State of Louisiana

Coastal Protection and Restoration Authority of Louisiana (CPRA)

2024 Operations, Maintenance, and Monitoring Report

for

Grand-White Lake Land Bridge Protection

State Project Number ME-19
Priority Project List 10

February 2024
Cameron Parish

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2022 Operations, Maintenance, and Monitoring Report
For
Grand-White Lake Land Bridge Protection (ME-19)

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Preface

The Grand-White Lake Land Bridge Protection (ME-19) project was funded through the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) on the 10th Priority Project List with the U.S. Fish and Wildlife Service (USFWS) as the federal sponsor and the Coastal Protection and Restoration Authority (CPRA). The 2022 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 2021, and annual Maintenance Inspections through October 5, 2021.

This report is the 4th report in a series of OM&M reports on the ME-19 project. Reports from 2007, 2011 and 2015 can be found in CIMS.

I. Introduction

The Grand-White Lake Land Bridge Protection project is composed of 1,530 ac (619 ha) of fresh marsh and open water in the Mermentau Basin of Cameron Parish, Louisiana. The project area includes shoreline along a portion of the southeast Grand Lake shoreline, the northern half of Collicon Lake shoreline, and Round Lake (Figure 1). In 2001, 35% of the project area was classified as fresh marsh and 65% as open water shrub/scrub. Soils in the area between Grand Lake, Collicon Lake, and adjacent to the old GIWW are Larose muck. The northeastern shore of Collicon Lake consists of organic Allemands muck. Both Larose muck and Allemands Muck are very poorly drained soils and are extremely vulnerable to erosion when exposed to hydrologic energy (USDA 1995).

Grand Lake and Collicon Lake are in danger of breaching into each other endangering the 13,281 acre (5374.6 ha) Grand-White Lake Land Bridge area. Wave induced erosion of the southeast shoreline of Grand Lake (15 mi/24.1 km northwest fetch) and the west shoreline of Collicon Lake (2 mi/3.2 km southeast fetch) has removed the lake rims and is endangering the narrow land bridge between the two lakes which is less than 450 ft (140 m) wide at the narrowest point. Measurements of shoreline loss at 10 transects at the southeast portion of Grand Lake yielded loss rates from 23.9-36.2 ft (7.3-11.0 m) per year (Clark et al. 1999). The small strip of marsh separating Collicon and Round Lake could be lost and the entire project area could become part of Grand Lake. Consequently, shoreline erosion would accelerate in the marsh between the former Collicon Lake and Alligator Lake and Lake Le Bleu as the shorelines of Grand Lake and White Lake advance towards each other through the Grand-White Lake Land Bridge.

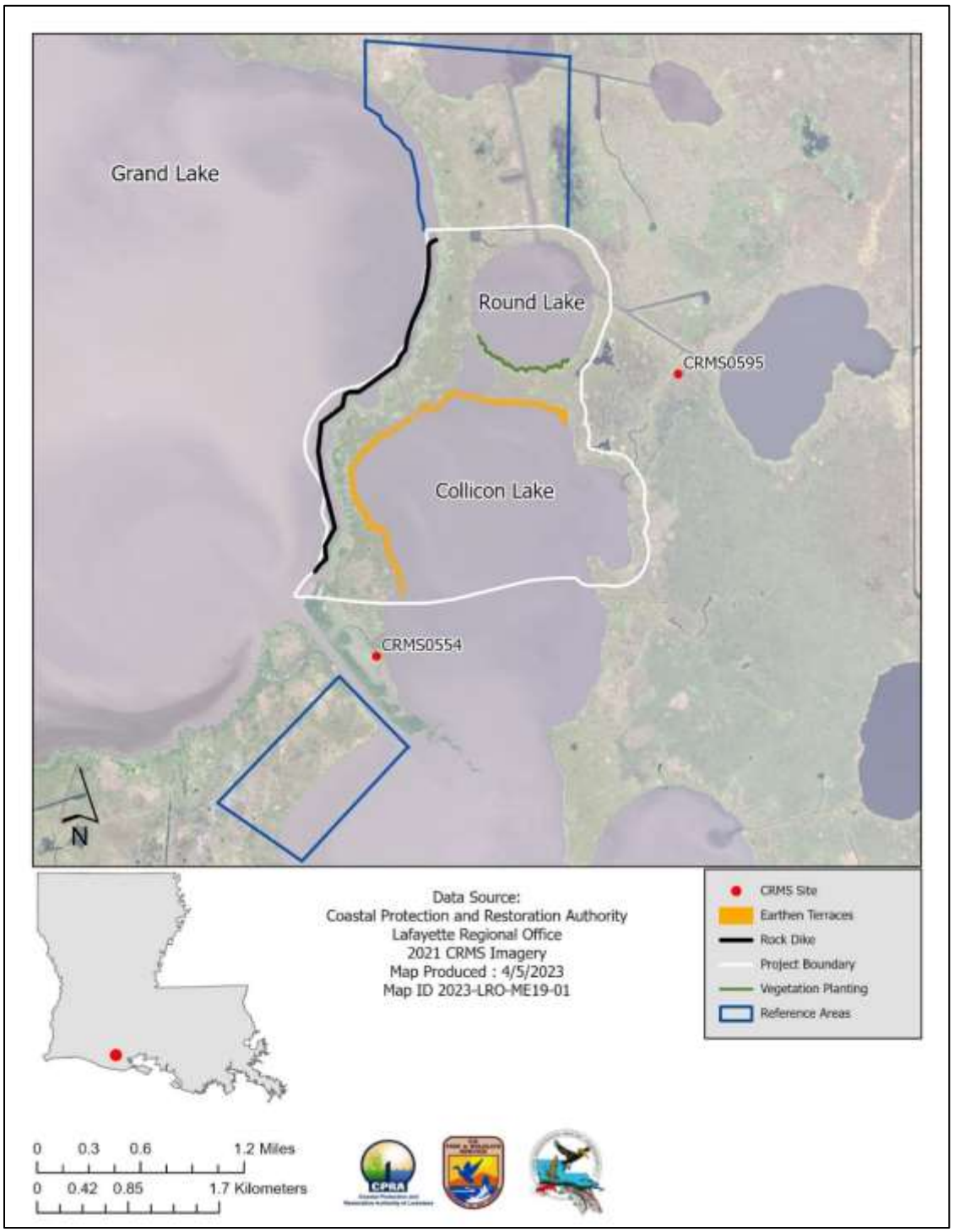

Figure 1. Grand-White Lake Bridge Protection Project (ME-19) project and reference areas showing shoreline planting, shoreline stabilization, CRMS-*Wetland* monitoring sites and terrace locations.

The project features designed to attain the objectives were divided into two construction units.

Unit 1, Grand Lake Shoreline Stabilization, features included installation of a foreshore dike with gaps constructed from limestone lakeward of the southeastern Grand Lake shoreline. Subaerial land was created in open water behind foreshore dike with access channel dredged material during construction. More specifically, construction in this unit included the following items:

1. Excavation of a barge access canal lakeward of the foreshore dike;
2. Placement of 12,024 ft (3,666 m) of limestone rock as a foreshore dike 150–250 ft (45.72–76.2 m) lakeward of the shoreline with 50 ft (15 m) gaps every 700–1,000 ft (213.36–304.8 m) for hydrologic connectivity and fish and wildlife access. Initial dimensions of the foreshore dike were 2.5 feet NAVD 88 (~1 ft [0.30 m] above average water level), a 3 ft (0.91 m) wide crown, a 29 ft (8.84 m) or less base width, and 3:1 side slopes;
3. Dredge material from the access canal was used to create subaerial land behind the foreshore dike; the material was seeded to reduce erosion and enhance marsh establishment (Clark and Dubois 2003).

In Unit 2, the Collicon Lake Terraces, earthen terraces were constructed to reduce erosion of fringing fresh marsh, create marsh, facilitate marsh building by trapping suspended sediments in adjacent shallow open water, and stimulate the growth of submerged aquatic vegetation. Unit 2 construction features consist of the following items.

1. Construction of two parallel rows of 83-385 ft (25-117 m) long terrace segments (92 total segments), with gaps between each segment. Total length was 19,544 ft (5,959 m).
2. Planting of terrace tops with three rows of *Paspalum vaginatum* (seashore paspalum) planted on 5 ft (1.52 m) centers. Terrace side slopes were planted with *Zizaniopis miliacea* (giant cutgrass) in one row on 5 ft (1.52 m) centers. The side slope facing Collicon Lake had two rows on 5 ft (1.52 m) centers.
3. Planting along the southern shoreline of Round Lake included one row of *Z. miliacea* alternated with *Schoenoplectus californicus* (California bulrush) on 5 ft (1.52 m) centers for a total distance of 4,000 ft (1,219.2 m).

Construction of the foreshore rock dike, Unit 1, was initiated in July 2003 and completed in November 2003. Construction of the lake terraces, Unit 2, was initiated in July 2004 and completed in September 2004.

II. Maintenance Activity

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Grand-White Lakes Landbridge Protection Project (ME-19) is to evaluate the constructed project features, 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 (O&M Plan, 2003). The annual inspection report also contains a summary of maintenance projects, if any, 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.

An inspection of the Grand-White Lakes Landbridge Protection Project (ME-19) was held on January 11, 2023 under partly cloudy skies and mild temperatures. In attendance were Mel Guidry, Stan Aucoin of CPRA and John Savell from USFWS. The boat was launched on Miami Corporation property at Superior Canal. The annual inspection began at approximately 10:30 a.m. at the north end of the rock dike along the east shoreline of Grand Lake.

The field inspection included a complete visual inspection of the rock dock project feature to assess future maintenance requirements. Staff gauge readings were not available to determine approximate elevations of water level or the rock dike. Photographs were taken of the rock dike project feature only. (Appendix A).

b. Inspection Results

Grand Lake Shoreline Protection

The foreshore rock dike feature is in good condition. Warning signs are present. There is vegetation behind the rock dike over the majority of length of dike. The south end of the rock dike needs to be extended approximately three hundred (300) linear feet to the existing shoreline to reduce erosion of the southern tie-in of the project.

Collicon Lake Terraces

Due to high water levels and limited visibility of the earthen terraces on the January 11, 2023 O & M Inspection, the earthen terraces on Collicon Lake were not inspected.

c. Maintenance Recommendations

i. Immediate/ Emergency Repairs

None

ii. Programmatic/ Routine Repairs

A Task Order is being developed for engineering design of a proposed three hundred (300') linear foot extension of the rock dike on the southern end of the project. Also the entire linear footage of the rock dike will be surveyed to identify any reaches which may need to be lifted. The proposed extension of the rock dike

along with lifting any low areas is part of a final O&M event for 20 year close-out of the project.

d. Maintenance History

General Maintenance: Below is a summary of completed maintenance projects and operation tasks performed since September 2004, the construction completion date of the Grand-White Lakes Landbridge Protection Project (ME-19).

2009 Stream Wetland Services, LLC – The lakeside earthen terraces were planted with 3,242 Roseau Cane plants to help with erosion to the terraces. The work was completed in March of 2009. The costs associated with this maintenance event were as follows:

E&D (by OCPR)	$ 5,000.00
Construction Contract	$24,120.48
TOTAL	**$29,120.48**

III. Operation Activity

Structure Operations:

There are no active operations associated with this project.

IV. Monitoring Activity

Pursuant to a CWPPRA Task Force decision on August 14, 2003 to adopt the Coastwide Reference Monitoring System-*Wetlands* (CRMS) for CWPPRA, updates were made to the ME-19 Monitoring Plan to merge it with CRMS 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 adjacent to the ME-19 project area (CRMS0595 to the northeast and CRMS0554 to the south) and another site within the Grand-White Lake Land Bridge area (CRMS0574).

a. Monitoring Goals

The objective of the project is to prevent the coalescence of Grand, Collicon, and Round lakes by:

a. Stopping erosion along the southeastern shoreline of Grand Lake and the northern and western shorelines of Collicon Lake.

b. Creating a total of 17 acres of emergent marsh along the southeastern shoreline of Grand Lake and 10 acres of emergent marsh along the northern and western shorelines of Collicon Lake.
c. Reducing erosion along the southern shoreline of Round Lake by 50 %.

b. Monitoring Elements

Aerial Photography

To evaluate the extent of marsh creation and erosion within the project and reference areas, near-vertical, color-infrared aerial photography (1:12,000 scale) was obtained as built in November 2004 ("as-built" following terrace construction) and in post-construction years 2014 and 2018. The photography was georectified, mosaicked, and land/water ratios determined using standard operating procedures described in Steyer et al. (1995, revised 2000). To compare to the historical context of the ME-19 project area, % land area data archived in the CRMS website (http://www.lacoast.gov/crms_viewer/) was used to generate percent land change trends for the ME-19 area before (1956-2004) and after (2004-2016) project construction.

To provide historical context for the ME-19 land bridge, the land change analysis (1956-1998) performed by the USGS for the environmental assessment of this project (Clark and Dubois 2003) was expanded through 2016 and includes a pre- versus post construction analysis of change rates. Distances from ten transects crossing the land bridge between Grand and Collicon/Round Lakes (Figure 6) were measured over time from aerial photography (historical pre-construction: 1956, 1978, 1988, 1994, 1998; post construction: 2004, 2005, 2007, 2008, 2010, 2013 and 2018). The historical pre-construction data was compiled from the environmental assessment, and the post construction data was collected from imagery on the SONRIS GIS platform. Cumulative change starting from 1956 was averaged from all transects and plotted. Change rates were determined via linear regression for each transect then averaged to compare pre- versus post construction periods with a least square means ANOVA (SAS Institute Inc. 2010).

Shoreline Change

To document shoreline movement, differential GPS was used to map the shoreline in both the project (behind the project features) and reference areas (Steyer et al. 1995). Contiguous, emergent vegetation was used to delineate the shoreline. Shoreline mapping behind the foreshore dike and its reference area was conducted in November 2003 (as built) and August 2006 (post construction). Shoreline mapping behind the earthen terraces and its reference area was conducted in October 2004 (as built). Post construction shoreline mapping behind the foreshore dike and terraces was conducted in October 2008, 2013, and 2021. Change rates for time intervals were calculated using Digital Shoreline Analysis System (DSAS) version 4.0, an ArcGIS® application. Transects spaced 20 m apart were established for the shoreline reaches, and change rates (EPR, m/y) were determined between dates of interest (Thieler et al. 2009).

In order to calculate the area that was gained on the east bank of Grand Lake, we outlined the space between the rock dike and the shoreline following the completion of construction in ArcGIS. In 2022, we again traced the space between the rock dike and the shore to create a new shape that

when subtracted from the original outline gave us the amount of land gained on the Grand Lake shoreline area. We did the same process for Collicon Lake.

Terrace Vegetation

The condition of the natural emergent, seeded, and planted vegetation on the Collicon Lake terraces is monitored at 10% of the total planted terraces over the life of the project. Twelve terraces were grouped by potential wave exposure, six are lakeside terraces (higher exposure) and six are marsh side terraces (lower exposure). Four sampling stations were established on selected terraces consisting of a station on the inner and outer slope and two stations on the crown. At each station (4 m^2 sample area) species composition, percent cover (total and by species), and dominant plant heights were documented (Steyer et al. 1995). Each station was marked with two corner poles to allow for revisiting the sites over time. Vegetation was evaluated at the sampling sites in the fall of 2004 (as built) and 2005 (post construction). Sampling was scheduled to continue in 2008, 2013, and 2021; however, by 2008 many of the terraces (especially the lakeside terraces) had eroded to the point that the permanent vegetation stations did not exist.

Because the permanent vegetation stations are eroding with the terraces, the evaluation of terrace vegetation was changed to a more adaptable method than fixed stations. Vegetation on the twelve terraces used for the initial vegetation evaluation is documented over the entire terrace rather than permanent vegetation stations. Previous vegetation data (2004 and 2005) collected from permanent vegetation stations were combined to describe each terrace and compare to future vegetation data. Vegetated portions of the twelve terraces are mapped to compliment the terrace vegetation evaluation and track the condition of the terraces over time concurrent with shoreline mapping. The twelve terraces are mapped using differential GPS (Steyer et al. 1995) as conducted for shoreline mapping. Terrace vegetation evaluation and mapping was conducted in March 2010, October 2013, and October 2021. Terrace areas were calculated from As-built drawings (September 2004), digitized aerial photography (November 2005 and October 2021), and dGPS mapping (May 2010 and October 2013) to describe changes over time. Because the lakeside terraces were built larger than the marsh side terraces, percent area change within each time interval was used for statistical analysis in full factoral ANOVA of position (lakeside, marsh side) and time interval (2004-2005, 2005-2010, 2010-2013, and 2013-2021). In addition to the 10% of terraces selected for vegetation assessment, the survival of all terraces was quantified. An assessment of percent of terraces remaining each year since construction was conducted by overlaying a 2005 terrace polygon layer over imagery from October 6, 2021 in Google Earth. If any vegetation was visible within the polygon, then the terrace was considered present; if no vegetation was visible, then it was considered absent.

c. Monitoring Results and Discussion

Aerial Photography

The stated goal of creating a total of 27 acres of emergent marshland was broken down into the creation of 17 acres on the southeastern shore of Grand Lake as well as an additional 10 acres combined on the north and west shores of Collicon Lake. In order to gather accurate data, baseline aerial photography for the project area was flown on November 24, 2004 immediately following terrace construction (Figure 2). The total project area was 32% land; the reference area for the

foreshore dike (to the north) was 76% land, and the reference area for the terraces (to the south) was 63% land. Land to water analysis to evaluate land change and compare among areas was conducted post construction in 2014 and 2018 (Figures 3-4). The total project area increased to 34% land in 2014 before decreasing slightly to 33% land in 2018. Both reference areas decreased in land area between 1 to 3 percent from 2004 to 2018. The northern reference area is 73% land and the southern reference area is 62% land as of 2018.

Percent land area stored on the CRMS website (http://www.lacoast.gov/crms_viewer/) was used to provide a historical perspective on the ME-19 project area (Figure 5). Prior to construction in 2004, the ME-19 project area was losing land at a rate of -0.31%. From 2004 to 2016 the ME-19 project area began gaining land at a rate of 0.33% with the addition of terraces, dredge spoil deposition, and increases in land in addition to dredge material deposition. Based on the land area change map from Couvillion et al. (2011), pre-construction loss appeared to be more associated with shoreline erosion, whereas post construction loss is more associated with interior marsh loss.

Within the project area, the land bridge narrowed significantly at a rate of -22.2 ft/y (6.6 m/y) during pre-construction (1956-2004; Figure 5). Since construction, the land bridge has slowly broadened at a rate of 4.9 ft/y (1.5 m/y). To reference this, the narrowest width of the land bridge (Transect 9) shrunk from 1405 ft (428 m) in 1956 to 422 ft (129 m) in 1998. Since construction of the ME-19 project the land bridge broadened to 568 ft (173 m) at this transect. Of the 10 transects, 8 have broadened from 1998 to 2018 at an average of 103 ft (31 m). The two transects that narrowed averaged -77 ft (-24 m). This land gain resulted from several of the marsh side terraces merging with the land bridge.

Shoreline Change

From construction to 2008 the only area to gain land was the project area behind the rock dike on Grand Lake (1.9 m/yr; Figure 6). The rock dike reference area, Collicon Lake project area and reference area lost land (-0.33, -0.06, and -1.26 m/yr, respectively). Since 2008, land has continued to erode in both Grand Lake and Collicon Lake reference areas (-1.73 and -1.38 m/yr, respectively; Figure 7-8). However, there has been land expansion behind the Grand Lake rock dike (0.52 m/yr) and the Collicon Lake project area (1.48 m/yr). Shoreline mapping in 2013 and 2021 revealed several terraces had expanded and merged with the existing shoreline along Collicon Lake (Figure 7). These terraces had vegetation growth that was clearly rooted and not simply floating on the water surface.

Based on data collected in 2021, the goal of creating more than 10 acres of emergent marsh on the north and west shores of Collicon Lake was achieved, yet the project's goal of creating 17 acres of emergent marsh for the southeastern shore of Grand Lake wasn't achieved (Figure 9). For Collicon Lake, 43 acres of emergent marsh were established, meaning that the marsh creation goal was exceeded by more than 33 acres. For Grand Lake, the goal of 17 acres wasn't achieved as only 10 acres were created by the end of the 2021 data collection. This puts the total amount of created emergent marsh at 53 acres total with the total goal only being set at 27 acres for the combined areas.

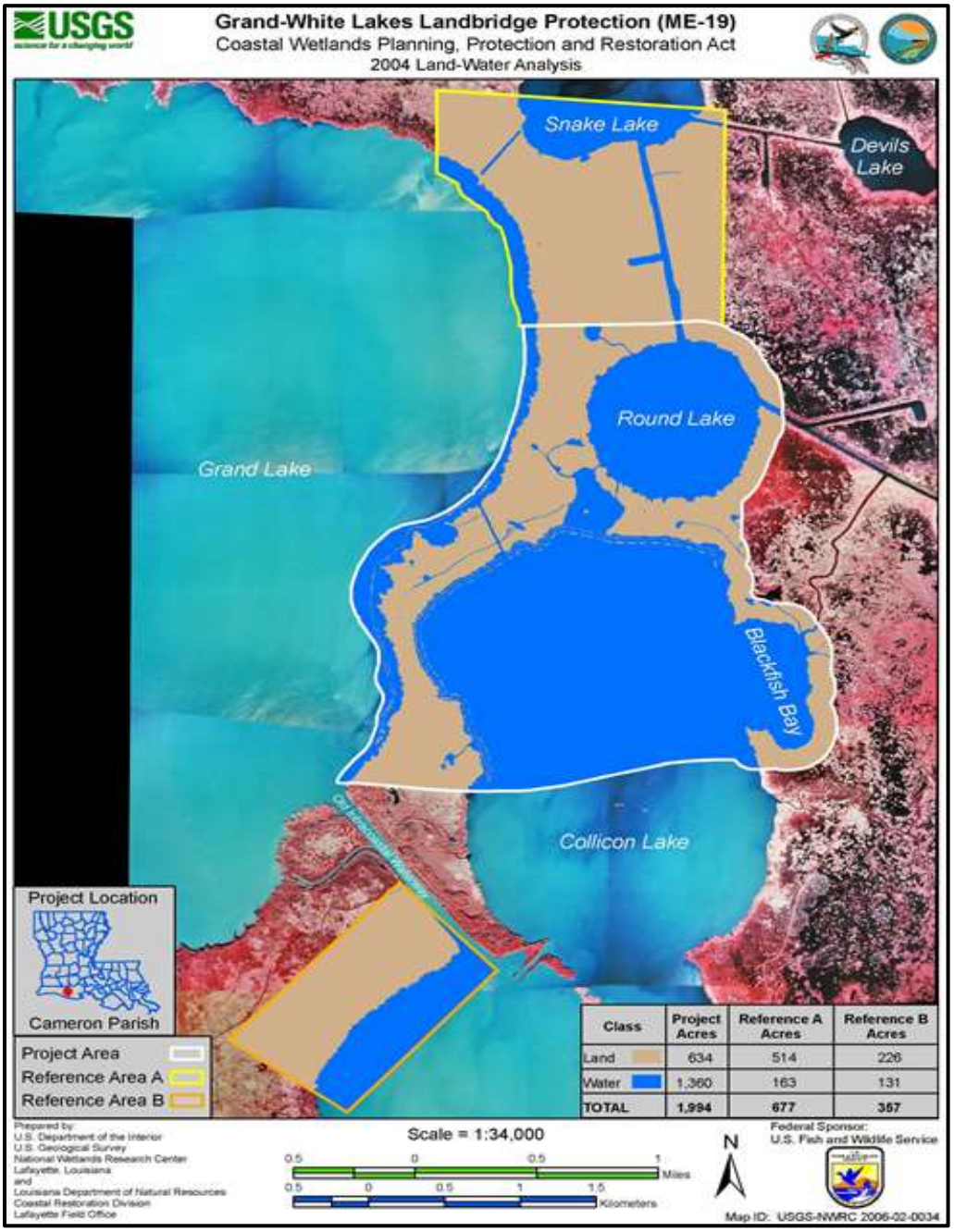

Figure 2. Land to water analysis for Grand-White Lake Landbridge Protection (ME-19), flown November 24, 2004 following completion of construction.

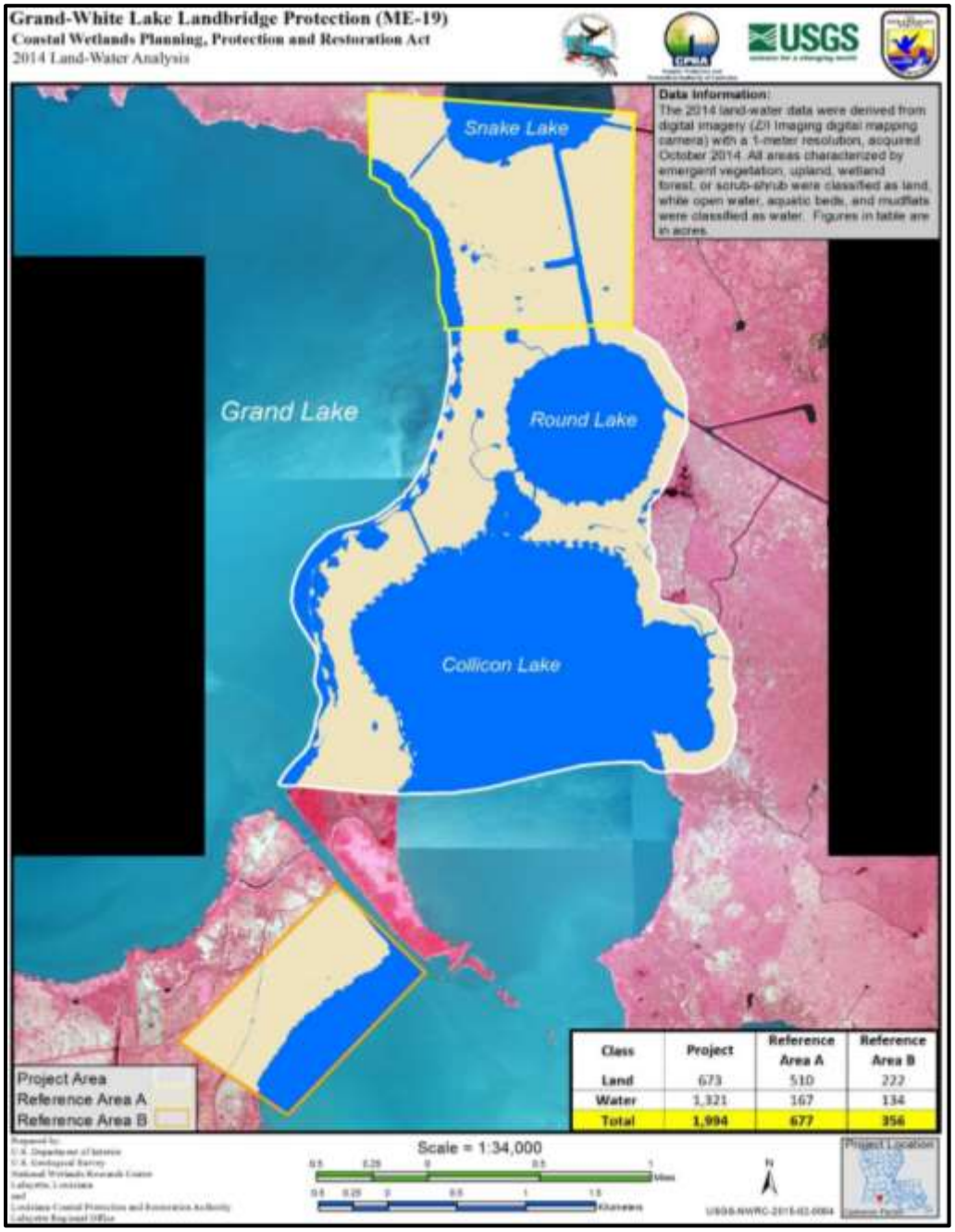

Figure 3. Land to water analysis for Grand-White Lake Landbridge Protection (ME-19), flown October 2014 post-construction.

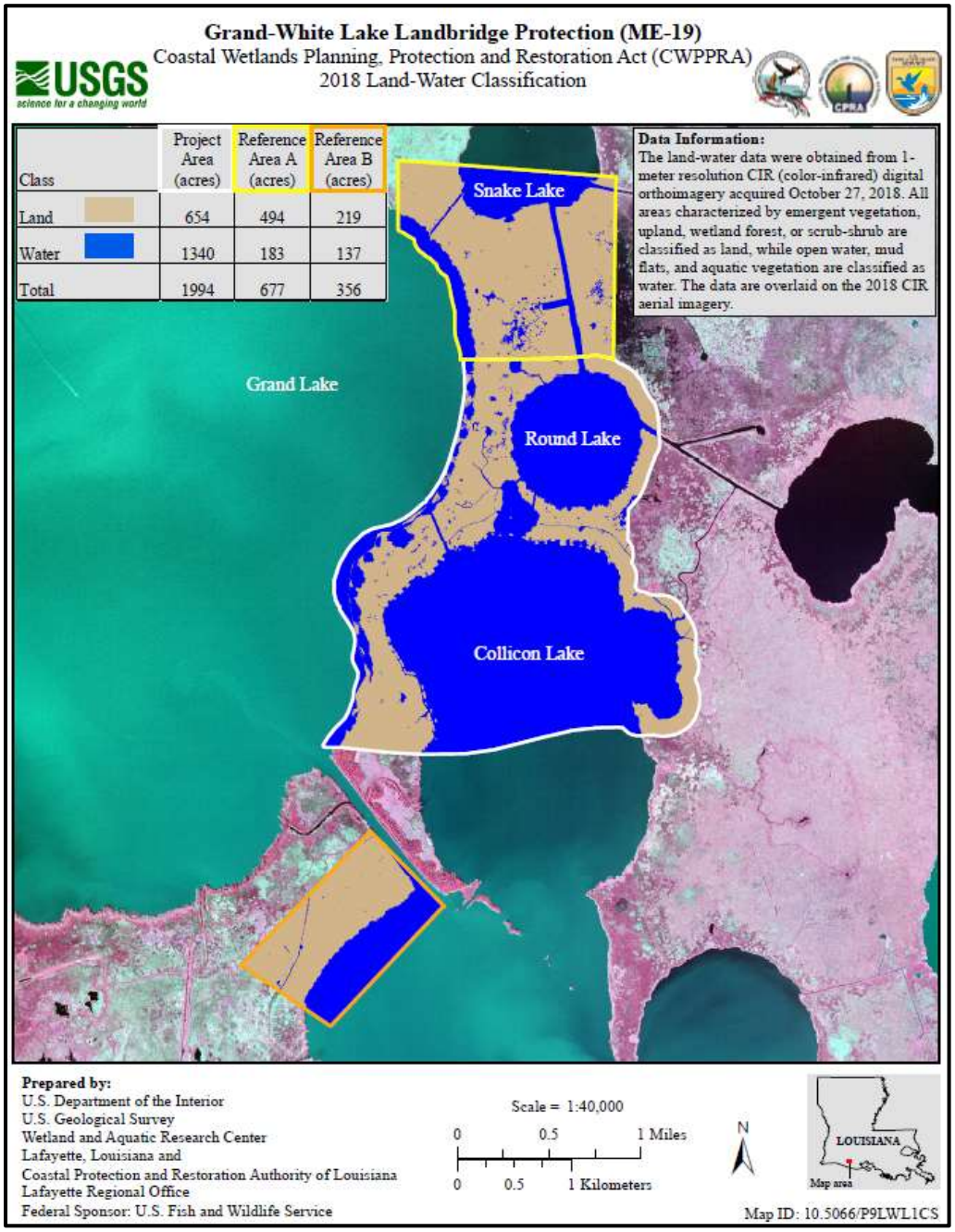

Figure 4. Land to water analysis for Grand-White Lake Landbridge Protection (ME-19), flown October 2018 post construction.

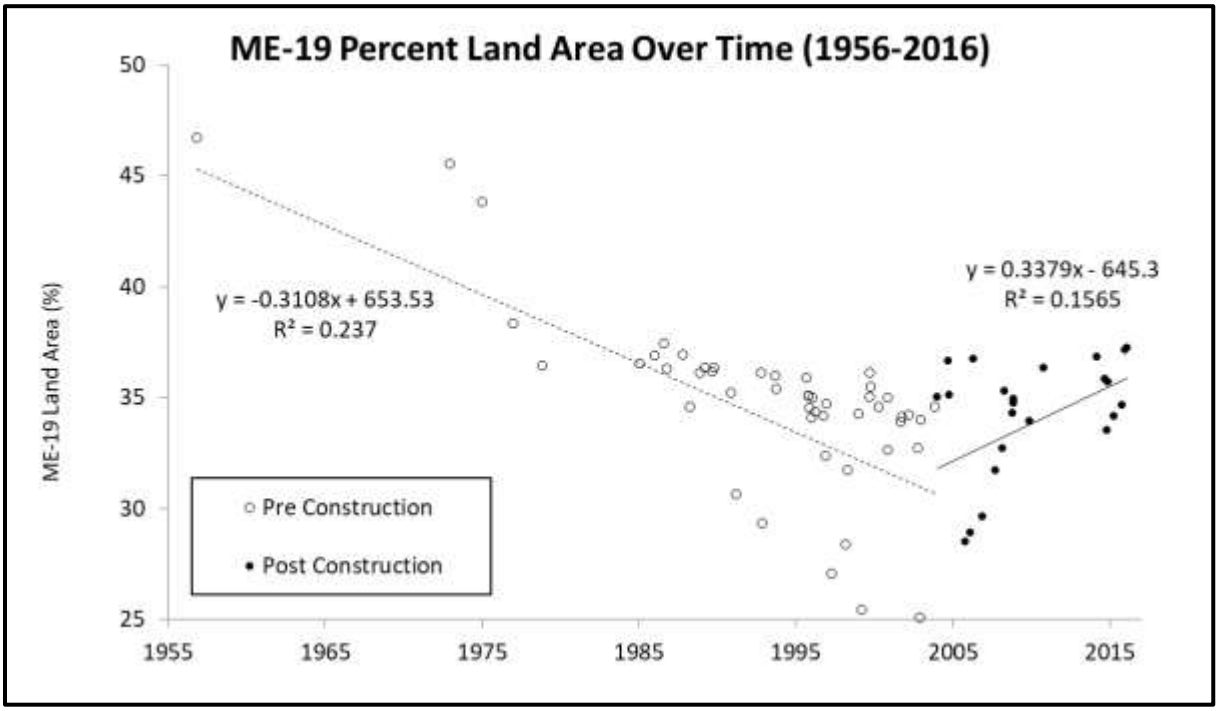

Figure 5: Pre and post construction change in land area over time (1956-2016) in the ME-19 project area. The values are the percent land area before (1956-2004) and after (2004-2016) project construction.

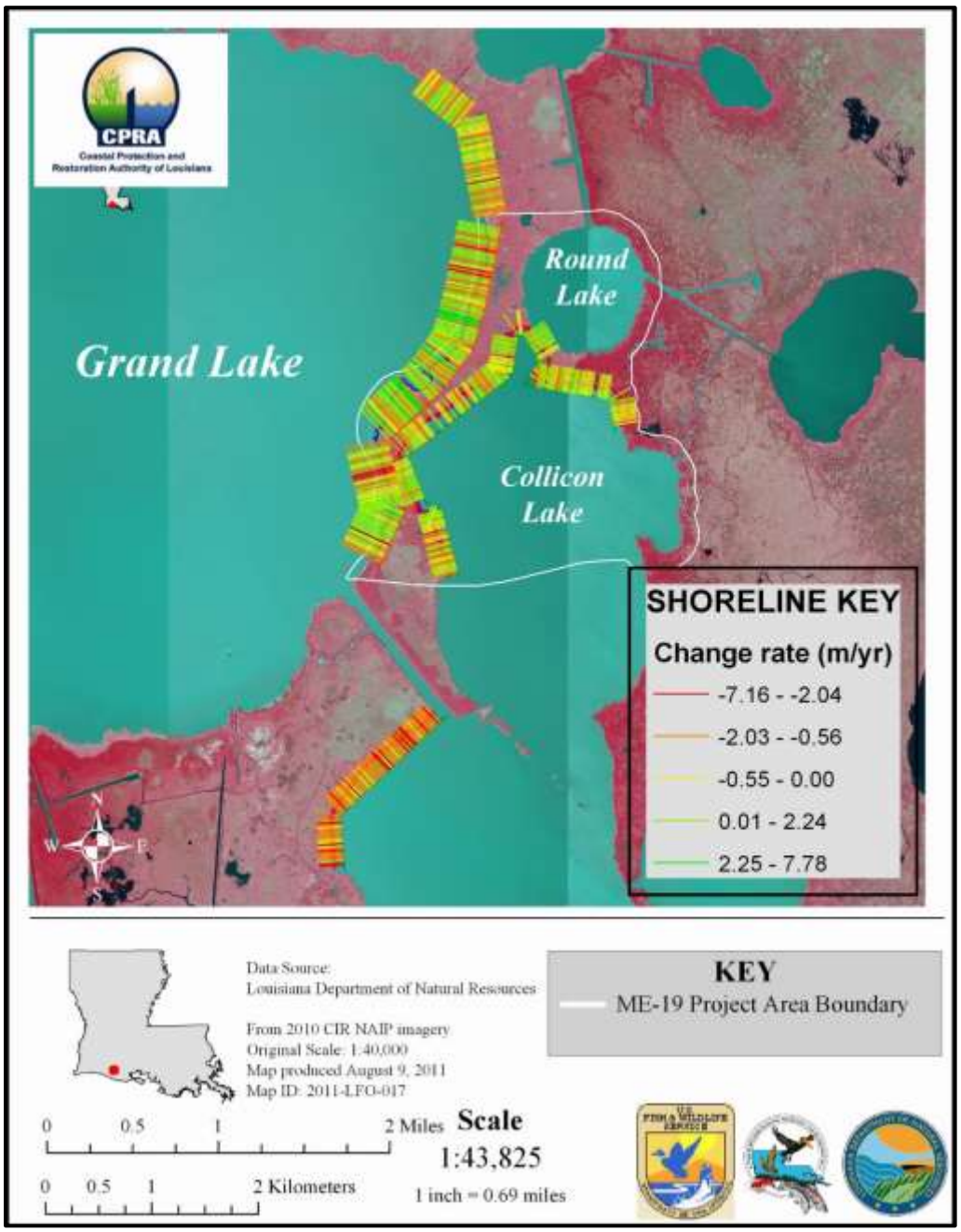

Figure 6. Shoreline mapping was conducted behind project structures (foreshore rock dike along Grand Lake and terraces along Collicon Lake) and corresponding reference areas of the ME-19 project area soon after construction (foreshore rock dike, November 2003; terraces, October 2004) and in October 2008, 2013 and 2021. The figure is from shoreline mapping post construction and in October 2008. Shoreline movement rates (mean, m/y) were calculated from 20 m spaced transects along Grand Lake and Collicon Lake; negative change rates indicate loss while positive change rates indicate gains.

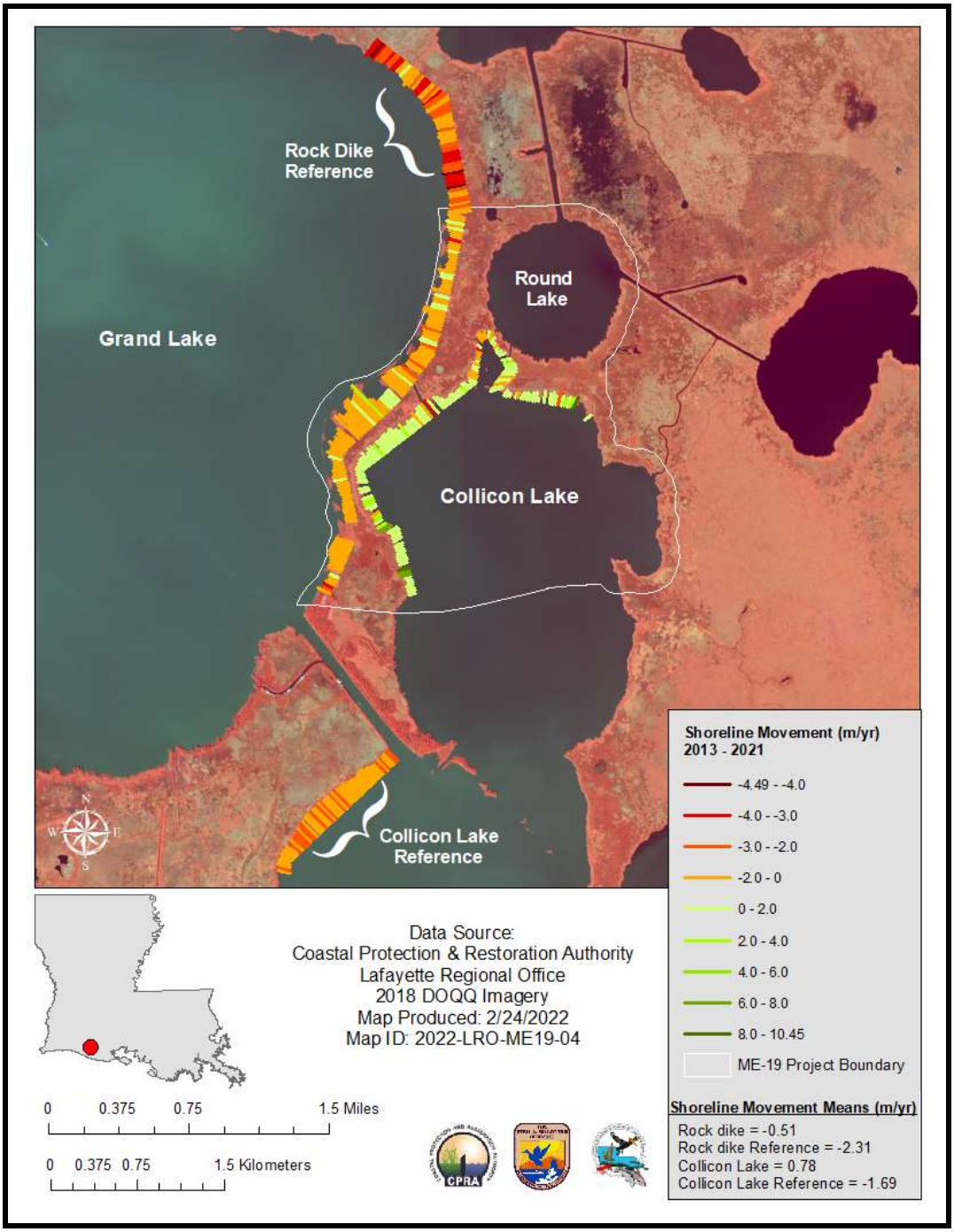

Figure 7. Shoreline mapping behind project structures (foreshore rock dike along Grand Lake and terraces along Collicon Lake) and corresponding reference areas of the ME-19 project area in October 2013 and 2021. Negative change rates indicate loss while positive change rates indicate gains.

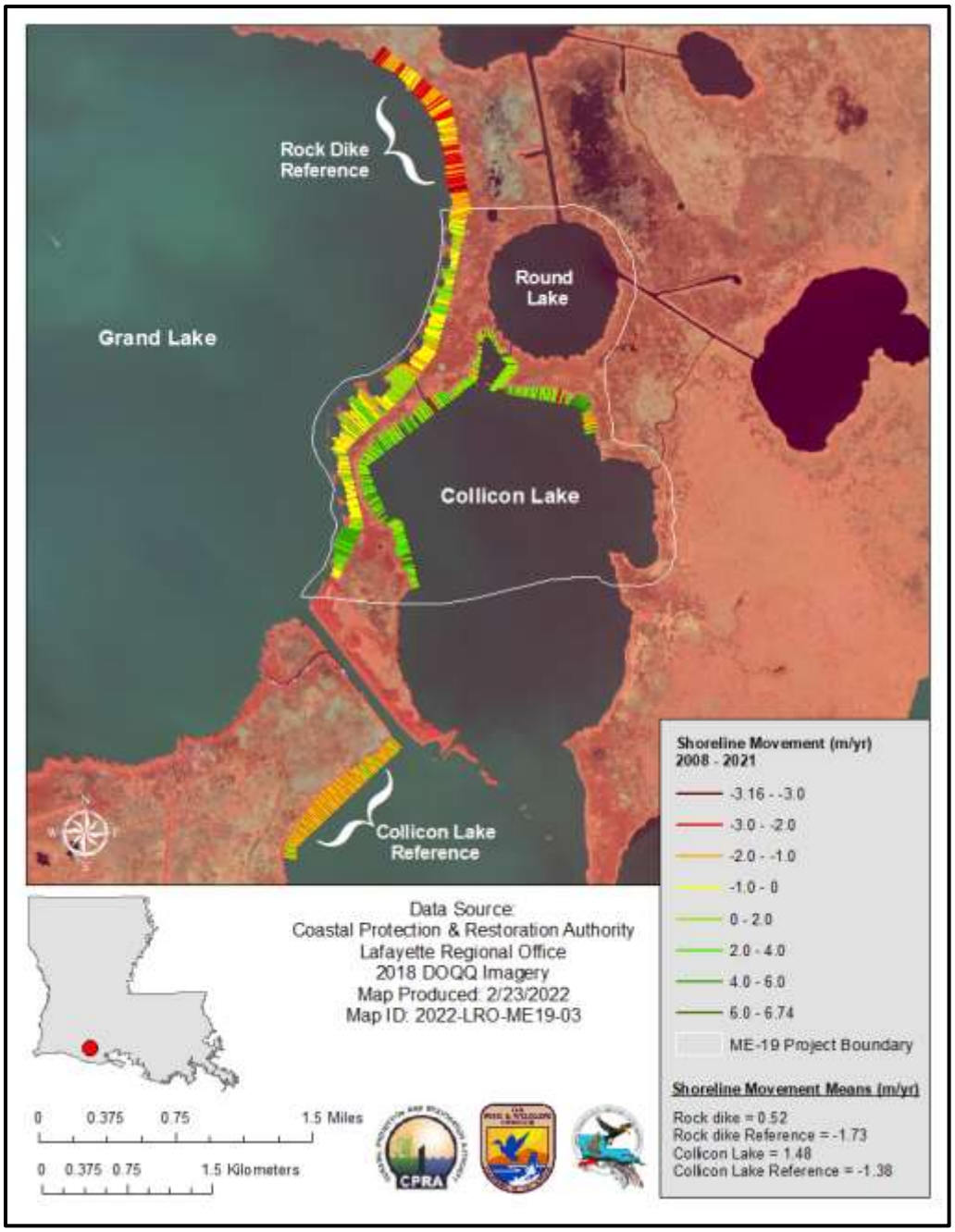

Figure 8. Shoreline mapping behind project structures (foreshore rock dike along Grand Lake and terraces along Collicon Lake) and corresponding reference areas of the ME-19 project area in October 2008 and 2021. Negative change rates indicate loss while positive change rates indicate gains.

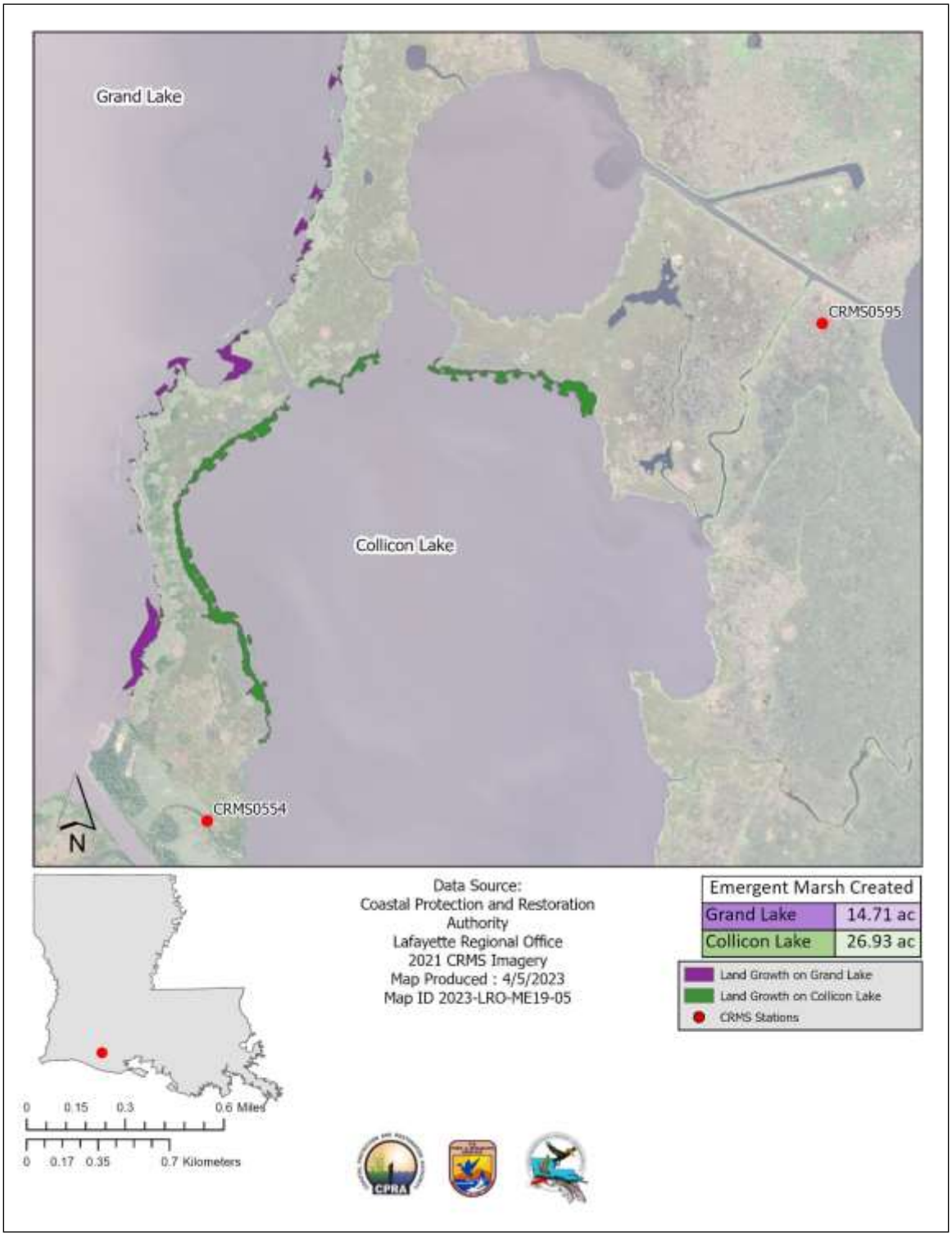
Grand Lake
Collicon Lake
CRMS0595
CRMS0554
N
Data Source:
Coastal Protection and Restoration Authority
Lafayette Regional Office
2021 CRMS Imagery
Map Produced : 4/5/2023
Map ID 2023-LRO-ME19-05
Emergent Marsh Created
Grand Lake 14.71 ac
Collicon Lake 26.93 ac
Land Growth on Grand Lake
Land Growth on Collicon Lake
CRMS Stations
0 0.15 0.3 0.6 Miles
0 0.17 0.35 0.7 Kilometers

Figure 9. Illustrated above are the areas that gained emergent marsh after completion of the project. The marsh creation numbers are from the 2004 shoreline shapes subtracted from the 2018 shoreline shapes, giving us the amounts of acreage created.

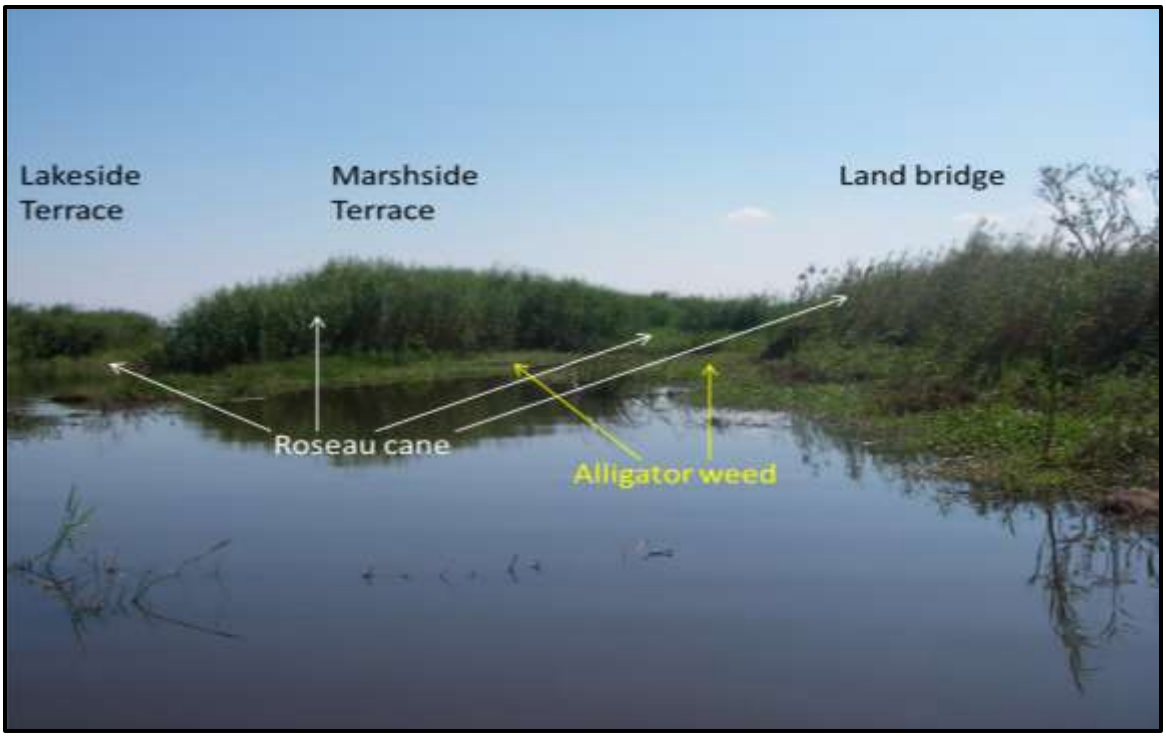

Figure 10. Vegetation along Collicon Lake expands as terrace and land bridge vegetation merge. At the time of this photograph (October 21, 2008) the vegetation between the land bridge and terrace was floating; therefore, the vegetative expansion was not included in the shoreline change analysis. If the merging vegetation anchors into the soil below, then it will be considered emergent and define the vegetated shoreline of the land bridge.

Terrace Vegetation

The purpose of the Collicon Lake terraces is to reduce erosion of fringing fresh marsh, create marsh, facilitate marsh building, and stimulate the growth of submerged aquatic vegetation. To achieve this goal, larger lakeside terraces (LS) were constructed to be sacrificial to the marsh side terraces (MS) long enough for the MS terraces to become established and fully revegetate. Based on 2021 aerial imagery, two-thirds (64%) of the LS terraces are still remaining while majority (98%) of the marsh side terraces remain (Figure 11). The 32% decline in LS terraces from 2007 to 2009 is attributed to the immaturity of the planting in a highly exposed environment and the effects of Hurricane Rita. Following the decline, both the LS and MS terraces have remained stable through 2021.

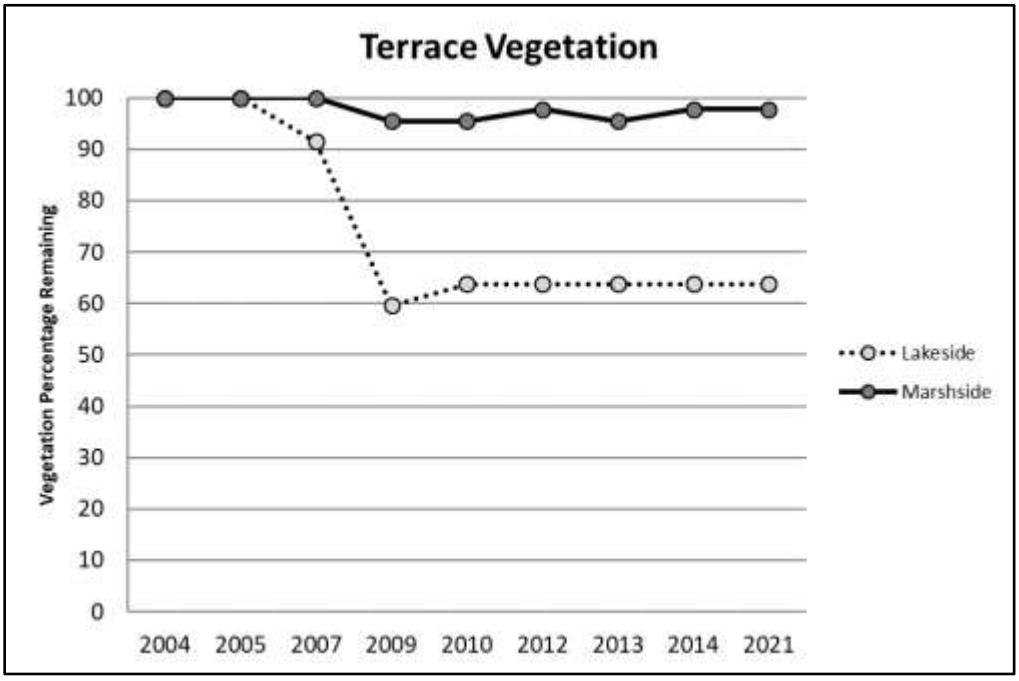

Figure 11. Percentages of terraces with vegetation remaining from construction in 2004 to 2021.

At the twelve terraces used for vegetative evaluation (6 LS and 6 MS), the percent vegetated area of the terraces changed differently by position (lakeside and marsh side) over time intervals based on a robust, full factoral Analysis of Variance terrace position (lakeside and marsh side) and time intervals; the greatest effect was Time Interval while the Position × Time Interval effect was significant (Table 2). Initially after construction of the terraces (2004-2005), terrace area sharply eroded as the sacrificial LS terraces also eroded and protected the MS terraces (Figure 12). Erosion slowed, but continued at both terraces positions from 2005 to 2010 (Figure 13). From 2010 to 2013, both terraces began increasing in areas at rates of 57%/yr on the marsh side and 30%/yr on the lakeside. This expansion is attributed to *Phragmites australis* (Roseau cane) expansion on the remnants of the terraces (Figure 14). The LS terraces added a greater percent of area because there

was more of an open footprint on the terrace to recolonize. Both terrace positions increased between 2014 and 2021 at slower rates of 7%/yr on the lakeside and 14%/yr on the marsh side as vegetation continues to expand on the terraces as well as into the open water areas surrounding the terraces. This expansion beyond the boundaries of the terraces can be observed on the MS terraces, where terrace area in 2021 is larger than terrace area post construction in 2004. Roseau cane expansion on marsh side terraces has begun to merge with land bridge vegetation, increasing MS terrace area.

Table 2. Analysis of Variance (ANOVA) results from full factorial analyses of terrace position (lakeside and marsh side) and time intervals (2004-2005, 2005-2010, 2010-2013, and 2013-2021) effects for percent area change rates (%/y) at ME-19. Significant (*) differences are set at α=0.05.

Source	df	F-ratio	p-value
Position	1	0.3649	0.5487
Time Interval	3	42.371	<0.0001*
Position x Time Interval	3	5.7905	0.0018*

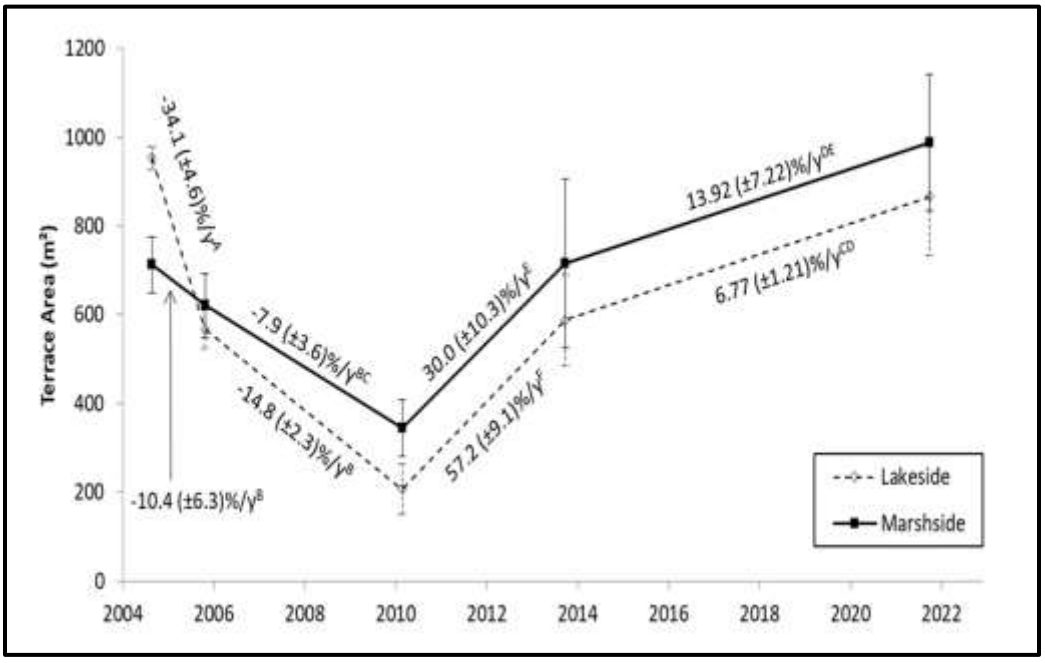

Figure 12. Terrace areas were determined for the Collicon Lake terraces for September 2004 (as-built), November 2005, March 2010, October 2013, and October 2021. Rates of change (values over lines) interactions were compared for terrace position (lakeside and marsh side) by time intervals (2004-2005, 2005-2010, 2010-2013, and 2013-2021); different superscript letters indicate significant difference among the rates.

Figure 13. Many terraces have eroded since construction, especially the lakeside terraces (e.g. LS42) which were intended to be sacrificial and buffer the marsh side terraces. Note the cane poles that mark the original corners of the terrace. Picture was taken on March 24, 2010.

Figure 14. October 2, 2013 photograph of LS42 a lakeside terrace, depicting vegetation growth. Note the expansion of Roseau cane since the 2010 photography in comparison to Figure 12 above.

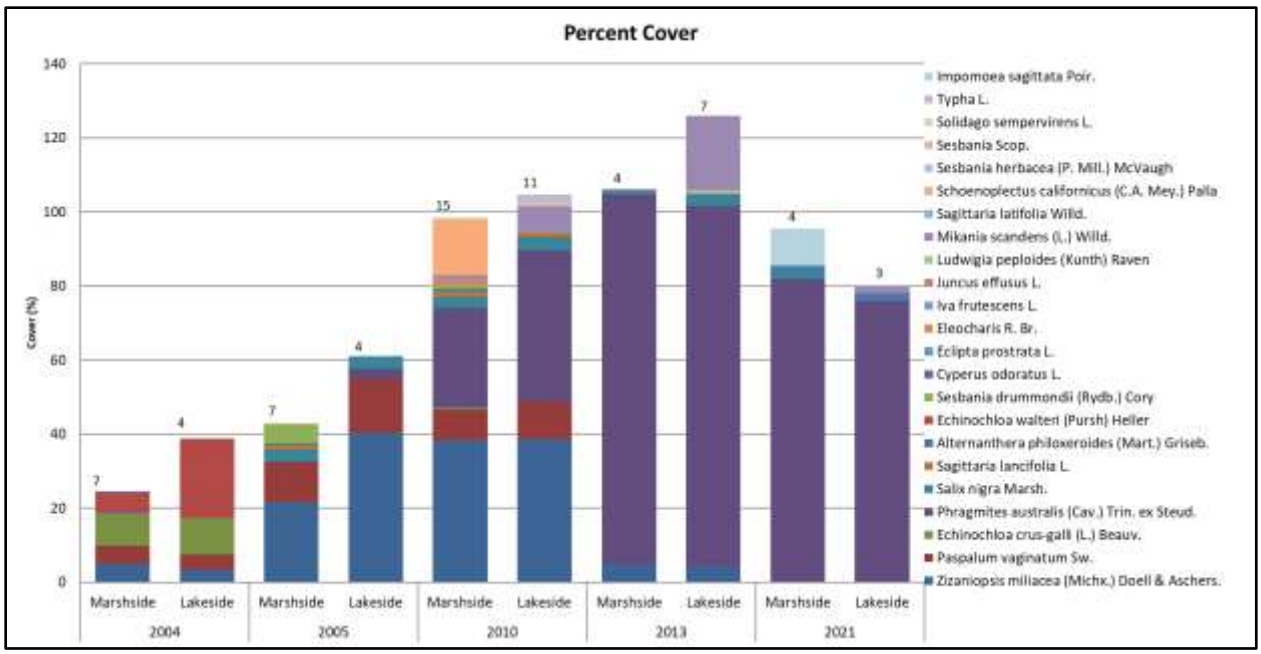

Figure 15. Vegetation observed on lakeside and marsh side terraces along Collicon Lake over time in ME-19 project area. Values are the percent area coverage (% Coverage).

During terrace construction, *Zizaniopsis miliacea* was planted on the terrace slopes and *Paspalum vaginatum* was planted on the terrace crowns. These species persisted on the terraces through 2013 before disappearing from both the LS and MS terraces in 2021 (Figure 15). *Echinochloa crus-galli*, which had been manually seeded on the crown, did not occur in the 2005 sampling but was found on one marsh side terrace in 2010 and was gone by 2013. The occurrence and coverage of *Phragmites australis* (Roseau cane) increased over time on both terrace positions. Roseau cane was not planted during the construction of these terraces and in 2005 it occurred at only 1 terrace (LS). By 2010, Roseau cane occurred on all but 1 terrace (MS) and continued to expand on all terraces as it out-competed other species such as *Zizaniopsis miliacea* and *Paspalum vaginatum* to become the dominant species on both terraces. Both percent cover and occurrence experienced a decline from 2020 to 2021 due to the effects of Hurricanes Laura and Delta.

CRMS Supplemental

Data from above figures can be complemented with the data collected from CRMS0554, CRMS0574 and CRMS095 located around the ME-19 Project Site, Reference A, and Reference B. Seen below are several plots that display the conditions at the sites over the duration of the project's lifetime. The observed attributes are hydrological, shown as inundation and salinity levels, and vegetation at the CRMS sites that are near the project.

Hydrological

The charts shown below are inundation charts downloaded from the CRMS website (https://lacoast.gov/crms/). The data in figure 16 shows inundation for the CRMS sites near the project area as well as monthly reported averages of inundation at each CRMS site.

Over the duration of inundation measurement at the three CRMS sites, we see a similar pattern. Lower water levels occurred in 2010-2011 due to an extended drought and lower rainfall amounts than typically seen in these areas. We see the opposite trends in 2016 through 2021 where we had rain heavy years that increase the amount and duration of flooding measured on average, except for a brief drought in the summer of 2018.

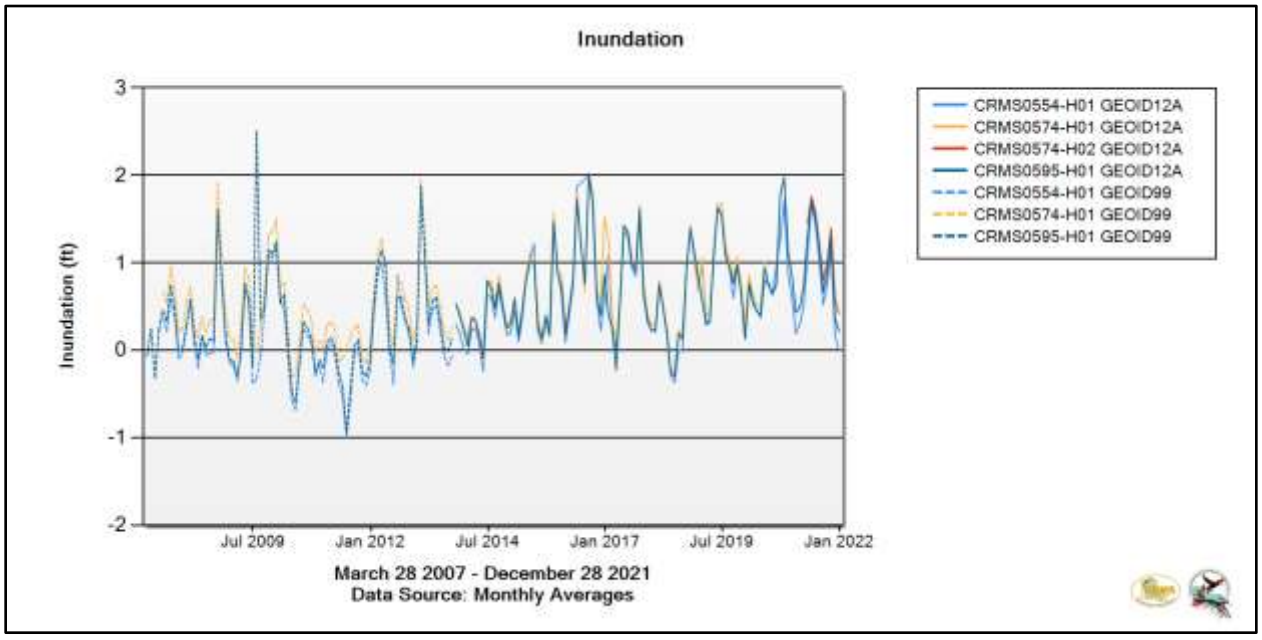

Figure 16. Monthly average inundation for CRMS0554, CRMS0574 and CRMS0595 (2007 - 2021) near the ME-19 project area.

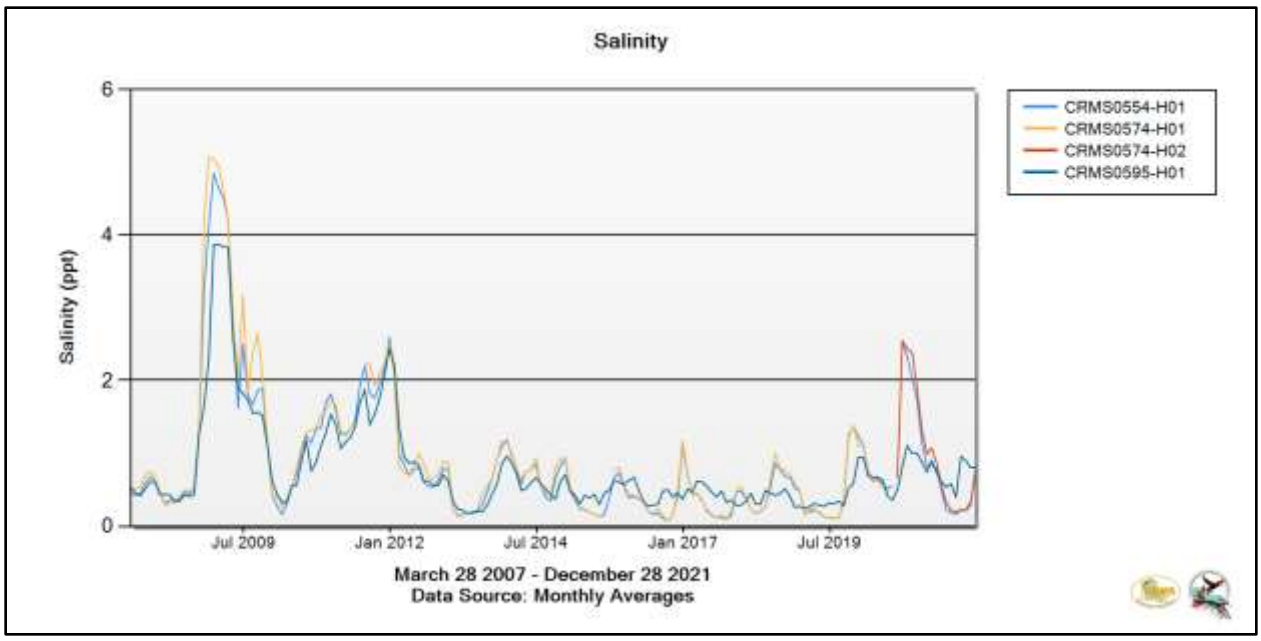

Figure 17. Salinity from CRMS0554, CRMS0574, and CRMS0595 (2007 - 2021) shows monthly data averages collected from each site gathered from the CRMS website.

Salinity for the sites also followed a similar pattern for the same period of measurement (Figure 17). The salinity spiked in September 2008 due to Hurricane Ike. Salinity increased again in 2011 due to a prolonged drought. Salinities remained low until 2020 when Hurricane Delta and Hurricane Laura made landfall southwest of the project.

Vegetation

Percent cover and the Floristic Quality Index (FQI) for the CRMS sites for 2006 to 2022 show similar flora and are reflective of the hydrology of the region. The flora at the sites are mainly freshwater, with the largest changes in plant species being based upon inundation times and precipitation inputs. At CRMS0554, We see a decrease in *Typha spp.* and the growth of *Phragmites australis* and *Spatina patens* from 2006 to 2011 during times of higher salinity brought on by hurricanes in 2005 and then again by a drought in 2011 (Figure 18). Between 2012 and 2017, we see higher amounts of flooding and inundation time which allowed for the growth of *Typha latifolia* with a reduction in *S. patens*. This relationship reversed during the drought of 2018. At CRMS0574, the site is dominated by *S. patens* through 2012. From 2014 on, the site is characterized by obligate freshwater plants that are adapted to frequent flooding, such as *Sagataria lancifolia, Panicum hemitomon,* and *T. latifolia*. For CRMS0595, we are also presented with very direct correlations between flora, salinity, and inundation time at the CRMS site. Due to the higher salinity at the beginning of the data period we see a decline in *Cladium mariscus*, which returns to higher amounts with the decline in salinity to more average levels. In the same spans where increases in *C. mariscus* were observed, growth of *S. lancifolia* and *P. hemitomon* also occurred (Figure 20).

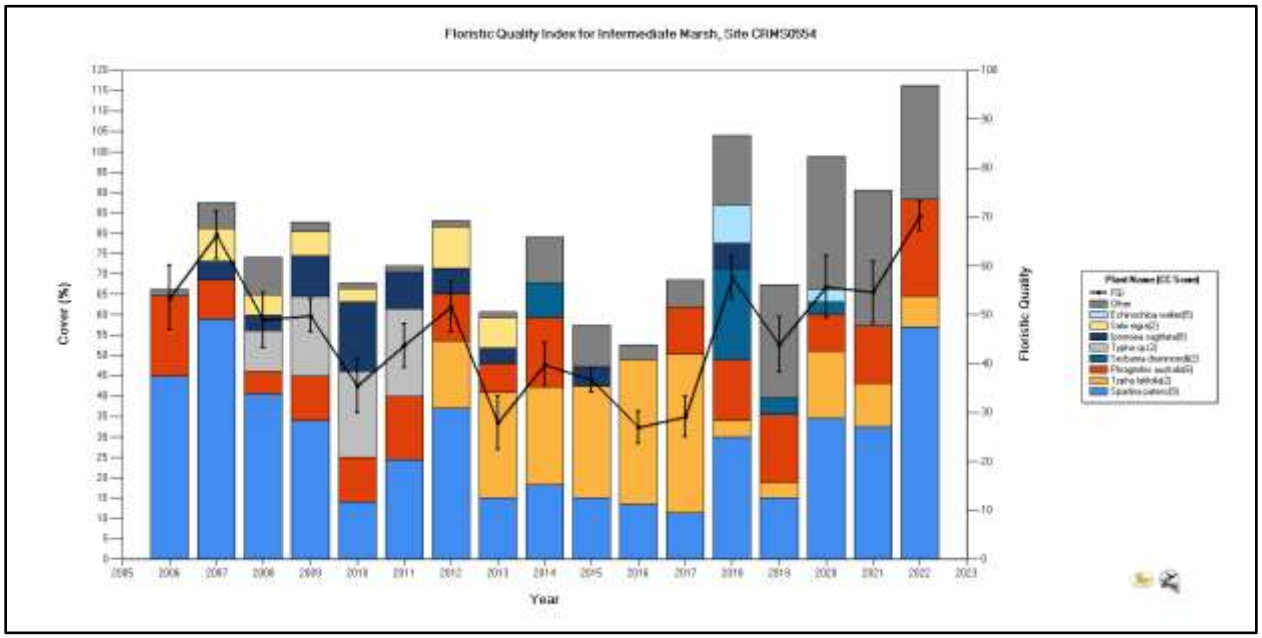

Figure 18. Percent coverage and the Floristic Quality Index (FQI) of flora taken from CRMS0554, located around 400 meters south of the ME-19 project area, from 2006 – 2022. The Coefficient of Conservatism (CC) scores represent the quality of individual species from 1 to 10 where 1 represents disturbance species and 10 indicates stable species.

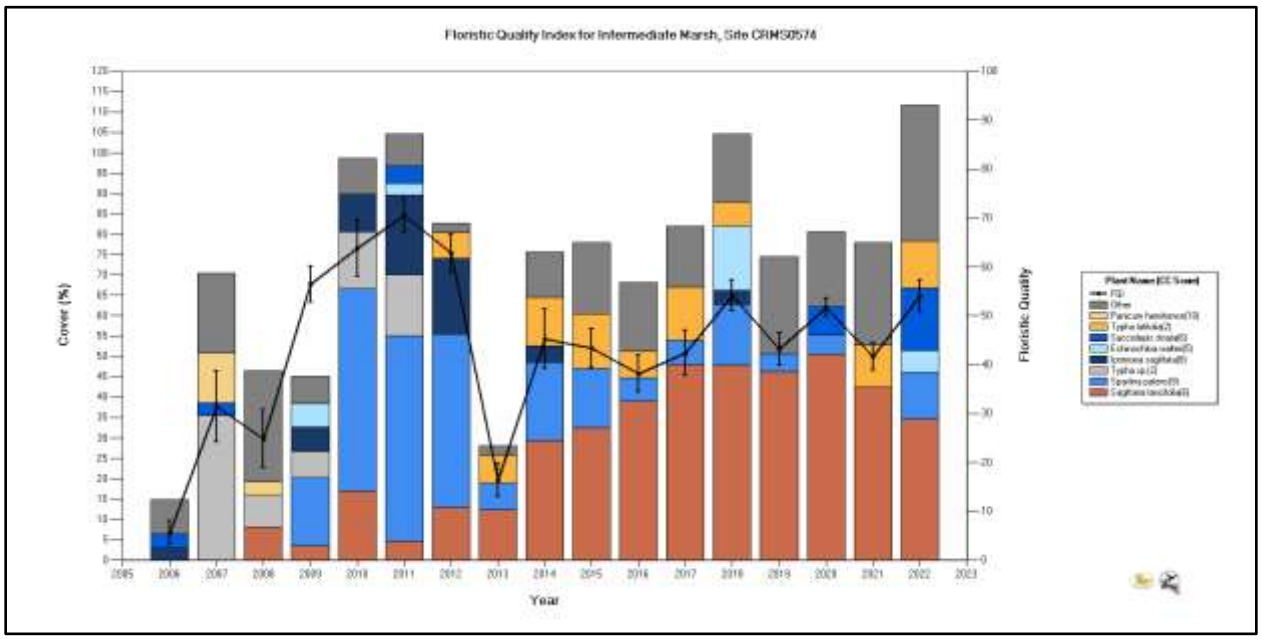

Figure 19. Percent coverage and the Floristic Quality Index (FQI) of flora taken from CRMS0574, located within the Grand-White Lake Landbridge, from 2006 – 2022. The Coefficient of Conservatism (CC) scores represent the quality of individual species from 1 to 10 where 1 represents disturbance species and 10 indicates stable species.

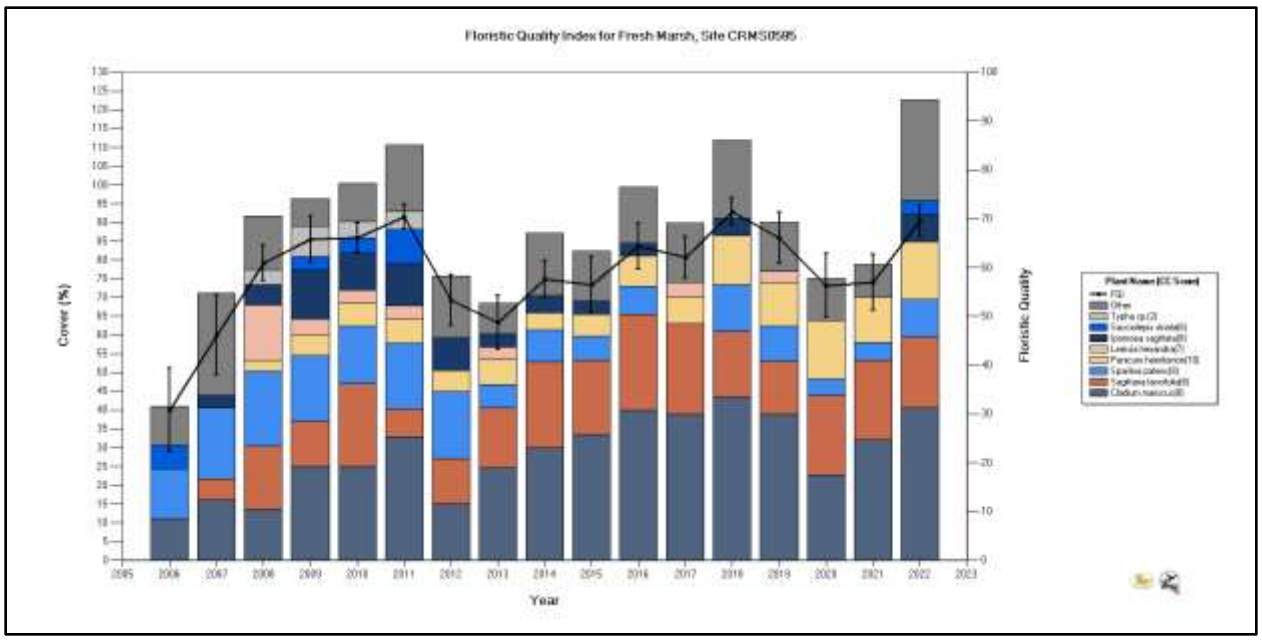

Figure 20. Percent coverage and the Floristic Quality Index of flora taken from CRMS0595, located around 800 meters east of the ME-19 project area, from 2006 – 2022. The Coefficient of Conservatism (CC) scores represent the quality of individual species from 1 to 10 where 1 represents disturbance species and 10 indicates stable species.

V. Conclusions

a. Project Effectiveness

The Grand/White Lake Land Bridge Protection project (ME-19) is achieving the main objective to prevent the coalescence of Grand, Collicon, and Round Lakes within the 20 year project life (2003-2023). The width of the land bridge between the foreshore dikes along Grand Lake has broadened and remained greater than 500 ft (152 m) at all surveyed transects. The terraces along Collicon Lake and plantings along Round Lake have also increased in area since project construction. Towards the specific project goals:

1. Shoreline change rates behind both project structures were significantly higher than their reference shorelines. The foreshore rock dike has not only stopped erosion but has gained land along the southeastern shoreline of Grand Lake, and the earthen terraces have significantly reduced erosion on the northern and western shorelines of Collicon Lake. Several marsh side terraces have merged with the land bridge increasing land acreage along Collicon Lake as well. However, many outer terraces have eroded and, without armoring, the inner terraces and land bridge can be expected to erode as well.
2. As of 2021, we saw a 14 acre increase of emergent marsh on the eastern side of Grand Lake, most of this land gain from the infilling behind the rock dike structure. We also saw a gain of 27 acres of emergent marsh on the northwestern side of Collicon Lake. Although the gain on the Grand Lake side didn't meet the expectations, we were able to more than double the goal of land for Collicon Lake.
3. The southern shoreline of Round Lake was not directly measured. However, the plantings that were added to the southern end of Round Lake to alleviate the chance of the lake's coalesce into Collicon Lake was successful in adding land to the small strip of area between the two. In addition, the Collicon Lake shoreline is expanding along the narrow land bridge adjacent to the southwestern shoreline of Round Lake.

b. Recommended Improvements

Armoring the lakeside slope of terraces along Collicon Lake should be considered to prevent future shoreline erosion.

c. Lessons Learned

Although the lakeside terraces were initially effective at buffering the marsh side terraces, the high rate of lakeside terrace loss has made the marsh side terraces vulnerable. The wind fetch across Collicon Lake from all directions is large enough to allow for the sizeable wave generation that has degraded the earthen terraces. However, the lakeside terraces were supportive long enough to allow expansion of several marsh side terraces into the landbridge. In terms of vegetation used as armor, *Phragmites australis* (Roseau cane) has been effective in maintaining terraces.

VI. Literature Cited

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Appendix A
Inspection Photographs

Foreshore Rock Dike 2023 O&M Inspection

Foreshore Rock Dike and Warning Sign 2023 O&M Inspection

Photo No. 1, Rock Dike and Signs on East Shoreline of Grand Lake (2012)

Photo No. 2, Vegetation and Rock Dike on East Shoreline of Grand Lake (2012)

Photo No. 3, Rock Dike on East Shoreline of Grand Lake (2012)

Photo No. 4, Earthen Terraces on North End of Collicon Lake (2012)

Photo No. 5, Earthen Terraces on Northwest and West Sides of Collicon Lake (2012)

Photo No. 6, Earthen Terraces on Southwest End of Collicon Lake (2012)

Photo No. 7. Post Hurricane Laura -Typical rock dike (2020)

Photo No. 8. Post Hurricane Laura -Typical rock dike (2020)

Appendix B
Three Year Budget Projection

GRAND-WHITE LAKES LANDBRIDGE/ ME-19 / PPL 10

Three-Year Operations & Maintenance Budgets 07/01/2023 - 06/30/2024

Project Manager	O & M Manager	Federal Sponsor	Prepared By
	Mel Guidry	*USFWS*	*Mel Guidry*

	2023/2024 (-19)	2024/2025 (-20)	
Maintenance Inspection	$ 9,767.00	$ 10,060.00	
Structure Operation			
State Administration	$25,000.00	$ 30,000.00	$ -
Federal Administration		$ -	$ -
Maintenance/Rehabilitation			

23/24 Description: E&D and Surveying

E&D	$95,000.00
Construction	
Construction Oversight	
Sub Total - Maint. And Rehab.	$ 95,000.00

24/25 Description: Rock Dike Tie-in to Bank

E&D	$ -	
Construction	$ 496,875.00	
Construction Oversight	$ -	
Sub Total - Maint. And Rehab.	$ 496,875.00	

25/26 Description:

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

	2023/2024 (-19)	2024/2025 (-20)	0	End of Life Oct 2024
Total O&M Budgets	**$ 129,767.00**	**$ 536,935.00**	**$ -**	

O &M Budget (3 yr Total)	**$ 666,702.00**
Unexpended O & M Budget	**$ 908,968.89**
Remaining O & M Budget (Projected)	**$ 242,266.89**

OPERATION AND MAINTENANCE BUDGET WORKSHEET

GRAND-WHITE LAKES LANDBRIDGE/ PROJECT NO. ME-19 / PPL NO. 10 / 2023-2024

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$9,767.00	**$9,767.00**
General Structure Maintenance	LUMP	0	$0.00	**$0.00**
Engineering and Design	LUMP	1	$75,000.00	**$75,000.00**
Operations Contract	LUMP	0	$0.00	**$0.00**
Construction Oversight	LUMP	0	$0.00	**$0.00**

ADMINISTRATION

CPRA Admin.	LUMP	1	$25,000.00	$25,000.00
FEDERAL SPONSOR Admin.	LUMP	0	$0.00	$0.00
SURVEY Admin.	LUMP	0	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$25,000.00**

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:					
Secondary Monument	EACH	0	$0.00	$0.00
Staff Gauge / Recorders	EACH	0	$0.00	$0.00
Bathymetry / Topography	LUMP	1	$20,000.00	$20,000.00
TBM Installation	EACH	0	$0.00	$0.00
Other	LUMP	0	$0.00	$0.00
			TOTAL SURVEY COSTS:	**$20,000.00**

GEOTECHNICAL

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

CONSTRUCTION

CONSTRUCTION DESCRIPTION: Rock Dike Tie-In to Bank

Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
Rip Rap	0	4.0	0	$85.00	$0.00
	0	1.0	0	$85.00	$0.00
	0	0.0	0	$0.00	$0.00
Filter Cloth / Geogrid Fabric		SQ YD	0	$0.00	$0.00
Navigation Aid		EACH	0	$0.00	$0.00
Signage		EACH	0	$0.00	$0.00
General Excavation / Fill		CU YD	0	$0.00	$0.00
Dredging		CU YD	0	$0.00	$0.00
Sheet Piles (Lin Ft or Sq Yds)			0	$0.00	$0.00
Timber Piles (each or lump sum)			0	$0.00	$0.00
Timber Members (each or lump sum)			0	$0.00	$0.00
Hardware		LUMP	0	$0.00	$0.00
Materials		LUMP	0	$0.00	$0.00
Mob / Demob		LUMP	0	$0.00	$0.00
			0	$0.00	$0.00
			0	$0.00	$0.00
			0	$0.00	$0.00
					$0.00
Contingency (25%)			0.25	$0.00	$0.00
				TOTAL CONSTRUCTION COSTS:	**$0.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: **$129,767.00**

OPERATION AND MAINTENANCE BUDGET WORKSHEET

GRAND-WHITE LAKES LANDBRIDGE/ PROJECT NO. ME-19 / PPL NO. 10 / 2024-2025

DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	ESTIMATED TOTAL
O&M Inspection and Report	EACH	1	$10,060.00	**$10,060.00**
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

CPRA Admin.	LUMP	1	$30,000.00	$30,000.00
FEDERAL SPONSOR Admin.	LUMP	0	$0.00	$0.00
SURVEY Admin.	LUMP	0	$0.00	$0.00
OTHER				$0.00
			TOTAL ADMINISTRATION COSTS:	**$30,000.00**

MAINTENANCE / CONSTRUCTION

SURVEY

SURVEY DESCRIPTION:					
Secondary Monument	EACH	0	$0.00	$0.00
Staff Gauge / Recorders	EACH	0	$0.00	$0.00
Bathymetry / Topography	LUMP	0	$0.00	$0.00
TBM Installation	EACH	0	$0.00	$0.00
Other	LUMP	0	$0.00	$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: Rock Dike Tie-In to Bank

Rip Rap	LIN FT	TON / FT	TONS	UNIT PRICE	
Rip Rap Tie-In	300	4.0	1,200	$85.00	$102,000.00
Capping Rock dike	2300	1.0	2,300	$85.00	$195,500.00
	0	0.0	0	$0.00	$0.00
Filter Cloth / Geogrid Fabric		SQ YD	0	$0.00	$0.00
Navigation Aid		EACH	0	$0.00	$0.00
Signage		EACH	0	$0.00	$0.00
General Excavation / Fill		CU YD	0	$0.00	$0.00
Dredging		CU YD	0	$0.00	$0.00
Sheet Piles (Lin Ft or Sq Yds)			0	$0.00	$0.00
Timber Piles (each or lump sum)			0	$0.00	$0.00
Timber Members (each or lump sum)			0	$0.00	$0.00
Hardware		LUMP	0	$0.00	$0.00
Materials		LUMP	0	$0.00	$0.00
Mob / Demob		LUMP	1	$100,000.00	$100,000.00
			0	$0.00	$0.00
			0	$0.00	$0.00
			0	$0.00	$0.00
CONSTRUCTION COSTS					**$397,500.00**
Contingency (25%)			0.25	$397,500.00	$99,375.00
				TOTAL CONSTRUCTION COSTS:	**$496,875.00**

TOTAL OPERATIONS AND MAINTENANCE BUDGET: $536,935.00