure D consists of an 8.0 feet NAVD88 dune elevation, 30.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure.
- Measure E consists of a 10.0 feet NAVD88 dune elevation, 40.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows starting at the seaward toe of the dune. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure.
- Measure F consists of an 8.0 feet NAVD88 dune elevation, 50.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows starting at the seaward toe of the dune. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure.

- Measure G consists of a 10.0 feet NAVD88 dune elevation, 20.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows starting at the seaward toe of the dune. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure.

- Measure H consists of an 8.0 feet NAVD88 dune elevation, 30.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of starting at the seaward toe of the dune. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure. Figure 6.3-3 shows a typical cross section for Measures A though H.

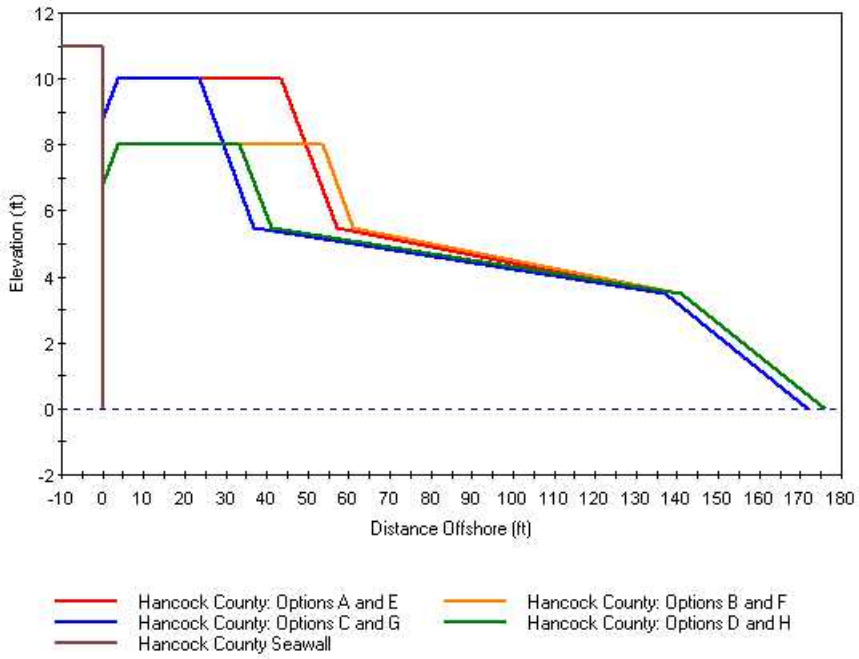


Figure 6.3-3. Typical Cross Section for Measures A through H

- Measures I and J are comparative with-project measures, for future evaluation, consisting of a design cross-section which includes a dune and berm constructed as a stand alone project which does not incorporate the Line of Defense 3 seawall. Measure I consists of a dune feature constructed approximately 50.0 feet seaward of the seawall at an elevation of 10.0 feet NAVD 88, with a crest width of 55.0 feet, and a dune slope of 1:3. The berm width would be extended to accommodate the placement of the dune feature. Sand fencing would be placed on the dunes to reduce sand transport due to the strong winds which frequently occur during storms. The cross section for Measure J is the same as Measure I; however the dune would be planted to provide for additional environmental habitat. For Measure J, sea oats would be planted on both the landward and seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of planted starting at the landward and seaward toes of the dune. The dunes will require initial and continued maintenance of vegetation and sand fencing. These measures are intended to be stand alone and are not dependent on the elevated roadway and seawall that is described in section 6.4.

- Measure K is also a measure for future evaluation which consists of an elevated berm section constructed primarily for the creation of environmental habitat. Measure K would be constructed as a stand alone measure which does not incorporate the Line of Defense 3 seawall. The elevated berm section would be constructed approximately 50.0 feet seaward of the existing seawall to an elevation 2.0 feet NAVD88 above the existing berm with a width of approximately 60.0 feet. The berm width would not be extended to accommodate the placement of the elevated berm feature. The new feature would be vegetated and sand fencing would be placed to create environmental habitat and to reduce sand transport due to the strong winds which frequently occur during storms. For Measure K, sea oats would be planted in a 30 by 30 inch grid pattern over the entire elevated berm area. The new feature will require initial and continued maintenance of vegetation and sand fencing. This measure is intended to be a stand alone and is not dependent on the elevated roadway and seawall that is described in section 6.4.

6.3.1.4 National Economic Development (NED)

This section describes the National Economic Development benefits for the various beach and dune placement measures in planning unit one that are attributable to hurricane and storm damage reduction. National economic development benefits are damages to structures and their contents that are reduced when a measure or alternative is implemented, or the difference between the with-project and without-project conditions.

There are two types of beach and dune placement measures for planning unit one; those that are dependent on the seawall and elevated roadway and those that can be implemented as stand alone measures. Those measures dependent on the seawall and elevated roadway, measures A through H, would be implemented to abut the seawall and elevated roadway and would be constructed to a maximum elevation of 1.0 foot lower than the seawall and elevated roadway, or to elevation 10.0 feet NAVD88, thus acting as a system. For these measures, equivalent annual damage reduction would be limited to structures that are physically located south of Beach Boulevard, since seawall and elevation of that roadway would be higher than the dune system itself. A visual description of this system can be seen above in figure 6.3-3. The remaining measures I, J, and K are stand alone, and would be implemented in lieu of the seawall and elevated roadway with dune system. The equivalent annual damage reduction attributable to the stand alone measures would impact structures located south of Beach Boulevard in planning unit one and some footprint of structures north of beach boulevard. Also, all beach and dune placement measures would provide some level of protection to the seawall and roadways that they abut, but those benefits are difficult to quantify and were not conducted in this analysis.

The Beach-FX program was selected to quantify the damage reduction benefits of all of the beach and dune placement measures. Beach-FX is a Monte Carlo based model that combines coastal processes economic conditions to evaluate damages from storm events and the level of damage reduction that would be attributable to a given measure. Chapter III of this appendix depicts the overall process of the Beach-FX evaluation. For this study, the exploration of the costal processes and economic inventorying was conducted. Further study would be required to combine the observed data and to evaluate the eleven alternatives previously mentioned. More detail on the further study can be found in the MsCIP Comprehensive Plan Main Report. Table 6.3-1 summarizes the costs by measure.

Summary of Costs

Table 6.3-1 summarizes the ROM costs at an FY-08 price level for the beach and dune placement measures for planning unit one.

Table 6.3-1.
Summary of Beach and Dune Costs by Measure for Planning Unit One

Measures	Implementation Cost ($)	IDC ($)	Total Implementation Cost ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A[1] (10FT by 40FT Dune no plantings)	$8,070,000	$178,700	$8,248,700	$443,139	$2,167,694	$2,610,833
Measure B[1] (8FT by 50FT Dune no plantings)	$6,100,000	$134,900	$6,234,900	$334,953	$1,638,530	$1,973,483
Measure C[1] (10FT by 20ft Dune no plantings)	$4,960,000	$109,600	$5,069,600	$272,350	$1,332,313	$1,604,663
Measure D[1] (8FT by 30FT Dune no plantings)	$4,030,000	$89,200	$4,119,200	$221,293	$1,082,504	$1,303,797
Measure E[1] (10FT by 40FT Dune with plantings)	$8,400,000	$185,900	$8,585,900	$461,254	$2,256,336	$2,717,590
Measure F[1] (8FT by 50FT Dune with plantings)	$6,440,000	$142,500	$6,582,500	$353,627	$1,729,857	$2,083,484
Measure G[1] (10FT by 20ft Dune with plantings)	$5,300,000	$117,300	$5,417,300	$291,030	$1,423,640	$1,714,670
Measure H[1] (8FT by 30FT Dune with plantings)	$4,360,000	$96,400	$4,456,400	$239,408	$1,171,146	$1,410,554
Measure I (10FT by 50FT Dune without plantings)	$19,100,000	$422,600	$19,522,600	$1,048,799	$5,130,478	$6,179,277
Measure J (10FT by 50FT Dune with plantings)	$19,450,000	$430,300	$19,880,300	$1,068,015	$5,224,492	$6,292,507
Measure K (2FT by 60FT Dune with plantings)	$4,640,000	$102,600	$4,742,600	$254,783	$0	$254,783

1/ Denotes measures that could not be implemented without the construction of the seawall, which is discussed in section 6.4.
2/ Cost include Construction Management, Supervision & Administration, and Contingencies. More detail on the costs can be found in the Cost Estimating Appendix.

6.3.1.6 National Ecosystem Restoration (NER)

The P&G defines the environmental quality account as, "displays of non-monetary effects on ecological, cultural, and aesthetic resources…" The EQ account is typically associated with ecosystem restoration projects, although it does address the following:

Cost Effective Analysis

The justification for the proposed section is evaluated on a cost effective and incremental cost basis in accordance with guidelines contained in ER 1105-2-100, *Planning – Planning Guidance Notebook*. The Corps' ecosystem restoration policy is described in more detail in ER 1165-2-501, *Water Resources Policies and Authorities – Civil Works Ecosystem Restoration Policy;* and EP 1165-2-501, *Water Resources Policies and Authorities – Ecosystem Restoration – Supporting Policy Information.* As cited in the *Planning Guidance Notebook,* Cost Effectiveness and Incremental Cost Analyses procedures are detailed in IWR Report 94-PS-2, Cost Effectiveness Analysis for Environmental Planning: Nine EASY steps; IWR Report 95-R-1, *Evaluation of Environmental Investments Procedures Manual Interim: Cost Effectiveness and Incremental Cost Analyses; and IWR Report 98-R-1, Making More Informed Decisions in Your Watershed When Dollars aren't Enough*. The analysis compares the cost effectiveness of the five measures based on their environmental outputs to determine the selected measure. Note: this section is intended to identify the cost effective environmental measures that can be constructed with the elevated roadway and seawall. Since measures I, J, and K are concept measures at the time of this report, and they were formulated based on reducing flood damages to be stand alone measures, they will automatically be carried forward for further consideration.

6.3.1.6.1 Cost Effective Analysis Assumptions

This analysis assumes a 50-year project life. Costs were amortized using the FY 2008 federal discount rate of 4.875-percent and are presented at October 2008 price levels. The outputs quantified in this cost effective analysis are defined as the quantification of expected improvements in target functions as related to project objectives (functional habitat index, FHI). FHI scores were based on an assessment protocol, which provide a basic level of stream health evaluation that is based on physical conditions within the assessment area. The assessment is used to record the scores for up to 15 assessment elements (i.e., channel condition, hydrologic alteration, riparian zone, bank stability, water appearance, nutrient enrichment, barriers to fish movement, instream fish cover, pools, insect/invertebrate habitat, canopy cover [warm water fishery], manure presence, salinity, riffle embeddedness, and macroinvertebrates observed). However, all assessment elements were not applicable to the assessment area and were not included.

The first step in cost-effective analysis is to display the environmental outputs (effects on habitat expressed in Functional Habitat Index, FHI) and the cost estimates of the management measure increments. Outputs and costs are displayed as average annual outputs and average annual costs. Both are acceptable so long as they are comparable. Average annual outputs and average annual costs were used for this analysis.

Table 6.3-2 displays the project measures and their associated average annual outputs and average annual costs. Project outputs for each measure are displayed in terms of functional habitat index (FHI) that can be supported for each measure considered.

Table 6.3-2.
Outputs and Costs by Measure

Measures	Annualized Implementation Cost ($)	Annual O&M ($)	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	$0	$0	0
Measure A	$443,139	$2,167,694	$2,610,833	142
Measure B	$334,953	$1,638,530	$1,973,483	172
Measure C	$272,350	$1,332,313	$1,604,663	142
Measure D	$221,293	$1,082,504	$1,303,797	154
Measure E	$461,254	$2,256,336	$2,717,590	304
Measure F	$353,627	$1,729,857	$2,083,484	330
Measure G	$291,030	$1,423,640	$1,714,670	250
Measure H	$239,408	$1,171,146	$1,410,554	276

The second step in incremental analysis is to identify combinable management measures. This involves the analysis of the management measures to determine those that can be implemented together from those that cannot be implemented together. Each of the measures in this analysis is independent of the others. After the selection of one of the measures, the other measures are not needed; therefore the measures are not combinable.

The next step is to calculate outputs and costs of combinations. The combinations of the management measures are defined and analyzed incrementally. In this step, each combination of output (FHI) and cost ($) is calculated. However, since the measures cannot be combined, this step is not necessary in this case.

Eliminating economically inefficient solutions is the fourth step in incremental analysis. In order to do this, the list of solutions is reordered so that they are listed in ascending order of their outputs. Where two or more solutions produce the same output, the solutions are ranked in ascending order of their costs. The result is a ranking of measures AA, A, C, D, B, G, H, E, and F as displayed below in table 6.3-3. At each level of output the least cost measure is determined. Measure A was identified as an inefficient measure because it provides the same output as measure C for a greater cost. Measure A will not be carried forward in this analysis.

Table 6.3-3.
List of Efficient Measures

Measures	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	0
		142
Measure C	$1,604,663	142
Measure D	$1,303,797	154
Measure B	$1,973,483	172
Measure G	$1,714,670	250
Measure H	$1,410,554	276
Measure E	$2,717,590	304
Measure F	$2,083,484	330

The fifth step in incremental analysis is to eliminate economically ineffective solutions. The outputs and costs undergo a pair-wise comparison. The results of the comparison are analyzed to determine which solutions will produce less output at equal or greater cost than subsequently ranked solutions. Those solutions that will produce less output at equal or greater cost than subsequently ranked solutions are deleted. Measures C, B, G, and E were eliminated because they were found to be ineffective solutions. Measure C was eliminated because measure D produces more output for less cost than measure C, measures B and G were eliminated because measure H produces more output for less cost, and measure E was eliminated because measure F produces more output for less cost. Table 6.3-4 summarizes the results of step five.

Table 6.3-4.
List of Effective Measures

Measures	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	0
		142
Measure D	$1,303,797	154
		172
		250
Measure H	$1,410,554	276
		304
Measure F	$2,083,484	330

Step six calculates the average cost of each of the cost effective solutions and eliminates those measures that yield less output at a higher cost than the measure with the lowest average cost per functional habitat index (FHI). Step seven repeats step six to further screen measures. Steps eight and nine perform an incremental cost analysis on the measures that were moved forward after going through steps six and seven.

Traditionally, these steps are part of the incremental analysis portion of the “Nine Easy Steps” and are performed on the remaining measures. However, since the Congressional Authority that was given to do the MsCIP Comprehensive study specifically directs the Corps of Engineers not to conduct Incremental Cost Analysis, this analysis will conclude at step six, with measures D, H and F moving forward for further consideration. Table 6.3-5 shows the environmentally cost effective measures for beach and dune placement for planning unit one that will be carried forward for further comparison.

Table 6.3-5.
List of Cost Effective Measures for Planning Unit One

Measures	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	0
Measure D	$1,303,797	154
Measure H	$1,410,554	276
Measure F	$2,083,484	330
Measure I	$6,179,277	136
Measure J	$6,292,507	216
Measure K	$254,783	248

6.3.1.7 Regional Economic Development (RED)

The purpose of this section is to show the regional economic impact of the cost effective measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Hancock County, Mississippi. The expenditures for the measures are estimated to be $4,030,000 for the Measure D measure, $6,440,000 for the Measure F measure, $4,360,000 for the Measure H measure, $19,100,000 for the Measure I measure, $19,450,000 for the Measure J measure and $4,640,000 for the Measure K measure. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $20,150,000 for the measure D, $32,200,000 for the measure F, $21,800,000 for the measure H, $95,500,000 for the measure I, $97,520,000 for the Measure J measure and $0 for the Measure K measure (assuming a 50-year period of analysis and an interest rate of 4.875 percent). Tables 6.3-6 through 6.3-9 summarize the EIFS model inputs and outputs for the beach and dune placement measures at for Planning Unit One.

Table 6.3-6.
EIFS Model Implementation Inputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Region of Influence (ROI)	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County
Change in Local Expenditures	$4,030,000	$6,440,000	$4,360,000	$19,100,000	$19,450,000	$4,640,000

Based of the given inputs the outputs are as follows:

Table 6.3-7.
EIFS Model Implementation Outputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Direct Sales Volume	$4,030,000	$6,440,000	$4,360,000	$19,100,000	$19,450,000	$4,640,000
Induced Sales Volume	$4,030,000	$6,440,000	$4,360,000	$19,100,000	$19,450,000	$4,640,000
Total Sales Volume	$8,060,000	$12,880,000	$8,720,000	$38,200,000	$38,900,000	$9,280,000
Direct Income	$971,774	$1,552,910	$1,051,349	$4,605,680	$4,690,077	$1,118,867
Induced Income	$971,774	$1,552,910	$1,051,349	$4,605,680	$4,690,077	$1,118,867
Total Income	$1,943,549	$3,105,820	$2,102,698	$9,211,359	$9,380,154	$2,237,733
Direct Employment	24	39	26	116	118	28
Induced Employment	24	39	26	116	118	28
Total Employment	49	78	53	231	235	56
Local Population	0	0	0	0	0	0

Table 6.3-8.
EIFS Model Operation and Maintenance Cost Inputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Region of Influence (ROI)	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County
Change in Local Expenditures	$20,150,000	$32,200,000	$21,800,000	$95,500,000	$97,250,000	$0

Based of the given inputs the outputs are as follows:

Table 6.3-9.
EIFS Model Operation and Maintenance Cost Outputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Direct Sales Volume	$20,150,000	$32,200,000	$21,800,000	$95,500,000	$97,250,000	$0
Induced Sales Volume	$20,150,000	$32,200,000	$21,800,000	$95,500,000	$97,250,000	$0
Total Sales Volume	$40,300,000	$64,400,000	$43,600,000	$191,000,000	$194,500,000	$0
Direct Income	$4,858,871	$7,764,549	$5,256,744	$23,028,398	$23,450,385	$0
Induced Income	$4,858,871	$7,764,549	$5,256,744	$23,028,398	$23,450,385	$0
Total Income	$9,717,743	$15,529,098	$10,513,489	$46,056,796	$46,900,769	$0
Direct Employment	122	195	132	578	588	0
Induced Employment	122	195	132	578	588	0
Total Employment	244	390	264	1156	1177	0
Local Population	0	0	0	0	0	0

6.3.1.8 Summary of Cost Effective Measures and their Benefits

Table 6.3-10 shows the potential measures that are being carried forward for further consideration. Measures D, H, and F are beach and dune placement measures that depend on the construction of the seawall in order to be implemented. Measures I, J, and K are stand alone measures that do not depend on the seawall and elevated roadway for implementation.

Table 6.3-10.
List of Cost Effective Measures Carried Forward for Further Consideration
Planning Unit One

Measures	Total Annual Cost ($)	Environmental Output (FHI)	Change in Sales Volume	Change in Income	Change in Employment
Measure AA (No Action)	$0	0	$0	$0	0
Measure D	$1,303,797	154	$48,360,000	$11,661,292	293
Measure H	$1,410,554	276	$52,320,000	$12,616,186	317
Measure F	$2,083,484	330	$77,280,000	$18,634,917	468
Measure I	$6,179,277	136	$229,200,000	$55,268,156	1,387
Measure J	$6,292,507	216	$233,400,000	$56,280,923	1,412
Measure K	$254,783	248	$9,280,000	$2,237,733	56

6.3.1.9 Public Access and Parking

An analysis of public access and parking was conducted on the sections where beach and dune construction would take place. It was determined that planning unit one has sufficient access and parking to satisfy the requirements established in Engineering Regulation (ER) 1165-2-100. Planning unit one has access along the entire stretch of beach with 592 parking spaces that are available to everyone for no cost. Addendum C describes the result of the access and parking analysis in greater detail.

6.3.2 Panning Unit Two

6.3.2.1 Background

The beaches of Hancock County are approximately 9 miles in length, and host one of the Gulf Coast's largest populations of Least Tern, a Federally-listed endangered species, plus a significant number of Piping Plover. The beaches possessed a dune system (pre-Katrina) that was maintained by local interests, that was vegetated and supported a significant ecosystem, in addition to passive recreation usage outside the dune system. This dune system provided not only ecosystem benefits, but some measure of hurricane or storm damage reduction due to its ability to absorb some of the surge and wave energy during those types of events. During Hurricane Katrina, this dune system was almost entirely destroyed by surge and wave action. Almost all ecosystem functions and values were eliminated during this single event. Much of the sand removed is believed to be close off shore in the near shore zone. The MsCIP Interim Chief's Report recommended that a beach and dune placement project be constructed in Panning Unit 3. This interim project consists of restoring approximately 26 miles of dune systems that were destroyed by Hurricane Katrina. The proposed project area for planning unit two is shown in figures 6.3.2-1 through 6.3.2-3.

6.3.2.1.1 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation
- Prevention or remediation of Saltwater Intrusion
- Preservation of Fish & Wildlife and restoration of their habitats
- Prevention or remediation of erosion
- Other related water resource purposes, such as ecosystem restoration or barrier island restoration



Figure 6.3.2-1. Project Sites for LOD2 in Panning Unit 2

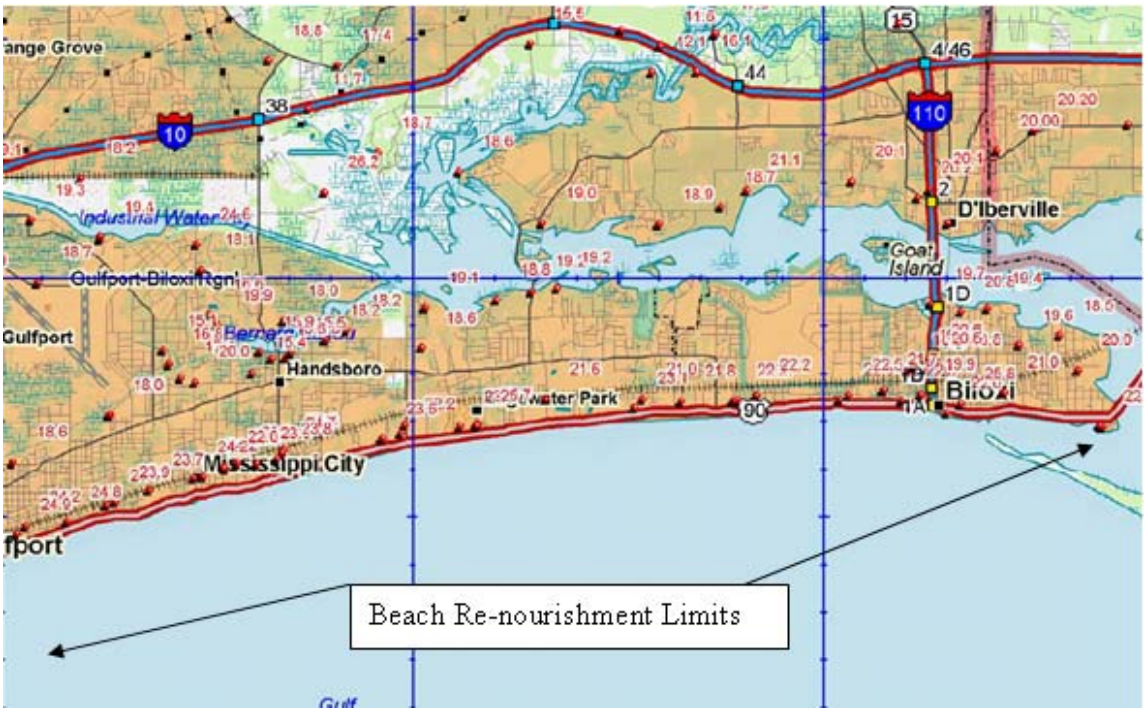


Figure 6.3.2-2. Eastern Project Limits for Line of Defense 2 in Panning Unit 2

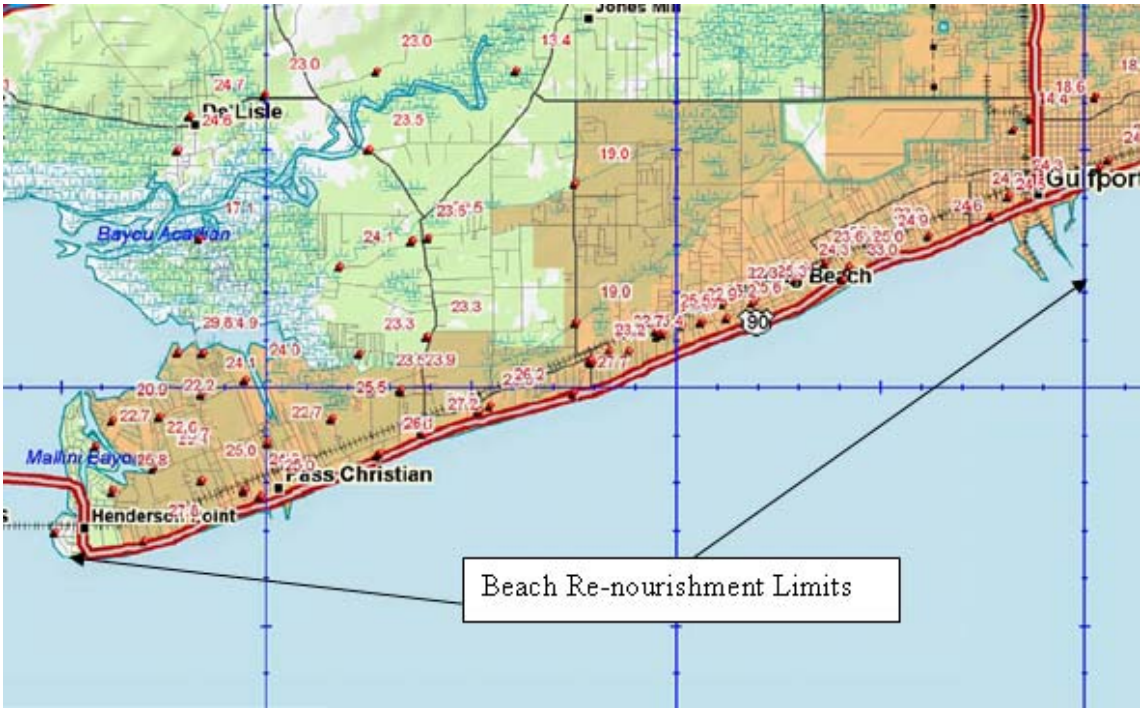


Figure 6.3.2-3. Western Project Limits for Line of Defense 2 in Panning Unit 2

6.3.2.2 General Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs
- Price levels are October, 2007 unless otherwise stated.
- A 50-year period of analysis was used to calculate average annual benefits and costs.

6.3.2.3 Measures

Eleven plans were evaluated for enhanced beach protection at the study site. All involve providing a dune and berm to the location. Some of the alternatives, Measures A through H described below, can not be constructed without the construction of the Seawall and Elevated roadway measure, which is evaluated in great detail later in this appendix. The measures for Line of Defense 2 in Panning Unit 2 are as follows:

- Measure A consists of a 15.0 feet NAVD88 dune elevation, 35.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 160.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure B consists of a 13.0 feet NAVD88 dune elevation, 45.0 feet NAVD88 dune crest width, with a dune slope of 1:3, and a berm with a 160.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure C consists of a 15.0 feet NAVD88 dune elevation, 25.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 170.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure D consists of a 13.0 feet NAVD88 dune elevation, 15.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 160.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure E consists of a 15.0 feet NAVD88 dune elevation, 35.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 160.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the seaward toe of the dune.
- Measure F consists of a 13.0 feet NAVD88 dune elevation, 45.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 160.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the seaward toe of the dune.
- Measure G consists of a 15.0 feet NAVD88 dune elevation, 25.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 170.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the seaward toe of the dune.
- Measure H consists of a 13.0 feet NAVD88 dune elevation, 15.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 160.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern,

with a total of three rows of plants starting at the seaward toe of the dune. Figure 6.3.2-4 shows a typical cross section for Measures A though H.

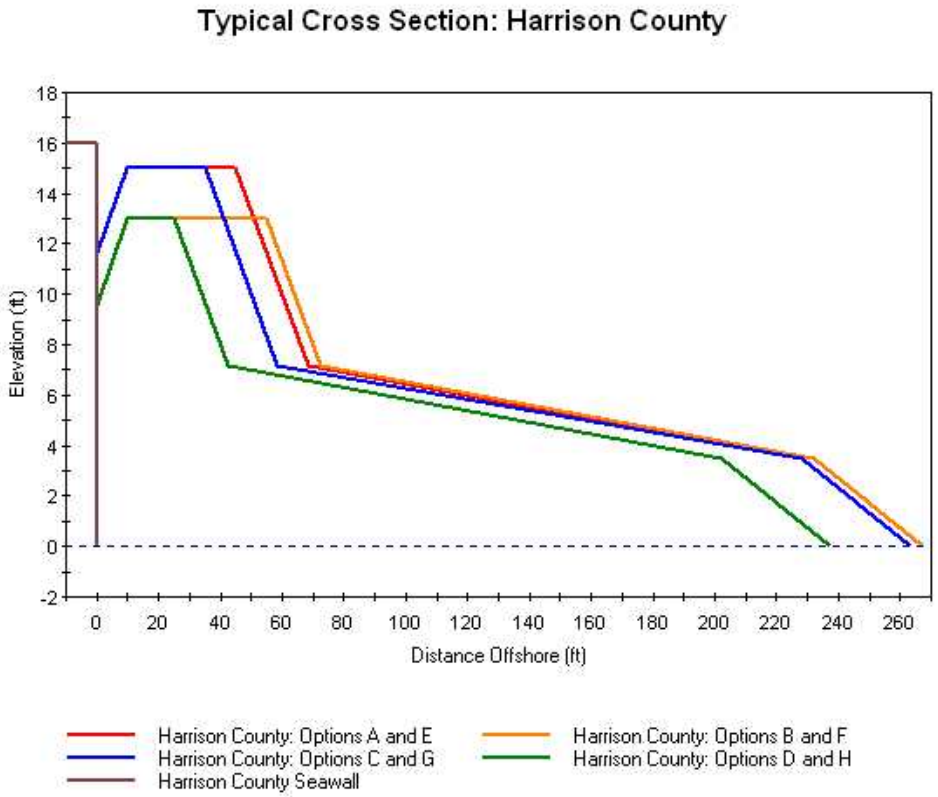


Figure 6.3.2-4. Typical Cross Section for Measures A through H

- Measures I and J are comparative with-project measures, for future evaluation, consisting of a design cross-section which includes a dune and berm constructed as a stand alone project which does not incorporate the Line of Defense 3 seawall. Measure I consists of a dune feature constructed approximately 50.0 feet seaward of the seawall at an elevation of 15.0 feet NAVD 88, with a crest width of 55.0 feet, and a dune slope of 1:3. The berm width would be extended to accommodate the placement of the dune feature. Sand fencing would be placed on the dunes to reduce sand transport due to the strong winds which frequently occur during storms. The cross section for Measure J is the same as Measure I; however the dune would be planted to provide for additional environmental habitat. For Measure J, sea oats would be planted on both the landward and seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the landward and seaward toes of the dune. The dunes will require initial and continued maintenance of vegetation and sand fencing. A typical cross section for Measures I and J is shown in Figure 6.3.2-5.

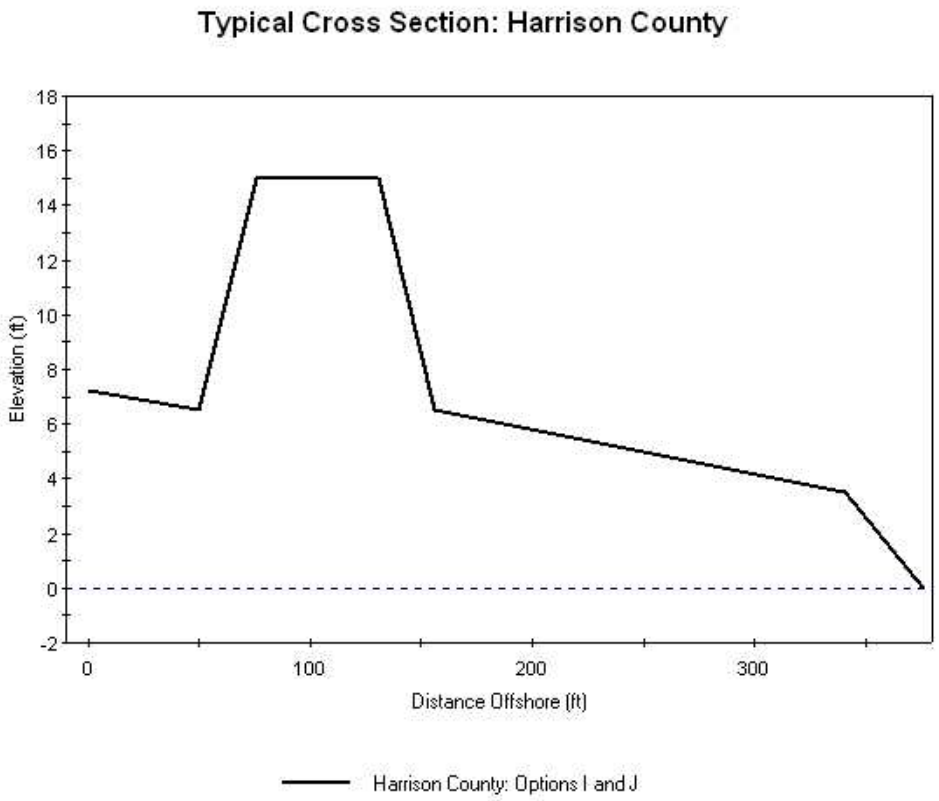


Figure 6.3.2-5. Typical Cross Section for Measures I and J

- Measure K is also a measure for future evaluation which consists of an elevated berm section constructed primarily for the creation of environmental habitat. Measure K would be constructed as a stand alone measure which does not incorporate the Line of Defense 3 seawall. The elevated berm section would be constructed approximately 50.0 feet seaward of the existing seawall to an elevation 2.0 feet above the existing berm with a width of approximately 60.0 feet. The berm width would not be extended to accommodate the placement of the elevated berm feature. The new feature would be vegetated and sand fencing would be placed to create environmental habitat and to reduce sand transport due to the strong winds which frequently occur during storms. For Measure K, sea oats would be planted in a 30 by 30 inch grid pattern over the entire elevated berm area. The new feature will require initial and continued maintenance of vegetation and sand fencing. A typical cross section for Measure K is shown in Figure 6.3.2-6.

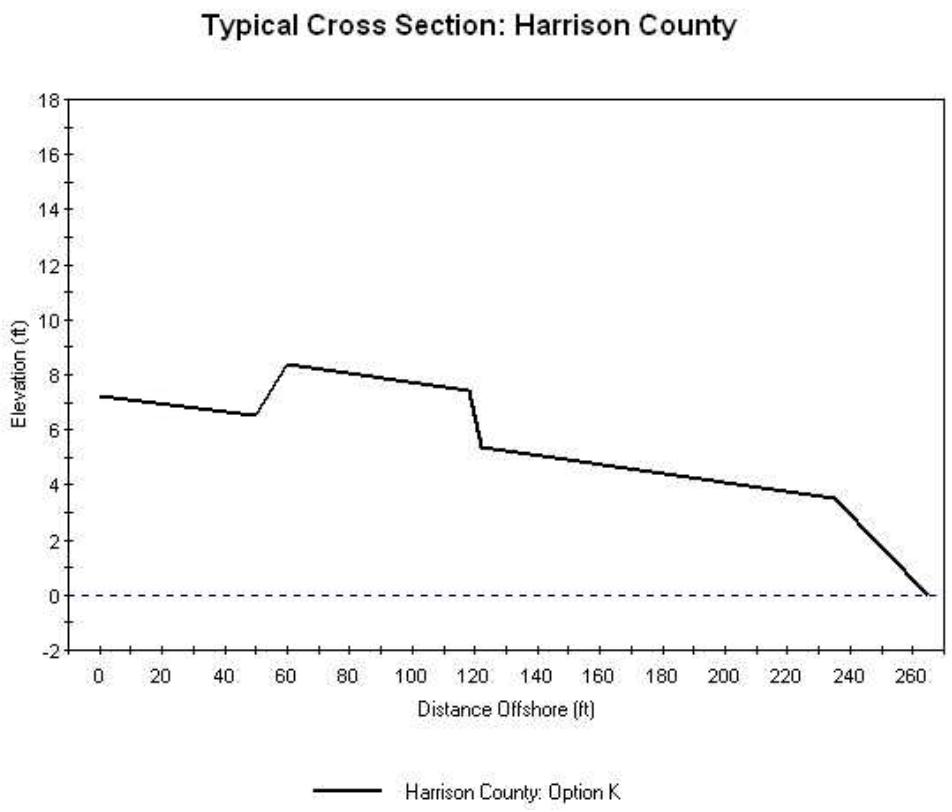


Figure 6.3.2-6. Typical Cross Section for Measure K

6.3.2.4 National Economic Development (NED)

This section describes the National Economic Development benefits for the various beach and dune placement measures in planning unit two that are attributable to hurricane and storm damage reduction. National economic development benefits are damages to structures and their contents that are reduced when a measure or alternative is implemented, or the difference between the with-project and without-project conditions.

There are two types of beach and dune placement measures for planning unit two; those that are dependent on the seawall and elevated roadway and those that can be implemented as stand alone measures. Those measures dependent on the seawall and elevated roadway, measures A through H, would be implemented to abut the seawall and elevated roadway and would be constructed to a maximum elevation of 1.0 foot lower than the seawall and elevated roadway, or to elevation 15.0 feet NAVD88, thus acting as a system. For these measures, equivalent annual damage reduction would be limited to structures that are physically located south of Beach Boulevard, since seawall and elevation of that roadway would be higher than the dune system itself. A visual description of this system can be seen above in figure 6.3-7. The remaining measures I, J, and K are stand alone, and would be implemented in lieu of the seawall and elevated roadway with dune system. The equivalent annual damage reduction attributable to the stand alone measures would impact structures located south of Beach Boulevard in planning unit two and some footprint of structures north of beach boulevard. Also, all beach and dune placement measures would provide some level of protection to the seawall and roadways that they abut, but those benefits are difficult to quantify and were not conducted in this analysis.

The Beach-FX program was selected to quantify the damage reduction benefits of all of the beach and dune placement measures. Beach-FX is a Monte Carlo based model that combines coastal processes economic conditions to evaluate damages from storm events and the level of damage reduction that would be attributable to a given measure. Chapter III of this appendix depicts the overall process of the Beach-FX evaluation. For this study, the exploration of the costal processes and economic inventorying was conducted. Further study would be required to combine the observed data and to evaluate the eleven alternatives previously mentioned. More detail on further study can be found in the MsCIP Comprehensive Plan Main Report. Table 6.3.2-1 summarizes the costs by measure for planning unit two.

6.3.2.6 National Ecosystem Restoration (NER)

The P&G defines the environmental quality account as, "displays of non-monetary effects on ecological, cultural, and aesthetic resources…" The EQ account is typically associated with ecosystem restoration projects, although it does address the following:

6.3.2.6.1 Cost Effective Analysis Assumptions

This analysis assumes a 50-year project life. Costs were amortized using the FY 2008 federal discount rate of 4.875-percent and are presented in October 2007 dollars. The outputs quantified in this cost effective analysis are defined as the quantification of expected improvements in target functions as related to project objectives (functional habitat index, FHI). FHI scores were based on an assessment protocol, which provide a basic level of stream health evaluation that is based on physical conditions within the assessment area. The assessment is used to record the scores for up to 15 assessment elements (i.e., channel condition, hydrologic alteration, riparian zone, bank stability, water appearance, nutrient enrichment, barriers to fish movement, instream fish cover, pools, insect/invertebrate habitat, canopy cover [warm water fishery], manure presence, salinity, riffle embeddedness, and macroinvertebrates observed). However, all assessment elements were not applicable to the assessment area and were not included.

The first step in cost-effective analysis is to display the environmental outputs (effects on habitat expressed in Functional Habitat Index, FHI) and the cost estimates of the management measure increments. Outputs and costs can be displayed as average annual outputs and average annual costs or total outputs and total costs. Both are acceptable so long as they are comparable. Average annual outputs and average annual costs were used for this analysis.

Table 6.3.2-2 displays the project alternatives and their associated average annual outputs and average annual costs. Project outputs for each alternative are displayed in terms of functional habitat index (FHI) that can be supported for each alternative considered.

Summary of Costs

Table 6.3.2-1 summarizes the ROM costs at an FY-08 price level for the beach and dune measures in planning unit two.

Table 6.3.2-1.
Summary of Beach and Dune Costs by Measure for Planning Unit Two

Measures	Implementation Cost (FY-08) ($)	IDC ($)	Total Implementation Cost ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A[1] (15FT by 35FT Dune without plantings)	$21,840,000	$752,800	$22,592,800	$1,213,737	$5,866,473	$7,080,210
Measure B[1] (13FT by 45FT Dune without plantings)	$18,600,000	$641,200	$19,241,200	$1,033,681	$4,996,172	$6,029,853
Measure C[1] (15FT by 25FT Dune without plantings)	$18,100,000	$624,100	$18,724,100	$1,005,901	$4,861,867	$5,867,768
Measure D[1] (13FT by 15FT Dune without plantings)	$10,400,000	$358,500	$10,758,500	$577,971	$2,793,559	$3,371,530
Measure E[1] (15FT by 35FT Dune with plantings)	$22,970,000	$791,800	$23,761,800	$1,276,538	$6,170,004	$7,446,542
Measure F[1] (13FT by 45FT Dune with plantings)	$19,760,000	$681,200	$20,441,200	$1,098,148	$5,307,761	$6,405,909
Measure G[1] (15FT by 25FT Dune with plantings)	$19,210,000	$662,100	$19,872,100	$1,067,575	$5,160,025	$6,227,600
Measure H[1] (13FT by 15FT Dune with plantings)	$11,520,000	$397,100	$11,917,100	$640,214	$3,094,403	$3,734,617
Measure I (Standalone 15FT Dune without plantings)	$40,290,000	$1,389,000	$41,679,000	$2,239,091	$10,822,354	$13,061,445
Measure J (Standalone 15FT Dune with plantings)	$41,460,000	$1,429,000	$42,889,000	$2,304,095	$11,136,629	$13,440,724
Measure K (Standalone 2FT Dune with plantings)	$9,680,000	$333,600	$10,013,600	$537,953	$0	$537,953

1/ Denotes measures that could not be implemented without the construction of the seawall, which is discussed in section 6.4.
2/ Cost include Construction Management, Supervision & Administration, and Contingencies. More detail on the costs can be found in the Cost Estimating Appendix.

Table 6.3.2-2.
Outputs and Costs by Measure

Measures	Annualized Implementation Cost ($)	Annual O&M ($)	Total Annual Cost ($)	Output (FHI)
Measure AA (No Action)	$0	$0	$0	0
Measure A	$1,213,737	$5,866,473	$7,080,210	142
Measure B	$1,033,681	$4,996,172	$6,029,853	172
Measure C	$1,005,901	$4,861,867	$5,867,768	154
Measure D	$577,971	$2,793,559	$3,371,530	130
Measure E	$1,276,538	$6,170,004	$7,446,542	304
Measure F	$1,098,148	$5,307,761	$6,405,909	330
Measure G	$1,067,575	$5,160,025	$6,227,600	276
Measure H	$640,214	$3,094,403	$3,734,617	250

The second step in cost effective analysis is to identify combinable management measures. This involves the analysis of the management measures to determine those that can be implemented together from those that cannot be implemented together. Each of the alternatives in this analysis is independent of the others. After the selection of one of the alternatives, the other alternatives are not needed; therefore the alternatives are not combinable.

The next step is to calculate outputs and costs of combinations. The combinations of the management measures are defined and analyzed incrementally. In this step, each combination of output (HU) and cost ($) is calculated. However, since the alternatives cannot be combined, this step is not necessary in this case.

Eliminating economically inefficient measures is the fourth step in cost effective analysis. In order to do this, the list of measures is reordered so that they are listed in ascending order of their outputs. Where two or more measures produce the same output, the measures are ranked in ascending order of their costs. The result is a ranking of measures AA, D, A, C, B, H, G, E, and F as displayed below in table 6.3.2-3. At each level of output the least cost measure is determined. No measures were identified as inefficient measures since all of the measures provide different levels of environmental lift; therefore all measures will be carried forward to the next step of this analysis.

Table 6.3.2-3.
List of Efficient Measures

Measures	Total Annual Cost ($)	Output (FHI)
Measure AA (No Action)	$0	0
Measure D	$3,371,530	130
Measure A	$7,080,210	142
Measure C	$5,867,768	154
Measure B	$6,029,853	172
Measure H	$3,734,617	250
Measure G	$6,227,600	276
Measure E	$7,446,542	304
Measure F	$6,405,909	330

The fifth step in cost effective analysis is to eliminate economically ineffective measures. The outputs and costs undergo a pair-wise comparison. The results of the comparison are analyzed to determine which measures will produce less output at equal or greater cost than subsequently ranked measures. Those measures that will produce less output at equal or greater cost than subsequently ranked measures are deleted. Measures A, C, and B were eliminated because they were found to be ineffective measures. Measure H produces more output for less cost than measures A, C, B. The results of this step are shown in table 6.3.2-4.

Table 6.3.2-4.
List of Effective Measures

Measures	Total Annual Cost ($)	Output (FHI)
Measure AA (No Action)	$0	0
Measure D	$3,371,530	130
		142
		154
		172
Measure H	$3,734,617	250
Measure G	$6,227,600	276
		304
Measure F	$6,405,909	330

Step six calculates the average cost of each of the cost effective measures and eliminates those measures that yield less output at a higher cost than the measure with the lowest average cost per functional habitat index (FHI). Step seven repeats step six to further screen alternatives. Steps eight and nine perform an incremental cost analysis on the measures that were moved forward after going through steps six and seven.

Traditionally, these steps are part of the cost effective analysis portion of the “Nine Easy Steps” and are performed on the remaining plans. However, since the Congressional Authority that was given to do the MsCIP Comprehensive study specifically directs the Corps of Engineers not to conduct Incremental Cost Analysis, this analysis will conclude at step five, with measures D, G, H and F moving forward for further consideration. Table 6.3.2-5 shows the environmentally cost effective plans for beach and dune placement for Panning Unit two that will be carried forward for further comparison.

Table 6.3.2-5.
List of Cost Effective Measures for Planning Unit Two

Measures	Total Annual Cost ($)	Output (FHI)
Measure AA (No Action)	$0	0
Measure D	$3,371,530	130
Measure H	$3,734,617	250
Measure G	$6,227,600	276
Measure F	$6,405,909	330
Measure I	$13,061,445	140
Measure J	$13,440,724	220
Measure K	$537,953	240

6.3.2.7 Regional Economic Development (RED)

The purpose of this section is to show the economic impact of the cost effective measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Harrison County, Mississippi. The expenditures for the measures are estimated to be $10,400,000 for the measure D, $19,760,000 for the measure F, $19,210,000 for measure G, $11,520,000 for the measure H, $40,290,000 for the measure I, $41,460,000 for the measure J, and $9,680,000 for the measure K. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $52,000,000 for the measure D, $98,800,000 for the measure F, $$96,050,000 for measure G, $57,600,000 for the measure H, $201,450,000 for the measure I, $207,300,000 for the measure J, and $0 for the measure K (assuming a 50-year period of analysis and an interest rate of 4.875 percent). Tables 6.3.2-6 through 6.3.2-9 summarize the EIFS model inputs and outputs for the beach and dune placement measures at Planning Unit Two.

Table 6.3.2-6.
EIFS Model Implementation Cost Inputs for LOD2

	Measure D	Measure F	Measure G	Measure H	Measure I	Measure J	Measure
Region of Influence (ROI)	Harrison County	Harrison County	Harrison County	Harrison County	Harrison County	Harrison County	Harrison County
Change in Local Expenditures	$10,400,000	$19,760,000	$19,210,000	$11,520,000	$40,290,000	$41,460,000	$9,680,000

Based of the given inputs the outputs are as follows:

Table 6.3.2-7.
EIFS Model Implementation Cost Outputs for LOD2

	Measure D	Measure F	Measure G	Measure H	Measure I	Measure J	Measure K
Direct Sales Volume	$10,400,000	$19,760,000	$19,210,000	$11,520,000	$40,290,000	$41,460,000	$9,680,000
Induced Sales Volume	$13,000,000	$24,700,000	$24,012,500	$14,400,000	$50,362,500	$51,825,000	$12,100,000
Total Sales Volume	$23,400,000	$44,460,000	$43,222,500	$25,920,000	$90,652,500	$93,285,000	$21,780,000
Direct Income	$2,201,423	$4,182,705	$4,066,283	$2,438,500	$8,528,399	$8,776,059	$2,049,017
Induced Income	$2,751,780	$5,228,381	$5,082,855	$3,048,125	$10,660,500	$10,970,076	$2,561,272
Total Income	$4,953,203	$9,411,086	$9,149,138	$5,486,625	$19,188,899	$19,746,135	$4,610,289
Direct Employment	66	125	122	73	256	263	61
Induced Employment	83	157	153	91	320	329	77
Total Employment	149	282	275	165	576	592	138
Local Population	0	0	0	0	0	0	0

Table 6.3.2-8.
EIFS Model Operation and Maintenance Cost Inputs for LOD2

	Measure D	Measure F	Measure G	Measure H	Measure I	Measure J	Measure K
Region of Influence (ROI)	Harrison County	Harrison County	Harrison County	Harrison County	Harrison County	Harrison County	Harrison County
Change in Local Expenditures	$52,000,000	$98,800,000	$96,050,000	$57,600,000	$201,450,000	$207,300,000	$0

Based of the given inputs the outputs are as follows:

Table 6.3.2-9.
EIFS Model Operation and Maintenance Cost Outputs for LOD2

	Measure D	Measure F	Measure G	Measure H	Measure I	Measure J	Measure K
Direct Sales Volume	$52,000,000	$98,800,000	$96,050,000	$57,600,000	$201,450,000	$207,300,000	$0
Induced Sales Volume	$65,000,000	$123,500,000	$120,062,500	$72,000,000	$251,812,500	$259,125,000	$0
Total Sales Volume	$117,000,000	$222,300,000	$216112,500	$129,600,000	$453,262,500	$466,425,000	$0
Direct Income	$11,007,117	$20,913,523	$20,331,415	$12,192,499	$42,641,995	$43,880,296	$0
Induced Income	$13,758,898	$26,141,907	$25,414,273	$15,240,626	$53,302,502	$54,850,378	$0
Total Income	$24,766,016	$47,055,430	45,745,688	$27,433,125	$95,944,497	$98,730,674	$0
Direct Employment	330	627	610	366	1,279	1,316	0
Induced Employment	413	784	763	457	1,600	1,646	0
Total Employment	743	1,412	1,373	823	2,879	2,962	0
Local Population	0	0		0	0	0	0

6.3.2.8 Summary of Cost Effective Measures

Table 6.3.2-10 shows the potential measures that are being carried forward for further consideration. Measures D, H, G, and F are beach and dune placement measures that depend on the construction of the seawall in order to be implemented. Measures I, J, and K are stand alone measures that do not depend on the seawall for implementation.

Table 6.3.2-10.
List of Measures Carried Forward for Further Evaluation in Planning Unit Two
Planning Unit Two

Measures	Total Annual Cost ($)	Total Annual Output (FHI)	Change in Sales Volume	Change in Income	Change in Employment
Measure AA (No Action)	$0	0	$0	$0	0
Measure D[1]	$3,371,530	130	$140,400,000	$29,719,219	892
Measure H[1]	$3,734,617	250	$155,520,000	$32,919,750	988
Measure G[1]	$6,227,600	276	$259,335,000	$54,894,826	1,647
Measure F[1]	$6,405,909	330	$266,760,000	$56,466,515	1,694
Measure I	$13,061,445	140	$543,915,000	$115,133,396	3,454
Measure J	$13,440,724	220	$559,710,000	$118,476,808	3,555
Measure K	$537,953	240	$21,780,000	$4,610,289	138

6.3.2.9 Public Access and Parking

A parking and access analysis was conducted on the sections where beach and dune constriction would take place for planning unit two. It was determined that planning unit two has sufficient access and parking to satisfy the requirements established in Engineering Regulation (ER) 1165-2-100. Planning unit two also has access along the entire twenty-six mile length of beach and has 2,788 free parking spaces. Addendum C describes the result of the access and parking analysis in greater detail.

6.3.3 Planning Unit Three

6.3.3.1 Background

The beaches of Jackson County are host one of the Gulf Coast's largest populations of Least Tern, a Federally-listed endangered species, plus a significant number of Piping Plover. During Hurricane Katrina, this dune system was almost entirely destroyed by surge and wave action. Almost all ecosystem functions and values were eliminated during this single event. Much of the sand removed is believed to be close off shore in the near shore zone. The MsCIP Interim Chiefs Report did not recommend a beach and dune placement project be constructed in planning unit three; therefore the without-project condition for this planning unit is the post storm condition. Maintenance occurs on the Jackson County beaches if it is determined that significant erosion occurs following a significant event; with the beaches restored to the pre-storm condition. There is no scheduled periodic maintenance of the beaches. The future without-project conditions assume continuation of the present maintenance activities to restore the berm only feature in Jackson. The berm elevation varies from approximately 5.0 feet NAVD88 at the seawall to 3.5 feet NAVD88 at the slope break to the Mississippi Sound. Figure 6.3.3-1 shows the project location for planning unit three.



Figure 6.3.3-1. Project Sites for Beach and Dune Placement in Planning Unit Three

6.3.3.1.1 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation
- Preservation of Fish & Wildlife and restoration of their habitats
- Prevention or remediation of erosion
- Other related water resource purposes, such as ecosystem restoration or barrier island restoration

6.3.3.2 General Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs
- Price levels are October, 2007 unless otherwise stated.
- A 50-year period of analysis was used to calculate average annual benefits and costs.

6.3.3.3 Measures

Two plans were evaluated for enhanced beach protection at the study site. All involve providing a dune and berm to the location. Some of the alternatives, Measures A through H described below, can not be constructed without the construction of the Seawall and Elevated roadway measure, which is evaluated in great detail later in this appendix. The measures for Line of Defense 2 in planning unit three are as follows:

- Measure A consists of a 10.0 feet NAVD88 dune elevation, 40.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure B consists of an 8.0 feet NAVD88 dune elevation, 50.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure C consists of a 10.0 feet NAVD88 dune elevation, 20.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure D consists of an 8.0 feet NAVD88 dune elevation, 30.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure E consists of a 10.0 feet NAVD88 dune elevation, 40.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the seaward toe of the dune.
- Measure F consists of an 8.0 feet NAVD88 dune elevation, 50.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the seaward toe of the dune.
- Measure G consists of a 10.0 feet NAVD88 dune elevation, 20.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the seaward toe of the dune.
- Measure H consists of an 8.0 feet NAVD88 dune elevation, 30.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern,

with a total of three rows of plants starting at the seaward toe of the dune. Figure 6.3.3-2 shows a typical cross section for Measures A though H.

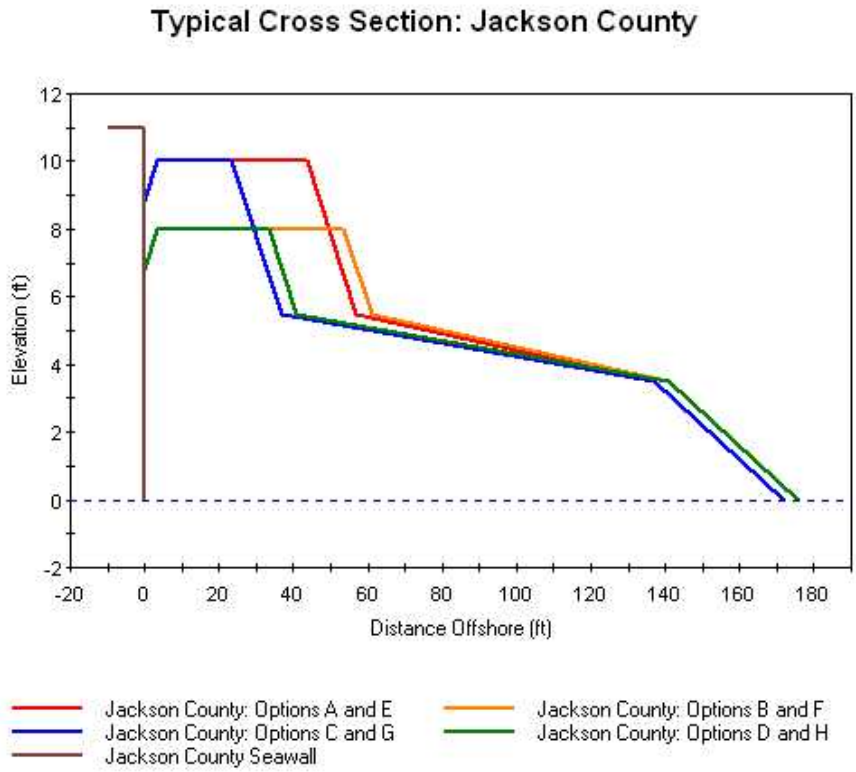


Figure 6.3.3-2. Typical Cross Section for Measures A through H

Measures I and J are comparative with-project measures, for future evaluation, consisting of a design cross-section which includes a dune and berm constructed as a stand alone project which does not incorporate the Line of Defense 3 seawall. Measure I consists of a dune feature constructed approximately 50.0 feet seaward of the seawall at an elevation of 10.0 feet NAVD 88, with a crest width of 55.0 feet, and a dune slope of 1:3. The berm width would be extended to accommodate the placement of the dune feature. Sand fencing would be placed on the dunes to reduce sand transport due to the strong winds which frequently occur during storms. The cross section for Measure J is the same as Measure I; however the dune would be planted to provide for additional environmental habitat. For Measure J, sea oats would be planted on both the landward and seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the landward and seaward toes of the dune. The dunes will require initial and continued maintenance of vegetation and sand fencing. Figure 6.3.3-3 shows the typical cross section for measures I and J.

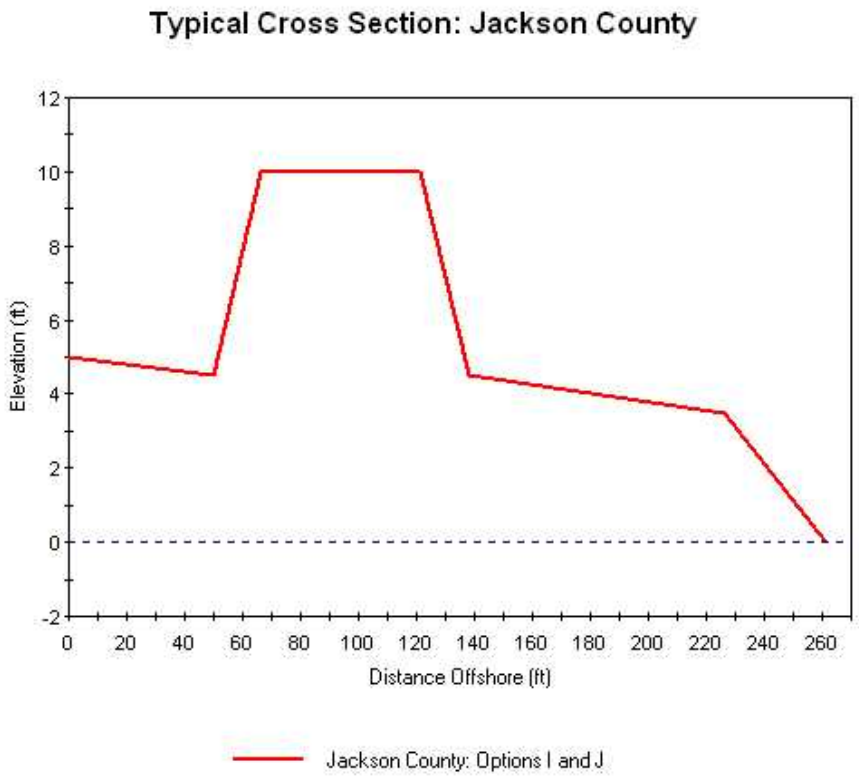


Figure 6.3.3-3. Typical cross section for Measures I and J

Measure K is also a measure for future evaluation which consists of an elevated berm section constructed primarily for the creation of environmental habitat. Measure K would be constructed as a stand alone measure which does not incorporate the Line of Defense 3 seawall. The elevated berm section would be constructed approximately 50.0 feet seaward of the existing seawall to an elevation 2.0 feet above the existing berm with a width of approximately 60.0 feet. The berm width would not be extended to accommodate the placement of the elevated berm feature. The new feature would be vegetated and sand fencing would be placed to create environmental habitat and to reduce sand transport due to the strong winds which frequently occur during storms. For Measure K, sea oats would be planted in a 30 by 30 inch grid pattern over the entire elevated berm area. The new feature will require initial and continued maintenance of vegetation and sand fencing. Figure 6.3.3-4 shows the typical cross section for measure K.

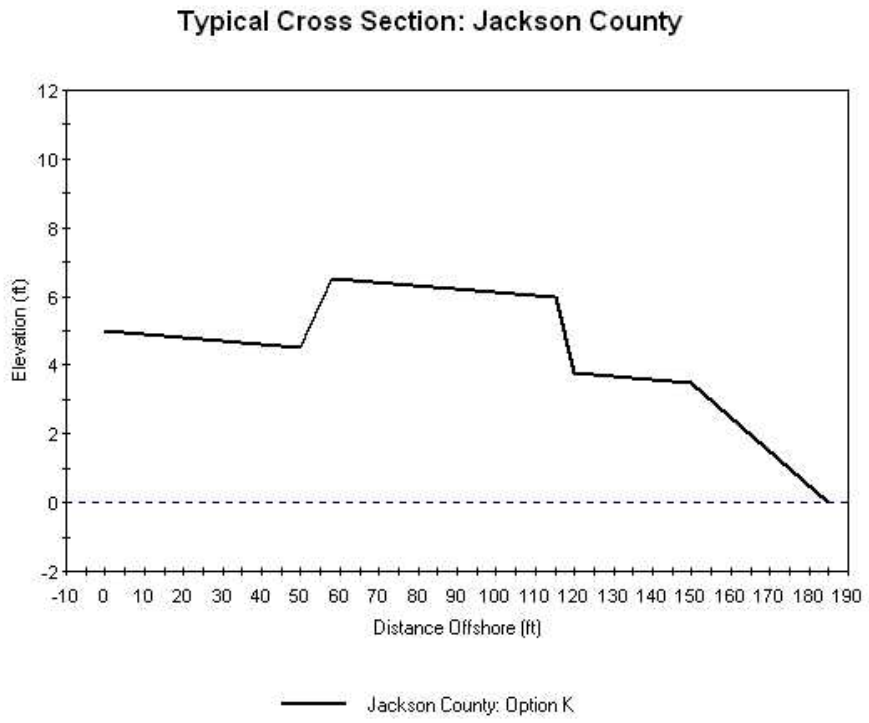


Figure 6.3.3-4. Typical cross section for measure K

6.3.3.4 National Economic Development (NED)

This section describes the National Economic Development benefits for the various beach and dune placement measures in planning unit three that are attributable to hurricane and storm damage reduction. National economic development benefits are damages to structures and their contents that are reduced when a measure or alternative is implemented, or the difference between the with-project and without-project conditions.

There are two types of beach and dune placement measures for planning unit three; those that are dependent on the seawall and elevated roadway and those that can be implemented as stand alone measures. Those measures dependent on the seawall and elevated roadway, measures A through H, would be implemented to abut the seawall and elevated roadway and would be constructed to a maximum elevation of 1.0 foot lower than the seawall and elevated roadway, or to elevation 10.0 feet NAVD88, thus acting as a system. For these measures, equivalent annual damage reduction would be limited to structures that are physically located south of Beach Boulevard, since seawall and elevation of that roadway would be higher than the dune system itself. A visual description of this system can be seen above in figure 6.3-11. The remaining measures I, J, and K are stand alone, and would be implemented in lieu of the seawall and elevated roadway with dune system. The equivalent annual damage reduction attributable to the stand alone measures would impact structures located south of Beach Boulevard in planning unit three and some footprint of structures north of Beach Boulevard. Also, all beach and dune placement measures would provide some level of protection to the seawall and roadways that they abut, but those benefits are difficult to quantify and were not conducted in this analysis.

The Beach-FX program was selected to quantify the damage reduction benefits of all of the beach and dune placement measures. Beach-FX is a Monte Carlo based model that combines coastal processes economic conditions to evaluate damages from storm events and the level of damage reduction that would be attributable to a given measure. Chapter III of this appendix depicts the overall process of the

Beach-FX evaluation. For this study, the exploration of the coastal processes and economic inventorying was conducted. Further study would be required to combine the observed data and to evaluate the eleven alternatives previously mentioned. More detail on the further study can be found in the MsCIP Comprehensive Plan Main Report. Table 6.3.3-1 summarizes the costs for the beach and dune construction measures for planning unit three. For this study, the exploration of the coastal processes and economic inventorying was conducted. Further study would be required to combine the observed data and to evaluate the eleven alternatives previously mentioned. More detail on the further study can be found in the MsCIP Comprehensive Plan Main Report. Table 6.3.3-1 summarizes the costs for the beach and dune construction measures for planning unit three.

6.3.3.5 Summary of Costs

Table 6.3.3-1 summarizes the ROM costs at an FY-08 price level for the beach and dune measures in planning unit three.

Table 6.3.3-1.
Summary of Beach and Dune Costs by Measure for Planning Unit Three

Measures	Implementation Cost ($)	IDC ($)	Total Implementation Cost ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A[1] (10FT by 40FT Dune without plantings)	$1,910,000	$42,200	$1,952,200	$104,877	$513,048	$617,924
Measure B[1] (8FT by 50FT Dune without plantings)	$1,450,000	$32,100	$1,482,100	$79,622	$389,487	$469,108
Measure C[1] (10FT by 20FT Dune without plantings)	$1,180,000	$26,400	$1,206,400	$64,811	$316,961	$381,772
Measure D[1] (8FT by 30FT Dune without plantings)	$960,000	$21,200	$981,200	$52,712	$257,867	$310,579
Measure E[1] (10FT by 40FT Dune with plantings)	$1,990,000	$44,000	$2,034,000	$109,271	$534,537	$643,808
Measure F[1] (8FT by 50FT Dune with plantings)	$1,530,000	$33,900	$1,563,900	$84,016	$410,975	$494,992
Measure G[1] (10FT by 20ft Dune with plantings)	$1,260,000	$27,900	$1,287,900	$69,189	$338,450	$407,639
Measure H[1] (8FT by 30FT Dune with plantings)	$1,040,000	$22,900	$1,062,900	$57,101	$279,356	$336,457
Measure I (10FT by 50FT Dune without plantings)	$4,490,000	$99,400	$4,589,400	$246,553	$1,206,065	$1,452,618
Measure J (10FT by 50FT Dune with plantings)	$4,570,000	$101,200	$4,671,200	$250,948	$1,227,554	$1,478,502
Measure K (2FT by 60FT Dune with plantings)	$1,110,000	$24,600	$1,134,600	$60,953	$0	$60,953

1/ Denotes measures that could not be implemented without the construction of the seawall, which is discussed in section 6.4.
2/ Cost include Construction Management, Supervision & Administration, and Contingencies. More detail on the costs can be found in the Cost Estimating Appendix.

6.3.3.6 National Ecosystem Restoration (NER)

The P&G defines the environmental quality account as, “displays of non-monetary effects on ecological, cultural, and aesthetic resources…” The EQ account is typically associated with ecosystem restoration projects, although it does address the following:

6.3.3.6.1 Cost Effective Analysis Assumptions

This analysis assumes a 50-year project life. Costs were amortized using the FY 2008 federal discount rate of 4.875-percent and are presented in October 2007 dollars. The outputs quantified in this cost effective analysis are defined as the quantification of expected improvements in target functions as related to project objectives (functional habitat index, FHI). FHI scores were based on an assessment protocol, which provide a basic level of stream health evaluation that is based on physical conditions within the assessment area. The assessment is used to record the scores for up to 15 assessment elements (i.e., channel condition, hydrologic alteration, riparian zone, bank stability, water appearance, nutrient enrichment, barriers to fish movement, instream fish cover, pools, insect/invertebrate habitat, canopy cover [warm water fishery], manure presence, salinity, riffle embeddedness, and macroinvertebrates observed). However, all assessment elements were not applicable to the assessment area and were not included.

The first step in cost-effective analysis is to display the environmental outputs (effects on habitat expressed in Functional Habitat Index, FHI) and the cost estimates of the management measure increments. Outputs and costs can be displayed as average annual outputs and average annual costs or total outputs and total costs. Both are acceptable so long as they are comparable. Average annual outputs and average annual costs were used for this analysis.

Table 6.3.3-2 displays the project alternatives and their associated average annual outputs and average annual costs. Project outputs for each alternative are displayed in terms of functional habitat index (FHI) that can be supported for each alternative considered.

Table 6.3.3-2.
Outputs and Costs by Increments by Measure

Measures	Annualized Implementation Cost ($)	Annual O&M ($)	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	$0	$0	0
Measure A	$104,877	$513,048	$617,924	142
Measure B	$79,622	$389,487	$469,108	172
Measure C	$64,811	$316,961	$381,772	142
Measure D	$52,712	$257,867	$310,579	154
Measure E	$109,271	$534,537	$643,808	304
Measure F	$84,016	$410,975	$494,992	330
Measure G	$69,189	$338,450	$407,639	250
Measure H	$57,101	$279,356	$336,457	276

The second step in cost effective analysis is to identify combinable management measures. This involves the analysis of the management measures to determine those that can be implemented together from those that cannot be implemented together. Each of the alternatives in this analysis is independent of the others. After the selection of one of the alternatives, the other alternatives are not needed; therefore the alternatives are not combinable.

The next step is to calculate outputs and costs of combinations. The combinations of the management measures are defined and analyzed incrementally. In this step, each combination of output (FHI) and cost ($) is calculated. However, since the alternatives cannot be combined, this step is not necessary in this case.

Eliminating economically inefficient solutions is the fourth step in cost effective analysis. In order to do this, the list of solutions is reordered so that they are listed in ascending order of their outputs. Where two or more solutions produce the same output, the solutions are ranked in ascending order of their costs. The result is a ranking of measures AA, A, C, D, B, G, H, E, and F as displayed below in table 6.3.3-3. At each level of output the least cost measure is determined. Measure A was identified as an inefficient measure and will not be carried forward in this analysis.

Table 6.3.3-3.
List of Economically Efficient Measures for Planning Unit Three

Measures	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	0
		142
Measure C	$381,772	142
Measure D	$310,579	154
Measure B	$469,108	172
Measure G	$407,639	250
Measure H	$336,457	276
Measure E	$643,808	304
Measure F	$494,992	330

The fifth step in cost effective analysis is to eliminate economically ineffective solutions. The outputs and costs undergo a pair-wise comparison. The results of the comparison are analyzed to determine which solutions will produce less output at equal or greater cost than subsequently ranked solutions. Those solutions that will produce less output at equal or greater cost than subsequently ranked solutions are deleted. Measures C, B, G, and E were eliminated because they were found to be ineffective solutions. These measures were eliminated from further consideration because measure D produces more output for less cost than measure C, measure H produces more output for less cost than measures B and G, and measure F produces more output at less cost than measure E. The results of this step are summarized in table 6.3.3-4.

Step six calculates the average cost of each of the cost effective solutions and eliminates those measures that yield less output at a higher cost than the measure with the lowest average cost per functional habitat index (FHI). Step seven repeats step six to further screen alternatives. Steps eight and nine perform an incremental cost analysis on the measures that were moved forward after going through steps six and seven.

Table 6.3.3-4.
List of Economically Effective Measures for Planning Unit Three

Measures	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	0
		142
Measure D	$310,579	154
		172
		250
Measure H	$336,457	276
		304
Measure F	$494,992	330

Traditionally, these steps are part of the cost effective analysis portion of the "Nine Easy Steps" and are performed on the remaining plans. However, since the Congressional Authority that was given to do the MsCIP Comprehensive study specifically directs the Corps of Engineers not to conduct Incremental Cost Analysis, this analysis will conclude at step six, with measures H and F moving forward for further consideration. Table 6.3.3-5 shows the environmentally cost effective plans for beach and dune placement for planning unit three that will be carried forward for further comparison.

Table 6.3.3-5.
List of Cost Effective Measures for Planning Unit Three

Measures	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	0
Measure D	$310,579	154
Measure H	$336,45	276
Measure F	$494,992	330
Measure I	$1,452,618	136
Measure J	$1,478,502	216
Measure K	$60,953	248

6.3.3.7 Regional Economic Development (RED)

The purpose of this section is to show the economic impact of the cost effective project measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Jackson County, Mississippi. The expenditures for the measures are estimated to be $960,000 for the measure D, $1,530,000 for the measure F, $1,040,000 for the measure H, $4,490,000 for the measure I, $4,570,000 for the measure J, and $1,110,000 for the measure K. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $4,800,000 for the measure D, $7,650,000 for the measure F, $5,200,000 for the measure H, $22,450,000 for the measure I, $22,850,000 for the Measure J measure, and $0 for the Measure K measure (assuming a 50-year period of analysis and an interest rate of 4.875 percent). Tables 6.3.3-6 through 6.3.3-9 show the EIFS model inputs and outputs for the measures ate planning unit three.

Table 6.3.3-6.
EIFS Model Implementation Inputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$960,000	$1,530,000	$1,040,000	$4,490,000	$4,570,000	$1,110,000

Based of the given inputs the outputs are as follows:

Table 6.3.3-7.
EIFS Model Implementation Outputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Direct Sales Volume	$960,000	$1,530,000	$1,040,000	$4,490,000	$4,570,000	$1,110,000
Induced Sales Volume	$1,075,200	$1,713,600	$1,164,800	$5,028,800	$5,118,400	$1,243,200
Total Sales Volume	$2,035,200	$3,243,600	$2,204,800	$9,518,800	$9,688,400	$2,353,200
Direct Income	$187,225	$298,389	$202,827	$875,665	$891,267	$216,478
Induced Income	$209,691	$334,196	$227,166	$980,744	$998,219	$242,456
Total Income	$396,916	$632,585	$429,992	$1,856,409	$1,889,486	$458,934
Direct Employment	5	9	6	25	26	6
Induced Employment	6	10	7	28	29	7
Total Employment	12	18	12	54	55	13
Local Population	0	0	0	0	0	0

Table 6.3.3-8.
EIFS Model Operation and Maintenance Cost Inputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$4,800,000	$7,650,000	$5,200,000	$22,450,000	$22,850,000	$0

Based of the given inputs the outputs are as follows:

Table 6.3.3-9.
EIFS Model Operation and Maintenance Cost Outputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Direct Sales Volume	$4,800,000	$7,650,000	$5,200,000	$22,450,000	$22,850,000	$0
Induced Sales Volume	$5,376,000	$8,568,000	$5,824,000	$25,144,000	$25,592,000	$0
Total Sales Volume	$10,176,000	$16,218,000	$11,024,000	$47,594,000	$48,442,000	$0
Direct Income	$936,123	$1,491,946	$1,014,133	$4,378,324	$4,456,334	$0
Induced Income	$1,048,457	$1,670,979	$1,135,829	$4,903,722	$4,991,094	$0
Total Income	$1,984,580	$3,162,924	$2,149,962	$9,282,046	$9,447,428	$0
Direct Employment	27	43	29	127	129	0
Induced Employment	30	49	33	142	145	0
Total Employment	58	92	62	269	274	0
Local Population	0	0	0	0	0	0

6.3.3.8 Summary of Cost Effective Measures and their Benefits for Planning Unit Three

Table 6.3.3-10 shows the potential measures that are being carried forward for further consideration. Measures D, H, and F are beach and dune placement measures that depend on the construction of the seawall in order to be implemented. Measures I, J, and K are stand alone measures that do not depend on the seawall for implementation.

Table 6.3.3-10.
List of Measures Carried Forward for Further Evaluation in Planning Unit Three

Measures	Total Annual Cost ($)	Total Annual Output (FHI)	Change in Sales Volume	Change in Income	Change in Employment
Measure AA (No Action)			$0	$0	0
Measure D[1]	$310,579	154	$12,211,200	$2,381,496	69
Measure F[1]	$494,992	330	$19,461,600	$3,795,509	110
Measure H[1]	$336,45	276	$13,228,800	$2,579,954	75
Measure I	$1,452,618	136	$57,112,800	$11,138,455	323
Measure J	$1,478,502	216	$58,130,400	$11,336,913	329
Measure K	$60,953	248	$2,353,200	$458,934	13

6.3.3.9 Public Access and Parking

A public access and parking analysis was conducted on the sections where beach and dune constriction would take place. It was determined that each of the three planning units has sufficient access and parking to satisfy the requirements established in Engineering Regulation (ER) 1165-2-100. Planning unit three has three access points for the Ocean Springs beach area that are all within the required half mile distance and have 300 free parking spaces all within a quarter mile of one of the access points. Addendum C describes the result of the access and parking analysis in greater detail.

6.4 Seawall and Elevated Roadway Area Measures

6.4.1 General

The Seawall and Elevated Roadway area is located in all three planning units just north of the roadways that run parallel to the beach. These areas are denoted by the coastal zone area. In planning unit one, the seawall area includes planning sub-units two, three and four, in planning unit two, planning sub-units eight, ten, thirteen, fifteen, eighteen, and twenty, and in planning unit three the planning sub-units are twenty-one and twenty-two. These areas are all highly populated and include several east/west evacuation routes.

6.4.2 Historic (Pre-Hurricane Katrina) Conditions

The pre-Hurricane Katrina conditions for planning sub-units three and four in planning unit one represented a mostly residential community. The areas in planning unit one included 27,310 tax parcels, of which 15,464 contained an asset with some economic value and 11,846 were vacant land. Of the 15,464 parcels that contain assets, 12,061 were residential one-story, 337 were residential two-story, 237 were mobile homes, 2,419 were commercial, and 410 were municipal. The areas in planning unit two included 34,028 tax parcels, of which 20,028 contained an asset with

some economic value and 14,000 were vacant land. Of the 20,028 parcels that contain assets, 18,628 were residential one-story, 658 were residential two-story, 318 were mobile homes, 256 were commercial, and 168 were municipal. The areas in planning unit three included 17,360 tax parcels, of which 12,705 contained an asset with some economic value and 4,655 were vacant land. Of the 12,705 parcels that contain assets, 11,380 were residential one-story, 315 were residential two-story, 85 were mobile homes, 793 were commercial, and 132 were municipal. Table 6.4-1 summarizes the assets by planning unit for the seawall and elevated roadway area.

Table 6.4-1.
Pre-Hurricane Katrina Economic Asset Characteristics for the Impacted Seawall and Roadway Areas

	Planning Unit One	Planning Unit Two	Planning Unit Three	
Asset Categories	**Assets by Category**	**Assets by Category**	**Assets by Category**	**Total**
Residential	12,398	19,286	11,695	43,379
Mobile Homes	237	318	85	640
Commercial	2,419	256	793	3,468
Municipal	410	168	132	710
Vacant Land	11,846	14,000	4,655	30,501
Total	**27,310**	**34,028**	**17,360**	**78,698**

Figure 6.4-1 denotes the various zones and shows the coastal zone in beige. Figure 6.4-2 shows the planning sub-units of the area by planning unit.

6.4.2.1 Existing (Post-Hurricane Katrina) Conditions

Hurricane Katrina made its Mississippi landfall just west of planning sub-units three and four. It is estimated that the storm destroyed 21,228 structures at least fifty-percent or more in these areas. Of those, 7.903 were destroyed in planning unit one, 12,789 in planning unit two, and 536 were destroyed in planning unit three. Table 6.4-2 displays the destroyed structures by category and by planning unit for these areas.

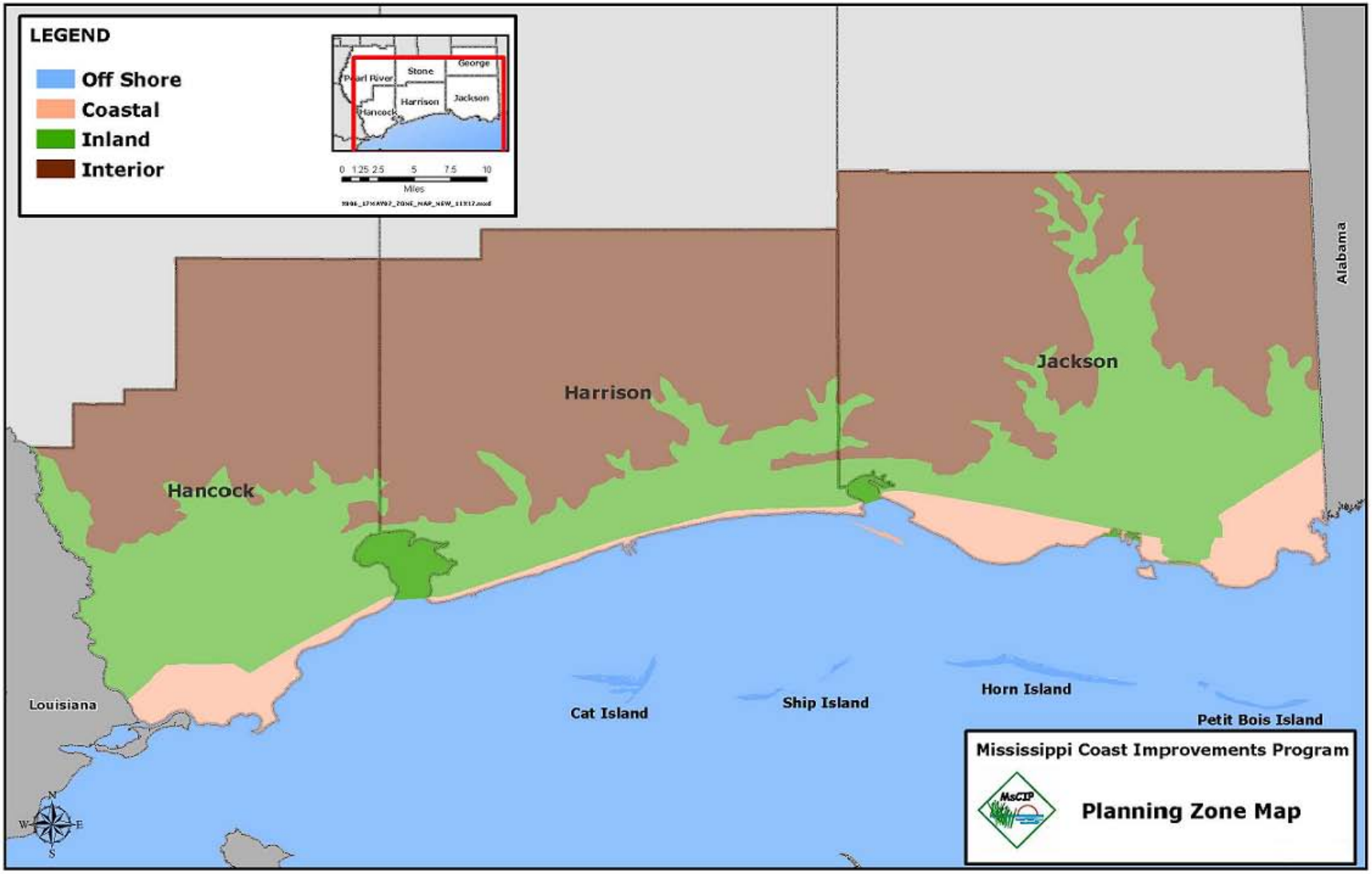


Figure 6.4-1. Planning Zones – Impacted area is the coastal zone

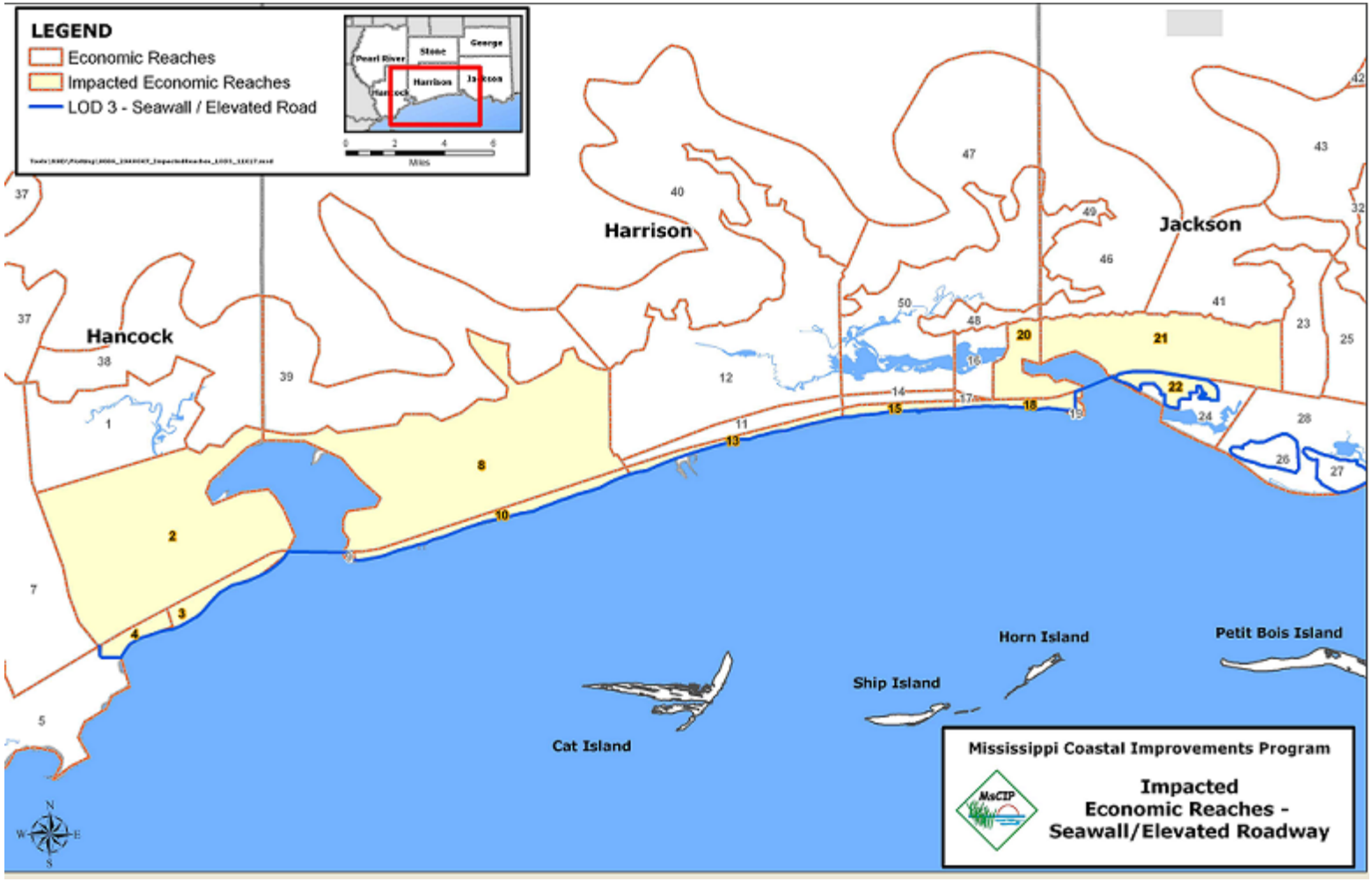


Figure 6.4-2. Planning sub-units in Coastal Area for Planning Unit One, Two, and Three

Table 6.4-2.
Destroyed Structures by Category and Planning Unit

	Planning Unit One	Planning Unit Two	Planning Unit Three	
Asset Categories	**Assets by Category**	**Assets by Category**	**Assets by Category**	**Total**
Residential	6,741	11,106	474	18,321
Mobile Homes	27	111	10	148
Commercial	1,054	1,492	44	2,590
Municipal	81	80	8	169
Total	**7,903**	**12,789**	**536**	**21,228**

6.4.3 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation.

6.4.4 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8-percent was used in estimating average annual benefits and costs.
- Price levels are October, 2007 unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs.
- Full redevelopment of the area will take place by the base year 2012.

6.4.5 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit one. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

- Measure A - LOD-3, Seawall and Elevated Roadway

This measure will elevate an existing 2-lane roadway up to an elevation of 11.0-feet NAVD88 in planning unit one, to an elevation of 16.0-feet NAVD88 in planning unit two, and up to an elevation of 11.0-feet NAVD88 in planning unit three. This will include raising an associated seawall, landward slope protection, interior drainage, and pumping stations as required. This measure also requires the installation of surge barriers across St. Louis Bay and Biloxi Bay to elevation 20.0-feet NAVD88. See the Engineering Appendix for more detail on this measure.

- Measure B – Nonstructural One

This measure includes the acquisition and flood proofing (elevate in place) of structures to an ABFE level of protection. See the Nonstructural Appendix for more detail on this measure.

- Measure C – Nonstructural Two

This measure includes the acquisition and flood proofing (elevate in place) of structures to approximately elevation 20.0-feet NAVD88. See the Nonstructural Appendix for more detail on this measure.

- Measure D – Nonstructural Three

This measure includes the acquisition and flood proofing (elevate in place) of structures to approximately elevation 30.0-feet NAVD88. See the Nonstructural Appendix for more detail on this measure. See the Nonstructural Appendix for more detail on this measure.

6.4.6 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "…***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits…"*** More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.4.6.1 Future Without-Project Conditions

Equivalent annual flood damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the alternatives were evaluated and compared to the without project conditions for three of the six future without project scenarios. Future without-project scenarios one, two, three, four, five and six were used to evaluate the flood damage reduction benefits for this area. These future scenarios were chosen because the redevelopment projected for this area could take the form it was before Hurricane Katrina or it could be redeveloped back as condominiums and condos.

Future scenario one is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Structures will be rebuilt to what they were pre-Hurricane Katrina; residential back to residential, commercial back to commercial, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Inland Barrier area.

Future scenario two is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Structures will be rebuilt to what they were pre-Hurricane Katrina; residential back to residential, commercial back to commercial, etc, with the exception of the water front areas for planning units one and two. In these planning units,

the scenario will address what if commercial and casino redevelopment would occur along the water front and Back Bay areas. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Inland Barrier area.

Future scenario three has the same redevelopment as future scenario one with a maximum relative sea level rise of 2.0-feet depending on location. Equivalent annual damages that could occur under this scenario are $426,040,000 (rounded to the nearest thousand).

Future scenario four has the same redevelopment as future scenario two with a maximum relative sea level rise of 2.0-feet depending on location. Equivalent annual damages that could occur under this scenario are $434,040,000 (rounded to the nearest thousand).

Future scenario five has the same redevelopment as future scenario one with a maximum relative sea level rise of 3.4-feet depending on location. Equivalent annual damages that could occur under this scenario are $475,200,000 (rounded to the nearest thousand). These damages are an 11.54-percent increase over the 2.0-feet relative sea level rise accounted for in future scenario two.

Future scenario six has the same redevelopment as future scenario two with a maximum relative sea level rise of 3.4-feet depending on location. Equivalent annual damages that could occur under this scenario are $483,700,000 (rounded to the nearest thousand). These damages are an 11.44-percent increase over future scenario four with a maximum of 2.0-feet relative sea level rise.

6.4.6.2 Equivalent annual damages Reduced and Residual Damages

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios and the damages incurred with the measure in place. The HECFDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without-project inventory except that footprints of seawall and elevated roadway and the acquisitions were deleted from the inventory and flood proofed (structure to be raised in place) structures were given a specific first floor elevation. The structure inventories for each of the HEC-FDA with-measure runs are as follows:

- Measure A – Seawall and Elevated Roadway

This measure includes the without-project inventory less 1,543 parcels that were deleted out of the inventory. Of those, 411 parcels were estimated to be impacted in planning unit one, 1,004 in planning unit two, and 128 in planning unit three. These parcels represent the footprint of the seawall and elevated roadway across the three planning units and some portion of the total would have to be purchase for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – ABFE Nonstructural

This measure includes the acquisition of 24,411 parcels some with structures and some vacant land, and the flood proofing (elevate structure in place) of 8,053 structures to an elevation ranging from 14.9-feet NAVD88 to 22.4-feet NAVD88 depending on the planning sub-unit the structures is assigned. This plan was formulated by the nonstructural flood proofing committee and details can be found in the Nonstructural Appendix. This elevation was determined to be approximately the ABFE

level of protection is defined as still water elevation, plus wave run-up plus and estimate for waves (depth divided by two), and is the minimum implementation elevation that a nonstructural measure do to the requirements of the National Flood Insurance Program (NFIP).

The equivalent annual damage reduction by measure for the Seawall and Elevated Roadway is shown in table 6.4-3.

Table 6.4-3.
Equivalent Annual Damage Reduction by Future Scenario

Measures	Equivalent Annual Damage Reduction Future 3 ($)	Equivalent Annual Damage Reduction Future 4 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Equivalent Annual Damage Reduction Future 6 ($)
(No Action)	$0	$0	$0	$0
Measure A Seawall/Elevated Roadway	$52,030,000	$54,260,000	$58,090,000	$59,920,000
Measure B ABFE Nonstructural	$200,860,000	$206,490,000	$220,160,000	$226,120,000

Equivalent annual damages reduced are rounded to the nearest thousand dollars.

6.4.6.3 Residual Damages

Residual damages are the equivalent annual damages that still remain even when a project is in place. Residual damages are calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damages is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table". Residual damage by measure is shown in table 6.4-4.

Table 6.4-4.
Residual Damages by Measure and by Future Scenario

Measures	Residual Damages Future 3 ($)	Residual Damages Future 4 ($)	Residual Damages Future 5 ($)	Residual Damages Future 6 ($)
(No Action)	$0	$0	$0	$0
Measure A Seawall/Elevated Roadway	$374,010,000	$379,780,000	$417,110,000	$423,780,000
Measure B ABFE Nonstructural	$225,180,000	$227,550,000	$255,040,000	$257,580,000

Equivalent annual damages reduced are rounded to the nearest thousand dollars.

6.4.7 Environmental Quality (EQ)

6.4.7.1 Impacts of Seawall Elevated Roadway Measure

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

1) A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.

2) A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.4-5 and 6.4-6 show the impacts of the Jackson, Hancock, and Harrison Counties Seawall footprints respectively.

Table 6.4-5.
Wetland Acres Impacted by Jackson County Seawall

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Total
22	0.0	0.7	0.2	0.5	1.4
24	0.6	0.6	0.0	0.0	1.3
Total	**0.6**	**1.4**	**0.2**	**0.5**	**2.7**

Table 6.4-6.
Wetland Acres Impacted by Hancock and Harrison Seawall

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Total
2	0.0	0.0	0.6	3.8	4.4
3	0.0	0.1	0.0	0.0	0.1
4	0.6	0.7	0.8	0.0	2.1
5	0.0	0.4	0.0	5.3	5.6
7	0.0	0.0	0.0	1.9	1.9
10	0.0	4.7	0.0	0.0	4.7
13	0.0	6.4	0.0	0.0	6.4
18	0.0	0.1	0.1	0.0	0.3
Total	**0.6**	**12.4**	**1.5**	**10.9**	**25.4**

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the coast wide area can be found in the Environmental Appendix.

6.4.8 Summary of Costs

Table 6.4-7 summarizes the ROM costs at an FY-08 price level by measure for the seawall and elevated roadway impact area.

Table 6.4-7.
Summary of Costs by Measure for Seawall and Elevated Roadway Area

Measures	Implement Cost (FY-08) ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0
Measure A Seawall and Elevated Roadway	$5,002,500,000	$245,979,051	$60,148,000	N/A	$306,127,051
Measure C ABFE Nonstructural	$8,580,261,000	$421,902,000	$110,000	N/A	$422,012,000

6.4.9 Regional Economic Development (RED)

The purpose of this section is to describe the economic impact of the proposed measure on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Hancock, Jackson, and Harrison Counties, Mississippi. The expenditures for the measures are estimated to be $5,002,500,000 for the seawall and elevated roadway measure, $8,580,261,333 for the ABFE nonstructural measure. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $1,223,235,756 for the seawall and elevated roadway measure, $2,237,081 for the ABFE nonstructural measure based on a 100-year period of analysis and an FY 08 discount rate of 4.875-percent. The EIFS model inputs and outputs for the seawall and elevated roadway area are summarized in tables 6.4-8 through 6.4-11.

Table 6.4-8.
EIFS Model Implementation Costs Inputs for the Seawall and Elevated Area

	Seawall & Elevated Roadway	ABFE Nonstructural
Region of Influence (ROI)	Hancock, Harrison & Jackson Counties	Hancock, Harrison & Jackson Counties
Change in Local Expenditures	$5,002,500,000	$8,580,261,333

Based of the given implementation cost inputs the outputs are as follows:

Table 6.4-9.
EIFS Model Implementation Costs Outputs for the Seawall and Elevated Area

	Seawall & Elevated Roadway	ABFE Nonstructural
Direct Sales Volume	$5,002,500,000	$8,580,261,333
Induced Sales Volume	$5,755,350,000	$9,336,803,805
Total Sales Volume	$10,757,850,000	$17,917,065,137
Direct Income	$1,115,405,211	$1,965,390,069
Induced Income	$1,274,630,230	$2,124,627,724
Total Income	$2,390,035,440	$4,090,017,793
Direct Employment	31,133	52,577
Induced Employment	35,915	57,351
Total Employment	67,048	109,928
Local Population	0	0

Table 6.4-10.
EIFS Model O&M Costs Inputs for the Seawall and Elevated Area

	Seawall & Elevated Roadway	ABFE Nonstructural
Region of Influence (ROI)	Hancock, Harrison & Jackson Counties	Hancock, Harrison & Jackson Counties
Change in Local Expenditures	$1,223,235,756	$2,237,081

Based of the given O&M cost inputs the outputs are as follows:

Table 6.4-11.
EIFS Model O&M Costs Outputs for the Seawall and Elevated Area

	Seawall & Elevated Roadway	ABFE Nonstructural
Direct Sales Volume	$1,223,235,756	$2,237,081
Induced Sales Volume	$1,393,527,224	$2,590,946
Total Sales Volume	$2,616,762,980	$4,828,027
Direct Income	$274,711,471	$484,736
Induced Income	$310,746,337	$558,828
Total Income	$585,457,808	$1,043,565
Direct Employment	7,602	14
Induced Employment	8,684	16
Total Employment	16,286	30
Local Population	0	0

6.5 Evaluation of Pearlington Area Measures

6.5.1 General

The Pearlington area, shown in figure 6.5-1, is located in the western area of planning unit one along the Pearl River. The area is denoted as planning sub-unit six and is depicted in the figure below. The pre-Hurricane Katrina conditions for this area represented a mostly residential community. As shown in Table 6.5-1, it was estimated from the field inventorying process that planning sub-unit six included 1,155 tax parcels, of which 1,152 contained a structure with some economic value and 3 ere vacant land. Of those 1,152 parcels that contain structures, 1,043 were residential one-story, 5 ere residential two-story, 17 were mobile homes, 64 were commercial, and 23 were municipal.

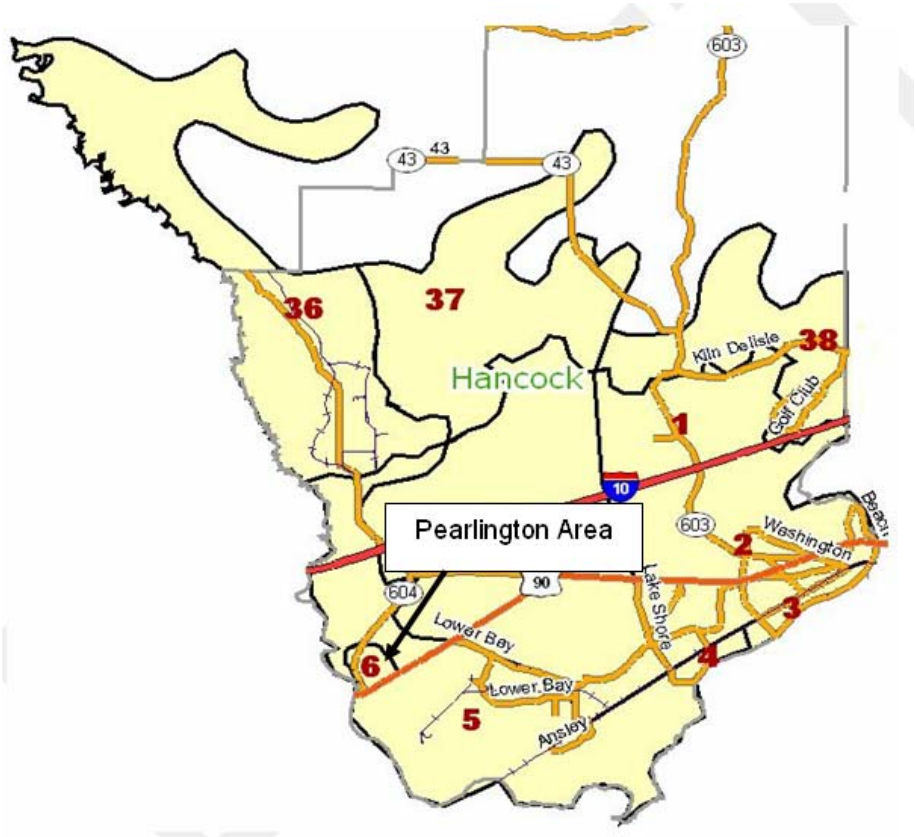


Figure 6.5-1. Pearlington Area – Planning Sub-unit Six

Table 6.5-1.
Pre-Hurricane Katrina Estimate of Structures
for the Pearlington Area Planning Sub-unit Six

Asset Categories	Assets by Category
Residential	1,048
Mobile Homes	17
Commercial	64
Municipal	23
Vacant Land	3
Total Tax Parcels	**1,155**

6.5.2 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation.

6.5.3 Assumptions

The following assumptions were used in this analysis:

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs.
- Price levels are October, 2007 unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs.

6.5.4 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit one. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

Measure A - Pearlington Ring Levee
This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 20.0-feet NAVD88.

Measure B - Pearlington Ring Levee
This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 30.0-feet NAVD88.

Measure C – Pearlington Nonstructural One
This measure includes the acquisition and flood proofing (elevate-in-place) of structures to the FEMA advisory base flood elevation (ABFE).

Measure D – Pearlington Nonstructural Two
This measure includes the acquisition and flood proofing of structures to approximately elevation 20.0-feet NAVD88.

Measure E – Pearlington Nonstructural Three
This measure includes the acquisition and flood proofing of structures to approximately elevation 30.0-feet NAVD88.

Figure 6.5-2 shows the measures for the Pearlington Area (planning sub-unit six); the red line represents the approximate footprint of the ring levees, the dark green within the ring levee footprint represents potential ABFE buyout areas and the light green area within the ring levee footprint represents potential flood proof (elevate-in-place) areas.

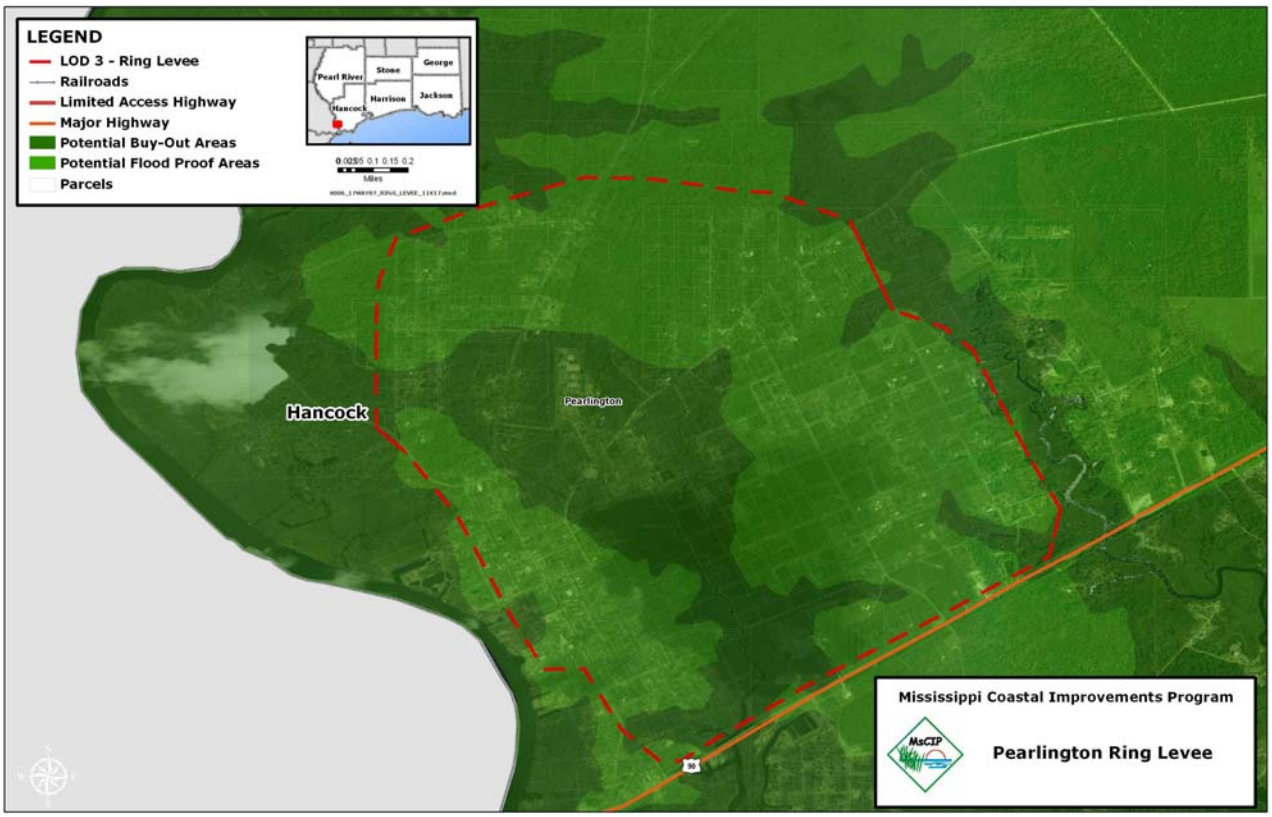


Figure 6.5-2. Display of Potential Measures for the Pearlington Area (Planning Sub-Unit Six)

6.5.5 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "…***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits…"*** More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.5.5.1 Existing Conditions Post-Hurricane Katrina)

The effects of Hurricane Katrina storm surge were devastating to the Pearlington Area. Peak water elevation in the area ranged from 16-to-19-feet NAVD88. It is estimated that between 95 and 99-percent of the structures in the area sustained significant inundation damage (fifty-percent or more). Destroyed residences and commercial structures have displaced the majority of the residences within the area. Expected redevelopment of the area is described in the following section.

6.5.5.2 Future Without-Project Conditions

Equivalent annual flood damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the measures were evaluated and compared to future without-project scenarios three, and five, as previously discussed in section 5.3. These future scenarios were chosen because the redevelopment projected for this area is anticipated to return to the pre-Katrina development. Futures scenarios two, four, and six were not used for evaluation purposes since this area is not accommodative for commercial and condominium redevelopment under those mixed redevelopment scenarios (see section 5.3 for more detail).

Future scenario one is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Table 6.5-2 shows structures by category and by elevation. The number of structures per elevation is added to the previous number of structures per elevation in each category. For example, in the residential category there is one structure with an elevation of 1-foot or lower, there are ten structures with an elevation of 2-feet or less, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Pearlington area.

Table 6.5-2.
Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years

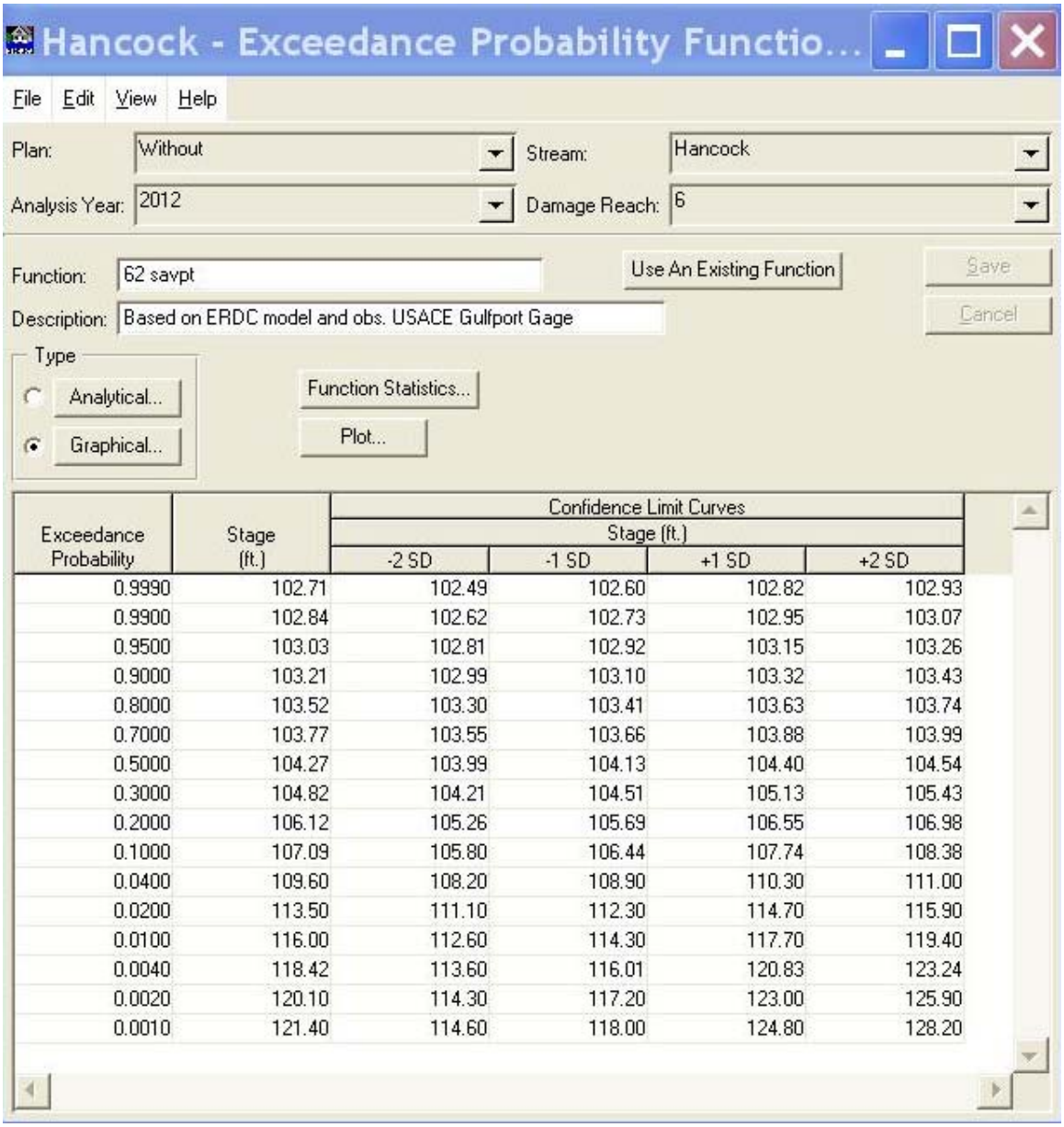
Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	1	0	0	0	1
2-foot	10	0	0	0	10
3-foot	22	0	0	0	22
4-foot	35	0	0	0	35
5-foot	51	0	0	0	51
6-foot	75	0	0	0	75
7-foot	125	0	0	0	125
8-foot	214	0	0	0	214
9-foot	351	0	0	0	351
10-foot	425	0	0	0	425
11-foot	452	0	0	0	452
12-foot	459	0	0	0	459
13-foot	460	0	0	0	460
14-foot	460	0	0	0	460
15-foot	460	0	0	0	460
16-foot	460	0	0	0	460
17-foot	460	0	0	0	460
18-foot	460	0	0	0	460
19-foot	460	0	0	0	460
20-foot	1,048	17	64	23	1,152
Total	**1,048**	**17**	**64**	**23**	**1,152**

Estimated first floor elevations can be compared to the exceedance probability functions or both future scenarios three and five.

Future scenario three is the full redevelopment of assets within the study area by the year 2012. Under this scenario, assets will be rebuilt as they were pre-Hurricane Katrina. For example, if the asset was a residential structure pre-Hurricane Katrina it will be rebuilt as a residential structure;

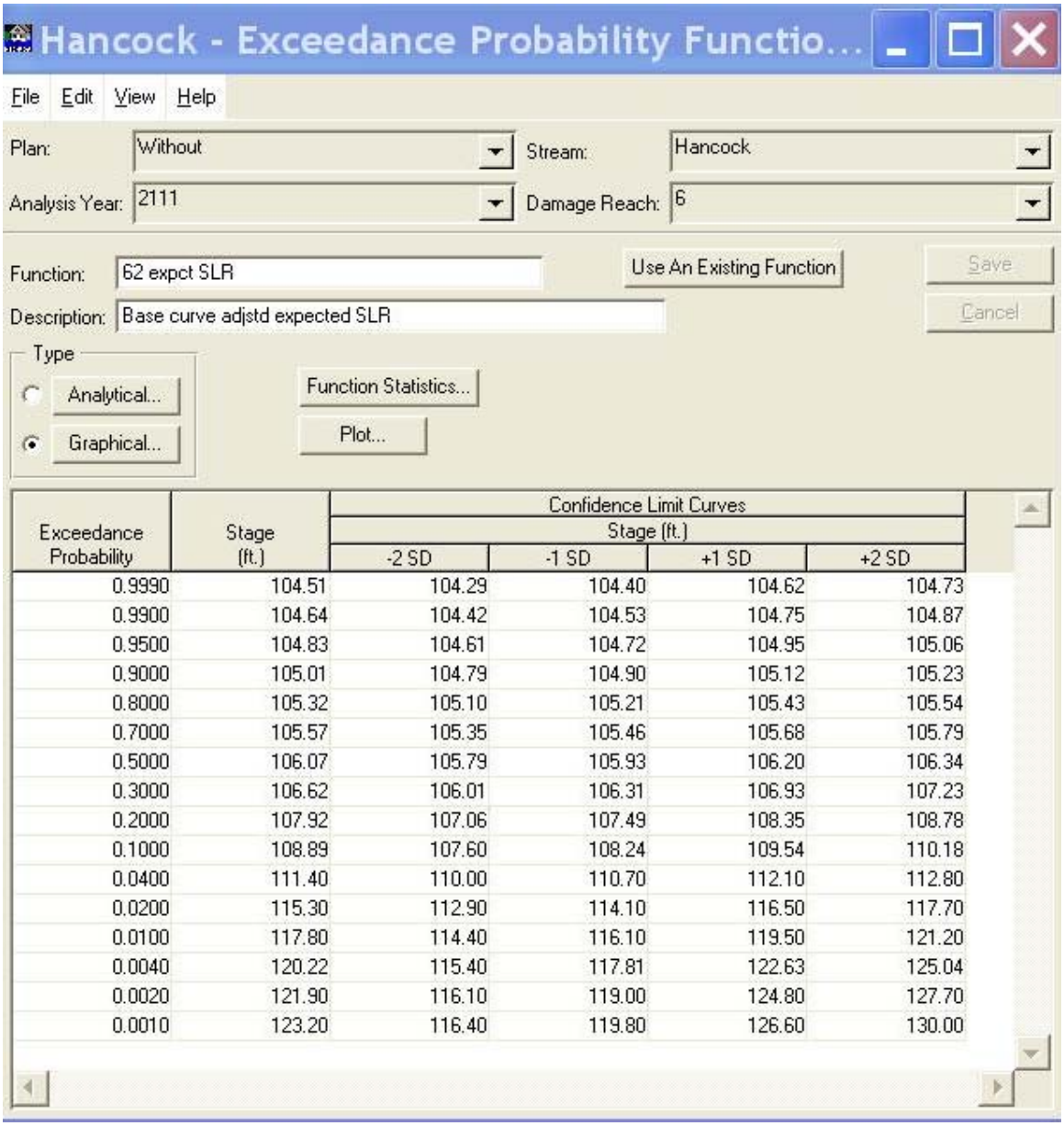
commercial structures will be built back to commercial structures; etc. Basically, future scenario three is the same structure inventory as future scenario one with the addition of an expected relative sea level rise over the 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $12,885,000 (rounded to the nearest thousand). The total number of structures in this scenario are the same as in scenario one and can be seen above in table 6.5-2. Figures 6.5-3 and 6.5-4 depict the base year and most likely future year exceedance probability functions for the Pearlington area (planning sub-unit six). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.5-4 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.

Future scenario five is the same as future scenario one with the addition of a high relative sea level rise 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $14,205,000 (rounded to the nearest thousand). These damages represent approximately a ten-percent (10.24%) increase over the expected relative sea level rise accounted for in future scenario three. The total number of structures in this scenario is the same as in scenarios one and three and can be seen above in table 6.5.2. Figures 6.5-5 and 6.5-6 depict the base year and most likely future year exceedance probability functions for the Pearlington area (planning sub-unit six). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.5-5 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



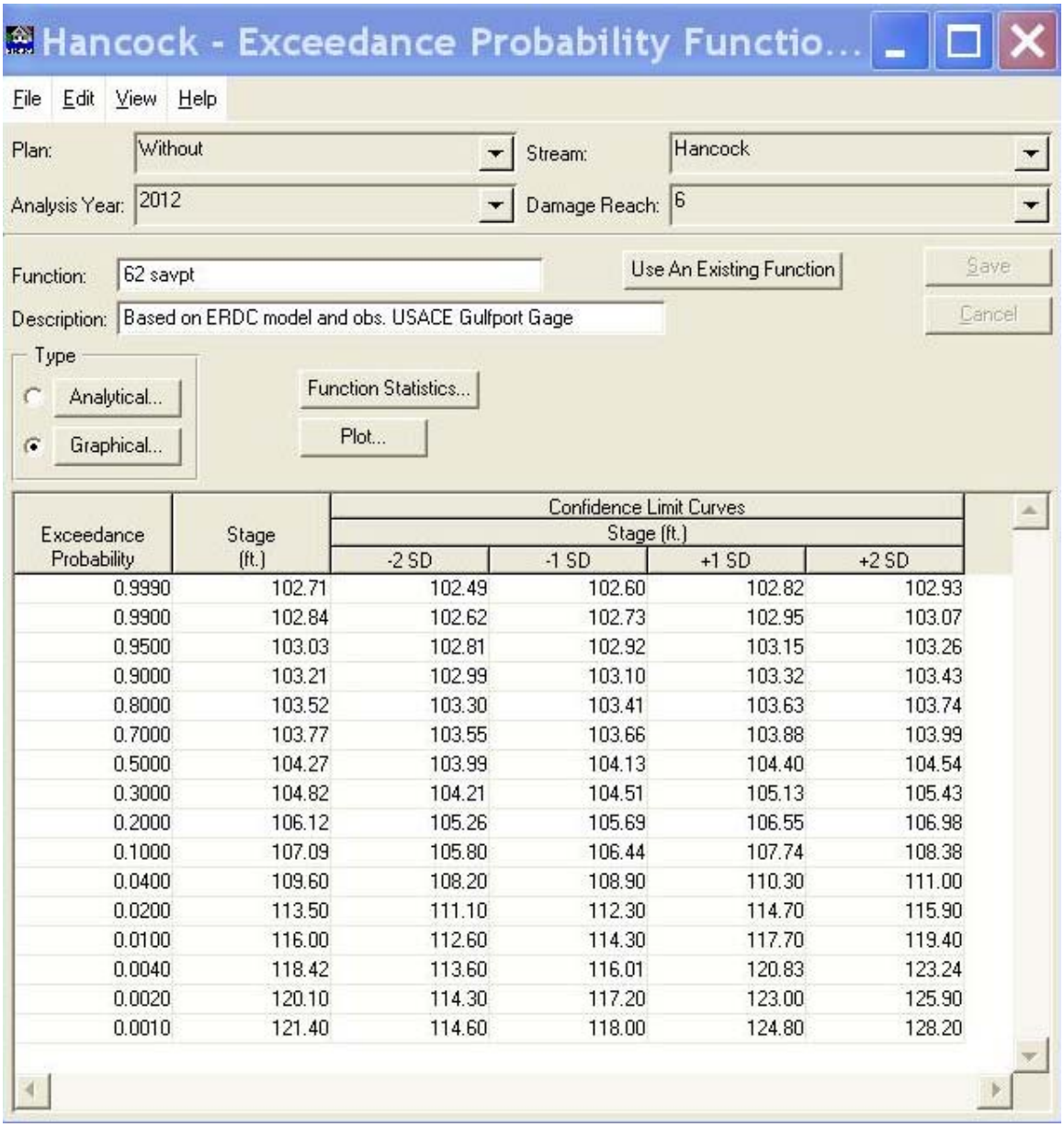
Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	102.71	102.49	102.60	102.82	102.93
0.9900	102.84	102.62	102.73	102.95	103.07
0.9500	103.03	102.81	102.92	103.15	103.26
0.9000	103.21	102.99	103.10	103.32	103.43
0.8000	103.52	103.30	103.41	103.63	103.74
0.7000	103.77	103.55	103.66	103.88	103.99
0.5000	104.27	103.99	104.13	104.40	104.54
0.3000	104.82	104.21	104.51	105.13	105.43
0.2000	106.12	105.26	105.69	106.55	106.98
0.1000	107.09	105.80	106.44	107.74	108.38
0.0400	109.60	108.20	108.90	110.30	111.00
0.0200	113.50	111.10	112.30	114.70	115.90
0.0100	116.00	112.60	114.30	117.70	119.40
0.0040	118.42	113.60	116.01	120.83	123.24
0.0020	120.10	114.30	117.20	123.00	125.90
0.0010	121.40	114.60	118.00	124.80	128.20

Figure 6.5-3 Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Pearlington Area



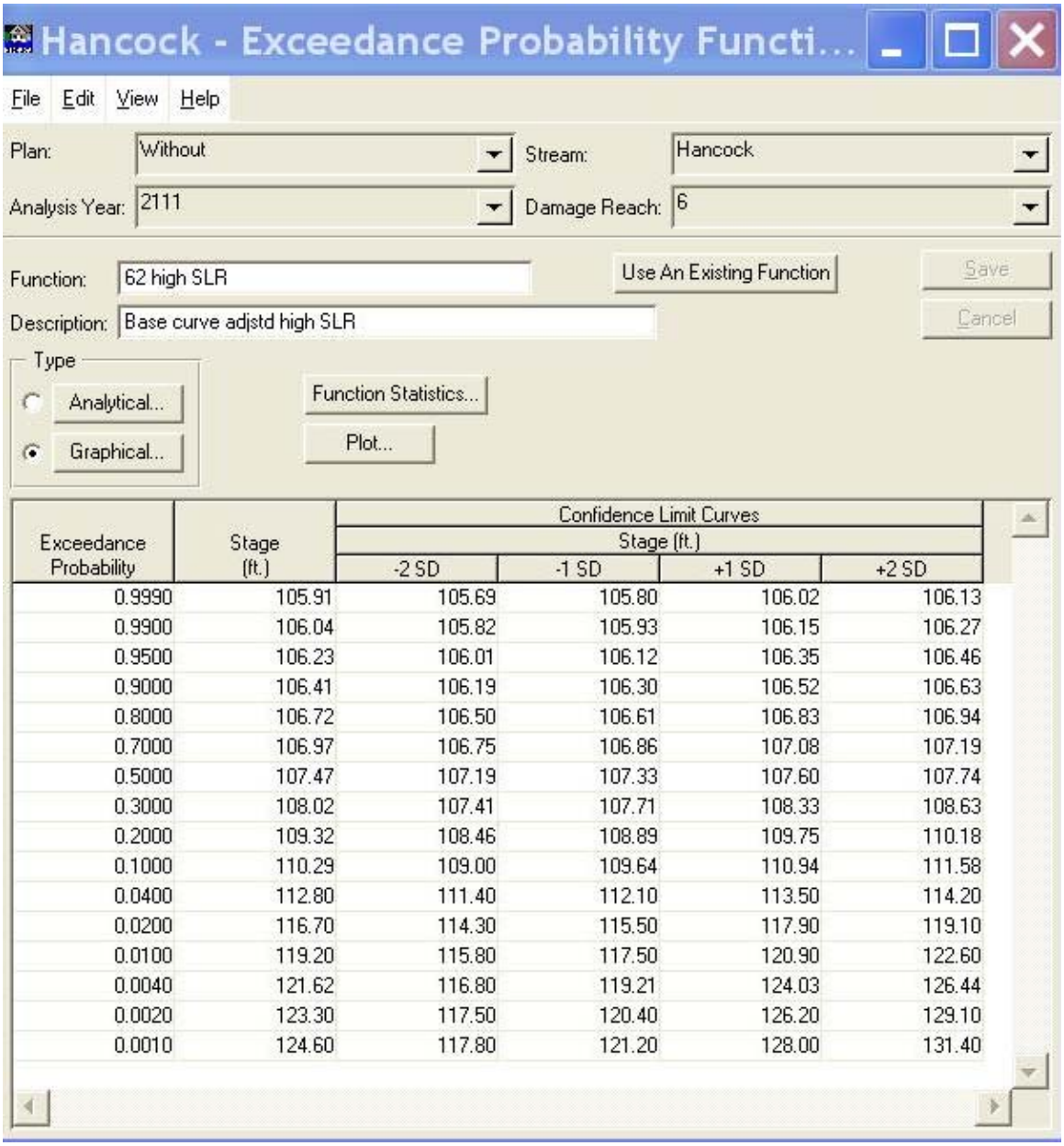
Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	104.51	104.29	104.40	104.62	104.73
0.9900	104.64	104.42	104.53	104.75	104.87
0.9500	104.83	104.61	104.72	104.95	105.06
0.9000	105.01	104.79	104.90	105.12	105.23
0.8000	105.32	105.10	105.21	105.43	105.54
0.7000	105.57	105.35	105.46	105.68	105.79
0.5000	106.07	105.79	105.93	106.20	106.34
0.3000	106.62	106.01	106.31	106.93	107.23
0.2000	107.92	107.06	107.49	108.35	108.78
0.1000	108.89	107.60	108.24	109.54	110.18
0.0400	111.40	110.00	110.70	112.10	112.80
0.0200	115.30	112.90	114.10	116.50	117.70
0.0100	117.80	114.40	116.10	119.50	121.20
0.0040	120.22	115.40	117.81	122.63	125.04
0.0020	121.90	116.10	119.00	124.80	127.70
0.0010	123.20	116.40	119.80	126.60	130.00

Figure 6.5-4 Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Pearlington Area – Includes an adjustment for relative sea level rise



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	102.71	102.49	102.60	102.82	102.93
0.9900	102.84	102.62	102.73	102.95	103.07
0.9500	103.03	102.81	102.92	103.15	103.26
0.9000	103.21	102.99	103.10	103.32	103.43
0.8000	103.52	103.30	103.41	103.63	103.74
0.7000	103.77	103.55	103.66	103.88	103.99
0.5000	104.27	103.99	104.13	104.40	104.54
0.3000	104.82	104.21	104.51	105.13	105.43
0.2000	106.12	105.26	105.69	106.55	106.98
0.1000	107.09	105.80	106.44	107.74	108.38
0.0400	109.60	108.20	108.90	110.30	111.00
0.0200	113.50	111.10	112.30	114.70	115.90
0.0100	116.00	112.60	114.30	117.70	119.40
0.0040	118.42	113.60	116.01	120.83	123.24
0.0020	120.10	114.30	117.20	123.00	125.90
0.0010	121.40	114.60	118.00	124.80	128.20

Figure 6.5-5 Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Pearlington Area



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	105.91	105.69	105.80	106.02	106.13
0.9900	106.04	105.82	105.93	106.15	106.27
0.9500	106.23	106.01	106.12	106.35	106.46
0.9000	106.41	106.19	106.30	106.52	106.63
0.8000	106.72	106.50	106.61	106.83	106.94
0.7000	106.97	106.75	106.86	107.08	107.19
0.5000	107.47	107.19	107.33	107.60	107.74
0.3000	108.02	107.41	107.71	108.33	108.63
0.2000	109.32	108.46	108.89	109.75	110.18
0.1000	110.29	109.00	109.64	110.94	111.58
0.0400	112.80	111.40	112.10	113.50	114.20
0.0200	116.70	114.30	115.50	117.90	119.10
0.0100	119.20	115.80	117.50	120.90	122.60
0.0040	121.62	116.80	119.21	124.03	126.44
0.0020	123.30	117.50	120.40	126.20	129.10
0.0010	124.60	117.80	121.20	128.00	131.40

Figure 6.5-6 Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Pearlington Area – Includes an adjustment for relative sea level rise

6.5.5.3 Equivalent annual damages Reduced and Equivalent Annual Residual Damages

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios three and five and the damages incurred with the measure in place. The HEC-FDA model was run for each measure to determine the damages reduced as compared to the without-project scenario. In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without project inventory except that footprints of levees and acquisitions were deleted from the inventory and flood proofed structures

(structures to be raised in place) were given a higher elevation. The structure inventories for each of the HEC-FDA measure runs are as follows:

- Measure A – Pearlington Ring Levee at elevation 20.0-feet NAVD88

This measure includes the without-project inventory less 138 parcels that were deleted out of the inventory. These parcels represent the footprint of the 20.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – Pearlington Ring Levee at elevation 30.0-feet NAVD88

This measure includes the without-project inventory less 138 parcels that were deleted out of the inventory. These parcels represent the footprint of the 30.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the parcels identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure C – Pearlington ABFE Nonstructural One

This measure includes the acquisition of 539 parcels that include a structure and the flood proofing (raise structure in place) of 588 structures to elevation of 19.35-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was determined to be approximately the ABFE level of protection and is defined as still water elevation, plus wave run-up, plus an estimate for waves (depth divided by two), and is the minimum implementation elevation that a nonstructural measure do to the requirements of the National Flood Insurance Program (NFIP).

- Measure D – Pearlington Nonstructural Two to elevation 20.0-feet NAVD88

This measure includes the acquisition of 950 parcels that include a structure and the flood proofing (raise structure in place) of 177 structures to an elevation of 20.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee at elevation 20.0-feet NAVD88.

- Measure E – Pearlington Nonstructural Three to elevation 30.0-feet NAVD88

This measure includes the acquisition of 1,127 parcels that include a structure. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee at elevation 30.0-feet NAVD88.

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damage is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table." Table 6.5-3 summarizes the without project damages, damages reduced, and the residual damage by measure and by future scenario.

Table 6.5-3.
Summary of Damages by Potential Measure and Applicable Future Scenario

Measures	Equivalent Annual Damages Future 3 ($)	Equivalent Annual Damage Reduction Future 3 ($)	Residual Damage Future 3 ($)	Equivalent annual damages Future 5 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Residual Damage Future 5 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A 20Ft Ring Levee	$12,885,000	$11,894,000	$991,000	$14,205,000	$13,088,000	$1,117,000
Measure B 30FT Ring Levee	$12,885,000	$12,267,000	$618,000	$14,205,000	$13,228,000	$977,000
Measure C ABFE Nonstructural	$12,885,000	$12,260,000	$625,000	$14,205,000	$13,520,000	$685,000
Measure D 20FT Nonstructural	$12,885,000	$ 12,813,000	$ 72,000	$14,205,000	$ 14,123,000	$ 82,000
Measure E 30FT Nonstructural	$12,885,000	$12,885,000	$0	$14,205,000	$14,205,000	$0

Damages are rounded to the nearest thousand dollars.

6.5.6 Environmental Quality (EQ)

6.5.6.1 Impacts of Ring Levee Measures

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

1. A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.

2. A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.5-4 and 6.5-5 show the impacts of the Pearlington ring levees at elevations 20.0-feet NAVD88, and 30.0-feet NAVD88 respectively.

Table 6.5-4.
Wetland acres impacted by elevation 20' Pearlington ring levee

Reach ID	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
5	1.1	0.6	0.1	1.9
6	2.7	0.7	0.0	3.4
Total	**3.8**	**1.3**	**0.1**	**5.3**

Table 6.5-5.
Wetland acres impacted by elevation 30' Pearlington ring levee

Reach ID	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
5	2.2	1.2	0.2	3.6
6	3.3	1.0	0.0	4.3
Total	**5.5**	**2.2**	**0.2**	**7.9**

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the Pearlington area can be found in the Environmental Appendix.

6.5.7 Summary of Costs

Table 6.5-6 summarizes the ROM costs at an FY-08 price level by measure for the Pearlington Area (planning sub-unit six).

Table 6.5-6.
Summary of Costs by Measure for the Pearlington Area

Measures	Implement Cost (FY-08) ($)	Capital Recovery Factor	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	0.049171225	$0	$0	$0	$0
Measure A 20FT Ring Levee	$104,800,000	0.049171225	$5,153,000	$1,320,000	N/A	$6,473,000
Measure B 30FT Ring Levee	$120,200,000	0.049171225	$5,910,000	$1,526,000	N/A	$7,436,000
Measure C ABFE Nonstructural	$274,808,000	0.049171225	$13,513,000	$10,000	N/A	$13,523,000
Measure D 20FT Nonstructural	$152,102,000	0.049171225	$7,479,000	$10,000	N/A	$7,489,000
Measure E 30FT Nonstructural	$152,102,000	0.049171225	$7,479,000	$10,000	N/A	$7,489,000

The implementation costs include 1/ supervision and administration (30 account), 2/ planning, engineering & design (31 account) and 3/ appropriate contingencies. See the Cost Appendix for more detail on the implementation cost breakdowns. Numbers are rounded to the nearest thousand.

6.5.8 Regional Economic Development (RED)

The purpose of this section is to describe the economic impact of the proposed measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Hancock County, Mississippi. The expenditures for the measures are estimated to be $104,800,000 for the 20.0-feet NAVD88 ring levee measure, $120,200,000for the 30.0-feet NAVD88 ring levee measure, $274,808,000 for the ABFE nonstructural measure, $152,102,000 for the 20.0-feet NAVD88 nonstructural measure, and $152,102,000 for the 30.0-feet NAVD88 nonstructural measure. Moreover, the total Operation and

Maintenance (O&M) expenditures, which are based on the total present worth of O&M costs over the period of analysis, are estimated to be $26,845,000 for the 20.0-feet NAVD88 ring levee measure, $31,034,000 for the 30.0-feet NAVD88 ring levee measure, $203,000 for the ABFE nonstructural measure, $203,000 for the 20.0-feet NAVD88 nonstructural measure, and $203,000 for the 30.0-feet NAVD88 nonstructural measure respectively (assuming a 100- year period of analysis and an interest rate of 4.875-percent). The following tables summarize the inputs and outputs of the EIFS model by measure.

Table 6.5-7.
EIFS Model Construction Costs Inputs for the Pearlington Area

	20-Foot Ring Levee	30-Foot Ring Levee	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural
Region of Influence (ROI)	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County
Change in Local Expenditures	$104,800,000	$120,200,000	$387,900,000	$152,102,000	$152,102,000

Based of the given inputs the outputs are as follows:

Table 6.5-8.
EIFS Model Construction Costs Outputs for the Pearlington Area

	20-Foot Ring Levee	30-Foot Ring Levee	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural
Direct Sales Volume	$104,800,000	$120,200,000	$387,900,000	$152,102,000	$152,102,000
Induced Sales Volume	$104,800,000	$120,200,000	$387,900,000	$152,102,000	$152,102,000
Total Sales Volume	$209,600,000	$240,400,000	$775,800,000	$304,204,000	$304,204,000
Direct Income	$25,270,954	$28,984,434	$93,536,290	$36,677,125	$36,677,125
Induced Income	$25,270,954	$28,948,434	$93,536,290	$36,677,125	$36,677,125
Total Income	$50,541,909	$57,968,868	$187,072,580	$73,354,250	$73,354,250
Direct Employment	634	727	2,347	920	920
Induced Employment	634	727	2,347	920	920
Total Employment	1,268	1,454	4,694	1,840	1,840
Local Population	0	0	0	0	0

Table 6.5-9.
EIFS Model O&M Costs Inputs for the Pearlington Area

	20-Foot Ring Levee	30-Foot Ring Levee	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural
Region of Influence (ROI)	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County
Change in Local Expenditures	$26,845,000	$31,034,000	$203,000	$203,000	$203,000

Based of the given inputs the outputs are as follows:

Table 6.5-10.
EIFS Model O&M Costs Outputs for the Pearlington Area

	20-Foot Ring Levee	30-Foot Ring Levee	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural
Direct Sales Volume	$26,845,000	$31,034,000	$203,000	$203,000	$203,000
Induced Sales Volume	$26,845,000	$31,034,000	$203,000	$203,000	$203,000
Total Sales Volume	$53,690,000	$62,068,000	$406,000	$406,000	$406,000
Direct Income	$6,473,271	$7,483,385	$48,950	$48,950	$48,950
Induced Income	$6,473,271	$7,483,385	$48,950	$48,950	$48,950
Total Income	$12,946,541	$14,966,771	$97,900	$97,900	$97,900
Direct Employment	162	188	1	1	1
Induced Employment	162	188	1	1	1
Total Employment	324	376	2	2	2
Local Population	0	0	0	0	0

6.6 Admiral Island Ecosystem Restoration Measures

This section describes the evaluation of ecosystem restoration measures at the Admiral Island area that is located within planning sub-unit two, which is part of planning unit one. The total area includes approximately 400 acres of state owned land. This area was selected for ecosystem restoration using the Decision Support System, a GIS based model created by the Corps' Engineer Research and Development Center (ERDC). For more details on the selection process for ecosystem restoration sites see the economic appendix. Figure 6.6-1 shows the location of the Admiral Island area.

6.6.1 Formulation of Alternatives

6.6.1.1 Assumption

In order for the Admiral Island site to undergo ecosystem restoration, it is assumed that there will be mandatory buy-outs of properties and removal of all existing structures within the footprint of the site. These buy-outs will be part of the flood damage reduction alternative and not this ecosystem restoration alternative.

6.6.1.2 Objectives

The following ecosystem restoration objectives were developed:

- Restore the natural hydrology
- Provide storm surge protection
- Restore native tidal wetland plant communities
- Provide fish and tidal wildlife habitat
- Prevent saltwater intrusion

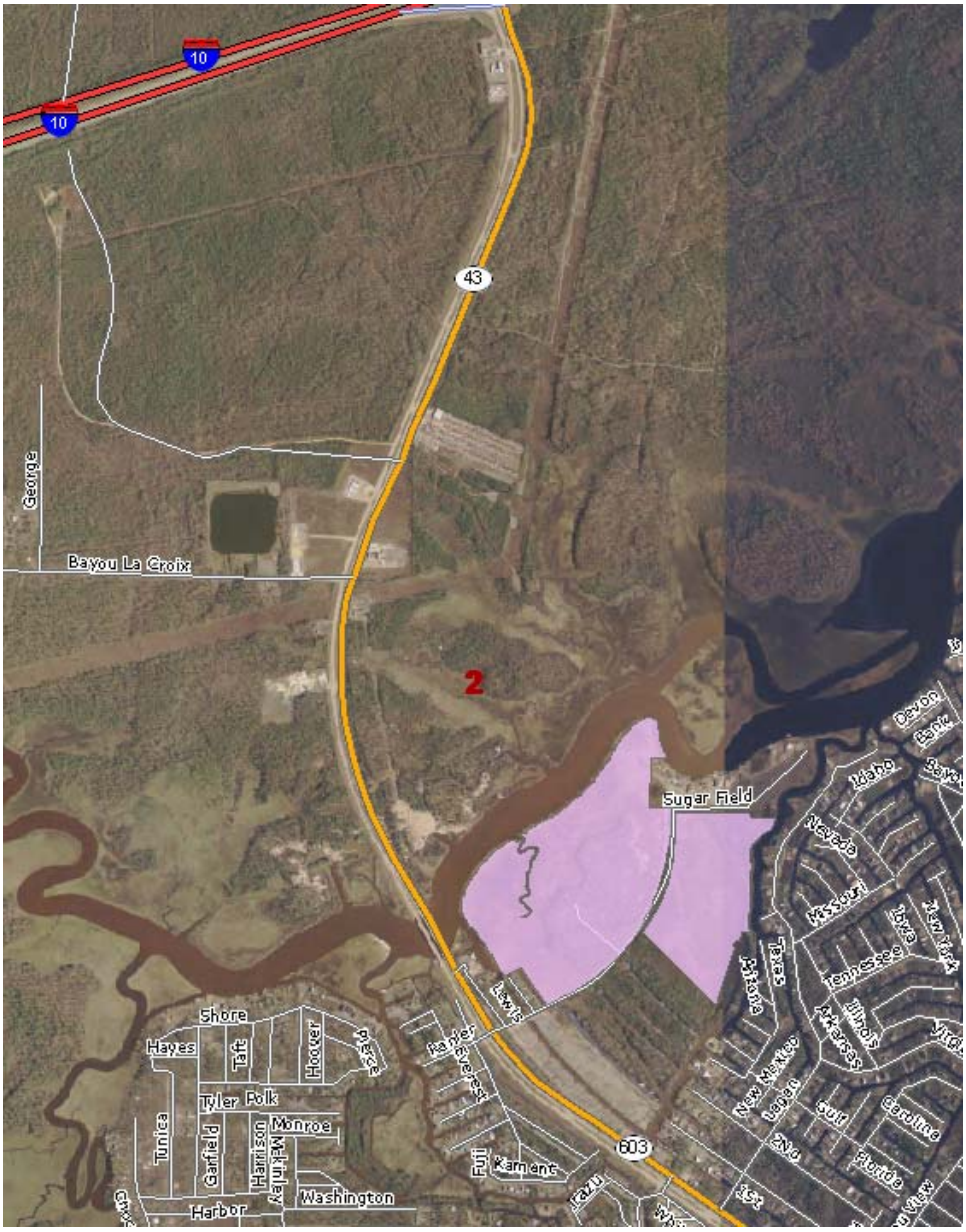


Figure 6.6-1. Location of the Admiral Island Restoration Area

6.6.1.3 Ecosystem Restoration Management Measures

Proposed restoration management measures are listed in Table 6.6-1. Narrative descriptions of each management measure follow this table.

Table 6.6-1.
Ecosystem Restoration Management Measures

Management Measure	Description
No Action	No Action
1	Excavate Old Fill Material
2	Remove Exotic Species
3	Fill Existing Artificial Ditches
4 *a* *b* *C*	Plant Native Vegetation - 0.5 meter spacing - 1.0 meter spacing - 2.0 meter spacing

6.6.1.4 Excavate Old Fill Material (1)

This management measure must be included in all alternatives for the restoration to be successful. It includes 90-95 percent removal of existing exotic species in the excavated areas. This measure positively affects the hydrologic regime.

6.6.1.5 Remove Exotic Species from Non-Excavated Areas and Maintenance of Exotics in All Areas over the Project Life (2)

This management measure must be included in all alternatives for the restoration to be successful. It includes 100 percent removal of exotic species from non-excavated areas over the life of the project. The exotic species include Chinese Tallow, Phragmites, and Cogon Grass. This measure positively affects the percentage of the area covered by exotic species.

6.6.1.6 Fill Existing Artificial Ditches and Channels (3)

This management measure does not need to be included in all alternatives for the restoration to be successful. It includes 100 percent removal of existing artificial ditches and channels. This measure provides additional positive affects to the hydrologic regime.

6.6.1.7 Plant Native Vegetation (4)

The types of native vegetation that will be planted include Spartina alterniflora (Smooth Cordgrass) at the seaward edge of marsh; Juncus roemerianus (Black Needle Rush) at a just slightly higher elevation; and Spartina patens (Saltmeadow Cordgrass) at the next slightly higher elevation.

This management measure must be included in all alternatives for the restoration to be successful. There are three different planting density options: (a) 0.5 meter spacing, (b) 1.0 meter spacing, and (c) 2.0 meters spacing. Planting emergent tidal marsh at varying densities will result in obtaining desired environmental output at varying years and costs. It is estimated that 2 re-planting efforts would be required for the two least dense plantings: 2.0 meters and 1.0 meter spacing. It is estimated that the 0.5 meter spacing will achieve full benefits in about 5 years while the 1.0 meter spacing and 2.0 meter spacing will achieve full benefits in about 7 and 10 years, respectively.

This measure affects the percent cover by woody plant species, wildlife habitat diversity, vegetation height, wetland indicator status and the mean percent cover emergent plant species.

6.6.1.8 Ecosystem Restoration Alternatives

These four management measures were combined to create six alternatives. Each alternative includes the mandatory management measures of excavating old fill material, removing exotic plant species from non-excavated areas, and planting native vegetation. Since there are three different planting densities, three alternatives are created with this combination of management measures. When the management measure of filling existing artificial ditches is added to this combination, this creates another three alternatives.

All alternatives will restore 123 acres. Alternative 1 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, planting native vegetation at a density of 0.5 meters, and filling existing artificial ditches. Alternative 2 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, planting native vegetation at a density of 1.0 meter, and filling existing artificial ditches. Alternative 3 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, planting native vegetation at a density of 2.0 meter, and filling existing artificial ditches. Alternative 4 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas and planting native vegetation at a density of 0.5 meters. Alternative 5 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas and planting native vegetation at a density of 1.0 meter. Alternative 6 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas and planting native vegetation at a density of 2.0 meters. Figure 6.6-2 shows the location of the Admiral Island restoration site. Table 6.6-2 displays a description of each ecosystem restoration alternative.



Figure 6.6-2 Admiral Island restoration site

Table 6.6-2.
Ecosystem Restoration Alternatives

Alternative	Management Measure	Description
0	No Action	No Action
1	1 + 2 +3+ 4a	Excavate Fill Remove Exotics Plant at Density 0.5m Fill Ditches
2	1 + 2 + 3+4b	Excavate Fill Remove Exotics Plant at Density 1.0m Fill Ditches
3	1 + 2 + 3+4c	Excavate Fill Remove Exotics Plant at Density 2.0m Fill Ditches
4	1 + 2 + 4a	Excavate Fill Remove Exotics Plant at Density 0.5m
5	1 + 2 + 4b	Excavate Fill Remove Exotics Plant at Density 1.0m
6	1 + 2 + 4c	Excavate Fill Remove Exotics Plant at Density 2.0m

6.6.1.9 Benefits

Benefits are measured in terms of Average Annual Functional Units (AAFU). The Hydrogeomorphic (HGM) approach was used to assess wetland function. A HGM assessment was performed in 2000 using the Regional Guidebook for Applying the HGM Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration alternatives. Table 6.6-3 displays the AAFU net benefits for each alternative. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration alternative and the total functional units for the no action alternative.

Table 6.6-3.
Summary of Benefits

Alternative	Alternative Description	Net AAFU Net Benefits
No Action	No Action	0
Alternative 1	Excavate Fill Remove Exotics Plant at Density 0.5m Fill Ditches	61
Alternative 2	Excavate Fill Remove Exotics Plant at Density 1.0m Fill Ditches	60
Alternative 3	Excavate Fill Remove Exotics Plant at Density 2.0m Fill Ditches	59
Alternative 4	Excavate Fill Remove Exotics Plant at Density 0.5m	51
Alternative 5	Excavate Fill Remove Exotics Plant at Density 1.0m	50.5
Alternative 6	Excavate Fill Remove Exotics Plant at Density 2.0m	49

6.6.1.10 Costs

The rough order magnitude (ROM) first costs of construction, which do not include interest during construction, include excavating 916,483 cubic yards of old fill material for $10,998,000 and planting native vegetation at densities of 0.5m, 1m and 2.0m spacing for $3,571,000, $1,786,000 and $893,000, respectively. The cost of filling ditches with 7,000 cubic yards of material is estimated at approximately $35,000. Herbicide application by hand to 62 acres of land not excavated is estimated at approximately $893,000. Mobilization and demobilization are estimated at approximately $2,400,000, and miscellaneous site items are estimated at approximately $1,000,000. A contingency of 25 percent and lands and damages costs of $25,000 were added to the construction cost. This cost was increased by an 8 percent planning, Engineering and Design (PED) cost and a 6 percent Construction Management cost.

For each alternative, these first costs of construction are presented in Table 6.6-4 in OCTOBER 2007 dollars along with the Interest During Construction (IDC), investment cost (first cost plus the IDC), Average Annual Investment Cost (AAIC), Average Annual Operations and Maintenance (AAO&M) cost and, ultimately, the Average Annual Costs (AAC).

Table 6.6-4.
Summary of Costs by Measure for Admiral Island Area

Alternative	Alternative Description	Implement-ation Cost (FY-08)	IDC	Investment Cost	AAIC	AAO&M	AAC
0	No Action	$0	$0	$0	$0	$0	$0
1	Excavate Fill Remove Exotics Plant at Density 0.5m Fill Ditches	$26,340,000	$580,000	$26,920,000	$1,447,000	$2,000	$1,449,000
2	Excavate Fill Remove Exotics Plant at Density 1.0m Fill Ditches	$23,790,000	$530,000	$24,320,000	$1,306,000	$58,000	$1,364,000
3	Excavate Fill Remove Exotics Plant at Density 2.0m Fill Ditches	$22,490,000	$500,000	$22,990,000	$1,235,000	$58,000	$1,293,000
4	Excavate Fill Remove Exotics Plant at Density 0.5m	$26,280,000	$580,000	$26,860,000	$1,443,000	$2,000	$1,445,000
5	Excavate Fill Remove Exotics Plant at Density 1.0m	$23,720,000	$530,000	$24,250,000	$1,302,000	$58,000	$1,360,000
6	Excavate Fill Remove Exotics Plant at Density 2.0m	$22,440,000	$500,000	$22,900,000	$1,232,000	$58,000	$1,290,000

Note: Numbers are rounded to the nearest thousand.

First costs of construction are used along with the duration of 12 months of construction and a discount rate of 4.875 percent to calculate IDC. The sum of the first costs of construction and IDC cost equal the investment cost. This cost is amortized at the Fiscal Year (OCTOBER) 2007 Federal discount rate of 4.875 percent over a 50-year economic period of analysis to calculate the AAIC. AAO&M costs for monitoring in years 2 through 6 and re-planting in years 3 and 5 were present valued and amortized at an interest rate of 4.875 percent over a 50-year economic period of analysis. The sum of the AAIC and AAO&M cost equal the AAC.

6.6.2 Comparison of Alternatives

Table 6.6-5 displays all alternatives with their respective AAC and AAFU in increasing order of AAFU.

To determine if an alternative is cost effective, economically inefficient alternatives must first be identified and eliminated. An economically inefficient alternative is an alternative that cost more for the same level of benefit. No alternatives are eliminated for the reason of economic inefficiency because each alternative produces a different level of benefit.

Table 6.6-5.
All Alternatives: AAC and AAFU for Admiral Island

Alternative	AAC	AAFU
No Action	$0	0
6	$1,290,000	49
5	$1,360,000	50.5
4	$1,445,000	51
3	$1,293,000	59
2	$1,364,000	60
1	$1,449,000	61

Note: The AAC values are rounded to the nearest thousand.

Lastly, economically ineffective alternatives are identified and eliminated to determine which alternatives are cost effective. An economically ineffective alternative is an alternative that will produce less benefit at an equal or greater cost than a subsequent alternative. The AAFU benefits are place in ascending order and a pair-wise comparison of the benefits and costs is conducted to eliminate economically ineffective alternatives.

As shown in Table 6.6-6, the two shaded alternatives, 5 and 6, were eliminated because they produced less benefit at greater cost than a subsequent alternative. For example, Alternative 4 produces 51 AAFU at an AAC of $1,445,000 while Alternative 3 produces 59 AAFU at an AAC $1,293,000. Alternative 4 produces less AAFU at a greater cost than Alternative 3. Therefore, Alternative 4 is eliminated. As shown in Table 6.6-7 and plotted in Figure 6.6-3, the cost effective alternatives are Alternative 6, Alternative 3, Alternative 2, and Alternative 1.

Table 6.6-6.
Elimination of Economically Ineffective Alternatives

Alternative	Alternative Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
6	Excavate Fill Remove Exotics Plant at Density 2.0m	$1,290,000	49	Yes
				No
				No
3	Excavate Fill Remove Exotics Plant at Density 2.0m Fill Ditches	$1,293,000	59	Yes
2	Excavate Fill Remove Exotics Plant at Density 1.0m Fill Ditches	$1,364,000	60	Yes
1	Excavate Fill Remove Exotics Plant at Density 0.5m Fill Ditches	$1,449,000	61	Yes

Note: The AAC values are rounded to the nearest thousand.

Table 6.6-7.
Cost Effective Alternatives

Alternative	Alternative Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
6	Excavate Fill Remove Exotics Plant at Density 2.0m	$1,290,000	49	Yes
3	Excavate Fill Remove Exotics Plant at Density 2.0m Fill Ditches	$1,293,000	59	Yes
2	Excavate Fill Remove Exotics Plant at Density 1.0m Fill Ditches	$1,364,000	60	Yes
1	Excavate Fill Remove Exotics Plant at Density 0.5m Fill Ditches	$1,449,000	61	Yes

Note: The AAC values are rounded to the nearest thousand.

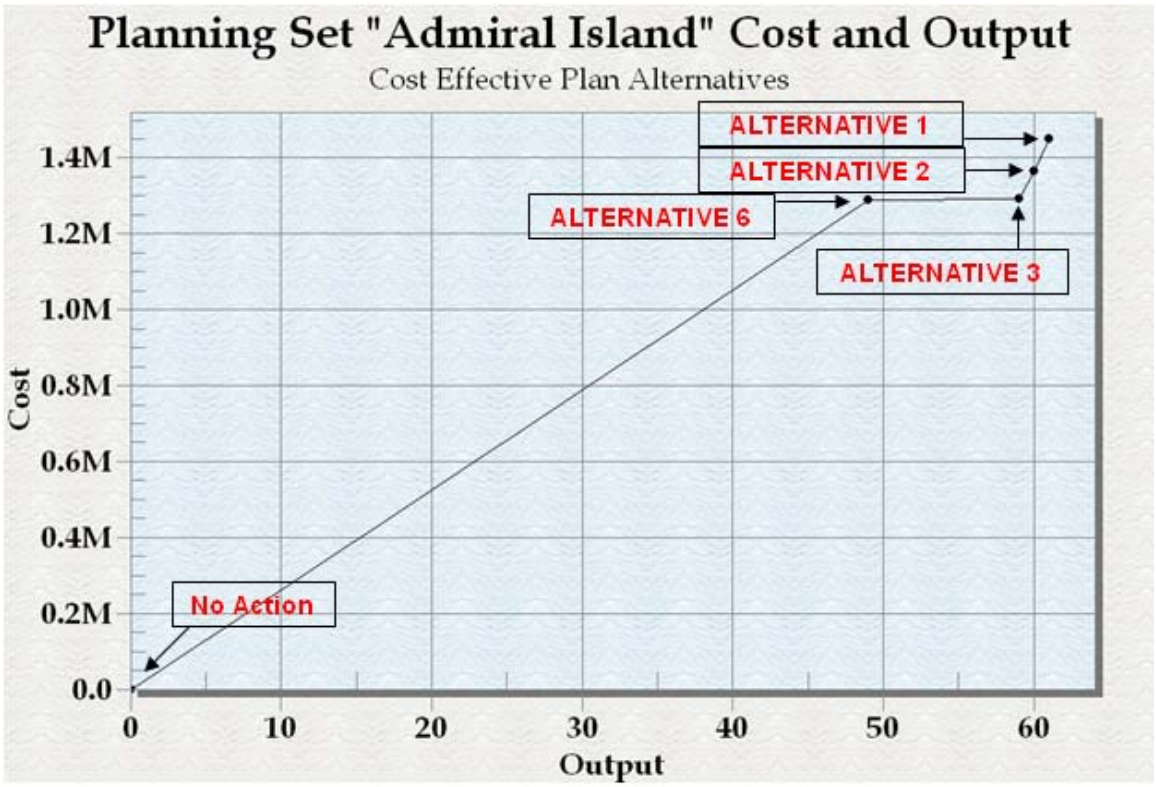


Figure 6.6-3 Display of Cost Effective Alternatives for the Admiral Island Area

6.6.3 Regional Economic Development (RED) Benefits

6.6.3.1 Socioeconomic Impacts using the Economic Impact Forecast System

The purpose of this analysis is to determine the economic impact of the proposed project alternatives on business (sales volumes), income, employment, and population of the local area. Each of the alternatives would affect the local area of Hancock County, Mississippi. The expenditures for the alternatives are estimated to be $26,300,000for Alternative 1, $23,800,000 for the Alternative 2, $22,500,000for Alternative 3, and $22,400,000 for Alternative 6. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $43,000for Alternative 1, $1,075,000 for Alternative 2, $1,075,000 for Alternative 3, and $1,075,000 for Alternative 6, (assuming a 50 year period of analysis and an interest rate of 4.875 percent). Tables 6.6-8 through 6.6-11 summarize the EIFS model inputs and outputs for the cost effective measures at Admiral Island.

Table 6.6-8.
EIFS Model Implementation Inputs for Admiral Island Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Region of Influence (ROI)	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County
Change in Local Expenditures	$0	$26,300,000	$23,800,000	$22,500,000	$22,400,000

Based of the given inputs the outputs are as follows:

Table 6.6-9.
EIFS Model Implementation Outputs for Admiral Island Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Direct Sales Volume	$0	$26,300,000	$23,800,000	$22,500,000	$22,400,000
Induced Sales Volume	$0	$26,300,000	$23,800,000	$22,500,000	$22,400,000
Total Sales Volume	$0	$52,600,000	$47,600,000	$45,000,000	$44,800,000
Direct Income	$0	$6,341,852	$5,739,014	$5,425,539	$5,401,425
Induced Income	$0	$6,341,852	$5,739,014	$5,425,539	$5,401,425
Total Income	$0	$12,683,704	$11,478,029	$10,851,078	$10,802,851
Direct Employment	0	159	144	136	136
Induced Employment	0	159	144	136	136
Total Employment	0	318	288	272	271
Local Population	0	0	0	0	0

Table 6.6-10.
EIFS Model O&M Inputs for Admiral Island Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Region of Influence (ROI)	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County
Change in Local Expenditures	$0	$43,000	$1,075,000	$1,075,000	$1,075,000

Based of the given inputs the outputs are as followed:

Table 6.6-11.
EIFS Model O&M Outputs for Admiral Island Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Direct Sales Volume	$0	$43,000	$1,075,000	$1,075,000	$1,075,000
Induced Sales Volume	$0	$43,000	$1,075,000	$1,075,000	$1,075,000
Total Sales Volume	$0	$86,000	$2,150,000	$2,150,000	$2,150,000
Direct Income	$0	$10,369	$259,220	$259,220	$259,220
Induced Income	$0	$10,369	$259,220	$259,220	$259,220
Total Income	$0	$20,738	$518,440	$518,440	$518,440
Direct Employment	0	0	7	7	7
Induced Employment	0	0	7	7	7
Total Employment	0	0	14	14	14
Local Population	0	0	0	0	0

6.7 Evaluation of Turkey Creek Ecosystem Restoration Measures

This section describes the evaluation of ecosystem restoration measures at the Turkey Creek area that is located within planning sub-unit 12, which is part of planning unit two. The total area includes 879 acres. There are no structures within the area, and the acquisition of the parcels would have to occur before the implementation of any of the alternatives. This area was selected for ecosystem restoration using the Decision Support System, a GIS based model created by the Corps' Engineer Research and Development Center (ERDC). For more details on the selection process for ecosystem restoration sites see the Economic Appendix. Figure 6.7-1 shows the location of the Turkey Creek area.

6.7.1 Formulation of Alternatives

6.7.1.1 Assumption

In order for the Turkey Creek site to undergo ecosystem restoration, it is assumed that there will be mandatory buy-outs of required properties in the site footprint. The costs of these buy-outs are accounted for in the flood damage reduction alternative and not in this ecosystem restoration alternative. However, there are non-building structures that require removal and disposal. These costs result from and are included in this ecosystem restoration alternative.

6.7.1.2 Objectives

The following objectives were developed for this ecosystem restoration study:

- Restore native vegetation
- Restore natural hydrology
- Restore fish and wildlife habitat
- Provide storm water storage protection

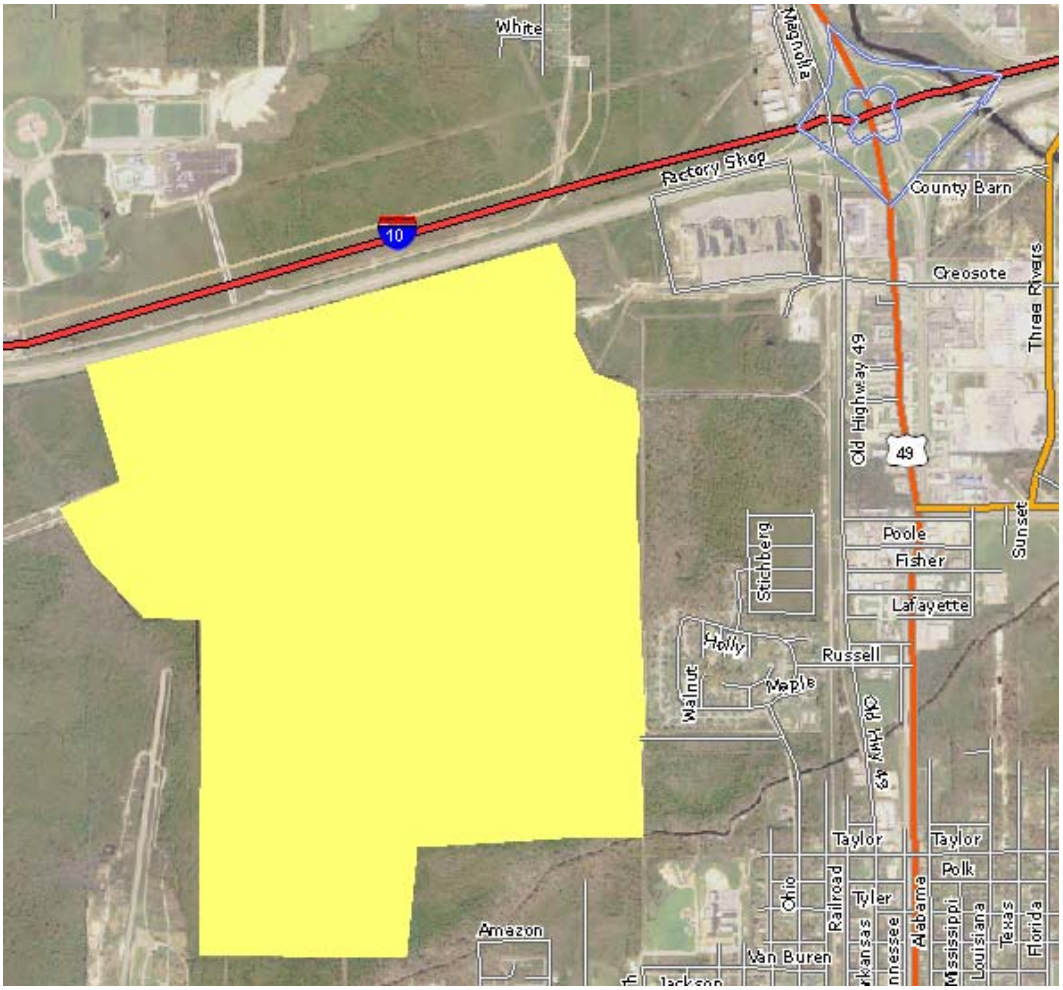


Figure 6.7-1. Location of Turkey Creek Restoration area in Planning Unit Two

6.7.1.3 Ecosystem Restoration Management Measures

Proposed restoration management measures are listed in table 6.7-1. Narrative descriptions of each management measure follow this table.

Table 6.7-1.
Ecosystem Restoration Management Measures

Management Measure	Description
No Action	No Action
1	Fill Ditches
2 a b	Maintain Vegetation By Burning By Mowing
3	Excavate and Remove Existing Roadbeds and Any Additional Fill

6.7.1.3.1 Fill Ditches (1)

This management measure must be included in all alternatives for the restoration to be successful. This measure affects the outflow of water. It measures the removal of water by ditches or drains.

6.7.1.3.2 Maintain Vegetation (2)

This management measure must be included in all alternatives for the restoration to be successful. There are two methods that will be analyzed for maintaining vegetation: (a) burning and (b) mowing. Fire benefits this ecosystem in many different ways. It creates a bare seedbed for pine seedlings and other fire dependent plants, reduces fuel loads and recycles nutrients. Periodic burning promotes early successional plants that are important to many species of wildlife indigenous to this ecosystem. Many of the plant species found in this ecosystem are fire dependent; for example, the federally endangered American Chaff seed flowers almost exclusively after a fire. It has been reduced to a fraction of its original range due to fire suppression and habitat destruction. Fire suppression is mainly due to liability issues and fear of litigation.

Mowing is a mechanical alternative that many land managers use to maintain early successional habitats. Although it is successful to some extent, it fails to provide all the necessary components that come from prescribed fire. This method also has a negative effect. Mowing requires the use of heavy equipment in sensitive areas. Tractors can create ruts in saturated soils, creating hydrologic problems and micro site conditions. Mowing can also introduce non-native species through the use of contaminated equipment. Another disadvantage of mowing is that the duff or litter layer remains on the ground, preventing seeds from reaching the bare ground needed for germination. This thick litter layer can also provide heavy fuel loads increasing the risk of wildfires during dry periods. Although mowing provides some level of habitat management in pine savannahs, it is not a substitute for prescribed fire. Mowing can maintain succession, but may inhibit other functions of the system.

6.7.1.3.3 Excavate and Remove Existing Roadbeds and Any Additional Fill (3)

This management measure must be included in all alternatives for the restoration to be successful. This measure affects the surface water storage.

6.7.1.4 Ecosystem Restoration Alternatives

These management measures were combined to create six alternatives. Each alternative requires filling ditches, maintaining vegetation growth by burning and mowing the project area in the initial year of construction as well as maintaining it by either burning every three years or mowing every year over the life of the project, and excavating and removing existing roadbeds and any additional fill. The difference between each alternative includes the number of acres restored and the method of maintaining vegetation over the life of the project.

Alternatives 1 and 2 consist of restoring the project areas north and south of the railroad: 897 acres. Alternative 1 maintains vegetation by burning once every three years. Alternative 2 maintains vegetation by mowing every year. Alternatives 3 and 4 consist of restoring only the project area south of the railroad: 689 acres. Alternative 3 maintains vegetation by burning once every three years. Alternative 4 maintains vegetation by mowing every year. Alternatives 5 and 6 consist of restoring only the project area north of the railroad: 190 acres. Alternative 5 maintains vegetation by burning once every three years. Alternative 6 maintains vegetation by mowing every year. Figure 6.7-2 shows the Turkey Creek restoration site. Table 6.7-2 displays a description of each ecosystem restoration alternative.

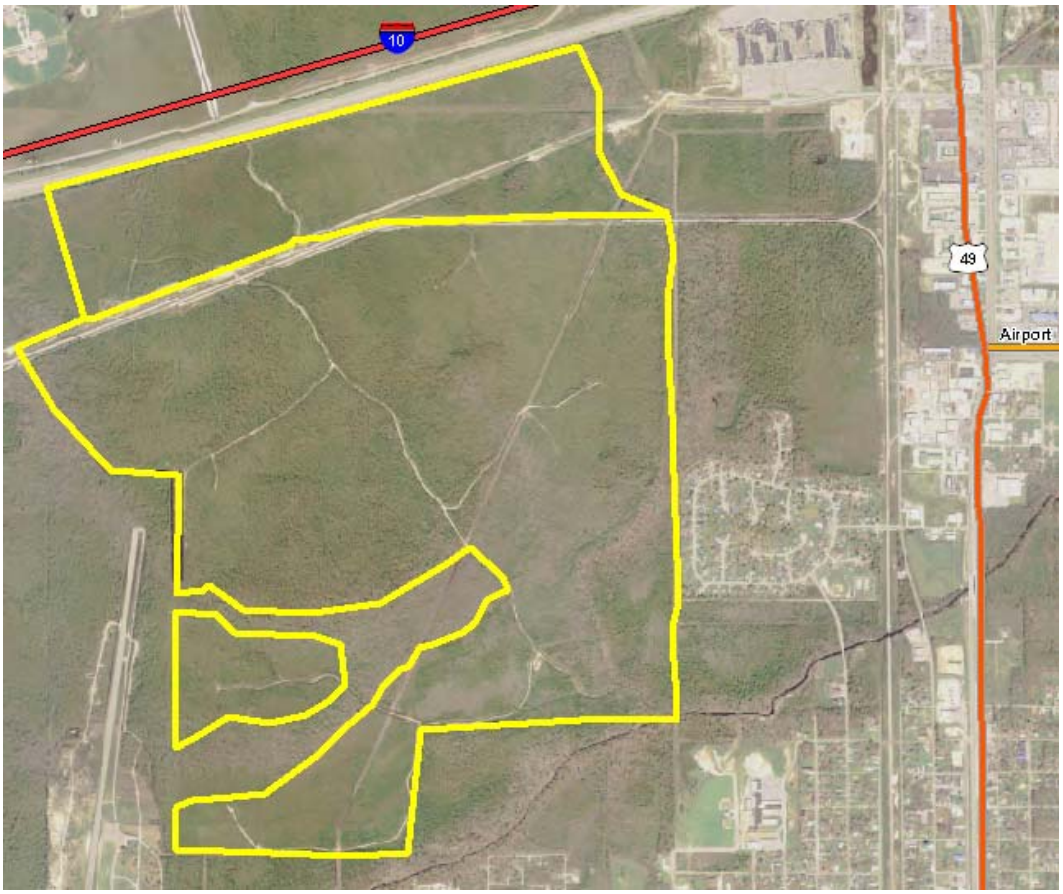


Figure 6.7-2. Turkey Creek Restoration Site

Table 6.7-2.
Ecosystem Restoration Alternatives

Alternative	Management Measures	Alternative Description
0	No Action	No Action
1	1 + 2a +3	879 Acre Restoration Maintain by Burning
2	1 + 2b + 3	879 Acre Restoration Maintain by Mowing
3	1 + 2a +3	689 Acre Restoration Maintain by Burning
4	1 + 2b + 3	689 Acre Restoration Maintain by Mowing
5	1 + 2a +3	190 Acre Restoration Maintain by Burning
6	1 + 2b + 3	190 Acre Restoration Maintain by Mowing

6.7.1.5 Benefits

In order to restore this area to a Wet Pine Savannah habitat, the higher areas will be designated as Wet Pine Savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water. The Wet Pine Savannah habitat will be restored with Wet Pine Flatwoods, such as Pinus elliotti, Morella cerifera, Ilex glabra, Spartina patens and Panicum virgatum.

Many species of wildlife are indigenous to the Wet Pine Savannah habitat. Understory plant communities may contain wiregrass, sedges, orchids, American Chaff seed and rough-leaved loosestrife. Insectivorous plants that may be found include pitcher plants, bladderworts, venus flytrap, and sundews. Rare, threatened or endangered birds that may occur in these areas include Henslowe's sparrow, Bachman's sparrow, red-cockaded woodpecker, and Mississippi Sandhill Crane. This ecosystem may also benefit the Mississippi Gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise.

Benefits are measured in terms of Average Annual Functional Units (AAFU). The Hydrogeomorphic (HGM) approach was used to assess wetland function. A HGM assessment was performed in 2000 using the Regional Guidebook for Applying the HGM Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration alternatives. Table 6.7-3 shows the total functional units under each alternative and the AAFU net benefit. It is assumed that functional units will remain the same under existing conditions and the no action alternative. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration alternative and the total functional units for the no action alternative.

Table 6.7-3.
Summary of Benefits

Alternative	Alternative Description	Total Functional Units	AAFU Net Benefit
Existing Condition (alternatives 1-2)	Existing Condition	1,222	-
Existing Condition (alternatives 3-4)	Existing Condition	1,012	-
Existing Condition (alternatives 5-6)	Existing Condition	210	-
No Action (alternatives 1-2)	No Action	1,222	0
No Action (alternatives 3-4)	No Action	1,012	0
No Action (alternatives 5-6)	No Action	210	0
Alternative 1	879 Acre Restoration Maintain by Burning	3,268	2,046
Alternative 2	879 Acre Restoration Maintain by Mowing	2,574	1,352
Alternative 3	689 Acre Restoration Maintain by Burning	2,577	1,565
Alternative 4	689 Acre Restoration Maintain by Mowing	2,037	815
Alternative 5	190 Acre Restoration Maintain by Burning	691	481
Alternative 6	190 Acre Restoration Maintain by Mowing	537	327

6.7.1.6 Costs

A rough order magnitude (ROM) cost estimate was developed for the 879, 190, and 689 acres of restoration. It included the cost of filling ditches with 130,200, 28,100, and 102,100 cubic yards of material for $1,562,420, $337,480, and $1,224,900, respectively; burning 879, 190, and 689 acres of vegetation for $131,850, 28,480, and 103,370, respectively; mowing 879, 190, and 689 acres for $74,720, 16,140, and 58,580, respectively; removing and disposing of structures, roads and utilities for $2,601,040, $560,530, and $2,040,510, respectively; mobilizing and demobilizing for $20,000; and miscellaneous site items for $45,000. These construction costs equaled $4,435,000, $1,008,000, and $3,492,000, respectively. A contingency cost of 25% and lands and damages costs of $1,126,000, $375,000, and 777,000 were added to the construction cost. Then, Planning, Engineering and Design (PED) costs of 8% and a Construction Management cost of 6% were added for a total first cost of construction. The first cost of 879 acres of restoration is estimated at $7,600,000. The first cost of 190 acres of restoration is estimated at $1,900,000. The first cost of 689 acres of restoration is estimated at $5,900,000.

The first cost plus Interest During Construction (IDC) equals the investment cost. IDC cost of 879, 190, and 689 acres of restoration is estimated at $168,900, $41,400, and $130,200, respectively. Investment cost of 897, 190, and 689 acres of restoration is estimated at $7,800,000, $1,910,000, and $6,020,000, respectively. O&M cost of burning every three years 879, 190, and 689 acres is estimated at $3,040,000, $2,384,000, and $656,000, respectively. O&M cost of mowing every year 879, 190, and 689 acres is estimated at $5,243,000, $4,116,000, and $1,127,000, respectively. Average Annual Investment Cost (AAIC) plus Average Annual Operations and Maintenance (AAO&M) cost equals Average Annual Costs (AAC).

- For Plan 1, AAIC of $419,000 plus AAO&M of $60,000.equals an AAC of $479,000.
- For Plan 2, AAIC of $419,000 plus AAO&M of $107,000.equals an AAC of $526,000.
- For Plan 3, AAIC of $101,000 plus AAO&M of $13,000.equals an AAC of $114,000.
- For Plan 4, AAIC of $101,000 plus AAO&M of $23,000.equals an AAC of $124,000.
- For Plan 5, AAIC of $323,000 plus AAO&M of $47,000.equals an AAC of $370,000.
- For Plan 6, AAIC of $323,000 plus AAO&M of $84,000.equals an AAC of $407,000.

For each alternative, the first costs of construction, IDC, investment cost, O&M cost, AAIC, AAO&M cost and AAC are presented in table 6.7-4 at October 2007 price levels.

First cost of construction is used along with the duration of 12 months of construction and a discount rate of 4.875 percent to calculate Interest During Construction (IDC). The sum of the first cost of construction and IDC cost equals the investment cost. This cost is amortized at the FY 2007 federal discount rate of 4.875 percent over a 50-year economic period of analysis to calculate the Average Annual Investment Cost (AAIC). Average Annual O&M (AAO&M) costs for burning once every three years or mowing every year were present valued and amortized at an interest rate of 4.875 percent over a 50-year economic period of analysis. The sum of the AAIC and AAO&M cost equals the Average Annual Costs (AAC).

Table 6.7-4.
Summary of Costs by Measure for Turkey Creek

Alternative	Alternative Description	Implementation Cost (FY-08)	IDC	Investment Cost	AAIC	AAO&M	AAC
0	No Action	$0	$0	$0	$0	$0	$0
1	879 Acre Restoration Maintain by Burning	$7,636,000	$169,000	$7,804,000	$419,000	$60,000	$479,000
2	879 Acre Restoration Maintain by Mowing	$7,636,000	$169,000	$7,804,000	$419,000	$107,000	$526,000
3	689 Acre Restoration Maintain by Burning	$5,887,000	$130,000	$6,017,000	$323,000	$47,000	$370,000
4	689 Acre Restoration Maintain by Mowing	$5,887,000	$130,000	$6,017,000	$323,000	$84,000	$407,000
5	190 Acre Restoration Maintain by Burning	$1,871,000	$41,000	$1,913,000	$101,000	$13,000	$114,000
6	190 Acre Restoration Maintain by Mowing	$1,871,000	$41,000	$1,913,000	$101,000	$23,000	$124,000

Note: Numbers are rounded to the nearest thousand dollars.

6.7.2 Comparison of Alternatives

Table 6.7-5 displays all alternatives with their respective AAC and AAFU.

Table 6.7-5.
All Alternatives: AAC and AAFU

Alternative	AAC	AAFU
No Action	$0	0
1	$479,000	2,046
2	$526,000	1,352
3	$370,000	1,565
4	$407,000	815
5	$114,000	481
6	$124,000	327

Note: The AAC values are rounded to the nearest thousand dollars.

In order to determine the cost effectiveness of each alternative, the list of alternatives is reordered so that they are listed in increasing order of their outputs (AAFU). This list is shown in table 6.7-6.

To determine if an alternative is cost effective, economically inefficient alternatives must first be identified and eliminated. An economically inefficient alternative is an alternative that cost more for the same level of benefit. No alternatives are eliminated for the reason of economic inefficiency because each alternative produces a different level of benefit.

Table 6.7-6.
All Alternatives Arrayed by Increasing Output

Alternative	AAC	AAFU
No Action	$0	0
6	$124,000	327
5	$114,000	481
4	$407,000	815
2	$526,000	1,352
3	$370,000	1,565
1	$479,000	2,046

Note: The AAC values are rounded to the nearest thousand dollars.

Lastly, economically ineffective alternatives are identified and eliminated to determine which alternatives are cost effective. An economically ineffective alternative is an alternative that cost more or the same as a subsequent alternative but produces less benefit than that subsequent alternative. As shown in table 6.7-7, the three shaded alternatives, 6, 4, and 2 were eliminated because they produced less benefit at greater cost than a subsequent alternative. For example, Alternative 6 produces 327 AAFU at an AAC of $124,000 while Alternative 5 produces 481 AAFU at an AAC $114,000. Alternative 6 produces less AAFU at a greater cost than Alternative 5. Therefore, Alternative 6 is eliminated. As shown in table 6.7-8 and plotted in figure 6.7-3, the cost effective alternatives are Alternative 5 (190 acres of restoration maintained by burning), Alternative 3 (689 acres of restoration maintained by burning) and Alternative 1 (879 acres of restoration maintained by burning).

Table 6.7-7.
Elimination of Economically Ineffective Alternatives

Alternative	Alternative Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
				No
5	190 Acre Restoration Maintain by Burning	$114,000	481	Yes
				No
				No
3	689 Acre Restoration Maintain by Burning	$370,000	1,565	Yes
1	879 Acre Restoration Maintain by Burning	$479,000	2,046	Yes

Note: The AAC values are rounded to the nearest thousand dollars.

Table 6.7-8.
Cost Effective Alternatives for the Turkey Creek Area

Alternative	Alternative Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
5	190 Acre Restoration Maintain by Burning	$114,000	481	Yes
3	689 Acre Restoration Maintain by Burning	$370,000	1,565	Yes
1	879 Acre Restoration Maintain by Burning	$479,000	2,046	Yes

Note: The AAC values are rounded to the nearest thousand dollars.

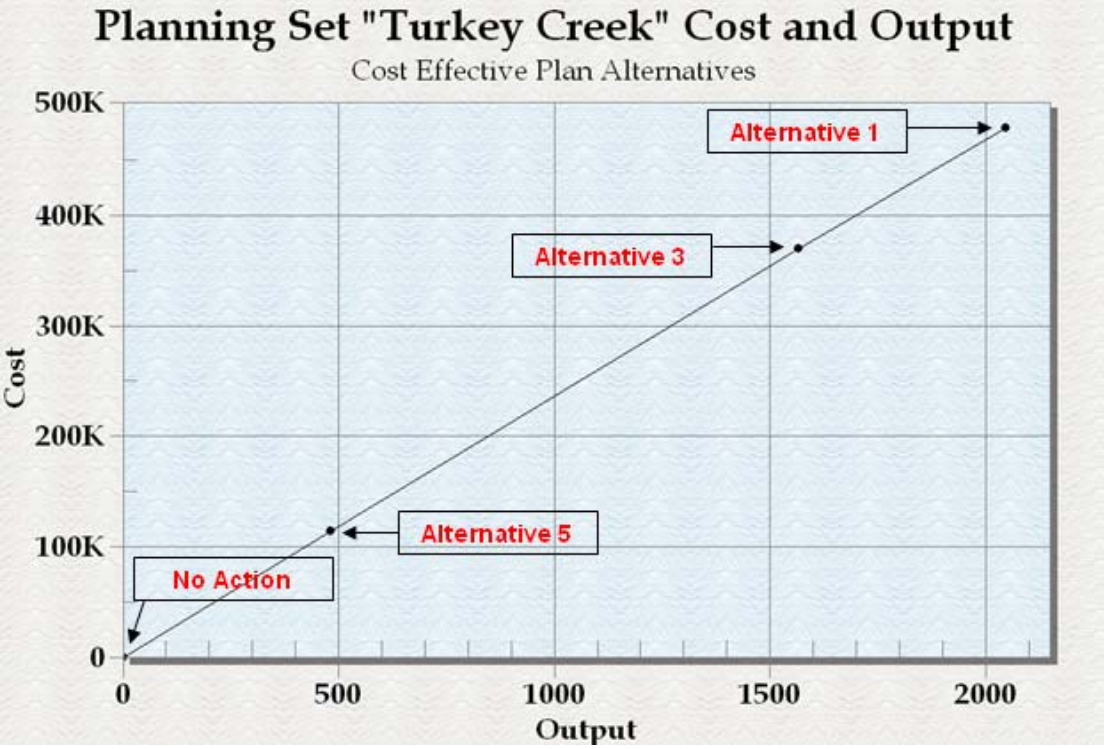


Figure 6.7-3. Display of Cost Effective Alternatives for the Turkey Creek Area

6.7.3 Regional Economic Development Benefits

6.7.3.1 Socioeconomic Impacts using the Economic Impact Forecast System

The purpose of this section is to show the economic impact of the proposed project alternatives on business (sale volumes), income, employment, and population of the local area. Each of the alternatives would affect the local area of Harrison County, Mississippi. The expenditures for the alternatives are estimated to be $7,600,000 for Alternative 1, $5,900,000 for Alternative 3, $1,900,000 for Alternative 5. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $1,112,000 for Alternative 1, $872,000 for Alternative 3, and $240,000 for Alternative 5 (assuming a 50 year period of analysis and an interest rate of 4.875 percent). Tables 6.7-9 through 6.7-12 show the EIFS model inputs and outputs for the cost effect alternatives.

Table 6.7-9.
EIFS Model Implementation Inputs for Turkey Creek Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Region of Influence (ROI)	Harrison County	Harrison County	Harrison County	Harrison County
Change in Local Expenditures	$0	$7,600,000	$5,900,000	$1,900,000

Based of the given inputs the outputs are as follows:

Table 6.7-10.
EIFS Model Implementation Outputs for Turkey Creek Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Direct Sales Volume	$0	$7,600,000	$5,900,000	$1,900,000
Induced Sales Volume	$0	$9,500,000	$7,375,000	$2,375,000
Total Sales Volume	$0	$17,100,000	$13,275,000	$4,275,000
Direct Income	$0	$1,608,733	$1,248,884	$402,183
Induced Income	$0	$2,010,916	$1,561,106	$502,729
Total Income	$0	$3,619,648	$2,809,990	$904,912
Direct Employment	0	48	37	12
Induced Employment	0	60	47	15
Total Employment	0	109	84	27
Local Population	0	0	0	0

Table 6.7-11.
EIFS Model O&M Inputs for Turkey Creek Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Region of Influence (ROI)	Harrison County	Harrison County	Harrison County	Harrison County
Change in Local Expenditures	$0	$1,112,000	$872,000	$240,000

Based of the given inputs the outputs are as follows:

Table 6.7-12.
EIFS Model O&M Outputs for Turkey Creek Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Direct Sales Volume	$0	$1,112,000	$872,000	$240,000
Induced Sales Volume	$0	$1,390,000	$1,090,000	$300,000
Total Sales Volume	$0	$2,502,000	$1,962,000	$540,000
Direct Income	$0	$235,383	$184,581	$50,802
Induced Income	$0	$294,229	$230,726	$63,503
Total Income	$0	$529,612	$415,307	$114,305
Direct Employment	0	7	6	2
Induced Employment	0	9	7	2
Total Employment	0	16	13	4
Local Population	0	0	0	0

6.8 Evaluation of Ocean Springs Area Measures

6.8.1 General

The Ocean Springs area, shown in figure 6.8-1, is located in the southwestern extent of planning unit three along the eastern shore of the Biloxi Bay. The area is denoted as planning sub-unit 22 and is depicted in the figure below. The pre-Hurricane Katrina conditions for this area represented a mostly residential community. As shown in table 6.8-1, it was estimated from the field inventorying process that planning sub-unit 22 included 3,722 tax parcels, of which 3,371 contained a structure with some economic value and 351 were vacant land. Of those 3,371 parcels that contain structures, 2,995 were residential one-story, 85 were residential two-story, 5 were mobile homes, 220 were commercial, and 66 were municipal.

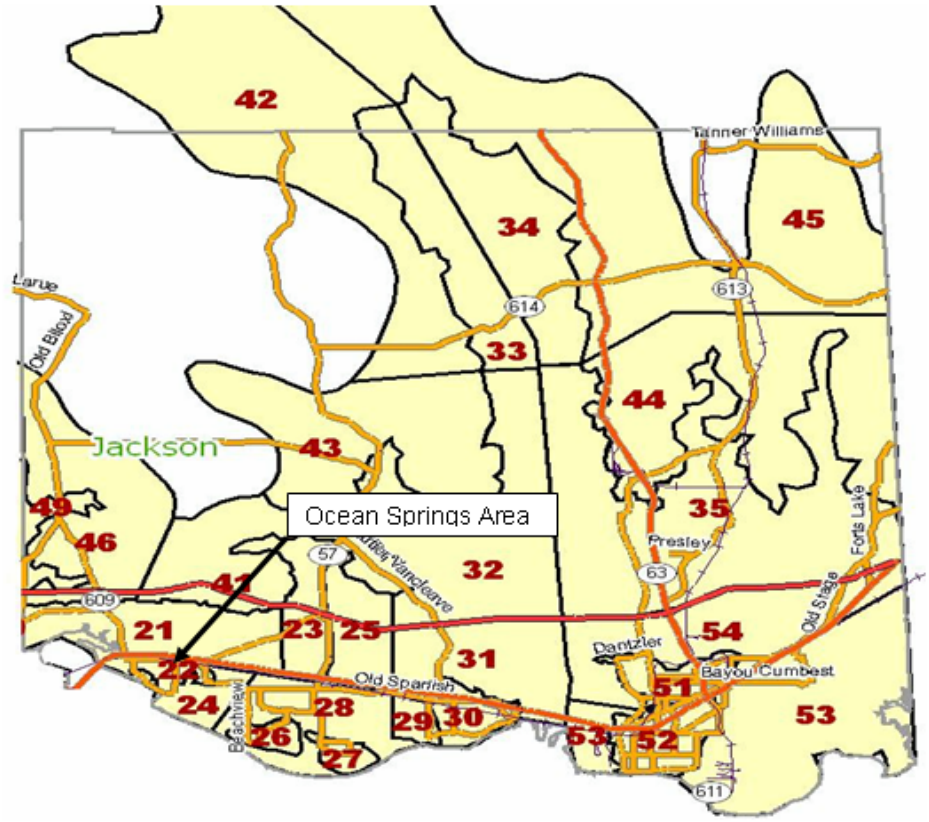


Figure 6.8-1. Ocean Springs Area – Planning Sub-unit 22

Table 6.8-1.
Pre-Hurricane Katrina Estimate of Structures for the Ocean Springs Area Planning Sub-unit 22

Asset Categories	Assets by Category
Residential	3,080
Mobile Homes	5
Commercial	220
Municipal	66
Vacant Land	351
Total Tax Parcels	**3,722**

6.8.2 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation

6.8.3 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4.875 percent was used in estimating average annual benefits and costs
- Price levels are October, 2007 unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs.

6.8.4 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit three. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

- Measure A – Ocean Springs 20-foot NAVD88 Ring Levee
  This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 20.0-feet NAVD88.
- Measure B – Ocean Springs 30-foot NAVD88 Ring Levee
  This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 30.0-feet NAVD88.
- Measure C – Ocean Springs Nonstructural One
  This measure includes the acquisition and flood proofing (elevate-in-place) of structures to the FEMA advisory base flood elevation (ABFE).

- Measure D – Ocean Springs Nonstructural Two
  This measure includes the acquisition and flood proofing of structures to approximately elevation 20.0-feet NAVD88.

- Measure E – Ocean Springs Nonstructural Three
  This measure includes the acquisition and flood proofing of structures to approximately elevation 30.0-feet NAVD88.

Figure 6.8-2 shows the measures for the Ocean Springs Area (planning sub-unit 22); the red line represents the approximate footprint of the ring levees, the dark green within the ring levee footprint represents potential ABFE buyout areas and the light green area within the ring levee footprint represents potential flood proof (elevate-in-place) areas.



Figure 6.8-2. Display of Potential Measures for the Ocean Springs Area (Planning Sub-Unit 22)

6.8.5 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December

2005, which states: "…***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits…"*** More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.8.5.1 Existing Conditions Post-Hurricane Katrina)

The effects of Hurricane Katrina storm surge were devastating to the Ocean Springs Area. Peak water elevation in the area ranged from 20-to-21-feet NAVD88. It is estimated that between 95 and 99-percent of the structures in the area sustained significant inundation damage (fifty-percent or more). Destroyed residences and commercial structures have displaced the majority of the residences within the area. Expected redevelopment of the area is described in the following section.

6.8.5.2 Future Without-Project Conditions

Equivalent annual flood damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the measures were evaluated and compared to future without-project scenarios three, and five, as previously discussed in section 5.3. These future scenarios were chosen because the redevelopment projected for this area is anticipated to return to the pre-Katrina development. Futures scenarios two, four, and six were not used for evaluation purposes since this area is not accommodative for commercial and condominium redevelopment under those mixed redevelopment scenarios (see section 5.3 for more detail).

Future scenario one is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Table 6.8-2 shows structures by asset category and by elevation. The number of structures per elevation is added to the previous number of structures per elevation in each category. For example, in the residential category there are no structures with an elevation of 1-foot or lower, and there is one structure with an elevation of 2-feet or less, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Ocean Springs area.

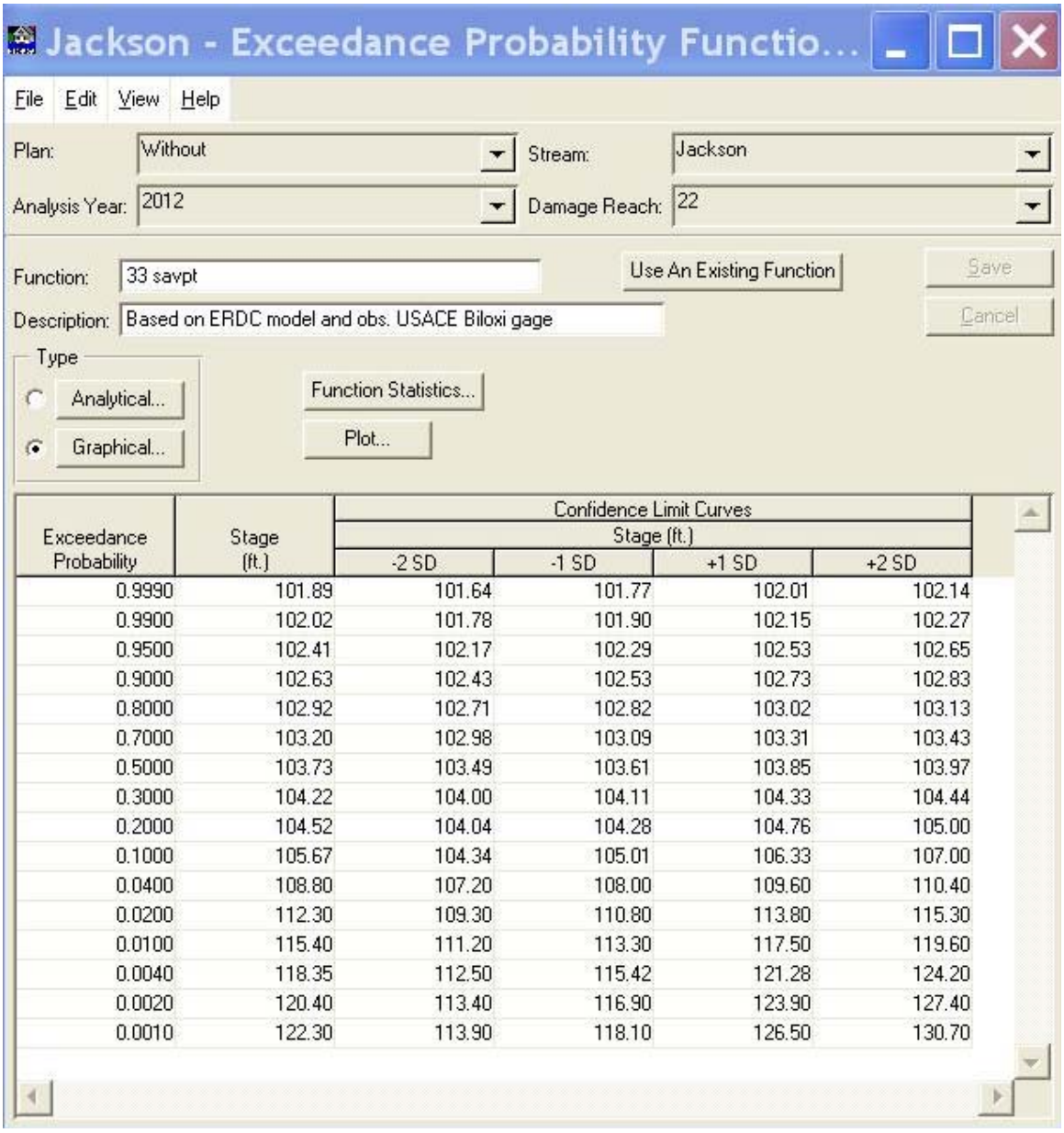
Table 6.8-2.
Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years

Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	0	0	0	0	0
2-foot	1	0	0	0	1
3-foot	2	0	0	0	2
4-foot	4	0	0	0	4
5-foot	5	0	0	0	5
6-foot	9	0	0	0	9
7-foot	13	0	0	0	13
8-foot	22	0	0	0	22
9-foot	33	0	0	0	33
10-foot	48	0	0	0	48
11-foot	56	0	0	0	56

Table 6.8-2.
Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years (continued)

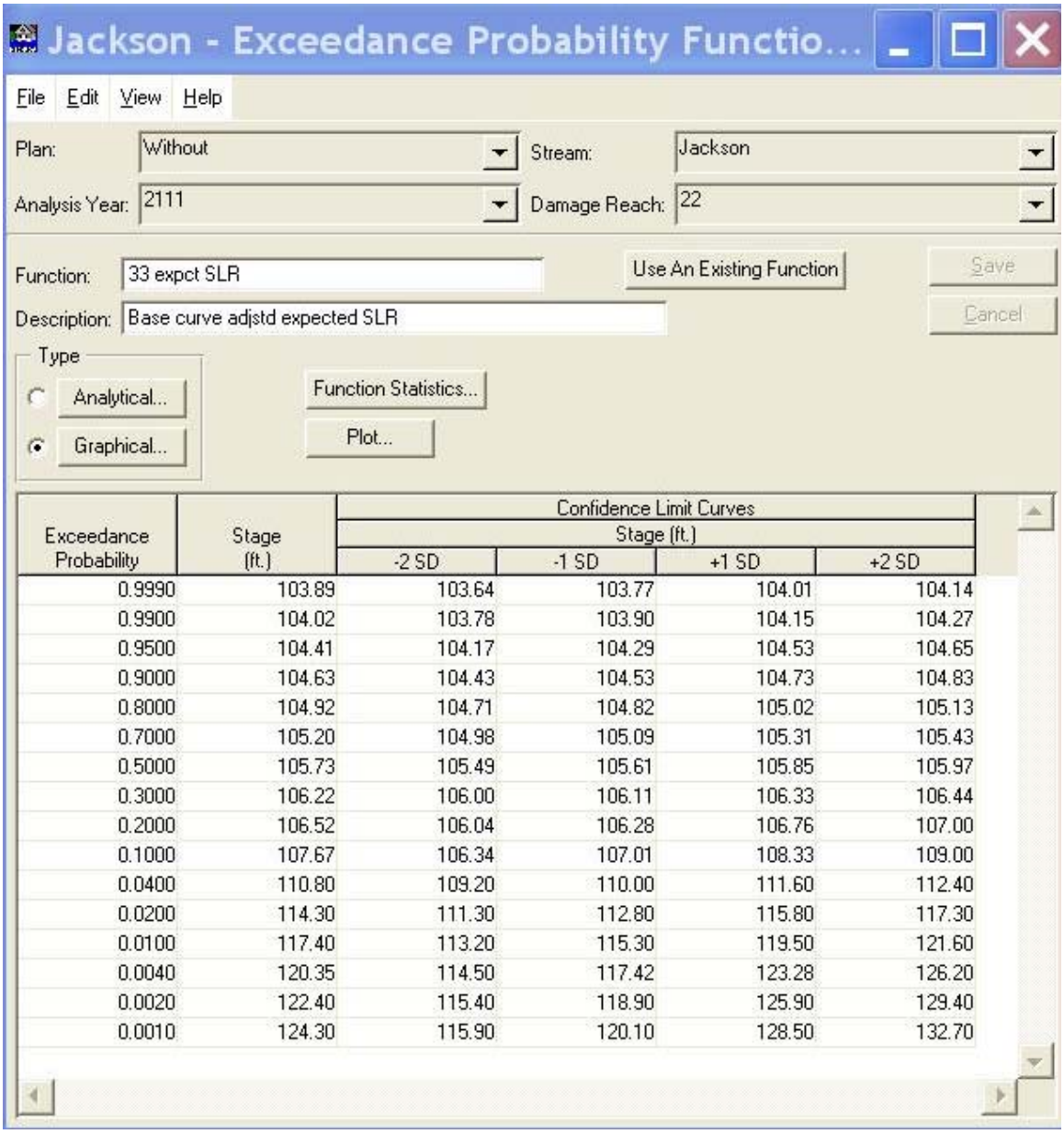
Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
12-foot	66	0	0	1	67
13-foot	78	0	0	1	79
14-foot	101	0	0	2	103
15-foot	122	0	0	2	124
16-foot	170	0	0	3	173
17-foot	296	1	9	13	319
18-foot	387	1	11	13	412
19-foot	577	1	17	14	609
20-foot	833	1	31	18	883
21-foot	1,150	1	46	20	1,217
22-foot	1,828	4	86	36	1,954
23-foot	2,687	5	169	52	2,913
24-foot	3,038	5	214	65	3,322
25-foot	3,075	5	220	66	3,366
26-foot	3,076	5	220	66	3,367
27-foot	3,077	5	220	66	3,368
28-foot	3,078	5	220	66	3,369
29-foot	3,079	5	220	66	3,370
30-foot	3,080	5	220	66	3,371
Total	**3,080**	**5**	**220**	**66**	**3,371**

Future scenario three is the full redevelopment of assets within the study area by the year 2012. Under this scenario, assets will be rebuilt as they were pre-Hurricane Katrina. For example, if the asset was a residential structure pre-Hurricane Katrina it will be rebuilt as a residential structure; commercial structures will be built back to commercial structures; etc. Basically, future scenario three is the same structure inventory as future scenario one with the addition of an expected relative sea level rise over the 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $1,958,000 (rounded to the nearest thousand dollars). The total number of structures in this scenario are the same as in scenario one and can be seen above in table 6.8-2. Figures 6.8-3 and 6.8-4 depict the base year and most likely future year exceedance probability functions for the Ocean Springs area (planning sub-unit 22). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.8-4 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	101.89	101.64	101.77	102.01	102.14
0.9900	102.02	101.78	101.90	102.15	102.27
0.9500	102.41	102.17	102.29	102.53	102.65
0.9000	102.63	102.43	102.53	102.73	102.83
0.8000	102.92	102.71	102.82	103.02	103.13
0.7000	103.20	102.98	103.09	103.31	103.43
0.5000	103.73	103.49	103.61	103.85	103.97
0.3000	104.22	104.00	104.11	104.33	104.44
0.2000	104.52	104.04	104.28	104.76	105.00
0.1000	105.67	104.34	105.01	106.33	107.00
0.0400	108.80	107.20	108.00	109.60	110.40
0.0200	112.30	109.30	110.80	113.80	115.30
0.0100	115.40	111.20	113.30	117.50	119.60
0.0040	118.35	112.50	115.42	121.28	124.20
0.0020	120.40	113.40	116.90	123.90	127.40
0.0010	122.30	113.90	118.10	126.50	130.70

Figure 6.8-3. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Ocean Springs Area

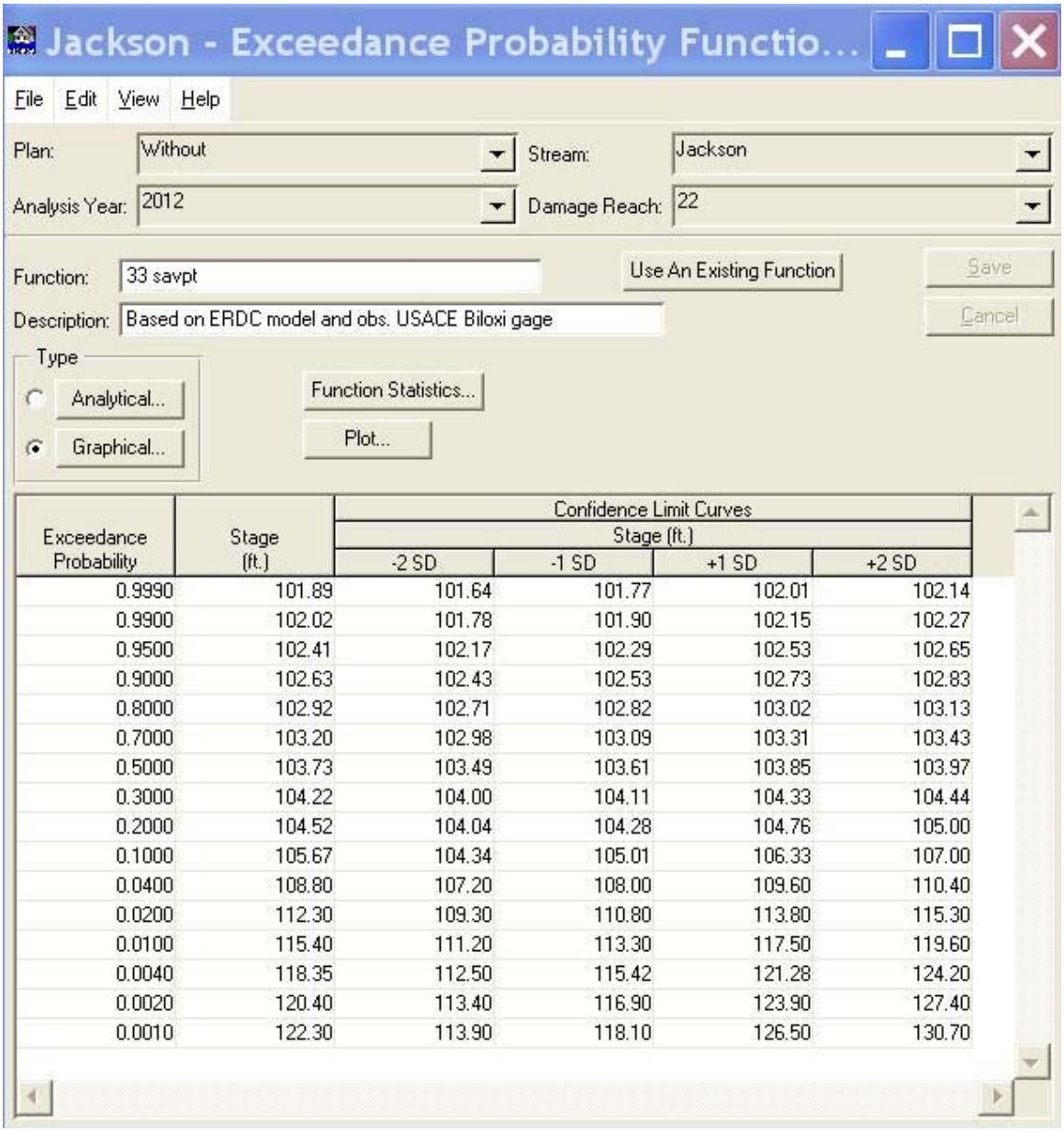


Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	103.89	103.64	103.77	104.01	104.14
0.9900	104.02	103.78	103.90	104.15	104.27
0.9500	104.41	104.17	104.29	104.53	104.65
0.9000	104.63	104.43	104.53	104.73	104.83
0.8000	104.92	104.71	104.82	105.02	105.13
0.7000	105.20	104.98	105.09	105.31	105.43
0.5000	105.73	105.49	105.61	105.85	105.97
0.3000	106.22	106.00	106.11	106.33	106.44
0.2000	106.52	106.04	106.28	106.76	107.00
0.1000	107.67	106.34	107.01	108.33	109.00
0.0400	110.80	109.20	110.00	111.60	112.40
0.0200	114.30	111.30	112.80	115.80	117.30
0.0100	117.40	113.20	115.30	119.50	121.60
0.0040	120.35	114.50	117.42	123.28	126.20
0.0020	122.40	115.40	118.90	125.90	129.40
0.0010	124.30	115.90	120.10	128.50	132.70

Figure 6.8-4. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Ocean Springs Area – Includes an adjustment for relative sea level rise

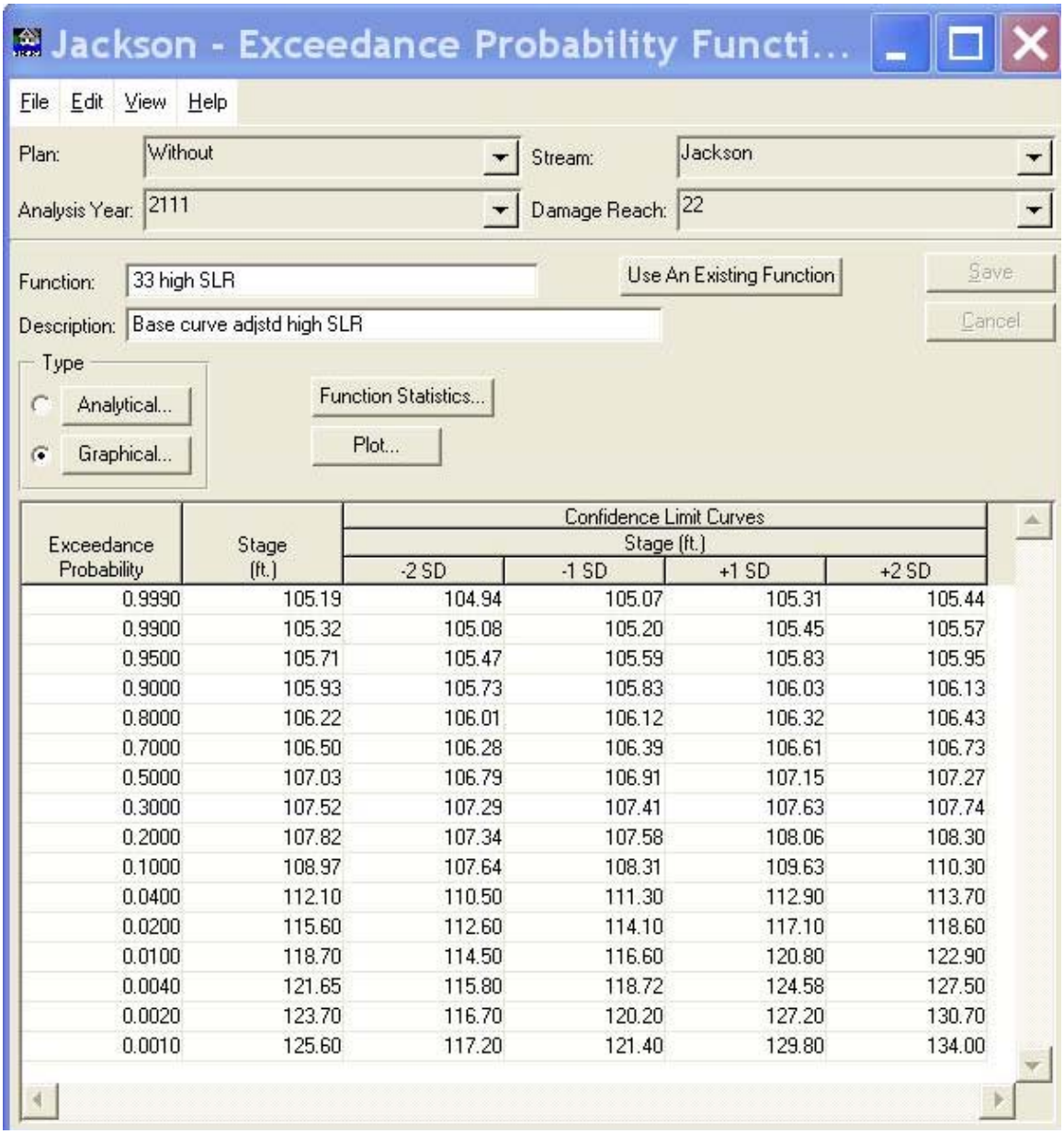
Future scenario five is the same as future scenario one with the addition of a high relative sea level rise 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $2,190,000 (rounded to the nearest thousand). These damages represent a approximately a ten-percent (10.2%) increase over the 2.0-feet of relative sea level rise accounted for in future scenario three. The total number of structures in this scenario is the same as in scenarios one and three and can be seen above in table 6.8-2. Figures 6.8-5 and 6.8-6 depict the base year and most likely future year exceedance probability functions for the Ocean Springs area (planning sub-unit 22). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.8-6 includes an adjustment for expected relative

sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	101.89	101.64	101.77	102.01	102.14
0.9900	102.02	101.78	101.90	102.15	102.27
0.9500	102.41	102.17	102.29	102.53	102.65
0.9000	102.63	102.43	102.53	102.73	102.83
0.8000	102.92	102.71	102.82	103.02	103.13
0.7000	103.20	102.98	103.09	103.31	103.43
0.5000	103.73	103.49	103.61	103.85	103.97
0.3000	104.22	104.00	104.11	104.33	104.44
0.2000	104.52	104.04	104.28	104.76	105.00
0.1000	105.67	104.34	105.01	106.33	107.00
0.0400	108.80	107.20	108.00	109.60	110.40
0.0200	112.30	109.30	110.80	113.80	115.30
0.0100	115.40	111.20	113.30	117.50	119.60
0.0040	118.35	112.50	115.42	121.28	124.20
0.0020	120.40	113.40	116.90	123.90	127.40
0.0010	122.30	113.90	118.10	126.50	130.70

Figure 6.8-5 Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Ocean Springs Area



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	105.19	104.94	105.07	105.31	105.44
0.9900	105.32	105.08	105.20	105.45	105.57
0.9500	105.71	105.47	105.59	105.83	105.95
0.9000	105.93	105.73	105.83	106.03	106.13
0.8000	106.22	106.01	106.12	106.32	106.43
0.7000	106.50	106.28	106.39	106.61	106.73
0.5000	107.03	106.79	106.91	107.15	107.27
0.3000	107.52	107.29	107.41	107.63	107.74
0.2000	107.82	107.34	107.58	108.06	108.30
0.1000	108.97	107.64	108.31	109.63	110.30
0.0400	112.10	110.50	111.30	112.90	113.70
0.0200	115.60	112.60	114.10	117.10	118.60
0.0100	118.70	114.50	116.60	120.80	122.90
0.0040	121.65	115.80	118.72	124.58	127.50
0.0020	123.70	116.70	120.20	127.20	130.70
0.0010	125.60	117.20	121.40	129.80	134.00

Figure 6.8-6 Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Ocean Springs Area – Includes an adjustment for relative sea level rise

6.8.5.3 Equivalent annual damages Reduced

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios three and five and the damages incurred with the measure in place. The HECFDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without project inventory except that footprints of levees and acquisitions were deleted from the inventory and flood proofed structures (structures to be raised in place) were given a higher elevation. The structure inventories for each of the HEC-FDA measure runs are as follows:

- Measure A – Ocean Springs Ring Levee at elevation 20.0-feet NAVD88

This measure includes the without-project inventory less 150 parcels that were deleted out of the inventory. These parcels represent the footprint of the 20.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – Ocean Springs Ring Levee at elevation 30.0-feet NAVD88

This measure includes the without-project inventory less 488 parcels that were deleted out of the inventory. These parcels represent the footprint of the 30.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure C – Ocean Springs Nonstructural One

This measure includes the acquisition of 50 parcels that include a structure and the flood proofing (raise structure in place) of 92 structures to an elevation of 16.1-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was determined to be approximately the ABFE level of protection and is defined as still water elevation, plus wave run-up, plus an estimate for waves (depth divided by two), and is the minimum implementation elevation that a nonstructural measure do to the requirements of the National Flood Insurance Program (NFIP).

- Measure D – Ocean Springs Nonstructural Two to elevation 20.0-feet NAVD88

This measure includes the acquisition of 93 parcels that include a structure and the flood proofing (raise structure in place) of 49 structures to an elevation of 20.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee at elevation 20.0-feet NAVD88.

- Measure E – Ocean Springs Nonstructural Three to elevation 30.0-feet NAVD88

This measure includes the acquisition of 142 parcels that include a structure. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing

Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee at elevation 30.0-feet NAVD88.

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damages is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table." Table 6.8-3 summarizes the equivalent annual without-project damages, damages reduced, and residual damages by measure and by future scenario.

Table 6.8-3.
Summary of Damages by Potential Measure and by Applicable Future Scenario

Measures	Equivalent annual damages Future 3 ($)	Equivalent Annual Damage Reduction Future 3 ($)	Residual Damage Future 3 ($)	Equivalent annual damages Future 5 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Residual Damage Future 5 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A 20FT Ring Levee	$1,958,000	$1,276,000	$682,000	$2,190,000	$1,434,000	$757,000
Measure B 30FT Ring Levee	$1,958,000	$1,873,000	$85,000	$2,190,000	$2,093,000	$97,000
Measure C ABFE Nonstructural	$1,958,000	$818,000	$1,140,000	$2,190,000	$913,000	$1,277,000
Measure D 20FT Nonstructural	$1,958,000	$1,089,000	$869,000	$2,190,000	$1,235,000	$955,000
Measure E 30FT Nonstructural	$1,958,000	$1,466,000	$492,000	$2,190,000	$1,658,000	$532,000

Damages are rounded to the nearest thousand dollars.

6.8.6 Environmental Quality (EQ)

6.8.6.1 Impacts of Levee Measures

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

3) A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.

4) A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.8-4 and 6.8-5 show the impacts of the Ocean Springs ring levees at elevations 20.0-feet NAVD88, and 30.0-feet NAVD88 respectively.

Table 6.8-4.
Wetland acres impacted by elevation 20' Ocean Springs ring levee

Reach ID	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Total
22	3.7	0.3	1.1	5.1
24	1.1	0.0	0.2	1.2
Total	**4.8**	**0.3**	**1.2**	**6.3**

Table 6.8-5.
Wetland acres impacted by elevation 30' Ocean Springs ring levee

Reach ID	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Total
22	5.2	0.4	4.7	10.3
24	2.4	0.0	2.6	5.0
Total	**7.5**	**0.4**	**7.3**	**15.2**

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the Ocean Springs area can be found in the Environmental Appendix.

6.8.7 Summary of Costs

Table 6.8-6 summarizes the ROM costs at an FY-08 price level by measure for the Ocean Springs area (planning sub-unit 22).

Table 6.8-6.
Summary of Costs by Measure for the Ocean Springs Area

Measures	Implementation Costs (FY-08) ($)	Capital Recovery Factor	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	0.049171225	$0	$0	$0	$0
Measure A 20FT Ring Levee	$152,100,000	0.049171225	$7,479.000	$1,414,000	N/A	$8,893,000
Measure B 30FT Ring Levee	$327,000,000	0.049171225	$16,079,000	$2,532,000	N/A	$18,611,000
Measure C ABFE Nonstructural	$59,219,000	0.049171225	$2,912,000	$10,000	N/A	$2,922,000
Measure D 20FT Nonstructural	$872,740,000	0.049171225	$42,914,000	$10,000	N/A	$42,924,000
Measure E 30FT Nonstructural	$872,740,000	0.049171225	$42,914,000	$10,000	N/A	$42,924,000

The implementation costs include 1/ supervision and administration (30 account), 2/ planning, engineering & design (31 account) and 3/ appropriate contingencies. See the Cost Appendix for more detail on the implementation cost breakdowns.

6.8.8 Regional Economic Development (RED)

This section summarizes how each of the measures would affect the local area of Jackson County, Mississippi. The expenditures for the measures are estimated to be $152,100,000 for the 20.0-feet NAVD88 measure, $327,000,000 for the 30.0-feet NAVD88 measure $59,219,000 for ABFE nonstructural measure, $617,965,000 for the 20.0-feet NAVD88 nonstructural measure, and $617,965,000 for the 30.0-feet NAVD88 nonstructural measure. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $28,757,000 for the 20.0-feet NAVD88 ring levee measure, $51,494,000 for the 30.0-feet NAVD88 ring levee measure, $203,000 for the ABFE nonstructural measure, $203,000 for the 20.0-feet NAVD88 nonstructural measure, and $203,000 for the 30.0-feet NAVD88 nonstructural measure respectively (assuming a 100 - year period of analysis and an interest rate of 4.875-percent). Tables 6.8-7 through 6.8-10 summarize the inputs and outputs of the EIFS model runs for the Ocean Springs area (planning sub-unit 22).

Table 6.8-7.
EIFS Model Implementation Costs Inputs for the Ocean Springs Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$152,100,000	$327,000,000	$59,219,000	$617,965,000	$872,740,000

Based of the given inputs the outputs are as follows:

Table 6.8-8.
EIFS Model Implementation Costs Outputs for the Ocean Springs Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$152,100,000	$327,000,000	$59,219,000	$617,965,000	$872,740,000
Induced Sales Volume	$170,352,000	$366,240,000	$66,325,280	$692,120,800	$977,468,800
Total Sales Volume	$322,452,000	$693,240,000	$125,544,280	$1,310,085,800	$1,850,208,800
Direct Income	$29,663,388	$63,773,358	$11,549,219	$120,518,970	$170,206,607
Induced Income	$33,222,990	$71,426,152	$12,935,123	$134,981,230	$190,631,376
Total Income	$62,886,378	$135,199,510	24,484,342	$255,500,200	$360,837,984
Direct Employment	861	1,851	335	3,498	4,940
Induced Employment	964	2,073	375	3,918	5,533
Total Employment	1,825	3,924	711	7,416	10,473
Local Population	0	0	0	0	0

Table 6.8-9.
EIFS Model O&M Cost Inputs for the Ocean Springs Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$28,757,000	$51,494,000	$203,000	$203,000	$203,000

Based of the given inputs the outputs are as follows:

Table 6.8-10.
EIFS Model O&M Cost Outputs for the Ocean Springs Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$28,757,000	$51,494,000	$203,000	$203,000	$203,000
Induced Sales Volume	$32,207,840	$57,673,280	$227,360	$227,360	$227,360
Total Sales Volume	60,964,840	$109,167,280	$430,360	$430,360	$430,360
Direct Income	$5,608,350	$10,042,646	$39,590	$39,590	$39,590
Induced Income	$6,281,351	$11,247,762	$44,341	$44,341	$44,341
Total Income	$11,889,701	$21,290,409	$83,931	$83,931	$83,931
Direct Employment	163	291	1	1	1
Induced Employment	182	326	1	1	1
Total Employment	345	617	2	2	2
Local Population	0	0	0	0	0

6.9 Evaluation of Gautier Area Measures

6.9.1 General

The Gautier area, shown in Figure 6.9-1, is located in the southern portion of planning unit three along the Mississippi Sound. The area is denoted as planning sub-unit 30 and is depicted in the figure below. The pre-Hurricane Katrina conditions for this area represented a mostly residential community. As demonstrated in table 6.9-1, it was estimated from the field inventorying process that planning sub-unit 30 included 3,113 tax parcels, of which 2,555 contained a structure with some economic value and 558 were vacant land. Of those 2,555 parcels that contain structures, 2,166 were residential one-story, 118 were residential two-story, 28 were mobile homes, 182 were commercial, and 61 were municipal.

6.9.2 Opportunities

The following opportunity was identified for this area:

- Hurricane storm damage reduction or remediation

6.9.3 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs
- Price levels are October, 2007 unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs.

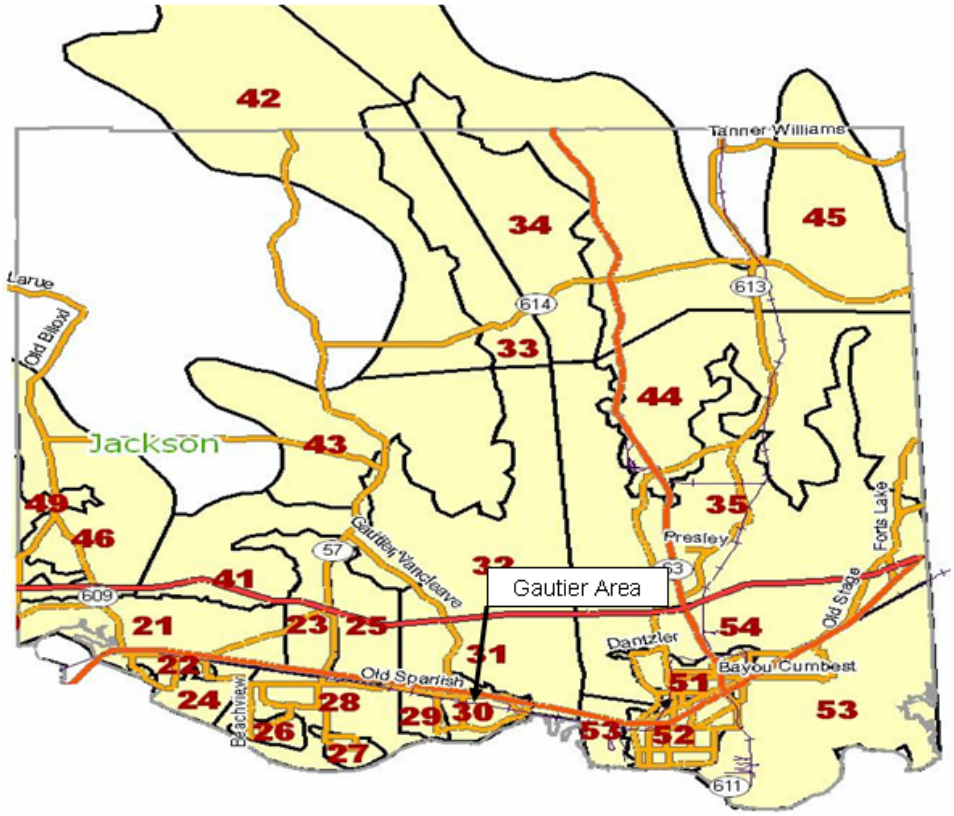


Figure 6.9-1. Gautier Area – Planning Sub-unit 30

Table 6.9-1.
Pre-Hurricane Katrina Estimate of Structures for the Gautier Area (Planning Sub-unit 30)

Asset Categories	Assets by Category
Residential	2,284
Mobile Homes	28
Commercial	182
Municipal	61
Vacant Land	558
Total Tax Parcels	**3,113**

6.9.4 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit three. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

Measure A – Gautier Ring Levee

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 20.0-feet NAVD88.

Measure B – Gautier Ring Levee

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 30.0-feet NAVD88.

Measure C – Gautier Nonstructural One

This measure includes the acquisition and flood proofing (elevation-in-place) of structures to the FEMA advisory base flood elevation (ABFE).

Measure D – Gautier Nonstructural Two

This measure includes the acquisition and flood proofing of structures to approximately elevation 20-feet NAVD88.

Measure E – Gautier Nonstructural Three

This measure includes the acquisition and flood proofing of structures to approximately elevation 30-feet NAVD88.

Figure 6.9-2 shows the measures for the Gautier Area (planning sub-unit 30); the red line represents the approximate footprint of the ring levees, the dark green within the ring levee footprint represents potential ABFE buyout areas and the light green area within the ring levee footprint represents potential flood proof (elevate-in-place) areas.

6.9.5 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "…***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits…"*** More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.9.5.1 Existing Conditions Post-Hurricane Katrina)

The effects of Hurricane Katrina storm surge were devastating to the Gautier Area. Peak water elevation in the area ranged from 15 to 18-feet NAVD88. It is estimated that 450 of the structures in the area, mostly residential structures, and sustained significant inundation damage (fifty-percent or more). Expected redevelopment of the area is described in the following section.

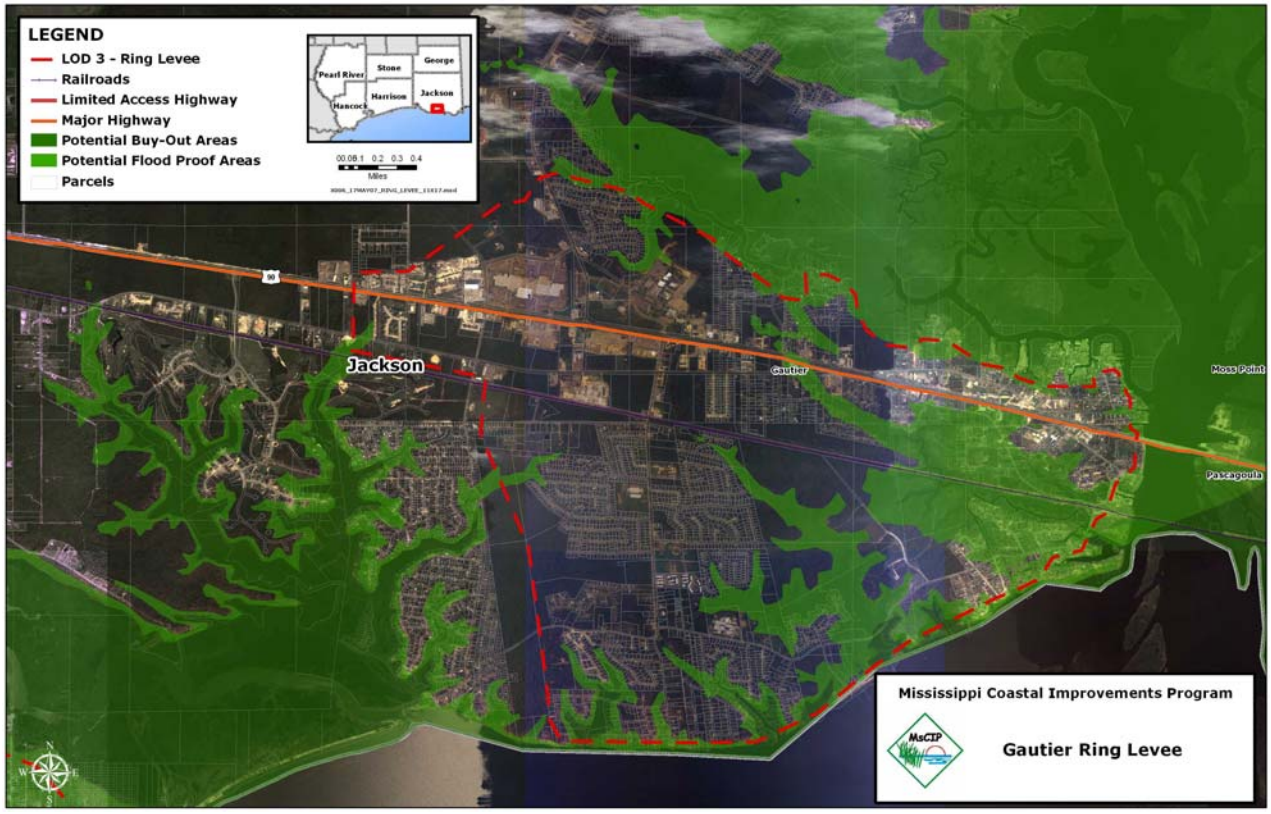


Figure 6.9-2. Display of Potential Measures for the Gautier Area (Planning Sub-Unit 30)

6.9.5.2 Future Without-Project Conditions

Equivalent annual flood damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the measures were evaluated and compared to future without-project scenarios three, and five, as previously discussed in section 5.3. These future scenarios were chosen because the redevelopment projected for this area is anticipated to return to the pre-Katrina development. Futures scenarios two, four, and six were not used for evaluation purposes since this area is not accommodative for commercial and condominium redevelopment under those mixed redevelopment scenarios (see section 5.3 for more detail).

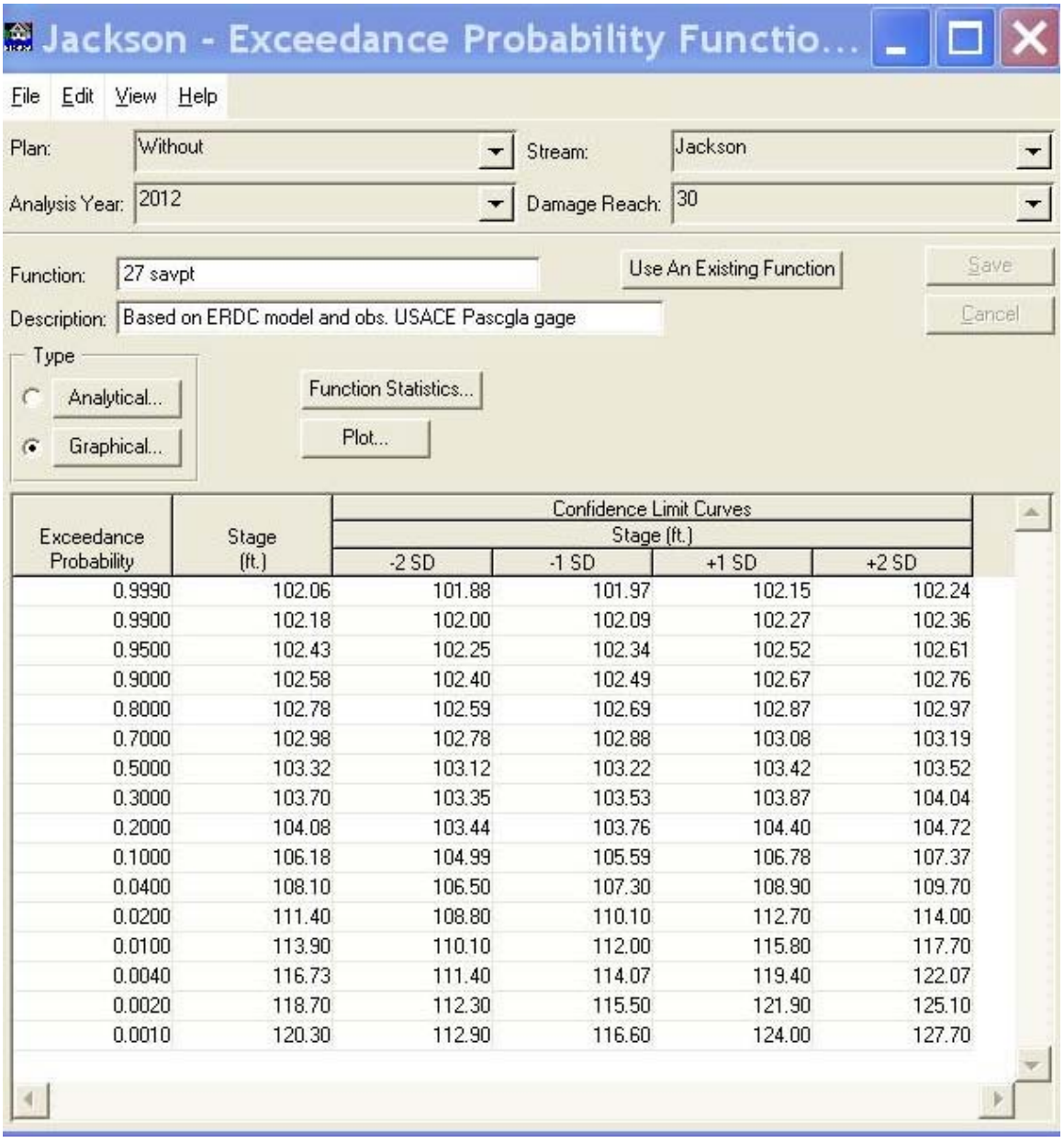
Future scenario one is the full redevelopment of assets within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Table 6.9-2 shows structures by asset category and by elevation. The number of structures per elevation is added to the previous number of structures per elevation in each category. For example, in the residential category there are two structures with an elevation of 1-foot or lower, there are five structures with an elevation of 2-feet or less, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Gautier area.

Table 6.9-2.
Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years

Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	2	0	0	0	2
2-foot	5	0	0	0	5
3-foot	14	0	0	0	14
4-foot	27	0	0	0	27
5-foot	38	0	0	0	38
6-foot	55	0	0	0	55
7-foot	66	0	0	0	66
8-foot	84	0	0	0	84
9-foot	110	0	0	0	110
10-foot	131	0	0	0	131
11-foot	169	0	0	0	169
12-foot	238	2	5	2	247
13-foot	320	4	15	5	344
14-foot	400	6	23	7	436
15-foot	521	7	34	10	572
16-foot	710	10	51	14	785
17-foot	1,354	16	84	40	1,494
18-foot	1,979	19	106	49	2,153
19-foot	2,221	22	124	52	2,419
20-foot	2,267	24	156	57	2,504
21-foot	2,275	26	171	60	2,532
22-foot	2,279	28	178	61	2,546
23-foot	2,280	28	182	61	2,551
24-foot	2,280	28	182	61	2,551
25-foot	2,282	28	182	61	2,553
26-foot	2,282	28	182	61	2,553
27-foot	2,282	28	182	61	2,553
28-foot	2,282	28	182	61	2,553
29-foot	2,282	28	182	61	2,553
30-foot	2,282	28	182	61	2,553
31-foot	2,283	28	182	61	2,554
32-foot	2,284	28	182	61	2,555
Total	**2,284**	**28**	**182**	**61**	**2,555**

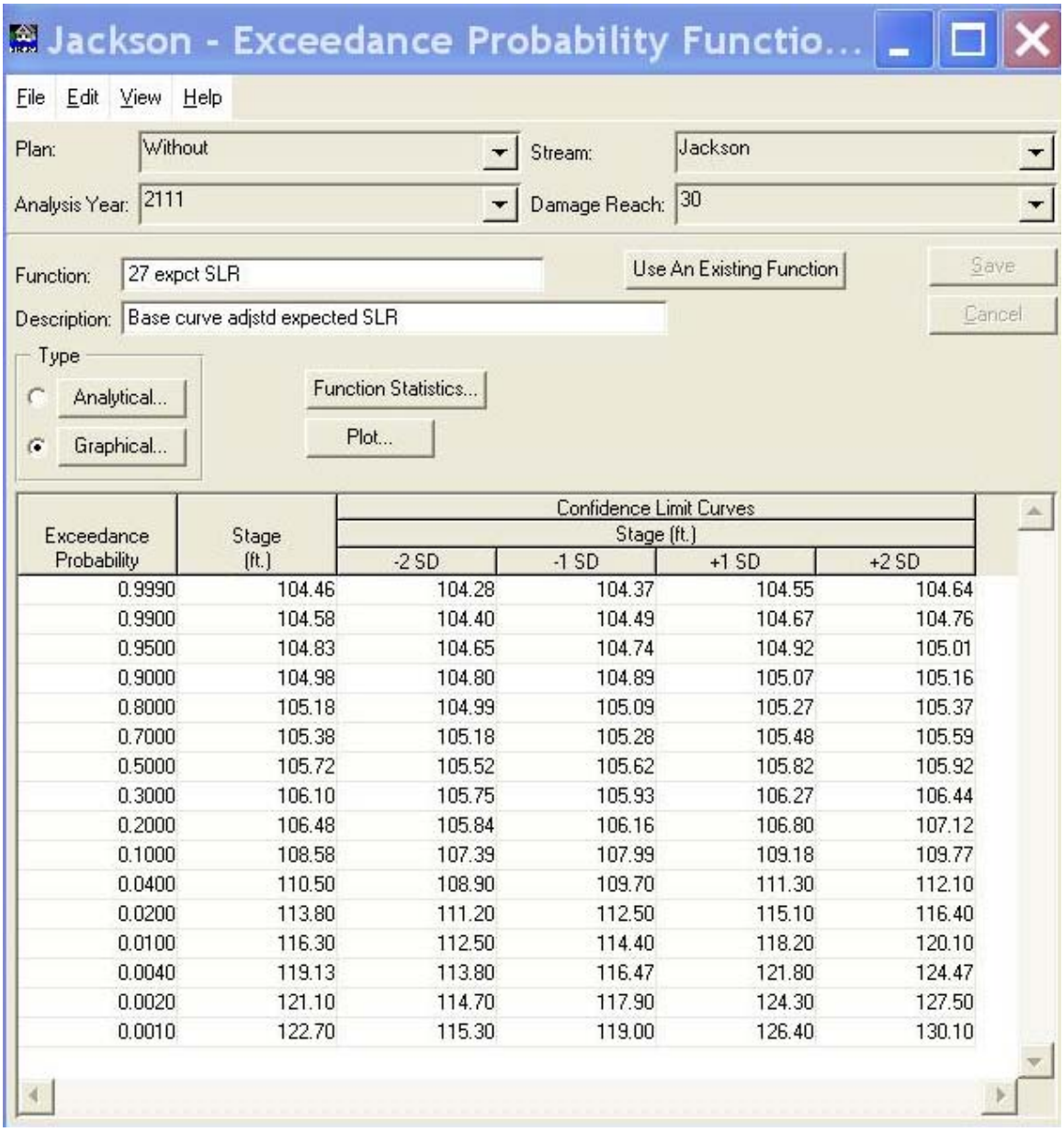
Future scenario three is the full redevelopment of assets within the study area by the year 2012. Under this scenario, assets will be rebuilt as they were pre-Hurricane Katrina. For example, if the asset was a residential structure pre-Hurricane Katrina it will be rebuilt as a residential structure; commercial structures will be built back to commercial structures; etc. Basically, future scenario three is the same structure inventory as future scenario one with the addition of an expected relative sea level rise over the 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $5,831,000 (rounded to the nearest thousand dollars). The total number of structures in this scenario are the same as in scenario one and can be seen above in

table 6.9-2. Figures 6.9-3 and 6.9-4 depict the base year and most likely future year exceedance probability functions for the Gautier area (planning sub-unit 30). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.9-4 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	102.06	101.88	101.97	102.15	102.24
0.9900	102.18	102.00	102.09	102.27	102.36
0.9500	102.43	102.25	102.34	102.52	102.61
0.9000	102.58	102.40	102.49	102.67	102.76
0.8000	102.78	102.59	102.69	102.87	102.97
0.7000	102.98	102.78	102.88	103.08	103.19
0.5000	103.32	103.12	103.22	103.42	103.52
0.3000	103.70	103.35	103.53	103.87	104.04
0.2000	104.08	103.44	103.76	104.40	104.72
0.1000	106.18	104.99	105.59	106.78	107.37
0.0400	108.10	106.50	107.30	108.90	109.70
0.0200	111.40	108.80	110.10	112.70	114.00
0.0100	113.90	110.10	112.00	115.80	117.70
0.0040	116.73	111.40	114.07	119.40	122.07
0.0020	118.70	112.30	115.50	121.90	125.10
0.0010	120.30	112.90	116.60	124.00	127.70

Figure 6.9-3. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Gautier Area

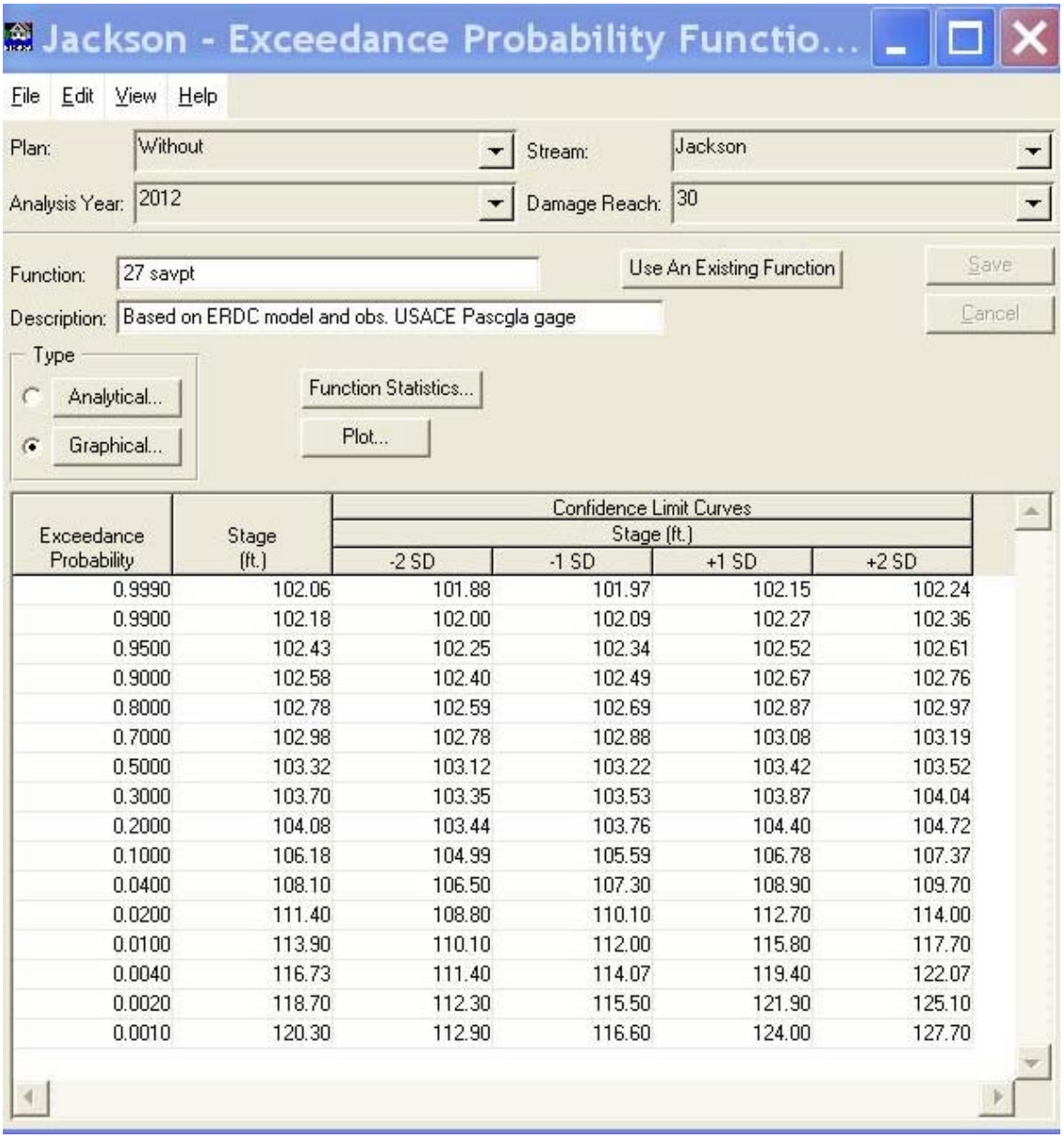


Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	104.46	104.28	104.37	104.55	104.64
0.9900	104.58	104.40	104.49	104.67	104.76
0.9500	104.83	104.65	104.74	104.92	105.01
0.9000	104.98	104.80	104.89	105.07	105.16
0.8000	105.18	104.99	105.09	105.27	105.37
0.7000	105.38	105.18	105.28	105.48	105.59
0.5000	105.72	105.52	105.62	105.82	105.92
0.3000	106.10	105.75	105.93	106.27	106.44
0.2000	106.48	105.84	106.16	106.80	107.12
0.1000	108.58	107.39	107.99	109.18	109.77
0.0400	110.50	108.90	109.70	111.30	112.10
0.0200	113.80	111.20	112.50	115.10	116.40
0.0100	116.30	112.50	114.40	118.20	120.10
0.0040	119.13	113.80	116.47	121.80	124.47
0.0020	121.10	114.70	117.90	124.30	127.50
0.0010	122.70	115.30	119.00	126.40	130.10

Figure 6.9-4. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Gautier Area – Includes an adjustment for relative sea level rise

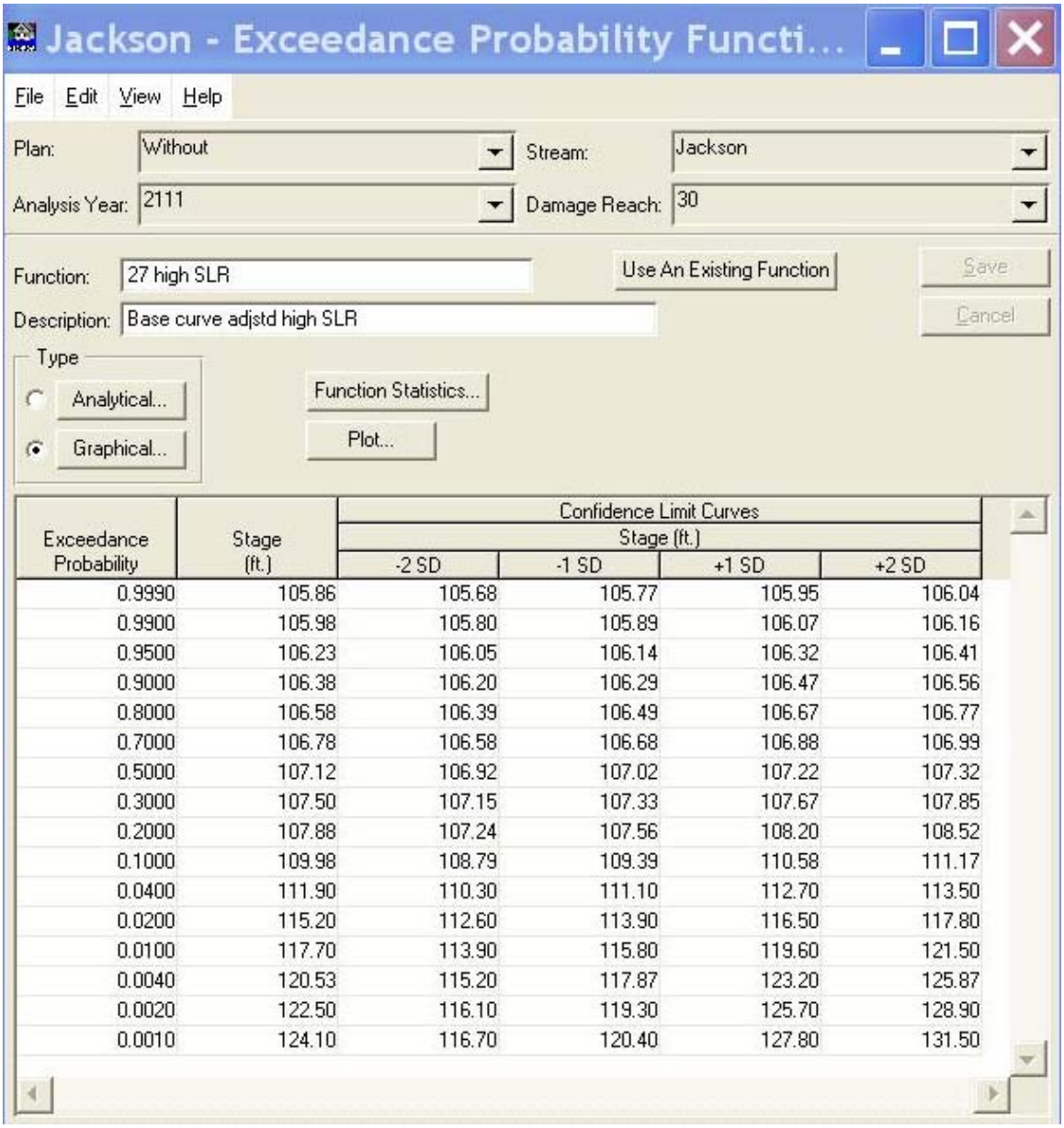
Future scenario five is the same as future scenario one with the addition of a high relative sea level rise 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $6,702,000 (rounded to the nearest thousand). These damages represent approximately a ten-percent (10.2%) increase over the expected relative sea level rise accounted for in future scenario three. The total number of structures in this scenario is the same as in scenarios one and three and can be seen above in table 6.9-2. Figures 6.9-5 and 6.9-6 depict the base year and most likely future year exceedance probability functions for the Gautier area (planning sub-unit 30). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.9-6 includes an adjustment for expected relative sea level

rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	102.06	101.88	101.97	102.15	102.24
0.9900	102.18	102.00	102.09	102.27	102.36
0.9500	102.43	102.25	102.34	102.52	102.61
0.9000	102.58	102.40	102.49	102.67	102.76
0.8000	102.78	102.59	102.69	102.87	102.97
0.7000	102.98	102.78	102.88	103.08	103.19
0.5000	103.32	103.12	103.22	103.42	103.52
0.3000	103.70	103.35	103.53	103.87	104.04
0.2000	104.08	103.44	103.76	104.40	104.72
0.1000	106.18	104.99	105.59	106.78	107.37
0.0400	108.10	106.50	107.30	108.90	109.70
0.0200	111.40	108.80	110.10	112.70	114.00
0.0100	113.90	110.10	112.00	115.80	117.70
0.0040	116.73	111.40	114.07	119.40	122.07
0.0020	118.70	112.30	115.50	121.90	125.10
0.0010	120.30	112.90	116.60	124.00	127.70

Figure 6.9-5. Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Gautier Area



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	105.86	105.68	105.77	105.95	106.04
0.9900	105.98	105.80	105.89	106.07	106.16
0.9500	106.23	106.05	106.14	106.32	106.41
0.9000	106.38	106.20	106.29	106.47	106.56
0.8000	106.58	106.39	106.49	106.67	106.77
0.7000	106.78	106.58	106.68	106.88	106.99
0.5000	107.12	106.92	107.02	107.22	107.32
0.3000	107.50	107.15	107.33	107.67	107.85
0.2000	107.88	107.24	107.56	108.20	108.52
0.1000	109.98	108.79	109.39	110.58	111.17
0.0400	111.90	110.30	111.10	112.70	113.50
0.0200	115.20	112.60	113.90	116.50	117.80
0.0100	117.70	113.90	115.80	119.60	121.50
0.0040	120.53	115.20	117.87	123.20	125.87
0.0020	122.50	116.10	119.30	125.70	128.90
0.0010	124.10	116.70	120.40	127.80	131.50

Figure 6.9-6. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Gautier Area – Includes an adjustment for relative sea level rise

6.9.5.3 Equivalent Annual Damages Reduced

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios three and five and the damages incurred with the measure in place. The HEC-FDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without-project inventory except that footprints of levees and acquisitions were deleted from the inventory and flood proofed structures (structures to be raised in place) were given a higher elevation. The structure inventories for each of the HEC-FDA measure runs are as follows:

- Measure A – Gautier Ring Levee at elevation 20.0-feet

This measure includes the without-project inventory less 177 parcels that were deleted out of the inventory. These parcels represent the footprint of the 20.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – Gautier Ring Levee at elevation 30.0-feet

This measure includes the without-project inventory less 206 parcels that were deleted out of the inventory. These parcels represent the footprint of the 30.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure C – Gautier ABFE Nonstructural One

This measure includes the acquisition of 66 parcels that include a structure and the flood proofing (raise structure in place) of 466 structures to an elevation of 16.1-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was determined to be approximately the ABFE level of protection and is defined as still water elevation, plus wave run-up, plus an estimate for waves (depth divided by two), and is the minimum implementation elevation that a nonstructural measure do to the requirements of the National Flood Insurance Program (NFIP).

- Measure D – Gautier Nonstructural Two to elevation 20.0-feet NAVD88

This measure includes the acquisition of 489 parcels that include a structure and the flood proofing (raise structure in place) of 44 structures to an elevation of 20.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee at elevation 20.0-feet NAVD88.

- Measure E – Gautier Nonstructural Three to elevation 30.0-feet NAVD88

This measure includes the acquisition of 533 parcels that include a structure. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing

Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee at elevation 30.0-feet NAVD88.

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damages is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table." Table 6.9-3 summarizes the equivalent annual without-project damages, damages reduced, and residual damages by measure and by future scenario.

Table 6.9-3.
Summary of Damages by Potential Measure and by Applicable Future Scenario

Measures	Equivalent annual damages Future 3 ($)	Equivalent Annual Damage Reduction Future 3 ($)	Residual Damage Future 3 ($)	Equivalent annual damages Future 5 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Residual Damage Future 5 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A 20Ft Ring Levee	$5,831,000	$5,166,000	$665,000	$6,702,000	$5,923,000	$779,000
Measure B 30FT Ring Levee	$5,831,000	$5,800,000	$31,000	$6,702,000	$6,663,000	$39,000
Measure C ABFE Nonstructural	$5,831,000	$3,623,000	$2,208,000	$6,702,000	$3,984,000	$2,718,000
Measure D 20FT Nonstructural	$5,831,000	$ 2,457,000	$3,374,000	$6,702,000	$2,839,000	$3,863,000
Measure E 30FT Nonstructural	$5,831,000	$ 5,278,000	$553,000	$6,702,000	$6,033,000	$669,000

Damages are rounded to the nearest thousand dollars.

6.9.6 Environmental Quality (EQ)

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

1. A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.

2. A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.9-4 and 6.9-5 show the impacts of the Gautier ring levees at elevations 20.0-feet NAVD88, and 30.0-feet NAVD88 respectively.

Table 6.9-4.
Wetland acres impacted by elevation 20' Gautier ring levee.

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
29	0.0	0.0	0.0	5.6	0.0	5.6
30	0.2	5.0	0.3	9.0	0.0	14.5
31	0.5	7.1	0.0	2.0	0.1	9.7
Total	**0.7**	**12.1**	**0.3**	**16.9**	**0.1**	**29.8**

Table 6.9-5.
Wetland acres impacted by elevation 30' Gautier ring levee.

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
29	0.0	0.0	0.4	9.7	0.0	10.2
30	0.3	7.2	1.2	19.8	0.0	28.5
31	1.2	10.3	0.0	6.1	0.2	17.9
Total	**1.5**	**17.5**	**1.6**	**35.7**	**0.2**	**56.5**

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the Gautier area can be found in the Environmental Appendix.

6.9.7 Summary of Costs

Table 6.9-6 summarizes the ROM costs at an FY-08 price level by measure for the Gautier Area (planning sub-unit 30).

Table 6.9-6.
Summary of Costs by Measure for the Gautier Area

Measures	Implementation Costs (FY-08) ($)	Capital Recovery Factor	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	0.049171225	$0	$0	$0	$0
Measure A 20Ft Ring Levee	$348,300,000	0.049171225	$17,126,000	$ 3,744,000	N/A	$20,870,000
Measure B 30FT Ring Levee	$450,100,000	0.049171225	$22,132,000	$ 4,904,000	N/A	$27,036,000
Measure C ABFE Nonstructural	$185,929,000	0.049171225	$9,142,000	$10,000	N/A	$9,152,000
Measure D 20FT Nonstructural	$783,100,000	0.049171225	$38,506,000	$10,000	N/A	$38,516,000
Measure E 30FT Nonstructural	$942,794,000	0.049171225	$46,358,000	$10,000	N/A	$46,368,000

6.9.8 Regional Economic Development (RED)

The purpose of this analysis is to determine the economic impact of the proposed project measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Jackson County, Mississippi. The expenditures for the measures are estimated to be $348,300,000 for the 20.0-feet NAVD88 measure, $450,100,000 for the 30.0-feet NAVD88 measure $185,929,000 for the ABFE nonstructural measure, $783,100,000 for the 20.0-feet NAVD88 nonstructural measure, and $783,100,000 for the 30.0-feet NAVD88 nonstructural measure. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $76,142,000 for the 20.0-feet NAVD88 ring levee measure, $99,733,000 for the 30.0-feet NAVD88 ring levee measure, $203,000 for the ABFE nonstructural measure, $203,000 for the 20.0-feet NAVD88 nonstructural measure, and $203,000 for the 30.0-feet NAVD88 nonstructural measure respectively (assuming a 100- year period of analysis and an interest rate of 4.875-percent). The following tables 6.9-7 through 6.9-10 summarize the EIFS inputs and outputs for the Gautier area.

Table 6.9-7.
EIFS Model Construction Costs Inputs for the Gautier Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$348,300,000	$450,100,000	$185,929,000	$783,100,000	$942,794,000

Based of the given inputs the outputs are as follows:

Table 6.9-8.
EIFS Model Construction Costs Outputs for the Gautier Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$348,300,000	$450,100,000	$185,929,000	$783,100,000	$942,794,000
Induced Sales Volume	$390,096,000	$504,112,000	$208,240,480	$877,072,000	$1,055,929,280
Total Sales Volume	$738,396,000	$954,212,000	$394,169,480	$1,660,172,000	$1,998,723,280
Direct Income	$67,927,403	$87,781,005	$36,260,907	$152,724,516	$183,868,928
Induced Income	$76,078,681	$98,314,713	$40,612,211	$171,051,437	$205,933,174
Total Income	$144,006,084	$186,095,717	$76,873,119	$323,775,953	$389,802,101
Direct Employment	1,971	2,547	1,052	4,432	5,336
Induced Employment	2,208	2,853	1,179	4,965	5,977
Total Employment	4,179	5,400	2,231	9,397	11,314
Local Population	0	0	0	0	0

Table 6.9-9.
EIFS Model O&M Cost Inputs for the Gautier Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$69,691,753	$91,284,283	$186,143	$186,143	$186,143

Based of the given inputs the outputs are as follows:

Table 6.9-10.
EIFS Model O&M Cost Outputs for the Gautier Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$69,691,753	$91,284,283	$186,143	$186,143	$186,143
Induced Sales Volume	$78,054,763	$102,238,397	$208,480	$208,480	$208,480
Total Sales Volume	$147,746,516	$193,522,680	$394,622	$394,622	$394,622
Direct Income	$13,591,673	$17,802,768	$36,303	$36,303	$36,303
Induced Income	$15,222,672	$19,939,098	$40,659	$40,659	$40,659
Total Income	$28,814,345	$37,741,867	$76,961	$76,961	$76,961
Direct Employment	394	517	1	1	1
Induced Employment	442	579	1	1	1
Total Employment	836	1095	2	2	2
Local Population	0	0	0	0	0

6.10 Evaluation of Gulf Park Estates Area Measures

6.10.1 General

The Gulf Park Estates area is located in the southern portion of planning unit three along the Mississippi Sound. The area is denoted as planning sub-unit 26 and is depicted in the figure 6.10-1, shown below. The pre-Hurricane Katrina conditions for this area represented a mostly residential community. As shown in table 6.10-1, it was estimated from the field inventorying process that planning sub-unit 26 included 2,391 tax parcels, of which 1,782 contained a structure with some economic value and 609 were vacant land. Of those 1,782 parcels that contain structures, 1,663 were residential one-story, 0 were residential two-story, 95 were mobile homes, 22 were commercial, and 2 were municipal.

6.10.2 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation

6.10.3 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4.875 percent was used in estimating average annual benefits and costs.
- Price levels are FY-08, unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs.

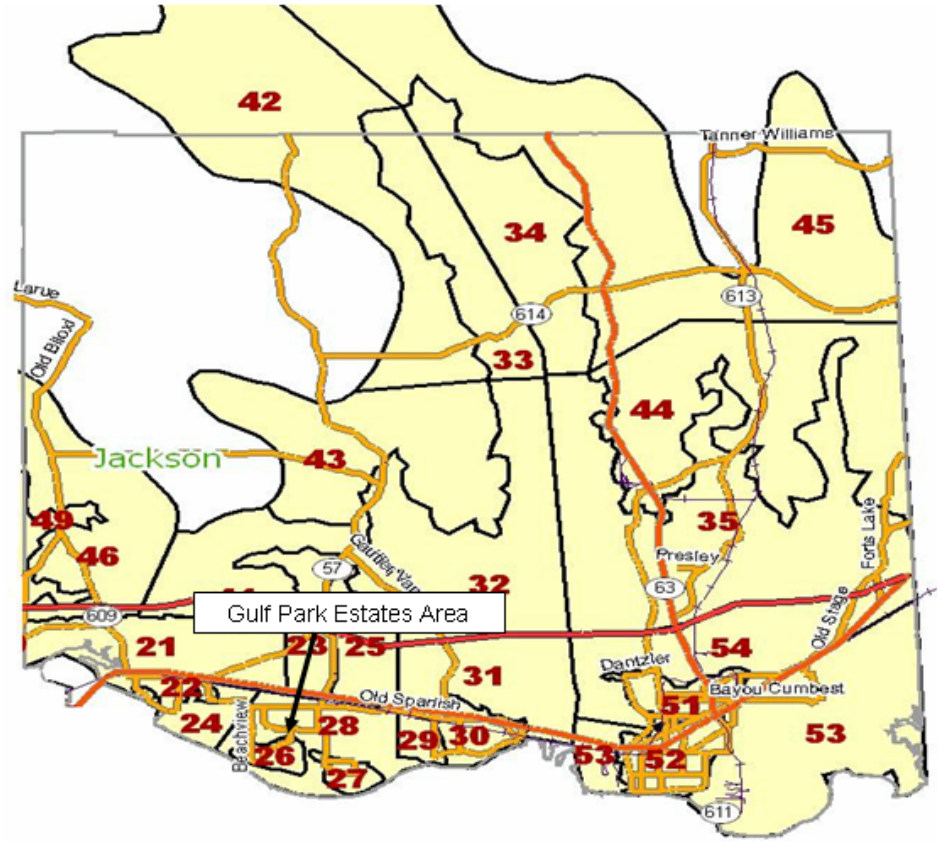


Figure 6.10-1. Gulf Park Estates Area – Planning sub-unit 26

Table 6.10-1.
Pre-Hurricane Katrina Estimate of Structures for the Gulf Park Estates Area Planning Sub-unit 26

Asset Categories	Assets by Category
Residential	1,663
Mobile Homes	95
Commercial	22
Municipal	2
Vacant Land	609
Total Tax Parcels	**2,391**

6.10.4 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit three. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

- Measure A – Gulf Park Estates Ring Levee A

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 20.0-feet NAVD88.

- Measure B – Gulf Park Estates Ring Levee B

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 30.0-feet NAVD88.

- Measure C – Gulf Park Estates Ring Levee C

This measure would include a ring levee at 20-feet NAVD88 on an alternate footprint from Measure A and the acquisition of structures and parcels that would have been included in measure A but are not within the alternate footprint.

- Measure D – Gulf Park Estates Ring Levee D

This measure would include a ring levee at 30-feet NAVD88 on an alternate footprint from Measure B and the acquisition of structures and parcels that would have been included in measure B but are not within the alternate footprint.

- Measure E – Gulf Park Estates Nonstructural One

This measure includes the acquisition and flood proofing (elevation-in-place) of structures to the FEMA advisory base flood elevation (ABFE).

- Measure F – Gulf Park Estates Nonstructural Two

This measure includes the acquisition and flood proofing of structures to approximately elevation 20-feet NAVD88.

- Measure G – Gulf Park Estates Nonstructural Three

This measure includes the acquisition of structures to approximately elevation 30-feet NAVD88.

Figure 6.10-2 shows the measures for the Gulf Park Estates Area (planning sub-unit 26); the red line represents the approximate footprint of the ring levees A and B, the green line represents the approximate footprint of the ring levees C and D, the dark green within the ring levee footprint represents potential ABFE buyout areas and the light green area within the ring levee footprint represents potential flood proof (elevate-in-place) areas.

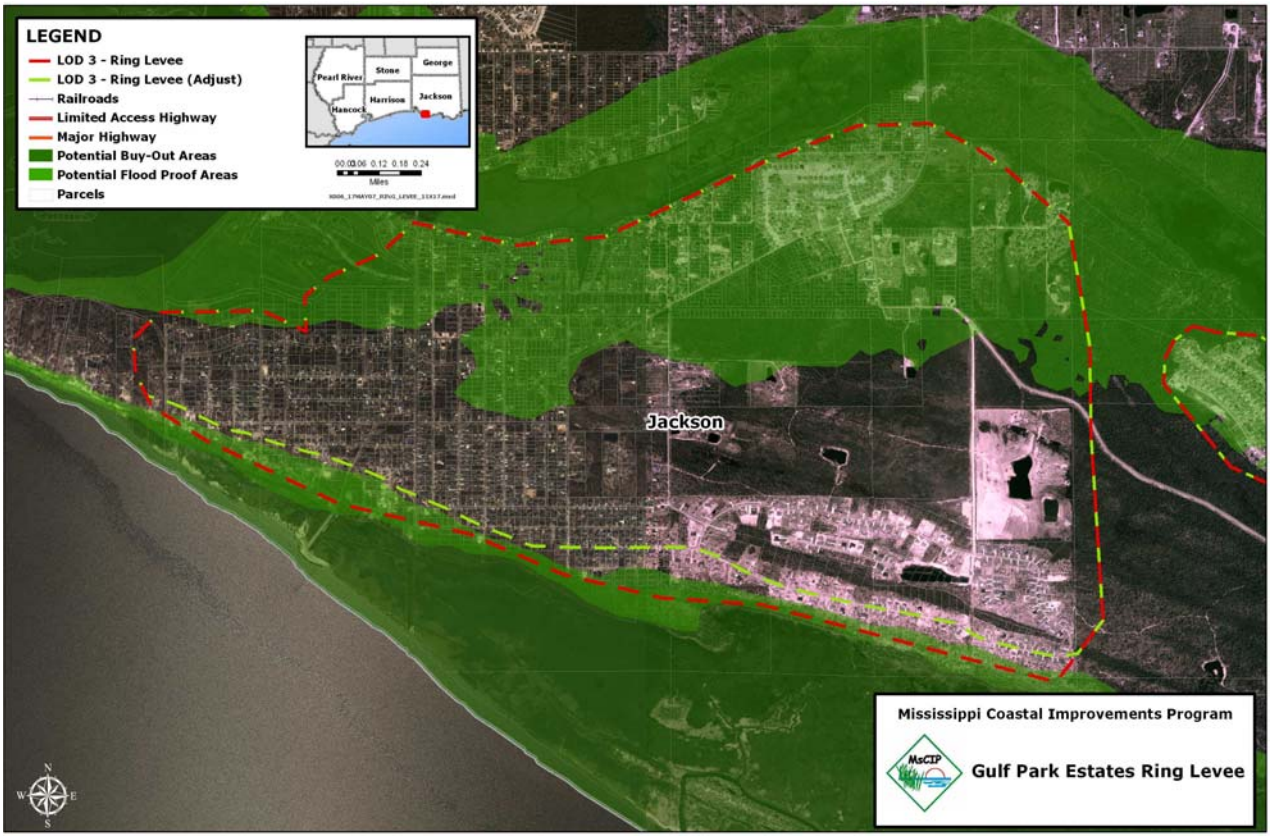


Figure 6.10-2. Display of Potential Measures for the Gulf Park Estates Area (Planning Sub-Unit 26)

6.10.5 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "…***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits…"*** More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.10.5.1 Existing Conditions Post-Hurricane Katrina)

The effects of Hurricane Katrina storm surge were devastating to the Gulf Park Estates Area. Peak water elevation in the area ranged from 19-to-20-feet NAVD88. It is estimated that 840 structures in the area, mostly residential, sustained significant inundation damage (fifty-percent or more). Expected redevelopment of the area is described in the following section.

6.10.5.2 Future Without-Project Conditions

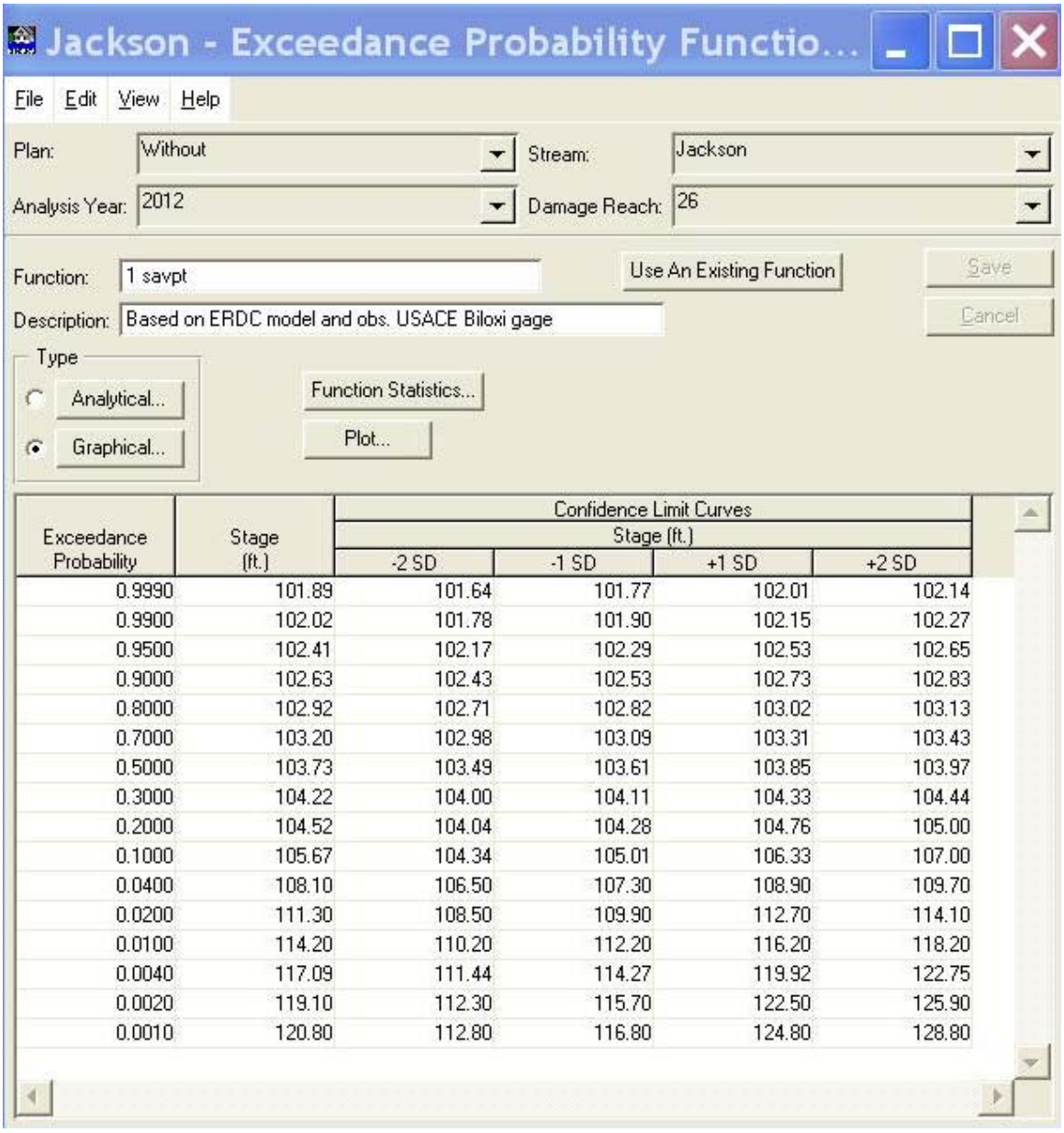
Equivalent annual flood damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the measures was evaluated and compared to future without-project scenarios three, and five, as previously discussed in section 5.3. These future scenarios were chosen because the redevelopment projected for this area is anticipated to return to the pre-Katrina development. Futures scenarios two, four, and six were not used for evaluation purposes since this area is not accommodative for commercial and condominium redevelopment under those mixed redevelopment scenarios (see section 5.3 for more detail).

Future scenario one is the full redevelopment of assets within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Table 6.10-2 shows structures by asset category and by elevation. The number of structures per elevation is added to the previous number of structures per elevation in each category. For example, in the residential category there are two structures with an elevation of 3-foot elevation or lower, there are six structures with an elevation of 4-feet or less, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Gulf Park Estates area.

Future scenario three is the full redevelopment of assets within the study area by the year 2012. Under this scenario, assets will be rebuilt as they were pre-Hurricane Katrina. For example, if the asset was a residential structure pre-Hurricane Katrina it will be rebuilt as a residential structure; commercial structures will be built back to commercial structures; etc. Basically, future scenario three is the same structure inventory as future scenario one with the addition of an expected relative sea level rise over the 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $6,273,000 (rounded to the nearest thousand dollars). The total number of structures in this scenario are the same as in scenario one and can be seen above in table 6.10-2. Figures 6.10-3 and 6.10-4 depict the base year and most likely future year exceedance probability functions for the Gulf Park Estates area (planning sub-unit 26). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.10-4 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.

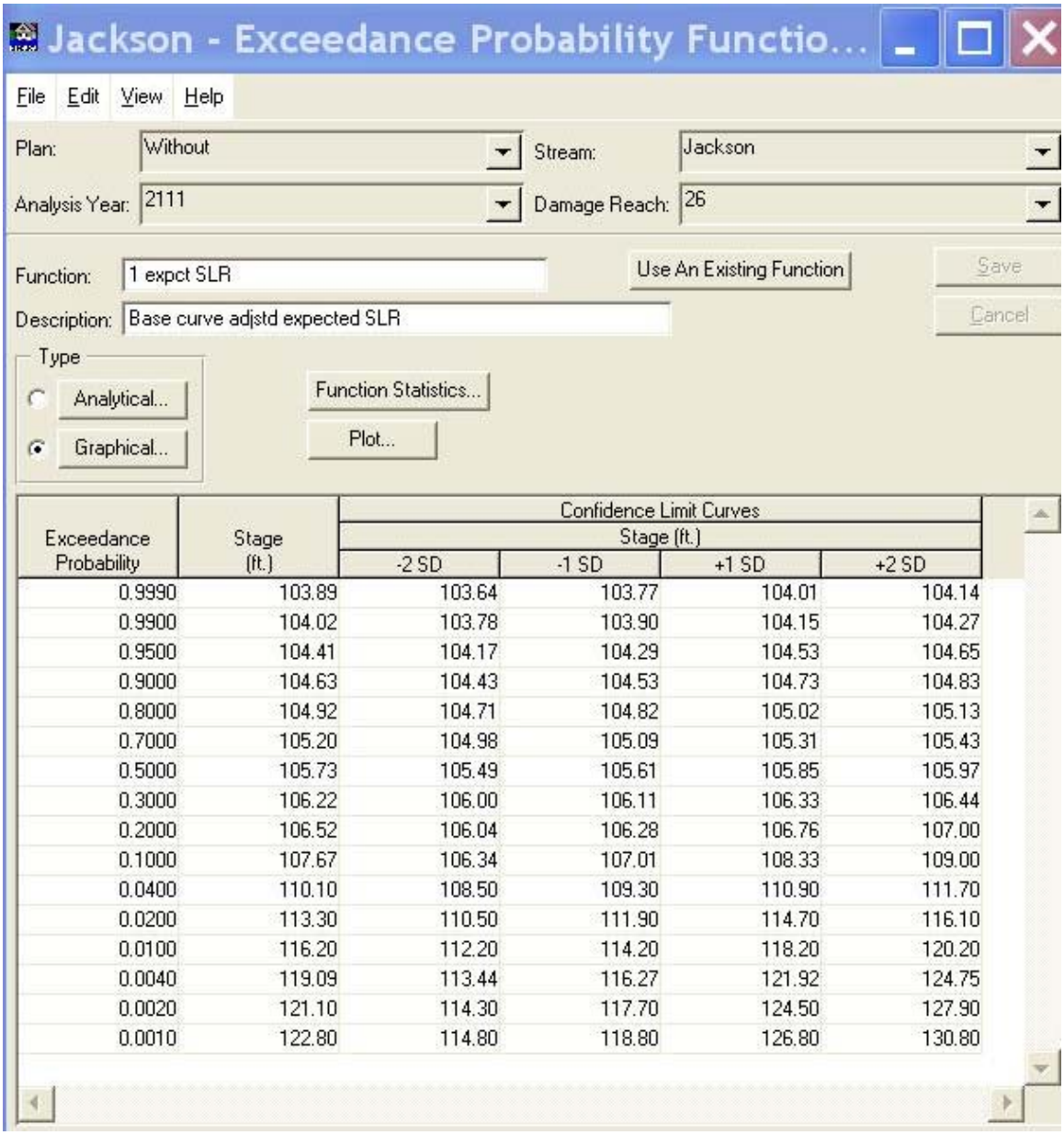
Table 6.10-2.
Cumulative Structures by Category and by Estimated First Floor Elevation
Future Scenarios One, Three, and Five
Applicable for Base Year and Most Likely Future Years

Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	0	0	0	0	0
2-foot	0	0	0	0	0
3-foot	2	0	0	0	2
4-foot	6	0	0	0	6
5-foot	22	0	0	0	22
6-foot	66	0	0	0	66
7-foot	118	0	0	0	118
8-foot	174	0	0	0	174
9-foot	251	0	0	0	251
10-foot	295	0	0	0	295
11-foot	336	0	0	0	336
12-foot	382	7	1	0	390
13-foot	444	18	3	0	465
14-foot	469	29	4	0	502
15-foot	497	34	4	0	535
16-foot	512	44	5	0	561
17-foot	547	50	8	0	605
18-foot	671	53	8	0	732
19-foot	1,319	91	20	2	1,432
20-foot	1,532	92	22	2	1,648
21-foot	1,644	93	22	2	1,761
22-foot	1,663	94	22	2	1,781
23-foot	1,663	95	22	2	1,782
Total	**1,663**	**95**	**22**	**2**	**1,782**



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	101.89	101.64	101.77	102.01	102.14
0.9900	102.02	101.78	101.90	102.15	102.27
0.9500	102.41	102.17	102.29	102.53	102.65
0.9000	102.63	102.43	102.53	102.73	102.83
0.8000	102.92	102.71	102.82	103.02	103.13
0.7000	103.20	102.98	103.09	103.31	103.43
0.5000	103.73	103.49	103.61	103.85	103.97
0.3000	104.22	104.00	104.11	104.33	104.44
0.2000	104.52	104.04	104.28	104.76	105.00
0.1000	105.67	104.34	105.01	106.33	107.00
0.0400	108.10	106.50	107.30	108.90	109.70
0.0200	111.30	108.50	109.90	112.70	114.10
0.0100	114.20	110.20	112.20	116.20	118.20
0.0040	117.09	111.44	114.27	119.92	122.75
0.0020	119.10	112.30	115.70	122.50	125.90
0.0010	120.80	112.80	116.80	124.80	128.80

Figure 6.10-3. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Gulf Park Estates Area

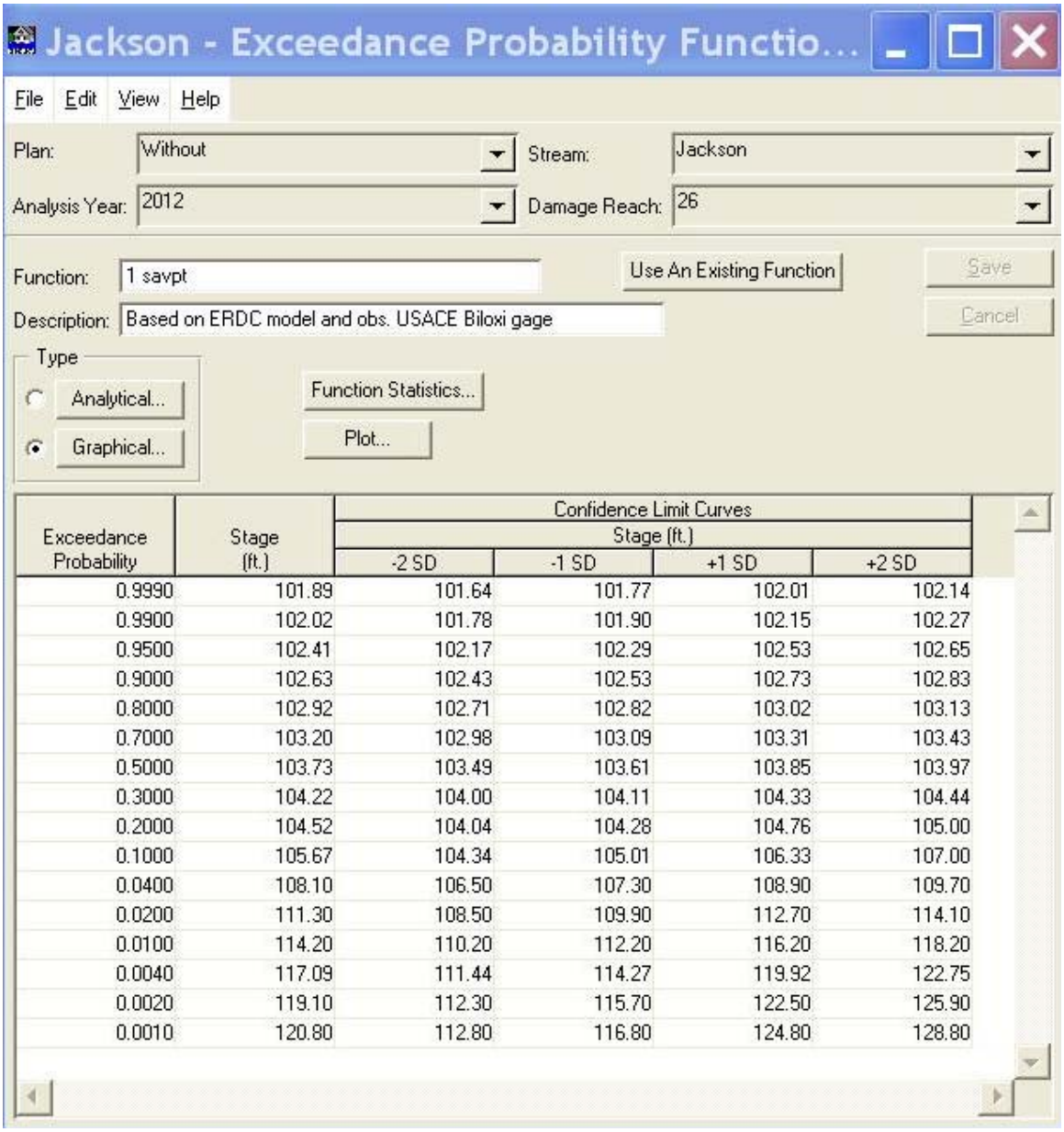


Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	103.89	103.64	103.77	104.01	104.14
0.9900	104.02	103.78	103.90	104.15	104.27
0.9500	104.41	104.17	104.29	104.53	104.65
0.9000	104.63	104.43	104.53	104.73	104.83
0.8000	104.92	104.71	104.82	105.02	105.13
0.7000	105.20	104.98	105.09	105.31	105.43
0.5000	105.73	105.49	105.61	105.85	105.97
0.3000	106.22	106.00	106.11	106.33	106.44
0.2000	106.52	106.04	106.28	106.76	107.00
0.1000	107.67	106.34	107.01	108.33	109.00
0.0400	110.10	108.50	109.30	110.90	111.70
0.0200	113.30	110.50	111.90	114.70	116.10
0.0100	116.20	112.20	114.20	118.20	120.20
0.0040	119.09	113.44	116.27	121.92	124.75
0.0020	121.10	114.30	117.70	124.50	127.90
0.0010	122.80	114.80	118.80	126.80	130.80

Figure 6.10-4. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Gulf Park Estates Area – Includes an adjustment for relative sea level rise

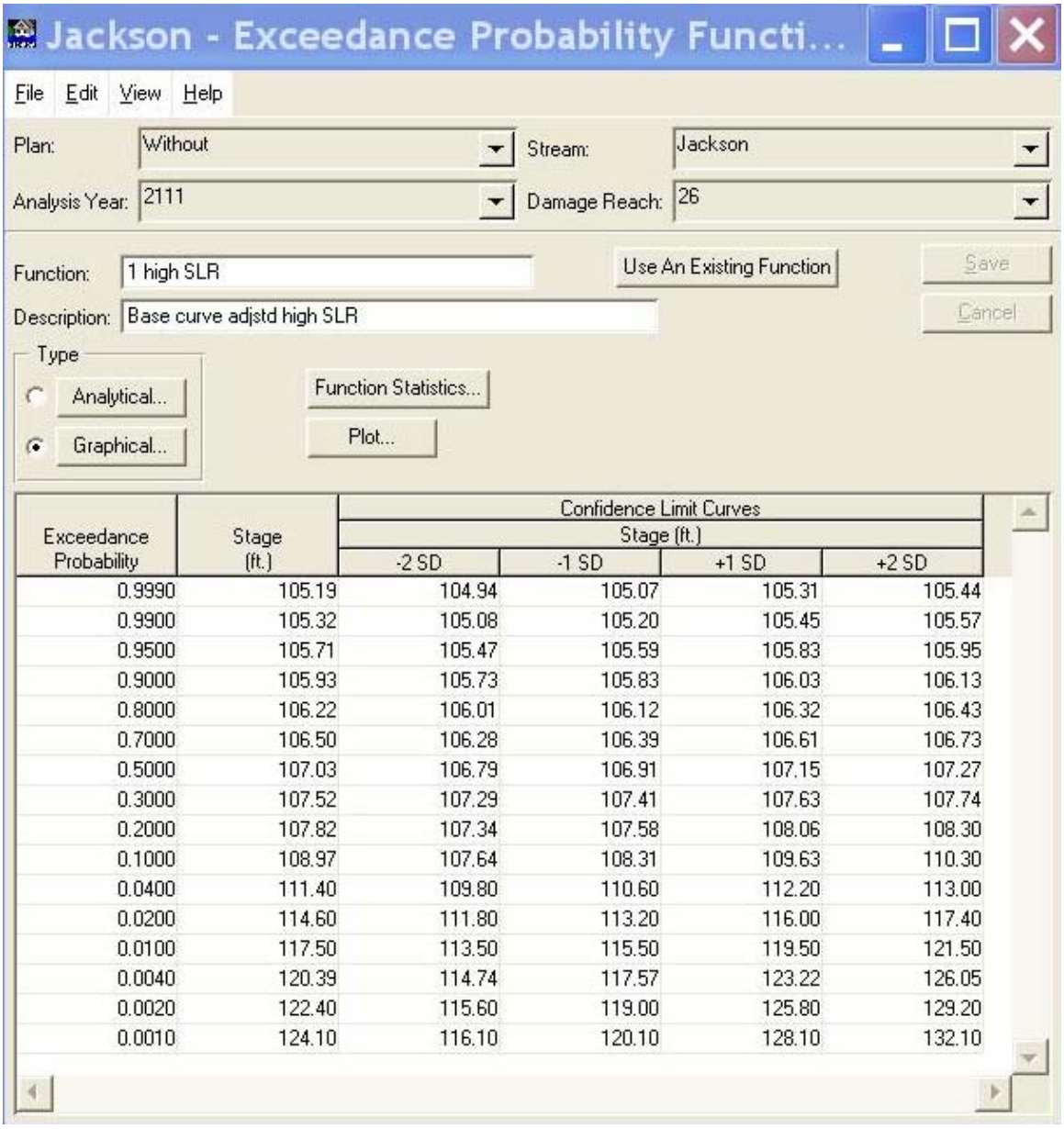
Future scenario five is the same as future scenario one with the addition of a high relative sea level rise 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $7,010,000 (rounded to the nearest thousand). These damages represent a approximately a seven-percent (6.8%) increase over the 2.0-feet relative sea level rise accounted for in future scenario three. The total number of structures in this scenario is the same as in scenarios one and three and can be seen above in table 6.10-2. Figures 6.10-5 and 6.10-6 depict the base year and most likely future year exceedance probability functions for the Gulf Park Estates area (planning sub-unit 26). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.10-6 includes an adjustment for expected

relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	101.89	101.64	101.77	102.01	102.14
0.9900	102.02	101.78	101.90	102.15	102.27
0.9500	102.41	102.17	102.29	102.53	102.65
0.9000	102.63	102.43	102.53	102.73	102.83
0.8000	102.92	102.71	102.82	103.02	103.13
0.7000	103.20	102.98	103.09	103.31	103.43
0.5000	103.73	103.49	103.61	103.85	103.97
0.3000	104.22	104.00	104.11	104.33	104.44
0.2000	104.52	104.04	104.28	104.76	105.00
0.1000	105.67	104.34	105.01	106.33	107.00
0.0400	108.10	106.50	107.30	108.90	109.70
0.0200	111.30	108.50	109.90	112.70	114.10
0.0100	114.20	110.20	112.20	116.20	118.20
0.0040	117.09	111.44	114.27	119.92	122.75
0.0020	119.10	112.30	115.70	122.50	125.90
0.0010	120.80	112.80	116.80	124.80	128.80

Figure 6.10-5. Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Gulf Park Estates Area



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	105.19	104.94	105.07	105.31	105.44
0.9900	105.32	105.08	105.20	105.45	105.57
0.9500	105.71	105.47	105.59	105.83	105.95
0.9000	105.93	105.73	105.83	106.03	106.13
0.8000	106.22	106.01	106.12	106.32	106.43
0.7000	106.50	106.28	106.39	106.61	106.73
0.5000	107.03	106.79	106.91	107.15	107.27
0.3000	107.52	107.29	107.41	107.63	107.74
0.2000	107.82	107.34	107.58	108.06	108.30
0.1000	108.97	107.64	108.31	109.63	110.30
0.0400	111.40	109.80	110.60	112.20	113.00
0.0200	114.60	111.80	113.20	116.00	117.40
0.0100	117.50	113.50	115.50	119.50	121.50
0.0040	120.39	114.74	117.57	123.22	126.05
0.0020	122.40	115.60	119.00	125.80	129.20
0.0010	124.10	116.10	120.10	128.10	132.10

Figure 6.10-6. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Gulf Park Estates Area – Includes an adjustment for relative sea level rise

6.10.5.3 Equivalent annual damages Reduced and Residual Damages

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios three and five and the damages incurred with the measure in place. The HECFDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without-project inventory except that footprints of levees and acquisitions were deleted from the inventory and flood proofed structures (structures to be raised in

place) were given a higher elevation. The structure inventories for each of the HEC-FDA measure runs are as follows:

- Measure A – Gulf Park Estates Ring Levee A at elevation 20.0-feet NAVD88

This measure includes the without-project inventory less 181 parcels that were deleted out of the inventory. These parcels represent the footprint of the 20.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – Gulf Park Estates Ring Levee B at elevation 30.0-feet NAVD88

This measure includes the without-project inventory less 210 parcels that were deleted out of the inventory. These parcels represent the footprint of the 30.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure C – Gulf Park Estates Ring Levee C at elevation 20.0-feet NAVD88

This measure would include a ring levee at 20-feet NAVD88 on an alternate footprint from Measure A and the acquisition of structures and parcels that would have been included in measure A but are not within the alternate footprint.

- Measure D – Gulf Park Estates Ring Levee D

This measure would include a ring levee at 30-feet NAVD88 on an alternate footprint from Measure B and the acquisition of structures and parcels that would have been included in measure B but are not within the alternate footprint.

- Measure E – Gulf Park Estates Nonstructural One

This measure includes the acquisition of 35 parcels that include a structure and the flood proofing (raise structure in place) of 951structures to an elevation of 18.3-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was determined to be approximately the ABFE level of protection and is defined as still water elevation, plus wave run-up plus an estimate for waves (depth divided by two), and is the minimum implementation elevation that a nonstructural measure do to the requirements of the National Flood Insurance Program (NFIP).

- Measure F – Gulf Park Estates Nonstructural Two to elevation 20.0-feet NAVD88

This measure includes the acquisition of 939 parcels that include a structure and the flood proofing (raise structure in place) of 47structures to an elevation of 20.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee measures at elevation 20.0-feet NAVD88.

- Measure G – Gulf Park Estates Nonstructural Three to elevation 30.0-feet NAVD88

This measure includes the acquisition of 986 parcels that include a structure to an elevation of 30.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee measures at elevation 30.0-feet NAVD88.

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damages is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table." Table 6.10-3 summarizes the equivalent annual without-project damages, damages reduced, and residual damages by measure and by future scenario.

Table 6.10-3.
Summary of Damages by Potential Measure and by Applicable Future Scenario

Measures	Equivalent annual damages Future 3 ($)	Equivalent Annual Damage Reduction Future 3 ($)	Residual Damage Future 3 ($)	Equivalent annual damages Future 5 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Residual Damage Future 5 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A 20Ft Ring Levee	$6,273,000	$5,924,000	$349,000	$7,010,000	$6,616,000	$394,000
Measure B 30FT Ring Levee	$6,273,000	$6,251,000	$23,000	$7,010,000	$6,984,000	$26,000
Measure C 20Ft Ring Levee	$6,273,000	$6,021,000	$252,000	$7,010,000	$6,762,000	$248,000
Measure D 30FT Ring Levee	$6,273,000	$6,258,000	$15,000	$7,010,000	$7,010,000	$0
Measure E ABFE Nonstructural	$6,273,000	$5,668,000	$605,000	$7,010,000	$6,327,000	$683,000
Measure F 20FT Nonstructural	$6,273,000	$5,924,000	$349,000	$7,010,000	$6,616,000	$394,000
Measure G 30FT Nonstructural	$6,273,000	$6,273,000	$0	$7,010,000	$7,010,000	$0

Damages are rounded to the nearest thousand dollars.

6.10.6 Environmental Quality (EQ)

6.10.6.1 Impacts of Ring Levee Measures

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

1. A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.

2. A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.10-4 and 6.10-5 show the impacts of the Gulf Park Estates ring levees at elevations 20.0-feet NAVD88, and 30.0-feet NAVD88 respectively.

Table 6.10-4.
Wetland Acres Impacted by Elevation 20' Gulf Park Estates Ring Levee

Reach ID	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Grand Total
26	1.1	1.2	8.1	0.0	10.4
28	3.4	0.3	9.6	0.2	13.4
Total	**4.5**	**1.5**	**17.7**	**0.2**	**23.9**

Table 6.10-5.
Wetland Acres Impacted by Elevation 30' Gulf Park Estates Ring Levee.

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
26	0.0	1.5	1.9	10.6	0.0	14.0
28	0.1	5.9	0.5	14.0	0.3	20.8
Total	**0.1**	**7.4**	**2.3**	**24.6**	**0.3**	**34.8**

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the Gulf Park Estates area can be found in the Environmental Appendix.

6.10.7 Summary of Costs

Table 6.10-6 summarizes the ROM costs at an FY-08 price level for the Gulf Park Estates measures (planning sub-unit 26).

Table 6.10-6.
Summary of Costs by Measure for Gulf Park Estates Area

Measures	Implementation Costs (FY-08) ($)	Capital Recovery Factor	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	0.049171225	$0	$0	$0	$0
Measure A 20FT Ring Levee A	$149,200,000	0.049171225	$7,336,000	$1,499,000	N/A	$8,835,000
Measure B 30FT Ring Levee B	$220,600,000	0.049171225	$10,847,000	$2,404,000	N/A	$13,251,000
Measure C 20FT Ring Levee C	$158,900,000	0.049171225	$7,813,000	$1,295,000	N/A	$9,108,000
Measure D 30FT Ring Levee D	$208,700,000	0.049171225	$10,262,000	$1,906,000	N/A	$12,168,000
Measure E ABFE Nonstructural	$270,873,000	0.049171225	$13,319,000	$10,000	N/A	$13,329,000
Measure F 20FT Nonstructural	$294,188,000	0.049171225	$14,466,000	$10,000	N/A	$14,476,000
Measure G 30FT Nonstructural	$438,492,000	0.049171225	$21,561,000	$10,000	N/A	$21,571,000

The implementation costs include 1/ supervision and administration (30 account), 2/ planning, engineering & design (31 account) and 3/ appropriate contingencies. See the Cost Appendix for more detail on the implementation cost breakdowns. Numbers are rounded to the nearest thousand.

6.10.8 Regional Economic Development (RED)

The purpose of this section is to describe the economic impact of the proposed measures would affect the local area of Jackson County, Mississippi. The expenditures for the measures are estimated to be $149,200,000 for the 20.0-feet NAVD88 ring levee measure A, $220,600,000 for the 30.0-feet NAVD88 ring levee measure B, $158,900,000 for the 20.0-feet NAVD88 ring levee measure C, $208,700,000 for the 30-foot ring levee measure D, $270,873,000 for the ABFE nonstructural measure, $294,188,000 for the 20.0-feet NAVD88 nonstructural measure, and $294,188,000 for the 30.0-feet NAVD88 nonstructural measure. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $30,485,000 for the 20.0-feet NAVD88 ring levee A measure, $48,890,000 for the 30.0-feet NAVD88 ring levee B measure, $26,337,000 the 20.0-feet NAVD88 ring levee C measure, $38,763,000 30.0-feet NAVD88 ring levee D measure, $203,000 for the ABFE nonstructural measure, $203,000 for the 20.0-feet NAVD88 nonstructural measure, and $203,000 for the 30.0-feet NAVD88 nonstructural measure respectively (assuming a 100- year period of analysis and an interest rate of 4.875-percent). The following tables, 6.10-7 through 6.10-10, summarize the EIFS model inputs and outputs for the Gulf Park Estates area.

Table 6.10-7.
EIFS Model Implementation Cost Inputs for the Gulf Park Estates Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$149,200,000	$220,600,000	$158,900,000	$208,700,000	$270,873,000	$294,188,000	$438,492,000

Table 6.10-8.
EIFS Model Implementation Cost Outputs for the Gulf Park Estates Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$149,200,000	$220,600,000	$158,900,000	$208,700,000	$270,873,000	$294,188,000	$438,492,000
Induced Sales Volume	$167,104,000	$247,072,000	$177,968,000	$233,744,000	$303,377,760	$329,490,560	$491,111,040
Total Sales Volume	$316,304,000	$467,672,000	$336,868,000	$442,444,000	$574,250,760	$623,678,560	$929,603,040
Direct Income	$29,097,814	$43,022,639	$30,989,561	$40,701,834	$52,827,159	$57,374,179	$85,517,148
Induced Income	$32,589,547	$48,185,349	$34,708,305	$45,586,049	$59,166,410	$64,259,073	$95,779,194
Total Income	$61,687,361	$91,207,988	$65,697,866	$86,287,883	$111,993,569	$121,633,252	$181,296,342
Direct Employment	844	1,249	899	1,181	1,533	1,665	2,482
Induced Employment	946	1,399	1,007	1,323	1,717	1,865	2,780
Total Employment	1,790	2,647	1,907	2,504	3,250	3,530	5,262
Local Population	0	0	0	0	0	0	0

Table 6.10-9.
EIFS Model O&M Cost Inputs for the Gulf Park Estates Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructl	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$30,485,000	$48,890,000	$26,337,000	$38,763,000	$203,000	$203,000	$203,000

Table 6.10-10.
EIFS Model O&M Cost Outputs for the Gulf Park Estates Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$30,485,000	$48,890,000	$26,337,000	$38,763,000	$203,000	$203,000	$203,000
Induced Sales Volume	$34,143,200	$54,756,800	$29,497,440	$43,414,560	$227,360	$227,360	$227,360
Total Sales Volume	$64,628,200	$103,646,800	$55,834,440	$82,177,560	$430,360	$430,360	$430,360
Direct Income	$5,945,354	$9,534,800	$5,136,388	$7,559,776	$39,590	$39,590	$39,590
Induced Income	$6,658,796	$10,678,974	$5,752,754	$8,466,948	$44,341	$44,341	$44,341
Total Income	$12,604,150	$20,213,774	$10,889,142	$16,026,724	$83,931	$83,931	$83,931
Direct Employment	173	277	149	219	1	1	1
Induced Employment	193	310	167	246	1	1	1
Total Employment	366	587	316	465	2	2	2
Local Population	0	0	0	0	0	0	0

6.11 Evaluation of Belle Fontaine Area Measures

6.11.1 General

The Belle Fontaine area is located in the southern portion of planning unit three along the Mississippi Sound. The area is denoted as planning sub-unit 27 and is depicted in the figure, 6.11-1, below. The pre-Hurricane Katrina conditions for this area represented a mostly residential community. As demonstrated in Table 6.11-1, it was estimated from the field inventorying process that planning sub-unit 27 included 2,930 tax parcels, of which 1,389 contained a structure with some economic value and 1,541 were vacant land. Of those 1,389 parcels that contain structures, 1,357 were residential one-story, 0 were residential two-story, 17 were mobile homes, 12 were commercial, and 3 were municipal.

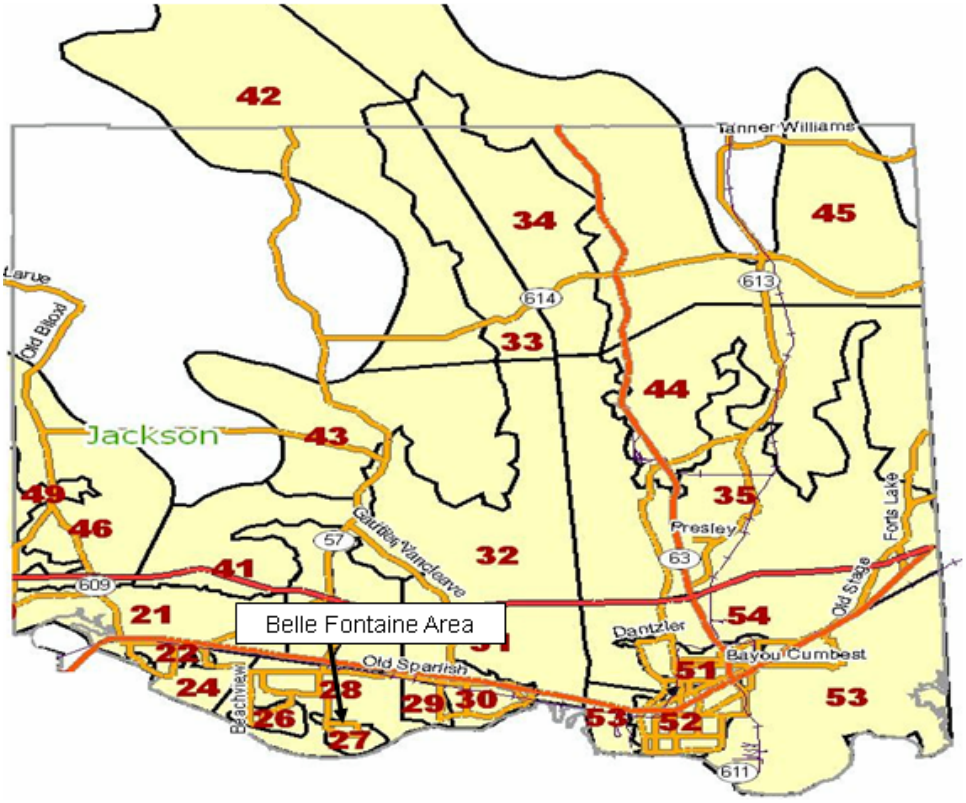


Figure 6.11-1. Belle Fontaine Area – Planning Sub-unit 27

Table 6.11-1.
Pre-Hurricane Katrina Estimate of Structures for the Belle Fontaine Area Planning Sub-unit 27

Structure Categories	Structures by Category
Residential	1,357
Mobile Homes	17
Commercial	12
Municipal	3
Vacant Land	1,541
Total Tax Parcels	**2,930**

6.11.2 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation,
- Preservation of Fish and Wildlife Habitat.

6.11.3 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs
- Price levels are October, 2007 unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs pertaining to the evaluation of measures for hurricane and storm damage reduction.

6.11.4 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit three. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

- Measure A – Belle Fontaine Ring Levee A

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 20.0-feet NAVD88.

- Measure B – Belle Fontaine Ring Levee B

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 30.0-feet NAVD88.

- Measure C – Belle Fontaine Ring Levee C

This measure would include a ring levee at 20-feet NAVD88 on an alternate footprint from Measure A and the acquisition of structures and parcels that would have been included in measure A but are not within the alternate footprint.

- Measure D – Belle Fontaine Ring Levee D

This measure would include a ring levee at 30-feet NAVD88 on an alternate footprint from Measure B and the acquisition of structures and parcels that would have been included in measure B but are not within the alternate footprint.

- Measure E – Belle Fontaine Nonstructural One

This measure includes the acquisition and flood proofing (elevate-in-place) of structures to the FEMA advisory base flood elevation (ABFE).

- Measure F – Belle Fontaine Nonstructural Two

This measure includes the acquisition and flood proofing of structures to approximately elevation 20-feet NAVD88.

- Measure G – Belle Fontaine Nonstructural Three

This measure includes the acquisition and flood proofing of structures to approximately elevation 30-feet NAVD88.

Figure 6.11-2 shows the measures for the Belle Fontaine Area (planning sub-unit 27); the red line represents the approximate footprint of the ring levee A and B measures, the green line represents the approximate footprint of the ring levee C and D measures, the dark green within the ring levee footprint represents potential ABFE buyout areas and the light green area within the ring levee footprint represents potential flood proof (elevate-in-place) areas.

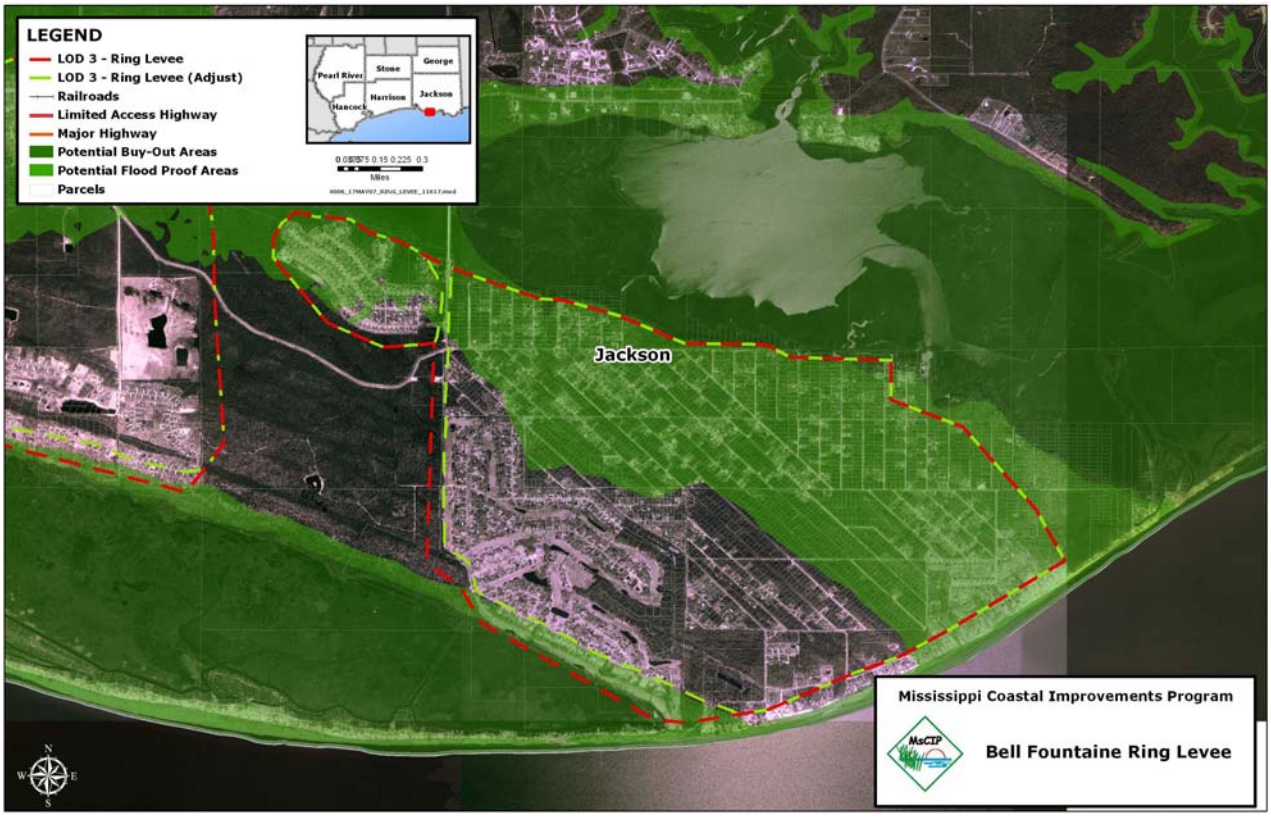


Figure 6.11-2. Display of Potential Measures for the Belle Fontaine Area (Planning Sub-unit 27)

6.11.5 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "…***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits…"*** More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.11.5.1 Existing Conditions Post-Hurricane Katrina)

The effects of Hurricane Katrina storm surge were devastating to the Belle Fontaine Area. Peak water elevation in the area was approximately19-feet NAVD88. It is estimated that 420 of the structures in the area (mostly residential) sustained significant inundation damage (fifty-percent or more). Expected redevelopment of the area is described in the following section.

6.11.5.2 Future Without-Project Conditions

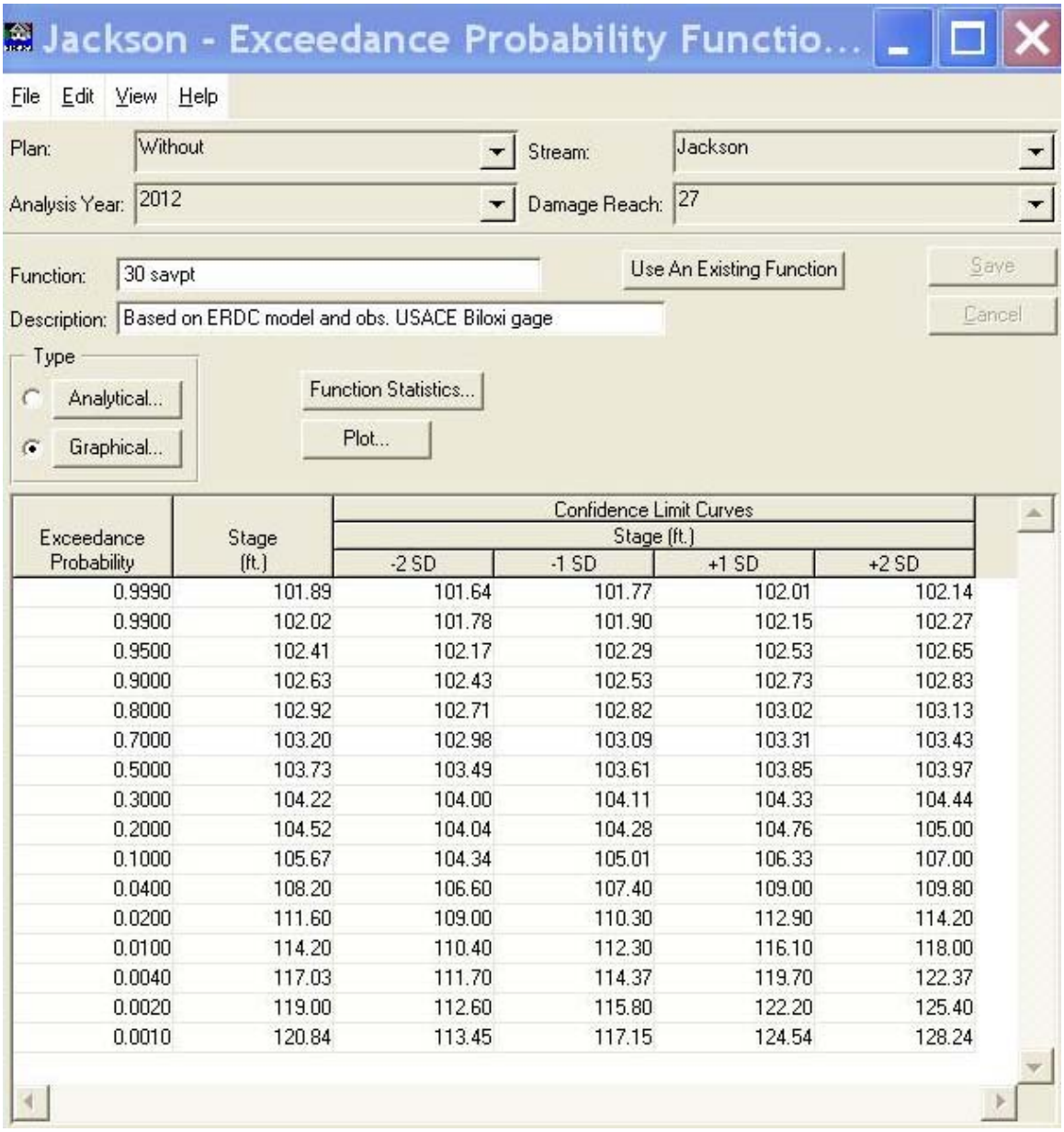
Equivalent annual flood damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the measures were evaluated and compared to future without-project scenarios three, and five, as previously discussed in section 5.3. These future scenarios were chosen because the redevelopment projected for this area is anticipated to return to the pre-Katrina development. Futures scenarios two, four, and six were not used for evaluation purposes since this area is not accommodative for commercial and condominium redevelopment under those mixed redevelopment scenarios (see section 5.3 for more detail).

Future scenario one is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Table 6.11-2 shows structures by category and by elevation. The number of structures per elevation is added to the previous number of structures per elevation in each category. For example, in the residential category there are three structures with an elevation of 5-feet or lower, and there are fourteen structures with an elevation of 6-feet or less, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Belle Fontaine area.

Table 6.11-2.
Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years

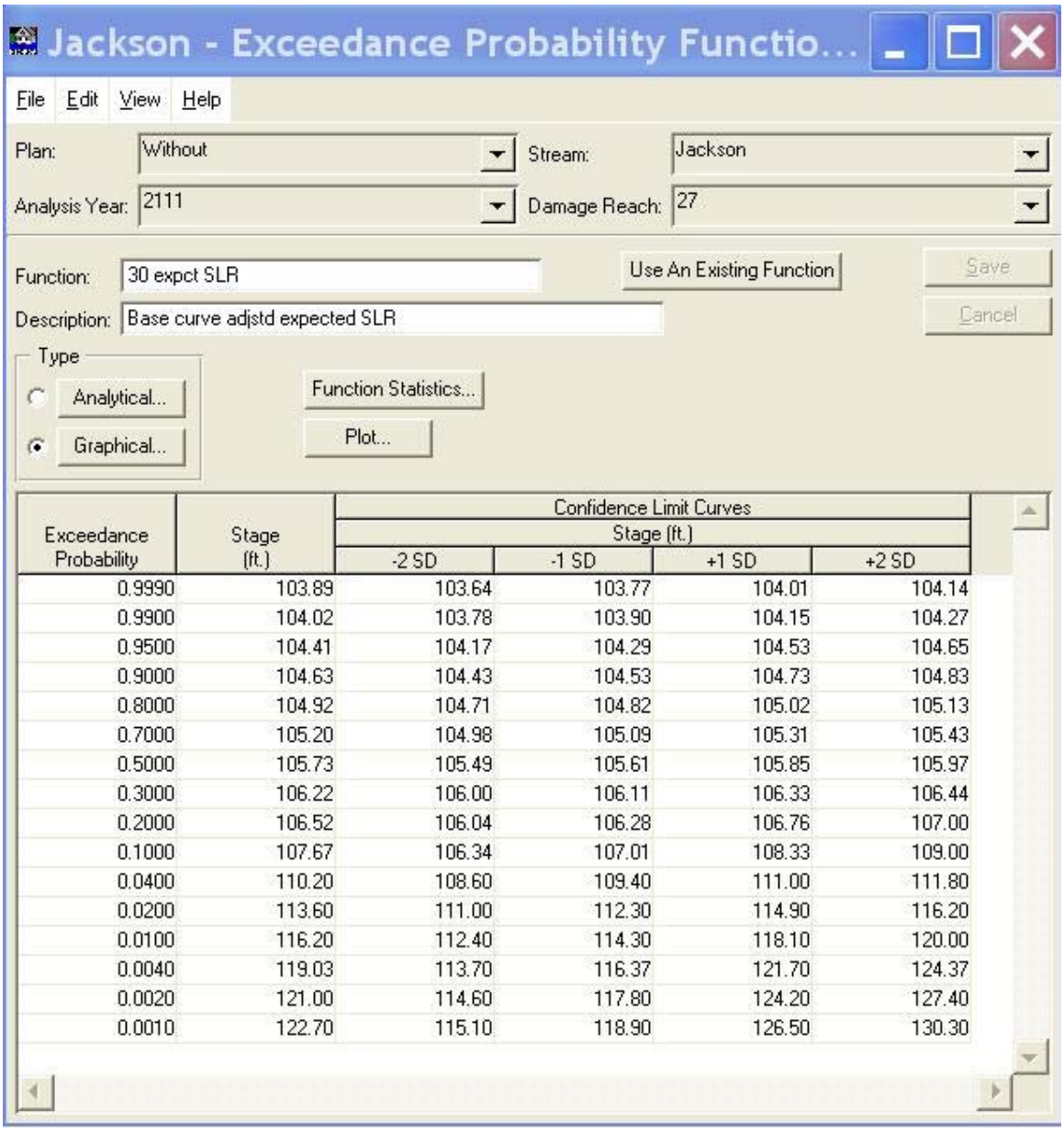
Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	0	0	0	0	0
2-foot	0	0	0	0	0
3-foot	0	0	0	0	0
4-foot	0	0	0	0	0
5-foot	3	0	0	0	3
6-foot	14	0	0	0	14
7-foot	16	0	0	0	16
8-foot	18	0	0	0	18
9-foot	19	0	0	0	19
10-foot	28	0	0	0	28
11-foot	170	0	0	0	170
12-foot	208	0	1	0	209
13-foot	376	1	5	0	382
14-foot	707	2	7	0	716
15-foot	1,111	3	8	2	1,124
16-foot	1,166	5	9	3	1,183
17-foot	1,245	6	10	3	1,264
18-foot	1,298	7	11	3	1,319
19-foot	1,339	13	11	3	1,366
20-foot	1,346	17	12	3	1,378
21-foot	1,355	17	12	3	1,387
22-foot	1,357	17	12	3	1,389
Total	**1,357**	**17**	**12**	**3**	**1,389**

Future scenario three is the full redevelopment of assets within the study area by the year 2012. Under this scenario, assets will be rebuilt as they were pre-Hurricane Katrina. For example, if the asset was a residential structure pre-Hurricane Katrina it will be rebuilt as a residential structure; commercial structures will be built back to commercial structures; etc. Basically, future scenario three is the same structure inventory as future scenario one with the addition of an expected relative sea level rise over the 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $2,506,000 (rounded to the nearest thousand dollars). The total number of structures in this scenario are the same as in scenario one and can be seen above in table 6.11-2. Figures 6.11-3 and 6.11-4 depict the base year and most likely future year exceedance probability functions for the Belle Fontaine area (planning sub-unit 27). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.11-4 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet.For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	101.89	101.64	101.77	102.01	102.14
0.9900	102.02	101.78	101.90	102.15	102.27
0.9500	102.41	102.17	102.29	102.53	102.65
0.9000	102.63	102.43	102.53	102.73	102.83
0.8000	102.92	102.71	102.82	103.02	103.13
0.7000	103.20	102.98	103.09	103.31	103.43
0.5000	103.73	103.49	103.61	103.85	103.97
0.3000	104.22	104.00	104.11	104.33	104.44
0.2000	104.52	104.04	104.28	104.76	105.00
0.1000	105.67	104.34	105.01	106.33	107.00
0.0400	108.20	106.60	107.40	109.00	109.80
0.0200	111.60	109.00	110.30	112.90	114.20
0.0100	114.20	110.40	112.30	116.10	118.00
0.0040	117.03	111.70	114.37	119.70	122.37
0.0020	119.00	112.60	115.80	122.20	125.40
0.0010	120.84	113.45	117.15	124.54	128.24

Figure 6.11-3. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Belle Fontaine Area

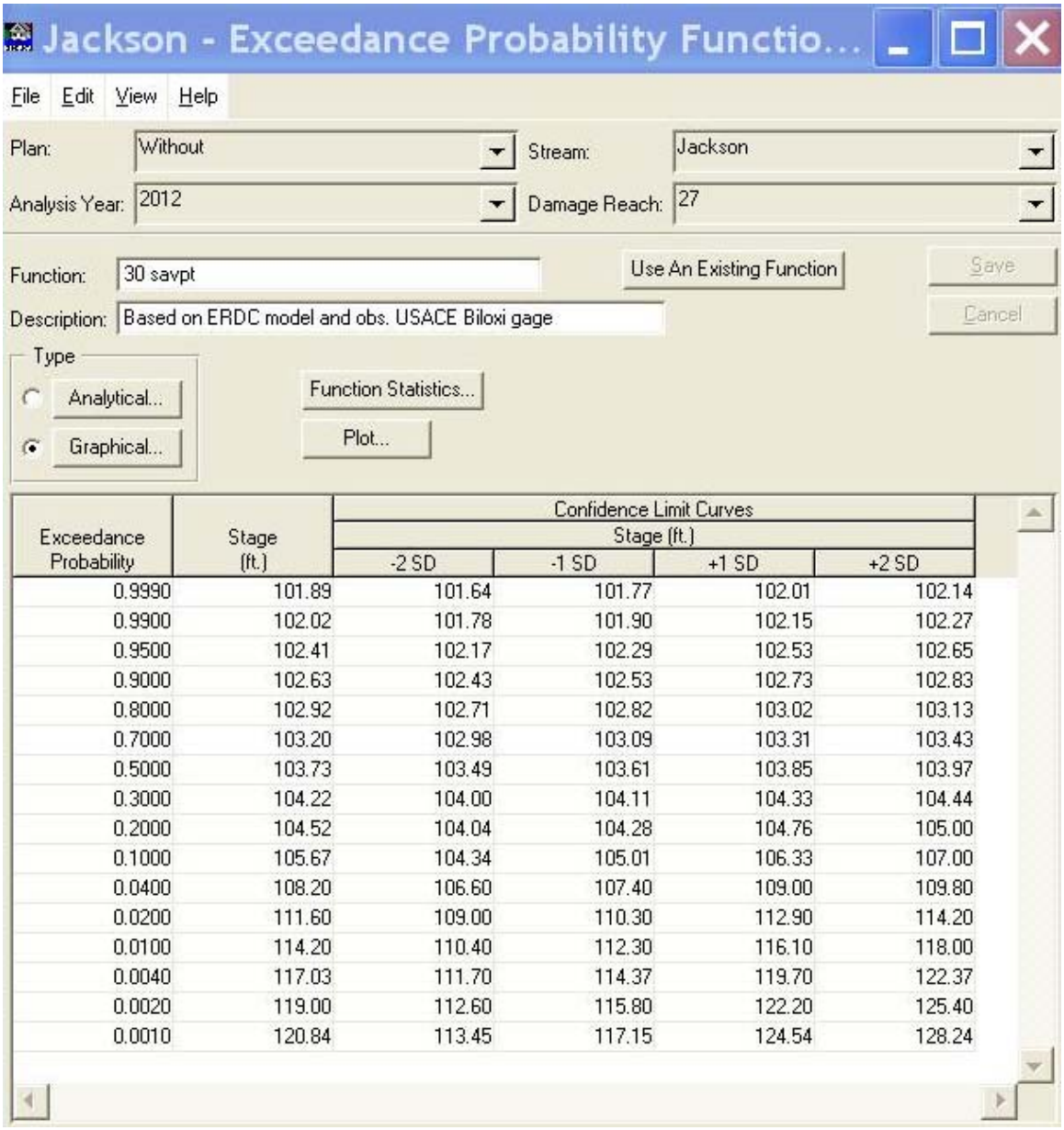


Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	103.89	103.64	103.77	104.01	104.14
0.9900	104.02	103.78	103.90	104.15	104.27
0.9500	104.41	104.17	104.29	104.53	104.65
0.9000	104.63	104.43	104.53	104.73	104.83
0.8000	104.92	104.71	104.82	105.02	105.13
0.7000	105.20	104.98	105.09	105.31	105.43
0.5000	105.73	105.49	105.61	105.85	105.97
0.3000	106.22	106.00	106.11	106.33	106.44
0.2000	106.52	106.04	106.28	106.76	107.00
0.1000	107.67	106.34	107.01	108.33	109.00
0.0400	110.20	108.60	109.40	111.00	111.80
0.0200	113.60	111.00	112.30	114.90	116.20
0.0100	116.20	112.40	114.30	118.10	120.00
0.0040	119.03	113.70	116.37	121.70	124.37
0.0020	121.00	114.60	117.80	124.20	127.40
0.0010	122.70	115.10	118.90	126.50	130.30

Figure 6.11-4. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Belle Fontaine Area – Includes an adjustment for relative sea level rise

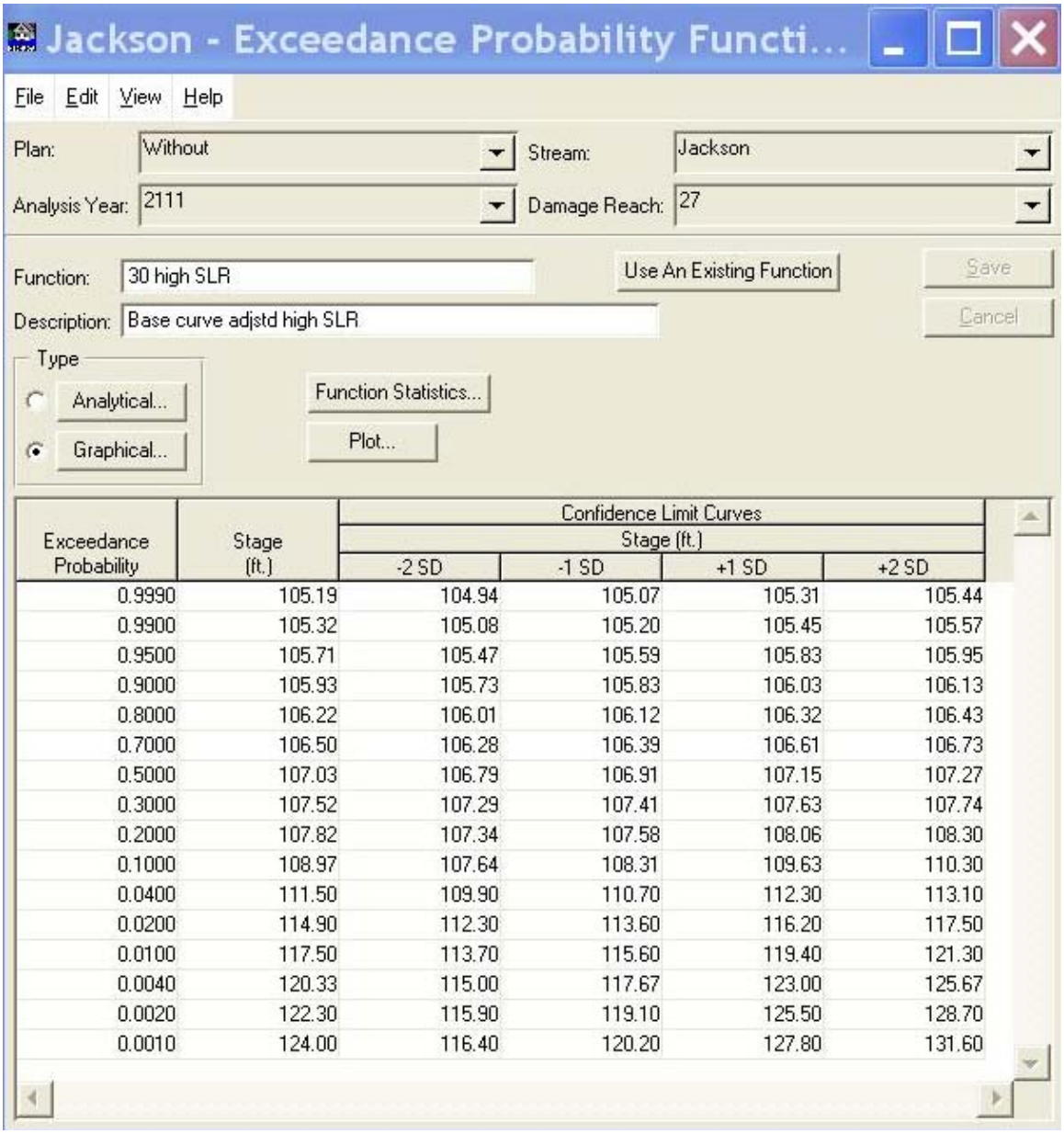
Future scenario five is the same as future scenario one with the addition of a high relative sea level rise 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $2,950,000 (rounded to the nearest thousand). These damages represent approximately an eighteen-percent (17.7%) increase over the expected relative sea level rise accounted for in future scenario three. The total number of structures in this scenario is the same as in scenarios one and three and can be seen above in table 6.11-2. Figures 6.11-5 and 6.11-6 depict the base year and most likely future year exceedance probability functions for the Belle Fontaine area (planning sub-unit 27). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.11-6 includes an adjustment for

expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet.For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	101.89	101.64	101.77	102.01	102.14
0.9900	102.02	101.78	101.90	102.15	102.27
0.9500	102.41	102.17	102.29	102.53	102.65
0.9000	102.63	102.43	102.53	102.73	102.83
0.8000	102.92	102.71	102.82	103.02	103.13
0.7000	103.20	102.98	103.09	103.31	103.43
0.5000	103.73	103.49	103.61	103.85	103.97
0.3000	104.22	104.00	104.11	104.33	104.44
0.2000	104.52	104.04	104.28	104.76	105.00
0.1000	105.67	104.34	105.01	106.33	107.00
0.0400	108.20	106.60	107.40	109.00	109.80
0.0200	111.60	109.00	110.30	112.90	114.20
0.0100	114.20	110.40	112.30	116.10	118.00
0.0040	117.03	111.70	114.37	119.70	122.37
0.0020	119.00	112.60	115.80	122.20	125.40
0.0010	120.84	113.45	117.15	124.54	128.24

Figure 6.11-5. Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Belle Fontaine Area



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	105.19	104.94	105.07	105.31	105.44
0.9900	105.32	105.08	105.20	105.45	105.57
0.9500	105.71	105.47	105.59	105.83	105.95
0.9000	105.93	105.73	105.83	106.03	106.13
0.8000	106.22	106.01	106.12	106.32	106.43
0.7000	106.50	106.28	106.39	106.61	106.73
0.5000	107.03	106.79	106.91	107.15	107.27
0.3000	107.52	107.29	107.41	107.63	107.74
0.2000	107.82	107.34	107.58	108.06	108.30
0.1000	108.97	107.64	108.31	109.63	110.30
0.0400	111.50	109.90	110.70	112.30	113.10
0.0200	114.90	112.30	113.60	116.20	117.50
0.0100	117.50	113.70	115.60	119.40	121.30
0.0040	120.33	115.00	117.67	123.00	125.67
0.0020	122.30	115.90	119.10	125.50	128.70
0.0010	124.00	116.40	120.20	127.80	131.60

Figure 6.11-6. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Belle Fontaine Area – Includes an adjustment for relative sea level rise

6.11.5.3 Equivalent annual damages Reduced

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios three and five and the damages incurred with the measure in place. The HECFDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without project inventory except that footprints of levees and acquisitions were deleted from the inventory and flood proofed structures (structures to be raised in

place) were given a higher elevation. The structure inventories for each of the HEC-FDA measure runs are as follows:

- Measure A – Belle Fontaine Ring Levee A at elevation 20.0-feet NAVD88

This measure includes the without-project inventory less 101 parcels that were deleted out of the inventory. These parcels represent the footprint of the 20.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – Belle Fontaine Ring Levee B at elevation 30.0-feet NAVD88

This measure includes the without-project inventory less 118 parcels that were deleted out of the inventory. These parcels represent the footprint of the 30.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure C – Belle Fontaine Ring Levee C at elevation 20.0-feet NAVD88

This measure would include a ring levee at 20-feet NAVD88 on an alternate footprint from Measure A and the acquisition of structures and parcels that would have been included in measure A but are not within the alternate footprint.

- Measure D – Belle Fontaine Ring Levee D

This measure would include a ring levee at 30-feet NAVD88 on an alternate footprint from Measure B and the acquisition of structures and parcels that would have been included in measure B but are not within the alternate footprint.

- Measure E – Belle Fontaine Nonstructural One

This measure includes the acquisition of 32 parcels that include a structure and the flood proofing (raise structure in place) of 1,028 structures to an elevation of 14.55-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was determined to be approximately the ABFE level of protection and is defined as still water elevation, plus wave run-up, plus an estimate for waves (depth divided by two), and is the minimum implementation elevation that a nonstructural measure do to the requirements of the National Flood Insurance Program (NFIP).

- Measure F – Belle Fontaine Nonstructural Two to elevation 20.0-feet NAVD88

This measure includes the acquisition of 177 parcels that include a structure and the flood proofing (raise structure in place) of 883 structures to an elevation of 20.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee measures at elevation 20.0-feet NAVD88.

- Measure G – Belle Fontaine Nonstructural Three to elevation 30.0-feet NAVD88

This measure includes the acquisition of 1,060 parcels that include a structure. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing

Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee measures at elevation 30.0-feet NAVD88.

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damages is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table." Table 6.11-3 summarizes the without project damages, damages reduced, and residual damages by measure and by future scenario.

Table 6.11-3.
Summary of Damages by Measure

Measures	Equivalent Annual Damages Future 3 ($)	Equivalent Annual Damage Reduction Future 3 ($)	Residual Damage Future 3 ($)	Equivalent Annual Damages Future 5 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Residual Damage Future 5 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A 20FT Ring Levee A	$2,506,000	$2,235,000	$271,000	$2,950,000	$2,641,000	$309,000
Measure B 30FT Ring Levee B	$2,506,000	$2,493,000	$13,000	$2,950,000	$2,933,000	$17,000
Measure C 20FT Ring Levee C	$2,506,000	$2,350,000	$156,000	$2,950,000	$2,765,000	$185,000
Measure D 30FT Ring Levee D	$2,506,000	$2,506,000	$0	$2,950,000	$2,950,000	$0
Measure C ABFE Nonstructural	$2,506,000	$1,425,000	$1,081,000	$2,950,000	$1,652,000	$1,298,000
Measure D 20FT Nonstructural	$2,506,000	$2,235,000	$271,000	$2,950,000	$2,641,000	$309,000
Measure E 30FT Nonstructural	$2,506,000	$2,506,000	$0	$2,950,000	$2,950,000	$0

Damages are rounded to the nearest thousand dollars.

6.11.6 Environmental Quality (EQ)

6.11.6.1 Impacts of Ring Levee Measures

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

1. A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.

2. A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.11-4 and 6.11-5 show the impacts of the Belle Fontaine ring levees at elevations 20.0-feet NAVD88, and 30.0-feet NAVD88 respectively.

Table 6.11-4.
Wetland Acres Impacted by Elevation 20' Belle Fontaine Ring Levee A

Reach ID	Estuarine and Marine Wetland	Freshwater Forested/ Shrub Wetland	Freshwater Pond	Total
27	4.7	14.2	0.4	19.3
28	9.5	18.0	0.2	27.6
Total	**14.2**	**32.2**	**0.5**	**46.9**

Table 6.11-5.
Wetland Acres Impacted by Elevation 30' Belle Fontaine Ring Levee B

Reach ID	Estuarine and Marine Wetland	Freshwater Forested/ Shrub Wetland	Freshwater Pond	Total
27	6.11	20.5	0.6	27.5
28	13.0	25.4	0.2	38.5
Total	**19.4**	**45.9**	**0.8**	**66.0**

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the Belle Fontaine area can be found in the Environmental Appendix.

6.11.7 Summary of Costs

Table 6.11-6 summarizes the ROM costs at an FY-08 price level by measure for the Belle Fontaine area (planning sub-unit 26).

Table 6.11-6.
Summary of Costs by Measure for the Belle Fontaine Area

Measures	Total Cost to Implement (First Cost) ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0
Measure A 20FT Ring Levee A	$137,600,000	$6,766,000	$1,371,000	N/A	$8,137,000
Measure B 30FT Ring Levee B	$191,900,000	$9,436,000	$1,939,000	N/A	$11,375,000
Measure C 20FT Ring Levee C	$103,900,000	$5,109,000	$989,000	N/A	$6,098,000
Measure D 30FT Ring Levee D	$142,900,000	$7,027,000	$1,414,000	N/A	$8,441,000
Measure E ABFE Nonstructural	$227,800,000	$11,201,000	$10,000	N/A	$11,211,000
Measure F 20FT Nonstructural	$290,726,000	$14,295,000	$10,000	N/A	$14,305,000
Measure G 30FT Nonstructural	$453,067,000	$22,278,000	$10,000	N/A	$22,288,000

The implementation costs include 1/ supervision and administration (30 account), 2/ planning, engineering & design (31 account) and 3/ appropriate contingencies. See the Cost Appendix for more detail on the implementation cost breakdowns. Numbers are rounded to the nearest thousand.

6.11.8 Regional Economic Development (RED)

The purpose of this analysis is to determine the economic impact of the proposed project measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Jackson County, Mississippi. The expenditures for the measures are estimated to be $137,600,000 for the 20.0-feet NAVD88 ring levee A measure, $191,900,000 for the 30.0-feet NAVD88 ring levee B measure, $103,900,000 for the 20.0-feet NAVD88 ring levee C measure, $142,900,000 for the 30.0-feet NAVD88 ring levee D measure, $227,800,000 for the ABFE nonstructural measures, $290,726,000 for the 20.0-feet NAVD88 nonstructural measures, and $290,726,000 for the 30.0-feet NAVD88 nonstructural measures. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $27,882,000 for the 20.0-feet NAVD88 ring levee A measure, $39,434,000 for the 30.0-feet NAVD88 ring levee B measure, $20,113,000 for the 20.0-feet NAVD88 ring levee C measure, $28,757,000 for the 30.0-feet NAVD88 ring levee D measure, $203,000 for the ABFE nonstructural measure, $203,000 for the 20.0-feet NAVD88 nonstructural measure, and $203,000 for the 30.0-feet NAVD88 nonstructural measure respectively (assuming a 100 year period of analysis and an interest rate of 4.875 percent). The following tables, 6.11-7 through 6.11-10, summarize the EIFS model inputs and outputs for the Belle Fontaine area.

Table 6.11-7.
EIFS Model Construction Costs Inputs for the Belle Fontaine Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$137,600,000	$191,900,000	$103,900,000	$142,900,000	$227,800,000	$290,726,000	$453,067,000

Based of the given inputs the outputs are as follows:

Table 6.11-8.
EIFS Model Construction Costs Outputs for the Belle Fontaine Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$137,600,000	$191,900,000	$103,900,000	$142,900,000	$227,800,000	$290,726,000	$453,067,000
Induced Sales Volume	$154,112,000	$214,928,000	$116,368,000	$160,048,000	$255,136,000	$325,613,120	$507,435,040
Total Sales Volume	$291,712,000	$406,828,000	$220,268,000	$302,948,000	$482,936,000	$616,339,120	$960,502,040
Direct Income	$26,835,517	$37,425,405	$20,263,156	$27,869,153	$44,426,823	$56,699,001	$88,359,645
Induced Income	$30,055,775	$41,916,448	$22,694,732	$31,213,447	$49,758,035	$63,502,873	$98,962,791
Total Income	$56,891,292	$79,341,853	$42,957,887	$59,082,599	$94,184,858	$120,201,874	$187,322,436
Direct Employment	778	1,086	588	809	1,289	1,646	2,564
Induced Employment	872	1,216	659	906	1,444	1,843	2,872
Total Employment	1,650	2,302	1,247	1,715	2,734	3,489	5,437
Local Population	0	0	0	0	0	0	0

Table 6.11-9.
EIFS Model O&M Cost Inputs for the Belle Fontaine Area (Planning Sub-unit 27)

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$27,882,000	$39,434,000	$20,113,000	$28,757,000	$203,000	$203,000	$203,000

Based of the given inputs the outputs are as follows:

Table 6.11-10.
EIFS Model O&M Cost Outputs for the Belle Fontaine Area (Planning Sub-unit 27)

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$27,882,000	$39,434,000	$20,113,000	$28,757,000	$203,000	$203,000	$203,000
Induced Sales Volume	$31,227,840	$44,166,080	$22,526,560	$32,207,840	$227,360	$227,360	$227,360
Total Sales Volume	$59,109,840	$83,600,000	$42,639,560	$60,964,840	$430,360	$430,360	$430,360
Direct Income	$5,437,703	$7,690,638	$3,922,549	$5,608,350	$39,590	$39,590	$39,590
Induced Income	$6,090,226	$8,613,513	$4,393,254	$6,281,351	$44,341	$44,341	$44,341
Total Income	$11,527,929	$16,304,151	$8,315,804	$11,889,701	$83,931	$83,931	$83,931
Direct Employment	158	223	114	163	1	1	1
Induced Employment	177	250	128	182	1	1	1
Total Employment	335	473	241	345	2	2	2
Local Population	0	0	0	0	0	0	0

6.12 Evaluation of Pascagoula - Moss Point Area Measures

6.12.1 General

The Pascagoula - Moss Point area, shown in Figure 6.12-1, is located in the southeastern portion of planning unit three along the eastern bank of the Pascagoula River. The area is denoted as planning sub-units 51 and 52 and is depicted in the figure below. The pre-Hurricane Katrina conditions for this area represented a mostly residential community. As shown in table 6.12-1, it was estimated from the field inventorying process that planning sub-units 51 and 52 included 16,158 tax parcels; of which 13,638 contained a structure with some economic value and 2,520 were vacant land. Of those 13,638 parcels that contain structures, 11,449 were residential one-story, 314 were residential two-story, 52 were mobile homes, 1,565 were commercial, and 258 were municipal.

6.12.2 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation
- Preservation of Fish and Wildlife

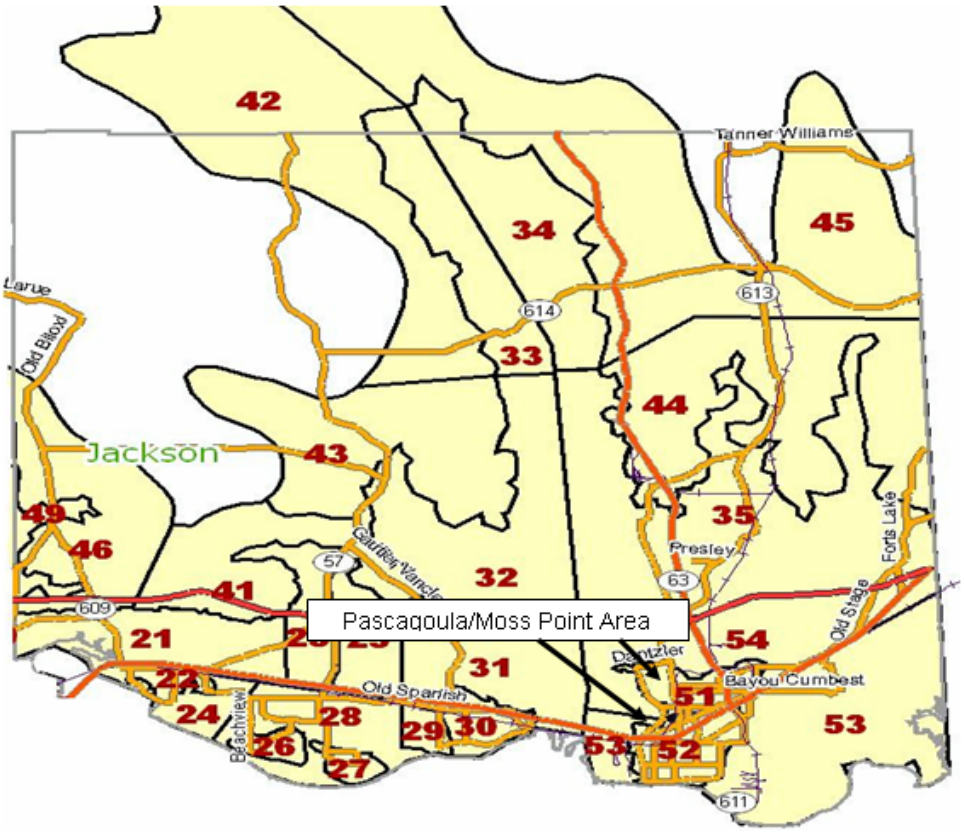


Figure 6.12-1. Pascagoula - Moss Point Area – Planning Sub-units 51 and 52

Table 6.12-1.
Pre-Hurricane Katrina Estimate of Structures for the
Pascagoula-Moss Point Area Planning Sub-units 51 and 52

Structure Categories	Structures by Category
Residential	11,763
Mobile Homes	52
Commercial	1,565
Municipal	258
Vacant Land	2,520
Total Tax Parcels	**16,158**

6.12.3 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4.875 percent was used in estimating average annual benefits and costs
- Price levels are October, 2007 unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs.

6.12.4 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit three. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

- Measure A – Pascagoula - Moss Point Ring Levee at Elevation 20.0-feet NAVD88

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 20.0-feet NAVD88.

- Measure B – Pascagoula - Moss Point Ring Levee Elevation 30.0-feet NAVD88

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 30.0-feet NAVD88.

- Measure C – Pascagoula - Moss Point Ring Levee at Elevation 20.0-feet NAVD88

This measure includes a combination of a ring levee at 20-feet NAVD88 on an alternate footprint from measure A that would include the acquisition of structures and parcels in the Moss Point area.

- Measure D – Pascagoula - Moss Point Ring Levee Elevation 30.0-feet NAVD88

This measure includes a combination of a ring levee at 30-feet NAVD88 on an alternate footprint from measure B that would include the acquisition of structures and parcels in the Moss Point area.

- Measure E – Pascagoula - Moss Point Ring Levee at Elevation 20.0-feet NAVD88

This measure includes a combination of a ring levee at 20-feet NAVD88 on an alternate footprint from measure A that would include the acquisition of structures and parcels in the Washington Avenue area.

- Measure F – Pascagoula - Moss Point Ring Levee Elevation 30.0-feet NAVD88

This measure includes a combination of a ring levee at 30-feet NAVD88 on an alternate footprint from measure B that would include the acquisition of structures and parcels in the Washington Avenue area.

- Measure G – Pascagoula - Moss Point Ring Levee at Elevation 20.0-feet NAVD88

This measure includes a combination of a ring levee at 20-feet NAVD88 on an alternate footprint from measure A that would include the acquisition of structures and parcels in the Moss Point and Washington Avenue areas.

- Measure H – Pascagoula - Moss Point Ring Levee Elevation 30.0-feet NAVD88

This measure includes a combination of a ring levee at 30-feet NAVD88 on an alternate footprint from measure B that would include the acquisition of structures and parcels in the Moss Point and Washington Avenue areas.

- Measure I – Pascagoula - Moss Point Nonstructural One

This measure includes the acquisition and flood proofing (elevate-in-place) of structures to the FEMA advisory base flood elevation (ABFE).

- Measure J – Pascagoula - Moss Point Nonstructural Two

This measure includes the acquisition and flood proofing of structures to approximately elevation 20-feet NAVD88.

- Measure K – Pascagoula - Moss Point Nonstructural Three

This measure includes the acquisition and flood proofing of structures to approximately elevation 30-feet NAVD88.

Figure 6.12-2 shows the measures for the Pascagoula-Moss Point Area (planning sub-units 51 and 52); the red line represents the approximate footprint of the ring levees A and B, the green line represents the approximate footprints of ring levees C through H, the dark green within the ring levee footprint represents potential ABFE buyout areas and the light green area within the ring levee footprint represents potential flood proof (elevate-in-place) areas.

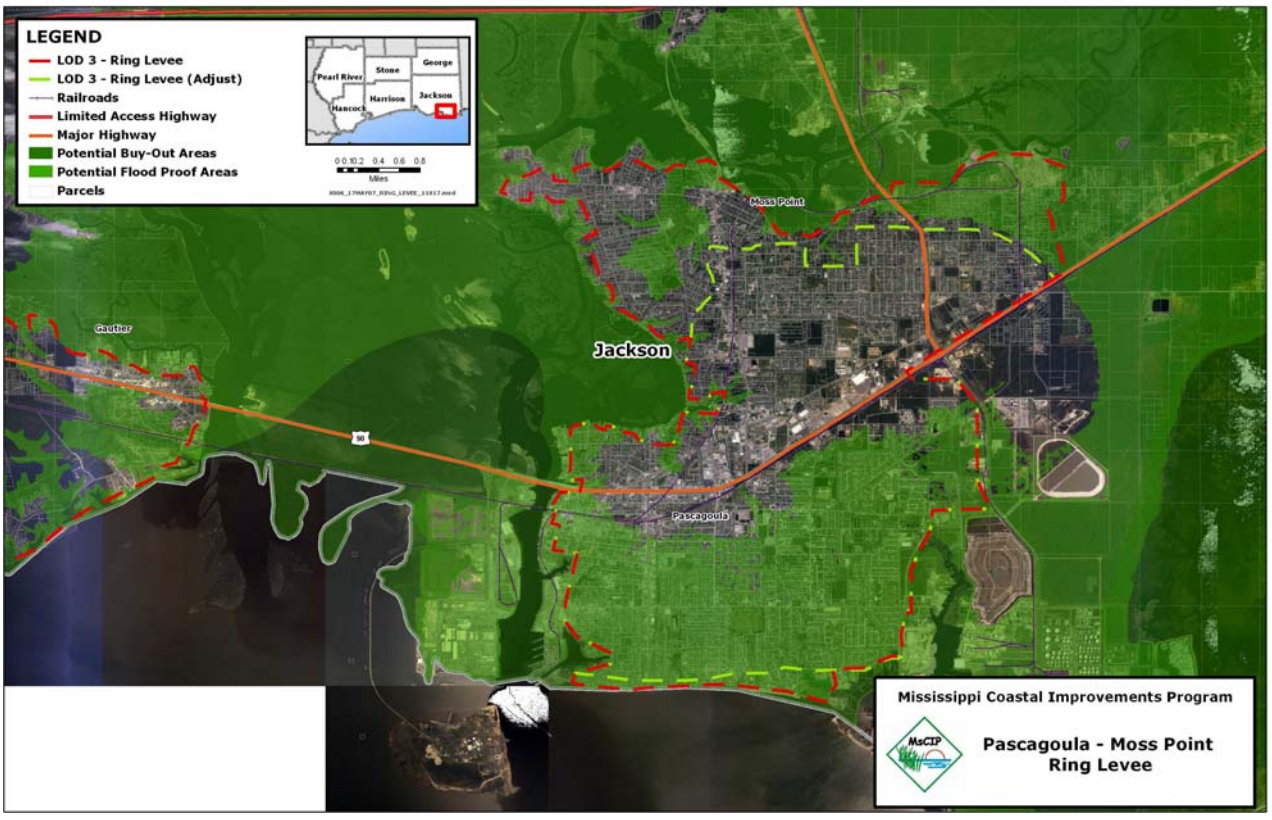


Figure 6.12-2. Display of Potential Measures for the Pascagoula-Moss Point Area (Planning Sub-units 51 and 52)

6.12.5 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "…***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits…"*** More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.12.5.1 Existing Conditions Post-Hurricane Katrina)

The effects of Hurricane Katrina storm surge were devastating to the Pascagoula-Moss Point Area. Peak water elevation in the area ranged from 14 and 16-feet NAVD88. It is estimated that approximately 3,840 (101 in planning sub-unit 51 and 3,743 in planning sub-unit 52) of the structures in the area (sustained significant inundation damage (fifty-percent or more). Expected redevelopment of the area is described in the following section.

6.12.5.2 Future Without-Project Conditions

Equivalent annual flood damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the measures were evaluated and compared to future without-project scenarios three, and five, as previously discussed in section 5.3. These future scenarios were chosen because the redevelopment projected for this area is anticipated to return to the pre-Katrina development. Futures scenarios two, four, and six were not used for evaluation purposes since this area is not accommodative for commercial and condominium redevelopment under those mixed redevelopment scenarios (see section 5.3 for more detail).

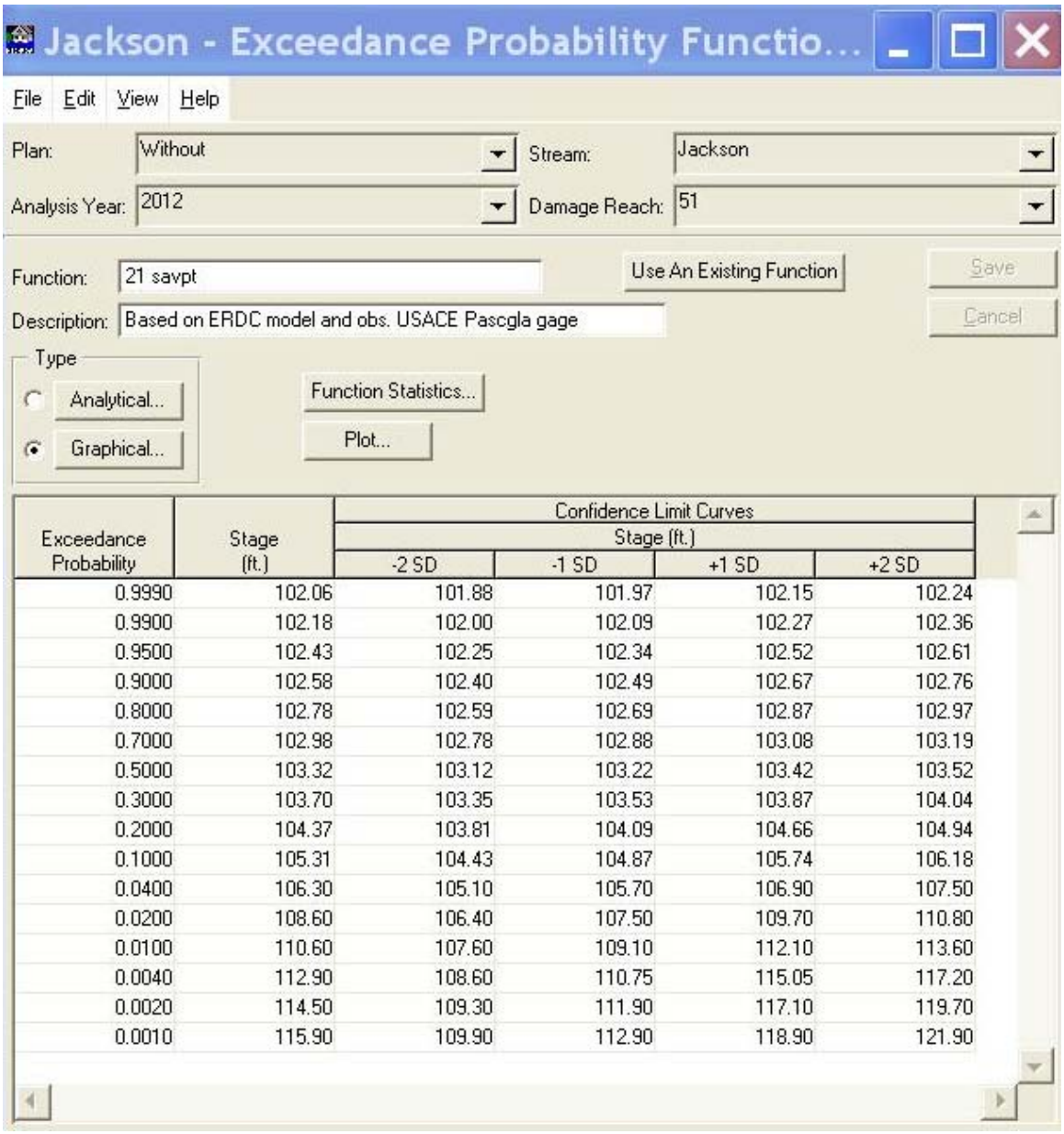
Future scenario one is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Table 6.12-2 shows structures by category and by elevation. The number of structures per elevation is added to the previous number of structures per elevation in each category. For example, in the residential category there are four structures with an elevation of 1-foot or lower, there are twelve structures with an elevation of 2-feet or less, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Pascagoula-Moss Point area.

Table 6.12-2.
Cumulative Structures by Category and by Estimated First Floor Elevation
Future Scenarios One, Three, and Five
Applicable for Base Year and Most Likely Future Years

Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	4	0	0	0	4
2-foot	12	0	0	0	12
3-foot	31	0	0	0	31
4-foot	62	0	0	0	62
5-foot	107	0	0	0	107
6-foot	158	0	2	1	161
7-foot	263	0	8	2	273
8-foot	435	0	16	5	456
9-foot	691	0	35	8	734
10-foot	1,002	1	50	11	1,064
11-foot	1,574	1	59	13	1,647
12-foot	2,850	2	148	32	3,032
13-foot	4,367	9	330	74	4,780
14-foot	5,344	13	597	104	6,058
15-foot	7,951	21	1,090	165	9,227
16-foot	8,367	22	1,231	174	9,794
17-foot	9,053	23	1,294	180	10,550
18-foot	10,153	23	1,384	202	11,762
19-foot	10,966	36	1,464	222	12,688
20-foot	11,346	51	1,499	231	13,127
21-foot	11529	52	1,531	237	13,349
22-foot	11,612	52	1,549	245	13,458
23-foot	11,650	52	1,557	248	13,507
24-foot	11,700	52	1,564	252	13,568
25-foot	11,749	52	1,565	256	13,622
26-foot	11,763	52	1,565	258	13,638
Total	**11,763**	**52**	**1,565**	**258**	**13,638**

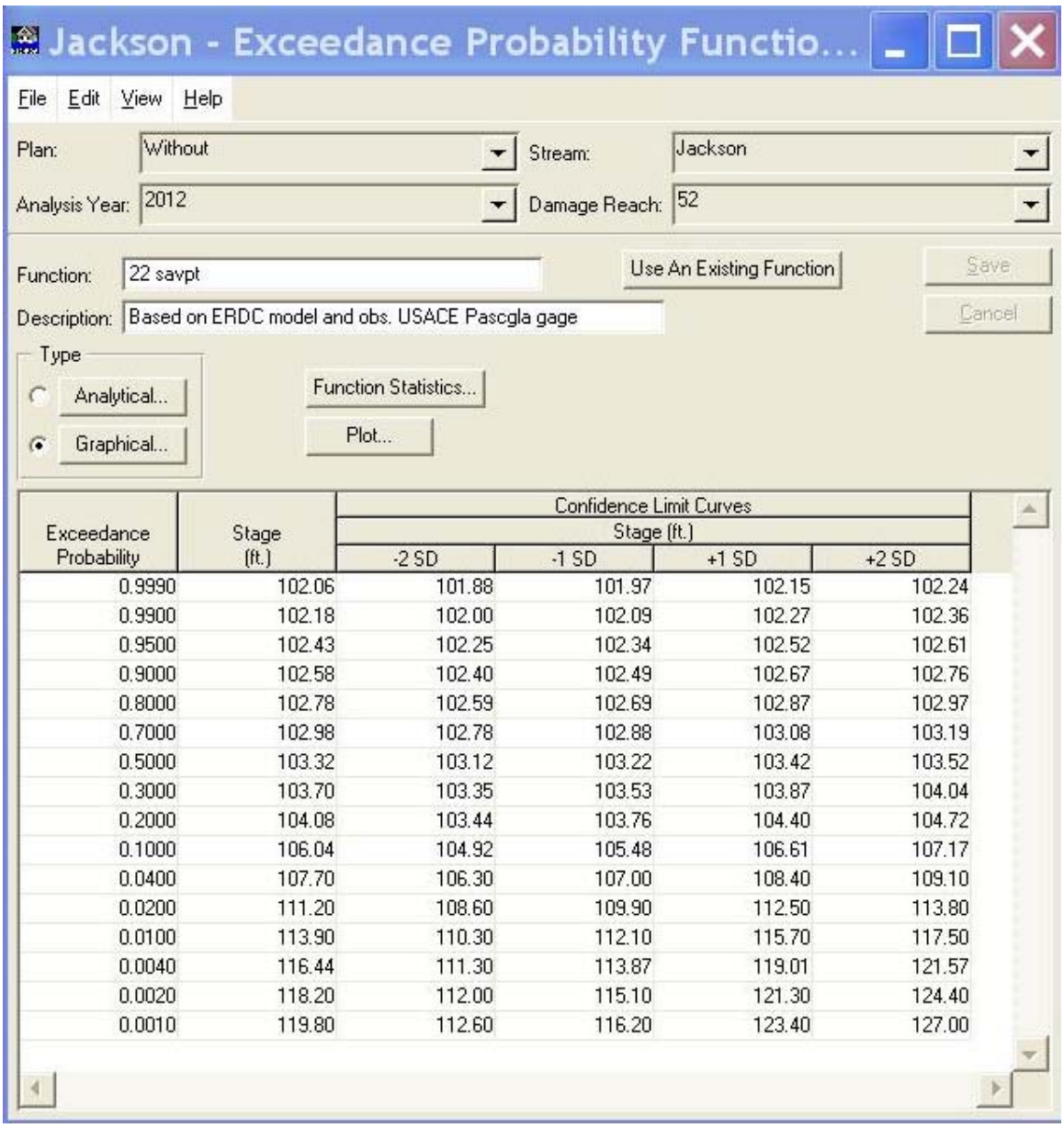
Future scenario three is the full redevelopment of assets within the study area by the year 2012. Under this scenario, assets will be rebuilt as they were pre-Hurricane Katrina. For example, if the asset was a residential structure pre-Hurricane Katrina it will be rebuilt as a residential structure; commercial structures will be built back to commercial structures; etc. Basically, future scenario three is the same structure inventory as future scenario one with the addition of an expected relative sea level rise over the 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $26,078,000 (rounded to the nearest thousand dollars). The total number of structures in this scenario are the same as in scenario one and can be seen above in table 6.12-2. Figures 6.12-3 and 6.12-4 depict the base years for planning sub-units 51 and 52 respectively, and figures 6.12-5 and 6.12-6 show the most likely future year exceedance probability functions for planning sub-units 51 and 52. The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most

likely future year exceedance probability function depicted in figure 6.12-5 ad 6.12-6 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



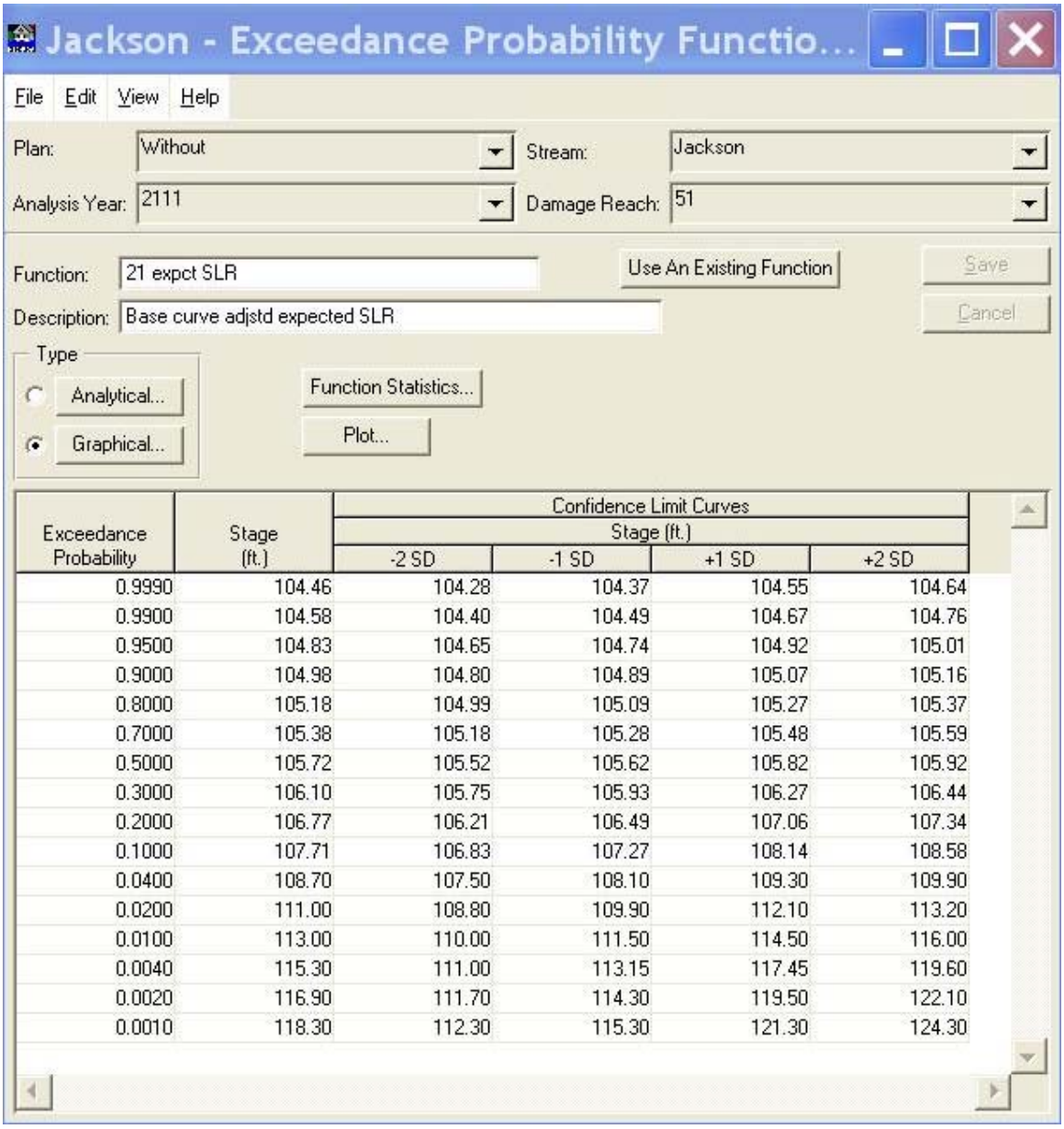
Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	102.06	101.88	101.97	102.15	102.24
0.9900	102.18	102.00	102.09	102.27	102.36
0.9500	102.43	102.25	102.34	102.52	102.61
0.9000	102.58	102.40	102.49	102.67	102.76
0.8000	102.78	102.59	102.69	102.87	102.97
0.7000	102.98	102.78	102.88	103.08	103.19
0.5000	103.32	103.12	103.22	103.42	103.52
0.3000	103.70	103.35	103.53	103.87	104.04
0.2000	104.37	103.81	104.09	104.66	104.94
0.1000	105.31	104.43	104.87	105.74	106.18
0.0400	106.30	105.10	105.70	106.90	107.50
0.0200	108.60	106.40	107.50	109.70	110.80
0.0100	110.60	107.60	109.10	112.10	113.60
0.0040	112.90	108.60	110.75	115.05	117.20
0.0020	114.50	109.30	111.90	117.10	119.70
0.0010	115.90	109.90	112.90	118.90	121.90

Figure 6.12-3. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Planning Sub-unit 51



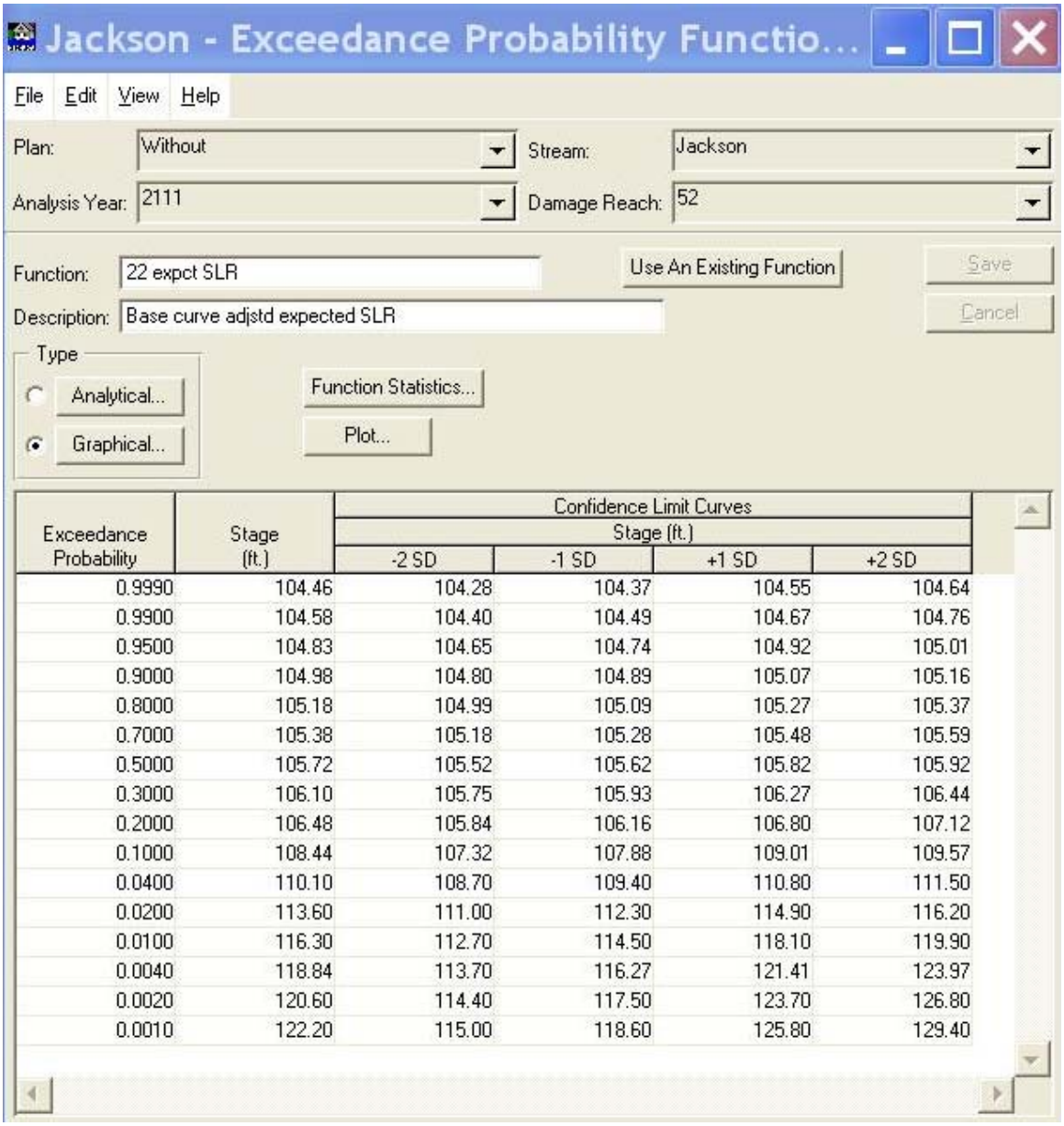
Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	102.06	101.88	101.97	102.15	102.24
0.9900	102.18	102.00	102.09	102.27	102.36
0.9500	102.43	102.25	102.34	102.52	102.61
0.9000	102.58	102.40	102.49	102.67	102.76
0.8000	102.78	102.59	102.69	102.87	102.97
0.7000	102.98	102.78	102.88	103.08	103.19
0.5000	103.32	103.12	103.22	103.42	103.52
0.3000	103.70	103.35	103.53	103.87	104.04
0.2000	104.08	103.44	103.76	104.40	104.72
0.1000	106.04	104.92	105.48	106.61	107.17
0.0400	107.70	106.30	107.00	108.40	109.10
0.0200	111.20	108.60	109.90	112.50	113.80
0.0100	113.90	110.30	112.10	115.70	117.50
0.0040	116.44	111.30	113.87	119.01	121.57
0.0020	118.20	112.00	115.10	121.30	124.40
0.0010	119.80	112.60	116.20	123.40	127.00

Figure 6.12-4. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Planning Sub-unit 52



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	104.46	104.28	104.37	104.55	104.64
0.9900	104.58	104.40	104.49	104.67	104.76
0.9500	104.83	104.65	104.74	104.92	105.01
0.9000	104.98	104.80	104.89	105.07	105.16
0.8000	105.18	104.99	105.09	105.27	105.37
0.7000	105.38	105.18	105.28	105.48	105.59
0.5000	105.72	105.52	105.62	105.82	105.92
0.3000	106.10	105.75	105.93	106.27	106.44
0.2000	106.77	106.21	106.49	107.06	107.34
0.1000	107.71	106.83	107.27	108.14	108.58
0.0400	108.70	107.50	108.10	109.30	109.90
0.0200	111.00	108.80	109.90	112.10	113.20
0.0100	113.00	110.00	111.50	114.50	116.00
0.0040	115.30	111.00	113.15	117.45	119.60
0.0020	116.90	111.70	114.30	119.50	122.10
0.0010	118.30	112.30	115.30	121.30	124.30

Figure 6.12-5. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Planning Sub-unit 51 – Includes an adjustment for relative sea level rise

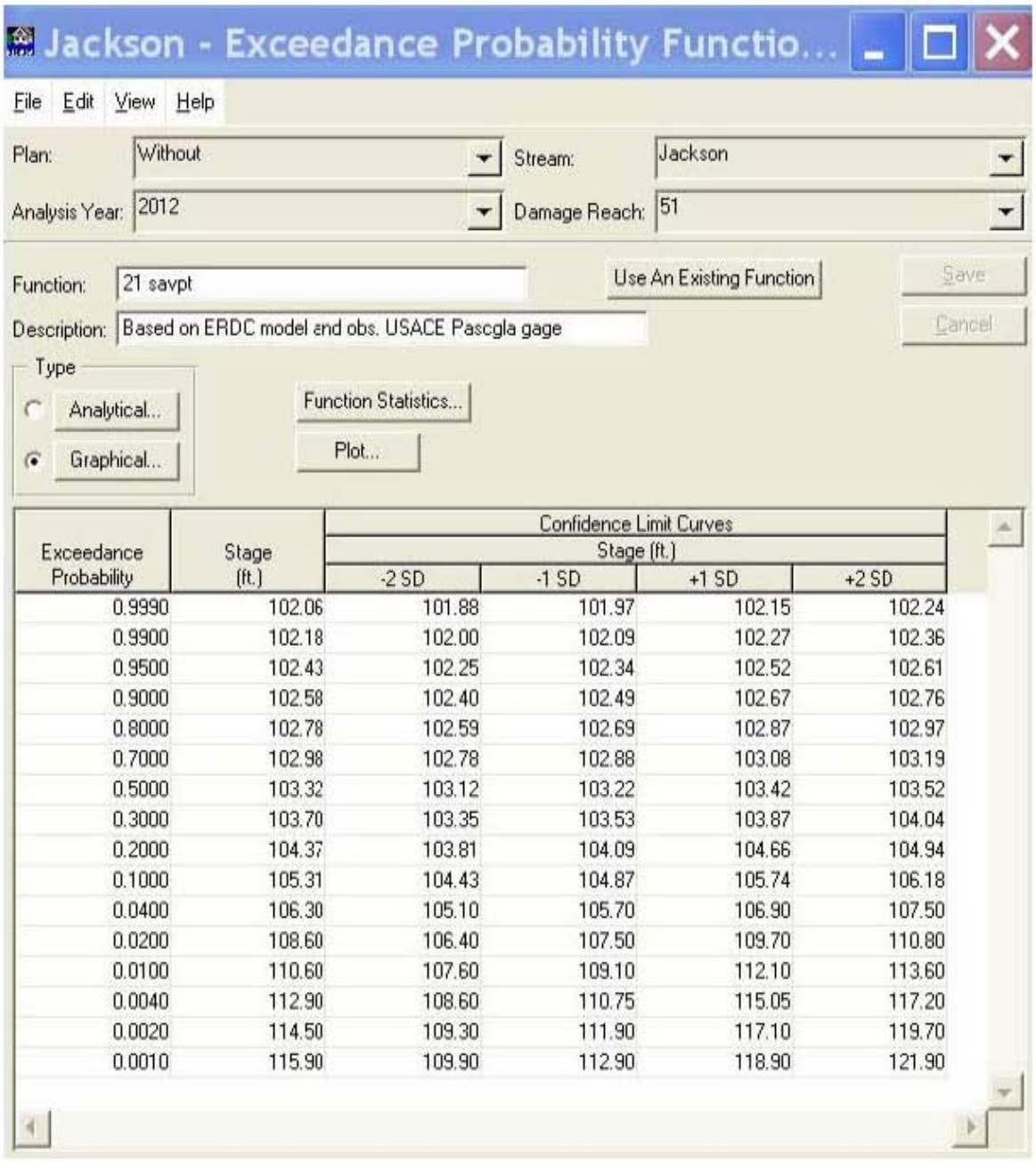


Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	104.46	104.28	104.37	104.55	104.64
0.9900	104.58	104.40	104.49	104.67	104.76
0.9500	104.83	104.65	104.74	104.92	105.01
0.9000	104.98	104.80	104.89	105.07	105.16
0.8000	105.18	104.99	105.09	105.27	105.37
0.7000	105.38	105.18	105.28	105.48	105.59
0.5000	105.72	105.52	105.62	105.82	105.92
0.3000	106.10	105.75	105.93	106.27	106.44
0.2000	106.48	105.84	106.16	106.80	107.12
0.1000	108.44	107.32	107.88	109.01	109.57
0.0400	110.10	108.70	109.40	110.80	111.50
0.0200	113.60	111.00	112.30	114.90	116.20
0.0100	116.30	112.70	114.50	118.10	119.90
0.0040	118.84	113.70	116.27	121.41	123.97
0.0020	120.60	114.40	117.50	123.70	126.80
0.0010	122.20	115.00	118.60	125.80	129.40

Figure 6.12-6. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Planning Sub-unit 52 – Includes an adjustment for relative sea level rise.

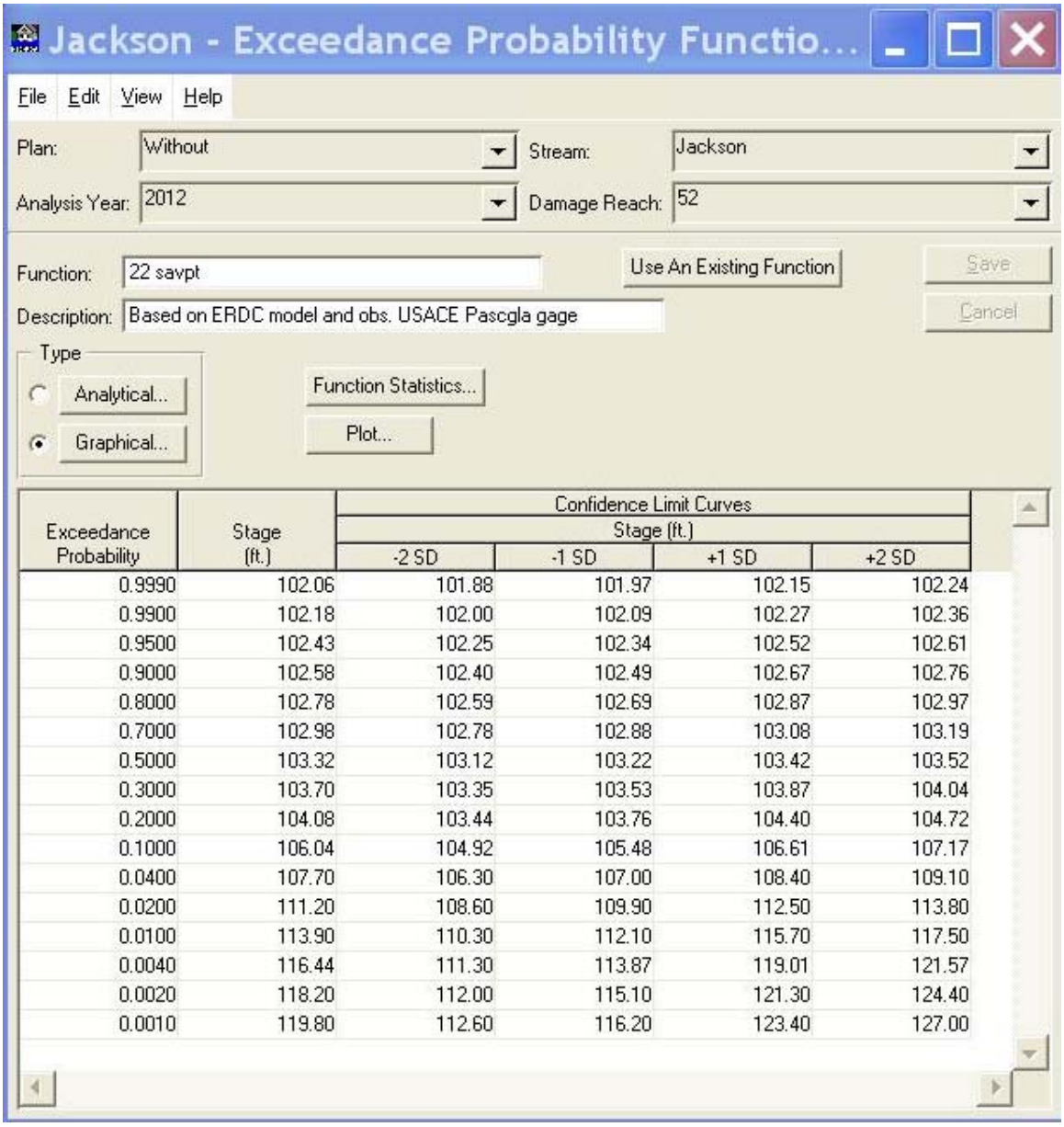
Future scenario five is the same as future scenario one with the addition of a high relative sea level rise 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $32,812,000 (rounded to the nearest thousand). These damages represent a approximately a twenty-six-percent (25.8%) increase over the expected relative sea level rise accounted for in future scenario three. The total number of structures in this scenario is the same as in scenarios one and three and can be seen above in table 6.12-2. Figures 6.12-7 and 6.12-8 depict the base year for planning sub-units 51 and 52 respectively, and figures 6.12-9 and 6.12-10 show the most likely future year exceedance probability functions for planning sub-units 51 and 52. The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability

function depicted in figures 6.12-9 and 6.12-10 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



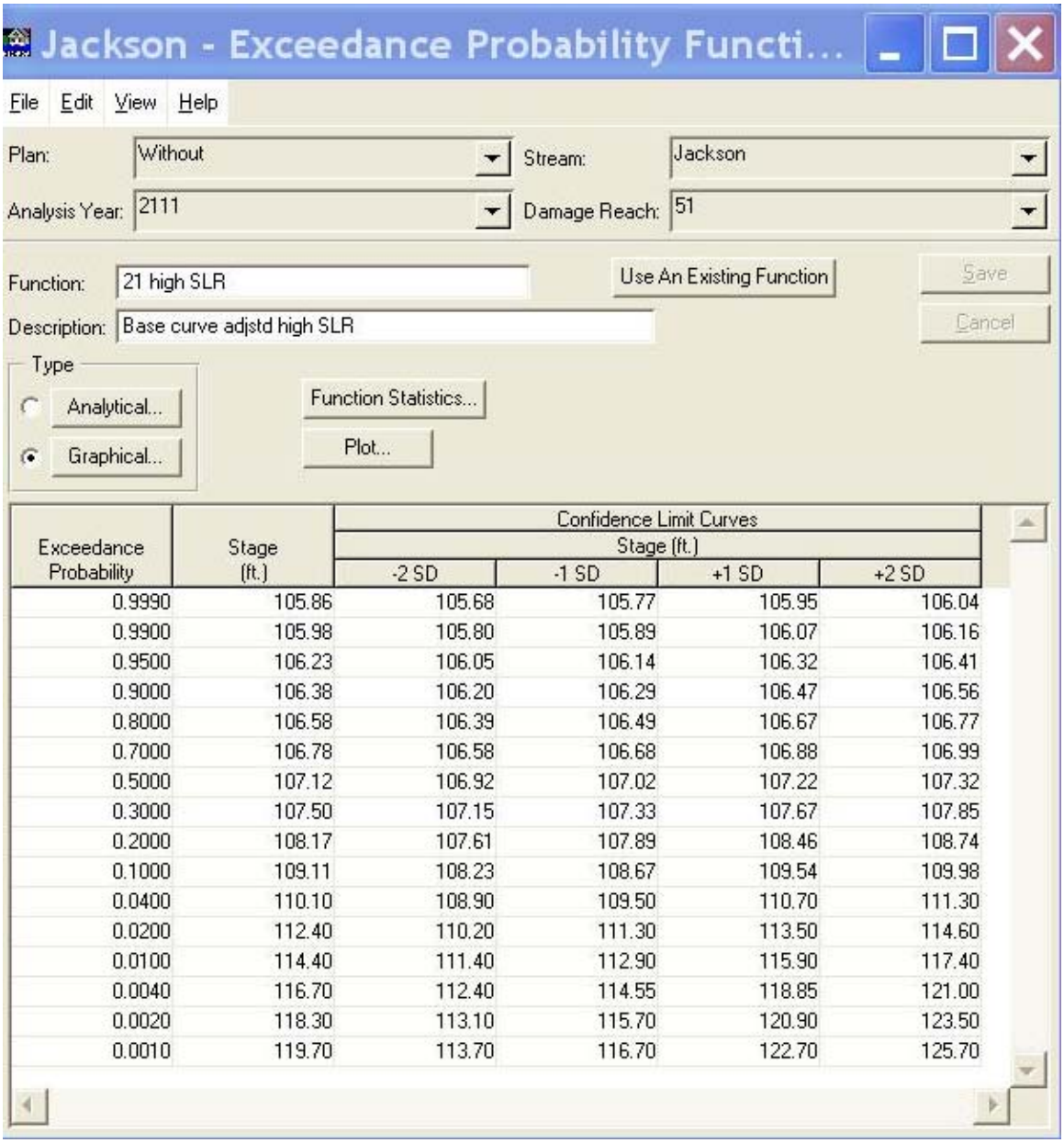
Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	102.06	101.88	101.97	102.15	102.24
0.9900	102.18	102.00	102.09	102.27	102.36
0.9500	102.43	102.25	102.34	102.52	102.61
0.9000	102.58	102.40	102.49	102.67	102.76
0.8000	102.78	102.59	102.69	102.87	102.97
0.7000	102.98	102.78	102.88	103.08	103.19
0.5000	103.32	103.12	103.22	103.42	103.52
0.3000	103.70	103.35	103.53	103.87	104.04
0.2000	104.37	103.81	104.09	104.66	104.94
0.1000	105.31	104.43	104.87	105.74	106.18
0.0400	106.30	105.10	105.70	106.90	107.50
0.0200	108.60	106.40	107.50	109.70	110.80
0.0100	110.60	107.60	109.10	112.10	113.60
0.0040	112.90	108.60	110.75	115.05	117.20
0.0020	114.50	109.30	111.90	117.10	119.70
0.0010	115.90	109.90	112.90	118.90	121.90

Figure 6.12-7. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Planning Sub-unit 51



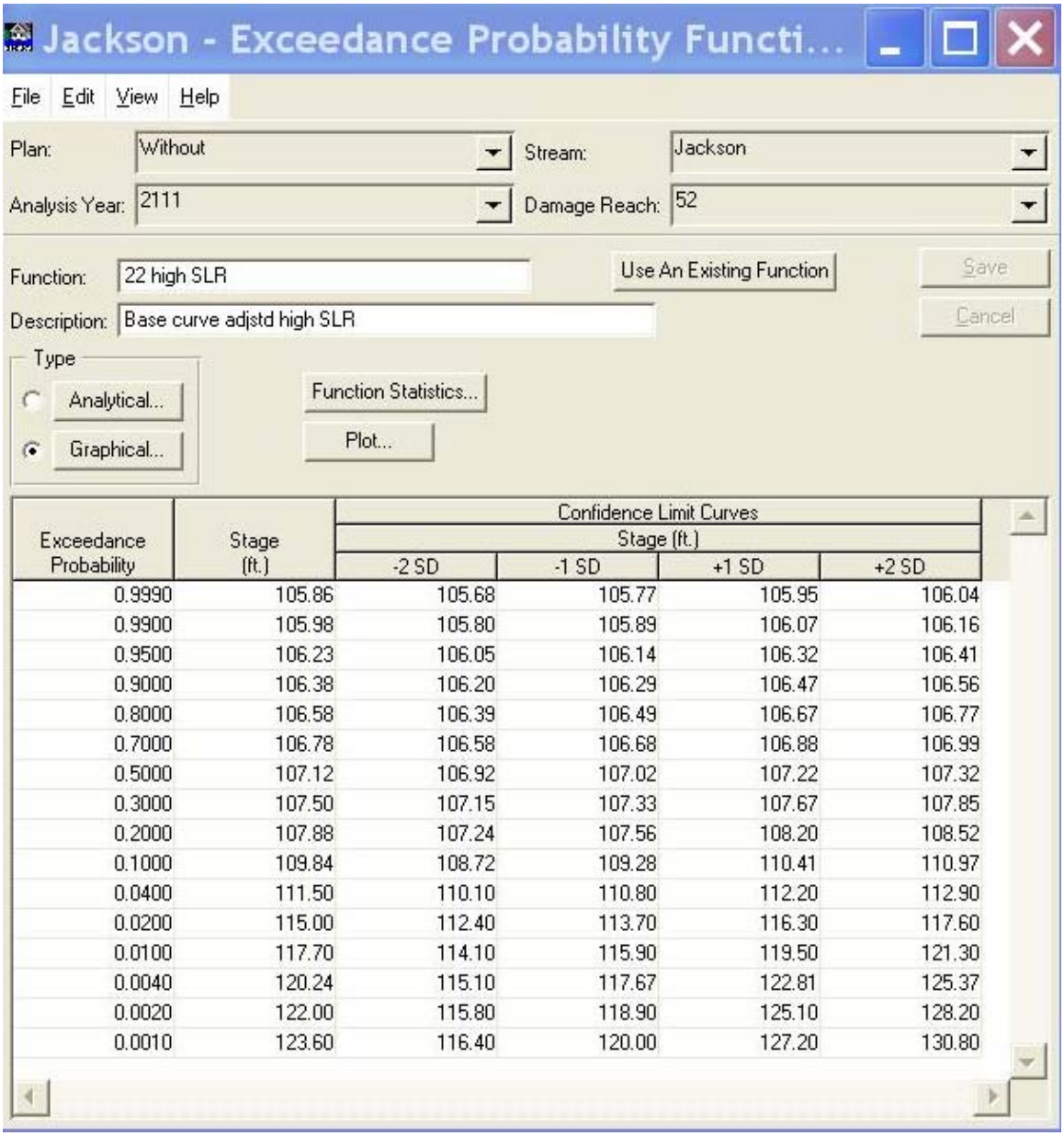
Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	102.06	101.88	101.97	102.15	102.24
0.9900	102.18	102.00	102.09	102.27	102.36
0.9500	102.43	102.25	102.34	102.52	102.61
0.9000	102.58	102.40	102.49	102.67	102.76
0.8000	102.78	102.59	102.69	102.87	102.97
0.7000	102.98	102.78	102.88	103.08	103.19
0.5000	103.32	103.12	103.22	103.42	103.52
0.3000	103.70	103.35	103.53	103.87	104.04
0.2000	104.08	103.44	103.76	104.40	104.72
0.1000	106.04	104.92	105.48	106.61	107.17
0.0400	107.70	106.30	107.00	108.40	109.10
0.0200	111.20	108.60	109.90	112.50	113.80
0.0100	113.90	110.30	112.10	115.70	117.50
0.0040	116.44	111.30	113.87	119.01	121.57
0.0020	118.20	112.00	115.10	121.30	124.40
0.0010	119.80	112.60	116.20	123.40	127.00

Figure 6.12-8. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Planning Sub-unit 52



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	105.86	105.68	105.77	105.95	106.04
0.9900	105.98	105.80	105.89	106.07	106.16
0.9500	106.23	106.05	106.14	106.32	106.41
0.9000	106.38	106.20	106.29	106.47	106.56
0.8000	106.58	106.39	106.49	106.67	106.77
0.7000	106.78	106.58	106.68	106.88	106.99
0.5000	107.12	106.92	107.02	107.22	107.32
0.3000	107.50	107.15	107.33	107.67	107.85
0.2000	108.17	107.61	107.89	108.46	108.74
0.1000	109.11	108.23	108.67	109.54	109.98
0.0400	110.10	108.90	109.50	110.70	111.30
0.0200	112.40	110.20	111.30	113.50	114.60
0.0100	114.40	111.40	112.90	115.90	117.40
0.0040	116.70	112.40	114.55	118.85	121.00
0.0020	118.30	113.10	115.70	120.90	123.50
0.0010	119.70	113.70	116.70	122.70	125.70

Figure 6.12-9. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Planning Sub-unit 51 – Includes an adjustment for high relative sea level rise



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	105.86	105.68	105.77	105.95	106.04
0.9900	105.98	105.80	105.89	106.07	106.16
0.9500	106.23	106.05	106.14	106.32	106.41
0.9000	106.38	106.20	106.29	106.47	106.56
0.8000	106.58	106.39	106.49	106.67	106.77
0.7000	106.78	106.58	106.68	106.88	106.99
0.5000	107.12	106.92	107.02	107.22	107.32
0.3000	107.50	107.15	107.33	107.67	107.85
0.2000	107.88	107.24	107.56	108.20	108.52
0.1000	109.84	108.72	109.28	110.41	110.97
0.0400	111.50	110.10	110.80	112.20	112.90
0.0200	115.00	112.40	113.70	116.30	117.60
0.0100	117.70	114.10	115.90	119.50	121.30
0.0040	120.24	115.10	117.67	122.81	125.37
0.0020	122.00	115.80	118.90	125.10	128.20
0.0010	123.60	116.40	120.00	127.20	130.80

Figure 6.12-10. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Planning Sub-unit 52 – Includes an adjustment for high relative sea level rise

6.12.5.3 Equivalent annual damages Reduced

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios three and five and the damages incurred with the measure in place. The HECFDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without project inventory except that footprints of levees and acquisitions were deleted from the inventory and flood proofed structures (structures to be raised in place) were given a higher elevation. The structure inventories for each of the HEC-FDA measure runs are as follows:

- Measure A – Pascagoula - Moss Point Ring Levee A at elevation 20.0-feet NAVD88

This measure includes the without-project inventory less 589 parcels that were deleted out of the inventory. These parcels represent the footprint of the 20.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its implementation. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – Pascagoula - Moss Point Ring Levee B at elevation 30.0-feet NAVD88

This measure includes the without-project inventory less 666 parcels that were deleted out of the inventory. These parcels represent the footprint of the 30.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its implementation. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure C – Pascagoula - Moss Point Ring Levee at Elevation 20.0-feet NAVD88

This measure includes a combination of a ring levee at 20-feet NAVD88 on an alternate footprint from measure A that would include the acquisition of structures and parcels in the Moss Point area.

- Measure D – Pascagoula - Moss Point Ring Levee Elevation 30.0-feet NAVD88

This measure includes a combination of a ring levee at 30-feet NAVD88 on an alternate footprint from measure B that would include the acquisition of structures and parcels in the Moss Point area.

- Measure E – Pascagoula - Moss Point Ring Levee at Elevation 20.0-feet NAVD88

This measure includes a combination of a ring levee at 20-feet NAVD88 on an alternate footprint from measure A that would include the acquisition of structures and parcels in the Washington Avenue area.

- Measure F – Pascagoula - Moss Point Ring Levee Elevation 30.0-feet NAVD88

This measure includes a combination of a ring levee at 30-feet NAVD88 on an alternate footprint from measure B that would include the acquisition of structures and parcels in the Washington Avenue area.

- Measure G – Pascagoula - Moss Point Ring Levee at Elevation 20.0-feet NAVD88

This measure includes a combination of a ring levee at 20-feet NAVD88 on an alternate footprint from measure A that would include the acquisition of structures and parcels in the Moss Point and Washington Avenue areas.

- Measure H – Pascagoula - Moss Point Ring Levee Elevation 30.0-feet NAVD88

This measure includes a combination of a ring levee at 30-feet NAVD88 on an alternate footprint from measure B that would include the acquisition of structures and parcels in the Moss Point and Washington Avenue areas.

- Measure I – Pascagoula - Moss Point Nonstructural One

This measure includes the acquisition of 145 (0 in planning sub-unit 51 and 145 in planning sub-unit 52) parcels that include a structure and the flood proofing (raise structure in place) of 7,603 (781 in planning sub-unit 51 and 6,822 in planning sub-unit 52) structures to an elevation of 12.0-feet NAVD88 for planning sub-unit 51 and 14.95-feet for planning sub-unit 52. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was determined to be approximately the 100-year level of protection and is defined as still water elevation, plus wave run-up plus an estimate for waves (depth divided by two), and is the minimum elevation that a nonstructural plan could provide.

- Measure J – Pascagoula - Moss Point Nonstructural Two to elevation 20.0-feet NAVD88

This measure includes the acquisition of 2,333 (718 in planning sub-unit 51 and 1,615 in planning sub-unit 52) parcels that include a structure and the flood proofing (raise structure in place) of 5,427 (64 in planning sub-unit 51 and 5,363 in planning sub-unit 52) structures to an elevation of 20.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levees at elevation 20.0-feet NAVD88.

- Measure K – Pascagoula - Moss Point Nonstructural Three to elevation 30.0-feet NAVD88

This measure includes the acquisition of 7,760 (782 in planning sub-unit 51 and 6,978 in planning sub-unit 52) parcels that include a structure to an elevation of 30.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levees at elevation 30.0-feet NAVD88.

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damage is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table." Table 6.12-3 summarizes the equivalent annual without-project damages, damages reduced, and residual damages by measure and by future scenario.

Table 6.12-3.
Summary of Damages by Measure

Measures	Equivalent annual damages Future 3 ($)	Equivalent Annual Damage Reduction Future 3 ($)	Residual Damage Future 3 ($)	Equivalent annual damages Future 5 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Residual Damage Future 5 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A 20FT Ring Levee A	$26,078,000	$24,244,000	$1,834,000	$32,812,000	$30,616,000	$2,196,000
Measure B 30FT Ring Levee B	$26,078,000	$26,078,000	$0	$32,812,000	$32,733,000	$79,000
Measure C 20FT Ring Levee C	$26,078,000	$24,901,000	$1,177,000	$32,812,000	$29,504,000	$3,308,000
Measure D 30FT Ring Levee D	$26,078,000	$26,078,000	$0	$32,812,000	$31,212,000	$1,600,000
Measure E 20FT Ring Levee E	$26,078,000	$24,910,000	$1,168,000	$32,812,000	$29,518,000	$3,294,000
Measure F 30FT Ring Levee F	$26,078,000	$26,078,000	$0	$32,812,000	$31,211,000	$1,601,000
Measure G 20FT Ring Levee G	$26,078,000	$24,933,000	$1,145,000	$32,812,000	$29,545,000	$3,267,000
Measure H 30FT Ring Levee H	$26,078,000	$26,078,000	$0	$32,812,000	$31,212,000	$1,600,000
Measure I ABFE Nonstructural	$26,078,000	$17,199,000	$8,879,000	$32,812,000	$21,629,000	$11,183,000
Measure J 20FT Nonstructural	$26,078,000	$24,349,000	$1,729,000	$32,812,000	$28,815,000	$3,997,000
Measure K 30FT Nonstructural	$26,078,000	$25,454,000	$624,000	$32,812,000	$30,115,000	$2,697,000

Damages are rounded to the nearest thousand dollars.

6.12.6 Environmental Quality (EQ)

6.12.6.1 Impacts of Ring Levee Measures

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

1. A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.

2. A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.12-4 and 6.12-5 show the impacts of the Pascagoula/Moss Point ring levees at elevations 20.0-feet NAVD88, and 30.0-feet NAVD88 respectively.

Table 6.12-4.
Wetland Acres Impacted by Elevation 20' Pascagoula/Moss Point Ring Levee A

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
51	0.5	2.8	0.1	3.2	0.5	7.0
52	0.0	2.4	0.0	14.3	0.1	16.8
53	0.3	3.2	0.0	3.8	0.0	7.2
54	0.6	5.2	0.5	19.6	0.1	25.9
Total	**1.4**	**13.6**	**0.5**	**40.8**	**0.7**	**57.0**

Table 6.12-5.
Wetland Acres Impacted by Elevation 30' Pascagoula/Moss Point Ring Levee B

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
51	0.5	3.5	0.1	4.8	0.8	9.7
52	0.0	3.2	0.0	22.7	0.1	26.0
53	1.5	4.8	0.0	5.8	0.0	12.1
54	1.2	7.9	0.6	26.3	0.2	36.2
Total	**3.2**	**19.3**	**0.7**	**59.7**	**1.1**	**84.1**

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the Pascagoula-Moss Point area can be found in the Environmental Appendix.

6.12.7 Summary of Costs

Table 6.12-6 summarizes the ROM costs by measure for the Pascagoula-Moss Point area.

Table 6.12-6.
Summary of Costs by Measure for the Pascagoula-Moss Point Area

Measures	Implement Costs (FY-08) ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0
Measure A 20FT Ring Levee A	$699,000,000	$34,371,000	$5,719,000	N/A	$40,090,000
Measure B 30FT Ring Levee B	$916,000,000	$45,041,000	$8,309,000	N/A	$53,350,000
Measure C 20FT Ring Levee C	$671,600,000	$33,023,000	$4,658,000	N/A	$37,681,000
Measure D 30FT Ring Levee D	$849,900,000	$41,791,000	$6,707,000	N/A	$48,498,000
Measure E 20FT Ring Levee E	$874,400,000	$42,995,000	$3,761,000	N/A	$46,756,000
Measure F 30FT Ring Levee F	$1,013,200,000	$49,820,000	$5,423,000	N/A	$55,243,000
Measure G 20FT Ring Levee G	$921,400,000	$45,306,000	$3,537,000	N/A	$48,843,000
Measure H 30FT Ring Levee H	$1,057,700,000	$52,008,000	$5,197,000	N/A	$57,205,000
Measure I ABFE Nonstructural	$2,272,975,000	$111,765,000	$20,000	N/A	$111,785,000
Measure J 20FT Nonstructural	$5,105,777,000	$251,057,000	$20,000	N/A	$251,077,000
Measure K 30FT Nonstructural	$5,105,777,000	$251,057,000	$20,000	N/A	$251,077,000

The implementation costs include 1/ supervision and administration (30 account), 2/ planning, engineering & design (31 account) and 3/ appropriate contingencies. See the Cost Appendix for more detail on the implementation cost breakdowns. Numbers are rounded to the nearest thousand.

6.12.8 Regional Economic Development (RED)

The purpose of this analysis is to determine the economic impact of the proposed project measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Jackson County, Mississippi. The expenditures, shown in Table 6.12-6, for the measures are estimated to be $699,000,000 for the 20.0-feet ring levee A measure, $916,000,000 for the 30.0-feet ring levee B measure, $671,600,000 for the 20.0-feet NAVD88 ring levee C measure, $849,900,000 for the 30.0-feet NAVD88 ring levee D measure, $874,400,000 for the 20.0-feet NAVD88 ring levee E measure, $1,013,200,000 for the 30.0-feet NAVD88 ring levee F measure, $921,400,000 for the 20.0-feet NAVD88 ring levee G measure, $1,057,700,000 for the 30.0-feet NAVD88 ring levee H measure, $2,272,975,000 for the ABFE nonstructural measure, $5,105,777,000 for the 20.0-feet NAVD88 nonstructural measure, and $5,105,777,000 for the 30.0-feet NAVD88 nonstructural measure. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $116,308,000 for the 20.0-feet NAVD88 ring levee A measure, $168,981,000 for the 30.0-feet NAVD88 ring levee B measure, $94,730,000 for the 20.0-feet NAVD88 ring levee C measure, $136,401,000 for the 30.0-feet NAVD88 ring levee D measure, $76,488,000 for the 20.0-feet NAVD88 ring levee E measure, $110,288,000 for the 30.0-feet NAVD88 ring levee F measure, $71,932,000 for the 20.0-feet NAVD88 ring levee G measure, $105,692,000 for the 30.0-feet NAVD88 ring levee H measure $406,000 for the ABFE nonstructural measure, $406,000 for the 20.0-feet NAVD88 nonstructural measure, and $406,000 for the 30.0-feet NAVD88 nonstructural measure respectively (assuming a 100- year period of analysis and an interest rate of 4.875-percent). The following tables, 6.12-7 through 6.12-14, summarize the EIFS model inputs and outputs for the Pascagoula-Moss Point Area measures.

Table 6.12-7.
EIFS Model Implementation Cost Inputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	20-foot Ring Levee E	30-foot Ring Levee F
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$699,000,000	$916,000,000	$671,600,000	$849,900,000	$874,400,000	$1,013,200,000

Table 6.12-8.
EIFS Model Implementation Cost Inputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee G	30-foot Ring Levee H	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$921,400,000	$1,057,700,000	$2,272,975,000	$5,105,777,000	$5,105,777,000

Based of the given implementation cost inputs the outputs are as follows:

Table 6.12-9.
EIFS Model Implementation Cost Outputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	20-foot Ring Levee E	30-foot Ring Levee F
Direct Sales Volume	$699,000,000	$916,000,000	$671,600,000	$849,900,000	$874,400,000	$1,013,200,000
Induced Sales Volume	$782,880,000	$1,025,920,000	$752,192,000	$951,888,000	$979,328,000	$1,134,784,000
Total Sales Volume	$1,481,880,000	$1,941,920,000	$1,423,792,000	$1,801,788,000	$1,853,728,000	$2,147,984,000
Direct Income	$136,322,866	$178,643,413	$130,979,166	$165,752,223	$170,530,350	$197,599,897
Induced Income	$152,681,591	$200,080,598	$146,696,648	$185,642,467	$190,993,968	$221,311,858
Total Income	$289,004,458	$378,724,011	$277,675,814	$351,394,691	$361,524,318	$418,911,755
Direct Employment	3,956	5,185	3,801	4,810	4,949	5,735
Induced Employment	4,432	5,807	4,258	5,388	5,544	6,424
Total Employment	8,388	10,992	8,059	10,199	10,493	12,158
Local Population	0	0	0	0	0	0

Table 6.12-10.
EIFS Model Implementation Cost Outputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee G	30-foot Ring Levee H	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$921,400,000	$1,057,700,000	$2,272,975,000	$5,105,777,000	$5,105,777,000
Induced Sales Volume	$1,031,968,000	$1,184,624,000	$2,545,732,000	$5,718,470,240	$5,718,470,240
Total Sales Volume	$1,953,368,000	$2,242,324,000	$4,818,707,000	$10,824,247,240	$10,824,247,240
Direct Income	$179,696,551	$206,278,535	$443,288,222	$995,757,019	$995,757,019
Induced Income	$201,260,112	$231,031,930	$496,482,747	$1,115,247,722	$1,115,247,722
Total Income	$380,956,663	$437,310,465	$939,770,969	$2,111,004,741	$2,111,004,741
Direct Employment	5,215	5,987	12,865	28,899	28,899
Induced Employment	5,842	6,706	14,411	32,371	32,371
Total Employment	11,057	12,692	27,276	61,269	61,269
Local Population	0	0	0	0	0

Table 6.12-11.
EIFS Model Operation and Maintenance Cost Inputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	20-foot Ring Levee E	30-foot Ring Levee F
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$116,308,000	$168,981,000	$94,730,000	$136,401,000	$76,488,000	$110,288,000

Table 6.12-12.
EIFS Model Operation and Maintenance Cost Inputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee G	30-foot Ring Levee H	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$71,932,000	$105,692,000	$407,000	$407,000	$407,000

Based of the given implementation cost inputs the outputs are as follows:

Table 6.12-13.
EIFS Model Operation and Maintenance Cost Outputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	20-foot Ring Levee E	30-foot Ring Levee F
Direct Sales Volume	$116,308,000	$168,981,000	$94,730,000	$136,401,000	$76,488,000	$110,288,000
Induced Sales Volume	$130,264,960	$189,258,720	$106,097,600	$152,769,120	$85,666,560	$123,522,560
Total Sales Volume	$246,572,960	$358,239,720	$200,827,600	$289,170,120	$162,154,560	$233,810,560
Direct Income	$22,683,033	$32,955,614	$18,474,771	$26,601,681	$14,917,115	$21,508,979
Induced Income	$25,404,994	$36,910,283	$20,691,741	$29,793,879	$16,707,167	$24,090,053
Total Income	$48,088,026	$69,865,897	$39,166,513	$56,395,561	$31,624,282	$45,599,032
Direct Employment	658	956	536	772	433	624
Induced Employment	737	1,071	601	865	485	699
Total Employment	1,396	2,028	1,137	1,637	918	1,323
Local Population	0	0	0	0	0	0

Table 6.12-14.
EIFS Model Operation and Maintenance Cost Outputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee G	30-foot Ring Levee H	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$71,932,000	$105,692,000	$407,000	$407,000	$407,000
Induced Sales Volume	$80,563,840	$118,375,040	$455,840	$455,840	$455,840
Total Sales Volume	$152,495,840	$224,067,040	$862,840	$862,840	$862,840
Direct Income	$14,028,579	$20,612,641	$79,375	$79,375	$79,375
Induced Income	$15,712,006	$23,086,156	$88,900	$88,900	$88,900
Total Income	$29,740,585	$43,698,797	$168,276	$168,276	$168,276
Direct Employment	407	598	2	2	2
Induced Employment	456	670	3	3	3
Total Employment	863	1,268	5	5	5
Local Population	0	0	0	0	0

6.13 Evaluation of Bayou Cumbest Area Ecosystem Restoration Measures

This Section describes the evaluation of measures for the Bayou Cumbest area. Bayou Cumbest is approximately 373 acres in planning unit three, planning sub-unit fifty-three just west of the Mississippi and Alabama state line. This area experienced water elevations between 16.0 and 18.0 ft. NAVD88 from Hurricane Katrina storm surge. Figure 6.13-1 shows the location of the Bayou Cumbest area.

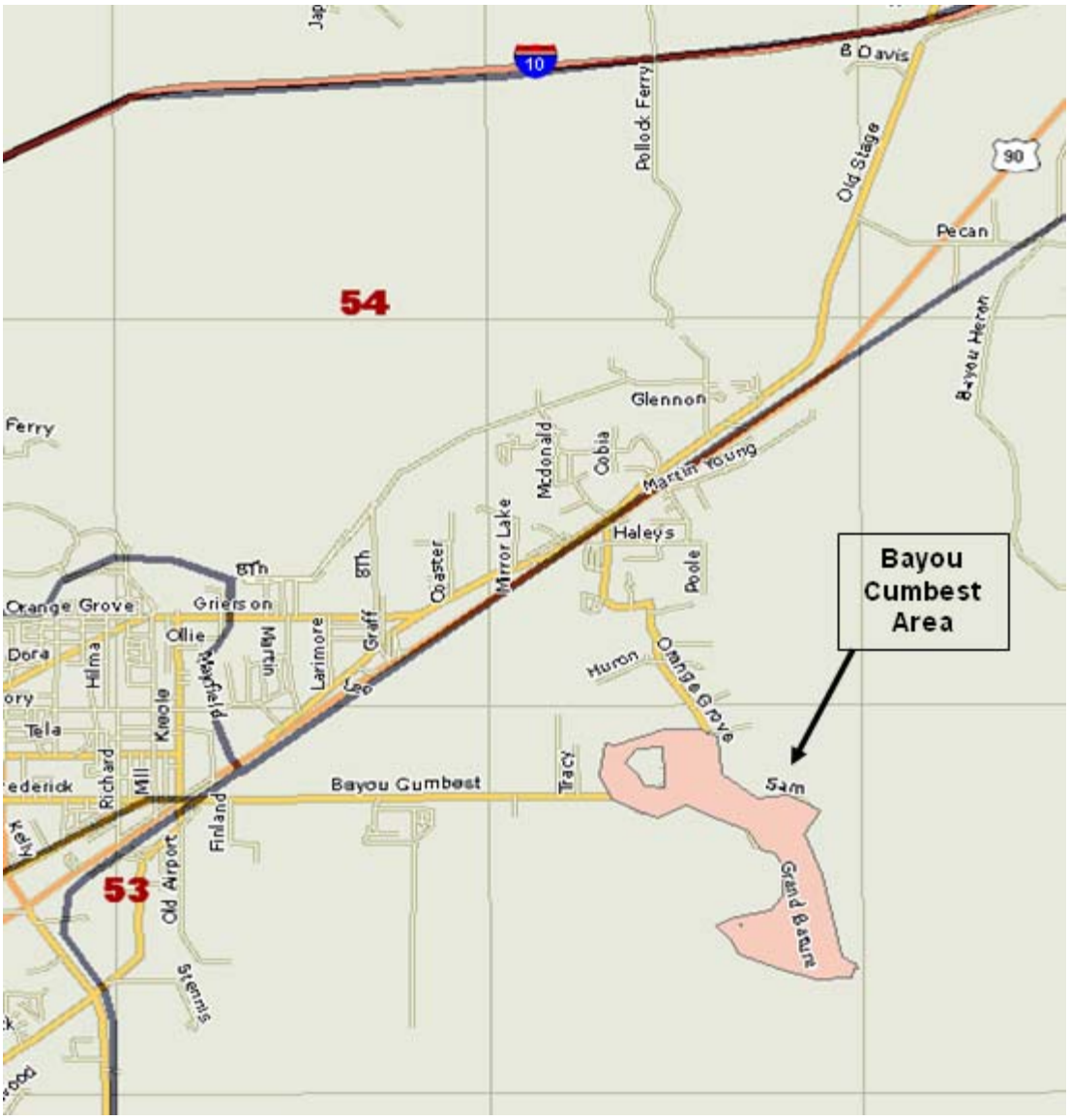


Figure 6.13-1 Bayou Cumbest Area, Planning Unit Three, Planning Sub-Unit fifty-three

This area was specifically identified for its ecosystem restoration potential using a Spatial Decision Support System (SDSS) tool, which was developed for the MsCIP Comprehensive Plan by the Engineer Research and Development Center (ERDC). The development of the GIS based SDSS tool allowed the Corps, Mobile District, working in cooperation with the USFWS and MDMR, to identify and prioritize potential wetland restoration areas throughout Coastal Mississippi. A subset of

potential restoration sites were identified by the SDSS tool and then ground-truthed by the MsCIP environmental team, including ERDC, Corps, MDMR, and USFWS. This interagency team allowed us to both confirm the accuracy of the SDSS results and to collect additional on-site information pertinent to restoration efforts.

There are some major benefits in using a GIS-based SDSS approach to wetland restoration. First, it allows for the relatively rapid assessment of the large number of restoration sites across the wide study area. Second, potential sites can be evaluated and restored in a watershed or landscape context, which allows us to comprehensively evaluate the overall natural system. This approach can maximize the benefits of wetland restoration, as opposed to simply restoring wetlands where convenient or where property is available. Essentially use of this SDSS tool allowed the MsCIP environmental team to assess the entire coastline as a holistic natural system; thus, the team was more effectively able to analyze needs in Coastal Mississippi.

The SDSS tool evaluated potential wetland restoration sites that had been initially selected based on having a non-natural land cover (i.e. urban, deforested, and agricultural land cover, based on MDMR 2001 land cover GIS layer) and were located in the 100-year floodplain. Numerous potential environmental restorations sites were initially identified. This initial group of sites was narrowed down based on the results of the SDSS. Sites with the following characteristics were screened out:

- < 5 acres in size
- Restorability class of Low or Medium Low
- Habitat class of Low or Medium Low
- Storm Surge/Flood Protection class of Low

6.13.1 Environmental Quality (EQ)

6.13.1.1 Ecosystem Restoration Assumptions

- In order for the Bayou Cumbest site to undergo ecosystem restoration, it is assumed that there will be buy-outs of properties within the area.
- A 50-year period of analysis was used to determine average annual outputs and costs.
- Construction implementation time is estimated to be twelve months.

6.13.1.2 Ecosystem Restoration Objectives

The following ecosystem restoration objectives were developed:

- Restore marsh to historical (pre-development ~1950's) conditions
- Provide storm surge protection
- Restore native tidal wetland plant community
- Provide fish and tidal wildlife habitat

6.13.1.3 Ecosystem Restoration Management Measures

Proposed restoration management measures are listed in table 6.13-1. Narrative descriptions of each management measure follow this table.

Table 6.13-1.
Ecosystem Restoration Management Measures

Management Measure	Description
No Action	No Action
1	Excavate Old Fill Material
2	Remove Exotic Species
3	Fill Existing Artificial Ditches
4 *a* *b* *c*	Plant Native Vegetation - 0.5 meter spacing - 1.0 meter spacing - 2.0 meter spacing

6.13.1.4 Excavate Old Fill Material (1)

This management measure must be included in all measures for the restoration to be successful. It includes 90-95 percent removal of existing exotic species in the excavated areas. This measure positively affects the hydrologic regime.

6.13.1.5 Remove Exotic Species from Non-Excavated Areas and Maintenance of Exotics in All Areas over the Project Life (2)

This management measure must be included in all measures for the restoration to be successful. It includes 100 percent removal of exotic species from non-excavated areas over the life of the project. The exotic species include Chinese Tallow, Phragmites, and Cogon Grass. This measure affects the percentage of the area covered by exotic species.

6.13.1.6 Fill Existing Artificial Ditches and Channels (3)

This management measure does not need to be included in all measures for the restoration to be successful. It includes 100 percent removal of existing artificial ditches and channels. This measure provides additional positive affects to the hydrologic regime.

6.13.1.7 Plant Native Vegetation (4)

This management measure must be included in all measures for the restoration to be successful. There are three different planting density options: (a) 0.5 meters spacing, (b) 1.0 meter spacing, and (c) 2.0 meter spacing. Planting emergent tidal marsh at varying densities will result in obtaining desired environmental output at varying years and costs. It is estimated that 2 re-planting efforts would be required for the two least dense plantings: 1.0 and 2.0 meter spacing. It is estimated that the 0.5 meter spacing will achieve full benefits in about 5 years while the 1.0 meter spacing and 2.0 meter spacing will achieve full benefits in about 7 and 10 years, respectively.

This measure affects the percent cover by woody plant species, wildlife habitat diversity, vegetation height, wetland indicator status and the mean percent cover emergent plant species.

6.13.1.8 Ecosystem Restoration Measures

These management measures were combined to create six measures. Each measure includes the mandatory management measures of excavating old fill material, removing exotic plant species from non-excavated areas, and planting native vegetation. Since there are three different planting densities, three measures are created with this combination of management measures. When the

management measure of filling existing artificial ditches is added to this combination, this creates another three measures.

All measures will restore 110 acres to tidal marsh. Measure 1 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, filling existing artificial ditches, and planting native vegetation such as Spartina alterniflora (Smooth Cordgrass) at the seaward edge of marsh; Juncus roemerianus (Black Needle Rush) at a slightly higher elevation; and Spartina patens (Saltmeadow Cordgrass) at a slightly higher elevation at a density of 0.5 meter. Measure 2 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, filling existing artificial ditches, and planting native vegetation at a density of 1.0 meter. Measure 3 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, filling existing artificial ditches, and planting native vegetation at a density of 2.0 meter. Measure 4 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, and planting native vegetation at a density of 0.5 meters. Measure 5 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas and planting native vegetation at a density of 1.0 meter. Measure 6 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas and planting native vegetation at a density of 2.0 meters. Figure 6.13-2 shows the location of the Bayou Cumbest restoration site. Table 6.13-2 displays a description of each ecosystem restoration measure.

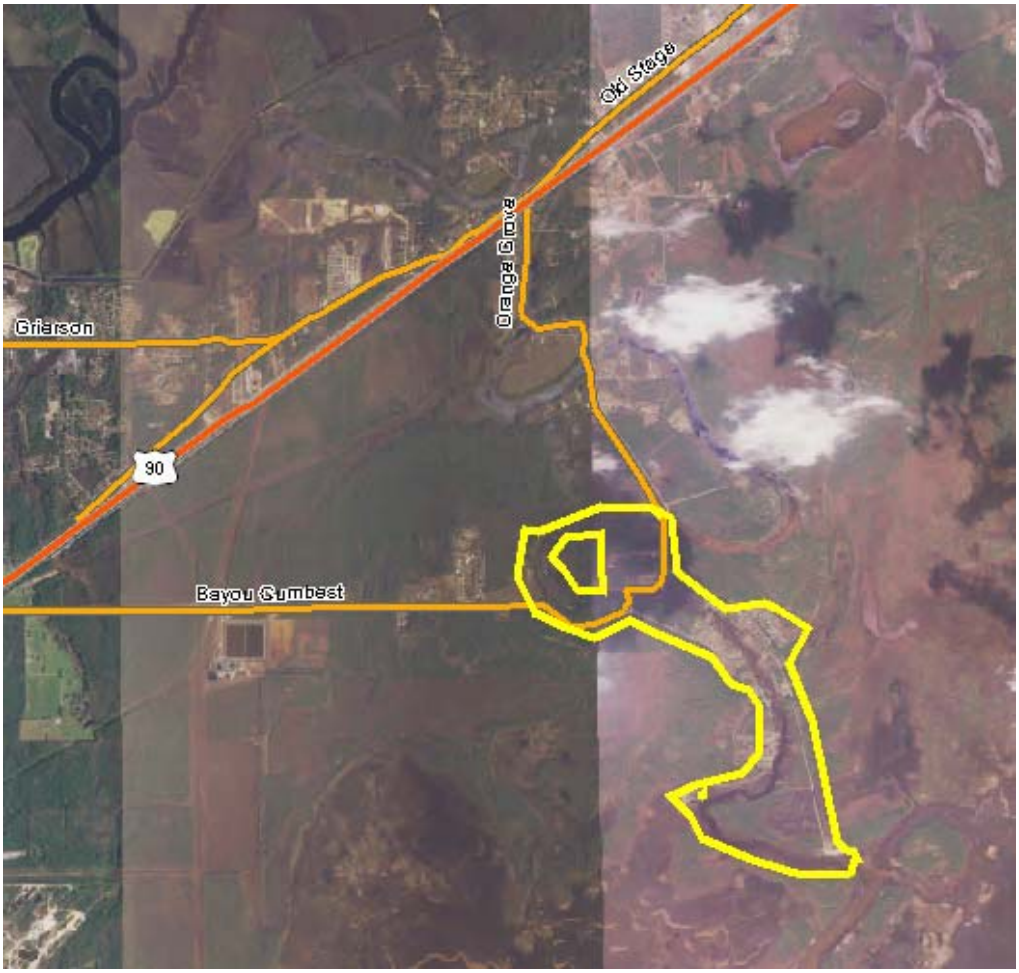


Figure 6.13-2 Bayou Cumbest restoration site

Table 6.13-2.
Ecosystem Restoration Measures

Measure	Management Measure	Description
0	No Action	No Action
1	1 + 2 + 3+ 4a	Excavate Fill Remove Exotics Fill Ditches Plant at Density 0.5m
2	1 + 2 + 3 + 4b	Excavate Fill Remove Exotics Fill Ditches Plant at Density 1.0m
3	1 + 2 + 3 + 4c	Excavate Fill Remove Exotics Fill Ditches Plant at Density 2.0m
4	1 + 2 + 4a	Excavate Fill Remove Exotics Plant at Density 0.5m
5	1 + 2 +4b	Excavate Fill Remove Exotics Plant at Density 1.0m
6	1 + 2 + 4c	Excavate Fill Remove Exotics Plant at Density 2.0m

6.13.3.9 Ecosystem Restoration Benefits and Costs

Benefits are measured in terms of Average Annual Functional Units (AAFU). The Hydrogeomorphic (HGM) approach was used to assess wetland function. A HGM assessment was performed in 2000 using the Regional Guidebook for Applying the HGM Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration measures. Table 6.13-3 shows the total functional units under each measure and the AAFU net benefit. It is assumed that functional units will remain the same under existing conditions and the no action measure. To calculate the AAFU net benefit, it is assumed all benefits are immediately accrued following measure implementation, and that the benefits are sustainable over the life of the project. Therefore, the AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration measure and the total functional units for the no action measure. Table 6.13-4 summarizes the ROM costs at an FY-08 price level Bayou Cumbest ecosystem restoration measures.

Table 6.13-3.
Summary of Benefits

Measure	Measure Description	AAFU Units Benefits
No Action	No Action	0
Measure 1	Excavate Fill Remove Exotics Fill Ditches Plant at Density 0.5m	191
Measure 2	Excavate Fill Remove Exotics Fill Ditches Plant at Density 1.0m	188
Measure 3	Excavate Fill Remove Exotics Fill Ditches Plant at Density 2.0m	184
Measure 4	Excavate Fill Remove Exotics Plant at Density 0.5m	172
Measure 5	Excavate Fill Remove Exotics Plant at Density 1.0m	169
Measure 6	Excavate Fill Remove Exotics Plant at Density 2.0m	164

Table 6.13-4.
Summary of Costs by Measure for Bayou Cumbest

Measure	Measure Description	Implementation Cost (FY-08)	IDC	Investment Cost	AAIC[1]	AAO&M[2]	AAC[3]
0	No Action	$0	$0	$0	$0	$0	$0
1	Excavate Fill Remove Exotics Fill Ditches Plant at Density 0.5m	$28,000,000	$620,000	$28,600,000	$1,538,000	$2,000	$1,540,000
2	Excavate Fill Remove Exotics Fill Ditches Plant at Density 1.0m	$23,350,000	$520,000	$23,870,000	$1,282,000	$114,000	$1,396,000
3	Excavate Fill Remove Exotics Fill Ditches Plant at Density 2.0m	$21,030,000	$470,000	$21,500,000	$1,155,000	$112,000	$1,267,000
4	Excavate Fill Remove Exotics Plant at Density 0.5m	$27,990,000	$620,000	$28,610,000	$1,537,000	$2,000	$1,539,000
5	Excavate Fill Remove Exotics Plant at Density 1.0m	$23,340,000	$520,000	$23,860,000	$1,282,000	$114,000	$1,396,000
6	Excavate Fill Remove Exotics Plant at Density 2.0m	$21,020,000	$470,000	$21,480,000	$1,154,000	$112,000	$1,266,000

Note: Numbers are rounded to the nearest thousand.
1.Average Annual Investment Cost
2.Average Annual Operations and Maintenance Cost
3.Average Annual Cost (total)

6.13.3.10 Comparison of Measures

Table 6.13-5 display all measures with their respective AAC and AAFU in increasing order of AAFU.

Table 6.13-5.
All Measures: Average Annual Costs and Average Annual Functional Units

Measure	AAC	AAFU
No Action	$0	0
6	$1,266,000	164
5	$1,396,000	169
4	$1,539,000	172
3	$1,267,000	184
2	$1,396,000	188
1	$1,540,000	191

Note: The AAC values are rounded to the nearest thousand.

To determine if a measure is cost effective, economically inefficient measures must first be identified and eliminated. An economically inefficient measure is a measure that cost more for the same level of benefit. No measures are eliminated for the reason of economic inefficiency because each measure produces a different level of benefit.

Lastly, economically ineffective measures are identified and eliminated to determine which measures are cost effective. An economically ineffective measure is a measure that cost more or the same as a subsequent measure but produces less benefit than that subsequent measure. As shaded in table 6.13-6, the measures 4 and 5 were eliminated because they produced less benefit at greater cost than a subsequent measure. For example, Measure 4 produces 172 AAFU at an AAC of $1,539,000 while Measure 3 produces 184 AAFU at an AAC $1,267,000. Measure 4 produces less AAFU at a greater cost than Measure 3. Therefore, Measure 4 is eliminated. As shown in table 6.13-7 and plotted in figure 6.13-3, the cost effective measures are Measure 1, Measure 2, Measure 3, and Measure 6.

Table 6.13-6.
Elimination of Economically Ineffective Measures

Measure	Measure Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
6	Excavate Fill Remove Exotics Plant at Density 2.0m	$1,266,000	164	Yes
				No
				No
3	Excavate Fill Remove Exotics Fill Ditches Plant at Density 2.0m	$1,267,000	184	Yes
2	Excavate Fill Remove Exotics Fill Ditches Plant at Density 1.0m	$1,396,000	188	Yes
1	Excavate Fill Remove Exotics Fill Ditches Plant at Density 0.5m	$1,540,000	191	Yes

Note: The AAC values are rounded to the nearest thousand.

Table 6.13-7.
Cost Effective Measures for Bayou Cumbest

Measure	Measure Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
6	Excavate Fill Remove Exotics Plant at Density 2.0m	$1,266,000	164	Yes
3	Excavate Fill Remove Exotics Fill Ditches Plant at Density 2.0m	$1,267,000	184	Yes
2	Excavate Fill Remove Exotics Fill Ditches Plant at Density 1.0m	$1,396,000	188	Yes
1	Excavate Fill Remove Exotics Fill Ditches Plant at Density 0.5m	$1,540,000	191	Yes

Note: The AAC values are rounded to the nearest thousand.

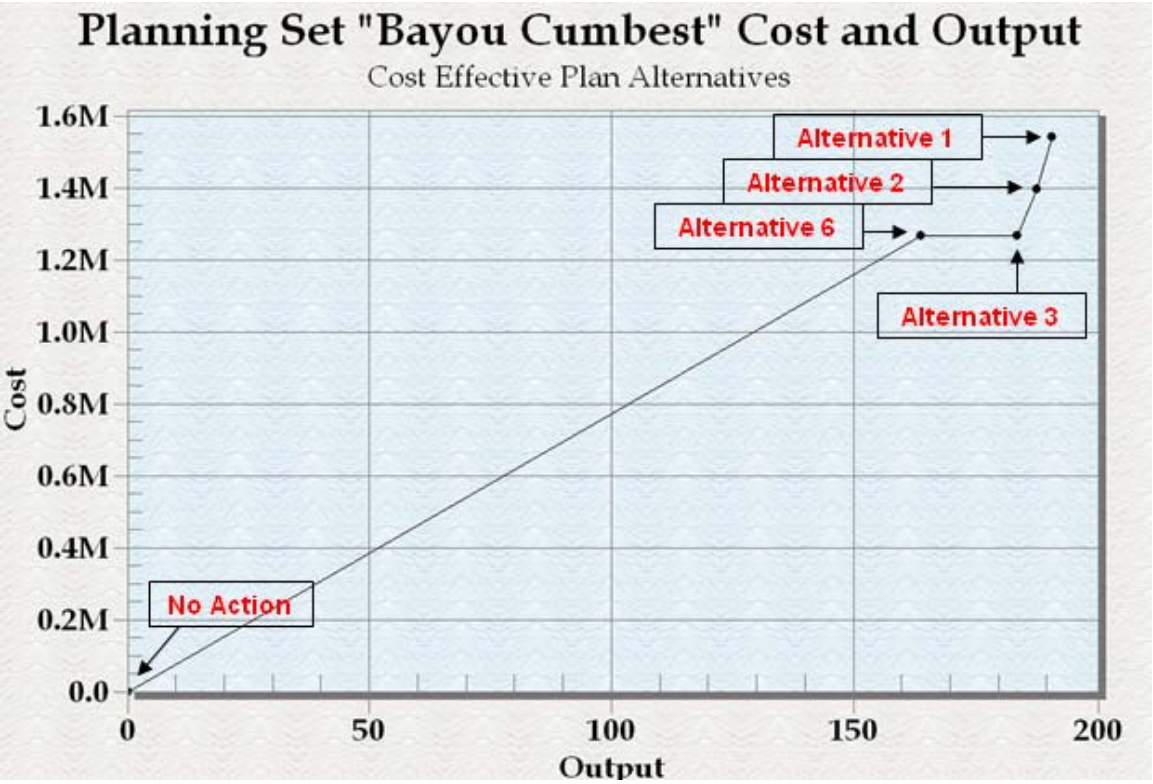


Figure 6.13-3 Cost Effective Measures for Bayou Cumbest Area

6.13.4 Regional Economic Development (RED)

The purpose of this section is to show the economic impact of the proposed project alternatives on business (sales volumes), income, employment, and population of the local area. Each of the alternatives would affect the local area of Jackson County, Mississippi. The expenditures for the alternatives are estimated to be $28,000,000 for Alternative 1, $23,400,000 for the Alternative 2, $21,000,000 for Alternative 3, and $21,000,000 for Alternative 6. Moreover, the present worth of the operation and maintenance (O&M) expenditures are estimated to be $43,000 for Alternative 1, $2,106,000 for Alternative 2, $2,071,000 for Alternative 3, and $2,071,000 for Alternative 6, (assuming a 50 year period of analysis and an interest rate of 4.875 percent). The following tables, 6.13-8 through 6.13-11 summarize the EIFS model inputs and outputs for the cost effective measures.

Table 6.13-8.
EIFS Model Implementation Cost Inputs for Bayou Cumbest Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$0	$28,000,000	$23,400,000	$21,000,000	$21,000,000

Based of the given inputs the outputs are as follows:

Table 6.13-9.
EIFS Model Implementation Cost Outputs for Bayou Cumbest Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Direct Sales Volume	$0	$28,000,000	$23,400,000	$21,000,000	$21,000,000
Induced Sales Volume	$0	$31,360,000	$26,208,000	$23,520,000	$23,520,000
Total Sales Volume	$0	$59,360,000	$49,608,000	$44,520,000	$44,520,000
Direct Income	$0	$5,460,716	$4,563,598	$4,095,537	$4,095,537
Induced Income	$0	$6,116,001	$5,111,229	$4,587,001	$4,587,001
Total Income	$0	$11,576,716	$9,674,827	$8,682,537	$8,682,537
Direct Employment	0	158	132	119	119
Induced Employment	0	178	148	133	133
Total Employment	0	336	281	252	252
Local Population	0	0	0	0	0

Table 6.13-10.
EIFS Model O&M Cost Inputs for Bayou Cumbest Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$0	$43,000	$2,106,000	$2,071,000	$2,071,000

Based of the given inputs the outputs are as followed:

Table 6.13-11.
EIFS Model O&M Cost Outputs for Bayou Cumbest Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Direct Sales Volume	$0	$43,000	$2,106,000	$2,071,000	$2,071,000
Induced Sales Volume	$0	$48,160	$2,358,720	$2,319,520	$2,319,520
Total Sales Volume	$0	$91,160	$4,464,720	$4,390,520	$4,390,520
Direct Income	$0	$8,386	$410,724	$403,898	$403,898
Induced Income	$0	$9,392	$460,011	$452,366	$452,366
Total Income	$0	$17,779	$870,734	$856,264	$856,264
Direct Employment	0	0	12	12	12
Induced Employment	0	0	13	13	13
Total Employment	0	0	25	25	25
Local Population	0	0	0	0	0

6.14 Dantzler Area Ecosystem Restoration Measures

This section describes the evaluation of ecosystem restoration measures at the Dantzler area that is located within planning sub-unit 53, which is part of planning unit three. The total area includes 385 acres of state owned land. This area was selected for ecosystem restoration using the Decision Support System, a GIS based model created by the Corps' Engineer Research and Development Center (ERDC). For more details on the selection process for ecosystem restoration sites see the Economic Appendix. Figure 6.14-1 shows the location of the Dantzler area.

6.14.1 Formulation of Measures

6.14.1.1 Assumptions

In order for the Dantzler site to undergo ecosystem restoration, it is assumed that all property and rights of way are owned by the State of Mississippi. Costs and benefits are based on a 50-year period of analysis and an FY-08 discount rate of 4.875-percent.

6.14.1.2 Objectives

The following objectives were developed for ecosystem restoration:

- Restore native wetland plant communities
- Restore natural fire regime
- Restore natural hydrology
- Restore fish and wildlife habitat
- Provide storm surge protection



Figure 6.14-1. Location of the Dantzler Ecosystem Restoration Area

6.14.1.3 Ecosystem Restoration Management Measures

Proposed restoration management measures are listed in table 6.14-1. Narrative descriptions of each management measure follow this table.

Table 6.14-1.
Ecosystem Restoration Management Measures

Management Measure	Description
No Action	No Action
1 *a* *b*	Maintain Native Savannah Vegetation *By Burning Every 3Years* *By Mowing Annually*
2	Remove Exotics and Plantation Pine
3	Fill Artificial Ditches

6.14.1.3.1 Maintain Native Savannah Vegetation (1)

This management measure must be included in all measures for the restoration to be successful. There are two methods that will be analyzed for maintaining vegetation: (a) burning and (b) mowing. Fire benefits this ecosystem in many different ways. It creates a bare seedbed for pine seedlings and other fire dependent plants, reduces fuel loads and recycles nutrients. Periodic burning promotes early successional plants that are important to many species of wildlife indigenous to this ecosystem. Many of the plant species found in this ecosystem are fire dependent; for example, the federally endangered American Chaff seed flowers almost exclusively after a fire. It has been reduced to a fraction of its original range due to fire suppression and habitat destruction. Fire suppression is mainly due to liability issues and fear of litigation.

Mowing is a mechanical alternative that many land managers use to maintain early successional habitats. Although it is successful to some extent, it fails to provide all the necessary components that come from prescribed fire. This method also has a negative effect. Mowing requires the use of heavy equipment in sensitive areas. Tractors can create ruts in saturated soils, creating hydrologic problems and micro site conditions. Mowing can also introduce non-native species through the use of contaminated equipment. Another disadvantage of mowing is that the duff or litter layer remains on the ground, preventing seeds from reaching the bare ground needed for germination. This thick litter layer can also provide heavy fuel loads increasing the risk of wildfires during dry periods. Although mowing provides some level of habitat management in pine savannahs, it is not a substitute for prescribed fire. Mowing can maintain succession, but may inhibit other functions of the system.

6.14.1.3.2 Removal of Exotics and Plantation Pines (2)

This management measure must be included in all measures for the restoration to be successful. This measure positively affects the percent cover by invasive or exotic species.

6.14.1.3.3 Fill Ditches (3)

This management measure must be included in all measures for the restoration to be successful. This measure positively affects the outflow of water. It measures the removal of water by ditches or drains.

6.14.1.3.4 Ecosystem Restoration Measures

These management measures were combined to create six measures. Each measure requires burning and mowing the project area in the initial year on construction and maintaining native savanna vegetation by either burning every three years or mowing every year, removing all exotics and plantation pine and maintaining their elimination over the project life, and filling all artificial ditches. The difference between each measure includes the number of acres restored and the method of maintaining vegetation over the life of the project.

Measures 1 and 2 consist of restoring the project areas north and south of the road: 385 acres. Measure 1 maintains vegetation by burning once every three years. Measure 2 maintains vegetation by mowing every year. Measures 3 and 4 consist of restoring only the project area north of the road: 151 acres. Measure 3 maintains vegetation by burning once every three years. Measure 4 maintains vegetation by mowing every year. Measures 5 and 6 consist of restoring only the project area south of the railroad: 234 acres. Measure 5 maintains vegetation by burning once every three years. Measure 6 maintains vegetation by mowing every year. Table 6.14-2 displays a description of each ecosystem restoration measure. Figure 6.14-2 shows the Dantzler restoration site.

Table 6.14-2.
Ecosystem Restoration Measures

Measure	Management Measures	Measure Description
0	No Action	No Action
1	1a + 2 +3	385 Acre Restoration Maintain by Burning
2	1b + 2 + 3	385 Acre Restoration Maintain by Mowing
3	1a + 2 +3	151 Acre Restoration Maintain by Burning
4	1b + 2 + 3	151 Acre Restoration Maintain by Mowing
5	1a + 2 +3	234 Acre Restoration Maintain by Burning
6	1b + 2 + 3	234 Acre Restoration Maintain by Mowing



Figure 6.14-2. Dantzler Restoration Site

6.14.1.4 Benefits

In order to restore this area to a Wet Pine Savannah habitat, the higher areas will be designated as Wet Pine Savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water. The Wet Pine Savannah habitat will be restored with Wet Pine Flatwoods, such as Pinus elliotti, Morella cerifera, Llex glabra, Spartina patens and Panicum virgatum.

Many species of wildlife are indigenous to the Wet Pine Savannah habitat. Understory plant communities may contain wiregrass, sedges, orchids, American Chaff seed and rough-leaved loosestrife. Insectivorous plants that may be found include pitcher plants, bladderworts, venus flytrap, and sundews. Rare, threatened or endangered birds that may occur in these areas include Henslowe's sparrow, Bachman's sparrow, red-cockaded woodpecker, and Mississippi Sandhill Crane. This ecosystem may also benefit the Mississippi Gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise.

Benefits are measured in terms of Average Annual Functional Units (AAFU). The Hydrogeomorphic (HGM) approach was used to assess wetland function. A HGM assessment was performed in 2000 using the Regional Guidebook for Applying the HGM Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration measures. Table 6.14-3 shows the AAFU net benefit

under each measure. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration measure and the total functional units for the no action measure.

Table 6.14-3.
Summary of Benefits

Measure	Measure Description	AAFU Net Benefit
No Action	No Action	0
Measure 1	385 Acre Restoration Maintain by Burning	1,244
Measure 2	385 Acre Restoration Maintain by Mowing	943
Measure 3	151 Acre Restoration Maintain by Burning	488
Measure 4	151 Acre Restoration Maintain by Mowing	370
Measure 5	234 Acre Restoration Maintain by Burning	756
Measure 6	234 Acre Restoration Maintain by Mowing	573

6.14.1.5 Costs

A rough order magnitude (ROM) cost estimate was developed for the 385, 151, and 234 acres of restoration. It included the cost of filling ditches with 65,560, 30,560, and 36,000 cubic yards of material for $798,720, $366,720, and $432,000, respectively; burning 385, 151, and 234 acres of vegetation for $57,750, $22,650, and $35,100, respectively; mowing 385, 151, and 234 acres for $32,725, $12,835, and $19,890, respectively; removing roads and utilities for $275,000, $121,000, and $154,000; mobilizing and demobilizing for $40,000, $20,000, and $20,000, respectively; and miscellaneous site items for $90,000, $45,000, and $45,000, respectively. Total construction costs for the 385, 151, and 234 acres of restoration equaled $1,294,195, $588,205, and $882,488. A contingency cost of 25 percent and lands and damages costs of $25,000 were added to the construction cost. Then, Planning, Engineering and Design (PED) costs of 8 percent and a Construction Management cost of 6 percent were added for a total first cost of construction of $1,881,000, $870,000, and $1,039,000.

For each measure, these first costs of construction are presented in Table 6.14-4 at October 2007 price levels along with the Interest During Construction (IDC), investment cost (first cost plus IDC), Average Annual Investment Cost (AAIC), Average Annual Operations and Maintenance (AAO&M) cost and, ultimately, the Average Annual Costs (AAC).

Investment cost, O&M cost and AAC for Measure 1 are $1,922,000, $1,328,000, and $129,000, respectively. The investment cost, O&M cost and AAC for Measure 2 are $1,922,000, $2,303,000, and $150,000, respectively. The investment cost, O&M cost and AAC for Measure 3 are $889,000, $528,000, and $58,000, respectively. The investment cost, O&M cost and AAC for Measure 4 are $889,000, $931,000, and $67,000, respectively. The investment cost, O&M cost and AAC for Measure 5 are $1,039,000, $816,000, and $73,000, respectively. The investment cost, O&M cost and AAC for Measure 6 are $1,039,000, $1,421,000, and $86,000, respectively.

Table 6.14-4.
Summary of Costs by Measure for Dantzler Area

Measure	Measure Description	Implement-ation Cost (FY-08)	IDC	Investment Cost	AAIC	AAO&M	AAC
0	No Action	$0	$0	$0	$0	$0	$0
1	879 Acre Restoration Maintain by Burning	$1,880,000	$41,000	$1,922,000	$103,000	$26,000	$129,000
2	879 Acre Restoration Maintain by Mowing	$1,880,000	$41,000	$1,922,000	$103,000	$47,000	$150,000
3	689 Acre Restoration Maintain by Burning	$870,000	$19,000	$889,000	$48,000	$10,000	$58,000
4	689 Acre Restoration Maintain by Mowing	$870,000	$19,000	$889,000	$48,000	$19,000	$67,000
5	190 Acre Restoration Maintain by Burning	$1,040,000	$23,000	$1,062,000	$57,000	$16,000	$73,000
6	190 Acre Restoration Maintain by Mowing	$1,040,000	$23,000	$1,062,000	$57,000	$29,000	$86,000

Note: Numbers are rounded to the nearest thousand dollars.

First cost of construction is used along with the duration of 12 months of construction and a discount rate of 4.875 percent to calculate Interest During Construction (IDC). The sum of the first cost of construction and IDC cost equals the investment cost. This cost is amortized at the FY 2007 federal discount rate of 4.875 percent over a 50-year economic period of analysis to calculate the Average Annual Investment Cost (AAIC). Average Annual O&M (AAO&M) costs for burning once every three years or mowing every year were present valued and amortized at an interest rate of 4.875 percent over a 50-year economic period of analysis. The sum of the AAIC and AAO&M cost equals the Average Annual Costs (AAC).

6.14.2 Comparison of Measures

Table 6.14-5 displays all measures with their respective AAC and AAFU.

Table 6.14-5.
All Measures: AAC and AAFU

Measure	AAC	AAFU
No Action	$0	0
1	$129,000	1,244
2	$150,000	943
3	$20,000	488
4	$29,000	370
5	$60,000	756
6	$73,000	573

Note: The AAC values are rounded to the nearest thousand dollars.

In order to determine the cost effectiveness of each measure, the list of measures is reordered so that they are listed in increasing order of their outputs (AAFU). This list is shown in Table 6.14-6.

Table 6.14-6.
All Measures Arrayed by Increasing Output

Measure	AAC	AAFU
No Action	$0	0
4	$29,000	370
3	$20,000	488
6	$73,000	573
5	$60,000	756
2	$150,000	943
1	$129,000	1,244

Note: The AAC values are rounded to the nearest thousand dollars.

To determine if a measure is cost effective, economically inefficient measures must first be identified and eliminated. An economically inefficient measure is a measure that cost more for the same level of benefit. No measures are eliminated for the reason of economic inefficiency because each measure produces a different level of benefit.

Lastly, economically ineffective measures are identified and eliminated to determine which measures are cost effective. An economically ineffective measure is a measure that cost more or the same as a subsequent measure but produces less benefit than that subsequent measure. As shown in Table 6.14-7, the three shaded measures, 2, 4, and 6 were eliminated because they produced less benefit at greater cost than a subsequent measure. For example, Measure 4 produces 370 AAFU at an AAC of $29,000 while Measure 3 produces 488 AAFU at an AAC $20,000. Measure 4 produces less AAFU at a greater cost than Measure 3. Therefore, Measure 4 is eliminated. As shown in table 6.14-8 and plotted in figure 6.14-3, the cost effective measures are Measure 1 (385 acres of restoration maintained by burning), Measure 3 (151 acres of restoration maintained by burning) and Measure 5 (234 acres of restoration maintained by burning).

Table 6.14-7.
Elimination of Economically Ineffective Measures

Measure	Measure Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
				No
3	151 Acre Restoration Maintain by Burning	$20,000	488	Yes
				No
5	234 Acre Restoration Maintain by Burning	$60,000	756	Yes
				No
1	385 Acre Restoration Maintain by Burning	$129,000	1,244	Yes

Note: The AAC values are rounded to the nearest thousand dollars.

Table 6.14-8.
Cost Effective Measures for Dantzler Area

Measure	Measure Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
3	151 Acre Restoration Maintain by Burning	$20,000	488	Yes
5	234 Acre Restoration Maintain by Burning	$60,000	756	Yes
1	385 Acre Restoration Maintain by Burning	$129,000	1,244	Yes

Note: The AAC values are rounded to the nearest thousand dollars.

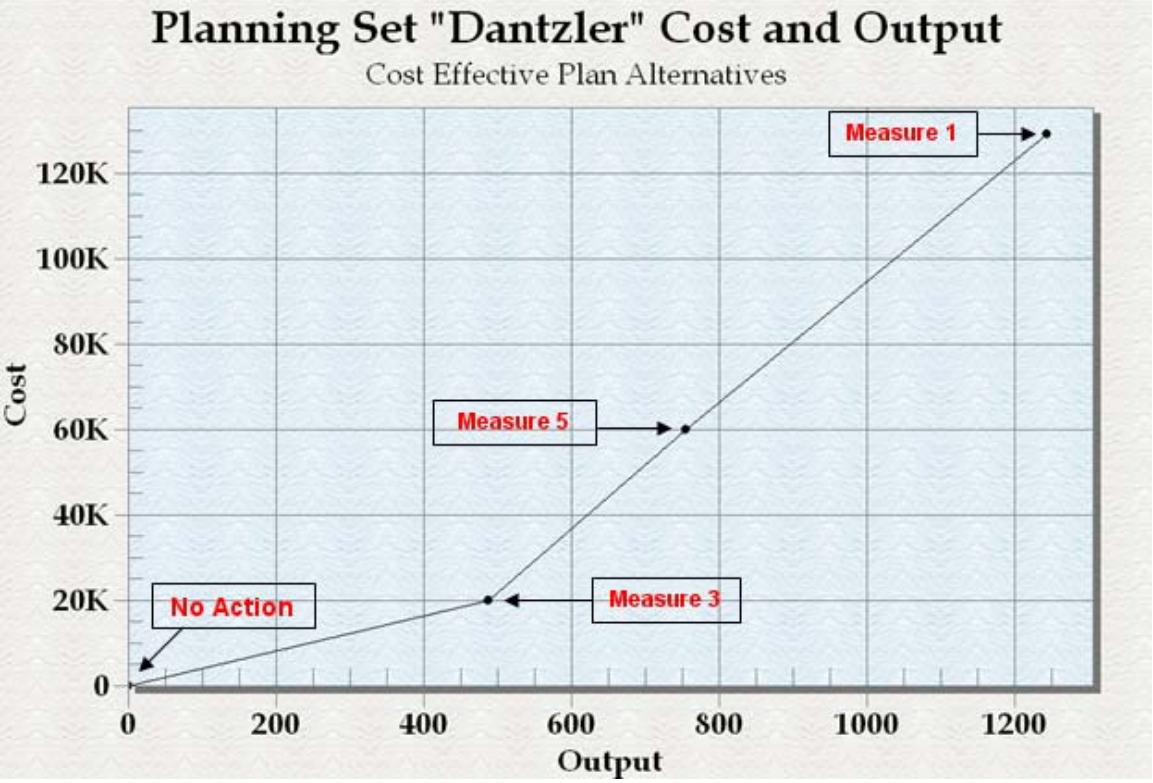


Figure 6.14-3. Display of Cost Effective Alternatives for the Dantzler Area

6.14.3 Regional Economic Development (RED) Benefits

6.14.3.1 Socioeconomic Impacts using the Economic Impact Forecast System

The purpose of this section is to show the economic impact of the cost effective alternatives on business (sale volumes), income, employment, and population of the local area. Each of the alternatives would affect the local area of Jackson County, Mississippi. The expenditures for the alternatives are estimated to be $1,900,000 for Alternative 1, $1,040,000 for Alternative 3, $870,000 for Alternative 5. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $484,000 for Alternative 1, $186,000 for Alternative 3, and

$298,000 for Alternative 5 (assuming a 50 year period of analysis and an interest rate of 4.875 percent).

6.14.4 Summary Explanation of the EIFS Model Output

The outputs shown in this section are based on the following input from the proposed project alternatives. EIFS model inputs and outputs are shown in tables 6.14-9 through 6.14-12. The inputs are as follows:

Table 6.14-9.
EIFS Model Implementation Inputs for the Dantzler Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$0	$1,900,000	$1,040,000	$870,000

Based of the given inputs the outputs are as follows:

Table 6.14-10.
EIFS Model Implementation Outputs for the Dantzler Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Direct Sales Volume	$0	$1,900,000	$1,040,000	$870,000
Induced Sales Volume	$0	$2,128,000	$1,164,800	$974,400
Total Sales Volume	$0	$4,028,000	$2,204,800	$1,844,400
Direct Income	$0	$370,549	$202,827	$169,672
Induced Income	$0	$415,014	$227,166	$190,033
Total Income	$0	$785,563	$429,992	$359,705
Direct Employment	0	11	6	5
Induced Employment	0	12	7	6
Total Employment	0	23	12	10
Local Population	0	0	0	0

Table 6.14-11.
EIFS Model O&M Inputs for the Dantzler Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$0	$484,000	$186,000	$298,000

Based of the given inputs the outputs are as follows:

Table 6.14-12.
EIFS Model O&M Outputs for the Dantzler Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Direct Sales Volume	$0	$484,000	$186,000	$298,000
Induced Sales Volume	$0	$542,080	$208,320	$333,760
Total Sales Volume	$0	$1,026,080	$394,320	$631,760
Direct Income	$0	$94,392	$36,275	$58,118
Induced Income	$0	$105,719	$40,628	$65,092
Total Income	$0	$200,112	$76,902	$123,209
Direct Employment	0	3	1	2
Induced Employment	0	3	1	2
Total Employment	0	6	2	4
Local Population	0	0	0	0

6.15 Franklin Ecosystem Restoration Measures

This section describes the evaluation of ecosystem restoration measures at the Franklin Creek area that is located within planning sub-unit 53, which is part of planning unit three. The total area includes 149 acres of land that was acquired during the interim phase of the MsCIP. This area was selected for ecosystem restoration using the Decision Support System, a GIS based model created by the Corps' Engineer Research and Development Center (ERDC). For more details on the selection process for ecosystem restoration sites see the Economic Appendix. Figure 6.15-1 shows the location of the Franklin Creek area.

6.15.1 Formulation of Alternatives

6.15.1.1 Assumptions

In order for the Franklin Creek site to undergo ecosystem restoration, it is assumed that all of the property is being acquired under the Mississippi Coastal Improvements Program Interim Projects.

6.15.1.2 Objectives

The following objectives were developed for ecosystem restoration:

- Restore native vegetation
- Restore natural fire regime
- Restore natural hydrology
- Restore fish and wildlife habitat
- Provide storm water storage protection

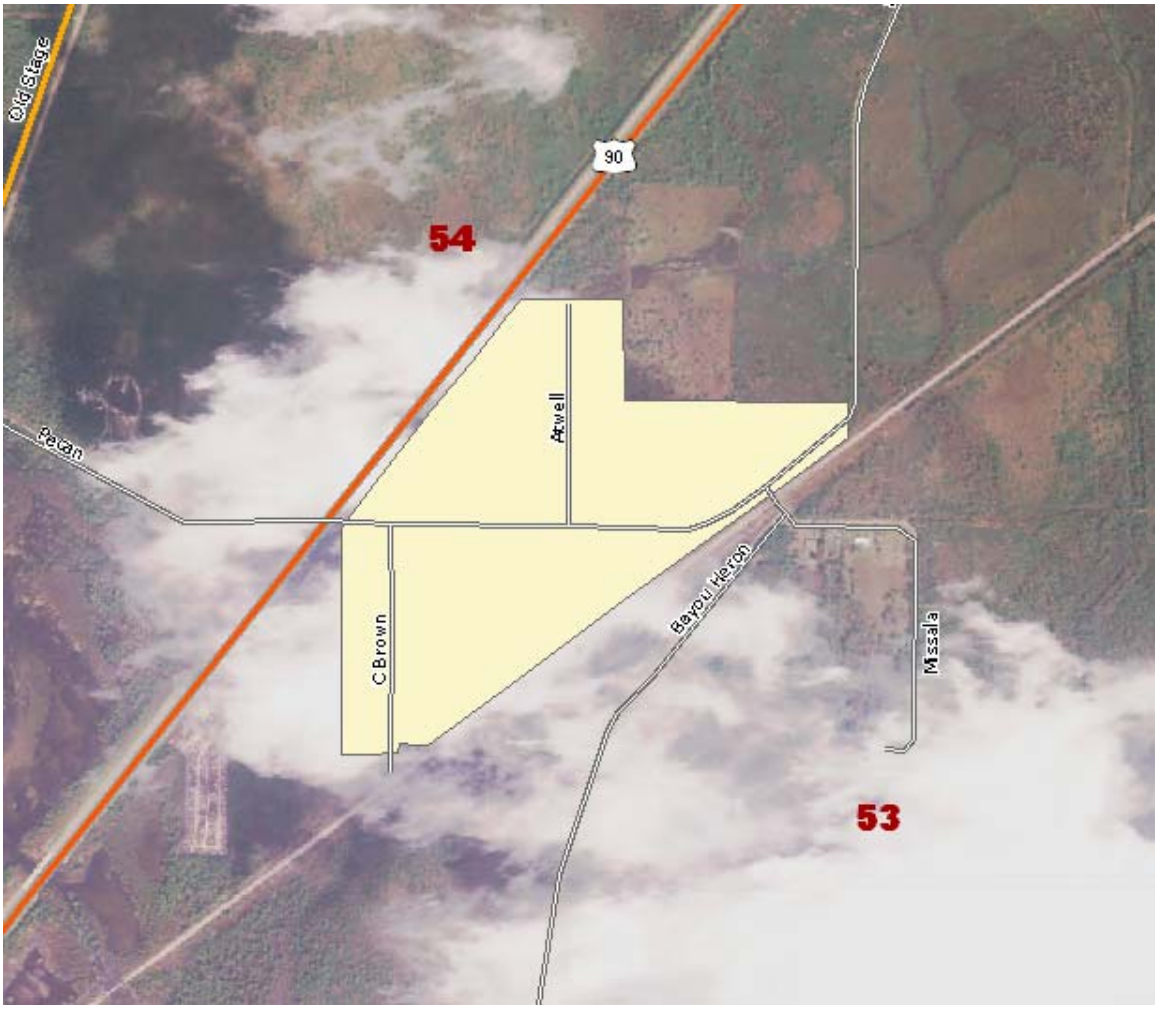


Figure 6.15-1. Franklin Creek Restoration Area.

6.15.1.3 Ecosystem Restoration Management Measures

Proposed restoration management measures are listed in table 6.15-1. Narrative descriptions of each management measure follow this table.

Table 6.15-1
Ecosystem Restoration Management Measures

Management Measure	Description
No Action	No Action
1	Fill Artificial Ditches
2 *a* *b*	Maintain Native Savannah Vegetation *By Burning Every 3Years* *By Mowing Annually*
3	Excavate & Remove Roadbeds & Fill
4	Add Culverts

6.15.1.4 Fill Ditches (1)

This management measure must be included in all alternatives for the restoration to be successful. This measure positively affects the outflow of water. It measures the removal of water by ditches or drains.

6.15.1.5 Maintain Native Savannah Vegetation (2)

This management measure must be included in all alternatives for the restoration to be successful. There are two methods that will be analyzed for maintaining vegetation: (a) burning and (b) mowing. Fire benefits this ecosystem in many different ways. It creates a bare seedbed for pine seedlings and other fire dependent plants, reduces fuel loads and recycles nutrients. Periodic burning promotes early successional plants that are important to many species of wildlife indigenous to this ecosystem. Many of the plant species found in this ecosystem are fire dependent; for example, the federally endangered American Chaff seed flowers almost exclusively after a fire. It has been reduced to a fraction of its original range due to fire suppression and habitat destruction. Fire suppression is mainly due to liability issues and fear of litigation.

Mowing is a mechanical alternative that many land managers use to maintain early successional habitats. Although it is successful to some extent, it fails to provide all the necessary components that come from prescribed fire. This method also has a negative effect. Mowing requires the use of heavy equipment in sensitive areas. Tractors can create ruts in saturated soils, creating hydrologic problems and micro site conditions. Mowing can also introduce non-native species through the use of contaminated equipment. Another disadvantage of mowing is that the duff or litter layer remains on the ground, preventing seeds from reaching the bare ground needed for germination. This thick litter layer can also provide heavy fuel loads increasing the risk of wildfires during dry periods. Although mowing provides some level of habitat management in pine savannahs, it is not a substitute for prescribed fire. Mowing can maintain succession, but may inhibit other functions of the system.

6.15.1.6 Excavate and Remove Existing Roadbeds and Fill (3)

This management measure must be included in all alternatives for the restoration to be successful. This measure affects the surface water storage. An ecological improvement would occur where existing roadbeds and fill are removed.

6.15.1.7 Add Culverts (4)

This measure increases the hydrologic connection between the two existing wetland areas separated by the elevated railway. The wetlands are primarily precipitation driven resulting in sheet flow drainage. Additional culverts will result in increased sheet flow drainage reducing standing surface water in the northern wetland area.

6.15.1.8 Ecosystem Restoration Alternatives

These management measures were combined to create four alternatives. Each alternative requires filling in ditches, maintaining native savannah vegetation by burning and mowing the project area in the initial year of construction with followed-up maintenance throughout the life of the project with either burning every 3 years or mowing every year, and excavating and removing existing roadbeds and any additional fill. Restoring the north and south acres together also includes adding culverts to increase hydrologic connectivity whereas restoring only the south portion does not include the culvert measure. Otherwise, the difference between each alternative includes the number of acres restored and/or the method of maintaining vegetation over the life of the project. Restoring only the north portion was not considered as an alternative since it would make the ecology worse off.

Alternatives 1 and 2 consist of restoring the project areas north and south of the railway: 149 acres. Alternative 1 maintains vegetation by burning once every three years. Alternative 2 maintains vegetation by mowing every year. Alternatives 3 and 4 consist of restoring only the project area south of the railway: 56 acres. Alternative 3 maintains vegetation by burning once every three years. Alternative 4 maintains vegetation by mowing every year. Table 6.15-2 displays a description of each ecosystem restoration alternative. Figure 6.15-2 shows the Franklin Creek restoration site divided by the railroad into the north (A) and south (B) acreages.

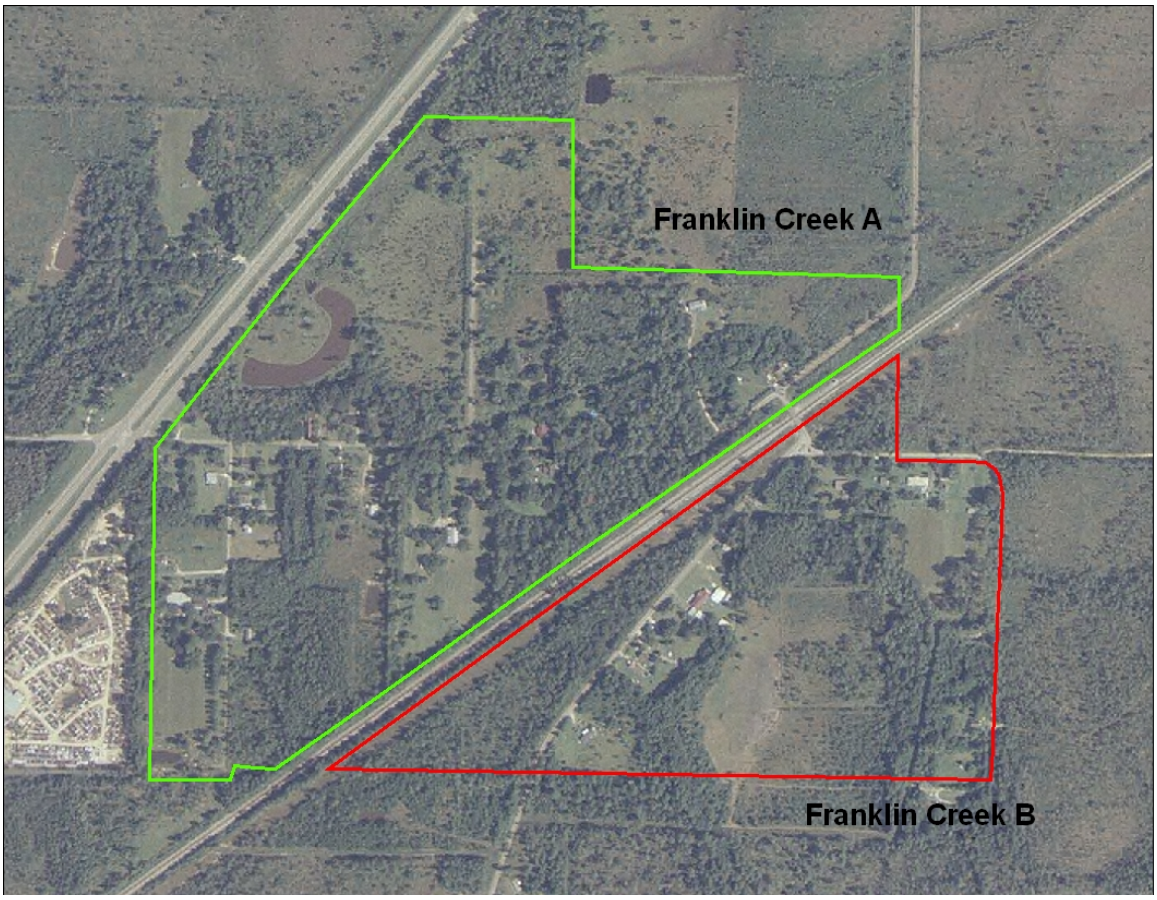


Figure 6.15-2. Franklin Creek Restoration Site

Table 6.15-2.
Ecosystem Restoration Alternatives

Alternative	Management Measures	Alternative Description
0	No Action	No Action
1	1 + 2a + 3 + 4	149 Acre Restoration Maintain by Burning
2	1 + 2b + 3 + 4	149 Acre Restoration Maintain by Mowing
3	1 + 2a +3	56 Acre Restoration Maintain by Burning
4	1 + 2b + 3	56 Acre Restoration Maintain by Mowing

6.15.1.9 Benefits

In order to restore this area to a Wet Pine Savannah habitat, the higher areas will be designated as Wet Pine Savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water. The Wet Pine Savannah habitat will be restored with Wet Pine Flatwoods, such as Pinus elliotti, Morella cerifera, Ilex glabra, Spartina patens and Panicum virgatum.

Many species of wildlife are indigenous to the Wet Pine Savannah habitat. Understory plant communities may contain wiregrass, sedges, orchids, American Chaff seed and rough-leaved loosestrife. Insectivorous plants that may be found include pitcher plants, bladderworts, venus flytrap, and sundews. Rare, threatened or endangered birds that may occur in these areas include Henslowe's sparrow, Bachman's sparrow, red-cockaded woodpecker, and Mississippi Sandhill Crane. This ecosystem may also benefit the Mississippi Gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise.

Benefits are measured in terms of Average Annual Functional Units (AAFU). The Hydrogeomorphic (HGM) approach was used to assess wetland function. A HGM assessment was performed in 2000 using the Regional Guidebook for Applying the HGM Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration alternatives. Table 6.15-3 shows the AAFU net benefit under each alternative. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration alternative and the total functional units for the no action alternative.

Table 6.15-3.
Summary of Benefits

Alternative	Alternative Description	AAFU Net Benefit
No Action (alternatives 1-2)	No Action (149 acres)	0
No Action (alternatives 3-4)	No Action (56 acres)	0
Alternative 1	149 Acre Restoration Maintain by Burning	516
Alternative 2	149 Acre Restoration Maintain by Mowing	399
Alternative 3	56 Acre Restoration Maintain by Burning	194
Alternative 4	56 Acre Restoration Maintain by Mowing	150

6.15.1.10 Costs

A rough order magnitude (ROM) cost estimate was developed for the 149 acres of restoration represented in Alternatives 1 and 2. The first costs for Alternatives 1 and 2 are estimated at $1,634,000. First costs include construction, contingency, lands and damages, PED, and construction management costs. Investment cost (first cost plus IDC) for Alternatives 1 and 2 are estimated at $1,670,000. The equivalent average annual cost (AAC), which includes AAC of investment of $90,000 and O&M of $11,000 and $19,000, for Alternatives 1 and 2 are $101,000 and $109,000, respectively. The first costs for Alternatives 3 and 4 representing 56 acres of restoration south of the railway are estimated at $548,000. Investment cost (first cost plus IDC) for Alternatives 1 and 2 are estimated at $560,000. The AAC, which includes AAC of investment of $30,000 and

O&M of $4,000 and $7,000, respectively, for Alternatives 3 and 4 are $34,000 and $37,000, respectively.

For each alternative, first costs of construction, Interest During Construction (IDC), total investment cost, Average Annual Investment Cost (AAIC), Average Annual Operations and Maintenance (AAO&M) cost and, ultimately, the Average Annual Costs (AAC) are presented in table 6.15-4 at October 2007 price levels.

Table 6.15-4.
Summary of Costs by Measure for Franklin Creek

Alternative	Alternative Description	Implement-ation Cost (FY-08)	IDC	Investment Cost	AAIC	AAO&M	AAC
0	No Action	$0	$0	$0	$0	$0	$0
1	149 Acre Restoration Maintain by Burning	$1,630,000	$36,000	$1,670,000	$90,000	$11,000	$101,000
2	149 Acre Restoration Maintain by Mowing	$1,630,000	$36,000	$1,670,000	$90,000	$19,000	$109,000
3	56 Acre Restoration Maintain by Burning	$550,000	$12,000	$560,000	$30,000	$4,000	$34,000
4	56 Acre Restoration Maintain by Mowing	$550,000	$12,000	$560,000	$30,000	$7,000	$37,000

Note: Values are rounded to the nearest thousand dollars.

First cost of construction is used along with the duration of 12 months of construction and a discount rate of 4.875 percent to calculate Interest During Construction (IDC). The sum of the first cost of construction and IDC cost equals the investment cost. This cost is amortized at the FY 2007 federal discount rate of 4.875 percent over a 50-year economic period of analysis to calculate the Average Annual Investment Cost (AAIC). Average Annual O&M (AAO&M) costs for burning once every three years or mowing every year were present valued and amortized at an interest rate of 4.875 percent over a 50-year economic period of analysis. The sum of the AAIC and AAO&M cost equals the Average Annual Costs (AAC).

6.15.2 Comparison of Alternatives

Table 6.15-5 displays all alternatives with their respective AAC and AAFU.

Table 6.15-5.
All Alternatives: AAC and AAFU

Alternative	AAC	AAFU
No Action	$0	0
1	$101,000	516
2	$109,000	399
3	$34,000	194
4	$37,000	150

Note: The AAC values are rounded to the nearest thousand dollars.

In order to determine the cost effectiveness of each alternative, the list of alternatives is reordered so that they are listed in increasing order of their outputs (AAFU). This list is shown in table 6.15-6.

Table 6.15-6.
All Alternatives Arrayed by Increasing Output

Alternative	AAC	AAFU
No Action	$0	0
4	$37,000	150
3	$34,000	194
2	$109,000	399
1	$101,000	516

Note: The AAC values are rounded to the nearest thousand dollars.

To determine if an alternative is cost effective, economically inefficient alternatives must first be identified and eliminated. An economically inefficient alternative is an alternative that cost more for the same level of benefit. No alternatives are eliminated for the reason of economic inefficiency because each alternative produces a different level of benefit.

Lastly, economically ineffective alternatives are identified and eliminated to determine which alternatives are cost effective. An economically ineffective alternative is an alternative that costs more or the same as a subsequent alternative but produces less benefit than that subsequent alternative. As shown in table 6.15-7, the two shaded alternatives 4 and 2 were eliminated because they produced less benefit at greater cost than a subsequent alternative. For example, Alternative 4 produces 150 AAFU at an AAC of $37,000 while Alternative 3 produces 194 AAFU at an AAC $34,000. Alternative 4 produces less AAFU at a greater cost than Alternative 3. Therefore, Alternative 4 is eliminated. As shown in table 6.15-8 and plotted in figure 6.15-3, the cost effective alternatives are Alternative 3 (56 acres of restoration maintained by burning) and Alternative 1 (149 acres of restoration maintained by burning).

Table 6.15-7.
Elimination of Economically Ineffective Alternatives

Alternative	Alternative Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
				No
3	56 Acre Restoration Maintain by Burning	$34,000	194	Yes
				No
1	149 Acre Restoration Maintain by Burning	$101,000	516	Yes

Note: The AAC values are rounded to the nearest thousand dollars.

Table 6.15-8.
Cost Effective Alternatives for Franklin Creek Area

Alternative	Alternative Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
3	56 Acre Restoration Maintain by Burning	$34,000	194	Yes
1	149 Acre Restoration Maintain by Burning	$101,000	516	Yes

Note: The AAC values are rounded to the nearest thousand dollars.

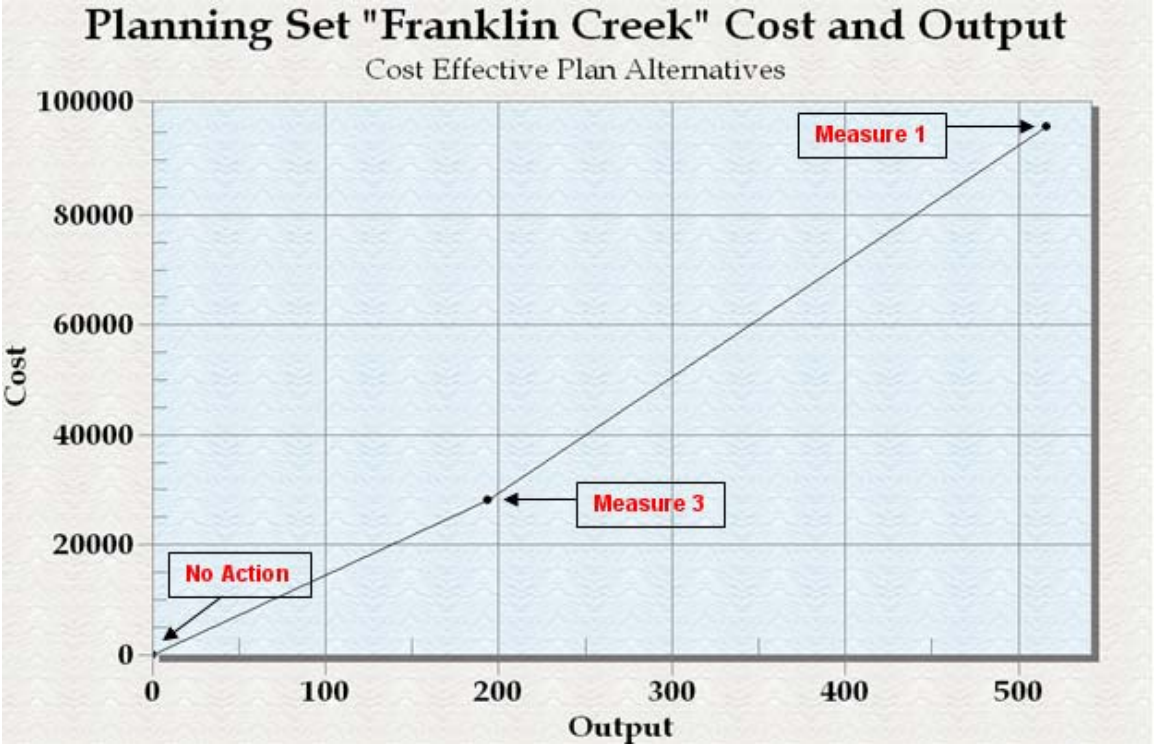


Figure 6.15-3. Display of Cost Effective Alternatives for the Franklin Creek Area

6.15.3 Regional Economic Development (RED) Benefits

6.15.3.1 Summary of Socioeconomic Impacts using the Economic Impact Forecast System

The purpose of this analysis is to show the economic impact of the cost effective alternatives on business (sale volumes), income, employment, and population of the local area. Each of the alternatives would affect the local area of Jackson County, Mississippi. The expenditures for the alternatives are estimated to be $960,000 for Alternative 1, $1,530,000 for Alternative 3. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $205,000 for Alternative 1 and $74,000 for Alternative 3 (assuming a 50 year period of analysis and an interest rate of 4.875 percent).

The outputs shown in this section are based on the following input from the proposed project measures. The inputs and outputs are shown in tables 6.15-9 through 6.15-12. The inputs are as follows:

Table 6.15-9.
EIFS Model Implementation Inputs for Franklin Creek Ecosystem

	No Action	Alternative 1	Alternative 3
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$0	$1,630,000	$550,000

Based of the given inputs the outputs are as follows:

Table 6.15-10.
EIFS Model Implementation Outputs for Franklin Creek Ecosystem

	No Action	Alternative 1	Alternative 3
Direct Sales Volume	$0	$1,630,000	$550,000
Induced Sales Volume	$0	$1,825,600	$616,000
Total Sales Volume	$0	$3,455,600	$1,166,000
Direct Income	$0	$317,892	$107,264
Induced Income	$0	$356,039	$120,136
Total Income	$0	$673,930	$227,400
Direct Employment	0	9	3
Induced Employment	0	10	3
Total Employment	0	19	6
Local Population	0	0	0

Table 6.15-11.
EIFS Model O&M Inputs for Franklin Creek Ecosystem

	No Action	Alternative 1	Alternative 3
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$0	$205,000	$74,000

Based of the given inputs the outputs are as follows:

Table 6.15-12.
EIFS Model O&M Outputs for Franklin Creek Ecosystem

	No Action	Alternative 1	Alternative 3
Direct Sales Volume	$0	$205,000	$74,000
Induced Sales Volume	$0	$229,600	$82,880
Total Sales Volume	$0	$434,600	$156,880
Direct Income	$0	$39,980	$14,432
Induced Income	$0	$44,778	$16,164
Total Income	$0	$84,758	$30,596
Direct Employment	0	1	1
Induced Employment	0	1	0
Total Employment	0	2	1
Local Population	0	0	0

6.16 Evaluation of Inland Barrier and Surge Barrier Flood Damage Reduction Measures

6.16.1 General

The Inland barrier and surge barrier area is located in all three planning units just north of the roadways that run parallel to the beach. These areas are denoted by the inland zone planning area. In planning unit one, the inland barrier area includes planning sub-units one, two, seven, thirty-seven, and thirty-eight; in planning unit two, planning sub-units eight, eleven, twelve, fourteen, sixteen, seventeen, twenty, thirty-nine, forty, forty-seven, forty-eight, and fifty; and in planning unit three the planning sub-units are twenty-one, twenty-three, forty-one, forty-six, and forty-nine.

6.16.2 Historic (Pre-Hurricane Katrina) Conditions

The pre-Hurricane Katrina conditions for planning sub-units three and four in planning unit one represented a mostly residential community as shown in Table 6.16-1. The areas in planning unit one included 35,770 tax parcels, of which 17,914 contained an asset with some economic value and 17,856, were vacant land. Of the 17,914 parcels that contain assets, 13,961 were residential one-story, 763 were residential two-story, 463 were mobile homes, 2,236 were commercial, and 491 were municipal. The areas in planning unit two included 76,487 tax parcels, of which 48,962 contained an asset with some economic value and 27,525 were vacant land. Of the 48,962 parcels that contain assets, 40,456 were residential one-story, 1,594 were residential two-story, 2,487 were mobile homes, 4,136 were commercial, and 289 were municipal. The areas in planning unit three included 21,353 tax parcels, of which 14,575 contained an asset with some economic value and 6,778 were vacant land. Of the 14,575 parcels that contain assets, 12,551 were residential one-story, 311 were residential two-story, 828 were mobile homes, 789 were commercial, and 96 were municipal.

Table 6.16-1.
Pre-Hurricane Katrina Estimate of Structures for Inland Zone Area

	Planning Unit One	Planning Unit Two	Planning Unit Three	
Asset Categories	**Assets by Category**	**Assets by Category**	**Assets by Category**	**Total**
Residential	14,724	42,050	12,862	**69,636**
Mobile Homes	463	2,487	828	**3,778**
Commercial	2,236	4,136	789	**7,161**
Municipal	491	289	96	**876**
Vacant Land	17,856	27,525	6,778	**52,159**
Total	**35,770**	**76,487**	**21,353**	**133,610**

Figure 6.16-1 denotes the various zones and shows the inland zone in green. Figures 6.16-2 shows the planning sub-units of the area by planning unit.

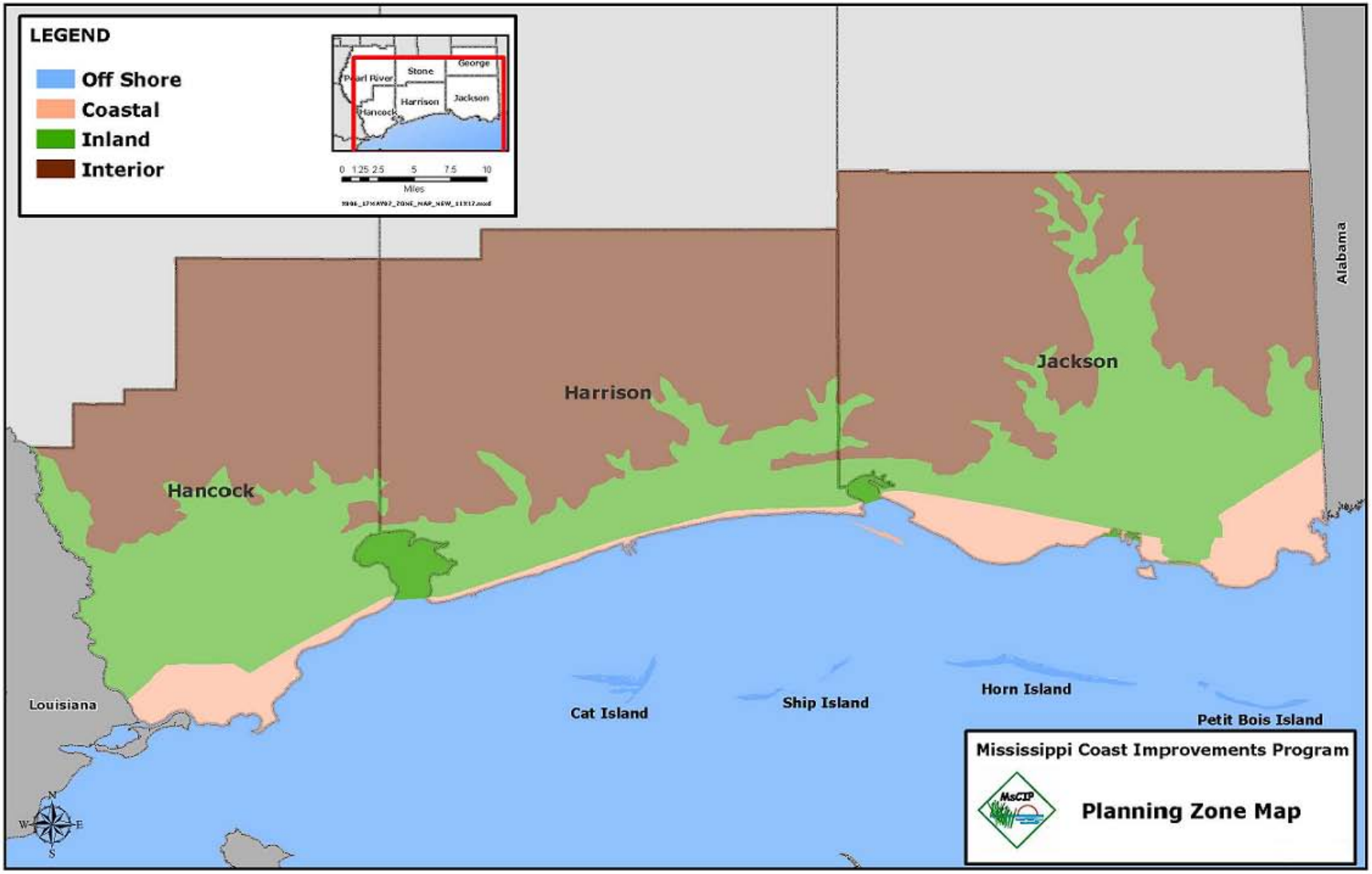


Figure 6.16-1. Planning Zones – Impacted area is the inland zone

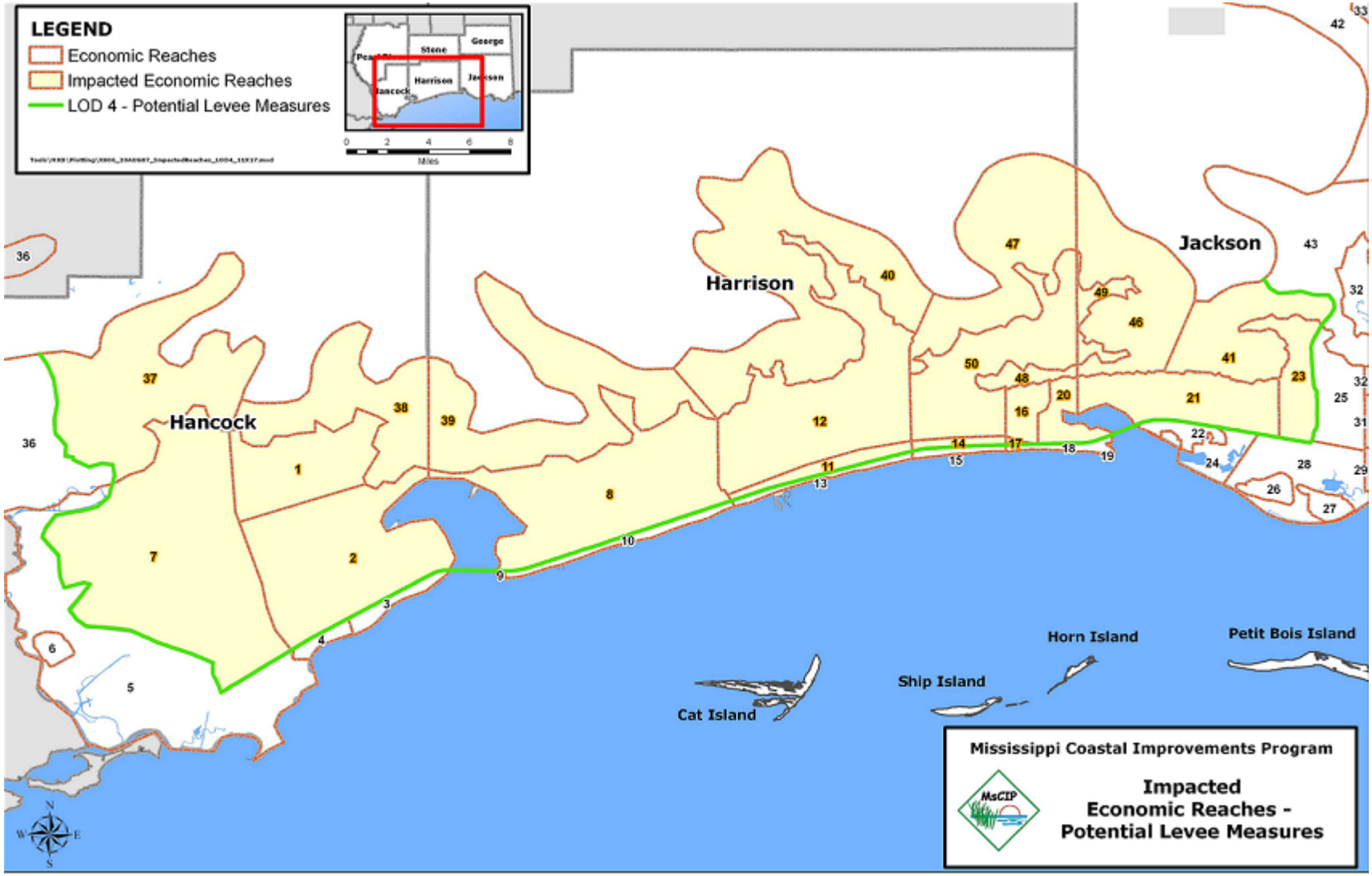


Figure 6.16-2 Planning sub-units in Inland Area for Planning Units One, Two, and Three

6.16.2.1 Existing (Post-Hurricane Katrina) Conditions

Hurricane Katrina made its Mississippi landfall just west of planning sub-units three and four. Damage from the surge was devastating across the three planning units. In the inland barrier impact area, it is estimated that 12,857 structures sustained significant damage (50-percent or more). Of those, 5,610 were destroyed in planning unit one, 6,850 in planning unit two, and 397 were destroyed in planning unit three. Table 6.16-2 displays the destroyed structures by category and by planning unit for these areas.

Table 6.16-2.
Destroyed Structures by Category and Planning Unit

	Planning Unit One	Planning Unit Two	Planning Unit Three	
Asset Categories	**Assets by Category**	**Assets by Category**	**Assets by Category**	**Total**
Residential	5,213	6,115	349	**11,677**
Mobile Homes	33	60	10	**103**
Commercial	311	648	38	**997**
Municipal	53	27	0	**80**
Total	**5,610**	**6,850**	**397**	**12,857**

6.16.3 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation.

6.16.4 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs.
- Price levels are FY-08, unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs for initial screening.
- Full redevelopment of the area will take place by the base year 2012.

6.16.5 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit one. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

- Measure A - LOD-4, Inland Barrier and Surge Barrier at 20.0-feet NAVD88 Elevation

This measure will consist of an elevation 20.0-feet NAVD88 earthen levee construction in planning unit one along an alignment that extends southward from the same ground surface elevation as the levee along the last watershed divide before entering the Pearl River basin and then turn eastward and extend along the south side of the CSX railroad track to the Bay St. Louis Surge Barrier. An elevation 20.0-feet NAVD88 surge barrier will extend across the mouth of St. Louis Bay from the western shore in Hancock County to the eastern shore in Harrison County. The structure will be located just south of the railway bridge. The barrier will consist of abutments extending from each shore with rising sector gates spanning most of the distance. The abutments will include gated culverts to provide proper circulation and tidal exchange. The earthen levee will then continue in planning unit two along an alignment that extends eastward from the Bay St. Louis Surge Barrier along the south side of the CSX railroad track to the Biloxi Bay Surge Barrier.

A second elevation 20.0-feet NAVD88 surge barrier will extend across the mouth of Biloxi Bay from the western shore in Harrison County to the eastern shore in Jackson County. The structure will be located just south of the existing railway bridge. The barrier will consist of abutments extending from each shore with rising sector gates spanning most of the distance. The abutments will include gated culverts to provide proper circulation and tidal exchange. In planning unit three, the earthen levee construction will continue along an alignment that extends eastward from the Biloxi Bay Surge Barrier along the south side of the CSX railroad track to the last watershed divide before entering the Pascagoula River basin. At the watershed divide, the alignment will follow the divide northward until it intersects the same ground surface elevation as the levee. This system will include interior drainage, pumping stations, and required road crossings. All required maintenance for the surge barrier facilities will be included.

- Measure B – LOD-4, Inland Barrier and Surge Barrier at 30.0-feet NAVD88 Elevation

This measure will consist of an elevation 30.0-feet NAVD88 earthen levee construction in planning unit one along an alignment that extends southward from the same ground surface elevation as the levee along the last watershed divide before entering the Pearl River basin and then turn eastward and extend along the south side of the CSX railroad track to the Bay St. Louis Surge Barrier. An elevation 30.0-feet NAVD88 surge barrier will extend across the mouth of St. Louis Bay from the western shore in Hancock County to the eastern shore in Harrison County. The structure will be located just south of the railway bridge. The barrier will consist of abutments extending from each shore with rising sector gates spanning most of the distance. The abutments will include gated culverts to provide proper circulation and tidal exchange. The earthen levee will then continue in planning unit two along an alignment that extends eastward from the Bay St. Louis Surge Barrier along the south side of the CSX railroad track to the Biloxi Bay Surge Barrier.

A second elevation 30.0-feet NAVD88 surge barrier will extend across the mouth of Biloxi Bay from the western shore in Harrison County to the eastern shore in Jackson County. The structure will be located just south of the existing railway bridge. The barrier will consist of abutments extending from each shore with rising sector gates spanning most of the distance. The abutments will include gated culverts to provide proper circulation and tidal exchange. In planning unit three, the earthen levee construction will continue along an alignment that extends eastward from the Biloxi Bay Surge Barrier along the south side of the CSX railroad track to the last watershed divide before entering the Pascagoula River basin. At the watershed divide, the alignment will follow the divide northward until it intersects the same ground surface elevation as the levee. This system will include interior drainage, pumping stations, and required road crossings. All required maintenance for the surge barrier facilities will be included.

- Measure C - LOD-4, Inland Barrier and Surge Barrier at 40.0-feet NAVD88 Elevation

This measure will consist of an elevation 40.0-feet NAVD88 earthen levee construction in planning unit one along an alignment that extends southward from the same ground surface elevation as the levee along the last watershed divide before entering the Pearl River basin and then turn eastward and extend along the south side of the CSX railroad track to the Bay St. Louis Surge Barrier. An elevation 40.0-feet NAVD88 surge barrier will extend across the mouth of St. Louis Bay from the western shore in Hancock County to the eastern shore in Harrison County. The structure will be located just south of the railway bridge. The barrier will consist of abutments extending from each shore with rising sector gates spanning most of the distance. The abutments will include gated culverts to provide proper circulation and tidal exchange. The earthen levee will then continue in planning unit two along an alignment that extends eastward from the Bay St. Louis Surge Barrier along the south side of the CSX railroad track to the Biloxi Bay Surge Barrier.

A second elevation 40.0-feet NAVD88 surge barrier will extend across the mouth of Biloxi Bay from the western shore in Harrison County to the eastern shore in Jackson County. The structure will be located just south of the existing railway bridge. The barrier will consist of abutments extending from each shore with rising sector gates spanning most of the distance. The abutments will include gated culverts to provide proper circulation and tidal exchange. In planning unit three, the earthen levee construction will continue along an alignment that extends eastward from the Biloxi Bay Surge Barrier along the south side of the CSX railroad track to the last watershed divide before entering the Pascagoula River basin. At the watershed divide, the alignment will follow the divide northward until it intersects the same ground surface elevation as the levee. This system will include interior drainage, pumping stations, and required road crossings. All required maintenance for the surge barrier facilities will be included.

- Measure D – Levee for Roadway - Elevation 20.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure E – Levee for Roadway - Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure F - Menge Ave. - Elevation 20.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure G - Menge Ave. - Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure H – Menge Ave. - Elevation 40.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure I – Levee for Roadway with Menge Ave. Alt - Elevation 20.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure J - Levee for Roadway with Menge Ave. Alt - Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure K - Non-structural One

This measure includes the acquisition and flood proofing (elevate in place) of structures to a 100-year level of protection. See the Non-structural Appendix for more detail on this measure.

- Measure L – Non-structural Two

REQUIRES FUTHER STUDY

- Measure M – Non-structural Three

REQUIRES FUTHER STUDY

- Measure N – Non-structural Four

REQUIRES FUTHER STUDY

Figure 6.16-3 shows the footprints for measures A through J. The alignment running from Hancock County to Jackson County is the footprint for measures A, through E, and the alignment going from Harrison County east to Jackson County is the footprint for measures F through J. The highlighted areas in figure 6.16-2 above represent the footprint of the nonstructural measures K through N.

6.16.6 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "…***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits…"*** More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.16.6.1 Future Without-Project Conditions

Equivalent annual surge damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the measures were evaluated and compared to the without-project conditions in order to calculate equivalent annual damage reduction. Future without-project scenarios three, four, five, and six were applicable for the inland barrier area.

Future scenario one is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Structures will be rebuilt to what they were pre-Hurricane Katrina; residential back to residential, commercial back to commercial, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Inland Barrier area.

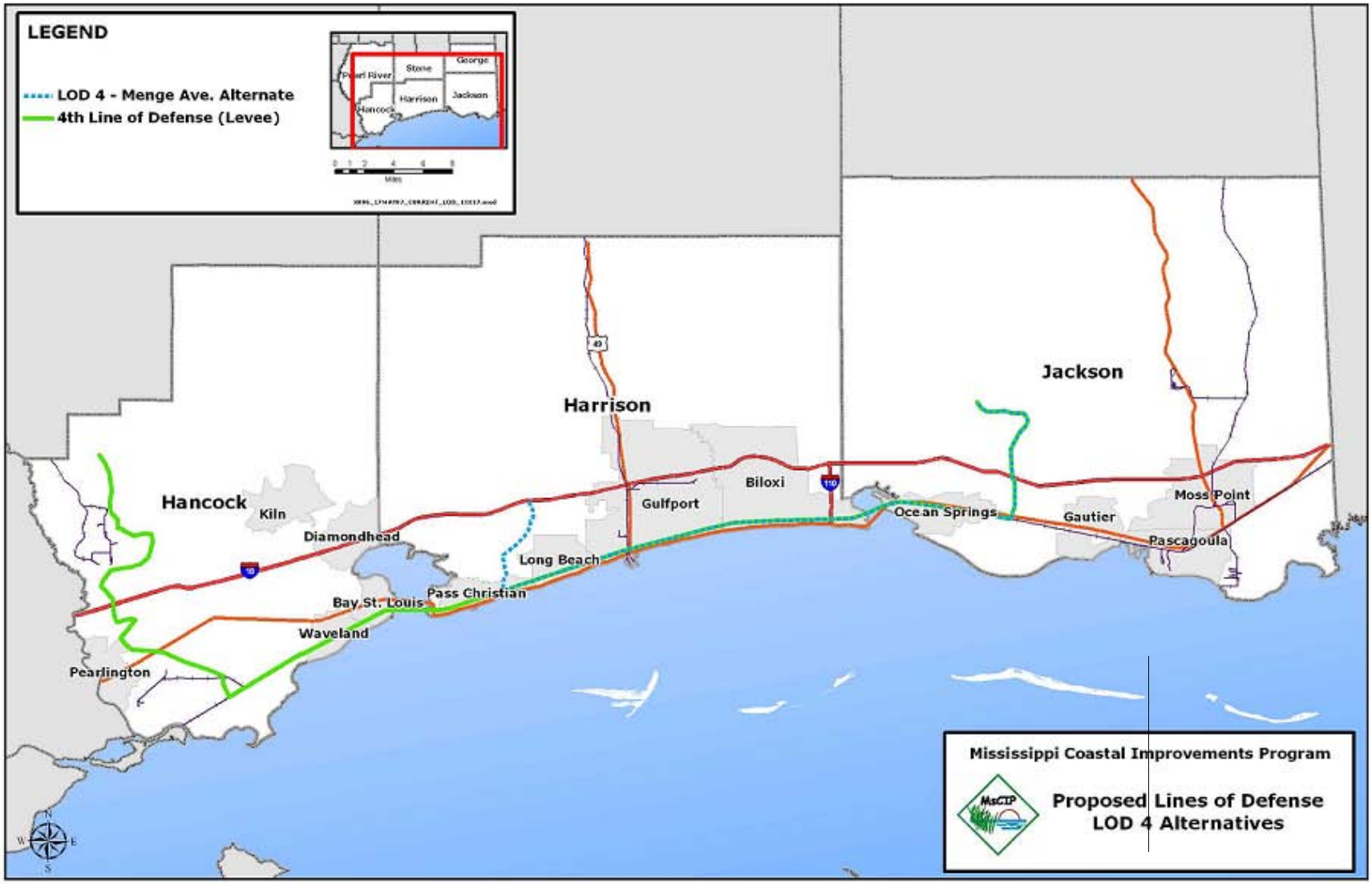


Figure 6.16-3. Footprints for the Inland Barrier Levees Alignments

Future scenario two is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Structures will be rebuilt to what they were pre-Hurricane Katrina; residential back to residential, commercial back to commercial, etc, with the exception of the water front areas for planning units one and two. In these planning units, the scenario will address what if commercial and casino redevelopment would occur along the water front and Back Bay areas. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Inland Barrier area.

Future scenario three has the same redevelopment as future scenario one with a maximum relative sea level rise of 2.0-feet NAVD88. Equivalent annual damages that could occur under this scenario are $426,040,000 (rounded to the nearest thousand). These damages are the damages expected for this scenario that are attributed to all fifty-four planning units without a project in place.

Future scenario four has the same redevelopment as future scenario two with a maximum relative sea level rise of 2.0-feet NAVD88. Equivalent annual damages that could occur under this scenario are $434,040,000 (rounded to the nearest thousand). These damages are the damages expected for this scenario that are attributed to all fifty-four planning units without a project in place.

Future scenario five has the same redevelopment as future scenario one with a maximum relative sea level rise of 3.4-feet NAVD88 over the period of analysis. Equivalent annual damages that could occur under this scenario are $475,200,000 (rounded to the nearest thousand). These damages are the damages expected for this scenario that are attributed to all fifty-four planning units without a project in place.

Future scenario six has the same redevelopment as future scenario two with a maximum relative sea level rise of 3.4-feet NAVD88 over the period of analysis. Equivalent annual damages that could occur under this scenario are $483,700,000 (rounded to the nearest thousand). These damages are the damages expected for this scenario that are attributed to all fifty-four planning units without a project in place.

6.16.6.2 Equivalent annual damages Reduced

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios and the damages incurred with the measure in place. The HEC-FDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without-project inventory except that footprints of inland barrier and surge barrier and the acquisitions were deleted from the inventory and flood proofed (structure to be raised in place) structures were given a specific first floor elevation. The structure inventories for each of the HEC-FDA with-measure runs are as follows:

- Measure A – Inland Barrier and Surge Barrier at Elevation 20.0-feet NAVD88

This measure includes the without-project inventory less 2,426 parcels that were deleted out of the inventory. Of those, 506 parcels were estimated to be impacted in planning unit one, 1,580 in planning unit two, and 340 in planning unit three. These parcels represent the footprint of the inland barrier and surge barrier across the three planning units and some portion of the total would have to be purchase for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted

from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – Inland Barrier and Surge Barrier at Elevation 30.0-feet NAVD88

This measure includes the without-project inventory less 2,746 parcels that were deleted out of the inventory. Of those, 576 parcels were estimated to be impacted in planning unit one, 1,784 in planning unit two, and 386 in planning unit three. These parcels represent the footprint of the inland barrier and surge barrier across the three planning units and some portion of the total would have to be purchase for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure C – Inland Barrier and Surge Barrier at Elevation 40.0-feet NAVD88

This measure includes the without-project inventory less 3,087 parcels that were deleted out of the inventory. Of those, 634 parcels were estimated to be impacted in planning unit one, 2,025 in planning unit two, and 428 in planning unit three. These parcels represent the footprint of the inland barrier and surge barrier across the three planning units and some portion of the total would have to be purchase for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure D – Levee for Roadway - Elevation 20.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure E – Levee for Roadway - Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure F - Menge Ave. - Elevation 20.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure G - Menge Ave. - Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure H – Menge Ave. - Elevation 40.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure I – Levee for Roadway with Menge Ave Alt - Elevation 20.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure J - Levee for Roadway with Menge Ave Alt - Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure K - Non-structural One

This measure includes the acquisition of 20,308 parcels with structures and vacant land, and the flood proofing (elevate in place) of 10,524 structures to a range of elevations from 11.0-feet to 22.35-feet NAVD88 depending on the planning sub-unit. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is

detailed in the Non-structural Appendix. This elevation was determined to be approximately the ABFE level of protection is defined as still water elevation, plus wave run-up plus and estimate for waves (depth divided by two), and is the minimum elevation that a non-structural plan could provide.

- Measure L – Non-structural Two to Elevation 20.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure M – Non-structural Three to Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure N – Non-structural Three to Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

The equivalent annual damage reduction by measure for the Inland barrier and surge barrier is shown in table 6.16-3.

Table 6.16-3.
Equivalent Annual Damage Reduction by Future Scenario

Measures	Equivalent Annual Damage Reduction Future 3 ($)	Equivalent Annual Damage Reduction Future 4 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Equivalent Annual Damage Reduction Future 6 ($)
(No Action)	$0	$0	$0	$0
Measure A	$46,818,000	$38,660,000	$51,650,000	$41,400,000
Measure B	$75,548,000	$84,460,000	$81,980,000	$77,840,000
Measure C	$77,066,000	$74,230,000	$84,520,000	$79,750,000
Measure D	RFS	RFS	RFS	RFS
Measure E	RFS	RFS	RFS	RFS
Measure F	RFS	RFS	RFS	RFS
Measure G	RFS	RFS	RFS	RFS
Measure H	RFS	RFS	RFS	RFS
Measure I	RFS	RFS	RFS	RFS
Measure J	RFS	RFS	RFS	RFS
Measure K	$207,760,000	$211,820,000	$303,000,000	$231,340,000
Measure L	RFS	RFS	RFS	RFS
Measure M	RFS	RFS	RFS	RFS
Measure N	RFS	RFS	RFS	RFS

Damages are rounded to the nearest thousand
RFS – Requires Further Study.

6.16.6.3 Residual Damage

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damage is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table". Residual damage by measure is shown in table 6.16-4.

Table 6.16-4.
Residual Damage by Measure and by Future Scenario

Measures	Residual Damage Future 3 ($)	Residual Damage Future 4 ($)	Residual Damage Future 5 ($)	Residual Damage Future 6 ($)
(No Action)	$0	$0	$0	$0
Measure A	$199,082,000	$395,380,000	$423,550,000	$442,300,000
Measure B	$170,352,000	$349,580,000	$393,220,000	$405,860,000
Measure C	$168,834,000	$359,810,000	$390,680,000	$403,950,000
Measure D	RFS	RFS	RFS	RFS
Measure E	RFS	RFS	RFS	RFS
Measure F	RFS	RFS	RFS	RFS
Measure G	RFS	RFS	RFS	RFS
Measure H	RFS	RFS	RFS	RFS
Measure I	RFS	RFS	RFS	RFS
Measure J	RFS	RFS	RFS	RFS
Measure K	$38,140,000	$222,220,000	$172,200,000	$252,360,000
Measure L	RFS	RFS	RFS	RFS
Measure M	RFS	RFS	RFS	RFS
Measure N	RFS	RFS	RFS	RFS

Damages are rounded to the nearest thousand.
RFS – Requires Further Study

6.16.7 Environmental Quality (EQ)

6.16.7.1 Impacts of Inland Barrier Area Measure

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

1. A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.

2. A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.16-5, and 6.16-6, and 6.16-7 show the impacts of the inland barrier and surge barrier at elevations 20.0, 30.0, and 40.0-feet NAVD88 respectively.

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the Inland Barrier area can be found in the Environmental Appendix.

Table 6.16-5.
Wetland Acres Impacted by Inland Barrier A, elevation 20.0-feet NAVD88

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
3	0	0	0	2.9	0	2.9
4	4.1	11.9	0	0	0	16.0
5	0.5	36.3	0	12.3	0	49.0
7	0	0	0	3.9	0	3.9
10	0	1.6	0.1	13.3	0	15.0
13	0	0	0	0.2	0	0.2
23	0	0	0.2	4.1	0	4.3
24	0	0	0	2.5	0	2.5
25	0	0	0.3	2.3	0.1	2.6
28	0	0.7	0	4.3	0	4.9
Total	**4.6**	**50.5**	**0.6**	**45.6**	**0.1**	**101.4**

Table 6.16-6.
Wetland Acres Impacted by Inland Barrier B, elevation 30.0-feet NAVD88

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
3	0	0	0.2	6.1	0	6.3
4	8.0	25.0	0	0	0	33.0
5	0.9	75.2	0	40.7	0	116.8
7	0	0	0	16.9	0	16.9
10	0	3.4	0.5	34.7	0	38.5
13	0	0	0	0.9	0	0.9
23	0	0	1.9	14.2	0	16.0
24	0	0	0	11.6	0	11.6
25	0	0	2.6	10.8	0.3	13.6
28	0	1.3	0	17.1	0	18.4
36	0	0	0.2	19.3	0	19.5
37	0	0	0.1	9.6	0	9.8
41	0	0	0	0.5	0	0.5
43	0	0	0	0.3	0	0.3
Total	**8.9**	**104.8**	**5.5**	**182.8**	**0.3**	**302.4**

Table 6.16-7.
Wetland Acres Impacted by Inland Barrier C, elevation 40.0-feet NAVD88

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
3	0	0	0.1	8.1	0	8.3
4	9.2	30.8	0	0.2	0	40.3
5	1.1	91.3	0	52.0	0	144.4
7	0	0	0	23.3	0	23.3
10	0	4.1	0.7	41.5	0	46.2
13	0	0	0	1.2	0	1.2
23	0	0	2.3	18.1	0	20.4
24	0	0	0	14.8	0	14.8
25	0	0	3.6	15.5	0.3	19.5
28	0	1.5	0	21.5	0	23.0
36	0	0	3.6	44.4	0	48.0
37	0	0	3.5	31.5	0	35.0
41	0	0	0	0.8	0	0.8
43	0	0	0	0.5	0	0.5
Total	**10.4**	**127.7**	**13.9**	**273.2**	**0.3**	**425.5**

6.16.8 Summary of Costs

Table 6.16-8 summarizes the ROM costs at an FY-08 price level by measure.

Table 6.16-8.
Summary of Costs by Measure for the Inland Barrier Area

Measures	Implement Cost (FY-08) ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	N/A	$0
Measure A	$3,559,900,000	$175,045,000	$42,660,000	N/A	$217,705,000
Measure B	$5,039,300,000	$247,789,000	$61,777,000	N/A	$309,566,000
Measure C	$6,176,800,000	$303,721,000	$76,522,000	N/A	$380,243,000
Measure D	$ 3,329,500,000	$163,716,000	$42,521,000	N/A	$206,237,000
Measure E	$ 5,076,000,000	$249,593,000	$61,843,000	N/A	$311,436,000
Measure F	$ 1,257,100,000	$61,813,000	$16,389,000	N/A	$78,202,000
Measure G	$ 1,809,000,000	$88,951,000	$23,726,000	N/A	$112,677,000
Measure H	$ 2,583,000,000	$127,009,000	$34,245,000	N/A	$161,254,000
Measure I	$ 1,295,300,000	$63,691,000	$16,662,000	N/A	$80,353,000
Measure J	$ 1,954,800,000	$96,120,000	$25,690,000	N/A	$121,810,000
Measure K	$7,395,182,000	$363,630,000	$210,000	N/A	$363,840,000
Measure L	RFS	RFS	RFS	N/A	RFS
Measure M	RFS	RFS	RFS	N/A	RFS
Measure N	RFS	RFS	RFS	N/A	RFS

6.16.9 Regional Economic Development (RED)

The purpose of this analysis is to show the economic impact of the proposed project measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local areas of Jackson County, Harrison County and Hancock County, Mississippi. The expenditures for the measures are estimated to be $3,559,900,000 for the Inland Barrier A measure, $5,039,300,000 for the Inland Barrier B measure, $6,176,800,000 for the Inland Barrier C measure, $3,329,500,000 for the Inland Barrier D measure, $5,076,000,000 for the Inland Barrier E measure, $1,257,100,000 for the Inland Barrier F measure, $1,809,000,000 for the Inland Barrier G measure, $2,583,000,000 for the Inland Barrier H measure, $1,295,300,000 for the Inland Barrier I measure, $1,954,800,000 for the Inland Barrier J measure. Moreover, the total Operation and Maintenance (O&M) expenditures, which are based on the total present worth O&M costs over the period of analysis, are estimated to be $867,581,000 for the Inland Barrier A measure, $1,256,365,000 for the Inland Barrier B measure, $1,5556,235,000 for the Inland Barrier C measure, $864,754,000 for the Inland Barrier D measure, $1,257,707,000 for the Inland Barrier E measure, $333,305,000 for the Inland Barrier F measure, $482,518,000 for the Inland Barrier G measure, $696,444,000 for the Inland Barrier H measure, $338,857,000 for the Inland Barrier I measure, $522,460,000 for the Inland Barrier J measure. The following tables, 6.16-9 through 6.16-16, summarize the EIFS model inputs and outputs for the various measures.

6.17 Evaluation of Coast Wide Nonstructural Flood Damage Reduction Measures

6.17.1 General

This section describes the evaluation of nonstructural measures for the entire fifty-four planning sub-units that compose the MsCIP study area. Formulation of potential measures evaluated in this section was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC). There are a number of measures that can be classified as “nonstructural”. In some cases such as dry flood proofing by the use of ring walls, a nonstructural measure can approximate a structural solution when expanded to protect a large contiguous complex (college campus, industry, or commercial area). When judiciously applied, nonstructural measures can result in reductions in inundation damages and losses of life to structure occupants.

6.17.2 Opportunities

The following opportunities were identified for the area:

- Hurricane storm damage reduction or remediation.
- Preservation of Fish and Wildlife.

Table 6.16-9.
EIFS Model Implementation Cost Inputs for the Inland Barrier Area

	Inland Barrier A	Inland Barrier B	Inland Barrier C	Inland Barrier D	Inland Barrier E	Inland Barrier F	Inland Barrier G	Inland Barrier H
Region of Influence (ROI)	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County
Change in Local Expenditures	$3,559,900,000	$5,039,300,000	$6,176,800,000	$3,329,500,000	$5,076,000,000	$1,257,100,000	$1,809,000,000	$2,583,000,000

Table 6.16-10.
EIFS Model Implementation Cost Inputs for the Inland Barrier Area

	Inland Barrier I	Inland Barrier J	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural	40-foot Nonstructural
Region of Influence (ROI)	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County
Change in Local Expenditures	$1,295,300,000	$1,954,800,000	$7,478,172,000	RFS	RFS	RFS

Based of the given implementation cost inputs the outputs are as followed:

Table 6.16-11.
EIFS Model Implementation Cost Outputs for the Inland Barrier Area

	Inland Barrier A	Inland Barrier B	Inland Barrier C	Inland Barrier D	Inland Barrier E	Inland Barrier F	Inland Barrier G
Direct Sales Volume	$3,559,900,000	$5,039,300,000	$6,176,800,000	$3,329,500,000	$5,076,000,000	$1,257,100,000	$1,809,000,000
Induced Sales Volume	$3,931,528,000	$5,565,951,000	$6,898,170,000	$3,643,528,000	$5,611,826,000	$1,554,878,000	$2,232,026,000
Total Sales Volume	$7,491,428,000	$10,605,251,000	$13,074,970,000	$6,973,028,000	$10,687,826,000	$2,811,978,000	$4,041,026,000
Direct Income	$810,567,613	$1,145,905,330	$1,395,933,868	$761,797,617	$1,153,673,815	$263,984,202	$379,177,804
Induced Income	$888,978,600	$1,256,935,279	$1,548,098,737	$828,016,097	$1,266,645,886	$326,762,954	$468,272,881
Total Income	$1,699,546,214	$2,402,840,609	$2,944,032,605	$1,589,813,714	$2,420,319,700	$590,747,156	$847,450,685
Direct Employment	21,916	31,000	38,093	20,453	31,233	7,895	11,332
Induced Employment	24,269	34,331	42,659	22,439	34,622	9,778	14,004
Total Employment	46,184	65,330	80,752	42,892	65,855	17,673	25,336
Local Population	0	0	0	0		0	0

Table 6.16-12.
EIFS Model Implementation Cost Outputs for the Inland Barrier Area

	Inland Barrier H	Inland Barrier I	Inland Barrier J	ABFE 0 Nonstructural	20-foot Nonstructural	30-foot Nonstructural	40-foot Nonstructural
Direct Sales Volume	$2,583,000,000	$1,295,300,000	$1,954,800,000	$7,478,172,000	RFS	RFS	RFS
Induced Sales Volume	$3,194,170,000	$1,602,628,000	$2,414,276,000	$8,149,059,000	RFS	RFS	RFS
Total Sales Volume	$5,777,170,000	$2,897,928,000	$4,369,076,000	$15,627,232,000	RFS	RFS	RFS
Direct Income	$542,328,539	$272,070,199	$410,040,067	$1,711,127,000	RFS	RFS	RFS
Induced Income	$671,166,769	$336,870,453	$506,850,715	$1,852,321,000	RFS	RFS	RFS
Total Income	$1,213,495,308	$608,940,652	$916,890,782	$3,563,448,000	RFS	RFS	RFS
Direct Employment	16,219	8,138	12,258	45,830	RFS	RFS	RFS
Induced Employment	20,083	10,082	15,161	50,063	RFS	RFS	RFS
Total Employment	36,302	18,219	27,419	95,892	RFS	RFS	RFS
Local Population	0	0	0	0	RFS	RFS	RFS

Table 6.16-13.
EIFS Model Operation and Maintenance Cost Inputs for the Inland Barrier Area

	Inland Barrier A	Inland Barrier B	Inland Barrier C	Inland Barrier D	Inland Barrier E	Inland Barrier F	Inland Barrier G	Inland Barrier H
Region of Influence (ROI)	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County
Change in Local Expenditures	$867,581,000	$1,256,365,000	$1,556,235,000	$864,754,000	$1,257,707,000	$333,305,000	$482,518,000	$696,444,000

Table 6.16-14.
EIFS Model Operation and Maintenance Cost Inputs for the Inland Barrier Area

	Inland Barrier I	Inland Barrier J	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural	40-foot Nonstructural
Region of Influence (ROI)	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County
Change in Local Expenditures	$338,857,000	$522,460,000	$4,474,000	RFS	RFS	RFS

Based of the given implementation cost inputs the outputs are as followed:

Table 6.16-15.
EIFS Model Operation and Maintenance Cost Outputs for the Inland Barrier Area

	Inland Barrier A	Inland Barrier B	Inland Barrier C	Inland Barrier D	Inland Barrier E	Inland Barrier F	Inland Barrier G
Direct Sales Volume	$867,581,000	$1,256,365,000	$1,556,235,000	$864,754,000	$1,257,707,000	$333,305,000	$482,518,000
Induced Sales Volume	$949,794,000	$1,380,545,000	$1,732,946,000	$946,260,000	$1,382,223,000	$414,466,000	$597,786,000
Total Sales Volume	$1,817,375,000	$2,636,910,000	$3,289,181,000	$1,811,014,000	$2,639,930,000	$747,770,000	$1,080,304,000
Direct Income	$198,984,000	$287,002,000	$352,854,000	$198,385,000	$287,286,000	$70,275,000	$101,450,000
Induced Income	$216,353,000	$313,205,000	$390,161,000	$215,605,000	$313,561,000	$87,422,000	$125,767,000
Total Income	$415,337,000	$600,207,000	$743,015,000	$413,990,000	$600,846,000	$157,697,000	$227,218,000
Direct Employment	5,339	7,728	9,601	5,321	7,737	2,105	3,036
Induced Employment	5,860	8,514	10,721	5,838	8,525	2,620	3,765
Total Employment	11,199	16,242	20,321	11,158	16,262	4,725	6,801
Local Population	0	0	0	0		0	0

Table 6.16-16.
EIFS Model Operation and Maintenance Cost Outputs for the Inland Barrier Area

	Inland Barrier H	Inland Barrier I	Inland Barrier J	ABFE Nonstructural	0 20-foot Nonstructural	30-foot Nonstructural	40-foot Nonstructural
Direct Sales Volume	$696,444,000	$338,857,000	$522,460,000	$4,474,000	RFS	RFS	RFS
Induced Sales Volume	$864,109,000	$421,406,000	$647,713,000	$5,206,000	RFS	RFS	RFS
Total Sales Volume	$1,560,553,000	$760,262,000	$1,170,173,000	$9,680,000	RFS	RFS	RFS
Direct Income	$146,594,000	$71,450,000	$109,905,000	$960,000	RFS	RFS	RFS
Induced Income	$181,986,000	$88,891,000	$136,336,000	$1,113,000	RFS	RFS	RFS
Total Income	$328,581,000	$160,341,000	$246,241,000	$2,073,000	RFS	RFS	RFS
Direct Employment	4,388	2,140	3,289	27	RFS	RFS	RFS
Induced Employment	5,450	2,664	4,082	32	RFS	RFS	RFS
Total Employment	9,839	4,804	7,371	59	RFS	RFS	RFS
Local Population	0	0	0	0	RFS	RFS	RFS

6.17.3 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs.
- Price levels are FY-08, unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs.

6.17.4 Types of Nonstructural Measures

The nonstructural measures described below can be grouped into several general categories including:

- Flood Preparedness
- Floodplain Management, Floodplain Zoning and Flood Insurance
- Building codes
- Land Use Regulation and Zoning
- Development Impact Fees, TDR, TPR, and Redirection
- Land Taxation policies and development
- Flood proofing (elevation of structure in place, wet/dry proof, etc.)
- Permanent evacuations (acquisitions)
- Relocations of public buildings

Corps of Engineers documents and regulations as well as the technical papers and bulletins of other Federal and state agencies that address flooding from storms and hurricanes contain lists of possible nonstructural measures. Generally speaking, each of these identified measures can be applied either singly or in combination with other nonstructural or structural measures to attain project goals and planning objectives. In an effort to simplify the formulation of nonstructural plans, the NSFPC went through an initial screening process to determine which plans were feasible for detailed evaluation. The screening process used by the NSFPC for each of these types of measures can be found in the Nonstructural Appendix.

6.17.5 Historic Conditions

The Mississippi Gulf Coast is no stranger to large storm surge events. On August 17, 1969, Hurricane Camille impacted the area in a similar fashion to Hurricane Katrina. Hurricane Camille made landfall at Bay St. Louis, Mississippi only a few miles way from Hurricane Katrina's landfall path. The total surge area ranged from lower Plaquemines Parish in Louisiana to Perdido Pass, Alabama. Maximum surge from Hurricane Camille on the Mississippi coast ranged from 21.7-feet above m.s.l. in planning unit one, to 24.2-feet above m.s.l. in planning unit two, and 15.8-feet above m.s.l. in planning unit 3.

Damage to the Mississippi Coast from Hurricane Camille was extensive. Federal relief expenditures topped 100 million dollars at 1970 prices, over 600 million dollars at today's prices after accounting

for inflation. The magnitude of this number is astounding considering that many of the relief programs that exist today did not exist for Hurricane Camille. Chapter IV of this appendix describes in detail damage statics caused by Hurricane Camille surge inundation.

6.17.6 Existing Conditions

On August 29, 2005, Hurricane Katrina made land fall in Hancock County, Mississippi just east of the Pearl River. By virtually all accounts, it was the single largest disaster in U.S. history. Storm surge from Hurricane Katrina was the largest that has ever hit the continental United States. The surge inundated approximately 484 square miles of southern Mississippi. The relief expenditures in Mississippi alone have totaled in the billions of dollars. Figure 6.17-1 shows the inundation footprint of Hurricane Katrina.



Figure 6.17-1. Hurricane Katrina Path and Extent of Hurricane Katrina Surge in Planning Units One, Two, and Three

The three planning units suffered tremendous devastation from Hurricane Katrina's surge. The PDT estimates that 32,446 structures were significantly destroyed (at least fifty-percent or more), with another 15,000 to 25,000 suffering moderate to minimal inundation damage. Of the structures sustaining significant destruction, 9,555 were in planning unit one, 16,528, in planning unit two, and 6,363 in planning unit three. Of those significant loss structures, approximately 19,000 claims were paid out by the Federal Emergency Management Agency's (FEMA's) National Flood Insurance Program (NFIP) totally over $2.3 Billion dollars, with the average claim around $137,000. Currently, no accurate data exists for uninsured losses, but estimates range in the billions of dollars. Table 6.17-1 displays the significantly damaged structures by planning unit and by structure category. Chapter IV of this appendix describes in greater detail the coast wide damage caused by Hurricane Katrina surge inundation.

Table 6.17-1.
Structures Damaged 50% or More by Planning Unit and by Category

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Commercial	1,267	1,794	378	**3,439**
Residential	8,099	14,500	5,780	**28,379**
Municipal	127	89	136	**352**
Mobile Home	62	145	69	**276**
Total	**9,555**	**16,528**	**6,363**	**32,446**

Source: Field inventory conducted by the Corps PDT.

6.17.7 Without-Project Conditions

This section summarizes the coast wide future without-project conditions used as the basis for the evaluation of nonstructural measures. Future without-project conditions are defined as the characteristics of the area over the period of analysis should no federal project be implemented. The coast wide future without-project conditions are described in greater detail in Chapter IV of this appendix.

Given the vast devastation caused by hurricane Katrina, the projection of the future without-project conditions contains significant uncertainty. In an attempt to reduce this uncertainty, scenario testing was implemented. Scenario testing is where multiple future scenarios are created in order to evaluate what would happen if observed variables or assumptions do not happen as projected, and attempts to answer the 'what if' questions that arise when making forecasting assumptions and predictions. Table 6.17-2 summarizes the six future-without project scenarios created for the MsCIP Comprehensive Plan. As described in chapter IV, Future without-project scenarios one and two are for testing the sensitivity of effects of the increment between a no relative sea level rise scenario and the expected relative sea level rise scenario. Therefore, only future without-project scenarios three, four, five, and six were used to evaluate the nonstructural measures.

Table 6.17-2.
Overview of Future Scenarios

Future Scenario	Redevelopment Type	Relative Sea Level Rise	Description
Future Scenario 1	Residential	None	Rebuild structures as existed pre-Hurricane Katrina with no relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 2	Mixed Residential & Commercial	None	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, no relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 3	Residential	Expected (up to 2.4-feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina with up to 2.4-feet relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 4	Mixed Residential & Commercial	Expected (up to 2.4-feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, a up to 2.4-feet relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 5	Residential	High Rate (up to 3.4-feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina with up to 3.4-feet of relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 6	Mixed Residential & Commercial	High Rate (Up to 3.4-feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, up to 3.4-feet of relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.

Future Scenarios One and Two are included only to evaluate the effects of relative sea level rise. These Future scenarios will not be used in the evaluation of potential measures. Futures Three, Four, Five, and Six will be the future scenarios by which potential measures will be evaluated depending on the planning unit.

Tables 6.17-3, 6.17-4, and 6.17-5 summarize the structure inventory for future without-project scenarios three and five.

Table 6.17-3.
Futures Without-Project Scenarios Three and Five Inventory Parcels by Planning Unit and by Structure Category

Structure Categories	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Residential	17,907	49,121	49,688	**116,716**
Mobile Homes	498	2,497	3,553	**6,548**
Commercial	3,255	5,618	4,266	**13,139**
Municipal	653	351	763	**1,767**
Vacant Land	22,843	29,984	29,779	**82,606**
Total	**45,156**	**87,571**	**88,049**	**220,776**

Table 6.17-4.
Futures Without Project Scenarios Three and Five Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation

Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	19	1	2	1	**23**
2-foot	115	1	16	4	**136**
3-foot	411	2	42	18	**473**
4-foot	1,015	2	88	34	**1,139**
5-foot	2,566	20	143	52	**2,781**
6-foot	3,117	77	196	68	**3,458**
7-foot	3,975	129	270	87	**4,461**
8-foot	5,111	183	350	108	**5,752**
9-foot	6,475	226	463	130	**7,294**
10-foot	8,012	270	576	163	**9,021**
11-foot	10,381	321	730	194	**11,626**
12-foot	14,068	396	1,064	256	**15,784**
13-foot	18,411	507	1,537	352	**20,807**
14-foot	22,416	617	2,128	465	**25,626**
15-foot	31,139	779	3,424	629	**35,971**
16-foot	34,210	878	3,829	692	**39,609**
17-foot	37,925	1,006	4,125	774	**43,830**
18-foot	42,793	1,144	4,771	865	**49,573**
19-foot	47,914	1,368	5,650	942	**55,874**
20-foot	56,895	1,606	7,244	1,089	**66,834**
21-foot	60,673	1,784	7,809	1,154	**71,420**
22-foot	64,417	1,960	8,158	1,221	**75,756**
23-foot	71,143	2,174	8,893	1,293	**83,503**
24-foot	75,711	2,331	9,295	1,345	**88,682**
25-foot	79,957	2,473	9,633	1,392	**93,455**
26-foot	83,944	2,648	9,901	1,428	**97,921**
27-foot	86,948	2,788	10,144	1,463	**101,343**
28-foot	89,743	2,887	10,405	1,487	**104,522**
29-foot	92,130	2,986	10,634	1,502	**107,252**

Table 6.17-4.
Futures Without Project Scenarios Three and Five Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation (continued)

Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
30-foot	94,042	3,057	10,873	1,521	**109,493**
31-foot	95,586	3,158	11,114	1,535	**111,393**
32-foot	96,621	3,242	11,324	1,545	**112,732**
33-foot	97,531	3,300	11,450	1,555	**113,836**
34-foot	98,165	3,364	11,559	1,572	**114,660**
35-foot	98,669	3,429	11,623	1,584	**115,305**
36-foot	99,075	3,481	11,651	1,590	**115,797**
37-foot	99,498	3,532	11,682	1,598	**116,310**
38-foot	99,952	3,589	11,711	1,600	**116,852**
39-foot	100,478	3,644	11,747	1,605	**117,474**
40-foot	116,716	6,548	13,139	1,767	**138,170**

Table 6.17-5.
Futures Without-Project Scenarios Three and Five Inventory Structure and Content Values by Category and Planning Unit

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Structure Values				
Residential	$2,415,885,807	$4,449,184,443	$3,200,940,955	**$10,066,011,205**
Mobile Homes	$8,518,174	$48,312,941	$52,053,731	**$108,884,846**
Commercial	$611,355,705	$4,526,104,161	$2,048,940,654	**$7,186,400,520**
Municipal	$335,220,287	$261,009,884	$303,986,556	**$900,216,727**
Structure Value Subtotal	**$3,370,979,973**	**$9,284,611,429**	**$5,605,921,896**	**$18,261,513,298**
Content Values				
Residential	$2,415,885,807	$4,449,184,443	$3,200,940,955	**$10,066,011,205**
Mobile Homes	$12,606,898	71503152.68	77039521.88	**$161,149,573**
Commercial	$1,213,472.28	$2,388,618,644	$428,362,111	**$2,818,194,227**
Municipal	$135,597,922	$102,609,763	$102,022,049	**$340,229,734**
Content Value Subtotal	**$2,565,304,099**	**$7,011,916,003**	**$3,808,364,637**	**$13,385,584,739**
Total	**$5,936,284,072**	**$16,296,527,432**	**$9,414,286,533**	**$31,647,098,037**

Tables 6.17-6, 6.17-7, and 6.17-8 summarize the structure inventory for future without-project scenarios four and six.

Table 6.17-6.
Futures Without-Project Scenarios Four and Six
Inventory Parcels by Planning Unit and by Structure Category

Structure Categories	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Residential	17,757	2,497	49,688	**69,942**
Mobile Homes	498	48,636	3,553	**52,687**
Commercial	3,408	6,101	4,266	**13,775**
Municipal	651	381	763	**1,795**
Vacant Land	22,842	29,956	29,779	**82,577**
Total	**45,156**	**87,571**	**88,049**	**220,776**

Table 6.17-7.
Futures Without-Project Scenarios Four and Six Inventory Cumulative Structures
for All Three Planning Units by Structure Category and One-foot Elevation

Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	19	1	3	1	**24**
2-foot	111	1	17	4	**133**
3-foot	403	2	43	18	**466**
4-foot	1,003	2	89	34	**1,128**
5-foot	2,543	20	144	52	**2,759**
6-foot	3,080	77	197	68	**3,422**
7-foot	3,932	129	271	87	**4,419**
8-foot	5,055	183	351	108	**5,697**
9-foot	6,408	226	464	130	**7,228**
10-foot	7,934	270	577	163	**8,944**
11-foot	10,291	321	730	194	**11,536**
12-foot	13,954	396	1,069	256	**15,675**
13-foot	18,266	507	1,546	352	**20,671**
14-foot	22,220	617	2,147	465	**25,449**
15-foot	30,880	779	3,468	630	**35,757**
16-foot	33,923	878	3,930	692	**39,423**
17-foot	37,611	1,006	4,272	775	**43,664**
18-foot	42,439	1,144	4,949	866	**49,398**
19-foot	47,513	1,368	5,840	943	**55,664**
20-foot	56,412	1,606	7,398	1,089	**66,505**
21-foot	60,178	1,784	7,975	1,153	**71,090**
22-foot	63,910	1,960	8,365	1,220	**75,455**
23-foot	70,535	2,174	9,137	1,292	**83,138**
24-foot	75,091	2,331	9,590	1,344	**88,356**
25-foot	79,328	2,473	9,986	1,391	**93,178**
26-foot	83,308	2,648	10,301	1,427	**97,684**

Table 6.17-7.
Futures Without-Project Scenarios Four and Six Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation (continued)

Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
27-foot	86,314	2,788	10,584	1,462	**101,148**
28-foot	89,112	2,887	10,878	1,486	**104,363**
29-foot	91,498	2,986	11,147	1,501	**107,132**
30-foot	93,409	3,057	11,406	1,520	**109,392**
31-foot	94,952	3,158	11,677	1,534	**111,321**
32-foot	95,986	3,242	11,902	1,544	**112,674**
33-foot	96,897	3,300	12,053	1,554	**113,804**
34-foot	97,531	3,364	12,178	1,571	**114,644**
35-foot	98,035	3,429	12,247	1,583	**115,294**
36-foot	98,441	3,481	12,278	1,589	**115,789**
37-foot	98,864	3,532	12,315	1,597	**116,308**
38-foot	99,318	3,589	12,345	1,599	**116,851**
39-foot	99,844	3,644	12,381	1,604	**117,473**
40-foot	116,081	6,548	13,775	1,795	**138,199**

Table 6.17-8.
Future Without-Project Scenarios Four and Six Inventory Structure and Content Values by Category and Planning Unit

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Structure Values				
Residential	$2,390,977,748	$4,402,477,082	$3,200,940,955	**$9,994,395,785**
Mobile Homes	$8,518,168	$48,312,740	$52,053,731	**$108,884,639**
Commercial	$1,500,399,292	$4,233,140,761	$2,048,940,654	**$7,782,480,707**
Municipal	$334,734,608	$261,025,195	$303,986,556	**$899,746,359**
Structure Value Subtotal	**$4,234,629,816**	**$8,944,955,778**	**$5,605,921,896**	**$18,785,507,490**
Content Values				
Residential	$2,390,977,748	$4,402,477,082	$3,200,940,955	**$9,994,395,785**
Mobile Homes	$12,606,888.64	$71,502,855.20	$77,039,521.88	**$161,149,266**
Commercial	$1,473,899,310	$2,498,045,931	$428,362,111	**$4,400,307,352**
Municipal	$135,240,760	$102,280,080	$102,022,049	**$339,542,889**
Content Value Subtotal	$4,012,724,707	$7,074,305,948	$3,808,364,637	**$14,895,395,292**
Total	**$8,247,354,523**	**$16,019,261,726**	**$9,414,286,533**	**$33,680,902,782**

Equivalent annual damages for future without-project scenarios three, four, five, and six were estimated using the HEC-FDA program and based on the structure inventories described in the previous tables. Table 6.17-9 summarizes the equivalent annual damages for those scenarios. More detail can be found in chapter IV.

Table 6.17-9.
Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario

Without-Project Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Planning Unit One	$218,050,000	$222,220,000	$237,310,000	$241,520,000
Planning Unit Two	$103,280,000	$107,120,000	$115,470,000	$119,760,000
Planning Unit Three	$104,700,000	$104,700,000	$122,420,000	$122,420,000
Total	**$426,040,000**	**$434,040,000**	**$475,200,000**	**$483,700,000**

1/ Damages are rounded to the nearest thousand.
2/ Futures Two, Four, and Six do not apply to planning unit three, therefore total damages are the same as future scenarios one, three, and five.

6.17.8 Equivalent Annual Damages Reduced and Residual Damages

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios three and five and the damages incurred with the measure in place. The HEC-FDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each of the nonstructural measures. The inventories are the same as the without project inventory except that footprints of the acquisitions were deleted from the inventory and floodproofed structures (structures to be elevated in place) were given a higher elevation. The structure inventories for each of the HEC-FDA measure runs are as follows:

- NS-Measure A Acquisition and Floodproofing to Advisory Base Flood Elevation (ABFE) Level

This measure includes the acquisition of 33,198 structures and vacant parcels and the flood proofing (raise structure in place) of 25,419 structures to the ABFE elevation that is applicable for the planning sub-unit. This elevation was determined to be approximately the ABFE level of protection and is defined as still water elevation, plus wave run-up, plus an estimate for waves (depth divided by two), and is the minimum implementation elevation that a nonstructural measure do to the requirements of the National Flood Insurance Program (NFIP).The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the nonstructural appendix. Figure 6.17-2 shows the areas included in this plan. Figures 6.17-3, 6.17-4, and 6.17-5 show the same areas by planning unit.

- NS Measure B: Acquisition and Floodproofing to elevation 20.0-feet NAVD88

Requires Further Study

- NS Measure C: Acquisition and Floodproofing to elevation 30.0-feet NAVD88

Requires Further Study

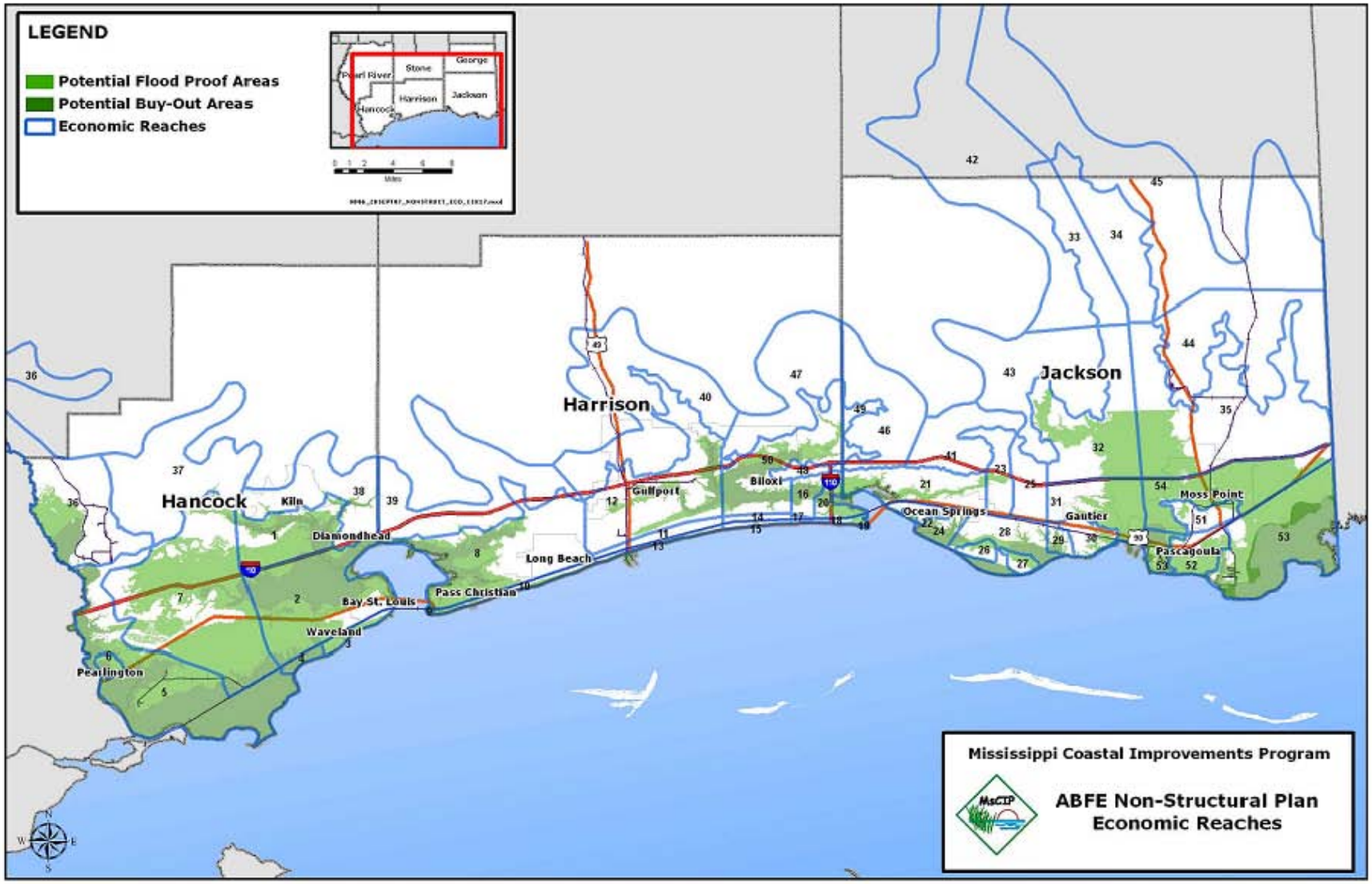


Figure 6.17-2. Nonstructural ABFE measure footprint

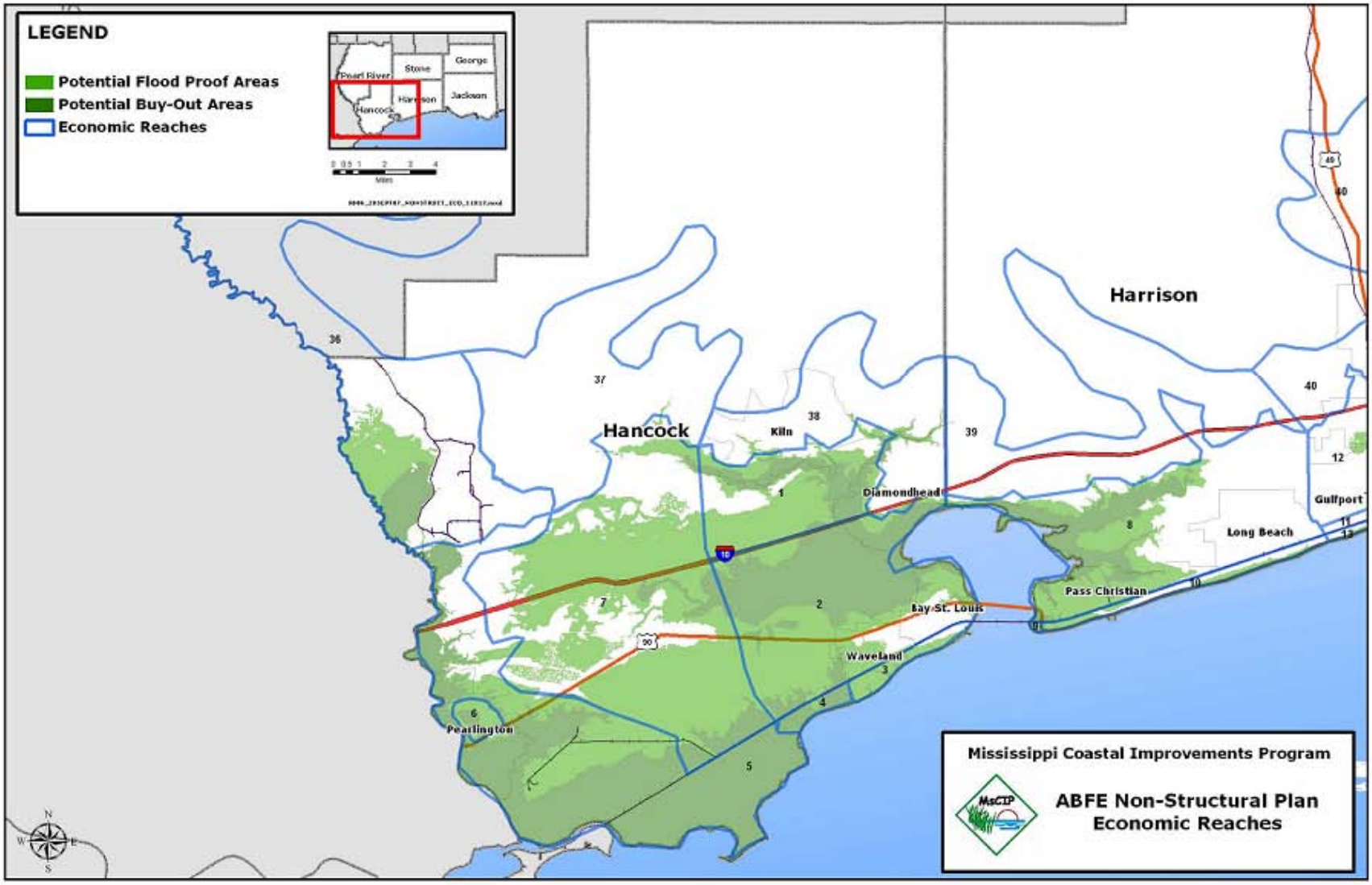


Figure 6.17-3. Nonstructural ABFE measure for planning unit one – Hancock County

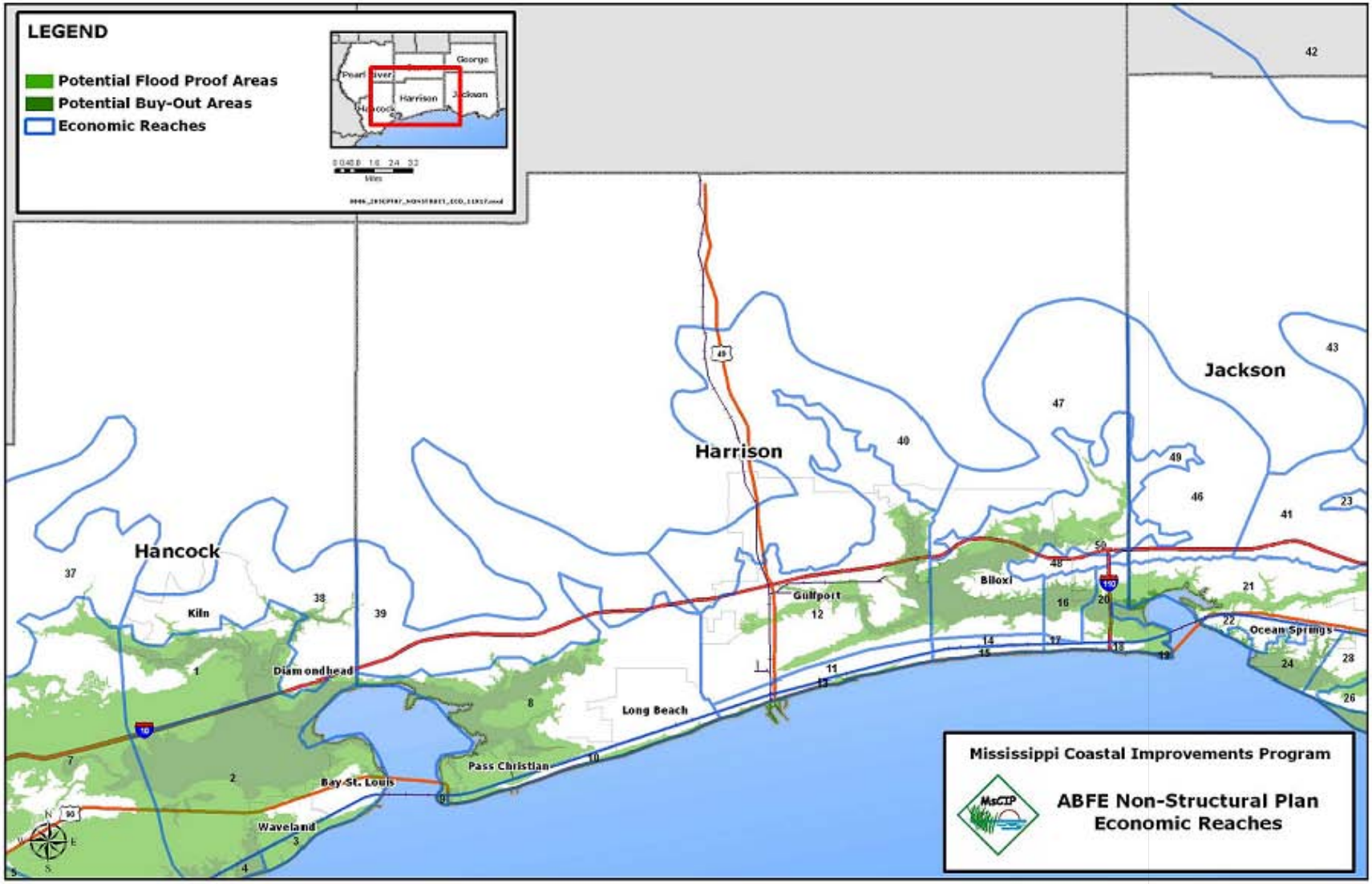


Figure 6.17-4. Nonstructural ABFE measure for Planning Unit Two – Harrison County

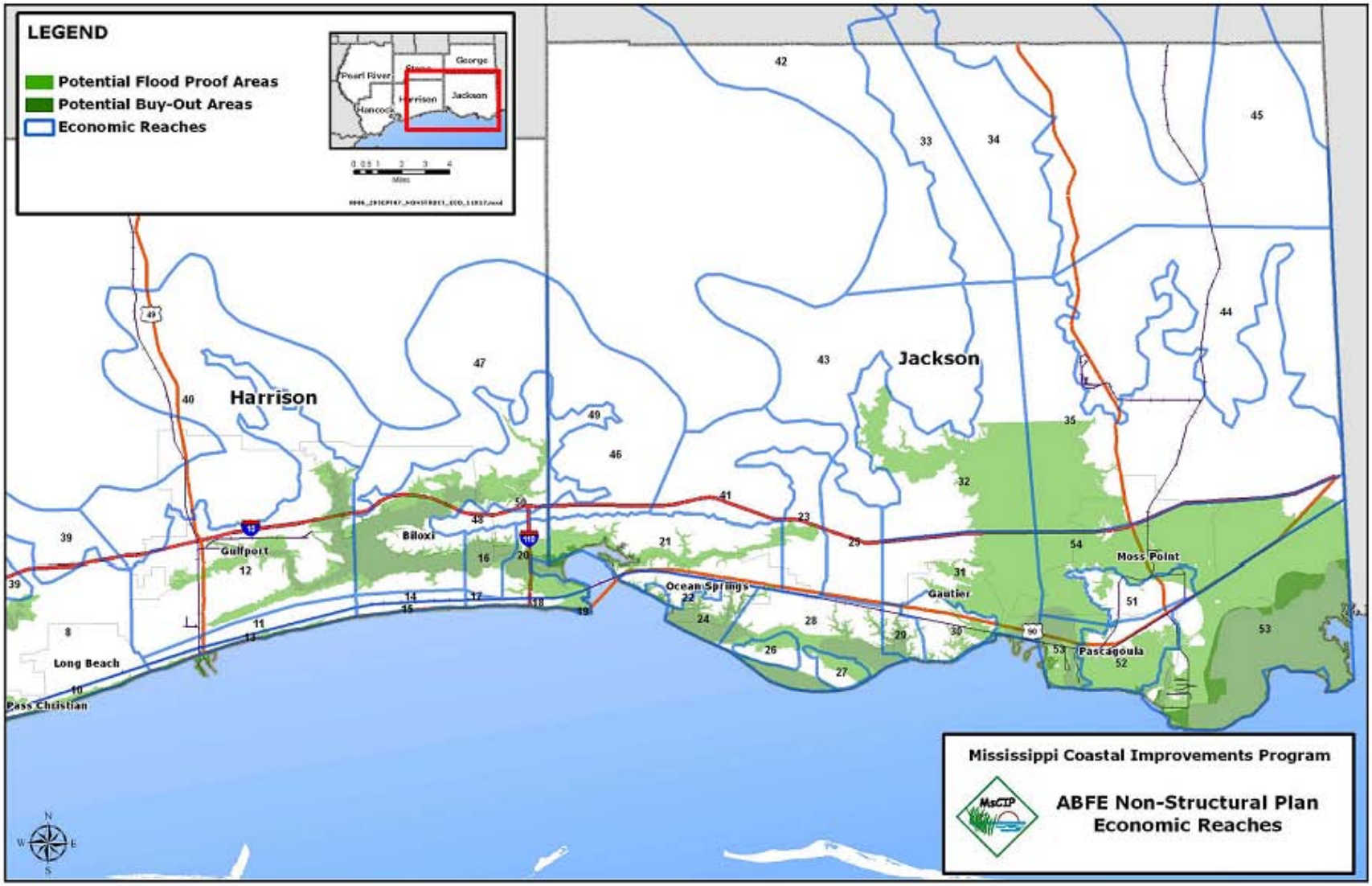


Figure 6.17-5. Nonstructural ABFE Measure for Planning Unit Three – Jackson County

- NS Measure D: Acquisition and Floodproofing to elevation 40.0-feet NAVD88

Requires Further Study

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damage is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table."

6.17.9. Summary of Damages

Table 6.17-10 summarizes the without-project damages, damages reduced, and residual damages by measure for scenarios three and five.

Table 6.17-10.
Summary of Damages by Potential Measure for Future Scenarios Three and Five

Measures	Equivalent Annual Damages Future 3 ($)	Equivalent Annual Damage Reduction Future 3 ($)	Residual Damage Future 3 ($)	Equivalent Annual Damages Future 5 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Residual Damage Future 5 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A ABFE Nonstructural	$426,040,000	$280,705,000	$145,335,000	$475,200,000	$307,305,000	$167,895,000
Measure B 20FT Nonstructural	RFS	RFS	RFS	RFS	RFS	RFS
Measure C 30FT Nonstructural	RFS	RFS	RFS	RFS	RFS	RFS
Measure D 40FT Nonstructural	RFS	RFS	RFS	RFS	RFS	RFS

Damages are rounded to the nearest thousand dollars.
RFS – Requires Further Study

Table 6.17-11 summarizes the without-project damages, damages reduced, and residual damages by measure for scenarios four and six.

Table 6.17-11.
Summary of Damages by Potential Measure for Future Scenarios Four and Six

Measures	Equivalent Annual Damages Future 4 ($)	Equivalent Annual Damage Reduction Future 4 ($)	Residual Damage Future 4 ($)	Equivalent Annual Damages Future 6 ($)	Equivalent Annual Damage Reduction Future 6 ($)	Residual Damage Future 6 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A ABFE Nonstructural	$434,040,000	$286,706,000	$147,334,000	$483,700,000	$311,333,000	$172,367,000
Measure B 20FT Nonstructural	RFS	RFS	RFS	RFS	RFS	RFS
Measure C 30FT Nonstructural	RFS	RFS	RFS	RFS	RFS	RFS
Measure D 40FT Nonstructural	RFS	RFS	RFS	RFS	RFS	RFS

Damages are rounded to the nearest thousand dollars.
RFS – Requires Further Study

6.17.10 Summary of Costs

Table 6.17-12 summarizes the costs by measure.

Table 6.17-12.
Summary of Costs by Nonstructural Measure

Measures	Total Cost to Implement (First Cost) ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC[1] ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0
Measure A ABFE Nonstructural	$16,782,494	$825,216,000	$400,000	N/A	$825,616,000
Measure B 20FT Nonstructural	RFS[2]	RFS	RFS	N/A	RFS
Measure C 30FT Nonstructural	RFS	RFS	RFS	N/A	RFS
Measure D 40FT Nonstructural	RFS	RFS	RFS	N/A	RFS

1/ Due to the massive scale and extended time frame of implementation of the coast wide nonstructural plans, IDC is not able to be calculated at this time. 2/ RFS – Requires Further Study.

6.17.11 Alternative Land Use

Each of the nonstructural measures contains some portion of the plan that consists of the acquisition of structures and parcels. Should any of the plans be implemented, the land contained in the footprint could never be used again for habitable use. However, there are alternative uses of land for these areas such as recreational areas, ecotourism areas, or environmental restoration. Each of these alternative uses of the acquisition area land would have associated benefits and costs. Further study would be required to determine the most cost effective use of the acquisition lands.

6.17.12 Other Social and Economic Benefits

In addition to the direct structure damage reduction benefits and the alternative use of land, acquisition of structures would have other social and economic benefits. These benefits include the reduction of risk to health and human safety, reduction of evacuation and subsistence costs (travel and stay to evacuate, non-profit assistance such as food, etc.), reduction of emergency costs following storm events (debris removal, temporary housing, etc.), reduction of residential reoccupation costs, reduction of commercial clean-up costs, and future infrastructure savings to the tax base for roads and utilities. For example, the bullets below are from the Louisiana Coastal Master Plan[4] estimates for damages in these categories. These numbers are based on Louisiana data and do not apply for Coastal Mississippi, but provide a sense of the potential costs savings that could be reduced.

- Combined federal, state, parish and municipality spending average of $1,450 for inundated residential structures and $3,850 for inundated non-residential structures,
- Evacuation and subsistence costs of up to $21,284 per household at risk,
- Reoccupation costs of up to $7,133 per inundated residential structure,
- Commercial clean-up and restoration costs of up to $16, 245 per inundated commercial structure.

Although these benefits can be shown on a per structure basis, significant economies of scale can be achieved with the acquisition of clusters of structures including streets, neighborhoods, and communities. Due to timing constraints of the study, quantifiable dollar amounts for these benefit categories could not be identified, but would be estimated as part of implementation or further study. Careful coordination between the Corps and local stakeholders would be required prior to implementation in order to optimize the economic efficiencies that could be gained from acquisition of parcels.

6.17.13 Summary of Regional Economic Development Benefits

The purpose of this section is to show the economic impact of the proposed measure on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of the three coastal counties of Mississippi. The first cost expenditures for the ABFE nonstructural measure are estimated to be $15,394,143,000, with an additional $8,134,000 for the total present worth of the operation and maintenance (O&M) expenditures assuming a 100-year period of analysis and an FY 08 discount rate of 4.875-percent. The 20FT elevation, 30FT elevation, and 40FT elevation coast wide nonstructural plans require further study to determine regional impacts. The following tables, 6.17-13 through 6.17-16, summarize the EIFS model inputs and outputs for the coast wide nonstructural plan.

[4] Louisiana Coastal Master Plan Appendix F: Economic Analysis.

Table 6.17-13.
EIFS Model Construction Costs Inputs for the Nonstructural Measures

	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural	40-Foot Nonstructural
Region of Influence (ROI)	Hancock, Harrison, and Jackson Counties	Hancock, Harrison, and Jackson Counties	Hancock, Harrison, and Jackson Counties	Hancock, Harrison, and Jackson Counties
Change in Local Expenditures	$16,782,494,000	RFS	RFS	RFS

RFS – Requires Further Study

Based of the given inputs the outputs are as followed:

Table 6.17-14.
EIFS Model Construction Costs Outputs for the Nonstructural Measures

	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural	40-Foot Nonstructural
Direct Sales Volume	$16,782,494,204	RFS	RFS	RFS
Induced Sales Volume	$18,593,365,860	RFS	RFS	RFS
Total Sales Volume	$35,375,860,065	RFS	RFS	RFS
Direct Income	$3,668,506,993	RFS	RFS	RFS
Induced Income	$4,041,514,947	RFS	RFS	RFS
Total Income	$7,710,021,941	RFS	RFS	RFS
Direct Employment	100,952	RFS	RFS	RFS
Induced Employment	112,040	RFS	RFS	RFS
Total Employment	212,992	RFS	RFS	RFS
Local Population	0	RFS	RFS	RFS

RFS – Requires Further Study

Table 6.17-15.
EIFS Model O&M Costs Inputs for the Nonstructural Measures

	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural	40-Foot Nonstructural
Region of Influence (ROI)	Hancock, Harrison, and Jackson Counties	Hancock, Harrison, and Jackson Counties	Hancock, Harrison, and Jackson Counties	Hancock, Harrison, and Jackson Counties
Change in Local Expenditures	$8,134,000	RFS	RFS	RFS

RFS – Requires Further Study

Based of the given inputs the outputs are as followed:

Table 6.17-16.
EIFS Model O&M Costs Outputs for the Nonstructural Measures

	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural	40-Foot Nonstructural
Direct Sales Volume	$8,134,000	RFS	RFS	RFS
Induced Sales Volume	$9,261,000	RFS	RFS	RFS
Total Sales Volume	$17,395,000	RFS	RFS	RFS
Direct Income	$1,718,000	RFS	RFS	RFS
Induced Income	$1,950,000	RFS	RFS	RFS
Total Income	$3,668,000	RFS	RFS	RFS
Direct Employment	49	RFS	RFS	RFS
Induced Employment	56	RFS	RFS	RFS
Total Employment	105	RFS	RFS	RFS
Local Population	0	RFS	RFS	RFS

RFS – Requires Further Study

6.18 Forrest Heights Levee, City of Gulfport, Harrison County

6.18.1 General

The culturally historical Forest Heights residential community in the City of Gulfport, Harrison County, Mississippi, has frequently been inundated by flood waters due to storm surges from the Mississippi Sound and from inland flooding along the lower Turkey Creek. Water reached a depth of 2-8 ft over the entire community during Hurricane Katrina inundation. The Forest Heights levee is proposed to be constructed as a pilot project for the MsCIP comprehensive plan. The levee will address the combination of storm surge protection, inland flooding protection, and evacuation. The levee is intended to be constructed to a height such that the levee might be certified under the National Flood Insurance Program. A preliminary engineering analysis suggests a levee built to approximately elevation 21 feet NAVD ’88 would satisfy or exceed certification elevation criteria.

Engineering performance and economic evaluations of protection options were done using the Hydrologic Engineering Center’s (HEC) Flood Damage Analysis (FDA) computer application HEC-FDA. HEC-FDA modeling was done using variations in with-project conditions compared to the future without-project conditions for the Turkey Creek study. Details regarding the methodology are presented in the Economic Appendix. Additional evaluation to determine the precise levee height will be performed during final engineering and design based upon analyzing the risk and uncertainty associated with the coincident occurrence of inland flooding and storm surge impacts.

6.18.2 Location

The Forrest Heights community is located in an area known as North Gulfport within the City of Gulfport on the Mississippi Gulf Coast. The location of the levee at Forrest Heights is shown below in Figures 6.18-1. The community lies along the lower Turkey Creek floodplain, which has a tendency to frequently exceed its stream channel capacity and flood adjacent low-lying areas.

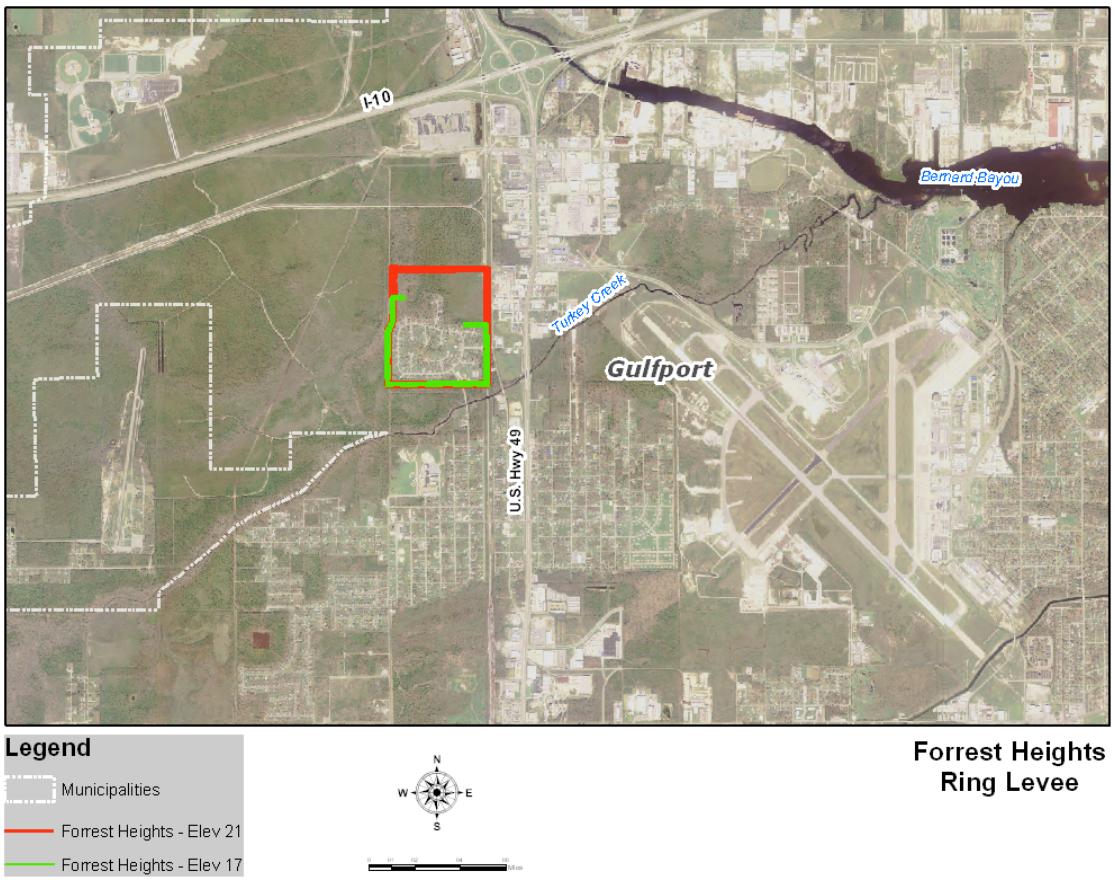


Figure 6.18-1. Forrest Heights Ring Levee Location

6.18.3 Assumptions

- The New Orleans District Corps of Engineers fresh water depth-damage relationships for residential and non-residential property were considered appropriate and accurate for the properties in this area,
- 50-year period of analysis,
- FY 2008 Federal discount rate of 4.875-percent,
- All values are equivalent to October 2007 dollars.

6.18.4 Existing Conditions

The community of Forrest Heights lies on the bank of Turkey Creek about 2.6 miles from the mouth at Bernard Bayou. Ground elevations over most of the residential area are between elevations 10-14 ft NAVD88. Drainage is mostly along streets and through natural drainage ways to the Turkey Creek. Impacts from flooding and hurricanes have been devastating. Hurricane Katrina in August, 2005 resulted in significant flood damages to residences in the Forrest Heights community. A levee with top width of 6 ft was constructed around the community to elevation 16.5 ft NGVD with side slopes of 1 vertical to 1.5 horizontal in 1969, prior to Hurricane Camille. It has not had adequate maintenance and is a state of disrepair. It is scheduled to be restored to as-built condition by January of 2009. However, the restored levee will not be sufficient to meet the present day standard for certification

according to the existing FEMA flood profiles in the vicinity. It is assumed that the as-built condition of this restored levee will be the existing condition for this report.

6.18.5 Without-Project Conditions

The without-project condition is the most likely case to occur during the 50-year period when a project could be in place. Because the Forrest Heights area has been developed since the 1800's, all of the usable land within the community is presently developed and rebuilt since Hurricane Katrina. Damages considered in the analysis were inundation damages and emergency cost damages that would occur from future storm events. Inundation damages and damages reduced were estimated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) computer software program. Three future without-project scenarios were identified for the Forrest Heights area: existing relative sea level rise, moderate relative sea level rise and high relative sea level rise.

6.18.5.1 Coastal Hydraulic Data

This section describes the development of the existing relative sea level rise scenario. High water marks taken by FEMA after Hurricane Katrina in 2005 as well as the 4-ft(blue), 8-ft(dark green), 12-ft(green), 16-ft(brown), 20-ft(orange), and 20-ft(pink) ground contour lines and Hurricane Katrina inundation limits are shown below in Figure 6.18-2. The data indicates the water was as high as 18-20 ft NAVD88 near the site, totally inundating the entire area.

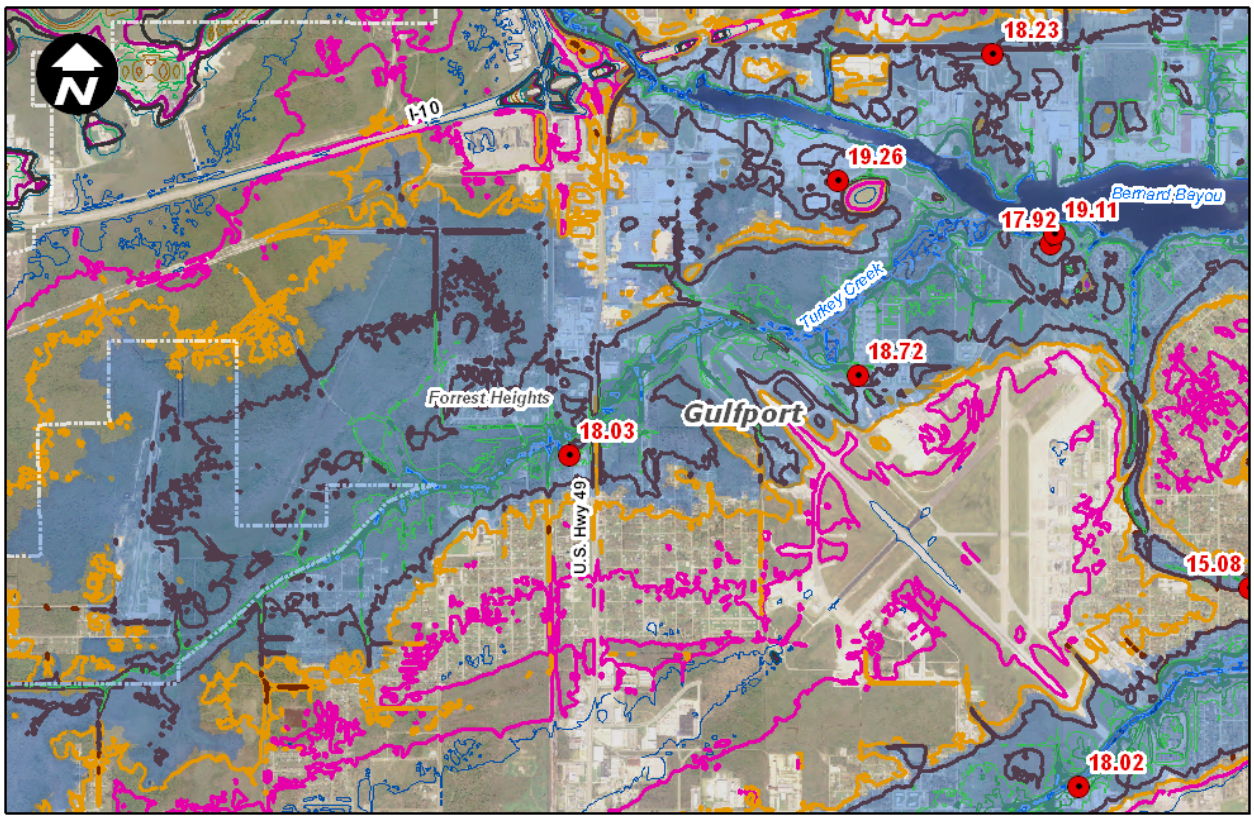


Figure 6.18-2. Hurricane Katrina Inundation and High Water, Forrest Heights

Stage-Frequency data for a suite of severe storms using Joint Probability Method (JPM) and hydrodynamic modeling were developed by the Engineer Research and Development Center (ERDC) for 80 locations along the study area. These data were combined with historical coastal tide gage frequencies for smaller storms to establish stage-frequency curves at 54 economic reaches in the study area. An expanded description of the procedure is presented in Section 2.13 of the Engineering Appendix. Points near Forrest Heights, at which data from hydrodynamic modeling was saved, are displayed in Table 6.18-1.

Table 6.18-1.
Surge Stage-Probability and Uncertainty

Annual Probability	Stage (Ft. NAVD88)	Standard Deviation (Feet)
0.04	8.8	0.6
0.02	11.6	1
0.01	13.7	1.5
0.002	17.2	2.5
0.001	18.3	2.9

It should be noted that the frequency curve reflects only that flooding resulting from storm surge in the gulf. The Forrest Heights community is also subject to riverine flooding by Turkey Creek. The preliminary FEMA Harrison County Flood Insurance Study (FIS) dated November 2007 provides computed Turkey Creek flood profiles which appear to have been adjusted for the effects of coincident surge in Back Bay of Biloxi. Table 6.18-2 shows relevant discharge and stage information from the FIS for Turkey Creek at Ohio Avenue, the southern entrance to the Forrest Heights community. In comparison to the preliminary FEMA Flood Insurance Study dated November 2007, which is based on contemporary (post-Katrina) FEMA contractor hydrodynamic modeling, the ERDC frequency curve, which is based on surge alone, suggests a lower stage associated with the annual one in one hundred chance (0.01 exceedance probability) event.

Table 6.18-2.
Turkey Creek Flood Stages At Ohio Avenue, Harrison County FIS.

Exceedance Probability	Discharge (cfs)	Stage (ft. NAVD '88)
0.1	2600	12
0.02	3650	14.2
0.01	5500	15.5
0.002	7950	18.3

Hydraulic data was developed for use in the Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) program. The HEC-FDA program uses risk-based analysis methods for evaluating flood damage and flood damage reduction alternatives. The program relies on hydrologic, hydraulic, and economic data input. Uncertainties in these data are input and used by the model for computing annual damages. Version 1.2.3b dated August 2007 was used. As described in chapter 2 of this appendix, this is a customized version of the current official release version 1.2 dated March 2000. This section describes the model's hydrologic and hydraulic input as applied to the Forrest Heights community.

Forrest Heights is subject to both riverine and surge flooding. For this reason, a discharge-frequency curve and a stage-discharge relationship (also known as a 'rating curve') were developed for input

into the HEC-FDA model. The discharge-frequency curve was computed in FDA using synthetic statistics using the 0.5-, 0.1-, and 0.01 annual exceedance probability discharges from the preliminary Harrison County FIS (see Table 3.3.6-2). The version of FDA used extends the stage frequency curve to the 0.999 and 0.0001 annual exceedance values. Uncertainty about the discharge-frequency curve was computed by the FDA program assuming an equivalent period of record. Sensitivity analysis of discharge uncertainty with respect to the equivalent period of record was conducted. Interpretation of the standard error and apparent period of record of the underlying hydrologic information used to develop the FIS discharge values versus discharge uncertainty computed by the FDA program suggested that an equivalent period of record of 20 years provided a reasonable preliminary estimate of uncertainty of discharge in the un-gaged stream. The resultant discharge-frequency curve and curves at the 5% and 95% confidence limits are shown below in Figure 6.18-3 and the values are shown in Table 6.18-3. These relationships are representative in the vicinity of Ohio Avenue.

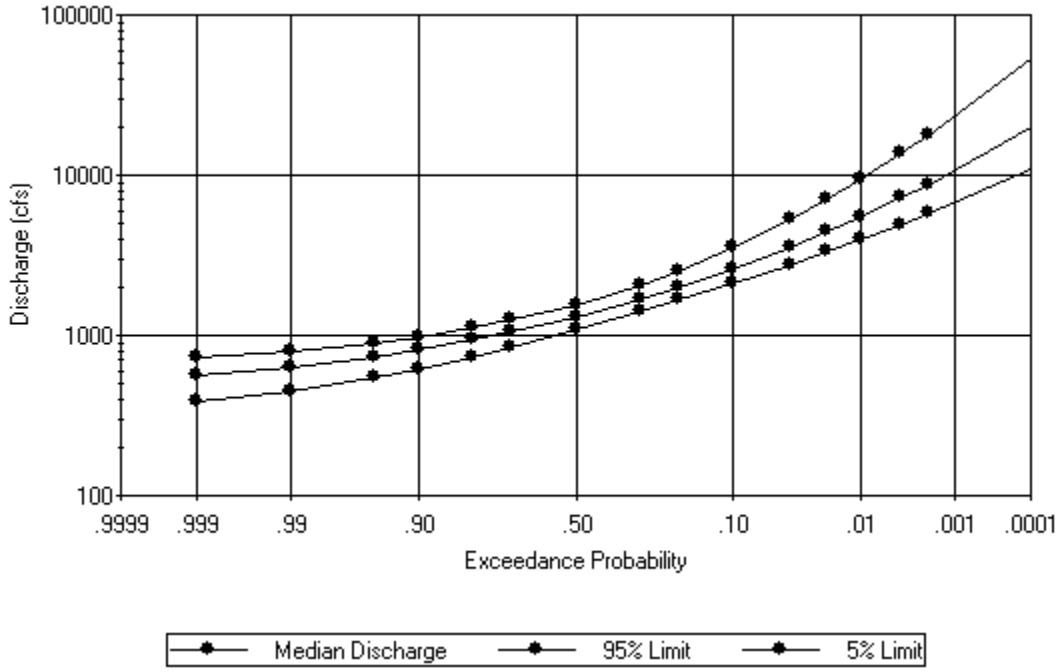


Figure 6.18-3. Computed Discharge-Frequency Curve, Turkey Creek at Ohio Avenue

Table 6.18-3.
Discharge-Frequency, Turkey Creek at Ohio Avenue

Exceedance Probability	Discharge (cfs)	Confidence Limit Curves Discharge (cfs) 95%	75%	25%	5%
0.9990	563	383	458	660	720
0.9900	634	447	525	733	795
0.9500	735	542	622	839	904
0.9000	811	614	696	918	986
0.8000	932	731	814	1,044	1,118
0.7000	1,045	840	924	1,165	1,245
0.5000	1,300	1,081	1,167	1,443	1,548
0.3000	1,678	1,412	1,511	1,882	2,051
0.2000	1,995	1,669	1,785	2,274	2,522
0.1000	2,601	2,118	2,281	3,066	3,515
0.0400	3,563	2,770	3,027	4,411	5,296
0.0200	4,449	3,330	3,684	5,716	7,104
0.0100	5,500	3,961	4,439	7,334	9,428
0.0040	7,211	4,935	5,625	10,093	13,561
0.0020	8,771	5,778	6,671	12,723	17,655
0.0001	19,704	11,042	13,464	33,224	52,792

The stage-discharge curve was developed by fitting an equation of the form $H = CQ^a$ (H = water surface elevation; Q is discharge; C and a determined by regression) through the Turkey Creek stage at cross section F as shown on the Turkey Creek Flood Profile, Plate 83P, of the preliminary FIS. The profile plate shows this location to have been adjusted for coincident probability of surge. The equation thus developed was used to extend the rating curve through a broader range of discharges than represented on the flood profiles. Uncertainty about the rating curve was assumed to be 1.5 feet at the 10-year and higher discharges based on FIS hydraulic modeling techniques and assuming a poor historic hydrologic data record (Turkey Creek is ungaged). The rating curve is shown in Figure 6.18-4.

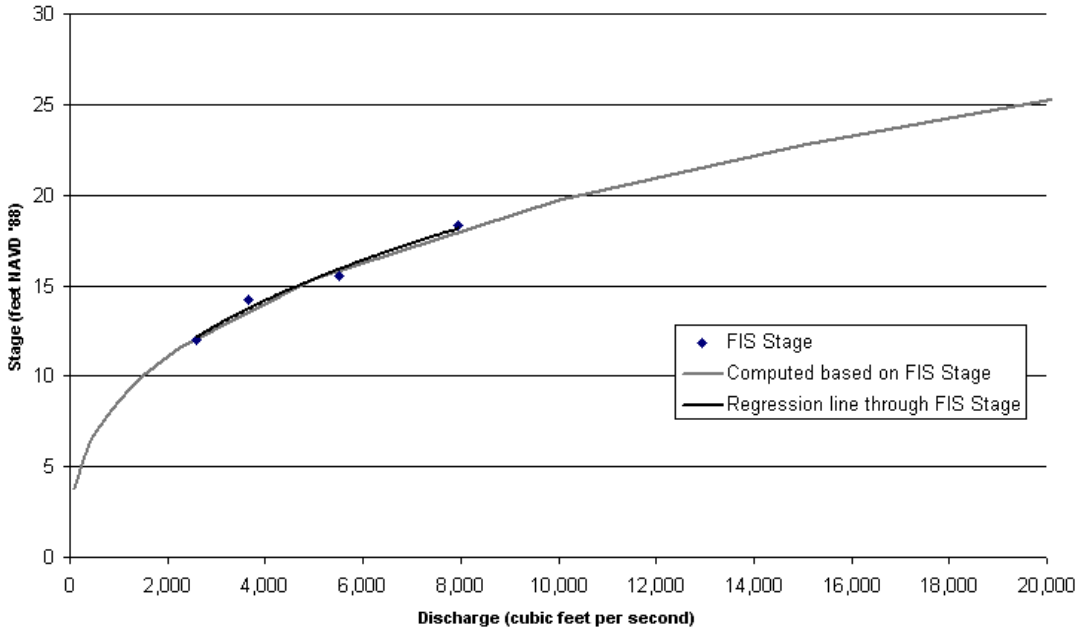


Figure 6.18-4. Computed Rating Curve, Turkey Creek at Ohio Avenue.

6.18.5.2 Summary of Without-Project Damages

Equivalent annual without-project damages for the Forrest Heights area were estimated using HEC-FDA program and evaluated for three future relative sea level rise scenarios; existing (Future 1), moderate (Future 3), and high (Future 5) relative sea level rise. The existing relative sea level rise condition, as described in the previous section, incorporates relative sea level rise to the base year, 2012, and does not project future relative sea level rise. The moderate and high relative sea level rise functions were used in the program by adding 0.9-feet for the moderate rate and 1.3-feet for the high rate to the existing relative sea level rise curves. Table 6.18-4 summarizes the without-project damages expected for the Forrest Heights area.

Table 6.18-4.
Without-Project Damages for the Forrest Heights Area by Future Scenario

Future Scenario 1	Future Scenario 3	Future Scenario 5
Existing Relative Sea Level Rise	Moderate Relative Sea Level Rise	High Relative Sea Level Rise
$107,550	$127,010	$141,290

6.18.6 List of Measures

- **Measure A - Elevation 17 ft NAVD88**

This option consists of an earthen dike around the Forrest Heights community as shown on the following Figure 6.18-5, along with the levee culvert/interior pump/detention location. The earth dike will be trapezoidal in shape with a 12-foot top width with one foot vertical to three foot horizontal slopes on both sides (1H:3V). For this option the two existing roadway entrances will be ramped over the restored levee. The total length of the levee will be approximately 7900 feet.

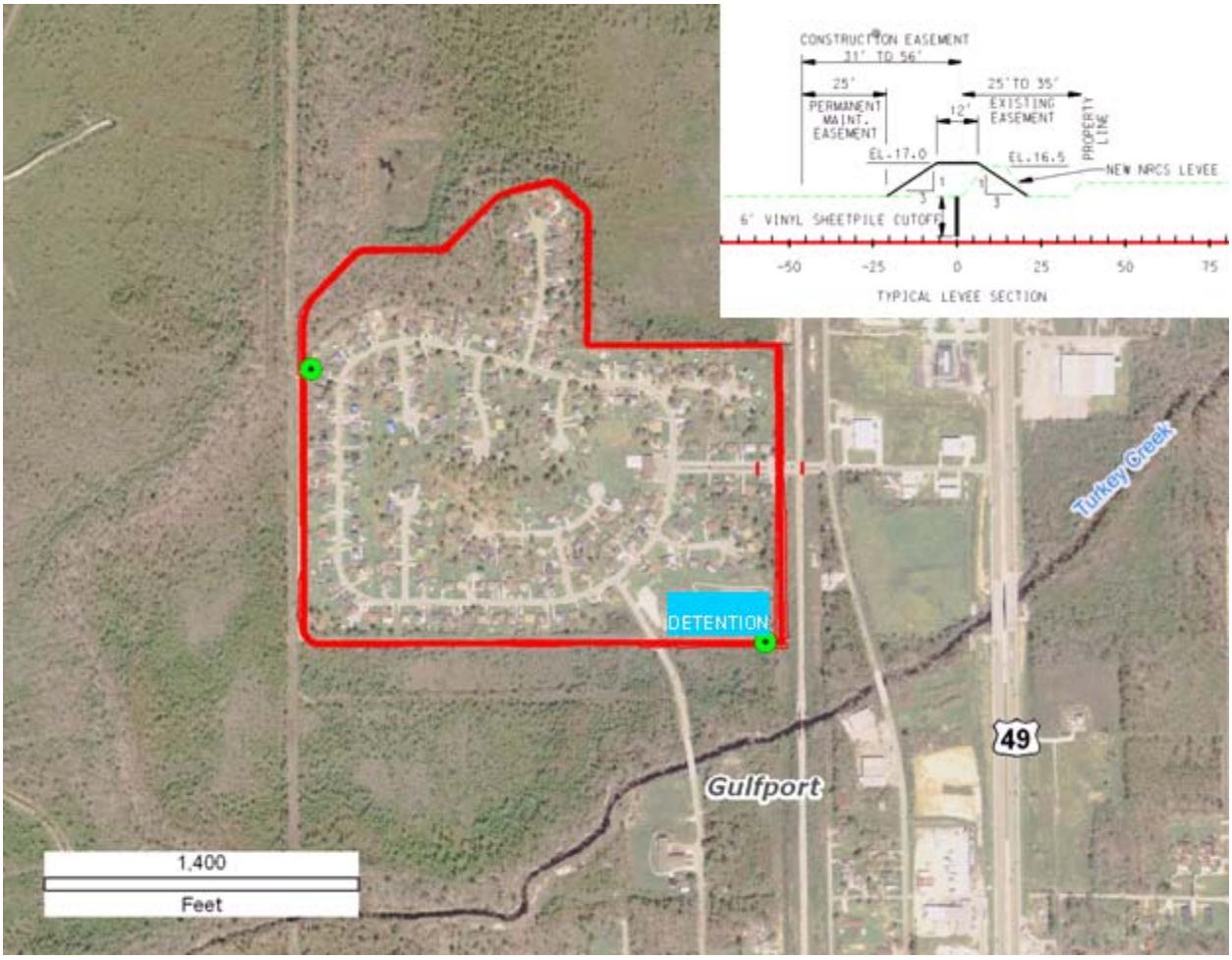


Figure 6.18-5. 17-ft Elevation Levee Alignment with Culvert and Pump/Detention Basin Locations

Levees reduce the storage capacity and overbank flow conveyance of the adjacent floodplain. The reductions in overbank flow area could induce higher water levels upstream. An HECRAS model was used to evaluate the potential for induced damages and solutions. The modeling indicates that selective clearing and snagging would prevent increases in water surface elevations upstream that would occur due the placement of the levees in the floodplain.

The selective clearing and snagging would extend for approximately 4.5 miles from the mouth of Turkey Creek at Bernard Bayou to the upstream limits as shown in Figure 6.18-6. Selective clearing and snagging would remove obstructions such as debris dams and excessive sedimentation that hinders the flow through the Turkey Creek channel. While the selective clearing and snagging component of the plan does not eliminate flooding along Turkey Creek, the plan does reduce flood damages along the creek and at the upper end of the canals at 28th Street. The main purpose of the selective clearing and snagging is to make sure that induced damages do not occur due to the construction of the levee.

The selective clearing and snagging work will follow Stream Obstruction Removal Guidelines established by the American Fisheries Society. Only debris, snags and sediment that obstruct the flow will be removed. Material to be removed includes: 1) fine sediment accumulations that obstruct flows and alter flow patterns; 2) Debris blockages that currently or in the near future cause obstructed flow and altered flow patterns; and 3) Rooted trees that obstruct flow or need to be cleared for equipment access. Access areas that are cleared will be reestablished at the conclusion

of the selective clearing and snagging activities. Some access points, however, may remain for the non-Federal sponsor to use for maintenance activity of the completed project. The existing bank alignment along the entire reach will not be changed, including the downstream reaches of Turkey Creek along the meander bends. Specific reaches to be cleared and snagged will be identified by an interdisciplinary team prior to construction.



Figure 6.18-6. Channel Clearing and Snagging Limits

Damage and failure by overtopping of levees could be caused by storm surges greater than the levee crest. Overtopping failures are caused by the high velocity of flow on the top and back side of the levee. Although significant wave attack on the seaward side of some of the New Orleans levees occurred during Hurricane Katrina, the duration of the wave attack was for such a short time that major damage did not occur from wave action. The erosion shown below in Figure 6.18-7 was caused by approximately 1-2 ft of overtopping crest depth.



Source: ERDC, Steven Hughes

Figure 6.18-7. Crown Scour from Hurricane Katrina at Mississippi River Gulf Outlet (MRGO) Levee in St. Bernard Parish, New Orleans, LA

An overtopping reach of the levee with a revetment at the detention/culvert location would be included in the levee design to prevent overtopping failure. The levee would be protected by gabions on filter cloth as shown in Figure 6.18-8, extending across a drainage ditch which carries water to nearby culverts and which would also serve to dissipate some of the supercritical flow energy during overtopping conditions.

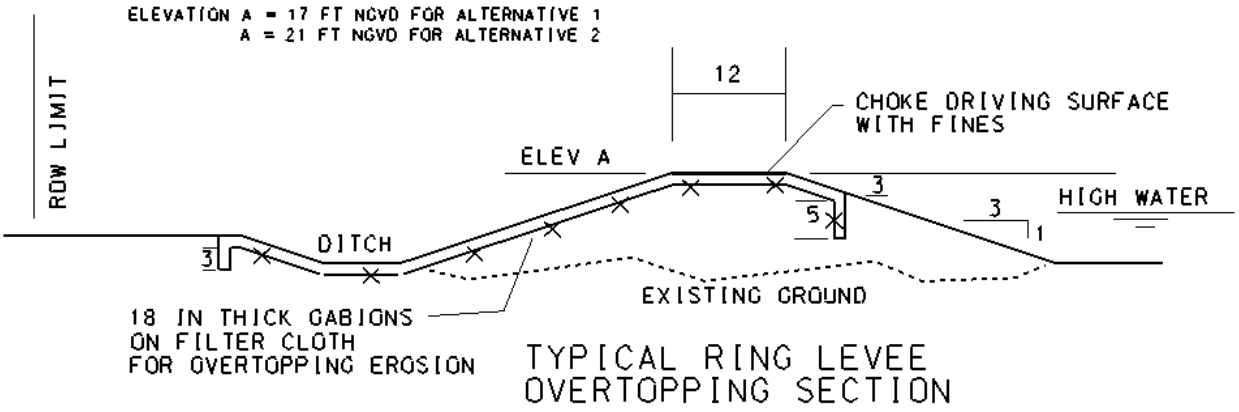


Figure 6.18-8. Typical Levee Overtopping Section

- **Option B - Elevation 21 ft NAVD88**

This option consists of an earthen levee around the entire community of Forrest Heights. The alignment of the levee is generally the same as Option A, above, with the required northern levee portion that would enclose the community within the levee as shown in Figure 6.18-3. The only difference between the description of this option and preceding description of Option A is the height of the levee and the length of the levee culverts. Other features and methods of analysis are the same.

6.18.7 With-Project Conditions

Equivalent annual damages reduced are those damages that are estimated to be reduced with a ring levee measure in place. Table 6.18-5 summarizes the equivalent annual damages reduced and table 6.18-6 summarizes residual damage.

Table 6.18-5.
Summary of Equivalent Annual Damages Reduced

Measure	Damages Reduced Future 1	Damages Reduced Future 3	Damages Reduced Future 5
No Action	$0	$0	$0
Measure A 17FT Levee	$8,860	$10,210	$11.580
Measure B 21FT Levee	$74,340	$89,340	$100,540

Table 6.18-6.
Summary of Equivalent Annual Residual Damages

Measure	Damages Reduced Future 1	Damages Reduced Future 3	Damages Reduced Future 5
No Action	$0	$0	$0
Measure A 17FT Levee	$98,690	$116,800	$129,710
Measure B 21FT Levee	$33,210	$37,670	$40,750

6.18.8 Summary of Costs

The rough order magnitude (ROM) costs for construction and for operations and maintenance are comparative-Level "Parametric Type" estimates and are based on Historical Data, Recent Pricing, and Estimator's Judgment. Quantities listed within the estimates represent Major Elements of the Project Scope and were furnished by the Project Delivery Team. Price Level of Estimate is April 07. Estimates excludes project Escalation and HTRW Cost. Table 6.18-7 summarizes the costs for the levee measures.

Table 6.18-7.
Summary of Costs by Measure for Forrest Heights

Measures	Total Cost to Implement (First Cost) ($)	IDC ($)	Total Initial Cost ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A 17FT Levee	$6,100,000	$135,000	$6,235,000	$335,000	$42,000	$377,000
Measure B 21FT Levee	$11,400,000	$252,000	$11,652,000	$626,000	$114,000	$740,000

The implementation costs include 1/ supervision and administration (30 account), 2/ planning, engineering & design (31 account) and 3/ appropriate contingencies. See the Cost Appendix for more detail on the implementation cost breakdowns. Numbers are rounded to the nearest thousand.

6.18.9 Regional Economic Development (RED) Benefits Socioeconomic Impacts using the Economic Impact Forecast System

The purpose of this analysis is to determine the economic impact of the proposed project alternatives on business (sales volumes), income, employment, and population of the local area. Each of the alternatives would affect the local area of Hancock County, Mississippi. The expenditures for the alternatives are estimated to be $6,100,000 for Alternative 1 and $11,400,000 for the Alternative 2. Moreover, the Annual Operation and Maintenance (O&M) expenditures are estimated to be $700,000 for Alternative 1 and $1,400,000 for Alternative 2 (assuming a 50 year period of analysis and an interest rate of 5.375-percent). Tables 6.18-8 through 6.18-11 summarize the EIFS model inputs and outputs for the cost effective measures at Admiral Island.

Table 6.18-8.
EIFS Model Implementation Inputs for the Forrest Heights Area

	No Action	17FT Levee	21FT Levee
Region of Influence (ROI)	Harrison County	Harrison County	Harrison County
Change in Local Expenditures	$0	$6,100,000	$11,400,000

Based of the given inputs the outputs are as follows:

Table 6.18-9.
EIFS Model Implementation Outputs for the Forrest Heights Area

	No Action	17FT Levee	21FT Levee
Direct Sales Volume	$0	$6,100,000	$11,400,000
Induced Sales Volume	$0	$7,625,000	$14,250,000
Total Sales Volume	$0	$13,725,000	$25,650,000
Direct Income	$0	$1,291,220	$2,413,099
Induced Income	$0	$1,614,025	$3,016,374
Total Income	$0	$2,905,244	$5,429,473
Direct Employment	0	39	72
Induced Employment	0	48	91
Total Employment	0	87	163
Local Population	0	0	0

Table 6.18-10.
EIFS Model O&M Inputs for the Forrest Heights Area

	No Action	17FT Levee	21FT Levee
Region of Influence (ROI)	Hancock County	Harrison County	Harrison County
Change in Local Expenditures	$0	$782,000	$2,122,000

Based of the given inputs the outputs are as followed:

Table 6.18-11.
EIFS Model O&M Outputs for the Forrest Heights Area

	No Action	17FT Levee	21FT Levee
Direct Sales Volume	$0	$782,000	$2,122,000
Induced Sales Volume	$0	$977,500	$2,652,500
Total Sales Volume	$0	$1,759,500	$4,774,500
Direct Income	$0	$165,530	$449,175
Induced Income	$0	$206,913	$561,469
Total Income	$0	$372,443	$1,010,644
Direct Employment	0	5	13
Induced Employment	0	6	17
Total Employment	0	11	30
Local Population	0	0	0

CHAPTER VII. SENSITIVITY ANALYSIS

7.1 Period of Analysis Sensitivity

This section describes the sensitivity of the period of analysis on the evaluation of equivalent annual damage reduction and average annual costs for the various measures. There are two significant drivers inherit in the period of analysis that will be addressed in this section. The first is the effect of relative sea level rise depending on a 50-year or a 100-year horizon and the other is the concept of the time value of money and amortization.

In order to describe the effects of these variables, two specific sites were chosen; Pearlington and Gautier areas. These areas were specifically chosen because they reside in the western and eastern planning units of the state, planning units one and three respectively, and because they have been formulated for the comparison of structural and nonstructural measures. Measures for each area were evaluated using the 100-year and 50-year periods of analysis. The measures included a ring levee at 20-feet NAVD88, a ring levee at 30-feet NAVD88, an ABFE level nonstructural plan (acquisitions and elevate-in-place), a nonstructural plan to a 20-foot NAVD88 elevation, and a nonstructural plan with a 30-feet NAVD88 elevation. These elevations were chosen to develop a cost and benefit curve, and were not assigned a particular event frequency. At some point, the curve would be used to determine the elevation for various frequency events. The evaluation of these measures to determine cost-effectiveness is located in Chapter VI of this appendix.

7.1.1 Effects of the Period of Analysis on Damages

The Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) program was used to calculate equivalent annual without-project damages and equivalent annual damages reduced for the various measures. The HECFDA model calculates equivalent annual damages for a base year and a most likely future year, and then linearly interpolates damages and damages reduced between the years. Figure 7.1-1 depicts this process. The process is the same for a 50-year period of analysis except that the most likely future would be 2061.

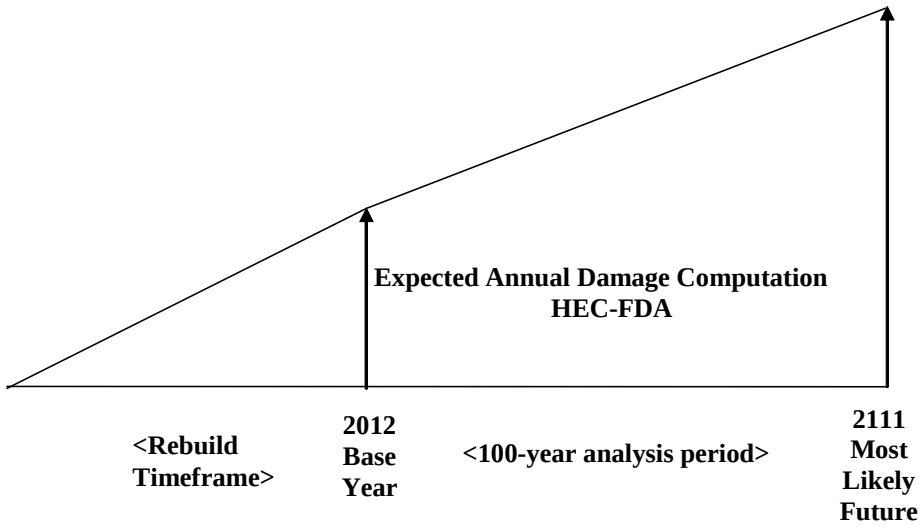


Figure 7.1-1. Calculation of Equivalent annual damages

There are six future without-project scenario conditions that were created for the MsCIP Comprehensive Plan. They are a combination of two different types of redevelopment scenarios with three types of relative sea level rise scenarios. Table 7.1-1 summarizes the six scenarios, which are described in greater detail in Chapter V of this appendix.

Table 7.1-1.
Overview of Future Scenarios

Future Scenario	Redevelopment Type	Relative Sea Level Rise 100-Years	Description
Future Scenario 1	Residential	Historical Only	Rebuild structures as existed pre-Hurricane Katrina with no relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 2	Mixed Residential & Commercial	Historical Only	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, no relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 3	Residential	Expected	Rebuild structures as existed pre-Hurricane Katrina with up to 2.4-feet relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 4	Mixed Residential & Commercial	Expected	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, a up to 2.4-feet relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 5	Residential	High Rate	Rebuild structures as existed pre-Hurricane Katrina with up to 3.4-feet of relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 6	Mixed Residential & Commercial	High Rate	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, up to3.4-feet of relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.

Future Scenarios One and Two are included only to evaluate the effects of relative sea level rise. These Future scenarios will not be used in the evaluation of potential measures. Futures Three, Four, Five, and Six will be the future scenarios by which potential measures will be evaluated depending on the planning unit.

The Pearlington and Gautier areas were on evaluated against future scenarios one, three, and five due to the geographic characteristics, historical development patterns, and political climate of the areas. SAM Engineering Division developed exceedance probability functions for each of the fifty-four planning sub-units; Pearlington is denoted as planning sub-unit six and Gautier as planning sub-unit thirty. The exceedance probability functions were developed by using an approach that combined historical Corps gage data and modeling conducted by the Engineer Research and Development Center (ERDC). The engineering appendix contains more information about the exceedance probability functions.

The exceedance probability function for the base year is the observed/modeled value, and the most like future year is the base year exceedance probability function plus some measure of relative sea level rise depending on the period of analysis. Future without-project scenario one is the full

redevelopment of the area back to pre-Hurricane Katrina levels with no addition for future relative sea level rise. Future without-project scenario three is the same redevelopment scenario as future one with an expected rate of relative sea level rise applied to the most likely future year (2111), and future without-project scenario five is the same redevelopment with a high rate of relative sea level rise included. Table 7.1-2 summarizes the future without-project scenario three and five conditions.

Table 7.1-2.
Details of Future Without-Project Scenarios One, Three, and Five 100-Year and 50-Year Periods of Analysis

Measure	Redevelopment Type	Approximate 100-Year Relative Sea Level Rise	Approximate 50-Year Relative Sea Level Rise
Pearlington Area (Planning sub-unit six)			
Future Scenario One	Redevelopment back to pre-Hurricane Katrina Levels	0.0-feet	0.0-feet
Future Scenario Three	Redevelopment back to pre-Hurricane Katrina Levels	1.8-feet	0.9-feet
Future Scenario Five	Redevelopment back to pre-Hurricane Katrina Levels	3.2-feet	1.3-feet
Gautier Area (Planning sub-unit 30)			
Future Scenario One	Redevelopment back to pre-Hurricane Katrina Levels	0.0-feet	0.0-feet
Future Scenario Three	Redevelopment back to pre-Hurricane Katrina Levels	2.4-feet	1.5-feet
Future Scenario Five	Redevelopment back to pre-Hurricane Katrina Levels	3.8-feet	2.0-feet

By comparing the change in equivalent annual damages, damages reduced, and residual damages for future without-project scenario one under the 100-year and 50-year periods of analysis, the effects of the time value of money can be isolated. This is true because future scenario one has no change in relative sea level rise whether it is being evaluated at 100-years or at 50-years. Thus, the only difference between future scenario one for the 100-year and 50-year is the change in the capital recovery factor. The Capital recovery factor is a ratio that is applied to total present worth damages in order to estimate the average annual value of a number. For damages, it is calculated as:

Average Annual damages = Total Present Worth of Damages x Capital Recovery Factor

Total Present Worth = $\sum_n$ (Cost / (1+ i) ^n)

Capital Recovery Factor (CRF) = i / (1-(1+i) ^-n)

Where:

i = discount rate

n = period of analysis

The capital recovery factor is calculated by the HEC-FDA program based on the user input discount rate (4.875-percent) and the period of analysis (100-years or 50-years). The HEC-FDA program was run for periods of analysis for future without-project scenario one. Without-project damages for the Pearlington area were $11,569,000 and $12,640,000 for the 100-year and 50-year analysis respectively, and without project damages for the Gautier area for future scenario one are

$4,920,000 and $5,376,000 for the 100-year and 50-year period of analysis respectively. This represents a 9.26-percent difference for the Pearlington area and a 9.27-percent difference for the Gautier area for equivalent annual without-project damages. Thus, the effects of a 50-year period of analysis are higher equivalent annual damages than would be expected under the 100-year period of analysis. The same higher effect can be seen for the equivalent annual damages reduced and the equivalent annual residual damages. Tables 7.1-3 and 7.1-4 show the comparison of the damages reduced and the residual damages for future without-project scenario one for the two periods of analysis.

Table 7.1-3.
Equivalent Annual Damage Reduction Comparison of 50-Year Compared to 100-Year Future Without-Project Scenario One Pearlington and Gautier Area Measures

Measure	100-Year Equivalent annual damages ($)	50-Year Equivalent annual damages ($)	Percent Difference 50-Yr to 100-Yr (%)
Pearlington Area Measures			
Ring Levee 20FT	$11,241,000	$12,282,000	9.26%
Ring Levee 30FT	$11,560,000	$12,630,000	9.26%
ABFE Nonstructural	$10,998,000	$12,016,000	9.26%
Gautier Area Measures			
Ring Levee 20FT	$4,378,000	$4,784,000	9.27%
Ring Levee 30FT	$4,897,000	$5,350,000	9.26%
ABFE Nonstructural	$3,104,000	$3,391,000	9.25%

Damages are rounded to the nearest thousand.

Table 7.1-4.
Equivalent Annual Residual Damage Comparison of 50-Year Compared to 100-Year Future Without-Project Scenario One Pearlington and Gautier Area Measures

Measure	100-Year Equivalent Annual Residual Damages ($)	50-Year Equivalent Annual Residual Damages ($)	Percent Difference 50-Yr to 100-Yr (%)
Pearlington Area Measures			
Ring Levee 20FT	$328,000	$358,000	9.15%
Ring Levee 30FT	$9,000	$10,000	11.11%
ABFE Nonstructural	$571,000	$624,000	9.28%
Gautier Area Measures			
Ring Levee 20FT	$542,000	$592,000	9.23%
Ring Levee 30FT	$23,000	$26,000	13.04%
ABFE Nonstructural	$1,816,000	$1,985,000	9.31%

Damages are rounded to the nearest thousand.

Future without-project scenarios three and five are different from future without-project scenario one in that they account for some rate of relative sea level rise over the period of analysis. As previously displayed in table 7.1-2, the 50-year period of analysis would constitute a smaller rate of relative sea level rise than the 100-year period of analysis. This smaller rate, given all other things equal, would mean that the equivalent annual without-project damages, equivalent annual damages reduced, and the equivalent annual residual damages for the 50-year period of analysis would be lower than the 100-year period of analysis. However, the time value of money effect that was described for future scenario one also comes into play for future scenarios three and five, resulting in and upward effect. Thus, there is a simultaneous push upward (time value of money) and downward (relative sea level rise) from these two variables when comparing the equivalent annual damages under a 50-year to the 100-year period of analysis. This can be seen in the effects of the change in equivalent annual without-project damages for future scenarios three and five are displayed in table 7.1-5. For the Pearlington area, the change to equivalent annual without-project damages is 3.24 and -4.01(negative 4.01)-percent for future without-project scenario conditions three and five respectively. The changes for the Gautier are 1.90 and -7.65 (negative 7.65)-percent for future scenarios three and five respectively. The effects of the change in scenario three are dominated by the time value of money factor, causing and increase in equivalent annual damages; where scenario five is dominated by a reduction in relative sea level rise (the difference in a 100-year estimate compared to a 50-year estimate), thus causing a lowering effect.

Table 7.1-5.
Equivalent Annual Without-Project Damage Comparison of 50-Year Compared to 100-Year Future Without-Project Scenarios Three and Five Pearlington and Gautier Area Measures

Measure	100-Year Equivalent annual damages ($)	50-Year Equivalent annual damages ($)	Percent Difference 50-Yr to 100-Yr (%)
Pearlington Area Measures			
Future Scenario Three Without Project Damages	$12,885,000	$13,303,000	3.24%
Future Scenario Five Without Project Damages	$14,205,000	$13,635,000	-4.01%
Gautier Area Measures			
Future Scenario Three Without Project Damages	$5,831,000	$5,942,000	1.90%
Future Scenario Five Without Project Damages	$6,702,000	$6,189,000	-7.65%

Damages are rounded to the nearest thousand.

Table 7.1-6 displays the equivalent annual damage reduction for the 100-year and 50-year periods of analysis for future without-project scenario three and table 7-1.7 for future without-project scenario five. Residual damages, damages that remain even if the measure were to be implemented, are shown in table 7.1-8 for future-without project scenario three and table 7.1-9 for future without-project scenario five.

Table 7.1-6.
Equivalent Annual Damage Reduction Comparison of 50-Year Compared to 100-Year Future Without-Project Scenario Three Pearlington and Gautier Area Measures

Measure	100-Year Equivalent annual damages ($)	50-Year Equivalent annual damages ($)	Percent Difference 50-Yr to 100-Yr (%)
Pearlington Area Measures			
Ring Levee 20FT	$11,894,000	$12,918,000	8.61%
Ring Levee 30FT	$12,267,000	$13,292,000	8.35%
ABFE Nonstructural	$12,260,000	$12,652,000	3.20%
Gautier Area Measures			
Ring Levee 20FT	$5,166,000	$5,279,000	2.19%
Ring Levee 30FT	$5,800,000	$5,912,000	1.93%
ABFE Nonstructural	$3,623,000	$3,713,000	-5.27%

Damages are rounded to the nearest thousand.

Table 7.1-7.
Equivalent Annual Damage Reduction Comparison of 50-Year Compared to 100-Year Future Without-Project Scenario Five Pearlington and Gautier Area Measures

Measure	100-Year Equivalent annual damages ($)	50-Year Equivalent annual damages ($)	Percent Difference 50-Yr to 100-Yr (%)
Pearlington Area Measures			
Ring Levee 20FT	$13,088,000	$13,236,000	1.13%
Ring Levee 30FT	$13,228,000	$13,623,000	2.99%
ABFE Nonstructural	$13,520,000	$12,970,000	-4.07%
Gautier Area Measures			
Ring Levee 20FT	$5,923,000	$5,492,000	-7.28%
Ring Levee 30FT	$6,663,000	$6,156,000	-7.61%
ABFE Nonstructural	$3,984,000	$3,844,000	-3.51%

Damages are rounded to the nearest thousand.

Table 7.1-8.
Equivalent Annual Residual Damage Comparison of 50-Year Compared to 100-Year Future Without-Project Three Pearlington and Gautier Area Measures

Measure	100-Year Equivalent Annual Residual Damages ($)	50-Year Equivalent Annual Residual Damages ($)	Percent Difference 50-Yr to 100-Yr (%)
Pearlington Area Measures			
Ring Levee 20FT	$991,000	$385,000	-61.15%
Ring Levee 30FT	$618,000	$11,000	-98.22%
ABFE Nonstructural	$625,000	$651,000	4.16%
Gautier Area Measures			
Ring Levee 20FT	$665,000	$663,000	-0.30%
Ring Levee 30FT	$31,000	$30,000	-3.24%
ABFE Nonstructural	$2,208,000	$2,229,000	0.95%

Damages are rounded to the nearest thousand.

Table 7.1-9.
Equivalent Annual Residual Damage Comparison of 50-Year Compared to 100-Year Future Without-Project Five Pearlington and Gautier Area Measures

Measure	100-Year Equivalent Annual Residual Damages ($)	50-Year Equivalent Annual Residual Damages ($)	Percent Difference 50-Yr to 100-Yr (%)
Pearlington Area Measures			
Ring Levee 20FT	$1,117,000	$399,000	-64.28%
Ring Levee 30FT	$977,000	$12,000	-98.77%
ABFE Nonstructural	$685,000	$665,000	-2.92%
Gautier Area Measures			
Ring Levee 20FT	$779,000	$697,000	-10.53%
Ring Levee 30FT	$39,000	$33,000	-15.38%
ABFE Nonstructural	$2,718,000	$2,345,000	-13.72%

Damages are rounded to the nearest thousand.

The results of the sensitivity of the period of analysis on future without project scenarios three and five vary by location and plan. As previously noted, this is due to the upward effect of the time value of money and the lowering effect that results from a lesser relate of relative sea level rise for the 50-year period of analysis. The only conclusive evidence that can be deduced from this exercise is that there will be higher residual damages under the 100-year period of analysis as compared to the 50-year period of analysis, and, in some cases, the difference in residual damages are very large.

It is important to note that the 20-feet NAVD88 and 30-feet NAVD88 elevations were fixed point elevations for cost and benefit evaluation purposes only, and not directly tied to a particular frequency event. When implemented to a particular frequency event, an elevation would have to be selected to provide for that level of protection. By using a 50-year period of analysis, the selection of an elevation for a particular event level would be lower than the selection for the same event level

under the 100-year period of analysis due to the difference in relative sea level rise. Thus, if you were to pick the elevation for the 1-percent event under the 50-year period of analysis and relative sea level rise were more like the 100-year period of analysis, the risk of overtopping and increased level of residual damages could be significant.

7.1.2 Effects of the Time Value of Money

7.1.2.1 Average Annual Implementation Cost

Traditionally, the Corps of Engineers reports costs on an average annual basis. Average annual costs are calculated by multiplying the total present worth of costs times the capital recovery factor.

Average Annual Implementation Costs = Total Present Worth of Costs x Capital Recovery Factor

Total Present Worth = Cost / (1+ i) ^n))

Capital Recovery Factor (CRF) = i / (1-(1+i) ^-n)

Where:

i = interest rate

n = period of analysis

Typically, costs are associated to the years they would be expended in should the project be constructed. Those expenditures are then brought back, or present worthed, to the same fiscal year (FY) as the benefits in order for a direct and accurate comparison. At this point in the analysis of the potential measures, the timing of expenditures have not yet been identified; therefore the total implementation cost act as the total present worth of the implementation costs and will be multiplied by the capital recovery factor to get the average annual implementation cost values.

A simple case example is to imagine that a project costs one dollar to implement, or the present worth of the project is one dollar. This is the same whether you chose a 50-year period of analysis or a 100-year period of analysis, thus the changing variable is the capital recovery factor. The capital recovery factors for a 100-year and 50-year period of analysis are 0.049171225 and 0.053722282 respectively. Using the average annual cost equation expressed above the average annual costs of the one dollar project is:

100-Year

$1 x 0.049171225 = $0.049

50-Year

$1 x 0.053722282 = $0.053

This simple comparison shows that the difference in cost for a 100-year period of analysis compared to a 50-year period of analysis is that the 50-year average annual cost is 9.26-percent higher. This result would be expected since the costs are attributed to a shorter period. The everyday example of this is a person saving to buy something. If you save monthly over two years compared to one year, you will have to save less every month to achieve the same goal. Table 7.1-10 shows this effect on the measures for the Pearlington area and the Gautier area. **Note:** Future without-project scenarios have no bearing on the implementation cost of the various measures.

Table 7.1-10.
Average Annual Implementation Cost Comparison of 50-Year Compared to 100-Year Pearlington and Gautier Area Measures

Measure	100-Year Average Annual Costs ($)	50-Year Average Annual Costs ($)	Percent Difference 50-Yr to 100-Yr (%)
Pearlington Area Measures			
Ring Levee 20FT	$4,754,857	$5,194,945	9.26%
Ring Levee 30FT	$5,620,271	$6,140,457	9.26%
ABFE Nonstructural	$19,073,518	$20,838,873	9.26%
Gautier Area Measures			
Ring Levee 20FT	$16,629,708	$18,168,876	9.26%
Ring Levee 30FT	$21,620,587	$23,621,687	9.26%
ABFE Nonstructural	$9,362,201	$10,228,723	9.26%

7.1.2.2 Interest During Construction

Interest during construction is an added economic cost because it is the opportunity cost of having construction monies tied up until the measure becomes fully operational. Since, at this point in the analysis, the length of construction for these measures have not been identified, interest during construction was not calculated for the analyzed Pearlington and Gautier area measures and is not included in the total average annual costs. Further study would be required in order to calculate interest during construction on each of the measures. However, since interest during construction is a function of the discount rate and the period of time it takes to construct the project, it will have no bearing on whether a 100-year or 50-year period of analysis is used, i.e. interest during construction would be the same regardless of the period of analysis.

Average annual operation and maintenance costs for the structural ring levee measures was calculated as two-percent of the contract cost for the structure. This number was provided by MOBILE DISTRICT (SAM) Engineering Division and would not be impacted under a 100-year or 50-year period of analysis. Average annual operation and maintenance costs for nonstructural measures were provided but the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and were based on factors that are not directly affected by the period of analysis.

7.2 First Floor Elevation Uncertainty Sensitivity

The HEC-FDA program is a Monte Carlo based program that allows and compensates for the uncertainty pertaining to multiple structure characteristic inputs. The main uncertainty variables are those pertaining to the exceedance probability function, structure value, content value, and first floor elevation. Initial sensitivity runs on these variables determined that the first floor elevation uncertainty is the most sensitive to change. For that reason, the first floor elevation was chosen for this sensitivity analysis.

In a typical feasibility level study, the first floor elevation of each structure is determined by a survey crew in the field. For the MsCIP Comprehensive Plan Report, the survey of over 130,000 structures was not feasible from a time, labor, and funding perspective. Therefore, a sampling technique was used to estimate the first floor elevation of each structure using a combination of LIDAR data and field estimation of the finished floor above ground elevation. The uncertainty pertaining to the

estimated first floor elevation was found to be 3.52-feet for one standard deviation. This was attained by surveying a two-percent sample, approximately 3,000 structures, using the typical feasibility level survey method and then comparing it to the estimates attained from the LIDAR plus finished floor estimates. Chapter IV describes the inventory sampling process and first floor elevation estimates in greater detail.

Given the nature of sensitivity and the magnitude of the uncertainty pertaining to the first floor elevation, a sensitivity analysis was conducted to determine the extent of influence this variable had on the equivalent annual damages that were estimated for the entire study area. The sensitivity analysis was conducted for the equivalent annual without-project damages for all six future without-project scenarios. Details on those scenarios can be found above in table 7.1.1 or in chapter V of this appendix.

The intent of this sensitivity analysis was to compare the first floor elevation uncertainty in the MsCIP Comprehensive data to the uncertainty expressed in previous Corps studies using more accurate and traditional surveying methods. In order to determine a typical uncertainty that is associated with the standard survey of ach structure, previous Mobile District reports were utilized. Uncertainty pertaining to the first floor elevation used for previous feasibility studies ranged from 0.3-feet and 0.9-feet for one standard deviation. For this sensitivity analysis, the mean of these values (0.6-feet) was used. The future without-project conditions for each of the six scenarios were run with both the 3.52-feet of uncertainty and the 0.6-feet of uncertainty and compared to determine the sensitivity. The following tables show the results of the first floor elevation sensitivity analysis on equivalent annual damages and damages reduced for the Pearlington and Gautier area measures.

Table 7.2-1.
First Floor Uncertainty Sensitivity on Equivalent Annual Without-Project Damages
Pearlington and Gautier Area Measures

Measure	3.52FT Uncertainty Equivalent annual damages ($)	0.6FT Uncertainty Equivalent annual damages ($)	Percent Difference (%)
Pearlington Area Measures			
Future Scenario One Without Project Damages	$11,569,000	$6,950,000	-39.93%
Future Scenario Three Without Project Damages	$12,885,000	$8,856,000	-31.27%
Future Scenario Five Without Project Damages	$14,205,000	$9,586,000	-32.52%
Gautier Area Measures			
Future Scenario One Without Project Damages	$4,920,000	$2,992,000	-39.19%
Future Scenario Three Without Project Damages	$5,831,000	$3,686,000	-36.79%
Future Scenario Five Without Project Damages	$6,702,000	$4,288,000	-36.02%

Damages are rounded to the nearest thousand.

Table 7.2-2.
First Floor Uncertainty Sensitivity on Equivalent annual damages Reduced Future Without Project Scenario One Pearlington and Gautier Area Measures

Measure	3.52FT Uncertainty Equivalent annual damages Reduced ($)	0.6FT Uncertainty Equivalent annual damages Reduced ($)	Percent Difference (%)
Pearlington Area Measures			
Ring Levee 20FT	$11,241,000	$6,611,000	-41.19%
Ring Levee 30FT	$11,560,000	$6,941,000	-39.96%
ABFE Nonstructural	$10,998,000	$6,501,000	-40.89%
Gautier Area Measures			
Ring Levee 20FT	$4,378,000	$2,410,000	-44.95%
Ring Levee 30FT	$4,897,000	$2,968,000	-39.39%
ABFE Nonstructural	$3,104,000	$1,917,000	-38.24%

Damages are rounded to the nearest thousand.

Table 7.2-3.
First Floor Uncertainty Sensitivity on Equivalent annual damages Reduced Future Without Project Scenario Three Pearlington and Gautier Area Measures

Measure	3.52FT Uncertainty Equivalent annual damages Reduced ($)	0.6FT Uncertainty Equivalent annual damages Reduced ($)	Percent Difference (%)
Pearlington Area Measures			
Ring Levee 20FT	$11,894,000	$8,421,000	-29.20%
Ring Levee 30FT	$12,267,000	$8,843,000	-27.91%
ABFE Nonstructural	$12,260,000	$8,315,000	-32.18%
Gautier Area Measures			
Ring Levee 20FT	$5,166,000	$2,975,000	-42.41%
Ring Levee 30FT	$5,800,000	$3,654,000	-37.00%
ABFE Nonstructural	$3,623,000	$2,405,000	-33.62%

Damages are rounded to the nearest thousand.

Table 7.2-4.
First Floor Uncertainty Sensitivity on Equivalent annual damages Reduced Future Without Project Scenario Five Pearlington and Gautier Area Measures

Measure	3.52FT Uncertainty Equivalent annual damages Reduced ($)	0.6FT Uncertainty Equivalent annual damages Reduced ($)	Percent Difference (%)
Pearlington Area Measures			
Ring Levee 20FT	$13,088,000	$9,115,000	-30.36%
Ring Levee 30FT	$13,228,000	$9,571,000	-27.65%
ABFE Nonstructural	$13,520,000	$9,047,000	-33.08%
Gautier Area Measures			
Ring Levee 20FT	$5,923,000	$3,451,000	-41.74%
Ring Levee 30FT	$6,663,000	$4,247,000	-36.26%
ABFE Nonstructural	$3,984,000	$2,809,000	-29.49%

Damages are rounded to the nearest thousand.

CHAPTER VIII. RECOMMENDED PLAN FEATURES

The recommended system wide plan features for the MsCIP Comprehensive plan, explained in more detail in the Main Report, have multiple levels. Some of the features will be recommended as work for entities other than the Corps of Engineers, some will be recommended for further construction, and some will be recommended for implementation. The list of measures in this appendix which are recommended for further study include the ring levee and nonstructural measures at the Pearlington, Ocean Springs, Gautier, Gulf Park Estates, Belle Fontaine, and Pascagoula/Moss Point areas, as well as further inquiry into the coast wide 20-foot, 30-foot, and 40-foot elevation nonstructural measures. Among the list of recommended plan features for construction that were analyzed in this appendix include barrier island restoration, beach and dune placement, ecosystem restoration at the Admiral Island, Turkey Creek, Bayou Cumbest, Dantzler, and Franklin Creek areas, the 21-foot elevation levee at the Forrest Heights area, and the acquisition of parcels within high risk areas.

For planning and screening purposes, the analysis in this appendix used a 100-year period of analysis for measures that were determined to be complex in nature such as the barrier island restoration or measures that had a high risk of residual damages due to relative sea level rise such as flood risk management measures. Other measures that were not as complex in nature, such as the beach and dune placement and the ecosystem restoration measures were evaluated at the traditional 50-year period of analysis used in Corps of Engineers studies. In order to show consistency among the plans recommended for construction, those measures that were initially screened at a 100-year period of analysis have been converted to a 50-year period of analysis for costs and benefits and are summarized in table 8-1. The costs in table 8-1 represent Rough Order Magnitude (ROM) utilized for screening. Detailed Micro-Computer Aided Cost Estimating System (MCACES) costs can be found in the cost estimating appendix.

Table 8-1.
Summaries of Benefits and Costs for Measures Recommended for Implementation[1]

	Equivalent annual damages Reduced Future 3 (Annual $)	Recreation (Annual $)	Environmental Impacts	Changes in Sales Volume ($)	Changes in Income ($)	Changes in Employment	Total First Cost with IDC[2] ($)	Average Annual Cost (Annual $)
Barrier Island Restoration	$18,028,000	$466,000	$43,618,000 Fishery Losses Avoided	$798,984,000	$167,850,000	4,920	$551,134,800	$29,608,000
Beach and Dune Placement	Moderate Reduction	N/A	736 Functional Habitat Index (FHI) Score	$33,413,200	$7,307,000	208	$25,192,300	$1,353,000
Acquisition in High Risk Areas	$22,000,000 to $33,000,000	Potential Recreational Opportunities	Potential Restoration Opportunities	$3,238,602,000	$706,330,000	19,452	$459,442,100	$24,682,000
Forrest Heights 21-FT Ring Levee	$89,000	N/A	3.6 Acres Impacted	$30,425,000	$6,440,000	193	$14,482,500	$778,000
Admiral Island Ecosystem Rest.	Increased Surge Storage	N/A	60 Average Annual Functional Units (AAFU)	$49,750,000	$ 11,996,000	301	$22,997,000	$1,235,000
Turkey Creek Ecosystem Rest.	Increased Surge Storage	N/A	1,565 Average Annual Functional Units (AAFU)	$15,237,000	$3,226,000	97	$7,206,300	$387,000
Bayou Cumbest Ecosystem Rest.	Increased Surge Storage	N/A	188 Average Annual Functional Units (AAFU)	$54,073,000	$ 10,546,000	306	$26,917,800	$1,446,000
Dantzler Ecosystem Rest.	Increased Surge Storage	N/A	1,244 Average Annual Functional Units (AAFU)	$ 5,054,000	$ 986,000	29	$2,331,800	$125,000
Franklin Creek Ecosystem	Increased Surge Storage	N/A	516 Average Annual Functional Units (AAFU)	$3,890,000	$ 759,000	22	$1,960,500	$105,000

1/ These measures were analyzed for economic benefits and do not represent the entire recommended plan features for implementation. See the main report for more detail.
2/ Implementation costs are based on ROM cost estimates and an FY 08 price level and do not include escalation. See the engineering appendix for more details on the costs.
3/ Average annual damages reduced and costs are based on a 50-year period of analysis and an FY 08 discount rate of 4.875-percent. Dollar values are rounded to the nearest thousand.

ADDENDUM A – HEC-FDA DEPTH DAMAGE FUNCTIONS

CHAPTER A-I. OVERVIEW

Damages for assets and contents were calculated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Damage of an structure and its contents are estimated as a function of stage, first floor elevation, depth of water in asset, percent of damage at each depth, and the value of the structure and its contents (see equation below). This function derives the stage damage in terms of dollar value damage for the structure and its contents. At each stage, the stage damage for all assets and their contents are aggregated to determine a total damage for each stage. The HEC-FDA model, described in detail in the Economic Appendix, applies a Monte Carlo simulation to the aggregated stage damage to determine Equivalent Annual Damages (EAD). The purpose of this addendum is to detail the depth-damage relationships (percent of damage at each depth) that were used in the HEC-FDA model runs, 2/ why they were used, 3/ how they were developed, and 4/ the uncertainty that is included within the relationships.

Stage Damage ($) = Stage – First Floor Elevation = water depth in structure = % damage x asset/content value

Depth-damage relationships are a mathematical function that describes the extent of damage to an structure and its contents for each foot of water that is deposited into the structure by a storm event. The general premise is that the entire structure and its contents are not damaged by just one foot of water within it, but increase as the water depth within the structure rises. Typically, depth-damage relationships are developed using a combination of observed data that is collected after a storm event and by expert elicitation. Depth-damage relationships take into account multiple variables such as whether the water is fresh water or salt water, the duration the water remains in the asset, the materials that the structure is constructed of, and whether a person or business occupies the asset.

A-1.1 Selection of Depth-Damage Relationships

The depth-damage relationships for assets and contents that were used in the HEC-FDA model runs for the Mississippi Coastal Improvement Program (MsCIP) Comprehensive Plan include generic relationships developed by the Institute for Water Resources and depth-damage relationships developed for the U.S. Army Corps of Engineers, New Orleans District. According to ER 1105-2-100, E-19q. (2), depth-damage relationships for feasibility studies should be developed either based on site-specific data or from comparable floodplain data. For this analysis, site-specific data was not readily available for use given the scope, complexity, and timing constraints pertaining to the MsCIP Comprehensive Plan Report; therefore, comparable floodplain data was used.

For residential structures, generic relationships for residential one-story and two-story assets and their contents are from The Corps of Engineers *Economic Guidance Memorandum (EGM) 01-03, Generic Depth Damage Relationships*. These relationships were developed for nation-wide applicability in flood damage reduction studies for assets without basements.

The depth-damage relationships used in association with commercial, municipal, and mobile home assets and their contents are those that were develop for the Lower Atchafalaya and Morganza Feasibility Studies. These relationships are saltwater short-term duration relationships, meaning that the period of inundation (the time that water is in the asset) is approximately twenty-four hours. The

Lower Atchafalaya and Morganza short-duration relationships were specifically chosen because of the vast similarities between structures in Louisiana and the Mississippi Gulf Coast. These similarities include building code requirements, quality of material and labor used for construction, size, and design, and other attributes that make the Lower Atchafalaya and Morganza short-duration relationships a perfect match for the MsCIP Comprehensive Plan Report. These curves are further described in section 1.4 of this addendum.

A-1.2 Uncertainty

A statistical definition of uncertainty is the 'estimated amount or percentage by which an observed or calculated value may differ from the true value.' Since depth-damage relationships are developed through data sampling and/or by using expert opinion, some amount of uncertainty naturally exists. To account for this uncertainty, each structure and content curve contains uncertainty bounds. For residential assets and their contents, a bell-curve distribution was used in which the mean and the standard deviation were input into the HEC-FDA model, and then the model accounted for two standard deviations of error, or approximately a ninety-five percent confidence level. For commercial and municipal assets and contents, an upper and lower bound surrounds a mean value.

The HEC-FDA model uses Monte Carlo simulation to randomly sample damage percentages at each stage. The random sampling allows for multiple values to be analyzed for depth-damage relationship. For example, one-foot of water depth within a Mobile Home asset, see Table A1-3 below, can equate to structure damage ranging from 42.5-percent to 53.6-percent to the Mobile Home. The Monte Carlo simulation used by the HEC-FDA model will select values within this range and determine a 'typical' damage for that one-foot water depth. Thus, the model incorporates the uncertainty of the depth-damage relationship in this process.

A-1.3 Residential Damage Relationships

Residential assets and their contents were divided into and analyzed as one-story, two-story, and mobile homes as per EGM 01-03. These residential relationships were developed based primarily on the findings of the Flood Damage Data Collection Program. According to EGM 01-03, "Proper planning and evaluation of flood damage reduction projects require knowledge of actual damage caused to various types of properties. The primary purpose of the Flood Damage Data Collection Program is to meet that requirement by providing Corps district offices with standardized relationships for estimating flood damage and other costs flooding that occurred in various parts of the United States in 1996, 1997, and 1998. Damage estimates are based on comprehensive accounting of losses from flood victims' records. The standardized functions represent a substantive improvement over other generalized depth-damage functions such as the Flood Insurance Administration (FIA) Rate Reviews." The residential depth-damage relationships for structure and content are shown in Tables 1, 2, and 3.

Table A1-1.
Residential One-Story Damage Relationship

Residential One-Story				
	Structure		Content	
Depth	Mean	Standard Deviation	Mean	Standard Deviation
-2	0%	0.0%	0%	0.0%
-1	2.5%	2.7%	2.4%	2.1%
0	13.4%	2.0%	8.1%	1.5%
1	23.3%	1.6%	13.3%	1.2%
2	32.1%	1.6%	17.9%	1.2%
3	40.1%	1.8%	22.0%	1.4%
4	47.1%	1.9%	25.7%	1.5%
5	53.2%	2.0%	28.8%	1.6%
6	58.6%	2.1%	31.5%	1.6%
7	63.2%	2.2%	33.8%	1.7%
8	67.2%	2.3%	35.7%	1.8%
9	70.5%	2.4%	37.2%	1.9%
10	73.2%	2.7%	38.4%	2.1%
11	75.4%	3.0%	39.2%	2.3%
12	77.2%	3.3%	39.7%	2.6%
13	78.5%	3.7%	40.0%	2.9%
14	79.5%	4.1%	40.0%	3.2%
15	80.2%	4.5%	40.0%	3.5%
16	80.7%	4.9%	40.0%	3.8%

[1] Source: EGM 01-01, 4 December, 2000

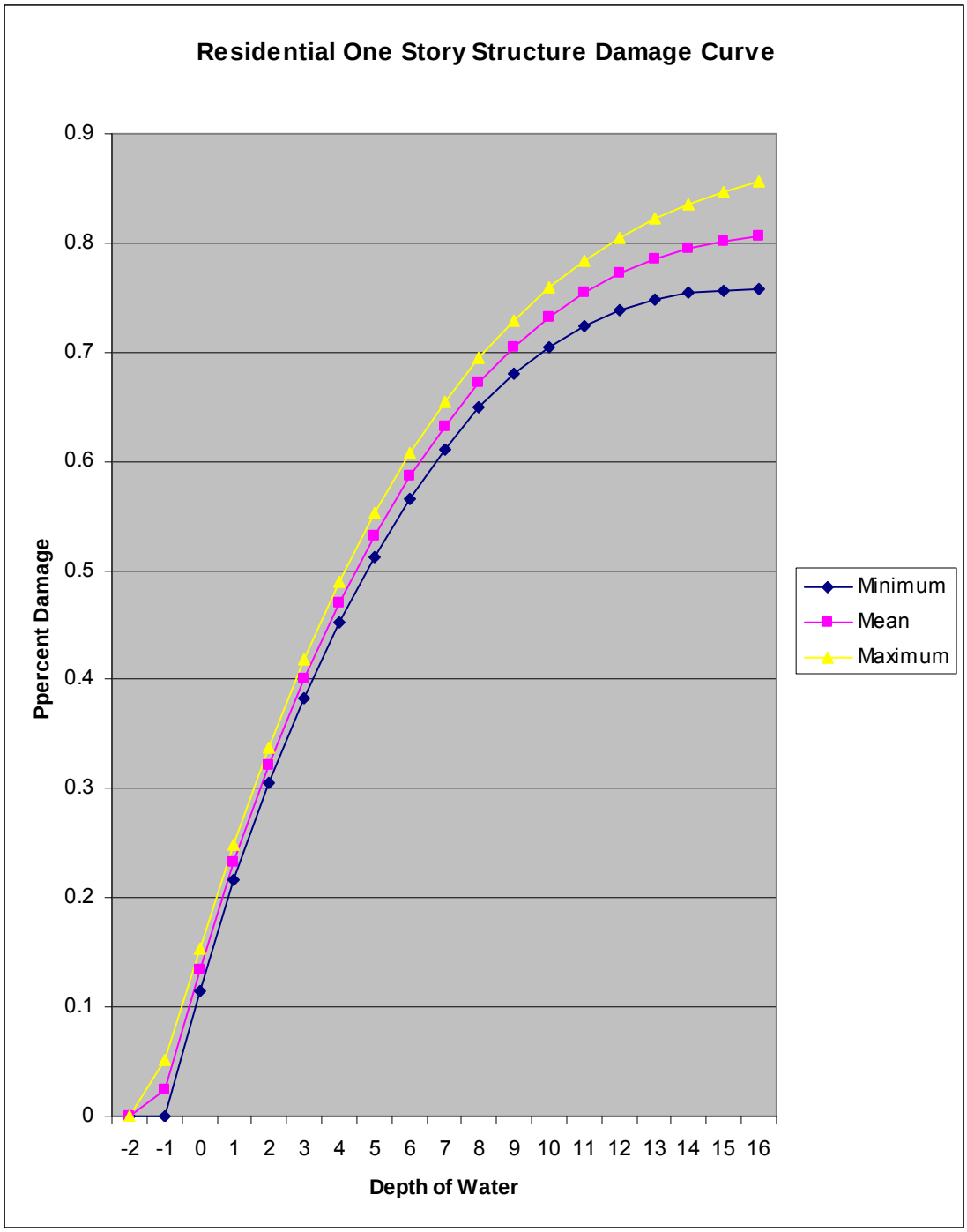


Figure A-1. Residential One-Story Structure Damage Relationship

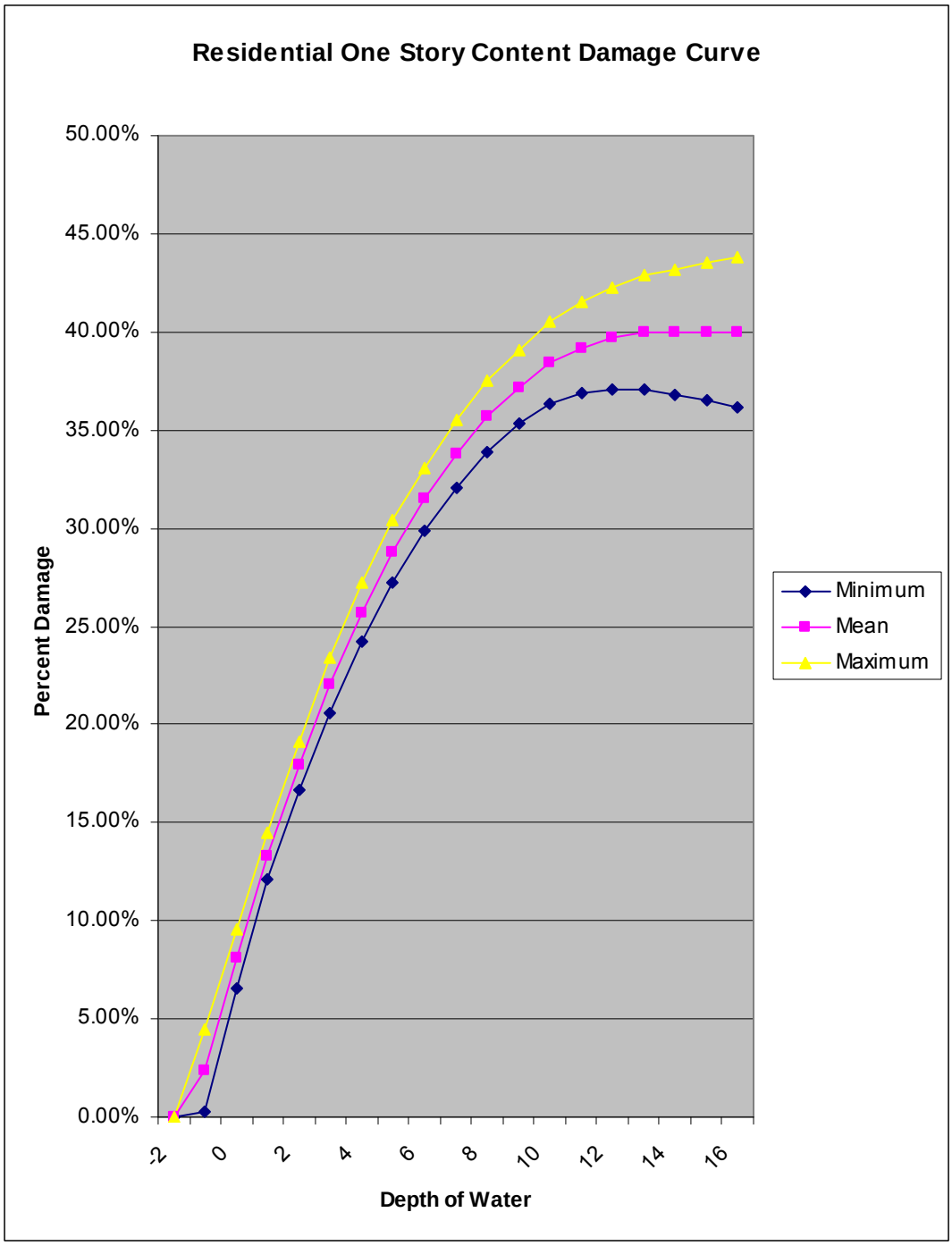


Figure A-2. Residential One-Story Content Damage Relationship

Table A1-2.
Residential Two-Story Damage Relationship

Residential Two-Story				
	Structure		Content	
Depth	Mean	Standard Deviation	Mean	Standard Deviation
-2	0%	0.0%	0%	0.0%
-1	3.0%	4.1%	1.0%	3.5%
0	9.3%	3.4%	5.0%	2.9%
1	15.2%	3.0%	8.7%	2.6%
2	20.9%	2.8%	12.2%	2.5%
3	26.3%	2.9%	15.5%	2.5%
4	31.4%	3.2%	18.5%	2.7%
5	36.2%	3.4%	21.3%	3.0%
6	40.7%	3.7%	23.9%	3.2%
7	44.9%	3.9%	26.3%	3.3%
8	48.8%	4.0%	28.4%	3.4%
9	52.4%	4.1%	30.3%	3.5%
10	55.7%	4.2%	32.0%	3.5%
11	58.7%	4.2%	33.4%	3.5%
12	61.4%	4.2%	34.7%	3.5%
13	63.8%	4.2%	35.6%	3.5%
14	65.9%	4.3%	36.4%	3.6%
15	67.7%	4.6%	36.9%	3.8%
16	89.2%	5.0%	37.2%	4.2%

[1] Source: EGM 01-01, 4 December, 2000

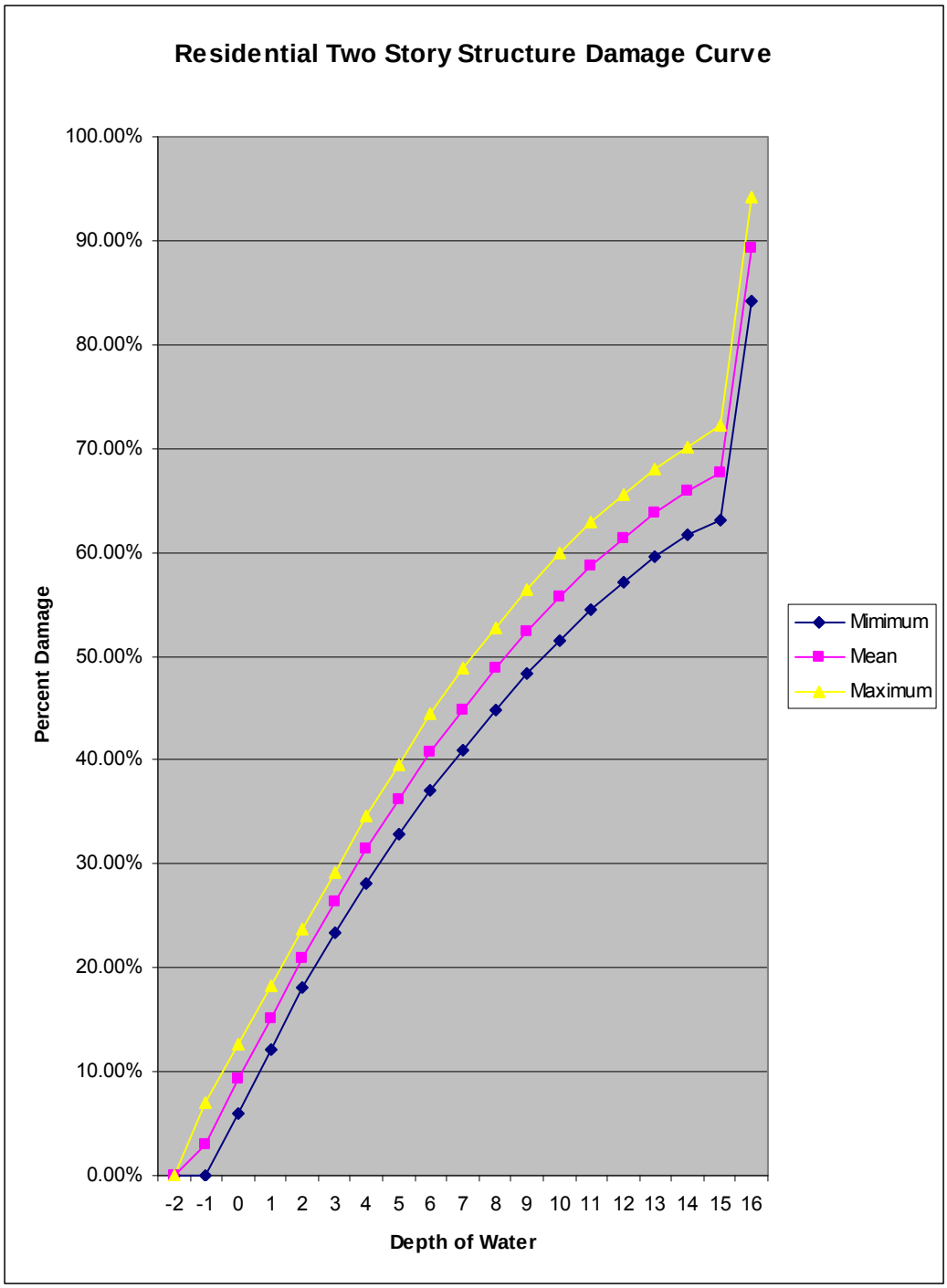


Figure A-3. Residential Two-Story Structure Damage Relationship

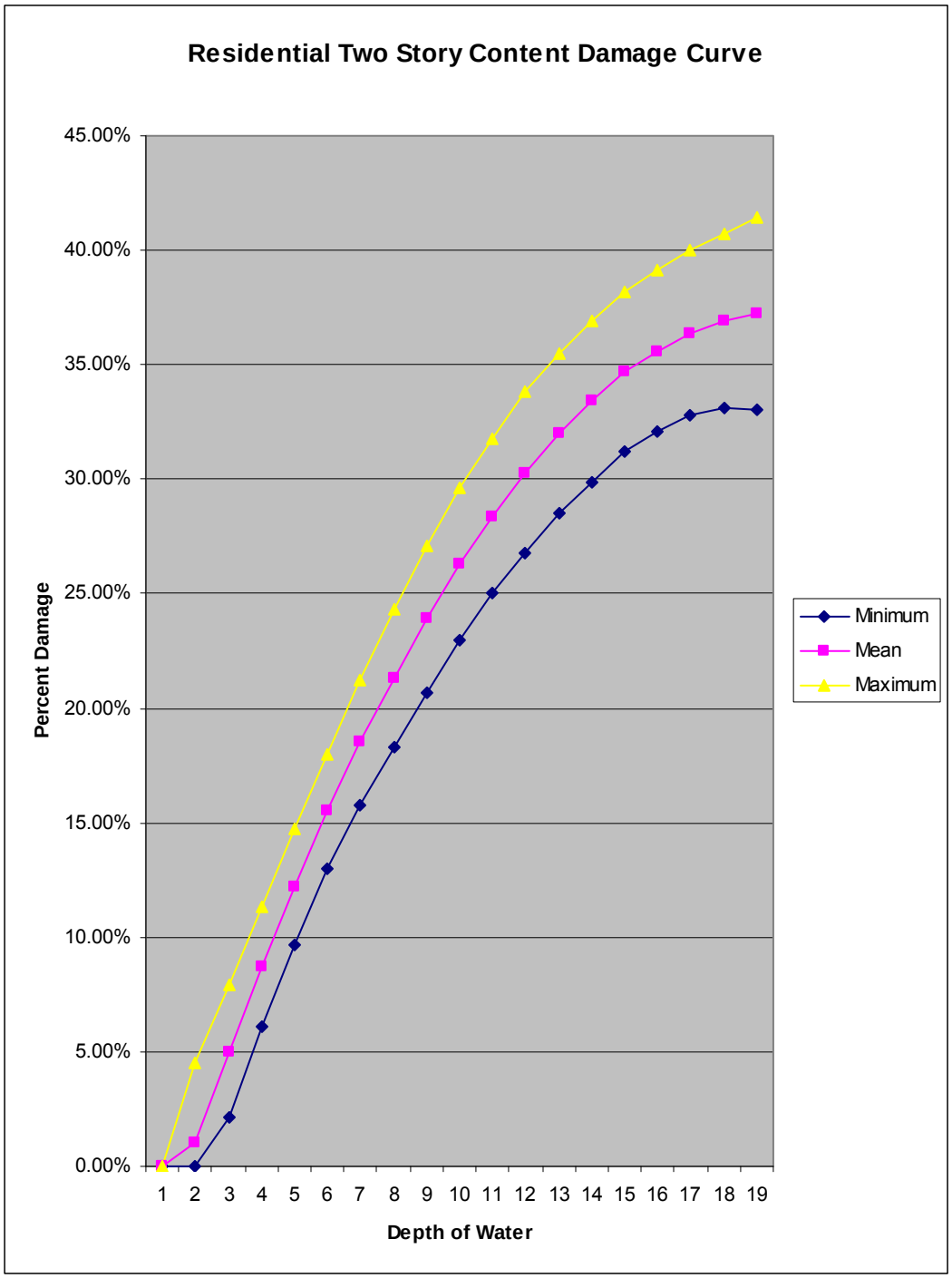


Figure A-4. Residential Two-Story Content Damage Relationship

Table A1-3.
Residential Mobile Home Damage Relationship

Residential: Mobile Homes						
	Structure			Content		
Depth	Mean	Minimum	Maximum	Mean	Minimum	Maximum
-1	6.4%	6.1%	7.7%	0.0%	0.0%	0.0%
-0.5	7.3%	6.9%	8.8%	0.0%	0.0%	0.0%
0	9.9%	9.4%	11.9%	0.0%	0.0%	0.0%
0.5	43.4%	41.2%	52.1%	36.7%	13.7%	48.0%
1	44.7%	42.5%	53.6%	45.4%	32.2%	53.7%
1.5	45.9%	43.6%	55.1%	48.8%	43.1%	53.7%
2	46.6%	44.3%	55.9%	64.3%	60.0%	73.3%
3	46.8%	44.5%	56.2%	71.2%	65.7%	73.9%
4	51.0%	48.5%	61.2%	82.2%	79.6%	84.5%
5	66.9%	63.5%	80.2%	92.1%	89.2%	94.7%
6	66.9%	63.5%	80.2%	92.3%	89.4%	94.9%
7	67.3%	64.0%	80.8%	95.7%	92.7%	100%
8	67.3%	64.0%	80.8%	95.7%	92.7%	100%
9	67.3%	64.0%	80.8%	95.7%	92.7%	100%
10	67.3%	64.0%	80.8%	95.7%	92.7%	100%
11	67.3%	64.0%	80.8%	95.7%	92.7%	100%
12	67.3%	64.0%	80.8%	95.7%	92.7%	100%
13	67.3%	64.0%	80.8%	95.7%	92.7%	100%
14	67.3%	64.0%	80.8%	95.7%	92.7%	100%
15	67.3%	64.0%	80.8%	95.7%	92.7%	100%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

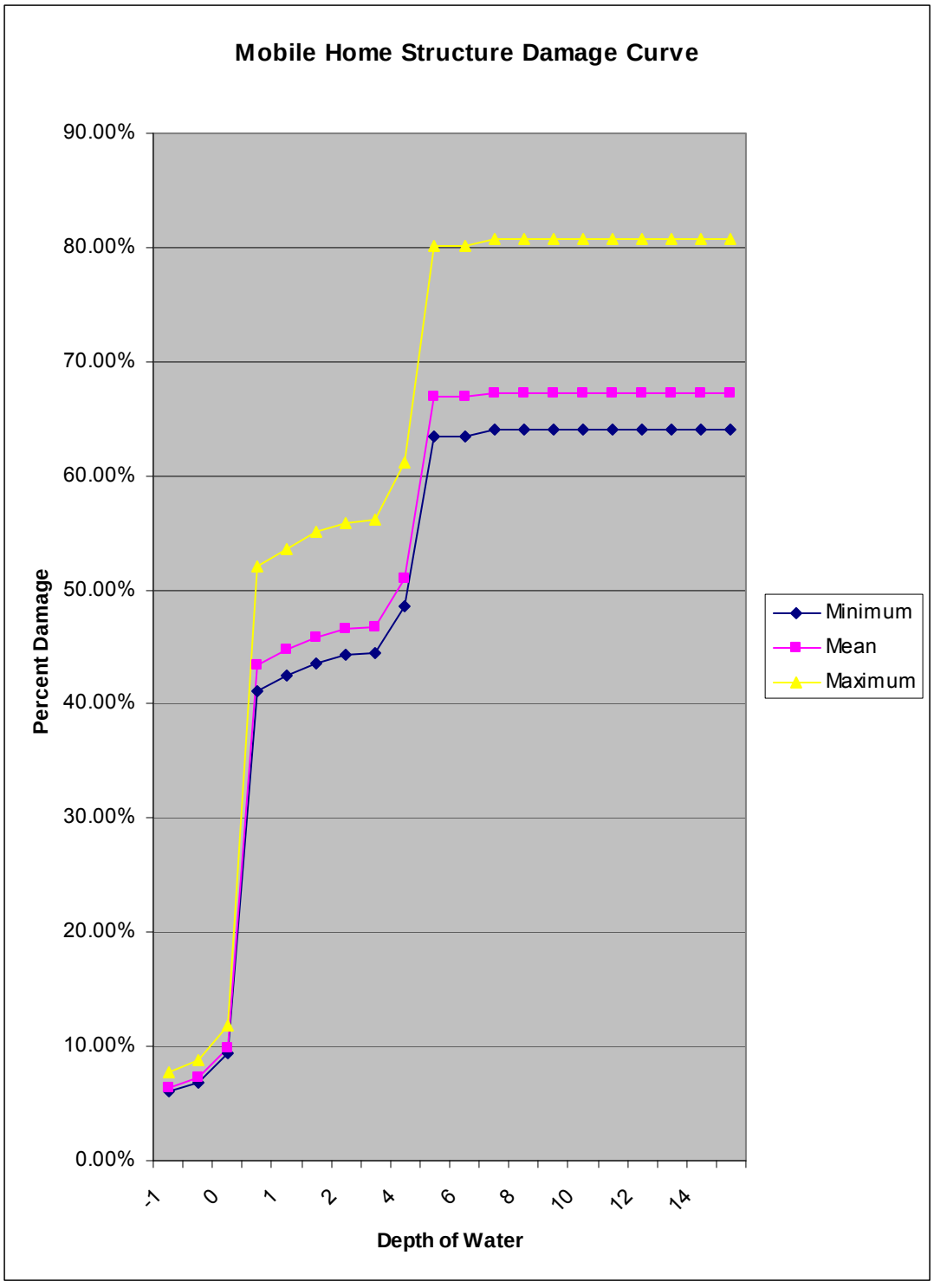


Figure A-5. Mobile Home Structure Damage Relationship

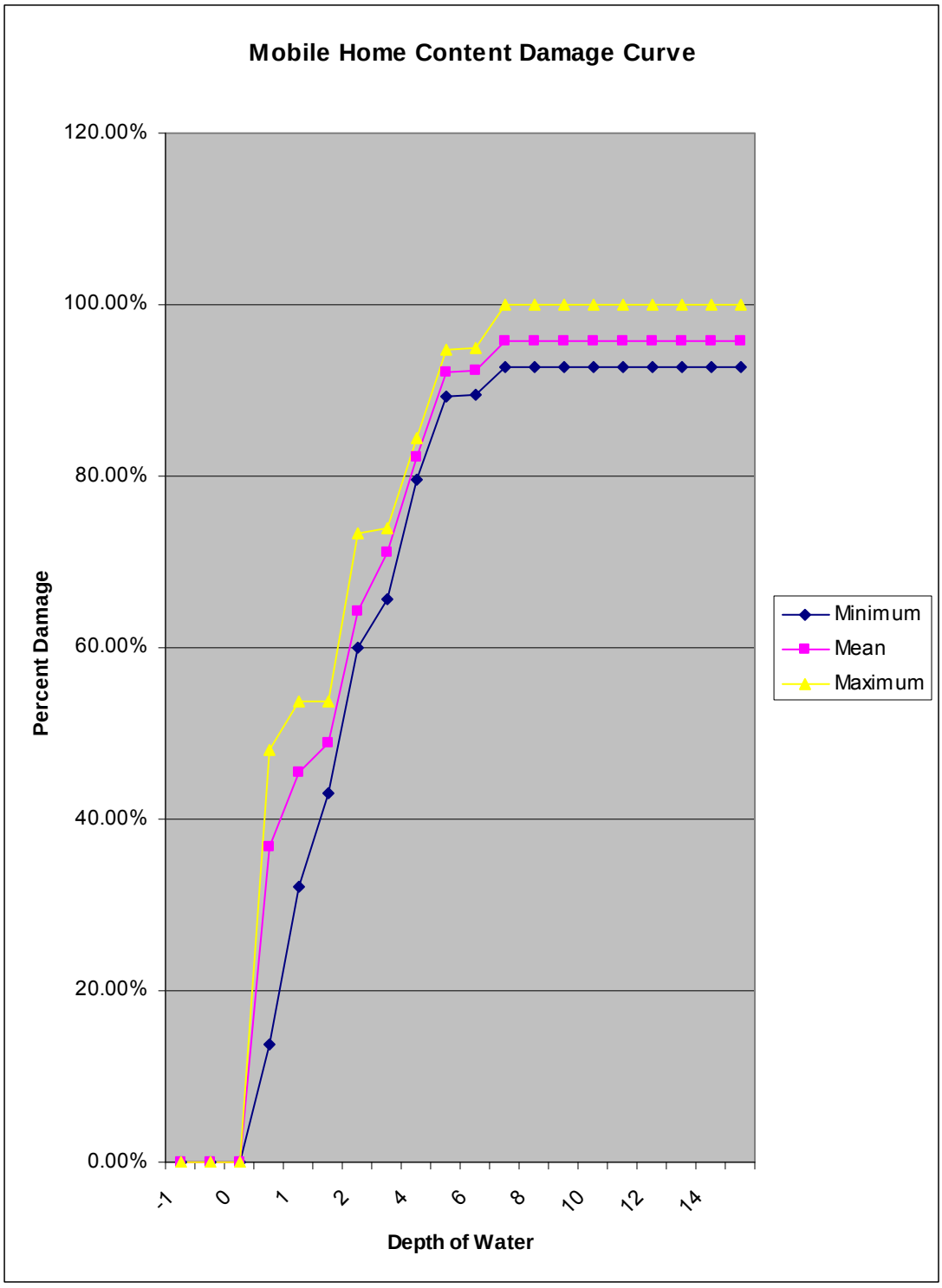


Figure A-6. Mobile Home Content Damage Relationship

A-1.4 Commercial Damage Relationships

Commercial and mobile home structure and content relationships are from the July 1997 final Report entitled Depth-Damaged Relationships for Assets, Contents, and Vehicles and Content-To-Asset Value Ratios (CSVR) in Support of the Lower Atchafalaya Reevaluation and Morganza to the Gulf, Louisiana Feasibility Studies prepared for New Orleans District Corps of Engineers. These relationships are based on field surveys, interviews, and expert panel opinions. Interviews with commercial operators yielded owner/operator estimates of damage that would occur to assets and contents at various flooding levels. Expert panel opinions were based on the "Expert Opinion" method described in the Handbook of Forecasting Techniques (IWR Contract Report 75-7, December 1975) and the Handbook of Forecasting Techniques, Part II, Description of 31 Techniques (Supplement of IWR Contract Report 75-7, August 1977). The panel was asked to determine depth-damage relationships for typical assets in the Lower Atchafalaya and Morganza study areas. The depth-damage relationship is the expected amount of damage either in dollars, or as a percentage of total value for each foot of flooding above or below the first floor of a asset. Commercial structure types were categorized as metal frame, masonry bearing walls, and wood or steel frame walls. However, commercial content categories were divided into the following types: (1) eating and recreation, (2) groceries and gas stations, (3) multi-family residences, (4) repair and home use, (5) retail and personal services, (6) professional business, (7) public, semi-public, and (8) warehouse and contractor services. The commercial depth-damage relationships for structure and content are shown in Tables 4 to 11.

Table A1-4.
Commercial Eating and Recreation Damage Relationship

Commercial: Eating and Recreation						
	Structure Type: Masonry Bearing Walls			Content		
Depth	Mean	Minimum	Maximum	Mean	Minimum	Maximum
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.8%	1.6%	2.1%	0.0%	0.0%	0.0%
0.5	13.2%	12.3%	15.9%	18.7%	16.8%	22.4%
1	13.2%	12.3%	15.9%	25.0%	22.5%	30.1%
1.5	18.9%	17.0%	22.7%	46.8%	42.1%	56.1%
2	19.1%	17.2%	23.5%	50.2%	45.2%	60.3%
3	24.7%	21.7%	29.6%	80.3%	72.3%	96.4%
4	29.0%	24.6%	36.2%	95.8%	86.2%	100%
5	32.5%	27.6%	40.6%	98.2%	88.4%	100%
6	32.5%	27.6%	40.6%	99.1%	89.2%	100%
7	32.5%	27.6%	40.6%	100%	90.0%	100%
8	35.1%	29.8%	43.9%	100%	90.0%	100%
9	46.5%	39.5%	58.1%	100%	90.0%	100%
10	53.3%	45.3%	66.6%	100%	90.0%	100%
11	57.7%	45.3%	66.6%	100%	90.0%	100%
12	57.7%	49.0%	72.1%	100%	90.0%	100%
13	57.7%	49.0%	72.1%	100%	90.0%	100%
14	57.7%	49.0%	72.1%	100%	90.0%	100%
15	57.7%	49.0%	72.1%	100%	90.0%	100%

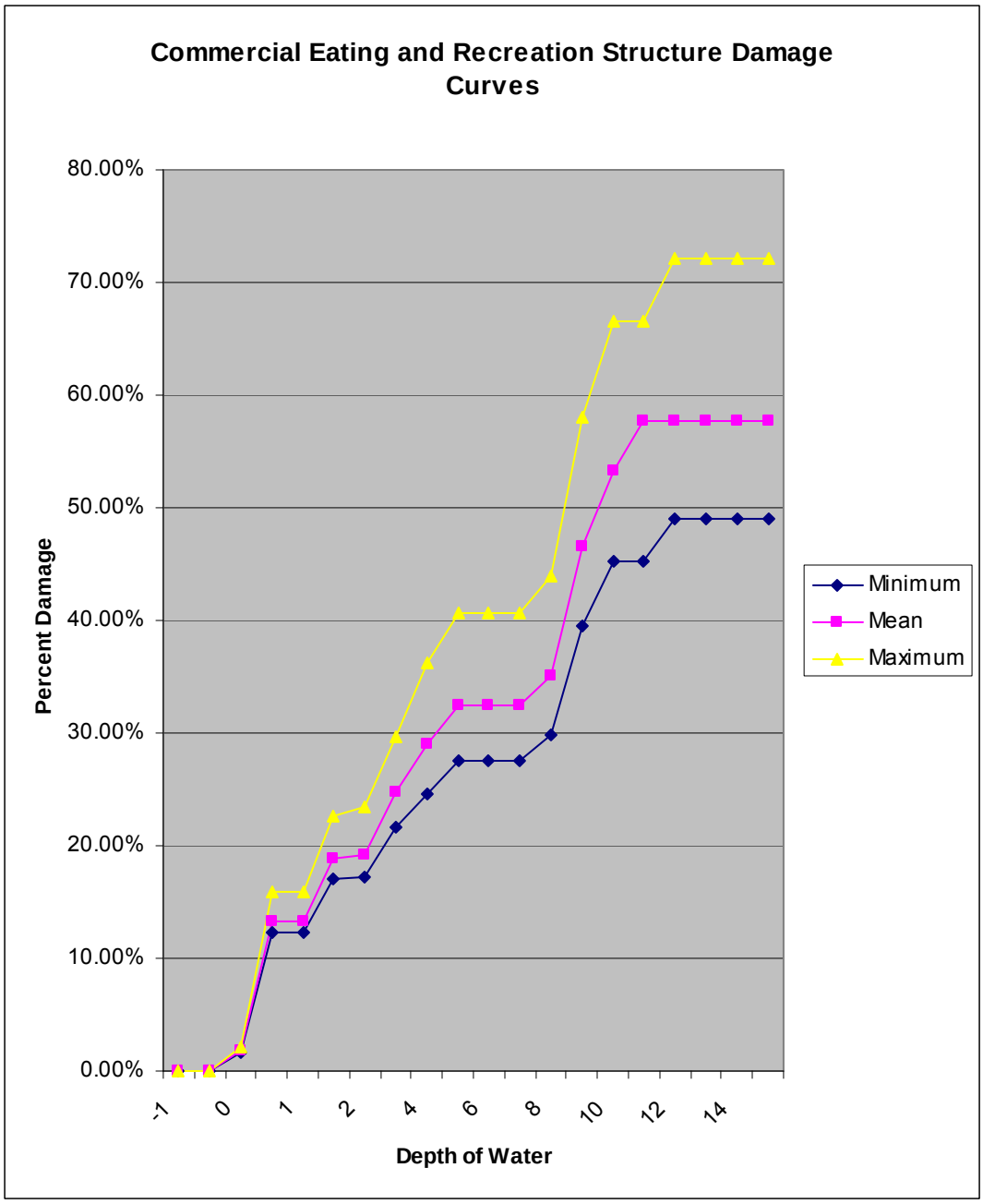


Figure A-7. Eating and Recreation Structure Damage Relationship

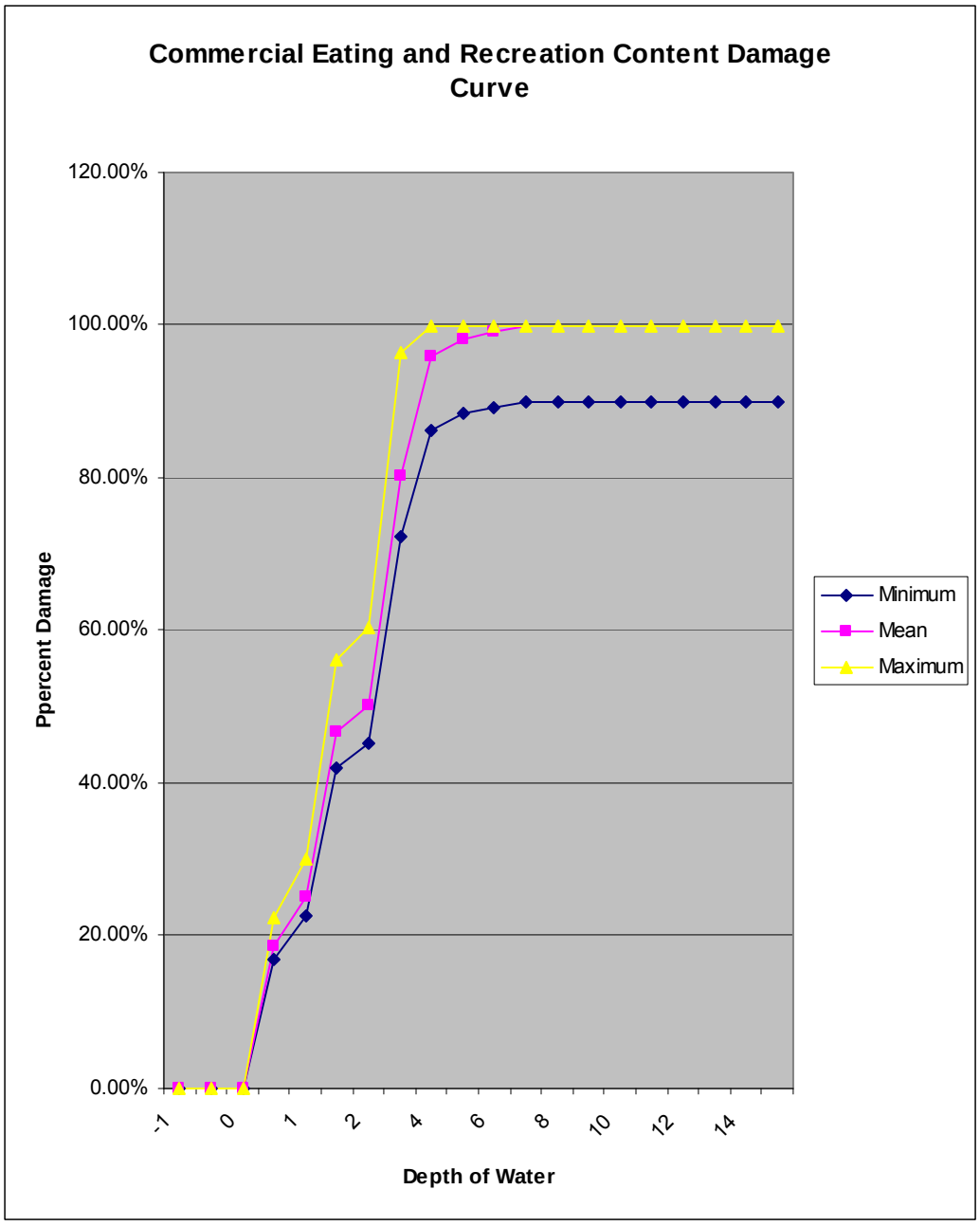


Figure A-8. Eating and Recreation Content Damage Relationship

Table A1-5.
Commercial Grocery and Gas Station Damage Relationship

Commercial: Gas Station and Grocery Store						
	Structure Type Masonry Bearing Walls			Content		
Depth	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.8%	1.6%	2.1%	0.0%	0.0%	0.0%
0.5	13.2%	12.3%	15.9%	18.7%	16.8%	22.4%
1	13.2%	12.3%	15.9%	25.0%	22.5%	30.1%
1.5	18.9%	17.0%	22.7%	46.8%	42.1%	56.1%
2	19.1%	17.2%	23.5%	50.2%	45.2%	60.3%
3	24.7%	21.7%	29.6%	80.3%	72.3%	96.4%
4	29.0%	24.6%	36.2%	95.8%	86.2%	100%
5	32.5%	27.6%	40.6%	98.2%	88.4%	100%
6	32.5%	27.6%	40.6%	99.1%	89.2%	100%
7	32.5%	27.6%	40.6%	100%	90.0%	100%
8	35.1%	29.8%	43.9%	100%	90.0%	100%
9	46.5%	39.5%	58.1%	100%	90.0%	100%
10	53.3%	45.3%	66.6%	100%	90.0%	100%
11	53.3%	45.3%	66.6%	100%	90.0%	100%
12	57.7%	49.0%	72.1%	100%	90.0%	100%
13	57.7%	49.0%	72.1%	100%	90.0%	100%
14	57.7%	49.0%	72.1%	100%	90.0%	100%
15	57.7%	49.0%	72.1%	100%	90.0%	100%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

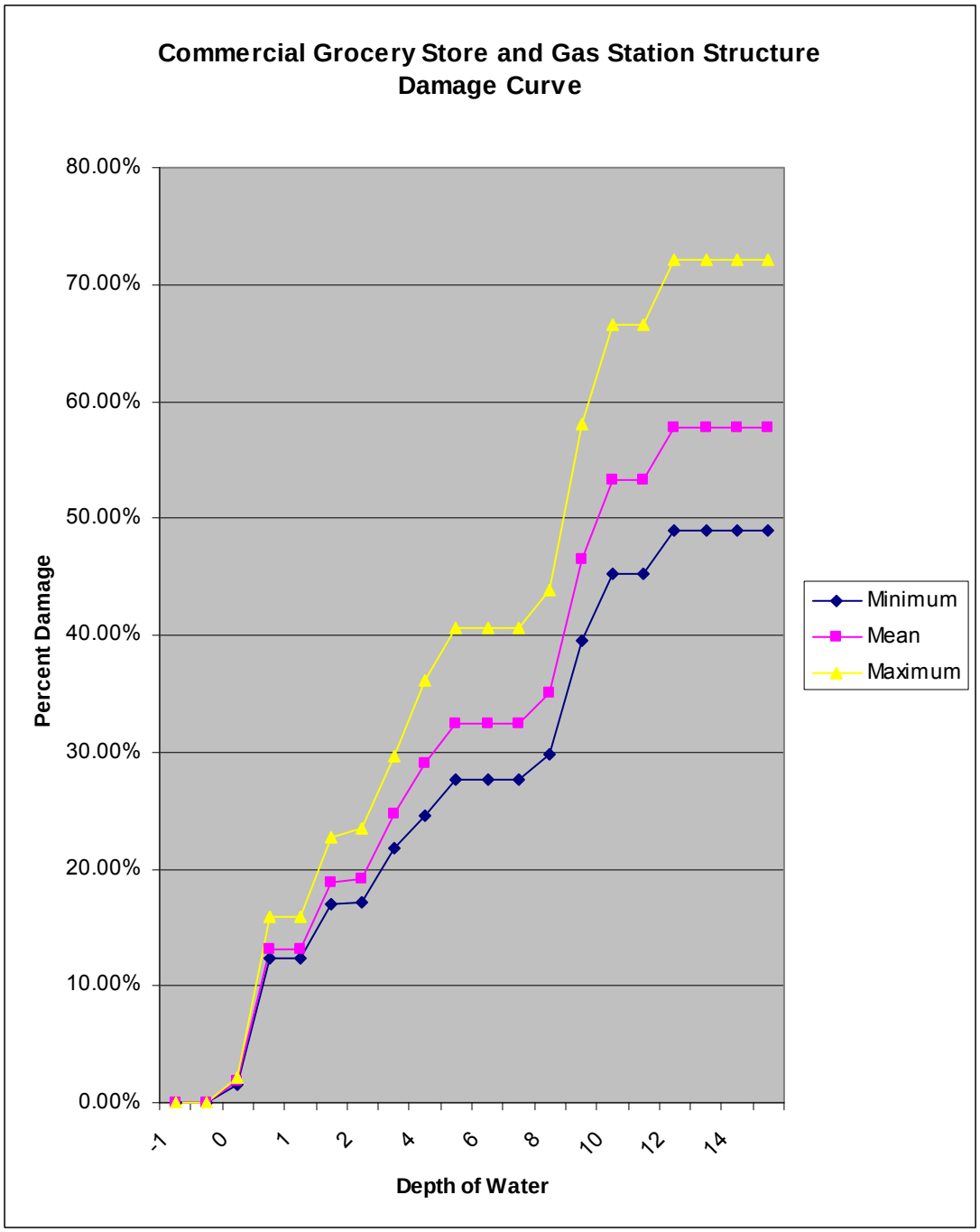


Figure A-9. Grocery Store and Gas Station Structure Damage Relationship

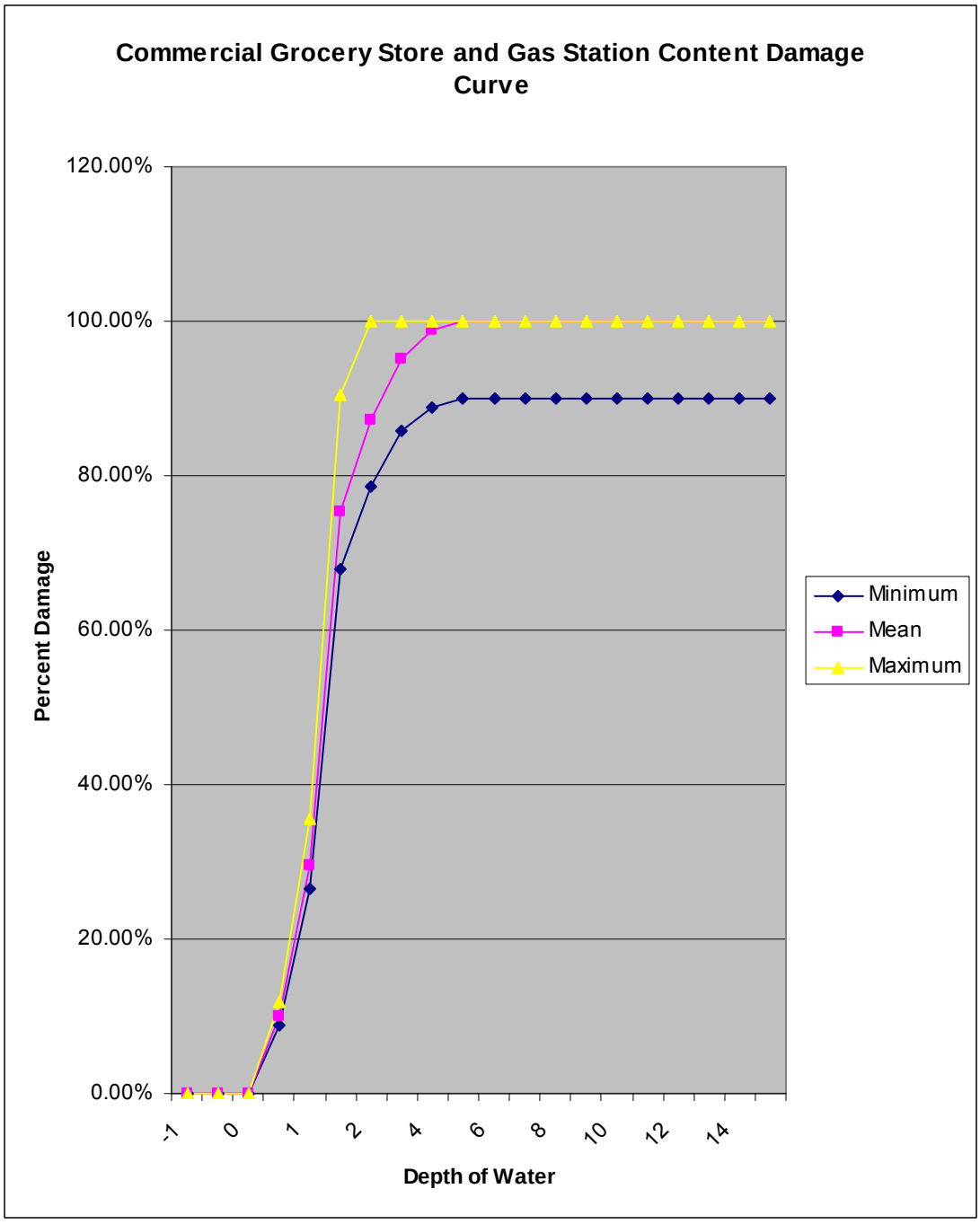


Figure A-10. Grocery Store and Gas Station Content Damage Relationship

Table A1-6.
Municipal Damage Relationship

Municipal Structures						
	Structure Type Masonry Bearing Walls			Content		
Depth	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.8%	1.6%	2.1%	0.0%	0.0%	0.0%
0.5	13.2%	12.3%	15.9%	40.0%	36.0%	50.0%
1	13.2%	12.3%	15.9%	72.0%	64.8%	90%
1.5	18.9%	17.0%	22.7%	72.0%	64.8%	90%
2	19.1%	17.2%	23.5%	72.0%	64.8%	90%
3	24.7%	21.7%	29.6%	99.7%	89.7%	100%
4	29.0%	24.6%	36.2%	100%	90%	100%
5	32.5%	27.6%	40.6%	100%	90%	100%
6	32.5%	27.6%	40.6%	100%	90%	100%
7	32.5%	27.6%	40.6%	100%	90%	100%
8	35.1%	29.8%	43.9%	100%	90%	100%
9	46.5%	39.5%	58.1%	100%	90%	100%
10	53.3%	45.3%	66.6%	100%	90%	100%
11	53.3%	45.3%	66.6%	100%	90%	100%
12	57.7%	49.0%	72.1%	100%	90%	100%
13	57.7%	49.0%	72.1%	100%	90%	100%
14	57.7%	49.0%	72.1%	100%	90%	100%
15	57.7%	49.0%	72.1%	100%	90%	100%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

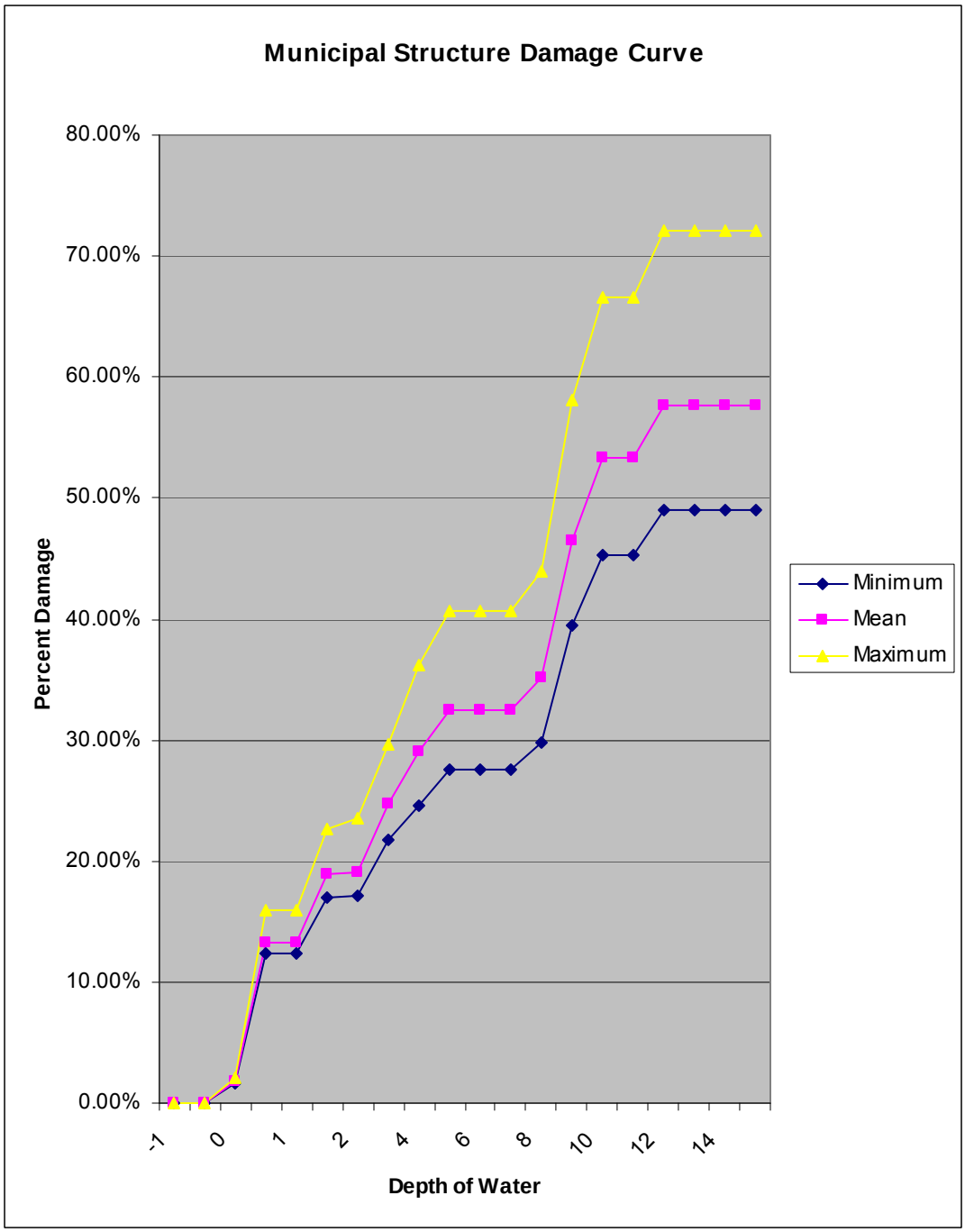


Figure A-11. Municipal Structure Damage Relationship

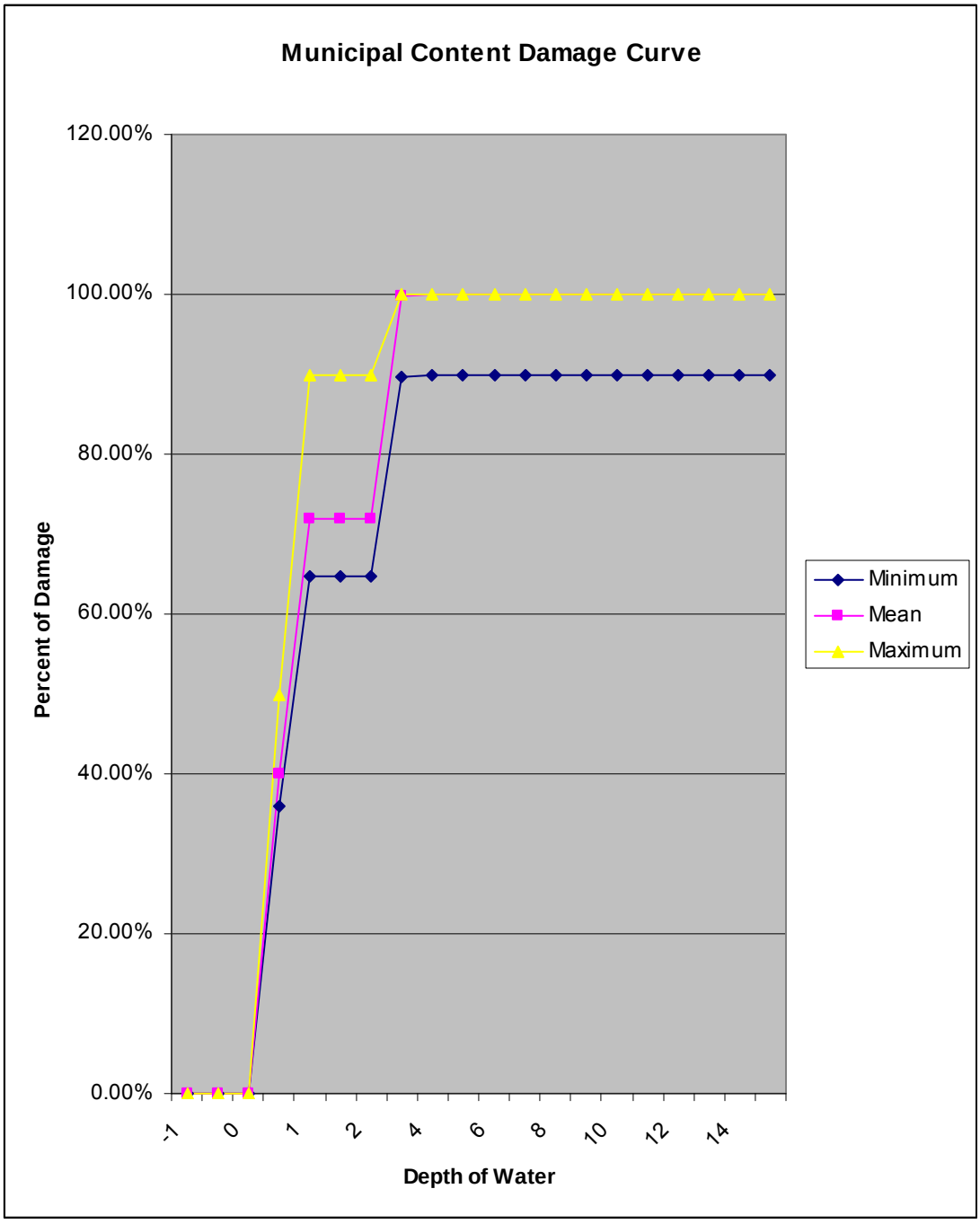


Figure A-12. Municipal Content Damage Relationship

Table A1-7.
Retail and Personal Services Damage Relationship

Commercial: Retail and Personal Services						
	Structure Type Masonry Bearing Walls			Content		
Depth	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.8%	1.6%	2.1%	0.0%	0.0%	0.0%
0.5	13.2%	12.3%	15.9%	12.0%	10.8%	14.4%
1	13.2%	12.3%	15.9%	25.3%	22.7%	30.3%
1.5	18.9%	17.0%	22.7%	36.6%	32.9%	43.9%
2	19.1%	17.2%	23.5%	60.5%	54.5%	72.6%
3	24.7%	21.7%	29.6%	75.4%	67.8%	90.5%
4	29.0%	24.6%	36.2%	85.1%	76.6%	100%
5	32.5%	27.6%	40.6%	94.5%	85.0%	100%
6	32.5%	27.6%	40.6%	100%	90.0%	100%
7	32.5%	27.6%	40.6%	100%	90.0%	100%
8	35.1%	29.8%	43.9%	100%	90.0%	100%
9	46.5%	39.5%	58.1%	100%	90.0%	100%
10	53.3%	45.3%	66.6%	100%	90.0%	100%
11	53.3%	45.3%	66.6%	100%	90.0%	100%
12	57.7%	49.0%	72.1%	100%	90.0%	100%
13	57.7%	49.0%	72.1%	100%	90.0%	100%
14	57.7%	49.0%	72.1%	100%	90.0%	100%
15	57.7%	49.0%	72.1%	100%	90.0%	100%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

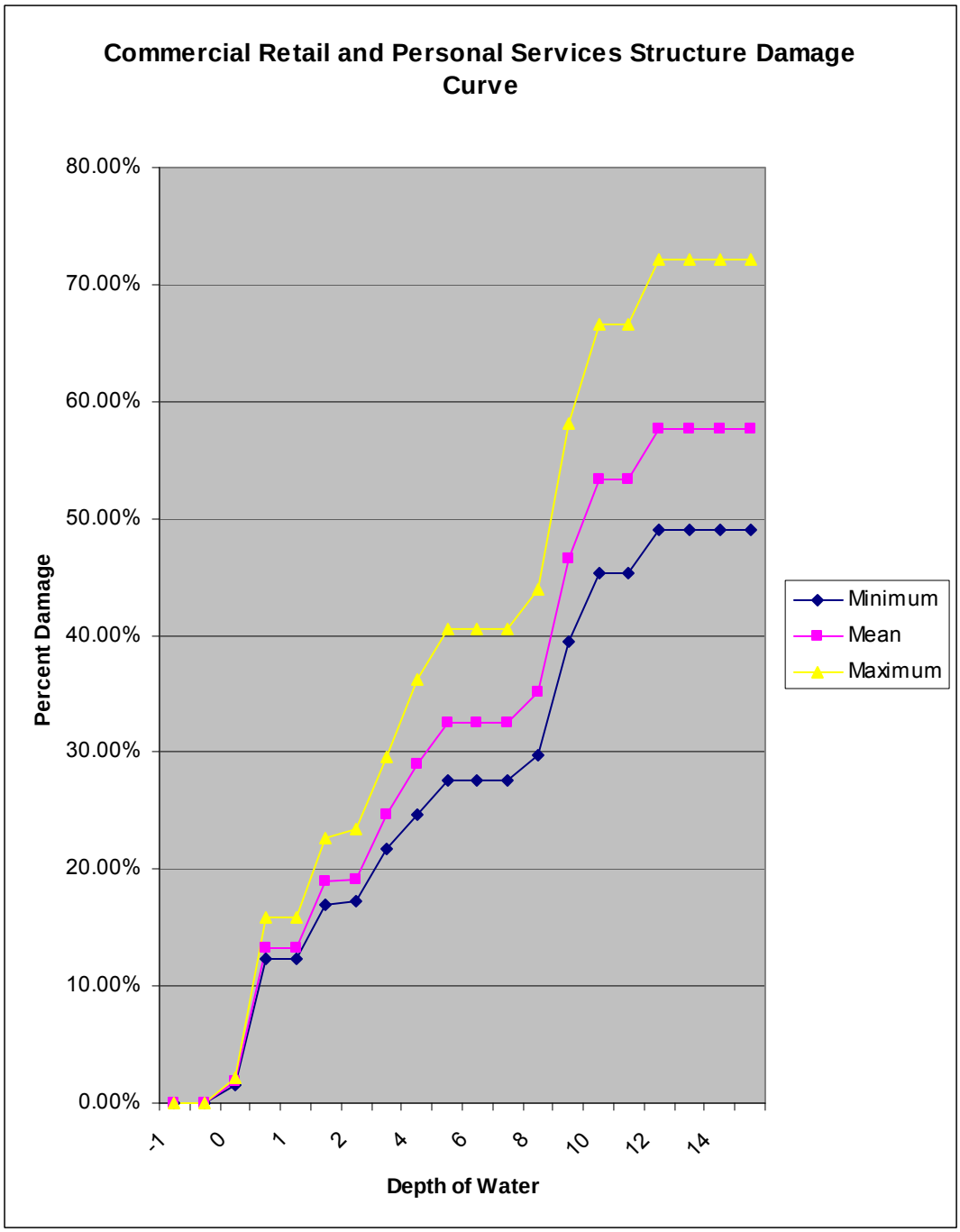


Figure A-13. Retail and Personal Services Structure Damage Relationship

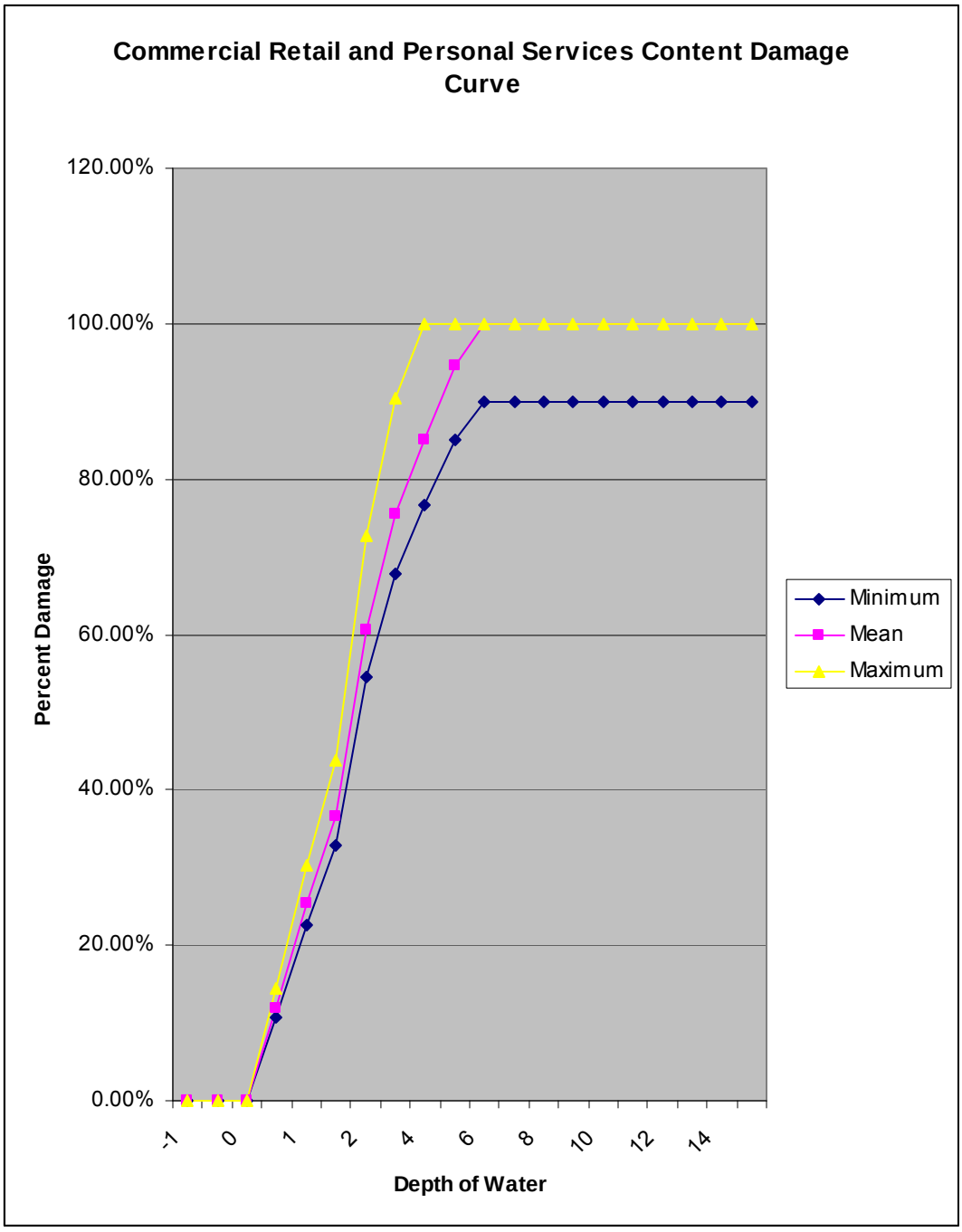


Figure A-14. Retail and Personal Services Content Damage Relationship

Table A1-8.
Multi-Family Damage Relationship

Municipal Structures						
	Structure Type Wood or Steel Frame			Content		
Depth	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.1%	1.0%	1.3%	0.0%	0.0%	0.0%
0.5	20.1%	18.7%	24.1%	7.9%	3.0%	10.3%
1	20.1%	18.7%	24.1%	15.3%	10.9%	18.1%
1.5	25.8%	18.7%	31.0%	18.8%	16.6%	20.5%
2	29.9%	23.2%	36.7%	23.5%	21.9%	26.7%
3	34.0%	26.9%	40.8%	39.7%	36.6%	41.2%
4	40.7%	29.9%	50.9%	45.3%	43.8%	46.5%
5	49.0%	34.6%	61.3%	47.2%	45.7%	48.5%
6	49.0%	41.7%	61.3%	47.2%	45.7%	48.5%
7	50.8%	41.7%	63.6%	47.2%	45.7%	50.3%
8	52.4%	43.2%	65.5%	47.2%	45.7%	50.3%
9	57.3%	44.5%	71.6%	47.2%	45.7%	50.3%
10	57.3%	48.7%	71.6%	55.1%	50.6%	72.1%
11	57.3%	48.7%	71.6%	66.0%	58.4%	72.1%
12	60.4%	51.3%	75.4%	86.9%	80.2%	90.2%
13	60.4%	51.3%	75.4%	92.5%	89.5%	95.1%
14	60.4%	51.3%	75.4%	94.4%	91.4%	97.1%
15	60.4%	51.3%	75.4%	94.4%	91.4%	97.1%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

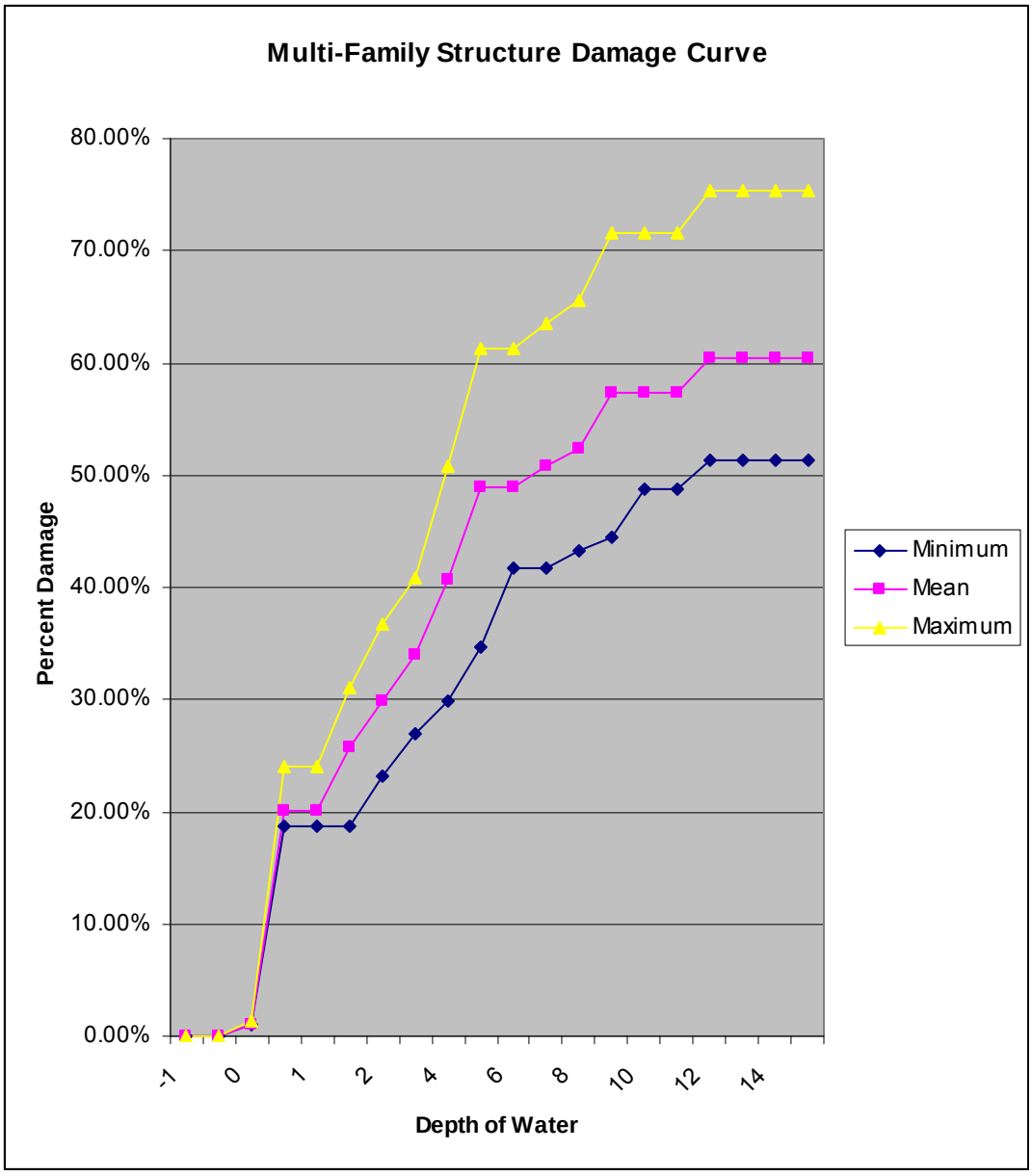


Figure A-15. Multi-Family Structure Damage Relationship

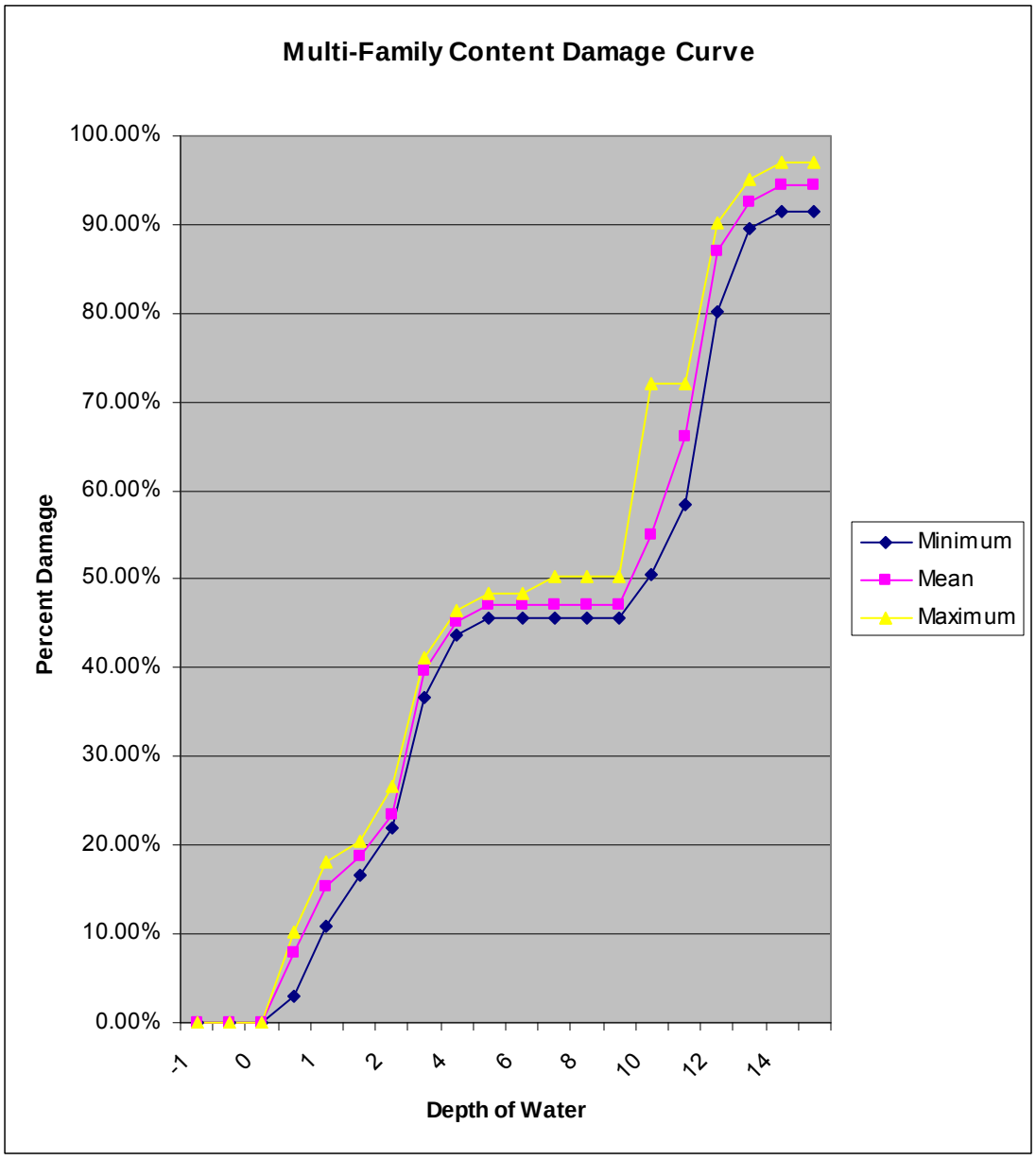


Figure A-16. Multi-Family Content Damage Relationship

Table A1-9.
Professional Businesses Damage Relationship

Professional Business Structures						
	Structure Type Wood or Steel Frame			Content		
Depth	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.1%	1.0%	1.3%	0.0%	0.0%	0.0%
0.5	20.1%	18.7%	24.1%	14.8%	13.3%	18.4%
1	20.1%	18.7%	24.1%	18.6%	16.7%	23.2%
1.5	25.8%	18.7%	31.0%	33.3%	30.0%	41.6%
2	29.9%	23.2%	36.7%	39.0%	35.1%	48.8%
3	34.0%	26.9%	40.8%	74.6%	67.1%	93.2%
4	40.7%	29.9%	50.9%	92.2%	83.0%	100%
5	49.0%	34.6%	61.3%	94.1%	84.7%	100%
6	49.0%	41.7%	61.3%	100%	90.0%	100%
7	50.8%	41.7%	63.6%	100%	90.0%	100%
8	52.4%	43.2%	65.5%	100%	90.0%	100%
9	57.3%	44.5%	71.6%	100%	90.0%	100%
10	57.3%	48.7%	71.6%	100%	90.0%	100%
11	57.3%	48.7%	71.6%	100%	90.0%	100%
12	60.4%	51.3%	75.4%	100%	90.0%	100%
13	60.4%	51.3%	75.4%	100%	90.0%	100%
14	60.4%	51.3%	75.4%	100%	90.0%	100%
15	60.4%	51.3%	75.4%	100%	90.0%	100%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

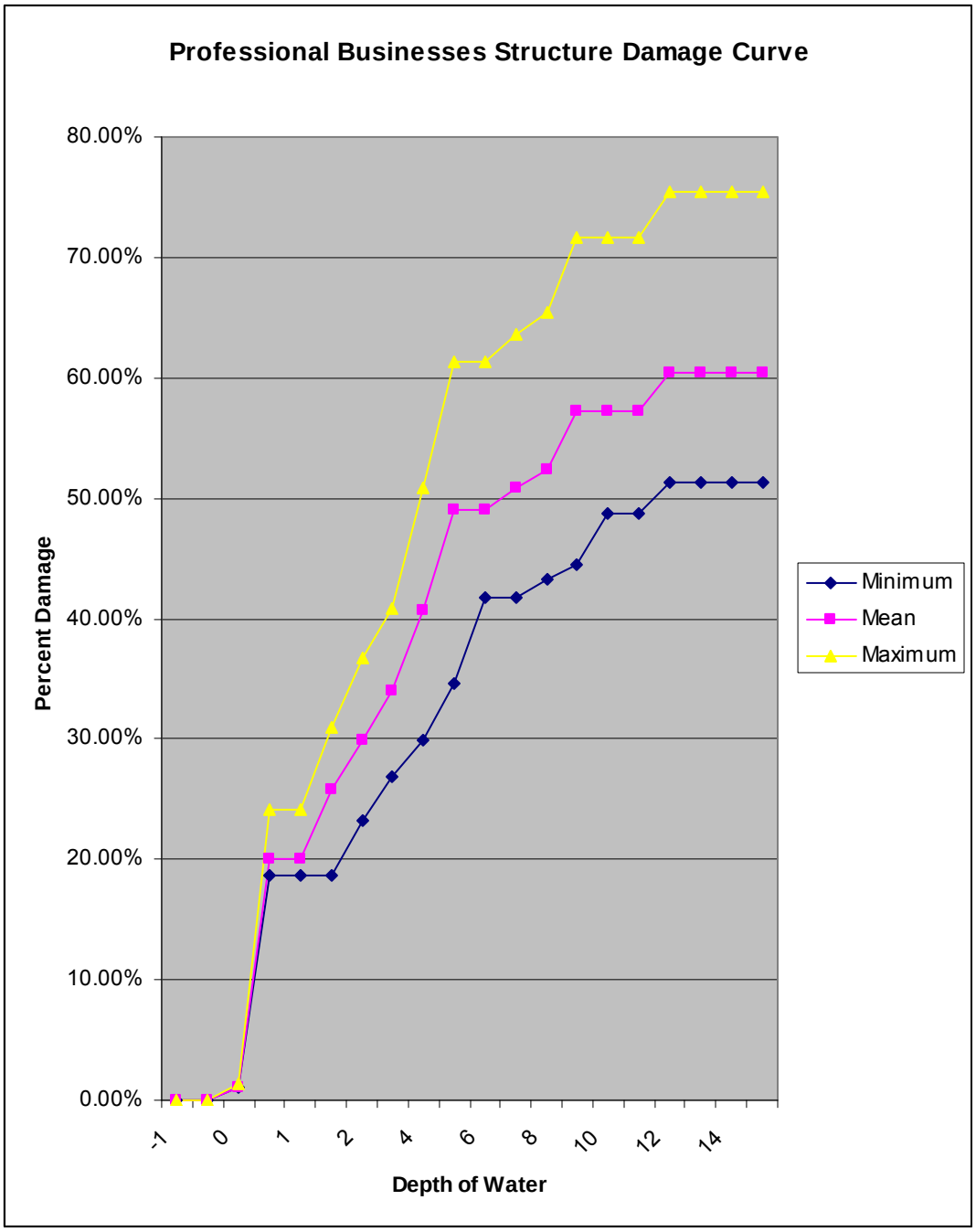


Figure A-17. Professional Businesses Structure Damage Relationship

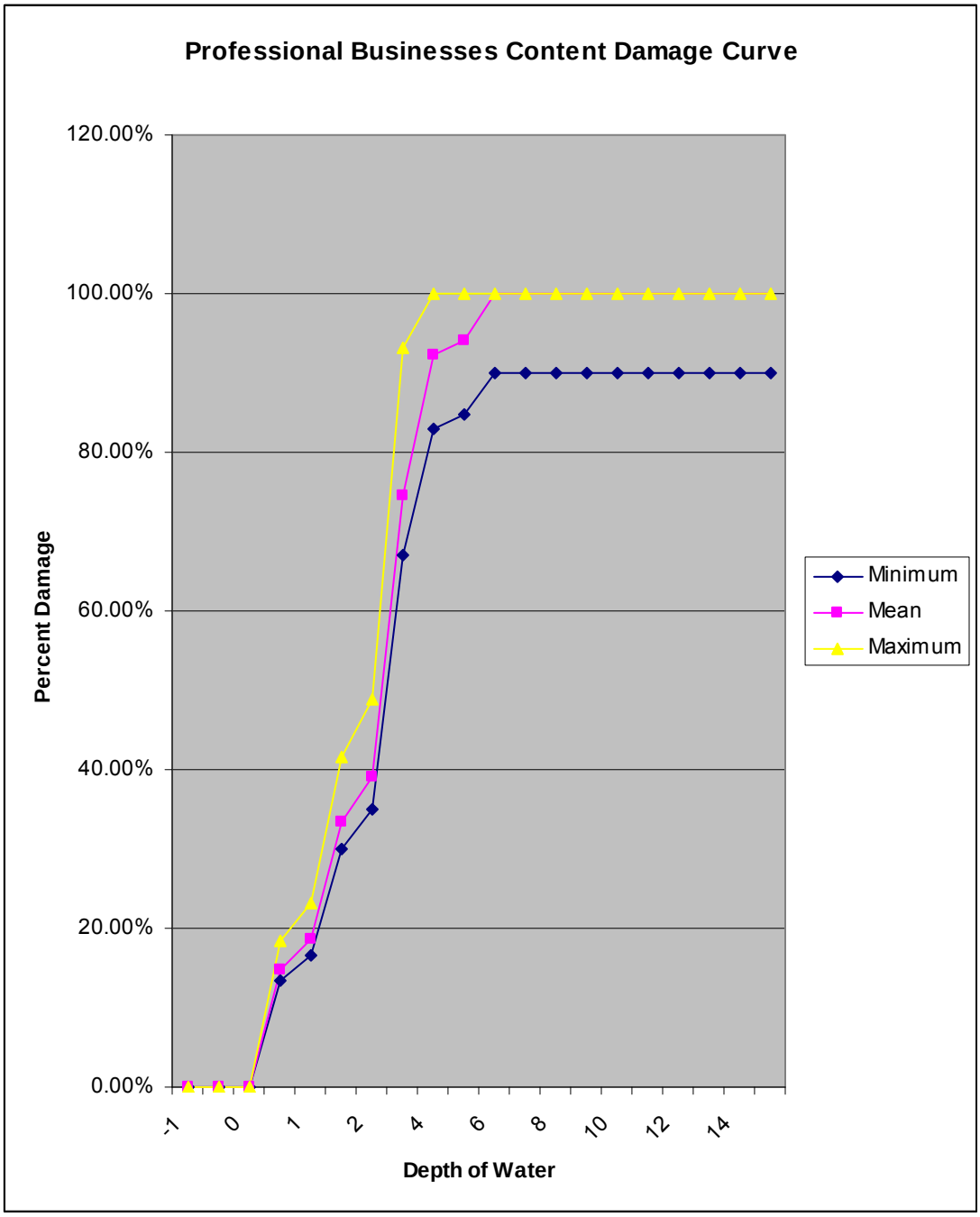


Figure A-18. Professional Businesses Content Damage Relationship

Table A1-10.
Commercial Repair and Home Damage Relationship

Commercial Repair and Home Use						
	Structure Type Wood or Steel			Content		
Depth	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.1%	1.0%	1.3%	0.0%	0.0%	0.0%
0.5	13.0%	12.1%	15.6%	14.6%	13.1%	17.5%
1	13.0%	12.1%	15.6%	20.6%	18.5%	24.7%
1.5	18.2%	16.4%	21.9%	31.8%	28.6%	38.2%
2	18.7%	16.9%	23.0%	32.8%	29.5%	39.3%
3	22.3%	19.6%	26.7%	66.0%	59.4%	79.2%
4	26.9%	22.8%	33.6%	67.4%	60.7%	80.9%
5	28.7%	24.4%	35.9%	68.8%	62.0%	82.6%
6	28.7%	24.4%	35.9%	76.9%	69.3%	92.3%
7	28.7%	24.4%	35.9%	79.9%	71.9%	95.9%
8	32.5%	27.6%	40.6%	79.9%	71.9%	95.9%
9	39.9%	34.0%	49.9%	79.9%	71.9%	95.9%
10	39.9%	34.0%	49.9%	79.9%	71.9%	95.9%
11	39.9%	34.0%	49.9%	79.9%	71.9%	95.9%
12	39.9%	34.0%	49.9%	79.9%	71.9%	95.9%
13	39.9%	34.0%	49.9%	79.9%	71.9%	95.9%
14	39.9%	34.0%	49.9%	79.9%	71.9%	95.9%
15	39.9%	34.0%	49.9%	79.9%	71.9%	95.9%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

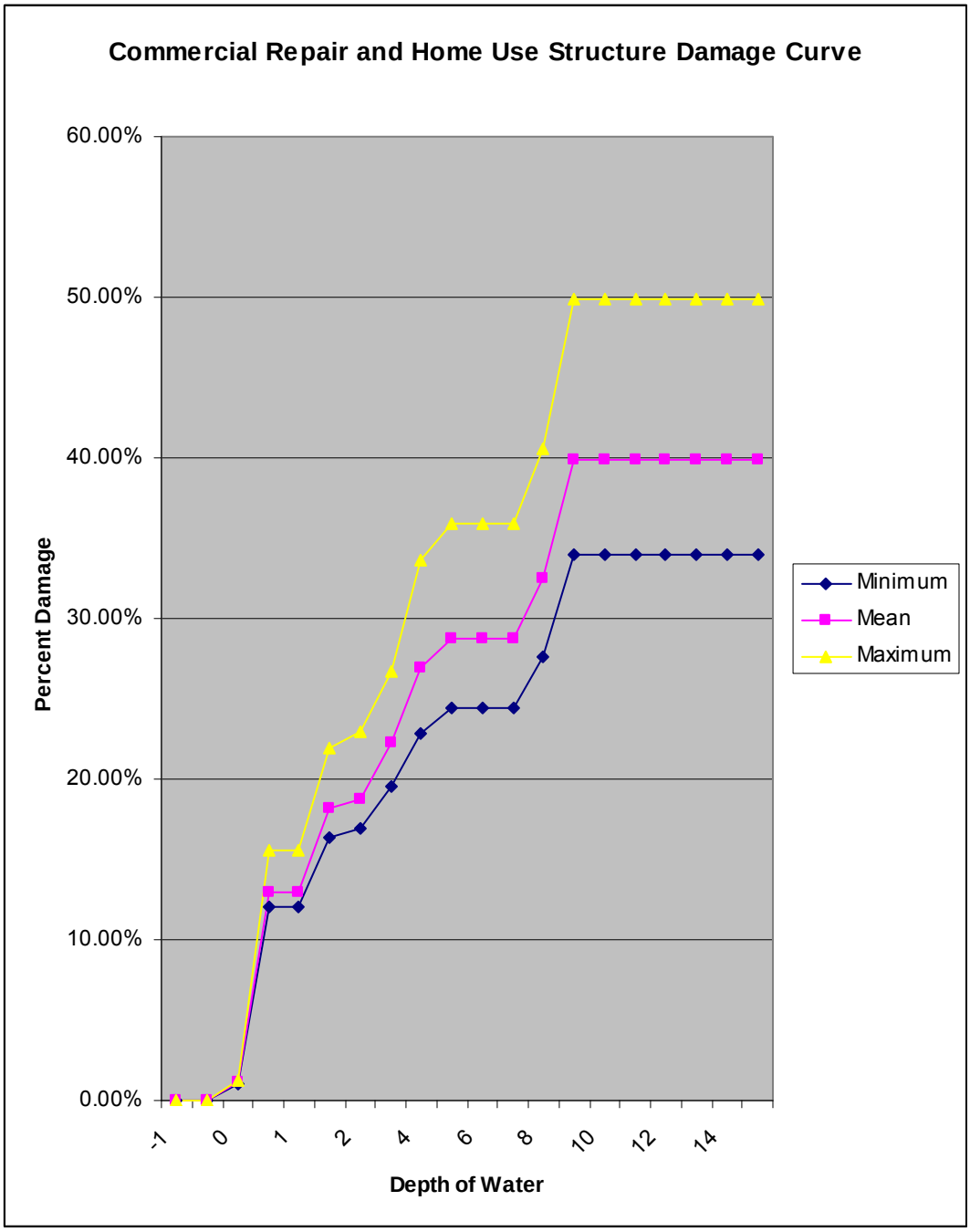


Figure A-19. Commercial Repair and Home Use Structure Damage Relationship

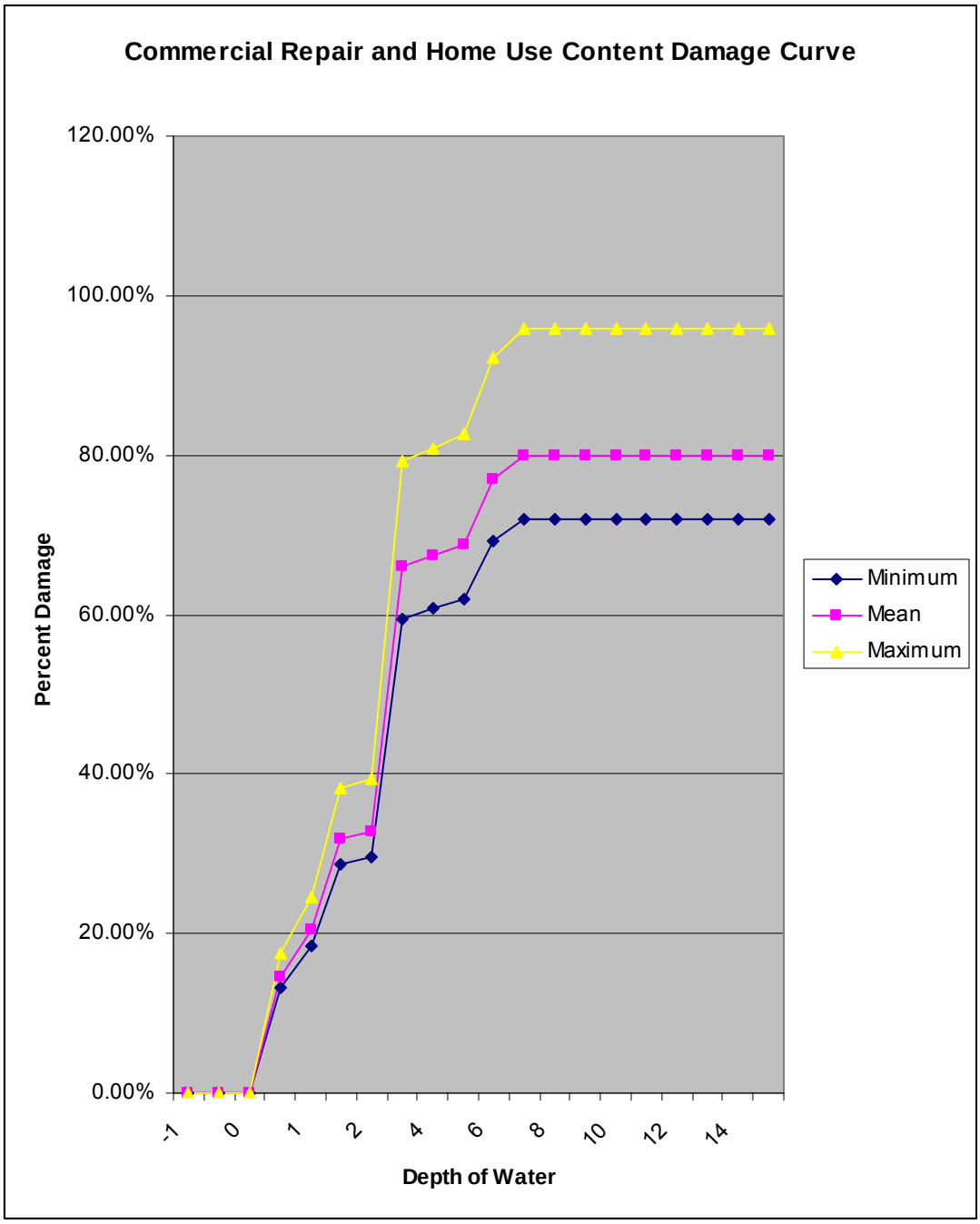


Figure A-20. Commercial Repair and Home Use Damage Relationship

Table A1-11.
Warehouse and Contractor Services Damage Relationship

Commercial Repair and Home Use						
	Structure Type Metal Frame			Content		
Depth	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.1%	1.0%	1.3%	0.0%	0.0%	0.0%
0.5	13.0%	12.1%	15.6%	8.5%	7.6%	10.2%
1	13.0%	12.1%	15.6%	12.6%	11.4%	15.2%
1.5	18.2%	16.4%	21.9%	16.8%	15.2%	20.2%
2	18.7%	16.9%	23.0%	21.1%	19.0%	25.4%
3	22.3%	19.6%	26.7%	27.9%	25.1%	33.5%
4	26.9%	22.8%	33.6%	32.5%	29.2%	39.0%
5	28.7%	24.4%	35.9%	40.9%	36.8%	49.1%
6	28.7%	24.4%	35.9%	48.5%	43.6%	58.2%
7	28.7%	24.4%	35.9%	56.1%	50.5%	67.3%
8	32.5%	27.6%	40.6%	63.7%	57.3%	76.4%
9	39.9%	34.0%	49.9%	71.3%	64.1%	85.5%
10	39.9%	34.0%	49.9%	76.1%	68.5%	91.3%
11	39.9%	34.0%	49.9%	76.1%	68.5%	91.3%
12	39.9%	34.0%	49.9%	76.1%	68.5%	91.3%
13	39.9%	34.0%	49.9%	76.1%	68.5%	91.3%
14	39.9%	34.0%	49.9%	76.1%	68.5%	91.3%
15	39.9%	34.0%	49.9%	76.1%	68.5%	91.3%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

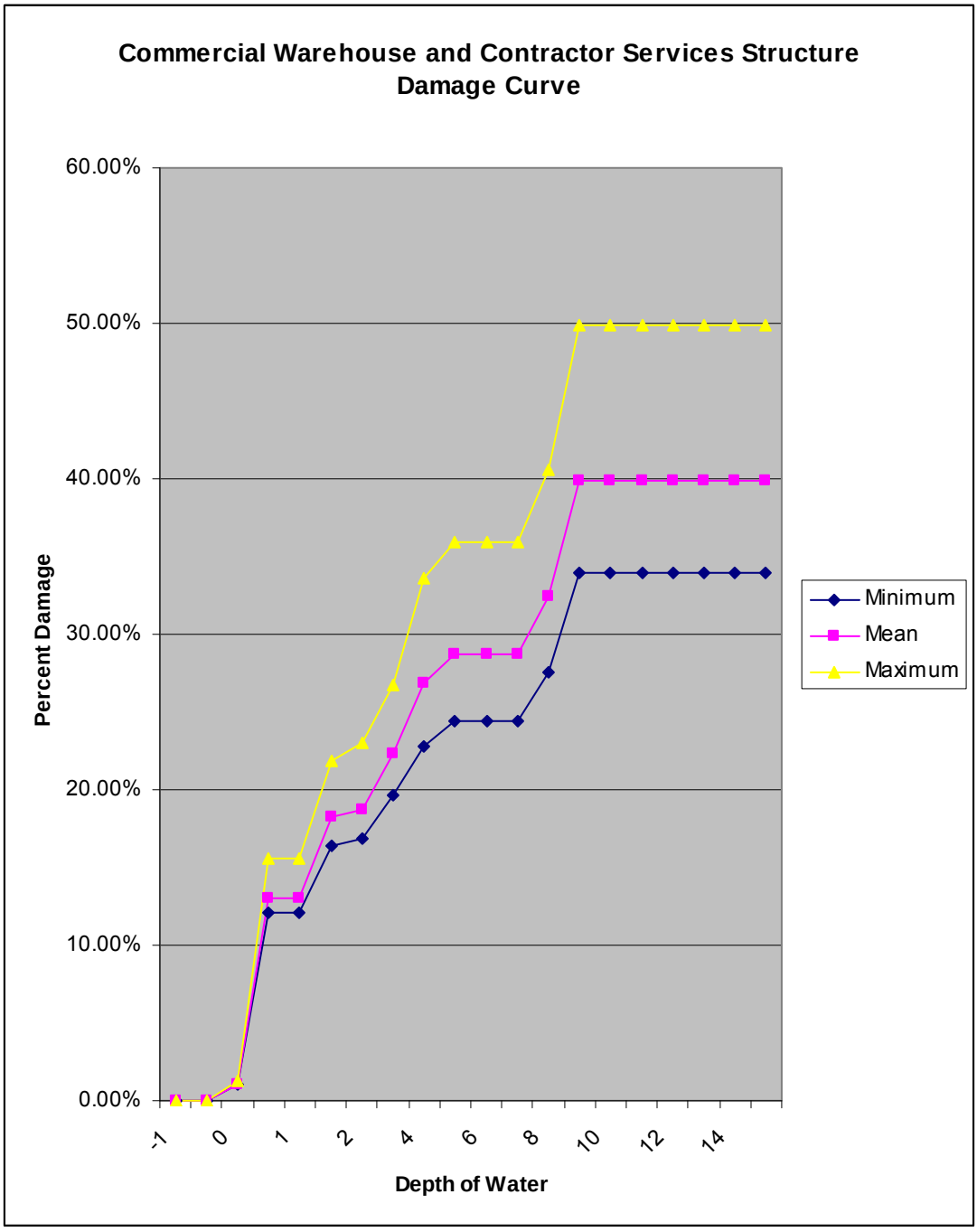


Figure A-21. Warehouse and Contractor Services Structure Damage Relationships

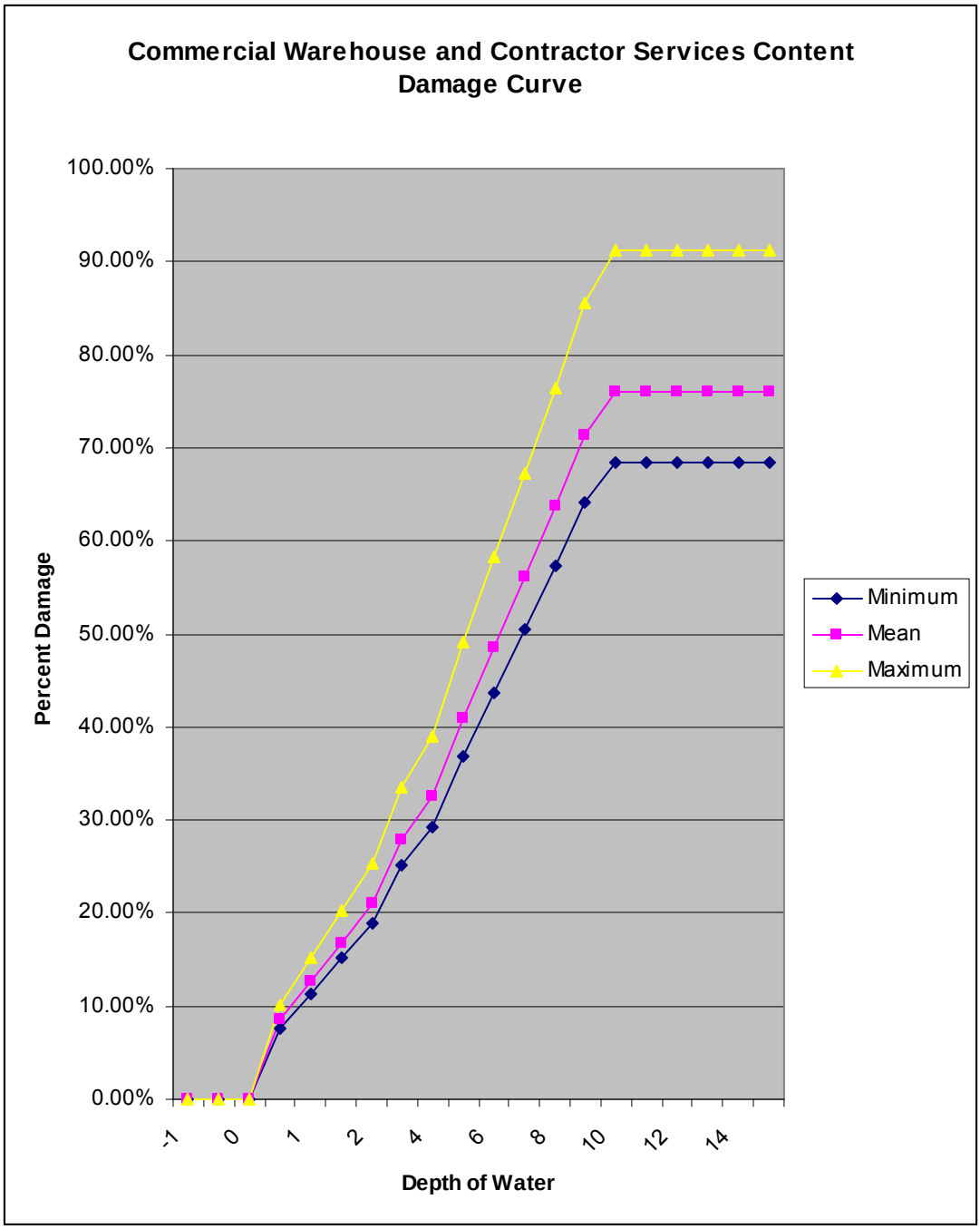


Figure A-22. Warehouse and Contractor Services Structure Damage Relationships

Moreover, each of the eight commercial content categories included a wide variety of business establishments as shown in the following list:

1/ Eating and Recreation: fast food restaurants, full-service restaurants, lounges, bowling alleys, movie theaters, etc.

2/ Groceries and Gas Stations: large and neighborhood groceries, bakeries, candy Stores, wine stores, liquor stores, drug stores, gas stations, convenience stores, and etc.

3/ Multi-Family Residences: garden apartments, high-rise apartments, condominiums, townhomes, motels, hotels, and etc.

4/ Professional Businesses: banks, real estates offices, legal offices, accounting firms, medical offices, veterinary offices, dentist offices, funeral homes, etc.

5/ Public and Semi Public: schools, civic associations, churches, government facilities, utility companies, etc.

6/ Repairs and Home Use: auto repair, watch repair, re-upholstery, home repair, and etc.

7/ Retail and Personal Services: department stores, furniture stores, clothing stores, shoe stores, barber shops, beauty salon, Laundromats, etc.

8/ Warehouse and Contractor Services: transit warehouse, distribution warehouse, storage warehouse, factory, manufacturers, plumbing services, heating and air condition services, carpeting services, etc.

ADDENDUM B – EXPERT ELICITATION ABSTRACT

Institute for Water Resources, U.S. Army Corps of Engineers

Version 1 dated June 19, 2009

COASTAL STORM DAMAGE RELATIONSHIPS BASED ON EXPERT OPINION ELICITATION

(DRAFT)

U. S. Army Corps of Engineers
USACE Institute for Water Resources
Humphreys Engineer Center, Casey Building
7701 Telegraph Road
Alexandria, VA 22315-3868

CHAPTER B-I. ABSTRACT

This report documents the results of the Coastal Storm Damage Workshop on June 5, 6, 2002 in Alexandria, Virginia where expert-opinion was elicited for economic consequence assessment of coastal storm damage. The objectives of this workshop were to discuss and recommend damage relationships needed for predicting structural damage from coastal storms as functions of hazard intensity levels, with associated uncertainties, resulting from erosion, waves, inundation, and their combined effects. Because information on the relationship between residential structural damage and storm parameters is limited, this workshop used expert-opinion as a means of gaining information on these relationships (see Aye 2001). This report describes the results of the workshop both in terms of damage relationships and future information needs identified by the experts at the workshop.

This workshop is part of longer-term research effort whose objective is to develop a peer-reviewed, step-by-step methodology for estimating coastal storm damages. The methodology will be incorporated as part of the inputs to a new hurricane and storm damage reduction estimation model being developed by IWR. The methodology will be able to stand alone for use in Corps' districts or by other national or local agencies including potential incorporation as an option in FEMA's HAZUS model.

CHAPTER B-II. INTRODUCTION

B-2.1 Program Overview

The objective of this research is to develop a peer-reviewed, step-by-step methodology for estimating damages from coastal storms to property and improvements. The methodology will also be incorporated as part of the inputs to a new hurricane and storm damage reduction estimation model being developed by the Institute for Water Resources (IWR). The methodology will be able to stand alone for use in Corps' districts or by other national or local agencies including potential incorporation as an option in FEMA's HAZUS model.

The objective will be achieved using a two-stage process to elicit opinions from experts to develop damage functions to estimate storm damages. The first stage of this process consisted of developing framework to quantitatively describe the damage done to a structure from storm hazards such as inundation, waves, erosion, and wind. Preliminary damage relationships (curves) were also developed. As a starting point for the first stage, the project core team from IWR proposed a “straw man” framework to be modified by a small group of experts. Inputs for this first stage included the models presently in use by Corps' offices (e.g. Wilmington and Jacksonville) and other agencies around the country, as well as a framework that is being developed for this purpose for the Corps’ Wilmington District. Experts were chosen from within the Corps’, from contractors and academics with experience in coastal storm damage, and from the Federal Emergency Management Authority. Although a focus was on the hurricane-prone southeastern U.S., the workshop also included expertise from the North Atlantic and California.

The second stage will involve additional data collection through a full review of the initial framework and relationships by a review team, by Corps' offices, and by the professional community at-large, and from damage data collected in post-storm surveys. Experts will then be convened in a formal expert elicitation to use this additional information to modify the preliminary depth-damage relationships and develop final estimates of likely economic damages from a coastal storm.

B-2.3 Needs and Existing Storm Damage Information

This study was prompted by a widely-perceived need for better information on coastal storm damage relationships. A December 2000 letter from the Assistant Secretary of the Army to the Wilmington District requested a “Corps-wide-survey of damage functions used for all types of structures and the rationale for using them, for hurricane and storm damage reduction projects”. The expectation was that “better guidance can be provided to field offices on the conduct of economic analysis if we have the benefit of … better tools to evaluate hurricane and storm damage projects”. This research seeks to provide these better tools.

In investigating storm damage relationships, available sources of information can be divided into two general categories: 1) data on storm damages and on existing structures, and 2) models of the relationships between storm parameters and damage. Whereas the relationships between storm parameters and damage are the ultimate purpose of this investigation, the relationships need to be grounded in the data on actual storm damages. As background for the research and in preparation for the workshop, the project core team from IWR reviewed coastal damage methodologies from various sources including: Corps Districts in Jacksonville, Wilmington, New Orleans, Mobile, New York, Philadelphia; the HAZUS model - a natural hazard loss estimation methodology developed by the Federal Emergency Management Agency in partnership with the National Institute of Building Sciences; FEMA building performance studies; Federal Insurance claims data; USACE reports on Hurricane Fran and on Shoreline Protection and Beach Erosion Control; state data from Hurricane Opal (FL); the Heinz Center’s Evaluation of Erosion Hazards, and various articles from the open literature (i.e. Budge 1991, King et al. 1991, Ulrich et al. 1994, Kato and Torii 2002, Tomalley et al. 2002).

B-2.4 Use of Expert Opinions

The primary reason for using expert opinions is provide "data" where little or no data exists about an issue or problem. It can also deal with uncertainty in selected technical issues related to a system of interest. Issues with significant uncertainty, issues that are controversial and/or contentious, issues that are complex, and/or issues that can have a significant effect on risk are most suited for expert-opinion elicitation. Here we used an informal, consensus-based elicitation process to promote creative thinking about potential frameworks and problem definition. The value of any expert-opinion elicitation comes from its initial intended uses as a heuristic tool, not a scientific tool, for exploring vague and unknowable issues that are otherwise inaccessible. It is not a substitute to scientific, rigorous research.

The identification of the need for the information developed during the elicitation process and its communication to experts are essential for the success of the elicitation. The need identification and communication should include the definition of the goal of the study and relevance of issues to this goal. Establishing this relevance would make the experts stakeholders and thereby increase their attention and sincerity levels. Relevance of each issue and/or question to the study needs to be established. This question-to-study relevance is essential to enhancing the reliability of collected data from the experts. Each question or issue needs to be relevant to each expert especially when dealing with subjects with diverse views.

The expert-opinion elicitation process can be defined as a formal, heuristic process of obtaining information or answers to specific questions about certain quantities, called issues, such as failure rates, unsatisfactory-performance consequences and expected service life. This process should not be used in lieu of rigorous reliability and risk analytical methods, but should be used to supplement them and to prepare for them. It should be preferably performed during a face-to-face meeting of members of an expert panel that is developed specifically for the issues under consideration. The

meeting of the expert panel should be conducted after communicating to the experts in advance to the meeting background information, objectives, list of issues, and anticipated outcome from the meeting. The different components of the expert-opinion elicitation process are described in Aye (2001).

B-2.5 Recent USACE Expert-Opinion Elicitation Studies

Expert-opinion elicitation is a technique for using a panel of individuals with various areas of specialized knowledge for estimating parameters or addressing issues of interest based on their expertise. The March 2002 expert elicitation conducted by IWR on the Economic Consequence Assessment of Residential Flood Damage is a recent example of use of the technique. Expert-opinion elicitation has also been recently applied by the New Orleans District's study of the Lower Atchafalaya Basin and reevaluation of the Morganza to the Gulf of Mexico feasibility studies, by Vicksburg District's Pearl River study, and by the Sacramento District's Feather River flood damage study. Building contractors, insurance adjusters, home decorators, and other individuals with knowledge of construction, prices, and typical home furnishings were used to estimate depth-damage and content-to-structure value ratios. Details on some of these studies are provided in Aye (1999 and 2001).

B-2.6 Residential Damage Due to Coastal Storms

The scope of this study consists of structural damage to single-family homes from coastal storms. These economic consequences can be described by mathematical functions that relate storm parameters such as wave crest height or the depth of still water flooding to the percent of damage that occurs to structures. The percent damage to structure refers to the percent of the depreciated replacement costs of the structure that is damaged. Coastal storms damage structures through wave action, still water flooding, wave run-up, erosion, and wind. These hazard types are described briefly below.

Waves: Most of the energy delivered to the shore by the ocean originates from the wind acting on the ocean to produce waves. Wave characteristics are determined by the wind direction, wind speed, wind duration, how far the wind blows over water, and how far the wave travels before reaching land. Wave action can cause significant damage to coastal structures. Conventional wisdom is that if breaking waves strike at or above a building's first floor elevation, that structure will be severely damaged. This is the rationale for the National Flood Insurance Program's (NFIP) characterization of a highly vulnerable zone (V-zone) for damage from wave action. The ability to prevent wave damage is considered a major benefit of Corps' shore protection measures. Although FEMA demarks the V-zone as an area subject to breaking waves at least 3 feet high, recent, FEMA-sponsored tests indicate that 1.5-foot waves can break away walls. This research suggests that the V-zone might more appropriately extend to all areas subject to 1.5-foot high breaking waves.

Stillwater flooding: Storms can cause inundation of structures with still water either through overtopping of a dunes system (coastal flooding) or through flood waters coming from the bay side of a coastal island (bay-side flooding). Coastal flooding implies still-water level flooding of structures because of overtopping of a dune system or storm surge breaking through from the coastal side and inundating beach areas. A major benefit of Corps' shore protection measures may be reduced coastal flooding damages. Bayside flooding implies still water level flooding of structures, with flooding coming from the bayside. Natural or man-made structures may have prevented flooding from storm surge on the coastal side of an island, but high seas inundated structures from the bay or backside of an island. Structures on the bayside of islands are frequently constructed with a lower level of flood protection than structures across the island on the oceanfront. For example bayside

houses may be built lower to the ground whereas oceanfront houses might be raised on piles. Damage from bayside flooding is generally not reduced through shore protection measures.

Erosion: On average, the nation's shorelines are receding at an annual rate of slightly more than one foot per year, although rates vary significantly across regions and across shoreline types. In addition to long-term erosion, erosion during a storm may destroy a dune and undermine shorefront structures. The extent of damage will depend on the amount of storm-induced erosion at the structure and structural characteristics such as foundation and piling embedment. Damages from storm-induced erosion can be significant, regardless of the long-term erosion rate or whether natural processes rebuild the dune in the months following a storm. Corps shore protection measures can provide significant reduction in damages attributable to erosion. Because erosion causes beaches to narrow over time, it is a major factor to consider in conducting a life cycle analysis of project benefits and costs.

Wave Run-up: Wave run-up is the upper level reached by a wave on a beach or coastal structure, relative to still-water level (Coastal Engineering Manual, 2002). Wave run-up applies pressure on a structure in both a vertical and horizontal direction and is a function of the water depth and the square of the water velocity. Wave run-up ceases to be a damage factor when breaking waves attack a structure.

Wind Damages: High winds associated with storms can cause significant damages to structures both on the coast and much further inland. High winds and associated flying projectiles can damage doors, windows or roofs. This damage to the integrity of the structure may combine with high winds to cause severe damage or structural failure. Such breaching also allows rainwater damage to the structure. Most of the damages from Hurricanes Andrew, Inky, and Hugo were caused by wind and wind-related rainwater as opposed to waves, flooding, wave run-up, or erosion. Because Corps' projects do not significantly affect the wind speed of storms, wind damage is not reduced through shore protection measures. Nonetheless, wind damage plays a significant role in life cycle cost analysis for Corps' storm damage reduction projects.

CHAPTER B-III. PARTICIPANTS

B-3.1 Requirements

The IWR project core team has the lead responsibility for achieving the project objectives, but relied on input from a larger, working group of experts to develop appropriate damage relationships. The working group represented Corps' Districts that had been active in shoreline protection projects and represented different geographic regions. In addition, it included outside experts from the Federal Emergency Management Agency, universities, and the private sector who had expertise in coastal storm damage assessment.

B-3.2 Participants

A list of the IWR project core team and working group for the workshop is below.

PROJECT CORE TEAM

Affiliation	**Name**	**Role**
IWR	Stuart Davis	Project Leader
IWR	Hal Cardwell	Project Leader
IWR	David Moser	IWR Program Manager

USACE-HQ	Lillian Almodovar	HQ Program Manager
BMA Engr/Un. of MD	Bilal Ayyub	Facilitator

WORKING GROUP

Affiliation	**Name**	**Role**
USACE/Wilmington	Bob Finch	In-house Technical Advisor (S.Atlantic)
USACE/Wilmington	Mike Wutkowski	In-house Technical Advisor (S.Atlantic)
USACE/Jacksonville	Dan Peck	In-house Technical Advisor (S.Atlantic)
USACE/Jacksonville	Tom Smith	In-house Technical Advisor (S.Atlantic)
USACE/SAD	Gerald Melton	In-house Technical Advisor (S.Atlantic)
USACE/New Orleans	Brian Maestri	In-house Technical Advisor (Gulf)
USACE/Los Angeles	Dan Sulzer	In-house Technical Advisor (W.Coast)
USACE/Los Angeles	Susie Ming	In-house Technical Advisor (W.Coast)
USACE-HQ	Harry Shoudy	In-house Technical Advisor
USACE-HQ	Charlie Chesnutt	In-house Technical Advisor
USACE-HQ	Jay Warren	In-house Technical Advisor
URS	Bill Coulbourne	Outside Technical Advisor (N.Atlantic)
URS	Mike Cannon	Outside Technical Advisor (N.Atlantic)
Consultant	Chris Jones	Outside Technical Advisor (S.Atlantic)
NC SeaGrant	Spencer Rogers	Outside Technical Advisor (S.Atlantic)
FEMA	Paul Tertell	Outside Technical Advisor

CHAPTER B-IV. WORKSHOP RESULTS

B-4.1 Straw man Coastal Storm Damage Framework

The starting point for discussions of coastal storm damage processes was a "straw man framework" for structural damage estimation that was put forth by the IWR project core team. The straw man framework assumes as known, the physical parameters of the area and of the storm. These parameters include surface water elevation, ground elevation, and shoreline type, wave heights, storm-induced erosion depth. Also assumed known are structural characteristics such as location, foundation type, height of lowest supporting beam of structures including their location. Long-term erosion is considered by progressively moving the shoreline landward, therefore increasing the storm-induced erosion and inundation potential from subsequent storms. Economic losses (damages) due to land lost are outside the scope. Wind damages are estimated outside of this framework; this estimate will be used to modify damage to structures from coastal flooding and erosion as appropriate. We also assume the surface water elevation accounts for bay-side flooding and dune breaches.

Inundation: Damage to both contents and structures from wave run-up, breaking waves, and still water flooding is assumed to be captured through the use of FIMA[5] V-zone curves for all areas that experience breaking waves of 1.5 ft above the lowest structural horizontal member of the structure. For areas that experience less than 1.5 feet of flooding, FIMA A-zone curves will be used for structure damage.

[5] The Federal Insurance and Mitigation Administration (FIMA – formerly the Federal Insurance Administration - FIA) developed and uses depth-damage curves to estimate actuarial premiums for flood insurance. FIMA has two sets of curves, A-zone curves for riverine and coastal areas without high wave velocity, and V-zone curves for coastal areas that are expected to experience wave action. FIMA defines the V-zone as those coastal areas expected to experience a 3-foot high breaking wave.

Storm-induced erosion: A curve relating damage to the depth of vertical erosion at the center of building will be developed for various foundation types. This curve will be applied for sandy beaches with small dunes (as defined by FEMA). An additional relationship for high dunes and sandy bluff shoreline types will describe storm-induced damages from near-vertical erosion scarps.

Combined Damage vectors: The total damage to a structure will be the sum of the inundation damages and the storm-induced erosion damages, with the total not to exceed the value of the structure.

B-4.2 Revised Framework

Discussion at the workshop produced consensus on a revised framework for structural damage estimation. Once the damage hazards were identified, the experts focused on determining the appropriate storm variable that would relate to damage for each hazard type. For example, depth of water above the walking surface for the lowest main floor was selected as the best variable to relate to still water flooding damages. This is the X-axis in a depth (or other variable) versus damage curve. The experts then agreed on the number of relationships that would have to be developed to properly predict damages to different foundation types (e.g. slab on grade or pile) or materials (wood, concrete, masonry) were appropriate for each damage hazard. Discussion then moved to different ways to combine the damages across hazards, and how to account for regional differences in shorelines, with a focus on estimating damages to bluffs. We describe the discussions and decisions in this section. Appendix A contains results in the form of quantified relationships (curves) for storm damages.

B-4.2.1 Inundation Damage

For damages from still water inundation the workshop determined that the appropriate storm variable to use was the “Depth of water above the walking surface of the lowest main floor”. Although damages to the floors of a structure occur before the water depth reaches the walking surface, using the depth of water surface is an easier variable to use for data collection. **Structural damages that occur from inundation of the floors at slightly lower depths can be included by assigning positive values to damages when depth of water above the walking surface is negative.**

The workshop determined that damages from inundation also depend on the foundation type, on material, number of floors, and, for structures on piles, on the existence of ground-level enclosures. Separate relationship (although using the same X-axis) would need to be developed for each of the following cases:

- Wood frame with piles (with & without enclosures – small medium and full)
- Wood frame without piles
- Concrete & masonry with piles (with & without enclosure – small medium and full)
- Concrete & masonry without piles
- Number of floors (1, 1.5 and 2)

The workshop considered various existing data sources to quantify the relationships for inundation. These data sources included FIMA coastal A-zone curves, curves from New Orleans District for structures on piles and on piers, and curves issued by the Corps in 2000 based on post-flood surveys of actual damages in various parts of the United States.

B-4.2.2 Waves Damage

For damages due to breaking waves the workshop determined that the appropriate storm variable to use was the "difference between the top of wave (crest) and the bottom of the lowest horizontal member". The workshop considered using the walking floor elevation as the datum for comparison with the top of the wave height for consistency with the measure suggested for inundation. However the workshop decided that the framework would be clearer and more rigorous if it used the bottom of the lowest horizontal member as the reference point because it is at this point that waves can start to damage the structure. If practical considerations preclude measurements of the bottom of the lowest horizontal member, this value can be estimated based on the elevation of the walking surface.

The workshop determined that damages from inundation also depended on the foundation type for structures on piles and on the existence of ground-level enclosures. Separate relationships (although using the same X-axis) would need to be developed for each of the following cases:

- Structures on piles (with & without enclosures – small medium and full)
- Structures not on piles

B-4.2.3 Wave Run-up Damage

The workshop concluded that damages from wave run-up were attributable to the "Difference between the top of water and the bottom of the lowest horizontal member, and its velocity at the seaward face of the structure". The force applied by wave run-up could be described as directly dependent on the depth of the water and the square of the velocity. Forces would likely act in both a horizontal and vertical direction and be measured in lbs/linear foot. However the workshop participants did not feel that the there was enough known about the damage from wave run-up to determine an appropriate storm variable to use, and opted to delay development of a damage relationship as a long-term need.

B-4.2.4 Erosion Damage

For damages from storm-induced erosion, the workshop determined that the appropriate storm variable to use both for structures with shallow foundations and ones on piers was the "percent of footprint compromised." Shallow foundation structures were defined as structures that are on slabs or on piers. Houses on bluffs that experience erosion can be considered as structures with shallow foundations. When a shallow foundation experiences vertical erosion such that it loses support from the ground, the foundation is compromised. Six inches of vertical erosion or undermining has been conventionally considered to cause a loss of support. Whereas the workshop participants felt that this definition was relatively straightforward for shallow foundations, the selection of a variable for deep or pile-supported foundations was more contentious.

The distinction was made between a structure that was undermined by erosion and one that had its foundation "compromised". Whereas for structures on shallow foundations undermining (six vertical inches of erosion) is equivalent to compromised, pile structures can be extensively undermined with little or no damage. In these cases the entire footprint could experience vertical erosion of six inches yet no damage would occur because, although undermined, the erosion does not compromise the ability of the foundation to support the structure. Conversely, a compromised pile can be defined as one whose remaining embedment depth renders it ineffective against lateral forces such as wind and waves. Using, as the independent variable (X-axis) the "percent of footprint compromised" would allow correct categorization of damages done to a pile-support house that, because of erosion, might have its entire footprint in the surf zone (and hence undermined), but yet had minimal damage because its foundation was not compromised. The workshop noted that relating storm

parameters to the percent of footprint compromised would be difficult and likely be regionally and structurally specific. Comment: This percent of footprint compromised is pretty useless to predict damage from a storm unless this can be predicted from the extent of vertical erosion at the structure. I don't think there will be any model that keeps track of all piles of a pile-founded structure. We will have to make assumptions about where piles are located and the extent of embedment.

Because the appropriate storm variable was defined so broadly, the workshop only called for two separate relationships to be developed for erosion damages: one for shallow foundation and one for deep foundations (piles). More relationships may need to be developed as definitions of "footprint compromised" are developed for specific regions and projects.

B-4.2.5 Combining Damages

Because a structure may be damaged by more than one of the four storm damage hazards identified by the workshop, a methodology must be developed for how to combine the damages. The Straw man Framework proposed a simple additive combination with a constraint that the total damages to a structure could not exceed its value. The can be expressed as %A + %B. A more commonly used rule for combining damages is to simply use the maximum percent damage from any hazard, or Max [%A, %B]. Whereas the first rule assumes that there is no common damage caused by different hazards, the latter rule assumes the other extreme - which no damage occurs that is not covered by the most damaging hazard. A third rule to consider would be the sum of the hazard percentages minus their product: %A + %B -%A%B. This framework was used in the Portland District and is akin to the probability of occurrence at least one of two independent events A and B.

The workshop concluded that the combination rule must be dependent on the types of hazard that cause damages. If both waves and inundation cause damage the workshop suggested the rule be to only use the damages caused by waves (this is consistent with FEMA's V-zone definition). If both erosion and inundation cause damage the proposed rule is to use the sum of the damages minus their product. Similarly, if both erosion and run-up cause damage the rule is to use the sum of the damages minus their product. For the case where both run-up and erosion cause damages, the workshop proposed two definitions, one for shallow foundation structures, where the rule is to use the maximum of the two damages, and one for pile foundation structures where the rule is to use the sum of the damages minus their product. We summarize these relationships below for the various cases of combination

Case 1 – Inundation + Waves	%W
Case 2 – Run-up + Waves	%W
Case 3 – Inundation + Run-up	will not occur
Case 4 – Inundation + Erosion	%I + %E - %I*%E
Case 5 – Run-up + Erosion	%R + %E - %R*%E
Case 6 – Waves + Erosion	Max %W, %E (shallow foundation)
	%W + %E - %W*%E (pile foundation)

These cases cover all likely combinations of hazards because a structure would not be subject to both moving water (run-up) at the same time as still-water inundation, and waves damages would subsume run-up as it does inundation damages. The workshop noted as a long term need, better information as to when to "switch" from the inundation damage curve to the wave damage curve. Similarly this could be one area of investigation when determining the run-up damage relationships.

Discussion at the workshop included concerns on how to calibrate damage relationships from multiple sources, and noted that the structure should permit direct data collection for the calibration

B-4.2.6 Coastlines with of Bluffs

Storm damages on coastlines with bluffs differ from those on a beach and dune coastline. Inundation is not an issue for bluffs, and neither are waves or run-up except as they promote erosion. Also, all foundations on bluffs can be treated as shallow foundations or slabs, because erosion from a bluff will undermine a deep pile foundation in the same way as a shallow foundation. Failure of a bluff can be from top to bottom or from bottom to top.

B-4.2.7 Long-term and Short-term Needs / Next Steps

The following table summarizes the long-term and short-term needs and future steps in this area:

Priority	Long-term and Short-term Needs / Next Steps
High	Methodology (including authority) for post storm data collection to determine flood conditions during event and erosion conditions at the end of an event.
High	Define/issue guidance for "Compromised" regional Differences
High	Beach profile translation
High	Contents
High	Land Loss/estimated value
High	Post storm data – wave crest water level elevations, lower limit (elevation) of wave damage.
High	Pre-storm building inventory
High	Collection of Existing loss information (including analysis of data from Fran)
Medium	Wave damage height threshold (1.5 ft vs 3 ft) – When do we abandon the inundation curve? How far inland is wave damage an issue?
Medium	RUN-UP RELATIONSHIPS - HOW TO QUANTIFY (WEST COAST)
Medium/Low	Sedimentation damage during inundation
Medium/Low	Duration of inundation
Low	Bluff Erosion processes
Low	Curves/response of engineered buildings, and other non residential structures
Low	Salt versus fresh water inundation damage

CHAPTER B-V. REFERENCES

Ayyub, B.M 2001. Elicitation of Expert Opinions for Uncertainty and Risks, CRC Press, Boca Raton, FL.

Ayyub, B.M 2000. Guidelines on Expert-Opinion Elicitation of Probabilities and Consequences for Corps Facilities, U. S. Army Corps of Engineers, Alexandria, Virginia, IWR Report 00-R-10

Ayyub, B.M, Blair, A.N., Patev, R.C.2000. Risk Analysis of Design-Improvement Alternatives to the Lindy C. Boggs Lock and Dam, USACE

Ayyub, B. M., Blair, A. N., Davis, S. A., 2001. Verification and Validation of the Corps of Engineers Floodplain Inventory Tool Flood Damage Assessment Model: Preliminary Assessment of CEFIT Flood Damage Model, The Institute for Water Resources, U. S. Army Corps of Engineers, Alexandria, Virginia.

Bodge, Kevin R., 1991. Damage Benefits and Cost Sharing for Shore Protection Projects, Shore and Beach, p11-18.

Davidson, Rachel A., and Kelly B. Lambert, 2001. "Comparing the Hurricane Disaster Risk of U.S. Coastal Counties. Natural Hazards Review, Vol 2. No 3. pp132-142.

Davis, S.A., Calson, B.D., and Moser, D.A., 2000. Depth-Damage Functions for Corps of Engineers Flood Damage Reduction Studies, Technical Analysis and Research Division, Institute for Water Resources Report.

EQE, Development of HAZUS Flood Loss Estimation Methodology, 2000. Preview Report on Models, Methods, and Data. Developed for National Institute of Building Sciences, Washington DC. July 28, 2000.

Hillyer, Theodore M., 1996. Shoreline Protection and Beach Erosion Control Study. Final Report: An Analysis of the U.S. Army Corps of Engineers Shore Protection Program. IWR Report 96 – PS - 1.

Kato, Fuminori and Ken-ichi Torii, 2002. “Damages to General Properties due to a storm surge in Japan, from Proceedings of Solutions to Coastal Disasters '02, ASCE, L. Ewing and L. Wallendorf eds. February 24-27, San Diego, CA.

King, Mona J. 1991. “The Economic Benefits of Hurricane and Storm Damage Reduction,” from Coastal Zone '91, Proceedings of the Seventh Symposium on Coastal and Ocean Management, ASCE, O.T. Magoon, H. Converse, V. Tippie, L.T. Tobin, and D. Clark editors. July 8-12.

National Research Council, 1995. Beach Nourishment and Protection.

Robinson, Dennis P., Laura Zepp, and Harry M. Shoudy, 2001. The Distribution of Shore Protection Benefits: A Preliminary Examination, Institute for Water Resources.

Rogers, Spencer 2002. “Erosion Damage Thresholds,” a draft paper of NC SeaGrant.

Skaggs, L.L. and F. McDonald, eds., National Economic Development Procedures Manual - Coastal Storm Damage and Erosion. IWR Report 91-R-6. September 1991.

Thomalla, Frank, James Brown, Ilan Kelman, Iris Möller, Robin Spence, and Tom Spencer, 2002. “Towards and Integrated Approach for Coastal Flood Impact Assessment,” from Proceedings of Solutions to Coastal Disasters '02, ASCE, L. Ewing and L. Wallendorf eds. Feb 24-27 San Diego CA.

Urlich, Cheryl P., Mona J. King, Evelyn H. Brown, Paul Miselis, 2002. “A Methodology for Quantifying "Hot-Spot" Erosion Benefits for Shore Protection Projects, Alternative Technologies in Beach Preservation,” Proceedings of the 7th National Conference on Beach Preservation Technology, Florida Shore and Beach Preservation Association, L.S. Tait ed. Feb 9-11.

NOTE: Should check out and reference as appropriate these reports.

The Heinz Center, 2000, The Hidden Costs of Coastal Hazards.

The Heinz Center, 2000, Evaluation of Erosion Hazards.

http://www.heinzctr.org/publications.htm

CHAPTER B-VI. DAMAGE RELATIONSHIP DETAILS

The following figures contain the details of the damage relationships developed in the workshop. The "Proposed" curve represents the experts' median estimate of damages, whereas the upper and lower represent estimates of the range of the damages. Here, 75 percent of the time damages will be less than the "Upper" curve and 25 percent of the time damages will be lower than the "Lower" curve. For the inundation curves, the upper and lower bounds were set equivalent to the estimates used by New Orleans district for structures on piers (N.O. pier), and by the FIMA coastal A-zone curves, respectively. For damages from inundation, the workshop only developed curves for the selected cases noted below. The workshop assumed that estimates for inundation damages in structures with partial enclosures would flow from the curves developed here. Likewise all curves apply for single story houses.

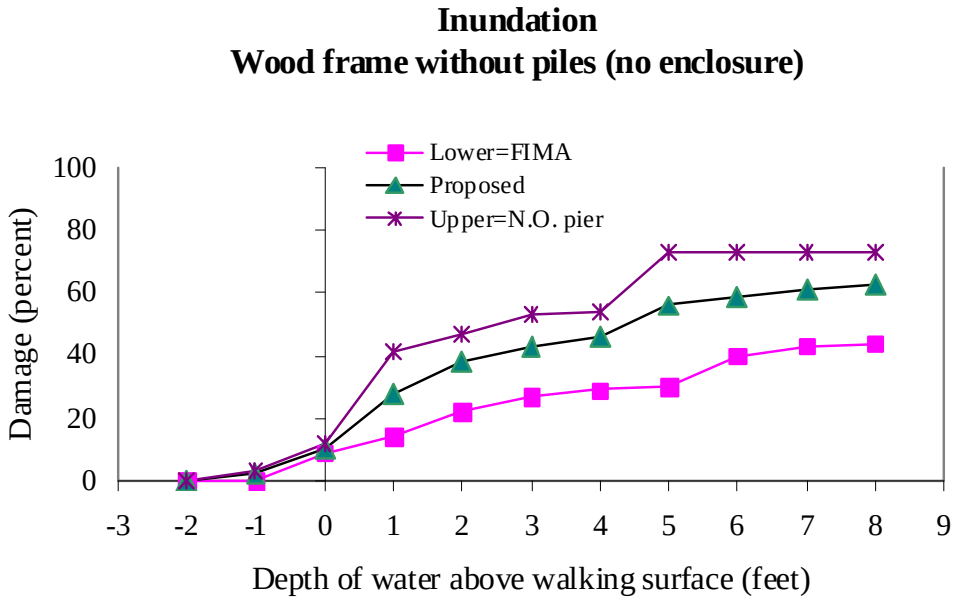


Figure B-1. Inundation Wood Frame without Piles (no enclosure)

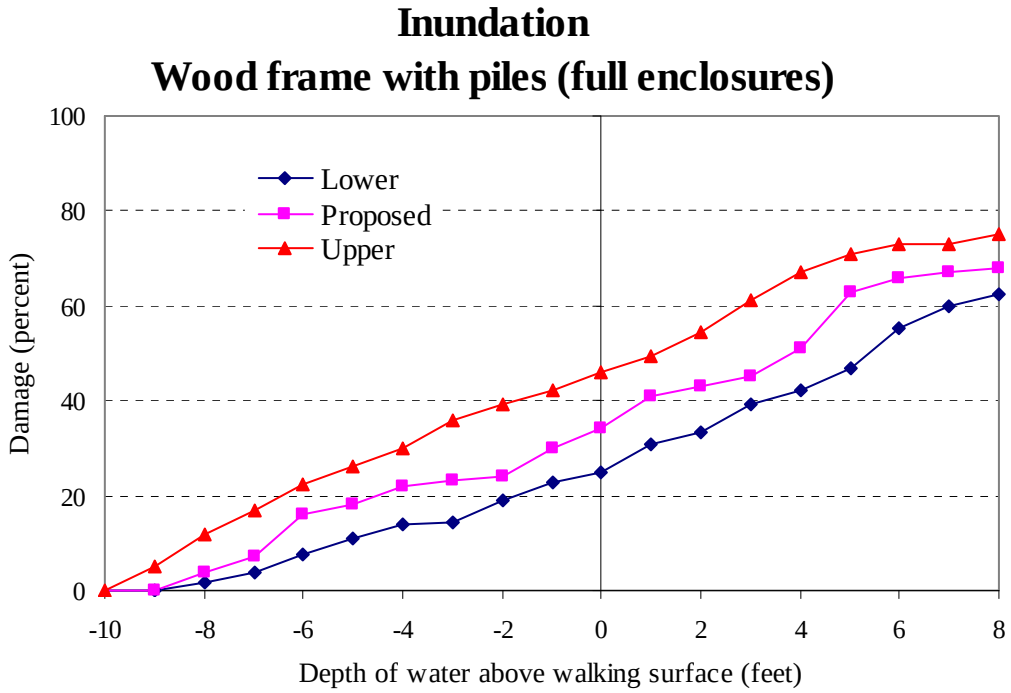


Figure B-2. Inundation Wood Frame with Piles (full enclosure)

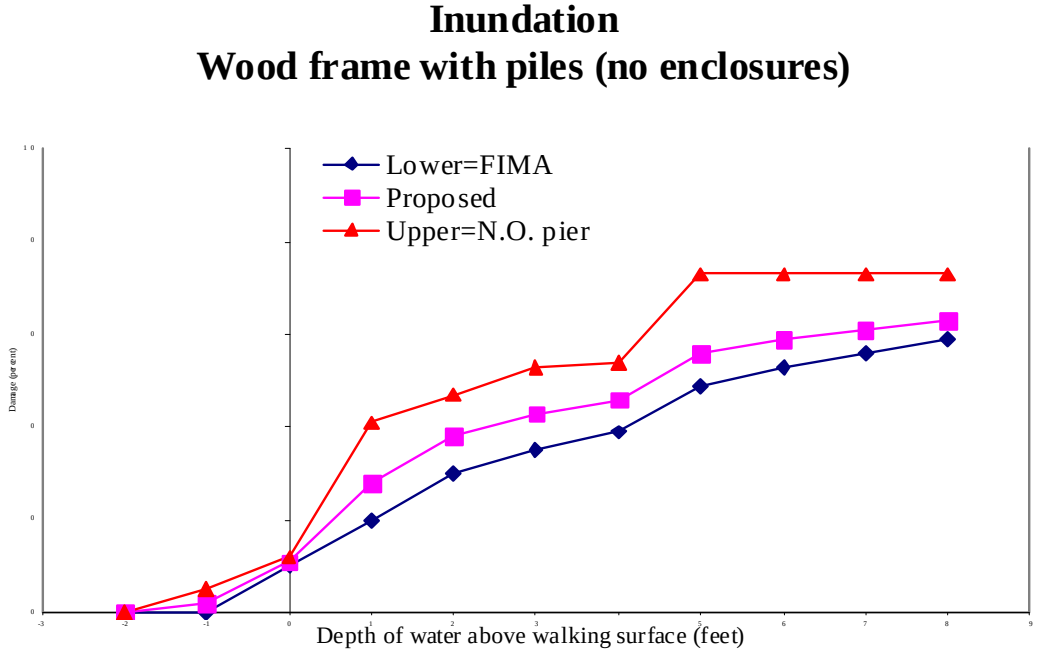


Figure B-3. Inundation Wood Frame with Piles (no enclosure)

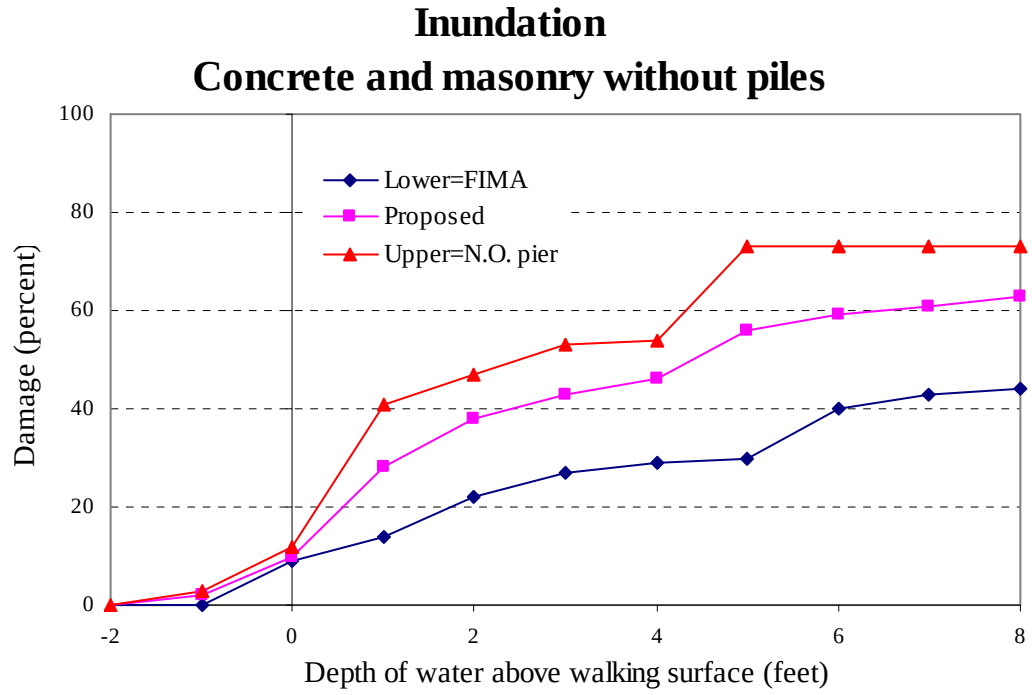


Figure B-4. Inundation Concrete and Masonry without Piles

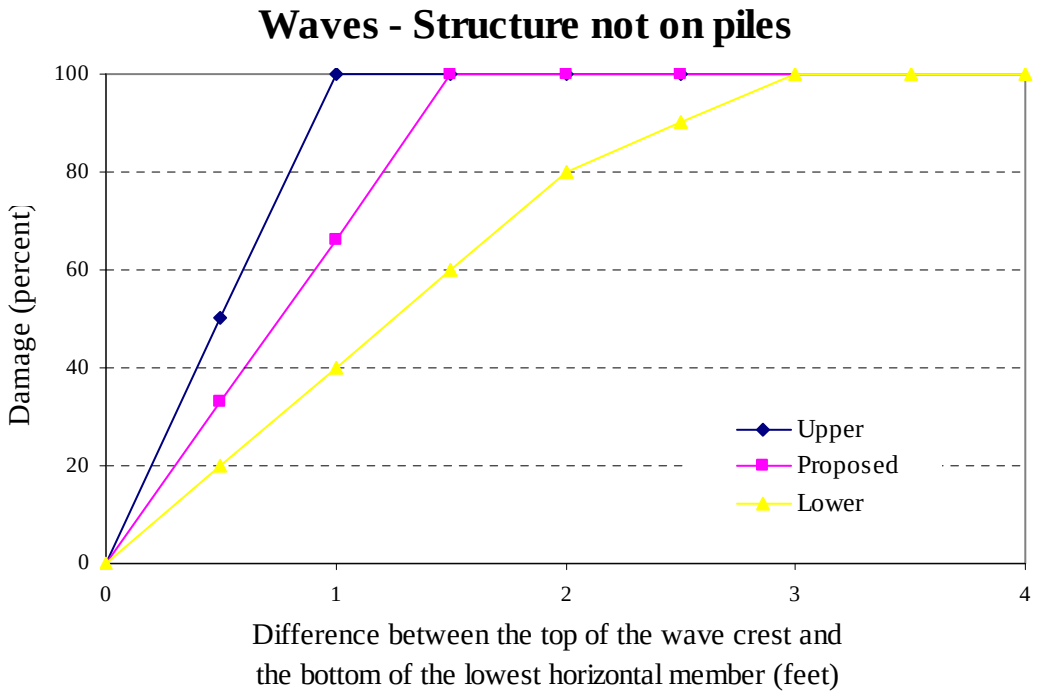


Figure B-5. Waves – Structure not on Piles

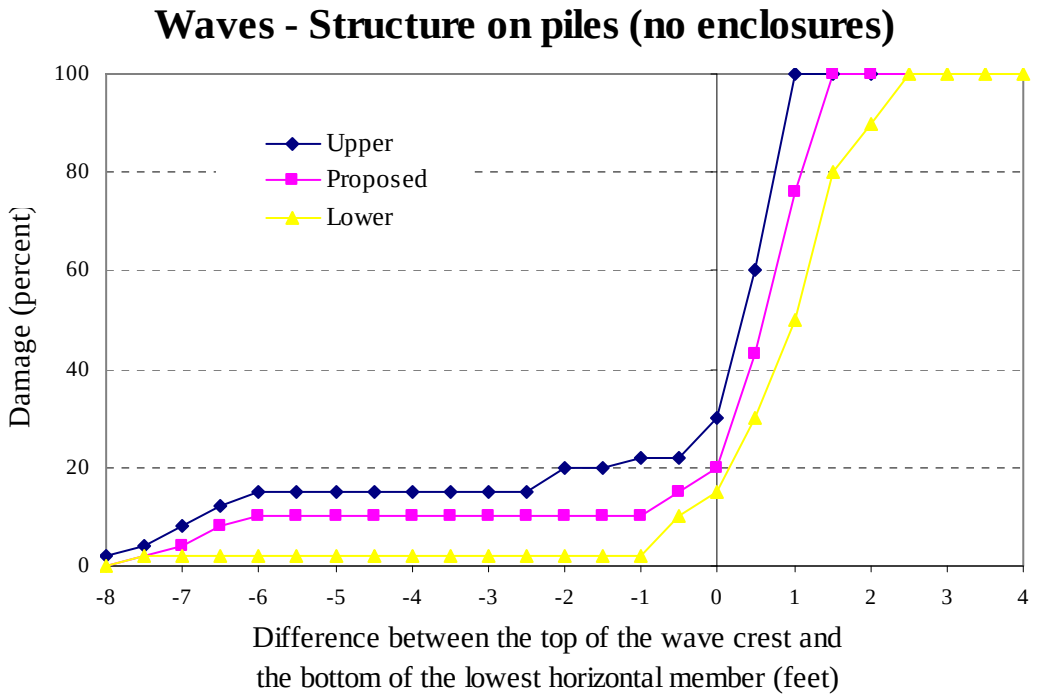


Figure B-6. Waves – Structure on Piles (no enclosure)

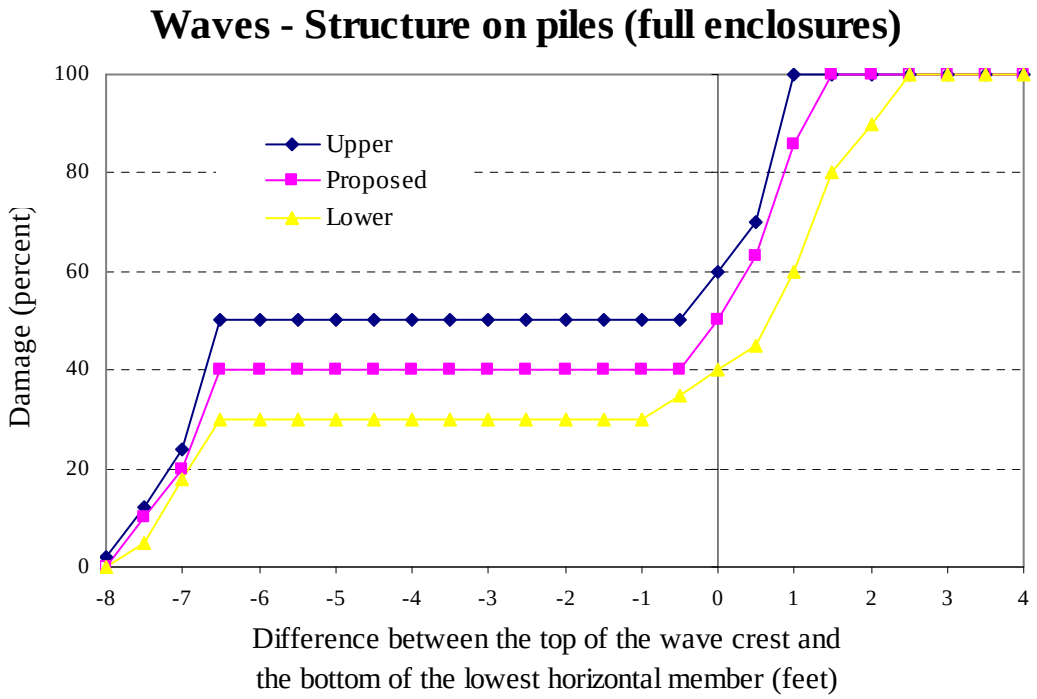


Figure B-7. Waves – Structure on Piles (full enclosure)

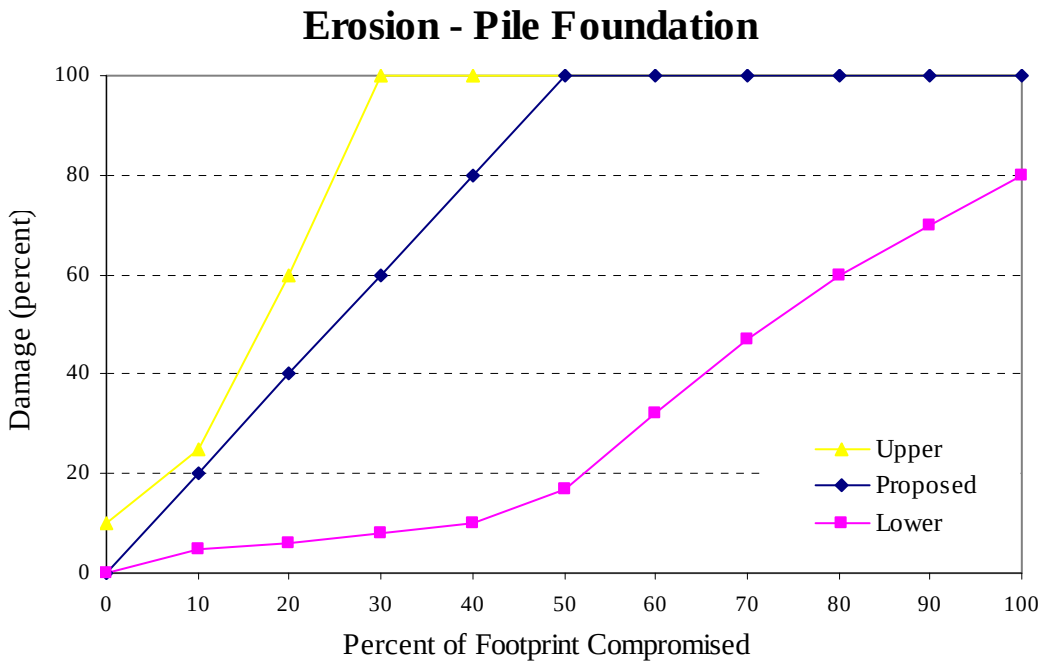


Figure B-8. Erosion – Pile Foundation

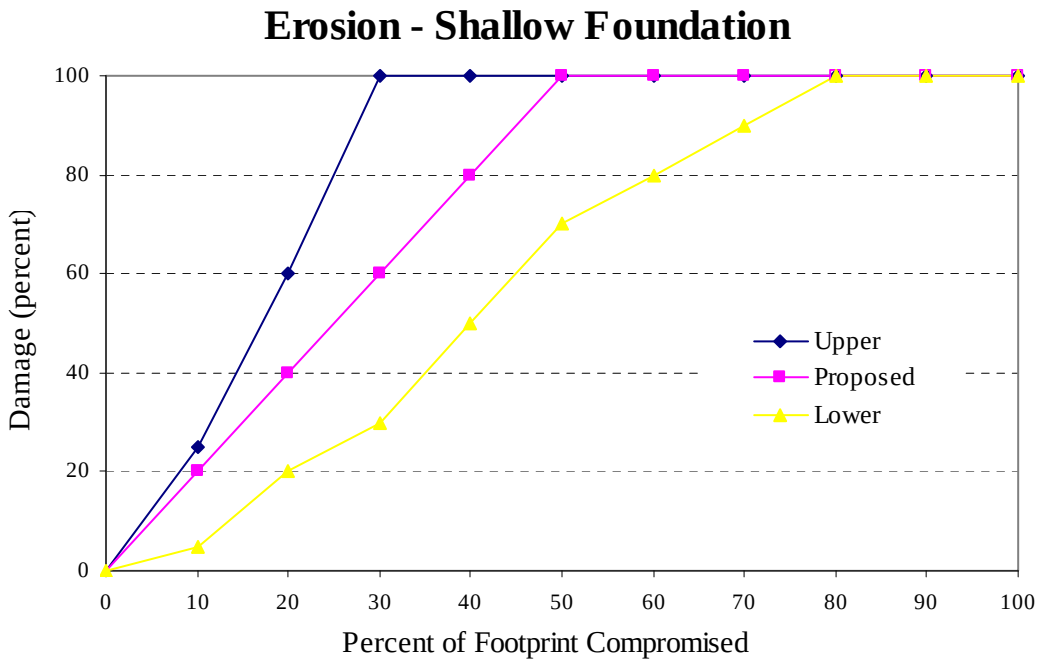


Figure B-9. Erosion – Shallow Foundation

ADDENDUM C – PARKING AND ACCESS

CHAPTER C-I. USER FEES, PUBLIC ACCESS AND PARKING

This addendum describes the public access, and parking for the length of the beach construction evaluated in the Mississippi Coastal Improvement Program (MsCIP) Comprehensive Report. This parking and access analysis was conducted in accordance with ER 1165-2-130 "Water Resource Policies and Authorities – Federal Participation in Shore Protection" dated 15 June 1989. The data provided in this addendum was collected through field verification.

According to ER 1165-2-130, "Unless the protection of privately-owned beaches is incidental to protection of public beaches (paragraph 9), they must be open to all visitors regardless of origin or home area, or provide protection to nearby public property to be eligible for Federal assistance. Items affecting public use are… 1/ parking, 2/ access, and 3/ user fees." Typically, these items serve a dual purpose of both identifying the basis for federal participation and to justify the recreation benefits of the proposed shoreline protection project. For the MsCIP Comprehensive Report, the shoreline protection measures (Line of Defense 2) have zero net recreational benefits, in other words, the future with project condition recreation benefits are the same as the future without project recreation benefits. Since there is no claim on recreation benefits, this analysis is not intended to show public availability for justifying benefits claimed, but merely to show whether or not there is sufficient availability to use that would warrant federal participation.

C-1.1 Parking

The coast of Mississippi is approximately 70 miles long and spans Hancock (planning unit 1), Harrison (planning unit 2) and Jackson Counties (planning unit 3), from west to east respectively. Within each county there is public parking and access to the beach. There are a total of 3,730 free parking spaces along the beach in the three-county study area.

The Coast of Hancock County is approximately 16 miles long. Beach Blvd spans 8 miles of the eastern portion of Hancock County's coast. Along Beach Blvd there are 592 free parking spaces, both in lots and along the street. The beach can be accessed without significant hindrance from virtually anywhere along South Beach Blvd.

The Coast of Harrison County is approximately 25 miles long. Highway 90 spans the entire coast of Harrison County. Along Highway 90 there are 2,788 free parking spaces, both in lots and along the street. The beach can be accessed without significant hindrance from virtually anywhere along Highway 90.

The Coast of Jackson County is approximately 29 miles long. There are a few roads which run along various portions of the coast. Some of these roads have parking either on the street or in lots. There are a total of 350 free parking spaces. In areas where there is both beach and road along the coast, the beach can be accessed without significant hindrance.

Data on the parking areas for each of the three counties are displayed separately in the tables below. Table C1-1 displays data for Hancock County. Table C1-2 displays data for Harrison County. Table C1-3 displays data for Jackson County. Each table begins with the parking area furthest west

in the county that it represents and ends with the parking area furthest east in the same county. Following the tables are maps of the study area and images of some parking areas.

Table C1-1.
Hancock County Parking

	Location	Spaces	Parking Type	Distance from Previous Access Point	Distance from previous lot (miles)
1	Silver Slipper Casino	241	Free, Lot	Continuous	0.0
2	Lakeshore Rd	100	Free, Street	Continuous	0.1
3	State Park Rd 1	10	Free, Street	Continuous	1.7
4	State Park Rd 2	40	Free, Street	Continuous	0.1
5	Terrace Ave	51	Free, Lot	Continuous	2.8
6	Washington St	150	Free, Lot	Continuous	2.8

Table C1-2.
Harrison County Parking

	Location	Spaces	Parking Type	Distance from previous access point	Distance from previous lot (miles)
1	5th Ave	20	Free, Street	Continuous	0.0
2	Boisdore Ave	8	Free, Street	Continuous	0.3
3	Sherman Ave	12	Free, Street	Continuous	0.2
4	Brown Ave	3	Free, Street	Continuous	0.1
5	Magnolia Ave	5	Free, Street	Continuous	0.8
6	Clarence Ave	30	Free, Lot	Continuous	0.3
7	Church Ave	7	Free, Street	Continuous	0.3
8	Hiern Ave	150	Free, Lot	Continuous	0.3
9	Market St	12	Free, Street	Continuous	0.3
10	Seal Ave	12	Free, Street	Continuous	0.5
11	Donlin Ave	5	Free, Street	Continuous	0.2
12	Courtenay Ave	3	Free, Street	Continuous	0.4
13	Hackett Ln	7	Free, Street	Continuous	0.1
14	Menge Ave	5	Free, Street	Continuous	0.6
15	Espy Ave	18	Free, Street	Continuous	0.9
16	Shadow Lawn Ave	10	Free, Street	Continuous	0.3
17	Least Tern Dr	7	Free, Street	Continuous	0.1
18	Emerald Ave	20	Free, Street	Continuous	0.2
19	Hayden Ave	25	Free, Street	Continuous	0.2
20	Holiday Ave	5	Free, Street	Continuous	0.2
21	White Harbor Rd	7	Free, Street	Continuous	0.3
22	N Seashore Ave	10	Free, Street	Continuous	0.6
23	S Lang Ave	7	Free, Street	Continuous	0.2
24	Oak Gardens Ave	95	Free, Lot	Continuous	0.5
25	Shelter Rock Dr	27	Free, Lot	Continuous	0.3
26	Russell Ave	20	Free, Street	Continuous	0.2
27	Winter Ln	10	Free, Street	Continuous	0.1

1

Table C1-2.
Harrison County Parking (continued)

	Location	Spaces	Parking Type	Distance from previous access point	Distance from previous lot (miles)
28	Jeff Davis Ave	180	Free, Lot	Continuous	0.3
29	S Cleveland Ave	190	Free, Lot	Continuous	0.3
30	Gulfview Ave	7	Free, Street	Continuous	0.1
31	N Nicholson Ave	5	Free, Street	Continuous	0.3
32	Beach Park Pl	37	Free, Lot	Continuous	0.1
33	E Azalea Dr	5	Free, Street	Continuous	0.2
34	Richards Ave	5	Free, Street	Continuous	0.1
35	S Ocean Wave Ave	5	Free, Street	Continuous	0.2
36	Rich Ave	32	Free, Lot	Continuous	0.1
37	Ruth Ave	16	Free, Lot	Continuous	0.2
38	Maria Ave	10	Free, Street	Continuous	0.1
39	Fournier Ave	10	Free, Street	Continuous	0.1
40	Camp Ave	49	Free, Lot	Continuous	0.2
41	41st Ave	21	Free, Street	Continuous	0.3
42	38th Ave	45	Free, Street	Continuous	0.2
43	33rd Ave	200	Free, Lot	Continuous	0.2
44	20th Ave	150	Free, Lot	Continuous	1.0
45	Pratt Ave	42	Free, Lot	Continuous	0.4
46	Thornton Ave	35	Free, Lot	Continuous	0.1
47	Hill Pl	5	Free, Street	Continuous	0.2
48	Kelly Ave	10	Free, Street	Continuous	0.2
49	Bert Ave	30	Free, Street	Continuous	0.1
50	Evans Ln	7	Free, Street	Continuous	0.1
51	Gulf Ave	5	Free, Street	Continuous	0.1
52	Roberts Ave	5	Free, Street	Continuous	0.2
53	Alfonso Dr	5	Free, Street	Continuous	0.2
54	Midway Ave	5	Free, Street	Continuous	0.1
55	Oak Ave	5	Free, Street	Continuous	0.1
56	Oask Ave #2	65	Free, Lot	Continuous	0.2
57	Arkansas Ave	50	Free, Lot	Continuous	0.2
58	Texas Ave	5	Free, Street	Continuous	0.1
59	Courthouse Rd	100	Free, Lot	Continuous	0.1
60	Palmetto Ln	3	Free, Street	Continuous	0.1
61	Tegarden Rd	7	Free, Street	Continuous	0.4
62	Paradise Ave	20	Free, Street	Continuous	0.2
63	Oleander Dr	5	Free, Street	Continuous	0.1
64	E Cedar Dr	5	Free, Street	Continuous	0.1
65	Cowan Rd	5	Free, Street	Continuous	0.3
66	Anniston Ave	5	Free, Street	Continuous	0.6
67	Southern Cir	10	Free, Street	Continuous	0.1
68	Mockingbird Ln	5	Free, Street	Continuous	0.1

Table C1-2.
Harrison County Parking (continued)

	Location	Spaces	Parking Type	Distance from previous access point	Distance from previous lot (miles)
69	Gateway Dr	20	Free, Street	Continuous	0.7
70	Eisenhower Dr	35	Free, Street	Continuous	0.4
71	Edgewater Dr	5	Free, Street	Continuous	0.4
72	Grande View Dr	7	Free, Street	Continuous	0.1
73	Oakmont Pl	60	Free, Street	Continuous	0.2
74	Beauvoir Ave	3	Free, Street	Continuous	0.1
75	Sadler Beach Dr	10	Free, Street	Continuous	0.6
76	Sadler Beach Dr 2	25	Free, Street	Continuous	0.1
77	Camellia St	25	Free, Street	Continuous	0.2
78	Treasure Bay Casino	275	Free, Lot	Continuous	0.3
79	Rodenberg Ave	108	Free, Lot	Continuous	0.9
80	Saint Peter Ave	5	Free, Street	Continuous	0.8
81	Saint Francis St	15	Free, Street	Continuous	0.3
82	Saint Paul St	3	Free, Street	Continuous	0.2
83	Morrison Ave	30	Free, Lot	Continuous	0.3
84	Azalea Dr	18	Free, Lot	Continuous	0.2
85	Porter Ave	61	Free, Lot	Continuous	0.3
86	Main St	70	Free, Lot	Continuous	1.0
87	Holley St	15	Free, Street	Continuous	0.5
88	Oak St	20	Free, Lot	Continuous	0.5
89	Cedar St	32	Free, Lot	Continuous	0.3

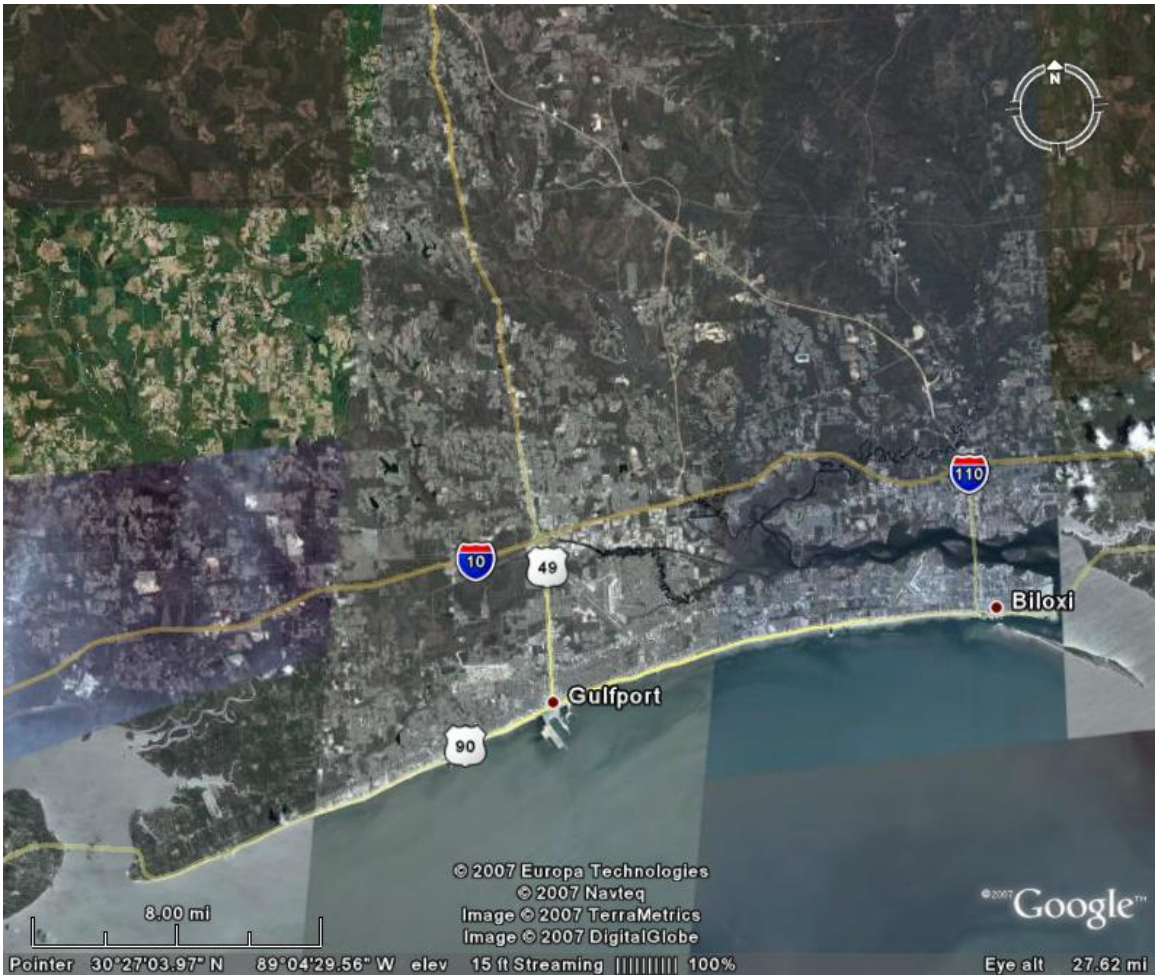
Table C1-3.
Jackson County Parking

	Location	Spaces	Parking Type	Distance from previous lot (miles)
1	Hillandale Ave	225	Free, Street	0.0
2	Shearwater Dr	25	Free, Street	1.7
3	Lake Mars Ave	25	Free, Lot	3.0



Source: Google Earth

Figure C1-1. Hancock County Map



Source: Google Earth

Figure C1-2. Harrison County Map



Source: Google Earth

Figure C1-3. Jackson County Map



Figure C1-4. Hancock County Parking Lot



Figure C1-5. Example of Harrison County Parking Lot.



Figure C1-6. Example Jackson County Parking Lot.

C-1.2 Access

Sufficient access to the public beach exists throughout the three planning units. Under both future without-project and future with-project conditions, the three planning units have access points that run along the entire length of beach in either the form of a board walk or a step down directly from the seawall. These access points are all on the right-of-way for the major road that abuts the beaches including North and South Beach Boulevard in planning unit one and U.S. Highway 90 in planning unit two. Planning unit three contains a combination of direct step downs from the seawalls that run along various sections and walkovers for those sections of beach that require them. All of the access points are on public and are accessible to all visitors on an equal basis at no charge. Figures 1-7, 1-8, and 1-9 illustrate examples of access points to the public beaches in the three planning units.

C-1.3 User Fees

User fees are sometimes charged to the public at beaches in order to recoup the costs of maintaining the beach. Per ER 1165-2-130, “A reasonable beach fee, uniformly applied to all, for use in recovery of the local share of project costs is allowable. Normal charges made by concessionaires and municipalities for use of facilities such as bridges, parking areas, bathhouses, and umbrellas are not construed as a charge for the use of the Federal beach project, if they are commensurate with the value of the service they provide and return only a reasonable profit. Fees for such services must be applied uniformly to all concerned and not as a prerequisite to beach use.” For the beaches in the three planning units in the MsCIP Comprehensive Plan, no fees are anticipated to be charged by the local community.

C-1.4 Conclusion

The results of the analysis indicate that the project meets the requirements of being open 'to all users on an equal basis', and there is sufficient parking and access for the entire length of shoreline protection projects within the three planning units in Mississippi to warrant federal participation. The analysis showed that there are 592 available parking spaces in Hancock County, 2,788 parking spaces in Harrison County, and 350 parking spaces in Jackson County. All spaces are located within a quarter mile of an access point and there is sufficient access to the public beaches either through boardwalk/seawall direct access (planning units one and two) or carefully located access points/crossovers (planning unit 3) along the entire length. User fees are not currently charged to anyone for use and are not anticipated should a project be constructed.