E C O L O G I C A L R E V I E W

Barataria Basin Landbridge Shoreline Protection Project (BA-27/27b, BA-27c, BA-27d)

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ECOLOGICAL REVIEW

Barataria Basin Landbridge Shoreline Protection Project

A separate ecological review will be prepared for each of the construction units. In August 2000, the Louisiana Department of Natural Resources initiated the Ecological Review to improve the likelihood of restoration project success. This is a process whereby each restoration project's biotic benefits, goals, and strategies are evaluated prior to granting construction authorization. This evaluation utilizes monitoring and engineering information, as well as applicable scientific literature, to assess whether or not, and to what degree, the proposed project features will cause the desired ecological response.

The Barataria Basin is delimited in the north and east by the Mississippi River, on the west by Bayou Lafourche, and on the South by the Gulf of Mexico. The upper basin is dominated by a freshwater system of natural levee ridges, cypress-tupelo swamps and freshwater marshes. The lower basin is dominated by estuarine and tidal processes with barrier islands, large bays and lakes, tidal channels and saline and brackish marshes (NRCS 2000).

The Barataria Basin Landbridge Shoreline Protection Project is intended to preserve a critical landmass, which extends southwest to northeast across the basin. The landmass hereafter referred to as the landbridge (Figure 1), has historically separated the freshwater dominated system of the upper basin from the marine and tidally dominated system of the lower basin. Bayou Perot and Bayou Rigolettes are the primary waterways connecting Lake Salvador in the northern Barataria Basin with the Little Lake system in the southwestern Barataria Basin. These two bayous, divided by a long peninsula of marsh, were historically narrow meandering water bodies typical of riverine flows (Reed 1995). Today, the hydrologic connections between the upper basin and the lower basin are much greater due to the dredging of waterways, Harvey Cutoff, and the enlargement of both Bayou Perot and Bayou Rigolettes. With the closing of Bayou Lafourche, and the transition of the basin from a river dominated to a tidally dominated system, both shores of the two bayous have eroded and enlarged.

This erosion was accelerated as the shoreline retreated into a complex of oil field canals (Reed 1995). Shoreline erosion rates from three locations in the project area for the period 1985-1990 were 114, 103 and 70 feet per year. From 1990 to 1995, erosion rates of 76, 101 and 97 feet per year were reported from the same three locations (NRCS 2000).

Shoreline protection along portions of Bayous Perot and Rigolettes, Little Lake, and Harvey Cutoff were proposed to reduce or eliminate shoreline erosion thereby helping to maintain the hydrologic and ecological integrity of the Barataria Basin. Coast 2050 identified the construction of the entire Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) Barataria Basin Landbridge Shoreline Protection Project as a regional ecosystem strategy which would maintain the landbridge and protect the freshwater marshes of the upper basin (LCWCRTF&WCRA 1998).

Phases 1, 2, 3, and 4 of the project, previously approved on Priority Project Lists seven, eight, nine, and eleven, respectively, constitute a total of 107,500 linear feet of shoreline protection, with an initial construction cost estimate of $48.3 million. Due to the prevalence of

weak and compressible Holocene deposits underlying the project area (Construction Units 1-6), alternatives to the traditional rock dike structures were developed to contend with the less than desirable soil conditions. To address the challenge, the 107,500 linear feet of shoreline protection has been divided into six construction units (CU) (Figure 2).

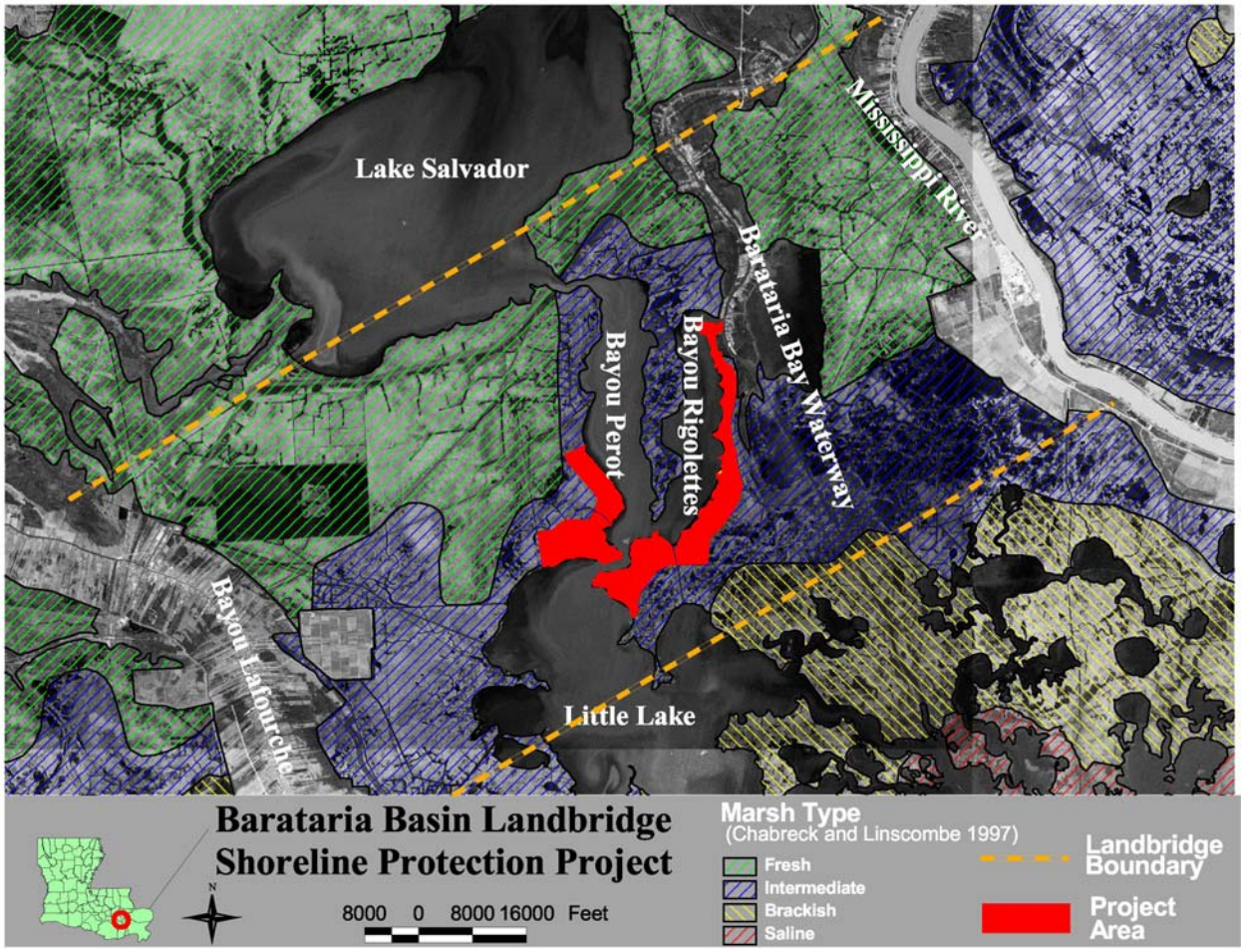

Figure 1: Barataria Basin Landbridge.

In order to identify the best shoreline protection technique for the poor substrate conditions, CU 1 was implemented in April-May 2001 to test the following five different designs: concrete pile structure, traditional foreshore rock dike, foreshore rock dike with a dredged spoil base, and a foreshore rock dike with a lightweight core material using two different construction techniques. The five different designs were constructed at one location along the west bank of Bayou Perot, and replicated at another location on the east bank of Bayou Rigolettes.

Construction Unit 2 and Construction Unit 3 represent segments of shoreline (6,100 feet and 10,700 feet, respectively) where geotechnical information has confirmed the existence of better soil conditions. It is believed that traditional rock structures were appropriate for these segments of shoreline. To facilitate overall project completion, CU 2 was constructed in October 2002, and CU3 was authorized to proceed to construction by the CWPPRA Task Force in January 2002.

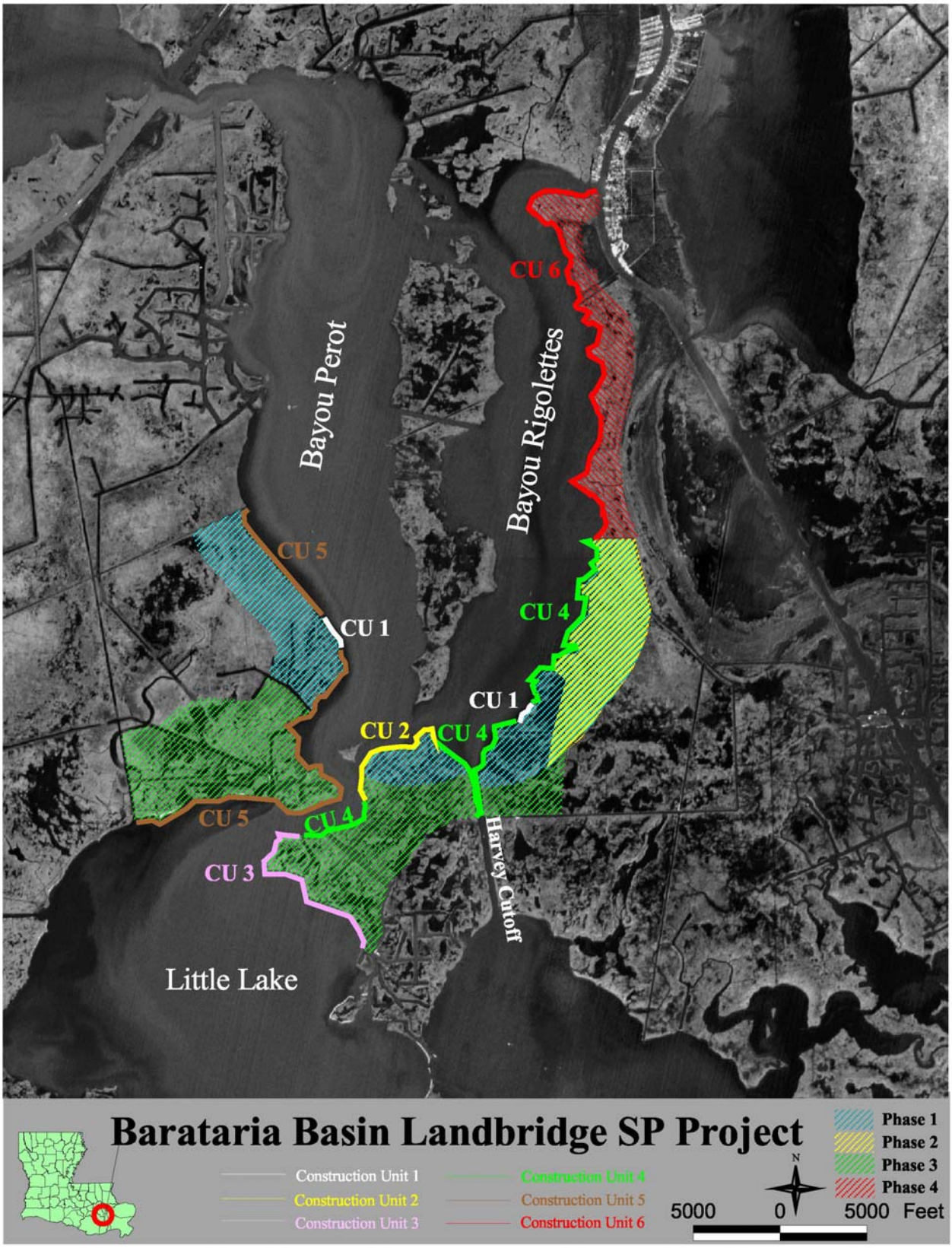

Figure 2: Barataria Basin Landbridge Shoreline Protection Project.

Following a full evaluation of the five different shoreline protection techniques in CU 1, as well as on-site field surveys and additional geotechnical investigations, the engineering and design of subsequent construction units was initiated. The selection of reaches for each subsequent construction unit was based on interaction with other approved projects, sequence of phased approvals, similarity of anticipated construction technique, and limiting the individual construction contracts to a manageable size. Construction Unit 4 will consist of approximately 31,350 linear feet of concrete pile wall, representing parts of Phases 1, 2, and 3, and will serve as the "front" containment for the dedicated dredging project, Dedicated Dredging on the Barataria Basin Landbridge (BA-36), which will fill open water areas in order to create new marsh and nourish existing marsh by using hydraulic dredges. Construction Unit 5 will consist of approximately 32,500 linear feet of shoreline protection, representing the balance of Phases 1 and 3. Construction Unit 6 will consist of approximately 29,500 linear feet of shoreline protection, representing the most recently approved phase, Phase 4.

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Barataria Basin Landbridge Shoreline Protection Project,
Construction Unit 3

September 2002

This document reflects the project design as of the 95% Design Review meeting, incorporates all comments and recommendations received following the meeting, and is current as of October 15, 2002.

ECOLOGICAL REVIEW

Barataria Basin Landbridge Shoreline Protection Project, Construction Unit 3

I. Introduction

The Barataria Basin Land Bridge Shoreline Protection Project Phases 1, 2, and 3 (Figure 1) are intended to preserve a critical landmass which has historically separated the freshwater dominated system of the upper basin from the marine and tidally dominated system of the lower basin. Shoreline protection along portions of Bayous Perot and Rigolettes, Little Lake, and Harvey Cutoff were designed to reduce or eliminate shoreline erosion thereby helping to maintain the hydrologic and ecological integrity of the Barataria Basin.

Phases 1, 2, and 3 of the project, previously approved under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) on priority lists seven, eight, and nine, respectively, will provide approximately 76,000 ft of shoreline protection. However, due to prevalence of weak and compressible Holocene deposits underlying the project area, alternatives to the traditional rock dike structures were developed to contend with the less than desirable soil conditions. Four alternative shoreline protection techniques, referred to as "test sections", will be evaluated in hopes of finding a foreshore dike or sheetpile system that will baffle wave energies and will not be rendered ineffective by excessive settlement. Two test sections of each alternative technique, both 400 ft in length, were completed in June 2001. The test sections will be evaluated for a year prior to deciding which alternative is to be employed.

A geotechnical investigation of Phase 3 of the project identified six general areas of similar soil conditions. One of those areas, referred to as construction unit 3 (CU3) and located on the east bank of Bayou Perot and northeastern Little Lake shoreline (Figure 2), was determined to be more suitable for supporting a rock dike structure than the others (STE 2000). Due to these findings, it has been proposed that CU3 proceed to construction ahead of the remaining project area. This Ecological Review focuses exclusively on CU3 of Phase 3 of the project.

II. Goal Statement

To stop erosion along the east bank of Bayou Perot and the northeastern Little Lake shoreline over the 20-year project life.

III. Strategy Statement

Placement of rock revetment on an approximately 11,000 ft section of the east bank of Bayou Perot and the northeastern Little Lake shoreline (CU3).

IV. Strategy-Goal Relationship

Shoreline protection will stop shoreline erosion by baffling wave action and boat wakes.

V. Project Feature Evaluation

A geotechnical investigation of Phase 3 of the project was conducted by Soil Testing Engineers, Inc. (STE). Soil conditions were determined and shoreline protection design specifications were recommended that took into account both structure stability and associated settlement. The rock revetment was designed with an elevation of 3.5 feet NAVD-88, a 4 ft top width, a 3(H):1(V) side slope, and will be underlain with a geotextile cloth (STE 2000). The

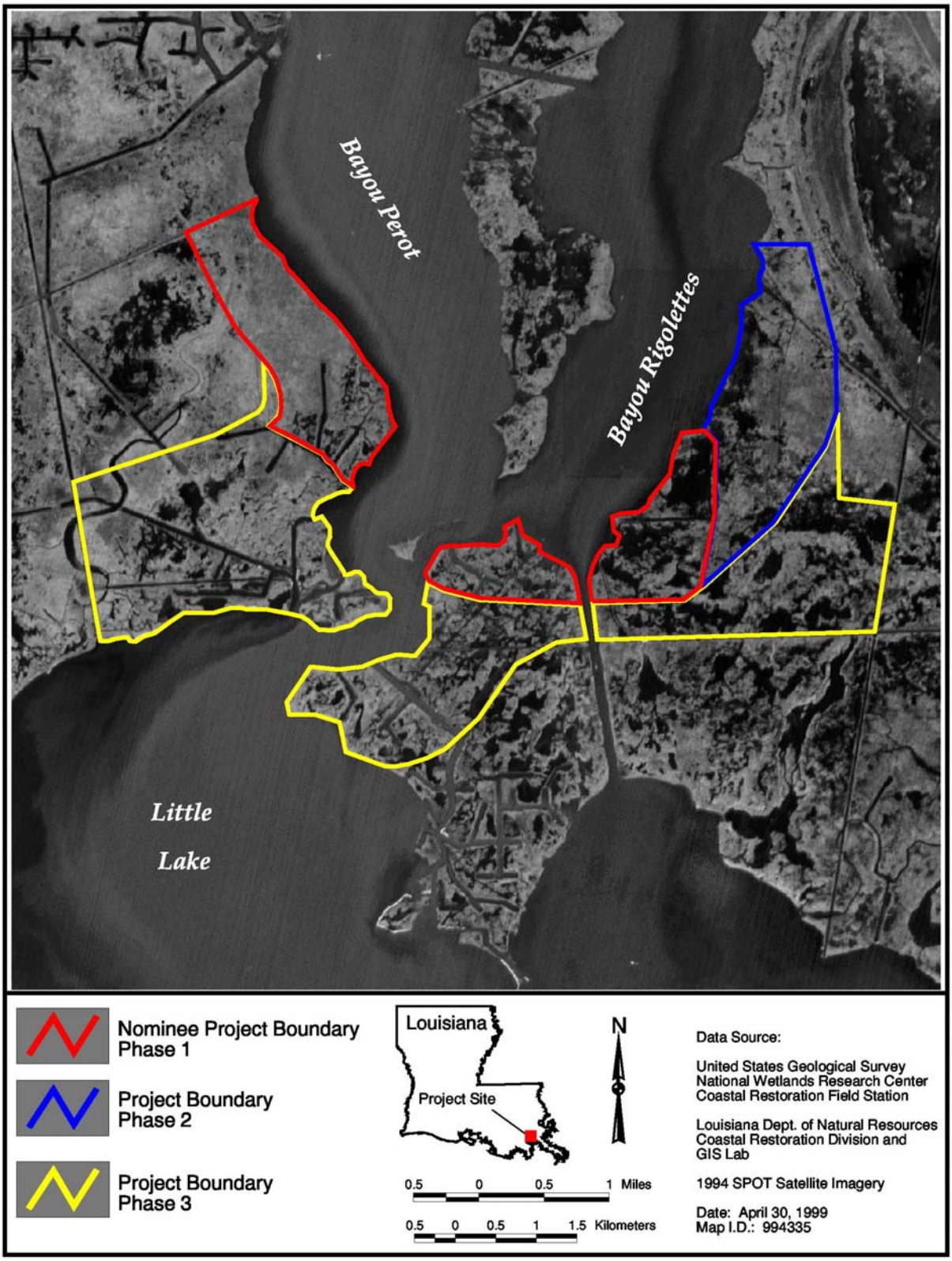

Figure 1: Barataria Basin Landbridge Shoreline Protection Project Phases 1-3, project area.

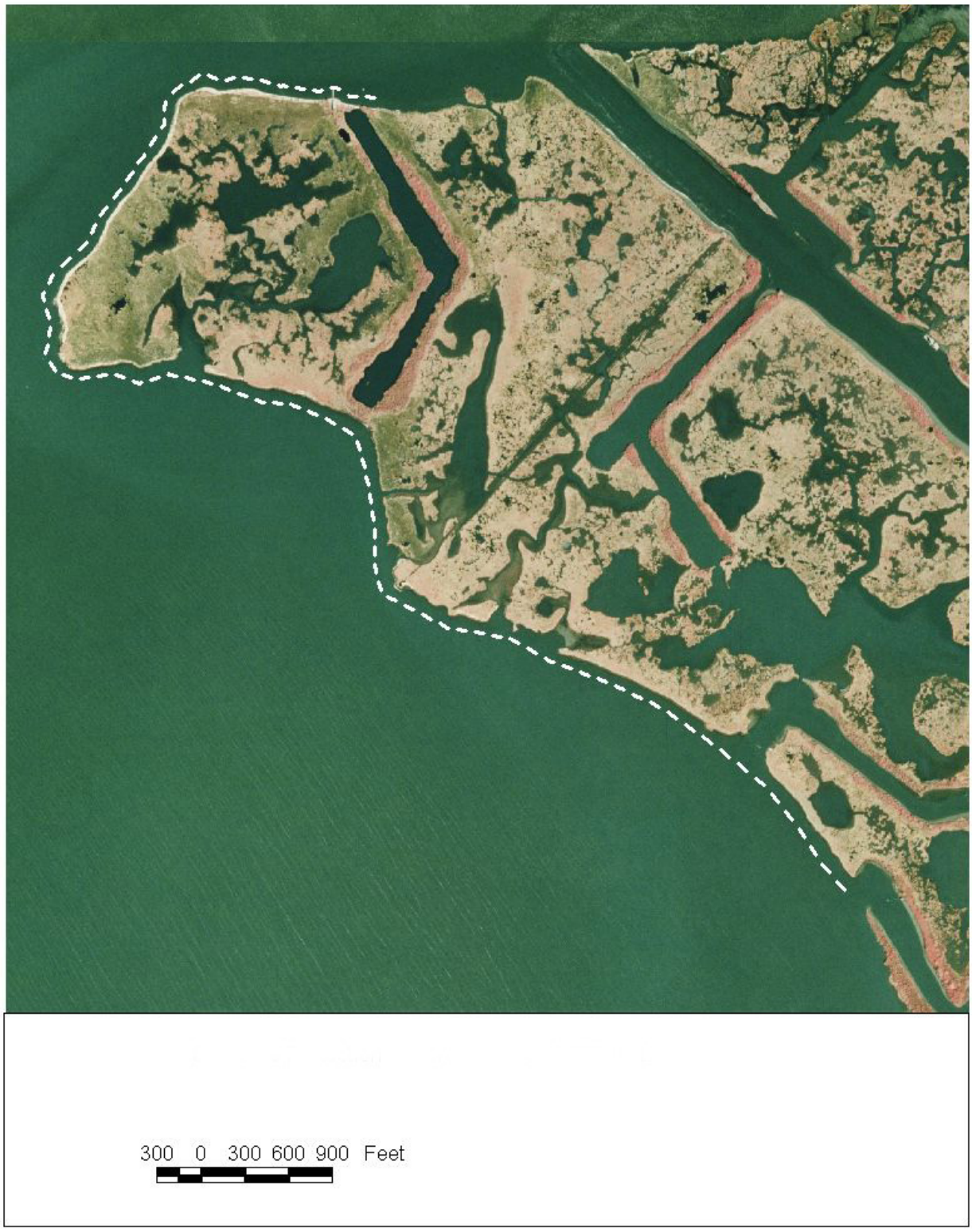

Figure 2: Barataria Basin Landbridge Shoreline Protection Project Phase 3 (CU3), project features.

construction specifications dictate the tensile strength of the geotextile fabric that is appropriate for the specified grade of rock. Previous NRCS-designed projects have demonstrated successful use of geotextile fabric. When traversing shoreline breaches the design will transition to a foreshore rock dike, incorporating 50 ft, 75 ft, or 100 ft wide organism access openings with a sill elevation at 2 ft below average tide.

This geotechnical investigation identified the 11,000 ft section of the east bank of Bayou Perot and northeastern Little Lake shoreline (CU3) as better suited for rock revetment construction as compared to the rest of the Phase 3 project area. Soil conditions within this stretch of shoreline, although not ideal, were determined adequate to support a rock revetment (STE 2000). The calculations of rock quantity for the contract take into account compaction and displacement. If the revetment settles over time, it will continue to provide protection until such time that the revetment settles below marsh elevation. As the revetment settles toward that critical elevation (1.2 ft NAVD-88), the maintenance component of the project can be employed.

Dredged spoil from the access canal is to be used to fill open-water ponds in the project area, creating up to 34 acres of emergent marsh. Target elevation of the constructed marsh is 1.2 ft NAVD-88, the average marsh elevation at the project site. Average marsh elevation was determined by the Natural Resources Conservation Service during an October-November 2001 engineering survey.

VI. Assessment of Goal Attainability

Shoreline protection via the installation of hard shoreline stabilization material has been implemented in the Louisiana coastal zone for several projects, to stabilize lake and bay shorelines, and navigation canal banks. Monitoring results and anecdotal information from projects constructed adjacent to lake shorelines, as is proposed for the Barataria Basin Landbridge Shoreline Protection Project Phases 1-3, indicate that shoreline protection measures have been generally effective at preventing or reducing erosion.

- The Boston Canal/Vermillion Bay shoreline Protection (TV-09) project was designed to reduce wind-driven wave erosion along Vermillion Bay and at the mouth of Boston Canal. A rock breakwater was constructed in 1995 to accomplish that objective. Initial results indicate that one year post construction, 1.4-4.5 ft of sediment was deposited between the breakwater and the shoreline (LDNR 1998a). Project shoreline change has not yet been determined; however the project seems to be functioning in stabilizing the shoreline.

- The Turtle Cove Shoreline Protection (PO-10) project was implemented in 1993 to protect a narrow strip of land in the Manchac Wildlife Management Area which separates Lake Pontchartrain from an area known as “The Prairie”. Wind-driven high energy waves caused a shoreline erosion rate of approximately 12.5 ft/yr (LDNR 1999a). The purpose of the project was to protect the lake shoreline with rock-filled gabions and to promote sediment deposition into the area behind the gabions. After construction of a 1,642 ft rock filled gabions 300 feet from shore, the shoreline prograded at a rate of 3.47 ft/year in the project area, and sediment elevation behind the gabions increased 0.26ft/yr from October 1994 to December

1997 (LDNR 1999). The Turtle Cove gabions have settled an average of -0.59 ft in just over three years (October 1994 to January 1997), due to the weak and compressible nature of the subsurface soils. The Prairie and Turtle Cove soils consist of Allemands-Carlin peat which are described as highly erodible organic peat and muck soils (USDA 1972).

- The Lake Salvador Shoreline Protection Demonstration (BA15) project evaluated a series of shoreline protection measures at Lake Salvador in St. Charles Parish, Louisiana. Constructed in 1998, this project evaluated the effectiveness of a rock berm to protect the lake shoreline from high energy wave erosion. Shoreline surveys conducted behind the berm five months after construction indicated that the shoreline was still eroding, and subsequent surveys were not conducted due to poor weather conditions. However it was reported that there was some vegetation colonization of the dredge spoil material behind the berm, and if this continued, the shoreline behind the berm may prograde further (LDNR 2000). The rock structure itself appears to be holding up well, showing little sign of deterioration and subsidence. Soil in the project area is composed mainly of Kenner muck with some areas of Allemands, Barbary, and Larose soils (LDNR 2000).

There are also several examples of successful projects involving the use of shoreline protection to stop erosion along navigation canal banks.

- The Cameron Prairie Refuge Protection (ME-09) is an example of such a project. This project located in north-central Cameron Parish consisted of constructing a 12,200 ft rock breakwater 0-50 ft from the northern bank of the Gulf Intracoastal Waterway to prevent waves caused from boat traffic from eroding the remaining spoil bank. Since project construction in 1994, shoreline erosion in the project area has ceased and 3.03 ac of vegetated wetland has been created (LDNR 1997).

- Another canal bank stabilization project, Freshwater Bayou Bank Protection (TV-11), was constructed in 1994. Data collection on this project was halted due to manpower and budgetary constraints, but one year following construction completion, rocks in segments of the dike were washed away by boat wakes thus compromising its structural integrity and leaving the underlying geotextile fabric exposed (LDNR 1996).

- The Freshwater Wetland Phase 1 (ME-04) project, constructed in 1995, has not only reversed wave-induced bank erosion, but initial monitoring efforts have indicated that the bank has prograded at a rate of 2.34 ft/yr over a 12-month period (LDNR 1998b).

Although shoreline protection techniques utilizing rock breakwaters have had good success in Louisiana, there are opportunities for failure such as structure subsidence due to the often times weak and compressible nature of soils found in Louisiana marshes. Though the results of the geotechnical surveys indicate soil conditions adequate for the construction of a rock breakwater in CU3, the example of gabion settlement in project

PO-10 emphasizes the need for continued maintenance and monitoring of these shoreline stabilization structures.

VII. Recommendations

Based on the investigation of similar restoration projects and a review of engineering principles, the proposed strategies of the Barataria Basin Land Bridge Shoreline Protection Project Phase 3, CU3, the Louisiana Department of Natural Resources is confident that the project will achieve the desired ecological goals. At this time, we recommend that the project proceed to construction pending a favorable 95% Design Review.

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Barataria Basin Landbridge Shoreline Protection Project,
Construction Unit 4

April 2004

This document reflects the project design as of the 95% Design Review meeting, incorporates all comments and recommendations received following the meeting, and is current as of May 3, 2004.

ECOLOGICAL REVIEW
Barataria Basin Landbridge Shoreline Protection Project, Construction Unit 4

I. Introduction

The Barataria Basin Landbridge Shoreline Protection Project, Phases 1, 2, 3, and 4 (Figure 2) are intended to preserve a critical landmass which has historically separated the freshwater dominated system of the upper basin from the marine and tidally dominated system of the lower basin. Shoreline protection along portions of Bayous Perot and Rigolettes, Little Lake, and Harvey Cutoff were designed to reduce or eliminate shoreline erosion thereby maintaining the hydrologic and ecological integrity of the Barataria Basin.

Construction Unit 4 comprises parts of Phases 1, 2, and 3, and involves the placement of a shoreline protection structure along the east bank of Bayou Perot, the southeast bank of Bayou Rigolettes, and both banks of a reach of Harvey Cutoff (Figures 2 and 3). The concrete pile structure of Construction Unit 4 will serve as both shoreline protection and as the "front" containment for the Dedicated Dredging on the Barataria Basin Landbridge project (BA-36), sponsored by the United States Fish and Wildlife Service, which will nourish and create marsh in open water areas of the southeastern shore of Bayou Rigolettes.

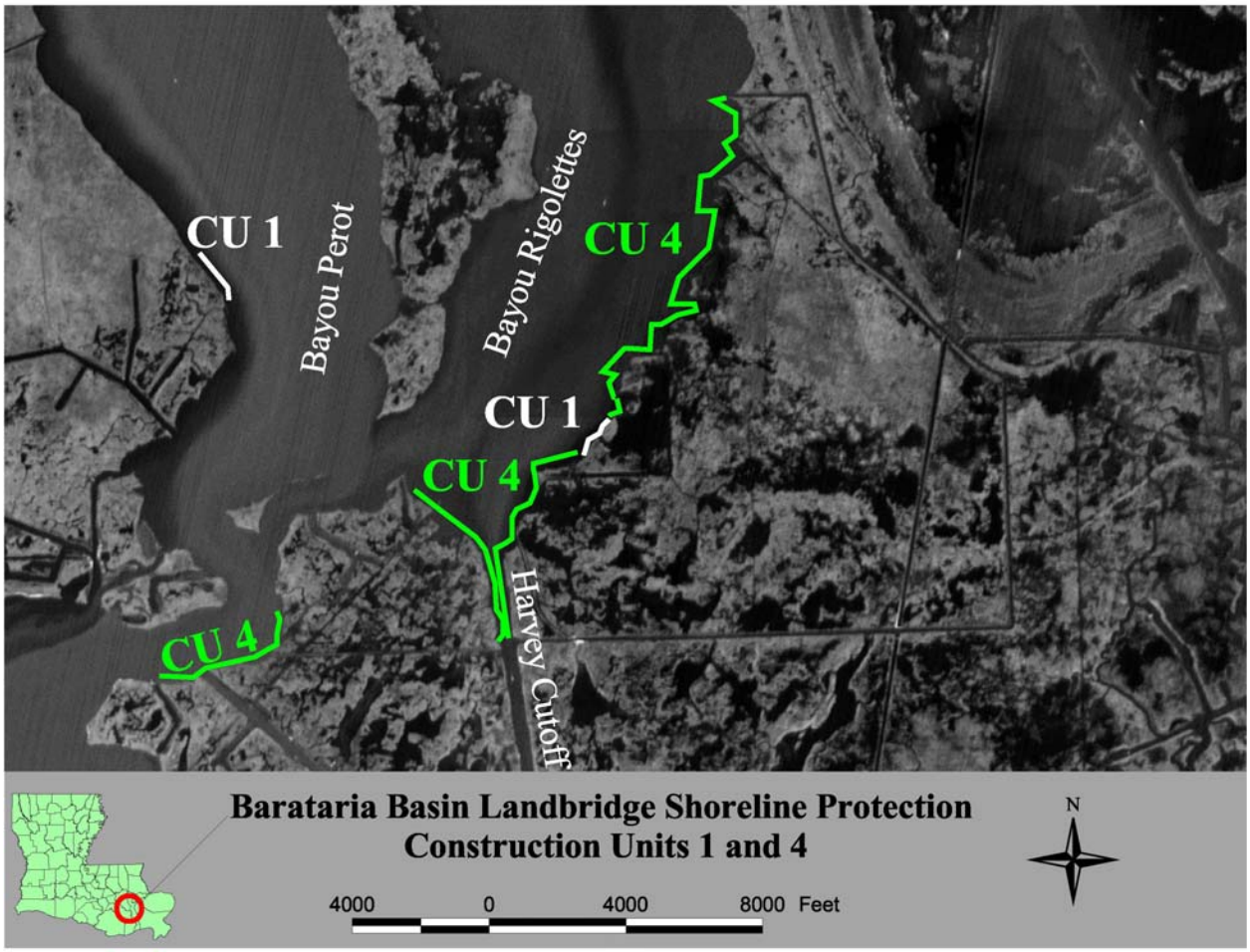

Figure 3: Barataria Basin Landbridge Shoreline Protection Construction Units 1 and 4.

II. Goal Statement

To eliminate erosion along the east bank of Bayou Perot, the southeast bank of Bayou Rigolettes, and both banks of a reach of Harvey Cutoff.

III. Strategy Statement

Placement of a concrete pile structure on an approximately 11,000 linear foot section of Bayou Perot, a 20,350 linear foot section of Bayou Rigolettes, and on both banks of a reach of Harvey Cutoff.

IV. Strategy-Goal Relationship

Shoreline protection will eliminate shoreline erosion by baffling wave action and boat wakes.

V. Project Feature Evaluation

Because of the need to identify a non-traditional shoreline protection technique for the poor substrate conditions, Construction Unit 1 (Figure 3) was implemented in April-May 2001 to test five different designs (concrete pile structure, traditional foreshore rock dike, foreshore rock dike with a dredged spoil base, and foreshore rock dike with a lightweight core material using two different construction techniques). The settlement of each structure was recorded 30, 60, 90, 180, 270, and 360 days post construction. The concrete pile structure exhibited insignificant settlement, and no horizontal movement (NRCS 2002). One section of the traditional foreshore rock dike and one section of the foreshore rock dike with a dredged material base failed during construction or immediately thereafter. All other structures settled 2-4 feet by one year. The concrete pile structure had the most structural stability and lower maintenance costs, and was therefore the shoreline protection structure selected for this project (NRCS 2002).

A total of 31,350 linear feet of concrete pile structures (Figure 3) will be constructed along the east bank of Bayou Perot, the southeast bank of Bayou Rigolettes, and both banks of a reach of Harvey Cutoff, and will include a total of 635 feet of openings distributed along 45 locations. The structure will be constructed by driving 80 foot concrete piles into the substrate to a top elevation of +4.0 feet NAVD-88, and placing 6-inch thick concrete panel sections between the piles (Figures 4A and 4B). The concrete panels will have a top elevation of +3.5 feet NAVD-88. The panels will be imbedded in the substrate, and a minimum of one foot thick blanket of surface coarse aggregate will extend 10 feet from all sides of the wall (Figure 4B). The placement of aggregate will provide further protection against scour. The structure will be constructed in open water approximately 20-100 feet from the shoreline, and dredged spoil material from the construction of the access channel will be placed behind the structure to create marsh.

The structure will include 10 to 30-foot gaps to allow water and sediment exchange and organism ingress and egress. The gaps will involve either breaks in the concrete structure, or the concrete structures will be staggered to create openings. The gaps will be lined with two-foot thick pads of rock riprap underlain with geotextile material, to protect against scour.

Figure 4A: Concrete pile structure, constructed as part of Construction Unit 1 in April-May 2001.

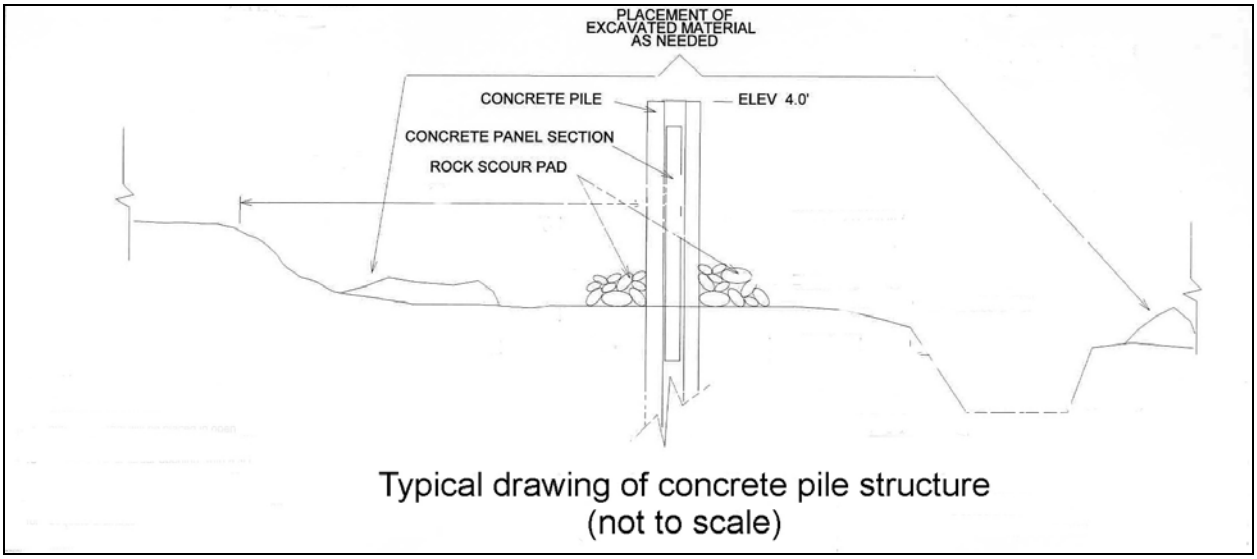

Figure 4B: Typical drawing of concrete pile structure.

A total of 450 linear feet of rock revetment will be installed to connect the structures to Construction Units 2, 3, and 4. The rock revetments will have an elevation of +3.5 feet NAVD-88 and a 3:1 side slope.

VI. Assessment of Goal Attainability

Shoreline protection via the installation of hard shoreline stabilization material has been implemented in the Louisiana coastal zone for several projects, to stabilize lake and bay shorelines, and navigation canal banks. Monitoring results and anecdotal information from projects constructed adjacent to lake shorelines, as is proposed for the Barataria Basin

Landbridge Shoreline Protection Project Phases 1-4, indicate that shoreline protection measures have been generally effective at preventing or reducing erosion.

Findings from Previously Constructed CWPPRA and State-funded Shoreline Protection Projects

- The Boston Canal/Vermilion Bay shoreline Protection (TV-09) project was designed to reduce wind-driven wave erosion along Vermilion Bay and at the mouth of Boston Canal. A 1,405 foot foreshore rock dike with a top elevation of +3.8 feet N.G.V.D. and vegetation plantings were installed in 1995 to accomplish that goal. Initial post-construction data indicate that 1.4 to 4.5 feet of sediment was deposited between the breakwater and the shoreline in less than one year. The rock breakwater at the mouth of Boston Canal was successful in stabilizing the shoreline (Thibodeaux 1998).

- The Turtle Cove Shoreline Protection (PO-10) project was implemented in 1993 to protect a narrow strip of land in the Manchac Wildlife Management Area which separates Lake Pontchartrain from an area known as "The Prairie." Wind-driven high energy waves caused a shoreline erosion rate of approximately 12.5 feet per year. The purpose of the project was to protect the lake shoreline with a rock-filled gabion and to promote sediment deposition behind the structure. Following construction of a 1,642 foot rock-filled gabion 300 feet from shore and at an elevation of 3 feet above mean high water level, the shoreline prograded at a rate of 3.47 feet per year in the project area, and sediment elevation behind the structure increased 0.26 feet per year from October 1994 to December 1997. The Turtle Cove gabions have settled 0.59 feet in just over three years (October 1994 to January 1997), due to the weak and compressible nature of the subsurface soils (O'Neil and Snedden 1999), and the structure had numerous breaches and required maintenance. The Prairie and Turtle Cove soils consist of Allemands-Carlin peat which is described as highly erodible organic peat and muck soils (USDA 1972).

- The Lake Salvador Shoreline Protection Demonstration (BA-15) project evaluated a series of shoreline protection measures at Lake Salvador in St. Charles Parish, Louisiana. Phase two of this project was conducted in 1998 and evaluated the effectiveness of a rock berm to protect the lake shoreline from higher energy wave erosion. Shoreline surveys conducted behind the berm five months after construction indicated that the shoreline was still eroding. Subsequent surveys were not conducted due to poor weather conditions (Lee et. al 2000). The rock structure itself appears to be holding up well, showing little sign of deterioration and subsidence. The structure was designed to be constructed with a crest elevation of +4.0 feet NAVD-88; however the structure average height in 2002 was +2.51 feet NAVD-88. The settlement of the structure, as measured from 1998 to 2002, was 0.26 feet, which indicates that the structure may have only been built to an elevation of +2.75 feet NAVD-88 (Darin Lee, LDNR, Personal Communications, July 19, 2002).

There are also several examples of successful projects involving the use of shoreline protection to stop erosion along navigation canal banks.

- The Cameron Prairie Refuge Protection (ME-09) project located in north-central Cameron Parish consisted of constructing a 12,200 foot rock breakwater with a top elevation of +3.7 feet NAVD-88, 1-50 feet from the northern bank of the Gulf Intracoastal Waterway to prevent waves caused from boat traffic from eroding the remaining spoil bank. Since project construction in 1994, shoreline erosion in the project area has ceased, and from 1994 to 2000, the shoreline has prograded at an average rate of 9.8 feet/year (Barilleaux and Clark 2002).

- Another canal bank stabilization project, Freshwater Bayou Bank Protection (TV-11), consisted of the placement of a 25,800 foot rock breakwater; it was constructed in 1994. Data collection on this project was halted due to manpower and budgetary constraints, but one year following construction completion, rocks in segments of the dike had been washed away by boat wakes, thus compromising its structural integrity and leaving the underlying geotextile fabric exposed (LDNR 1996).

- The Freshwater Bayou Wetland Phase 1 (ME-04) project, constructed in 1995, consisted of a 28,000 foot rock breakwater constructed with a top elevation of +4.0 feet NAVD-88. The project has not only reversed wave-induced bank erosion, but initial monitoring has indicated that the bank has prograded at a rate of 2.34 feet/yr over a 12-month period (LDNR 1998). Subsequent monitoring efforts indicate that the effectiveness of the structure decreased over time due to the deterioration of the structure. The structure was constructed using material salvaged from the U.S. Army Corps of Engineers removal of a rock weir. The material contained a mix of stones, mud and wood, and the size of the rock was inappropriate for the ME-04 project structure (Raynie and Visser 2002).

Summary/Conclusions

According to the results of the geotechnical investigation (Burns Cooley Dennis, Inc. 2003), a traditional rock dike constructed in the poor soil conditions found in CU-4, would be expected to settle up to 3.55 feet in some reaches over the 20 year project life. This led to the need to identify a non-traditional shoreline protection technique to implement in CU-4. Construction Unit 1 was implemented in April-May 2001 to test five different designs (concrete sheetpile structure, traditional foreshore rock dike, foreshore rock dike with a dredged spoil base, foreshore rock dike with a lightweight core material using two different construction techniques), and the study identified concrete pile structures as the best alternative. Though concrete pile structures have never been used in previous shoreline protection projects in the Louisiana coastal zone, based on the investigation of similar restoration projects, a review of the results of the test section in Construction Unit 1, and a review of engineering principles, the concrete sheet pile structure will likely achieve the project goal.

VII. Recommendations

Based on the investigation of similar restoration projects and a review of engineering principles, the proposed strategies of the Barataria Basin Landbridge Shoreline Protection Project, CU4, will likely achieve the desired ecological goal. At this time, the level of design of the project's physical effects warrant continued progress toward construction pending a favorable 95% Design Review.

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Barataria Basin Landbridge Shoreline Protection Project,
Construction Unit 5

August 2004

This document reflects the project design as of the 95% Design Review meeting, incorporates all comments and recommendations received following the meeting, and is current as of September 16, 2004.

ECOLOGICAL REVIEW

Barataria Basin Landbridge Shoreline Protection Project, Construction Unit 5

I. Introduction

The Barataria Basin Landbridge Shoreline Protection Project, Phases 1, 2, 3 and 4 (Figure 2) are intended to preserve a critical landmass which has historically separated the freshwater dominated system of the upper basin from the marine and tidally dominated system of the lower basin. Shoreline protection structures along portions of Bayous Perot and Rigolettes, Little Lake, and Harvey Cutoff were designed to reduce or eliminate shoreline erosion thereby maintaining the hydrologic and ecological integrity of the Barataria Basin. Construction Unit 5 comprises parts of Phases 1 and 3, and involves the placement of shoreline protection structures along the west bank of Bayou Perot, and the northwestern shoreline of Little Lake (figure 3).

II. Goal Statement

Stop erosion along a portion of the west bank of Bayou Perot and the northwestern shoreline of Little Lake over the 20-year project life.

III. Strategy Statement

Placement of a concrete pile structure on an approximately 14,426 linear foot section of the west bank of Bayou Perot, a rock revetment on a 20,358 linear foot section of the west bank of Bayou Perot and northwest Little Lake, and a rock breakwater on a 2,453 linear foot section of northwest Little Lake (Figure 3).

IV. Strategy-Goal Relationship

Shoreline protection structures will stop shoreline erosion by baffling wave action and boat wakes.

V. Project Feature Evaluation

The results of the geotechnical investigation of the Barataria Basin Landbridge project area (Burns, Cooley, Dennis, Inc. 2003) identified the need for two different types of shoreline protection structures. A concrete pile structure will be used in areas with weak compressible soils, as identified by soil borings, and a rock revetment will be used in the remainder of the project area. However, because of the presence of an archeological site (shell midden) on the northwestern Little Lake shoreline (Earth Search Inc. 2002), a section of rock revetment will be replaced with a foreshore rock dike so as not to disturb the site (Figure 3).

Concrete Sheet Pile

The non-traditional concrete sheet pile structure was devised as an alternative design for use in the Barataria Basin in a study implemented in April-May 2001. Construction Unit 1 of the Barataria Basin Landbridge Shoreline Protection project was implemented to test five different designs (concrete sheet pile structure, traditional foreshore rock dike, foreshore rock dike with a dredged spoil base, and foreshore rock dike with a lightweight core material using two different construction techniques). The settlement of each structure was recorded 30, 60, 90, 180, 270, and 360 days post-construction. The concrete sheet pile structure exhibited insignificant settlement and no horizontal movement. One section of the traditional foreshore rock dike and

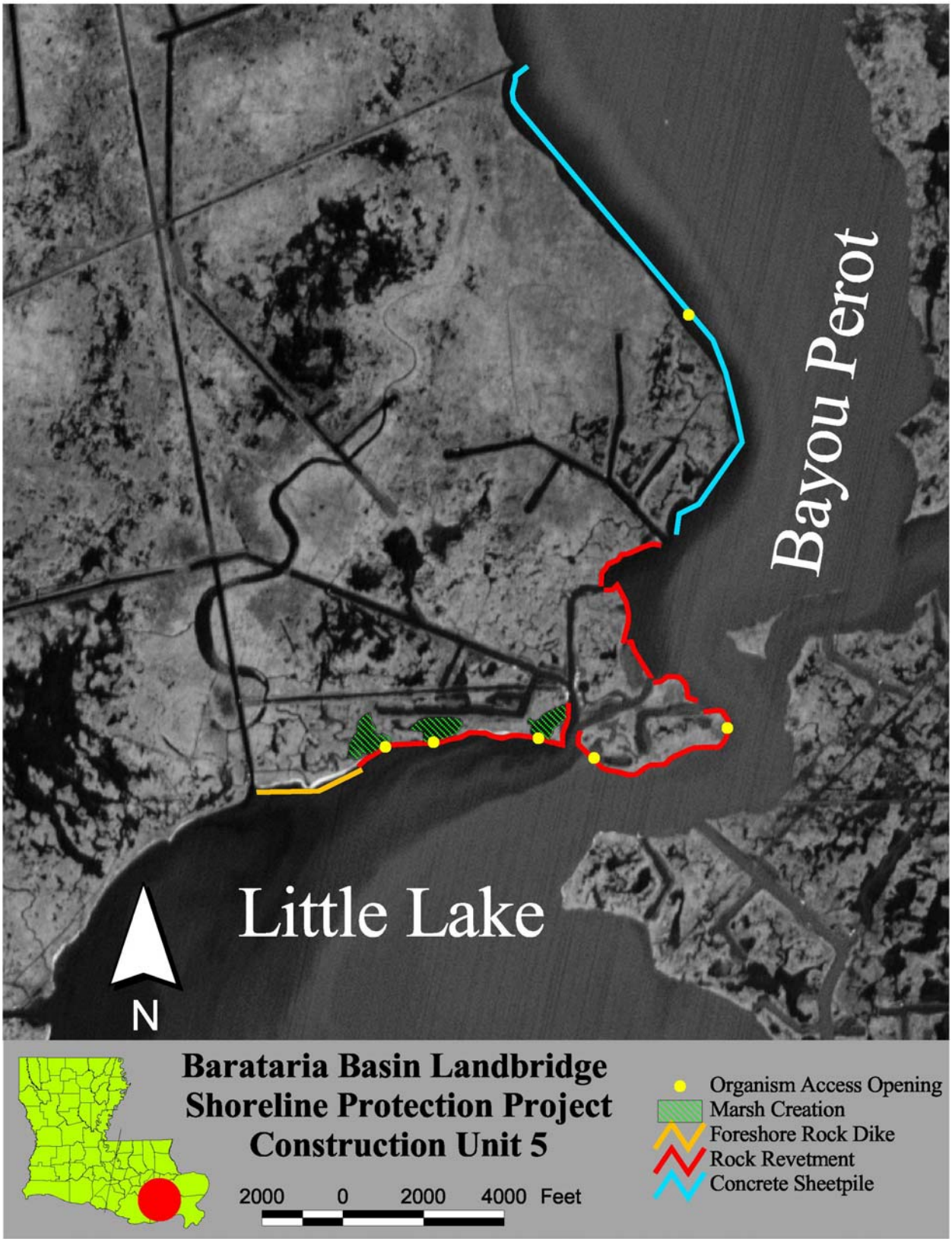

Figure 3: Construction Unit 5 project features.

one section of the foreshore rock dike with a dredged soil base failed during construction or immediately after. All other structures settled 2-4 feet one year post-construction. The concrete pile structure had the most structural stability and lower maintenance costs, and was therefore the shoreline protection structure selected for CU 4 and CU 5 (NRCS 2002).

A 14,426 linear foot concrete pile structure (Figure 3) will be constructed along the west bank of Bayou Perot. The structure will be constructed by driving 80 foot concrete piles into the substrate to a top elevation of +4.0 feet NAVD-88, and placing concrete panel sections between the piles at a top elevation of +3.5 feet NAVD-88 (Figure 4A and 4B). The panels will be imbedded in the substrate and a one foot thick rock scour pad will be placed for further protection against scour.

Figure 4A: Concrete pile structure, constructed as part of CU 1 in April-May 2001.

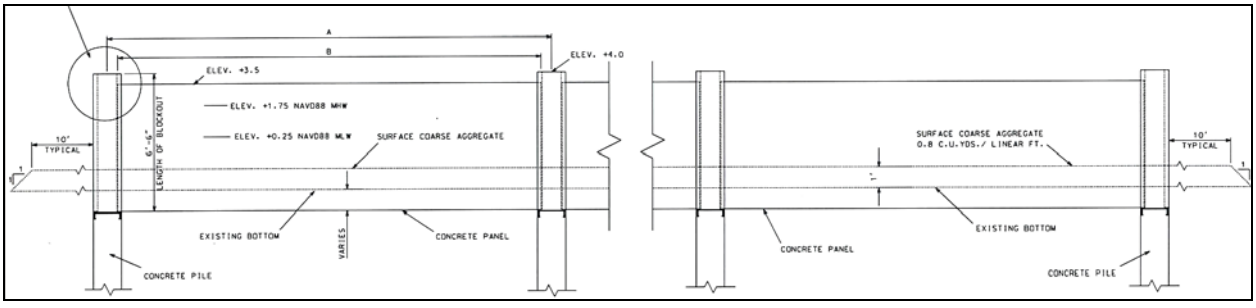

Figure 4B: Typical drawing of concrete pile structure (NRCS 2004a).

The structure will include approximately 33 gaps of varying widths, between 25 and 100 feet, to allow water and sediment exchange and organism access. The gaps will involve either breaks in the concrete structure lined with a scour pad, or the concrete structures will be staggered to create openings that will also be lined with scour pads (Figure 5). The sill height of the gaps will be set at two feet below mean water level. The 19 year mean water level in Little

Lake was +0.97 feet NAVD-88 (mean high water level was +1.28 feet NAVD-88, and the mean low water was +0.67 feet NAVD-88) (LDNR 2003).

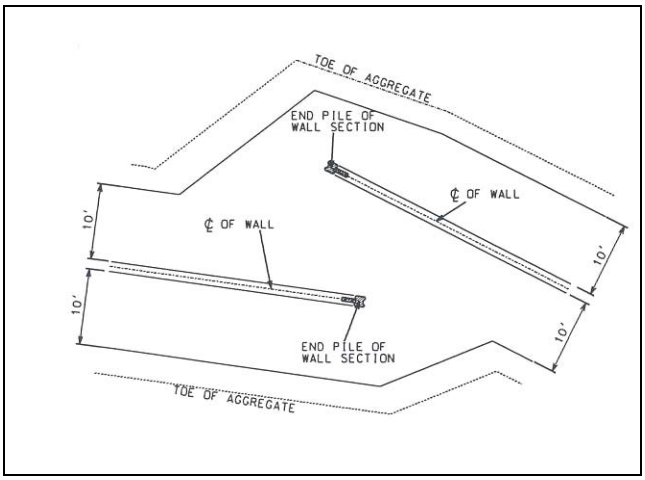

Figure 5: Detail of concrete panel wall with gaps (NRCS 2004a).

Rock Revetment

A 20,358 linear foot rock revetment will be constructed along the northwestern Little Lake shoreline at an elevation of +3.5 feet NAVD-88, with a 4 foot top width, a 3(H):1(V) side slope, and will be underlain with a geotextile cloth (Figure 6). When traversing shoreline breaches the design will transition to a foreshore rock dike, incorporating five 46-76 foot wide organism access openings with a sill elevation at 2 feet below average tide. The results of the geotechnical investigation and calculations by NRCS engineers estimated an anticipated structure settlement of 1.9-8.6 feet during the 20 year project life (NRCS 2004b). Much of the structure's settlement is expected to occur during the first six months of construction. To offset this initial settlement, the rock revetment will be constructed in two different stages so that a second lift of rock can be added to the revetment prior to demobilization, to ensure that the revetment is at grade at the end of the construction period.

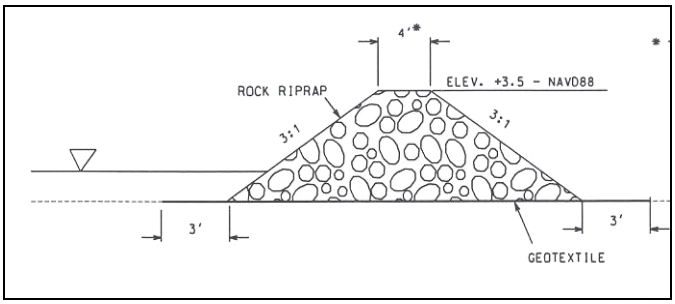

Figure 6: Detail of rock revetment and foreshore rock dike (NRCS 2004a).

Foreshore Rock Dike

A 2,453 linear foot foreshore rock dike will be used along a section of the northwestern Little Lake shoreline instead of the rock revetment, to prevent impacting the archeological site. The rock dike will be constructed along a -2 to -4 foot contour at an elevation of +3.5 feet NAVD-88 and will have a 3(H):1(V) side slope (Figure 6).

Marsh Creation

Dredged spoil from the access canal is to be used to fill open-water ponds in the project area, creating up to 40 acres of emergent marsh. Target elevation of the constructed marsh is +1.0 feet NAVD-88. This target elevation corresponds with the average marsh elevation at the project site (NRCS 2004b). Average marsh elevation was determined by the Natural Resources Conservation Service during an October-November 2001 engineering survey.

VI. Assessment of Goal Attainability

Shoreline protection via the installation of hard shoreline stabilization material has been implemented in the Louisiana coastal zone for several projects, to stabilize lake and bay shorelines, and navigation canal banks. Monitoring results and anecdotal information from projects constructed adjacent to lake shorelines, as is proposed for the Barataria Basin Landbridge Shoreline Protection Project Phases 1-4, indicate that shoreline protection measures have been generally effective at preventing or reducing erosion.

Findings from Previously Constructed CWPPRA and State-funded Shoreline Protection Projects

- The Boston Canal/Vermilion Bay Bank Protection (TV-09) project was designed to abate wind-driven wave erosion along Vermilion Bay and at the mouth of Boston Canal (Thibodeaux 1998). To accomplish that goal a 1,405 foot foreshore rock dike was constructed in 1995 at an elevation of +3.8 feet NGVD-29 along the bank of Boston Canal extending into Vermilion Bay. Initial post-construction data indicate that 1.4 to 4.5 feet of sediment was deposited between the breakwater and the shoreline in less than one year, and two years after construction, the project was estimated to have protected 57.2 acres of marsh while the reference area continued to erode. The rock breakwater at the mouth of Boston Canal was successful in stabilizing the shoreline (Thibodeaux 1998).

- The Turtle Cove Shoreline Protection (PO-10) was initiated in 1993 to protect a narrow strip of land in the Manchac Wildlife Management Area which separates Lake Pontchartrain from an area known as “the Prairie” (O’Neil and Snedden 1999). Wind induced waves contributed to a shoreline erosion rate of 12.5 feet per year. A 1,642 foot rock filled gabion was constructed 300 feet from shore at an elevation of 3 feet above mean water level with the goal of reducing erosion and increasing sediment accretion behind the structure. Post construction surveys conducted during the period of October 1994 to December 1997 revealed that the shoreline had prograded at a rate of 3.47 feet per year in the project area. The rate of sediment accretion, as determined from elevation surveys conducted in January 1996 and January 1997, was 0.26 feet per year.

  The soils in The Prairie and Turtle Cove area consist of Allemands-Carlin peat which is described as highly erodible organic peat and muck soils (USDA 1972). Due to the weak and compressible nature of the subsurface soils, the gabions settled 0.59 feet in just over two years (October 1994 to January 1997) (O’Neil and Snedden 1999). Also, five years after construction the rock filled gabion structure exhibited numerous

breaches and required extensive maintenance in August 2000 (John Hodnet, LDNR, Personal Communications, August 2004).

- The Lake Salvador Shore Protection Demonstration (BA-15) project evaluated a series of shoreline protection measures at Lake Salvador in St. Charles Parish, Louisiana. Phase two of this project was conducted in 1998 and evaluated the effectiveness of a rock berm to protect the lake shoreline from higher energy wave erosion. Shoreline surveys conducted behind the berm five months after construction indicated that the shoreline was still eroding; however later surveys of the area revealed that the rock dike was successful in stabilizing the shoreline and some accretion was occurring behind the structure (Curole et al. 2001). The rock structure itself appears to be holding up well, showing little sign of deterioration and subsidence. The structure was designed with a crest elevation of +4.0 feet NAVD-88; however the structure average height in 2002 was +2.51 feet NAVD-88. The average settlement of the structure, as measured from 1998 to 2002, was 0.29 feet (Raynie and Visser 2002), which indicates that the settlement may have only been built to an elevation of +2.75 feet NAVD-88 (Darin Lee, LDNR, Personal Communications, July 19, 2002).

There are also several examples of successful projects involving the use of shoreline protection to stop erosion along navigation canal banks.

- The Cameron Prairie National Wildlife Refuge Shoreline Protection (ME-09) project, constructed in 1994, is located in north-central Cameron Parish and includes 350 acres of freshwater wetlands (Barrilleaux and Clark 2002). A 13,200-foot rock breakwater was constructed at an elevation of +3.7 feet NAVD-88, 50 feet from (and parallel to) the northern shore of the GIWW to prevent wave action from eroding the bank and breaching into the interior marsh. Aerial photography and survey points were used to monitor any changes in land to water ratio and shoreline position. Three years after construction results indicate that the project area shoreline advanced 9.8 ± 7.1 feet per year while the reference area retreated 4.1 ± 3.1 feet per year. A two-sample t-test reveled a significant difference was detected between the shoreline change rate and the project reference areas ($P < 0.001$).

- Another canal bank stabilization project, the state funded Freshwater Bayou Bank Protection (TV-11), was constructed in 1994. Data collection on this project was halted due to manpower and budgetary constraints, but one year following construction completion, rocks in segments of the dike were washed away by boat wakes, thus compromising its structural integrity and leaving the underlying geotextile fabric exposed (LDNR 1996).

- The Freshwater Bayou Wetlands Protection (ME-04) project is positioned on the western bank of Freshwater Bayou Canal. Construction of this project was initiated in January 1995 and includes construction of water control structures and a 28,000 linear foot foreshore rock dike designed with a crown elevation of +4.0 feet NAVD-88. Analysis of initial monitoring data suggests that the rock dike reduced wave-

induced shoreline erosion after construction. The average rate of shore progradation between June 1995 and July 1996 was measured at 2.2 feet per year while the reference area continued to erode at an average rate of 6.7 feet per year (Raynie and Visser 2002). In contrast, between March 1998 and May 2001, the protected shoreline eroded an average of 2.6 feet per year while the reference area eroded at an average of 10.0 feet per year (Raynie and Visser 2002). Substandard recycled construction material and inadequate funds for maintenance of the structure, which were not disbursed in a timely manner, are believed to be the reason for the increase in erosion rates in the project area (Raynie and Visser 2002).

Summary/Conclusions

Though concrete pile structures are a relatively new technology, based on the investigation of similar restoration projects, a review of the results of the test section in Construction Unit 1, and a review of engineering principles, the concrete sheet pile structure will likely achieve the project goal. Settlement of the concrete sheet pile structure is anticipated to be negligible.

According to the results of the geotechnical investigation and calculations performed by NRCS engineers, the rock revetment structure is expected to settle up to 8.6 feet in some reaches over the 20 year project life. Much of the settlement is expected to occur in the first six months of the project, so to offset this initial settlement, the rock revetment will be constructed in two different stages, so that a second lift of rock can be added to the revetment, prior to demobilization to ensure that the revetment is at grade at the end of the construction period. The LDNR believes that this construction methodology, in combination with a comprehensive Operations and Maintenance plan, will adequately address the anticipated structure settlement.

The review of monitoring results from previously constructed shoreline protection projects along the Louisiana coast shows that the placement of the structures will likely halt shoreline erosion. The lessons learned from those projects have been incorporated into the design of this project. For instance, in two projects, TV-11 and ME-04, the structures were constructed with rock riprap of inappropriate size. This caused the rocks to wash away, reducing the effectiveness of the structures and allowing waves to impact the shoreline. The size of the rock that will be utilized on this project, 400 pound riprap, will adequately address this issue.

Dredged spoil from the access canal will be used beneficially to fill open-water ponds in the project area, to create up to 40 acres of emergent marsh. The target elevation of the constructed marsh is +1.0 feet NAVD-88, the average marsh elevation at the project site; however, in view of the shrinkage, settlement, and compaction of the material, it is not likely that the created marsh platform will remain intertidal (mean high water level was +1.28 feet NAVD-88, and the mean low water was +0.67 feet NAVD-88) for the duration of the 20-year project life. Considering the current design constraints for the targeted created marsh elevation (unconfined placement), and that the required material quantities are conditioned on the need for access canals, it is likely that this is the best design that can be achieved at this time.

VII. Recommendations

Based on the investigation of similar restoration projects, a review of the results of the test section in Construction Unit 1, and a review of engineering principles, the proposed strategies of the Barataria Basin Landbridge Shoreline Protection Project, CU 5, will likely achieve the desired ecological goal. At this time, the level of design of the project's physical effects and confidence in goal attainability warrant continued progress toward construction authorization pending a favorable 95% Design Review.

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Barataria Basin Landbridge Shoreline Protection Project,
Construction Unit 6

January 2004

This document reflects the project design as of the 95% Design Review meeting, incorporates all comments and recommendations received following the meeting, and is current as of January 27, 2004.

ECOLOGICAL REVIEW

Barataria Basin Landbridge Shoreline Protection Project, Construction Unit 6

I. Introduction

The Barataria Basin Landbridge Shoreline Protection Project, Phases 1, 2, 3 and 4 (Figure 2, Previous Section) are intended to preserve a critical landmass which has historically separated the freshwater dominated system of the upper basin from the marine and tidally dominated system of the lower basin. Shoreline protection structures along portions of Bayous Perot and Rigolettes, Little Lake, and Harvey Cutoff were designed to reduce or eliminate shoreline erosion thereby maintaining the hydrologic and ecological integrity of the Barataria Basin.

Construction Unit 6 is entirely contained within the boundaries of Phase 4 of the Barataria Basin Landbridge Shoreline Protection project (Figure 2, Previous Section). Construction Unit 6 involves the placement of rock revetment along the east bank of Bayou Rigolettes from the northern end of Construction Unit 4 north to the confluence of Bayou Rigolettes and the Barataria Bay Waterway (Figure 3).

II. Goal Statement

To eliminate shoreline erosion along a portion of the east bank of Bayou Rigolettes.

III. Strategy Statement

Placement of a rock revetment on an approximately 29,500 linear foot section of the east bank of Bayou Rigolettes.

IV. Strategy-Goal Relationship

Shoreline protection will eliminate shoreline erosion by baffling wave action and boat wakes.

V. Project Feature Evaluation

A geotechnical investigation identified the 29,500 linear foot section of the east bank of Bayou Rigolettes as suited for rock revetment construction. Soil conditions within this stretch of shoreline, although not ideal, were determined adequate to support a rock revetment (Burns Cooley Dennis, Inc. 2003). The analysis of 9 soil borings taken along the alignment of the revetment indicates that the soils are composed of a layer of peat underlain with soft or very soft clay.

The rock revetment will be constructed with an elevation of 3.5 feet NAVD-88, a 4 foot top width, a 3(H):1(V) side slope, will be constructed using 400 lb rock riprap, and will be underlain with a geotextile cloth. When traversing shoreline breaches the design will transition to a foreshore rock dike, incorporating 50-150 foot wide organism access openings with a sill elevation at 2 feet below average water level. Seven organism access openings are included in the project design (Figure 3).

The results of the geotechnical investigation and calculations by NRCS estimate an anticipated structure settlement of 1.8-4.2 feet during the 20 year project life, and established a

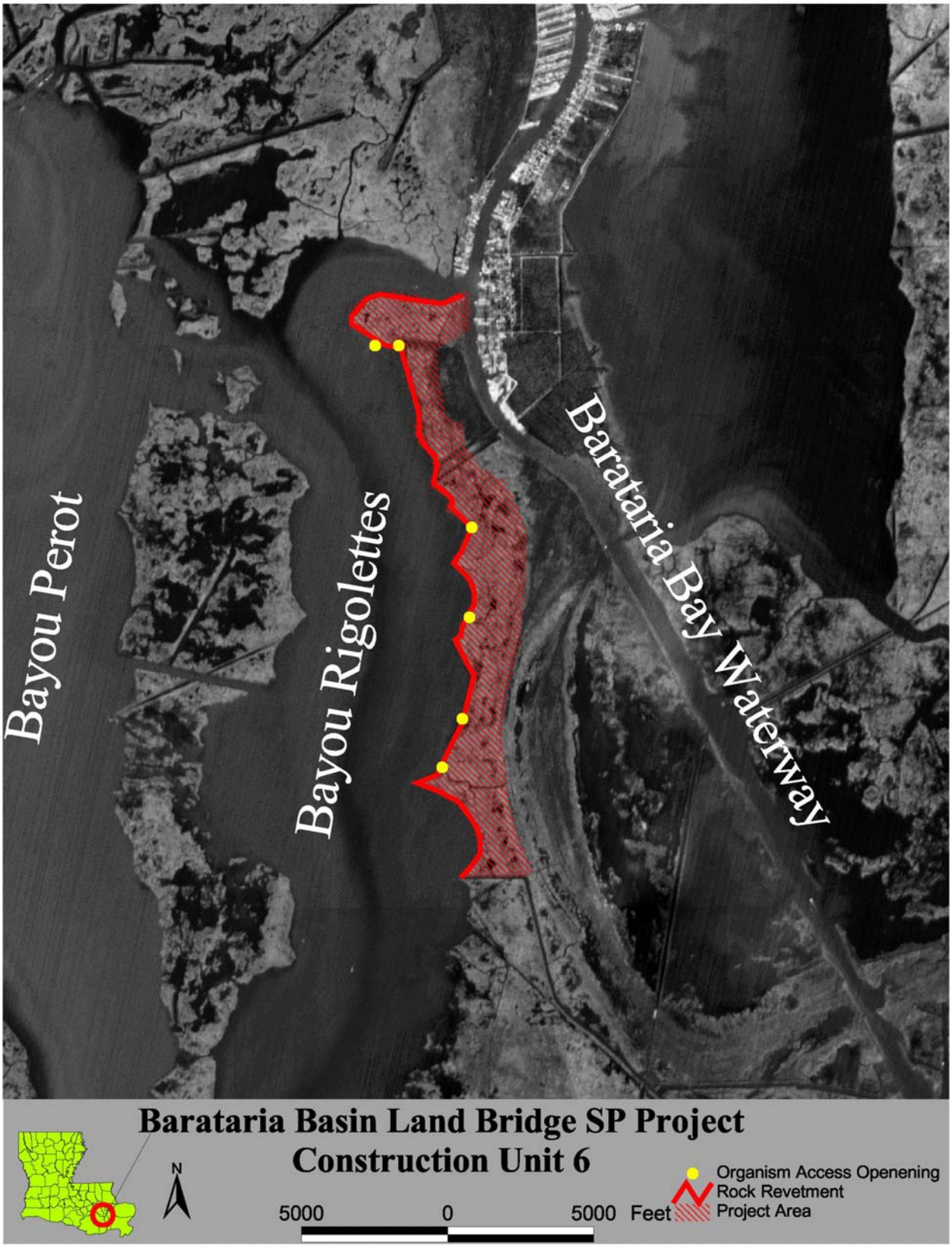

Figure 3: Construction Unit 6 project features.

minimum acceptable safety factor of 1.3 for slope stability (NRCS 2003). The accepted measure of a slope's stability is its safety factor which is the ratio of the forces or moments tending to prevent failure (soil strength, primarily) to those that cause failure (soil and surcharge weights plus seepage forces, primarily). A side slope safety factor of 1.4-3.2 was found for the soil conditions found within the project area.

Much of the structure's settlement is expected to occur during the first six months of construction (44%). The construction schedule of the rock revetment is designed so that more rock will be added to the revetment to compensate for the initial settlement of the structure, such as to reduce the overall anticipated settlement.

VI. Assessment of Goal Attainability

Shoreline protection via the installation of hard shoreline stabilization material has been implemented in the Louisiana coastal zone for several projects, to stabilize lake and bay shorelines, and navigation canal banks. Monitoring results and anecdotal information from projects constructed adjacent to lake shorelines, as is proposed for the Barataria Basin Landbridge Shoreline Protection Project Phases 1-4, indicate that shoreline protection measures have been generally effective at preventing or reducing erosion.

Findings from Previously Constructed CWPPRA and State-funded Shoreline Protection Projects

- The Boston Canal/Vermilion Bay shoreline Protection (TV-09) project was designed to reduce wind-driven wave erosion along Vermilion Bay and at the mouth of Boston Canal. A 1,405 foot foreshore rock dike with a top elevation of 3.8 feet N.G.V.D. and vegetation plantings were installed in 1995 to accomplish that goal. Initial post-construction data indicate that 1.4 to 4.5 feet of sediment was deposited between the breakwater and the shoreline in less than one year. The rock breakwater at the mouth of Boston Canal was successful in stabilizing the shoreline (Thibodeaux 1998).

- The Turtle Cove Shoreline Protection (PO-10) project was implemented in 1993 to protect a narrow strip of land in the Manchac Wildlife Management Area which separates Lake Pontchartrain from an area known as "The Prairie." Wind-driven high energy waves caused a shoreline erosion rate of approximately 12.5 feet per year. The purpose of the project was to protect the lake shoreline with a rock-filled gabion and to promote sediment deposition behind the structure. Following construction of a 1,642 foot rock-filled gabion 300 feet from shore and at an elevation of 3 feet above mean high water level, the shoreline prograded at a rate of 3.47 feet per year in the project area, and sediment elevation behind the structure increased 0.26 feet per year from October 1994 to December 1997. The Turtle Cove gabions have settled 0.59 feet in just over three years (October 1994 to January 1997), due to the weak and compressible nature of the subsurface soils (O'Neil and Snedden 1999), and the structure had numerous breaches and required maintenance. The Prairie and Turtle Cove soils consist of Allemands-Carlin peat which is described as highly erodible organic peat and muck soils (USDA 1972).

- The Lake Salvador Shoreline Protection Demonstration (BA-15) project evaluated a series of shoreline protection measures at Lake Salvador in St. Charles Parish, Louisiana. Phase two of this project was conducted in 1998 and evaluated the effectiveness of a rock berm to protect the lake shoreline from higher energy wave erosion. Shoreline surveys conducted behind the berm five months after construction indicated that the shoreline was still eroding. Subsequent surveys were not conducted due to poor weather conditions (Lee et. al 2000). The rock structure itself appears to be holding up well, showing little sign of deterioration and subsidence. The structure was designed to be constructed with a crest elevation of 4.0 feet NAVD-88; however the structure average height in 2002 was 2.51 feet NAVD-88. The settlement of the structure, as measured from 1998 to 2002, was 0.26 feet, which indicates that the structure may have only been built to an elevation of 2.75 feet NAVD-88 (Darin Lee, Personal Communication 2002).

There are also several examples of successful projects involving the use of shoreline protection to stop erosion along navigation canal banks.

- The Cameron Prairie Refuge Protection (ME-09) project located in north-central Cameron Parish consisted of constructing a 12,200 foot rock breakwater with a top elevation of 3.7 feet NAVD-88, 1-50 feet from the northern bank of the Gulf Intracoastal Waterway to prevent waves caused from boat traffic from eroding the remaining spoil bank. Since project construction in 1994, shoreline erosion in the project area has ceased, and from 1994 to 2000, the shoreline has prograded at an average rate of 9.8 feet/year (Barilleaux and Clark 2002).

- Another canal bank stabilization project, Freshwater Bayou Bank Protection (TV-11), consisted of the placement of a 25,800 foot rock breakwater; it was constructed in 1994. Data collection on this project was halted due to manpower and budgetary constraints, but one year following construction completion, rocks in segments of the dike had been washed away by boat wakes, thus compromising its structural integrity and leaving the underlying geotextile fabric exposed (LDNR 1996).

- The Freshwater Bayou Wetland Phase 1 (ME-04) project, constructed in 1995, consisted of a 28,000 foot rock breakwater constructed with a top elevation of 4.0 feet NAVD-88. The project has not only reversed wave-induced bank erosion, but initial monitoring has indicated that the bank has prograded at a rate of 2.34 feet/yr over a 12-month period (LDNR 1998). Subsequent monitoring efforts indicate that the effectiveness of the structure decreased over time due to the deterioration of the structure. The structure was constructed using material salvaged from the U.S. Army Corps of Engineers removal of a rock weir. The material contained a mix of stones, mud and wood, and the size of the rock was inappropriate for the ME-04 project structure (Raynie and Visser 2002).

Summary/Conclusions

According to the results of the geotechnical investigation and calculation performed by the NRCS, the structure is expected to settle up to 4.2 feet in some reaches of the revetment over

the 20 year project life. Much of the settlement is expected to occur in the first six months of the project, this will allow for the addition of another lift of rock to the target elevation. The LDNR believes that this construction methodology, in combination with a comprehensive Operations and Maintenance plan, will adequately address the anticipated structure settlement. The review of monitoring results from previously constructed shoreline protection projects in the Louisiana Coastal Zone shows that the placement of a rock revetment on the shoreline of Bayou Rigolettes will likely halt shoreline erosion. The lessons learned from those projects have been incorporated into the design of this project. For instance, in two projects, TV-11 and ME-04, the structures were constructed with rock riprap of inappropriate size. This caused the rocks to wash away, reducing the effectiveness of the structures and allowing waves to impact the shoreline. The size of the rock that will be utilized on this project, 400 lb riprap, will adequately address this issue. Both structures benefited from the implementation of an O&M plan that repaired the structures to achieve the goals of halting shoreline erosion.

VII. Recommendations

Based on the investigation of similar restoration projects and a review of engineering principles, the proposed strategies of the Barataria Basin Landbridge Shoreline Protection Project, CU5, will likely achieve the desired ecological goal. At this time, the level of design of the project's physical effects warrant continued progress toward construction pending a favorable 95% Design Review.

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