Mississippi Valley Division,
Regional Planning and Environment Division South

St. Tammany Parish, Louisiana Feasibility Study

Draft Integrated Feasibility Report with Draft Environmental Impact Statement Appendix D – Engineering Appendix

June 2021

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ANNEXES

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Section 1
Introduction

1.1 DATUM

All elevations are referenced to the North American Vertical Datum of 1988 (NAVD 88 (2004.65)) unless otherwise noted.

1.2 PERIOD OF ANALYSIS

The period of analysis for the project is 50 years; from year 2032 to year 2082.

1.3 ALTERNATIVES OF FINAL ARRAY

The Final Array of Alternatives carried forward from hydraulic and hydrologic modeling, preliminary engineering and design, development of full cost estimates, and environmental and resource analysis. The Final Array of Alternatives including the measures for each alternative is summarized in the main report. Refer to Annex 1 of this appendix for maps of each alternative of the final array.

For levee design criteria, refer to Section 2 of this appendix.

1.3.1 Alternative 1: No Action

Under the No Action Alternative, no risk reduction would occur. The area would continue to experience damages from riverine, rainfall, surge, and coastal storm related flooding.

1.3.2 Alternative 2: Nonstructural

This alternative consists of parish wide non-structural measures in areas of flood damages (Flood Risk Management and Coastal Storm Risk Management) to structures. This alternative would include flood proofing, structure raising, buyouts, and relocations.

NOTE- THERE IS NO ALTERNATIVE 3 IN THE FINAL ARRAY OF ALTERNATIVES. ALTERNATIVE 3 WAS SCREENED EARLIER IN THE PLANNING PROCESS AND WAS NOT CARRIED FORWARD TO THE FINAL ARRAY.

1.3.3 Alternative 4: Lacombe

Alternative 4 includes three potential alignments of a new levee to reduce flooding. Measures 4a, 4a.1, and 4b were evaluated in the final array, resulting in the possible selection of one for the Tentative Selected Plan (TSP). Alternatives 4a, 4a.1, and 4b are mutually exclusive, only one levee alignment could be selected if justified; however, a justified levee could be combined with other alternatives. Refer to Figure D:1-1.

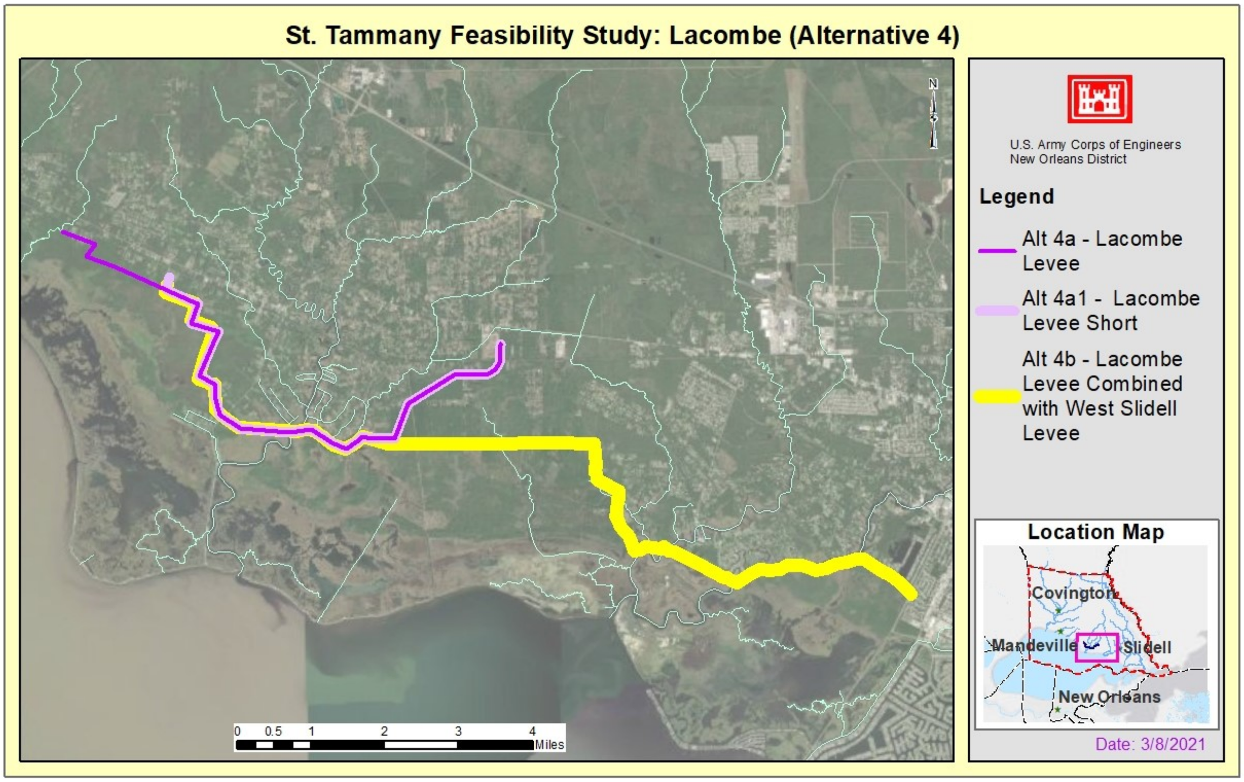


Figure D:1-1 Alternative 4 Lacombe

1.3.3.1 Alternative 4a: Lacombe

Alternative 4a consists of approximately 9 miles (47,700 feet) of a new levee in the unincorporated community of Lacombe, Louisiana, (Lacombe) to reduce flooding.

This alternative also consists of floodwalls, pump stations, floodgates, vehicular floodgates, and ramps. Refer to Figure D:1-2.

Description of Alignment

The levee would be constructed on the south side of US Highway 190 in Lacombe from east of Bayou Cane to east of Cypress Bayou and consist of approximately 9 miles (47,700 feet) of continuous levee.

Levee Design Section and Borrow Quantities

The new levee would be designed using a preliminary design elevation of 12.5 feet NAVD 88 and would use the existing ground elevations obtained from the LIDAR raster dataset. The preliminary assumptions made by the project delivery team (PDT) is that the levee would have a 10-feet wide levee crown and side slopes of 1V:3H. Berm sections would be determined once data is available for analysis**.** The construction of this levee alignment would impact approximately 110 acres. This levee alignment would require 595,000 cubic yards of fill (borrow material) (includes 30 percent contingency).

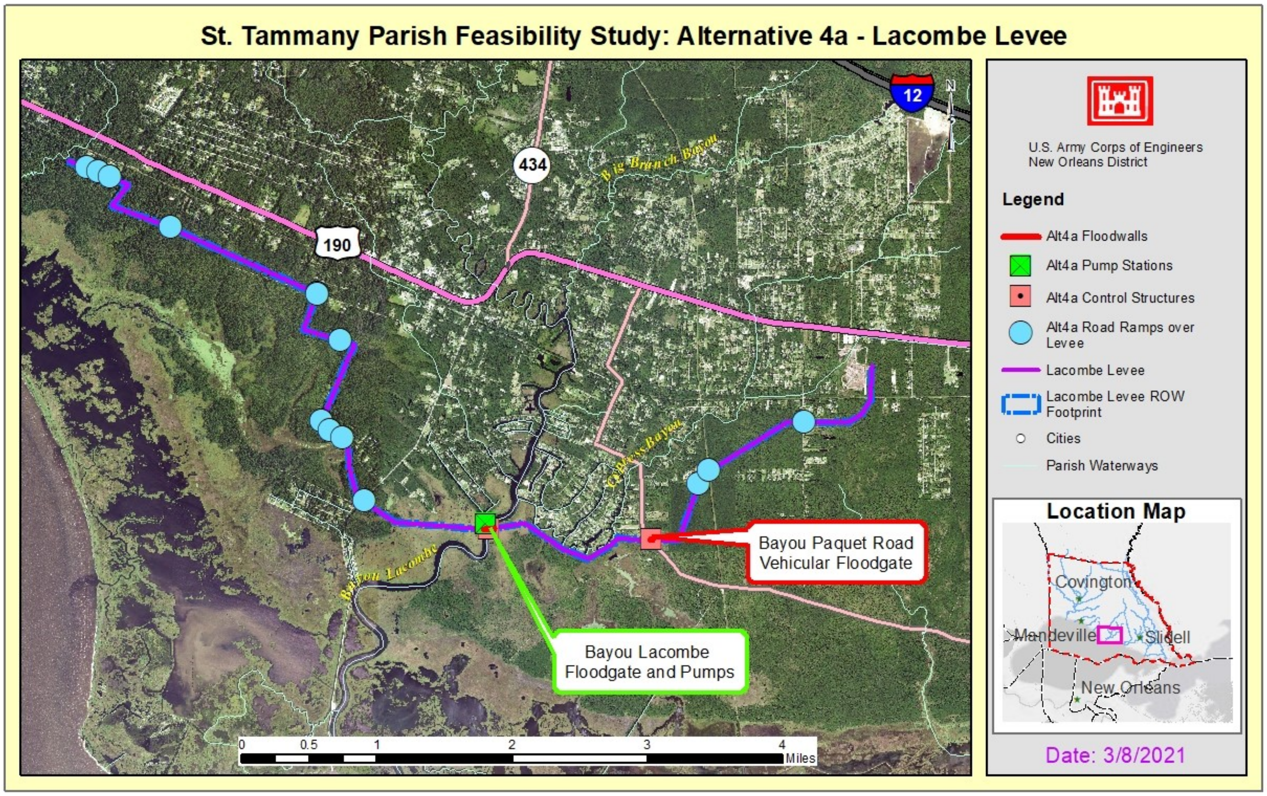


Figure D:1-2 Alternative 4a Lacombe Levee

Pump Stations and Floodgates

Alternative 4a includes a 3,200 cfs and 300-foot long pump station complex across Bayou Lacombe. This complex includes a 20-foot navigable floodgate. The construction of the pump station and floodgate would impact 12.6 acres. The preliminary design elevation for the levee in the vicinity of Bayou Lacombe would be 14.5 feet NAVD 88.

Vehicular Floodgates and Ramps

This alternative includes 14 vehicular road ramps over the levee and one vehicular floodgate to provide vehicular access through the levee.

The ramps, listed from west to east, would be located at the following road crossings: Ferrier Estates Street, Monique Street, Dalmas Street, Pontchartrain Drive #1, 24th Street, Pontchartrain Drive #2, Barringer Road #1, Barringer Road #2, Barringer Road #3, Barringer

Road #4, and Lake Road/LA Highway 434. On the east of Bayou Lacombe Pump Station and Gate Complex, there would be a vehicular floodgate at Bayou Paquet Road, and ramps at Chene Drive #1, Chene Drive #2, and Transmitter Road.

1.3.3.2 Alternative 4a.1: Lacombe Levee Short

Alternative 4a.1 consists of a shorter levee alignment on the west side of the community of Lacombe, when compared to Alternative 4a. The levee alignment consists of approximately 7.5 miles (39,000 feet) in Lacombe to reduce flooding.

This alternative also consists of floodwalls, floodgates, vehicular floodgates, and ramps. Refer to Figure D:1-3.

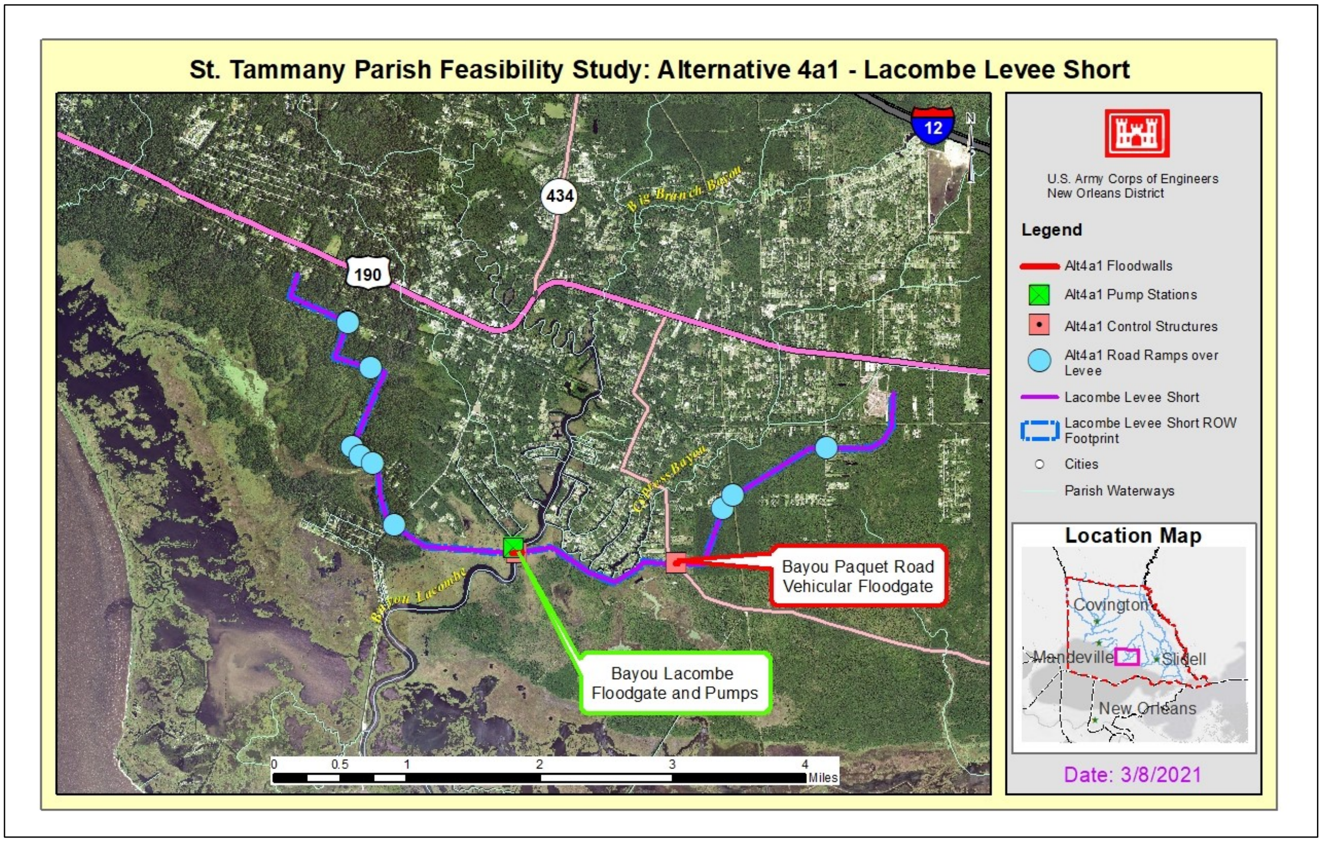


Figure D:1-3 Alternative 4a.1 Lacombe Levee Short

Description of Alignment

The new levee extends on the south side of US Highway 190 from Shelby Drive to east of Cypress Bayou and consists of approximately 7.5 miles (39,000 feet) of continuous levee.

Levee Design Section and Borrow Quantities

The new levee would be designed using a preliminary design elevation of 12.5 feet NAVD 88 and the PDT would use the elevations of the existing ground obtained from the LIDAR raster dataset. The preliminary assumptions of the PDT are that the new levee would have a 10-feet wide levee crown and side slopes of 1V:3H. Berm sections would be determined once data is available for analysis. The construction of this alignment would impact 90 acres. This levee alignment would require 574,000 cubic yards of fill or borrow material (includes 30 percent contingency).

Pump Stations and Floodgates

Alternative 4a.1 includes a 3,200 cfs and a 300-feet long pump station complex across Bayou Lacombe. This complex includes a 20-feet navigable floodgate. The construction of the pump station and floodgate would impact 12.6 acres. The preliminary design elevation in the vicinity of Bayou Lacombe would be 14.5 feet NAVD 88.

Vehicular Floodgates and Ramps

This alternative includes 10 vehicular road ramps over the levee and one vehicular floodgate to provide vehicular access through the levee.

The vehicular ramps, listed from west to east, would be located at the following road crossings: 24th Street, Pontchartrain Drive, Barringer Road #1, Barringer Road #2, Barringer Road #3, Barringer Road #4, and Lake Road/LA Highway 434.

On the east side of Bayou Lacombe Pump Station and Gate Complex, there would be a vehicular floodgate at Bayou Paquet Road, and ramps at Chene Drive #1, Chene Drive #2, and Transmitter Road.

Structural Assumptions for Alternative 4a and 4a.1

The new Bayou Lacombe Pump Station is assumed to have similar components and configuration as the USACE West Shore Lake Pontchartrain Reserve Relief Canal Pumping Station (WSLP Pump Station).

1.3.3.3 Alternative 4b: Lacombe Levee Combined with West Slidell Levee

This alternative consists of approximately 13.7 miles (72,000 feet) of levee, which would combine the Lacombe Levee from Alternative 4a.1 and the West Slidell Levee from Alternative 5, to reduce flooding in the Lacombe, Slidell, and the area between the two cities.

This alternative also consists of floodwalls, floodgates, vehicular floodgates, and ramps. Refer to Figure D:1-4.

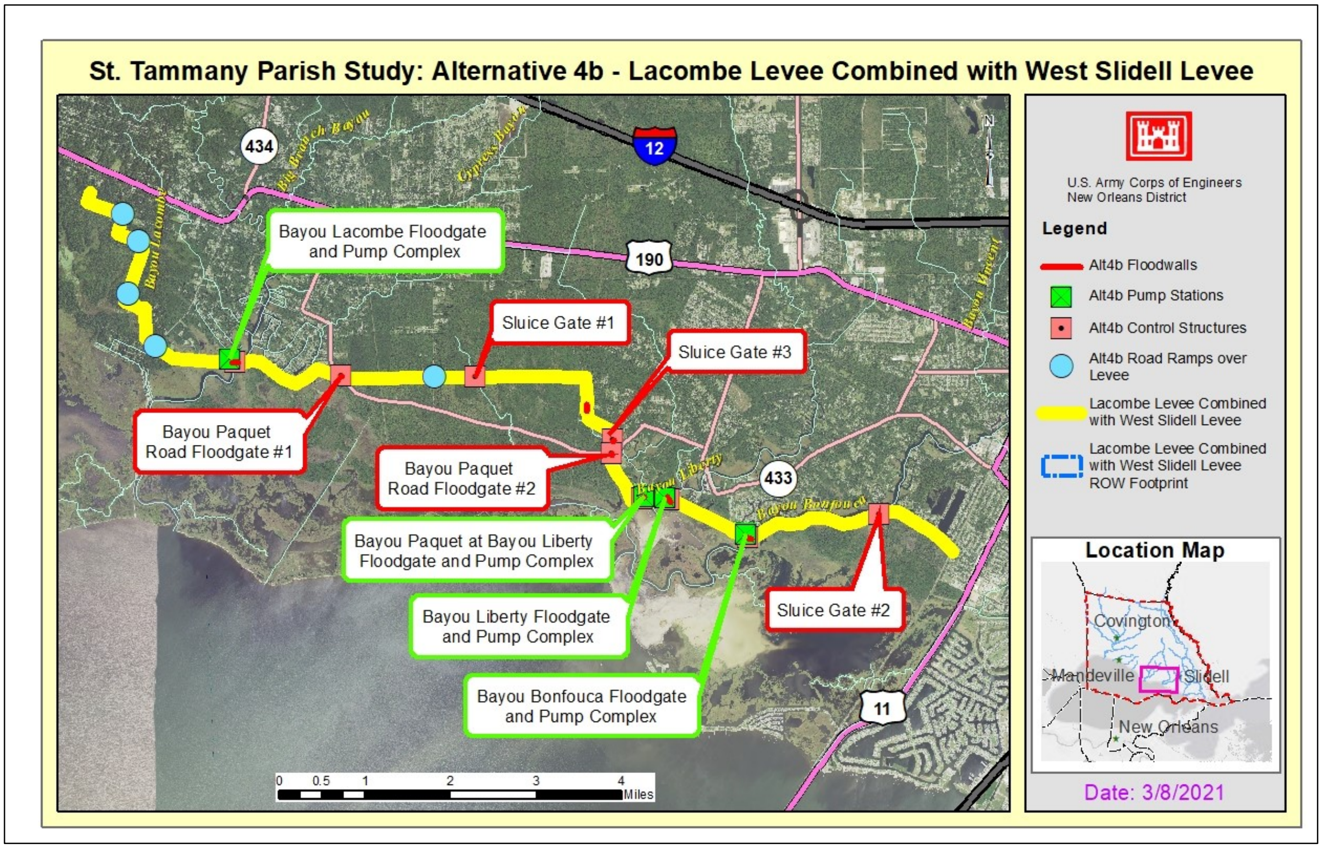


Figure D:1-4 Alternative 4b Lacombe Levee Combined with Wet Slidell Levee

Description of Alignment

The new levee would be continuous and would start on the unincorporated community of Lacombe, Louisiana on the south side of US Highway 190 on Shelby Drive. Then it would continue east and cross Bayou Paquet at two locations. The levee would continue east and cross Bayou Liberty, and Bayou Bonfouca, along the northern perimeter of the Big Branch Marsh National Wildlife Refuge. The levee would terminate on the westside of the Norfolk Southern Railway Corp. railroad tracks (west of US Highway 11 in the vicinity of Delwood Pump Station) in Slidell.

Levee Design Section and Borrow Quantities

The new levee elevation would vary depending on the levee location. In the Lacombe area, the elevation is 12.5 feet, except in the vicinity of Bayou Lacombe, which is 14.5 feet. The levee in the area between Lacombe and West Slidell is 13 feet. The elevation of the west Slidell portion varies between 13 feet and 17 feet depending on the location. The existing elevations were obtained from the LIDAR raster dataset. The preliminary assumptions made by the PDT are that the new levee would have a 10-feet wide levee crown and side slopes of 1V:3H. Berm sections would be determined once data is available for analysis. The construction of the levee alignment would impact 165 acres. This levee alignment would require 1,205,000 cubic yards of fill/borrow (includes 30 percent contingency).

Floodwall Elevation and Location

There is 0.07-mile (350 feet) floodwall segment with top of wall elevation of 17 feet.

It is located approximately 3,500 feet north and west of Bayou Paquet Road floodgate. Floodwall is designed to fit the alignment between some properties at the western end of West Doucette Road and a utility corridor that is located west of those properties.

The construction of this floodwall segment would impact approximately 0.4 acres.

Typical Floodwall Section

The typical T-wall section would consist of 3 feet thick, 8.5-feet wide slab with a 1.5-feet thick stem. The height of the stem would vary. Preliminary assumptions are two rows of 1H:3V battered H12 x 74 piles, 60 feet deep, spaced at 5 feet centers, and 30-feet deep steel PZ sheet pile. Approximately 1,850 square feet of slope protection would be provided at floodwall/levee tie-ins. The design of the T-wall, including the foundation, is subject to change once detailed geotechnical investigations are conducted. Refer to Figure D:1-5 for additional information on the typical floodwall section.

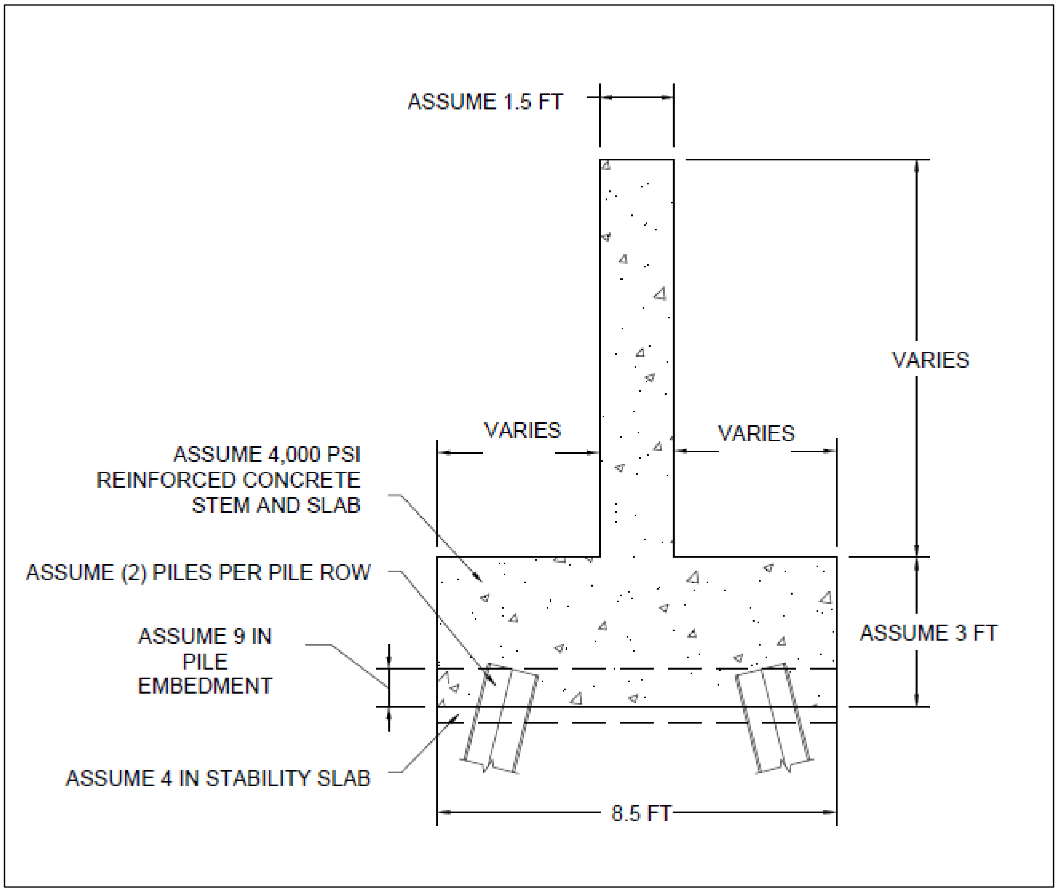


Figure D:1-5 Typical Floodwall Cross Section for all Alternatives with Floodwalls

Pump Stations and Floodgates

There are a series of pump station complexes (four with navigable floodgates) and sluicegates that are part of this alternative. Pump stations complexes and floodgates locations are listed in order starting on the west side of alternative 4b:

- Bayou Lacombe Pump Station (3,200 cfs and 300-feet long) complex. This complex includes a 20-feet navigable floodgate (12.6 acres of construction area)

- Sluicegate #1 would be located at Bayou Bonfouca West Tributary Number 1 (0.25 acres of construction area)

- Sluicegate #3 would be located at an upstream tributary of Bayou Paquet (0.25 acres of construction area). There is no pump station at this location.

- Bayou Paquet at Bayou Liberty Pump Station complex (500 cfs and 400 foot long) (12.6 acres of construction area). The complex includes a 20-foot navigable floodgate

- Bayou Liberty Pump Station complex (3,200 cfs and 400 foot long). The complex includes a 20-foot navigable floodgate (12.6 acres of construction area)

- Bayou Bonfouca Pump Station complex (3,700 cfs and 300 foot long). The complex includes a 20-foot navigable floodgate (12.6 acres of construction area)

- and Sluicegate #2 would be located at a crossing of Bayou Bonfouca with an unamend waterway where the bayou turns north (0.25 acres of construction area).

Vehicular Floodgates and Ramps

This alternative includes a series of vehicular ramps where the roads cross the levee alignment to provide vehicular access. There are five road ramps and two vehicular floodgates.

Features along Combined Levee are listed from west to east:

Pontchartrain Drive, Barringer Road #1, Barringer Road #2, and Lake Road/LA Highway 434. East of Bayou Lacombe Pump Station and floodgate, there is a vehicular floodgate at Bayou Paquet Road (west), and a ramp at Transmitter Road. After Sluicegate # 1, and Bayou Paquet Pump Station and floodgate, there is a 30-feet vehicular floodgate at Bayou Paquet Road (east).

Structural Assumptions for Alternative 4b

1.) Pump Stations:
   a. Bayou Lacombe Pump Station
      i. Assumed to have similar components and configuration as WSLP Pump Station.
      ii. Assumed sill elevation to be equal to inlet at Lake Pontchartrain.
      iii. Assumed integrated navigable floodgate for recreational vessels.
   b. Bayou Paquet at Bayou Liberty Pump Station:
      i. Assumed to have similar components and configuration as WSLP Pump Station.
      ii. Assumed sill elevation to be equal to inlet at Lake Pontchartrain.
      iii. Assumed integrated navigable floodgate for recreational vessels.
   c. Bayou Liberty Pump Station:
      i. Assumed to have similar components and configuration as WSLP Pump Station.
      ii. Assumed sill elevation to be equal to inlet at Lake Pontchartrain.
      iii. Assumed integrated navigable floodgate for recreational vessels.
   d. Bayou Bonfouca Pump Station:

i. Assumed to have similar components and configuration as WSLP Pump Station.
ii. Assumed sill elevation to be equal to inlet at Lake Pontchartrain.
iii. Assumed integrated navigable floodgate for recreational vessels.

2.) Floodwalls:
- a. 350 linear feet floodwall reach
  - i. Assumed T-wall for this alignment reach as the alignment is adjacent to private property.
  - ii. Assumed T-wall dimensions and configurations like USACE New Orleans to Venice Non-Federal West NOV-NF-W-06B.5 Magnolia Pump Station T-walls.
  - iii. Assumed 60- feet, 1:3 battered H-piles based on geotechnical analysis.
  - iv. Assumed T-wall construction area 50 feet to either side from center line of alignment.
  - v. Assumed permanent access to be included in construction area.

3.) Access Floodgates:
- a. Paquet Road West floodgate
  - i. Assumed floodgate.
  - ii. Assumed rough ground elevation via Google Earth.
  - iii. Assumed floodgate width based on road width.
- b. Paquet Road East floodgate
  - i. Assume roller floodgate.
  - ii. Assumed rough ground elevation via Google Earth.
  - iii. Assumed floodgate width based on road width.

4.) Control Floodgates:
- a. Sluicegates #1, #2 and #3
  - i. Assumed sluicegate.
  - ii. Assumed width based on stream width.
  - iii. Assumed sill is 5 feet below ground elevation.

1.3.4 Alternative 5: Bayou Liberty/ Bayou Vincent/ Bayou Bonfouca

1.3.4.1 West Slidell Levee West Slidell Levee

The West Slidell Levee consists of a combination of 6.5 miles of levee and floodwall alignment to reduce flooding. This alignment is a combination of approximately 6.5 miles (34,000 feet) of levees and 0.08 miles (450 feet) of floodwall.

This alternative also consists of floodwalls, floodgates, sluicegates, vehicular floodgates, ramps, detention pond with weir, and channel improvements. See Figures D:1-6; D:1-7; D:1-8; D:1-9; and D:1-10.

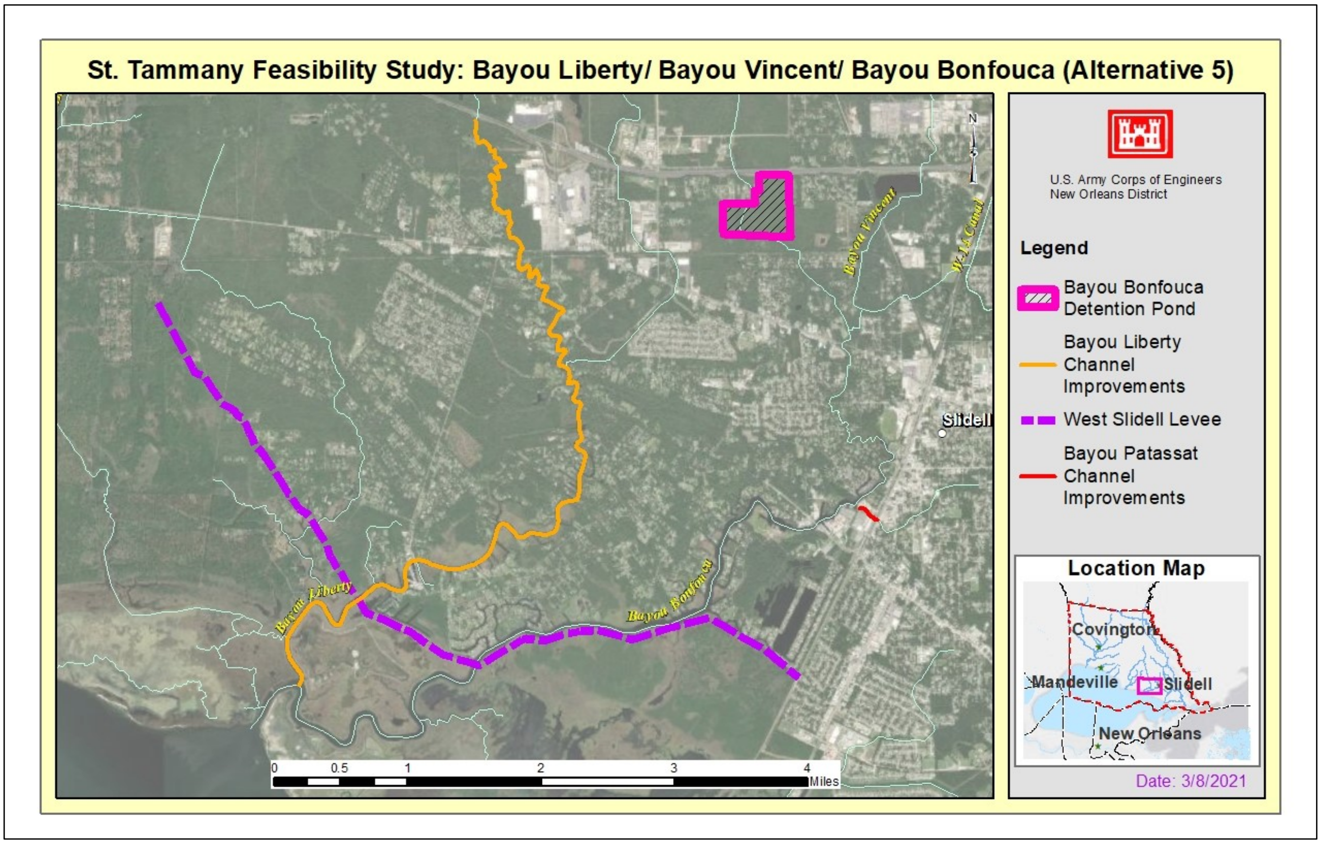


Figure D:1-6 Alternative 5 Bayou Liberty/ Bayou Vincent/ Bayou Bonfouca

Description of Alignment

This alignment is located on the west side of the City of Slidell, Louisiana. The levee extends from south of Highway 190 on the southwest of South Tranquility Road, would cross Bayou Paquet, continue to Bayou Liberty, and continue to Bayou Bonfouca. The levee would continue east along the northern perimeter on the Big Branch Marsh National Wildlife Refuge and would terminate on the westside of the Norfolk Southern Railway Corp. railroad tracks (west of US Highway 11 in the vicinity of Delwood Pump Station) in Slidell.

Levee Design Section and Borrow Quantities

The elevation of the new West Slidell levee varies between 13 feet and 17 feet depending on the location. The elevation of the existing ground was used as per the LIDAR raster dataset. The preliminary assumptions are that the levee would have a 10-feet wide levee crown and side slopes of 1V:3H. Berm sections would be determined once data is available for analysis. The construction of this levee alignment would impact 78 acres. This levee alignment would require 611,000 cubic yards of fill/borrow (includes 30 percent contingency).

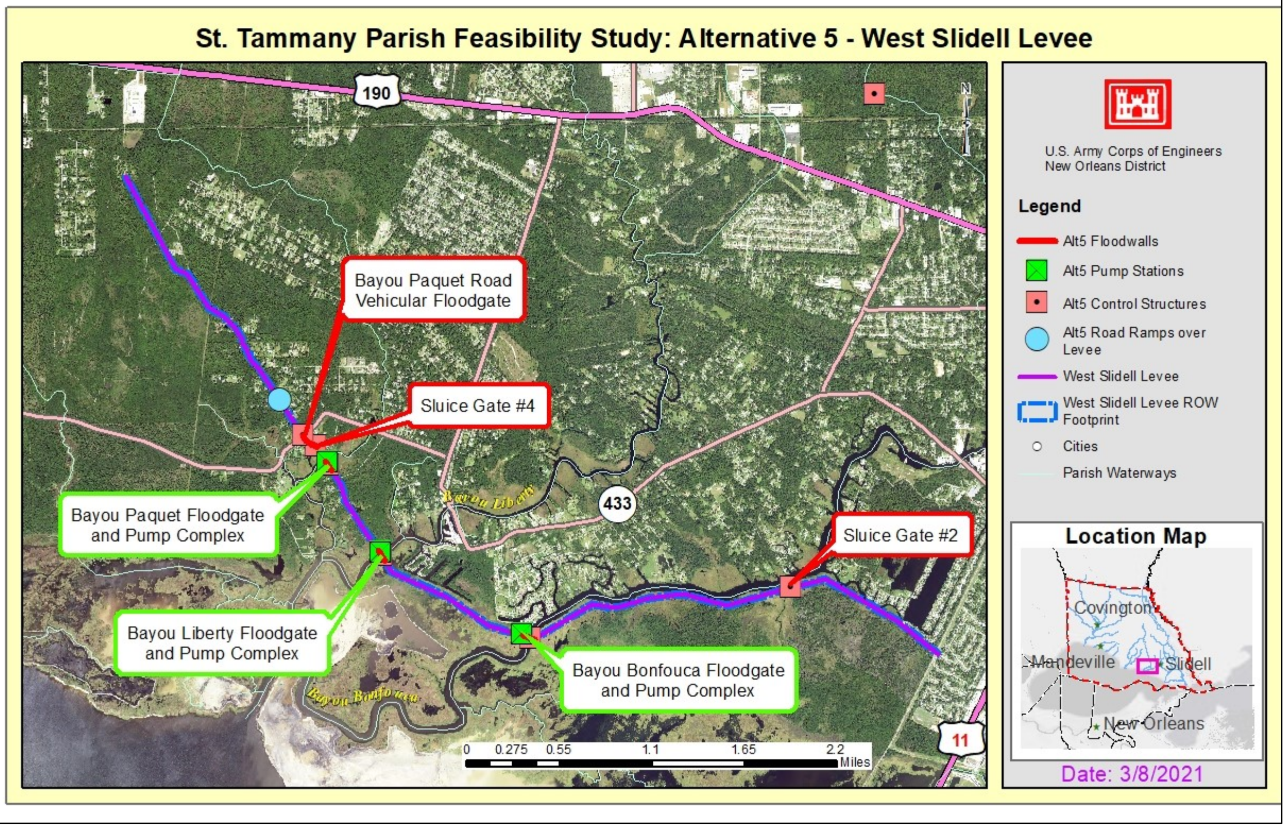


Figure D:1-7 Alternative 5 West Slidell Levee Focus

Floodwall Elevation and Location

There is one floodwall segment of a length of approximately 0.08 mile (450 feet) within the levee alignment. This segment would be located approximately 3,500 feet north and west of Bayou Paquet Road floodgate. The floodwall would be at elevation 13 feet (total construction area for these segments would be 1 acre).

Typical Floodwall Section

The typical T-wall section consists of a 3-feet thick, 8.5-feet wide slab with a 1.5- feet thick stem. The height of the stem varies. Preliminary assumptions are two rows of 1H:3V battered steel H12 x 74 piles, 60-feet deep, spaced at 5 feet centers, and 30-feet deep steel PZ sheetpile. Approximately 1,850 square feet of slope protection would be provided at floodwall/levee tie-ins. The design of the T-wall including the foundation is subject to change once detailed geotechnical investigations are conducted.

Pump Stations and Floodgates

There are 3 pump stations, 3 floodgates, and 2 sluicegates that are part of this alternative:

- Sluicegate #4 is a 25-foot sluicegate serving a tributary of Bayou Paquet between Bayou Paquet Road and Jummonville Road (0.25 acres of construction area)
- Bayou Paquet Pump Station complex (500 cfs and 100-foot long) located between Jummonville Road and Mayer Drive. The complex includes a 20-foot navigable floodgate (construction area is 12.6 acres)
- Bayou Liberty Pump Station complex (3,200 cfs and 400-foot long). The complex includes a 20-foot navigable floodgate (construction area would be 12.6 acres)
- Bayou Bonfouca Pump Station complex (3,700 cfs and 300-foot long). The complex includes a 20-foot navigable floodgate (12.6 acres required for construction)
- Sluicegate #2 would be located at a crossing of Bayou Bonfouca with an unamend waterway where the bayou turns north. (0.25 acres of construction area). Note that Sluicegate #4 would not be at the same location as Sluicegate #3 in Alternative 4b

Vehicular Floodgates and Ramps

Alternative 5 includes a vehicular road ramp at Cousins Road and a 30-feet vehicular floodgate at Bayou Paquet Road.

Structural Assumptions for Alternative 5

1.) Pump Stations:
   a. Bayou Paquet at Bayou Liberty Pump Station
      i. Assumed to have similar components and configuration as WSLP Pump Station.
      ii. Assumed sill elevation to be equal to inlet at Lake Pontchartrain.
      iii. Assumed integrated navigable floodgate for recreational vessels.
   b. Bayou Liberty Pump Station:
      i. Assumed to have similar components and configuration as WSLP Pump Station.
      ii. Assumed sill elevation to be equal to inlet at Lake Pontchartrain.
      iii. Assumed integrated navigable floodgate for recreational vessels.
   c. Bayou Bonfouca Pump Station:
      i. Assumed to have similar components and configuration as WSLP Pump Station.
      ii. Assumed sill elevation to be equal to inlet at Lake Pontchartrain.
      iii. Assumed integrated navigable floodgate for recreational vessels.

2.) Floodwalls:
   a. 450-feet floodwall reach

i. Assumed T-wall for this alignment reach as the alignment is adjacent to private property.
ii. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station T-walls.
iii. Assumed 60 foot 1:3 battered H-piles based on geotechnical analysis.
iv. Assumed T-wall construction area 50 feet to either side from center line of alignment.
v. Assumed permanent access to be included in construction area.

3.) Access Floodgates:
   a. Paquet Road East floodgate
      i. Assumed floodgate.
      ii. Assumed rough ground elevation via Google Earth.
      iii. Assumed floodgate width based on road width.

4.) Control Floodgates:
   a. Sluicegates #2 and #4
      i. Assumed sluicegate.
      ii. Assumed width based on stream width.
      iii. Assumed sill is 5 feet below ground elevation.
   b. Bayou Bonfouca Detention Pond Weir:
      i. Assumed weir.
      ii. Assumed 100-feet long.
      iii. Assumed top of weir at 5 feet above ground level.

1.3.4.2 Bayou Bonfouca Detention Pond

Alternative 5 includes the construction of the Bayou Bonfouca Detention Pond to address rainfall and riverine flooding. This detention pond would be located south of the Interstate 12 (I-12). The construction of the detention pond would impact 109 acres and have a water detention capacity of 1,308 acre-feet. It is assumed that there is an existing average elevation of 12 feet NAVD 88. The depth of the pond would be 12 feet with 1V:3H side slopes. Approximately 125 acres would have to be cleared and grubbed prior to excavation. Approximately 2,500,000 cubic yards of excavated material is assumed. A 65-foot temporary right-of-way (ROW) (16 AC) would be needed around the perimeter for access during construction. The detention pond also includes the construction of a weir. Refer to Figure D:1-8.

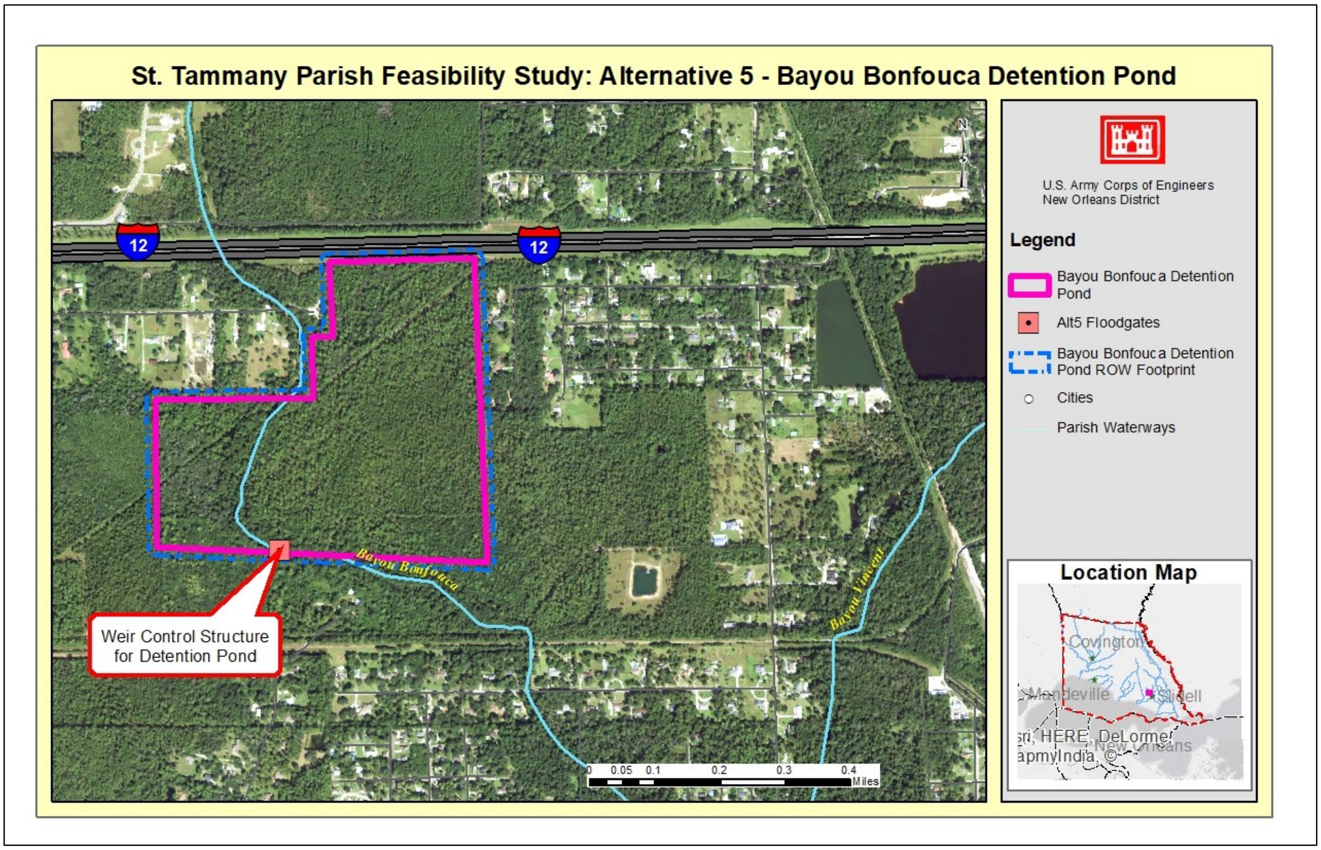


Figure D:1-8 Alternative 5 Bayou Bonfouca Detention Pond Focus

1.3.4.3 Bayou Patassat Channel Improvements

The Bayou Patassat Channel Improvements would be performed between Bayou Vincent Pump Station and US Highway 11. Bayou Patassat is a small tributary of Bayou Bonfouca. The preliminary design of the Bayou Patassat channel improvements assumes that an existing bank elevation of 1 foot, a 10-feet bottom width at Elevation (-) 5 feet NAVD 88, with bank side slopes of 1V:3H. The work would be located in Bayou Patassat between Bayou Vincent Pump Station and US Highway 11. Land access to the site would be through Bayou Lane or the existing Bayou Vincent pump station.

The lands required for the implementation of for the Bayou Patassat channel improvements are all public property and owned by either St. Tammany Parish or the city of Slidell, LA. Possible staging areas include the city-owned land around the bayou and pump station or at the grassy area at the end of Bayou Lane. It is assumed that access to the bayou would be via the city-owned property along the channel. There would be enough ROW for two-way access on the northside of the channel. If necessary, a temporary culvert can be placed in the channel to allow for crossing over to the southernmost bank.

Approximately 0.17 miles (900 feet) of clearing and snagging would occur in the channel. Material removed may include trees, debris, trash, or other obstructions within the channel. For the Bayou Patassat channel improvements would require approximately 2 acres of ROW for a temporary easement within the Bayou Patassat Channel. In addition, another approximate 0.6 acres of ROW would be tree-clearing, with the majority of the work taking place on the southernmost bank. All trees and debris cleared would likely be chipped on site and then hauled to the nearest landfill. The nearest landfills are the Slidell Landfill (east of Interstate 10 and south of LA Highway 433) and Waste Management (2685 Gause Boulevard West, Slidell, LA 70460). The assumed haul distance is 15 miles. Refer to Figure D:1-9.

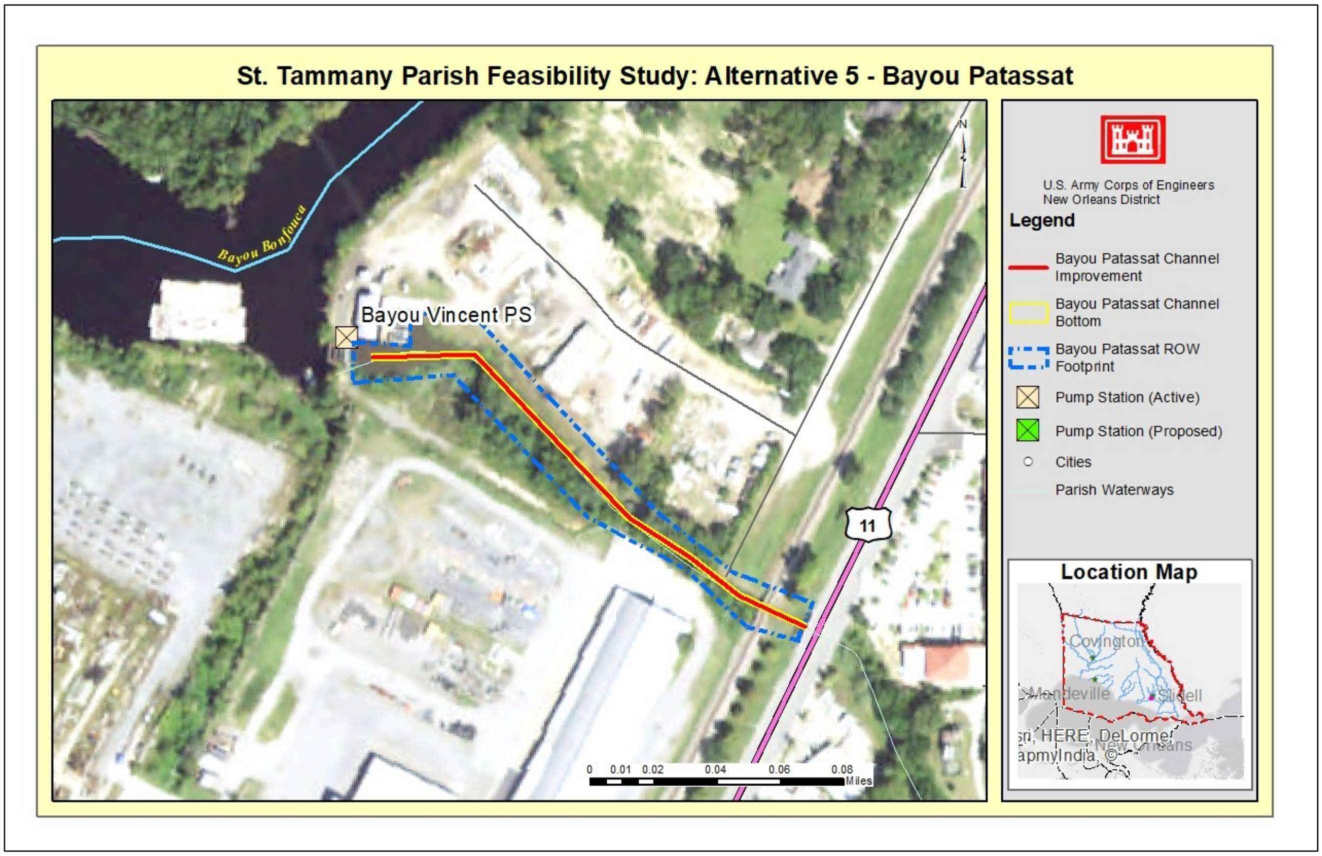


Figure D:1-9 Alternative 5 Bayou Patassat Focus

1.3.4.4 Bayou Liberty Channel Improvements

Alternative 5 includes the Bayou Liberty channel improvements to address rainfall and riverine flooding. The channel improvements run north-south, starting immediately south of the I-12, crossing US Highway 190, the bridge that crosses the Tammany Trace , and LA Highway 433, and ending at the confluence with Bayou Bonfouca in the proximity of Lake Pontchartrain. The channel improvements include clearing and snagging of 8 miles (41,232 feet) of the channel. The preliminary design of the channel improvements assumes an existing bank elevation of 1 foot, a 10-foot bottom width at Elevation (-) 5 feet NAVD 88, and bank side slopes of 1V:3H. Material removed may include trees, debris, or other obstructions within the waterway.

All trees and debris cleared would likely be chipped on site and then hauled to the nearest landfill. The nearest landfills are the Slidell Landfill (east of Interstate 10 and south of LA Highway 433) and Waste Management (2685 Gause Boulevard West, Slidell, LA 70460). The assumed haul distance is 15 miles. Refer to Figure D:1-10.

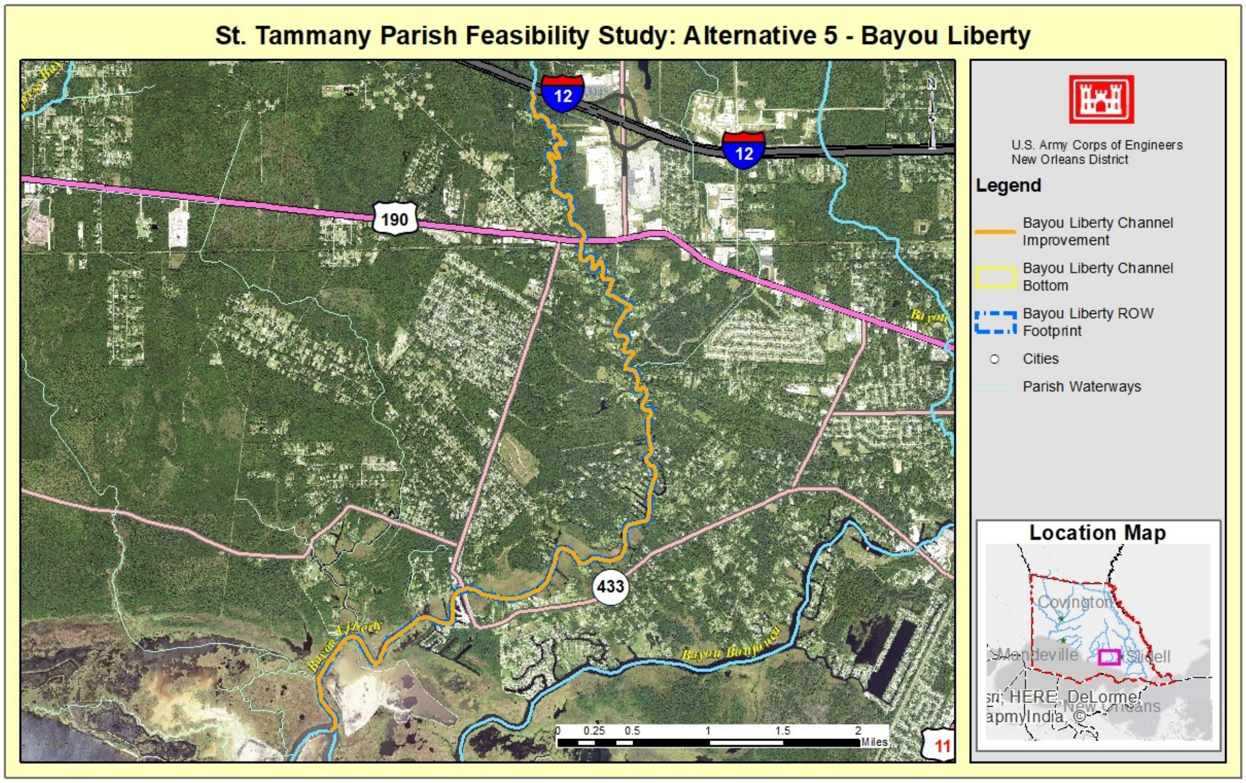


Figure D:1-10 Alternative 5 Bayou Liberty Focus

Due to the length of Bayou Liberty, the work was broken up into four reaches. The first two reaches would be done via the top of bank and the last two would be done via floating plant.

Reach 1: I-12 to US Highway 190 (8,050 feet)

Access to Reach 1 would be from Frontage Road. A one-acre access corridor would be from Frontage Road to the bayou along an existing opening in the woods. Approximately 9 acres of clearing and snagging would occur from top-of-bank to top-of bank within the channel. If necessary, a temporary culvert could be placed in the channel to allow for crossing over to the opposite bank. Material removed may include trees, debris, trash, or other obstructions within the waterway.

Reach 2: US Highway 190 to the Tammany Trace (200 feet)

Access to Reach 2 would be from the trailhead off US Highway 190. A 25-feet wide access corridor (0.2 AC) would be located on the right descending bank side south of where the bayou intersects the highway. Clearing would be needed for this access corridor. An additional access corridor would be located along both sides of the channel, offset 25 feet from each top of bank from the intersection of US Highway 190 to the bridge that crosses Tammany Trace. The combined acreage for access on both sides would be approximately 0.3 acres. This would also need to be cleared to be used for access. Approximately 0.2 acres of clearing and snagging would occur from top-of-bank to top-of bank within the channel. If necessary, a temporary culvert can be placed in the channel to allow for crossing over to the opposite bank. Material removed may include trees, debris, trash, or other obstructions within the waterway.

Reach 3: Tammany Trace Bridge to the LA Highway 433 (22,726 feet)

Due to the boathouses along the bank of the bayou, access for construction would not work from the bank. All work would be done from the water (i.e. using a floating plant). This reach would be primarily snagging operations. There are two access points to reach 3. Access 1 (0.3 AC) would be via Elks Road. There is a boat launch and a staging area (0.4 AC). No clearing would be needed for this access corridor or staging area. Access 2 (0.15 AC) would be via Jefferson Avenue along with an accompanying staging area (0.15 AC) and boat launch. No clearing would be needed for this access corridor or staging area. Approximately 24 acres of clearing and snagging would occur from top-of-bank to top-of bank within the channel, although the primary operation would be snagging. Material removed may include trees, debris, trash, or other obstructions within the waterway.

Reach 4: LA Highway 433 to the Mouth (10,065 feet)

Due to the boathouses along the bank of Bayou Liberty, access for construction would not work from the bank. All work would be done from the water (i.e. using a floating plant). This reach would be primarily snagging operations. Access (0.05 AC) would be via Rivet Drive. There is a boat launch and a staging area (0.3 AC). No clearing would be needed for this access corridor or staging area. Approximately 11 acres of clearing and snagging would occur from top-of-bank to top-of bank within the Bayou Liberty channel, although the primary operation would be snagging. Material removed may include trees, debris, trash, or other obstructions within the waterway.

Assumptions for channel improvements include a ROW measured 65 feet from the centerline to each side of the channel as a general guideline (total width of 130 feet); which includes space for equipment access. All work would be within the project footprint. The temporary work easement would be within ROW. The material requiring disposal would be trucked away from the site. Assumption is that all access would be through public lands.

1.3.5 Alternative 6: South Slidell

Alternative 6 consists of a combination of levees, floodwalls, and pump stations. This alternative also consists of floodgates, vehicular floodgates and ramps.

There are three existing ring levees in the city of Slidell: (1) the King's Point ring levee which consists of two ring levees on the northeast side of the City of Slidell, (2) the Lakeshore Estates ring levee on the southeast side of the City of Slidell, and (3) the Oak Harbor ring levee in the vicinity of the Eden Isle community (Eden Isle). The proposed levee and floodwall independent alternative alignments under Alternative 6 (Alternatives 6a, 6b, and 6c) tie into some of these existing ring levees as described herein. Existing levees are represented in yellow in Figure D:1-11.

There are three independent alternative levee and floodwall alignments in Alternative 6. These three Alternatives (Alternatives 6a, 6b, and 6c) are stand-alone Alternatives and cannot be combined with one another but can be combined with other justified measures in the Final Array.

Alternative 6a consists of the South Slidell levee alignment. Alternative 6b consists of a combination of the South Slidell levee alignment from Alternative 6a and the Eden Isle floodwall alignments. Alternative 6c consists of a combination of portions of levee from the proposed Alternative 5 (except for the western portion of alignment) and the South Slidell levee alignment proposed in Alternative 6a (except for the northwestern portion of alignment). The two alignments would be connected with a new railroad floodgate across the existing Norfolk Southern Railway Corp. railroad tracks.

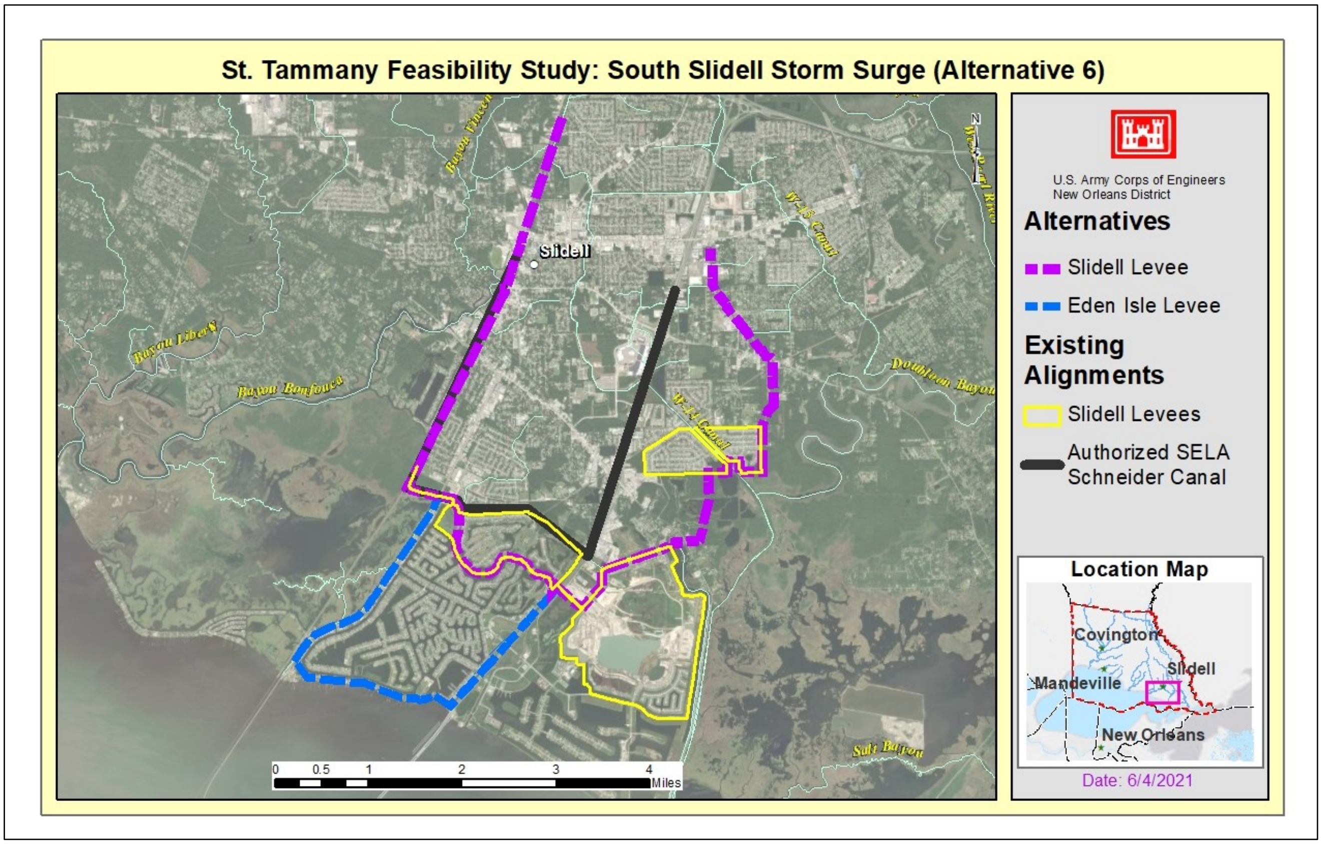


Figure D:1-11 Alternative 6 South Slidell

1.3.5.1 Alternative 6a: South Slidell

This alternative consists of 13 miles of alignment with a combination of approximately 7.3 miles of levees (38,500 feet) and approximately 5.9 miles (30,000 feet) of floodwall located in the city of Slidell, Louisiana. This alignment does not include Eden Isle.

This alternative also consists of pump stations, floodgates, vehicular floodgates, and ramps. Refer to Figure D:1-12.

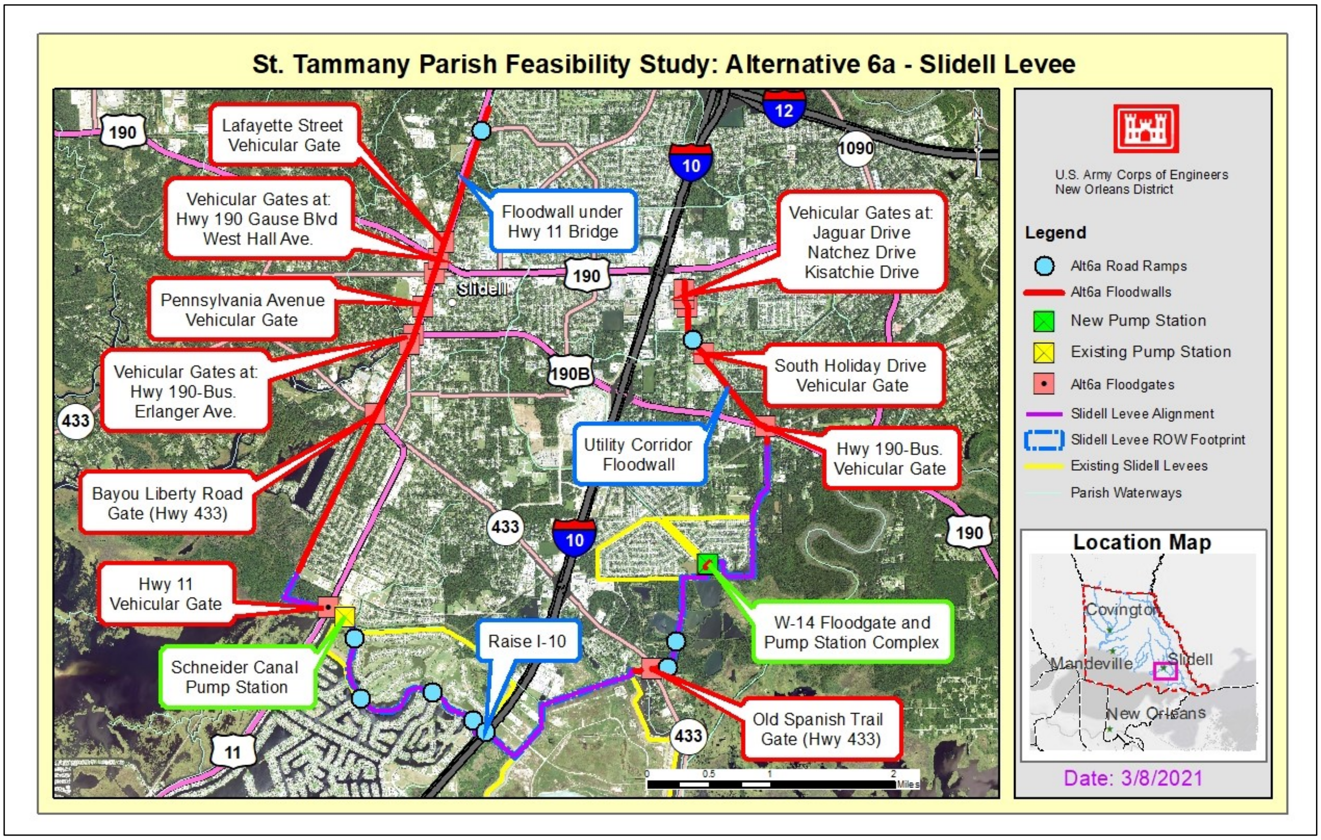


Figure D:1-12 Alternative 6a Slidell Levee

Description of Alignment

Starting on the northwest, the alternative consists of the construction of a floodwall running on the east side of the Norfolk Southern Railway Corp. railroad tracks from Pinewood Country Club in a north to south direction. The floodwall would transition into a levee just south of First Baptist Church Christian School. Then the levee turns east and then south. This reach consists of a levee with floodwall segments. This reach includes the new Schneider Canal Pump Station (assume the same footprint as the existing facility). The new levee would tie to a segment of the existing Oak Harbor levee along Oak Harbor Boulevard (existing levee would be raised to Elevation 15 feet), and then the I-10 would be raised to ramp over the new levee section. The new levee would tie to a section of the northern perimeter of the existing Lakeshore Estates levee (existing levee would be raised to Elevation 15 feet). The new levee would cross LA Highway 433 and then tie to a section of the existing King's Point west levee (existing levee would be raised to Elevation 15 feet). The levee would tie to the new pump station at the W-14 canal and then tie to the existing King's Point east ring levee (existing levee would be raised to Elevation 15 feet). The new levee would turn north towards US Highway 190 Business (Fremaux Avenue). The new levee would cross US Highway 190 Business (Fremaux Avenue) where it would tie to a new floodwall across US Highway 190 Business. The floodwall would run on the west side of the existing CLECO Corporate Holdings, LLC utility corridor and cross South and North Holiday Drives. The floodwall would exit the CLECO Corporate Holdings, LLC utility corridor to run on the east side of Carol Drive, continue north on the east side of Yaupon Drive, and terminate at Manzella Drive (one block south of Gause Boulevard).

CLECO Corporate Holdings, LLC has right-of-way use requirements pertaining to USACE work around their existing utility lines on the northeast corner of the floodwall alignment that would have to be met to provide clearance for construction activities (i.e. pile driving).

Interstate 10 Elevation

The I-10 would be raised to ramp over the new levee section by constructing ramps to the preliminary design elevation of 15 feet. The existing elevation of the I-10 at the proposed location is approximately 12.8 feet as per LIDAR raster dataset. This proposed location is the highest elevation of the I-10 in the vicinity of the proposed alignment. The I-10 elevation is lower (approximately 10 feet) on the adjacent areas. This feature would be designed in the feasibility level of design for the study.

Levee Design Section and Borrow Quantities

The elevation of the new South Slidell levee varies between 13 feet NAVD 88 and 15 feet NAVD 88 depending on the location. The elevations of the existing ground were used as per the LIDAR raster dataset. The preliminary assumptions are that the levee has a 10-foot wide levee crown and side slopes of 1V:3H. Berm sections would be determined once data is available for analysis. The construction of the levee alignment would impact 88 acres. This levee alignment would require 851,000 cubic yards of fill/borrow (includes 30 percent contingency).

Floodwall Elevation and Location

The elevation for the floodwall segments would vary from 13.5 feet to 15 feet NAVD 88. The locations of the floodwall segments are:

There are approximately 4.1 miles (21,750 feet) of floodwall segment from Pinewood Country Club to just south of First Baptist Church Christian School (16 acres of construction area).

There is a 0.06 mile (300 feet) Old Spanish Trail Floodwall segment (0.3 acres of construction area).

Across from LA Highway 433, there is a 0.09 mile (450 feet) Old Spanish Trail Floodwall segment by Espirit du Lac Street (construction area is 0.5 acres).

There is 0.04-mile (200 feet) floodwall segment near Belaire Drive (0.2 acres of construction area).

The next floodwall segment is on the north side along US Highway 190 Business (Fremaux Avenue) for 0.08 miles (430 feet) and then the floodwall turns into the CLECO Corporate Holdings, LLC utility corridor for approximately 1.4 miles (7,200 feet) before terminating at Manzella Drive. The total length of this floodwall alignment is 1.5 miles (7,700 feet) (total construction area is 9 acres).

Typical Floodwall Section

The typical T-wall section consists is a 3-foot thick by 8.5-foot-wide slab with a 1.5-foot thick stem. The height of the stem varies. Preliminary assumptions are two rows of 1H:3V battered HP12 x 74 piles, 60-foot deep, spaced at 5-foot centers, and 30-foot deep steel PZ sheetpile. Approximately 1,850 square feet of slope protection would be provided at floodwall/levee tie-ins. The design of the T-wall including the foundation is subject to change once detailed geotechnical investigations are conducted.

Pump Stations and Floodgates

The structural components for the Slidell Alternative 6a include, starting from the northwest:

- 1,200 cfs and 150-foot long Schneider Canal Pump Station complex with a 30-foot floodgate (construction area is 12.6 acres)
- 1,200 cfs and 150-foot long W-14 Pump Station complex with a 30-foot floodgate (construction area is 12.6 acres).

Vehicular Floodgates and Ramps

There would be 8 vehicular ramps over the levee, 14 vehicular ` floodgates to provide access through the levee, and the Interstate 10 roadway would be raised to ramp over the new levee section. Starting from the northwest:

Ramp on North Avenue

The following vehicular floodgates would be constructed:

- 50-foot, Lafayette Street,
- 75-foot, US Highway 190 (Gause Boulevard),
- 40-foot, West Hall Avenue,
- 30-foot, West Pennsylvania Avenue,
- 30-foot, US Highway 190 Business (Fremaux Ave),
- 30-foot, Erlanger Avenue,
- 40-foot, Bayou Liberty Road (LA Highway 433) west side crossing,
- 75-foot, Pontchartrain Drive (US Highway 11).

There would be ramps at:

- Cypress Lakes Drive (levee alignment).
- Mariner's Cove Boulevard,
- Oak Harbor Country Club entrance,
- Grand Champions Lane.

The Interstate 10 roadway would be raised to ramp over the new levee section.

There would be a 30-foot vehicular floodgate at LA Highway 433 east (Old Spanish Trail). There would be ramps at Fleur Du Lac Street and at Nunez Road. There would vehicular floodgates in the following roads:

- 50-foot, US Highway 190 Business (east)
- 20-foot, South Holiday Drive

There would be a ramp at North Holiday Drive

- 20-foot, Jaguar Drive
- 20-foot, Natchez Drive
- 20-foot, Kisatchie Drive.

It is assumed that on the northwest side of the alignment, there would be no need for a vehicular floodgate at North Boulevard. On the northeast side of the alignment, it is assumed that there would be no need for a vehicular floodgate on North Holiday Drive.

Structural Assumptions for Alternative 6a and Alternative 6b

1.) Pump Stations:
   a. Schneider Canal Pump Station
      i. Assumed 1,200 cfs, based on previous feasibility studies.
      ii. Assumed complete redesign of all components.
      iii. Assumed navigable floodgate for recreational vessels.
      iv. Assumed same configuration as the USACE West Shore Lake Pontchartrain Reserve Relief Canal Pumping Station (WSLP Pump Station).
   b. W-14 Pump Station:
      i. Assumed 1,200 cfs, based on hydraulic estimates.
      ii. Assumed all new construction.
      iii. Assumed navigable floodgate for recreational vessels.
      iv. Assumed same configuration as the USACE West Shore Lake Pontchartrain Reserve Relief Canal Pumping Station (WSLP Pump Station).
2.) Floodwalls:
   a. 21,750 linear feet floodwall reach along Slidell railroad tracks

   i. Assumed alignment starts between railroad and Pinewood Country Club and ends behind First Baptist Church Christian School recreational area.
   ii. Assumed T-wall for this alignment reach as the alignment is adjacent to railroad tracks and there is not enough room for levee.
   iii. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station T-walls.
   iv. Assumed 60-feet, 1:3 battered H-piles based on geotechnical analysis.
   v. Assumed 50-feet T-wall construction area to side opposite railroad tracks.
   vi. Assumed permanent access to be included in construction area.

b. 300 linear feet floodwall reach near Old Spanish Trail:
   i. Assumed T-wall for this alignment reach as the alignment is adjacent to a private warehouse near Old Spanish Trail
   ii. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station T-walls.
   iii. Assumed 60-feet, 1:3 battered H-piles based on geotechnical analysis.
   iv. Assumed T-wall construction area 50 feet to either side from center line of alignment.
   v. Assumed permanent access to be included in construction area.

c. 200 linear feet floodwall south of US Highway 190 Business:
   i. Assumed T-wall for this alignment reach as the alignment is between an energy substation and private property near US Highway 190 Business.
   ii. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station T-walls.
   iii. Assumed 60-foot 1:3 battered H-piles based on geotechnical analysis.
   iv. Assumed T-wall construction area 50 feet to either side from center line of alignment.
   v. Assumed permanent access to be included in construction area.

d. 7,700 linear feet floodwall reach along power easement north of US Highway 190 Business:
   i. Assumed T-wall for this alignment reach is between US Highway 190 Business and US Highway 190 (Gause Boulevard).
   ii. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station T-walls.
   iii. Assumed 60-foot 1:3 battered H-piles based on geotechnical analysis.
   iv. Assumed T-wall construction area is 50 feet to either side from center line of alignment.
   v. Assumed permanent access to be included in construction area.

3.) Access Gates:
   a. Vehicular Roller floodgates
      i. Assumed all Alternative 6a vehicular floodgates to be roller floodgates.
      ii. Assumed sill to be at existing ground level.

1.3.5.2 Alternative 6b: South Slidell with Eden Isle

Alternative 6b consists of the Slidell levee and floodwall system and incorporates an Eden Isle floodwall. This alternative would reduce the risk of storm surge to Slidell including Eden Isle. This alternative consists of 17.1 miles of alignment with a combination of levee and floodwall. The alignment would have 5.2 miles of levees (27,400 feet). The alignment has approximately 6 miles (31,000 feet) of floodwall at Eden Isle and 5.9 miles (30,000 feet) of floodwall in the Slidell levee alignment. The floodwall alignment totals 11.9 miles (61,000 feet).

This alternative also consists of floodgates, navigable floodgate, vehicular floodgates and ramps. Refer to Figure D:1-13.

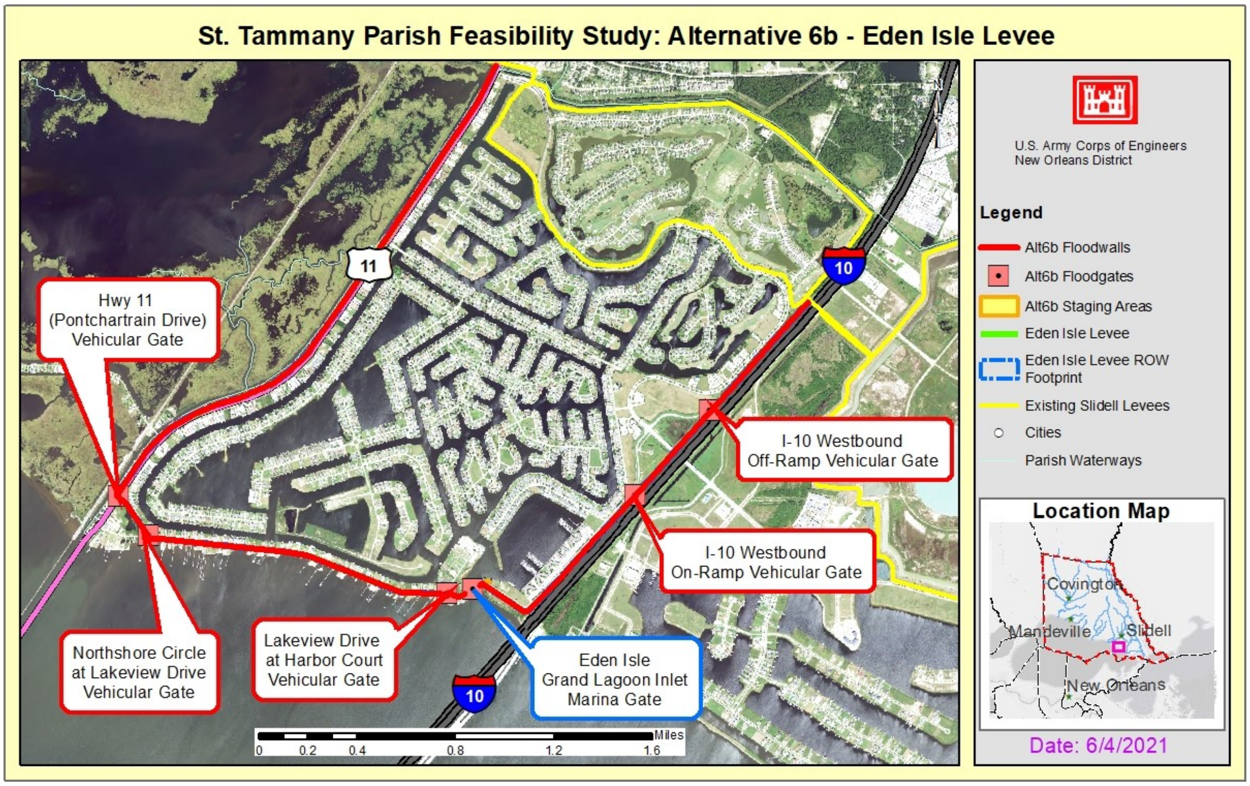


Figure D:1-13 Alternative 6b Eden Isle Levee

Description of Alignment

Starting on the northwest, the alternative consists of the construction of a floodwall running on the east side of the Norfolk Southern Railway Corp. railroad tracks from Pinewood Country Club in a north to south direction. The floodwall would transition into a levee just south of First Baptist Church Christian School. The levee would then transition into floodwall at Eden Isle. There would be approximately 6 miles (31,000 feet) of floodwall. This floodwall would start on the west side of Oak Harbor Drive and follow along the west side of US Highway 11, would turn southeast on Lakeview Drive and would cross Oak Harbor Marina, where it would run parallel to the Interstate 10. The Interstate 10 roadway would be raised to the preliminary design elevation of 15 feet NAVD 88. The alignment would transition into a levee and tie to a section of the northern perimeter of the existing Lakeshore Estates levee. The new levee would cross LA Highway 433 and then tie to a section of the existing King's Point west levee (existing levee would be raised to Elevation 15 feet). The alignment would connect to the new W-14 pump station at the W-14 canal and then tie to the existing King's Point east levee (existing levee would be raised to Elevation 15 feet). The new levee would turn north towards US Highway 190 Business (Fremaux Ave). The new levee would cross US Highway 190 Business (Fremaux Ave) would transition into a floodwall across US Highway 190 Business. The floodwall would run on the west side of the CLECO Corporate Holdings, LLC utility corridor and would cross South and North Holiday Drives. The floodwall would exit the utility corridor to run on the east side of Carol Drive, would continue north on the east side of Yaupon Drive, and would terminate at Manzella Drive (one block south of Gause Boulevard).

CLECO Corporate Holdings, LLC has right-of-way use requirements pertaining to USACE work around their existing utility lines on the northeast corner of the floodwall alignment that would have to be met to provide clearance for construction activities (i.e. pile driving).

Interstate 10 Elevation

The I-10 would be raised to ramp over the new levee section by constructing ramps to the preliminary design elevation of 15 feet. The existing elevation of the I-10 at the proposed location is approximately 12.8 feet as per LIDAR raster dataset. This proposed location is the highest elevation of the I-10 in the vicinity of the proposed alignment. The I-10 elevation is lower (approximately 10 feet) on the adjacent areas. This feature would be designed in the feasibility level of design for the study.

Levee

For this alternative, a section of the new Slidell levee (alternative 6a) would not be constructed (11,000 feet of levee and 800 feet of floodwall). This section would be between US Highway 11 (Pontchartrain Drive) on the west side and the Interstate 10 on the east side. A significant part of the alignment that would not be constructed is part of the existing Oak Harbor levee.

Levee Design Section and Borrow Quantities

The elevation of the new Slidell levee for Alternative 6b varies between 13 feet NAVD 88 and 15 feet NAVD 88 depending on the location. The elevations of the existing ground were used as per the LIDAR raster dataset. The preliminary assumptions are that the levee would have a 10-foot wide levee crown and side slopes of 1V:3H. Berm sections would be determined once data is available for analysis. The levee alignment would impact 63 acres of construction area. This levee alignment would require 742,000 cubic yards of fill (includes 30 percent contingency).

Floodwall Elevation and Location

For Eden Isle, the preliminary design elevation of the new floodwall varies from 13.5 feet to 21 feet NAVD 88 depending on the location. For the remaining portion of the Slidell levee and floodwall system, the new floodwall elevation would vary from 13.5 feet to 16.5 feet NAVD 88.

For the Eden Isle portion, the alignment would consist entirely of new floodwall. Note that on Lakeview Drive the floodwall would be located at the center of the road with one lane on either side of the floodwall to allow access to homes.

For the Slidell portion of the alignment, there would be approximately 4.1 miles (21,750 feet) of floodwall segment from Pinewood Country Club to just south of First Baptist Church Christian School (construction area is 16 acres). There would be a 0.06 mile (300 feet) Old Spanish Trail Floodwall segment (construction area is 0.3 acres). Across from LA Highway 433, there would be a 0.09 mile (450 feet) Old Spanish Trail Floodwall segment by Espirit du Lac Street (construction area is 0.5 acres). There would be a 0.04-mile (200 feet) floodwall segment near Belaire Drive (construction area would be 0.2 acres). The next floodwall segment would be on the north side along US Highway 190 Business (Fremaux Ave) for 0.08 miles (430 feet) and then the floodwall would turn into the CLECO Corporate Holdings, LLC utility corridor for approximately 1.4 miles (7,200 feet) and would terminate at Manzella Drive. The total length of this floodwall alignment would be 1.5 miles (7,700 feet) long (total construction area would be 9 acres).

Typical Floodwall Section

The typical T-wall section consists is a 3 foot thick by 8.5-feet wide slab with a 1.5-foot thick stem. The height of the stem would vary. Preliminary assumptions are two rows of 1H:3V battered HP12 x 74 piles, 60-foot deep, spaced at 5-foot centers, and 30-foot deep steel PZ sheetpile. Approximately 1,850 square feet of slope protection would be provided at floodwall/levee tie-ins. The design of the T-wall including the foundation is subject to change once detailed geotechnical investigations are conducted.

Pump Stations and Floodgates

For Eden Isle:

- 100-foot-long Eden Isle (Grand Lagoon) Oak Harbor Marina navigable floodgate structure would be constructed (construction area would be 2 acres).

For the Slidell levee portion:

- 1,200 cfs and 150-foot long Schneider Canal Pump Station complex with a 30-foot floodgate (construction area is 12.6 acres)
- 1,200 cfs and 150-foot long W-14 Pump Station complex with a 30-foot floodgate (construction area is 12.6 acres).

Vehicular Floodgates and Ramps

For Eden Isle, there would be 5 vehicular floodgates for access in the floodwall locations starting from the northwest:

- 75-foot, Pontchartrain Drive (US Highway 11)
- 50-foot, Northside Circle at Lakeview Drive vehicular floodgate
- 50-foot, Lakeview Drive (Harbor View Court) floodgate
- two 50-foot Interstate 10 access road floodgates (westbound on-ramp and I-10 off-ramp)

For the Slidell levee portion, there would be 4 vehicular ramps over the levee, 13 vehicular floodgates to provide access, and the Interstate 10 roadway would be raised to ramp over the new levee section. Starting from the northwest, there would be a North Avenue ramp.

The following vehicular floodgates would be constructed:

- 50-foot, Lafayette Street
- 75-foot, US Highway 190 (Gause Boulevard)
- 40-foot, West Hall Avenue
- 30-foot, West Pennsylvania Avenue
- 30-foot, US Highway 190 Business (Fremaux Ave)
- 30-foot, Erlanger Avenue
- 40-foot, Bayou Liberty Road (LA Highway 433) west side crossing.
- The I-10 would be raised to ramp over the new levee section.
- There will be a 30-feet vehicular floodgate at LA Highway 433 east (Old Spanish Trail)

There would be 2 vehicular ramps at:

- Fleur Du Lac Street

- Nunez Road

There would vehicular floodgates at:

- 50-foot, US Highway 190 Business (east)
- 20-foot, South Holiday Drive

Ramp on North Holiday Drive

There would vehicular floodgates at:

- 20-foot, Jaguar Drive
- 20-foot, Natchez Drive
- 20-foot, Kisatchie Drive

It is assumed that on the northwest side of the alignment, there would be no need for a vehicular floodgate at North Boulevard. On the northeast side of the alignment, it is assumed that there would be no need for a vehicular floodgate on North Holiday Drive.

1.3.5.3 Alternative 6c: South Slidell Storm Surge with West Slidell

Alternative 6c consists of a combination of portions of the West Slidell levee alignment proposed in Alternative 5 and the South Slidell levee and floodwall system alignment proposed in Alternative 6a (except for the northwestern portion of that alignment) with the two alignments being connected by a new railroad gate across the existing Norfolk Southern Railway Corp. railroad tracks.

Alternative 6c consists of a total of 16.3 miles (85,900 feet) of a levee and floodwall alignment, with approximately 14 miles (73,700 feet) of levees constructed in two separate (non-continuous) segments, and 2.3 miles (12,200 feet) of two separate (non-continuous) segments of a floodwall.

This alignment would include 49,100 feet of south Slidell segment and 36,800 feet of west Slidell segment of the Alternatives of the Final Array. This Alternative also consists of pump stations, floodgates, vehicular floodgates, and ramps. See Figures D:1-14.

Description of Alignment

Starting on the western side, the levee alignment would start on the south side of US Highway 190 from southwest of Bayou Paquet, would cross Bayou Liberty, Bayou Bonfouca, along the northern perimeter on the Big Branch Marsh National Wildlife Refuge and would meet the Norfolk Southern Railway Corp. railroad tracks west of US Highway 11 in the vicinity of Delwood Pump Station in Slidell. The alignment would cross the railroad tracks and continue into South Slidell. Then the alignment would transition into a floodwall running on the east side of the railroad track from Delwood Pump Station (Sun Valley Drive) in a north to south direction. The floodwall would turn into a levee just south of First Baptist Church Christian School. Then the levee would turn east and then south. This reach would consist of a levee alignment with floodwall segments. This reach would include the new Schneider Canal Pump Station (assume the same footprint as the existing facility). Then the levee would tie to a section of the existing Oak Harbor levee along Oak Harbor Boulevard, and then the I-10 would be raised to ramp over the new levee section. The new levee would follow a section of the northern perimeter of the existing Lakeshore Estates levee. The new levee would cross LA Highway 433 and would tie to a section of the existing King's Point west levee (existing levee would be raised to Elevation 15 feet). The alignment would tie to the new pump station at the W-14 canal and would tie to the existing King's Point east levee (existing levee would be raised to Elevation 15 feet). The new levee would turn north towards US Highway 190 Business (Fremaux Ave). The new levee would cross US Highway 190 Business (Fremaux Ave) and would transition into a floodwall across US Highway 190 Business. The floodwall would run on the west side of the CLECO Corporate Holdings, LLC's utility corridor and would cross South and North Holiday Drives. The floodwall would exit the utility corridor to run on the east side of Carol Drive, would continue north on the east side of Yaupon Drive, and would terminate at Manzella Drive (one block south of Gause Boulevard).

Interstate 10 Elevation

The I-10 would be raised to ramp over the new levee section by constructing ramps to the preliminary design elevation of 15 feet. The existing elevation of the I-10 at the proposed location is approximately 12.8 feet as per LIDAR raster dataset. This proposed location is the highest elevation of the I-10 in the vicinity of the proposed alignment. The I-10 elevation is lower (approximately 10 feet) on the adjacent areas. This feature would be designed in the feasibility level of design for the study.

Levee Design Section and Borrow Quantities

The new levee elevation would vary depending on location. The preliminary assumptions are that the new levee would have a 10-feet wide levee crown and side slopes of 1V:3H. Berm sections would be determined once data is available for analysis. The existing elevations were obtained from the LIDAR raster dataset. The elevation of the west Slidell portion would vary between 13 feet and 17 feet depending on the location. The elevation of the South Slidell levee would vary between 13 feet and 15 feet depending on the location. The construction of the total levee alignment would impact approximately 169 acres. This levee alignment would require approximately 1,528,000 cubic yards of fill (includes 30 percent contingency).

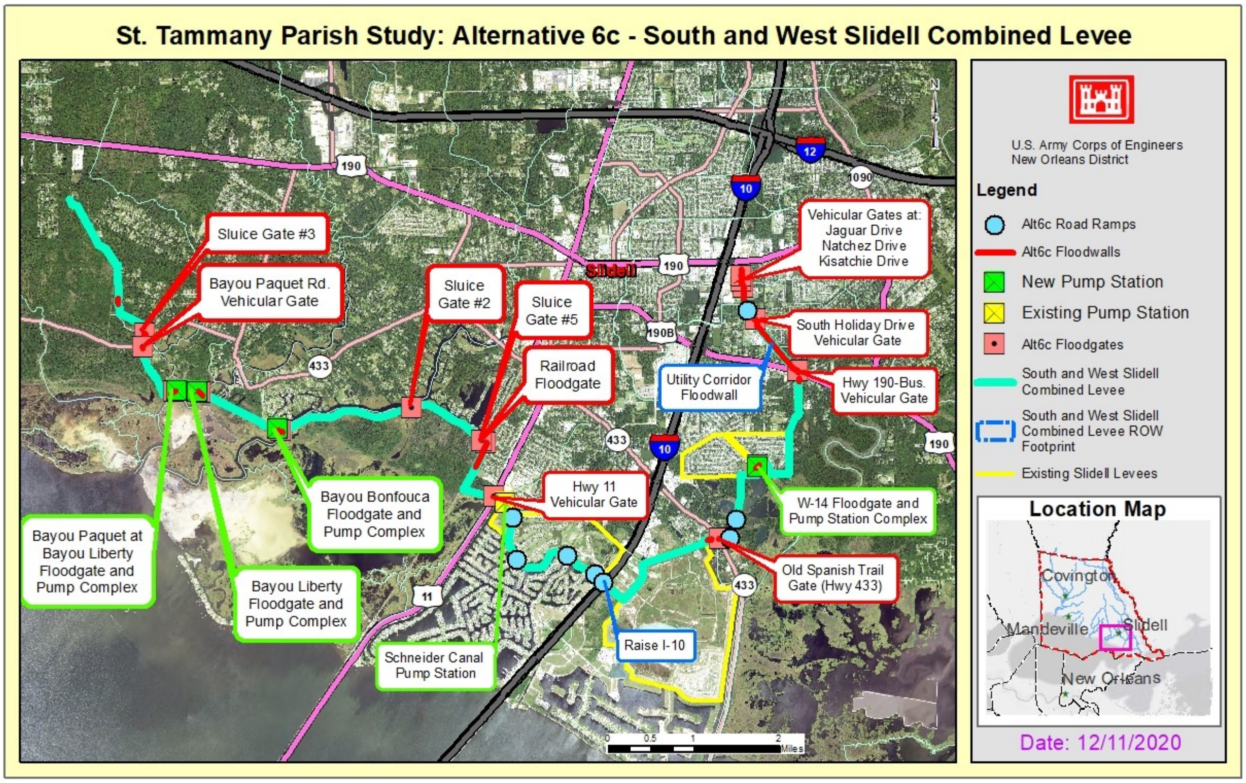


Figure D:1-14 Alternative 6c South and West Slidell Combined Levee

Floodwall Elevation and Location

For this alignment, the elevation of the floodwall segments would vary from 13.5 feet to 17 feet.

Starting on the west:

- 0.07 miles (350 feet) of floodwall segment going through a group of properties. Top of wall elevation of 17 feet. The construction area would be 0.4 acres.
- On the east side of the railroad tracks:
- 0.3 miles (1,600 feet) of T-wall along Railroad between Delwood Pump Station and Baptist Church (this is a change that is not part of alt 6a)
- 0.06 miles (300 feet) of Old Spanish Trail Floodwall segment (construction area would be 0.3 acres).
- Across from LA Highway 433, there would be a 0.09 mile (450 feet) Old Spanish Trail Floodwall segment by Espirit du Lac Street (construction area would be 0.5 acres).
- 0.04 miles (200 feet) of floodwall segment near Belaire Drive (construction area would be 0.2 acres).

- The next floodwall segment would be on the north side along US Highway 190 Business (Fremaux Ave) for 0.08 miles (430 feet) and then the floodwall would turn into the CLECO Corporate Holdings, LLC utility corridor for approximately 1.4 miles (7,200 feet) and would terminate at Manzella Drive. The total length of this floodwall alignment would be 1.5 miles (7,700 feet) long (total construction area would be 9 acres).

Typical Floodwall Section

The typical T-wall section would consist of a 3-foot thick by 8.5-foot wide slab with a 1.5-feet thick stem. The height of the stem would vary. Preliminary assumptions are two rows of 1H:3V battered HP12 x 74 piles, 60 feet deep, spaced at 5 feet centers, and 30 feet deep steel PZ sheetpile. Approximately 1,850 square feet of slope protection would be provided at floodwall/levee tie-ins. The design of the T-wall including the foundation is subject to change once detailed geotechnical investigations are conducted.

Pump Stations and Floodgates

There would be a series of pump stations and sluicegates as part of this alternative. Starting on the west:

- Bayou Paquet Pump Station complex (500 cfs and 100-foot long) located between Jummonville Road and Mayer Drive. The complex includes a 20-foot navigable floodgate (construction area is 12.6 acres)
- Bayou Liberty Pump Station complex (3,200 cfs and 400-foot long). The complex includes a 20-foot navigable floodgate (construction area would be 12.6 acres)
- Bayou Bonfouca Pump Station complex (3,700 cfs and 300-foot long). The complex includes a 20-foot navigable floodgate (12.6 acres required for construction

On the east side of the railroad tracks:

- Schneider Canal Pump Station complex (1,200 cfs and 150-foot long) with a 30-foot floodgate (construction area would be 12.6 acres)
- W-14 Pump Station complex (1,200 cfs and 150-feet long) with a 30-foot floodgate (construction area would be 12.6 acres).

Sluicegates, Vehicular Floodgates and Ramps

There would be a total of three sluicegates, eight vehicular floodgates, one railroad floodgate, and seven ramps. The I-10 would be raised to ramp over the new levee section.

Starting on the west of the alignment:

- Sluicegate # 3 at Bayou Paquet (0.25 acres of construction area)

- 30-feet vehicular floodgate at Bayou Paquet Road
- Sluicegate #2 (located east of three major proposed pump stations complexes with floodgates)
- Sluicegate #5 (on the opposite side of the railroad tracks from Delwood Pump Station), (0.25 acres of construction area). Further refinement would be needed at this location.
- 60-foot railroad floodgate (added for 6c)
- 75-foot Pontchartrain Drive vehicular floodgate (US Highway 11)
- Ramp at Cypress Lakes Drive
- Ramp at Mariner's Cove Boulevard
- Ramp at the Oak Harbor Country Club entrance
- Ramp at Grand Champions Lane
- The I-10 would be raised to ramp over the new levee section
- 30-feet vehicular floodgate at LA Highway 433 East (Old Spanish Trail)
- Ramp at Fleur Du Lac Street
- Ramp at Nunez Road
- 50-foot vehicular floodgate at US Highway 190 Business (East)
- 20-foot vehicular floodgate at South Holiday Drive
- Ramp at North Holiday Drive
- 20-foot vehicular floodgate at Jaguar Drive
- 20-foot vehicular floodgate at Natchez Drive
- 20-foot vehicular floodgate at Kisatchie Drive

For Item 5 above, the railroad double-swing floodgate was added for Alternative 6c. The analysis was based on Mississippi River Levee (MRL) Carrollton Railroad Gate.

On the northeast side of the alignment, it is assumed that there would be no need for a vehicular floodgate on North Holiday Drive.

Structural Assumptions for Alternative 6c

1.) Pump Stations:
   a. Bayou Paquet at Bayou Liberty Pump Station
      i. Assumed to have similar components and configuration as WSLP Pump Station.
      ii. Assumed sill elevation to be equal to inlet at Lake Pontchartrain.
      iii. Assumed integrated navigable floodgate for recreational vessels.
   b. Bayou Liberty Pump Station:
      i. Assumed to have similar components and configuration as WSLP Pump Station.
      ii. Assumed sill elevation to be equal to inlet at Lake Pontchartrain.
      iii. Assumed integrated navigable floodgate for recreational vessels.
   c. Bayou Bonfouca Pump Station:

    i. Assumed to have similar components and configuration as WSLP Pump Station.
    ii. Assumed sill elevation to be equal to inlet at Lake Pontchartrain.
    iii. Assumed integrated navigable floodgate for recreational vessels.

d. Schneider Canal Pump Station:
    i. Assumed 1,200 cfs based on previous feasibility studies.
    ii. Assumed complete redesign of all components.
    iii. Assumed navigable floodgate for recreational vessels.
    iv. Assumed same configuration as the USACE West Shore Lake Pontchartrain Reserve Relief Canal Pumping Station (WSLP Pump Station).

e. W-14 Pump Station:
    i. Assumed 1,200 cfs based on hydraulic estimates.
    ii. Assumed all new construction.
    iii. Assumed navigable floodgate for recreational vessels.
    iv. Assumed same configuration as the USACE West Shore Lake Pontchartrain Reserve Relief Canal Pumping Station (WSLP Pump Station).

2.) Floodwalls:

Assumed all Alternative 6a and West Slidell floodwalls will be included in Alternative 6c except the floodwall portions of 6a that run along the east side of the Norfolk Southern Railway Corp railroad tracks north of the railroad crossing

a. 0.07 miles (350 feet) floodwall segment passing through several properties. Top of wall elevation of 17 feet. The construction area would be 0.4 acres.
    i. Assumed T-wall for this alignment reach as the alignment is adjacent to private property.
    ii. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station T-walls.
    iii. Assumed 60 foot 1:3 battered H-piles based on geotechnical analysis.
    iv. Assumed T-wall construction area 50 feet to either side from center line of alignment.
    v. Assumed permanent access to be included in construction area.

On the east side of the railroad tracks:

b. 0.3 miles (1,600 feet) of T-wall along Railroad between Delwood Pump Station and Baptist Church

i. Assumed T-wall for this alignment reach as the alignment is adjacent to railroad tracks and there is not enough room for levee.
ii. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station T-walls.
iii. Assumed 60-feet, 1:3 battered H-piles based on geotechnical analysis.
iv. Assumed 50-feet T-wall construction area to side opposite railroad tracks.
v. Assumed permanent access to be included in construction area.

c. 0.06 miles (300 feet) Old Spanish Trail Floodwall segment (construction area would be 0.3 acres).
   i. Assumed T-wall for this alignment reach as the alignment is adjacent to a private warehouse near Old Spanish Trail
   ii. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station T-walls.
   iii. Assumed 60-feet, 1:3 battered H-piles based on geotechnical analysis.
   iv. Assumed T-wall construction area 50 feet to either side from center line of alignment.
   v. Assumed permanent access to be included in construction area.
d. Across from LA Highway 433, there would be 0.09 miles (450 feet) Old Spanish Trail Floodwall segment by Espirit du Lac Street (construction area would be 0.5 acres).
   i. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station T-walls.
   ii. Assumed 60-feet, 1:3 battered H-piles based on geotechnical analysis.
   iii. Assumed T-wall construction area 50 feet to either side from center line of alignment.
   iv. Assumed permanent access to be included in construction area.
b. 200 linear feet floodwall south of US Highway 190 Business:
   i. Assumed T-wall for this alignment reach as the alignment is between an energy substation and private property near US Highway 190 Business.
   ii. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station T-walls.
   iii. Assumed 60-foot 1:3 battered H-piles based on geotechnical analysis.
   iv. Assumed T-wall construction area 50 feet to either side from center line of alignment.
   v. Assumed permanent access to be included in construction area.
e. 7,700 linear feet floodwall reach along power easement north of US Highway 190 Business:
   vi. Assumed T-wall for this alignment reach is between US Highway 190 Business and US Highway 190 (Gause Boulevard).
   vii. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station T-walls.

viii. Assumed 60-foot 1:3 battered H-piles based on geotechnical analysis.
ix. Assumed T-wall construction area is 50 feet to either side from center line of alignment.
x. Assumed permanent access to be included in construction area.

3.) Access Floodgates:
- a. Paquet Road East floodgate
  - i. Assumed floodgate.
  - ii. Assumed rough ground elevation via Google Earth.
  - iii. Assumed floodgate width based on road width.
- b. Vehicular Roller Access Floodgates
  - i. Assumed all Alternative 6c vehicular floodgates to be roller floodgates.
  - ii. Assumed sill to be at existing ground level.

4.) Control Floodgates:
- a. Sluicegates #2 and #4
  - i. Assumed sluicegate.
  - ii. Assumed width based on stream width.
  - iii. Assumed sill is 5 feet below ground elevation.
- b.
  - i. .

1.3.6 Alternative 7: Eastern Slidell

Alternative 7 would include a levee, diversion channel, and channel improvements to address flooding. This alternative also consists of pump stations, floodgates, vehicular floodgates, and ramps. The features in this Alternative are all separate and combinable and could all be implemented if justified. Refer to Figures D:1-15; D;1-16; D:1-17; D:1-18; and D:1-19.

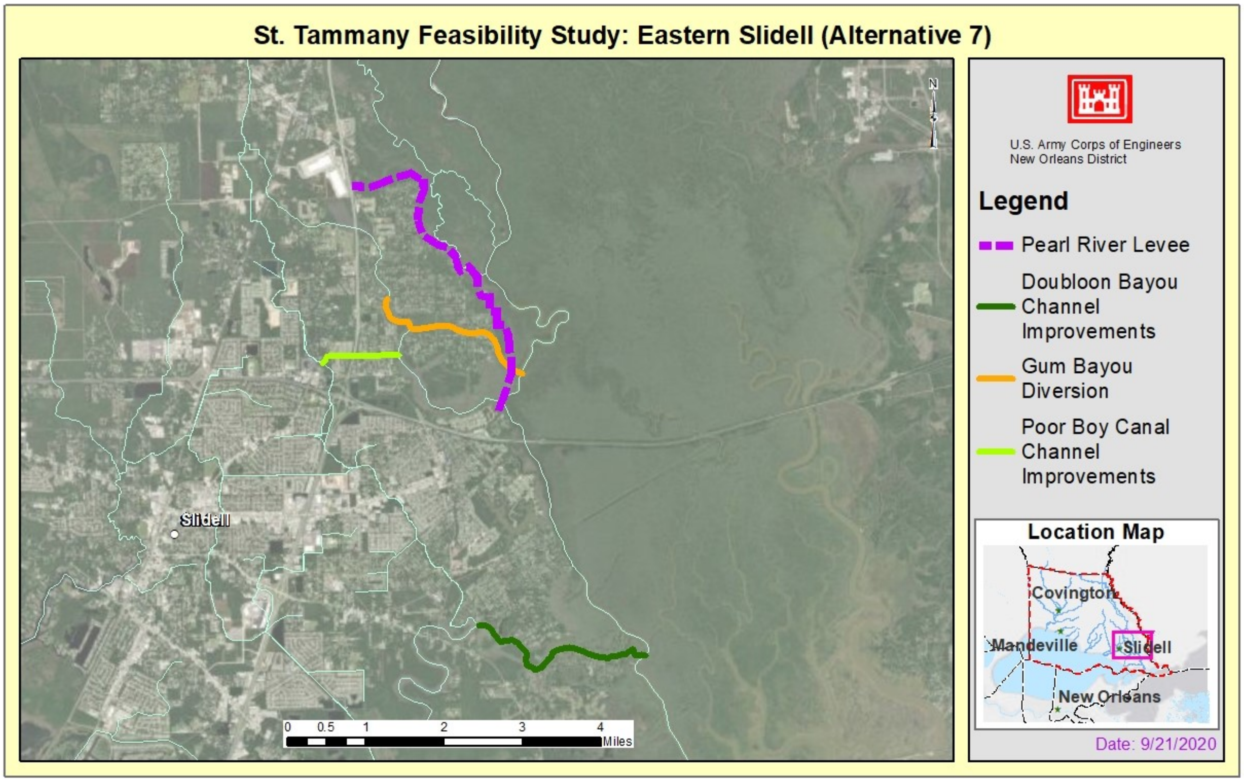


Figure D:1-15 Alternative 7 Eastern Slidell

Levee

The overall length of the Pearl River levee would be approximately 4.8 miles (25,000 feet). The levee would extend from Interstate 59 (I-59) running east and would turn south running along the Pearl River Tributaries to the intersection of the West Pearl River and Gum Bayou. The Pearl River levee alternative would reduce risk of riverine flooding. The alignment would stay clear from existing residential streets and houses. This alternative also would maintain a buffer distance from the closest tributary channel for Pearl River. The Pearl River levee has been adjusted to push the alignment to the east out of the residential neighborhoods wherever possible but keeping the Pearl River Tributary as a constraining factor.

Levee Design Section and Borrow Quantities

The new levee is designed using a preliminary design elevation that ranges from 16.2 feet to 19 feet along the alignment of 15 feet NAVD 88 and uses the elevations of the existing ground obtained from the LIDAR raster dataset. The preliminary assumptions are that the levee would have a 10-foot wide levee crown and side slopes of 1V:3H. Berm sections would be determined once data is available for analysis. The construction of this levee alignment would impact approximately 57 acres. This levee alignment would require 350,000 cubic yards of fill/borrow (includes 30 percent contingency).

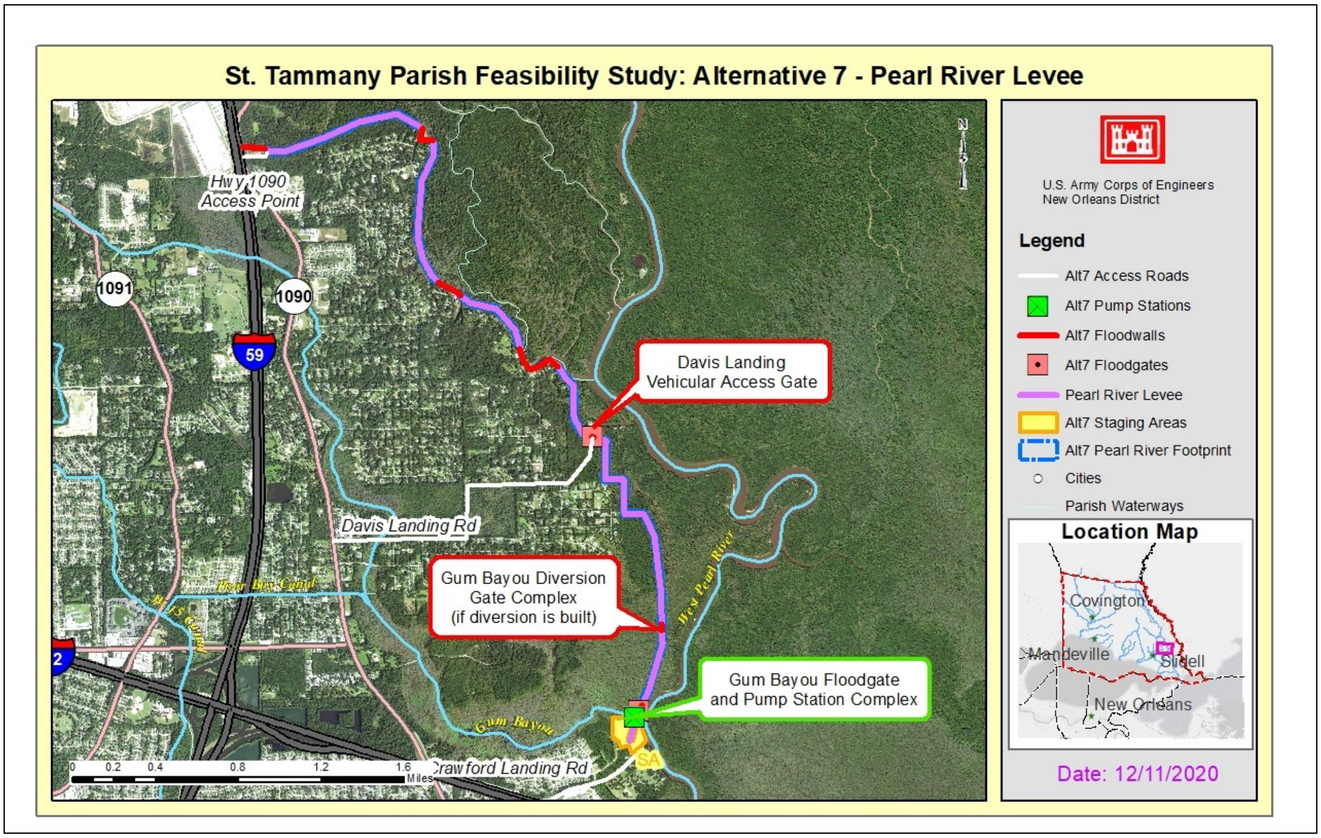


Figure D:1-16 Alternative 7 Pearl River Levee

Floodwall Elevation and Location

For this alignment, the elevation of the floodwall segments would be 15 feet.

There would be four floodwall sections for a total of 0.64 miles (3,400 feet). Three of them would remain in residential neighborhoods, at locations where the houses are built adjacent to the Pearl River Tributary. The construction of these floodwall segments would impact approximately 3 acres.

There would be 0.11-mile (600 feet) floodwall segment near I-59. The floodwall segment starts at the tie-in to Highway 190 (which runs on the east side of I-59) passing on the north side of a residential property that has access to US Highway 190.

There would be two 0.12-mile (650 feet) floodwall segments. One is around a cluster of several properties at the northeast end of Forest Drive in Morgan Bluff neighborhood. The levee alignment turns from running east to running south near this location. Levee runs south along Old Pearl River tributary. The other floodwall segment would be located behind several residential properties near the end of Houmas Court in Morgan Bluff neighborhood.

There would be a 0.27-mile (1,500 feet) floodwall segment behind several residential properties near the eastern end of Smith Baggert Rd in Morgan Bluff neighborhood.

Typical Floodwall Section

The typical T-wall section would consist of a 3-feet thick, 8.5-feet wide slab with a 1.5-feet thick stem. The height of the stem would vary. Preliminary assumptions are two rows of 1H:3V battered HP12 x 74 piles, 60 feet deep, spaced at 5 feet centers, and 30 feet deep steel PZ sheetpile. Approximately 1,850 square feet of slope protection would be provided at floodwall/levee tie-ins. The design of the T-wall including the foundation is subject to change once detailed geotechnical investigations are conducted.

Pump Stations and Floodgates

There would be a 600-cfs pump station where Gum Bayou and West Pearl River intersect, and a 30-foot floodgate.

If the Gum Bayou Diversion is constructed, there would be a 30-foot sluicegate.

Vehicular Floodgates and Ramps

There would be a 30-foot vehicular floodgate at Davis Landing Road.

1.3.6.1 Gum Bayou Diversion

This alternative would include the unmanned Gum Bayou Diversion (Diversion), to address rainfall and riverine flooding. The Diversion channel would divert the existing Gum Bayou to the Pearl River through a new channel. The new alignment of the Diversion has been shifted to a more southern location for the Diversion, following the low ground of a previous Pearl River Tributary channel. This revised alignment decreases the number of houses that would be impacted by this measure. The Diversion would extend from Oak Alley Drive and would run to the West Pearl River. The length of the Diversion would be 1.8 miles (9,300 feet). The upstream end of the Diversion channel would tie into the existing channel invert of Gum Bayou (+4.48 feet NAVD 88) and along the entire Gum Bayou channel. The invert would decline a total of 5 feet until it would tie into the West Pearl River (-0.48 feet NAVD 88).

The existing ground elevation is between 8 feet NAVD 88 and 10 feet NAVD 88. The preliminary design of the Diversion assumes an existing bank elevation 10 feet NAVD88, a 10-foot bottom width, and a bank with 1V:3H slope. A maximum of 100,000 cubic yards of material would be removed from the alignment of the Diversion. For the Diversion, approximately 35 acres of ROW would be needed for a temporary easement. A key assumption includes a 50-foot access corridor on the top of bank of each side of the Gum Bayou channel. The material requiring disposal would be trucked away from the site or sidecast along the bankline of the Gum Bayou channel. Refer to Figure D:1-17.

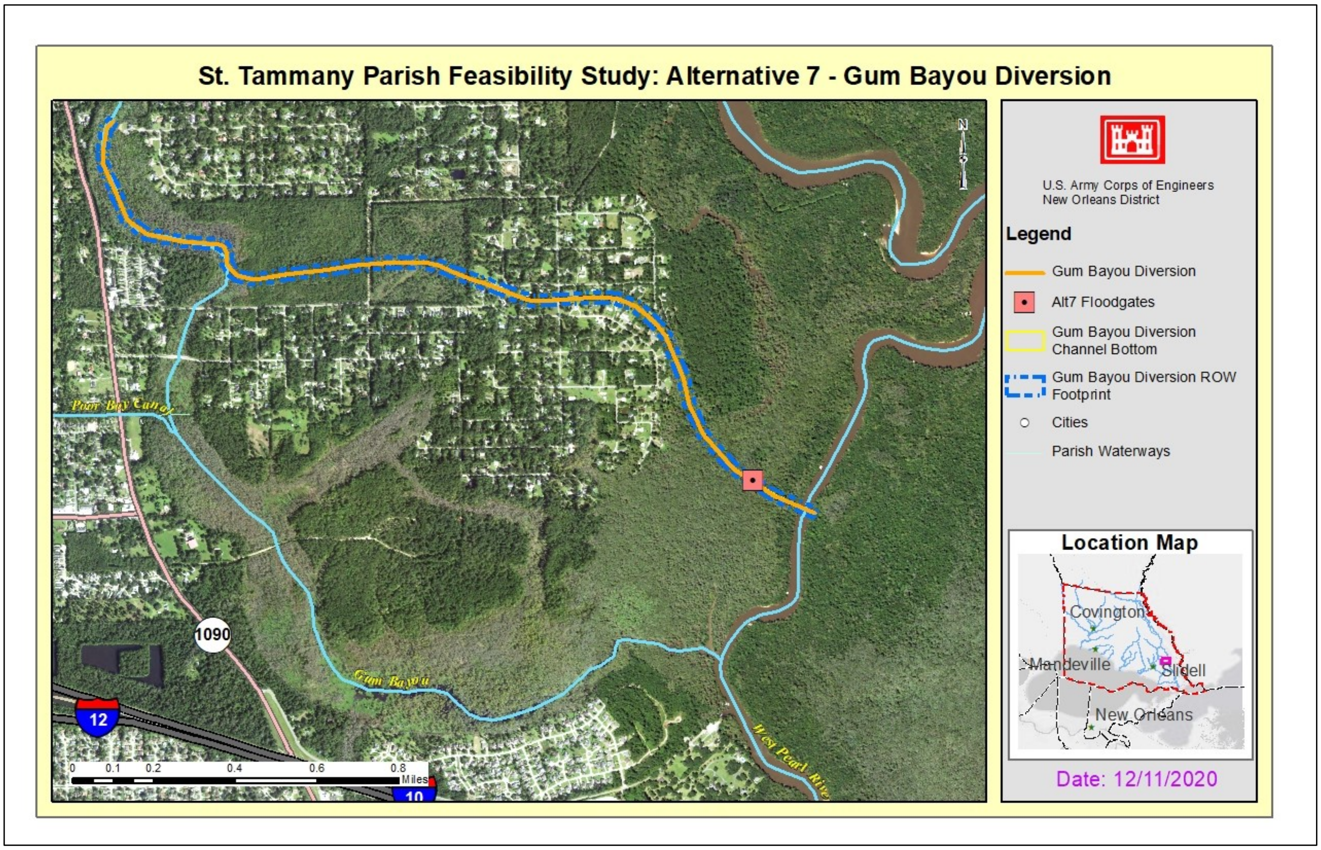


Figure D:1-17 Alternative 7 Gum Bayou Diversion

1.3.6.2 Poor Boy Canal Channel Improvements

This alternative includes the Poor Boy Canal channel improvements (channel improvements) to address rainfall and riverine flooding. The channel improvements in Poor Boy Canal would extend from LA Highway 1091, would cross LA Highway 59 and North Military Road, and would end into the Gum Bayou. This alternative consists of channel improvements of approximately 1 mile (5,288 feet) of channel. The preliminary design of the channel improvements assumes an existing bank elevation of 1 foot, and a 10-feet bottom width. The bank would be at 1V:3H slope. The improvements would include clearing and snagging and mechanical dredging of the Poor Boy Canal channel. The channel bottom would be lowered by 5 feet. Approximately 12 acres of Poor Boy Canal channel would be cleared and grubbed prior to mechanical dredging. An assumed maximum of 80,000 cubic yards of material may be removed from the Poor Boy Canal channel. Material removed may include sediment, trees, debris, or other obstructions within the waterway. For the channel improvements, approximately 16 acres of ROW would be needed for a temporary easement for construction. Potential staging areas would be at the intersection of the channel and North Military Road on the right descending bank east of the road (0.6 AC), the corner of canal street and N Military Road on the right descending bank of the channel (0.3 AC), and along LA Highway 1090 adjacent to the channel (0.7 AC).

Assumptions for channel improvements include ROW at 65 feet from the centerline to each side of the Poor Boy Canal channel as a general guideline (total width of 130 feet), which includes space for equipment access. All work would be within the project footprint. A temporary work easement would be within ROW. The material requiring disposal would be trucked away from the site. Assumption is that all access would be through public lands. Refer to Figure D:1-18.

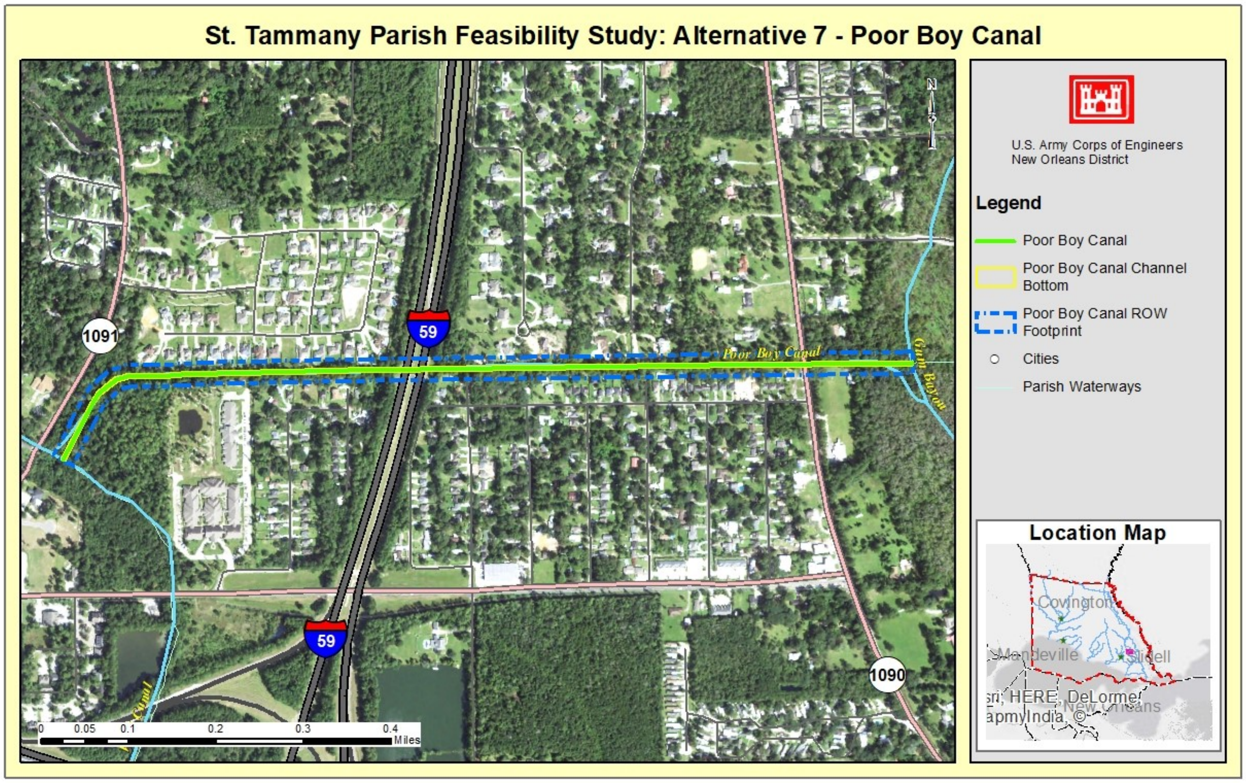


Figure D:1-18 Alternative 7 Poor Boy Canal Channel Improvements

1.3.6.3 Doubloon Bayou Channel Improvements

This alternative includes the Doubloon Bayou channel improvements to address rainfall and riverine flooding. The Doubloon Bayou channel improvements would extend from the intersection of Doubloon Bayou and W-15 Canal and end on West Pearl River. This alternative would consist of channel improvements of approximately 3 miles (13,500 feet) of channel. The preliminary design of the channel improvements assumes an existing bank elevation of 1 foot, and a 25-feet bottom width. The bank would be at 1V:3H slope. The improvements would include clearing and snagging and mechanical dredging of the Doubloon Bayou channel. The channel bottom would be lowered by 5 feet. Approximately 30 acres of channel would be cleared and grubbed prior to mechanical dredging. An assumed maximum of 190,000 cubic yards of material may be removed from Doubloon Bayou. Material removed may include sediment, trees, debris, or other obstructions within the waterway. Method for removal can be by a small hydraulic dredge (10-inch to 14-inch cutterhead or suction depending on the material) or by clamshell bucket. The lower portion of the bayou would be hydraulically dredged whereas the upper portion of Doubloon Bayou would need to be mechanically dredged. The material would need to be pumped to a disposal area or pumped/placed into a barge for hauling away and disposed of downriver. The disposition of the 190,000 cubic yards of material assumed to be removed from the Doubloon Bayou channel is as follows:

- 20 percent hydraulic dredged (38,000 CY) (2,700 LF)
- 35 percent mechanically dredged and hauled away (66,500 CY) (4,725 LF)
- 45 percent mechanically dredged and side cast (85,500 CY) (6,075 LF)

For the channel improvements, approximately 40 acres of ROW would be needed for a temporary easement. Assumptions for channel improvements include 65 feet from the centerline of each side of the Doubloon Bayou channel for ROW as a general guideline (total width of 130 feet); which includes space for equipment access. All work would be within the project footprint. The temporary work easement would be within ROW. Refer to Figure D:1-19.

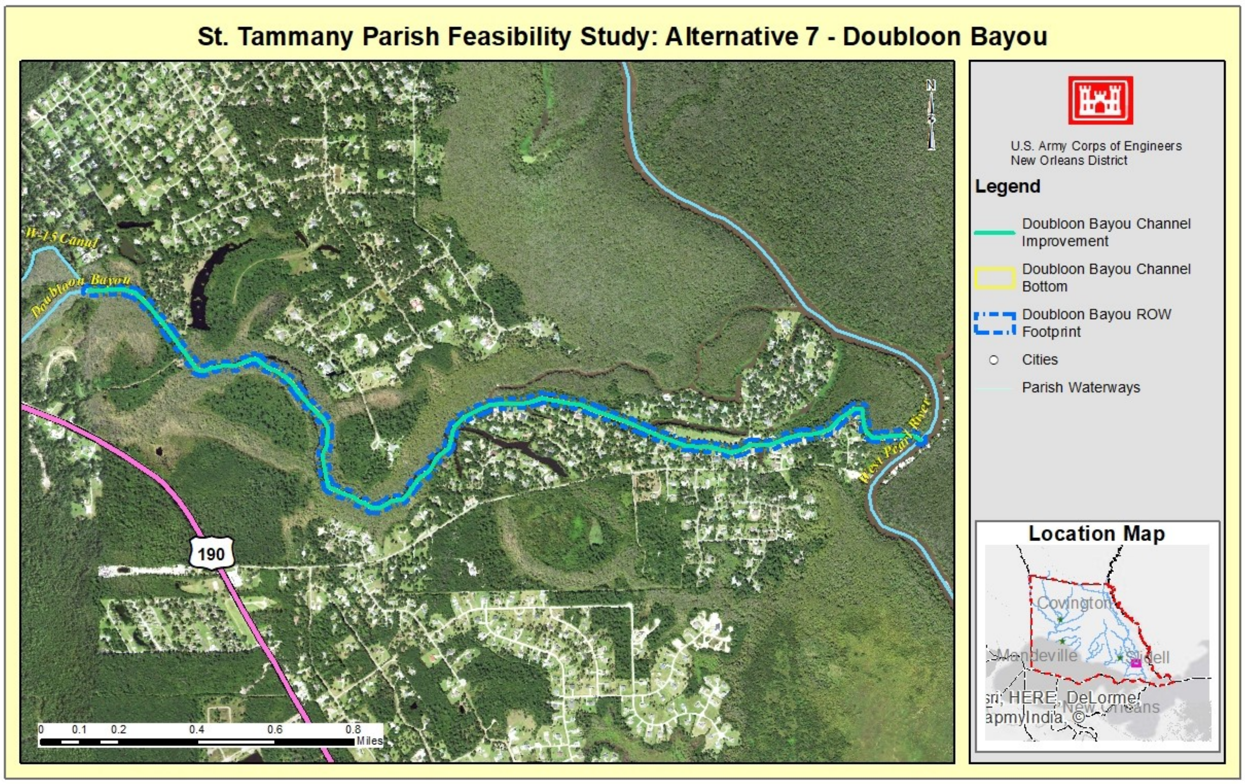


Figure D:1-19 Alternative 7 Doubloon Bayou

Structural Assumptions for Alternative 7

1.) Pump Stations:
   a. Gum Bayou Pump Station
      i. Assumed 600 cfs based on hydraulic estimates.

ii. Assumed new construction.
iii. Assumed no navigable floodgate for recreational vessels.
iv. Assumed location at existing Gum Bayou outlet.

2.) Floodwalls:
- a. 600-foot floodwall near I-59
  - i. Assumed T-Wall as alignment is too close to development.
  - ii. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station T-walls.
  - iii. Assumed 60-feet 1:3 battered H-piles based on geotechnical analysis.
  - iv. Assumed T-wall construction area 50 feet to either side from center line of alignment.
  - v. Assumed permanent access to be included in construction area.
- b. 650-foot floodwall near Forest Drive:
  - i. Assumed T-Wall as alignment is too close to development.
  - ii. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station T-walls.
  - iii. Assumed 60-feet 1:3 battered H-piles based on geotechnical analysis.
  - iv. Assumed T-wall construction area 50 feet to either side from center line of alignment.
  - v. Assumed permanent access to be included in construction area.
- c. 650-foot floodwall near Houmas Court:
  - i. Assumed T-Wall as alignment is too close to development.
  - ii. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station T-walls.
  - iii. Assumed 60-feet 1:3 battered H-piles based on geotechnical analysis.
  - iv. Assumed T-wall construction area 50 feet to either side from center line of alignment.
  - v. Assumed permanent access to be included in construction area.
- d. 1,500-foot floodwall near Smith Baggert Road:
  - i. Assumed T-Wall as alignment is too close to development.
  - ii. Assumed T-wall dimensions and configurations similar to NOV-NF-W-06B.5 Magnolia Pump Station t-walls.
  - iii. Assumed 60-feet 1:3 battered H-piles based on geotechnical analysis.
  - iv. Assumed T-wall construction area 50 feet to either side from center line of alignment.
  - v. Assumed permanent access to be included in construction area.

3.) Floodgates:
- a. Vehicular Roller Access Floodgate at Davis Landing Road:
  - i. Assumed 30-foot roller floodgate.

ii. Assumed rough ground elevation via Google Earth.
iii. Assumed floodgate width based on road width.

4.) Control Floodgates:
   a. Control floodgate at Gum Bayou Diversion:
      i. Assumed 30-foot sluicegate.

1.3.7 Alternative 8 Upper Tchefuncte/Covington

The Upper Tchefuncte/Covington Channel alternative includes measures to reduce rainfall and riverine flooding in the upper reaches of the Tchefuncte and Bogue Falaya Rivers. The measures in this alternative are all separate. They are combinable within this alternative or could also be combined with other alternatives. If justified, all the above measures could be implemented. Refer to Figure D:1-20.

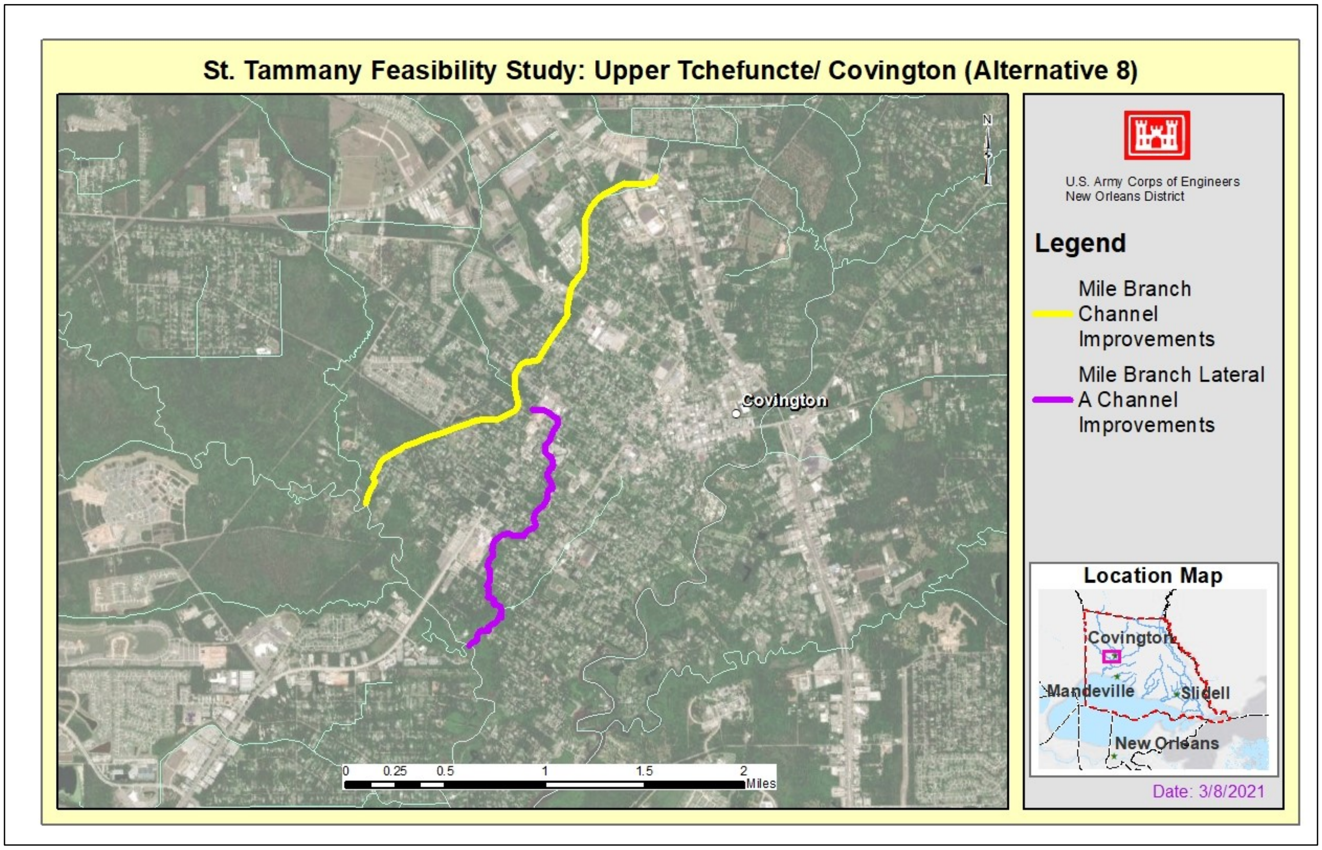


Figure D:1-20 Alternative 8 Upper Tchefuncte/Covington

1.3.7.1 Mile Branch Channel Improvements

The Mile Branch channel improvements starts at the intersection of Mile Branch and US Highway 190, crossing US Highway 190 Business, and would end at the intersection of Mile Branch and the Tchefuncte River. This measure consists of channel improvements on the lower 2.15 miles (11,341-foot channel) of Mile Branch in Covington, LA.

The improvements would include clearing and grubbing and mechanical dredging of the channel. The channel bottom would be lowered by 5 feet. Approximately 20 acres of channel would be cleared and grubbed prior to mechanical dredging. An assumed maximum of 130,000 cubic yards of material may be mechanically dredged from the channel. The preliminary design assumes an existing bank elevation of 1 foot, and a 10-feet bottom width. The bank would be at 1V:3H slope. Material removed may include sediment, trees, debris, or other obstructions within the waterway. For the channel improvements, approximately 34 acres of ROW would be needed for temporary work areas. The material will be hauled away from the site.

The Mile Branch channel improvements may include bridge replacements or culverts (starting from north to south) at 29th, 28th, 25th, 23rd, 21st, 19th, and 18th Avenues. No work would be anticipated at the 15th and 11th Avenue channel crossings as those bridges have been replaced prior to this study (and the new bridges were designed to safely pass higher flows on Mile Branch). Refer to Figure D:1-21.

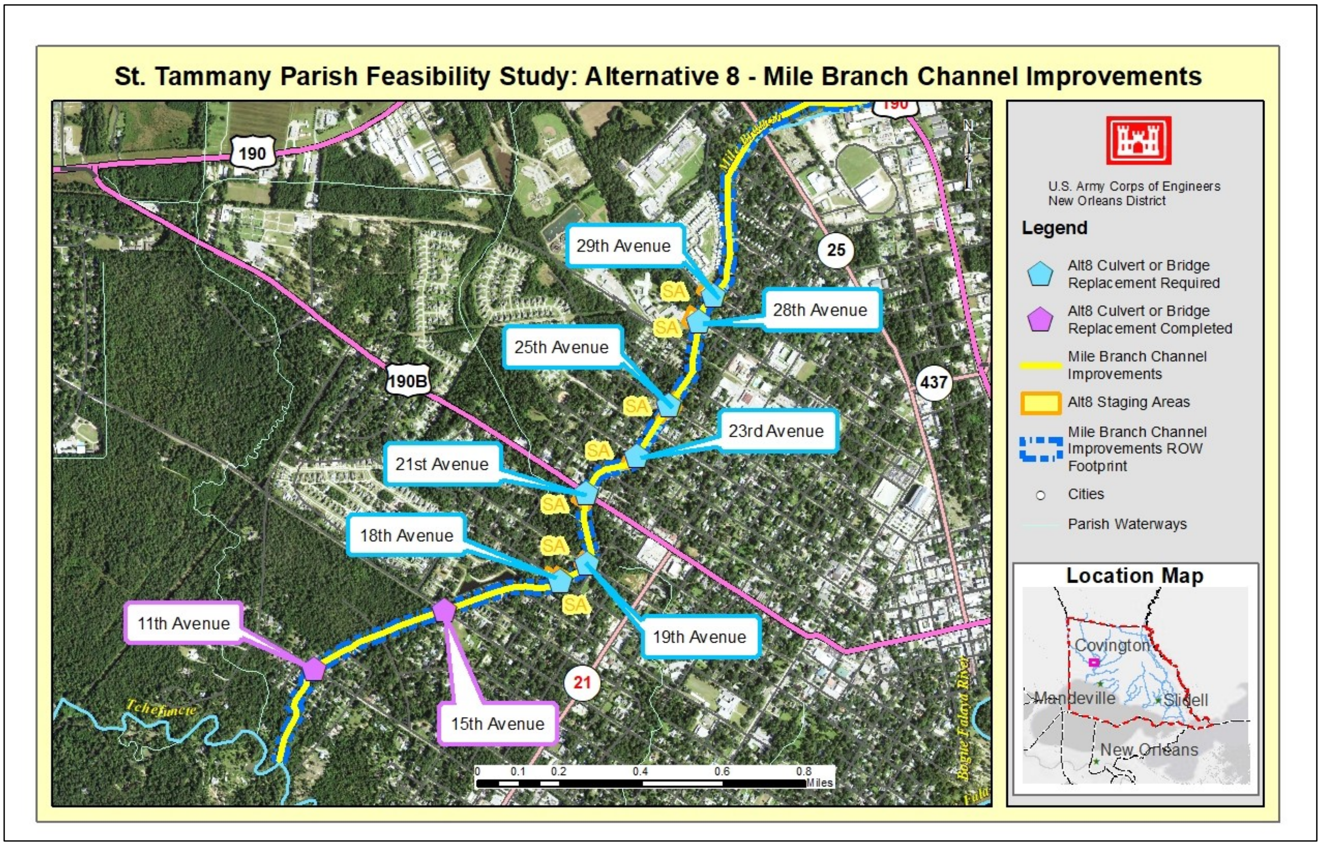


Figure D:1-21 Alternative 8 Mile Branch Channel Improvements

1.3.7.2 Lateral A Mile Branch Channel Improvements

This alternative includes channel improvements to the Lateral A Mile Branch to address rainfall and riverine flooding. The work would extend from just southwest of the intersection of US Highway 190 and LA Highway 21. The channel improvements would include clearing and snagging approximately 1.73 miles (9,129 feet channel) of Lateral A Mile Branch. The preliminary design of the channel improvements for Lateral A Mile Branch assumes an existing bank elevation of 1 foot, and a 10-feet bottom width. The bank would be at a 1V:3H slope. The channel bottom would be lowered by 5 feet. Approximately 16 acres of channel would be cleared and grubbed prior to mechanical dredging. An assumed maximum of 104,000 cubic yards of material may be removed from the channel. Material removed may include sediment, trees, debris, or other obstructions within the waterway. For the channel improvements, approximately 28 acres of ROW would be needed for a temporary easement. The material will be hauled away from the site.

The Lateral A Mile Branch channel improvements may include bridge replacements or culverts (starting from north to south) at the intersection of Tyler Street and LA Highway 21, and at 19th, 17th, 16th, 15th, 14th, 13th, 11th, and 8th Avenues. Assumptions for channel improvements include a ROW limit measured 65 feet from the centerline to each side of the channel for as a general guideline (total width of 130 feet); which includes space for equipment access. All work would be within the project footprint. Temporary work easement would be within ROW. The material requiring disposal would be trucked away from the site. Assumption is that all access would be through public lands. Refer to Figure D:1-22.

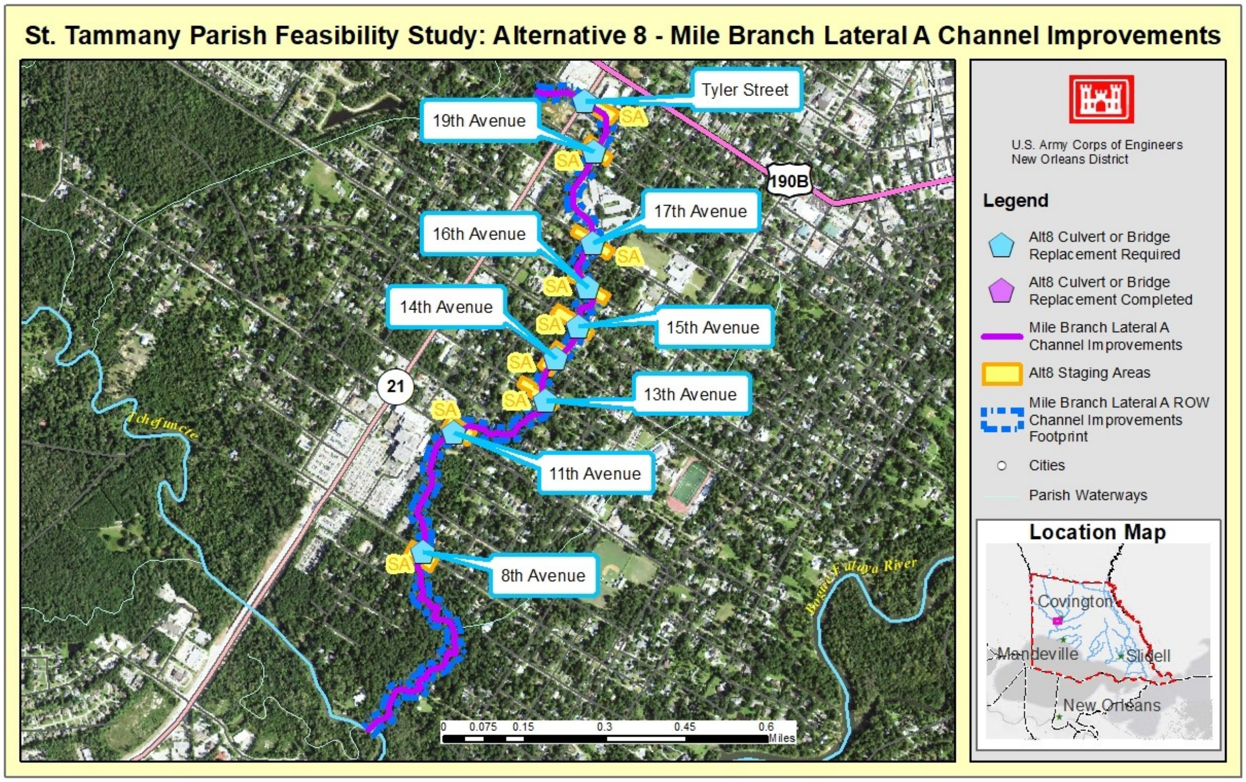


Figure D:1-22 Alternative 8 Mile Branch Lateral A Channel Improvements

Structural Assumptions for Alternative 8

1.) Pump Stations:
   a. Assume none
2.) Floodwalls:
   a. Assume none
3.) Access Floodgates:
   a. Assume none
4.) Control Floodgates:
   a. Assume none

1.3.8 Alternative 9 Mandeville Lakefront

This alternative is proposed to reduce the risk from a coastal storm. The following variations to Alternative 9 would be mutually exclusive within the alternative. This means that only one variation within alternative 9 could be implemented, if justified, to become part of the TSP. Refer to Figure D:1-23.

- Alternative 9a would replace the existing lakefront seawall to Elevation 7.3 feet NAVD 88 and would add a passive drainage option on Bayou Ravine Aux Coquilles and Little Castine Bayou.
- Alternative 9b would replace the existing seawall to Elevation 7.3 feet NAVD 88 and would add pump stations at the lakefront at Girod Street and Ravine Aux Coquilles.
- Alternative 9c would replace the existing seawall to Elevation 18 feet NAVD 88 and would add pump stations at the lakefront at Girod Street and Ravine Aux Coquilles.

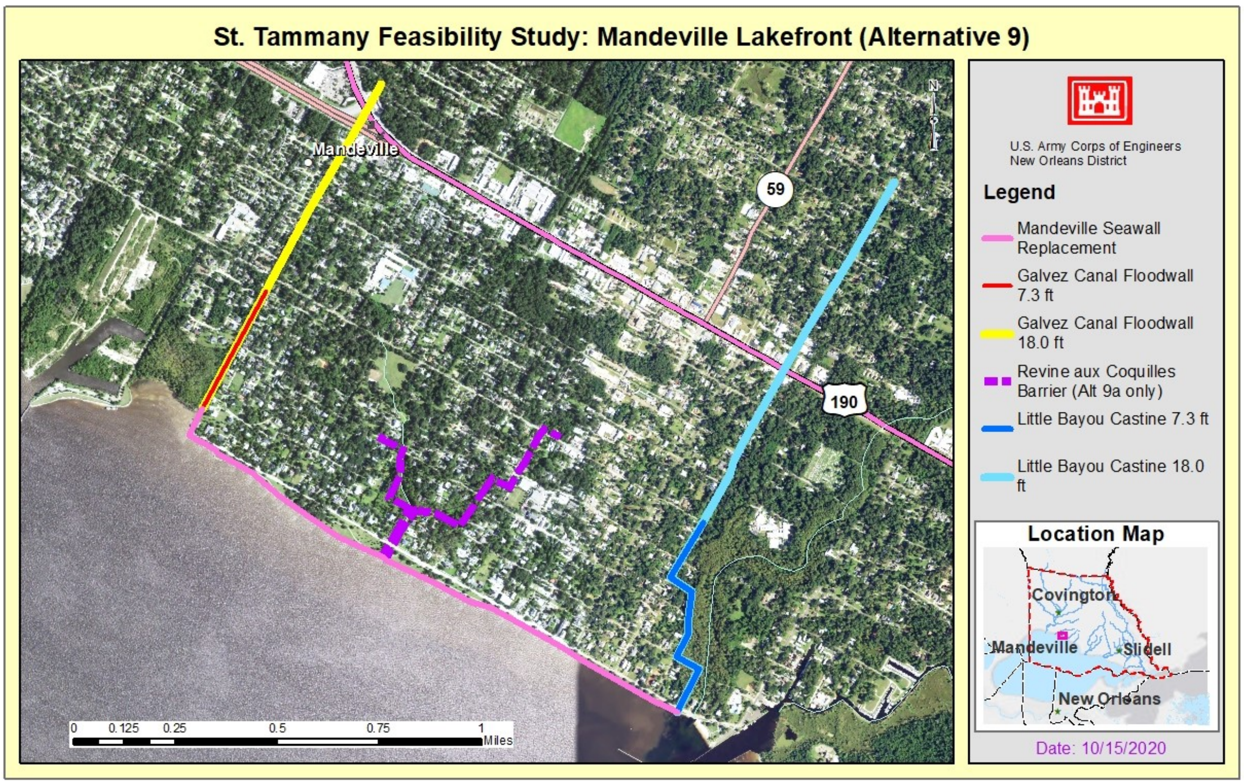


Figure D:1-23 Alternative 9 Mandeville Lakefront

1.3.8.1 Alternative 9a Mandeville Lakefront – Seawall Passive Drainage

Alternative 9a would consist of a passive system in conjunction with the new 7.3 feet seawall at the lakefront of Mandeville, Louisiana. There would be an opening in the lakefront seawall at Ravine Aux Coquilles. The design elevation for the seawall would be 7.3 feet NAVD 88, which is above the 20-year surge level in the planned project completion year of 2032. Elevation 7.3 feet would be 2 feet higher than the existing seawall. Local interests communicated a strong preference for this elevation. Refer to Figures D:1-24, D:1-25, D:1-26, and D:1-27.

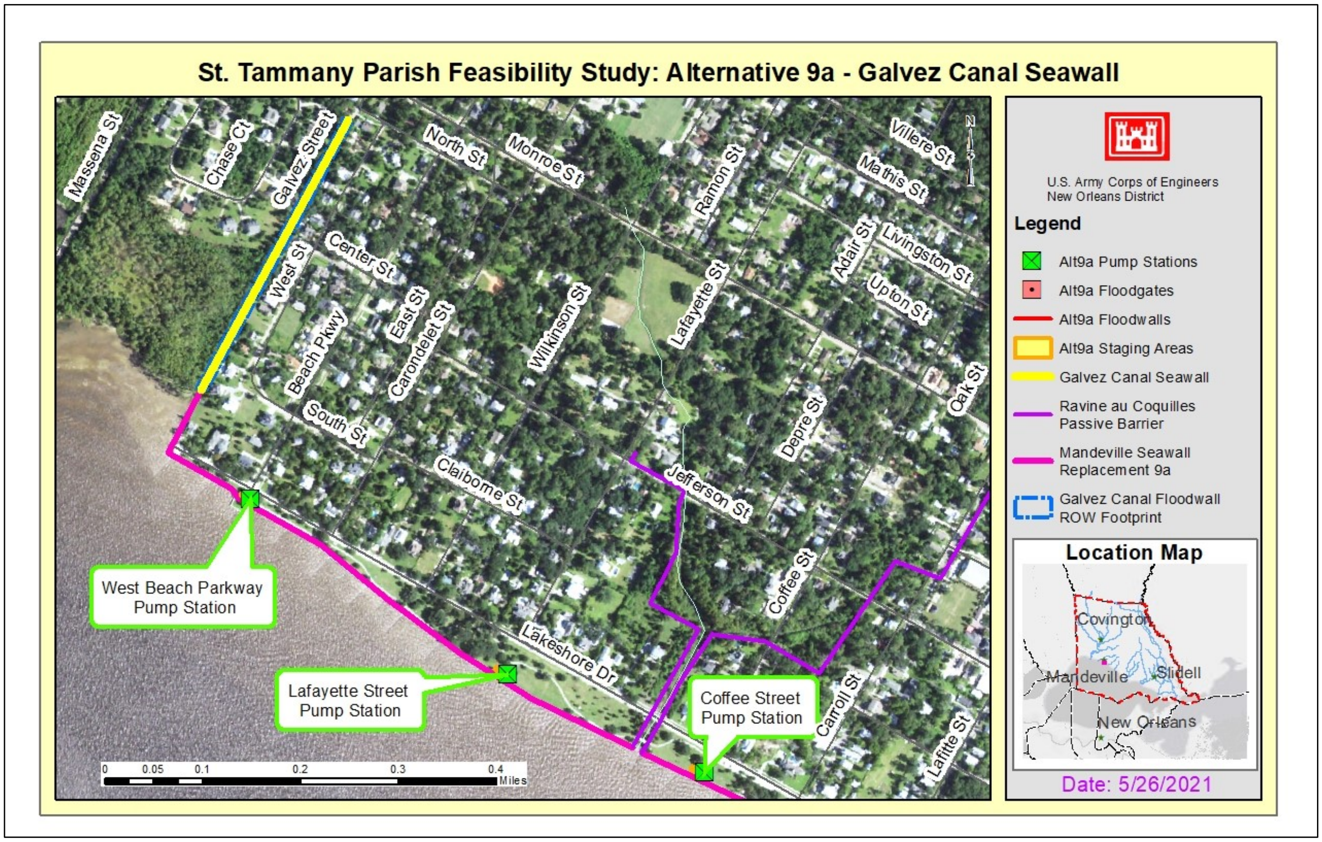


Figure D:1-24 Alternative 9a Galvez Canal Seawall

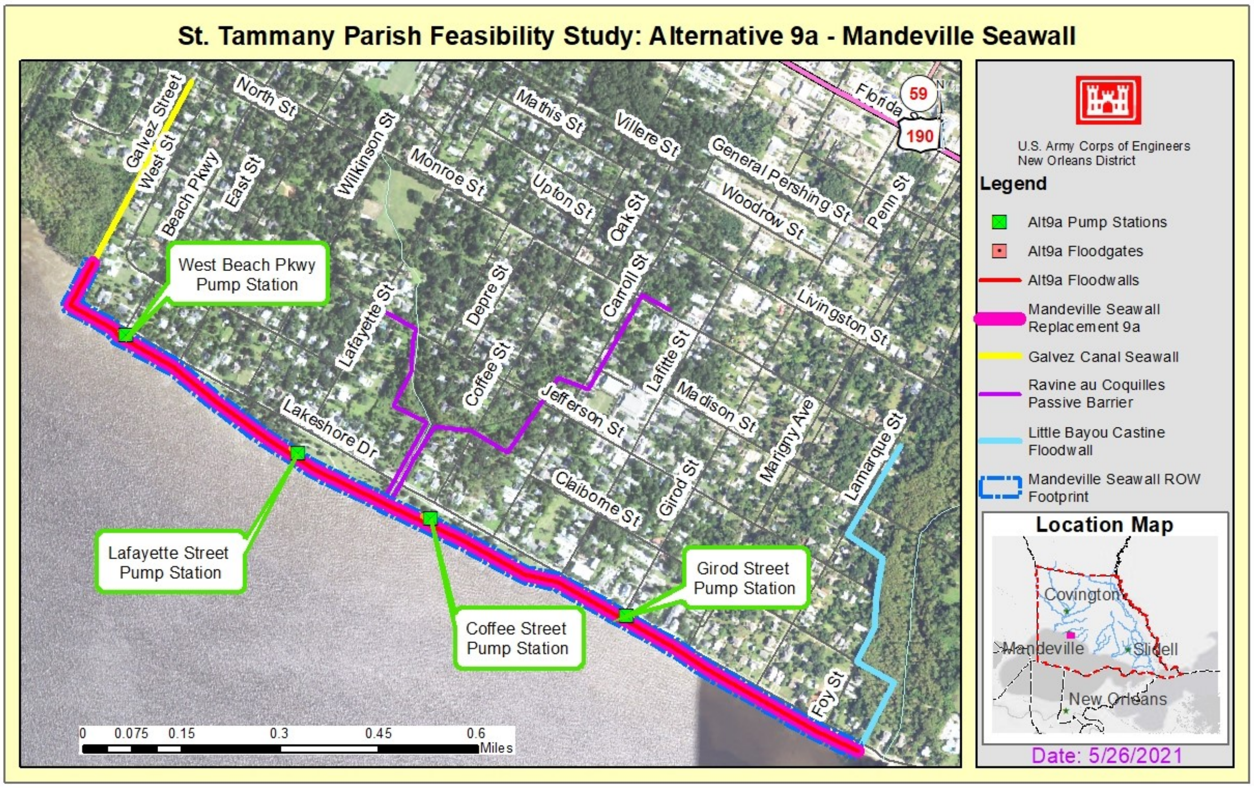


Figure D:1-25 Alternative 9a Mandeville Seawall

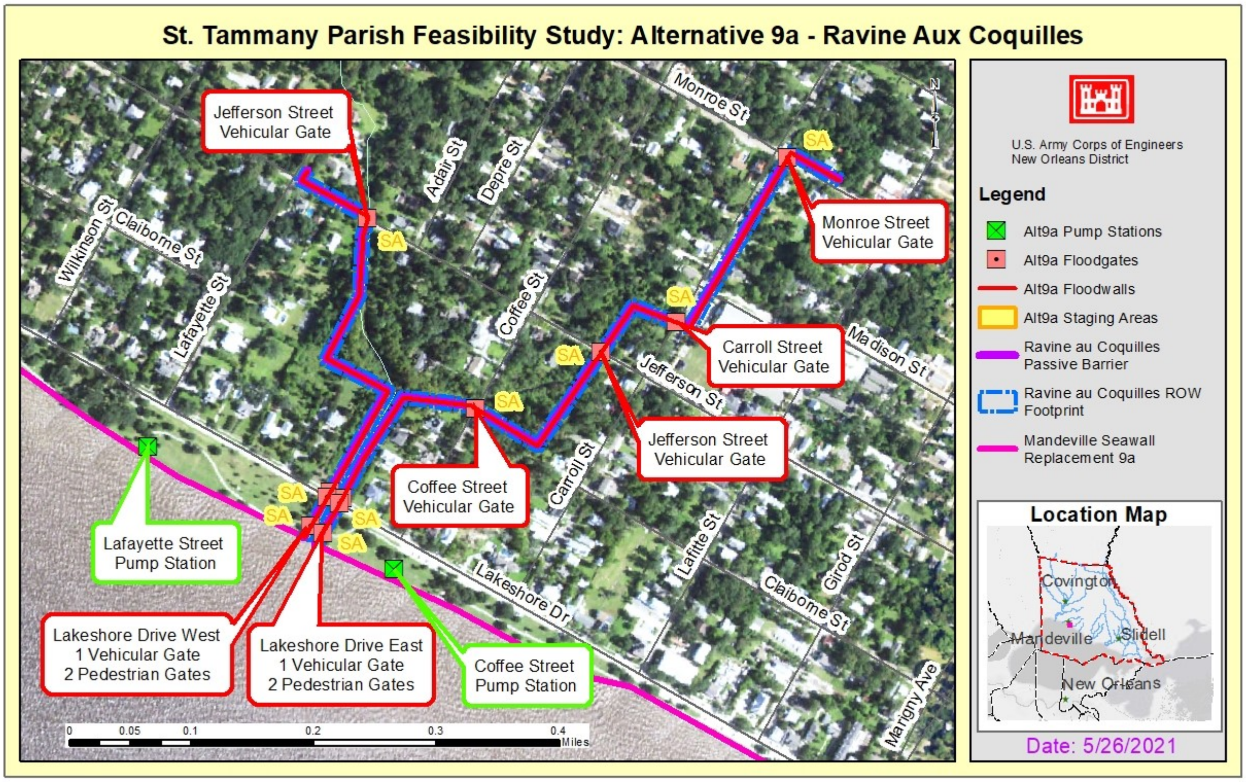


Figure D:1-26 Alternative 9a Ravine Aux Coquilles

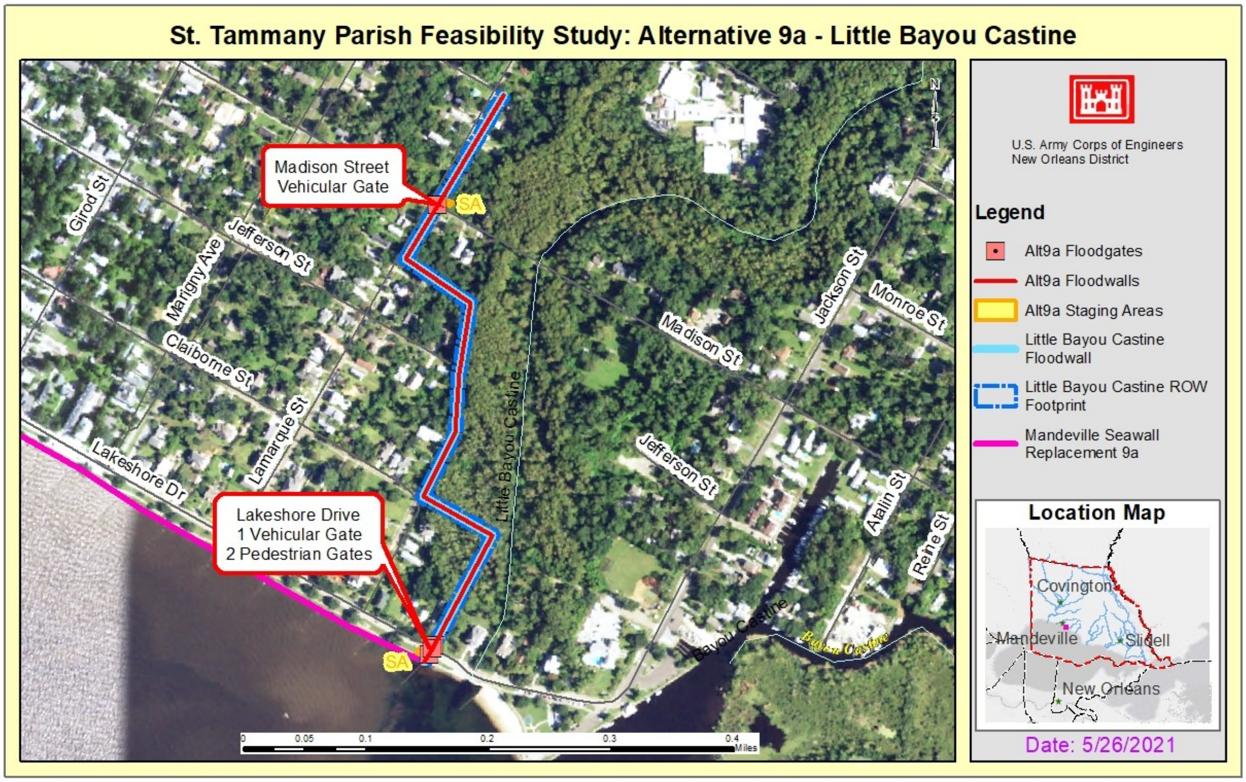


Figure D:1-27 Alternative 9a Little Bayou Castine

Description of Alignment

For Alternative 9a, the seawall would be replaced in its entirety on the same alignment as the existing seawall. The seawall would run parallel to and on the south side of Lakeshore Drive. On the west side it would continue on the Galvez Canal to North Street, connecting to floodwalls (passive barrier) on the west and east sides of Ravine Aux Coquilles, and ending on the west side of Little Bayou Castine where it would connect to the floodwall (passive barrier) for Little Bayou Castine. This new floodwall would run along the Little Bayou Castine and would end on Monroe and Lamarque Streets.

Floodwall Elevation and Location

For elevation 7.3 feet NAVD 88, the new seawall would be approximately 1.5 miles long (7,703 feet). The new floodwall at Galvez Canal would be at elevation 7.3 feet NAVD 88 and 0.3 miles (1,740 feet) long.

The total floodwall length would be approximately 18,000 feet. This length includes Ravine Aux Coquilles West Passive Barrier (length 2,067 feet), Ravine Aux Coquilles East Passive Barrier (length 3,485 feet), and Little Bayou Castine West Passive Barrier (length 3,000 feet).

Typical Floodwall Section

The typical I-wall section for the seawall would consist of a 30-feet deep steel PZ sheetpile with a concrete cap. The new seawall would impact 10.3 acres of construction area. The typical passive floodwall at Ravine Aux Coquilles would be a combination of T-wall and I–wall. The floodwall at Galvez Canal would be an I-wall. The existing seawall would be demolished prior to the construction of the new seawall. It was assumed that for the existing seawall the concrete cap is 3 feet by 1.5 feet and the length of the wall is 7,500 feet. The existing vinyl sheetpile at Galvez Canal (length of 2,050 feet) would be demolished and would be replaced with seawall. The design of the floodwalls, including the foundation, is subject to change once detailed geotechnical investigations are conducted.

The new passive alignment floodwalls would keep storm surge from reaching the developed areas adjacent to them, while maintaining natural drainage in the bayous. The passive drainage floodwalls would be located at Ravine Aux Coquilles West Passive Barrier, Ravine Aux Coquilles East Passive Barrier, and Little Bayou Castine West Passive Barrier.

More detailed information on the new floodwalls includes:

- Ravine Aux Coquilles West Passive Barrier: length of 0.4 miles or 2,067 feet (1,817 feet of T-Wall and 250 feet of I-Wall), and 2.4 acres of construction area.
- Ravine Aux Coquilles East Passive Barrier: length of 0.7 miles or 3,485 feet (2,562 feet of T-Wall and 923 feet of I-Wall), and 4 acres of construction area.
- Little Bayou Castine West Passive Barrier: length of 0.6 miles or 3,000 feet (1,300 feet of T-Wall and 1,700 feet of I-Wall), 3.9 acres of construction area.

Pump Stations and Floodgates

Four pump stations would be constructed at the lakefront seawall on West Beach Parkway (116 cfs), Lafayette Street (33 cfs), Coffee Street (106 cfs), and Girod Street (139 cfs). Each pump station would need a construction area of 0.009 acres for a total 0.03 acres for the four pump stations. A 100 feet by 50 feet staging area for seawall within the lakefront was assumed. There would be no pump station at Foy Street. There would be no floodgates on Galvez Canal for the elevation 7.3 feet NAVD 88 floodwall.

Vehicular Floodgates and Ramps

There would be a total of nine vehicular floodgates and six pedestrian floodgates for Alternative 9a.

At Ravine Aux Coquilles East floodwall, there would be vehicular floodgates for access, one on each street for a total of four on each of the following streets: Coffee Street, Jefferson Street, Carroll Street, and Monroe Street (LA Highway 1087), one vehicular floodgate and two pedestrian floodgates at Lakeshore Drive East. There would be designated staging areas adjacent to the construction areas for all the floodgates.

At Ravine Aux Coquilles West floodwall, there would be a vehicular floodgate at Jefferson Street, one vehicular floodgate and two pedestrian floodgates at Lakeshore Drive West. There would be designated staging areas within each of the floodgates.

At Little Bayou Castine there would be four floodgates from south to north, there would be a vehicular gate at Madison Street, one vehicular floodgate and two pedestrian floodgates at Lakeshore Drive. There would be designated staging areas adjacent to the construction areas for all the floodgates.

Structural Assumptions for Alternative 9a

1.) Pump Stations:
   a. West Beach Parkway Pump Station
      i. Assumed 116.1 cfs based on hydraulic analysis.
      ii. Assumed pump station to be located adjacent to seawall.
      iii. Assumed pump station to be enclosed in prefabricated metal building.
      iv. Assumed same configuration as the USACE West Shore Lake Pontchartrain Prescott Road Pumping Station.

   b. Lafayette Street Pump Station:
      i. Assumed 32.9 cfs based on hydraulic analysis.
      ii. Assumed Pump station to be located adjacent to seawall.
      iii. Assumed pump station to be enclosed in prefabricated metal building.
      iv. Assumed same configuration as the USACE West Shore Lake Pontchartrain Prescott Road Pumping Station.

   c. Coffee Street Pump Station:
      i. Assumed 105.6 cfs based on hydraulic analysis.
      ii. Assumed pump station to be located adjacent to seawall.
      iii. Assumed pump station to be enclosed in prefabricated metal building.
      iv. Assumed same configuration as the USACE West Shore Lake Pontchartrain Prescott Road Pumping Station.

   d. Girod Street Pump Station:
      i. Assumed 138 cfs based on hydraulic analysis.
      ii. Assumed pump station to be located adjacent to seawall.
      iii. Assumed pump station to be enclosed in prefab metal building.
      iv. Assumed same configuration as the USACE West Shore Lake Pontchartrain Prescott Road Pumping Station.

2.) Floodwalls:
   a. Ravine Aux Coquilles western floodwall
      i. Assumed T-wall with sill at Elevation 0 to extend from seawall to Elevation 5.

- ii. Assumed I-wall for alignment elevations from 5 to 7.3.
- iii. Assumed alignment to avoid infringing on private property.
- iv. Assumed alignment to cross at two pedestrian paths, Lakeshore Drive, and Jefferson Street.

b. Ravine Aux Coquilles eastern floodwall
- i. Assumed T-wall with sill at Elevation 0 to extend from seawall to Elevation 5.
- ii. Assumed I-wall for alignment elevations from 5 to 7.3.
- iii. Assumed alignment to avoid infringing on private property.
- iv. Assumed alignment to cross at two pedestrian paths, Lakeshore Drive, Coffee Street, Jefferson Street, Carroll Street, and Monroe Street.

c. Little Bayou Castine western floodwall
- i. Assumed T-wall with sill at Elevation 0 to extend from seawall to Elevation 5.
- ii. Assumed I-wall for alignment elevations from 5 to 7.3.
- iii. Assumed alignment to avoid infringing on private property.
- iv. Assumed alignment to cross at two pedestrian paths, Lakeshore Drive, and Madison Street.

d. Lakefront Seawall
- i. Assumed complete replacement of existing I-wall seawall
- ii. Assumed complete replacement of Galvez Canal seawall
- iii. Assumed Seawall to extend from North Street tie-in to Little Bayou Castine inlet.

3.) Access Floodgates:

a. Vehicle Roller floodgates
- i. Assumed vehicle roller floodgates at intersection of proposed alignment and streets.

b. Pedestrian Roller floodgates
- i. Assumed pedestrian swing floodgates at intersections of proposed alignment and pedestrian paths.

4.) Control Floodgates:

a. Assumed none.

1.3.8.2 Alternative 9b Mandeville Lakefront – Seawall and Pump Stations

Alternative 9b would consist of a series of inlet pumps in conjunction with the new seawall at the lakefront in Mandeville, Louisiana. This alternative would include a pump station at Bayou Ravine Aux Coquilles. For the seawall replacement, elevation of 7.3 feet NAVD 88 was analyzed. The design elevation for the seawall would be 7.3 feet NAVD 88, which is above the 20-year surge level in the planned project completion year 2032. Elevation 7.3 feet would be 2 feet higher than the existing seawall elevation. Local interests communicated a strong preference for this elevation. Refer to Figures D:1-28, D:1-29, D:1-30, and D1-31.

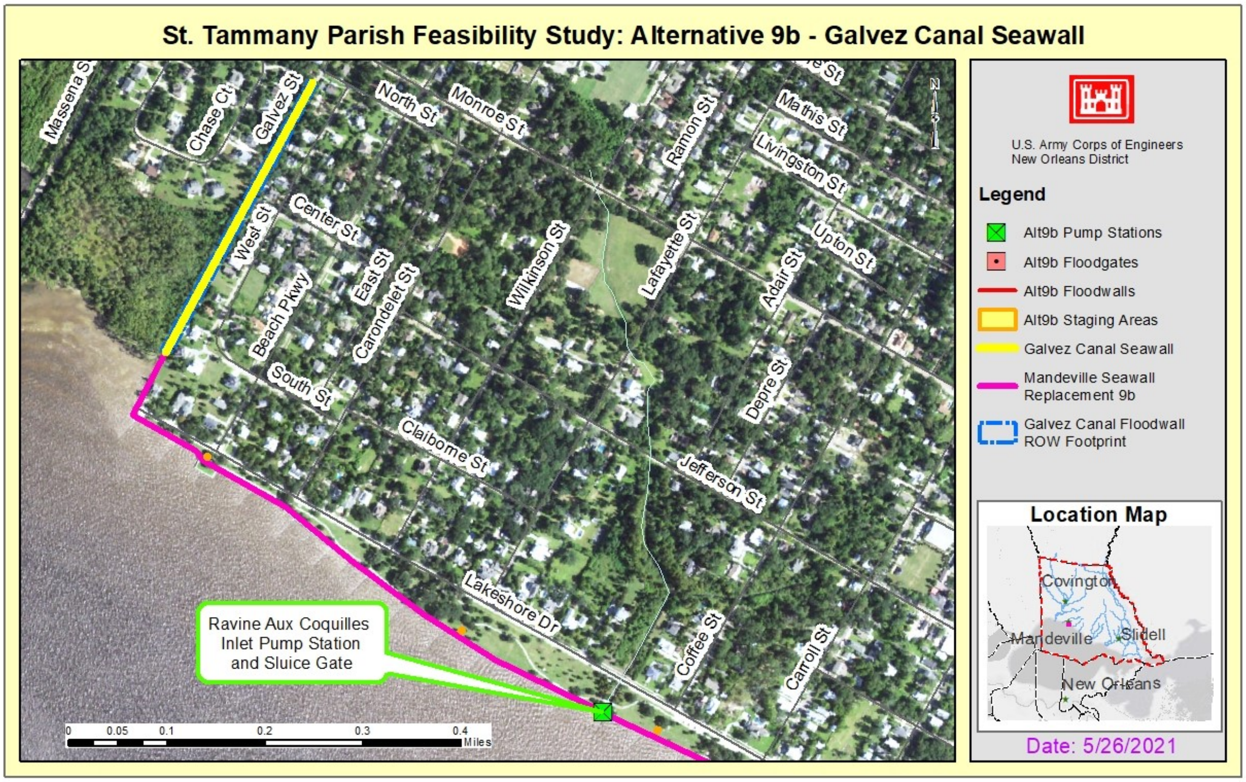


Figure D:1-28 Alternative 9b Galvez Canal Seawall

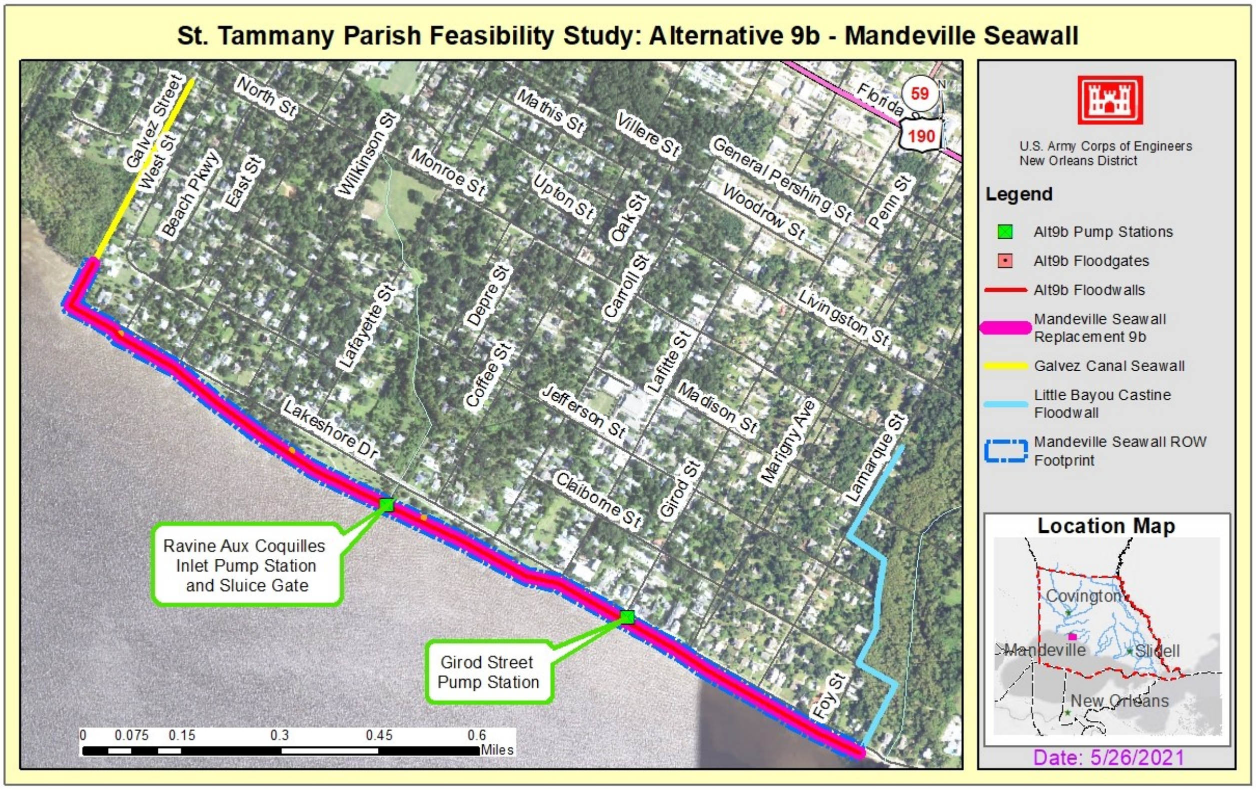


Figure D:1-29 Alternative 9b Mandeville Seawall

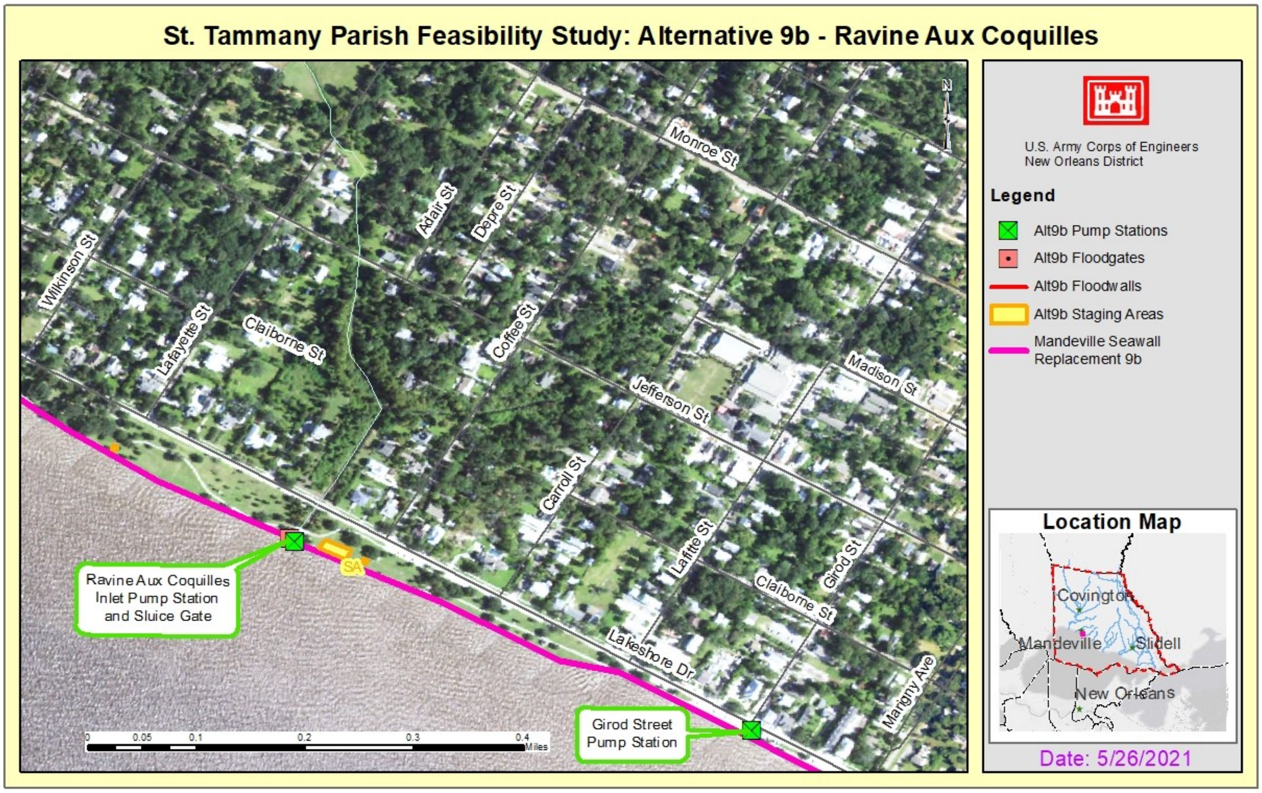


Figure D:1-30 Alternative 9b Ravine Aux Coquilles

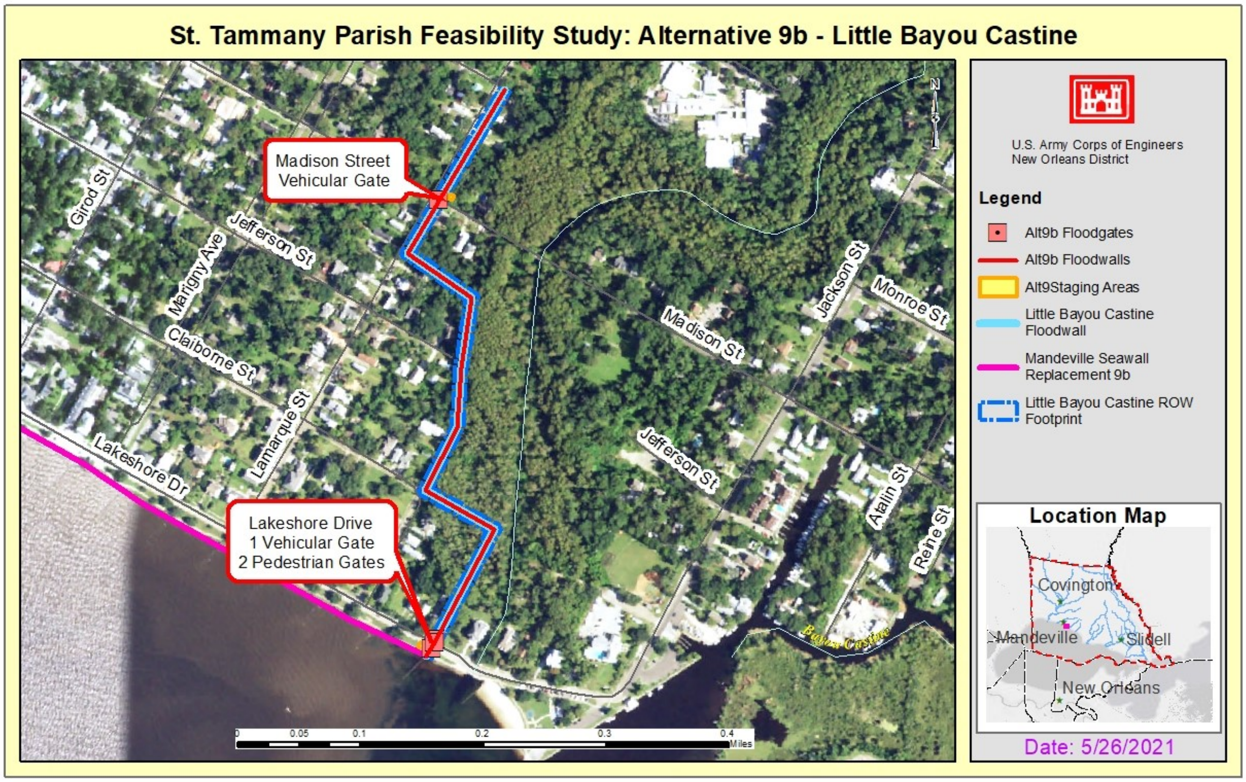


Figure D:1-31 Alternative 9b Little Bayou Castine

Description of Alignment

For Alternative 9b, the seawall would be replaced in its entirety on the same alignment as the existing seawall. The new seawall would run parallel to and on the south side of Lakeshore Drive; on the west side it would continue on the Galvez Canal to North Street, and the new seawall will end on the west side of Little Bayou Castine where it would connect to the new floodwall on the bayou. This new floodwall would run along the Little Bayou Castine and would end on Monroe and Lamarque Streets.

Floodwall Elevation and Location

For Elevation 7.3 feet NAVD 88, the new seawall would be approximately 1.5 miles long (7,703 feet). The new floodwall in Galvez Canal would be at elevation 7.3 feet NAVD 88 and 0.3 miles (1,740 feet) long. The new floodwall at Little Bayou Castine would be at elevation 7.3 feet NAVD 88 and 0.64 miles (3,400 feet) long. Total floodwall would be approximately 12,900 feet.

Typical Floodwall Section

The typical I-wall section for the new seawall would consist of a 30-feet deep steel PZ sheet pile with a concrete cap. The new seawall would impact 10.3 acres of construction area. The typical floodwall at Little Bayou Castine would be a combination of T-wall and I–wall. The floodwall at Galvez Canal would be an I-wall. The existing seawall would be demolished prior to the construction of the new seawall. It was assumed that for the existing seawall the concrete cap would be 3 feet by 1.5 feet and the length of the wall would be 7,500 feet. The existing vinyl sheetpile at Galvez Canal (length of 2,050 feet) would be demolished and would be replaced with a new seawall. The design of the floodwalls including the foundation is subject to change once detailed geotechnical investigations are conducted.

Pump Stations and Floodgates

A pump station would be constructed at the lakefront seawall on Girod Street (preliminary estimated capacity of 200 cfs) with a construction area of 0.009 acres. Assumption was 100 feet by 50 feet staging area for the seawall within the riverfront park.

A 500 cfs pump station and 20-foot sluicegate would be constructed at Ravine Aux Coquilles at the lakefront (construction area is 2 acres). There would be no floodgates on Galvez Canal for Elevation 7.3 feet NAVD 88 floodwall.

Vehicular Floodgates and Ramps

At Little Bayou Castine there would be four vehicular floodgates from south to north, there would be a 30 feet vehicular floodgate at Madison Street, one 75-feet vehicular floodgate and two 10-feet pedestrian floodgates at Lakeshore Drive. There would be designated staging areas adjacent to the construction areas for all the floodgates.

Note that for Alternative 9b there would be no pump station or floodgate at Little Bayou Castine as the risk reduction ends on the west side of this bayou. There would be no new floodwalls in the interior of Ravine Aux Coquilles for this alternative.

Structural Assumptions for Alternative 9b

1.) Pump Stations:
   a. Ravine Aux Coquilles Pump Station
      i. Assumed 500 cfs based on hydraulic analysis.
      ii. Assumed pump station to be located at outlet of Ravine Aux Coquilles.
      iii. Assumed pump station to be enclosed in prefab metal building.
   b. Girod Street pump station
      i. Assumed 200 cfs based on hydraulic analysis.
      ii. Assumed pump station to be located adjacent to seawall.
      iii. Assumed pump station to be enclosed in prefab metal building.
2.) Floodwalls:
   a. Little Bayou Castine western floodwall

i. Assumed T-wall with sill at Elevation 0 to extend from seawall to Elevation 5.
ii. Assumed I-wall for alignment elevations from 5 to 7.3.
iii. Assumed alignment to avoid infringing on private property.
iv. Assumed alignment to cross at 2 pedestrian paths, Lakeshore Drive, and Madison Street.

b. Lakefront Seawall:
i. Assumed complete replacement of existing I-wall seawall.
ii. Assumed complete replacement of Galvez Canal seawall.
iii. Assumed Seawall to extend from North Street tie-in to Little Bayou Castine inlet.

3.) Access Floodgates:
a. Vehicle Roller floodgates
i. Assumed vehicle floodgates at intersection of proposed alignment and streets.
b. Pedestrian Roller Floodgates
i. Assumed pedestrian swing floodgates at intersections of proposed alignment and pedestrian paths.

4.) Control Floodgates:
a. Ravine Aux Coquilles Outlet Floodgate
i. Assumed 20-feet sluicegate.

1.3.8.3 Alternative 9c Mandeville Lakefront – 18 Ft

Alternative 9c would consists of a series of inlet pumps in conjunction with the new seawall at the lakefront in Mandeville, Louisiana. This alternative would include a pump station at Bayou Ravine Aux Coquilles. For the seawall replacement, elevation of 18 feet (NAVD 88) was analyzed. The elevation to provide 1 percent risk reduction (100-year) in future conditions in the year 2082 (planned project completion year 2032) was analyzed. The 1 percent risk reduction would require the new seawall at Elevation 18 feet NAVD 88, according to preliminary MVN ED Hydraulics, Hydrology and Coastal Branch (HH&C) data. Refer to Figure D:1-32, D:1-33, and D:1-34.

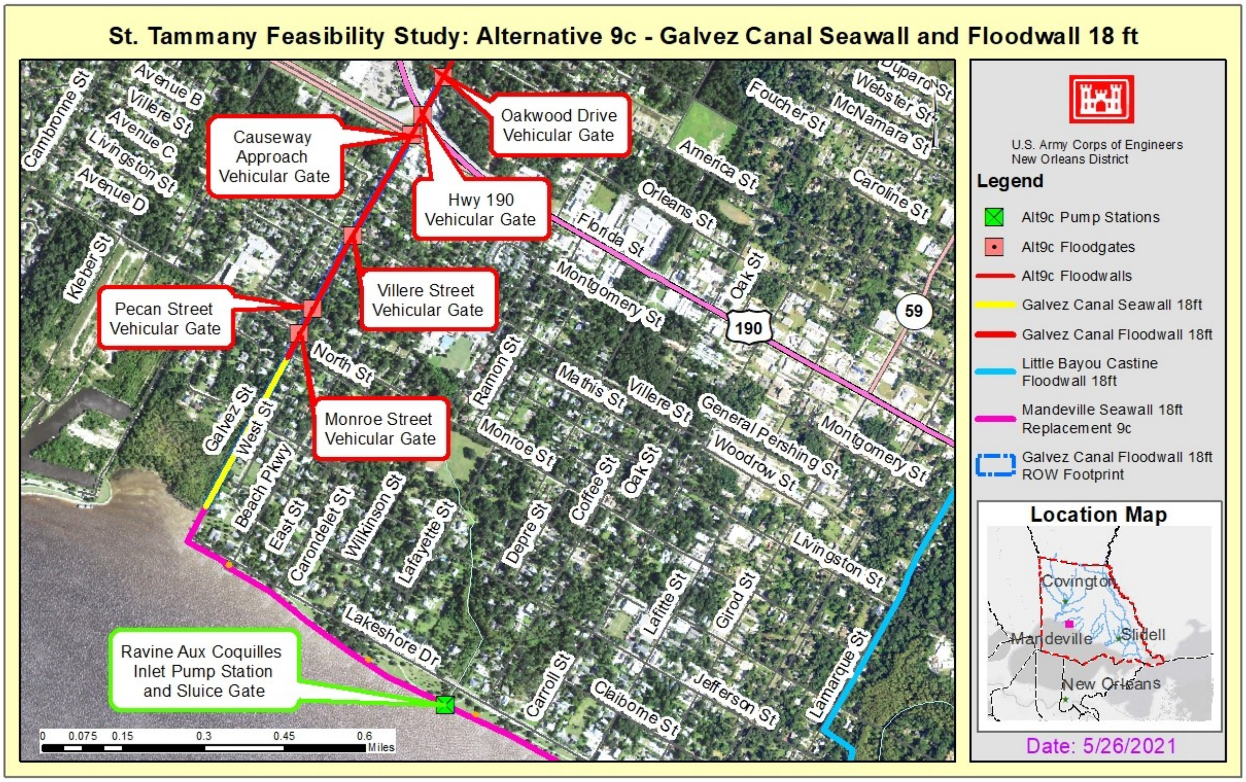


Figure D:1-32 Alternative 9c Galvez Canal Seawall and Floodwall 18 Ft

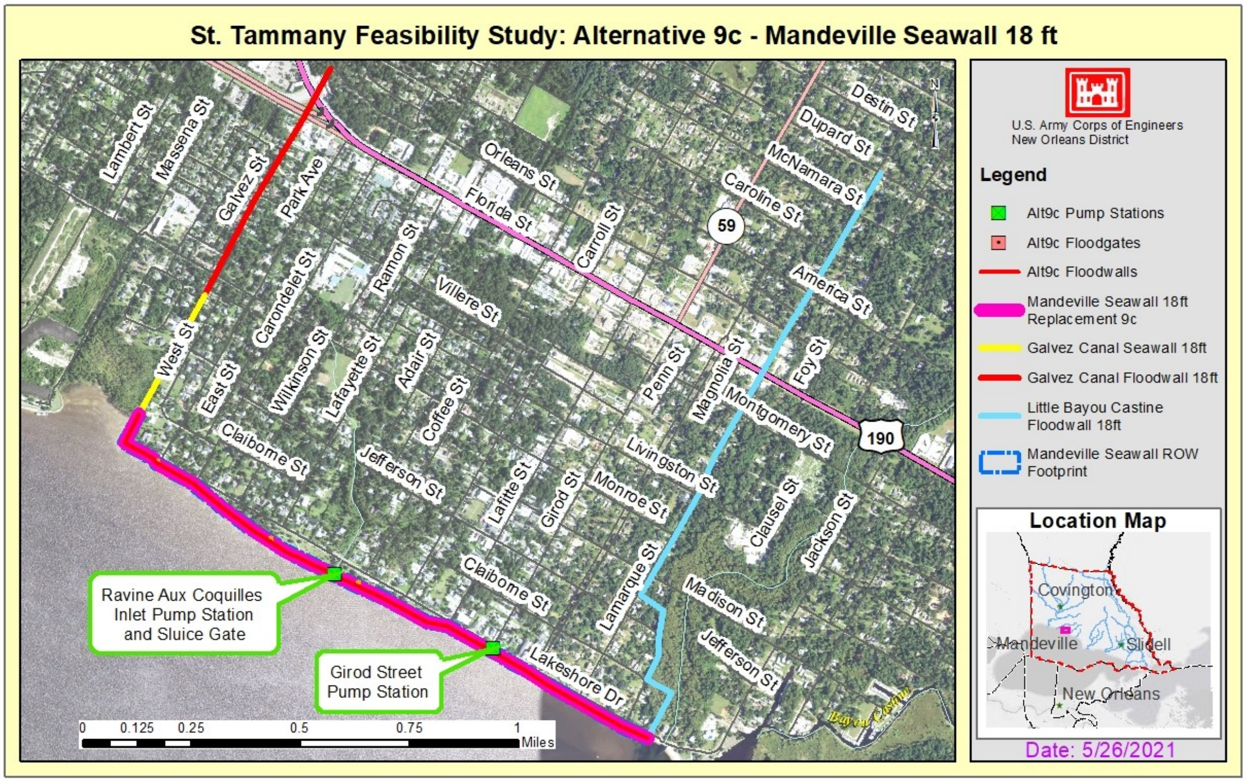


Figure D:1-33 Alternative 9c Mandeville Seawall 18 Ft

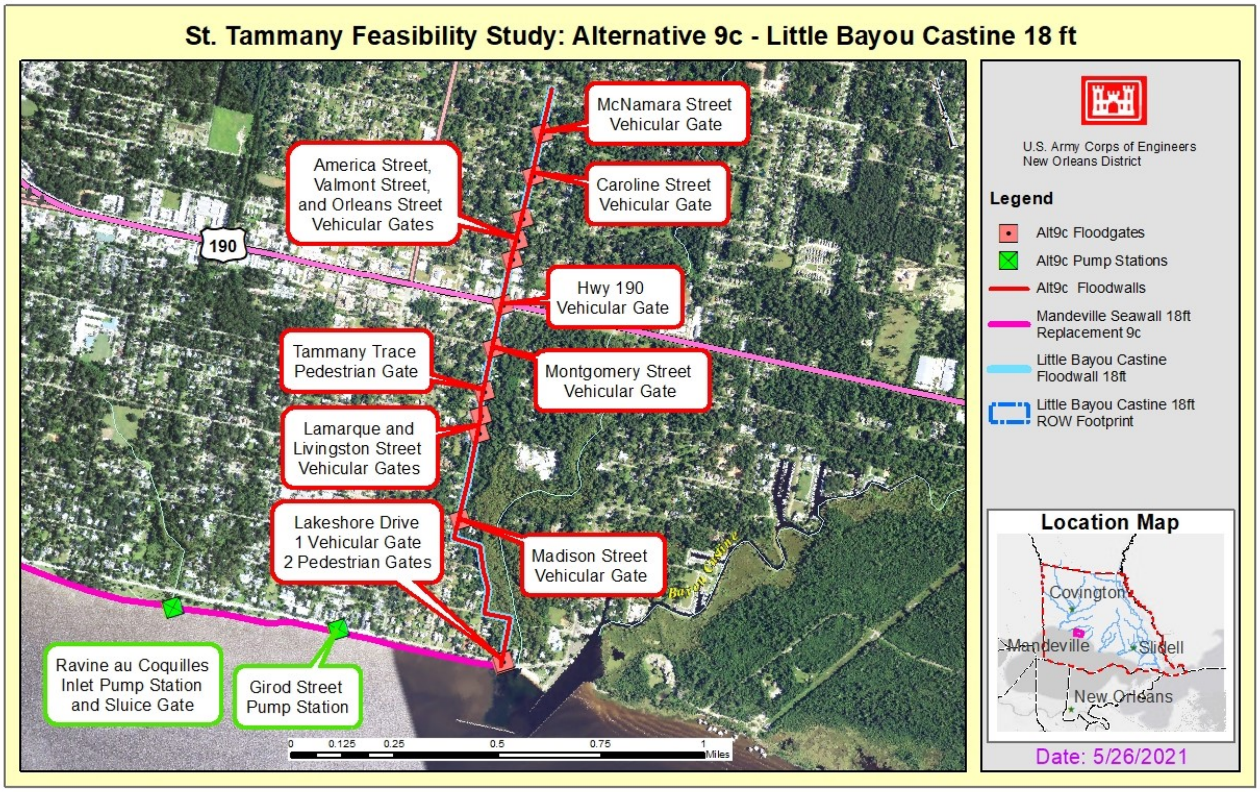


Figure D:1-34 Alternative 9c Little Bayou Castine 18 Ft

Description of Alignment

For Alternative 9c, the seawall would be replaced in its entirety on the same location as the existing seawall. The seawall would run parallel to and on the south side of Lakeshore Drive. On the west side it would continue on the Galvez Canal to North Street, where it would transition into a floodwall. The new floodwall (T-wall) on Galvez Canal would cross the Causeway Approach, where the T-wall would transition into an I-wall and would end at Oakwood Drive. On the east side of Lakeshore Drive, the new seawall would end on the west side of Little Bayou Castine where it would connect to the floodwall on the bayou. This floodwall (T-wall) would run along the Little Bayou Castine, continue on Monroe and Lamarque Streets, and would cross US Highway 190 where it would transition into an I-wall and would end on Dupard and Lamarque Streets.

Floodwall Elevation and Location

The new seawall would be approximately 1.8 miles long (9,600 feet) and would be built to elevation 18 feet NAVD 88. The new floodwall in Galvez Canal would be at elevation 18 feet NAVD 88 and would be 0.5 miles (2,700 feet) long. The new floodwall at Little Bayou Castine would be at Elevation 18 feet NAVD 88 and would be 1.7 miles (9,000 feet) long. The total floodwall length would be approximately 21,000 feet.

Typical Floodwall Section

The typical T-wall section for the seawall would consist of a 30 feet deep steel PZ sheetpile with a concrete cap. The foundation would be pile-founded. The new seawall would impact 10.3 acres of construction area. The typical floodwall at Little Bayou Castine would be a combination of T-wall and I–wall. The floodwall at Galvez Canal would be a combination of a T-wall and I-wall. The existing seawall would be demolished prior to the construction of the new seawall. It was assumed that for the existing seawall the concrete cap is 3 feet by 1.5 feet and the length of the wall is 7,500 feet. The existing vinyl sheetpile at Galvez Canal (length of 2,050 feet) would be demolished and would be replaced with the seawall. The design of the new floodwalls, including the foundation, is subject to change once detailed geotechnical investigations are conducted.

Pump Stations and Floodgates

A pump station would be constructed at the lakefront seawall on Girod Street (preliminary estimated capacity of 450 cfs) with a construction area of 0.009 acres. Assume a 100 feet by 50-feet staging area for seawall within the riverfront park.

A 500 cfs pump station complex with a 20-foot sluicegate would be constructed at Ravine Aux Coquilles at the lakefront (construction area would be 2 acres).

Vehicular Floodgates and Ramps

At Galvez Canal for the 18 feet NAVD 88 floodwall, there would be six 30-feet vehicular floodgates, from south to north: Monroe Street, Pecan Street, Villere Street, East Causeway Approach, LA Highway 190, and Oakwood Drive.

At Little Bayou Castine, there would 11 vehicular floodgates and 3 pedestrian floodgates, starting from south to north as follows:

- 10-foot Lakefront Drive Pedestrian Floodgate #1,
- 75-foot Lakeshore Drive,
- 10-foot Lakeshore Drive Pedestrian Floodgate #2,
- 30-foot Madison Street,
- 30 feet Livingston Street,
- 30-foot Lamarque Street,
- 30-foot Tammany Trace Pedestrian Floodgate,
- 30-foot Montgomery Street,
- 60-foot US Highway 190/Florida Street,
- 30-feet Orleans Street,
- 30-foot Valmont Street,
- 30-foot America Street,
- 30-foot Caroline Street, and

- 30-foot McNamara Street.

There would be designated staging areas adjacent to the construction areas for all floodgates. Note that on the north side of US Highway 190, there would be floodgates at alternate street crossings to reduce the total number of floodgates. This plan means that Orleans Street and Caroline Street would not cross the floodwall and two additional floodgates may be needed. Note that for Alternative 9c there would be no pump station or floodgate at Little Bayou Castine as the risk reduction would end on the west side of this bayou. There would be no floodwalls in the interior of Ravine Aux Coquilles for this alternative.

Structural Assumptions for Alternative 9c

1.) Pump Stations:
   a. Ravine Aux Coquilles Pump Station
      i. Assumed 500 cfs based on hydraulic analysis.
      ii. Assumed pump station to be located at outlet of Ravine Aux Coquilles.
      iii. Assumed pump station to be enclosed in prefab metal building.
   b. Girod Street Pump Station
      i. Assumed 400 cfs based on hydraulic analysis.
      ii. Assumed pump station to be located adjacent to seawall.
      iii. Assumed pump station to be enclosed in prefab metal building.
2.) Floodwalls:
   a. Little Bayou Castine western floodwall
      i. Assumed T-wall with sill at Elevation 0 to extend from seawall to Elevation 15.
      ii. Assumed I-wall for alignment elevations from 15 to 18.
      iii. Assumed alignment to avoid infringing on private property.
      iv. Assumed alignment to cross at two pedestrian paths, Lakeshore Drive, Madison Street and all streets and pedestrian paths up Lamarque Street to and excluding Dupard Street.
   b. Lakefront Seawall
      i. Assumed complete replacement of existing I-wall seawall.
      ii. Assumed complete replacement of Galvez Canal seawall.
      iii. Assumed Seawall to extend from North Street tie-in to Little Bayou Castine inlet.
   c. Galvez Canal seawall extension
      i. Assumed T-wall with sill at Elevation 0 to extend from seawall to Elevation 15.
      ii. Assumed I-wall for alignment elevations from 15 to 18.
      iii. Assumed alignment to cross all streets along Galvez street across US Highway 190 to dead-end at Oakwood Drive.

3.) Access Floodgates:
   a. Vehicle Floodgates
      i. Assumed vehicle roller floodgates at intersection of proposed alignment and streets.
   b. Pedestrian Roller Floodgates
      i. Assumed pedestrian swing floodgates at intersections of proposed alignment and pedestrian paths.

4.) Control Floodgates:
   a. Ravine Aux Coquilles Outlet Floodgate
      i. Assumed 20 feet sluicegate.

Section 2

General Assumptions for Levees for Final Array

The levee cross sections for all alternatives of the final array were estimated using engineering judgement based on the limited data available during this study. Throughout this document, they will be referred as "levees." The study designs utilize the Hurricane and Storm Damage Risk Reduction System (HSDRRS) standards, the latest USACE guidance documents (e.g. Engineering Manuals, Engineering Circulars, etc.), as well as updated hydraulic modeling techniques as applicable and appropriate for the features presented herein.

The HSDRRS Guidelines may be found at:

https://www.mvn.usace.army.mil/Missions/Engineering/Hurricane-Design-Guidelines/Hurricane-Design-Guidelines/

The levee crown elevation would vary from Elevation +10 to +15 throughout. Final elevations were determined through hydraulic analysis. The design levee section would be 10-feet crown width and 1V:3H slopes for all levees. Due to the lack of survey and geotechnical data at the time of the proposed design, a 30 percent contingency was added to the levee quantities. The width of the proposed levee at the toes would vary up to 100 feet. With the addition of a clear zone width of 15 feet on each side, the width of the levee footprint would be a maximum 130 feet. Allowing for 10 feet on each side for access, a 150 feet ROW for the levee construction and maintenance would be needed. Levee reaches that require berms will need a wider footprint to include the necessary area for berm construction. A berm section was not included at this phase and project width is subject to change once engineering data is available and analysis is complete. The alignment of the various levee alternatives is subject to change for various reasons ranging from obtaining ROW to potential environmental concerns.

Section 3

General Assumptions for Structures for Final Array

The analysis comprises scoping level engineering estimates for the 1 percent future (year 2082) hydraulic design elevation for each structure with an additional 2 feet of structural superiority added to the computed design elevations.

For additional information on the pump station assumptions, refer to USACE West Shore Lake Pontchartrain, refer to:

https://www.mvn.usace.army.mil/About/Projects/BBA-2018/West-Shore-Lake-Pontchartrain/

Section 4
Relocations for Final Array

4.1 GENERAL

The Fifth Amendment to the Constitution of the United States provides for compensation to be paid for the acquisition of private property for public use. This acquisition of an interest in real estate is necessary for the Federal Government to subordinate such interest in real estate. In publicly owned roads and utility systems, the Federal Courts have held that the liability of the United States for such acquisition is the cost of providing substitute facilities where substitute facilities are, in fact, necessary. This is the basis of the facility and utility relocation process. Therefore, it was incumbent that an investigation of the existing public utilities and facilities located within the study area of the alternatives of the final array be conducted, while accounting for the current design requirements for the TSP. In the event of a facility, utility, cemetery, or town would affect the construction, operation, maintenance, repair, replacement or rehabilitation of a USACE project or study, then the appropriate disposition of the impacted facility must be determined. Some facilities may require either a permanent or temporary physical adjustment or displacement to support project activities, engineering requirements, and operation and maintenance needs.

Investigating, identifying, and verifying public facilities and utilities located for the final array within the study area was performed. Database research included the National Pipeline Database, State Online Natural Resources Information System (SONRIS), Louisiana Department of Natural Resources (LADNR), HIS, Inc. dataset, Penwell and the National Pipeline Mapping System (NPMS) data. Based on the research and investigations conducted as part of the study effort, multiple facilities or utilities located within the study area of the alternatives for the final array would be expected to be impacted. Refer to Annex 2 for maps of the various utilities in the study area of each alternative of the final array.

4.2 METHODOLOGY

A review of multiple pipeline databases was used to investigate the facilities located within the study area for the alternatives of the final array. A site visit was not performed. The facilities that could be potentially impacted by the alternatives of the final array were the pipelines, overhead electrical transmission lines, and electrical distribution lines shown in Annex 2.

The impacts on the pipelines were based on the assumption the Hurricane and Storm Damage Risk Reduction System (HSDRRS) Design Guidelines, dated February 2012, which describes the following as acceptable methods of pipeline crossing: directional drilling, structural elevated support, T-wall construction and direct contact, would be used. It was decided to use the T-wall and direct contact methods (up and over) for this study.

With the direct contact method (up and over), the pipeline owner has the option of placing the pipeline in direct contact with the surface of the newly constructed levee. This would require the owner to relocate the pipeline when the levee is raised because of settlement or change in design grade. The owners must also determine that the pipeline can sustain the settlement and resulting stresses that are associated with it. Slope pavement or other approved armoring methods must be installed over the pipeline throughout the transition area. This method was assumed for single or dual pipelines that have enough space to bypass or re-route up-and-over the new levee design section.

If applicable, the T-wall construction method focuses on passing the pipeline through the T-wall, with the existing pipeline remaining in place. This method consists of constructing a pile-founded, inverted T-wall flanked by a sheet pile wall on either side to provide seepage reduction for flood control. The T-wall is built around the in-situ pipeline. This method is more conducive for pipelines that are approximately 20 feet or less apart and are unable to bypass their right-of-way on a temporary basis.

Electric Transmission Lines were assumed to meet the minimum clearance criteria over the proposed levee crossings, which is 22 feet at 50 kV, plus 0.4 inches for every 1.0 kV above 50 kV.

4.3 RAILROAD CONSIDERATIONS

A key preliminary assumption is that when a feature crosses or impacts a railroad (RR), in some instances there are communications lines and/or electrical lines that service the RR within the RR ROW. These lines can be used for the RR signal lights or track switches. There are also cases where utilities such as underground water or sewer lines run under the RR to service nearby buildings. Another preliminary assumption is that all utilities servicing the Delwood Pump Station do not run under the RR, so there could be communication lines or electric lines near the Norfolk Southern Railway Corp. railroad tracks. Further refinement of the utility investigation will be needed.

4.4 CONSIDERATIONS FOR THE UTILITY CORRIDOR

CLECO Corporate Holdings, LLC has right-of-way use requirements pertaining to USACE work around their existing utility lines on the northeast corner of the floodwall alignment that would have to be met to provide clearance for construction activities (i.e. pile driving).

4.5 RESULTS

Relocation costs for the final array are provided in Table D:4-1. The results of the facility relocations investigations shown in Tables D:4-2 through D:4-5, which includes a description of the only facilities located within the study area for the respective alternatives of the final array. Refer to Annex 5 Cost Engineering for additional cost information.Table D:4-1. Relocation Costs for Final Array

Alternative	Relocations Cost- 2020 Dollars (Includes 28% contingency)
4a	$25,860,000
4a.1	$18,302,000
4b	$13,323,000
5	$933,000
6a	$16,000
6b	$16,000
6c	$887,000

Table D:4-2. Alternative 4a - Bayou Lacombe Levee

Utility Owner	Utility Type	Method of Relocation
Kinder Morgan	Natural Gas 26-inch pipeline	Up and Over Pipeline Relocation
Kinder Morgan	Natural Gas 24-inch pipeline	Up and Over Pipeline Relocation
Kinder Morgan	Natural Gas 20-inch pipeline	Up and Over Pipeline Relocation
Southern Natural Gas	Natural Gas 20-inch pipeline	Up and Over Pipeline Relocation
Southern Natural Gas	Natural Gas 24-inch pipeline	Up and Over Pipeline Relocation
Ferrier Estates Street	12 ft. Roadway w/ distribution power poles & lines, 6-inch waterline, 6-inch sewerline on one side	Up and Over Roadway Relocation
Monique Street	12 ft. Roadway w/ distribution power poles & lines, 6-inch waterline, 6-inch sewerline on one side	Up and Over Roadway Relocation
Dalmas Street	12 ft. Roadway w/ distribution power poles & lines, 6-inch waterline, 6-inch sewerline on one side	Up and Over Roadway Relocation
Pontchartrain Drive #1	12 ft. Roadway w/ distribution power poles & lines, 6-inch waterline, 6-inch sewerline on one side	Up and Over Roadway Relocation
24th Street	12 ft. Roadway w/ distribution power poles & lines, 6-inch waterline, 6-inch sewerline on one side	Up and Over Roadway Relocation
Pontchartrain Drive #2	12 ft. Roadway w/ distribution power poles & lines, 6-inch waterline, 6-inch sewerline on one side	Up and Over Roadway Relocation
Barringer Road #1	12 ft. Roadway w/ distribution power poles & lines, 6-inch waterline, 6-inch sewerline on one side	Up and Over Roadway Relocation
Barringer Road #2	12 ft. Roadway w/ distribution power poles & lines, 6-inch waterline, 6-inch sewerline on one side	Up and Over Roadway Relocation
Barringer Road #3	12 ft. Roadway w/ distribution power poles & lines, 6-inch waterline, 6-inch sewerline on one side	Up and Over Roadway Relocation
Barringer Road #4	12 ft. Roadway w/ distribution power poles & lines, 6-inch waterline, 6-inch sewerline on one side	Up and Over Roadway Relocation
Lake Road/LA Highway 434	12 ft. Roadway w/ 4 ft. shoulders w/ Distribution powerlines, 6-inch waterline, 6 - inch sewerline on one side	Up and Over Roadway Relocation

Assumptions for Table D:4-2:

- Assumed that proposed protection would be 10-foot wide levee crown, side slopes 1V:3H and Elevation 12.5 feet.
- 500 feet of each utility would be affected by the alternative. To be finalized once USACE meets with utility owner during PED.

Table D:4-3. Alternative 4b - Combined Levee from Lacombe to West Slidell

Utility Owner	Utility Type	Method of Relocation	Proposed Effective Length of Utility
Kinder Morgan	Natural Gas 26-inch pipeline	Up and Over Pipeline Relocation	500 ft
Kinder Morgan	Natural Gas 24-inch pipeline	Up and Over Pipeline Relocation	500 ft
Kinder Morgan	Natural Gas 20-inch pipeline	Up and Over Pipeline Relocation	500 ft
Southern Natural Gas	Natural Gas 20-inch pipeline	Up and Over Pipeline Relocation	500 ft
Southern Natural Gas	Natural Gas 24-inch pipeline	Up and Over Pipeline Relocation	500 ft
ExxonMobil	Natural Gas 16-inch pipeline	Up and Over Pipeline Relocation	500 ft
Pontchartrain Drive #2	12 ft. Roadway w/ distribution power poles & lines, 6-inch waterline, 6-inch sewerline on one side	Up and Over Roadway Relocation	1,500 ft
Barringer Road #1	12 ft. Roadway w/ distribution power poles & lines, 6-inch waterline, 6-inch sewerline on one side	Up and Over Roadway Relocation	1,500 ft
Barringer Road #2	12 ft. Roadway w/ distribution power poles & lines, 6-inch waterline, 6-inch sewerline on one side	Up and Over Roadway Relocation	1,500 ft
Lake Road/LA Highway 434	12 ft. Roadway w/ 4 ft. shoulders w/ Distribution powerlines, 6-inch waterline, 6 - inch sewerline on one side	Up and Over Roadway Relocation	1,500 ft

Assumption for Table D:4-3:

- Assumed that the levee would have a 10-foot wide crown, side slopes 1V:3H and crown elevation of 12.5 feet.

Table D:4-4. Alternative 5 - Bayou Liberty/ Bayou Vincent/ Bayou Bonfouca

Utility Owner	Type/Size of Utility	Method of Relocation	Proposed Effective Length of Utility
ExxonMobil	Natural Gas 16-inch pipeline	Up and Over Pipeline Relocation (Levee)	500 ft
Boardwalk	Natural Gas 6-inch pipeline	Pipeline Protection (Clear and Snag Bayou Liberty Channel)	
Boardwalk	Natural Gas 6-inch pipeline	Pipeline Protection (Excavation on Either Side of Pipelines)	
Boardwalk	Natural Gas 6-inch pipeline (assumed)	Pipeline Protection (Excavation on Either Side of Pipelines)	

Assumption for Table D:4-4:

- Assumed that the levee would have a 10-foot wide levee crown, side slopes 1V:3H and Elevation 12.5 feet.

Table D:4-5. Alternative 6- South Slidell Levee

Utility Owner	Type/Size of Utility	Method of Relocation
CLECO Corporate Holdings, LLC	Transmission Lines - 240KV	De-energizing Powerlines

Assumption for Table D:4-5:

- Assumed that levee would have a 10-foot wide levee crown, side slopes 1V:3H and Elevation 12.5 feet.

4.6 PIPELINE OWNERS

There are multiple pipelines within the study area of the alternatives mentioned previously. These pipelines cross access corridors or run parallel to the proposed features and their alignments. Refer to Tables D:4-2 through D:4-5, as well as Annex 2 for more information.

4.7 CONCLUSIONS

Based on the preliminary findings of the relocations investigation, it was determined that the existing pipelines within the area of the alternatives of the final array would be impacted, either requiring relocation of the utilities affected, or requiring pipeline protection over the affected utilities during construction. In such situations, USACE would incorporate the relocations process towards compensability and coordinate with utility owners throughout the design and development of the plans and specifications during preconstruction, engineering and design (PED).

Section 5
Geotechnical Investigations for Final Array

5.1 BACKGROUND

This section summarizes the limited data available from the preliminary geotechnical design results for the final alternatives. The amount of geotechnical investigations, associated testing, and geologic profiles was limited. Soil borings were not collected, and soil testing was not performed for this study. Soil unit weights and shear strengths were assigned based on USACE geotechnical experience in the region and limited soil boring information. The results presented in this Appendix are only intended for feasibility-level cost estimating purposes and to support determining the technical feasibility of the alternatives of the final array.

Earthwork stability analyses, settlement, and time-rate of settlement curves were performed on levee features of the various measures and used for elimination of alternatives in the selection of a TSP. Pile capacity analyses and Lane's weighted creep analyses were performed on structural features of the various measures to assist in quantity estimates for structural pile and sheet pile lengths in the final array. The process began with a review of existing soil information. Information was limited and often not on the proposed alignment given in the different alternatives. Boring locations were plotted on a map to find proximities and ascertain which borings could be utilized on which features. Refer to Annex 3.

5.2 FURNISHED INFORMATION AND SOIL DESIGN

USACE has very limited geotechnical data information on the study area. Geotechnical reports from investigations previously performed by Eustis Engineering, LLC (Eustis) for the NFS in St. Tammany Parish were obtained. Existing boring information was taken and plotted in Google Earth software. Borings of appropriate depth were considered. The closest available geotechnical investigations were used to develop parameters. Levees were not broken into individual geotechnical reaches and rather analyzed as one reach. Geotechnical information from Eustis that was the most appropriate was used to get soil information for development of parameters. Parameters were utilized throughout the entire length of the measure of the final array (levee or structural features).

Future analyses should take site specific information and a more refined parameter selection process should be developed. This could result in more geotechnical reaches needing more analyses within an individual levee measure in a feasibility phase. The levee alignments for several alternatives are many miles long, so a levee feature may have multiple reaches requiring checks instead of one per feature as done for the selection of the TSP. The lack of geotechnical information and the number of assumptions required as a result are noted in the risk register developed for the study. Alternatives that have features requiring geotechnical input are provided below. The Eustis job number, boring information including number and depth, proximity to feature, and assumptions are set forth below.

Alternative 4: Lacombe

The borings from Eustis Job No. 09318 were used for the alternatives 4a, 4a.1, and for the western portion of Alternative 4b up to Bayou Paquet Floodgate No. 1. The closest borings to the Bayou Lacombe alignment are two 40-foot borings taken at the Mandeville Marina as part of Eustis Job No. 09318. This boring is 4.75 miles away from the westernmost section of the Bayou Lacombe alignment and is used for the entirety of the Bayou Lacombe alignment. The closest boring to the Bayou Lacombe floodgate is an 80-foot boring taken at Delwood Pump Station as part of Eustis Job No. 13965. This boring is 3.7 miles away.

Alternative 5: Bayou Liberty/Bayou Vincent/Bayou Bonfouca

The borings from Eustis Job No. 13965 were used for the Alternative 4b on the eastern side of the Bayou Paquet Floodgate No. 1, and for Alternative 5. The closest boring is an 80-foot boring taken at Delwood Pump Station as part of Eustis Job No. 13965. This boring is right at the western terminus of the alignment and is utilized for the entire alignment. The same Delwood Pump Station boring was utilized for all the structural features along the West Slidell alignment. The 80-foot boring taken at Delwood Pump Station boring is closest to the West Slidell sluicegate at about 1 mile away. It is about 2.3 miles away from the Bayou Bonfouca floodgate, about 3.3 miles from the Bayou Liberty area, and about 4 miles from the Bayou Paquet area. No parameters were developed for channel improvements or detention ponds for this stage of the final array.

Alternative 6: South Slidell Storm Surge

The borings listed below were used for alternatives 6a, 6b, and 6c. There are several geotechnical investigations in the Slidell area and three different Eustis jobs were used for three different levee sections: one for Alternative 6b (Eden Isle alignment), one for the Alternative 6a (Lakeshore Estates existing ring levee), and one for Alternative 6 (Oak Harbor existing ring levee). The closest boring to Alternative 6 b (Eden Isle alignment) is 80 feet boring taken at the St Tammany Event Center project as part of Eustis Job No. 16613. This boring is 0.75 miles away from the eastern side of the Eden Isle alignment. The closest boring to the Oak Harbor existing levee alignment is the 80-foot boring taken 0.20 miles away at the Eden Isle expansion project as part of Eustis Job No. 10120. It should be noted that this is closer to the Slidell levee alignment than the Alternative 6 b (Eden Isle levee alignment) as currently laid out. The two levee sections had the same overlapping alignment just north of Alternative 6 b (Eden Isle alignment) for the Eustis project versus this study. The Oak Harbor borings are taken from Eustis Job No. 11044 and make up the southeastern portion of the Oak Harbor alignment for Alternative 6a. There are 9 borings in total that are 40 to 45 feet in depth (the Eden Isle alignment was modified after the above analysis was completed).

There are seven main structural features in four areas: South Slidell Surge reduction on the western side, the W-14 floodgate to the east, the I-10 floodgates to the southeast, and the Eden Isle sections to the south. The same boring at Delwood Pump Station as part of Eustis Job No. 13965 was utilized for the South Slidell Surge reduction wall pile capacities. It is closer to this feature than the Lacombe/ West Slidell wall features. The boring is approximately 60 feet from the alignment's southern end. The W-14 floodgate and Old Spanish Trail floodgate and any unmarked walls in their vicinity utilized the Oak Harbor pump station borings from Eustis Job No. 10463. This has borings ranging from 40 to 100 feet. The geotechnical investigations from Oak Harbor are 1.7 miles away from Old Spanish Trail floodgate and 1.9 miles away from W-14 floodgate.

The I-10 access floodgates and the Eden Isle measures including the Oak Harbor Marina floodgate utilize the St. Tammany Event Center (Event Center) borings which are 60 feet and taken from Eustis Job No. 16613. Deeper than 60 feet use the Oak Harbor geotechnical investigation information to inform on pile capacities. The Event Center boring is approximately 3,500 feet from the I-10 floodgates, 1.5 miles from the Oak Harbor Marina floodgate and Lakeshore Drive floodgate and 2.8 miles from the Pontchartrain Drive floodgate. This is just as close as the Eden Isle borings in Eustis Job No. 10120 and run 10 feet deeper, so the decision was made to utilize the Event Center boring (the alignment in the vicinity of the I-10 was modified after the above analysis was completed).

Alternative 7: Eastern Slidell

The borings listed below were used for Alternative 7. The closest borings are four 40 feet boring taken at Slidell Memorial Hospital as part of Eustis Job No. 13418. These borings are 4 miles away from the southern terminus of the Pearl River levee alignment and are utilized for the entire 4.8 miles. There are four floodwall sections for a total of 0.5 miles (2,750 feet) for this alternative along the Pearl River alignment. The same Slidell Memorial Hospital borings from Eustis Job No. 13418 are also used for structural analyses. No parameters were developed for channel improvements or diversion channel for this stage of the final array.

Alternative 9: Mandeville Lakefront

Alternative 9a replaces the existing lakefront seawall to Elevation 7.3 feet NAVD 88 and adds a passive drainage option on Bayou Ravine Aux Coquilles and Little Castine Bayou. Sub-alternatives include pump stations at Girod Street and Ravine Aux Coquilles. Eustis Job No. 12464 geotechnical report contains a bulkhead design for three reaches of the Mandeville Seawall. The Eustis report was directly used for this alternative of the final array.

5.3 METHODOLOGY AND ASSUMPTIONS

The HSDRRS design criteria were used as a reference to direct design criteria for the final array but was not fully utilized. The scope of this study does not include all cases required by the HSDRRS guidelines for a full hurricane damage risk reduction analysis. The scope of this study only includes an evaluation of the Q-case (i.e., undrained) parameters for the top of levee for the 2032 design elevation and low water cases. Still water level, construction grade, and project grade should be considered once a TSP is chosen. Also, the S-case (i.e. drained) analysis should be completed on the chosen TSP option.

For structural features, HSDRRS criteria was followed to create pile capacity curves for HP12x73 and HP14x74 H-piles. These were used to help inform on pile lengths for quantity estimates in the final array. Lane's weighted creep analyses were performed assuming water loads to the top of the wall for 2082 design elevations. These were used to help inform on sheet pile lengths for quantity estimates in the final array.

5.3.1 Design Information

A simple levee section was analyzed on the different alternatives for stability and settlement. For stability, a 10-feet crown with 1V:3H slopes were analyzed to check stability for a minimum levee section. Stability was checked at the highest 2032 design elevation along a given levee alignment. With more site-specific data, and a full HSDRRS analysis, the levee as designed here may no longer be feasible and stability berms, reinforcement geotextile, or deep-soil mixing may be necessary to meet HSDRRS criteria.

For settlement, a 10-feet crown with 1V:4H slopes were analyzed to give a heavier loading for a simple levee section. Settlement was checked on an overbuild section that was 2.5 feet above the 2032 design elevation and plotted on a 50-year gradient line with 2032 to 2082 design elevations.

Test results taken from the borings found in the Eustis reports mentioned in section 1.15.1 were used to create parameters for stability analysis. This test information can be found in Annex 3, Section 2. No settlement test data was available, so correlations were utilized from the test data. Design parameters used in stability analyses can be found in Annex 3, Section 3. Design parameters used in settlement analyses can be found in Annex 3, Section 3.

5.3.2 Stability Analysis

The stability of the earthen levees was analyzed in SLOPE/W version 10.0.0.17401 from the Geostudio Suite of programs used the Spencer method to determine typical cross sections to be used in the cost estimate. Entry-exit searches with tension cracks applied to the driving side were checked for water at the top of the levee and low water at the ground surface. A more complete HSDRRS design check will be conducted during feasibility level design. The stability results for these levee sections is set forth in Table D:5-1.

Table D:5-1. Stability Results for Levee Sections for Alternatives of the Final Array

Alternative	Feature	2032 Design Elevation Analyzed	Top of Levee Factor of Safety	Low Water Factor of Safety
4	Bayou Lacombe	+12.5	3.68	3.69
5	West Slidell Levee Section	+14.5	1.75	1.81
6	South Slidell Levee Section	+15.0	2.33	2.35
6b	Eden Isle Levee	+14.0	1.87	2.49
6	Oak Harbor Levee	+13.5	2.58	2.57
7	Pearl River Levee	+15.0	2.09	1.57

5.3.3 Settlement Analysis

Settle3D Version 4.013 by Rocscience Inc., was used for the settlement analysis for the levee sections. Embankment sections with a 10-feet crown with 1V:4H slopes (preliminary) were used to model the loading on the soil. No settlement test data was available, so correlations were utilized from the test data. Soil was assumed to be normally consolidated with an over consolidation ratio, OCR=1 and a Cv value of 25 for clays unless an LL value was available to correlate to graph. The time-rate of settlement curves were created with a family of settlement curves based on USACE experience with soft soils in southeastern Louisiana. Time-rate of settlement curves were created for each levee feature except for Pearl River levee for which only settlement was calculated.

Alternative 4: Lacombe

The preliminary design elevation is 12.5 feet NAVD 88 for the new levee. A general new levee section of 15 feet (2.5 feet above the 2032 design elevation) with an assumed ground surface of 3 (taken from LIDAR dataset), 1 on 4 slopes and a 10-foot crown was used as a cross section in the initial lift in 2032. The second lift is estimated to elevation +16.0 in 2035 followed by a lift to elevation +16.5 in 2040, elevation +17.0 in 2053, and elevation +17.5 in 2068.

Alternative 5: Bayou Liberty/Bayou Vincent/Bayou Bonfouca

The west Slidell levee section has two different 2032 design elevations. The preliminary design elevation is 13.0 feet NAVD 88 for the eastern and western sections and 14.5 feet NAVD 88 for the central section. A general levee section of 15.5 feet for the Slidell Eastern and Western section and 17 for the central section with an assumed ground surface of 2 for all of the Slidell Levee (taken from LIDAR dataset), 1 on 4 slopes and a 10 feet crown was used as a cross section in the initial lift in 2032. Eastern and Western sections have three successive lifts afterwards: elevation +16.5 in 2039, elevation +17.5 in 2057, and elevation +18 in 2068. Central section has three successive lifts also: elevation +18.0 in 2037, elevation +19.0 in 2050, and elevation +20 in 2065.

Alternative 6: South Slidell Storm Surge

This alternative has three different new alignments: South Slidell alignment, the Eden Isle, and the Oak Harbor levees. There are four different preliminary design elevations between them (the Eden Isle alignment was modified after this analysis was completed).

The preliminary design elevation for the new South Slidell levee section is 15.0 feet NAVD88 for the levee. A general levee section of +17.5 feet (2.5 feet above the 2032 design elevation) with an assumed ground surface of 0 (taken from LIDAR dataset), 1 on 4 slopes and a 10-feet crown was used as a cross section in the initial lift in 2032. The second lift is estimated to Elevation +18.5 in 2038 followed by a lift to Elevation +19.5 in 2051, and Elevation +20.5 in 2067.

The Eden Isle levee section has two different 2032 design elevations. The preliminary design elevation is +13.5 feet NAVD88 for the southeastern sections and 14.0 feet NAVD88 for the Eastern section. A general levee section of +16.0 feet for the southeastern section and +16.5 feet for the central section with an assumed ground surface of 5 for all of the Slidell Levee (taken from LIDAR dataset), 1 on 4 slopes and a 10-feet crown was used as a cross section in the initial lift in 2032. The southeastern section has five successive lifts afterwards: Elevation +17.5 in 2037, Elevation +19.0 in 2047, Elevation +20.5 in 2057, Elevation +22 in 2067, and Elevation +23 in 2075. The eastern section has three successive lifts: Elevation +17.5 in 2042, Elevation +18.5 in 2057, and Elevation +19 in 2072.

The preliminary design elevation for the Oak Harbor levee section is 13.5 feet NAVD88 for the levee. A general levee section of +16.0 feet (2.5 feet above the 2032 design elevation) with an assumed ground surface of 0 (taken from LIDAR dataset), 1 on 4 slopes and a 10-feet crown was used as a cross section in the initial lift in 2032. The second lift is estimated to Elevation +17.0 in 2037 followed by a lift to Elevation +18.0 in 2047, a lift to Elevation +19.0 in 2062, and Elevation +19.0 in 2077.

The Eden Isle alignment was changed from levee to floodwall subsequent to this analysis.

Alternative 7: Eastern Slidell

The preliminary design elevation for the Pearl River levee section is 15.0 feet NAVD88 for the levee. A general levee section of +17.0 feet (2.0 feet above the 2032 design elevation) with an assumed ground surface of 0 (taken from LIDAR dataset), 1 on 4 slopes and a 10-feet crown were used as a cross section in the initial lift in 2032. No lift was estimated to stay above the design grade in the future.

5.3.4 H-Piles and Sheet Piles

Pile capacities were performed on HP12x73 and HP14x74 H-piles for quantity estimates for the final array. A proprietary spreadsheet was used to calculate pile capacities. Densities were derived from the material tests from the individual Eustis reports.

Alternative 4: Lacombe

The preliminary design elevation for the Bayou Lacombe floodgate is 14.5 feet NAVD88. Soil properties such as unit weight, cohesion, and material type were taken from the boring at Delwood Pump Station and used for analyses. Pile capacity analyses and Lane's Weighted Creep Analysis were performed to help inform on pile lengths for quantity estimates in the final array. Sheet Pile length was recommended to be 35 feet.

Alternative 5: Bayou Liberty/Bayou Vincent/Bayou Bonfouca

The preliminary design elevation for the Bayou Paquet floodgate and the floodwall is 14.5 feet NAVD88. The preliminary design for the Bayou Paquet and liberty floodwall is 16 feet NAVD88. The preliminary design for Bayou Liberty is 17 feet NAVD88. The preliminary design for Bayou Bonfouca was 16.5 NAVD88. All these structural features also utilized the boring from Delwood Pump Station for soil properties such as unit weight, cohesion, and material type. Pile Capacity analyses and Lane's weighted Creep analyses were performed to determine sheet pile lengths and pile lengths for quantity estimates. Sheet pile length was recommended to be 35 feet.

Alternative 6: South Slidell Storm Surge

There are 7 main structural features in four areas: South Slidell Surge reduction on the western side, the W-14 floodgate to the east, the I-10 floodgates to the southeast, and the Eden Isle sections to the south. The preliminary design elevation for the South Slidell surge reduction floodwall is 14.5 feet NAVD88. The two I-10 access floodgates have a design elevation of 16.5 NAVD88. For Eden Isle, the preliminary design elevation of the floodwall varies from 13.5 feet to 21 feet NAVD88 depending on the location. For the Slidell levee, the floodwall elevation would vary from 13.5 feet to 15 feet NAVD88. Soil properties such as unit weight, cohesion, and material type were taken from the borings taken from the previously referenced Eustis geotechnical reports. Pile Capacity analyses and Lane's weighted Creep analyses were performed to determine sheet pile lengths and pile lengths for quantity estimates. A 20 feet sheet pile length is recommended for the South Slidell surge reduction floodwall. The W-14 floodgate is recommended to have a 25 feet length. The Eden Isle I-10 walls are recommended to have 30 feet long sheets. The Eden Isle Marina Floodgate, South, Southwest, and West Structures are recommended to have 35 feet sheets.

Alternative 7: Eastern Slidell

The preliminary design elevation for the structures is 19 feet NAVD88. Soil properties such as unit weight, cohesion, and material type were taken from the boring at Slidell Memorial Hospital and used for analyses. Pile Capacity analyses and Lane's weighted Creep analyses were performed to determine sheet pile lengths and pile lengths for quantity estimates. Pile Capacity curves revealed very limited capacity and were not used to estimate quantities. It is possible that the information used underestimated capacity at the site. Site specific information will be needed to get a more accurate assessment of capacity in the area. A sheet pile length of 35 feet is recommended for the Pearl River floodwall.

5.4 CONCLUSIONS AND RECOMMENDATIONS

Geotechnical Analysis were performed on levee features and structural features on the alternatives that had these features. Geotechnical data was limited. For many features, the closest geotechnical investigations were utilized rather than site specific borings. Also, the number of borings that may have been available for a given feature may have been limited. This resulted in few borings not on the alignment to help inform decisions on the final array. Consequently, analyses made a lot of assumptions to complete preliminary checks. These assumptions were fine for informing as to whether options used in the alternatives were even viable, but as the scope narrows, geotechnical investigations should be completed with associated testing to better inform soil conditions along an alignment.

Section 6
Borrow

The PDT investigated potential borrow sites in the vicinity of the St. Tammany Parish. Through the process 34 sites were identified and screened. See Section 4 of Appendix B for documentation of the identification and evaluation of the borrow sites. ED conducted an evaluation to document the geology and geotechnical information on a subset of the 34 locations in St. Tammany Paris sites to help with the screening process. These five sites are referred to as potential borrow locations STP-1, STP-3, STP-5, STP-6, and STP-9 as discussed in this section. Most of these sites had very little subsurface data to base a geologic description on. For example, confident geologic understanding of the subsurface typically is relied on a combination of geologic profiles, borings, and Cone Penetration Test (CPT) data. More reliable geologic assumptions could be made with additional data consisting of geologic profiles, borings, and CPTs. Potential borrow sites evaluated with respect to geology and geotechnical information for the western side of the study area are shown in Figure D:6-1. Potential borrow sites evaluated with respect to geology and geotechnical information for the northern portion of the study area are shown in Figure D:6-2. In addition to the sites identified in St. Tammany Parish additional sites were identified in Hancock County, MS (MS-1 and MS-2); these sites have previous geologic and geotechnical investigation and are described in Individual Environmental Report #19 Pre-Approved Contractor Furnished Borrow Material Jefferson, Orleans, St. Bernard, Iberville, and Plaquemines Parishes, Louisiana, and Hancock County, Mississippi and Individual Environmental Report # 23 Pre-Approved Contractor Furnished Borrow Material # 2 St. Bernard, St. Charles, Plaquemines Parishes, Louisiana, and Hancock County, Mississippi.

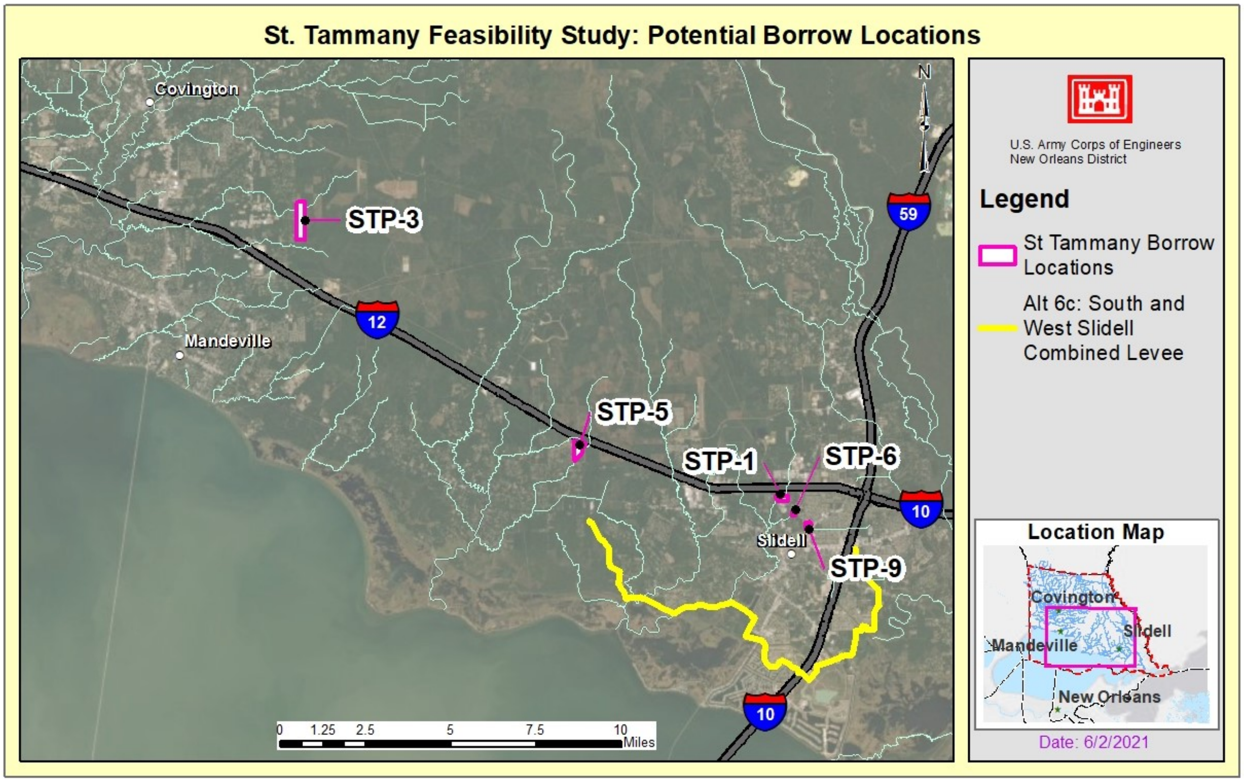


Figure D:6-1 Borrow Locations STP-1, STP-3, STP-5, STP-6, and STP-9

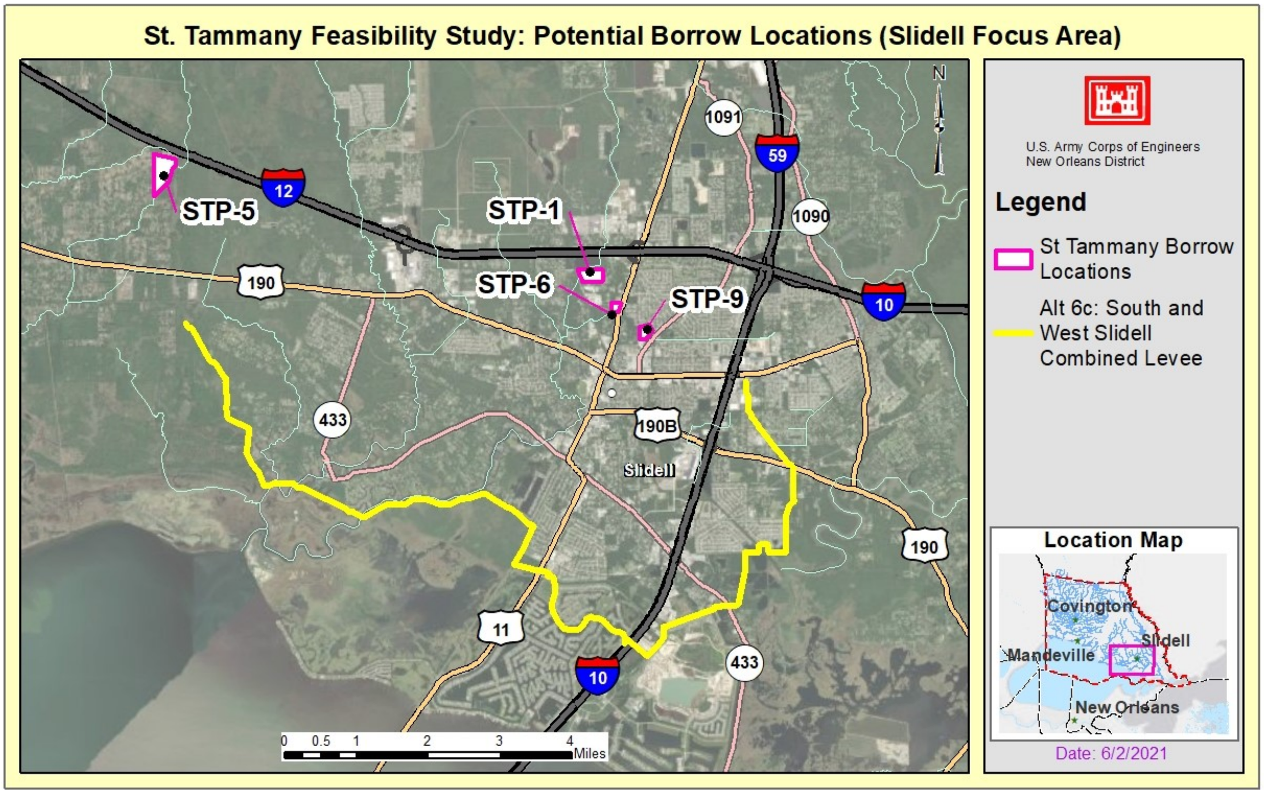


Figure D:6-2. Closer Look at Borrow Locations STP-1, STP-5, STP-6, and STP-9

Potential Borrow Location STP- 1

Geology at Location STP-1 cannot be described precisely as there is no boring, CPT, or geologic profile data at the location to base a description after. A generalization of the location is given based off the closest borings to the location (approximately 0.62 mile away; borings from Location STP- 6). Without any data of the subsurface, accuracy and confidence of subsurface stratigraphy is not high. The top 20 feet of the subsurface is likely to be composed of Pleistocene Prairie Terrace deposits, medium to very stiff lean and fat clay. A 5-feet layer of silt likely exists directly below the ground surface. Location STP- 1 is 33.88 acres and the biggest risk to the area is the complete lack of data to confirm any of the stratigraphy. However, if the assumed geology is correct, it could potentially serve as a viable embankment clay source. As of now, Location STP- 1 is *not actively* being considered due to tree coverage at its surface.

Potential Borrow Location STP- 3

Geology at Location STP- 3 cannot be described precisely as there is no boring, CPT, or geologic profile data at the location to base a description after. A generalization of the location is given based off the closest borings to the location (4 10-ft borings approximately 2.95 miles away). Without any data of the subsurface, accuracy and confidence of subsurface stratigraphy is not high. The top 10 feet of the subsurface is likely to be composed of Pleistocene Prairie Terrace deposits, medium to very stiff lean and fat clay. It is also likely that these Pleistocene Prairie Terrace deposits extend hundreds of feet below the subsurface. Location STP- 3 is 174.91 acres and the biggest risk to the area is the complete lack of data to confirm any of the stratigraphy. However, if the assumed geology is correct, it could potentially serve as a viable embankment clay source. Additionally, the site appears to be covered in trees. Removal of these trees serves as additional costs to the project.

Potential Borrow Location STP- 5

Geology at Location STP- 5 is based on data contributed to by nine borings in the area. These borings show that marsh deposits, depending upon the location, make up the top 2 to 10 feet of the subsurface. These marsh deposits are composed of soft organic clays with some sand layers. Below marsh deposits and in some places at the surface, Pleistocene Prairie Terrace deposits are present. These deposits span at least 40 feet below and are composed of predominantly medium to very stiff clay, however, some borings show an approximately 10-foot thick sand layer around 5-20 feet below the ground surface. Location STP- 5 consists of 72.97 acres and the biggest risk to the area is the 10-feet thick or more sand layer present around 5-20 feet below the ground surface in some areas of Location STP- 5.

Potential Borrow Location STP- 6

Geology at Location STP- 6 is based off two 20-foot borings in the location. These borings show that the top 20 feet of the subsurface is composed of Pleistocene Prairie Terrace deposits, medium to very stiff lean and fat clay. A 5-foot layer of silt exists directly below the ground surface. Location STP- 6 consists of 9.83 acres and serves as the best potential source of borrow material. The biggest risk for Location STP- 6 is that the borings show only 20-feet below the ground surface, so it is unknown exactly what is below this layer.

Potential Borrow Location STP- 9

Geology at Location STP- 9 is based off data contributed to by three borings near the area. Closer to Location STP- 9, borings show that marsh deposits make up the top approximately 10 feet of the subsurface. These marsh deposits are composed of organic lean and fat clay with some silt layers. Below the marsh deposits, beginning around 7 to 10 feet below the ground surface, Pleistocene Prairie Terrace deposits are present. These deposits span up to 60 feet below (in borings closer to Location STP- 9) and are composed of predominantly medium to very stiff clay. However, borings indicate that with increasing distance from Location STP- 9, a deep abandoned channel nears the surface, appearing at a depth of approximately 60 feet below the ground surface just 0.15 miles from the site and only 10 feet below the ground surface just 0.25 miles from the site. This abandoned channel is composed of poorly graded sands and silty sands and is approximately 35 feet thick. There is a possibility the abandoned channel is present at Location STP- 9, too. Additional boring, CPT, or geologic profile data would confirm exact locations of this abandoned channel layer, but currently, the data is not present. Location STP- 9 consists of 17.44 acres and the biggest risk to the site is the potential of a 35 feet thick sand layer present, although signs indicate that it might be deeper than 60 feet below the ground surface at Location STP- 9.

Section 7
Life Safety Risk Assessment

Refer to Annex 4 for Life Safety Risk Assessment.

Section 8
Hydraulics and Hydrology

Refer to Appendix E for Hydraulics analysis.

Section 9
Cost Engineering

Refer to Annex 5 for Cost analysis.

Section 10
Tentatively Selected Plan

10.1 DESCRIPTION OF THE TENTATIVELY SELECTED PLAN

The TSP is a comprehensive plan that includes Coastal Storm Risk Management (CSRM), Flood Risk Management (FRM), and nonstructural features to address flooding parish-wide.

The TSP comprises these measures:

- Alignment that includes levee and floodwall sections in west and south Slidell.
- Bayou Patassat channel improvements in Slidell.
- Mile Branch channel improvements in Covington.

Nonstructural home elevations and floodproofing for the rest of the parish based on structures located in the 50-year flood plain (residual risk)

Note: Refer to main report for details on Alternative 2 Non-structural.

Figure D:10-1 shows an overview of the TSP features for the whole parish and Figure D:10-2 shows an overview of the TSP features within the Slidell area.

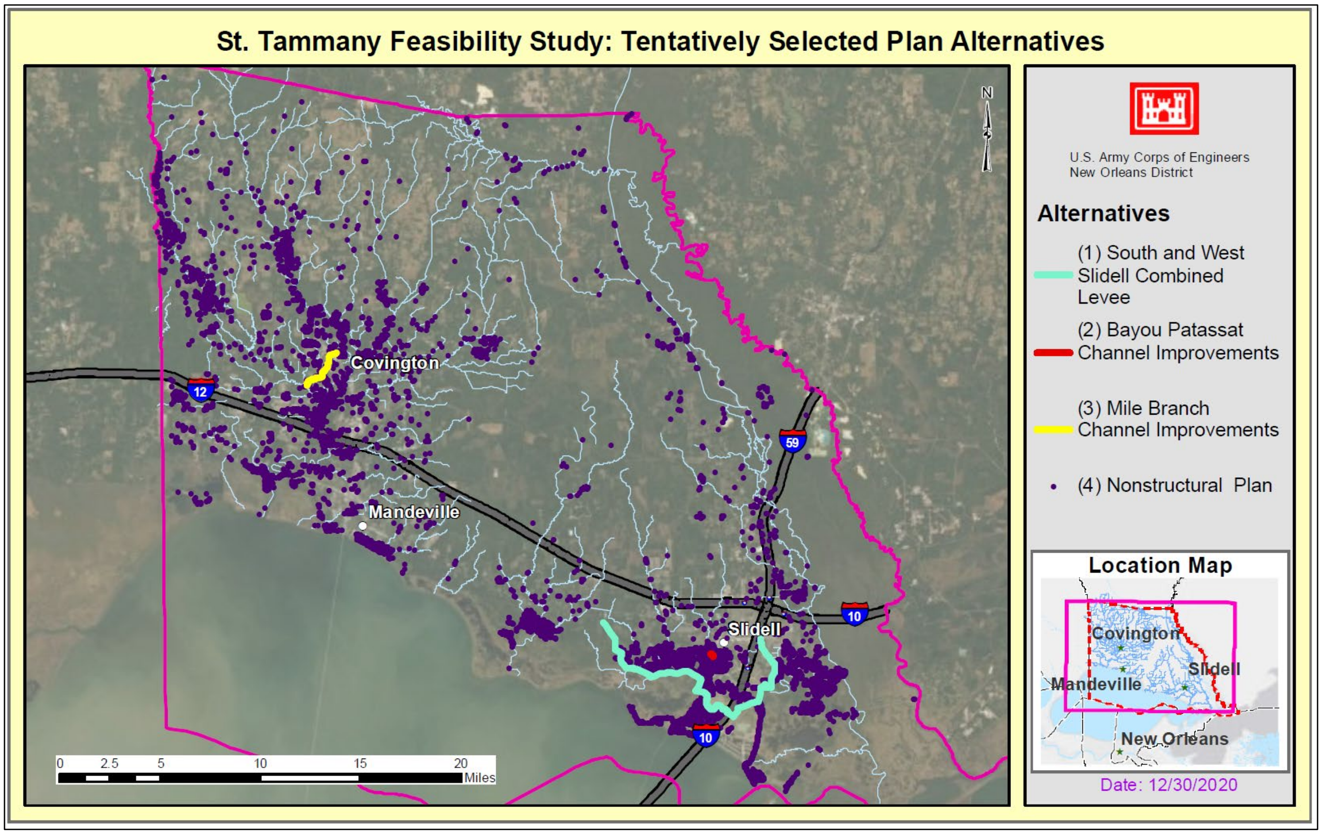


Figure D:10-1. Tentatively Selected Plan

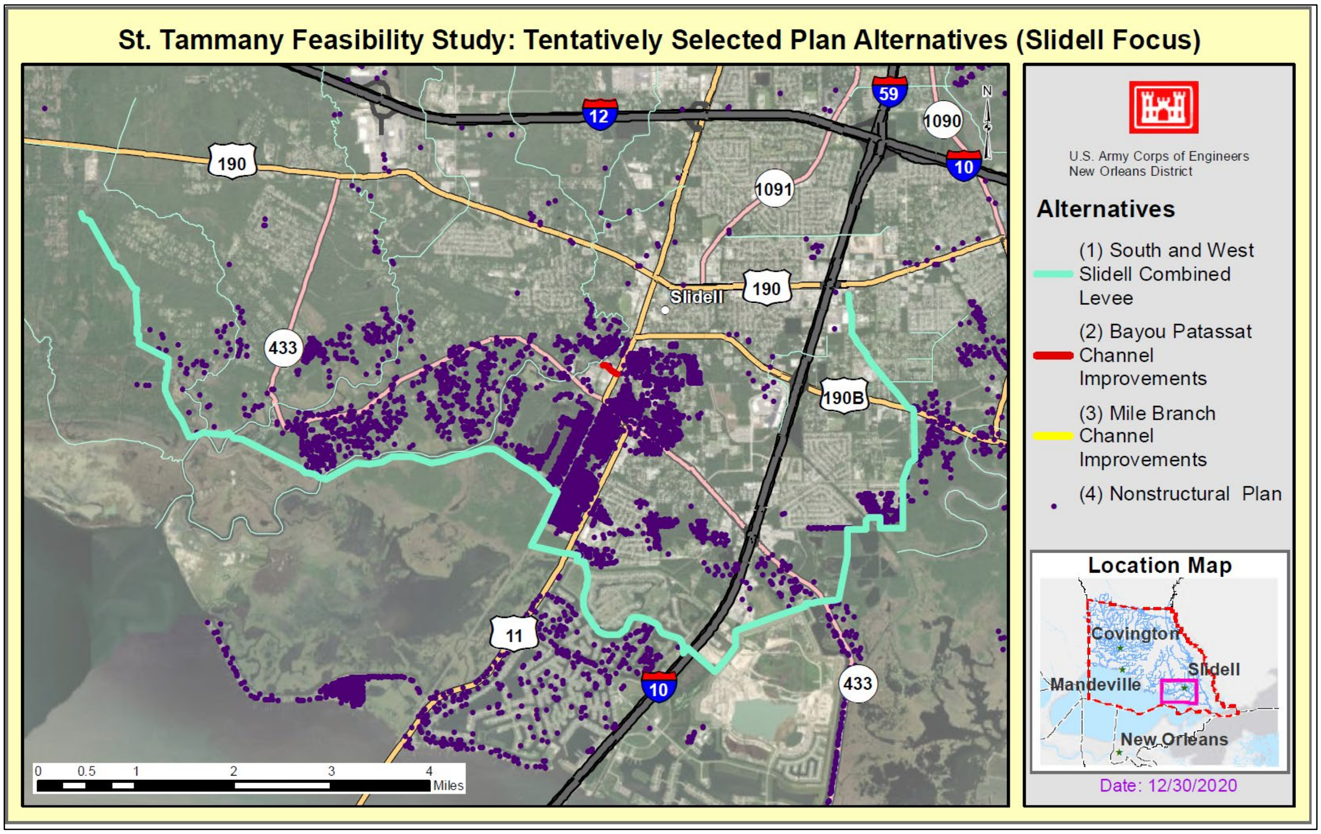


Figure D:10-2 Tentatively Selected Plan Focus

10.2 LEVEE ALIGNMENT

Alternative 6c consists of a combination of portions of the Slidell levee alignment proposed in Alternative 5 (except for the western portion of that alignment) and the South Slidell levee alignment proposed in Alternative 6a (except for the northwestern portion of that alignment), with the two alignments being connected by a new railroad gate across the existing Norfolk Southern Railway Corp. railroad tracks.

Alternative 6c consists of a total of 16.3 miles (85,900 feet) of a levee and floodwall alignment, with approximately 14 miles (73,700 feet) of levees constructed in two separate (non-continuous) segments, and 2.3 miles (12,200 feet) of two separate (non-continuous) segments of a floodwall.

This alignment would include 49,100 feet of south Slidell segment and 36,800 feet of west Slidell segment of the Alternatives of the Final Array. This Alternative also consists of pump stations, floodgates, vehicular floodgates, and ramps.

10.3 DESCRIPTION OF LEVEE ALIGNMENT

Starting on the western side, the new federal levee alignment would commence on the south side of US Highway 190 from southwest of Bayou Paquet. This new western alignment would consist of a levee with a floodwall segment on the east side of Bayou Paquet Road. The new alignment would cross Bayou Liberty and Bayou Bonfouca, along the northern perimeter of the Big Branch Marsh National Wildlife Refuge and would meet the Norfolk Southern Railway Corp railroad tracks west of US Highway 11 in the vicinity of Delwood Pump Station in Slidell. The new alignment would continue across the railroad tracks into South Slidell. Then the new alignment would transition into a floodwall running on the east side of the railroad track from Delwood Pump Station (Sun Valley Drive) in a north to south direction. The new floodwall would transition into a new levee just south of the First Baptist Church Christian School, where it would turn east and then south. This reach would consist of a new levee alignment with new floodwall segments. This reach would include the new Schneider Canal Pump Station (which are assumed to remain within the same footprint as the existing facility). The new levee would tie to a segment of the existing Oak Harbor levee along Oak Harbor Boulevard (existing levee would be raised to Elevation 15 feet), and then the I-10 would be raised to ramp over the new levee section. The new levee would tie to a section of the northern perimeter of the existing Lakeshore Estates levee (existing levee would be raised to Elevation 15 feet). The new levee would cross LA Highway 433 and turn north and would tie to a section of the existing King’s Point west levee (existing levee would be raised to Elevation 15 feet). The new alignment would connect to the new pump station at the W-14 canal and would tie to the existing King’s Point east levee (existing levee would be raised to Elevation 15 feet). The new levee would continue north towards US Highway 190 Business (Fremaux Ave). The new levee would cross US Highway 190 Business (Fremaux Ave) and would transition into a floodwall across US Highway 190 Business. The new floodwall would run on the west side of the CLECO Corporate Holdings, LLC utility corridor and cross South and North Holiday Drives. The new floodwall would exit the utility corridor to run on the east side of Carol Drive, would continue north on the east side of Yaupon Drive, and would terminate at Manzella Drive (one block south of Gause Boulevard).. Refer to Figure D:10-3.

CLECO Corporate Holdings, LLC has right-of-way use requirements pertaining to USACE work around their existing utility lines on the northeast corner of the floodwall alignment that would have to be met to provide clearance for construction activities (i.e. pile driving

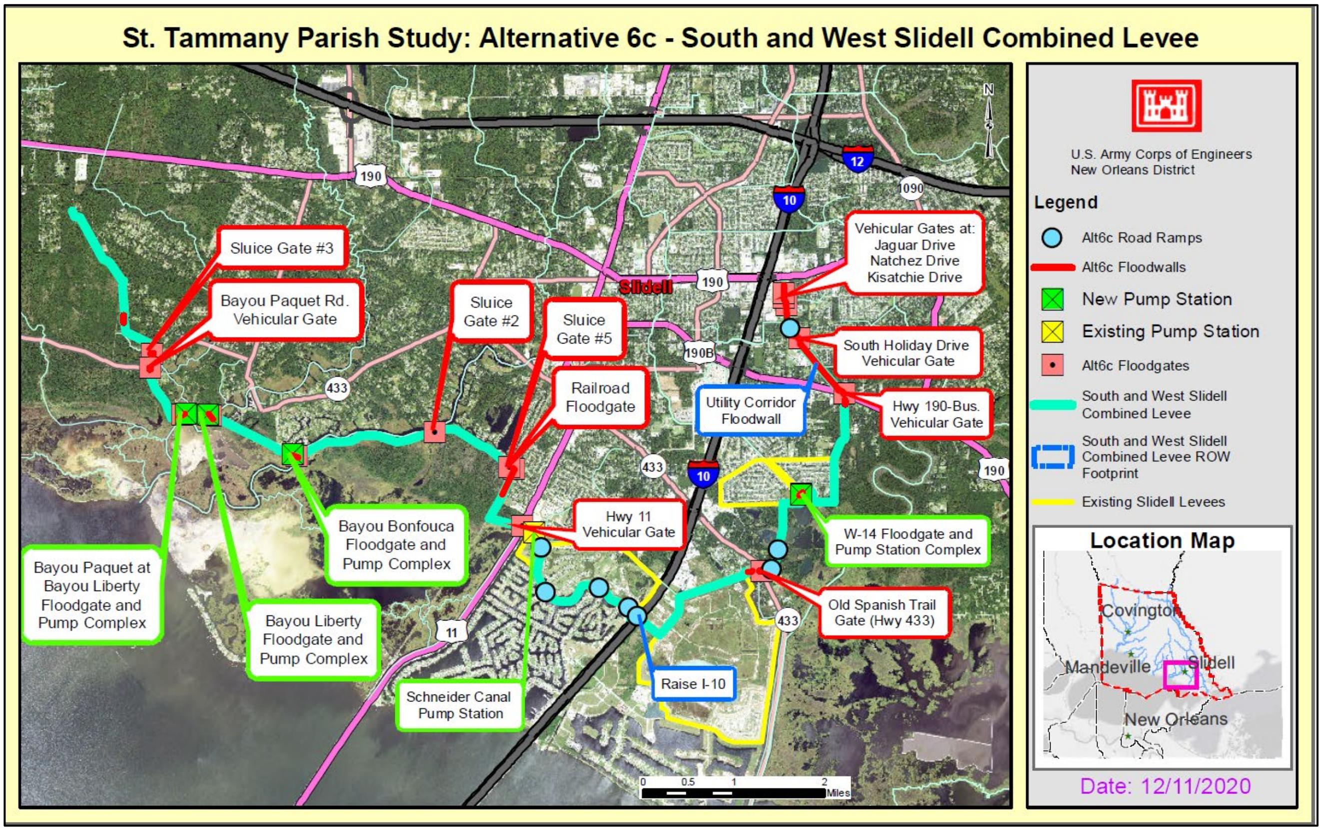


Figure D:10-3 Tentatively Selected Plan with Details

10.3.1 Interstate 10 Elevation

The I-10 would be raised to ramp over the new levee section by constructing ramps to the preliminary design elevation of 15 feet. The existing elevation of the I-10 at the proposed location is approximately 12.8 feet as per LIDAR raster dataset. This proposed location is the highest elevation of the I-10 in the vicinity of the proposed alignment. The I-10 elevation is lower (approximately 10 feet) on the adjacent areas. This feature would be designed in the feasibility level of design for the study.

10.4 LEVEE TYPICAL CROSS-SECTION AND QUANTITIES

For levee design criteria, refer to Section 2 of this appendix.

The proposed levee elevation varies depending on location. The preliminary assumptions are that the levee would have a 10 feet wide levee crown and side slopes of 1V:3H. Berm sections would be determined once data is available for analysis. The existing elevations were obtained from the LIDAR raster dataset.

The elevation of the new West Slidell levee would vary between 13 feet and 14.5 feet depending on the location. The elevation of the new South Slidell levee would vary between 13 feet and 15 feet depending on the location. The total levee alignment would impact approximately 169 acres of construction area. This levee alignment would require approximately 1,528,000 cubic yards of fill (includes 30 percent contingency).

10.5 DESCRIPTION OF FLOODWALL SEGMENTS

The new floodwall segments would be as follows. Starting on the west:

1- 0.07 miles (350 feet) floodwall segment passing through several properties. Top of wall elevation of 17 feet. The construction area would be 0.4 acres.

On the east side of the railroad tracks:

2- 0.3 miles (1,600 feet) of T-wall along Railroad between Delwood Pump Station and Baptist Church

3- 0.06 miles (300 feet) Old Spanish Trail Floodwall segment (construction area would be 0.3 acres).

4- Across from LA Highway 433, there would be 0.09 miles (450 feet) Old Spanish Trail Floodwall segment by Espirit du Lac Street (construction area would be 0.5 acres).

5- 0.04 miles (200 feet) floodwall segment near Belaire Drive (construction area would be 0.2 acres).

6- The next floodwall segment would be on the north side along US Highway 190 Business (Fremaux Ave) for 0.08 miles (430 feet) and then the new floodwall would turn into the CLECO Corporate Holdings, LLC utility corridor for approximately 1.4 miles (7,200 feet) and would terminate at Manzella Drive. The total length of this new floodwall alignment would be 1.5 miles (7,700 feet) long (total construction area would be 9 acres).

10.6 FLOODWALL TYPICAL SECTION AND ELEVATIONS

The typical T-wall section would consist of 3 feet thick by 8.5 feet wide slab with a 1.5 feet thick stem. The height of the stem would vary. Preliminary assumptions are two rows of 1H:3V battered H12 x 74 piles, 60 feet deep, spaced on 5 feet centers, and 30 feet-deep steel PZ sheet pile. Approximately 1,850 square feet of slope protection would be provided at floodwall/levee tie-ins. The design of the new T-wall including the foundation is subject to change once detailed geotechnical investigations are conducted.

For this alignment, the preliminary design elevation of the floodwall segments would vary from 13.5 feet to 17 feet. Refer to Figure D:10-4 for details on the typical cross-section.

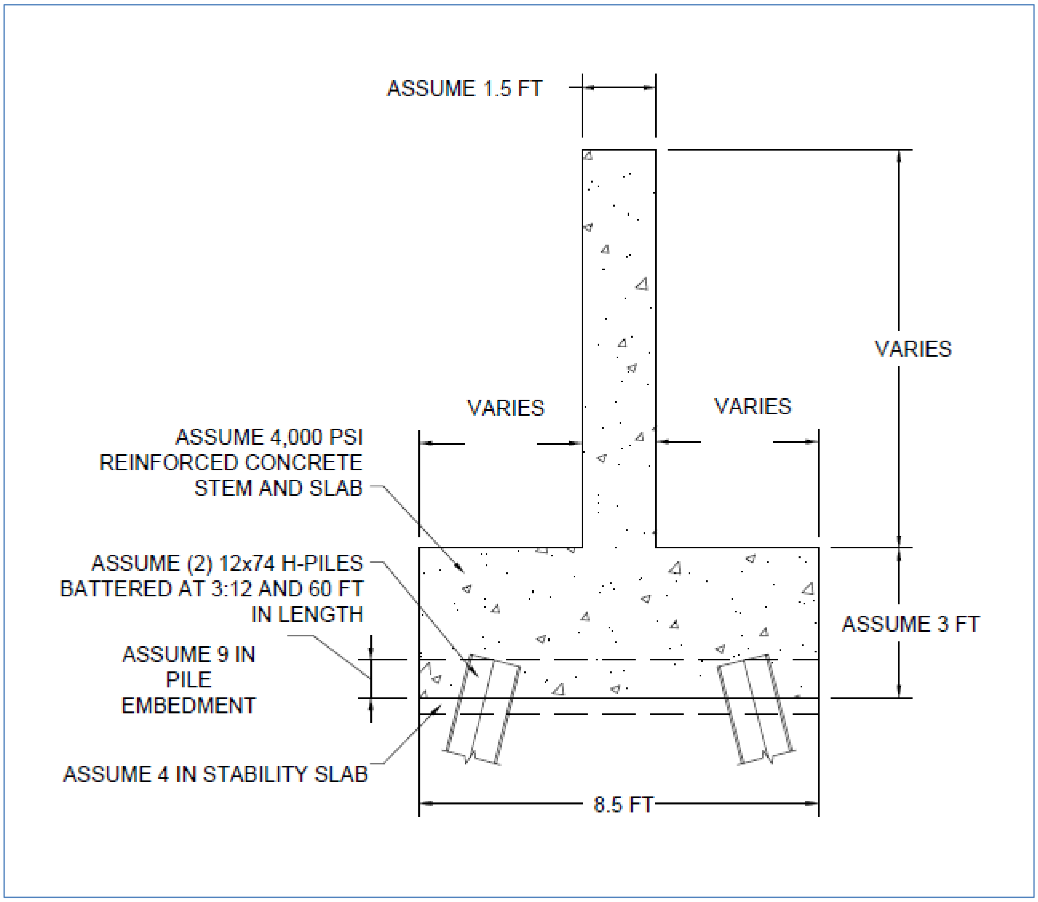


Figure D:10-4. Typical Floodwall Cross Section for the TSP

The analysis comprises scoping level engineering estimates for the 1% future (2082) hydraulic design elevation for each structure, with an additional 2 feet of structural superiority added to the computed design elevations.

10.7 FLOODGATES AND RAMPS

There would be a total of three sluicegates, eight vehicular floodgates, one railroad floodgate, and seven ramps. The I-10 would be raised to ramp over the new levee section.

Starting on the west of the alignment:

- Sluicegate # 3 at Bayou Paquet (0.25 acres of construction area)
- 30-feet vehicular floodgate at Bayou Paquet Road

- Sluicegate #2 (located east of three major proposed pump stations and floodgate complexes)
- Sluicegate #5 (on the opposite side of the railroad tracks from Delwood Pump Station), (0.25 acres of construction area). Further refinement would be needed at this location.
- 60-foot railroad floodgate (added for 6c)
- 75-foot Pontchartrain Drive vehicular floodgate (US Highway 11)
- Ramp at Cypress Lakes Drive
- Ramp at Mariner's Cove Boulevard
- Ramp at the Oak Harbor Country Club entrance
- Ramp at Grand Champions Lane
- The I-10 would be raised to ramp over the new levee section
- 30-feet vehicular floodgate at LA Highway 433 East (Old Spanish Trail)
- Ramp at Fleur Du Lac Street
- Ramp at Nunez Road
- 50-foot vehicular floodgate at US Highway 190 Business (East)
- 20-foot vehicular floodgate at South Holiday Drive
- Ramp at North Holiday Drive
- 20-foot vehicular floodgate at Jaguar Drive
- 20-foot vehicular floodgate at Natchez Drive
- 20-foot vehicular floodgate at Kisatchie Drive

For Item 5 above, the railroad double-swing floodgate was added for Alternative 6c. The analysis was based on Mississippi River Levee (MRL) Carrollton Railroad Gate.

On the northeast side of the alignment, it is assumed that there would be no need for a vehicular floodgate on North Holiday Drive.

10.8 PUMP STATIONS AND FLOODGATES

There would be five pump stations and sluicegates that would be part of the TSP. Starting on the west:

- Bayou Paquet Pump Station complex (500 cfs and 100-foot long) located between Jummonville Road and Mayer Drive. The complex includes a 20-foot navigable floodgate (construction area is 12.6 acres)
- Bayou Liberty Pump Station complex (3,200 cfs and 400-foot long). The complex includes a 20-foot navigable floodgate (construction area would be 12.6 acres)
- Bayou Bonfouca Pump Station complex (3,700 cfs and 300-foot long). The complex includes a 20-foot navigable floodgate (12.6 acres required for construction)

On the east side of the railroad tracks:

- Schneider Canal Pump Station complex (1,200 cfs and 150-foot long) with a 30-foot floodgate (construction area would be 12.6 acres)
- W-14 Pump Station complex (1,200 cfs and 150-foot long) with a 30-foot floodgate (construction area would be 12.6 acres).

10.9 BAYOU PATASSAT CHANNEL IMPROVEMENTS

The Bayou Patassat Channel Improvements would be performed between Bayou Vincent Pump Station and US Highway 11. Bayou Patassat is a small tributary of Bayou Bonfouca. The preliminary design of the channel improvements assumes an existing bank elevation of 1 foot, a 10-feet bottom width at elevation (-) 5 feet, and bank slopes at 1V:3H slope. The work would be located between Bayou Vincent Pump Station and US Highway 11. Land access to the site would be through Bayou Lane or the existing pump station access road.

The lands required for the implementation of this Measure are all public property and owned by either St. Tammany Parish or the city of Slidell, LA. Possible staging areas would include the city-owned land around the bayou and the Bayou Vincent pump station or at the grassy area at the end of Bayou Lane. It is assumed that access to the bayou would be via the city-owned property along the channel. Note that there is enough ROW for two-way access on the northside of the channel. If necessary, a temporary culvert could be placed in the channel to allow for crossing over to the southernmost bank.

Approximately 0.17 miles (900 feet) of clearing and snagging would occur in the channel. Material removed may include trees, debris, trash, or other obstructions within the waterway. For the channel improvement, approximately 2 acres of ROW would be needed for a temporary easement within the Bayou Patassat Channel. In addition, another approximate 0.6 acres of ROW would be tree-clearing, with the majority of the work taking place on the southernmost bank All trees and debris cleared would likely be chipped on site and then hauled to the nearest landfill. The nearest landfills are the Slidell Landfill (east of Interstate 10 and south of LA Highway 433) and Waste Management (2685 Gause Boulevard West, Slidell, LA 70460). The assumed haul distance is 15 miles.

10.10 MILE BRANCH CHANNEL IMPROVEMENTS

The Mile Branch channel improvements would start at the intersection of Mile Branch and US Highway 190, cross US Highway 190 Business, and would end at the intersection of Mile Branch and the Tchefuncte River. This measure would consist of channel improvements on the lower 2.15 miles (11,341 feet channel) of Mile Branch in Covington, LA.

The improvements would include clearing and grubbing and mechanical dredging of the channel. The channel bottom would be lowered by 5 feet. Approximately 20 acres of channel would be cleared and grubbed prior to mechanical dredging. An assumed maximum of 130,000 cubic yards of material may be mechanically dredged from the channel. The preliminary design assumes an existing bank elevation of 1 foot, and a 10-feet bottom width.

The bank would be at 1V:3H slope. Material removed may include sediment, trees, debris, or other obstructions within the waterway. For the channel improvements, approximately 34 acres of ROW would be needed for temporary work areas.

The Mile Branch channel improvements may include bridge replacements or culverts (starting from north to south) at 29th, 28th, 25th, 23rd, 21st, 19th, and 18th Avenues. No work is anticipated at the 15th and 11th Avenue channel crossings as those bridges were replaced prior to this study (and the new bridges were designed to safely pass higher flows on Mile Branch).

10.11 GEOTECHNICAL

For geotechnical criteria of the TSP, refer to Section 5 of this appendix.

10.12 RELOCATIONS

The pipelines that would impact the TSP are listed in Table D:10-1.

Table D:10-1. Utilities for TSP

Utility Owner	Type/Size of Utility	Method of Relocation	Method of Relocation
ExxonMobil	Natural Gas 16-inch pipeline	Up and Over Pipeline Relocation (Levee)	500 feet
CLECO Corporate Holdings, LLC	Transmission Lines - 240KV	De-energizing Powerlines	NA

Assumption for Table D:10-1:

- It is assumed that the levee would have a 10-foot wide crown, side slopes of 1V:3H, and a crown elevation of 12.5 feet.

The TSP includes a railroad floodgate at Norfolk Southern Railway Corp. railroad tracks to connect the West Slidell portion and the South Slidell portion of the alignment. Preliminary assumptions when crossing a railroad (RR), are that in some instances there are communications lines and/or electrical lines that service the RR within the RR right of way. These lines can be used for the RR signal lights or track switches. There are also cases where utilities run under the RR to service nearby buildings, such as underground water or sewer lines. The preliminary assumption was that all utilities servicing the Delwood Pump Station do not run under the RR, so there could be communication lines or electric lines near the Norfolk Southern Railway Corp. RR tracks. Further refinement would be needed. There are several requirements from CLECO Corporate Holdings, LLC that would have to be met to provide clearance between the construction activities associated with pile driving and the existing utility line on the northeast corner of the new alignment.

10.13 ACCESS

Construction access and staging areas would be needed along the alignment for all elements of TSP. Project access post-construction for future maintenance would be needed for all elements except the non-structural home raisings. Permanent access would include access to the levee alignment and to the channel improvements.

References and Resources

Project References:

NA

Websites:

<u>Note for all GSI maps in this Appendix:</u>

Source: Esir, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Full Citation: World Imagery provides one meter or better satellite and aerial imagery in many parts of the world and lower resolution satellite imagery worldwide. The map includes 15m TerraColor imagery at small and mid-scales (~1:591M down to ~1:288k) for the world. The map features Maxar imagery at 0.3m resolution for select metropolitan areas around the world, 0.5m resolution across the United States and parts of Western Europe, and 1m resolution imagery across the rest of the world. In addition to commercial sources, the World Imagery map features high-resolution aerial photography contributed by the GIS User Community. This imagery ranges from 0.3m to 0.03m resolution (down to ~1:280 in select communities). For more information on this map, including the terms of use, visit http://goto.arcgisonline.com/maps/World_Imagery.

Software:

NA

List of Acronyms and Abbreviations

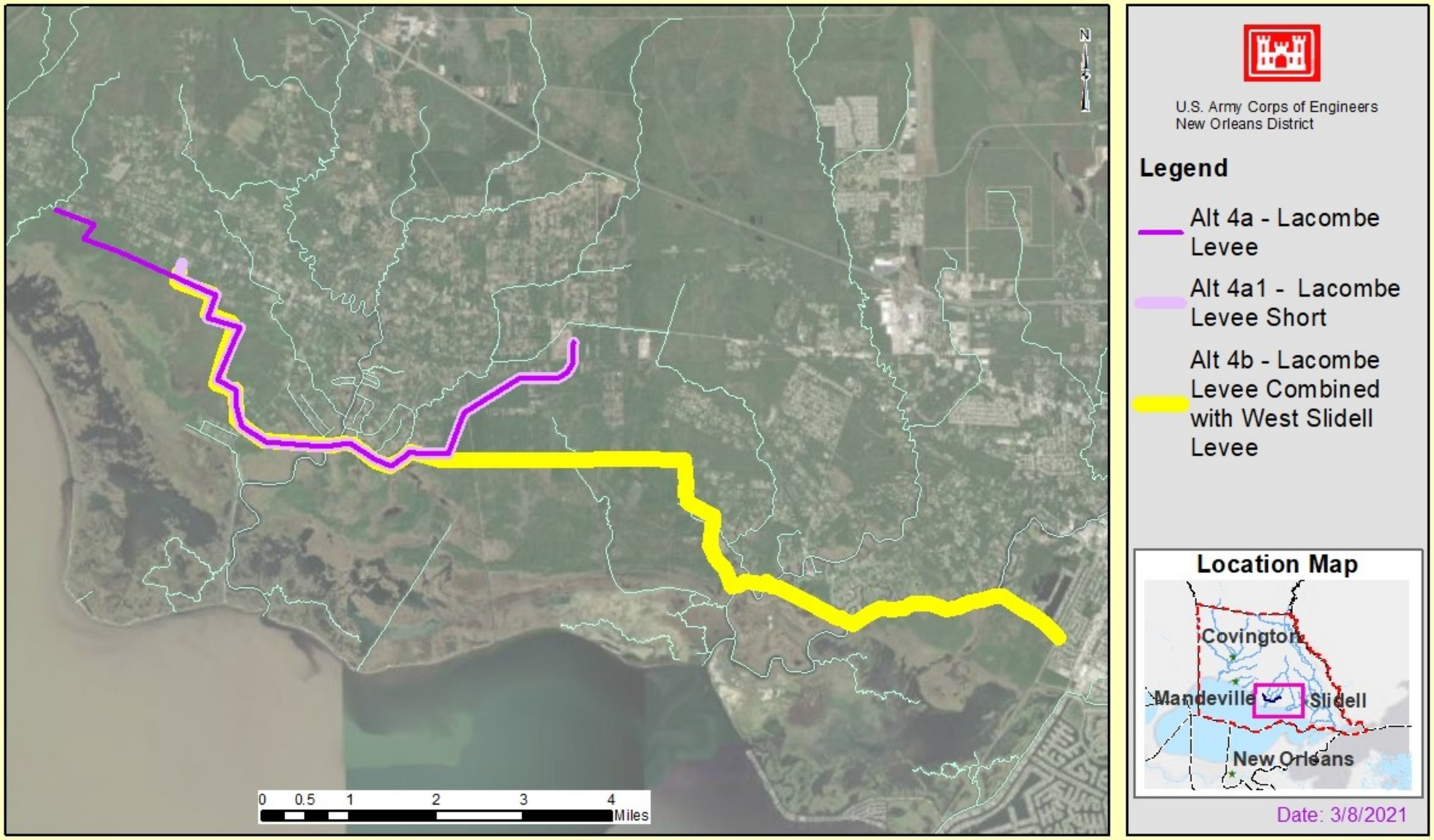
CPT	Cone Penetrometer Test
TSP	Tentatively Selected Plan
HSDRRS	Hurricane and Storm Damage Risk Reduction System
MRL	Mississippi River Levee
NOV-NF	New Orleans to Venice Non-Federal West
ROW	Right of Way
RR	Railroad

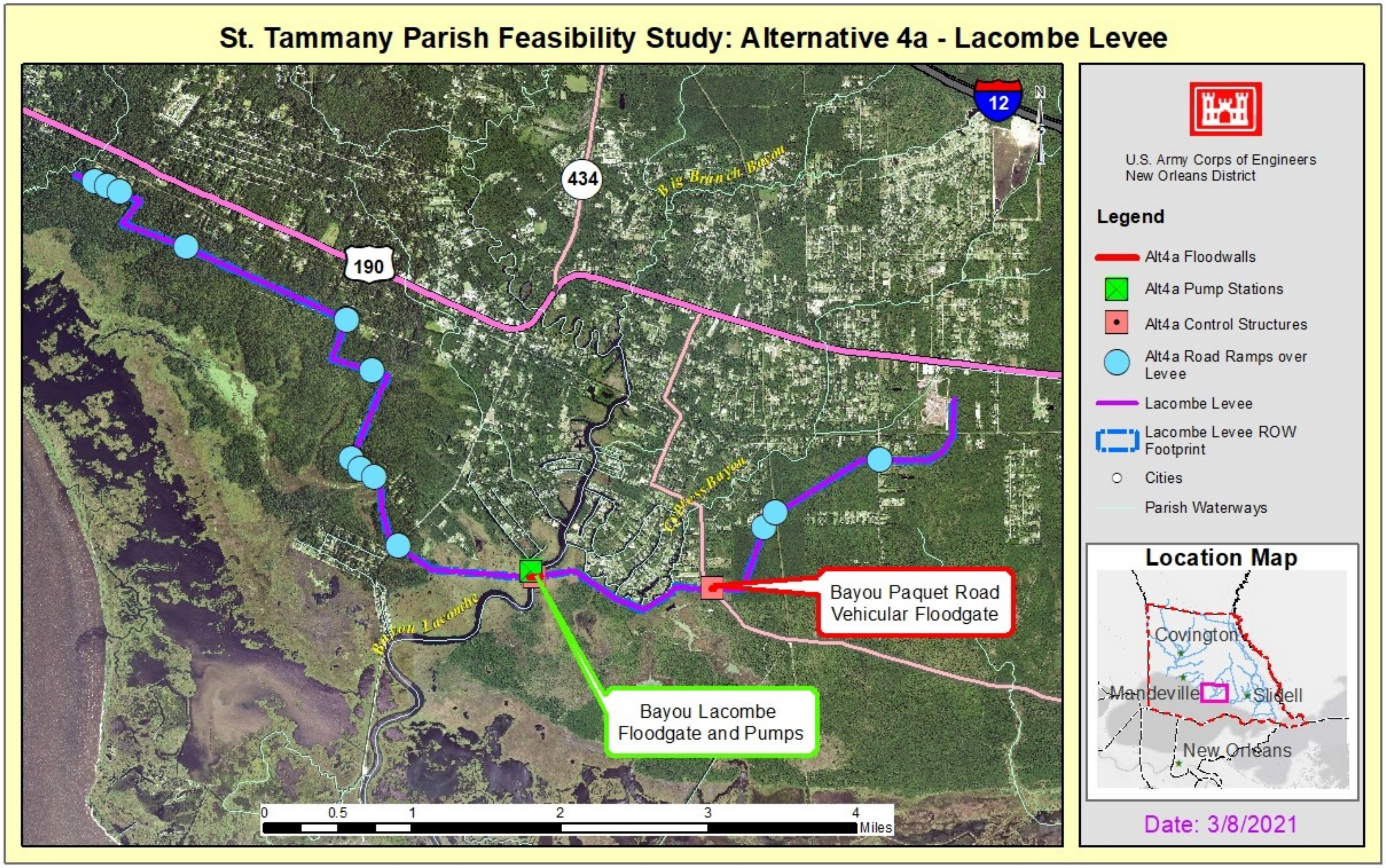
St. Tammany Parish Feasibility Study

Annex 1 to the Engineering Appendix D

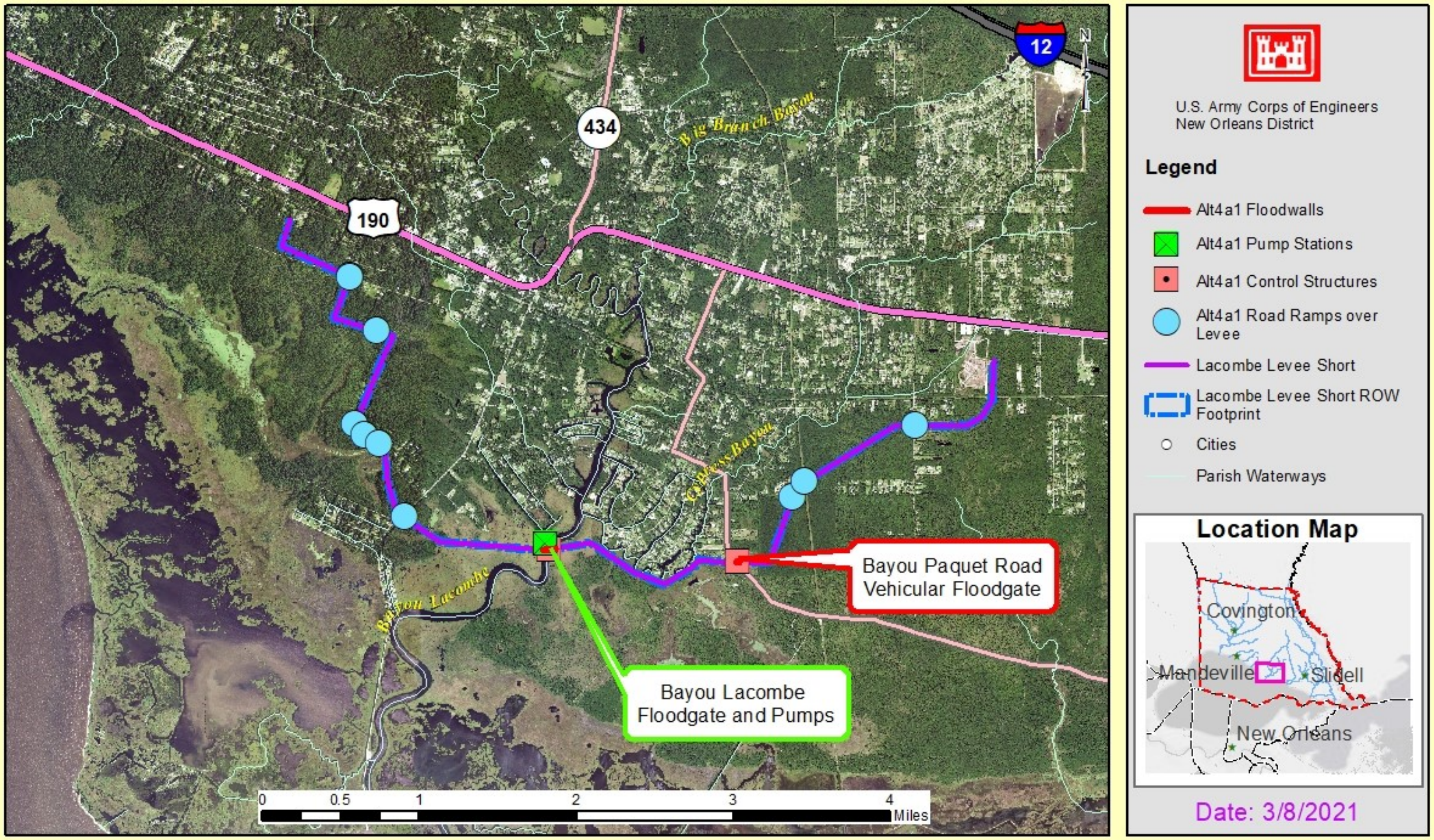
June 2021

St. Tammany Feasibility Study: Lacombe (Alternative 4)

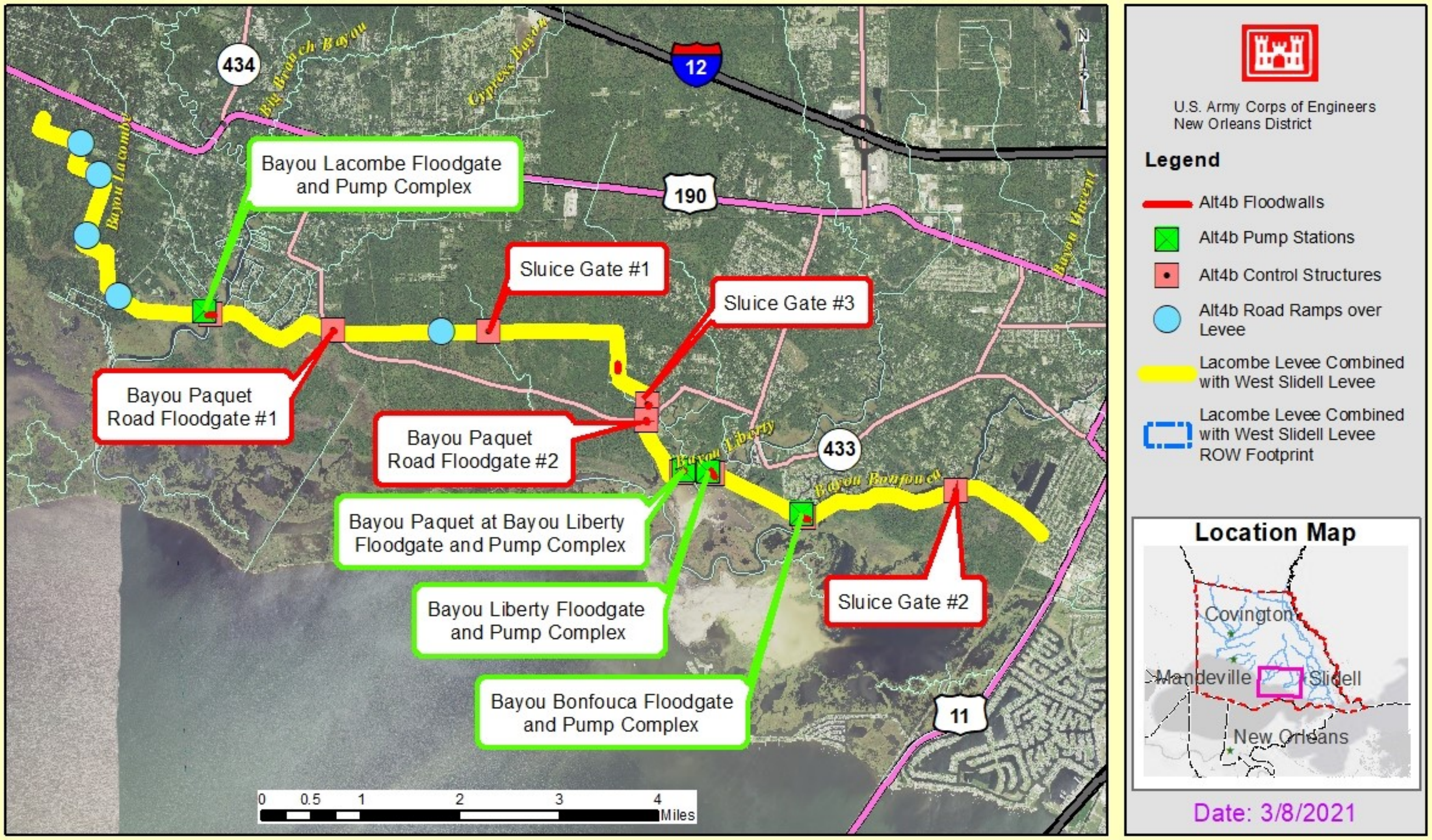


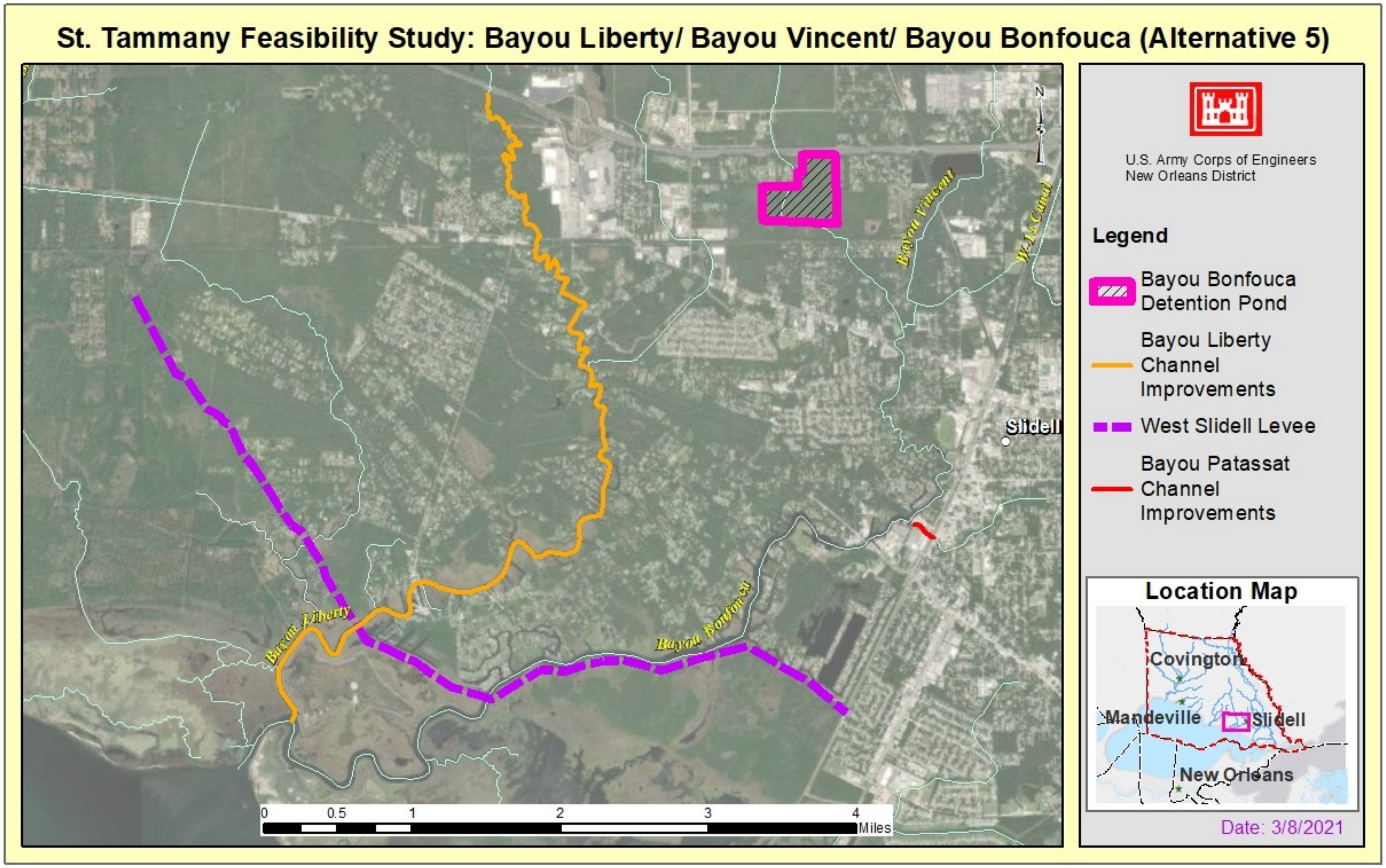

St. Tammany Parish Feasibility Study: Alternative 4a - Lacombe Levee
12
434
190
Big Branch Bayou
Cypress Bayou
Bayou Lacombe
Bayou Paquet Road
Vehicular Floodgate
Bayou Lacombe
Floodgate and Pumps
0 0.5 1 2 3 4 Miles
U.S. Army Corps of Engineers
New Orleans District
Legend
Alt4a Floodwalls
Alt4a Pump Stations
Alt4a Control Structures
Alt4a Road Ramps over Levee
Lacombe Levee
Lacombe Levee ROW Footprint
Cities
Parish Waterways
Location Map
Covington
Mandeville
Slidell
New Orleans
Date: 3/8/2021

St. Tammany Parish Feasibility Study: Alternative 4a1 - Lacombe Levee Short

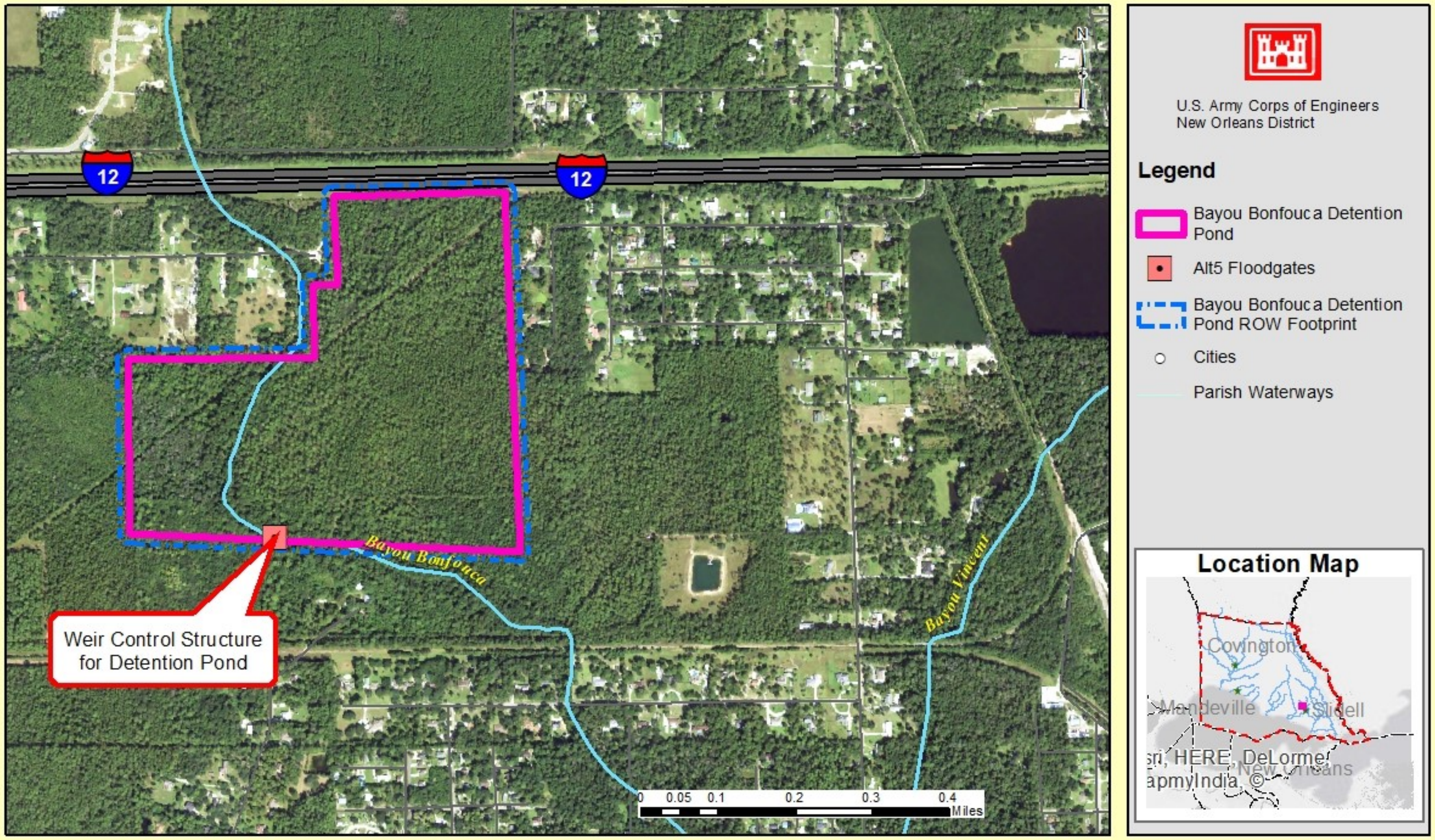


St. Tammany Parish Study: Alternative 4b - Lacombe Levee Combined with West Slidell Levee

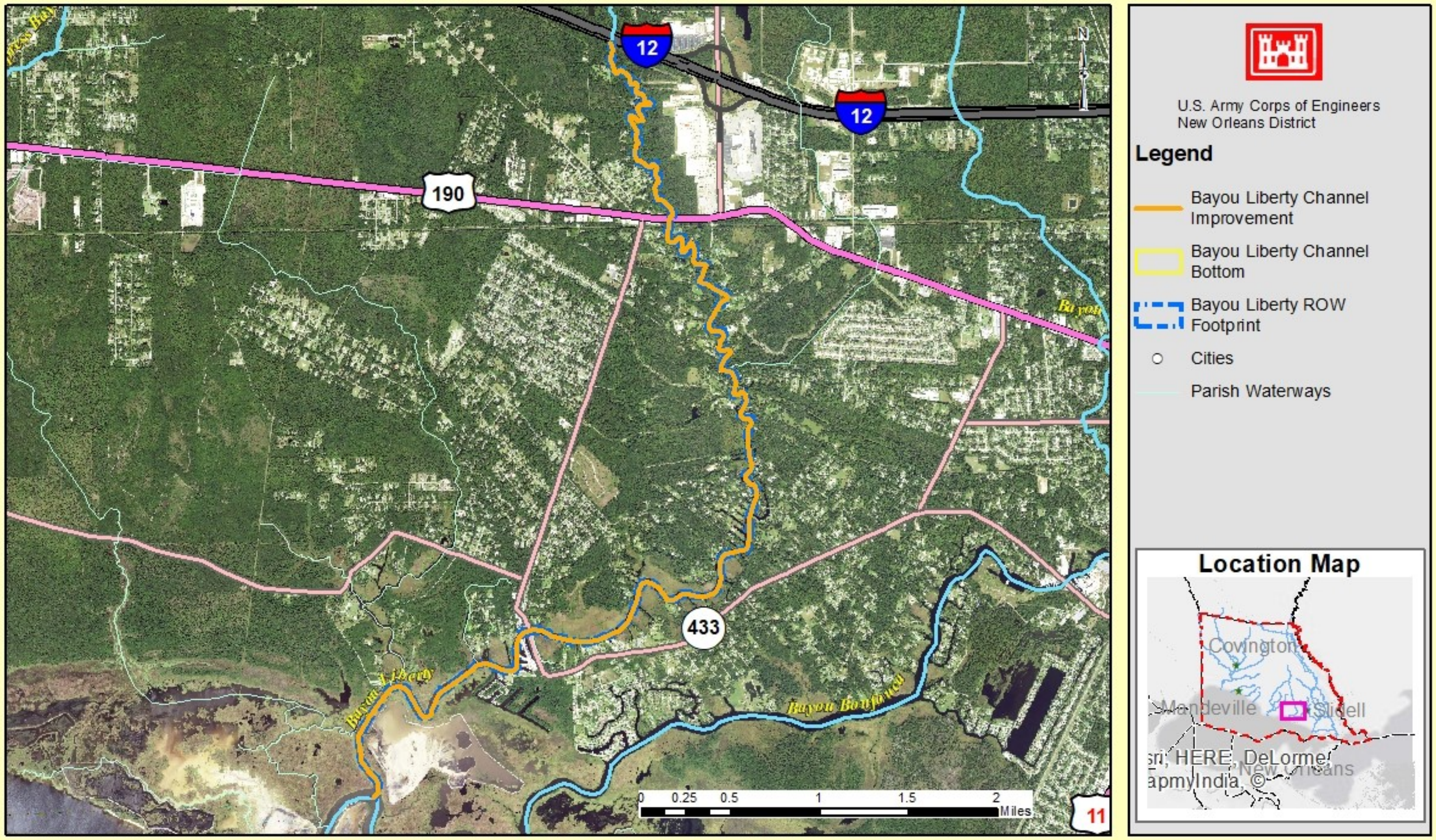



St. Tammany Feasibility Study: Bayou Liberty/ Bayou Vincent/ Bayou Bonfouca (Alternative 5)
U.S. Army Corps of Engineers
New Orleans District
Legend
Bayou Bonfouca Detention Pond
Bayou Liberty Channel Improvements
West Slidell Levee
Bayou Patassat Channel Improvements
Location Map
Covington
Mandeville
Slidell
New Orleans
Bayou Vincent
W-14 Canal
Slidell
Bayou Liberty
Bayou Bonfouca
0 0.5 1 2 3 4 Miles
Date: 3/8/2021

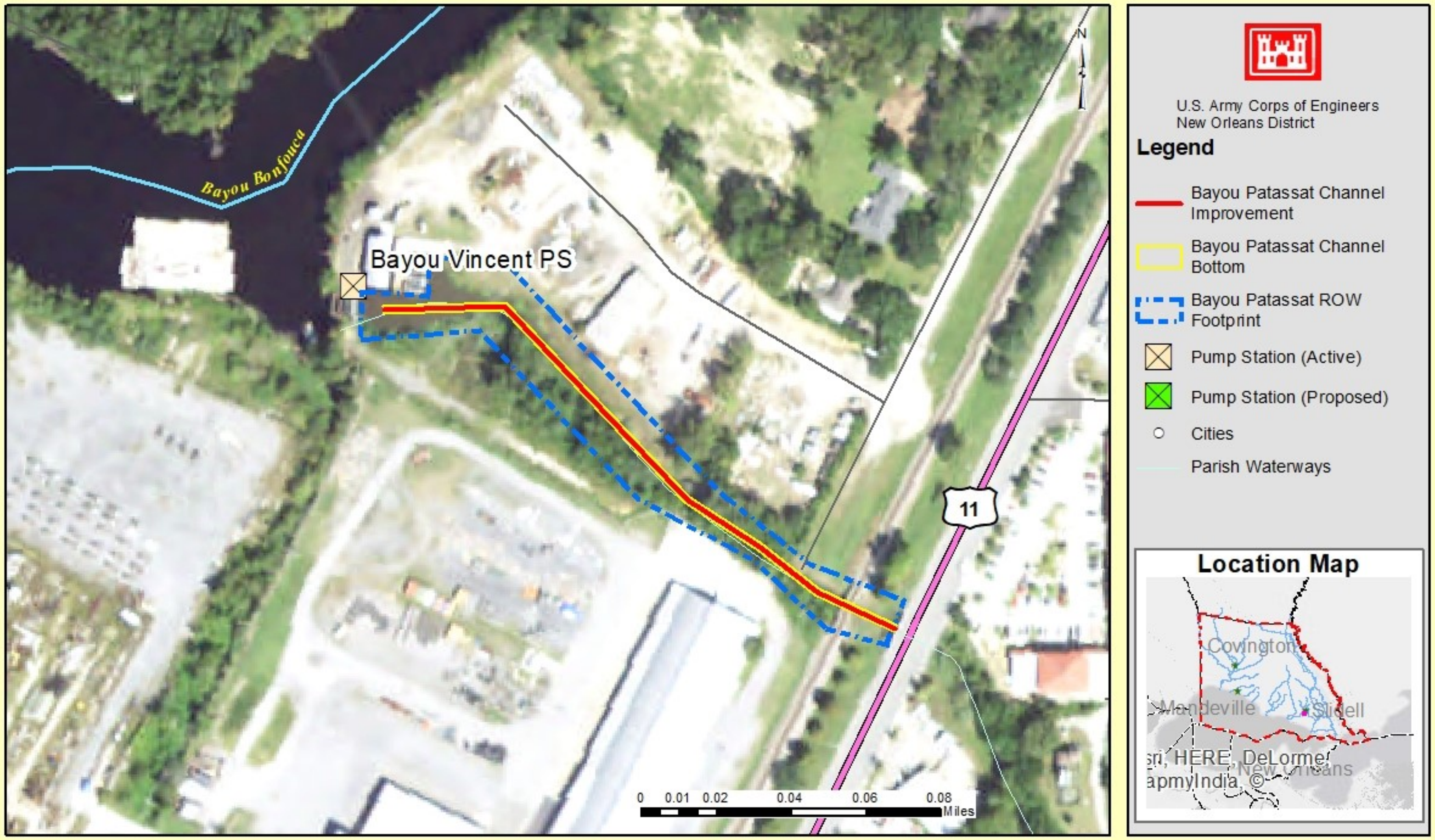
St. Tammany Parish Feasibility Study: Alternative 5 - Bayou Bonfouca Detention Pond



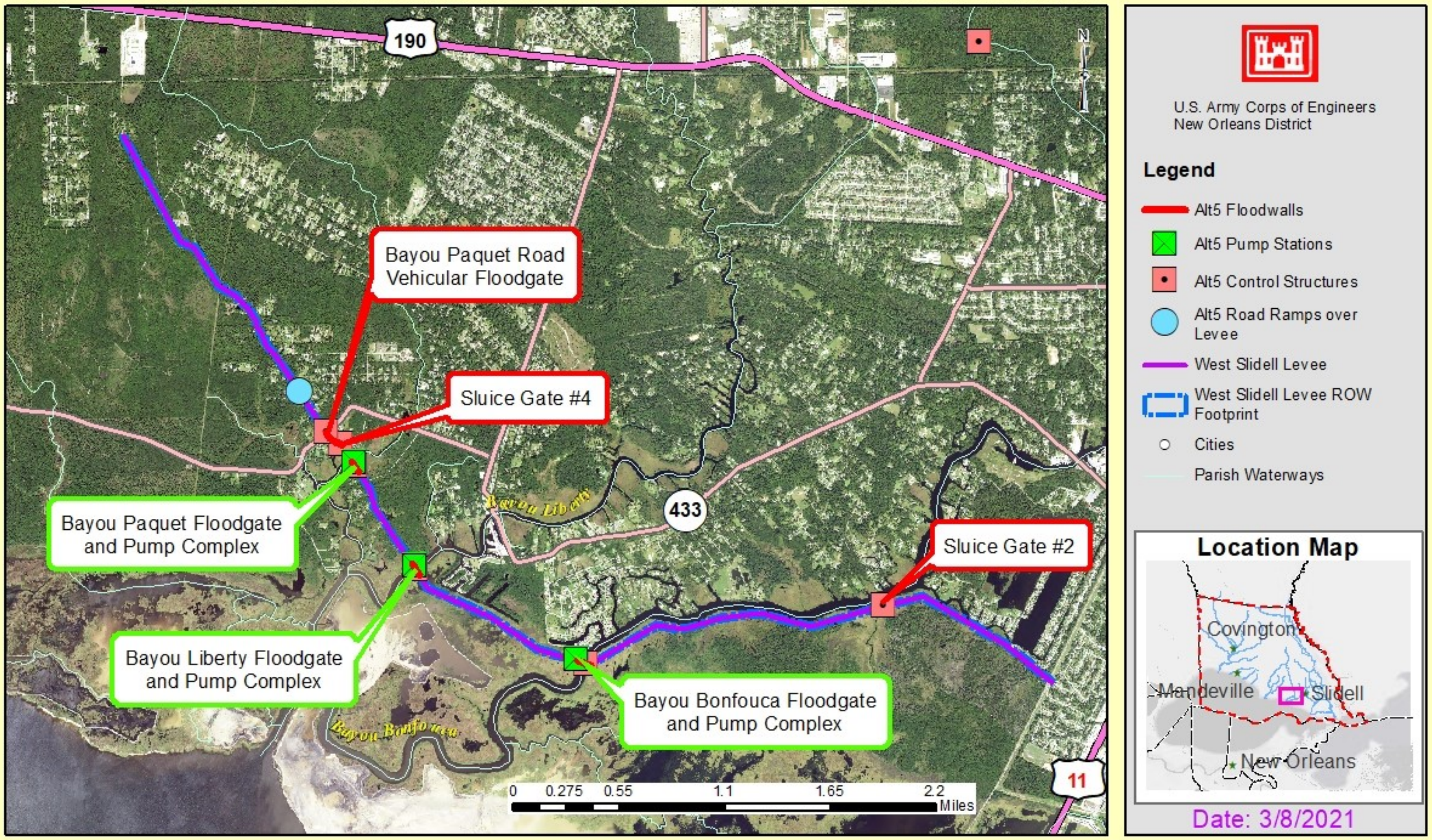
St. Tammany Parish Feasibility Study: Alternative 5 - Bayou Liberty



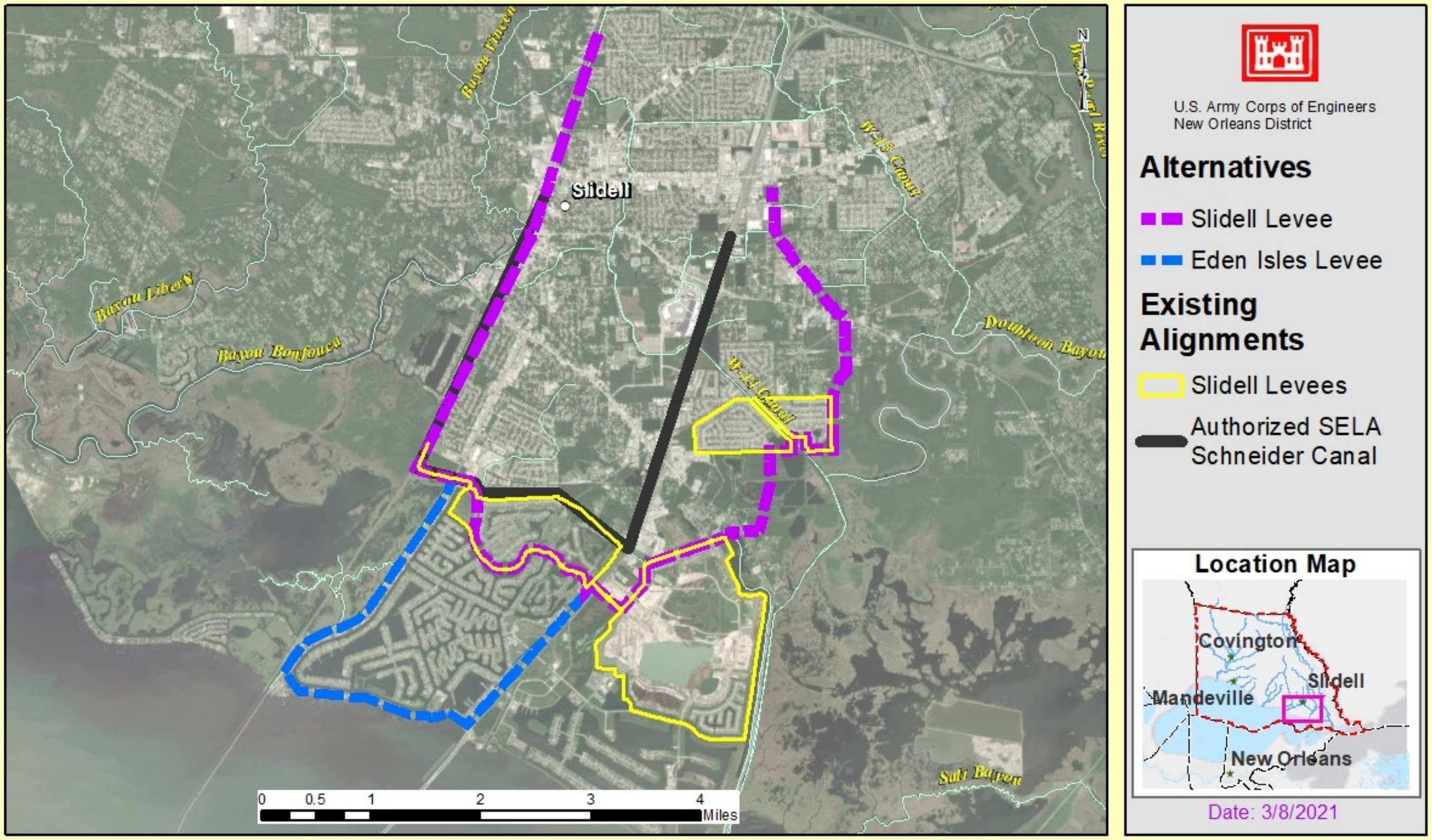
St. Tammany Parish Feasibility Study: Alternative 5 - Bayou Patassat



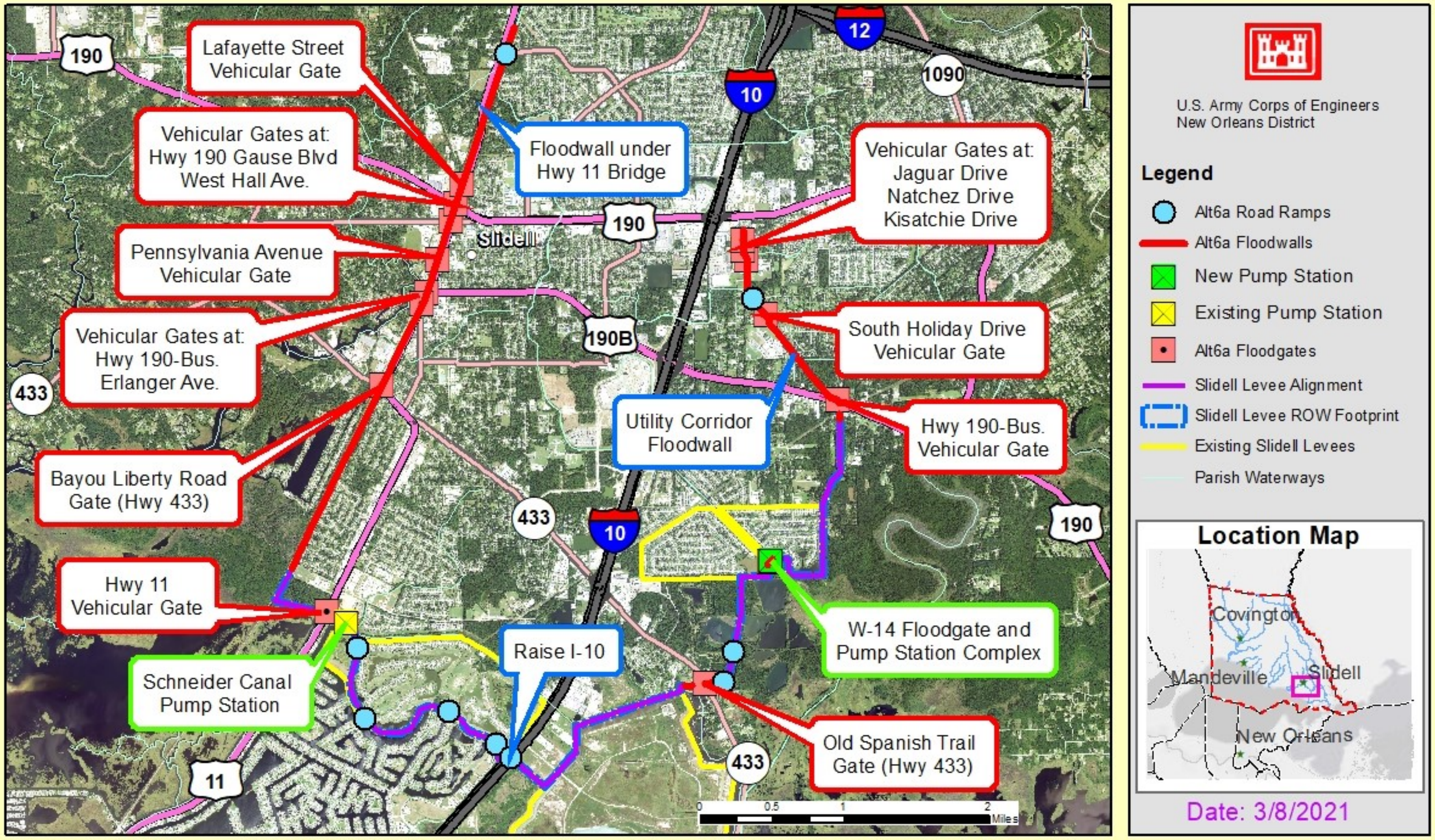
St. Tammany Parish Feasibility Study: Alternative 5 - West Slidell Levee



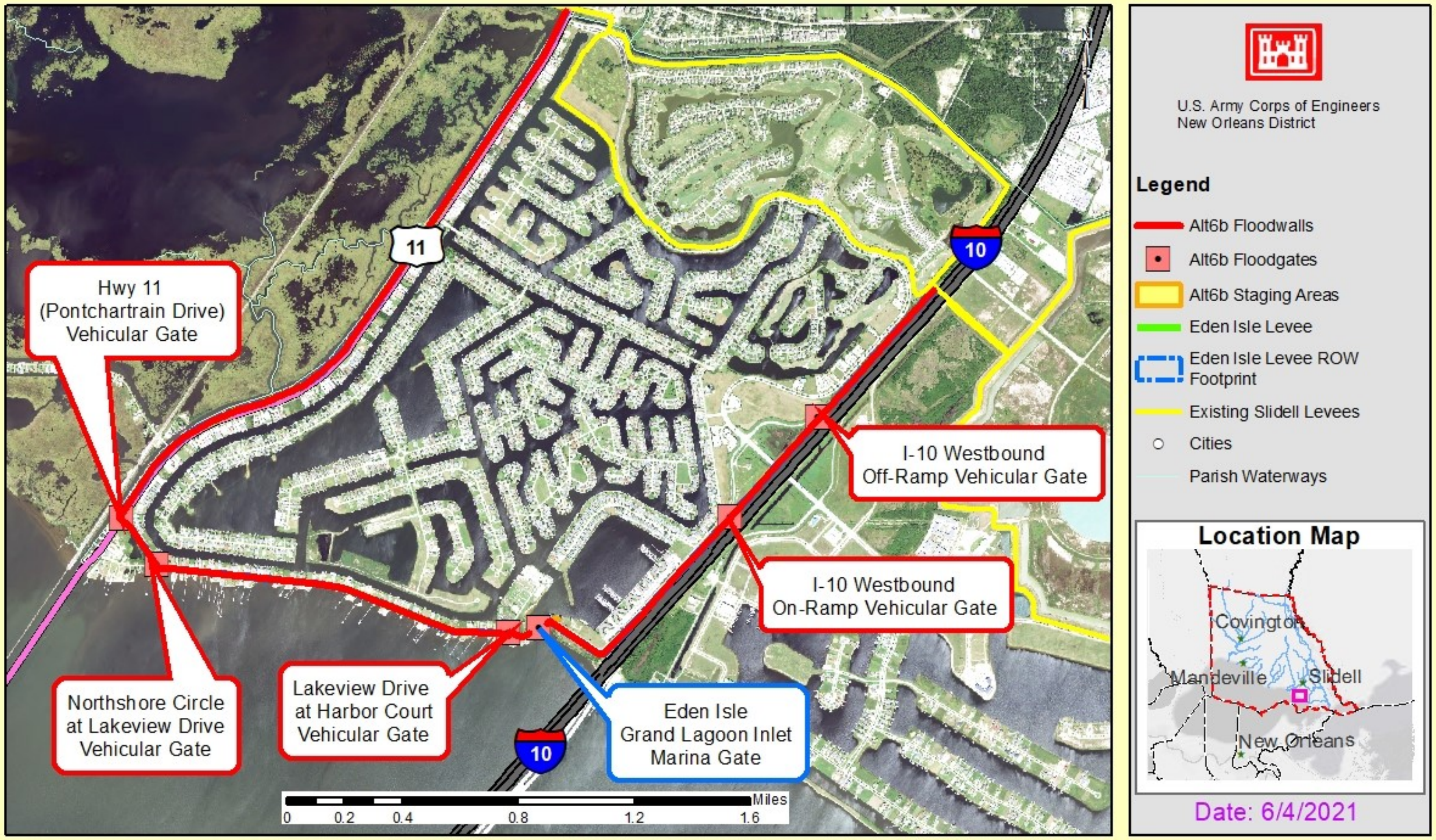
St. Tammany Feasibility Study: South Slidell Storm Surge (Alternative 6)

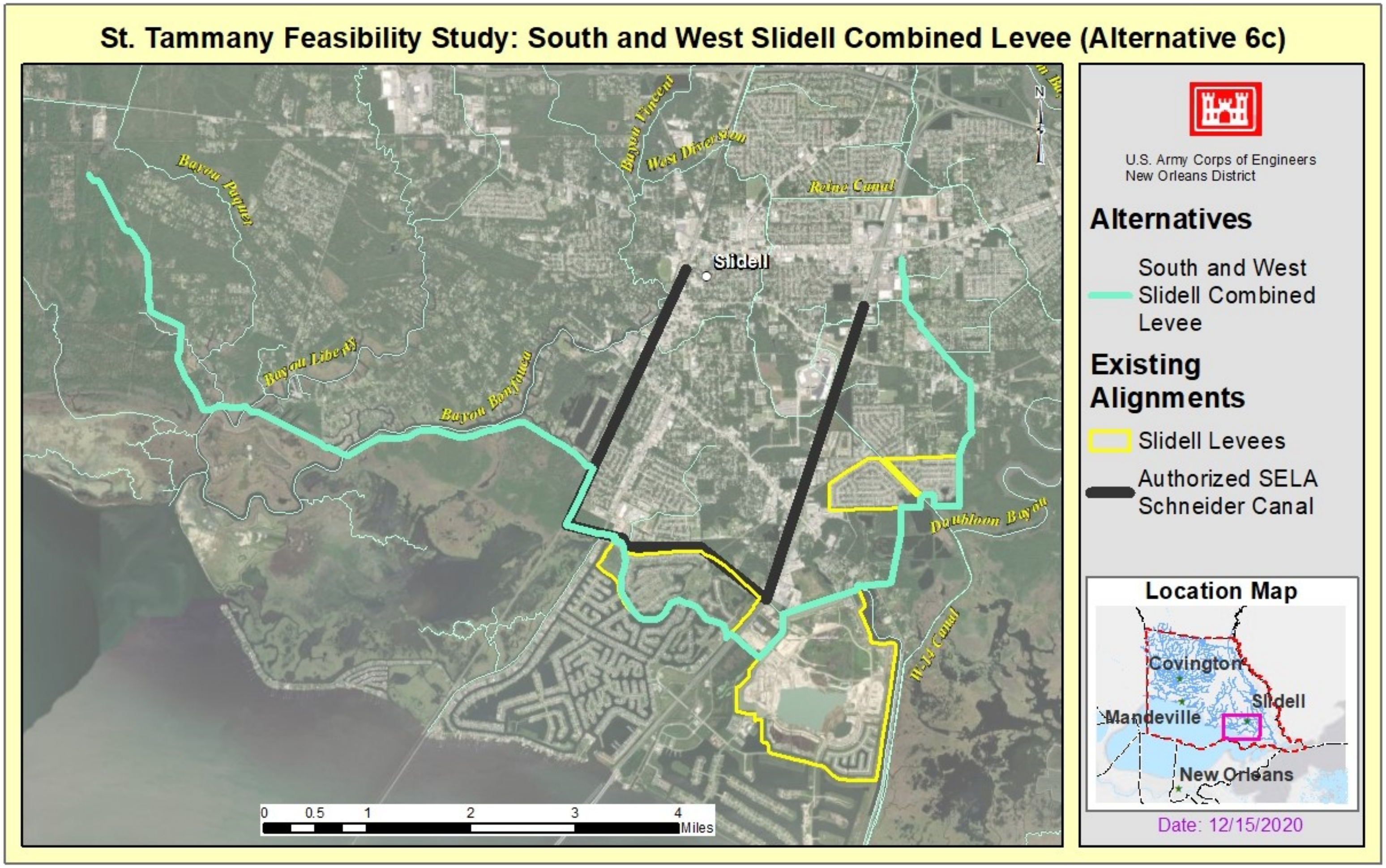


St. Tammany Parish Feasibility Study: Alternative 6a - Slidell Levee

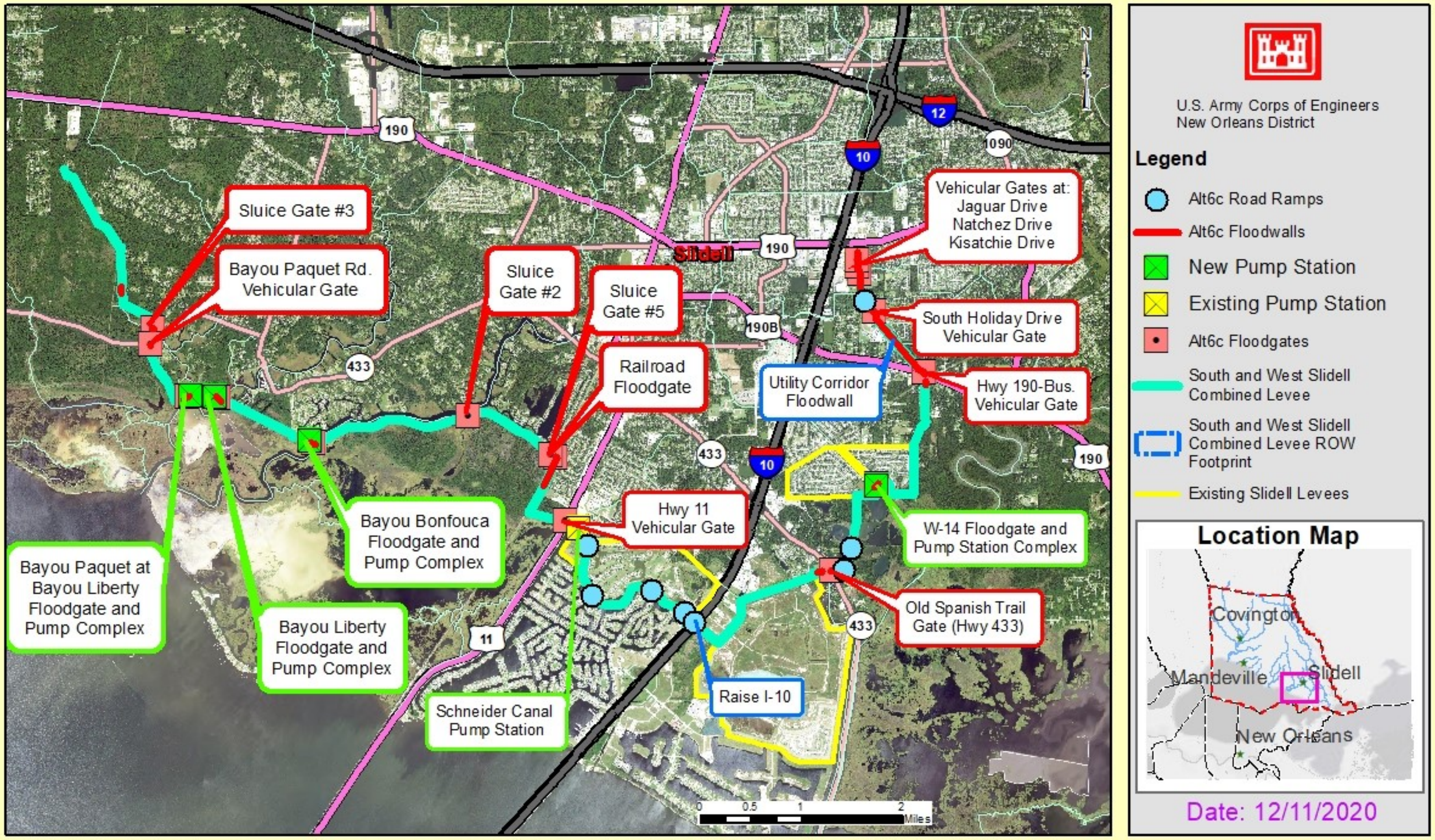


St. Tammany Parish Feasibility Study: Alternative 6b - Eden Isle Levee

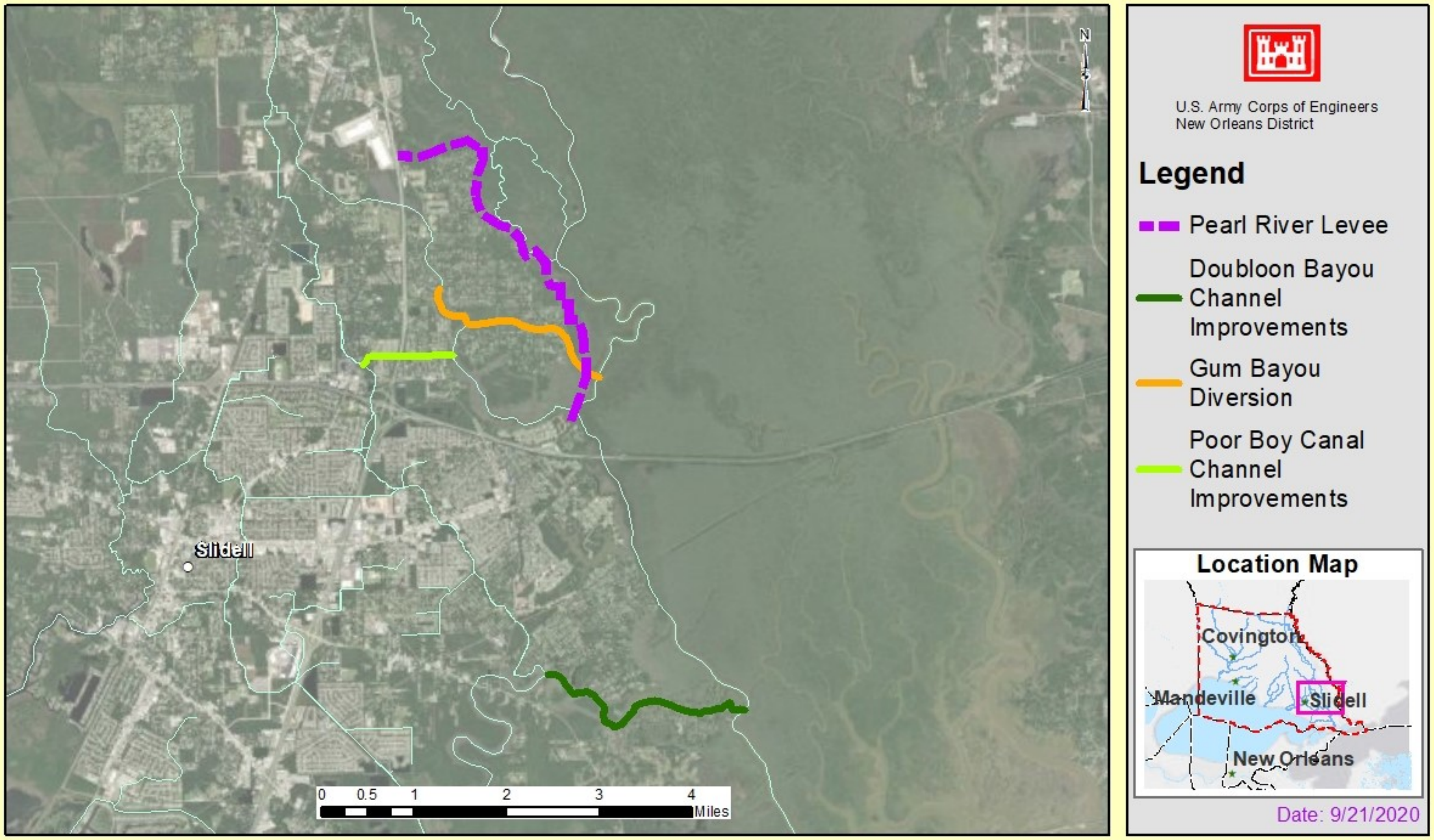



St. Tammany Feasibility Study: South and West Slidell Combined Levee (Alternative 6c)
Bayou Paquet
Bayou Vincent
West Diversion
Reine Canal
Slidell
Bayou Liberty
Bayou Bonfouca
Doubloon Bayou
W-14 Canal
0 0.5 1 2 3 4 Miles
U.S. Army Corps of Engineers
New Orleans District
Alternatives
South and West Slidell Combined Levee
Existing Alignments
Slidell Levees
Authorized SELA Schneider Canal
Location Map
Covington
Slidell
Mandeville
New Orleans
Date: 12/15/2020

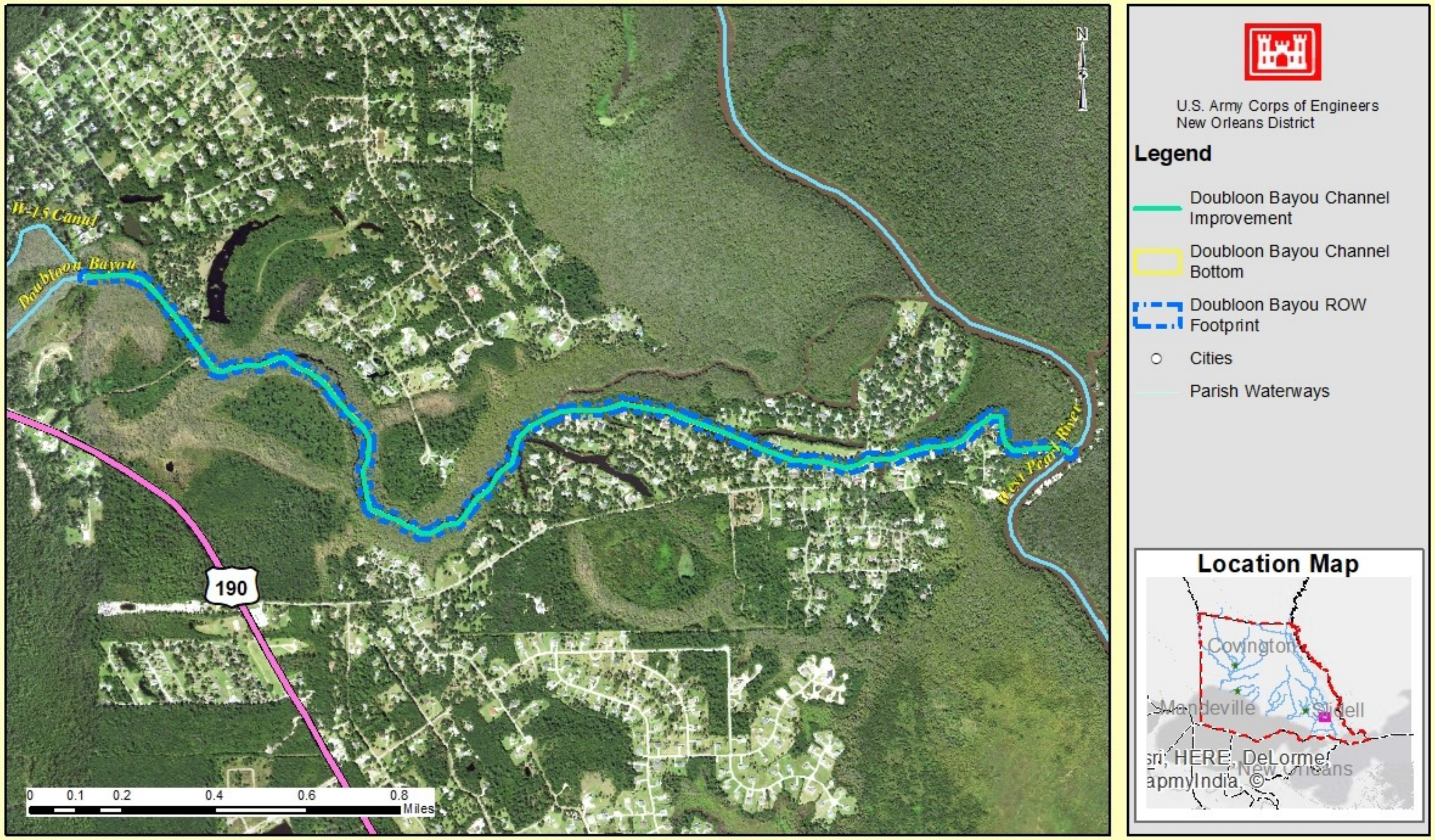
St. Tammany Parish Study: Alternative 6c - South and West Slidell Combined Levee



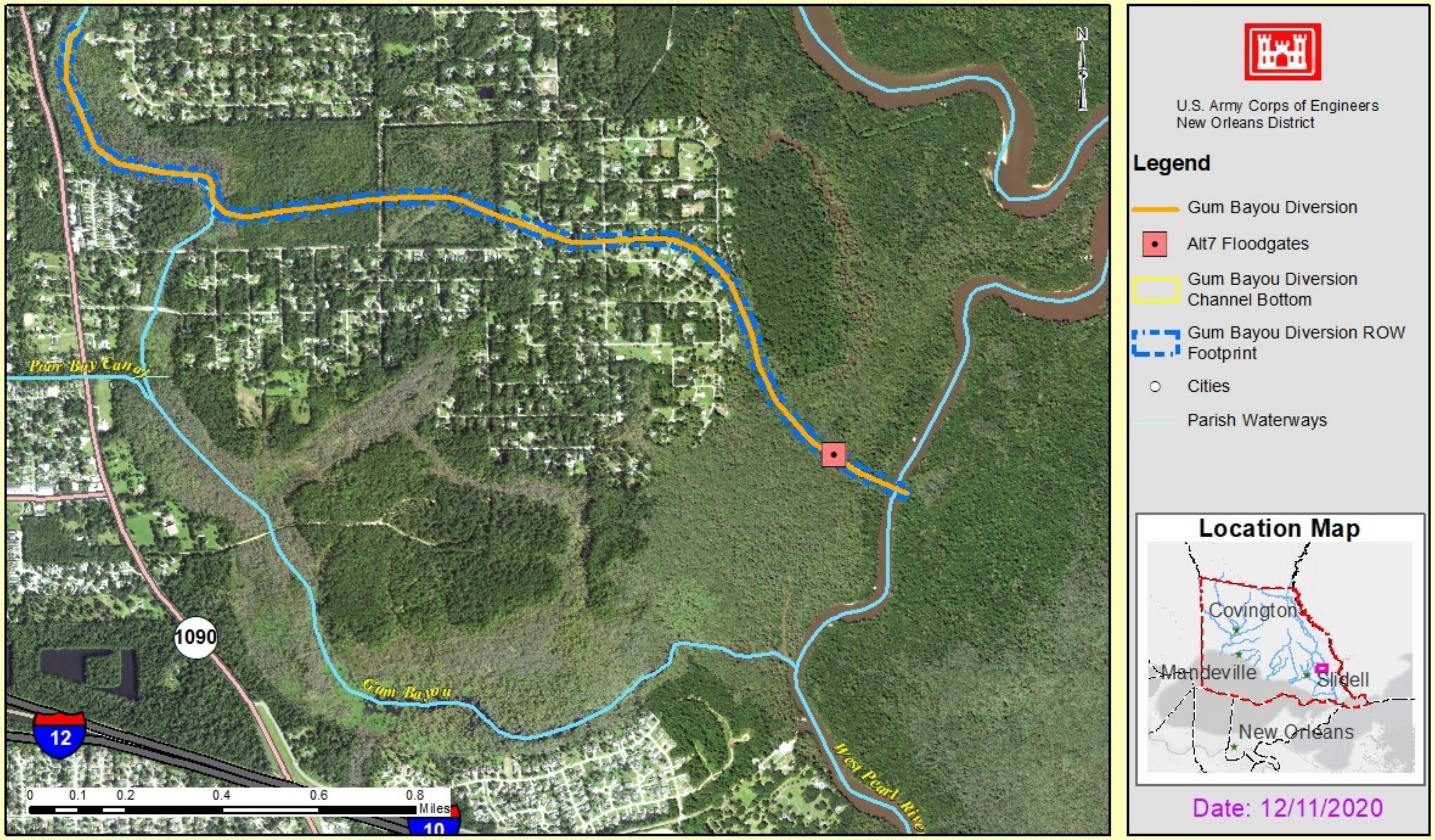
St. Tammany Feasibility Study: Eastern Slidell (Alternative 7)



St. Tammany Parish Feasibility Study: Alternative 7 - Doubloon Bayou

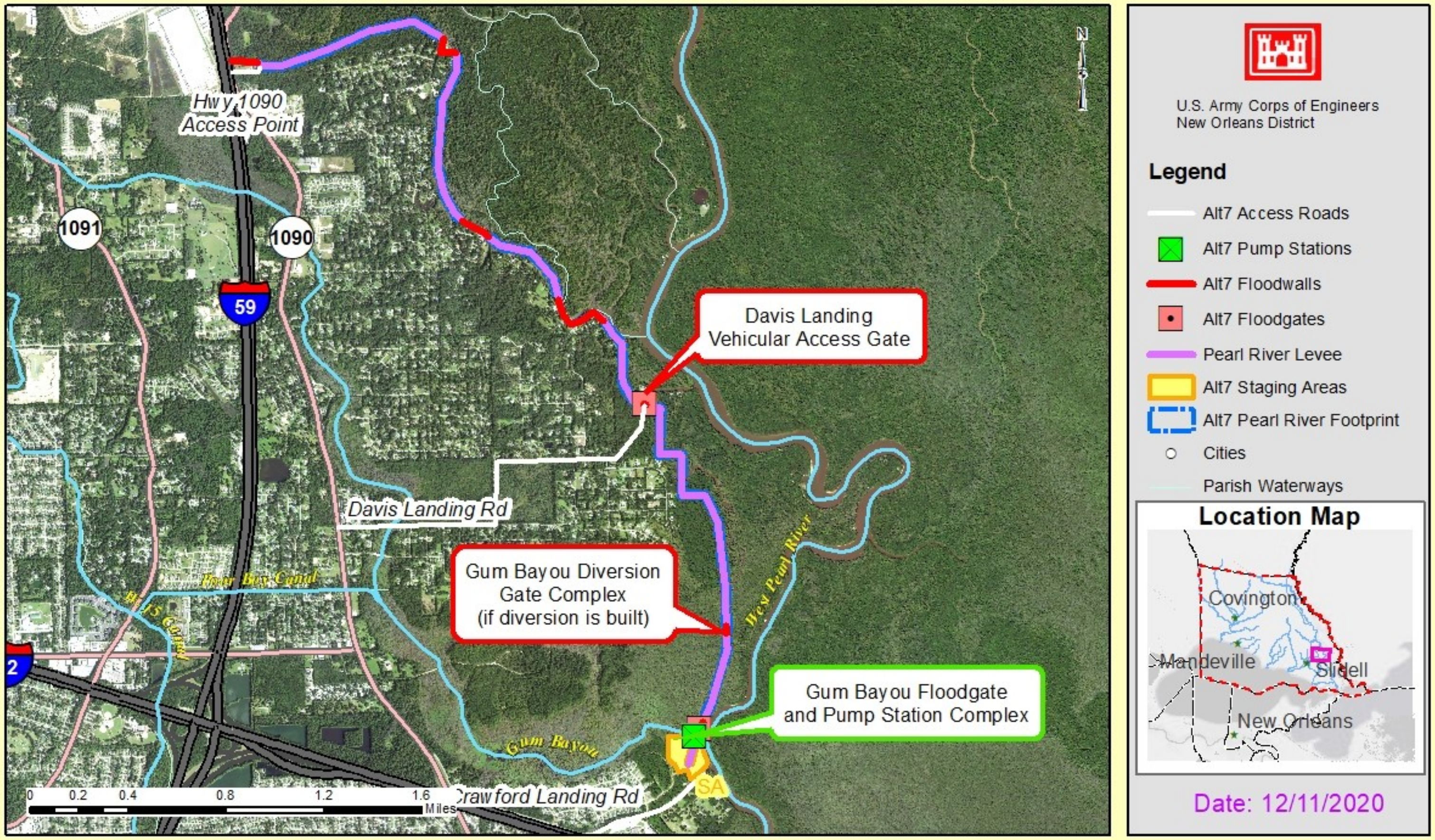


St. Tammany Parish Feasibility Study: Alternative 7 - Gum Bayou Diversion



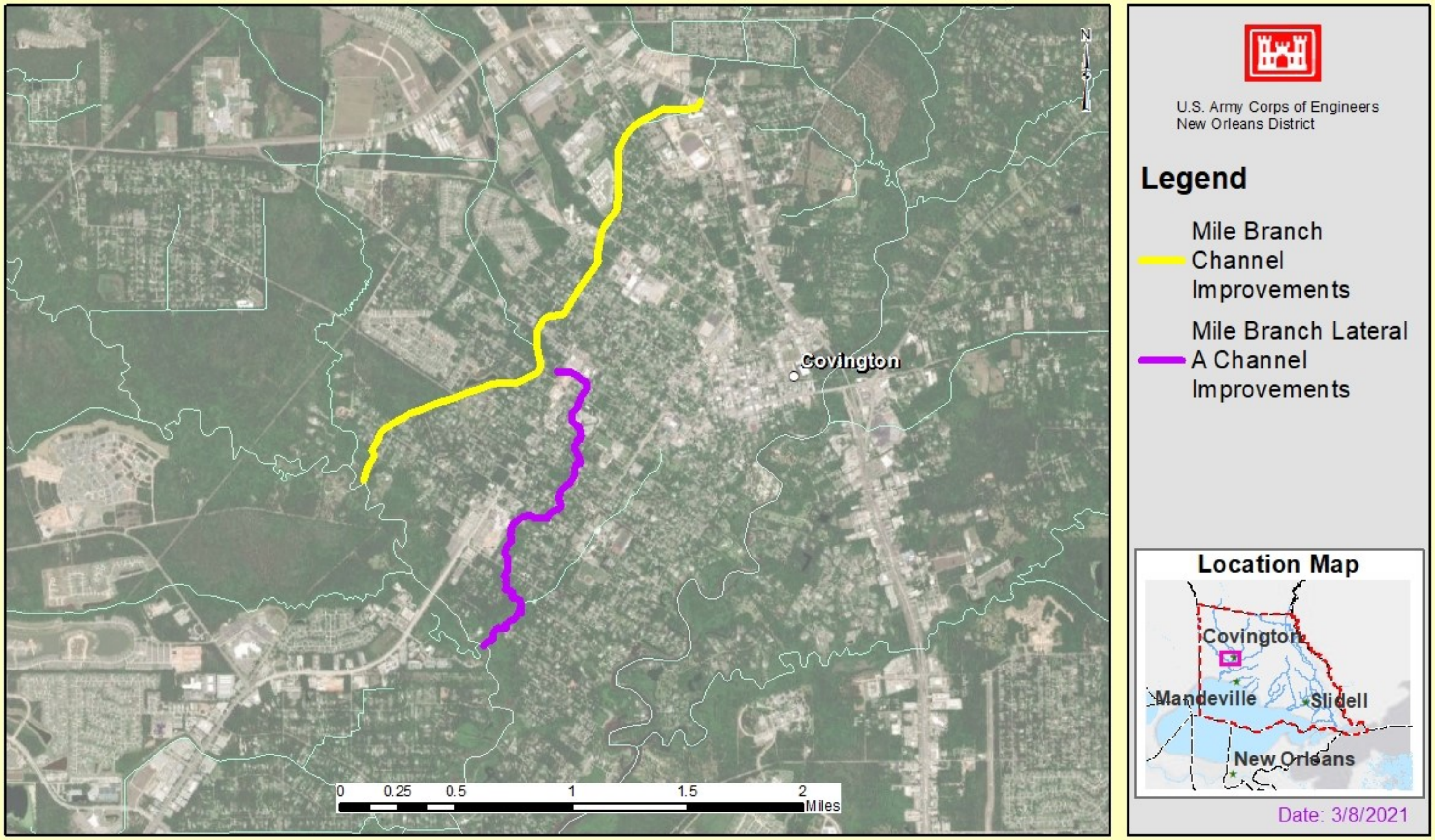
Date: 12/11/2020

St. Tammany Parish Feasibility Study: Alternative 7 - Pearl River Levee

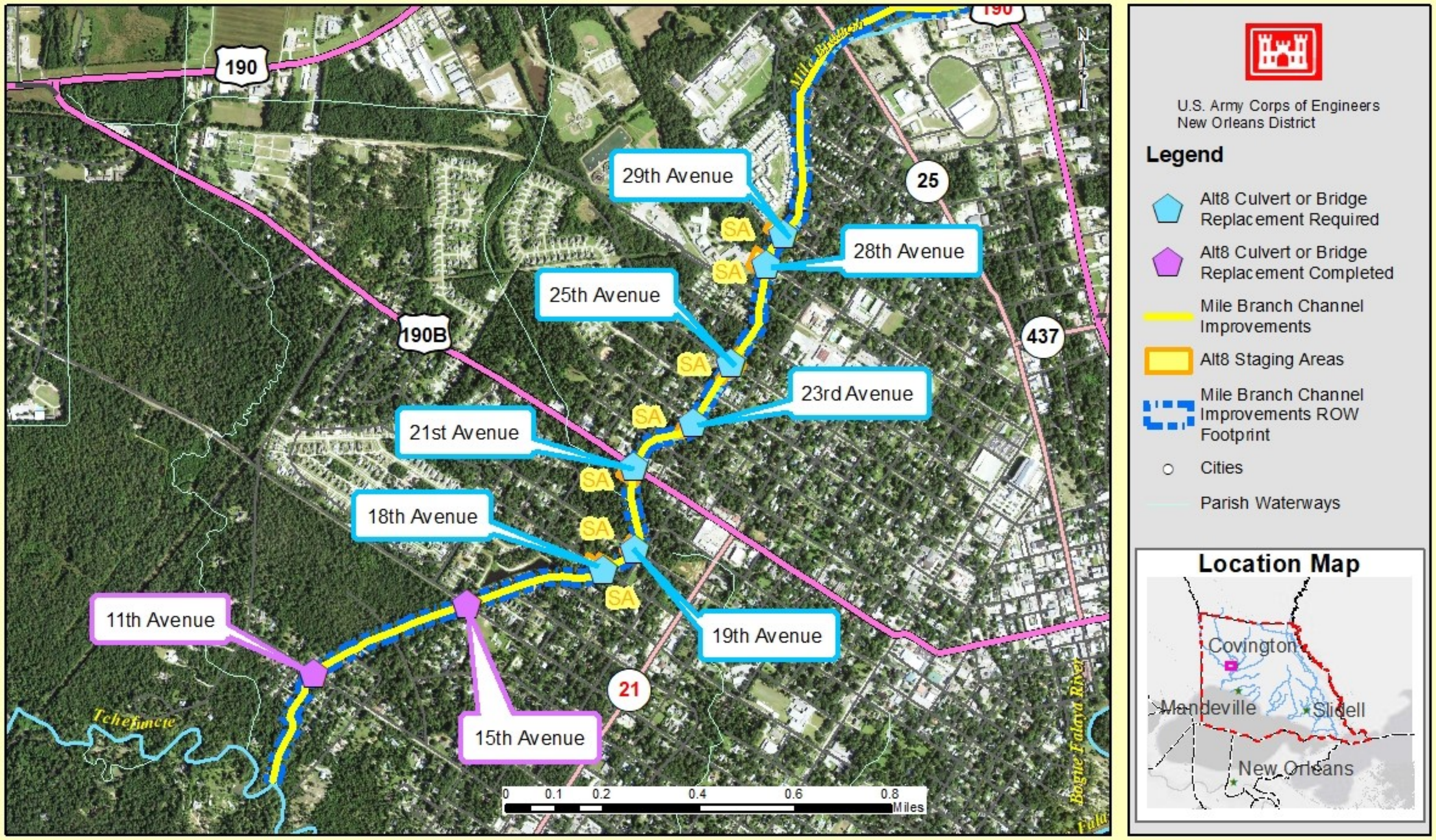


St. Tammany Parish Feasibility Study: Alternative 7 - Poor Boy Canal

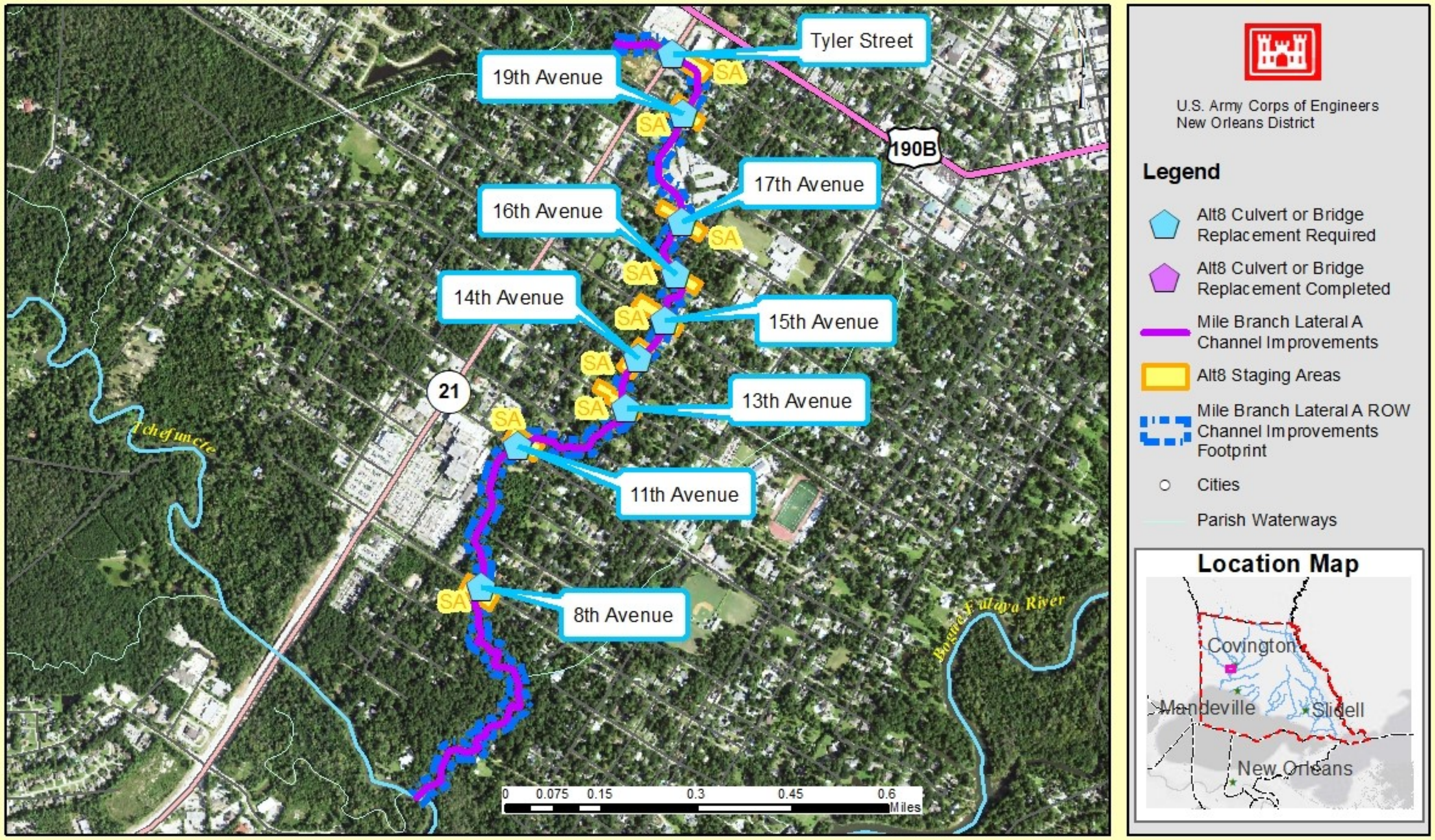
St. Tammany Feasibility Study: Upper Tchefuncte/ Covington (Alternative 8)



St. Tammany Parish Feasibility Study: Alternative 8 - Mile Branch Channel Improvements

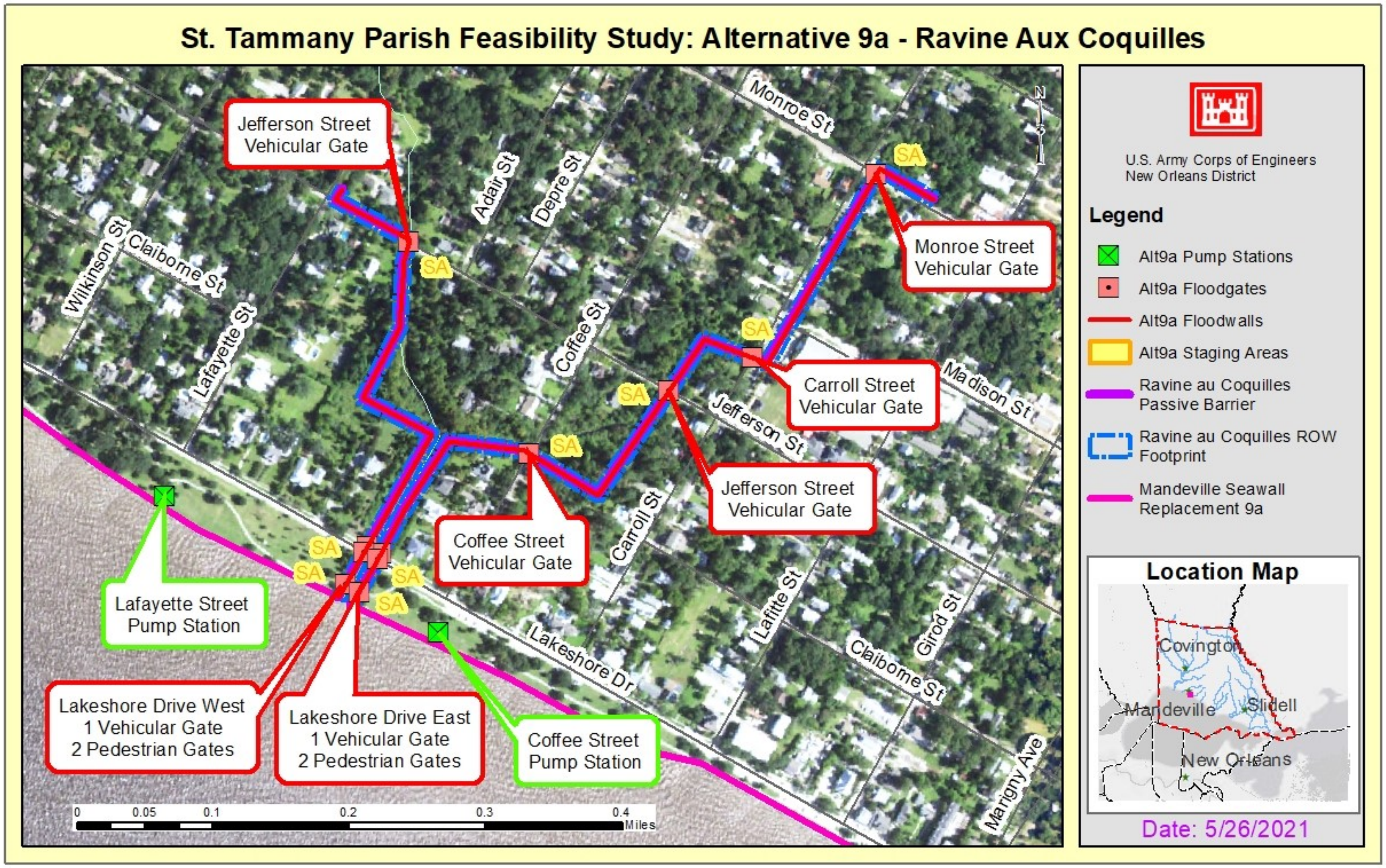


St. Tammany Parish Feasibility Study: Alternative 8 - Mile Branch Lateral A Channel Improvements

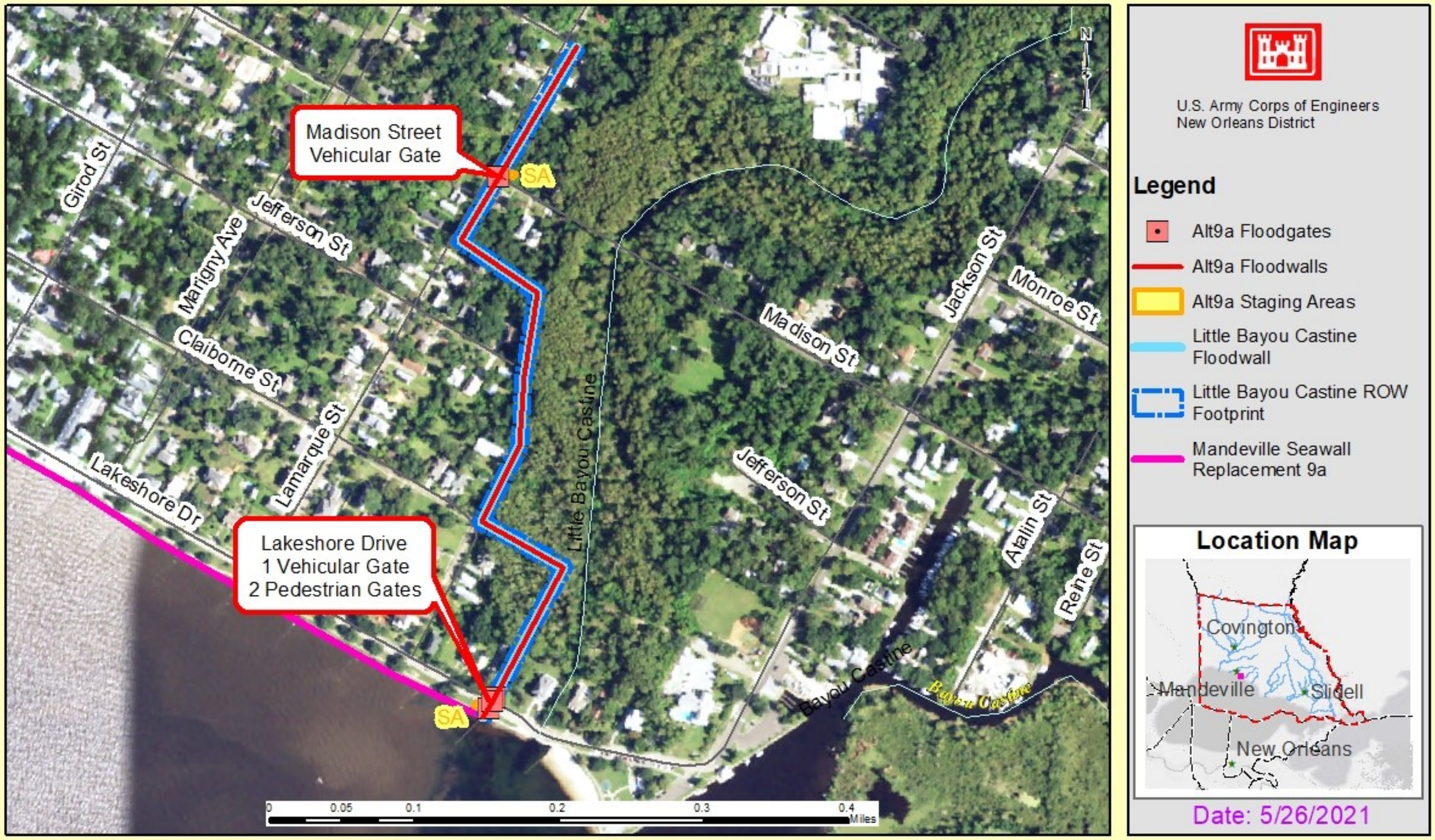


St. Tammany Feasibility Study: Mandeville Lakefront (Alternative 9)

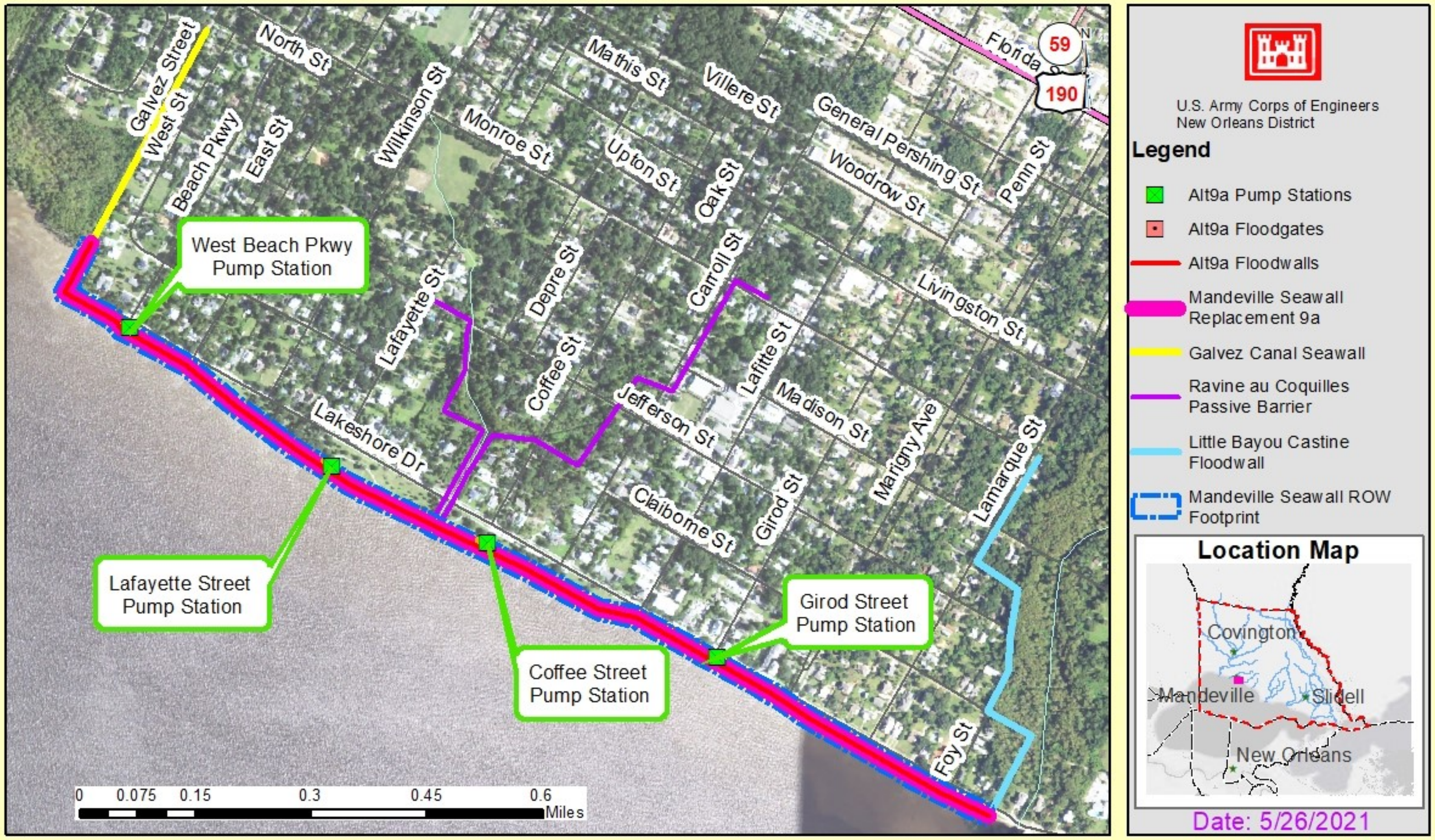
St. Tammany Parish Feasibility Study: Alternative 9a - Galvez Canal Seawall


St. Tammany Parish Feasibility Study: Alternative 9a - Ravine Aux Coquilles
Jefferson Street Vehicular Gate
Monroe Street Vehicular Gate
Carroll Street Vehicular Gate
Jefferson Street Vehicular Gate
Coffee Street Vehicular Gate
Lafayette Street Pump Station
Lakeshore Drive West 1 Vehicular Gate 2 Pedestrian Gates
Lakeshore Drive East 1 Vehicular Gate 2 Pedestrian Gates
Coffee Street Pump Station
SA
Monroe St
Adair St
Depre St
Wilkinson St
Claiborne St
Lafayette St
Coffee St
Madison St
Jefferson St
Carroll St
Lafitte St
Girod St
Claiborne St
Lakeshore Dr
Marigny Ave
0 0.05 0.1 0.2 0.3 0.4 Miles
U.S. Army Corps of Engineers New Orleans District
Legend
Alt9a Pump Stations
Alt9a Floodgates
Alt9a Floodwalls
Alt9a Staging Areas
Ravine au Coquilles Passive Barrier
Ravine au Coquilles ROW Footprint
Mandeville Seawall Replacement 9a
Location Map
Covington
Mandeville
Slidell
New Orleans
Date: 5/26/2021

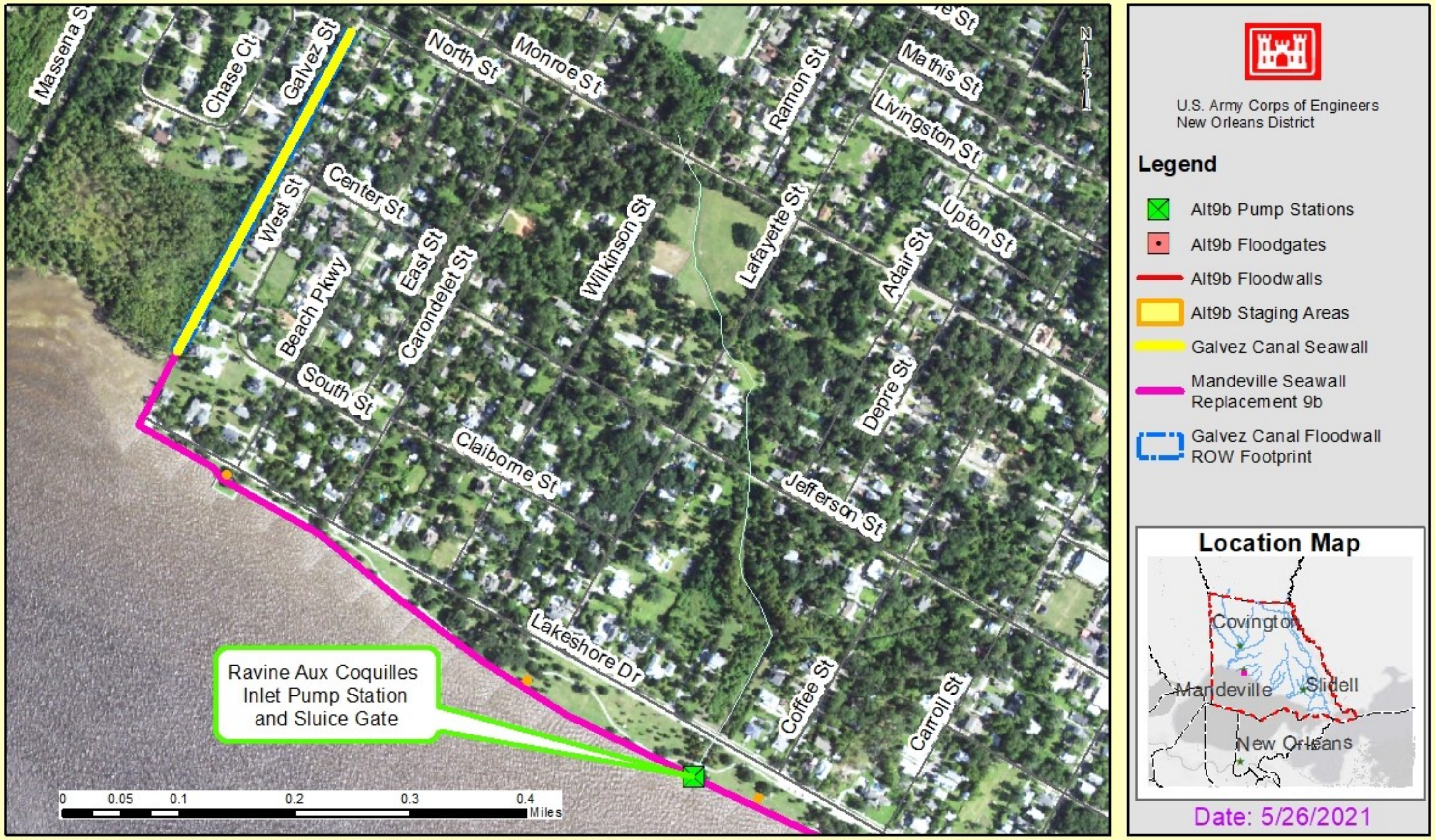
St. Tammany Parish Feasibility Study: Alternative 9a - Little Bayou Castine



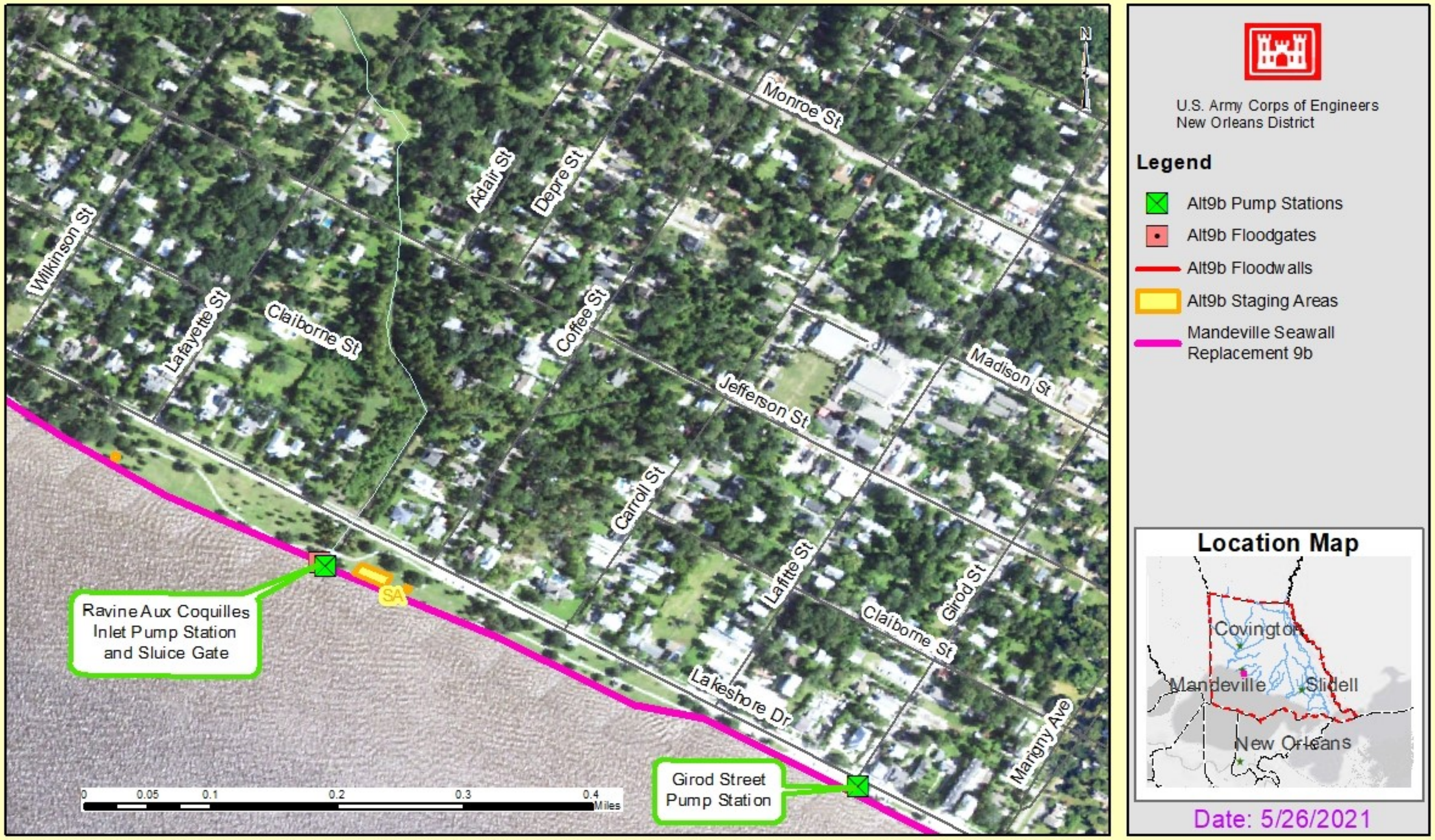
St. Tammany Parish Feasibility Study: Alternative 9a - Mandeville Seawall



St. Tammany Parish Feasibility Study: Alternative 9b - Galvez Canal Seawall

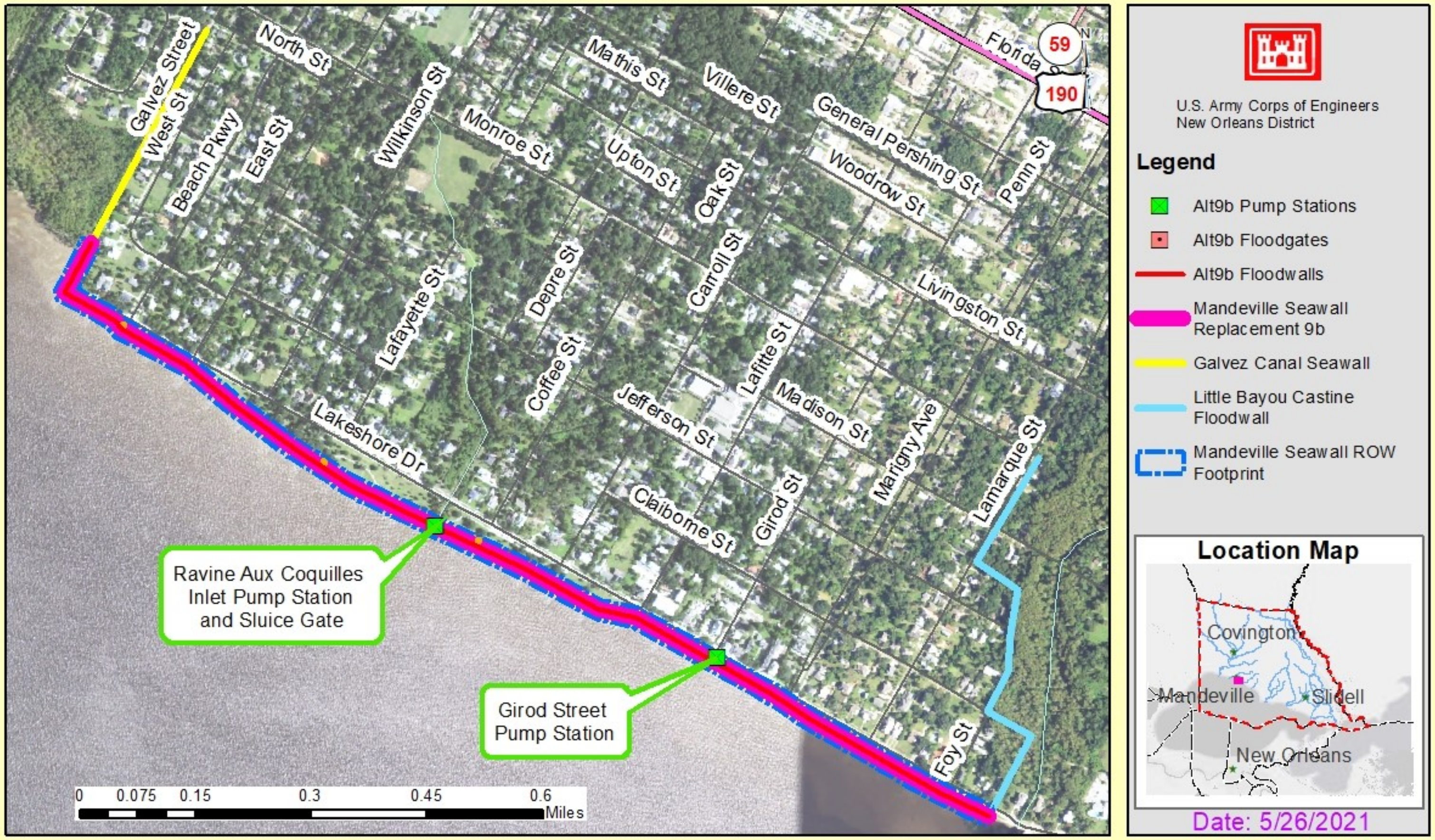


St. Tammany Parish Feasibility Study: Alternative 9b - Ravine Aux Coquilles

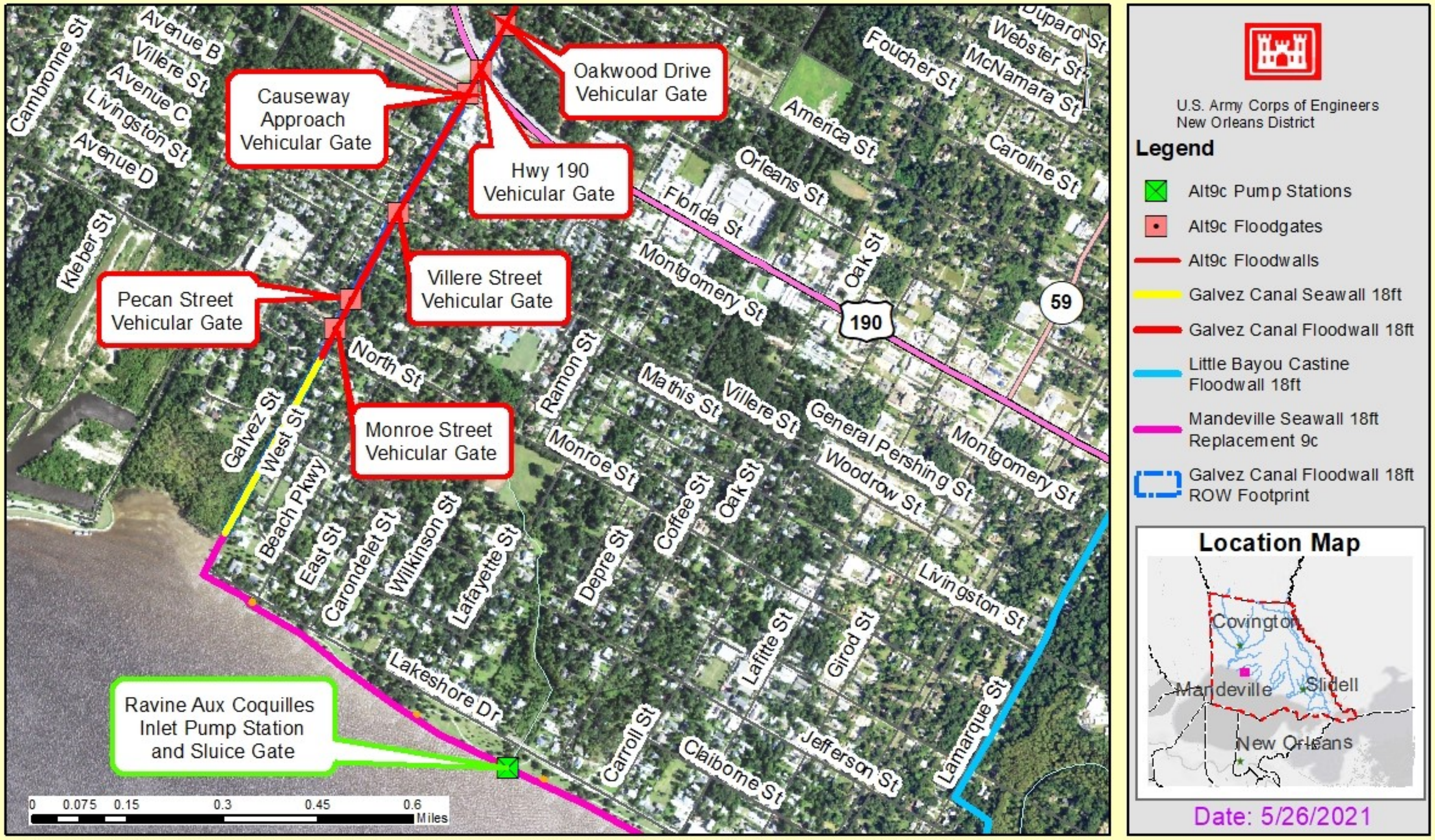


St. Tammany Parish Feasibility Study: Alternative 9b - Little Bayou Castine

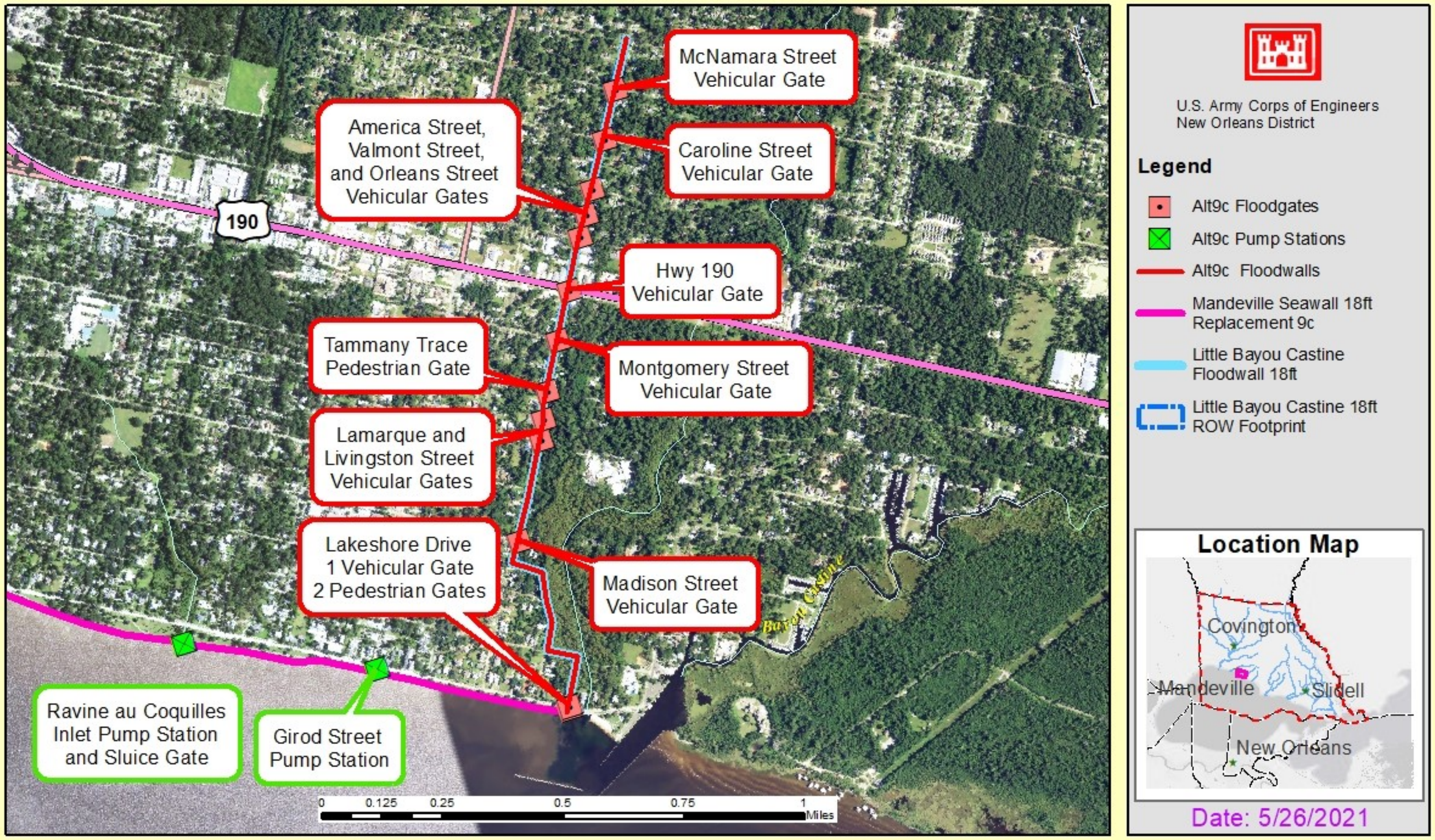
St. Tammany Parish Feasibility Study: Alternative 9b - Mandeville Seawall



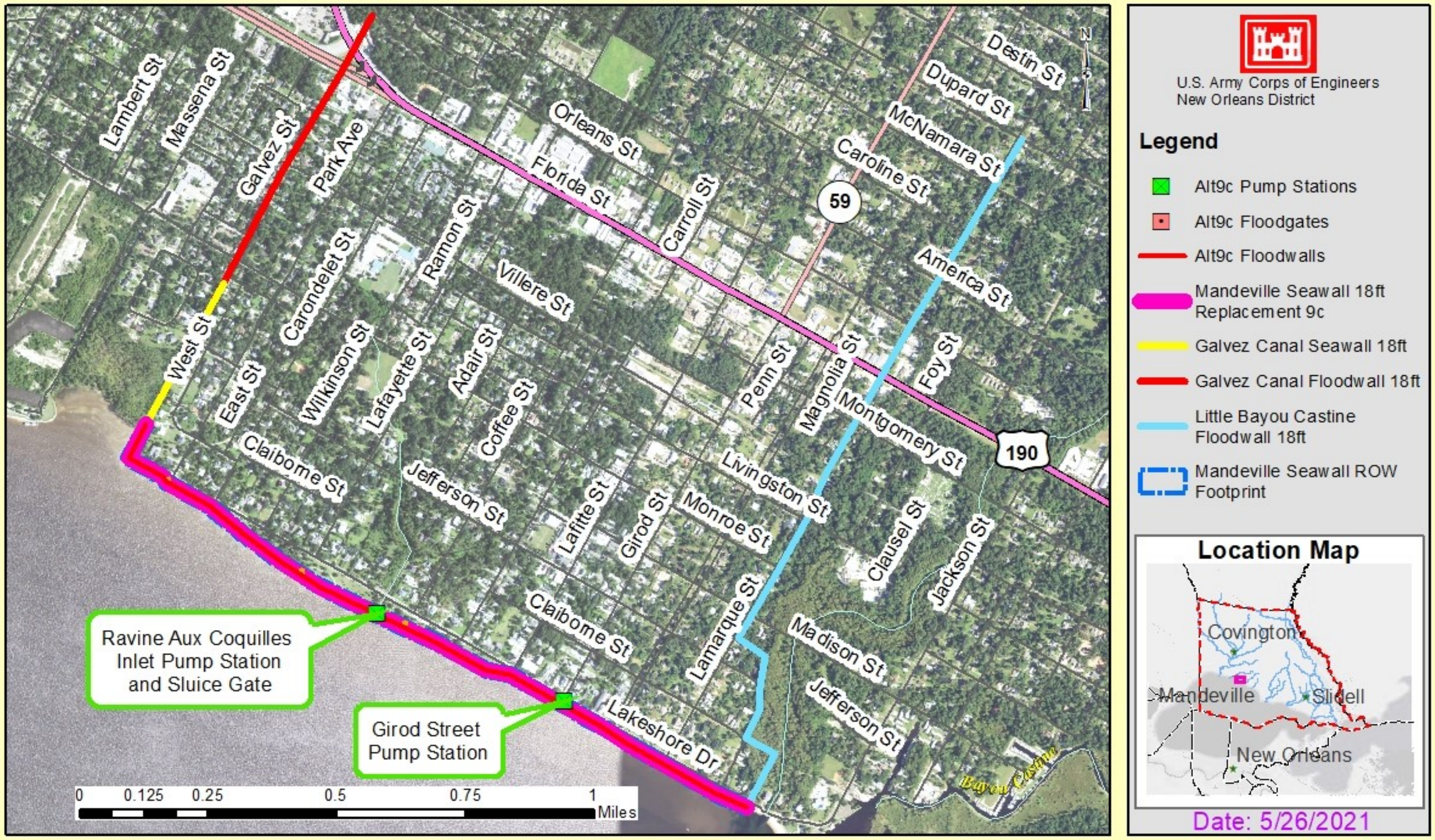
St. Tammany Feasibility Study: Alternative 9c - Galvez Canal Seawall and Floodwall 18 ft



St. Tammany Feasibility Study: Alternative 9c - Little Bayou Castine 18 ft



St. Tammany Feasibility Study: Alternative 9c - Mandeville Seawall 18 ft



ANNEX 2
Relocations

South and West Slidell Combined Levee - West Side Detail with Relocations

ANNEX 3

Geotech

SECTION 1

Maps of Closest Borings

Borings from Eustis Job 09318

Used for

Lacombe Levees Alternative 4

Boring 09318
western det basin 21309 (10')
Location 4
detention basin 21311 (10')
Marina 09318 (40')
Location 5
detention basin 21312 (10')
Google Earth
4 mi
N

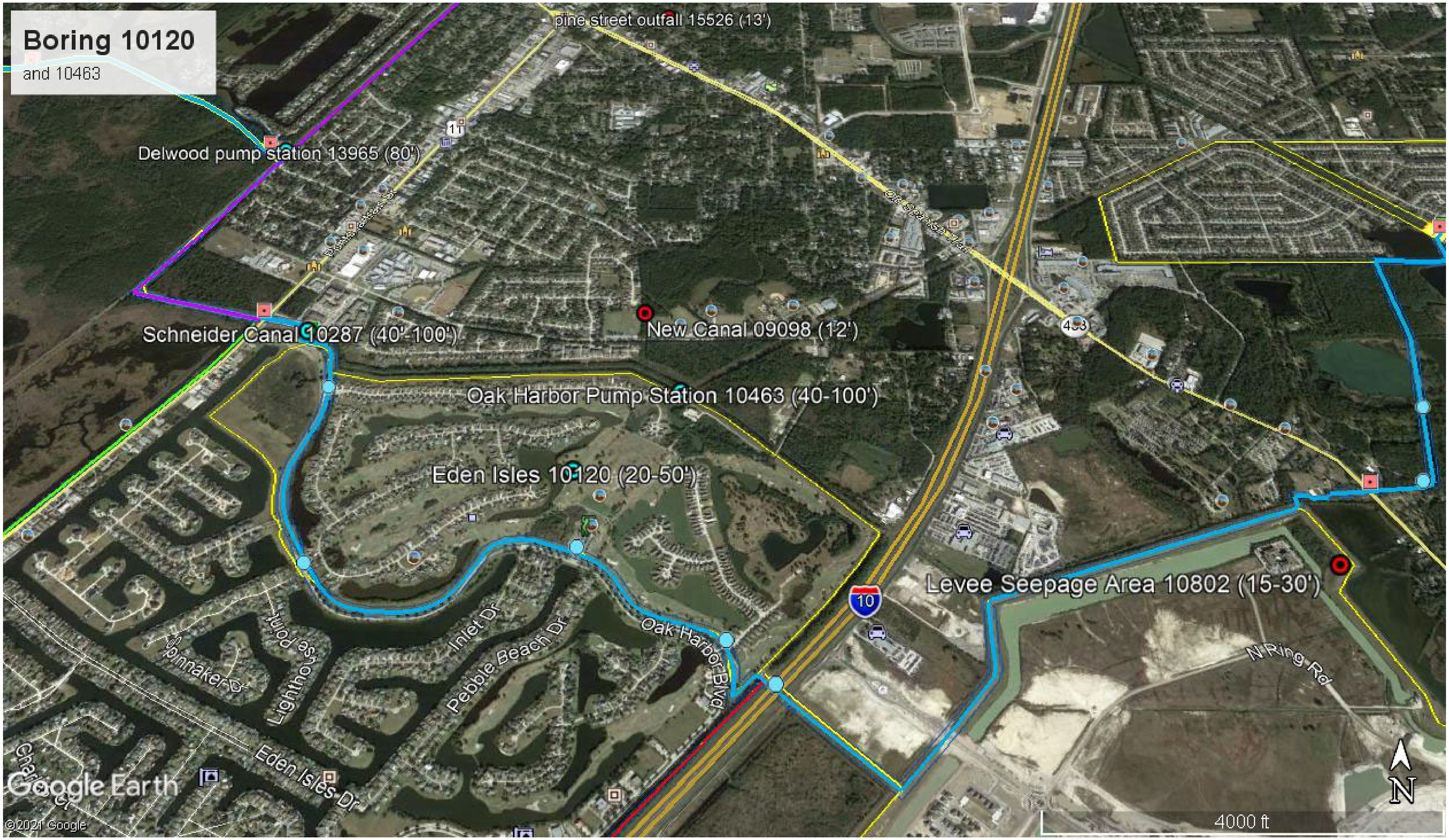
Borings from Eustis Job 10120

Used for South Slidell Levees Alternative 6

Borings from Eustis Job 10463

Used for

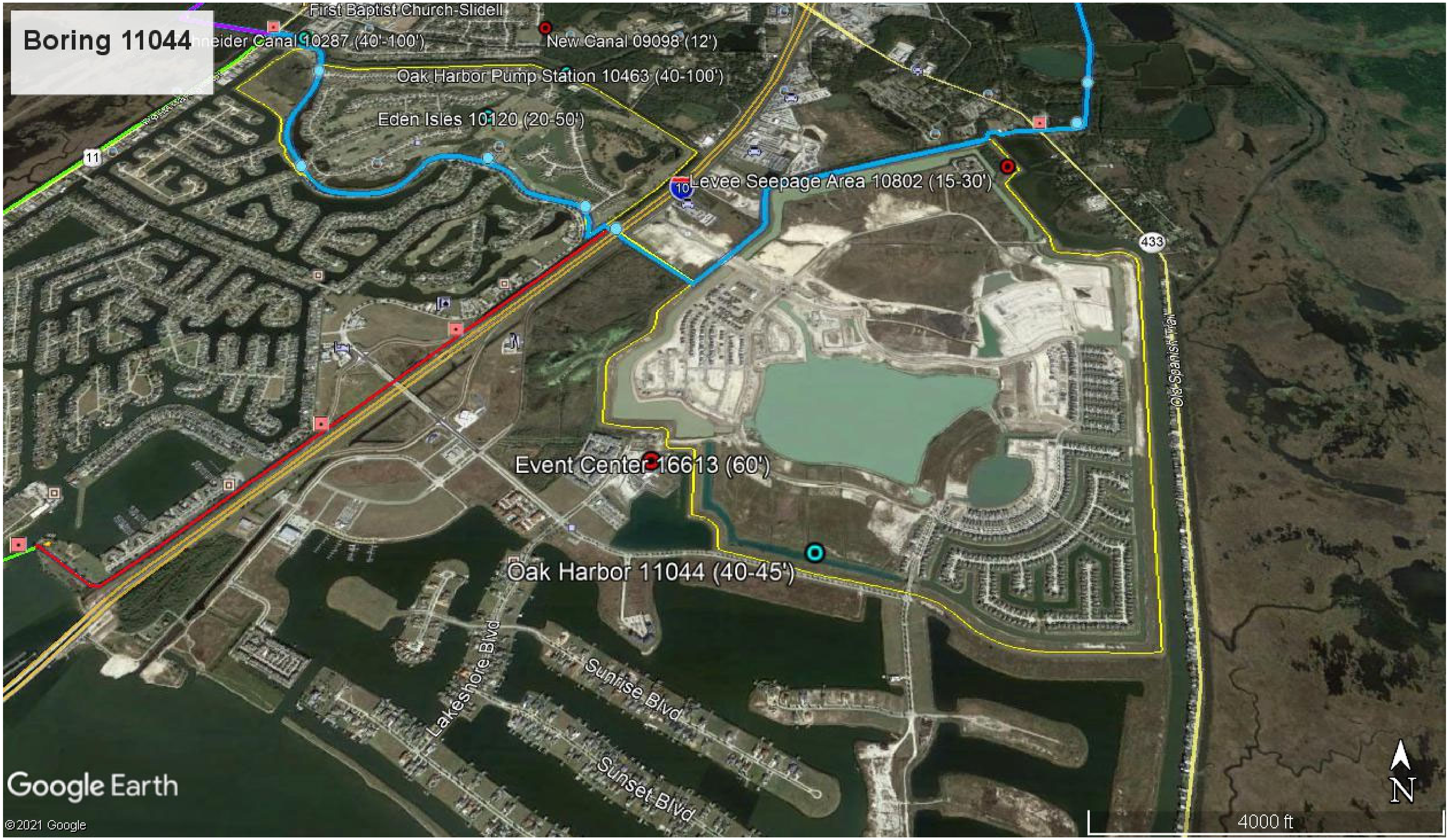
W-14 Floodgate/Old Spanish Trail Floodgate Alternative 6



Boring 10120
and 10463
pine street outfall 15526 (13')
Delwood pump station 13965 (80')
Schneider Canal 10287 (40'-100')
New Canal 09098 (12')
Oak Harbor Pump Station 10463 (40-100')
Eden Isles 10120 (20-50')
Levee Seepage Area 10802 (15-30')
Oak Harbor Blvd
Inlet Dr
Pebble Beach Dr
Spinnaker Dr
Lighthouse Point
Eden Isles Dr
N Ring Rd
10
Google Earth
©2021 Google
4000 ft
N

Borings from Eustis Job 11044

Used for South Oak Harbor Levees Alternative 6

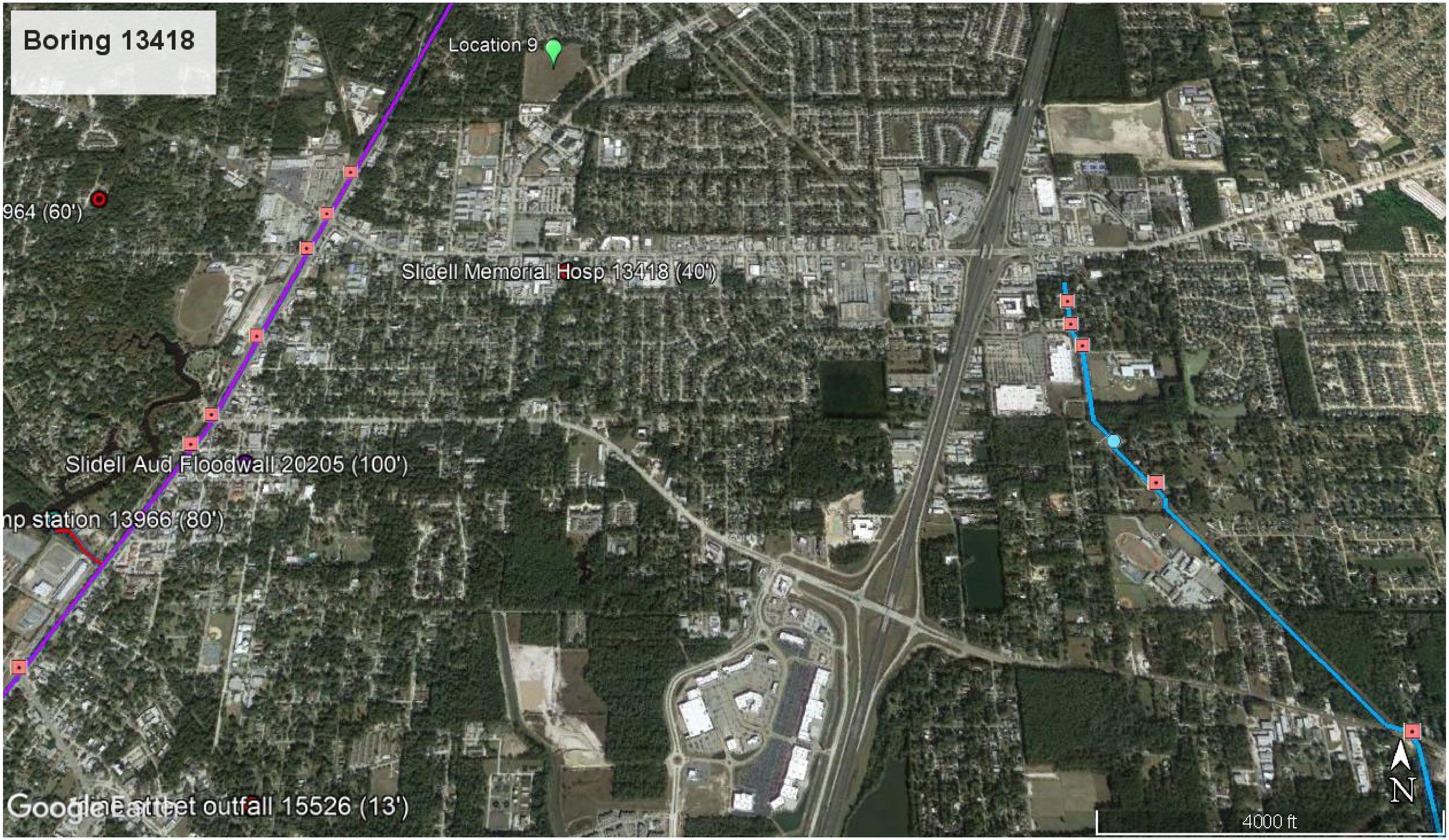


Boring 11044
First Baptist Church-Slidell
Schneider Canal 10287 (40'-100')
New Canal 09098 (12')
Oak Harbor Pump Station 10463 (40-100')
Eden Isles 10120 (20-50')
Levee Seepage Area 10802 (15-30')
Event Center 16613 (60')
Oak Harbor 11044 (40-45')
Lakeshore Blvd
Sunrise Blvd
Sunset Blvd
Old Spanish Trail
11
10
433
Google Earth
©2021 Google
4000 ft
N

Borings from Eustis Job 13418

Used for

Pearl River Levees Alternative 7



Boring 13418
Location 9
964 (60')
Slidell Memorial Hosp 13418 (40')
Slidell Aud Floodwall 20205 (100')
np station 13966 (80')
street outfall 15526 (13')
4000 ft
N

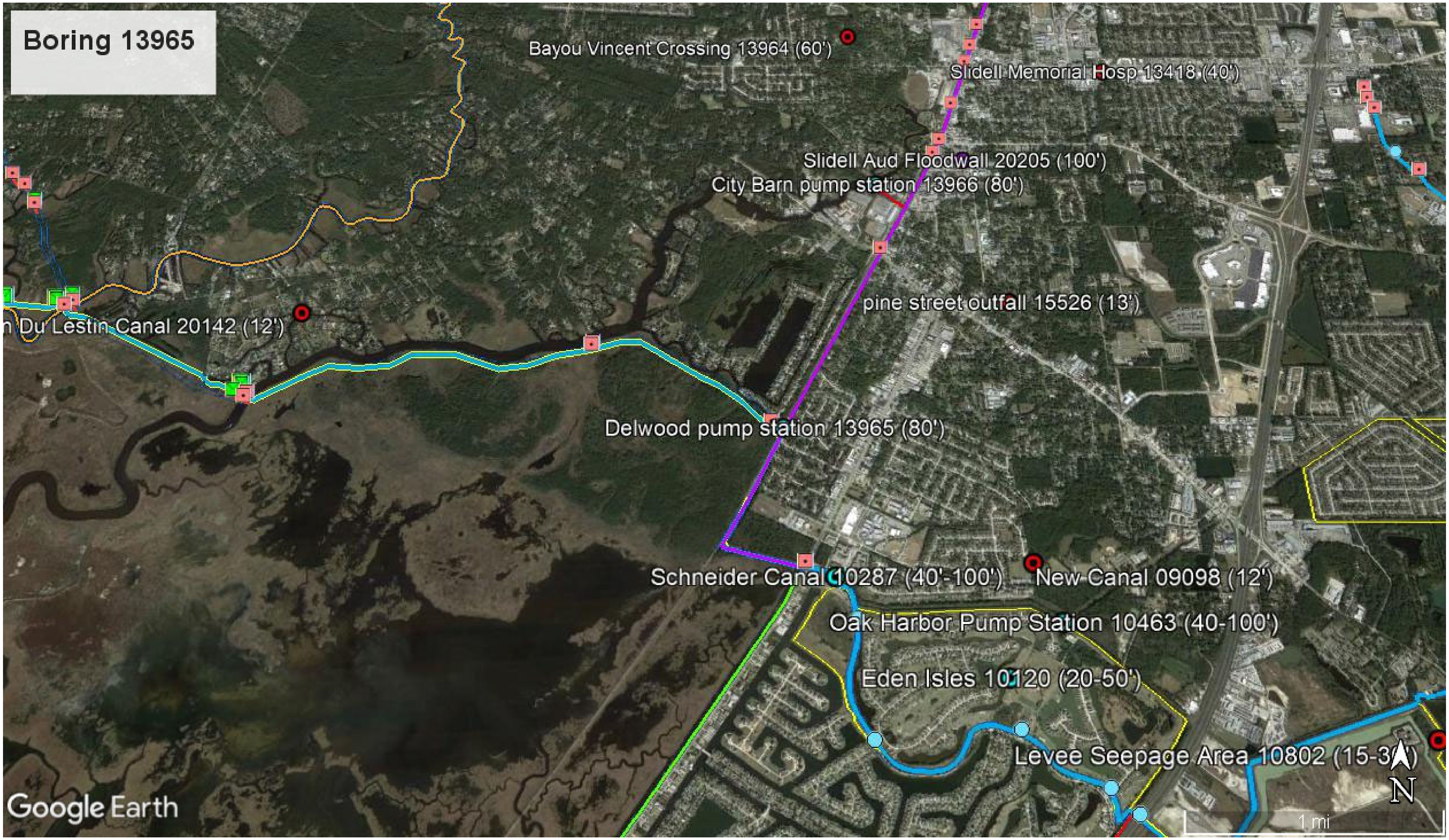
Borings from Eustis Job 13965

Used for

Bayou Lacombe Flood Gate Alternative 4

Bayou Liberty/Bayou Vincent/Bayou Bonfouca Structures Alternative 5

West Slidell Levees Alternative 5

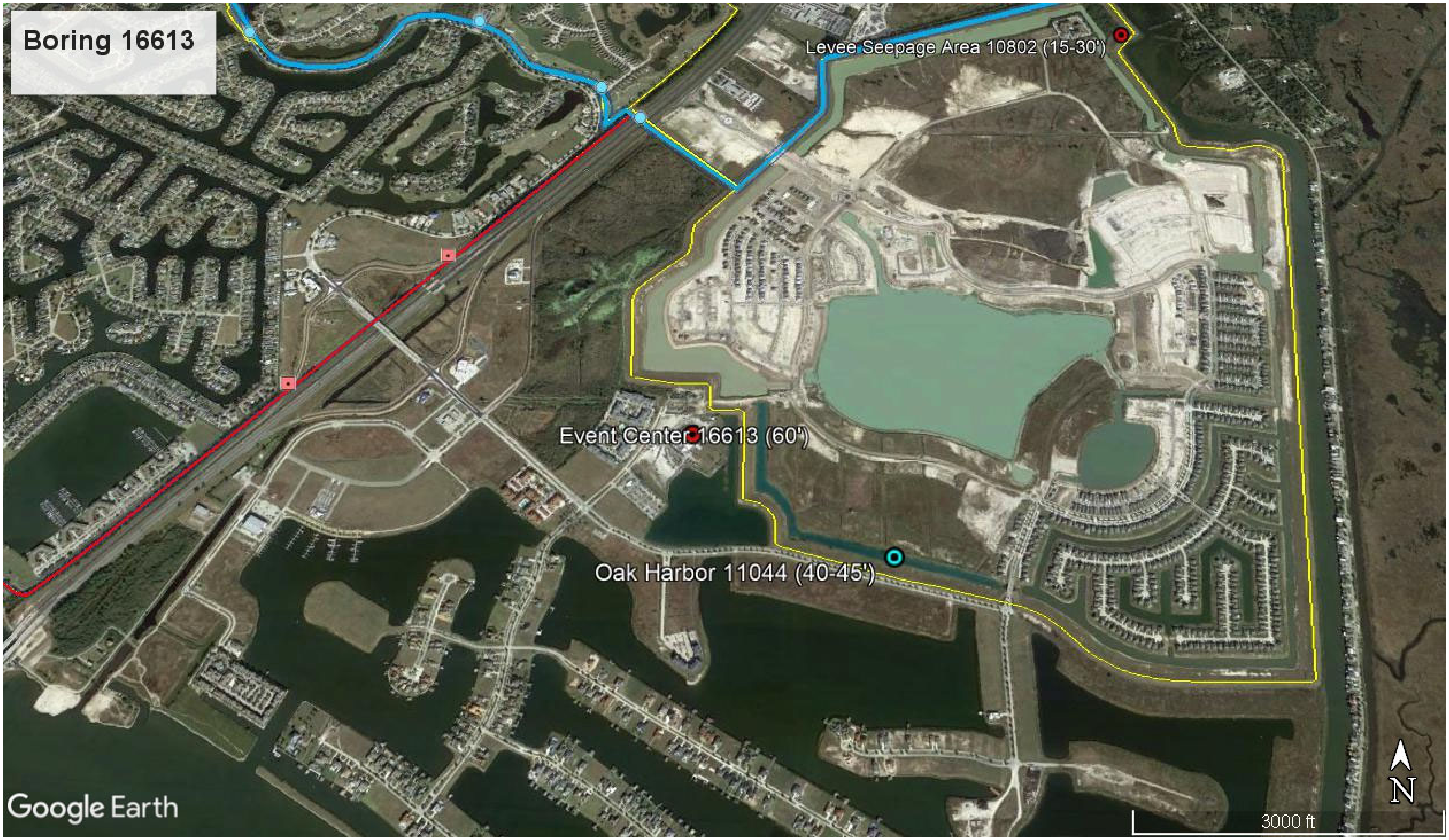

Boring 13965
Bayou Vincent Crossing 13964 (60')
Slidell Memorial Hosp 13418 (40')
Slidell Aud Floodwall 20205 (100')
City Barn pump station 13966 (80')
pine street outfall 15526 (13')
Du Lestin Canal 20142 (12')
Delwood pump station 13965 (80')
Schneider Canal 10287 (40'-100')
New Canal 09098 (12')
Oak Harbor Pump Station 10463 (40-100')
Eden Isles 10120 (20-50')
Levee Seepage Area 10802 (15-3
Google Earth
N
1 mi

Borings from Eustis Job 16613

Used for

Eden Isle Levees Alternative 6

Eden Isle Structures/I-10 Gates Alternative 6


Boring 16613
Levee Seepage Area 10802 (15-30')
Event Center 16613 (60')
Oak Harbor 11044 (40-45')
Google Earth
N
3000 ft

SECTION 2

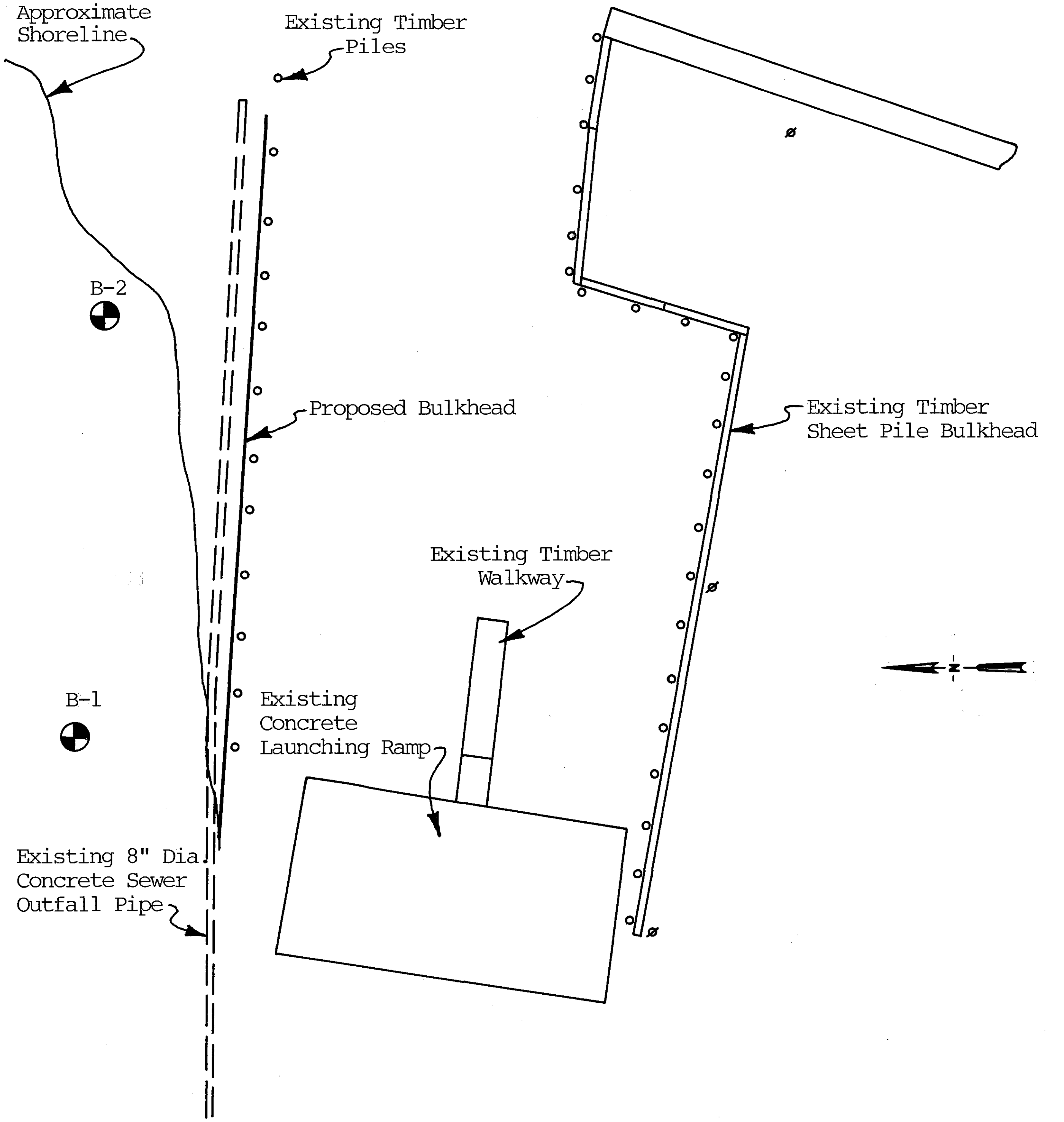
Borings Taken from

Eustis St. Tammany Projects

Borings from Eustis Job 09318

Used for

Lacombe Levees Alternative 4



LOCATION OF BORINGS

Scale: 1" = 20'

Geotechnical Investigation
City of Mandeville
Marina Improvements
Mandeville, Louisiana

For: City of Mandeville, Louisiana

Dyer & Moody, Inc., Consulting Engineers, Baker, Louisiana

Fig. 1

EUSTIS ENGINEERING COMPANY
SOIL AND FOUNDATION CONSULTANTS
METAIRIE, LOUISIANA

LOG OF BORING

EUSTIS ENGINEERING COMPANY

SOIL AND FOUNDATION CONSULTANTS

METAIRIE, LA.

Name of Project: City of Mandeville

Marina Improvements, Mandeville, Louisiana

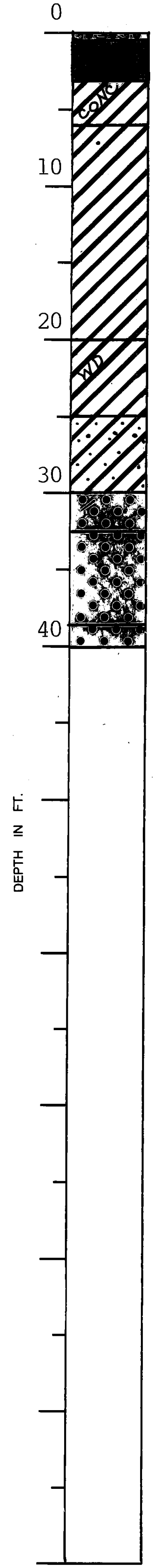
For: City of Mandeville, Louisiana

Dyer & Moody, Inc., Consulting Engineers, Baker, Louisiana

Boring No. 1 **Soil Technician** R. Elkins **Date** 26 December 1985

Ground Elev. ______ **Datum** ______ **Gr. Water Depth** See Text

Sample No.	SAMPLE Depth — Feet		DEPTH STRATUM Feet		VISUAL CLASSIFICATION	*STANDARD PENETRATION TEST	
	From	To	From	To			
			0.0	0.5	Compact gray shells & sand		
1	1.5	2.5	0.5	3.0	Very soft gray sandy clay w/silty sand		
					& humus layers		
2	4.5	5.5	3.0	6.0	Soft gray & tan clay w/concretions		
3	7.5	8.5	6.0		Medium stiff to stiff gray & tan clay		
					w/trace of sand		
4	10.5	11.5			Ditto		
5	13.5	14.5			Medium stiff to stiff gray & tan clay		
6	18.0	19.0		20.0	Ditto		
7	23.0	24.0	20.0	25.0	Stiff gray clay w/some decayed wood		
8	28.0	29.0	25.0	30.0	Stiff greenish-gray sandy clay w/sand		
					layers		
9	30.0	31.5	30.0	32.5	Dense greenish-gray sand w/trace of	10	42
					clay		
10	32.5	34.0	32.5		Dense gray sand	7	41
11	35.0	36.5		38.5	Ditto	5	38
12	38.5	40.0	38.5	40.0	Very dense gray sand	14	50=10"

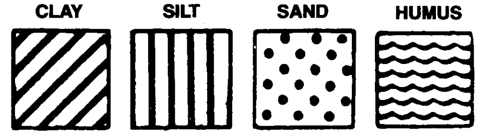


*Number in first column indicates number of blows of 140-lb. hammer dropped 30 in. required to seat 2-in. O. D. splitspoon sampler 6 in. Number in second column indicates number of blows of 140-lb. hammer dropped 30 in. required to drive 2-in. O. D. splitspoon sampler 1 ft. after seating 6 in.

WHILE THIS LOG OF BORING IS CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT ITS RESPECTIVE LOCATION ON THE DATE SHOWN, IT IS NOT WARRANTED THAT IT IS REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

Remarks: ______

CLAY SILT SAND HUMUS



Predominant type shown heavy. Modifying type shown light.

Fig. 2

LOG OF BORING

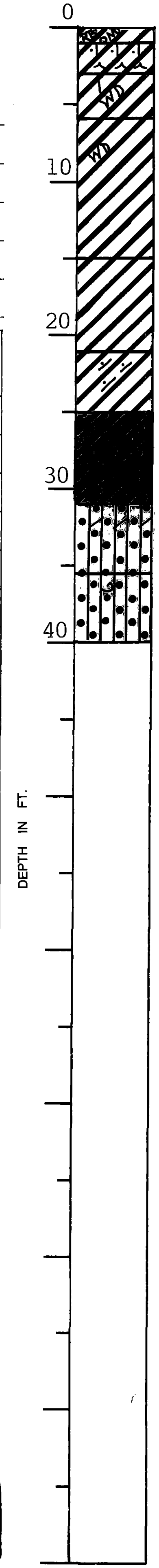
EUSTIS ENGINEERING COMPANY
SOIL AND FOUNDATION CONSULTANTS
METAIRIE, LA.

Name of Project: City of Mandeville
Marina Improvements, Mandeville, Louisiana
For: City of Mandeville, Louisiana
Dyer & Moody, Inc., Consulting Engineers, Baker, Louisiana

Boring No. 2 **Soil Technician** R. Elkins **Date** 26 December 1985

Ground Elev. ______ **Datum** ______ **Gr. Water Depth** See Text

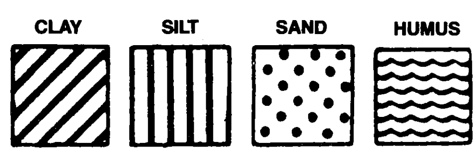
Sample No.	SAMPLE Depth — Feet From	SAMPLE Depth — Feet To	DEPTH STRATUM Feet From	DEPTH STRATUM Feet To	VISUAL CLASSIFICATION	*STANDARD PENETRATION TEST	
1	0.0	0.5	0.0	1.0	Very soft gray clay w/roots & organic		
					matter		
2	1.5	2.5	1.0	3.0	Soft gray & tan clay w/sandy silt &		
					humus layers		
3	4.5	5.5	3.0	6.0	Very soft gray clay w/trace of silt &		
					wood		
4	7.5	8.5	6.0		Medium stiff tan & gray clay w/wood		
5	10.5	11.5			Ditto		
6	13.5	14.5		15.0	Medium stiff tan & gray clay		
7	18.0	19.0	15.0	21.0	Stiff tan & gray clay		
8	23.0	24.0	21.0	25.0	Medium stiff gray clay w/sandy clay		
					pockets & lenses		
9	28.0	29.0	25.0	31.0	Medium stiff greenish-gray sandy clay		
					w/sand layers		
10	33.0	34.5	31.0	35.5	Medium dense gray silty sand w/clay	7	21
					layers		
11	35.5	37.0	35.5		Dense gray silty sand	7	34
12	38.5	40.0		40.0	Dense gray silty sand w/trace of shell	12	40
					fragments		



*Number in first column indicates number of blows of 140-lb. hammer dropped 30 in. required to seat 2-in. O. D. splitspoon sampler 6 in. Number in second column indicates number of blows of 140-lb. hammer dropped 30 in. required to drive 2-in. O. D. splitspoon sampler 1 ft. after seating 6 in.

WHILE THIS LOG OF BORING IS CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT ITS RESPECTIVE LOCATION ON THE DATE SHOWN, IT IS NOT WARRANTED THAT IT IS REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

Remarks: ______



Predominant type shown heavy. Modifying type shown light.

Fig. 3

Geotechnical Investigation
City of Mandeville
Marina Improvements
Mandeville, Louisiana

For: City of Mandeville, Louisiana

Dyer & Moody, Inc., Consulting Engineers, Baker, Louisiana

SUMMARY OF LABORATORY TEST RESULTS

BORING 1

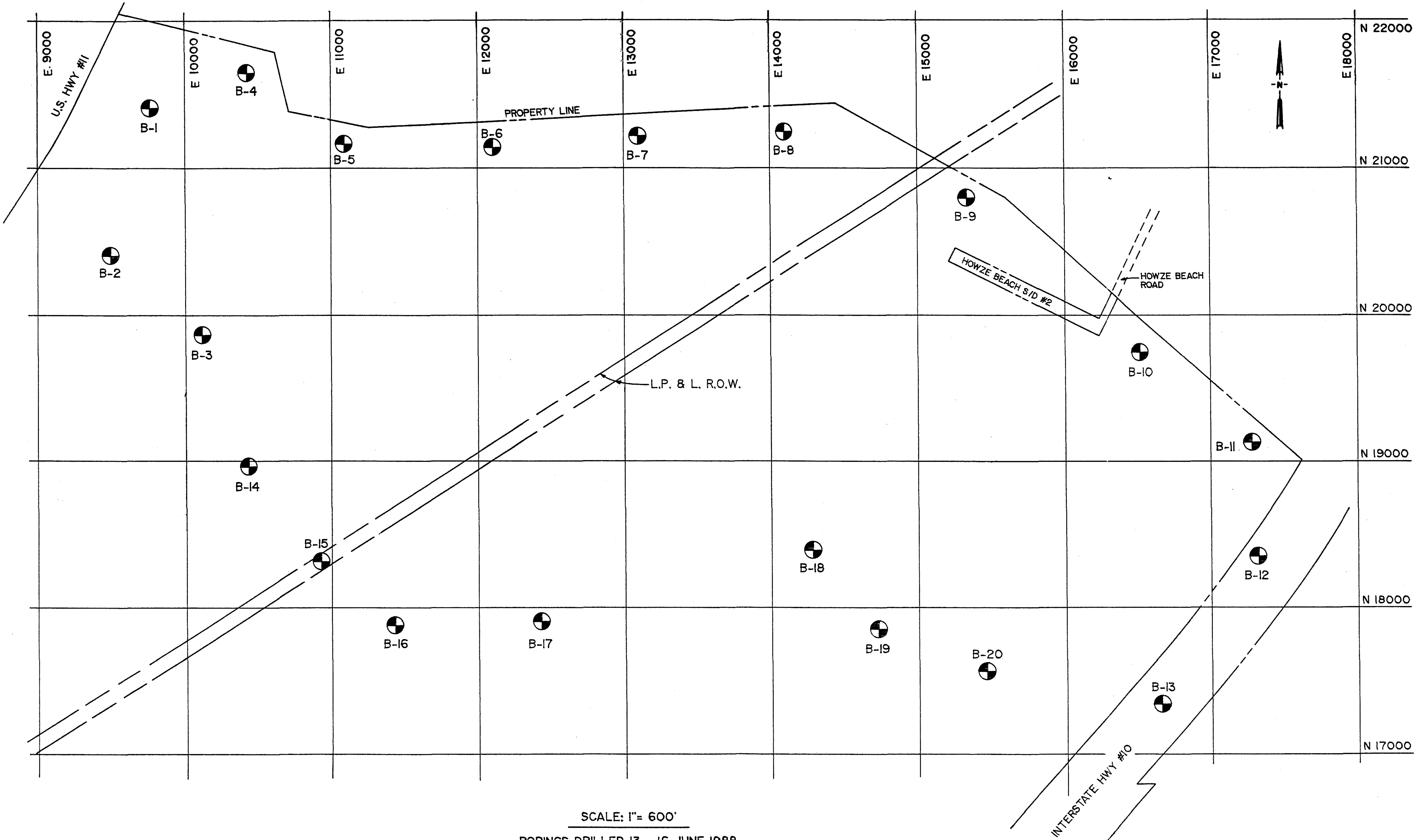
Sample No.	Depth In Feet	Classification	Water Content Percent	Density PCF Dry	Density PCF Wet	Unconfined Compressive Strength PSF
1	1.5	Very soft gray sandy clay w/clayey sand layers & humus pockets	27.1	88.6	112.6	295*
2	4.5	Soft gray & tan sandy clay w/concretions	26.2	97.1	122.5	770
3	7.5	Stiff gray & tan clay w/sand pockets	29.5	93.9	121.6	2455
4	10.5	Medium stiff gray & tan clay w/vertical clayey sand lenses	31.3	89.3	117.2	1135*
5	13.5	Medium stiff gray & tan clay	43.8	77.4	111.3	1685
6	18.0	Stiff gray & tan clay	24.3	104.0	129.2	2385
7	23.0	Stiff gray clay w/sand pockets	29.7	92.2	119.6	2240
8	28.0	Stiff greenish-gray sandy clay w/clayey sand layers	23.1	101.8	125.3	----
		BORING 2				
2	1.5	Soft gray & tan clay w/sandy clay layers & humus pockets	43.8	71.6	102.9	535
3	4.5	Very soft gray clay w/organic matter & decayed roots	58.9	63.3	100.5	460
4	7.5	Medium stiff gray & tan clay w/few roots	41.3	80.0	113.0	1235
5	10.5	Medium stiff tan & gray clay	42.9	78.5	112.2	1690
6	13.5	Ditto	46.2	73.6	107.6	1105
7	18.0	Stiff tan & gray clay	29.6	92.5	119.9	3515
8	23.0	Medium stiff gray clay w/sand pockets	29.1	93.2	120.3	1420
9	28.0	Medium stiff greenish-gray sandy clay w/clayey sand layers & pockets	20.5	105.9	127.6	1390*

*Unconsolidated Undrained Triaxial Compression Test - One Specimen; Confined at the approximate overburden pressure.

Fig. 4

Borings from Eustis Job 10120

Used for South Slidell Levees Alternative 6



SCALE: 1"= 600'

BORINGS DRILLED 13 - 16 JUNE 1988

LOCATION OF BORINGS

EDEN ISLES EXPANSION
PROPOSED LEVEE SYSTEM
VICINITY OF SLIDELL, LOUISIANA

EUSTIS ENGINEERING

FIGURE 1

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/15/88 Boring: 1 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	1.00			Medium stiff tan & gray silty clay w/organic matter & roots	CL	1	2-3	26	94	118	UC	—	930					
5																		
	1.50			Stiff gray silty clay w/decayed wood	CL	2	5-6	19	111	132	UC	—	1520					
	1.25			Stiff gray & tan clay w/silt lenses & pockets	CH	3	8-9											
10																		
	1.80					4	11-12	24	100	125	UC	—	1280					
15	1.75					5	14-15											
20	2.10			Stiff tan & gray clay w/silt lenses	CH	6	19-20	44	77	110	UC	—	1400					
25	2.50					7	24-25											
30	0.75			Soft gray clay w/sand layers	CH	8	29-30	46	74	108	UC	—	330	63	21	42		
35	0.60					9	34-35											
40	0.90			Medium stiff gray fissured clay w/shell layers	CH	10	39-40	55	66	105	UC	—	750					
45	2.50			Stiff greenish-gray fissured clay w/silt lenses	CH	11	44-45											
50	2.75					12	49-50	35	85	115	UC	—	1120					

Boring offset 40 feet west of staked location.

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/16/88 Boring: 2 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	0.45				Medium compact gray clayey silt	ML	1	2-3	22	105	127	OB	—	765	25	19	6		
5	0.35				Medium stiff light gray silty clay	CL	2	5-6	22	104	127	UC	—	740					
	1.25				Medium stiff greenish-gray silty clay	CL	3	8-9	23	102	125	UC	—	920					
10	1.65				Medium stiff greenish-gray & tan clay w/silt pockets	CH	4	11-12	36	85	116	UC	—	855					
15	1.75				Stiff gray & tan clay w/silt lenses	CH	5	14-15											
20	1.75				Stiff tan & gray clay	CH	6	18-19	47	75	109	UC	—	1100					

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/16/88 Boring: 3 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					Loose black organic clay w/roots & humus	OH	1	0-1	148										
	1.10				Medium stiff dark gray silty clay w/roots	CL	2	2-3	24	101	124	UC	—	725					
5	0.50				Medium stiff greenish-gray silty clay	CL	3	5-6	25	99	124	UC	—	860					
	1.80				Stiff gray & tan clay w/silty sand pockets	CH	4	8-9	24	101	125	UC	—	1220					
10	1.95						5	11-12											
15	2.45				Medium stiff gray & tan clay w/silt lenses	CH	6	14-15	37	84	115	UC	—	690					
20	1.50				Stiff gray & tan clay	CH	7	18-19											

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: 6.2' Job No: 10120 Date Drilled: 6/13/88 Boring: 4 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Loose tan fine sand	SP	1	1-2	4										
5	0.40		Very loose tan & gray clayey sand	SC	2	4-5	17	116	136	UC	—	135					
	0.80		Medium dense tan sand w/some clay	SP	3	6-7	13	119	134								
		28	Medium dense tan & gray fine sand	SP	4	8-9											
10		29			5	10-11											
		55	Very dense tan & gray fine sand	SP	6	12-13											
15		31	Dense tan & gray fine sand	SP	7	14-15											
			Medium dense gray fine sand	SP													
20		18			8	19-20											

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/15/88 Boring: 5 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Loose tan & gray sand w/roots & some silt	SP	1	2-3	16	98	114	OB	—	440					
5	0.30		Very soft gray & tan sandy clay	CL	2	5-6	23	103	126	UC	—	210					
	1.55		Stiff tan & gray clay w/few silt pockets	CH	3	8-9	30	92	120	UC	—	1805					
10	1.90		Stiff tan & gray silty clay	CL	4	11-12	28	94	121	UC	—	1045					
15	1.50				5	14-15											
20	1.50		Stiff tan & gray fissured clay	CH	6	19-20	43	77	110	UC	—	1090					

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: 6.3' Job No: 10120 Date Drilled: 6/15/88 Boring: 6 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Medium dense tan sand w/roots & trace of clay	SP	1	2-3	16	94	109	OB	—	985					
5			Medium stiff gray & tan sandy clay	CL	2	5-6	22	105	127	OB	—	805					
			Stiff tan & gray sandy clay	CL	3	8-9	17	112	131	UC	—	1040					
10	1.20		Medium dense tan & gray clayey sand	SC	4	11-12	22	104	127								
		17	Medium dense tan sand	SP	5	13-14											
15		24			6	16-17											
20		32	Dense tan sand	SP	7	19-20											

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/15/88 Boring: 7 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ∅	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Medium compact gray & tan clayey silt	ML	1	2-3	22	103	125	OB	—	885					
5	0.90		Medium stiff gray & tan silty clay	CL	2	5-6	23	103	127	UC	—	590					
	0.75		Medium stiff greenish-gray & tan silty clay	CL	3	8-9	34	88	118	UC	—	755					
10	0.75		Soft light gray silty clay w/clayey silt layers	CL	4	11-12	26	97	122	OB	—	355					
15	1.50		Medium stiff tan & gray fissured clay w/silt lenses	CH	5	14-15											
20	1.75				6	19-20	49	73	108	UC	—	690					

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/15-16/88 Boring: 8 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
					Medium compact gray & tan clayey silty w/some sand	ML	1	1-2	22	97	118	OB	—	695					
					Soft dark gray silty clay w/roots	CL	2	3-4	24	100	124	UC	—	445					
5	1.50				Stiff tan & gray silty clay	CL	3	5-6	20	108	129	UC	—	1610					
	1.10						4	8-9	23	102	126	UC	—	1195					
10																			
	1.60						5	11-12											
					Medium stiff gray & tan fissured clay w/silt lenses	CH													
15	2.20						6	14-15	38	81	112	UC	—	595					
20	2.00						7	19-20											
					Medium stiff gray clay w/trace of silt & shell fragments	CH													
25	0.75						8	24-25	48	74	109	UC	—	745	66	21	45		
					Stiff greenish-gray clay w/silty sand lenses & pockets	CH													
	2.50						9	28-29	28	96	122	UC	—	1090					
30																			
					Medium stiff gray clay w/silty sand lenses & shell fragments	CH													
	0.40						10	33-34	44	76	109	UC	—	710					
35																			
					Medium stiff gray clay w/shell fragments	CH													
	0.75						11	38-39	58	66	104	UC	—	875	79	22	57		
40																			
	0.30				Medium stiff gray & brown clay w/decayed wood, organic clay layers and roots	CH	12	42-43	101	44	88	UC	—	585					
	1.85				Stiff dark gray silty clay	CL	13	43-44	27	97	123	UC	—	1440					
45																			
					Medium stiff gray clay w/silty sand pockets	CH													
	2.30						14	48-49	28	95	121	UC	—	865				1.20	
50																			

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/16/88 Boring: 9 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
	0.25				Very soft gray & tan silty clay	CL	1	2-3	36	82	112	UC	—	215					
5	0.75				Soft tan & gray silty clay	CL	2	5-6	28	96	122	UC	—	490	40	20	20		
10	2.25				Stiff tan & gray clay w/silt pockets	CH	3	8-9	22	103	126	UC	—	1385					
	1.75				Medium stiff gray & tan clay	CH	4	11-12											
15	1.25				w/silt lenses		5	14-15	34	86	115	UC	—	800					
20	1.15				Stiff tan & gray clay	CH	6	18-19											

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/16/88 Boring: 10 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	0.95				Medium stiff tan & gray clay w/many silt lenses & pockets	CH	1	2-3	23	102	125	UC	—	765					
5	1.50				Medium stiff gray & tan clay w/clayey silt lenses & pockets	CH	2	5-6	23	103	126	UC	—	950					
	2.25				Stiff gray & tan clay	CH	3	8-9											
10	1.75				Medium stiff gray & tan clay w/silt lenses	CH	4	11-12	35	86	116	UC	—	850					
15	1.95				Stiff tan & gray clay	CH	5	14-15											
20	1.75						6	18-19	44	77	111	UC	—	1075					

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/16/88 Boring: 11 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	T.V. TSF	Other Tests
	1.40				Stiff gray & tan sandy clay w/clay pockets & roots	CL	1	2-3	17	112	131	UC	—	1520					
5					Medium dense dark gray silty sand w/roots	SM	2	5-6	22	92	112	OB	—	685					
	0.90				Medium stiff gray & tan sandy clay	CL	3	8-9	21	106	128	UC	—	885					
10	1.50				Very stiff tan & gray sandy clay w/clay layers	CL	4	11-12	19	108	129	UC	—	2130					
15	2.50				Very stiff gray & tan clay w/sand pockets	CH	5	14-15											
20	1.70				Stiff tan & gray clay w/clayey silt layers	CH	6	18-19	34	86	115	OB	—	1055				1.18	

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: 5.0' Job No: 10120 Date Drilled: 6/15/88 Boring: 12 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
		26	Medium dense tan & gray sand w/clay pockets & trace of shell fragments	SP	1	1-2	15										
5		21	Medium dense gray sand	SP	2	4-5	27										
			Very loose gray clayey sand w/small roots & organic matter	SC	3	6-7	21										
10			Very soft gray & tan sandy clay w/roots	CL	4	8-9	23										
	2.25		Stiff gray & tan sandy clay	CL	5	11-12	17	111	130	UC	—	1370					
15	1.95		Very stiff gray & tan clay w/sand pockets	CH	6	14-15	18	110	130	UC	—	3105					
20	1.90		Stiff gray & tan clay w/sandy clay layers	CH	7	18-19	18	105	124	OB	—	1510					

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/15/88 Boring: 13 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
		28			Medium dense tan & gray sand w/trace of clay & shells	SP	1	1-2	7										
5		18			Medium dense tan & gray sand w/shells	SP	2	4-5	11										
		3			Very loose gray shells w/sand	SI	3	7-8											
10		2			Very loose brown & gray organic clayey sand w/small roots	SC	4	9-10	32										
					Very loose gray clayey sand w/small roots	SC	5	11-12	20										
15	2.25				Medium dense tan & gray clayey sand	SC	6	14-15	20	107	128	OB	—	770					
20	2.20				Stiff gray & tan clay w/sand pockets	CH	7	18-19	21	105	127	UC	—	1745					

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/16/88 Boring: 14 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	T.V. TSF	Other Tests
					Medium dense gray & tan clayey sand w/small roots	SC	1	2-3	17	110	129	OB	—	620					
5	0.85				Medium stiff tan & gray sandy clay	CL	2	5-6	23	103	126	UC	—	630				0.875	
10	1.25				Medium stiff gray & tan fissured clay w/sand pockets & lenses	CH	3	8-9	35	85	115	UC	—	540				0.975	
	0.70				Medium stiff gray & tan clay w/sandy silt lenses & pockets	CH	4	11-12	37	84	115							0.375	
15	1.20				Medium stiff gray & tan clay w/clayey silt layers	CH	5	14-15	41	80	112	OB	—	735					
20	1.60				Stiff gray & tan clay	CH	6	18-19											

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: 7.7' Job No: 10120 Date Drilled: 6/13/88 Boring: 15 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits			T.V. TSF	Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
	1.00				Stiff tan & gray clay w/sandy silt lenses & pockets	CH	1	2-3	22	104	127	UC	—	1390					
5	0.70				Medium stiff gray & tan clay w/sandy silt pockets & shell fragments	CH	2	5-6	33	88	117	UC	—	625	55	21	34	0.475	
10	0.75				Medium stiff gray & tan silty clay w/sand pockets & decayed roots	CL	3	8-9	29	94	121	UC	—	645					
	0.60				Medium stiff dark gray & tan sandy clay w/decayed roots	CL	4	11-12	21	108	131	UC	—	620					
15	0.80				Medium stiff tan & gray sandy clay w/decayed roots	CL	5	14-15	23	103	127	UC	—	865					
20	1.10				Medium compact gray & tan clayey silt w/clay lenses	ML	6	18-19	30	93	120	OB	—	615					
25	1.30				Stiff tan & gray clay w/silt pockets & lenses	CH	7	23-24											
30	2.20				Medium stiff tan & gray fissured clay	CH	8	28-29	44	78	112	UC	—	770				1.25	
35	2.00						9	33-34											
40	1.60				Medium stiff gray clay w/sand pockets & shell fragments	CH	10	38-39	29	92	119	UC	—	990				0.900	
45	1.15				Medium stiff gray fissured clay w/sand pockets & shell fragments	CH	11	43-44											
50	1.25						12	48-49	54	69	106	UC	—	760				0.600	

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/13/88 Boring: 16 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	T.V. TSF	Other Tests
	1.00				Medium stiff greenish-gray & tan clay w/silty clay layers & organic matter	CH	1	2-3	38	86	119	UC	—	640					
5	0.70				Medium stiff tan & gray sandy clay w/clay lenses & organic matter	CL	2	5-6	24	99	122	UC	—	950					
	0.65				Soft greenish-gray & tan silty clay w/trace of organic matter	CL	3	8-9	38	83	115								
10	0.70				Medium stiff gray & tan silty clay w/roots & trace of sand	CL	4	11-12	25	102	127	UC	—	560	43	20	23		
15	1.20				Stiff greenish-gray & tan clay w/sand pockets	CH	5	14-15	27	99	125	UC	—	1110				1.63	
20	1.35						6	18-19											

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/13/88 Boring: 17 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	1.10				Soft tan & gray clay w/clayey silt pockets	CH	1	2-3	37	84	115	UC	—	435					
5	0.85				Soft greenish-gray & tan clay w/sandy clay layers	CH	2	5-6	32	89	118	UC	—	360					
10	0.40				Loose gray clayey sand w/humus & roots	SC	3	8-9	28	94	120	OB	—	425					
	0.75				Soft gray & tan sandy clay w/decayed roots	CL	4	11-12	23	103	127	UC	—	365					
15	2.20				Stiff greenish-gray & tan clay w/sand pockets	CH	5	14-15	23	102	127	UC	—	1585					
20	1.50				Stiff tan & gray clay w/silt lenses & pockets	CH	6	18-19											

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/16/88 Boring: 18 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
	1.25				Medium stiff gray & tan silty clay	CL	1	2-3	22	102	125	UC	—	890					
5	0.35				Medium stiff dark gray silty clay w/roots	CL	2	5-6	20	107	128	UC	—	695					
10	0.35				Soft gray & tan silty clay w/roots & trace of sand	CL	3	8-9	26	97	122	UC	—	410	47	21	26		
	2.25				Stiff light gray clay w/silt lenses & pockets	CH	4	11-12	21	106	128	UC	—	1755					
15	2.50						5	14-15											
20	1.50				Medium stiff gray & tan clay w/silt pockets	CH	6	18-19	34	86	114	UC	—	905					

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/15/88 Boring: 19 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	0.50				Medium stiff tan & gray silty clay w/trace of sand	CL	1	2-3	25	98	122	UC	—	860					
5	0.05				Medium stiff gray & tan clay w/clayey silt lenses	CH	2	5-6	23	101	124	UC	—	560					
	0.50				Medium compact gray clayey silt w/many roots	ML	3	8-9	22	103	126	OB	—	830					
10	0.85				Soft gray & tan sandy clay	CL	4	11-12	24	101	126	OB	—	325					
15	2.20				Stiff gray & tan sandy clay w/silt pockets	CL	5	14-15	20	106	128	UC	—	1185					
20	2.85				Very stiff gray & tan clay w/sand pockets	CH	6	18-19	25	99	123	UC	—	2055					

Boring drilled at staked location

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Eden Isles Expansion, Proposed Levee System, Vicinity of Slidell, Louisiana

Ground Elev.: Datum: Gr. Water Depth: See Text Job No: 10120 Date Drilled: 6/15/88 Boring: 20 Refer To "Legends & Notes"

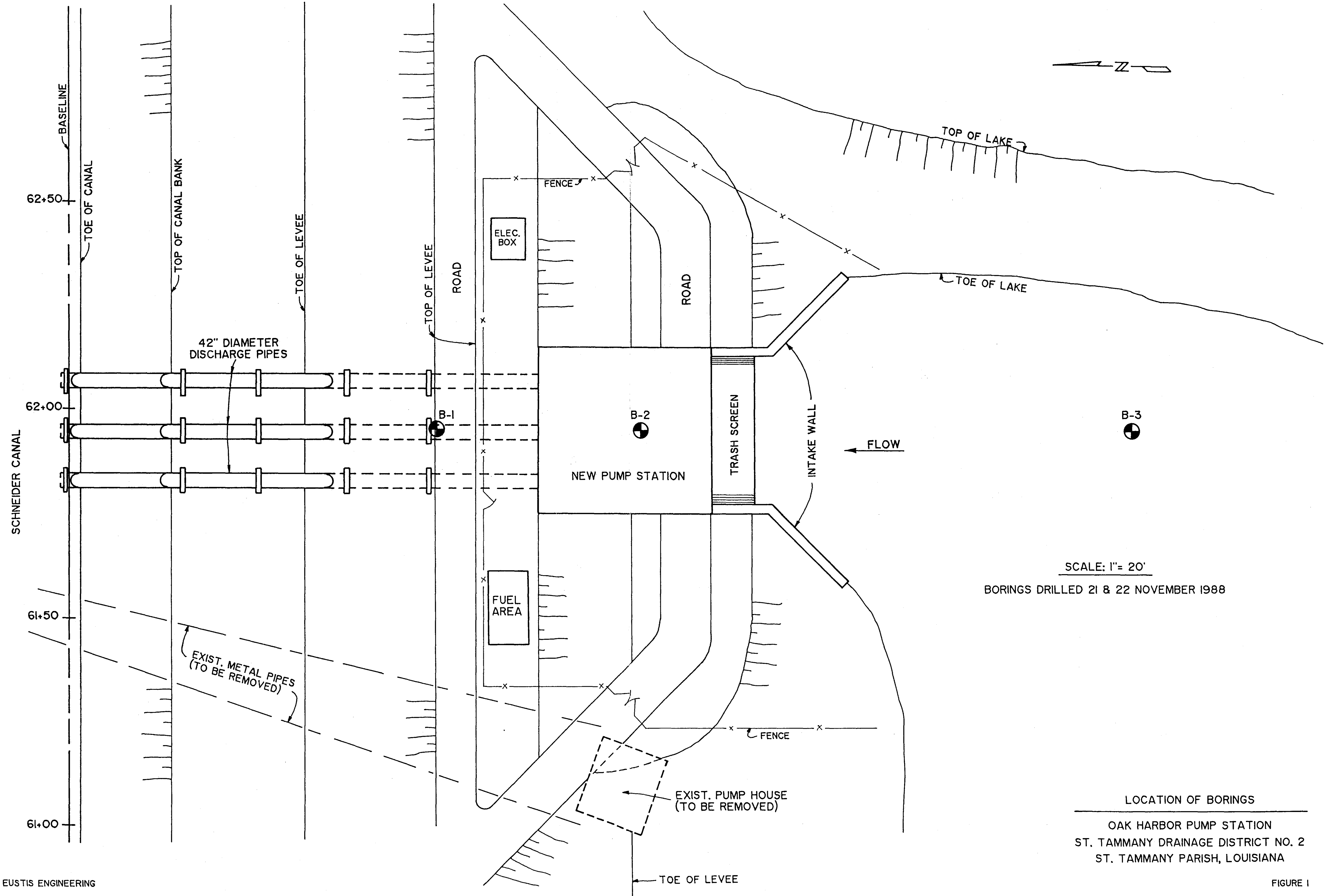
Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	0.75				Medium stiff tan & gray clay w/silt pockets & trace of organic matter (fill)	CH	1	2-3	36	84	114	UC	—	575					
5	1.20				Medium stiff greenish-gray & tan clay w/sand pockets & lenses (fill)	CH	2	5-6	22	99	121	UC	—	595					
					Very soft gray sandy clay w/organic matter & some roots	CL	3	8-9	26										
10	0.85				Medium stiff gray & tan sandy clay w/few small roots	CL	4	11-12	19	110	131	UC	—	620					
15	1.25				Stiff gray & tan sandy clay	CL	5	14-15	23	100	123	UC	—	1020					
20	1.30				Medium stiff gray & tan clay w/silty sand lenses & layers	CH	6	18-19	29	93	119	UC	—	810					
25	2.55				Very stiff gray & tan clay w/silt lenses & pockets	CH	7	23-24											
30	3.05				Stiff greenish-gray clay	CH	8	28-29	41	80	113	UC	—	1825					
35	0.60				Medium stiff gray clay w/trace of shell fragments & clayey sand layers	CH	9	33-34											
40	0.95				Soft gray clay w/sand lenses & layers	CH	10	38-39	36	82	111	UC	—	345					
45	0.65				Medium stiff gray clay w/shell fragments	CH	11	43-44											
50	0.70						12	48-49	53	70	107	UC	—	895					

Boring drilled at staked location

Borings from Eustis Job 10463

Used for

W-14 Floodgate/Old Spanish Trail Floodgate Alternative 6



SCALE: 1"= 20'

BORINGS DRILLED 21 & 22 NOVEMBER 1988

LOCATION OF BORINGS

OAK HARBOR PUMP STATION
ST. TAMMANY DRAINAGE DISTRICT NO. 2
ST. TAMMANY PARISH, LOUISIANA

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FIGURE 1

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LOG OF BORING AND TEST RESULTS

Oak Harbor Pump Station, St. Tammany Drainage District No. 2, St. Tammany Parish, Louisiana

Ground Elev.: 1.60 Datum: MSL Gr. Water Depth: See Text Job No: 10463 Date Drilled: 11/22/88 Boring: 1 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	0.25		Very soft gray & tan sandy clay w/roots & gravel (fill)	CL	1	2-3	25	97	121	UC	—	175					
5			Very soft tan & gray silty clay w/organic matter, glass, tin, etc. (fill)	CL	2	5-6	30										
	0.90		Medium stiff gray & tan clay w/sand lenses & pockets	CH	3	8-9	23	101	125	UC	—	1000					
10	1.90		Medium stiff to stiff gray & tan clay w/silty clay layers	CH	4	11-12	27	96	121	UC	—	1145					
15	2.30		w/silt lenses & pockets		5	14-15	40	81	113	UC	—	710					
	1.50		Soft gray & tan clay	CH	6	18-19	42	79	113	UC	—	460					
20																	
	2.50		Stiff greenish-gray & tan clay w/silt pockets	CH	7	23-24	36	84	115	UC	—	1225					
25																	
			Soft gray sandy clay w/clayey sand pockets	CL	8	28-29	35										
30																	
	0.25		Medium stiff gray clay w/sandy clay pockets & layers	CH	9	33-34	39	82	114	UC	—	665					
35																	
		25	Medium dense gray fine sand	SP	10	37-38											
40		7	Loose gray clayey sand w/clay layers	SC	11	40-41	28										
45		50=7"	Very dense gray fine sand	SP	12	44-45											
50		50=9"			13	49-50											

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Oak Harbor Pump Station, St. Tammany Drainage District No. 2, St. Tammany Parish, Louisiana

Ground Elev.: 2.15 Datum: MSL Gr. Water Depth: See Text Job No: 10463 Date Drilled: 11/21/88 Boring: 2 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Medium compact shells, sand & clay pockets														
			Compact tan & gray sandy silt w/organic matter & shell fragments	ML	1	2-3	56										
5	0.25		Soft light gray & tan silty clay w/silt pockets	CL	2	4-5	23	104	128	UC	—	355					
			Stiff gray & tan silty clay w/clayey silt	CL													
	1.30				3	8-9	19	109	130	UC	—	2115					
10			Stiff light gray & tan clay w/silty sand pockets	CH													
	2.00				4	11-12	25	100	125	UC	—	1605					
			Medium stiff to stiff gray & tan clay w/silt pockets	CH													
15	2.25				5	14-15	39	81	113	UC	—	940	70	24	46		
	1.90				6	18-19	40	81	114	UC	—	1130					
20			Stiff gray & greenish-gray clay w/silt pockets	CH													
	2.00				7	23-24	39	82	115	UC	—	1445					
25			Medium stiff gray clay w/clayey sand pockets	CH													
	0.30				8	28-29	45	76	110	UC	—	480	61	21	40		
30																	
			Medium stiff gray sandy clay	CL													
	0.25				9	33-34	34	87	117	OB	—	515					
35			Loose gray fine sand w/clay pockets	SP													
					10	38-39	27	97	124	OB	—	760					
40			Loose gray clayey sand w/clay pockets	SC													
	0.30				11	42-43	26	98	123	OB	—	680					
45		50=10"	Very dense gray fine sand	SP	12	44-45											
		50=7"			13	47-48											
50																	

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LOG OF BORING AND TEST RESULTS

Oak Harbor Pump Station, St. Tammany Drainage District No. 2, St. Tammany Parish, Louisiana

(Sheet 2 of 2)

Ground Elev.: 2.15 Datum: MSL Gr. Water Depth: See Text Job No: 10463 Date Drilled: 11/21/88 Boring: 2 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
		50=7"		Very dense gray fine sand	SP	14	50-51											
55		50=8"				15	54-55											
60		50=7"				16	59-60											
65		50=6"				17	64-65											
				Dense gray medium coarse sand w/gravel & clay layers	SP													
70		34				18	69-70											
				Very dense gray fine sand	SP													
75		50=7"				19	74-75											
80		50=10"				20	79-80											
85		50=10"				21	84-85											
90		50=7"		w/silt		22	89-90											
95		50=7"				23	94-95											
100		50=4"				24	99-100											

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

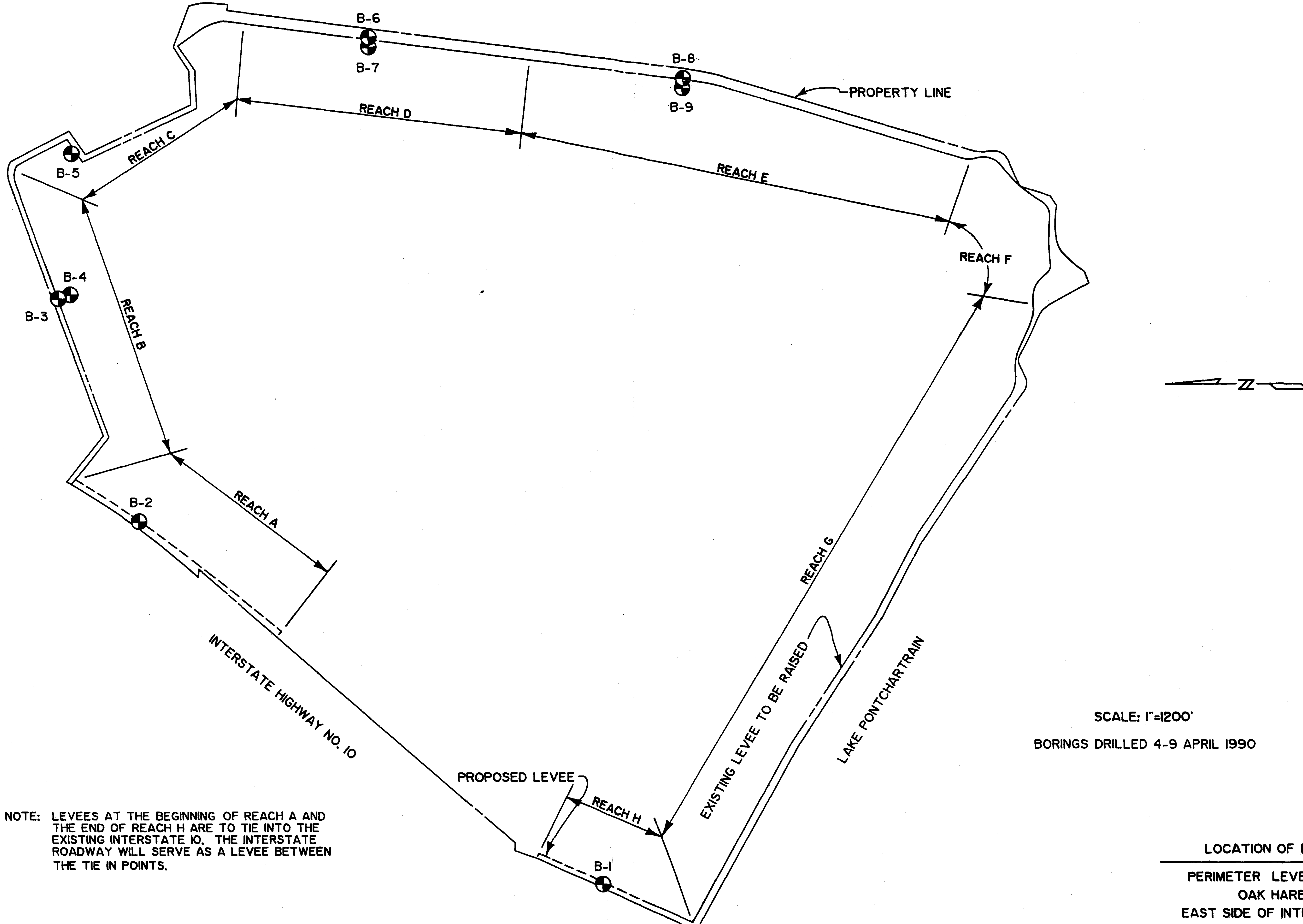
Oak Harbor Pump Station, St. Tammany Drainage District No. 2, St. Tammany Parish, Louisiana

Ground Elev.: 5.00 Datum: MSL Gr. Water Depth: See Text Job No: 10463 Date Drilled: 11/22/88 Boring: 3 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			Loose gray & tan fine sand w/clay pockets (fill)	SP	1	2-3											
5			Very stiff tan & gray sandy clay w/roots	CL	2	5-6	15	112	129	UC	—	2413					
	0.90		Medium stiff light gray & tan & red sandy clay	CL	3	8-9	22	103	125	UC	—	720					
10	4.25		Very stiff gray sandy clay w/silty sand pockets	CL	4	11-12	17	111	130	UC	—	2037					
15			Medium stiff gray silty clay w/vertical silty sand lenses	CL	5	14-15	21										
		15	Medium dense gray fine sand	SP	6	18-19											
20		48	Dense gray fine sand	SP	7	21-22											
25		22	Medium dense gray fine sand	SP	8	25-26											
30		4	Soft gray sandy clay w/silty clay pockets	CL	9	29-30	32										
35	0.40		Medium stiff gray silty clay w/sand lenses & pockets	CL	10	33-34	38	83	115	OB	—	890					
40	0.50		Medium stiff gray sandy clay w/clay lenses	CL	11	38-39	39	82	114	OB	—	651	36	21	15		
45	0.40				12	43-44	39	82	114	OB	—	915					
			Loose gray clayey sand	SC	13	47-48											
50		33	Dense gray fine sand	SP	14	49-50											

Borings from Eustis Job 11044

Used for South Oak Harbor Levees Alternative 6



SCALE: 1"=1200'

BORINGS DRILLED 4-9 APRIL 1990

NOTE: LEVEES AT THE BEGINNING OF REACH A AND THE END OF REACH H ARE TO TIE INTO THE EXISTING INTERSTATE 10. THE INTERSTATE ROADWAY WILL SERVE AS A LEVEE BETWEEN THE TIE IN POINTS.

LOCATION OF BORINGS

PERIMETER LEVEE SYSTEM
OAK HARBOR
EAST SIDE OF INTERSTATE 10
VICINITY OF SLIDELL, LOUISIANA

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FIGURE 1

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Perimeter Levee System, Oak Harbor, East Side of Interstate 10, Vicinity of Slidell, Louisiana

Ground Elev.: -1.50 Datum: NGVD Gr. Water Depth: See Text Job No: 11044 Date Drilled: 4/03/90 Boring: 1 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	Other Tests
	0.50		Medium stiff gray & tan silty clay w/clay & clayey silt pockets, organic matter & roots (fill)	CL	1	2-3	41									
5	0.75		Medium stiff gray & tan clay w/silty sand lenses & organic clay layers (fill)	CH	2	5-6	42	80	113	UC	—	670				
10	0.60		Medium stiff gray & light gray sandy clay w/silty sand pockets & lenses	CL	3	8-9	19	112	133	UC	—	1020				
	0.20		Very soft gray clay w/sand & organic clay pockets & decayed roots	CH	4	11-12	60	65	103	UC	—	250				
15	0.15				5	14-15	83	53	97	UC	—	155	92	26	66	
20	2.50		Very stiff gray & light gray sandy clay	CL	6	18-19	20	107	128	UC	—	4570				
25	2.35		Stiff gray & greenish-gray silty clay	CL	7	23-24	25	98	122	UC	—	1160				
					8	27-28										
30		29	Medium dense gray fine sand w/clayey sand pockets	SP	9	29-30										
		6	Loose gray fine sand	SP	10	32-33										
35		6	w/clay layers		11	35-36										
40	0.20		Medium stiff gray clay w/sand pockets & lenses	CH	12	38-39	46	76	111	OB	—	590				

Coordinates: 10760 N; 11830 E

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Perimeter Levee System, Oak Harbor, East Side of Interstate 10, Vicinity of Slidell, Louisiana

Ground Elev.: 1.0 Datum: NGVD Gr. Water Depth: See Text Job No: 11044 Date Drilled: 4/04/90 Boring: 2 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	1.20		Medium stiff gray & tan silty clay w/clayey silt & clayey sand layers & roots	CL	1	2-3	21	104	125	OB	—	840					
5	0.75				2	5-6	23	103	127	UC	—	690					
	1.50		Stiff tan & gray clay w/sand & silt pockets & lenses	CH	3	8-9	22	104	127	UC	—	1425					
10	1.90				4	11-12	27	96	122	UC	—	1135					
15	1.50				5	14-15											
	1.50				6	18-19	37	84	115	UC	—	940					
20																	
	1.70		w/fissures		7	23-24											
25			Loose gray clayey sand w/clay layers, pockets & shell fragments	SC													
	0.75				8	28-29	32	91	120	OB	—	455					
30			Stiff gray clay w/clayey sand & silty sand pockets	CH													
	1.75				9	33-34	28	95	121	UC	—	960					
35			Medium stiff gray clay w/clayey silt lenses & shell fragments	CH													
	0.50				10	38-39	58	66	104	UC	—	480	79	24	55		
40																	

Coordinates: 17900 N; 17340 E

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Perimeter Levee System, Oak Harbor, East Side of Interstate 10, Vicinity of Slidell, Louisiana

Ground Elev.: 6.78 Datum: NGVD Gr. Water Depth: See Text Job No: 11044 Date Drilled: 4/04/90 Boring: 3 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	1.50			FILL	Stiff tan & gray clay w/sand pockets & clayey sand layers (fill)	CH	1	2-3	24	102	125	UC	—	1375	56	20	36		
5	0.60			FILL	Medium stiff tan & gray clay w/clayey silt & clayey sand pockets (fill)	CH	2	5-6	22	104	127	UC	—	685					
	0.10				Soft tan & gray silty clay w/concretions & clayey silt layers	CL	3	8-9	22	103	126	OB	—	250					
10	1.75				Very stiff gray & tan sandy clay w/sand & clayey sand pockets & roots	CL	4	11-12	17	113	132	UC	—	2170					
15	2.25				Very stiff tan & gray clay w/sandy clay layers	CH	5	14-15											
	3.50						6	18-19	25	101	126	UC	—	3560					
20																			
	2.30				Stiff tan & gray clay w/silt pockets	CH	7	23-24											
25																			
	2.20			FISS	w/fissures		8	28-29	40	80	113	UC	—	1540					
30																			
	0.70				Loose gray & tan clayey sand	SC	9	33-34											
35																			
	1.75				Stiff gray & tan clay w/silt pockets & lenses	CH	10	38-39	34	87	116	UC	—	1090					
40																			
	0.60				Medium stiff gray clay w/shell fragments	CH	11	43-44	58	66	104	UC	—	650					
45																			

Coordinates: 18681 N; 20362 E

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Perimeter Levee System, Oak Harbor, East Side of Interstate 10, Vicinity of Slidell, Louisiana

Ground Elev.: 0.5 Datum: NGVD Gr. Water Depth: See Text Job No: 11044 Date Drilled: 4/05/90 Boring: 4 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	0.10				Soft gray & tan sandy clay w/roots & concretions	CL	1	2-3	23	105	129	OB	—	255					
5	0.60						2	5-6	24	104	128	OB	—	445					
	1.30				Medium stiff gray & tan clay w/sand pockets & lenses	CH	3	8-9	28	96	123	UC	—	940					
10	2.60				Stiff tan & gray silty clay w/clayey sand pockets	CL	4	11-12	29	93	121	UC	—	1200					
15	2.60				Stiff tan & gray clay w/clayey silt lenses & fissures	CH	5	14-15											
	2.10						6	18-19	45	77	111	UC	—	1120					
20	1.16				Stiff tan & gray clay w/fissures & clayey sand layers & concretions	CH	7	23-24	44	78	112	UC	—	1650					
25	1.70				Medium stiff gray & tan clay w/clayey silt pockets & shell fragments	CH	8	28-29	29	91	118	UC	—	785					
30	0.60				Medium stiff gray clay w/clayey silt & silty sand lenses, layers & shell fragments	CH	9	33-34	45	78	112	UC	—	560					
35	0.50						10	38-39	57	68	106	UC	—	520					
40																			

Coordinates: 18571 N; 20399 E

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Perimeter Levee System, Oak Harbor, East Side of Interstate 10, Vicinity of Slidell, Louisiana

Ground Elev.: -1.50 Datum: NGVD Gr. Water Depth: See Text Job No: 11044 Date Drilled: 4/05/90 Boring: 5 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	0.10		Very soft black humus	Pt	1	2-3	517	11	67	UC	—	60	448	131	317		
5	0.20		Loose gray silty fine sand w/clayey sand layers	SM	2	5-6	26	98	124	OB	—	375					
10	1.70		Stiff gray sandy clay w/clayey sand pockets, layers & lenses	CL	3	8-9	19	111	132	UC	—	1695					
	3.75		Stiff gray & greenish-gray sandy clay w/sand pockets	CL	4	11-12	17	111	130	UC	—	1350					
15	4.20		Stiff light gray sandy clay w/clayey sand pockets & layers	CL	5	14-15	17	115	134	OB	—	1470					
	2.75		Medium dense to dense light gray silty fine sand	SM	6	17-18											
20		42	Dense gray fine sand w/trace of wood	SP	7	19-20											
		46			8	22-23											
25		27	Medium dense gray fine sand	SP	9	25-26											
30		47	Dense gray fine sand	SP	10	29-30											
35		37			11	34-35											
40		50=10"	Very dense gray fine sand	SP	12	39-40											

Coordinates: 18469 N; 22752 E

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Perimeter Levee System, Oak Harbor, East Side of Interstate 10, Vicinity of Slidell, Louisiana

Ground Elev.: 5.55 Datum: NGVD Gr. Water Depth: See Text Job No: 11044 Date Drilled: 4/06/90 Boring: 6 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	0.75				Medium stiff tan & gray clay w/roots & clayey sand pockets (fill)	CH	1	2-3	30	90	117	UC	—	700					
5	1.60				Medium stiff to stiff tan & gray clay w/silty clay & sandy clay pockets & layers	CH	2	5-6	31	93	121	UC	—	1070					
	1.20						3	8-9	24	102	127	UC	—	900					
10	0.90				Soft tan & gray clay w/silty clay layers	CH	4	11-12	35	88	119	UC	—	430					
15	0.00				Loose gray clayey sand w/clay pockets	SC	5	14-15	21										
	2.75				Stiff gray sandy clay w/clayey sand layers	CL	6	18-19	14	121	138	OB	—	1890	25	19	6		
20 / 25	1.30				Stiff gray & tan clay w/sandy silt pockets & fissures	CH	7	23-24	41	79	112	UC	—	1515					
30	1.75				Medium stiff tan & gray clay w/silt pockets & decayed wood	CH	8	28-29	39	83	115	UC	—	965					
35	0.40				Soft gray sandy clay w/clayey sand pockets & shell fragments	CL	9	33-34	34	89	119	UC	—	370	35	20	15		
40	1.30				Stiff gray clay w/silt pockets & lenses & shell fragments	CH	10	38-39	40	81	113	UC	—	1025					
45	3.10				Very stiff greenish-gray clay w/silty clay layers & pockets	CH	11	43-44	25	99	124	UC	—	2625					

Coordinates: 14373 N; 24368 E

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Perimeter Levee System, Oak Harbor, East Side of Interstate 10, Vicinity of Slidell, Louisiana

Ground Elev.: -1.50 Datum: NGVD Gr. Water Depth: See Text Job No: 11044 Date Drilled: 4/10/90 Boring: 7 Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	0.30				Medium stiff dark brown organic clay w/humus layers	OH	1	2-3	234	22	72	UC	—	590					
5	0.10				Very soft dark brown & gray organic clay w/humus & sand pockets	OH	2	5-6	166	30	80	UC	—	130	169	41	128		
	0.90				Medium stiff light gray sandy clay w/clayey sand layers	CL	3	8-9	21	106	128	OB	—	735					
10	1.20				Medium dense gray clayey sand w/sandy clay pockets	SC	4	11-12	14	121	139	OB	—	1380					
15		37			Dense gray & tan silty fine sand	SM	5	13-14											
		8			Medium stiff gray & greenish-gray clay	CH	6	16-17											
20	1.40				Stiff tan & gray clay	CH	7	18-19	45	75	109	UC	—	1050					
25	0.50				Loose gray clayey sand w/clay pockets & organic matter	SC	8	23-24											
30	1.50				Stiff gray clay w/clayey sand pockets & organic matter	CH	9	28-29	30	93	120	UC	—	1020					
35	0.50				Medium stiff gray clay w/shell fragments & organic matter	CH	10	33-34	60	63	102	UC	—	640	82	24	58		
40	2.20				Stiff greenish-gray clay w/silt pockets & layers	CH	11	38-39	30	92	120	OB	—	1045					

Coordinates: 14382 N; 24295 E

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Perimeter Levee System, Oak Harbor, East Side of Interstate 10, Vicinity of Slidell, Louisiana

Ground Elev.: 7.17 Datum: NGVD Gr. Water Depth: See Text Job No: 11044 Date Drilled: 4/09/90 Boring: 8 Refer To "Legends & Notes"

Scale in Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	0.75		Medium dense tan & gray clayey sand w/trace of clay	SC	1	2-3	13	117	133	OB	—	730					
5	0.80		Dense light gray & tan fine sand w/clay pockets	SP	2	5-6	16	114	132	OB	—	2070					
	0.40		Loose gray clayey sand w/organic matter	SC	3	8-9	15	118	136	OB	—	465					
10	1.50		Medium dense tan & gray clayey sand	SC	4	11-12	16	116	135	OB	—	845					
15	1.60																
		50=11"	Very dense tan & gray fine sand w/clay pockets	SP	5	16-17											
20		8	Loose tan & gray fine sand w/clay layers	SP	6	19-20											
		5	Medium stiff gray & tan clay w/silt lenses, sand pockets & fissures	CH	7	22-23											
25	1.70				8	24-25	40	80	111	UC	—	585					
	1.60		Stiff tan & gray clay w/silt & sand pockets	CH	9	28-29	46	76	111	UC	—	1405					
30																	
	1.90		Stiff gray & tan clay w/fissures	CH	10	33-34	46	76	110	UC	—	1040					
35			Loose gray clayey sand w/clay layers & organic matter	SC	11	38-39											
40			Very stiff greenish-gray clay w/silty sand pockets & shell fragments	CH	12	43-44	34	87	117	UC	—	1085					
45																	

Coordinates: 10021 N; 23715 E

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Perimeter Levee System, Oak Harbor, East Side of Interstate 10, Vicinity of Slidell, Louisiana

Ground Elev.: 1.25 Datum: NGVD Gr. Water Depth: See Text Job No: 11044 Date Drilled: 4/09/90 Boring: 9 Refer To "Legends & Notes"

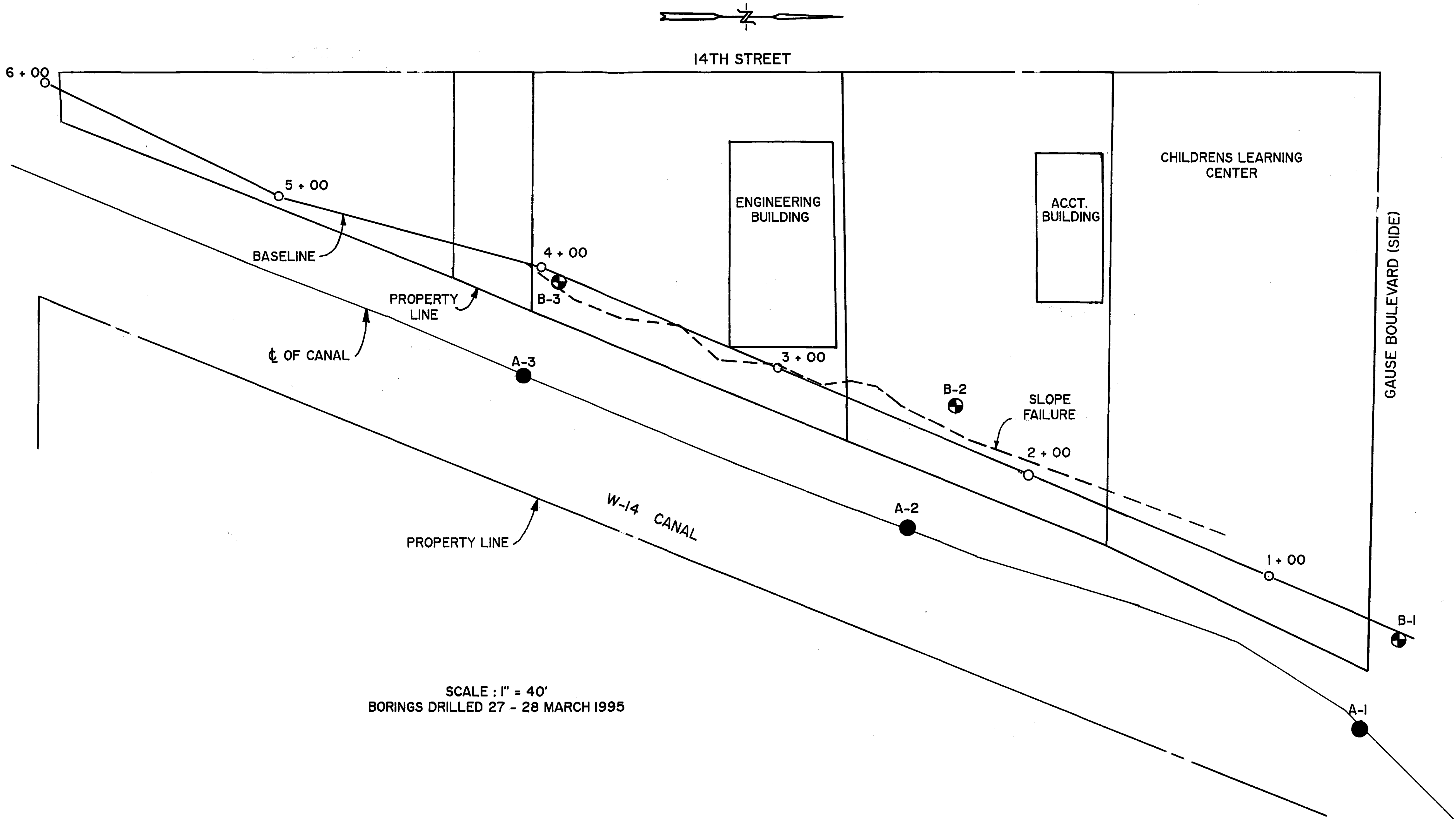
Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
	0.75				Medium dense gray & tan clayey sand w/humus layers, roots & organic matter	SC	1	2–3	16	116	135	OB	—	515					
5	0.75						2	5–6	16	116	135	OB	—	745	15	12	3		
	0.70				Loose gray & tan fine sand w/clay pockets	SP	3	8–9	18	110	130	OB	—	380					
10		13			Medium dense gray fine sand	SP	4	10–11											
		4			Soft gray & tan clay w/silt pockets	CH	5	13–14	35										
15	1.70				Medium stiff gray & tan clay w/silty sand pockets	CH	6	14–15	30	93	121	UC	—	835					
20	3.10				Stiff tan & gray clay w/silty clay & sand pockets	CH	7	18–19	34	87	117	UC	—	1060					
25	2.10						8	23–24											
30	1.60				Stiff gray & tan clay w/fissures	CH	9	28–29	46	75	110	UC	—	1200					
35	1.60				Stiff greenish-gray sandy clay w/clayey sand & clay layers	CL	10	34–35											
40	0.50				Medium stiff gray sandy clay w/shell fragments	CL	11	39–40	35	87	117	UC	—	655					

Coordinates: 10032 N; 23643 E

Borings from Eustis Job 13418

Used for

Pearl River Levees Alternative 7



LOCATION OF BORINGS

SLIDELL MEMORIAL HOSPITAL
BANK STABILIZATION STUDY
W-14 DRAINAGE CANAL
SLIDELL, LOUISIANA

FIGURE 1

EUSTIS ENGINEERING COMPANY, INC.

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

SLIDELL MEMORIAL HOSPITAL, BANK STABILIZATION STUDY
W-14 DRAINAGE CANAL, SLIDELL, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth: See Text** **Job No.: 13418** **Date Drilled: 3/28/95** **Boring: 1** **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
			8" Asphalt Pavement														
		8	Loose tan fine sand	SP	1	1-2											
			Loose gray clayey silt														
			Loose brown & gray sandy silt w/few roots	ML	2	3-4	14	114	130								
5	0.40		Soft tan & light gray sandy clay w/clayey sand pockets	CL	3	5-6	19	102	122	OB	--	410					
	2.70		Stiff tan & gray sandy clay w/clayey sand pockets	CL	4	8-9	23	100	123	OB	--	1195					
10	3.00		Dense light gray clayey sand	SC	5	11-12	19	108	128	OB	--	1910					
15			Loose light gray clayey sand	SC	6	14-15	21	103	125	OB	--	440					
			Loose light gray fine sand	SP	7	18-19											
20		16	Medium dense light gray fine sand	SP	8	21-22											
25		13			9	24-25											
30		10	Loose light gray fine sand	SP	10	29-30											
35		23	Medium dense gray fine sand	SP	11	34-35											
40		19			12	39-40											
45																	
50																	

Boring located at Station 0+45, 3 feet east of baseline and 6 feet west of failure.

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

SLIDELL MEMORIAL HOSPITAL, BANK STABILIZATION STUDY
W-14 DRAINAGE CANAL, SLIDELL, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth: See Text** **Job No.: 13418** **Date Drilled: 3/28/95** **Boring: 2** **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					3.5" Loose white shells		1	0-0.3											
	0.10				Very loose light gray clayey sand w/trace of organic matter & clayey silt layers	SC	2	2-3	24	98	122	OB	--	75					
5	0.60				Stiff tan & gray sandy clay w/few concretions	CL	3	5-6	21	101	123	UC	--	1055					
	2.50				Stiff tan & light gray clay w/sand pockets & lenses	CH	4	8-9	19	104	123	UC	--	1375					
10	2.60				Medium stiff light gray clay w/vertical clayey sand lenses	CH	5	11-12	27	95	120	UC	--	980					
15	2.70				w/few clayey sand pockets		6	14-15											
	1.70				Medium stiff light gray & tan clay w/fissures & silt lenses & pockets	CH	7	18-19	36	84	115	OB	--	630					
20	1.50				Stiff brown & gray clay	CH	8	23-24											
25																			
					Medium dense greenish-gray clayey sand	SC	9	28-29	25	98	123	OB	--	1635					
30																			
	1.25				Stiff gray clay w/clayey silt & clayey sand lenses & trace of organic matter	CH	10	33-34											
35																			
	0.40				Loose gray clayey sand w/clay lenses & pockets	SC	11	38-39	29	93	120	OB	--	480					
40																			
45																			
50																			

Boring located at Station 2+34, 12 feet west of baseline and 8 feet west of failure.

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

SLIDELL MEMORIAL HOSPITAL, BANK STABILIZATION STUDY
W-14 DRAINAGE CANAL, SLIDELL, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth: See Text** **Job No.: 13418** **Date Drilled: 3/27/95** **Boring: 3** **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
					4" Asphalt pavement														
		6			8" Medium dense white shells	ML	1	1-2	16										
	0.20				Loose gray clayey silt w/shell fragments	ML	2	3-4	22	103	125	OB	--	230					
5					Very loose dark gray clayey silt														
	1.10				Medium stiff light gray & tan clay w/clayey sand pockets	CH	3	5-6	25	99	123	UC	--	605					
	1.50				Stiff light gray & tan clay w/sand pockets	CH	4	8-9	28	95	121	UC	--	1335					
10					Very stiff light gray & tan clay	CH													
	2.50						5	11-12											
15	3.00				w/sand pockets		6	14-15	25	98	123	UC	--	2190					
	2.20				w/few silt lenses		7	18-19											
20																			
	1.60				Medium stiff gray & tan clay w/sand pockets	CH	8	23-24	33	86	114	UC	--	875					
25																			
	0.75				Medium stiff gray & dark gray clay w/silty sand layers	CH	9	28-29											
30																			
	1.30				Soft gray & reddish-brown clay w/silty sand pockets & lenses & trace of organic matter	CH	10	33-34	49	72	108	OB	--	430					
35																			
	0.40				Soft gray sandy clay w/clayey sand pockets	CL	11	38-39											
40																			
45																			
50																			

Boring located at Station 3+92, 3 feet west of failure.

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

SLIDELL MEMORIAL HOSPITAL, BANK STABILIZATION STUDY
W-14 DRAINAGE CANAL, SLIDELL, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth: See Text** **Job No.: 13418** **Date Drilled: 3/27/95** **Boring: A-1 - A-3** **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	Ø	C	LL	PL	PI		
					AUGER BORING A-1														
0					Very loose gray & tan fine sand	SP	1	0-1	26	98	123								
					Very loose gray & tan sandy silt	ML	2	1-2	25	101	126	OB	--	210					
					Loose light gray silty sand	SM	3	3-4											
5							4	5-6											
							5	7-8	25										
10					Very soft light gray sandy clay	CL	6	9-10											
					Station 0+45														
					AUGER BORING A-2														
0					Soft gray & tan silty clay w/trace of sand	CL	1	0-1											
							2	1-2	30	91	119	OB	--	480					
							3	3-4											
5					Medium stiff gray & tan clay w/silt pockets & fissures	CH	4	5-6	48										
							5	7-8											
10							6	9-10	49										
					Station 2+34														
					AUGER BORING A-3														
0					Loose gray & tan sandy silt		1	0-0.5	36										
					Medium stiff gray & tan clay w/sand & organic clay layers	SC	2	1.5-2	38										
					Very loose gray & tan clayey sand w/clay layers	CL	3	3-4	38										
5					Very soft gray & tan silty clay w/trace of sand	CL	4	5-6											
					Stiff tan & gray sandy clay		5	7-8											
10							6	9-10											
					Station 3+92														

Borings located near canal centerline. Depths referenced from existing mudline.

Borings from Eustis Job 13965

Used for

Bayou Lacombe Flood Gate Alternative 4

Bayou Liberty/Bayou Vincent/Bayou Bonfouca Structures Alternative 5

West Slidell Levees Alternative 5

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

DELWOOD PUMPING STATION
FRONT STREET
SLIDELL, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text **Job No.:** 13965 **Date Drilled:** 3/27/96 **Boring:** 1 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	φ	C	LL	PL	PI		
0					Loose dark gray & tan clayey silt w/silty clay layers, shells & roots	ML	1	0-0.5											
	2.80				Very stiff tan & gray silty clay w/clay layers, shells & roots	CL	2	2-3	17									DIST.	
					Loose tan fine sand w/clayey sand pockets	SP	3	5-6											
	2.10				Stiff gray & tan silty clay w/clayey silt layers	CL	4	8-9	21	105	126	UC	--	1600	43				
10					Medium stiff gray & tan silty clay w/clayey silt layers	CL	5	11-12	28	94	121	OB	--	580					
	1.60				Stiff tan & gray clay w/clayey silt lenses	CH	6	14-15	45	76	111	OB	--	345					
	1.60						7	18-19	35						74				
20																			
	1.50				Medium stiff gray & tan clay w/shell fragments & fissures	CH	8	23-24	50	72	107	OB	--	630					
					Loose gray clayey sand w/shell fragments	SC	9	28-29	26										
30																			
	0.40				Soft gray clay w/silty sand layers, pockets & concretions	CH	10	33-34	40	82	114	OB	--	345					
	0.60				Medium stiff gray clay w/clayey silt lenses & shell fragments	CH	11	38-39	48	73	108	UC	--	580					
40																			
	0.60				w/shell fragments		12	43-44	48	74	109	UC	--	445					
50					Medium compact gray clayey silt w/shell	ML	13	48-49											

Comments:

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

DELWOOD PUMPING STATION
FRONT STREET
SLIDELL, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text **Job No.:** 13965 **Date Drilled:** 3/27/96 **Boring:** 1 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ϕ	C	LL	PL	PI		
50					Medium compact gray clayey silt w/shell fragments	ML													
	1.80				Stiff greenish-gray clay w/clayey silt pockets & shell fragments	CH	14	53-54	33	88	117	OB	--	955					
	1.60				w/fissures & shell fragments		15	58-59	35	85	115	OB	--	1105					
60																			
					Loose gray clayey sand	SC	16	62-63											
	0.60				Medium stiff brown & gray clay w/organic matter & fissures	CH	17	64-65	64	60	99	OB	--	515					
	0.90						18	68-69	71	57	97	OB	--	805					
70																			
	1.80				Stiff greenish-gray clay w/silt pockets	CH	19	73-74	30	92	119	OB	--	2225					
	2.70				Stiff greenish-gray & tan clay w/fissures	CH	20	78-79	44	76	110	OB	--	835					
80																			
90																			
100																			

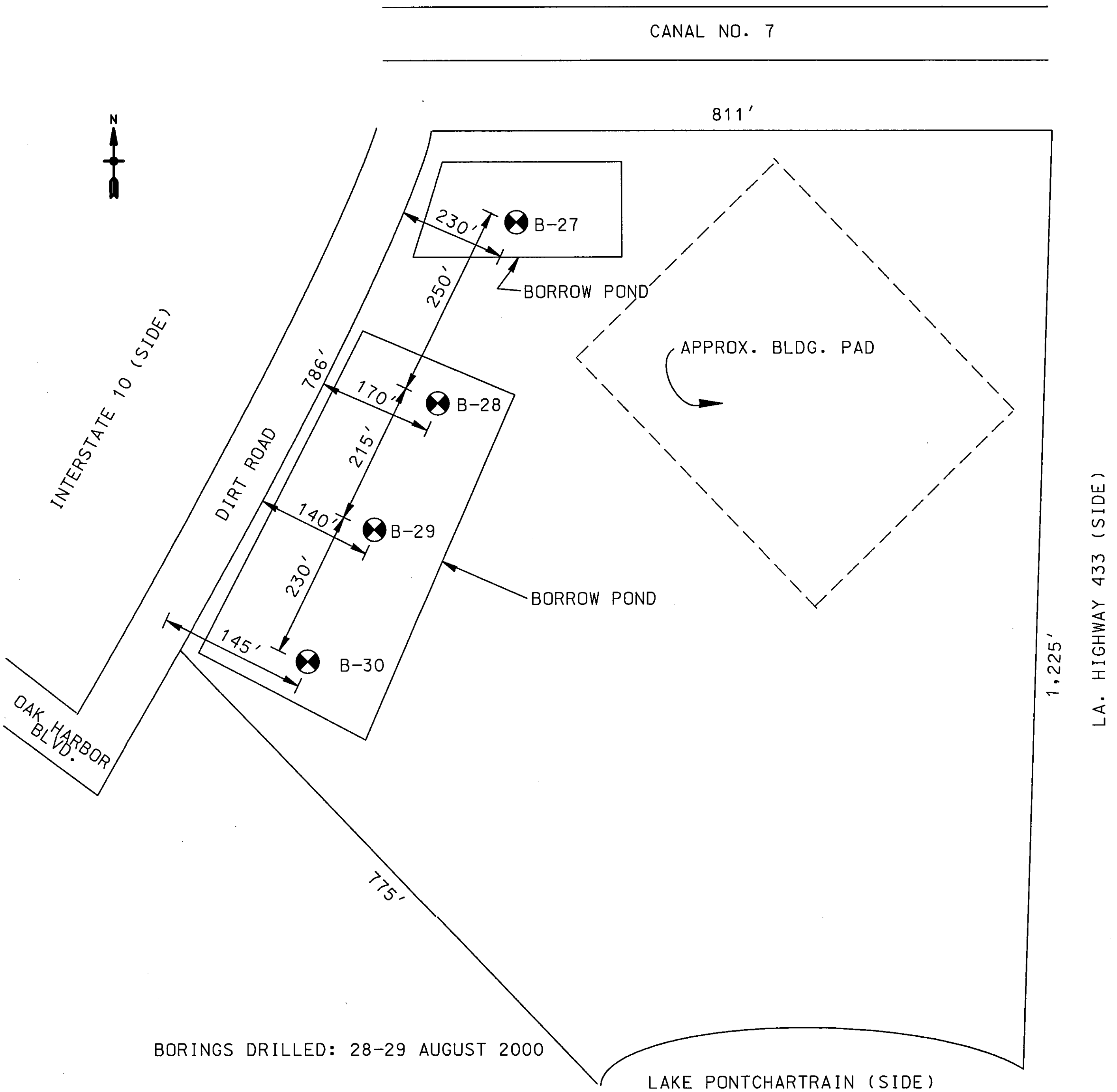
Comments:

Borings from Eustis Job 16613

Used for

Eden Isle Levees Alternative 6

Eden Isle Structures/I-10 Gates Alternative 6



BORINGS DRILLED: 28-29 AUGUST 2000

UNDISTURBED BORING LOCATION

NOT TO SCALE

LOCATION OF BORINGS

EAST ST. TAMMANY EVENTS CENTER
PROPOSED BORROW PONDS
VICINITY OF OAK HARBOR BOULEVARD AND INTERSTATE 10
ST. TAMMANY PARISH, LOUISIANA

EUSTIS ENGINEERING COMPANY, INC. **ENCLOSURE 1**

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

EAST ST. TAMMANY EVENTS CENTER
PROPOSED BORROW PONDS
VICINITY OF OAK HARBOR BOULEVARD AND INTERSTATE 10
ST. TAMMANY PARISH, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth:** **Job No.:** 16613 **Date Drilled:** 8/29/00 **Boring:** 27 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests φ	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
0					Loose dark gray clayey silt w/organic matter	ML	1	0-0.5	36										
					Loose brown & gray clayey sand	SC	2	2-3	15										
					Loose gray & tan clayey sand w/organic matter	SC	3	5-6	19	109	129	OB	--	560					
					Soft gray & tan sandy clay w/organic matter	CL	4	8-9	22						25	14	11		
10					Very soft light gray sandy clay	CL	5	11-12	21	107	130	UC	--	150					
					Very soft gray & tan sandy clay	CL	6	14-15	32						26	17	9		
20	0.50				Medium stiff greenish-gray clay w/silt lenses	CH	7	18-19	36	84	114	UC	--	665					
	1.80				Medium stiff greenish-gray clay		8	23-24	47	75	111	UC	--	805					
30	2.00				Stiff greenish-gray & tan clay w/clayey sand lenses	CH	9	28-29	47										
	1.00				Soft gray sandy clay w/shell fragments & roots	CL	10	33-34	27	96	122	UC	--	415					
40	0.25				Medium stiff gray clay w/sand pockets & organic matter	CH	11	38-39	42	78	111	UC	--	605					
					Loose gray shells w/clayey sand	GP	12	43-44	24										
50	0.50				Medium stiff gray clay w/silt pockets, organic matter, & large roots	CH	13	48-49	36	84	115	UC	--	785					

Comments:

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

EAST ST. TAMMANY EVENTS CENTER
PROPOSED BORROW PONDS
VICINITY OF OAK HARBOR BOULEVARD AND INTERSTATE 10
ST. TAMMANY PARISH, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth:** **Job No.:** 16613 **Date Drilled:** 8/29/00 **Boring:** 27 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ϕ	C	LL	PL	PI		
50					Medium stiff gray clay w/trace of sand & organic matter	CH													
	0.25						14	53-54											
	0.30				w/trace of sand		15	58-59	26										
60					Loose gray fine sand	SP	16	59.5-60											
70																			
80																			
90																			
100																			

Comments:

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

EAST ST. TAMMANY EVENTS CENTER
PROPOSED BORROW PONDS
VICINITY OF OAK HARBOR BOULEVARD AND INTERSTATE 10
ST. TAMMANY PARISH, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth:** **Job No.:** 16613 **Date Drilled:** 8/29/00 **Boring:** 28 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ϕ	C	LL	PL	PI		
50					Stiff gray clay w/trace of organic matter	CH													
	1.00						14	53-54	30	93	121	UC	--	1295					
							15	57-58											
		48			Dense gray fine sand w/clayey sand layers	SP	16	59-60											
60																			
70																			
80																			
90																			
100																			

Comments:

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

EAST ST. TAMMANY EVENTS CENTER
PROPOSED BORROW PONDS
VICINITY OF OAK HARBOR BOULEVARD AND INTERSTATE 10
ST. TAMMANY PARISH, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth:** **Job No.:** 16613 **Date Drilled:** 8/29/00 **Boring:** 28 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	φ	C	LL	PL	PI		
0					Medium stiff dark gray silty clay w/organic matter & roots	CL	1	0-0.5											
							2	2-3	25										
	1.75				Stiff gray & tan sandy clay w/organic matter	CL	3	5-6	19	110	131	UC	--	1680	35	12	23		
	1.50				Medium stiff light gray clay w/sand pockets & layers	CH	4	8-9	28	95	121	UC	--	755					
10	1.50				Medium stiff gray clay w/sand lenses & pockets	CH	5	11-12	30	93	120	UC	--	745	69	17	52		
	1.25				Medium stiff gray & tan clay w/clayey sand pockets	CH	6	14-15	32										
20	2.25				Stiff gray & tan clay w/sand lenses & pockets	CH	7	18-19											
	1.75				Medium stiff light gray & tan clay w/organic matter	CH	8	23-24	46	76	111	UC	--	980					
30	1.50						9	28-29											
					Soft gray clay w/trace of shell fragments	CH	10	33-34	62	63	102	UC	--	410					
40	0.25				Medium stiff gray clay w/clayey sand lenses & layers	CH	11	38-39	29	93	120	UC	--	595					
	0.25				Soft gray clay w/shell fragments	CH	12	43-44	59	65	103	UC	--	430					
50	0.75				Medium stiff gray clay w/sand pockets & organic matter	CH	13	48-49											

Comments:

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

EAST ST. TAMMANY EVENTS CENTER
PROPOSED BORROW PONDS
VICINITY OF OAK HARBOR BOULEVARD AND INTERSTATE 10
ST. TAMMANY PARISH, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth:** **Job No.:** 16613 **Date Drilled:** 8/28/00 **Boring:** 29 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests φ	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
0					Loose dark gray clayey silt w/organic matter & roots	ML	1	0-0.5	35						71	19	52		
					Soft gray sandy clay w/organic matter	CL	2	2-3	17	109	127	UC	--	430	24	12	12		
	2.50				Medium stiff to stiff greenish-gray sandy clay w/trace of organic matter	CL	3	5-6	20	105	126	UC	--	710	50	15	35		
	2.25				Medium stiff to stiff greenish-gray sandy clay		4	8-9	22	103	126	UC	--	1350	55	15	40		
10	1.00				Medium stiff light gray clay w/sand lenses & pockets	CH	5	11-12	29	94	121	UC	--	820					
	0.75				Medium stiff gray & tan clay w/sand lenses & concretions	CH	6	14-15	34	93	125	UC	--	435					
	2.25				Stiff gray & tan clay w/sand pockets	CH	7	18-19											
20	1.25				Medium stiff gray & tan clay w/concretions & trace of organic matter	CH	8	23-24	45	75	109	UC	--	755					
	1.75				Stiff greenish-gray & tan clay	CH	9	28-29											
30					Soft gray clay w/sand lenses & shell fragments	CH	10	33-34	59	65	103	UC	--	450					
40					w/silt lenses & pockets, shell fragments, & trace of organic matter		11	38-39	48	73	108	UC	--	465					
	0.25				Medium stiff gray clay w/silt pockets & shell fragments	CH	12	43-44	57	67	105	UC	--	555					
50					Medium stiff brown sandy clay w/roots, wood, & organic matter	CL	13	48-49	36	84	114	UC	--	855					

Comments:

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

EAST ST. TAMMANY EVENTS CENTER
PROPOSED BORROW PONDS
VICINITY OF OAK HARBOR BOULEVARD AND INTERSTATE 10
ST. TAMMANY PARISH, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth:** **Job No.:** 16613 **Date Drilled:** 8/28/00 **Boring:** 29 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ϕ	C	LL	PL	PI		
50					Medium stiff gray sandy clay w/organic matter	CL													
							14	53-54	28	96	122	UC	--	575					
					Loose gray clayey sand	SC	15	58-59											
60																			
70																			
80																			
90																			
100																			

Comments:

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

EAST ST. TAMMANY EVENTS CENTER
PROPOSED BORROW PONDS
VICINITY OF OAK HARBOR BOULEVARD AND INTERSTATE 10
ST. TAMMANY PARISH, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth:** **Job No.:** 16613 **Date Drilled:** 8/28/00 **Boring:** 30 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	φ	C	LL	PL	PI		
0					Medium stiff dark gray silty clay w/organic matter & roots	CL	1	0-0.5	62										
					Medium stiff light brown sandy clay	CL	2	2-3	19	109	129	UC	--	555	24	14	10		
	1.75				Medium stiff gray sandy clay w/organic matter	CL	3	5-6	22	102	125	UC	--	625	39	14	25		
	2.20				Medium stiff light gray clay w/large sand pockets	CH	4	8-9	20	103	124	UC	--	160	63	16	47		
10	1.50				Stiff gray & tan clay w/sand pockets	CH	5	11-12	30	92	120	UC	--	1155	67	16	51		
	2.25						6	14-15											
	1.50				Medium stiff gray & tan clay w/clayey silt pockets	CH	7	18-19	36	85	115	UC	--	705					
20																			
	2.30				Stiff gray & tan clay w/sand pockets	CH	8	23-24											
	2.25				w/silt lenses		9	28-29											
30																			
					Soft gray clay w/sand pockets & shell fragments	CH	10	33-34	63	62	101	UC	--	455					
	0.60				w/clayey silt pockets & trace of organic matter		11	38-39	36	85	115	UC	--	360					
40																			
	0.25				Soft dark gray clay w/silt lenses & pockets, & trace of shell fragments	CH	12	43-44	56	67	105	UC	--	480					
					Loose gray clayey sand w/shell fragments	SC	13	48-49											
50																			

Comments:

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

EAST ST. TAMMANY EVENTS CENTER
PROPOSED BORROW PONDS
VICINITY OF OAK HARBOR BOULEVARD AND INTERSTATE 10
ST. TAMMANY PARISH, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth:** **Job No.:** 16613 **Date Drilled:** 8/28/00 **Boring:** 30 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests φ	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
50		32			Dense gray & brown fine sand w/organic matter	SP	14	50-51	26										
		22			Medium dense gray fine sand	SP	15	53-54											
		11			Medium stiff gray silty clay	CL	16	56-57	27										
	0.40				Soft gray clay w/organic matter	CH	17	58-59											
60																			
70																			
80																			
90																			
100																			

Comments:

SECTION 3

Parameters for Estimates

Stability Parameter Tables

Eustis Job No. 09318 Used For Lacombe Levee Analysis

Material	Top EL	Bottom EL	thickness	density	C-top	C-bottom
CL	0	-7	7 ‘	103	700	700
CH	-7	-15	8 ‘	112	1200	1200
CH	-15	-28	13 ‘	120	1400	1400
SM	-28	-40	12 ‘	122	0	0

Eustis Job No. 13965 Used For West Slidell Levee, Bayou Lacombe Floodgate, Bayou Lacombe Floodgate, Bayou Bonfouca Floodgate, Bayou Liberty Floodgate, Bayou Vincent Floodgate, Bayou Pacquet Floodgate, South Slidell Surge Reduction Wall

Material	Top EL	Bottom EL	thickness	density	C-top	C-bottom
CL	0	-13	13 ‘	105	580	580
CH	-13	-26	13 ‘	107	400	400
SC	-26	-32	6 ‘	122	0	0
CH	-32	-48	16 ‘	108	400	400
ML	-48	-52	4 ‘	117	200	200
CH	-52	-80	28 ‘	105	800	800

Eustis Job No. 16613 + 10463 from -54 to -100 Used For Eden Isle Levee, Eden Isle Marina Gate, Eden Isle South Floodwall, Eden Isle Southwest Floodwall, Eden Isle West Floodwall

Material	Top EL	Bottom EL	thickness	density	C-top	C-bottom
SC	0	-7	7 ‘	122	0	0
CL	-7	-15	8 ‘	120	700	700
CH	-15	-30	15 ‘	111	700	700
CH	-30	-46	16’	110	600	600
SP	-46	-54	8 ‘	122	0	0
SP	-54	-100	46’	122	0	0

Eustis Job No. 10120 Used For South Slidell Levee Analysis

Material	Top EL	Bottom EL	thickness	density	C-top	C-bottom
CH	0	-10	10 ‘	125	640	640
CH	-10	-20	10 ‘	123	800	800
CH	-20	-35	15 ‘	111	725	725
CH	-35	-50	15 ‘	110	760	760

Eustis Job No. 11044 Used For Oak Harbor Levee Analysis

Material	Top EL	Bottom EL	thickness	density	C-top	C-bottom
CH	0	-10	10 ‘	125	650	650
CH	-10	-29	19 ‘	118	1030	1030
SM	-29	-34	5 ‘	122	0	0
CH	-34	-50	16 ‘	110	640	640

Eustis Job No. 10463 Used For W-14 Floodgate, Old Spanish Trail Floodgate

Material	Top EL	Bottom EL	thickness	density	C-top	C-bottom
ML	0	-3	3 ‘	117	200	200
CH	-3	-16	13 ‘	125	1000	1000
SP	-16	-26	10 ‘	122	0	0
CH	-26	-44	18 ‘	108	600	600
SP	-44	-100	4 ‘	122	0	0

Eustis Job No.13418 Used For Pearl River Levee and Pearl River Floodgate

Material	Top EL	Bottom EL	thickness	density	C-top	C-bottom
CL	0	-15	15 ‘	124	500	50
SM	-15	-22	7 ‘	122	0	0
CH	-22	-29	7 ‘	114	900	900
SM	-29	-33	4 ‘	122	0	0
CH	-33	-40	7 ‘	120	450	450

Settlement Parameter Tables

Eustis Job No. 09318 Used For Lacombe Levee Analysis (Correlations Based on Water Content)

Material	Top EL	Bottom EL	thickness	density	Cc	e0	Cr
CL	0	-7	7 ‘	103	0.16	0.71	0.32
CH	-7	-15	8 ‘	112	0.43	1.14	0.86
CH	-15	-28	13 ‘	120	0.2	0.8	0.040
SM	-28	-40	12 ‘	122	NA	NA	NA

Eustis Job No. 13965 Used For West Slidell Levee Analysis (Correlations Based on Water Content)

Material	Top EL	Bottom EL	thickness	density	Cc	e0	Cr
CL	0	-13	13 ‘	105	0.16	0.62	0.032
CH	-13	-26	13 ‘	107	0.43	1.03	0.086
SC	-26	-32	6 ‘	122	NA	NA	NA
CH	-32	-48	16 ‘	108	0.39	1.1	0.078
ML	-48	-52	4 ‘	117	0.26	0.9	0.052
CH	-52	-80	28 ‘	105	0.52	1.2	0.100

Eustis Job No. 10120 Used For South Slidell Levee Analysis (Correlations Based on Water Content)

Material	Top EL	Bottom EL	thickness	density	Cc	e0	Cr
CH	0	-10	10 ‘	125	0.11	0.65	0.022
CH	-10	-20	10 ‘	123	0.15	0.79	0.030
CH	-20	-35	15 ‘	111	0.45	1.19	0.090
CH	-35	-50	15 ‘	110	0.36	0.945	0.072

Eustis Job No. 16613 Used For Eden Isle Levee Analysis (Correlations Based on Water Content)

Material	Top EL	Bottom EL	thickness	density	Cc	e0	Cr
SC	0	-7	7 ‘	122	NA	NA	NA
CL	-7	-15	8 ‘	120	0.17	0.75	0.034
CH	-15	-30	15 ‘	111	0.49	1.25	0.098
CH	-30	-46	16’	110	0.41	1.1	0.082
SP	-46	-54	8 ‘	122	NA	NA	NA

Eustis Job No. 11044 Used For Oak Harbor Levee Analysis (Correlations Based on Water Content)

Material	Top EL	Bottom EL	thickness	density	Cc	e0	Cr
CH	0	-10	10 ‘	125	0.11	0.59	0.022
CH	-10	-29	19 ‘	118	0.21	0.79	0.042
SM	-29	-34	5 ‘	122	NA	NA	NA
CH	-34	-50	16 ‘	110	0.3	1.08	0.060

Eustis Job No.13418 Used For Pearl River Levee Analysis (Correlations Based on Water Content)

Material	Top EL	Bottom EL	thickness	density	Cc	e0	Cr
CL	0	-15	15 ‘	124	0.11	0.65	0.022
SM	-15	-22	7 ‘	122	NA	NA	NA
CH	-22	-29	7 ‘	114	0.27	0.89	0.054
SM	-29	-33	4 ‘	122	NA	NA	NA
CH	-33	-40	7 ‘	120	0.49	0.78	0.098

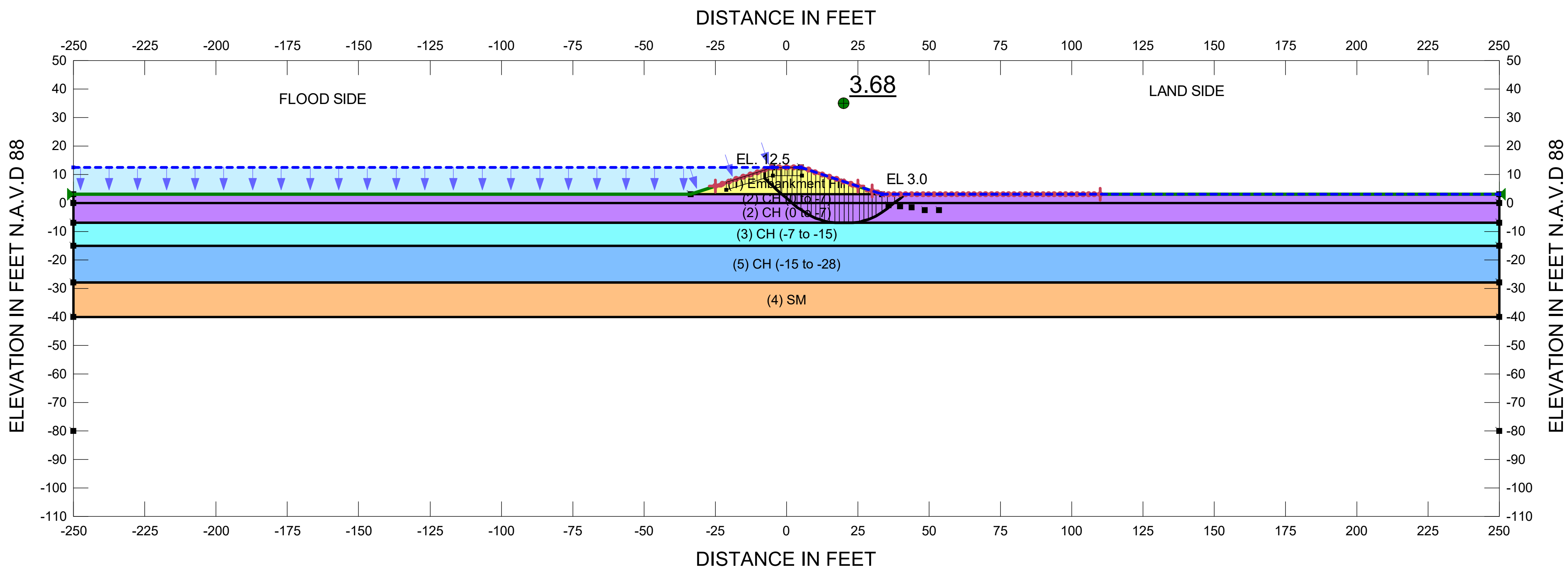
SECTION 4

Stability Plates

Spencer's Analysis Entry/Exit

Lacombe Levees

Alternative 4

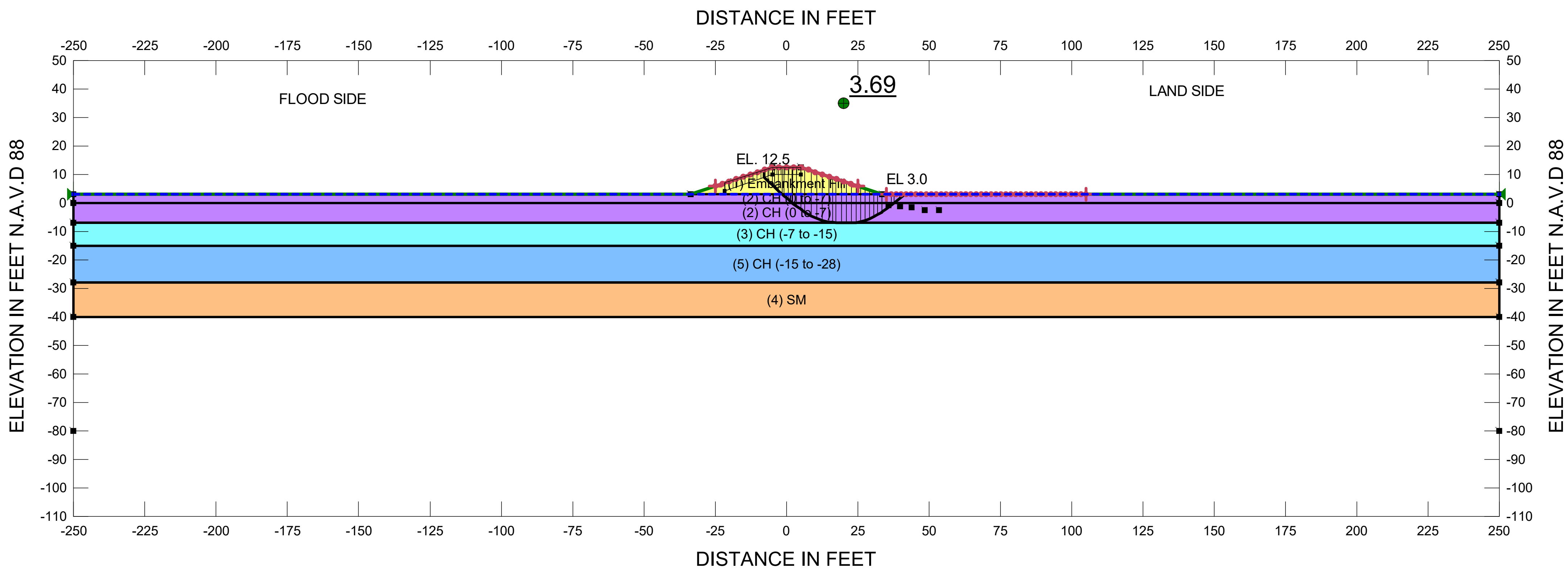


Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	(1) Embankment Fill	Mohr-Coulomb	115	600	0
	(2) CH (0 to -7)	Mohr-Coulomb	103	700	0
	(3) CH (-7 to -15)	Mohr-Coulomb	112	1,200	0
	(4) SM	Mohr-Coulomb	122	0	30
	(5) CH (-15 to -28)	Mohr-Coulomb	120	1,400	0

LACOMBE LEVEES

CASE: ALTERNATIVE 4

US Army Corps of Engineers®
New Orleans District



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	(1) Embankment Fill	Mohr-Coulomb	115	600	0
	(2) CH (0 to -7)	Mohr-Coulomb	103	700	0
	(3) CH (-7 to -15)	Mohr-Coulomb	112	1,200	0
	(4) SM	Mohr-Coulomb	122	0	30
	(5) CH (-15 to -28)	Mohr-Coulomb	120	1,400	0

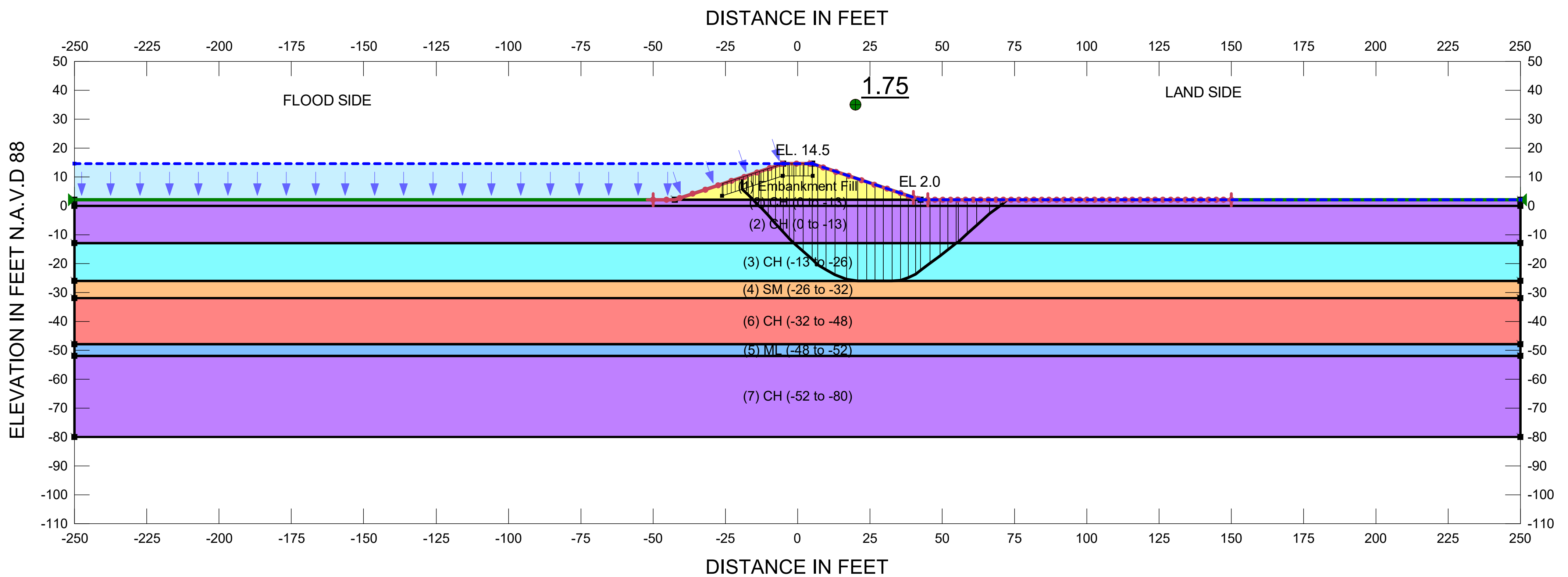
LACOMBE LEVEES

CASE: ALTERNATIVE 4

US Army Corps of Engineers®
New Orleans District

West Slidell Levees

Alternative 5

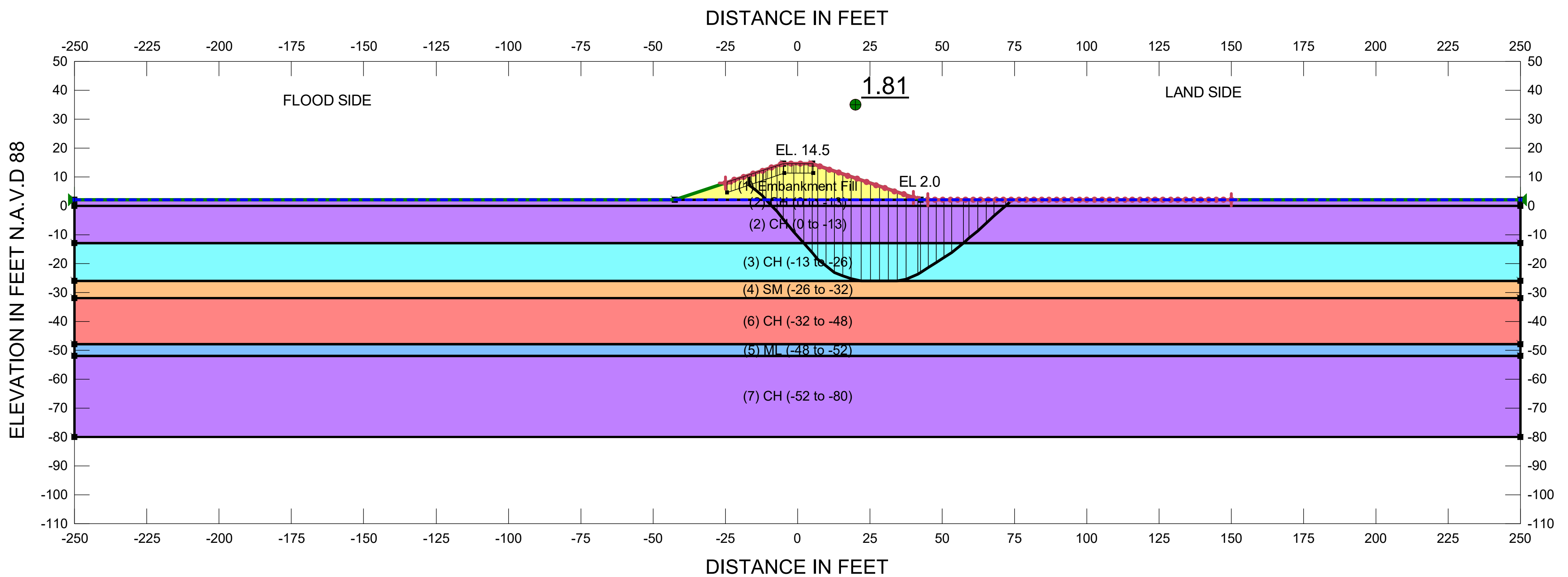


Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	(1) Embankment Fill	Mohr-Coulomb	115	600	0
	(2) CH (0 to -13)	Mohr-Coulomb	105	580	0
	(3) CH (-13 to -26)	Mohr-Coulomb	107	400	0
	(4) SM (-26 to -32)	Mohr-Coulomb	122	0	30
	(5) ML (-48 to -52)	Mohr-Coulomb	117	200	15
	(6) CH (-32 to -48)	Mohr-Coulomb	108	400	0
	(7) CH (-52 to -80)	Mohr-Coulomb	105	800	0

WEST SLIDELL LEVEES

CASE: ALTERNATIVE 5

US Army Corps of Engineers®
New Orleans District



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	(1) Embankment Fill	Mohr-Coulomb	115	600	0
	(2) CH (0 to -13)	Mohr-Coulomb	105	580	0
	(3) CH (-13 to -26)	Mohr-Coulomb	107	400	0
	(4) SM (-26 to -32)	Mohr-Coulomb	122	0	30
	(5) ML (-48 to -52)	Mohr-Coulomb	117	200	15
	(6) CH (-32 to -48)	Mohr-Coulomb	108	400	0
	(7) CH (-52 to -80)	Mohr-Coulomb	105	800	0

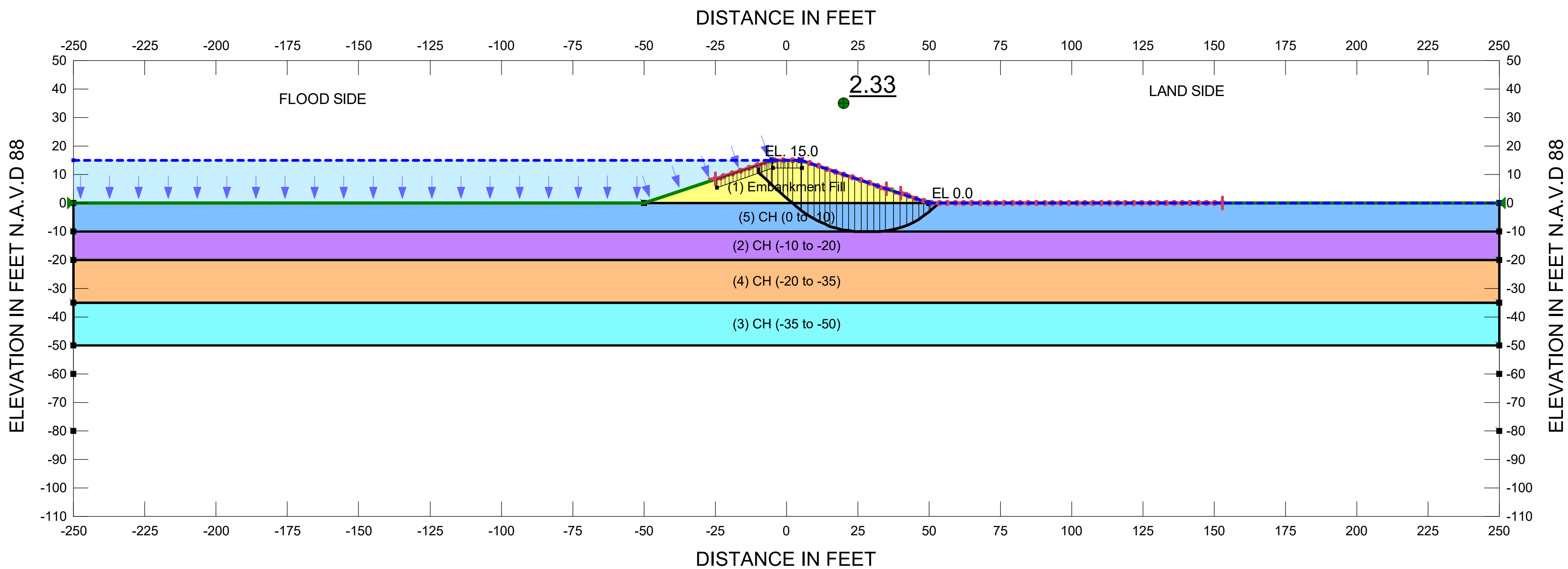
WEST SLIDELL LEVEES

CASE: ALTERNATIVE 5

US Army Corps of Engineers®
New Orleans District

South Slidell Levees

Alternative 6

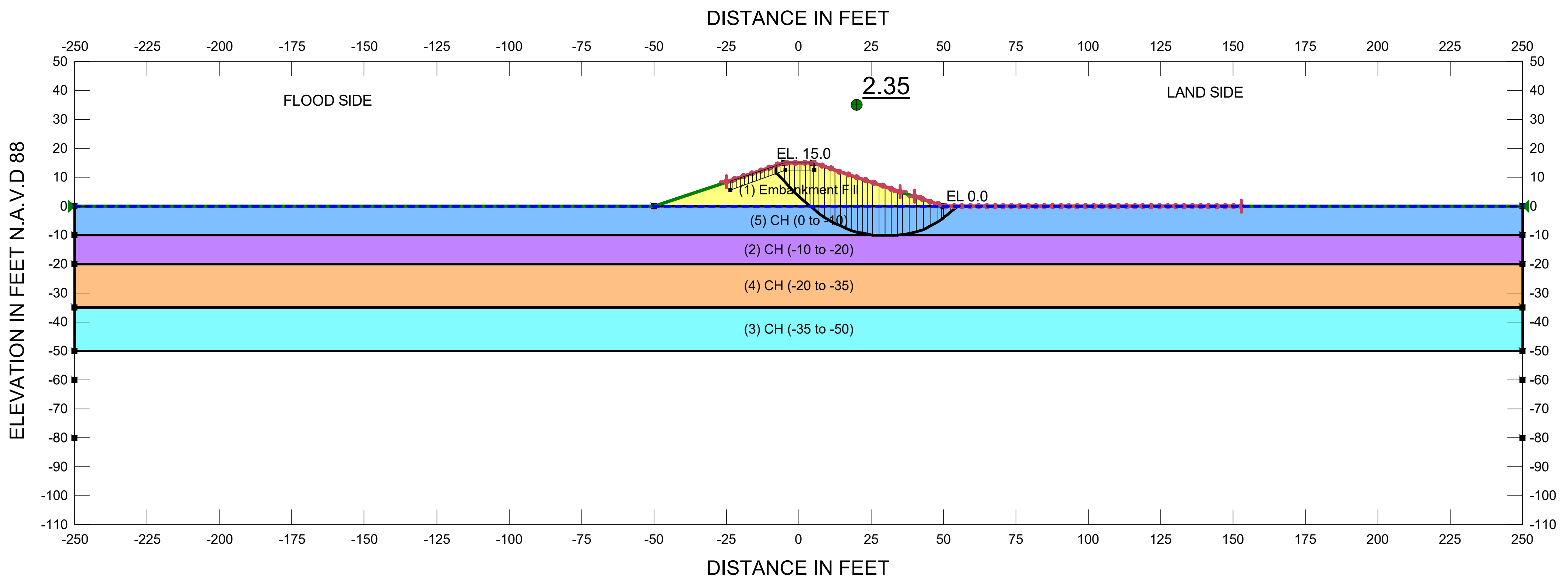


Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	(1) Embankment Fill	Mohr-Coulomb	115	600	0
	(2) CH (-10 to -20)	Mohr-Coulomb	123	800	0
	(3) CH (-35 to -50)	Mohr-Coulomb	110	760	0
	(4) CH (-20 to -35)	Mohr-Coulomb	111	725	0
	(5) CH (0 to -10)	Mohr-Coulomb	125	640	0

SOUTH SLIDELL

CASE: ALTERNATIVE 6

US Army Corps of Engineers®
New Orleans District



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	(1) Embankment Fill	Mohr-Coulomb	115	600	0
	(2) CH (-10 to -20)	Mohr-Coulomb	123	800	0
	(3) CH (-35 to -50)	Mohr-Coulomb	110	760	0
	(4) CH (-20 to -35)	Mohr-Coulomb	111	725	0
	(5) CH (0 to -10)	Mohr-Coulomb	125	640	0

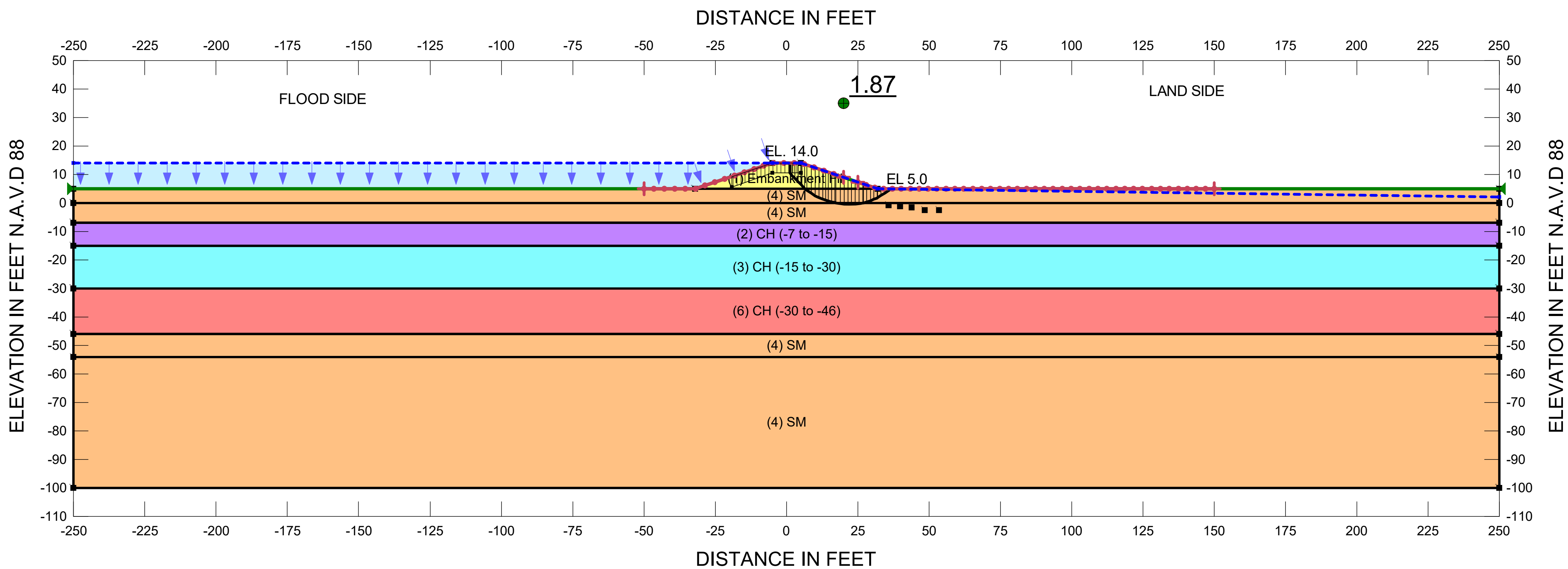
SOUTH SLIDELL

CASE: ALTERNATIVE 6

US Army Corps of Engineers®
New Orleans District

Eden Isle Levees

Alternative 6

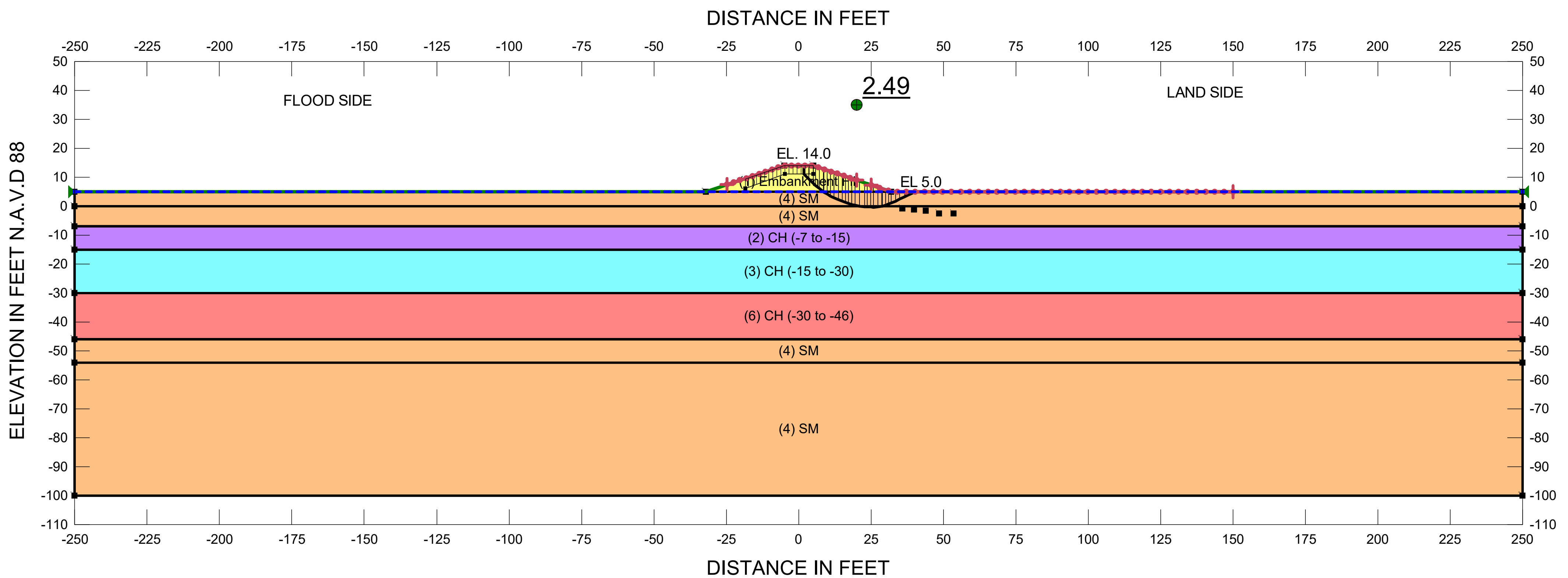


Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	(1) Embankment Fill	Mohr-Coulomb	115	600	0
	(2) CH (-7 to -15)	Mohr-Coulomb	120	700	0
	(3) CH (-15 to -30)	Mohr-Coulomb	111	700	0
	(4) SM	Mohr-Coulomb	122	0	30
	(6) CH (-30 to -46)	Mohr-Coulomb	110	600	0

EDEN ISLE LEVEES

CASE: ALTERNATIVE 6

US Army Corps of Engineers®
New Orleans District



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	(1) Embankment Fill	Mohr-Coulomb	115	600	0
	(2) CH (-7 to -15)	Mohr-Coulomb	120	700	0
	(3) CH (-15 to -30)	Mohr-Coulomb	111	700	0
	(4) SM	Mohr-Coulomb	122	0	30
	(6) CH (-30 to -46)	Mohr-Coulomb	110	600	0

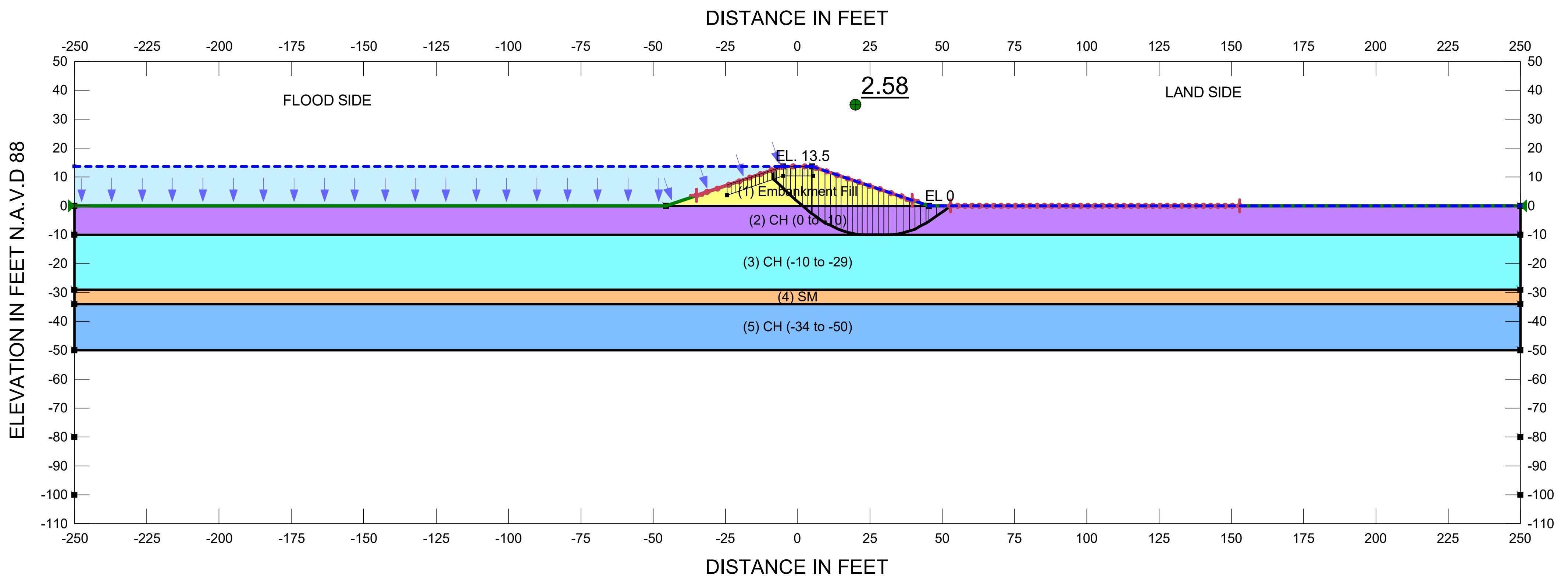
EDEN ISLE LEVEES

CASE: ALTERNATIVE 6

US Army Corps of Engineers®
New Orleans District

Oak Harbor Levees

Alternative 6

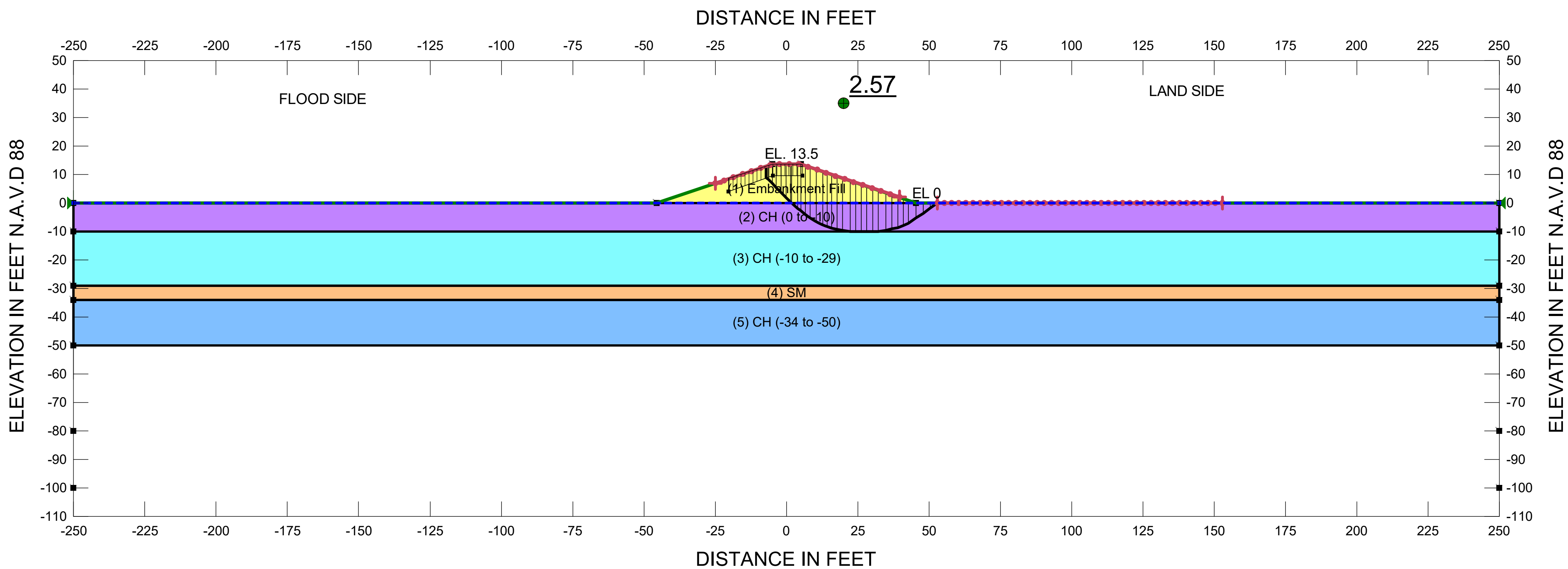


Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	(1) Embankment Fill	Mohr-Coulomb	115	600	0
	(2) CH (0 to -10)	Mohr-Coulomb	125	650	0
	(3) CH (-10 to -29)	Mohr-Coulomb	118	1,030	0
	(4) SM	Mohr-Coulomb	122	0	30
	(5) CH (-34 to -50)	Mohr-Coulomb	110	640	0

OAK HARBOR LEVEES

CASE: ALTERNATIVE 6

US Army Corps of Engineers®
New Orleans District



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	(1) Embankment Fill	Mohr-Coulomb	115	600	0
	(2) CH (0 to -10)	Mohr-Coulomb	125	650	0
	(3) CH (-10 to -29)	Mohr-Coulomb	118	1,030	0
	(4) SM	Mohr-Coulomb	122	0	30
	(5) CH (-34 to -50)	Mohr-Coulomb	110	640	0

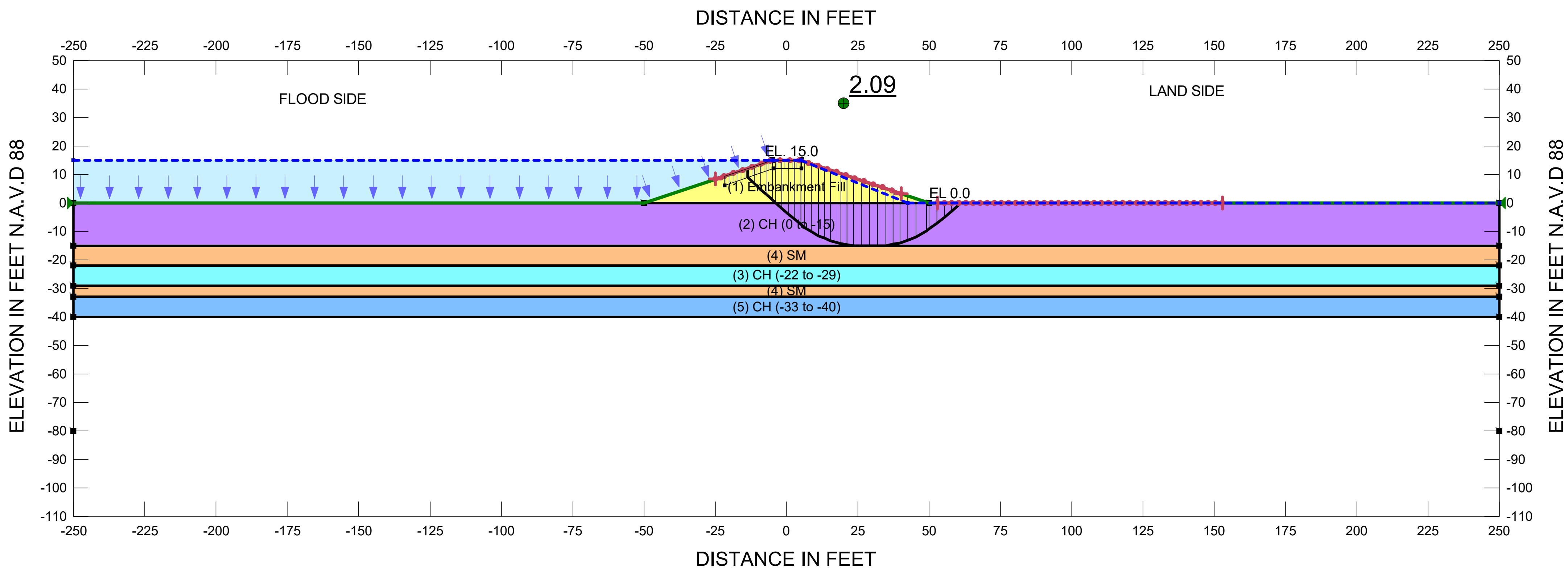
OAK HARBOR LEVEES

CASE: ALTERNATIVE 6

US Army Corps of Engineers®
New Orleans District

Pearl River Levees

Alternative 7

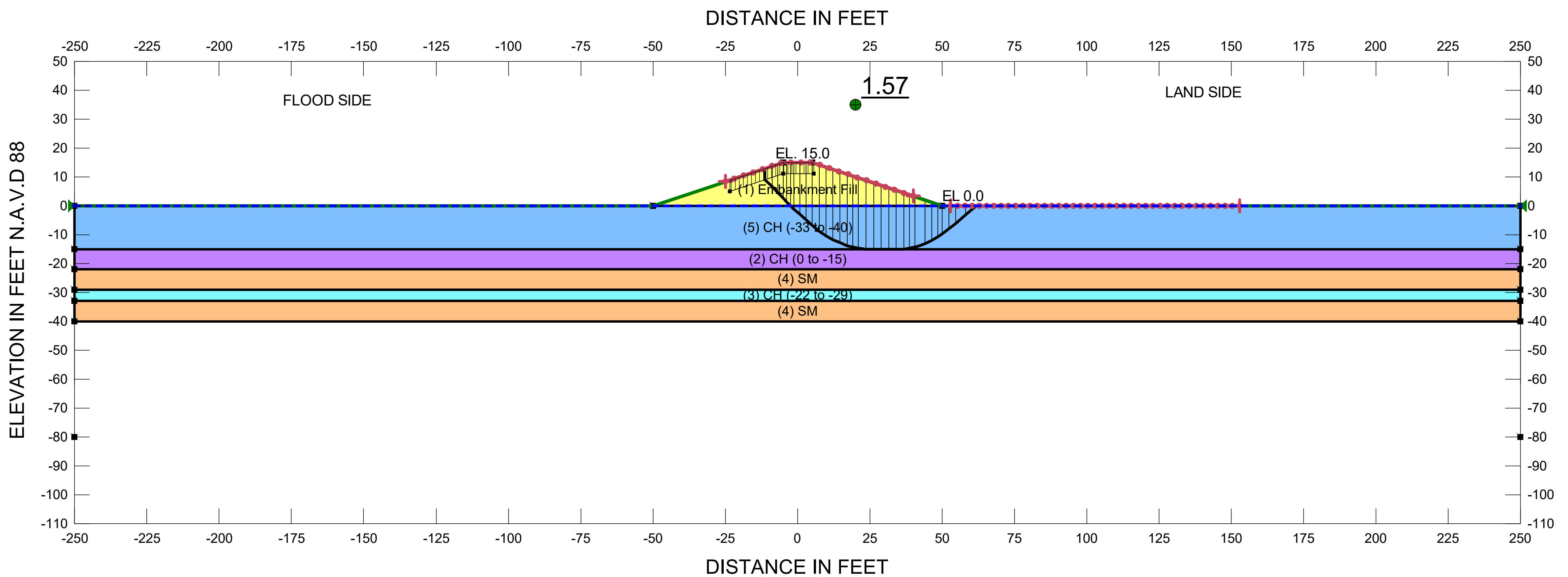


Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	(1) Embankment Fill	Mohr-Coulomb	115	600	0
	(2) CH (0 to -15)	Mohr-Coulomb	124	605	0
	(3) CH (-22 to -29)	Mohr-Coulomb	114	1,000	0
	(4) SM	Mohr-Coulomb	122	0	30
	(5) CH (-33 to -40)	Mohr-Coulomb	120	430	0

PEARL RIVER LEVEE

CASE: ALTERNATIVE 7

US Army Corps of Engineers®
New Orleans District



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	(1) Embankment Fill	Mohr-Coulomb	115	600	0
	(2) CH (0 to -15)	Mohr-Coulomb	124	605	0
	(3) CH (-22 to -29)	Mohr-Coulomb	114	1,000	0
	(4) SM	Mohr-Coulomb	122	0	30
	(5) CH (-33 to -40)	Mohr-Coulomb	120	430	0

PEARL RIVER LEVEE

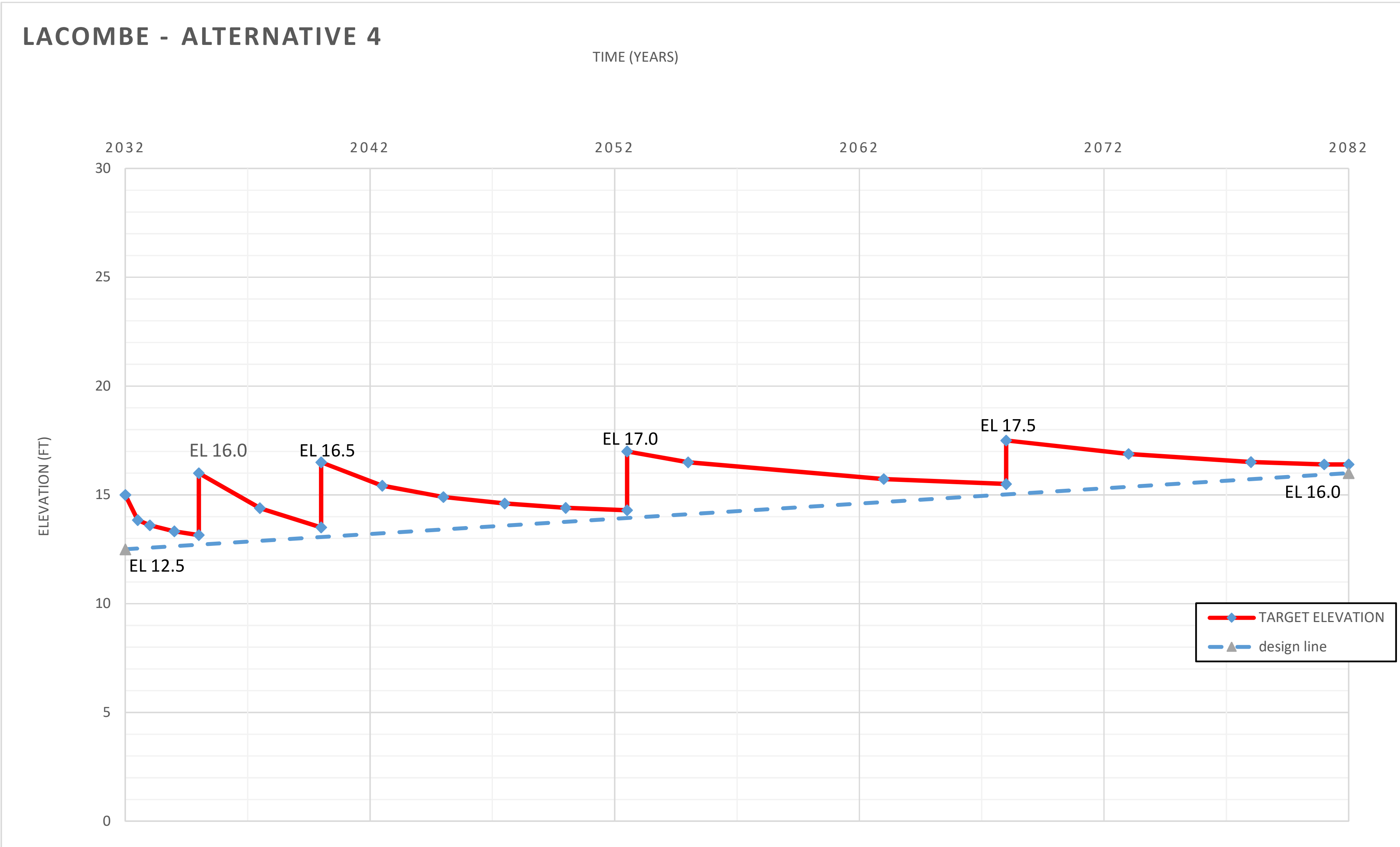
CASE: ALTERNATIVE 7

US Army Corps of Engineers®
New Orleans District

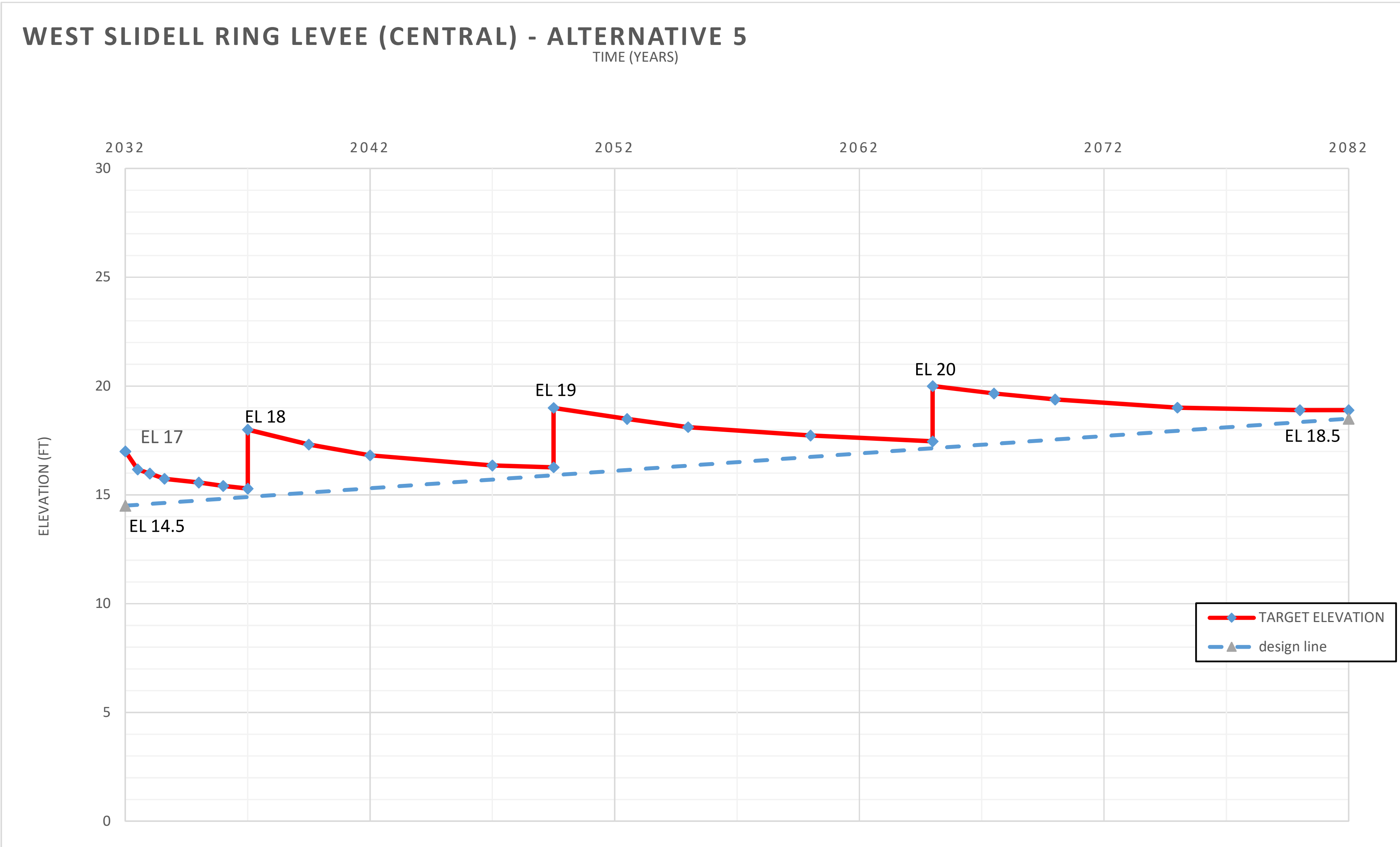
SECTION 5

Lift Estimates

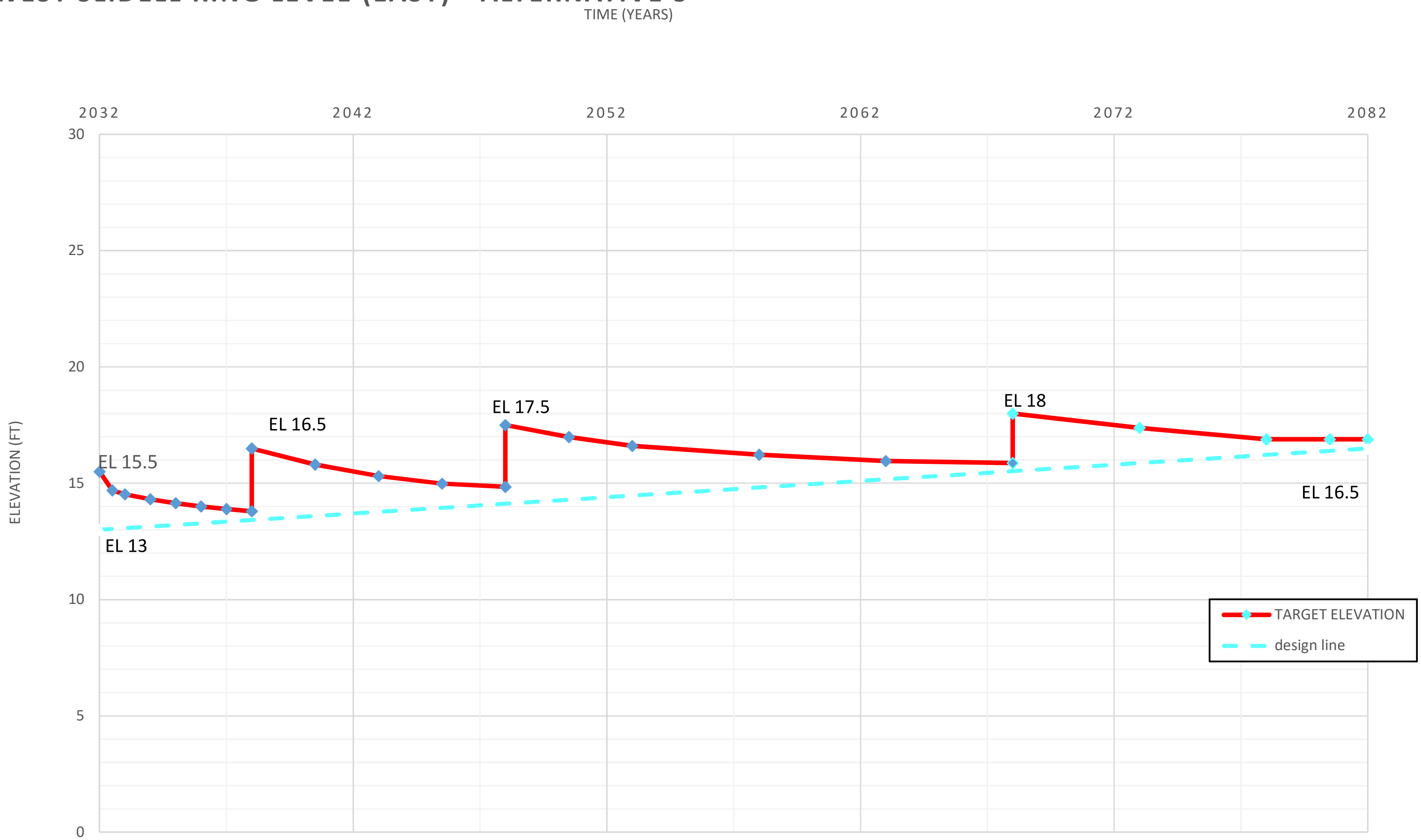
Settlement



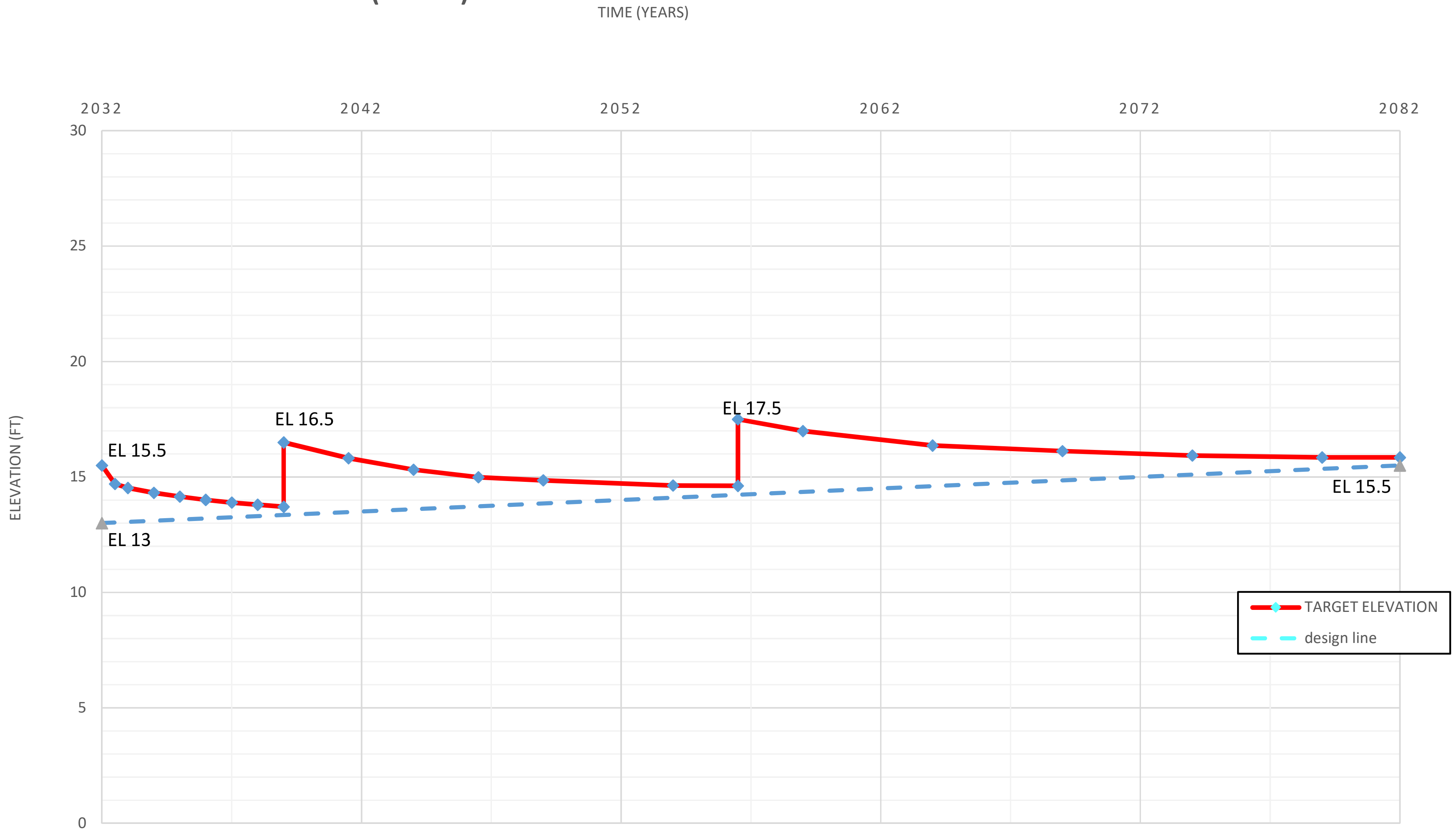
LACOMBE - ALTERNATIVE 4
TIME (YEARS)
2032
2042
2052
2062
2072
2082
30
25
20
15
10
5
0
ELEVATION (FT)
EL 16.0
EL 16.5
EL 17.0
EL 17.5
EL 12.5
EL 16.0
TARGET ELEVATION
design line

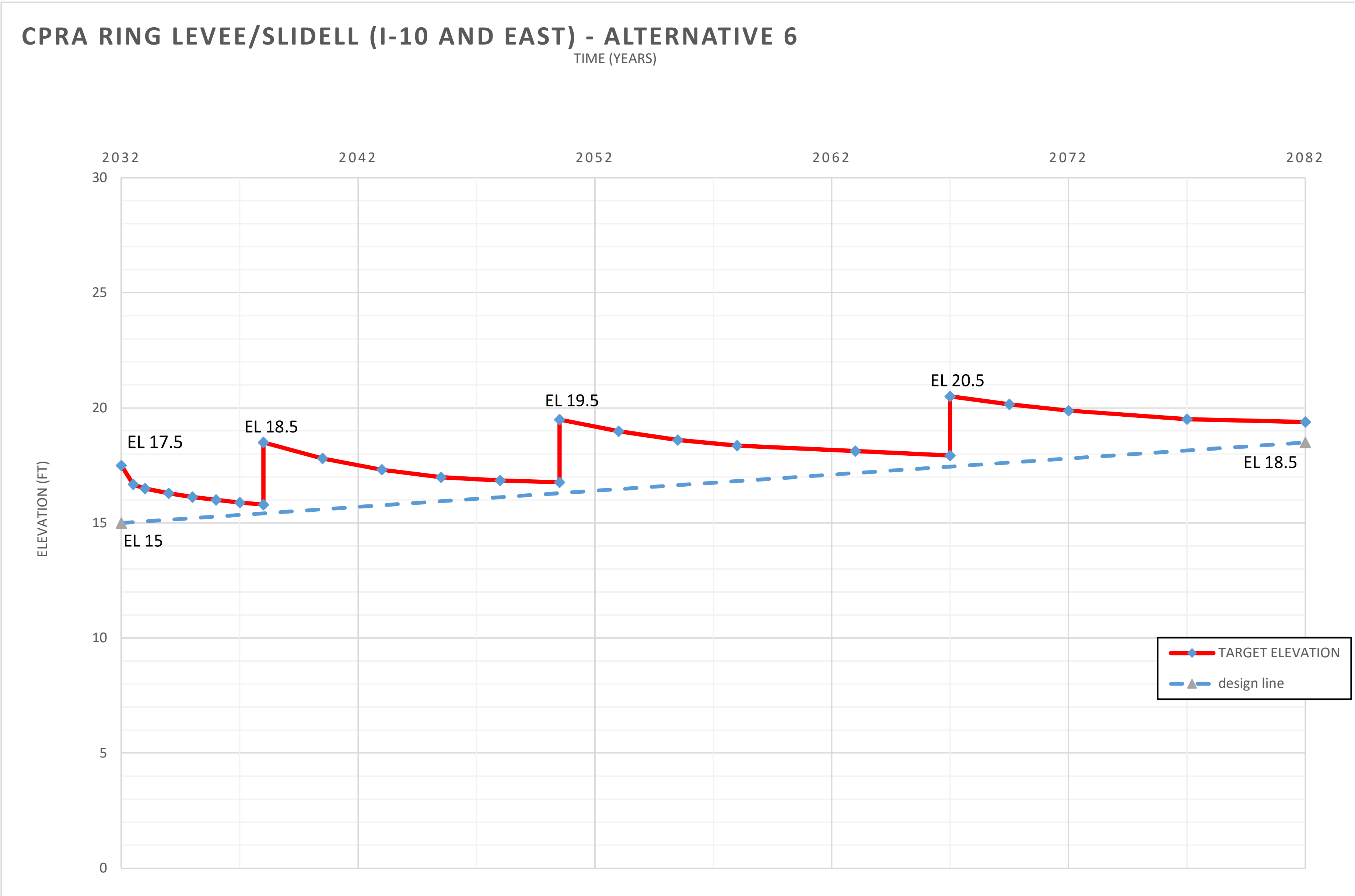

WEST SLIDELL RING LEVEE (CENTRAL) - ALTERNATIVE 5
TIME (YEARS)
2032
2042
2052
2062
2072
2082
30
25
20
15
10
5
0
ELEVATION (FT)
EL 17
EL 18
EL 19
EL 20
EL 14.5
EL 18.5
TARGET ELEVATION
design line

WEST SLIDELL RING LEVEE (EAST) - ALTERNATIVE 5

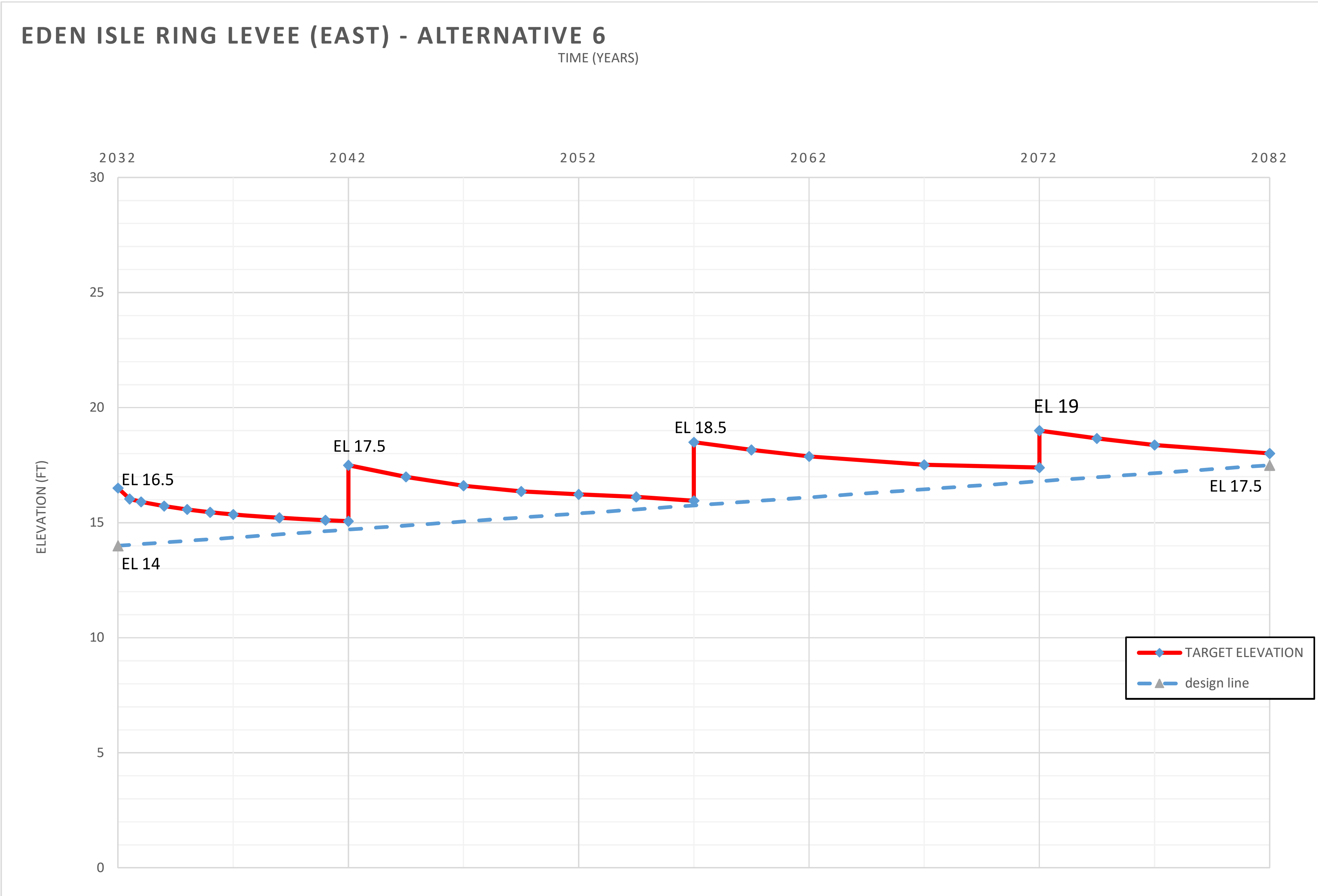


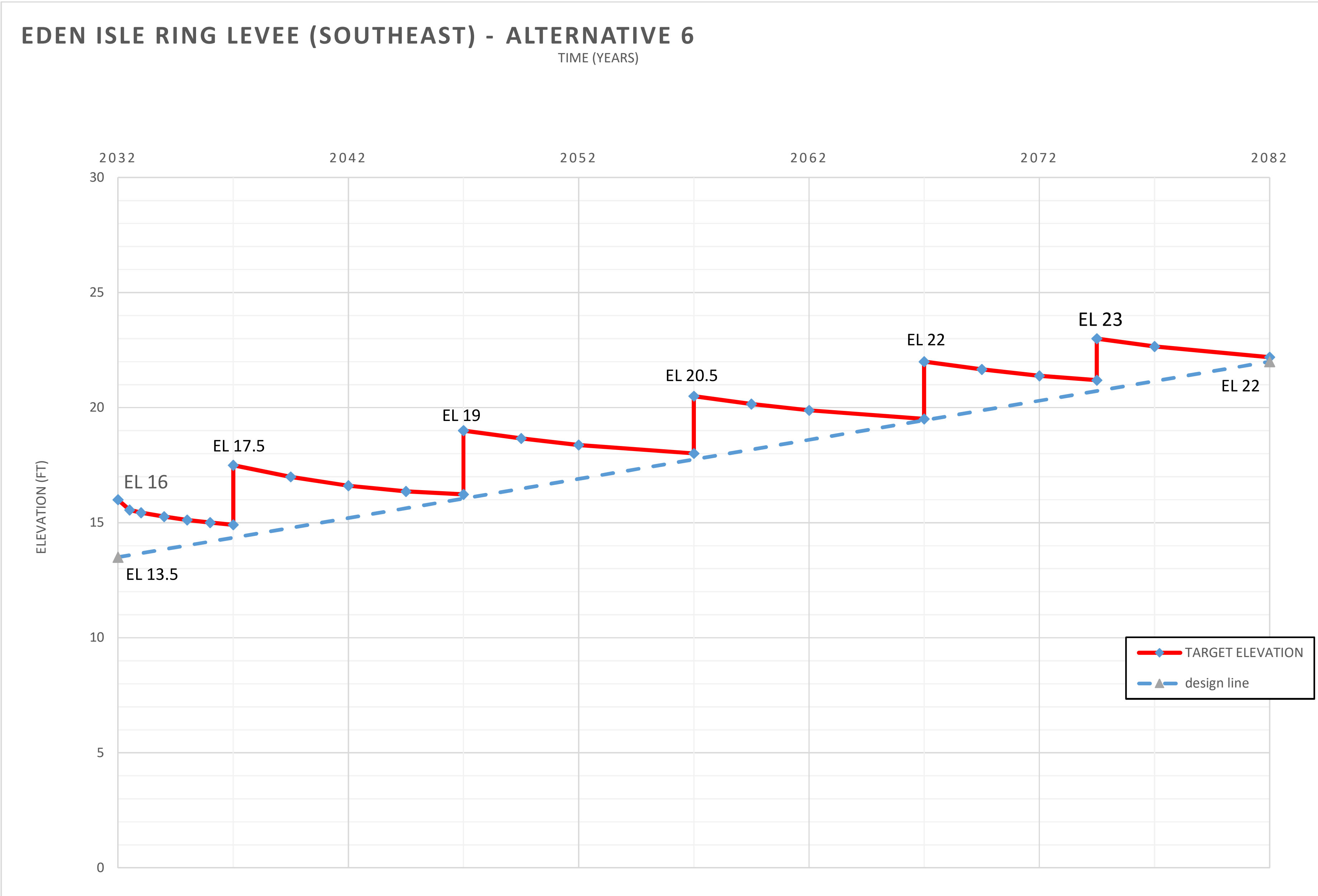
WEST SLIDELL RING LEVEE (WEST) - ALTERNATIVE 5

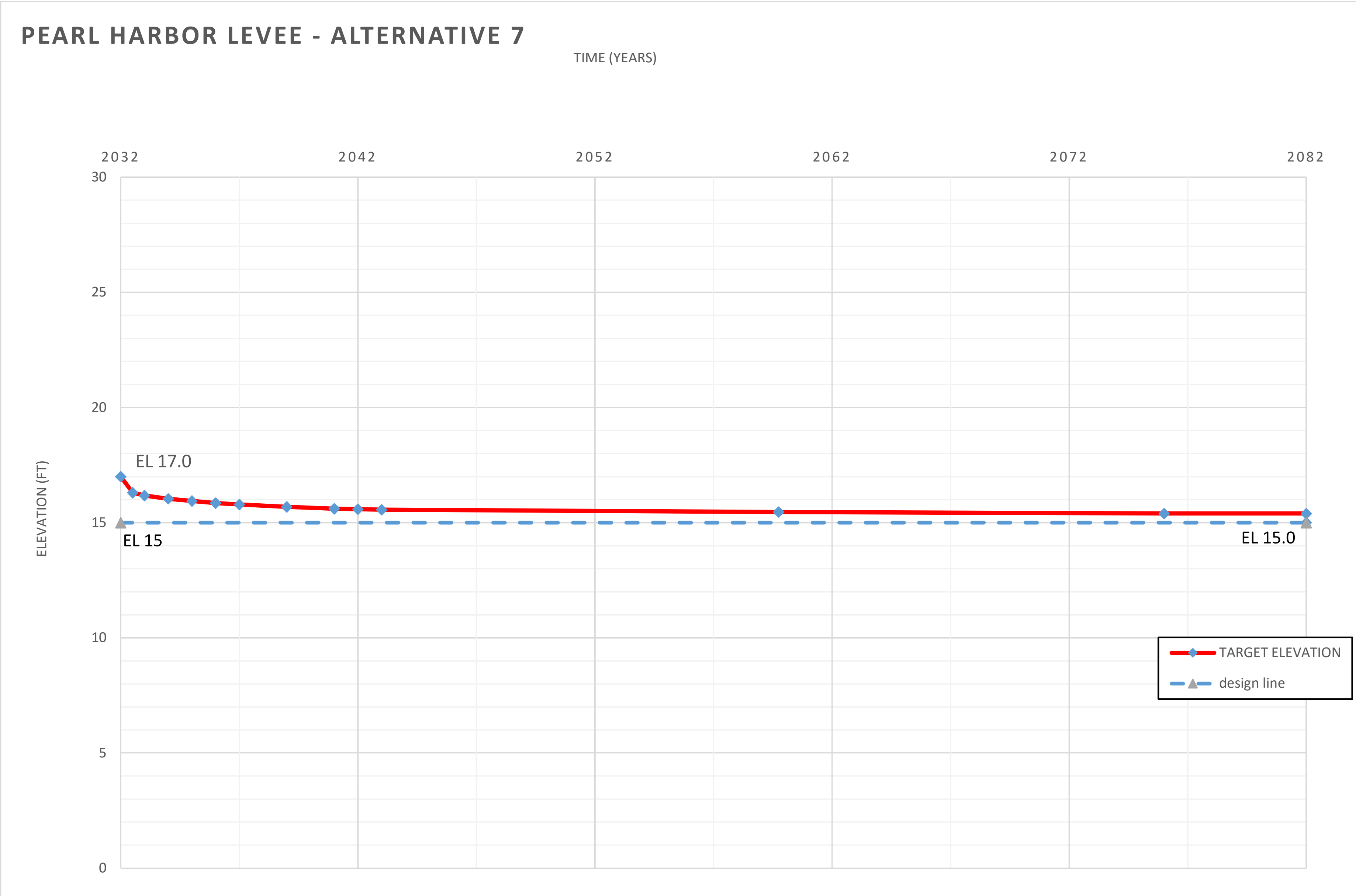




CPRA RING LEVEE/SLIDELL (I-10 AND EAST) - ALTERNATIVE 6
TIME (YEARS)
2032
2042
2052
2062
2072
2082
30
25
20
15
10
5
0
ELEVATION (FT)
EL 17.5
EL 18.5
EL 19.5
EL 20.5
EL 15
EL 18.5
TARGET ELEVATION
design line


EDEN ISLE RING LEVEE (EAST) - ALTERNATIVE 6
TIME (YEARS)
2032
2042
2052
2062
2072
2082
30
25
20
15
10
5
0
ELEVATION (FT)
EL 16.5
EL 17.5
EL 18.5
EL 19
EL 17.5
EL 14
TARGET ELEVATION
design line


EDEN ISLE RING LEVEE (SOUTHEAST) - ALTERNATIVE 6
TIME (YEARS)
2032
2042
2052
2062
2072
2082
30
25
20
15
10
5
0
ELEVATION (FT)
EL 16
EL 17.5
EL 19
EL 20.5
EL 22
EL 23
EL 22
EL 13.5
TARGET ELEVATION
design line


PEARL HARBOR LEVEE - ALTERNATIVE 7
TIME (YEARS)
2032
2042
2052
2062
2072
2082
ELEVATION (FT)
30
25
20
15
10
5
0
EL 17.0
EL 15
EL 15.0
TARGET ELEVATION
design line

SECTION 6

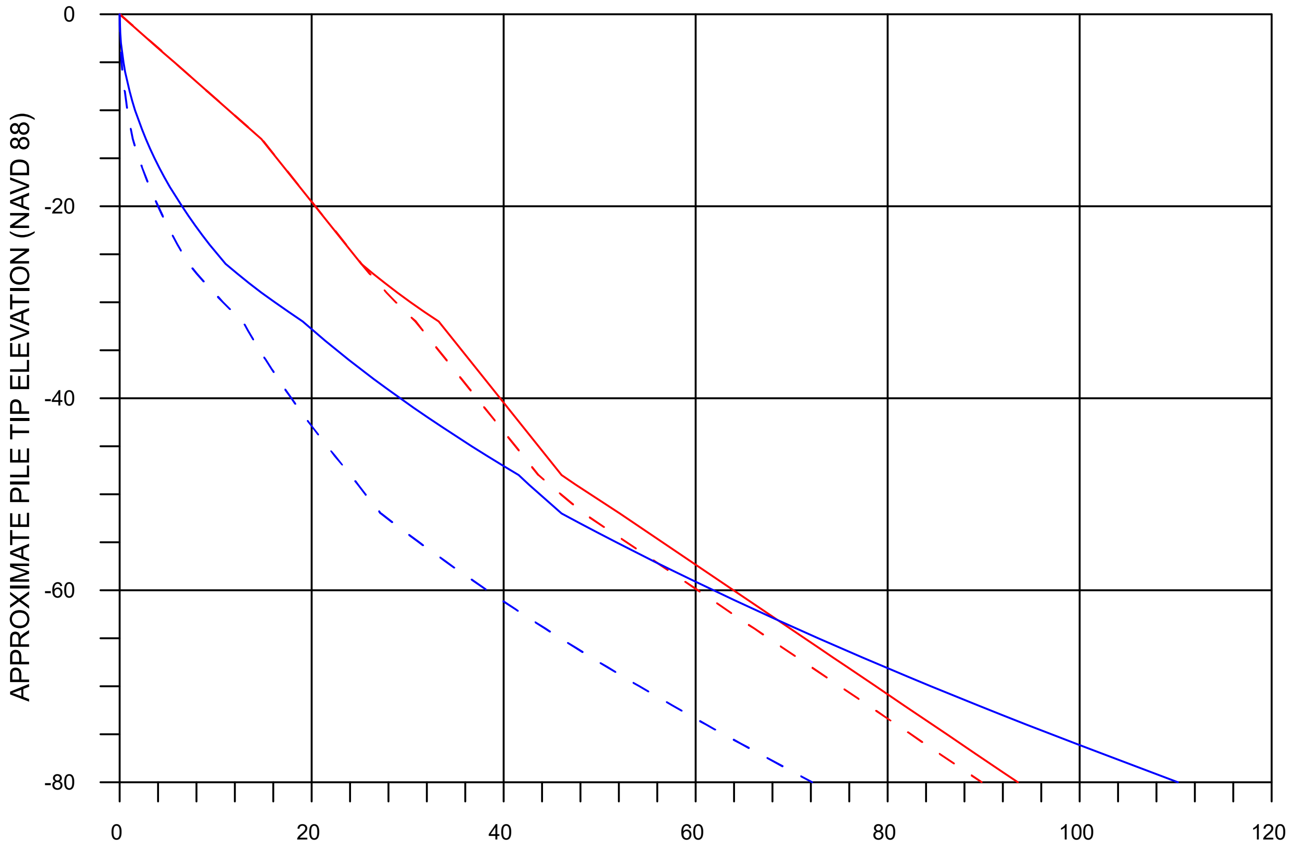
Pile Capacities

BAYOU LACOMBE/BONFOUCA/LIBERTY/PACQUET/VINCENT FLOODGATE

Alternative 4 &5

Pile Capacities

ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITIES
ST. TAMMANY BBA-18 (BAYOU LACOMBE/BONFOUCA/LIBERTY/PACQUET/VINCENT FLOODGATE)
12 x 74 INCH STEEL H-PILES
ALTERNATIVE 4 AND 5



ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITY IN TONS
FACTOR OF SAFETY = 1

LEGEND

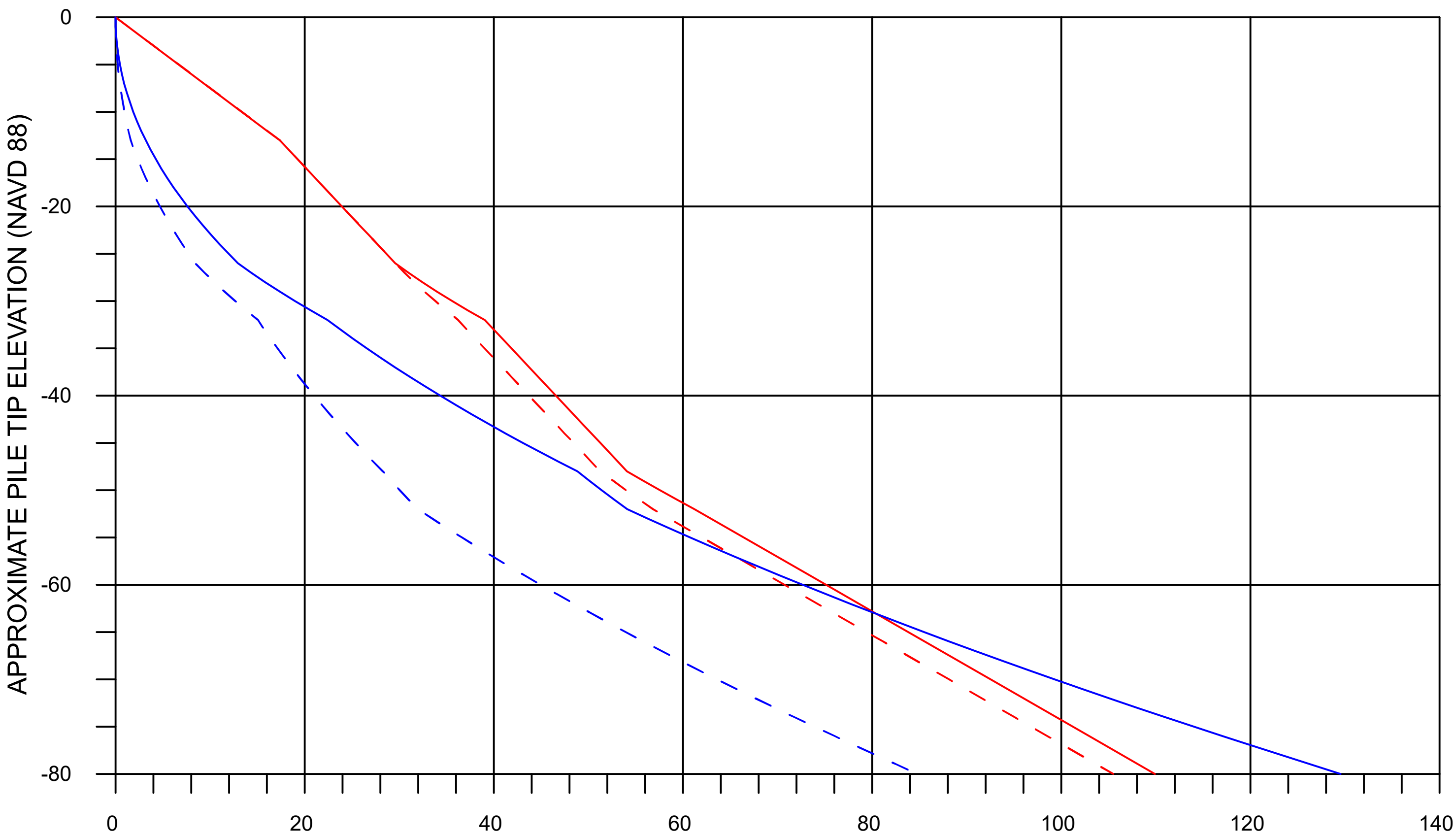
Q-CASE: COMPRESSION PILE CAPACITY
Q-CASE: TENSION PILE CAPACITY
S-CASE: COMPRESSION PILE CAPACITY
S-CASE: TENSION PILE CAPACITY

ALLOWABLE PILE LOAD CAPACITIES
12 x 74 INCH STEEL H-PILES

ST. TAMMANY BBA-18
(BAYOU LACOMBE/BONFOUCA/LIBERTY/
PACQUET/VINCENT FLOODGATE)
ALTERNATIVE 4 AND 5

DRAWN BY: M.C.M	16 DECEMBER 2020	CHECKED BY:

ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITIES
ST. TAMMANY BBA-18 (BAYOU LACOMBE/BONFOUCA/LIBERTY/PACQUET/VINCENT FLOODGATE)
14 x 73 INCH STEEL H-PILES
ALTERNATIVE 4 AND 5



ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITY IN TONS
FACTOR OF SAFETY = 1

LEGEND

- Q-CASE: COMPRESSION PILE CAPACITY
- Q-CASE: TENSION PILE CAPACITY
- S-CASE: COMPRESSION PILE CAPACITY
- S-CASE: TENSION PILE CAPACITY

ALLOWABLE PILE LOAD CAPACITIES
14 x 73 INCH STEEL H-PILES

ST. TAMMANY BBA-18
(BAYOU LACOMBE/BONFOUCA/LIBERTY/
PACQUET/VINCENT FLOODGATE)
ALTERNATIVE 4 AND 5

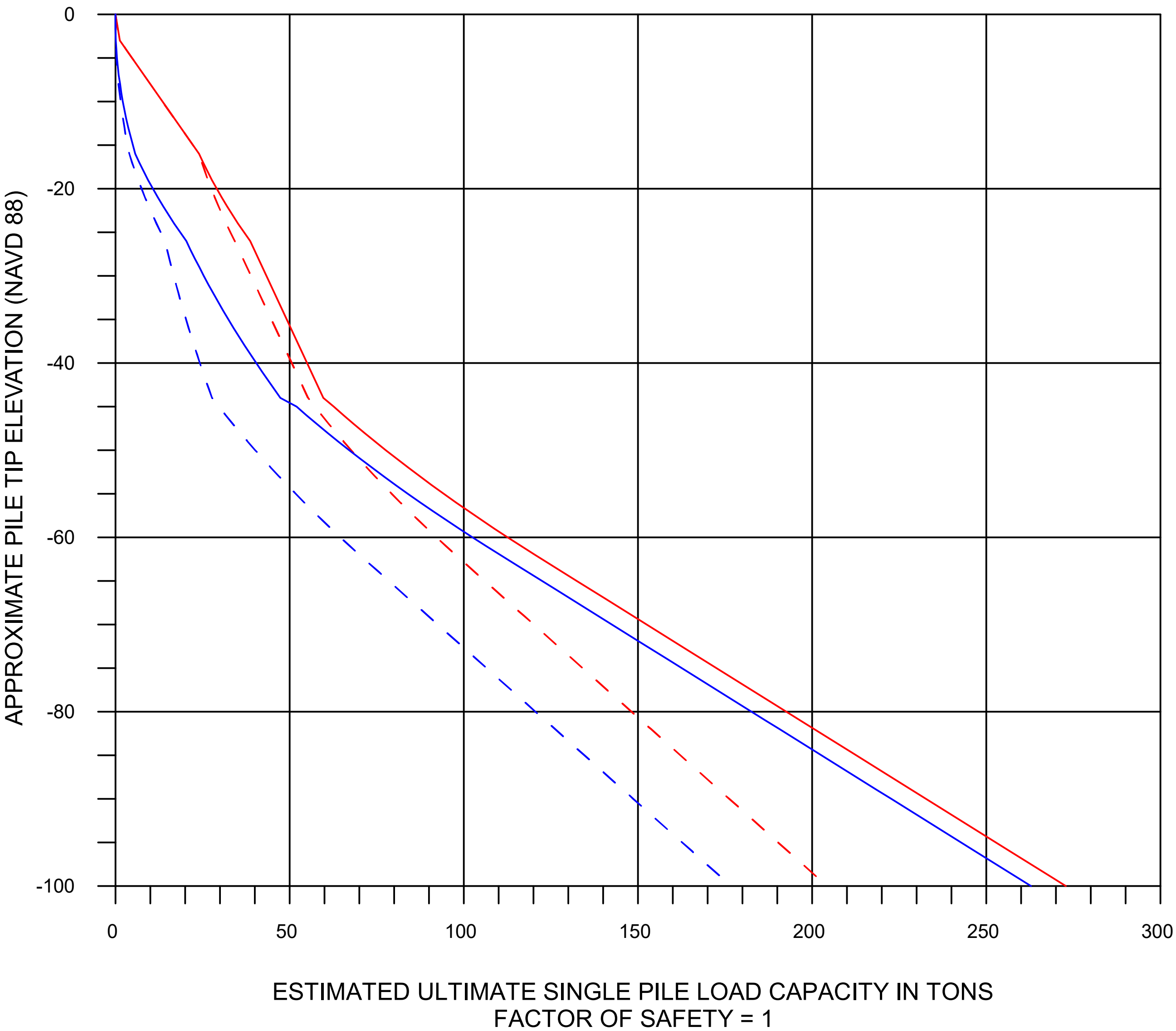
DRAWN BY: M.C.M	16 DECEMBER 2020	CHECKED BY:

W-14 FLOODGATE AND OLD SPANISH TRAIL FLOODGATE

Alternative 6

Pile Capacities

ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITIES
ST. TAMMANY BBA-18 (W-14 FLOODGATE AND OLD SPANISH TRAIL FLOODGATE)
12 x 74 INCH STEEL H-PILES
ALTERNATIVE 6



LEGEND

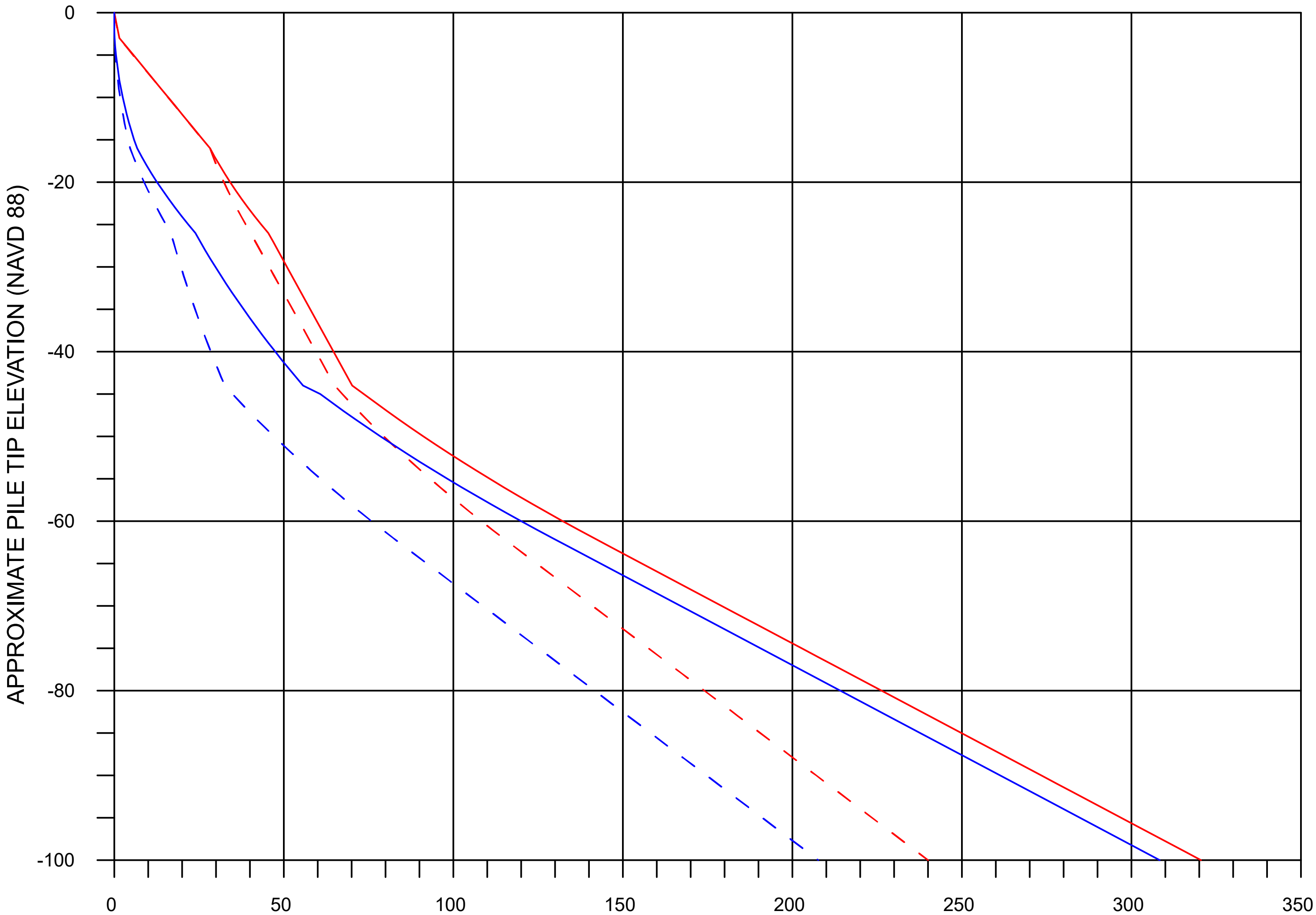
Q-CASE: COMPRESSION PILE CAPACITY
Q-CASE: TENSION PILE CAPACITY
S-CASE: COMPRESSION PILE CAPACITY
S-CASE: TENSION PILE CAPACITY

ALLOWABLE PILE LOAD CAPACITIES
12 x 74 INCH STEEL H-PILES

ST TAMMANY BBA-18
(W-14 FLOODGATE AND OLD SPANISH TRAIL FLOODGATE)
ALTERNATIVE 6

DRAWN BY: M.C.M	16 DECEMBER 2020	CHECKED BY:

ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITIES
ST. TAMMANY BBA-18 (W-14 FLOODGATE AND OLD SPANISH TRAIL FLOODGATE)
14 x 73 INCH STEEL H-PILES
ALTERNATIVE 6



ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITY IN TONS
FACTOR OF SAFETY = 1

LEGEND

- Q-CASE: COMPRESSION PILE CAPACITY
- Q-CASE: TENSION PILE CAPACITY
- S-CASE: COMPRESSION PILE CAPACITY
- S-CASE: TENSION PILE CAPACITY

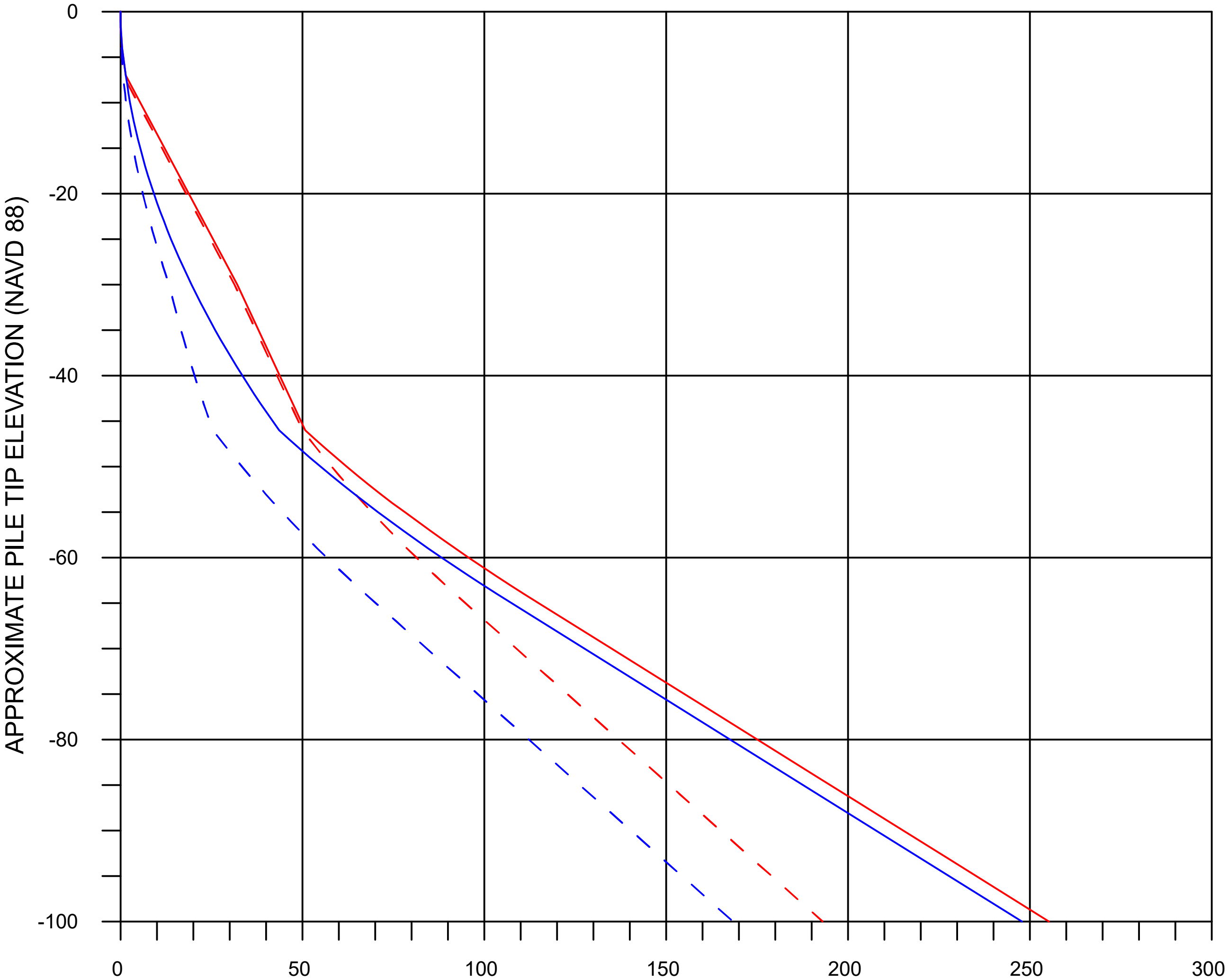
ALLOWABLE PILE LOAD CAPACITIES= 14 x 73 INCH STEEL H-PILES ST TAMMANY BBA-18 (W-14 FLOODGATE AND OLD SPANISH TRAIL FLOODGATE) ALTERNATIVE 6		
DRAWN BY: M.C.M	16 DECEMBER 2020	CHECKED BY:

I-10 ACCESS GATES, EDEN ISLE MARINA GATE, SOUTH, SOUTHWEST, WEST FLOODWALLS

Alternative 6

Pile Capacities

ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITIES
ST. TAMMANY BBA-18
(I-10 ACCESS GATES, EDEN ISLE MARINA GATE, SOUTH, SOUTHWEST, WEST FLOODWALLS)
12 x 74 INCH STEEL H-PILES
ALTERNATIVE 6



ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITY IN TONS
FACTOR OF SAFETY = 1

LEGEND

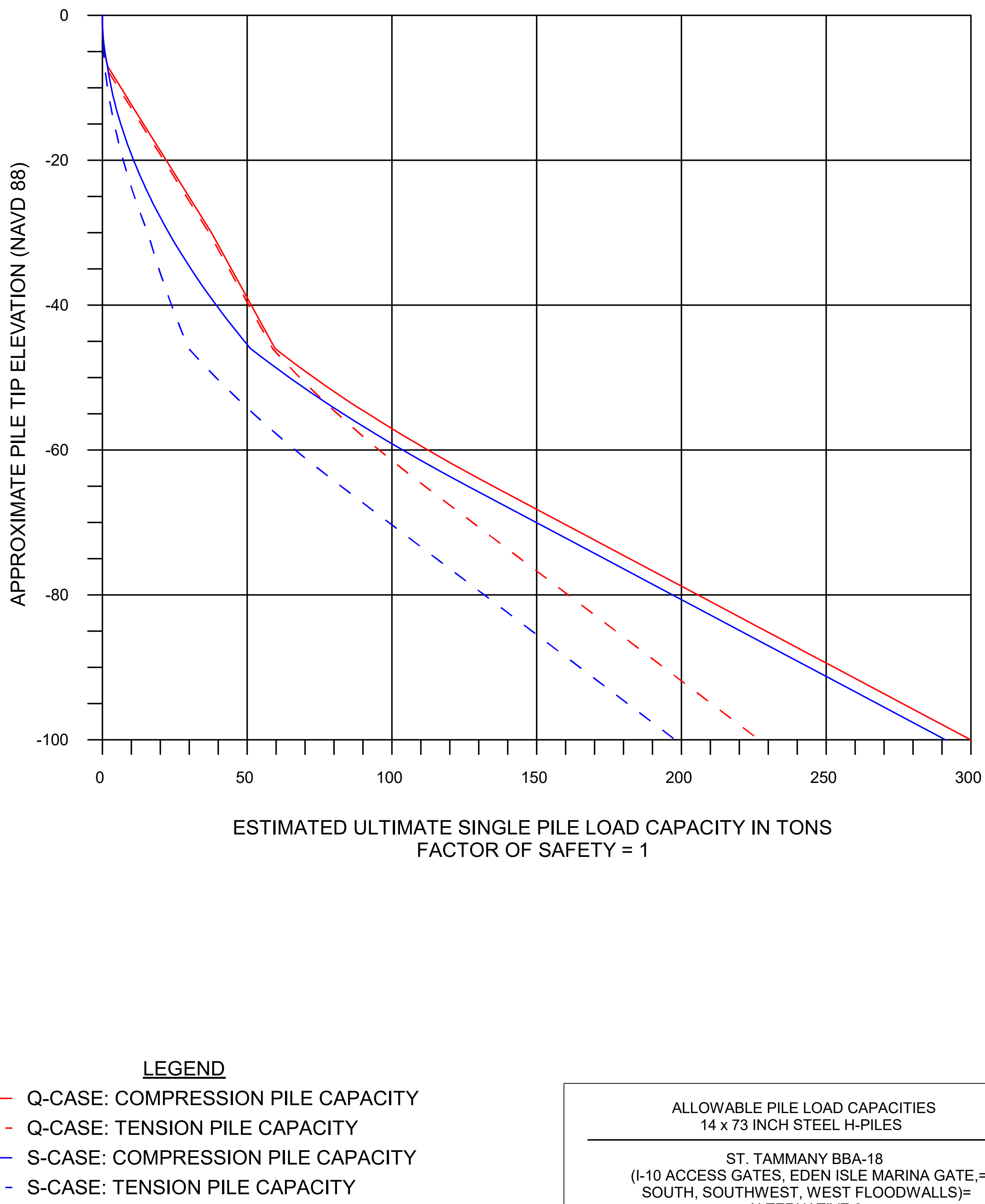
- Q-CASE: COMPRESSION PILE CAPACITY
- Q-CASE: TENSION PILE CAPACITY
- S-CASE: COMPRESSION PILE CAPACITY
- S-CASE: TENSION PILE CAPACITY

ALLOWABLE PILE LOAD CAPACITIES
12 x 74 INCH STEEL H-PILES

ST. TAMMANY BBA-18
(I-10 ACCESS GATES, EDEN ISLE MARINA GATE,=
SOUTH, SOUTHWEST, WEST FLOODWALLS)=
ALTERNATIVE 6

DRAWN BY: M.C.M	16 DECEMBER 2020	CHECKED BY:

ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITIES
ST. TAMMANY BBA-18
(I-10 ACCESS GATES, EDEN ISLE MARINA GATE, SOUTH, SOUTHWEST, WEST FLOODWALLS)
14 x 73 INCH STEEL H-PILES
ALTERNATIVE 6



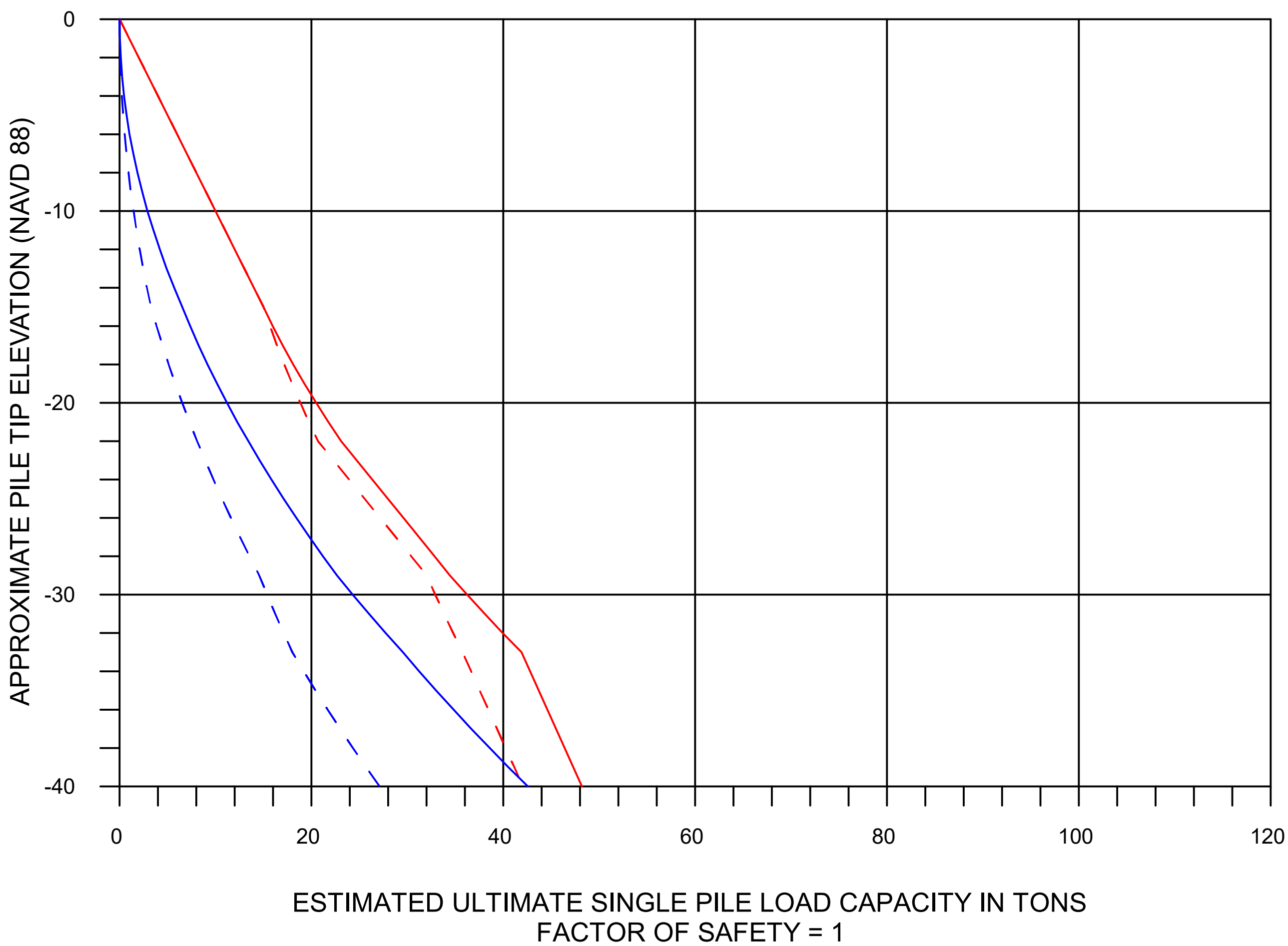
ALLOWABLE PILE LOAD CAPACITIES 14 x 73 INCH STEEL H-PILES ST. TAMMANY BBA-18 (I-10 ACCESS GATES, EDEN ISLE MARINA GATE,= SOUTH, SOUTHWEST, WEST FLOODWALLS)= ALTERNATIVE 6		
DRAWN BY: M.C.M	16 DECEMBER 2020	CHECKED BY:

PEARL RIVER FLOODWALLS

Alternative 7

Pile Capacities

ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITIES
ST. TAMMANY BBA-18 (PEARL RIVER FLOODWALLS)
12 x 74 INCH STEEL H-PILES
ALTERNATIVE 7

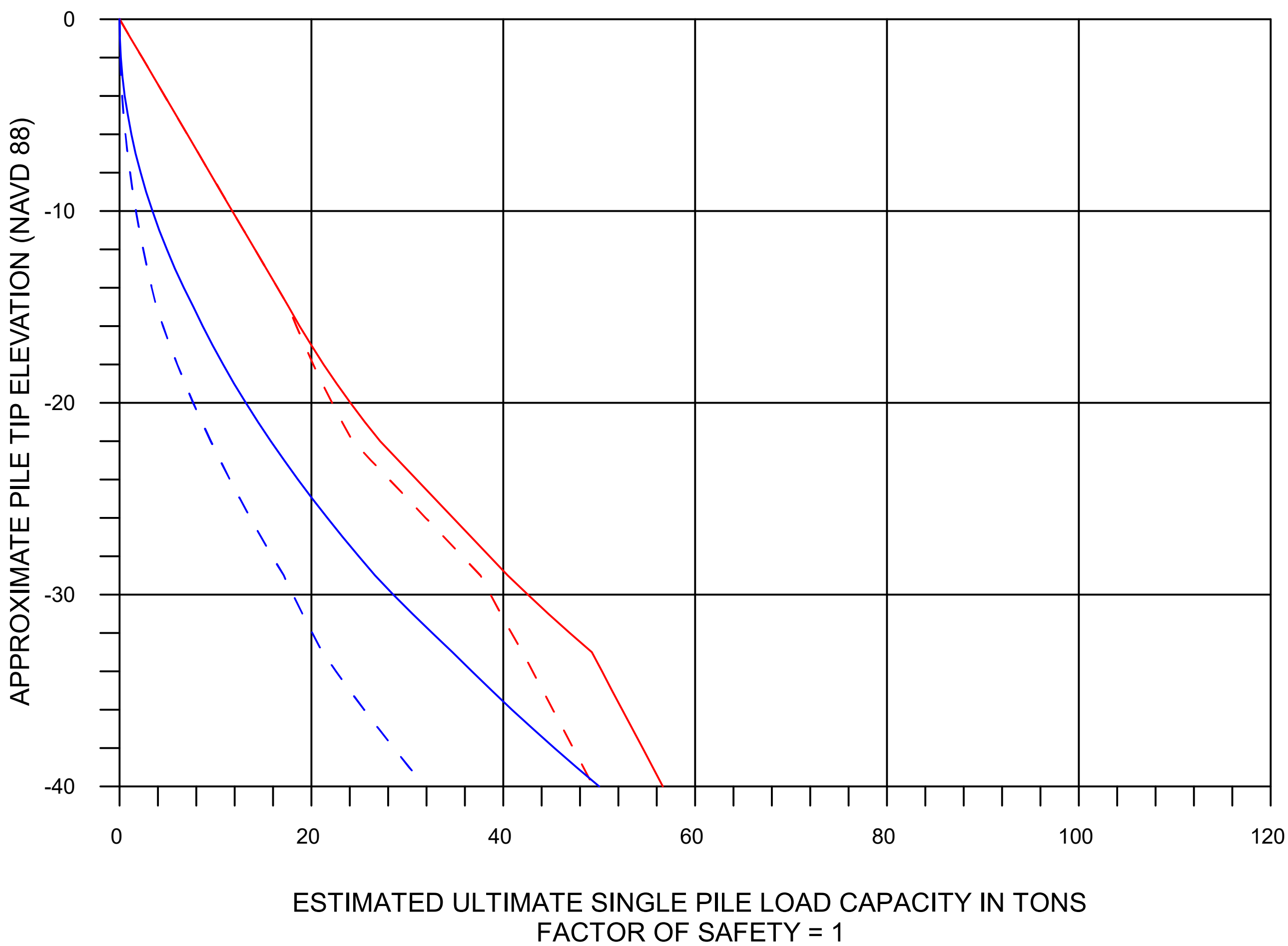


LEGEND

- Q-CASE: COMPRESSION PILE CAPACITY
- Q-CASE: TENSION PILE CAPACITY
- S-CASE: COMPRESSION PILE CAPACITY
- S-CASE: TENSION PILE CAPACITY

ALLOWABLE PILE LOAD CAPACITIES 12 x 74 INCH STEEL H-PILES ST. TAMMANY BBA-18 (PEARL RIVER FLOODWALLS) ALTERNATIVE 7		
DRAWN BY: M.C.M	16 DECEMBER 2020	CHECKED BY:

ESTIMATED ULTIMATE SINGLE PILE LOAD CAPACITIES
ST. TAMMANY BBA-18 (PEARL RIVER FLOODWALLS)
14 x 73 INCH STEEL H-PILES
ALTERNATIVE 7



LEGEND

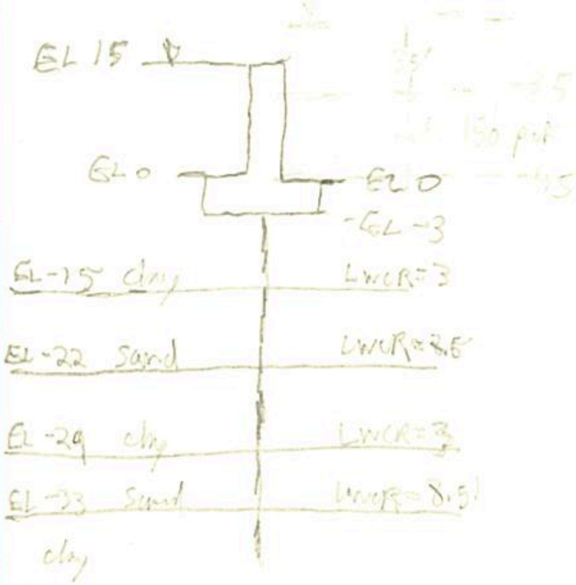
- Q-CASE: COMPRESSION PILE CAPACITY
- Q-CASE: TENSION PILE CAPACITY
- S-CASE: COMPRESSION PILE CAPACITY
- S-CASE: TENSION PILE CAPACITY

ALLOWABLE PILE LOAD CAPACITIES 14 x 73 INCH STEEL H-PILES ST. TAMMANY BBA-18 (PEARL RIVER FLOODWALLS) ALTERNATIVE 7		
DRAWN BY: M.C.M	16 DECEMBER 2020	CHECKED BY:

SECTION 7

Lane’s Weighted Creep

Sheetpile Lengths



$$LWCR = \frac{\frac{H}{3} + \Sigma v}{h} \Rightarrow \text{assume } H = 0 \text{ for estimate on quantity}$$

$$V = \frac{(LWCR)(h)}{2} = \frac{3(15')}{2} = 22.5'$$

Equivalent thickness:

clay $= \frac{3}{3}(12') = 12'$ and $\frac{3}{3}(7') = 7'$

sand $= \frac{3}{8.5}(7') = 2.5'$ and $\frac{3}{8.5}(4') = 1.4'$

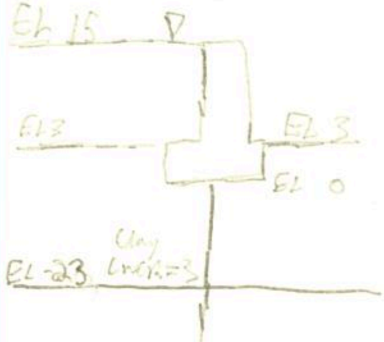
Need to cover 23'

$12' + 2.5' + 7' + 1.4 = 22.9$ extend 5' into clay

So, use 35' sheetpiles for alternate "I" floodwalls

Soil properties based on Slidell memorial hospital boring for Eustis job 13418 which was closest available geotech data

St. Tammany Feasibility	South Slidell	Final Array

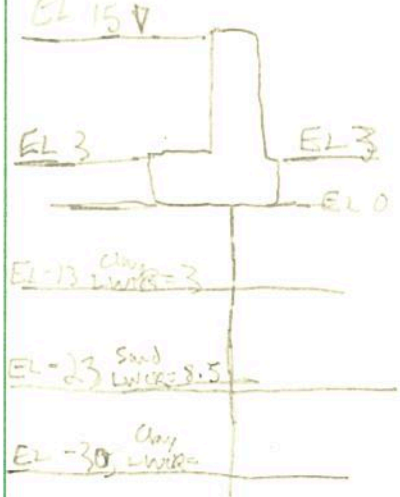


$$LWCR = \frac{\frac{H}{3} + 2v}{h} \Rightarrow$$ assume H=0 for estimate on quantity

$$V = \frac{(LWCR)(h)}{2}$$

$$V = \frac{3(12)}{2} = 18'$$ ∴ 18' sheet should be fine

Check same water loading at another location.



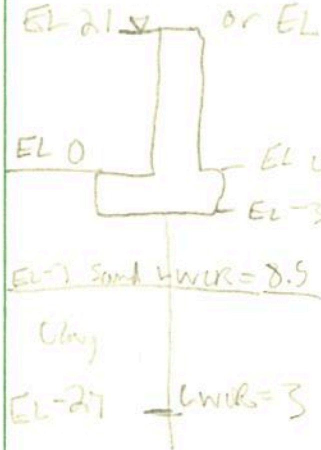
$V = 18'$

equivalent thickness: clay $= \frac{3}{3}(10') = 10'$
sand $= \frac{3}{8.5}(10') = 3.5'$
clay $= \frac{3}{3}(7') = 7'$
$20.5'$

Will use different sheet lengths at different locations:
Use 20' length for the South Slidell surge reduction which has larger sand
Use 25' length for W-14 gate which has deeper sand

Surge reduction use 13965 Eustis project
W-14 use 10463 Eustis project

St. Tammany Feasibility | Eden Isles | Final Array Sheetpile length



$$LWCR = \frac{\frac{H}{3} + 2v}{h}$$ => assume H = 0 for estimate on quantity

$$V = \frac{(LWCR)(h)}{2} = \frac{3(21)}{2} = 31.5$$

$$\text{or } V = \frac{3(17)}{2} = 25.5$$

Equivalent thickness:

$$\text{Sand} = \frac{3}{8.5}(4') = 1.5$$

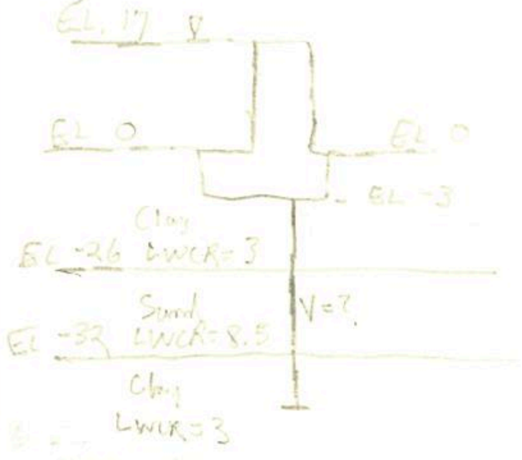
and Clay for 24' or 30'

Soil properties based on St Tammany Events Center boring for Eustis job 16613 which has closest available geotech data

Use 30' for jobs with less water loading in alternative 6

Eden Isle I-10 walls will utilize 30' sheets

Eden Isles Marina Gate, South, SW, West utilize 35' sheets



$$LWCR = \frac{H/3 + 2V}{h} \Rightarrow$$ assume H=0 for estimate on quantity $$V = \frac{(LWCR)(h)}{2}$$

Equivalent thickness

clay $= \frac{3}{3}(23') = 23'$

sand $= \frac{3}{8.5}(6') = 2.1'$

$$V = \frac{3\,(17)}{2} = 25.5$$ ← clay equivalent

25.1 < 25.5, extend into clay

So, use 35' sheetpiles for all alternate 4 floodwalls

Soil properties based on Delwood Pumping Station boring for Gustis job 13965 which was closest available geotechnical data at

Other assumptions:

- assumed base width of 0
- assumed clay for first 26 ft, then 6 ft sand
  * geology could change with site specific boring
- assumed 3 ft. slab and ground elev at 0
- assumed top of slab at ground elevation

Can also apply to alternative 5

ST. TAMMANY PARISH, LOUISIANA

DRAFT FEASIBILITY REPORT

AND

INTEGRATED ENVIRONMENTAL IMPACT STATEMENT

LIFE SAFETY RISK ASSESSMENT

ANNEX 4

(Engineering Appendix)

June 2021

1.0 Introduction

A life safety risk assessment was conducted as part of the flood reduction feasibility study for St Tammany Parish and included as an Annex to the Engineering Appendix. The life safety assessment evaluated the 9 primary alternatives using the available information. The life safety assessment is qualitative and prepared prior to completion of the engineering appendix and without consequence modeling.

2.0 Background

The project is a composite of proposed alternatives included to benefit multiple locations to provide flood risk reduction for both coastal and riverine flooding. The nine initial project alternatives included elements of levees, floodwalls, pumping stations, and channel improvements. The alternatives evaluated are included on the Life Safety Measure/Plan Evaluation Matrix located at the end of this appendix. The design project flood frequency is a 1% annual exceedance probability (or 100-year flood risk reduction). The project includes incorporation some existing systems as well as new work. The alternatives are briefly described in the following sections. See the main body of the report for a project map of all the alternatives and the Engineering Appendix for full descriptions.

2.1 Alternative 1

No Action Alternative.

2.2 Alternative 2

Alternative 2 has parish wide coverage in areas of flood damages (FRM and CSRM) to structures. It includes flood proofing, structure raising, buyouts and relocations.

2.3 Alternative 4

Alternative 4 includes multiple potential alignments of levee to reduce coastal flooding. Alternative 4a consists of approximately 9 miles (47,700 ft) of levee in the City of Lacombe, Louisiana, to reduce coastal flooding. Alternative 4b is comprised of approximately 13.7 miles (72,000 ft) of levee, which combines the Lacombe Levee from Alternative 4a.1 and the West Slidell Levee from Alternative 5, to reduce coastal flooding in Lacombe, Slidell, and the area between the two cities.

2.4 Alternative 5

This alternative is a combination of approximately 6.5 miles (34,000 ft) of levees and 0.08 miles (450 ft) of floodwall located on the west side of the City of Slidell, Louisiana.

2.5 Alternative 6

There are three existing ring levees in the City of Slidell: the King's Point System which consists of two ring levees on the northeast side, the Lakeshore Estates Levee on the southeast side, and the Oak Harbor Levee in the vicinity of Eden Isle. There is also an authorized Southeast Louisiana (SELA) Schneider Canal Study currently under-way.

The South Slidell is a combination of levees and pump stations, which are proposed to reduce risk of storm surge flooding. There are three alignments for this alternative. Alternative 6a consists of the South Slidell levee alignment. Alternative 6b consists of a combination of South Slidell levee and Eden Isle floodwall. Alternative 6c is a combination of portions of levee from alternative 5 (except for west portion of alignment) and alternative 6a (except for northwest portion of alignment). The two alignments are tied together with a railroad gate across the railroad tracks.

2.6 Alternative 7

Alternative 7 includes the Pearl River levee which is approximately 4.8 miles (25,000 ft), diversion channel and channel improvements to address riverine flooding. The features in this alternative are all separate and combinable and could all be implemented if justified.

2.7 Alternative 8

The Upper Tchefuncte/Covington- Channel alternative includes channel modifications that reduce rainfall and riverine flooding in the upper reaches of the Tchefuncte and Bogue Falaya Rivers. The alternative does not include structural flood control features such as levees or floodwalls.

2.8 Alternative 9

Alternative 9a replaces the existing lakefront seawall to elevation 7.3 ft NAVD88 and adds a passive drainage option on Bayou Ravine Aux Coquilles and Little Castine Bayou. Alternative 9b replaces the existing seawall to elevation 7.3 ft NAVD88 and adds pump stations at the lakefront at Girod Street and Ravine Aux Coquilles. Alternative 9c replaces the existing seawall to elevation 18 ft NAVD88 and adds pump stations at the lakefront at Girod Street and Ravine Aux Coquilles.

3.0 Consequences

Limited modeling has been done to inform the potential benefits and consequences of the flood reduction alternatives. HEC-LifeSIM modeling was not available at the time of this screening level life safety risk assessment. At the time of this assessment, the Project Delivery Team has not made the determination to complete HEC-LifeSIM during Planning or Preconstruction Engineering and Design (PED) Phase. Currently, the Planning PDT does not include a HEC-LifeSIM modeler. Hydraulic modeling input is required to generate consequences. The determination of when to complete this effort is currently pending.

4.0 Loading

4.1 Seismic

No significant seismic concerns are expected. The seismic chapter will be produced in the Preconstruction Engineering and Design Phase (PED).

4.2 Hydrology and Hydraulics

HEC-RAS (2D) and ADCIRC modeling is complete. Additional iterations will be made with flood gates in place for multiple bayou crossings and design of the pump stations. Additional RAS modeling needed may impact gate dimensions and operating procedures.

4.3 Sea Level Change

Sea Level Rise. Sea level rise and subsidence considerations must be investigated for both design and the future condition risk assessment.

5.0 Tentatively Selected Plan (TSP)

5.1 South and West Slidell Combined Levee

The TSP alignment includes levee and floodwall sections in west and south Slidell, referred to as Alternative 6c (combination of portions of Alternatives 5 and 6a). Figure 1 depicts the levee system components for the Tentatively Selected Plan (TSP).

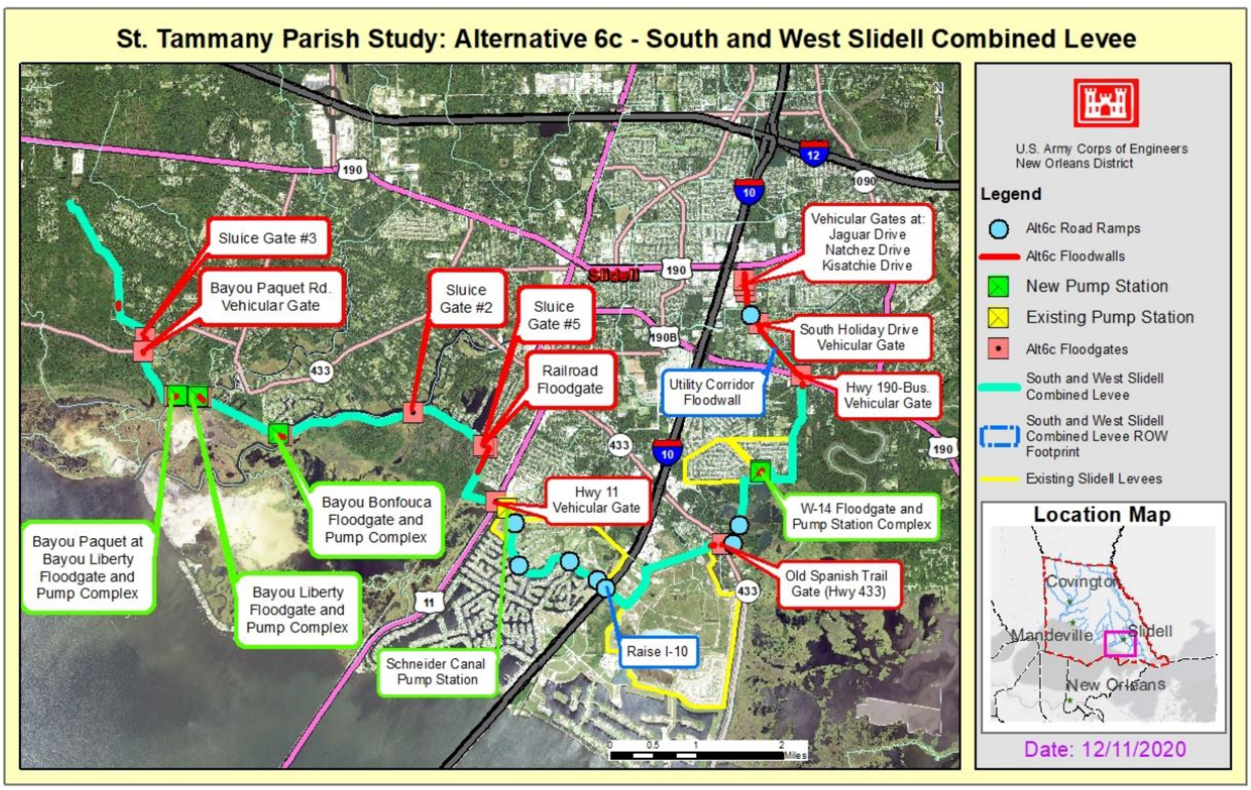


Figure 1. Project Plan for TSP

The preliminary assumptions are that the levee has a 10 ft wide levee crown and side slopes of 1V:3H. Berm sections will be determined in the next phase of the study. The elevation of the new West Slidell levee will vary between 13 ft and 14.5 ft the new South Slidell levee will vary between 13 ft and 15 ft. The typical T-wall section will consist of a 3 ft thick by 8.5 ft wide slab with a 1.5 ft thick stem. Preliminary assumptions are two rows of 1H:3V battered H-piles, 60 ft deep, spaced on 5 ft centers, and 30 ft-deep steel PZ sheet pile. The design of the new T-wall including the foundation is subject to change once detailed geotechnical investigations are conducted. The preliminary design elevation of the floodwall segments will vary from 13.5 ft to 17 ft.

The full TSP alignment was not considered during this assessment, but a Semi-Quantitative Risk Assessment will be conducted on the TSP during a later stage of the study.

5.2 Project Features outside Realm of Risk Assessment
Other features included in the TSP but not considered for the Life Safety Risk Assessment include channel improvement for multiple channels and nonstructural raising of residential structures. Channel improvement includes both channel enlargement and clearing and snagging.

- Mile Branch Channel Improvements
- Bayou Patassat Clearing and Snagging
- Nonstructural home elevations

6.0 Engineering Concerns

6.1 Geotechnical Exploration
Limited existing data exists along the proposed levee alignment for the TSP. For this stage of the feasibility study no additional exploration or testing was conducted to further inform the design efforts. Significant potential foundation and constructability concerns, including proximity to waterways and highly compressible foundations exist along the alignment.

6.2 Design Data Available
Coordination with local entities for St. Tammany has not yielded complete design surveys, design reports, as-built drawings, or monitoring reports for prior locally designed or constructed flood risk reduction features. Historic records should include levees and structures (fronting protection). This data will influence the data exploration needed and better inform existing system performance in the risk assessment.

6.3 Geotechnical and Geological Concerns

Coastal geomorphology and possible historic channel crossings within levee alignment create concerns for both foundation settlement and seepage. Portions of the levee alignment are near environmentally sensitive areas, which historically has resulted in alignment and design changes. In addition, portions of the proposed levee alignments are alongside Bayou Bonfouca. At the time of this assessment, the depth and dimensions of the bayou were unknown to life safety risk team. The engineering unknowns create uncertainty with the performance of the planned alignment, proposed levee section without berm and floodwall designs, and existing features.

7.0 Semi-Quantitative Risk Assessment (SQRA)

7.1 A life safety risk assessment was initiated in the very beginning of the study phase of this project. The Planning PDT provided very limited information at this early stage. Due to complexity of the project with multiple benefit areas, the early concept was to use life safety risk as a criterion for determining the TSP. Due to the very short period between the TSP milestone and report submission, the life safety risk assessment team did not have a report to review at time of preparation for this annex. The next phase will include an Engineering Appendix as a reference. Reaches of the project have not been physically seen by the life safety risk assessment team due to the remote location and short schedule for submission date of this Appendix. No risk assessment team members have seen any of the sites.

7.2 The SQRA is currently targeted for completion early during PED, should the project be authorized and appropriated.

7.3 Potential Failure Mode Analysis (PFMA) is an early step of the SQRA. The PFMA will be accomplished with the PDT design team and the life safety risk assessment team. The life safety risk assessment team members chosen at this time have experience with design of the project features. Shared experience with existing design PDT can assist with proposed exploration plan and subsequently ensure all current guidelines are met.

7.4 Risk Drivers identified during the SQRA process will assist in development and refinement of design criteria. Overtopping rates will consider the 1% annual exceedance probability limit of 0.1 cfs/ft overtopping. Discussion during elicitation on risk drivers may inform construction sequencing. Sea level rise and subsidence along with storm frequencies beyond the current project scope will be included in the risk assessment. Ongoing land loss rates will be checked to assess future conditions. The project life is defined as 50 years.

7.5 When completed, the SQRA will meet current Risk Management Center (RMC) criteria and greatly assist the subsequent need for National Flood Insurance Protection (NFIP) analysis.

8.0 Life Safety Risk Assessment

8.1 Assessment Results

The matrix below summarizes the results of the life safety analysis on the Alternatives based on the information provided to the life safety risk assessment team at the time of analysis.

Alternatives	Metric					
	Expected Annual LL[1]	Flood Velocity LLR	Warning Time LLR[2]	Evacuation LLR	Vulnerable Population > 2ft[3]	Incremental Risk[3]
No Action	Low	Medium	Low	Low	-	Low
Non-Structural	Low	Medium	Low	Low	-	Low
Alternative 4a	Low	Low	Low	Low	-	Medium
Alternative 4a.1	Low	Low	Low	Low	-	Medium
Alternative 4b	Low	Low	Low	Low	-	Medium
Alternative 5	Low	Low	Low	Low	-	Medium
Alternative 6	Medium	Medium	Low	Low		High
Alternative 7	Low	Low	Low	Low		Medium
Alternative 8	Low	Low	Low	Low		Low
Alternative 9	Medium	Medium	Low	Low		High

Notes: LL – Life Loss, LLR – Life Loss Risk

1. Expected annual life loss is assumed to be low to medium for all scenarios based on population density
2. Warning time based on the tropical storm forecasting occurs days in advance of an event
3. Inundation maps generated through HEC-LifeSIM were unavailable at time of assessment, Incremental Risk is based on evaluation of proposed flood control features and populations of protected areas

The life safety assessment was completed on the alternatives, concentrating on levee and floodwalls, with channel improvement projects not contributing significantly to the evaluation. Alternatives 4 and 5 were considered substantially similar and received the same ratings. Alternatives 6 and 9 contained floodwalls near populated areas and were evaluated with similar risks. The high incremental risk for Alternatives 6 and 9 were due to the potential for incremental life loss due to the density of the population adjacent to the flood control structures. The team considered the incremental risk of the floodwalls and levees in the highly populated Slidell area higher than the proposed levee alignments of Alternatives 4 and 5 with lower population density. The Alternative 7 life safety evaluation primarily considered the Pearl River Levee.

8.2 Uncertainties

The life safety risk assessment was conducted using the information provided by the PDT. At the time of the assessment the engineering appendix was not available. Significant uncertainties and unknowns are incorporated into this assessment. The engineering unknowns, particularly the lack of geotechnical data resulting in major assumption in the foundation design, result in uncertainty with the potential long-term performance of the levees and floodwalls as currently presented. In addition, no life consequence data was available to the team for the assessment. Assumptions were made about the performance and the potential consequences. Additional geotechnical, hydrological, and structural design along with consequence modeling would provide necessary information to reduce the uncertainty to tolerable levels.

ST. TAMMANY PARISH, LOUISIANA

DRAFT FEASIBILITY REPORT

AND

INTEGRATED ENVIRONMENTAL IMPACT STATEMENT

COST ENGINEERING

ANNEX 5

(Engineering Appendix)

June 2021

TABLE OF CONTENTS

1 COST

1.1 Cost Estimates for Final Array of Alternatives (Alternates 4, 5, 6, 7, 8, and 9)

1.1.1 Cost Estimate Development

The project cost estimate was developed in the MCACES MII cost estimating software and used the standard approaches for a feasibility estimate structure regarding labor, equipment, materials, crews, unit prices, quotes, sub-contractor markups and prime contractor markups. This philosophy was taken wherever practical within the time constraints. It was supplemented with estimating information from other sources where necessary such as from quotes, bid data, and Architect-Engineer (A-E) estimates. It is to be noted that after development of the Cost and Schedule Risk Analysis (CSRA), the Alternatives within the final array were further refined so some minor inconsistencies between the Cost Appendix and the Engineering Appendix may be present.

Cost estimates for the final array of structural alternatives (Alternatives 4a, 4a.1, 4b, 5, 6a, 6b, 6c, 7, 8, 9a, and 9b) were developed at a Class 4 level of effort utilizing largely parametric unit prices from sources such as historical Government and Commercial bid data, A-E cost estimates available from design reports, the 2019 Gordian/RS Means Cost Data Books and other available historical cost data sources. For developing costs for levee and floodwall construction items such as “Clearing and Grubbing”, “Embankment, Compacted Fill”, and “Reinforced Concrete Floodwall,” the standard approaches for developing a feasibility cost regarding cost elements such as labor, equipment, materials, crews, unit prices, subcontractor and prime contractor markups were used.

There are twelve (12) new unique pump station (PS) structures included in the Coastal Storm Risk Management (CSRM) alignments, which include Alternatives 4a, 4a.1, 5, 6a, 6b, 6c, 7, 9a, and 9b. The unique pump stations are Bayou Lacombe PS, Bayou Pacquet PS, Bayou Liberty PS, Bayou Bonfuca PS, Schneider Canal PS, W-14 PS, Gum Bayou PS, West Beach Avenue PS, Lafayette Street PS, Coffee Street PS, Girod Street PS, and Ravine Aux Coquilles PS, which are all located within St. Tammany Parish. The Hydraulics designer stated no additional pump stations will be required for any of the final array of alternatives, but new costs for these pump stations will be needed depending on the size (CFS). Updated and more accurate design is necessary and additional costs will be included where necessary. During feasibility level design of the TSP, all of the pump stations within the proposed alignments will be further developed and the associated costs individually defined. The West Shore Lake Pontchartrain (WSLP) 35% Conceptual Design Submittal, dated August 2020, was very useful to the feasibility study in developing costs for pump station features of work. The WSLP had already developed 35% conceptual designs for pump stations of similar size, scope and site layout of the pump station alternatives presented in the final array. The A-E cost estimates were developed from the WSLP, which included itemized quantities in sufficient enough detail as to be useful in prorating the quantities for twelve (12) representative pump stations. Unit costs for the representative structures were reviewed for reasonableness and then applied to the revised quantities to develop new total costs for the representative structures. The cost factor differential for each representative structure was then applied to other similar structures within each alignment.

Historical cost pricing data was very useful to the feasibility study in developing costs for the six (6) Sluice Gates, nine (9) marine sector gates, eleven (11) pedestrian roller gates and sixty-six (66) vehicular roller gates within all final array alternatives. Unit costs for the representative gate structures were reviewed for reasonableness and then applied to the revised quantities to develop new total costs for the representative structures. The cost factor differential for each representative structure was then applied to other similar structures within each alignment. In the final step, cost of each structure was then escalated to 4th Quarter 2020 pricing to develop new costs for all structures.

Cost estimates for the final array of channel improvements and clearing and snagging features were developed at a Class 4 level of effort utilizing largely parametric unit prices from sources such as historical Government and Commercial bid data, A-E cost estimates available from design reports, the 2019 Gordian/RS Means Cost Data Books and other available historical cost data sources. Historical unit costs for the representative channel improvements were reviewed for reasonableness and then applied to the revised quantities to develop new total costs for the channel improvements. During feasibility level design of the TSP, the Channel Improvement features within the proposed alignments will be further developed and the associated costs individually defined.

The intent of the cost estimate was to provide or convey a “fair and reasonable” estimate and where cost detail was provided, it depicted the local market conditions. The construction work (e.g., levees, floodwalls, gate structures, control structures, dredging, excavation, dewatering, pilings, rock, etc.) is common to the Gulf Coast region. The construction sites are mostly accessible from land with additional water access available for the construction of the barge gate structure. Site access is easily provided from US Hwy 190, Interstate I-10, Interstate I-12, and other various local highways. Water access is available from the Mississippi River through the Inner Harbor Navigation Canal (IHNC), Lake Pontchartrain, Lake Borgne, and the Pearl River to reach waterways for the various waterway alternatives.

1.1.2 Estimate Structure

The estimates have been subdivided by alternative and each estimate contains U.S. Army Corps of Engineers (USACE) feature Work Breakdown Structure (WBS) codes. Each WBS cost is subdivided into base cost, contingency and total cost.

1.1.3 Bid Competition

It is assumed there will not be an economically-saturated market, and that bidding competition will be present.

1.1.4 Contract Acquisition Strategy

There is no declared contract acquisition plan/type at this time. It is assumed that the contract acquisition strategy will be similar to past projects with some negotiated contracts, with a focus and preference for small business/8(a) along with some large, unrestricted design-bid-build contracts.

1.1.5 Labor Shortages

It is assumed there will be a normal labor market pulled from the Gulf Coast region.

1.1.6 Labor Rates

Labor rates were developed comparing regional Gulf Coast labor market wages with the local Davis-Bacon Wage Determination, using whichever was determined greater. Regional Gulf Coast wage information was formulated from data gathered from approximately 20 different USACE, New Orleans District (CEMVN) construction projects in the Greater New Orleans region and is assumed to be a fair representation of wage rates for the St. Tammany area.

1.1.7 Materials

As parametric unit costs were used for the major construction items such as concrete, steel H-piling and sheet piling, silt fence, reinforcing steel, etc., no material quotes were obtained at this time. Material prices for steel piping used in relocation costs were taken from the 2019 Heavy Construction Costs RS Means Data Book. It is assumed that materials, except for borrow material, will be purchased as part of the construction contract and prices include delivery of materials.

Cost quotes are used on major construction items when available (such as the associated costs used for pump stations and vehicular and pedestrian roller and swing gates). Material price quotes were taken from previous jobs or from other historical data.

All borrow material is assumed to be government furnished. Specific sources for borrow material have not yet been established. There is considerable farmland and commercial borrow sites (e.g., Raceland Raw Sugars and River Birch) within a 15-mile radius of the project. Therefore, the PDT assumed an average one-way haul distance of 15 miles until a committed borrow source has been confirmed to be available. Haul speeds are estimated using a 35 mph average speed, given the rural access roads and highways that exist in the area.

Until a borrow source has been confirmed, the borrow quantity calculations will follow the CEMVN Geotechnical guidance as follows: for hauled levee material, 10 bank cubic yards (BCY) of borrow material = 12 loose cubic yards (LCY) hauled = 8 embankment cubic yards (ECY) compacted.

1.1.8 Quantities

Quantities for levees were provided by CEMVN Civil Branch – Levees Section. Quantities for floodwalls, pump stations, and access gates were provided by CEMVN Structures Branch. Quantities for channel improvements and clearing and snagging were provided by CEMVN Civil Branch – Waterways Section.

The PDT decided that for each alternative a comprehensive quantity of each levee feature would be provided. Alternatives 4a, 4a.1, 4.b, 5, 6a, 6b, 6c, and 7 contained levee features. The levee elevation varies depending on location. The preliminary assumptions are that the levee has a 10 ft wide levee crown and side slopes of 1V:3H. The existing elevations were obtained from the LIDAR raster dataset. Since the levee design elevation was variable, the designer calculated the area per station and multiplied it by the length. Quantities for levee construction were developed by the civil designer for the various alternatives and are provided in the Engineering Appendix. The Project Delivery Team (PDT) also decided at this time that the design elevation for all levees may need to be further investigated to address levee settlement and global subsidence to comply with the latest HSDRRS design criteria.

Design parameters and quantities for the floodwalls, pump stations, vehicular and pedestrian roller gates, and marine sector gates were selected to be included in the final array of alternatives. Each alternative contains several of these features. Quantities for the pump stations and gates were scaled from historical data. The design parameters and quantities for each representative pump station or access gate were changed by the structural designer to meet the new design criteria for each alternative and new costs were developed for each representative structure for each alternative. The quantities and costs were scaled for each of these structures that was then applied to other similar structures in the alignment to generate new costs for those structures. During feasibility-level design of the TSP, all the structures within the proposed alignment will be further developed and the associated quantities individually defined.

Within Alternatives 5, 7, and 8, the various channel improvement and clearing and snagging feature quantities were developed using the LIDAR raster dataset. The preliminary design assumed a bank elevation depending on the location, required bottom width dependent on the channel requirements, and a typical bank at a 1V:3H slope. Staging areas were scoped and provided along with potential access points. The design parameters and quantities for each representative channel were provided by the civil designer to meet the required design depths for each feature and costs were developed for each representative channel for each feature within the alternative.

1.1.9 Equipment

Rates used for “Clearing and Grubbing” and “Embankment, Compacted Fill” cost items were based on the 2018 version of USACE EP-1110-1-8, Region III. Equipment was selected based on historical knowledge of similar projects.

Rates used are based on the latest USACE EP-1110-1-8, Region III. Adjustments are made for fuel and facility capital cost of money (FCCM). Full FCCM/Cost of Money rate is the latest available. The MII program takes the EP-recommended discount, but no other adjustments have been made to the FCCM. Equipment was chosen based on historical knowledge of similar projects.

1.1.10 Rental Rates

Judicious use of owned verses rented rates was considered based on typical contractor usage and local equipment availability. Where rental of equipment is typical, rental rates were applied (i.e. for marsh excavators in “Heavy Clearing and Grubbing” cost item; Tugboat, marine barges, etc., for barge gate structures and fronting protection where needed).

1.1.11 Fuels

Fuels (e.g., gasoline and diesel fuel) for rental equipment were based on local market averages for the Gulf Coast area. The fuel rates were reviewed over a period of time and a composite, conservative cost was used. Due to the volatility of fuel and significant potential escalation of fuel rate, conservative costs were used in the estimates.

1.1.12 Crews

Major crew and productivity rates were developed and studied by senior USACE estimators familiar with the type of work. The work is typical to the Gulf Coast area and is well understood by CEMVN cost engineers. The crews and productivity rates were checked by local CEMVN estimators and comparisons with historical cost data were referenced. Crews and productivity rates were adjusted as necessary based upon those findings to reflect reasonable crew sizes and production rates. Major crews are used for hauling, earthwork, piling, pump stations, floodwalls and concrete slope pavement.

A 10% markup on labor for weather delay was selectively applied to the labor in major earthwork-placing detail items, and associated items that would be affected by the weather, creating unsafe or difficult conditions to operate (e.g., trying to run dump trucks on a wet levee) or would be detrimental/non-compliant to the work being performed (such as trying to place/compact material in the rain). The 10% markup was to cover the common practice of paying for labor “showing up” to the job site and then being sent home due to minor weather conditions, which is part of known average weather impacts as reflected within the standard contract specifications.

Most crew work hours are assumed to be 10 hours, 6 days/week, which is typical for the project area.

1.1.13 Unit Prices

The unit prices found within the various project estimates fluctuate within a range between similar construction unit prices. Such pricing data was used for items such as pump stations, access gates, floodwall concrete, earthwork, concrete slope pavement, transitions, and piling. Variances are a result of differing haul distances (by truck or barge), small or large business markups, subcontracted items, designs and estimates by others. Unit prices were used in the development of the various cost estimates and are based upon historical data of recent jobs with a similar size and scope.

1.1.14 Relocation Costs

Relocation costs are defined as the relocation of public roads, bridges, railroads and utilities required for project purposes. In cases where potential significant impacts were known, relocation costs were included within the cost estimate. Information from the Relocations Designer showed no relocations of public roads, bridges or railroads were required for Alternatives 7, 8, 9a, and 9b, but Alternatives 4a, 4.1, 4b, 5, 6a, 6b, and 6c all contain some sort of relocations. The Relocations Designer did provide all utilities to be relocated for each of the alternatives (i.e. pipe - ownership, diameter, material, product, location) and these are shown in the Engineering Appendix. In addition, the Relocation Designer provided the proposed method of flood protection for underground pipe (i.e. whether the pipeline is sleeved through a T-wall or is relocated over the new earthen levee). Relocation of a pipeline to be relocated over the earthen levee includes excavation of a trench, including a Temporary Retaining Structure (TRS), if needed, hot tapping, demo/disposal of the existing pipeline, routing the new pipeline, and backfill and removal of the TRS. Relocation of a pipeline to be sleeved through a T-wall includes excavation, installation of the TRS, installation of the temporary support pipe, installation of the jack-in sheet pile, installation of the pipe sleeve, and backfill and removal of the TRS. The cost provided was based on historical bid data. In addition to “Pipeline Protection” and “Up-and-Over" pipeline relocations, Alternatives 6a, 6b, and 6c all require de-energizing of powerlines, which is a matter of contacting the utility company and re-routing the overhead lines. Cost was developed using historical cost data and the 2019 Heavy Construction Gordian/RS Means Data Book. Additionally, an Owner Preconstruction Engineering Design (PED) of 22% and Supervision and Administration (S&A) of 5% was added to the cost of each relocation. Relocation costs were placed in Work Breakdown Structure WBS-02 Relocations.

1.1.15 Mobilization

Contractor mobilization and demobilization are based on the assumption that most of the contractors will be coming from within the Gulf Coast or Southern Region. Mobilization and Demobilization costs are based upon historical studies and detailed Government estimates with relevant historical cost pricing data, which are typically in the range of 3-5% of the construction costs. With undefined acquisition strategies and assumed individual project limits, the estimates utilize a 5% value of Cost to Prime for Mobilization and Demobilization for all alternatives.

1.1.16 Field Office Overhead

The estimated percentages for Field Office Overhead vary based upon the type of work being completed, as "Clearing and Snagging" field overhead differs from "Floodwall" field overhead. The rates were based upon estimating and negotiation experience, and consultation with local construction representatives. The estimates used a field office overhead rate based on the average of relevant jobs with a similar scope and magnitude. Different percentages are used when considering the scope of work for each feature. However, when reviewing historical cost pricing data, a range of 15 -25% is typically used. The field office overhead rate of 18% was used for the prime contractors, which was based on historical projects.

1.1.17 Overhead Assumptions

Overhead assumptions may include costs for the superintendent, the office manager, pickup trucks, periodic travel costs, communications, temporary offices (contractor and Government), office furniture, office supplies, computers and software, as-built drawings and minor designs, tool trailers, staging setup, camp/facility/kitchen maintenance and utilities, utility service, toilets, safety equipment, security and fencing, small hand and power tools, project signs, traffic control, surveys, temporary fuel tank station, generators, compressors, lighting and minor miscellaneous items.

1.1.18 Home Office Overhead

The estimated percentages vary based upon consideration of 8(a), small business and unrestricted prime contractors. The rates were based upon estimating and negotiating experience, and consultation with local construction representatives. Different percentages are used when considering the contract acquisition strategy regarding small business 8(a), competitive small business and large business, high to low, respectively. For Home Office Overhead a percentage of 9% was assumed.

1.1.19 Taxes

Local taxes on supplies and materials needed for construction would be applied based on the parishes that contain the work. Reference the tax rate website for Louisiana: http://www.salestaxstates.com. The contracts are located in many different areas within St. Tammany Parish. Usually the tax rate ranges from 8 to 10%. For this project it was decided to use 9.75%.

1.1.20 Bond

The Bond interest rate was assumed to be 1%, applied against the prime contractor, assuming large contracts. There was no differentiation between large and small businesses.

1.1.21 Real Estate Costs

Real Estate (RE) costs were developed and provided by the Realty Specialist and placed in WBS-02 Lands and Damages. The RE cost for each alternative includes land costs, acquisition costs (including acquisition of agricultural land for borrow) and 25% for contingencies.

1.1.22 Environmental Costs

Environmental costs were provided by the Environmental team and placed in Work Breakdown Structure WBS-06 Fish and Wildlife Facilities. The Environmental costs for each alternative includes only mitigation of the flood protection alignment footprint.

1.1.23 Cultural Resources Costs

Cultural Resources (CR) costs were provided by the Archaeologist-Natural/Cultural Resources Analyst and placed in WBS-13 Cultural Resources Preservation. The CR costs for each alternative include Phase I & II Cultural Surveys and mitigation of resources if required. For borrow sites, known or identified cultural resource sites will be avoided.

1.1.24 Pre-Construction Engineering and Design (PED)

The PED cost included such costs as USACE project management, engineering, planning, designs, investigations, studies, reviews, value engineering (VE) and engineering during construction. Historically, a rate of approximately 12% for Engineering and Design (E&D) portion, plus small percentages for other support functions, is applied against the estimated construction costs. Other USACE civil works districts such as St. Paul, Memphis and St. Louis have reported values ranging from 10% to 15% for E&D. Additional support functions might include project management, engineering, planning, designs, investigations, studies, reviews and VE. A PED rate of 20.5% was applied for this project.

1.1.25 Supervision and Administration (S&A)

Historically, a range from 5% to 15%, depending on project size and type, has been applied against the estimated construction costs. Other USACE civil works districts such as St. Paul, Memphis and St. Louis report values ranging from 7.5% to 10%. Consideration is given that a portion of the

Supervision and Administration (S&A) effort could be performed by contractors. An S&A rate of 11% was applied for this project.

1.1.26 Contingencies

Contingencies for the final array of structural alternatives were developed using the USACE Abbreviated Cost Risk Analysis (ARA) program. An ARA is a qualitative approach used by the PDT to address key risk concerns for major features of work and their impact to cost and schedule drivers such as Project Scope Growth, Acquisition Strategy, Construction Elements, Quantities, Specialty Fabrication or Equipment, Cost Estimate Assumptions and External Project Risks. A separate ARA was conducted for all Alternatives, with each analysis resulting in a composite risk contingency of ranging between 41 to 56%. As Alternative 6c was added very late as a final alternative, it was decided by the PDT that the same 45% composite risk contingency from Alternatives 6a and 6b could logically be applied to Alternative 6c, since each of the structural alternatives in Alternative 6 had the same features of work and very similar risk concerns. It should be noted Real Estate, PED and S&A costs were not included in formulating the composite risk contingency.

1.1.27 Escalation

The escalation for the structural items taken from the historical cost pricing data were based upon the latest version of the USACE Engineering Manual (EM) 1110-2-1304, "Civil Works Construction Cost Index System (CWCCIS)".

1.1.28 Hazardous, Toxic and Radioactive Waste (HTRW)

Phase 1 surveys have not been performed, but preliminary investigation by the Biologist indicates no issues were found along the proposed final alternative alignments and the risk of finding HTRW in the mostly rural and residential areas that are along the alignment is low. At this time there is no reason to believe HTRW will be found, therefore, the estimates do not include costs for any potential HTRW.

1.1.29 Schedule

The project schedule for each structural alternative was developed based on the construction features of work. A generic construction schedule was applied to all of the alternatives for comparison purposes.

Plan Formulation/Project Management for the St. Tammany Parish study have directed that construction of the system be assumed to begin in 2027 with a complete risk reduction system in place by 2032. The expected construction period for each alternative is five (5) years each. For the purposes of this study, construction was assumed to begin in 2027 and continue through 2032 with additional levee lifts (to maintain levee height due to sinking and subsidence) occurring at three times post-initial construction: 5-7 years, 15-20 years, and 30 years. For the levees, the first levee lifts would be overbuilt and allowed to settle for several years before the successive levee lift is added for each alternative.

1.1.30 Cost Estimates

The final array of alternatives, from which a TSP was selected, consisted of Alternatives 4a, 4a.1, 4b, 5, 6a, 6b, 6c, 7, 8, 9a, and 9b and the future without project conditions. Tables 1-1 through 1-11 show the baseline project cost for each structural alternative in the final array. All costs are at October 2020 price levels.

***Table 1-1: Alternative 4a – Lacombe Levee**

Feature	Cost	Contingency	Total
01 Lands and Damages	$7,059,000	$1,190,000	$8,249,000
02 Relocations	$20,203,000	$5,657,000	$25,860,000
06 Fish and Wildlife Facilities	$45,324,000	$25,835,000	$71,159,000
11 Levees and Floodwalls	$18,341,000	$7,887,000	$26,228,000
13 Pumping Plant	$178,073,000	$78,352,000	$256,426,000
18 Cultural Resources Preservation	$155,000	$56,000	$210,000
30 Planning, Engineering & Design	$44,438,000	$19,971,000	$64,409,000
31 Construction Management	$23,845,000	$10,716,000	$34,561,000
TOTAL	$337,439,000	$149,663,000	**$487,101,000**

***Table 1-2: Alternative 4a.1 – Shorter Lacombe Levee**

Feature	Cost	Contingency	Total
01 Lands and Damages	$5,707,000	$1,032,000	$6,739,000
02 Relocations	$14,299,000	$4,004,000	$18,302,000
06 Fish and Wildlife Facilities	$37,724,000	$21,503,000	$59,227,000
11 Levees and Floodwalls	$17,570,000	$7,555,000	$25,125,000
13 Pumping Plant	$178,073,000	$78,352,000	$256,426,000
18 Cultural Resources Preservation	$130,000	$47,000	$177,000
30 Planning, Engineering & Design	$43,065,000	$19,371,000	$62,436,000
31 Construction Management	$23,108,000	$10,394,000	$33,502,000
TOTAL	$319,676,000	$142,258,000	**$461,934,000**

***Table 1-3: Alternative 4b – Lacombe/West Slidell Levee**

Feature	Cost	Contingency	Total
01 Lands and Damages	$4,739,000	$810,000	$5,549,000
02 Relocations	$10,408,000	$2,914,000	$13,323,000
06 Fish and Wildlife Facilities	$84,947,000	$48,420,000	$133,368,000
11 Levees and Floodwalls – Levees	$31,834,000	$15,121,000	$46,955,000
11 Levees and Floodwalls – Floodwalls	$6,155,000	$2,339,000	$8,493,000
13 Pumping Plant	$609,391,000	$237,662,000	$847,053,000
18 Cultural Resources Preservation	$232,000	$84,000	$316,000
30 Planning, Engineering & Design	$134,894,000	$55,656,000	$190,550,000
31 Construction Management	$72,382,000	$29,864,000	$102,246,000
TOTAL	$954,983,000	$392,870,000	**$1,347,853,000**

***Table 1-4: Alternative 5 – Lacombe/West Slidell Levee**

Feature	Cost	Contingency	Total
01 Lands and Damages	$5,723,000	$1,459,000	$7,182,000
02 Relocations	$729,000	$204,000	$933,000
06 Fish and Wildlife Facilities	$102,483,000	$58,416,000	$160,899,000
09 Channels and Canals	$3,241,000	$5,250,000	$8,491,000
11 Levees and Floodwalls – Levees	$16,531,000	$7,852,000	$24,383,000
11 Levees and Floodwalls – Floodwalls	$4,786,000	$1,867,000	$6,653,000
13 Pumping Plant	$431,317,000	$170,370,000	$601,688,000
15 Floodway Control and Diversion Structures	$45,315,000	$16,314,000	$61,629,000
18 Cultural Resources Preservation	$528,000	$190,000	$718,000
30 Planning, Engineering & Design	$103,002,000	$44,317,000	$147,318,000
31 Construction Management	$55,269,000	$23,780,000	$79,049,000
TOTAL	$768,925,000	$330,018,000	**$1,098,943,000**

***Table 1-5: Alternative 6a – South Slidell without Eden Isle**

Feature	Cost	Contingency	Total
01 Lands and Damages	$5,416,000	$1,089,000	$6,505,000
02 Relocations	$13,000	$3,000	$16,000
06 Fish and Wildlife Facilities	$43,133,000	$24,586,000	$67,719,000
11 Levees and Floodwalls – Levees	$32,359,000	$15,370,000	$47,729,000
11 Levees and Floodwalls – Floodwalls	$263,957,000	$95,025,000	$358,982,000
13 Pumping Plant	$227,264,000	$99,996,000	$327,261,000
18 Cultural Resources Preservation	$352,000	$127,000	$478,000
30 Planning, Engineering & Design	$107,409,000	$44,531,000	$151,940,000
31 Construction Management	$57,634,000	$23,895,000	$81,529,000
TOTAL	$737,537,000	$304,621,000	**$1,042,158,000**

***Table 1-6: Alternative 6b – South Slidell with Eden Isle**

Feature	Cost	Contingency	Total
01 Lands and Damages	$5,022,000	$1,135,000	$6,157,000
02 Relocations	$13,000	$3,000	$16,000
06 Fish and Wildlife Facilities	$62,919,000	$35,864,000	$98,783,000
11 Levees and Floodwalls – Levees	$27,452,000	$13,040,000	$40,491,000
11 Levees and Floodwalls – Floodwalls	$588,181,000	$240,566,000	$828,746,000
13 Pumping Plant	$227,264,000	$99,996,000	$327,261,000
18 Cultural Resources Preservation	$489,000	$176,000	$666,000
30 Planning, Engineering & Design	$172,897,000	$74,332,000	$247,229,000
31 Construction Management	$92,774,000	$39,885,000	$132,659,000
TOTAL	$1,177,011,000	$504,997,000	**$1,682,008,000**

***Table 1-7: Alternative 6c – West Slidell and South Slidell Levee Combination**

Feature	Cost	Contingency	Total
01 Lands and Damages	$11,139,000	$2,660,000	$13,799,000
02 Relocations	$739,000	$148,000	$887,000
06 Fish and Wildlife Facilities	$75,197,000	$42,862,000	$118,059,000
11 Levees and Floodwalls – Levees	$49,864,000	$23,835,000	$73,699,000
11 Levees and Floodwalls – Floodwalls	$131,888,000	$59,613,000	$191,501,000
13 Pumping Plant	$658,582,000	$289,776,000	$948,358,000
18 Cultural Resources Preservation	$730,000	$263,000	$993,000
30 Planning, Engineering & Design	$172,570,000	$78,380,000	$250,950,000
31 Construction Management	$92,598,000	$42,058,000	$134,656,000
TOTAL	$1,193,306,000	$539,595,000	**$1,732,901,000**

***Table 1-8: Alternative 7 – Eastern Slidell**

Feature	Cost	Contingency	Total
01 Lands and Damages	$4,417,000	$836,000	$5,253,000
02 Relocations	---	---	---
06 Fish and Wildlife Facilities	$47,561,000	$27,110,000	$74,671,000
09 Channels and Canals	$11,696,000	$585,000	$12,281,000
11 Levees and Floodwalls – Levees	$10,831,000	$5,145,000	$15,975,000
11 Levees and Floodwalls – Floodwalls	$25,839,000	$14,470,000	$40,309,000
13 Pumping Plant	$56,817,000	$19,318,000	$76,135,000
18 Cultural Resources Preservation	$371,000	$134,000	$505,000
30 Planning, Engineering & Design	$21,639,000	$9,435,000	$31,073,000
31 Construction Management	$11,611,000	$5,063,000	$16,673,000
TOTAL	$190,782,000	$82,094,000	**$272,876,000**

***Table 1-9: Alternative 8 – Upper Tchefuncte**

Feature	Cost	Contingency	Total
01 Lands and Damages	$5,656,000	$1,367,000	$7,023,000
02 Relocations	---	---	---
06 Fish and Wildlife Facilities	$3,266,000	$1,861,000	$5,127,000
08 Roads, Railroads, & Bridges – Culverts	$7,929,000	$4,361,000	$12,291,000
09 Channels and Canals	$11,424,000	$6,283,000	$17,708,000
18 Cultural Resources Preservation	$113,000	$41,000	$153,000
30 Planning, Engineering & Design	$3,991,000	$2,203,000	$6,193,000
31 Construction Management	$2,141,000	$1,182,000	$3,323,000
TOTAL	$34,520,000	$17,298,000	**$51,818,000**

***Table 1-10: Alternative 9a – Mandeville Lakefront – 7.3 ft with Passive Barrier**

Feature	Cost	Contingency	Total
01 Lands and Damages	$9,955,000	$2,536,000	$12,491,000
02 Relocations	---	---	---
06 Fish and Wildlife Facilities	$5,416,000	$3,087,000	$8,503,000
11 Levee and Floodwalls – Seawall	$21,115,000	$10,557,000	$31,672,000
11 Levee and Floodwalls – Floodwall	$45,713,000	$19,657,000	$65,370,000
11 Levee and Floodwalls – I – Wall	$5,263,000	$2,263,000	$7,526,000
13 Pumping Plant	$7,833,000	$2,193,000	$10,027,000
18 Cultural Resources Preservation	$135,000	$48,000	$183,000
30 Planning, Engineering & Design	$16,412,000	$7,259,000	$23,671,000
31 Construction Management	$8,806,000	$3,895,000	$12,702,000
TOTAL	$120,648,000	$51,496,000	**$172,144,000**

***Table 1-11: Alternative 9b – Mandeville Lakefront – 7.3 ft with Tributary Closure**

Feature	Cost	Contingency	Total
01 Lands and Damages	$9,955,000	$2,536,000	$12,491,000
02 Relocations	---	---	---
06 Fish and Wildlife Facilities	$5,323,000	$3,034,000	$8,357,000
11 Levee and Floodwalls – Seawall	$21,115,000	$10,557,000	$31,672,000
11 Levee and Floodwalls – Floodwall	$10,670,000	$4,588,000	$15,259,000
11 Levee and Floodwalls – I – Wall	$3,376,000	$1,452,000	$4,828,000
13 Pumping Plant	$54,309,000	$19,551,000	$73,860,000
18 Cultural Resources Preservation	$61,000	$22,000	$83,000
30 Planning, Engineering & Design	$18,354,000	$7,586,000	$25,940,000
31 Construction Management	$9,848,000	$4,070,000	$13,919,000
TOTAL	$133,011,000	$53,397,000	**$186,409,000**

The total baseline project cost for the comprehensive nonstructural alternative for floodproofing both the CSRM and FRM 50-year floodplain is $4,501,184,454.

1.1.31 NED Plan/Tentatively Selected Plan

The final array of alternatives was compared based on a variety of factors such as input from economics, hydraulic impacts and non-Federal sponsor coordination. Within each alternative, each respective feature was analyzed independently for net benefits and a Coastal Storm Risk Management (CSRM), Flood Risk Management (FRM), and Nonstructural plan was selected to form one comprehensive Tentatively Selected Plan (TSP).

For the analysis of the CSRM features, the West Slidell Levee (feature in Alternative 4), South Slidell Levee (feature in Alternative 5), a combined South Slidell and West Slidell Levee (feature in Alternative 6a), and the South Slidell Levee with Eden Isle Floodwall (feature in Alternative 6b) were found to have net positive benefits within the CSRM analysis, which had net benefits of 1.2, 1.9, 1.7, and 1.5 respectively. CSRM measures that were not economically beneficial were the Lacombe Levee (feature in Alternative 4a), the Shorter Lacombe Levee (feature in Alternative 4a.1), the Combined Lacombe and West Slidell Levee (feature in Alternative 5), and the Mandeville Floodwall (features in Alternative 9a and 9b). Those respective features were not economically justifiable with BCR's of 0.4, 0.5, 0.9, 0.2, and 0.4 respectively. Based on the economic analysis of the final array of each feature within the alternatives for the Coastal Storm Risk Management Plan, the West Slidell and South Slidell Levees were combined and selected as the PDTs CSRM feature within the TSP with a net benefit to cost ratio 1.8.

For the analysis of the FRM features, the Bayou Patassat Clearing and Snagging (feature in Alternative 5) and Mile Branch Channel Improvements (feature in Alternative 8) were found to have positive net benefits, 2.9 and 2.2 respectively. All of the other Flood Risk Management features such as the Bayou Liberty Channel Improvements, Bayou Bonfuca Detention Pond, Pearl River Levee, Gum Bayou Diversion, Poor Boy Canal Channel Improvements, Doubloon Bayou Channel Improvement, and Mile Branch Lateral A Channel Improvement were not economically beneficial with standalone BCR's of 0.4, 0.2, 0.4, 0.0, 0.0, -1.2, and 0.3 respectively. Based on the economic analysis of the final array of each feature within the alternatives for the Flood Risk Management (FRM) Plan, Bayou Patassat Clearing and Snagging and Mile Branch Channel Improvements were selected as the PDTs FRM feature within the TSP with a net benefit to cost ratio of 2.9 and 2.2 respectively.

To complete the selection for the comprehensive TSP, nonstructural features for both the FRM and CSRM were also analyzed independently for benefit to cost ratio. Nonstructural home elevations and floodproofing for the rest of the Parish based on the 50-year flood plain (residual risk) were found to have a net benefit to cost ratio of 1.9 and were included in the PDTs TSP.

The comprehensive TSP selected by the PDT to address flooding Parish-wide includes CSRM, FRM and Nonstructural features. Those features included are the West Slidell and South Slidell Levees, Bayou Patassat Clearing and Snagging, Mile Branch Channel Improvements, and nonstructural home elevations and floodproofing for the rest of the Parish based upon the 50-year flood plain risk. This comprehensive plan was evaluated and found to have a positive net benefit to cost ratio of 1.8.

As part of system optimization during Feasibility Level design, in conjunction with new hydraulic information from "Future with Project Conditions" and associated overtopping conditions, non-structural measures could be re-introduced in certain targeted populated areas.