State of Louisiana

Coastal Protection and Restoration Authority (CPRA)

2017 Operations, Maintenance, and Monitoring Report

for

Perry Ridge Shore Protection

State Project Number CS-24
Priority Project List 14

October 2017
Calcasieu Parish

Prepared by:

Mark Mouledous, Bernard Wood
and
Mel Guidry

Operations Division
Lafayette Regional Office
Abdalla Hall, Room 201
635 Cajundome Boulevard
Lafayette, LA 70506

Suggested Citation:

Mouledous, M., Wood, B., and Guidry, M. 2017. *2017 Operations, Maintenance, and Monitoring Report for Perry Ridge Shore Protection (CS-24),* Coastal Protection and Restoration Authority, Lafayette, Louisiana. 33pp and Appendices.

2017 Operations, Maintenance, and Monitoring Report
For
Perry Ridge Shore Protection (CS-24)

Table of Contents

Preface

The Perry Ridge Shoreline (CS-24) project was funded through the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) on the 14th Priority Project List with the National Resources Conservation Service (NRCS) as the federal sponsor and the Coastal Protection and Restoration Authority (CPRA) as the state sponsor. The 2017 OM&M Report format combines the Operations and Maintenance annual project inspection information with the Monitoring data and analyses for the project. This report includes monitoring data collected through December 2016, and annual Maintenance Inspections through June 2013.

The 2017 report is the 6th and final report in a series of reports. For additional information on lessons learned, recommendations and project effectiveness please refer to previous OM&M reports (2004, 2005, 2008, 2011, and 2014) and annual O&M inspection reports (2005-2017) on the CPRA web site (http://lacoast.gov/new/Projects/Info.aspx?num=CS-24).

I. Introduction

The Perry Ridge Shore Protection (CS-24) project was proposed on the 14th priority list of the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) and is co-sponsored by the Natural Resources Conservation Service (NRCS) and the Coastal Protection and Restoration Authority (CPRA). The project provides features to directly protect 1,203 ac (481 ha) of vegetated shoreline along the Gulf Intracoastal Waterway (GIWW), which in turn will benefit an additional 5,945 ac (2,378 ha) of predominantly intermediate marsh located north of the project shoreline (Figure 1). The project area is located in Calcasieu Parish, Louisiana in the Calcasieu-Sabine Basin, Region 4 of the Coast 2050 Plan (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998). The project extends along the north bank of the GIWW from Perry Ridge to the Vinton Drainage Canal, and is bounded on the north by an arbitrary line connecting the north tip of Big Island and the Gray Canal, on the south by the GIWW, on the east by the Vinton Drainage Canal and the Gray Canal, and on the west by Perry Ridge and Big Island.

The major problems in this region, post anthropogenic hydrologic alterations, are marsh loss caused by saltwater intrusion, rapid water level fluctuation produced by tidal forces, and direct shoreline erosion due to wake and wave energy (U.S. Department of Agriculture, Soil Conservation Service [USDA/SCS] 1988). Marsh loss in the vicinity of Perry Ridge has been caused by water level fluctuations and tidal scour resulting from water exchange through breaches in the northern spoil bank of the GIWW (U.S. Department of Agriculture, Natural Resources Conservation Service [USDA/NRCS] 1996). These phenomenon were also identified on the southern bank of the GIWW directly across from the CS-24 project area and a National Marine Fisheries Service (NMFS) project was installed to mitigate some of these deleterious forces. That CWPPRA project's the Black Bayou Hydrologic Restoration (CS-27), and it share many of the same features as CS-24, however CS-27 has multiple large waterways that enter into and traverse the project area, namely Black Bayou creating an added dimension

of salinity control (Wood and Aucoin 2015). Just west of the CS-24 project area from Perry Ridge west to the Sabine River is the GIWW - Perry Ridge West Bank Stabilization (CS-30) project which is very similar to CS-24 and was constructed in 2002 in partnership with NRCS. CS-30 differs from CS-24 by including terraces in the project features and having an earthen plug at a point of heavy tidal exchange between the project area and the GIWW.

The CS-24 shoreline erosion rate along the north bank of the GIWW in the vicinity of the project area was 10 ft/yr (3.05 m/yr), based on aerial photography (USDA/SCS 1992). Several factors contribute to the erosion rate. Double-wide barges that are allowed in this section of the GIWW cause more wake energy to reach the bank. The construction of the Calcasieu Ship Channel, deepening of Sabine Pass, the construction of the Sabine-Neches waterway, and the removal of the bar at the mouth of the Calcasieu River have all resulted in increased tidal flux and salinity in the GIWW. The construction of the GIWW has shifted the project area from an essentially non-tidal or micro tidal system to an extremely tidal system.

The 30 ft (9.1 m) depth of the GIWW allows for a very large exchange of water volume with the bordering Calcasieu Ship Channel and Sabine River, allowing more extremes of water level and much higher salinities to reach the Perry Ridge project area than was possible before the GIWW's construction. Historically, the project area consisted of freshwater wetlands (USDA/NRCS 1996). After construction of the GIWW, Chabreck and Linscombe classified this area a mostly intermediate marsh (Chabreck and Linscombe, 1968, 1978, and 1988) (Table 1). Chabreck and Linscombe again categorized the area as intermediate in 1997, then the project area converting to a majority of fresh marsh in 2001. This conversion to fresh marsh in 2001 was reversed back to intermediate marsh by 2007 likely due to the storm surge and salinity increase brought in by Hurricane Rita in 2005. This intermediate marsh has remained and dominants the entire project area that is not upland as of the most recent coastwide vegetation survey in 2013 (Sasser and Visser 2008 and 2014).

Approximately 23,300 linear ft (7.1 km) of free-standing rock dike was constructed along the north bank of the GIWW from west of Perry Ridge to the Vinton Drainage Canal. Construction of the project was completed in February 1999 and the project features have remained intact with little maintenance through the last inspection as of 2017.

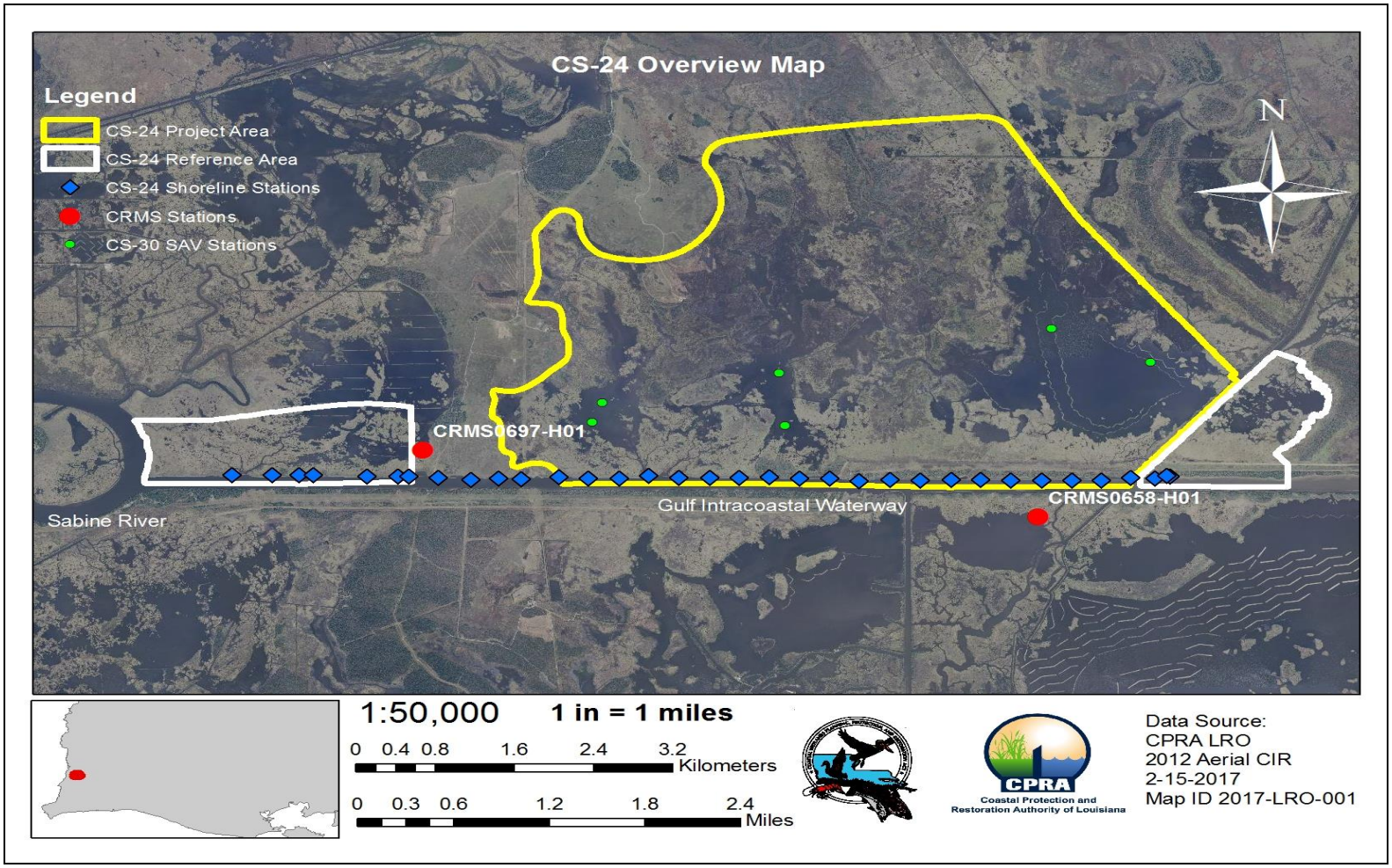

Figure 1. Perry Ridge (CS-24) Project and Reference area along with associated project and CRMS station locations.

Table 1. Marsh type trends within the CS-24 project area over the past 65 years. In 1949 only a small portion of the project area was assessed, but it is likely most of the project area was fresh marsh during this time frame.

Year	Fresh	Intermediate	Brackish	Upland/Other	Total
1949	362.63	NA	NA	NA	NA
1968	25.95	6,067.67	40.77	0	6,134.39
1978	554.75	5,579.64	0	0	6,134.39
1988	1,815.61	4,318.78	0	0	6,134.39
1997	32.12	6,063.97	0	38.30	6,134.39
2001	3,959.25	2,146.72	0	28.42	6,134.39
2007	0	6,047.90	58.07	28.42	6,134.39
2013	224.25	5,844.04	27.80	38.30	6,134.39

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Perry Ridge Shoreline Protection Project (CS-24) is to evaluate the constructed project features and 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, CPRA 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 Perry Ridge Shoreline Project (CS-24) are outlined in Section IV.

An annual O & M inspection of the Perry Ridge Shoreline Project (CS-24) was held on June 13, 2013 under sunny skies and warm temperatures. In attendance were Mel Guidry, Stan Aucoin, and Darrell Pontiff of CPRA, along with Frank Chapman and Brandon Samson of NRCS, and Josh Carson for other inspections. The boat was launched at Intracoastal Park located at the foot of the Ellender Bridge (LA Hwy 27) over the Gulf Intracoastal Waterway. The inspection began at 11:30am at the eastern end of the project.

The field inspection included a complete visual inspection on the entire project site. Staff gauge readings and existing benchmarks were not available to determine approximate water level and existing elevation of the foreshore rock dike. Photographs were taken at each project feature (see Appendix A) and field inspection notes were compiled to record measurement and deficiencies (Appendix C).

b. Inspection Results

Site 1—Foreshore rock dike

The dike is in good condition with a few low areas below constructed elevation. One 50 foot gap was noted where the dike was disturbed by a barge. Visible signs of accretion are occurring behind the rock dike. No maintenance is recommended at this time. (Photos: Appendix A, Photo 1-2)

c. Maintenance Recommendations

i. Immediate/ Emergency Repairs

None

ii. Programmatic/ Routine Repairs

None

d. Maintenance History

General Maintenance: Below is a summary of completed maintenance projects and operation tasks performed since February 1999, the construction completion date of the Perry Ridge Shoreline Protection Project (CS-24).

There has been no maintenance on this project.

III. Operation Activity

a. Operation Plan

There are no water control structures associated with this project; therefore no Structural Operation Plan is required.

b. Actual Operations

There are no water control structures associated with this project, 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 CS-24 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 two CRMS sites located in the vicinity of the project area (CRMS0658 and CRMS0697), these sites while not in the project area are located in very similar projects and marsh types to that of CS-24.

a. Monitoring Goals

The objectives of the Perry Ridge Shore Protection Project are:

1. Protect the existing emergent wetlands along the north bank of the GIWW and prevent their further deterioration from shoreline erosion and tidal scour.
2. Prevent the widening of the GIWW into the project area wetlands.
3. Reduce the occurrence of salinity spikes within the project area.

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

1. Decrease the rate of shoreline erosion along the north bank of the GIWW using a rock dike.

b. Monitoring Elements

Aerial Photography:

To document shoreline position, and land and water areas along the GIWW in the project and reference areas, near-vertical, color-infrared aerial photography (1:12,000 scale, with ground controls) was obtained once prior to construction in 1997, and in post-construction 2001. The original photography was checked for flight accuracy, color correctness, and clarity and was subsequently archived. Aerial photography was scanned, mosaicked, and georectified by USGS/NWRC personnel according to standard operating procedures (Steyer et al. 1995, revised 2000). No additional land-water photography was be collected.

Aerial photography (color infrared, CIR) and satellite imagery (Landsat Thematic Mapper, TM) have been collected for the entire coast through CRMS. The aerial photography is analyzed for CRMS stations at one meter resolution. The satellite imagery is analyzed to determine land and water areas for the entire coast. This imagery will be a subset and used to evaluate changes in land and water areas within the CS-24 project area at a coarse (30m) resolution. The CRMS spatial viewer provided historic data for land water quantification in the project area starting in 1932. There are 17 years analyzed for land water quantities through the CRMS viewer which span 1932 to 2010. The data provided by this tool is at a large spatial scale and is designed to show trends in land loss, not exact acreages or locations.

Shoreline Change:

To document the changes in shoreline position along the GIWW, shoreline markers were placed at 12 points along the vegetated marsh edge adjacent to the rock breakwater. Twelve transects were measured and differentiated by shoreline type in the project and reference areas (minimum of 3 but not to exceed 1 per 1,000 ft [305 m]). On each transect, a PVC pole was installed to mark the vegetated edge of the bank (VEB), and a post was installed at the end point in the marsh or on the spoil bank to establish a hub for use in relocating each transect. Shoreline position relative to the shoreline markers along the transects was measured at the same time of the year, once as-built in 1999, and post-construction in 2002, 2004, 2007, 2010, 2013, and 2016.

Salinity:

Salinity measurements were to be collected for one year after the next significant drought post 1996 to determine the rock dike's effect on salinity spikes in the project area behind the dike.

Hourly salinity and water levels (ft, NAVD88 GEOID 99) in the area were monitored with a continuous recorder south of the project area in CS-27 that has some exchange with the GIWW (station CS27-25) from May 2000 to present. Salinity data is also currently being monitored hourly utilizing two CRMS-*Wetlands* stations (0658 and 0697) one within CS-27 and another in CS-24's sister project CS-30. Continuous data were used to characterize average annual salinities throughout the project area analog and reference areas.

Submerged Aquatic Vegetation (SAV):

To document changes in the occurrence of SAV in the project area SAV was monitored over time using the modified rake method (Chabreck and Hoffpauir 1962). Six transects oriented north to south were established across three open water locations (Figure 1). Submerged aquatic vegetation was sampled repeatedly along each transect by dragging a rake on the pond bottom for one second. The presence or absence of vegetation was recorded for each sample to determine the percent occurrence on a transect (% occurrence = (number of samples with SAV/number of samples) × 100). When vegetation was present, the species present was recorded in order to determine the frequencies of individual species (Nyman and Chabreck 1996). This SAV data was originally collected as part of the monitoring for the CS-30 project as reference data but it is now inside the CS-24 project area.

Hydrologic Index:

The Hydrologic Index (HI) assesses the relationship between the combined effect of mean salinity and percent time flooded on vegetation primary productivity for 5 different wetland classifications in coastal Louisiana (swamp, fresh, intermediate, brackish, and saline). The index score ranges from 0 - 100, representing the percent of maximum vegetation productivity expected to occur if the separate effects of salinity and inundation on productivity interact in a multiplicative fashion.

c. Monitoring Results and Discussion

Aerial Photography:

Land area has increased in the project area post construction after being relatively stable through the previous two decades. This is directly attributable to the project features reversing shoreline erosion and reducing the tidal export of material from the interior wetlands. Pre-construction photography, flown on November 23, 1997, indicated that the project area was 60.4% land and 39.6% water (Figures 2 and 3). Aerial photography flown on November 17, 2001 documented 65.4% land and 34.6% water in the project area, indicating a land gain of 5% or 306.5 ac (124.0 ha). The higher land to water ratio indicates expansion of the interior marsh behind the protected shoreline. In areas without shoreline protection, the western reference area remained 58.8% land and 41.2% water, and the eastern reference area made a slight gain from 61.4% land and 38.6% water in 1997 to 62.7% land and 37.3% water in 2001.

The general land change trend in the CS-24 project area from 1932-2010 agrees with the project specific land change data showing a slight increase in percent land after project construction in 1999 through 2010, and likely continuing at present though data is not currently available (Figure 4). This period of gradually increasing land was preceded by a very stable period from the mid 80's until project construction. Which followed a significant loss of land near 40%, from the 1930's through the end of the 1970's. The early dates in this analysis are estimated from land water figures and are not exact percentages until after 1985. The land loss trend from the 1950's through the 1970's is similar to that of the entire Calcasieu Sabine Basin. However the lack of a pronounced land loss event between 2004 and 2006 is likely a result of project features and proximity. Hurricane Rita did extensive damage to the Calcasieu Sabine Basin as a whole, but CS-24 was generally unaffected from a land loss perspective do to being in the northern reaches of the basin and having an armored southern boundary. The southern spoil bank and rock dike along the GIWW was a major rack depositional area, which suggests that much of the storm surge stopped just to the south of the project area.

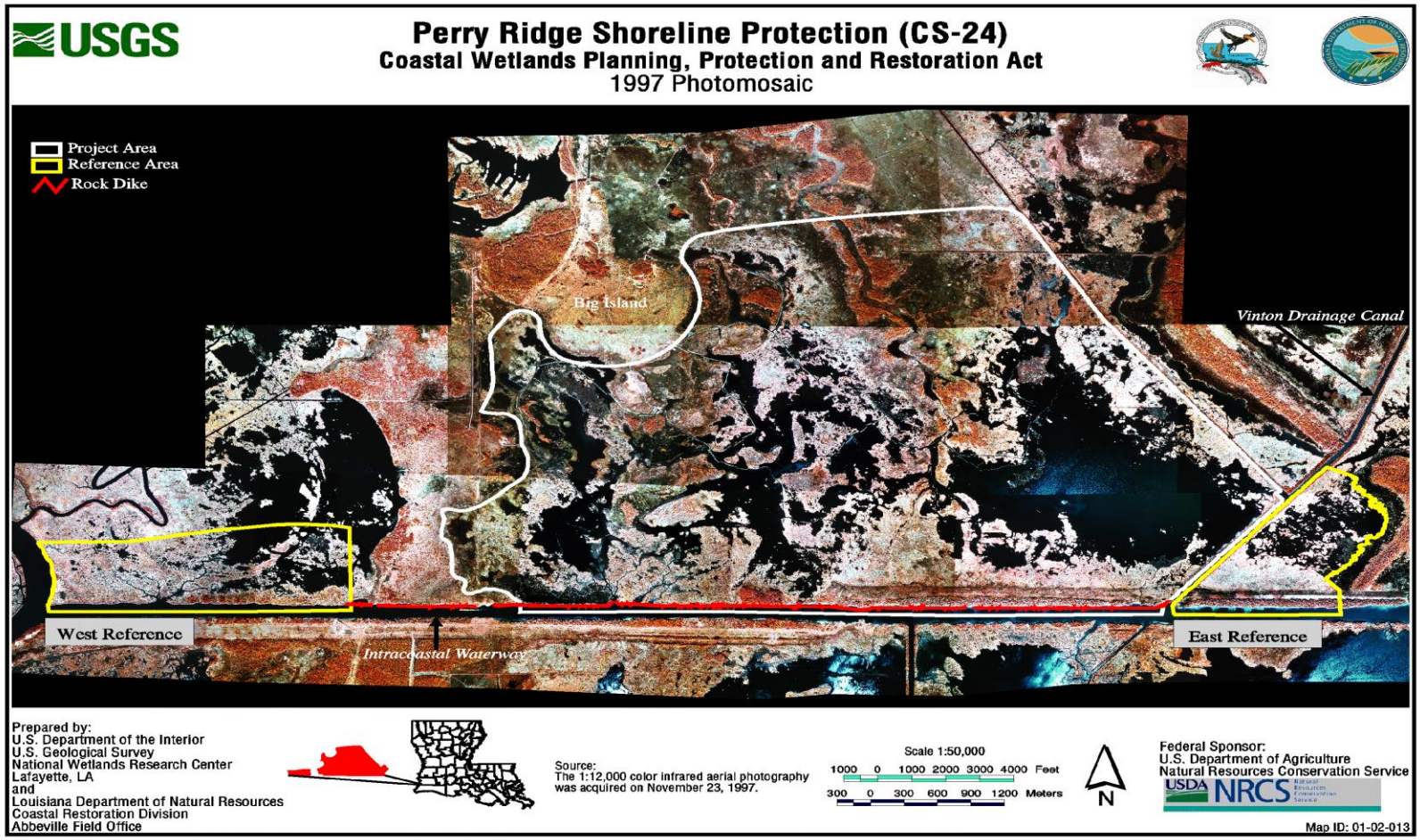

Figure 2. Photomosaic of the Perry Ridge (CS-24) project and reference areas from aerial photography flown November 23, 1997

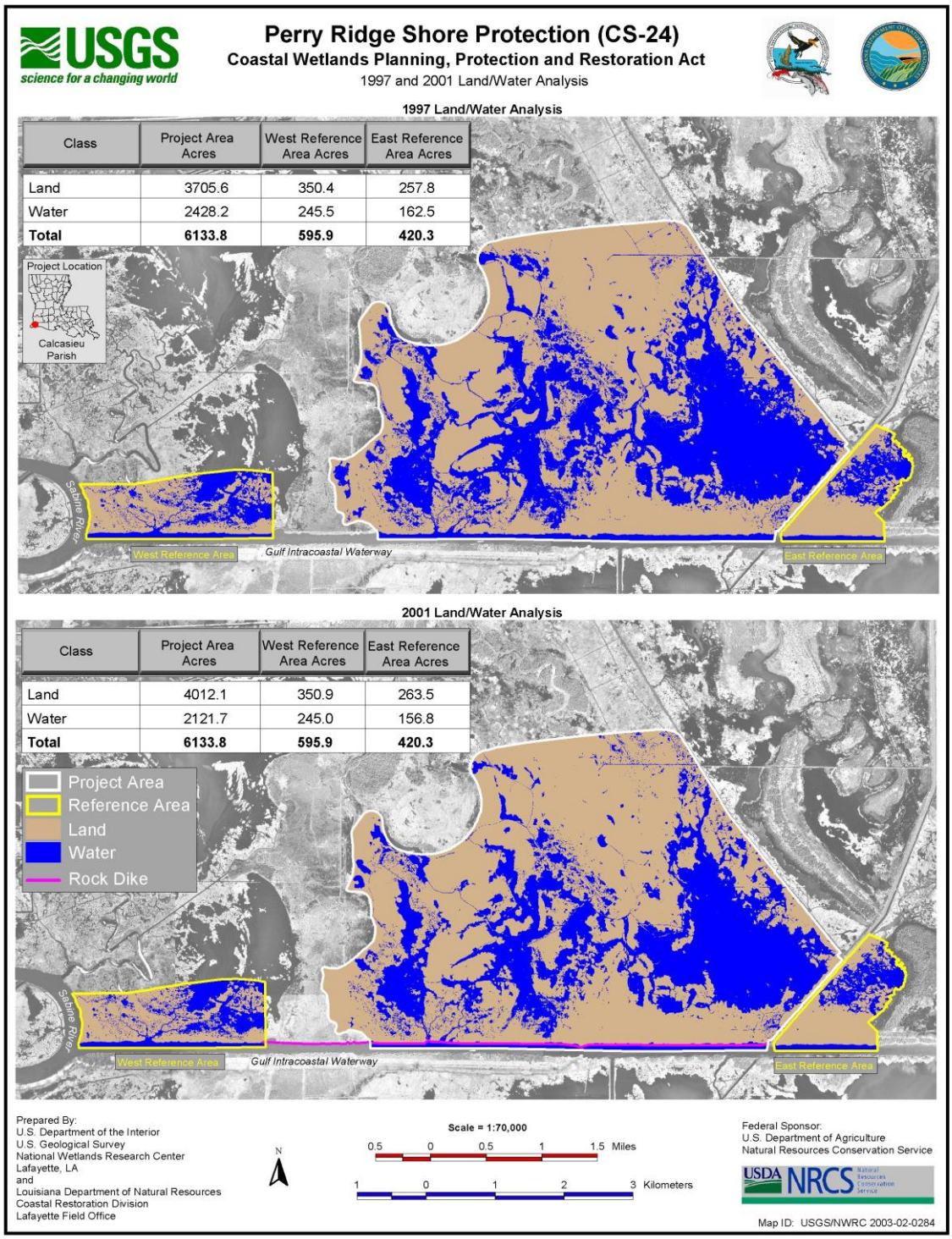

Figure 3. Pre and Post-construction land/water analysis of the Perry Ridge (CS-24) project.

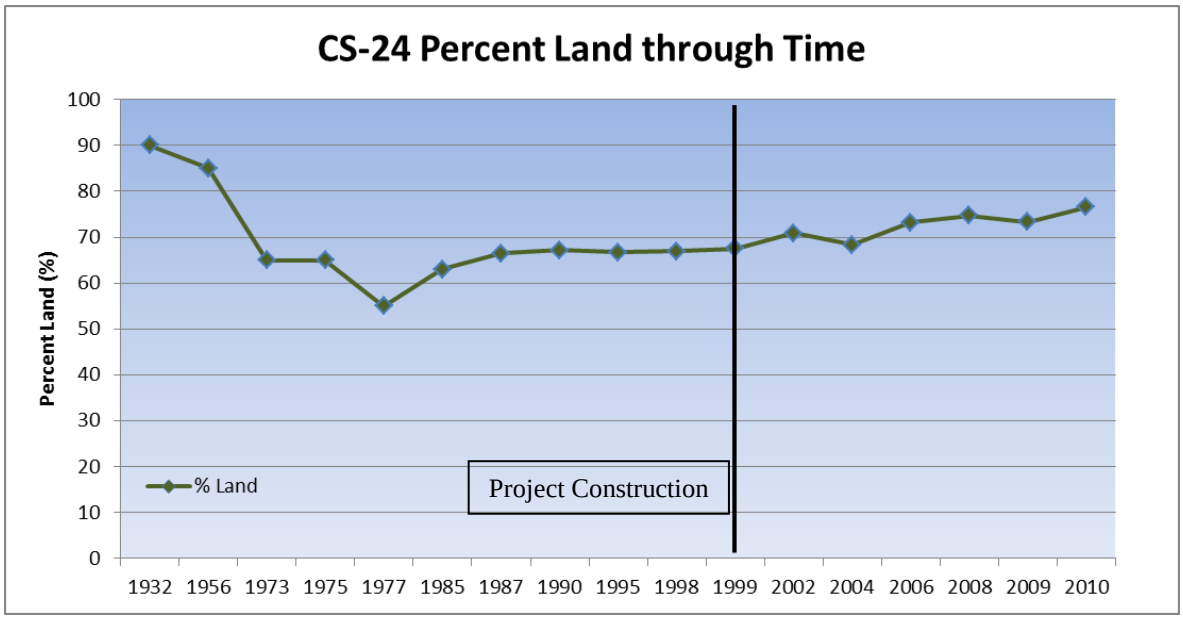

Figure 4. The general land change trends in the CS-24 project area from 1932-2010 agrees with the project specific land change data showing a slight increase in percent land after project construction in 1999.

Shoreline Position:

The average shoreline change rates across all surveys in the project and reference areas are presented below (Table 2). The 2016 data indicate an average gain of 2.42 ft/yr in the project area; this is the second highest rate of shoreline increase for any period in the projects history, even as there is less area available to vegetate. It appears that the land building is continuing at a good pace even as the available area that can support land formation is reduced. The filling in of deeper areas behind the rock dike likely takes many years to complete and the project is now showing some of those gains. The average loss within the reference area over the most recent survey period, 2013-2016, was -2.8 ft/yr. This rate of shoreline loss in the reference area is equal to the largest loss of any period measured suggesting that the reference area has not reached a stable point and that shoreline loss in the reference area will continue if no intervention is forthcoming. From project construction to 2016 the rate of land gain in the project area is slightly less than the current period at 2.0 ft/yr, while over the same 18 year span the reference area is losing at the inverse rate of -2.0 ft/yr. Along the shoreline in the project area, 21 of 25 monitoring stations are either prograding or had no change since the 2013 survey (Figure 5). At many of the project stations, substantial vertical accretion has taken place allowing vegetation to colonize up to the rock breakwater (Figure 6). It is important to note that the shoreline advance observed, as well as any future advance, will be restricted by the un-vegetated area behind the rock breakwater. This may explain the high rate of land gain in the project compared to previous surveys, as sediments are focused into fewer areas of low elevation for settlement. Also heavy upland rains from 2012-2016 have undoubtedly increased the available sediment load in the water column of the GIWW and likely increased the project's sediment trapping potential. This same heavy upland rainfall and

increased current and water movement in the GIWW was an erosive force in the reference area where station CS24-9R was completely washed way between 2013 and the 2016 survey (Figure 7). This means that a minimum of fifty feet of shoreline erosion occurred in the reference area since project inception to the 2016 survey and likely significantly more, which can no longer be accurately measured due to the benchmark being lost to open water.

Table 2. Shoreline movement rates along CS-24 project and reference area shorelines over time.

Time Periods	Average Gain/Loss	
	Project Area (ft/yr)	Reference Area (ft/yr)
1999-2002	1.83	-2.8
2002-2004	1.61	-2.6
2004-2007	1.96	-1.7
2007-2010	3.4	-2.2
2010-2013	0.41	-0.1
2013-2016	2.42	-2.8
Total (1999-2016)	2.0	-2.0

CS-24 Perry Ridge
Shoreline Position Change 1999-2016

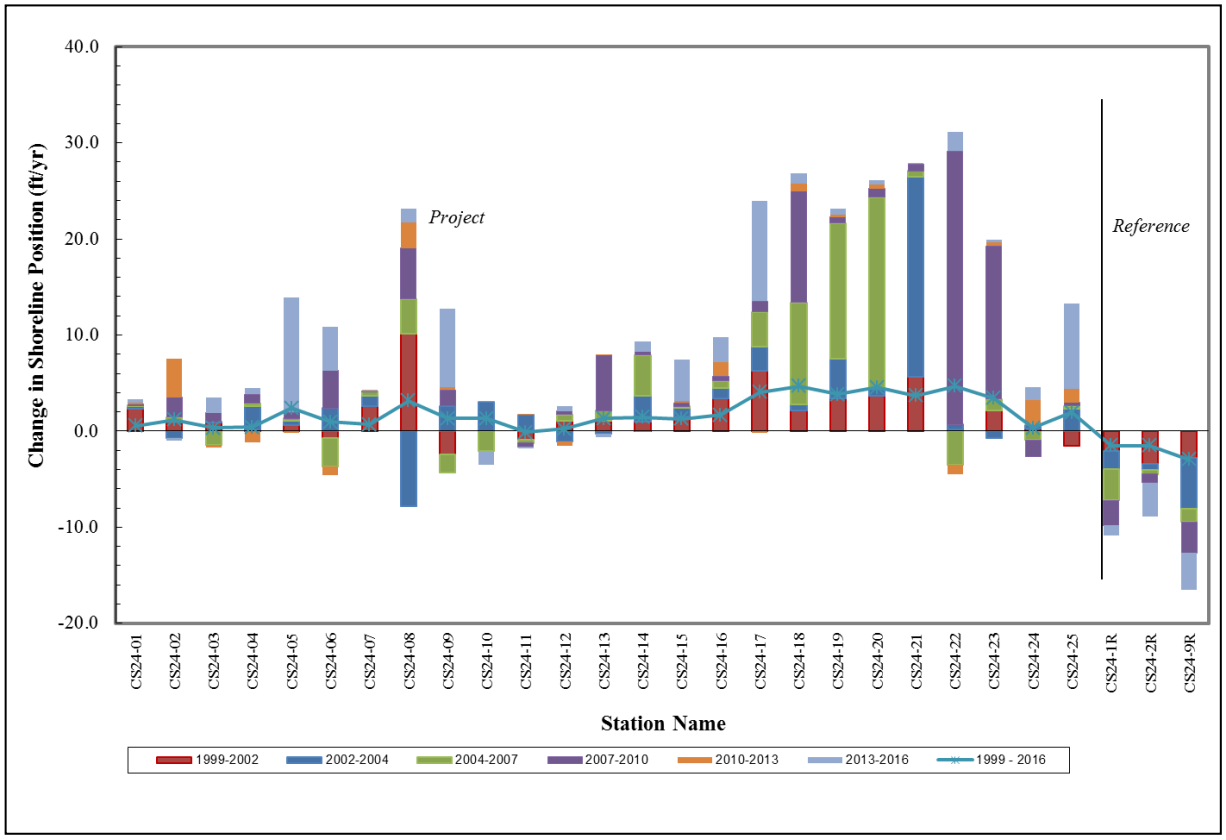

Figure 5. Shoreline position change (ft/yr) from direct measurements in the Perry Ridge (CS-24) project and reference area from 1999-2016.

Figure 6. A typical shoreline reach at Perry Ridge (CS-24) illustrating the rock dike, shoreline stations, and expanding marsh shoreline at the confluence of Black Bayou Cutoff Canal and the GIWW in the central region of the project.

Figure 7. The reference shoreline at Perry Ridge (CS-24) containing shoreline stations and historic shoreline positions at the confluence of the Vinton Canal and the GIWW just east of the project area.

Salinity:

The foreshore rock dike, new growth of emergent marsh, and remnants of the GIWW spoil bank keep salinity in the CS-24 project area lower than the GIWW channel and marshes to the south, especially during drought conditions. CRMS data and project specific CS-27 salinity data allow for the analysis of CS-24's salinity regime. The CS27-25 project specific SONDE is located south of the CS-24 project area and has some direct exchange with the waters of the GIWW. CRMS0658 is also south of the project area just on the other side of the GIWW and does exchange water with the GIWW (Wood et al 2015). CRMS0697 is west of the CS-24 project area in CS-30 which was formally the reference area until 2002 when CS-30 was completed. The two project areas are very similar in salinity regime due to the similarity of the project features of CS-24 and CS-30 (Mouledous et al 2016). The project foreshore rock dike does allow some exchange between the CS-24 project area and the GIWW, however do to the re-vegetation of emergent marsh and the remains of the GIWW's northern spoil bank there is a reduction in salinity compared just a standalone rock dike (Figure 8). During periods of high salinity the project rock dike and vegetation seem to reduce the peak salinity found south of the GIWW, though these are still less than what would be in the GIWW channel proper. In the 2010-2011 drought, CRMS0697 average salinity was 5ppt less than the stations south of the GIWW on a monthly basis. And again in 2012 and 2013, the project area analog was more than 5ppt less than the reference stations. The project features appear to efficiently reduce high salinity waters from entering the project area, especially under low water drought conditions. This pattern of salinity reduction was not true during Hurricane Ike in 2008 when the storm surge overwhelmed the region. But during periods of high salinity and average to below average water levels, the project area likely experiences lower salinity spikes than the areas directly south of the GIWW in the CS-27 project area which also have a foreshore rock dike, but with multiple large channels that traverse the interior wetlands and much less vegetation between the rock dike and the remnants of the GIWW's spoil bank.

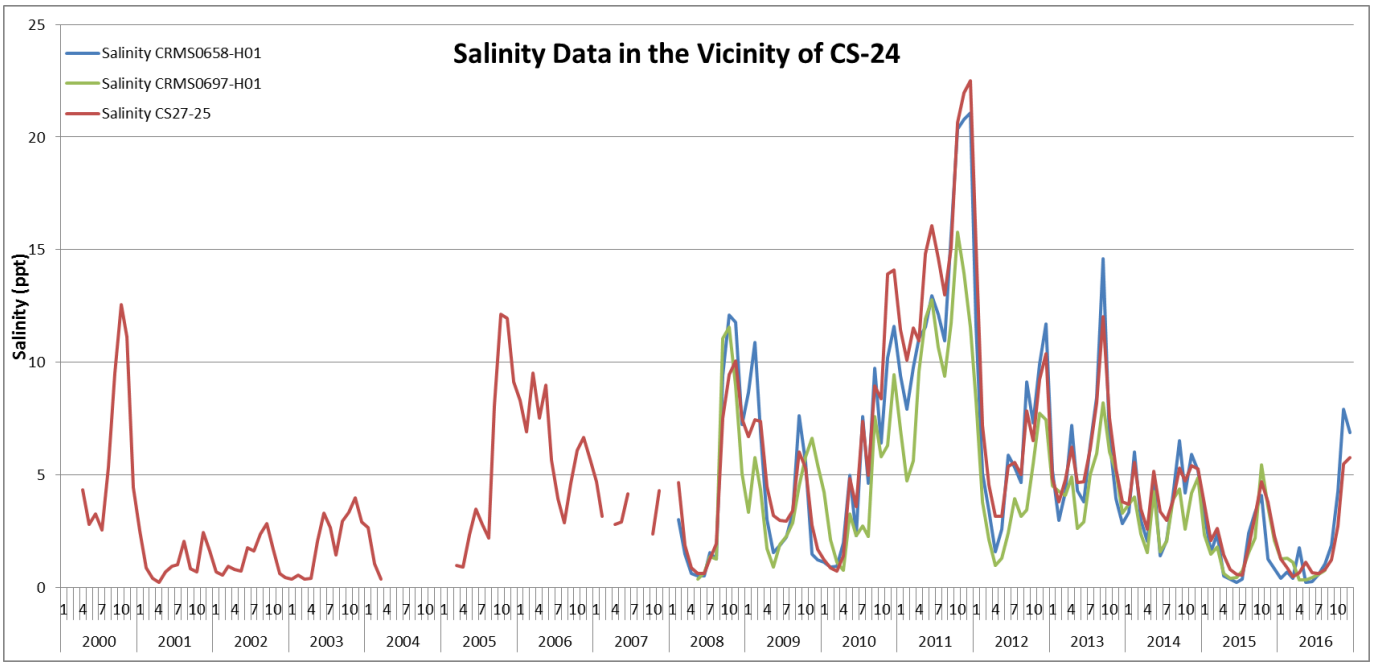

Figure 8. Long term salinity data from nearby CRMS station 0697, which represents the project area and two reference stations CS27-25 and CRMS0658 which are in the CS-27 project area and are more connected to the GIWW than CS-24.

Submerged Aquatic Vegetation (SAV):

The CS-24 project likely enhanced SAV habitat by reducing high salinity events and slowing tidal movement in the project area, however the project area contained some SAV before construction. The large ponds and lakes on the east side of the project area were devoid of substantial SAV beds after the project's construction. These areas later colonized with SAV after terrace construction began in the area in approximately 2006 and continued through 2013. Data was collected along 12 transects in 2000, 2003, 2005, 2007, 2010 and 2015. This data was originally collected as part of the monitoring for CS-24's parallel project CS-30 but 6 of the transects were in CS-24, two of which now contain non project funded terraces. The similarity between the two projects in the SAV data yields credence to the hydrologic and salinity regime comparisons. The frequency of occurrence of SAV remained the same between the 2000 and 2003 surveys (near 100%) in both projects (Figure 9). SAV coverage dropped to 66% in both projects following Hurricane Rita in 2005, but recovered in both areas in 2007 to pre-storm levels. In the 2010 survey, frequency of occurrence increased in CS-24, but dropped slightly in 2015, while the CS-30 remained near 100% in both surveys. There was no significant difference in total SAV coverage between the two project areas. However, the number of species has generally increased between 2000 and 2015 (Figure 10). Over time, both the CS-30 and CS-24 saw a decrease in *Ruppia maritima*, an indicator of more saline conditions, and an increase in fresher species such as *Myriophyllum spicatum, Najas guadalupensis and Potamogeton* sp. The CS-24 non project terraces had a significant impact on SAV growth along two of the transects in the largest eastern pond in the project area. After

Hurricane Rita in the fall of 2005 an initial set of terraces was constructed that formed a large ring effectively reducing the area of the pond by roughly half. This effect is visible in the species frequency of occurrence. Additional non project terraces where constructed in 2008 and 2013 all in the same general location, again shrinking the open water distances upon which waves could build. This converted a large sparsely SAV populated area to a dense area of SAV production.

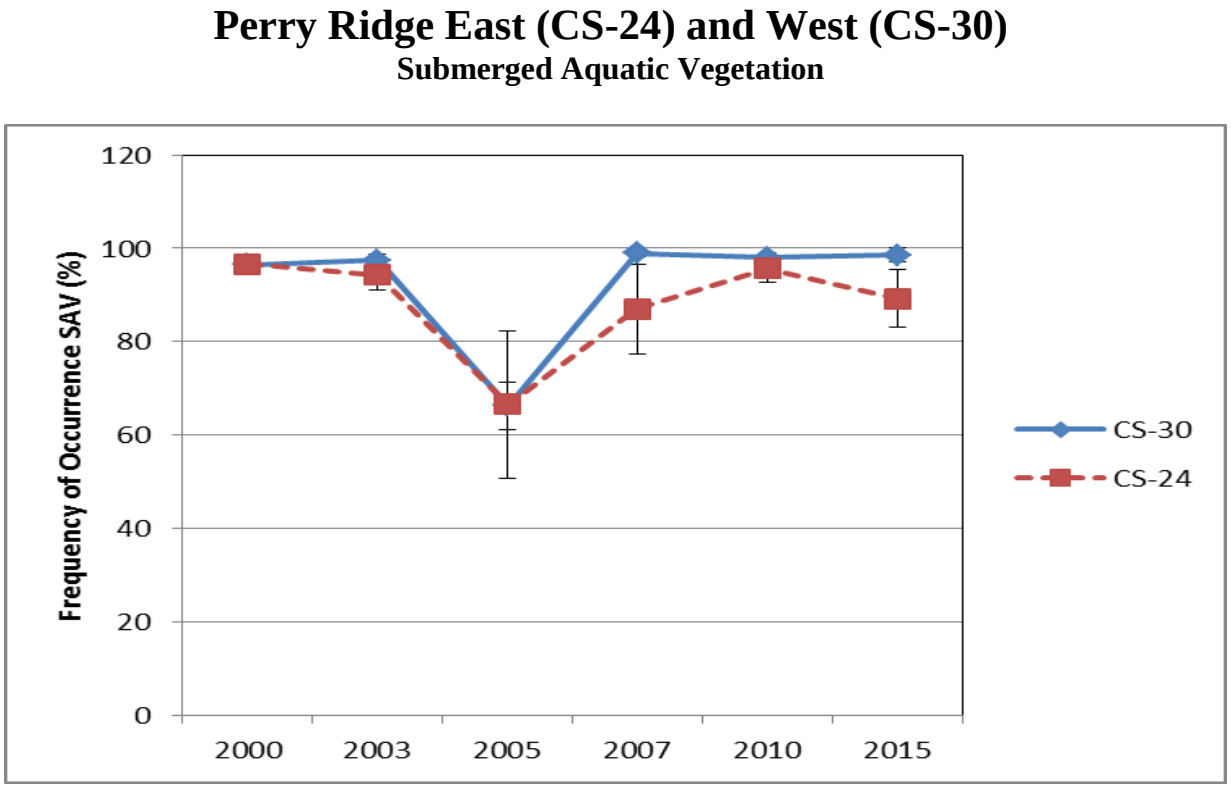

Figure 9. Total percent cover of SAV by Project in years 2000, 2003, 2005, 2007, 2010 and 2015 (means ± SE).

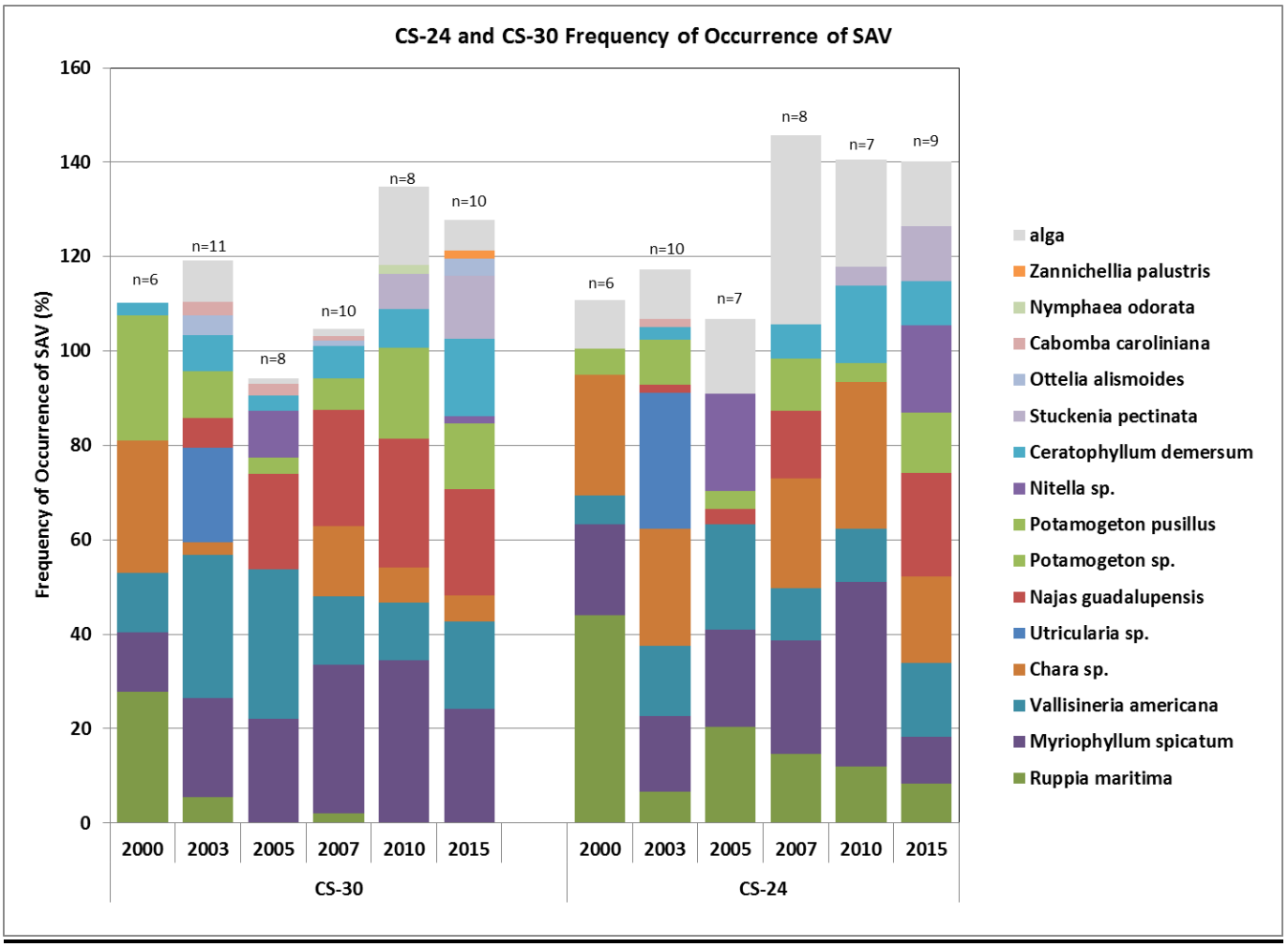

Figure 10. SAV species frequency of occurrence for CS-24 and CS-30 in years 2000, 2003, 2005, 2007, 2010 and 2015.

Hydrologic Index:

High Hydrologic Index (HI) scores indicate that flooding and salinity conditions are ideal for vegetation growth in a given marsh type. In 2015 and 2016 the HI scores were extremely high at CRMS site 0697 within the CS-30 project which is being used as an analog for the CS-24 project area do to their similar project features and close proximity (Figure 11). In most years the HI scores in the project area were similar to or significantly higher than other CRMS sites in and out of projects. At all sites, low scores in 2011 and 2012 were due to very high average annual salinity for the given marsh type and higher salinity combined with moderate flooding respectively. It does not appear that the HI scores correlate well with the SAV data, this is likely due to the areas SAV production only responding to the extreme environmental disruption of the 2005 hurricane season and otherwise always being at or near 100% frequency of occurrences. Also the project area was not sampled in 2011, 2012, or 2013 when the project

area presumably had its lowest HI scores, although a large drop in SAV occurrence could have been possible.

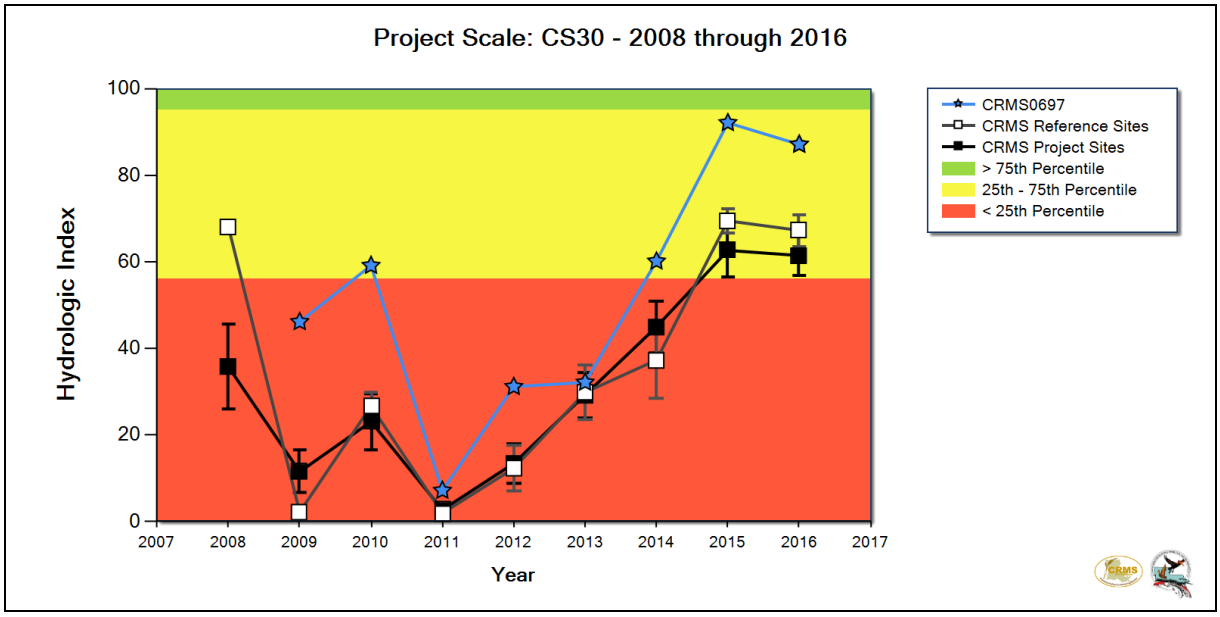

Figure 11 Hydrologic Index score for CRMS0697 in the CS-30 project area which is extremely similar to the CS-24 project area shown over time relative to all other CRMS sites (CWPPRA project and reference) within similar marsh types within the Calcasieu/Sabine Basin.

V. Conclusions

a. Project Effectiveness

The project has been effective at preventing shoreline erosion. The protected shoreline accreted while the reference shoreline continued to erode. The structural components of the Perry Ridge Shoreline Protection Project are in good condition and functioning as designed. Overall the project foreshore rock dike, the created emergent marsh, along with the remaining GIWW spoil bank are not only protecting the interior marsh from mechanical wave and wake damage, but also appear to reduce salinity spikes into the area under normal and low water levels. This has the added benefit of supporting a large and diverse SAV population in the project area which was bolstered by the addition of non-project terraces in the projects eastern end.

b. Recommended Improvements

The addition of non-project terraces increased SAV abundance. This indicates that the project area was a good candidate for terraces at the time of project construction. Other projects with similar attributes, such as low salinity, large shallow open ponds, with minimal tidal interaction such as Clear Marais (CS-22) and Perry Ridge West (CS-30) could or have also benefited from terrace construction.

c. Lessons Learned

Foreshore rock dikes are extremely effective at reducing erosion, creating land and protecting interior wetlands on waterways such as the Gulf Intracoastal Waterway and Freshwater Bayou Canal.

d. End of Project Life

The foreshore rock dike on the northern bank of the GIWW from the Vinton canal west to Perry Ridge has been highly successful at eliminating shoreline erosion while capturing sediment in formerly open water areas behind the rocks. This feature should, under normal environmental conditions including hurricanes, continue to create more emergent marsh with the continued deposition of sediments behind the rock dike. The rock dike has needed little maintenance over the 20 year project life and this trend is expected to continue into the foreseeable future. However, there are occasional low spots and minor damage that occur to the rock dike from barge collisions and anchoring. Even as these minor damages to the project occur, the vast majority of the project still functions correctly. If the CS-24 project features are removed after its 20 year economic life, immediate erosion of the deposited marsh would begin and the erosion would be at a significantly increased rate compared to that of the reference area which is a large clay spoil bank. This would also create the same concerns that caused the need for the project originally, such as direct connection from the GIWW into

interior sensitive wetlands, saltwater intrusion to the north, and the loss of highly productive SAV beds. However this is not likely to occur as the project will likely remain in place after is 20 year life has ended.

VI. Literature Cited

Chabreck, R. H., T. Joanen, and A. W. Palmisano 1968. Vegetation type map of the Louisiana coastal marshes. Louisiana Department of Wildlife and Fisheries, New Orleans. Scale 1:62,500.

Chabreck, R. H., and G. Linscombe 1978 and1988. Vegetation type map of the Louisiana coastal marshes. Louisiana Department of Wildlife and Fisheries, New Orleans. Scale 1:62,500.

Chabreck, R.H., and Linscombe, G., 1997, Vegetative type map of the Louisiana coastal marshes: Baton Rouge, Louisiana Department of Wildlife and Fisheries.

Couvillion, B.R., Barras, J.A., Steyer, G.D., Sleavin, William, Fischer, Michelle, Beck, Holly, Trahan, Nadine, Griffin, Brad, and Heckman, David, 2011, Land area change in coastal Louisiana from 1932 to 2010: U.S. Geological Survey Scientific Investigations Map 3164, scale 1:265,000, 12 p. pamphlet.

Linscombe, G., and Chabreck, R., [n.d.], Task III.8—Coastwide aerial survey, brown marsh 2001 assessment: Salt marsh dieback in Louisiana—Brown marsh data information management system, accessed June 4, 2006, at http://brownmarsh.net/data/III_8.htm

Louisiana Coastal Wetlands Conservation and Restoration Task Force and Wetlands Conservation and Restoration Authority. 1998. Coast 2050: Toward a Sustainable Coastal Louisiana. Louisiana Department of Natural Resources, Baton Rouge, La. 161pp.

Mouledous, M., and M. Guidry 2016. 2016 Operations, Maintenance, and Monitoring Report for GIWW - Perry Ridge West Bank Stabilization (CS-30), Coastal Protection and Restoration Authority of Louisiana, Lafayette, Louisiana. 27pp and Appendices.

Nyman, J. A. and R. H. Chabreck 1996. Some effects of 30 years of weir management on coastal marsh aquatic vegetation and implications to waterfowl management. Gulf of Mexico Science 14:16-25.

O'Neil, T., 1949, The muskrat in Louisiana coastal marshes: New Orleans, Louisiana Wildlife and Fisheries Commission, 28 p.

Sasser, C.E., Visser, J.M., Mouton, Edmond, Linscombe, Jeb, and Hartley, S.B., 2008, Vegetation types in coastal Louisiana in 2007: U.S. Geological Survey Open-File Report 2008–1224, 1 sheet, scale 1:550,000.

Sasser, C.E., Visser, J.M., Mouton, Edmond, Linscombe, Jeb, and Hartley, S.B., 2014, Vegetation types in coastal Louisiana in 2013: U.S. Geological Survey Scientific Investigations Map 3290, 1 sheet, scale 1:550,000.

Steyer, G. D., R. C. Raynie, D. L. Steller, D. Fuller, and E Swenson 1995. Quality management plan for Coastal Wetlands Planning, Protection, and Restoration Act monitoring plan. Open-file series 95-01. Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration Division.

U.S. Department of Agriculture, Soil Conservation Service 1988. Soil Survey of Calcasieu Parish, Louisiana. Publication No. 1988 0 - 493-544. Washington, D.C.:U.S. Government Printing Office. 161 pp, 86 maps. Scale 1:20,000.

_____1992. Wetland Value Assessment, Alexandria, LA.: Soil Conservation Service. 3 pp.

U.S. Department of Agriculture, Natural Resources Conservation Service 1996. Environmental Assessment, USDA-NRCS, Calcasieu Parish, Louisiana. 18 +pp.

Wood, B., and Aucoin, S. 2015. 2015 Operations, Maintenance, and Monitoring Report for Black Bayou Hydrologic Restoration (CS-27). Coastal Protection and Restoration Authority of Louisiana, Lafayette, Louisiana. 64 pgs. and appendices.

APPENDIX A
(Inspection Photographs)

Photo No.1, Typical Rock Dike

Photo No.2, Accretion behind Rock Dike

APPENDIX B
(Three Year Budget Projection)

PERRY RIDGE SHORELINE PROTECTION/ CS-24 /PPL 4

Three-Year Operations & Maintenance Budgets 07/01/2017 - 06/30/2020

Project Manager	O & M Manager	Federal Sponsor	Prepared By
Pat Landry	*Mel Guidry*	*NRCS*	*Mel Guidry*

	2017/2018 (-19)	2018/2019 (-20)	2019/2020 (-21)
Maintenance Inspection	$ 7,269.00	$ 7,487.00	$ 7,712.00
Structure Operation			
State Administration		$ -	$ -
Federal Administration		$ -	$ -
Maintenance/Rehabilitation			

17/18 Description:

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

18/19 Description

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

19/20 Description:

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

	2017/2018 (-19)	2018/2019 (-20)	2019/2020 (-21)
Total O&M Budgets	**$ 7,269.00**	**$ 7,487.00**	**$ 7,712.00**

O &M Budget (3 yr Total)	**$ 22,468.00**
Unexpended O & M Budget	**$ 357,668.00**
Remaining O & M Budget (Projected)	**$ 335,200.00**

OPERATION AND MAINTENANCE BUDGET 07/01/2017-06/30/2018

PERRY RIDGE SHORE PROTECTION/CS-24/PPL4

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$7,269.00	**$7,269.00**
General Structure Maintenance	LUMP	0	$0.00	**$0.00**
Engineering and Design	LUMP	0	$0.00	**$0.00**
Operations Contract	LUMP	0	$0.00	**$0.00**
Construction Oversight	LUMP	0	$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
Navagation 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	0	$0.00	$0.00
Materials		LUMP	0	$0.00	$0.00
Mob / Demob		LUMP	0	$0.00	$0.00
Contingency		LUMP	0	$0.00	$0.00
General Structure Maintenance		LUMP	0	$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: **$7,269.00**

OPERATION AND MAINTENANCE BUDGET 07/01/2018-06/30/2019

PERRY RIDGE SHORE PROTECTION/CS-24/PPL4

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$7,487.00	**$7,487.00**
General Structure Maintenance	LUMP	0	$0.00	**$0.00**
Engineering and Design	LUMP	0	$0.00	**$0.00**
Operations Contract	LUMP	0	$0.00	**$0.00**
Construction Oversight	LUMP	0	$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
Navagation 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	0	$0.00	$0.00
Materials		LUMP	0	$0.00	$0.00
Mob / Demob		LUMP	0	$0.00	$0.00
Contingency		LUMP	0	$0.00	$0.00
General Structure Maintenance		LUMP	0	$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: **$7,487.00**

OPERATION AND MAINTENANCE BUDGET 07/01/2019-06/30/2020

PERRY RIDGE SHORE PROTECTION/CS-24/PPL4

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$7,712.00	**$7,712.00**
General Structure Maintenance	LUMP	0	$0.00	**$0.00**
Engineering and Design	LUMP	0	$0.00	**$0.00**
Operations Contract	LUMP	0	$0.00	**$0.00**
Construction Oversight	LUMP	0	$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
	Navagation 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	0	$0.00	$0.00
	Materials		LUMP	0	$0.00	$0.00
	Mob / Demob		LUMP	0	$0.00	$0.00
	Contingency		LUMP	0	$0.00	$0.00
	General Structure Maintenance		LUMP	0	$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: **$7,712.00**

APPENDIX C
(Field Inspection Notes)

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: CS-24 Perry Ridge Shoreline Protection

Date: June 13, 2013

Structure No.

Inspector(s): Mel Guidry, Stan Aucoin, Darrell Pontiff (CPRA)
Frank Chapman, Brandon Samson (NRCS), Josh Carson (COE)

Structure Description: Rock Dike

Water Level: Gage Not Available

Type of Inspection: Annual

Weather Conditions: Sunny and Warm

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	Rock Dike in good condition. A few low areas below original construction elevation. One 50 foot gap in dike possibly due to a barge nosing into rock. Accretion occurring behind rock dike.
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?