Mid-Barataria Sediment Diversion

Memorandum

To	MBSD Pump Station Design Team		
From	Erica Green		
Date	October 24, 2013 (Updated February 2014)	Job No.	BA 153-01

RE: Cheniere Traverse Bayou Pump Station Outfall Hydraulic Model

General Background

Construction of the Mid-Barataria Sediment Diversion (MBSD) would disrupt an existing forced drainage system, preventing stormwater from being conveyed to the Wilkinson Canal Pump Station. To maintain current levels of flood risk reduction, a new pump station north of the sediment diversion channel has been proposed. The hydrologic analysis is discussed in the Drainage Report for Cheniere Traverse Bayou Pump Station (Coastal Protection and Restoration Authority of Louisiana [CPRA] 2014).

The proposed location of the Cheniere Traverse Bayou Pump Station is at the intersection of Cheniere Traverse Bayou (CTB) and the Non-Federal Levee (NFL), north of West Ravenna Road in Plaquemines Parish, Louisiana. Inflow to the pump station would be from the interior levee drainage channel and discharge would be into CTB just west of the NFL. Previous analysis by HDR recommends that a maximum pumping rate of 740 cubic feet per second (cfs) from the pump station would be needed to convey the 25-year storm event. Figure 1 shows the proposed pump station location.

The purpose of this modeling effort is to analyze hydraulic conditions in the outfall area of the proposed Cheniere Traverse Bayou Pump Station. The hydraulic modeling completed for this report was prepared with the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center HEC-GeoRAS and HEC-RAS computer programs. The versions used include version 10.1 of the HEC-GeoRAS for ArcGIS 10.1 software and version 4.1.0 of the HEC-RAS software.

Existing Conditions

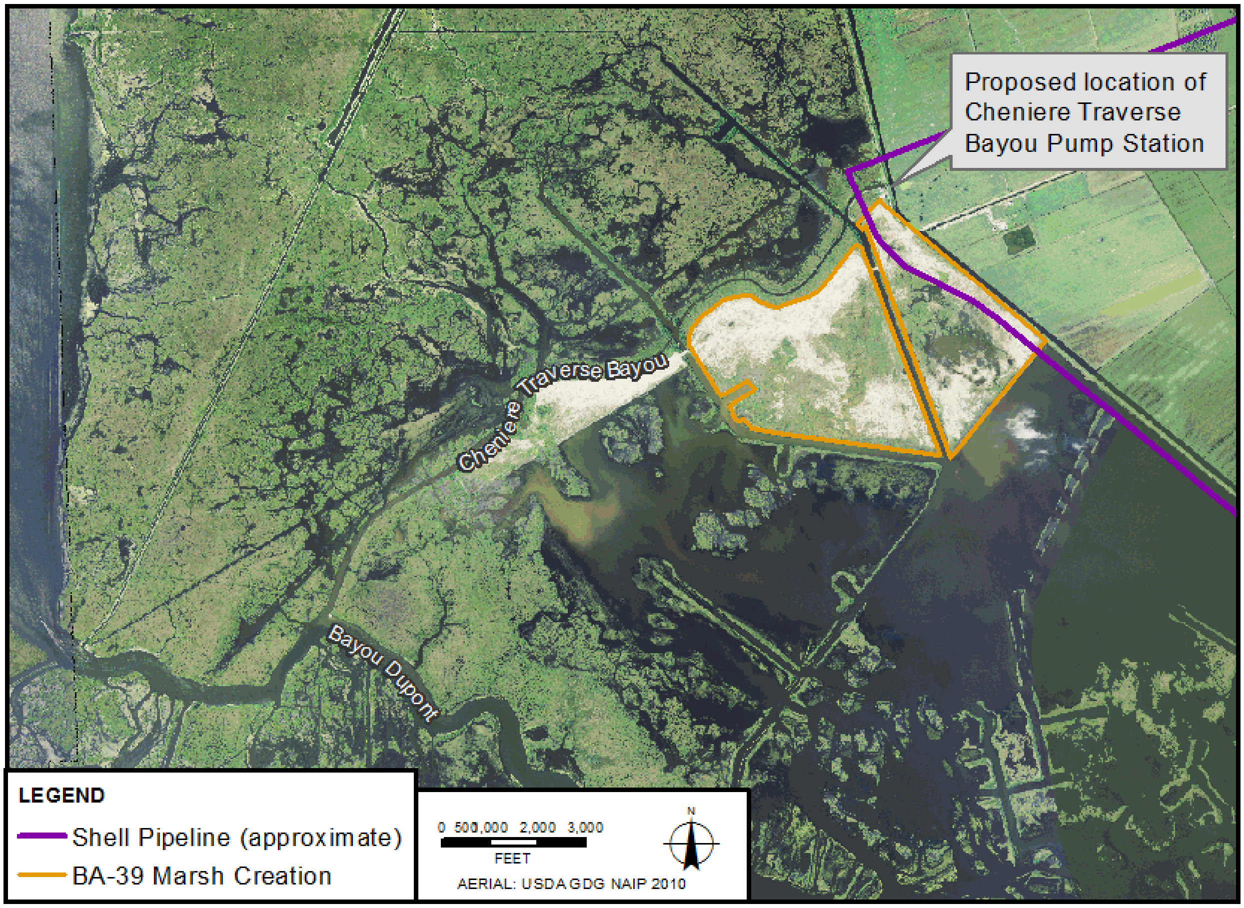
Barataria Basin was built by the Mississippi River through sediment deposition over the past 7,000 years (Reed 1995). Historically, the basin received river flow from Bayou Lafourche to the west and the Mississippi River to the east until flood control efforts eliminated overland flow though the use of artificial levees and channelization (Connor and Day 1987). Precipitation and constructed canals provide freshwater inputs today. The area is tidally influenced from the Gulf of Mexico. Water level variation in Barataria Basin is generally governed by the combined effects of tides and weather events. Tides in the basin are generally small and diurnal with a range of only about 1 foot near the Gulf of Mexico and 0.1 foot in the upper basin (Reed 1995; Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993). A period of record from a tidal station at Grand Isle, Louisiana, recorded a mean high water of +0.87 foot[1] and mean low water of +0.50 foot (National Oceanic and Atmospheric Administration [NOAA] 2011).

CTB is a relict bayou that runs in a generally east to west direction from the NFL to Bayou Dupont. Aerial images taken in 1952 show CTB continuing from its current course into the now levee-protected

[1] All elevations in this report are referenced to the North American Vertical Datum of 1988 (NAVD 88).

area to the east (Cartographic Information Center 2013). Today, CTB has bank elevations of +1.0 to +2.0 feet and bottom elevations of approximately –3.0 to –4.0 feet in the vicinity of the proposed pump station (Fugro Geospatial Services John Chance Land Surveys, Inc. [Fugro JCLS] 2013). The channel is presently used as a private marina for marsh access and is susceptible to heavy siltation. A pipeline owned by Shell Oil Company runs parallel to the NFL throughout the MBSD project area, crossing CTB to the west of the pump station outfall, the approximate location of which is shown in Figure 1 (Fugro JCLS 2013).

Figure 1. Pump station location



An unnamed channel intersects CTB approximately 1,000 feet from the proposed pump station outfall. It is a straight channel, which is typical of the network of canals in the basin. While the channel is currently deeper and wider than CTB, it does not appear on the 1952 aerial image and was, therefore, created sometime after, probably for oil and gas development.

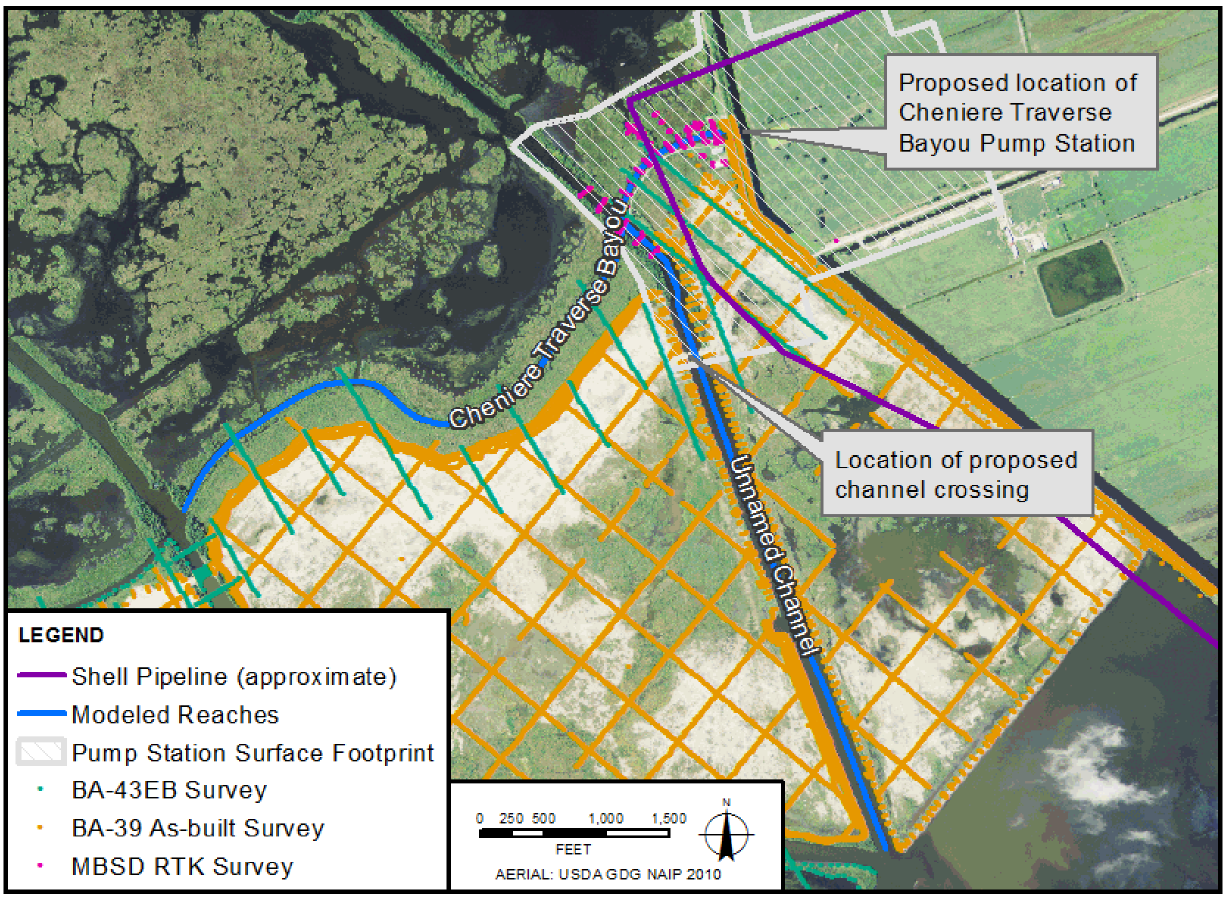
A marsh creation project, Bayou Dupont Sediment Delivery System (BA-39), is located to the south of CTB on both sides of the unnamed channel. This project created 470 acres of marsh using sandy sediment dredged from the Alliance borrow site in the Mississippi River. Construction was completed by February 2010 and the restored area is depicted in Figure 1.

The Mississippi River Long Distance Sediment Pipeline (BA-43EB) is a proposed restoration project, part of which will run alongside CTB. BA-43EB will dredge sediment from the Mississippi River and pump it via a pipeline to create marsh and ridges in the western portion of Barataria Basin. Bayou Dupont Marsh and Ridge Creation (BA-48) is another proposed project designed to create and nourish approximately 317 acres of brackish marsh through pipeline delivery of sediment from the Mississippi River, as well as to create approximately 15 acres of ridge habitat along Bayou Dupont. The BA-43EB/BA-48 bid plans propose a permanent crossing of the unnamed channel south of where it crosses CTB (CPRA 2013). The plans show three circular culverts with 30-inch diameters resting on the channel bottom, shown at an approximate elevation of –3.0 feet (CPRA 2013). The plan for this crossing is in Attachment A. However, recent survey performed for MBSD found bottom elevations of the unnamed channel at approximately –7.0 feet in a stretch of the channel approximately 1,000 feet north of the proposed crossing (Fugro JCLS 2013). Current data collection efforts have not found any post-BA-39 bathymetric survey nearer to the proposed crossing, including survey collected for BA-43EB.

Proposed Conditions

The proposed location of the Cheniere Traverse Bayou Pump Station is at the intersection of CTB with the NFL, north of West Ravenna Road in Plaquemines Parish, Louisiana (Figure 2). Further detail of the hydrologic analysis can be found in the Drainage Report for Cheniere Traverse Bayou Pump Station (CPRA 2014).

Figure 2. Survey coverage



Conceptual-level design of the pump station outfall recommends dredging to –4.0 feet and slightly widening CTB in the immediate outfall area. Additionally, a sheet-pile wall placed in the middle of the channel has been suggested to shield a nearby boat launch and boat house, the top of which would be at +4.0 feet, and extending approximately 200 feet. In addition, sheet-pile wall has also been recommended on nearby banks.

Hydraulic Model Setup

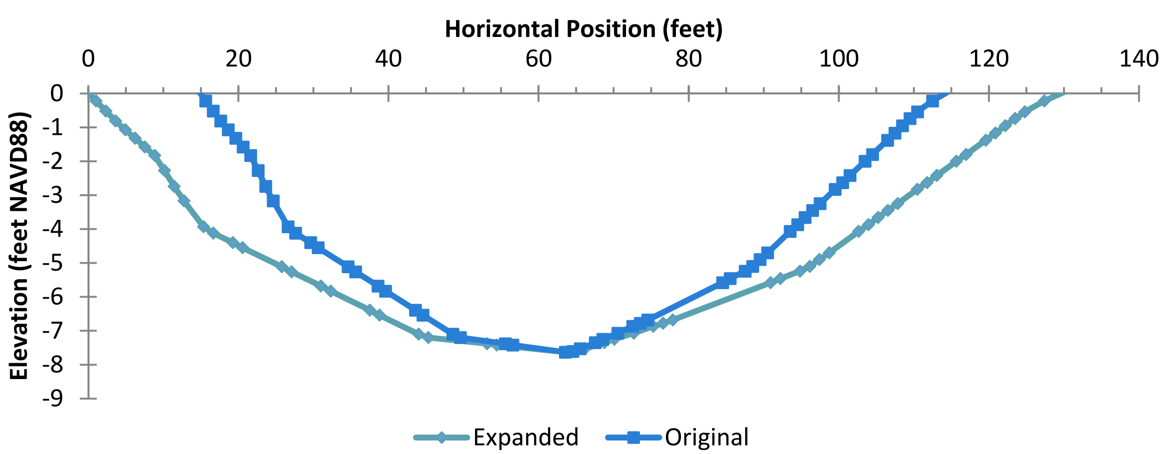
Geometry

Data Sources. Several sources of topographic and bathymetric information were used to construct the model geometry. Fugro JCLS was contracted to provide geospatial services for the MBSD and provided topographic and bathymetric information in the vicinity of the proposed pump station. A combination of Light Detection and Ranging (LIDAR) and real-time kinematic (RTK) survey data collected by Fugro JCLS in 2013 was used by HDR to produce a three-dimensional design surface.

Additional surveys were used to supplement this information in areas farther away from the proposed pump station. Survey transects collected from July through October 2011 as part of BA-43EB provided bathymetric data for the reach of CTB west of the intersection with the unnamed channel (CPRA 2011). As-built survey data from BA-39 were used to represent the recently restored marsh area that runs along a portion of CTB's southern bank.[2] Figure 2 shows the layout of survey information used.

As mentioned previously, no recent bathymetric survey exists for the southern portion of the unnamed channel. To fill in the missing information, the last and most southern MBSD bathymetric survey was repeated in lower cross sections. The top width of the surveyed channel is approximately 100 feet, whereas farther south the channel expands to approximately 130 feet (based on aerial image inspection). To adjust to this wider cross section, the survey data were expanded horizontally while maintaining the same vertical elevations except by lowering the invert slightly to create an assumed channel slope of 0.00018 foot per foot. This slope is the same as the estimated slope from the lower portion of CTB. An example of the cross section expansion is shown in Figure 3, and the HEC-GeoRAS reaches, cross sections, and the channel crossing are presented in Figure 4.

Figure 3. Unnamed channel cross section expansion



Hydraulic Structures. The proposed unnamed channel crossing was modeled as a culvert with three circular corrugated metal pipe culverts. Two culvert diameters were modeled: 30 inches as proposed in the BA-43EB/BA-48 plan set and 48 inches to evaluate the effects on the flow distribution and water surface elevations (WSEs) upstream (CPRA 2013). The deck elevation of the crossing was +4.0 feet as

[2] Survey data provided by Ricardo Johnson, PLS, of Fugro JCLS, in an email message to Garland Pennison, PE, of HDR, on October 4, 2013

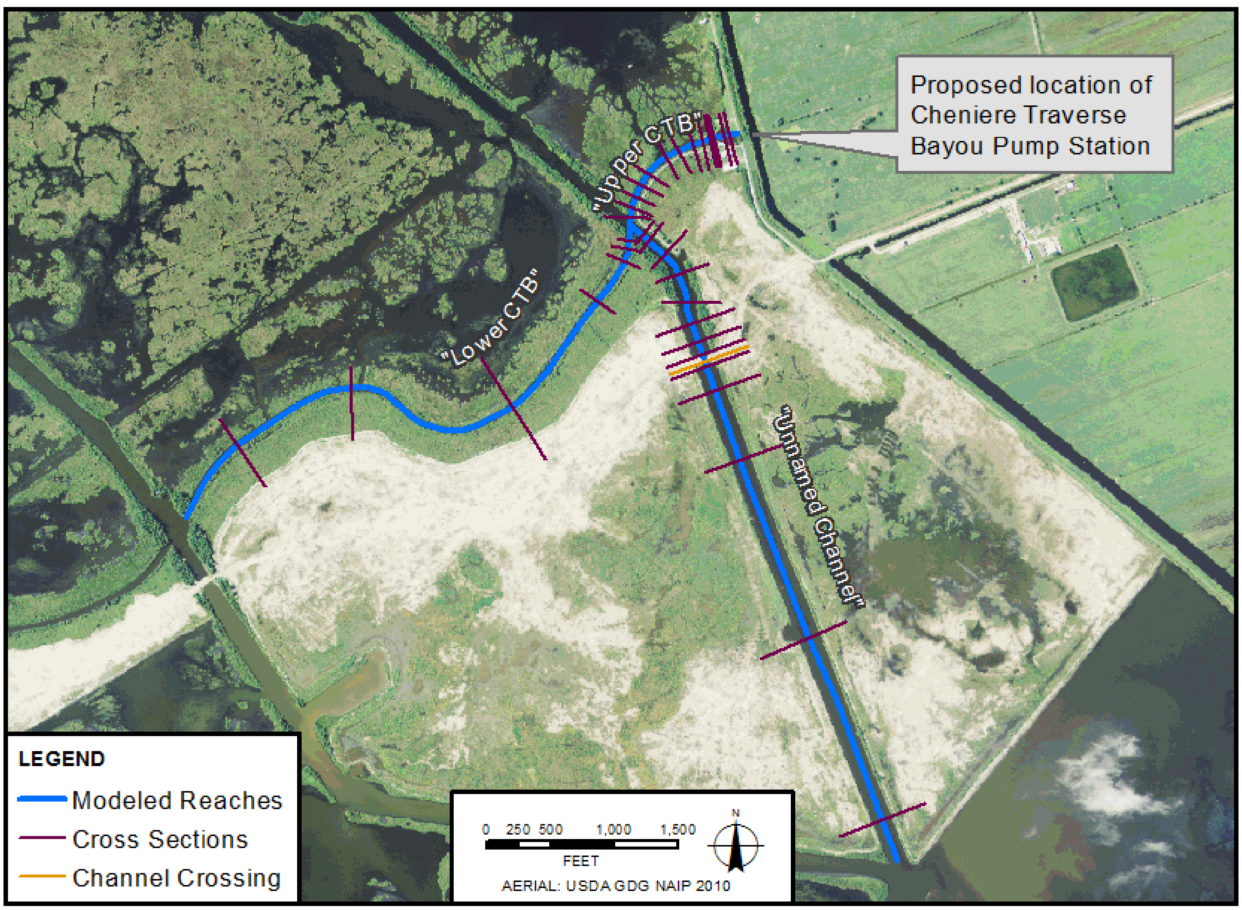
shown in the plan set, while the cross-section bathymetry was duplicated and expanded from an upstream area, using the method depicted in Figure 3.

Hydraulic Roughness. An approximate Manning's roughness coefficient of 0.035 was estimated for the channels. Areas outside the main channels were modeled using a roughness coefficient of 0.12, to represent the dense marsh found in the basin.

Ineffective Areas. Ineffective areas were used to account for the reduced effective cross-sectional area associated with flow expansion and contraction. Flow expansion and contraction ratios were calculated based on guidance in Appendix B of USACE's HEC-RAS River Analysis System Hydraulic Reference Manual (dated 2010). Expansion ratios in the main channel, such as for the bridge crossing and after the sheet pile wall ends, were assumed to be 1.5:1. Due to unknown flow patterns to the north of CTB, this area was considered ineffective to be conservative. Thus, the 1.5:1 expansion occurs only to the south in the area above the channel junction. For flow expansion in the floodplain, a ratio of 2:1 was assumed. To simulate flow contraction upstream of the culvert crossing, an assumed contraction ratio of 1:1 was used.

The unnamed channel north and west of the junction was modeled as ineffective area. The magnitude and direction of flow through the channel is not known, so this assumption was necessary. In addition, there are several relatively minor channels or bank cuts connecting CTB to marshy areas to its north that were also represented as ineffective areas for the same reason.

Figure 4. HEC-RAS hydraulic model geometry



Boundary Conditions and Modeling Methods

Flow Data. The hydraulic modeling assumed steady state flow conditions in the subcritical regime with pump station discharge entering the model in the uppermost cross-section of CTB. Four pump station discharges were selected as the inflows to the model. The preliminary design for the pump station shows a maximum pumping rate of 740 cfs with four 48-inch pumps rated at 185 cfs each. Thus, the flows modeled were 185, 370, 555, and 740 cfs, representing one, two, three, or four pumps on, respectively.

Split Flow Approach. The intersection of CTB and the unnamed channel was modeled as a junction using split flow optimization and an energy based solution.

Downstream Boundary Conditions. Two downstream boundary conditions were necessary for each modeled discharge, one for CTB and one for the unnamed channel. Analysis conducted for the design of BA-48 found a mean high water elevation (MHW) of +0.87 foot based on the Grand Isle tidal record (NOAA 2011; CPRA 2013). This value was assumed to be a conservative WSE in the basin near the pump station, and thus the downstream WSEs in the model could not drop below this level. To maintain this condition, different types of downstream boundary conditions were enforced for the two lower flow rates versus the two higher flow rates.

For the two lower pump station flows of 555 cfs and 740 cfs, a normal depth boundary condition based on a slope of 0.00018 foot per foot was estimated for CTB. This slope is an average of the overall channel slope of lower CTB. A WSE of +0.87 foot was assumed for the downstream boundary condition of the unnamed channel because just past the last cross section the channel flows into an open water body.

For 185 cfs and 370 cfs, the WSE of +0.87 foot was assumed for both downstream boundaries. This is because the normal depth in lower CTB would be below +0.87 foot at these lower flow rates, and the channel would then be inundated to +0.87 foot from the surrounding basin.

Results

The modeling results indicate that some areas will likely be exposed to high water for pump station discharges of 555 cfs and 740 cfs. For the 185 cfs and 370 cfs pumping rates, discharge was largely confined to the main channels. Figure 5 shows the hydraulic profiles for all four modeled flow rates assuming a 30-inch culvert diameter at the channel crossing. The upper half of the figure shows the profile from the pump station outfall in upper CTB to the last cross-section in lower CTB. The lower half of the figure depicts the profile from the pump station outfall in upper CTB to the last cross section in the unnamed channel. This figure also depicts the channel crossing, which appears to be overtopped for some flows but actually has a deck elevation of +4.0 feet that is not displayed but was modeled as such.

Figure 5. HEC-RAS hydraulic profiles with 30-inch culverts at the channel crossing

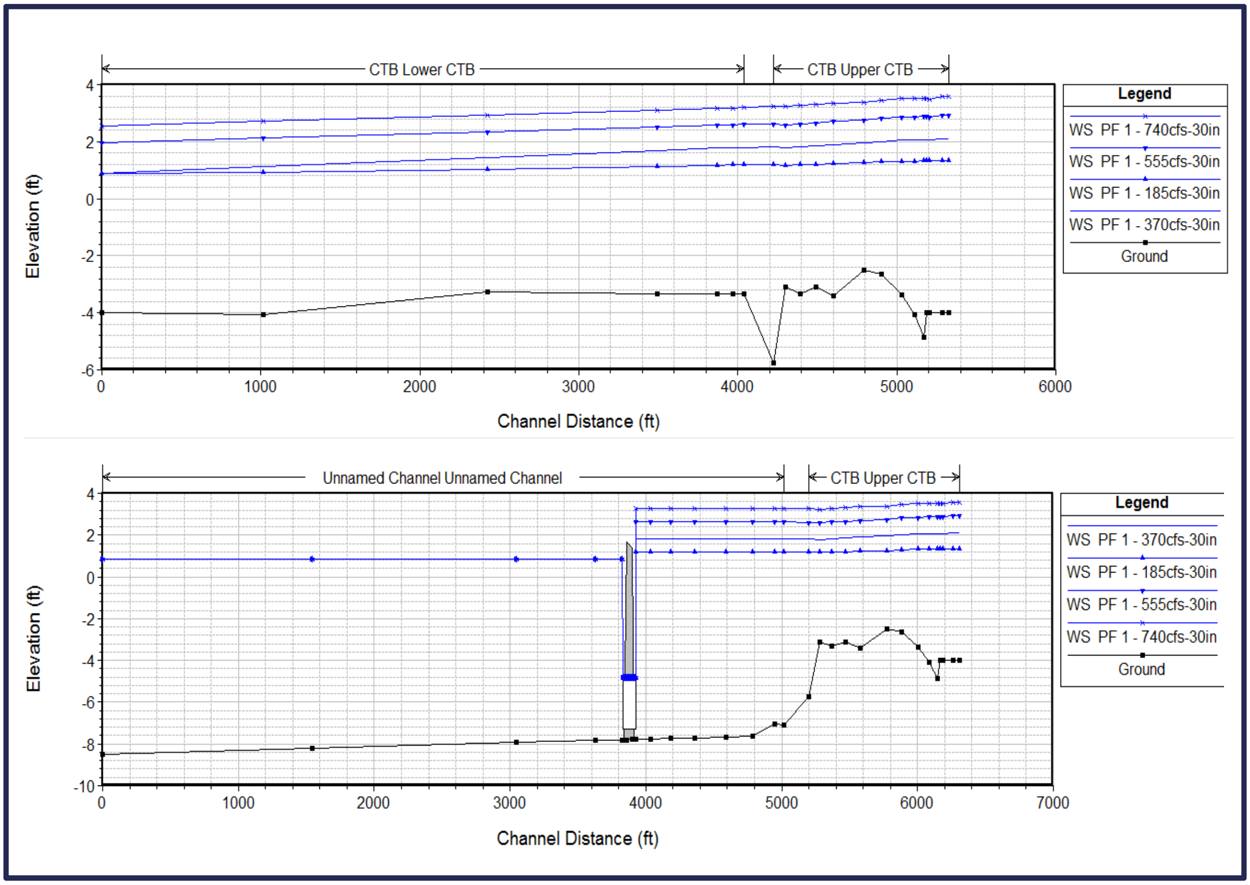
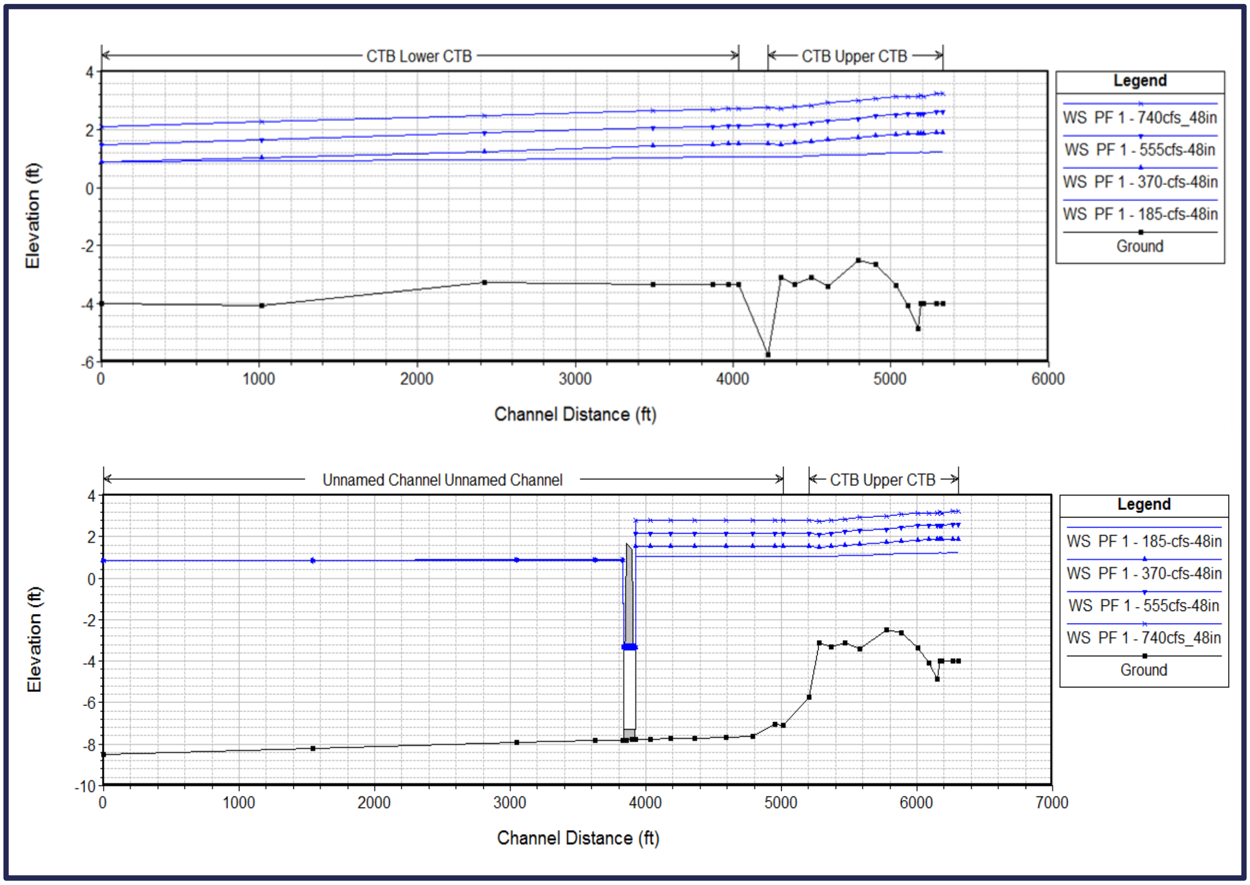


Figure 6. HEC-RAS hydraulic profiles with 48-inch culverts at the channel crossing



The proposed channel crossing of the unnamed channel influences the flow distribution between CTB and the unnamed channel and thus affects WSEs upstream in the unnamed channel and the upper CTB reach, as well as in the lower CTB reach. Increasing the diameters of the culvert from 30-inch to 48-inch decreases WSEs from between 0.1 foot to 0.5 foot across the different discharge rates. Table 1 provides the flow distributions at the junction for all modeled scenarios, and Table 2 provides WSEs at select locations for all modeled scenarios. The WSE south (that is, downstream) of the channel crossing is governed by the downstream boundary condition of the unnamed channel and thus remains at +0.87 foot for all modeled flows.

Survey information from Fugro JCLS shows the concrete slab elevation of the boathouse near the outfall as an elevation of +2.33 feet. Results for the 555 cfs and 740 cfs pumping rates at both culvert diameters show WSEs above the concrete slab elevation. At 555 cfs, the WSE was +2.9 feet for the 30-inch culvert and +2.5 feet for the 48-inch culvert. At 740 cfs, the WSE was +3.1 feet for the 30-inch culvert and +3.5 feet for the 48-inch culvert. These results and WSEs from other locations are shown in Table 2.

Table 1. Flow distribution at channel junction

Flows are in cubic feet per second (cfs)

Pump station discharge	185 cfs		370 cfs		555 cfs		740 cfs	
Culvert diameters (inches)	30	48	30	48	30	48	30	48
Lower CTB	155	115	319	241	485	372	658	518
Unnamed channel	30	70	51	129	70	183	82	222

Table 2. Water surface elevations at select locations

Water surface elevations are in feet NAVD 88

Pump station discharge		185 cfs		370 cfs		555 cfs		740 cfs	
Culvert diameters (inches)		30	48	30	48	30	48	30	48
Location	Near boathouse	1.3	1.2	2.1	1.9	2.9	2.5	3.5	3.1
	Channel junction	1.2	1.1	1.8	1.5	2.6	2.2	3.2	2.8
	Downstream end of CTB	0.87[a]	0.87[a]	0.87[a]	0.87[a]	2.0	1.5	2.6	2.1
	North of channel crossing	1.2	1.1	1.8	1.5	2.6	2.2	3.3	2.8
	South of channel crossing	0.87[a]	0.87[a]	0.87[a]	0.87[a]	0.87[a]	0.87[a]	0.87[a]	0.87[a]

[a] denotes downstream boundary condition

Recommendations

An update to this modeling during the next design phase will be necessary to analyze for scour associated with pump station discharge. It is anticipated that the Shell pipeline will need to be protected in place where it crosses CTB. However, the crossing was not modeled for potential scour at this stage. It should also be noted that due to the previously discussed assumptions and data limitations, the WSEs provided in this report are not intended for floodplain mapping purposes. HDR does not recommend using the results from this analysis or the associated models for any purpose other than those stated explicitly in this report.

The planned channel crossing has the potential to influence WSEs both in CTB and in the unnamed channel, especially during high discharge rates. It is recommended that diameters of the pipes used be increased to at least 48 inches from the planned 30 inches.

References

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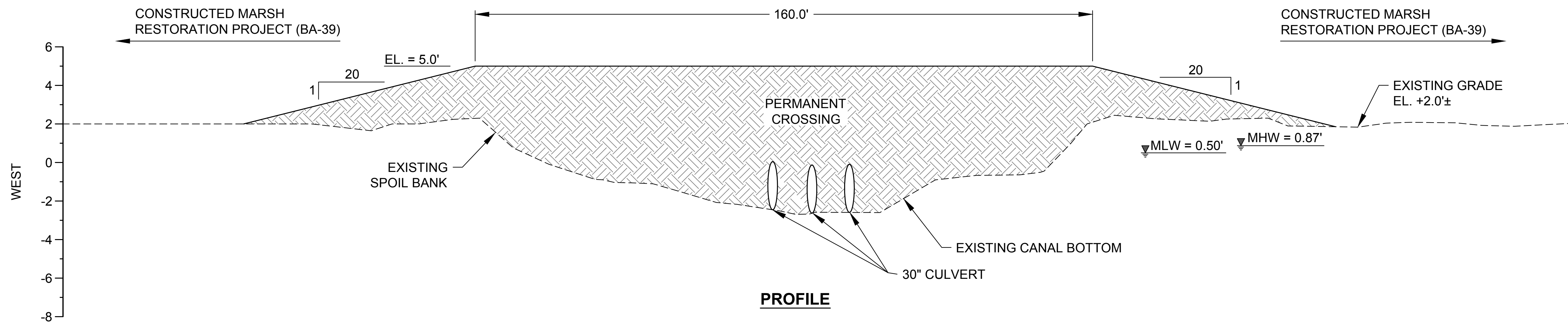
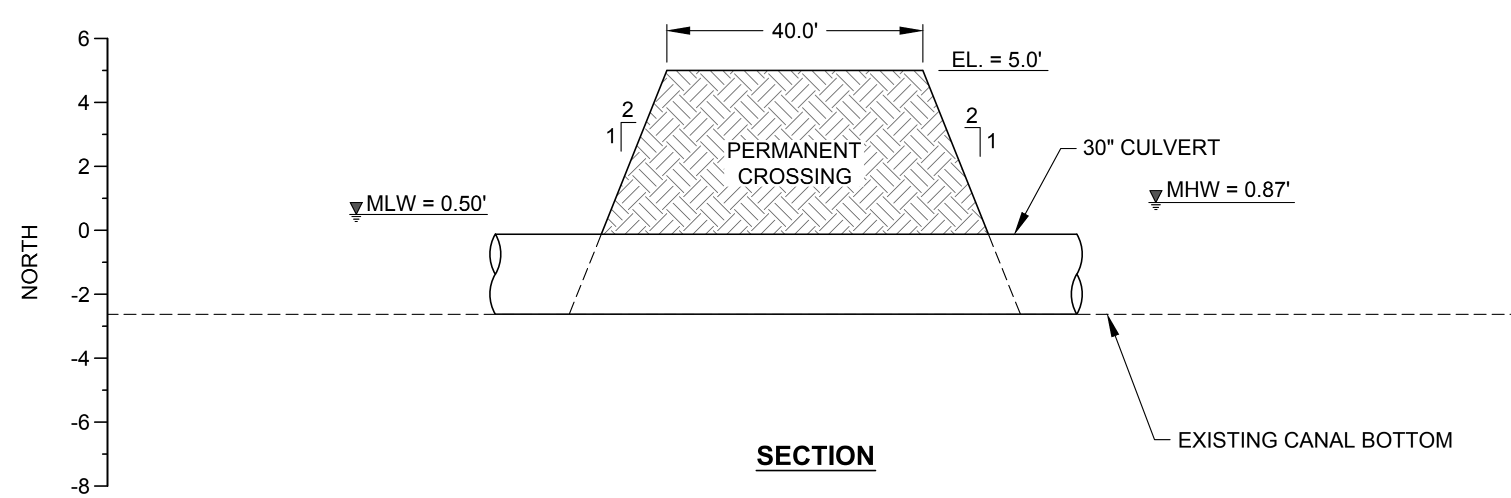
Attachment A. Permanent Canal Crossing Detail



PROFILE



SECTION

9/12 PERMANENT CANAL CROSSING DETAIL

SCALE: HOR. 1" = 50'
VER. 1" = 10'

FINAL DRAFT BID SET

10' 5' 0' 10' 20'
VERTICAL SCALE

50' 25' 0' 50' 100'
HORIZONTAL SCALE

REV.	DATE	DESCRIPTION	BY

MOFFATT & NICHOL
ONE AMERICAN PLACE
301 MAIN STREET, SUITE 800
BATON ROUGE, LA 70825
225-336-2075

COASTAL PROTECTION AND RESTORATION AUTHORITY
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

MISSISSIPPI RIVER LDSP AND
BAYOU DUPONT MARSH & RIDGE CREATION

STATE PROJECT NUMBER: BA-43 (EB) AND BA-48

PERMANENT CANAL CROSSING DETAIL

DATE: FEBRUARY 15, 2013

DRAWN BY: YC | DESIGNED BY: SA | APPROVED BY: MAURY CHATELLIER, P.E. | SHEET 44 OF 79