Coastal Protection and Restoration Authority of Louisiana

State of Louisiana
Coastal Protection and Restoration Authority
Office of Coastal Protection and Restoration

2011 Operations, Maintenance, and Monitoring Report

for

Brady Canal Hydrologic Restoration (TE-28)

State Project Number TE-28
Priority Project List 3

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Terrebonne Parish

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Operations, Maintenance, and Monitoring Report
For
Brady Canal Hydrologic Restoration
(TE-28)

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Preface

This report includes monitoring data collected through March 2011, and annual Maintenance Inspections through April 2011.

The 2011 report is the 3rd report in a series of reports. For additional information on lessons learned, recommendations and project effectiveness please refer to the 2004 and 2005 Operations, Maintenance, and Monitoring Report on the LDNR web site.

I. Introduction

The Brady Canal Hydrologic Restoration (TE-28) project consists of 7,653 ac (3,097 ha) located in Terrebonne Parish, within the Bayou Penchant-Lake Penchant Basin. The project is bounded by Bayou Penchant, Brady Canal, and Little Carencro Bayou to the north, Bayou Decade and Turtle Bayou to the south, Superior Canal to the east, and Little Carencro Bayou and Voss Canal to the west (figure 1). The project was federally sponsored by the Natural Resources Conservation Service (NRCS) and locally sponsored by the Louisiana Office of Coastal Protection and Restoration (OCPR) under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA, Public Law 101-646, Title III).

Historically, the Atchafalaya River provided freshwater and sediments to the Penchant Basin through the diversion of flood waters into Bayou Cocodrie via Bayou Boeuf at Morgan City, and into Bayou Penchant via Bayou Shaefer and Bayou Chene (USDA/NRCS 1995). The Atchafalaya River influenced the establishment of freshwater plant species within the Brady Canal Hydrologic Restoration (TE-28) project area (USDA/NRCS 1995). In 1968, the vegetation in the project area was classified as freshwater, intermediate, and brackish marsh (Chabreck et al. 1968). In 1978, the project area was classified as intermediate marsh with a small area of brackish marsh in the southern portion of the project along Bayou Decade (Chabreck and Linscombe 1988). Over time, hydrologic conditions in the Penchant Basin were altered by the construction of numerous canals, levees, local water management structures, and major public works projects, resulting in diminished freshwater input and sediment retention. Additionally, the dredging of numerous canals in the basin resulted in the breaching of natural hydrologic barriers, allowing for a strong tidal influence from the south. These anthropogenic changes have resulted in an acceleration of tidal exchange between freshwater distribution channels and tidal channels, thus reducing freshwater retention, accelerating erosion, and facilitating saltwater intrusion (USDA/NRCS 1995).

The existence of a natural ridge, the Mauvais Bois Ridge (figure 1), which bisects the Brady Canal Hydrologic Restoration (TE-28) project, further complicates the hydrologic balance in the project area, resulting in different hydrologic regimes to the north and south of the ridge. The northern section of the project area still receives freshwater and sediments which are provided through overbank flow from Bayou Penchant, Little Carencro Bayou, and Brady Canal. However, freshwater and sediment retention has diminished in the southern portion of

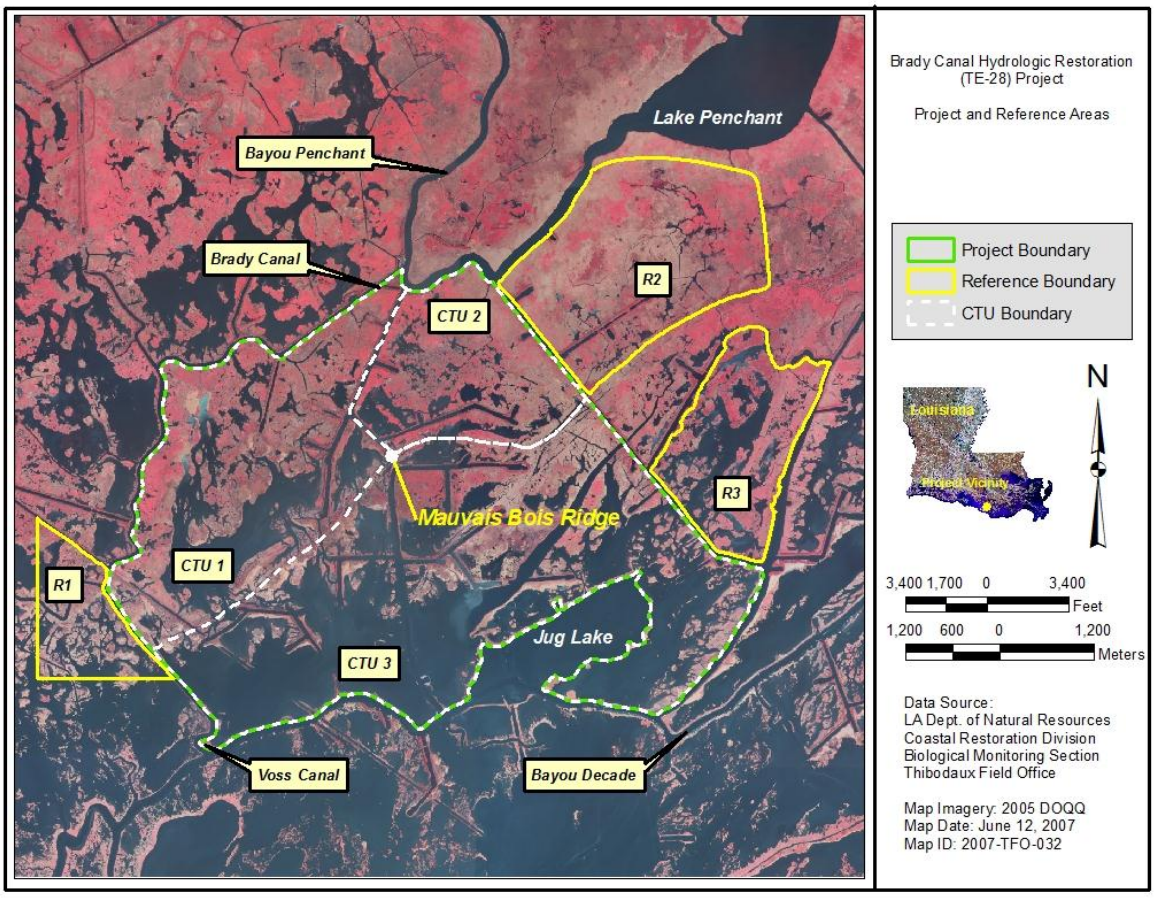

Figure 1. Brady Canal Hydrologic Restoration (TE-28) project and reference areas.

the project area due to unimpeded through flow and tidal exchange combined with a decrease in available freshwater and sediment.

Due to differences in marsh type and hydrologic regimes within the project area, the Brady Canal Hydrologic Restoration (TE-28) project was subdivided into conservation treatment units (CTU's). Three CTU's were established to measure the performance of the project. These treatment units were designated as CTU 1, CTU 2, and CTU 3 (figure 1). Each CTU was paired with a reference area to assess the effectiveness of the project. Marsh type, hydrology, and soils were the criteria used to select reference areas for the CTU's. CTU 1 was paired with reference area 1 (R1), CTU 2 was paired with reference area 2 (R2), and CTU 3 was paired with reference area 3 (R3) (figure 1).

Land loss data show that during the period from 1932 to 1990, about 1,818 ac (736 ha) of land were converted to open water in the Brady Canal Hydrologic Restoration (TE-28) project area. Approximately 52% of the loss occurred over a 16-year period between 1958 and 1974.

The average loss between 1932 and 1958 was approximately 18 ac (7.3 ha) per year while the average loss of 31 ac (12.5 ha) per year occurred between 1983 and1990.

The increase of land loss in the project area was a result of major changes: (1) the hydrology of the Penchant Basin, both natural and human induced, was altered, (2) the natural levee ridge of Bayou Decade had eroded below marsh elevation along the southern end of the project area, (3) higher salinity waters from the south began infiltrating the lower saline environment, (4) the tidal exchange at the southern end of the project area began to increase, and (5) there was a reduction in freshwater and sediment retention.

The infiltration of higher salinity waters and increased tidal exchange can be attributed to the degradation of the natural levee ridge of Bayou Decade along the southern boundary of the project. This has created a direct hydrologic connection between the higher salinity waters from the south and the project area, and has led to decreasing protection from storm surges and tidal scouring. Oilfield access canals extending from within the project area to the Bayou Decade levee ridge have also increased tidal exchange and provided direct routes for saltwater intrusion and reduced freshwater and sediment retention (USDA/NRCS 1995).

The Brady Canal Hydrologic Restoration (TE-28) project involved the installation and maintenance of canal plugs along with the repair, construction, and maintenance of levees, several different types of weirs, rock plugs, earthen and/or rock and earthen embankments, as well as the construction and maintenance of stabilized channel cross-sections. The structures are designed to reduce adverse tidal effects in the project area as well as to better utilize available freshwater and sediment. Project construction began in August 1999 and was completed on July 10, 2000. During this period, the following features were constructed: three fixed crest weirs with variable crest section(s) (figure2, Structures 14, 21, and 23), a fixed crest weir with barge bay (figure 2, structure 6), a fixed crest weir (figure 2, structure 24), two rock armored channel liners (figure 2, structures 10 and 20), a rock plug (figure 2, structure 7), and three different embankment types (rock armored earthen embankment, rock dike, and earthen embankment) (figure 2).

A subsequent project, the Penchant Basin Plan (TE-34), authorized under the 6th Project Priority List, encompasses the entire Penchant Basin Project, which includes the Brady Canal Hydrologic Restoration (TE-28) project. Due to ongoing development of the Penchant Basin Plan (TE-34), two (2) construction features originally planned to be included under the Brady Canal Hydrologic Restoration (TE-28) project were never constructed. These features included the northernmost structure located along Bayou Penchant and the overflow banks along Brady Canal in the northern section of the project. The Brady Canal Hydrologic Restoration (TE-28) project also included provisions for the closure of several large breaches along Bayou Decade between Jug Lake and Turtle Bayou, which were not closed due to budget constraints. However, in August of 2003 OCPR completed the closure of these breaches through the operation, maintenance, and rehabilitation program.

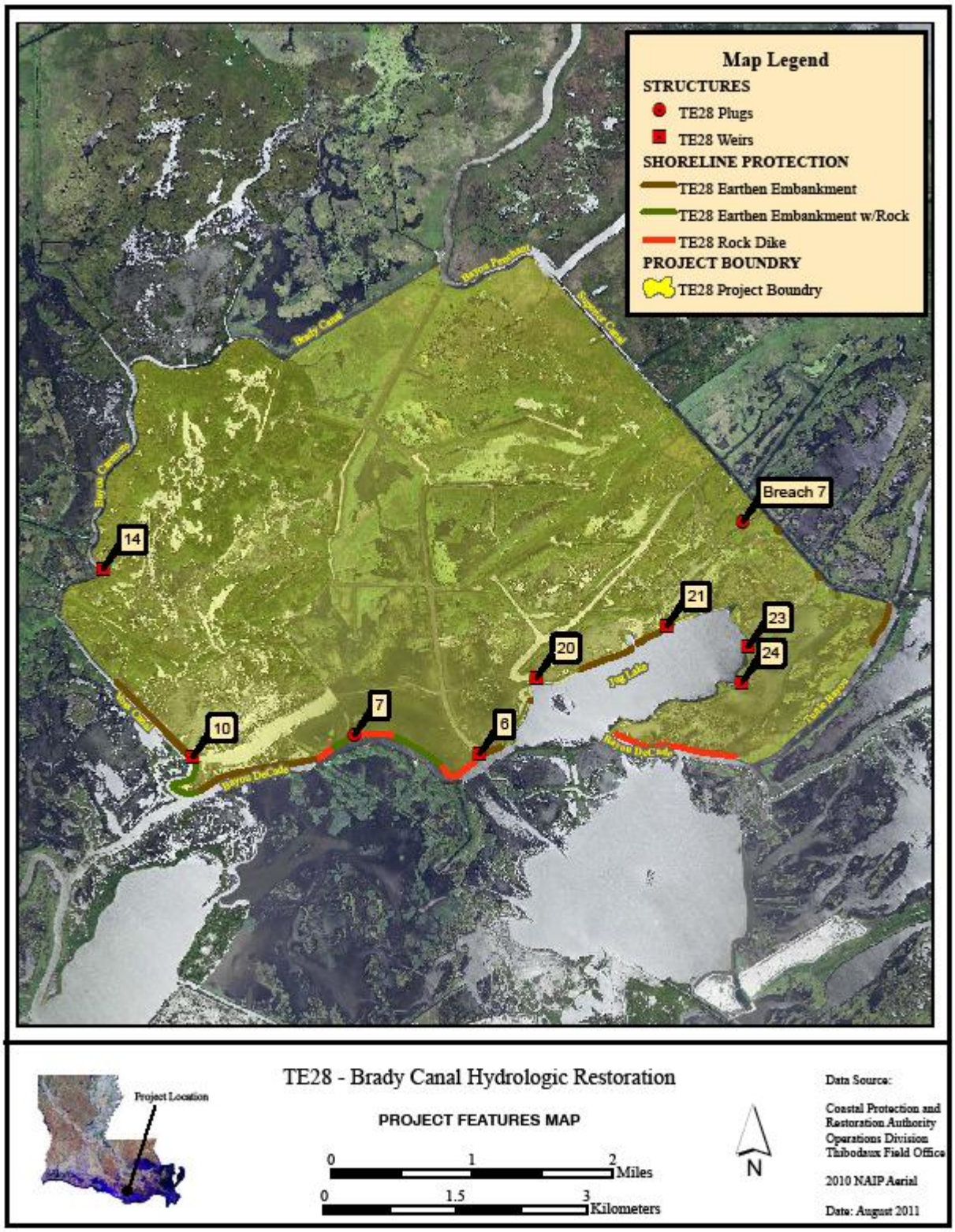

Figure 2. Brady Canal Hydrologic Restoration (TE-28) project features map.

II. Maintenance Activity

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Brady Canal Hydrologic Restoration project (TE-28) is to evaluate the constructed project features, identify any deficiencies, and prepare a report detailing the condition of the project features including recommendations for corrective actions, as needed. Should it be determined that corrective actions are required, OCPR shall provide in the inspection report, a detailed cost estimate for engineering, design, bidding, construction oversight and supervision, project contingencies, and an assessment of the urgency of such repairs (LDNR_CRD; Pyburn and Odom, 2002 OM&R Plan). The annual inspection report also contains a summary of the completed maintenance projects and an estimated projected budget for the upcoming three (3) years for operations, maintenance and rehabilitation. The three (3) year projected operations and maintenance budget is shown in Appendix B. A summary of completed operation and maintenance projects are outlined in Section IV of this report.

An inspection of the Brady Canal Hydrologic Restoration (TE-28) project was held on April 7, 2011 under partly cloudy skies and windy conditions. In attendance were Brian Babin, Shane Triche and Adam Ledet from OCPR, Quin Kinler and John Boatman with NRCS, and the landowners; Buddy Smith with ConocoPhilips and Archie Domanigue representing Apache Minerals, Inc. The attendees met at the Falgout Canal Boat Launch. The inspection began at approximately 10:00 a.m. at the intersection of Turtle Bayou and Bayou Decade and ended at 12:30 p.m. along Brady Canal near the Apache Camp.

The field inspection included a complete visual inspection of all constructed features within the project area. Photographs of all project features were taken during the field inspection and are shown in Appendix A. Staff gauge readings, where available, were documented and used to estimate approximate water elevations, elevations of rock weirs, earthen embankments, and other project features.

b. Inspection Results

Structure 6 – Fixed crest weir with barge bay

This structure looks to be in overall good condition. There are no apparent deficiencies in the steel bulkhead or its tie-ins to the earthen embankment. All navigational lights appear to be operational and navigational signs are visible with some minor degradation due to exposure. The only damage to the structure observed during the inspection was the two timber pile dolphins on the south side of the structure. These piles are both cracked and displaced from center. It is assumed the oilfield service barges are using these piles as assistance to navigate through the barge bay, due to the sharp 90 degree turn from Bayou Decade, causing excessive wear and

tear on the timber. The damage to the timber pile support dolphin on the south side of the structure was observed during the 2010 annual inspection, and is recommended for replacement under the 2011 Maintenance Project. In addition to the new timber navigational aid structure, all existing navigation signs will be replaced. These recommended upgrades are scheduled to be completed later this year in the 2011 Maintenance Project (see Appendix A, Photos 42 through 48).

Structure 7 – Rock Plug

Structure 7 is in overall good condition with no observed settlement of the rock plug or signs of erosion around the tie-ins to the earthen embankment. This structure does not require maintenance at his time therefore there are no recommendations for repair (see Appendix A, Photos 54 and 55).

Structure 10 – Stabilization rock armored channel liner

This structure along Voss Canal seems to be in good condition. There is no structural damage and no additional settlement or displacement of the rock from previous inspections. A handheld depth sounder was used to obtain the water depth in the boat bay, and depth above the rock crest was recorded as 6.0' below the water line. With a water level reading of +1.2' NAVD observed at the CRMS station near structure 6, the current crest of structure 10 is approximately -4.8' NAVD. As previously reported in the 2009 annual inspection report, the timber piles holding the warning signs on the northeast side of the structure are leaning and no longer vertical. It is recommended that the existing timber piles and signs be replaced, and this corrective action is included in the 2011 Maintenance Project and should be completed later this year (see Appendix A, Photos 61 through 63).

Structure 14 – fixed crest weir w/ variable crest section

This structure appears to be in overall good condition. There is no apparent damage to the steel bulkhead, railings, platform, or warning signs and their timbers. There is some noticeable erosion around the tie-ins on the west side of the structure, but no more than was noticed in the 2010 annual inspection. Because there was no significant change, there will be no recommendations to restore the tie-ins at this time, but they will continue to be monitored for further erosion on future visits (see Appendix A, Photos 67 through 69).

Structure 20 – Stabilization rock armored channel liner

This structure appears to be in fair condition as some settlement of the rock riprap can be observed on both exposed sides of the structure as well as the submerged crest. Using a handheld depth sounder in the center of the boat bay, the water depth above the rock crest was recorded as 7.0' below the water line. With a water level reading of +1.2' NAVD observed at the CRMS station near structure 6, the current crest of structure 20 is approximately -5.8' NAVD. According to the as-built drawings, the center of the rock crest was constructed to an elevation of -4.75' NAVD, therefore it has settled approximately 1.05'. It is recommended that a survey profile across the structure be conducted to confirm the field measurement before we proceed with any

corrective action. All other warning signs and timber piles are in good condition (see Appendix A, Photos 36 through 38).

Structure 21 – fixed crest weir w/ three (3) variable crest sections

This structure is in overall good condition as there is no visual damage to the steel bulkhead, railings, decking, warning signs or timbers. There is substantial erosion of the earthen tie-ins, exposing the end of the steel bulkhead on both sides of the structure, and causing a breach on the east side of the structure. To prevent further erosion of the embankment, both sides require refurbishment and more robust tie-ins. These improvements are part of the 2011 Maintenance Project and include the reconstruction of the tie-ins with borrow material from the lake and then reinforcing approximately 100 linear feet on both sides of the structure with rock riprap. The upgrades are scheduled to be completed later this year (see Appendix A, Photos 27 through 28).

Structure 23 – fixed crest weir w/ two (2) variable crest sections

This structure is in overall good condition as there is no visual damage to the steel bulkhead, railings, decking, warning signs or timbers. However, both of the structures earthen tie-ins have now been breached due to erosion. The north tie-in has been repaired several times in the past, but to prevent further erosion of the embankment, both sides require refurbishment and more robust tie-ins. These improvements are part of the 2011 Maintenance Project and include the reconstruction of the tie-ins with borrow material from the lake and then reinforcing approximately 100 linear feet on both sides of the structure with rock riprap. The upgrades are scheduled to be completed later this year (see Appendix A, Photos 20 through 22).

Structure 24 – fixed crest weir

This structure appears to be in good condition. All structural components are undamaged with no signs of corrosion. The warning signs and their timber piles are visible and upright. The earthen tie-ins, refurbished by Apache Minerals Inc. in July 2007, are still intact and holding well. Although no repairs are needed at this time, there are some provisions in the 2011 Maintenance Project to protect the tie-ins which are usually susceptible to erosion. This includes the reconstruction of the tie-ins with borrow material from the lake and then reinforcing approximately 100 linear feet on both sides of the structure with rock riprap. These upgrades are scheduled to begin later this year (see Appendix A, Photo 17 through 19).

Earthen Embankments

The inspection of the earthen embankments progressed from Superior Canal, Turtle Bayou, Bayou Decade, through Voss Canal, Bayou Carencro, and concluded along Brady Canal. All earthen banks along Turtle Bayou and Superior Canal are in good shape and do not require repair. As reported in the 2010 annual inspection report, there is a low area in the earthen embankment along Bayou DeCade between the west rim of Jug Lake and Structure 6 (see Appendix A, Photo 42). This section has been previously identified as in need of repair and was included in the 2011 Maintenance

Project. It will not be armored, but rebuilt to its original design specification with borrow material dredged from Bayou DeCade. The remaining sections along Bayou DeCade are in fair condition with some erosion between Structures 7 and 10 (see Appendix A, Photo 57-58). This section has experienced minimal change since the last annual inspection, and because there is little threat of breaching, the section was not included in the 2011 Maintenance Project but will continue to be monitored for further deterioration. Since the last annual inspection, there have been six (6) breaches repaired by ConocoPhillips along Little Carencro Bayou, Carencro Bayou and Brady Canal. There are only two remaining breaches in this area, Breach 6 adjacent to an existing timber bulkhead at the end of Brady Canal and Breach 7 along the south bank of Brady Canal, just north of the timber bulkhead. These two breaches are included in the 2011 Maintenance Project scheduled to be completed later this year. All breaches can be seen in the 2010/2011 Work Plan in Appendix D.

The edge of Jug Lake is the area of most concern throughout the entire Brady Canal Project. This boundary is approximately 20,000 ft. in length and is oriented in a northeasterly to southwesterly direction. Over the past several years, with the help of Hurricanes Katrina and Rita, the earthen rim along the perimeter of Jug Lake has deteriorated to thin and narrow embankments with multiple breaches. There is very little marsh left inside of the project area, therefore the rim is exposed to high wave energies from both the lake and open water in the project area. The complete degradation of the lake rim would have extremely negative impacts to the project area as it would render three (3) water control structures ineffective and allow large quantities of high saline water into project areas that are mainly brackish. Taking into consideration the negative impacts related to the failure of the Jug Lake earthen embankment, OCPR has implemented the 2011 Maintenance Project to refurbish the entire 20,000 linear foot perimeter of Jug Lake. The repairs will include using borrow material form the lake to reconstruct the earthen rim around Jug Lake, and to further combat erosion, a 100 linear foot rock revetment will be installed above the earthen rim on both sides of the water control structures to protect the tie-ins. These repairs are scheduled to be completed later this year.

Rock Armored Embankments

The rock armored repair located along the oil field access canal connecting to Superior canal is in good overall condition. There is no observed settlement along the length of the embankment and no erosion or washouts around the embankment tie-ins. There are no recommendations for corrective action at this time, but will continue to be monitored on future inspections (see Appendix A, Photos 1-2).

The rock armored embankments found along the north bank of Bayou DeCade and Voss Canal are in good overall condition. The earthen embankment with rock revetment beginning at the intersection of Bayou Decade and Voss Canal to Structure 10 along the east bank of Voss Canal appears to have some settlement since its initial construction, but no significant change since the last annual inspection and no breaching or severe rock displacement. OCPR will continue to monitor the condition

of rock dike structure on future field investigations. The earthen embankment with rock revetment along Bayou Decade between Structure 6 and 7 and just west of Structure 7 appear to in very good condition with no apparent settlement or rock displacement. The rock dike along the north bank of Bayou Decade between Turtle Bayou and Jug Lake constructed under the 2003 Maintenance Project appeared to be in fair condition with isolated low areas and moderate displacement. Despite the minor deficiencies, there is no evidence the structure is not performing as intended, therefore there are no repair recommendations at this time (see Appendix A, Photos 3-10, 49-53 and 57-60).

c. Maintenance Recommendations

Since annual inspections of the Brady Canal Hydrologic Restoration (TE-28) project began in 2001, a number of deficiencies have been documented that will require maintenance and/or refurbishment. In January 2010, OCPR initiated maintenance of the Brady Canal Project – 2011 Maintenance Project by contracting Arcadis, Inc. of Baton Rouge to perform the design and the preparation of the necessary contract documents for maintenance event. The 2011 Maintenance Project will be the second major maintenance event since the 2003 Maintenance Project to refurbish earthen embankments along Turtle Bayou, Superior Canal, and the installation of the rock dike along the north bank of Bayou Decade between Turtle Bayou and Jug Lake was completed. Prior to the design and plan preparations, OCPR contracted with T. Baker Smith, Inc. of Houma, La. to perform the necessary design surveys for the project. The initial survey for the project was completed at the end of May 2010; however, a task amendment was issued in June 2010 to collect additional data for deficiencies identified during the 2010 Annual Inspection. All survey work for design has been completed. In May 2011, the plans and specifications had been reviewed by NRCS and OCPR design section, and Arcadis, Inc. is making the final corrections to address both state and federal comments. The modification to the existing permit was submitted for joint review to the DNR-CMD and COE. The project was bid in December 2011, and upon receiving the bids, all bids were rejected as they exceeded the project budget. CPRA and NCRS are scheduled to discuss options for the maintenance project during the annual inspection on February 7, 2012.

Below is a summary of the identified deficiencies and recommended methods of repair that will be included in the Brady Canal - 2011 Maintenance Project (Appendix D, 2011 Work Plan):

Structure 6 – Timber Cluster Pile Replacement

The timber cluster pile replacement shall include removal of two (2) existing timber pile structures on the south side of Structure 6 and replacing them with new treated timber piles, supports, cables and hardware. It is also recommended that the new structure be more rigid with additional lateral support. This could be accomplished by

adding another batter pile to the timber pile cluster. This work shall also include removal and reinstallation of the navigation aid system and installation of new signs.

Structure 10 – Warning Sign Replacement

Warning sign replacement shall include the removal of four (4) existing timber piles and signage and replacement with new material including timber piles, hardware and warning signs.

Structure 21, 23 and 24 – Variable Crest Weir Structures

Maintenance to Structures No.21, 23 and 24 shall include refurbishment of the earthen wing walls using barrow material from Jug Lake to restore the existing embankment to the original design elevations. Once the embankment is restored, a 100' long rock riprap blanket will be constructed over the new constructed embankment to protect the tie-ins at the wing walls on both sides of the structures.

Earthen Embankments – Jug Lake

The refurbishment of the lake rim shall include clearing and grubbing trees and brush along 20,000 linear feet of the existing rim and excavating material from the lake bottom to restore the rim to the original designed section, followed by seeding of the entire crest and slope of the rim.

Earthen Embankments – Bayou Decade

The refurbishment of a low, unarmored section along the north bank of Bayou Decade east of Structure 6 shall include clearing and grubbing trees and brush along the existing embankment and excavating material from Bayou Decade to restore the existing embankment to the original design elevations. The entire crest and slope of the 1,200 linear foot section shall be seeded following reconstruction of the embankment.

Earthen Embankments – Breaches 6 and 7

Due to the depth of Breach 6 and the close proximity to an existing timber bulkhead, the breach will be closed using rock riprap. Prior to placement of the rock riprap material, a geotextile fabric shall be used to line the breach and adjacent bank. The breach closure shall be constructed to the existing elevation of the timber bulkhead. Repairs to Breach 7 shall include excavating material from Brady Canal to reconstruct the existing overflow bank to the permitted elevation. The new constructed breach closure shall be seeded after construction is complete.

Vegetative Plantings

In addition to seeding the earthen embankment along Jug Lake following the rim refurbishment project, we also would like to plant a salt tolerant smooth-cord grass along the most critical sections of the degraded embankment along Voss Canal north of Structure No.10. At this time, we are unsure of the number of plants that will be required to cover the degraded areas.

d. Maintenance History

General Maintenance: Below is a summary of maintenance projects and operation tasks performed since the completion of the Brady Canal Hydrologic Restoration (TE-28) project.

Under Article II of the Brady Canal Cost Share Agreement, the landowners, ConocoPhillips, formerly Burlington Resources and the Apache Minerals Corporation were granted in-kind service credits to repair existing earthen embankments within the project area. Below is a description of work and cost associated with the maintenance performed by the landowners:

In Kind Service Credits

7/30/2007 – Apache Corporation contracted Dupre Brothers Construction, Inc. of Houma, La. to repair several breaches along the east bank of Jug Lake and reinforce earthen embankment tie-ins adjacent to variable crest weir structures #21, #23, and #24. The repairs were completed on 7/30/2008 at a total cost of $9,103.12

9/30/2006 – Conoco Phillips contracted Dupre Brothers, Inc. of Houma, La. to repair several breaches along Carencro Bayou, Little Carencro Bayou and Brady Canal using material from adjacent bayous. The total cost for refurbishment and repair of these breaches was $25,890.

9/20/2006 - Apache Corporation contracted Frisco Construction Co. Inc. of Houma, La. to repair breaches and refurbish low areas of the spoil banks along the east bank of Jug Lake and embankment tie-ins adjacent to structures #21, #23 and #24. The repairs were completed on 9/20/2006 at a total cost of $9,265.

10/31/2003 - Apache Corporation contracted Berry Bros. General Contractors to completed 5,050 linear feet of levee refurbishment along the west bank of Jug Lake. The cost for the levee refurbishment including construction oversight was $34,284.87. Following the levee refurbishment, Shaw Coastal performed an as-built survey of the repairs at a cost of $5,100.60. The total project cost for this maintenance event was $39,385.47.

8/15/2003 – ConocoPhillips, formerly Burlington Resources, completed the repair of two (2) large breaches along Little Carencro Bayou following Hurricane Lili. The

maintenance project was completed on 8/15/2003 at a total cost of $31,642.57, including construction oversight and administration.

10/21/2002 - Apache Corporation contracted Frisco Construction Co. to repair and restore the existing levee embankment along Turtle Bayou, Superior Canal, and along the west bank of Jug Lake. This work was completed at a total cost of $5,310.

Brady Canal Breach Repair Project (2003) – LDNR: This maintenance project was completed on August 13, 2003 and included the installation of approximately 9,667 tons of riprap along the north bank of Bayou Decade, 2,325 linear feet of levee refurbishment and earthen breach repair along Turtle Bayou and Superior Canal, and replacement of a timber pile on the navigational aid structure at Weir 6. The cost associated with the engineering, design and construction of the 2003 Brady Canal Breach Repair Project is as follows:

Construction:	$471,329.65
Engineering & Design:	$ 54,473.00
Bidding:	$ 4,100.00
Construction Administration:	$ 8,020.00
Construction Oversight:	$ 49,635.00
As-built Survey and Drawings:	$ 12,873.00
Project Total:	$600,430.65

III. Operations Activity

a. Actual Operations

Structure Operations: In accordance with the operation schedule outlined in the Operation and Maintenance Plan, Structures #14, #21, and #23 have been operated twice annually beginning in April 2002. Below is a summary of costs incurred for structure operations:

03/02	Pyburn & Odom	$9,772.50
09/02	CEEC	$4,674.00
03/03	CEEC	$4,022.58
09/03	CEEC	$3,612.93
03/04	Shaw Coastal	$4,676.18
9/04	Shaw Coastal	$5,365.25
03/05	T. Baker Smith	$8,804.83
09/05	T. Baker Smith	$8,886.60
03/06	T. Baker Smith	$7,668.59
09/06	T. Baker Smith	$9,970.37
03/07	T. Baker Smith	$8,602.12
09/07	T. Baker Smith	$9,203.61

03/08	T. Baker Smith	$7,595.99
10/08	Apache Minerals	$6,000.00
03/09	Apache Minerals	$6,000.00
10/09	Apache Minerals	$6,000.00
03/10	Apache Minerals	$6,000.00
10/10	Apache Minerals	$6,000.00
03/11	Apache Minerals	$6,000.00

Prior to the scheduled operations in September 2008, the OCPR entered into a sole-source agreement with Apache Minerals for the landowner to assume responsibility of operating all water control structures associated with the Brady Canal (TE-28) project. The cost proposal submitted by Apache to complete this work in accordance with terms of the agreement is $12,000, annually. Apache began structure operations in September 2008.

Navigational Aids Maintenance: During the operation and maintenance phase of the Brady Canal Hydrologic Restoration (TE-28) Project, the navigational aids at Structure 6 along Bayou Decade have been repaired several times. Below are the dates and costs associated with the repair and maintenance of these navigation lights:

2/2007 – LDNR received bids for a state-wide maintenance contract for inspection, diagnostic testing and maintenance of twenty-seven (27) navigational aid systems at ten (10) separate locations throughout the state. Four (4) the twenty-seven (27) navigational aid structures are located at Structure 6 within the Brady Canal project area. The total cost of the state-wide maintenance contract is approximately $83,000 annually, with an option to extend the contract for an additional two (2) years. Inspections of the navigational aids at Structure 6 began in February 2007 under the current maintenance contract.

11/2003 – Ernest P. Breaux Electrical Inc. replaced 20 lamps, 4 – batteries, 1 – lamp changer, 1 – photo cell at structure 6. The cost for parts and labor to service these navigational aids was $4,132.30.

8/2002 - Automatic Power, Inc. of Larose, La. performed trouble shooting services to determine a schedule of parts requiring replacement – Cost: $465.

8/2002 – B&B Electromatic of Norwood, La. repaired the navigation lights at structure 6 including parts and labor for a total cost of $2,039.

Since the fall of 2008, Apache Minerals has taken over responsibilities for operating the three (3) variable crest weir structures within the project area. The sole-source contract between Apache Mineral and the OCPR requires the structures be operated in accordance with the project permits. At the time of the inspection, the stop logs at Structure No.14 were positioned at the lowest position or channel bottom.

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 TE-28 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 three CRMS sites located on the edge of the project area; CRMS0294, CRMS0398, and CRMS4045.

a. Monitoring Goals

The objective of the Brady Canal Hydrologic Restoration (TE-28) project is two-fold: (1) to maintain and enhance existing marshes in the project area by reducing the rate of tidal exchange and (2) to improve the retention of introduced freshwater and sediment. The following goals will contribute to the evaluation of the above objective:

1. Decrease the rate of marsh loss.

2. Maintain or increase the abundance of plant species typical of a freshwater and intermediate marsh.

3. Decrease variability in water level within the project area.

4. Decrease variability in salinities in the southern portion of the project.

5. Increase vertical accretion within the project area.

6. Increase the frequency of occurrence of submerged aquatic vegetation (SAV) within the project area.

b. Monitoring Elements

The following monitoring elements will provide the information necessary to evaluate the specific goals listed above:

Salinity

One continuous recorder is located in each CTU to monitor salinities and two CRMS sites were used as references. One additional recorder is located outside the project area on Bayou Penchant, where Brady Canal begins, near a water control structure. Discrete salinities are measured monthly at sites within each CTU and at the reference recorder on Bayou Penchant (TE28-07R). Salinity data have been collected from 1996 to 2000 (pre-construction) and from 2000 to 2011 (post-construction), and will continue. Hourly and discrete salinity data collection was discontinued in the

reference areas in April 2004 due to the implementation of CRMS-*Wetlands*. Figure 3 illustrates location of active and inactive hourly sampling stations, while figure 4 illustrates the location of discrete sampling stations.

Water Level

To monitor water level variability, one continuous recorder is located within each CTU (figure 4) and two CRMS sites were used as references. One additional recorder, TE-28-07R, is located outside the project area on Bayou Penchant near a water control structure. Water level data was collected from 1997 to 2000 (pre-construction) and 2000-20011 (post-construction), and will continue. Hourly water level data was discontinued in the reference areas, except for station TE28-07R, in April 2004, due to the implementation of CRMS-*Wetlands*.

Vegetation

Vegetation stations were established in the Brady Canal Hydrologic Restoration (TE-28) project areas to document species composition and percent cover over time. Plots were placed in CTU 1, CTU 2, and CTU 3 (figure 5). Sites were sampled in 1996 (pre-construction), 1999 (as-built), and in 2002, 2006, and 2009 (post-construction) via the semi-quantitative Braun-Blanquet method (Mueller-Dombois and Ellenberg 1974; Sawyer and Keeler-Wolf 1995; Barbour et al. 1999). Plant species inside each $4m^2$ plot were identified, and cover values were ocularly estimated using Braun-Blanquet units (Mueller-Dombois and Ellenberg 1974) as described in Steyer et al. (1995). The cover classes used were: solitary, <1%, 1-5%, 6-25%, 26-50%, 51-75%, and 76-100%. After sampling the plot, the residuals within a 5 m (16 ft) radius were inventoried. Relative cover was calculated to summarize vegetation data.

Accretion

Vertical accretion is determined in triplicate at each of the five representative stations within each CTU, and reference area prior to 2006, using techniques described in Steyer et al. (1995). The location of vertical accretion sites corresponds with the location of vegetation sampling sites (figure 5). Sites were sampled in 1997/1998 (pre-construction), and in 2000/2001 and 2006/2007 (post-construction). Sampling in 2009, 2012, and 2015 (post-construction) will not be completed, as it was determined that the marsh is floating and the soil is composed of decaying organic matter. Accretion data were not collected in 2004 due to the implementation of CRMS-*Wetlands*. Data were not collected from stations in the reference areas in 2006.

Habitat Mapping

To document habitats within the Brady Canal Hydrologic Restoration (TE-28) project and reference areas, color infrared (CIR) aerial photography (1:12,000 scale with

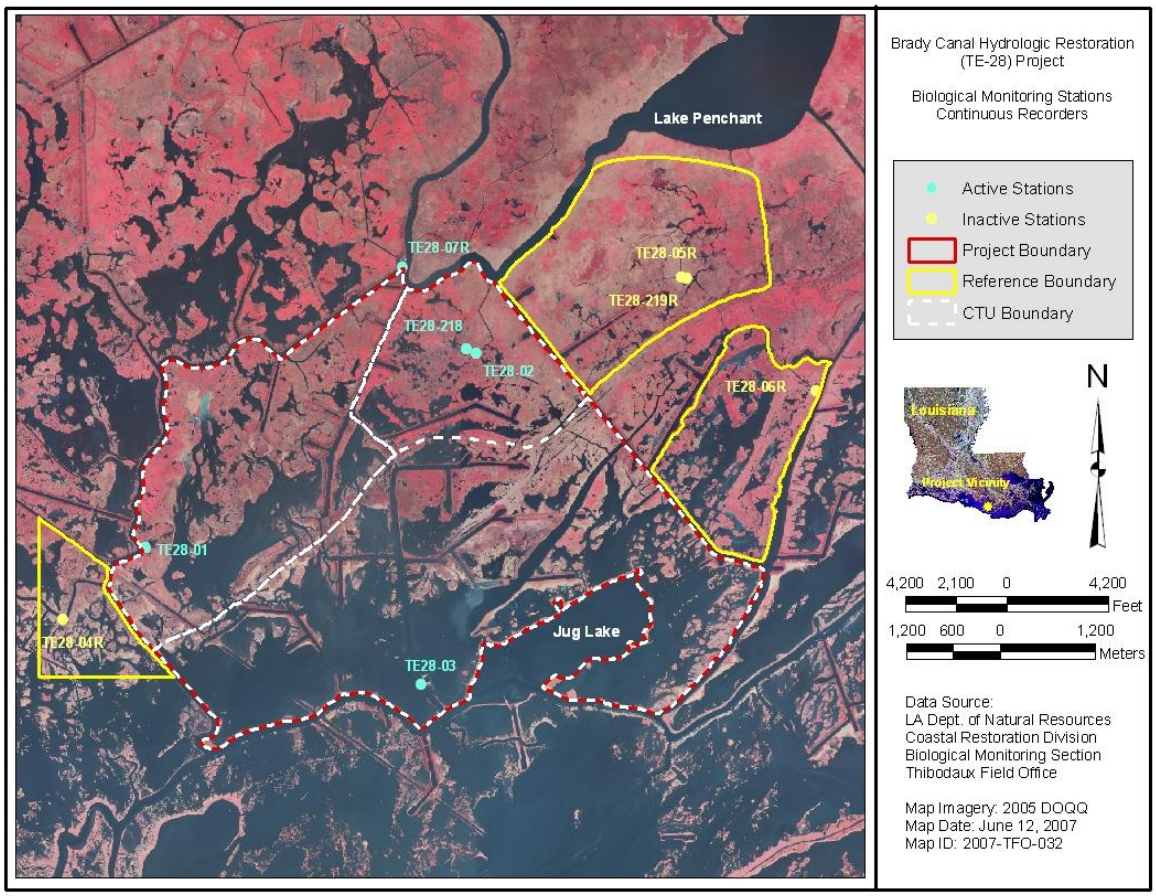

Figure 3. Location of active and inactive continuous salinity and water level recorders in the Brady Canal Hydrologic Restoration (TE-28) project. Stations were inactivated in April 2004 as a result of CRMS-*Wetlands*.

ground controls) was obtained. The photography was photointerpreted, scanned, mosaicked, georectified and analyzed by National WetlandsResearch Center (NWRC) personnel according to the standard operating procedure described in Steyer et al. (1995). The photography was obtained in 1998 (preconstruction) and in 2002 (post-construction), 2008 (post construction) and will be obtained in 2017 (post-construction).

Marsh Mat Movement

One continuous recorder (TE28-218) is located within CTU 2 to monitor marsh mat movement (figure 3). Mean weekly water level variability were determined for post-construction interval from 2007 to 2011 and compared to data collected from CRMS0294-M01. The continuous recorder at station TE28-219R was deactivated in February 2002 because data showed that this thick marsh mat did not exhibit vertical movement during high water events like the marsh mat at station TE28-218, nor did it

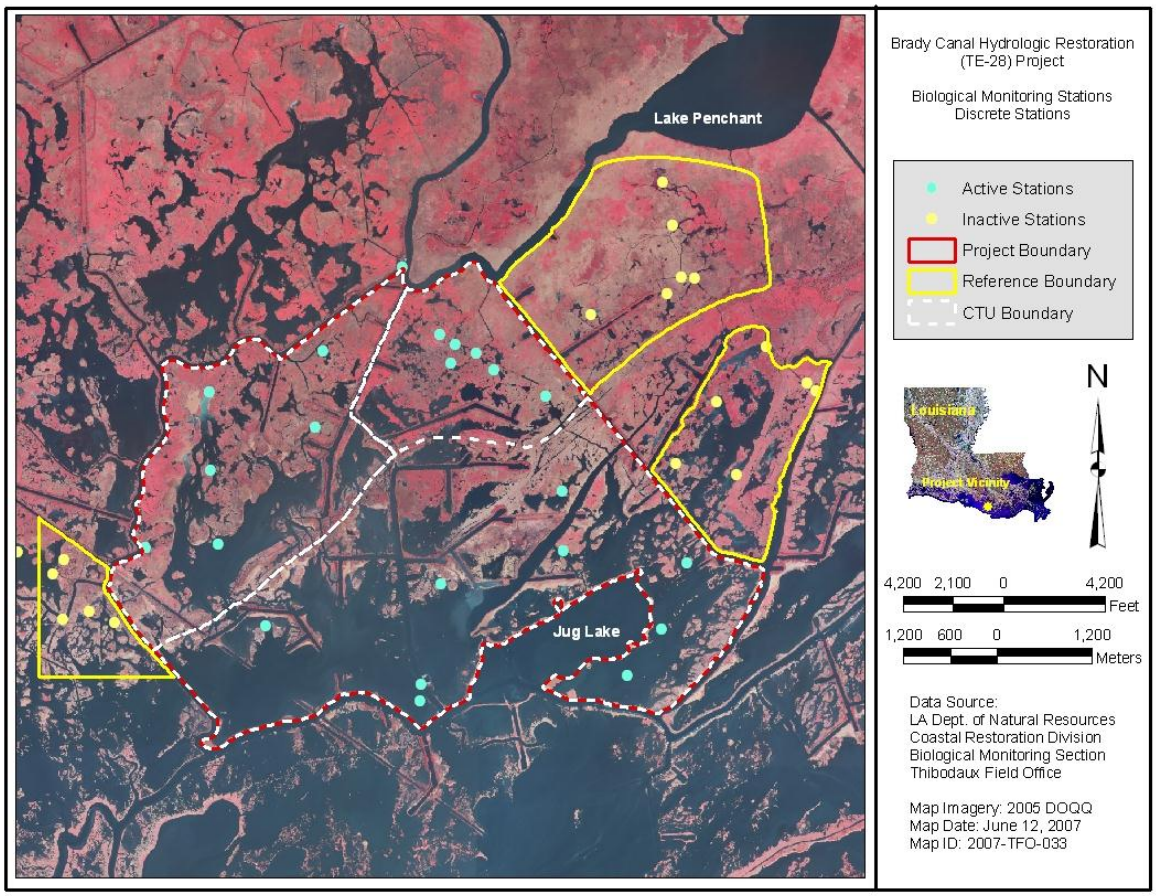

Figure 4. Location of active and inactive discrete sampling stations in the Brady Canal Hydrologic Restoration (TE-28) project. Stations were inactivated in April 2004 as a result of the CRMS-*Wetlands* program.

move vertically with normal water level changes (Folse and Babin 2007). Marsh mat movement data at TE28-218 were collected from 1998 to 2000 (pre-construction) and 2000-2006 (post-construction) and will continue to be collected utilizing the recorder located in CTU 2.

Submerged Aquatic Vegetation (SAV)

The frequency of occurrence of SAV was compared between project and reference areas. Within the project (by CTU) and reference areas, five ponds were sampled during the fall (October or November) in 1996 and 1999 (pre-construction) and in 2002 (post-construction). Sampling that was to take place in 2006, 2012, and 2015 (post-construction) will not occur due to the CRMS-*Wetlands* project (Folse 2003). Methods described in Nyman and Chabreck (1996) were used to determine the frequency of occurrence of SAV. The presence/absence of SAV is determined at a

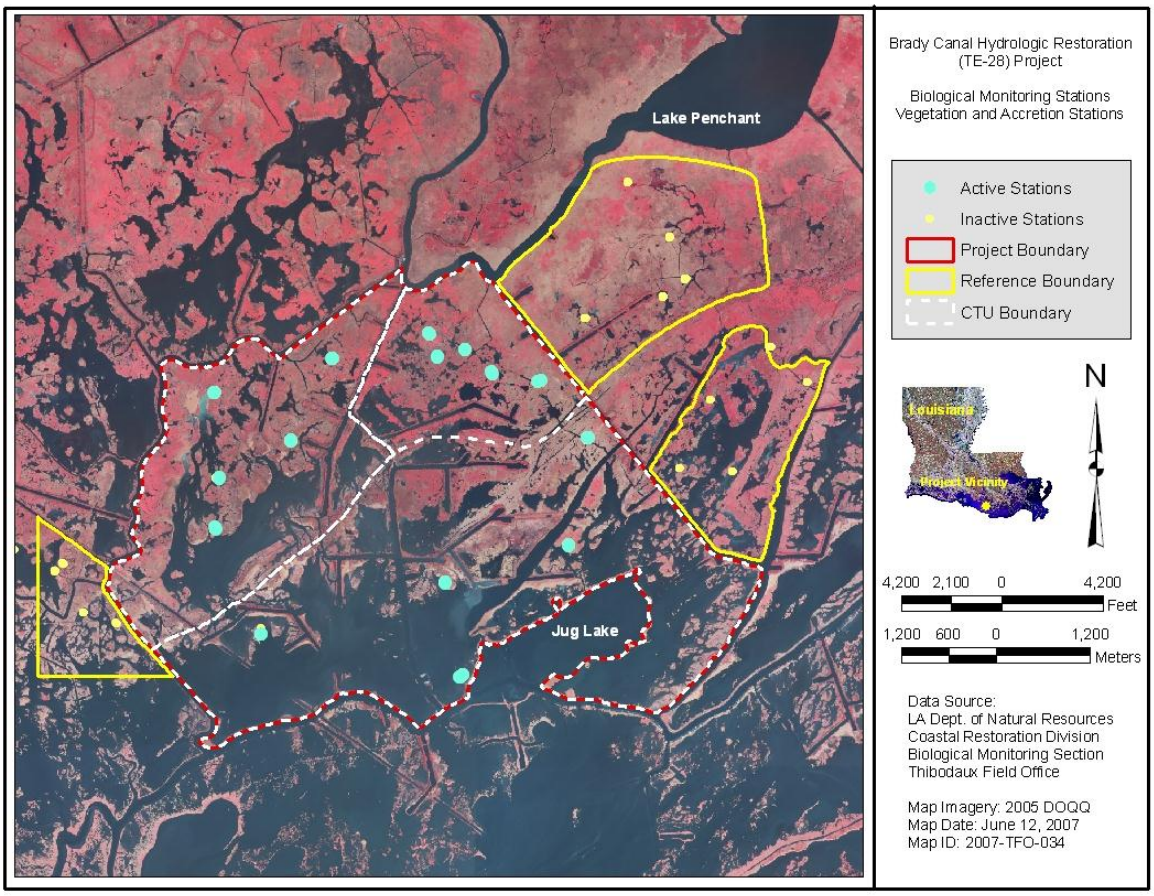

Figure 5. **Location of active and inactive emergent vegetation and accretion stations in the Brady Canal Hydroligic Restoration (TE-28) project.**

minimum of 20 random points within each pond sampled. Frequency of occurrence is determined for each pond from the number of points at which SAV occurred and the total number of points sampled. The species was noted as present when SAV occurred at a point sampled. Results from SAV sampling are located in Folse and Babin (2007).

CRMS Supplemental

Additional data collected at CRMS-*Wetlands* stations which can be used as supporting or contextual information for this project. Data types collected at CRMS sites include hydrologic, emergent vegetation, physical soil characteristics, discrete porewater salinity, marsh surface elevation change, vertical accretion, and land/water analysis of 0.4 mi^2 (1.0 km^2) area encompassing the station. For this report, land/water analysis, and vegetation data from three sites situated just outside the project area (CRMS0294, CRMS0398, and CRMS4045) will be used to characterize the structure of the adjacent fresh and intermediate marshes (figure 6). Hydrologic data from CRMS0294 and CRMS4045 were also used to analyze the performance of the TE-28 project. In the future, data collected from the CRMS network over a sufficient amount of time to develop valid trends will be

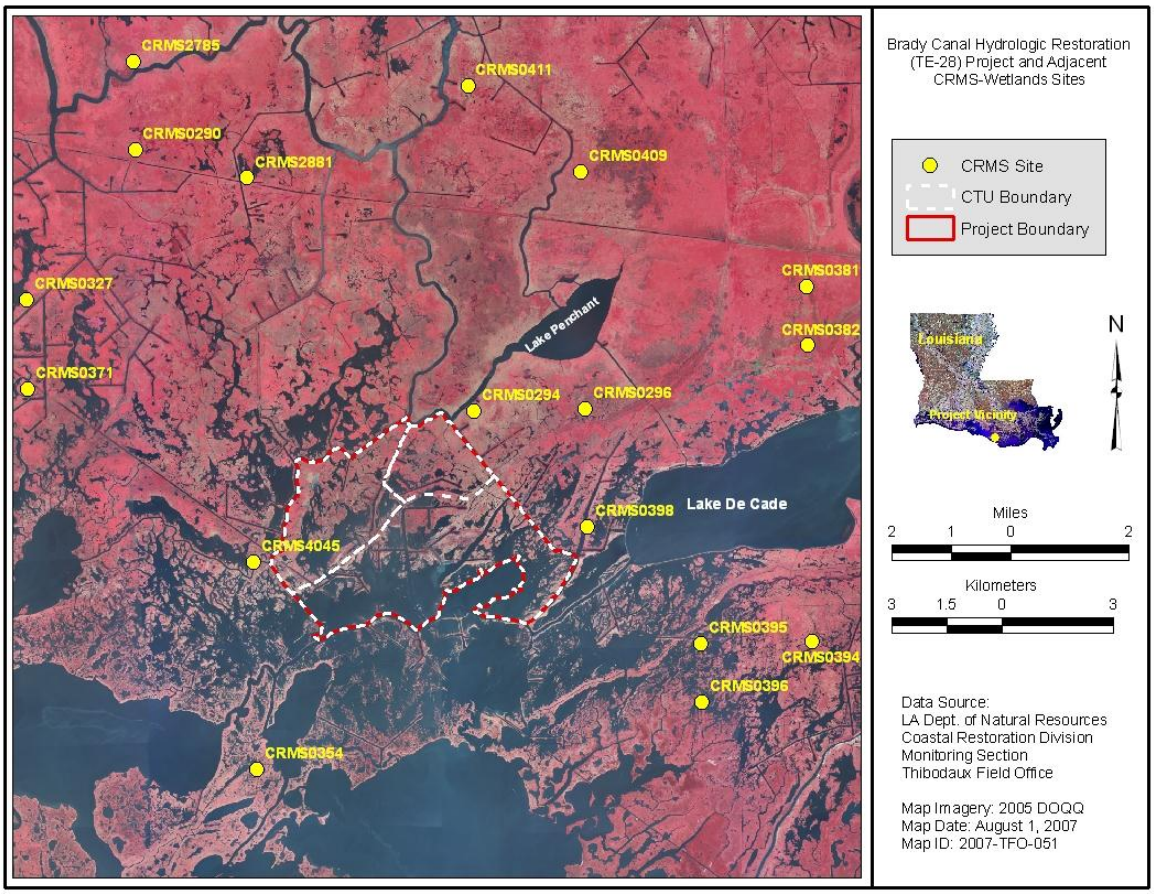

Figure 6. **CRMS-*Wetlands* sites in the vicinity of the Brady Canal Hydrologic Restoration (TE-28) project.**

used to develop integrated data indices at different spatial scales (local, basin, coastal) to which we can compare project performance.

Land/Water Classification CRMS0294, CRMS0398, and CRMS4045

Because of the inclusion of three Coast-wide Reference Monitoring System-*Wetlands* (CRMS) sites (CRMS0294, CRMS0398, and CRMS4045) on the perimeter of the Brady Canal Hydrologic Restoration (TE-28) project area (figure 6), land/water analysis was performed on a 0.4 mi^2 (1.0 km^2) small portion of the project area. The U.S. Geological Survey's National Wetlands Research Center (USGS/NWRC) obtained 3.3 ft (1.0 m) resolution color infrared (CIR) aerial photography to delineate land and water habitats over time. A pre-construction aerial image was captured on November 1, 2005. This image was analyzed, interpreted, processed, and verified for quality and accuracy using protocols established in Folse et al. (2008). Specifically, habitats in the 0.4 mi^2 (1.0 km^2) were condensed to a land or water classification. Land was considered to be a

combination of emergent marsh, scrub-shrub, wetland forested, and upland habitats. The open water, beach/bar/flat, and submerged aquatics (SAV) habitat classes were considered water. Once grouped into these two classes, the percentage of land and water and the land to water ratio for the pre-construction period were calculated. After the analysis was complete, the classification data and the photomosaic were mapped to spatially view the data.

Vegetation CRMS0294, CRMS0398, and CRMS4045

Because of the inclusion of three Coast-wide Reference Monitoring System-*Wetlands* (CRMS) sites (CRMS0294, CRMS0398, and CRMS4045) on the perimeter of the Brady Canal Hydrologic Restoration (TE-28) project area (figure 6), vegetation data was collected adjacent to the project area. Vegetation stations were established in the CRMS sites to document species composition and percent cover over time. Ten (10) plots were placed inside the 239 yd^2 (200 m^2) square, which is nested within the 0.4 mi^2 (1.0 km^2) square, as per Folse et al. (2008). Vegetation data were collected in 2006, 2007, 2008, 2009 and 2010 via the semi-quantitative Braun-Blanquet method (Mueller-Dombois and Ellenberg 1974; Sawyer and Keeler-Wolf 1995; Barbour et al. 1999). Plant species inside each $4m^2$ plot were identified, and cover values were ocularly estimated using Braun-Blanquet units (Mueller-Dombois and Ellenberg 1974) as described in Folse et al. (2008). The cover classes used were: solitary, <1%, 1-5%, 6-25%, 26-50%, 51-75%, and 76-100%. After sampling the plot, the residuals within a 16 ft (5 m) radius were inventoried.

Mean percent cover was calculated to summarize the vegetation data and was grouped by year. Floristic quality index (FQI) was also estimated using the Cretini and Steyer (2011) protocol.

Hydrologic Data CRMS0294, CRMS0398, and CRMS4045

Because of the inclusion of two Coast-wide Reference Monitoring System-*Wetlands* (CRMS) sites (CRMS0294-H01 and CRMS4045-H01) on the perimeter of the Brady Canal Hydrologic Restoration (TE-28) project area (figure 6), hydrologic data is being collected adjacent to the project area. Hydrologic data from these two sites were used as reference data in the weekly mean and tidal analyses. CRMS0294-M01 was also used as reference to compare the movement of project (TE28-218) and reference marsh mats.

c. Preliminary Monitoring Results

Salinity

Analysis of salinity was conducted for all sites using average weekly means to reduce the effects of diurnal tides (figure 7). Significant variation in mean weekly salinity was present among the sites tested ($F=20.1$, $p<2.2\times10^{-16}$). These differences are between two groups of sites which are clustered by geographic proximity. The first group includes sites TE28-01, TE28-03, and CRMS4045-H01, which all have mean salinities slightly greater than 1 ppt (figure 7). The second group of sites consists of TE28-02, TE28-07R, and CMRS0294-H01, which have mean salinities of ~0.3-0.5 ppt (figure 7). Sites within each of these groups are not significantly different from one another. Thus, geographic proximity plays a strong role in mean salinity. Additionally, the project does not appear to have had an impact on salinity as both groups of sites include project and reference sites, indicating that within a local geographic area the project has not affected mean weekly salinity.

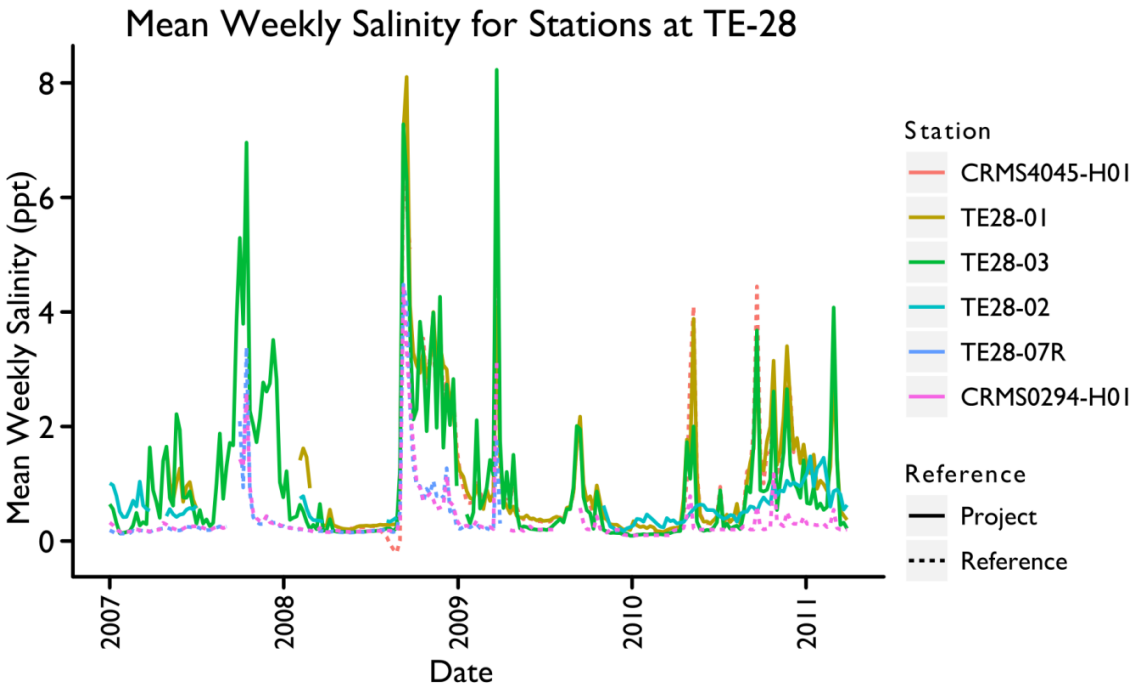

Figure 7. Mean weekly salinity (ppt) inside the Brady Canal Hydrologic Restoration (TE-28) project and reference areas from 2007 to 2011.

Water Level-Tidal Difference

To better identify the effects of this project on water level variability, a tidal analysis was completed. A program was written which identified continuous recorder observations corresponding to the maximum and minimum elevations for each tidal period. Data were partitioned into two spatial groups, project and reference, based on whether the station was within project boundaries or outside of project boundaries.

Figure 8 shows an analysis of elevation level data from the 1st of January to the 12th of February in 2007 at station TE28-07R. This analysis clearly identifies high (in red) and low (in blue) tides for each cycle; cycles greater than 20 hours in length are excluded. Overall the analysis does an excellent job of identifying high and low tidal points.

Tidal difference was calculated for all data by identifying maximum and minimum elevations for each cycle, then subtracting from the maximum elevation the minimum elevation following that particular maximum; i.e., tidal difference is the high tide elevation minus the following low tide elevation. An examination of monthly mean tidal differences indicates a 'break' in tidal difference that corresponds with geographic locality (figure 9). The CRMS0294-H01 site and TE28-02, which are geographically proximate, show similarly low levels of tidal difference. This is also reflected in the overall mean tidal difference (figure 10). Consistent with this, the range of tidal differences and overall means at sites CRMS4045-H01, TE28-01, and TE28-03, which are geographically proximate, are similar to one another.

A stated goal of this project is to reduce water level variability inside the project bounds. An Analysis of Variance (ANOVA) was conducted on the data to determine if tidal differences were significantly different between sites outside and inside of the project bounds. Sites were split into two groups based on geographic proximity. The project site TE28-02 and reference sites TE28-07R and CRMS0294 were included in the first group (Group North or N). These sites show significant variability in tidal difference ($F=234$, $p<2.2\times10^{-16}$). The project site, TE28-02, has significantly less tidal variability as the reference sites CRMS0294 and TE28-07R (figure 10). The second group of sites consists of the reference site CRMS4045-H01 and project sites TE28-01 and TE28-03 (Group West or W). Again, among these sites there is significant variability in tidal difference ($F=57$, $p<2.2\times10^{-16}$). Both project sites, TE28-01 and TE28-03, show significantly less tidal variability than the reference site CRMS4045-H01 (figure 10).

Thus, both analyses are consistent with the hypothesis that the project has had an impact by lowering water level variability. In both comparisons, the project site showed significantly lower tidal differences than the reference site. Whether natural variability plays a role in these differences is uncertain as a complete pre-project data set is unavailable**.**

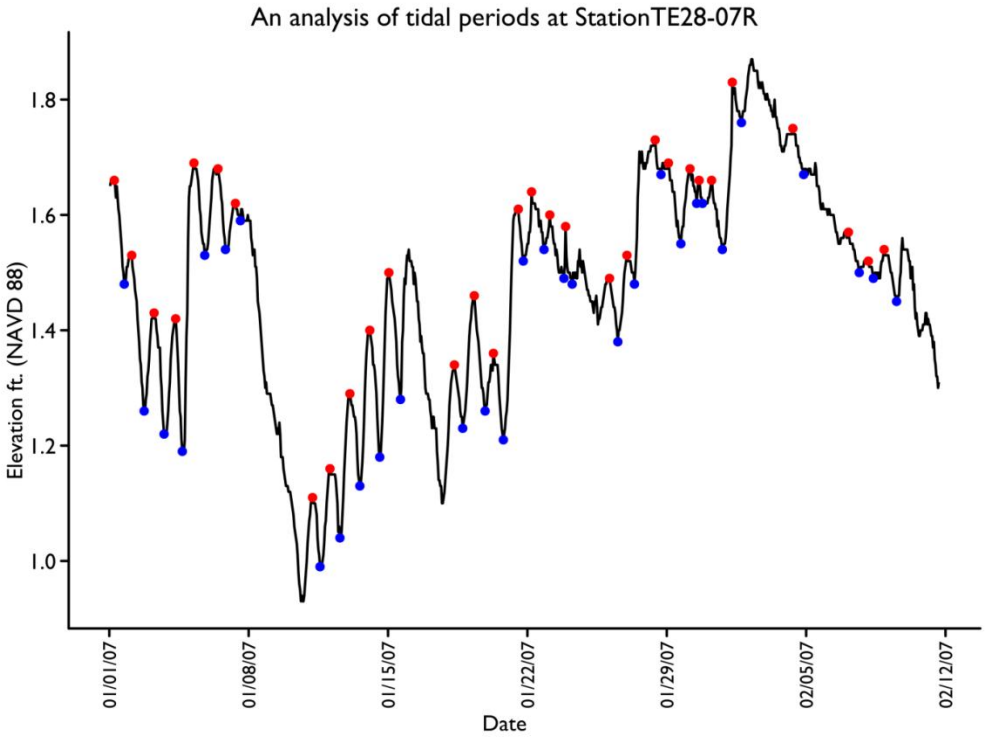

Figure 8. **Example of tidal cycle highs and lows for project-specific continuous recorder station TE28-07R.**

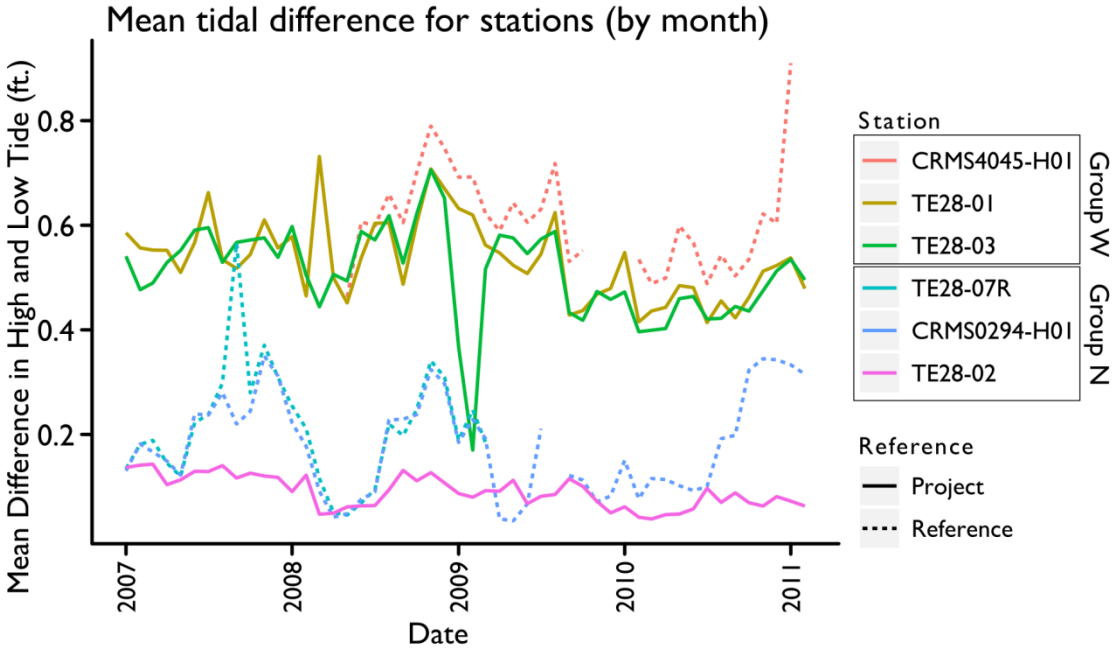

Figure 9. **Comparison of the monthly mean tidal range for the 2007-2010 period for project-specific and CRMS-Wetlands continuous recorder stations.**

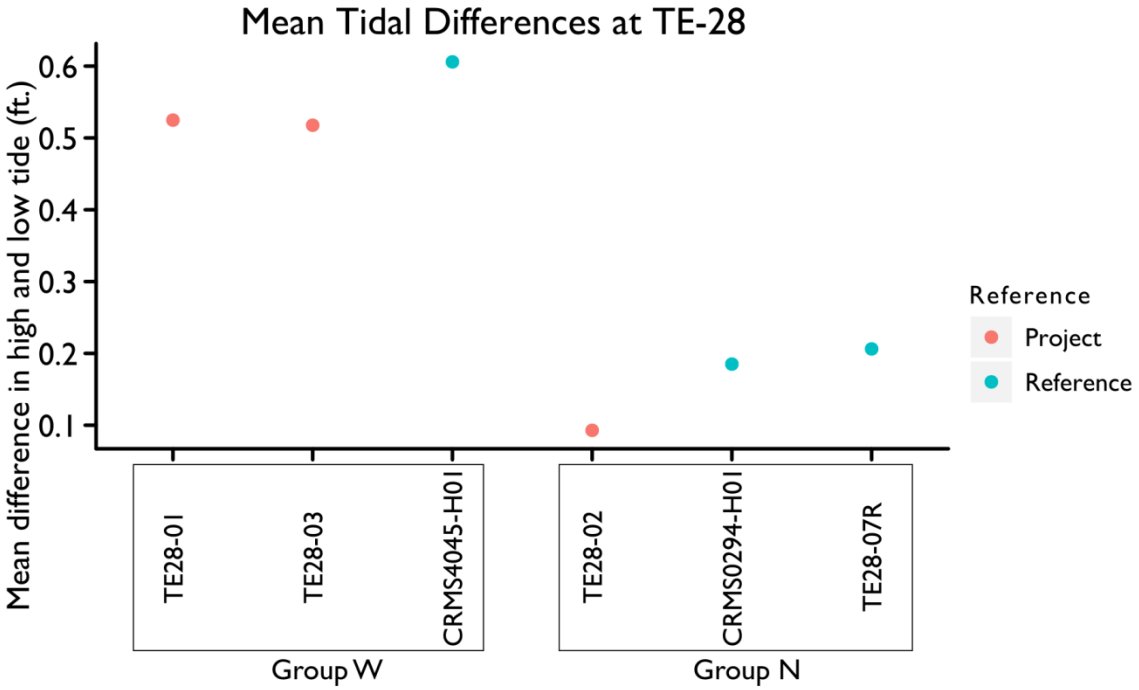

Figure 10. **Mean differences between high and low tide for project-specific and CRMS-Wetlands continuous recorder stations.**

Marsh Mat Movement

Mean weekly elevation (2007-2011) was calculated for the marsh-mat stations TE28-218 and CRMS0294-H01. Daily mean elevation is first calculated and then weekly mean elevation is calculated by averaging these daily means. Mean weekly marsh mat elevation showed a narrow range of variation, with the exception of one period in late 2008 where elevation for both stations spiked above 3 ft., and one period in mid-2009 for CRMS0294-M01, where elevation dropped to 0 ft (figure 11). Excluding these periods, elevation ranged from 1-2 ft. Despite this narrow range, differences in mean weekly elevation are significantly different when compared with an ANOVA ($F=9.5$, $p=0.002$). The CRMS0294 station has a slightly higher mean elevation (1.5 ft) than the project station TE28-218 (1.3 ft), which is suggested by a visual examination of the mean weekly elevations.

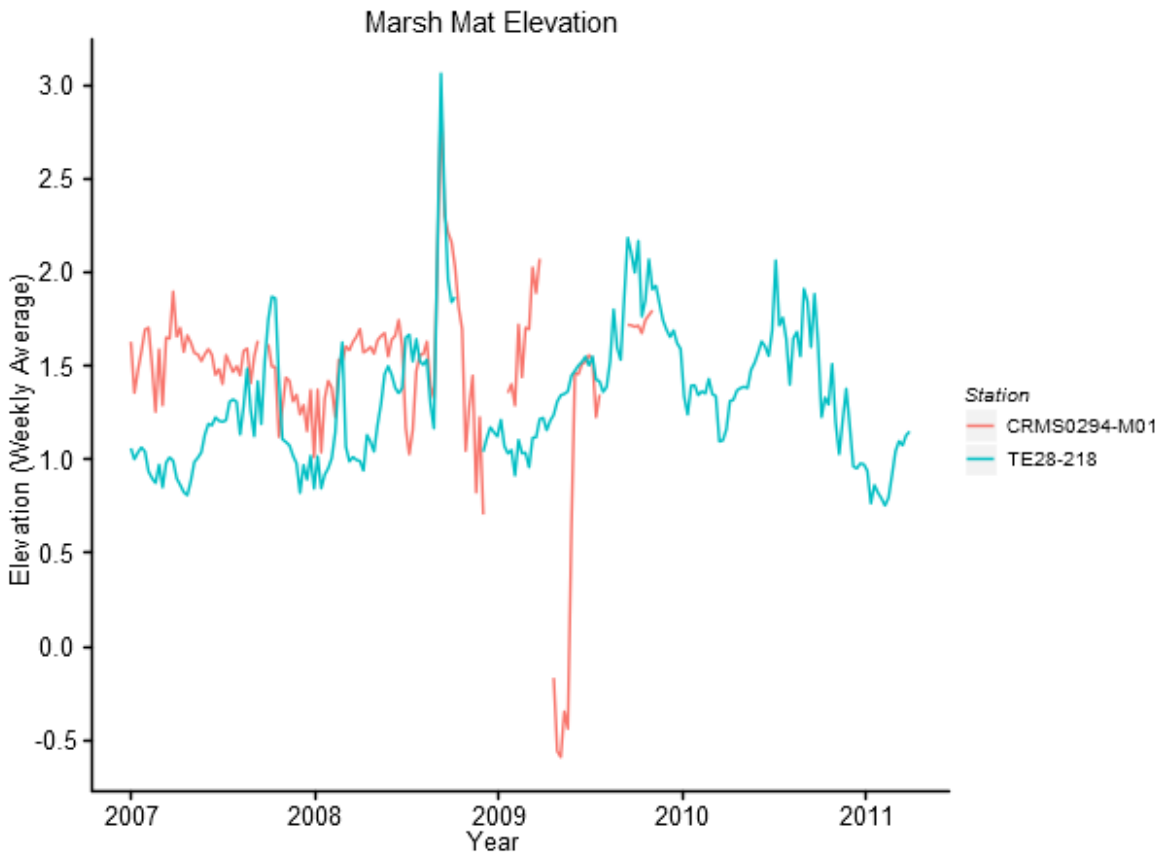

Figure 11. **Mean weekly marsh mat elevations at TE28-218 and CRMS0294-M01 from 2001 to 2011.**

Emergent Vegetation

Sagittaria lancifolia L. (bulltongue arrowhead), *Spartina patens (Ait.) Muhl.* (saltmeadow cordgrass), and *Sacciolepis striata (L.)* Nash (American cupscale) were the dominant vegetation species found in the Brady Canal Hydrologic Restoration (TE-28) project areas (CTU 1, CTU 2, and CTU 3) (figure 12). Excluding 2002, the vegetative cover in CTU 1 and CTU 3 remained relatively constant over the sampling periods. In 2002 the vegetative cover in CTU 1 and CTU 3 declined. However, the vegetative cover also decreased in CTU 2 during 2002 (figure 12). Indicating that, environmental factors likely affected cover in 2002. The vegetative cover in CTU 2 fluctuated from over 90% in 1999 and 2006 to 60% in 2002 and 2009. Generally, the influence of the dominant species diminished over time in all CTU's because other species had higher cover values.

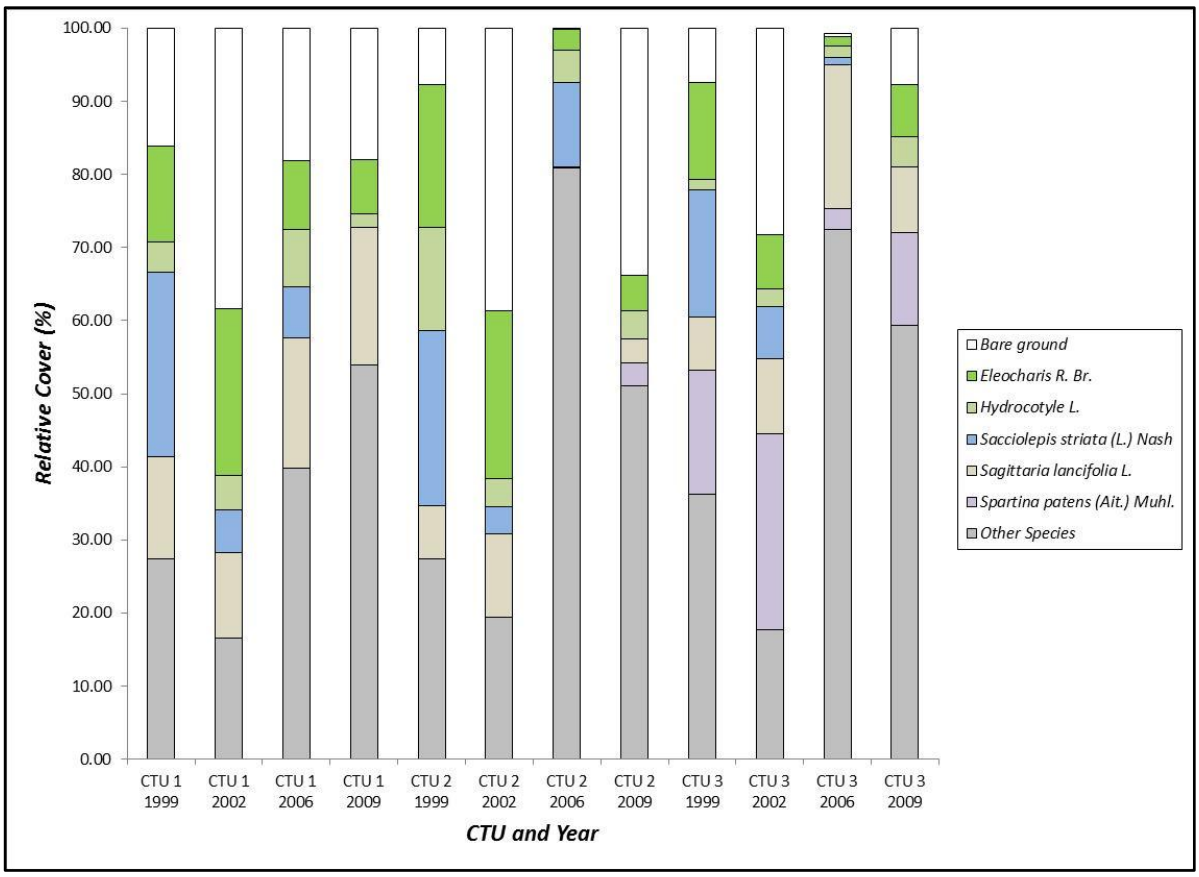

Figure 12. Relative cover of the top five vegetation species populating the Brady Canal Hydrologic Restoration (TE-28) project areas from 1999 to 2009. Ocular vegetation data were grouped by CTU and year.

Habitat Mapping

Color-infrared 9x9 photography and digital imagery was acquired for the Brady Canal Hydrologic Restoration (TE-28) project according to the monitoring plan specification. Hydrologic restoration projects require detailed habitat mapping or land/water classification in order to assess restoration success or failure. The basic goal of habitat mapping is to provide a consistency of products by using the U.S. Fish and Wildlife Service's (USFWS) National Wetland Inventory (NWI) wetland classification system. This system is used so wetland habitat changes are accurately and similarly assessed throughout the project's life. The Brady Canal Hydrological Restoration (TE-28) project requires detailed mapping, thus the photography is photointerpreted by bringing the digital mosaic of the project area into ArcMap Software. Habitat types are delineated by overlaying project area boundaries onto the imagery and editing features. Ancillary data sets from 1998 through 2010 are used to help classify areas that may be difficult to identify. Imagery of the project area is also viewed in stereo which helps determine vegetation height and proper classification.

The habitat class and change analysis baseline data was gathered in 1998 and repeated in 2002 and 2008. Change analyses included in this report are from the 1998-2002 period and the 1998-2008 period for both the project and reference area.

The Brady Canal Hydrologic Restoration (TE-28) project area habitat class and change analysis illustrates change for both land and water habitat. The project area experienced a net loss/gain equal to 0 of fresh marsh habitat from 1998-2008, but lost 217 acres of fresh marsh habitat in the intermediate habitat change period of 1998-2002. An increase in intermediate marsh habitat is documented in the project area for both habitat change periods. Upland barren habitat gained approximately 5 acres during both the 1998-2002 and 1998-2008 change analysis time periods. Upland forested habitat exhibited a loss of 51 acres during the 1998-2002 time period and 56 acres between 1998 and 2008. Upland range and upland shrub-scrub habitats gained several acres during each time period, while wetland forested and wetland scrub-shrub had net gains of 10 acres and 39 acres, respectively, from 1998-2008. Mudflat habitat lost a few acres during the 1998-2002 change analysis period, but gained 172 acres during the 1998-2008 change analysis period. The most notable change occurred in the open water-fresh and open water-intermediate habitats, with a net loss of 457 acres of open water-fresh and a net gain of 167 acres of open water- intermediate habitats from the 1998-2008 change analysis period.

Table 1. National Wetlands Inventory habitat classes, acreages and change for 1998, 2002, and 2008 for the Brady Canal Hydrological Restoration (TE-28) project.

Habitat Class and Change Project Area	*1998 Acres*	*2002 Acres*	*2008 Acres*	*98-02 Change*	*98-08 Change*
Marsh-Fresh	2177	1960	2177	-217	0
Marsh-Imtermediate	359	446	474	87	115
Upland Barren	1	6	5	5	4
Upland Forested	65	14	9	-51	-56
Upland Range	0	8	3	8	3
Upland Shrub-Scrub	7	16	12	9	5
Upland Urban	6	6	5	0	-1
Wetland Forested	206	294	216	88	10
Wetland Scrub-Shrub	220	305	259	85	39
Mudflat	4	1	176	-3	172
Open Water-Fresh	3,401	3,089	2,944	-312	-457
Open Water-Intermediate	1,036	1,338	1,203	302	167
TOTAL	7,482	7,482	7,482	0	0

Habitat class and change was analyzed for land and water in the reference area as well as the Brady Canal Hydrological Restoration (TE-28) project area. In the reference area, marsh-fresh habitat lost 89 acres from 1998-2002 and 235 acres from 1998-2008, while marsh –intermediate habitat gained 82 acres from 1998-2002 and 192 acres from 1998-2008. Upland barren, upland forested, upland range, upland scrub-shrub and upland urban habitats acreages remained essentially the same from 1998-2002 and 1998-2008. The wetland forested habitat experienced a net gain of a few acres over both time periods and the wetland scrub-shrub experienced a net loss of several acres over both change analysis periods. Mudflat habitat incurred a net gain of 37 acres from 1998-2002 and 1998-2008. The most notable changes occurred in the open water- fresh and open water- intermediate habitats with a net loss of 178 acres of open water-fresh habitat and a net gain of 184 acres of open water-intermediate habitat over both change analysis period 1998-2002 and 1998-2008.

Table 2. National Wetland Inventory habitat classes, acreages and change for 1998, 2002, 2008 at Brady Canal Hydrological Restoration (TE-28) Project Reference area.

Habitat Class and Change Reference Area	*1998 Acres*	*2002 Acres*	*2008 Acres*	*98-02 Change*	*98-08 Change*
Marsh-Fresh	1660	1571	1425	-89	-235
Marsh-Imtermediate	275	357	467	82	192
Upland Barren	1	0	0	-1	-1
Upland Forested	0	0	1	0	1
Upland Range	0	0	0	0	0
Upland Shrub-Scrub	0	0	0	0	0
Upland Urban	2	2	2	0	0
Wetland Forested	50	92	53	42	3
Wetland Scrub-Shrub	88	44	85	-44	-3
Mudflat	3	0	40	-3	37
Open Water-Fresh	476	455	298	-21	-178
Open Water-Intermediate	319	350	503	31	184
TOTAL	2,873	2,871	2,873	0	0

The habitat class and change analysis for the Brady Canal Hydrological Restoration (TE-28) Project and reference areas appear to follow a similar trend. Although the project area change analysis indicates a net gain/loss of 0 in Fresh Marsh Habitat from 1998-2008, the interim change analysis from the 1998-2002 time period indicates a loss of 217 acres of fresh marsh habitat. The habitat class and change analysis from the reference area indicates a net loss of 235 acres from 1998-2008, with 89 acres lost during the interim habitat change period of 1998-2002. Both the project and reference areas show a gain of marsh-intermediate habitat during both change analysis periods. In both areas, the upland barren, upland range, upland scrub-shrub and upland urban habitats do not show much, if any, change from 1998-2002 or 1998-2008. However, in the project area, upland forested habitat experienced a net loss of 56 acres from 1998-2008, while the reference area gains 1 acre during the same habitat change

period. Wetland scrub-shrub habitat gained 39 acres in the project area, while losing 3 acres in the reference area during the same habitat change period. Mudflat habitat is gained in both areas. More notably, 457 acres open water-fresh habitat is lost in the project area and 178 acres in the reference area from 1998-2008. Open water Intermediate is gained in both areas from 1998-2008; 167 acres in the project area and 184 acres in the reference area.

CRMS Supplemental

Land/Water Classification CRMS0294, CRMS0398, and CRMS4045

The Land/Water classification of CRMS0294, CRMS0398, and CRMS4045 showed that the 0.4 mi^2 (1.0 km^2) square portions of these sites were experiencing minor subaerial land loss from 2005 to 2008. The land/water maps for CRMS0294, CRMS0398, and CRMS4045 are provided in appendix D. The percentage of subaerial land inside CRMS0294 were 87% in 2005 and 85% in 2008 while the CRMS0398 percentages were 46% in 2005 and 45% in 2008. The CRMS4045 site remained at 49% land in 2005 and 2008 (figure 13). These percentages correspond to land to open water ratios of 1:7 (CRMS0294 in 2005), 1:6 (CRMS0294 in 2008). Both the CRMS0398 and CRMS4045 sites recorded ratios of 1:1 for all time periods. CRMS0294 subaerial land habitat declined by 5 acres (2 ha) or 2 acres/yr (1 ha/yr) and the CRMS0398 habitat declined by 2 acres (1 ha) or 1 acre/yr (0.4 ha/yr) during this interval. CRMS4045 gained 1 acre (0.4 ha) or 0.3 acre/yr (0.1 ha/yr) for the 2005 to 2008 interval. The CRMS0294 site displayed small expansions in ponds and creeks in the northwest and southeast quadrants of the 0.4 mi^2 (1.0 km^2) square. CRMS0398 showed very minor land loss on the perimeter of the 200 m square. No ocular changes could be detected from the CRMS4045 land/water maps. As a result, the marshes adjoining the Brady Canal Hydrologic Restoration (TE-28) project area exhibited only negligible conversions to water from 2005 to 2008.

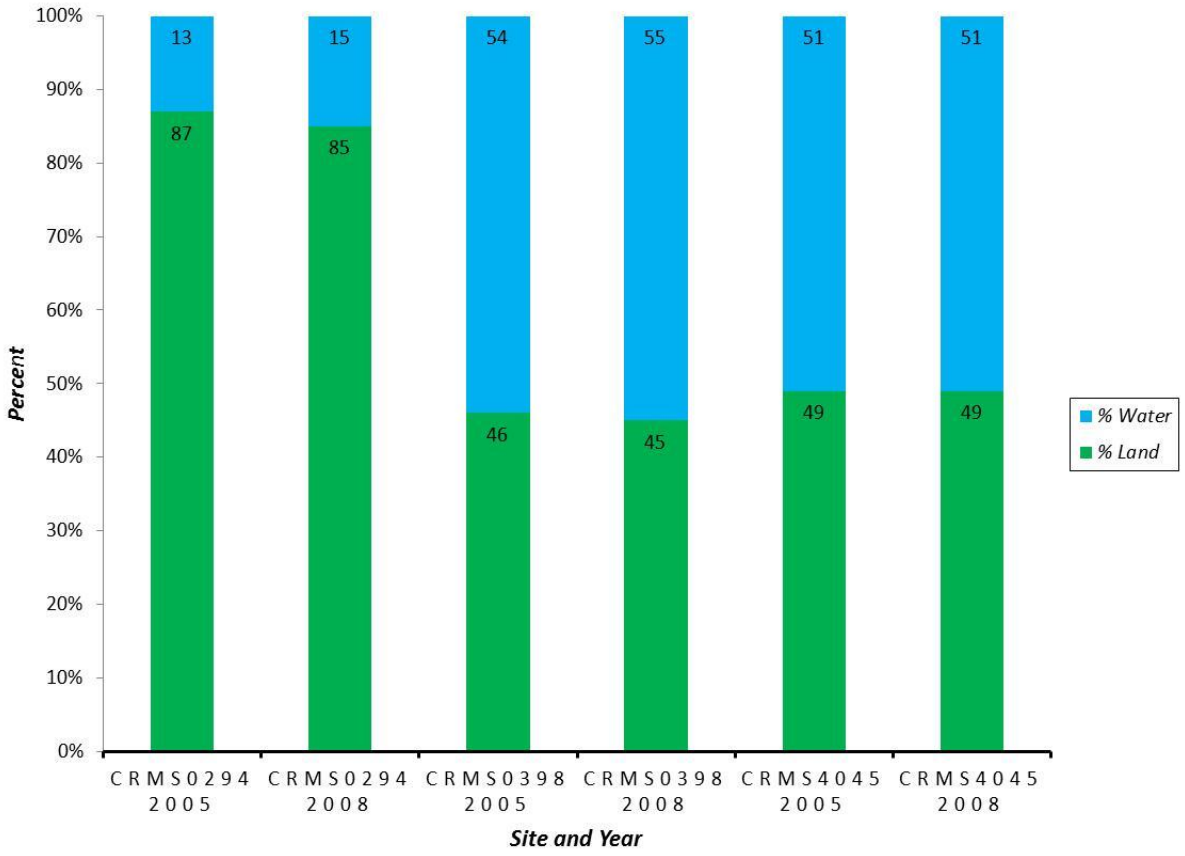

Figure 13. Percentage of land and water inside the CRMS reference areas in 2005 and 2008.

Vegetation CRMS0294, CRMS0398, and CRMS4045

The CRMS0294, CRMS0398, and CRMS4045 vegetation data confirms the classification of the Brady Canal Hydrologic Restoration (TE-28) project areas as fresh and intermediate marsh. The dominant species found in freshwater habitats (CRMS0294) were *Polygonum punctatum Elliot* (dotted smartweed), *Ludwigia grandiflora (Michx.) Greuter & Burdet* (large-flower primrose-willow), and *Typha L.* (cattail) (figure 14). The dominant species found at CRMS0398 (intermediate marsh) were *Spartina patens (Ait.) Muhl.* (saltmeadow cordgrass) and *Schoenoplectus americanus (Pers.) Volk. ex Schinz & R. Keller* (chairmaker's bulrush) (figure 15). The dominant species found at CRMS4045 (intermediate marsh) were *Sagittaria lancifolia L.* (bulltongue arrowhead), *Polygonum punctatum Elliot* (dotted smartweed), *Baccharis halimifolia L.* (eastern baccharis), and *Solidago sempervirens L.* (seaside goldenrod) (figure 16). The CRMS data show that there is spatial variation in the vegetation communities on the perimeter of the TE-28 project. The mean cover and FQI values for CRMS0294 declined over time, the values for CRMS0398 remained parallel over time, and the values for CRMS4045 increased over time. Therefore, the communities surrounding the TE-28 project differed in species composition, mean cover, and FQI.

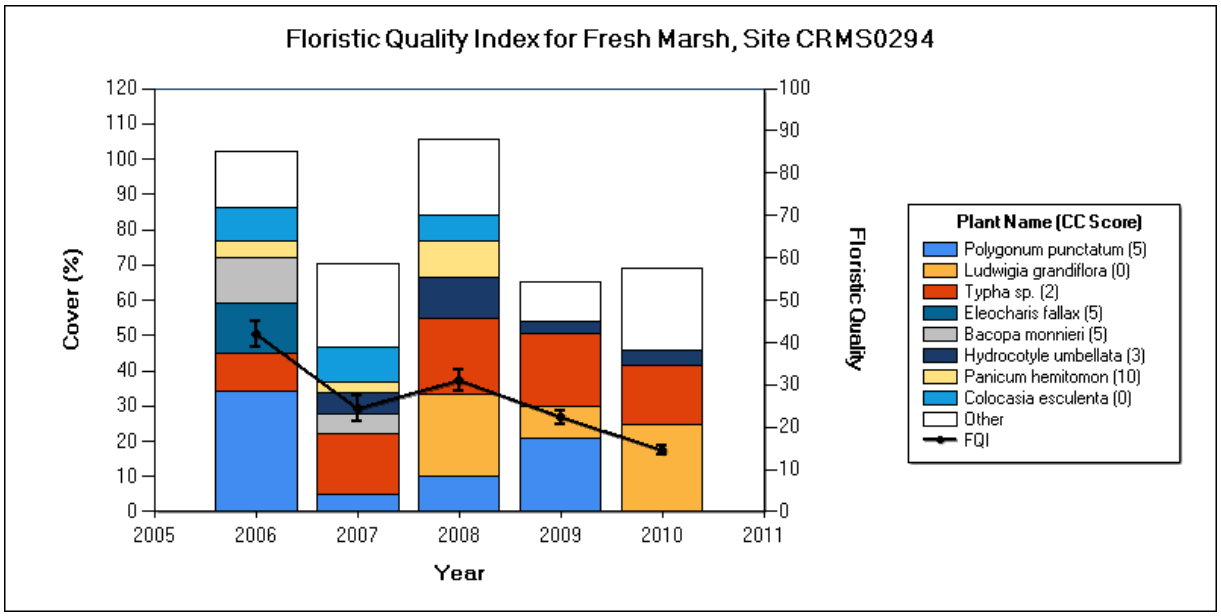

Figure 14. **Mean percent cover and floristic quality index for the vegetation species populating CRMS0294 reference areas in 2006, 2007, 2008, 2009, and 2010.**

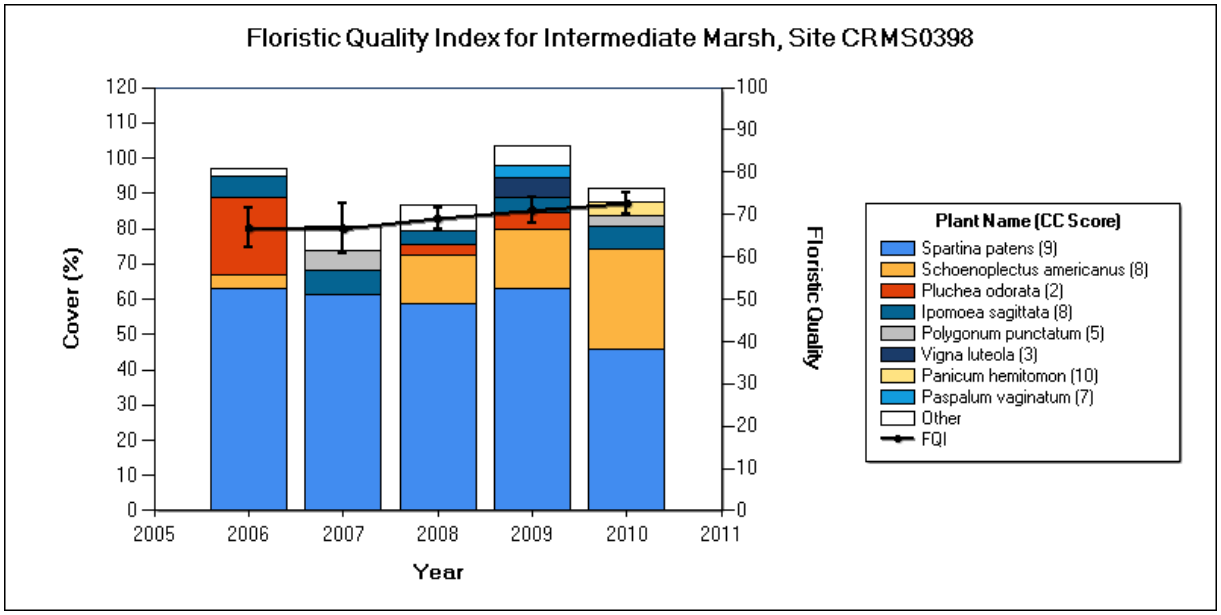

Figure 15. **Mean percent cover and floristic quality index for the vegetation species populating CRMS0398 reference areas in 2006, 2007, 2008, 2009, and 2010.**

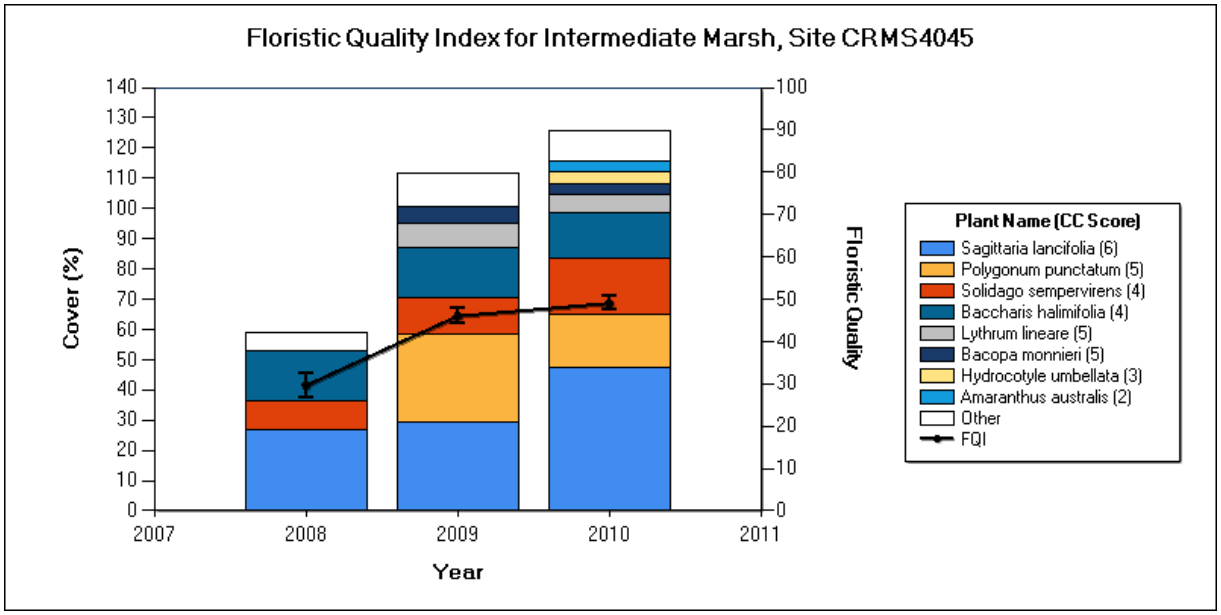

Figure 16. **Mean percent cover and floristic quality index for the vegetation species populating CRMS4045 reference areas in 2008, 2009, and 2010.**

e. Discussion

The results of the Brady Canal Hydrologic Restoration (TE-28) project seem to suggest that most the project goals are being maintained. The project goal of decreasing marsh loss was attained as the acreages of fresh marsh habitat remained the same in the project area during the change analysis period of 1998-2008 while the reference areas experienced considerable conversions of fresh to intermediate marsh. Also, intermediate marsh and wetland scrub-shrub habitats expanded during this same time period in the project area while open water and upland forested habitats declined. In comparison, the reference areas lost 235 acres of fresh marsh habitat from 1998-2008 and gained 192 acres of intermediate marsh habitat.

The vegetation species found in the Brady Canal Hydrologic Restoration (TE-28) project areas were consistent with freshwater and intermediate marsh communities. The dominant species found were *Sagittaria lancifolia L*. (bulltongue arrowhead), *Spartina patens (Ait.) Muhl.* (saltmeadow cordgrass), and *Sacciolepis striata (L.)* Nash (American cupscale). Generally, the influence of the dominant species diminished over time in all CTU's because other species had higher cover values. However, the species present were freshwater and intermediate marsh vegetation and cover values are fairly high. The reference sites had different community structures but were populated by freshwater or intermediate marsh species. As a result, the goal to maintain or increase the abundance of freshwater and intermediate marsh species seems to have been achieved to date.

The Brady Canal Hydrologic Restoration (TE-28) project also seems to have had an impact by lowering water level variability. The project and reference areas were split into two groups because monthly mean tidal differences indicated a 'break' in tidal difference that corresponds with geographic locality Both groups showed significantly lower tidal differences in the project areas than the reference sites. Mean weekly marsh mat elevation showed a narrow range of variation. Despite this narrow range, differences in mean weekly elevation were significantly different. The reference area had a slightly higher mean elevation than the project station TE28-218. Therefore, the goal to decrease water level variability seems to have been achieved because water level variability is lower in the project area.

Salinity data showed that geographic proximity plays a strong role in mean salinity at the Brady Canal Hydrologic Restoration (TE-28) project. Significant variation in mean weekly salinity was present among the sites tested. These differences are between the two groups of sites which are clustered by geographic proximity. Sites within each of these groups are not significantly different from one another. Additionally, the project does not appear to have had an impact on salinity as both groups of sites include project and reference sites, indicating that within a local geographic area the project has not affected mean weekly salinity. Therefore, the goal to decrease salinity variability has not been achieved to date.

V. Conclusions

a. Project Effectiveness

The results of the Brady Canal Hydrologic Restoration (TE-28) project reveal that three of the project goals were achieved while the other goal was not realized as of this time. The first goal to decrease the rate of marsh loss was achieved as of this time. No freshwater marsh loss occurred within the TE-28 project area while the reference areas experienced considerable conversions of fresh to intermediate marsh. In addition, wetland scrub-shrub, intermediate marsh, and mudflat habitats increased while open water and upland forested habitats declined in the project area. The second goal to maintain or increase the abundance of freshwater and intermediate marsh species was attained to date. The vegetation species inside the TE-28 project areas were consistent with freshwater and intermediate marsh communities. Although the influence of the dominant species seems to have declined over time, the species present were freshwater and intermediate marsh vegetation. The third goal to decrease water level variability seems to have been accomplished to date. The TE-28 project areas had significantly lower tidal differences than the reference sites. While geographic locality did affect the tidal signature, the corresponding reference areas exhibited higher water level variability than their respective project areas. Furthermore, mean weekly marsh mat elevations were significantly different between project and reference sites. The reference area had a slightly higher mean elevation than the project area. The fourth goal to decrease salinity variability has not been reached to date. Similar to water tidal differences, the TE-28 project does have a geographic separation in salinity. Project and reference areas were partitioned into two groups based on mean salinity. Project and reference areas within each of these groups were not significantly different from one another. Therefore, within a local geographic area the project does not appear to have lowered mean weekly salinity.

b. Recommended Improvements

Many of the structural components that shape the Brady Canal Hydrologic Restoration Project have experienced some form of degradation since the last maintenance event in 2003. Some deterioration of the structures is expected due to their exposure to tidal exchanges, natural weathering and extreme storm events, but some of the structures have deteriorated to the point in which they can no longer achieve their design goals. Recommended improvements to the TE-28 project include the refurbishment of these structures which require maintenance, and to repair the structures which no longer help achieve the project goals. The structures which have been identified as in need of maintenance have been included in the 2011 Maintenance Project and are described in detail in a previous section. This 2011 Maintenance Project is scheduled to begin the bid process in November 2011 with construction expected to begin in the spring of 2012.

c. Lessons Learned

One monitoring lesson was learned from the Brady Canal Hydrologic Restoration (TE-28) project. The monitoring lesson is that the location of the TE-28 project complicates the analysis of water level, salinity, and vegetation data. The position of the project in an area that transitions from fresh to intermediate habitats caused the project to be divided into subdivisions (CTU's). Fortunately, resource managers had the foresight to pair reference areas with each CTU. Subsequently, CRMS sites replaced the project specific reference areas. However, the CRMS sites were placed within or in the vicinity of the former reference areas resulting in a parallel conversion in reference areas. Water level and salinity data was partitioned into two groups based on means and geographic proximity. Without this pairing of data, accurate assessment of project performance would not be possible because many of the areas are inherently significantly different due to the transitions from fresh to intermediate habitats. In conclusion, the lesson learned from the TE-28 project is that future restoration projects that are constructed in areas that have transitions in marsh type and/or hydrology should have multiple (paired) reference areas to establish performance standards for each subdivision of the project.

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Appendix A
(Inspection Photographs)

Photo 1: Armored breach repair located in oil field access off Superior Canal, looking northeast

Photo 2: Armored breach repair located in oil field access off Superior Canal, looking northeast

Photo 3: Bayou DeCade Rock Dike and breach closure constructed in 2003, looking north

Photo 4: Bayou DeCade Rock Dike and breach closure constructed in 2003, looking north

Photo 5: Bayou DeCade Rock Dike and breach closure constructed in 2003, looking north

Photo 6: Bayou DeCade Rock Dike and breach closure constructed in 2003, looking north

Photo 7: Bayou DeCade Rock Dike and breach closure constructed in 2003, looking north

Photo 8: Bayou DeCade Rock Dike and breach closure constructed in 2003, looking north

Photo 9: Bayou DeCade Rock Dike and breach closure constructed in 2003, looking north

Photo 10: Bayou DeCade Rock Dike and breach closure constructed in 2003, looking north

Photo 11: Southeast section of Jug Lake Shoreline looking southeast

Photo 12: Large breach along southeast bank of Jug Lake, location N 29° 22’ 14.2” W 90° 56’ 40.8”

Photo 13: Large breach along southeast bank of Jug Lake, location N 29° 22’ 14.2” W 90° 56’ 40.8”

Photo 14: Bankline along southeast side of Jug Lake

Photo 15: Bankline along southeast side of Jug Lake

Photo 16: Bankline along southeast side of Jug Lake

Photo 17: Structure 24 along Jug Lake shoreline, looking east

Photo 18: Embankment tie-in south of Structure 24, looking east

Photo 19: Embankment tie-in north of Structure 24, looking east

Photo 20: Embankment tie-in south of Structure 23 Tie-In Erosion, looking east

Photo 21: Two bay variable crest Structure 23, looking east

Photo 22: Structure 23 Tie-In Breach on north side of structure, looking east

Photo 23: Shoreline along northern bank of Jug Lake, looking northwest

Photo 24: Shoreline along northern bank of Jug Lake, looking northwest

Photo 25: Shoreline along northern bank of Jug Lake, looking northwest

Photo 26: Tie-in erosion on northeast side of Structure 21 causing exposed bulkhead

Photo 27: Three bay variable crested weir Structure 21, looking northwest

Photo 28: Tie-in erosion on southwest side of Structure 21 causing exposed bulkhead

Photo 29: Shoreline along the northwest bank of Jug Lake south of Structure No. 21, looking northwest.

Photo 30: Shoreline along the northwest bank of Jug Lake south of Structure No. 21, looking northwest

Photo 31: Shoreline along the northwest bank of Jug Lake south of Structure No. 21, looking northwest

Photo 32: Small breach along the northwest shoreline of Jug Lake located between Structure 20 and Structure 21

Photo 33: Small breach along the northwest shoreline of Jug Lake located between Structure 20 and Structure 21

Photo 34: Jug Lake Shoreline to be repaired in 2011 Maintenance Project, looking northwest

Photo 35: Shoreline along the northwest side of Jug Lake north of Structure 20, looking northwest.

Photo 36: Rock armored channel liner of Structure 20, looking north

Photo 37: Structure 20 channel liner bank tie-in on west side, looking north

Photo 38: Structure 20 channel liner bank tie-in on east side, looking north

Photo 39: Low bank line along the north bank of Bayou Decade near the entrance to Jug Lake.

Photo 40: Existing north bankline of Bayou Decade between Jug Lake and Structure No.6

Photo 41: Existing north bankline of Bayou Decade between Jug Lake and Structure No.6

Photo 42: Fixed crest weir tie-in on east side of Structure 6, looking north

Photo 43: Navigational sign on east side of Structure 6, to be replaced in 2011 Maintenance Project

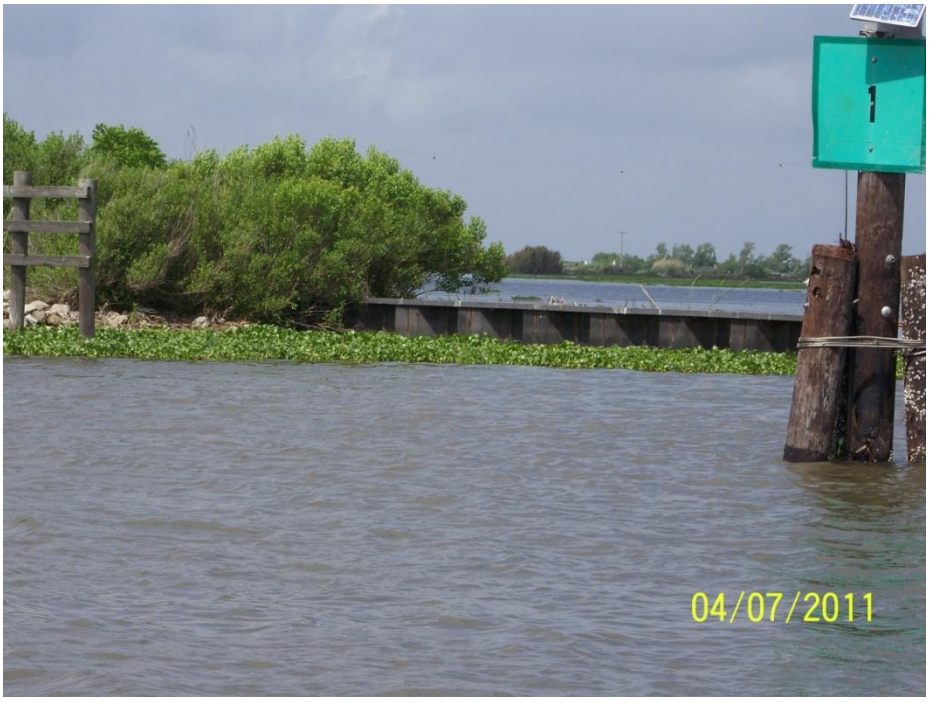

Photo 44: Fixed crest weir tie-in on west side of Structure 6, looking north

Photo 45: Navigational sign on west side of Structure 6, to be replaced in 2011 Maintenance Project

Photo 46: Steel sheetpile weir and timber bumper guards on the west side of the barge bay of Structure No.6

Photo 47: Navigational aids on west side of Structure 6, looking south

Photo 48: Navigational aids on east side of Structure 6, looking sout

Photo 49: Low area of rock dike along Bayou DeCade north shoreline, located between Structure 6 and 7

Photo 50: Low area of rock dike along Bayou DeCade north shoreline, located between Structure 6 and 7

Photo 51: Low area of rock dike along Bayou DeCade north shoreline, located between Structure 6 and 7

Photo 52: Embankment with rock along Bayou DeCade north shoreline located between Structure 6 and 7

Photo 53: Low area of rock dike along Bayou DeCade north shoreline, located between Structure 6 and 7

Photo 54: Structure 7 rock plug located on north bank of Bayou DeCade, looking north

Photo 55: Structure 7 rock plug located on north bank of Bayou DeCade, looking north

Photo 56: Earthen embankment along north bank of Bayou Decade, looking north

Photo 57: Transition to earthen embankment with rock along north bank of Bayou Decade

Photo 58: Bayou DeCade and Voss Canal intersection, earthen embankment with rock

Photo 59: Bayou DeCade and Voss Canal intersection, earthen embankment with rock

Photo 60: Embankment with rock on east side of Voss Canal

Photo 61: Structure 10 warning signs are down, to be replaced in 2011 Maintenance Project, looking east

Photo 62: Structure 10 rock armored channel liner along Voss Canal, looking west

Photo 63: Structure 10 rock armored channel liner along Voss Canal, looking west

Photo 64: Earthen embankment along east side of Voss Canal between Structure 10 and 14

Photo 65: Earthen embankment along east side of Voss Canal between Structure 10 and 14

Photo 66: East bank of Voss Canal between Structure 10 and 14

Photo 67: Bank tie-in on the south side of Structure 14, looking east

Photo 68: Structure 14 fixed crest weir with variable crest section, looking east

Photo 69: Bank tie-in on the north side of Structure 14, looking east

Appendix B
(Three Year Budget Projection)

OPERATIONS & MAINTENANCE BUDGET WORKSHEET

Project: TE-28 Brady Canal Hydrologic Restoration

FY 11/12 –

OCPR Administration		**$ 18,000***
O&M Inspection & Report		**$ 6,085**
Operation/Navigational Aid Maintenance:		**$ 17,000****
Maintenance:		**$1,350,256**
E&D:	**$ 12,346**	
Surveying:	**$ 0**	
Construction:	**$1,260,160*****	
Construction Oversight:	**$ 77,750********	

Operation and Maintenance Assumptions:

Refurbishment of the earthen embankments along the perimeter Jug Lake estimated to be approximately 20,000 linear feet in length. The proposed embankment sections shall be constructed to an elevation of +4.0' NAVD with a 10' wide top width and 6:1 side slopes. It is assumed that the existing embankment will make up 40% of the proposed section. Therefore, we are reducing the cross sectional area of the proposed section by 40%.

Area: 276 sf. x 20,000/ 27 = 204,444 cy – 81,777 = 122,666 cy. Use: 123,000 c.y.

Cap approximately 100 linear feet of the earthen embankment on both ends of Structures 21, 23, & 24. The rock blanket shall be approximately 2' thick and extend the lake floor.

Area: 166 sf. x 200'/27 = 1,230 cy. x 1.5 = 1,845 tons x 3 (structures) = 5,535 tons

Breach closures at eight (8) locations along Carencro Bayou, Little Carencro Bayou and Brady Canal.

Replacement of timber piling and warning signs at Structure No.10.

Seeding of refurbished levee and installation of salt tolerant plants to protect earthen embankment.

Structure Operations: 3 – structures are operated twice annually by landowner for a total $12,000, OCPR administration: $3,000* Navigational Aid inspection, maintenance and repairs: $5,000****

2011/2012 Maintenance Project - Construction Cost:

Mobilization and Demobilization:	**$ 75,000**
Clearing and Grubbing:	**$ 25,000**
Earthen Embankments: (123,000 cy. @ $4.00/cy.)	**$492,000**
Armored embankment: (5,535 tons @ $80/ton)	**$442,800**
Breach Repairs (Carencro Bayou):	**$ 25,000**
Replacement of signs (Structure 10):	**$ 10,000**
Seeding and Vegetative Plantings	**$ 50,000**
	$1,119,800
Contingency: (20%)	**$223,960**
Total Construction Costs:	**$1,343,760*****

Subtract funding from alternate source (FEMA)	**$83,600**
Total Construction Costs (less FEMA):	**$1,260,160**

Engineering and Design Cost:

Design, Plans and Specifications: **$75,754 (Act. - $12,346 remaining)**
(Actual Cost Proposal)

Surveying: **$60,303 (Act. – $0 Task Completed)**
(Actual Cost Proposal)

Construction Inspection: **$65,000****
(1000hrs @ $65/hr)

Construction Administration: **$12,750****
(150 hrs @ $85/hr)

OCPR Administration: **$20,000* (est. $15,000 remaining)**

Total E&D and Construction Oversight: **$105,096 (Total remaining)**

Total Overall Estimated 2010 Maintenance Project: **$1,365,256**

FY 12/13 –

Administration		**$ 7,000***
O&M Inspection & Report		**$ 6,268**
Operation/Navigational Aid:		**$ 17,000****
Maintenance:		**$ 60,881**
E&D:	**$ 0**	
Construction:	**$ 57,881*****	
Construction Oversight:	**$ 3,000********	

Operation and Maintenance Assumptions:
Structure Operations: 3 – structures are operated twice annually by landowner for a total $12,000, OCPR administration: $3,000***
Routine Breach Repairs/Levee Refurbishment: 55,125 x 5% inflation = $57,881* Construction Oversight: $3,000******
OCPR Admin: $2,500*, NRCS Admin: $1,500*

Navigational Aid inspection, maintenance and repairs: $5,000**

FY 13/14 –

Administration		**$ 0***
O&M Inspection & Report		**$ 6,456**
Operation/Navigational Aid:		**$ 17,000****
Maintenance:		**$ 0**
E&D:	**$ 0**	
Construction:	**$ 0**	
Construction Oversight:	**$ 0**	

Operation and Maintenance Assumptions:

Structure Operations: 3 – structures are operated twice annually by landowner for a total $12,000, OCPR Navigational Aid inspection, maintenance and repairs: $5,000****

2011-2014 Accounting

Total Expenditure (from Lana Report)	**$1,054,149.62**
OCPR Expenditure	**$ 115,521.16**
NRCS MIPR	**$ 94,083.00**
Total Expenditures	**$1,263,753.78**
Current O&M Budget (less COE administration)	**$2,469,288.00**
Unexpended O&M Funds	**$1,205,534.22**

Brady Canal/ TE-28 / PPL 3

Three-Year Operations & Maintenance Budgets 07/01/2011 - 06/30/14

Project Manager	O & M Manager	Federal Sponsor	Prepared By
	Adam Ledet	*NRCS*	*Adam Ledet*

	2011/2012	2012/2013	2013/2014
Maintenance Inspection	$ 6,085.00	$ 6,268.00	$ 6,456.00
Structure Ops/ Nav Aid	$ 17,000.00	$ 17,000.00	$ 17,000.00
OCPR Administration	$ 18,000.00	$ 7,000.00	$ -
Maintenance/Rehabilitation	$ -	$ -	$ -

11/12 Description: 2011 Maintenance Project - E&D complete, Bidding ($12,346), Construction, Construction Oversight

E&D	$12,346.00	
Construction	$1,260,160.00	
Construction Oversight	$77,750.00	
Sub Total - Maint. And Rehab.	$ 1,350,256.00	

12/13 Description: Routine Breach Repairs and Navigational Aid inspection and maintenance

E&D		$ -	
Construction		$ 57,881.00	
Construction Oversight		$ 3,000.00	
	Sub Total - Maint. And Rehab.	$ 60,881.00	

13/14 Description: Routine Breach Repairs and Navigational Aid Inspection and Maintenance

E&D			$ -
Construction			
Construction Oversight			
		Sub Total - Maint. And Rehab.	$ -

	2011/2012	2012/2013	2013/2014
Annual O&M Budgets	$ 1,391,341.00	$ 91,149.00	$ 23,456.00

O &M Budget (3 yr Total)	**$ 1,505,946.00**
Unexpended O & M Funds	**$1,205,534.22**
Remaining O & M Budget (Projected)	**($178,192.00)**

Appendix C
(Habitat Maps)

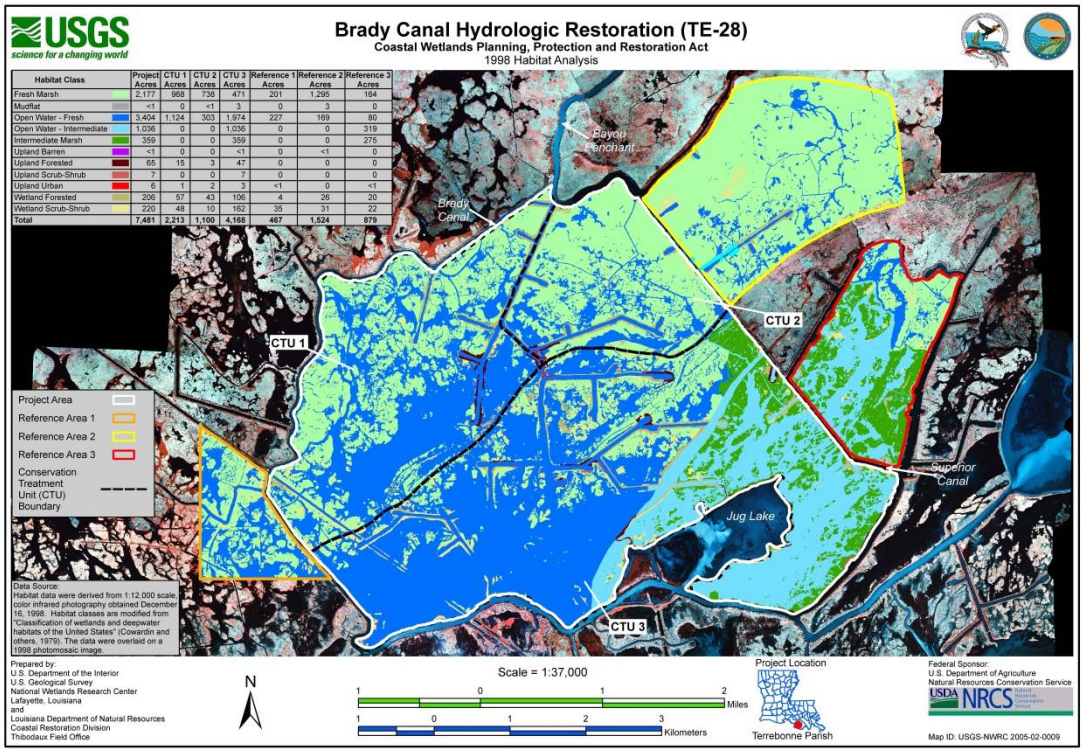

Figure. Pre-construction (1994) habitat analysis of the Brady Canal Hydrologic Restoration (TE-28) project and reference areas.

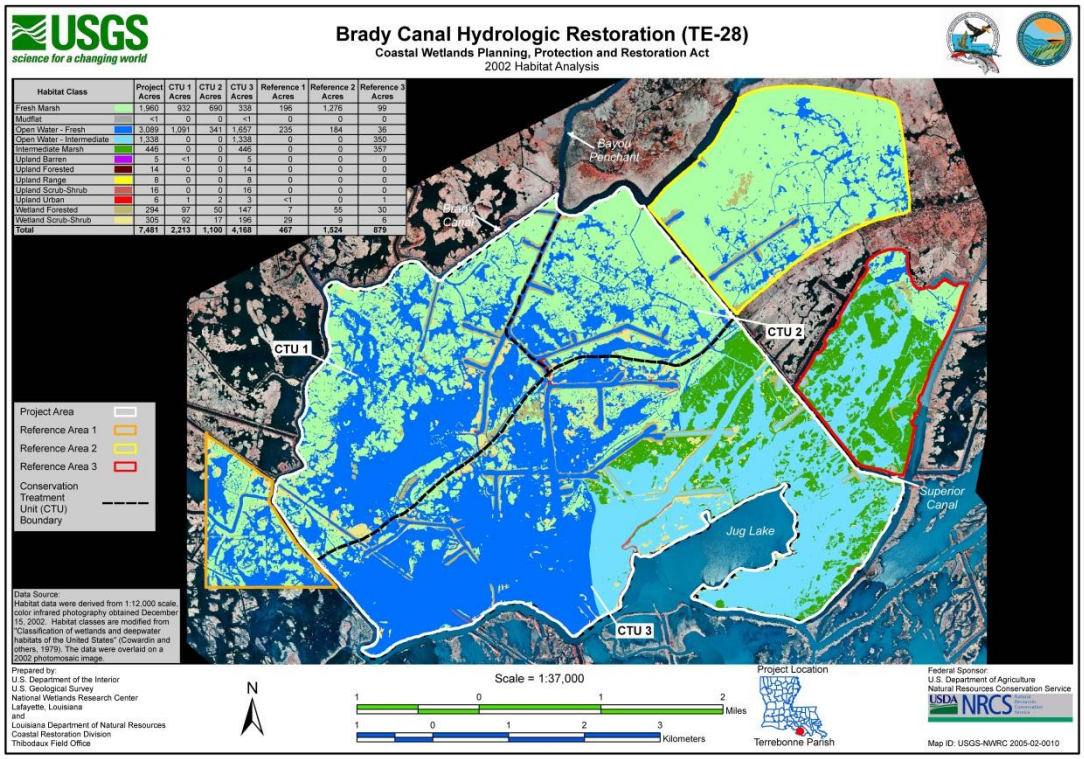

Figure. Pre-construction (2002) habitat analysis of the Brady Canal Hydrologic Restoration (TE-28) project and reference areas.

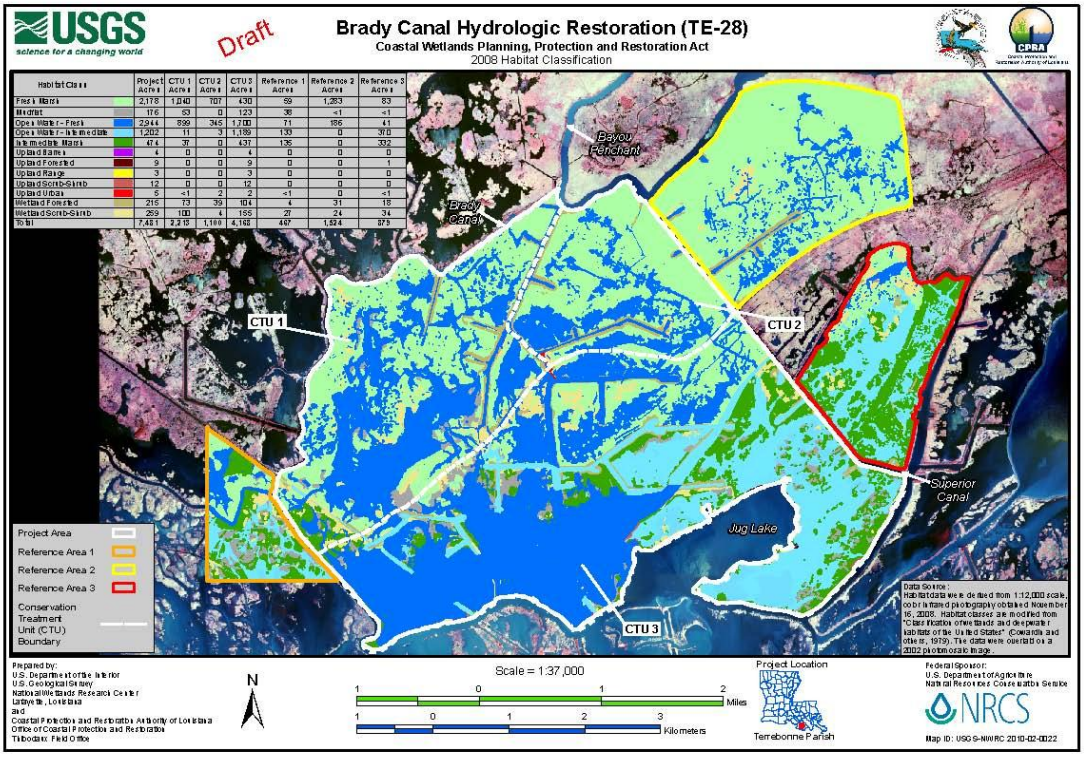

Figure. Post-construction (2008) habitat analysis of the Brady Canal Hydrologic Restoration (TE-28) project and reference areas.

Appendix D
(CRMS Land/Water Maps)

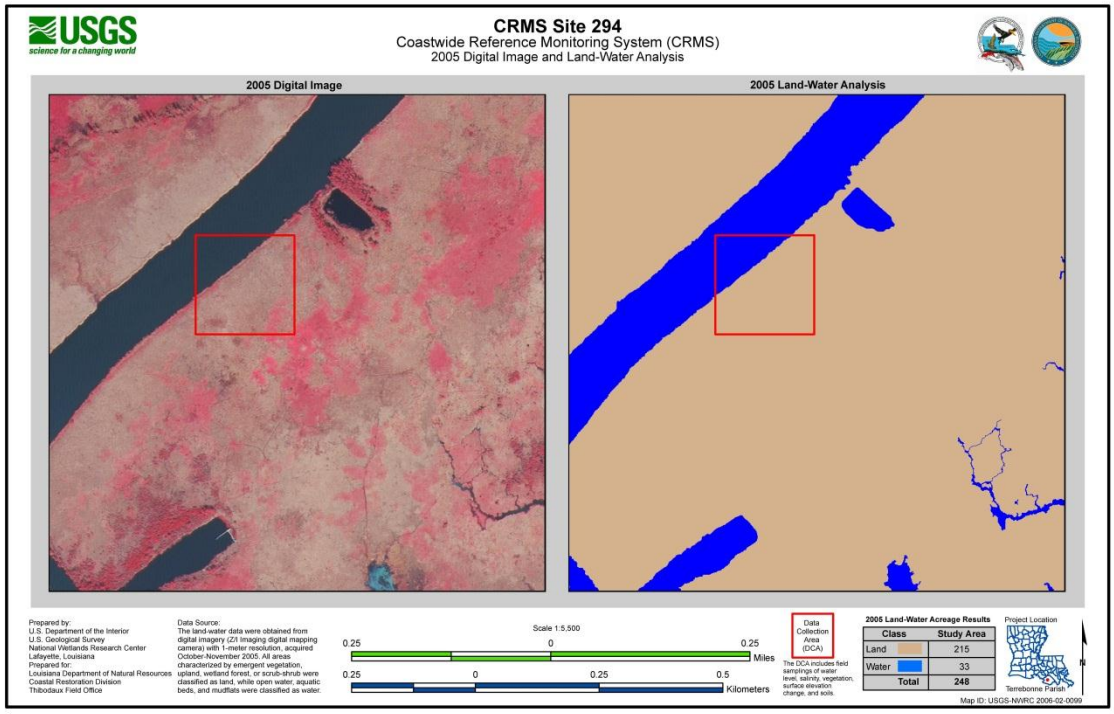

Figure. 2005 land/water classification of the CRMS0294 1 km square.

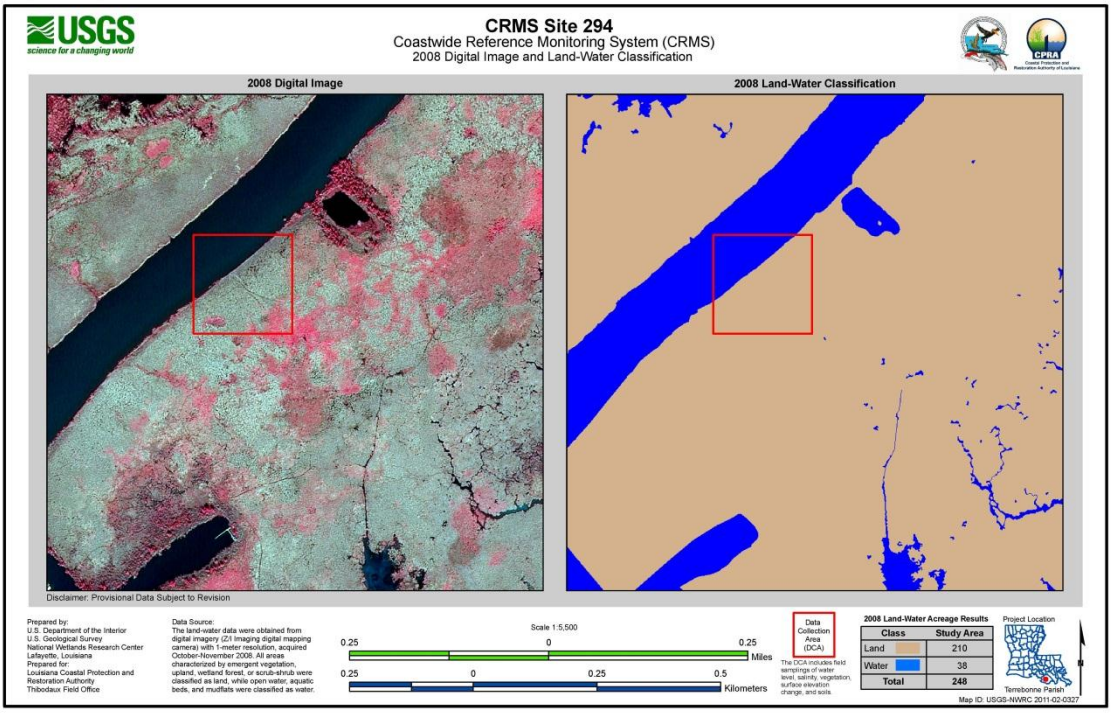

Figure. 2008 land/water classification of the CRMS0294 1 km square.

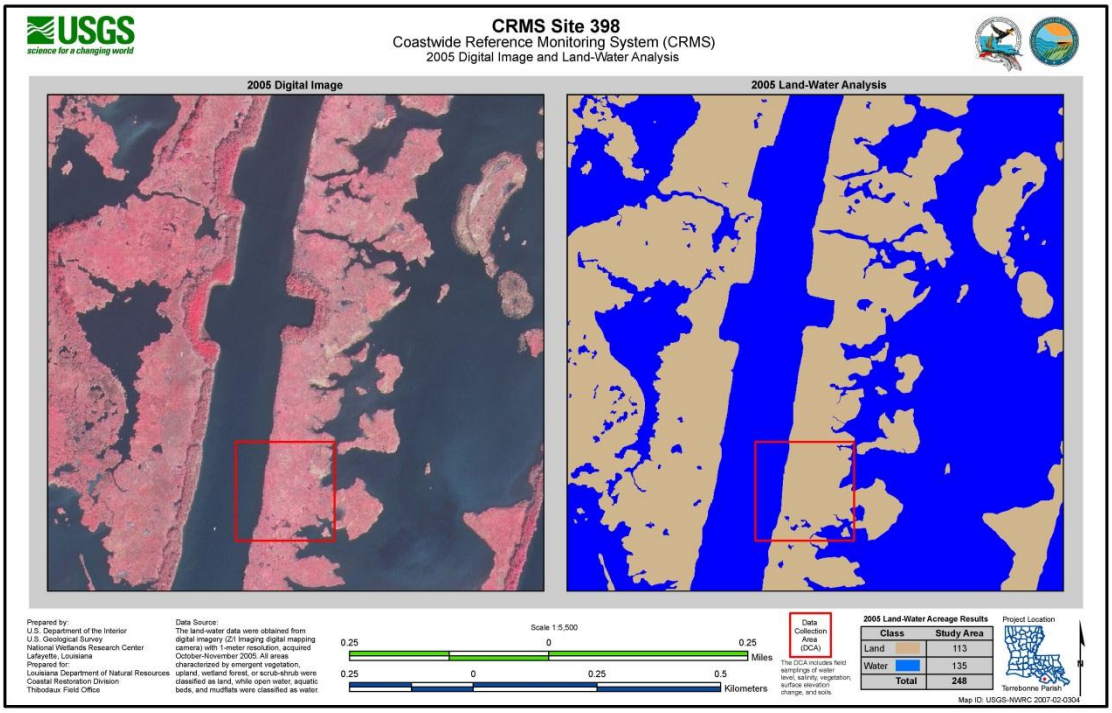

Figure. 2005 land/water classification of the CRMS0398 1 km square.

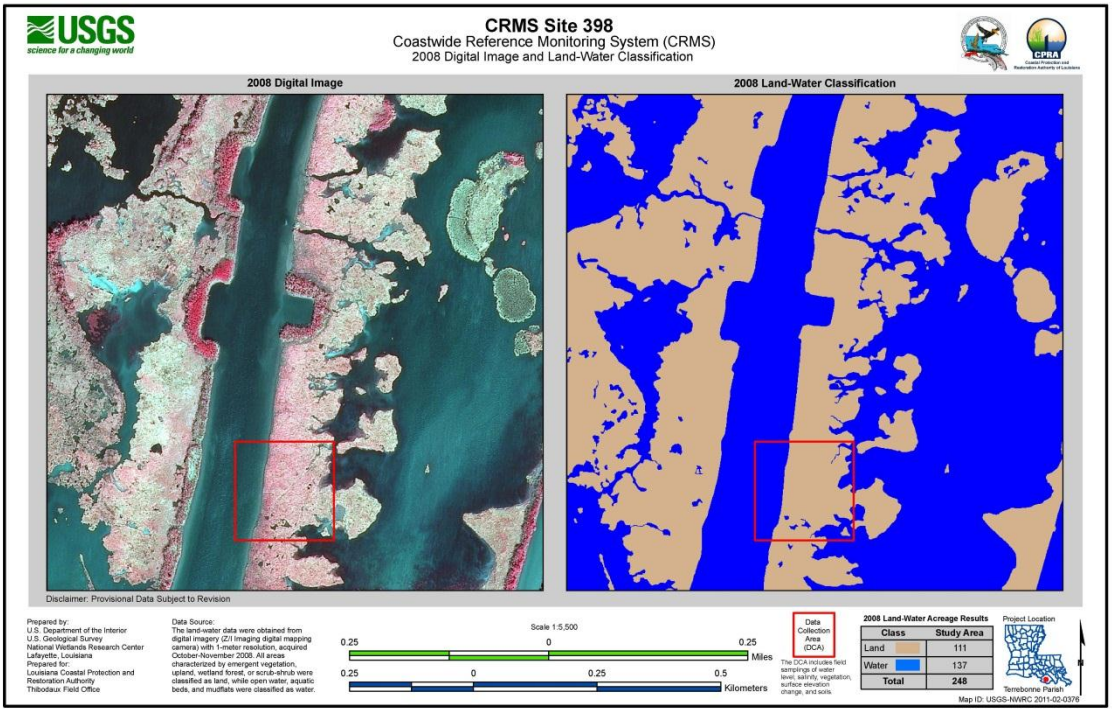

Figure. 2008 land/water classification of the CRMS0398 1 km square.

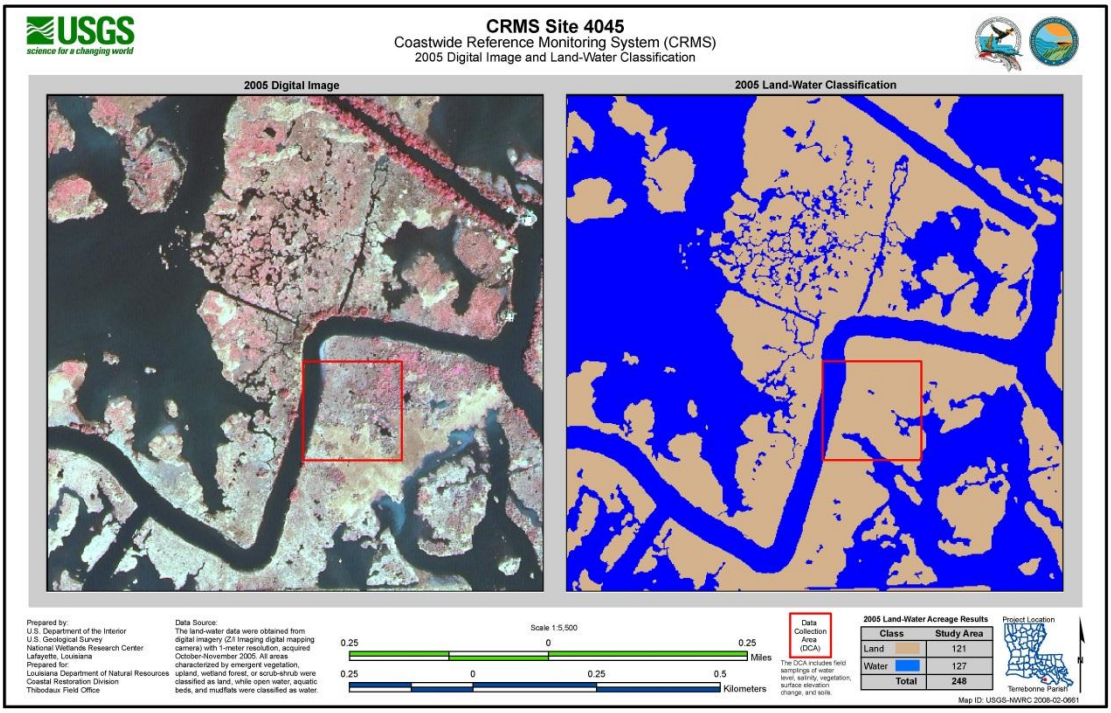

Figure. 2005 land/water classification of the CRMS4045 1 km square.

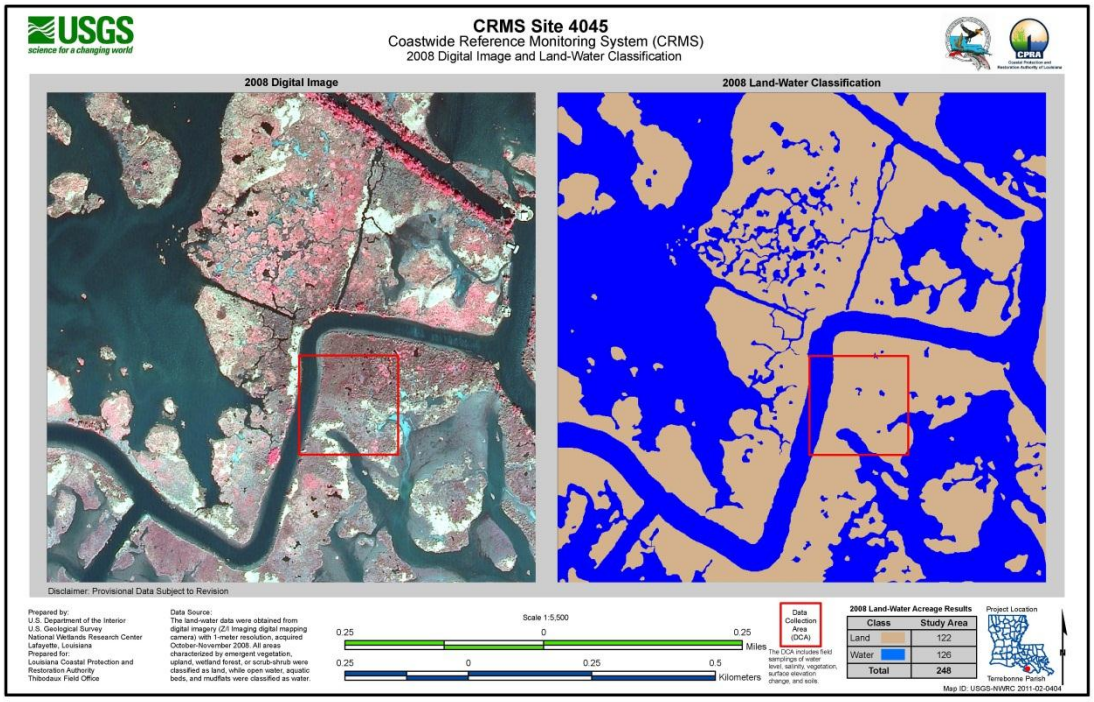

Figure. 2008 land/water classification of the CRMS4045 1 km square.