# Appendix A

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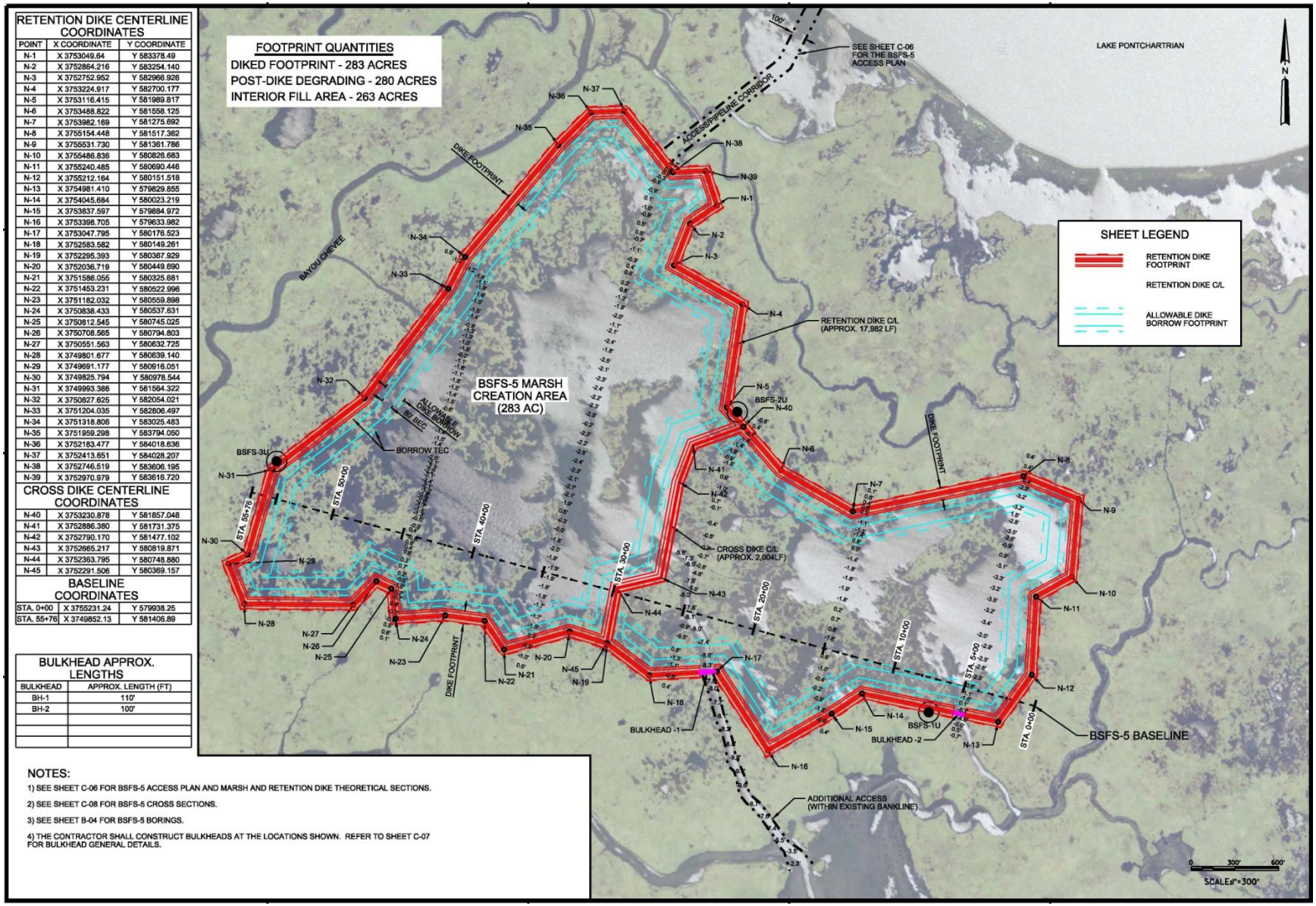



| RETENTION DIKE CENTERLINE COORDINATES | | |
|---|---|---|
| POINT | X COORDINATE | Y COORDINATE |
| N-1 | X 3753049.64 | Y 583378.49 |
| N-2 | X 3752864.216 | Y 583254.140 |
| N-3 | X 3752752.952 | Y 582966.926 |
| N-4 | X 3753224.917 | Y 582700.177 |
| N-5 | X 3753116.415 | Y 581989.817 |
| N-6 | X 3753488.822 | Y 581558.125 |
| N-7 | X 3753982.169 | Y 581275.692 |
| N-8 | X 3755154.448 | Y 581517.362 |
| N-9 | X 3755531.730 | Y 581361.786 |
| N-10 | X 3755486.836 | Y 580826.683 |
| N-11 | X 3755240.485 | Y 580690.446 |
| N-12 | X 3755212.164 | Y 580151.518 |
| N-13 | X 3754981.410 | Y 579829.855 |
| N-14 | X 3754045.684 | Y 580023.219 |
| N-15 | X 3753837.597 | Y 579884.972 |
| N-16 | X 3753398.705 | Y 579633.982 |
| N-17 | X 3753047.795 | Y 580176.523 |
| N-18 | X 3752583.582 | Y 580149.261 |
| N-19 | X 3752295.393 | Y 580367.929 |
| N-20 | X 3752036.719 | Y 580449.690 |
| N-21 | X 3751586.055 | Y 580325.681 |
| N-22 | X 3751453.231 | Y 580522.996 |
| N-23 | X 3751182.032 | Y 580559.898 |
| N-24 | X 3750838.433 | Y 580537.631 |
| N-25 | X 3750812.545 | Y 580745.025 |
| N-26 | X 3750708.565 | Y 580794.803 |
| N-27 | X 3750551.563 | Y 580632.725 |
| N-28 | X 3749801.677 | Y 580639.140 |
| N-29 | X 3749691.177 | Y 580916.051 |
| N-30 | X 3749825.794 | Y 580978.544 |
| N-31 | X 3749993.386 | Y 581564.322 |
| N-32 | X 3750627.625 | Y 582054.021 |
| N-33 | X 3751204.035 | Y 582806.497 |
| N-34 | X 3751318.806 | Y 583025.483 |
| N-35 | X 3751959.298 | Y 583794.050 |
| N-36 | X 3752183.477 | Y 584018.636 |
| N-37 | X 3752413.651 | Y 584028.207 |
| N-38 | X 3752746.519 | Y 583606.195 |
| N-39 | X 3752970.979 | Y 583616.720 |
| CROSS DIKE CENTERLINE COORDINATES | | |
| N-40 | X 3753230.878 | Y 581857.048 |
| N-41 | X 3752886.380 | Y 581731.375 |
| N-42 | X 3752790.170 | Y 581477.102 |
| N-43 | X 3752665.217 | Y 580819.871 |
| N-44 | X 3752363.795 | Y 580748.880 |
| N-45 | X 3752291.506 | Y 580369.157 |
| BASELINE COORDINATES | | |
| STA. 0+00 | X 3755231.24 | Y 579938.25 |
| STA. 55+76 | X 3749852.13 | Y 581406.89 |

| BULKHEAD APPROX. LENGTHS | |
|---|---|
| BULKHEAD | APPROX. LENGTH (FT) |
| BH-1 | 110' |
| BH-2 | 100' |
| | |
| | |
| | |

NOTES:

1) SEE SHEET C-06 FOR BSFS-5 ACCESS PLAN AND MARSH AND RETENTION DIKE THEORETICAL SECTIONS.

2) SEE SHEET C-08 FOR BSFS-5 CROSS SECTIONS.

3) SEE SHEET B-04 FOR BSFS-5 BORINGS.

4) THE CONTRACTOR SHALL CONSTRUCT BULKHEADS AT THE LOCATIONS SHOWN. REFER TO SHEET C-07 FOR BULKHEAD GENERAL DETAILS.

Figure 1: Bayou Sauvage Flood Side Brackish Marsh Restoration Project, BSFS5 Feature

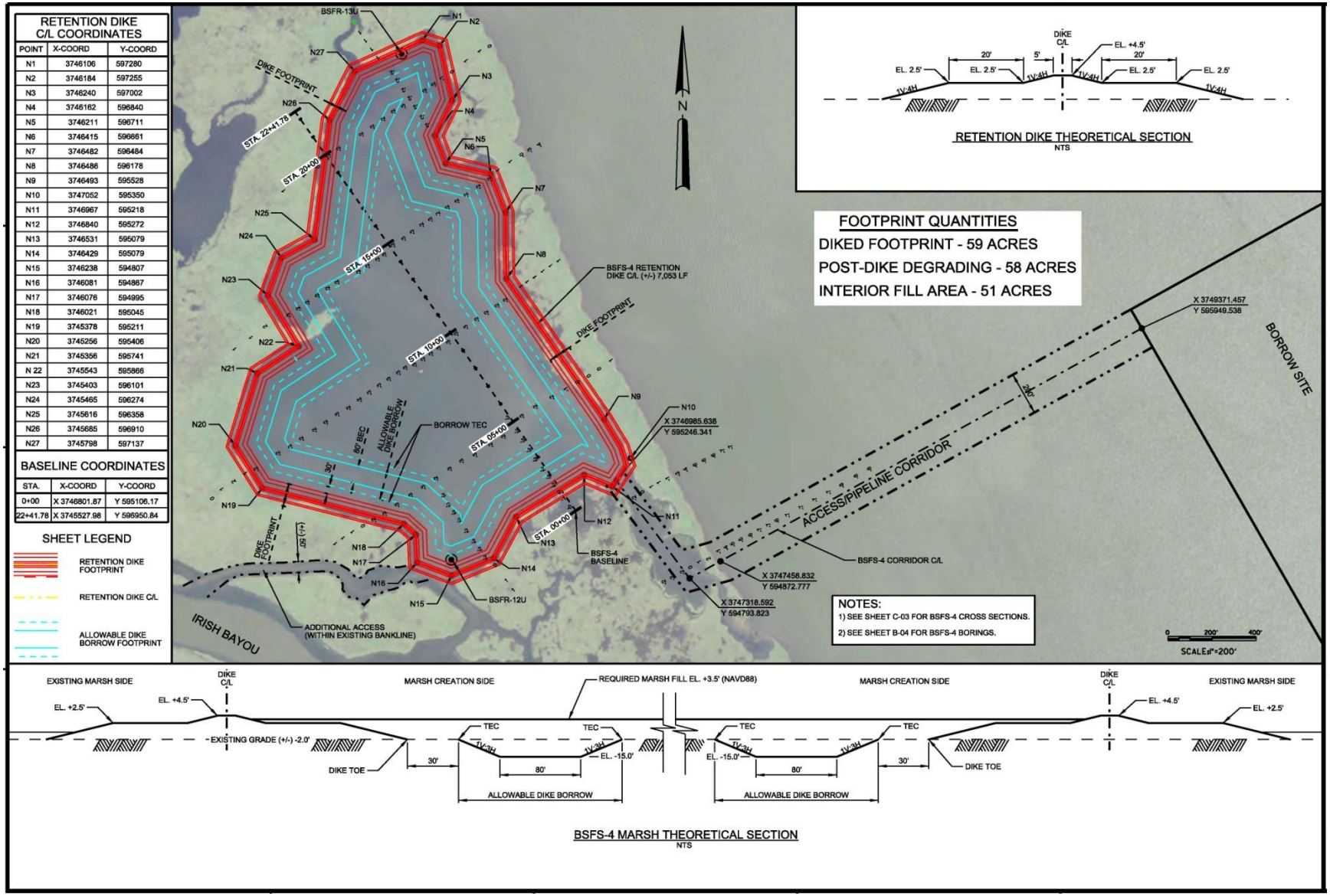



Figure 2: Bayou Sauvage Flood Side Brackish Marsh Restoration Project, BSFS4 Feature

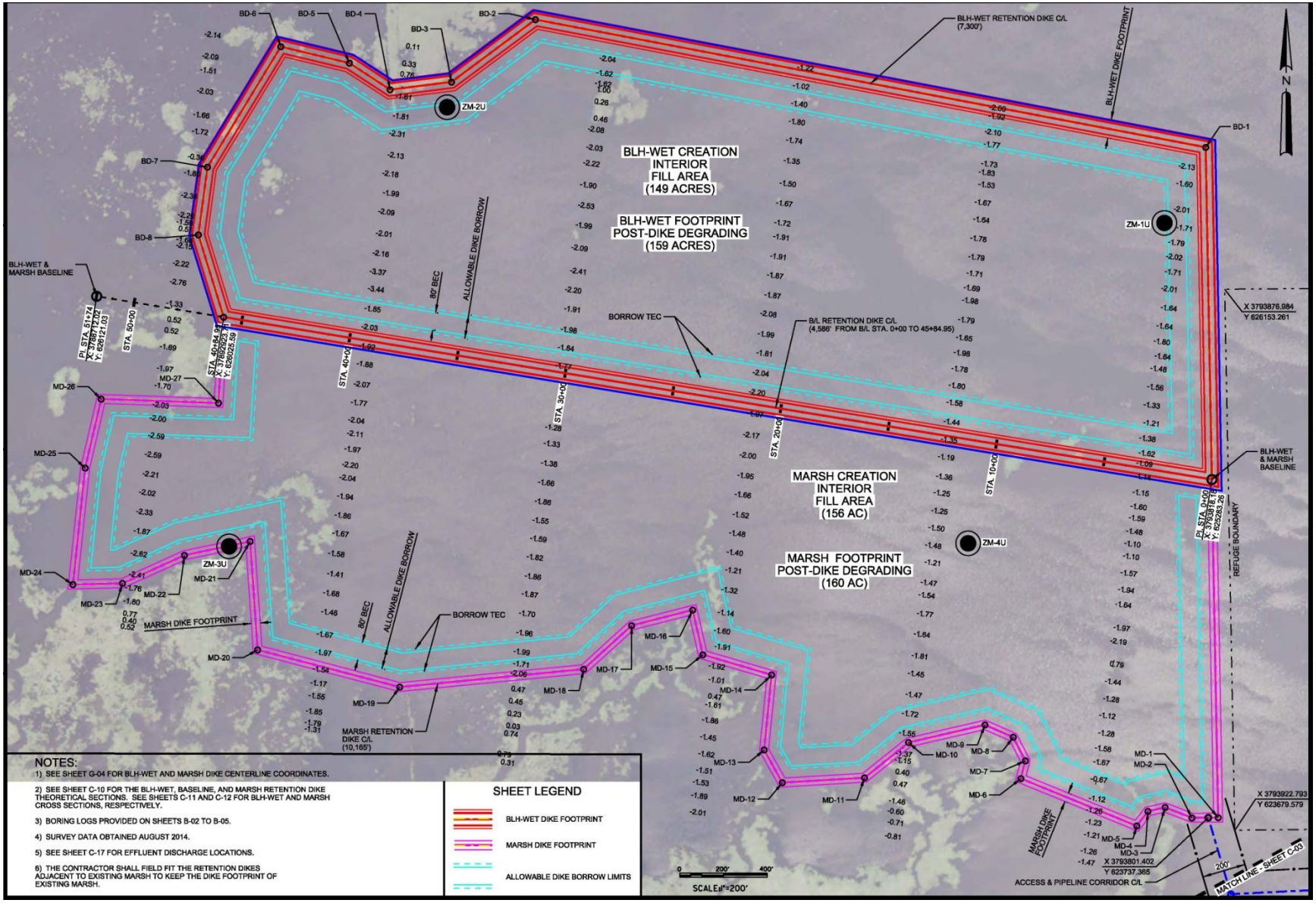



Figure 3: New Zydeco Ridge Brackish Marsh and BLH-Wet Projects

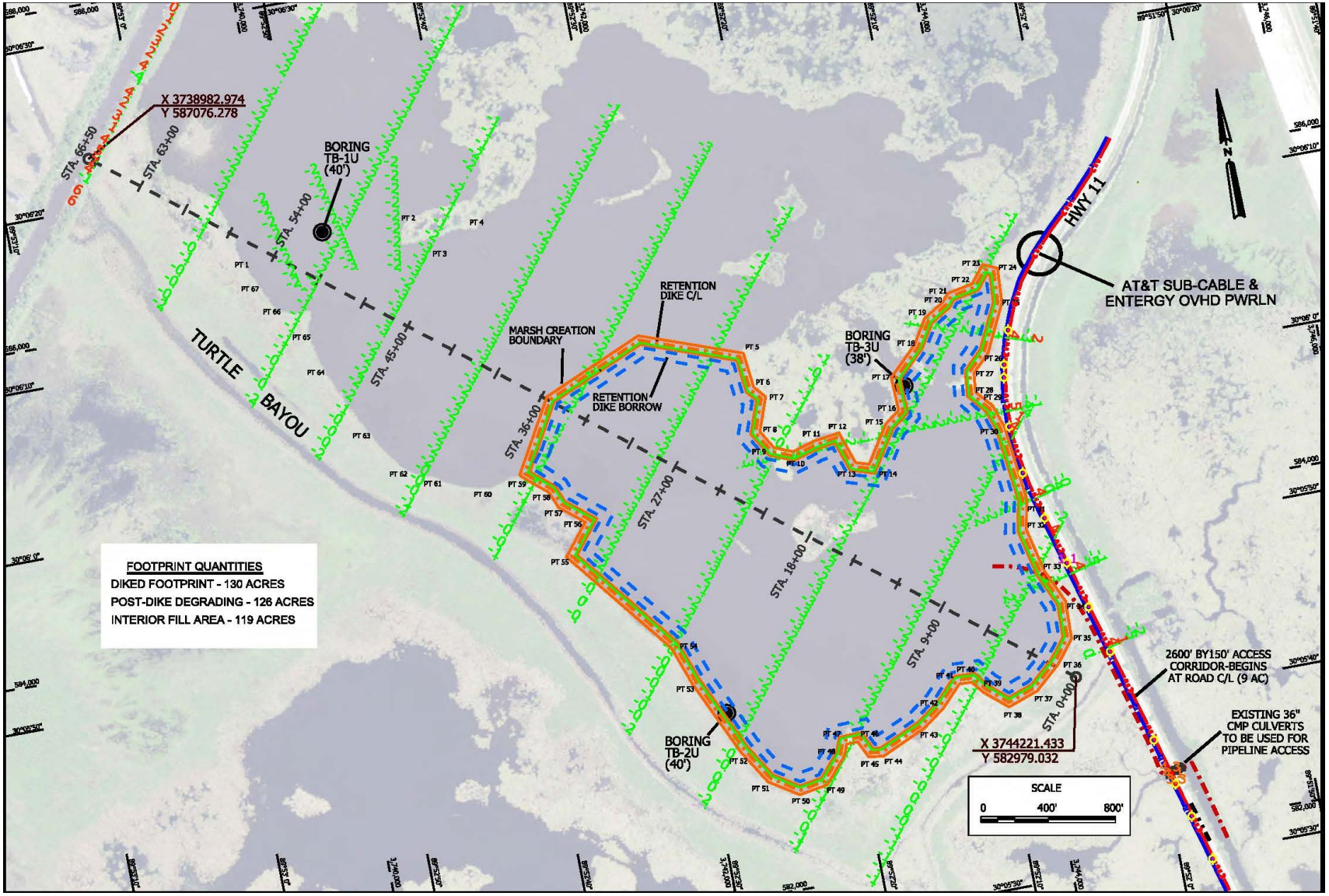



Figure 4: Turtle Bayou Protected Side Intermediate Marsh Project

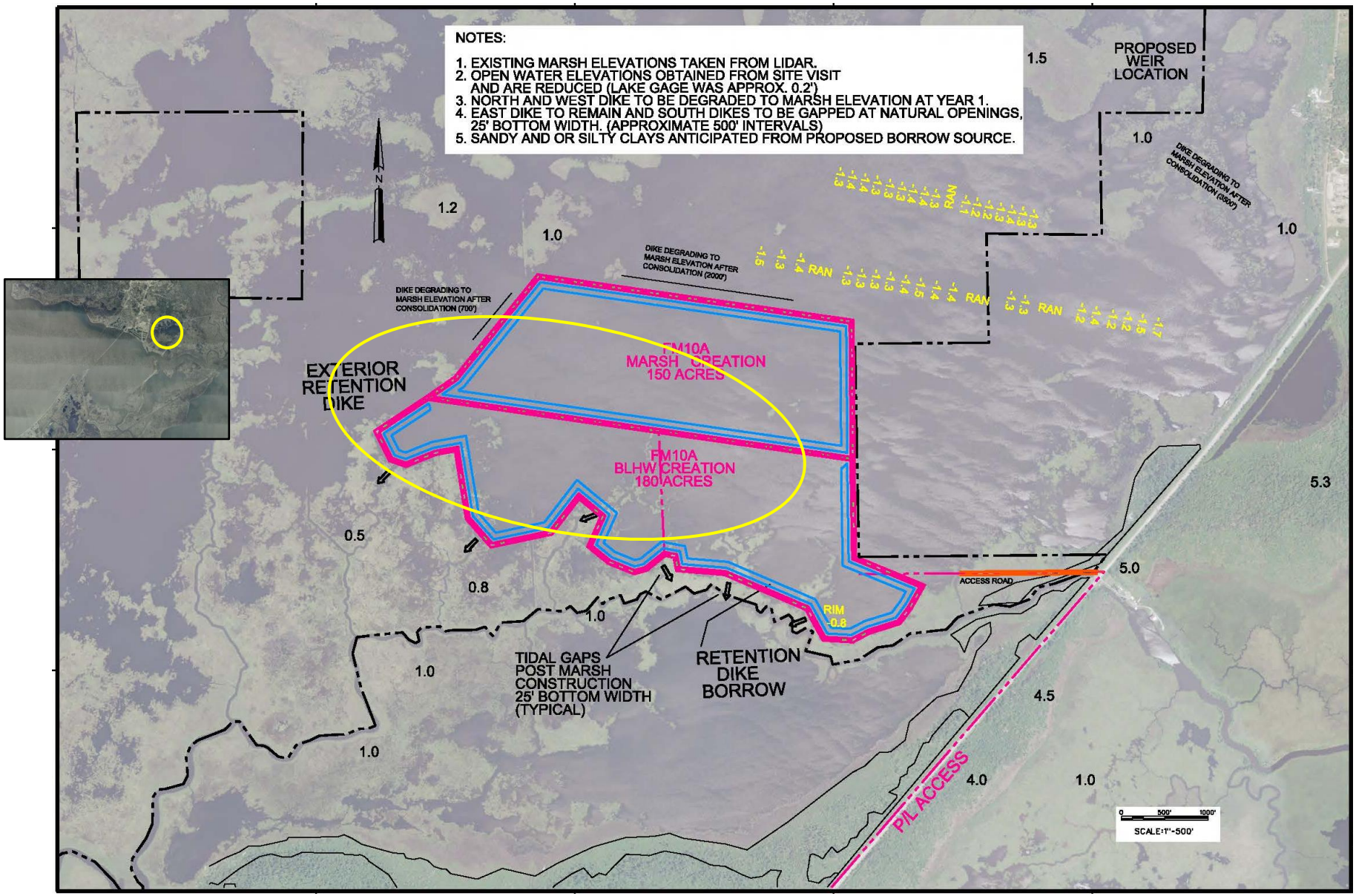


Figure 5. Bottomland Hardwood Option: New Zydeco Ridge

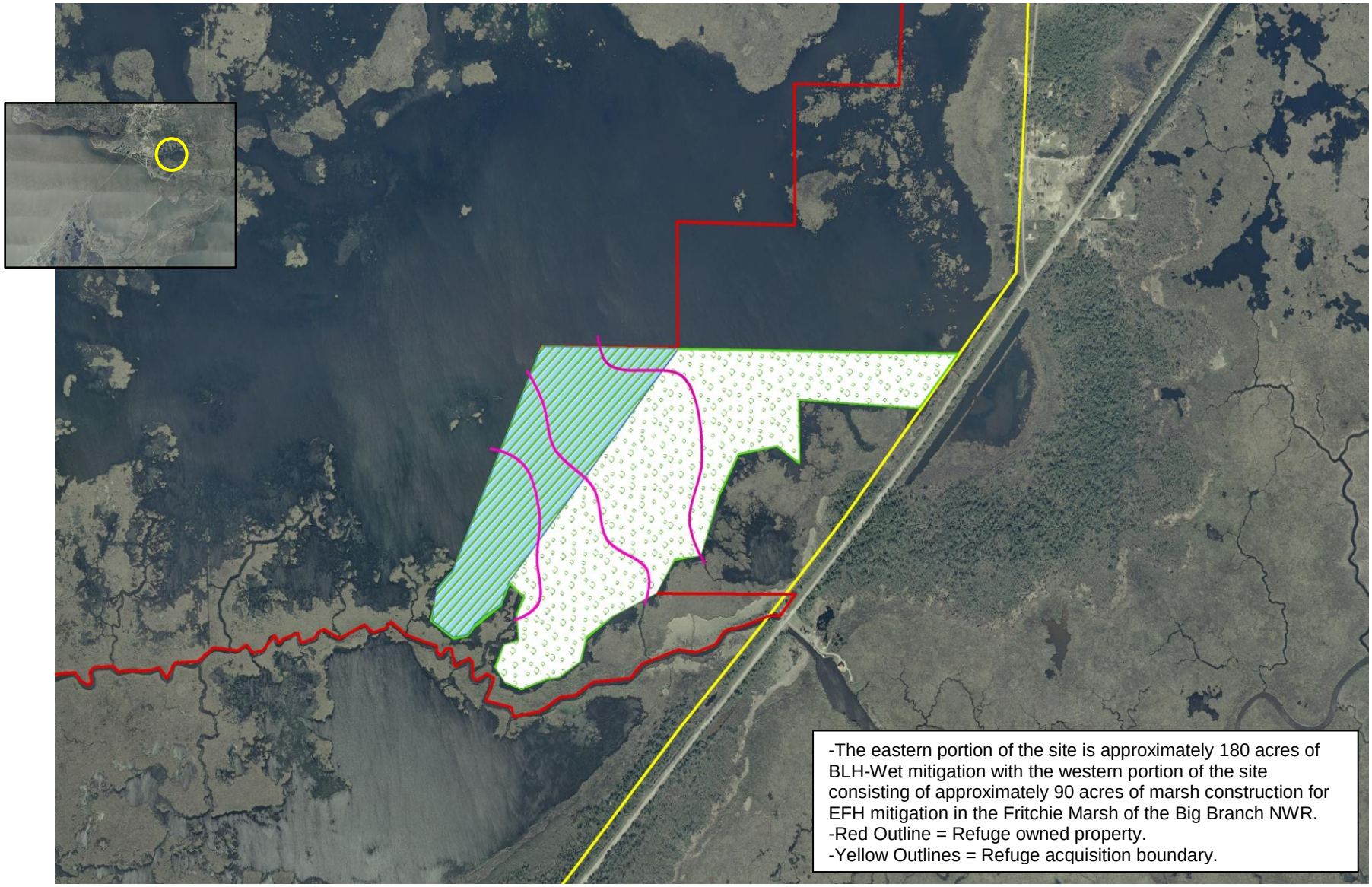



Figure 6. Bottomland Hardwood Option: Salt Bayou Private

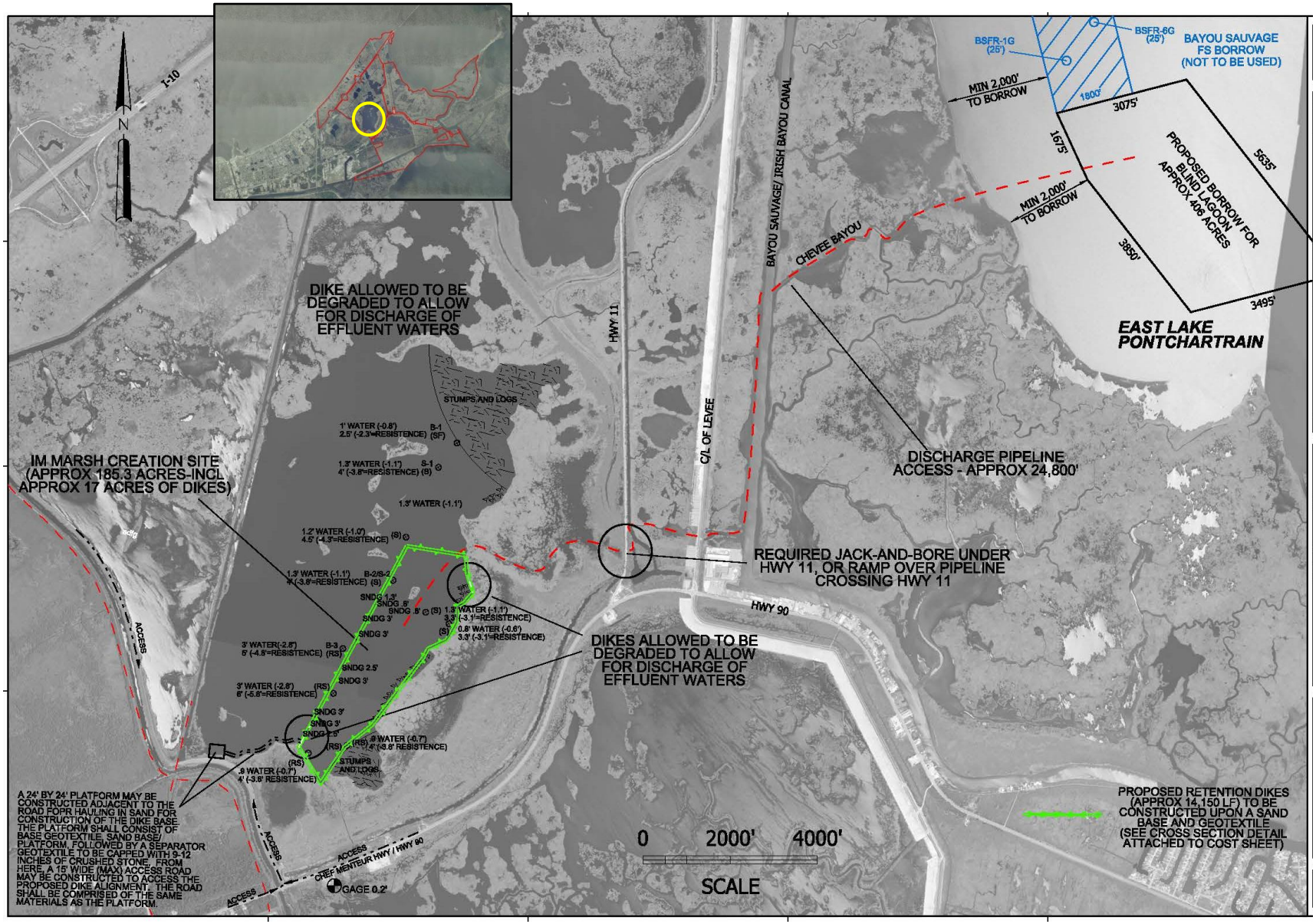



Figure 7. Fresh/Intermediate Marsh Option: Blind Lagoon, Protected-Side

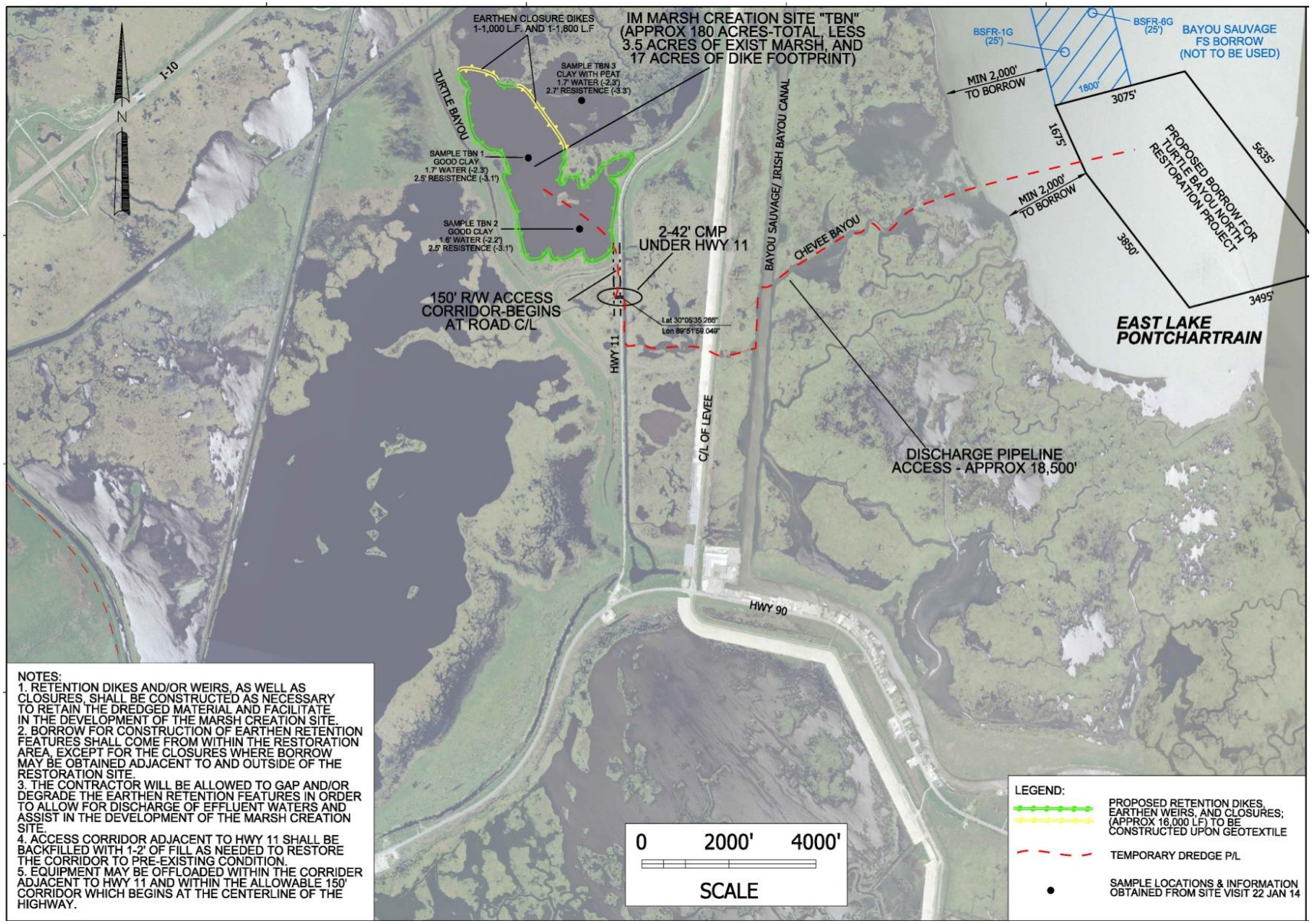



Figure 8. Fresh/Intermediate Marsh Option: Turtle Bayou North, Protected-Side

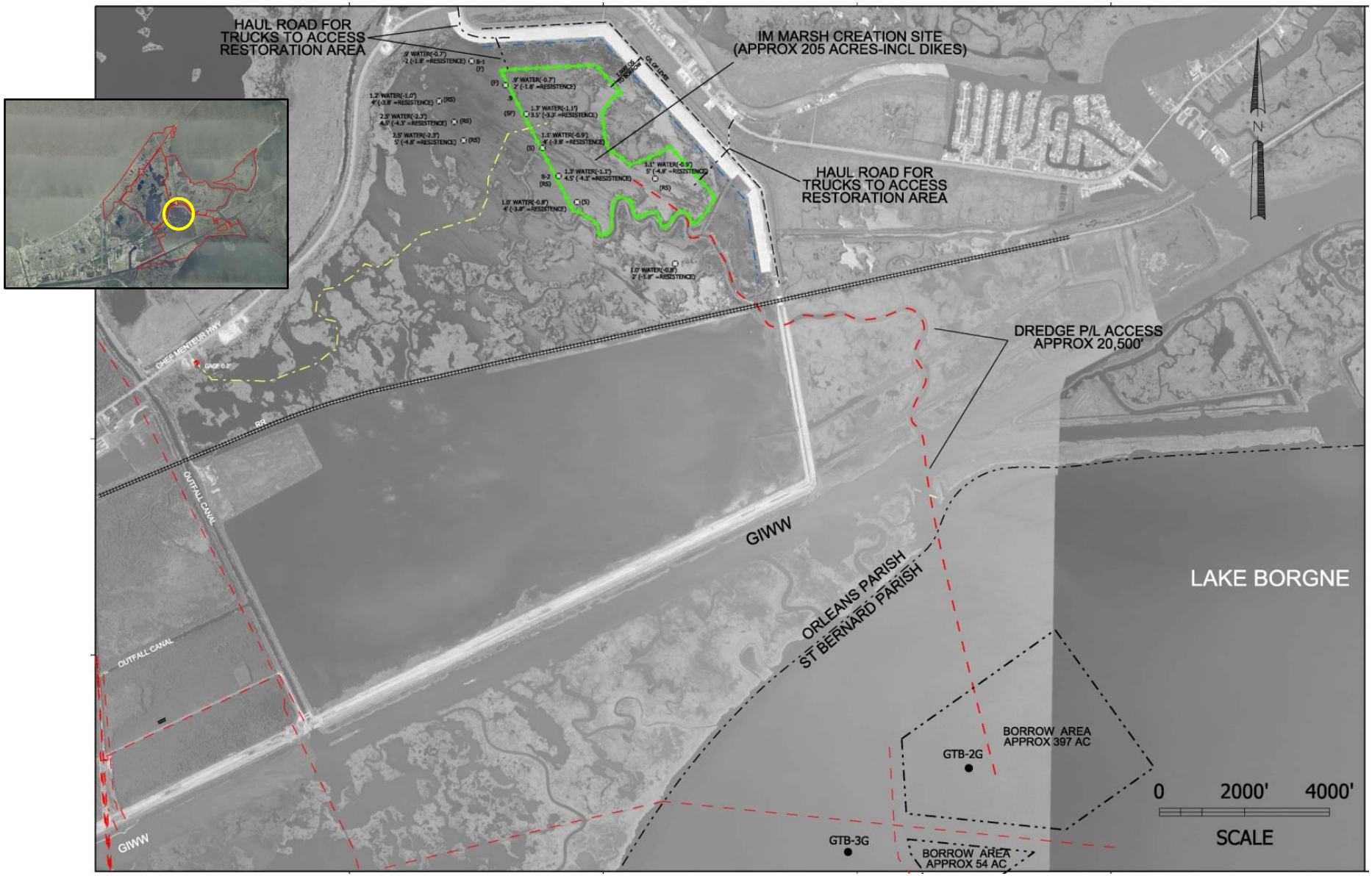



Figure 9. Fresh/Intermediate Marsh Option: Thomas Bayou, Protected-Side

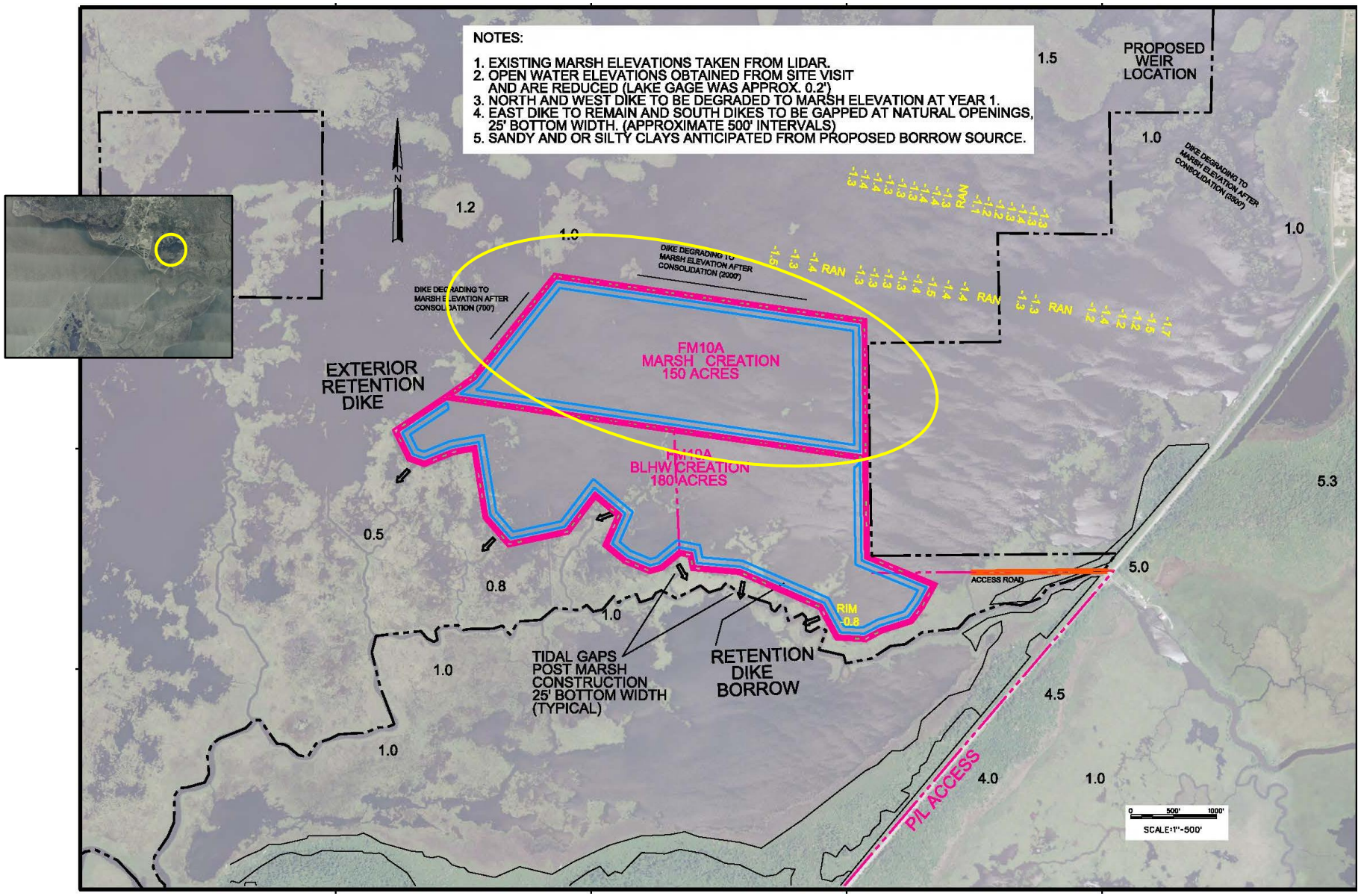


Figure 10. Fresh/Intermediate Marsh Option: Salt Bayou

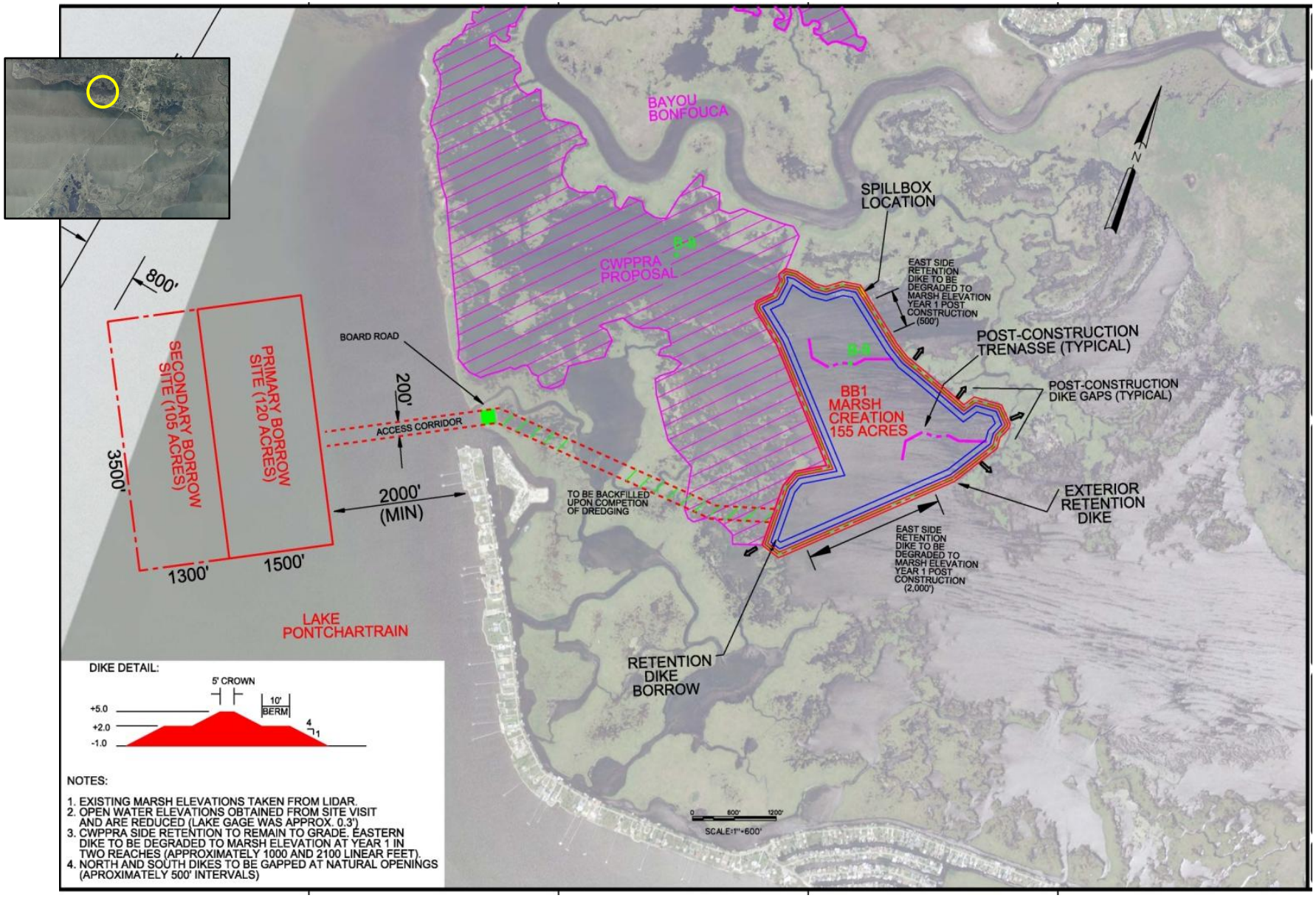



Figure 11. Fresh/Intermediate Marsh Option: Salmen

# APPENDIX B

# WVA ASSUMPTIONS

# FINAL
# Wetland Value Assessment Project Information Sheet

June 15, 2015

**Prepared for:**
U.S. Army Corps of Engineers

**Prepared by**
U.S. Fish and Wildlife Service

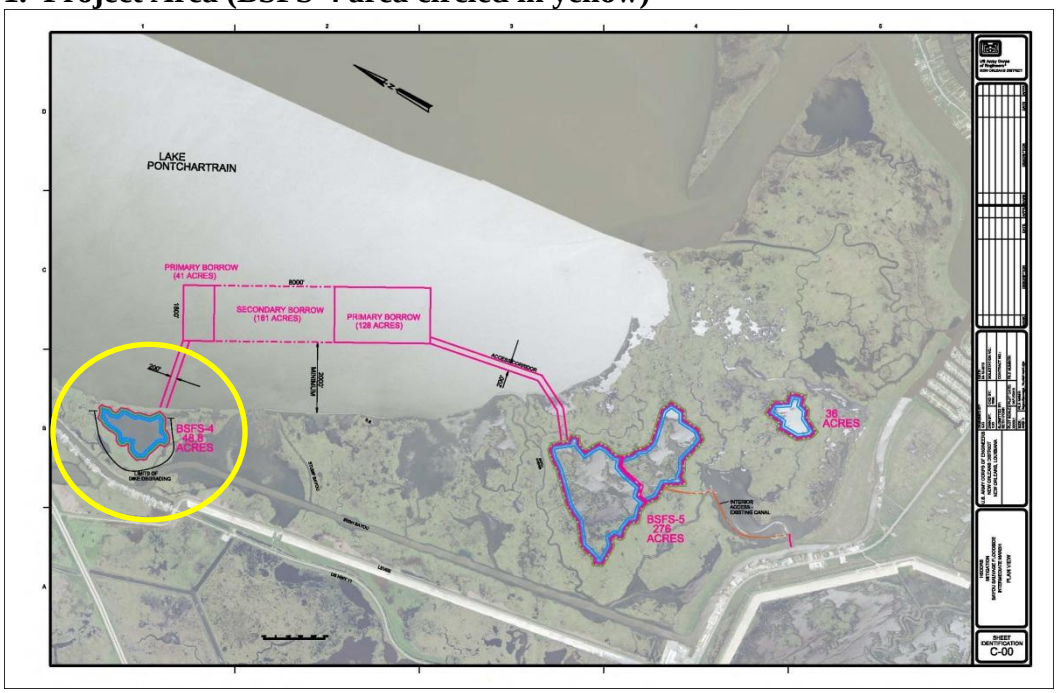
**Project Name:** LPV HSDRRS Mitigation- Bayou Sauvage Flood Side Marsh Creation Site

***Mitigation Potential:** *0.31 aahus/acre*

**Project Type(s):** Marsh Creation

**Project Area:** The Bayou Sauvage Marsh Creation site, BSFS-4, is located within the Bayou Sauvage National Wildlife Refuge (BSNWR) at the extreme east but within the city limits of New Orleans, in Orleans Parish, Louisiana (Figure 1). The site is south of I-10 along the shoreline of Lake Pontchartrain.

**Figure 1. Project Area (BSFS-4 area circled in yellow)**




**Problem:** According to the Coast 2050 Report, from 1932 to 1990, Lake Pontchartrain Basin lost approximately 74,800 acres of marsh out of a total of 322,000. Overall, 23% of the 1932

marsh was lost (Coast 2050 Report- Appendix C 1999). The project area is impacted by natural subsidence and wave erosion of the shoreline marshes.

**Project Goal:**

This Bayou Sauvage FS Mitigation project (BSFS-4 and BSFS-5) is being implemented to mitigate 96.13 AAHUs of general impacts and 9.21 AAHUs of refuge impacts totaling 105.34 AAHUs. The most northern currently proposed marsh total footprint (BSFS-4) is 59 acres and is located immediately east of Louisiana Highway 11, fronting the community of Irish Bayou in Orleans Parish, Louisiana. Completion of this project will result in marsh creation that will provide some protection to the U.S. Highway 90, U.S. Interstate 10, and the Irish Bayou Community. Survey data obtained indicates fairly uniform bottom elevations ranging from approximately -2.0 to -2.5' NAVD88. Two site specific soil borings reveal an approximate 4 foot organic peat layer underlain by very soft clays. Significant settlement of the dredge filled platform is anticipated.

**Project Description:** See Appendix A.

59 acres – Total project area
53 acres – Within retention dike
13 acres – Internal borrow channels*
58 acres – Benefit area after dikes degraded, of this
52.2 acres – Emergent Marsh (2 acres of dike along shoreline remains in place)
5.8 acres – Open Water (borrow canals)
1.0 acres – Open Water associated with dike construction

*5.8 acres – Remaining open water from interior borrow channels – per communication with Keith O'Cain , Corps Eng, 50-60% would be backfilled to target elevations (55% of 13 ac= 7.2 ac, 13 - 7.2 = 5.8 ac )

**Table 1: WVA Target Years for Construction and O&M activities**

| TY | Start | Finish | Notes |
|---|---|---|---|
| **0** | | **Aug-16** | **FWOP conditions end when construction begins** |
| **Construction (0)** | **Aug- 16** | **Nov-2017** | assume benefits begin once 2nd demob starts, restoration platform is in place at the target elevations estimated for at that year. |
| **1** | **Nov-17** | **Nov-18** | (2017) |
| **2** | **Nov-18** | | |
| | Jan-19 | Feb-19 | degrade/gap dikes, remove plugs |
| | Mar- 19 | Jun- 19 | Marsh plantings |
| | | **Nov-19** | |

**Habitat Assessment Method**
The WVA operates under the assumption that optimal conditions for general fish and wildlife

habitat within a given coastal wetland type can be characterized, and that existing or predicted conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is estimated or expressed through the use of a mathematical model developed specifically for each wetland type. Each model consists of 1) a list of variables that are considered important in characterizing fish and wildlife habitat, 2) a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality (Suitability Index) and different variable values, and 3) a mathematical formula that combines Suitability Index for each variable into a single value for wetland habitat quality; that single value is referred to as the Habitat Suitability Index, or HSI.

The WVA model for marsh habitat attempts to assess the suitability of each habitat type for providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species. While the model does not specifically assess other wetland functions and values such as storm-surge protection, floodwater storage, water quality improvement, nutrient import/export, and aesthetics, it can be generally assumed that these functions and values are positively correlated with fish and wildlife habitat quality.

The procedure for evaluating project benefits on fish and wildlife habitats, the WVA model, uses a series of variables that are intended to capture the most important conditions and functional values of a particular habitat. Values for these variables are derived for existing conditions and are estimated for conditions projected into the future if no restoration efforts are applied (i.e., future-without-project), and for conditions projected into the future if the proposed restoration project is implemented (i.e., future-with-project), providing an index of quality or habitat suitability of the habitat for the given time period. The habitat suitability index (HSI) is combined with the acres of habitat to get a number that is referred to as "habitat units". Expected project benefits are estimated as the difference in habitat units between the future-with-project (FWP) and future-without project (FWOP). To allow comparison of WVA benefits to costs for overall project evaluation, total benefits are averaged over a 50-year period, with the result reported as Average Annual Habitat Units (AAHUs).

**Variable $V_1$ – Percent of wetland area covered by emergent vegetation**

**Existing –** The project area is open water. Surrounding marsh has been classified as brackish marsh consistently from 1949 to 2007 (O'Neil 1949, Chabreck and Linscombe 1997, Sasser et al. 2007).

The two major soil types in the project area are classified by Trahan (1987) as Lafitte muck and Clovelly muck. Both soil types are very poorly drained, very fluid organic soils typical of brackish marsh. They are generally flooded and ponded most of the time and have a high subsidence potential.

**Land Loss Data**

To calculate loss rates USGS evaluated a 5,079 acre extended boundary (Figure 3) to obtain land/water data through the 1985-2010 timeframe. The Service calculated land loss rate using the same USGS Land/Water data (1985-2010), using a linear regression (Land Acres: Time). The FWS percent loss rate was determined as a percent of the 1985 land area and also included

all data points provided by USGS. That rate was used to calculate land/water values over the life of the project.

**Figure: 2. USGS Extended Boundary for Bayou Sauvage (09)**

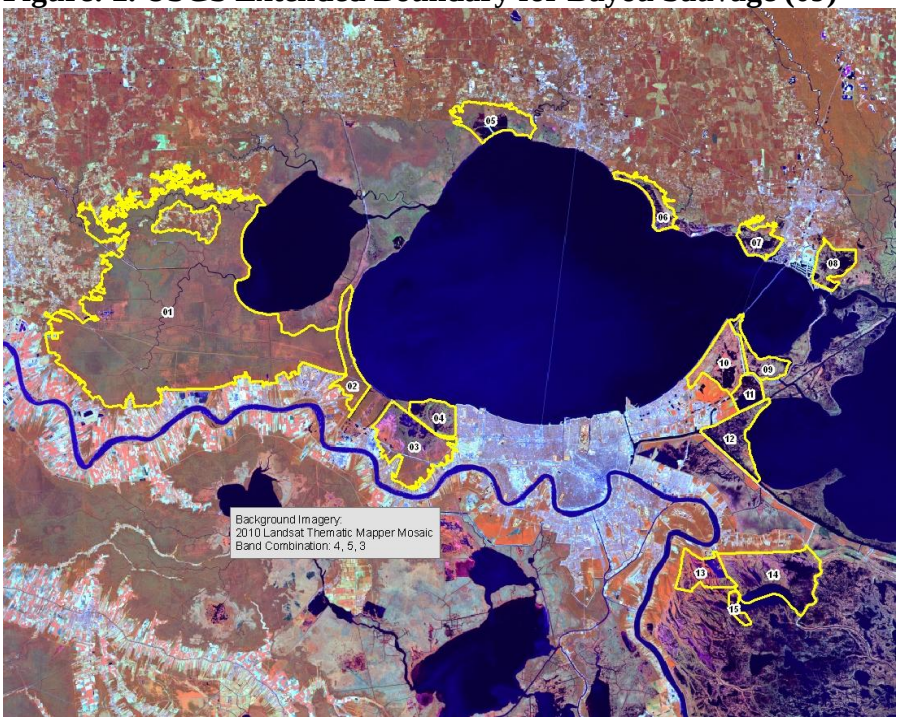
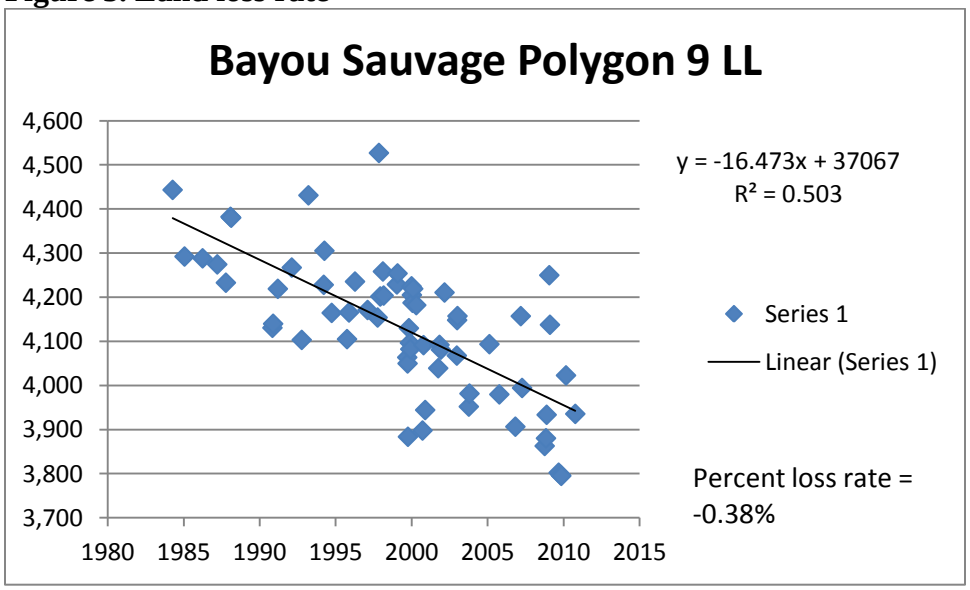



**Figure 3. Land loss rate**




**FWOP**

TY0-50
Marsh: 0 acres (0%)

Water: 59 acres (100%)

**FWP**

For use in the WVA models, projected Relative Sea Level Rise (RSLR) estimates were developed according to EC 1165-2-211, using a nearby reference gage (Rigolets gauge) in the Lake Pontchartrain and Vicinity mitigation watershed. The reference gage was used to develop low, intermediate and high RSLR estimates. Based on MVD planning guidance, the Intermediate RSLR scenario was used for the purpose of WVA modeling for alternative comparison and for design. Analysis of USGS landloss data indicates that land change is still occurring under the low SLR scenario. Therefore, the FWS applied the intermediate RSLR scenario starting from the last year of USGS landloss data, 2010.

Created marsh platform has limited marsh function until settlement, breaching of retention dikes, and vegetation occurs. Land loss is applied at the time of marsh creation. A settlement period of 5 years was also applied based on the Corps settlement analysis that indicates 66% of settlement occurs in the first 5 years, and marsh elevations has settled to an elevation that is flooded 1% of the time. Once functional elevations are achieved, the loss rate of the created marsh is assumed to be 50% of the background loss rate until 10 inches of sediment is assumed to have accreted on the marsh. At that time background loss rate is resumed. This assumption will delay when the loss rate changes back to 100% (YR, Settlement curves). Percent loss rate is of the entire project area acreage.

Research by Nyman et al. (1993) suggests that coastal marshes may undergo rapid degradation and conversion to open water beyond a critical rate of submergence/inundation. Louisiana Coastal Protection and Restoration Authority (CPRA) personnel working to model marsh loss for the 2012 Louisiana Coastal Master Plan have used statewide Coastal Reference Monitoring System data to develop plant productivity vs inundation (i.e., accretion deficit) relationships. From those relationships, they identified inundation ranges at the primary production low-end points to predicting onset of abrupt marsh collapse (Coastal Protection and Restoration Authority of Louisiana 2012). In this study, the median value for intermediate marsh (34.4 cm) was considered to predict onset of abrupt marsh collapse; however, marsh collapse does not occur under the intermediate RSLR scenario.

FWP (reduced by 50%) BSFS-4 Project Area Marsh Creation Acre per year lost rate = - 0.10 acres /year. (Rate reverts back to FWOP rate when water level rise equals 10 inches (-0.20 ac/year).

Reduced Functional Marsh Credit Assumption applied:
TY1 - 0% credit
TY2 - 10% dikes degraded, 55% of borrow areas filled
TY3 – 25%
TY4 – 62.5% (Note: this is a linear assumption, therefore TY4 is not needed in the spreadsheet)
TY5 – 100% credit of remaining marsh platform

Containment dikes are degraded at TY2, and therefore, associated marsh benefits are not

assumed until TY2. However, we are already applying a reduced credit assumption, and that captures the delay in dike acre benefit.

Containment dikes will be constructed to an elevation of 4.5 to 5.0 ft. The Corps proposed to allow the eastern CD to remain in place as an enhanced shoreline for additional protection. To account for the enhanced shoreline being above emergent marsh elevations, that acreage is removed from the benefits until TY 6 (assuming that the reduced functional marsh credit already accounts for those acres). According to CRMS 3784 water level data (2008-2014), the elevation at which the marsh would be flooded at least 1% of the time is 2.24 feet NAVD88 (FWS (NOLB WVA) 2014).

**Table 2. FWP Marsh Acres**

| FWP | | | | | |
|---|---|---|---|---|---|
| | | marsh (ac) | marsh % | OW (ac) | OW (%) |
| 2016 | TY0 | 0.0 | 0% | 59.0 | 100% |
| 2017 | TY1 | 0.0 | 0% | 6.9 | 12% |
| 2018 | TY2 | 5.2 | 9% | 7.0 | 12% |
| 2019 | TY3 | 13.0 | 22% | 7.1 | 12% |
| 2021 | TY5 | *49.7 | *84% | 7.3 | 12% |
| 2022 | TY6 | 51.5 | 87% | 7.5 | 13% |
| 2050 | TY34 | 46.5 | 79% | 12.5 | 21% |
| 2066 | TY50 | 41.0 | 70% | 18.0 | 30% |

* represents acres of benefits minus the 2 acres of enhanced shoreline

**Variable $V_2$ – Percent of open water covered by aquatic vegetation**

**Existing Conditions –**The project area is primarily shallow open water with SAV abundant in all sites. Optical area estimation and transect visual sampling for presence or absence was conducted on April 6, 2011 by USFWS, NOAA, and Corps personnel. It was estimated that 83% of the open water area had SAV cover dominated by *Myriophyllum spicatum* (Eurasian watermilfoil).

**FWOP –** While collecting water depths during an April 6, 2011, field trip, presence and absence of SAVs were determined at each water depth location along each transect. The entire site was then averaged to determine the total percent coverage of SAVs. It was determined that the project area contained approximately 83% SAV.

Existing conditions are expected to continue, with a decline in abundance as RSLR causes water depths to increase thus attenuating light penetration through the water column and reducing growth. Also, as the surrounding marsh decreases, the project area will eventually open to Lake Pontchartrain. Even without those breaches, the size of the open water area will increase, which will increase the fetch and wave energy. Increased wave energy may lead to increased turbidity and will also affect the amount of light available for optimal SAV growth.

| | |
|---|---|
| TY 0 | 83% |
| TY 34 | 62% (75% of baseline; losses due to factors described above) |
| TY 50 | 12% (15% of baseline; assume 85% loss from baseline – standard assumptions) |

**FWP –** When the marsh land platform is constructed, all existing SAV will be buried. Until the created marsh platform settles to marsh elevation and the retention dikes are breached.

| | |
|---|---|
| TY 0 | 83% |
| TY 1-3 | 0% |
| TY 5 | 83% (100% of baseline) |
| TY 6 | 91% (increase baseline by 10%) |
| TY34 | 91% (increase baseline by 10%) |
| TY 50 | 21% (25% of baseline; 75% loss from baseline – standard assumptions) |

**Variable $V_3$ – Marsh edge and interspersion**

**Existing Conditions –**The project area is open water; therefore the project area is assigned a Class 5 value for TY 50.

**FWOP –**.

| | |
|---|---|
| TY 0 – 50: | 100% Class 5 |

**FWP –**

| | |
|---|---|
| TY 0 | 100 % Class 5 |
| TY 1 | 100% Class 5 |
| TY 2-3 | 100% Class 3 (“carpet marsh”) |
| TY 5 | 50% Class 3/ 50% Class 1 |
| TY 6 | 100% Class 1 |
| TY34 | 100% Class 2 (79% marsh) |
| TY 50 | 100% Class 2 (70% marsh) |

**Variable $V_4$ – Percent of open water area <=1.5 feet deep in relation to marsh surface**

**Existing -**
Water depths were measured with a survey rod in the project area on 6 April 2011. The average water depth for the area was calculated using the nearby CRMS3626 gage data and data from the Rigolets at Lake Pontchartrain gage. Using the gage data, the collected data was corrected for the effect of the tides and wind on the day the measurements were recorded. The Corps’ RSLR estimates predict a sea-level rise of approximately 1.0 feet for the year 2063 under the Intermediate RSLR scenario (Appendix). It was assumed that RSLR will reduce the existing shallow open water for FWOP and FWP at TY50 by 1/3 and 1/6 respectively.

**FWOP**

| | |
|---|---|
| TY0 | 15% |
| TY1 | 15% |
| TY3 | 15% |
| TY5 | 15% |
| TY6 | 15% |
| TY34 | 15% |
| TY50 | 10% |

**FWP-** the mitigation project land platform would be built to a subaerial elevation with dredged material. Marsh that is lost is assumed to become open water <= 1.5 feet deep until TY50. At that point, it is assumed that 1/6 of the shallow open water would become deeper than 1.5 feet.

| | |
|---|---|
| TY0 | 15% |
| TY1 | 100% |
| TY3 | 100% |
| TY5 | 100% |
| TY6 | 100% |
| TY34 | 100% |
| TY50 | 83% |

**Variable $V_5$ - Salinity**

**Existing conditions** - Currently estimates for salinity in the area are available from the CRMS3626 station which is within the vicinity of the project area. The average annual salinity recorded by that station for the 2011- 2013 data collection period was 4.82 ppt.

**FWOP & FWP**
TY0 – TY50 4.82 ppt

**Variable $V_6$ – Aquatic organism access**

**Existing conditions –** The project area is not impounded nor hydrologically controlled by structures.

**FWOP** Existing conditions are expected to persist.
TY0 – TY50 = 1.0

**FWP** During construction, retention dikes will block all aquatic organism access. After the dikes are breached in TY2, it is assumed that aquatic organisms will have total and equal access to sites that make up the project area.

| | |
|---|---|
| TY0 | 1.0 |
| TY1 | 0.0001 |

| | |
|---|---|
| TY2 – TY50 | 1.0 |

## Literature Cited

Fish and Wildlife Service. 2014. Draft - New Orleans Landbridge Shoreline Stabilization and Marsh Creation Wetland Value Assessment. PPL 24. Coastal Wetlands Planning, Protection and Restoration Act Program. September 2014.

Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority. 1999. Coast 2050: Toward a Sustainable Coastal Louisiana, The Appendices. Appendix C – Region 1 Supplemental Information. Louisiana Department of Natural Resources. Baton Rouge, La.

Trahan, Larry. 1987. Soil Conservation Service Soil Survey of Orleans Parish, Louisiana. United States Department of Agriculture, Soil Survey Service. January 1987.

# FINAL
# Wetland Value Assessment Project Information Sheet

June 24, 2015

**Prepared for:**
U.S. Army Corps of Engineers

**Prepared by**
U.S. Fish and Wildlife Service

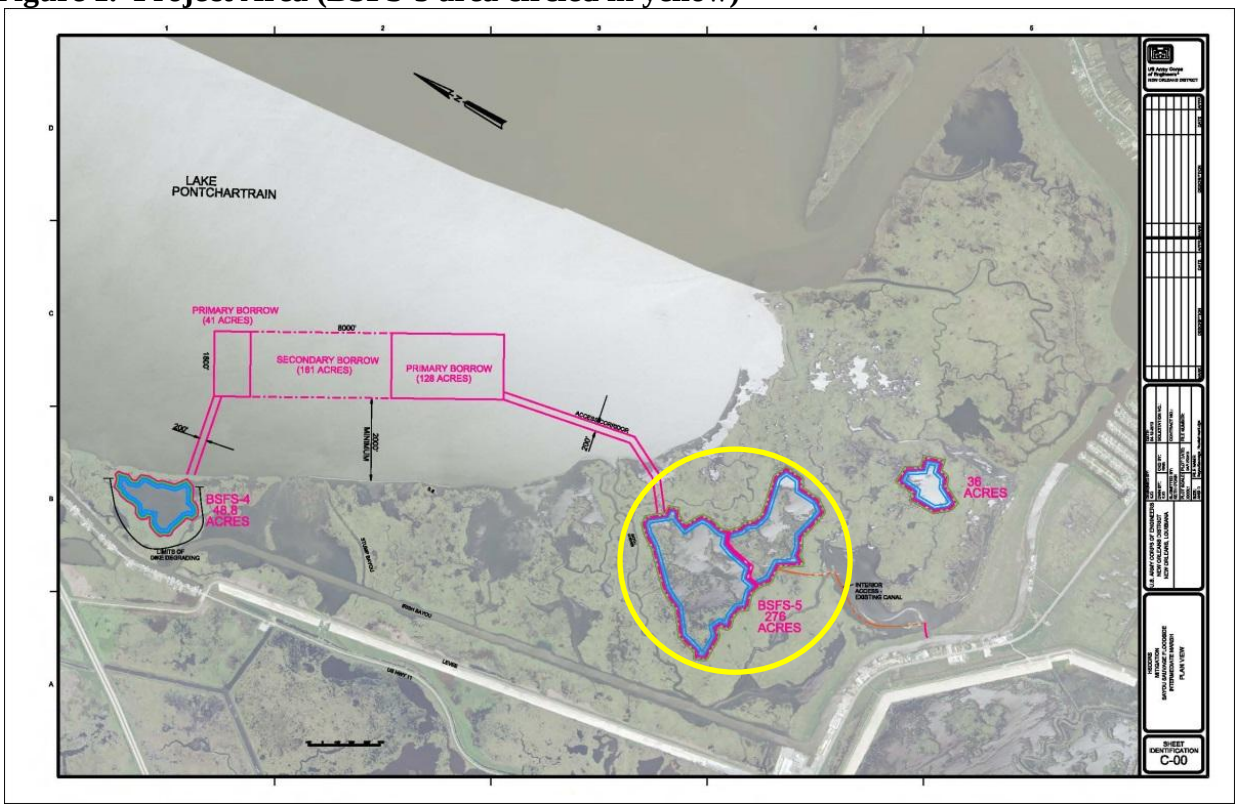
**Project Name:** LPV HSDRRS Mitigation- Bayou Sauvage Flood Side (BSFS-5) Marsh Creation Site

***Mitigation Potential:** 0.30 aahus/ac

**Project Type(s):** Marsh Creation & Nourishment

**Project Area:** The Bayou Sauvage Marsh Creation site, BSFS-5, is located within the Bayou Sauvage National Wildlife Refuge (BSNWR) at the extreme east but within the city limits of New Orleans, in Orleans Parish, Louisiana (Figure 1). The site is south of I-10 along the shoreline of Lake Pontchartrain

**Figure 1. Project Area (BSFS-5 area circled in yellow)**



**Problem:** According to the Coast 2050 Report, from 1932 to 1990, Lake Pontchartrain Basin lost approximately 74,800 acres of marsh out of a total of 322,000. Overall, 23% of the 1932 marsh was lost (Coast 2050 Report- Appendix C 1999). The project area is impacted by natural subsidence and wave erosion of the shoreline marshes.

**Project Goal:**

This Bayou Sauvage FS Mitigation project (BSFS-4 and BSFS-5) is being implemented to mitigate 96.13 AAHUs of general impacts and 9.21 AAHUs of refuge impacts totaling 105.34 AAHUs. The southern proposed marsh footprint (BSFS5) is a combination of open water and broken marsh; however evaluation of historic photography reveals continued degradation of the broken marsh component. Based on surveys conducted by the Corps the truly open water area elevations are similar to the northern site, ranging from -1.5 to -2.5' NAVD88; getting slightly deeper in the northwestern corner where elevations increase to approximately -3.0' NAVD88. Three (3) site specific soil borings reveal an approximate 6 foot organic peat layer underlain by very soft clays and silty sand layers. Again, significant settlement of the dredge filled platform is anticipated.

**Project Description:** See Appendix A.

Project Acres:
283 acres – Total Footprint

- 181.2 acres – Marsh Creation
- 84 acres – Marsh Nourishment
- 14.8 acres – Remaining open water from interior borrow canals
- 3 acres – Remaining open water from dike construction

**Table 1: WVA Target Years for Construction and O&M activities**

| TY | Start | Finish | Notes |
|---|---|---|---|
| **0** | | **Aug-16** | **FWOP conditions end when construction begins** |
| **Construction (0)** | **Aug- 16** | **Nov-2017** | assume benefits begin once 2nd demob starts, restoration platform is in place at the target elevations estimated for at that year. |
| **1** | **Nov-17** | **Nov-18** | (2017) |
| **2** | **Nov-18** | | |
| | Jan-19 | Feb-19 | degrade/gap dikes, remove plugs |
| | Mar- 19 | Jun- 19 | Marsh plantings |
| | | **Nov-19** | |

**Habitat Assessment Method**
The WVA operates under the assumption that optimal conditions for general fish and wildlife habitat within a given coastal wetland type can be characterized, and that existing or predicted

conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is estimated or expressed through the use of a mathematical model developed specifically for each wetland type. Each model consists of 1) a list of variables that are considered important in characterizing fish and wildlife habitat, 2) a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality (Suitability Index) and different variable values, and 3) a mathematical formula that combines Suitability Index for each variable into a single value for wetland habitat quality; that single value is referred to as the Habitat Suitability Index, or HSI.

The WVA model for marsh habitat attempts to assess the suitability of each habitat type for providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species. While the model does not specifically assess other wetland functions and values such as storm-surge protection, floodwater storage, water quality improvement, nutrient import/export, and aesthetics, it can be generally assumed that these functions and values are positively correlated with fish and wildlife habitat quality.

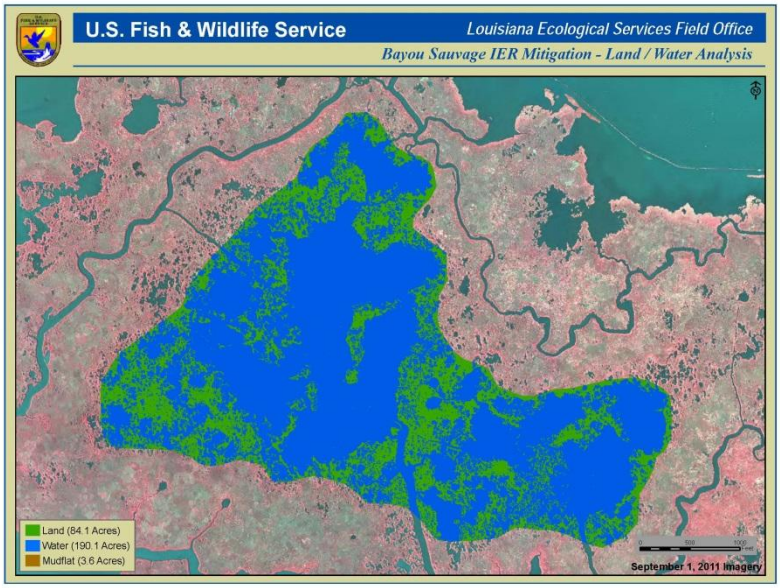
The procedure for evaluating project benefits on fish and wildlife habitats, the WVA model, uses a series of variables that are intended to capture the most important conditions and functional values of a particular habitat. Values for these variables are derived for existing conditions and are estimated for conditions projected into the future if no restoration efforts are applied (i.e., future-without-project), and for conditions projected into the future if the proposed restoration project is implemented (i.e., future-with-project), providing an index of quality or habitat suitability of the habitat for the given time period. The habitat suitability index (HSI) is combined with the acres of habitat to get a number that is referred to as "habitat units". Expected project benefits are estimated as the difference in habitat units between the future-with-project (FWP) and future-without project (FWOP). To allow comparison of WVA benefits to costs for overall project evaluation, total benefits are averaged over a 50-year period, with the result reported as Average Annual Habitat Units (AAHUs).

**Variable $V_1$ – Percent of wetland area covered by emergent vegetation**

**Existing –** The 283 acre project area has been classified by the Service as 30% marsh ("**BSFS5-MN**") and 70% water ("**BSFS5-MC**") based on 2011 aerial imagery (Figure 2). The 3.6 acres classified as mudflat is considered in the open water (or marsh creation) classification. The project area and surrounding marsh has been classified as brackish marsh consistently from 1949 to 2007 (O'Neil 1949, Chabreck and Linscombe 1997, Sasser et al. 2007).

The two major soil types in the project area are classified by Trahan (1987) as Lafitte muck and Clovelly muck. Both soil types are very poorly drained, very fluid organic soils typical of brackish marsh. They are generally flooded and ponded most of the time and have a high subsidence potential.

Figure 2. Land Water Classification




## Land Loss Data

To calculate loss rates USGS evaluated a 5,079 acre extended boundary (Figure 3) to obtain land/water data through the 1985-2010 timeframe. The Service calculated land loss rate using the same USGS Land/Water data (1985-2010), using a linear regression (Land Acres: Time). The FWS percent loss rate was determined as a percent of the 1985 land area and also included all data points provided by USGS. That rate was used to calculate land/water values over the life of the project.

**Figure: 3. USGS Extended Boundary for Bayou Sauvage (09)**

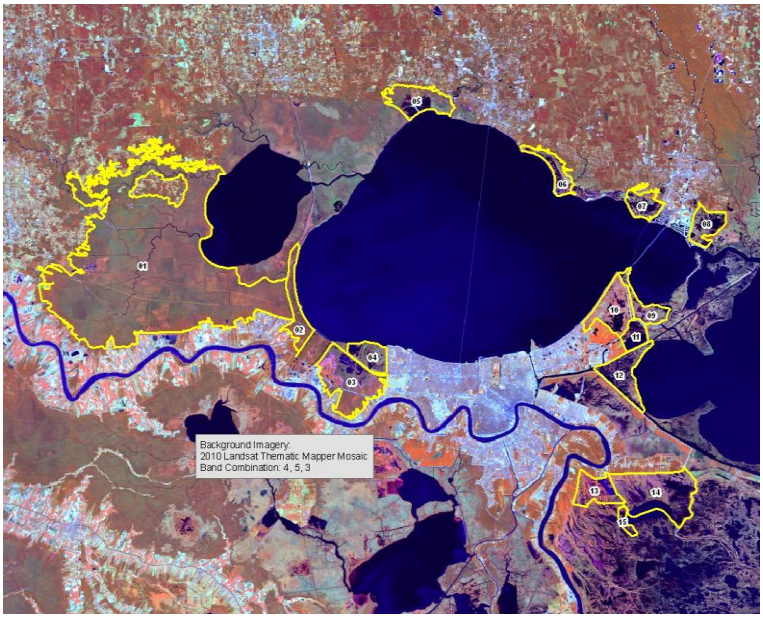
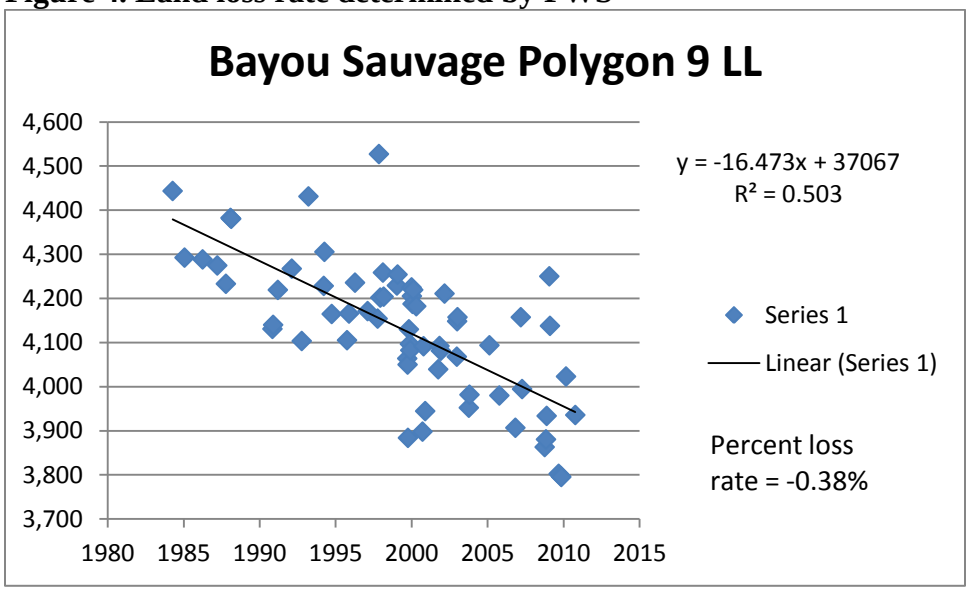


**Figure 4. Land loss rate determined by FWS**




For use in the WVA models, projected Relative Sea Level Rise (RSLR) estimates were developed according to EC 1165-2-211, using a nearby reference gage (Rigolets gauge) in the Lake Pontchartrain and Vicinity mitigation watershed. The reference gage was used to develop low, intermediate and high RSLR estimates. Based on MVD planning guidance, the Intermediate RSLR scenario was used for the purpose of WVA modeling for alternative comparison and for design. Analysis of USGS landloss data indicates that land change is still occurring under the low SLR scenario. Therefore, the FWS applied the intermediate RSLR scenario starting from the last year of USGS landloss data, 2010.

**FWOP**

FWS FWOP Project Area Loss Rate = -0.32 ac/yr based on the marsh acres available at TY0.

**Table 1: FWOP BSFS5**

| | | | | |
|---|---|---|---|---|
| (0)2016 | 82.3 | 29.1% | 201 | 70.90% |
| (1)2017 | 82.00 | 29.0% | 201 | 71.02% |
| (34)2050 | 67.48 | 23.8% | 216 | 76.15% |
| (50)2066 | 58.30 | 20.6% | 225 | 79.40% |

**FWP**

Created marsh platform has limited marsh function until settlement, breaching of retention dikes, and vegetation occurs. Land loss is applied at the time of marsh creation. A settlement period of 5 years was also applied based on the Corps settlement analysis that indicates 66% of settlement occurs in the first 5 years, and marsh elevations has settled to an elevation that is flooded 1% of the time. Once functional elevations are achieved, the loss rate of the created marsh is assumed

to be 50% of the background loss rate until 10 inches of sediment is assumed to have accreted on the marsh. At that time background loss rate is resumed. This assumption will delay when the loss rate changes back to 100% (YR, Settlement curves). Percent loss rate is of the entire project area acreage.

Research by Nyman et al. (1993) suggests that coastal marshes may undergo rapid degradation and conversion to open water beyond a critical rate of submergence/inundation. Louisiana Coastal Protection and Restoration Authority (CPRA) personnel working to model marsh loss for the 2012 Louisiana Coastal Master Plan have used statewide Coastal Reference Monitoring System data to develop plant productivity vs inundation (i.e., accretion deficit) relationships. From those relationships, they identified inundation ranges at the primary production low-end points to predicting onset of abrupt marsh collapse (Coastal Protection and Restoration Authority of Louisiana 2012). In this study, the median value for intermediate marsh (34.4 cm) was considered to predict onset of abrupt marsh collapse; however, marsh collapse does not occur under the intermediate RSLR scenario.

Reduced functional marsh credit assumption applied to created marsh:
TY1 – 0% credit
TY2 – 10% dikes degraded, 55% of borrow areas filled
TY3 – 25%
TY4 – 62.5% (Note: this is a linear assumption, therefore TY4 is not needed in the spreadsheet)
TY5 – 100% credit of remaining marsh platform

Reduced Functional Marsh Credit Assumption applied to nourished marsh:
TY1 – 0%,
TY2 – 25%
TY3 – 50%
TY4 – 75% (Note: this is a linear assumption, therefore TY4 is not needed in the spreadsheet)
TY5 – 100%

**Table 2: FWP Marsh Acres**

| FWP | | | | | |
|---|---|---|---|---|---|
| | | marsh (ac) | marsh % | OW (ac) | OW (%) |
| 2016 | TY0 | 82.3 | 29% | 200.7 | 71% |
| 2017 | TY1 | 0.0 | 0% | 20.0 | 7% |
| 2018 | TY2 | 38.5 | 14% | 20.6 | 7% |
| 2019 | TY3 | 85.9 | 30% | 21.1 | 7% |
| 2021 | TY5 | 260.7 | 92% | 22.3 | 8% |
| 2022 | TY6 | 260.1 | 92% | 22.9 | 8% |
| 2050 | TY34 | 234.3 | 83% | 48.7 | 17% |
| 2066 | TY50 | 208.6 | 74% | 74.4 | 26% |

Further details can be found within the LLR-SLR Spreadsheet:
"BSFS_5_Brackish_Marsh_LLR_SLR_20150601_95prcnt.xlsx"

FWS FWP Project Area Loss Rate for created acres = -0.34 ac/yr (reduced by 50%), and for nourished acres = -0.18 ac/year. Loss rate reverts back to FWOP rate when water level rise equals 10 inches (-0.68 ac/year for created, -0.35 acres/yr for nourished).

**Variable $V_2$ – Percent of open water covered by aquatic vegetation**

**Existing Conditions –**The extended project area is a brackish marsh with interior open water ponds that are expanding in size as marsh loss continues. The immediate project area is approximately 70% water and 30% marsh. SAV is abundant. Based on observations during a May 20, 2014, field trip, it was estimated that 100% of the open water area had SAV cover (Eurasian watermilfoil and widgeon grass, or *Ruppia,* was observed).

**FWOP –** Existing conditions are expected to continue. This area is not expected to breach into the lake within the project life based on loss rates. Even without those breaches, the size of the open water area will increase, which will increase the fetch and wave energy. Increased wave energy may lead to increased turbidity and will also affect the amount of light available for optimal SAV growth. The existing foreshore rock dikes will provide diminishing wave energy protection for SAV as they subside below the water level.

BSFSN5- MC & MN

| | |
|---|---|
| TY 0-1 | 100% |
| TY 34 | 75% (75% of baseline; losses due to factors described above) |
| TY 50 | 60% (60% of baseline, assuming the area is still classified as an interior pond) |

**FWP –** When the marsh land platform is constructed, all existing SAV will be buried. Until the created marsh platform settles to marsh elevation and the retention dikes are breached, it is assumed that very little open water, or SAV volunteers exists to support SAV growth.

BSFSN5- MC & MN

| | |
|---|---|
| TY 0 | 100% |
| TY 1-3 | 0% |
| TY 5 | 100% (100% of baseline) |
| TY 6 | 100% |
| TY 34 | 100% |
| TY 50 | 75% |

**Variable $V_3$ – Marsh edge and interspersion**

**Existing Conditions –** The 283 acre project area is 30% marsh and 70% open water, which can be considered 100% Class 4 (0.2 SI), or 30% Class 2 and 70% Class 5 (O.25 SI).
If this variable is divided into two WVAs, BSFS5-MC (70%) would be a Class 5 and BSFS5-MN (30%) would be a Class 2.

The classification with the higher SI for FWOP was used to be conservative.

**FWOP–** The total area will continue to deteriorate converting to a Class 5 by TY50.

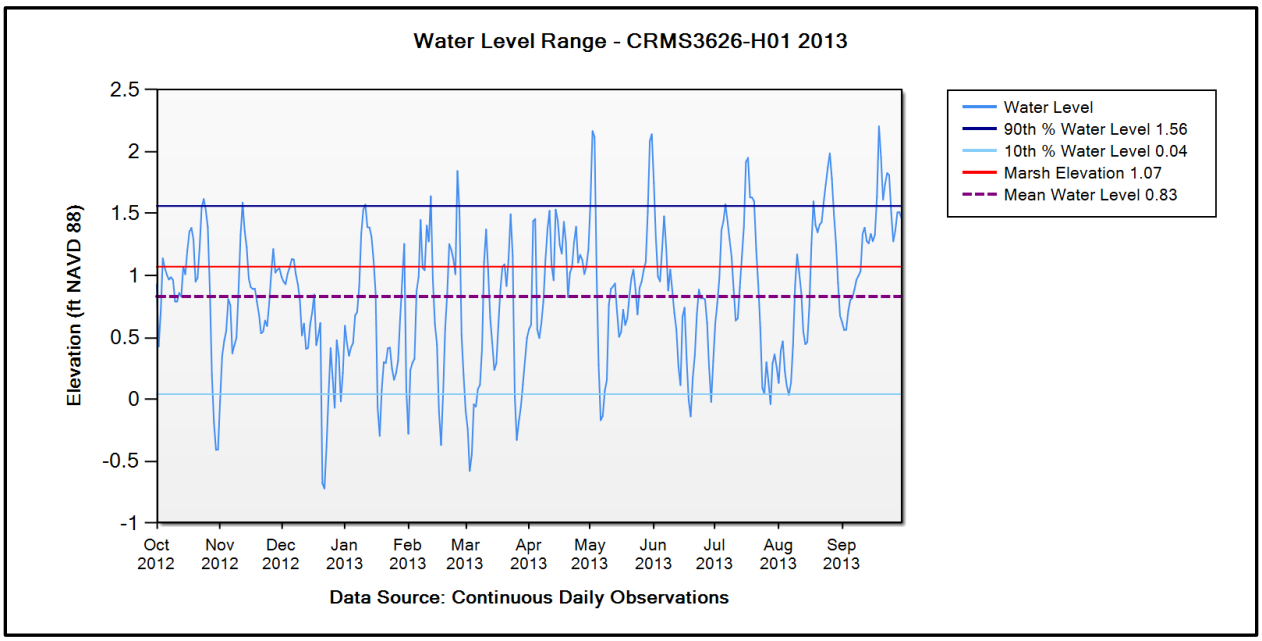
| | |
|---|---|
| TY0-1: | 70% Class 5, 30% Class 2 |
| TY34: | 100% Class 4 (~25% marsh) |
| TY50: | 100% Class 5 (~20% marsh in the entire project area) |

*note: MP is not sensitive to changes in the Interspersion value

**FWP –** Both BSFS5 MC and MN would be filled to target marsh elevations.

| | |
|---|---|
| TY 0: | 70% Class 5, 30% Class 2 |
| TY 1 | 100% Class 5 |
| TY 2-3 | 100% Class 3 ("carpet marsh") |
| TY 5 | 50% Class 3, 50% Class 1 |
| TY 6 | 100% Class 1 |
| TY 34 | 100% Class 1 (marsh is ~83%) |
| TY 50 | 100% Class 2 (marsh is ~74%) |

**Variable $V_4$ – Percent of open water area <=1.5 feet deep in relation to marsh surface**




**Existing**

Bottom elevations (water bottoms and marsh elevations) were collected by the Corps throughout the project area. That data can be provided upon request. Of the 840 data points, only 12 points measured above +1.0 ft NAVD (marsh elevation). Bottom elevations were subtracted from the average water elevation measured at CRMS3626 (+0.83 ft NAVD). For the BSFS 5 WVA SOW

will be determined using all points. If just open water areas were used SOW within and near the marsh would not be accounted for and the variable would favor the deeper areas. Based on all data points, 25% of the average water depth is >/= 1.5 feet.

**FWOP**
The Corps' RSLR estimates predict a sea-level rise of approximately 2.0 feet for the year 2063 under the Intermediate RSLR scenario. It was assumed that RSLR will reduce the existing shallow open water for FWOP and FWP at TY50 by 1/3 and 1/6 respectively.

| | |
|---|---|
| TY0 | 25% |
| TY1 | 25% |
| TY34 | 25% |
| TY50 | 17% |

**FWP-** The project area will be filled to target marsh elevations. Marsh that is lost is assumed to become open water <= 1.5 feet deep until TY50. At that point, it is assumed that 1/6 of the shallow open water would become deeper than 1.5 feet.

| | |
|---|---|
| TY0 | 25% |
| TY1 | 100% |
| TY3 | 100% |
| TY5 | 100% |
| TY6 | 100% |
| TY34 | 100% |
| TY50 | 83% |

**Variable $V_5$ - Salinity**

**Existing conditions** - Currently estimates for salinity in the area are available from the CRMS3626 station which is within the vicinity of the project area. The average annual salinity recorded by that station for the 2011- 2013 data collection period was 4.82 ppt.

**FWOP & FWP**

| | |
|---|---|
| TY0 – TY50 | 4.82 ppt |

**Variable $V_6$ – Aquatic organism access**

**Existing conditions –** The project area is not impounded or hydrologically controlled by any structures. There is a foreshore rock dike between the project area and Lake Pontchartrain, but there is a hydrologic connection of the project area marsh through bayous and a canal to the open waters of the lake and the surrounding marsh. Access to all parts of project area is assumed to be equal.

**FWOP** Existing conditions are expected to continue.

TY0 – TY50 = 1.0

**FWP** After construction, retention dikes will block all aquatic organism access. After the dikes are breached in TY3, it is assumed that aquatic organisms will have total and equal access to sites that make up the project area.

| | |
|---|---|
| TY0 | 1.0 |
| TY1 | 0.0001 |
| TY2 | 1.0 |
| TY5 – TY50 | 1.0 |

## Literature Cited

Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority. 1999. Coast 2050: Toward a Sustainable Coastal Louisiana, The Appendices. Appendix C – Region 1 Supplemental Information. Louisiana Department of Natural Resources. Baton Rouge, La.

Trahan, Larry. 1987. Soil Conservation Service Soil Survey of Orleans Parish, Louisiana. United States Department of Agriculture, Soil Survey Service. January 1987.

# FINAL
# Wetland Value Assessment Project Information Sheet

July 28, 2015

**Prepared for:**
U.S. Army Corps of Engineers

**Prepared by**
U.S. Fish and Wildlife Service

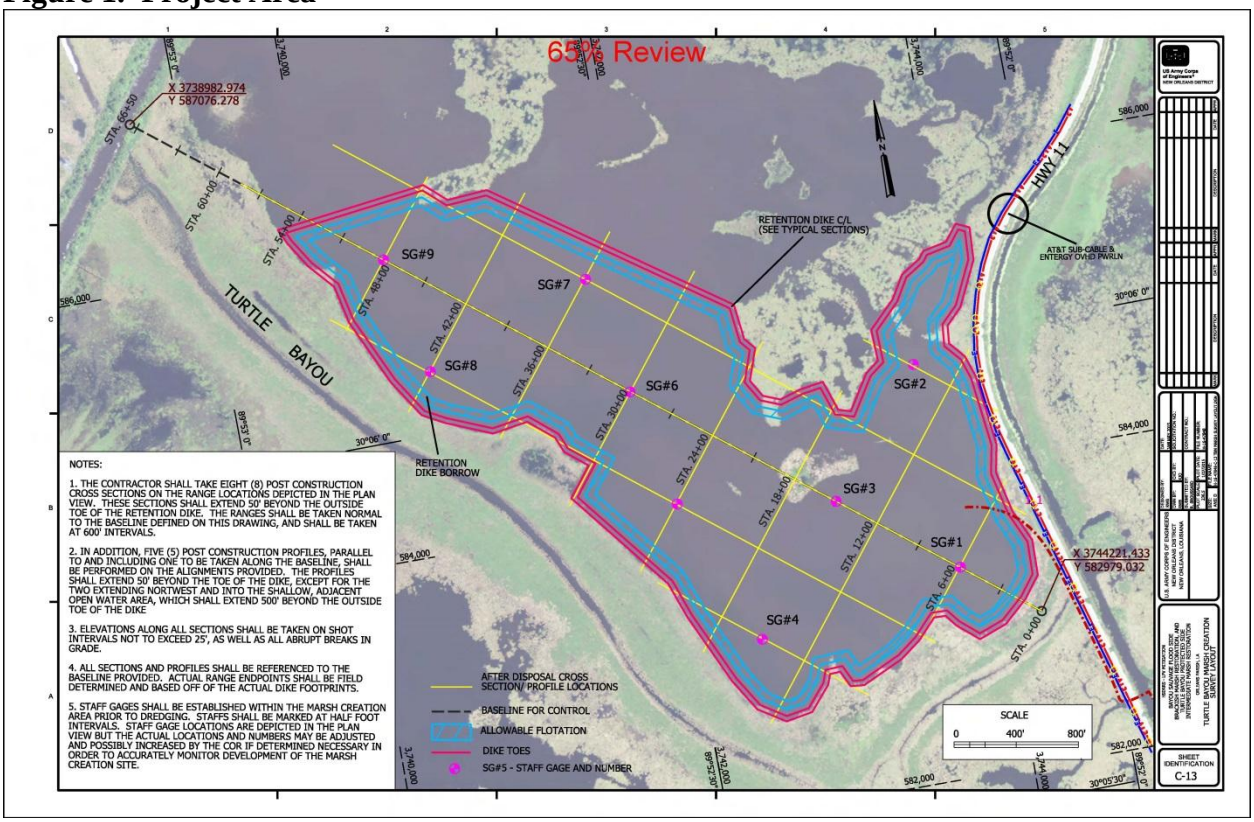
**Project Name:** LPV HSDRRS Mitigation- Turtle Bayou Protected Side Fresh/Intermediate Marsh Mitigation

**Mitigation Potential:** 0.39 AAHUs/acre; 45.24 Total AAHUs for 118 acres

**Project Type(s):** Protected Side, Fresh/Intermediate marsh restoration project

**Project Area:** The Turtle Bayou marsh mitigation project is located in the Bayou Sauvage National Wildlife Refuge 16 mi (25.8 km) east of New Orleans in Orleans Parish.

**Figure 1. Project Area**



**Project Goal:** Restore a sufficient amount of intermediate marsh habitat within the project area to mitigate for the 42.9 AAHUs of protected side, on-refuge, fresh and intermediate marsh habitat impacted by the LPV HSDRRS.

**Project Description:** See Appendix A.

**Project Construction Schedule:** construction start date – 12/2015, TY1 = 2017

TY0 – pre construction, FWOP conditions
Construction - November 2016 -June 2017: Physical Construction: Dredge, Dike work, etc.
TY1 – 2017 (May 2017 - May 2018: Settlement (1-yr))
TY2 – 2019 Jan-Feb 2019: Degrading dikes
TY2 – 2019 Mar-June 2019: Plantings

**Project Acres (estimated before resizing to 117.5):**
Total Area = 180.6 acres (marsh platform + containment dikes) as determined by ArcGIS files.
FWOP Existing Marsh @ 2010* = 4.4 acres
Marsh Creation Platform* = 164.7 acres
Containment Dike (CD) = 11.5 acres, degraded to marsh elevations @ TY 2
CD Borrow Area = 17.1 acres within marsh platform area, Corps Eng. assumption that 90% would be filled to marsh elevations = 15.4 ac marsh + 1.7 ac open water
Total Marsh = 164.7 +11.5 -1.7 + 4.4 = 178.9 acres marsh platform @ TY 2 (not including background subsidence/loss rate)

*Note: a background subsidence has been applied which will change the TY0 (2016) marsh creation acres and open water acres. See V1 assumptions.

The mitigation potential will be calculated based on the 180.6 acre area of analysis.

**Habitat Assessment Method**
The WVA operates under the assumption that optimal conditions for general fish and wildlife habitat within a given coastal wetland type can be characterized, and that existing or predicted conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is estimated or expressed through the use of a mathematical model developed specifically for each wetland type. Each model consists of 1) a list of variables that are considered important in characterizing fish and wildlife habitat, 2) a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality (Suitability Index) and different variable values, and 3) a mathematical formula that combines Suitability Index for each variable into a single value for wetland habitat quality; that single value is referred to as the Habitat Suitability Index, or HSI.

The WVA models assess the suitability of each habitat type for providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species. This standardized, multi-species, habitat-based methodology facilitates the assessment of project-induced impacts on fish and wildlife resources. The coastal marsh WVA model consists of six variables: 1) percent of wetland area covered by emergent vegetation; 2) percent of open water

area covered by aquatic vegetation; 3) marsh edge and interspersion; 4) percent of open water area ≤ 1.5 feet deep in relation to marsh surface; 5) salinity; and 6) aquatic organism access.

Values for those variables are derived for existing conditions and are estimated for conditions projected into the future if no restoration efforts are applied (i.e., future-without-project), and for conditions projected into the future if the proposed restoration project is implemented (i.e., future-with-project), providing an index of quality or habitat suitability of the habitat for the given time period. The habitat suitability index (HSI) is combined with the acres of habitat to get a number that is referred to as "habitat units". Expected project benefits are estimated as the difference in habitat units between the future-with-project (FWP) and future-without project (FWOP). To allow comparison of WVA benefits to costs for overall project evaluation, total benefits are averaged over a 50-year period, with the result reported as Average Annual Habitat Units (AAHUs).

**V1 - Emergent Vegetation**

**Existing –** The project area is classified as predominantly open water as determined by FWS analysis of 2013 aerial photography. Approximately 4.4 acres of marsh, in the form of small islands and marsh edge, exists within the proposed marsh creation area. Sasser et al. classified the area as intermediate marsh in 2007 and 2013.

According to USFWS (1994, per 2003 CWPPRA PO-18 Monitoring Report), the project area was over 90% non-fresh marsh (intermediate or brackish marsh) in 1956, 60% non-fresh marsh in 1978, and 14% non-fresh marsh in 1990. This was a 76% loss of non-fresh marsh. However, this non-fresh marsh loss was somewhat offset by an increase from 0% fresh marsh in 1956 to 30% fresh marsh in 1988. Probably the most dramatic indication of the project area deterioration due to impoundment was the increase in open-water area from 6.0 % in 1956 to 30% in 1988. The open-water ponds were about a third covered with submersed aquatics in 1978, but all of the submersed aquatic vegetation had disappeared by 1990. The loss of the non-fresh marsh and submersed aquatic vegetation has resulted in large open-water ponds, some over 1 mi (1.6 km) wide and approximately 1 ft (0.3 m) deep.

The soils are mainly Lafitte, Clovelly and Gentilly mucks characterized by very fluid organic soils underlain by clay. The higher areas are Aquent soils, which are highly variable and slightly saline. The remnants of the Pine Island Beach Ridge, which cross the area, were more highly drained sands and silts, but were mined for material for Interstate 10.

**Land Loss Data**

To calculate loss rates USGS evaluated 10,506 acre extended boundary (Figure 2, plygon10). USGS determined the 1985-2010 rate from a linear regression that is depicted in Figure 3. The rate (0.19%/yr), which shows slight land gain, was calculated from percent land values (acres) from that 1984-2010 timeframe. In some cases, USGS excludes some data points from the regression analysis due to low and high water events.

USGS's percent is of the total area (marsh + water). The FWS percent change rate was

determined as a percent of the 1985 land area and also included all data points provided. Typically, in WVAs and other such evaluations, we have used the FWS method as there might in some cases be non-wetlands within the polygon and then use of the total polygon area would result in obvious errors. Therefore, the FWS method has been the standard method used in the past. Based on the data provided by USGS, the FWS determined a change rate of 0.029% per year.

Typically, for FWP it is assumed that the loss rate would be reduced by 50% until a point when post-construction accretion exceeds 10 inches above the created marsh platform; however, since this area is showing land gain, no loss or reduction in loss is applied.

**Subsidence – Subsidence (Rigolets Gauge = 3.0 mm/yr) was factored into the land change analysis.

**Figure: 2. USGS Extended Boundary for Turtle Bayou Marsh - polygon 10**

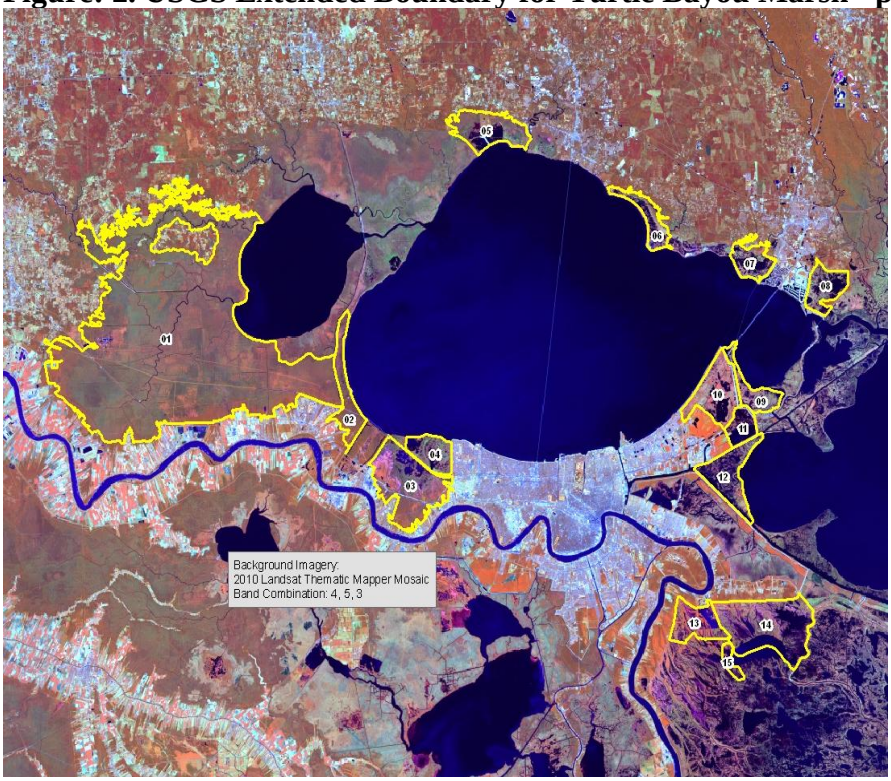
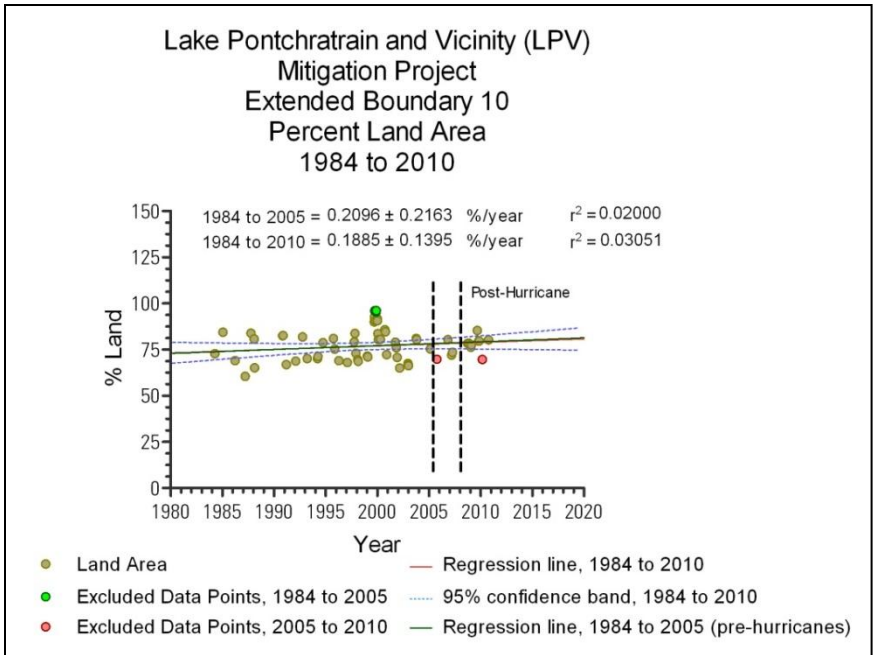



**Figure3. Land loss rate determined by USGS (Ext Boundary 10)**




**FWOP**

Land Change Rate: incorporated the background subsidence rate provided by the Corps to be conservative, no marsh loss rate was applied.

| | V1 | | | | |
|---|---|---|---|---|---|
| FWOP | | | | | |
| | | marsh (ac) | marsh % | OW (ac) | OW (%) |
| 2016 | TY0 | 4.3 | 4% | 113.2 | 96% |
| 2017 | TY1 | 4.3 | 4% | 113.2 | 96% |
| 2018 | TY2 | 4.3 | 4% | 113.2 | 96% |
| 2019 | TY3 | 4.3 | 4% | 113.2 | 96% |
| 2020 | TY4 | 4.3 | 4% | 113.2 | 96% |
| 2021 | TY5 | 4.3 | 4% | 113.2 | 96% |
| 2026 | TY10 | 4.2 | 4% | 113.3 | 96% |
| 2036 | TY20 | 4.0 | 4% | 113.5 | 97% |
| 2046 | TY30 | 3.9 | 3% | 113.6 | 97% |
| 2053 | TY37 | 3.8 | 3% | 113.7 | 97% |
| 2066 | TY50 | 3.6 | 3% | 113.9 | 97% |

**FWP**

Projected Eustatic Sea Level Rise (SLR) estimates were not considered because this project is located within the flood protection system. Land change (gain) rates were also not applied to be conservative. Additionally, background subsidence rates were applied for this analysis to account for the uncertainty of construction methods and future conditions (long-term operation of pumps). Created marsh platform has limited marsh function until settlement, breaching of

retention dikes, and vegetation occurs. Those assumptions are applied through TY 5.
Credit assumption applied:

TY1 - 0% credit
TY2 - 10%
TY3 – 25%
TY4 – 62.5%
TY5 – 100% credit of remaining marsh platform

See Appendix B for estimated settlement rates for the constructed marsh platform. Based on the operation plan, the constructed marsh elevations could be within the range of manipulated flooding regimes at TY 1, however, containment dikes may be in place through TY2. It is assumed that two years of settlement occurs before accretion is initiated, which factors into the loss rate reduction assumption.

Land Change Rate: 0 acres/year (FWS LLR), subsidence rate of 3 mm/yr applied.

| FWP | | | | | |
|---|---|---|---|---|---|
| | | marsh (ac) | marsh % | OW (ac) | OW (%) |
| 2016 | TY0 | 4.3 | 4% | 113.2 | 96% |
| 2017 | TY1 | 4.3 | 4% | 0.5 | 0% |
| 2018 | TY2 | 15.6 | 13% | 0.5 | 0% |
| 2019 | TY3 | 32.5 | 28% | 0.5 | 0% |
| 2020 | TY4 | 74.7 | 64% | 0.5 | 0% |
| 2021 | TY5 | 117.0 | 100% | 0.5 | 0% |
| 2026 | TY10 | 115.0 | 98% | 2.5 | 2% |
| 2036 | TY20 | 111.2 | 95% | 6.3 | 5% |
| 2046 | TY30 | 107.3 | 91% | 10.2 | 9% |
| 2053 | TY37 | 104.6 | 89% | 12.9 | 11% |
| 2066 | TY50 | 99.5 | 85% | 18.0 | 15% |

**V2 – Submerged Aquatic Vegetation (SAV)**

The 2003 CWPPRA monitoring report gives indication that the area has not supported SAVs over the recent years. During a May 20, 2014, HSDRRS WVA field trip SAV was not observed.

**FWOP**

TY0-50 0%

**FWP**
Although it is anticipated that SAV will reestablish with the creation of marsh in the area, to be

conservative FWOP conditions are assumed.

TY0-50 0%

**V3 – Interspersion**

The marsh creation cell is predominantly open water. For the HSDRRS Mitigation alternatives analysis it is assumed that marsh creation would occur within the entire cell and, therefore, no marsh nourishment would be credited. Therefore, the site will be classified as Class 5 for FWOP.

**FWOP**

TY0-50 100% Class 5

**FWP**

The created marsh will be considered a "carpet marsh" at TY3 (i.e., 100% Class 3) transitioning to a Class 1 by TY5.

| | |
|---|---|
| TY0 | 100% Class 5 |
| TY1 | 100% Class 5 |
| TY2 | 100% Class 3 ("carpet marsh") |
| TY3 | 100% Class 3 ("carpet marsh") |
| TY4 | 50% Class 3 ("carpet marsh"), 50% Class 1 |
| TY5 | 100% Class 1 (projected elevations are at TMEs) |
| TY37 | 100% Class 1 *(89% marsh) |
| TY50 | 100% Class 1 (85% marsh) |

* USGS Interspersion tool assumes marsh areas >82% marsh = Class 1

**V4 – Shallow Open Water Habitat**

Water depths were taken throughout the project site during a May 20, 2014, field investigation with an average depth of 1.7 (not correct using an average water elevation). Based upon data obtained by the Corps during a January 22, 2014, the average water depth within the restoration area was approximately 1.7'. The gage at the boat launch, located off of LA Hwy 11 and north of the restoration site, read -0.6', placing the average elevation of water bottoms within the restoration area at approximately -2.3'. This area is influenced predominately by rainfall and water control pumps associated with the Bayou Sauvage NWR Hydrologic Restoration project authorized under Coastal Wetlands Protection, Planning, and Restoration Act (CWPPRA PO-18). That project goal is to promote reestablishment of emergent marsh by lowering water levels to -0.5 feet to 0.0 feet of marsh sediment elevation in the spring and summer and to within 0.5 feet of marsh sediment elevations throughout the rest of the year. After Katrina those pumps were not operated due to impacts associated with the storm and improvements to the levee system. The Corps replaced the pumps in 2011.

It is assumed that under FWP and FWOP water levels are 1.5 feet or less throughout the area due to management goals.

**FWOP & FWP**

TY0-50 - 100%

**V5 – Salinity**

**Existing conditions -** The water within the area has variable salinities. Also, if the proposed borrow areas in Lake Pontchartrain and Lake Borgne are utilized, brackish water and sediment may be introduced into the project area. The rate of evaporation and rainfall control the water salinity. Currently estimates for salinity in the area are only available south of Louisiana Highway 11 (CRMS4107). The mean salinity recorded by that station for the 2013 growing season was 2.7 ppt.

**FWOP & FWP**
TY0 – TY50 2.7 ppt

**V6 – Fish Access**

The project area is located within the HSDDRS levee system. Aquatic organisms within protection system have access to the area through gaps in canal banks. Access within this unit is also impeded by LA Hwy 11 and Interstate 10. Fish Access will not be improved under with project conditions.

**FWOP -** Existing conditions are expected to persist.
TY0-TY50: 0.0001

**FWP -** Existing conditions are expected to persist.
TY0 – TY50**:** 0.0001

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# FINAL
# Wetland Value Assessment Project Information Sheet

May 29, 2015

**Prepared for:**
U.S. Army Corps of Engineers

**Prepared by**
U.S. Fish and Wildlife Service
Angela Trahan
Angela_Trahan@fws.gov

**Project Name:** LPV HSDRRS Mitigation- New Zydeco BLH-wet Restoration

**Mitigation Potential:** 0.60 AAHUs, without Open Water analysis; 159 acres, 95.05 Total AAHUs

**Project Type:** Create BLH-wet habitat in open water habitat

**Project Area:** The project area (Appendix A) is located approximately 3 miles southeast of Slidell, St. Tammany Parish, Louisiana, near the north shore of Lake Pontchartrain. The area is bounded by Salt Bayou to the south and east, U.S. Highway 90 further to the east, and open water to the north and west. Further west is Louisiana Highway 433.

**Project Description:** See Appendix B

**Acres:**
Dike center line = 152 acres
Elevation to +5.5 fill line at TY1 = 149 acres
Post-dike degradation at TY2 = 159 acres
Borrow footprint = 20 acres

## Habitat Assessment Method

The WVA operates under the assumption that optimal conditions for general fish and wildlife habitat within a given coastal wetland type can be characterized, and that existing or predicted conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is estimated or expressed through the use of a mathematical model developed specifically for each wetland type. Each model consists of 1) a list of variables that are considered important in characterizing fish and wildlife habitat, 2) a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality (Suitability Index) and different variable values, and 3) a mathematical formula that combines Suitability Index for each variable into a single value for wetland habitat quality; that single value is referred to as the Habitat Suitability Index, or HSI.

The WVA model for BLH habitat attempts to assess the suitability of each habitat type for providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species. While the model does not specifically assess other wetland functions and values such as storm-surge protection, floodwater storage, water quality improvement, nutrient import/export, and aesthetics, it can be generally assumed that these functions and values are positively correlated with fish and wildlife habitat quality.

The procedure for evaluating project benefits on fish and wildlife habitats, the WVA model, uses a series of variables that are intended to capture the most important conditions and functional values of a particular habitat. Values for these variables are derived for existing conditions and are estimated for conditions projected into the future if no restoration efforts are applied (i.e., future-without-project), and for conditions projected into the future if the proposed restoration project is implemented (i.e., future-with-project), providing an index of quality or habitat suitability of the habitat for the given time period. The habitat suitability index (HSI) is combined with the acres of habitat to get a number that is referred to as "habitat units". Expected project benefits are estimated as the difference in habitat units between the future-with-project (FWP) and future-without project (FWOP). To allow comparison of WVA benefits to costs for overall project evaluation, total benefits are averaged over a 50-year period, with the result reported as Average Annual Habitat Units (AAHUs).

The St. Tammany Soil Survey (http://websoilsurvey.nrcs.usda.gov) characterizes the project area soils as equally Clovelly muck and Lafitte muck typical of organic, brackish marshes over fluid clayey alluvium. Suitability of this site to be converted to BLH habitat is considered to be a slight risk considering the soils and future salinity impacts associated with RSLR.

**Table 1: WVA Target Years for Construction and O&M activities**

| TY | Start | Finish | Notes |
|---|---|---|---|
| **0** | | **Oct-15** | **FWOP conditions end when construction begins** |
| **Construction** | **Oct-15** | **Jul-16** | assume benefits begin once demob starts, restoration platform is in place at the target elevations estimated for at that year. |
| **1** | **Jul-16** | **Jul-17** | (2016) |
| **2** | **Jul-17** | | |
| | Nov-17 | Dec-17 | degrade/gap dikes |
| | Dec-17 | Jan-18 | BLH plantings (age of seedling will be reflected in WVA) |
| | Mar-18 | May-18 | Marsh plantings |
| | | **Jul-18** | |

**Variable $V_1$ – Stand Structure**

**Existing –** There is no forest, only open water. The project area contains small marsh fragments.

**FWOP –** The project area is expected to persist as open water. Remaining marsh will convert to open water.

**FWP –**
Land shaping/grading would be required to restore surface grades to elevations that would support forested habitat and to allow for natural hydrologic patterns to occur.

Service BLH mitigation guidelines suggest that the entire acreage be planted with mast-producing species suited to the soil(s) and site conditions. Mid-story species (i.e., shrub species) could include mayhaw, hawthorn, and persimmon. Planting of mast-producing species would be on by 9-foot x 9-foot centers (538/acre) and mid-story species on 20-foot x 20-foot centers (109/acre) in order to quickly establish a dense canopy and to minimize the re-establishment and growth of Chinese tallow-trees. Hard to soft mast tree species ratio should range between 60 and 70 hardmast species to 30-40 softmast species.

- TY0: Class 1
- TY1: Class 1
- TY2: Class 5 as planted but not full function value; not mature canopy
- TY20: Class 5, mature canopy
- TY50: Class 5, salinity impacts and increased hydrology are a concern. However, for this analysis the highest target elevation of 3 feet is assumed. By TY50 the site could experience an elevation of 1.7 feet, best case scenario.

  **Potential salinity issues**
  Salinities range from 2 ppt to 4 ppt during the growing season. Planted vegetation should be chosen that has tolerance for low salinity water. As RSLR increases salinity intrusion will likely be more prevalent.

**Variable $V_2$ – Stand Maturity**

**Existing Conditions –**open water

**FWOP –** open water/no forest habitat potential.

**FWP –**
TY 2: age = 2
TY 50: age = 50

**Variable $V_3$ – Understory / Midstory**

**Existing Conditions –** open water

**FWOP –** open water/no forest habitat potential.

**FWP –** It is suggested that some shrub/scrub species (e.g., mayhaw, hawthorn, and persimmon) be planted on 20-foot x 20-foot centers (109/acre) in order to quickly establish a dense canopy and to minimize the re-establishment and growth of Chinese tallow-trees to ensure diversity within the forest.

TY 0 – 0/0 (U/M)
TY 1 & 2– 100/0
TY 20 – 25/60
TY 50 – 30/30

**Variable $V_4$ – Hydrology**

**Existing**
Relative Sea Level Rise (RSLR) projections provided by the Corps were incorporated into the assessment (note: for marsh analysis the Service incorporated USGS land change analysis and reevaluated the RSLR starting in 2011). For the Fritchie project area the Rigolets gage in Lake Pontchartrain was used. The low RSLR rate is an extrapolation of historic Relative Sea Level Rise (RSLR) rate experienced at the gage site. The intermediate rate is based on an estimate of local subsidence from the gage record and NRC curve I eustatic, and high rate is based on an estimate of local subsidence from the gage record and NRC curve III eustatic SLR. For the alternatives analysis the intermediate SLR was used for the WVA. The project area is considered to be influenced by a baseline RSLR rate of 4.70 mm/yr.

Under existing conditions the open water site experiences moderate tidal exchange through Salt Bayou and is permanently flooded; however it does not exist as a forested habitat. Therefore, the lowest SI value was assumed.

**FWOP –** existing conditions persist, no functional forest hydrology

**FWP-** It has been suggested restore surface grades to elevations that would support forested habitat (e.g., 3+ feet elevation for BLH-dry, 2-3 feet elevation for BLH-wet, 1.5-2 feet elevation for swamp); however, overbuilding may be considered in light of sea-level rise to ensure mitigation goals are achieved throughout the life of the project.

The Rigolets gage indicates that a 1.1 foot rise in sea level will occur by 2066 (TY50), which is the lowest rate of the five gages including WBV. If a target elevation of +3.15 feet is achieved the following FWP conditions are assumed:

TY: platform elevation, MHW elevation
(2016) TY1: +4.5 ft elevation, containment dikes in place
(2017) TY2: +4.4 ft elevation, containment dikes gapped/degraded
TY10: +3.2 ft elevation, MHW = 1.3 ft
TY25: +3.2 ft elevation, MHW = 1.5 ft
TY50: +3.2 ft elevation, MHW = 2.1 ft

**Table 2: Projected FWP and FWOP Hydrologic Conditions**

| | Flooding Duration | Flow/Exchange | SI |
|---|---|---|---|
| **FWOP TY0-TY1** | Permanent | None | 0.10* entered lowest value since conditions do not represent a BLH |
| **TY50** | Permanent | None | 0.10* |
| **FWP TY1** | Permanent | None | 0.10 |
| **TY2** | Temporary | None | 0.50 |
| **TY25** | Temporary | Low | 0.70 |
| **TY50** | Seasonal | moderate | 0.75 |

**Variable $V_5$ - Size of Contiguous Forested Area**

The project area is not forested and, therefore, only the FWP has a value greater than 0 for this variable.

**FWOP –** open water/no forest habitat potential.

**FWP**
TY 10-2 = Class 1
Ty 20-50 – Class 4 – 159 acres BLH

**Variable $V_6$ – Suitability and Traversability of Surrounding Land Uses**

**FWOP**
Marsh = 20%
Water ("Pasture/Hayfields) = 80%

**FWP -** FWP includes marsh mitigation
Marsh = 35%
Water = 65%

A development rate was not applied to this area. Impact assessments were evaluated with the assumption that no development rate increase would be realized through the life of the project.

**Variable $V_7$ – Disturbance**

**FWP & FWOP – SI = 1**

The project area is positioned parallel to U.S. Highway 90.

Major Highway (T Class 1) < 1,500 feet: D Class 3 = 1

Appendix A - Project Area

# FINAL
# Wetland Value Assessment Project Information Sheet

July 28, 2015

**Prepared for:**
U.S. Army Corps of Engineers

**Prepared by**
U.S. Fish and Wildlife Service
Angela Trahan
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**Project Name:** LPV HSDRRS Mitigation- New Zydeco Marsh Mitigation (for OW impacts and for shortfall at BSFS)

**Mitigation Potential:** 0.32 AAHUs/acre Intermediate Marsh; 46.79 Total AAHUs (146 acres)

**Project Type:** Intermediate Marsh Creation

**Project Area:** The project area is located approximately 3 miles southeast of Slidell, St. Tammany Parish, Louisiana, near the north shore of Lake Pontchartrain. The marsh is bounded by U.S. Highway 90 to the south and east, Louisiana Highway 433 to the west, and U.S. Highway 190, just to the west of the Pearl River.

**Project Features:** The project will consist of restoring approximately 146 acres of marsh through dedicated dredging of material to be borrowed from Lake Pontchartrain. This marsh mitigation project is proposed to mitigate impacts to submerged aquatic habitat associated with bottomland hardwood mitigation as well as brackish marsh impacts that could not be addressed at the Bayou Sauvage mitigation area (BSFS4 & BSFS5). Details of marsh mitigation design can be found in Appendix A.

**Table 1: WVA Target Years for Construction and O&M activities**

| TY | Start | Finish | Notes |
|---|---|---|---|
| **0** | | **Oct-15** | **FWOP conditions end when construction begins** |
| **Construction (0)** | **Oct-15** | **Jul-16** | assume benefits begin once demob starts, restoration platform is in place at the target elevations estimated for at that year. |
| **1** | **Jul-16** | **Jul-17** | (2016) |
| **2** | **Jul-17** | | |
| | Nov-17 | Dec-17 | degrade/gap dikes |
| | Dec-17 | Jan-18 | BLH plantings (age of seedling will be reflected in WVA) |

| | | | |
|---|---|---|---|
| | Mar-18 | May-18 | Marsh plantings |
| | | **Jul-18** | |

**V1 - Emergent Vegetation**

Excerpt from (PPL 19) Fritchie Marsh Terracing and Marsh Creation Project WVA Information Sheet (2009):

Historical and Present Vegetative Communities

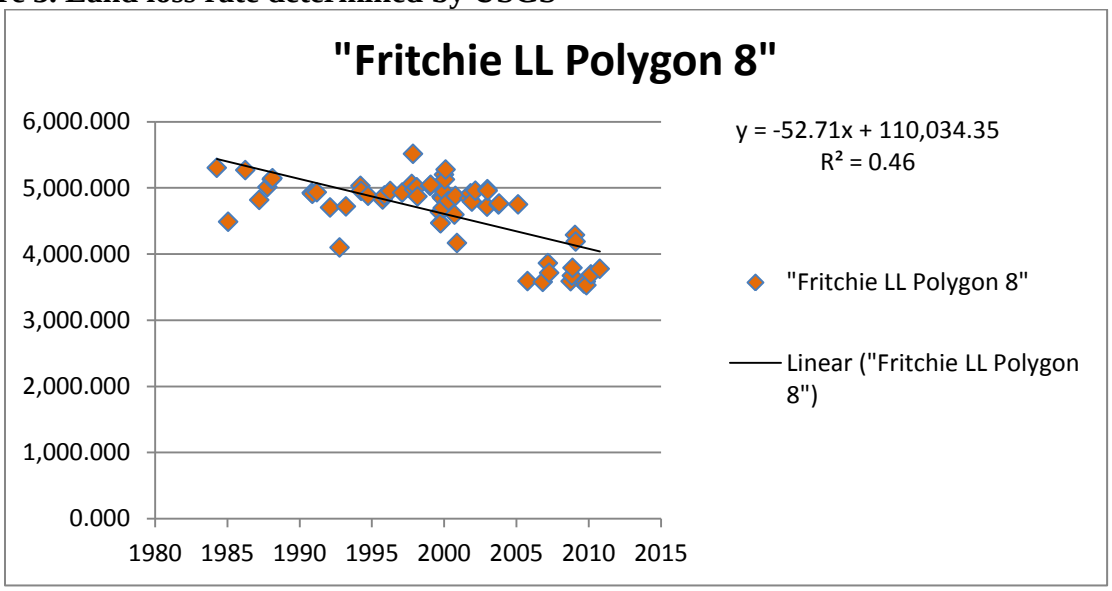
…Project area wetlands within the terrace field transitioned from predominantly fresh marsh in 1956 and 1978 to brackish marsh in 1988. The 2000 data shows an almost even split within the terrace field between intermediate and brackish marsh. In the 2007 Operations, Maintenance, and Monitoring Report for the Fritchie Marsh Restoration Project (PO-06), salinity data was collected throughout the project area pre-construction, from 1997-2000, and from 2001-2005. The summary statistics showed that during the monitoring period, salinity averaged about 3 ppt post construction. This average was considerably higher pre-construction at about 6 ppt. Measurements taken during the WVA trip in June 2009 showed measurements around 3 ppt as well. The 2007 report discussion on vegetative composition indicated that portions of the vegetative communities were trending brackish, with the predominant vegetation being *Spartina patens* and *Schoenoplectus americanus*; however, there are several areas that are trending intermediate. Information provided during the July 29 WVA meeting from Larry Rouse, NRCS, and the OCPR indicates that Lake Pontchartrain salinities have been decreasing, which combined with the closure of the MRGO may further contribute to the Fritchie watershed becoming more fresh. For these reasons, the WVA group agreed to evaluate the project under the intermediate marsh model.

**Land Loss Data**

To calculate loss rates USGS evaluated a 6,072 acre extended boundary (polygon 08, Figure 2) to get land/water data for a 1984-2010 timeframe. The FWS percent loss rate was determined as a percent of the 1984 land area and also included all data points provided. Typically, in WVAs and other such evaluations, we have used the FWS method as there might in some cases be non-wetlands within the polygon and then use of the total polygon area would result in errors. Therefore, the FWS method has been the standard method used in the past. Based on the data provided by USGS, the FWS determined a loss rate of -0.88% per year. For FWP it is assumed that the loss rate would be reduced by 50% until a point when post-construction accretion exceeds 10 inches above the created marsh platform; and therefore, a loss rate of -0.77 acres per year was applied under the FWP scenario.

**Figure: 2. USGS Extended Boundary for Fritchie Marsh (polygon 08)**

**Figure 3. Land loss rate determined by USGS**




## FWOP

Using 2013 aerial photography, it was determined that approximately 2 acres of marsh occurred within the project area. Loss rates were applied to determine the FWOP conditions through the project life.

Loss Rate: Extended Boundary Loss Rate -0.98% /year (FWS LLR,-0.0195 ac/yr)

| | | |
|---|---|---|
| TY0 – | Marsh | 1.9 acres (1%) |
| | Water | 146 acres (99%) |
| TY1 (2016) – | Marsh | 1.9 acres (1%) |
| | Water | 146 (99%) |

| | | |
|---|---|---|
| TY50 – | Marsh | 0.7 acres (0%) |
| | Water | 147 acres (100%) |

**FWP**

For use in the WVA models, projected Relative Sea Level Rise (RSLR) estimates were developed according to EC 1165-2-211, using a nearby reference gage (Rigolets gauge) in the Lake Pontchartrain and Vicinity mitigation watershed. The reference gage was used to develop low, intermediate and high RSLR estimates. Based on MVD planning guidance, the Intermediate RSLR scenario was used for the purpose of WVA modeling for alternative comparison and for design. Analysis of USGS landloss data indicates that land change is still occurring under the low SLR scenario. Therefore, the FWS applied the intermediate RSLR scenario starting from the last year of USGS landloss data, 2010.

Created marsh platform has limited marsh function until settlement, breaching of retention dikes, and vegetation occurs. Land loss is applied at the time of marsh creation. The rate is 50% of the background loss rate until at least 10 inches of water is assumed to cover the marsh and, therefore, 10 inches of post-construction accretion is assumed to occur. The year after 10 inches of water covers the marsh the background loss rate is resumed (2054, TY39).

Corps settlement analysis that indicates 66% of settlement occurs in the first 5 years (Appendix B). This assumption will delay when the loss rate changes back to 100% (YR, Settlement curves). Percent loss rate is of the entire project area acreage.

Research by Nyman et al. (1993) suggests that coastal marshes may undergo rapid degradation and conversion to open water beyond a critical rate of submergence/inundation. Louisiana Coastal Protection and Restoration Authority (CPRA) personnel working to model marsh loss for the 2012 Louisiana Coastal Master Plan have used statewide Coastal Reference Monitoring System data to develop plant productivity vs inundation (i.e., accretion deficit) relationships. From those relationships, they identified inundation ranges at the primary production low-end points to predicting onset of abrupt marsh collapse (Coastal Protection and Restoration Authority of Louisiana 2012). In this study, the median value for intermediate marsh (34.4 cm) was considered to predict onset of abrupt marsh collapse; however, marsh collapse does not occur under the intermediate RSLR scenario.

Project Area Loss rate = -0.71 ac/yr for 146 acres (reduced by 50%), reverts to -1.42 acres/yr inTY39.

| | | |
|---|---|---|
| TY1 | Marsh: | 1.9 ac (1%, assume 0% credit of the created marsh platform) |
| | Water: | 0.9 acres (1%) |
| TY2 | Marsh | 16.3 acres (11%) (assume 10% credit of the remaining marsh platform for gapping/planting) |
| | Water | 1.6 acres (1%, marsh loss; borrow area is expected to fill 100% to marsh elevations) |
| TY3 | Marsh | 37.8 acres (26% - assume 25% credit of remaining marsh platform) |
| | Water | 2.3 acres (2%) |
| TY5 | Marsh | 144.2 acres (97% - assume full credit of remaining marsh platform) |

| | | |
|---|---|---|
| | Water | 3.8 acres (3%) |
| TY6 | Marsh | 143.4 acres (97%) |
| | Water | 4.6 acres (3%) |
| TY39 | Marsh | 111.15 acres (75%) |
| | Water | 36.85 acres (25%) |
| TY50 | Marsh | 90.7 acres (61%) |
| | Water | 57.34 acres (39%) |

**V2 – Submerged Aquatic Vegetation**

Observations made during a 2009 CWPPRA field trip determined open water areas in the project area had 20 % SAV cover (NMFS 2009). During an April 14, 2011, field trip SAV was observed at 13 of 32 (41%) sample points. It is assumed that 41% of the site is SOW. These assumptions were averaged for existing conditions.

**FWOP**

TY0-1 31%
Intermediate/Brackish – based on CWPPRA assumptions carried out to TY50.
TY50 20%

**FWP**
For the HSDRRS Mitigation alternatives analysis the interagency team developed the following assumptions for a 50 year project life:

Intermediate
TY0 31%
TY1-3 (0%)
TY5 31% (100% of baseline)
TY6 36% (increase baseline X 15%)
TY39 36% (increase baseline X 15%)
TY50 16% (decrease baseline X 50%)* should be 50% of baseline/same 3/6/2012

**V3 – Interspersion**

At TY0 the marsh creation cell has approximately 1% existing marsh; therefore, the site will be classified as Class 5 for FWOP.

FWP, marsh creation will initiate a Class 5 area. This will transition to Class 3 ("carpet marsh") by TY3 and Class 1 thereafter.

**FWOP**

TY0 Class 5

| | |
|---|---|
| TY1 | Class 5 |
| TY50 | Class 5 |

**FWP**

| | | |
|---|---|---|
| TY1 | Class 5 (Supra-tidal elevations persist, correlates with assumptions table and settlement data) | |
| TY2-3 | Class 3 ("carpet marsh") | |
| TY5 | 50% Class 3; 50% Class 1 | |
| TY6 | 100% Class 1 | Marsh: 97% |
| TY39 | 100% Class 2 | Marsh: 75% |
| TY50 | 100% Class 3 | Marsh: 61% |

**V4 – Shallow Open Water Habitat**

The Fritchie draft 35 % design report indicates that based on aerial photography, it appears the target marsh site is very shallow open water and anticipates that the existing bottom elevations within the open water project area is approximately -1.0 NAVD88. Field reconnaissance and the 2007 OM&M report all indicate that the majority of both project areas are less than 1.5 ft deep (NMFS 2009). Additional data was collected during the April 14, 2011, field trip for the HSDDRS mitigation project. An average water elevation was obtained from two CRMS locations (4407 & 4406). Water depths collected on that day were adjusted to the average of the two water elevations (0.44 ft NAVD88). Of those sample locations 66% were less than or equal to 1.5 feet.

**FWOP**

| | |
|---|---|
| TY0 | 66% |
| TY1 | 66% |
| TY50 | 44% (1/3 SOW becomes deep = 33.33%) |

**FWP**

| | |
|---|---|
| TY1 | 100% (no open water) |
| TY2-6 | 100% |
| TY39 | 100% Marsh loss is greater in this area; however, subsidence as documented at the Rigolets gage is comparably lower.* |
| TY50 | 83% (of the 36 % water) =1/6 of shallow open water (marsh loss) becomes deep based RSLR |

*PPL 19 CWPPRA project assumed that 100% of the marsh creation site will remain shallow and within the intertidal range after 20 years of subsidence.

**V5 – Salinity**

CRMS 4406 along Salt Bayou references a 2010 mean growing season salinity of 3.63 ppt, while CRMS 4407, located north of Salt Bayou references1.79 ppt for 2010 (2.71=average). A salinity of 2.4 ppt was measured during the April 14, 2011, field trip.

Excerpt from (PPL 19) Fritchie Marsh Terracing and Marsh Creation Project WVA Information Sheet (2009):

> *In the 2007 Operations, Maintenance, and Monitoring Report for the Fritchie Marsh Restoration Project (PO-06), salinity data was collected throughout the project area pre-construction, from 1997-2000, and from 2001-2005. The summary statistics showed that during the monitoring period, salinity averaged about 3 ppt post construction. This average was considerably higher pre-construction at about 6 ppt. Field measurements taken during a 2009 WVA trip showed measurements around 3 ppt as well. The 2007 report discussion on vegetative composition indicated that the vegetative communities were trending brackish, and that the predominant vegetation is Spartina patens, and Schoenoplectus americanus. Given the influence of the Rigolettes on the Fritchie watershed, and the increasing salinities seen in Lake Pontchartrain, it is assumed that salinities will continue to increase. This is expected to be abated, however, by increasing freshwater entering through Salt Bayou after the planned NRCS bayou maintenance.*

**FWOP & FWP**

CRMS 4406 along Salt Bayou references a 2010 mean growing season salinity of 3.63 ppt, while CRMS 4407, located north of Salt Bayou references 1.79 ppt for 2010 (2.71=average). A salinity of 2.4 ppt was measured during the April 14, 2011, field trip.

The Fritchie Marsh Terracing and Marsh Creation Project WVA Information Sheet (PPL21, 2011) based salinity values on CRMS data from 2007 to 2011, which resulted in a 3.2 ppt average.

TY0-50 = 3.2 ppt

**V6 – Fish Access**

The mitigation project area lies within the "north area" of the CWPPRA PPL 19 Fritchie Marsh Terracing and Marsh Creation Project. After further consideration, it was determined that 70% of the area was influenced by the Louisiana Highway 433 Bridge (structure rating = 1.0) and 30% from the HWY 90 open culverts (structure rating = 0.5) (NMFS 2009).

(0.70*1.0) + (0.30*0.5) = 0.70+0.15= 0.85

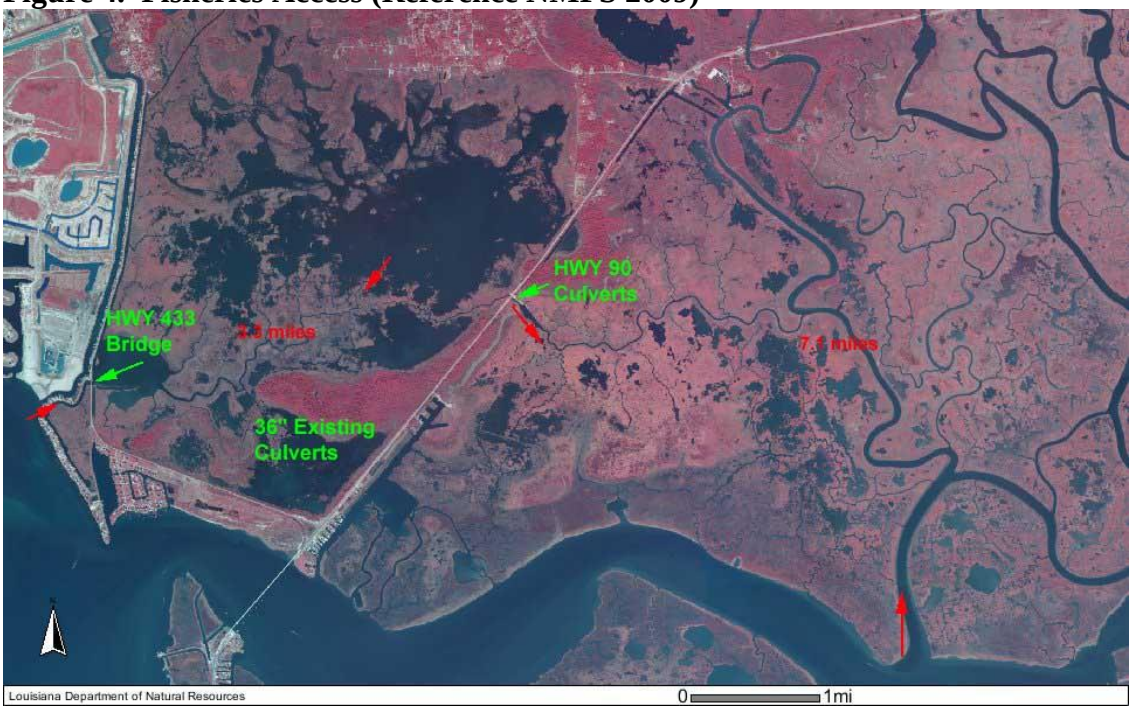
**FWOP** = 0.85

**FWP**

| | |
|---|---|
| TY1 | 0.0001 |
| TY3 | 0.0001 |

TY5-50 0.85

**Figure 4. Fisheries Access (Reference NMFS 2009)**

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# BAYOU SAVAGE, TURTLE BAYOU & NEW ZYDECO RIDGE RESTORATION PROJECTS: MITIGATION PLAN FOR WEST BANK AND VICINITY IMPACTS TO GENERAL AND REFUGE BRACKISH MARSH, AND REFUGE INTERMEDIATE MARSH AND BOTTOMLAND HARDWOOD HABITATS

## INTRODUCTION

This document follows the general mitigation guidelines developed for both the Lake Pontchartrain and Vicinity (LPV) and the West Bank and Vicinity (WBV) Hurricane Storm Damage and Risk Reduction System (HSDRRS) Mitigation Program. They were developed by the U.S. Army Corps of Engineers (USACE) in coordination with an Interagency Team and the non-Federal project sponsor (NFS), Louisiana Coastal Protection and Restoration Authority Board (LA CPRAB). The original guidelines were included as Appendix J in the PIER 36. This appendix describes project specific adjustments and outlines project specific guidelines including plans for planting, monitoring, and reporting. Success criteria for the mitigation sites are also presented in this appendix. The mitigation sites are fully described in SIER 36 and summarized in Table 1.

**Table 1. Mitigation Projects included in SIER 36**

| Habitat | Project | Action | Acres |
|---|---|---|---|
| Refuge Protected Side (PS) & Flood Side (FS) BLH-Wet | New Zydeco | Construct BLH-Wet platform from open water on Big Branch National Wildlife Refuge (NWR) and plant BLH-Wet species. | 159 |
| Refuge FS Intermediate/ Brackish Marsh (IM/BM) | New Zydeco | Construct marsh platform from open water on Big Branch NWR and plant IM/BM species. Action includes constructing retention dikes that will be degraded after settlement and dewatering (approx 1 yr). | 160 |
| General and Refuge FS Brackish Marsh (BM) | Bayou Sauvage | Construct marsh platform from open water and broken marsh on and adjacent to Bayou Sauvage NWR and plant BM species. Action includes constructing retention dikes that will be degraded after settlement and dewatering (approx 1 yr). | 338 |
| Refuge Protected Side Intermediate Marsh (IM) | Turtle Bayou | Construct marsh platform from open water on and adjacent to Bayou Sauvage NWR and plant IM species. Action includes constructing retention dikes that will be degraded after settlement and dewatering (approx 1 yr). | 126 |

The proposed mitigation actions under the SIER 36 include construction, with the NFS responsible for operation and maintenance of functional portions of the work as they are completed. On a cost shared basis, the USACE would monitor the completed mitigation to determine whether additional construction, invasive species control and/or planting are necessary to achieve mitigation success. The USACE would undertake additional actions necessary to achieve mitigation success in accordance with cost sharing applicable to the project and subject to the availability of funds. Once the USACE

determines that the mitigation has achieved initial success criteria, monitoring would be performed by the NFS as part of its OMRR&R obligations. If, after meeting initial success criteria, the mitigation fails to meet its intermediate and/or long-term ecological success criteria, the USACE would consult with other agencies and the NFS to determine whether operational changes would be sufficient to achieve ecological success criteria. If, instead, structural changes are deemed necessary to achieve ecological success, the USACE would implement appropriate adaptive management measures in accordance with the contingency plan and subject to cost sharing requirements, availability of funding, and current budgetary and other guidance.

USFWS Southeast NWR office must determine if all construction, maintenance, and monitoring activities are compatible with the established purpose and mission of the Refuge and will require a Special-Use Permit from the respective NWR prior to any entrance onto the refuge. As such, the Corps and/or the NFS, and their contractors should coordinate with refuge personnel until construction of the flood protection project and restoration projects are complete and prior to any subsequent maintenance or monitoring. Points of contacts for that refuge are Stacey Armitage (985-882-2003, stacy_armitage@fws.gov), Project Leader for the Service's Southeast National Wildlife Refuge Complex; Danny Breaux (985-882-2030, daniel_breaux@fws.gov), Refuge Manager for the Big Branch NWR; and Shelley Stiaes (985- 882-2000, shelley_stiaes@fws.gov), Refuge Manager for the Bayou Sauvage NWR.

The respective responsibilities for the construction, monitoring, and maintenance of the SIER 36 are as follows:

1. Construction and planting (the "construction phase") - performed by the USACE per applicable cost-sharing;

2. After construction and planting, the USACE issues Notice of Construction Complete (NCC) and provides the Operation, Maintenance, Repair, Replacement, and Rehabilitation manual to the NFS (the "O&M phase");

3. Notwithstanding NCC, the USACE would monitor the project on a cost-shared basis until it reaches its Initial Success Criteria;

4. If, after NCC, but before Initial Success Criteria are achieved, the project needs additional construction, invasive species control or planting, the USACE would perform these items subject to applicable cost-sharing and availability of funds;

5. After Initial Success Criteria are achieved, the NFS would monitor project;

6. If, after Initial Success Criteria are achieved, there is a problem that can be corrected through a change in operation, the NFS would be responsible to change its operation of the project; and

7. If, after Initial Success Criteria are achieved, there is a problem that requires structural changes, the USACE would implement adaptive management according to applicable cost-sharing and subject to availability of funds.

For the Bayou Sauvage, Turtle Bayou, and New Zydeco Ridge Restoration projects, "construction" is defined as:

1. Mobilization and de-mobilization of required construction equipment to the site.

2. Construction of temporary retention/perimeter dikes and associated spill boxes to contain dredged material.

3. Dredging material from the bottom of Lake Pontchartrain and pumping the material via hydraulic pipeline along a defined access corridor to the designated fill site to establish marsh and BLH platforms at design elevation.

4. Surveying to determine fill height during dredge material disposal, at the end of the dredging operation, and 1 year after conclusion of the dredging operation.

5. Degrading the perimeter dikes and gapping the dikes to allow water exchange once target elevations have been reached.

6. Initial (typically during first year after establishment of marsh and BLH-WET platforms) invasive and nuisance plant species control.

7.Testing of the soil 1 year after fill event and before planting to determine the suitability of the soil for the planting of BLH. If soil parameters are not met for BLH, delay planting until achieved.

8. One year after the establishment of the marsh and BLH-WET platforms, the planting of native, herbaceous, wetland vegetation and BLH-WET species throughout the fill areas would occur.

## NEW ZYDECO RIDGE BLH-WET RESTORATION

### Mitigation Work Plan

Section 2.3.3 of the SIER provides a detailed description of the proposed mitigation work plan (i.e. mitigation project description). Figure 1 depicts the proposed BLH-Wet restoration feature discussed herein. The key elements of the proposed work plan or mitigation construction/implementation plan are as follows.

- Placement of fill (borrow material) within the mitigation features as necessary to attain the desired final target grade elevation of approximately 3 to 3.5 feet NAVD88. The borrow material would be dredged from Lake Pontchartrain, south of the mitigation site. The borrow material would be

transported to the mitigation feature in a pipeline extending from the borrow site to the shoreline adjacent to Hwy 433. The pipeline would then traverse under 433 and proceed down the north side of Hwy 433 to Hwy 90. It would then follow Hwy 90 north to just east of the proposed mitigation site and cross the existing marsh to the west to terminate at the mitigation site.

- As necessary, follow-up eradication of invasive/nuisance plant species within the mitigation features through ground-based application of appropriate herbicides to the target species, prior to the initial planting of native BLH-Wet species within this feature.

- Initial planting (initial installation) of native BLH-Wet canopy and midstory species in the mitigation features following the settling/dewatering necessary to meet the final target elevation of the mitigation feature and following soil testing to determine the adequacy of the soil chemistry (including salinity) for planting. Refer to the following planting specifications. The successful completion of this initial planting event will mark the end of the mitigation construction phase.

- One re-planting of native BLH-Wet canopy and midstory species in the mitigation features following completion of the initial planting event may be required. It is assumed that approximately 20% of the total number of canopy species and approximately 20% of the total number of midstory species initially planted would have to be re-planted in order to satisfy the plant survival requirements set forth in native vegetation success criterion 2B. However, this re-planting event will not be performed if the applicable success criteria are satisfied.

- As necessary, follow-up eradication of invasive/nuisance plant species within the mitigation features through ground-based application of appropriate herbicides to the target species, following the initial planting cited above. There will likely be multiple invasive/nuisance plant species eradication events performed during various years following completion of the initial planting event.

## PLANTING GUIDELINES

### Soil Chemistry

Once the project area has dewatered and settled soil sampling and testing would be conducted to determine soil chemistry (including salinity) of the constructed habitat in preparation for planting. Determining the suitability of soils is essential to ensure the success of vegetative plantings on the created BLH habitats. Soil samples will initially be collected one year after initial construction is complete, in late summer if possible (when the concentration of salt in the top soil is highest), and every six months thereafter until adequate soil chemistry for planting is identified. If adequate soil chemistry is not identified in the initial round of testing, at least one of the subsequent rounds of testing will be conducted between June and September. One composite sample will be taken every 10 acres. Samples shall be distributed throughout the area

but should ensure that all elevations by 0.5 foot increments are sampled (weighted distribution by elevation or something similar). Samples should be taken from the same location each time to help reduce variations associated with varying topography and soil conditions. Samples will not be taken immediately after a rain.

Composite samples will be created from equal volume subsamples collected from five equally spaced locations within a 15-ft diameter sampling area. Each soil sample location will be prepared by removing leaves, grass, or other surface debris. If a salt crust has formed, it will be included and not scraped off. Samples will be collected from the surface down to 10 inches using a tube sampler. The five subsamples will be thoroughly mixed together to create a composite sample for analysis. Soil samples from the same location will be collected together in a large clean bucket and mixed thoroughly with a clean stainless steel spoon or rod to create a composite sample. Stones, sticks, and plant material will be removed and any large soil clods will be broken down. Approximately one pint of each composite sample will be transferred to a clean (labeled) soil sampling carton or heavy-duty plastic zippered bag for transport to the lab. Composite samples will be submitted to the Louisiana State University (LSU) AgCenter Soil Testing & Plant Analysis Lab (STPAL) for testing. The Levee Test will be conducted on each composite sample. The Levee Test is a combination of the Routine Test, which provides pH and extractable nutrients, and the Flood Test, which provides water soluble nutrients, salts, conductivity, and sodium adsorption ratio (SAR). This test is appropriate for projects on levees in south Louisiana (LSU-STPAL 2015).

**Planting**

This project includes the planting of BLH-Wet species as part of project construction phase. The following guidelines will apply to all initial and replanting efforts, including those that could occur after the construction phase is complete. Once the project area's soil chemistry is within the acceptable range for BLH survival (see attached USFWS memo), canopy species would be planted on 9-foot centers (average) to achieve a minimum initial stand density of 538 seedlings (trees) per acre. Midstory species would be planted on 18-foot centers (average) to achieve a minimum initial stand density of 134 seedlings per acre. Stock would be at least 1 year old, at least 2 feet in height, have a minimum root collar diameter of 3/8 inch, have a root length of at least 8 to 10 inches with at least 4 to 8 lateral roots, and must be obtained from a registered licensed regional nursery/grower and of a regional eco-type species properly stored and handled to ensure viability. The plants would typically be installed during the period from December through March 15 (planting season/dormant season); however unanticipated events such as spring flooding may delay plantings until late spring or early summer. The seedlings would be installed in a manner that avoids monotypic rows of canopy and midstory species (i.e. goal is to have spatial diversity and mixture of planted species) and takes into account the resulting topography (concentrate more wet tolerant species in the lowest elevations). Seedling protection devices such as plastic seedling protectors would be installed around each planted seedling.

The canopy species installed would be in general accordance with the species lists provided in tables 2A and 2B. Plantings would be conducted such that the total number

of plants installed in a given area consists of approximately 60 percent hard mast-producing species (table 2A) and approximately 40 percent soft mast-producing species (table 2B). The species composition of the plantings for each of the two groups of canopy species (e.g. hard mast species and soft mast species) should mimic the percent composition guidelines indicated in tables 2A and 2B. However, site conditions (factors such as hydrologic regime, soils, composition of existing native canopy species, etc.) and planting stock availability may necessitate deviations from the species lists and/or the percent composition guidelines indicated in these tables. Any deviations should first be approved by the USACE, CPRAB and the Interagency Team. In general, a minimum of four hard mast species and a minimum of four soft mast species should be utilized.

The midstory species installed would be selected from the species list provided in table 2C. Plantings would consist of at least three different species. The species used and the proportion of the total midstory plantings represented by each species (percent composition) would be dependent on various factors including site conditions (composition and frequency of existing native midstory species, hydrologic regime, soils, etc.) and planting stock availability. Once determined they should be documented in the monitoring reports.

**Table 2A: Preliminary Planting List for BLH-Wet Habitat, Hard Mast-Producing Canopy Species (60% of Total Canopy Species)**

| Common Name | Scientific name | Percent Composition |
|---|---|---|
| Nuttall oak* | Quercus nuttalli, Q. texana | 30% - 40% |
| Willow oak | Quercus phellos | 30% - 40% |
| Water oak | Quercus nigra | 5% |
| Overcup oak | Quercus lyrata | 10% - 20% |
| Swamp chestnut oak | Quercus michauxii | 10% - 20% |
| Water hickory* | Carya aquatica | 10% - 20% |

*more water tolerant species

**Table 2B: Preliminary Planting List for BLH-Wet Habitat, Soft Mast-Producing Canopy Species (40% of Total Canopy Species)**

| Common Name | Scientific name | Percent Composition |
|---|---|---|
| Drummond red maple* | Acer rubrum var. drummondii | 15% - 25% |
| Sugarberry | Celtis laevigata | 15% - 25% |
| Green ash* | Fraxinus pennsylvanica | 15% - 25% |
| Sweetgum | Liquidambar styraciflua | 10% - 20% |
| American elm | Ulmus americana | 10% - 20% |
| Bald cypress* | Taxodium distichum | 5% - 15% |

*more water tolerant species

**Table 2C: Preliminary Planting List for BLH-Wet Habitat, Midstory Species**

| Common Name | Scientific name | Percent Composition |
|---|---|---|
| Saltbush* | Baccharis halimifolia | TBD |
| Buttonbush* | Cephalanthus occidentalis | TBD |
| Roughleaf dogwood* | Cornus drummondii | TBD |
| Mayhaw | Crataegus opaca | TBD |
| Green hawthorn | Crataegus viridis | TBD |

| | | |
|---|---|---|
| Common persimmon | Diospyros virginiana | TBD |
| Honey locust | Gleditsia triacanthos | TBD |
| Possumhaw | Ilex decidua | TBD |
| Dahoon holly | Ilex cassine | TBD |
| Red mulberry | Morus rubra | TBD |
| Wax myrtle* | Myrica cerifera | TBD |

TBD = To Be Determined; *more water tolerant species

## MITIGATION SUCCESS CRITERIA AND MITIGATION MONITORING

### 1. General Construction

A. For mitigation features established in existing open water areas, complete initial construction activities and as built survey in TY1 and complete all final construction activities in Mitigation TY2 after dewatering and settlement (2018), in accordance with the mitigation work plan as well as the final project plans and specifications. The necessary TY2 activities would vary with the mitigation site. Examples include, but are not limited to: degrading or "gapping" of perimeter retention dikes; construction of water management structures (weirs, etc.). These requirements classify as initial success criteria.

### 2. Native Vegetation

A. Complete initial planting of canopy and midstory species in accordance with the authorized initial planting plan. This requirement classifies as an initial success criterion.

B. 1 Year Following Completion of Initial Plantings (at end of first growing season following the year plants are first installed) –

- Achieve a minimum average survival of 50 percent of planted canopy species (i.e. achieve a minimum average canopy species density of 269 seedlings/ac.). The surviving plants must approximate the species composition and the species percentages specified in the initial plantings component of the Mitigation Work Plan. These criteria would apply to the initial plantings as well as any subsequent replantings necessary to achieve this initial success requirement.
- Achieve a minimum average survival of 80% of planted midstory species (i.e. achieve a minimum average midstory species density of 108 seedlings/ac.). The surviving plants must approximate the species composition percentages specified in the initial plantings component of the Planting Plan. These criteria will apply to the initial plantings as well as any subsequent replantings necessary to achieve this initial success requirement.
- The requirements above classify as initial success criteria.

C. 4 Years Following Completion of Initial Plantings –

- Achieve a minimum average density of 269 living native canopy species per acre (planted trees and/or naturally recruited native canopy species).

- Achieve an average cover of 60% living, native, hard mast-producing species and 40% living soft-mast producing species in the canopy stratum (planted trees and/or naturally recruited native canopy species). These criteria will thereafter remain in effect for the duration of the overall monitoring period. Modifications to these criteria could be necessary for reasons such as avoidance of tree thinning if thinning is not warranted and the long-term effects of sea level rise on tree survival. Proposed modifications must first be approved by the USACE in coordination with the Interagency Team.
- Achieve a minimum average density of 75 living native midstory species per acre (planted midstory and/or naturally recruited native midstory species).
- For BLH-Wet habitats -- Demonstrate that vegetation satisfies the USACE hydrophytic vegetation criteria. This criterion (requirement) will thereafter remain in effect for the duration of the overall monitoring period.
- The requirements above classify as intermediate success criteria; with the exception that the requirement to demonstrate vegetation satisfies the USACE hydrophytic vegetation criteria throughout the duration of the overall monitoring period classifies as a long-term success criterion.

D. Within 10 Years Following Completion of Initial Plantings –

- Attain a minimum average canopy cover of 80% by planted canopy species and/or naturally recruited native canopy species. This criterion will thereafter remain in effect for the duration of the overall monitoring period. This requirement to meet the specified minimum average cover within 10 years following completion of initial plantings classifies as an intermediate success criterion. The requirement to meet the specified minimum average cover for the duration of the overall monitoring period classifies as a long-term success criterion.

E. 15 Years Following Completion of Initial Plantings –

- Average cover by native species in the midstory stratum must be greater than 20%. This criterion will thereafter remain in effect for the duration of the overall monitoring period. This requirement classifies as intermediate and long term success criteria.

Note: The requirement that the above criteria remain in effect for the duration of the overall monitoring period may need to be modified later due to factors such as the effect of sea level rise on vegetative cover. Proposed modifications must first be approved by the USACE in coordination with the Interagency Team.

**3. Invasive and Nuisance Vegetation**

A. Complete the initial eradication of invasive and nuisance plant species. This requirement classifies as an initial success criterion.

B. Maintain all areas such that they are essentially free from invasive and nuisance plant species immediately following a given maintenance event and such that the total average vegetative cover accounted for by invasive and nuisance species each constitute

less than 5 percent of the total average plant cover during periods between maintenance events. Note -These criteria must be satisfied throughout the duration of the overall monitoring period. Until such time that monitoring responsibilities are transferred from the USACE to the NFS, this requirement classifies as an initial success criterion. Following the transfer of monitoring responsibilities, this requirement classifies as a long-term success criterion.

**4. Topography**

A. For mitigation features restored from existing open water areas – (a) In the year that final construction activities are completed (anticipated in TY2, 2018), demonstrate that at least 80 percent of the total area within each feature is within approximately 0.5 feet of the proposed target soil surface elevation (e.g. the desired soil surface elevation), and; (b) In the year after final construction activities are completed, demonstrate that at least 85 percent of the total graded area within each feature is within approximately 0.5 feet of the proposed target soil surface elevation. These requirements classify as initial success criteria.

**5. Thinning of Native Vegetation (Timber Management)**

The USACE, in cooperation with the Interagency Team, may determine that thinning of the canopy and/or midstory strata is warranted to ensure the achievement of success criteria within the plan. This determination would be made approximately 15 to 20 years following completion of initial plantings. If, under normal climatic conditions, two or more successive monitoring reports do not indicate average growth rates for the species installed and site conditions are being achieved then remedial actions will be discussed with the resource agencies. If it is decided that timber management efforts are necessary, the NFS would develop a Timber Stand Improvement/Timber Management Plan, and associated long-term success criteria, in coordination with the USACE and Interagency Team. Following approval of the plan, the NFS would perform the necessary thinning operations and demonstrate that these operations have been successfully completed. Timber management activities would only be allowed for the operations that have been successfully completed.

Reference Table 2. Desired stand conditions for bottomland hardwood forests within the MS Alluvial Valley. (Page 23) in the following Handbook:

LMVJV Forest Resource Conservation Working Group. 2007. Restoration. Mangement, and Monitoring of Forest Resources in the Mississippi Alluvial Valley: Recommendations for Enhancing Wildlife Habitat. Edited by R. Wilson, K. Ribbeck, S. King, and D. Twedt.

## 6. Hydrology

A. Ground surface elevations must be conducive to establishment and support of hydrophytic vegetation, and re-establishment and maintenance of hydric soil characteristics.

B. Two years following attainment of the one-year survivorship criteria, site hydrology will be restored such that the Property meets the wetland criterion as described in the 1987 Manual as well as the November 2010 Regional Supplement to the Corps of Engineers wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region Version 2.0 (USACE 1987, 2010). Data demonstrating that wetland hydrology is being or has been re-established is to be presented in the monitoring report.

## MITIGATION MONITORING GUIDELINES

### Baseline Monitoring Report

The mitigation site would be monitored and a baseline monitoring report prepared after final construction is complete. Monitoring and reporting requirements for the baseline report include the following items:

A. A detailed discussion of all mitigation activities completed.

B. A description of the various features and habitats within the mitigation site.

C. A plan view drawing of the mitigation site showing the approximate boundaries of the mitigation features, monitoring plots, monitoring transect locations, and photo station locations. Conceptual designs and locations of the monitoring plot, transects, photo stations, and staff gage locations, identified by global positioning system (GPS) coordinates, are shown in Figure 1.The exact locations of the monitoring plots, soil chemistry sample sites, transects, quadrats, photo stations, and staff gage locations will be determined during the initial site visit and the baseline monitoring event. Once finalized, the final monitoring design will need to be coordinate with the USACE. If available aerial imagery of the mitigation site will also be included.

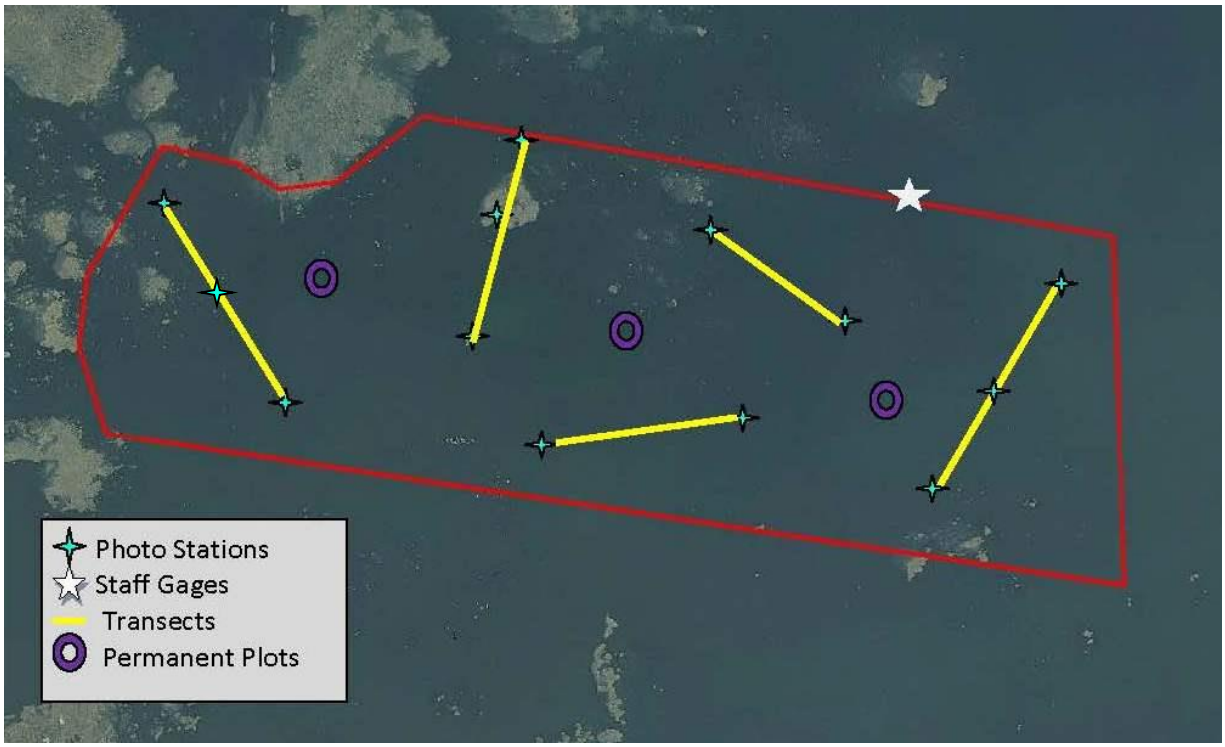


**Figure 1. Areas of interest for monitoring plan design at New Zydeco BLH.**

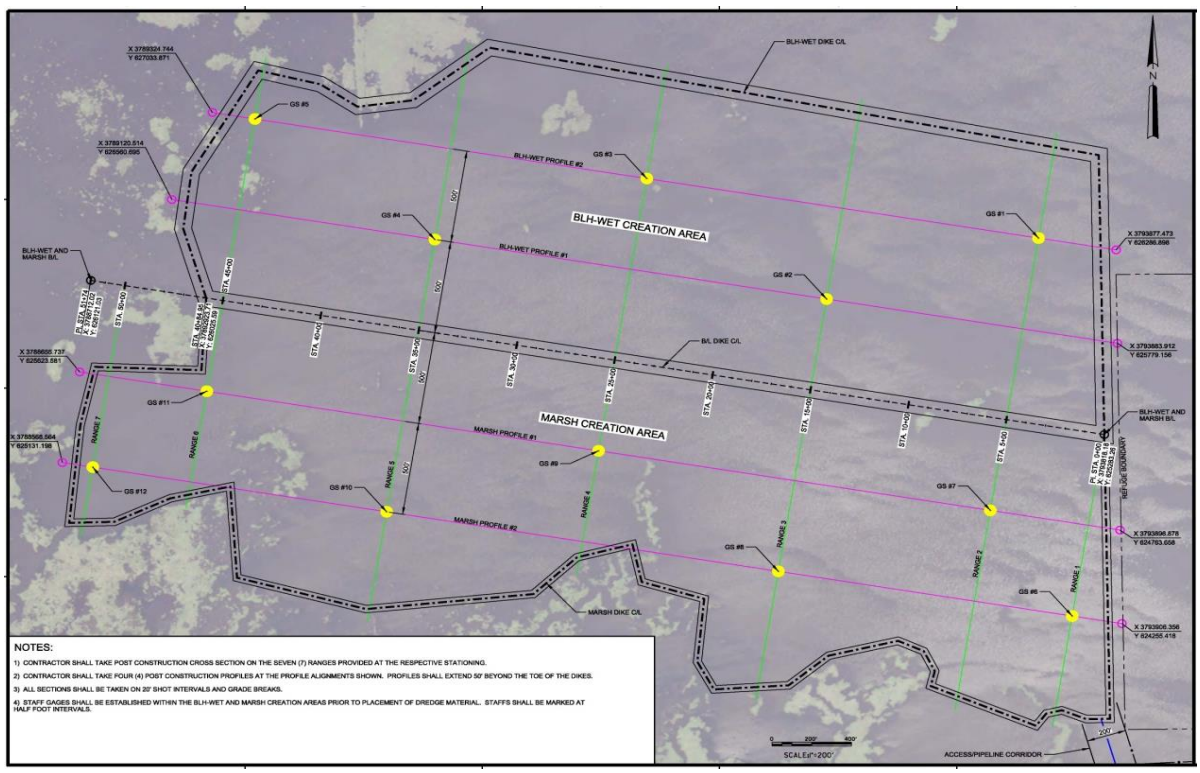


**Figure 2. Project Area Showing Topographic Survey Grid**

D. An as-built survey of surface elevations (topographic survey) of the project area would be conducted, along with an as-built survey of any construction as part of

the specific mitigation features. Since the BLH habitat will be restored in existing open water areas, the as-built survey must include a topographic survey of the entire restoration feature. The layout of the as-built survey is shown on Figure 2.

E. A detailed inventory of all canopy and midstory species planted, including the number of each species planted and the stock size planted. In addition, provide a breakdown itemization indicating the number of each species planted in a particular portion of the mitigation site and correlate this itemization to the various areas depicted on the plan view drawing of the mitigation site.

F. Photographs documenting conditions in the mitigation feature at the time of monitoring would be included. Photos would be taken at approximately 13 permanent photo stations within the mitigation feature. Preliminarily photo stations are planned at each end of the monitoring transects and approximately half way through the longest transects. At least 4 photos would be taken at each station with the view of each photo always oriented north, south, east and west. See Figure 1.

G. Water level elevation readings would be collected at the time of monitoring from a single staff gauge. The monitoring report would provide the staff gauge data along with mean high and mean low water elevation data. The report would further address estimated mean high and mean low water elevations at the mitigation site based on field indicators. See Figure 1 for the proposed location. The exact location of the proposed staff gauge would be determined during the initial site visit and the baseline monitoring event.

H. Various qualitative observations would be made in the mitigation site to help assess the status and success of mitigation and maintenance activities. These observations would include: General estimate of the average percent cover by native plant species; general estimates of the average percent cover by invasive and nuisance plant species; general observations concerning colonization of the mitigation site by volunteer native plant species; general condition of native vegetation; trends in the composition of the plant community; wildlife utilization as observed during monitoring; observations regarding general surface inundation indicators. General observations made during the course of monitoring would also address potential problem zones and other factors deemed pertinent to the success of the mitigation program.

I. A summary of monthly rainfall data collected during the year preceding the monitoring report based on rainfall data recorded at a station located on or in close proximity to the mitigation site.

J. For mitigation features restored from existing open water areas, provide an as-built topographic survey of all such mitigation features in the year immediately following the baseline/“time zero” monitoring event. No additional topographic surveys will typically be required following this second survey. However if the

second survey indicates topographic success criteria have not been achieved and supplemental topographic alterations are necessary, then another topographic survey may be required following completion of the supplemental alterations. This determination will be made by the USACE in coordination with the Interagency Team.

K. A summary assessment of all data and observations along with recommendations as to actions necessary to help meet mitigation and management/maintenance goals and mitigation success criteria.

L. A brief description of anticipated maintenance/management work to be conducted during the period from the current monitoring report to the next monitoring report.

M. Soil chemistry samples locations will be provided with a GPS location for the center of all soil sample locations, such sample locations should be indicated on a map with the most recent topography, results from LSU soil analysis of surface and sub-surface samples should be provided by location and elevation. The monitoring report should also indicate the suitability of soil to support bottomland hardwood vegetation.

**Additional Monitoring Reports**

All monitoring reports generated after the initial baseline report would provide the following information unless otherwise noted:

N. All items listed for the baseline monitoring report with the exception of: (a) the topographic/as-built survey, unless additional topographic/as-built surveys are available; (b) the inventory of planted species; although such an inventory must be provided in any monitoring report generated for a year in which a feature is re-planted to meet applicable success criteria.

O. Quantitative plant data collection and results. Methodology includes a combination of various sized plots for measuring the canopy, midstory, and understory/groundcover.

- Permanent Plots: Quantitative plant data collected from permanent monitoring plots measuring approximately 90 feet X 90 feet in size or from circular plots having a radius of approximately 53 feet. The permanent monitoring plots will be located within mitigation areas where initial planting of canopy and midstory species is necessary. A conceptual plan for plot siting is provided as Figure 1. The exact location of the plots would be determined during the initial site visit and the baseline monitoring event. Whichever method is chosen for the initial monitoring report must be followed for all subsequent reports.

- Data recorded in each permanent plot will include:

- number of living planted canopy species present and the species composition;
- number of living planted midstory species present and the species composition;
- average density of all native species in the canopy stratum,
- the total number of each species present the canopy stratum,
- the wetland indicator status of each species the canopy stratum;
- average cover by native species in the canopy stratum;
- average density of all native species in the midstory stratum,
- the total number of each species present midstory stratum,
- and the wetland indicator status of each species midstory stratum;
- average cover by native species in the midstory stratum
- average percent cover accounted for by invasive plant species (all vegetative strata combined)
- average percent cover accounted for by nuisance plant species (all vegetative strata combined).

- Transects: Quantitative plant data collected from either: (1) permanent transects sampled using the point-centered quarter method with a minimum of 20 sampling points established along the course of each transect, or; (2) permanent belt transects approximately 50 feet wide. It is proposed that approximately 5 transects will be placed run diagonally across the project area. An example of the potential placement of a transect is shown in Figure 1 (all required transects are not included). The methodology and transect location chosen for the initial monitoring report must be followed for all subsequent reports.

Data recorded from the sampling transects will include:

- average density of living planted canopy species present and the species composition;
- average density of living planted midstory species present and the species composition;
- average density of all native species in the canopy stratum along with the species composition and the wetland indicator status of each species;
- average percent cover by all native species in the canopy stratum; average height of native species in the canopy stratum;
- average density of native species in the midstory stratum, the total number of each species present, and the wetland indicator status of each species;
- average percent cover by native species in the midstory stratum;
- average height of native species in the midstory stratum;
- if present, average percent cover accounted for by invasive species present in the canopy and midstory strata (combined).

- Quadrats: Quantitative data concerning plants in the understory (ground cover) stratum and concerning invasive plant species will be gathered from sampling quadrats. These sampling quadrats will be established either along the axis of the belt transects discussed above, or at sampling points established along point-centered quarter transects discussed above, depending on which sampling method is used. Each sampling quadrat will be approximately 2 meters X 2 meters in size. The methodology chosen for the initial monitoring report must be followed for all subsequent reports.

Data recorded from the sampling quadrats will include:

- average percent cover by native subcanopy species;
- composition of native subcanopy species and the wetland indicator status of each species;
- average percent cover by invasive plant species;
- average percent cover by nuisance plant species.

P. A summary of water elevation data (NAVD88 or current) collected from a water level recorder in the same immediate hydrologic area of the mitigation site. As determined by the USACE and the Interagency Team, if a nearby Coastwide Reference Monitoring System [CRMS] station is available, its data may be used. If no CRMS station is available, a data logger must be installed immediately adjacent to the project. Water level data will be collected to provide average annual mean, high and low water levels as determined by the USACE and the Interagency Team. Once hydrology success criteria have been satisfied, water level monitoring will no longer be required. However, monitoring reports generated subsequent to the attainment of success criteria will include a general discussion of water levels and hydroperiod based on qualitative observations (e.g., wrack lines, water marks, etc.) and CRMS or other publicly available water level data in the same immediate hydrologic area.

Q. A brief description of maintenance and/or management work performed since the previous monitoring report along with a discussion of any other significant occurrences would be included.

R. In addition to the above items, the monitoring report prepared upon completion of the final mitigation construction activities and the monitoring report prepared for 3 years following completion of final mitigation construction activities would include a topographic survey of each restoration feature. These surveys would cover the same components as described for the topographic survey conducted for the baseline monitoring report. In addition to the surveys themselves, each of the two monitoring reports involving topographic surveys would include an analysis of the data as regards attainment of applicable topographic success criteria. If the second survey indicates topographic success criteria have not been achieved and supplemental topographic alterations are necessary, then another topographic survey may be required following completion of the supplemental

alterations. This determination would be made by the USACE in coordination with the Interagency Team and NFS.

S. Re-planting of certain areas within the mitigation site may be necessary to ensure attainment of applicable native vegetation success criteria. Any monitoring report submitted following completion of a re-planting event must include an inventory of the number of each species planted and the stock size used. It must also include a depiction of the areas re-planted, cross-referenced to a listing of the species and number of each species planted in each area.

**Monitoring Reports Involving Timber Management Activities**
In cases where timber management activities (thinning of trees and/or shrubs in the canopy and/or midstory strata) have been approved by the USACE in coordination with the Interagency Team, monitoring would be required in the year immediately preceding and in the year following completion of the timber management activities (i.e. pre-timber management and post-timber management reports). These reports must include data and information that are in addition to the typical monitoring requirements. The NFS's proposed Timber Stand Improvement/Timber Management Plan must include the proposed monitoring data and information that would be included in the pre-timber management and post-timber management monitoring reports. The proposed monitoring plan must be approved by the USACE in coordination with the Interagency Team prior to the monitoring events and implementation of the timber management activities.

**Monitoring Reports Following Re-Planting Activities**
Re-planting of certain areas within the mitigation site may be necessary to ensure attainment of applicable native vegetation success criteria. Any monitoring report submitted following completion of a re-planting event must include an inventory of the number of each species planted and the stock size used. It must also include a depiction of the areas re-planted, cross-referenced to a listing of the species and number of each include a depiction of the area species planted in each area.

## MITIGATION MONITORING SCHEDULE AND RESPONSIBILITIES

Monitoring for BLH-Wet would typically take place in late summer of the year of monitoring, but may be delayed until later in the growing season due to site conditions or other unforeseen circumstances. Monitoring reports would be submitted by December 31 of each year of monitoring. Monitoring reports would be provided to the USACE, the NFS, and the agencies comprising the Interagency Team. The various monitoring and reporting responsibilities addressed in this section are all subject to the provisions set forth in the Introduction section.

The USACE would be responsible for conducting the monitoring events and preparing the associated monitoring reports until such time that the following mitigation success criteria are achieved (criteria follow numbering system used in success criteria section):

1. General Construction – 1.A or 1.B, as applicable.
2. Native Vegetation – A and B.
3. Invasive & Nuisance Vegetation – A, plus B until such time as monitoring responsibilities are transferred to the NFS.
4. Topography – A.

Monitoring events associated with the above would include the "time zero" (first or baseline) monitoring event plus annual monitoring events thereafter until the monitoring responsibilities are transferred to the NFS. The NFS would be responsible for conducting the required monitoring events and preparing the associated monitoring reports after the USACE has demonstrated the mitigation success criteria listed above have been achieved. The overall responsibility for management, maintenance, and monitoring of the mitigation would typically be transferred to the Sponsor during the first quarter of the year immediately following submittal of the monitoring report that demonstrates attainment of said criteria, subject to the provisions identified in the Introduction section.

Once monitoring responsibilities have been transferred to the NFS, the next monitoring event would typically take place during the year that attainment of success criterion 2.C (native vegetation criterion applicable 4 years after completion of initial plantings) must be demonstrated. The next monitoring events would occur 2 and 5 years after the attainment of success criterion 2.C. Thereafter, monitoring would typically be conducted every 5 years throughout the 50-year period of analysis (based on 50-year period of analysis beginning in 2016 (TY0) and ending in 2067 (TY50)).

If the initial survival criteria for planted canopy and midstory species are not achieved (i.e. the 1-year survival criteria specified in native vegetation success criteria 2.B), a monitoring report would be required for each consecutive year until two annual sequential reports indicate that all survival criteria have been satisfied (i.e. that corrective actions were successful). The USACE would be responsible for conducting this additional monitoring and preparing the monitoring reports. The USACE would also be responsible for the purchase and installation of supplemental plants needed to attain this success criterion, subject to the provisions mentioned in the Introduction section.

If the native vegetation success criteria specified for 4 years following completion of initial plantings are not achieved (i.e. native vegetation success criteria 2.C), a monitoring report would be required for each consecutive year until two annual sequential reports indicate that these criteria have been satisfied. The NFS would be responsible for conducting this additional monitoring and preparing the monitoring reports. The NFS would also be responsible for the purchase and installation of supplemental plants needed to attain these success criteria.

Once monitoring responsibilities have transferred to the NFS, the NFS would retain the ability to modify the monitoring plan and the monitoring schedule should this become necessary due to unforeseen events or to improve the information provided through monitoring. Twenty years following completion of initial plantings, the number of

monitoring plots and/or monitoring transects that must be sampled during monitoring events may be reduced if it is clear that mitigation success is proceeding as anticipated. Any significant modifications to the monitoring plan or the monitoring schedule must first be approved by the USACE in coordination with the Interagency Team.

## MITIGATION MONITORING COSTS

Table 3 provides a cost estimate based on the currently available information and may need to be revised in the future as additional information regarding the mitigation feature designs and construction schedule become available.

**Table 3. Estimated Monitoring Costs for New Zydeco BLH-Wet Restoration**

| Target Year | Calendar Year | Work Item | Work Item Description | Cost |
|---|---|---|---|---|
| | | | | |
| **0** | **2016** | Begin Construction | Start of mitigation construction activities (approx. Aug. 1st). | |
| | | | | |
| **1** | **2017** | Complete Initial Construction | Finish retention dikes, placement of dredged material (approx. March 22nd - approx 8 months after start of construction). | |
| | | | | |
| **2** | **2018** | Begin Final Construction | Approx. March 16 (1 year after completion of initial construction). Area settles to target grade. Begin: degrading/gapping dikes; installing fish dips in rip-rap dikes as applicable; forming trenasses, interspersion features. | |
| | | Topographic/As-Built Survey | Perform as-built topographic survey. Includes survey of any structures installed plus cross-sections of significant ditches or berms removed, and for any new drainage features. Results documented in mitigation monitoring report. | |
| | | Soil Testing | Complete analysis of soil to determine if soil chemistry suitable for planting | |
| | | Initial Plantings | Install canopy and midstory species by April 15. | |
| | | Nutria guards | Install nutria guards for all initial plantings | |
| | | End Final Construction | Approx. May 11 (approx 1 and 1/2 months after begin final construction). Completion of activities above. | |
| | | Analysis for Notice of Construction Complete | Review As-Builts and O&M manual. | |
| | | **NCC** | Notice of Construction Complete issued to the Non-Federal Sponsor. The USACE will continue to monitor and conduct activities necessary to ensure initial success criteria are met | |
| | | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (Aug?, Sept.?). | |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | |
| | | | | |
| **3** | **2019** | Topographic/As-Built Survey | Perform as-built topographic survey. Includes survey of any structures installed plus cross-sections of significant ditches or berms removed, and for any new drainage features. Results documented in mitigation monitoring report. | |
| | | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (April-May?). | |

| | | | | |
|---|---|---|---|---|
| | | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (Aug?, Sept.?). | |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | |
| | | | | |
| **4** | **2020** | Additional Plantings* | Re-plant restoration features where plant survival success criteria not achieved (Feb. thru mid-March). | |
| | | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (April-May?). | |
| | | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (Oct.?). | |
| | | Monitoring & Report* | Perform field mitigation monitoring. Submit report by Dec. 31. This monitoring required only if area had to be replanted in TY5 per success criteria requirements. | |
| | | | | |
| **5** | **2021** | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (April-May?). | |
| | | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (Oct.?). | |
| | | Monitoring & Report* | Perform field mitigation monitoring. Submit report by Dec. 31. This monitoring required only if area had to be replanted in TY5 per success criteria requirements. | |
| | | | | |
| **6** | **2022** | Aerial Photography | Obtain rectified aerial photo of restoration features if available. Provide as part of mitigation monitoring report. | |
| | | Analysis for satisfaction of initial success criteria. | Review monitoring report from prior year and other data to make determination to completely turn over project to Non-Federal Sponsor. (Jan.) | |
| | | **NFS Begins Monitoring** | Non-Federal Sponsor assumes monitoring responsibilities in addition to other OMRR&R responsibilities (Feb. thru April?). Note: transfer of monitoring occurs early this year unless topographic corrections and/or marsh planting required. | |
| | | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (April-May?). | $31,800 |
| | | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (Aug?, Sept.?). | $31,800 |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $20,700 |
| | | | | |
| **8** | **2024** | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (April-May?). | $31,800 |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $20,700 |
| | | | | |
| **13** | **2029** | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (April-May?). | $31,800 |
| | | | | |
| **18** | **2034** | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (April-May?). | $31,800 |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $20,700 |
| | | | | |
| **23** | **2039** | Aerial Photography | Obtain rectified aerial photo of restoration features. Provide as part of mitigation monitoring report. | |

| | | | | |
|---|---|---|---|---|
| | | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (April-May?). | $20,700 |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $31,800 |
| | | | | |
| **28** | **2044** | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (April-May?). | $31,800 |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $20,700 |
| | | | | |
| **33** | **2049** | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (April-May?). | $31,800 |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $20,700 |
| | | | | |
| **38** | **2054** | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (April-May?). | $31,800 |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $20,700 |
| | | | | |
| **43** | **2059** | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (April-May?). | $31,800 |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $20,700 |
| | | | | |
| **48** | **2064** | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (April-May?). | $31,800 |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $20,700 |
| | | | | |
| **50** | **2067** | Invasive/Nuisance Plant Eradication | Follow-up eradication of invasive and nuisance plant species in restoration features. Ground application. (April-May?). | $31,800 |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $20,700 |
| | | | | |
| | | | Total Cost during OMRR&R Phase (after NFS begins monitoring) | $588,600 |
| | | | Total Cost during OMRR&R Phase (after NFS begins monitoring) + 25% | $735,750 |
| Activities only necessary if replanting occurs. If no replanting occurs then schedule would jump to the activities in yr 6. | | | | |

## BAYOU SAUVAGE, TURTLE BAYOU, AND NEW ZYDECO INTERMEDIATE/BRACKISH MARSH RESTORATION

### Mitigation Work Plan

Sections 2.3.1, 2.3.2, and 2.3.3 of the SIER provides a detailed description of the proposed mitigation work plan (i.e. mitigation project description). Figures 3, 5, 7, and 9 depict the proposed marsh restoration features discussed herein. The key elements of the proposed work plan or mitigation construction/implementation plan are as follows.

- Placement of fill (borrow material) within the mitigation features as necessary to attain the desired final target grade elevation of approximately +1.5 to +0.5 feet NAVD88. The borrow material for the New Zydeco site would be

dredged from Lake Pontchartrain, south of the mitigation site and transported to the mitigation site using the same route as the New Zydeco BLH-Wet restoration project. The borrow for the Turtle Bayou and Bayou Sauvage sites would be dredged from Lake Pontchartrain southeast of the mitigation projects and transported via pipeline laid within existing bayous and across existing marsh in the vicinity of the project. To minimize marsh impacts, the pipeline and equipment would follow open water and canals as much as possible.

- As necessary, follow-up eradication of invasive/nuisance plant species within the mitigation features through ground-based application of appropriate herbicides to the target species, prior to the initial planting of native marsh species within these features.

- Initial planting (initial installation) of native marsh species in the mitigation features following the settling/dewatering necessary to meet the final target elevation of the mitigation feature. Refer to the following planting specifications. The successful completion of this initial planting event will mark the end of the mitigation construction phase.

- As necessary, follow-up eradication of invasive/nuisance plant species within the mitigation features through ground-based application of appropriate herbicides to the target species, following the initial planting cited above.

**PLANTING GUIDELINES**

These projects include planting of intermediate and brackish marsh species as part of project construction phase. Although the Bayou Sauvage project consists of enhancement as well as restoration features, the resulting final platform will be the same and require the same amount of planting as the restoration feature. Additionally, salinities at the New Zydeco site fluctuate between intermediate and brackish depending on rainfall and tidal conditions. As such, the site would either be planted with intermediate or brackish species or a combination of the two based on site conditions the year planting is scheduled to occur. Such determination would be made in coordination with the Interagency Team.

Herbaceous species would be planted on 7-foot centers (average) to achieve a minimum density of 889 plants per acre. Stock would typically be either 4-inch container size or bare-root or liner stock, depending on the species involved. Plants must be obtained from a registered licensed regional nursery/grower and of a regional eco-type species properly stored and handled to ensure viability. Plant installation should be conducted during the period from March 15 through June 15. Planting should not be undertaken later than approximately July 15, however, with approval from the USACE, CPRAB, and Interagency Team, planting during the early fall may be deemed acceptable on a case-by-case basis.

Species installed in proposed intermediate marsh habitats would be selected from the species list provided in table 4. Plantings would consist of at least two different species. The species used and the proportion of the total plantings represented by each species would be dependent on various factors including site conditions and plantings represented by planting stock availability.

**Table 4: Preliminary Planting List for Intermediate Marsh Habitats**

| Common Name | Scientific Name |
|---|---|
| California bulrush | Schoenoplectus californicus |
| Black needle rush | Juncus roemerianus |
| Giant cutgrass | Zizaniopsis miliacea |
| Marsh-hay cordgrass | Spartina patens |
| Maidencane | Panicum hemitomon |
| Common threesquare | Schoenoplectus americanus |
| Big cordgrass | Spartina cynosuroides |
| Seashore paspalum | Paspalum vaginatum |

Species installed in proposed brackish marsh habitats would be selected from the species list provided in table 5. Plantings would consist of at least two different species. The species used and the proportion of the total plantings represented by each species would be dependent on various factors including site conditions and planting stock availability.

**Table 5: Preliminary Planting List for Brackish Marsh Habitats**

| Common Name | Scientific Name |
|---|---|
| Marsh-hay cordgrass | Spartina patens |
| Black needle rush | Juncus roemerianus |
| Smooth cordgrass | Spartina alterniflora |
| Common threesquare | Schoenoplectus americanus |
| Saltmarsh bulrush | Schoenoplectus robustus |
| Salt grass | Distchilis spicata |

## 1. General Construction

A. Within approximately 8 months following the start of mitigation construction, complete all initial mitigation construction activities (e.g. construction of temporary retention/perimeter dikes, placement of fill (borrow material/dredged material) into mitigation site, construction of permanent dikes if applicable, etc.), in accordance with the mitigation work plan and in accordance with final project plans and specifications. Complete as-built survey. These requirements classify as initial success criteria

B. Approximately 1 year following completion of all initial mitigation construction activities (when the restored marsh feature has attained the desired target soil surface elevation), complete all final mitigation construction activities, in accordance with the mitigation work plan and in accordance with final project plans and specifications. Such activities could include, but are not limited to: degrading temporary retention dikes such that the areas occupied by these dikes have a surface elevation equivalent to the desired target marsh elevation; completion of armoring, if required, of any permanent

dikes; “gapping” or installation of “fish dips” in permanent dikes; and construction of trenasses or similar features within marsh features as a means of establishing shallow water interspersion areas within the marsh. Finishing the aforementioned construction components would be considered as the “completion of final mitigation construction activities.” As noted previously, this is anticipated to occur approximately 1 year after placement of fill material in the mitigation feature is completed. The requirements stated herein classify as initial success criteria.

**2. Topography**

A. Upon completion of final mitigation construction activities (after 1 year dewatering, approximate Target Year 2) –

- Demonstrate that at least 80 percent of each mitigation feature has a surface elevation that is within 0.5 feet of the desired target surface elevation. This requirement classifies as an initial success criterion.

B. 1 Year following completion of final mitigation construction activities (approximate Target Year 3) –

- Demonstrate that at least 80 percent of the mitigation site has a surface elevation that is within 0.5 feet of the desired target surface elevation. This requirement classifies as an initial success criterion.

C. 3 years following completion of final mitigation construction activities (approximate Target Year 5) –

- Demonstrate that at least 90 percent of the mitigation site has a surface elevation that is within the functional marsh elevation range. This requirement classifies as an intermediate success criterion.

**3. Native Vegetation**

A. For intermediate marsh and brackish marsh restoration features –

- Complete initial marsh planting in accordance with applicable initial marsh planting guidelines. This requirement classifies as an initial success criterion.

B. For intermediate marsh and brackish marsh restoration features only; 1 year following completion of initial plantings–

- Attain at least 80 percent survival of planted species, or; Achieve a minimum average cover of 25 percent, comprised of native herbaceous species (includes planted species and volunteer species).
- Demonstrate that vegetation satisfies the USACE hydrophytic vegetation criteria. This criterion would thereafter remain in effect for the duration of the overall monitoring period.
- The requirements above classify as initial success criteria; with the exception that the requirement to demonstrate vegetation satisfies the USACE hydrophytic vegetation criteria throughout the duration of the overall monitoring period classifies as a long-term success criterion.

C. For intermediate marsh and brackish marsh restoration features; 3 years following completion of initial plantings –

- Achieve a minimum average cover of 75 percent, comprised of native herbaceous species (includes planted species and volunteer species). This requirement classifies as an intermediate success criterion.

D. For all marsh restoration features (intermediate and brackish) –

- For the period beginning 5 years following completion of final mitigation construction activities and continuing through 20 years following completion of final mitigation construction activities, maintain a minimum average cover of 80 percent, comprised of native herbaceous species. This requirement classifies minimum average cover of 80 percent, as a long-term success criterion.

**4. Invasive and Nuisance Vegetation**

A. Complete the initial eradication of invasive and nuisance plant species within 1 year of completion of final mitigation construction activities. This requirement classifies as an initial success criterion.

B. Maintain all areas such that they are essentially free from invasive and nuisance plant species immediately following a given maintenance event and such that the total average vegetative cover accounted for by invasive and nuisance species each constitute less than 5 percent of the total average plant cover during periods between maintenance events. These criteria must be satisfied throughout the duration of the overall monitoring period. Until such time that monitoring responsibilities are transferred from the USACE to the NFS, this requirement classifies as an initial success criterion. Following the transfer of monitoring responsibilities, this requirement classifies as a long-term success criterion.

## MITIGATION MONITORING GUIDELINES

The guidelines for mitigation monitoring provided herein are applicable to all the types of marshes being restored (i.e. intermediate and brackish), unless otherwise indicated.

Baseline Monitoring Report

The mitigation sites will be monitored and a baseline monitoring report prepared for each marsh site (Bayou Sauvage, Turtle Bayou, and New Zydeco). Shortly after completion of all initial mitigation activities (e.g. initial eradication of invasive plants, first/initial planting of native species, completion of initial earthwork, grading, surface water management system alterations/construction, etc.), the mitigation sites will be monitored and a baseline or monitoring report will be prepared for each site (Bayou Sauvage, Turtle Bayou, and New Zydeco). The New Zydeco BLH-Wet and marsh projects may be combined into 1 report with a section for each habitat type. Monitoring and reporting requirements for the baseline reports include the following items:

A. A detailed discussion of all mitigation activities completed.

B. A plan view drawing of the mitigation site showing the approximate boundaries of the restored marsh features, monitoring transect locations, sampling quadrat locations, photo station locations, and staff gage locations is provided in Figures 3, 5, 7, and 9. The exact locations will be determined and documented using GPS coordinates and coordinated with the USACE, CRPA, and Interagency Team during the initial site visit and the baseline monitoring event. If aerial imagery of the mitigation site is available, it will also be included.

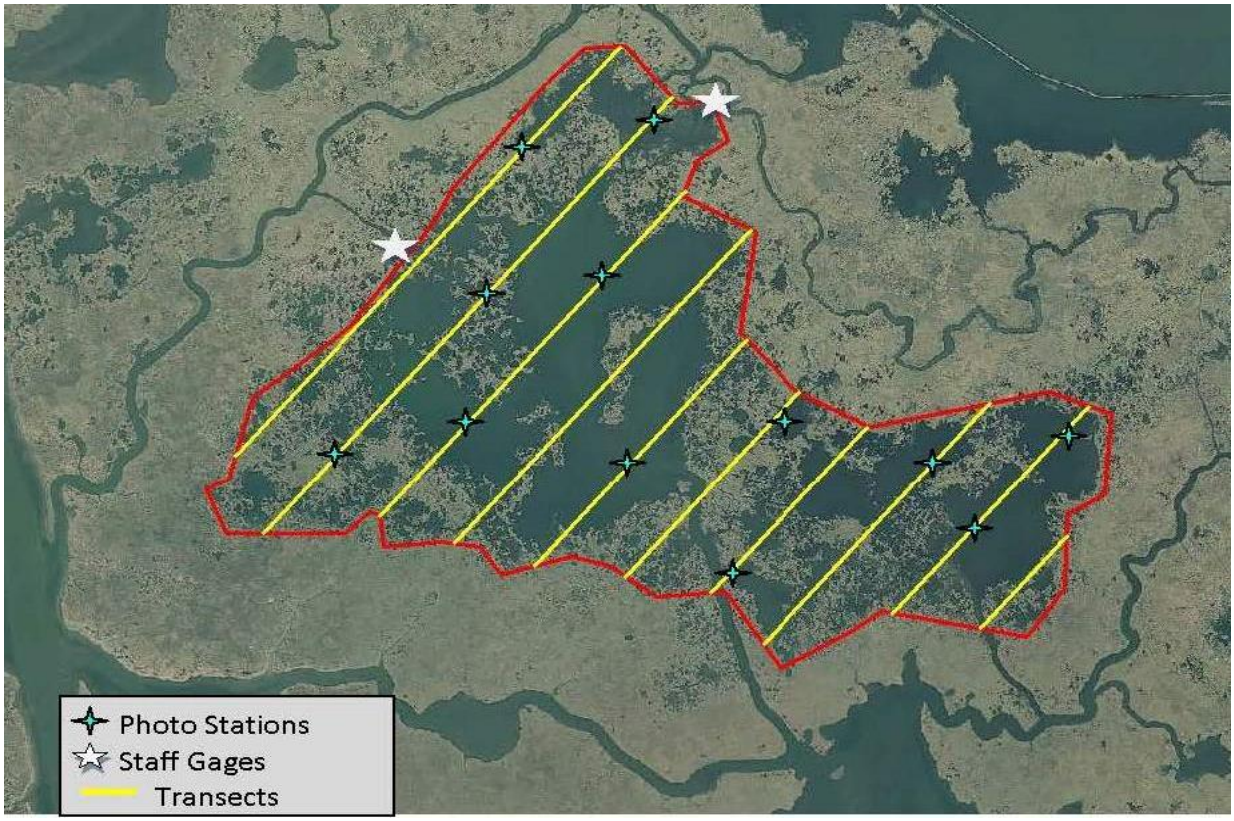


**Figure 3. Areas of interest for monitoring plan design at Bayou Sauvage. A minimum of 140 quadrats would be established for this 280 acre site.**

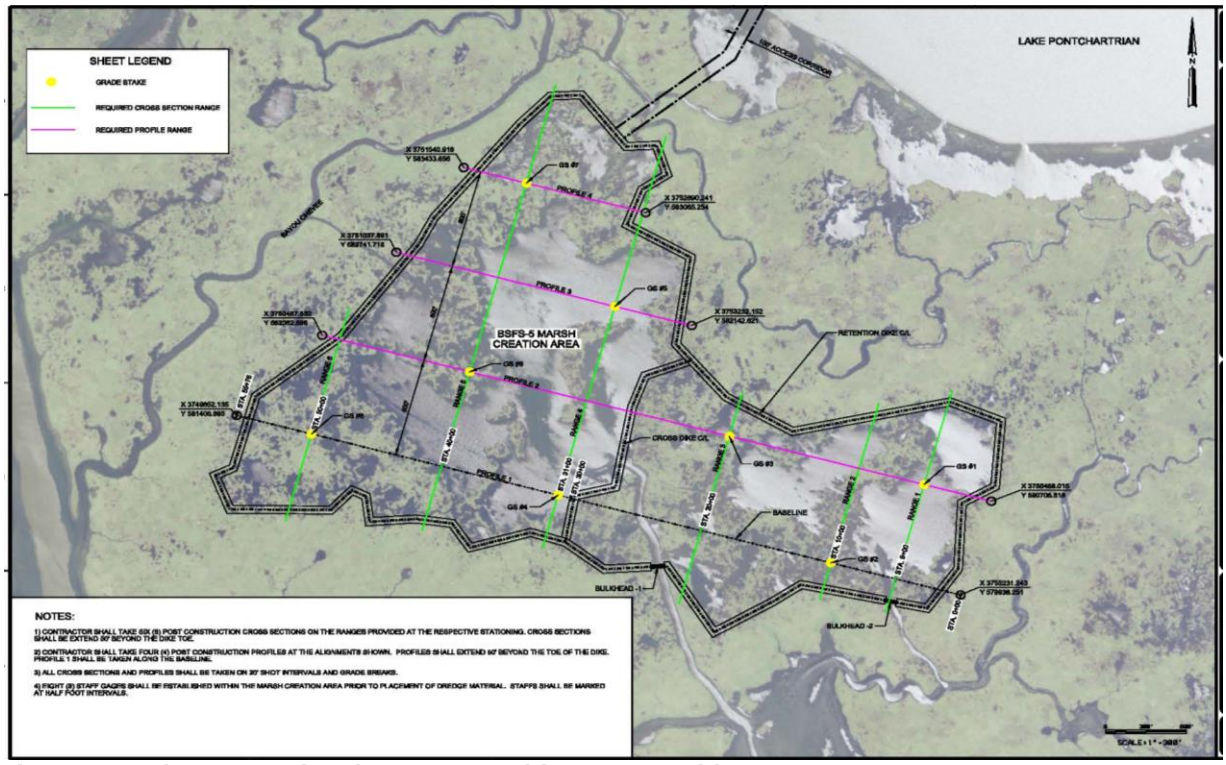


**Figure 4. Project Area Showing Topographic Survey Grid**

**Figure 5. Areas of interest for monitoring plan design at Bayou Sauvage. A minimum of 29 quadrats would be established for this 58 acre site.**

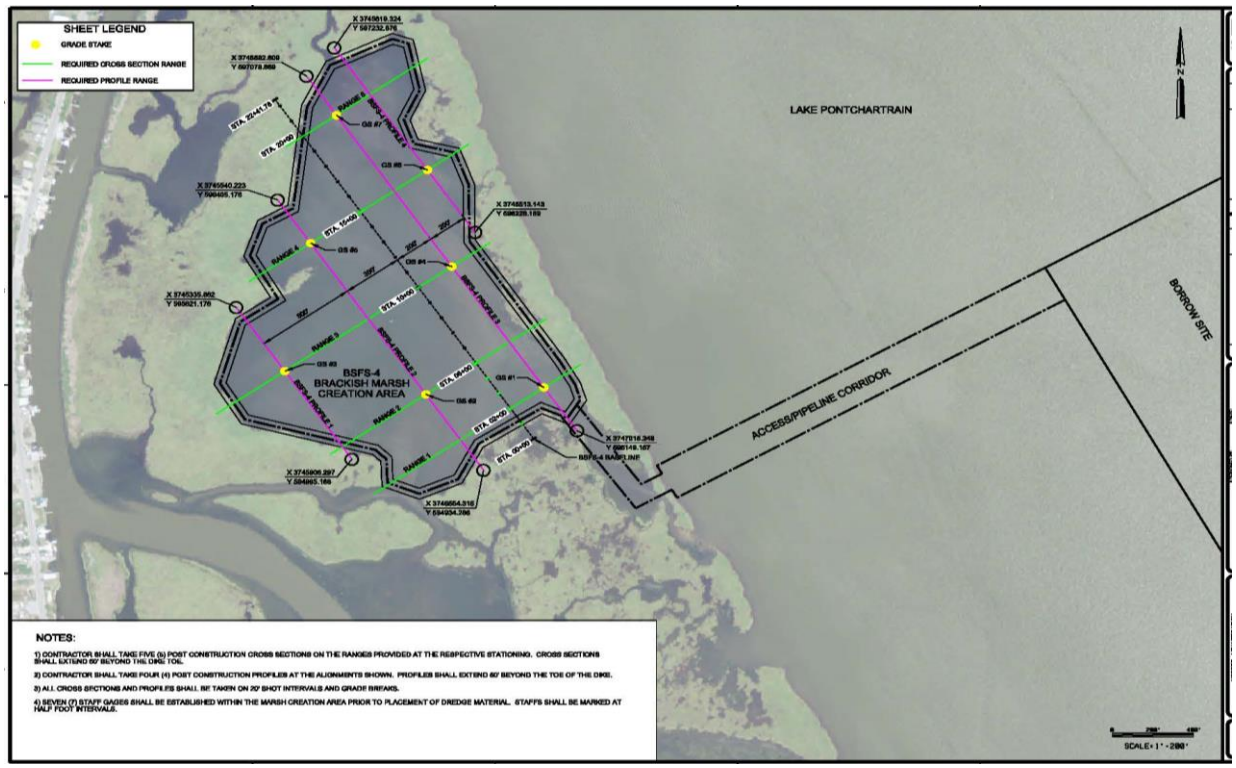


**Figure 6. Project Area Showing Topographic Survey Grid**

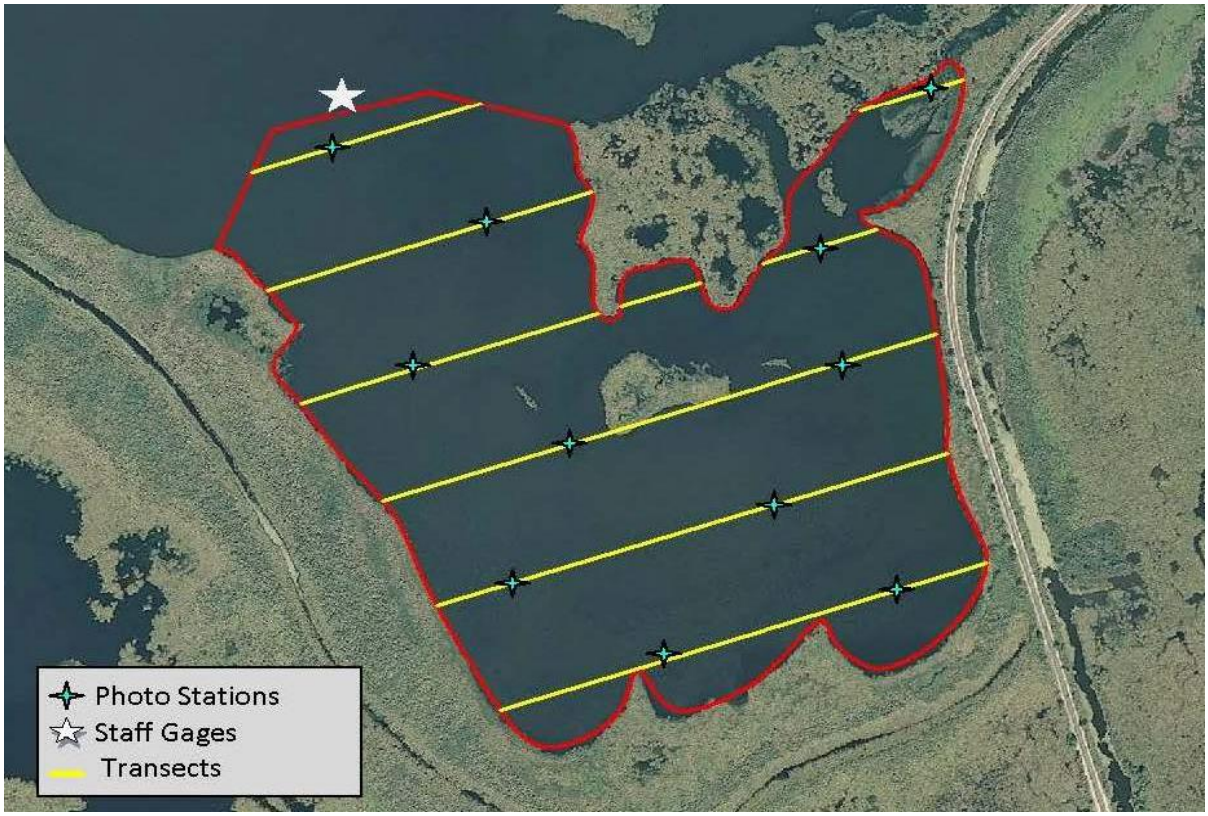


**Figure 7. Areas of interest for monitoring plan design at Turtle Bayou. A minimum of 65 quadrats would be established for this 130 acre site.**

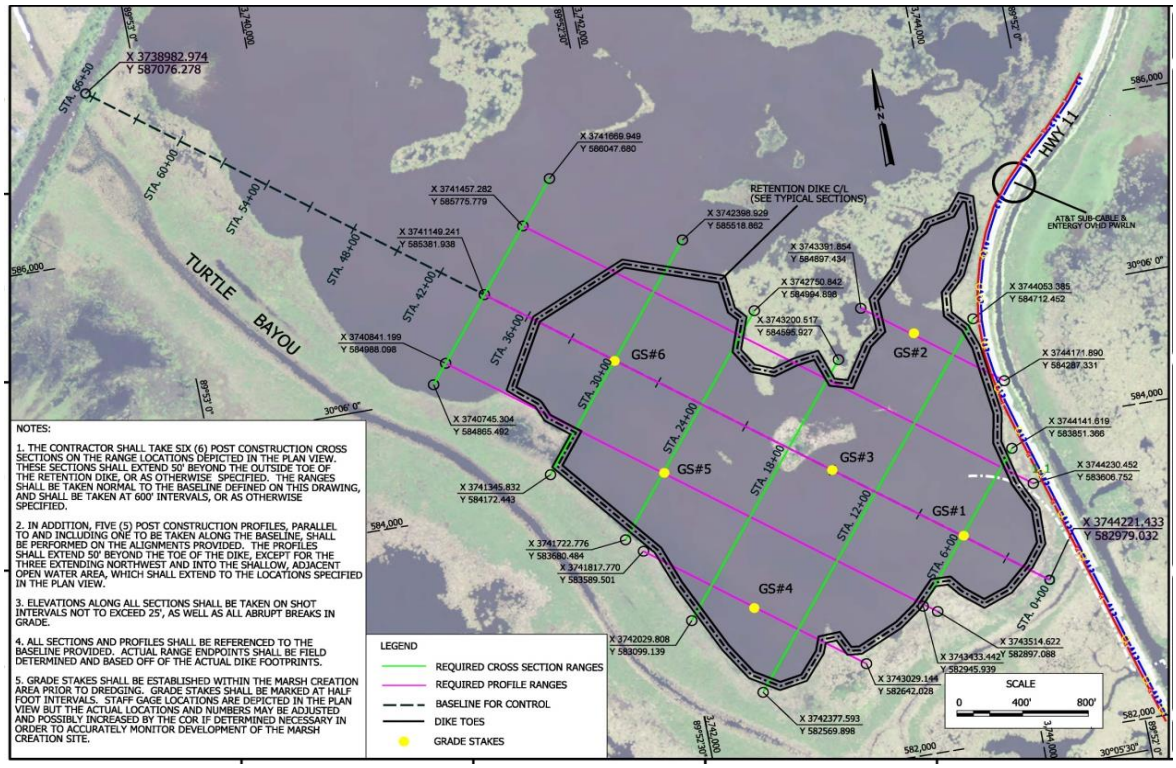


**Figure 8. Project Area Showing Topographic Survey Grid**

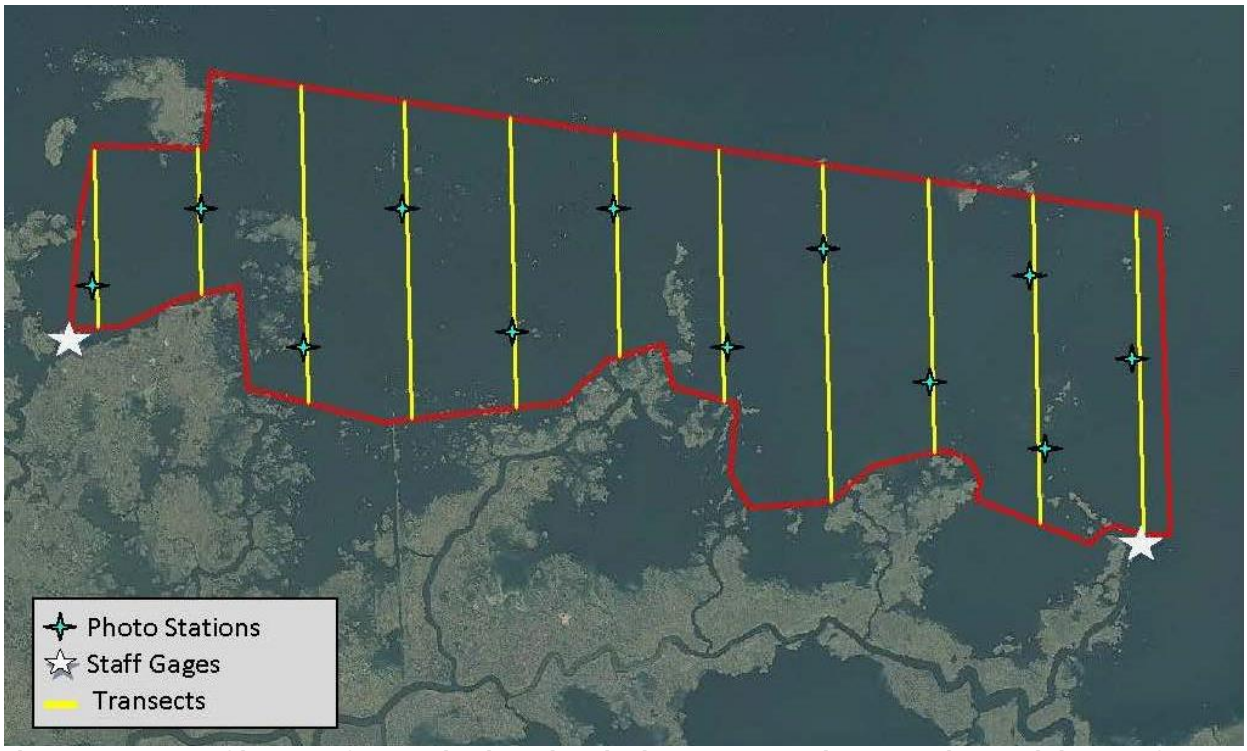


**Figure 9. Areas of interest for monitoring plan design at New Zydeco Marsh. A minimum of 80 quadrats would be established for this 160 acre site.**

C. An as-built survey of surface elevations (topographic survey) within each marsh feature, along with an as-built survey of any permanent dikes constructed as part of the marsh restoration features including any “gaps” or “fish dips” established in such dikes. The layout of the as-built surveys is shown on figures 2, 4, 6, and 8. If a particular marsh feature is immediately adjacent to existing marsh habitat, the topographic survey will include spot elevations collected within the existing marsh habitat near the restored marsh feature. In addition to the survey data, an analysis of the data will be provided addressing attainment of topographic success criteria.

D. Photographs documenting conditions in each restored marsh feature at the time of monitoring. Photos will be taken at permanent photo stations within the marsh features. At least two photos will be taken at each station with the view of each photo always oriented in the same general direction from one monitoring event to the next. The number of photo stations required as well as the locations of these stations will vary depending on the mitigation site and will be finalized during the baseline monitoring event. Figures 3, 5, 7, and 9 illustrate potential locations and areas of interest for the photo stations and should represent the minimal number of stations.

E. Water level elevation readings collected at the time of monitoring from a single staff gage installed right outside of each of the restored marsh features. The final location of the staff gage will be determined during the initial site visit and

installation of the gauges. Potential areas of interests for the gages are indicated in Figures 3, 5, 7, and 9. The monitoring report will provide the staff gage data along with mean high and mean low water elevation data as gathered from a tidal elevation recording station in the general vicinity of the mitigation site (the stations will be identified and referenced within the monitoring report). The report will further address estimated mean high and mean low water elevations at the mitigation site based on field indicators such as observations of inundation, soil saturation, water marks, drift lines, sediment deposits or drainage patterns.

F. Various qualitative observations will be made in the mitigation site to help assess the status and success of mitigation and maintenance activities. These observations will include: general estimate of the average percent cover by native plant species; general estimates of the average percent cover by invasive and nuisance plant species; general observations concerning colonization of the mitigation site by volunteer native plant species; general condition of native vegetation; trends in the composition of the plant community; wildlife utilization as observed during monitoring (including fish species and other aquatic organisms); the condition of interspersion features (tidal channels, trenasses, depressions, etc.) constructed within the marsh features, noting any excessive scouring and/or siltation occurring within such features; the natural formation of interspersion features within restored marshes; observations regarding general surface water flow characteristics within marsh interspersion features; the general condition of “gaps”, “fish dips”, or similar features constructed in permanent dikes; if present, the general condition of any armoring installed on permanent dikes. General observations made during the course of monitoring will also address potential problem zones and other factors deemed pertinent to the success of the mitigation program.

G. Quantitative data concerning plants in the ground cover stratum. Data will be collected from permanent sampling quadrats established at approximately equal intervals along permanent monitoring transects established within each marsh feature. Each sampling quadrat will be approximately 2 meters X 2 meters in size, although the dimensions of each quadrat may be increased if necessary to provide better data if planted marsh features are added after initial construction. The number of monitoring transects and number of sampling quadrats per transect will vary depending on the mitigation site and will be finalized during the initial site visit and coordinated with the USACE, but should consist of at least one quadrat per 2 acres. A conceptual design showing areas of interest for the transects is provided in Figures 3, 5, 7, and 9, these should represent the minimal number of transects. The methodology and locations chosen for the initial monitoring report must be followed for all subsequent reports.

Data recorded from the sampling quadrats will include:

- average percent cover by native plant species;
- average percent cover by invasive plant species;
- average percent cover by nuisance plant species;

- composition of plant species and the wetland indicator status of each species

H. A summary assessment of all data and observations along with recommendations as to actions necessary to help meet mitigation and management/maintenance goals and mitigation success criteria.

I. A brief description of anticipated maintenance/management work to be conducted during the period from the current monitoring report to the next monitoring report.

**Additional Monitoring Reports**
All monitoring reports generated after the initial baseline report will provide the following information unless otherwise noted:

J. All items listed for the time zero baseline monitoring report.

K. A brief description of maintenance and/or management work performed since the previous monitoring report along with a discussion of any other significant occurrences.

L. In addition to the above items, the monitoring report prepared for 1 year following completion of mitigation construction activities and the monitoring report prepared for TY 3 and 5 will include a topographic survey of each marsh restoration feature. These surveys will cover the same components as described for the topographic survey conducted for the baseline monitoring report. In addition to the surveys themselves, each of the two monitoring reports involving topographic surveys will include an analysis of the data as regards attainment of applicable topographic success criteria. If the second survey indicates topographic success criteria have not been achieved and supplemental topographic alterations are necessary, then another topographic survey may be required following completion of the supplemental alterations. This determination will be made by the USACE in coordination with the Interagency Team.

M. Although not proposed in the initial mitigation plan, plantings of herbaceous species within the restored marsh features may also be necessary to attain applicable native vegetation success criteria. Any monitoring report submitted following completion of initial plantings must include an inventory of the number of each species planted and the stock size used. It must also include a depiction of the areas planted cross-referenced to a listing of the species and number of each species planted in each area.

### Monitoring Reports Following Re-Planting Activities in Intermediate or Brackish Marsh Features

Re-planting of certain areas within restored intermediate and/or brackish marsh habitats may be necessary to ensure attainment of applicable native vegetation success criteria. Any monitoring report submitted following completion of a re-planting event must include an inventory of the number of each species planted and the stock size used. It must also include a depiction of the areas re-planted, cross-referenced to a listing of the species and number of each species planted in each area.

## MITIGATION MONITORING SCHEDULE AND RESPONSIBILITIES

Monitoring would typically take place in mid to late summer of the year of monitoring, but may be delayed until later in the growing season due to site conditions or other unforeseen circumstances. Monitoring reports would be submitted by December 31 of each year of monitoring. Monitoring reports would be provided to the USACE, the NFS, and the agencies comprising the Interagency Team. The various monitoring and reporting responsibilities addressed in this section are all subject to the provisions set forth in the Introduction section.

The USACE would be responsible for conducting the monitoring events and preparing the associated monitoring reports until such time that the following mitigation success criteria are achieved (criteria follow numbering system used in success criteria section):

1. General Construction – A and B.
2. Topography – A and B.
3. Native Vegetation – For intermediate marsh and brackish marsh features, criteria 3.A and 3.B
4. Invasive & Nuisance Vegetation – A, plus B until monitoring responsibilities are transferred to the NFS.

Monitoring events associated with the above would include the “time zero” (first or baseline) monitoring event (estimated in TY2, 2019) and a second monitoring event 1 year after the time zero monitoring event (estimated in TY3, 2020). The USACE would be responsible for conducting these monitoring activities and preparing the associated monitoring reports.

The NFS would be responsible for conducting the required monitoring events and preparing the associated monitoring reports after the USACE has demonstrated the initial mitigation success criteria listed above have been achieved. Once monitoring responsibilities have been transferred to the NFS, the next monitoring event should take place in 2022 (TY5) in order to demonstrate attainment of success criteria 2.C and 3.C. Thereafter, monitoring would be conducted every 5 years throughout the remaining 50-year period of analysis (based on 50-year period of analysis beginning in 2016 (TY0) and ending in 2067 (TY50)).

In certain cases it is possible that the marsh mitigation features may be established along with other mitigation features, like swamp or bottomland hardwood habitats, at the same mitigation site. This scenario could require some adjustments to the typical monitoring schedule described previously in order to develop a reasonable and efficient monitoring schedule that covers all the mitigation features. Such adjustments, if necessary, must be in general accordance with the guidance provided above and would be prepared by the USACE in coordination with the Interagency Team and the NFS.

If certain success criteria are not achieved, failure to attain these criteria would trigger the need for additional monitoring events not addressed in the preceding paragraphs. The USACE would be responsible for conducting such additional monitoring and preparing the associated monitoring reports until the mitigation site satisfies all initial success criteria. The following lists instances requiring additional monitoring that would be the responsibility of the USACE:

(A) For intermediate and brackish marsh features –

- If the initial survival criterion for planted species or the initial vegetative cover criterion are not achieved (i.e. the criteria specified in success criteria 3.C), a monitoring report would be required for each consecutive year until two sequential annual reports indicate that the applicable survival criterion or vegetative cover criteria have been satisfied (i.e. that corrective actions were successful). The USACE would also be responsible for the purchase and installation of supplemental plants needed to attain the success criteria.

(B) For all types of marsh features (intermediate, brackish) –

- If topographic success criteria 2.A or 2.B are not achieved, a monitoring report would be required for each consecutive year until two sequential annual reports indicate the applicable criteria have been satisfied. Since failure to meet topographic success criteria would mandate corrective actions such as addition of fill, removal of fill, or other actions to change grades within the subject marsh feature, the USACE would also be responsible for performing the necessary corrective actions.

There could also be cases where failure to attain certain success criteria would trigger the need for additional monitoring events for which the NFS would be responsible:

(A) For intermediate and brackish marsh features –

- If the vegetative cover criterion specified for 3 years after the initial planting of marsh features is not achieved (i.e. success criterion 3.E), a monitoring report would be required for each consecutive year until two sequential annual reports indicate that the vegetative cover criterion has been satisfied. The Sponsor would also be responsible for the purchase and installation of supplemental plants needed to attain the success criterion.

(C) For all types of marsh features (intermediate, brackish) –

- If the topographic success criterion 2.C is not achieved, a monitoring report would be required for each consecutive year until two sequential annual reports indicate success criteria have been satisfied. Since failure to meet this topographic success criteria would mandate corrective actions such as addition of fill, removal of fill, or other actions to change grades within the subject marsh feature, the Sponsor would also be responsible for performing the necessary corrective actions.

- Native vegetation success criterion 3.D is applicable to the period extending from 5 years through 20 years following completion of mitigation construction activities and is applicable to all marsh features. If this criterion is not satisfied at the time of monitoring, the NFS would be responsible for implementing corrective actions. Such actions could include installing additional plants in the subject marsh (probable course of action), adding sediment to the subject marsh in problem zones (marsh nourishment), or a combination of these activities. Under this scenario, a monitoring report would be required for each consecutive year following completion of the corrective actions until two sequential annual reports indicate that the vegetative cover criterion has been attained. The NFS would be responsible for conducting these additional monitoring events and preparing the associated monitoring reports.

Once monitoring responsibilities have been transferred to the NFS, the NFS would retain the ability to modify the monitoring plan and the monitoring schedule should this become necessary due to unforeseen events or to improve the information provided through monitoring. Twenty years following completion of mitigation construction activities, the number of monitoring transects and/or quadrats that must be sampled during monitoring events may be reduced if it is clear that mitigation success is proceeding as anticipated. Any significant modifications to the monitoring plan or the monitoring schedule must first be approved by the USACE in coordination with the Interagency Team.

## MITIGATION MONITORING COSTS

Table 6 provides a cost estimate based on the currently available information and may need to be revised in the future as additional information regarding the mitigation feature designs and construction schedule become available.

**Table 6. Estimated Monitoring Costs for Marsh Projects (Bayou Sauvage, Turtle Bayou and New Zydeco)**

| Target Year | Calendar Year | Work Item | Work Item Description | Cost |
|---|---|---|---|---|
| | | | | |
| **0** | **2016** | Begin Initial Construction | Start of mitigation construction activities (approx. Aug 1, 2016). | |
| | | | | |
| **1** | **2018** | Complete Initial Construction | Finish retention dikes, placement of dredged material (approx. Jan 23rd - 16 months after start of construction). | |
| | | | | |

| | | | | |
|---|---|---|---|---|
| **2** | **2019** | Begin Final Construction | Approx. Jan 8th (1 year after completion of initial construction). Area settles to target grade. Begin: degrading/gapping dikes; installing fish dips in rip-rap dikes as applicable; forming trenasses, interspersion features. | |
| | | Topographic Survey | Perform as-built topographic survey of restored marsh areas. Results documented in mitigation monitoring report. | |
| | | Initial Plantings | Initial (first) planting of restored marsh features. Install herbaceous species (start approx. March 15th, simultaneously with "begin final construction"). | |
| | | End Final Construction | Approx. May 2 (4 months after begin final construction). Completion of activities above. | |
| | | Analysis for Notice of Construction Complete | Review As-Builts and O&M manual | |
| | | **NCC** | Notice of Construction Complete issued to the Non-Federal Sponsor. The USACE will continue to monitor and conduct activities necessary to ensure initial success criteria are met | |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | |
| | | | | |
| **3** | **2020** | Topographic Survey | Perform topographic survey of restored marsh areas. Results documented in mitigation monitoring report (one year after as-built topographic survey). | |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | |
| | | | | |
| **4** | **2021** | Aerial Photography | Obtain rectified aerial photo of restored marsh areas if available. Provide as part of mitigation monitoring report. | |
| | | Analysis for satisfaction of initial success criteria. | Review monitoring report from prior year and other data to make determination to completely turn over project to Non-Federal Sponsor. (Jan.) | |
| | | **NFS Begins Monitoring** | Non-Federal Sponsor assumes monitoring responsibility in addition to other OMRR&R responsibilities (Feb. thru April?). Note: transfer of monitoring occurs early this year unless topographic corrections and/or marsh planting required. | |
| | | | | |
| **5** | **2022** | Topographic Survey | Perform topographic survey of restored marsh areas. Results documented in mitigation monitoring report. | $50,000 |
| | | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $95,584 |
| | | | | |
| **10** | **2027** | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $95,584 |
| | | | | |
| **15** | **2032** | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $95,584 |
| | | | | |
| **20** | **2037** | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $95,584 |
| | | | | |
| **25** | **2042** | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $95,584 |
| | | | | |
| **30** | **2047** | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $95,584 |
| | | | | |

| | | | | |
|---|---|---|---|---|
| **35** | **2052** | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $95,584 |
| | | | | |
| **40** | **2057** | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $95,584 |
| | | | | |
| **45** | **2062** | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $95,584 |
| | | | | |
| **50** | **2067** | Monitoring & Report | Perform field mitigation monitoring (Sept.? Oct.?). Submit report by Dec. 31. | $95,584 |
| | | | | |
| | | | Total cost during OMRR&R Phase (after NFS begins monitoring) | $1,005,840 |
| | | | Total cost during OMRR&R Phase (after NFS beigns monitoring) + 25% | $1,257,300 |
| | | | | |

## DEFINITION OF TERMS

***Growing Season***
As used herein, the growing season is considered to be the period from April through October of any given year, although some deviation from this typical range is allowed.

***Interagency Team***
The "Interagency Team" consists of representatives from the following resource agencies; US Fish and Wildlife Service, National Marine Fisheries Service, US Environmental Protection Agency, Louisiana Department of Wildlife and Fisheries, State of Louisiana Office of Coastal Protection and Restoration, Louisiana Department of Natural Resources.

***Interspersion Features***
This term refers to shallow open water features situated within marsh habitats. Examples include tidal channels, creeks, trenasses, and relatively small, isolated ponds. Emergent vegetation is typically absent in such features although they may contain submerged aquatic vegetation. They provide areas of foraging and nursery habitat for fish and shellfish along with associated predators, and provide loafing areas for waterfowl and other waterbirds. The marsh/open water interface forms an ecotone where post-larval and juvenile organisms can find cover and where prey species frequently concentrate.

***Invasive Plant Species***
All plant species identified as invasive or as non-indigenous (exotic) in the following two sources:

> Louisiana Aquatic Invasive Species Task Force. 2005. State Management Plan for Aquatic Invasive Species in Louisiana, Appendix B. Invasive Species in Louisiana (plants). Center for Bioenvironmental Research,

Tulane & Xavier Universities, New Orleans, LA. (Website - http://is.cbr.tulane.edu/docs_IS/LAISMP7.pdf)

Barataria-Terrebonne National Estuary Program (BTNEP). 2012. Exotic Invasive Species of the Barataria-Terrebonne, Invasive Species in Louisiana. BTNEP, Thibodaux, LA. (Website – http://invasive.btnep.org/invasivesvsnatives/invasivesinla2list.aspx)

In addition, invasive plant species include; Japanese climbing fern (*Lygodium japonicum*), tall fescue (*Festuca arundinacea*), chinaberry (*Miscanthus sinensis*), Brazilian vervain (*Verbena litoralis* var. *brevibrateata*), coral ardisia (*Ardisia crenata*), Japanese ardisia (*Ardisia japonica*), cogon grass (*Imperata cylindrical*), golden bamboo (*Phyllostachys aurea),* and rescuegrass (*Bromus catharticus*).

***Native Plant Species***
This category includes all plant species that are not classified as invasive plant species and are not considered to be nuisance plant species.

***Non-Federal Sponsor (NFS)***
This term refers to the Non-Federal Sponsor for the mitigation projects. In this case, the NFS is the Louisiana Coastal Protection & Restoration Authority Board (CPRAB).

***Nuisance Plant Species***
Nuisance plant species would include native species deemed detrimental due to their potential adverse competition with desirable native species. Nuisance plant species identified for the mitigation project include; dog-fennel (*Eupatorium* spp.), ragweed (*Ambrosia* spp.), cattail (*Typha* spp.), grapevine (*Vitis* spp.), wild balsam apple (*Momordica charantia*), climbing hempvine (*Mikania scandens, M. micrantha*), pepper vine (*Ampelopsis arborea*), common reed (*Phragmites australis*), catbrier (*Smilax* spp.), blackberry (*Rubus* spp.), black wouldow (*Salix nigra*), and box elder (*Acer negundo*). Following completion of the initial mitigation activities (e.g. placement of fill, initial plantings), the preceding list may be expanded to include other nuisance plant species. Any such addition to the list would be based on the results of the standard monitoring reports. The determination of whether a particular new plant species should be considered as a nuisance species and therefore eradicated or controlled would be determined by the USACE in coordination with the NFS and Interagency Team.

***Planting Season***
This is generally considered to be the period from approximately December 15 through March 15, although some deviation from this typical range is allowed.

***Target Year***
This document often refers to a "Target Year." Target Years are the years in which construction or monitoring activities are expected to occur, based on Target Year 1 as the year in which the initial mitigation construction activities are anticipated to be completed, which is presently estimated to occur in calendar year 2016. Target Year 2 (2017) is the year in which the final construction contract is expected to be completed. Target years increase from this time forward in concert with the corresponding calendar year.

***USACE Hydrophytic Vegetation Criteria***
Reference to satisfaction of the USACE hydrophytic vegetation criteria (i.e. plant community is dominated by hydrophytic vegetation) shall mean that sampling of the plant community demonstrates that one or more of the hydrophytic vegetation indicators set forth in the following reference is achieved:

> USACE. 2010. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0); ERDC/EL TR-10-20. USACE Engineer Research and Development Center, Vicksburg, MS.

***Wetland Indicator Status of Plant Species***
The wetland indicator status of plants is a means of classifying the estimated probability of a species occurring in wetlands versus non-wetlands. Indicator categories include; obligate wetland (OBL), facultative wetland (FACW), facultative (FAC), facultative upland (FACU), and obligate upland (UPL). The wetland indicator status of a particular plant species shall be as it is set forth in the following reference (the "2012 National Wetland Plant List"), using the Region 2 listing contained therein. If the USACE approves and adopts a new list in the future, the new list would apply.

> Lichvar, Robert W. and J.T. Kartesz. 2009. North American Digital Flora: National Wetland Plant List, version 2.4.0 (https://wetland_plants.usace.army.mil). USACE, Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH and BONAP, Chapel Hill, NC.