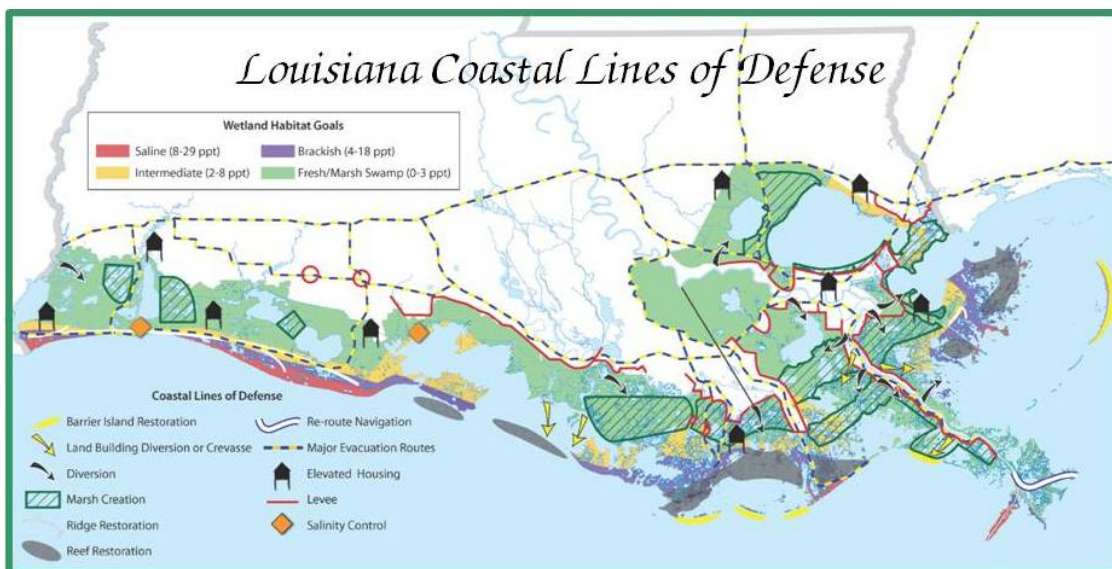


Comprehensive Recommendations Supporting the Use of the Multiple Lines of Defense Strategy to Sustain Coastal Louisiana

2008 Report (Version I)

This report recommends integrated coastal projects and levee alignments for the entire coast of Louisiana with the overriding goal of improving hurricane flood protection and sustaining the coastal estuaries.



Summary Map of Multiple Lines of Defense

“It may be hubris to think we could ever engineer our way out of this fix, when nature seems so aligned against us. It is certainly hubris to think we could do it without taking nature's assistance when it is offered.”

Quote from comments on the draft report by David Yeargin

Funding provided by the McKnight Foundation
Report is available at MLODS.org, SaveOurLake.org, or CRCL.org



Table of Contents

Appendices	4
List of Tables.....	4
List of Figures	5
Executive Summary	9
Introduction	15
Coastal Land Loss Maps.....	15
Evaluation of Risk - Hurricanes and Surge Maps	19
Report Planning Process	27
Multiple Lines of Defense Strategy	28
Sustainability	29
Types of Lines of Defense	30
Importance of Wetland Habitat Goals	32
Levee Alignments: Natural Ridges, Back Levees, Ring Levees	39
Implementation Criteria for Urban Polders	46
Structural Protection Features.....	50
Coastal Restoration Features	50
Old River Control Structure.....	53
River Flood Restoration Action Plan.....	58
Evacuation Routes	62
Non-structural Measures & Municipal Drainage	65
Report Formulation Guidelines	76
Planning Unit 1 (Pontchartrain Basin)	78
General Description	78
General Recommendations	85
Specific Recommendations	86
Planning Unit 2 (Barataria Basin)	116
General Description	116
General Recommendations	126
Specific Recommendations	128
Planning Unit 3a (Terrebonne Basin).....	146
General Description	146
General Recommendations	168
Specific Recommendations	170
Planning Unit 3b (Atchafalaya/Vermilion Basin).....	177
General Description	177
General Recommendations	183
Specific Recommendations	185
Planning Unit 4 (Chenier Plain)	189

General Description	189
General Recommendations	200
Specific Recommendations	202
References	215

Appendices

Appendix A - Multiple Lines of Defense	221
Appendix B - Global Climate Change and Sea Level Rise	244
Appendix C - Gulf Hypoxia	247
Appendix D - Composite Land Change Map of USACE and USGS Historical Land Loss	250
Appendix E - List of Acronyms	252
Appendix F - Public Comments	Online/CD Only

List of Tables

Table 1: Wetland Habitat Goals	33
Table 2: Modeled Surge Levels and Wave Heights for a GIWW Alignment (Alignment 1)	43
Table 3: Increased Sediment Load on the Mississippi River during 2008 High Water	59
Table 4: Non-structural Options	69
Table 5: Pontchartrain Basin Wetland Loss 1932 to 2005	78
Table 6: Planning Unit 1 – Lines of Defense Measures	83
Table 7: Estimates of Costs to Re-build Wetlands in the Barataria Basin to Historical Extents. ...	119
Table 8: Planning Unit 2 – Lines of Defense Measures	124
Table 9: Concerns with pre-Hurricane Katrina 100 year Morganza to the Gulf (USACE 2002 alignment)	150
Table 10: Concerns with post-Hurricane Katrina 100 year Morganza to the Gulf Project	154
Table 11: Land use for the Morganza project Area as reported by USACE (2002)	157
Table 12: General Comparison of Proposals for Flood Protection in Terrebonne Parish	164
Table 13: Planning Unit 3a – Lines of Defense Measures	166
Table 14: Planning Unit 3b – Lines of Defense Measures	181
Table 15: Planning Unit 4 – Lines of Defense Measures	198
Table 16: Historical Hydrologic Alteration to the GIWW in the Calcasieu–Sabine Region	211

List of Figures

Introductory

Figure 1: The Multiple Lines of Defense Strategy Diagram.....	10
Figure 2: Composite Land Change Map of both the USGS and USACE.....	16
Figure 3: Percent Land Changes from 1932 to 2005 (post-Hurricanes Katrina and Rita).....	17
Figure 4: Seismic (Earthquake) Hazard Maps of Louisiana and California.	20
Figure 5: Expected Landfall of Hurricanes within a 100 Year Time Period.	21
Figure 6: Graph of Gulf Coast Historical Hurricanes by Pressure and Size.....	22
Figure 7: Risk on a 30-year Mortgage from a 100-year Hurricane.....	23
Figure 8: Preliminary composite Map of the Statistical Maximum Surge - 50 Year Period	24
Figure 9: Preliminary composite Map of the Statistical Maximum Surge - 100 Year Period	24
Figure 10: Preliminary composite Map of the Statistical Maximum Surge - 500 Year Period	25
Figure 11: Planning Units Used in this Report	28
Figure 12: The Lines of Defense Profile Illustration	31
Figure 13: Proposed Wetland Habitat Goals for Louisiana	36
Figure 14: Existing Wetland Habitat Types of Coastal Louisiana, circa 2007	37
Figure 15: Profile Illustration of Typical Development on Natural Ridges in Coastal Louisiana..	39
Figure 16: Map Illustration of Relation of Natural Ridges to the Estuary.....	40
Figure 17: Examples of Back Levees in South Louisiana	41
Figure 18: Example of the Historic Impoundment and Consequent Land Loss of Avoca Island..	44
Figure 19: Generalized Existing Incidental Polders (Bowls).....	48
Figure 20: Proposed Additional “urban polders” in New Orleans.....	48
Figure 21: Coastwide Map of Specific Proposed Lines of Defense Measures by Type.....	54
Figure 22: Coastwide Map of Generalized Proposed Lines of Defense Measures Overlain over the Habitat Goals.....	55
Figure 23: Population Map of South Louisiana from the USACE Planning Atlas.	56
Figure 24: Proposed Total Discharges, Through Diversions and Controlled Crevasses, and Marsh Creation for Each Planning Unit.	57
Figure 25: Satellite Image of Southeast Louisiana and the Mississippi River During the Great Flood of 2008.....	58
Figure 26: Satellite photograph of the New Orleans Area in April 2008	59
Figure 27: Graph of Mississippi River Discharge Frequency and Relation to Sediment Load and Sediment Concentration	60
Figure 28: Official evacuation Route Map for the State of Louisiana. Black Circles Indicate Critical Areas in Need of Improvements.....	63
Figure 29: Evacuation Routes Superimposed on other Lines of Defense Measures Map	64
Figure 30: Elevated St. Bernard Parish Camps/Homes that Survived Hurricanes Katrina and Rita Outside of Levee Protection.....	66
Figure 31: Elevated Broadmoor Home in New Orleans that Survived Hurricane Katrina Flooding	66
Figure 32: Two Historic Broadmoor Homes in New Orleans Being Raised.....	67
Figure 33: Modified FEMA Illustration of Stillwater Level and V-zone	68
Figure 34: Modified FEMA Illustration.....	68
Figure 35: Non-structural Measures.....	74

Figure 36: Coastwide Inundation Map from Hurricanes Katrina and Rita by FEMA (2006).	75
---	----

Planning Unit 1

Figure 37: Relic Swamp Classification in Maurepas.	80
Figure 38: Sub-estuaries of Planning Unit 1 (Pontchartrain Basin).....	81
Figure 39: Map of Wetland Habitat Goals for Planning Unit 1	81
Figure 40: Planning Unit 1 Lines of Defense Measures Map.....	84
Figure 41: Alternative Levees, Gates, and Spillway Alignments for Planning Unit 1	87
Figure 42: Illustration of Restoration and Stabilization of the Lake Pontchartrain Shoreline.....	91
Figure 43: Map of USACE Projects on the MRGO--Lake Borgne Land Bridge	93
Figure 44: Restoration of the South Flank of Bayou la Loutre Ridge.	95
Figure 45: Illustration of Restoration of the South Flank of the Bayou la Loutre Ridge.	95
Figure 46: Historic Oyster Reefs of the Biloxi Marsh and Mississippi Sound.....	96
Figure 47: Wetland Habitat Goals for Planning Unit 1 (Including the Ford and Palmisano Lines).97	
Figure 48: Chandeleur Islands Recovery in February 2007.....	98
Figure 49: USGS Map Illustrating Apparent Wetland Loss During the 2005 Hurricane Season....	99
Figure 50: Map from DEQ Illustrating the Location of the “Clean Corridor”	102
Figure 51: Map of the Historic Sub-estuaries in the Vicinity of the Violet Diversion	104
Figure 52: Eastward Shift of Isohalines from a Diversion at Violet, Louisiana, with a Constriction of the MRGO at Bayou la Loutre.....	104
Figure 53: Graph of Actual Discharge and the Estimated Potential Discharge through Caernarvon for 2004.	106
Figure 54: USGS Illustration of Pre- and Post-growing Season Imagery in 2006	106
Figure 55: Apparent Post-Hurricane Katrina Recovery in 2006.....	107
Figure 56: High Mississippi River Water in 2008, Overtopping the Limestone Rubble Road Just Down River of the Old Bohemia Diversion Structure	109
Figure 57: Breach of Limestone Rubble Road and Metal Culverts at the Site of the Old Bohemia Structure	110
Figure 58: Location of CWPPRA PPL 17 Diversion Project.	111
Figure 59: Bohemia Culverts Breached by High River Water in 2008	111
Figure 60: East Bank Natural Levee and Ridge in Planning Unit 1	112
Figure 61: Proposed Location of a Controlled Crevasse Structure.....	113
Figure 62: Recommended Delta Management Elements of the Lower Mississippi River.	114
Figure 63: Imagery (1985) of the sediment plume of the Mississippi River.	115

Planning Unit 2

Figure 64: 1988 Wetland Habitat Map for Barataria and Terrebonne Basins in BTNEP (1995)...	117
Figure 65: USGS map of Historical and Projected Land Loss	118
Figure 66: Key Restoration Recommendations for Planning Unit-2.	121
Figure 67: Map of 2007 Oyster Leases and Seed Grounds in Planning Unit 2.	122
Figure 68: Planning Unit 2 Lines of Defense Measures Map.....	125
Figure 69: Barataria Basin Land Bridge with CWPPRA Projects.....	131
Figure 70: Composite USGS and USACE Land Loss Map of the Barataria Basin Land Bridge...	132
Figure 71: USGS Land Loss Map in Lower Plaquemines Parish.....	133

Figure 72: 2002 Satellite Image of the Gulf Shoreline near the Empire Canal and Jetties.....	134
Figure 73: Map and Aerial Photograph of Raccoon Island.....	135
Figure 74: Sand Management for the Gulf Shorelines in Planning Units 2 and 3a.	136
Figure 75: Area of Two Proposed Diversions near Myrtle Grove.....	137
Figure 76: Former Bays and Wetland Extent near Buras	142
Figure 77: 2005 Imagery of the Coast near Buras	142
Figure 78: “New Adams Bay” and “New Bastian Bay” near Buras.....	143
Figure 79: Subsidence Patterns in South Louisiana.	143
Figure 80: Map from USACE (Britsch and Dunbar, 2006).	144
Figure 81: Restoration Recommendations for the West Bank of Lower Plaquemines Parish.....	144

Planning Unit 3a

Figure 82: 2002 Satellite image of Planning Unit 3a.....	147
Figure 83: LIDAR Imagery Representing Ground Elevation	147
Figure 84: Historic Land Loss and the Morganza to the Gulf Levee Alignment.....	149
Figure 85: 2005 Imagery and Proposed Morganza to the Gulf Levee Alignment.....	151
Figure 86: Planning Unit 3a Recommendations near Houma.....	153
Figure 87: Maximum Statistical Surge Map of 500 Year Storm Simulations.	156
Figure 88: Profile of Surge across Terrebonne Parish for the 400 Year Surge Simulations.....	156
Figure 89: Map of Additional Surge Created by the Morganza to the Gulf Levee	159
Figure 90: Maps of Required Levee Heights with 100 Year Storm Simulations.	159
Figure 91: Aerial Photograph of the J-1 Reach Under Construction	161
Figure 92: Summary Map of the Flood Protection System for Terrebonne Parish.	162
Figure 93: Profile Illustration of the Recommended Lines of Defense for Planning Unit 3a.....	163
Figure 94: Planning Unit 3a Lines of Defense Measures Map.	167

Planning Unit 3b

Figure 95: Historic and Projected Land Loss in Planning Unit 3b	177
Figure 96: 1878 Coast Survey Map of Atchafalaya Bay and White Shell Keys Reef.....	179
Figure 97: Planning Unit 3b Lines of Defense Measures Map.....	182
Figure 98: Location of Proposed East Atchafalaya Restoration Spillway.....	187
Figure 99: Map of Percent Land using USGS Land Water Classification in 2005.	188

Planning Unit 4

Figure 100: Mermentau River mouth and Bypass Channel.	190
Figure 101: Some Hydrologic Modifications to the Calcasieu/Mermentau Basins.....	191
Figure 102: Historical dimensions of the Sabine Neches Ship Channel.....	192
Figure 103: Photograph of the Calcasieu River Jetties	193
Figure 104: Sabine/Calcasieu Basins Wetland Habitat Map	194
Figure 105: Average Porewater Salinity in Freshwater and Intermediate Marshes following the Impacts of Hurricanes Katrina and Rita.	195
Figure 106: Water Surface Elevations for a 1 in 1,000 Year Storm Surge Event.....	196
Figure 107: Planning Unit 4 Lines of Defense Measures Map.....	199

Figure 108: Flood Inundation Map from Hurricane Rita for Vermilion Parish.....	203
Figure 109: Imagery and Quad Map near Gueydan.....	203
Figure 110: Imagery and Quad Map near Kaplan.....	204
Figure 111: USACE Land Loss Map from the Area South of Grand Chenier Ridge.....	206
Figure 112 : Imagery of a Portion of the Marsh South of Grand Chenier (2002 satellite)	207
Figure 113: Imagery of Deforested Grand Chenier Ridge just Southwest of Grand Lake	208
Figure 114: Calcasieu and Sabine Lakes Region of “Pump Effect” Salt Water Intrusion.....	210
Figure 115: Discharge Record for the Sabine River at Ruliff, Texas	212
Figure 116: The Mermentau Basin Map	213