Final (95%) Design Report October 2012

Lost Lake Marsh Creation and Hydrologic Restoration Project

TE - 72

Terrebonne Parish, Louisiana

CPRA
Louisiana Coastal Protection and Restoration Authority

Coastal Wetlands Planning, Protection, and Restoration Act

U.S. Fish & Wildlife Service
Department of the Interior

Table of Contents

List of Tables

List of Figures

Appendices

1.0 INTRODUCTION

The Lost Lake Marsh Creation and Hydrologic Restoration Project (herein referred to as TE-72) is located in the Terrebonne Basin near the vicinity of Lost Lake as shown in Figure 1. The Louisiana Coastal Wetlands Planning, Protection and Restoration Task Force designated TE-72 as part of the 19th Priority Project List (PPL). The United States Fish and Wildlife Service (USFWS) was designated as the federal sponsor with funding approved on January 20, 2010, through the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) of 1990 by the United States Congress and the Wetlands Conservation Trust Fund by the State of Louisiana. The Louisiana Coastal Protection and Restoration Authority (CPRA) is serving as the local sponsor and will also be performing the engineering and design.

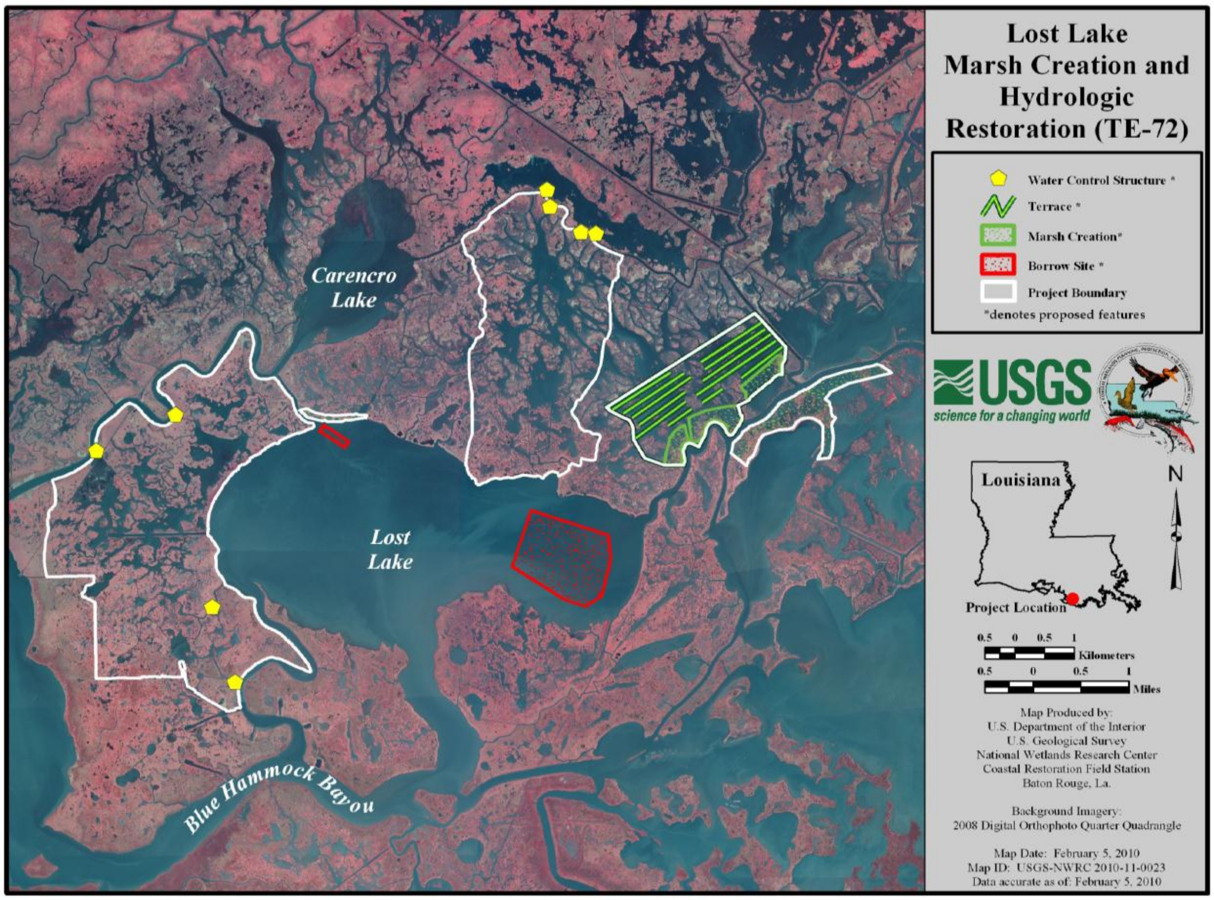

Figure 1: Phase 0 Project Features for TE-72

Restoration strategies developed during Phase 0 for this project included the construction of marsh creation areas, earthen terraces, and hydrologic restoration features as shown in Figure 1. The proposed marsh creation features included dredging sediment from Lost Lake to fill open water and broken marsh areas along Bayou Decade and the Lake Pagie lake rim. An earthen terrace field was included in open water north of Bayou Decade in order to minimize damage to the existing marsh caused by local wind-induced waves.

Six fixed-crest weirs and two plugs to the north and west of Lost Lake were proposed to be removed and replaced with variable-crest weir control structures in an effort to increase flow rates of freshwater into the existing marsh while allowing water levels to be maintained during the waterfowl season (i.e., November to January).

Engineering and design is being conducted by the CPRA Engineering Division. Data collection activities including topographic, bathymetric and magnetometer surveys, and a geotechnical subsurface investigation were performed. Additionally, water level data have also been collected by the CPRA to aid in the design of the hydrologic restoration project features. The collected data and survey information have been utilized to design the proposed restoration project features and develop construction methodology criteria for each restoration feature to the 95% level of completion as required by the CWPPRA Standard Operating Procedures Manual.

2.0 HISTORICAL WATER LEVELS

Historical water level calculations were performed during the design of the TE-72 project. These calculated parameters were used during the development and design of the marsh creation fill areas and the hydrologic restoration structures.

The United States Geological Survey (USGS) stage recorder #0738165067 (no longer in service) was selected to determine historical water levels due to its close proximity to the proposed project area and database availability. Stage recorder #0738165067 was located in Bayou Raccourci at 29°20'18"N, 90°57'08"W to the south east of the TE-72 project area (Figure 2). Daily maximum and minimum water level data were recorded from August 27, 1999 to March 19, 2002. These data were used to determine mean high water (MHW) and mean low water (MLW) values for the project area.

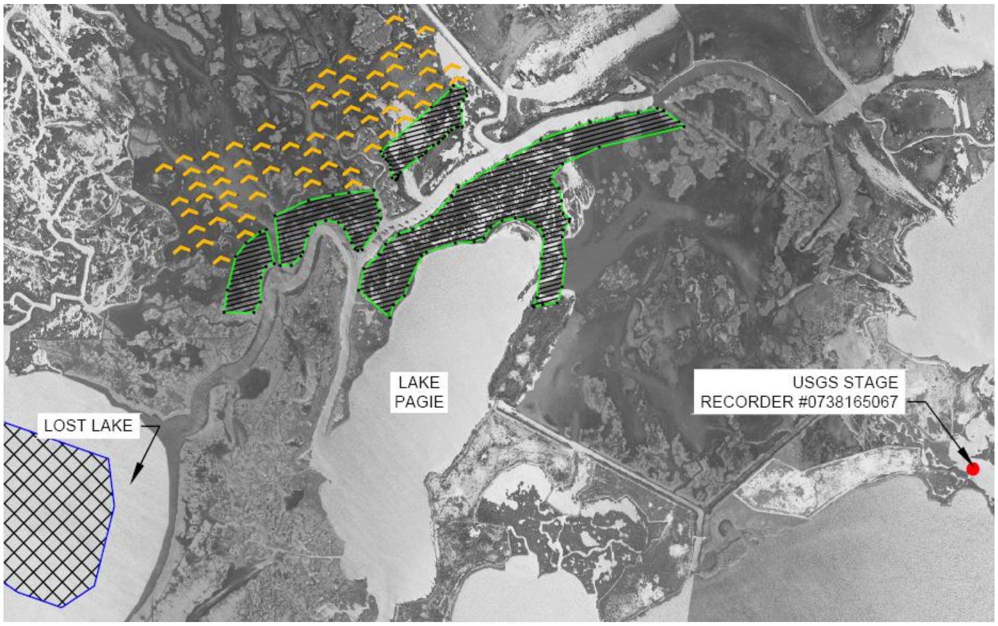

Figure 2: USGS Stage Recorder Location

A normal tidal epoch lasts approximately 19 years. In order to accurately estimate MHW and MLW, a data set with less than 19 years of data should be correlated to a gauge which has a data set of at least 19 years. NOAA station #8761724 located at Grand Isle near Barataria Pass at 29°15'48"N, 89°57'24"W (Figure 3) was used as a control station for making this correlation. The period of record used for the 19 year tidal epoch was from January 1, 1984 to December 31, 2002. The methodology used to make this correlation is summarized in Table 1.

Figure 3: NOAA Gage Station Location

KNOWN VARIABLES	ELEV. FT NAVD88
MHW_C= 19 Year Mean High Water At Control Station	1.38
MTL_C= 19 Year Mean Tide Level At Control Station	0.83
MLW_C= 19 Year Mean Low Water At Control Station	0.29
MR_C= 19 Year Mean Tide Range At Control Station	1.09
TL_C= Mean Tide Level For The Observation Period At Control Station	0.88
R_C= Mean Tide Range For The Observation Period At Control Station	1.04
TL_S= Mean Tide Level For The Observation Period At Subordinate Station	0.90
R_S= Mean Tide Range For The Observation Period At Subordinate Station	1.12
CALCULATED VARIABLES	
MHW_S= 19 Year Mean High Water At Subordinate Station (MHW = MTL + MR/2)	1.44
MTL_S= 19 Year Mean Tide Level At Subordinate Station (MTL = TL+MTL-TL)	0.86
MLW_S=19 Year Mean Low Water At Subordinate Station (MLW=MTL-MR/2)	0.27
MR_S=19 Year Mean Tide Range At Subordinate Station (MR=(MR*R)/R)	1.17

Table 1: Summary of Tidal Datum Methodology

3.0 SURVEYS

Topographic, bathymetric, and magnetometer surveys were conducted by Pyburn & Odom in May 2011. This survey effort was intended to facilitate the planning and design efforts pertaining to the proposed project features.

3.1 Horizontal and Vertical Control

The horizontal and vertical position of the existing permanent secondary monument, designated as TE-34-SM-04, was updated by the Pyburn and Odom GPS Survey Team. Two 5-hour static sessions were observed and corrected using NOAA's Online Positioning User Service (OPUS). The observed positions were comparable to both the published position and the Gulfnet Virtual Real Time Network (VRS) position. The published position of the monument is listed below. The survey monument data sheet can be found in Appendix A.

Lat. = 29°21'45.4779"N NAD83
Long. = 90°59'34.13005"W NAD83
EL = 2.99 ft NAVD88

3.2 Marsh Creation Fill Areas and Earthen Terrace Field

Survey transects were established at 500 foot survey intervals throughout the marsh creation fill areas and within the proposed earthen terrace field. Position, elevation and water depth were recorded every 25 feet along each transect and where there was an elevation change of greater than .5 feet. Several transects extended across Bayou Decade to aid in determining the location for earthen containment dikes along the bayou. This will enable the use of existing spoil banks to minimize the amount of material used in earthen containment dike construction. Additional transects were established outside of the limits of the fill sites to provide additional information if needed. The survey transects are shown on Sheet 11 in Appendix B (Survey Plan).

3.3 Magnetometer Survey

In order to locate the horizontal and vertical position of existing pipelines and other potential obstructions which could interfere with construction activities, the CPRA tasked Pyburn & Odom to perform a magnetometer survey in the project area. Data was collected using a G-881 Cesium marine magnetometer. Magnetometer lines were run within the borrow area, marsh creation fill areas, and earthen terrace field. Anomalies were observed, compiled, and compared to the CPRA's GIS pipeline database for verification.

3.4 Healthy Marsh Elevation Survey

A survey of the average marsh elevation in the project area was conducted near the proposed marsh creation fill areas. The survey consisted of at least 20 elevation shots taken in the different areas determined by CPRA biologists to be healthy marsh. The marsh elevation for each shot was defined as the point where the survey rod was resting among living vegetative stems and is supported by soil containing living vegetative roots. The average marsh elevation data along with the evaluation of healthy marsh in the area were used to assist in the determination of the target marsh elevation of +1.14 ft NAVD88.

4.0 GEOTECHNICAL INVESTIGATION

In order to determine the suitability of the soils in the TE-72 project area for the various proposed construction alternatives, a geotechnical subsurface investigation was performed by GeoEngineers and completed on August 26, 2011. GeoEngineers was tasked to collect geotechnical data and perform geotechnical engineering analyses to aid in the development of recommendations for marsh creation fill areas, earthen terracing, and hydrologic restoration features.

4.1 Soils Investigation

A total of 20 subsurface soil borings were drilled in the project area at locations shown in Figure 4. Four of the borings were taken in the proposed dredge borrow area sites, nine soil borings were taken in the proposed marsh creation fill areas and earthen terrace field, and seven soil borings were taken at locations for proposed weir removal and replacement.

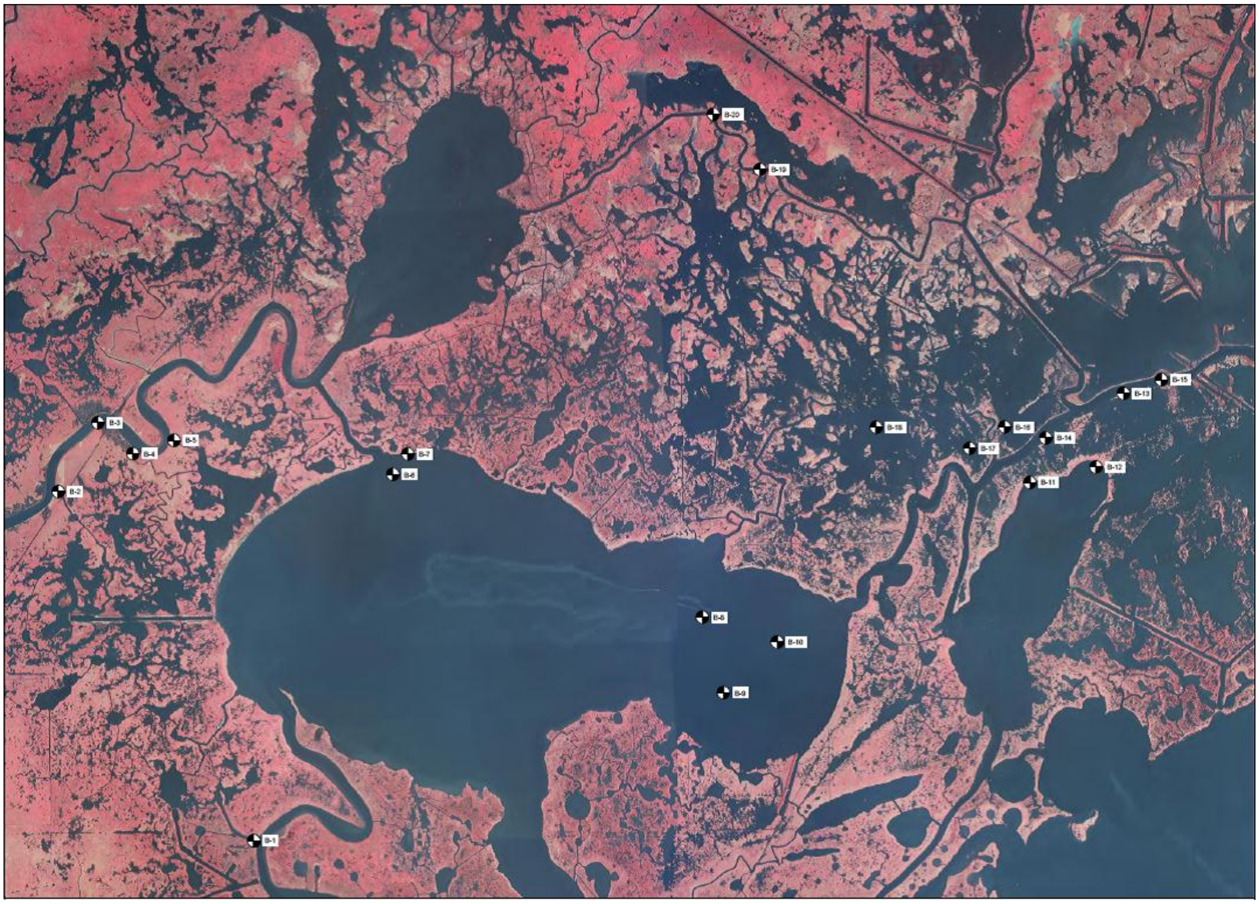

Figure 4: Soil Boring Locations

4.2 General Geologic Evaluation

The site is generally underlain by weak and highly compressible Delta Plain, Marsh deposits of Holocene Age (normally consolidated) to approximately Elev. -500 feet (+/-) NAVD88. More competent Pleistocene materials begin below that depth. The majority of the borings encountered very soft cohesive soil with varying amounts of organic matter. Layers of peat were encountered at a few of the borings at various depths. Several borings in the marsh creation fill areas encountered semi-cohesive and non-cohesive soils at intermittent depths. The detailed soil boring logs are presented in Appendix C.

4.3 Marsh Creation Settlement Analyses

The height of dredged material in a contained area is reduced by primary consolidation, secondary compression, and desiccation within the dredged fill, as well as settlement of soil beneath the fill. The consolidation settlement and time rate of settlement of the fill areas were determined using the Primary consolidation, Secondary consolidation, and Desiccation of Dredged Fill (PSDDF) program.

In addition to dredged material settlement, the soil beneath the marsh creation fill areas will consolidate from the additional weight added by the marsh fill material. This consolidation was calculated using load area dimensions and pressures consistent with the dredged fill. The sum of the dredged fill settlement and the underlying soil settlement was used to determine the total settlement of the marsh creation fill areas for the design life of 20 years. This process of settlement is shown in Figure 5.

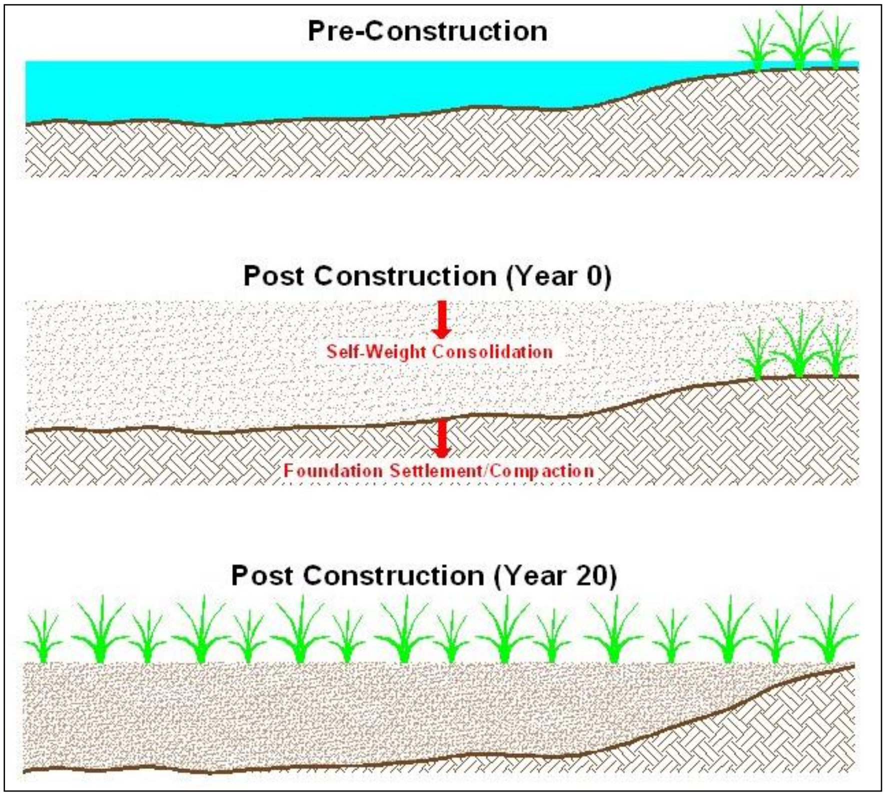

Figure 5: Marsh Fill Settlement

The goal of the project is to have the elevation of the marsh fill be intertidal as soon as possible while remaining intertidal for the 20 year life of the project. This target marsh elevation should also remain near the average healthy marsh elevation (+1.14 feet NAVD88) for the longest duration possible. Marsh creation fill area settlement estimates were initially evaluated for a one lift construction system utilizing construction marsh fill elevations of +2.0 feet, +2.5 feet, and +3.0 feet NAVD88. The settlement curve shown in Figure 6 represents the marsh fill elevation when constructed to +3.0 feet NAVD88 in Fill Area 1 using one initial lift. Also represented are the MHW, MLW, and healthy marsh elevations for the proposed marsh creation fill areas. This construction marsh fill elevation (CMFE) is the elevation of the top of the marsh fill upon construction acceptance. The construction acceptance period is typically 28-30 days following the completion of dredge material placement activities. This is also depicted as the marsh fill elevation at Target Year 0 (TY 0).

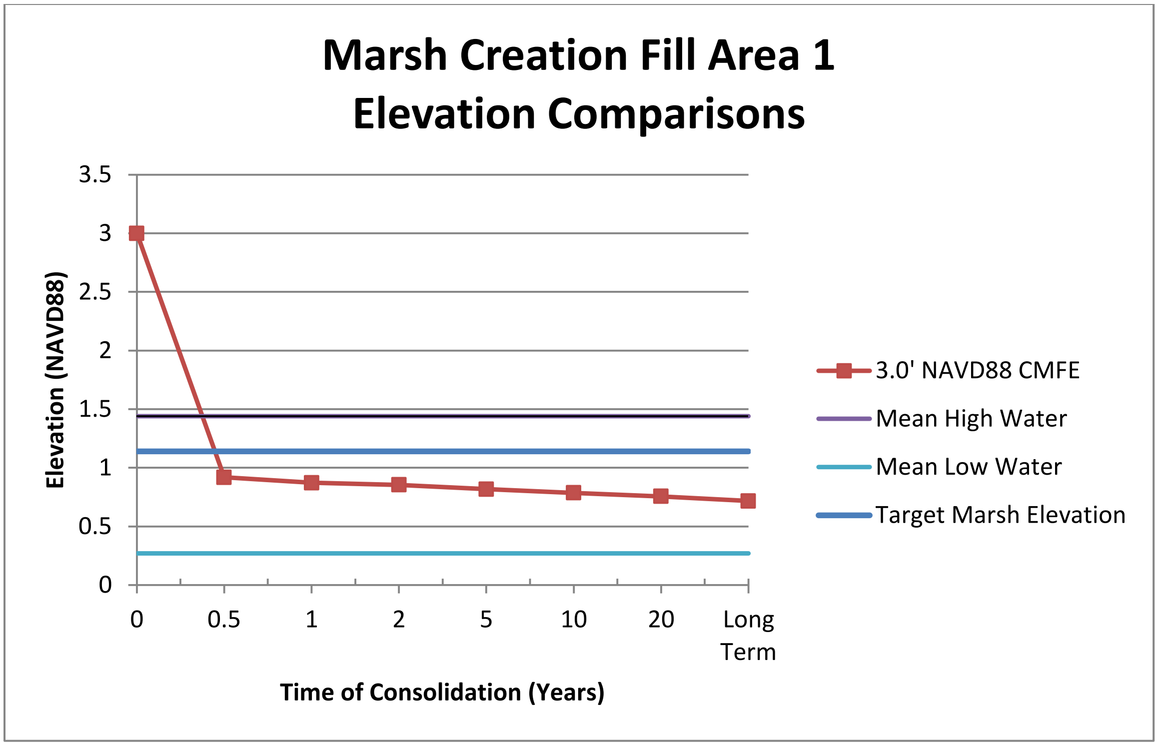

Figure 6: Settlement Curve – Marsh Creation Fill Area 1

For the evaluation shown in Figure 6, the elevation of the marsh creation fill area is predicted to be intertidal within the first 6 months post-construction and should remain intertidal for the 20 year life of the project. However, the marsh fill elevation is also predicted to be below the target marsh elevation for the entire project life which would not meet the goals established for the project. Therefore, additional geotechnical evaluations were performed to determine a marsh fill strategy that would achieve a desirable and sustainable marsh elevation.

Due to the lower marsh elevations over time using the one lift approach, the design team determined that a two lift marsh fill construction system would be needed to achieve marsh fill elevation project goals. GeoEngineers performed this evaluation with an initial construction marsh fill elevation of +1.5 feet NAVD88, followed by a 30 day waiting period to facilitate dewatering and initial consolidation. A second lift would then be placed to a maximum construction marsh fill elevation of +3.5 feet NAVD88. The settlement curve shown in Figure 7 represents this evaluation for marsh creation Fill Area 1. The settlement curves for all other marsh creation fill areas can be found in Appendix D.

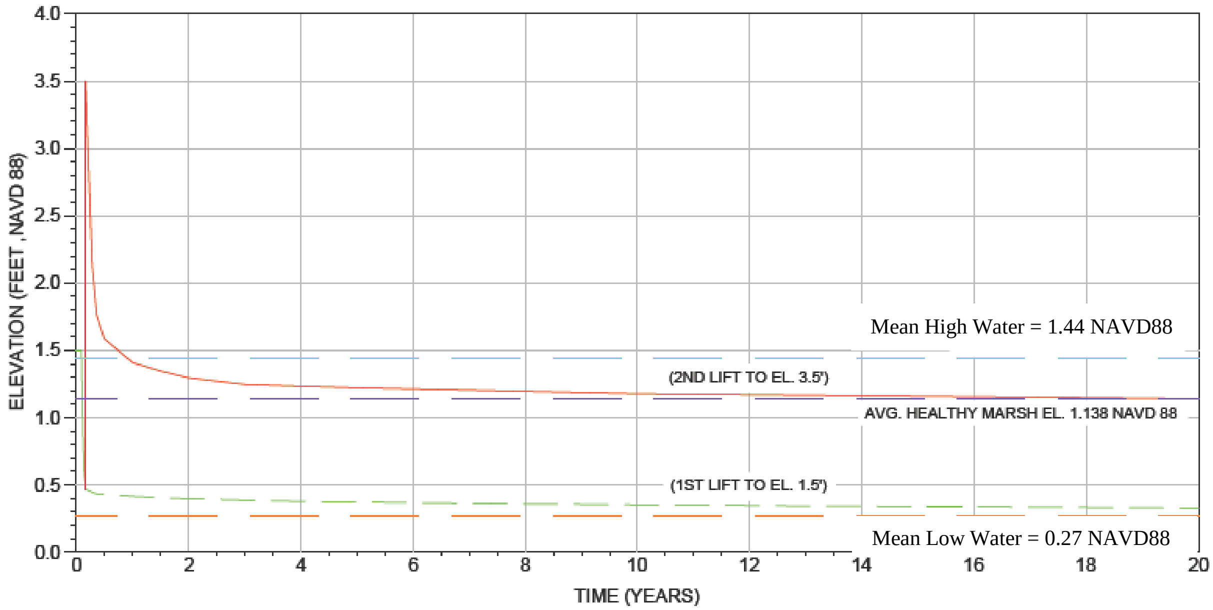

Figure 7: Two Lift Settlement Curve – Marsh Creation Fill Area 1

As shown on the two lift settlement curve, this construction method meets the goals of the project because the elevation of the marsh fill becomes intertidal within the first year post construction and remains intertidal for the 20 year project design life, while staying near the average healthy marsh elevation.

The Louisiana Applied Coastal Engineering and Science (LACES) Division of CPRA calculated a relative sea-level rise prediction for the TE-72 project area of 0.3209 meters (1.053 feet) by year 2033. This sea-level rise value was then applied to the current water levels and applied to the settlement curves (Figure 8). After accounting for RSLR, the proposed marsh creation fill area will remain intertidal for 17 years, which is 85% of the project's design life. It should be noted that RSLR does not account for the accretion of the marsh organics which could provide a positive elevation to the marsh fill area. However, an accretion rate has not been provided due to the lack of research near the project area.

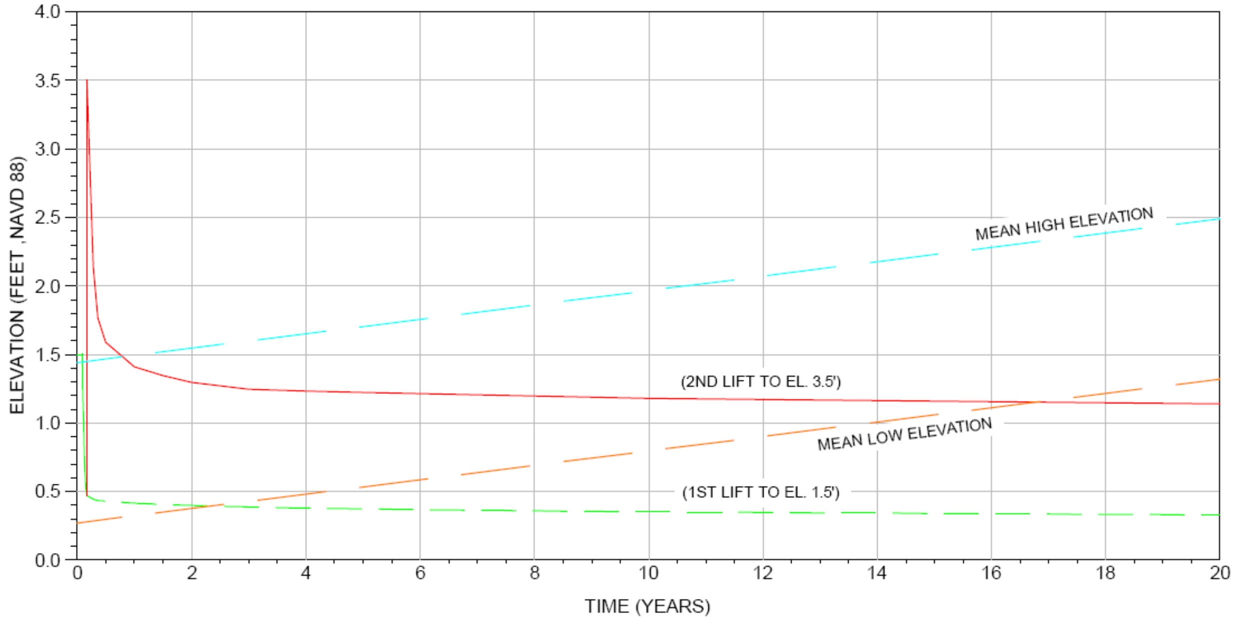

Figure 8: Two Lift Settlement Curve – Relative Sea Level Rise

5.0 MARSH CREATION DESIGN

This project proposes to create marsh by dredging and hydraulically pumping sediment from a borrow area in Lost Lake into the proposed marsh creation fill areas using hydraulic dredging techniques. The three components evaluated in this process are the borrow area, the marsh creation fill areas, and the earthen containment dikes.

5.1 Fill Area

The marsh fill portion of TE-72 has been delineated into four different marsh creation fill areas and one marsh nourishment area. These areas are located in open, shallow-water areas that border Bayou Decade to the northeast of Lost Lake (Figure 9) and on the northwestern lake rim of Lost Lake (Figure 10). The configuration of these marsh creation fill areas does not significantly vary from the original (Phase 0) layout.

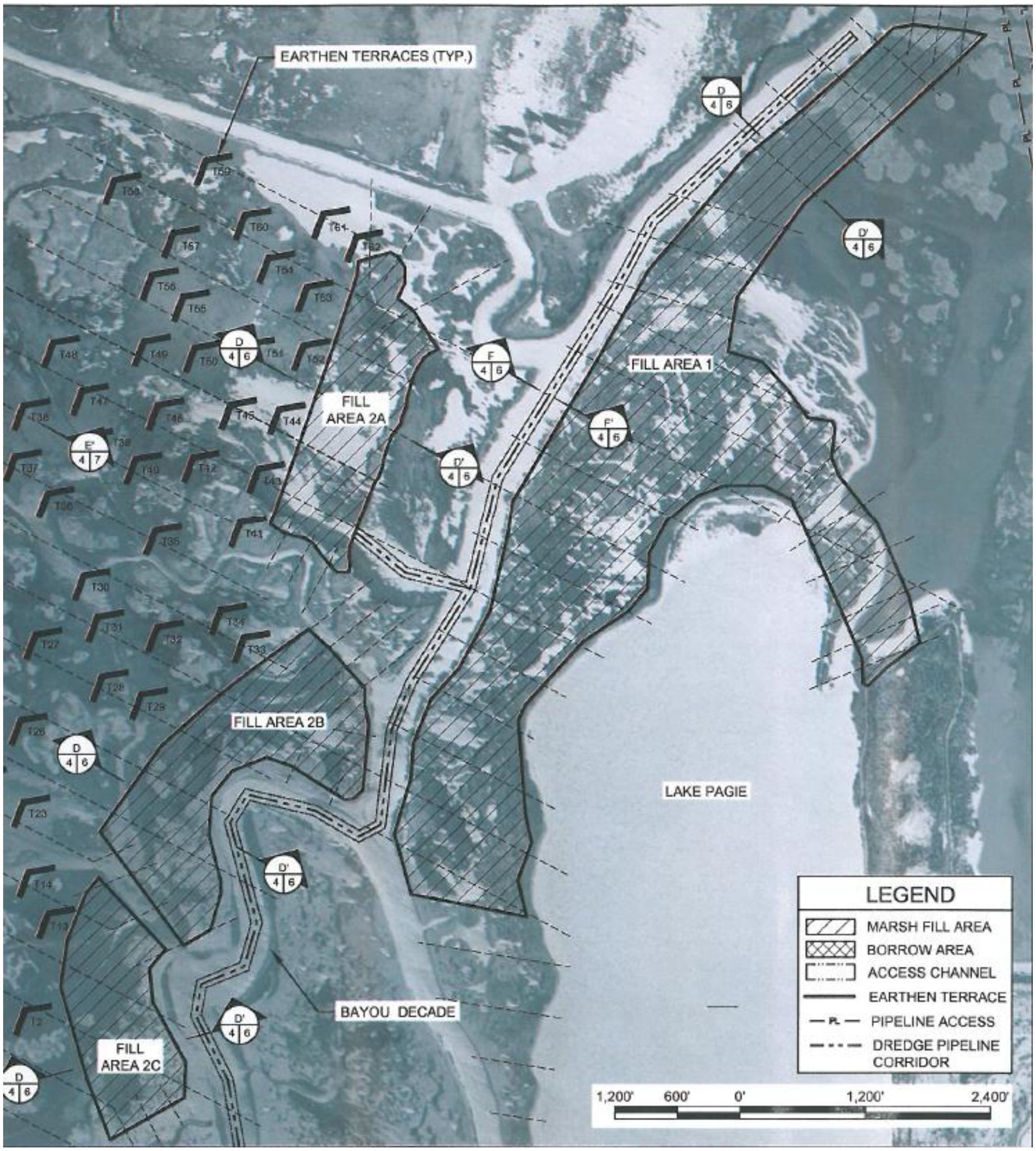

Figure 9: Marsh Creation Fill Area Layout – Fill Area 1, 2A, 2B, and 2C

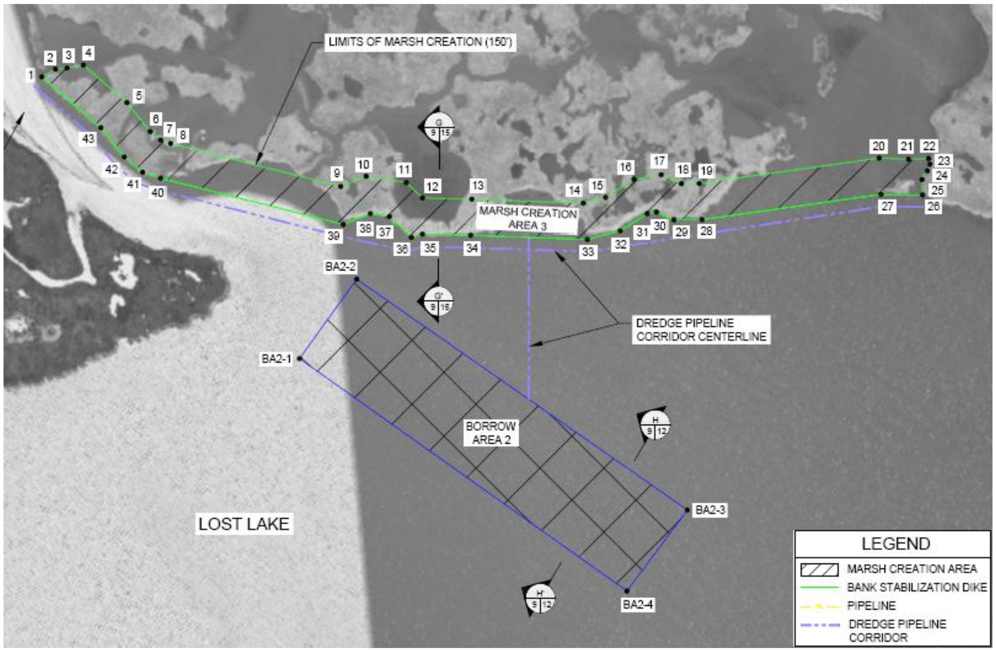

Figure 10: Marsh Creation Fill Area Layout – Fill Area 3

The key design component of the marsh creation fill areas is the estimated fill volume of material required to achieve the construction marsh fill elevation. This elevation was chosen based on the mean high water elevation, mean low water elevation, and target marsh elevation. The goal is to have the marsh elevation below Mean High Water (+1.44 feet NAVD88) shortly after construction and above Mean Low Water (+.27 feet NAVD88) at Year 20, while staying as close to the target marsh elevation (+1.14 feet NAVD88) for the longest period of time. Several fill elevations and techniques were evaluated, as described in Section 4.3, in order to determine the final construction marsh fill elevation. Marsh Creation Fill Areas 1, 2A, 2B, and 2C will be constructed to +1.5 feet NAVD88, followed by a 30 day minimum waiting period, and then constructed to +3.5 feet NAVD88. Using this two-lift construction methodology, each of these fill areas are expected to settle to an approximate elevation between +0.8 and +1.3 feet NAVD88 by Year 20, which will meet the goals of the project.

In order to optimize costs and improve constructability, Marsh Creation Fill Area 3 will be constructed without the use of containment dikes on the northern (landward) side of the fill area. This construction technique will eliminate the need of nearly 8,000 linear feet of earthen containment dikes. This unconfined flow will create approximately 13 acres of marsh at an elevation of approximately +2.0 feet NAVD88. This acreage will begin at the existing shoreline and extend approximately 150 feet northward. From this point, the marsh fill will begin a gradual slope, approximately 100H:1V until reaching the existing marsh elevation. The marsh fill material will be pumped from the nearby Borrow Area 2 (Figure 10) by the use of a small (10-12”) hydraulic dredge.

After determining the construction marsh fill elevations, the volume of material required for each fill site was calculated. Cross sectional areas of each transect in the fill sites were computed using the data collected in the marsh creation fill area survey described in

Section 3.2. The required in-place volume for each marsh creation fill area was then calculated using these areas. The estimated fill volumes needed for each fill area are shown below in Table 2.

Marsh Creation Fill Area	Area (Acres)	Volume of In-Place Marsh Fill (yds^3)
1	280	1,365,620
2A	50	305,554
2B	71	344,751
2C	41	215,973
3	13*	79,807
Total	**442**	**2,311,705**

* Not including marsh nourishment "runoff"

Table 2: Summary of Marsh Fill Acreage and In-Place Marsh Fill Volume

<u>5.2 Borrrow Area</u>

The controlling factors in the design of a borrow area are the location, size, and depth. It is ideal that the borrow area be located in close proximity to the marsh creation fill areas in order to minimize the pumping distance of the material. It is also more feasible that the borrow area be clear of any existing oyster leases, pipelines, and other obstructions. The borrow area chosen, Borrow Area 1, during the Phase 0 stage of the project satisfies all of these criteria.

The size of the borrow area is determined by the total volume of marsh fill required for the project. The borrow area should also provide sufficient latitude for the contractor to select the most effective area to dredge and access. A cut to fill ratio should be applied when placing hydraulically dredged material. This is to account for any lost material during the dredging and dewatering processes of construction. Based on past projects in the area under normal circumstances, it takes approximately 1.3 to 1.5 cubic yards of hydraulically removed material to fill 1.0 cubic yards in the placement area. For TE-72, a conservative 1.5:1 cut to fill ratio was applied to determine the cut volume in the borrow area. A summary of in-place fill and cut volumes for each marsh creation fill area is presented in Table 3.

Marsh Creation Fill Area	Volume of In-Place Marsh Fill (yds^3)	Volume of Cut (yds^3)
1	1,365,620	2,048,430
2A	305,554	458,331
2B	344,751	517,126
2C	215,973	323,959
3	79,807	119,710
Total	**2,311,705**	**3,467,556**

Table 3: Summary of In- Place Marsh Fill and Cut Volumes

In order to limit the ecological impacts to the existing environment, the depth of cut used during inshore hydraulic dredging projects is typically limited to an elevation of -15 feet NAVD88. The borrow area chosen during the Phase 0 stage of the project has an area of

448 acres. Cross sectional areas of each transect in the borrow area were calculated using the data collected in the borrow area survey. The available volume of material within this borrow area was then calculated using these areas. The chosen borrow area has approximately 7.5 million cubic yards of mostly cohesive material (soft clay with varying amounts of organic matter) available. Additional information is provided for the borrow area and is presented on the boring logs for B-6, B-8, B-9, and B-10 in Appendix C.

5.3 Earthen Containment Dikes (ECD)

The primary design parameters for earthen containment dikes include crown elevation, crown width, and side slopes. In order to prevent overtopping during construction, engineering judgment and experience on similar projects indicates that a minimum 1.0 foot of freeboard should exist between the top of the earthen containment dike and the maximum construction marsh fill elevation. With a maximum construction fill elevation of +3.5 feet NAVD88, the crown elevation for containment dikes will be +4.5 feet NAVD88. Based on slope stability analyses, GeoEngineers recommended side slopes of 4H:1V with a 15 foot berm width from the ECD toe to the borrow channel bank. The borrow channel will be excavated to a maximum depth of -10 feet NAVD88 with a 4H:1V side slope. A crown width of 4 feet is recommended for all earthen containment dikes. A typical cross section for the marsh creation fill areas and earthen containment dikes is shown in Figure 11.

Settlement analyses for this typical section indicate that the elevation of the earthen containment dike will provide at least 1.0 foot of freeboard as the earthen containment dike and marsh fill settle concurrently. If unexpected earthen containment dike settlement occurs, CPRA's construction specifications require that an adequate elevation of the earthen containment dike be maintained throughout the duration of construction by the contractor.

At Marsh Fill Area 3 a more robust earthen containment dike with a 10 foot crest width and 6H:1V side slopes will be constructed along the lake rim to an initial elevation of +3.5 feet NAVD88. This larger earthen containment dike is needed in order to preserve the existing shoreline and provide protection to the newly created marsh.

A mechanical dredging cut to fill ratio of 2.0:1 was applied to the calculated fill volumes. Table 4 provides the approximate lengths and volumes for earthen containment dikes.

Fill Area	Containment Length (ft)	In-Place Fill Volume (yds^3)	Cut Volume (yds^3)
1	27,962	159,646	319,292
2A	7,439	38,365	76,730
2B	9,278	40,876	81,752
2C	5,983	33,442	66,884
3	3,928	58,510	117,020
TOTAL	**54,590**	**330,839**	**661,678**

Table 4: Earthen Containment Dike Lengths and Volumes

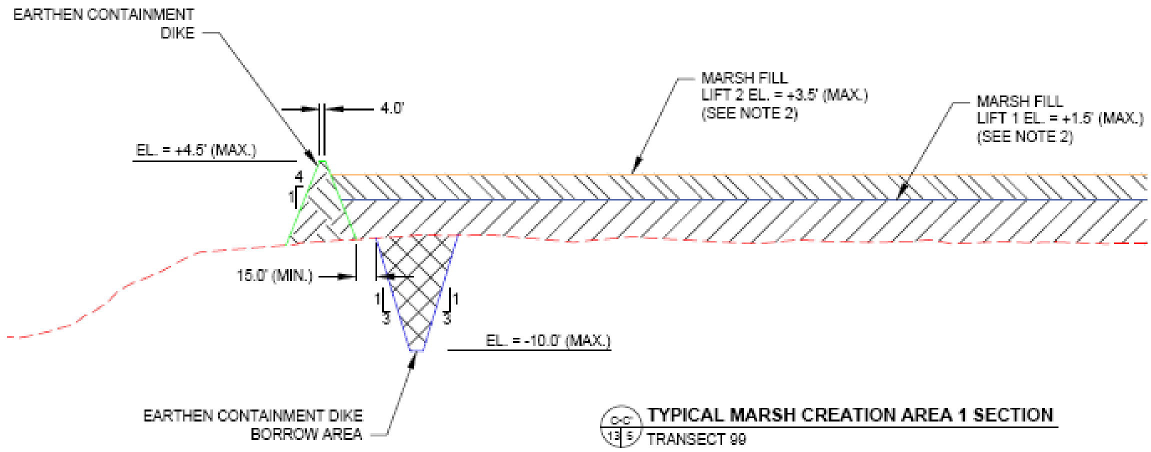

Figure 11: Typical Marsh Fill Area Cross Section

6.0 EARTHEN TERRACE DESIGN

Another proposed project feature is the construction of approximately 30,000 linear feet of earthen terraces. The earthen terraces will play a major role in creating edge habitat and allowing submerged aquatic vegetation to grow, while limiting fetch in open water areas.

The main design component of the earthen terrace field involves the development of the earthen terrace template. CPRA tasked GeoEngineers to conduct slope stability, settlement and bearing capacity analyses for an earthen terrace with a 10 foot crown width, 5H:1V side slopes, and +3.0 foot NAVD88 crown elevation. Based on calculations provided by GeoEngineers, a 15 foot berm will be needed from the toe of the earthen terrace to the adjacent borrow area bank. These analyses show that this typical cross section will provide a minimum factor of safety of 1.51, which is greater than the recommended 1.2. The earthen terraces are expected to have a maximum settlement of 12 inches by year 20 of the project life. This means that the crown elevation of the terraces will be approximately 0.5 feet above MHW for the majority of the project life.

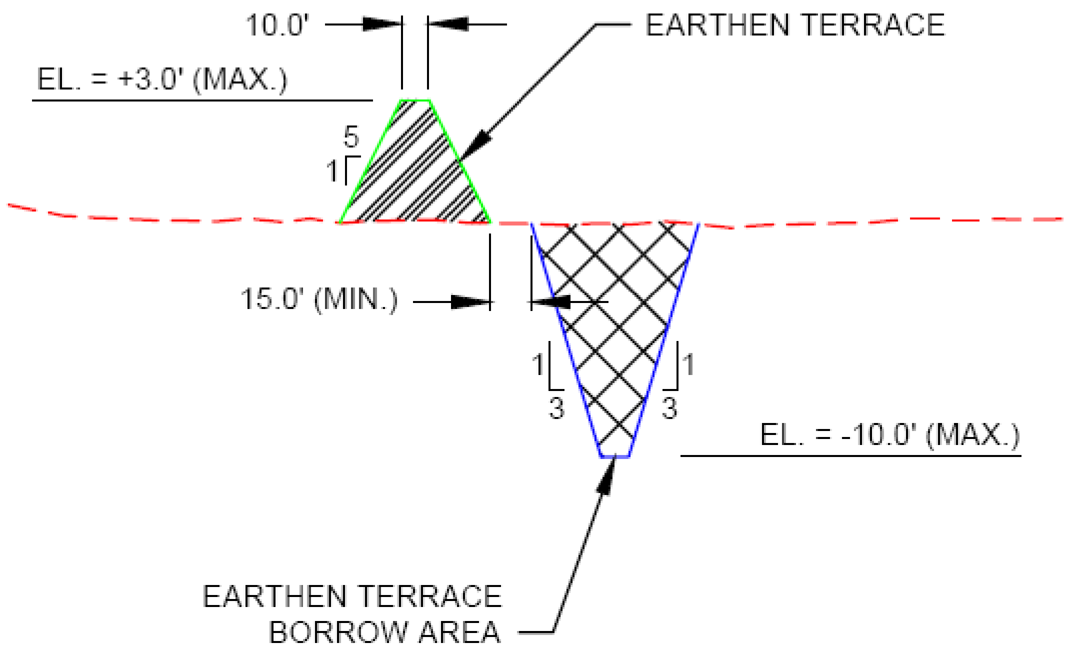

Figure 12: Typical Earthen Terrace Section

The earthen terraces will be oriented so that the footprints of each terrace will minimize impact to any existing vegetation. A "duck-wing" shape for each terrace was chosen to account for winds with varying directions. A typical cross section for the earthen terraces is shown in Figure 12 and the plan view layout of the terraces is shown in Figure 13.

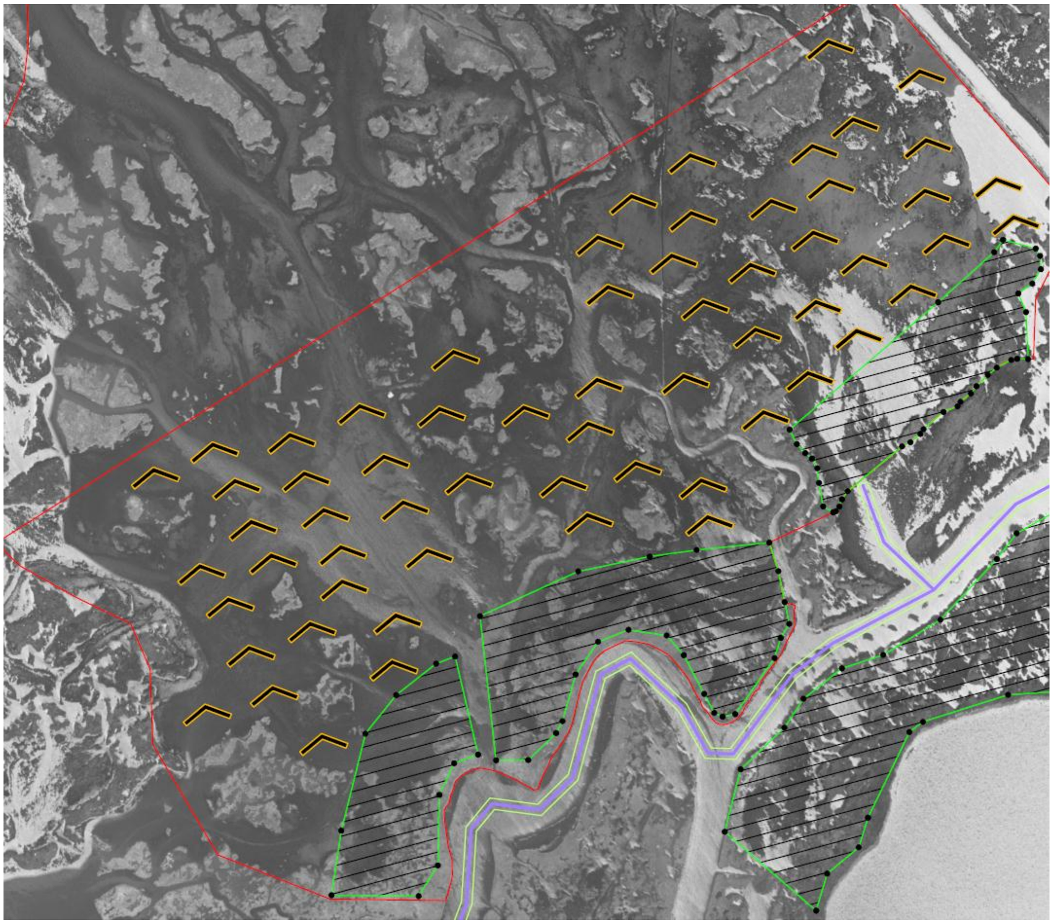

Figure 13: Earthen Terrace Layout

6.1 Vegetative Plantings

Each earthen terrace will be planted in order to promote growth and to protect the newly created terrace. Two rows of smooth cordgrass will be planted on a 3-foot spacing in the intertidal region on each side of all terraces. Two rows of seashore paspalum will be planted along the crest of each terrace with five-foot spacing between each plant.

7.0 HYDROLOGIC RESTORATION

The interior marsh areas to the west and the north of Lost Lake have been identified as areas that could benefit from increased freshwater flow from sources north of the project area. These areas contain numerous fixed crest weir structures that contribute to the declining health of the existing marsh. Six of these weirs, as well as two earthen plugs, in the TE-72 project area were recommended for replacement during Phase 0 in order to increase the delivery of freshwater from the north into the degrading marshes near Lost Lake (Figure 1). Topographic survey data were collected for thirteen structures in the area so that all could be considered for replacement.

Following Preliminary (30%) Design, five sites were chosen for Final Design. These sites include WC-1, WC-4, WC-5, WC-6, and newly established Site-1. Site-1 is located on Little Carencro Bayou where an earthen plug limits the flow of water from the bayou into the interior marsh to the south. These sites are shown in Figures 15 and 16. The structures at sites WC-3, WC-12, and WC-13 have been eliminated from consideration during final design due to lack of benefit, contractor access, and other constructability issues.

The Phase 0 goal was to replace the existing structures with variable crest weirs in order to improve hydrologic connectivity while preserving the ability to control water levels within the interior marsh during certain times of the year. An existing fixed crest structure in the project area is shown in Figure 14.

Figure 14: Existing Fixed Crest Weir (WC-3)

In April 2011, four continuous water level data recorders were installed in the project area. Two recorders (TE-72-01 and TE-72-02) were installed west of Lost Lake in the vicinity of structures WC-1, WC-4, WC-5 and WC-6; and two recorders (TE-72-03, and TE-72-04) were installed north of Lost Lake in the vicinity of the new structure at Site-1. The locations of these recorders are shown below in Figures 15 and 16.

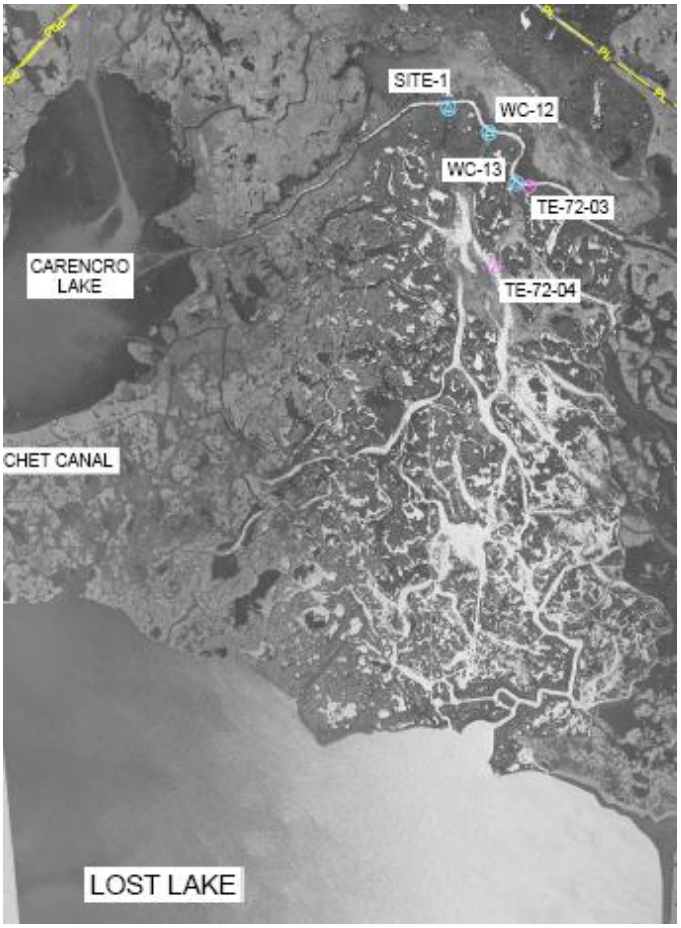

Figure 15: Data Collection Stations and Existing Structures North of Lost Lake

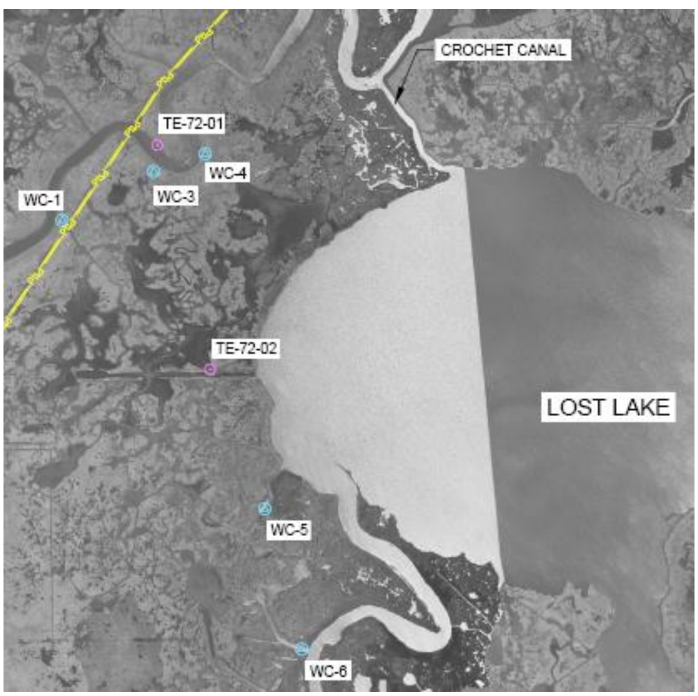

Figure 16: Data Collection Stations and Existing Structures West of Lost Lake

Water levels were recorded simultaneously at fifteen minute intervals for a period of twelve months in order to get a difference in water levels between the two corresponding recorders. The differences in water levels can be used to calculate the head differential across each proposed structure. Positive head differentials reflect that the water levels outside the interior marsh are higher than those within the interior marsh. Since flows move in the direction of the lower water level, the flows are oriented so that positive flow rates are entering the interior marsh and negative flow rates are exiting the interior marsh.

7.1 Flow Calculations

After analyzing the water level information, a basic sharp-crested weir equation was used to compute the flow rate over the existing and proposed structures. A summary of the existing flow rates is shown in Tables 5. Structures WC-9, WC-11, WC-12, and WC-13 are earthen plugs that do not allow any flow.

	Average Flow (cfs)	Average Positive Flow (cfs)	Max Positive Flow (cfs)	Average Negative Flow (cfs)	Max Negative Flow (cfs)
WC-1	1	28	350	27	497
WC-4	0	7	182	7	260
WC-5	229	610	1,981	380	1,675
WC-6	(2)	39	564	42	803
Site-1 (Earthen Plug)	0	0	0	0	0

Table 5: Existing Fixed Crest Weir Flow Rates

7.2 Proposed Weir Design

The proposed weirs will consist of a variable number of bays (each 5-ft wide) with an invert elevation of -2.5ft NAVD88. The weir crest will have a top elevation of +3.0ft with sheet pile wing walls extending into the left and right channel banks. In cases where the upstream water surface exceeds the height of the weir, flow will crest these wing walls at an elevation of 3.0ft. A rectangular weir equation will be used to determine this remainder of flow over the crest and will be added to the flow through the bays in order to arrive at the total flow. In order to satisfy the needs of the landowner, stoplogs will be placed in the structures during the waterfowl season. These stoplogs will be placed to elevation 0.0 ft. to maintain interior marsh water levels. The proposed flow rates shown below in Table 6 were calculated under the assumption that the head differential does not change as water enters or exits the system.

	WC-1	WC-4	WC-5	WC-6	Site-1
Weir Length = # bays @ 5' ea	50'	20'	50'	70'	35'
Average Positive Flow (cfs)	489	193	489	687	186
Maximum Positive Flow (cfs)	1,034	451	1,012	1,422	405
Average Negative Flow (cfs)	450	177	450	632	274
Maximum Negative Flow (cfs)	1,469	639	1,433	1,992	1,135
Maximum Velocity (fps)	5.6	5.5	5.6	5.7	4.3
Average Positive Flow (cfs) Feb 1 – Oct 31	485	191	485	681	190

Table 6: Proposed Variable Crest Weir Flow Rates

After comparing the proposed weir flow rates (Table 6) with the existing weir flow rates (Table 5), a significant increase in flow rates both into and out of the interior marsh was noticed, with the exception of structure WC-5. It was noticed during a site visit to WC-5 that the existing weir has blown out and is no longer functioning as intended, thus creating the higher than expected flowrates.

In order to facilitate flows, the channels will be regraded in the area of the proposed weir structures with 3H:1V side slopes extending from the top bank of the existing channel down to -7.0ft NAVD88. Consideration was given to the increase in velocity through the channel and the potential for unwanted scour/erosion. To resist the maximum velocity of 5.7 feet per second through the open bays of the structure, a two foot thick rip rap (55#) blanket will be placed along the weir structure and will extend 15 feet on the interior and exterior of the structure.

8.0 COST ESTIMATE

A cost estimate (Table 7) for the TE-72 project was completed using the CWPPRA PPL 22 Engineering Work Group cost spreadsheet. Mobilization and demobilization costs include the use of a small dredge accessing Borrow Area 2 to construct Marsh Fill Area 3. Item No. 6 Water Control Structures includes the cost to remove the existing weir structure and install all proposed variable crest weir structures discussed in Section 7.2. The hydraulic dredging and marsh nourishment quantities are cut quantities. The duration of construction has been estimated to be 346 days. An estimated construction schedule and all necessary assumptions can be found in Appendix F.

Project:	Lost Lake Marsh Creation and Hydrologic Rest.	Date:	9-Oct-12	Revised:	
Computed by:	T. Byland	*Project Priority List 22* (ver.071012)			
Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization/Demobilization	1	LS	$2,878,000	$2,878,000
2	Marsh Creation	3,347,846	CY	$3.75	$12,554,423
3	Marsh Nourishment	119,710	CY	$3.75	$448,913
4	Containment Dikes	661,678	CY	$3.50	$2,315,873
5	Terraces	315,981	CY	$4.00	$1,263,924
6	Water Control Structures (5)	1	LS	$1,851,444	$1,851,444
7	Containment Dike Gapping	8,846	CY	$3.50	$30,960
8	Tidal Creeks (via marsh buggy tracking)	2	Days	$3,800	$7,600
9	Terrace Plantings-Smooth Cordgrass	40,748	EA	$3.00	$122,244
10	Terrace Plantings-Seashore Paspalum	12,200	EA	$5.00	$61,000
11	Warning Signs	10	EA	$2,000	$20,000
12	Construction Surveys	1	LS	$461,638.40	$461,638
	ESTIMATED CONSTRUCTION COST				**$22,016,019**
	ESTIMATED CONSTRUCTION + 25% CONTINGENCY				**$27,520,023**

Table 7: Construction Cost Estimate

9.0 MODIFICATIONS FROM THE PHASE 0 and 30% PROJECT

All project features, which include marsh creation/nourishment, earthen terraces, and the four water control structures west of Lost Lake, remain essentially unchanged from the Phase 0 project. Slight changes were made to the boundaries of the marsh creation fill areas to adjust to current conditions and to improve the constructability of the marsh creation fill area.

During Preliminary (30%) Design the project team decided that only two water control structures will be installed to benefit the area north of Lost Lake as compared to the replacement of four structures as proposed in the Phase 0 project. As the project progressed through Final (95%) Design, it was decided that only one variable-crest weir would be constructed north of Lost Lake at Site-1. Four structures (WC-1, WC-4, WC-5, WC-6) will be replaced with variable crest weirs on the western side of Lost Lake.

10.0 REFERENCES

GeoEngineers, Inc. *Geotechnical Engineering Report for Lost Lake Marsh Creation and Hydrologic Restoration Project (TE-72)* Baton Rouge, LA. August 2011.

Pyburn and Odom, Inc. *Survey Report for Lost Lake Marsh Creation and Hydrologic Restoration Project (TE-72).* Baton Rouge, LA. May 2011.

United States Army Corps of Engineers, EM 1110-2-5027. *Confined Disposal of Dredged Material.* Washington, D.C. 1987.

DeMarco, K. E., J. Mouton., J. W. Pahl. (January 2012 Version). Recommendations for Anticipating Sea-level Rise impacts on Louisiana Coastal Resources on Project Planning and Design: Technical Report {HYPERLINK “"http://www.lacpra.org/assets/docs/LACES/LACEStech02_06_.pdf”}.

Sigma Consulting Group, Inc. *Technical Memorandum – Proposed Variable Crest Weir Structures.* Lost Lake Marsh Creation and Hydrologic Restoration Project (TE-72). September 2012.