State of Louisiana

Coastal Protection and Restoration Authority (CPRA)

2023 Operations, Maintenance, and Monitoring Report

for

Four Mile Canal Terracing and Sediment Trapping

State Project Number TV-0018
Priority Project List #9

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Vermilion Parish

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For
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Preface

This report includes monitoring data collected through Fall 2022, the annual maintenance inspection from April 2016, the Hurricane Laura Damage Assessment from October 2020, and a final site visit from May 2024. The Four Mile Canal Terracing and Sediment Trapping (TV-18) project is a 20-year Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA, Public Law 101-646, Title III, Priority List 5) project administered by the National Marine Fisheries Service (NMFS) and the Coastal Protection and Restoration Authority of Louisiana (CPRA).

The 2023 report is the 5th and final report in a series of reports. For additional information on lessons learned, recommendations and project effectiveness please refer to the 2004, 2005, 2008, and 2011 Operations, Maintenance, and Monitoring Reports and prior O&M annual inspection reports on the CPRA website at http://coastal.Louisiana.gov. These reports will be made available for download at the following website: http://cims.coastal.la.gov.

I. Introduction

The Four Mile Canal Terracing and Sediment Trapping (TV-18) was proposed on the 9th priority list of the Coastal Wetlands Planning, Protection, and Restoration Act. The project is located approximately 4 miles (6.44 km) south of Intracoastal City in Vermilion Parish, Louisiana, and includes Little White Lake and the portion of Little Vermilion Bay immediately west of Four Mile Canal also known as the Vermilion River Cutoff (Figure 1). The project consists of earthen terraces meant to protect the shorelines of Little White Lake and Four Mile Canal from further erosion.

The Flood Control Act of 18 August 1941 enacted by the United States Congress provided for improvements in the Vermilion River. Vermilion River Cutoff, an 8 ft by 80 ft (2.4 m by 24 m) channel from the -8 foot contour in Vermilion Bay to the Gulf Intracoastal Waterway (GIWW), was constructed for improving navigation from Lafayette, LA to Vermilion Bay. The materials excavated to build the canal were deposited on spoil banks along the canal which prevented river water from nourishing the adjacent marsh (USACE 1993; HNTB 2002). The main cause of marsh loss in this area is shoreline erosion. The 1978 Louisiana Department of Transportation and Development (LDOTD) inventory and assessment of shoreline erosion in coastal Louisiana documented erosion rates of 1.6 ft/yr (0.5 m/yr) and 2.6 ft/yr (0.8 m/yr) in the vicinity of Little Vermilion Bay (Adams et al. 1978). Shoreline change in the project area from 1978 to 1988 was 2.86 ft/yr (0.87 m/yr) (USGS 2003). The TV-18 project area was relatively unprotected and thus heavily affected by storm events emerging from Vermilion Bay. The project was intended to allow sub-aerial marsh development from sediments introduced to the area by the GIWW through the Vermilion River and Four Mile Canal (LDNR 1999) by preventing shoreline erosion.

Land loss in the region mostly occurred between 1956 and 1978 and was along the edge of Four Mile Canal and the Little Vermilion Bay shoreline (USGS 2002). Within the project area, there were approximately 160 acres (65 ha) of land and 2,109 acres (854 ha) of open water in 1993 which accounted for 93 and 7% of project area respectively.

The soils surrounding the project area include Clovelly and Lafitte muck with two patches of Udifluvents. Clovelly and Lafitte series are poorly drained organic soils that formed in herbaceous plant material over clayey alluvium. Udifluvents are sandy to clayey soils that were hydraulically excavated during the construction and maintenance of navigable waterways (USDA 1996). Soil boring samples collected in Little White Lake and Little Vermilion Bay revealed two to five feet of very soft clay over two to eight feet of organic clay (HNTB 2002).

The surrounding marsh was brackish in 1949 (O'Neil 1949) and 1968 (Chabreck et al. 1968) and was intermediate in 1978, 1988, and 1997 (Chabreck and Linscombe 1978, 1988, 1997). In 2004 observed emergent vegetation on the shore around Little White Lake included *Phragmites australis* (common reed), *Zizaniopsis mileacea* (giant cutgrass), *Spartina alterniflora* (smooth cordgrass), *Hymenocallis caroliniana* (Carolina spiderlily), *Triadica sebifera* (tallowtree), and *Sesbania drummondii* (poisonbean). In 1998, area vegetation consisted of *Spartina patens* (saltmeadow cordgrass), *Cladium mariscus ssp. jamaicense* (Jamaica sawgrass), and *Schoenoplectus robustus* (sturdy bulrush) with scattered SAVs including *Myriophyllum spicatum* (spike watermilfoil), *Ceratophyllum demersum* (coon's tail) and *Najas guadalupensis* (southern waternymph) (United States Department of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Service 2000).

The project goals include:

1. Create 70 acres (28.3 ha) of earthen terraces within the project area immediately after construction.
2. Reduce shoreline erosion rates by 50% (reduce from 8 ft/yr to 4 ft/yr) over the 20 year project life.
3. As a result of goals 1 and 2, achieve a 9% (approximately 17 acres [6.9 ha]) net increase in marsh habitat by the end of the 20 year project.
4. Increase submerged aquatic vegetation (SAV) coverage from 0% to 25% of the project area by the end of the 20 year project life.
5. Increase fisheries utilization of the project area.

The construction of terraces in Little White Lake and Little Vermilion Bay was meant to buffer existing marsh against shoreline erosion by reducing wave and wake energy and creating marsh both by the planting of *S. alterniflora* along the crowns and slopes of the constructed terraces and by allowing suspended sediments introduced from Four Mile Canal and the Vermilion River to be trapped in the shallow open water adjacent to the terraces. Terraces may indirectly reduce water-column turbidity within the project area which, in conjunction with decreased wave and wake energy, should create habitat suitable for the colonization by submerged aquatic vegetation (SAV). Fisheries habitat may also be enhanced by the marsh edge created by the terraces and the propagation of SAV.

Approximately 40,300 linear ft (12,280 m) of terraces in the eastern portion of Little Vermilion Bay area adjacent to Four Mile Canal (Figure 2 and Appendix A, Sheet 3) and 28,150 linear ft (8,580 m) in the Little White Lake area (Figure 3 and Appendix A, Sheet 3) were constructed to deter wave erosion and enhance sediment deposition. The terraces were arranged in either a linear or "fish-net" orientation in the open water areas. Terraces in the Little Vermilion Bay area were built to + 5.0 ft (+1.5 m) NAVD88 with a 20 ft crown and 4:1 ft side slopes. Terraces in the Little White Lake area were also built to + 5.0 ft (+1.5 m) NAVD88, but have a 15 ft (4.6 m) crown with 4:1 ft side slopes (Figure 4). Post consolidation elevation of all terraces was

expected to be between 2 and 3 ft NAVD88. The borrow or floatation channel is located on the land side of all terraces and was constructed to a maximum depth of 10 ft below the existing water bottom. In order to minimize erosive energies, the terrace slopes and crowns were planted with *Spartina alterniflora* (smooth cordgrass). Construction was completed in May, 2004. Vegetative plantings of *Schoenoplectus californicus* (California bulrush) were completed in the Vermilion Bay area of the project as part of LA-39 year 3 (Fall 2014) and year 7 (Fall 2018).

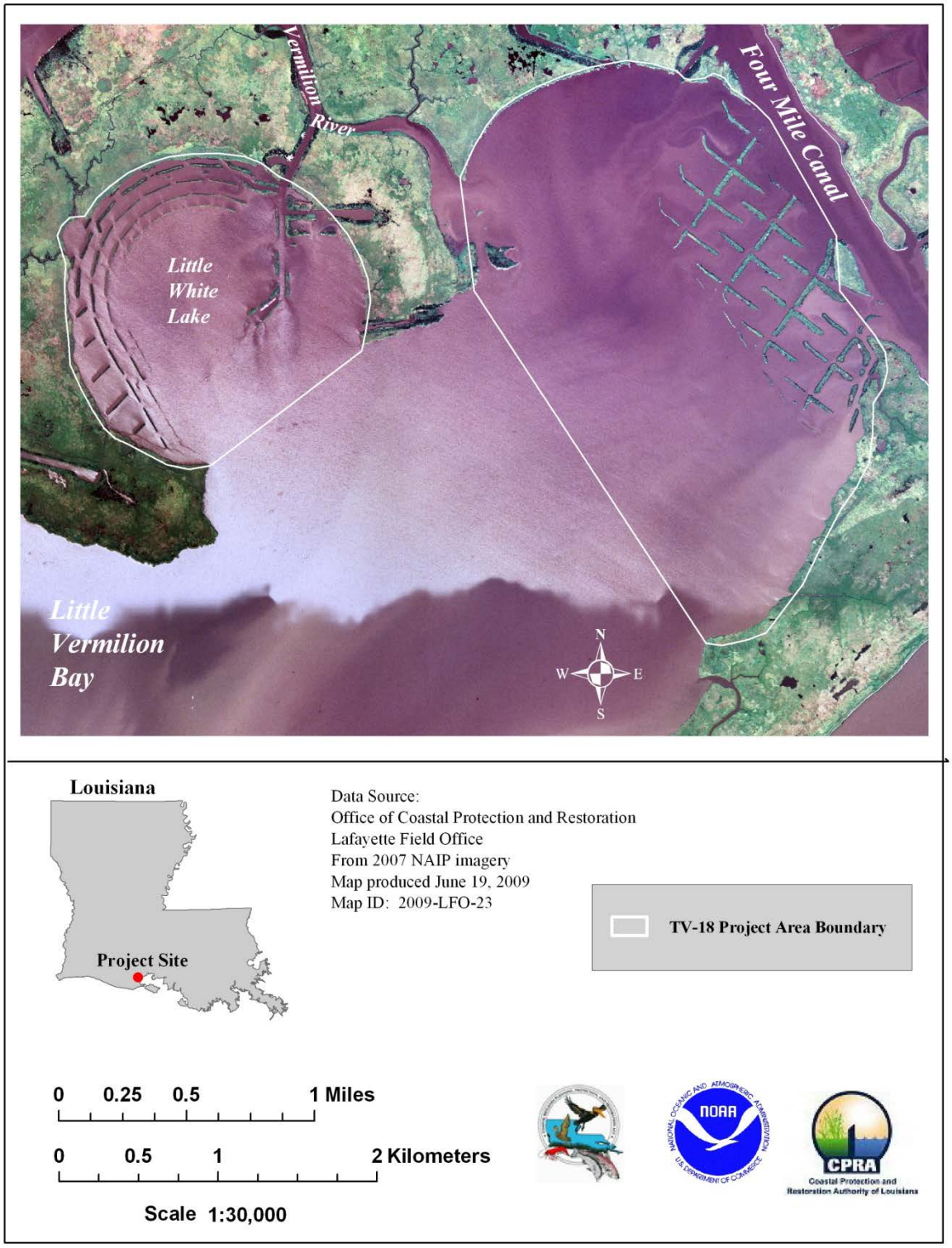


Figure 1. Four Mile Canal Terracing and Sediment Trapping (T/V-18) project area showing boundary and terrace locations.

II. Maintenance Activity

a. Project Feature Inspection Procedures

The purpose of the annual inspection of the Four Mile Canal Terracing and Sediment Trapping Project (TV-18) is to evaluate the constructed project features to identify any deficiencies and prepare a report detailing the condition of project features and recommended corrective actions needed. Should it be determined that corrective actions are needed, 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 completed since initial construction of project features. A summary of past operation and maintenance projects completed since completion of the Four Mile Canal Project is outlined in Section IV.

An inspection of the Four Mile Canal Terracing and Sediment Trapping Project (TV-18) was held on April 21, 2016 under mostly cloudy skies and mild temperatures. In attendance were Stan Aucoin and Mel Guidry from CPRA and John Foret, and Rick Hartman from NOAA Fisheries. The annual inspection began at the site of the terraces constructed in Little White Lake.

Subsequent to the 2016 inspection, a final site visit was conducted by CPRA on May 1, 2024, under mostly clear skies and hot temperatures. In attendance were Jacques Boudreaux, Adam Constantin, and Stuart Hebert from CPRA.

The field inspection included a visual inspection of the project site. Staff gauge readings were used, when available, to determine approximate elevations of water and earthen terraces. Photographs were taken at each project feature (see Appendix B).

b. Inspection Results

Site 1—Earthen terraces

During the 2016 observation, water depths at the entrance to the terrace field in Little White Lake had continued to shallow. The 3rd row of terraces had fewer terraces visible, while the 2nd row had continued to suffer effects of the waves. The 1st row remains in excellent condition. The eastern terraces adjacent to the Four Mile Canal continue to erode as well as the western most terraces. The boat wakes continue to damage these terraces. Interior terraces were inspected on this trip and found to be in excellent condition. Vegetation between the terraces in both fields is expanding. (Photos: Appendix B, Photos 1-4)

Since that time, the 2024 observation revealed continued deterioration of the interior rows of terraces at Little White Lake, with only the 1st row of terraces remaining visible. Water depths were noticeably very shallow in portions of Little White Lake approaching the historic lake rim, indicating a likely shallowing aided by restoration efforts of the TV-0018 project. Advanced erosion was noted on the east side of the Four Mile Canal project area, though locations of shell hash deposits were noted nearby. (Photos: Appendix B, Photos 5-8)

Site 2—Vegetation plantings

Vegetation on stable terraces in both areas continues to do extremely well. Emergent vegetation has become established and continues to expand. No maintenance with regard to the plantings is needed at this time.

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 May 2004, the construction completion date of the Four Mile Canal Terracing and Sediment Trapping Project.

There has been no required 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 Structural Operation Plan is required.

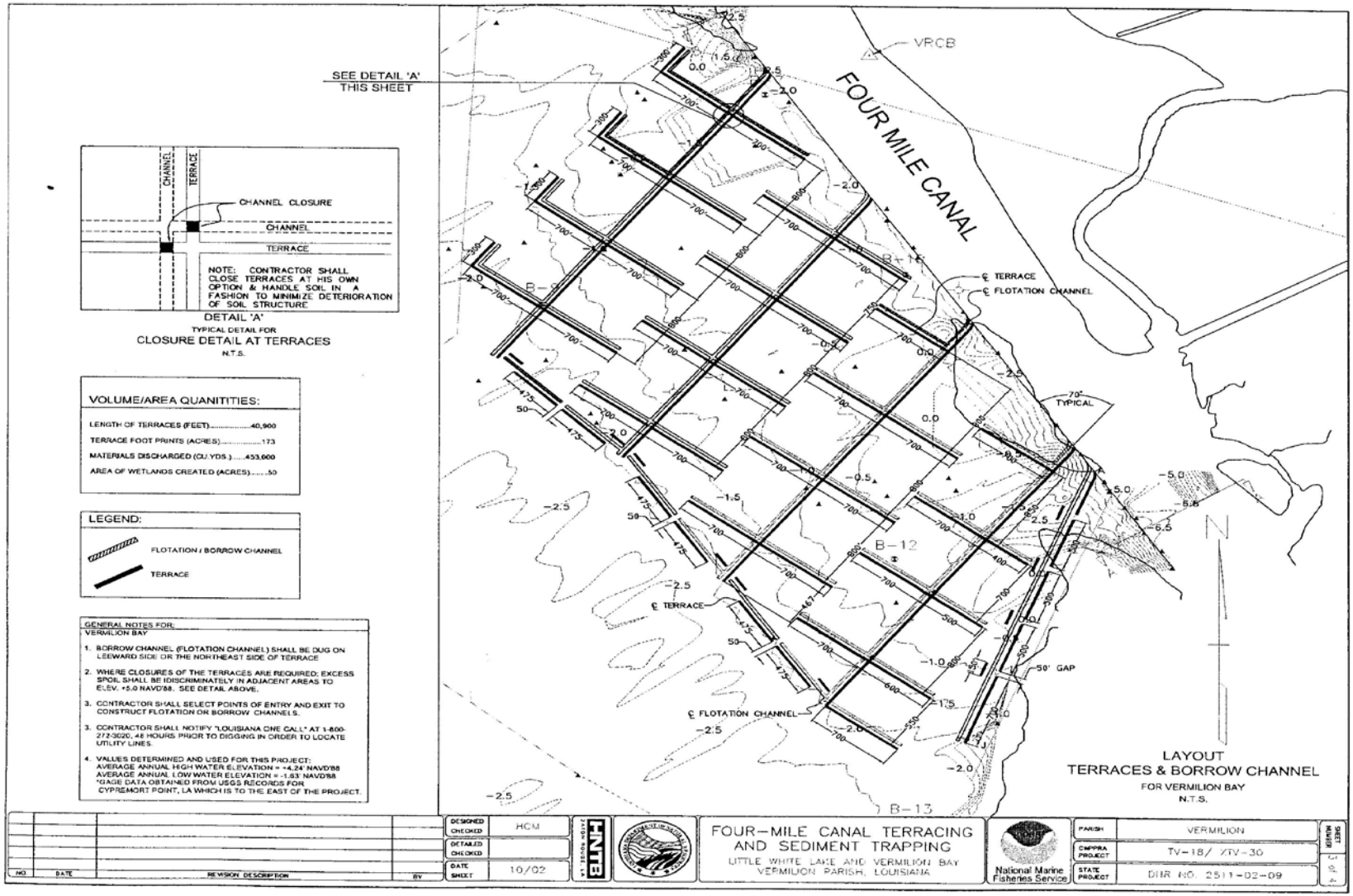


Figure 2. Proposed schematic for Four Mile Canal Terracing and Sediment Trapping (T/V-18) for terraces in the eastern section of Little Vermilion Bay (HNTB 2002).

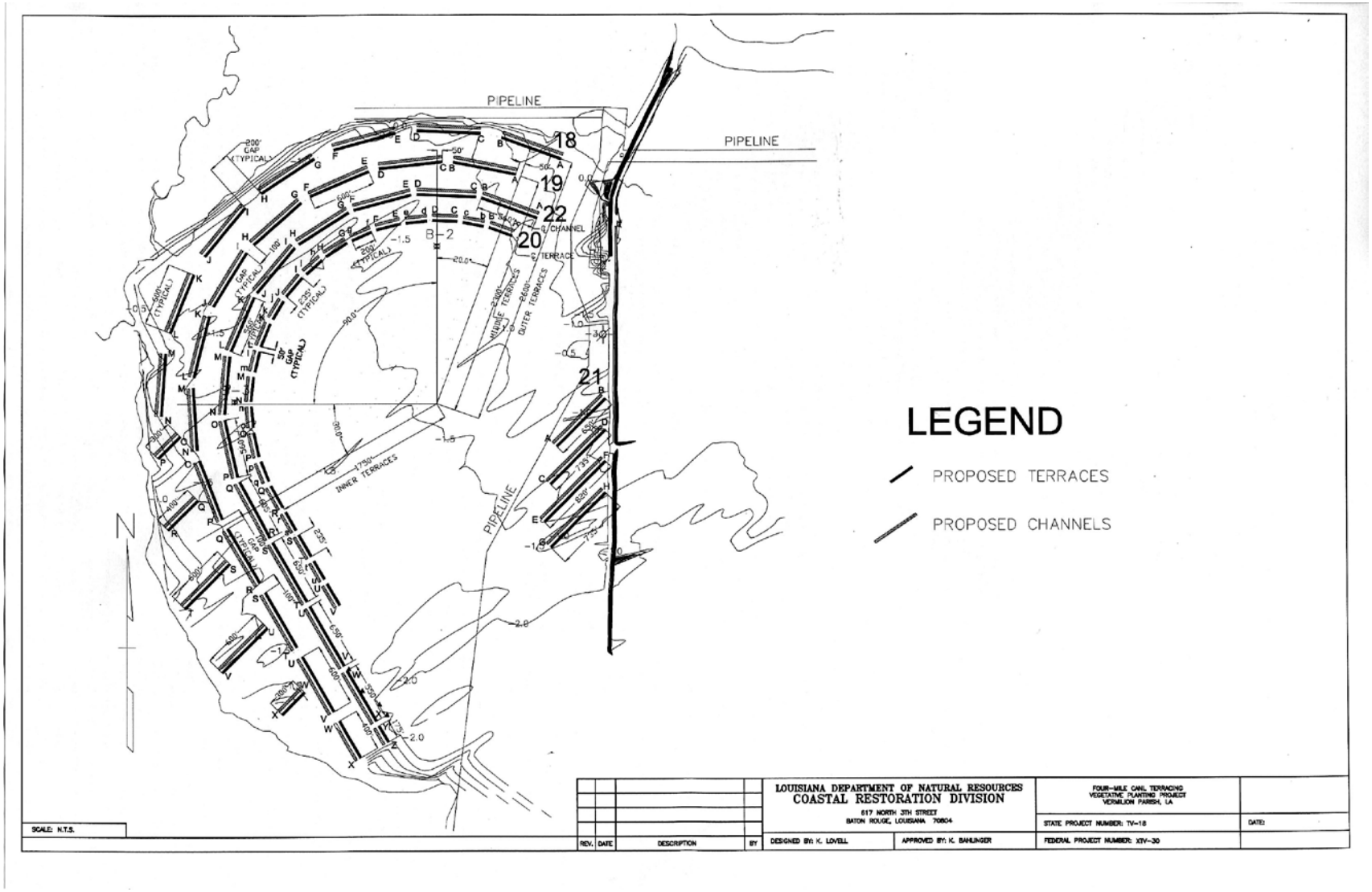


Figure 3. Schematic for Four Mile Canal Terracing and Sediment Trapping (T/V-18) for terraces in the western section of Little White Lake (HNTB 2002).

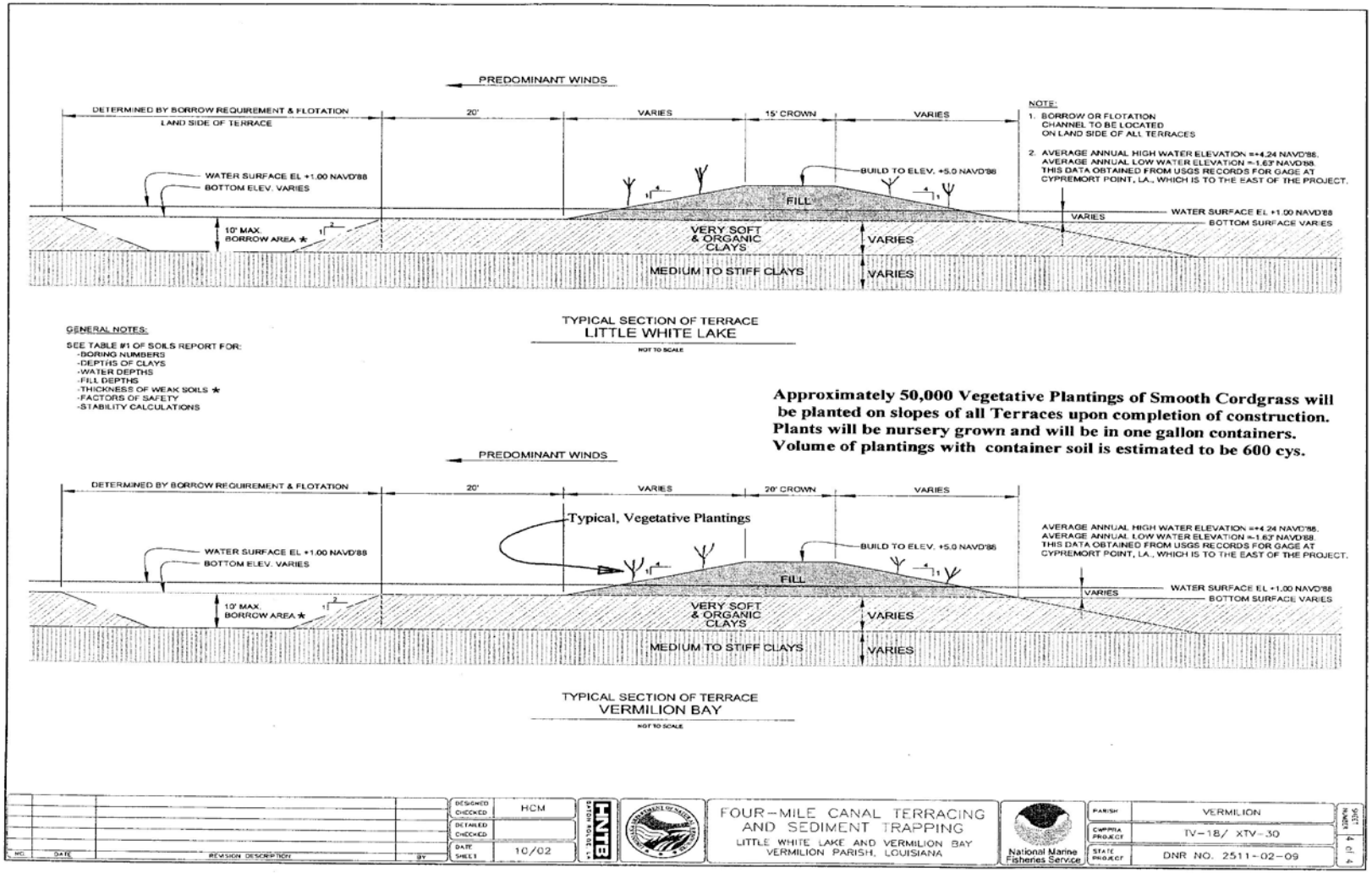


Figure 4. Typical layout and cross section of terraces constructed in Little Vermilion Bay and Little White Lake for the Four Mile Canal Terracing and Sediment Trapping (TV-18) project (HNTB 2002).

IV. Monitoring Activity

a. Monitoring Goals

The objectives of the Four Mile Canal Terracing and Sediment Trapping project are to reduce shoreline erosion rates and increase marsh habitat, SAV and fisheries utilization, and to increase freshwater and sediment flow from Four Mile Canal into the project area by constructing conveyance channels adjacent to earthen terraces.

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

Specific Monitoring Goals:

1 Evaluate the rate of erosion along the shoreline of the project area (Little White Lake and adjacent Little Vermilion Bay).
2 Evaluate establishment of emergent vegetation on planted terraces.
3 Evaluate sediment deposition within the project area.
4 Evaluate land/water ratios with respect to initial and secondary land gains.

b. Monitoring Elements

Shoreline Survey

To document shoreline movement, differential GPS was used to map the shoreline in Little Vermilion Bay and Little White Lake in 2004, 2010, and 2022. Differential GPS was used as described in Steyer et al. (1995). Differentially corrected GPS data sets were obtained in 2004 (as built), and post-construction in 2010 and 2022. GPS data was taken during the Spring of each monitoring year to minimize errors associated with taking data at different times of the year, not accounting for seasonal changes that might occur to the shoreline.

Terrace Vegetation

The condition of the natural emergent and planted vegetation on the terraces over the life of the project was monitored using a stratified sampling scheme on 16 of the total planted terraces using a modified Braun-Blanquet sampling method as outlined in Steyer et al. (1995). Transect lines and plots were established across selected terraces to include both high and low energy environments. Three sampling plots were established on randomly selected transect lines which will include a plot on both slopes and 1 plot on the crown. At each station, percent cover, dominant plant height, and species composition were documented in a 4 m^2 sample area. Each plot was marked with 2 corner poles to allow for revisiting the sites over time. Vegetation was evaluated at the sampling sites in the Spring of 2004 (as built), and post-construction in the Springs of 2007 and 2010 and the Fall of 2022.

Bathymetry/Topography

Sediment deposition was monitored along existing transects used in bathymetry map creation. Twenty eight (28) transects encompassing an array of terrace and channel formations were selected for development of elevation profiles. Elevation of the water bottom sediments was determined along each transect in a similar fashion to that in the initial survey. Surveys were

conducted by a professional engineering firm in 2003 (prior to and immediately post-construction), and were replicated in 2023.

Digital Color Infrared Video Imagery

To document land to open-water ratios and marsh loss/gain rates in the project area, color infrared video imagery (1:12,000) was obtained in the summer of 2004 (as built), and post-construction in 2005, 2007, 2011, and 2018. To track project feature progress in earlier stages of project (2004, 2005, and 2007), imagery was delineated to classify all land in the project area as either (1) preexisting wetlands, (2) vegetated and non-vegetated terraces, and (3) non-terrace, newly developed wetlands (i.e., those that develop in open water areas between the terraces or adjacent to the preexisting perimeter levees).

CRMS Supplemental

In addition to the project specific monitoring elements listed above, a variety of other data is collected at CRMS-*Wetlands* stations which can be used as supporting or contextual information. Data types collected at CRMS sites include hydrologic from continuous recorder, vegetative, physical soil characteristics, discrete porewater salinity, surface elevation change, vertical accretion and land-water analysis of a 1 km^2 area encompassing the station (Folse et al. 2008). For this report, vegetation data from CRMS2041 was used to contrast emergent vegetation on the terraces and in existing marsh.

c. Monitoring Results and Discussion

Shoreline Position

DGPS shoreline surveys were performed in June 2004 and June 2010 (Figure 5, Table 1), with a final shoreline survey in 2022 (Figure 6, Table 2). On average the shoreline erosion rate in Little White Lake was 0.00 m/yr from 2004–2010 and +0.78 m/yr (+2.55 ft/yr) from 2010–2022. There was consistent loss on the west side where the outer terraces had eroded with -0.65 m/yr (-2.1 ft/yr) from 2004–2010 and -0.43 m/yr (-1.43 ft/yr) from 2010–2022. Conversely, there was consistent gain on the more protected north side of Little White Lake with +0.58 m/yr (+1.9 ft/yr) from 2004–2010 and +2.67 m/yr (+8.77 ft/yr) from 2010-2022. In combination with its more protected location, the gain in the northern Little White Lake area may be due to trapped sediment from upstream alluvium and storm events. The more rapid recent increase is so drastic because it captures the connection of the innermost terrace to the existing shoreline.

The average shoreline change rate for the Little Vermilion Bay area was +0.58 m/yr (+1.9 ft/yr) from 2004–2010 and -0.39 m/yr (-1.27 ft/yr) from 2010–2022. There was more gain on the protected south side than the unprotected northern shore from 2004–2010, with +1.73 m/yr (+5.7 ft/yr) in the south and 0.14 m/yr (-0.5 ft/yr) in the north. The positive shore movement in the south appears to be due in part to sediment deposition trapped behind the terraces from Hurricanes Katrina, Rita and Gustav. The positive effect of these storms appears to be gradually counteracted by erosional forces from 4-mile Canal. Shoreline movement in the Little Vermilion Bay area was slightly negative from 2010–2022, with -0.24 m/yr (-0.78 ft/yr) in the south and -0.48 m/yr (-1.56 ft/yr) in the north.

Table 1. Shoreline Change Rate from 2004 to 2010.

	m/yr				ft/yr			
	Mean	**± Std Error**	**Min**	**Max**	**Mean**	**± Std Error**	**Min**	**Max**
Little White Lake	0.00	0.09	-2.41	5.39	0	0.3	-7.9	17.7
LWL-W	-0.65	0.07	-2.41	0.79	-2.1	0.2	-7.9	2.6
LWL-N	0.58	0.13	-1.96	5.39	1.9	0.4	-6.4	17.7
Little Vermilion Bay	0.58	0.16	-2.20	13.91	1.9	0.5	-7.2	45.6
LVB-N	-0.14	0.06	-1.31	3.36	-0.5	0.2	-4.3	11
LVB-S	1.73	0.37	-2.20	13.91	5.7	1.2	-7.2	45.6

Table 2. Shoreline Change Rate from 2010 to 2022.

	m/yr				ft/yr			
	Mean	**± Std Error**	**Min**	**Max**	**Mean**	**± Std Error**	**Min**	**Max**
Little White Lake	0.78	0.10	-1.03	10.53	2.55	0.33	-3.38	34.55
LWL-W	-0.43	0.04	-1.03	1.05	-1.43	0.14	-3.38	3.44
LWL-N	2.67	0.45	-0.80	10.53	8.77	1.48	-2.62	34.55
Little Vermilion Bay	-0.39	0.04	-1.73	3.29	-1.27	0.14	-5.68	10.79
LVB-N	-0.48	0.06	-1.73	3.29	-1.56	0.21	-5.68	10.79
LVB-S	-0.24	0.10	-1.70	1.97	-0.78	0.33	-5.58	6.46

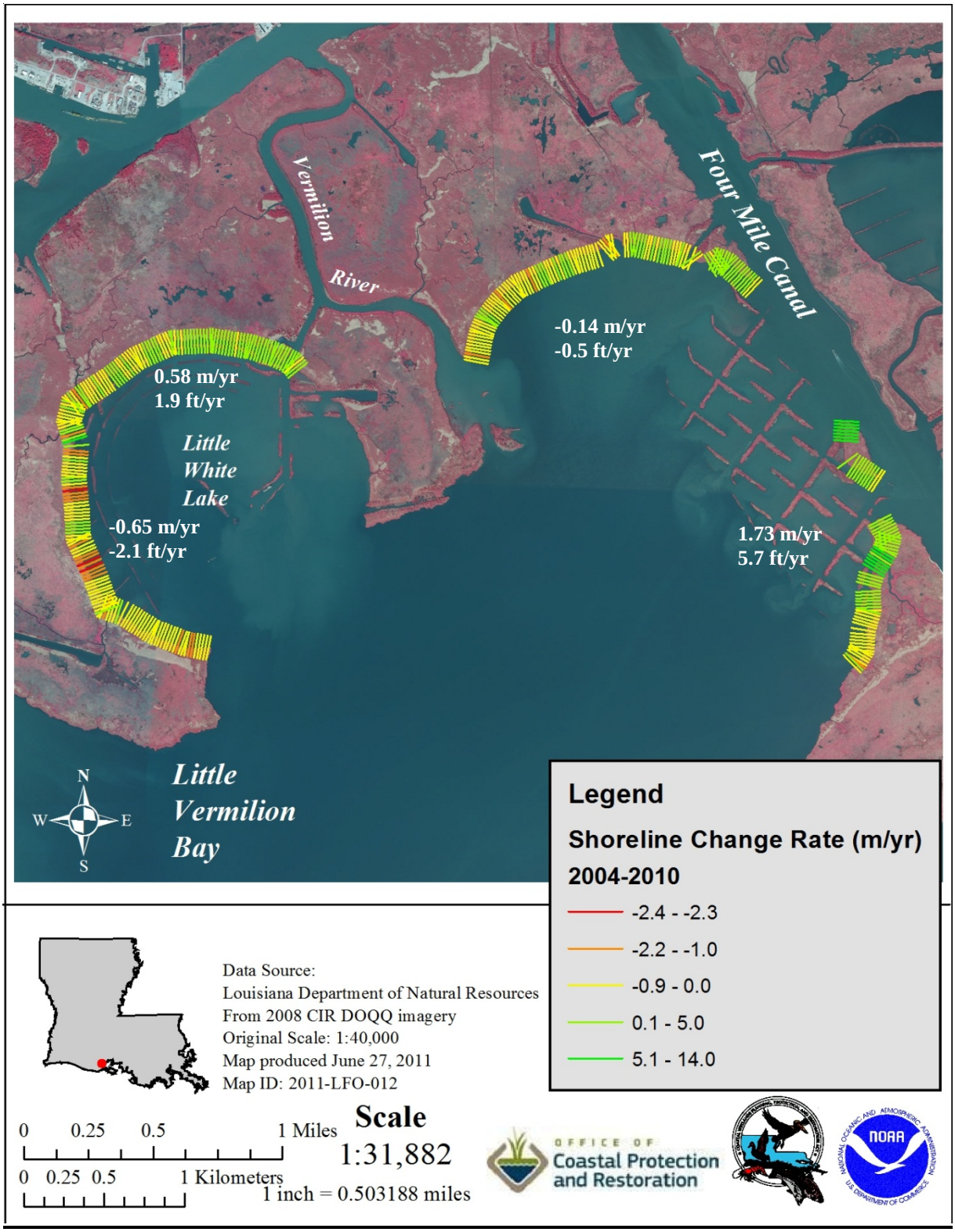


Figure 5. Four Mile Canal Terracing and Sediment Trapping DGPS shoreline change rates (m/yr) from 2004 to 2010.

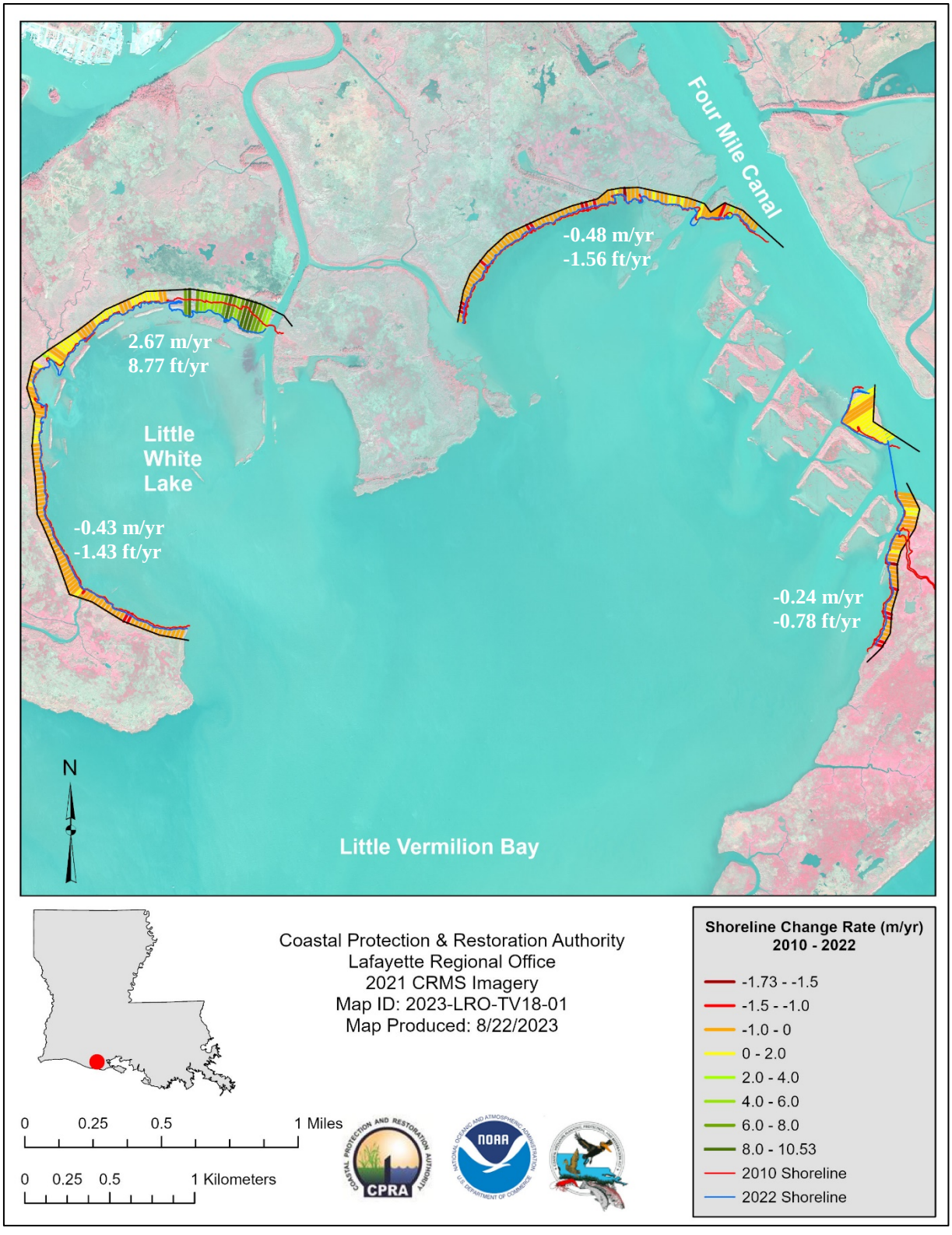


Figure 6. Four Mile Canal Terracing and Sediment Trapping DGPS shoreline change rates (m/yr) from 2010 to 2022.

Terrace Vegetation

Total percent cover of vegetation within Little White Lake increased for years 2004, 2007 and 2010 from 12.3%, 38.1% and 44.6% respectively then decreased to 14.9% for 2022(Figure 7, Photos: Appendix B). Little Vermilion Bay had a slight decrease of 71.6%, 69.7%, 61.2%, 49.7% for 2004, 2007, 2010, and 2022, respectively.

Species richness was stable over project life, with the mean N species range of <1 for both areas. There have consistently been more species within Little Vermilion Bay than Little White Lake (Figure 8). In Little White Lake, the terraces located on the northeast lake rim were protected by the terrace rows in front of them and showed a higher number of species. The outer most terrace row was subjected to more wave energies and experienced the lowest number of species, high rates of erosion, and an eventual collapse. In Little Vermilion Bay, terraces located behind an existing island and in the innermost terrace field had the highest number of species while the first set of terrace rows opened to the large fetch experienced the most erosion and low species numbers.

Cover, species richness, and floristic quality (FQI) increased over time on the Little White Lake terraces from 2004 to 2010 then decreased from 2010 to 2022 (Figure 9). The decrease in cover and FQI was drastic in 2022, with values similar to the beginning of the project in 2004. Cover, richness, and FQI began much higher on the Little Vermilion Bay terraces and gradually decreased over time. The dominant species in both areas was the planted species, *Spartina alterniflora* until 2022, in which species assemblages switched to more freshwater *Panicum repens* and *Sagittatia lancifolia*. Many of the species colonizing the Little Vermilion Bay terraces receive low FQI scores indicative of a disturbed environment. This is indicative of the volatility of the ecosystem, which due to its position in the landscape is exposed to harsh environmental forces.

Vegetation at nearby CRMS2041 has a few species in common with the community on the Little Vermilion Bay terraces although the dominants are not the same (Figure 10). The CRMS site is consistently dominated by *Phragmites australis*, which is present on the Vermilion Bay terraces, but the CRMS site has little *Spartina alterniflora.* The CRMS site also has had *Carex spp* presence documented since 2019, which is present only in the latest (2022) project vegetation survey and only at the Little Vermilion Bay stations. FQI scores are much higher at CRMS2041 (Figure 10).

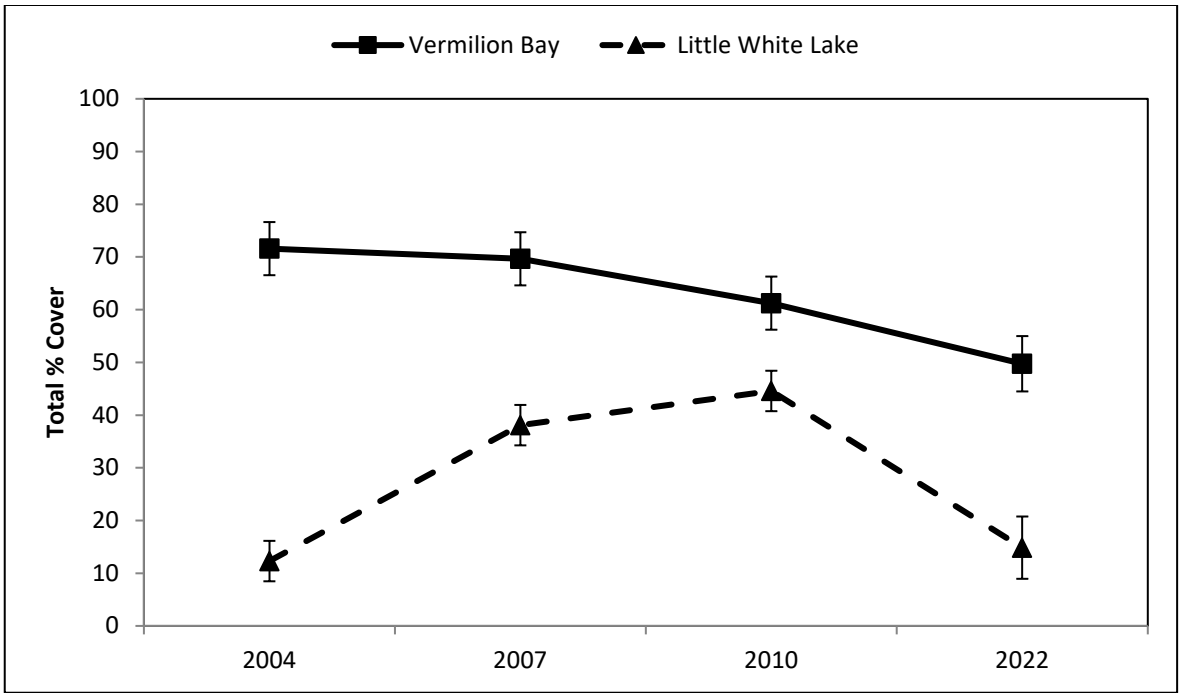


Figure 7. Little Vermilion Bay stations were higher in total % cover over time than Little White Lake stations for all years.

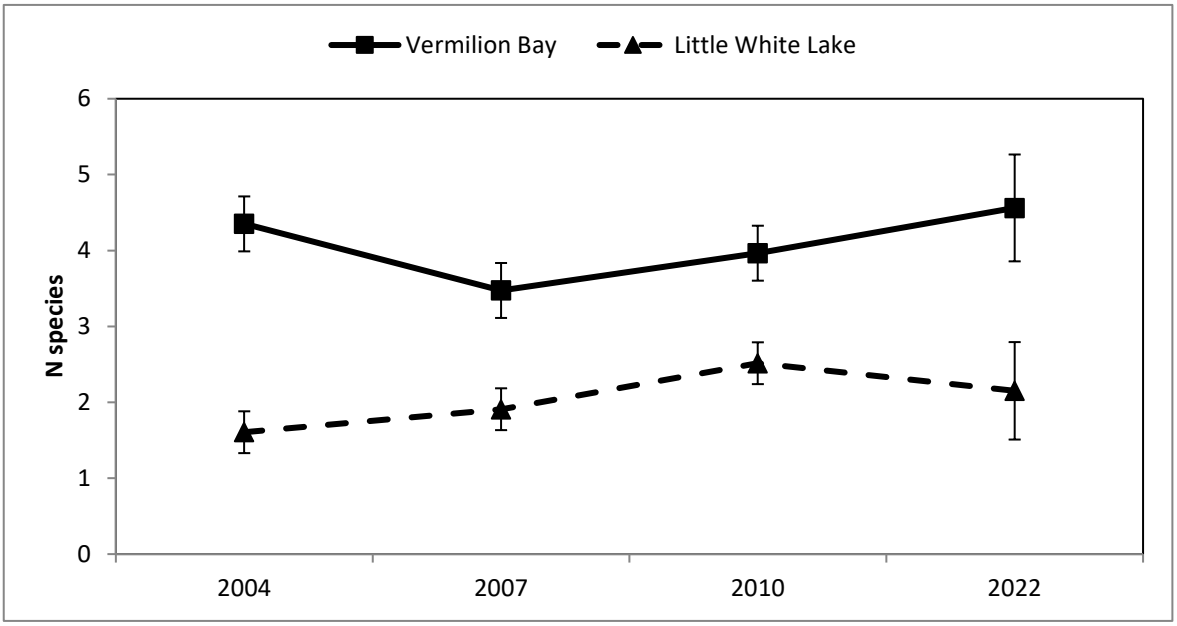
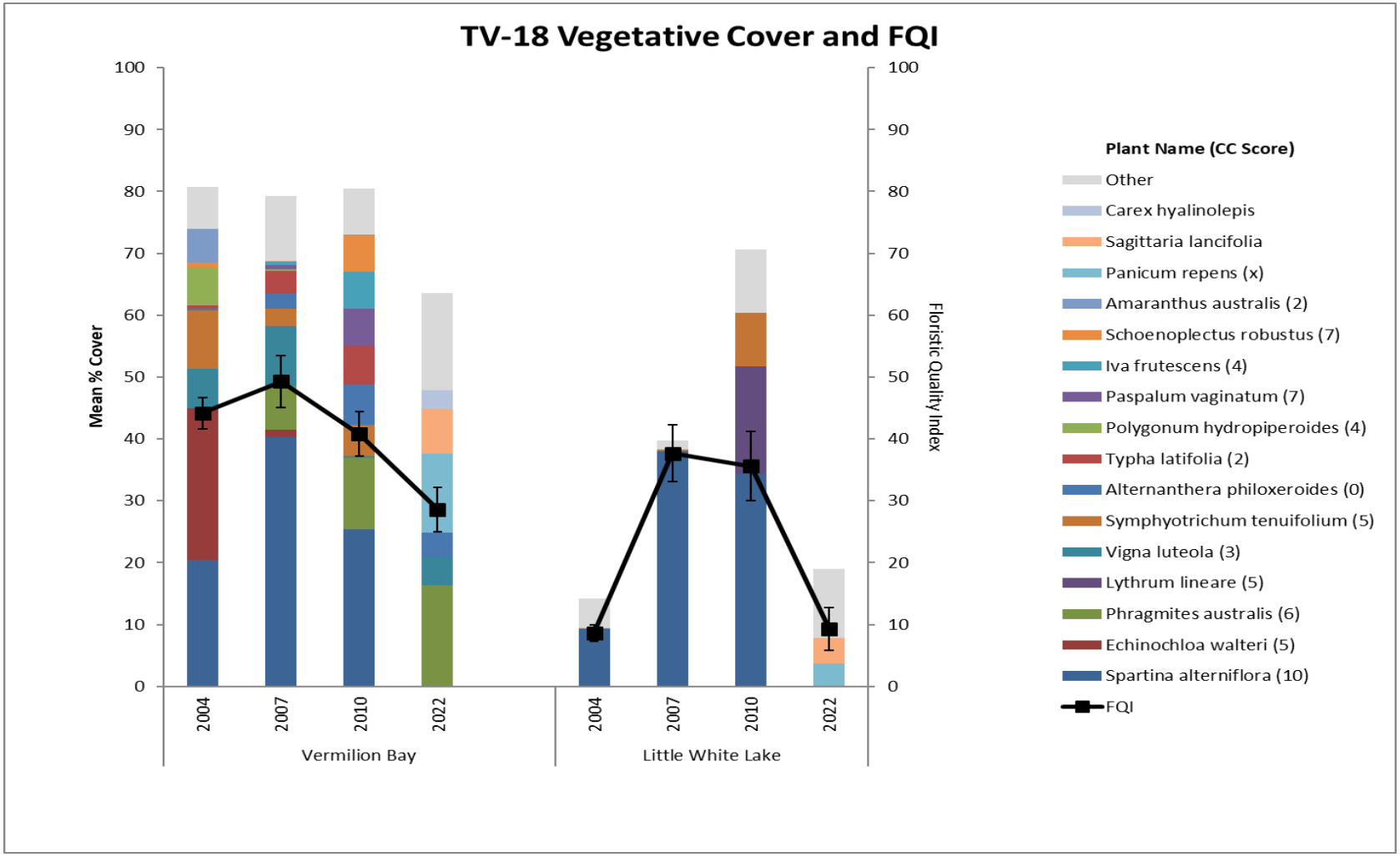


Figure 8. There has consistently been a higher N of plant species observed at Little Vermilion Bay than Little White Lake.

Figure 9. Percent coverage of species and floristic quality index of vegetation data collected on the Little Vermilion Bay and Little White Lake terraces. Values are means of 57 stations within the Little Vermilion Bay site and 33 stations within the Little White Lake site; therefore, the sum of % coverage of individual species can be greater than 100 %.



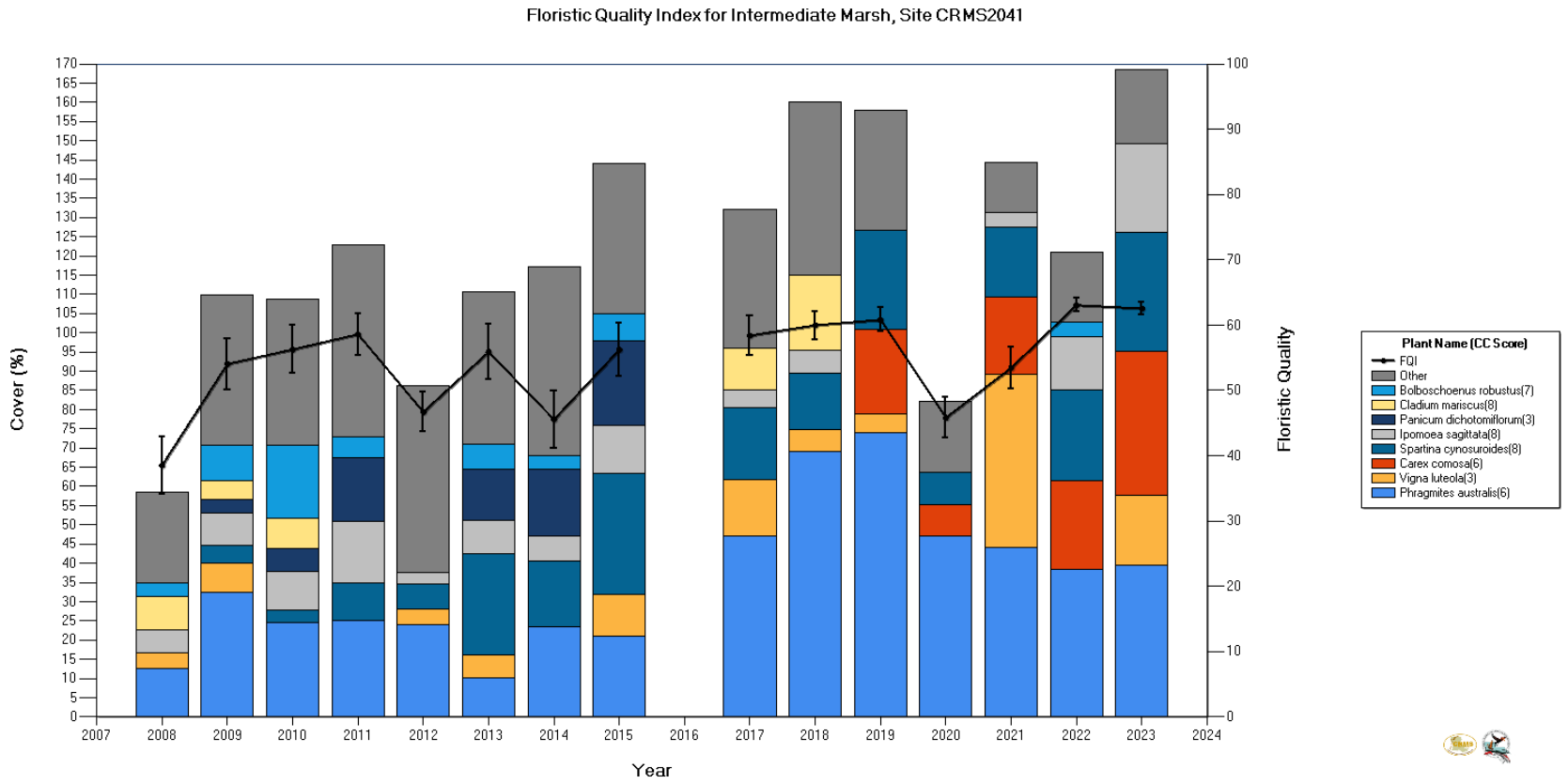


Figure 10. Percent coverage of species and floristic quality index of vegetation data collected on at CRMS station 2041 approximately a quarter mile north of Little White Lake .

Bathymetry/Topography

Data from professional elevation surveys completed in 2003 and 2023 was used to quantify elevation change for the project (Figures 11 and 12). As-built data was compiled using best available data sources. Pre-construction bathymetry (water bottom) data was used from Little White Lake due to absence of as-built bathymetry data. Further, topographic as-built data from Vermilion Bay was used to characterize terrace elevation profile for both areas (Figure 12).

Elevation loss was observed across all elevation survey classes across the 20-year project life. Terrace crown is the only elevation survey class that was had a positive elevation mean value for both Little White Lake (0.88 ft., NAVD88 Geoid 12B) and Vermilion Bay (1.34 ft., NAVD88 Geoid 12B) at the end of project life. Those mean elevation values are comparable to that of natural vegetated marsh in Vermilion Bay captured in 2023 (0.92 ft., NAVD88 Geoid 12B). Mean water bottom elevation loss was the least drastic of all survey classes, with the lowest elevations occurring in Vermilion Bay project area (Figures 11 and 12).

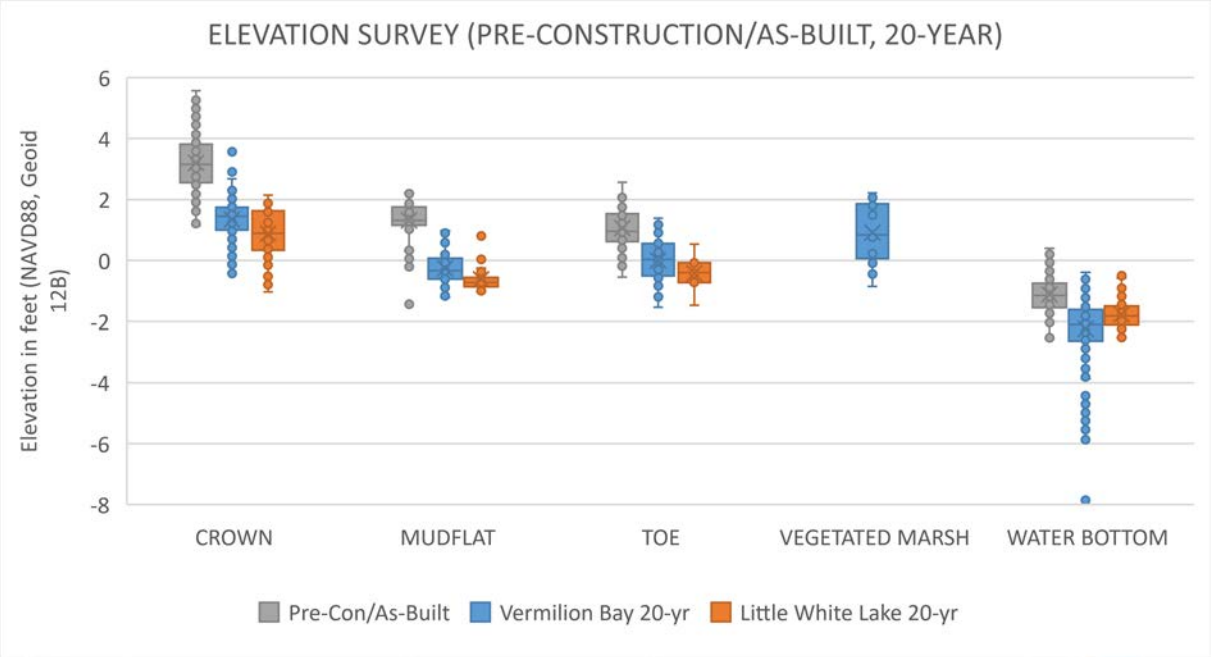


Figure 11. Elevation survey data collected in 2003 and 2023 within the T/V 18 project area at Little White Lake and Vermilion Bay.

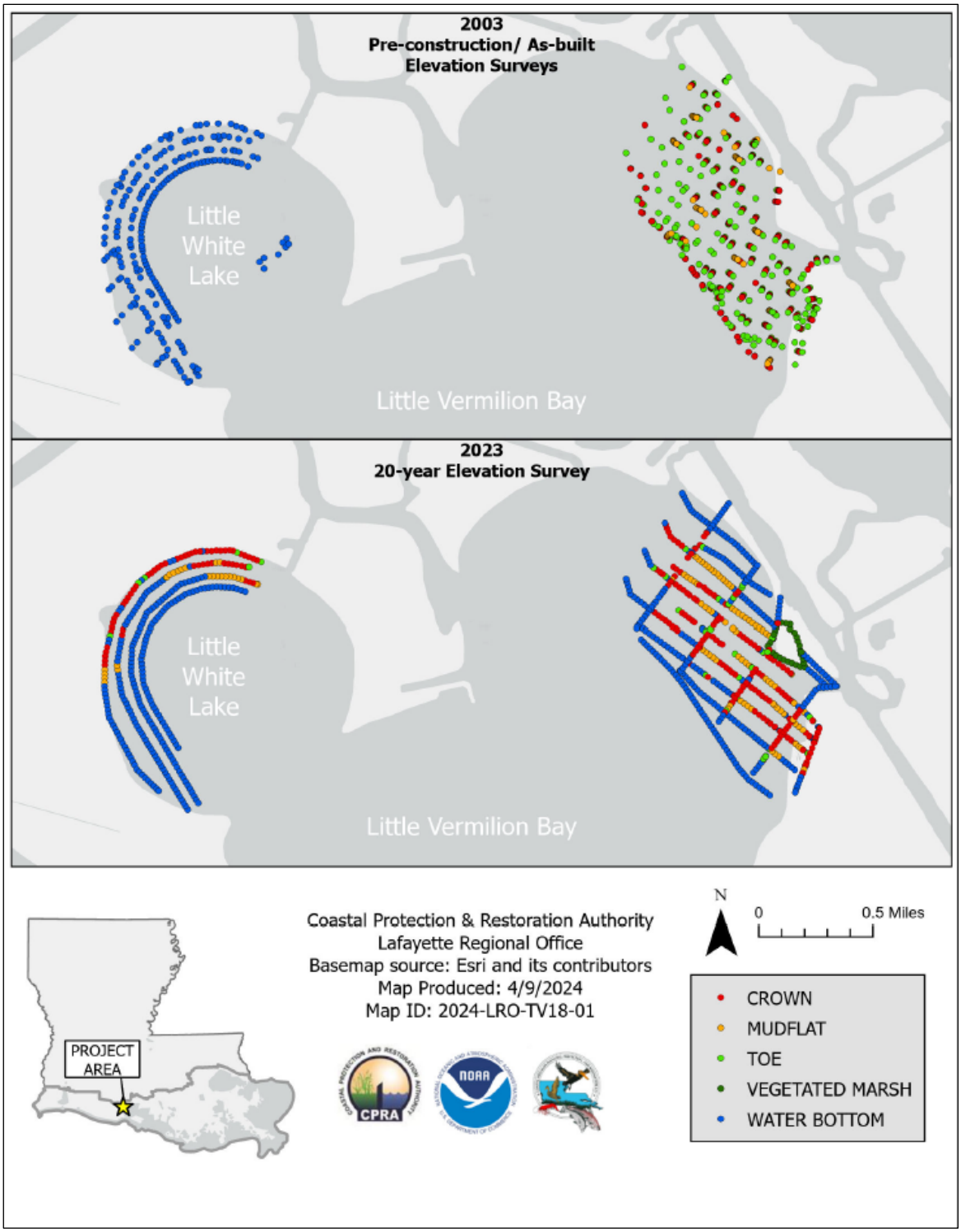


Figure 12. Data layout for elevation survey transects within the Four Mile Canal Terracing and Sediment Trapping (TV-18).

Digital Color Infrared Video Imagery:

Analysis of digital color infrared video taken in 2004, Z-1 imaging for 2005 and color infrared aerial photography for 2007, 2015, and 2018 for the entire project area are presented in Figures 13-17. The total project area is 2,270 acres. The Little White Lake project area consists of 708 acres and the Little Vermilion Bay project area consists of 1,562 acres. The Little White Lake area decreased by 4 acres from 2004 to 2005 but had an increase of 11 acres from 2005 to 2007 and another increase of 1 acre from 2007 to 2015, which remaining consistent through 2018. The Little Vermilion Bay area had an increase in land of 15 acres from 2004 to 2005 and another 3 acres from 2005 to 2007, which remained consistent through 2015, with another increase of 8 acres from 2015 - 2018 (Table 3). The losses within the Little White Lake area were attributed to the erosion of the outer terraces on the western shore as a result of wave action and fetch from across Little Vermilion Bay. The gains within both areas were attributed to the deposition of sediment behind the terraces where sediment was trapped and became vegetated. Hurricanes Katrina, Rita and Gustav could be a contributing factor to the gradual increase in land behind the terraces. Sediments appeared to have been trapped behind the terraces after the storms.

There were 10 acres of newly developed wetlands in the Little Vermilion Bay terrace area and 11 acres in the Little White Lake terrace area in 2007 (Figure 15). Although wetland classes were not included in the 2015 and 2018 Land/Water analysis, it appeared that wetland growth continued to occur on the edge of the terraces with small pockets in protected existing wetlands. Wetland growth in Vermilion Bay between 2007 and 2018 could also partially be attributed to LA-39 plantings in the Falls of 2014 and 2018. Total land gain from 2004-2018 was 34 acres, eight in Little White Lake and 26 in Little Vermilion Bay.

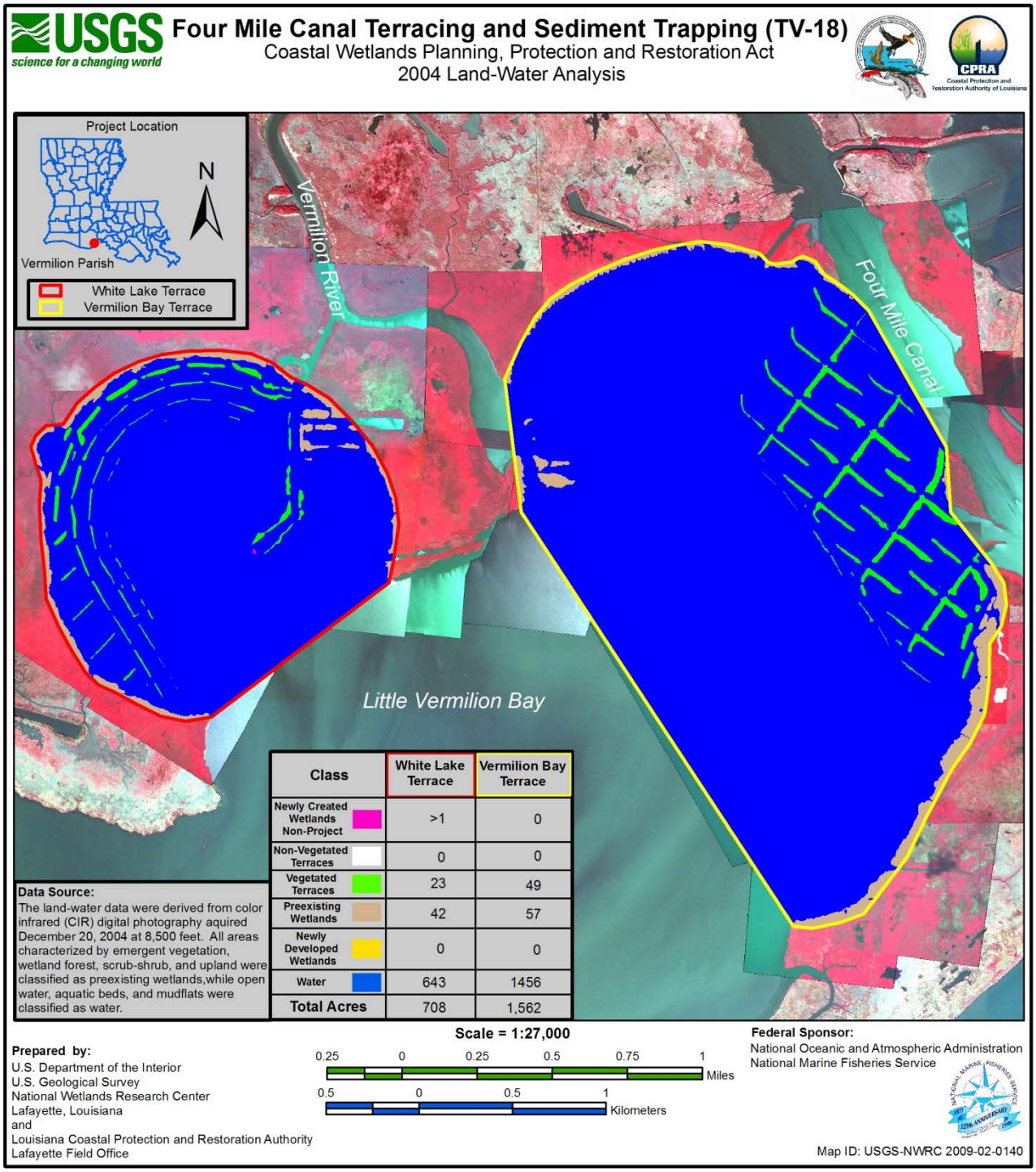


Figure 13. Four Mile Canal Terracing and Sediment Trapping (TV-18) 2004 land water analysis.

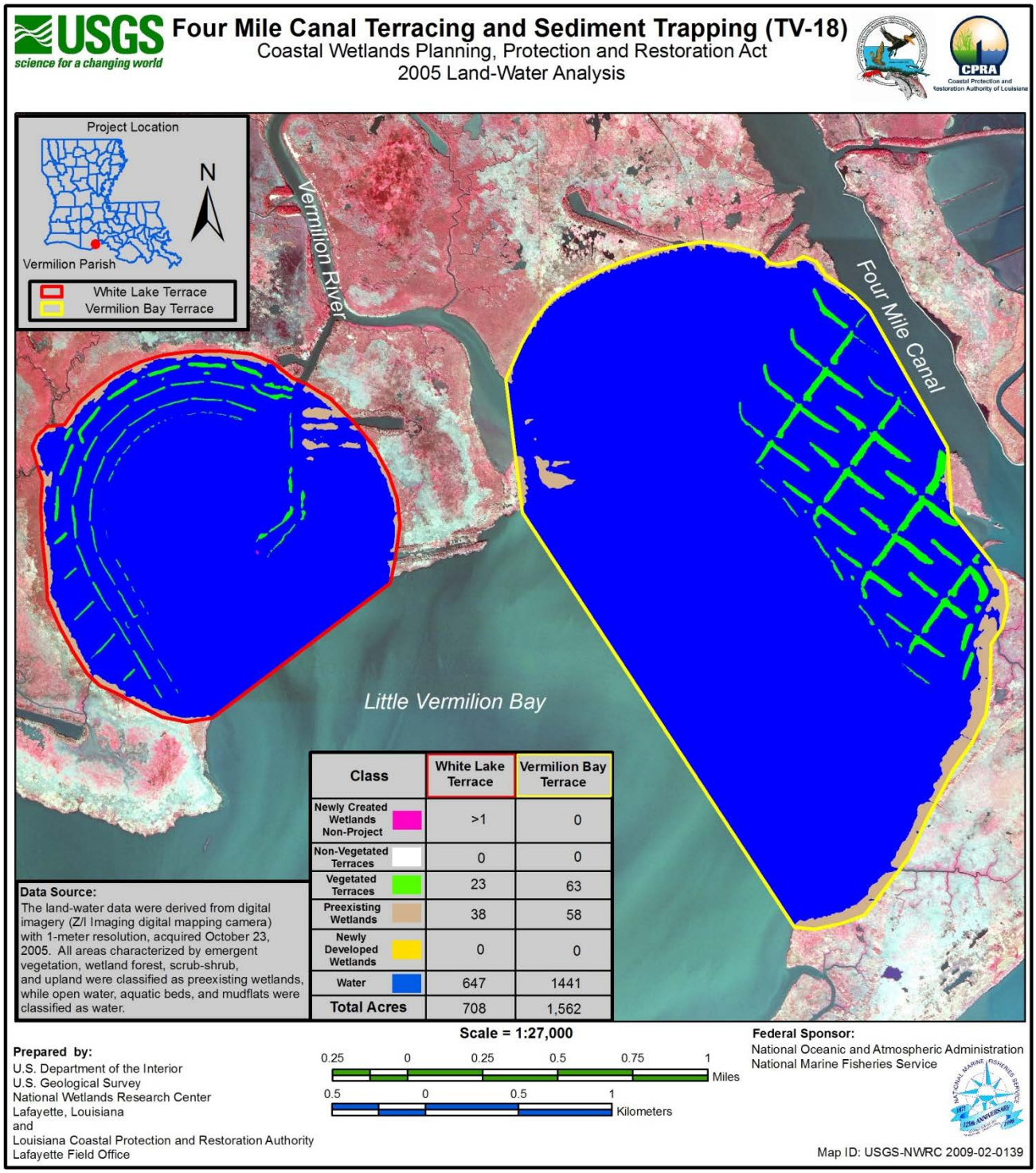


Figure 14. Four Mile Canal Terracing and Sediment Trapping (TV-18) 2005 land water analysis.

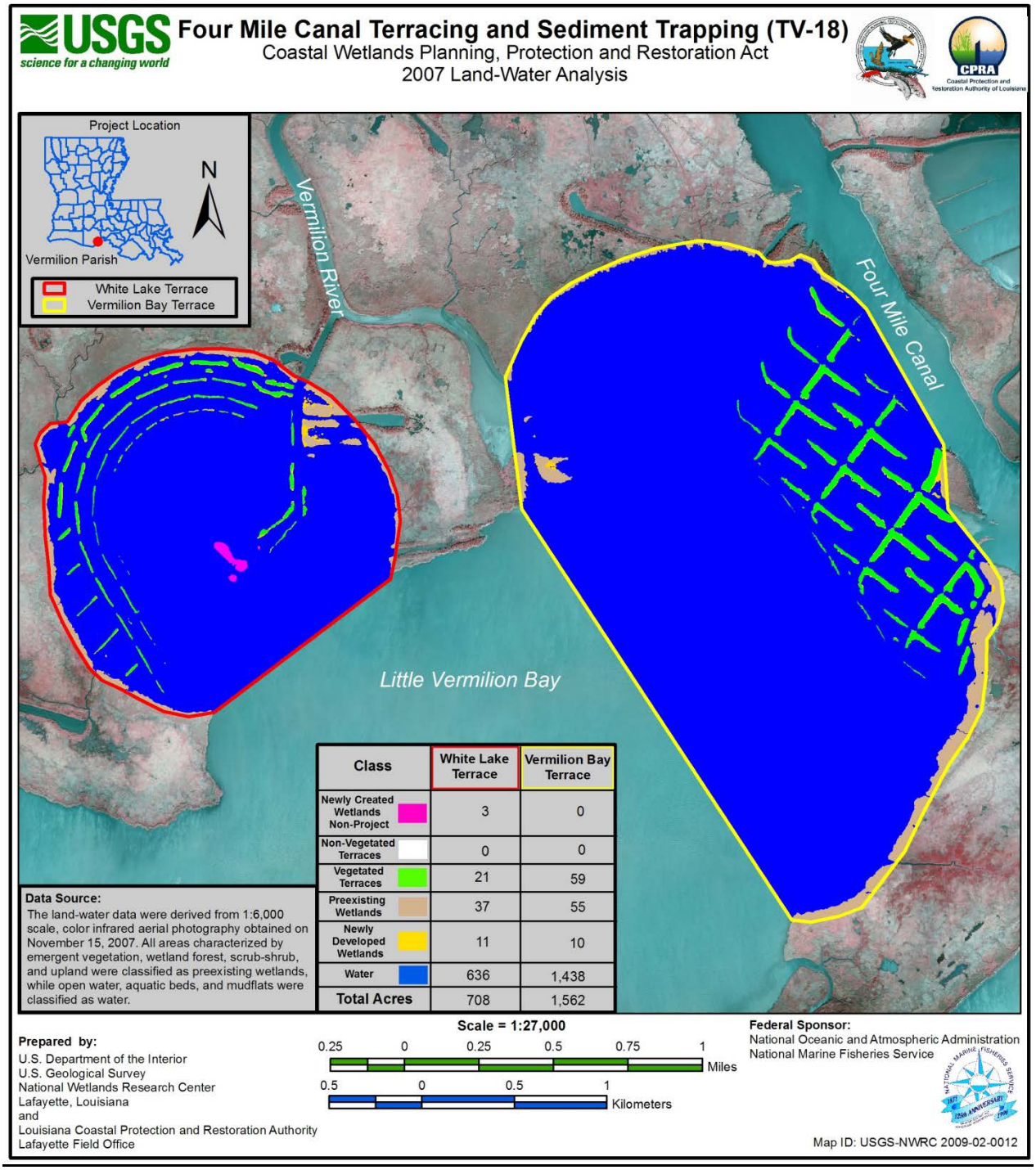


Figure 15. 2007 Land Water analysis for Four Mile Canal Terracing and Sediment Trapping (TV-18).

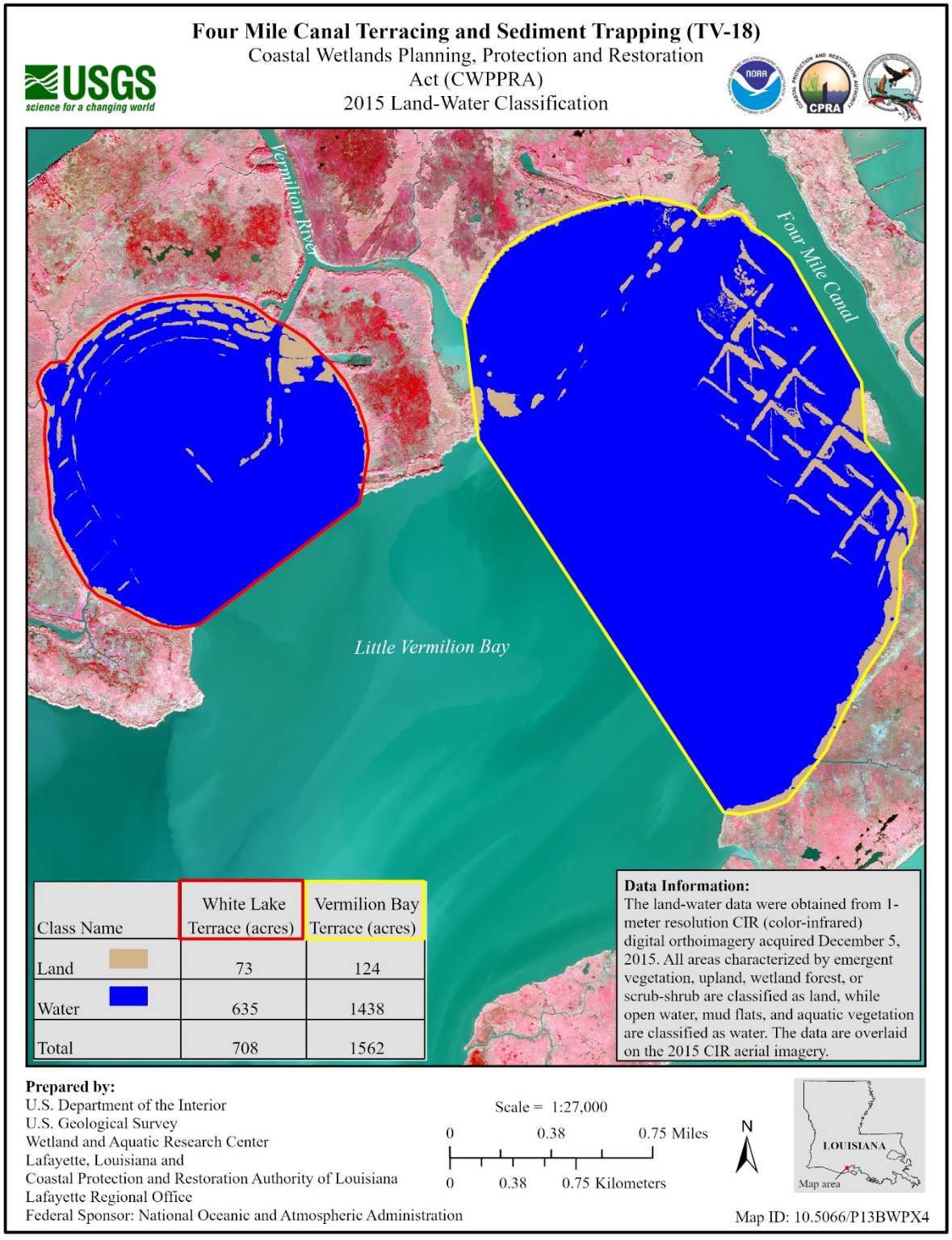


Figure 16. 2015 Land Water analysis for Four Mile Canal Terracing and Sediment Trapping (TV-18).

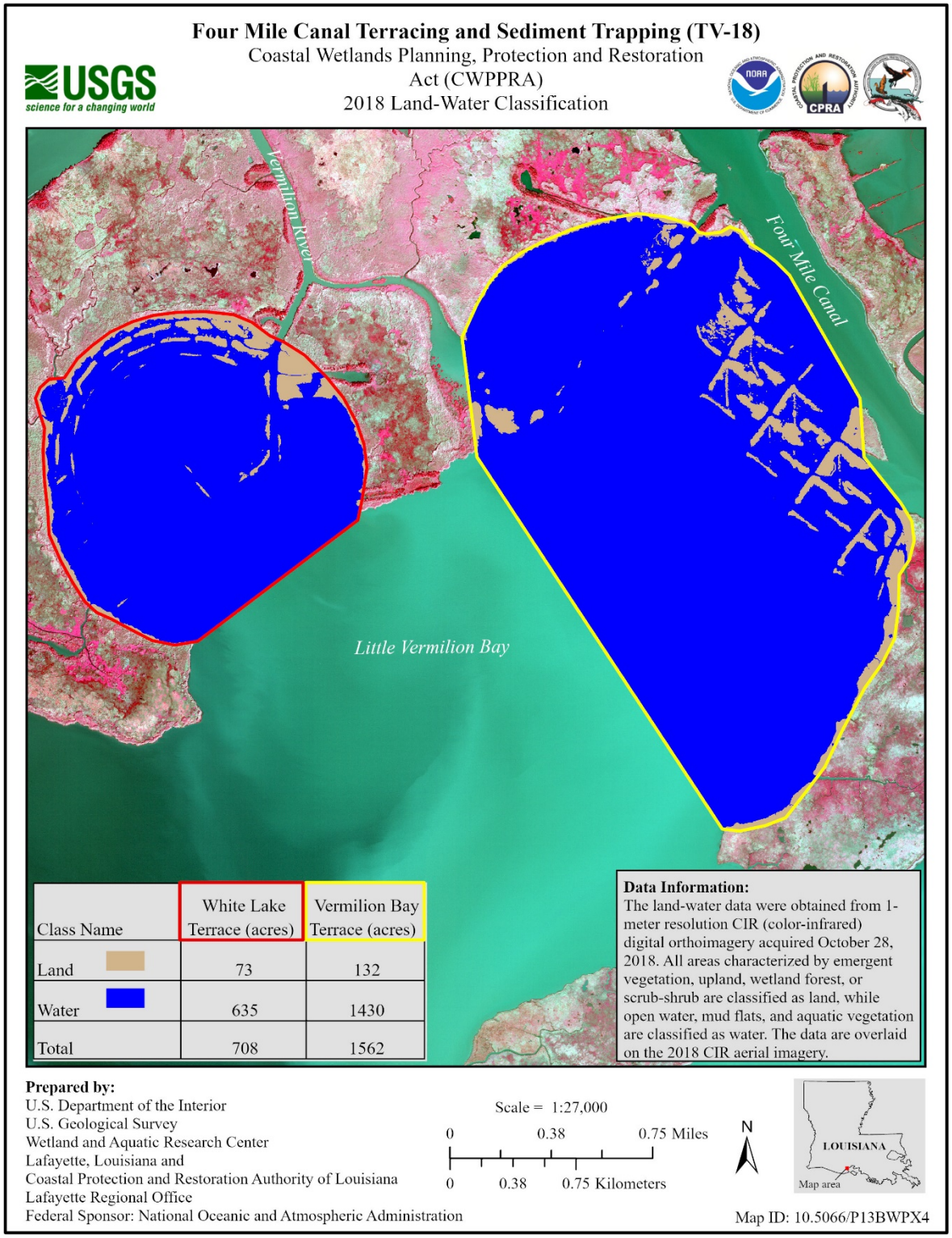


Figure 17. 2018 Land Water analysis for Four Mile Canal Terracing and Sediment Trapping (TV-18).

Table 3. Percent land and water for the for the Little White Lake and Vermilion Bay terrace areas for 2004, 2005, 2007, 2015, and 2018

	Little White Lake									
	2004		2005		2007		2015		2018	
	acres	%	acres	%	acres	%	acres	%	acres	%
Land	65	9.2	61	8.6	72	10.2	73	10.3%	73	10.3%
Water	643	90.8	647	91.4	636	89.8	635	89.7%	635	89.7%
Total	708		708		708		708		708	
	Vermilion Bay									
	2004		2005		2007		2015		2018	
	acres	%	acres	%	acres	%	acres	%	acres	%
Land	106	6.8	121	7.7	124	7.9	124	7.9%	132	8.5%
Water	1456	93.2	1441	92.3	1438	92.1	1438	92.1%	1430	91.5%
Total	1562		1562		1562		1562		1562	

V. Discussion

The resilience of marsh ecosystems in the TV-18 project area is largely influenced by erosional forces. Monitoring over the project life span demonstrated a clear effect of fetch length, large wakes from larges water vessels, alluvial inputs, and the presence of shoreline protection. Shoreline movement was stable to positive in project areas that were the most protected, either by natural or man-features. Most of the outside terraces of the Little White Lake side of the project were lost. However, in the more protected northern area, the outside terraces played a sacrificial role in allowing the inner terraces to persist and in some areas connect with existing shoreline. In the Vermilion Bay side of the project the effect of terraces was less drastic, but still observable. This is due to the relative natural protection of the northern side of the project area when compared to the west side of the Little White Lake project area.

The terraces in Vermilion Bay have shown expansion of vegetation, which has helped to stabilize sediment and allow the land mass in the project area to remain relatively stable over time. Channelization between terraces as a result of wave action from Four Mile Canal is apparent when looking at bathymetric data in the area. This area has direct sediment input and relatively less fetch, but more wave action from large water vessels. A hard shoreline structure would be necessary if this influence from the Canal were to be mitigated, though the presence these channels does not appear to have a net negative impact on the integrity of surrounding marsh.

Vegetation in the project area has recently shifted (since 2010) to favor a more freshwater plant species assemblage. Freshwater influence and sediment availability/dynamics have had a most drastic impact on the vegetation and land cover in the northern area of Little While Lake. Plantings from two separate LA-39 projects have facilitated maintenance and expansion of healthy marsh in the Vermilion Bay portion of the project area. With that, it appears likely that the TV-18 project would have met the metrics for success without the influence of the LA-39 plantings.

Over the last 20 years, the project area has seen a range of impacts from various external sources. As a means of shoreline protection, the presence of terraces was shown to have a positive impact on shoreline stability and overall ecosystem resilience, particularly in the absence of exceptional erosional forces as seen in the southern portion of the Little White Lake area. With adequate hard shoreline protection, terrace stability would no doubt be further enhanced, especially in high wave-energy environment.

VI. Conclusions

a. Project Effectiveness

The Four Mile Canal Terracing and Sediment Trapping Project is in good condition and functioning as intended. The outer rows of terraces have eroded in the highest energy environments but the shorelines have been protected for the most part.

The terraces effectively protected the shoreline in Little Vermilion Bay where the protected southern shoreline gained land behind the terraces and the unprotected northern shoreline

continued to erode. Parts of the western shore of Little White Lake continued to erode despite being protected while the northern shoreline gained land, and in some areas, became attached to created terrace.

The planted vegetation colonized most of the terraces then switched to a more freshwater plant species assemblage between 2010 and 2022.

Land to water ratios have increased over time in both areas. Project goals for shoreline erosion and marsh habitat creation have been exceeded at the end of the project's 20-year life cycle. If based on the amount of suitable habitat increase in the project area, it can be assumed that submerged aquatic vegetation and fisheries utilization project goals have been met as well.

Overall, the project has created functional marshland and is expected to maintain the integrity of the marsh it has been protecting.

b. Recommended Improvements

There are no recommended improvements for this project.

c. Lessons Learned

The life-cycle of terrace restoration projects is dependent on environmental conditions, predominantly the intensity of erosional forces and the presence of a sediment source. Terraces created in high energy environments such as the ones located adjacent to the Four Mile Canal may benefit from a hard structure, fence, or breakwater to minimize the erosive effects from boat wake traffic. When used as a shoreline stabilization method, design for terrace marsh creation should also employ locations with an active sediment source (or the resilience to persist through deposition storm events and, if possible, relatively short fetch). These conditions would serve to facilitate the eventual attachment of the innermost terrace to the existing shoreline, which is an apt goal for an integrated, sustainable marsh creation at the end of a project life.

There are locations adjacent to this project that may benefit from similar terrace marsh creations, particularly in the north Little Vermilion Bay shoreline area. This area has ample sediment deposition from the old mouth of the Vermilion River, and is a logical expansion of the existing TV-18 project adjacent to Four Mile Canal. The results from this project and the enhancements from LA-39 plantings indicate that employing a similar design, with more proactive planting project schedule may be a viable option for a future terrace creation project in the area.

d. End of Project Life

Terraces in this environment have been largely successful at reducing shoreline erosion while capturing sediment in formerly open water areas around the terraces. These features should continue to mature and potentially create emergent marsh. The terraces have needed little maintenance over the 20 year project life and this trend is expected to continue into the foreseeable future. The sacrificial southern terraces in the northern portion of Little White Lake area have served their purpose to facilitate the establishment of a stable shoreline in contrast with the southern portion of Little White Lake, likely due to a combination of sediment

availability from the Old Vermilion River and a disparity in the intensity of wind and wave energy. The project is to be closed out without removal with no recommended repairs. In combination with LA-39 planting efforts to create sustainable emergent marsh around the terraces in Little Vermilion Bay, the project will help to mitigate the erosive forces received by the project area, thus prolonging its economic life well beyond the 20 year threshold.

VII. Literature Cited

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Appendix A
(As-Built Drawings)

INDEX TO SHEETS

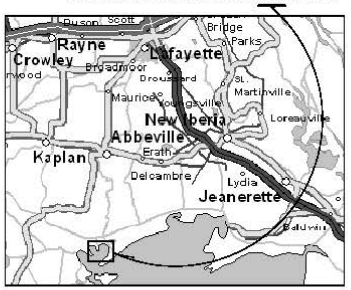
SHEET No.	DESCRIPTION
1	TITLE SHEET
2	SITE MAP & QUANTITIES
3	TERRACE & CHANNEL LAYOUT - LITTLE WHITE LAKE & VERMILION BAY
4	TERRACE & CROSS SECTIONS - LITTLE WHITE LAKE & VERMILION BAY
5	COORDINATE TABLE

PLANS OF PROPOSED

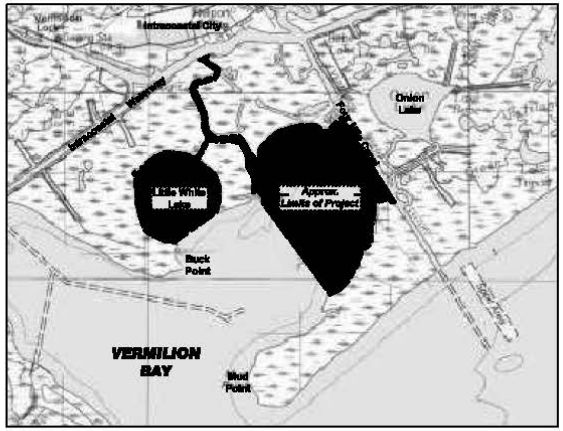
FOUR-MILE CANAL TERRACING AND SEDIMENT TRAPPING PROJECT

VERMILION BAY & LITTLE WHITE LAKE
VERMILION PARISH
DNR PROJECT NO. 2511-01-19
OCR PROJECT NO. 435-20-0394
FOR
NATIONAL MARINE FISHERIES SERVICE,
U.S. DEPARTMENT OF COMMERCE - NOAA &
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
COASTAL RESTORATION DIVISION
CWPPRA PROJECT NO. TV-18 / XTV-30

CWPPRA PROJECT NO. TV-18/XTV-30



VICINITY MAP
SCALE : 1" = 17 MILES



LOCATION MAP

SCALE : 1" = .75 MILES

1 mile 0.5 mile 0 1 mile 2 miles 3 miles

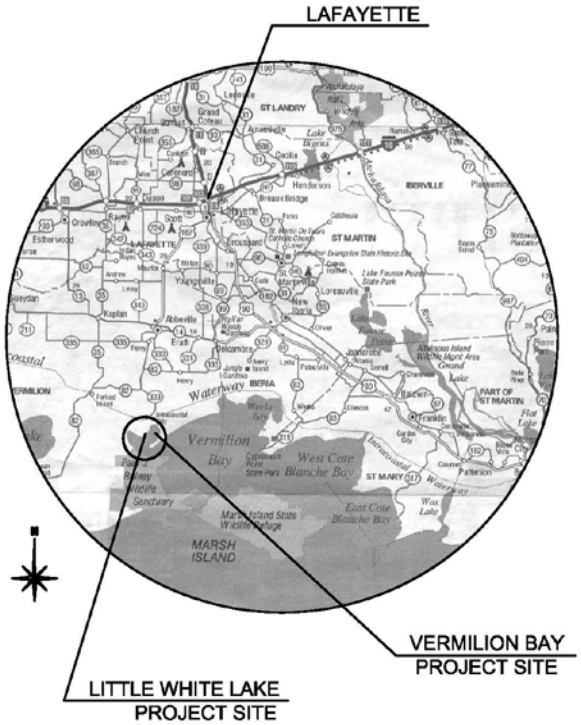
AS-BUILT DRAWINGS

TYPE OF CONSTRUCTION:
TERRACES & SEDIMENT TRAPPING & SHORE PROTECTION

APRIL, 2004

AUCOIN & ASSOCIATES, INC.
CONSULTING ENGINEERS
BUNGE, LOUISIANA

VERMILION
TV-18/ XTV-30
DNR NO. 2511-03-09
FOUR-MILE CANAL TERRACING AND SEDIMENT TRAPPING
D.P.H.
KIL/DPH
4/22/04



PROJECT SITES

SCALE : 1" = 8.5 MILE

0 5 miles 10 miles 20 miles 30 miles 40 miles

TOTAL AREA OF MARSH CREATED:
LITTLE WHITE LAKE = 25.5 ACRES
VERMILION BAY = 76.7 ACRES

SUMMARY OF AS-BUILT QUANTITIES			
LITTLE WHITE LAKE			
ITEM NO.	ITEM	UNIT	TOTAL
1	MOBILIZATION	LUMP SUM	
2	EMBANKMENT CONSTRUCTION	STATION	263

SUMMARY OF AS-BUILT QUANTITIES			
VERMILION BAY			
ITEM NO.	ITEM	UNIT	TOTAL
3	MOBILIZATION	LUMP SUM	
4	EMBANKMENT CONSTRUCTION	STATION	403

AS-BUILT
DRAWINGS

AUCOIN & ASSOCIATES, INC.
CONSULTING ENGINEERS
EUNICE, LOUISIANA

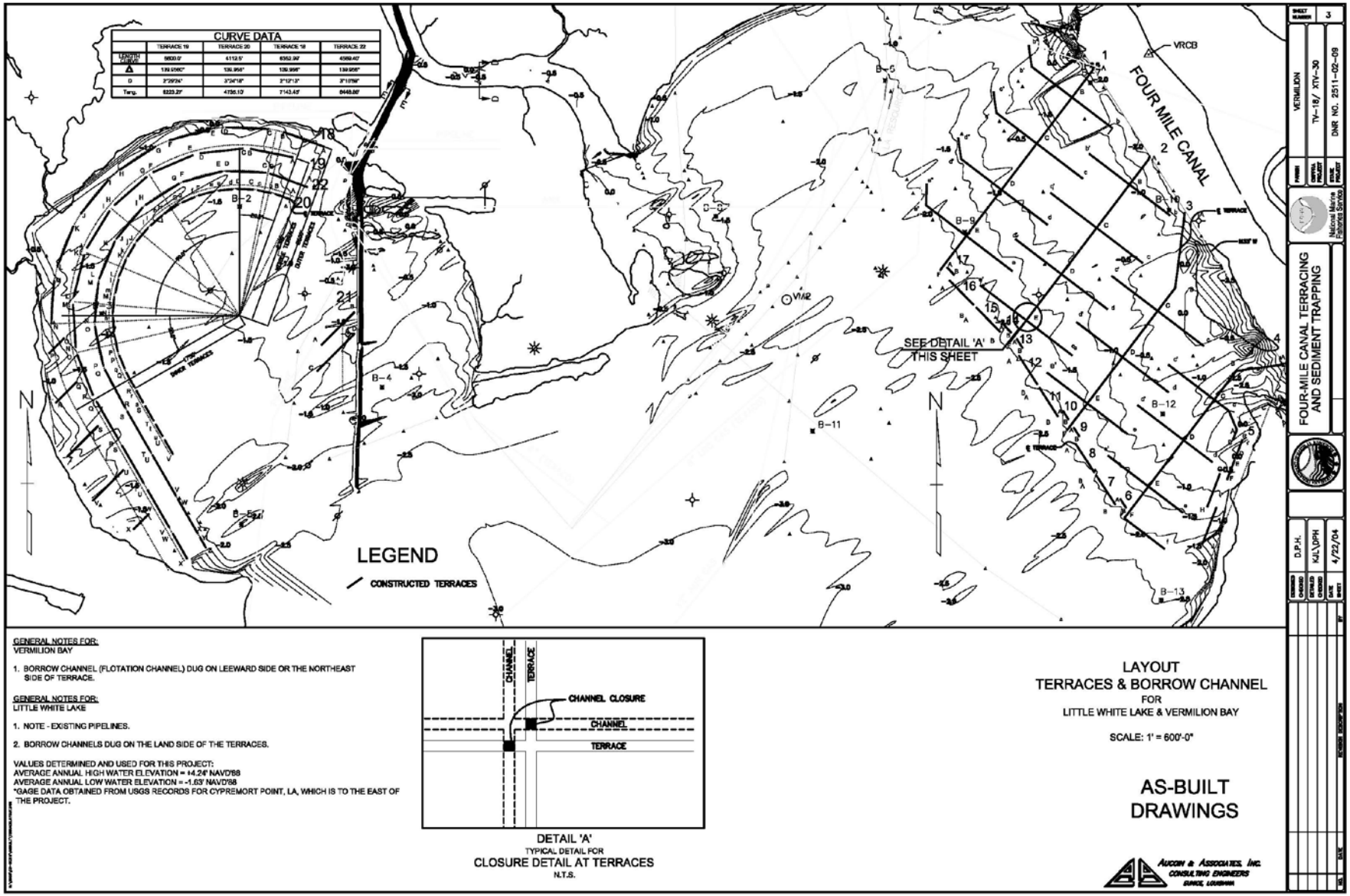
VERMILION | TV-18/ XTV-30 | DNR NO. 2511-02-09 | SHEET NUMBER 2

National Marine Fisheries Service

FOUR-MILE CANAL TERRACING AND SEDIMENT TRAPPING

D.P.H. | KJL\DPH | 4/22/04

H:\2003\03-0031B\ASBUILT\PROJECTSITEA.DWG



GENERAL NOTES FOR:
VERMILION BAY

1. BORROW CHANNEL (FLOTATION CHANNEL) DUG ON LEEWARD SIDE OR THE NORTHEAST SIDE OF TERRACE.

GENERAL NOTES FOR:
LITTLE WHITE LAKE

1. NOTE - EXISTING PIPELINES.
2. BORROW CHANNELS DUG ON THE LAND SIDE OF THE TERRACES.

VALUES DETERMINED AND USED FOR THIS PROJECT:
AVERAGE ANNUAL HIGH WATER ELEVATION = +4.24' NAVD'88
AVERAGE ANNUAL LOW WATER ELEVATION = -1.63' NAVD'88
*GAGE DATA OBTAINED FROM USGS RECORDS FOR CYPREMORT POINT, LA, WHICH IS TO THE EAST OF THE PROJECT.

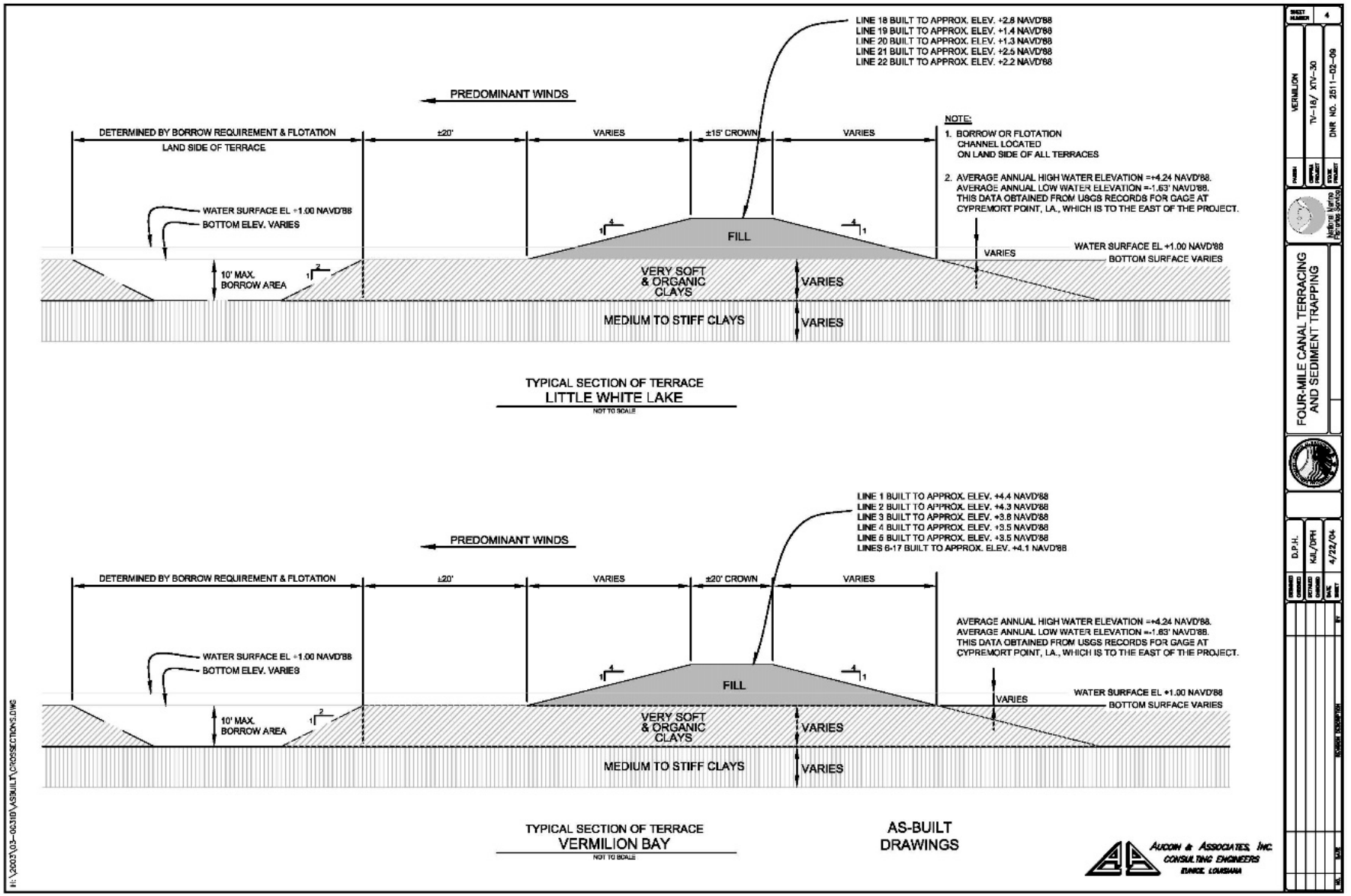
DETAIL 'A'
TYPICAL DETAIL FOR
CLOSURE DETAIL AT TERRACES
N.T.S.

LAYOUT
TERRACES & BORROW CHANNEL
FOR
LITTLE WHITE LAKE & VERMILION BAY

SCALE: 1' = 600'-0"

AS-BUILT
DRAWINGS

AUCOIN & ASSOCIATES, INC.
CONSULTING ENGINEERS
BUNGE, LOUISIANA


LINE 18 BUILT TO APPROX. ELEV. +2.8 NAVD'88
LINE 19 BUILT TO APPROX. ELEV. +1.4 NAVD'88
LINE 20 BUILT TO APPROX. ELEV. +1.3 NAVD'88
LINE 21 BUILT TO APPROX. ELEV. +2.5 NAVD'88
LINE 22 BUILT TO APPROX. ELEV. +2.2 NAVD'88
PREDOMINANT WINDS
DETERMINED BY BORROW REQUIREMENT & FLOTATION
LAND SIDE OF TERRACE
±20'
VARIES
±15' CROWN
VARIES
NOTE:
1. BORROW OR FLOTATION CHANNEL LOCATED ON LAND SIDE OF ALL TERRACES
2. AVERAGE ANNUAL HIGH WATER ELEVATION =+4.24 NAVD'88. AVERAGE ANNUAL LOW WATER ELEVATION =-1.63' NAVD'88. THIS DATA OBTAINED FROM USGS RECORDS FOR GAGE AT CYPREMORT POINT, LA., WHICH IS TO THE EAST OF THE PROJECT.
WATER SURFACE EL +1.00 NAVD'88
BOTTOM ELEV. VARIES
FILL
WATER SURFACE EL +1.00 NAVD'88
VARIES
BOTTOM SURFACE VARIES
10' MAX. BORROW AREA
VERY SOFT & ORGANIC CLAYS
VARIES
MEDIUM TO STIFF CLAYS
VARIES
TYPICAL SECTION OF TERRACE
LITTLE WHITE LAKE
NOT TO SCALE
LINE 1 BUILT TO APPROX. ELEV. +4.4 NAVD'88
LINE 2 BUILT TO APPROX. ELEV. +4.3 NAVD'88
LINE 3 BUILT TO APPROX. ELEV. +3.8 NAVD'88
LINE 4 BUILT TO APPROX. ELEV. +3.5 NAVD'88
LINE 5 BUILT TO APPROX. ELEV. +3.5 NAVD'88
LINES 6-17 BUILT TO APPROX. ELEV. +4.1 NAVD'88
PREDOMINANT WINDS
DETERMINED BY BORROW REQUIREMENT & FLOTATION
±20'
VARIES
±20' CROWN
VARIES
AVERAGE ANNUAL HIGH WATER ELEVATION =+4.24 NAVD'88. AVERAGE ANNUAL LOW WATER ELEVATION =-1.63' NAVD'88. THIS DATA OBTAINED FROM USGS RECORDS FOR GAGE AT CYPREMORT POINT, LA., WHICH IS TO THE EAST OF THE PROJECT.
WATER SURFACE EL +1.00 NAVD'88
BOTTOM ELEV. VARIES
FILL
VARIES
WATER SURFACE EL +1.00 NAVD'88
BOTTOM SURFACE VARIES
10' MAX. BORROW AREA
VERY SOFT & ORGANIC CLAYS
VARIES
MEDIUM TO STIFF CLAYS
VARIES
TYPICAL SECTION OF TERRACE
VERMILION BAY
NOT TO SCALE
AS-BUILT DRAWINGS
AUCOIN & ASSOCIATES, INC.
CONSULTING ENGINEERS
EUNICE, LOUISIANA
VERMILION
TV-18/ XIV-30
DNR NO. 2511-02-09
FOUR-MILE CANAL TERRACING AND SEDIMENT TRAPPING
D.P.H.
KJL/DPH
4/22/04
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TERRACE COORDINATES TABLE

REVISED COORDINATES

TERRACE END POINTS	COORDINATES (VERMILION BAY) NORTHING	EASTING	TERRACE END POINTS	COORDINATES (VERMILION BAY) NORTHING	EASTING	TERRACE END POINTS	COORDINATES (LITTLE WHITE LAKE) NORTHING	EASTING
			5A	455186.04	3028302.96			
1A	461123.04	3027930.96	6B	455061.00	3028385.04	19K	458330.00	3014085.00
1B	460715.04	3027636.96				19L	457710.96	3016167.00
1b	460290.96	3028194.00	7A	455504.04	3027975.00	19M	457858.04	3012972.00
1b'	461139.00	3027080.04	7B	455106.96	3028235.04	19N	457269.96	3013908.96
1b''	461436.26	3027009.52				19O	457173.00	3013931.04
1C	460079.04	3027150.96	8A	455942.96	3027687.96	19P	456612.96	3014145.00
1c	459994.92	3027787.94	8B	455546.04	3027948.00	19Q	456527.04	3014196.00
1c'	460503.00	3026594.04				19R	456008.04	3014496.00
1c''	460800.53	3026552.87	9A	456171.00	3027659.04	19S	455921.04	3014546.04
1D	459443.04	3026665.04	9B	456045.00	3027741.00	19T	455400.96	3014846.04
1d	458959.19	3027305.30				19U	455315.04	3014895.96
1d'	459867.00	3026109.00	10A	456404.04	3027509.04	19V	454794.96	3015195.96
1d''	460164.80	3026068.23	10B	456278.04	3027590.04	19W	454707.96	3015246.00
1E	458808.00	3026178.96				19X	454361.04	3015444.96
1e	458383.06	3026816.35	11A	456719.04	3027186.96			
1e'	459287.04	3025619.04	11B	456319.96	3027444.00	20A	459308.04	3016972.00
1e''	459586.63	3025634.56				20B	459387.96	3016650.96
1F	458331.00	3025815.96	12A	457161.00	3026903.04	20C	459446.04	3016356.96
2A	459912.96	3028709.04	12B	456761.04	3027159.96	20D	459456.00	3016182.96
2B	459515.04	3028439.04				20E	459423.00	3015823.96
2b	459095.04	3028986.00	13A	457389.96	3026874.96	20F	459366.00	3015597.96
2b'	459939.00	3027878.04	13B	457263.96	3026955.96	20G	459245.04	3015324.00
2C	458918.04	3027975.00				20H	459114.96	3015126.96
2c	458434.12	3028611.60	14A	457581.96	3026694.00	20I	458916.96	3014904.00
2c'	459403.01	3027308.32	14B	457476.00	3026799.00	20J	458739.00	3014750.04
2D	458282.04	3027491.04				20K	458480.04	3014598.96
2d	457797.48	3028187.16	15A	457821.96	3026316.00	20L	458262.96	3014310.04
2d'	458766.36	3026053.67	15B	457484.04	3026649.00	20M	457971.96	3014439.96
2E	457646.04	3027006.00				20N	457739.04	3014417.04
2e	457160.83	3027642.72	16A	458196.96	3025947.96	20O	457440.00	3014442.00
2e'	458189.72	3026369.43	16B	457857.96	3026280.96	20P	457209.00	3014490.00
2F	457350.00	3026781.84				20Q	456933.96	3014603.04
			17A	458375.04	3025911.96	20R	456726.00	3014715.96
3A	459135.02	3029195.14	17B	458270.04	3026016.96	20S	456465.96	3014865.00
3B	458093.46	3029089.29				20T	456261.96	3014982.00
3C	457775.04	3028817.04	18A	460034.04	3017334.00	20U	456003.00	3015134.04
3c	457290.70	3029453.71	18B	459839.96	3016770.96	20V	455799.00	3015249.96
3c'	458259.59	3028180.42	18C	460278.96	3016574.04			
3D	457137.96	3028332.96	18D	460304.04	3015975.00	21A	457302.00	3017292.96
3d	456653.66	3028968.96	18E	460281.00	3015774.96	21B	457761.86	3017752.28
3d'	457622.94	3027693.98	18F	460128.96	3015197.04	21C	456942.96	3017832.96
3E	456501.96	3027848.04	18G	460041.96	3015014.04	21D	457462.22	3017751.92
4A	458353.85	3029098.50	18L	458388.00	3013636.00			
4B	456950.04	3029901.39	18M	458193.00	3013611.96			
4C	456582.00	3029597.04	18N	457595.04	3013569.00			
4c	456400.45	3029797.97	18O	457401.96	3013749.96			
4c'	457036.58	3028961.97	18P	457190.04	3013539.00			
4D	455994.96	3029175.00	18Q	456792.96	3013916.04			
4d	455691.96	3029373.04	18R	456510.00	3013632.96			
4d'	456479.12	3028937.78	18S	456192.00	3014217.00			
4E	455358.00	3028689.96	18T	455768.04	3013791.96			
4e	454995.00	3029168.04	18U	455586.00	3014565.96			
4e'	455781.96	3028133.04	18V	455162.04	3014142.00			
4F	454920.00	3028956.96	18W	454980.00	3014916.00			
4f	454497.00	3028914.00	18X	454767.96	3014703.96			
5A	456138.59	3029907.67	19A	459988.96	3016904.04			
5B	455998.56	3029853.90	19B	460005.96	3016316.04			
5C	456009.17	3029987.59	19C	460010.04	3016217.04			
5D	455775.79	3029897.96	19D	459945.00	4215621.00			
5E	455729.11	3029880.04	19E	459918.96	3015924.04			
5F	455449.05	3029778.49	19F	459684.00	3014972.04			
5G	455539.11	3029677.46	19G	459624.96	3014891.04			
5H	455072.24	3029498.21	19H	459230.04	3014439.96			
5I	455073.64	3029629.09	19I	459153.96	3014375.04			
5J	454368.20	3029431.92	19J	458642.04	3014064.00			

ADDITIONAL COORDINATES

TERRACE END POINTS	COORDINATES (LITTLE WHITE LAKE) NORTHING	EASTING
20b	459398.40	3016602.04
20c	459437.20	3016405.84
20d	459451.25	3016073.46
20e	459429.13	3015874.69
20F	459346.07	3015551.99
20g	459263.09	3015369.08
20h	459082.36	3015090.21
20I	458949.69	3014940.59
20J	458693.70	3014783.15
20k	458583.18	3014624.06
20l	458214.68	3014498.86
20m	458020.21	3014432.15
20n	457689.36	3014420.86
20o	457490.05	3014437.34
20p	457163.68	3014508.57
20q	456978.37	3014583.82
20r	456693.10	3014740.93
20s	456509.57	3014840.26
20t	456218.94	3015006.97
20u	456046.09	3015107.56
22A	459479.24	3017105.08
22B	459668.07	3016580.22
22C	459677.80	3016531.18
22D	459702.05	3015973.92
22E	459696.62	3015924.22
22F	459552.45	3015385.22
22G	459532.35	3015339.44
22H	459233.24	3014869.82
22I	459200.32	3014831.18
22J	458773.66	3014471.90
22K	458730.97	3014445.87
22L	458216.14	3014231.20
22M	458167.61	3014219.18
22N	457612.09	3014169.91
22O	457562.19	3014172.01
22P	457017.19	3014290.77
22Q	456970.52	3014309.70
22R	456437.26	3014592.63
22S	456393.96	3014617.63
22T	455932.12	3014942.01
22U	455789.81	3014967.01
22V	455225.90	3015292.01
22W	455182.60	3015317.01
22X	454706.29	3015592.01
22Y	454662.98	3015617.01
22Z	454509.88	3015704.50

AS-BUILT DRAWINGS

AUCOIN & ASSOCIATES, INC. CONSULTING ENGINEERS LAFAYETTE, LOUISIANA

VERMILION | TV-18/ XTV-30 | DNR NO. 2511-02-09

FOUR-MILE CANAL TERRACING AND SEDIMENT TRAPPING

National Marine Fisheries Service

SHEET NUMBER 5

D.P.H. | KJL/DPH | 4/22/04

H:\2003\03-0031\ASBUILT\COORDINATES2.DWG

Appendix B
(Photographs)

Photo 1: Little White Lake Terraces, Interior Row (April 2016)

Photo 2: Little White Lake Terraces, 2nd Row (April 2016)

Photo 3: Four Mile Canal Terraces (April 2016)

Photo 4: Emergent Vegetation Within Four Mile Canal Terraces (April 2016)

Photo 5: Little White Lake Terraces (May 2024)

Photo 6: Little White Lake Terraces (May 2024)

Photo 7: Four Mile Canal Terraces (May 2024)

Photo 8: Emergent Vegetation within Four Mile Canal Terraces (May 2024)