

EAST LEEVILLE MARSH CREATION  
AND NOURISHMENT PROJECT  
BA-194  
Lafourche Parish

FEASIBILITY STUDY  
TECHNICAL REPORT

August 7, 2017



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## Introduction

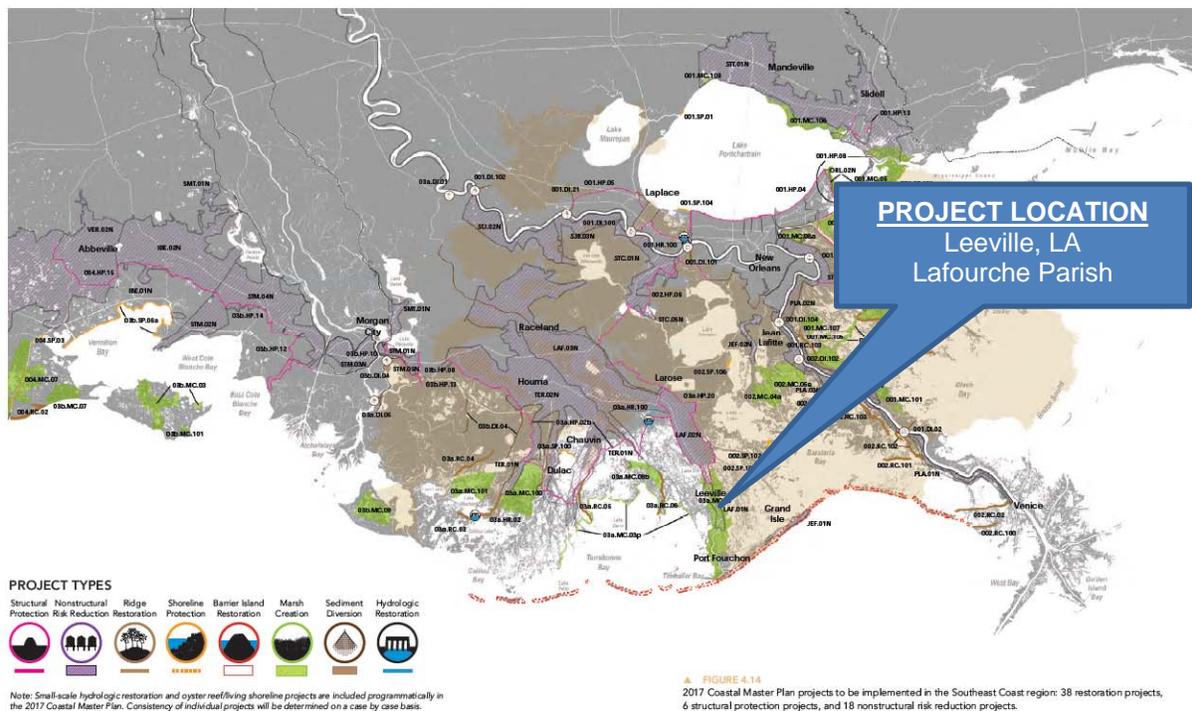
The East Leeville Marsh Creation and Nourishment Project (BA-194) is funded by the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) under Priority Project List 25 in partnership with the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS). The Coastal Protection and Restoration Authority (CPRA) is serving as the local sponsor and is also performing the engineering and design work.

The project site is located in Lafourche Parish, Louisiana, approximately 1 to 3 miles east of Leeville. The proposed project area is bisected by the Southwest Louisiana Canal. The approximate coordinates of the center of the project areas are: 29° 15' 18"N and 90° 11' 20"W.

4: 2017 COASTAL MASTER PLAN

4: 2017 COASTAL MASTER PLAN

### SOUTHEAST COAST PROJECTS



**Figure 1: Project Location**

This project area and surrounding areas are experiencing widespread and rapid land loss resulting from oil and gas exploration, subsidence, wind and wave erosion, storms, and altered hydrology. The limits of Southwestern Louisiana Canal have become difficult to determine in some areas because land loss is causing the coalescence of the canal with adjacent water bodies. A large section of the western bank of the South Lake has been lost, increasing wave fetch and further coalescence of natural lakes with adjacent waters that were once marsh. Natural tidal flow and drainage patterns which once existed are currently circumvented by the increasing area of open water. The wetland loss rate for the project area is -1.53% per year based on USGS data from 1984 to 2015. Data suggests that from 1932 to 1990, the basin lost over 245,000 ac of marsh, and from 1978 to 1990, Barataria Basin experienced the highest rate of wetland loss along the entire coast. (BA-194 Fact Sheet)

The overall goal of the project is to establish an arc of wetlands along the northern side of the Southwestern Canal, Lake Jesse, and the west side of South Lake. This is to begin rebuilding the structural framework of wetlands east of Leeville and provide protection for Leeville from southeasterly winds and tides.

The objective of the project is to create and/or nourish up to 500 acres of marsh by hydraulically dredging material from a nearby borrow source and pumping it to designated fill sites. The fill sites will be formed by constructing earthen dikes around the boundaries of the marsh creation areas. The earthen dikes will be constructed with a mechanical dredge utilizing in-situ borrow material.

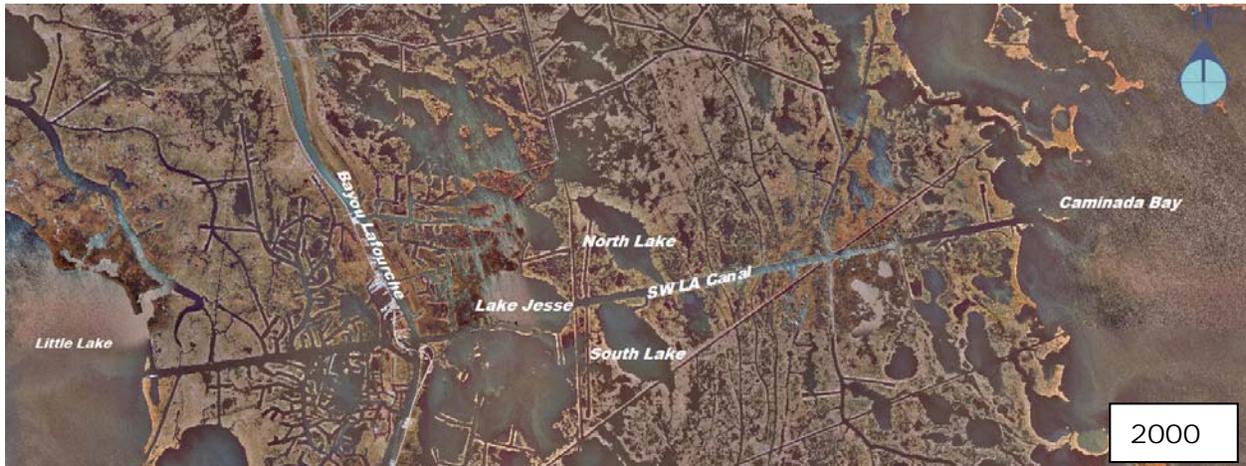


Figure 2: Project Area

The marsh creation sites included in the PPL-25 presentations are shown below:

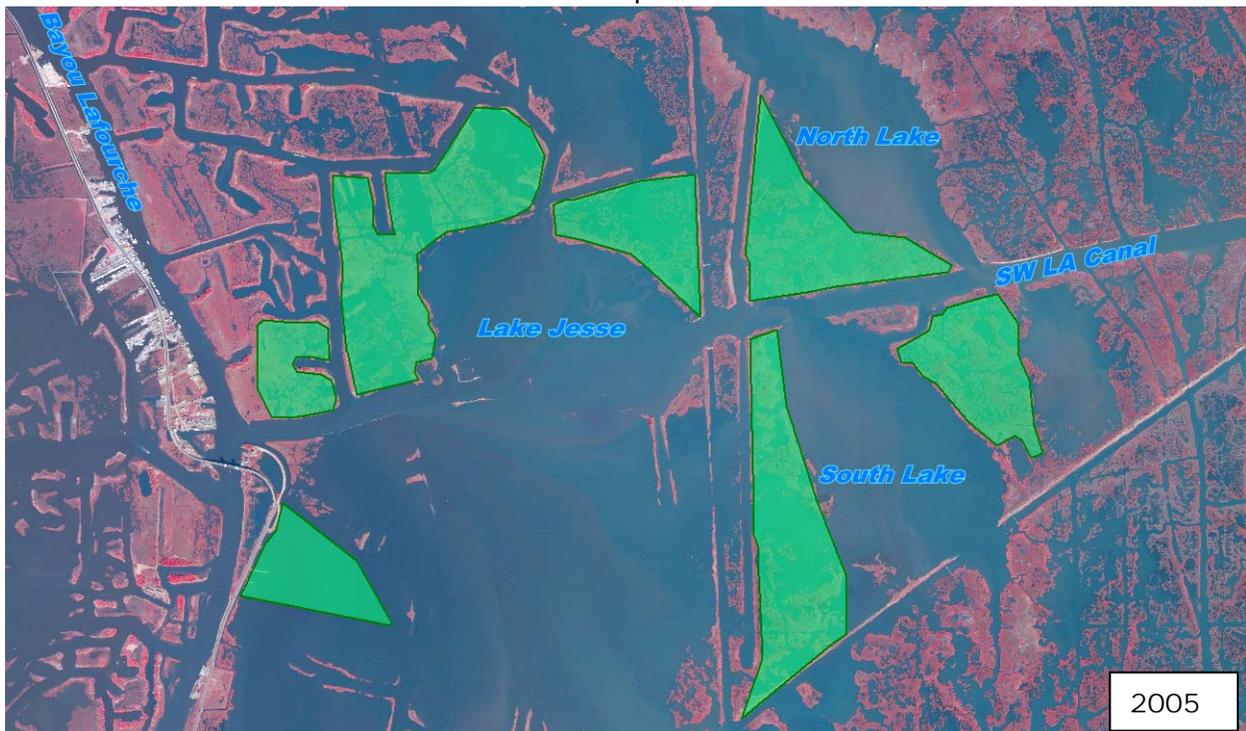


Figure 3: Project Priority List 25 Marsh Creation Areas

Sigma Consulting Group, Inc. was contracted by CPRA to perform a feasibility assessment and alternatives development for the proposed project. The recommended alternatives provide a cost-effective solution to achieve the project goals and objectives as described above. These alternatives include multiple marsh fill sites, dredge borrow sites, dredge pipeline corridors, and construction equipment access routes.

## **Site Background and Historical Setting**

Louisiana's deltaic plain was created by progradation of a series of Mississippi River courses and delta. During the last 9,000 years, a series of delta complexes were formed—one of them being The Lafourche Delta Complex. The Lafourche Delta Complex was responsible for the geomorphic development of southern Lafourche Parish. For over a thousand years, Bayou Lafourche flowed from the Mississippi River to the Gulf of Mexico at Fourchon.

“Bayou Lafourche carried some Mississippi River water until 1906 when it was dammed off from the Mississippi at its head at Donaldsonville. As a result, the Lafourche delta has been deprived of fresh water. Rapid deterioration has occurred with tributary levees being reduced in height, width, and length and marshes have become ponds, lakes, and bays. The bayou was partially reconnected to the river in the 1950's with the installation of a pump/siphon station which averaged approximately 200 cfs.” (Chauvin 2006)

The Southwestern Louisiana Canal (SWLA Canal) was originally cut by the South Louisiana Canal and Navigation Company as part of a proposed major east-west waterway across the Lafourche delta. Construction began in 1879 and was completed in 1888. The canal was cut 30 feet wide and not less than four feet deep at mean tide.

“In 1951, the State of Louisiana acquired ownership of the SWLA Canal. The eastern section from Bayou Lafourche to Caminada Bay was dredged to give a depth of 9.5 feet below sea level and a bottom width of 90 feet. The spoil was placed 30 to 50 feet back from the water line. The western section, from Bayou Lafourche to Little Lake, was left in the original state and has not been dredged except at pipeline crossings.” (Doiron 1974)

As part of the design effort for the LA 1 Improvements Project performed by the Louisiana Department of Transportation and Development, Dr. Sherwood Gagliano investigated geological faulting in the project area (“Evaluation of Geological Fault Hazards along Proposed New Alignment of Hwy LA 1”, Coastal Environments, Inc.). Preliminary study results indicate both natural ground faults and ongoing geologically-based ground subsidence occur in the project area. Rates of vertical settlement of 0.2 ft. to over 0.5 ft. of ground settlement over 17 years have been identified.

All three lakes (Lake Jesse, North Lake and South Lake) included in the study area are natural lakes and are shown on the 1935 Mink Bayou and Leeville USGS quad maps. As shown in these maps, the area surrounding the lakes were virgin saline marshes with little or no man-made waterways other than the Southwestern Louisiana Canal.

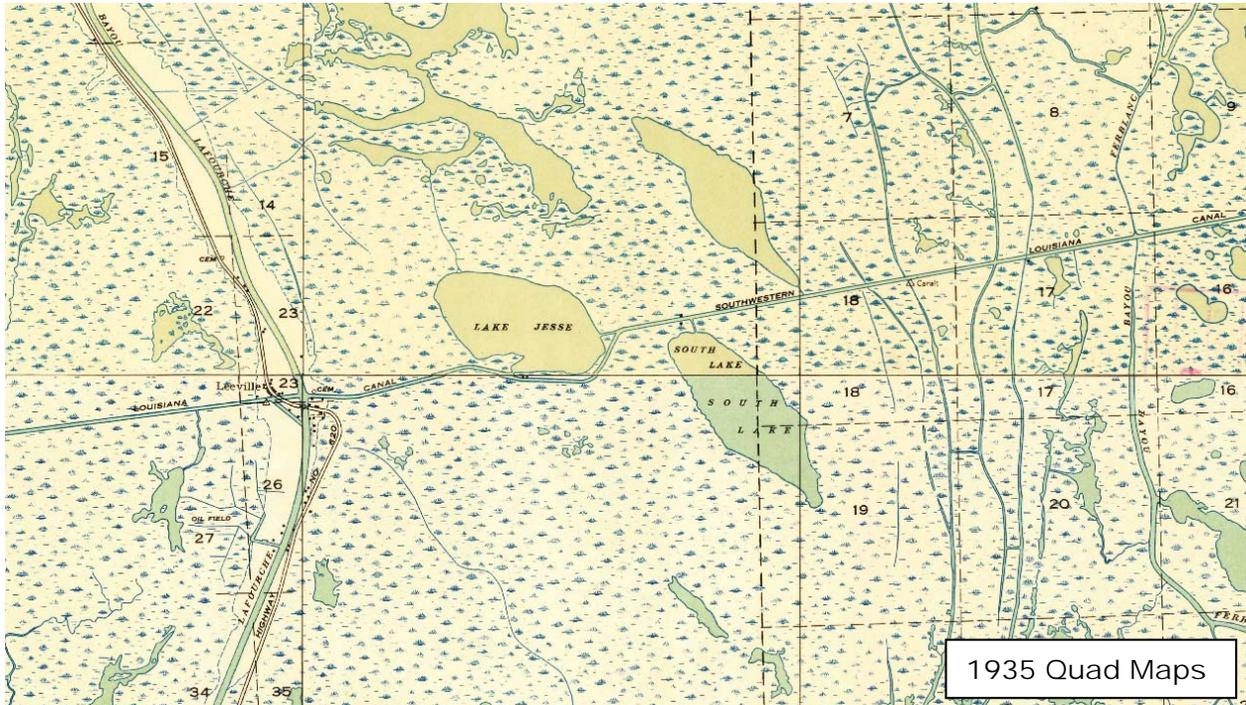


Figure 4: 1935 Mink Bayou and Leeville Quad Maps

Historical photography available for the project site was reviewed to determine changes in the landscape caused by various sources such as subsidence, marsh degradation, wave action from winds, tropical storms and hurricanes, oil and gas access canals, etc.



Figure 5: 1958 Aerial Photography of Project Area

The 1958 photography shows oil and gas access canals and existing saline marsh throughout the project area. The banks of the lakes are discernable from the SWLA Canal.



**Figure 6: 2005 Aerial Photography of Project Area**

The 2005 photography shows significant land loss south of Lake Jesse, diminishing saline marsh around the lakes, and additional oil and gas access canals in the project area.

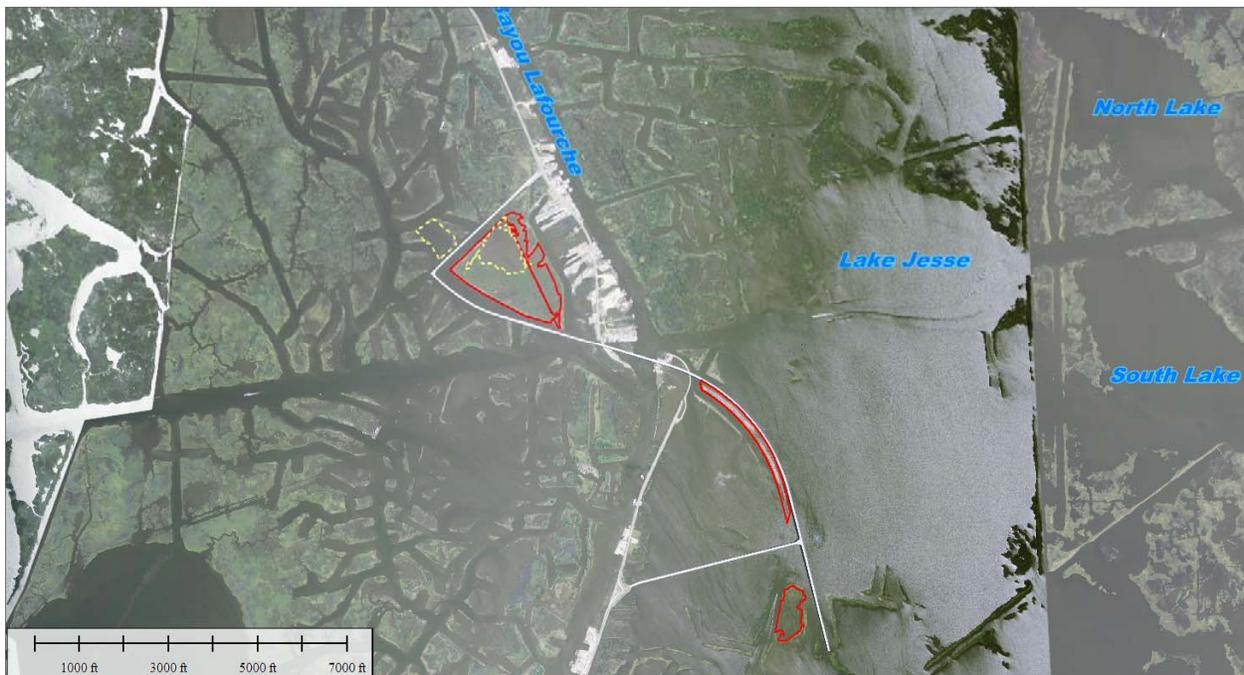


**Figure 7: 2015 Aerial Photography of Project Area**

The 2015 photography shows extensive degradation and loss of saline marsh throughout the project area. There is little or no differentiation between the limits of Lake Jesse and the banks of the SWLA Canal.

## LA1 Improvements Marsh Creation – Leeville LA

As part of the LA1 Improvements Project – Phase 1 which extends from Leeville to Fourchon, LA, the Louisiana Department of Transportation and Development created 77 acres of saline marsh in the Leeville area. This marsh creation was constructed in 2005 as mitigation for wetland impacts caused by the projects. The marsh creation consisted of several sites that were created using bucket dredging for containment berms and hydraulic dredging for filling. These sites were created prior to Hurricanes Katrina and Rita in 2005 and have sustained a 90% survivability over a 10 year period.



**Figure 8: LA1 Phase 1 Marsh Creation Sites**

These sites were constructed with similar site conditions and anticipated construction techniques as the BA-194 East Leeville project. The successful construction and survivability of these sites indicate a favorable feasibility and expectation for the proposed marsh creation in BA-194. Marsh creation sites self-vegetated within the first year. Settlement and average marsh elevations stabilized within the first year and remained consistent through the first 3 years. No maintenance dredging lifts were required to maintain the desired marsh elevation.



**Figure 9: 2015 Aerial View – Leeville Marsh Creation Ten Years Post-Construction**

## Existing Oil & Gas Infrastructure Desktop Analysis

The project site is included in the Leeville Oil and Gas Field. This is one of the oldest oil and gas fields in the State of Louisiana, with the first well spud in 1930. By 1938, over 100 wells were located in the Leeville area. Since its inception, several major transmission and distribution pipelines have been placed throughout the field. Due to the age of the field, many old flowlines that were abandoned in place and replaced still exist.

Public records and maps of the field were gathered and reviewed to determine the field's existing condition and potential activity in the project area. These sources included maps provided by the current field operators, data collected by Sigma as part of our involvement with the LA1 Improvements Project for LA DOTD, SONRIS GIS datasets, and physical evidence identified by imagery and field visits.

Exhibit A-1 in Appendix A shows all oil and gas infrastructure data gathered for this feasibility study. Notable infrastructure that may impact the project include:

- MARS / LOOP / SHELL Pipelines on the west side of Lake Jesse
- Several Flowlines throughout Lake Jesse Area
- Overhead Entergy Transmission Lines East of Lake Jesse
- To the west of Bayou Lafourche – Multiple Active transmission and flow lines cross SWLA Canal running in a north-south direction
- Multiple pipelines on the south bank of SWLA Canal between Little Lake and Bayou Lafourche

The oil and gas field is currently maintained by Marquis Operations. According to Ryan Prosperie ([rprosperie@eagle-facilities.com](mailto:rprosperie@eagle-facilities.com) or 985-226-5249), field manager at the Leeville office, a majority if not all of the flowlines and wells in the studied marsh creation areas are inactive. The figure below shows the currently active or potentially active oil and gas infrastructure in the project area. These should be investigated further in future phases of the project.

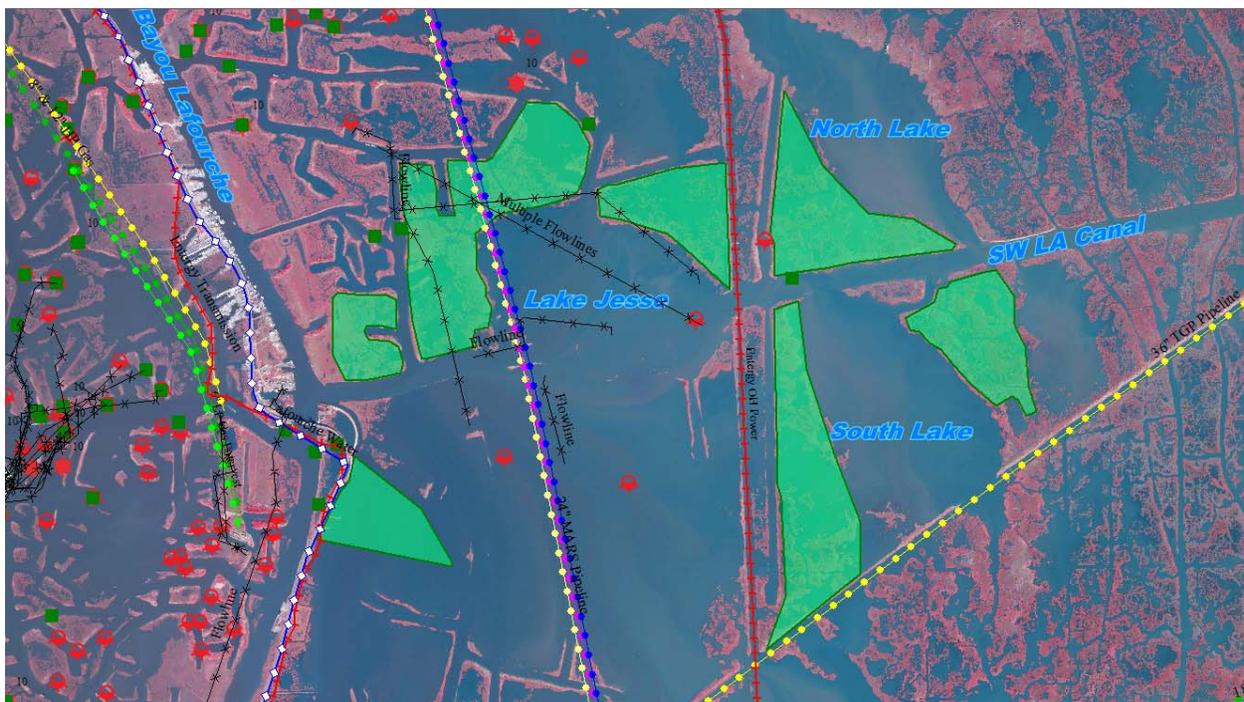


Figure 10: Active or Potentially Active Oil & Gas Infrastructure near the MCA sites

To the west of Leeville, an active tank battery (Tank Battery #4) has multiple flowlines, platforms, and heaters that are interconnected throughout the oil and gas field. These lines cross the SWLA Canal and are critical infrastructure for the oil and gas field. In 2015, Shoreline Southeast, Inc. installed multiple lines on the southern bank of the SWLA Canal which include a 6" oil line, 6" water line, and two 8" gas lines. (Reference CUP P20121433 in SONRIS)

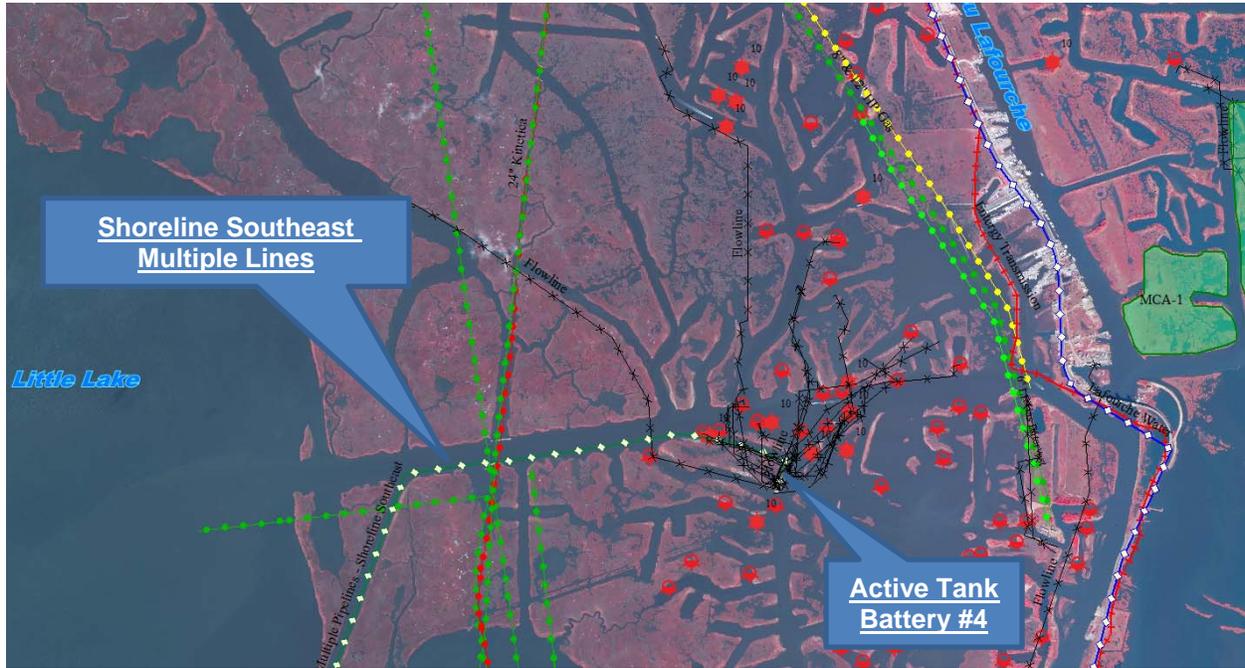


Figure 11: Active or Potentially Active Oil & Gas Infrastructure West of Leeville

There are also multiple oil and gas transmission lines to the east and west of the tank battery. These lines also cross SWLA Canal and proceed northward towards Golden Meadow, LA. These lines may conflict with any borrow source sediment transport lines originating in Little Lake. Also, the primary water line from the Lafourche Water District crosses Bayou Lafourche at its intersection with the SWLA Canal. This line is depicted in blue in Figures 11 and 12. This water line is the primary water source for Port Fourchon and Grand Isle.

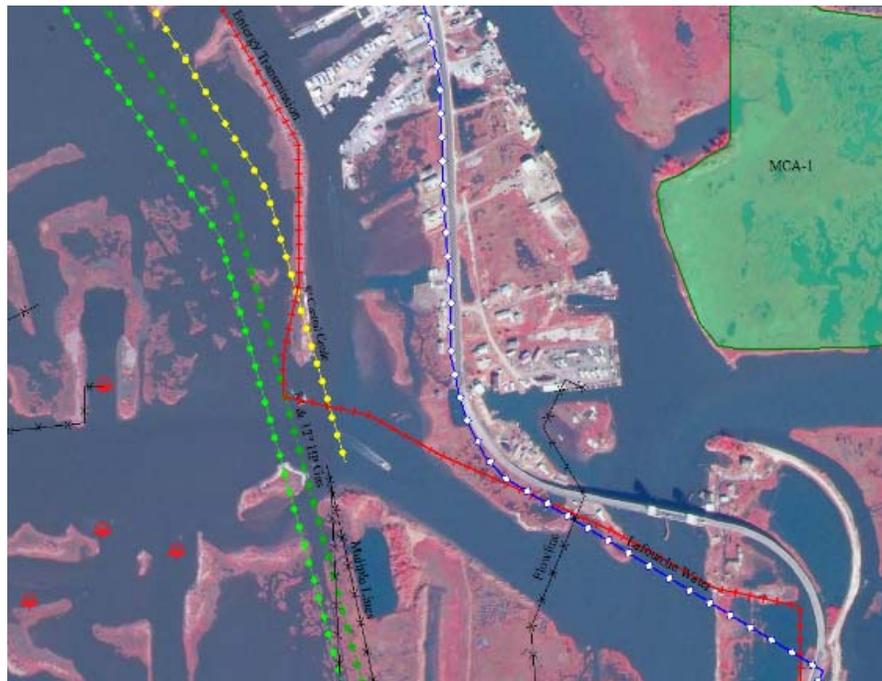


Figure 12: Active or Potentially Active Oil & Gas Infrastructure @ SWLA Canal and Bayou Lafourche

## Notable Infrastructure

The LeFort Cemetery at the northeast corner of the Bayou Lafourche and SWLA Canal intersection may potentially be impacted by the project. This site is recommended for a cultural resource investigation during Phase 1 of the project and/or avoided altogether. Other notable infrastructure in the project vicinity includes the Leeville public boat launch on the west bank of Bayou Lafourche and high voltage Entergy transmission lines adjacent to the LA1 expressway. Any pipeline crossings or impacts to navigation along Bayou Lafourche will require permitting and environmental clearance from the US Coast Guard.



Figure 13: Leeville Infrastructure – Looking Northeast



Figure 14: LeFort Cemetery Circa 2003 (Earth Search, Inc.)

There are several oyster leases in the project vicinity that may be impacted by project features. These leases were identified in the Louisiana Department of Wildlife and Fisheries Oyster Map found on their website at <http://www.wlf.louisiana.gov/fishing/oyster-maps>.

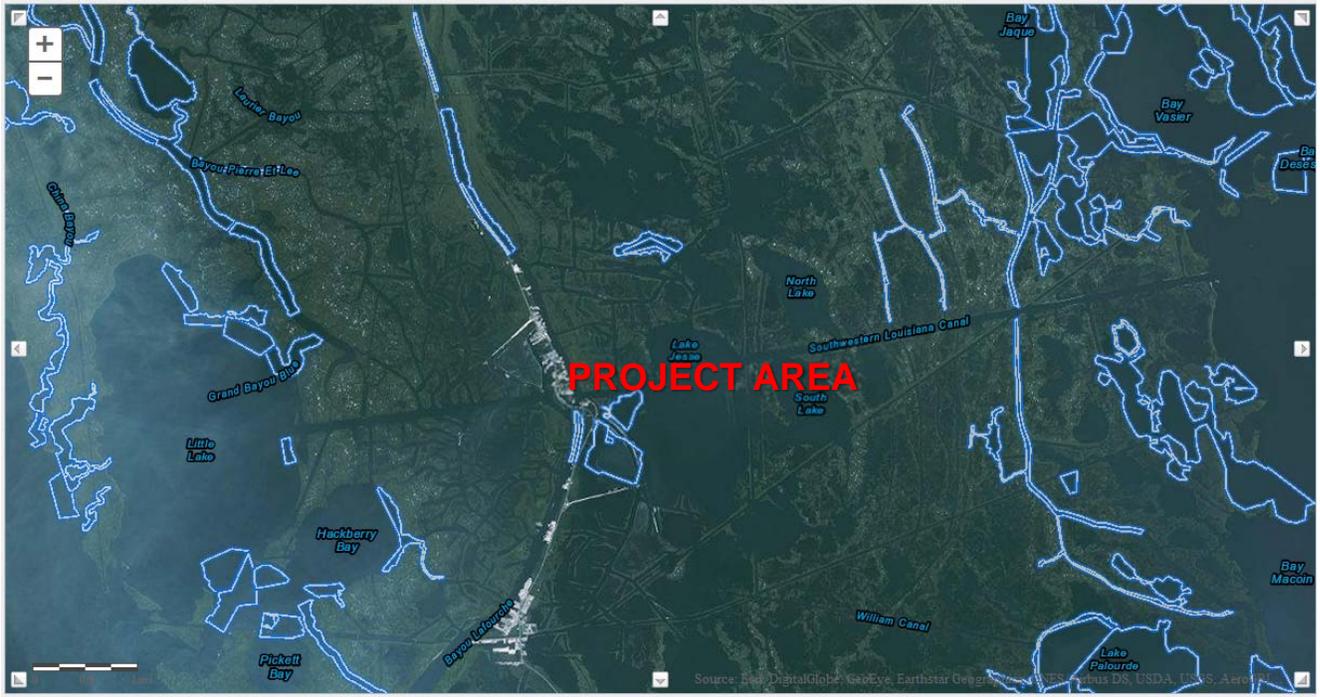


Figure 15: LA Dept. of Wildlife & Fisheries – Oyster Map

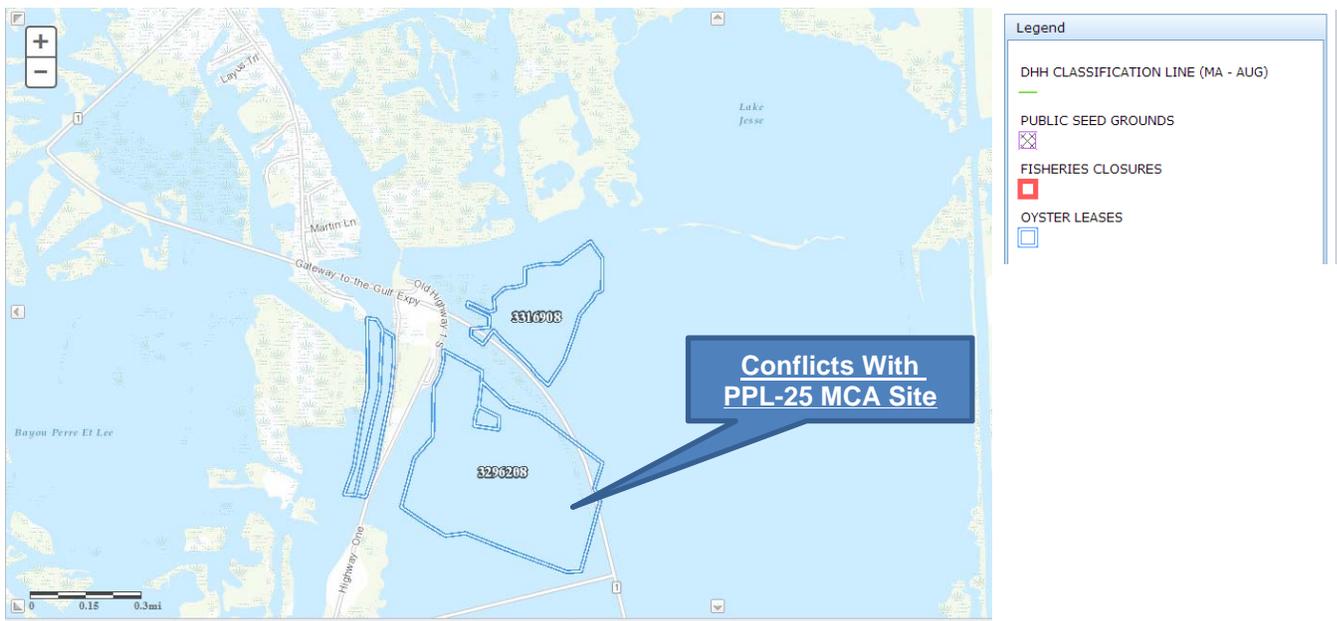


Figure 16: LA Dept. of Wildlife & Fisheries – Oyster Map - Leeville

The oyster leases located in Bayou Lafourche and near LA1 in Leeville shown in Figure 16 could have significant impact on potential marsh creation sites and sediment transport pipeline corridors identified in the PPL-25 list. Also, marine access will need to be maintained for those leases whose primary access is from the SWLA Canal.

## Existing Topography & Bathymetry Desktop Analysis

As part of the LA1 Compensatory Mitigation Plan implementation and subsequent marsh creation project for LA DOTD, Sigma was able to review relevant survey data near the East Leeville Marsh Creation project. The LA1 Improvements surveys used the Coastal Zone Network Primary Monument “876 2084 C TIDAL” as a bench mark. The elevation of this monument as per the Coastal Zone Network Datasheet is +3.76 ft NAVD88(2003) and was updated in 2006 with an elevation of +3.02 ft (NAVD88)(2006.81). The elevation of this monument was included in a height modernization survey conducted by LA DOTD in 2005. The resulting elevation of the monument was +3.09 ft NAVD88(2005). Based on the 2005 elevation, the LA1 Marsh Creation project utilized an average marsh elevation of +1.5 ft ( $\pm$ ) for a target elevation. The existing water bottoms through a majority of the marsh creation sites had an average elevation of -2.0 ft ( $\pm$ ).

Sigma performed site reconnaissance to determine cursory water bottom and marsh elevations in the East Leeville Marsh Creation project area. The 876 2084 C TIDAL bench mark was recovered and measurements were taken from the top of the disk to the water surface. The measurement was taken near high tide. Using the +3.02 ft elevation, a water surface elevation of approximately +1.07 ft was determined for our investigation. Soundings with a level rod throughout the marsh creation areas indicated water bottoms in the range of -2.0 ft to -3.0 ft. Also, existing saline marsh appeared to be in the range of 0.5 ft to 1.0 ft above the existing water surface. These findings are consistent with the surveyed elevations used for the LA1 Improvements project.

Sigma performed additional investigations for existing water elevations by researching Coastwide Reference Monitoring System (CRMS) data in the project vicinity. Due to their proximity to the project site the CRMS 0175 and CRMS 0164 were utilized to establish the average tidal range and the Mean High Water (MHW) and Mean Low Water (MLW) levels for this project. Both of these stations are located in the interior coastal marsh so are representative of the project conditions. CRSM 0175 is located at 29° 17' 24.29"N, 90° 08' 31.92"W, approximately 3.8 miles northeast of Lake Jesse. CRSM 0164 is located at 29° 11' 40.02"N, 90° 10' 14.52"W, approximately 4.2 miles south of Lake Jesse. Both stations had hourly water level data that covered the period from June 5, 2006 to April 4, 2017 that was utilized in our evaluation.



Figure 16: Bench Mark 867 2084 C Tidal



Figure 17: Existing Average Marsh Elevation at Marsh Creation Sites



## **Existing Geotechnical Data Desktop Analysis**

Sigma provided GeoEngineers with soil data from Golden Meadow, Louisiana to Fourchon, Louisiana from the LA 1 expansion project as well as vibracore sampling in Lake Jesse found through the Department of Natural Resources LASARD database. Geology maps published by the USACE and the United States Geological Survey show the project area consisting of deltaic marsh deposits consisting of cyclically interbedded interdistributary peat and clay, natural levee silt and clay, distributary sand, and mud and clay. The depth to the Pleistocene surface at the site is between 350 and 375 feet NGVD.

Available data shows marsh deposits consisting of very soft to soft clay material with layers of organics and silt throughout. The borings along LA 1 consistently showed very soft peat within the top 5 feet below the ground surface, which is underlain by soft to medium gray clay with various amounts of silt, sandy silt and silty sand layers throughout as well as traces of organic matter and shells.

A critical component of the project will be the magnitude of settlement that occurs while placing dredged fill material. Typically, greater settlement occurs in areas with more peat and organic clay materials. Settlement in the native soils and the dredged material must be considered while making fill estimates. Additional data that is specific to the proposed marsh creation area and borrow area will need to be collected to provide accurate settlement estimations.

Given the estimated strength of the soils in the area, the proposed 3H:1V slope for the containment dikes may be difficult to achieve. Placing the fill material in multiple lifts and allowing consolidation time between lifts can reduce the size of the containment structure while obtaining desired target elevations. While weak soils may be prevalent in the project area, it should be noted that a component of the LA1 project included several successful marsh creation areas. Sigma has direct experience with the construction of these marsh creation areas and did not observe issues with construction of the containment dikes related to the slopes. As previously mentioned, sand and silt layers were encountered in the LA1 soil borings. Sand and silt layers and lenses within clay material will increase the rate of consolidation and provide stability.

From aerial imaging it appears that multiple channels, natural and man-made, cross the proposed marsh nourishment and creation areas. Construction of the containment dikes may be difficult to accomplish in these areas where the mudline is deeper. Construction methods other than bucket dredge may need to be considered to achieve target containment dike crown elevations. Alternative methods such as sheet piling, hay bales or fabrics have been successfully used in similar applications on previous CPRA projects.

There are various pipelines crossing the area, contractors should be aware of pipelines within the vicinity of construction activities, in mobilization routes and while transporting dredged material from the borrow site to the displacement locations. Settlement of pipelines that run through the marsh creation area and under containment dikes must also be considered in the design phase.

Given the provided data, Sigma's experience with the LA1 marsh creation area construction, and the experience gained by GeoEngineers in the area and other similar type projects, the construction of the marsh creation and nourishment within the proposed area should be feasible.

Additional geotechnical data will need to be obtained to design the marsh creation areas and containment dikes. A proposed exploration program, shown in Appendix B, is recommended for implementation in order to gain data needed to estimate marsh settlement and containment dike stability.

## Marsh Creation Alternative Development

The marsh creation areas shown in Figure 3 were used as the basis for alternative development and feasibility determination. These areas were included in PPL-25 and carried forward for additional consideration. After studying these sites relative to the parameters identified in this feasibility study, the following sites are recommended for consideration by the Technical Committee for implementation.

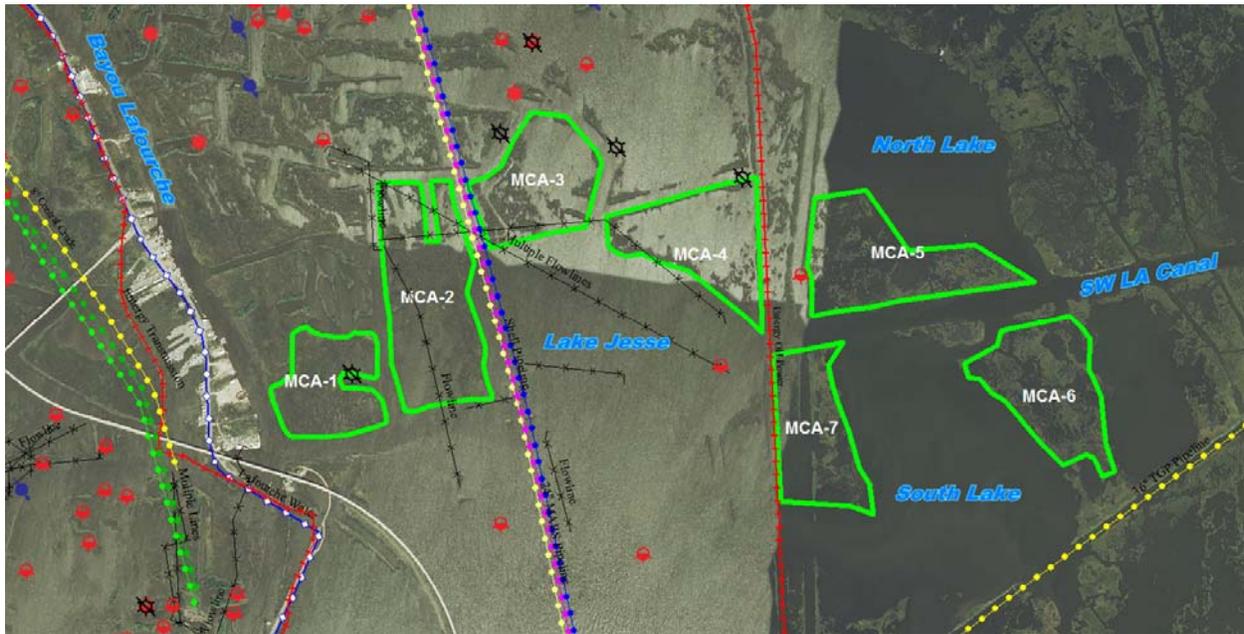


Figure 19: Proposed Marsh Creation Site Locations

### **Marsh Creation Area 1 (MCA-1)**

Marsh Creation Area 1 is a 62 acre site located at the northeast corner of the intersection of Bayou Lafourche and SWLA Canal. The LeFort Cemetery is located at the southwest corner of this site. The site consists of predominately broken saline marsh with natural containment adjacent to Bayou Lafourche and spoil banks for oil/gas canals. Containment will be necessary along the southern and eastern perimeter.

### **Marsh Creation Area 2 (MCA-2)**

Marsh Creation Area 2 is a 126 acre site located on the western shoreline of Lake Jesse. The site consists mostly of open water with pockets of broken marsh. It is bounded by the SWLA Canal to the south, existing oil and gas canals with moderate spoil banks to the west and north, and the MARS, Shell, LOOP pipelines to the east. Containment will be necessary along the southern and eastern perimeter. It is recommended that containment adjacent to Lake Jesse be constructed as bank stabilization dikes and borrow taken from the lake. Oil and gas flow lines are included in the MCA and will require magnetometer locates during the site survey.

### **Marsh Creation Area 3 (MCA-3)**

Marsh Creation Area 3 is an 80 acre site on the northern shoreline of Lake Jesse. The site consists mostly of open water with pockets of broken marsh. It is bounded by the MARS, Shell, LOOP pipelines to the west, existing oil and gas canals with modest spoil banks to the north and east, and Lake Jesse to the south. Containment will be necessary along the entire perimeter. It is recommended that containment adjacent to Lake Jesse be constructed as bank stabilization

dikes and borrow taken from the lake. Oil and gas flow lines are included in the MCA and will require magnetometer locates during the site survey.

#### **Marsh Creation Area 4 (MCA-4)**

Marsh Creation Area 4 is an 85 acre site on the northern and eastern shoreline of Lake Jesse. The site consists mostly of open water with very small pockets of broken marsh near Lake Jesse. It is bounded by oil and gas canals with modest spoil banks to the north, spoil banks from the Entergy transmission lines to the east, and shoreline marsh from Lake Jesse to the south and west. Containment will be necessary along the entire perimeter; however, only minor reinforcement or raised containment will be necessary along the eastern perimeter. It is recommended that containment adjacent to Lake Jesse be constructed as bank stabilization dikes and borrow taken from the lake. Oil and gas flow lines may be included in the MCA and will require magnetometer locates during the site survey.

#### **Marsh Creation Area 5 (MCA-5)**

Marsh Creation Area 5 is a 100 acre site located between the southwestern shoreline of North Lake and the northern banks of the SWLA Canal. The site consists predominately of broken saline marsh and shallow open water. It is bounded by a spoil bank from an old oil and gas canal to the west, shallow open water from deteriorated marsh to the north, shallow pockets of saline marsh along the bank of North Lake to the east, and a receding marsh line along the SWLA Canal to the south. Containment will be necessary along the entire perimeter. It is recommended that containment adjacent to North Lake be constructed as bank stabilization dikes and borrow taken from the lake. The northern extents of this site were eliminated due to lack of stable existing marsh to serve as a base for containment development.

#### **Marsh Creation Area 6 (MCA-6) / Marsh Nourishment**

Marsh Creation Area 6 is an 87 acre site located on the northeast shoreline of South Lake. The site consists predominately of moderately diminishing marsh and sporadic areas of open water. The marsh along the shoreline of South Lake appears healthy; however, the site begins losing continuity towards the east. It is bounded by South Lake to the west, existing spoil banks to the northwest, receding marsh line along the SWLA Canal to the north, and broken areas of open water and marsh to the east and south. Containment will be necessary along the east and south perimeter. MCA-6 is expected to only require nourishment to promote additional vegetative growth in areas that have turned to open water.

#### **Marsh Creation Area 7 (MCA-7)**

Marsh Creation Area 7 is a 76 acre site located on the western shoreline of South Lake. The site consists of very shallow open water with sporadic pockets of saline marsh. It is bounded by the receding shoreline of South Lake to the east, open water with remnants of marsh to the south, open water once covered by the Entergy transmission spoil bank to the west, and receding marsh along the southern bank of the SWLA Canal to the north. An abandoned oil and gas canal with moderate spoil banks and water depths of less than 1 ft runs through the middle of the site. Containment will be necessary along the entire perimeter. It is recommended that containment adjacent to South Lake be constructed as bank stabilization dikes and borrow taken from the lake. The acreage of this site was reduced due to more open water to the south and acreage limits identified in the project goals. This site could potentially be enlarged should other MCA's be eliminated. It should be noted that a 36" Tennessee Gas Pipeline is located at the southern shoreline of South Lake. This pipeline has existing spoil banks that could potentially be used as containment should the site be enlarged.

**Estimated Fill Quantity Assessment**

In order to determine the feasibility of the project, estimated fill quantities were computed for each MCA. The following assumptions were made in computing the volumes:

- Existing water bottom elevation: -2.0 ft
- Required fill height elevation: +4.0 ft
- Estimated required fill percentage based on visual assessment of current aerial photography for existing marsh coverage. This accounts for existing marsh that would not require the full height of borrow material.
- Cut:Fill Ratio of 1:1.3
- Containment berm and bank stabilization dike borrow and fill were not included in the MCA fill estimates for this level of study. The linear feet of containment for each MCA is estimated based on visual evidence from the recent aerial photography. Segments of existing spoil banks were removed from the MCA perimeter and considered as existing containment.

**Table 2: Marsh Creation Area Containment and Fill Quantity Estimates**

Site	Type	Estimated Containment Perimeter (ft)	Area (S.F.)	Area (AC)	Est. Fill Height (ft)	Estimated Req'd Fill Percentage	Req'd Fill Volume (CY)
1	Creation & Nourishment	4,000	2,700,000	62	6	50%	300,000
2	Creation	7,000	5,503,000	126	6	80%	978,311
3	Creation	7,400	3,480,000	80	6	90%	696,000
4	Creation	9,100	3,721,000	85	6	95%	785,544
5	Creation	10,400	4,310,000	99	6	90%	862,000
6	Nourishment	4,000	3,795,000	87	3	40%	168,667
7	Creation	10,400	3,318,000	76	6	80%	589,867
<b>TOTAL</b>		<b>52,300</b>		<b>615</b>			<b>4,380,389</b>

Assumed Cut:Fill Factor 1.3

**Adjusted Req'd Fill Volume (CY) 5,694,506**

Approximately 5,700,000 cubic yards of fill material and 52,300 linear feet of containment berms would be necessary to construct all of the marsh creation areas identified.

## Borrow Area & Dredge Pipeline Alternative Development

Three general borrow areas were identified as part of the alternative analysis, 1) the three lakes adjacent to the marsh creation areas, 2) Caminada Bay to the east, and 3) Little Lake to the west.

### Lake Borrow Areas

Due to the close proximity of Lake Jesse, North Lake and South Lake to the marsh creation sites, these lakes were investigated as a potential borrow source. The lakes are predominately flat and shallow with water bottoms ranging in elevation from -2.0' to -3.0' in elevation. In order to protect the marsh creation sites against failures into a borrow source, a 150' minimum offset from the marsh creation sites was used to designate the borrow area. Additional acreage was removed from the west side of Lake Jesse to avoid impacts to the MARS, Shell and LOOP pipelines. The available borrow volumes were determined using a dredge depth of 5 ft. Modeling will be necessary to adequately determine the acceptable dredge depth and potential impacts to the marsh creation sites. Wind driven wave action, storm surge and localized failures of the marsh creation areas are of concern and should be modeled.

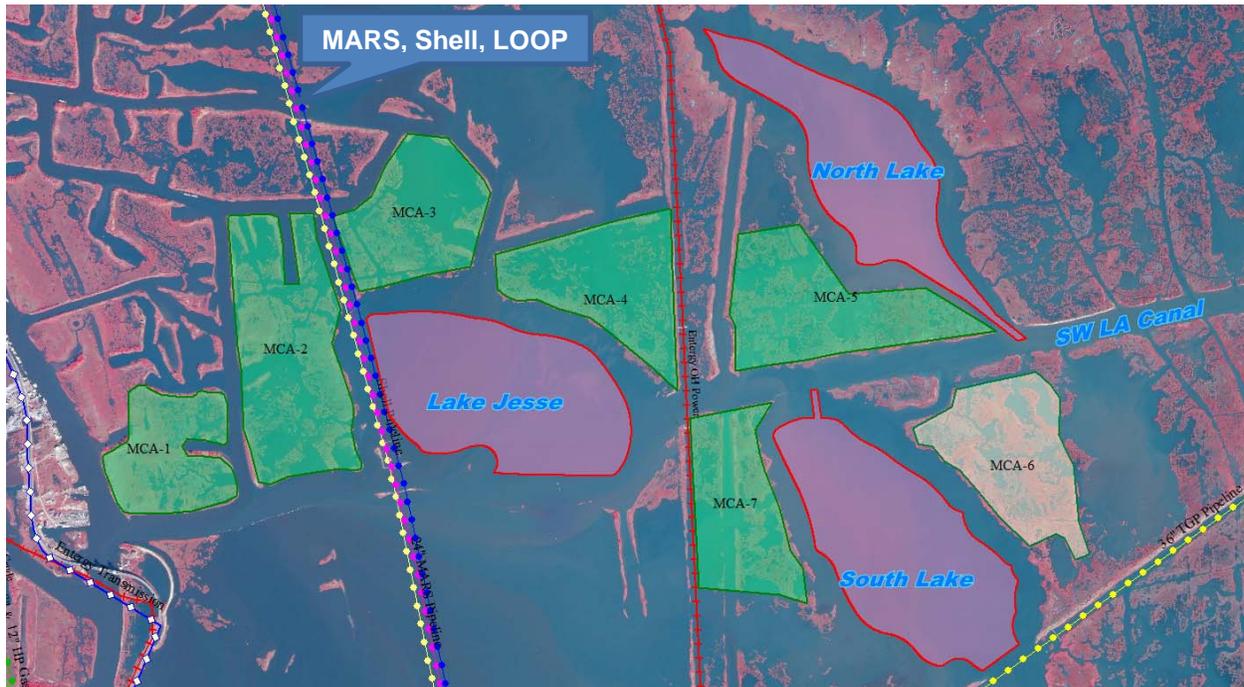


Figure 20: Lake Borrow Areas

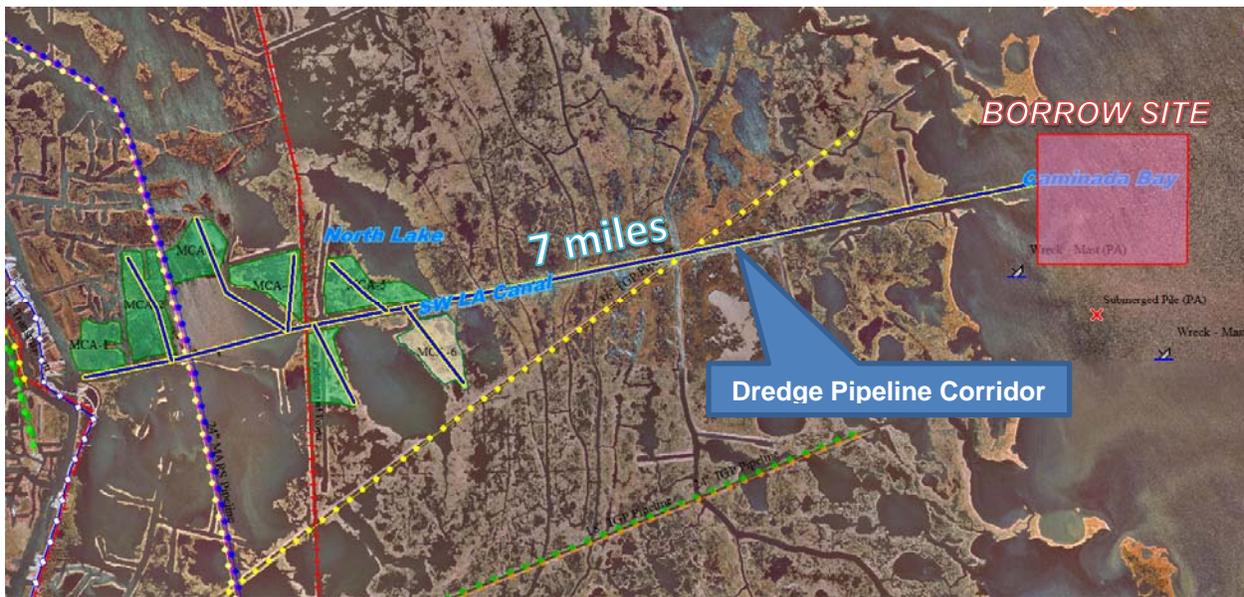
The following are planning level volume calculations for available borrow from the lakes:

Table 3: Lake Borrow Area Volume Estimates

Site	Area (S.F.)	Area (Acres)	Dredge Depth (ft)	Material Qty (C.Y.)
Lake Jesse	6,993,000	161	5	1,295,000
North Lake	5,404,000	124	5	1,001,000
South Lake	7,290,000	167	5	1,350,000
<b>Total</b>		<b>452</b>		<b>3,646,000</b>

### Caminada Bay Borrow Area

For the Caminada Bay borrow area, a combination of floating and submerged sediment transport pipelines can be placed near the northern bank of the SWLA Canal. Submerged pipeline segments can be used in areas where marine traffic would require access to adjacent bayous or pipeline crossings. Accommodations for existing oyster lease access may be necessary (See Figure 15). The sediment transport pipeline length is approximately 7 miles from the borrow site to the marsh creation sites. Multiple booster pumps may be required depending on the size of dredge pipeline used. No major restrictions for pipeline corridors were noted during this level of study other than maintaining marine access along the SWLA Canal and major pipeline crossings.

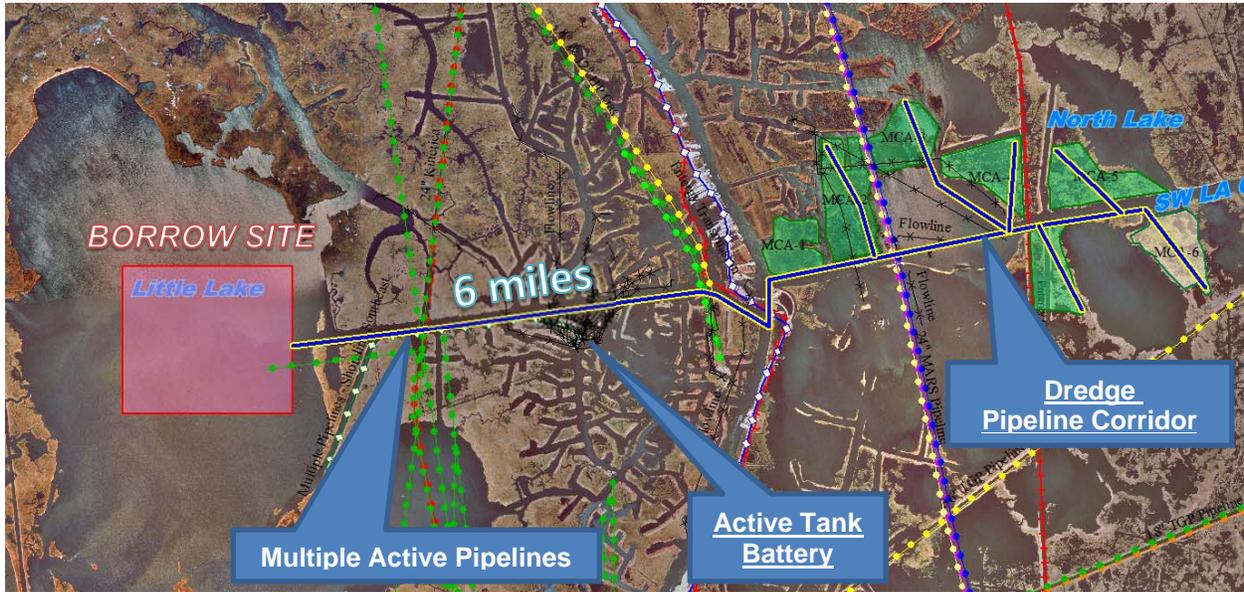


**Figure 21: Caminada Bay Borrow Area and Pipeline Corridor**

The borrow site is approximately 5,000 ft by 5,500 ft and is sized to produce up to 6,000,000 cubic yards of material with an estimated cut depth of 6 ft. Additional geotechnical investigations are necessary to ensure that material from this site area is suitable for marsh creation. It should be noted that NOAA Waterway Charts indicate 3 potential hazards near the borrow site. These should be properly located during the topographic/bathymetric survey. No oil and gas infrastructure was noted in the borrow area vicinity during this feasibility study; however, a magnetometer survey is recommended.

### Little Lake Borrow Area

For the Little Lake borrow area, a combination of floating and submerged sediment transport pipelines would be necessary over approximately 6 miles. Several conflicts with existing infrastructure and marine vessel access were noted during the study. Existing active transmission pipelines, distribution pipelines, and service flowlines exist between Little Lake and Bayou Lafourche, including an active major tank battery, production, and heater platform just south of the SWLA Canal. Also, in order to reach the marsh creation sites, the sediment transport pipeline would require crossing Bayou Lafourche in an area with significant marine traffic and cross currents from the SWLA Canal. An extensive environmental clearance and permitting effort would be required to implement this corridor.



**Figure 22: Little Lake Borrow Area and Pipeline Corridor**

The borrow site is approximately 5,000 ft by 5,500 ft and is sized to produce up to 6,000,000 cubic yards of material with an estimated cut depth of 6 ft. Additional geotechnical investigations are necessary to ensure that material from this site area suitable for marsh creation. No oil and gas infrastructure was noted in the borrow area vicinity during this feasibility study; however, a magnetometer survey is recommended.

## Construction Equipment Access

Construction equipment access for dredging, marsh creation and construction accommodations are readily available in the project area. Bayou Lafourche is the primary waterway in the area and connects the Intracoastal Waterway in Larose, LA to the north with the Gulf of Mexico and Port Fourchon to the south. Water depths are adequate for marine vessel access year round. LA Highway 1 provides land based access to the project site with both public and private docking facilities, housing, and construction suppliers located in the project vicinity. Lafourche Parish and Port Fourchon have infrastructure and capabilities readily available to support construction of a project such as the East Leeville Marsh Creation and Nourishment project.

## Conclusion

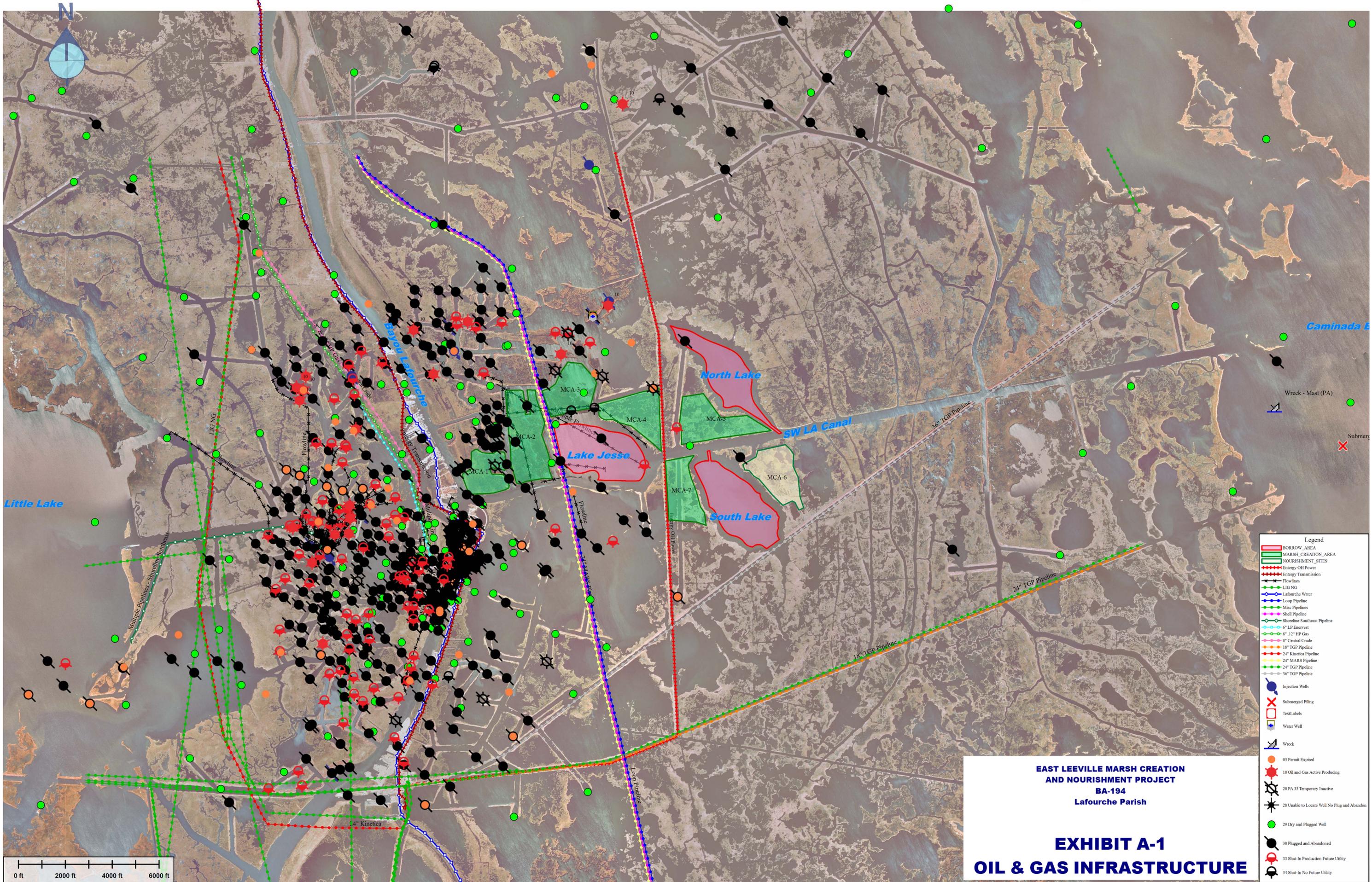
The East Leeville Marsh Creation and Nourishment Project (BA-194) is a feasible and constructible project. Additional evaluation by the Technical Committee regarding implementation of marsh creation areas, borrow sites, and estimated construction costs are necessary to proceed with design. A scope of work for surveying and geotechnical investigations were prepared by Sigma and GeoEngineers for CPRA and submitted for their review and approval. Electronic copies of this report and references identified on the following page were provided to CPRA as part of this report.

## References

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- Booklet Chart Intracoastal Waterway – Barataria and Bayou Lafourche Waterways, NOAA Chart 11365 23<sup>rd</sup> Ed., Dec. 2012*. National Oceanic and Atmospheric Administration, National Ocean Service, Office of Coast Survey.
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- EM 1110-2-5025 Dredging and Dredged Material Management, US Army Corps of Engineers Engineering and Design, July 31, 2015
- Historic Aerial Photography: 1951, 1958, 1963, 1998 DOQQ, 2000 DOQQ, 2005 DOQQ, 2010 NAIP, 2015 USGS National Map
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- SONRIS GIS Datasets, Oil & Gas, Coastal Management, Coastal Protection & Restoration, Water Wells, [www.sonris.com](http://www.sonris.com)
- S.P. No. 829-32-0007 LA1 Relocated Leeville Bridge Approaches & Connectors (Phase 1B)*. Log of Test Borings Plan Sheets 1301-1342. LA DOTD. Sept. 19, 2005.

# **Appendix A**

## **Exhibits**





**VICINITY MAP** Not to Scale

Reproduced from Louisiana 2005 DOQQ

**Station Name: "876 2084 C TIDAL"**

**Location:** Described by Louisiana Transportation and Development 1987, located about 0.5 km (0.3 mi) south of Leeville on State Highway 1 from the north end of the bridge over Bayou Lafourche. To reach the station from Leeville, proceed southerly on State Highway 1 in Leeville to the bridge over Bayou Lafourche. Go over the bridge and turn left (east) at the end of the bridge onto the old road and the mark set across from the Standard Oil Building 40 meters (127.8 ft) south-southeast from a fire hydrant located on the north side of standard supply company, 8.3 meters (27.2 ft) west from a black and white reflector marker on the north side of State Highway 1 and 0.5 meters (1.6 ft) south from a witness post.

**Monument Description:** Tidal Station Disk on top of stainless steel rod set at a depth of 79 ft to refusal in PVC pipe.

**Stamping:** 2084 C 1986

**Installation Date:** 1986 **Date of Survey:** March 2003

**Monument Established By:** NOAA **For:** NOAA

**Adjusted NAD83 Geodetic Position (NSRS2007)**

Lat. 29°14'51.33691" N  
 Long. 090°12'22.76173" W

**Adjusted NAD83 Datum LSZ (1702) Ft (NSRS2007)**

N= 273,646.48  
 E= 3,640,253.42

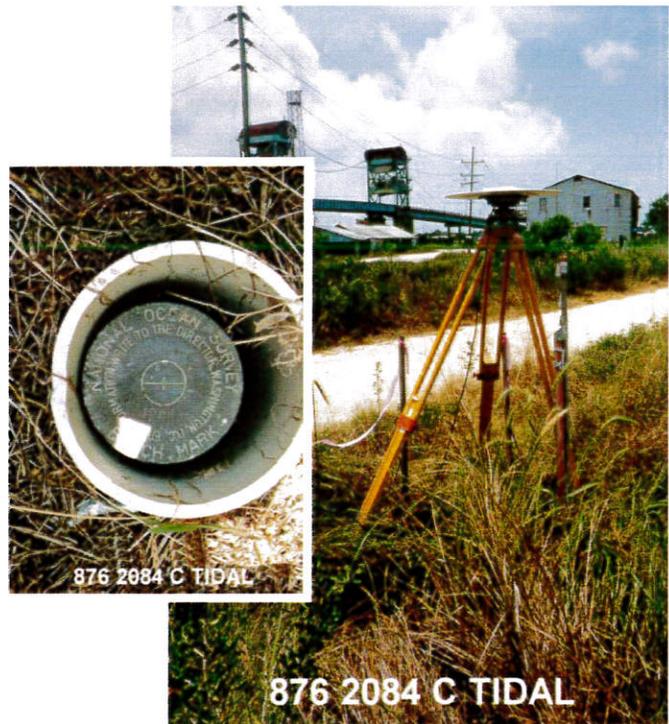
**Adjusted NAVD88 Height (2006.81)**

Elevation = 3.02 feet (0.922 mtrs)

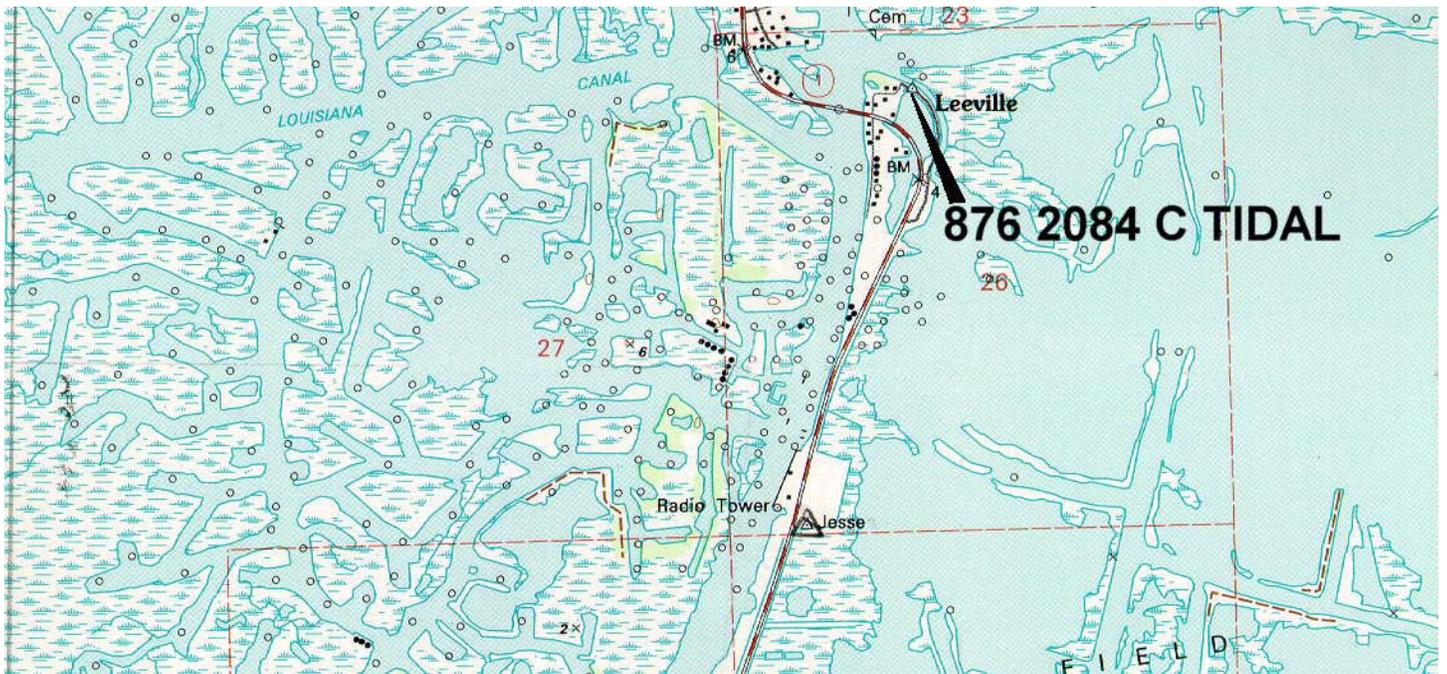
*Ellipsoid Height = -23.223 mtrs.  
 Geoid03 Height = -24.145 mtrs. (2004.65)*

**FOR REFERENCE ONLY**

LCZ Adjusted NAVD88 Height (Geoid99)  
 Elevation = 3.76 feet (1.145 mtrs)



*Adjusted Position Established John Chance Land Surveys, Inc. for the Coastal Protection & Restoration Authority of Louisiana, OCPA*



**VICINITY MAP** Scale: 1" = 2000'

Reproduced from USC&GS "LEEVILLE" Quadrangle

**Station Name: "876 2084 C TIDAL" (HARN)**

**Monument Location:** From the intersection of State Highway 1 and State Highway 308 in Golden Meadow, Louisiana, proceed southerly on State Highway 1 to the bridge over Bayou Lafourche. Continue over the bridge for 0.5 mile to a paved road on left (Old Highway 1) near the south end of the bridge. Turn left and go northwesterly on old Highway 1 for 0.3 mile to the station on right. The station is 15.1 feet northeast of the centerline of the road, 1.6 feet southwest of a witness post.

**Monument Description:** Standard survey disk attached to a steel rod driven to refusal within a sleeve set in concrete and stamped "876 0849 A 1985".

**Date:** October 2000      **Revised:** January 2003

**Monument Established By:** Louisiana Department of Transportation

**Published NAD 83 (1992) Geodetic Position**

Lat. 29° 14' 51.33677" N  
 Long. 90° 12' 22.76042" W

**Published NAVD88 Height**

Elevation = 3.71 feet

**Adjusted NAD 83 Geodetic Position**

Lat. 29° 14' 51.336625" N  
 Long. 90° 12' 22.760499" W

**Adjusted NAD 1983 Datum LSZ (1702) Ft**

N= 273,646.45  
 E= 3,640,253.53

**Adjusted NAVD88 Height**

Elevation = 3.76 feet (1.145 mtrs)

Geoid99 Height = -24.300 mtrs.

Ellipsoid Height = -23.155 mtrs.

Adjusted CORS Height = 3.66 ft (1.115 mtrs)  
 Avg. OPUS Solutions = 3.70 ft (1.127 mtrs)



**EXHIBIT A-2.1**

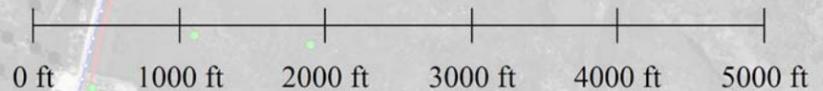


**LEGEND**

- Entergy OH Power
- Entergy Transmission
- Flowline
- LIG NG
- Lafourche Water
- Loop Pipeline
- Multiple Flowlines
- Multiple Pipelines - Shoreline Southeast
- Shell Pipeline
- 6" LP Gas Entervest
- 8" - 12" HP Gas
- 8" Central Crude
- 18" TGP Pipeline
- 24" Kinetica
- 24" MARS Pipeline
- 24" TGP Pipeline
- 36" TGP Pipeline
- Injection Wells
- 03 Permit Expired
- 10 Active Producing
- 20 PA-35 Temporary Inactive
- 22 Revert to Single Completion
- 23 Act 404 Orphan Well
- 28 Unable to Locate/No P&A
- 29 Dry and Plugged Well
- 30 Plugged & Abandoned
- 33 Shut-In Production Future Utility
- 34 Shut-In Production No Future Utility
- 73 Water Well

**EAST LEEVILLE MARSH CREATION  
AND NOURISHMENT PROJECT  
BA-194  
Lafourche Parish**

**EXHIBIT A-3  
1951 AERIAL PHOTOGRAPHY**



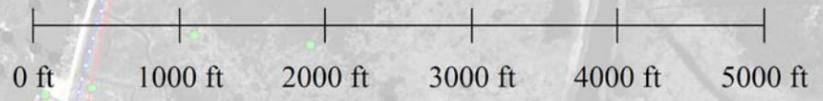


**LEGEND**

- Entergy OH Power
- Entergy Transmission
- Flowline
- LIG NG
- Lafourche Water
- Loop Pipeline
- Multiple Flowlines
- Multiple Pipelines - Shoreline Southeast
- Shell Pipeline
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- 8" Central Crude
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- 73 Water Well

**EAST LEEVILLE MARSH CREATION  
AND NOURISHMENT PROJECT  
BA-194  
Lafourche Parish**

**EXHIBIT A-4  
1958 AERIAL PHOTOGRAPHY**



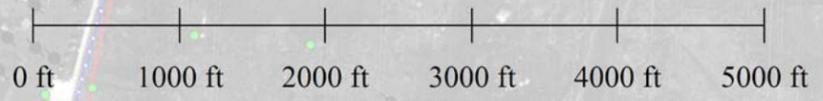


**LEGEND**

- Entergy OH Power
- Entergy Transmission
- Flowline
- LIG NG
- Lafourche Water
- Loop Pipeline
- Multiple Flowlines
- Multiple Pipelines - Shoreline Southeast
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- 73 Water Well

**EAST LEEVILLE MARSH CREATION  
AND NOURISHMENT PROJECT  
BA-194  
Lafourche Parish**

**EXHIBIT A-5  
1963 AERIAL PHOTOGRAPHY**



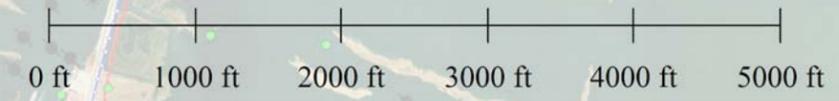


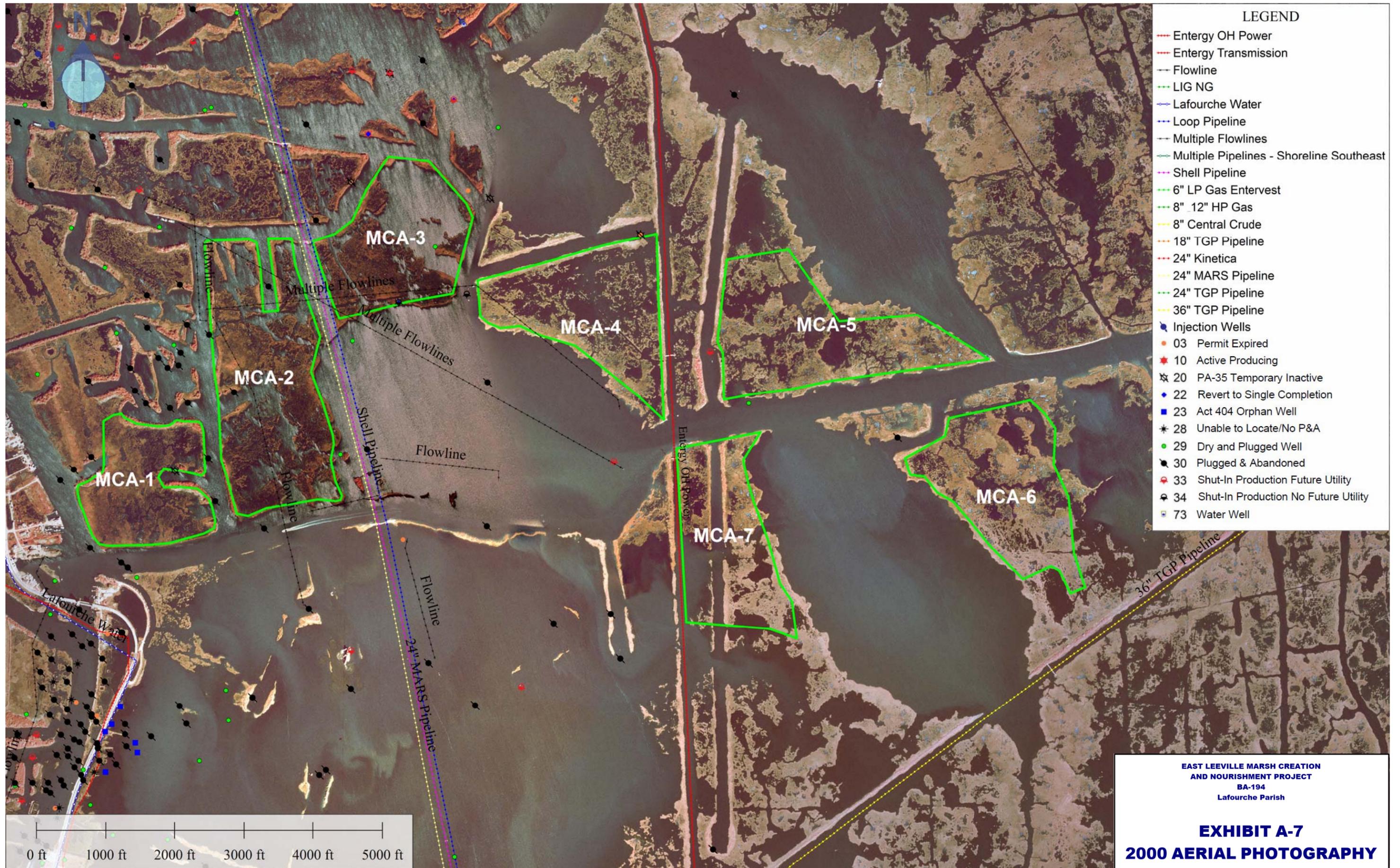
**LEGEND**

- Entergy OH Power
- Entergy Transmission
- Flowline
- LIG NG
- Lafourche Water
- Loop Pipeline
- Multiple Flowlines
- Multiple Pipelines - Shoreline Southeast
- Shell Pipeline
- 6" LP Gas Entervest
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- 8" Central Crude
- 18" TGP Pipeline
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- 24" TGP Pipeline
- 36" TGP Pipeline
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- 34 Shut-In Production No Future Utility
- 73 Water Well

**EAST LEEVILLE MARSH CREATION  
AND NOURISHMENT PROJECT  
BA-194  
Lafourche Parish**

**EXHIBIT A-6  
1998 AERIAL PHOTOGRAPHY**



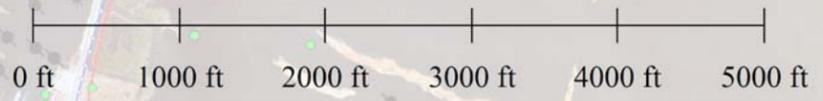


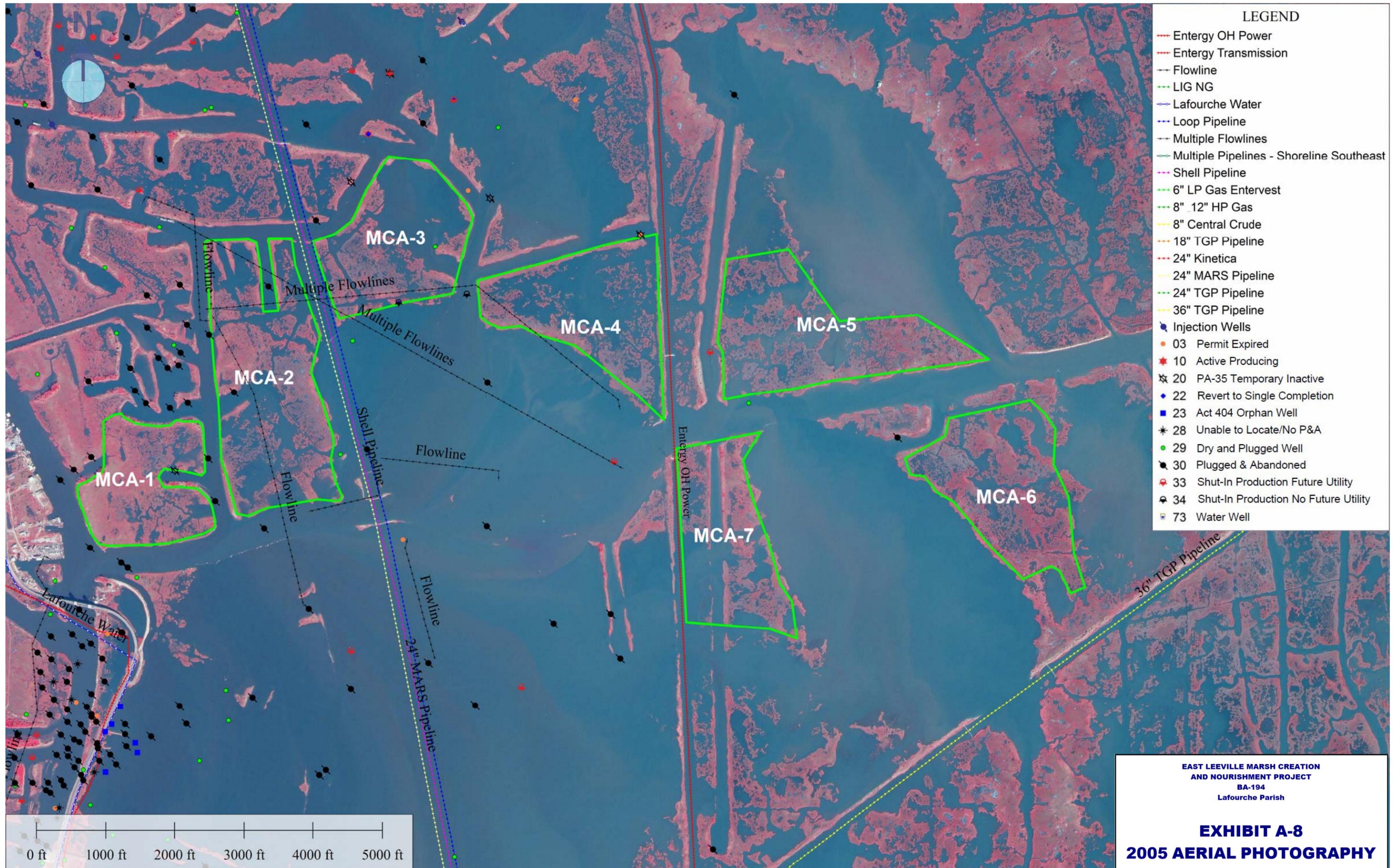
**LEGEND**

- Entergy OH Power
- Entergy Transmission
- Flowline
- LIG NG
- Lafourche Water
- Loop Pipeline
- Multiple Flowlines
- Multiple Pipelines - Shoreline Southeast
- Shell Pipeline
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- 34 Shut-In Production No Future Utility
- 73 Water Well

**EAST LEEVILLE MARSH CREATION  
AND NOURISHMENT PROJECT  
BA-194  
Lafourche Parish**

**EXHIBIT A-7  
2000 AERIAL PHOTOGRAPHY**



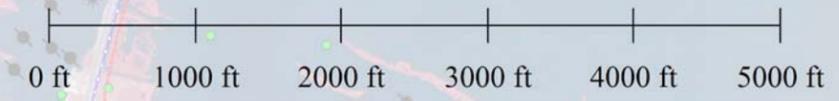


**LEGEND**

- Entergy OH Power
- Entergy Transmission
- Flowline
- LIG NG
- Lafourche Water
- Loop Pipeline
- Multiple Flowlines
- Multiple Pipelines - Shoreline Southeast
- Shell Pipeline
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- 8" Central Crude
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- 34 Shut-In Production No Future Utility
- 73 Water Well

**EAST LEEVILLE MARSH CREATION  
AND NOURISHMENT PROJECT  
BA-194  
Lafourche Parish**

**EXHIBIT A-8  
2005 AERIAL PHOTOGRAPHY**



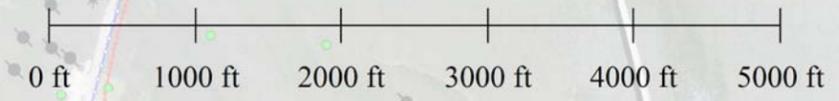


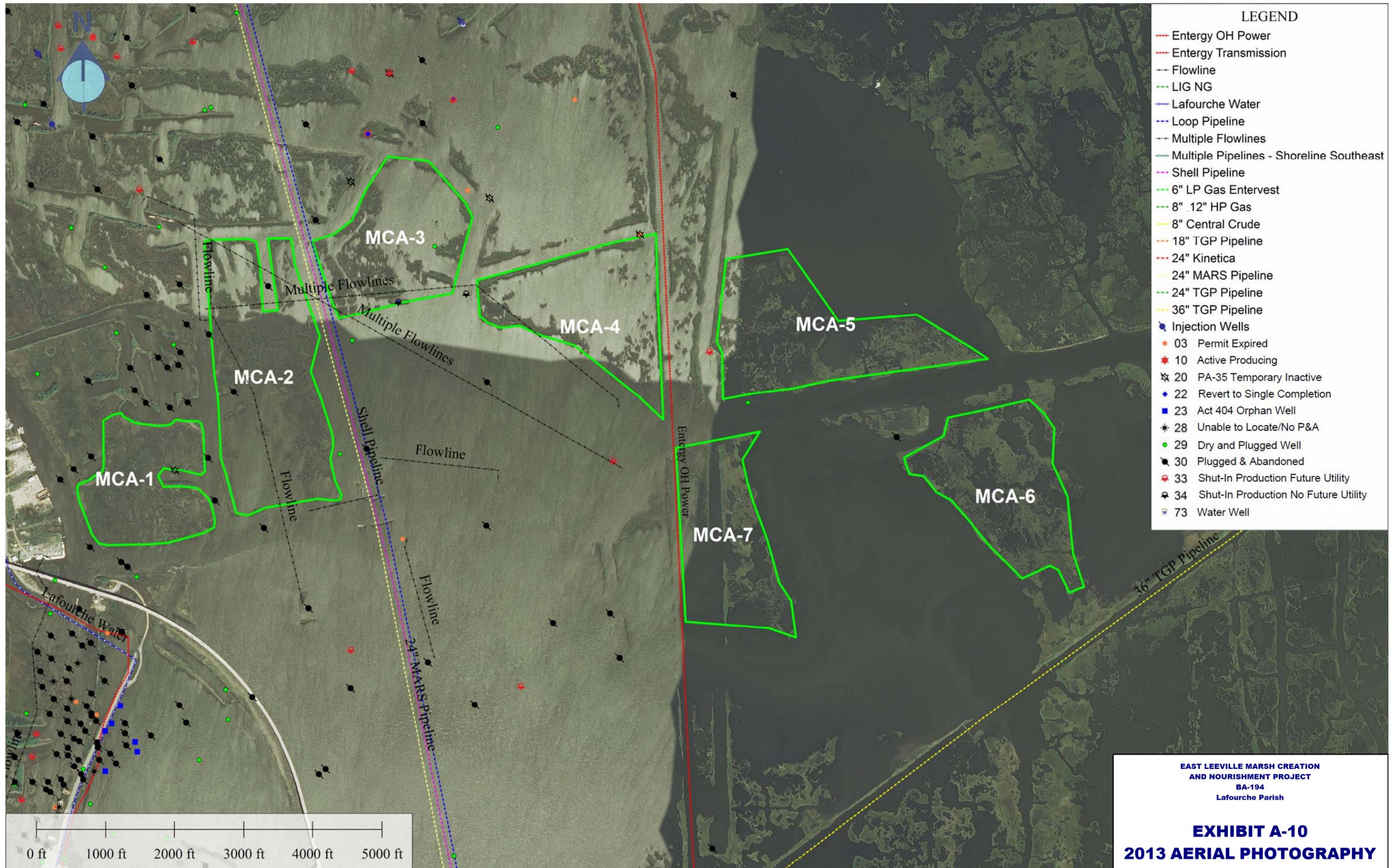
**LEGEND**

- Entergy OH Power
- Entergy Transmission
- Flowline
- LIG NG
- Lafourche Water
- Loop Pipeline
- Multiple Flowlines
- Multiple Pipelines - Shoreline Southeast
- Shell Pipeline
- 6" LP Gas Entervest
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- 34 Shut-In Production No Future Utility
- 73 Water Well

**EAST LEEVILLE MARSH CREATION  
AND NOURISHMENT PROJECT  
BA-194  
Lafourche Parish**

**EXHIBIT A-9  
2010 AERIAL PHOTOGRAPHY**



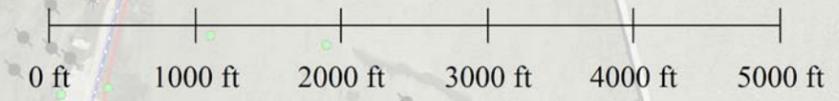


**LEGEND**

- Entergy OH Power
- Entergy Transmission
- Flowline
- LIG NG
- Lafourche Water
- Loop Pipeline
- Multiple Flowlines
- Multiple Pipelines - Shoreline Southeast
- Shell Pipeline
- 6" LP Gas Entervest
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- 34 Shut-In Production No Future Utility
- 73 Water Well

**EAST LEEVILLE MARSH CREATION  
AND NOURISHMENT PROJECT  
BA-194  
Lafourche Parish**

**EXHIBIT A-10  
2013 AERIAL PHOTOGRAPHY**



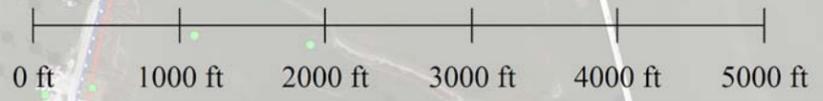


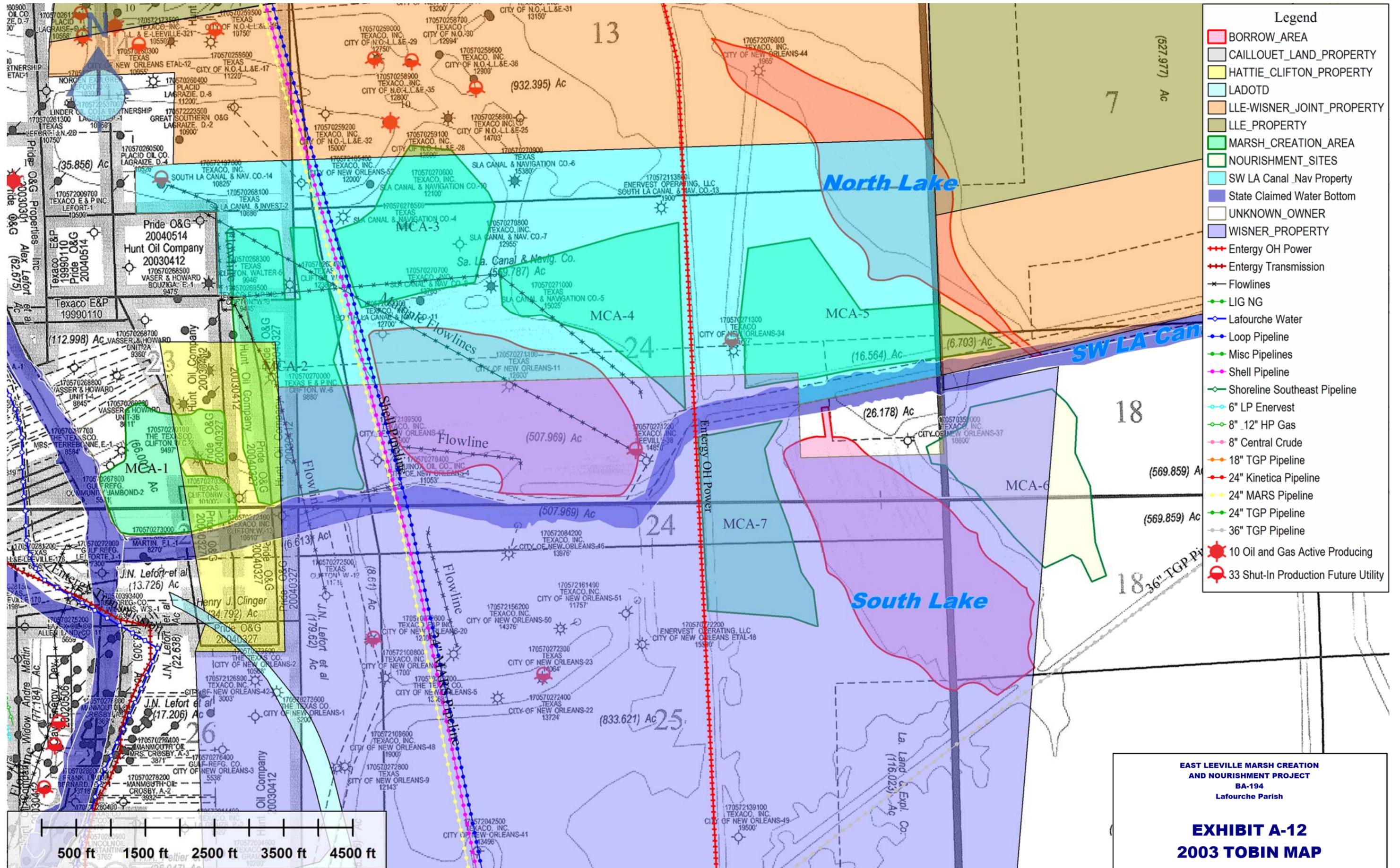
**LEGEND**

- Entergy OH Power
- Entergy Transmission
- Flowline
- LIG NG
- Lafourche Water
- Loop Pipeline
- Multiple Flowlines
- Multiple Pipelines - Shoreline Southeast
- Shell Pipeline
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**EAST LEEVILLE MARSH CREATION  
AND NOURISHMENT PROJECT  
BA-194  
Lafourche Parish**

**EXHIBIT A-11  
2015 AERIAL PHOTOGRAPHY**





- Legend**
- BORROW\_AREA
  - CAILLOUET\_LAND\_PROPERTY
  - HATTIE\_CLIFTON\_PROPERTY
  - LADOTD
  - LLE-WISNER\_JOINT\_PROPERTY
  - LLE\_PROPERTY
  - MARSH\_CREATION\_AREA
  - NOURISHMENT\_SITES
  - SW LA Canal\_Nav Property
  - State Claimed Water Bottom
  - UNKNOWN\_OWNER
  - WISNER\_PROPERTY
  - Entergy OH Power
  - Entergy Transmission
  - Flowlines
  - LIG NG
  - Lafourche Water
  - Loop Pipeline
  - Misc Pipelines
  - Shell Pipeline
  - Shoreline Southeast Pipeline
  - 6" LP Enervest
  - 8" 12" HP Gas
  - 8" Central Crude
  - 18" TGP Pipeline
  - 24" Kinetica Pipeline
  - 24" MARS Pipeline
  - 24" TGP Pipeline
  - 36" TGP Pipeline
  - 10 Oil and Gas Active Producing
  - 33 Shut-In Production Future Utility

**EAST LEEVILLE MARSH CREATION  
AND NOURISHMENT PROJECT  
BA-194  
Lafourche Parish**

**EXHIBIT A-12  
2003 TOBIN MAP**

500 ft 1500 ft 2500 ft 3500 ft 4500 ft



LEGEND	
	Borrow - Caminada
	Dredge Pipeline
	LIG NG
	Lafourche Water
	Loop Pipeline
	Multiple Pipelines - Shoreline Southeast
	Shell Pipeline
	6" LP Gas Entervest
	8" - 12" HP Gas
	8" Central Crude
	18" TGP Pipeline
	24" Kinetica
	24" MARS Pipeline
	24" TGP Pipeline
	36" TGP Pipeline
	Nav Chart - Wreck
	Submerged Pile (PA)
	Wreck - Mast (PA)

**EAST LEEVILLE MARSH CREATION  
 AND NOURISHMENT PROJECT  
 BA-194  
 Lafourche Parish**  
**EXHIBIT A-13**  
**CAMINADA BORROW AREA**  
**NAVIGATION HAZARDS**

# **Appendix B**

**Geotechnical Data Review & Feasibility Study**

**By: GeoEngineers**

**August 7, 2017**

August 7, 2017

Sigma Consulting Group, Inc.  
10305 Airline Highway  
Baton Rouge, Louisiana 70816

Attention: Robert J. Lear, Jr., PE, LSI  
Vice President / Senior Project Manager

Subject: Data Review and Feasibility Study  
East Leeville Marsh Creation and Nourishment (BA-194)  
Lafourche Parish, Louisiana  
File No. 18274-004-00

## **INTRODUCTION**

Located one to three miles east of the town of Leeville and Bayou Lafourche, one of Louisiana's marsh environments has experienced widespread and rapid land loss resulting from subsidence, wind erosion, storms, and altered hydrology. The objective of the East Leeville Marsh Creation and Nourishment project is to create an arc of wetlands along the northern side of the Southwestern Louisiana Canal, Lake Jesse, and the west side of South Lake. To support this project GeoEngineers, Inc. (GeoEngineers) performed a review of existing and available data within the project area to assess project feasibility and to propose an exploration plan that will support the project's completion.

## **PROJECT UNDERSTANDING**

The proposed project is estimated to create and/or nourish approximately 500 acres of marsh. The preferred construction method is as follows:

1. Earthen containment dikes around the marsh fill areas will be constructed by mechanically dredging in-situ material;
2. Fill material from an established borrow area will be excavated by hydraulic dredging methods; and
3. Fill material will be liquefied into dredged slurry and transported to the fill site in a permitted corridor via sediment discharge pipeline.

CPRA requested a feasibility assessment and development of alternatives for the proposed project. Sigma Consulting Group, Inc. (Sigma) requested GeoEngineers' assistance with the preliminary geotechnical assessment of proposed marsh creation areas based on existing subsurface information and also recommendations for additional field exploration for a design level study.

## **FEASIBILITY STUDY**

Sigma provided GeoEngineers with soil data from Golden Meadow, Louisiana to Fourchon, Louisiana from the LA 1 expansion project as well as vibrocore sampling in Lake Jesse found through the Department of Natural Resources LASARD database. Geology maps published by the USACE and the United States Geological Survey show the project area consisting of deltaic marsh deposits consisting of cyclically interbedded interdistributary peat and clay, natural levee silt and clay, distributary sand, and mud and clay. The depth to the Pleistocene surface at the site is between 350 and 375 feet NGVD.

Available data shows marsh deposits consisting of very soft to soft clay material with layers of organics and silt throughout. The borings along LA 1 consistently showed very soft peat within the top 5 feet below the ground surface, which is underlain by soft to medium gray clay with various amounts of silt, sandy silt and silty sand layers throughout as well as traces of organic matter and shells.

A critical component of the project will be the magnitude of settlement that occurs while placing dredged fill material. Typically we have seen greater settlement occur in areas with more peat and organic clay materials. Settlement in the native soils and the dredged material should be considered while making fill estimates. Additional data that is specific to the proposed marsh creation area and borrow area will need to be collected to provide accurate settlement estimations.

Given the estimated strength of the soils in the area the proposed 3H:1V slope for the containment dikes may be difficult to achieve. Placing the fill material in multiple lifts and allowing consolidation time between lifts can reduce the size of the containment structure while obtaining desired target elevations. It should be noted that a component of the LA 1 project included a marsh creation area. Sigma has direct experience with the construction of the marsh creation area and did not observe issues with construction of the containment dikes related to the slopes. As previously mentioned, sand and silt layers were encountered in the LA soil borings. Sand and silt layers and lenses within clay material will increase the rate of consolidation and provide stability.

From aerial imaging it appears that multiple channels, natural and man-made, cross the proposed marsh nourishment and creation areas. Construction of the containment dikes may be difficult to accomplish in these areas where the mudline is deeper. Construction methods other than bucket dredge may need to be considered to achieve target containment dike crown elevations. We have seen alternative methods such as sheet piling and hay bales used in similar applications on previous projects.

There are various pipelines crossing the area, contractors should be aware of pipelines within the vicinity of construction activities, in mobilization routes and while transporting dredged material from the borrow site to the displacement locations. Settlement of pipelines that run through the marsh creation area and under containment dikes should also be considered in the design phase.

Given the provided data, Sigma's experience with the LA 1 marsh creation area construction, and our experience in the area and other similar type projects, it is our opinion that construction of the marsh creation and nourishment within the proposed area should be feasible.

## **RECOMMENDED FIELD EXPLORATION PROGRAM**

Additional geotechnical data will need to be obtained to design the marsh creation areas and containment dikes. We have provided a proposed exploration program, as shown in Figure 1, which will assist in

gathering data needed to estimate marsh settlement and containment dike stability. As the exact borrow area(s) has not been selected at this time, we have provided proposed exploration locations for all the proposed borrow areas. Proposed exploration areas and quantities have been provided in the following table. Proposed spacing of the exploration locations for the borrow areas, marsh creation areas, and containment dikes has been selected in accordance with our previous experience with marsh creation projects and CPRA's guidance for soil boring and CPT spacing included in their *Draft Marsh Creation Design Guidelines MCDG.V1*.

Proposed Investigation	Quantity
Marsh Creation and Containment Dike	22
Little Lake Borrow Area	6
Caminada Bay Borrow Area	6
Lake Jesse Borrow Area	4
South Lake Borrow Area	4
North Lake Borrow Area	4
<b>Total</b>	<b>46</b>

**CLOSING**

We appreciate the opportunity to perform these services for Sigma Consulting Group, Inc. Please contact us at 225.293.2460 if you have any questions concerning this report.

Sincerely,  
GeoEngineers, Inc.

Jennifer E. Aguetant, PE  
Geotechnical Engineer

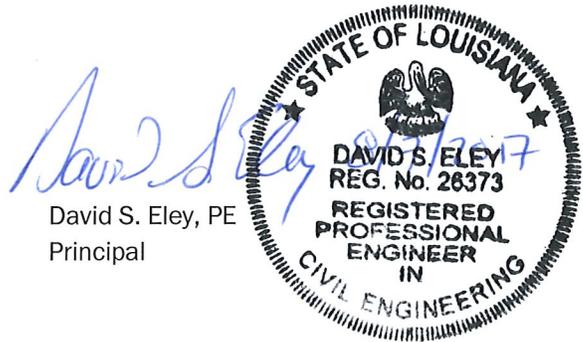
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Attachments:  
Figure 1 Conceptual Plan of Exploration Locations

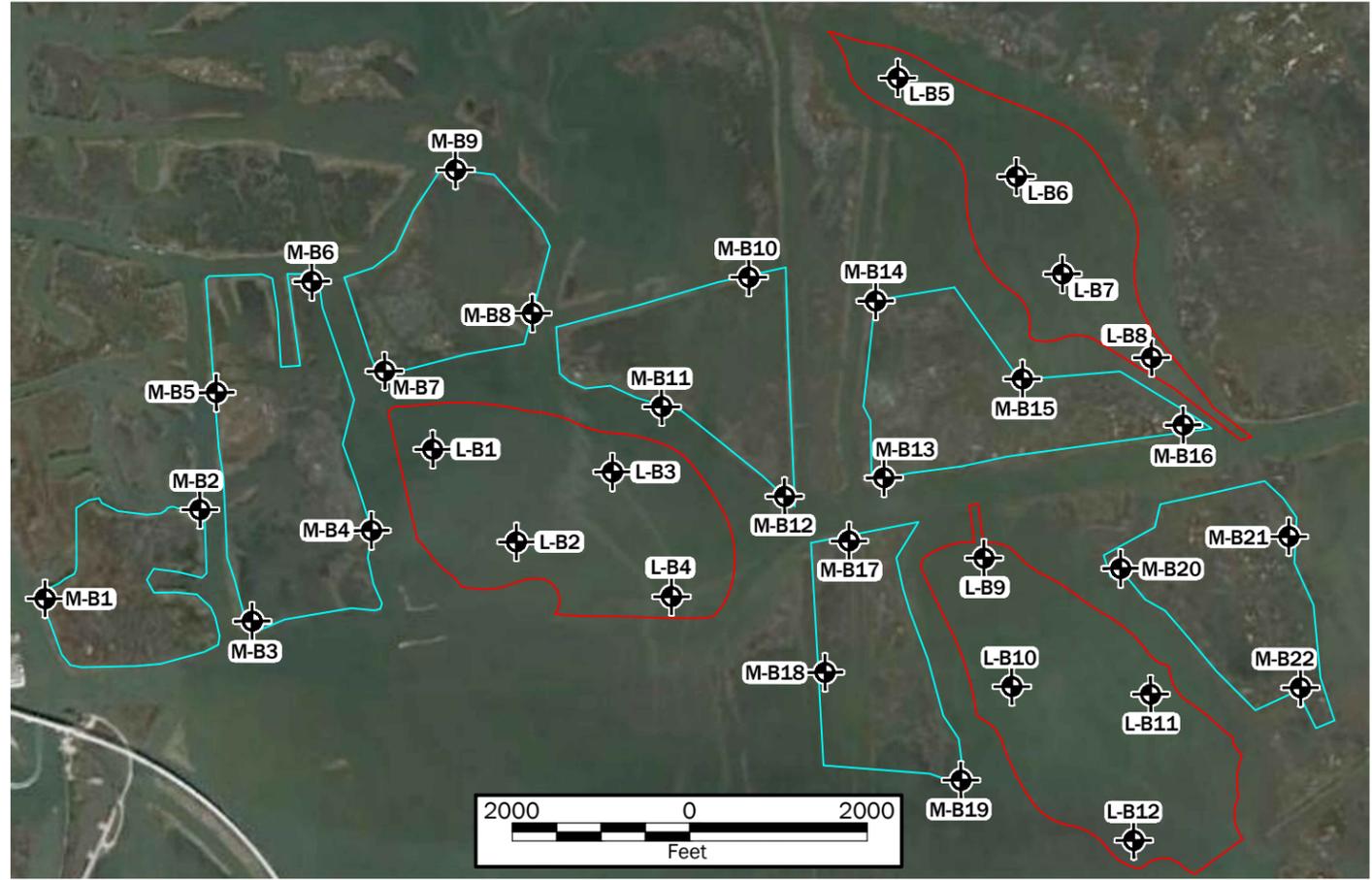
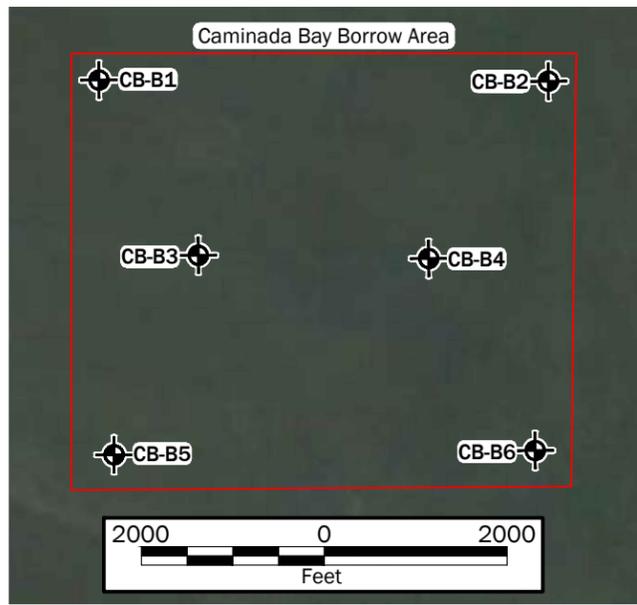
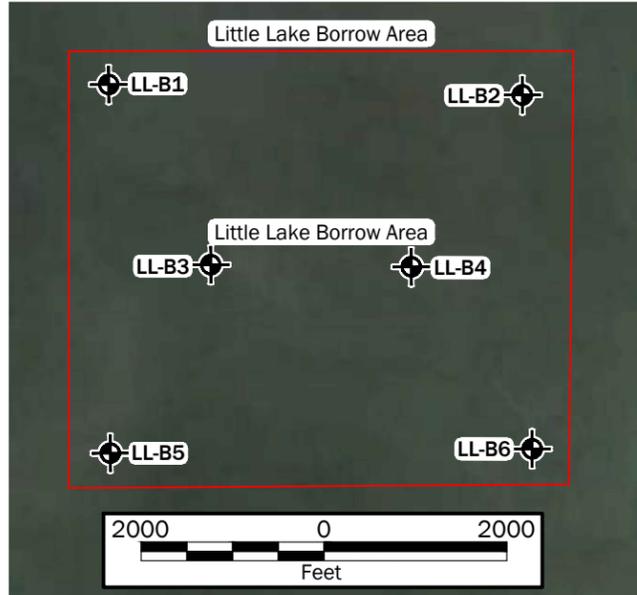
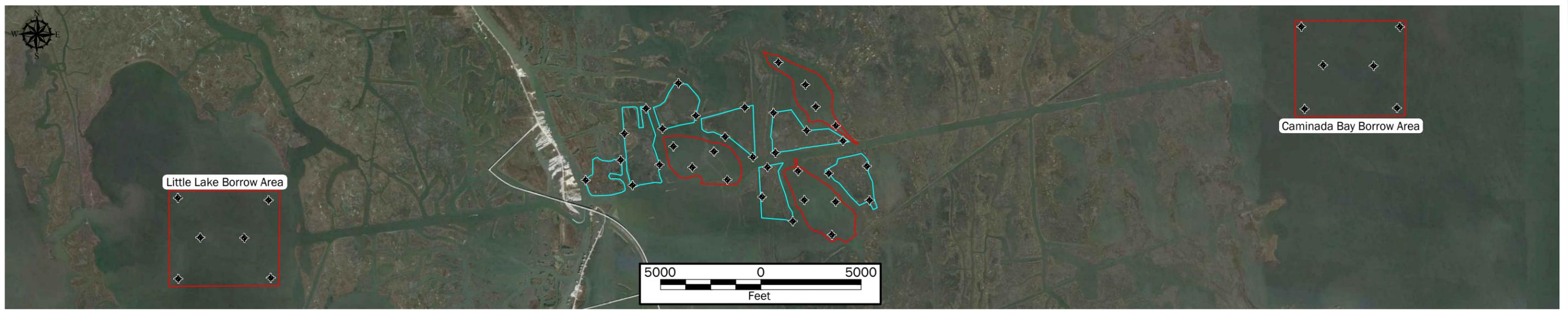
One copy submitted electronically

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- Legend**
- LL-B1 Conceptual Exploration Locations
  - Borrow Areas
  - Marsh Creation Areas

Boring Details		
Boring #	Latitude	Longitude
LL-B1	N29°14'58.01"	W90°16'20.39"
LL-B2	N29°14'56.47"	W90°15'29.35"
LL-B3	N29°14'38.45"	W90°16'8"
LL-B4	N29°14'38.02"	W90°15'43.25"
LL-B5	N29°14'18.2"	W90°16'20.62"
LL-B6	N29°14'18.24"	W90°15'28.54"
CB-B1	N29°16'16.72"	W90°5'47.03"
CB-B2	N29°16'16.08"	W90°4'51.54"
CB-B3	N29°15'57.69"	W90°5'35"
CB-B4	N29°15'57.06"	W90°5'6.56"
CB-B5	N29°15'36.23"	W90°5'45.67"
CB-B6	N29°15'36.2"	W90°4'53.67"
L-B1	N28°5'56.07"	W101°31'3.99"
L-B1	N29°15'21.02"	W90°11'41.24"
L-B2	N29°15'10.63"	W90°11'30.71"
L-B3	N29°15'18.3"	W90°11'18.41"
L-B4	N29°15'4.36"	W90°11'11.05"
L-B5	N29°16'1.84"	W90°10'41.57"
L-B6	N29°15'50.73"	W90°10'26.61"
L-B7	N29°15'39.84"	W90°10'20.87"
L-B8	N29°15'30.42"	W90°10'9.64"
L-B9	N29°15'8.29"	W90°10'31.23"
L-B10	N29°14'53.97"	W90°10'27.84"
L-B11	N29°14'52.95"	W90°10'10.21"
L-B12	N29°14'36.69"	W90°10'12.54"

Boring Details		
Boring #	Latitude	Longitude
M-B1	N29°15'4.82"	W90°12'30.77"
M-B2	N29°15'14.57"	W90°12'10.95"
M-B3	N29°15'2.09"	W90°12'4.44"
M-B4	N29°15'12.05"	W90°11'49.14"
M-B5	N29°15'27.59"	W90°12'8.7"
M-B6	N29°15'39.84"	W90°11'56.42"
M-B7	N29°15'29.78"	W90°11'47.26"
M-B8	N29°15'36.11"	W90°11'28.39"
M-B9	N29°15'52.1"	W90°11'37.98"
M-B10	N29°15'39.83"	W90°11'0.8"
M-B11	N29°15'25.51"	W90°11'12.05"
M-B12	N29°15'15.38"	W90°10'56.55"
M-B13	N29°15'17.33"	W90°10'43.87"
M-B14	N29°15'37.04"	W90°10'44.75"
M-B15	N29°15'28.2"	W90°10'26.11"
M-B16	N29°15'22.89"	W90°10'5.71"
M-B17	N29°15'10.35"	W90°10'48.38"
M-B18	N29°14'55.76"	W90°10'51.6"
M-B19	N29°14'43.59"	W90°10'34.44"
M-B20	N29°15'6.98"	W90°10'13.86"
M-B21	N29°15'10.35"	W90°9'52.4"
M-B22	N29°14'53.51"	W90°9'51.12"

- Notes:**
- The locations of all features shown are approximate.
  - This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Aerial was taken from Google Earth Pro., Imagery Dated: 11/20/2016  
 Projection: LA State Plane, South Zone, NAD83, US Foot

**Conceptual Plan of Exploration Locations**

East Leeville Marsh Creation and Nourishment  
(BA-0194)  
Lafourche Parish, Louisiana

**Figure 1**

# **Appendix C**

## **Interim Results Presentation**

**July 12, 2017**

**EAST LEEVILLE MARSH CREATION  
AND NOURISHMENT PROJECT**  
(BA-194)  
LAFOURCHE PARISH, LA

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**CPRA**

# INTERIM RESULTS PRESENTATION

July 12, 2017



**SIGMA  
CONSULTING  
GROUP, INC.**



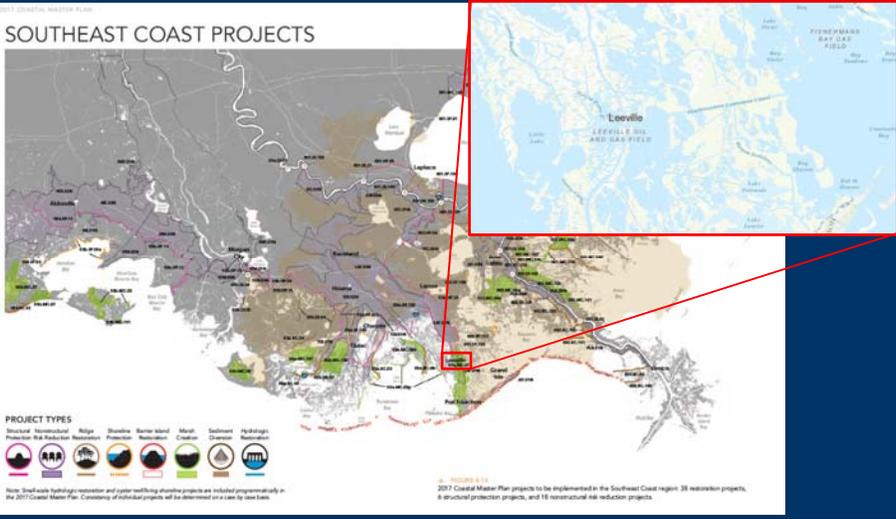
**NOAA  
FISHERIES**

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**PROJECT LOCATION**

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**SOUTHEAST COAST PROJECTS**



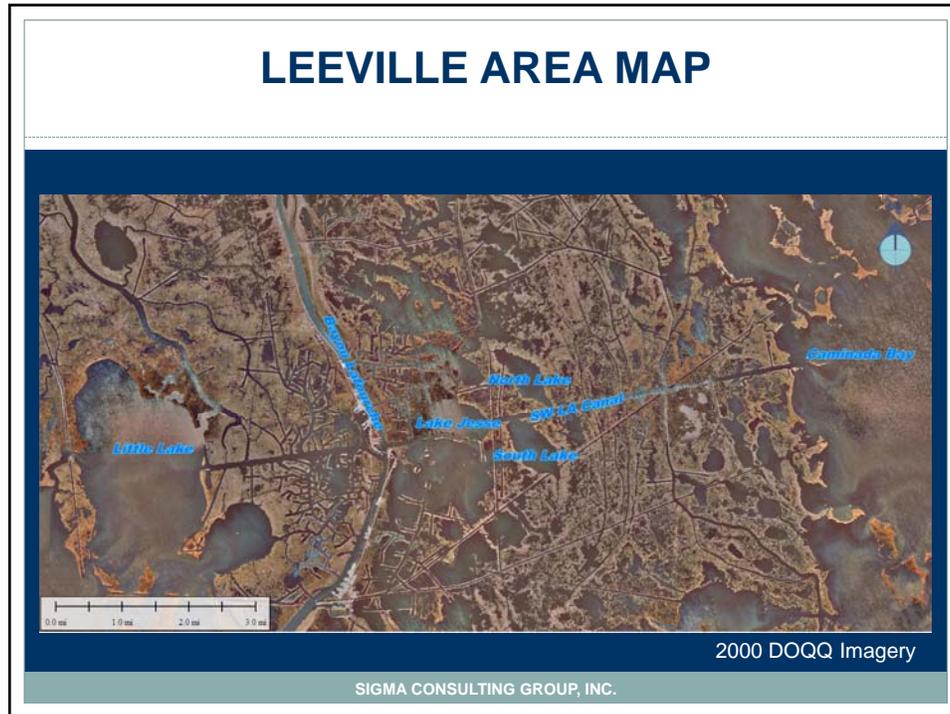
**PROJECT TYPES**

 Structural Protection	 Recreation	 Ridge Protection	 Shoreline Protection	 Barrier Island Creation	 Marsh Creation	 Sediment Deposition	 Hydrology Restoration
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Note: Small scale hydrology restoration and water quality improvement projects are included geographically in the 2017 Coastal Master Plan. Consistency of individual projects will be determined on a case by case basis.

© 2017 Coastal Master Plan projects to be implemented in the Southeast Coast region: 38 restoration projects, 6 structural protection projects, and 18 nonstructural risk reduction projects.

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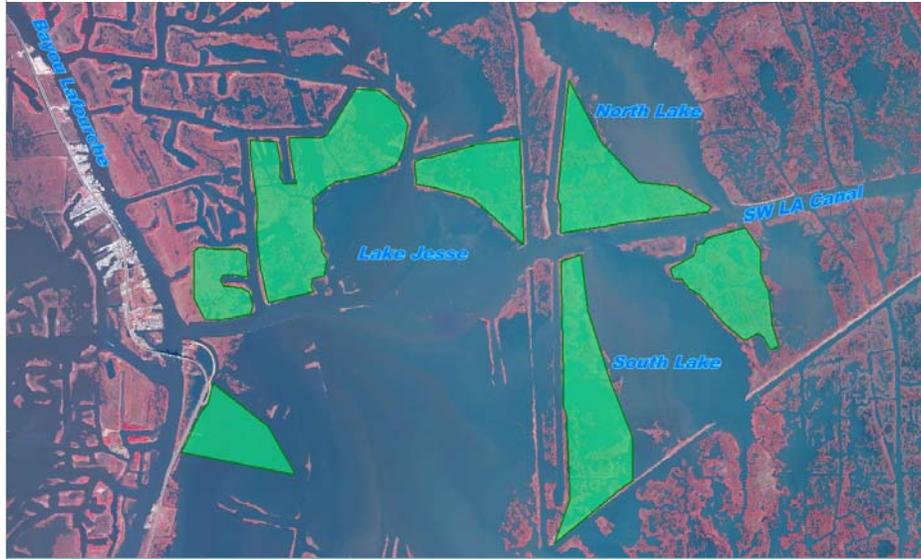


### PROJECT GOALS & OBJECTIVES

- **GOAL:** Establish an arc of wetlands along the northern side of the Southwestern Canal, Lake Jesse, and the west side of South Lake
  - Rebuild the structural framework of wetlands east of Leeville
  - Provide protection for Leeville from southeasterly winds & tides
- **OBJECTIVE:** Create and/or nourish up to 500 acres of marsh by hydraulically dredging material from a nearby borrow source and pumping it to designated fill sites

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## ORIGINAL PPL-25 SITES



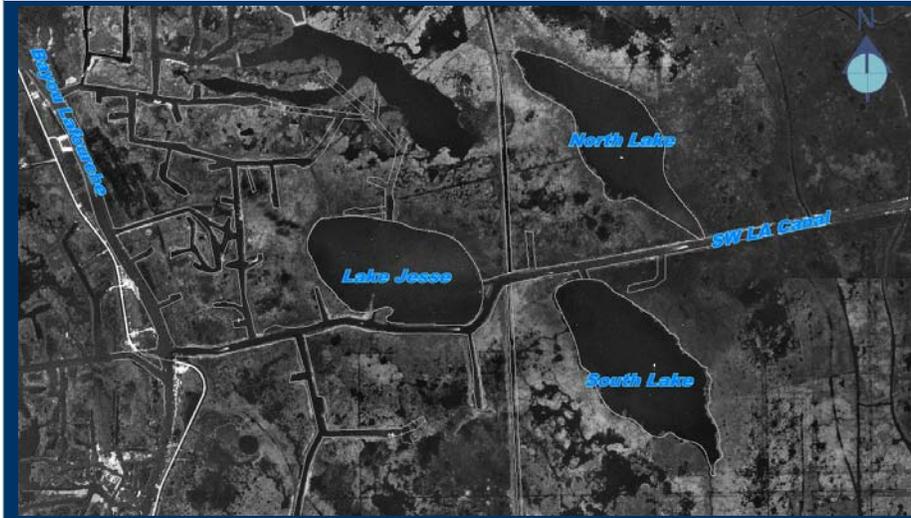
## FEASIBILITY STUDY OBJECTIVES

- Review Site Background & Historical Setting
- Existing Data Analysis (Desktop Review)
  - Infrastructure (Oil & Gas)
  - Bathymetric & Topographic Analysis
  - Limited Geotechnical Analysis
- Develop Alternatives for:
  - Marsh Creation Sites
  - Dredge Borrow Sites
  - Dredge Pipeline Corridor
  - Construction Equipment Access Routes

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## LEEVILLE AREA - 1958

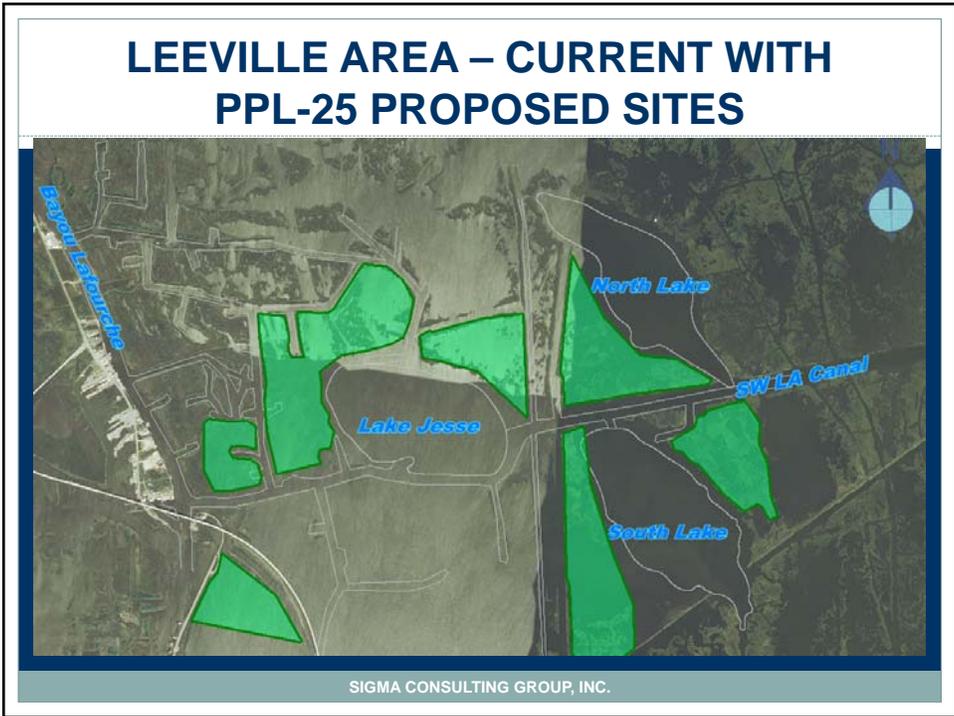
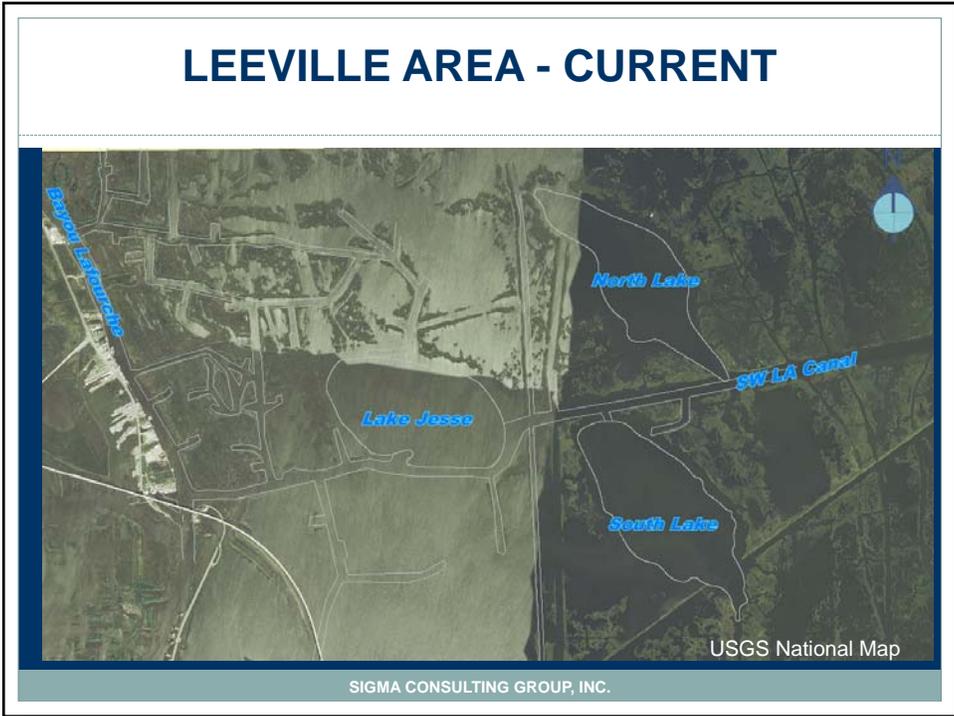


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## LEEVILLE AREA - 2005



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## LA1 - LEEVILLE MARSH CREATION

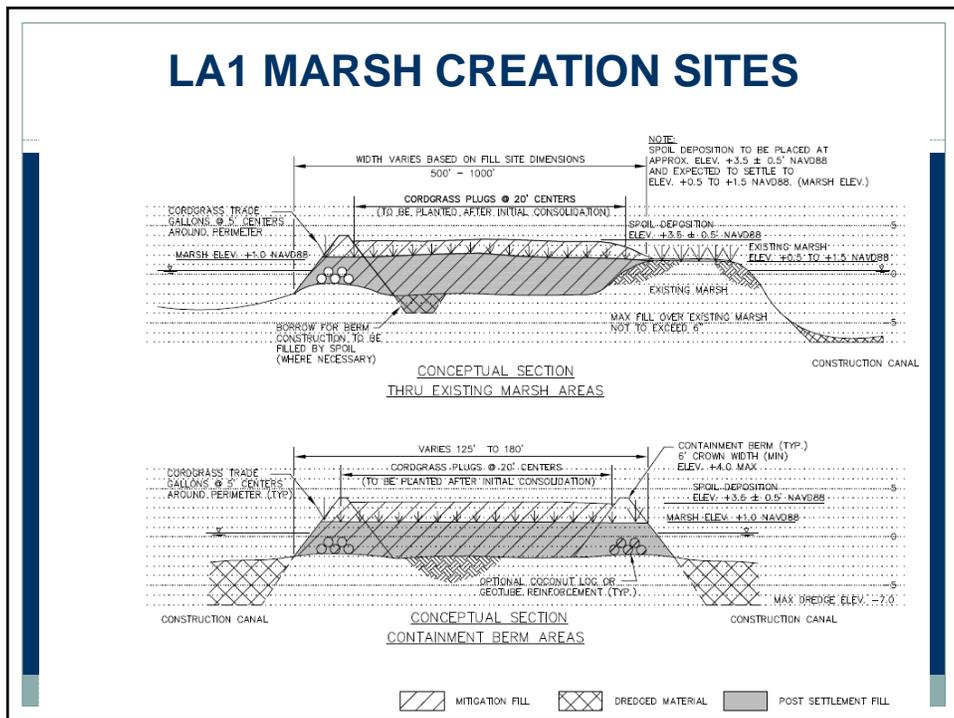
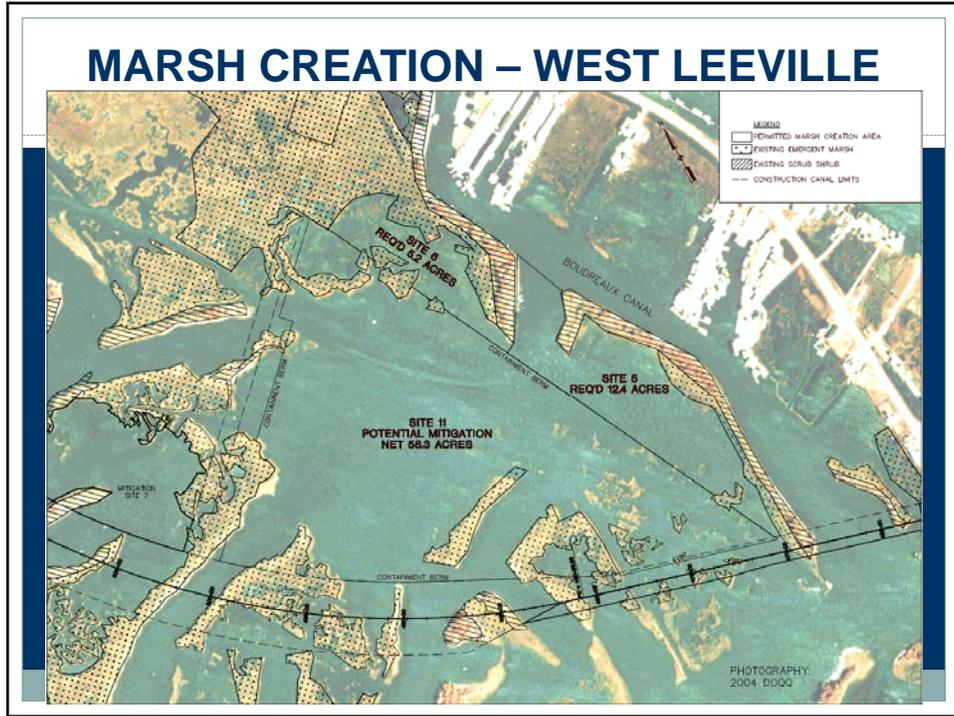
- LA DOTD Marsh Creation – Mitigation for LA1 Bridge
- Constructed 77 acres in 2005 prior to Katrina
- Constructed using Bucket and Hydraulic Dredging
- 90% Survivability over the past 10 years
- Existing Pipeline Removal / Clean-Up of Borrow Site
- Met LDNR AAHU/CHU requirements in 10 years without maintenance dredging
- Successful marsh creation project

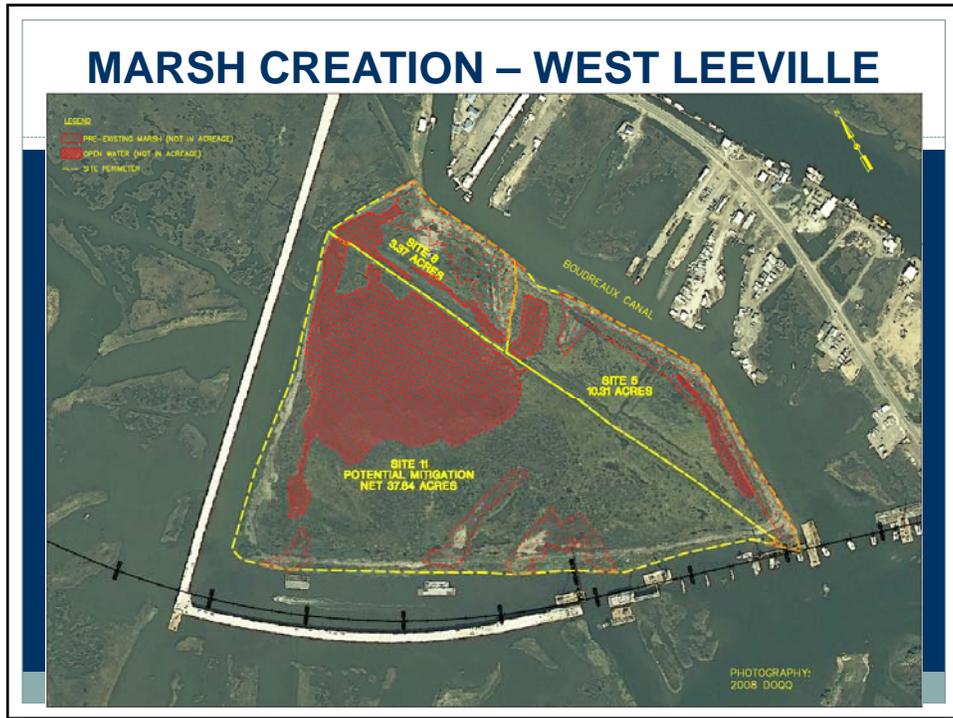
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## LA1 MARSH CREATION SITES



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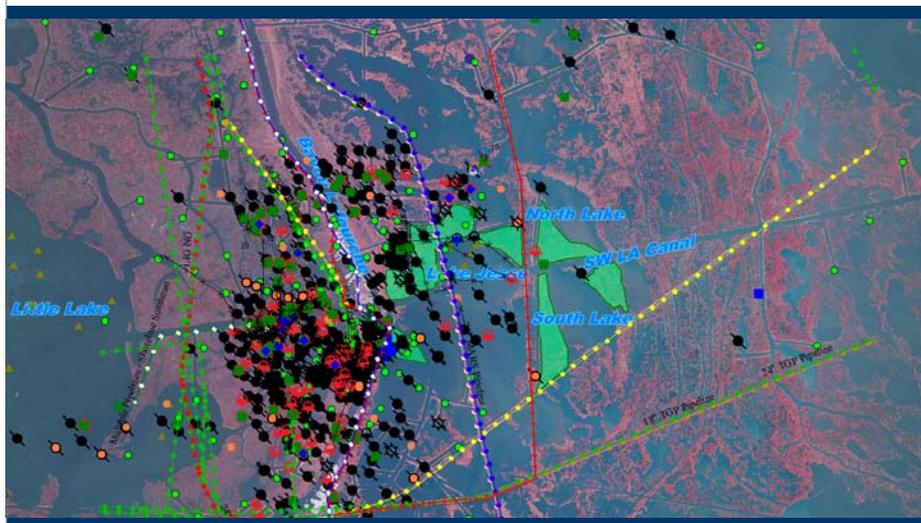


## EAST LEEVILLE – EXISTING OIL & GAS

- Desktop review of multiple data sources
  - SONRIS / LDNR Permit Database
  - DOTD LA1 project pipeline mapping
  - Interview current oil and gas field operators (Marquis and Kinetica)
  - Review historical photographic evidence
- Followed up with field visit for visible evidence of infrastructure

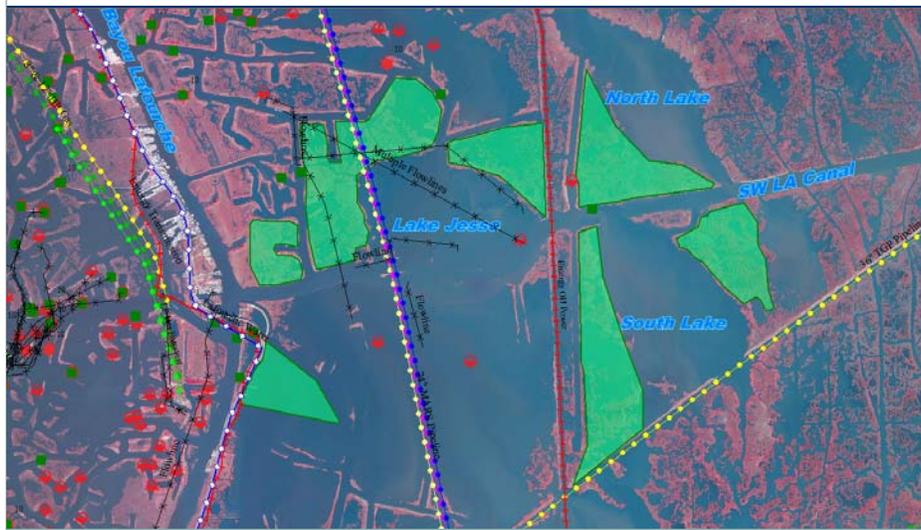
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## PROJECT AREA OIL & GAS INFRASTRUCTURE



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## MARSH CREATION SITE OIL & GAS INFRASTRUCTURE

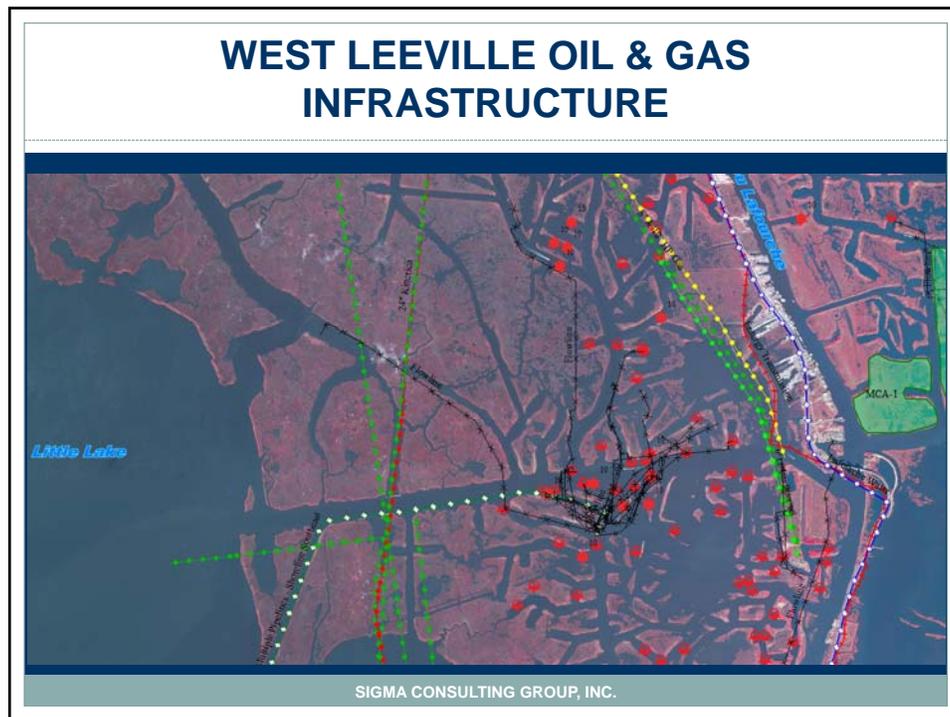


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## MAJOR OIL & GAS INFRASTRUCTURE CONSTRAINTS

- MARS / LOOP / SHELL Pipelines on the west side of Lake Jesse
- Several Flowlines throughout Lake Jesse Area
  - Marquis Operations stated that most if not all lines around the Lake Jesse Area are dead lines (not in use)
- Overhead Entergy Transmission Lines East of Lake Jesse
- To the west of Bayou Lafourche – Multiple Active transmission and flow lines cross SWLA Canal running in a north-south direction
- Multiple pipelines on the south bank of SWLA Canal between Little Lake and Bayou Lafourche

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- ### OTHER NOTABLE INFRASTRUCTURE
- New Leeville Public Boat Launch at Bayou Lafourche
  - LeFort Cemetery at the northeast corner of the Bayou Lafourche and SWLA Canal intersection
    - Cultural significance to the Leeville Area
  - Bayou Lafourche is a congressionally regulated Waterway of the United States.
    - Any crossings of Bayou Lafourche for dredge sediment transport or site access will require coordination with the US Coast Guard
  - Major Lafourche Parish Water line feeding Port Fourchon and Grand Isle is located on the west bank of Bayou Lafourche and crosses SWLA Canal near the Public Boat Launch
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## LEEVILLE INFRASTRUCTURE



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## EAST LEEVILLE – TOPO/BATHY REVIEW

- Extensive surveying performed under LA1 project
- CZN Primary Monument “876 2084 C TIDAL” was used for LA1 Project Surveying.
- CZN Elev. +3.71 ft NAVD88(2003)
- Height Mod Update: +3.09 ft NAVD88(2005)
- Elevation no longer published by NGS
- Average Marsh Elev. +1.5 ft ( $\pm$ )
- Average Water Bottom Elev. -2.0 ft ( $\pm$ )



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876 2084 C TIDAL

## 876 2084 C TIDAL (CURRENT)



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## FIELD INVESTIGATION EXISTING MARSH



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## CRMS WATER ELEVATION EVALUATION

- Used CRMS Sites to determine MLW and MHW NAVD88 (Geoid 12A) elevations
- MHW = +1.08 ft
- MLW = +0.15 ft
- Additional investigations in future stages of the project



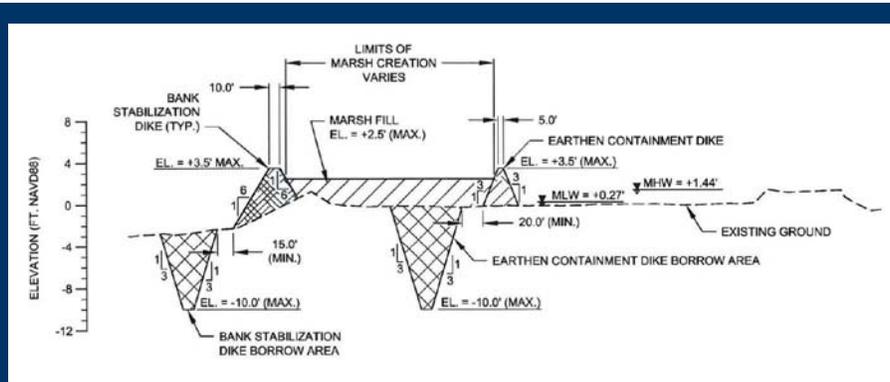
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## LIMITED GEOTECHNICAL ANALYSIS

- Reviewed extensive boring logs from the adjacent LA1 Bridge construction project
- LASARD borings within Lake Jesse
- Upper layer is predominately soft clays, silts and organics
- Geotechnical strata are consistent with other similar coastal projects

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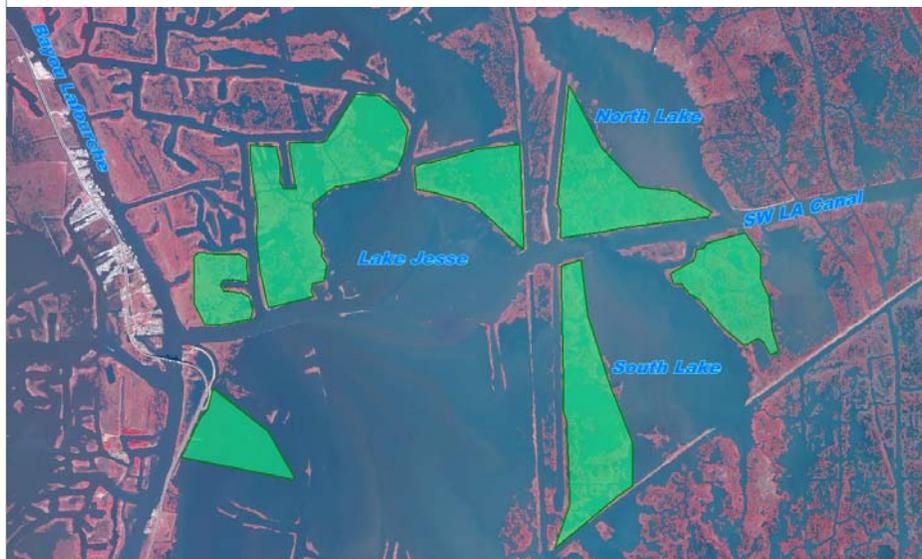
## TYPICAL CONTAINMENT / FILL SECTIONS



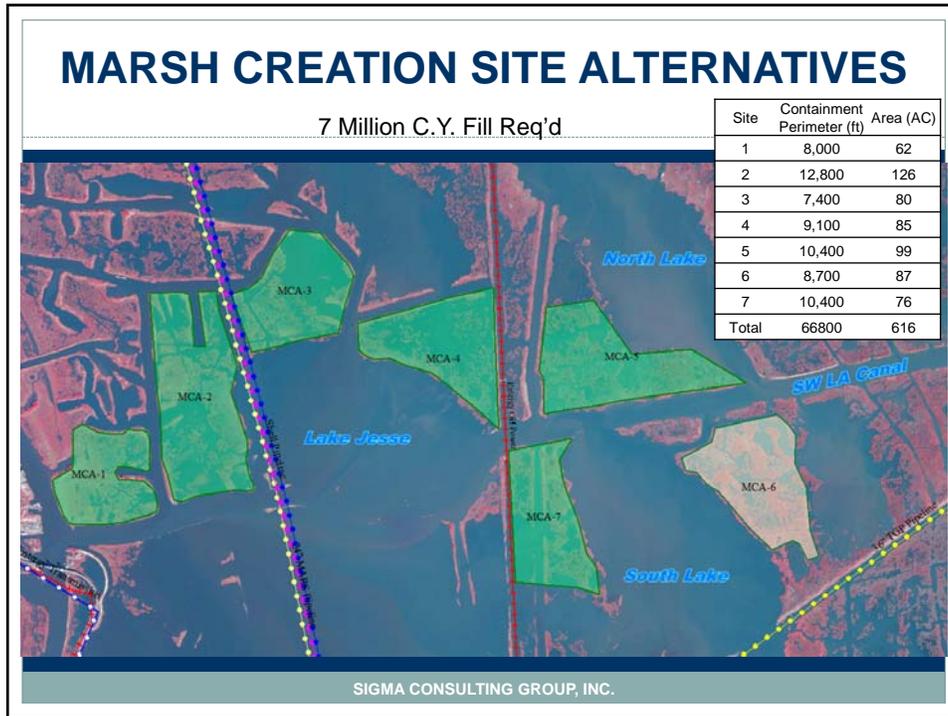
FILL SECTION FROM TE-72  
LOST LAKE MARSH CREATION

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## ORIGINAL PPL-25 SITES



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## BORROW SITE 2 – CAMINADA BAY

- 7 miles dredge pipeline on north bank of SWLA Canal



## BORROW SITE 3 – LITTLE LAKE

- 6 miles dredge pipeline with multiple conflict points



## CONSTRUCTION EQUIPMENT ACCESS

- Full marine access via Bayou Lafourche from both north and south directions
- Intracoastal Waterway to the north in Larose
- Gulf of Mexico access to the south via Belle Pass
- Land based access via LA Highway 1
- Multiple suppliers for construction activities throughout Lafourche Parish including Port Fourchon

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## OPEN DISCUSSION



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