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

Mississippi River Sediment Delivery System – Bayou Dupont
CWPPRA Priority Project List 12
State No. BA-39

November 7, 2007

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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 November 21, 2007.

Mississippi River Sediment Delivery System – Bayou Dupont

In August 2000, the Louisiana Department of Natural Resources (LDNR) 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.

I. Introduction

The objective of the Mississippi River Sediment Delivery System – Bayou Dupont (BA-39) project is to create marsh in a rapidly deteriorating section of the Barataria Basin Landbridge. The Barataria Basin Landbridge, which extends southwest to northeast across the basin between Lake Salvador and Little Lake, hydrologically separates the freshwater-dominated upper basin from the marine-dominated lower basin (Figure 1). The BA-39 project is located between Bayou Dupont and Cheniere Traverse Bayou, approximately 3.7 miles northwest of Myrtle Grove (Figure 2). The project area encompasses 493 acres, of which only 102 acres are remnant brackish marsh.

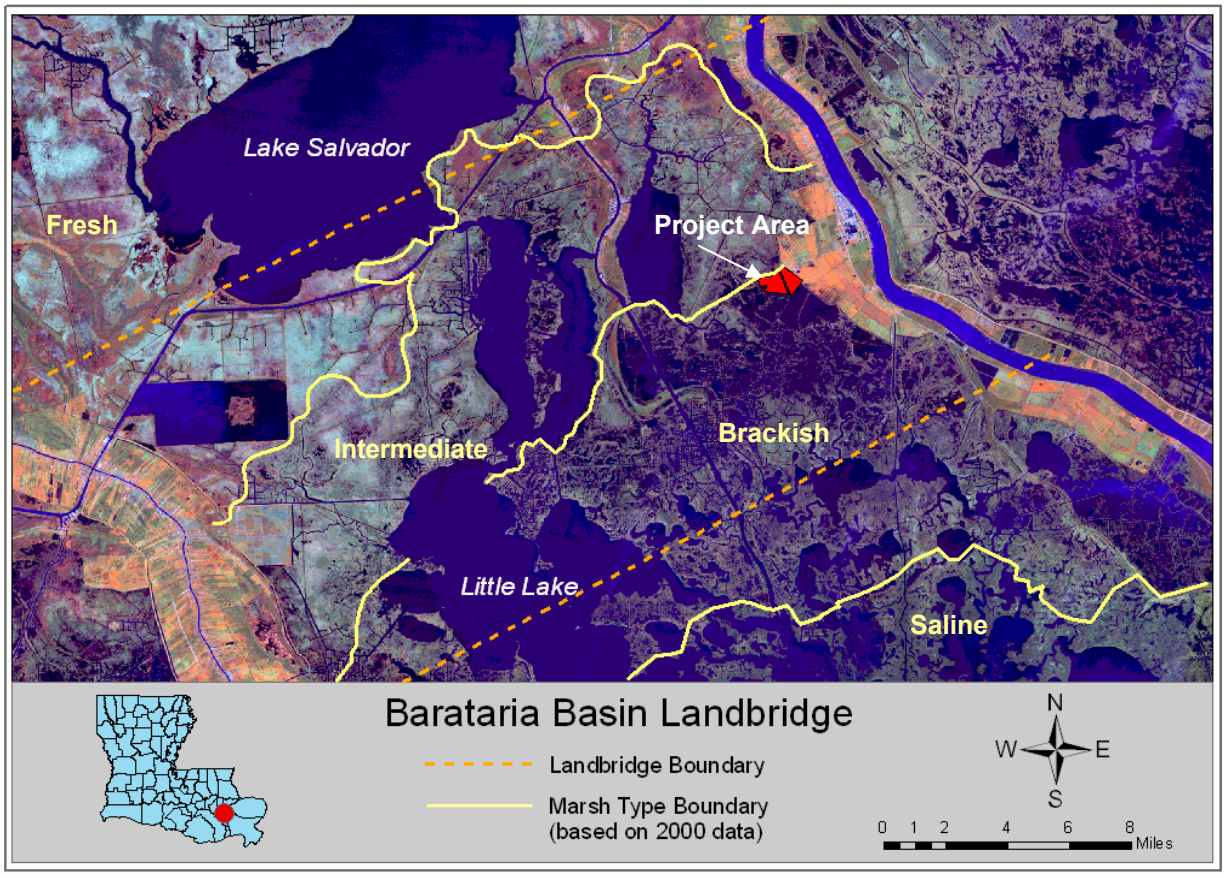

Figure 1. Location of BA-39 project within the Barataria Landbridge.

Marshes in this section of the landbridge are badly degraded mostly due to anthropogenic modifications that have occurred over the last century. The Mississippi River flood-control levee system has prevented riverine sediment and nutrients from reaching adjacent marsh, thus impairing the marsh's ability to keep pace with subsidence (Baumann et al. 1984). In addition, an extensive network of canals dredged for navigation and the oil and gas industry has altered natural hydrology and increased saltwater intrusion resulting in the conversion of large areas of freshwater marsh to open water (Sasser et al. 1986). As open water areas have expanded and fetch has increased, the remaining marsh has been exposed to erosion from wind-generated waves. Because of these impacts, land loss rates in the area are high: 2.59% per year between 1956 and 1993, and 2.94% per year between 1974 and 1990 (Environmental Protection Agency [EPA] 2002). Analyses for more recent time periods have been unable to detect a land loss rate for the area, likely because most of the project area has already converted to open water (EPA 2002). However, analyses for the nearby PPL 17 candidate project, Bayou Dupont Marsh and Ridge Creation, found a land loss rate of 1.72% per year between 1988 and 2006 (National Marine Fisheries Service 2007).

Coast 2050 has identified dedicated dredging of sediment to create marsh as a Region 2 ecosystem strategy that will help stabilize the landbridge and protect freshwater marsh of the upper basin from increased marine/tidal influence (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1999). Because of its proximity to the Mississippi River, the BA-39 project provides an excellent opportunity to design a sediment delivery system that will utilize the river's renewable bedload sediment to create and restore marsh (EPA 2002). The relatively new concept of using river sediment, as opposed to dredging material from adjacent shallow waters, will minimize disturbance to local habitats.

II. Goal Statement

Create 493 acres of marsh, by the end of construction, in an area that is currently open water.

III. Strategy Statement

Marsh creation will be achieved by hydraulically-dredging sediment from the Mississippi River and transporting it via pipeline to fill open water and deteriorated marsh in the project area. The perimeter of the marsh platforms will be planted with native wetland species upon construction completion, and additional plantings may be installed one year after construction depending on the success of colonization (Thompson 2007).

IV. Strategy-Goal Relationship

Sediment dredged from the river will be pumped into two marsh creation areas: Area 1 which encompasses approximately 295 acres, and Area 2 which encompasses approximately 198 acres (Figure 2). As the sediment settles and consolidates, the areas should become established with marsh vegetation resulting in 493 acres of marsh habitat.

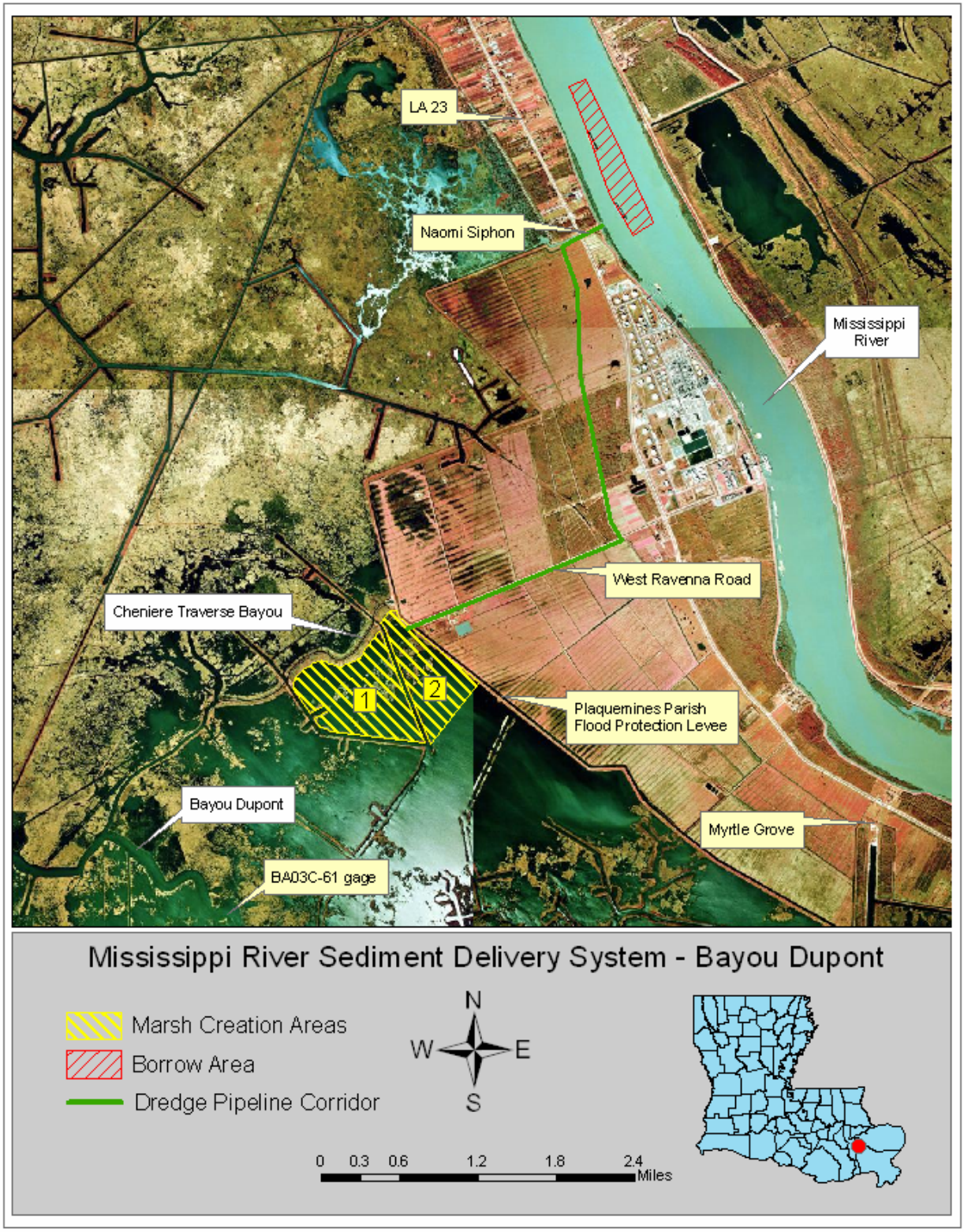

Figure 2. Mississippi River Sediment Delivery System – Bayou Dupont (BA-39) project area and features.

V. Project Feature Evaluation

Marsh Creation Design

The average elevation of existing marsh in the project area is +0.88 feet NAVD 88 (T. Baker Smith and Son, Inc. 2005). However, this marsh consists of small patches of vegetation surrounded by open water and is not representative of healthy marsh. Consequently, project team members estimated healthy marsh elevation to be approximately +1.3 feet NAVD 88, based on best professional judgment and the local tidal datum. In addition, this elevation is nearly equivalent to that of the nearby Bayou Dupont - Dedicated Dredging (LA-01 b) created marsh (elevation: +1.34 feet NAVD 88), which appears to be very healthy (Thompson 2007). To determine the appropriate construction fill elevation, foundation settlement and self-weight consolidation tests were performed using soil samples collected from the marsh creation and borrow areas, respectively (Eustis Engineering Company, Inc. [EEC] 2006; Louis J. Capozzoli and Associates, Inc. [LJC] 2007). After evaluating a range of potential elevations, a fill elevation of +2.0 feet NAVD 88 was chosen because it would yield desirable marsh elevations for most of the project life. Filling to this elevation, most of the foundation settlement and self-weight consolidation would occur within two years after construction. The created marsh platforms would settle to +1.3 feet NAVD 88 at year 10, and to +1.2 feet NAVD 88 at the end of the 20-year project life (Figure 3).

The perimeter of the marsh platforms will be planted with native wetland species upon construction completion. Additional plantings may be installed one-year after construction depending on the success of colonization.

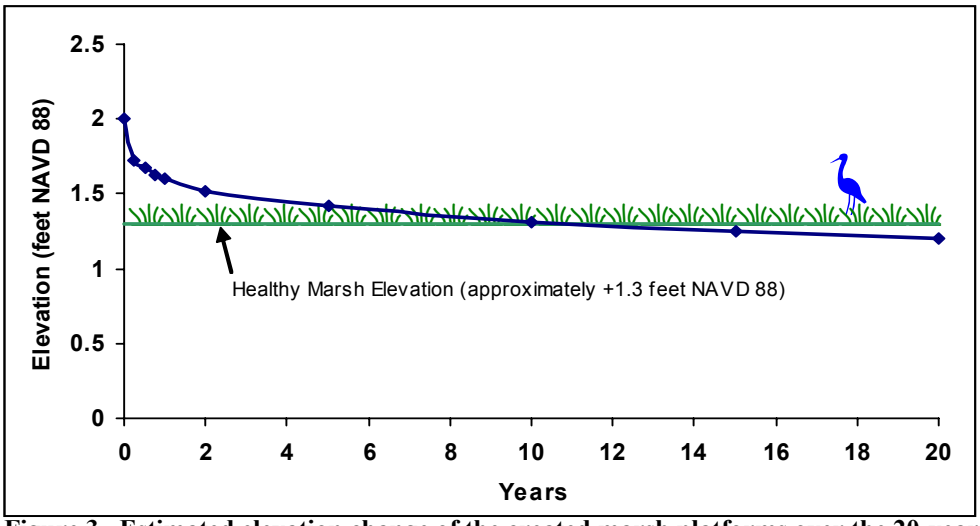

Figure 3. Estimated elevation change of the created marsh platforms over the 20-year project life (Thompson 2007).

Containment Dikes

Eustis Engineering Company, Inc (2006) recommended that containment dikes be built with a crown elevation of +3.0 feet NAVD 88 (allowing one foot of freeboard above the marsh fill), a crown width of 6 feet, and side slopes of 1(V):3(H) producing a slope stability factor of 1.64 (Figure 4). The two marsh creation areas are mostly enclosed by pre-existing spoil banks and, therefore, a minimal amount of material will be needed to raise these banks to the recommended elevation. A complete containment dike, though, will be constructed on the southeastern boundary of Area 2. The dikes will be constructed using material mechanically-dredged from within the marsh creation areas.

Settlement of the containment dikes is estimated to be 1.0 to 1.25 feet over the project life (EEC 2006), which would result in the dikes being about 0.55 to 0.80 feet above the marsh platforms at year 20. Therefore, to achieve a consistent marsh platform elevation, the dikes constructed from existing spoil banks will be degraded to marsh elevation at the end of construction (Thompson 2007). The southeast dike of marsh creation Area 2, however, will likely remain in place to protect against erosion from wave action generated in the adjacent open water area (Whitney Thompson, LDNR, Personal Communication, October 10, 2007).

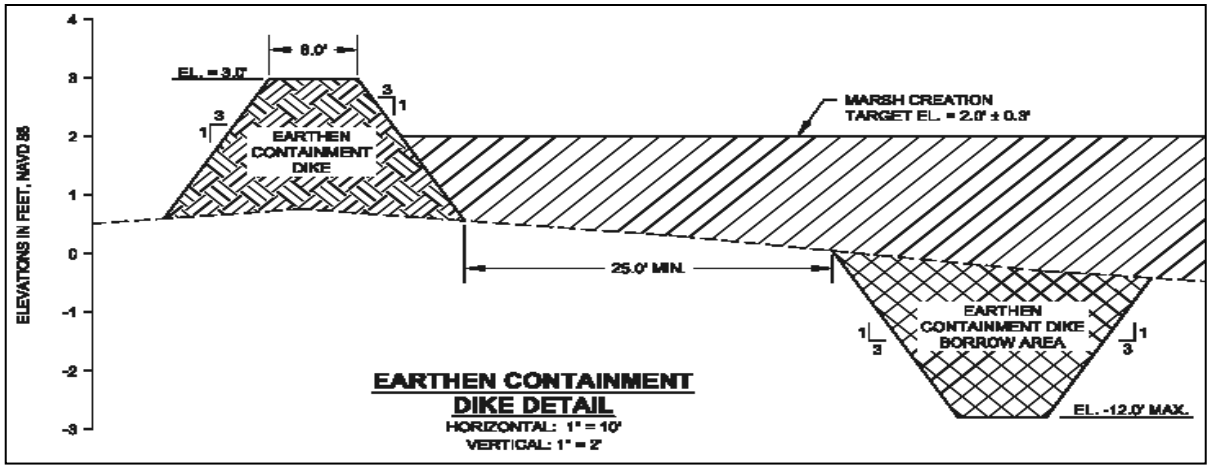

Figure 4. Details of earthen containment dike and containment dike borrow area (Thompson 2007).

Borrow Area and Dredge Pipeline Corridor

Assuming a cut to fill ratio of 1.5:1, a total of 3,502,665 cubic yards of sediment will be required to fill the marsh creation areas (Thompson 2007). Sufficient dredgeable sediment was found between Mississippi River miles 63.6 and 65.0 on an expanding sand bar (Figure 2). Channel deposits in this area are predominantly medium and fine sand (median particle size 0.3 mm; LJC 2007). The borrow area was delineated in accordance with U.S. Army Corps of Engineers' Mississippi River dredging restrictions, which are designed to protect bridges, navigation channels, and the adjacent levee system (Thompson 2007). The potential effects such large-scale dredging would have on the river's hydraulics were also considered. Tony Thomas of Mobile Boundary Hydraulics, PLLC evaluated the project's design specifications and concluded that there would be no adverse impacts and modeling of the borrow area would not be necessary (Thompson 2007).

Sediment will be hydraulically-dredged from the borrow area and transported to the marsh creation areas via a 30-inch diameter dredge slurry pipeline. The pipeline will cross the Mississippi River levee in Plaquemines Parish's tract of land surrounding the Naomi Siphon (Figure 2). The pipeline will then pass through a 36-inch casing and a 36-inch culvert that will be installed underneath the New Orleans and Gulf Coast Railroad and Highway 23, respectively (Thompson 2007). After these crossings, the pipeline will extend south through pastures to West Ravenna Road, where it will be buried underneath a layer of crushed aggregate to accommodate vehicle crossings. The pipeline will then be placed along the southern side of West Ravenna Road to the Plaquemines Parish flood protection levee. After crossing this levee, the pipeline will discharge into the marsh creation areas.

VI. Assessment of Goal Attainability

When addressing the likelihood that the proposed project features will provide the desired ecological response, it is important to evaluate the lessons learned from scientific research and past projects that are similar in scope to the Mississippi River Sediment Delivery System – Bayou Dupont (BA-39) project. The findings of this review follow.

- The Bayou LaBranche Wetland Creation (PO-17) project, located on the southwestern shore of Lake Pontchartrain, was the first project constructed through the CWPPRA program, with construction completed on April 1, 1994. The project was designed to reach a minimum 70% emergent marsh to 30% open-water ratio 5 years after construction. In 1997, the project area was approximately 82% land and 18% water; however, only 51% of the land was emergent marsh with the rest being scrub-shrub and upland habitats (Boshart 2004). The low amount of emergent marsh was attributed to sediment elevations being higher than suitable for emergent vegetation. The target range of sediment elevation for this project, after five years of consolidation, was estimated at +0.65 to 1.62 feet NAVD (Boshart 2004). As of August 2002, elevations at eleven of the 19 staff gauge stations were within this target range. In addition, soil properties and vegetation communities have continued to develop toward characteristic wetland habitats for the region.

- The Barataria Bay Waterway Wetland Restoration (BA-19) project intended to enlarge Queen Bess Island by creating 9 acres of vegetated wetlands using sediment from maintenance dredging of the waterway. The elevation of the marsh platform was projected to be +1.22 feet NGVD 29 after settlement and consolidation; however, two years after construction the elevation was +0.79 feet NGVD 29 (Curole 2001). This was because it was later realized that the project area was filled to an elevation lower than the design elevation (Smith 2003). As a result, the project area is constantly flooded and no appreciable vegetation growth has occurred.

- The Atchafalaya Sediment Delivery (AT-02) project was designed to utilize sediment dredged from two channels in the Atchafalaya Delta to create islands suitable for the establishment of emergent marsh vegetation (Rapp et al. 2001). However, inaccurate elevation surveys made prior to construction caused the dredged material to be piled too high (Raynie and Visser 2002). As a result, the created islands have become dominated by wetland forest vegetation rather than the targeted emergent marsh species that colonized nearby natural crevasse splays. This was attributed to the greater elevation, and therefore lower flooding frequency and duration, of the created islands.

- The goal of the West Belle Pass Headland Restoration (TE-23) project was to reduce the encroachment of Timbalier Bay into the headland by creating 184 acres of marsh using sediment dredged from Bayou Lafourche. Failed containment dikes, though, allowed a large quantity of sediment to be washed out of the marsh creation sites before the material had settled/consolidated. Furthermore, large sections of the project area were filled to levels significantly higher or lower than the targeted +1.7 feet NAVD 88 elevation. As a result, only 31 acres of saline marsh were created by this project, with the remainder being upland, beach/bar/flat, and subaqueous habitats (Curole and Huval 2005).

- The goal of the Lake Chapeau Sediment Input and Hydrologic Restoration, Point Au Fer Island (TE-26) project was to create 260 acres of marsh, which would act as a hydrologic barrier between two watersheds in the project area. The marsh platform was designed to have an elevation of +1.5 feet NGVD 29 at construction, and +0.5 feet NGVD 29 (or existing marsh elevation) after settlement/consolidation. However, portions of the project area were not filled to the correct elevation, and some of the sediment was removed by tidal flow coming through containment dike failures and the dredge pipeline corridor (Raynie and Visser 2002). Consequently, the created marsh has a lower elevation than adjacent natural marsh, leading to more frequent and longer inundation than optimal for healthy marsh. The TE-26 project only created approximately 139.5 acres of new land (Lear and Triche 2004).

- The Sabine Refuge Marsh Creation, Cycle 1 (CS-28-1) project is part of an overall effort to create approximately 1,120 acres of emergent marsh using sediment from maintenance dredging of the Calcasieu Ship Channel. The goal of the first cycle, completed in February 2002, was to create approximately 125 acres. The marsh platforms were designed to have an elevation of +3.08 feet NAVD 88 at construction, and an elevation of +1.08 feet NAVD 88 after five years (Sharp and Juneau 2005). Although post-construction elevation surveys have not been conducted, vegetation surveys found that the marsh platforms were densely covered by emergent vegetation within two years of construction (Sharp and Juneau 2005).

Summary/Conclusions

This review clearly shows that elevation is one of the most important factors dictating the success of marsh creation projects. The elevation of the marsh surface controls its frequency and duration of flooding, which in turn affects vegetation zonation and productivity. For the BA-39 project, the elevation of the marsh platforms would be around +1.2 to +1.3 feet NAVD 88 for much of the project life. At these elevations, the platforms would be inundated approximately 25% of the time, based on five years of water level data from the nearby BA03C-61 gage (29°37'23.30"N, 90°01'53.18"W) (Figure 5). Although this level of inundation is lower than optimal for many species of emergent vegetation, it would be suitable for the locally-dominant *Spartina patens*, which is less tolerant of flooding and more productive in irregularly-inundated habitats (Burdick and Mendelssohn 1987, Broome et al. 1995).

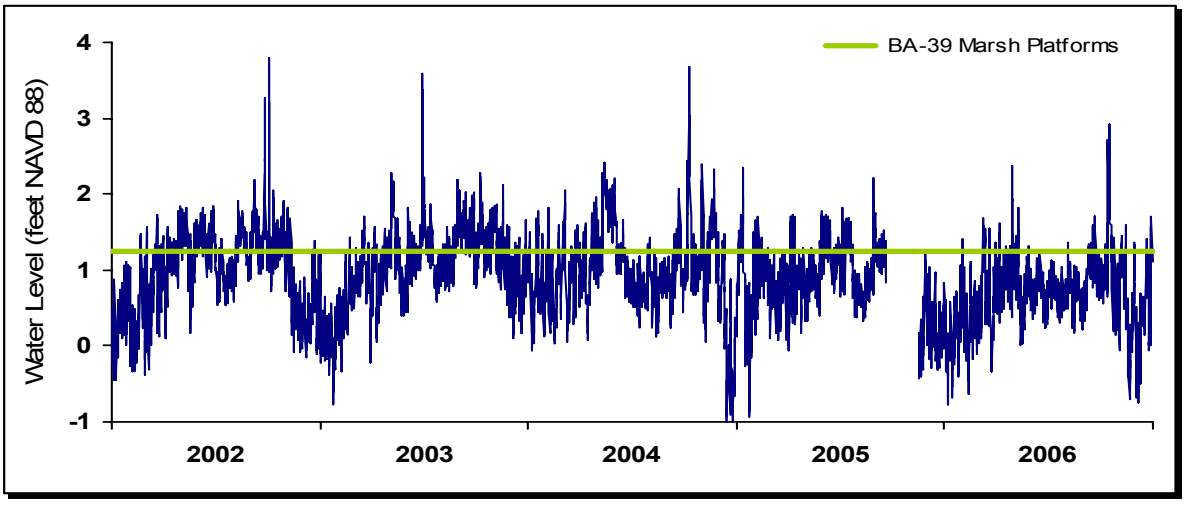

Figure 5. Water level at the BA03C-61 gage for the years 2002 to 2006 (from LDNR data).

It is important to quickly establish vegetation on created marsh platforms to stabilize the sediment and prevent its loss from erosive processes. The rate that marsh vegetation naturally colonizes bare sediment is dependent on substrate characteristics and the availability of recruits (Broome et al. 1988). The borrow material that will be used in the BA-39 project is predominantly medium and fine sand. Such material typically does not have the nutrient concentrations necessary for rapid plant establishment (Broome et al. 1988, Streever 2000). Furthermore, because there is not much marsh near the BA-39 project area, there may be a limited supply of propagules (i.e., seeds or plant fragments) available to colonize the marsh platforms. Under these circumstances, plantings can greatly accelerate vegetative establishment and development (Broome et al. 1988). The BA-39 project proposes to initially plant the perimeter of the created marsh platforms. Once established, these plantings should provide a source of propagules for the remainder of the marsh platform, so that vegetative colonization can occur on a more natural progression. However, if development is inadequate, then further plantings will be warranted.

The long-term sustainability of the created marsh is dependent on maintaining natural hydrologic exchange between the marsh and adjacent water bodies. Levees and canal spoil banks interrupt this exchange resulting in prolonged flooding and drying events, reduced sediment and nutrient inputs, and ultimately marsh degradation and loss (Swenson and Turner 1987, Turner 1987, Kuhn et al. 1999). The BA-39 project area is bounded on two sides by established hydrologic barriers (i.e., the Plaquemines Parish Flood Protection Levee and the Cheniere Traverse Bayou natural ridge, Figure 2); therefore, it is important that hydrologic exchange is unimpeded elsewhere along the perimeter of the created marshes. The project's containment dikes will be degraded to the elevation of the marsh platforms following construction, and they should continue to settle along with the marsh platforms. However, if the dikes do not settle as anticipated and remain above the marsh platforms, then they may act as hydrologic barriers and should be mechanically-gapped.

The BA-39 project represents the first CWPPRA project to propose using Mississippi River bedload sediment to restore marsh. The efficacy of this restoration technique is relatively unknown; therefore, future projects of this kind will greatly benefit from comprehensive documentation and monitoring of the implementation and performance of the BA-39 project.

VII. Recommendations

Based on the evaluation of available ecological, geological, and engineering information, and a review of scientific literature and similar restoration projects, the proposed strategies of the Mississippi River Sediment Delivery System – Bayou Dupont project will likely achieve the desired ecological goals. At this time, it is recommended that this project be considered for Phase 2 authorization. However, we recommend that:

- If the degraded containment dikes remain above and impound the created marsh, then they should be mechanically-gapped to ensure tidal exchange.

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