



State of Louisiana

**Coastal Protection and Restoration Authority
of Louisiana**

Office of Coastal Protection and Restoration

2011 Operations, Maintenance, and Monitoring Report

for

Freshwater Bayou Canal Wetland Protection

State Project Number ME-04
Priority Project List 2

June 2011
Vermilion Parish

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Suggested Citation:

Mouledous, M. and D. Broussard 2011. *2011 Operations, Maintenance, and Monitoring Report for Freshwater Bayou Wetland Protection (ME-04), Coastal Protection and Restoration Authority of Louisiana, Office of Coastal Protection and Restoration, Lafayette, Louisiana. 46pp.*



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I. Introduction

The Freshwater Bayou Wetlands project area encompasses 36,928 ac (14,945 ha) of fresh, intermediate, and brackish marsh located between Intracoastal City and Pecan Island in Vermilion Parish, Louisiana (figure 1). Centered approximately at Lat. 29E 40' 00" N and Long. 92E 18' 00" W, the area is bounded on the north by the old Intracoastal Waterway (Schooner Bayou), on the west by LA Hwy 82 and the Acadiana Marina Canal, on the south by Humble Canal (Acadiana Marina Canal), and on the east by Freshwater Bayou Canal (FBC).

The project plan (USDA/SCS 1994) divides the project area into three Conservation Treatment Units (CTU's), with CTU 1 and 3 benefiting directly from the shoreline protection work implemented under Phase 1 of the project (figure 1). Phase 2 of this CWPPRA project authorized the installation of eight (8) box-type water control structures with a single flapgate, a variable-crest weir, and two fixed-crest weirs (one with a 4 inch vertical slot) in the project area. Three structures are located in CTU 1, three in CTU 2, and two in CTU 3 (sites 28-35 in figure 1). A number of water control structures were already in place prior to the project. Additional structures were installed by the landowner at the landowner's expense, to enhance the operation of the eight CWPPRA structures.

The southernmost unit, CTU 1, consists of 13,800 ac (5,585 ha) of predominantly fresh marsh with zones of intermediate and brackish marsh along its eastern and southern boundaries. It is predominated by *Sagittaria lancifolia* (bulltongue) and *Spartina patens* (wiregrass). Ponds range in depth from 1.7-2.0 ft (0.52 - 0.61 m), and contain over 50% cover with aquatic plants (USDA/SCS 1994). The Phase 1 dike is now protecting the eastern edge of CTU 1 from wave erosion and salt water intrusion from Freshwater Bayou Canal. CTU 2 consists of 9,300 ac (3,764 ha) of fresh marsh, dominated by *Echinochloa walteri* (Walter's millet) and *S. lancifolia*, located in the west central portion of the project area. Pond depths range from 1.7-2.3 ft (0.52 - 0.70 m). The northern section of the project area comprises CTU 3, which consists of 13,800 ac (5,585 ha) of predominantly fresh marsh dominated by *S. lancifolia*, *E. walteri*, and *Alternanthera philoxeroides* (alligatorweed), with intermediate and brackish marsh zones dominated by *S. patens* and *Scirpus americanus* (Olney's bulrush) along its eastern boundary along Freshwater Bayou Canal. Pond depths range from 2.2-3.0 ft (0.67 - 0.91 m) in CTU 3.

Reference areas R1 and R2 (figure 1) were established to monitor shoreline erosion along two 0.5 mi (0.8 km) segments of unprotected shoreline located along the east bank of Freshwater Bayou Canal, opposite the south end (R1) and the north end (R2) of the ME-04 dike. These two reference areas were used for comparison with erosion rates along the section of canal bank protected by the ME-04 rock dike within CTU 1. The vegetation type is identical to the project area, and like the project area shoreline, the reference area R1 and R2 shorelines include both intact and deteriorated sections of spoil bank. Reference area R3 is representative of much of the fresh marsh in the northwest section of the project area today, in

terms of soil type, salinity, water levels, and the frequency and duration of inundation. Reference area R4 is a small tidally influenced area of brackish marsh just outside the boundary of CTU 1. Marsh loss rates were monitored by comparison of all four reference areas with all three CTUs.

Wetlands in the project area are adversely affected by the influence of high water levels from the Grand/White Lake system to the west, where elevated water levels are artificially maintained by several locks and water control structures for navigation and agricultural purposes (LWCRTF 1993). Water flowing out of White Lake can enter the project area from the west via oil field canals, the borrow canals and culverts under LA Hwy 82, and from the north via natural openings along the south bank of Schooner Bayou.

Some wetland acreage in the project area has been lost through the dredging of oil field access canals. However, most wetland loss in the project area has resulted from the gradual degradation and conversion of fresh marsh to open water, mainly between 1956-1978. In 1956, wetlands accounted for 97.9% of the project area and only 1.3% of the area was open water. By 1978, wetlands accounted for 88.9% of the project area, the open water areas having increased to 8.3% of the area. By 1990, wetlands accounted for 87.5% of the project area, while the open water area had increased to 8.9% of the project area. Thus, between 1956 and 1990, approximately 7.6% (3,720 ac [1,514 ha]) of the emergent wetlands in the project area were lost.

The potential for tidal exchange between Vermilion Bay and the interior marshes in the project area has greatly increased over the past 40 years through the construction of numerous oil and gas exploration canals, the old GIWW, and Freshwater Bayou Canal. Initially, the fragile organic soils of the interior marshes were protected from saltwater intrusion and tidal scour by spoil banks along these channels. However, much of the spoil banks along Humble Canal and Freshwater Bayou Canal have been destroyed, largely by boat wake-induced shoreline erosion, exposing the interior wetlands to these detrimental forces.

Based on data provided in a feasibility report by Brown and Root (1992), between 1968-1992, an average of 34,051 large vessels (crew boats, jack-up barges, supply boats, and fishing boats) traveled through the Freshwater Bayou Canal lock and channel each year, contributing to an average shoreline erosion rate of 12.5 ft per year (3.8 m/yr) on each bank for this period.

Phase 1 construction, which included the placement of rock breakwaters along FBC, was completed in January 1995. Phase 2 construction, which included earthen plugs and water control structures, was completed in October 1998.

Hurricane Rita struck the coast of southwestern Louisiana on September 24, 2005 with maximum storm surge of 8-9 ft (2.4 – 2.7 m) in the ME-04 project area (FEMA 2006). USGS calculated the amount of land that changed to water resulting from the storm to be 98 square miles in southwestern Louisiana, 62 square miles in the Mermentau basin (Barras 2006). This loss can be attributed to several patterns. Shearing, which is ripping and removal of marsh vegetation in historically healthy marshes was observed in marshes bordering the east bank of

Freshwater Bayou. The removal of remnant marsh from areas with historical land loss from the surge was observed due east of Pecan Island, south of Sweet Lake, and due east of Deep Lake. A large area of open water also formed within CTU 1 (see figure 3).

Hurricane Ike struck near Galveston, Texas on September 13, 2008. A maximum storm surge of 7 - 8 ft (2.1 – 2.4 m) NAVD 88 was reported for the ME-04 project area (East et al. 2008).

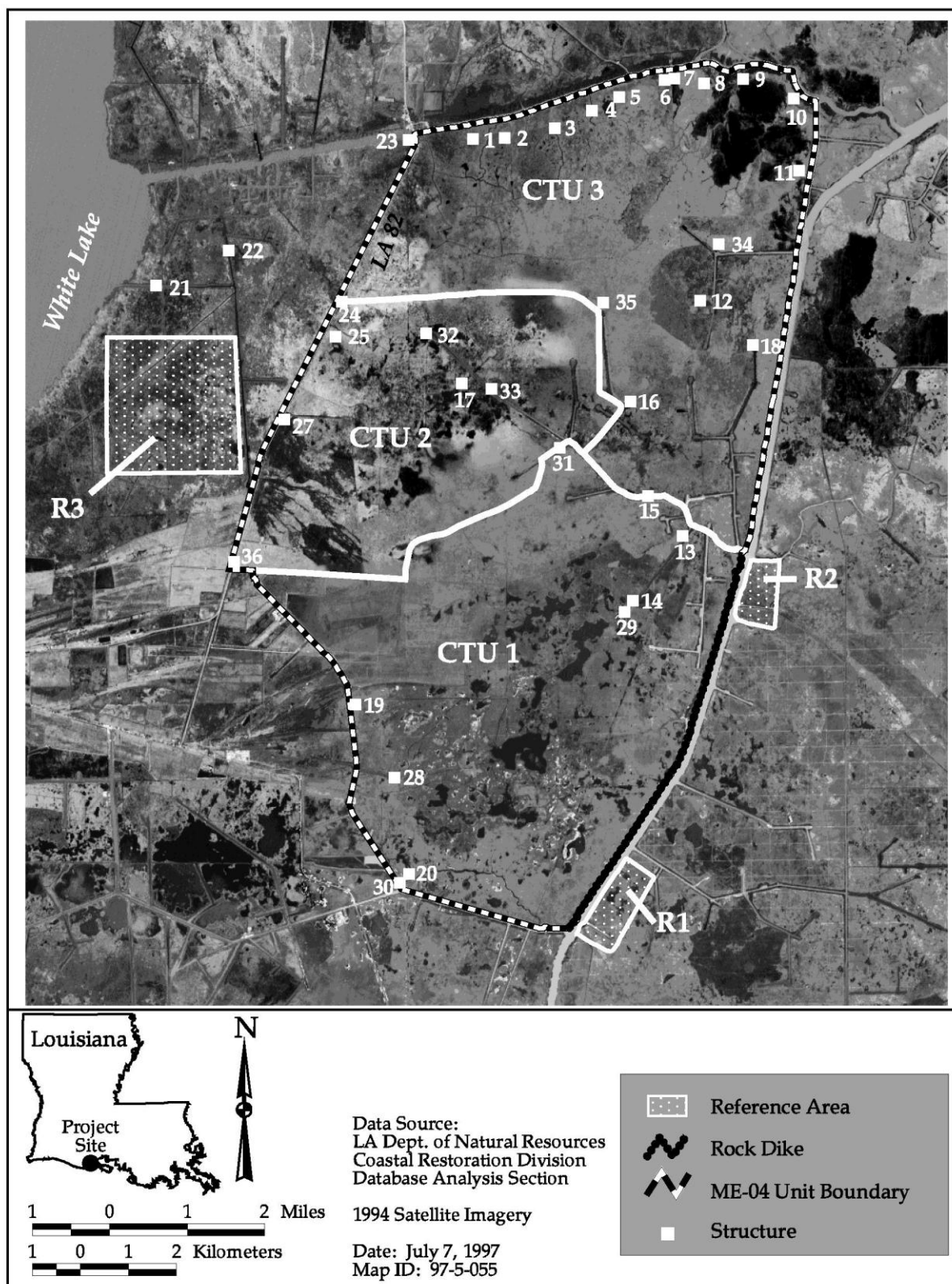


Figure 1: Freshwater Bayou Wetland Protection (ME-04) project and reference areas.

II. Maintenance Activity

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Freshwater Bayou Wetlands Project (ME-04) is to evaluate the constructed project features to identify any deficiencies and prepare a report detailing the condition of project features and recommended corrective actions needed. Should it be determined that corrective actions are needed, LDNR shall provide, in the report, a detailed cost estimate for engineering, design, supervision, inspection, and construction contingencies, and an assessment of the urgency of such repairs. The annual inspection report also contains a summary of maintenance projects which were completed since completion of constructed project features and an estimated projected budget for the upcoming three (3) years for operation, maintenance and rehabilitation. The three (3) year projected operation and maintenance budget is shown in Appendix B. A summary of past operation and maintenance projects completed since completion of the Freshwater Bayou Wetlands Project are outlined in Section IV.

An inspection of the Freshwater Bayou Wetlands Project (ME-04) was held on April 12, 2011, under sunny skies and cool temperatures. In attendance were Dion Broussard, Darrell Pontiff and Mel Guidry from (OCPR); Loland Broussard and Charles Slocum representing (NRCS). The inspection began at the southern end of the rock dike alignment at 1:20 pm.

The field inspection included a complete visual inspection of the entire project site. Staff gauge readings when available and existing temporary benchmarks were used to determine approximate water level and foreshore rock dike elevation. (See Appendix C).

b. Inspection Results

Site 1—Foreshore rock dike

The inspection revealed the 11,420 linear feet of foreshore dike repaired in the 2005 maintenance project is in good condition. The additional 2,000 linear feet of foreshore rock dike have sections below elevation 4.0' NAVD and have recently been surveyed by NRCS personnel. An estimate will be prepared based on this survey data of what it will take to restore these sections of dike to original elevation. The funding request will be submitted to CWPPRA in 2012. (Photos: Appendix A, Photos 1 & 2)

c. Maintenance Recommendations

i. Immediate/ Emergency Repairs

ii. Programmatic/ Routine Repairs



II. Maintenance Activity (continued)

d. Maintenance History

General Maintenance: Below is a summary of completed maintenance projects and operation tasks performed since March 1995, the construction completion date of the Freshwater Bayou Wetlands Project (ME-04).

2002 - Freshwater Bayou Wetlands Maintenance Project – LDNR: This maintenance project included the installation of approximately 26,750 tons of 1000 lb gradation stone to repair fifteen thousand, two hundred and sixty-three linear feet of bank. Quantity limitations prevented the repair of all sections required. Construction was completed on 4/22/2002. The cost associated with the engineering, design and construction of the Freshwater Bayou Wetlands Maintenance Project is as follows:

Construction:	\$615,900.00
Engineering & Design:	\$ 46,882.86
Construction Administration:	\$ 36,954.00
Construction Oversight/As built:	<u>\$ 17,311.06</u>

TOTAL CONSTRUCTION COST: \$717,047.92

2005 - Freshwater Bayou Wetlands Maintenance Project – LDNR (Luhr Bros. Contractor): This maintenance project included the installation of approximately 21,370 tons of 1,250 lb gradation stone to repair 11,426 linear feet of bank. Quantity limitations prevented the repair of all sections required. Construction was completed on 12/15/2005. The cost associated with the engineering, design and construction of the Freshwater Bayou Wetlands Maintenance Project is as follows:

Construction:	\$472,660.50
Engineering & Design:	\$ 1,282.84
Construction Administration:	\$ 5,625.00
Construction Oversight/As built:	<u>\$ 4,419.68</u>

TOTAL CONSTRUCTION COST: \$483,988.02



III. Operation Activity

a. Operation Plan

There are no water control structures associated with this project under the direct responsibility of OCPR, therefore no Structural Operation Plan is required.

b. Actual Operations

There are no water control structures associated with this project under the direct responsibility of OCPR, therefore no required structural operations.

IV. Monitoring Activity

Pursuant to a CWPPRA Task Force decision on August 14, 2003 to adopt the Coastwide Reference Monitoring System-*Wetlands* (CRMS-*Wetlands*) for CWPPRA, updates were made to the ME-04 Monitoring Plan to merge it with CRMS-*Wetlands* and provide more useful information for modeling efforts and future project planning while maintaining the monitoring mandates of the Breaux Act. There are 5 CRMS-*Wetlands* stations in the ME-04 project area (Figure 3). Data collected from these stations will be used in future reports to determine marsh response to project features and environmental variables.

a. Monitoring Goals

The objectives of the Freshwater Bayou Wetlands Project are:

1. Protect the existing emergent wetlands along the west bank of Freshwater Bayou Canal and prevent their further deterioration from shoreline erosion and tidal scour.
2. Prevent the widening of the Freshwater Bayou Canal channel into the Freshwater Bayou Wetlands project area.
3. Reduce ponding and marsh loss in the project area wetlands.
4. Maintain target salinity levels in the project area wetlands.
5. Increase vegetation cover in shallow open water areas within the project area wetlands.

The following goals will contribute to the evaluation of the above objectives:

1. Decrease the rate of spoil bank erosion along the west bank of Freshwater Bayou Canal using a rock breakwater.
2. Reduce water levels to within the target range for fresh to intermediate marsh vegetation, which is 6 in (15 cm) below to 2 in (5 cm) above marsh level.
3. Maintain salinity levels within the target range for fresh to intermediate marsh vegetation, which is 0-5 ppt.
4. Decrease the duration and frequency of flooding over the marsh.
5. Decrease the rate of marsh loss.
6. Increase the coverage of emergent vegetation in shallow open water areas within the project area.



b. Monitoring Elements

Aerial Photography:

Near-vertical color-infrared aerial photography (1:12,000 scale) was used to document land and water areas, marsh loss rates, and shoreline movement in the ME-04 project area. Photography was obtained in 1997 (pre-construction) and in 2001 (post-construction). The original photography was checked for flight accuracy, color correctness, and clarity and was subsequently archived. Aerial photography was scanned, mosaicked, and geo-rectified by USGS/NWRC personnel according to standard operating procedures (Steyer et al. 1995, revised 2000). No additional project specific aerial photography will be flown due to the implementation of CRMS-Wetlands. Five CRMS stations are located within the ME-04 project area. Aerial photography of each 1 km² station will be obtained every 3 years. Only the 2005 photography has been processed thus far.

Shoreline Change:

To document shoreline movement along Freshwater Bayou Canal, shoreline markers were placed at maximum intervals of 1,000 ft (305 m) on the marsh edge along the west bank of the canal between its confluence with the Humble Canal and with North Prong Belle Isle Bayou, at 31 points corresponding to the pre-construction survey cross-sections, and at 3 points along each of the two 0.5 mi (0.8 km) long reference areas located along the east side of the channel opposite the north and south ends of the proposed breakwater (figure 2). Shoreline position relative to shoreline markers was documented by direct measurement in 1995, 1996, 1998, and 2001.

Water Level:

To evaluate the extent of ponding within the project area, water level relative to marsh level and NGVD was monitored at seven continuous data recorders (figure 3): one in each of the project area CTUs, one in the reference area R2, one in reference area R3, one in N. Prong Belle Ile Bayou Canal between CTUs 1 and 3, and one in Acadiana Marina Canal south of CTU 1 (removed September 26, 2003). Water level data is used to document the variability in water level, and the frequency, duration, and range of marsh inundation in the project and reference areas. Water level was monitored in 1996-1998 (pre-construction) and in 1999-2006 (post-construction). The recorders were removed in September 2006. Discrete measurements were discontinued prior to 2003. CRMS monitoring in the project area began in 2006.

Salinity:

Salinities were monitored at continuous data recorders in each CTU and in reference areas (figure 3). Salinity data is used to characterize the spatial variation in salinity throughout the project area, and to determine if project area salinity is being maintained within the target

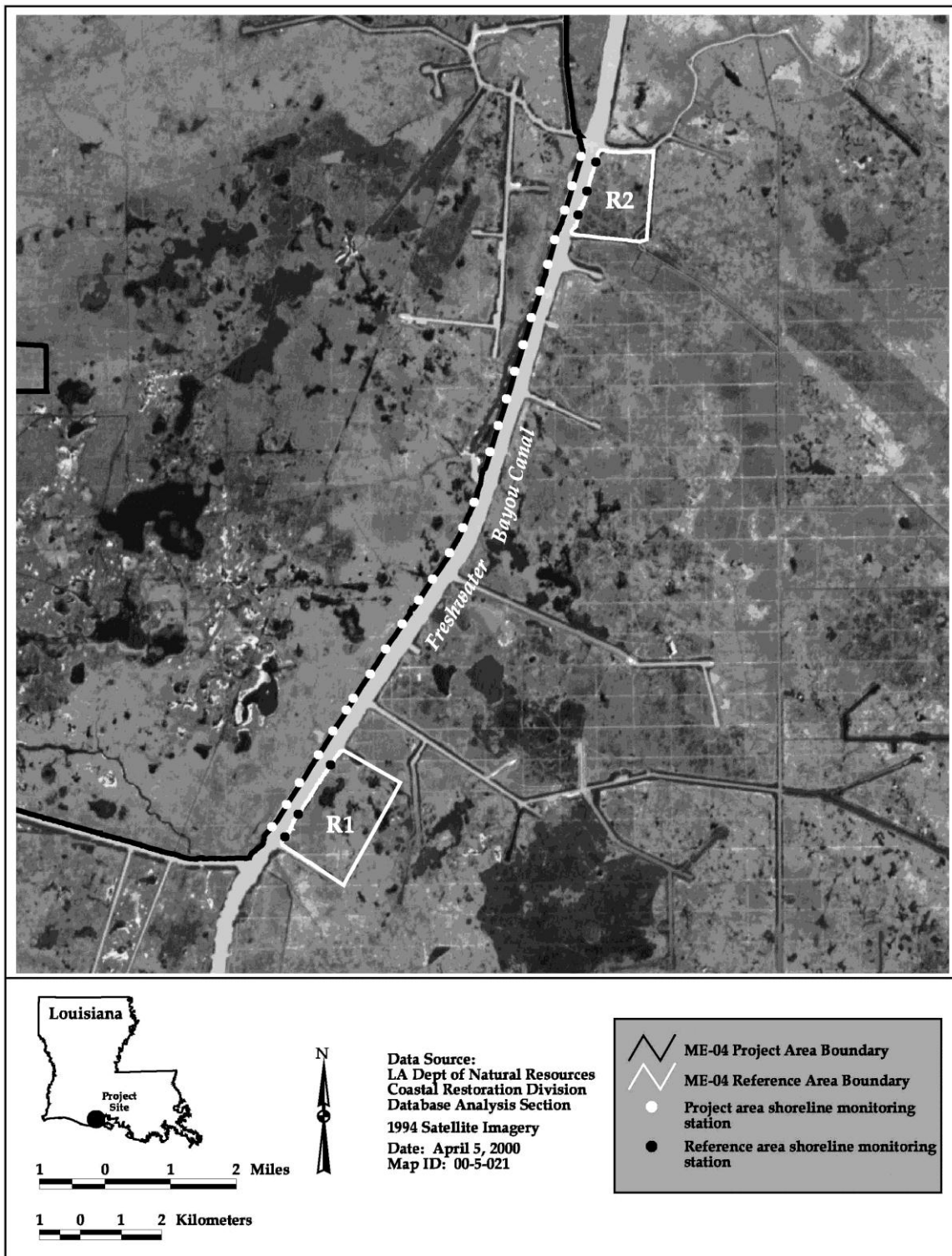


Figure 2. Approximate locations of the project and reference area shoreline monitoring stations.

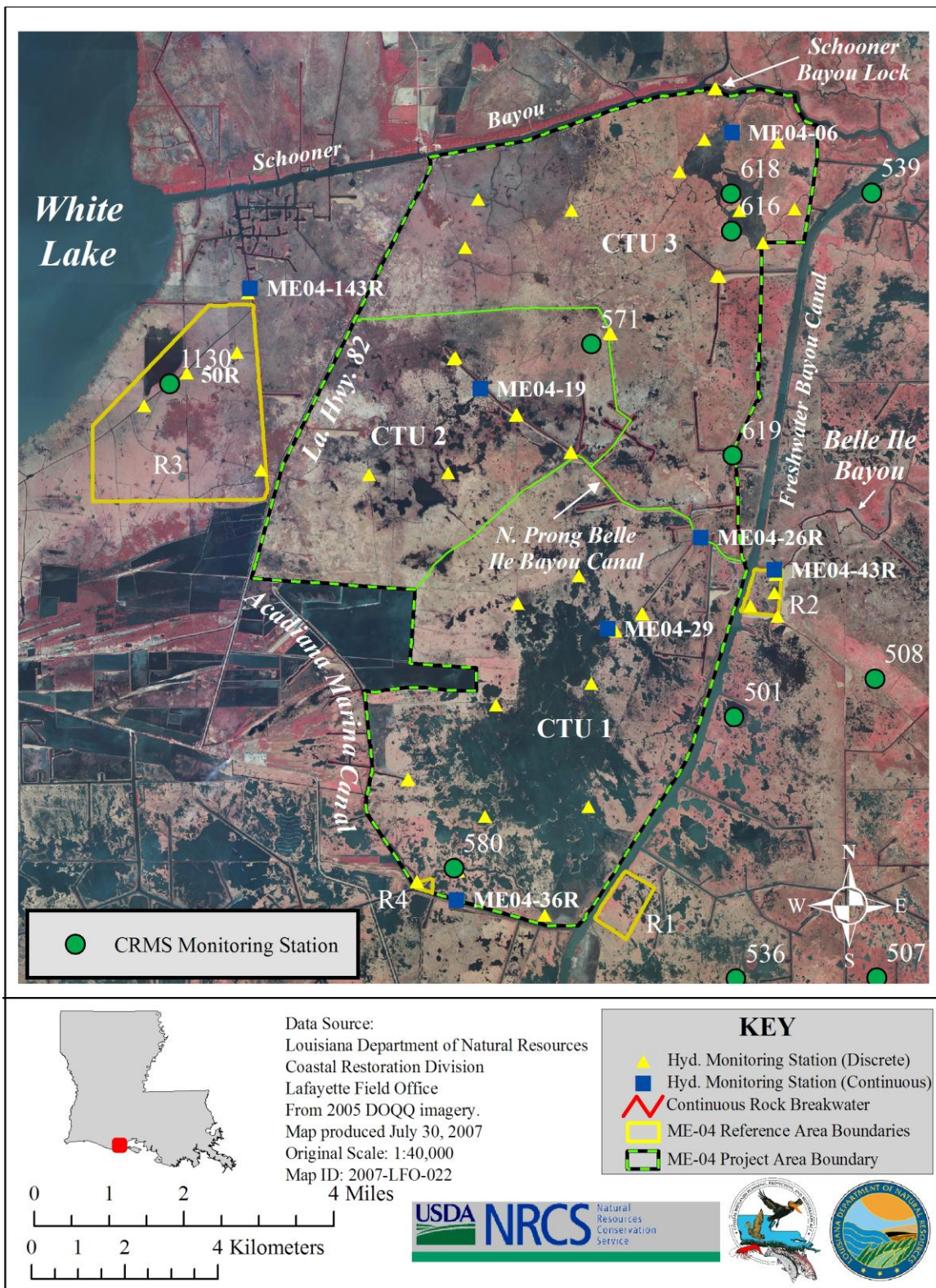


Figure 3. ME-04 project area with locations of continuous data recorders, discrete sampling stations and CRMS-Wetlands monitoring stations.

range. Salinity was monitored in 1996-1998 (pre-construction) and in 1999-2006 (post-construction). The recorders were removed in September 2006.

Discrete monthly salinity and water depth were also measured at 49 monitoring stations, including the seven recorder stations (figure 3), 30 located inside the project area and 19 located outside the project area (in reference areas R2 and R3, in exterior canals at two recorder stations, and inside and outside of the eight CWPPRA structures). Staff gauge water level readings (in ft NAVD88) were also recorded monthly at the seven continuous recorder stations, inside and outside of the eight CWPPRA structures, and at the Vermilion Corporation boat house near the southeast corner of reference area R2. Salinity and water level readings taken by the USACE inside and outside of Schooner Bayou Lock were also recorded once a month during the same week that monthly discrete data were collected by CRD personnel. The discrete monthly salinity data were used to calculate a mean monthly salinity for the early growing season (March-June), the late growing season (July-October), and the dormant season (November-February) at each station, for the pre-construction (March 1996 through September 1998) and post-construction (October 1998 through December 2002) time periods. These data are used to produce figures showing the spatial distribution of water salinity by season during the pre- and post-construction time periods. Discrete measurements were discontinued prior to 2003.

Salinity is currently being monitored hourly utilizing 4 CRMS-*Wetlands* stations (571, 580, 616, 619) within the project area and selected reference sites (501, 507, 1130). Continuous data were used to characterize average annual salinities throughout the project and reference areas.

At each servicing, a measurement of interstitial water salinity is collected adjacent to each CRMS-*Wetlands* gauge. Interstitial water salinity is also determined at 5 of the vegetation plots when vegetation is surveyed.

Emergent Vegetation:

To document the condition of emergent vegetation in the project area over the life of the project, vegetation was monitored at thirty-seven sampling stations established systematically in the project and reference areas (figure 4). Six east-west transects were established uniformly across the project area. Sampling stations were established uniformly along each transect line to obtain an even distribution of sampling stations throughout the project area. Similar east-west transects were delineated across reference areas R2 and R3 to establish four sampling stations in each reference area. Percent cover, dominant plant heights, and species composition were documented in 2 m² sampling plots marked with 2 corner poles to allow for revisiting the sites over time. Vegetation was evaluated at the sampling sites in the fall of 1996 and 1998 (pre-construction) and in the fall of 2001 (post-construction). A subset of the vegetation stations were sampled after Hurricane Rita in 2005, 2006, 2007 and 2008.

Individual species' cover data from project specific monitoring were summarized according to the Floristic Quality Index (FQI) method utilized by CRMS (Cretini and Steyer 2011) where cover is

qualified by scoring species according to whether they are generally associated with disturbance or stability.

Vegetation composition and cover was estimated from 10 permanent 2x2 m plots that are randomly distributed along a transect in the emergent marsh within each of the 1 km² CRMS-*Wetlands* sites. Data were collected at four CRMS stations located within the ME-04 project area (571, 580, 616, 619), one within reference area 3 (1130) and two selected reference sites (501, 507) beginning in 2006 using the Braun Blanquet method.

CRMS Supplemental

In addition to the project specific monitoring elements listed above, a variety of other data is collected at CRMS-*Wetlands* stations which can be used as supporting or contextual information. Data types collected at CRMS sites include hydrologic from continuous recorder, vegetative, physical soil characteristics, discrete porewater salinity, surface elevation change, vertical accretion and land:water analysis of a 1 km² area encompassing the station (Folse et al. 2008). For this report, hydrologic, vegetation and porewater were used to assess project goals and soil characteristic data were used to provide contextual information for the project. Data from CRMS sites 571, 580, 616, and 619 within the project area is compared to data from CRMS sites 501, 507, and 1130 outside the project area in a traditional project versus reference manner. Data from CRMS site 618 was omitted due to its similarity to site 616. In the future, data collected from the CRMS network over a sufficient amount of time to develop valid trends will be used to develop integrated data indices at different spatial scales (local, basin, coastal) to which we can compare project performance.

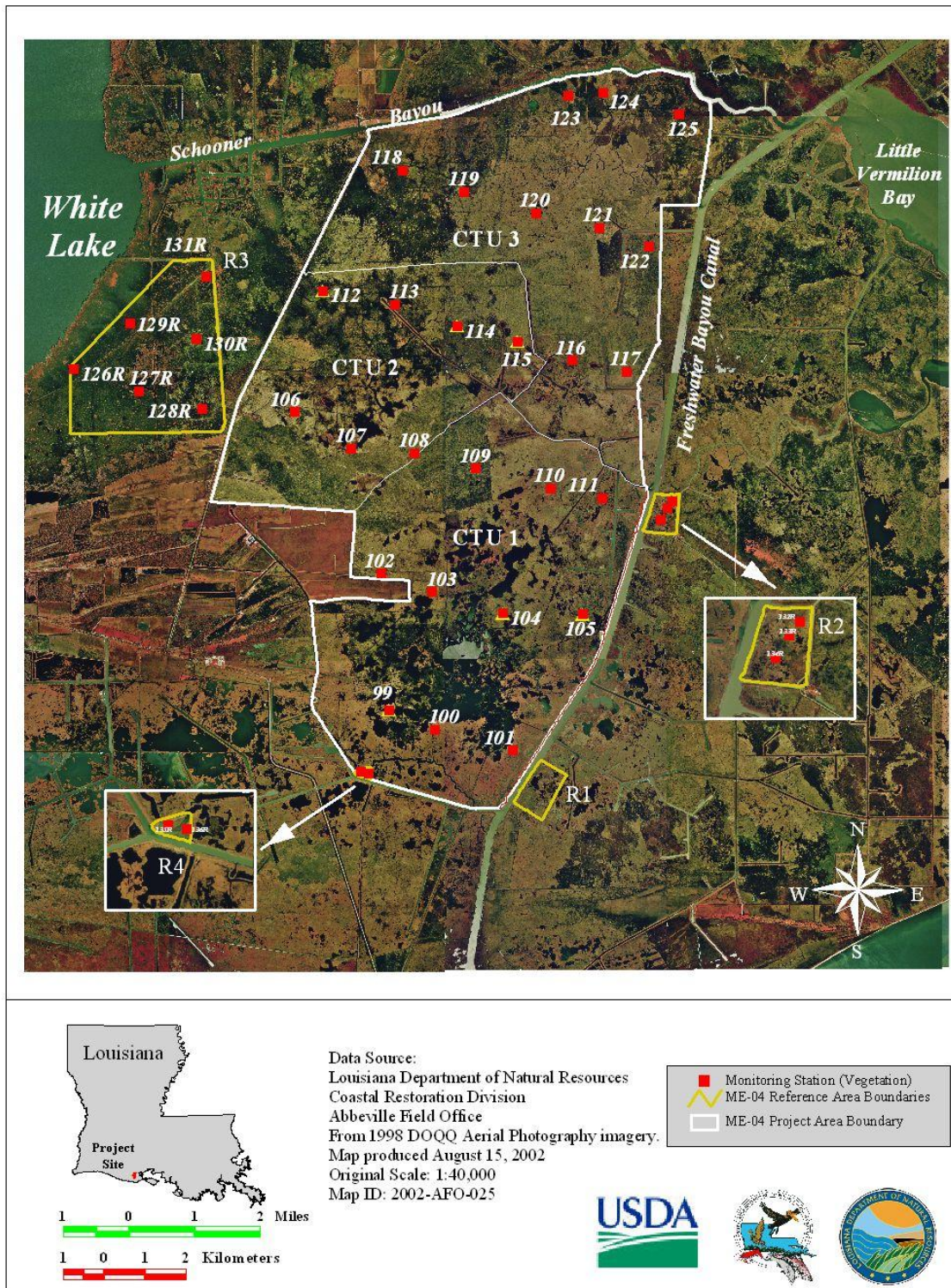


Figure 4. Locations of emergent vegetation sampling plots established in 1996 and 1997 in the ME-04 project and reference areas (R2, R3, and R4).

IV. Monitoring Activity (continued)

c. Preliminary Monitoring Results and Discussion

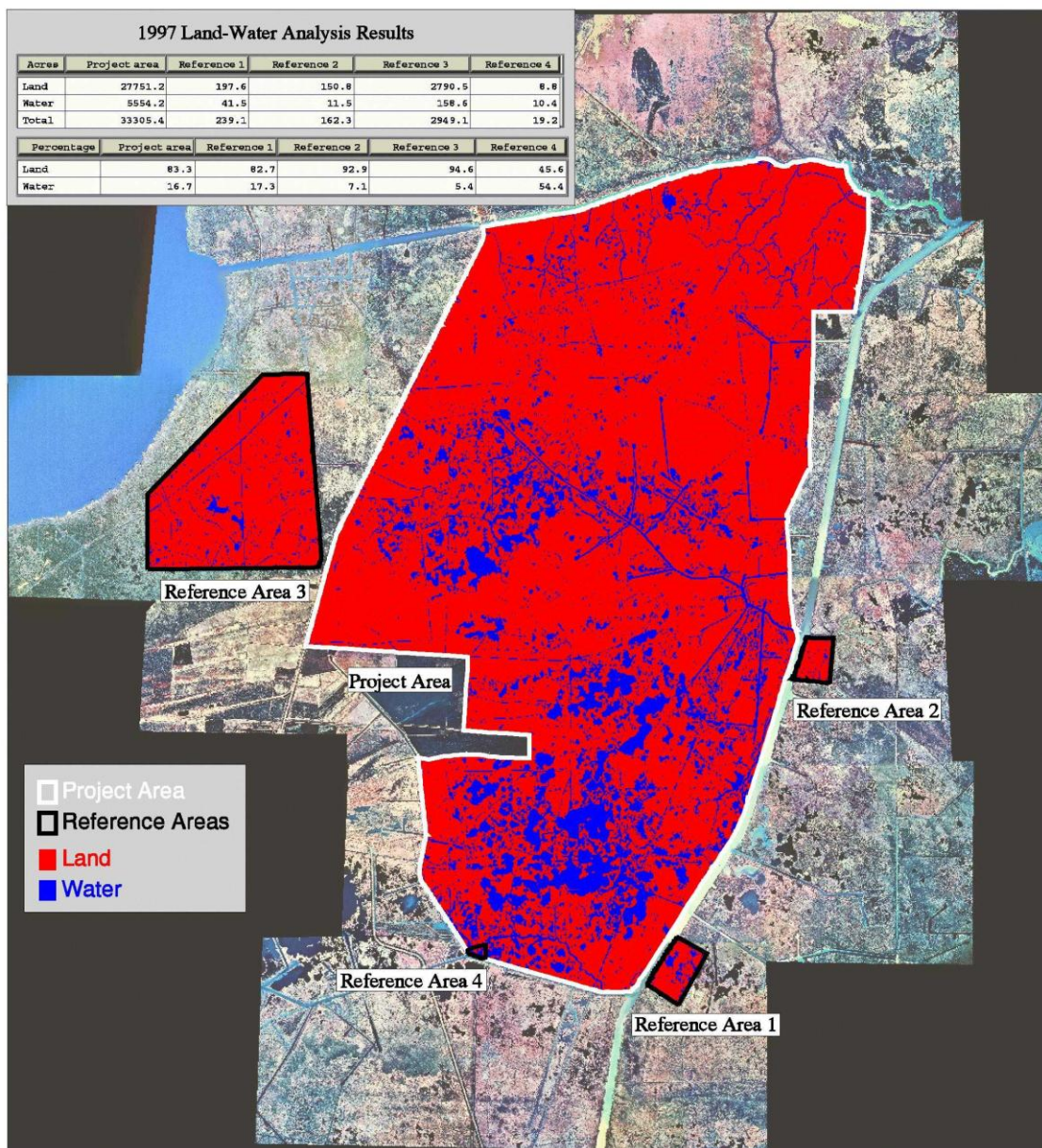
Aerial photography:

Pre-construction land/water analysis was completed for 1997 aerial photography (figure 5). Habitat analysis was completed for 1997 pre-construction aerial photography (figure 6) and for 2001 post-construction aerial photography (figure 7). Land to water analyses of the pre-construction imagery taken on 11 January 1997 indicate that over 80% of the project area, and reference area units R1, R2, and R3 was classified as land, while less than 45% of reference area R4 was classified as land. The post-construction imagery taken on December 18, 2001 was not formally classified as land and water, however, by adding land and water acreages from the 1997 and 2001 analyses of habitat types, informal comparisons can be made. Between 1997 and 2001, the percentage of land area remained stable within the total project area with 85.4% land area in 1997 and 85.1% land area in 2001. The reference areas also remained stable with land area 94.2% to 93.6% from 1997 to 2001.

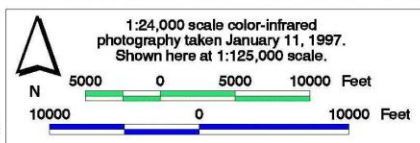
The project area experienced a decrease of fresh marsh, especially prevalent in CTU 1. The decrease of fresh marsh in CTU 1 was marked by a change to intermediate and brackish marsh, and to a lesser extent by conversion to open water. In contrast, CTU 2 and CTU 3 experienced increases of fresh marsh, while CTU 3 also showed a decrease of intermediate marsh. Overall, the reference areas showed an increase of fresh marsh, a complete loss of intermediate marsh, and an increase in brackish marsh. Only R1 and R2 experienced significant changes, both showing conversion of intermediate marsh to brackish marsh with some loss to open water.



Coastal Wetlands Planning, Protection and Restoration Act Project ME-04: Freshwater Bayou 1997 Land-Water Analysis



Prepared by:
 U.S. Department of the Interior
 U.S. Geological Survey
 National Wetlands Research Center
 Lafayette, Louisiana
 and
 Louisiana Department of Natural Resources
 Coastal Restoration Division
 Abbeville Field Office



Federal Sponsor:



Map ID: 99-02-059

Figure 5. Pre-construction analysis showing the acreage of land and water in the project and reference areas of Freshwater Bayou Canal Wetland Protection in 1997.



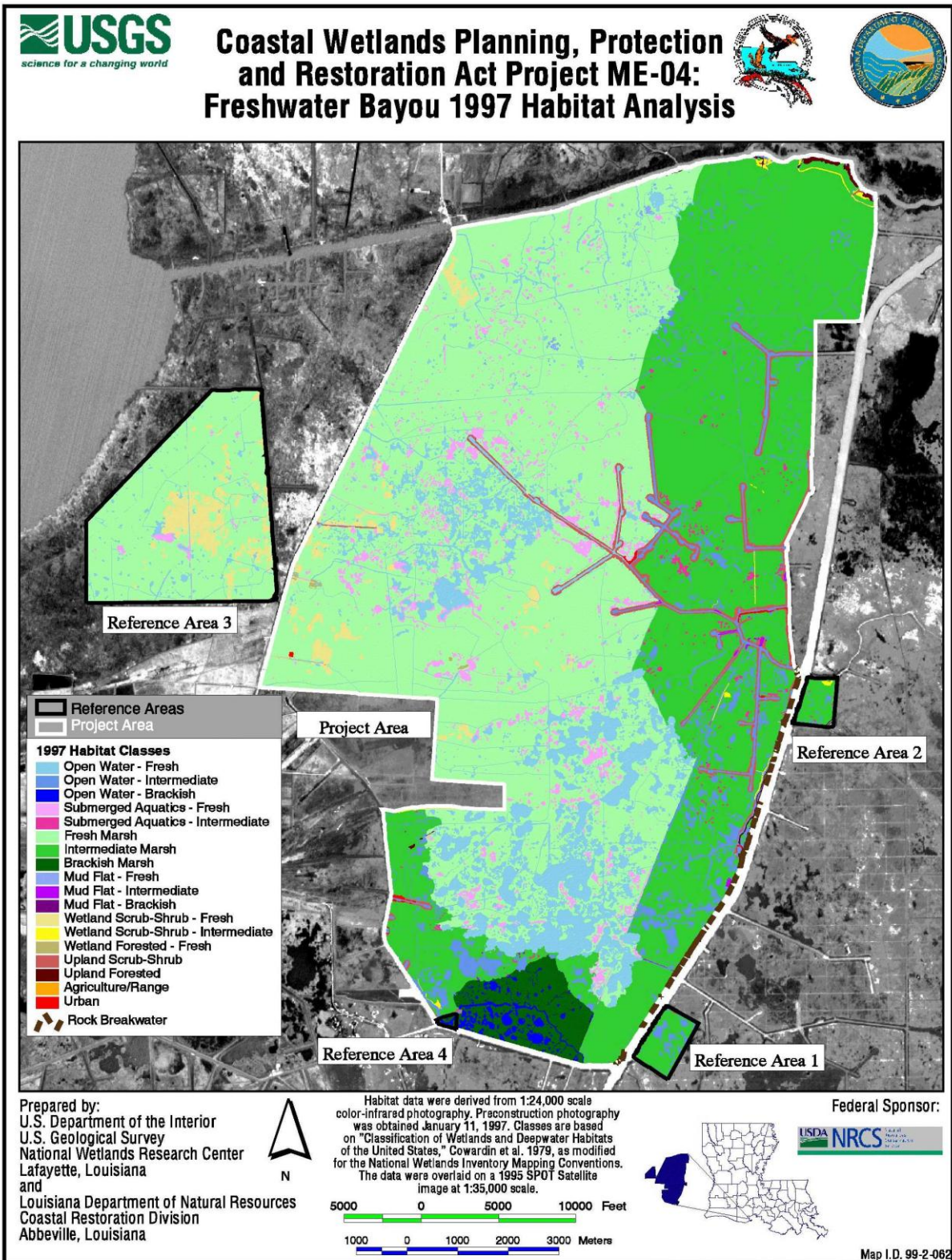


Figure 6. Pre-construction analysis showing acreage of habitats in the project and reference areas in Freshwater Bayous Canal Wetland Protection in 1997.

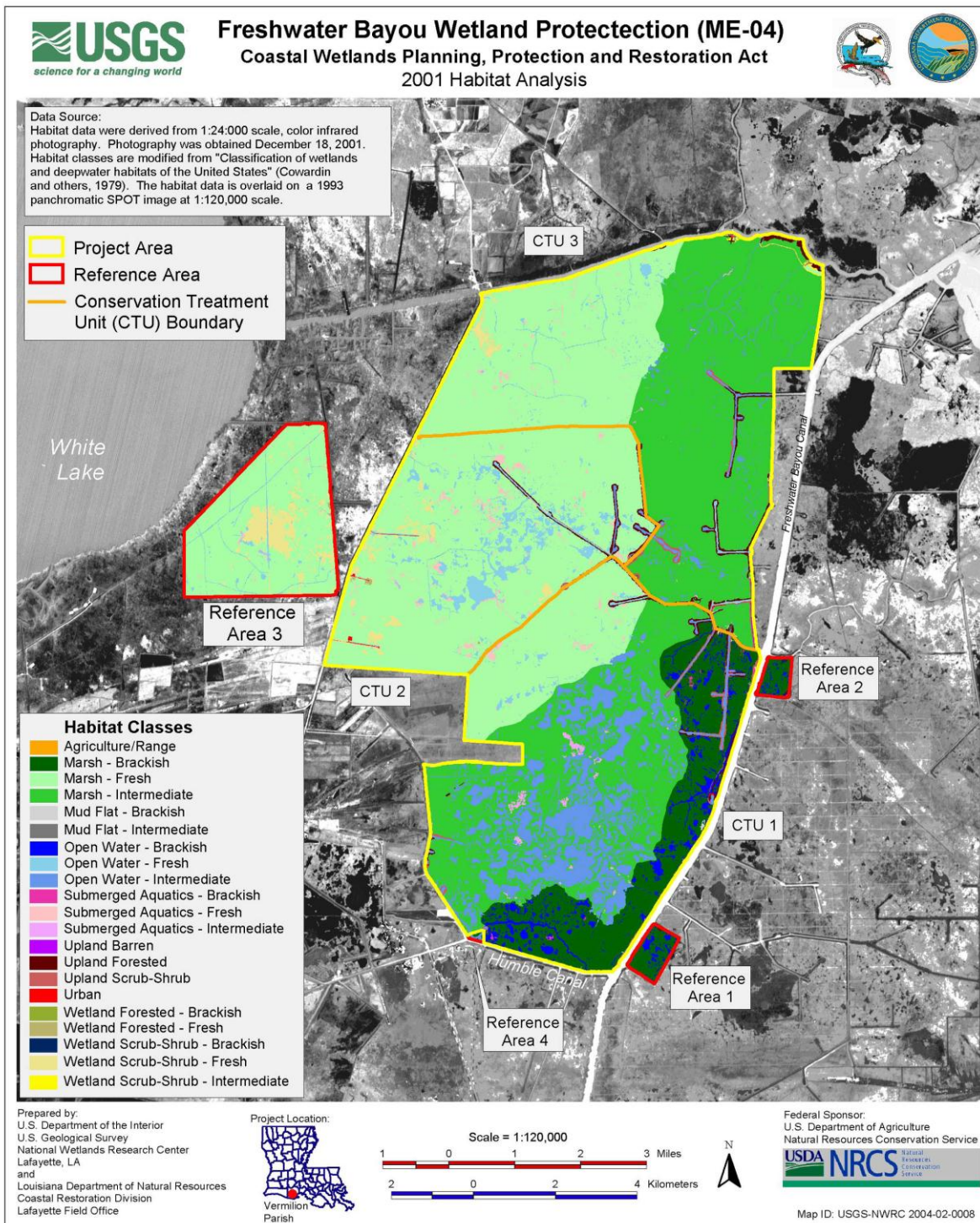


Figure 7. Post-construction analysis showing acreage of habitats in the project and reference areas in Freshwater Bayou Canal Wetland Protection in 2001.

Shoreline change:

The project area shoreline prograded an average of 2.17 ft/yr (0.66 m/yr) between June 1995 and July 1996 (figure 8), and an average of 0.89 ft/yr (0.27 m/yr) between August 1996 and February 1998, but eroded an average of -2.62 ft/yr (-0.80 m/yr) between March 1998 and May 2001 (figure 8). Overall, the average shoreline change rate on the west canal bank behind the rock dike was -0.83 ft/yr (-0.25 m/yr) between June 1995 and May 2001.

Conversely, erosion was documented at all six reference area monitoring stations on each survey conducted, averaging -6.69 ft/yr (-2.04 m/yr) between April 1995 and July 1996, -11.15 ft/yr (-3.40 m/yr) between August 1996 and February 1998, and -9.99 ft/yr (-3.05 m/yr) between March 1998 and May 2001 (figure 8). Overall, the average shoreline change rate along the two reference areas on the east canal bank was -9.55 ft/yr (-3.03 m/yr) between June 1995 and May 2001.

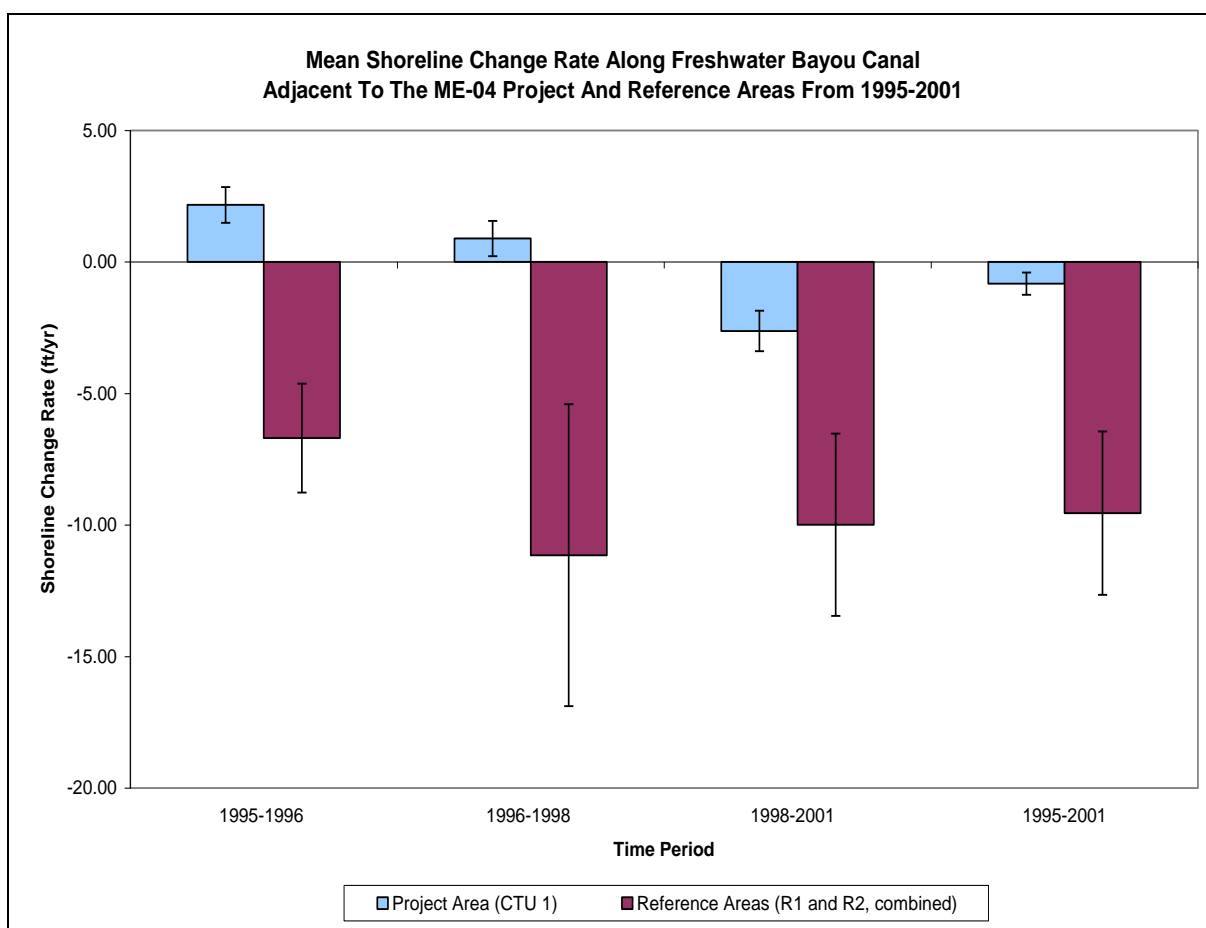


Figure 8. Mean shoreline change rate along Freshwater Bayou Canal adjacent to the ME-04 project and reference areas from 1995-2001.

Water level:

The goal to reduce water levels to within the target range of 6 in (15 cm) below to 2 in (5 cm) above marsh level was not met. Water levels in the project area were within the target range less than 50% of the year during 10 years of project-specific data collection. However, project area water levels were within the target range a greater percentage of time than the reference area (figure 9).

In general, when reference area water levels were out of the target range, they tended to be greater than 2" above the marsh surface. Project area water levels were less than 6" below marsh surface more often than reference stations. This would be expected since the reference area stations are located along major waterways and are subject to higher tidal amplitude, while the three project area stations are located in interior marsh areas influenced by water control structures. Water levels were higher during all years in the project area compared to the reference area (Vincent 2003).

This trend continued through 2010 at the CRMS sites (Figure 10). The CRMS sites chosen as reference had nearly identical water levels to project area sites 580 and 616. Site 571 (in the northeastern part of CTU 2) had very high water levels compared to the other stations.

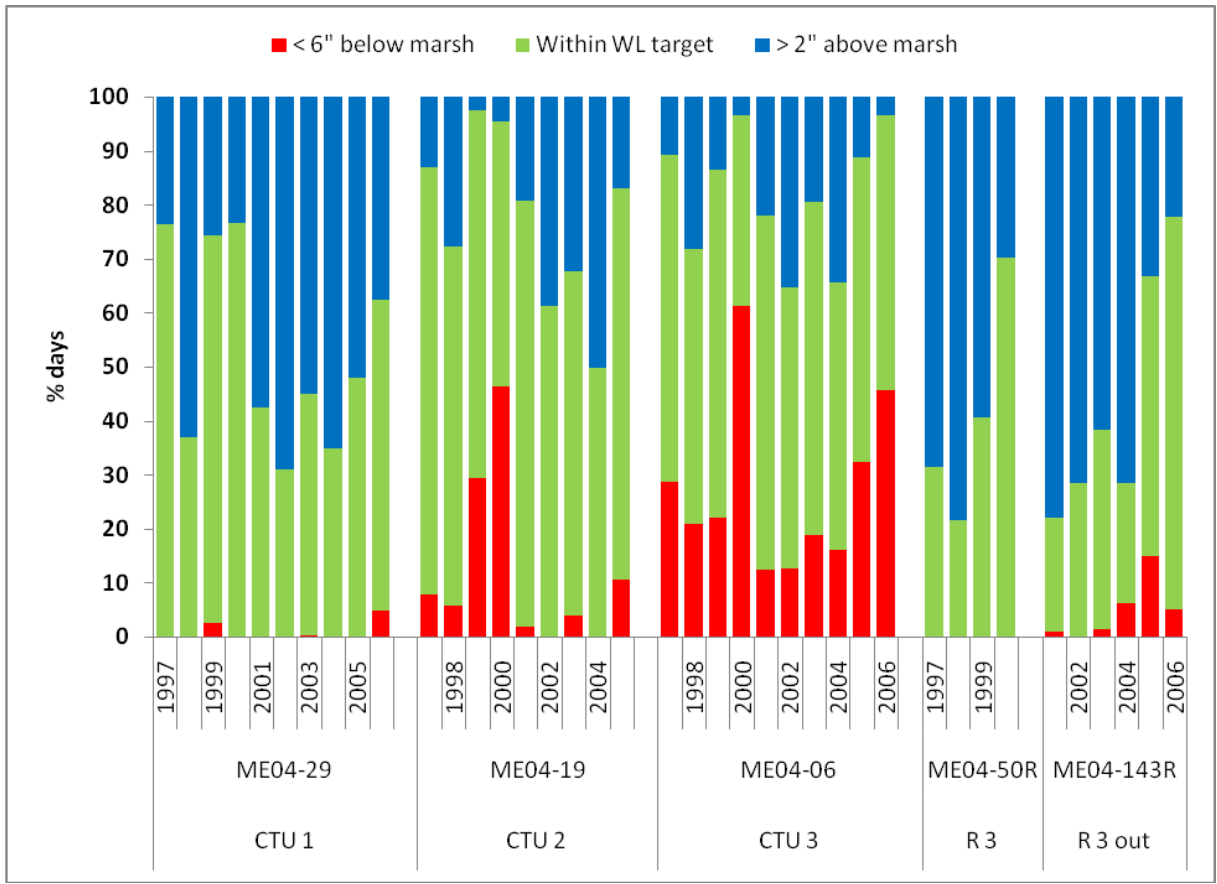


Figure 9. Percentage of days per year water levels were inside and outside of target range within the project and reference areas at project-specific stations.

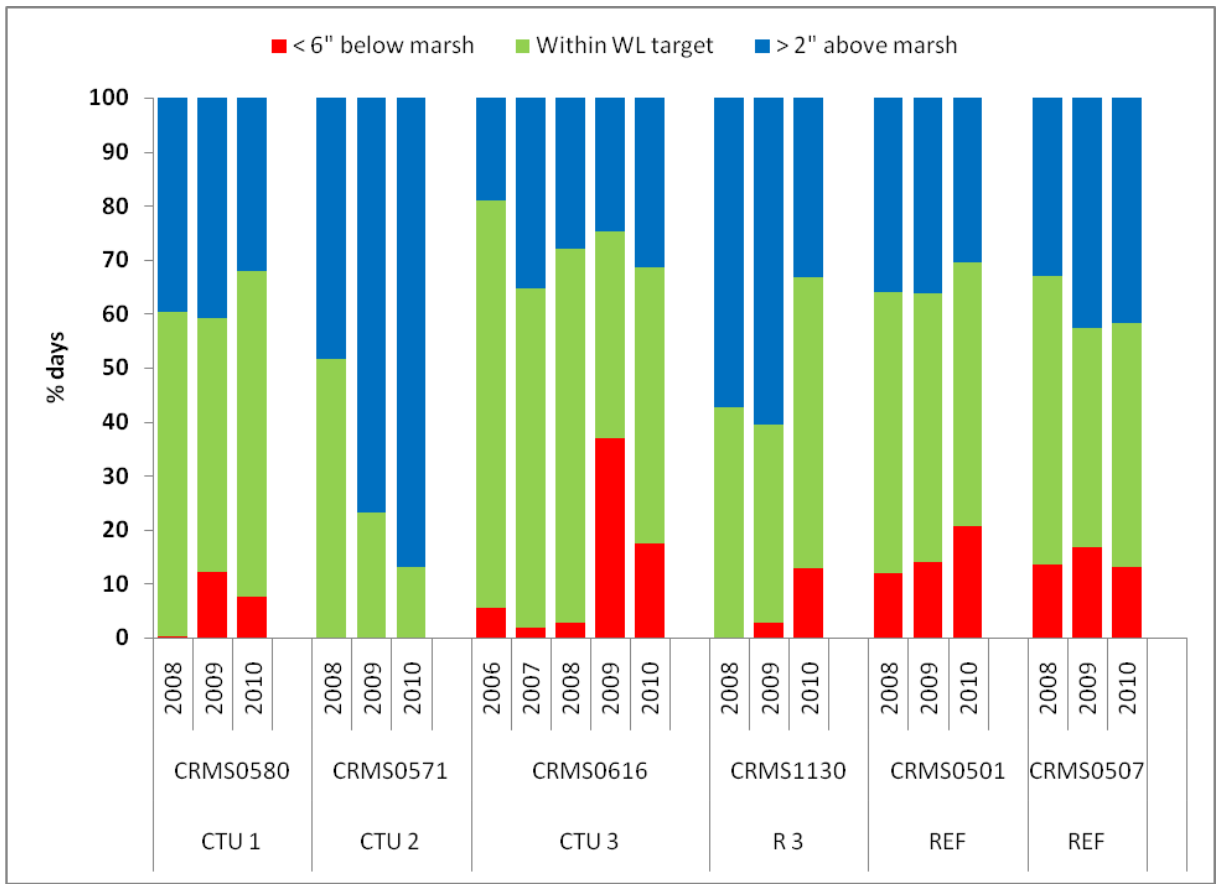


Figure 10. Percentage of days per year water levels were inside and outside of target range within the project and reference areas at CRMS stations.

Salinity:

The goal to reduce salinity levels to within the target range of less than 5 ppt for fresh to intermediate marsh vegetation was partially met, however since salinity trends in the project and reference areas were similar pre- and post-construction, this cannot be attributed to the project. Prior to construction, salinities within the project area were greater than 5ppt about 13% of the time, compared to around 8% within the reference area (figure 11). In years 1998, 2001, 2002, 2003, and 2004, salinities were outside of the target range less than 10% of the time in the both the project and reference areas. High salinities were prevalent within both project and reference areas in 1999 and 2000 due to drought conditions. In part of 2005 and all of 2006, the target range was exceeded more than 70% of the time. This is likely due to after effects of Hurricane Rita's storm surge and was reflected in both project and reference areas.

Project area CRMS sites showed an increase in salinities in 2009 following Hurricane Ike, but the effects weren't as extreme as Hurricane Rita (Figure 12). The target range was exceeded about 50% of the time. By 2010, most of the sites were recovering to pre-storm levels, except

for 616 in CTU 3 which showed a slight increase in salinities. The reference sites showed the same pattern, except the sites on the east side of Freshwater Bayou (501, 507) appear to be slower to recover. CRMS1130, located in R3, actually saw lower salinities in 2009 compared to 2008. By 2010, it was in the target range 94% of the time.

Discrete monthly water salinity readings taken at the eight CWPPRA structure sites do show that water salinity “inside” and “outside” of the structures was higher during the post-construction period than during the pre-construction period at all eight structures (figure 13).

Means by month of interstitial water salinity at the CRMS sites is presented in Figures 14a and 14b. The highest salinities occurred at reference station 507, located on the east side of Freshwater Bayou, averaging around 9 ppt, while the lowest occurred at 1130 in Reference area 3, averaging under 5 ppt. Generally, interstitial salinities in the project area were below 5 ppt at the 10 cm level prior to Hurricane Ike. Since Hurricane Ike, salinities at the 10 and 30 cm levels have remained above 5 ppt except for a few months in the early part of 2010.

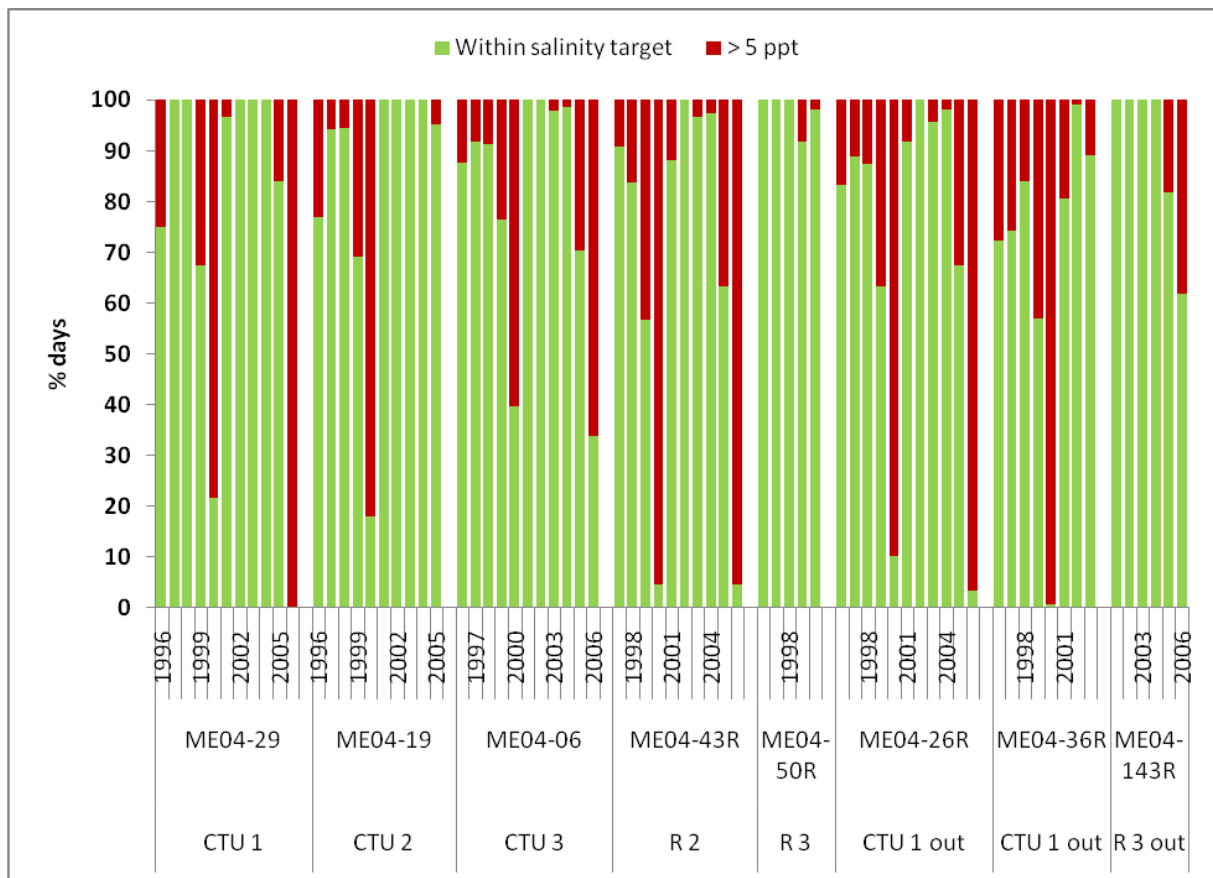


Figure 11. Percentage of time that project and reference area salinities were above the target range of 5 ppt at project-specific stations.

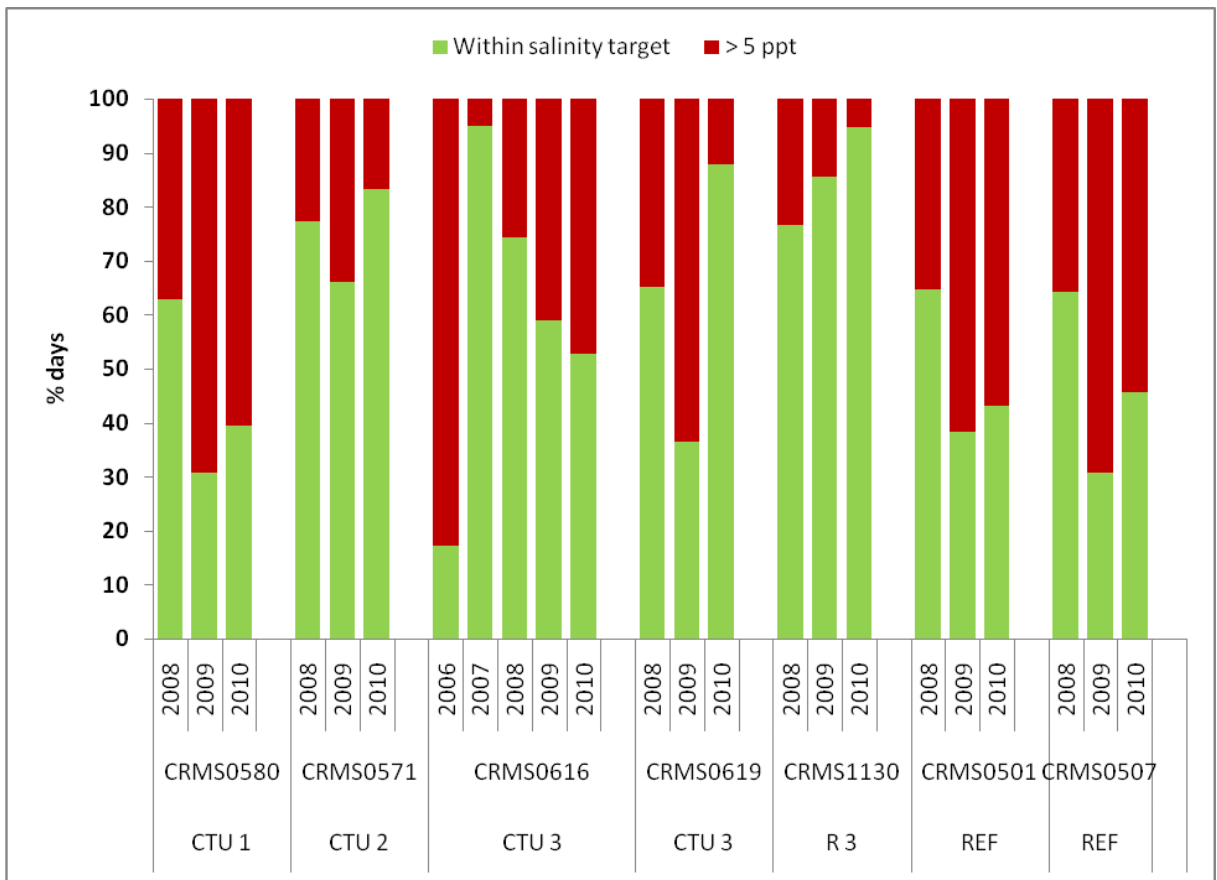


Figure 12. Percentage of time that project and reference area salinities were above the target range of 5 ppt at CRMS stations.

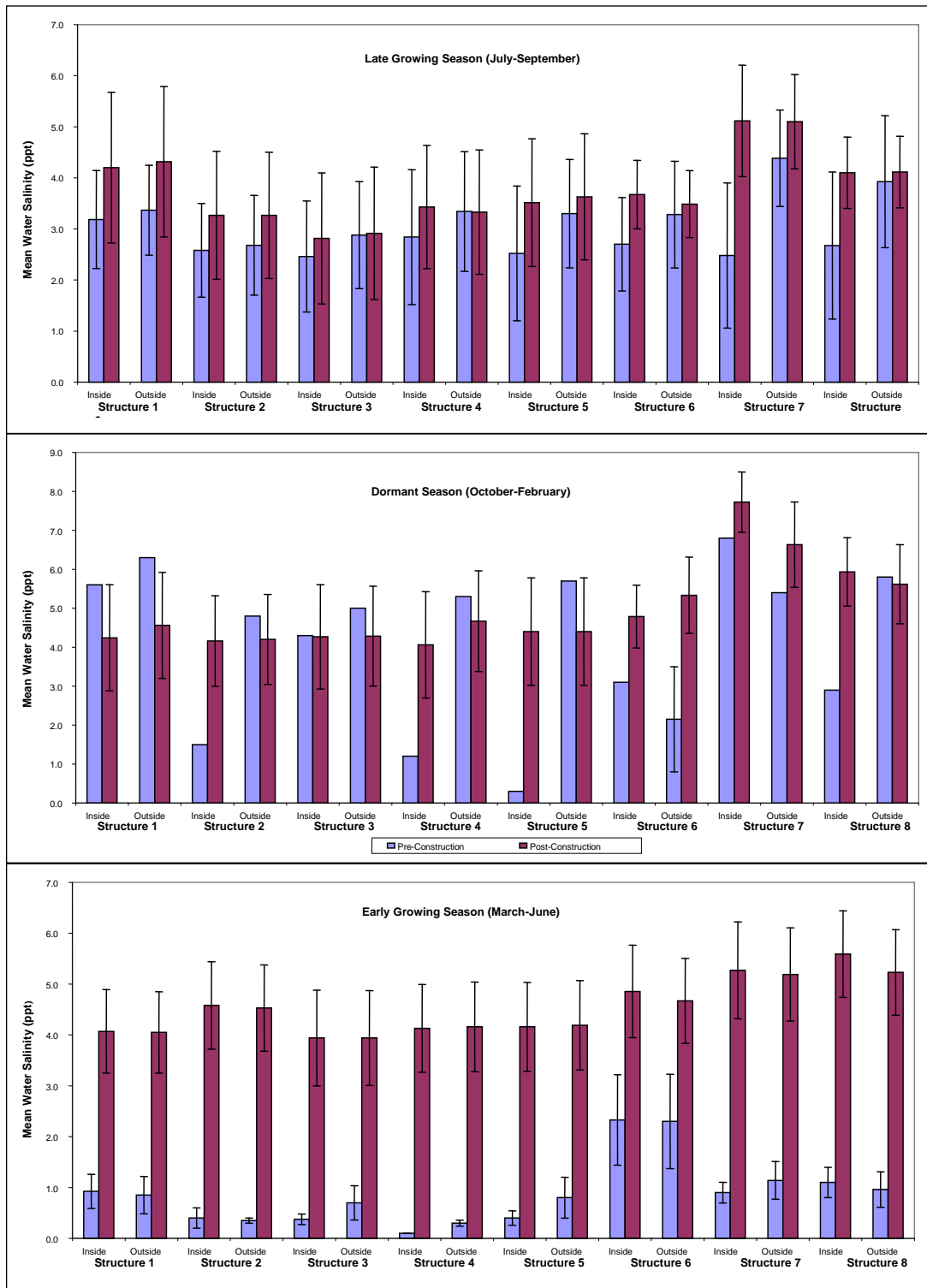


Figure 13. Comparison of mean seasonal water salinity (ppt) inside and outside of the 8 CWPPRA structures at ME-04 during the pre-construction (March 1996-September 1998) vs. the post-construction (October 1998-May 2002) time periods. Error bars represent ± 1 standard error.

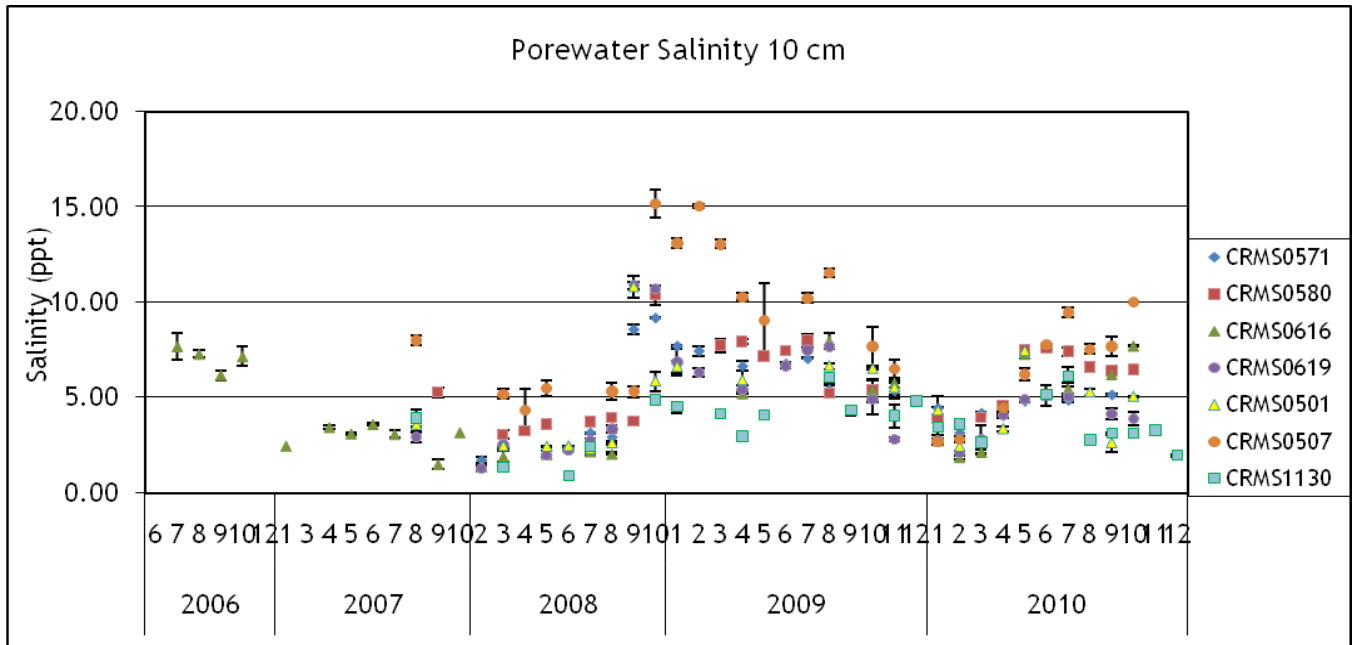


Figure 14a. Interstitial water salinity at 10 cm below the soil surface. Error bars, where present, represent the means of stations in that class for that month ± 1 Std Err.

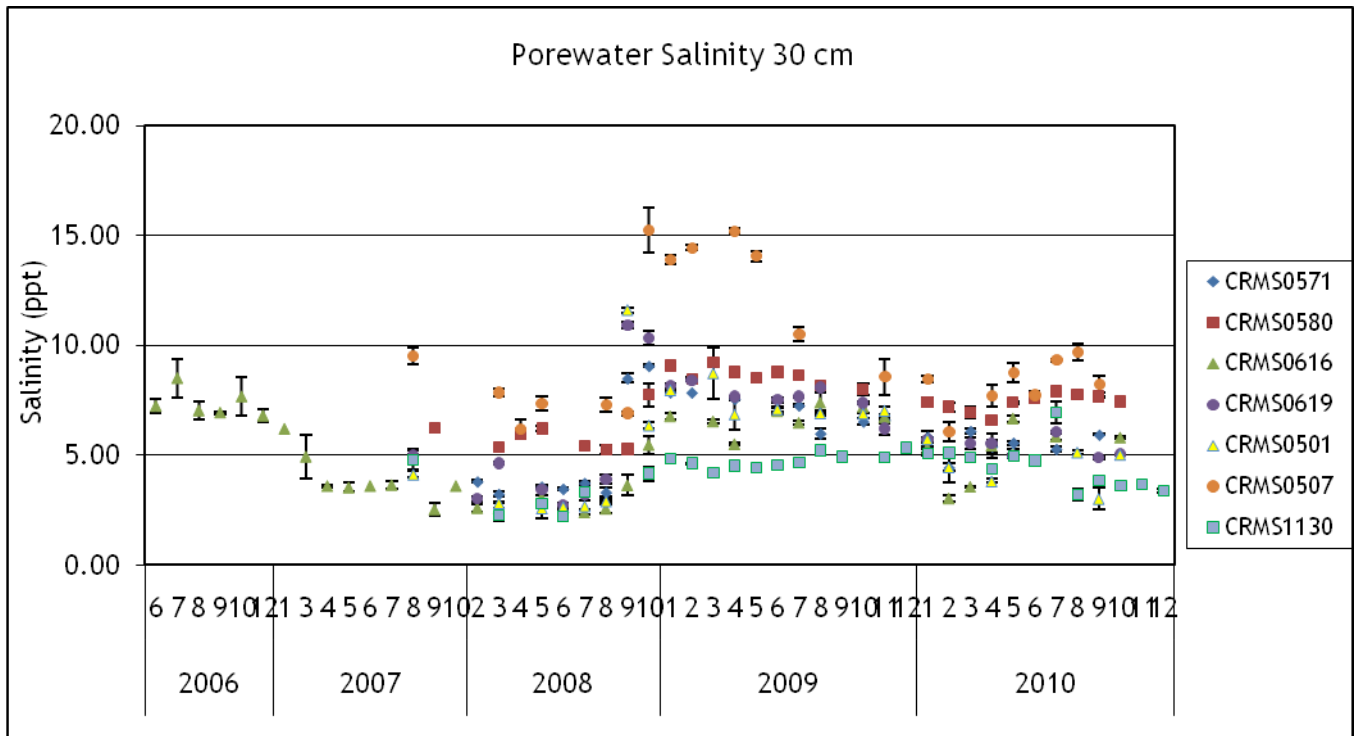


Figure 14b. Interstitial water salinity at 30 cm below the soil surface. Error bars, where present, represent the means of stations in that class for that month ± 1 Std Err.

Vegetation:

Total percent cover decreased from 1996 to 1998 in all units except CTU 3 where cover remained about the same (figure 15). Total percent cover then increased from 1998 to 2001 in all units except R3 where cover continued to decrease. Following Hurricane Rita, cover as well as FQI score dropped in all units, though only slightly in R4 (R2 and R3 weren't sampled in 2005). In 2006, cover and quality increased in all units but CTU 1, though only near pre-storm levels in R4. There was also an increase in disturbance species in all plots. All units showed a good recovery in 2007, except for R3. Following Hurricane Ike in 2008, CTU 2 was the only unit that showed an increase in cover as well as CC score. CTU 3 saw a small increase in cover, but a drop in FQI score, indicated less desirable species had populated the area.

The CRMS sites showed an increase in cover and FQI score in 2008 at all sites except for 580 in CTU 1 which had a small loss (figure 16a - g). However, the CRMS sites were sampled in August, before Hurricane Ike made landfall and therefore don't reflect the effects of the hurricane as the project-specific stations do. Through 2010, all units showed a recovery to near pre-Hurricane Rita levels except for CTU 1 which has continued to decrease in cover and CC score.

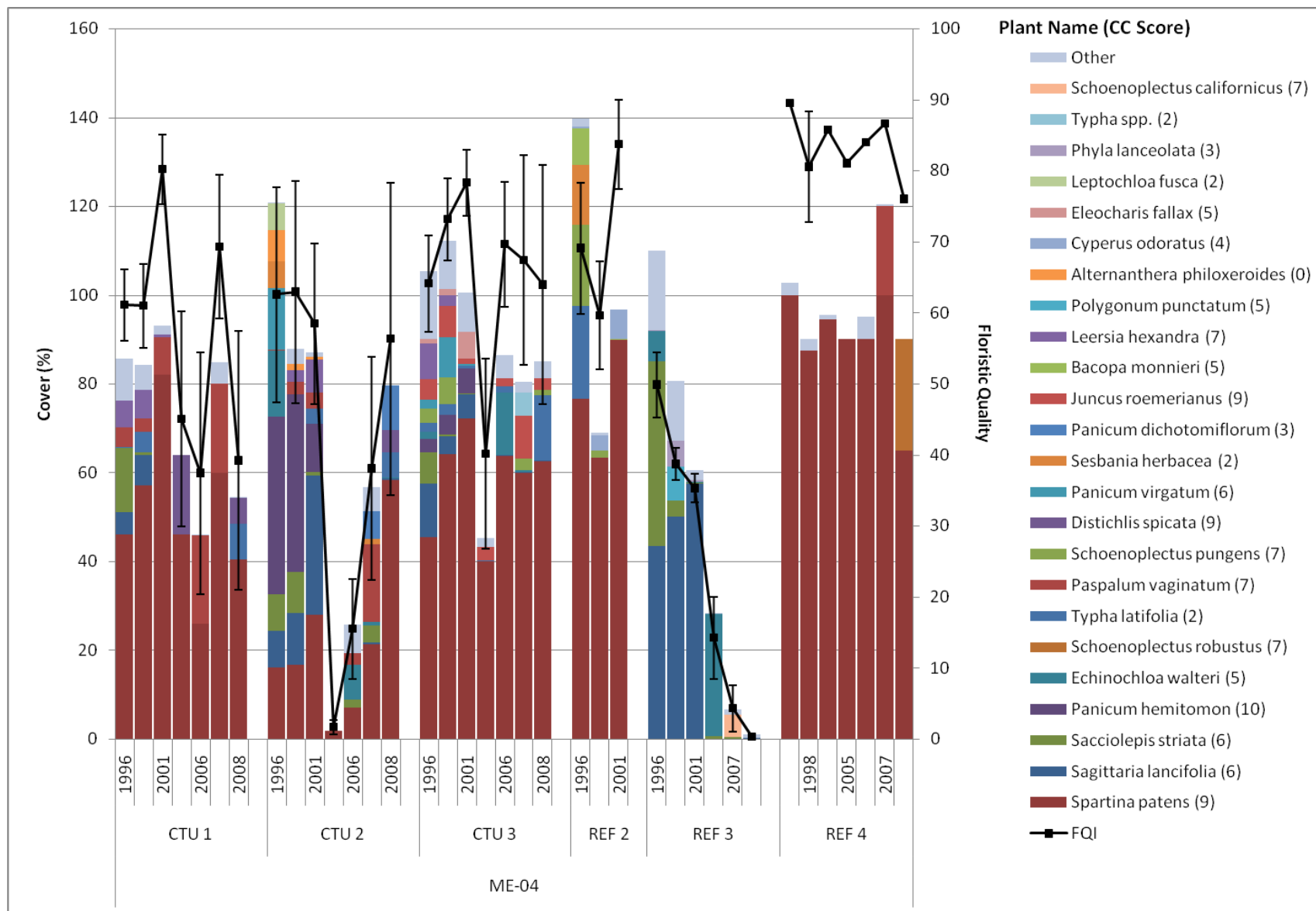


Figure 15. Percent coverage and floristic quality index of species collected in the ME-04 project and reference areas in each year. The CC Scores represent the quality of individual species from 1 to 10 where 1 represents disturbance species and 10 indicates stability.

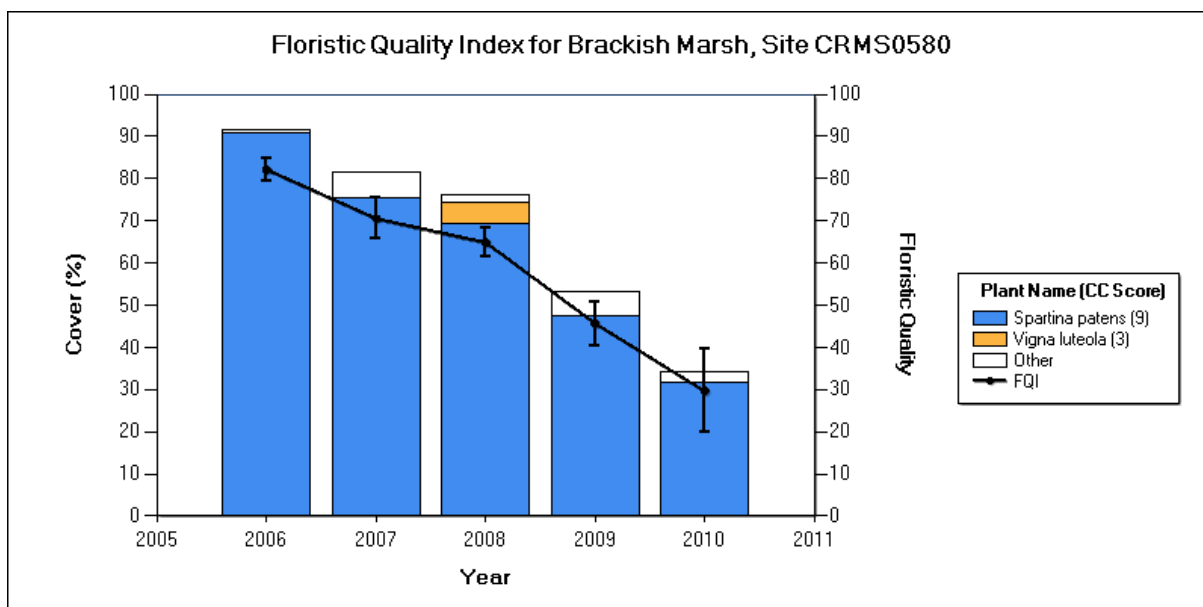


Figure 16a. Percent coverage and floristic quality index of species collected from CRMS project site 580 within CTU 1 in years 2006 – 2010. The CC scores represent the quality of individual species from 1 to 10 where 1 represents disturbance species and 10 indicates stability.

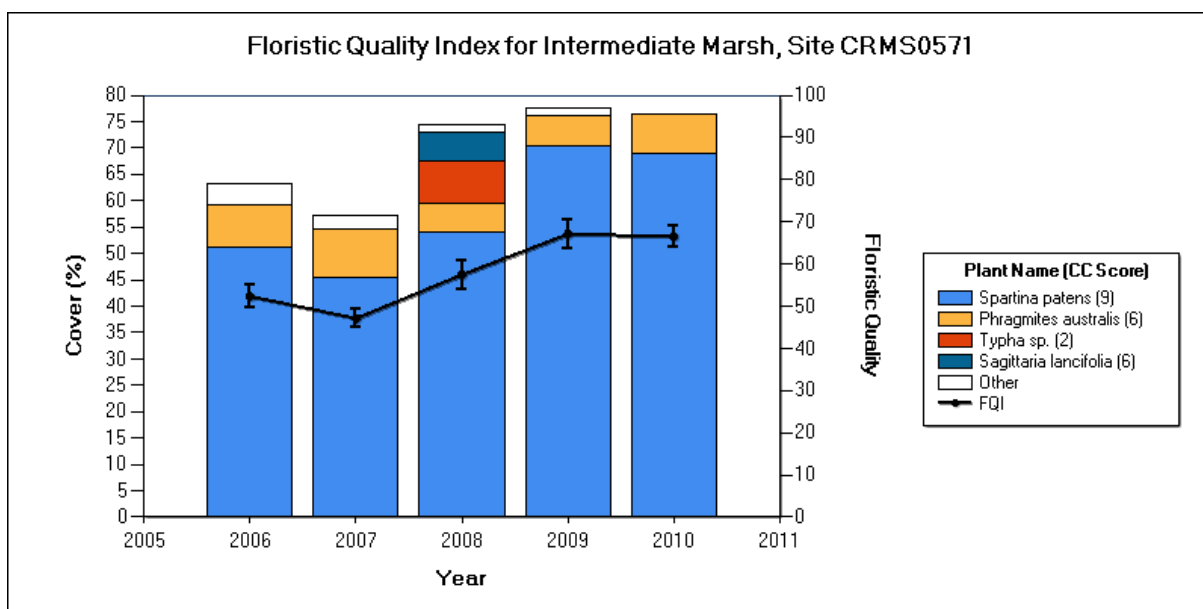


Figure 16b. Percent coverage and floristic quality index of species collected from CRMS project site 571 within CTU 2 in years 2006-2010. The CC scores represent the quality of individual species from 1 to 10 where 1 represents disturbance species and 10 indicates stability.

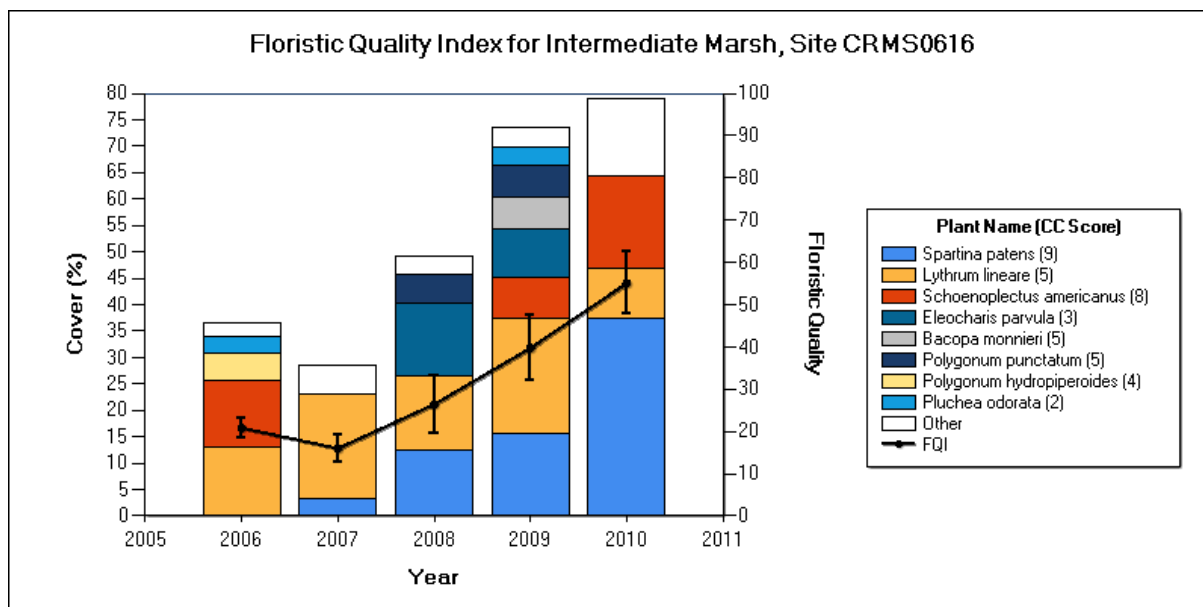


Figure 16c. Percent coverage and floristic quality index of species collected from CRMS project site 616 within CTU 3 in years 2006-2010. The CC scores represent the quality of individual species from 1 to 10 where 1 represents disturbance species and 10 indicates stability.

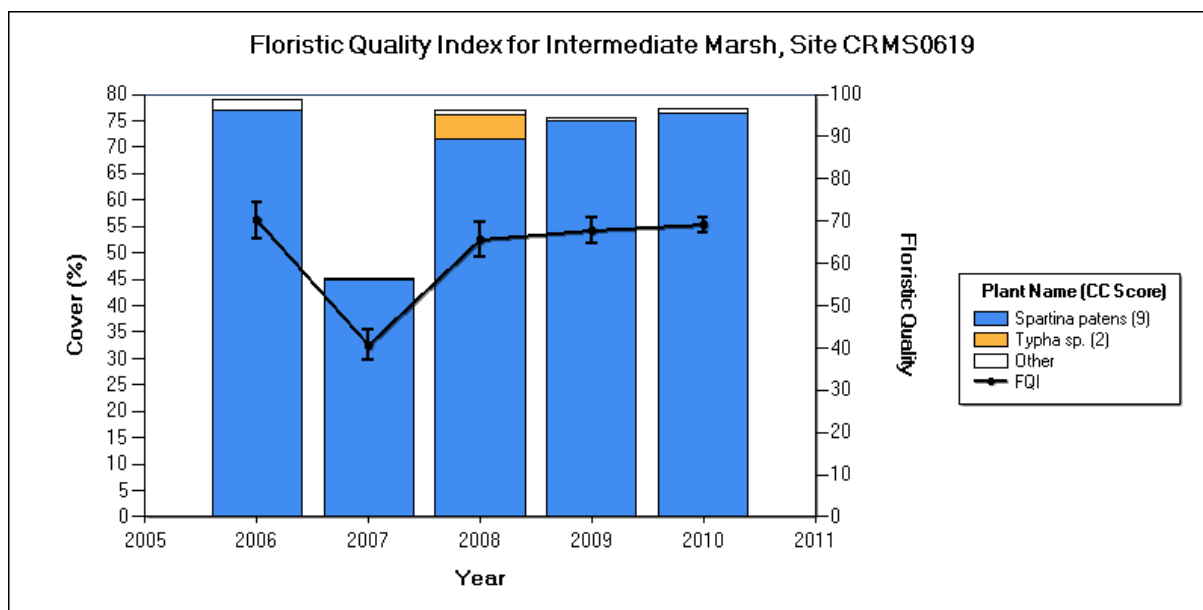


Figure 16d. Percent coverage and floristic quality index of species collected from CRMS project site 619 within CTU 3 in years 2006-2010. The CC scores represent the quality of individual species from 1 to 10 where 1 represents disturbance species and 10 indicates stability.

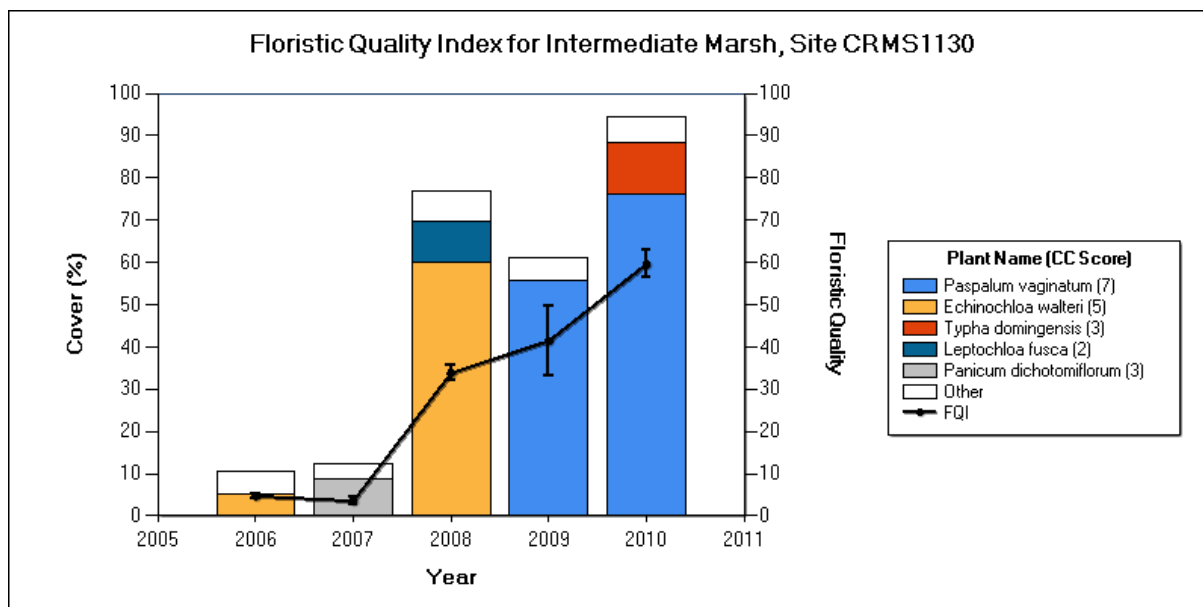


Figure 16e. Percent coverage and floristic quality index of species collected from CRMS reference site 1130 in R3 in years 2006 – 2010. The CC scores represent the quality of individual species from 1 to 10 where 1 represents disturbance species and 10 indicates stability.

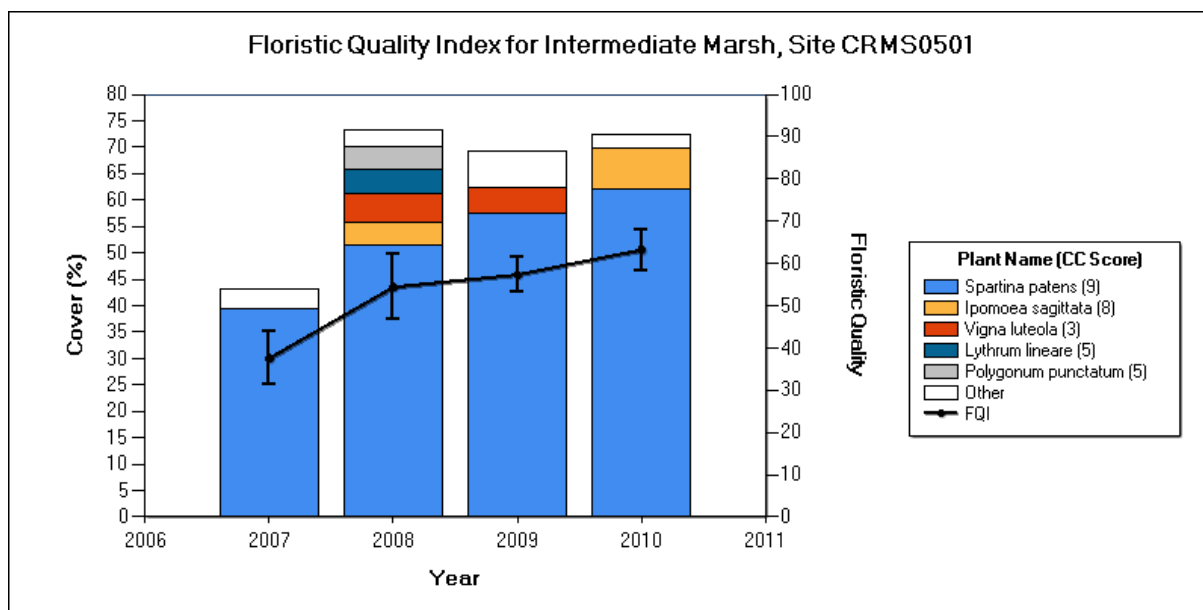


Figure 16f. Percent coverage and floristic quality index of species collected from CRMS reference site 501 in years 2007 – 2010. The CC scores represent the quality of individual species from 1 to 10 where 1 represents disturbance species and 10 indicates stability.

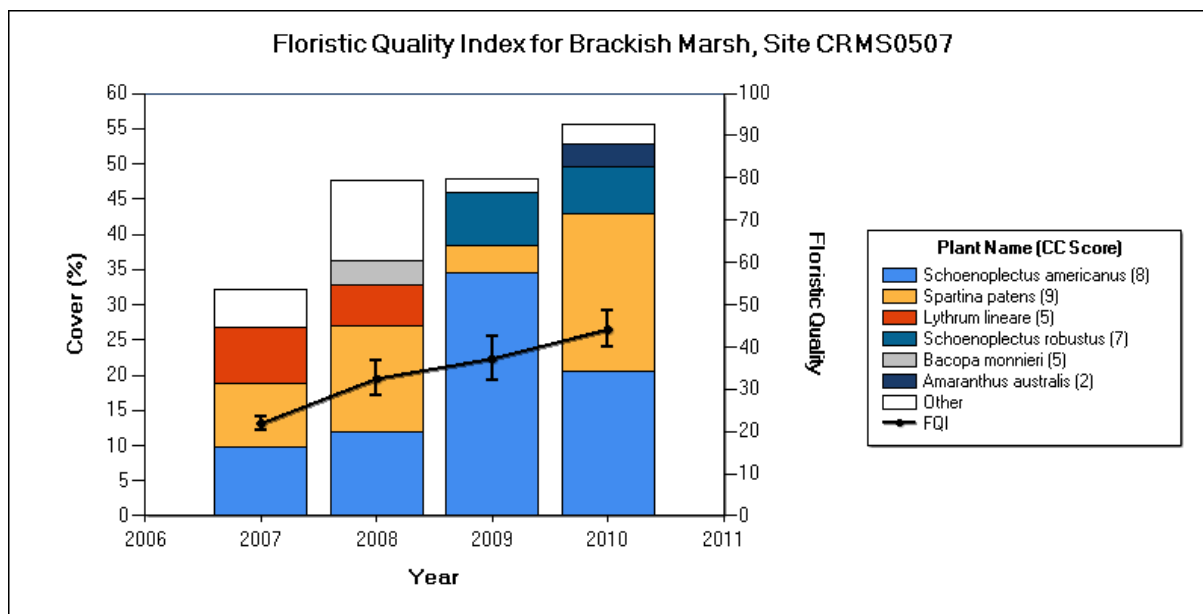


Figure 16g. Percent coverage and floristic quality index of species collected from CRMS reference site 507 in years 2007 – 2010. The CC scores represent the quality of individual species from 1 to 10 where 1 represents disturbance species and 10 indicates stability.

CRMS Supplemental:

Soils:

Soil cores were collected one time (within a year of site establishment) to describe soil properties (bulk density and percent organic matter). Three, 4" (10.16-cm) diameter cores were collected to a depth of 24 cm and divided into 6, 4-cm sections at the site. All cores were sampled after Hurricane Rita. Figures for mean bulk density and percent organic matter (OM%) by CRMS station are presented in Figures 18a and 18b. Bulk density profiles are similar for all stations except 571 which has higher bulk density below 16 cm. OM% was also highest at site 571. Marsh elevation change and vertical accretion data are being collected at all CRMS sites but the current estimates are preliminary and will not be presented at this time.

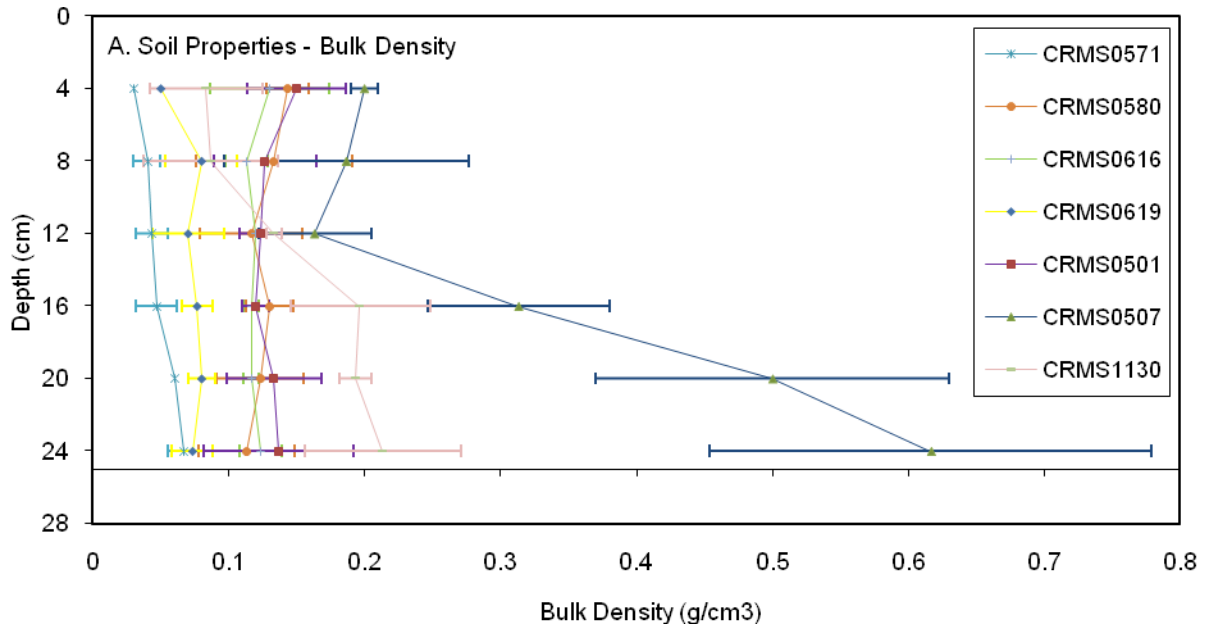


Figure 17a. Mean soil bulk density collected at project and reference CRMS stations. Error bars represent standard deviation.

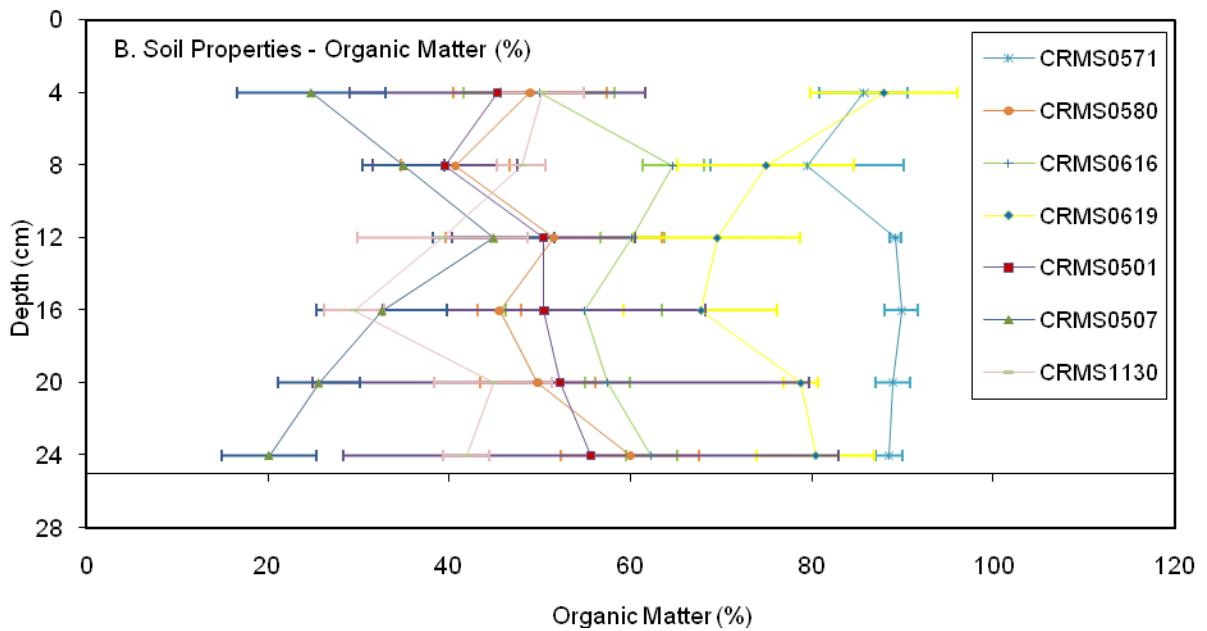


Figure 17b. Mean soil organic matter content collected at project and reference CRMS stations. Error bars represent standard deviation.

V. Conclusions

a. Project Effectiveness

Shoreline along the west bank of FBC in the project area has benefited from the construction of the rock dike, as indicated by the significantly reduced erosion rates relative to the reference areas. However, the rate of erosion increases when the elevation of the rock material sinks below the originally constructed top elevation, as noted in 2001. Maintenance events in 2002 and 2005 lifted the rock dike back to the prescribed elevations. However, a large breach has occurred at the Transco Pipeline exposing the interior marsh of CTU 1 to the tidal effects of Vermilion Bay, which was already severely impacted by Hurricanes Rita and Ike. A maintenance event is planned to cap the existing rock dike and the breach at the Transco Pipeline will be addressed at that time.

The ME-04 project does not appear to be effective in keeping water levels within the desired range since project area stations stayed within range less than half the time during all years and project area water levels were higher than the reference area. Salinity stayed within the target range at project area stations for most years, but this cannot be attributed to project features since the project and reference stations were similar pre- and post-construction. Salinity spikes observed have been associated with periods of droughts and tropical storm or hurricane activity.

Marsh loss was lower than historic levels, although land gain did not occur in either project or reference areas. Since construction, there has been little or no increase of total vegetation cover or quality at monitoring stations within the project area. Habitat analysis indicates that intermediate and brackish marsh has overtaken former areas of fresh marsh in the southeastern part of the ME-04 project area.

Vegetation in the project area was severely impacted by Hurricane Rita and to a lesser extent by Hurricane Ike. Species assemblages have reverted to more salt tolerant species. Through 2010, all units were recovering to near pre-Hurricane Rita levels except for CTU 1 which has continued to decrease in cover. A large blowout in CTU 1, caused by Hurricane Rita, in combination with the tidal exchange through the breach in the spoil bank levee is causing stress to the vegetation and erosion of organic soils in that unit. Porewater salinities at the 30 cm level averaged over 8 ppt in 2009 and over 7 ppt in 2010 at CRMS site 580.

b. Recommended Improvements

Overall the Freshwater Bayou Wetlands Project structural components are in good condition. The 2,000 linear feet of foreshore dike mentioned above will be addressed in an upcoming maintenance event as well as the breach at the Transco Pipeline location. A funding request will be submitted to CWPPRA in 2012.



c. Lessons Learned

The water control structures that were constructed, operated and maintained by the land owner are not included in the DNR Operation and Maintenance Plan. Implementation of CWPPRA projects where the landowner has total control over the operation of existing water control structures, and over the installation and operation of additional structures as part of the features of a CWPPRA project, as was the case for ME-04, has been discontinued.

In order to prevent further wetland degradation along FBC, especially in the ME-04 project and reference areas and adjacent marshes, and to prevent increased saltwater intrusion into this part of the Chicot Aquifer, any deepening and widening of the Freshwater Bayou Canal to Port of Iberia Canal shipping lane must be mitigated by the installation and maintenance of canal embankments, preferably armored with rock or protected by rock dikes. The proposed deepening and widening of FBC, Gulf Intracoastal Waterway, and Port of Iberia Canal on the ME-04 project and reference areas and adjacent marsh areas would introduce additional saltwater into fresh and intermediate marshes. It appears unlikely that, with the low elevation, the fresh bulltongue marsh would convert to a mesohaline wiregrass marsh habitat. It is more likely that these marshes will convert to a less productive shallow pond habitat (LCWCRTF, 2002). The Cameron-Creole Wetlands and Sabine National Wildlife Refuge Freshwater Impoundment (Unit 5) are historically similar in soils and marsh types to those in the Freshwater Bayou project and reference areas. Navigation channel-induced saltwater intrusion due to widening and deepening of the Calcasieu Ship Channel in the 1950's caused major land loss by killing vegetation in the fresh sawgrass marsh and converting it to shallow open water ponds (LCWCRTF, 2002).

VI. Literature Cited

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Vincent, Karl A., 2003. Freshwater Bayou Wetlands (ME-04) Comprehensive Monitoring Report. Louisiana Coastal Protection and Restoration Authority. Office of Coastal Protection and Restoration. Baton Rouge, LA. 118 pp.

APPENDIX A

(Inspection Photographs)

Appendix A
(Inspection Photographs)



Photo No. 1, Typical rock dike



Photo No. 2, View showing accretion behind rock dike

Appendix B (Three Year Budget Projection)

FRESHWATER BAYOU / ME04 / PPL2
Three-Year Operations & Maintenance Budgets 07/01/2011 - 06/30/2014

<u>Project Manager</u>	<u>O & M Manager</u>	<u>Federal Sponsor</u>	<u>Prepared By</u>
<i>Darrell Pontiff</i>	<i>Mel Guidry</i>	<i>NRCS</i>	<i>Mel Guidry</i>

	2011/2012 (-17)	2012/2013 (-18)	2013/2014 (-19)
Maintenance Inspection	\$ 6,086.00	\$ 6,269.00	\$ 6,457.00
Structure Operation	\$ -	\$ -	\$ -
Administration	\$ 5,000.00	\$ -	\$ -

Maintenance/Rehabilitation

07/08 Description:

<i>E&D</i>	\$ 10,000.00
<i>Construction</i>	\$ 239,760.00
<i>Construction Oversight</i>	\$ 5,000.00
<i>Sub Total - Maint. And Rehab.</i>	<u>\$ 254,760.00</u>

08/09 Description:

<i>E&D</i>	\$ -
<i>Construction</i>	\$ -
<i>Construction Oversight</i>	\$ -
<i>Sub Total - Maint. And Rehab.</i>	<u>\$ -</u>

09/10 Description:

<i>E&D</i>	\$ -
<i>Construction</i>	\$ -
<i>Construction Oversight</i>	\$ -
<i>Sub Total - Maint. And Rehab.</i>	<u>\$ -</u>

	2011/2012 (-17)	2012/2013 (-18)	2013/2014 (-19)
<u>Total O&M Budgets</u>	<u>\$ 265,846.00</u>	<u>\$ 6,269.00</u>	<u>\$ 6,457.00</u>

<u>O & M Budget (3 yr Total)</u>	<u>\$ 278,572.00</u>
<u>Unexpended O & M Budget</u>	<u>\$ 78,070.00</u>
<u>Remaining O & M Budget (Projected)</u>	<u>\$ (200,502.00)</u>



OPERATION AND MAINTENANCE BUDGET 07/01/2011-06/30/2012
FRESHWATER BAYOU/ME-04/PPL2

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	\$6,086.00	\$6,086.00
General Structure Maintenance	LUMP	0	\$0.00	\$0.00
Engineering and Design	LUMP	1	\$10,000.00	\$10,000.00
Operations Contract	LUMP	0	\$0.00	\$0.00
Construction Oversight	LUMP	1	\$5,000.00	\$5,000.00

ADMINISTRATION

OCPR / CRD Admin.	LUMP	1	\$5,000.00	\$5,000.00
FEDERAL SPONSER Admin.	LUMP	1	\$0.00	\$0.00
SURVEY Admin.	LUMP	0	\$0.00	\$0.00
OTHER				\$0.00
TOTAL ADMINISTRATION COSTS:				\$5,000.00

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:				
Secondary Monument	EACH	0	\$0.00	\$0.00
Staff Gauge / Recorders	EACH	0	\$0.00	\$0.00
Marsh Elevation / Topography	LUMP	0	\$0.00	\$0.00
TBM Installation	EACH	0	\$0.00	\$0.00
OTHER				\$0.00
TOTAL SURVEY COSTS:				\$0.00

GEOTECHNICAL

GEOTECH DESCRIPTION:				
Borings	EACH	0	\$0.00	\$0.00
OTHER				\$0.00
TOTAL GEOTECHNICAL COSTS:				\$0.00

CONSTRUCTION

CONSTRUCTION DESCRIPTION:					
Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
	0	0.0	0	\$0.00	\$0.00
	0	0.0	0	\$0.00	\$0.00
	0	0.0	0	\$0.00	\$0.00
Filter Cloth / Geogrid Fabric	SQ YD	0		\$0.00	\$0.00
Navigation Aid	EACH	0		\$0.00	\$0.00
Signage	EACH	0		\$0.00	\$0.00
General Excavation / Fill	CU YD	0		\$0.00	\$0.00
Dredging	CU YD	0		\$0.00	\$0.00
Sheet Piles (Lin Ft or Sq Yds)		0		\$0.00	\$0.00
Timber Piles (each or lump sum)		0		\$0.00	\$0.00
Timber Members (each or lump sum)		0		\$0.00	\$0.00
Hardware	LUMP	1		\$0.00	\$0.00
Materials	LUMP	1		\$0.00	\$0.00
Mob / Demob	LUMP	1		\$0.00	\$0.00
Contingency	LUMP	1		\$0.00	\$0.00
General Structure Maintenance	LUMP	1		\$0.00	\$0.00
OTHER				\$0.00	\$0.00
OTHER				\$0.00	\$0.00
OTHER				\$0.00	\$0.00
TOTAL CONSTRUCTION COSTS:					\$0.00

TOTAL OPERATIONS AND MAINTENANCE BUDGET: **\$26,086.00**



OPERATION AND MAINTENANCE BUDGET 07/01/2012-06/30/2013
FRESHWATER BAYOU/ME-04/PPL2

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	\$6,269.00	\$6,269.00
General Structure Maintenance	LUMP	1	\$0.00	\$0.00
Engineering and Design	LUMP	1	\$0.00	\$0.00
Operations Contract	LUMP	1	\$0.00	\$0.00
Construction Oversight	LUMP	1	\$0.00	\$0.00

ADMINISTRATION

LDNR / CRD Admin.	LUMP	0	\$0.00	\$0.00
FEDERAL SPONSER Admin.	LUMP	0	\$0.00	\$0.00
SURVEY Admin.	LUMP	0	\$0.00	\$0.00
OTHER				\$0.00
TOTAL ADMINISTRATION COSTS:				\$0.00

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:					
Secondary Monument	EACH	0	\$0.00	\$0.00	
Staff Gauge / Recorders	EACH	0	\$0.00	\$0.00	
Marsh Elevation / Topography	LUMP	0	\$0.00	\$0.00	
TBM Installation	EACH	0	\$0.00	\$0.00	
OTHER				\$0.00	
TOTAL SURVEY COSTS:				\$0.00	

GEOTECHNICAL

GEOTECH DESCRIPTION:					
Borings	EACH	0	\$0.00	\$0.00	
OTHER				\$0.00	
TOTAL GEOTECHNICAL COSTS:				\$0.00	

CONSTRUCTION

CONSTRUCTION DESCRIPTION:						
Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE		
	0	0.0	0	\$0.00	\$0.00	
	0	0.0	0	\$0.00	\$0.00	
	0	0.0	0	\$0.00	\$0.00	
Filter Cloth / Geogrid Fabric	SQ YD	0	\$0.00	\$0.00		
Navigation Aid	EACH	0	\$0.00	\$0.00		
Signage	EACH	0	\$0.00	\$0.00		
General Excavation / Fill	CU YD	0	\$0.00	\$0.00		
Dredging	CU YD	0	\$0.00	\$0.00		
Sheet Piles (Lin Ft or Sq Yds)		0	\$0.00	\$0.00		
Timber Piles (each or lump sum)		0	\$0.00	\$0.00		
Timber Members (each or lump sum)		0	\$0.00	\$0.00		
Hardware	LUMP	1	\$0.00	\$0.00		
Materials	LUMP	1	\$0.00	\$0.00		
Mob / Demob	LUMP	1	\$0.00	\$0.00		
Contingency	LUMP	1	\$0.00	\$0.00		
General Structure Maintenance	LUMP	1	\$0.00	\$0.00		
OTHER			\$0.00	\$0.00		
OTHER			\$0.00	\$0.00		
OTHER			\$0.00	\$0.00		
TOTAL CONSTRUCTION COSTS:				\$0.00		

TOTAL OPERATIONS AND MAINTENANCE BUDGET: **\$6,269.00**



OPERATION AND MAINTENANCE BUDGET 07/01/2013-06/30/2014
FRESHWATER BAYOU/ME-04/PPL2

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	\$6,457.00	\$6,457.00
General Structure Maintenance	LUMP	1	\$0.00	\$0.00
Engineering and Design	LUMP	1	\$0.00	\$0.00
Operations Contract	LUMP	1	\$0.00	\$0.00
Construction Oversight	LUMP	1	\$0.00	\$0.00

ADMINISTRATION

LDNR / CRD Admin.	LUMP	1	\$0.00	\$0.00
FEDERAL SPONSER Admin.	LUMP	1	\$0.00	\$0.00
SURVEY Admin.	LUMP	1	\$0.00	\$0.00
OTHER				\$0.00
TOTAL ADMINISTRATION COSTS:				\$0.00

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:				
Secondary Monument	EACH	0	\$0.00	\$0.00
Staff Gauge / Recorders	EACH	0	\$0.00	\$0.00
Marsh Elevation / Topography	LUMP	0	\$0.00	\$0.00
TBM Installation	EACH	0	\$0.00	\$0.00
OTHER				\$0.00
TOTAL SURVEY COSTS:				\$0.00

GEOTECHNICAL

GEOTECH DESCRIPTION:				
Borings	EACH	0	\$0.00	\$0.00
OTHER				\$0.00
TOTAL GEOTECHNICAL COSTS:				\$0.00

CONSTRUCTION

CONSTRUCTION DESCRIPTION:					
Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
	0	0.0	0	\$0.00	\$0.00
	0	0.0	0	\$0.00	\$0.00
	0	0.0	0	\$0.00	\$0.00
Filter Cloth / Geogrid Fabric	SQ YD	0		\$0.00	\$0.00
Navigation Aid	EACH	0		\$0.00	\$0.00
Signage	EACH	0		\$0.00	\$0.00
General Excavation / Fill	CU YD	0		\$0.00	\$0.00
Dredging	CU YD	0		\$0.00	\$0.00
Sheet Piles (Lin Ft or Sq Yds)		0		\$0.00	\$0.00
Timber Piles (each or lump sum)		0		\$0.00	\$0.00
Timber Members (each or lump sum)		0		\$0.00	\$0.00
Hardware	LUMP	1		\$0.00	\$0.00
Materials	LUMP	1		\$0.00	\$0.00
Mob / Demob	LUMP	1		\$0.00	\$0.00
Contingency	LUMP	1		\$0.00	\$0.00
General Structure Maintenance	LUMP	1		\$0.00	\$0.00
OTHER				\$0.00	\$0.00
OTHER				\$0.00	\$0.00
OTHER				\$0.00	\$0.00
TOTAL CONSTRUCTION COSTS:					\$0.00

TOTAL OPERATIONS AND MAINTENANCE BUDGET: **\$6,457.00**



APPENDIX C

(Field Inspection Notes)

Appendix C (Field Inspection Notes)

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: ME-04 Freshwater Bayou

Date of Inspection: April 12, 2011 Time: 1:20 pm

Structure No. N/A

Inspector(s): Dion Broussard, Mel Guidry, Darrell Pontiff (OCPR)
Charles Slocum, Dale Garber (NRCS)

Structure Description: Foreshore Rock Dike

Type of Inspection: Annual

Water Level
Weather Conditions: Sunny and cool

Item	Condition	Physical Damage	Corrosion	Photo #	Observations and Remarks
Steel Bulkhead / Caps	N/A				
Steel Grating	N/A				
Stop Logs	N/A				
Hardware	N/A				
Timber Piles	N/A				
Timber Wales	N/A				
Galv. Pile Caps	N/A				
Cables	N/A				
Signage / Supports	N/A				
Rip Rap (fill) (foreshore dike)	Good			1 & 2	Recent maintenance work to restore dike to constructed elevation still in good condition. Approx. 2,000 LF still below +4.0 NAVD88 and will be addressed through a proposed maintenance event.
Earthen Embankment	N/A				

What are the conditions of the existing levees?
Are there any noticeable breaches?
Settlement of rock plugs and rock weirs?
Position of stoplogs at the time of the inspection?
Are there any signs of vandalism?