Appendix C
Engineering Report

October 2024
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

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Prepared for Cedar Port Navigation and Improvement District

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TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

ABBREVIATIONS

AdH	Adaptive Hydraulics
ATON	aid to navigation
BMP	best management practice
cfs	cubic foot per second
CPNID	Cedar Port Navigation and Improvement District
CSRA	Cost and Schedule Risk Analysis
CTXS	*Coastal Texas Protection and Restoration Feasibility Study*
cy	cubic yard
DMMP	Dredged Material Management Plan
ECIP	Expansion Channel Improvement Project
EL	elevation
ERDC	U.S. Army Engineer Research and Development Center
ER	USACE Engineer Regulation
ESA	Endangered Species Act
FS/EIS	Feasibility Study/Environmental Impact Statement
GAR	Green-Amber-Red
H:V	horizontal to vertical (ratio)
HSC	Houston Ship Channel
HTRW	Hazardous, Toxic, and Radioactive Waste
LiDAR	Light Detection and Ranging
LOA	length overall
MLLW	mean lower low water
MLT	mean low tide
mm/yr	millimeter per year
NEPA	National Environmental Policy Act
NFS	non-federal sponsor
NOAA	National Oceanic and Atmospheric Administration
O&M	operation and maintenance
ODMDS	Ocean Dredged Material Disposal Site
PDT	Project Delivery Team
PED	Planning, Engineering, and Design
POA	period of analysis
SLAT	Sea Level Analysis Tool
SLR	sea level rise
study	new terminal planned for the Cedar Port Industrial Park in Baytown, Texas
TSP	tentatively selected plan

USACE	U.S. Army Corps of Engineers
USC	*United States Code*
WRDA	Water Resources Development Act

Executive Summary

The Cedar Port Navigation and Improvement District (CPNID) is investigating the opportunities to modify the existing U.S. Army Corps of Engineers (USACE) constructed Cedar Bayou Channel Improvement Project and to develop a new deep-draft federal navigation channel to connect the Houston Ship Channel (HSC) to a new terminal planned for the Cedar Port Industrial Park in Baytown, Texas (study). The CPNID is serving as the non-Federal Sponsor (NFS), as defined in the Flood Control Act of 1970, as amended (42 *United States Code* 1962d-5b(b)) for the study. This Engineering Report is Appendix C of the draft Integrated Feasibility Study/Environmental Impact Statement (FS/EIS) supporting the study. The primary objectives of this report are as follows:

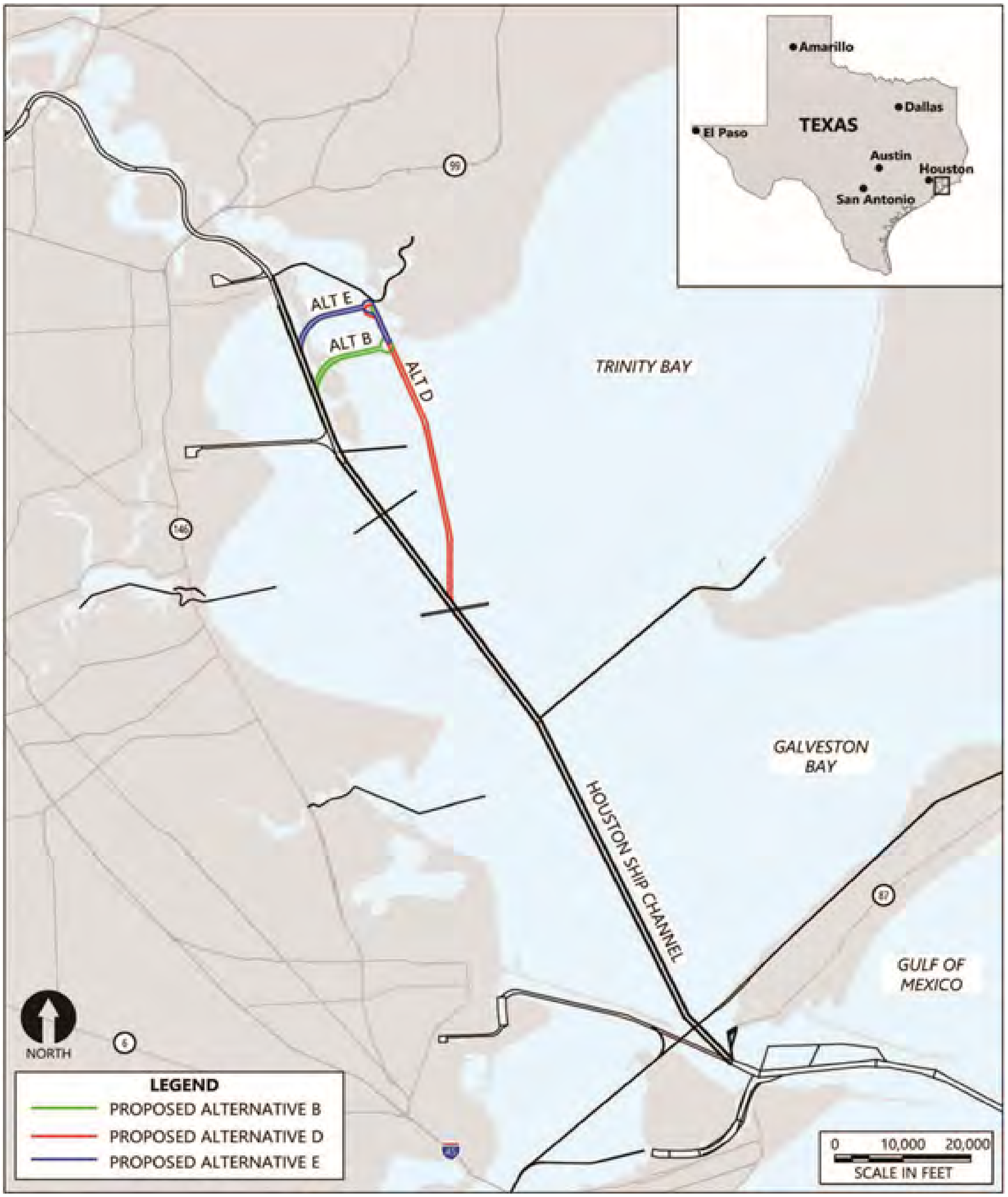
- To provide engineering data and analyses to sufficiently evaluate the alternatives under consideration
- To support the development of a project schedule and cost estimate for the preferred alternative

The plan formulation process completed for the study identified an array of alternatives based on their ability to meet study objectives while avoiding impacts to—and potentially enhancing—infrastructure and environmental resources. Most of the initial alternatives were rejected because of significant impacts related to navigation constraints, utility infrastructure, and habitats. As stated in the August 2023 Notice of Intent, four channel alternatives were initially identified to provide deep-draft vessels access to the proposed terminal at Cedar Port Industrial Park: Alternative A (the existing Cedar Bayou Channel), Alternative B, Alternative C, and Alternative D.

A simulation using the same vessel designs as those found in the *Houston Ship Channel Expansion Channel Improvement Project, Harris, Chambers, and Galveston Counties, Texas Final Integrated Feasibility Report-Environmental Impact Statement* (USACE SWG 2019), known as HSC Project 11, was performed in August 2023 and resulted in changes to the four prospective alternatives. Alternative A was eliminated because of navigational issues, and Alternative B was modified with input from the pilots and engineers involved in the simulation and deemed a viable alternative. Subsequent input from the USACE led to the development of Alternative E, which is north of Alternative B to avoid Placement Area 15. An additional vessel simulation run in April 2024 confirmed the feasibility of Alternative E. The vessel simulation report included recommendations to consider in the next phase of engineering, including increasing the channel width and turning basin diameter, modifying the turn, and adding tugboat shelves for better maneuverability and vessel control. The recommendations were considered during the Cost and Schedule Risk Analysis (CSRA) and contingency calculations. Alternatives B, D, and E (and the No-Action Alternative) were evaluated as part of the draft Integrated FS/EIS. All alternatives include new infrastructure and nature-based solutions consistent with U.S. Army Corps of Engineers (USACE) guidelines and procedures.

Figure ES-1 presents the alternative channel alignments. Further investigations of possible improvements would occur during Planning, Engineering, and Design (PED).

Figure ES-1
Alternative Channel Routes



All alternative channel routes are assumed to have authorized bottom elevations (ELs) of –46.5 feet below mean lower low water (MLLW), to match the depth of the HSC after the Project 11 improvements. Accounting for additional depth for advance maintenance and allowable over-dredging for vertical tolerances consistent with USACE channel design guidelines (USACE 2006), the resulting bottom ELs are expected to be -50.5 feet MLLW. Channels and turning basins are all assumed to have the same authorized depths, with widths of 400 feet, but they differ in length and terminus location with the HSC.

Excavation of all alternative channel routes includes beneficial use of the dredged material to minimize habitat impacts and create fish and wildlife habitat. Dredged material, depending on its volume and condition, would be placed in approved ocean PAs, used to create beneficial use islands, or used in the construction and development of port infrastructure. The beneficial use islands common to each alternative would be built over time and designed to incorporate nature-based approaches to shoreline stability and the establishment of native habitats. They would have gentle slopes for oyster habitat and low to high marsh to minimize any impacts to habitat as a result of construction activities, plus additional area for a net increase in upland habitat. The beneficial use islands would also promote resiliency by protecting headlands against some storm surge and wave action.

In addition, because Alternatives B and E cut across the existing Atkinson Island beneficial use site and PAs, these alternatives would use a portion of the dredged material to rebuild the containment structure slopes of the Atkinson Island beneficial use sites and PA levees.

The NFS worked with the USACE, Galveston District at all phases of engineering to identify alternatives, locate sources of information and field studies, identify additional information needed, and review the results of the feasibility-level engineering and analyses. Substantial bathymetric and geotechnical data were collected to evaluate the feasibility of the alternatives to reduce uncertainty and increase confidence in the proposed plan cost and schedule for the tentatively selected plan (TSP). Geotechnical field data were obtained along the perimeter of the Atkinson Island beneficial use area but only information from historical boring logs within the beneficial use area itself could be obtained. Therefore, this area was assigned a higher risk rating and contingency during the CSRA and would be further investigated during PED.

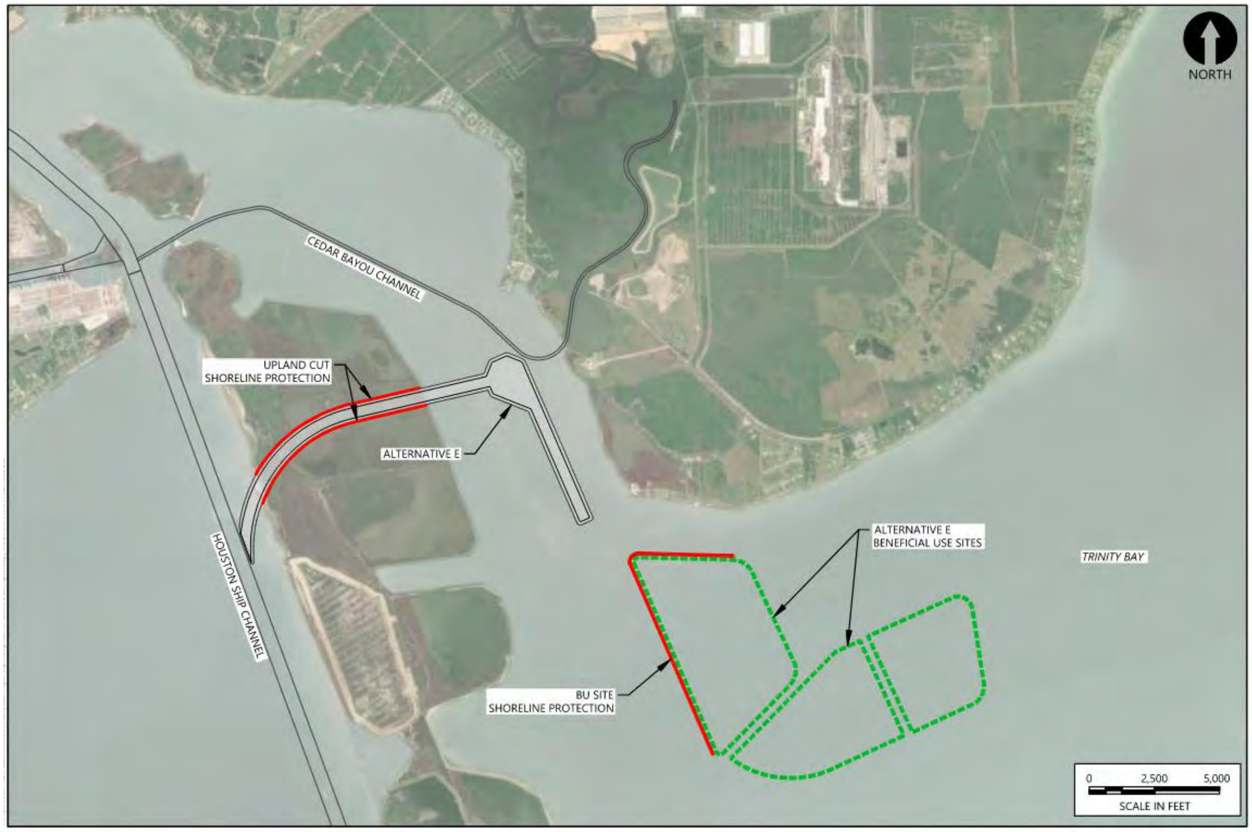
Resiliency and adaptability measures have been identified to ensure the infrastructure can adapt to the harsh marine environment susceptible to changing conditions associated with potential increases in sea level rise. The goal will be to increase the resiliency of engineered structures to reduce maintenance and increase the life of the structures.

As discussed in the draft Integrated FS/EIS. Alternative E, which is shown in Figure ES-2, is the TSP. ES-3 identifies the area of shoreline protection. This engineering report addresses the following general areas for construction related to Alternative E:

- Dredging of the channel
- Placement of dredged material at the proposed new terminal, the proposed new beneficial use site(s), or the offshore placement site(s)
- Slope protection for passing vessel waves at Atkinson Island
- Modification to PA 16
- Breakwaters to protect shorelines from passing vessel waves
- Beneficial use site construction, including to support habitat creation and long term maintenance dredging capacity

Figure ES-2
Alternative E, the Tentatively Selected Plan

Figure ES-3
Shoreline Protection



The engineering effort focused on reducing uncertainty for high-risk items in support of developing the cost and schedule with an appropriate contingency for planning purposes. Although all the engineering information and analyses presented in this report should be confirmed and further refined, the engineering team has noted the following key areas to focus on in the next phase of engineering to further define the scope of work and reduce uncertainty for the tentatively selected plan (TSP): additional vessel simulations, additional geotechnical field data collection, breakwater design, detailed mapping and natural resource surveys, and mapping utilities and pipelines.

This engineering report does not include the Dredged Material Management Plan (DMMP) or the Hazardous, Toxic, and Radioactive Waste (HTRW) report. They are provided as Appendix D and Appendix E of the draft Integrated FS/EIS, respectively. In addition, the costs associated with the study actions are presented in Appendix E, Cost Engineering. No HTRW concerns were identified during the feasibility study.

1 Introduction

Pursuant to the National Environmental Policy Act (NEPA), as amended, the Cedar Port Navigation and Improvement District (CPNID), acting as the non-federal sponsor (NFS) under authority of the Water Resources Development Act (WRDA) Section 203, as amended (33 *United States Code* [USC] 2231), has prepared a draft Integrated Feasibility Study and Environmental Impact Statement (FS/EIS) to investigate the opportunities to modify the existing U.S. Army Corps of Engineers (USACE) constructed Cedar Bayou Channel Improvement Project. The new terminal planned for the Cedar Port Industrial Park in Baytown, Texas (study) is being conducted under the authority found in Section 216 of the Flood Control Act of 1970, as amended. The CPNID is serving as the NFS, as defined in the Flood Control Act of 1970, as amended (42 USC 1962d-5b(b)), for the study. CPNID is completing this study under the authority granted in WRDA Section 203, as amended.

The draft Integrated FS/EIS evaluates the feasibility of constructing a navigable connection between the Houston Ship Channel (HSC) and a planned deep-draft terminal in the study area to enhance efficient, safe, and reliable transportation of goods and products into the Houston region. The alternatives considered in this FS/EIS would accommodate current problems and future cargo growth projections for the region.

This report is Appendix C of the draft Integrated FS/EIS. It documents an engineering evaluation of the feasibility-level engineering evaluation of the proposed study and an array of reasonable alternatives that would achieve study goals. The report is based on the results of field studies, modeling, and analyses completed for the study and included as attachments to this report, as follows:

- Attachment C-1: Geotechnical Field Results Investigations and Engineering Analysis
- Attachment C-2: Coastal Engineering Report
  - Attachment C-2-1: Screening Level Application of the Coastal Storm Modeling System (CSTORM MS) for Storm Surge and Wave Conditions for the Cedar Port Navigation District Channel Deepening Project, Baytown, Texas
- Attachment C-3: *Feasibility-Level Ship Simulation Study of Alternative Channels for Cedar Port*
- Attachment C-4: Drawings

The purpose of this engineering report is to evaluate the feasibility of the study and to support the evaluation of potential effects on the environment as presented in the draft Integrated FS/EIS. The primary objectives of this report are as follows:

- To provide engineering data and analyses to sufficiently evaluate the alternatives under consideration
- To support the development of a project schedule and cost estimate for the preferred alternative

The following USACE guidance was used to inform this Engineering Report:

- EM 1110-2-5027 Confined Disposal of Dredged Material (USACE 1987)
- ER 1130-2-520 Navigation and Dredging Operations and Maintenance Policies (USACE, 1996)
- ER 1110-2-8159 Life Cycle Design and Performance (USACE, 1997)
- ER 1110-2-1913 Design and Construction of Levees (USACE, 2000)
- ER 1105-2-100 Planning Guidance Notebook *(*USACE, 2000).

1.1 Study Area

The study area for this report is the Upper Galveston Bay and portions of Trinity Bay and Tabbs Bay near Baytown, Texas; the Cedar Bayou Navigation Channel; the HSC south of the Fred Hartman Bridge between Baytown and LaPorte, and the Ocean Dredged Material Disposal Site (ODMDS) located in the Gulf of Mexico. The study area includes portions of Galveston, Liberty, Harris and Chambers-counties including the CPNID, the Port of Houston, and the Chambers-Liberty Counties Navigation District.

USACE operates and maintains two shipping channels within the study area that would be potentially affected by the study: the deep-draft HSC (and branch channels) and the shallow-draft Cedar Bayou Navigation Channel. The HSC supports the Port of Houston, a mixed-use port complex comprising 8 public terminals along a 52-mile waterway managed by the Port of Houston Authority, and more than 200 private terminals serving industrial companies. As the number of vessels and the tonnage of cargo have increased to the Houston region, the HSC navigational system and port facilities have become inefficient and as such, modifications to the federal channel have been required. The most recent authorized modification, known as Project 11 and analyzed in *Houston Ship Channel Expansion Channel Improvement Project Final Integrated Feasibility Report*, was authorized in 2020 to deepen the channel to a depth of -46.5 feet. The Cedar Bayou Navigation Channel is a federally authorized shallow-draft barge channel that connects the HSC at the mouth of Cedar Bayou to the Cedar Port Industrial Park and supports more than 1.5 million tons of cargo per year. It primarily serves the chemical, aggregate, steel, and asphalt industries.

This study does not investigate any modifications or deepening of the HSC; rather, it is focused on the potential construction of a deep-draft channel that connects the planned deep-draft terminal at Cedar Port Industrial Park to the HSC. The channels, HSC and the proposed Cedar Port Industrial Park channel are expected to be dredged to 46.5 feet plus 2 feet of advance maintenance and 2 feet of allowable overdepth below mean lower low water (MLLW).

1.2 Alternative Development

As discussed fully in the draft Integrated FS/EIS, the following three problems were identified in the study are: inefficient cargo movement, navigational safety and current and future container capacity. The problems identified in the study area present opportunities to do the following: 1) reduce the inefficient double handling of cargo; 2) reduce or eliminate vehicles from Houston-area roads to reduce air emissions and traffic congestion; 3) identify navigational modifications to increase navigational safety and alleviate berth inefficiencies; and 4) identify opportunities for beneficial use (beneficial use) from dredged material.

The need for action is to improve the current and future efficiency and safety of the importation of products into the United States in a manner that contributes to the NED plan, is consistent with protecting the nation’s environment; provides safer and efficient travel on local Houston roads by reducing the number of trucks on public roads and providing nature-based solutions.

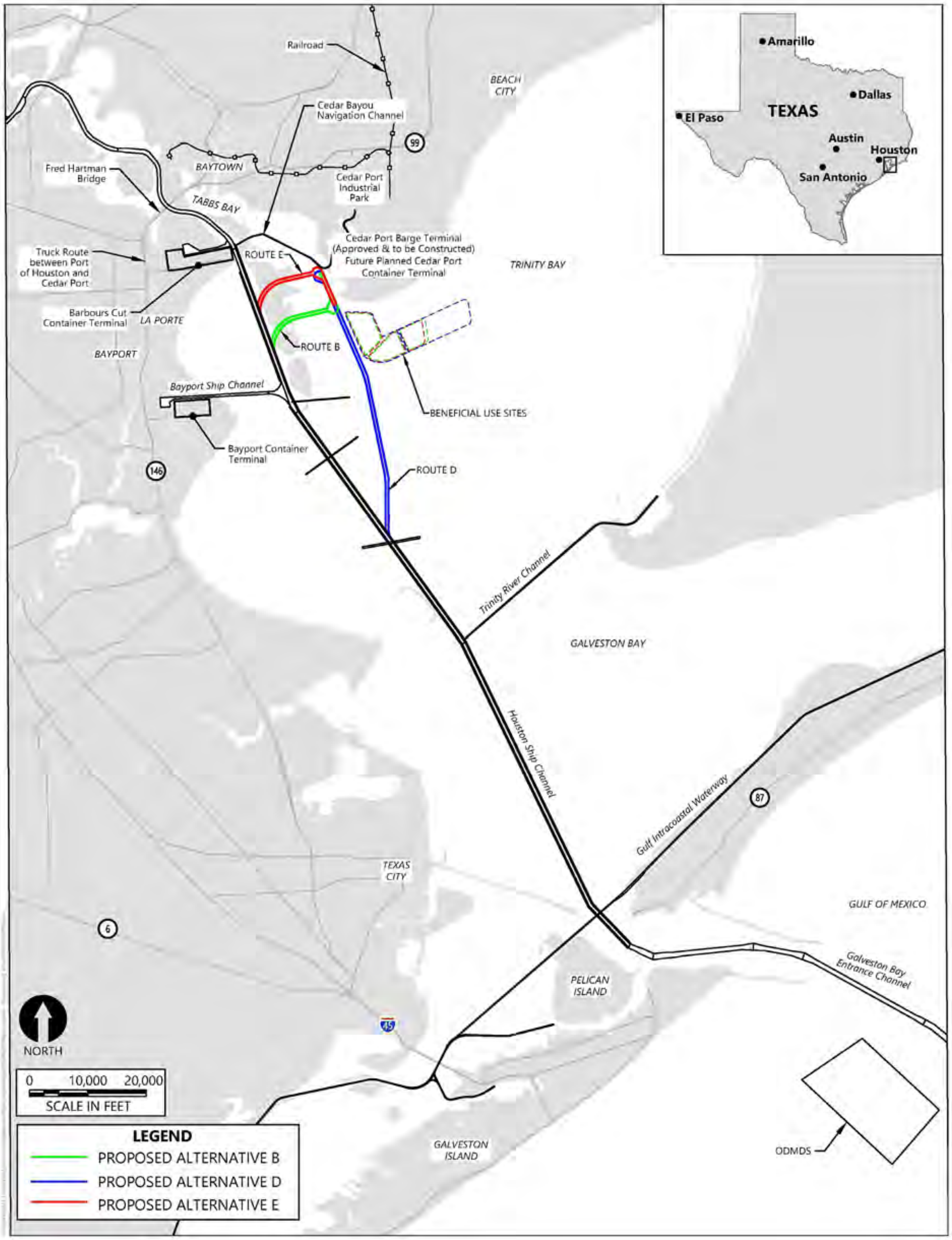
The following objectives were used in the formulation and evaluation of alternative plans:

- Reduce navigation and transportation inefficiencies by reducing double-handing of cargo.
- Develop new pathways for the safe and efficient movement of cargo via deep-draft navigable channel to meet present and future demands.
- Develop environmentally suitable placement alternatives for dredged material in accordance with the USACE and congressional mandate to maximize beneficial use of dredged material and to construct federal water resources development projects using sound nature-based solutions.

The formulation process identified an array of alternatives based on their ability to meet identified study objectives while avoiding impacts to—and potentially enhancing—infrastructure and environmental resources. Fifteen alternatives (identified by a mix of locations and the alternatives routes labels A, B, C, D, and E) were initially considered. Most were rejected because of significant impacts related to navigation constraints, utility infrastructure, and habitats. Following the initial feasibility evaluation, Alternatives B, D, and E (and the No-Action Alternative) were evaluated as part of the draft Integrated FS/EIS. All of the alternatives include new infrastructure and nature-based solutions consistent with USACE guidelines and procedures.

The alternatives are fully detailed and discussed in Section 3 of the draft Integrated FS/EIS and shown on Figure 1.

Figure 1
Proposed Alternatives Evaluated



1.2.1 No Action Alternative

The No Action Alternative, which NEPA requires to be considered in an EIS, represents what would reasonably be expected to occur in the foreseeable future if the proposed action were not approved. Under this alternative, no new channel would be developed, and deep-draft vessels would not be able to access Cedar Port. Containers would be handled at the two Port of Houston container terminals. A portion of the containerized cargo offloaded at the Bayport and Barbours Cut terminals would be barged to the Cedar Port area. Once the capacity of the barge system is reached, cargo would be trucked on average of 16.2 miles from the Port of Houston Container Terminals to the CPNID.

1.2.2 Dredge New Deepwater Channel to Planned Cedar Port Terminal

Under these alternatives, a new deepwater channel would be dredged connecting the HSC to a new planned deepwater terminal at Cedar Port. The channel would include necessary flares to connect to the HSC and a turning basin to facilitate vessel access to the new planned terminal. All alternative channel routes are assumed to be dredged to a depth of -46.5 feet MLLW meet the depth of the HSC after the Project 11 improvements plus authorized overdredge allowance as called for in the USACE channel design guidelines to a total depth of -50.5 feet MLLW. All channel widths would be 400 feet wide (bottom width). Dredging would be done hydraulically with a hopper dredge and material would be managed to prioritize beneficial use of material. Dredged material would be placed in three ways depending on its volume and condition: approved ocean disposal, beneficial use islands, and beneficial use of material in port infrastructure construction and development.

1.2.2.1 Alternative B

Alternative B involves excavating a new deep-draft channel from the HSC through a portion of the dredged material management site south of Atkinson Island and in upper Galveston Bay. Under Alternative B, all silts, sands, and organic dredged material will be transported by tugs to the ODMDS. Dredged clay material would be used to rebuild the slopes of the land cuts and create a 614-acre beneficial use island, with any remaining material beneficially used at the terminal. The 614-acre island would be designed with gentle slopes for oyster habitat and low to high marsh to support wetlands. Future maintenance dredged material would be used to create a second 839-acre island that would be filled with material over time.

1.2.2.2 Alternative D

Alternative D involves excavating a new deep-draft channel from the HSC south of Blue Water Atoll through upper Galveston Bay to near the mouth of Cedar Bayou. Under Alternative D, all silts, sands, and organic dredged material will be transported by tugs to the ODMDS. Dredged clay material would be used create a 1,100-acre beneficial use island, with any remaining material beneficially used at the terminal. The 1,100-acre island would be designed with gentle slopes for oyster habitat and low to high marsh to support wetlands. Future maintenance dredged material would be used to create a second 1,130-acre island that would be filled with material over time

1.2.2.3 Alternative E

Alterative E involves excavating a new deep-draft channel from the HSC through Atkinson Island north of Alternative B. Under Alternative e, all silts, sands, and organic dredged material will be transported by tugs to the ODMDS. Dredged clay material would be used to rebuild the slopes of the land cuts and create a 614-acre beneficial use island, with any remaining material beneficially used at the terminal. The 614-acre island would be designed with gentle slopes for oyster habitat and low to high marsh to support wetlands. Future maintenance dredged material would be used to create a second 770-acre island that would be filled with material over time.

1.2.3 Nature-Based Solutions Elements Common to All Dredge Alternatives

All channel alternatives would include nature-based solutions for coastal storm surge protection and habitat creation, such as beneficial use islands, breakwaters and living shorelines adjacent to the Bay Oaks areas and a jetty or series of jetties at the southern edge of Cedar Point.

The beneficial use islands would be built over time and designed to incorporate nature-based approaches to shoreline stability and the establishment of native habitats. The first island would be constructed with material dredged during channel development, and additional islands would be built of material from future maintenance dredging. Like the beneficial use islands, the beneficial use levees would be designed to have gentle slopes conducive to oyster recruitment. At the top of the range, the slope would increase to the levee crest for wetland vegetation planting and establishment. The top of the beneficial use sites would be designed as bird island habitat. In addition to creating habitat, the establishment of vegetation on the designated slopes would help stabilize the levees and help reduce erosion. These areas would rely on a combination of planting and natural recruitment and potentially living shoreline sills to attenuate some wave energy. Each alternative route would include development of a beneficial use island with gentle slopes for oyster habitat and low to high marsh to offset any habitat losses at applicable mitigation ratios plus an additional area for a net increase in upland habitat. The beneficial use islands would promote increased coastal resiliency, attenuating some wave and current energy against the adjacent shorelines. Table 1 presents a summary of the dredge alternatives.

Table 1
Summary of Dredge Alternatives

Alternative	Channel Length	Virgin Dredge Volume (cy)	BUS-1 Area	BUS-2 Area	Estimated Construction Duration[1]
Alternative B	3.81 miles	23,000,000 cy	614 acres	839 acres	6.8 years
Alternative D	8.84 miles	40,000,000 cy	1,101 acres	1,130 acres	8.3 years
Alternative E	3.72 miles	19,000,000 cy	614 acres	770 acres	6.3 years

Note:

1. Construction duration per Appendix F, DMMP, Table 13

2 Existing Conditions

This section describes existing conditions related to the physical environment including surveys, datums, tides, currents and water levels, and sea level rise (SLR).

2.1 Surveys and Datums

2.1.1 Surveys

Hydrographic surveys of all alternatives and the proposed beneficial use site were obtained in 2023 and 2024. Topographic surveys and publicly available Light Detection and Ranging (LiDAR) information were used for Atkinson Island. During Planning, Engineering, and Design (PED), updated topographic surveys of the island, the beneficial use site, and the Dredged Material Placement Area (DMPA) would be obtained. Engineers would review the available hydrographic surveys and determine whether additional surveys are required.

2.1.2 Datum

The horizontal datum for the study area is based on the Texas State Plane Coordinate System, South Central Zone 4204, North American Datum of 1983. The vertical datum is MLLW.

Prior projects in the USACE Galveston District area of responsibility have used the USACE vertical datum mean low tide (MLT). The USACE, Galveston District has completed the process of converting the vertical datum for all navigation projects from MLT to MLLW (USACE 2015). From Bolivar Roads to Beacon 76, MLLW is 1 foot above MLT. From Beacon 76 to the end of the HSC, MLLW is 1.5 feet above MLT.

2.1.3 Tides, Currents, Wind, Waves, and Water Level

Tides in the study area can be both diurnal—with one daily high and low tide—or semidiurnal—with two daily high and low tides. The study area is considered a microtidal environment with a mean tide range of 1.1 feet as measured at the National Oceanic and Atmospheric Administration (NOAA) tidal station 8770613, Morgans Point, Barbours Cut, Texas (NOAA 2024a). Elevated water levels can occur in the study area because of spring tides and storms. The highest water level recorded at NOAA station 8770613 since the start of its operation in 1995 is 9.1 feet North American Vertical Datum of 1988, measured on September 13, 2008, during Hurricane Ike.

Freshwater inflows into Galveston Bay peak during the summer because of increased seasonal precipitation and associated runoff. The nearest source of freshwater inflow to the study area is Cedar Bayou, which borders the Cedar Port Industrial Park to the west. Based on long-term estimates of freshwater inflows in Cedar Bayou calculated by the Texas Water Development Board from 1977 to 2018 (TWDB 2024), mean discharge from Cedar Bayou into Galveston Bay is approximately

600 cubic feet per second (cfs), and the mean annual peak discharge is approximately 13,000 cfs. Increased seasonal freshwater inflows into Galveston Bay typically result in increased vertical stratification of freshwater and saltwater (i.e., the formation of a salt wedge) in the deeper areas of Galveston Bay like the HSC.

Water circulation and currents in the vicinity of the study area are the result of tides, freshwater inflows, and wind. The prevailing winds in the study vicinity, as determined from historical measurements at NOAA station 8770613, blow from the southeast and south. Sustained winds from these directions can cause elevated water levels in the study area by pushing water against the northern shorelines of Galveston Bay and can produce countercurrent nearshore eddies (USACE SWG 2019). Residence times of water in Galveston Bay are generally long and controlled mainly by the shallow bathymetry and small tide range. Flushing times for the entire bay range from 75 to 280 days, and flushing times for the deeper HSC range from 16 to 28 days (USACE SWG 2019).

Galveston Bay's typically low-energy wave environment is due to its shallow bathymetry and limited connection to the Gulf of Mexico via three inlets. The barrier islands that enclose Galveston Bay to the south effectively separate it from the water of the Gulf of Mexico and block wave energy from entering the bay. Field measurements of locally generated waves near the middle of Trinity Bay between August 2004 and May 2005 found significant wave heights up to 2.8 feet (Dupuis and Anis 2013). Larger waves are associated with tropical storms and hurricanes because of their higher winds and increased water depth from storm surge.

2.1.4 Relative Sea Level Change

SLR is an environmental change that can impact the performance of coastal projects over time. Guidance for incorporating the effects of projected future SLR over a project's life cycle is given in USACE Engineer Regulation (ER) 1100-2-8162, *Incorporating Sea Level Change in Civil Works Programs* (USACE 2019). This guidance specifies the evaluation of a range of possible future SLR rates, represented by "low," "intermediate," and "high" scenarios, which are described as follows:

- The USACE "low" SLR scenario uses the historical rate of local mean sea level, recommended to be determined by local tide measurements covering a historical period of at least 40 years.
- The USACE "intermediate" scenario uses the modified National Research Council Curve I, corrected for local vertical land movement.
- The USACE "high" scenario uses the modified National Research Council Curve III, corrected for local vertical land movement.

The USACE guidance for evaluation of SLR distinguishes between two project time scales, namely, the period of analysis (POA) and the planning horizon. For most water resources development projects—such as the recent USACE HSC Expansion Channel Improvement Project (ECIP), located adjacent to the study site—the POA is 50 years (USACE SWG 2019), which is considered appropriate because SLR projections beyond 50 years involve much greater uncertainty. The planning horizon corresponds to the actual physical life of the study, which may extend far beyond the POA and include environmental changes to the design conditions that require maintenance actions to support continued study operations and performance. Consistent with the FS/EIS evaluations performed for the HSC ECIP (USACE SWG 2019), the study POA is 50 years, and the planning horizon is 100 years.

Evaluation of potential SLR was performed at three time horizons for each of the three SLR scenarios defined in the USACE (2019) guidance. The first time horizon represents a time in the future immediately at the completion of a project's construction and is hereafter referred to as "Year 0" of the study. The second time horizon represents the end of the POA, 50 years after the completion of construction; this time horizon is hereafter referred to as Year 50 of the study. The third time horizon represents the end of the planning horizon, 100 years after the completion of construction; this time horizon is hereafter referred to as Year 100 of the study.

Estimated construction schedules were developed for Alternatives B, D, and E as part of the Dredged Material Management Plan (DMMP) presented in Appendix D of the FS/EIS. The lengthiest duration of construction (corresponding to Alternative Route D) was estimated to be completed in 2035. Therefore, 2035 was selected as Year 0 for the study because any of the alternatives would be expected to be completed by that time, making Year 50 of the study 2085 and Year 100 of the study 2135. Projected SLR values were calculated with the online USACE Sea Level Analysis Tool (SLAT) implementation of the USACE (2019) SLR formulas (USACE 2024). Data from NOAA station 8771450, Galveston Pier 21, Texas, (NOAA 2024b) were used to establish the local historical SLR trend for these projections because it is the station closest to the study area where data were collected for at least the 40-year minimum recommended in the USACE (2019) guidance. The historical mean sea level trend at the NOAA Galveston Pier 21 station from 1904 to 2024 was determined to be 6.65 millimeters per year (mm/yr).

Relative SLR refers to the combination of SLR and local vertical land movement. To estimate relative SLR, the SLAT SLR projections were combined with local estimates of vertical land movement available through the online U.S. Geological Survey Groundwater and Land Subsidence interactive map (USGS 2024). Average 5-year rates of vertical land movement from 2016 through 2020 at 53 GPS and extensometer monitoring stations bordering Galveston Bay and the HSC ranged from -4.4 to 6.9 mm/yr with an average of -0.1 mm/yr. The average 5-year rate of vertical land movement of -0.1 mm/yr was combined with the SLAT SLR projections to obtain estimates of relative SLR at the study Year 0, Year 50, and Year 100 time horizons. A summary of these relative SLR estimates is shown in Table 2.

Table 2
Summary of Relative SLR Estimates

Year	Description	Low (feet)	Intermediate (feet)	High (feet)
2035	Study Year 0	0.96	1.12	1.65
2085	Study Year 50	2.07	2.84	5.29
2135	Study Year 100	3.19	5.01	10.78

Note:
The relative SLR values in this table are relative to 1992, which is the start date of the USACE (2019) SLR curves corresponding to the midpoint of the current National Tidal Datum Epoch of 1983 to 2001.

As shown in Table 2, future relative SLR estimates span a wide range of values, representing a large envelope of uncertainty. Consistent with the methodology of the HSC ECIP FS/EIS evaluations, coastal engineering models (summarized in Section 3.2 and described in more detail in Appendix C-2 of the FS/EIS) were used to evaluate the study alternatives at Year 0 and Year 50 of the POA based on relative SLR projections using the USACE "intermediate" SLR scenario at these two time horizons. Potential impacts of relative SLR on study operations and performance between Year 50 and Year 100 would be monitored and addressed via adaptive management techniques as needed.

3 Field Studies and Modeling Overview

Engineering design was based on geotechnical engineering field studies—which inform the designs of channels, beneficial use islands, other needed structures, and coastal engineering modeling, which indicates how the locations of the channels and beneficial use sites are affected by and may affect regional coastal processes. A vessel navigation simulation study was conducted to inform the navigational design. The three study reports are provided as attachments to this report and summarized in this section.

3.1 Geotechnical Investigations and Engineering Analysis

Geotechnical field studies were conducted to determine viable engineering concepts for channel side slope design, upland cut shoreline protection against waves and vessel wakes, and construction of beneficial use sites through material placement, all supporting the design of alternative routes.

The geotechnical evaluation was informed by available USACE historical information, Tolunay-Wong (2021) along Cedar Bayou (i.e., Alternative A), and two separate field investigations during the FS/EIS. The first field effort was conducted between July 30 and August 6, 2023, and focused on Alternatives B, C, and D; the second effort, completed in May 2024, focused on Alternative E and the beneficial use site. Attachment C-2 presents a synopsis of the field efforts, a discussion of the material properties of the soils encountered, laboratory testing data and boring logs from the field investigations, and the results of the geotechnical evaluations conducted.

3.2 Coastal Engineering

Once alternative channel routes were selected for evaluation as part of feasibility planning, coastal engineering modeling analyses were performed to address the following questions as part of the FS/EIS evaluation:

1. What are the potential effects of the alternatives on salinities in Galveston Bay, Trinity Bay, and the HSC?
2. What are the potential effects of the alternatives on circulation patterns in upper Galveston Bay?
3. What are the predicted shoaling volumes in the alternative channels?
4. What are the potential effects of alternatives on storm surge and storm waves at adjacent shorelines in Galveston and Trinity Bays?
5. What are the potential effects of the alternatives on adjacent shorelines in Galveston Bay and Trinity Bay because of ship waves (wakes)?

To address these study questions, the following coastal engineering modeling evaluations were conducted. Details of the model simulations and results are included in Attachment C-2.

3.2.1 Annual Hydrodynamics, Salinity, and Sediment Transport

Consistent with the methodology presented in the numerical modeling appendix to the HSC ECIP FS/EIS (McAlpin et al. 2019), the 3D Adaptive Hydraulics (AdH) modeling suite was used to simulate coupled hydrodynamics, salinity, and sediment transport in Galveston Bay and the HSC.

For consistency with the HSC ECIP FS/EIS simulations, the 3D AdH model calibrated, validated, and used by the U.S. Army Engineer Research and Development Center (ERDC) for the HSC ECIP FS/EIS evaluations was provided to Anchor QEA by ERDC through coordination with the USACE, Galveston District. The HSC ECIP model files were updated by Anchor QEA for the study evaluations and executed on the ERDC high-performance computing system.

3.2.2 Storm Surge and Waves

Consistent with the methodology of the *Coastal Texas Protection and Restoration Feasibility Study* (CTXS; Massey et al. 2019), a 2D coupled ADCIRC and STWAVE modeling system (ADCIRC+STWAVE) was used to simulate coupled storm surge and storm waves in Galveston Bay. ADCIRC is the Advanced Circulation model for computing water levels and depth-averaged currents, and STWAVE is the Steady State Wave Model for computing nearshore phase-averaged wave heights, periods, and directions.

For consistency with the CTXS, the 2D ADCIRC+STWAVE model used for the CTXS storm surge evaluations was used as a starting point for the alternative evaluations. Using site-specific data provided by Anchor QEA, the ERDC storm surge modeling team updated the CTXS 2D ADCIRC+STWAVE model as needed for the alternative evaluations and executed a subset of the CTXS storm simulations, which were selected through collaboration among Anchor QEA; ERDC; and the USACE, Galveston District.

3.2.3 Vessel Wakes

To evaluate potential vessel wakes associated with the alternative channel routes and the effects on adjacent shorelines, the 2D XBeach modeling suite was used. XBeach includes the relevant processes for generating and propagating vessel wakes and has been shown to reproduce the primary and secondary wave fields produced by transiting vessels (Alstrom et al. 2021; Bluteau et al. 2023).

XBeach model grids for the study alternatives were developed by Anchor QEA using site-specific data consistent with the AdH and ADCIRC+STWAVE modeling evaluations. Simulations included inbound and outbound vessel trips along each alternative channel route using vessel characteristics consistent with the navigation simulations presented in Section 3.3 and the channel design presented in Section 4.1.

3.3 Navigation Simulations

Feasibility-level ship simulations were conducted by Locus, which is also the managing entity of the Maritime Pilots Institute, in August 2023 for Alternative A through D and by the Maritime Simulation program at San Jacinto State College in April 2024 for Alternative E. The San Jacinto Maritime Report *Feasibility-Level Ship Simulation Study of Alternative Channels for Cedar Port* (Burkley et al. 2024) addresses all the vessel simulations and is Attachment C-3 of this report.

The purpose of the simulations was to evaluate the feasibility of the alternative ship channel routes and to identify potential hazards to ship navigation. Eight ship pilots took part in this study. Two retired Houston pilots participated in the August 2023 simulations for Alternatives A through D, and six pilots from the Houston Pilots Association Safety Committee attended the April 2024 simulations focused on Alternative E.

Forty-one ship simulation risk scenarios or runs were performed with a K-Sim Kongsberg Full Mission Bridge ship simulator. The runs focused on the arrival and departure of the design vessel under ideal environmental conditions with slack water and daylight visibility. Some sensitivity runs conducted to provide insights for future studies included sustained winds of 15 to 20 knots from the southeast or the north-northwest. The simulations did not test bathymetry and currents, limited visibility scenarios, other HSC vessel traffic, or cargo vessels of various sizes and types other than the design vessel (Burkley et al. 2024).

Pilots were debriefed after each run. "During the debrief, the pilot was asked to describe how they felt about the run, identify potential hazards to navigation, and assess the overall run on a Green-Amber-Red (GAR) risk assessment scale. Additionally, roundtable discussions with the pilots, research team members, and attendees led to multiple iterative rounds of channel design changes. These discussions also led to the conclusions and recommendations made in [their] report" (Burkley et al. 2024, p. 2).

Burkley et al. (2024) provides the following conclusions about the channel design and layout:

- Alternative E "is the preferred corridor for designing a ship channel connecting HSC to Cedar Port Industrial Park."
- Alternatives B, D, and E are all feasible for navigation.
- "Each feasible ship channel has multiple potential hazards that need to be addressed during PED when developing the optimum ship channel. The results section of [the] report identifies these potential hazards, which are reflected in the GAR scores associated with each run."
- Alternative A is not feasible for navigation.

The report also provides recommendations for optimizing the routes during PED and includes comments on channel design and layout, tugboat operations and size, and pilot operations. Notably, the report cites as a concern “mental fatigue” from the “high cognitive load from the pilots” during the constant arcing turn. "The optimization of a ship channel during PED should explore various navigation philosophies, such as straightaways, turn wideners, and other geometry for the channel’s turns. Additionally, adjustments to the proposed turning basin, including flares, siting and diameter should be considered” as well as the use of larger tugs and more frequent use of tugs in making the turns” (Burkley et al. 2024, p. 5).

4 Channel and Turning Basin Design

The design and layout of the alternative channels followed an iterative process beginning with the USACE guidance document on the design of channels, *Hydraulic Design of Deep-Draft Navigation Projects* (USACE 2006), feedback from vessel movements in the channel from Locus, and the vessel simulations. The design vessel, channel width, channel depth, and turning basins are discussed further in this section. The design of the channel assumes one-way vessel traffic and best aids to navigation (ATONs). Currents are assumed to be negligible based on input from vessel operators in the region.

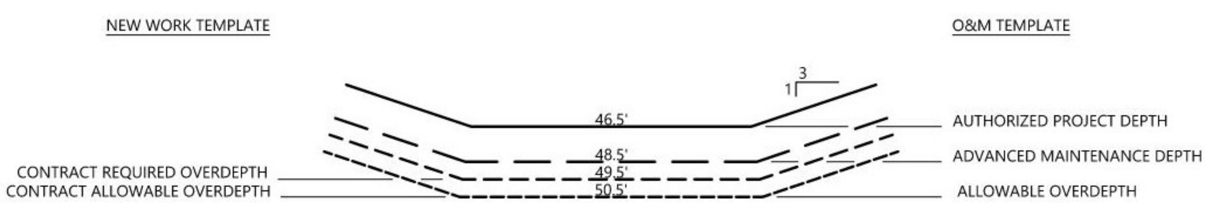
4.1 Design Vessel

The design vessel selected for this study matches the HSC Project 11 study because access to the channel is from the improved HSC. That study used USACE guidelines for selecting the "largest ship of the major commodity movers expected to use study improvements on a frequent and continuing basis…" (Appendix C of USACE SWG 2019, p. 3-2). The study determined the "largest potential container ship size is a hybrid of the 1,000-foot length overall (LOA) by 158-foot beam and a 1,202-foot LOA by 140-foot beam. Therefore, a hybrid container ship size was selected to evaluate design considerations" for navigating from the improved HSC to the planned future terminal (Appendix C of USACE SWG 2019, p. 3-1). The design vessel used for the feasibility design of the channel and ship simulations is a container ship measuring 1,202 feet LOA by 158-foot beam by maximum 49.8-foot draft.

4.2 Channel Depth

The channel depths corresponded to the HSC Project 11 study. The authorized depth is EL (-) 46.5 feet MLLW, with 2 feet for advanced maintenance reaching EL (-) 48.5 feet MLLW, and another 2 feet for allowable overdepth reaching EL (-) 50.5 feet MLLW. See Figure 2.

Figure 2
Proposed New Channel Depth Templates for New Work and O&M Dredging



4.3 Channel Width

The channel width for the alternatives is based on USACE design guidelines and discussions with the Houston pilots and vessel simulation engineers. The alternative routes have a uniform cross section that can be characterized as a canal, a trench, or some combination of the two. USACE (2006) indicates a range of recommended widths 2.5 to 2.75 times the beam for the stated conditions and possibly as low as 2.0 for similar scenarios. "Simulator studies have consistently showed that it is possible to control ships sailing in quite narrow channels and that the available USACE and international design criteria are overly conservative," according to (USACE 2006, p. 8-4). A beam multiplier of 2.5, which yields a minimum channel width of 400 feet, was chosen.

4.3.1 Channel Width in Turns

The channel width in turns and bends is based on input from stakeholders, previous vessel simulations in the region, and consideration of the USACE guidelines. The use of circular turns for the routes is due to large deflection angles in the alignment required to reach the proposed new terminal from the HSC. Previous simulations in the HSC with the same design vessel indicated the length-to-radius ratio could be reduced for the design vessel and channel width could be maintained. Additionally, Alternative D has two cutoff turns with width increases of 100 feet, per the recommendation from the vessel simulation report. Vessel simulations performed for this study proved the turns and associated widths used for the channel design are feasible.

4.4 Channel Slope Stability

The geotechnical analysis described in Engineering Appendix C-1 confirmed side slopes of 3 horizontal to 1 vertical (3H:1V) were acceptable for all alternative routes. This is consistent with the HSC Project 11 study, which states, "For construction of channel modifications, the historic practice is to utilize a template with 3H:1V slopes" (Appendix C of USACE SWG 2019, p. 3-4).

4.5 Turning Basins

A turning basin at the edge of the proposed terminal would facilitate vessel ingress and egress for all proposed alternative routes. The turning basin would have the same depth and side slopes as the channel design. The turning basin diameter is a function of the design ship of 1,200 feet LOA and the currents. USACE guidance states that a turning basin should provide a minimum turning diameter at least 1.2 times the ship length where currents are low (USACE 2006, p. 9-2), which, in this case, yields a minimum diameter of 1,440 feet. The turning basin diameter for all alternatives is 1,500 feet, which is greater than the minimum.

5 Beneficial Use Islands

The proposed beneficial use islands would be built incrementally over time, as they are needed. The first island will be constructed using virgin dredged material, and additional islands would be built using imported clay, on-site materials in the footprint of the proposed island, or material mined in the channels where critical shoals develop. Construction of the beneficial use islands would include best management practices (BMPs) to control turbidity to protect adjacent waters and habitats. Silty soils would not be used during construction of the levees and would, instead, be deposited within the finished beneficial use island containment levees or at the terminal development as stated in the DMMP. The islands would be located to minimize impacts to existing oyster reefs.

5.1 Design

The proposed beneficial use levees would be designed to have gentle exterior slopes conducive to oyster recruitment. At the top of the range, the slope would increase to the levee crest for wetland vegetation planting and establishment. The top of the beneficial use sites would be designed as bird island habitat. In addition to creating habitat, the establishment of vegetation on the designated slopes would stabilize the levee and help reduce erosion. These areas would rely on a combination of planting and natural recruitment. Shoreline areas susceptible to vessel wakes would be protected with living shoreline breakwaters or traditional armoring. Material from maintenance dredging would be pumped as slurry into the interior of the beneficial use site and contained by the berms.

Subsurface geotechnical borings have been obtained at the site of the proposed beneficial use islands, and geotechnical analysis has informed the design of the proposed beneficial use island development. Geotechnical analysis confirmed side slopes would be stable at angles up to 3H:1V, although the actual constructed slopes are expected to be significantly flatter to facilitate vegetation planting and growth. The settlement of the consolidation layer of soil below the beneficial use berms is estimated to be between 3 and 8 inches.

6 Engineering Evaluations

The coastal modeling and geotechnical analyses were used to inform the conceptual engineering design and construction of proposed shoreline protection, breakwaters, and beneficial use sites.

6.1 Shoreline Protection

Shoreline protection from passing vessel waves is expected to be needed where Alternative E is cut through Atkinson Island. The feasibility design assumes an armoring layer of riprap 3 feet thick, extending to depths necessary to protect against wave action. Figure 3 shows the approximate extents of shoreline protection through Atkinson Island. Figure 4 shows a cross section of Alternative E through Atkinson Island and the Beneficial Use Group cells.

Figure 3
Approximate Extents of Alternative E Shoreline Protection Through Atkinson Island

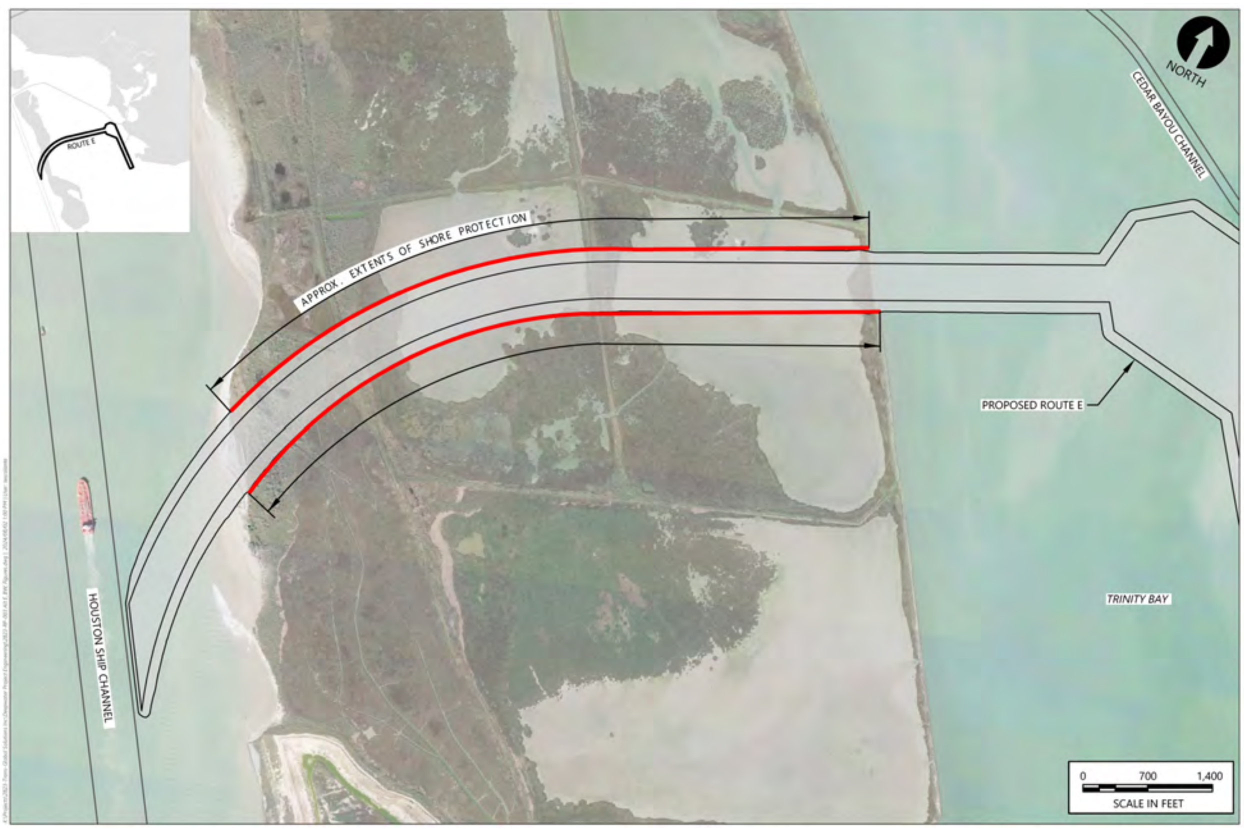
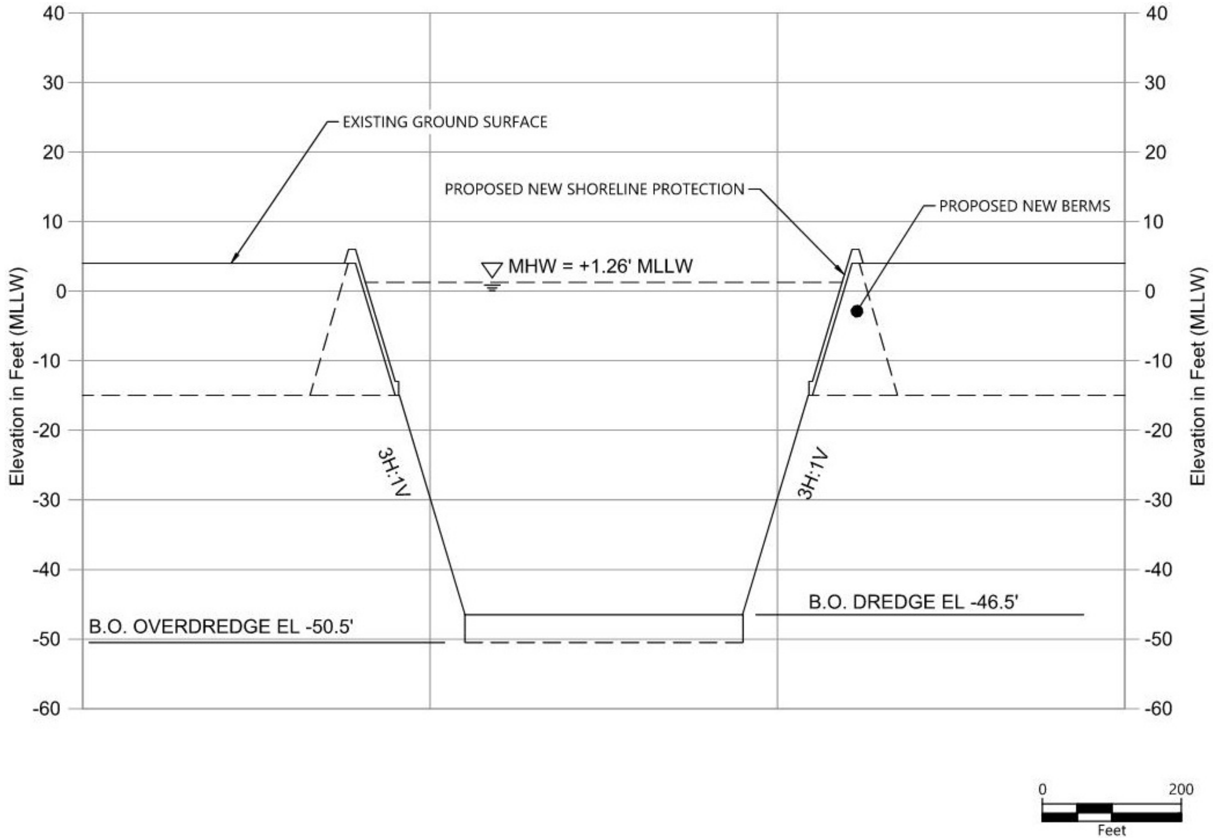


Figure 4
Cross Section of Alternative E through Atkinson Island and the beneficial use Cells



6.2 Breakwaters

Coastal modeling predicts vessel surges propagating to the north and south of Alternative E that will require protection of the shoreline. The breakwater design is expected to take the form of a rubble-mound structure or earthen berms with complete riprap covering designed to absorb the vessel wakes and surges and protect the shoreline from erosion. They are expected to be detached breakwaters roughly parallel to shore north of Alternative E and a potential jetty extending outward from the shore south of Alternative E. Breakwater dimensions, EL, and locations would be confirmed during PED to avoid existing pipelines and sensitive environmental sites. The general sizing for riprap in the breakwater design for the study is expected to be the same as the rock armoring on the side slopes of the channel. A breakwater north of Alternative E would be approximately 2.5 miles long, and the southern breakwater would be approximately 2,500 feet long.

6.3 Existing Dredged Material Placement Areas

Existing USACE DMPAs may be impacted by the proposed new channel's placement, resulting in reductions in the planned future capacity for holding maintenance dredged material. The containment levees for existing PAs impacted by the proposed new channel would be reconstructed as required to continue placement of dredged material. The proposed new beneficial use islands would have sufficient space to accommodate any losses incurred.

6.4 Aids to Navigation

ATONs would be required to delineate the proposed new channel's limits. The relocation or addition of ATONs in the HSC will be required. At the time this report was written, ATONs were being relocated as part of the HSC Project 11 widening. The current ATONs in Cedar Bayou are not expected to be affected by the proposed new turning basin.

The modification of existing ATONs and the placement of new ones to support the proposed new channel would be coordinated with the U.S. Coast Guard during PED.

7 Hazardous and Toxic Materials

A feasibility-level Hazardous, Toxic, and Radioactive Waste (HTRW) evaluation was completed for the study, including a records search, was conducted following the rules and guidance of ER 1165-2-132: HTRW Guidance for Civil Works Projects, and ASTM E1527-13: Standard Practice for Environmental Site Assessment: Phase 1 Environmental Site Assessment Process. No sites were identified that had recognized environmental conditions within the search radius that could impact the study.

Further, the feasibility-level sampling program indicated that throughout all nine elutriate, water, and sediment samples tested for this investigation, few analytes were detected, and those analytes that were detected primarily fell below the benchmark screening levels. The only benchmark exceeded was ammonia as nitrogen for three elutriate samples. This exceedance is short lived and will rapidly oxidize in well-oxygenated water. The results from the chemical analysis presented in this report do not indicate a cause for concern with the dredging or placement of sediment from these sample locations.

The HTRW Assessment is Appendix F.

8 Resiliency and Adaptability

Measures will be taken to ensure the infrastructure can adapt to the harsh marine environment susceptible to changing conditions associated with potential increases in SLR. The goal will be to increase the resiliency of the engineered structures to reduce maintenance and increase the life of the structures. The following items will be incorporated during PED:

- Utilize durable materials to increase the lifespan
- Wider base for levees and shoreline protection to accommodate future SLR and lessen disruptions
- Additional slope protection or channel modifications to reduce the likelihood of tug propwash
- Foundation capacity to accommodate future rise of levees

Levees, berms, and breakwaters will be designed and constructed with a wider foundation to support future height increases. The first phase of construction will disrupt a larger area but allows for all future work to be accomplished within the footprint, reduce potentially significant rework, and limit disruption outside the work area during any subsequent construction activities.

9 Construction

All alternatives include dredging and beneficially using the dredged material to build islands to create oyster, wetlands, and upland wildlife habitats supporting nature-based solutions to habitat protection and shoreline resiliency, in addition to shoreline protection features.

Dredged material would be placed in the following areas based on material type:

- Approved disposal in the Ocean Dredged Material Disposal Site
- Beneficial use islands
- Use of the material in future port infrastructure construction and development

The beneficial use islands would be designed with gentle slopes for oyster habitat, minimization of habitat impacts with low to high marsh, and would include additional area for a net increase in upland habitat. The beneficial use islands would also promote resiliency by protecting against storm surge and wave action. Future beneficial use islands are designed to accept the 50-year operation and maintenance (O&M) volumes for each alternative.

All construction phases are assumed to occur continuously and sequentially. That means one phase will immediately follow another, and no work would be expected to occur simultaneously. During PED, however, opportunities for efficiencies, such as simultaneous operations, would be analyzed and explored.

9.1 Dredging and Construction

In general, all the following construction phases are assumed to occur sequentially:

- The existing pipelines would be removed or relocated as required.
- The new navigational channel would be constructed using hydraulic and mechanical dredges supported by various tenders, boats, barges and scows.
- The dredged material would be disposed of at various sites depending on material type and capacity.
- All overburden material (fines and silts not useful in land creation) would be mechanically dredged and transported to the permitted ocean dredged material disposal site located on average, 30 miles to the south of the dredging sites.
- Structural clays and materials from hydraulic dredging would be used to support the levee construction at DMPAs being dredged through from passing vessel waves at DMPA 15, 16, or Atkinson Island.
- Hydraulic dredging would transport suitable material to future beneficial use sites for levee construction and beneficial use fill.
- Any remaining structural clays and material would be transported for use as fill at a future deep-draft terminal at the Cedar Port Industrial Park.

- The initial beneficial use site would be constructed in phases.
- The initial cell would be constructed using structural clays and material dredged from channel construction. At the time of channel construction, material would be transported hydraulically to the beneficial use sites. Material would be first used to build containment levees and then to fill the interior of site to the design ELs. The beneficial use levees would be built using marsh excavators and be designed so the exterior slopes have a gentle slope conducive to oyster recruitment for a range of ELs starting at the seafloor and extending upward. At the top of the range, the slope would increase up to the levee crest for wetland vegetation planting and establishment. The top of the beneficial use sites would be designed to support bird habitat.
- Future cells would be built in generally the same manner. Levees with gentle slopes would be built first, and maintenance dredged material would be used to fill the site. A second beneficial use island would differ in size depending on the amounts of materials available from future maintenance dredging.
- A second cell would be designed to include extra capacity available to replace any capacity lost by dredging through existing USACE PAs.
- Rock breakwaters and shoreline protection will be constructed as required.
- ATONs will be constructed, installed, and commissioned.

9.2 Expected Construction Operations

Dredging operations would occur 24 hours a day, 7 days a week. Disposal activities would also likely occur up to 24 hours per day, 7 days per week, to complete the study as quickly as possible. Upland operations associated with the cut through of PA 15, PA 16, and the beneficial use cells would occur 24 hours a day, 7 days a week. Construction of the breakwater, jetty, and revetment are assumed to occur 12 hours a day, 7 days a week.

Construction activities will be adjacent to the HSC and to the east within Trinity Bay. Impact to existing HSC vessel traffic will need to be carefully monitored during dredging and for modifications to the ATONs.

9.3 Best Management Practices

The development of suitable management controls to minimize impacts from dredging and construction would be developed during PED once the specifics related to channel geometry and material types expected for each segment have been formalized. Management controls can include both operational and structural techniques. Some examples of each are presented below.

9.3.1 Example Operational Controls

For hydraulic dredges, the following three fundamental controls are typically used: 1) reduce cutterhead rotation speed; 2) reduce swing speed; and 3) eliminate bank undercutting. Reducing cutterhead rotation speed reduces the potential for side casting the excavated sediment away from the suction entrance and resuspending sediment. This measure is typically effective only for maintenance or relatively loose, fine grain sediment. Reducing the swing speed ensures the dredge head does not move through the cut faster than it can hydraulically pump the sediment. Reducing swing speed reduces the volume of resuspended sediment. The goal is to swing the dredge head at a speed that allows as much of the disturbed sediment as possible to be removed with the hydraulic flow. Eliminating bank undercutting means that dredgers should remove the sediment in maximum lifts equal to 80% or less of the cutterhead diameter.

For mechanical dredges, the following three fundamental controls are also typically used: 1) increase cycle time; 2) eliminate multiple bites; and 3) eliminate bottom stockpiling. Increasing the cycle time for each grab of the bucket reduces the velocity of the ascending loaded bucket through the water column, which reduces potential to wash sediment from the bucket. However, limiting the velocity of the descending bucket reduces the volume of sediment picked up and requires more total bites to remove study material, so this practice must be balanced with target production rates. Eliminating multiple bites reduces resuspension because, when the clamshell bucket hits the bottom, an impact wave of suspended sediment travels along the bottom away from the dredge bucket. When the clamshell bucket takes multiple bites, the bucket loses sediment as it is reopened for subsequent bites. Sediment is also released higher in the water column as the bucket is raised, opened, and lowered. Eliminating bottom stockpiling of the dredged sediment in areas with silty sediment has a similar effect as multiple-bite dredging; an increased volume of sediment is released into the water column from the operation.

9.3.2 Example Structural Controls

Structural controls to minimize the loss of sediment during placement and potential impacts associated with equipment placement can include a variety of options. Cofferdams, Geotubes, and sheet piling can be used to create temporary barriers for settling basins during dike construction at the proposed beneficial use areas. These are then typically removed once the dikes have been formed and more natural settling areas are created. For areas not exposed to frequent wind and high currents, silt curtains can sometimes be used for this same purpose. Once settling areas have been constructed, operational techniques such as altering discharge rates, using diffusers and baffles to promote settling versus dispersion and minimizing placement activities during periods of high wind that tends to broadcast material over large areas.

Protection of habitat structures in the vicinity of the construction area can be facilitated by using techniques like floating pipelines in areas with sufficient water depth or using piling supports to keep the pipelines suspended so they do not damage underlying structures (e.g., oyster reefs or seagrass beds).

The following BMPs and construction controls would be included in the construction plans and specifications to ensure the study is completed in accordance with the design and applicable regulations: Additional BMPs would be added as applicable based on final designs and specifications during PED.

- Contractors would regularly inspect and maintain all mechanized equipment operated near surface waters to prevent contamination of surface waters from fuels, lubricants, hydraulic fluids, and other toxic materials. Noise generation during working hours would be managed whenever possible using mufflers and silencers on equipment. Booster pumps would be required to use a silencer around the pump.
- Proper construction oversight (e.g., daily site inspections of perimeter controls by the construction manager) would be used to ensure no negative impacts to adjacent water quality.
- Turbidity curtains would be used during beneficial use island construction for resuspension control. The turbidity curtains would consist of high-flow fabric with pyramid-type anchors to hold the curtains in place.
- Turbidity curtains would be constructed of materials in which sea turtles cannot become entangled. Turbidity curtains would remain in place only for the necessary period and would be removed once construction is complete.
- The following BMPs would be added to protect threatened and endangered species:
    - Study workers shall not harass or impact any marine mammals, waterfowl, or fish in the study area.
    - All study personnel would be instructed about the potential presence of threatened or endangered species. Personnel shall be made aware of the civil or criminal penalties for harming, harassing, or killing such species, which are protected by the Endangered Species Act (ESA) and Marine Mammal Protection Act.
    - Observations of threatened or endangered species would be recorded in a daily log and summarized at the end of the study. If species are observed by any on-site personnel in or adjacent to an active work area, work would be stopped and shift to another area until the species leave the work area of their own accord without harassment, consistent with U.S. Fish and Wildlife Service guidance and the ESA.
    - Prior to any proposed construction on Atkinson's Island, areas of higher marsh EL along the planned route would be surveyed for the presence of nests. If eastern black rail

nests are located and eggs are present, the U.S. Fish and Wildlife Service would be consulted to safely relocate the nest to another site of similar EL.

- If any artifact, or an unusual amount of bone, shell, or nonnative stone, is encountered during construction, work would be immediately stopped and relocated to another area. The contractor would stop construction within 10 meters (30 feet) of the exposure of these finds until a qualified archaeologist can be retained to evaluate the finds (36 *Code of Federal Regulations* 800.11.1 and 14 California Code of Regulations 15064.5[f]). If the resources are found to be significant, they would be avoided or mitigated for if avoidance is not possible. Mitigation would be developed in coordination with the State Historic Preservation Office and could include data recovery and interpretation of results for the public.

Additional BMPs would be added as applicable based on final designs and specifications during PED.

10 Operation and Maintenance

The O&M considerations are reported in the DMMP (Appendix D).

11 Conclusion

As noted, the purpose of this engineering report is to evaluate the feasibility and potential effects on the environment of constructing, operating, and maintaining a deep-draft channel between the HSC and Cedar Port Industrial Park, as presented in the draft Integrated FS/EIS based on the following objectives:

- To provide engineering data and analyses to sufficiently evaluate the alternatives under consideration
- To support the development of a study schedule and cost estimate for the preferred alternative

The NFS worked with the USACE Project Delivery Team (PDT) to identify alternatives, locate sources of information and field studies, and identify and gather additional information needed to reduce the risk and uncertainty commensurate with the FS/EIS. Key tasks for each engineering discipline were developed with the PDT and conducted in accordance with USACE guidelines and recommendations. The team worked with various stakeholders in an iterative process to perform the engineering to identify, develop, and evaluate the alternatives.

The coastal modeling and geotechnical analyses were used to inform the conceptual engineering design, which includes dredging a new deep-draft channel and providing shoreline protection, breakwaters, and using nature-based solutions for the beneficial use of the dredged material placement associated with the preferred alternative. No HTRW concerns were identified in the analysis for the feasibility study (draft Integrated FS/EIS; Appendix F).

The conceptual engineering design was used to inform the DMMP (draft Integrated FS/EIS; Appendix D), which presents the study's construction schedule based on regional sediment management practices. The DMMP integrates the dredging and dredged material placement needs for each alternative channel route analyzed and the conceptual 50-year DMMP with the placement needs associated with each route. The DMMP identifies the base plan placement needs for the new dredging work and the 50-year maintenance dredging needs for each alternative as documented in the draft Integrated FS/EIS. In addition, the 50-year O&M was analyzed for maintenance dredging frequency, capacity requirements, and costs for each route plan. The DMMP was used to develop preliminary costs, which were provided to USACE for cost engineering and are included in Appendix E.

11.1 Tentatively Selected Plan

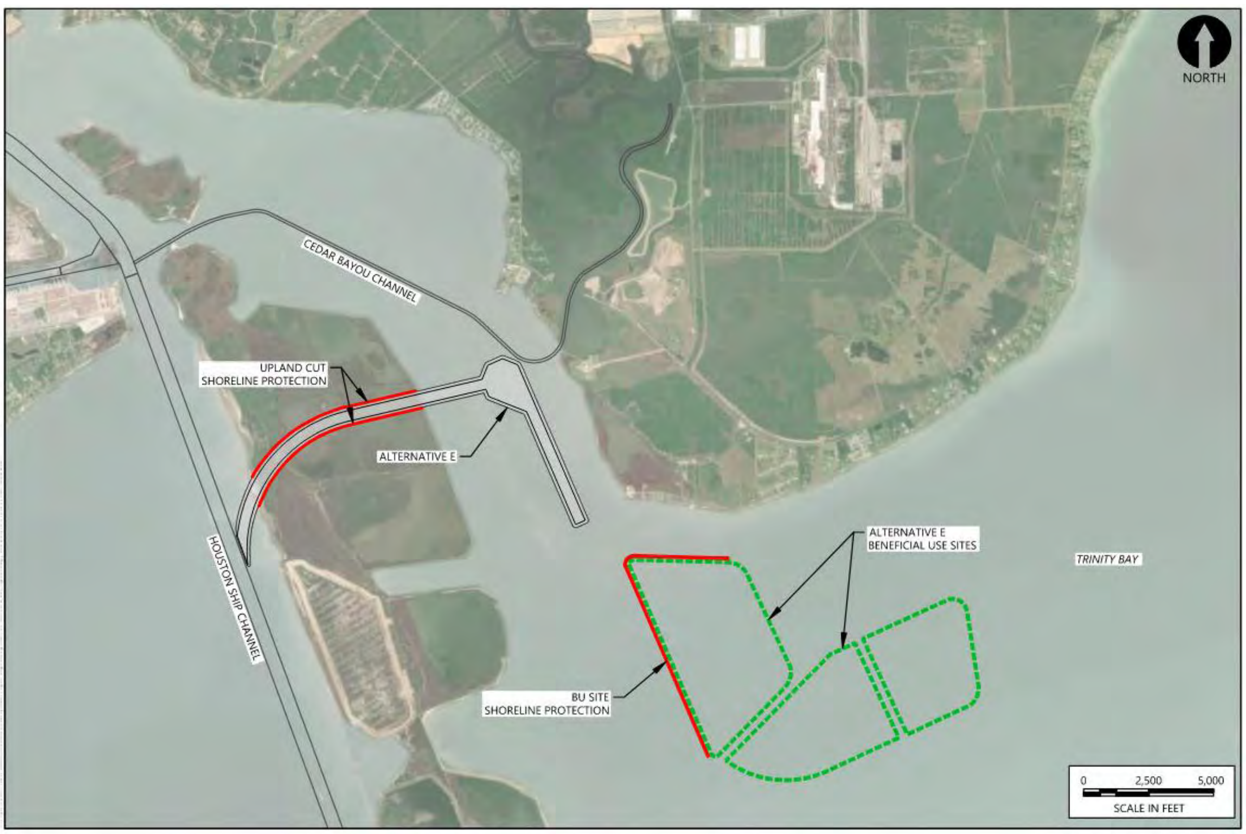
Based on the analysis prepared to support the draft Integrated FS/EIS, Alternative E, consisting of new in-water built infrastructure and nature-based solutions, is the TSP. The TSP would involve dredging a new 3.5-mile deep-draft channel through Atkinson Island to connect the HSC to

Cedar Port Industrial Park. As detailed in the DMMP, depending on its type, the dredged material would be placed in the offshore dredged material disposal site (silts and organics), used to build beneficial use islands, and used in future port infrastructure construction and development.

The proposed beneficial use island design promotes the beneficial use of dredged material to create oysters, wetlands, and upland wildlife habitats supporting nature-based solutions. The proposed beneficial use islands would have gentle slopes to provide oyster habitat and low to high marsh to minimize any habitat losses, plus additional area for a net increase in upland habitat. The proposed beneficial use islands would also promote coastal resiliency by protecting against some storm surge and wave action. Future beneficial use islands would be constructed to contain the 50-year O&M dredged material volumes for each of the alternatives and to provide additional capacity, if needed, for HSC dredged material displaced because of the cut through Atkinson Island.

Future design recommendations for the TSP are presented in Figure 5.

Figure 5
Future Design Recommendations for the TSP



The construction of the TSP would enable deep-draft vessels to access Cedar Port Industrial Port from the HSC and help reduce vessel congestion, increase safety in the upper HSC by providing an additional channel to accommodate projected vessel calls, and promote more efficient cargo movement at the Port of Houston and Cedar Port Industrial Park.

11.2 Pre-Construction Engineering Design

The feasibility-level engineering effort focused on reducing uncertainty for high-risk items in support of developing the cost and schedule with an appropriate contingency for planning purposes. Although all the engineering information and analyses presented in this report should be confirmed and further refined, the engineering team has noted the following key areas to focus on in the next phase of engineering to further define the scope of work and reduce uncertainty for the TSP: additional vessel simulations, additional geotechnical field data collection, breakwater design, detailed mapping and natural resource surveys, and mapping utilities and pipelines.

11.2.1 Channel Design

Additional vessel simulations will be run on Alternative E to identify ways to improve navigation safety, which may lead to potential design modifications. These include increasing the channel width and turning basin diameter, modifying the turn, and adding tugboat shelves for better maneuverability and vessel control (Attachment C-3). Potential increases in dredged material volume were considered during the CSRA and contingency planning in the feasibility study, as well as identified in the environmental analysis, but any modifications would need to be revisited during PED.

It is recommended to review the channel design with the stakeholders and conduct additional vessel simulations to optimize the channel design as soon as possible. Vessel simulations should also consider currents, winds, and vessel traffic at the junction with the HSC, although current Vessel Traffic Control could mitigate vessel traffic congestion. The design of the channel influences coastal modeling and environmental analyses, O&M, and the construction cost and schedule.

11.2.2 Subsurface Investigations

A substantial amount of geotechnical data have been collected and reviewed for a feasibility-level evaluation of the alternatives to increase confidence in the proposed plan cost and schedule for the TSP. Geotechnical information was obtained along the perimeter of the existing beneficial use area of Atkinson Island, but the interior could not be accessed. Historical boring logs from within the area were used for the preliminary evaluation. The placement of dredged material represents a large cost and contingency in the cost estimate to allow placement of the material in offshore PAs. This item also represents a large potential cost savings if the material can be placed at a beneficial use site or used in the terminal construction process instead of being placed in an ocean dredged material disposal site. In addition, more information is needed to design the levees, breakwaters, and shoreline protection in this area. Using beneficial use methods and Engineering with Nature practices could significantly reduce current and future O&M placement costs.

11.2.3 Breakwater Design

The location, length, and dimensions of the breakwaters will be determined during PED consistent with the resiliency and adaptability measures identified in this report. Real estate concerns, stakeholder input, additional resource surveys, geotechnical explorations, and coastal modeling will inform the design.

11.2.4 Detailed Mapping and Natural Resource Surveys

Detailed field surveys will be carried out on Atkinson Island to supplement and confirm the LiDAR information previously collected as well as any changes to the USACE PA 16 levees and interior volume. Bathymetric surveys will be needed at the breakwater locations once they are sited.

Additional natural resource surveys will be carried out to support the breakwater design and location(s), as well as to supplement existing surveys.

11.2.5 Verify Pipeline and Utility Locations

The location, size and type of utilities will be determined during PED. Subsurface utilities and pipelines should be mapped in the vicinity of the proposed new channel, breakwaters, beneficial use islands, and in areas expected to be traversed by water-based equipment during construction. Much of the area is relatively shallow and may require special equipment or additional dredging to facilitate construction.

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Attachment C-1
Geotechnical Field Results Investigations and Engineering Analysis

October 2024
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

Attachment C-1: Geotechnical Investigations and Engineering Analysis

Prepared for Cedar Port Navigation and Improvement District

October 2024
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

Attachment C-1: Geotechnical Investigations and Engineering Analysis

Prepared for
Cedar Port Navigation and Improvement District
2727 Allen Parkway, Suite 1100
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Project Number: 232823-01.01
https://anchorqea.sharepoint.com/sites/CPNDDeepwater-Portal/AQ Internal Documents/3. Draft FS_EIS/Appendix C Engineering Report/2. Appendix C-1 Geotechnical Analyis.docx

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

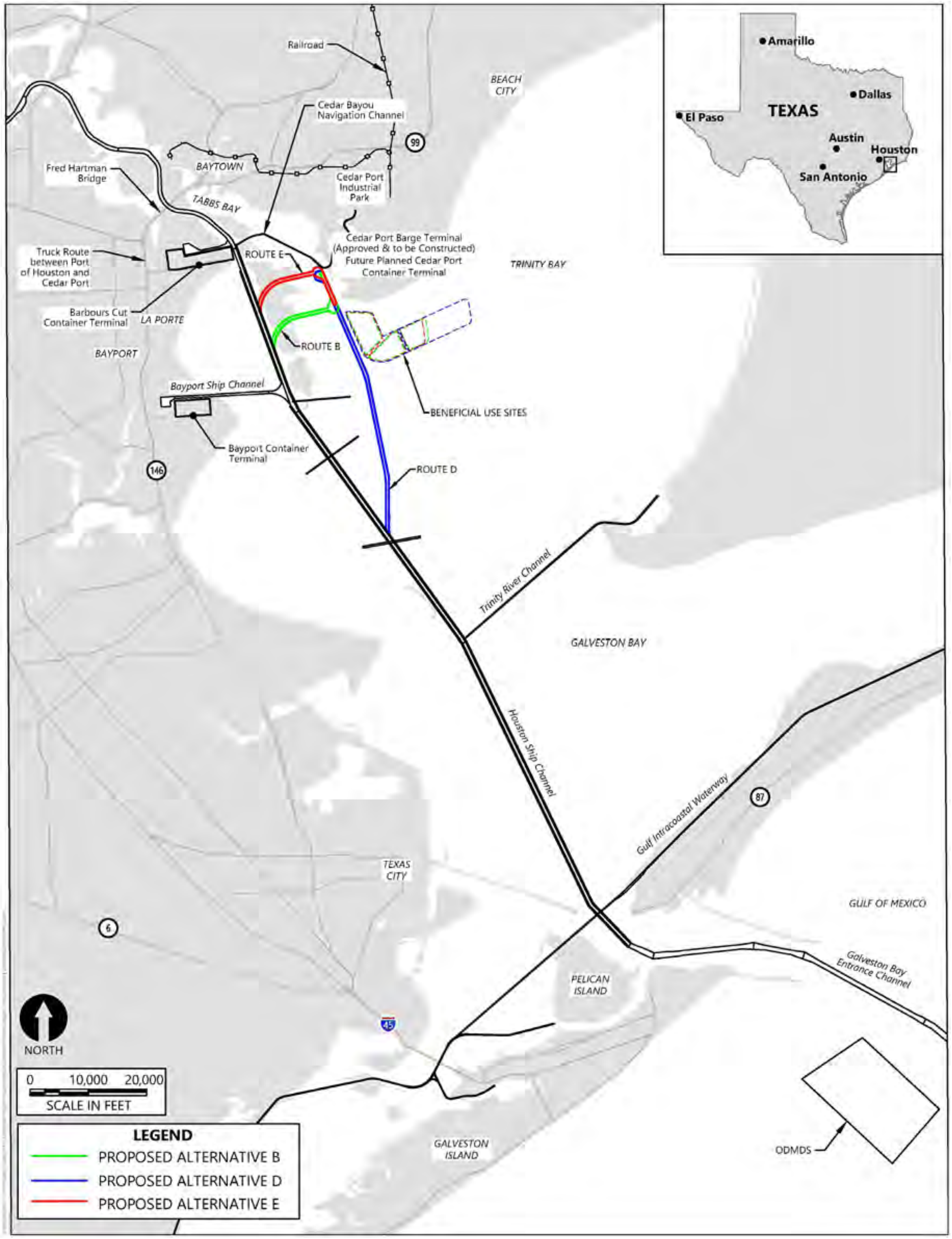
ABBREVIATIONS

ASTM	ASTM International
Cce	Modified Compression Index
CL/CH	stiff clay
CL/CH-ML	soft sediment
Ev	vertical strain
FOS	factor of safety
H:V	horizontal to vertical (ratio)
MC	moisture content
MLLW	mean lower low water
N/A	not applicable
psf	pound per square foot
SM	silty sand
SPT	standard penetration test
study	new terminal planned for the Cedar Port Industrial Park in Baytown, Texas
tsf	ton per square foot
USACE	U.S. Army Corps of Engineers

1 Introduction

This report documents a feasibility-level geotechnical engineering evaluation of various design elements and alternative routes for a new deep-draft federal navigation channel proposed by the Cedar Port Navigation and Improvement District to connect the Houston Ship Channel to a new terminal planned for the Cedar Port Industrial Park in Baytown, Texas. Various alternative routes were identified for the planned ship channel (Figure 1). Each alternative route is assumed to be excavated to a required elevation of -46.5 feet mean lower low water (MLLW), plus 2 feet of advance maintenance and another 2 feet of allowable overdepth, resulting in an expected final elevation of –50.5 feet MLLW.

Figure 1
Proposed Alternative Routes



The specific directive of this report is to assess and compare the subsurface material properties of the different soil units observed in the potential channel alignments and to develop engineering concepts for the following project features:

- Dredged channel side slopes
- Upland cut shoreline protection
- Construction of beneficial use sites
- Conceptual design for breakwaters

2 Site and Subsurface Conditions

The area for the new terminal planned for the Cedar Port Industrial Park in Baytown, Texas (study) lies entirely in the Galveston Bay area on the east side of the Atkinson Island marshes. This area is a 600 square mile estuary where fresh and saltwater mix. The water depth in this area is between 5 and 12 feet MLLW. The climate is humid subtropical, and the tidal change between mean higher high water and MLLW levels is roughly 1.3 feet (NOAA 2024).

2.1 Field Effort

The geotechnical evaluation described in this report was informed by geotechnical explorations conducted during different episodes as follows:

- In 2021, prior to Anchor QEA's involvement, a series of explorations was conducted as part of a different study along Cedar Bayou (Alternative A, the northernmost alternative route) by Tolunay-Wong Engineers. Ten overwater borings and three land borings were performed as part of this program and were documented in a geotechnical engineering report shown in Attachment 3 (TWE 2021).
- For this study, a new series of explorations was conducted between July 30 and August 6, 2023, and involved a series of barge-mounted overwater mud rotary borings advanced to a termination depth of 65 feet MLLW. These borings were focused on Alternatives B, C, and D.
- A final series of explorations was conducted from April 23 to 26, 2024, and focused on Alternative E and the beneficial use sites to collect more data to support soil classification in general and the evaluation of potential consolidation settlement more specifically. This report contains a synopsis of the field investigations, an explanation of the method of analysis used with the collected data, a discussion of the material properties of the soil, and geotechnical engineering evaluations applied to the different project elements. The results of these field efforts were used to inform conceptual design development for dredged channel design and other project features.

Attachment 1 presents the locations of the various geotechnical borings relative to different channel route alternatives.

Nine exploratory boring locations, labeled borings B-1 through B-9, were selected to characterize the existing subsurface conditions and conditions at the proposed channel depths. Four additional borings were collected later for other analysis. Attachment 2 presents the boring logs for all thirteen collected borings.

Borings were advanced to depths of -65 feet MLLW to obtain information through the entire planned dredging thickness and into the underlying materials. Soil samples were obtained at 2-foot depth intervals to 20 feet below the existing mudline and at 5-foot intervals thereafter to the full boring depths.

Most samples were collected using standard penetration test (SPT) methods in accordance with ASTM International (ASTM) D1586. Driving resistance of the split-barrel sampler and blow counts were recorded to provide information on sediment composition and strength. Samples resulting from SPT sampling were collected and placed in moisture-sealed containers for laboratory delivery.

In selected cases where fine-grained, cohesive soils were encountered, thin-walled sample tubes with a diameter of 2.5 to 3 inches were used in accordance with ASTM D1587 to obtain relatively undisturbed samples. Field strength measurements were obtained for such fine-grained materials using a pocket penetrometer or hand torvane device. Samples were appropriately placed in moisture-sealed containers for transport to the laboratory.

2.2 Laboratory Analysis

Geotechnical laboratory analyses were completed for selected samples obtained from the borings and are compiled in Attachment B. The performed are listed in Table 1.

Table 1
Geotechnical Laboratory Analyses Performed

Test	ASTM Standard
Particle Size Analysis	D422
Particle-Size Distribution of Fine-Grained Soils with Hydrometer	D7928
Moisture Content	D2216
Atterberg Limits (Liquid Limit, Plastic Limit, and Plasticity Index)	D4318
Bulk Density, Unit Weight	D7263
Standard Proctor Compaction	D698
Unconfined Compression	D2166
Unconsolidated undrained triaxial strength	D2850

These results, along with the boring logs from the 2023 field investigations, were used to develop soil parameters used in this geotechnical evaluation. The stability parameters of soil units were determined through the evaluation of available soil strength data consistent with methods described in *Principles of Geotechnical Engineering* (Das 2006). Effective friction angles were determined through typical correlations to corrected split-spoon sampler blow counts. Cohesion of the fine-grained material was determined by referencing correlations from laboratory strength testing data from Shelby tubes collected during the 2023 field activity (NAVFAC 2022).

2.3 Review of Subsurface Materials Encountered

Subsurface materials found in the overwater borings and confirmed through laboratory testing can be grouped into the following three units:

- **Soft Sediment (CL/CH-ML):** The soft sediment unit is a surficial unit across all borings that varies in thickness. This unit has the highest dredge-ability and could indicate a good channel alignment based on its thickness increasing. This unit ranged from 2 (at boring B-9) to 15 feet thick (at boring B-1) and was characterized by an SPT N value of effectively zero—the split-spoon sample penetrated fully under weight of hammer and rod. The material is generally characterized as fine grained, ranging from clay to silt with sand material. This unit is very soft and has a high average moisture content (MC) of 75%.
- **Silty Sand (SM):** This sand unit was encountered in all borings, ranging from 2 to 30 feet thick. This unit tended to be shallower (nearer to the surface) and thicker toward the north and east. The presence of an island system to the east, the nearby shore to the north, and shell samples observed throughout suggest that this unit is a prehistoric beach buried under clay brought in by the more modern depositional environment. This unit ranges from loose to dense, with SPT N value blow counts from zero to 40 depending on depth and thickness. The nearer surface and thinner units had lower blow counts. The average MC of this unit was 25%.
- **Stiff Clay (CL/CH):** The clay unit was also observed in all the borings. There were a variety of fat versus lean samples in different borings, but the general material properties are assumed in this case to align based on the laboratory data. The clay unit ranges from medium stiff to very stiff. No SPT samples were collected in this unit because Shelby tubes were used to collect undisturbed samples for laboratory testing. In-field index testing of compressive strength (using a pocket penetrometer) indicated values ranging from 0.9 to more than 4 tons per square foot (tsf), and the triaxial tests and unconfined compression tests in this unit suggest an undrained strength of 1,000 pounds per square foot (psf), which increases linearly at a rate of 20 psf per foot. This means that at 100 feet of layer thickness, the undrained strength, or cohesion, at the base of the layer would be 3,000 psf or 1.5 tsf. This unit was generally the deepest, although in one boring, B5, the deepest unit was the SM unit.

3 Selected Geotechnical Parameters

Laboratory testing data and boring logs from the 2023 field investigations were used to develop soil unit weight and strength parameters for the geotechnical evaluation. Unit weights were determined consistent with methods described in Das (2006). Effective friction angles were determined through typical correlations to corrected split-spoon sampler blow counts. Cohesion of the fine-grained material was determined by referencing correlations from laboratory strength testing data from Shelby tubes collected during the 2023 field activity (NAVFAC 2022).

The values that were developed and used for the geotechnical engineering analyses are summarized in Table 2.

Table 2
Estimated Soil Parameters for Soil Units

Soil Unit	Material Description	Source	Total Unit Weight (pcf)	Undrained Strength Analysis	Drained Strength Analysis		Consolidation Properties
				Cohesion (psf)	Internal Friction Angle	Ev	Cce
CL/CH-ML	Clay and silt with sand	In situ	115	Su[1] = 250 + 18*z	26°	N/A	0.074
CL/CH	Sandy, silty clay	In situ	120	Su[1] = 1,000 + 20*z	34°	1.9%	N/A
SM	Silty sand	In situ	130	N/A	32°	N/A	N/A

Note:

1. Su is undrained shear strength. In this case, "z" is depth from top of layer in feet. This equation identifies the soil unit strength as a function of its thickness.

Three hypothetical soil profiles were developed for Slide2 analysis based on the results of borings and laboratory tests. This set of three soil profiles is intended to mimic several representative soil scenarios across all the proposed channel alignments. They do not specifically correspond to alternative channel routes since the study area is so large relative to the number of borings performed. Hypothetical profile 1 is based largely on Boring B3. Hypothetical profile 2 is based largely on B2, and hypothetical profile 3 is based largely on B5. Data from other borings were also considered in developing these hypothetical profiles to normalize them for application across the site because they are intended to mimic several representative soil scenarios across all the proposed channel alignments.

General properties of the hypothetical profiles are shown in Table 3.

Table 3
Selected Properties for Hypothetical Soil Profiles

Property	Hypothetical Profile 1	Hypothetical Profile 2	Hypothetical Profile 3
CL/CH-ML	15 feet thick	0–2 feet	0–35 feet
SM	N/A	2–11 and 35–41 feet	35–57 feet
CL/CH	To depth	11–35 and below 41 feet	Below 57 feet

Note:

1. The selected layer thicknesses presented here do not necessarily correspond to specific boring logs; rather, they have been selected to be generally representative of several borings and locations at once.

4 Geotechnical Engineering Analyses and Conceptual Design Recommendations

4.1 Channel Dredging Side Slopes

Slope stability was modeled using commercial software (Slide2; Rocscience 2021; referred to here as the Slide analysis), which uses limit equilibrium methods of analysis to determine the factor of safety (FOS) for stability of excavated side-slope angles for the dredged channel. The model assumes the anticipated sliding mass remains rigid (i.e., nondeformable) and the soil strength along the slip plane is fully mobilized at failure. This method is intended to provide a reasonable indication of the overall stability of a slope and is the standard of practice for these types of engineering evaluations. Circular and noncircular (wedge-shaped) failure planes were evaluated using methods of calculating slices outlined in Morgenstern and Price (1965) and Spencer (1967).

4.1.1 Results of Slope Stability (Slide) Analyses

The Slide analyses were designed to test several different scenarios across the channel alignments and assess the viability of possible side-slope inclinations: 2 horizontal to 1 vertical (2H:1V), 2.5H:1V, and 3H:1V. Both drained and undrained cases were assessed, representing different possible modes of slope stability, and three different soil profiles were selected based on their potential to be the "worst case" for slope stability. This assessment was based on unit soil parameters and relative thicknesses at depth for the borings collected on site.

Table 4 lists the results of the analyses. The typical recommended target FOS for engineered slopes is 1.3 for short-term (undrained) conditions and 1.5 for long-term (drained) conditions (USACE 2003).

Table 4
Summary of Factors of Safety Determined for Different Soil Profiles and Slope Angles

Slope Stability Results	2H:1V Case		2.5H:1V Case		3H:1V Case	
	Drained	**Undrained**	**Drained**	**Undrained**	**Drained**	**Undrained**
Soil Profile 1	1.4	4.6	1.7	5.2	2	5.7
Soil Profile 2	1.4	2.5	1.7	2.8	2	3.2
Soil Profile 3	1.1	1.9	1.3	2.1	1.5	2.4

Note:
FOS values below the target are shown in red.

These results show that a slope of 3H:1V is appropriate for the conceptual design of the dredged channels. There is a possibility that a benching system could allow the use of a 2.5H:1V slope, but this was not analyzed because it would result in increased costs for dredging a benched slope. The results show that the thickness of the soft material near the surface dictates the overall stability of the slope. Soft to very soft material was observed in some borings to be 15 feet thick—in some cases, 35 feet or thicker. It is these cases where the sidewalls cannot support a 2.5H:1V or 2H:1V slope. This slope angle would reduce the total construction time, reduce the total volume of material removed, and stop or reduce sloughing into the central channel, allowing it to function longer.

4.1.2 Construction of Berm Slopes by Direct Placement

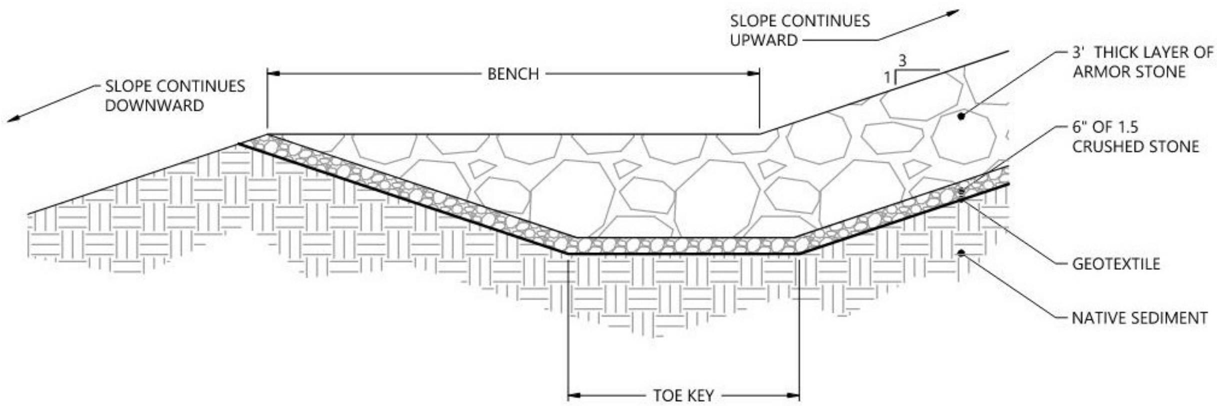
A different slope stability situation would apply to slopes built above the water surface using the self-consolidating, direct placement method because this method results in a variable slope angle as the material assumes its natural angle of repose upon being laid down loosely. The slope angle for berms constructed using this method is highly dependent on the water content of the material placed, the plasticity of the material, remolding of the competent clays, and the method of dredging. Overall, it is expected that a slope flatter than 3H:1V would be formed, so some cutting back would be necessary if a 3H:1V berm side-slope geometry is desired.

4.2 Upland Cut Shoreline Protection

Shoreline protection will be needed along sides of the channel cut through Atkinson Island, where slope faces have the potential to be impacted significantly by waves and passing vessel wakes. The most appropriate and constructable form of shoreline protection will be rock riprap, and an appropriate riprap gradation is expected to have 50% to 100% of the stones weighing more than 1,500 pounds (similar to U.S. Army Corps of Engineers [USACE] Gradation R-1500) and an overall layer thickness of 3 feet. Further engineering design phases will refine this expectation using standard of practice methods for riprap sizing based on bottom velocity, winds, waves, and other factors in the expected impact zones.

The down-slope extent that the riprap reaches will depend on the nature and extent of disturbances from waves, currents, vessel wakes, and prop wash. In some cases, it is likely that the riprap armoring on the slope will not need to extend to the full depth of the dredge channel. When this is the case, an approximately 5-foot-wide bench and toe key will be constructed in the slope to provide stability at the base of the placed riprap layer. Riprap would be underlain by a layer of appropriate filtering material (gravel) or a layer of geosynthetic fabric. A typical cross section for the base of the riprap shoreline protection layer is shown in Figure 2.

Figure 2
Detail at Base of Shoreline Protection Layer



4.3 Construction of Beneficial Use Sites

This section discusses geotechnical engineering considerations related to the design and construction of perimeter berms and interior fills for beneficial use sites. The primary concern of design at this stage centers on an estimate of the settlement expected in the area of the beneficial use site berms and how that settlement relates to the increase in potential import costs during construction. This section discusses general construction expectations and conceptual design parameters for the beneficial use berms, with the understanding that the overall design and construction plan is subject to change during further design stages.

An appropriate berm crest elevation and width are described in the Dredge Material Management Plan (Appendix D) section 4.3.2. Appropriate side-slope angles are no steeper than 3H:1V. Shallower slope angles may be more realistic for the reasons discussed in Section 4.1 because the properties of the placed material, the dredging methods, and the staging have yet to be finalized—all of which can greatly affect the final slope angle of a berm. If constructed using the self-consolidation method resulting in a relatively flat berm, some cutting back would likely be needed to achieve a steeper inclination.

The settlement of the consolidation layer of soil below the beneficial use berms was calculated to be between 3 and 8 inches based on the consolidation test data collected during the second investigation conducted by Anchor QEA on the site and on standard settlement estimation methods (Holts and Kovacs 1981). These values are subject to change as more data are collected in future design phases.

The amount of material pumped into the interior of the beneficial use site as slurry and contained by the berm is expected to be significantly greater than the amount of settlement estimated for the perimeter berm because the slurry will be a mixture of solids and water. Based on conversations with the USACE Dredge Material Management group in Galveston, the maintenance materials will result in 0.7 cubic yard of placed material for every cubic yard of dredged material. This settlement was not estimated during this feasibility phase of the work but will be developed as part of later design efforts.

4.3.1 Breakwater Design

This section discusses geotechnical engineering considerations related to the design and construction of breakwater structures. Breakwater concept designs expected are expected to take the form of detached breakwaters roughly parallel to shore and a potential jetty extending outward from the shore. Detached breakwaters are generally smaller, relatively short breakwaters or earthen berms with complete riprap covering designed to reduce beach erosion. Generally, they are built parallel to the shore or earthen structure that wave action could erode, and they act as a barrier to erosion-causing waves from storms, tides, or boat activity. Detached breakwaters are often built as rubble-mound structures with low crest elevations that can be overtopped during storms. A series of detached breakwaters is sometimes used to mitigate erosion, with the breakwaters getting smaller and closer to shore as they move "down" the coast relative to high wave action.

The expected crest width and elevation of breakwaters are described in the Engineering Report. The general sizing for riprap in the breakwater design can be the same as that for upland cut shoreline protection along channel side slopes. The stone selection can consist of a single gradation, with a 16-ounce geotextile paired with a geogrid beneath to function as a base filter layer.

Construction is expected to be completed with hydraulically placed soil, followed by stone placed by a "lightering" technique in which material is moved from larger barges to smaller barges with less draft to get into the shallow waters. The concepts described here are consistent with USACE (2011) coastal engineering guidance.

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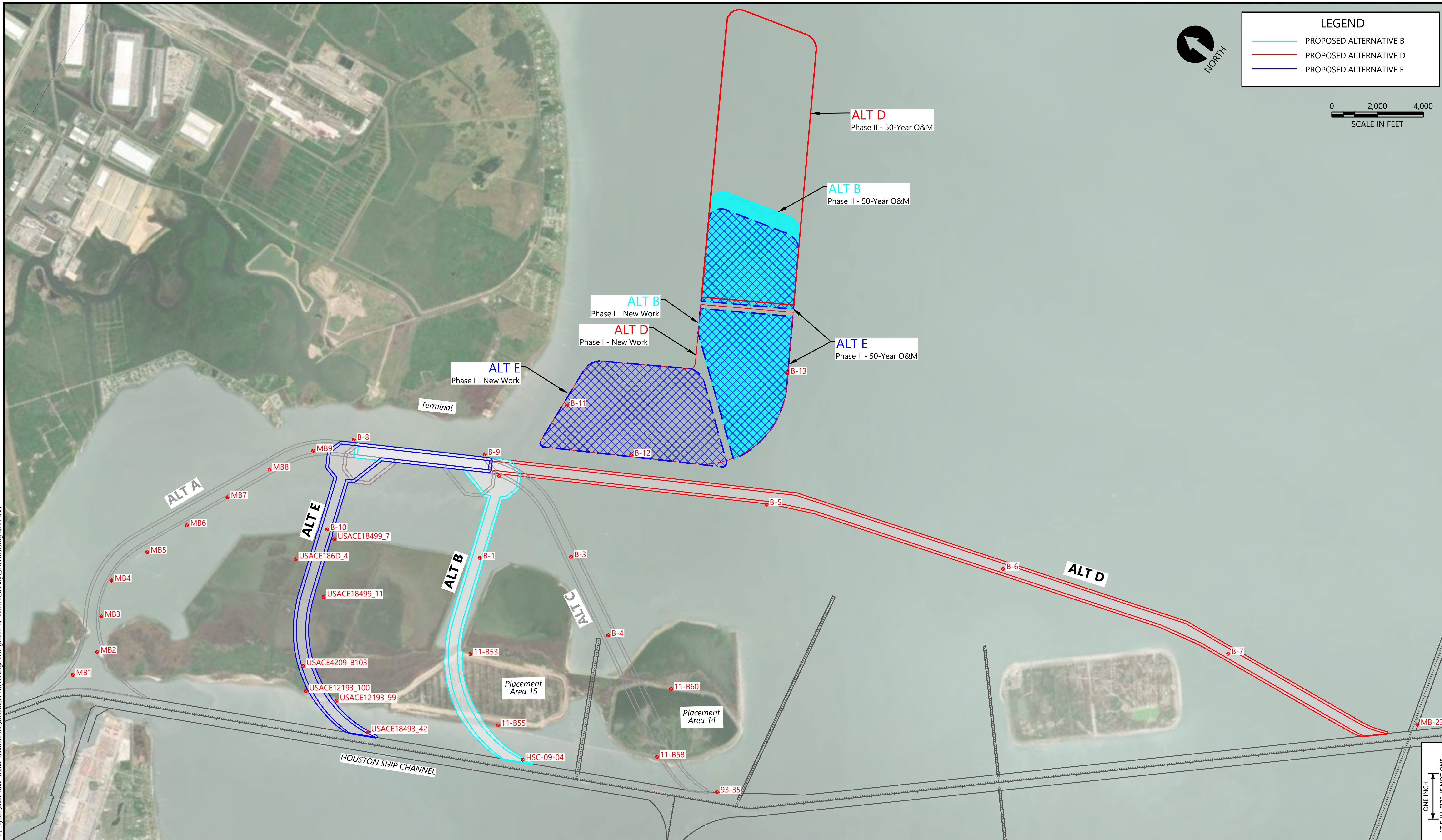
Attachment 1
Boring Locations Map



K:\Projects\2823-Trans-Global Solutions Inc\Deepwater Project Engineering\2823-RP-006 Alts_Borings_Overview.dwg SITE PLAN

Aug 20, 2024 10:36am sescalante

ANCHOR QEA

REVISIONS

REV	DATE	BY	APP'D	DESCRIPTION
	8/20/24			FOR REFERENCE ONLY

DESIGNED BY: J.FISHER
DRAWN BY: S.ESCALANTE
CHECKED BY:
APPROVED BY:
SCALE: AS NOTED
DATE: 8/20/24

CPNID DEEPWATER PROJECT
DREDGED MATERIAL MANAGEMENT

ALTERNATIVES OVERVIEW - BORING LOCATIONS

SHEET # 1 OF 1

Attachment 2

Boring Logs for 2023/2024

LOG OF BORING B-1

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 39' 02.53" W 94° 56' 24.69"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
Water												
Very soft gray SANDY FAT CLAY (CH)		WOR/ 18"		90								
-w/ shell fragments @ 7.5'-9'		WOR/ 18"										
		WOR/ 18"		51								
		WOR/ 18"		48								
		WOR/ 18"		30								
		WOR/ 18"		35								
		WOR/ 18"		43							64	
		WOR/ 18"		48								
		WOR/ 18"										
		WOR/ 18"		43								
		WOH/ 18"		74		80	45					
-firm & w/ organic @ 33.5'-35'	(P)0.75			80	40				*			CU

ELEVATION (FT) / DEPTH (FT): 0, -5 / 5, -10 / 10, -15 / 15, -20 / 20, -25 / 25, -30 / 30, -35 / 35

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 8/6/2023
DATE BORING COMPLETED: 8/6/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-1

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 39' 02.53" W 94° 56' 24.69"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-35	35	Stiff gray SANDY FAT CLAY (CH)												
			(P)1.75			32	91			1.11	15			
-40	40													
		Very stiff gray LEAN CLAY (CL) w/ ferrous nodules	(P)3.25			19	111	39	21	2.32	10			
-45	45													
			(P)3.00			21	109				*		95	CU
-50	50													
		Loose gray SILTY SAND (SM) w/ organic		10/6" 6/6" 4/6"		18								
-55	55													
		-medium dense @ 58.5'-60'		9/6" 13/6" 13/6"		24								
-60	60													
		-dense @ 63.5'-65'		14/6" 15/6" 25/6"		22								
-65	65	Bottom @ 65'												
-70	70													

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 8/6/2023
DATE BORING COMPLETED: 8/6/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-2

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 39' 11.75" W 94° 55' 44.27"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
0	0	Water												
-5	5													
		Very soft gray FAT CLAY (CH)		WOR/ 18"		35								
		Very loose gray SILTY SAND (SM)		2/6" 1/6" 2/6"		25		0	NP				23	
-10	10			WOH/ 18"		24								
				WOR/ 18"										
-15	15	-w/ clay pockets @ 14.5'-16'		3/6" 0/6" 1/6"		25								
		Very soft gray FAT CLAY (CH) -w/ shell fragments @ 16.5'-18'		WOR/ 18"		45								
				WOR/ 18"		55								
-20	20	-w/ shell fragments @ 20.5'-22'		WOR/ 18"		60								
				WOR/ 18"		61		70	41				96	
		-stiff @ 24'-26'	(P)1.00			51	71			0.54	4 *			
-25	25													
		-firm @ 28'-30'	(P)0.75			58	66				*			CU
-30	30													
		Very soft gray SANDY LEAN CLAY (CL) w/ clay pockets		0/6" 2/6"		60								
-35	35													

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/7/2023
DATE BORING COMPLETED: 8/8/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-2

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 39' 11.75" W 94° 55' 44.27"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT)	DEPTH (FT)	SAMPLE TYPE	SYMBOL	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-35	35			Very soft gray SANDY LEAN CLAY (CL) w/ clay pockets		0/6"										
				Very loose gray SILTY SAND (SM) w/ clay pockets		1/6" 2/6" 1/6"										
-40	40															
						2/6" 0/6" 2/6"		46								
-45	45															
				Stiff gray FAT CLAY (CH) w/ sand pockets		0/6" 4/6" 5/6"		24								
-50	50															
				-w/ gravel @ 53.5'-55'		0/6" 4/6" 6/6"		39								
-55	55															
				Dense gray SILTY SAND (SM)		10/6" 16/6" 20/6"		18								
-60	60															
				-very dense, w/ rocks @ 63.5'-65'		9/6" 26/6" 33/6"		18								
-65	65															
				Hard gray & brown FAT CLAY (CH)	(P)4.50+			30		67	41					
-70	70															

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/7/2023
DATE BORING COMPLETED: 8/8/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-2

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 39' 11.75" W 94° 55' 44.27"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		Hard gray & brown FAT CLAY (CH)												
		-w/ ferrous nodules @ 73'-75'	(P)4.50+			18	116			4.52	8	25		
-75	75													
		-slickensided @ 78'-80'	(P)4.50+			19	113							
-80	80													
		Very stiff gray & brown SANDY LEAN CLAY (CL)	(P)3.25			20								
-85	85													
		Very stiff brown FAT CLAY (CH)		7/6" 13/6" 7/6"										
-90	90													
		-hard & gray @ 93'-95'	(P)4.50+			23	104			3.07	3			
-95	95													
		Hard gray LEAN CLAY (CL) w/ sand pockets	(P)4.50+			18	113							
-100	100													
			(P)4.00			17		42	23					
-105	105													

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/7/2023
DATE BORING COMPLETED: 8/8/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-2

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 39' 11.75" W 94° 55' 44.27"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		Hard gray & brown LEAN CLAY (CL)												
		-brown @ 108'-115' -slickensided @ 108'-110'	(P)4.50+			25	102			1.64	2 *			
-110	110													
			(P)4.50+			21	109							
-115	115													
		Very dense blue SILTY CLAYEY SAND (SC-SM) w/ sand lens		8/6" 24/6" 28/6"		23								
-120	120													
		Hard brown FAT CLAY (CH)	(P)4.50+			21	104							
-125	125													
		-very stiff & gray @ 128'-150' -w/ sand seams @ 128'-140'	(P)3.50			27		59	30	2.09	3			
-130	130													
			(P)3.50			28	95							
-135	135													
			(P)3.50											
-140	140													

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/7/2023
DATE BORING COMPLETED: 8/8/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-2

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 39' 11.75" W 94° 55' 44.27"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		Very stiff gray FAT CLAY (CH)												
			(P)3.25			43	77							
-145	145													
			(P)3.50											
-150	150	Bottom @ 150'												
-155	155													
-160	160													
-165	165													
-170	170													
-175	175													

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/7/2023
DATE BORING COMPLETED: 8/8/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

LOG OF BORING B-3

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc, Houston, TX

COORDINATES: N 29° 38' 27.81" W 94° 56' 02.95"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
0	0	WATER												
		Very soft gray FAT CLAY (CH)		WOR/ 18"		53								
				WOR/ 18'		48								
		Very soft gray SANDY LEAN CLAY (CL) w/ shell fragments		WOH/ 18"		25								
				WOR/ 18"										
				WOR/ 18"		23		33	15					
		Very loose gray SILTY SAND (SM)		WOR/ 18"		22								
				WOR/ 18"		23								
		-w/ clay pockets @ 22.5'-24'		0/6" 0/6" 1/6"		21								
		Firm brown FAT CLAY (CH)		0/6" 2/6" 5/6"		41		65	39					
		-stiff @ 26.5'-28'		3/6" 3/6" 7/6"		32								
		Loose gray SILTY SAND (SM) w/ shell fragments		4/6" 1/6" 0/6"		21							12	
		Hard gray FAT CLAY (CH) slickensided & w/ ferrous nodules	(P)4.50+			36	86	63	40					CU
-35	35													

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 8/5/2023
DATE BORING COMPLETED: 8/5/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

LOG OF BORING B-3

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 38' 27.81" W 94° 56' 02.95"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-35	35	Hard gray FAT CLAY (CH) slickensided & w/ ferrous nodules												
		Very stiff gray SANDY LEAN CLAY (CL)	(P)3.00			27	99			0.70	6			
-40	40													
				7/6" 8/6" 12/6"		24								
-45	45													
		-w/ sand lens @ 48.5'-50'		8/6" 11/6" 9/6"		25							66	
-50	50													
		Dense gray SILTY SAND (SM)		6/6" 13/6" 17/6"		29								
-55	55													
				8/6" 13/6" 22/6"										
-60	60													
				13/6" 15/6" 24/6"		22								
-65	65	Bottom @ 65'												
-70	70													

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 8/5/2023
DATE BORING COMPLETED: 8/5/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

LOG OF BORING B-4

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 37' 57.67" W 94° 56' 28.78"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
0	0	WATER												
-5	5													
		Very soft gray & light brown SANDY LEAN CLAY (CL) w/ silt pockets		WOR/ 18"		82								
				WOR/ 18"		92								
-10	10													
		-w/ sand pockets & shell fragments @ 10.5'-14'		WOR/ 18"		35								
				WOR/ 18"		35								
-15	15			WOR/ 18"		30								
				WOR/ 18"		45								
		-w/ sand pockets & shell fragments @ 18.5'-20'		WOR/ 18"				49	23				61	
-20	20			WOR/ 18"		60								
		-w/ shell fragments @ 22.5'-24'		WOR/ 18"		71								
		-w/ ferrous stains & sand pockets @ 24'-26'	(P)0.50			64	59							CU
-25	25													
		Very loose gray SANDY SILT (ML) -w/ clay pockets @ 28.5'-40'		1/6" WOH/ 6" WOH/ 6"		32								
-30	30													
				WOH/ 18"				31	7				59	
-35	35													

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 8/12/2023
DATE BORING COMPLETED: 8/12/2023
LOGGER: J. Sparks/Charlie
PROJECT NO.: 23.14.175

NOTES: 75 ft from original coordinates.
SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-4

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc, Houston, TX

COORDINATES: N 29° 37' 57.67" W 94° 56' 28.78"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-35	35	Loose gray SILTY SAND (SM)												
		-becomes light gray @ 38.5'-55'		4/6" 1/6" 4/6"		23								
-40	40													
		-medium dense @ 43.5'-45'		4/6" 6/6" 12/6"		22								
-45	45													
		-dense @ 48.5'-50'		10/6" 16/6" 26/6"		21								
-50	50													
		-loose & w/ clay pockets @ 53.5'-55'		6/6" 3/6" 5/6"		35								
-55	55													
		Very stiff gray FAT CLAY (CH) w/ ferrous stains, calcareous nodules & shell fragments	(P)2.75			35 35	87 85			1.24	2 * *			CU
-60	60													
		Medium dense light gray SILTY SAND (SM) w/ clay pockets		8/6" 12/6" 15/6"										
-65	65	Bottom @ 65'												
-70	70													

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 8/12/2023
DATE BORING COMPLETED: 8/12/2023
LOGGER: J. Sparks/Charlie
PROJECT NO.: 23.14.175

NOTES: 75 ft from original coordinates.
SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

LOG OF BORING B-5

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 37' 23.63" W 94° 54' 54.80"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
0	0	WATER												
-5	5													
-10	10	Very loose gray SILT W/ SAND (ML)		WOR/ 18"		71								
		-w/ shell fragments @ 12.5'-22'		WOR/ 18"		53								
-15	15			WOR/ 18"		55								
				WOR/ 18"		45								
				WOR/ 18"		50								
-20	20													
				WOR/ 18"				0	NP				79	
				WOR/ 18"		57								
-25	25			WOR/ 18"		78								
		Firm gray ORGANIC CLAY (OH)	(P)0.75			55	69							CU
		-very soft @ 28.5'-35'		WOR/ 18"		96								
-30	30													
				WOH/ 18"				118	65				95	
-35	35													

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 8/2/2023
DATE BORING COMPLETED: 8/5/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

LOG OF BORING B-5

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc, Houston, TX

COORDINATES: N 29° 37' 23.63" W 94° 54' 54.80"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-35	35	Very soft gray ORGANIC CLAY (OH)												
		Loose gray SILTY SAND (SM) -w/ gravel @ 38.5'-50'		0/6" 3/6" 5/6"		53								
-40	40													
		-very loose @ 43.5'-45'		1/6" 1/6" 0/6"		20								
-45	45													
				1/6" 3/6" 2/6"		22								
-50	50													
		-very loose @ 53.5'-55'		1/6" 1/6" 2/6"		16								
-55	55													
		-medium dense @ 58.5'-60'		6/6" 7/6" 8/6"		22								
-60	60													
		Bottom @ 65'		2/6" 2/6" 2/6"		18								
-65	65													
-70	70													

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 8/2/2023
DATE BORING COMPLETED: 8/5/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-6

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 35' 40.00" W 94° 54' 28.04"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
0	0	WATER												
-10	10	Very soft gray FAT CLAY W/ SAND (CH)		WOR/ 18"		81								
				WOR/ 18"				53	33				78	
		-very stiff & w/ shell fragments @ 14'-18' -becomes brown @ 14'-35'	(P)2.00			33	91				*			CU
			(P)3.50			29								
		-firm @ 18.5'-20'		1/6" 3/6" 4/6"		29								
-20	20	-very stiff @ 20'-24'	(P)3.25			26	97			2.25	4			
			(P)2.50			31								
		-hard @ 24'-26'	(P)4.00											
		-very stiff @ 26'-30'	(P)3.00			28	94			0.67	1 *			
			(P)2.75			37								
			(P)3.75			31								
-35	35													

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 8/1/2023
DATE BORING COMPLETED: 8/2/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-6

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 35' 40.00" W 94° 54' 28.04"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-35	35	Very stiff gray FAT CLAY (CH)												
		-w/ shell fragments @ 38'-40'	(P)2.50			39	83			1.31	3			
-40	40													
			(P)2.50			39	82	86	47				100	
-45	45													
			(P)2.25			36								
-50	50													
			(P)3.00			33	91							CU
-55	55													
		Stiff gray SANDY LEAN CLAY (CL)		3/6" 5/6" 4/6"		24								
-60	60													
		Medium dense gray SILTY SAND (SM)		7/6" 8/6" 8/6"		27								
-65	65	Bottom @ 65'												
-70	70													

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 8/1/2023
DATE BORING COMPLETED: 8/2/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

LOG OF BORING B-7

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 33' 56.70" W 94° 54' 13.00"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: 0' to 65'
Air Bored: to
Wash Bored: to

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
0	0	WATER												
-10	10	Very soft gray FAT CLAY (CH)		WOR/ 6"		100								
		-w/ shell fragments @ 12.5'-16'		WOR/ 18"		62								
-15	15			WOR/ 18"		69								
		-hard @ 16'-18' -brown @ 16'-26'	(P)4.50			33	90			0.83	5			
		-very stiff @ 18'-22'	(P)2.50			27								
-20	20		(P)3.50			18	105				*			CU
		-hard @ 22'-24'	(P)4.50+			29	98	67	39				99	
		-very stiff & w/ sand seams @ 24'-26'	(P)2.75			22								
-25	25	Loose brown SILTY SAND (SM)		2/6" 3/6" 4/6"		19								
		Stiff brown FAT CLAY (CH)		2/6" 5/6" 6/6"		27								
-30	30													
				3/6" 7/6" 7/6"		23								
-35	35													

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 7/31/2023
DATE BORING COMPLETED: 7/31/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-7

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 33' 56.70" W 94° 54' 13.00"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: 0' to 65'
Wash Bored: to

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-35	35	Stiff brown FAT CLAY (CH)												
		Stiff brown SILTY CLAY (CL-ML)		4/6" 5/6" 7/6"		34								
-40	40													
		Stiff brown FAT CLAY (CH)		5/6" 6/6" 6/6"		33								
-45	45													
				3/6" 5/6" 6/6"		36								
-50	50													
		-very stiff @ 53'-55' -gray @ 53'-65'	(P)2.25			37	81			1.86	4			
-55	55													
		-firm @ 58.5'-60' s		2/6" 3/6" 4/6"				56	32				98	
-60	60													
		-very stiff @ 63'-65'	(P)3.00											
-65	65	Bottom @ 65'												
-70	70													

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 7/31/2023
DATE BORING COMPLETED: 7/31/2023
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

LOG OF BORING B-8

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 40' 14.40" W 94° 56' 01.40"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT) / DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
0 / 0	Water												
-5 / 5	Very soft gray FAT CLAY (CH) w/ silt pockets -w/ shell fragments @ 4.5'-8'		WOR/ 18"										
			WOR/ 18"				62	36					
	-brown @ 8.5'-10'		WOR/ 18"										
-10 / 10													
	-w/ shell fragments @ 10.5'-14'		WOH/ 18"										
			WOH/ 18"										
-15 / 15			WOH/ 18"										
	-w/ shell fragments @ 16.5'-24'		WOH/ 18"				75	44				95	
			WOH/ 18"										
-20 / 20													
	-w/ sand layers @ 20.5'-22'		WOH/ 18"										
	-firm @ 22'-24'	(P)0.50 (T)0.50			64	64							
-25 / 25													
	-very stiff, w/ ferrous stains & sand pockets @ 28'-30'	(P)2.00											
-30 / 30													
	Stiff gray LEAN CLAY W/ SAND (CL) w/ ferrous stains, calcareous nodules & sand pockets	(P)1.25											
-35 / 35													

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/12/2023
DATE BORING COMPLETED: 8/16/2023
LOGGER: Charlie Hughes
PROJECT NO.: 23.14.175

NOTES: Barge 56' from orginal coordinates.
SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-8

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 40' 14.40" W 94° 56' 01.40"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-35	35	Very stiff gray LEAN CLAY W/ SAND (CL)												
			(P)2.00			25	102			0.81	5			
-40	40													
		Medium dense gray SILTY SAND (SM) w/ clay pockets		5/6" 7/6" 9/6"										
-45	45													
		Very stif gray FAT CLAY (CH) w/ ferrous stains & silt lens	(P)2.50											
-50	50													
		-stiff @ 53'-60'	(P)1.25			49	73				*			CU
-55	55													
			(P)1.00			49	73			1.26	2 *	20		
-60	60													
		Dense gray SILTY SAND (SM) -w/ coarse sand, clay pockets & gravel @ 63.5'-70'		15/6" 18/6" 21/6"									16	
-65	65													
		-medium dense @ 68.5'-70'		14/6" 10/6" 10/6"										
-70	70													

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/12/2023
DATE BORING COMPLETED: 8/16/2023
LOGGER: Charlie Hughes
PROJECT NO.: 23.14.175

NOTES: Barge 56' from orginal coordinates.
SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-8

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 40' 14.40" W 94° 56' 01.40"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		Dense gray SILTY SAND (SM)												
-75	75			13/6" 26/6" 25/6"										
		Hard bluish gray & reddish brown FAT CLAY (CH) -w/ silt lens @ 78'-95' -w/ sand pockets & calcareous nodules @ 78'-80	(P)4.25			23	104	55	33	3.36	10	25		
-80	80													
		-w/ sand layers @ 83'-90'	(P)4.50+											
-85	85													
		-very stiff @ 88'-100'	(P)3.50			27	97							
-90	90													
		-slickensided @ 93'-95' -w/ calcareous nodules @ 93'-100'	(P)4.25											
-95	95													
			(P)4.00			25	100			2.55	2			
-100	100													
		-w/ silt lens, sand seams & slickensided @ 103'-110'	(P)4.50+			24	106							
-105	105													

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/12/2023
DATE BORING COMPLETED: 8/16/2023
LOGGER: Charlie Hughes
PROJECT NO.: 23.14.175

NOTES: Barge 56' from orginal coordinates.
SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

LOG OF BORING B-8

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc, Houston, TX

COORDINATES: N 29° 40' 14.40" W 94° 56' 01.40"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		Hard bluish gray & reddish brown FAT CLAY (CH)												
			(P)4.50+			24	102			3.95	2			
-110	110													
		-w/ sand pockets, silt pockets & shell fragments @ 113'-150' -very stiff @ 113'-120'	(P)3.25											
-115	115													
			(P)2.25											
-120	120													
		-w/ sand layers @ 123'-130' -stiff & light gray @ 123'-125'	(P)1.75			31	88			1.37	6			
-125	125													
		-very stiff @ 128'-140' -light brown @ 128'-130'	(P)2.50											
-130	130													
		-gray @ 133'-150'	(P)2.25											
-135	135													
			(P)2.50											
-140	140													

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/12/2023
DATE BORING COMPLETED: 8/16/2023
LOGGER: Charlie Hughes
PROJECT NO.: 23.14.175

NOTES: Barge 56' from orginal coordinates.
SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

LOG OF BORING B-8

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 40' 14.40" W 94° 56' 01.40"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		Stiff gray FAT CLAY (CH)												
			(P)1.75			26	103			0.66	5			
-145	145													
			(P)1.50											
-150	150	Bottom @ 150'												
-155	155													
-160	160													
-165	165													
-170	170													
-175	175													

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/12/2023
DATE BORING COMPLETED: 8/16/2023
LOGGER: Charlie Hughes
PROJECT NO.: 23.14.175

NOTES: Barge 56' from orginal coordinates.
SPT Hammer Type: Automatic Hammer
CU: Consolidated Undrained Triaxial Test

LOG OF BORING B-9

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 39' 21.43" W 94° 55' 37.61"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
0	0	Water												
		Very soft gray FAT CLAY (CH) w/ silt pockets & shell fragments		WOR/ 18"										
		Loose light gray SILTY SAND (SM) w/ shell fragments		4/6" 5/6" 2/6"										
-10	10	-very loose @ 10.5'14' -gray @ 10.5'-16' -w/ clay pockets @ 10.5'-12'		1/6" 2/6" 0/6"										
				0/6" 0/6" 1/6"										
-15	15			2/6" 3/6" 2/6"										
		Very soft gray SANDY LEAN CLAY (CL) w/ shell fragments		2/6" 0/6" 0/6"									53	
		-no recovery @ 18.5'-20'		2/6" 0/6" 0/6"										
-20	20	Very soft gray FAT CLAY W/ SAND (CH) -w/ shell fragments @ 20.5'-22'		0/6" 0/6" 2/6"										
		-brown @ 22.5'-40'		0/6" 1/6" 1/6"									79	
		-very stiff @ 24'-26'	(P)2.25											
-25	25													
		-w/ sand pockets @ 28'-30'	(P)3.50											
-30	30													
			(P)2.25			32	91	75	39	1.49	4 *	10		
-35	35													

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/12/2023
DATE BORING COMPLETED: 8/14/2023
LOGGER: Charlie Hughes
PROJECT NO.: 23.14.175

NOTES: 45' from orginal coordinates.
SPT Hammer Type: Automatic Hammer

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-9

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc
Houston, TX

COORDINATES: N 29° 39' 21.43"
W 94° 55' 37.61"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-35	35	Hard brown FAT CLAY W/ SAND (CH)												
			(P)4.00											
-40	40													
		-very stiff & gray @ 43'-55' -w/ ferrous nodules @ 43'-45'	(P)3.00											
-45	45													
			(P)2.75			32	91	76	44	2.25	5 *			
-50	50													
			(P)3.25											
-55	55													
		Medium dense gray POORLY GRADED SAND W/ SILT (SP-SM)		6/6" 9/6" 11/6"									3	
-60	60													
		-very dense @ 63.5'-65'		9/6" 25/6" 39/6"										
-65	65													
		-dense @ 68.5'-75'		13/6" 14/6" 26/6"										
-70	70													

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/12/2023
DATE BORING COMPLETED: 8/14/2023
LOGGER: Charlie Hughes
PROJECT NO.: 23.14.175

NOTES: 45' from orginal coordinates.
SPT Hammer Type: Automatic Hammer

LOG OF BORING B-9

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 39' 21.43" W 94° 55' 37.61"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT) / DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	Dense gray POORLY GRADED SAND W/ SILT (SP-SM)												
	-brown @ 73.5'-75'		16/6" 20/6" 24/6"									7	
-75 / 75													
	-very dense & gray @ 78.5'-80'		12/6" 21/6" 34/6"										
-80 / 80													
	Hard brown FAT CLAY (CH)	(P)4.25					77	42					
-85 / 85													
		(P)4.50+			32	93			1.37	1 *			
-90 / 90													
	-blue @ 93'-100'	(P)4.50+											
-95 / 95													
		(P)4.50											
-100 / 100													
	Hard light brown & gray LEAN CLAY W/ SAND (CL)	(P)4.50+			20	110	31	12	1.30	3			
-105 / 105													

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/12/2023
DATE BORING COMPLETED: 8/14/2023
LOGGER: Charlie Hughes
PROJECT NO.: 23.14.175

NOTES: 45' from orginal coordinates.
SPT Hammer Type: Automatic Hammer

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-9

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 39' 21.43" W 94° 55' 37.61"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		Very stiff brown & gray LEAN CLAY W/ SAND (CL)												
		-w/ sand pockets & silt pockets @ 108'-109'	(P)3.75											
-110	110													
		Very stiff bluish gray SANDY LEAN CLAY (CL) w/ sand layers, sand pockets & silt pockets	(P)3.75											
-115	115													
		-stiff @ 118'-120'	(P)1.25			22	102			1.77	11	20		
-120	120													
		Hard bluish gray FAT CLAY (CH) slickensided w/ silt lens & calcareous nodules	(P)4.50+											
-125	125													
			(P)4.25			22	106			6.48	2 *	108		
-130	130													
		Very stiff light gray SANDY LEAN CLAY (CL) w/ sand layers & sand pockets	(P)3.00			24	100							
-135	135													
		-stiff @ 138'-139'	(P)1.75			16	108							
-140	140													

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/12/2023
DATE BORING COMPLETED: 8/14/2023
LOGGER: Charlie Hughes
PROJECT NO.: 23.14.175

NOTES: 45' from orginal coordinates.
SPT Hammer Type: Automatic Hammer

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-9

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 39' 21.43" W 94° 55' 37.61"
SURFACE ELEVATION: 0
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 150'

ELEVATION (FT)	DEPTH (FT)	SAMPLE TYPE	SYMBOL	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
				Very stiff gray SANDY LEAN CLAY (CL)												
				-w/ sand pockets & shell fragments @ 143'-145'	(P)2.00											
-145	145															
				Very stiff light gray FAT CLAY (CH) w/ silt lens & sand pockets	(P)3.00			36	87			2.92	3			
				Bottom @ 150'												
-150	150															
-155	155															
-160	160															
-165	165															
-170	170															
-175	175															

COMPLETION DEPTH: 150 ft
DATE BORING STARTED: 8/12/2023
DATE BORING COMPLETED: 8/14/2023
LOGGER: Charlie Hughes
PROJECT NO.: 23.14.175

NOTES: 45' from orginal coordinates.
SPT Hammer Type: Automatic Hammer

TOLUNAY-WONG ENGINEERS, INC.

Preliminary Boring Logs & Key to Symbols and Terms

Borings B-10, B-11, B-12, and B-13

LOG OF BORING B-10

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 40' 06.64" W 94° 56' 47.63"
SURFACE ELEVATION:
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
6	Very soft gray FAT CLAY (CH)		WOH/ 18"										
8.5			WOH/ 18"										
10.5			WOH/ 18"										
12.5	-w/ shell fragments @ 12.5'-14'		WOH/ 18"										
15	Very loose gray SILTY SAND (SM) w/ shell fragments		2/6" 1/6" 2/6"										
17	Very soft gray FAT CLAY (CH)		WOH/ 18"										
18.5	-stiff @ 18.5'-20' -brown @ 18.5'-26'		6/6" 5/6" 6/6"										
20	-very stiff @ 20'-26'	(P)3.25											
22		(P)3.00											
24	-gray @ 24'-39'	(P)3.00											
28	-stiff @ 28'-30'	(P)2.00											
33	-very stiff @ 33'-35'	(P)3.75											

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 04/25/2024
DATE BORING COMPLETED: 04/26/2024
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: 6' from orginal coordinates.
SPT Hammer Type: Automatic Hammer
Water Depth - 6 ft @ 12:50 on 4/25/24.

LOG OF BORING B-10

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 40' 06.64" W 94° 56' 47.63"
SURFACE ELEVATION:
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

ELEVATION (FT) / DEPTH (FT)	SAMPLE TYPE	SYMBOL	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
35			Very stiff gray FAT CLAY (CH)												
			-stiff @ 38'-39'	(P)2.50											
40			Stiff gray LEAN CLAY (CL)												
			Very stiff gray FAT CLAY (CH)	(P)3.00											
45															
			Medium dense gray SILTY SAND (SM)		5/6" 8/6" 6/6"										
50															
					6/6" 9/6" 11/6"										
55															
					9/6" 11/6" 11/6"										
60															
			-dense @ 63.5'-65'		12/6" 14/6" 17/6"										
65			Bottom @ 65'												
70															

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 04/25/2024
DATE BORING COMPLETED: 04/26/2024
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: 6' from orginal coordinates.
SPT Hammer Type: Automatic Hammer
Water Depth - 6 ft @ 12:50 on 4/25/24.

LOG OF BORING B-11

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 38' 56.66" W 94° 54' 56.80"
SURFACE ELEVATION:
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

ELEVATION (FT) / DEPTH (FT)	SAMPLE TYPE	SYMBOL	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
0															
5															
10			Very soft gray FAT CLAY (CH)		0/6" 0/6" 0/6"										
					0/6" 0/6" 0/6"										
			-w/ shell fragments @ 13.5'-15'		0/6" 0/6" 0/6"										
15			Very loose gray SILTY SAND (SM) w/ shell fragments		0/6" 0/6" 0/6"										
			-brown @ 17.5'-35'		1/6" 2/6" 1/6"										
20			-w/ shell fragments @ 19.5'-25'		5/6" 2/6" 1/6"										
					0/6" 1/6" 1/6"										
					1/6" 2/6" 1/6"										
25			-loose @ 25.5'-27'		4/6" 2/6" 4/6"										
			-medium dense @ 27.5'-35'		5/6" 7/6" 9/6"										
30															
35			-w/ clay pockets @ 33.5'-35'		7/6" 7/6" 9/6"										

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 04/23/2024
DATE BORING COMPLETED: 04/23/2024
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: 9' from orginal coordinates.
SPT Hammer Type: Automatic Hammer
Water Depth - 9 ft @ 0820 on 4/23/24.

LOG OF BORING B-11

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 38' 56.66" W 94° 54' 56.80"
SURFACE ELEVATION:
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
35	Medium dense brown SILTY SAND (SM)												
38-40			12/6" 12/6" 15/6"										
43	Very stiff brown FAT CLAY (CH)	(P)3.00											
48		(P)4.00											
53	-stiff @ 53'-55'	(P)2.00											
58	-very stiff @ 58'-60' -gray @ 58'-65'	(P)3.25											
63	-very stiff to hard w/ calcareous deposits @ 63'-65'	(P)4.50											
65	Bottom @ 65'												

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 04/23/2024
DATE BORING COMPLETED: 04/23/2024
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: 9' from orginal coordinates.
SPT Hammer Type: Automatic Hammer
Water Depth - 9 ft @ 0820 on 4/23/24.

LOG OF BORING B-12

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc
Houston, TX

COORDINATES: N 29° 38' 25.39"
W 94° 55' 04.27"
SURFACE ELEVATION:
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

DEPTH (FT)	MATERIAL DESCRIPTION	STD. PENETRATION TEST BLOWCOUNT
10	Very soft gray FAT CLAY (CH)	WOR/ 18"
12.5		WOR/ 18"
14.5	-w/ shell fragments @ 14.5'-23'	WOR/ 18"
16.5		WOR/ 18"
18.5		WOH/ 18
20.5		WOH/ 18"
23	Very soft gray SANDY LEAN CLAY (CL)	WOH/ 18"
25	Very loose gray SILTY SAND (SM)	WOH/ 18"
27		WOH/ 18"
29		WOH/ 18"
33.5	-medium dense @ 33.5'-45' -tan @ 33.5'-65'	2/6" 4/6" 8/6"

Other columns (blank): ELEVATION (FT); SAMPLE TYPE; SYMBOL; (P) POCKET PEN (tsf) (T) TORVANE (tsf); N_{60}; MOISTURE CONTENT (%); DRY UNIT WEIGHT (pcf); LIQUID LIMIT (%); PLASTICITY INDEX (%); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi); PASSING #200 SIEVE (%); OTHER TESTS PERFORMED

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 04/24/2024
DATE BORING COMPLETED: 04/25/2024
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
Water Depth - 10 ft @ 13:05 on 4/24/24.

LOG OF BORING B-12

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc
Houston, TX

COORDINATES: N 29° 38' 25.39" W 94° 55' 04.27"
SURFACE ELEVATION:
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

DEPTH (FT)	MATERIAL DESCRIPTION	STD. PENETRATION TEST BLOWCOUNT
35	Medium dense tan SILTY SAND (SM)	
38.5-40		8/6" 5/6" 6/6"
43.5-45		6/6" 6/6" 7/6"
48.5-50	-dense @ 48.5'-50'	6/6" 21/6" 27/6"
53.5-55	-medium dense @ 53.5'-55'	17/6" 15/6" 13/6"
58.5-60	-very dense @ 58.5'-65'	12/6" 27/6" 36/6"
63.5-65	Bottom @ 65'	14/6" 26/6" 37/6"

Other columns: ELEVATION (FT); SAMPLE TYPE; SYMBOL; (P) POCKET PEN (tsf) (T) TORVANE (tsf); N_{60}; MOISTURE CONTENT (%); DRY UNIT WEIGHT (pcf); LIQUID LIMIT (%); PLASTICITY INDEX (%); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi); PASSING #200 SIEVE (%); OTHER TESTS PERFORMED

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 04/24/2024
DATE BORING COMPLETED: 04/25/2024
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
Water Depth - 10 ft @ 13:05 on 4/24/24.

LOG OF BORING B-13

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc
Houston, TX

COORDINATES: N 29° 37' 42.22"
W 94° 53' 52.10"
SURFACE ELEVATION:
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
9	Very soft gray FAT CLAY (CH)		WOR/ 18"										
11.5			WOR/ 18"										
13.5			WOR/ 18"										
15.5			WOR/ 18"										
17.5			WOR/ 18"										
19.5	-w/ shell fragments @ 19.5'-21'		WOR/ 18"										
21.5			WOR/ 18"										
23.5	Very loose gray SILTY SAND (SM)		1/6" 2/6" 2/6"										
25.5	-brown @ 25.5'-29'		WOR/ 6" 1/6" 2/6"										
27.5			1/6" 2/6" 2/6"										
33.5	Stiff brown FAT CLAY (CH)		5/6" 5/6"										

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 04/23/24
DATE BORING COMPLETED: 04/24/2024
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
Water Depth - 9 ft @ 7:45am on 4/24/24.

TOLUNAY-WONG ENGINEERS, INC.

LOG OF BORING B-13

PROJECT: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

CLIENT: Trans-Global Solutions, Inc Houston, TX

COORDINATES: N 29° 37' 42.22" W 94° 53' 52.10"
SURFACE ELEVATION:
DRILLING METHOD:
Dry Augered: to
Air Bored: to
Wash Bored: 0' to 65'

ELEVATION (FT) / DEPTH (FT)	SAMPLE TYPE	SYMBOL	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
35			Stiff brown FAT CLAY (CH)		5/6"										
38-40				(P)2.50											
43-45			-very stiff @ 43'-45'	(P)3.50											
48-50			-stiff @ 48'-55' -gray @ 48'-65'	(P)2.75											
53-55				(P)2.00											
58-60			-very stiff @ 58'-60'	(P)3.00											
63-65			-stiff @ 63'-65'	(P)2.50											
65			Bottom @ 65'												

COMPLETION DEPTH: 65 ft
DATE BORING STARTED: 04/23/24
DATE BORING COMPLETED: 04/24/2024
LOGGER: Josh Sparks
PROJECT NO.: 23.14.175

NOTES: SPT Hammer Type: Automatic Hammer
Water Depth - 9 ft @ 7:45am on 4/24/24.

SYMBOLS AND TERMS USED ON BORING LOGS

Common Unified Soil Classification System Groups

- Well Graded Gravel (GW)
- Well Graded Gravel with Sand (GW)
- Poorly Graded Gravel (GP)
- Silty Gravel (GM)
- Clayey Gravel (GC)
- Well Graded Sand (SW)
- Well Graded Sand with Gravel (SW)
- Poorly Graded Sand (SP)
- Poorly Graded Sand with Silt (SP-SM)
- Silty Sand (SM)
- Clayey Sand (SC)
- Silty Clayey Sand (SC-SM)
- Lean Clay (CL)
- Lean Clay with Sand (CL)
- Sandy Lean Clay (CL)
- Silty Clay (CL-ML)
- Sandy Silty Clay (CL-ML)
- Silt (ML)
- Silt with Sand (ML)
- Sandy Silt (ML)
- Fat Clay (CH)
- Fat Clay with Sand (CH)
- Sandy Fat Clay (CH)
- Elastic Silt (MH)
- Peat (PT)

Miscellaneous Materials

- Asphalt and/or Base
- Concrete
- Fill

Sampler Types

- Pavement / Rock Core
- Thin-Walled Tube
- SPT Split-Barrel
- Auger
- Sampling Attempt With No Recovery
- TxDOT Cone Penetrometer Test
- California Split-Barrel Sampler

Field Test Data

P = 2.5	Pocket Penetrometer Measurement (tsf)
8/6"	Blow Count per 6-in. Interval of the Standard Penetration Test
T = 0.8	Torvane Measurement (tsf)
WOR	Weight of Rod
WOH	Weight of Hammer
	Observed Water Level During Drilling
	Observed Water Level After Drilling

Laboratory Test Data

*	Failed on slickensided plane.
**	Did not fail at 15% strain.

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Relative Density	Typical SPT N_{60} Value Range*
Very Loose	0-4
Loose	5-10
Medium Dense	11-30
Dense	31-50
Very Dense	Over 50

* N_{60} is the number of blows from a 140-lb weight having a free fall of 30-in. required to penetrate the final 12-in. of an 18-in. sample interval, corrected for field procedure to an average energy ratio of 60% (Terzaghi, Peck, and Mesri, 1996).

CONSISTENCY OF FINE-GRAINED SOILS

Consistency	Typical Compressive Strength (tsf)	Typical SPT "N_{60}" Value Range**
Very soft	$q_u < 0.25$	≤ 2
Soft	$0.25 \leq q_u < 0.50$	3-4
Firm	$0.50 \leq q_u < 1.00$	5-8
Stiff	$1.00 \leq q_u < 2.00$	9-15
Very Stiff	$2.00 \leq q_u < 4.00$	16-30
Hard	$q_u \geq 4.00$	≥ 31

** The correlation of consistency with a typical SPT "N_{60}" value range is approximate.

SUMMARY OF LABORATORY TESTS

Project No. 23.14.175 Client: Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements;
Proposed Cedar Port Improvement & Navigation District
and Dock Related Feasibility Study

Boring No.	Sample No.	Depth (ft)	Pocket Pen. (tsf)	Torvane (tsf)	Soil Description	USCS	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plast. Index	Finer than #200 Sieve (%)	pH	Lab Vane Shear (tsf)	Uc/UU. Compr. (tsf)	Failure Strain (%)	Conf. Pres. (psi)	Failure Type
B-1																		
		0																
		5																
		5.5				CH	89.5											
		7.5																
		9.5				CH	51.1											
		11.5				CL	47.6											
		13.5				CL	29.8											
		15.5				CL	34.7											
		17.5			Gray SANDY LEAN CLAY; shell fragments	CL	42.6					63.5						
		19.5				CH	48.3											
		21.5																
		23.5				CH	42.6											
		28.5				CH	74.4		80	35	45							
		33	0.75		Dark gray FAT CLAY	CH	80.3	39.9							0.33	1.2	58.0	Multiple shear
		35																
		38	1.75		Dark grey FAT CLAY; ferrous nodules	CH	31.6	91.1							1.11	14.8		Bulge
		43	3.25		Tan LEAN CLAY with SAND; ferrous	CL	18.8	110.9	39	18	21				2.32	9.8		Multiple shear
		48	3.00		Gray tan FAT CLAY	CH	20.5	109.1				94.8			1.01	1.1	58.0	Slickensid
		53.5				SM	17.7											
		58.5				SM	23.7											
		63.5																
		63.5				SM	21.8											
		65																
B-2																		
		0																
		6																
		6.5				CH	34.5											
		8.5			Brown SILTY SAND	SM	24.7		NV	NP	NP	23.0						
		10.5				CL	23.5											
		12.5																
		14.5				CL	25.0											
		16.5				CH	45.4											
		18.5				CH	54.6											
		20.5				CH	59.9											
		22.5			Gray FAT CLAY	CH	61.1		70	29	41	95.6						
		24	1.00		Dark grey and dark brown FAT CLAY	CH	51.1	71.3							0.54	3.8		Slickensid
		28	0.75		Dark grey FAT CLAY	CH	57.9	66.0							0.64	2.5	25.0	Slickensid

SUMMARY OF LABORATORY TESTS

Project No. 23.14.175 Client: Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements;
Proposed Cedar Port Improvement & Navigation District
and Dock Related Feasibility Study

Boring No.	Sample No.	Depth (ft)	Pocket Pen. (tsf)	Torvane (tsf)	Soil Description	USCS	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plast. Index	Finer than #200 Sieve (%)	pH	Lab Vane Shear (tsf)	Uc/UU. Compr. (tsf)	Failure Strain (%)	Conf. Pres. (psi)	Failure Type
		33.5				CH	60.2											
		35																
		38.5																
		43.5				CH	45.7											
		48.5				CL	24.2											
		53.5				CH	38.7											
		58.5				SM	18.0											
		63.5				SM	17.5											
		68	4.50			CH	30.1		67	26	41							
		70																
		73	4.50		Brown SANDY LEAN CLAY	CL	17.8	115.9							4.52	7.8	25.0	Multiple shear
		78	4.50			CL	18.9	112.9										
		83	3.25			CL	19.6											
		88.5																
		93	4.50		Brown FAT CLAY	CH	22.9	103.6							3.07	2.6		Vertical shear
		98	4.50			CL	17.9	113.2										
		103	4.00			CL	16.8		42	19	23							
		105																
		108	4.50		Reddish-brown FAT CLAY	CH	24.6	101.7							1.64	1.6		Slickensid
		113	4.50			CH	21.2	108.8										
		118.5				SC-SM	22.5											
		123	4.50			CH	20.7	104.0										
		128	3.50		Brown and grey FAT CLAY	CH	27.3		59	29	30				2.09	2.9		Vertical shear
		133	3.50			CH	27.8	95.0										
		138	3.50															
		140																
		143	3.25			CH	43.4	77.4										
		148	3.50															
		150																
B-3																		
		0																
		8																
		8.5				CH	52.5											
		10.5				CH	47.6											
		12.5				CH	24.7											
		14.5																
		16.5				CL	22.9		33	18	15							

SUMMARY OF LABORATORY TESTS

Project No. 23.14.175 Client: Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements;
Proposed Cedar Port Improvement & Navigation District
and Dock Related Feasibility Study

Boring No.	Sample No.	Depth (ft)	Pocket Pen. (tsf)	Torvane (tsf)	Soil Description	USCS	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plast. Index	Finer than #200 Sieve (%)	pH	Lab Vane Shear (tsf)	Uc/UU. Compr. (tsf)	Failure Strain (%)	Conf. Pres. (psi)	Failure Type
		18.5				CL	22.0											
		20.5				CL	23.0											
		22.5				SC	21.1											
		24.5				CH	40.7		65	26	39							
		26.5				CL	32.0											
		28.5			Brown SILTY SAND; shell fragments	SM	21.0					12.1						
		33	4.50		Gray FAT CLAY	CH	35.8	86.4	63	23	40				0.73	0.9	45.0	Multiple shear
		35																
		38	3.00		Brown and tan FAT CLAY; ferrous nodules	CH	26.6	98.7							0.70	5.5		Vertical shear
		43.5				CL	24.3											
		48.5			Brown and gray SANDY LEAN CLAY	CL	24.9					65.7						
		53.5				CL	29.1											
		58.5																
		63.5				CL	21.7											
		65																
B-4																		
		0																
		6																
		6.5				CH	81.8											
		8.5				CH	92.1											
		10.5				CH	34.7											
		12.5				CH	34.8											
		14.5				CH	29.9											
		16.5				CH	45.0											
		18.5			Gray SANDY LEAN CLAY	CL			49	26	23	61.3						
		20.5				CH	60.3											
		22.5				CH	71.2											
		24	0.50		Gray FAT CLAY; organics	CH	64.3	58.8							0.46	4.0	25.0	60 degree
		28.5				SC-SM	32.3											
		33.5			Gray SANDY SILTY CLAY	CL-ML			31	24	7	58.6						
		35																
		38.5				SM	23.2											
		43.5				SM	21.5											
		48.5				SM	21.4											
		53.5				CH	35.4											
	Uc	58	2.75		Gray FAT CLAY	CH	35.2	87.0							1.24	1.9		Slickensid
	CU	58.1			Gray FAT CLAY with SAND; calcareous	CH	35.2	85.4							0.67	0.9	45.0	Slickensid

SUMMARY OF LABORATORY TESTS

Project No. 23.14.175

Client: Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements;
Proposed Cedar Port Improvement & Navigation District
and Dock Related Feasibility Study

Boring No.	Sample No.	Depth (ft)	Pocket Pen. (tsf)	Torvane (tsf)	Soil Description	USCS	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plast. Index	Finer than #200 Sieve (%)	pH	Lab Vane Shear (tsf)	Uc/UU. Compr. (tsf)	Failure Strain (%)	Conf. Pres. (psi)	Failure Type
		63.5																
		65																
B-5																		
		0																
		10																
		10.5				CH	70.6											
		12.5				CH	53.3											
		14.5				CH	55.2											
		16.5				CH	45.1											
		18.5				CH	50.2											
		20.5			Gray SILT with SAND	ML			NV	NP	NP	78.5						
		22.5				CH	56.6											
		24.5				CH	78.0											
		26	0.75		Gray FAT CLAY	CH	54.7	69.3							0.49	3.7	35.0	Bulge
		28.5				OH	96.2											
		33.5			Gray ORGANIC CLAY	OH			118	53	65	95.0						
		35																
		38.5				CH	53.1											
		43.5				SM	20.1											
		48.5				SM	22.2											
		53.5				SM	15.7											
		58.5				SM	21.9											
		63.5				SM	18.1											
		65																
B-6																		
		0																
		10																
		10.5				CH	80.5											
		12.5			Gray FAT CLAY with SAND; shell fragments	CH			53	20	33	77.7						
		14	2.00		Reddish-brown FAT CLAY	CH	32.7	91.0							0.68	2.2	45.0	Slickensid
		16	3.50			CH	28.7											
		18.5				CH	29.2											
		20	3.25		Reddish-brown FAT CLAY	CH	26.4	97.4							2.25	4.1		Vertical shear
		22	2.50			CH	31.2											
		24	4.00															
		26	3.00		Reddish-brown FAT CLAY	CH	28.4	93.9							0.67	0.7		Slickensid
		28	2.75			CH	37.1											
		33	3.75			CH	30.5											
		35																

SUMMARY OF LABORATORY TESTS

Project No. 23.14.175 Client: Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements;
Proposed Cedar Port Improvement & Navigation District
and Dock Related Feasibility Study

Boring No.	Sample No.	Depth (ft)	Pocket Pen. (tsf)	Torvane (tsf)	Soil Description	USCS	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plast. Index	Finer than #200 Sieve (%)	pH	Lab Vane Shear (tsf)	Uc/UU. Compr. (tsf)	Failure Strain (%)	Conf. Pres. (psi)	Failure Type
		38	2.50		Brown FAT CLAY	CH	39.1	82.7							1.31	3.1		Vertical shear
		43	2.50		Gray ORGANIC CLAY	OH	39.4	81.7	86	39	47	99.7						
		48	2.25			CH	35.5											
		53	3.00		Gray and brown FAT CLAY	CH	32.6	90.8							1.58	1.6	55.0	Bulge
		58.5				SM	24.1											
		63.5				SC-SM	26.6											
		65																
B-7																		
		0																
		10																
		10.5				CH	100.2											
		12.5				CH	61.7											
		14.5				CH	69.3											
		16	4.50		Brown FAT CLAY	CH	32.7	89.9							0.83	4.7		Vertical shear
		18	2.50			CH	27.4											
		20	3.50		Gray FAT CLAY	CH	17.6	105.0							0.78	1.0	58.0	Slickensid
		22	4.50		Gray FAT CLAY	CH	28.8	97.6	67	28	39	99.3						
		24	2.75			CH	21.7											
		26.5				CH	18.9											
		28.5				CH	27.2											
		33.5				CH	23.1											
		35																
		38.5				CH	33.8											
		43.5				CH	32.8											
		48.5				CH	35.7											
		53	2.25		Brown FAT CLAY	CH	37.4	81.0							1.86	4.3		Vertical shear
		58.5			Gray FAT CLAY	CH			56	24	32	97.9						
		63	3.00															
		65																
B-8																		
		0																
		4																
		4.5																
		6.5				CH			62	26	36							
		8.5																
		10.5																
		12.5																

SUMMARY OF LABORATORY TESTS

Project No. 23.14.175 Client: Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements;
Proposed Cedar Port Improvement & Navigation District
and Dock Related Feasibility Study

Boring No.	Sample No.	Depth (ft)	Pocket Pen. (tsf)	Torvane (tsf)	Soil Description	USCS	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plast. Index	Finer than #200 Sieve (%)	pH	Lab Vane Shear (tsf)	Uc/UU. Compr. (tsf)	Failure Strain (%)	Conf. Pres. (psi)	Failure Type
		14.5																
		16.5				CH			75	31	44	95.0						
		18.5																
		20.5																
		22	0.50	0.50		CH	64.4	63.7										
		28	2.00															
		33	1.25															
		35																
		38	2.00		Grey LEAN CLAY with SAND	CL	24.9	101.5							0.81	4.9		Vertical shear
		43.5																
		48	2.50															
		53	1.25		Gray and black FAT CLAY	CH	49.2	73.0							1.09	2.8	47.0	Slickensid
		58	1.00		Grey FAT CLAY	CH	48.8	72.6							1.26	2.4	20.0	Slickensid
		63.5				SM						15.5						
		68.5																
		70																
		73.5																
		78	4.25		Brown and grey FAT CLAY; calcareous and aggregate	CH	23.0	103.7	55	22	33				3.36	10.1	25.0	Vertical shear
		83	4.50															
		88	3.50			CH	26.9	97.4										
		93	4.25															
		98	4.00		Grey FAT CLAY	CH	24.6	99.8							2.55	1.8		Vertical shear
		103	4.50			CH	24.0	106.0										
		105																
		108	4.50		Brown and grey FAT CLAY	CH	23.7	101.6							3.95	2.3		Vertical shear
		113	3.25															
		118	2.25															
		123	1.75		Grey FAT CLAY	CH	31.2	88.0							1.37	5.5		Vertical shear
		128	2.50															
		133	2.25															
		138	2.50															
		140																
		143	1.75		Grey FAT CLAY	CH	25.8	102.6							0.66	4.9		Vertical shear
		148	1.50															

SUMMARY OF LABORATORY TESTS

Project No. 23.14.175 Client: Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements;
Proposed Cedar Port Improvement & Navigation District
and Dock Related Feasibility Study

Boring No.	Sample No.	Depth (ft)	Pocket Pen. (tsf)	Torvane (tsf)	Soil Description	USCS	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plast. Index	Finer than #200 Sieve (%)	pH	Lab Vane Shear (tsf)	Uc/UU. Compr. (tsf)	Failure Strain (%)	Conf. Pres. (psi)	Failure Type
		150																
B-9																		
		0																
		6																
		6.5																
		8.5																
		10.5																
		12.5																
		14.5																
		16.5				CL-ML						52.6						
		18.5																
		20.5																
		22.5				CH						78.7						
		24	2.25															
		28	3.50															
		33	2.25		Reddish-brown FAT CLAY	CH	31.8	91.2	75	36	39				1.49	3.8	10.0	Slickensid
		35																
		38	4.00															
		43	3.00															
		48	2.75		Grey FAT CLAY	CH	32.0	91.3	76	32	44				2.25	5.3		Slickensid
		53	3.25															
		58.5				SP						3.4						
		63.5																
		68.5																
		70																
		73.5				SP-SM						6.8						
		78.5																
		83	4.25			CH			77	35	42							
		88	4.50		Reddish-brown FAT CLAY	CH	31.5	93.3							1.37	0.9		Slickensid
		93	4.50															
		98	4.50															
		103	4.50		Grey LEAN CLAY with SAND	CL	20.3	109.9	31	19	12				1.30	3.4		Vertical shear
		105																
		108	3.75															
		113	3.75															
		118	1.25		Grey SANDY LEAN CLAY	CL	22.1	101.5							1.77	10.6	20.0	Vertical shear
		123	4.50															
		128	4.25		Dark grey FAT CLAY; calcareous nodules	CH	22.0	105.5							6.48	2.2	108.0	Slickensid

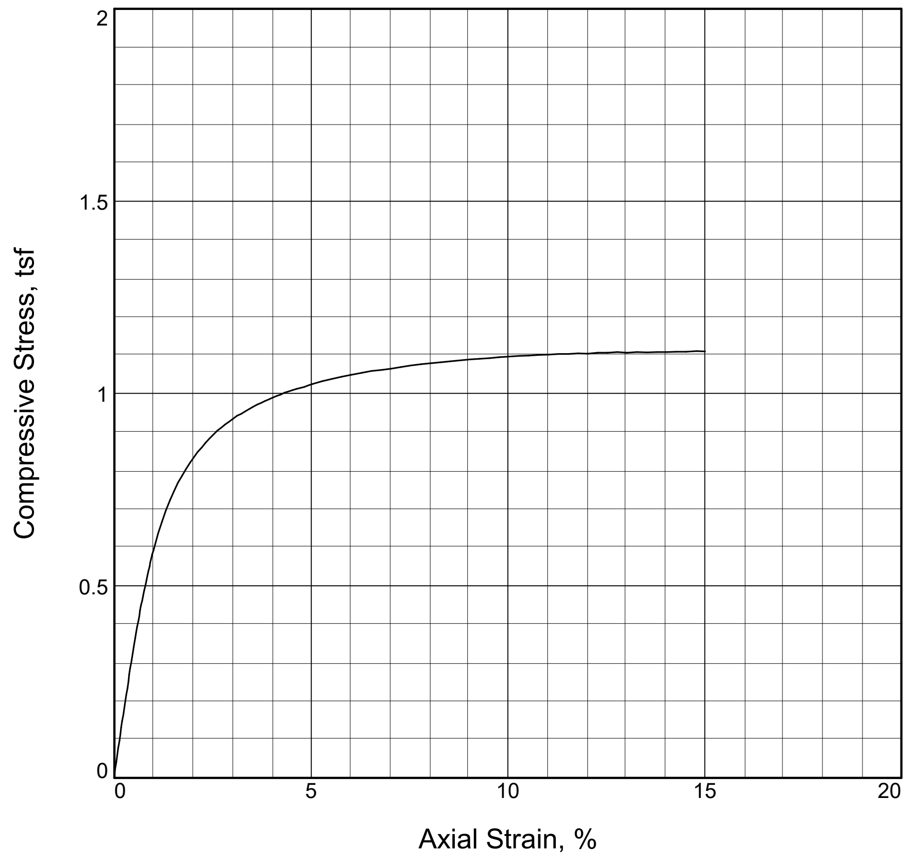
SUMMARY OF LABORATORY TESTS

Project No. 23.14.175   Client: Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements;
Proposed Cedar Port Improvement & Navigation District
and Dock Related Feasibility Study

Boring No.	Sample No.	Depth (ft)	Pocket Pen. (tsf)	Torvane (tsf)	Soil Description	USCS	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plast. Index	Finer than #200 Sieve (%)	pH	Lab Vane Shear (tsf)	Uc/UU. Compr. (tsf)	Failure Strain (%)	Conf. Pres. (psi)	Failure Type
		133	3.00		Grey FAT CLAY; sand seams	CH	24.0	99.5										
		138	1.75			CH	15.7	107.9										
		140																
		143	2.00															
		148	3.00		Grey FAT CLAY	CH	35.6	86.7							2.92	3.0		Vertical shear
		150																

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.110			
Undrained shear strength, tsf	0.555			
Failure strain, %	14.8			
Strain rate, %/min.	1.00			
Water content, %	31.6			
Wet density, pcf	119.9			
Dry density, pcf	91.1			
Saturation, %	98.3			
Void ratio	0.8843			
Specimen diameter, in.	2.86			
Specimen height, in.	5.98			
Height/diameter ratio	2.10			

Description: Dark grey FAT CLAY; ferrous nodules

LL =	**PL =**	**PI =**	**Assumed GS=** 2.75	**Type:** Undisturbed

Project No.: 23.14.175
Date Sampled: 8/24/23
Remarks:

Test method: ASTM D2166
Failure type: Bulge

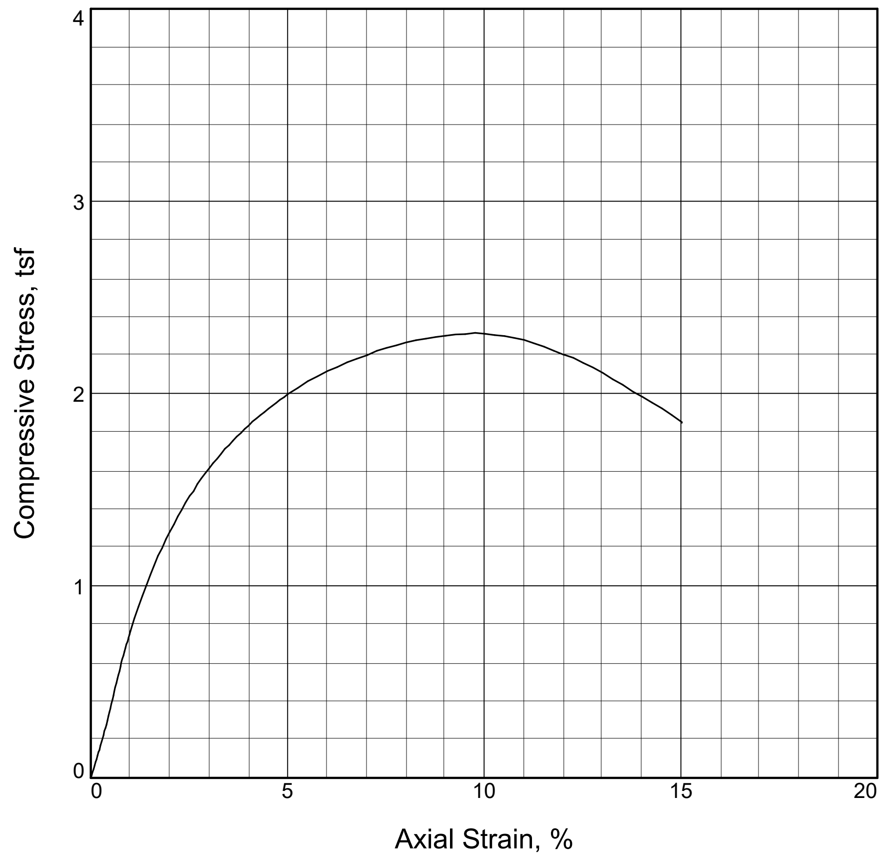
Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-1 **Depth:** 38

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: BP

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.315			
Undrained shear strength, tsf	1.157			
Failure strain, %	9.8			
Strain rate, %/min.	1.00			
Water content, %	18.8			
Wet density, pcf	131.7			
Dry density, pcf	110.9			
Saturation, %	97.5			
Void ratio	0.5195			
Specimen diameter, in.	2.86			
Specimen height, in.	5.99			
Height/diameter ratio	2.10			

Description: Tan LEAN CLAY with SAND; ferrous

LL = 39	**PL =** 18	**PI =** 21	**Assumed GS=** 2.70	**Type:** Undisturbed

Project No.: 23.14.175
Date Sampled: 8/24/23
Remarks:

Test method: ASTM D2166
Failure type: Multiple shear

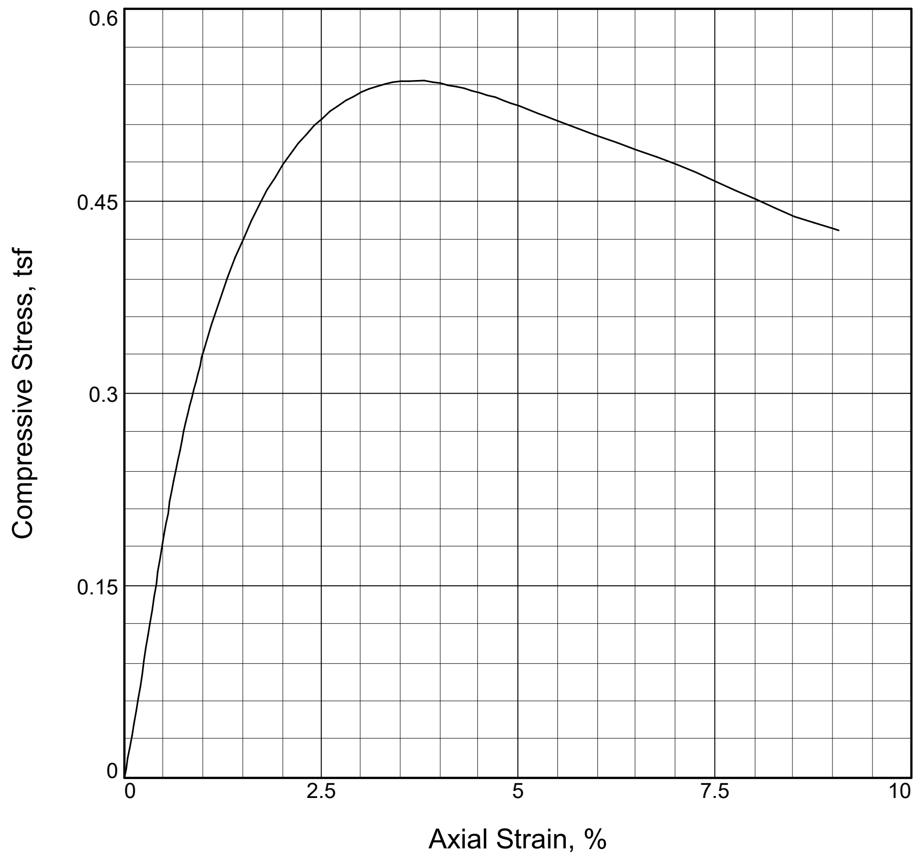
Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-1 **Depth:** 43

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: BP

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.544			
Undrained shear strength, tsf	0.272			
Failure strain, %	3.8			
Strain rate, %/min.	1.00			
Water content, %	51.1			
Wet density, pcf	107.8			
Dry density, pcf	71.3			
Saturation, %	99.9			
Void ratio	1.4063			
Specimen diameter, in.	2.86			
Specimen height, in.	5.96			
Height/diameter ratio	2.08			

Description: Dark grey and dark brown FAT CLAY

LL =	**PL =**	**PI =**	**Assumed GS=** 2.75	**Type:** Undisturbed

Project No.: 23.14.175
Date Sampled: 8/24/23
Remarks:

Test method: ASTM D2166
Failure type: Slickensided

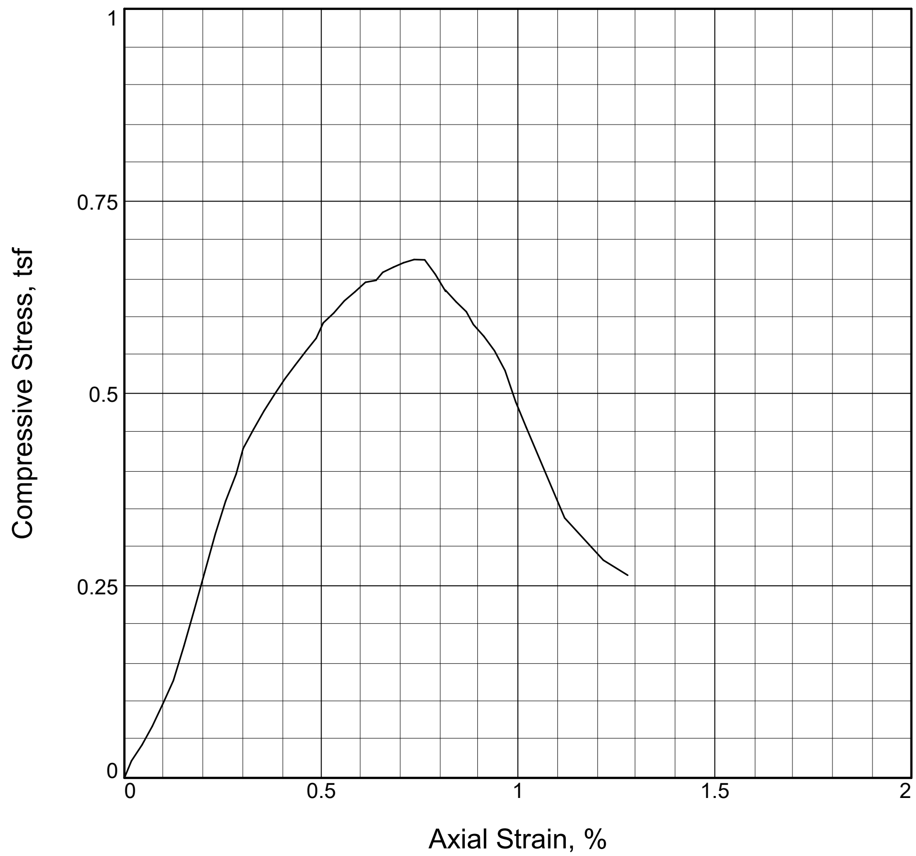
Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements;
Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-2 **Depth:** 24

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: BP

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.674			
Undrained shear strength, tsf	0.337			
Failure strain, %	0.7			
Strain rate, %/min.	1.00			
Water content, %	28.4			
Wet density, pcf	120.5			
Dry density, pcf	93.9			
Saturation, %	96.3			
Void ratio	0.7958			
Specimen diameter, in.	2.88			
Specimen height, in.	5.91			
Height/diameter ratio	2.05			

Description: Reddish-brown FAT CLAY

LL =	PL =	PI =	Assumed GS= 2.70	Type: Undisturbed

Project No.: 23.14.175
Date Sampled: 8/25/23
Remarks:

Test method: ASTM D2166
Failure type: Slickensided

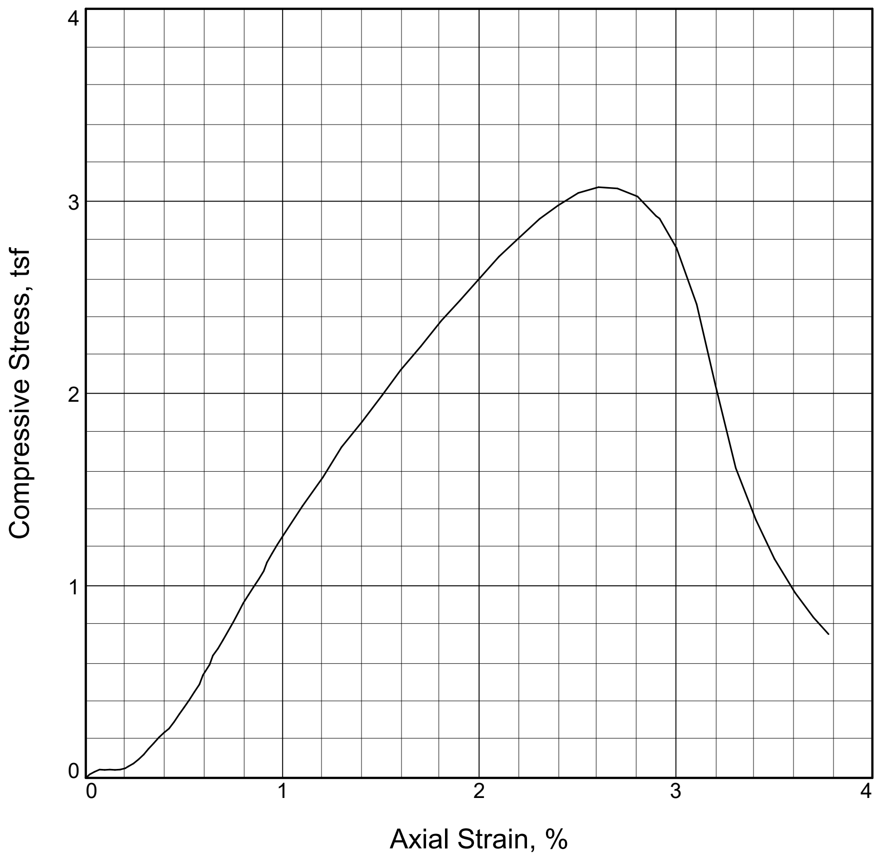
Figure _______

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-6 **Depth:** 26

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	3.073			
Undrained shear strength, tsf	1.537			
Failure strain, %	2.6			
Strain rate, %/min.	1.00			
Water content, %	22.9			
Wet density, pcf	127.3			
Dry density, pcf	103.6			
Saturation, %	98.5			
Void ratio	0.6275			
Specimen diameter, in.	2.86			
Specimen height, in.	5.91			
Height/diameter ratio	2.07			

Description: Brown FAT CLAY

LL =	PL =	PI =	Assumed GS= 2.70	Type: Undisturbed

Project No.: 23.14.175
Date Sampled: 9/13/23
Remarks:

Test method: ASTM D2166
Failure type: Vertical shear

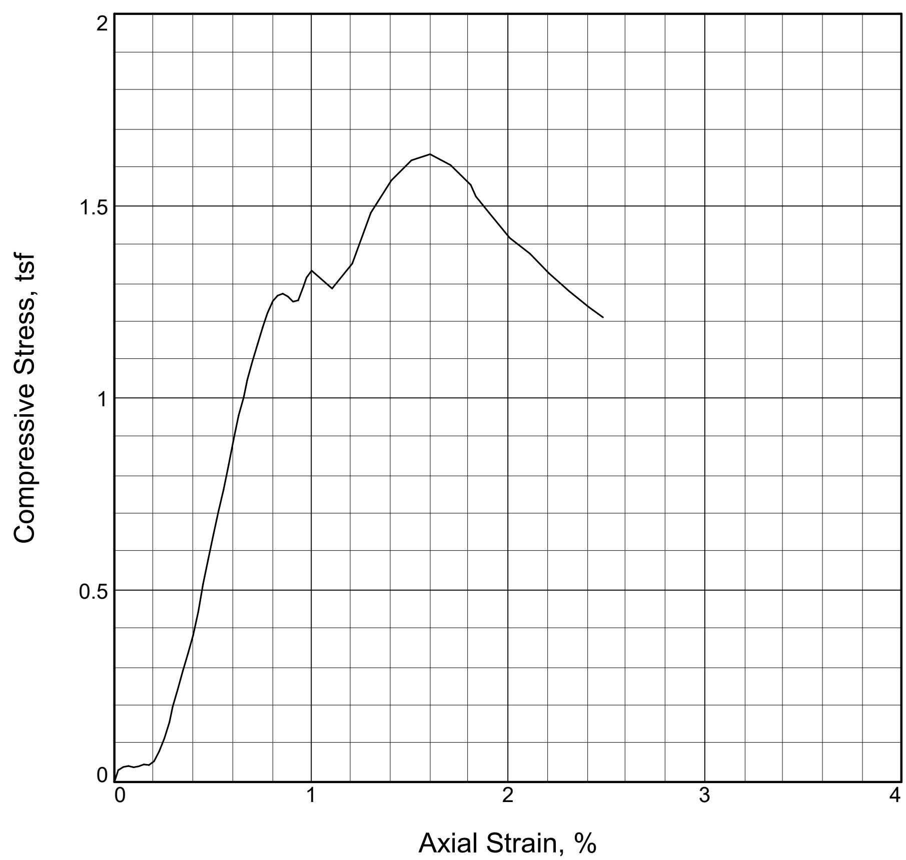
Figure _______

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-2 **Depth:** 93

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.635			
Undrained shear strength, tsf	0.817			
Failure strain, %	1.6			
Strain rate, %/min.	1.00			
Water content, %	24.6			
Wet density, pcf	126.7			
Dry density, pcf	101.7			
Saturation, %	98.3			
Void ratio	0.6877			
Specimen diameter, in.	2.88			
Specimen height, in.	5.91			
Height/diameter ratio	2.05			

Description: Reddish-brown FAT CLAY

LL =	PL =	PI =	Assumed GS= 2.75	Type: Undisturbed

Project No.: 23.14.175
Date Sampled: 9/13/23
Remarks:

Test method: ASTM D2166
Failure type: Slickensided

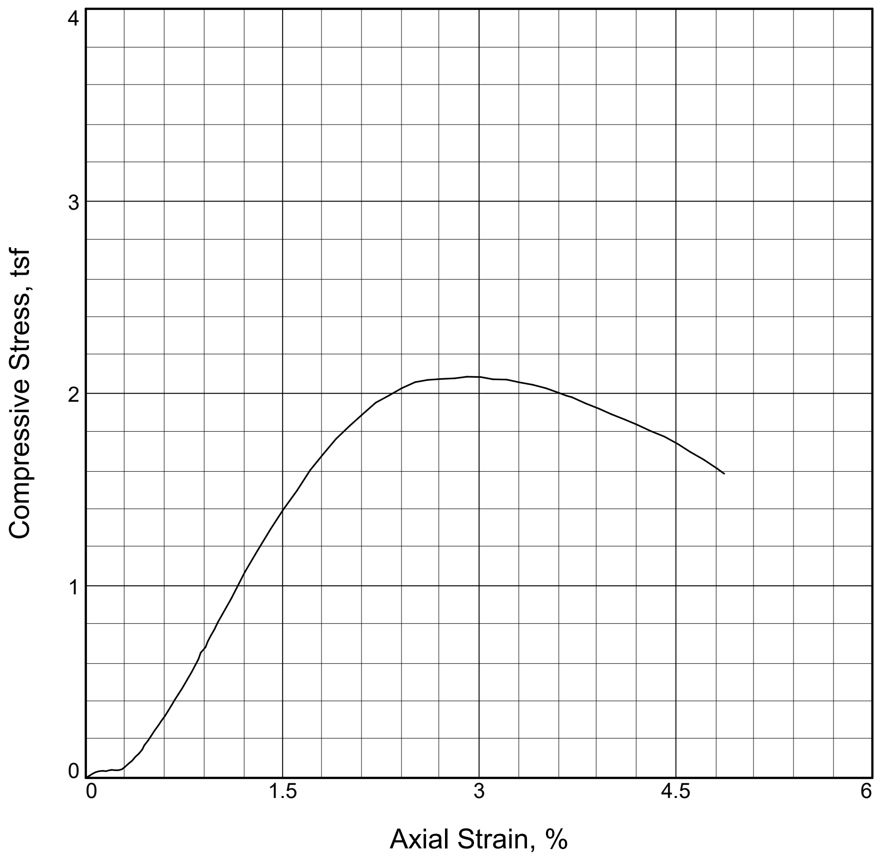
Figure _______

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-2 **Depth:** 108

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.087			
Undrained shear strength, tsf	1.043			
Failure strain, %	2.9			
Strain rate, %/min.	1.00			
Water content, %	27.3			
Wet density, pcf	119.6			
Dry density, pcf	94.0			
Saturation, %	92.7			
Void ratio	0.7941			
Specimen diameter, in.	2.88			
Specimen height, in.	5.90			
Height/diameter ratio	2.05			

Description: Brown and grey FAT CLAY

LL = 59	**PL =** 29	**PI =** 30	**Assumed GS=** 2.70	**Type:** Undisturbed

Project No.: 23.14.175
Date Sampled: 9/13/23
Remarks:

Test method: ASTM D2166
Failure type: Vertical shear

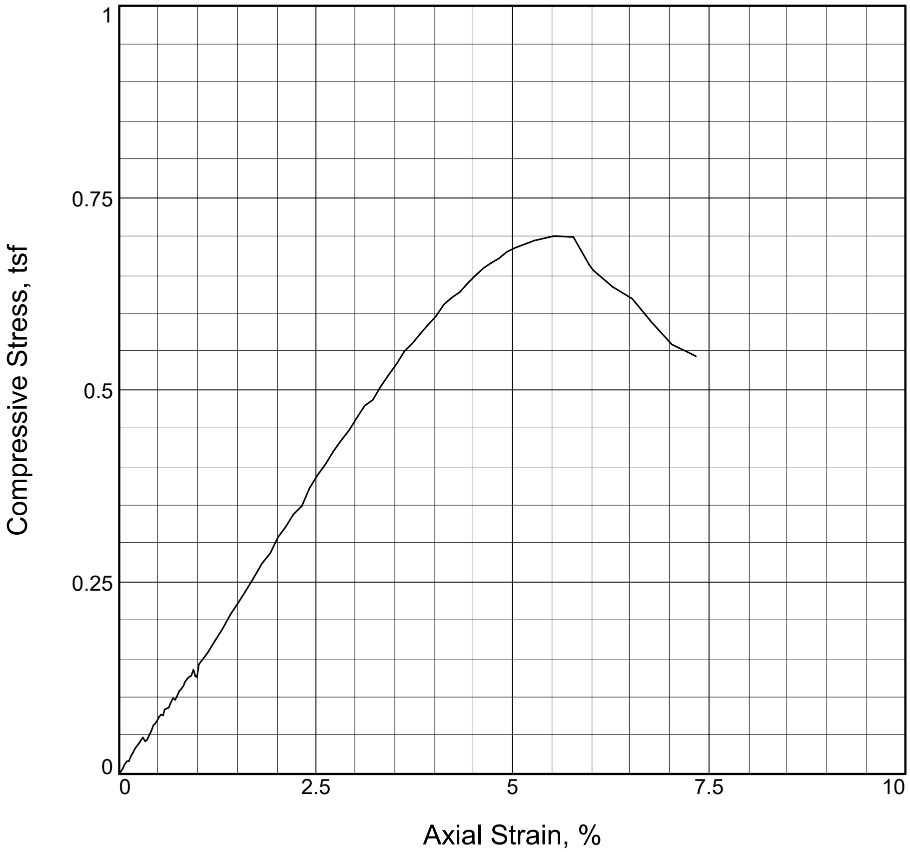
Figure _______

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-2 **Depth:** 128

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.701			
Undrained shear strength, tsf	0.350			
Failure strain, %	5.5			
Strain rate, %/min.	1.00			
Water content, %	26.6			
Wet density, pcf	125.0			
Dry density, pcf	98.7			
Saturation, %	99.1			
Void ratio	0.7396			
Specimen diameter, in.	2.90			
Specimen height, in.	5.77			
Height/diameter ratio	1.99			

Description: Brown and tan FAT CLAY; ferrous nodules

LL =	PL =	PI =	Assumed GS= 2.75	Type: Undisturbed

Project No.: 23.14.175
Date Sampled: 8/24/23
Remarks:

Test method: ASTM D2166
Failure type: Vertical shear

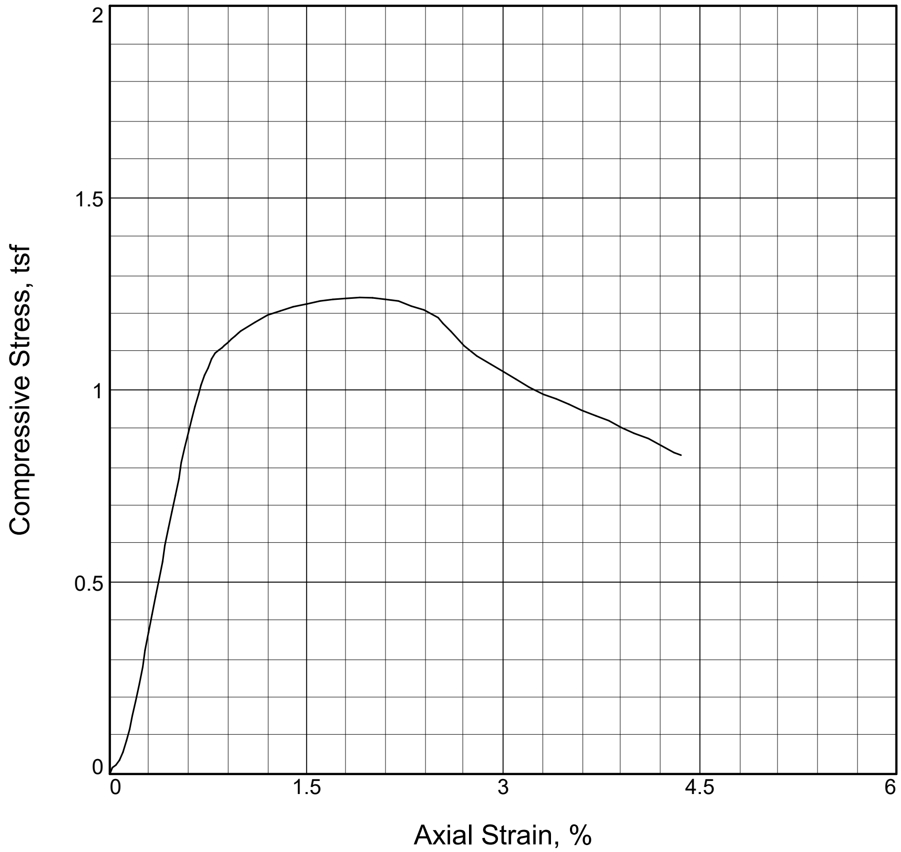
Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-3 **Depth:** 38

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: BP

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.241			
Undrained shear strength, tsf	0.620			
Failure strain, %	1.9			
Strain rate, %/min.	1.00			
Water content, %	35.2			
Wet density, pcf	117.7			
Dry density, pcf	87.0			
Saturation, %	99.6			
Void ratio	0.9724			
Specimen diameter, in.	2.86			
Specimen height, in.	5.75			
Height/diameter ratio	2.01			

Description: Gray FAT CLAY

LL =	PL =	PI =	Assumed GS= 2.75	Type: Undisturbed

Project No.: 23.14.175
Date Sampled: 8/28
Remarks:
Test type: ASTM D2166
Failure type: Slickensided

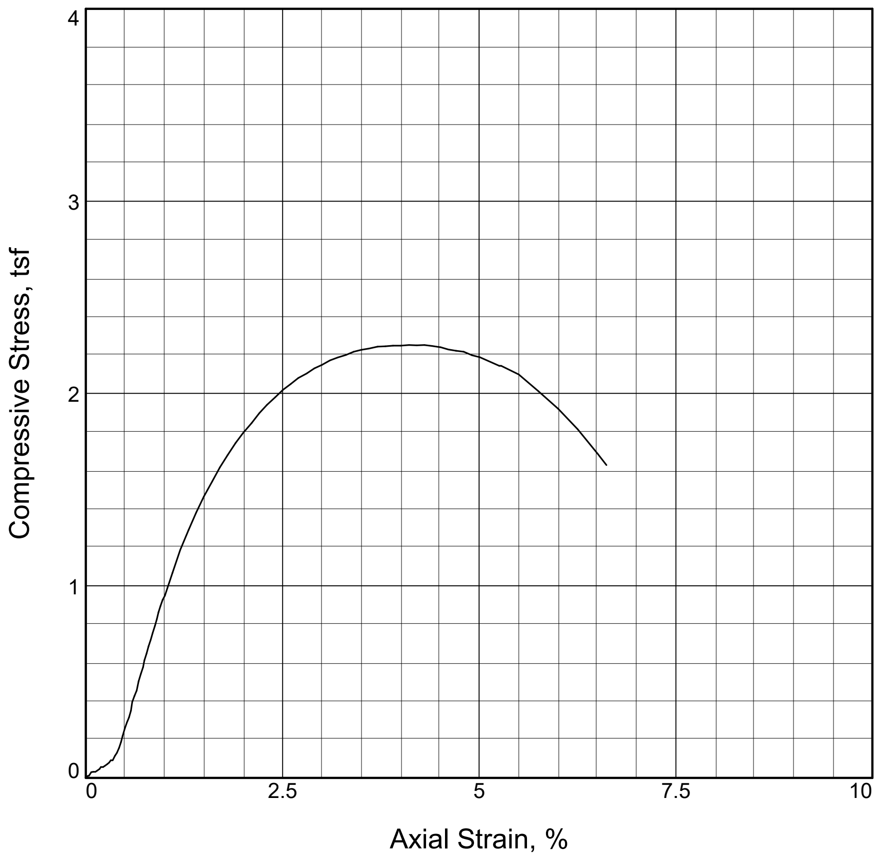
Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-4 **Depth:** 58

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: DM

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.252			
Undrained shear strength, tsf	1.126			
Failure strain, %	4.1			
Strain rate, %/min.	1.00			
Water content, %	26.4			
Wet density, pcf	123.1			
Dry density, pcf	97.4			
Saturation, %	97.6			
Void ratio	0.7310			
Specimen diameter, in.	2.88			
Specimen height, in.	5.91			
Height/diameter ratio	2.05			

Description: Reddish-brown FAT CLAY

LL =	**PL =**	**PI =**	**Assumed GS=** 2.70	**Type:** Undisturbed

Project No.: 23.14.175
Date Sampled: 8/25/23
Remarks:

Test method: ASTM D2166
Failure type: Vertical shear

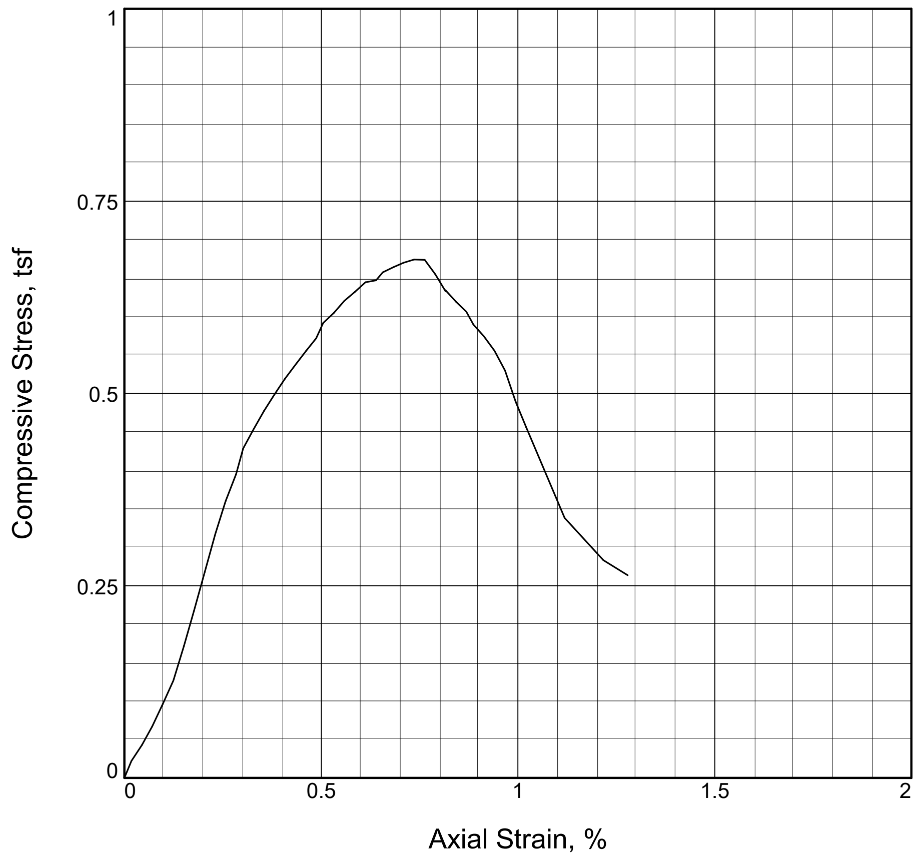
Figure _______

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-6 **Depth:** 20

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.674			
Undrained shear strength, tsf	0.337			
Failure strain, %	0.7			
Strain rate, %/min.	1.00			
Water content, %	28.4			
Wet density, pcf	120.5			
Dry density, pcf	93.9			
Saturation, %	96.3			
Void ratio	0.7958			
Specimen diameter, in.	2.88			
Specimen height, in.	5.91			
Height/diameter ratio	2.05			

Description: Reddish-brown FAT CLAY

LL =	**PL =**	**PI =**	**Assumed GS=** 2.70	**Type:** Undisturbed

Project No.: 23.14.175
Date Sampled: 8/25/23
Remarks:

Test method: ASTM D2166
Failure type: Slickensided

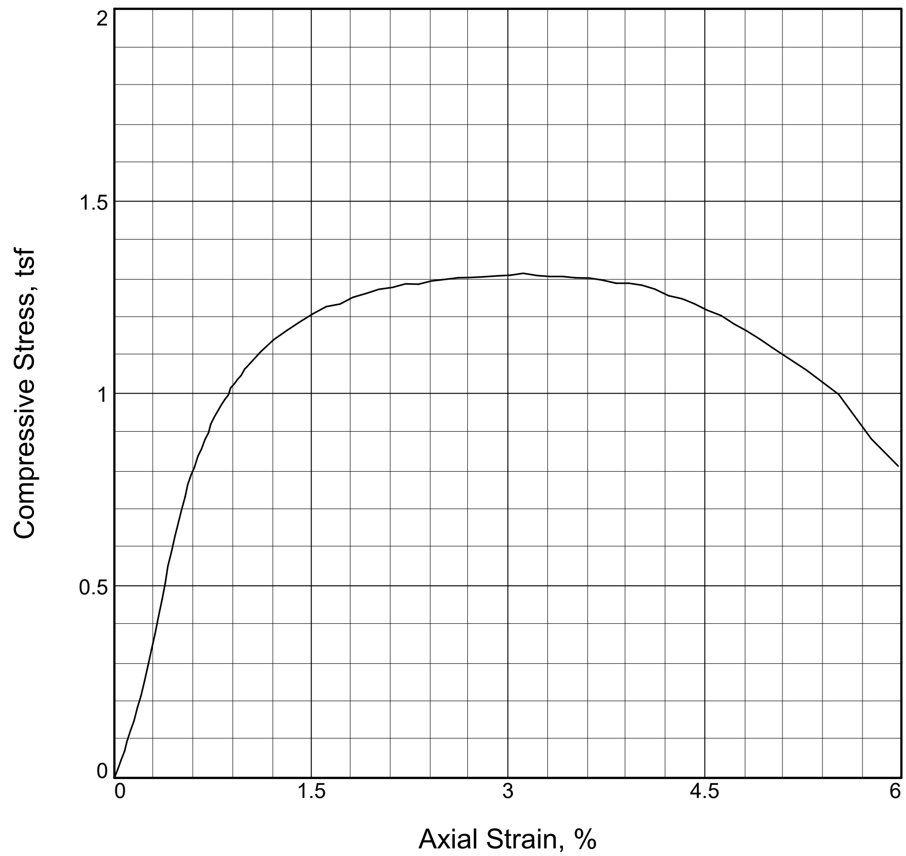
Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-6 **Depth:** 26

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.312			
Undrained shear strength, tsf	0.656			
Failure strain, %	3.1			
Strain rate, %/min.	1.00			
Water content, %	39.1			
Wet density, pcf	115.1			
Dry density, pcf	82.7			
Saturation, %	98.4			
Void ratio	1.1130			
Specimen diameter, in.	2.80			
Specimen height, in.	5.91			
Height/diameter ratio	2.11			

Description: Brown FAT CLAY

LL =	PL =	PI =	Assumed GS= 2.80	Type: Undisturbed

Project No.: 23.14.175
Date Sampled: 8/25/23
Remarks:

Test method: ASTM D2166
Failure type: Vertical shear

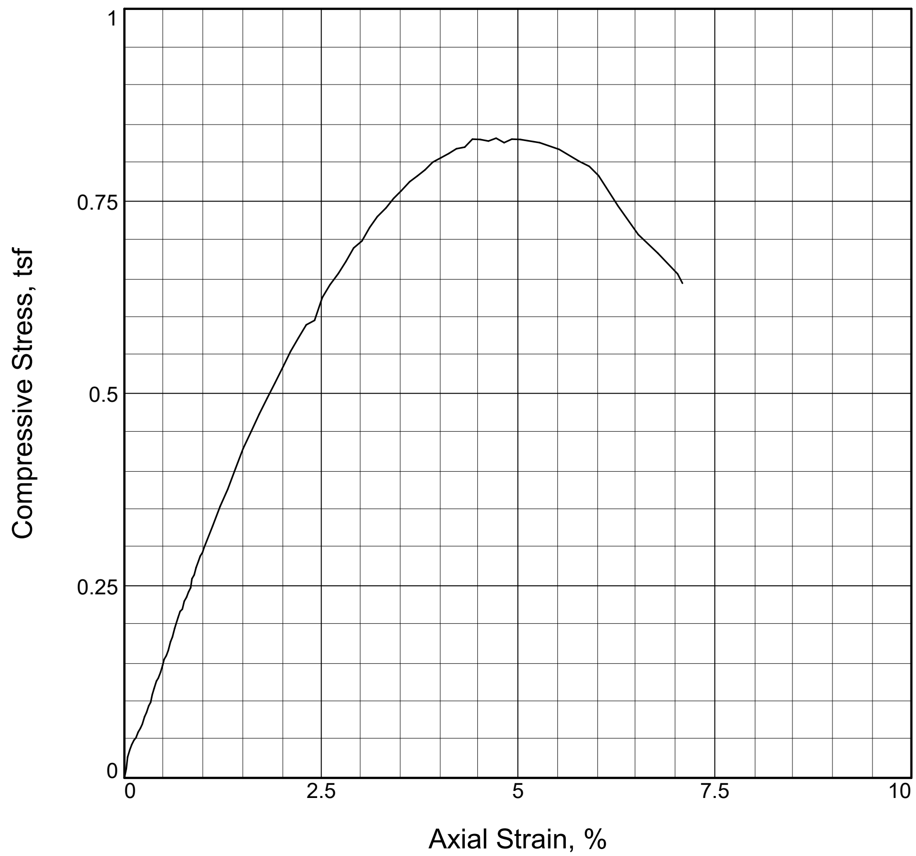
Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-6 **Depth:** 38

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.832			
Undrained shear strength, tsf	0.416			
Failure strain, %	4.7			
Strain rate, %/min.	1.00			
Water content, %	32.7			
Wet density, pcf	119.4			
Dry density, pcf	90.0			
Saturation, %	99.0			
Void ratio	0.9086			
Specimen diameter, in.	2.87			
Specimen height, in.	5.89			
Height/diameter ratio	2.06			

Description: Brown FAT CLAY

LL =	**PL =**	**PI =**	**Assumed GS=** 2.75	**Type:** Undisturbed

Project No.: 23.14.175
Date Sampled: 8/25/23
Remarks:

Test method: ASTM D2166
Failure type: Vertical shear

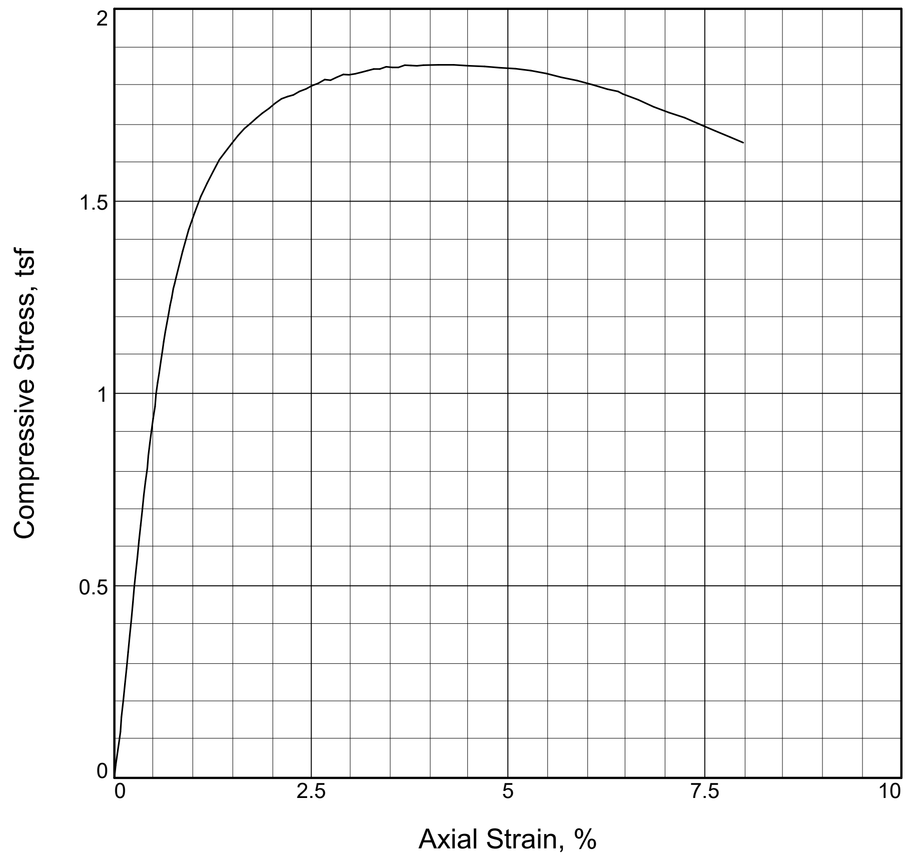
Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-7 **Depth:** 16

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.855			
Undrained shear strength, tsf	0.927			
Failure strain, %	4.3			
Strain rate, %/min.	1.00			
Water content, %	37.4			
Wet density, pcf	111.3			
Dry density, pcf	81.0			
Saturation, %	93.4			
Void ratio	1.0816			
Specimen diameter, in.	2.87			
Specimen height, in.	5.46			
Height/diameter ratio	1.91			

Description: Brown FAT CLAY

LL =	PL =	PI =	Assumed GS= 2.70	Type: Undisturbed

Project No.: 23.14.175
Date Sampled: 8/25/23
Remarks:

Test method: ASTM D2166
Failure type: Vertical shear

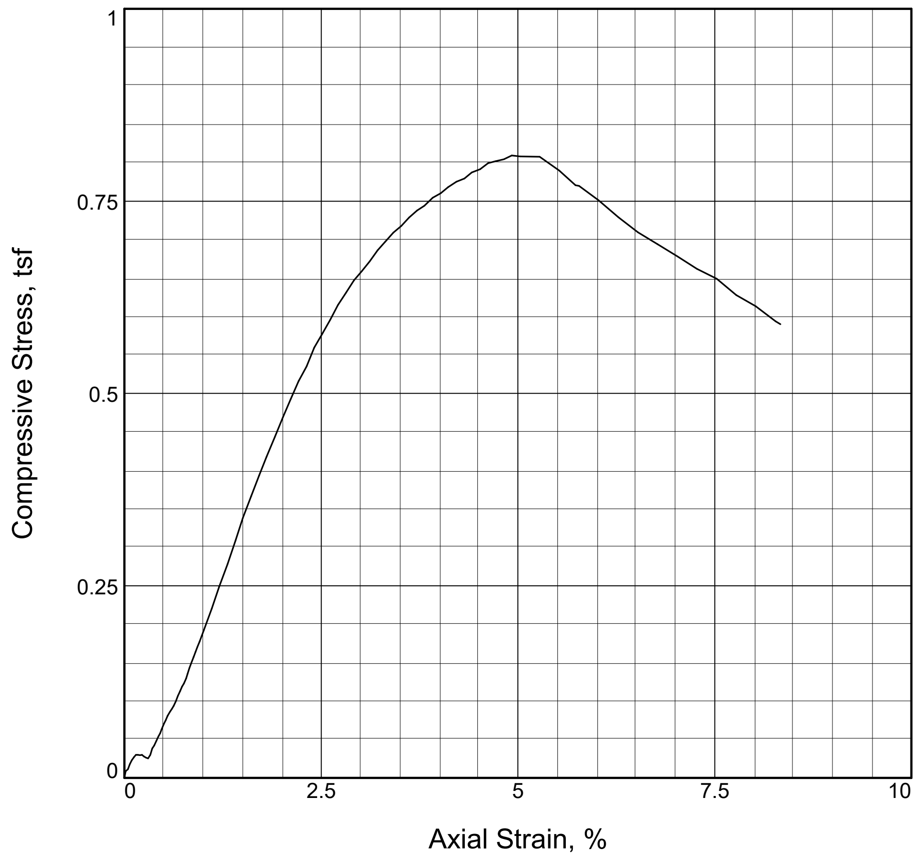
Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-7 **Depth:** 53

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.810			
Undrained shear strength, tsf	0.405			
Failure strain, %	4.9			
Strain rate, %/min.	1.00			
Water content, %	24.9			
Wet density, pcf	126.7			
Dry density, pcf	101.5			
Saturation, %	99.0			
Void ratio	0.6919			
Specimen diameter, in.	2.86			
Specimen height, in.	5.86			
Height/diameter ratio	2.05			

Description: Grey LEAN CLAY with SAND

LL =	**PL =**	**PI =**	**Assumed GS=** 2.75	**Type:** Undisturbed

Project No.: 23.14.175
Date Sampled: 9/13/23
Remarks:

Test method: ASTM D2166
Failure type: Vertical shear

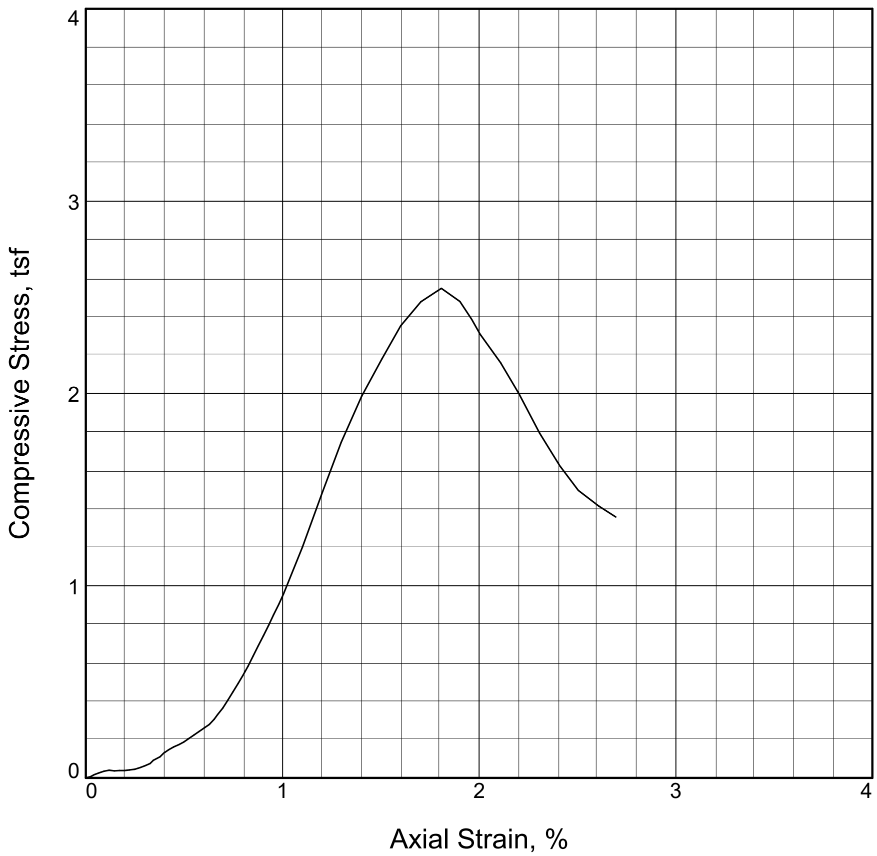
Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-8 **Depth:** 38

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.547			
Undrained shear strength, tsf	1.274			
Failure strain, %	1.8			
Strain rate, %/min.	1.00			
Water content, %	24.6			
Wet density, pcf	124.4			
Dry density, pcf	99.8			
Saturation, %	96.6			
Void ratio	0.6886			
Specimen diameter, in.	2.89			
Specimen height, in.	5.91			
Height/diameter ratio	2.04			

Description: Grey FAT CLAY

LL =	PL =	PI =	Assumed GS= 2.70	Type: Undisturbed

Project No.: 23.14.175
Date Sampled: 9/13/23
Remarks:

Test method: ASTM D2166
Failure type: Vertical shear

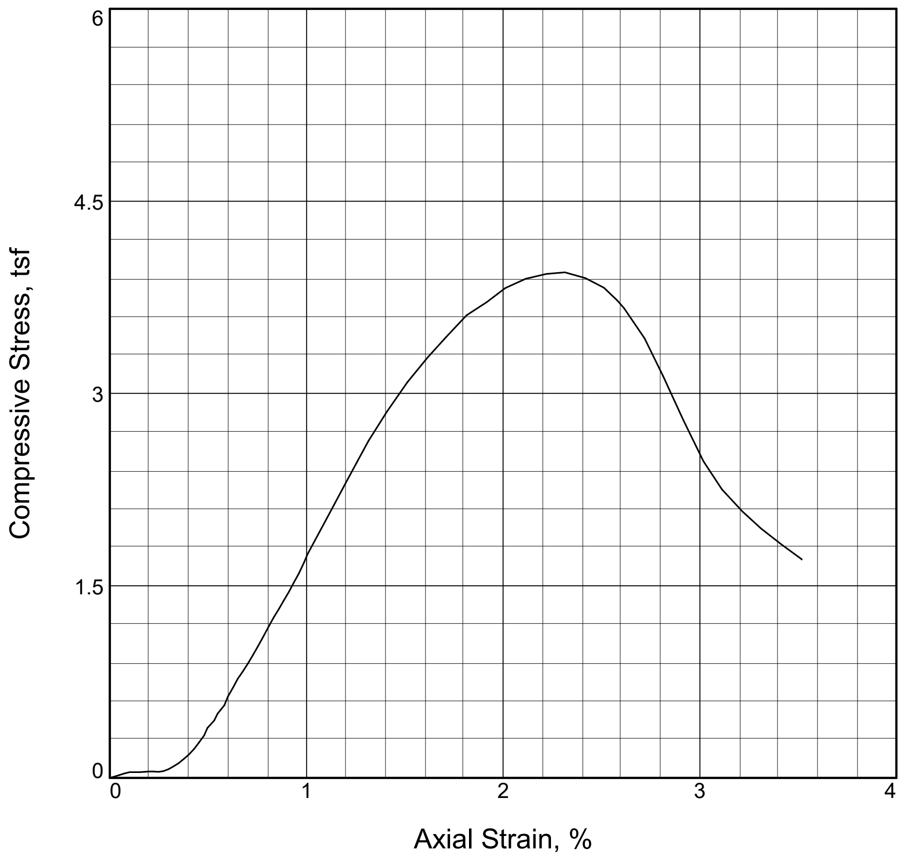
Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-8 **Depth:** 98

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	3.946			
Undrained shear strength, tsf	1.973			
Failure strain, %	2.3			
Strain rate, %/min.	1.00			
Water content, %	23.7			
Wet density, pcf	125.7			
Dry density, pcf	101.7			
Saturation, %	97.1			
Void ratio	0.6577			
Specimen diameter, in.	2.90			
Specimen height, in.	5.90			
Height/diameter ratio	2.04			

Description: Brown and grey FAT CLAY

LL =	PL =	PI =	Assumed GS= 2.70	Type: Undisturbed

Project No.: 23.14.175
Date Sampled: 9/13/23
Remarks:

Test method: ASTM D2166
Failure type: Vertical shear

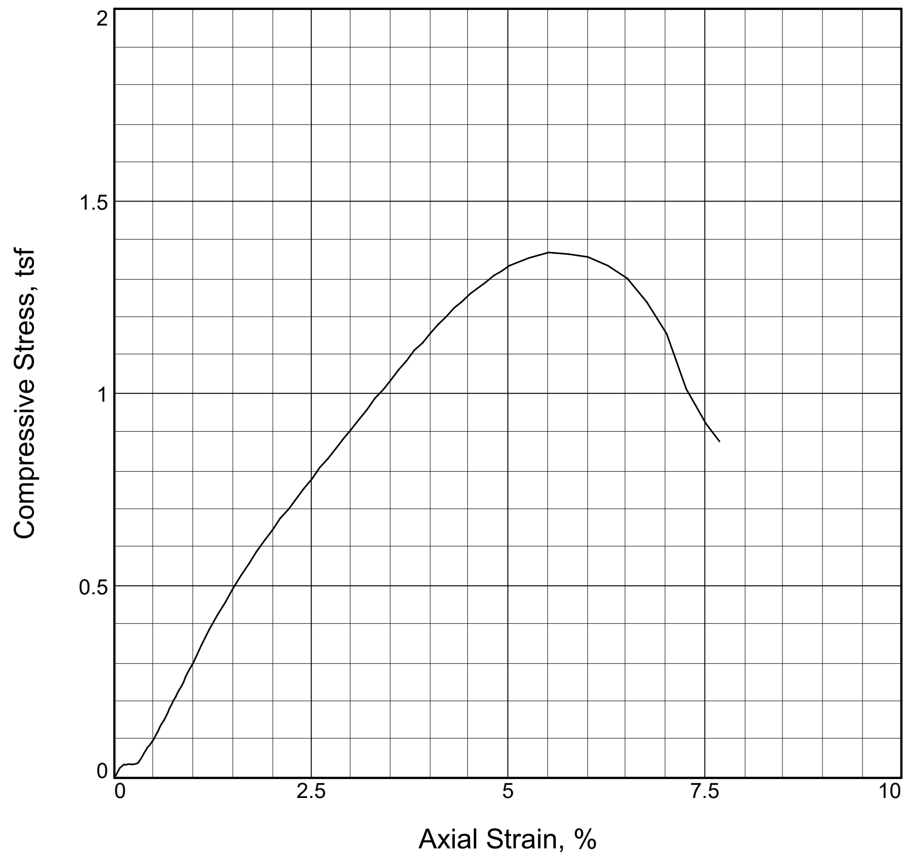
Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-8 **Depth:** 108

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.366			
Undrained shear strength, tsf	0.683			
Failure strain, %	5.5			
Strain rate, %/min.	1.00			
Water content, %	31.2			
Wet density, pcf	115.5			
Dry density, pcf	88.0			
Saturation, %	92.0			
Void ratio	0.9149			
Specimen diameter, in.	2.93			
Specimen height, in.	5.85			
Height/diameter ratio	2.00			

Description: Grey FAT CLAY

LL =	**PL =**	**PI =**	**Assumed GS=** 2.70	**Type:** Undisturbed

Project No.: 23.14.175
Date Sampled: 9/13/23
Remarks:

Test method: ASTM D2166
Failure type: Vertical shear

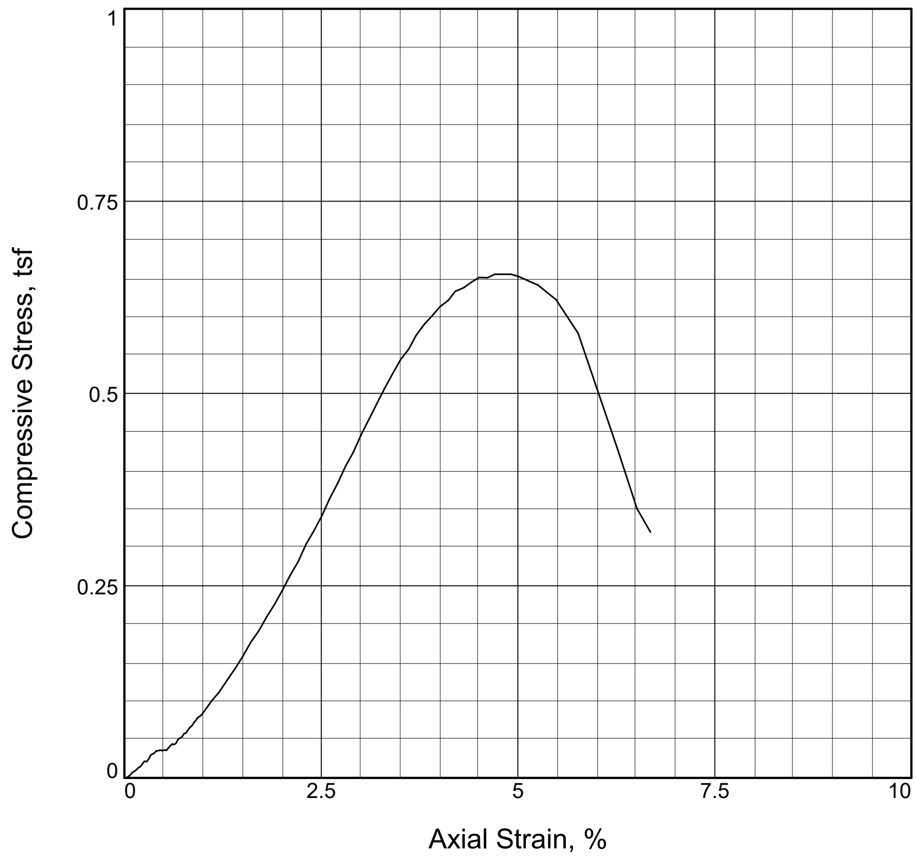
Figure _______

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-8 **Depth:** 123

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.655			
Undrained shear strength, tsf	0.328			
Failure strain, %	4.9			
Strain rate, %/min.	1.00			
Water content, %	25.8			
Wet density, pcf	129.0			
Dry density, pcf	102.6			
Saturation, %	100.0			
Void ratio	0.7341			
Specimen diameter, in.	2.82			
Specimen height, in.	5.77			
Height/diameter ratio	2.04			

Description: Grey FAT CLAY

LL =	**PL =**	**PI =**	**Assumed GS=** 2.85	**Type:** Undisturbed

Project No.: 23.14.175
Date Sampled: 9/13/23
Remarks:

Test method: ASTM D2166
Failure type: Vertical shear

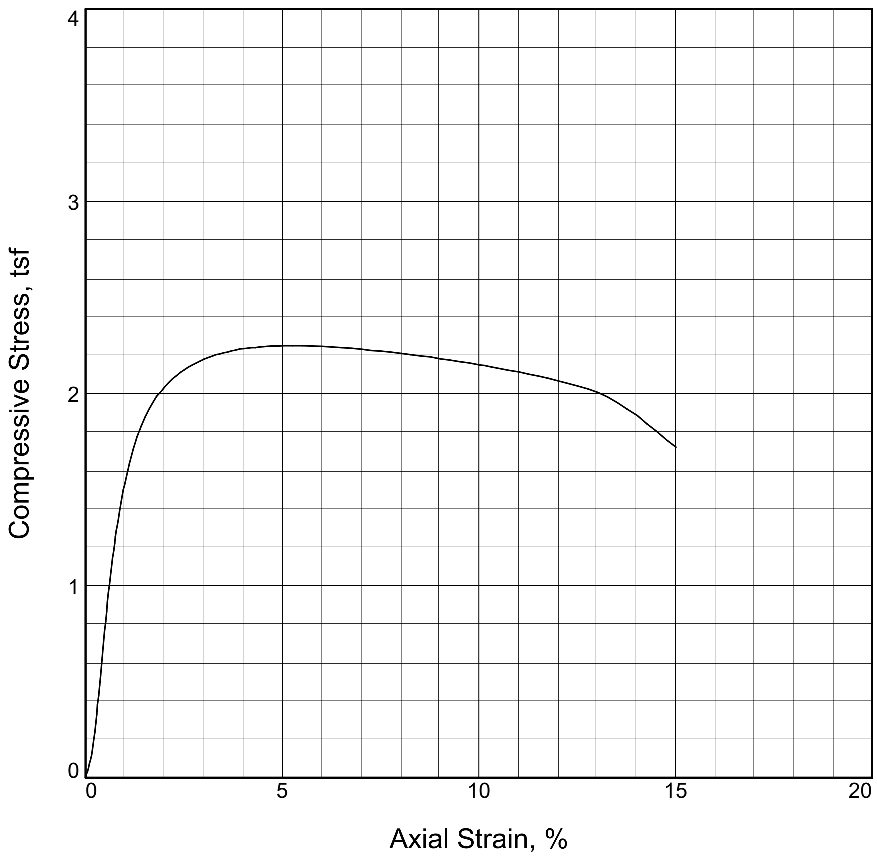
Figure _______

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-8 **Depth:** 143

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.249			
Undrained shear strength, tsf	1.125			
Failure strain, %	5.3			
Strain rate, %/min.	1.00			
Water content, %	32.0			
Wet density, pcf	120.5			
Dry density, pcf	91.3			
Saturation, %	100.0			
Void ratio	0.8803			
Specimen diameter, in.	2.84			
Specimen height, in.	5.90			
Height/diameter ratio	2.08			

Description: Grey FAT CLAY

LL = 76	**PL =** 32	**PI =** 44	**Assumed GS=** 2.75	**Type:** Undisturbed

Project No.: 23.14.175
Date Sampled: 9/14/23
Remarks:

Test method: ASTM D2166
Failure type: Slickensided

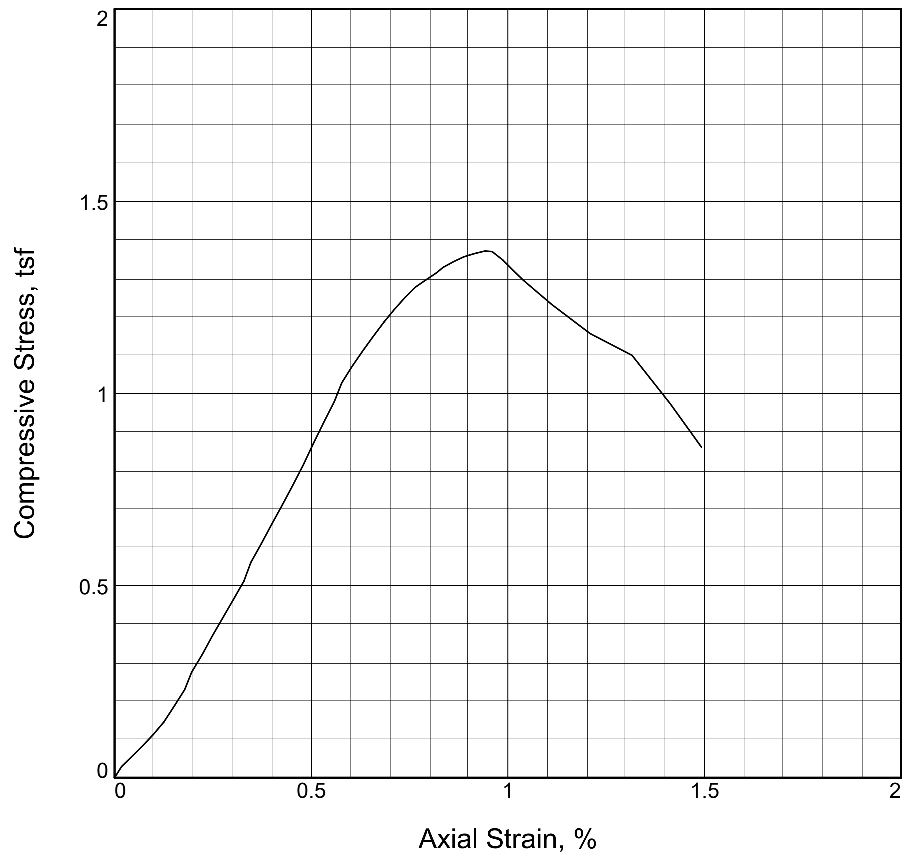
Figure _______

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-9 **Depth:** 48

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.371			
Undrained shear strength, tsf	0.685			
Failure strain, %	0.9			
Strain rate, %/min.	1.00			
Water content, %	31.5			
Wet density, pcf	122.7			
Dry density, pcf	93.4			
Saturation, %	99.0			
Void ratio	0.9056			
Specimen diameter, in.	2.86			
Specimen height, in.	5.91			
Height/diameter ratio	2.06			

Description: Reddish-brown FAT CLAY

LL =	PL =	PI =	Assumed GS= 2.85	Type: Undisturbed

Project No.: 23.14.175
Date Sampled: 9/14/23
Remarks:

Test method: ASTM D2166
failure type: Slickensided

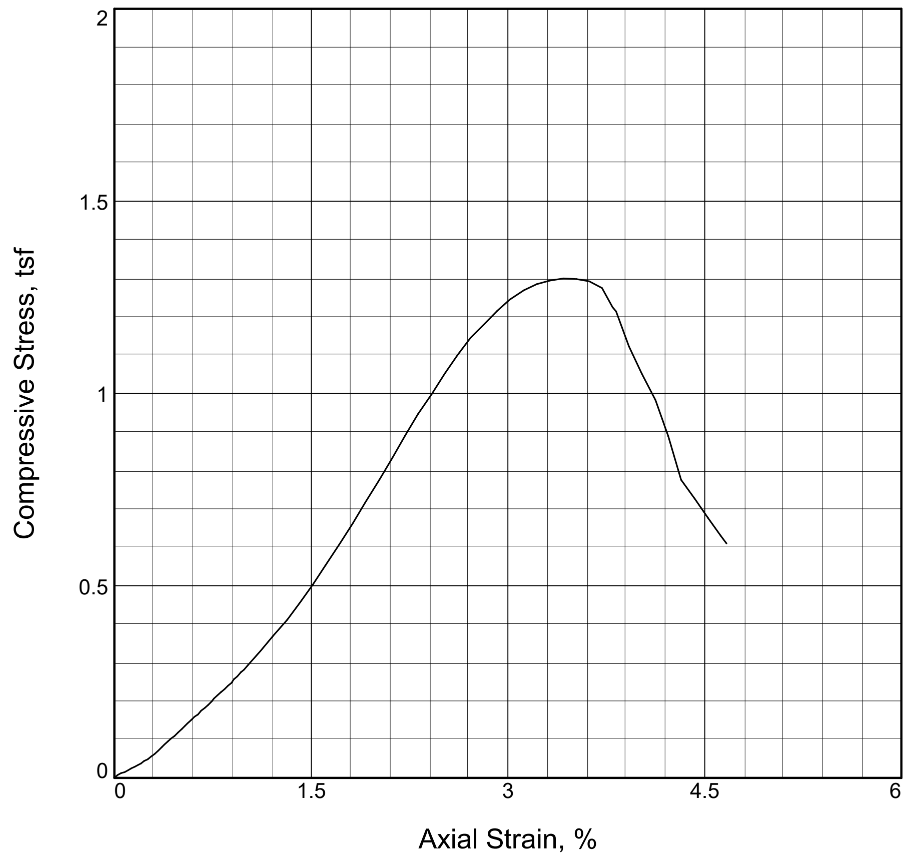
Figure _______

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-9 **Depth:** 88

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.299			
Undrained shear strength, tsf	0.650			
Failure strain, %	3.4			
Strain rate, %/min.	1.00			
Water content, %	20.3			
Wet density, pcf	132.2			
Dry density, pcf	109.9			
Saturation, %	99.3			
Void ratio	0.5622			
Specimen diameter, in.	2.85			
Specimen height, in.	5.87			
Height/diameter ratio	2.06			

Description: Grey LEAN CLAY with SAND

LL = 31	**PL =** 19	**PI =** 12	**Assumed GS=** 2.75	**Type:** Undisturbed

Project No.: 23.14.175
Date Sampled: 9/14/23
Remarks:

Test method: ASTM D2166
Failure type: Vertical shear

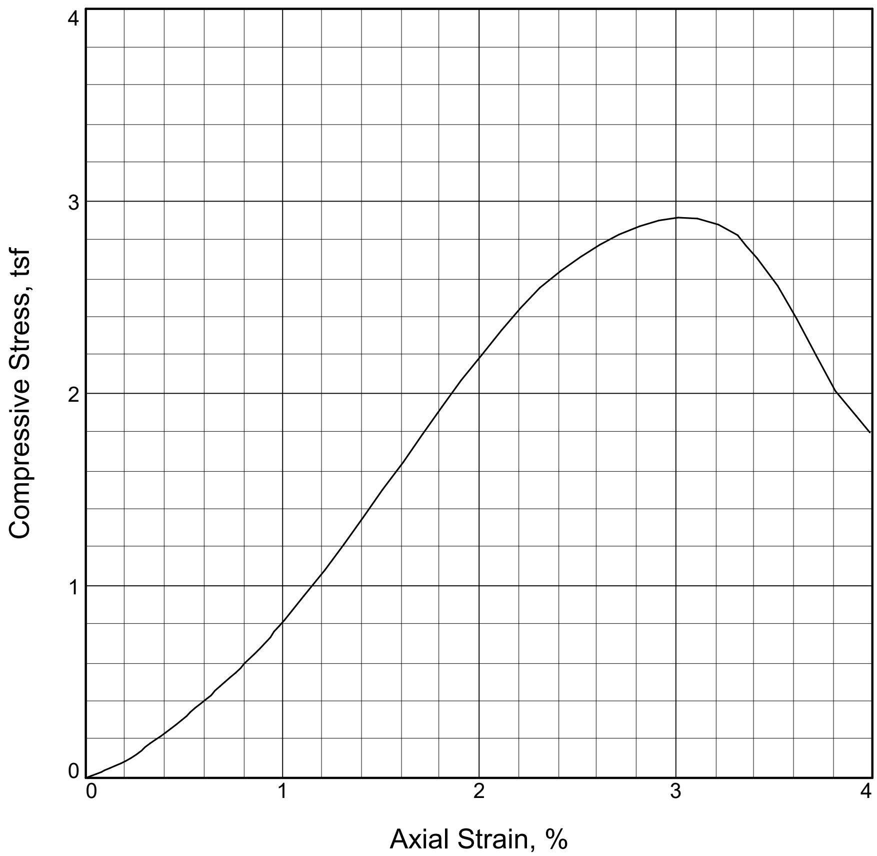
Figure _______

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-9 **Depth:** 103

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.915			
Undrained shear strength, tsf	1.457			
Failure strain, %	3.0			
Strain rate, %/min.	1.00			
Water content, %	35.6			
Wet density, pcf	117.6			
Dry density, pcf	86.8			
Saturation, %	99.9			
Void ratio	0.9785			
Specimen diameter, in.	2.87			
Specimen height, in.	5.89			
Height/diameter ratio	2.05			

Description: Grey FAT CLAY

LL =	PL =	PI =	Assumed GS= 2.75	Type: Undisturbed

Project No.: 23.14.175
Date Sampled: 9/15/23
Remarks:

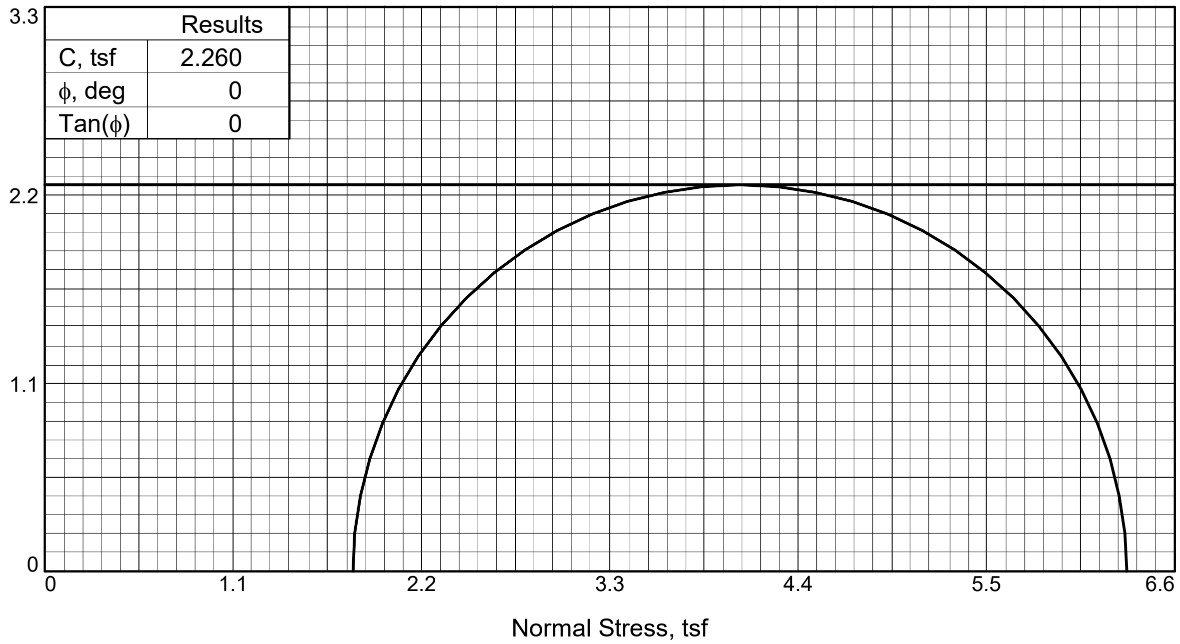
Test method: ASTM D2166
Failure type: Vertical shear

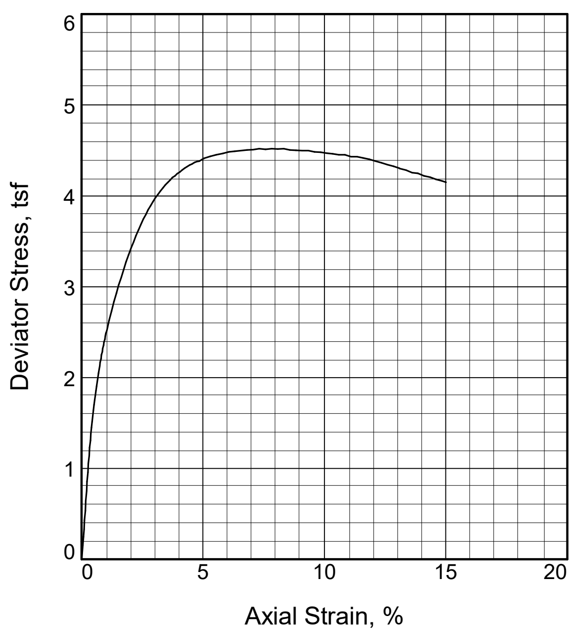
Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-9 **Depth:** 148

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL





Sample No.		1
Initial	Water Content, %	17.8
	Dry Density, pcf	115.9
	Saturation, %	98.3
	Void Ratio	0.5085
	Diameter, in.	2.84
	Height, in.	5.90
At Test	Water Content, %	16.9
	Dry Density, pcf	115.9
	Saturation, %	93.2
	Void Ratio	0.5085
	Diameter, in.	2.84
	Height, in.	5.90
Strain rate, %/min.		1.00
Back Pressure, psi		0.00
Cell Pressure, psi		25.00
Fail. Stress, tsf		4.52
Strain, %		7.8
Ult. Stress, tsf		
Strain, %		
σ_1 Failure, tsf		6.32
σ_3 Failure, tsf		1.80

Type of Test:
Unconsolidated Undrained

Sample Type: Undisturbed

Description: Brown SANDY LEAN CLAY

Assumed Specific Gravity= 2.80

Remarks:

Test method: ASTM D2850

Failure type: Multiple shear

Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX

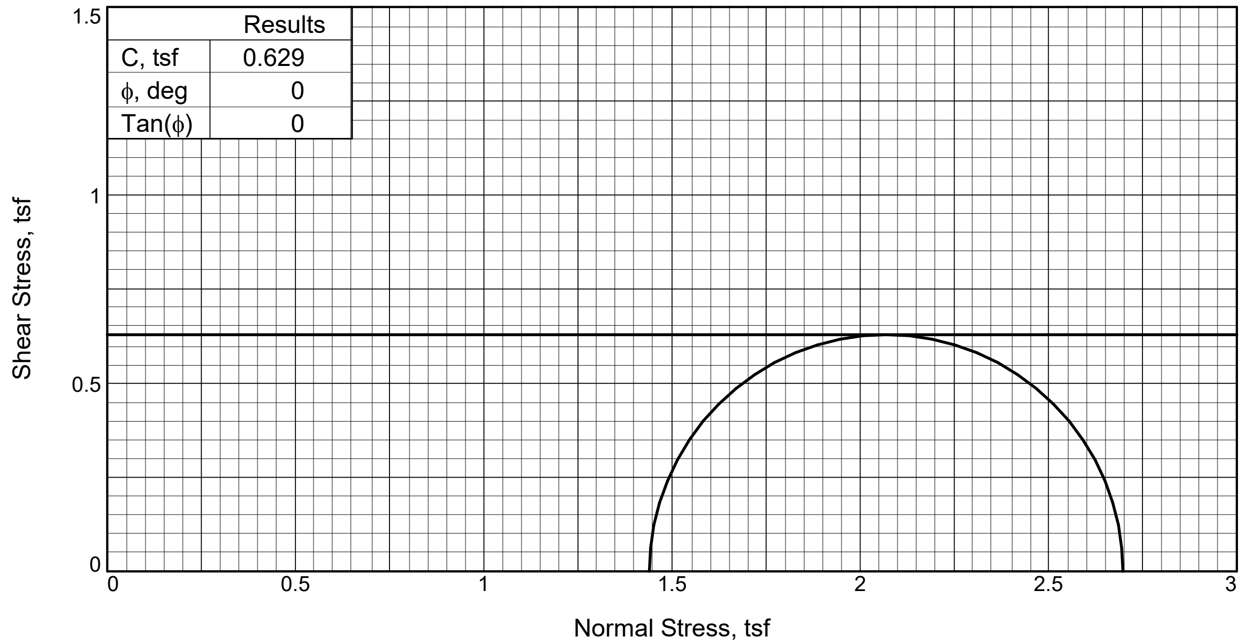
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

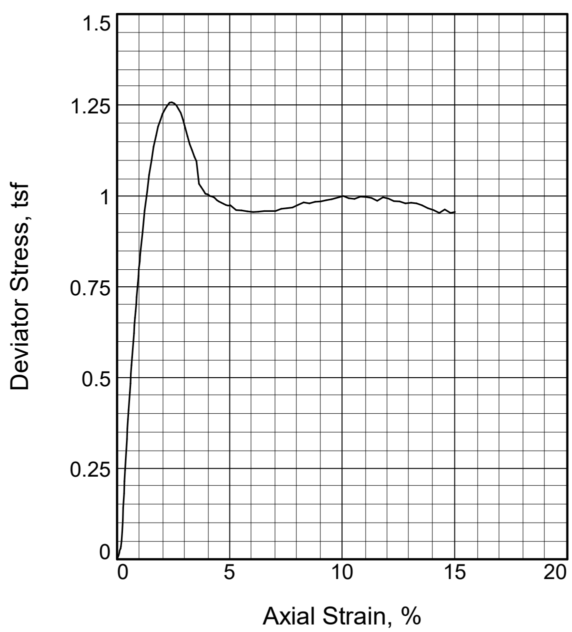
Source of Sample: B-2 **Depth:** 73

Proj. No.: 23.14.175 **Date Sampled:** 9/13/23

TRIAXIAL SHEAR TEST REPORT
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL





Sample No.		1
Initial	Water Content, %	48.8
	Dry Density, pcf	72.6
	Saturation, %	99.7
	Void Ratio	1.3223
	Diameter, in.	2.86
	Height, in.	5.90
At Test	Water Content, %	48.5
	Dry Density, pcf	72.6
	Saturation, %	99.0
	Void Ratio	1.3223
	Diameter, in.	2.86
	Height, in.	5.90
Strain rate, %/min.		1.00
Back Pressure, psi		0.00
Cell Pressure, psi		20.00
Fail. Stress, tsf		1.26
Strain, %		2.4
Ult. Stress, tsf		
Strain, %		
σ_1 Failure, tsf		2.70
σ_3 Failure, tsf		1.44

Type of Test:
Unconsolidated Undrained
Sample Type: Undisturbed
Description: Grey FAT CLAY

Assumed Specific Gravity= 2.70
Remarks:
Test method: ASTM D2850
Failure type: Slickensided

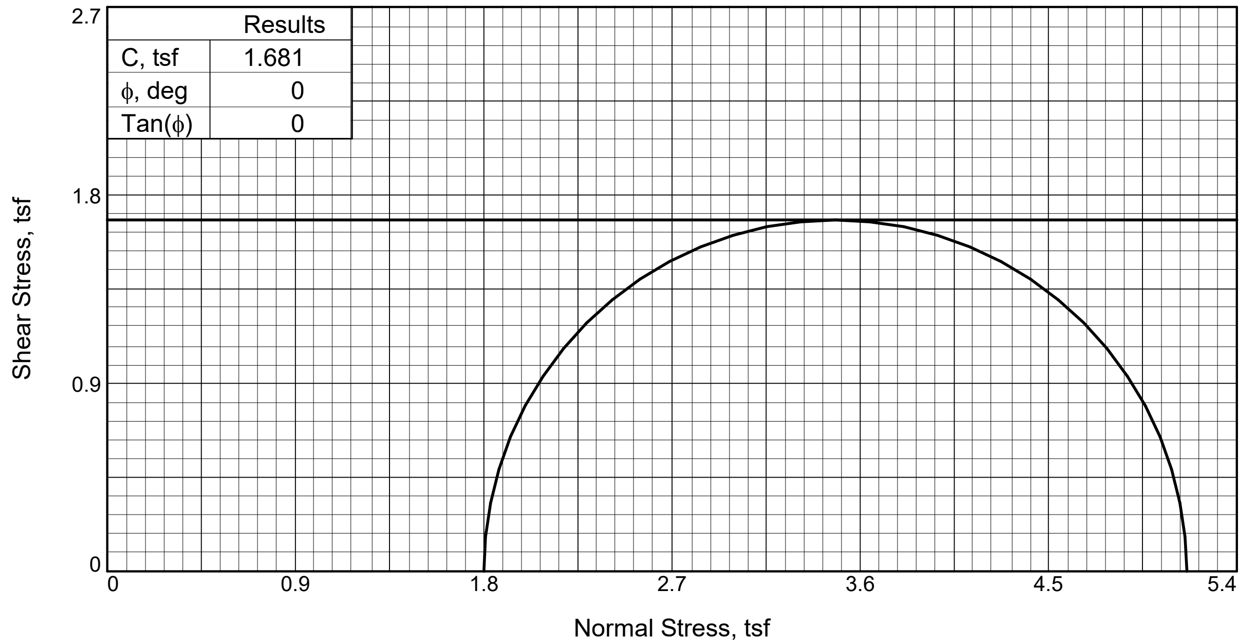
Figure ________

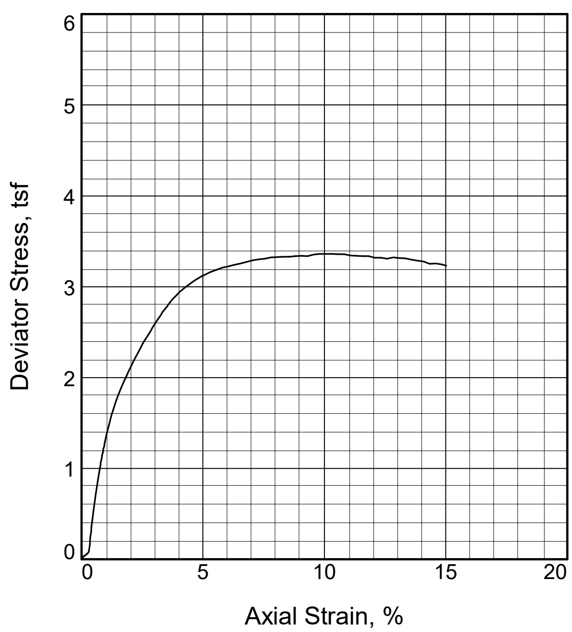
Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-8 **Depth:** 58

Proj. No.: 23.14.175 **Date Sampled:** 9/13/23

TRIAXIAL SHEAR TEST REPORT
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL





Sample No.		1
Initial	Water Content, %	23.0
	Dry Density, pcf	103.7
	Saturation, %	99.3
	Void Ratio	0.6259
	Diameter, in.	2.89
	Height, in.	5.91
At Test	Water Content, %	16.6
	Dry Density, pcf	103.7
	Saturation, %	71.5
	Void Ratio	0.6259
	Diameter, in.	2.89
	Height, in.	5.91
Strain rate, %/min.		1.00
Back Pressure, psi		0.00
Cell Pressure, psi		25.00
Fail. Stress, tsf		3.36
Strain, %		10.1
Ult. Stress, tsf		
Strain, %		
σ_1 Failure, tsf		5.16
σ_3 Failure, tsf		1.80

Type of Test:
Unconsolidated Undrained
Sample Type: Undisturbed
Description: Brown and grey FAT CLAY; calcareous and aggregate
LL= 55 **PL=** 22 **PI=** 33
Assumed Specific Gravity= 2.70
Remarks:
Test method: ASTM D2850
Failure type: Vertical shear

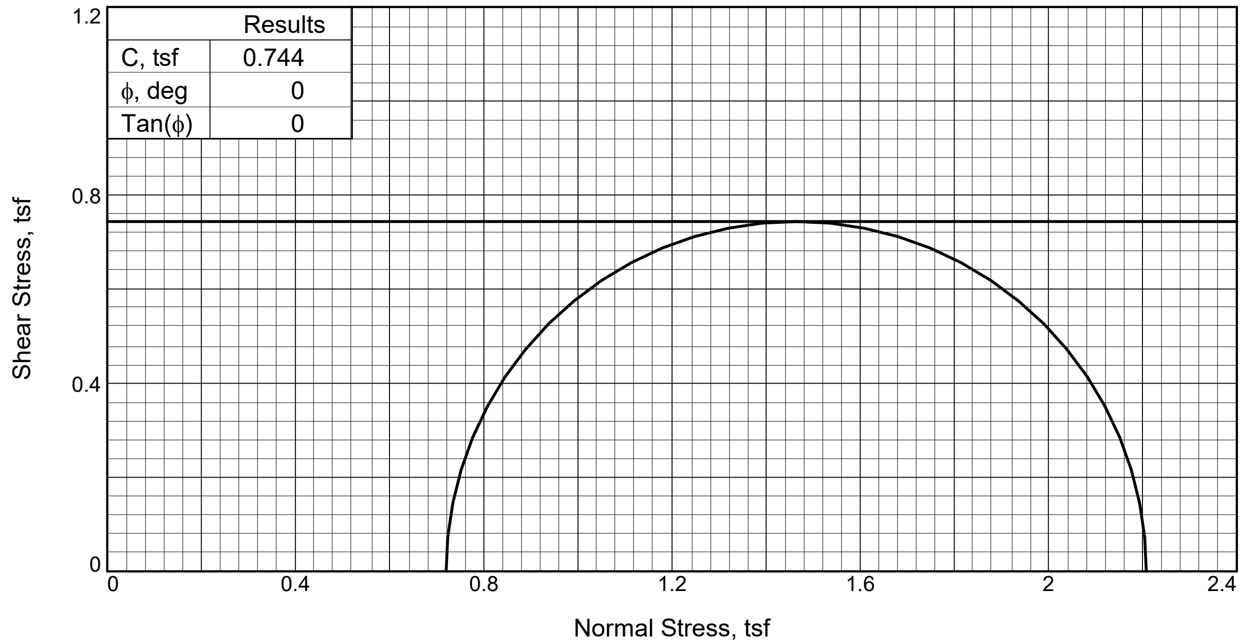
Figure ________

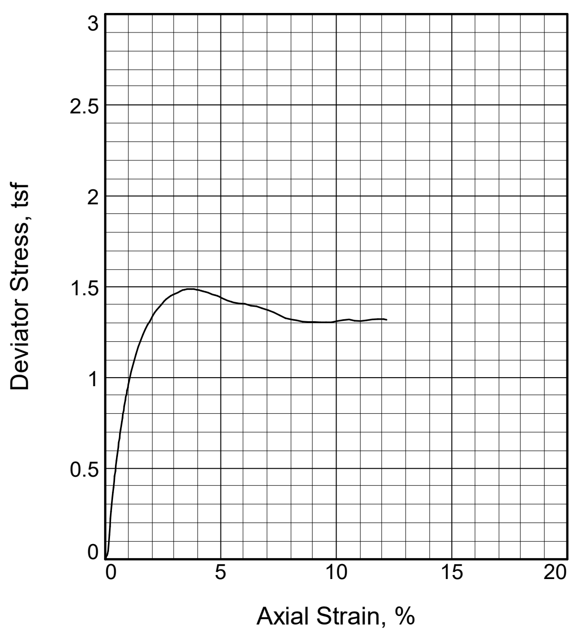
Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-8 **Depth:** 78

Proj. No.: 23.14.175 **Date Sampled:** 9/13/23

TRIAXIAL SHEAR TEST REPORT
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL





Sample No.		1
Initial	Water Content, %	31.8
	Dry Density, pcf	91.2
	Saturation, %	99.0
	Void Ratio	0.8832
	Diameter, in.	2.84
	Height, in.	5.89
At Test	Water Content, %	31.9
	Dry Density, pcf	91.2
	Saturation, %	99.2
	Void Ratio	0.8832
	Diameter, in.	2.84
	Height, in.	5.89
Strain rate, %/min.		1.00
Back Pressure, psi		0.00
Cell Pressure, psi		10.00
Fail. Stress, tsf		1.49
Strain, %		3.8
Ult. Stress, tsf		
Strain, %		
σ_1 Failure, tsf		2.21
σ_3 Failure, tsf		0.72

Type of Test:
Unconsolidated Undrained
Sample Type: Undisturbed
Description: Reddish-brown FAT CLAY

LL= 75 **PL=** 36 **PI=** 39
Assumed Specific Gravity= 2.75
Remarks:
Test method: ASTM D2166
Failure type: Slickensided

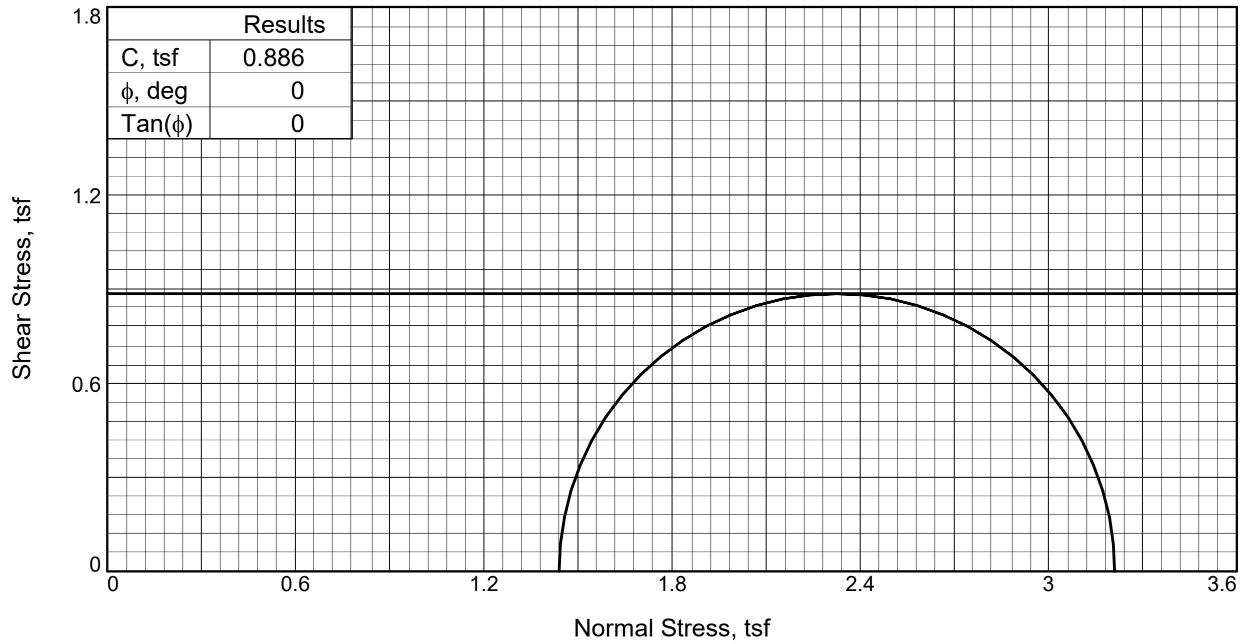
Figure ________

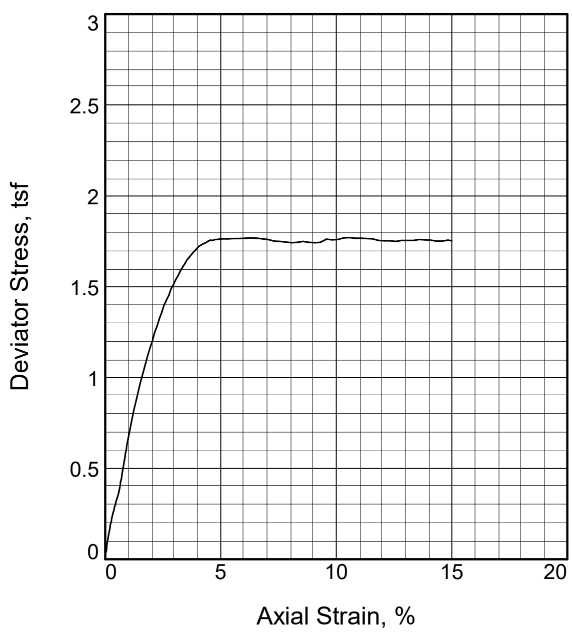
Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements;
Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-9 **Depth:** 33

Proj. No.: 23.14.175 **Date Sampled:** 9/13/23

TRIAXIAL SHEAR TEST REPORT
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL





Sample No.		1
Initial	Water Content, %	22.2
	Dry Density, pcf	101.4
	Saturation, %	90.5
	Void Ratio	0.6616
	Diameter, in.	2.88
	Height, in.	5.75
At Test	Water Content, %	20.4
	Dry Density, pcf	101.4
	Saturation, %	83.2
	Void Ratio	0.6616
	Diameter, in.	2.88
	Height, in.	5.75
Strain rate, %/min.		1.00
Back Pressure, psi		0.00
Cell Pressure, psi		20.00
Fail. Stress, tsf		1.77
Strain, %		10.6
Ult. Stress, tsf		
Strain, %		
σ_1 Failure, tsf		3.21
σ_3 Failure, tsf		1.44

Type of Test:
Unconsolidated Undrained

Sample Type: Undisturbed

Description: Grey SANDY LEAN CLAY

Assumed Specific Gravity= 2.70

Remarks:
Test method: ASTM D2850
Failure type: Vertical shear

Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX

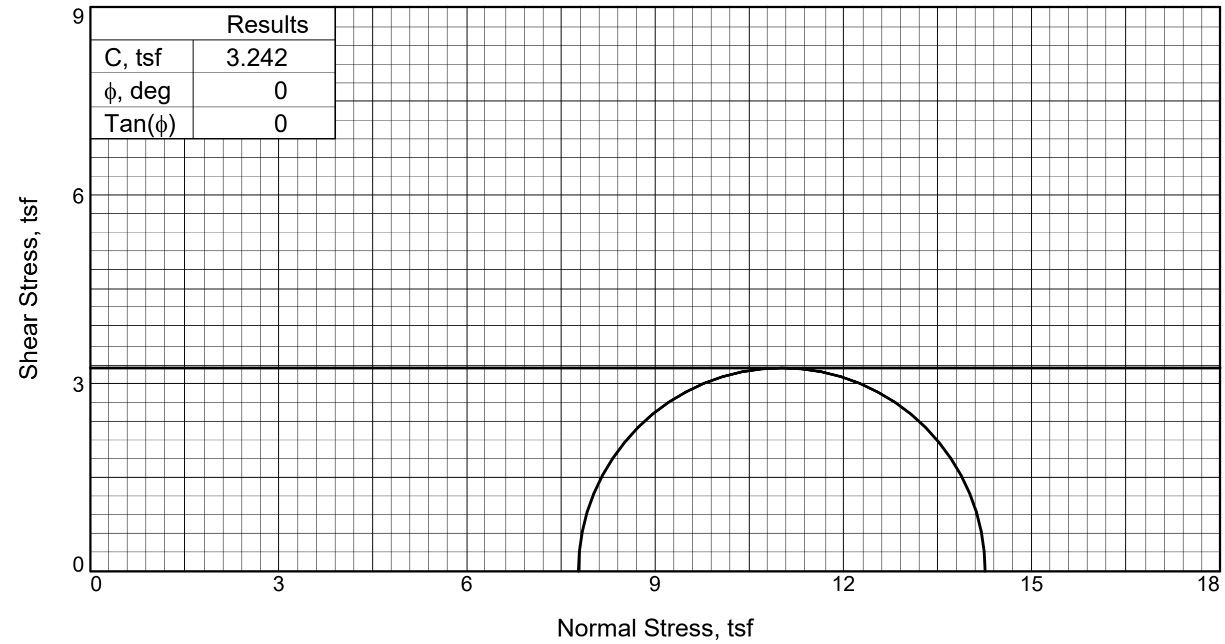
Project: Sampling & Laboratory Testing - Channel Improvements;
Proposed Cedar Port Improvement & Navigation District

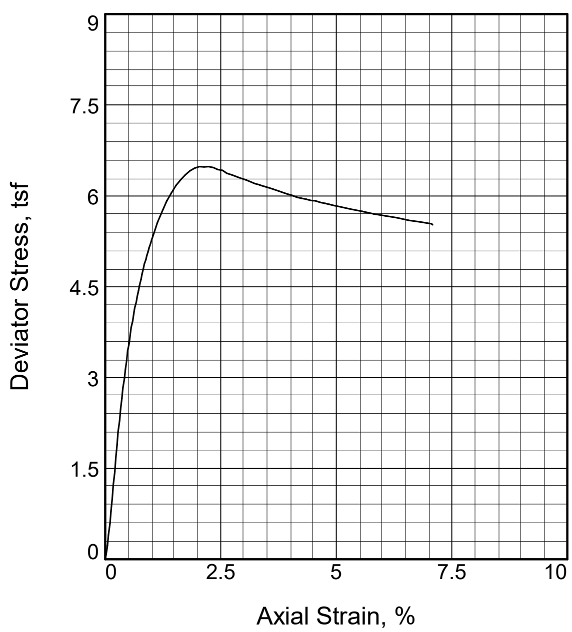
Source of Sample: B-9 **Depth:** 118

Proj. No.: 23.14.175 **Date Sampled:** 9/13/23

TRIAXIAL SHEAR TEST REPORT
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: ALL





Sample No.		1
Initial	Water Content, %	22.2
	Dry Density, pcf	107.6
	Saturation, %	99.3
	Void Ratio	0.6248
	Diameter, in.	2.00
	Height, in.	4.00
At Test	Water Content, %	22.0
	Dry Density, pcf	107.6
	Saturation, %	98.8
	Void Ratio	0.6248
	Diameter, in.	2.00
	Height, in.	4.00
Strain rate, %/min.		1.00
Back Pressure, psi		0.00
Cell Pressure, psi		108.00
Fail. Stress, tsf		6.5
Strain, %		2.2
Ult. Stress, tsf		
Strain, %		
σ_1 Failure, tsf		14.3
σ_3 Failure, tsf		7.8

Type of Test:
Unconsolidated Undrained

Sample Type: Undisturbed

Description: Dark grey FAT CLAY; calcareous nodules

Assumed Specific Gravity= 2.80

Remarks:
Test type: ASTM D2850
Failure type: Slickensided

Figure ________

Client: Trans-Global Solutions, Inc
Houston, TX

Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

Source of Sample: B-9 **Depth:** 128

Proj. No.: 23.14.175 **Date Sampled:** 9/22/23

TRIAXIAL SHEAR TEST REPORT
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: DM

Laboratory Test Assignment Forms

Tolunay-Wong Engineers, Inc.

Project Name: Cedar port

Project Number: 23.14.175

Client Name:

Date Assigned:

Due Date:

Department:

Assigned By:

Project Manager:

Laboratory:

Sample ID			Soil Properties											Dispersion			Strength Tests					Volume Change Tests						Other
Boring Name	Depth (ft)	(C)ore, (J)ar, (B)ag	Water Content	Dry Unit Weight	Atterberg Limit	% Minus 200	Sieve Analysis	Sieve & Hydro	pH	Organic Content	Sulfates / Chlorides	Electrical Resistivity	Thermal Conductivity	Pinhole Dispersion	Crumb Dispersion	Hydraulic Conductivity	Torvane	Lab Vane Shear	UC Test S/S Curve (Y/N)	UU Triaxial Test S/S Curve (Y/N)	CU Triaxial Test w/ Pore Pressure	Incremental Consolidation	CRS Consolidation	Perform Consol QA	Overburden Stress for Consol. Test Q/A	Swell (Meth. A, B or C)	Free Swell (Holtz & Gibbs)	Remarks
B10	6-8	B																										
	8-10	B																										
	10-12	B																										
	12-14	B																										
	14-16	B																										
	16-18	B																										
	18-20	B																										
	20-22	C																										
	22-24	C																										
	24-26	C																										
	28-30	C																										
	33-35	C																										
	38-40	C																										
	43-45	C																										
	48-50	B																										
	53-55	B																										
	58-60	B																										
	63-65	B																										
TOTALS																												

Geotechnician: Josh S.

Date: 4-26-24

Date Assignments Received:

Received by:

Notes:

Tolunay-Wong Engineers, Inc.

Project Name: Cedar port
Project Number: 23.14.175
Client Name:

Date Assigned:
Due Date:
Department: HOU HEG

Assigned By:
Project Manager:
Laboratory:

Sample ID			Soil Properties											Dispersion			Strength Tests					Volume Change Tests						Other
Boring Name	Depth (ft)	(C)ore, (J)ar, (B)ag	Water Content	Dry Unit Weight	Atterberg Limit	% Minus 200	Sieve Analysis	Sieve & Hydro	pH	Organic Content	Sulfates / Chlorides	Electrical Resistivity	Thermal Conductivity	Pinhole Dispersion	Crumb Dispersion	Hydraulic Conductivity	Torvane	Lab Vane Shear	UC Test S/S Curve (Y/N)	UU Triaxial Test S/S Curve (Y/N)	CU Triaxial Test w/ Pore Pressure	Incremental Consolidation	CRS Consolidation	Perform Consol QA	Overburden Stress for Consol. Test Q/A	Swell (Meth. A, B, or C)	Free Swell (Holtz & Gibbs)	Remarks
B11	9-11	B																										
	11-13	B																										
	13-15	B																										
	15-17	B																										
	17-19	B																										
	19-21	B																										
	21-23	B																										
	23-25	B																										
	25-27	B																										
	27-29	B																										
	33-35	B																										
	38-40	B																										
	43-45	C																										
	48-50	C																										
	53-55	C																										
	58-60	C																										
	63-65	C																										
TOTALS																												

Geotechnician: Josh S.
Date: 4-23-24
Date Assignments Received:
Received by:

Notes:

Tolunay-Wong Engineers, Inc.

Project Name: Cedar port

Project Number: 23.146.175

Client Name:

Date Assigned:

Due Date:

Department: HOU HEG

Assigned By:

Project Manager:

Laboratory:

Sample ID			Soil Properties											Dispersion			Strength Tests					Volume Change Tests						Other
Boring Name	Depth (ft)	(C)ore, (J)ar, (B)ag	Water Content	Dry Unit Weight	Atterberg Limit	% Minus 200	Sieve Analysis	Sieve & Hydro	pH	Organic Content	Sulfates / Chlorides	Electrical Resistivity	Thermal Conductivity	Pinhole Dispersion	Crumb Dispersion	Hydraulic Conductivity	Torvane	Lab Vane Shear	UC Test S/S Curve (Y/N)	UU Triaxial Test S/S Curve (Y/N)	CU Triaxial Test w/ Pore Pressure	Incremental Consolidation	CRS Consolidation	Perform Consol QA	Overburden Stress for Consol. Test Q/A	Swell (Meth. A, B or C)	Free Swell (Holtz & Gibbs)	Remarks
B12	10-12	B																										
	12-14	B																										
	14-16	B																										
	16-18	B																										
	18-20	B																										
	20-22	B																										
	22-24	B																										
	24-26	B																										
	26-28	B																										
	28-30	B																										
	33-35	B																										
	38-40	B																										
	43-45	B																										
	48-50	B																										
	53-55	B																										
	58-60	B																										
	63-65	B																										
TOTALS																												

Geotechnician: Josin S.

Date: 4-24 / 4-25

Date Assignments Received:

Received by:

Notes:

Tolunay-Wong Engineers, Inc.

Project Name: Cedar Port
Project Number: 23.14.175
Client Name: Trans-Global Solutions

Date Assigned:
Due Date:
Department: HOU HEG

Assigned By:
Project Manager:
Laboratory:

Sample ID			Soil Properties											Dispersion			Strength Tests					Volume Change Tests						Other
Boring Name	Depth (ft)	(C)ore, (J)ar, (B)ag	Water Content	Dry Unit Weight	Atterberg Limit	% Minus 200	Sieve Analysis	Sieve & Hydro	pH	Organic Content	Sulfates / Chlorides	Electrical Resistivity	Thermal Conductivity	Pinhole Dispersion	Crumb Dispersion	Hydraulic Conductivity	Torvane	Lab Vane Shear	UC Test S/S Curve (Y/N)	UU Triaxial Test S/S Curve (Y/N)	CU Triaxial Test w/ Pore Pressure	Incremental Consolidation	CRS Consolidation	Perform Consol QA	Overburden Stress for Consol. Test Q/A	Swell (Meth. A, B or C)	Free Swell (Holtz & Gibbs)	Remarks
B-13	9-11	B																										
	11-13	B																										
	13-15	B																										
	15-17	B																										
	17-19	B																										
	19-21	B																										
	21-23	B																										
	23-25	B																										
	25-27	B																										
	27-29	B																										
	33-35	B																										
	38-40	C																										
	43-45	C																										
	48-50	C																										
	53-55	C																										
	58-60	C																										
	63-65	C																										
TOTALS																												

Geotechnician: Josh Sparks
Date: 04/04/24
Date Assignments Received:
Received by:

Notes:

Tolunay-Wong Engineers, Inc.

10710 S. Sam Houston Pkwy W., Suite 100 / Houston, TX 77031 / 713-722-7064 / Fax 713-777-0341

COVER SHEET Email

To: Mr. Andrew Barrett
(abarrett@anchorqea.com)
Anchor QEA, LLC

Cc: Sara Flaherty
(Sflaherty@anchorqea.com)

Eric Haynes
(ehaynes@tweinc.com)

Ref: Laboratory Testing

From: Arthur J. Stephens, P.E.

Direct: 713-821-5842
Phone: 713-722-7064
Fax: 713-777-1424 / 713-722-0309
Cell: 832-741-2179
Email: astephens@tweinc.com

Date: May 16, 2024
TWEI #: 23.14.175

Comments:

1) Attached are the results of the testing completed to date.
2) The following are still in progress.
   a. Consolidation test – 1
   b. Sieve and hydrometer tests – 2
3) These test results will be sent when completed.
4) We have only received laboratory assignments for boring B-10; please confirm.

Regards,

Tolunay-Wong Engineers, Inc.

TBPELS Firm Registration No.: F-000124

Arthur J. Stephens, P.E.
Executive Vice President

Art/dee/bxg

SUMMARY OF LABORATORY TESTS

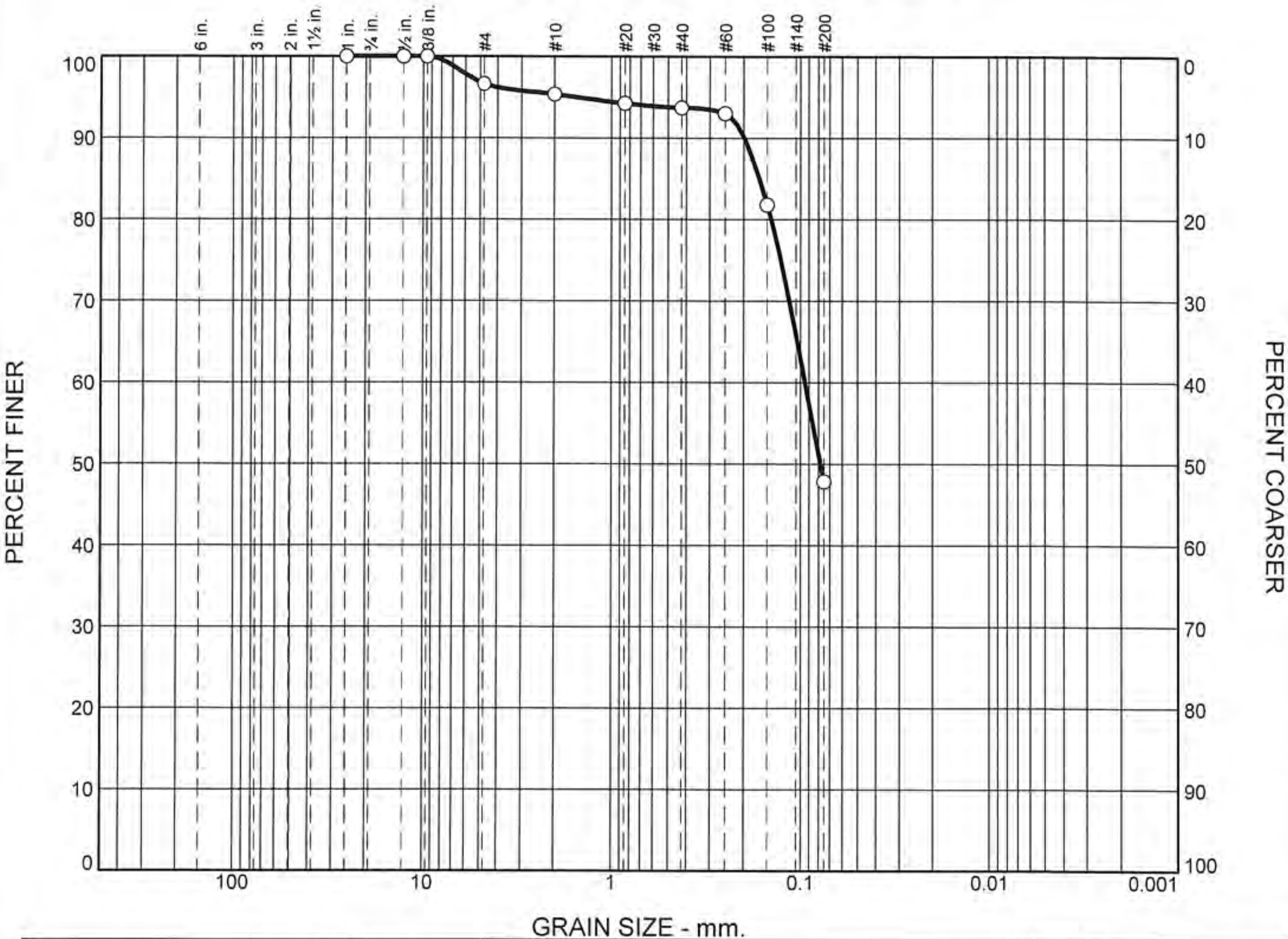
Project No. 23.14.175

Client: Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements;
Proposed Cedar Port Improvement & Navigation District
and Dock Related Feasibility Study

Boring No.	Sample No.	Depth (ft)	Pocket Pen. (tsf)	Torvane (tsf)	Soil Description	USCS	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plast. Index	Finer than #200 Sieve (%)	pH	Lab Vane Shear (tsf)	Uc/UU. Compr. (tsf)	Failure Strain (%)	Conf. Pres. (psi)	Failure Type
B-10																		
		0																
		6				CH	82.4											
		8.5				CH	56.2											
		10.5				CH	46.7											
		12.5				CH	44.9											
		14.5			Grey CLAYEY SAND; shells	SC	32.7					47.9						
		16.5				CH	44.3											
		18.5				CH	37.3											
		20	3.25		Tan FAT CLAY	CH	36.8	84.7	67	22	45				0.89	6.0		Vertical shear
		22	3.00			CH	38.4	83.9										
		24	3.00			CH	41.7											
		26				CH	46.3		52	19	33							
		28	2.00			CH	47.0											
		33	3.75			CH	35.5											
		35																
		38	2.50			CH	33.9											
		39																
		43	3.00			CH	23.0		113	29	84							
		48.5			Tan and grey SILTY SAND	SM	23.5					31.0						
		53.5																
		58.5																
		63.5																
		65																

ASTM D6913 Sieve Analysis



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	3.4	1.2	1.7	45.8	47.9	

SOIL DATA

	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-10		14.5	Grey CLAYEY SAND; shells	SC

Tolunay-Wong Engineers, Inc.
Houston, Texas

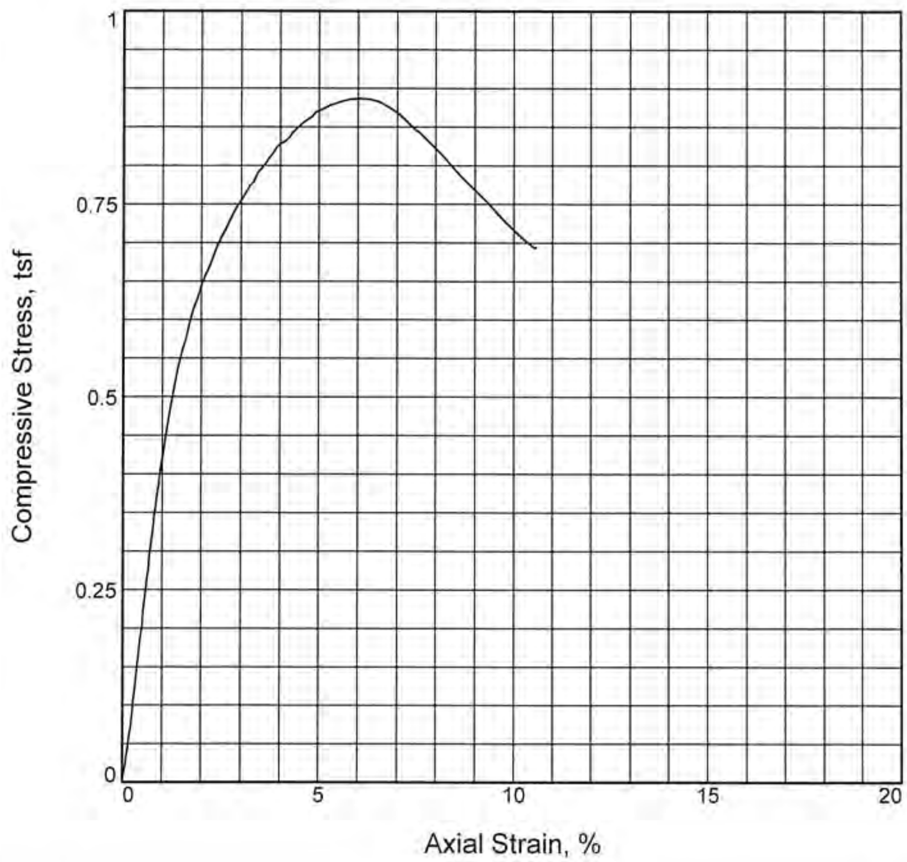
Client: Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District and Dock Related Feasibility Study

Project No.: 23.14.173

Figure

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.886			
Undrained shear strength, tsf	0.443			
Failure strain, %	6.0			
Strain rate, %/min.	1.00			
Water content, %	36.8			
Wet density, pcf	115.9			
Dry density, pcf	84.7			
Saturation, %	98.6			
Void ratio	1.0265			
Specimen diameter, in.	2.87			
Specimen height, in.	5.88			
Height/diameter ratio	2.05			

Description: Tan FAT CLAY

LL = 67	**PL =** 22	**PI =** 45	**Assumed GS=** 2.75	**Type:** Undisturbed

Project No.: 23.14.175
Date Sampled: 5/13/24
Remarks:

Test method: ASTM D2166
Failure type: Vertical shear

Figure _______

Client: Trans-Global Solutions, Inc
Houston, TX
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District
Source of Sample: B-10 **Depth:** 20

UNCONFINED COMPRESSION TEST
Tolunay-Wong Engineers, Inc.
Houston, Texas

Tested By: JM

Tolunay-Wong Engineers, Inc.

10710 S. Sam Houston Pkwy. W, Suite 100 Houston, TX 77031

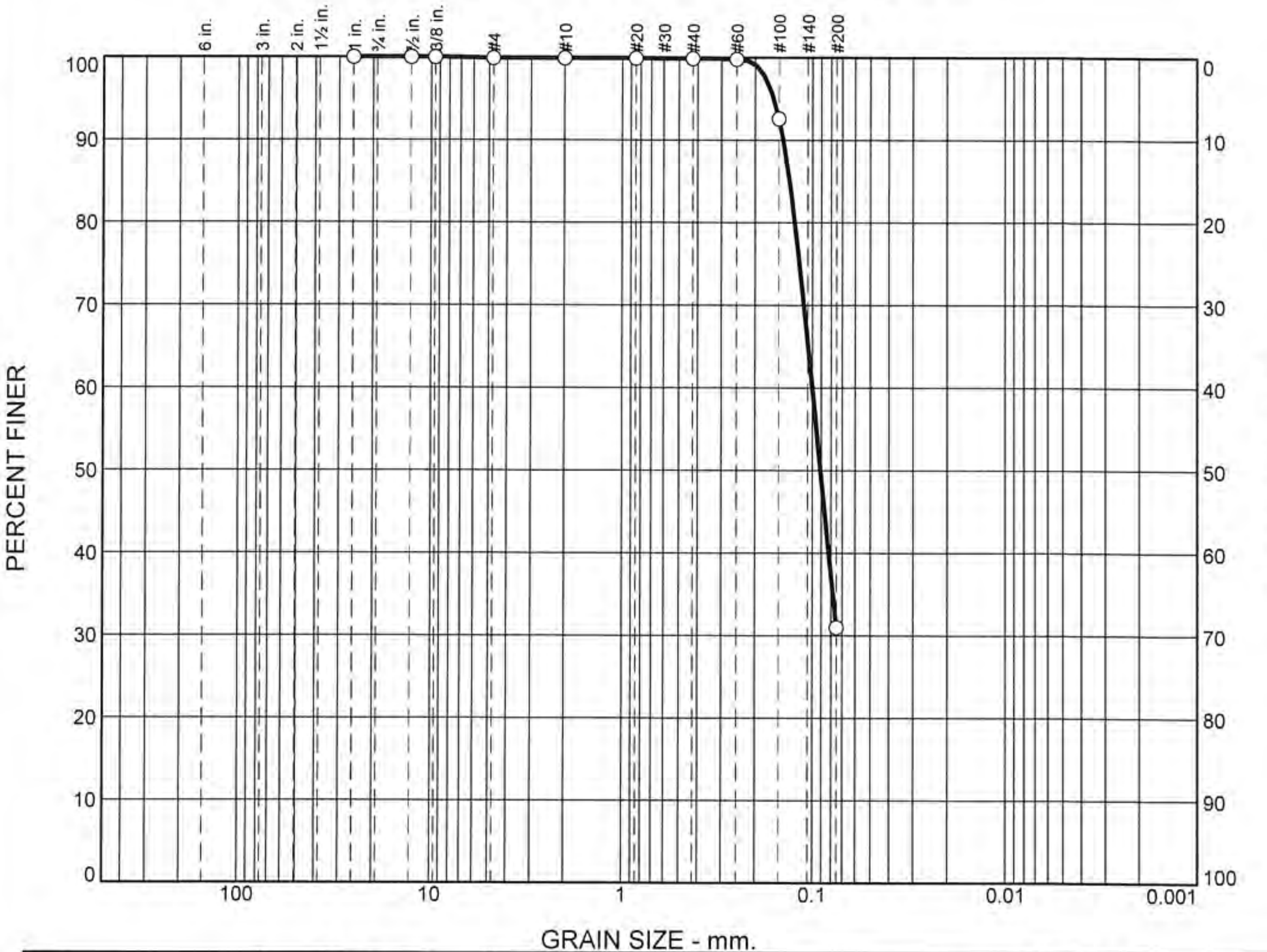
Specific Gravity of Soil - ASTM D854

Project Number	23.14.175	Date of Test	5/15
Report Number		Technician	MOE

Test Number	1	2	3	4
Test Method Used				
Sample Identification	B10 (24-26)			
Sample Description	Grey FAT CLAY			
Maximum Particle Size (sieve no.)				
Pycnometer No.	6			
Dry Mass of Soil, g	35.00			
Mass of Pycnometer + Water, g	343.25			
Mass of Pycnometer + Water + Soil, g	365.02			
Temperature of Contents of Pycnometer, C	24.5			
Specific Gravity at Test Temperature	2.65			
Temperature Correction Factor, K	0.9990			
Specific Gravity at 20C	2.64			

Calculated By	FNT	Reviewed By	EHH
Date	5/15/24	Date	5/15/24

ASTM D6913 Sieve Analysis



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.1	0.0	0.1	68.8	31.0	

SOIL DATA

	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-10		48.5	Tan and grey SILTY SAND	SM

Tolunay-Wong Engineers, Inc. Houston, Texas

Client: Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District and Dock Related Feasibility Study

Project No.: 23.14.175

Figure

Updated Summary
Sieve & Hydrometer Tests

B-10 at 22 ft, B-10 at 33 ft

SUMMARY OF LABORATORY TESTS

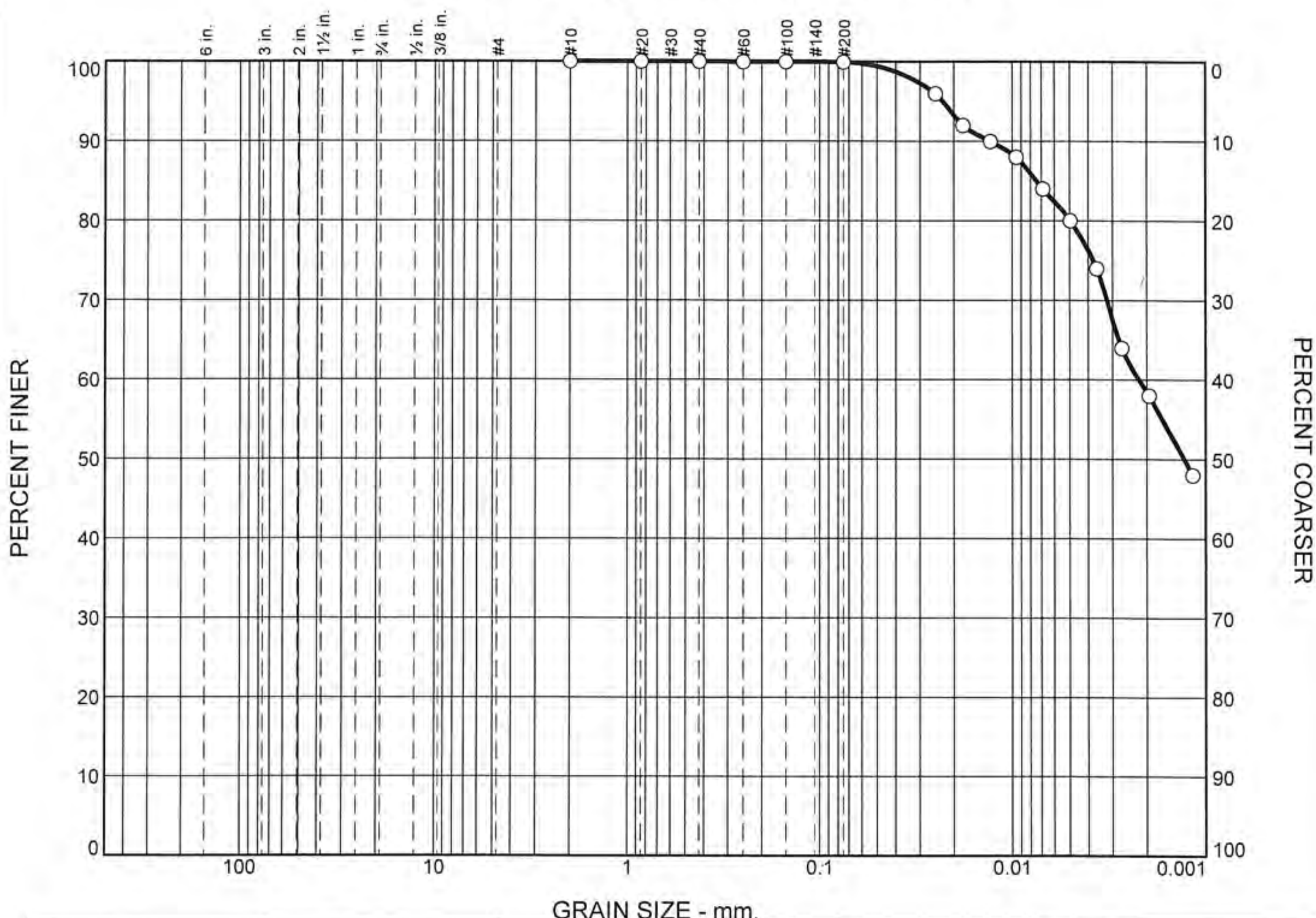
Project No. 23.14.175

Client: Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements;
Proposed Cedar Port Improvement & Navigation District
and Dock Related Feasibility Study

Boring No.	Sample No.	Depth (ft)	Pocket Pen. (tsf)	Torvane (tsf)	Soil Description	USCS	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plast. Index	Finer than #200 Sieve (%)	pH	Lab Vane Shear (tsf)	Uc/UU. Compr. (tsf)	Failure Strain (%)	Conf. Pres. (psi)	Failure Type
B-10																		
		0																
		6				CH	82.4											
		8.5				CH	56.2											
		10.5				CH	46.7											
		12.5				CH	44.9											
		14.5			Grey CLAYEY SAND; shells	SC	32.7					47.9						
		16.5				CH	44.3											
		18.5				CH	37.3											
		20	3.25		Tan FAT CLAY	CH	36.8	84.7	67	22	45				0.89	6.0		Vertical shear
		22	3.00		Tan and grey FAT CLAY	CH	38.4	83.9				99.9						
		24	3.00			CH	41.7											
		26				CH	46.3		52	19	33							
		28	2.00			CH	47.0											
		33	3.75		Grey FAT CLAY	CH	35.5					97.5						
		35																
		38	2.50			CH	33.9											
		39																
		43	3.00			CH	23.0		113	29	84							
		48.5			Tan and grey SILTY SAND	SM	23.5					31.0						
		53.5																
		58.5																
		63.5																
		65																

ASTM D422 Hydrometer Analysis



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.0	0.1	41.4	58.5

SOIL DATA

	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-10		22	Tan and grey FAT CLAY	CH

Tolunay-Wong Engineers, Inc.
Houston, Texas

Client: Trans-Global Solutions, Inc

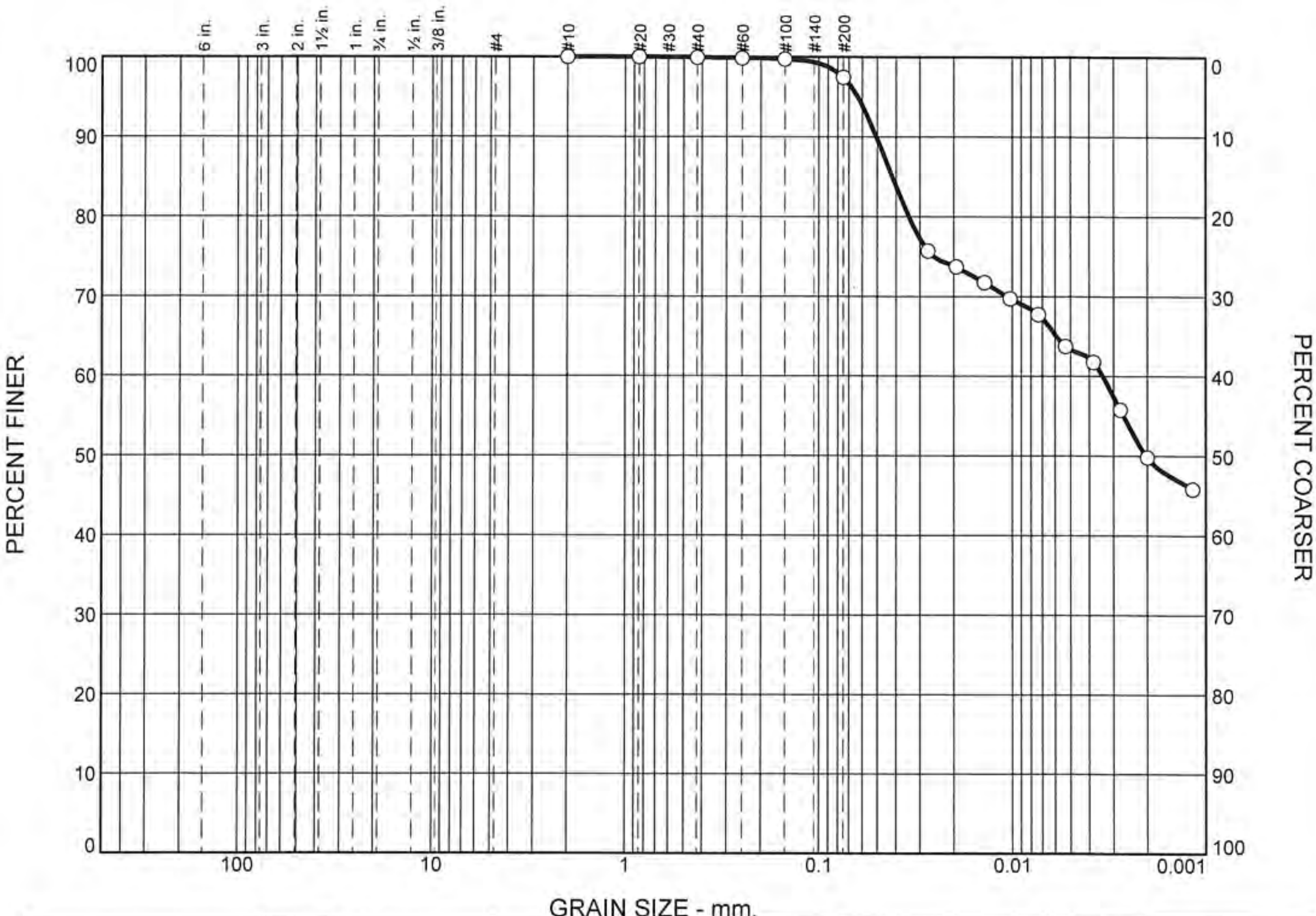
Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District and Dock Related Feasibility Study

Project No.: 23.14.173

Figure

Tested By: JM

ASTM D422 Hydrometer Analysis



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.1	2.4	47.7	49.8

SOIL DATA

	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-10		33	Grey FAT CLAY	CH

Tolunay-Wong Engineers, Inc. Houston, Texas

Client: Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District and Dock Related Feasibility Study

Project No.: 23.14.173

Figure

Tested By: JM

Tolunay-Wong Engineers, Inc.

10710 S. Sam Houston Pkwy W., Suite 100 / Houston, TX 77031 / 713-722-7064 / Fax 713-777-0341

COVER SHEET

Email

To:	Mr. Andrew Barrett (abarrett@anchorqea.com) Anchor QEA, LLC	**From:**	Arthur J. Stephens, P.E. **Direct:** 713-821-5842 **Phone:** 713-722-7064 **Fax:** 713-777-1424 / 713-722-0309 **Cell:** 832-741-2179 **Email:** astephens@tweinc.com
Cc:	Sara Flaherty (Sflaherty@anchorqea.com) Eric Haynes (ehaynes@tweinc.com)	**Date:** **TWEI #:**	June 5, 2024 23.14.175
Ref:	Laboratory Testing		

Comments:

Attached are the results of the consolidation tests. Please call if you have any questions.

Regards,

Tolunay-Wong Engineers, Inc.

TBPELS Firm Registration No.: F-000124

Arthur J. Stephens, P.E.
Executive Vice President

Art/dee

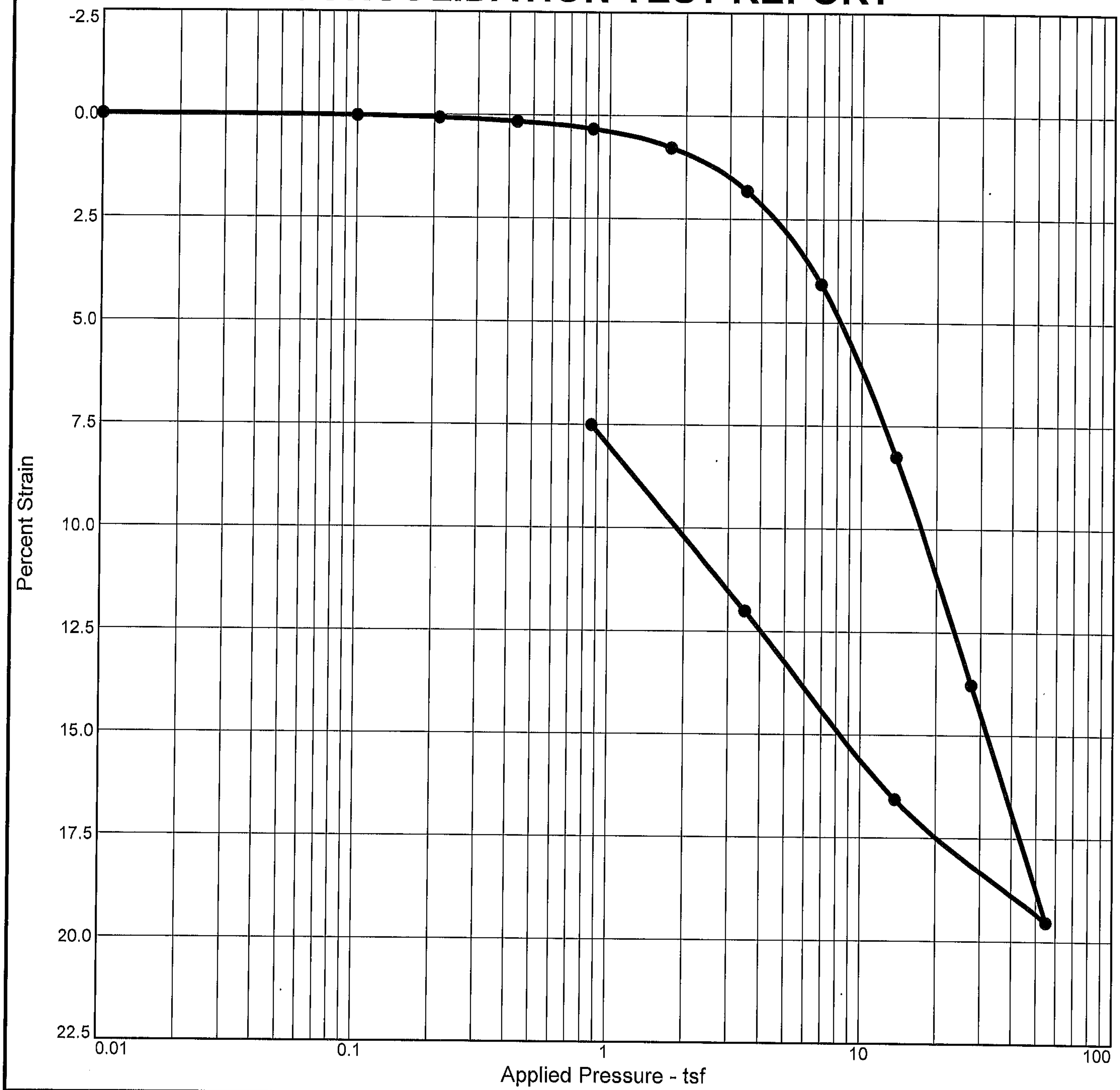
Attachments: Consolidation Test Reports: Boring 11 @ 48 ft
Boring 13 @ 38 ft
Boring 13 @ 48 ft
Boring 13 @ 63 ft

Consolidation Test Reports

Boring 11 @ 48 ft
Boring 13 @ 38 ft
Boring 13 @ 48 ft
Boring 13 @ 63 ft

Boring 11 @ 48 ft

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
99.7 %	38.0 %	84.5			2.80	CH		1.068

MATERIAL DESCRIPTION

Brown FAT CLAY

Project No. 23.14.175 **Client:** Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

Source of Sample: B-11 **Depth:** 48

Tolunay-Wong Engineers, Inc.

Houston, Texas

Remarks:

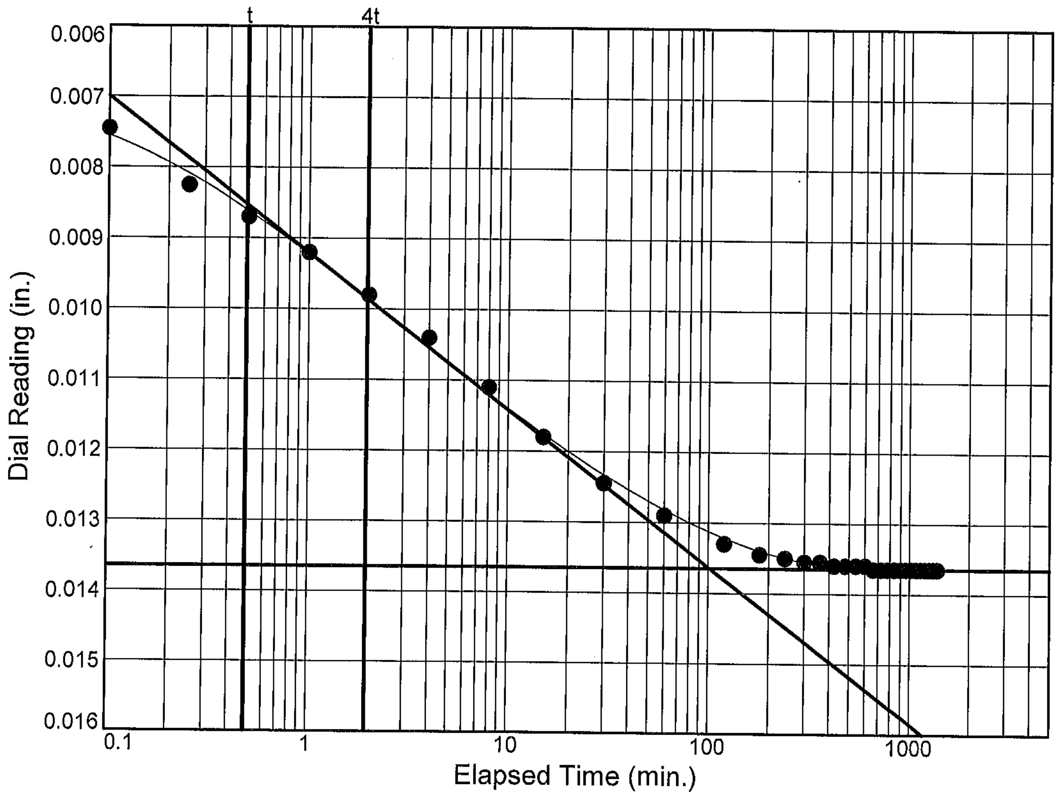
Test method: ASTM D2435
Specific gravity: Assumed

Figure

Dial Reading vs. Time

Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

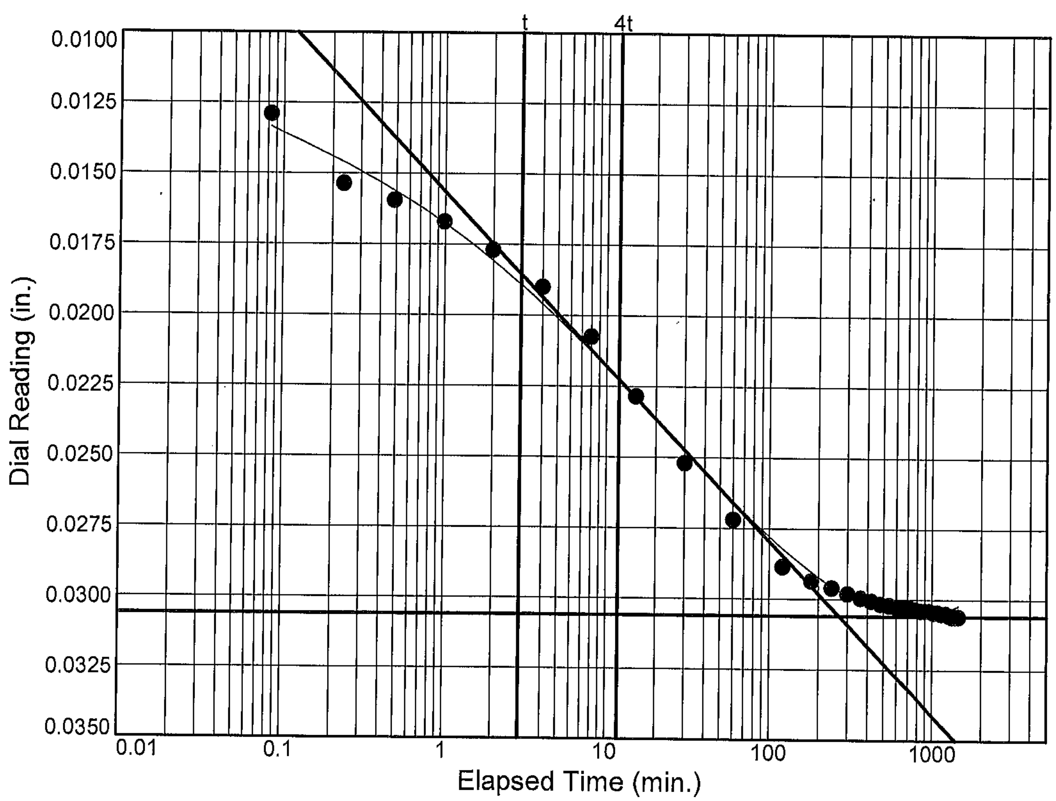
Source of Sample: B-11 Depth: 48



Load No.= 7
Load= 3.49 tsf
D_0 = 0.0073
D_{50} = 0.0105
D_{100} = 0.0137
T_{50} = 3.84 min.

C_v @ T_{50}
25.8 ft.^{2}/yr.

C_α = 0.000



Load No.= 8
Load= 6.87 tsf
D_0 = 0.0156
D_{50} = 0.0231
D_{100} = 0.0306
T_{50} = 16.02 min.

C_v @ T_{50}
6.0 ft.^{2}/yr.

C_α = 0.000

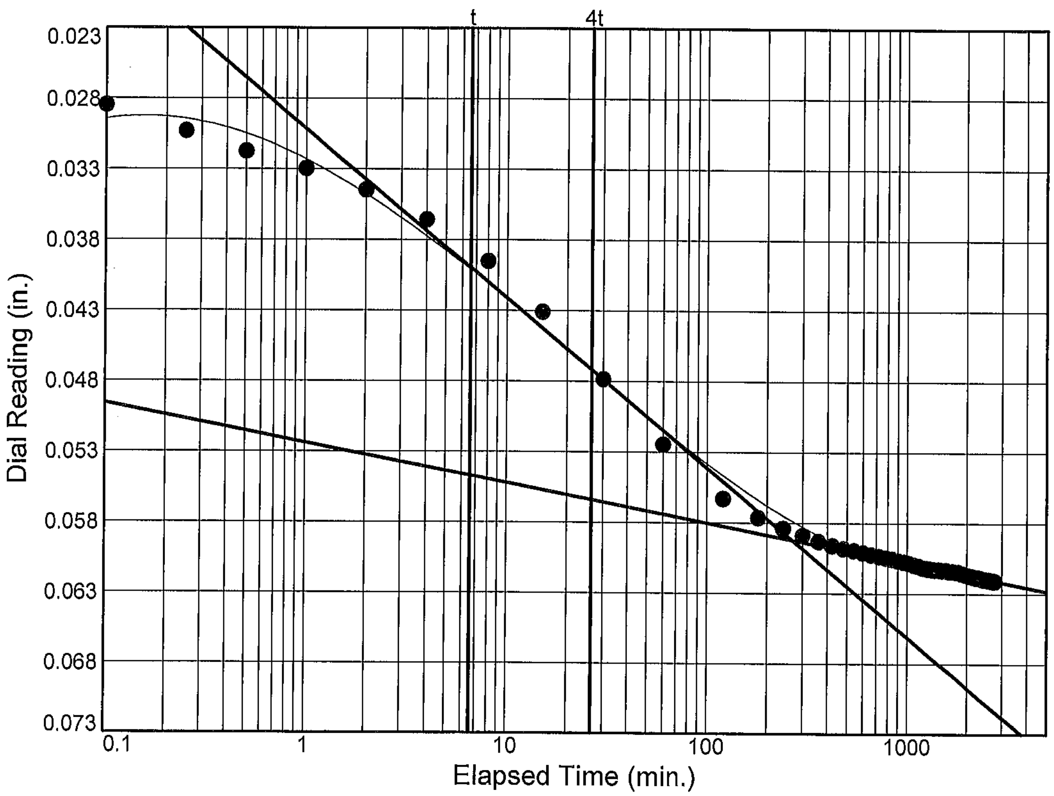
Figure

TOLUNAY-WONG ENGINEERS, INC.

Dial Reading vs. Time

Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

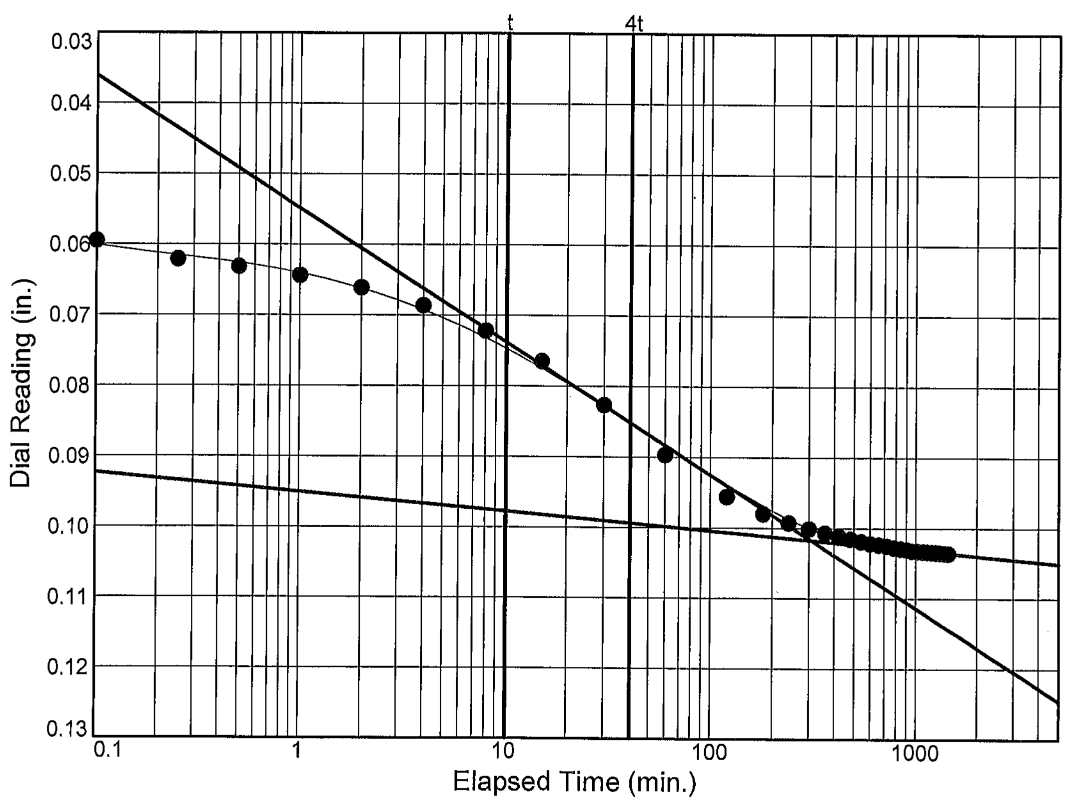
Source of Sample: B-11 Depth: 48



Load No.= 9
Load= 13.75 tsf
D_0 = 0.0330
D_{50} = 0.0461
D_{100} = 0.0592
T_{50} = 21.38 min.

C_v @ T_{50}
4.2 ft.^{2}/yr.

C_α = 0.008



Load No.= 10
Load= 27.50 tsf
D_0 = 0.0642
D_{50} = 0.0830
D_{100} = 0.1018
T_{50} = 30.95 min.

C_v @ T_{50}
2.6 ft.^{2}/yr.

C_α = 0.007

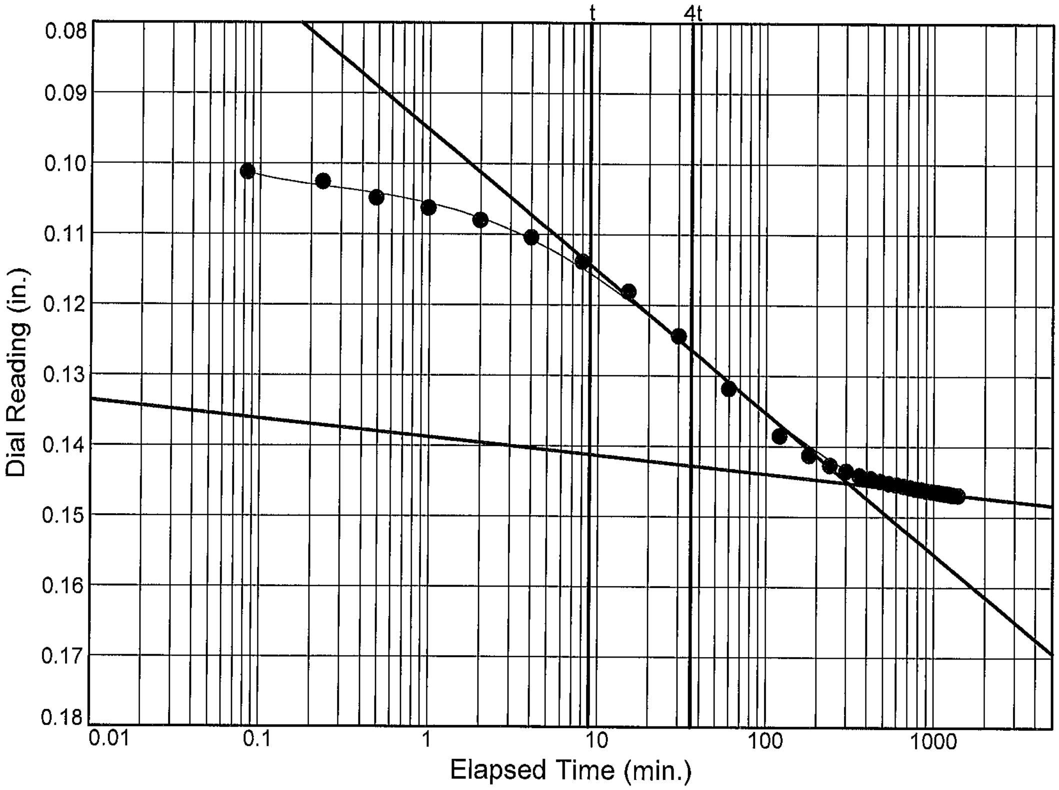
Figure

TOLUNAY-WONG ENGINEERS, INC.

Dial Reading vs. Time

Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

Source of Sample: B-11 Depth: 48



Load No.= 11

Load= 54.99 tsf

D_0 = 0.1047

D_{50} = 0.1249

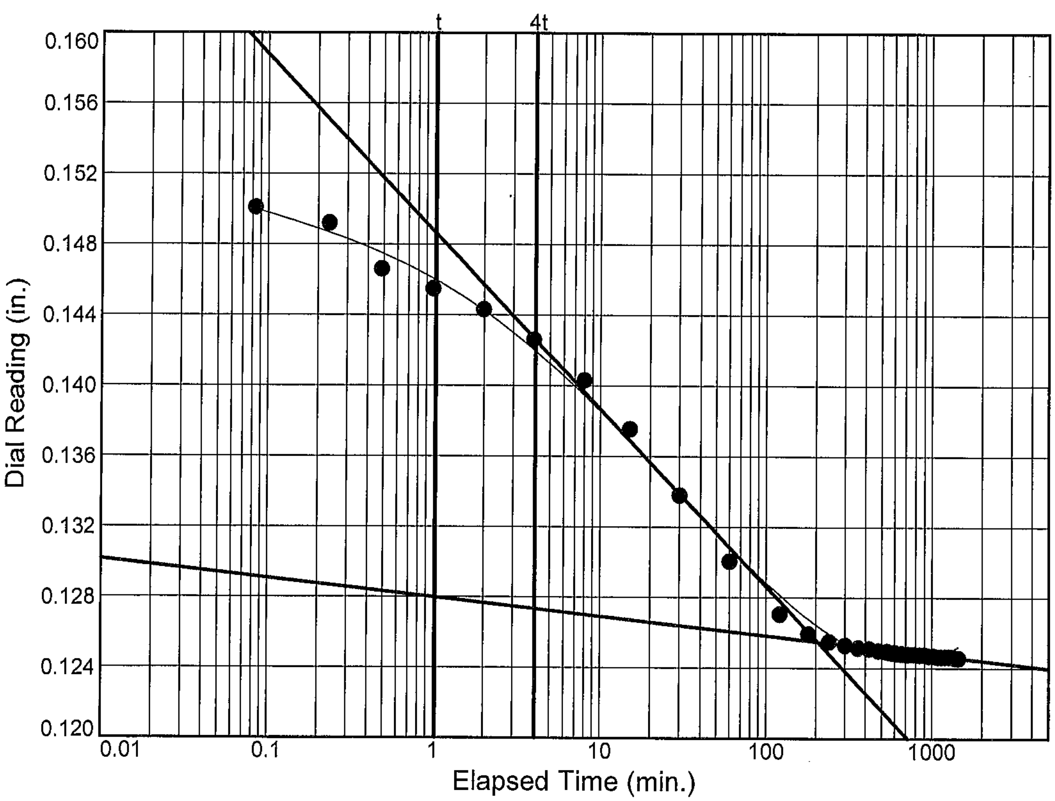
D_{100} = 0.1452

T_{50} = 30.19 min.

C_v @ T_{50}

2.3 ft.^{2}/yr.

C_α = 0.007



Load No.= 12

Load= 13.75 tsf

D_0 = 0.1500

D_{50} = 0.1378

D_{100} = 0.1255

T_{50} = 12.15 min.

C_v @ T_{50}

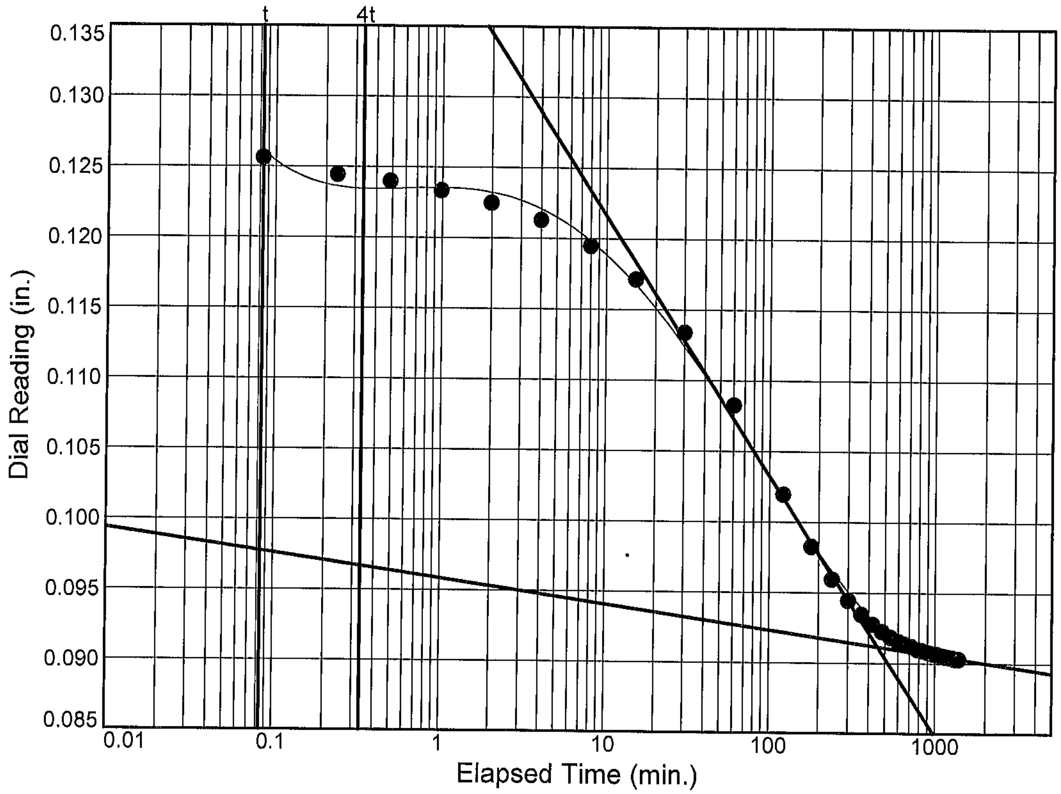
5.6 ft.^{2}/yr.

Figure

Dial Reading vs. Time

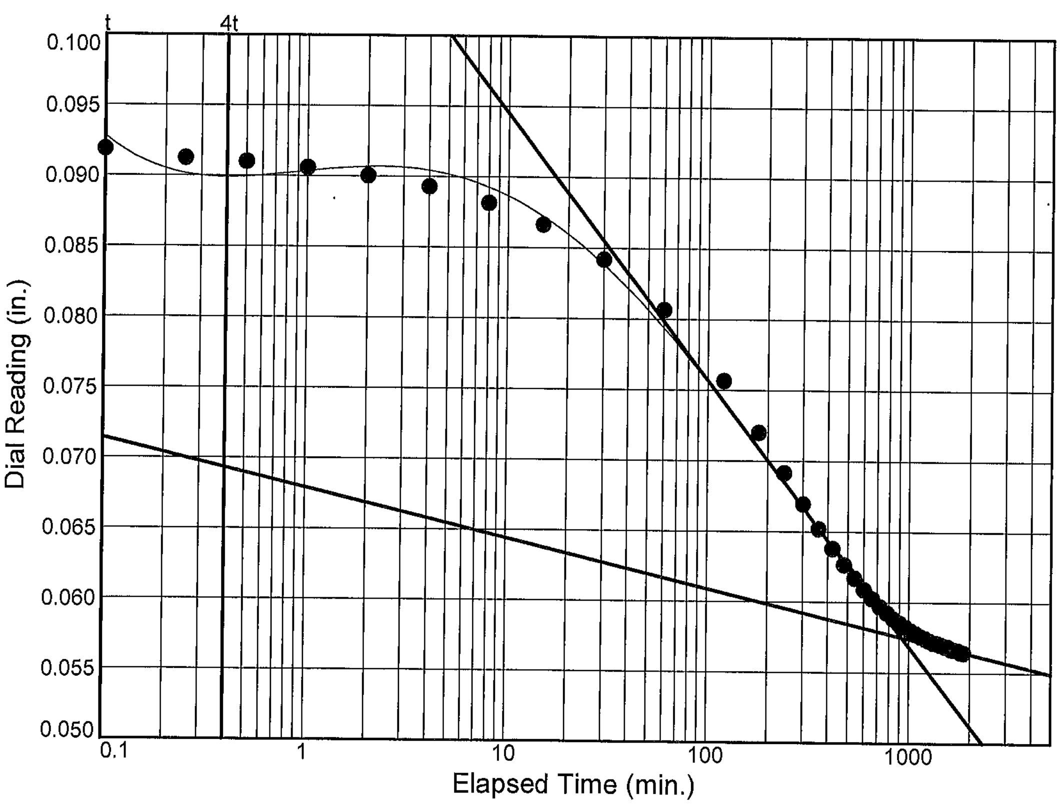
Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

Source of Sample: B-11 Depth: 48



Load No.= 13
Load= 3.49 tsf
D_0 = 0.1288
D_{50} = 0.1100
D_{100} = 0.0911
T_{50} = 42.04 min.

C_v @ T_{50}
1.8 ft.^{2}/yr.



Load No.= 14
Load= 0.86 tsf
D_0 = 0.0957
D_{50} = 0.0766
D_{100} = 0.0575
T_{50} = 87.42 min.

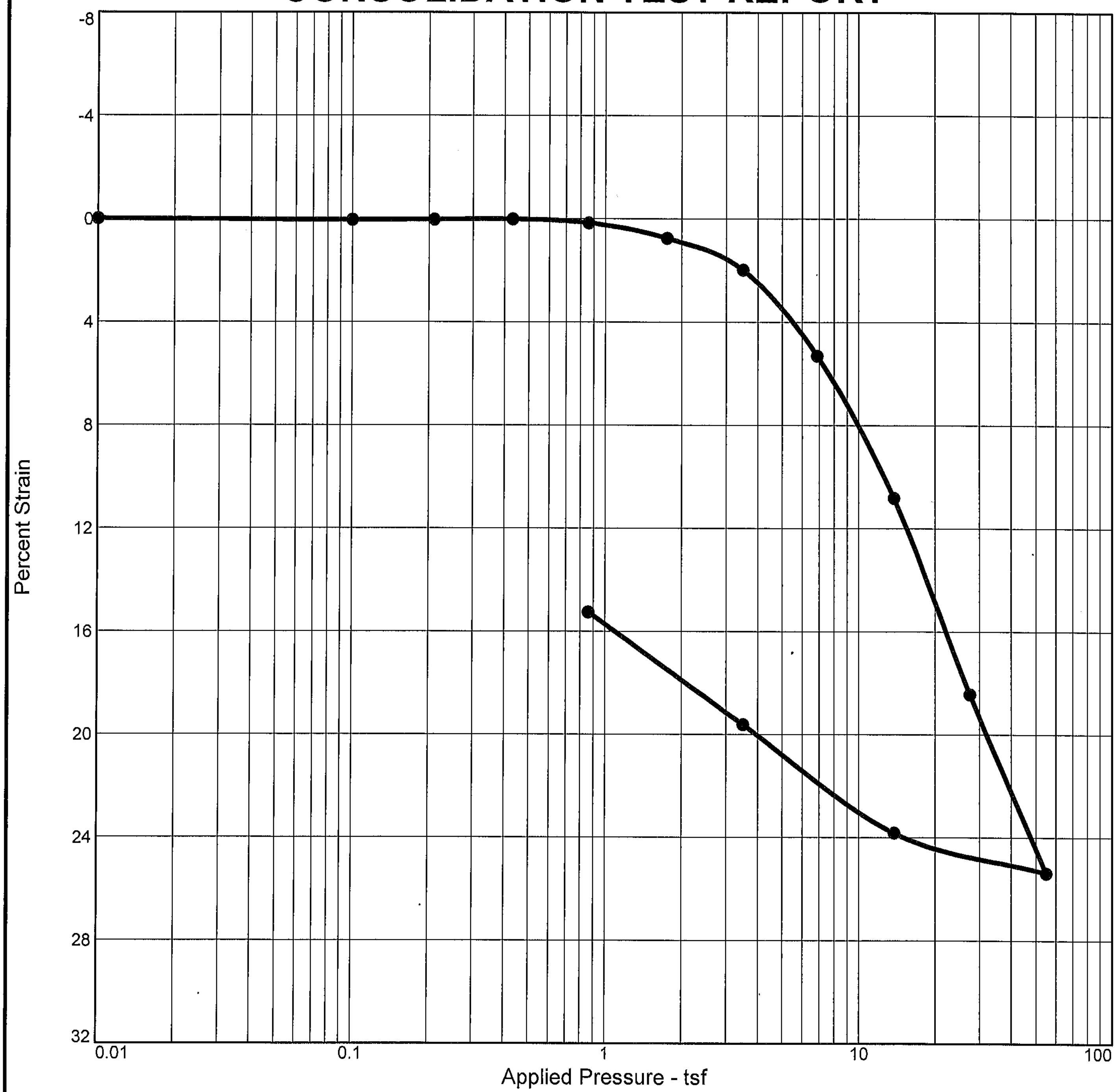
C_v @ T_{50}
0.9 ft.^{2}/yr.

Figure

TOLUNAY-WONG ENGINEERS, INC.

Boring 13 @ 38 ft

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
97.4 %	36.0 %	85.2			2.75	CH		1.016

MATERIAL DESCRIPTION

Brown FAT CLAY

Project No. 23.14.175 **Client:** Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

Source of Sample: B-13 **Depth:** 38

Tolunay-Wong Engineers, Inc.

Houston, Texas

Remarks:

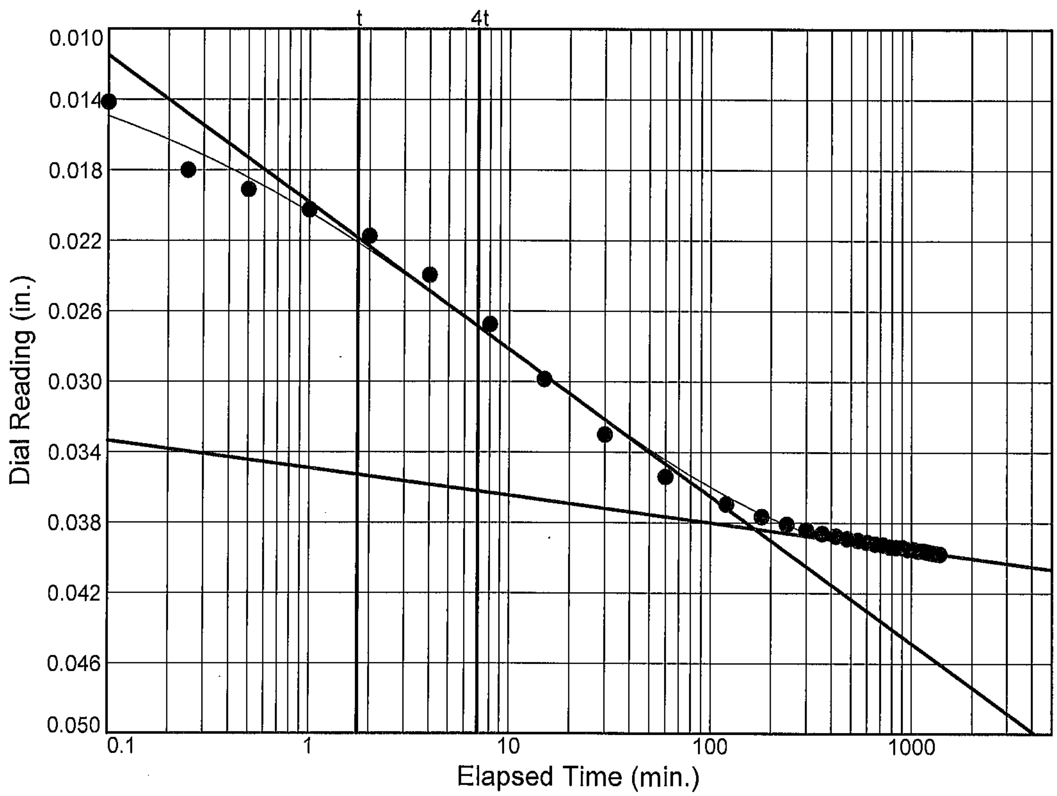
Test method: ASTM D2435
Specific gravity: Assumed

Figure

Dial Reading vs. Time

Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

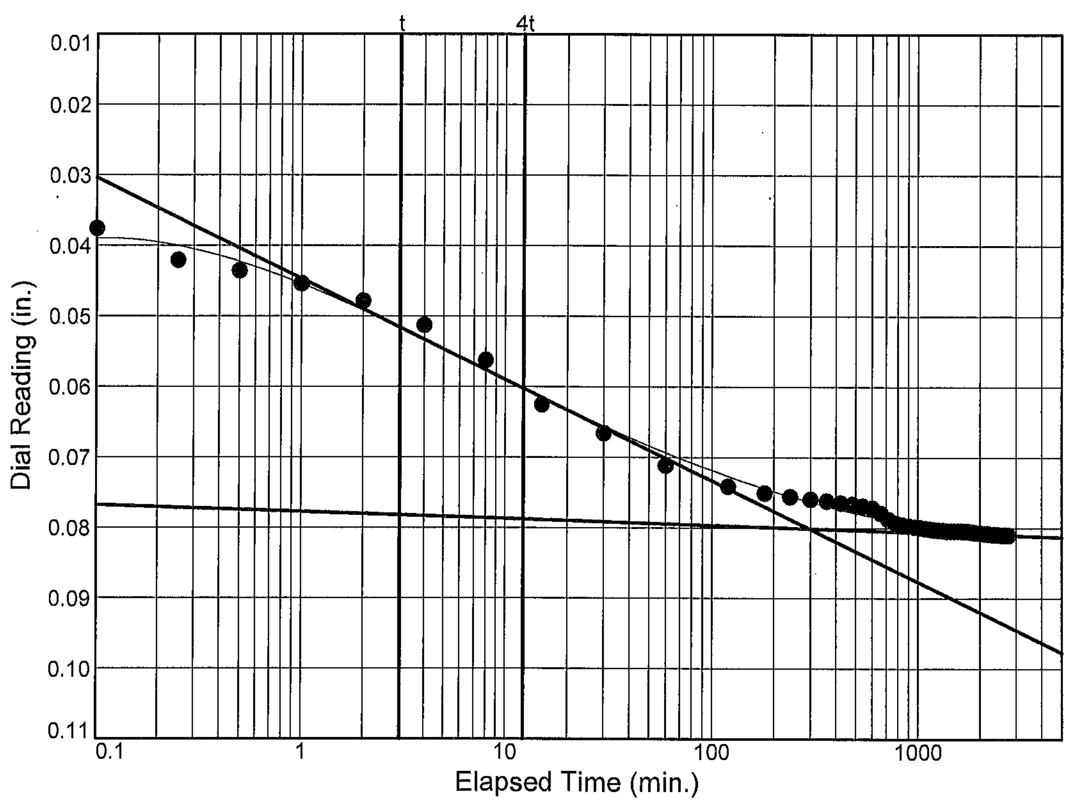
Source of Sample: B-13 Depth: 38



Load No.= 8
Load= 6.87 tsf
D_0 = 0.0173
D_{50} = 0.0278
D_{100} = 0.0383
T_{50} = 9.12 min.

C_v @ T_{50}
10.3 ft.^{2}/yr.

C_α = 0.004



Load No.= 9
Load= 13.75 tsf
D_0 = 0.0431
D_{50} = 0.0616
D_{100} = 0.0801
T_{50} = 15.28 min.

C_v @ T_{50}
5.6 ft.^{2}/yr.

C_α = 0.003

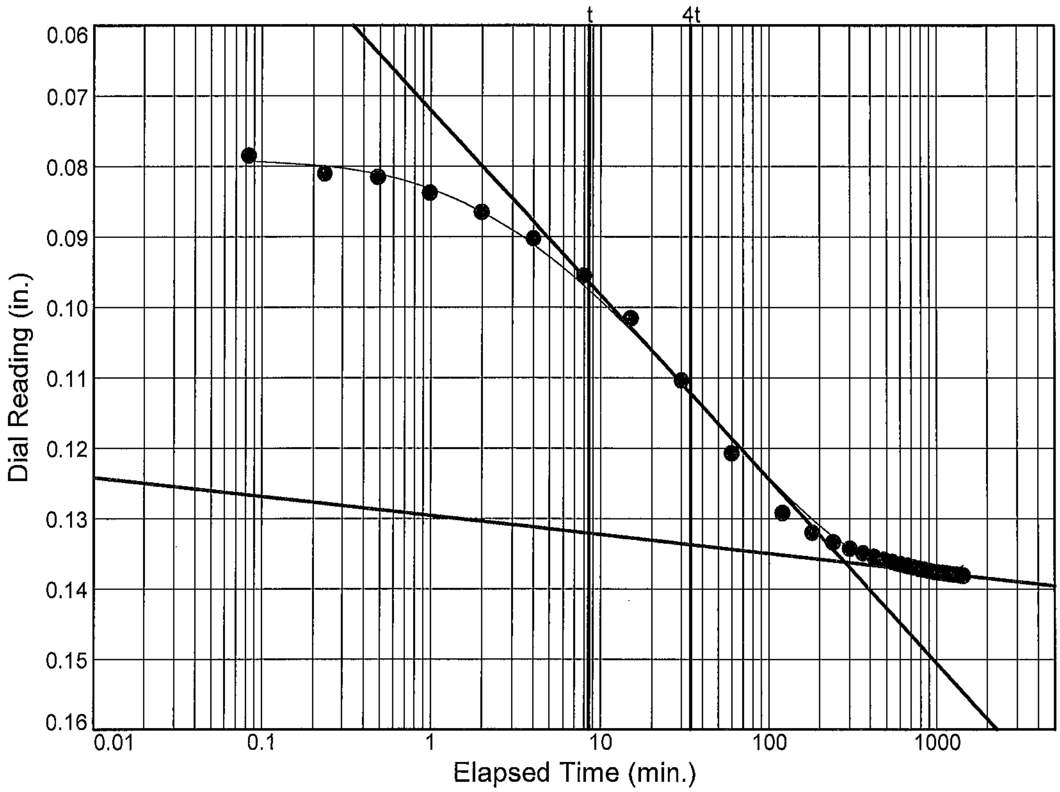
Figure

TOLUNAY-WONG ENGINEERS, INC.

Dial Reading vs. Time

Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

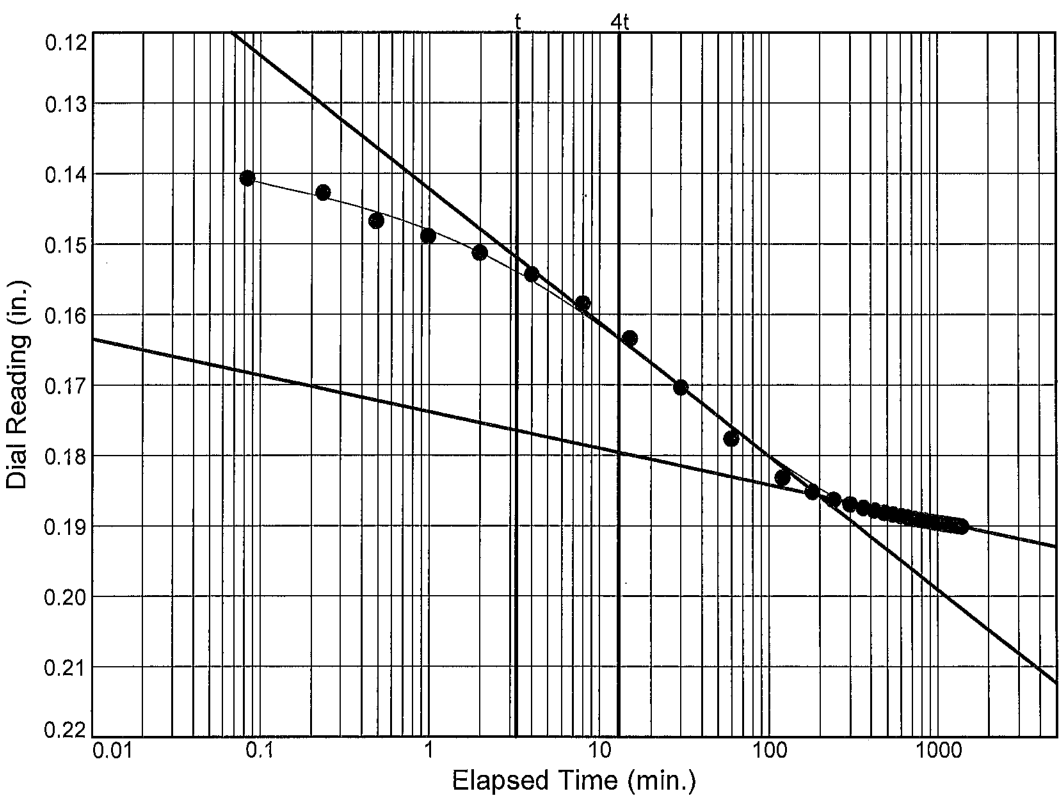
Source of Sample: B-13 Depth: 38



Load No.= 10
Load= 27.50 tsf
D_0 = 0.0829
D_{50} = 0.1095
D_{100} = 0.1362
T_{50} = 26.82 min.

C_v @ T_{50}
2.7 ft.^{2}/yr.

C_α = 0.007



Load No.= 11
Load= 54.99 tsf
D_0 = 0.1444
D_{50} = 0.1651
D_{100} = 0.1857
T_{50} = 15.77 min.

C_v @ T_{50}
3.9 ft.^{2}/yr.

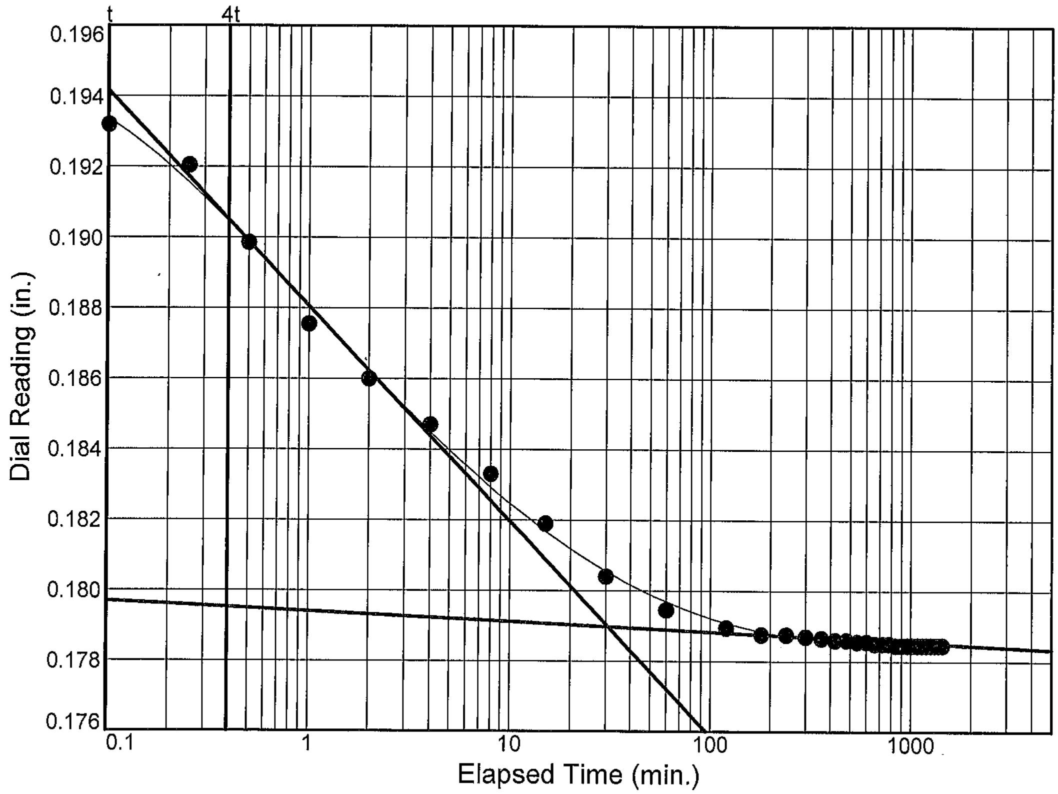
C_α = 0.014

Figure

Dial Reading vs. Time

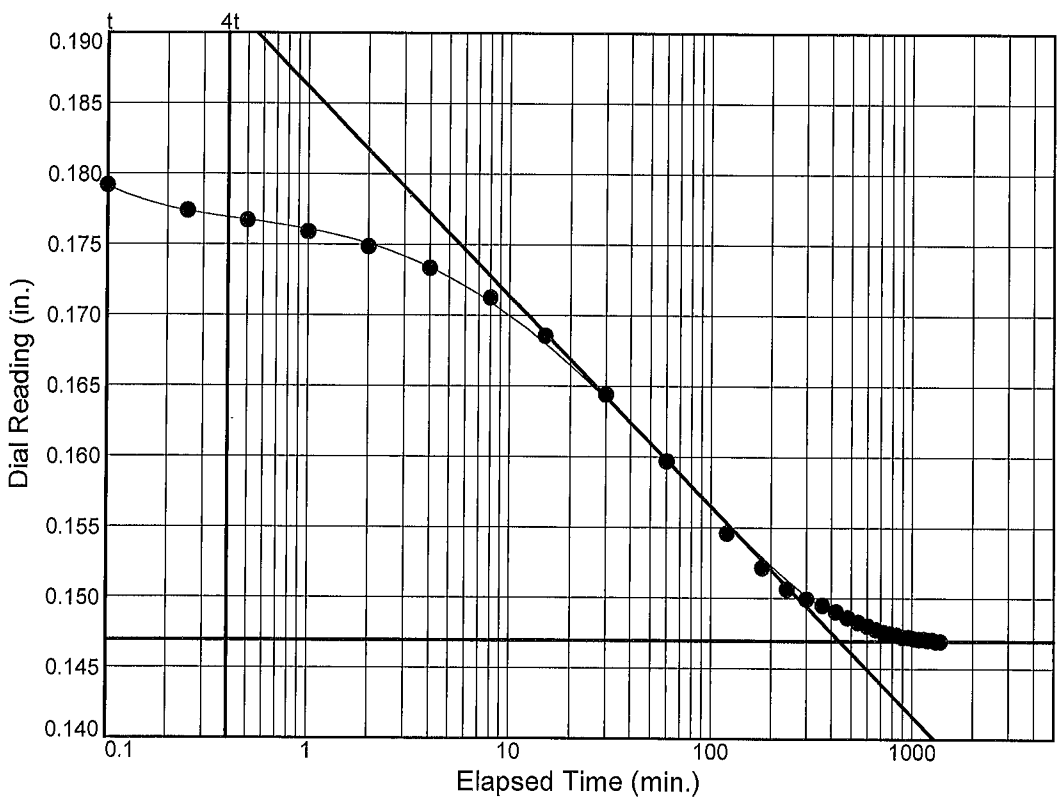
Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

Source of Sample: B-13 Depth: 38



Load No.= 12
Load= 13.75 tsf
D_0 = 0.1963
D_{50} = 0.1876
D_{100} = 0.1790
T_{50} = 1.17 min.

C_v @ T_{50}
48.7 ft.^{2}/yr.



Load No.= 13
Load= 3.49 tsf
D_0 = 0.1814
D_{50} = 0.1642
D_{100} = 0.1469
T_{50} = 29.76 min.

C_v @ T_{50}
2.1 ft.^{2}/yr.

C_α = 0.000

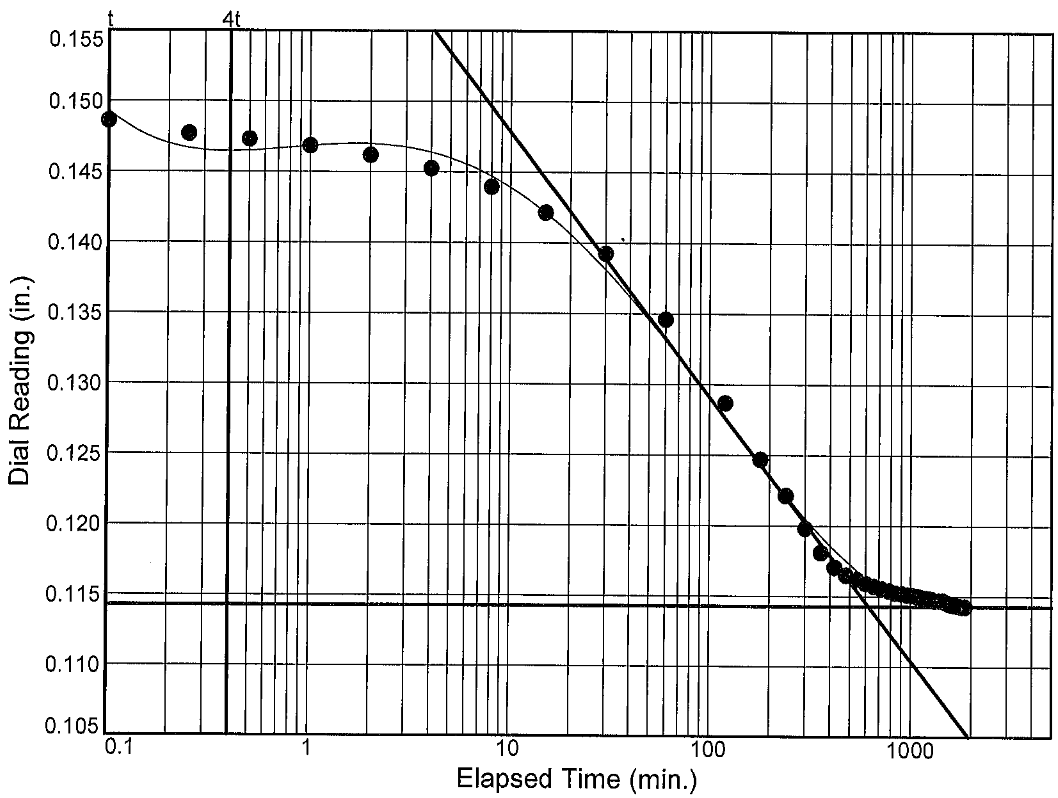
Figure

TOLUNAY-WONG ENGINEERS, INC.

Dial Reading vs. Time

Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

Source of Sample: B-13 Depth: 38



Load No.= 14
Load= 0.86 tsf
D_0 = 0.1522
D_{50} = 0.1332
D_{100} = 0.1143
T_{50} = 59.57 min.

C_v @ T_{50}
1.2 ft.^{2}/yr.

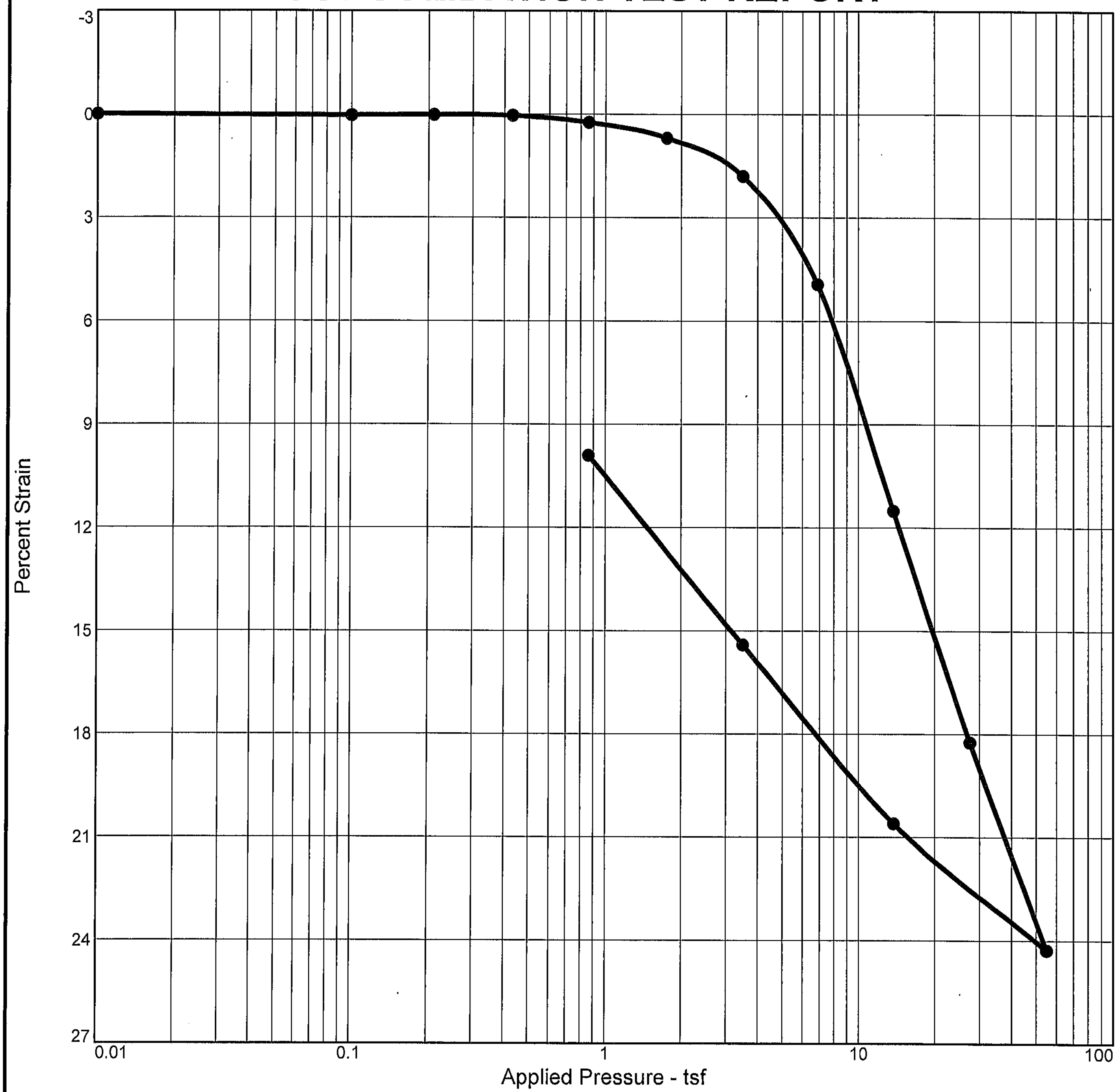
C_α = 0.000

Figure

TOLUNAY-WONG ENGINEERS, INC.

Boring 13 @ 48 ft

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
98.0 %	40.2 %	79.9			2.70	CH		1.108

MATERIAL DESCRIPTION

Grey FAT CLAY

Project No. 23.14.175 **Client:** Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

Source of Sample: B-13 **Depth:** 48

Tolunay-Wong Engineers, Inc.

Houston, Texas

Remarks:

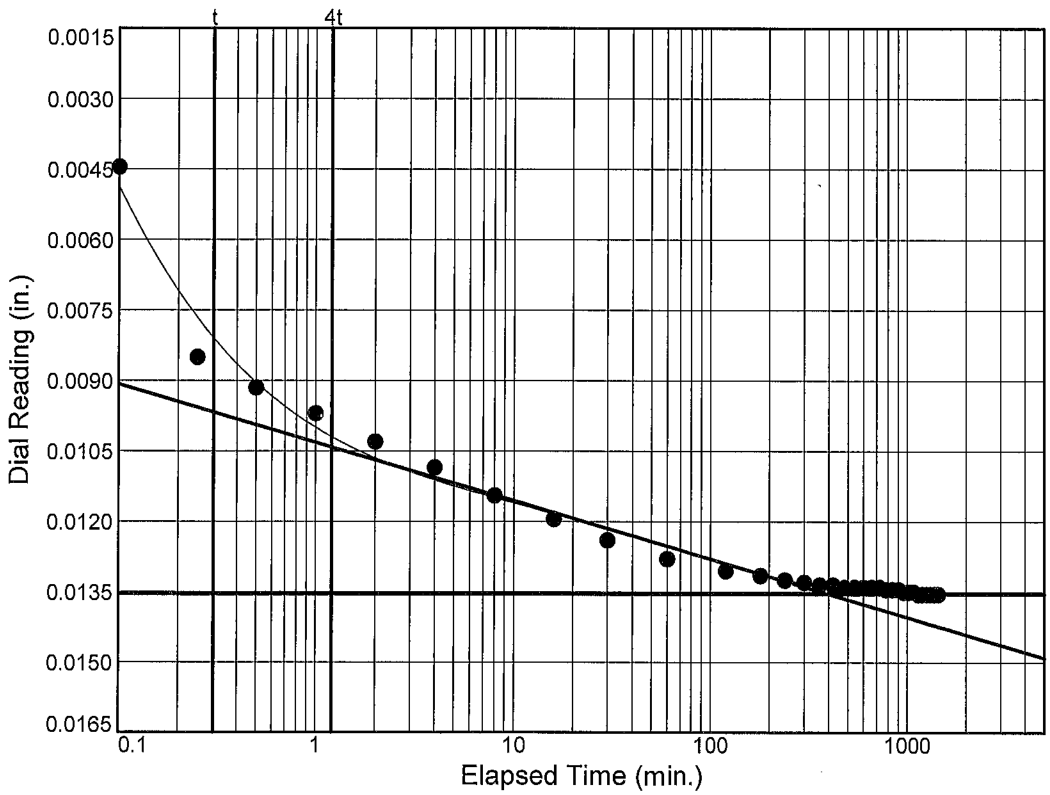
Test method: ASTM D2435
Specific gravity: Assumed

Figure

Dial Reading vs. Time

Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

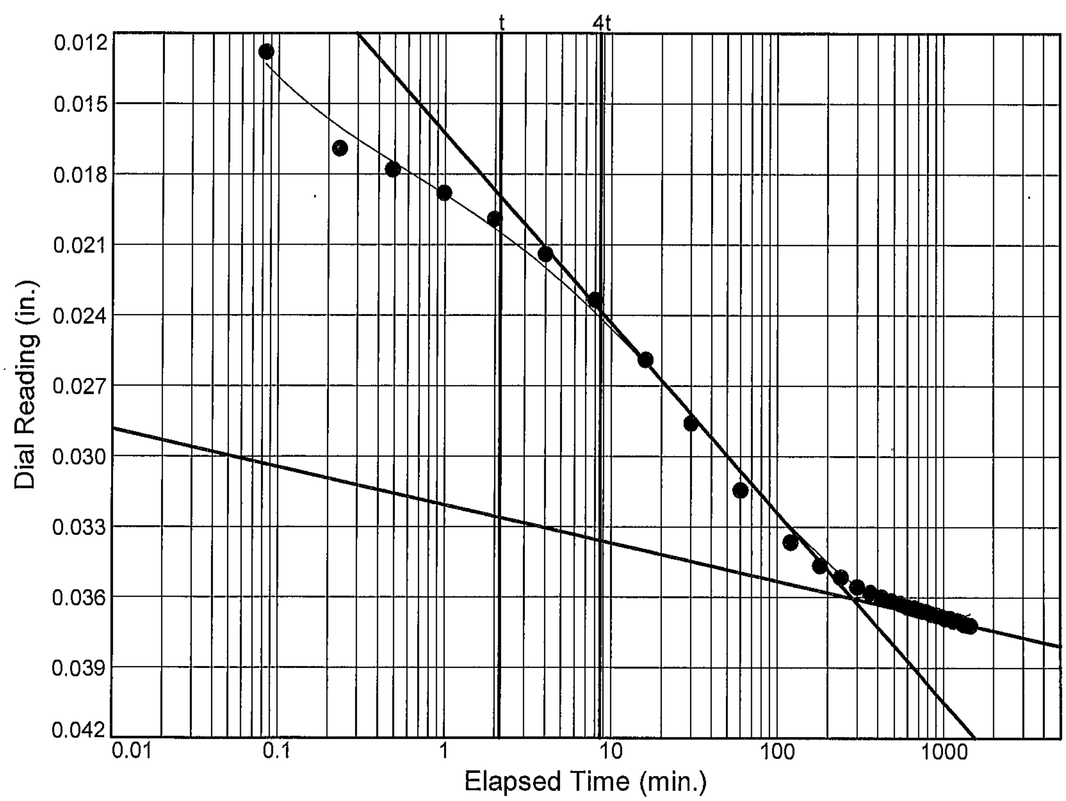
Source of Sample: B-13 Depth: 48



Load No.= 7
Load= 3.49 tsf
D_0 = 0.0060
D_{50} = 0.0098
D_{100} = 0.0136
T_{50} = 0.82 min.

C_v @ T_{50}
121.2 ft.^{2}/yr.

C_α = 0.000



Load No.= 8
Load= 6.87 tsf
D_0 = 0.0169
D_{50} = 0.0265
D_{100} = 0.0360
T_{50} = 17.93 min.

C_v @ T_{50}
5.3 ft.^{2}/yr.

C_α = 0.005

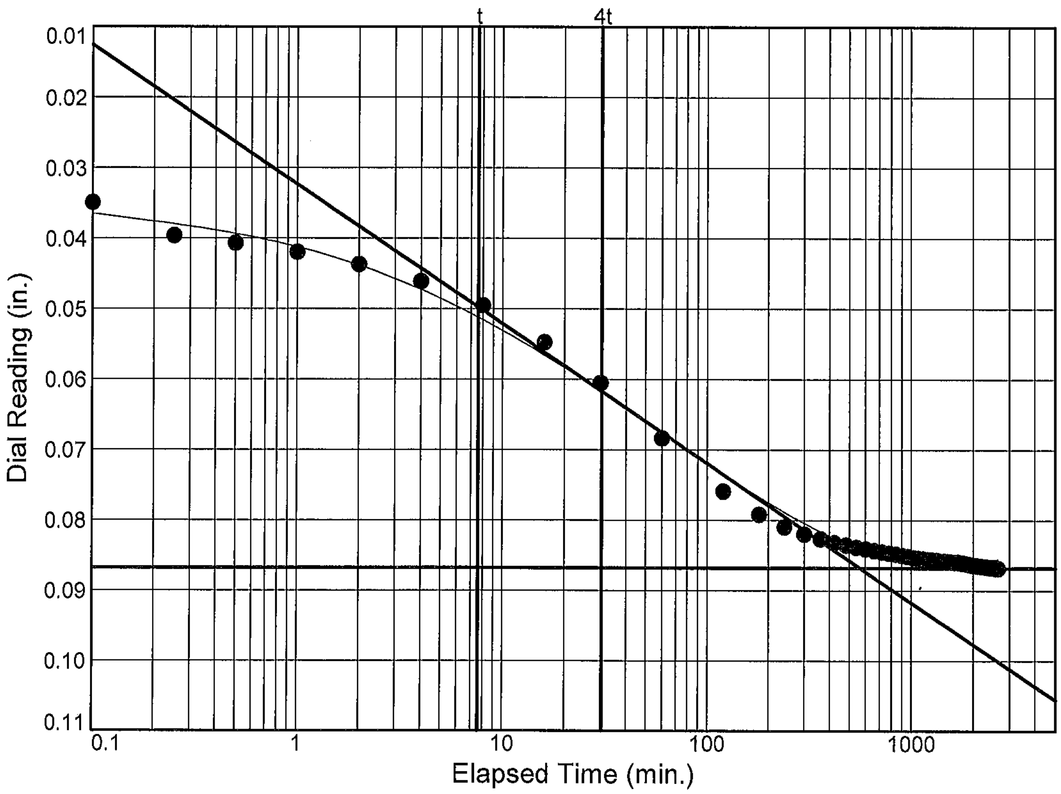
Figure

TOLUNAY-WONG ENGINEERS, INC.

Dial Reading vs. Time

Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

Source of Sample: B-13 Depth: 48



Load No.= 9

Load= 13.75 tsf

D_0 = 0.0407

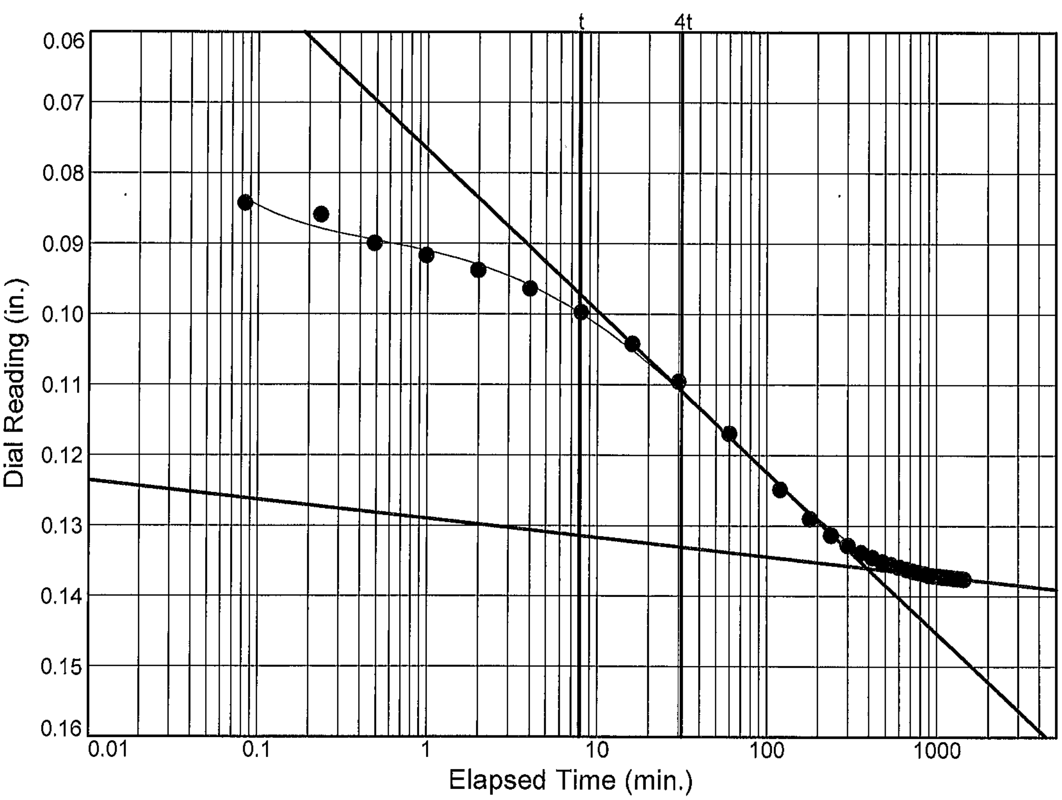
D_{50} = 0.0637

D_{100} = 0.0868

T_{50} = 38.35 min.

C_V @ T_{50}
2.2 ft.^{2}/yr.

C_α = 0.000



Load No.= 10

Load= 27.50 tsf

D_0 = 0.0886

D_{50} = 0.1123

D_{100} = 0.1360

T_{50} = 35.65 min.

C_V @ T_{50}
2.1 ft.^{2}/yr.

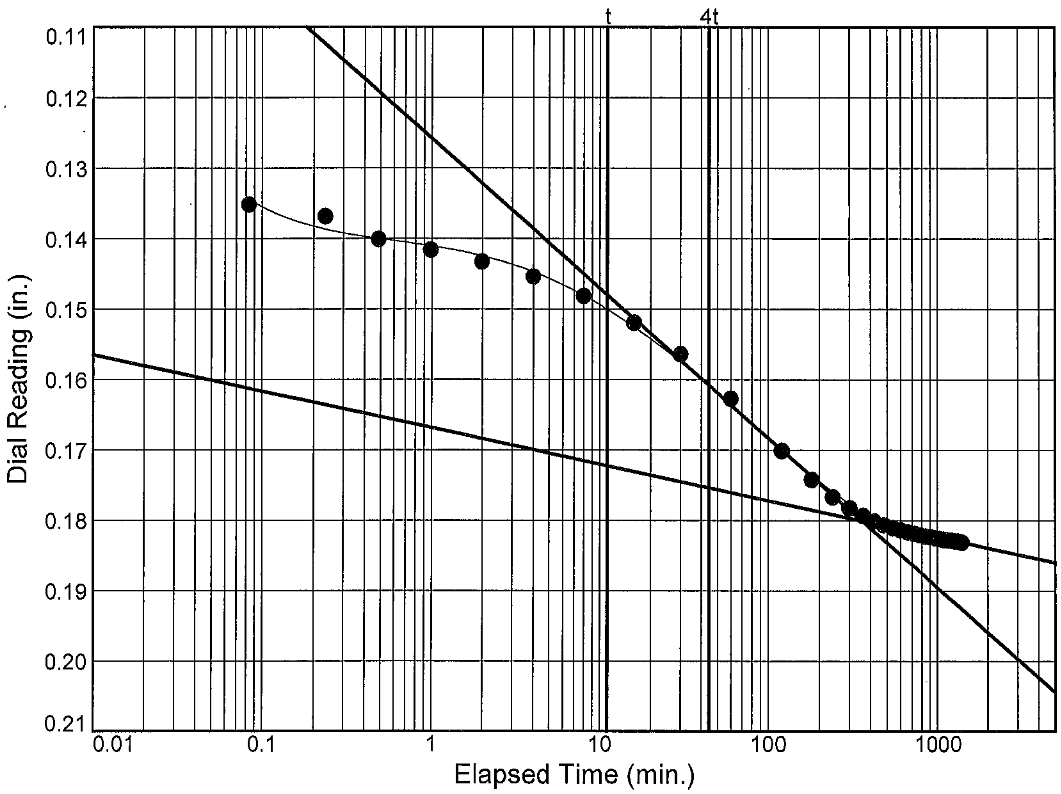
C_α = 0.008

Figure

Dial Reading vs. Time

Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

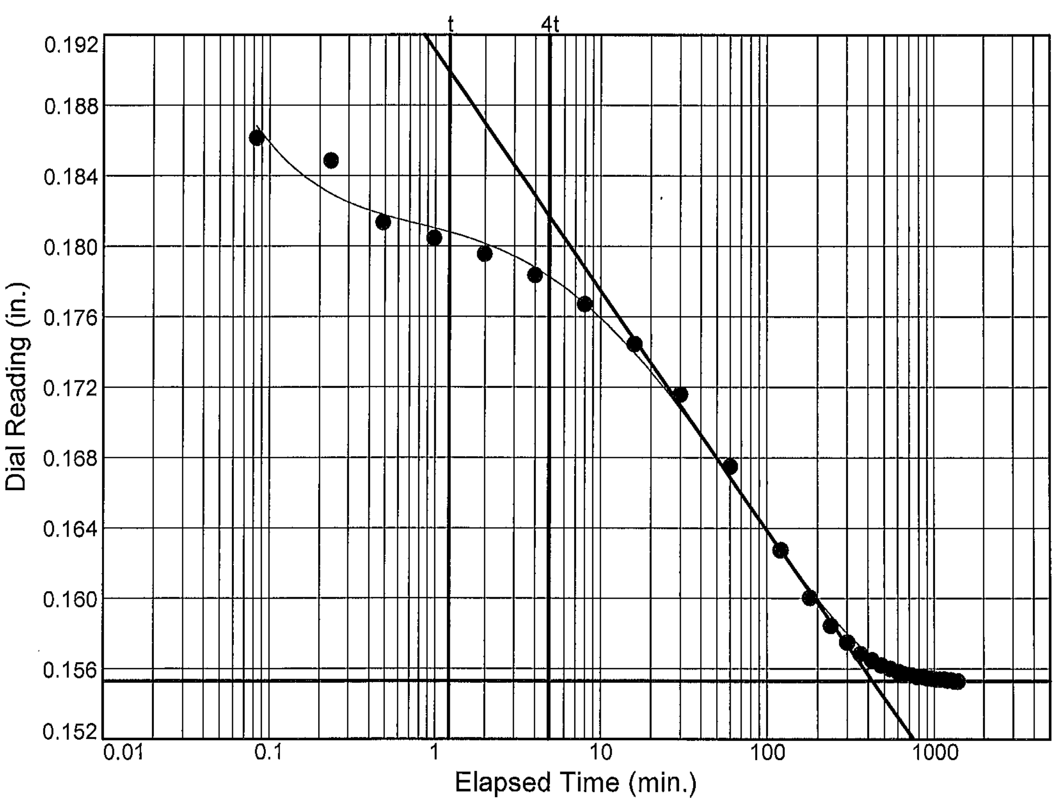
Source of Sample: B-13 Depth: 48



Load No.= 11
Load= 54.99 tsf
D_0 = 0.1392
D_{50} = 0.1596
D_{100} = 0.1800
T_{50} = 38.38 min.

C_v @ T_{50}
1.7 ft.^{2}/yr.

C_α = 0.014



Load No.= 12
Load= 13.75 tsf
D_0 = 0.1833
D_{50} = 0.1693
D_{100} = 0.1553
T_{50} = 39.19 min.

C_v @ T_{50}
1.6 ft.^{2}/yr.

C_α = 0.000

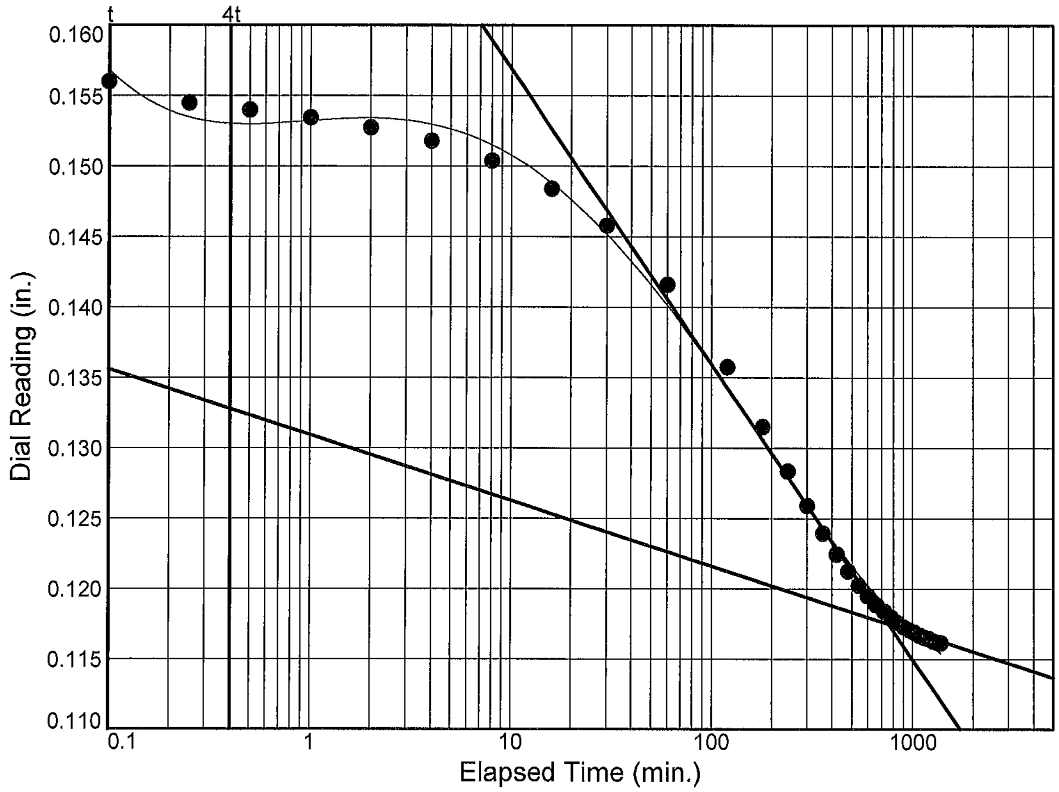
Figure

TOLUNAY-WONG ENGINEERS, INC.

Dial Reading vs. Time

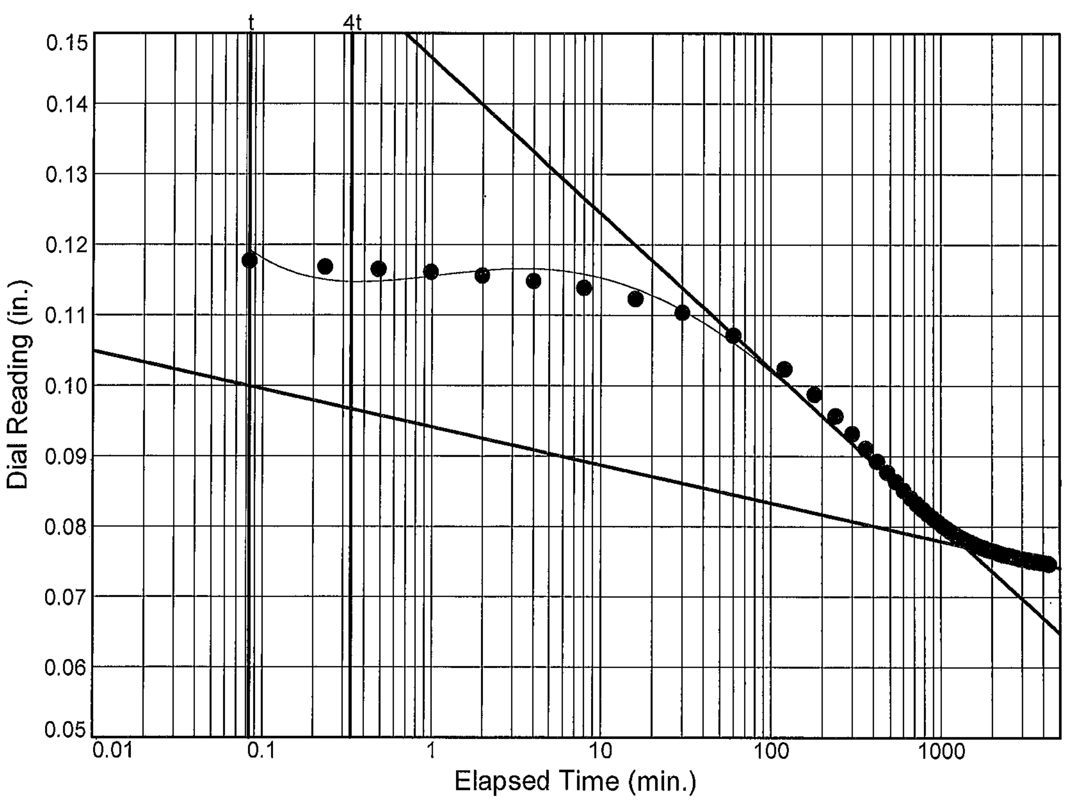
Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

Source of Sample: B-13 Depth: 48



Load No.= 13
Load= 3.49 tsf
D_0 = 0.1606
D_{50} = 0.1390
D_{100} = 0.1175
T_{50} = 68.68 min.

C_v @ T_{50}
1.0 ft.^{2}/yr.



Load No.= 14
Load= 0.86 tsf
D_0 = 0.1238
D_{50} = 0.1004
D_{100} = 0.0771
T_{50} = 119.07 min.

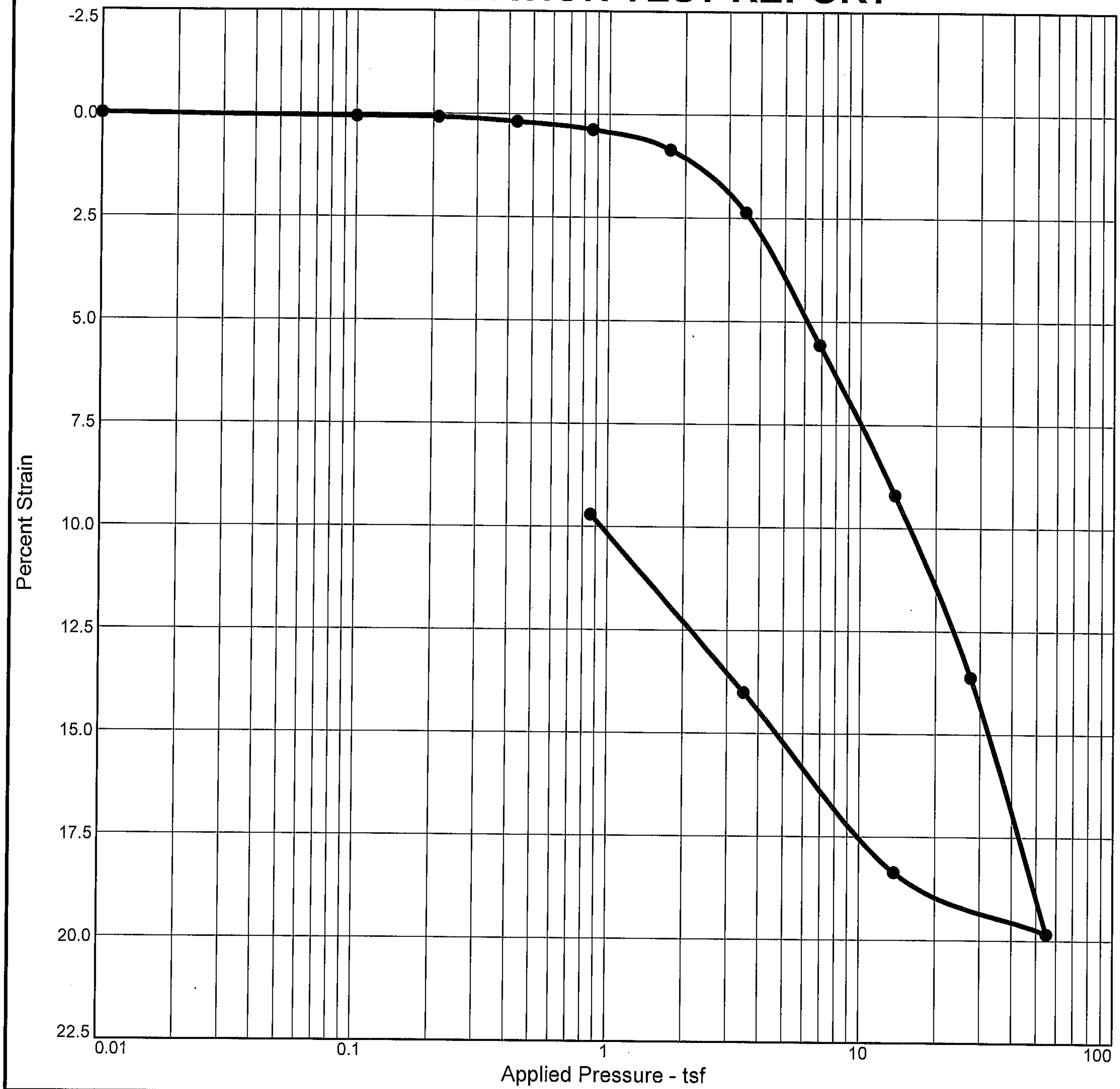
C_v @ T_{50}
0.7 ft.^{2}/yr.

Figure

TOLUNAY-WONG ENGINEERS, INC.

Boring 13 @ 63 ft

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
99.3 %	38.2 %	83.4			2.75	CH		1.058

MATERIAL DESCRIPTION
Grey FAT CLAY

Project No. 23.14.175 **Client:** Trans-Global Solutions, Inc

Project: Sampling & Laboratory Testing - Channel Improvements; Proposed Cedar Port Improvement & Navigation District

Source of Sample: B-13 **Depth:** 63

Tolunay-Wong Engineers, Inc.

Houston, Texas

Remarks:

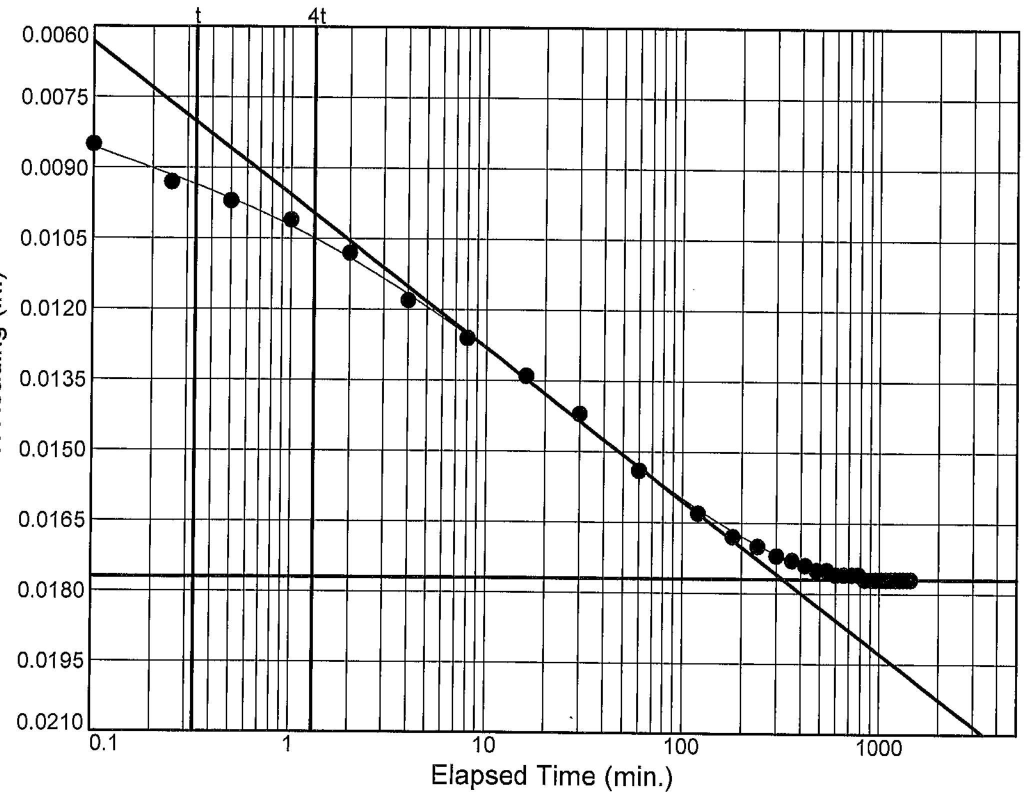
Test method: ASTM D2435
Specific gravity: Assumed

Figure

Dial Reading vs. Time

Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

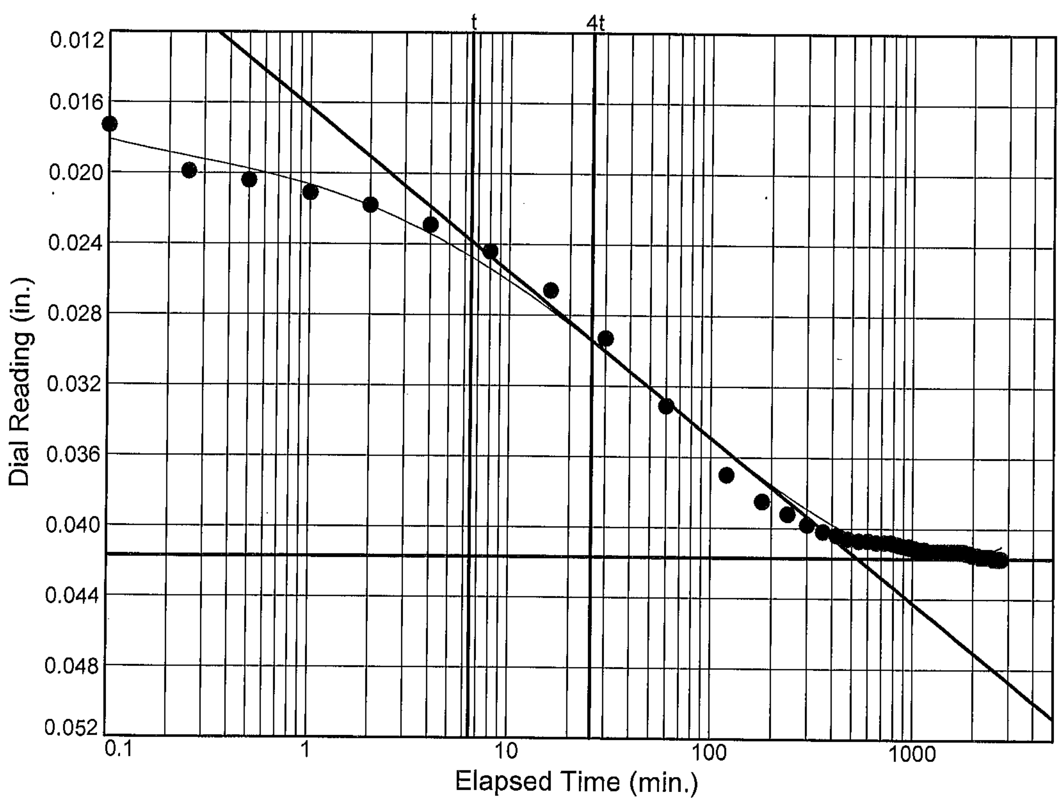
Source of Sample: B-13 Depth: 63



Load No.= 7
Load= 3.49 tsf
D_0 = 0.0082
D_{50} = 0.0130
D_{100} = 0.0177
T_{50} = 10.96 min.

C_v @ T_{50}
8.9 $ft.^2/yr.$

C_α = 0.000



Load No.= 8
Load= 6.87 tsf
D_0 = 0.0200
D_{50} = 0.0308
D_{100} = 0.0417
T_{50} = 36.34 min.

C_v @ T_{50}
2.6 $ft.^2/yr.$

C_α = 0.000

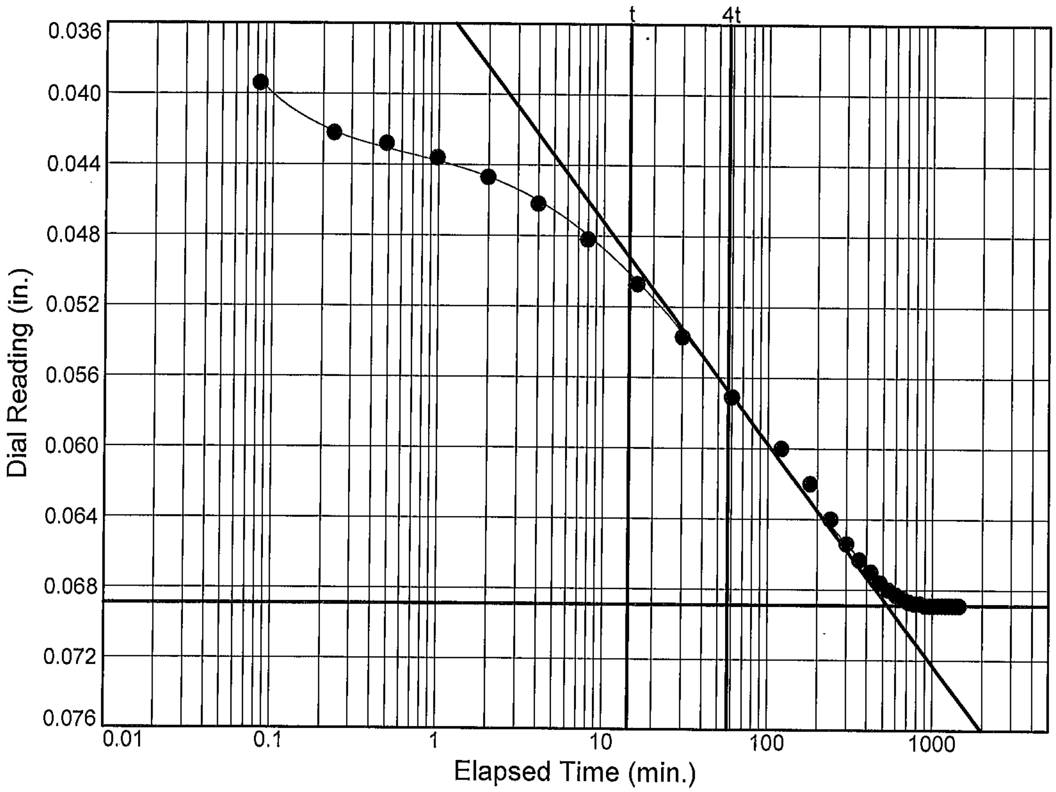
Figure

TOLUNAY-WONG ENGINEERS, INC.

Dial Reading vs. Time

Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

Source of Sample: B-13 Depth: 63



Load No.= 9

Load= 13.75 tsf

D_0 = 0.0434

D_{50} = 0.0562

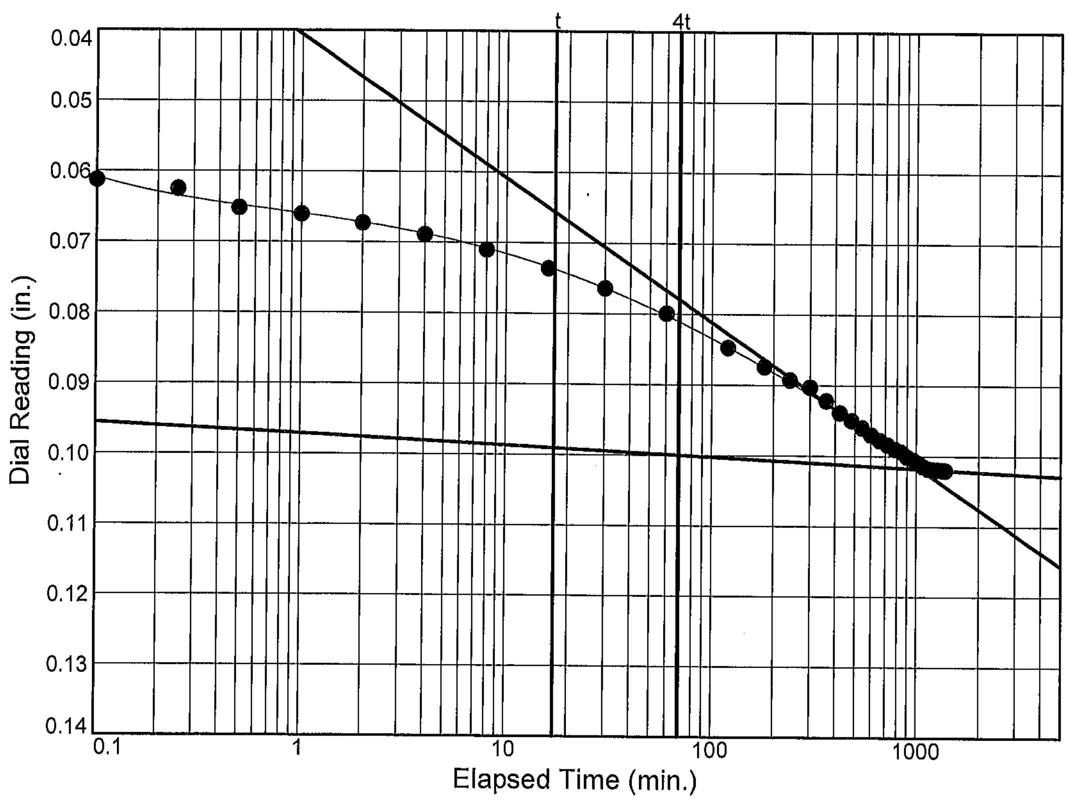
D_{100} = 0.0689

T_{50} = 51.23 min.

C_v @ T_{50}

1.7 ft.^{2}/yr.

C_α = 0.000



Load No.= 10

Load= 27.50 tsf

D_0 = 0.0664

D_{50} = 0.0841

D_{100} = 0.1018

T_{50} = 110.87 min.

C_v @ T_{50}

0.7 ft.^{2}/yr.

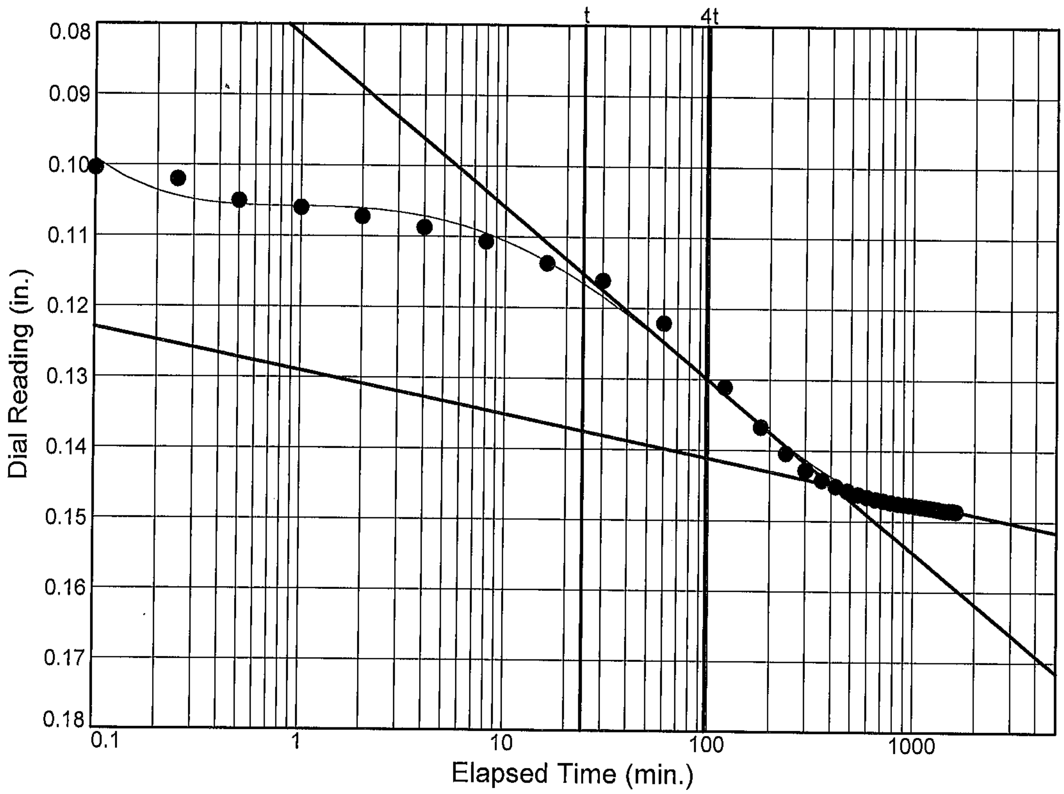
C_α = 0.004

Figure

Dial Reading vs. Time

Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

Source of Sample: B-13 Depth: 63



Load No.= 11

Load= 54.99 tsf

D_0 = 0.1032

D_{50} = 0.1241

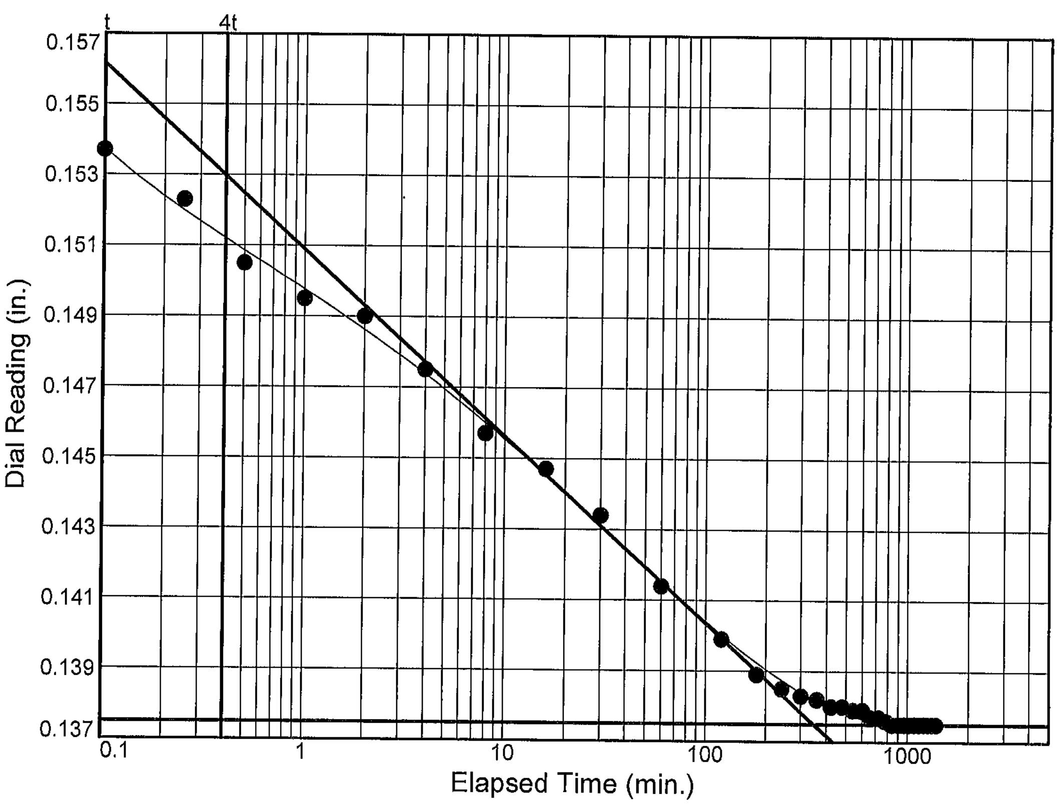
D_{100} = 0.1449

T_{50} = 55.20 min.

C_v @ T_{50}

1.3 ft.^{2}/yr.

C_α = 0.017



Load No.= 12

Load= 13.75 tsf

D_0 = 0.1563

D_{50} = 0.1469

D_{100} = 0.1375

T_{50} = 5.18 min.

C_v @ T_{50}

12.7 ft.^{2}/yr.

C_α = 0.000

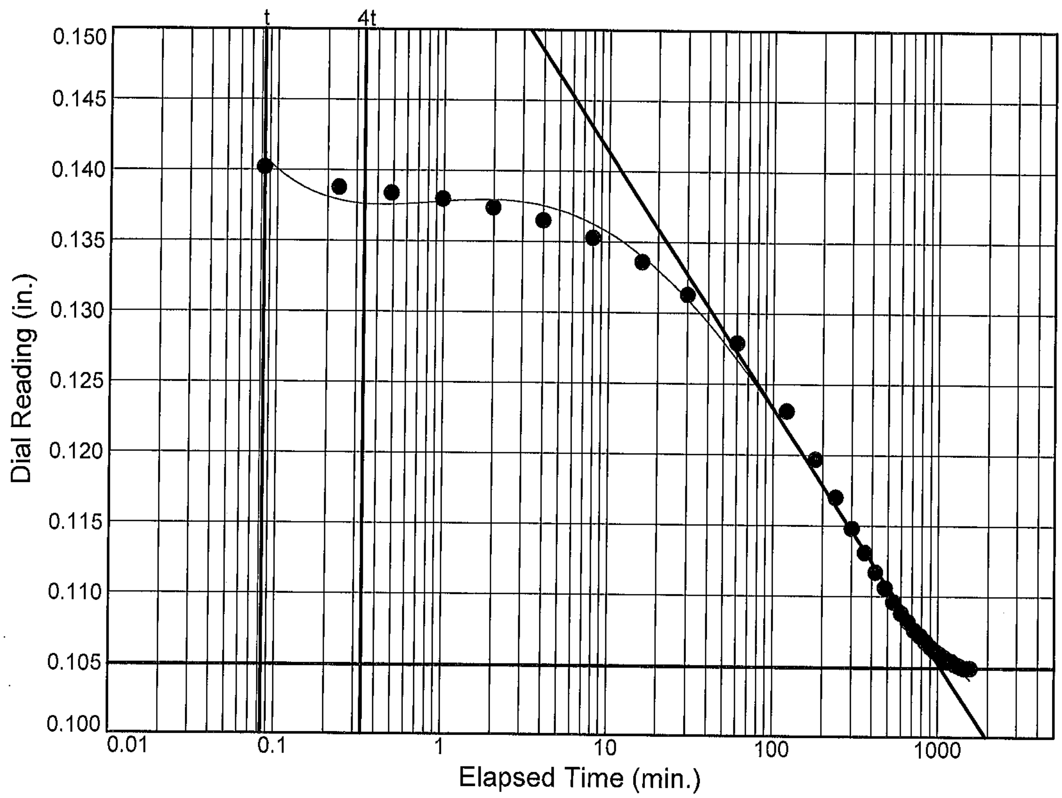
Figure

TOLUNAY-WONG ENGINEERS, INC.

Dial Reading vs. Time

Project No.: 23.14.175
Project: Sampling & Laboratory Testing - Channel Improvements;

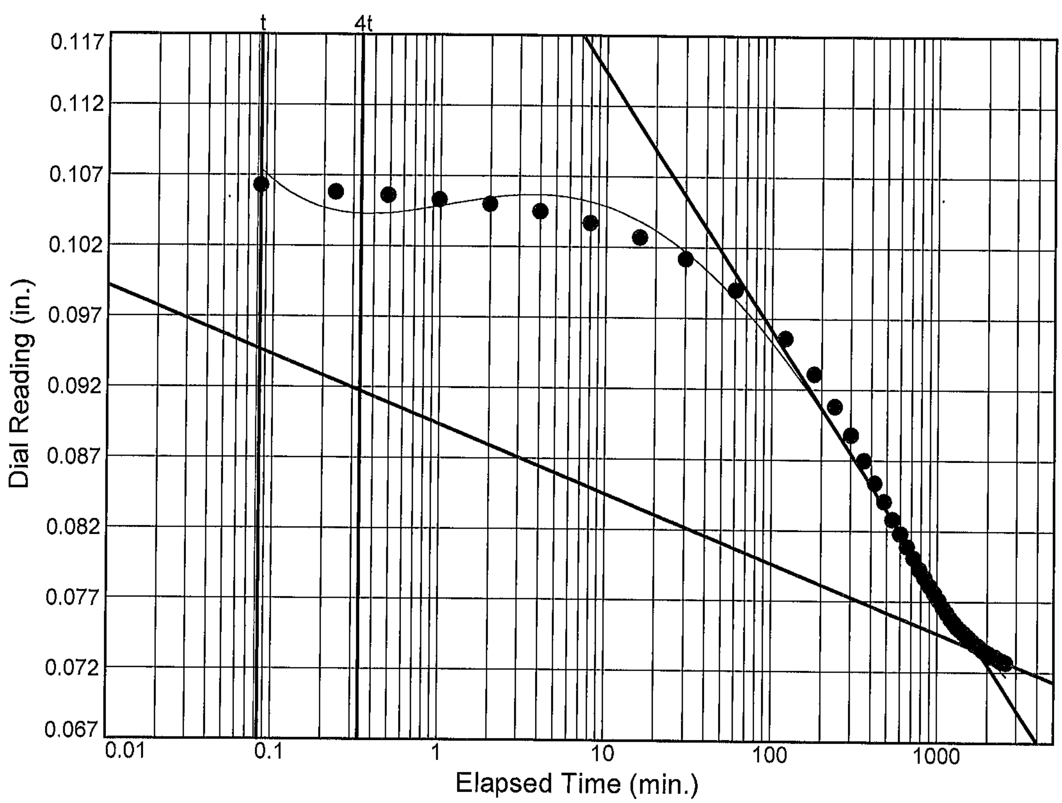
Source of Sample: B-13 Depth: 63



Load No.= 13
Load= 3.49 tsf
D_0 = 0.1442
D_{50} = 0.1245
D_{100} = 0.1049
T_{50} = 82.48 min.

C_v @ T_{50}
0.9 ft.^{2}/yr.

C_α = 0.000



Load No.= 14
Load= 0.86 tsf
D_0 = 0.1106
D_{50} = 0.0920
D_{100} = 0.0735
T_{50} = 161.73 min.

C_v @ T_{50}
0.5 ft.^{2}/yr.

Figure

TOLUNAY-WONG ENGINEERS, INC.

Attachment 3

Tolunay-Wong Engineers 2021 Report

TOLUNAY-WONG
ENGINEERS

PROPOSAL FOR GEOTECHNICAL SERVICES
CEDAR BAYOU DEEPENING/WIDENING
CHAMBERS COUNTY IMPROVEMENT DISTRICT #1
CHAMBERS COUNTY, TEXAS

Prepared for:

TGS Cedar Port Partners, LP
7500 FM 1405
Baytown, Texas 77523

Prepared by:

Tolunay-Wong Engineers, Inc.
2455 West Cardinal Drive, Suite A
Beaumont, Texas 77705

February 8, 2021

TWE Proposal No. P20-B352 (Revision 2)

Geotechnical Engineering
Construction Materials Testing
Geophysical Services
Deep Foundations Testing
Environmental Field Services

www.tweinc.com
1-888-887-9932

February 8, 2021

TGS Cedar Port Partners, LP
7500 FM 1405
Baytown, Texas 77523

Attn: Mr. James Scott
JScott@tgsgroup.com

Ref: Proposal for Geotechnical Services
Cedar Bayou Deepening/Widening
Chambers County Improvement District #1
Chambers County, Texas
TWE Proposal No. P20-B352 (Revision 2)

Dear Mr. Scott,

Tolunay-Wong Engineers, Inc. (TWE) is pleased to submit this revised proposal to provide geotechnical services for the referenced project. This proposal includes an introduction to TWE, a general description of the project, our proposed scope of services to be provided and the estimated cost for completion of our services associated with the project.

Introduction

TWE is familiar with the subsurface conditions within the vicinity of the project site based on geotechnical investigations performed in the past for various Clients and Owners. We have previously performed similar projects involving dredging for marine dock expansions and pre-dredge sampling projects for various Clients and Owners as listed below.

- Marine Dock Projects
  - TWE Project No. 19.23.052 – Energy Transfer Partners, LP – Ship Dock 1 – Nederland, Texas
  - TWE Project No. 19.23.143 – Kinder Morgan Operating, LP – Troika FEED Project – Port Arthur, Texas
  - TWE Project No. 20.23.035 – Lanier & Associates Consulting Engineers, Inc. – Grain Dock Wharf Replacement – Port of Beaumont – Beaumont, Texas
- Pre-Dredge Sampling Projects
  - TWE Project No. 18.23.073 – DiSorbo Consulting, LLC – Jefferson Energy Terminal – Beaumont, Texas
  - TWE Project No. 19.23.113 – GT Logistics – Omniport Dock – Port Arthur, Texas
  - TWE Project No. 20.23.030 – DiSorbo Consulting, LLC – Chevron Phillips Chemical Company – Orange, Texas

This project experience will be integrated into the specific evaluations of the current scope using our team of experienced geotechnical engineers and the resources of our office in Beaumont, Texas. Our Beaumont office organizational chart is provided in Appendix A for reference. Appendix B includes resumes for key personnel which will be involved with the project.

Quality & Safety Measures

This project will be executed in accordance with our Quality Manual and the requirements of the specific Scope of Work provided by the Client. All work performed by TWE under this scope of work will comply with Client and Engineer requirements. Table of contents of our QA/QC Manual, are provided in Appendix C for reference. Mr. Patrick J. Kenney, P.E., Senior Vice President, will review the technical aspects of the project and confirm that our QA/QC procedures are followed throughout the scope of services.

Project Overview

The project includes geotechnical explorations within Cedar Bayou to provide geotechnical information and recommendations required to facilitate dredging of the channel by the Chambers County Improvement District #1 (CCID1). Project exhibits, provided by the Client, are provided in Appendix E for reference. The channel alignment extends from the Houston Ship Channel at the western boundary and terminates at a proposed turning basin near proposed barge and ship docks at the eastern boundary. A 200-ac Dredge Material Placement Area (DMPA) is also being considered landside of the proposed dock area. The ship channel will be widened from 100-ft to 300-ft and deepened to El. (-)45-ft to (-)50-ft. Current water depths range from 2-ft to 12-ft along the alignment. Side slope gradients on the order of 1(V):2(H) to 1(V):3(H) are being considered.

Scope of Services

This revised proposal covers the scope of work activities that will be performed to conduct the geotechnical study for the referenced project. Please note this revised proposal does not include provisions for United States Army Corps of Engineers (USACE) permitting. The geotechnical activities and main categories of our scope of work for this project are provided below:

Pre-Commencement

Our pre-commencement activities include the critical elements for a safe, cost-effective and technically complete geotechnical exploration program. Our pre-commencement activities include the following critical tasks:

1) Notification of the explorations by TWE to the Texas 811 One Call system to request location services from all Participants which could have subsurface pipelines or utilities within the site.

2) Coordination of a Pre-Job Meeting to discuss site history, the potential presence or absence of subsurface utilities, obstructions or anomalies at the proposed exploration locations and daily work schedule and permit procedures.

3) Coordination with our Subcontractor, Peninsula Marine, Inc., to provide a lift boat or tug boat and spud barge to conduct the marine test borings using conventional TWE drilling and sampling equipment.

4) Coordination with our Subconsultant, DiSorbo Consulting, LLC., to provide environmental/analytical field, laboratory and reporting services per USACE guidelines to meet federal DMPA use or beneficial use requirements.

Field Program

The subsurface soil conditions within the channel alignment will be investigated by performing ten (10) test borings (TBs) to depths of 50-ft below the existing mudline, one (1) TB to a depth of 200-ft below the existing mudline and obtaining four (4) sediment samples (SS) of the existing channel bed. Environmental sampling will be performed at test boring locations MB-1, MB-4, MB-7 and MB-10. DiSorbo Consulting, LLC will accompany our field crew to assist and oversee the environmental sampling efforts and to ensure field procedures are in accordance with the appropriate USACE guidelines. The approximate TB and SS locations are shown on TWE Drawing No. P20-B352.1 (Revision 1) provided in Appendix F.

Test Borings (TBs)

The test borings will be performed and logged by experienced Geotechnicians under the direction of a Professional Engineer experienced in geotechnical engineering. Geotechnical drilling, sampling and grouting will be performed in accordance with ASTM International standards. Soil samples will be obtained on 3-ft depth intervals to a depth of 20-ft below the existing mudline and at 5-ft depth intervals thereafter until the 120-ft depth is reached. From 120-ft to 200-ft below the mudline, soil samples will be obtained at 10-ft depth intervals. All soil samples within the proposed dredging depths will be screened with a Photoionization Detector (PID) to determine if contaminants are present.

The marine test borings will be performed utilizing a conventional truck-mounted drilling rig placed on a self-elevating lift boat or on a spud barge maneuvered by a towboat provided by Peninsula Marine, Inc. We anticipate the water depth at the boring locations will be approximately 12-ft. Threaded steel casing, with a diameter of 6-in, will be installed into the mudline at the marine test boring locations to prevent borehole sloughing or collapse until competent materials are encountered. Wash or mud-rotary drilling methods will then be utilized from the existing mudline to the boring completion depth. Upon drilling and sampling completion, the threaded steel casing will be removed and the boreholes will be abandoned in-place.

Fine-grained, cohesive soils will be sampled using pushed, thin-walled tubes with an inside diameter of 2.87-in. Our Geotechnicians will conduct field strength measurements using a pocket penetrometer or hand torvane device on each cohesive soil sample recovered. The samples will be wrapped in foil, placed in moisture sealed containers and handled to minimize disturbance prior to transport to our laboratory.

Where coarse-grained, cohesionless or semi-cohesionless soils are encountered, sampling will be performed using standard penetration test (SPT) methods. Our Geotechnicians will monitor the driving resistance of the split barrel sampler and record blow counts while performing the SPTs. The disturbed samples from SPT sampling will be placed in moisture sealed containers and delivered to our laboratory.

Sediment Sampling (SS)

Channel bed sediment samples will be obtained using a clamshell sampler at four (4) boring locations (MB-3, MB-5, MB-7 and MB-9) along the project alignment. A clamshell sampler consists of two (2) quarter-cylindrical buckets which are lowered to the channel bed and manually closed. The loose sediments entrapped in the buckets will then be returned to the surface, containerized and labeled by both DiSorbo Consulting, LLC. and TWE and then transported to the respective laboratories for geotechnical and environmental/analytical laboratory testing assignments. Our budget estimate associated with this proposal assumes sediment samples will be obtained intermittently during drilling operations and an additional mobilization of marine equipment will not be required.

Laboratory Testing

Selected samples obtained from clam shell sampling and from the test borings will be used for geotechnical laboratory testing in accordance with ASTM International standards as well as environmental and analytical laboratory testing. The scope and extent of the geotechnical laboratory testing program will depend on the subsurface conditions encountered and assignments selected by the Geotechnical Engineer. Our proposed geotechnical laboratory testing program is summarized in Table 1 below.

Table 1 - Geotechnical Laboratory Testing Program

Test Description	Test Method
Standard Proctor Compaction	ASTM D698
Amount of Material in Soils Finer than No. 200 Sieve	ASTM D1140
Water (Moisture) Content	ASTM D2216
Unconsolidated-Undrained Triaxial Compression	ASTM D2850
Liquid Limit, Plastic Limit and Plasticity Index	ASTM D4318
Density (Unit Weight)	ASTM D7263
Particle Size Distribution of Fine-Grained Soils (Hydrometer)	ASTM D7928

Our scope of services described herein also includes the evaluation of compaction characteristics of the dredged materials. At this time, our proposal assumes moisture-density relations (Proctor compaction) testing will be performed on composite samples compiled from the test borings.

The environmental and analytical testing program, proposed DiSorbo Consulting, LLC, is provided in Appendix D of this revised proposal. The environmental and analytical laboratory testing will be performed on four (4) full-depth samples compiled from soil samples obtained from test borings MB-1, MB-4, MB-7 and MB-10 which capture the entire dredging envelope. Additional environmental/analytical scope details are provided in the electronic mail communication in Appendix D.

Log Compilation/Engineering Analysis/Report Preparation

Compilation of test boring logs will be performed as information becomes available from the field and laboratory. This data will be processed and developed into design subsurface profiles which will serve as the basis of our engineering analyses. Engineering analyses will be conducted utilizing this information to provide the geotechnical recommendations needed for the dredging of the channel and placement within the DMPA as well as foundations to support the proposed barge and ship dock structures. The results and findings of our geotechnical services will be provided in a final written report. Our final report will include following:

a) Discussion and conclusions of our findings including:
   i. Summary of field and laboratory tasks;
   ii. Existing project site conditions;
   iii. Test boring logs presenting tabulated field and laboratory geotechnical test results;
   iv. Test results of environmental and analytical laboratory testing and associated conclusions regarding use of the dredged material for placement within designated DMPA;
   v. Subsurface profiles showing soil stratification along the channel alignment; and,

b) Geotechnical conclusions and recommendations including:
   i. Characterization of subsurface soils to be dredged;
   ii. Suitability of dredged soils for use as fill material;
   iii. Suitable channel side slopes determined from global stability analyses;
   iv. Recommendations for site development using dredged materials within the proposed DMPA; and,
   v. Axial pile capacities and lateral pile analysis design parameters for proposed dock piles.

Schedule

Our proposed schedule to perform the scope of services described herein is shown in Table 2 below.

Table 2: Proposed Project Duration	
Item	**Duration**
Pre-Commencement Activities	2 Weeks 1)
Field Program – TBs/SSs	2 Weeks
Geotechnical Laboratory Testing	2 to 3 Weeks
Environmental/Analytical Laboratory Testing	2 to 3 Weeks
Engineering Analysis/Report Preparation	2 to 3 Weeks
Total Estimated Project Duration	**6 to 8 Weeks**

1) Dependent on current field schedule, Subcontractor availability, site access, weather contingencies and clearance of subsurface utilities and/or pipelines within the project alignment.

We understand time is of the essence for preliminary development of the overall project scope. TWE and our Project Team will conduct the tasks provided in Table 3 simultaneously and interim information will be provided as requested to maintain the overall project schedule.

Estimated Cost

The estimated not-to-exceed budget for our geotechnical services associated with this project is **$156,755.00** as shown in the itemized budget estimate in Appendix G. Every reasonable effort will be made to stay within this proposed budget. Should unforeseen conditions or situations occur beyond the control of TWE, we will not exceed this lump sum amount without prior approval from the Client. However, due to unknowns associated with site conditions and various project scope items, we propose to conduct our services on a time and materials basis using the unit rates in Appendix G.

Acceptance of Proposal

To authorize TWE to proceed with this project, please provide a Contract Agreement, Purchase Order or similar document for our review and execution. If no such document is available, please sign the following page of this proposal and return a copy to our office and TWE will provide a Contract Agreement. Contractual documents should be sent to toconnor@tweinc.com with copy to thenneke@tweinc.com.

Closing

If you have any questions regarding this revised proposal, please contact us at **(409) 840-4214.** We appreciate your consideration for this project and we look forward to working with TGS Cedar Port Partners, LP.

Sincerely,

TOLUNAY-WONG ENGINEERS, INC.
TBPELS Firm Registration No. F-000124

Trey O'Connor, E.I.T.
Project Geotechnical Engineer

Tyler G. Henneke, P.E.
Vice President

TO/TGH/to

Appendices:
- A) TWE Beaumont Office Organizational Chart
- B) TWE Resumes of Key Personnel
- C) TWE QA/QC Table of Contents
- D) DSC Environmental/Analytical Testing Program
- E) L&A Project Exhibits
- F) TWE Field Program Location Plan
- G) TWE Itemized Budget Estimate

Agreed to and accepted by:

Signature: ______________________________

Name: ______________________________

Company: ______________________________

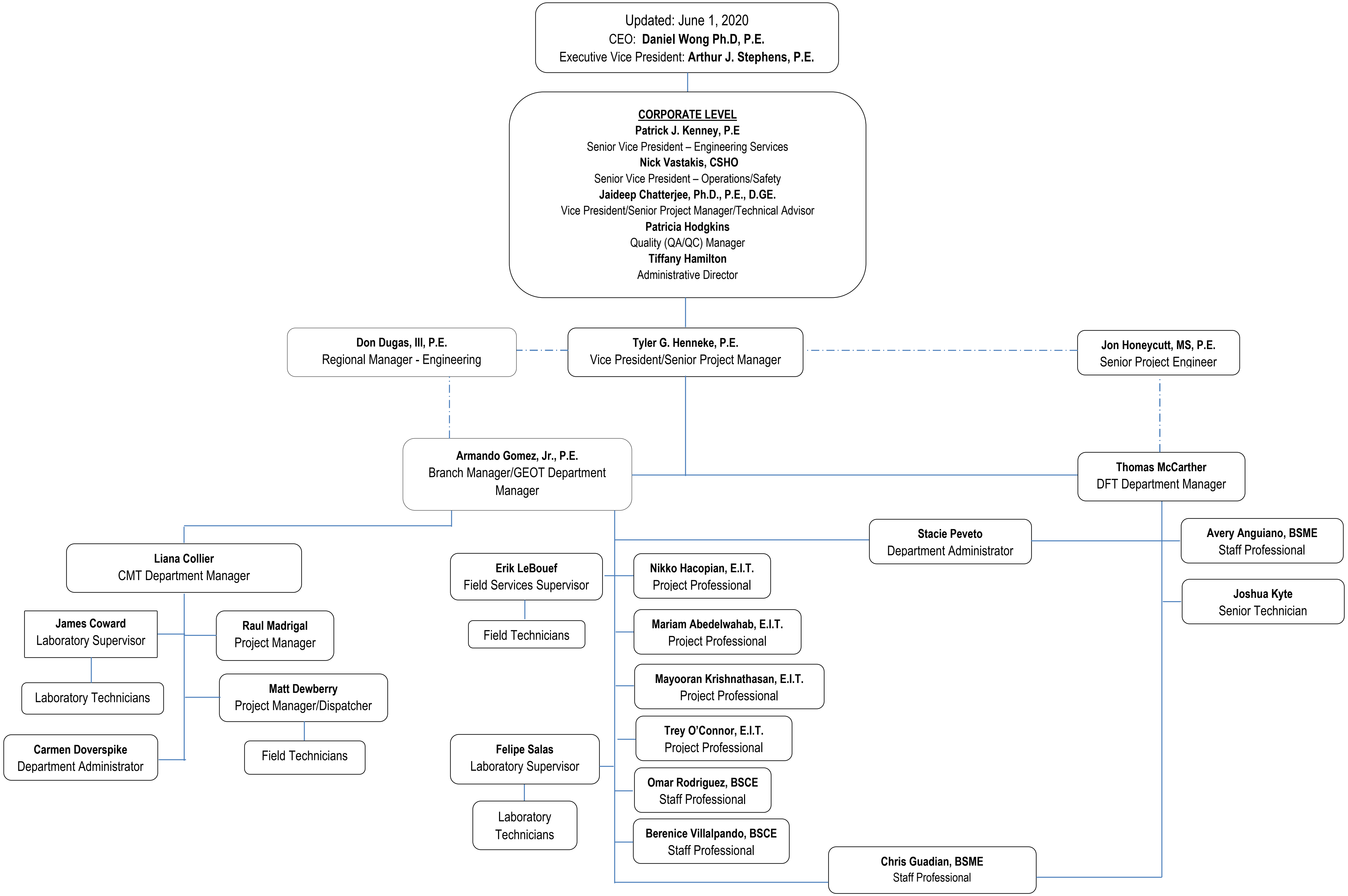
Date: ______________________________

APPENDIX A

TWE BEAUMONT OFFICE ORGANIZATIONAL CHART

Tolunay-Wong Engineers, Inc.

Beaumont, Texas - Branch Organizational Chart



APPENDIX B

TWE RESUMES OF KEY PERSONNEL

PATRICK J. KENNEY, P.E.
SENIOR VICE PRESIDENT – ENGINEERING SERVICES

SPECIALIZATION

Mr. Kenney has over 30 years experience in geotechnical and civil engineering project management, design and consulting. He has technical and managerial responsibility for onshore and marine projects for commercial, municipal, power and oil and gas/energy sectors. Mr. Kenney's expertise includes geotechnical analyses and design of shallow and deep foundation systems, earthen embankments, slope stability, lateral support of deep excavations, ground improvement systems, heavy haul roads, laydown yards and pavement systems, drainage and utilities for land and subdivision development projects. Experience also includes deep foundations testing and development of pile testing programs including WEAP analysis, static load testing, dynamic testing with PDA, pile integrity testing. He has experience in business management including business planning, budgeting, labor and expense management and control.

PROFESSIONAL HISTORY

Tolunay-Wong Engineers, Inc., Beaumont, Texas, 2009 - Present
ENGlobal Engineering, Inc., Beaumont, Texas, 2006 – 2009
Stork Southwestern Laboratories, Inc., Beaumont, Texas, 2000 – 2006
Harrison and Associates, Monroe, Louisiana, 1997 – 2000
Professional Service Industries, Inc., New Orleans, Louisiana/Beaumont Texas, 1988-1997

EDUCATION, REGISTRATIONS AND CERTIFICATIONS

BS in Civil Engineering, Louisiana Tech University, Ruston, Louisiana, 1988
Professional Engineer, State of Texas (No. 87994)
Professional Engineer, State of Louisiana (No. 25669)
Professional Engineer, State of Mississippi (No. 13263)
Professional Engineer, State of Arkansas (No. 15259)
Professional Engineer, State of New Mexico (No. 24751)

AFFILIATIONS

American Society of Civil Engineers (ASCE)
National Society of Professional Engineers (NSPE)
Texas Society of Professional Engineers (TSPE) – Past President – Sabine Chapter
Engineer of the Year Award 2009

PROFESSIONAL HISTORY

2009 - Present **Senior Vice President – Engineering Services**, Tolunay-Wong Engineers, Inc.

Project experience includes detailed geotechnical studies, laboratory testing, geotechnical consultation and project management for a variety of industrial, commercial, residential land development and government projects including feasibility studies, preliminary engineering design and final engineering design. Detailed geotechnical studies include paving, drainage and utilities, shallow and deep foundation design, detailed settlement analyses, ground improvement methods, cone penetrometer testing, seismocone testing, earthen embankments, sheet pile, retaining walls, slope stability analyses and temporary earth retaining systems. Experience also includes extensive background in geotechnical instrumentation installation, monitoring and consultation as well as deep

foundation testing including static load testing, dynamic testing with PDA, pile integrity testing (PIT) and cross-hole sonic integrity logging.
Representative Projects:

- Shell Gas to Liquids Project – Convent, LA
- Natural Gas to Gasoline Project – Natgasoline, LLC/OCI – Beaumont, TX
- Sabine Pass LNG – Soil Stabilization - Cameron, LA
- Cameron LNG – Soil Stabilization/CPT/Pile Testing – Hackberry, LA
- Sasol North America – Haul Roads and Laydown Yard – Lake Charles, LA
- Motiva Expansion – Aromatics and Cracker Units – Port Arthur, TX
- Valero St. Charles Refinery – Diamond Green Diesel Project – Norco, LA
- ExxonMobil Beaumont Refinery – Hurricane Flood Protection Project
- Interstate 10 Widening Project – Siegen Ln. to Highland Rd. – Baton Rouge, LA
- Interstate 12 Widening Project – O'Neal Lane Overpass – Livingston, LA
- Sienna Plantation Subdivision, Fort Bend County, TX (Multiple Phases)
- Westview Landing Subdivision, Harris County, TX (Multiple Phases)

2006 - 2009 **Senior Civil Engineer,** ENGlobal Engineering, Inc.

Civil/Structural Design experience includes structural steel and concrete foundation design for various structures for petrochemical facilities including pipe racks, electrical power line distribution structures, tanks and vessels. Experience also includes site development for both temporary construction and permanent facilities including laydown areas, buildings and heavy haul roads for a major refinery expansion project.

Representative Projects:

- Motiva Enterprises LLC – Port Arthur Refinery – Crude Expansion Project
- Hovensa St. Croix Refinery, USVI – Flue Gas Cooler Replacement Project

2000 - 2006 **Office Manager/ Manager of Engineering**, Stork Southwestern Laboratories, Inc.

Responsibilities have included coordination of all projects from start to finish, supervision of geotechnical laboratory testing, soils and foundation consulting and geotechnical report preparation. In addition managed quality control inspection and testing services for major construction projects and supervises construction inspection personnel. Served as office manager and geotechnical engineer for a wide variety of commercial, heavy industrial, medical and transportation projects covering the Southeast Texas area including Beaumont, Port Arthur, Orange, Kirbyville, Newton and Jasper.

Representative Projects:

- Fort Bend County Westpark Tollway (TxDOT) – Houston, Texas
- U.S. Highway 69 Widening Project (TxDOT) – Buna, TX to Kirbyville, TX
- Sabine Pass LNG Facility – Cameron Parish, Louisiana
- Motiva Enterprises LLC – Numerous Projects - Port Arthur, Texas
- LNVA North Reginal Treatment Plant – Reservoir and Evacuation Route

- St. Elizabeth Hospital Parking Garage & Ambulatory Care Facility
- Premcor Refinery - Refinery Expansion, Port Arthur, Texas
- Power Transmission Lines – Entergy - Various Locations, Gulf Coast Area
- Hartburg Substation Expansion – Entergy - Hartburg, Texas
- Water Treatment Plant Expansions - Winnie & Anahuac, Texas
- Sabine Shipyard – New Dock Facility - Sabine Pass, Texas

1997 - 2000

Civil Engineering Consulting and Surveying. Project Engineer, Harrison and Associates, Inc.

Responsible for engineering design and project management with municipal and public works projects including drainage improvement projects, street and highway design and reconstruction, flood control and subdivision development.

Representative Projects:

- Yester Oaks Drainage Improvements – Prepared drainage map and determined watershed boundaries and computed runoff volumes to size drainage structures. Developed plans and specifications, contract administration and construction inspection.
- Puckett Estates Road and Drainage Improvements – Prepared drainage map and determined watershed boundaries and computed runoff volumes to size drainage structures. Designed new roads for the subdivision and developed plans and specifications, contract administration and construction inspection.
- Managed Drainage and Flood Control Program for Ouachita Parish including overall drainage map for the Parish and planning for flood control projects including site selection right-of-way acquisition and computation of storage and discharge volumes and sizing of flood control structures.

1988 - 1997

Office Manager, Professional Service Industries, Inc.

Geotechnical Engineering and Construction Materials Services. Office Manager (Various Locations) –Served as office manager and geotechnical engineer for local geotechnical consultants covering the Southeast Texas area including Beaumont, Port Arthur, Orange, Kirbyville, Newton and Jasper. Provided geotechnical consulting in the Louisiana and Mississippi Gulf Coast area from Baton Rouge and New Orleans to Gulport/Biloxi, as well as Northeast Louisiana, North Central Mississippi and South Arkansas.

Representative Projects:

- Nine Mile Point Transmission Line – Mississippi River Crossing – New Orleans, LA
- Sunbeam/Oster Manufacturing/Distribution Facility – Hattiesburg, MS
- Poydras Plaza Office Tower / Parking Garage – New Orleans, LA
- New 6-Story Library – Northeast Louisiana University, Monroe, LA
- New 102.6 Megawatt Hydroelectric Power Station – Arkansas River – Dam No. 2 - Dumas, Arkansas

Tolunay-Wong Engineers, Inc.

JAIDEEP CHATTERJEE, PhD, PE, DGE
VICE PRESIDENT

SUMMARY

Dr. Chatterjee has 14+ years of experience in geotechnical and civil engineering design and consulting practice. His professional experience encompasses a broad range of heavy industrial onshore and near shore projects and medium to large residential and commercial developments in the Gulf Coast Region of Texas and Louisiana as well as in the Permian Basin Region. Representative project experience includes large scale geotechnical studies for new LNG facilities, chemical manufacturing plants, crude oil refineries and large vessel ports and liquid, bulk and LNG/LPG terminals. His experience also includes geotechnical studies for directional drilling, flood control, slope stabilization and transportation projects. He had significantly contributed to geotechnical design of numerous New Orleans hurricane and flood protection projects undertaken by USACE post Hurricane Katrina. He has published numerous papers in reputed peer reviewed geotechnical engineering journals and conferences. He is a licensed professional engineer in multiple states, a core committee member of the Houston Chapter of the Geo-Institute of ASCE and a frequent speaker at various technical meetings and geotechnical engineering conferences. Dr. Chatterjee has Diplomate, Geotechnical Engineering (DGE) certification (highest distinction in geotechnical practice) from the Academy of Geo-Professionals (AGP) of the American Society of Civil Engineers (ASCE).

PROFESSIONAL HISTORY

Tolunay-Wong Engineers, Inc., Houston, TX, August 2013 – Present
Geosyntec Consultants, Houston, TX, December 2012 – August 2013
Burns Cooley Dennis, Inc., Ridgeland, MS, February. 2007 – December 2012
Jackson State University, Jackson, MS, January 2009 – December 2012
State University of New York at Buffalo, Buffalo, NY, 2002 – 2007
Development Consultants Ltd, India, 1997 – 2000

EDUCATION

PhD, Civil (Geotechnical) Engineering, State University of New York (SUNY) at Buffalo, 2007
MS, Civil (Geotechnical) Engineering, State University of New York (SUNY) at Buffalo, 2002
BS, Civil Engineering, Jadavpur University, Calcutta, India, 1997

PROFESSIONAL LICENSES AND CREDENTIALS

Professional Engineer – Texas (111154), Louisiana (36547), Oklahoma (30245), Mississippi (19982)
Diplomate, Geotechnical Engineering (DGE), Academy of Geo-Professionals (AGP), ASCE
Board Certified Geotechnical Engineer - American Society of Civil Engineers (ASCE)
Pre-Certified in All Geotechnical Services Categories - Texas Department of Transportation (TxDOT)
Transportation Worker Identification Credential (TWIC) Card – Transportation Security Administration
Eight (8) Hours Environmental Health and Safety Training Certificate

AFFILIATIONS AND COMMITTEES

American Society of Civil Engineers (ASCE) and Geo-Institute (G-I), Member
Geo-Institute, ASCE - Houston Branch, Committee Member
Deep Foundation Institute (DFI), Member
National Society of Professional Engineers (NSPE), Member
Texas Society of Professional Engineers (TSPE) – Greater Houston Chapter, Member
International Society for Soil Mechanics and Foundation Engineering (ISSMGE), Member
University at Buffalo Alumni Association, Life Member

PROFESSIONAL EXPERIENCE

Tolunay-Wong Engineers, Inc., Houston, TX
Vice President / Senior Geotechnical Manager
August 2013 – Present

At TWE, Dr. Chatterjee oversees geotechnical studies for medium to large projects, primarily across the Texas and Louisiana Gulf Coast Region covering Houston-Greater Houston, Beaumont-Port Arthur, Corpus Christi, Lake Charles, Baton Rouge and New Orleans areas. His responsibilities include mentoring junior staff, providing technical guidance and leadership, maintaining client relationship, assisting in marketing and business development, participating in local professional societies, peer review of engineering work products and providing technical and managerial oversight to various projects teams across various TWE offices covering Texas and Louisiana Gulf Coast Regions. He resolves abstract problems/difficult technical matters independently and serve as a technical resource throughout the company, being responsible for overall technical execution, quality and consistency.

Dr. Chatterjee's general project responsibilities include coordination of projects and communications with the Clients, supervision of engineering tasks, preparation of project proposals and reports, review of reports, design calculation packages, peer review, project monitoring, performing engineering analyses and providing overall technical guidance to various project teams from start to completion of the projects.

Representative Petrochemical, Industrial and Port and Marine Projects

- Phillips 66 – Beaumont Terminal Crude Oil and Refined Product Terminal Expansion Project and Master Storage Tanks Program - Nederland, Texas
- ExxonMobil Corporation – Beaumont Light Atmospheric Distillation Expansion (BLADE) Project - Beaumont, Texas
- Shell – Layberth Project – Shell Deer Park Facility - Deer Park, Texas
- Motiva Port Arthur Refinery – New Aromatics and Polyethylene Units - Port Arthur, Texas
- Valero Port Arthur Refinery - Crane Lift Evaluation, Design of Reactor Foundation and Evaluation of Heavy Haul Route for Reactor Transport - Port Arthur, Texas
- Energy Transfer Partners, LP – New Ship Dock 1 - Nederland, Texas
- Valero Corporation - Valero DCU 844 OSBL Project - Port Arthur, Texas
- ExxonMobil Corporation Beaumont Refinery – SCANfining (Selective Catalytic Naphtha Hydrofining Unit) Project - Beaumont, Texas
- Orascom E &C USA, Inc. - Natgasoline Methanol Plant - Beaumont, Texas
- Kinder Morgan – Troika Project - Port Arthur, Texas
- Enterprise Products Partners, LP – Refined Products and Crude Oil Terminals - Beaumont, Texas
- Chevron Phillips Chemical – U.S. Gulf Coast II Petrochemical Project - Orange, Texas
- Entergy Corporation – New Power Transmission Lines and Substations - Multiple Locations in US Gulf Coast Region covering Louisiana and Texas
- Oiltanking Beaumont, Inc. – Geotechnical Studies for New Crude Storage Tanks - Beaumont, Texas
- Port of Houston – Turning Basin Terminal – Wharf City Dock Rehabilitation - Houston, Texas
- Energy Transfer Partners, LP – Ship Dock 1 - Nederland, Texas
- Methanex, Louisiana – Geismar Unit Expansion Projects - Geismar, Louisiana
- Sasol Chemicals (USA), LLC - Lake Charles Chemical Complex - Lake Charles, Louisiana
- Shell Oil Company, US – Geotechnical Study for Proposed Gas to Diesel (GTL) Conversion Project - Geismar, Louisiana

Engineering tasks for petrochemical and industrial projects generally included subsurface investigation (soil borings and Cone Penetration Testing), laboratory testing assignments, development of design subsurface profiles and soil parameters, shallow foundations (spread footing, slab-on-grade, drilled footings, tank ring wall foundation) and deep foundations (driven piles, drilled shaft and augured cast-in-place piles) analyses and design, bearing capacity and settlement analyses, evaluation of dynamic soil properties using seismic cone or downhole seismic survey geophysical testing data, seismic site class evaluation and rigid and flexible pavement analyses and design recommendations using AASHTO for various project structures within petrochemical facilities including equipment, manifold structures, pipe racks, storage tanks and vessels and other ancillary project structures and components. Typical engineering tasks also included crane lift evaluation, site development for both temporary construction and permanent facilities including laydown areas, buildings and slab-on-grade, retaining structures and heavy haul roads for transporting heavy modular units, slope stability evaluation of containment levees and dikes, developing dynamic foundation stiffness and damping parameters using dynamic soil-structure computer programs.

For the substation and transmission line projects, engineering tasks included developing shallow and deep foundations recommendations for substation structures and electrical power line distribution structures. General site preparation and construction recommendations were also provided for the above projects.

For port and marine facilities and dock projects, engineering tasks generally included subsurface investigation (soil borings and Cone Penetration Testing), laboratory testing assignments, development of design subsurface profiles and soil parameters, developing deep foundations recommendations for various dock structures such as mooring and breasting dolphins, dock and access platform, developing shallow and deep foundations recommendations for landside dock structures and pipe racks, slope stability evaluation of bank slope, analysis and design of sheet pile bulkhead retention system, providing general site preparation and construction recommendations.

Representative Slope Stabilization, Hurricane Protection and Flood Control Projects:

- USACE Galveston District – Design of Sabine Pass to Galveston Bay, Port Arthur and Vicinity, Coastal Storm Risk Management Program – Geotechnical Investigation – Port Arthur, Texas
- USACE Galveston District and Jefferson County Drainage District 7 - Port Arthur Emergency Floodwall Repair Project Post Hurricane Harvey - Port Arthur, Texas
- McNeese State University – Contraband Bayou Erosion Project - Lake Charles, Louisiana
- LJA Engineering, Inc. – Port of Texas City Industrial Canal Slope Modification - Texas City, Texas
- Harris County Flood Control District - Greens Bayou Greenway 2020 Project - Harris County, Texas
- Harris County Flood Control District – Sims Bayou Hike and Bike Trail – Harris County, Texas
- Marathon Petroleum Corporation – Texas City Hurricane Protection Levee Evaluation, Marathon Galveston Bay Refinery - Texas City, Texas
- Lanier Associates – City of Beaumont Riverfront Park Restoration Project – Beaumont, Texas

Flood control, erosion protection, hurricane protection and slope stabilization project tasks included subsurface investigation, laboratory testing assignments, development of design subsurface profiles and soil parameters, slope stability evaluation of urban levee systems, remediation of over-steepened slopes, design of new sheetpile bulkhead, slope stability evaluation of trails and retaining walls under the jurisdiction of various federal, state and local agencies such as U.S. Army Corps of Engineers (USACE), Harris County Flood Control District, Harris and Fort Bend Counties, City of Houston and others. For the USACE projects, performed geotechnical studies following their Engineering Manuals and various USACE approved methods and computer programs. For the HCFCD projects, engineering tasks included performing slope stability evaluation using HCFCD guidelines, design of mechanically stabilized earth retaining wall systems and providing general slope construction and remediation guidelines.

Representative Directional Drilling Projects:

- Laney Directional Drilling – Sabine-Neches Waterway Direct Pipe Project - Port Arthur, Texas
- Praxair, Inc. – HDD Pipeline Relocation under Houston Ship Channel – Harris County, Texas
- Lower Neches Valley Authority (LNVA) – Evaluation of Existing Hurricane and Flood Protection Urban Levees and HDD Crossings - Port Arthur, Texas
- LJA Engineering, Inc. – Morgan's Point Line Relocation at Cedar Bayou, HDD Crossing - Chambers County, Texas
- Enterprise Products Partners, LP - Interstate 10 HDD Crossing - Fort Stockton, Texas
- Kinder Morgan Pipeline Relocation Projects, various HDD Crossings – Southeast Texas, West Texas and New Mexico
- Enterprise Products Partners, LP - Tehucana Creek HDD Crossing, Freestone County, Texas

Geotechnical tasks for Horizontal Directional Drilling (HDD) and Direct Pipe (DP) projects included subsurface investigation, laboratory testing assignments, development of design subsurface profiles and soil parameters, evaluation of feasibility of directional drills based on explored subsurface conditions, developing soil formation limit pressures in accordance with Delft Method and hydraulic fracture evaluation.

Representative Transportation Projects:

- Texas Department of Transportation (TxDOT) – New Virginia Avenue Overpass over MLK Parkway - Jefferson County, Texas
- AIA Engineers – South End Overpass Project - Jefferson County, Texas
- Interstate 10 Widening Project – Highland Road to LA 73 Interchange - East Baton Rouge and Ascension Parishes, Louisiana
- Texas Department of Transportation (TxDOT) - Grand Parkway Segments Extension Project - H & I, US 59N to IH-10 – Northeast Houston, Texas

Engineering tasks for the overpass project included subsurface exploration using Texas Cone Penetrometer (TCP) Methods, developing soil boring logs using TxDOT Wincore Programs, developing deep foundation recommendations using TxDOT methods, developing geotechnical recommendations for mechanically stabilized earth retaining walls, performing settlement studies for access roadway embankments and providing pavement design recommendations for the bridge structure.

Representative Residential and Commercial Developments, Water Plant, Transportation Projects:

- Brown and Gay Engineers - Sueba Katy Boardwalk, 24-Acre Single Family Development - Fort Bend County, Texas
- Walter P. Moore – Julia Ideson Library Building - Houston, Texas
- Taylor Morrison – Grand Vista North Recreation Center - Fort Bend County, Texas
- Toll Brothers – Sienna Plantation, Section 21, Utilities and Paving - Fort Bend County, Texas
- Ventata Development – Trails of Katy, Section 3, Residential Foundations - Fort Bend County, Texas
- Brown and Gay Engineers – MCMUD No. 113 WWTP Expansion - Montgomery County, Texas
- Texas Department of Transportation (TxDOT) – New Virginia Avenue Overpass over MLK Parkway - Jefferson County, Texas
- AIA Engineers – South End Overpass Project - Jefferson County, Texas
- Interstate 10 Widening Project – Highland Road and Bayou Manchac Bridge Structures - East Baton Rouge and Ascension Parishes, Louisiana

For the land development, residential subdivision and commercial projects, engineering tasks typically included subsurface investigation (soil borings and Cone Penetration Testing), laboratory testing assignments, development of design subsurface profiles and soil parameters, developing shallow and deep foundation recommendations, developing Post Tension Institute (PTI) slab design parameters, evaluation of soil expansive potential and remediation and providing general site preparation and construction recommendations.

Geosyntec Consultants, Houston, TX
Project Engineer
December 2012 – August 2013

Worked on FEED studies of several large LNG projects and on a joint-industry partnership research project on the use of helical piles for offshore wind tower foundation. As Client's engineer, his primary responsibilities included peer review of deliverables pertaining to site investigation reports, geotechnical factual, interpretive and design reports, foundation design calculations, preparation of technical review reports and performing independent engineering analyses.

Engineering studies and analysis generally included but not limited to review of onshore and offshore site investigation reports containing boring and CPT data and laboratory test results, soil design profile and parameters development across the plant site, shallow and deep foundation analyses, slope stability evaluation and deep mixing ground improvement for retaining walls, bearing capacity, settlement analyses, soil liquefaction evaluation and seismic hazard analysis.

Representative Projects:

- Confidential Client – A Proposed Large LNG Facility - British Columbia, Canada
- AMEC Foster Wheeler - Offshore Gas Exploration Project - Offshore Romania
- ExxonMobil Corporation – Offshore Gas Exploration Projects - Turkey
- Repsol, UK – A Feasibility Study to Evaluate Use of Large Diameter Helical Piles as an Alternative to Driven Pile Foundations for Offshore Wind Turbines - Offshore Scotland, UK

FFEB, JV, LLC (Fugro, Stantec, Eustis, and Burns Cooley Dennis – A Joint Venture), Kenner, LA
Project Engineer / Senior Geotechnical Engineer
February 2007 – December 2012

Worked extensively on the detailed geotechnical engineering analyses and design for numerous large-scale projects as part of a large joint venture project team (FFEB JV, LLC, led by Fugro Consultants) pertaining to re-building of the New Orleans Hurricane and Flood Protection and Fronting Protection Systems. The work was performed for the US Army Corps of Engineers (USACE), New Orleans (MVN) District. The projects included design of various Mississippi riverbank and canal system Levees and Floodwalls, Flood Gates and Control Structures to provide 100-year flood protection.

Representative Hurricane Protection Levee Projects

- NOV-11 & 12, Port Sulphur to Venice Levee Enlargement - Plaquemines Parish, LA
- NOV-16, Empire to Buras Levee Enlargement - Plaquemines Parish, LA
- Carrollton Levee Enlargement and Floodwall - Orleans Parish, Louisiana
- Phoenix to Bohemia Levee Enlargement and Concrete Slope Repairs - Plaquemines Parish, Louisiana
- New Orleans International Airport Runway East-West Levee, Phase 2 - Jefferson Parish, Louisiana

For the above major hurricane protection levee projects, engineering tasks included development of Design Quality Control Plan (DQCP), preparation of project proposal and cost estimate, review, coordination, analysis, synthesis and compilation of subsurface and laboratory test data, development of soil profiles and parameters, identification of design soil reaches, development of design shear strength parameters using the undisturbed shear strength data and CPT data, settlement analysis for the estimation of levee overbuild and comprehensive slope stability and underseepage analyses and development of comprehensive geotechnical reports.

Engineering analyses and design were performed in struct accordance with various USACE Engineering Manual and guidance (Ems, ETLs and others) and the Hurricane and Storm Damage Risk Reduction System Design Guidelines (HSDRRSDG) developed by the USACE.

Performed extensive slope stability analyses of levees using computer programs “Stability with Uplift” (based on LMVD Method of Planes, MOP) and computer programs Slope/W (based on Spencer’s Method of analysis). For these levee projects, performed extensive underseepage analysis using USACE design guidelines (based on Blanket Theory) and Seep/W (based on Finite Element Method) and compared the results of different analyses to evaluate the reliability and accuracy of the results. Performed rigorous consolidation settlement analysis using a USACE computer program CSETT to estimate the required overbuild of the levee sections prior to performing the slope stability analyses. Performed remedial design analyses for the deficient levee reaches which did not meet either stability and/or seepage criteria.

The remedial designs for the stability included design of Stability Berm and Deep Soil Mixing Columns. The remedial measures for seepage included design of Relief Well and Seepage Berms. Significantly contributed to the preparation of plans and specification and engineering during construction.

Representative Hurricane Protection Floodwall Projects

- WBV-90-404C, Drainage Structure and Floodwall - Jefferson Parish, Louisiana.
- Bonnabel Floodgate, Phase 2 - Jefferson Parish, Louisiana
- West Return Canal Floodwall and its New South Wall Alignment - Jefferson Parish, Louisiana
- T-wall design for West Bank and Vicinity, Hurricane Protection Project, WBV14g.2, Old Estelle Pump Station to New Estelle Pump Station - Jefferson Parish, Louisiana

Performed geotechnical design and analyses of floodwalls (such as the design of T-wall and I-wall) which are major components of the recently developed hurricane protection system in the New Orleans area. Specific project duties in these floodwall projects included but not limited to analysis and synthesis of soil laboratory test data and cone penetration data, development of soil parameters for design and rigorous slope stability and seepage analyses. For the pile supported T-wall, performed extensive unbalanced load analyses using the computer programs Slope/W and MOP. Developed modulus of horizontal subgrade reaction and pile capacity curves for the pile supported T-walls based on USACE guidelines. Performed extensive lateral load analyses of piles using computer program L-PILE. For the projects involving I-wall and sheet pile system, performed extensive comparative slope stability analyses considering gap between the I-Wall and soil at the flood side of the sheet pile. In addition, performed global stability analysis of sheet pile supported I-wall. Performed local stability analysis of the I-wall using the computer program CWALSHT. Evaluated the safe water elevations for the I-wall system from the consideration of seepage and stability. Performed pile downdrag analysis and pile bending moment analysis due to consolidation of the supporting fill based on the USACE design guidelines. Significantly contributed to the preparation of the geotechnical design report and contributed to the preparation of plans and specification and engineering during construction.

Representative Fronting Protection and Strom Proofing of Pump Stations Projects:

- Fronting Protection at Elmwood Pumping Station - Jefferson Parish, Louisiana
- Storm proofing of Westwego No.1 Pump Station, JSP-15, Storm Proofing of Interior Pump Stations - Jefferson Parish, Louisiana

Engineering tasks included preparation of project scope and cost estimate, coordination with structural and hydraulics engineer for the loading data, review of subsurface data, development of design soil strength profiles, axial and lateral pile capacity analysis, design of braced excavation, sheet pile wall design, compilation and annotation of design calculations and preparation of geotechnical design report

Representative Outfall and Navigation Canals Projects

- Safe Water Level determination of three Outfall Canals (17-th St, Orleans Avenue and London Avenue Canals) in Orleans Parish, LA satisfying stability and seepage criteria for 100-year protection
- Engineering Alternate Report for 100-year hurricane protection for the Inner Harbor Navigation canal (IHNC) and Gulf Intercoastal Waterway (GIWW) Canals in East New Orleans

Performed extensive geotechnical analyses for the evaluation of the safe water level to determine the level of protection for future hurricanes for the levees and floodwalls along the west bank of Inner Harbor Navigation Canal (IHNC) and the Outfall Canals in the Lake Pontchartrain vicinity satisfying all of the criteria set forth in HSDRRSDG.

The various structures assessed for safe water elevation included levees, I-Walls and T-walls and Flood Gates along the IHNC and GIWW Canals. Performed internal and external stability analysis for remediation of deficient areas of New Orleans Outfall Canals (17-th street, London Avenue and Orleans Canal) using Deep Mixed Shear Walls. Significantly contributed to the preparation of the geotechnical design reports. Performed technical review of work performed by other firms involved in these projects.

Other Representative Project Experience

- Seepage Evaluation of Mississippi River Levees and Remediation

Worked on two major seepage evaluations and remediation projects for USCAE (New Orleans District) in Point Pleasant Parish and Point Coupee Parish in Louisiana. Performed extensive engineering analyses including development of seepage analysis parameters, development of levee sections and extents for analysis, underseepage analysis of Mississippi River levees, identification of seepage deficient reaches and design of two alternative measures, relief well and seepage berms for each deficient reach that did not meet the required factor of safety.

- Quality Control, Quality Assurance and Technical Review, Hurricane Protection Projects

Performed QA/QC work for various HPO projects. Reviewed geotechnical design work performed by other consulting engineering firms and provided recommendations to USACE as independent technical reviewer. Also assisted with the Independent Technical Review (ITR) of work performed by others.

Burns Cooley Dennis, Inc., Ridgeland, MS
Senior Geotechnical Engineer/ Project Engineer
February 2007 – December 2012

As a Project Engineer with BCD, worked on a variety of projects in Mississippi, Tennessee and Louisiana for various private Clients and State and Federal Agencies such as the Mississippi Department of Transportation (MDOT), NRCS and USACE. Routinely performed day-to-day operations of conventional geotechnical engineering projects involving subsurface investigation, supervision of laboratory testing, geotechnical analyses and report preparation.

Representative Projects

- Seepage Evaluation, Instrumentation, Monitoring and Remediation for Earth Dam - Ridgeland, MS

Performed seepage evaluation and designed remedial measures for the Ross Barnett Reservoir Dam in Rankin County, Mississippi for Pearl River Valley Water Supply District (PRVWSD). Piezometers were installed on the downstream side of the dams to record the fluctuation of pore pressure head with the upstream water level. The design analysis soil profile was generated by means of several soil borings. The simulated finite element analysis agreed well with the observed piezometer readings. Proposed remedial measures included seepage berms and drainage trench.

- Natural Resources Conservation Projects – MRL Dike Construction, Mississippi and Louisiana

Performed extensive settlement analysis for various US Natural Resource Conservation Services (NRCS) Projects, performed rock dike settlement analysis for various Mississippi River basins (such as Mouth of Bayou Penchant Basin and Mouth of Decade Penchant Basin in Terrebonne Parish, Louisiana) using computer program CSETT and developed time-settlement curves to simulate different stages of dike construction.

- Seismic Evaluation, New Madrid Fault – Memphis, Tennessee

Performed seismic assessment and developed site-specific response spectrum for various Canadian National Railroad projects in Tennessee near the New Madrid Fault.

- Wave Induced Liquefaction Analysis, Wastewater Treatment Plant - Pascagoula, MS

Performed liquefaction analysis and vibration induced settlement analysis for a Wastewater Treatment Plant in Pascagoula, Mississippi.

- Landslide Remediation and Slope Stabilization - Various Projects in MS and LA

Worked on several landslide and slope stabilization projects in Mississippi where the remediation was accomplished using Soil Nail and Anchor. Dr. Chatterjee performed mechanically stabilized earth (MSE) Wall analysis and design for various slope stabilization projects.

- Drilling, Sampling and Field Testing Operations, Various Projects in MS

Observed and assisted with drilling and sampling operations, monitoring field logging operations and SPT testing, drilled shaft construction and pile driving operations for various small and medium size residential, commercial and DOT projects in Mississippi.

Jackson State University, Civil and Environmental Engineering, Jackson, Mississippi
Adjunct Faculty in Civil (Geotechnical) Engineering
January 2009 – December 2012

As a part time adjunct faculty in the Department of Civil and Environmental Engineering, taught graduate geotechnical engineering courses on Advanced Soil Mechanics, Advanced Foundation Engineering, Earth Dams and Slope Stability, Finite Elements in Geotechnical Engineering, Soil Dynamics and Earthquake Engineering and Structural Dynamics. Most of the students in the class were practicing professionals working towards the MS Degree in Civil Engineering.

Performed research work in collaboration with the civil engineering department on the comparative slope stability analyses to assess the adequacy of the hurricane protection measures in New Orleans, Louisiana and vicinity. Worked on a research project which was focused on detailed engineering analysis of comparative slope stability using the Method of Planes, Limit Equilibrium Methods as well as the Finite Element Methods. Most of these research findings have been published in peer reviewed reputed geotechnical engineering journals.

State University of New York (SUNY) at Buffalo, Buffalo, NY
Research and Teaching Assistant
September 2000 – December 2007

Carried out research work on geotechnical engineering applications of Finite and Boundary Element Methods focusing on nonlinear soil behavior and deformation and collapse analyses of foundations., He investigated the bearing capacity factors of strip foundations, stability of slopes and earth retaining structures, soil consolidation and time dependent collapse of footings and embankments and analysis of fiber reinforced composites using numerical analysis techniques. Developed efficient algorithms and implemented constitutive models in high level computer programs developed in-house to perform practical geotechnical engineering analyses using these tools. A significant amount of the above research work resulted in a doctoral dissertation and has been published in reputed peer reviewed engineering journals. As a graduate student, also worked as a Teaching Assistant and helped faculties with preparation of course materials, classes and grading for undergraduate statics, dynamics, soil mechanics and foundation engineering courses.

SOFTWARES AND COMPUTER SYSTEMS PROFICIENCY

Proficient with the use of Geotechnical Engineering Analysis Programs SLOPE/W, SEEP/W, SIGMA/W, SLIDE, SETTLE-3D, UNISETTLE, UNIPILE, GROUP, RS-2, PLAXIS, FLAC, CSETT, CWALLSHT, SUPPORT-IT, MDOT PILE, A-PILE, L-PILE, SHAFT, PY-WALL, MSEW, DYNA 5, LMVD Method of Planes (USACE), GEOSYSTEMS, gINT, CLIQ, CPeT-IT, WinPAS, working knowledge of AUTOCAD.

AWARDS AND HONORS

Diplomate Geotechnical Engineering (DGE) – American Society of Civil Engineers
University at Buffalo – CSEE Graduate Fellowship ($15000), September 2002-July 2005, Graduate Teaching and Research Assistantships, 2000-2006

PUBLICATIONS

Peer reviewed journals

Wang, C.B., **Chatterjee, J**. and Banerjee, P. K. (2007) 'An efficient implementation of BEM for two- and three-dimensional multi-region elastoplastic Analyses,' Computer Methods in Applied Mechanics and Engineering, Elsevier Applied Science, Vol. 196, No. 4-6, pp. 829-842.

Chatterjee, J., Ma, F., Henry, D.P. and Banerjee, P. K. (2007) 'Two- and three-dimensional transient heat conduction and thermoelastic analyses by BEM via efficient time convolution,' Computer Methods in Applied Mechanics and Engineering, Elsevier Applied Science, Vol. 196, No. 29-30. pp. 2828-2838.

Ma, F., **Chatterjee, J**. and Banerjee, P. K. (2007) 'New fast convolution algorithm in Boundary element methods for two and three-dimensional linear soil consolidation analysis,' International Journal of Geomechanics, ASCE, Vol. 7, No. 3, pp. 236-249.

Henry, D.P., Ma, F., **Chatterjee, J**. and Banerjee, P. K. (2007) 'Steady state thermoelastic analysis of 3D solids with fiber inclusions by boundary element method,' Computer Methods in Applied Mechanics and Engineering, Elsevier Applied Science, Vol. 197, No. 1-4, pp. 294-307.

Ma, F., **Chatterjee, J**., Henry, D.P. and Banerjee, P. K. (2008) 'Transient heat conduction analysis of composites by boundary element method,' International Journal for Numerical Methods in Engineering, Wiley Inter Science, Vol. 73, No. 8, pp. 1113-1136.

Chatterjee, J., Henry, D.P., Ma, F. and Banerjee, P. K. (2008) 'An efficient BEM formulation for three-dimensional steady state heat conduction analysis of composites,' International Journal of Heat and Mass Transfer, Elsevier Applied Science, Vol. 51, No. 5-6, pp. 1439-1452.

Chatterjee, J., Ma, F., Henry, D.P. and Banerjee, P. K. (2008) 'Advanced boundary element analysis of three-dimensional elastic solids with fiber reinforcements,' Journal of Engineering Mechanics, ASCE, Vol. 134, No. 9, pp. 739-749.

Chatterjee, J., Amini, F. and Cooley, L.A. (2009) 'A comparative slope stability analysis of New Orleans I-wall subjected to hurricane loading,' International Journal of Geotechnical Engineering, J. Ross Publication, Vol. 3, No. 3, pp. 459-467.

Chatterjee, J. and Amini, F. (2011) 'Slope stability modeling and analysis of T-wall subjected to hurricane loading,' International Journal of Geotechnical Engineering, J. Ross Publication, Vol. 5, No. 1, pp. 103-112.

Xu, Y., **Chatterjee, J**. and Amini, F. (2011) 'A comparative slope stability analysis of New Orleans levee subjected to hurricane loading' Electronic Journal of Geotechnical Engineering, Vol. 18, Bund. C, pp. 325-336.

Chatterjee, J. and Amini, F. (2011) 'A comparative assessment of slope stability of New Orleans I-wall with gap between the wall and layered cohesive backfill,' Geomechanics and Geoengineering, An International Journal, Taylor and Francis, Vol. 6, No. 3, pp. 217-225.

Chatterjee, J. and Amini, F. (2012) 'A comparative slope stability analysis of New Orleans hurricane protection I-wall with sheet pile penetrating into sand layer,' Geomechanics and Geoengineering, An International Journal, Taylor and Francis, iFirst 2012, PP. 1-7.

Peer reviewed conference proceedings

Chatterjee, J. (2009) 'Collapse Analysis in Geomechanics using the Boundary Element Method, Joint ASCE-ASME-SES Conference on Mechanics and Materials, Virginia Tech, Blacksburg, VA.

Chatterjee, J. and Amini, F. (2010) 'A Comparative evaluation of unbalanced load in the stability analysis of New Orleans T-Wall subjected to hurricane loading,' Geo-Florida 2010, Advances in Geotechnical Modeling and Design, Geotechnical Special Publication of ASCE, Reston, VA, No. 199, pp. 2173-2181.

Chatterjee, J., and Amini, F. (2010). Slope Stability Modeling of New Orleans Hurricane Protection Levees with Geotextile Reinforcement', 6-th International Conference on Environmental. Geotechnics for Sustainable Development, Tata McGraw Hill, pp. 1699-1704.

Chatterjee, J. and Amini, F. (2011) 'An investigation on the effect of seepage on the stability analysis of sheet pile supported I-wall in New Orleans, Louisiana', Geo-Frontier 2011, Advances in Geotechnical Engineering, Geotechnical Special Publication of ASCE, Reston, VA, No. 211, pp. 3536-3545.

Chatterjee, J. and Amini, F. (2012) 'An investigation of the design criteria for the analysis of I-wall in New Orleans, Louisiana for flood side gap condition ', Geo-Congress 2012, State of the Art and Practice in Geotechnical Engineering, Geotechnical Special Publication of ASCE, Reston, VA, No. 225, pp. 507-515.

Byrne, B., Houlsby, G., Sancio, R.B. and **Chatterjee, J.** (2013) 'A feasibility study evaluating the use of large screw pile for offshore wind tower foundations as an alternative to driven pile foundation,' Marine Foundation Conference, Deep Foundation Institute (DFI), Seattle, WA, August 2013.

<u>PRESENTATIONS AT TECHNICAL MEETINGS AND CONFERENCES</u>

A comparative slope stability analysis of New Orleans levee and I-wall subjected to hurricane loading, Invited Presentation at the Annual Meeting of the Mississippi Chapter of ASCE, Jackson, MS, October 2008.

Nonlinear deformation and collapse Analysis using BEM, Presented at Joint ASCE-ASME Conference on Mechanics and Materials, Virginia Tech, Blacksburg, VA, June 2009.

A Comparative evaluation of unbalanced load in the stability analysis of New Orleans T-Wall subjected to hurricane loading, Presented at Geo Florida 2010, Annual Geo Congress of ASCE, West Palm Beach, FL, February 2010.

An overview of slope stability analysis of New Orleans hurricane protection systems, Presented at ASCE Student Chapter Meeting, Mississippi State University, Starkville, MS, April 2010.

An investigation on the effect of seepage on the stability analysis of sheet pile supported I-wall in New Orleans, Louisiana, Presented at Geo Frontier 2011, Annual Geo Congress of ASCE, Dallas, TX, March 2011.

An investigation of the design criteria for the analysis of I-wall in New Orleans, Louisiana for flood side gap condition, Presented at Geo Congress 2012, Annual Geo Congress of ASCE, Oakland, CA, March 2012.

A feasibility study to evaluate the use of screw pile as foundation for offshore wind towers, Presented at Annual Technology Exchange and Business Development Conference of Geosyntec Consultants, Somerville, MA, April 2013.

Use of large diameter helical piles for offshore wind turbines as an alternative to driven pile foundations, Presented at Louisiana Civil Engineering Conference and Show, ASCE and ACI, New Orleans Branch, Metairie, LA, September, 2016.

A Critical Review of New Orleans I-Wall Analysis Procedures for Flood Side Gap Condition, Presented at Louisiana Civil Engineering Conference and Show, ASCE and ACI, New Orleans Branch, Metairie, LA, September, 2017.

Geotechnical Design Considerations of Ground Storage Tanks in Southeast Texas and Louisiana, Presented at Infrastructure, Energy, Geotechnical, Flooding and Sustainability Conference, CIGMAT 2018, University of Houston, Houston, Texas, March, 2018.

Geotechnical Considerations of Ground Storage Tanks on Texas Gulf Coast Soils, Presented at ASCE Corpus Christi Branch Monthly Meeting, Corpus Christi, Texas, January, 2019.

Tolunay-Wong Engineers, Inc.

TYLER G. HENNEKE, P.E.
VICE PRESIDENT

SUMMARY

Mr. Henneke's responsibilities include coordinating, supervising, managing and performing all phases of geotechnical engineering services, construction materials testing services and deep foundation testing services for TWE's Beaumont, Texas office. Mr. Henneke's responsibilities also include intercompany coordination of engineering, geophysical and deep foundation testing departments from the Houston, Texas office for all TWE offices across the Texas and Louisiana Gulf Coast region.

EDUCATION, REGISTRATIONS AND CERTIFICATIONS

B.S. Degree in Civil Engineering – Lamar University, Beaumont, TX, 2005-2010
Professional Engineer, State of Texas, 115724

ACCOMPLISHMENTS, AFFILIATIONS AND MEMBERSHIPS

Various Roles – TSPE Sabine Chapter – 2014 to Present
Board Member (Specialty Contractor) – Association of General Contractors of Southeast Texas – 2016-Present
Board Member – Junior Achievement of the Golden Triangle – 2016-Present
Recipient – Young Engineer of the Year Award – TSPE Sabine Chapter – 2015
Recipient – 40 Professionals Under 40 – Southeast Texas Young Professionals Organization – 2015
Recipient – Gerry E. Pate Scholarship in Civil Engineering – Lamar University
Member – Chi Epsilon – National Civil Engineering Honor Society
Member – National Society of Professional Engineers (NSPE)
Member – Texas Society of Professional Engineers (TSPE)
Member – American Society of Civil Engineers (ASCE)
Member – ASTM International (ASTM)
Member – Deep Foundations Institute (DFI)
Member – Pile Driving Contractors Association (PDCA)
Member – American Concrete Institute (ACI)

PROFESSIONAL HISTORY

Tolunay-Wong Engineers, Inc. – October 2008 to Present

Vice President – May 2020 to Present

Primarily responsible for the operations of the Beaumont, Texas office operations which includes geotechnical engineering, construction materials testing and deep foundations testing services. Also responsible for coordinating intercompany departments from Houston, Texas office which include engineering, geophysical and deep foundation testing assignments across the Texas and Louisiana Gulf Coast region. Personnel under Mr. Henneke's direction include licensed professional engineers, engineers-in-training, project managers, staff professionals, engineering assistants, laboratory technicians, field technicians, licensed drillers, driller helpers and administrative assistants.

Branch Manager – June 2016 to May 2020

Responsible for a network of over 55 personnel involved in the geotechnical engineering, construction materials testing and deep foundations testing fields. Personnel under Mr. Henneke's direction include licensed professional engineers, project managers, staff professionals, engineering assistants, laboratory technicians, field technicians, licensed drillers, driller helpers and administrative assistants. Main Client and Owner interface for TWE Beaumont office.

Engineering Manager – September 2013 to June 2016

Responsible for a network of over 30 personnel involved in the geotechnical engineering, deep foundations testing and construction materials testing fields for TWE's Beaumont, Texas and Sulphur, Louisiana offices. Personnel under direction include licensed professional engineers, staff professionals, engineering assistants, laboratory technicians, field technicians, licensed drillers, driller helpers and administrative assistants. Client and Owner interface for geotechnical engineering and deep foundation testing projects in Southeast Texas and Southwest Louisiana for TWE.

Department Manager – June 2011 to September 2013

Responsible for geotechnical engineering and deep foundations testing groups for TWE's Beaumont, Texas and Sulphur, Louisiana offices. Duties included direct communication with Clients and Owners, attending project meetings for business and project development, direct oversight of field, laboratory and office personnel from proposal development to performance of field and laboratory programs to engineering analysis and final reporting.

Staff Professional – May 2010 to June 2011

Managed projects under the direct supervision of licensed professional engineers in the geotechnical engineering consulting and deep foundations testing fields. Duties included attending project meetings with Clients and Owners, oversight of field and laboratory personnel, selection of laboratory test assignments, development of soil boring and CPT sounding logs, engineering analysis for shallow foundations, deep foundations, earth retaining structures, marine facilities, ground storage tanks, below grade structures/utilities, pavements and final reporting. Field tasks consisted of construction materials inspection, high-strain dynamic pile testing (PDA), low-strain pile integrity testing (PIT), low-strain sonic integrity logging, static axial compression, tension and lateral load testing, electrical resistivity (ER) surveys, ground penetrating radar (GPR) surveys, electromagnetic (EM) surveys and anchor bolt pull testing. Also responsible for the development of technical proposals and cost estimates for geotechnical engineering and deep foundations testing assignments.

Engineering Assistant – November 2008 to May 2010

Directly involved with supporting licensed professional engineers by providing field coordination, logging of soil borings, coordination of cone penetrometer testing (CPT), installation of geotechnical instrumentation, geotechnical laboratory test data entry, compilation of boring logs, drafting of boring location plans using AutoCAD and the development of technical proposals and cost estimates for geotechnical engineering and deep foundations testing assignments.

A representative list of projects or experience can be provided upon request.

Tolunay-Wong Engineers, Inc.

TREY O'CONNOR, E.I.T.
PROJECT GEOTECHNICAL ENGINEER – BEAUMONT, TEXAS

SUMMARY

Mr. O'Connor's responsibilities include oversight of field and laboratory tasks, selection of laboratory test assignments, compilation of soil boring logs and CPT sounding logs, development of soil design parameters, engineering analysis for deep and shallow foundation systems, settlement estimates, below grade structures, pavements, railways and pipeline installations utilizing horizontal directional drilling (HDD) methods. Mr. O'Connor is also responsible for the development of technical proposals and cost estimates for geotechnical engineering project as well as technical reports presenting results from field and laboratory tasks and geotechnical recommendations.

EDUCATION, REGISTRATIONS AND CERTIFICATIONS

- B.S. Degree in Civil Engineering – Lamar University, Beaumont, TX, 2015-2019
- Registered Engineer-In-Training, State of Texas (E.I.T. No. 66937)
- Passed Professional Engineer's (PE) Exam – Texas Board of Professional Engineers (TBPE) (Anticipated Licensure Date – March 2022)

AFFILIATIONS

Member – Chi Epsilon – National Civil Engineering Honor Society
Board Member – American Society of Civil Engineers (ASCE) – Southeast Texas Branch

PROFESSIONAL HISTORY

Tolunay-Wong Engineers – February 2018 to Present

Project Geotechnical Engineer (March 2020 – Present)

Responsibilities include managing projects under the supervision of licensed Professional Engineers, communication with Clients and Owners, attending project meetings, oversight of field and laboratory activities, selection of laboratory testing assignments, compilation of soil boring and CPT sounding logs, development of soil design parameters for engineering analysis, geotechnical engineering analysis for deep and shallow foundation systems, below grade structures, earth retaining structures, ground storage tanks, pavements, railways and HDD pipeline installations as well as the development of technical proposals and reports.

Staff Professional (June 2019 – March 2020)

Mr. O'Connor's duties as Staff Professional included attending project meetings with Clients, Owners and Project Managers, oversight of field and laboratory activities, selection of laboratory testing assignments, compilation of soil boring and CPT sounding logs. Responsibilities also include development of technical proposals and geotechnical reports. Field tasks consisted of deep foundations testing (DFT) such as low-strain pile integrity testing (PIT), static axial and lateral load testing and pile instrumentation.

Laboratory Technician (February 2018 – June 2019)

Duties include performing standard geotechnical laboratory index and strength testing such as moisture content, unit weight, Atterberg limits, particle size distribution, unconfined compression (UC) and unconsolidated undrained (UU) triaxial compression. Responsibilities also include performing specialty laboratory testing such as one-dimensional consolidation testing, organic content, electrical resistivity as well as moisture density relation testing such as standard proctor compaction tests. Mr. O'Connor also assisted in bench scale programs for the treatment and stabilization of clay soils.

REPRESENTATIVE PROJECTS

Comprehensive or specific project lists can be provided upon request.

APPENDIX C

TWE QA/QC TABLE OF CONTENTS

Tolunay-Wong Engineers, Inc.
10710 S. Sam Houston Parkway W., Suite 100
Houston, Texas 77031
Corporate Office

Company Quality Manual

Chief Executive Officer/President: Daniel O. Wong; Ph.D., P.E.

Corporate Quality (QAQC) Manager: Patricia Hodgkins

Corporate Technical Manager Patrick Kenney, P.E.

Date of Issue: 10/02/2017

UNCONTROLLED COPY

Quality Manual

This Quality Manual meets the requirements of ISO 17025, ISO 9001, AASHTO R-18 and ASME NQA-1. This Quality Manual is confidential and assigned as outlined below.

Issued to:

☐ Controlled Copy - Issue No: ________________________
☒ Uncontrolled Copy

Table of Contents

APPENDIX D

DSC ENVIRONMENTAL/ANALYTICAL TESTING PROGRAM

Trey O'Connor

From: Bob Davis <bdavis@disorboconsult.com>
Sent: Friday, February 5, 2021 11:17 AM
To: Tyler Henneke; Chris Guy
Cc: Trey O'Connor; Joanne Scarf; David Cowart; Kathleen Alsup; Patrick Kenney
Subject: RE: Cedar Bayou Deepening & Widening - Chambers County, Texas

Here are some additional thoughts for the email string going here.

- Beneficial Use testing requirements vary depending on the landowner's prerogative, but as you know Dredging Permits often go out for interagency commentary, so sometimes the regulators (TPWD, EPA, others) insert themselves if there is the potential for return water or elutriate to affect public waters or offsite receptors. In cases where the Corps get involved in BU, I have seen them use the same criteria as their federal DMPA's.

- Sometimes the EPA gets involved if requested by the Corps, (that is, it would be specified as a condition in the Dept of Army permit), for example the Oil Tanking/Enterprise Pdts work a few years back, which was BU placement. For the recent CP Chem Orange work, spoils are primarily intended for privately owned BU, but federal PA is the backup plan. Both of those examples required (by either Corps, or landowner in the case of CP Chem) the conventional Corps list of testing PLUS dioxins/furans (D/F) and organotins. D/F will undoubtedly be asked for in the testing program at Cedar IF a federal placement area is requested as an option, due to the site of dredging and placement being in the Houston Area and downstream of the HSC and two particular superfund sites (San Jacinto River Waste Pits and Highlands Acid Pit, which are both in the SJ river floodplain).

- Chris, I would be hesitant to combine the geotechnical drilling and environmental core sampling in the same-barge collection event, IF we do dioxin/furan testing, since the toxicities and detection limits are so very low for D/F. The possibility of cross contamination could occur, and that outcome would not be good for anyone. I am not opposed to combining them in the same-barge collection event, however, if we leave out dioxin/furans this time around, since you say this is mainly preliminary core testing work. While we have not combined them before, I believe our crew can adopt practices that will allow them to pull aliquots from the geotech cores and eliminate cross-contamination for the conventional list of analytes.

- For the CP Chem work, we conducted comparisons of the sediment results to BOTH (1) USACE screening criteria, and (2) TCEQ Texas Risk Reduction Program (TRRP) health-based numbers, the latter being for the BU land disposal option. This is an "above-reproach" approach if trying to defend the beneficial use option. In this case (Cedar Port Industrial Park), we could do either or both for about the same cost (assuming we leave dioxin/furans and organotins off for now).

I will price my proposal without analytical for now, but I will also give you an estimated lab cost based on what I have seen. That way you can weigh the EAS pricing simultaneously.
Bob

Bob Davis
Senior Consultant

Trey O'Connor

From: Bob Davis <bdavis@disorboconsult.com>
Sent: Friday, February 5, 2021 2:08 PM
To: Trey O'Connor
Cc: Chris Guy; Tyler Henneke
Subject: RE: Cedar Bayou Deepening & Widening - Chambers County, Texas
Attachments: Cost Breakout for Cedar Ind Park Pre-Dredge 2021.pdf; TESTING LIST - NORMAL USACE + VOA.pdf

Trey and Tyler –

Here is my scope & estimated cost for this 'environmental field work, evaluation, and reporting' in a form that should be acceptable to the USACE, if used for preliminary or final assessment purposes.
A couple of mentions:

- The sample count may or may not be fully accepted by the Corps, depending on the quantity of material in the dredging work. They try to correlate sample counts to volume, for representation.
- The work assumes full-depth core samples at each of the 4 stations, made up by combining grabs from regular intervals when logging, then mixing these grabs on-deck for a homogeneous composite sample of entire core length of the dredging envelope at that station. I mention this, because sometimes the affected material (w/contaminants) is more concentrated near the top of the sediment column. Therefore, if there appear to be significant differences using a PID instrument in the field, it is prudent to collect two samples in a sediment column, so that if there is a hotspot in the upper more recent material it can possibly be separated out for disposal differently if justified, during the actual dredging work. This keeps a single or upper zone hotspot from disqualifying the entire core, hopefully that makes sense.
- We normally have two techs working together in the field, but I have given costs for one DiSorbo person working alongside your crew, as you requested. If we can add, and there is room for, another DiSorbo person, that would add $2,000., which would be my preference because they really help each other out when sampling and recording.
- I have given an estimate ($8k) of the contract laboratory cost for this sample count (9) and analytical list, and if we can bid that part out it might be even less. That cost is shown near the bottom of the spreadsheet, but not included in the total, per my understanding of our original conversation. To help you compare lab apples if you want to, I have also attached here a typical analyte list applicable for both federal DMPAs and BU areas.
- The bullets given in my last note to the larger group gives more context to this quote, thus I have not included dioxin/furan and organotins categories of lab testing here. Those may be required later.

We thank your team for reaching out to us, and we would be delighted to work with you on this important project.

Best regards,
Bob

Bob Davis
Senior Consultant

DiSorbo Consulting, LLC
9737 Great Hills Trail, Suite 340

Analyte/ Parameter	NOTES
VOCs	
1,1,1,2-Tetrachloroethane	
1,1,1-Trichloroethane	
1,1,2,2-Tetrachloroethane	
1,1,2-Trichloroethane	
1,1-Dichloroethane	
1,1-Dichloroethylene	
1,1-Dichloropropene	
1,2,3-trichlorobenzene	
1,2,3-Trichloropropane	
1,2,4-Trichlorobenzene	
1,2,4-Trimethylbenzene	
1,2-Dibromo-3-chloropropane	
1,2-Dibromoethane	
1,2-Dichlorobenzene	
1,2-Dichloroethane	
1,2-Dichloropropane	
1,3,5-Trimethylbenzene	
1,3-Dichlorobenzene	
1,3-Dichloropropane	
1,4-Dichlorobenzene	
2,2-Dichloropropane	
2-Chlorotoluene	
4-Chlorotoluene	
4-Isopropyltoluene	
Benzene	
Bromobenzene	
Bromochloromethane	
Bromodichloromethane	
Bromoform	
Bromomethane	
Carbon tetrachloride	
Chlorobenzene	
Chloroethane	
Chloroform	
Chloromethane	
cis-1,2-Dichloroethylene	
cis-1,3-Dichloropropene	
Dibromochloromethane	

Analyte/ Parameter	NOTES
Dibromomethane	
Dichlorodifluoromethane	
Ethylbenzene	
Isopropylbenzene	
m- & p-Xylenes	
MEK	
Methylene chloride	
Naphthalene	
n-Butylbenzene	
n-Propylbenzene	
o-Xylene	
sec-Butylbenzene	
Styrene	
t-butylbenzene	
Tetrachloroethylene	
Toluene	
trans-1,2-Dichloroethylene	
trans-1,3-Dichloropropene	
Trichloroethylene	
Trichlorofluoromethane	
Vinyl Chloride	
SVOCs	
1,2,4-Trichlorobenzene	
1,2-Dichlorobenzene	
1,3-Dichlorobenzene	
1,4-Dichlorobenzene	
2,4-Dichlorophenol	
2,4-Dimethylphenol	
2,4-Dinitrophenol	
Acenaphthene	
Acenaphthylene	
Anthracene	
Benzo(a)anthracene	
Benzo(a)pyrene	
Benzo(b&k)fluoranthene	
Benzo(g,h,i)perylene	
Chrysene	
Dibenzo(a,h)anthracene	
Diethyl phthalate	
Fluoranthene	
Fluorene	

Analyte/ Parameter	NOTES
Hexachlorobenzene	
Indeno(1,2,3-cd)pyrene	
Naphthalene	
Pentachlorophenol	
Phenanthrene	
Phenol	
Pyrene	
PESTICIDES AND PCBs	
4,4-DDD	
4,4-DDE	
4,4-DDT	
alpha-BHC	
Alpha-Chlordane	
Aldrin	
beta-BHC	
Chlordane	
delta-BHC	
Dieldrin	
Endosulfan I	
Endosulfan II	
Endosulfan sulfate	
Endrin	
Endrin aldehyde	
Endrin ketone	
gamma-BHC (Lindane)	
Heptachlor	
Heptachlor epoxide	
Toxaphene	
g-Chlordane	
PCBs, Total	
ORGANOTINS	
Dibutyltin dichloride	not necessary
Monobutyltin trichloride	unless there
Tetrabutyltin	had been vessel
Tributyltin hydride	repairs nearby
METALS	
Antimony	
Arsenic	

Analyte/ Parameter	NOTES
Cadmium	
Chromium, total	
Copper	
Lead	
Mercury	
Nickel	
Silver	
Zinc	
MISCELLANEOUS	
Ammonia	
% Clay	sediment only
% Sand and Gravel	sediment only
% Silt	sediment only
Solids Content (%)	sediment only
Total Organic Carbon	
TPH	
RCI - for initial waste characterization	
Reactivity - sulfides, cyanides	
Corrosivity or pH	
Ignitability or flashpoint	sediment only

APPENDIX E

L&A PROJECT EXHIBITS

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\CIVIL\11612-C1.DWG

CEDAR PORT INDUSTRIAL PARK
TGS

LANIER & associates
CONSULTING ENGINEERS, INC
FIRM F-2981
LA: C-1120

REV	DATE	BY	DESCRIPTION	REV	DATE	BY	DESCRIPTION

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DATE DEC. '20
SCALE NOTED
DESIGN *
DRAWN PJC
CHECK *
APPR'D CSG
CAD NO 11612-C1

CHAMBERS COUNTY IMPROVEMENT DISTRICT #1
CEDAR BAYOU TEXAS

CEDAR BAYOU
DEEPENING PERMIT
PROPOSED NEW PLAN

9813-15
SHEET NO.

C1

CEDAR PORT INDUSTRIAL PARK

TGS

LANIER & associates
CONSULTING ENGINEERS, INC
FIRM F-2981
LA: C-1120

REV	DATE	BY	DESCRIPTION	REV	DATE	BY	DESCRIPTION

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DATE DEC. '20
SCALE NOTED
DESIGN *
DRAWN PJC
CHECK *
APPR'D CSG
CAD NO 11612-C2

CHAMBERS COUNTY IMPROVEMENT DISTRICT #1
CEDAR BAYOU TEXAS

CEDAR BAYOU
DEEPENING PERMIT
PROPOSED NEW PLAN

9813-15
SHEET NO.

C2

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\CIVIL\11612-C2.DWG

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\CIVIL\11612-C3.DWG

CEDAR PORT INDUSTRIAL PARK TGS

LANIER & associates CONSULTING ENGINEERS, INC
FIRM F-2981
LA: C-1120

REV	DATE	BY	DESCRIPTION	REV	DATE	BY	DESCRIPTION

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DATE DEC. '20
SCALE NOTED
DESIGN *
DRAWN PJC
CHECK *
APPR'D CSG
CAD NO 11612-C3

CHAMBERS COUNTY IMPROVEMENT DISTRICT #1
CEDAR BAYOU TEXAS

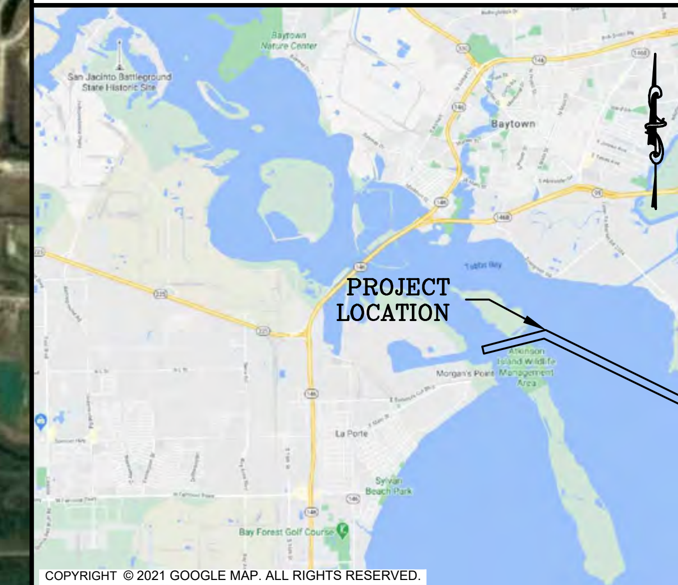
CEDAR BAYOU
DEEPENING PERMIT
POTENTIAL FUTURE SITE PLAN

9813-15
SHEET NO.
C3

APPENDIX F

TWE FIELD PROGRAM LOCATION PLAN

VICINITY MAP



FIELD PROGRAM COORDINATES

ITEM	DEPTH	LATITUDE	LONGITUDE
MB–1*	50'	29° 41' 03.48" N	94° 58' 49.18" W
MB–2	50'	29° 41' 09.92" N	94° 58' 34.73" W
SS/MB–3	50'	29° 41' 16.75" N	94° 58' 18.70" W
MB–4*	50'	29° 41' 20.05" N	94° 57' 59.73" W
SS/MB–5	50'	29° 41' 11.73" N	94° 57' 36.55" W
MB–6	50'	29° 41' 02.89" N	94° 57' 17.19" W
SS/MB–7*	50'	29° 40' 54.14" N	94° 56' 57.56" W
MB–8	50'	29° 40' 45.03" N	94° 56' 37.31" W
SS/MB–9	50'	29° 40' 36.21" N	94° 56' 21.21" W
MB–10*	50'	29° 40' 22.72" N	94° 56' 04.86" W
MB–11	200'	29° 40' 14.53" N	94° 55' 51.04" W

LEGEND

SYMBOL	DESCRIPTION
(red symbol)	TEST BORING LOCATION
(blue symbol)	TEST BORING W/ SEDIMENT SAMPLING LOCATION
*	ENVIRONMENTAL/ANALYTICAL SAMPLING LOCATION

Tolunay-Wong Engineers, Inc.

PROPOSED FIELD PROGRAM LOCATION PLAN
CEDAR BAYOU DEEPENING/WIDENING
CHAMBERS COUNTY IMPROVEMENTS DISTRICT #1
CHAMBERS COUNTY, TEXAS

Drawn	*O.R.*	*02–08–2021*
Checked	*T.O.*	*02–08–2021*
Approved	*T.G.H.*	*02–08–2021*
Scale	*N.T.S.*	

TWE DRAWING NO. P20–B352.1 REVISION 2

APPENDIX G

TWE ITEMIZED BUDGET ESTIMATE

Tolunay-Wong Engineers, Inc.

2455 West Cardinal Drive, Suite A - Beaumont, Texas 77705 - Phone (409) 840-4214

Proposed Budget Estimate					
Description		Unit	Quantity	Rate	Extension
Pre-Commencement Activities					
1	Senior Project Manager	hour	8	$200.00	$1,600.00
2	Project Professional	hour	8	$130.00	$1,040.00
3	Field Services Supervisor	hour	8	$95.00	$760.00
4	DSC Pre-Commencement Preparations	lump sum	1	$3,520.00	$3,520.00
Field Program - Marine TBs/SSs					
5	Transports of Geotechnical Equipment/Personnel	each	2	$300.00	$600.00
6	6-in Diameter Threaded Steel Casing	foot	30	$25.00	$750.00
7	PMI Load/Unload Crane Barge	each	2	$225.00	$450.00
8	PMI Towboat/Barge/Fuel Consumption	day	10	$3,850.00	$38,500.00
9	DSC Field Execution/Personnel/Supplies	lump sum	1	$10,010.00	$10,010.00
10	3-Man Crew/Equipment	day	10	$2,600.00	$26,000.00
11	Senior Technician	day	10	$775.00	$7,750.00
12	Support Boat	day	10	$450.00	$4,500.00
13	Support Vehicles	day	10	$225.00	$2,250.00
14	Field Services Supervisor	hour	10	$95.00	$950.00
Laboratory Testing					
15	Standard Classification/Strength Laboratory Testing	foot	700	$10.00	$7,000.00
16	Particle Size Analysis with Hydrometer	each	15	$135.00	$2,025.00
17	Classification/Standard Proctor Series (ASTM D689)	each	11	$300.00	$3,300.00
18	DSC Environmental/Analytical Testing (Expedited)	lump sum	1	$13,200.00	$13,200.00
Log Compilation/Engineering Analysis/Report Preparation/Project Meetings					
19	Principal	hour	8	$225.00	$1,800.00
20	Senior Project Manager	hour	40	$200.00	$8,000.00
21	Project Professional	hour	80	$130.00	$10,400.00
22	Staff Professional	hour	28	$100.00	$2,800.00
23	DSC Evaluation/Reporting	lump sum	1	$9,550.00	$9,550.00
Total Budget Estimate					**$156,755.00**

TOLUNAY-WONG ENGINEERS

DRAFT

DRAFT GEOTECHNICAL ENGINEERING REPORT
CEDAR BAYOU DEEPENING & WIDENING PROJECT
CHAMBERS COUNTY IMPROVEMENT DISTRICT #1
CHAMBERS COUNTY, TEXAS

Prepared for:

Trans-Global Solutions, Inc.
1735 West Cardinal Drive
Beaumont, Texas 77705

Prepared by:

Tolunay-Wong Engineers, Inc.
2455 West Cardinal Drive, Suite A
Beaumont, Texas 77705

August 17, 2021

TWE Project No. 21.23.029 / Report No. 120938

Geotechnical Engineering
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August 17, 2021

Trans-Global Solutions, Inc.
1735 West Cardinal Drive
Beaumont, Texas 77705

Attn: Mr. James Scott
JScott@tgsgroup.com

Ref: Draft Geotechnical Engineering Report
Cedar Bayou Deepening & Widening Project
Chambers County Improvement District #1
Chambers County, Texas
TWE Project No. 21.23.029 / Report No. 120938

Dear Mr. Scott,

Tolunay-Wong Engineers, Inc. (TWE) is pleased to submit this draft report of our geotechnical study conducted for the Cedar Bayou Deepening & Widening Project for Chambers County Improvement District #1 in Chambers County, Texas. This report contains a detailed description of the field and laboratory work performed for this study, logs of test borings, laboratory test results and our geotechnical design and construction recommendations for the referenced project. If you have any questions regarding this report or if we can be of further assistance, please do not hesitate to contact us.

Sincerely,

TOLUNAY-WONG ENGINEERS, INC.
TBPELS Firm Registration No. F-124

Trey O'Connor, E.I.T.
Project Geotechnical Engineer

Tyler G. Henneke, P.E.
Vice President

TO/TGH/to

DRAFT

TABLE OF CONTENTS

TABLES AND APPENDICES

TABLES

APPENDICES

1 INTRODUCTION AND PROJECT DESCRIPTION

This report presents the results of our geotechnical engineering study performed for the referenced project. Our investigations were conducted in general accordance with TWE Proposal No. P20-B352 (Revision 2) dated February 8, 2021 and authorized by Trans-Global Solutions, Inc. (TGS) via Subcontract Agreement dated March 3, 2021.

The project includes dredging the existing Cedar Bayou channel between Cedar Port Industrial Park and the Houston Ship Channel. The ship channel will be widened from 100-ft to increase the channel bottom to a width ranging from 300-ft to 450-ft and deepened to an approximate elevation of El. (-)45-ft. A side slope gradient on the order of to 1V:2H is being considered at this time. Current water depths within the channel range from 2-ft to 12-ft along the project alignment.

The project also includes the design and construction of a dock and barge fleeting area which will consist of a new dock platform and approachway, mooring structures and a roll-on/roll-off (RORO) ramp. We understand a 256-ac Dredge Material Placement Area (DMPA) is also being considered landside of the proposed Dock Area. Lanier & Associates Consulting Engineers (L&A) will be the Engineer responsible for the design and construction of the proposed dock and barge fleeting area. Project exhibits, provided by the Engineer, are provided in Appendix A of this report.

2 PURPOSE AND SCOPE OF SERVICES

The purposes of our geotechnical engineering study were to investigate the subsurface soil and groundwater conditions along the project alignment and to assist the Client in the preliminary design phase of the project. Our scope of services for this study consisted of:

1. Conducting ten (10) marine test borings and three (3) landside test borings to evaluate subsurface stratigraphy and groundwater conditions along the project alignment;

2. Performing geotechnical laboratory tests on recovered soil samples from the test borings to evaluate the physical and engineering properties of the strata encountered;

3. Performing environmental and analytical laboratory tests to provide preliminary conclusions regarding the use of dredged material for placement within the designated DMPA;

4. Preparing a synopsis of our findings including existing project site conditions, subsurface soil and groundwater conditions and boring logs presenting tabulated field and laboratory test results;

5. Performing evaluations of global slope stability of the proposed dredged channel side slopes for comparison to the recommended USACE factors of safety;

6. Providing geotechnical design recommendations for deep foundation systems including axial compression and tension capacities, lateral pile response analysis, pile group considerations and settlement estimates;

7. Performing rotational (internal) and global (external) stability analyses of the proposed anchored bulkhead to determine required sheet pile embedment depth and required sheet pile section modulus; and,

8. Geotechnical recommendations for site development using dredged materials, ground improvements, fill and backfill placement, compaction requirements, foundation installation guidelines and overall quality control testing, monitoring and inspection guidelines.

Our scope of services did not include any environmental assessments for the presence or absence of wetlands at this site. Any statements in this report or on the boring logs regarding odors, colors, unusual items and conditions are strictly for the information of the Client. A geological fault study was also beyond the scope of our investigations.

3 FIELD PROGRAM

The field program performed for this project included ten (10) marine test borings within the channel and three (3) landside test borings in the location of the proposed barge fleeting area. The test boring locations and depths explored are presented on TWE Drawing Nos. 21.23.029-1 and 21.23.029-2 provided in Appendix B.

3.1 Test Borings

3.1.1 Drilling Methods

The marine test borings (MB-1 to MB-10) were performed from March 12 to March 18, 2021 using conventional truck-mounted drilling equipment positioned on a lift boat. The marine equipment, including the lift boat and a support boat, was provided by our Subcontractor, Peninsula Marine, Inc. Wash-rotary drilling techniques were utilized from the existing mudline to the boring completion depths. At test boring locations MB-1, MB-5, MB-7 and MB-9 our field crew was accompanied by representatives of DiSorbo Consulting, LLC to collect soil samples for the environmental and analytical scope of the project.

The landside test borings were performed from March 29 to April 1, 2021 using conventional highland buggy-mounted drilling equipment. The boreholes were advanced using dry-auger drilling methods until groundwater was encountered or until borehole conditions required the use of wash-rotary drilling techniques.

The soil borings were performed in general accordance with the Standard Practice for Soil Investigation and Sampling by Auger Borings (ASTM D1452). Soil samples were obtained continuously at 3-ft depth intervals to a depth of 20-ft and at 5-ft depth intervals thereafter until the boring completion depths were reached.

3.1.2 Soil Sampling

Fine-grained, cohesive soil samples were recovered from the soil boring by hydraulically pushing a 3-in diameter, thin-walled tube to about 24-in. The field sampling procedures were conducted in general accordance with the Standard Practice for Thin-Walled Tube Sampling of Soils (ASTM D1587). Our Geotechnicians visually classified the recovered soils and obtained field strength measurements of the recovered soils using a calibrated pocket penetrometer and/or hand torvane device. The tube samples were extruded in the field, wrapped in foil, placed in moisture-sealed plastic bags and protected from disturbance prior to transport to the laboratory. The recovered soil sample depths and field strength measurements are shown on the project boring logs presented Appendix C.

Cohesive soils thought to be coarse-grained, as well as cohesionless and semi-cohesionless coarse-grained soils, were collected with the Standard Penetration Test (SPT) sampler driven 18-in by blows from a 140-lb hammer falling 30-in in accordance with the Standard Test Method for Standard Penetration Test (SPT) and Spilt-Barrel Sampling of Soils (ASTM D1586). The number of blows required to advance the sampler three (3) consecutive 6-in depths are recorded for each corresponding sample on the boring log. The N-value, in blows per foot, is obtained from SPTs by adding the last two (2) blow count numbers. The consistency of cohesive soils and the relative density of cohesionless and semi-cohesionless soils can be inferred from the N-value. The samples obtained from the split-barrel sampler were visually classified, placed in moisture-sealed plastic bags and transported to our laboratory. SPT sampling intervals and blow counts are presented on the project boring logs in Appendix C.

At test boring locations MB-3, MB-5, MB-7 and MB-9 sediment samples were collected from the bottom of the channel. The sediment samples were obtained using a manual clamshell sampler. The sediment samples were obtained from the clamshell sampler were visually classified, placed in moisture-sealed plastic bags and transported to the laboratory.

3.1.3 Boring Logs

Our interpretations of general subsurface soil and groundwater conditions encountered in the project borings are included on the logs in Appendix C. The interpretations of the soil types throughout the boring depths and the locations of strata changes were based on visual classifications during field sampling and laboratory testing using the Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) [ASTM D2487] and the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) [ASTM D2488]. A key to symbols and terms used on the boring logs is also included presented in Appendix C.

3.1.4 Groundwater Measurements

Groundwater level measurements were attempted in the open landside boreholes during dry-auger drilling. Measurements were taken initially during dry-auger drilling when groundwater was first encountered and at 5-min intervals thereafter over a 15-min time period. The groundwater measurements observed within the soil borings are described in Section 5.4 of this report.

4 LABORATORY SERVICES

A geotechnical laboratory testing program was conducted on select soil samples from the test borings to assist in classification and evaluation of the physical and engineering properties of the soils encountered at the project site. Laboratory tests were performed in general accordance with ASTM International standards. The types and brief descriptions of the geotechnical and analytical laboratory tests performed are presented in Tables 4-1 below.

Table 4-1: Geotechnical Laboratory Testing Program	
Test Description	**Test Method**
Amount of Material in Soils Finer than No. 200 Sieve	ASTM D1140
Water (Moisture) Content of Soil	ASTM D2216
One-Dimensional Consolidation Using Incremental Loading	ASTM D2435
Unconsolidated-Undrained Triaxial Compression on Cohesive Soils	ASTM D2850
Liquid Limit, Plastic Limit and Plasticity Index of Soils	ASTM D4318
Consolidated Undrained (CU) Triaxial Compression Test on Cohesive Soils	ASTM D4767
Density (Unit Weight) of Soil Specimens	ASTM D7263
Particle-Size Distribution Using Hydrometer Analysis	ASTM D7928

Standard geotechnical laboratory test results are presented on the project boring logs provided in Appendix C. Results of the geotechnical laboratory tests performed on sediment samples are provided in Appendix D. Results of the one-dimensional consolidation (landside samples only) and CU tests performed on select samples are presented graphically in Appendices E and F, respectively. The CU tests performed for the project were completed by our Subcontractor, TRI Environmental, Inc.

4.1 Consolidation Testing

Sample disturbance issues related to consolidation test results are discussed in detail in published literature for soft clays (Anderson and Kolstad, 1979, DeGroot et al., 2005) as well as for over-consolidated clays (Sabatini et al., FHWA Circular No. 5, 2002). According to the referenced FHWA publication, sample disturbance can occur during handling and transportation to laboratory despite best efforts to maintain structural integrity and moisture condition of the samples.

Anderson and Kolstad (1979) suggest the volumetric strain required to consolidate the sample back to its in-situ vertical effective stress is a relative indicator of sample quality. Table 4-2 on the following page shows the Sample Quality Designations (SQD) suggested by Anderson and Kolstad (1979) which were used for screening of the consolidation samples.

Table 4-2: Sample Quality Designation	
Volumetric Strain (%)	**Specimen Quality Designation (Description)**
< 1	A (Very Good to Excellent)
1 – 2	B (Good)
2 – 4	C (Fair)
4 – 8	D (Poor)
> 8	E (Very Poor)

Actual SQD determinations for the soil samples tested are provided in Table 4-3 below. Soil stress history and compressibility parameters derived from the consolidation tests are also presented in Table 4-3 below. Graphical results of the one-dimensional consolidation tests performed on selected samples are presented in Appendix E.

Table 4-3: Summary of One-Dimensional Consolidation Test Results								
Test Boring	**Depth (ft)**	**Soil Classification**	**e_o**	**p_c (tsf)**	**C_c**	**C_r**	**OCR**	**SQD**
LB-1	6 – 8	Fat Clay (CH)	0.710	5.3	0.21	0.026	12.6	A
LB-1	28 – 30	Fat Clay (CH)	0.860	8.1	0.25	0.031	7.5	A
LB-1	48 – 50	Fat Clay (CH)	0.953	9.9	0.35	0.044	6.0	A
LB-2	93 – 95	Lean Clay with Sand (CL)	0.692	4.7	0.17	0.021	1.6	D*
LB-3	4 – 6	Fat Clay (CH)	0.785	1.9	0.24	0.030	6.3	A
LB-3	23 – 25	Fat Clay (CH)	0.705	5.8	0.20	0.025	6.8	A

*Samples with an SQD of D were not considered in our evaluations.

Symbol Key:

e_o = Initial Void Ratio
p_c = Pre-consolidation Pressure
C_c = Compression Index
C_r = Recompression Index
OCR = Overconsolidation Ratio
SQD = Sample Quality Designation

4.2 Environmental and Analytical Testing

Pre-dredge environmental and analytical sampling and testing was also performed as a part of our scope of services for this project. A separate report, submitted by our Subconsultant (DiSorbo Consulting, LLC) under separate cover in May 2021, provides details regarding the results of the preliminary testing performed for the proposed dredge envelope. A redacted findings report is provided in Appendix L for the purposes of this geotechnical report. The executive summary of the environmental findings report is discussed further in Section 5.5 herein.

5 PROJECT SITE CONDITIONS

Our interpretations of soil and groundwater conditions along the project alignment are based on geotechnical information obtained at the locations of the test borings performed for this study. This information has been used as the basis for our geotechnical design and construction recommendations included in this report. Subsurface conditions could vary at areas not explored by the test borings referenced herein. Significant variations in areas not explored by the test borings could require additional investigations.

5.1 Site Description and Surface Conditions

The project alignment is located between Cedar Port Industrial Park and the Houston Ship Channel in Chambers County, Texas. At the time of our field program, the water levels within the channel at the test boring locations were measured to range from 2-ft to 10.4-ft. The depth from the water surface to mudline at test boring MB-1 was not measured in the field. An approximate mudline elevation was selected at this location using the bathymetric information provided by the Engineer. Surface conditions at the landside test borings were undulating and consisted of grass cover accessible by highland buggy-mounted ATV rigs.

5.2 Subsurface Soil Stratigraphy

The generalized subsurface soil conditions within the project site were interpreted from the test boring logs presented in Appendix C. Two (2) sets of subsurface design groups were developed within the channel based on the subsurface strata encountered. The generalized subsurface profiles encountered within the channel alignment are summarized in Table 5-1 and Table 5-2 below. The generalized subsurface profile encountered landside near the barge fleeting area is summarized in Table 5-3 on the following page.

Table 5-1: Generalized Subsurface Soil Stratigraphy – MB-1 & MB-2		
Approximate Elevation Range (ft)		**Strata Description**
(-)4	(-)10	Very Loose Sand
(-)10	(-)22	Very Soft to Soft Clay
(-)22	(-)33	Very Loose to Medium Dense Sand
(-)33	(-)38	Stiff Clay
(-)38	(-)60	Very Stiff Clay

Table 5-2: Generalized Subsurface Soil Stratigraphy – MB-3 to MB-10		
Approximate Elevation Range (ft)		**Strata Description**
(-)4	(-)22	Very Soft to Firm Clay
(-)22	(-)48	Firm to Stiff Clay
(-)48	(-)60	Loose to Very Dense Sand

Table 5-3: Generalized Subsurface Soil Stratigraphy – LB-1 to LB-3		
Approximate Elevation Range (ft)		**Strata Description**
(+)10	(-)6	Stiff Clay
(-)6	(-)13	Firm Clay
(-)13	(-)59	Stiff to Very Stiff Clay
(-)59	(-)86	Dense to Very Dense Sand
(-)86	(-)106	Stiff to Very Stiff Clay
(-)106	(-)112	Loose to Medium Dense Sand
(-)112	(-)122	Stiff Clay
(-)122	(-)142	Medium Dense Sand
(-)142	(-)162	Very Stiff Clay
(-)162	(-)182	Very Dense Sand
(-)182	(-)194	Very Stiff Clay

Details of the soil conditions encountered in the project borings can be found on the corresponding test boring logs presented Appendix C. Cross-sectional subsurface profiles are also included in Appendix C.

5.3 Design Soil Parameters

Design soil parameters for engineering analyses were developed based on field and laboratory measurements, published literature and our experience with soils in the area. A ratio of undrained cohesion to effective overburden pressure (c/p) equaling 0.22 was used to determine minimum undrained shear strength values with depth according to the SHANSEP (Soil Stress History and Normalized Soil Engineering Properties) relation (Ladd and Foote, 1974). The design soil parameters developed for the project are presented in Appendix G.

Please note the generalized design soil stratification and soil types along with depth, assumed for engineering analyses purposes, can vary from the soil types and conditions encountered in the individual soil borings. In addition to the three (3) subsurface stratigraphy groups presented in Tables 5-1 through 5-3 above, a set of soil design parameters based solely on test boring MB-10 was developed for offshore dock structures. Details of the soil conditions encountered in the soil borings can be found on the corresponding soil boring logs presented in Appendix C.

5.4 Groundwater Observations

Groundwater measurements obtained from the landside soil borings when groundwater was first encountered during dry-auger drilling and after a 15-min hold period. The groundwater measurements obtained within the boreholes are provided in Table 5-4 on the following page.

Table 5-4: Groundwater Level Measurements				
Test Boring	**Boring Completion Depth (ft)**	**Free Water Depth during Dry-Auger Drilling (ft)**	**15-minute Static Water Level (ft)**	**15-min Total Hole Depth (ft)**
LB-1	120	17.0	7.7	16.0
LB-2	200	11.0	7.3	8.0
LB-3	25	12.0	4.6	8.7

Groundwater levels at the project site could fluctuate with climatic and seasonal variations and should be verified before construction. Accurate determination of static groundwater levels is typically made with standpipe piezometers. Installation of standpipe piezometers to evaluate long-term groundwater conditions within the project site was not included in our scope of services for this project.

5.5 Environmental and Analytical Assessment

A separate report including details of the environmental and analytical program has been prepared by our Subconsultant, DiSorbo Consulting, LLC. The primary purpose of this study was to determine, in a preliminary capacity, if the soils cut from the dredge envelope are suitable for placement in Dredge Material Placement Areas (DMPAs). The results of the environmental and analytical testing indicate the materials dredged from the channel are suitable for placement in both private and federal placement areas. Please refer to the Executive Summary in the redacted Pre-Dredge Environmental Findings Report in Appendix L for further information.

6 DISCUSSION

The purpose of our geotechnical study was to provide geotechnical design and construction considerations for the preliminary design phase of the referenced project. As previously discussed, preliminary plans consist of dredging the channel to an elevation of El. (-)45-ft and widening the channel to widths ranging from 300-ft to 450-ft. The project will also include the design and construction of a proposed dock and barge fleeting area.

6.1 Global Stability Analysis

Dredging the bottom of slopes or in the lower part of slopes has the same effect as making the slope steeper or higher. When dredging or filling makes a slope steeper or higher, the active forces increase and the resisting (passive) forces are reduced, which leads to an increased risk of slope failures. Results of our slope stability analyses for short-term and long-term cases for the proposed channel side slope are provided in Section 7 of this report.

6.2 Site Grade Raise Fill Placement

We understand fill is planned to raise site grade within the shoreline area of the proposed dock and barge fleeting area to facilitate site drainage and construction activities of the proposed RORO ramp and storage lot. Based on drawings provided by the Engineer, we expect final site grade in this landside area to range from El. (+)5-ft to El. (+)12-ft. Existing site grade ranges from El. (+)2-ft to El. (+)14-ft. Estimated settlement due to area fill placement is discussed in Section 8 of this report.

6.3 Deep Foundation Systems

We anticipate deep foundations will be used for support of the proposed dock and barge fleeting structures. We considered driven piles such as steel open-ended pipe piles (OEPPs), square precast concrete piles (PCPs), cylindrical spun cast concrete piles (CSCCPs), Class B southern pine timber piles, and steel H-piles for this project. Recommendations for deep foundation systems are provided in Section 9 of this report. If additional pile types or sizes are considered, TWE should be contacted to include them in our final report.

6.4 Sheet Pile Bulkhead

We understand the construction of an anchored sheet pile bulkhead is being considered for the barge fleeting and RORO ramp area at this time. Based on information provided by the Engineer, we understand the anchored bulkhead will have a top of wall elevation of (+)12-ft and (+)5-ft at the dock area and RORO ramp area, respectively. We understand the loading behind the wall at the dock area and RORO ramp area is expected to be on the order of 1,250-psf and 250-psf, respectively. General recommendations for the sheet pile bulkheads are provided in Section 10 of this report.

6.5 Construction Considerations

General site and subgrade preparation, and other recommended construction guidelines such as fill and backfill types, are provided in Section 11 of this report.

7 CHANNEL SLOPE STABILITY

An evaluation of global slope stability of the dredged channel was performed considering the proposed channel cross section provided by the Engineer. Our analysis considered a channel bottom elevation of El. (-)49-ft to consider over-dredging and/or maintenance and side slopes on the order of 2H:1V.

7.1 Methodology

We performed global stability analyses of the proposed channel cross sections using the computer program Slide 2018 by Rocscience. Slide is a two-dimensional (2D) limit equilibrium slope stability program for evaluating the safety factor of failure surfaces in soil slopes. Slide analyzes the stability of slip surfaces using vertical slice limit equilibrium methods. Spencer's (1967) method was used which satisfies both force and moment equilibriums.

Stability of the channel side slopes was evaluated for short-term (undrained or total stress) and long-term (drained or effective stress) conditions. The short-term (end of construction) condition corresponds to the slope's state immediately after completion. In this condition, excess pore water pressures in the soils within the slope are assumed to have not been dissipated due to rapid application of the loading. Therefore, the soils are assumed to be in an undrained state. The long-term condition represents the case where the excess pore water pressures in the soils within the slope have dissipated over time and an effective stress or drained state has developed.

7.2 Results and Discussion

The results of our global stability evaluations are presented in Appendix H. According to the guidance provided in U.S. Army Corps of Engineers (USACE) Engineer Manual for Slope Stability (EM 1110-2-1902), the minimum required factor of safety considered appropriate for short-term stability cases is 1.3 and 1.5 for long-term global stability cases. Based on the results of our analyses, side slopes on the order of 2H:1V meet the USACE requirements.

It should be noted that several layers of loose to medium dense sand were encountered within the test borings performed within the channel alignment. Shallow surface slides and erosion of the slope caused by the flow of the channel can be expected. We recommend the constructed slopes be monitored long-term after construction and that proper maintenance of the channel is performed as needed.

8 SITE GRADE RAISE FILL PLACEMENT

Fill placed above existing site grade within the landside of the dock and barge fleeting area will affect design of foundations planned for the project due to settlement from increased overburden pressure of the fill. Impact of settlement as a result of fill placement primarily applies to structures supported at or near grade such as shallow foundations, paving, drainage alignments/tie-ins and interfaces between pile-supported and grade-supported structures. For deep foundations, effects of settlement from fill will be more significant if piles are tipped in clay soils and less significant if piles are tipped into competent sand strata.

Some settlement of the native site soils can be expected from the weight of the fill used to raise site grade. The magnitude of settlement will depend on the actual fill depths and the compressibility of the underlying soils. Based on the topographic information provided by the Engineer, existing site grade at the locations where fill is expected be placed ranges from approximately El. (+)2-ft to El. (+)10-ft. We evaluated area settlement due to placement of 3-ft, 6-ft, 9-ft and 12-ft of fill to raise site grade using a total unit weight of 120-pcf for the fill assuming dredged materials from the proposed Cedar Bayou channel will be used.

We performed an analysis of consolidation settlement due to fill placement using the computer program UniSettle (Version 4.0). Immediate settlement is expected to occur during or shortly after fill placement and therefore, was not considered in our analysis. Consolidation settlement will begin upon fill placement and continue at a decreasing rate over a period of 10-years or longer after construction is complete. The results of our analysis are summarized in Table 8-1 below.

Table 8-1: Summary of Fill Settlement Analyses

Fill Height	Consolidation Settlement
3-ft	2.0-in
6-ft	4.0-in
9-ft	7.7-in
12-ft	14.0-in

Please note the above settlement estimates could be +/-30% of the actual values realized during development of the site as areal settlement will depend on sequence of placement and actual fill thicknesses which should be monitored accordingly. We recommend settlement plates with extendable rods be installed prior to fill placement so that conventional surveying measurements can be made during construction to monitor actual settlements. Vibrating wire piezometers (VWPs) could also be installed to monitor pore water pressure during fill placement in critical areas of the site. If the above settlements are not tolerable, or if settlement needs to be accelerated, TWE should be contacted to discuss potential ground improvement options.

9 DEEP FOUNDATION SYSTEMS

This section applies to landside and marine structures which will be supported using deep foundation systems. Deep foundation systems considered herein consist of driven steel open-ended pipe piles (OEPPs), square precast concrete piles (PCPs), cylindrical spun cast concrete piles (CSCCPs), class B southern pine timber piles and H-piles. Geotechnical recommendations for these foundation types are provided in the following sections. If other pile types or sizes will be considered, TWE should be contacted to provide this information in our final report.

The pile capacities derived for offshore driven piles were based solely on subsurface information obtained from test boring MB-10 as preliminary information. Additional test borings in the location of the proposed dock are recommended to verify subsurface stratigraphy closer to the final structure locations.

9.1 Axial Pile Capacity

For driven piles, we computed ultimate compression and tension capacities of a single pile using the static method of analysis recommended by American Petroleum Institute (API RP 2A - WSD, 2002). The analyses were performed using the computer code APILE Plus, Version 2019 (Ensoft, Inc.). The ultimate axial pile capacity curves for the various pile types and sizes considered are provided in Appendix I. Ultimate axial pile capacity plots for offshore piles are provided in Figures 1 through 12 in Appendix I for varying mudline elevations. Ultimate axial pile capacity curves for piles driven landside are provided in Figures 13 through 16 in Appendix I. To calculate the capacity of battered piles, a generalized procedure for computing approximate axial and horizontal capacity is presented in Appendix J.

Ultimate axial pile capacities obtained from the curves in Appendix I should be reduced by an appropriate factor of safety to compute the allowable axial shaft capacity. A factor of safety of 2.5 is recommended to compute allowable compression capacity. A factor of safety of 3.0 is recommended to compute allowable tension capacity. If load testing will be conducted as part of the construction scope, reduced factors of safety as low as 2.0 could be considered. The buoyant weight of the piles can be added to the tension capacity. The computed weight of the piles should be reduced by a factor of 1.2 for design.

We discounted frictional resistance of the soils to 5-ft below existing grade or mudline to account for pile cut-off elevation and possible disturbances during construction. It should be noted the tension capacity is based solely on soil/pile interaction. Piles and pile cap connections should be structurally capable of resisting design uplift loads.

9.1.1 Individual Pile Settlement

A detailed analysis of axial load versus settlement for deep foundations was beyond the scope of this investigation. However, for single-isolated piles designed in accordance with the computed allowable values of side friction and end bearing, individual pile settlements should be less than about 0.5-in.

9.2 Lateral Pile Response

For deep foundations, lateral loads are resisted by the soil as well as the rigidity of the pile. Lateral capacity will vary with pile type and properties, degree of fixity and pile spacing. Typically, lateral loads are analyzed using the p-y method in which the soil is modeled as a series of non-linear springs.

This procedure with appropriate computer codes (i.e., LPILE by Ensoft, Inc.,) has the advantage that major factors influencing soil resistance are inherently included in the semi-empirical p-y design criteria. For the subsurface conditions observed within the project site, we recommend the LPILE soil design parameters presented in Appendix K for use with lateral and moment analysis of foundations associated with the project. Separate sets of lateral analysis soil design parameters were developed for piles driven offshore or landside.

9.3 Pile Groups

9.3.1 Axial Group Efficiency

The overall axial compression capacity of a pile group depends on several factors including soil type, pile type and spacing as well as the number of piles in the group. Therefore, groups of piles having a center-to-center spacing of less than three (3) diameters/widths should be analyzed for group efficiency considering both block and individual modes of failure. If pile groups are planned for this project, TWE should be contacted to analyze group capacities once the final pile size, depth and group configurations are selected.

9.3.2 Lateral Group Effects

The effects of close pile spacing results primarily in a reduction in the maximum soil resistance which can be mobilized as compared to the sum of the lateral resistances of individual piles within the group. This leads to the concept of a "p-multiplier" or the Pm factor. If pile groups are planned for this project, TWE should be contacted to analyze lateral group effects and appropriate Pm factors once the final pile size, depth and group configurations are selected.

9.3.3 Pile Group Settlement

Pile group design is typically governed by group settlement rather than axial group capacity or lateral group response. The settlement of a group of piles is significantly influenced by the size of the pile group and the compressibility of the soils below the pile tips. For typical spacing of about three (3) widths/diameters center-to-center, settlement estimates of pile groups (4 x 4 or larger) should be determined.

10 SHEET PILE BULKHEAD

We understand an anchored sheet pile bulkhead will be installed adjacent to the proposed 20-ac storage lot in the dock and barge fleeting area. We understand the anticipated loading behind the proposed sheet pile walls will be 1,250-psf behind the dock wall and 250-psf behind the RORO ramp wall. Details regarding the size of the sheet pile wall and anchor were not available at the time of this report. Based on information provided by the Engineer, we understand the mudline on the passive side of the wall will be sloped with a gradient of 3H:1V away from the wall starting at El. (-)15-ft to the final dredge elevation of El. (-)45-ft at the fenderline.

10.1 Lateral Earth Pressures

For lateral pressures on a permanent structure, the controlling factors include the nature of the retained material, the drainage of the material, and the relative rigidity of the walls. Two (2) soil conditions exist for analyzing lateral pressures on walls, permanent (long-term, drained soil condition) and temporary (short-term, undrained soil condition). Recommended design soil parameters for retention system design for both conditions are tabulated in Figure 7 of Appendix G.

The design of the permanent earth retention structures should consider long-term lateral earth and hydrostatic pressures and the hydrostatic uplift pressures at the base of the structures if the bottom of the structure is below the static groundwater level. For hydrostatic pressure considerations, the static groundwater level was assumed to be at El. 0-ft.

10.2 Stability Analysis

10.2.1 Rotational Stability Analysis

Rotational stability analyses of the sheet pile wall sections were performed using the soil design parameters provided in Figure 7 of Appendix G. The rotational stability analyses were performed considering both undrained (short-term) and drained (long-term) conditions using the computer program CWALSHT developed by U.S. Army Corps of Engineers (USACE) at the Engineering Research & Development Center in Vicksburg, Mississippi. CWALSHT (Dawkins, 1990) uses classical methods of sheet pile analysis based on limit equilibrium in accordance with USACE EM 1110-2-2504 (Design of Sheet Pile Walls).

The evaluation was performed using the Design Mode of the program which determines the embedment depth of the sheet pile section using factored soil shear strengths. The fixed earth support method was assumed. The design bending moment and anchor loads were determined using un-factored soil strengths to avoid compounding factors of safety. We assume the Engineer will use adequate factors of safety for the structural design of the sheet pile section and for anchor design.

In accordance with USACE EM 1110-2-2504, the factors of safety used on the soil strength for active and passive earth pressure computations are presented in Table 10-1 on the following page. Factors of safety are not typically used on soil strength for active pressure computation when the sheet pile deflections are not severely restricted.

Table 10-1: Factors of Safety Applied for Rotational Stability			
Sheet Pile	**Loading Condition**	**Factor of Safety on Soil Strength**	
		Active Pressure	**Passive Pressure**
Permanent Anchored Bulkhead	Short Term	1.0	2.0
	Long Term	1.0	1.5

The minimum sheet pile tip embedment depth was determined from the most critical case of stability analysis which was the rotational stability under long-term (drained) conditions for the dock wall and global stability under long-term (drained) conditions for the RORO ramp wall. Figures 1 and 2 below illustrate the sheet pile configuration and anticipated elevations of final site grade/mudline for the dock wall and RORO ramp wall, respectively.

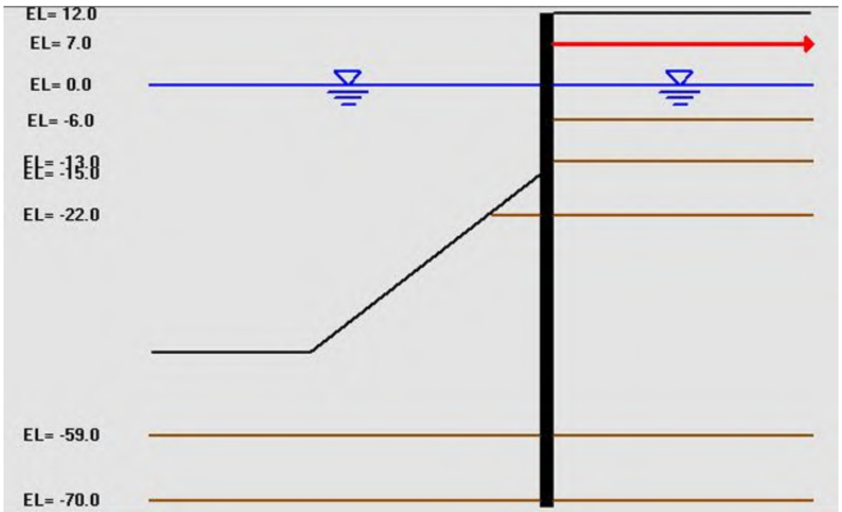


Figure 1: Dock Wall Configuration

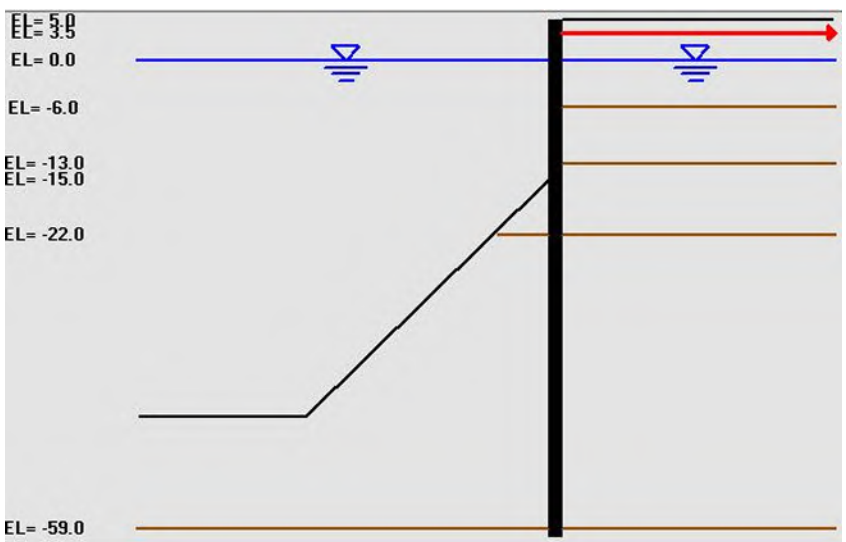


Figure 2: RORO Ramp Wall Configuration

Based on our rotational and global stability analyses, the results of anchored sheet pile bulkheads for the dock and RORO ramp areas are summarized in Table 10-2 and 10-3, respectively.

Table 10-2: Summary of Anchored Sheet Pile Analysis – Dock Wall

Design Parameters	Anchored Wall
Top of Sheet Pile Elevation	(+)12-ft
Anchor Location Elevation	(+)7-ft
Design Sheet Pile Tip Elevation	(-)66-ft
Design Embedment Depth	51-ft*
Design Sheet Pile Length	78-ft
Maximum Bending Moment	97.1-kip-ft/ft
Maximum Scaled Deflection	2.72×10^{10} lb-in^3
Horizontal Anchor Load	15.0 kips/ft

*Assumes mudline elevation of El. (-)15-ft at mudline/wall interface.

Table 10-3: Summary of Anchored Sheet Pile Analysis – RORO Ramp Wall

Design Parameters	Anchored Wall
Top of Sheet Pile Elevation	(+)5-ft
Anchor Location Elevation	(+)3.5-ft
Design Sheet Pile Tip Elevation	(-)36-ft
Design Embedment Depth	21-ft*
Design Sheet Pile Length	41-ft
Maximum Bending Moment	11.4-kip-ft/ft
Maximum Scaled Deflection	8.29×10^{8} lb-in^3
Horizontal Anchor Load	2.4 kips/ft

*Assumes mudline elevation of El. (-)15-ft at mudline/wall interface.

The required section modulus of sheet pile can be estimated by dividing the maximum bending moment by the allowable bending stress of the sheet pile material. The actual modulus of the selected sheet pile section should be greater than the required section modulus. The anticipated maximum deflection of the sheet pile can be determined by dividing the scaled deflection by elastic modulus (E) and moment of inertia (I) of the selected sheet pile section.

10.2.2 Global Stability Analysis

We performed global stability analyses of the critical sheet pile section using the computer program Slide 2018 by Rocscience. We selected the sheet pile embedment depth obtained from the critical case of rotational stability analysis [El. (-) 66-ft]. Global stability analysis was performed using Spencer's (1967) method for short-term and long-term conditions using undrained (total stress) and drained (effective stress) parameters, respectively. The computed factors of safety for global slope failure meet the USACE requirements for both short-term and long-term conditions. The results of our global stability analyses for the bulkhead are presented in Figures 5 through 8 of Appendix H.

11 CONSTRUCTION CONSIDERATIONS

This section provides our geotechnical recommendations pertaining to site preparation, fill material placement and compaction guidelines, foundation installation and overall construction monitoring and quality control.

11.1 Site Preparation

Areas designated for fill placement should be cleared and stripped of vegetation, organics, major root systems and other deleterious fill materials to the depth of competent subgrade capable of supporting proofrolling activities. After stripping, areas to receive fill should be graded to establish positive drainage across the site so that ponding of surface water does not collect and inhibit site access or construction activities. After site grading is completed to establish positive drainage, the exposed subgrade soils should be proofrolled as indicated below.

Prior to placement of fill, we recommend existing subgrade soils be proofrolled with a rubber tire pneumatic roller with a weight of at least 20-tons to detect significant weak areas. Such weak areas should either be removed and replaced with fill or stabilized in-place in general accordance with the recommendations provided herein. We do not recommend using off-road earth moving equipment (e.g. loaders or scrapers) or tracked vehicles for proofrolling.

Proofrolling should extend at least 5-ft beyond the construction limits. Proofrolling specifications should provide acceptance criteria such as rut depths less than 2-in and no visual evidence of pumping. TWE should be present to observe and document proofrolling and to delineate areas of weak or compressible soils, if encountered.

11.2 Fill and Backfill Soils

Fill soil types can be grouped according to their application. Fill soils that are used to support foundations and structures are typically identified as structural fill and are usually associated with engineering specifications. Fill soils that are used for general site grading and raising are typically identified as general fill. The recommended material and compaction requirements for various fill applications are described in the following report sections.

Fills should be placed in uniform layers or lifts. The maximum fill lift thickness should be controlled to maintain compaction throughout the entire fill lift and will depend on the type of compaction equipment used. Typically, a maximum 8-inch lift thickness (loose measure) is appropriate for most conventional compactors.

Prior to any filling operations, samples of the proposed fill materials should be obtained by TWE for laboratory classification and moisture-density relationship testing. The tests will provide a basis for evaluation of fill compaction by in-place density testing. A representative of TWE should also be present to perform sufficient in-place density tests during the filling operations to verify proper levels of compaction are obtained.

11.2.1 General Fill

General Fill can be used for raising site grade including laydown areas, storage lots and roadways. General Fill can also be used in the lower regions (up to 3-ft below final grade) of deep fill areas where foundations are planned. General fill can also be used for backfill around pile caps.

General Fill should be free of organics, deleterious or otherwise unsuitable materials with a maximum particle size of 3-in or less. Based on borings MB-1 through MB-10, the soils to be dredged from the Cedar Bayou channel are mostly comprised of fat clay (CH) and lean clay (CL) soils which meet General Fill requirements. However, some lenses of cohesionless and semi-cohesionless sand soils were encountered throughout the marine borings at various elevations and boring MB-3 encountered organic clay (OH) in the depth range of 11-ft to 28.5-ft below mudline.

Based on our experience with marine dredging operations, we anticipate the soil solids will separate as natural dewatering occurs once the materials are pumped landside. We expect the clays, sands and silts will propagate and collect in isolated areas depending on the actual sequence of dredging. We do not recommend silts or silty soils classifying as ML, CL-ML, SM, SP-SM, SC-SM or SW-SM be used as General Fill material for this project.

General Fill should be placed in thin lifts, not exceeding 8-in loose measure, moisture-conditioned between -2% and +3% of optimum moisture content and compacted to a minimum 95% of the maximum dry density as determined by ASTM D698 (standard Proctor).

11.2.2 Structural Clay Fill

Structural Clay Fill should be considered for placement beneath soil-supported shallow foundations or other permanent structures sensitive to potential shrink/swell movements from the native or dredged soils. We anticipate Structural Clay Fill will need to be imported from an off-site borrow source and consist of a clean, low-plasticity sandy clay with a liquid limit of less than 40, a plasticity index between 10 and 20, and a maximum particle size of 3-in. In general, the soils encountered in the project borings did not meeting these Structural Clay Fill requirements.

Structural Clay Fill should be placed in thin lifts, not exceeding 8-in loose measure, moisture conditioned between -2% and +3% of optimum moisture content and compacted to a minimum 95% of the maximum dry density as determined by ASTM D698 (standard Proctor).

11.2.3 Structural Sand Fill

We recommend Structural Sand Fill be used as backfill behind the proposed sheet pile bulkheads. Structural Sand Fill material should consist of clean sand with less than 15% material finer than the No. 200 sieve. The sand should be placed in maximum 8-inch loose lifts and uniformly compacted to at least 70% relative density as determined by ASTM D4253 and ASTM D4254.

11.2.4 Structural Fill Alternatives

We understand the material dredged from the Cedar Bayou channel is being considered for beneficial use as much as applicable for the referenced project. As a structural fill alternative, for dredged materials that do not meet the General Fill, Structural Clay Fill or Structural Sand Fill designations, they could be stabilized with a chemical admixture such as lime, cement, fly ash, or a combination thereof, depending on their soil type and corresponding properties. Chemically-modified soils can be used in all applications where Structural Fill is required.

The type and quantity of chemical stabilization required should be determined by performing laboratory treatability studies on the actual soils planned for use. TWE would be pleased to further evaluate composition of available samples and potential stabilization options upon request.

11.3 Deep Foundation Installation

Performance of project structures supported on deep foundation systems will be directly related to the Contractor's adherence to the recommendations in this report and the project plans and specifications. Therefore, we recommend pile installation monitoring services be provided by TWE for this project. Pile installation monitoring services will provide verification the piles are installed in accordance with the intentions of this report and the project driving or installation criteria.

11.3.1 Driven Piles

Pile driving hammers should be selected according to pile type, length, size and weight of pile, as well as potential vibrations resulting from pile driving operations. Care should be taken to ensure the hammer selected is capable of achieving the desired penetration without causing damage to the piles or causing excessive vibrations which could cause damage to nearby structures.

We recommend the Contractor submit a pre-construction wave equation analysis (GRLWEAP or equivalent) prior to mobilization to appropriately size the hammer for the planned pile size and the site subsurface profile. It should be noted the piles could be driven through alternating clay and sand soil layers whereby compression and tension stresses could be of concern during driving. Each pile should be driven to the desired tip elevation and driving resistance without interruption in the driving operations. Pile driving records should be maintained by TWE on-site throughout the duration of pile driving.

It should be noted that a dense to very dense sand strata at elevations ranging from El. (-) 59-ft to El. (-) 88-ft were encountered at the project site. The sand strata encountered within this range could impact the installation of driven piles. It is recommended WEAPs and driveability studies are performed to estimate driving resistance and required hammer energy for driven piles installed for this project.

Some pile heaving could be experienced during installation of adjacent driven displacement type piles. It is therefore recommended that tip elevations of piles be recorded and if significant heave is noted after driving of subsequent piles, provisions should be made for reseating them.

11.4 Pile Load and Integrity Testing

TWE would be pleased to develop a detailed integrity and load testing program for the deep foundations being considered for this project. The purpose of the integrity and load tests would be to evaluate the as-built conditions of the piles, loading/unloading versus displacement response, evaluate ultimate axial compression, axial tension and lateral capacity of the piles, compare measured capacities and deflections with design criteria and develop installation guidelines for the remaining deep foundations to be installed for the project.

The load testing program could include a combination of static pile testing and high-strain dynamic testing to investigate a variety of pile types, sizes and depths. Refined WEAP analyses could also be performed for driven piles utilizing the data obtained from the static and dynamic tests. Using this information, pile driving criteria can be developed to establish a reliable relationship between hammer blow count and pile capacity and to establish pile driving and refusal criteria.

11.4.1 Dynamic Load Testing

We recommend all driven piles included in the test program be dynamically monitored during initial driving and during restrike events after the end of initial driving. Dynamic monitoring should utilize the most current state-of-the-art equipment and software including CAPWAP and WEAP Analysis programs. Additional pile sizes and lengths of interest which are not tested using static methods can be tested by dynamic testing methods at relatively low cost as compared to static testing.

For driven piles, we recommend full-drive monitoring of selected piles during initial driving to evaluate hammer performance, driving behavior, pile stresses and to establish pile driving or refusal criteria. We recommend dynamic monitoring also be performed on driven piles during specific restrike events after the end of initial driving to evaluate pile set up and long-term axial capacity.

11.4.2 Integrity Testing

If used for the project, we recommend the driven PCP piles be tested for quality and consistency using the Pile Integrity Tester (PIT) developed by Pile Dynamics, Inc. The PIT consists of low-strain dynamic testing to approximate relative cross-sectional changes along the length of the pile. Data is obtained with an accelerometer and instrumented weighted hammers in accordance with ASTM D5882.

12 LIMITATIONS

12.1 Limitations

This report has been prepared for the exclusive use of Trans-Global Solutions, Inc. and their project team for specific application to the Cedar Bayou Deepening & Widening Project in Chambers County, Texas. This report has been prepared in accordance with generally accepted geotechnical engineering practices common to the local area. No other warranty, expressed or implied, is made.

The geotechnical explorations performed within the site represent the in-situ condition at these specific locations. They have been used for the basis of the geotechnical design and construction recommendations provided in this report. The soil borings indicate subsurface conditions only at the specific locations and at the times they were performed and only to the depths penetrated. The soil borings do not necessarily reflect strata variations that could exist at other locations within the site.

The validity of the recommendations provided is based in part on assumptions about the stratigraphy made by the Geotechnical Engineer. Such assumptions can be confirmed only during construction and installation of the proposed foundations. Our recommendations presented in this report must be reevaluated if subsurface conditions during construction are different from those described in this report.

If any changes in the nature, design or location of the project are planned, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed, and the conclusions modified or verified in writing by TWE. TWE is not responsible for any claims, damages or liability associated with interpretation or reuse of the subsurface data or engineering analyses without the expressed written authorization of TWE.

12.2 Design Review and Construction Monitoring

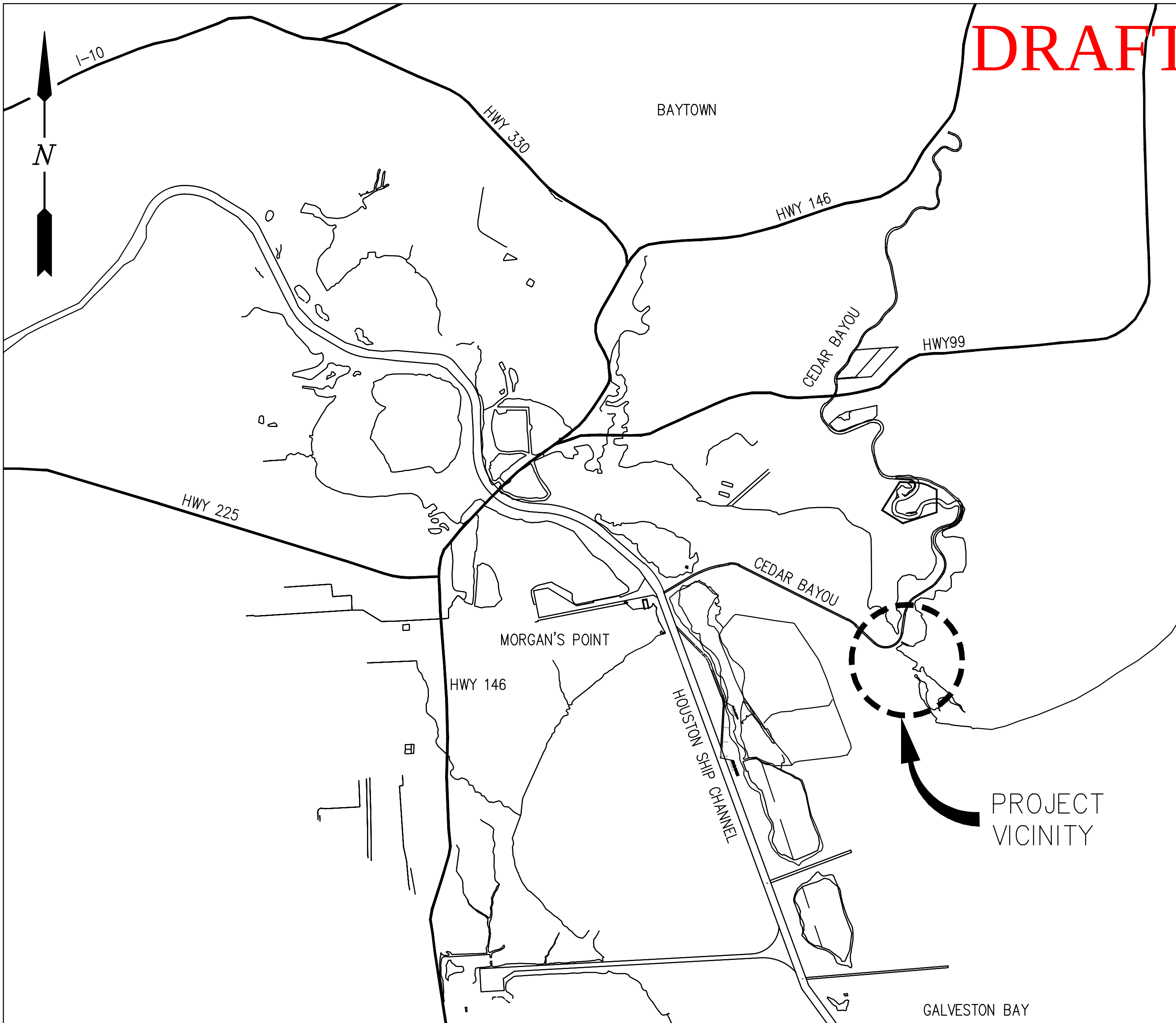
Review of the design and construction drawings should be performed by TWE before release. The review is aimed at determining if the geotechnical design and construction recommendations contained in this report have been properly interpreted. Design review is not within our authorized scope of services for this study at this time.

Construction surveillance by TWE is recommended and has been assumed in preparing our recommendations. These field services are required to check for changes in conditions which could result in modifications to our recommendations. The quality of the construction practices will affect foundation performance and should be monitored by TWE accordingly.

APPENDIX A

PROJECT EXHIBITS

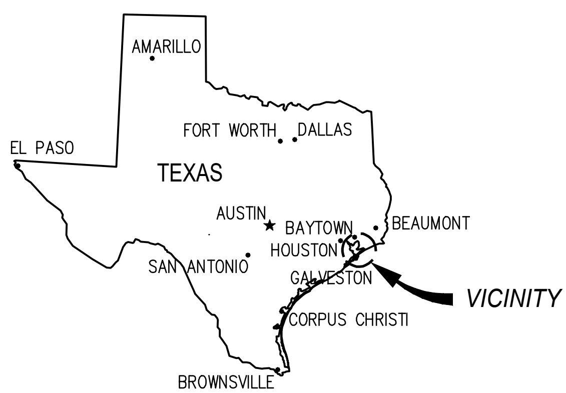
DRAFT



CHAMBERS COUNTY
LAT. 29° 40' 00.00" N
LONG. 94° 55' 36.00" W

VICINITY MAP

1 0 0.5 1 2
(IN MILES)



AREA MAP

CHRISTOPHER S. GUY P.E.
TX PE #116477

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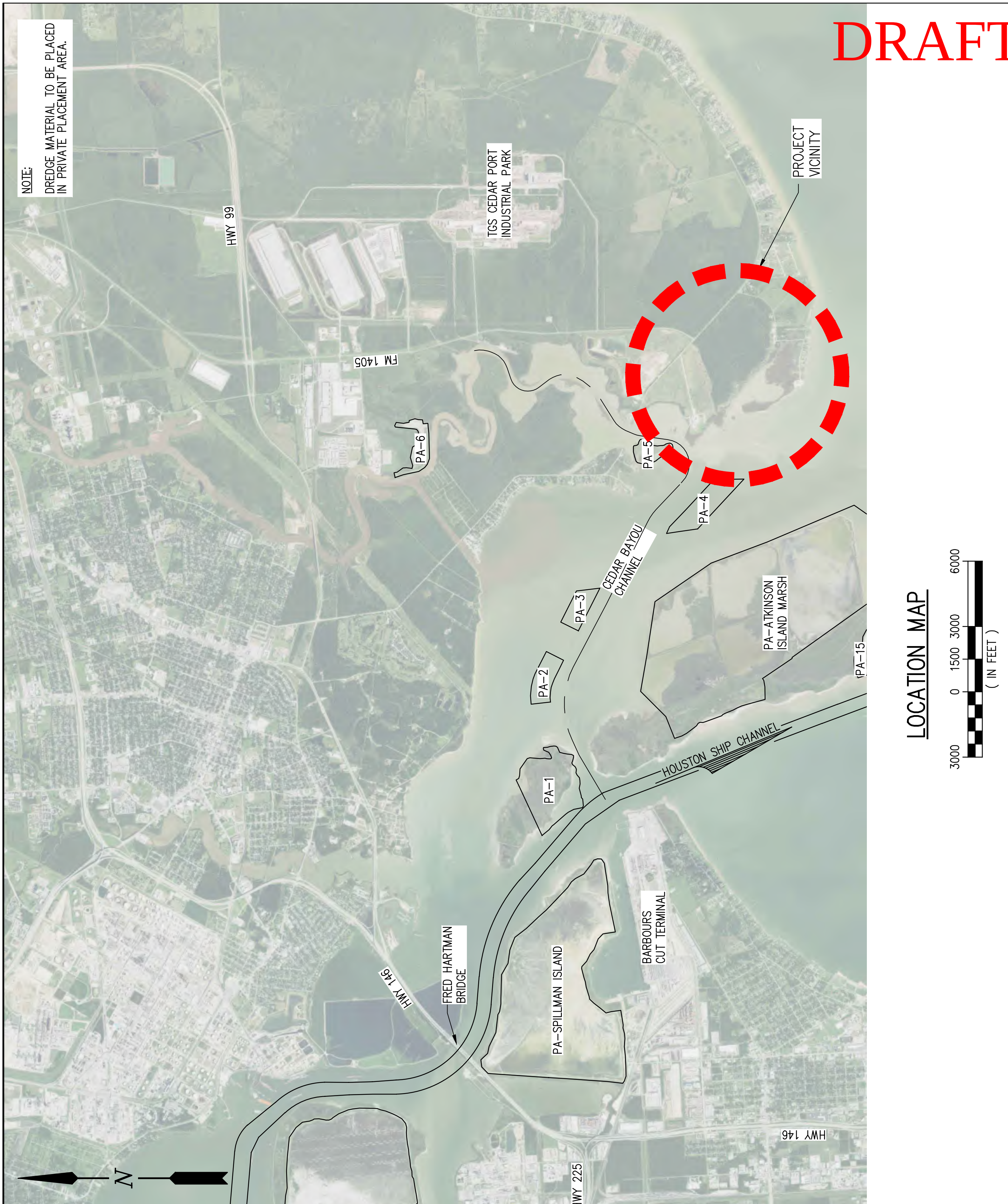
TGS CEDAR PORT PARTNERS, L.P.
CEDAR BAYOU TEXAS

CEDAR PORT BARGE DOCK
& BARGE FLEETING
VICINITY MAP

DATE	AUG. '20
DESIGN	CSG
DRAWN	PJC
CHECK	DLC
JOB NO	11407
SHEET No.	1 OF 11

J:\11000S\11407 TGS CEDAR POINT BARGE DOCK\DRAWINGS\PERMIT - 8_5X11\11407-P1.DWG



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CEDAR PORT BARGE DOCK & BARGE FLEETING LOCATION MAP

DATE AUG. '20
DESIGN CSG
DRAWN PJC
CHECK DLC
JOB NO 11407
SHEET No. 2 OF 11

J:\11000S\11407 TGS CEDAR POINT BARGE DOCK\DRAWINGS\PERMIT – 8_5X11\11407-P3.DWG

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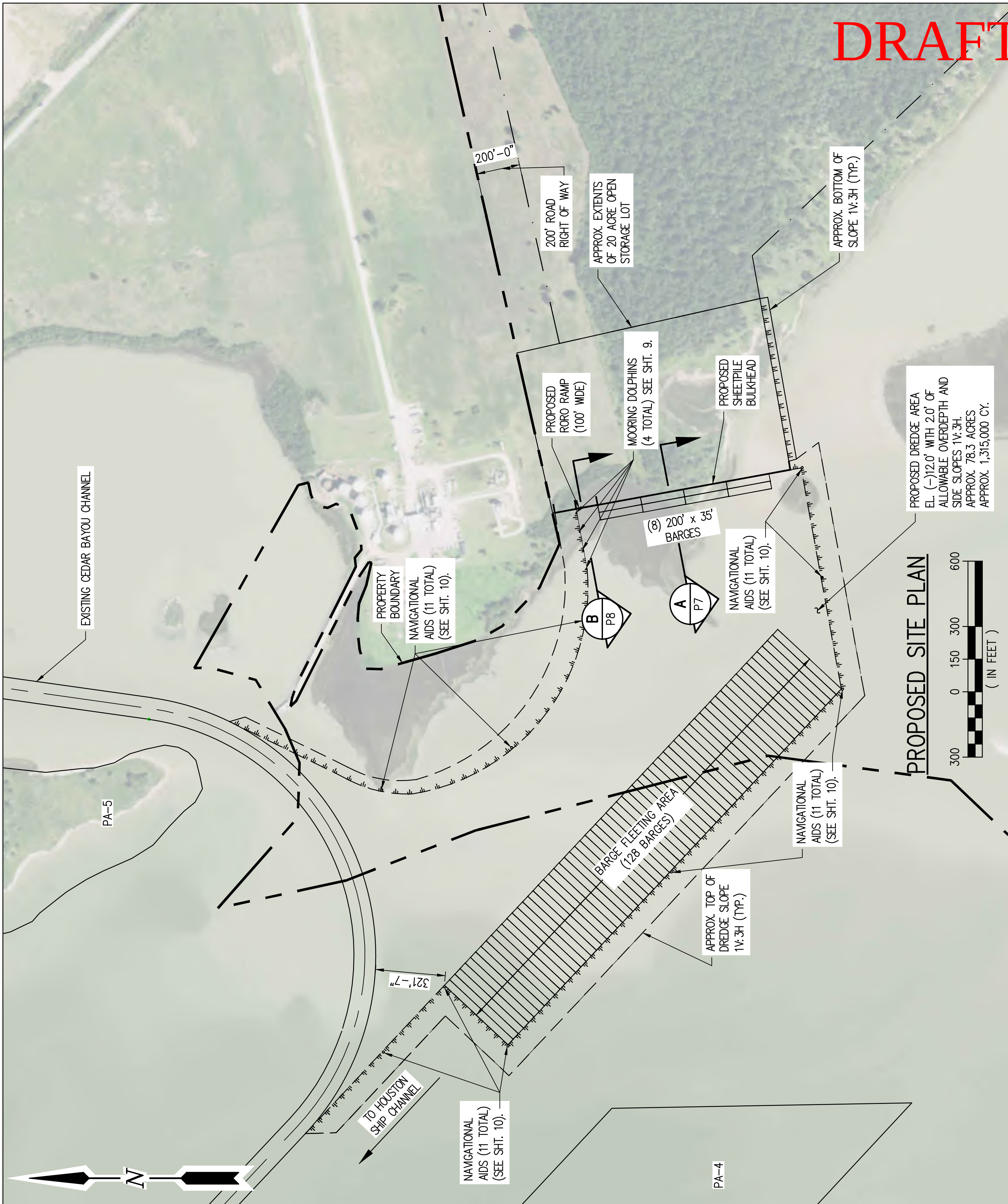
CEDAR PORT BARGE DOCK
& BARGE FLEETING
EXISTING SITE PLAN

DATE	AUG. '20
DESIGN	CSG
DRAWN	PJC
CHECK	DLC
JOB NO	11407
SHEET No.	3 OF 11

DRAFT



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CEDAR PORT BARGE DOCK
& BARGE FLEETING
PROPOSED SITE PLAN

DATE AUG. '20
DESIGN CSG
DRAWN PJC
CHECK DLC
JOB NO 11407
SHEET No. 4 OF 11

J:\11000S\11407 TGS CEDAR POINT BARGE DOCK\DRAWINGS\PERMIT - 8_5X11\11407-P4.DWG

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CEDAR PORT BARGE DOCK
& BARGE FLEETING
PROPOSED DREDGE PLAN

DATE AUG. '20
DESIGN CSG
DRAWN PJC
CHECK DLC
JOB NO 11407
SHEET No.
5 OF 11

J:\11000S\11407 TGS CEDAR POINT BARGE DOCK\DRAWINGS\PERMIT - 8_5X11\11407-P5.DWG

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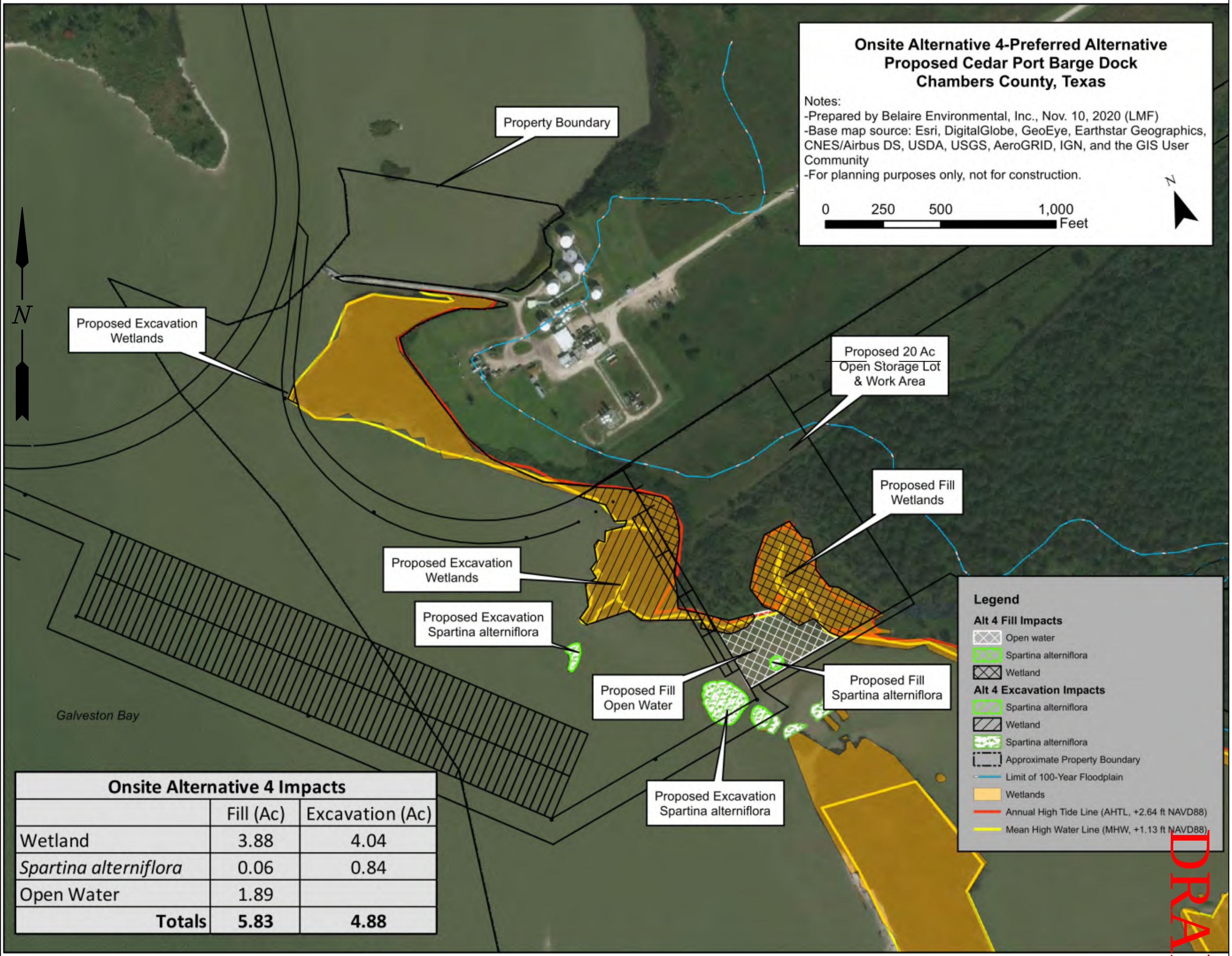

Onsite Alternative 4 Impacts

	Fill (Ac)	Excavation (Ac)
Wetland	3.88	4.04
Spartina alterniflora	0.06	0.84
Open Water	1.89	
Totals	**5.83**	**4.88**

WETLAND IMPACTS

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CEDAR PORT BARGE DOCK
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WETLAND IMPACTS

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DESIGN CSG
DRAWN PJC
CHECK DLC
JOB NO 11407
SHEET No. 6 OF 11

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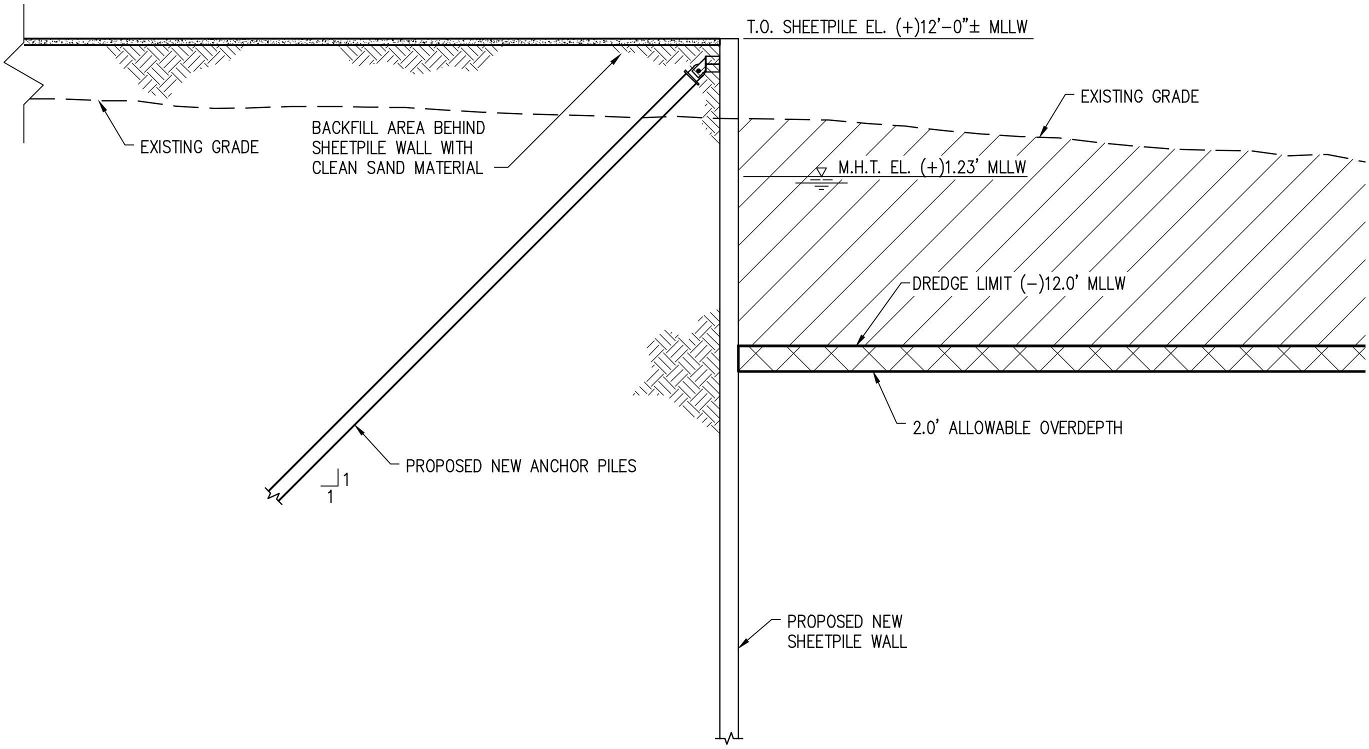
CEDAR PORT BARGE DOCK
& BARGE FLEETING
PROPOSED PRIVATE PLACEMENT AREA

DATE AUG. '20
DESIGN CSG
DRAWN PJC
CHECK DLC
JOB NO 11407
SHEET No. 7 OF 11

DRAFT



SECTION A P4
1" = 15'

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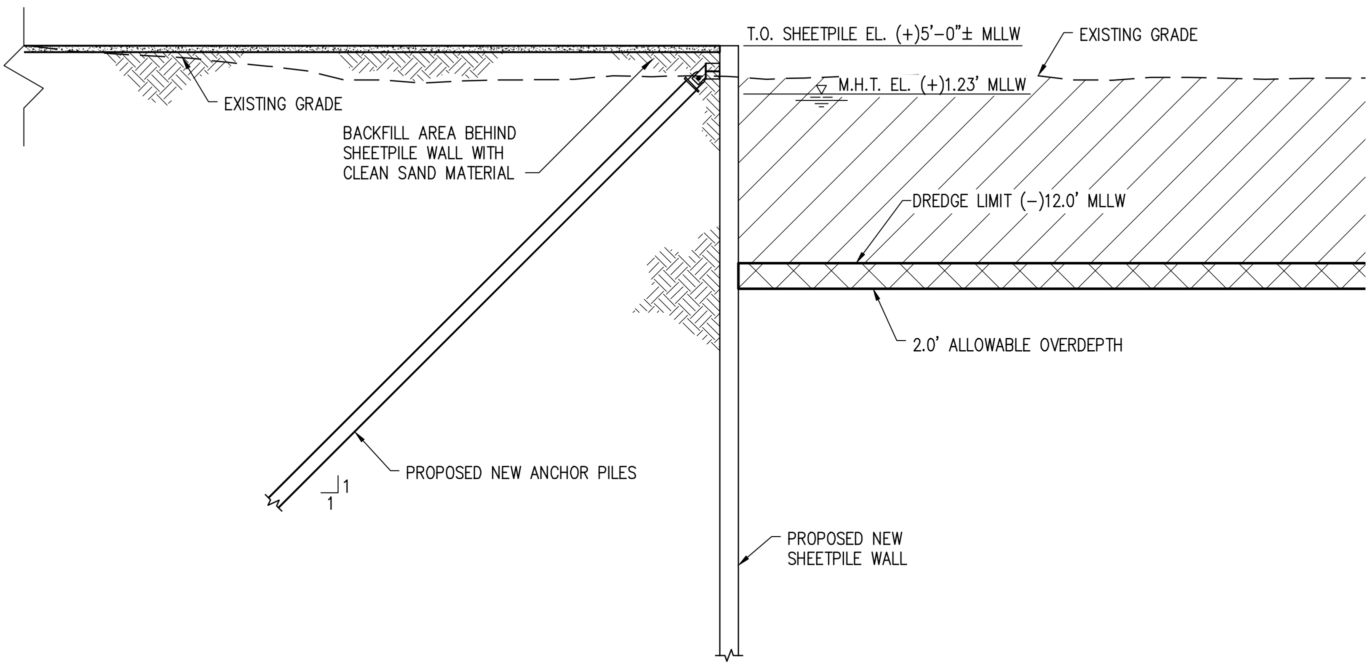
CEDAR PORT BARGE DOCK
& BARGE FLEETING
TYPICAL CROSS SECTION

DATE AUG. '20
DESIGN CSG
DRAWN PJC
CHECK DLC
JOB NO 11407
SHEET No. 8 OF 11

J:\11000S\11407 TGS CEDAR POINT BARGE DOCK\DRAWINGS\PERMIT - 8_5X11\11407-P8.DWG

DRAFT



HEAVY CARGO DOCK
TYPICAL SECTION
1" = 15'
B
P4

J:\11000S\11407 TGS CEDAR POINT BARGE DOCK\DRAWINGS\PERMIT - 8_5X11\11407-P9.DWG

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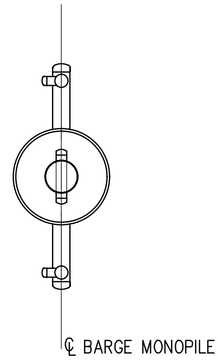
CEDAR PORT BARGE DOCK
& BARGE FLEETING
HEAVY CARGO DOCK - SECTION

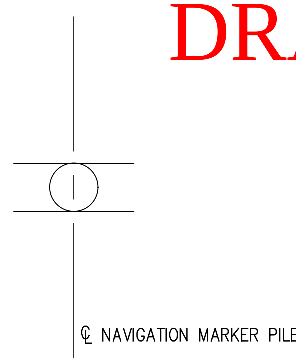
DATE AUG. '20
DESIGN CSG
DRAWN PJC
CHECK DLC
JOB NO 11407
SHEET No. 9 OF 11

DRAFT



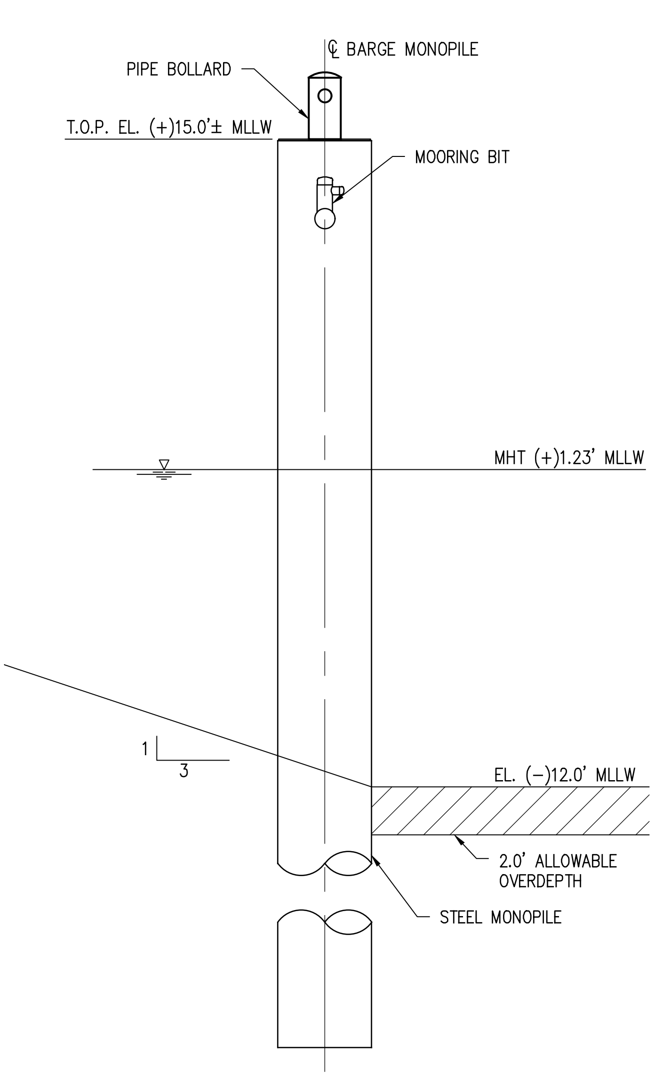
BARGE MONOPILE PLAN

N.T.S.



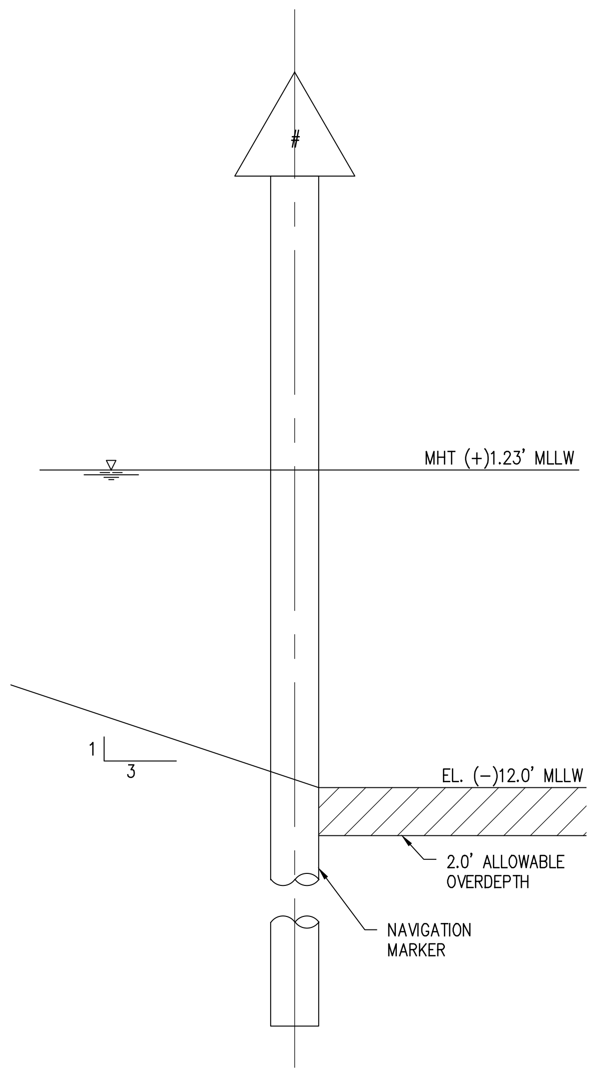
NAVIGATION MARKER PILE PLAN

N.T.S.



BARGE MONOPILE ELEVATION

N.T.S.
(4 REQUIRED)



NAVIGATION MARKER PILE ELEVATION

N.T.S.
(11 REQUIRED)

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CEDAR PORT BARGE DOCK
& BARGE FLEETING
PROPOSED NEW STRUCTURES

DATE AUG. '20
DESIGN CSG
DRAWN PJC
CHECK DLC
JOB NO 11407
SHEET No. 10 OF 11

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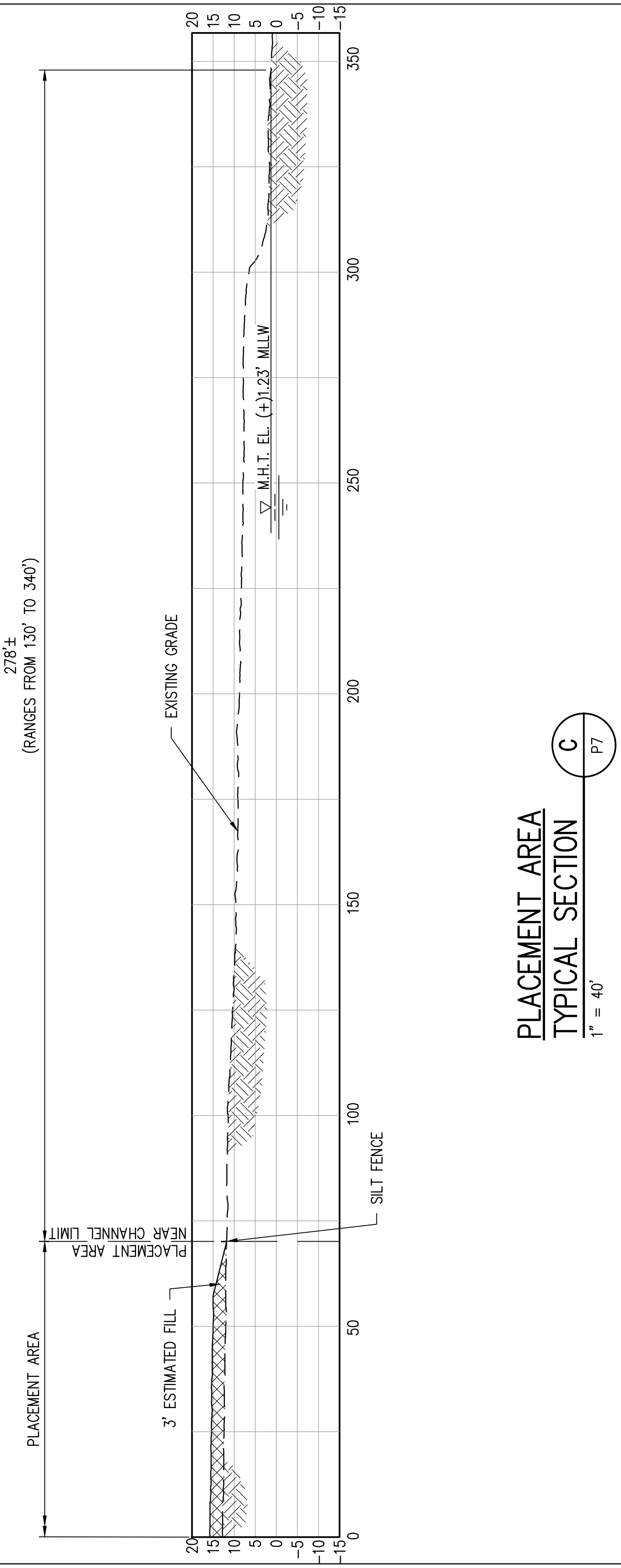

PLACEMENT AREA
TYPICAL SECTION
1" = 40'
C
P7

J:\11000S\11407 TGS CEDAR POINT BARGE DOCK\DRAWINGS\PERMIT - 8_5X11\11407-P11.DWG

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CEDAR PORT BARGE DOCK
& BARGE FLEETING
PLACEMENT AREA - SECTION

DATE AUG. '20
DESIGN CSG
DRAWN PJC
CHECK DLC
JOB NO 11407
SHEET No.
11 OF 11

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MARCH 05, 2021

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\CIVIL\11612-C1 - CONTOURS.DWG

CEDAR PORT INDUSTRIAL PARK TGS

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LA: C-1120

REV	DATE	BY	DESCRIPTION

REV	DATE	BY	DESCRIPTION

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DATE MAR '21
SCALE NOTED
DESIGN *
DRAWN PJC
CHECK *
APPR'D CSG
CAD NO 11612-C1

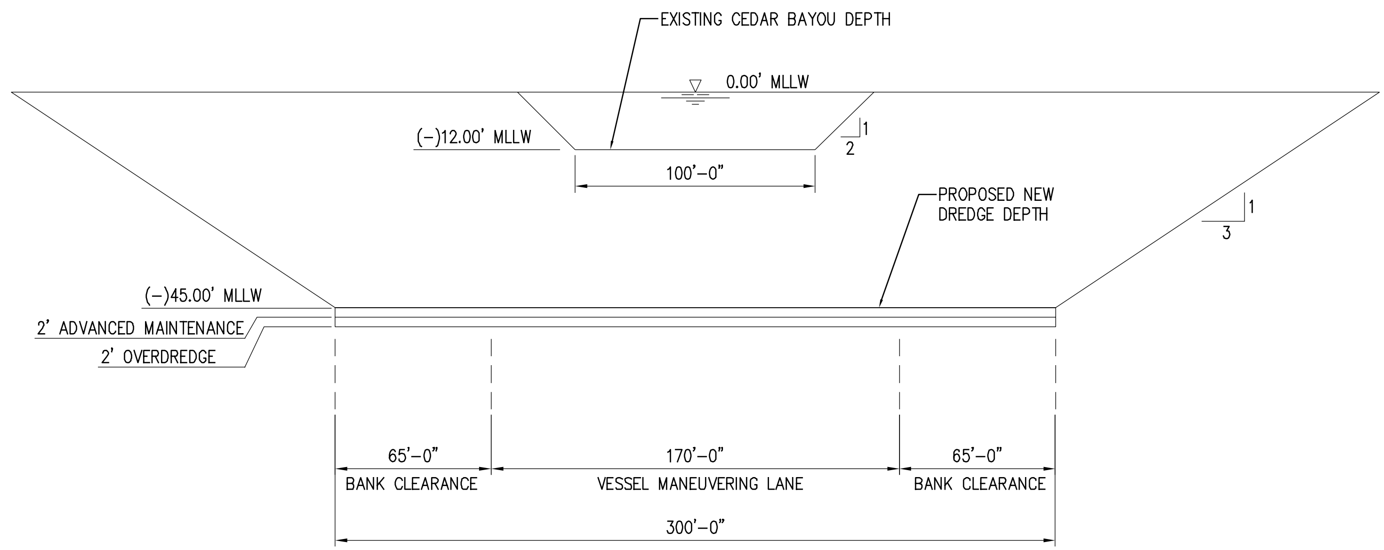
CHAMBERS COUNTY IMPROVEMENT DISTRICT #1
CEDAR BAYOU TEXAS

CEDAR BAYOU
DEEPENING PERMIT
PROPOSED NEW PLAN

9813-15
SHEET NO.
C1

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\03 - PERMITS\11612-X1.DWG

DRAFT



TYPICAL CHANNEL CROSS-SECTION

SCALE: HORIZONTAL 1"=40'
VERTICAL 1"=20'

NOTES:

1. ALL ELEVATIONS IN MLLW U.N.O.
2. DESIGN VESSEL WIDTH B=106'
3. BANK CLEARANCE~0.6B
4. VESSEL MANEUVERING LANE~1.6B
5. TIDES PER NOAA GAGE AT MORGANS POINT:
   - MLLW = 0.00'
   - MEAN TIDE = (+)0.67'
   - MHW = (+)1.23'
   - MHHW = (+)1.31'

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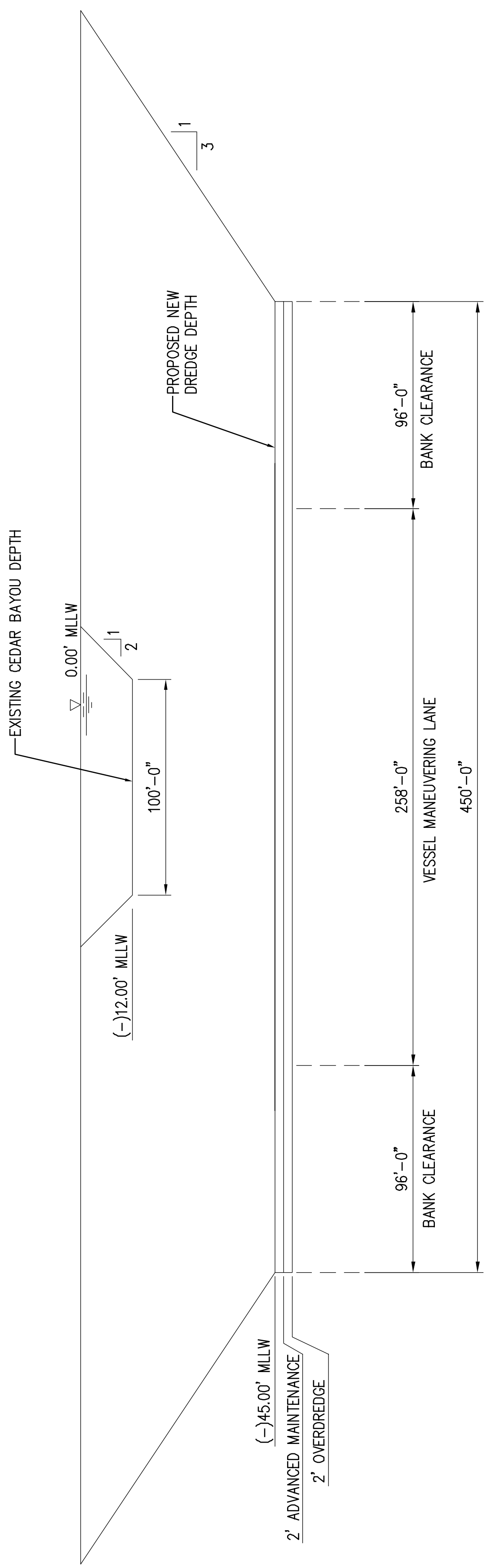
CEDAR BAYOU DEEPENING
CEDAR BAYOU TEXAS

CEDAR BAYOU DEEPENING
TYPICAL CHANNEL CROSS-SECTION
ONE-WAY TRAFFIC, BEAM = 106'

DATE	NOV '19
DESIGN	CSG
DRAWN	ADG
CHECK	DLC
JOB NO	11047
SHEET No.	1 OF 2

DRAFT



TYPICAL CHANNEL CROSS-SECTION

SCALE: HORIZONTAL 1"=40'
VERTICAL 1"=20'

NOTES:

1. ALL ELEVATIONS IN MLLW U.N.O.
2. DESIGN VESSEL WIDTH B=160'
3. BANK CLEARANCE~0.6B
4. VESSEL MANEUVERING LANE~1.6B
5. TIDES PER NOAA GAGE AT MORGANS POINT:
   - MLLW = 0.00'
   - MEAN TIDE = (+)0.67'
   - MHW = (+)1.23'
   - MHHW = (+)1.31'

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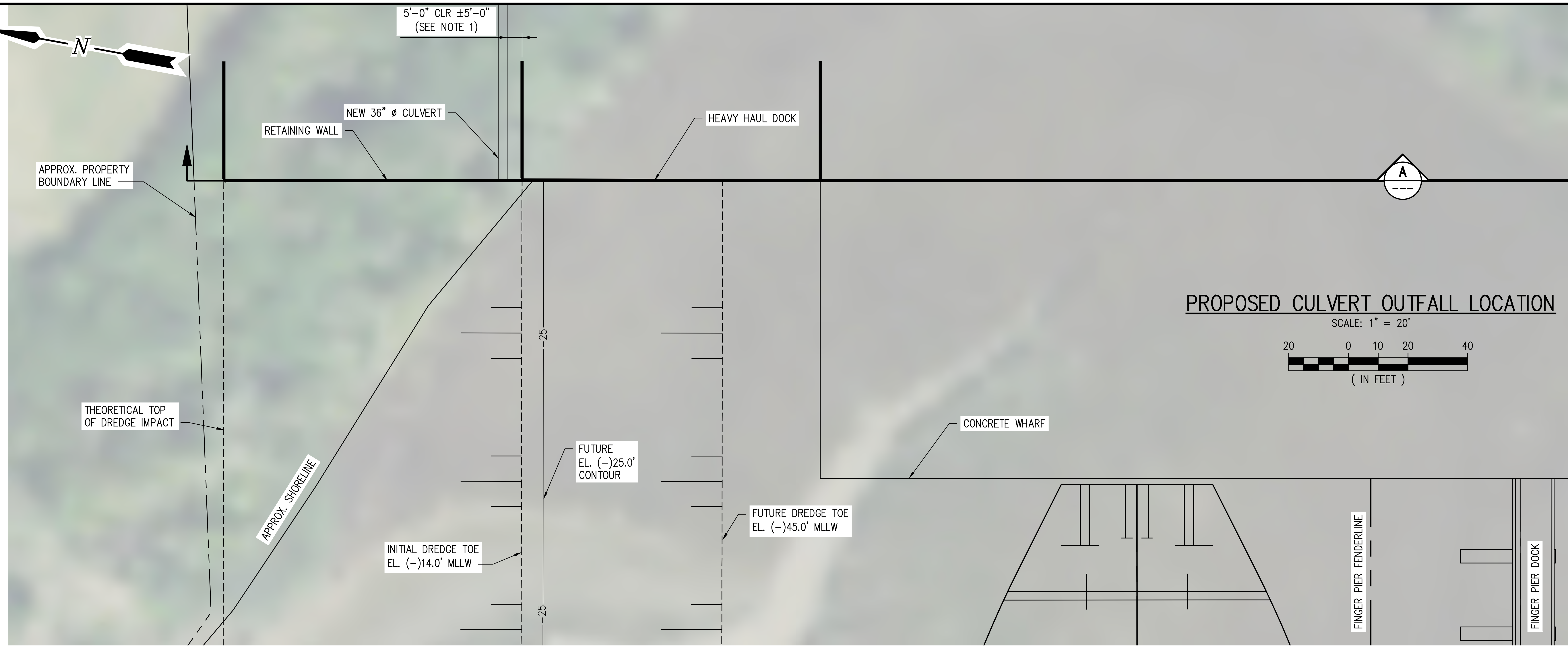
CEDAR BAYOU DEEPENING
CEDAR BAYOU TEXAS

CEDAR BAYOU DEEPENING
TYPICAL CHANNEL CROSS-SECTION
ONE-WAY TRAFFIC, BEAM = 160'

DATE	NOV '19
DESIGN	CSG
DRAWN	ADG
CHECK	DLC
JOB NO	11047
SHEET No.	2 OF 2

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\03 - PERMITS\11612-X2.DWG

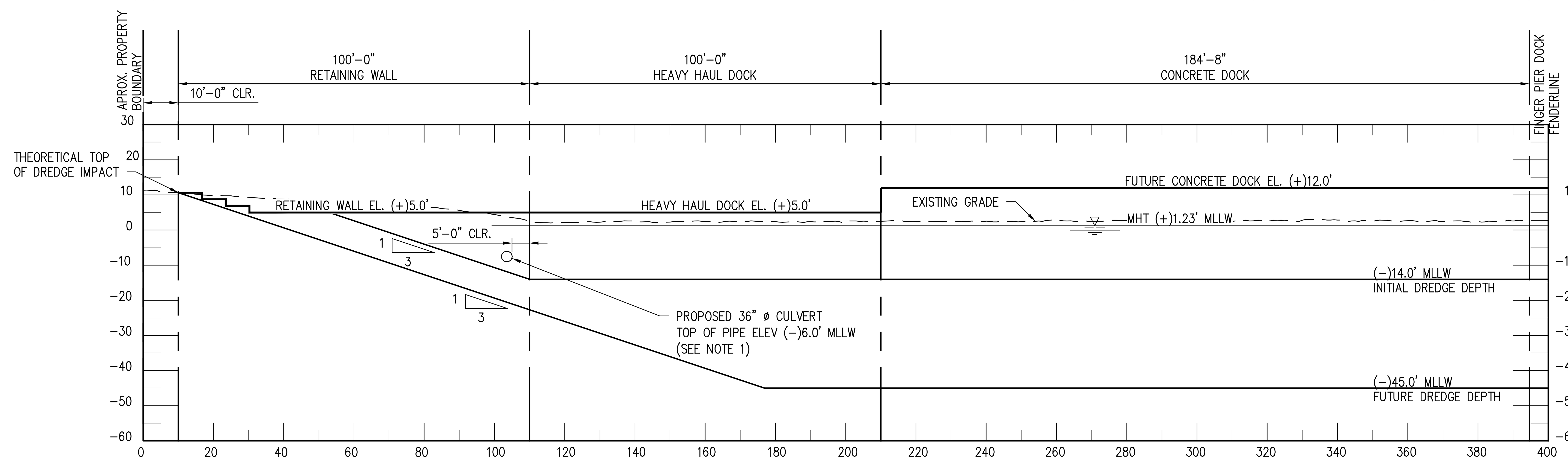
DRAFT



PROPOSED CULVERT OUTFALL LOCATION

SCALE: 1" = 20'

(IN FEET)



PROPOSED OUTFALL CULVERT SECTION (A)

SCALE: 1" = 20'

NOTES:

1. CULVERT OUTFALL LOCATION DEPENDENT ON RETAINING WALL TIE BACK.

PRELIMINARY
MARCH 1, 2021

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\CIVIL\11612-C4.DWG

CEDAR PORT INDUSTRIAL PARK

TGS

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SCALE NOTED
DESIGN *
DRAWN PJC
CHECK *
APPR'D CSG
CAD NO 11612-C2

CHAMBERS COUNTY IMPROVEMENT DISTRICT #1
CEDAR BAYOU TEXAS

CEDAR BAYOU
DEEPENING PERMIT
PROPOSED CULVERT OUTFALL LOCATION

11612-20
SHEET NO.
C4

DRAFT

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\CIVIL\11612-C1A.DWG

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SCALE NOTED
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DRAWN PJC
CHECK *
APPR'D CSG
CAD NO 11612-C1A

CHAMBERS COUNTY IMPROVEMENT DISTRICT #1
CEDAR BAYOU TEXAS

CEDAR BAYOU DEEPENING PERMIT
OVERALL SITE PLAN AND DRAWING INDEX

11612-21
SHEET NO.
C1A

DRAFT

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\CIVIL\11612-C1B.DWG

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DATE MAR. '21
SCALE NOTED
DESIGN *
DRAWN PJC
CHECK *
APPR'D CSG
CAD NO 11612-C1B

CHAMBERS COUNTY IMPROVEMENT DISTRICT #1
CEDAR BAYOU TEXAS

CEDAR BAYOU
DEEPENING PERMIT
EXISTING CONTOURS

11612-21
SHEET NO.
C1B

DRAFT

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\CIVIL\11612-C1C.DWG

CEDAR PORT INDUSTRIAL PARK TGS

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DATE MAR. '21
SCALE NOTED
DESIGN *
DRAWN PJC
CHECK *
APPR'D CSG
CAD NO 11612-C1B

CHAMBERS COUNTY IMPROVEMENT DISTRICT #1
CEDAR BAYOU TEXAS

CEDAR BAYOU
DEEPENING PERMIT
EXISTING CONTOURS

11612-21
SHEET NO.
C1C

DRAFT

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\CIVIL\11612-C1D.DWG

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DATE MAR. '21
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DESIGN *
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CHECK *
APPR'D CSG
CAD NO 11612-C1B

CHAMBERS COUNTY IMPROVEMENT DISTRICT #1
CEDAR BAYOU TEXAS

CEDAR BAYOU
DEEPENING PERMIT
EXISTING CONTOURS

11612-21
SHEET NO.
C1D

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\CIVIL\11612-C1E.DWG

CEDAR PORT INDUSTRIAL PARK TGS

LANIER & associates CONSULTING ENGINEERS, INC
FIRM F-2981
LA: C-1120

REV	DATE	BY	DESCRIPTION	REV	DATE	BY	DESCRIPTION

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DATE MAR. '21
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DESIGN *
DRAWN PJC
CHECK *
APPR'D CSG
CAD NO 11612-C1B

CHAMBERS COUNTY IMPROVEMENT DISTRICT #1
CEDAR BAYOU TEXAS

CEDAR BAYOU DEEPENING PERMIT EXISTING CONTOURS

11612-21
SHEET NO.
C1E

APPENDIX B

BORING LOCATION PLANS

VICINITY MAP

DRAFT

FIELD PROGRAM COORDINATES

ITEM	DEPTH	LATITUDE	LONGITUDE
MB-1*	50'	29° 41' 15.00" N	94° 58' 49.90" W
MB-2	50'	29° 41' 09.90" N	94° 58' 34.70" W
SS/MB-3	50'	29° 41' 15.50" N	94° 58' 18.10" W
MB-4	50'	29° 41' 18.90" N	94° 58' 00.00" W
SS/MB-5*	50'	29° 41' 10.90" N	94° 57' 39.30" W
MB-6	50'	29° 41' 01.20" N	94° 57' 18.30" W
SS/MB-7*	50'	29° 40' 50.93" N	94° 56' 56.29" W
MB-8	50'	29° 40' 40.90" N	94° 56' 34.60" W
SS/MB-9*	50'	29° 40' 28.10" N	94° 56' 16.70" W
MB-10	200'	29° 40' 19.60" N	94° 55' 56.40" W

LEGEND

SYMBOL	DESCRIPTION
(red symbol)	TEST BORING LOCATION
(blue symbol)	TEST BORING W/ SEDIMENT SAMPLING LOCATION
*	ENVIRONMENTAL/ANALYTICAL SAMPLING LOCATION

Tolunay-Wong Engineers, Inc.

FIELD PROGRAM LOCATION PLAN
CEDAR BAYOU DEEPENING/WIDENING
CHAMBERS COUNTY IMPROVEMENTS DISTRICT #1
CHAMBERS COUNTY, TEXAS

Drawn	B.V.	03-16-2021
Checked	T.O.	06-04-2021
Approved	T.G.H.	06-04-2021
Scale	N.T.S.	

TWE DRAWING NO. 21.23.029-1

VICINITY MAP

DRAFT

FIELD PROGRAM COORDINATES

ITEM	DEPTH	LATITUDE	LONGITUDE
LB–1	120'	29° 40' 08.40" N	94° 55' 34.50" W
LB–2	200'	29° 40' 03.40" N	94° 55' 35.60" W
LB–3	25'	29° 40' 00.70" N	94° 55' 27.40" W

LEGEND

SYMBOL	DESCRIPTION
⊕	TEST BORING LOCATION

Tolunay-Wong Engineers, Inc.

FIELD PROGRAM LOCATION PLAN
CEDAR BAYOU DEEPENING/WIDENING
CHAMBERS COUNTY IMPROVEMENTS DISTRICT #1
CHAMBERS COUNTY, TEXAS

Drawn	*B.V.*	*03–09–2021*
Checked	*T.O.*	*06–04–2021*
Approved	*T.G.H.*	*06–04–2021*
Scale	*N.T.S.*	

TWE DRAWING NO. *21.23.029–2*

DRAFT

APPENDIX C

BORING LOGS AND CROSS-SECTIONAL
SUBSURFACE PROFILES

LOG OF BORING MB-1

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 41' 15.00" W 94° 58' 49.90"

SURFACE ELEVATION: -4.0'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
Gray CLAYEY SAND (SC)			31								36	
Very soft gray ORGANIC CLAY (OH), with sand seams	(T)0.10		126		52	31					90	
Soft gray FAT CLAY (CH), with shell fragments	(T)0.10		29	113				0.50	12	11		
Very soft gray LEAN CLAY (CL), with shell fragments		WOH	27		31	16						
Gray POORLY GRADED SAND with SILT (SP-SM)			24								7	
-becomes loose at 18.5'		1/6" 2/6" 3/6"										
Loose gray POORLY GRADED SAND (SP)		2/6" 2/6" 4/6"	20								1	
		1/6" 3/6" 2/6"	21								3	
Stiff, gray and tan LEAN CLAY (CL)		5/6" 6/6" 5/6"			47	29						

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/16/2021
DATE BORING COMPLETED: 03/16/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: Depth to mudline measurement not obtained. WOH: Weight of Hammer.

LOG OF BORING MB-1

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 41' 15.00" W 94° 58' 49.90"
SURFACE ELEVATION: -4.0'
DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

DEPTH (FT)	ELEVATION (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
35	-39	Stiff, gray and tan LEAN CLAY (CL)												
38	-42	-becomes very stiff at 38'	(P)3.25											
43	-47	Gray and tan CLAYEY SAND (SC), with calcareous nodules			19	125	28	9					35	
48.5	-52.5	Brown and gray LEAN CLAY (CL), with calcareous nodules and sand pockets			17		45	25						
50	-54	Bottom @ 50'												

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/16/2021
DATE BORING COMPLETED: 03/16/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: Depth to mudline measurement not obtained. WOH: Weight of Hammer.

Tolunay-Wong Engineers, Inc.

LOG OF BORING MB-2

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 41' 09.90"
W 94° 58' 34.70"

SURFACE ELEVATION: -9.2'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
Very soft gray SANDY FAT CLAY (CH)		WOH	59		67	40					70	
Very loose gray SILTY SAND (SM), with clay pockets		WOH	30								21	
Soft gray FAT CLAY (CH)	(T)0.15		62	72	70	38		0.27	7	9		
-becomes very soft at 9'	(T)0.08		70									
Very loose gray POORLY GRADED SAND (SP), with shell fragments		WOH	21								4	
		WOH										
		WOH	23								4	
Stiff, gray and tan SANDY LEAN CLAY (CL) -with ferrous nodules from 23.5' to 25'		WOH 4/6" 5/6"	26		47	26						
-becomes very stiff at 28.5' -with calcareous nodules from 28.5' to 40'		10/6" 11/6" 14/6"	15		39	26						
-hard from 30' to 32' -with ferrous nodules from 30' to 40'	(P)4.50		19								68	
	(P)4.50		13	119	33	19		3.12	15	28		

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/16/2021
DATE BORING COMPLETED: 03/16/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 9.2-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer.

LOG OF BORING MB-2

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 41' 09.90"
W 94° 58' 34.70"

SURFACE ELEVATION: -9.2'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-44.2	35	Very stiff, gray and tan SANDY LEAN CLAY (CL)												
	38	-becomes hard, brown and gray at 38'	(P)4.50											
	43.5	Very stiff, brown and gray FAT CLAY (CH), with calcareous and ferrous nodules		6/6" 8/6" 11/6"										
	48		(P)4.50		20	110	54	38		3.23	15	41		
-59.2	50	Bottom @ 50'												

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/16/2021
DATE BORING COMPLETED: 03/16/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 9.2-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer.

LOG OF BORING MB-3

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 41' 15.50"
W 94° 58' 18.10"

SURFACE ELEVATION: -2.0'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
Very soft gray FAT CLAY (CH)	(T)0.03											
-with shell fragments from 3' to 5' -with sand seams from 3' to 11'	(T)0.06		71	56				0.08	8	4		
	(T)0.04		72		72	41					86	
	(T)0.09											
Very soft gray ORGANIC CLAY (OH)												
	(T)0.10		91		119	71					99	
	(T)0.08		97	47				0.13	15*	12		
	(T)0.12		98		124	79						
-with sand seams from 23' to 25'	(T)0.12		97		119	74					97	
Firm gray SANDY LEAN CLAY (CL)		3/6" 3/6" 5/6"	23								65	
-becomes stiff at 33.5'		3/6" 6/6" 7/6"	22		44	28						

ELEVATION (FT): 0, -5, -10, -15, -20, -25, -30, -35
DEPTH (FT): 0, 5, 10, 15, 20, 25, 30, 35

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/18/2021
DATE BORING COMPLETED: 03/18/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 2.0-ft beneath the water surface at the time of drilling.

Tolunay-Wong Engineers, Inc.

LOG OF BORING MB-3

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 41' 15.50"
W 94° 58' 18.10"

SURFACE ELEVATION: -2.0'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

ELEVATION (FT) / DEPTH (FT)	SAMPLE TYPE	SYMBOL	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
35			Stiff gray SANDY LEAN CLAY (CL)												
-40 / 40			Medium dense gray POORLY GRADED SAND with SILT (SP-SM)		4/6" 5/6" 6/6"	20								9	
-45 / 45			Very stiff, brown and gray FAT CLAY (CH) -with sand partings from 43' to 45'	(P)4.50		24	96	82	52		2.92	5 *	33		
-50				(P)3.25		21									
50			Bottom @ 50'												
-55 / 55 / -60 / 60 / -65 / 65 / -70 / 70															

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/18/2021
DATE BORING COMPLETED: 03/18/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 2.0-ft beneath the water surface at the time of drilling.

LOG OF BORING MB-4

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 41' 18.90"
W 94° 58' 00.00"

SURFACE ELEVATION: -6.5'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
Very soft gray FAT CLAY with SAND (CH)	(T)0.05		70		65	42					84	
Very soft gray ORGANIC CLAY with SAND (OH)	(T)0.07		101									
Gray CLAYEY SAND (SC)			16		40	15					30	
Soft gray FAT CLAY (CH) -with sand pockets from 9' to 20' -with shell fragments from 9' to 25'	(T)0.11		85					0.34	12	10		
	(T)0.15		76								95	
	(T)0.16		78		78	58						
	(T)0.13											
	(T)0.15		76		77	32						
	(T)0.15											
Gray SILTY CLAYEY SAND (SC-SM)			22		23	7					46	

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/15/2021
DATE BORING COMPLETED: 03/15/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 6.5-ft beneath the water surface at the time of drilling.WOH: Weight of Hammer.

LOG OF BORING MB-4

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 41' 18.90"
W 94° 58' 00.00"

SURFACE ELEVATION: -6.5'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

ELEVATION (FT)	DEPTH (FT)	SAMPLE TYPE	SYMBOL	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	35			Gray SILTY CLAYEY SAND (SC-SM)												
-45	40															
-50	45			Soft gray LEAN CLAY with SAND (CL)	(T)0.15		24								71	
-55	50			Loose gray SILTY SAND (SM)		7/6" 5/6" 4/6"	21								32	
				Bottom @ 50'												
-60	55															
-65	60															
-70	65															
-75	70															

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/15/2021
DATE BORING COMPLETED: 03/15/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 6.5-ft beneath the water surface at the time of drilling.WOH: Weight of Hammer.

LOG OF BORING MB-5

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 41' 10.90" W 94° 57' 39.30"
SURFACE ELEVATION: -8.0'
DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
0	Very soft gray FAT CLAY (CH), with shell fragments	(T)0.05				63	41						
	Very soft gray SANDY FAT CLAY (CH), with shell fragments	(T)0.05		38								56	
	Very soft gray FAT CLAY (CH), with shell fragments	(T)0.09											
	Gray CLAYEY SAND (SC)	(T)0.10		38		122	83					40	
	Firm gray SANDY FAT CLAY (CH), with shell fragments	(P)0.50		25	101				0.56	12	13		
	Very soft gray FAT CLAY (CH)		WOH	57		67	36						
	-with shell fragments from 18' to 35'	(T)0.12											
	-becomes soft at 23'	(T)0.20		53		74	37						
		(T)0.13											
35		(T)0.15											

ELEVATION (FT) scale: -10, -15, -20, -25, -30, -35, -40; DEPTH (FT) scale: 0, 5, 10, 15, 20, 25, 30, 35

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/16/2021
DATE BORING COMPLETED: 03/16/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 8.0-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer.

LOG OF BORING MB-5

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 41' 10.90"
W 94° 57' 39.30"

SURFACE ELEVATION: -8.0'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	35	Soft gray FAT CLAY (CH)												
-45														
			(T)0.15		48		81	39						
	40													
-50														
				1/6" 2/6" 2/6"										
	45													
-55														
		Medium dense gray SILTY SAND (SM)		3/6" 6/6" 12/6"	28			NP					40	
	50	Bottom @ 50'												
-60														
	55													
-65														
	60													
-70														
	65													
-75														
	70													

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/16/2021
DATE BORING COMPLETED: 03/16/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 8.0-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer.

LOG OF BORING MB-6

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 41' 10.90" W 94° 57' 39.30"

SURFACE ELEVATION: -4.3'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

ELEVATION (FT): -5, -10, -15, -20, -25, -30, -35

DEPTH (FT): 0, 5, 10, 15, 20, 25, 30, 35

MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
Very soft gray FAT CLAY (CH)	(T)0.05		71		67	37						
Very soft gray SANDY FAT CLAY (CH)	(T)0.07		49								65	
Very soft gray CLAYEY SAND (SC), with shell fragments		WOH	40								46	
Very soft gray SANDY LEAN CLAY (CL)	(T)0.10		32		36	21						
-with shell fragments from 12' to 25'	(T)0.06		31								52	
-becomes soft at 15'	(T)0.12		41		46	27						
	(T)0.13											
-with ferrous nodules from 23' to 33'	(T)0.17		32		38	21						
	(T)0.15		41	86				0.45	14	22		
Firm gray FAT CLAY with SAND (CH), with ferrous nodules	(P)1.00		40		50	28					76	

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/14/2021
DATE BORING COMPLETED: 03/14/2021
LOGGER: S. Cortinas
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 4.3-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer.

LOG OF BORING MB-6

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 41' 10.90" W 94° 57' 39.30"
SURFACE ELEVATION: -4.3'
DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

ELEVATION (FT)	DEPTH (FT)	SAMPLE TYPE	SYMBOL	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-40	35			Firm gray FAT CLAY with SAND (CH), with ferrous nodules												
				Loose gray SILTY SAND (SM)		1/6" 2/6" 3/6"	25								15	
-45	40															
				-becomes medium dense at 43.5'		4/6" 6/6" 7/6"										
-50	45															
				Medium dense gray POORLY GRADED SAND with SILT (SP-SM		6/6" 7/6" 8/6"	20								7	
-55	50			Bottom @ 50'												
-60	55															
-65	60															
-70	65															
	70															

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/14/2021
DATE BORING COMPLETED: 03/14/2021
LOGGER: S. Cortinas
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 4.3-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer.

LOG OF BORING MB-7

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 40' 51.10"
W 94° 56' 56.80"

SURFACE ELEVATION: -7.0'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

ELEVATION (FT): -10, -15, -20, -25, -30, -35, -40
DEPTH (FT): 0, 5, 10, 15, 20, 25, 30, 35

MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
Gray CLAYEY SAND (SC)			41								40	
Very soft gray LEAN CLAY (CL)		WOH										
-with shell fragments from 6' to 8'	(T)0.08		41		46	25						
Firm, brown and gray FAT CLAY (CH)		1/6" 2/6" 3/6"										
-stiff from 12' to 14'	(P)1.75		35		66	38						
	(P)2.75		38	86				0.96	15*	13		
-becomes stiff at 18' -with calcareous nodules from 18' to 20'	(P)1.75		34		95	65						
-with shell fragments from 23' to 25'	(P)2.00		42	80				1.25	11	22		
-becomes gray at 28' -with calcareous nodules from 28' to 30'	(P)2.00											
-becomes very stiff at 33' -with sand pockets from 33' to 35'	(P)3.50		22		61	39					88	

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/17/2021
DATE BORING COMPLETED: 03/17/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 7.0-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer.

LOG OF BORING MB-7

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 40' 51.10"
W 94° 56' 56.80"

SURFACE ELEVATION: -7.0'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	35	Very stiff gray FAT CLAY (CH), with sand pockets												
-45		Firm gray SANDY LEAN CLAY (CL)	(P)1.50		26	102				0.67	11	34	54	
-50		Medium dense gray SILTY SAND (SM)		5/6" 10/6" 15/6"										
				5/6" 7/6" 11/6"	23								41	
	50	Bottom @ 50'												

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/17/2021
DATE BORING COMPLETED: 03/17/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 7.0-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer.

Tolunay-Wong Engineers, Inc.

LOG OF BORING MB-8 DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 40' 40.90"
W 94° 56' 34.60"

SURFACE ELEVATION: -7.1'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
Very soft gray FAT CLAY (CH), with shell fragments	(T)0.05		91		99	56						
Very soft gray LEAN CLAY (CL), with shell fragments and sand pockets	(T)0.10		24		38	20						
-becomes firm, gray and tan at 6'	(T)0.08		19	118				0.61	11	8		
Very loose gray POORLY GRADED SAND with SILT (SP-SM)		WOH	28								11	
Firm, gray and brown FAT CLAY (CH) -slickensided with calcareous and ferrous nodules from 12.5' to 14'		2/6" 2/6" 6/6"	32		73	35						
-becomes very stiff at 15' -brown and red with silt pockets from 15' to 17'	(P)3.00											
-slickensided with ferrous nodules from 18' to 35'	(P)2.75		39	84	102	46		2.41	15**	16		
-stiff from 23' to 25'	(P)2.75											
-becomes gray and tan at 28'	(P)3.00											
-becomes stiff and gray at 33' -with wood fragments from 33' to 35'	(P)2.50		32		85	42						

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/14/2021
DATE BORING COMPLETED: 03/14/2021
LOGGER: S. Cortinas
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 7.1-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer.

LOG OF BORING MB-8

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 40' 40.90"
W 94° 56' 34.60"

SURFACE ELEVATION: -7.1'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

ELEVATION (FT)	DEPTH (FT)	SAMPLE TYPE	SYMBOL	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	35			Stiff gray FAT CLAY (CH)												
-45																
	40			Medium dense gray POORLY GRADED SAND with SILT (SP-SM)		6/6" 9/6" 13/6"										
-50				-becomes dense at 43.5'		10/6" 19/6" 28/6"	21								8	
	45															
-55				Dense gray POORLY GRADED SAND (SP)		15/6" 18/6" 24/6"	18								4	
	50			Bottom @ 50'												
-60	55															
-65	60															
-70	65															
-75	70															

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/14/2021
DATE BORING COMPLETED: 03/14/2021
LOGGER: S. Cortinas
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 7.1-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer.

LOG OF BORING MB-9

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 40' 28.10"
W 94° 56' 16.70"

SURFACE ELEVATION: -10.4'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

Depth (ft)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
0	Very soft gray FAT CLAY (CH)		WOP			66	39						
3	-with shell fragments from 3' to 8'	(T)0.06		79	53	59	34		0.16	14	7		
6		(T)0.12											
9		(T)0.10		80		106	67						
12	-very stiff from 12' to 14' -becomes brown and gray at 12'	(P)3.00											
15	-firm from 15' to 17'	(P)1.25		30	95	57	32		0.85	15**	16		
18	-very stiff from 18' to 20'	(P)3.25											
23	-becomes stiff at 23'	(P)1.75		43		102	70						
28	-slickensided from 28' to 30'	(P)2.25		36	87				1.73	5 *	27		
33	Firm gray SANDY FAT CLAY (CH)	(T)0.40		30								68	

Elevation scale (ft): -15 at 5 ft depth, -20 at 10, -25 at 15, -30 at 20, -35 at 25, -40 at 30, -45 at 35.

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/17/2021
DATE BORING COMPLETED: 03/17/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 10.4-ft beneath the water surface at the time of drilling. WOP: Weight of Pipe.

LOG OF BORING MB-9

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 40' 28.10"
W 94° 56' 16.70"

SURFACE ELEVATION: -10.4'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 50'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	35	Firm gray SANDY FAT CLAY (CH)												
-50	40	Medium dense gray POORLY GRADED SAND with SILT (SP-SM)		6/6" 7/6" 7/6"	23								12	
-55	45			7/6" 9/6" 14/6"										
-60	50	Dense gray POORLY GRADED SAND (SP)		11/6" 13/6" 20/6"	21								4	
		Bottom @ 50'												
-65	55													
-70	60													
-75	65													
-80	70													

COMPLETION DEPTH: 50 ft
DATE BORING STARTED: 03/17/2021
DATE BORING COMPLETED: 03/17/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 10.4-ft beneath the water surface at the time of drilling. WOP: Weight of Pipe.

LOG OF BORING MB-10

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 40' 19.60" W 94° 55' 56.40"
SURFACE ELEVATION: -9.8'
DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 200'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-10	0													
		Very soft, gray and tan FAT CLAY (CH) -with ferrous nodules from 0' to 2'		WOH	63		60	32						
		-becomes soft at 3' -with sand pockets from 3' to 5'	(T)0.13		60	71				0.40	12	7	99	
-15	5													
		Very soft gray LEAN CLAY (CL) -with shell fragments from 6.5' to 8' -no recovery with shelby tube from 6' to 8'		WOP	43		46	19						
		-no recovery with shelby tube from 9' to 11'		WOH										
-20	10													
		-becomes soft at 12' -with shell fragments from 12' to 17'	(T)0.12		44	74	48	17		0.28	11	13		
-25	15													
			(T)0.17											
		Firm gray FAT CLAY (CH), with sand pockets	(T)0.30		37		63	17					90	
-30	20													
		-with ferrous nodules from 23' to 30'	(T)0.38		66	77				0.64	15	21		
-35	25													
			(T)0.35		61		85	39						
-40	30													
		Firm gray SANDY FAT CLAY (CH), with ferrous nodules	(T)0.35		65								67	
	35													

COMPLETION DEPTH: 200 ft
DATE BORING STARTED: 03/12/2021
DATE BORING COMPLETED: 03/14/2021
LOGGER: S. Cortinas
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 9.8-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer. WOP: Weight of Pipe.

LOG OF BORING MB-10

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 40' 19.60"
W 94° 55' 56.40"

SURFACE ELEVATION: -9.8'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 200'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-45	35	Firm gray SANDY FAT CLAY (CH), with ferrous nodules												
		Gray SANDY SILT (ML), with ferrous nodules	(P)1.25		42	80	42	11		0.77	15**	31	69	
-50	40													
			(P)4.25											
-55	45													
		Gray CLAYEY SAND (SC), with ferrous nodules			18		30	16					48	
-60	50													
		Stiff gray FAT CLAY (CH), with ferrous nodules	(P)2.00		55	71	99	60		1.39	11	44		
-65	55													
		Dense gray POORLY GRADED SAND (SP)		6/6" 10/6" 25/6"	18								2	
-70	60													
		-becomes very dense at 63.5'		29/6" 31/6" 34/6"										
-75	65													
		-becomes medium dense at 68.5'		5/6" 10/6" 18/6"	17								3	
	70													

COMPLETION DEPTH: 200 ft
DATE BORING STARTED: 03/12/2021
DATE BORING COMPLETED: 03/14/2021
LOGGER: S. Cortinas
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 9.8-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer. WOP: Weight of Pipe.

LOG OF BORING MB-10

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 40' 19.60"
W 94° 55' 56.40"

SURFACE ELEVATION: -9.8'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 200'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-80		Medium dense gray POORLY GRADED SAND (SP)												
		Dense gray CLAYEY SAND (SC)		12/6" 15/6" 18/6"	22								20	
-85	75													
		Very stiff, brown and gray FAT CLAY (CH), with ferrous nodules -with calcareous nodules from 78.5' to 85'		5/6" 10/6" 14/6"	25		63	44						
-90	80													
		-slickensided from 83' to 85'	(P)4.25											
-95	85													
		-becomes gray and tan at 88' -with sand pockets from 88' to 105'	(P)4.50		27	104	56	36		3.81	11	73		
-100	90													
		-becomes hard and slickensided at 93' -with calcareous nodules from 93' to 95'	(P)4.50											
-105	95													
		-becomes gray at 98'	(P)4.50		24		55	38						
-110	100													
		-becomes brown and gray at 103'	(P)4.50		23								99	
	105													

COMPLETION DEPTH: 200 ft
DATE BORING STARTED: 03/12/2021
DATE BORING COMPLETED: 03/14/2021
LOGGER: S. Cortinas
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 9.8-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer. WOP: Weight of Pipe.

LOG OF BORING MB-10

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 40' 19.60" W 94° 55' 56.40"
SURFACE ELEVATION: -9.8'
DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 200'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-115		Hard, brown and gray FAT CLAY (CH), slickensided												
		Very stiff gray LEAN CLAY (CH), with ferrous nodules and sand seams	(P)4.50		18	105	36	22		3.86	15**	81		
-120	110													
			(P)3.25		22								95	
-125	115													
		Very stiff gray FAT CLAY (CH), with ferrous nodules and shell fragments	(P)3.00		34	103				3.29	15**	98		
-130	120													
-135	125													
		-with sand seams from 128' to 130'	(P)3.50		32		66	41						
-140	130													
-145	135													
		Very stiff gray LEAN CLAY (CL), with calcareous nodules -with sand seams from 138' to 140'	(P)3.75		25		46	27						
	140													

COMPLETION DEPTH: 200 ft
DATE BORING STARTED: 03/12/2021
DATE BORING COMPLETED: 03/14/2021
LOGGER: S. Cortinas
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 9.8-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer. WOP: Weight of Pipe.

LOG OF BORING MB-10

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 40' 19.60"
W 94° 55' 56.40"

SURFACE ELEVATION: -9.8'

DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 200'

ELEVATION (FT)	DEPTH (FT)	SAMPLE TYPE	SYMBOL	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-150				Very stiff gray LEAN CLAY (CL), with calcareous nodules												
-155	145															
				-becomes stiff at 148' -with ferrous nodules from 148' to 150'	(P)2.25		26	106				1.61	15*	110		
-160	150															
-165	155															
				Very stiff gray FAT CLAY (CH), with organics, wood fragments and sand pockets		8/6" 10/6" 15/6"	46		61	22						
-170	160															
-175	165															
				Very stiff, brown and gray LEAN CLAY (CL), with ferrous nodules and sand pockets	(P)4.25											
-180	170															
	175															

COMPLETION DEPTH: 200 ft
DATE BORING STARTED: 03/12/2021
DATE BORING COMPLETED: 03/14/2021
LOGGER: S. Cortinas
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 9.8-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer. WOP: Weight of Pipe.

LOG OF BORING MB-10

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 40' 19.60" W 94° 55' 56.40"
SURFACE ELEVATION: -9.8'
DRILLING METHOD:
Dry Augered: - to -
Wash Bored: 0' to 200'

ELEVATION (FT)	DEPTH (FT)	SAMPLE TYPE	SYMBOL	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-185				Very stiff, brown and gray LEAN CLAY (CL), with ferrous nodules and sand pockets												
-190	180			Brown and gray SILT (ML)		7/6" 11/6" 14/6"	32		35	9					95	
-195	185															
-200	190			Very stiff gray FAT CLAY (CH), with ferrous nodules -no recovery with Shelby tube from 188' to 190'		8/6" 9/6" 10/6"										
-205	195															
-210	200			Very dense gray CLAYEY SAND (SC)		30/6" 41/6" 50/5.5"	23								29	
				Bottom @ 200'												
-215	205															
	210															

COMPLETION DEPTH: 200 ft
DATE BORING STARTED: 03/12/2021
DATE BORING COMPLETED: 03/14/2021
LOGGER: S. Cortinas
PROJECT NO.: 21.23.029

NOTES: The depth to mudline at the boring location was approximately 9.8-ft beneath the water surface at the time of drilling. WOH: Weight of Hammer. WOP: Weight of Pipe.

LOG OF BORING LB-1

DRAFT

PROJECT: Cedar Bayou Deepening and Widening, Chambers County, Texas
CLIENT: Trans - Global Solutions, Inc., Beaumont, Texas

COORDINATES: N 29° 40' 08.40" W 94° 55' 34.50"
SURFACE ELEVATION: 10.0'
DRILLING METHOD:
Dry Augered: 0' to 17'
Wash Bored: 17' to 120'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
10	0	Stiff, brown and tan FAT CLAY (CH) -with ferrous nodules from 0' to 5'	(P)2.25		24		73	48						
		-becomes tan and gray at 3' -with calcareous nodules from 3' to 11'	(P)2.25		24	103				1.56	15*	3		
5	5	-becomes very stiff at 6' -slickensided from 6' to 8'	(P)3.25		27		79	50						CON
			(P)3.00		25		72	46						
0	10	Stiff, tan and gray LEAN CLAY (CL) -with calcareous nodules from 12' to 14'	(P)2.25		22								95	
-5	15	-becomes firm at 15' -with sand seams from 15' to 17'	(P)1.25		26	101	31	12		0.93	15*	13		
				2/6" 2/6" 3/6"	31								96	
-10	20													
		Very stiff, tan and gray FAT CLAY (CH) -slickensided from 23' to 45'	(P)3.25		27		75	49						
-15	25													
		-becomes brown and tan at 28' -with calcareous nodules from 28' to 30'	(P)3.50		34									CON
-20	30													
			(P)4.00		28		79	50						
-25	35													

COMPLETION DEPTH: 120 ft
DATE BORING STARTED: 03/29/2021
DATE BORING COMPLETED: 03/30/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: Free Water Depth = 17.0-ft. 15-min Static Water Depth = 7.7-ft. 15-min Total Hole Depth = 16.0-ft. Borehole was backfilled with cement-bentonite grout. CON: One-Dimensional Consolidation.

LOG OF BORING LB-1

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 40' 08.40"
W 94° 55' 34.50"

SURFACE ELEVATION: 10.0'

DRILLING METHOD:
Dry Augered: 0' to 17'
Wash Bored: 17' to 120'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-25	35	Very stiff, brown and tan FAT CLAY (CH)												
		-hard from 38' to 45'	(P)4.50											
-30	40													
			(P)4.25		26	95				4.29	7	37		
-35	45													
			(P)4.00		35		89	60						CON
-40	50													
		-becomes gray and brown at 53'	(P)2.75											
-45	55													
			(P)2.50		30	94				2.35	10	49		
-50	60													
			(P)2.50		32		78	55						
-55	65													
		Very dense, gray and tan POORLY GRADED SAND with SILT (SP-SM)		14/6" 21/6" 34/6"	20								5	
-60	70													

COMPLETION DEPTH: 120 ft
DATE BORING STARTED: 03/29/2021
DATE BORING COMPLETED: 03/30/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: Free Water Depth = 17.0-ft. 15-min Static Water Depth = 7.7-ft. 15-min Total Hole Depth = 16.0-ft. Borehole was backfilled with cement-bentonite grout. CON: One-Dimensional Consolidation.

LOG OF BORING LB-1

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 40' 08.40"
W 94° 55' 34.50"

SURFACE ELEVATION: 10.0'

DRILLING METHOD:
Dry Augered: 0' to 17'
Wash Bored: 17' to 120'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		Very dense, gray and tan POORLY GRADED SAND with SILT (SP-SM)												
		-gray from 73.5' to 80'		14/6" 22/6" 30/6"										
-65	75													
		-dense from 78.5' to 85'		11/6" 16/6" 24/6"	21								5	
-70	80													
				10/6" 19/6" 27/6"										
-75	85													
				15/6" 35/6" 48/6"	19								7	
-80	90													
		-becomes gray at 93.5' -with rock fragments from 93.5' to 95'		18/6" 37/6" 32/6"										
-85	95													
		Very stiff gray LEAN CLAY (CL), with sand pockets	(P)3.25		24		49	30					96	
-90	100													
		Very stiff gray FAT CLAY (CH), with sand pockets	(P)4.00		31	93				3.57	6	87		
-95	105													

COMPLETION DEPTH: 120 ft
DATE BORING STARTED: 03/29/2021
DATE BORING COMPLETED: 03/30/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: Free Water Depth = 17.0-ft. 15-min Static Water Depth = 7.7-ft. 15-min Total Hole Depth = 16.0-ft. Borehole was backfilled with cement-bentonite grout. CON: One-Dimensional Consolidation.

LOG OF BORING LB-1

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 40' 08.40"
W 94° 55' 34.50"

SURFACE ELEVATION: 10.0'

DRILLING METHOD:
Dry Augered: 0' to 17'
Wash Bored: 17' to 120'

DEPTH (FT)	ELEVATION (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		Very stiff gray FAT CLAY (CH), with sand pockets												
108		-stiff from 108' to 110'	(P)2.50		28		55	34					94	
110	-100													
			(P)3.50		27	98				2.66	4 *	95		
115	-105													
118.5		-becomes stiff at 118.5' -with organics from 118.5' to 120'		2/6" 3/6" 8/6"	45		92	71					90	
120	-110	Bottom @ 120'												

COMPLETION DEPTH: 120 ft
DATE BORING STARTED: 03/29/2021
DATE BORING COMPLETED: 03/30/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: Free Water Depth = 17.0-ft. 15-min Static Water Depth = 7.7-ft. 15-min Total Hole Depth = 16.0-ft. Borehole was backfilled with cement-bentonite grout. CON: One-Dimensional Consolidation.

LOG OF BORING LB-2

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 40' 03.40"
W 94° 55' 35.60"

SURFACE ELEVATION: 6.0'

DRILLING METHOD:
Dry Augered: 0' to 11'
Wash Bored: 11' to 200'

MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
Stiff, brown and gray FAT CLAY (CH)	(P)2.25		21		53	38						
-becomes gray and tan at 3' -with ferrous nodules from 3' to 8'	(P)2.00		20		60	43						
-with calcareous nodules from 6' to 8'	(P)1.50		22	103				1.04	15**	6		
Very soft, gray and tan SANDY LEAN CLAY (CL)		WOH	26								55	
-becomes soft at 12.5' -with calcareous nodules from 12.5' to 17'		1/6" 1/6" 2/6"										
-firm from 15.5' to 17'		3/6" 4/6" 3/6"										
-becomes tan at 18.5'		1/6" 2/6" 2/6"	27								57	
Stiff, gray and tan FAT CLAY with SAND (CH)		3/6" 6/6" 7/6"	29		71	49					71	
Medium dense, gray and tan SILTY SAND (SM)		3/6" 7/6" 10/6"	26								36	
Very stiff, gray and tan SANDY LEAN CLAY (CL)		2/6" 4/6" 12/6"	31								70	

ELEVATION (FT): 5, 0, -5, -10, -15, -20, -25
DEPTH (FT): 0, 5, 10, 15, 20, 25, 30, 35

COMPLETION DEPTH: 200 ft
DATE BORING STARTED: 03/30/2021
DATE BORING COMPLETED: 04/01/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: Free Water Depth = 11.0-ft. 15-min Static Water Depth = 7.3-ft. 15-min Total Hole Depth = 8.0-ft. Borehole was backfilled with cement-bentonite grout. CON: One-Dimensional Consolidation. WOH: Weight of Hammer.

LOG OF BORING LB-2

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 40' 03.40"
W 94° 55' 35.60"

SURFACE ELEVATION: 6.0'

DRILLING METHOD:
Dry Augered: 0' to 11'
Wash Bored: 11' to 200'

DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
35	Very stiff, gray and tan SANDY LEAN CLAY (CL)												
38	Very stiff, brown and gray FAT CLAY (CH) -slickensided from 38' to 40'	(P)4.50		27	96				3.00	3 *	33		
43		(P)4.00		38		100	65						
48	-becomes gray and tan at 48'	(P)3.00		41		108	64						
53	-slickensided from 53' to 55'	(P)2.75		41	82				2.91	3 *	45		
58	Gray CLAYEY SAND (SC)	(P)2.75		20		35	19					32	
63	Dense gray POORLY GRADED SAND with SILT (SP-SM)		10/6" 20/6" 26/6"	21								6	
68			8/6" 12/6" 21/6"										

Depth scale (FT): 35, 40, 45, 50, 55, 60, 65, 70
Elevation scale (FT): -30, -35, -40, -45, -50, -55, -60

COMPLETION DEPTH: 200 ft
DATE BORING STARTED: 03/30/2021
DATE BORING COMPLETED: 04/01/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: Free Water Depth = 11.0-ft. 15-min Static Water Depth = 7.3-ft. 15-min Total Hole Depth = 8.0-ft. Borehole was backfilled with cement-bentonite grout. CON: One-Dimensional Consolidation. WOH: Weight of Hammer.

LOG OF BORING LB-2

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 40' 03.40"
W 94° 55' 35.60"

SURFACE ELEVATION: 6.0'

DRILLING METHOD:
Dry Augered: 0' to 11'
Wash Bored: 11' to 200'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-65		Dense gray POORLY GRADED SAND with SILT (SP-SM)												
	75			12/6" 21/6" 27/6"	20								7	
-70														
	80			11/6" 18/6" 18/6"										
-75														
		-becomes very dense at 83.5'		20/6" 29/6" 36/6"	20								7	
	85													
-80														
		Very stiff gray LEAN CLAY with SAND (CL)	(P)4.50		21	105	40	20		3.00	14	74	83	
	90													
-85														
		-stiff from 93' to 95'	(P)2.50		25		41	21						CON
	95													
-90														
			(P)2.75		24	101				2.51	14	83	85	
	100													
-95														
		Stiff gray FAT CLAY (CH) -with calcareous nodules from 103' to 105'	(P)2.75		28		63	43						
	105													

COMPLETION DEPTH: 200 ft
DATE BORING STARTED: 03/30/2021
DATE BORING COMPLETED: 04/01/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: Free Water Depth = 11.0-ft. 15-min Static Water Depth = 7.3-ft. 15-min Total Hole Depth = 8.0-ft. Borehole was backfilled with cement-bentonite grout. CON: One-Dimensional Consolidation. WOH: Weight of Hammer.

LOG OF BORING LB-2

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 40' 03.40"
W 94° 55' 35.60"

SURFACE ELEVATION: 6.0'

DRILLING METHOD:
Dry Augered: 0' to 11'
Wash Bored: 11' to 200'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-100		Stiff gray FAT CLAY (CH)												
	110	Very loose gray CLAYEY SAND (SC)		1/6" 2/6" 2/6"	26		29	12					49	
-105														
	115	-with organics from 113.5' to 115'		1/6" 2/6" 4/6"										
-110														
	120	Firm gray FAT CLAY with SAND (CH)		1/6" 3/6" 5/6"	35								80	
-115														
	125													
-120														
	130	Brown and gray CLAYEY SAND (SC) -with organics from 128' to 130'	(P)1.50		32		65	31					25	
-125														
	135													
-130														
	140	-becomes loose and gray at 138.5'		1/6" 3/6" 7/6"	24								41	

COMPLETION DEPTH: 200 ft
DATE BORING STARTED: 03/30/2021
DATE BORING COMPLETED: 04/01/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: Free Water Depth = 11.0-ft. 15-min Static Water Depth = 7.3-ft. 15-min Total Hole Depth = 8.0-ft. Borehole was backfilled with cement-bentonite grout. CON: One-Dimensional Consolidation. WOH: Weight of Hammer.

LOG OF BORING LB-2

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc
Beaumont, Texas

COORDINATES: N 29° 40' 03.40"
W 94° 55' 35.60"

SURFACE ELEVATION: 6.0'

DRILLING METHOD:
Dry Augered: 0' to 11'
Wash Bored: 11' to 200'

MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
Loose gray CLAYEY SAND (SC)												
Stiff gray FAT CLAY (CH)		2/6" 4/6" 6/6"	36		74	51						
Very stiff gray LEAN CLAY (CL)	(P)2.25		27	98				2.11	10	93	99	
Very dense gray SILTY SAND (SM)		23/6" 40/6" 37/5"										

ELEVATION (FT): -135, -140, -145, -150, -155, -160, -165
DEPTH (FT): 145, 150, 155, 160, 165, 170, 175

COMPLETION DEPTH: 200 ft
DATE BORING STARTED: 03/30/2021
DATE BORING COMPLETED: 04/01/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: Free Water Depth = 11.0-ft. 15-min Static Water Depth = 7.3-ft. 15-min Total Hole Depth = 8.0-ft. Borehole was backfilled with cement-bentonite grout. CON: One-Dimensional Consolidation. WOH: Weight of Hammer.

Tolunay-Wong Engineers, Inc.

LOG OF BORING LB-2

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 40' 03.40"
W 94° 55' 35.60"

SURFACE ELEVATION: 6.0'

DRILLING METHOD:
Dry Augered: 0' to 11'
Wash Bored: 11' to 200'

ELEVATION (FT)	DEPTH (FT)	MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		Very dense gray SILTY SAND (SM)												
				15/6" 29/6" 30/6"	21								40	
		Firm gray FAT CLAY (CH) -with organics and shell fragments from 188.5' to 190'		2/6" 3/6" 5/6"	39		71	49						
		-becomes very stiff at 198'	(P)4.00		31	93				2.37	15	100		
		Bottom @ 200'												

Elevation scale: -170, -175, -180, -185, -190, -195, -200
Depth scale: 180, 185, 190, 195, 200, 205, 210

COMPLETION DEPTH: 200 ft
DATE BORING STARTED: 03/30/2021
DATE BORING COMPLETED: 04/01/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: Free Water Depth = 11.0-ft. 15-min Static Water Depth = 7.3-ft. 15-min Total Hole Depth = 8.0-ft. Borehole was backfilled with cement-bentonite grout. CON: One-Dimensional Consolidation. WOH: Weight of Hammer.

LOG OF BORING LB-3

DRAFT

PROJECT: Cedar Bayou Deepening and Widening
Chambers County, Texas

CLIENT: Trans - Global Solutions, Inc.
Beaumont, Texas

COORDINATES: N 29° 40' 00.70"
W 94° 55' 27.40"

SURFACE ELEVATION: 4.0'

DRILLING METHOD:
Dry Augered: 0' to 12'
Wash Bored: 12' to 25'

ELEVATION (FT) / DEPTH (FT) / SAMPLE TYPE / SYMBOL

MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (tsf)	STD. PENETRATION TEST BLOWCOUNT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LAB MINI VANE SHEAR (tsf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
Stiff brown LEAN CLAY (CL), with organics	(P)1.50		22		33	14						
Stiff, gray and tan FAT CLAY (CH), with ferrous nodules	(P)1.75		26	101				1.31	15	3		
-with calcareous nodules from 4' to 8'	(P)2.00		25		77	59						CON
	(P)2.25											
Firm , gray and tan SILTY CLAY with SAND (CL-ML)	(P)1.50		23	103	28	7		0.87	15	8	73	
Firm tan LEAN CLAY with SAND (CL)		1/6" 2/6" 4/6"	28								83	
-becomes gray and tan at 13.5'		1/6" 3/6" 4/6"	27		38	21						
Stiff, gray and tan LEAN CLAY (CL), with calcareous nodules and sand seams	(P)2.25		26		47	26					97	
Very stiff, brown and gray FAT CLAY (CH), with calcareous nodules	(P)3.75		29		73	49						CON

Bottom @ 25'

COMPLETION DEPTH: 25 ft
DATE BORING STARTED: 04/01/2021
DATE BORING COMPLETED: 04/01/2021
LOGGER: C. Watts
PROJECT NO.: 21.23.029

NOTES: Free Water Depth = 12.0-ft. 15-min Static Water Depth = 4.6-ft. 15-min Total Hole Depth = 8.7-ft. Borehole was backfilled with cement-bentonite grout. CON: One-Dimensional Consolidation.

Tolunay-Wong Engineers, Inc.

KEY TO SYMBOLS AND TERMS USED ON BORING LOGS FOR SOIL

Most Common Unified Soil Classifications System Symbols

- Lean Clay (CL)
- Lean Clay w/ Sand (CL)
- Sandy Lean Clay (CL)
- Fat Clay (CH)
- Fat Clay w/ Sand (CH)
- Sandy Fat Clay (CH)
- Silty Clay (CL-ML)
- Sandy Silty Clay (CL-ML)
- Silty Clayey Sand (SC-SM)
- Clayey Sand (SC)
- Sandy Silt (ML)
- Silty Sand (SM)
- Silt w/ Sand (ML)
- Well Graded Sand (SW)
- Well Graded Sand w/ Gravel (SW-GM)
- Poorly Graded Sand (SP)
- Poorly Graded Sand w/ Silt (SP-SM)
- Silt (ML)
- Elastic Silt (MH)
- Elastic Silt w/ Sand (MH-SP)
- Silty Gravel (GM)
- Clayey Gravel (GC)
- Well Graded Gravel (GW)
- Well Graded Gravel w/ Sand (SP-GM)
- Poorly Graded Gravel (GP)
- Peat

Miscellaneous Materials

- Fill
- Concrete
- Asphalt and/or Base

Sampler Symbols	Meaning
	Pavement core
	Thin - walled tube sample
	Standard Penetration Test (SPT)
	Auger sample
	Sampling attempt with no recovery
	TxDOT Cone Penetrometer Test

Field Test Data

2.50	Pocket penetrometer reading in tons per square foot
(T)1.13	Torvane Measurement in tons per square foot
8/6"	Blow count per 6 - in. interval of the Standard Penetration Test
	Observed free water during drilling
	Observed static water level

Laboratory Test Data

Wc (%)	Moisture content in percent
Dens. (pcf)	Dry unit weight in pounds per cubic foot
Qu (tsf)	Unconfined compressive strength in tons per square foot
UU (tsf)	Compressive strength under confining pressure in tons per square foot
Str. (%)	Strain at failure in percent
LL	Liquid Limit in percent
PI	Plasticity Index
#200 (%)	Percent passing the No. 200 mesh sieve
( )	Confining pressure in pounds per square inch
*	Slickensided failure
**	Did not fail @ 15% strain

RELATIVE DENSITY OF COHESIONLESS & SEMI-COHESIONLESS SOILS

The following descriptive terms for relative density apply to cohesionless soils such as gravels, silty sands, and sands as well as semi-cohesive and semi-cohesionless soils such as sandy silts, and clayey sands.

Relative Density	Typical N_{60} Value Range*
Very Loose	0-4
Loose	5-10
Medium Dense	11-30
Dense	31-50
Very Dense	Over 50

* N_{60} is the number of blows from a 140-lb weight having a free fall of 30-in. required to penetrate the final 12-in. of an 18-in. sample interval, corrected for field procedure to an average energy ratio of 60% (Terzaghi, Peck, and Mesri, 1996).

CONSISTENCY OF COHESIVE SOILS

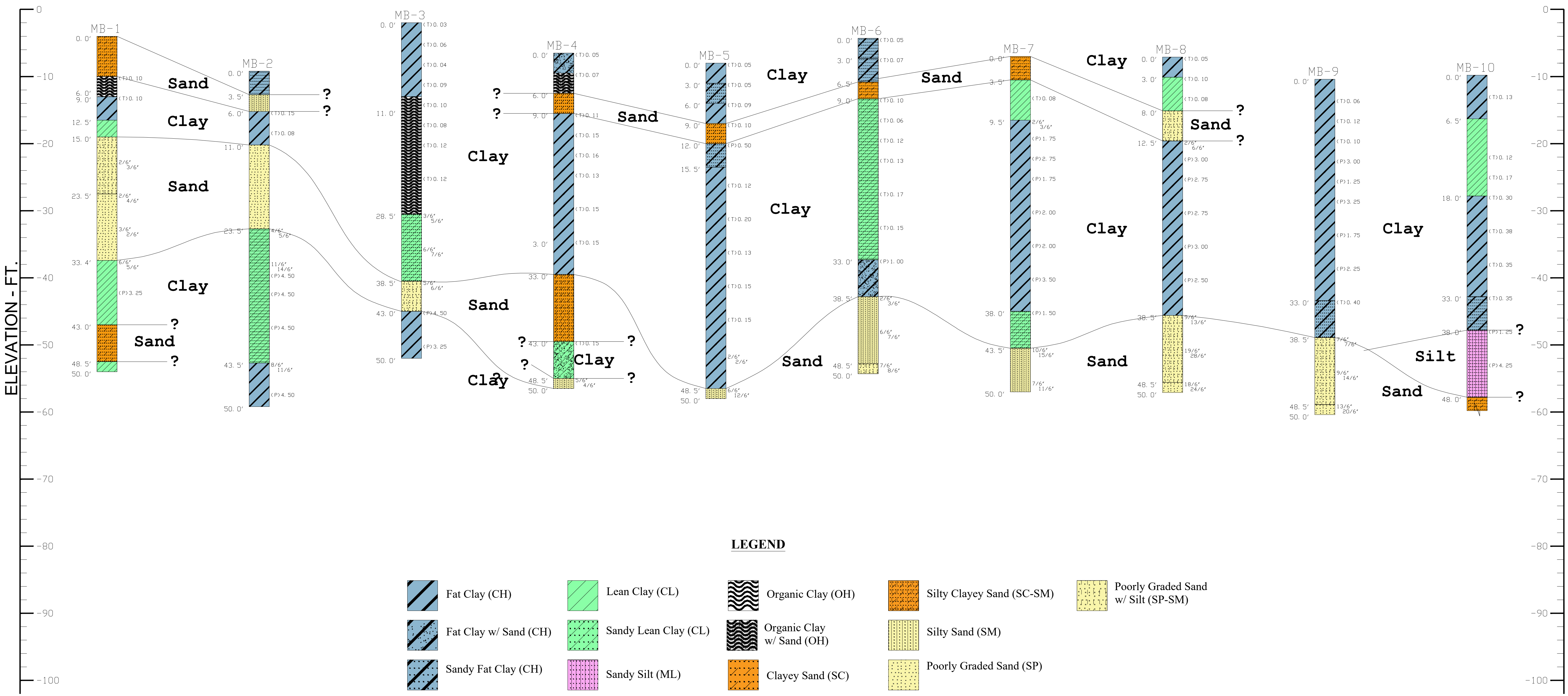
The following descriptive terms for consistency apply to cohesive soils such as clays, sandy clays, and silty clays.

Typical Compressive Strength (tsf)	Consistency	Typical SPT "N_{60}" Value Range**
$q_u < 0.25$	Very soft	≤ 2
$0.25 \leq q_u < 0.50$	Soft	3-4
$0.50 \leq q_u < 1.00$	Firm	5-8
$1.00 \leq q_u < 2.00$	Stiff	9-15
$2.00 \leq q_u < 4.00$	Very Stiff	16-30
$q_u \geq 4.00$	Hard	≥ 31

** An "N_{60}" value of 31 or greater corresponds to a hard consistency. The correlation of consistency with a typical SPT "N_{60}" value range is approximate.

DRAFT

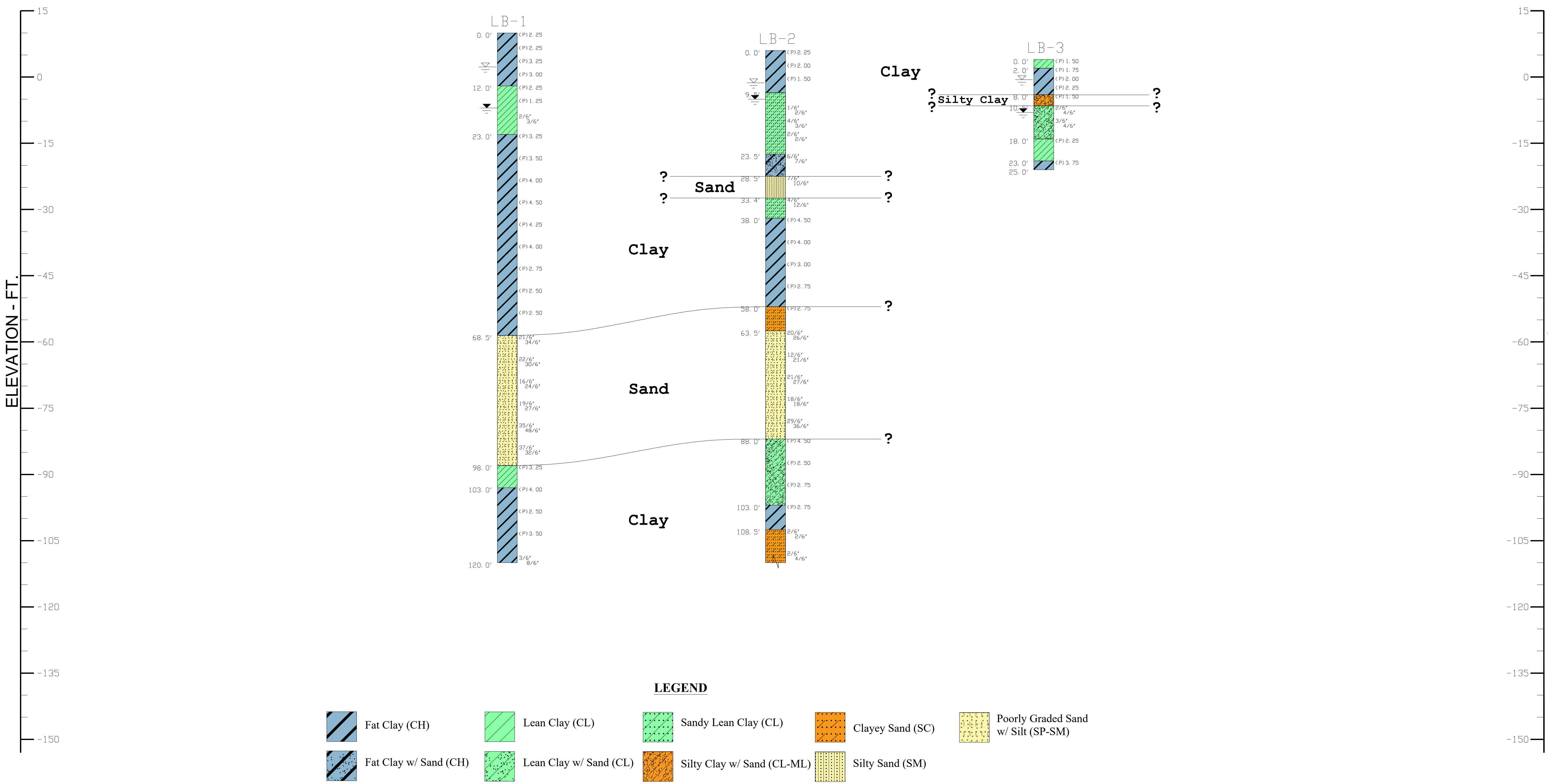
SUBSURFACE PROFILE
CROSS SECTION A-A'



CEDAR BAYOU DEEPING & WIDENING PROJECT CHAMBERS COUNTY, TEXAS	Tolunay-Wong Engineers, Inc.	SUBSURFACE PROFILE CROSS SECTION A-A'
TRANS GLOBAL SOLUTIONS, INC. BEAUMONT, TEXAS		PROJECT NO.: 21.23.029 — FIGURE 1

DRAFT

SUBSURFACE PROFILES
CROSS SECTION B-B'



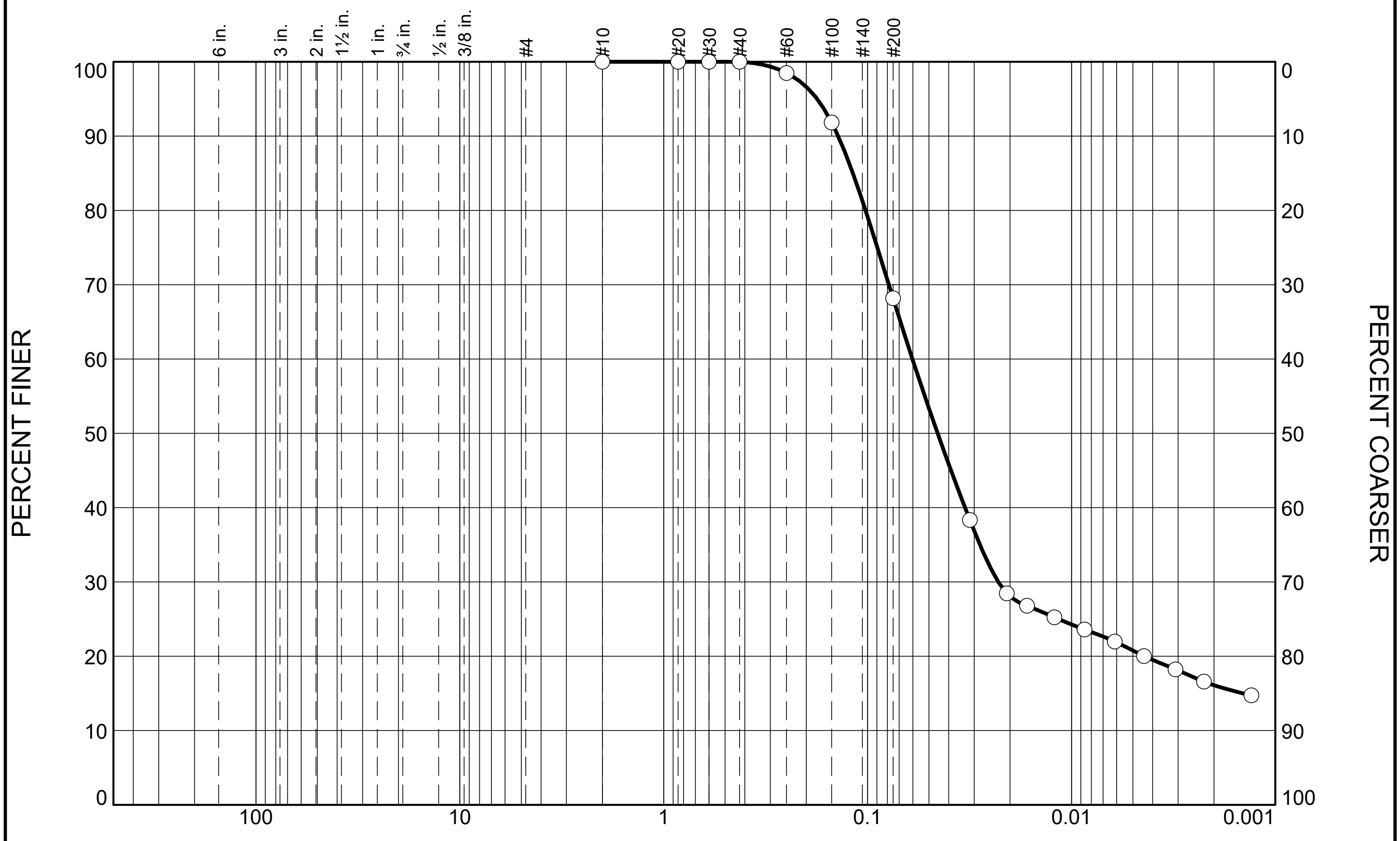
CEDAR BAYOU DEEPING & WIDENING PROJECT CHAMBERS COUNTY, TEXAS	Tolunay-Wong Engineers, Inc.	SUBSURFACE PROFILE CROSS SECTION B-B'
TRANS GLOBAL SOLUTIONS, INC. BEAUMONT, TEXAS		PROJECT NO.: 21.23.029 — FIGURE 2

APPENDIX D

LABORATORY RESULTS – SEDIMENT SAMPLES

DRAFT

ASTM D7928



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	31.8	52.1	16.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#30	100.0		
#40	100.0		
#60	98.5		
#100	91.8		
#200	68.2		

* (no specification provided)

Material Description

Gray SANDY LEAN CLAY (CL)

Atterberg Limits

PL= 19 LL= 38 PI= 19

Coefficients

D_{90}= 0.1394 D_{85}= 0.1180 D_{60}= 0.0603
D_{50}= 0.0453 D_{30}= 0.0229 D_{15}= 0.0014
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(11)

Remarks

Source of Sample: MB-3 Sediment Sample **Depth:** --

Date:

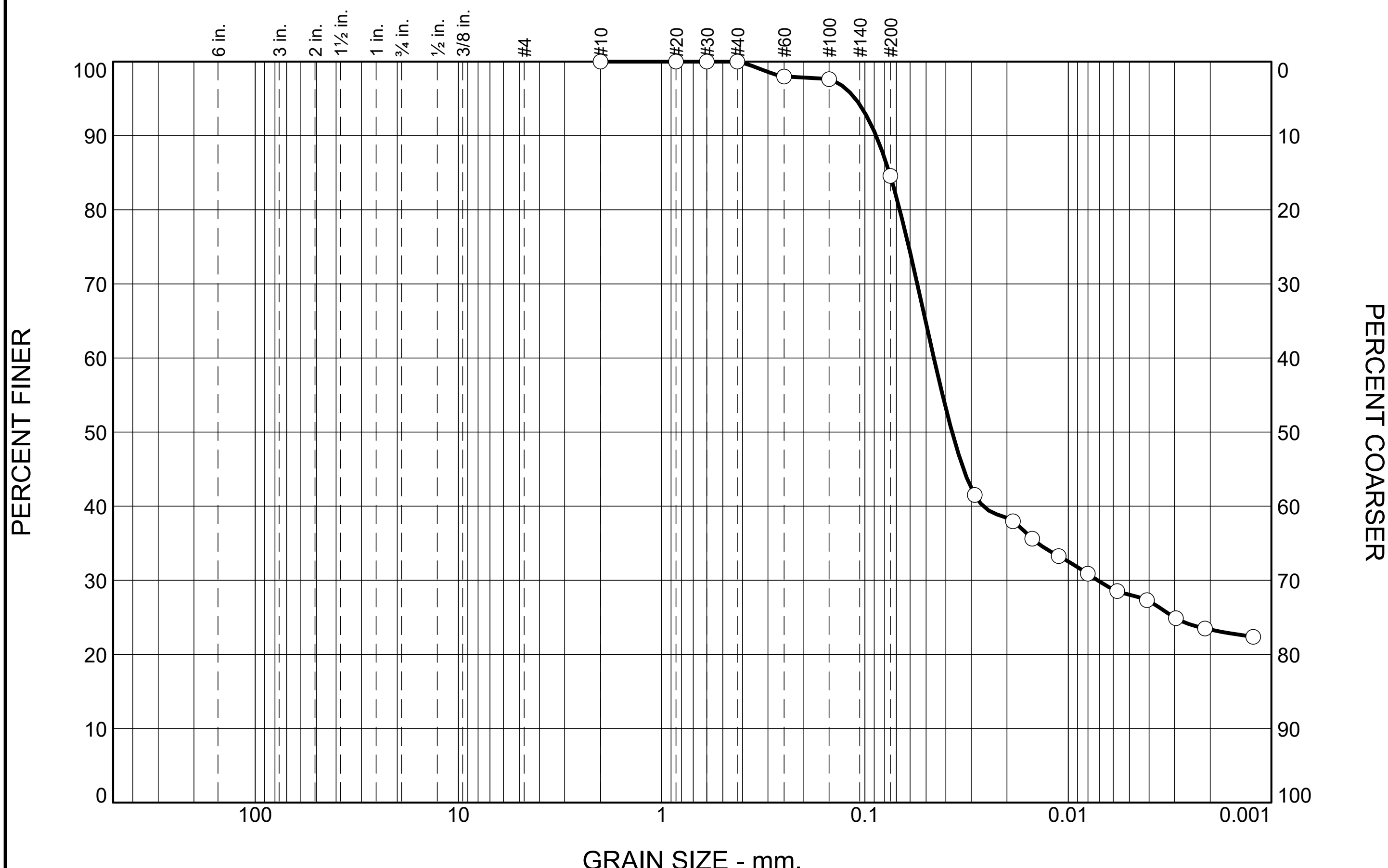
Tolunay-Wong Engineers, Inc.

Beaumont, TX

Client: Trans - Global Solutions, Inc.
Project: Cedar Bayou Deepening and Widening
Chambers County, Texas
Project No: 21.23.029 **Figure**

DRAFT

ASTM D7928



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	15.4	61.3	23.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#30	100.0		
#40	100.0		
#60	98.0		
#100	97.6		
#200	84.6		

* (no specification provided)

Material Description

Gray LEAN CLAY with SAND (CL)

Atterberg Limits

PL= 22 LL= 49 PI= 27

Coefficients

D_{90}= 0.0881 D_{85}= 0.0758 D_{60}= 0.0458
D_{50}= 0.0373 D_{30}= 0.0072 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(24)

Remarks

Source of Sample: MB-5 Sediment Sample **Depth:** --

Date:

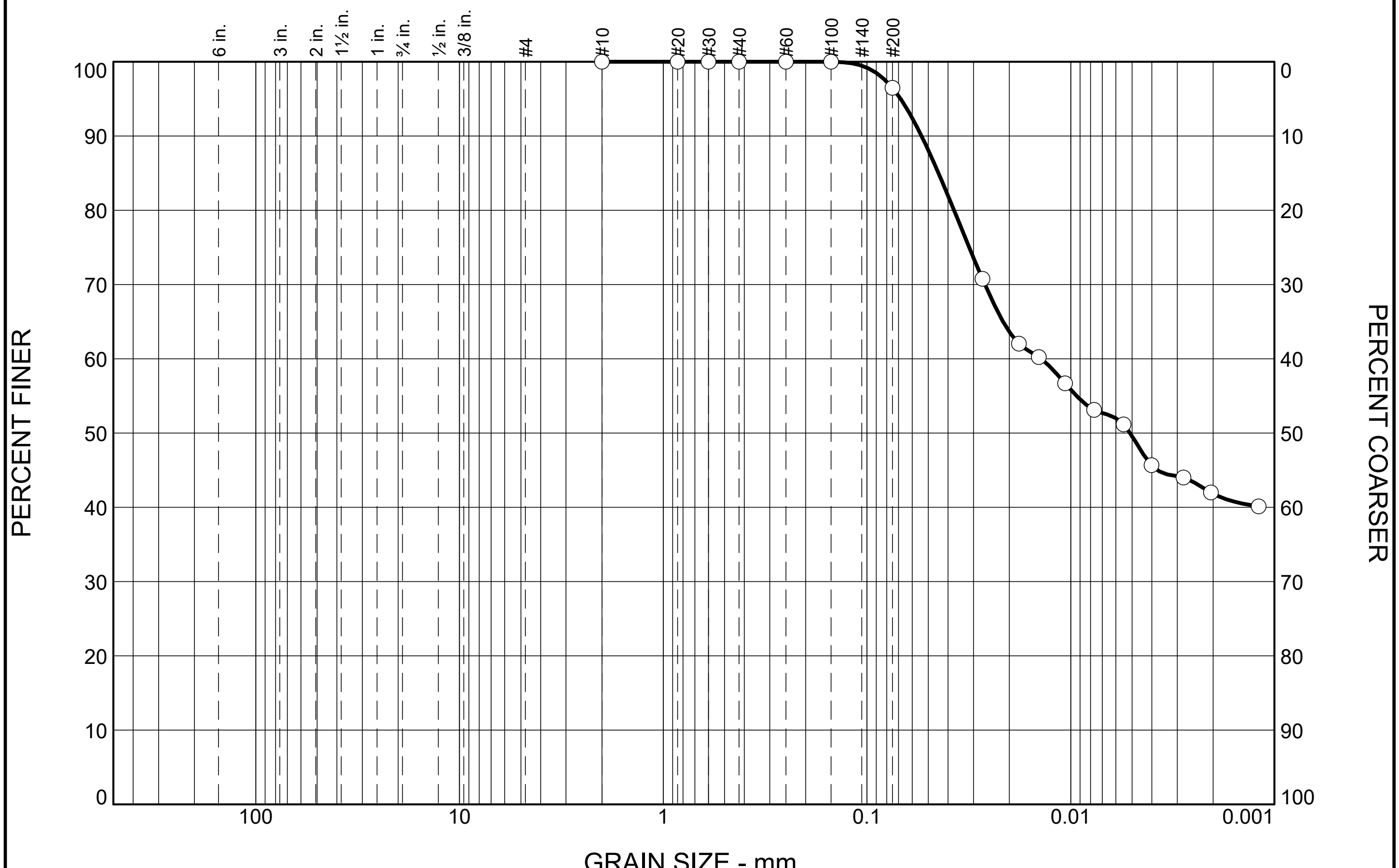
Tolunay-Wong Engineers, Inc.

Beaumont, TX

Client: Trans - Global Solutions, Inc.
Project: Cedar Bayou Deepening and Widening
Chambers County, Texas
Project No: 21.23.029 **Figure**

DRAFT

ASTM D7928



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	3.5	54.7	41.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#30	100.0		
#40	100.0		
#60	100.0		
#100	100.0		
#200	96.5		

* (no specification provided)

Material Description

Gray FAT CLAY (CH)

Atterberg Limits

PL= 34 LL= 91 PI= 57

Coefficients

D_{90}= 0.0540 D_{85}= 0.0446 D_{60}= 0.0139
D_{50}= 0.0051 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CH AASHTO= A-7-5(66)

Remarks

Source of Sample: MB-7 Sediment Sample **Depth:** --

Date:

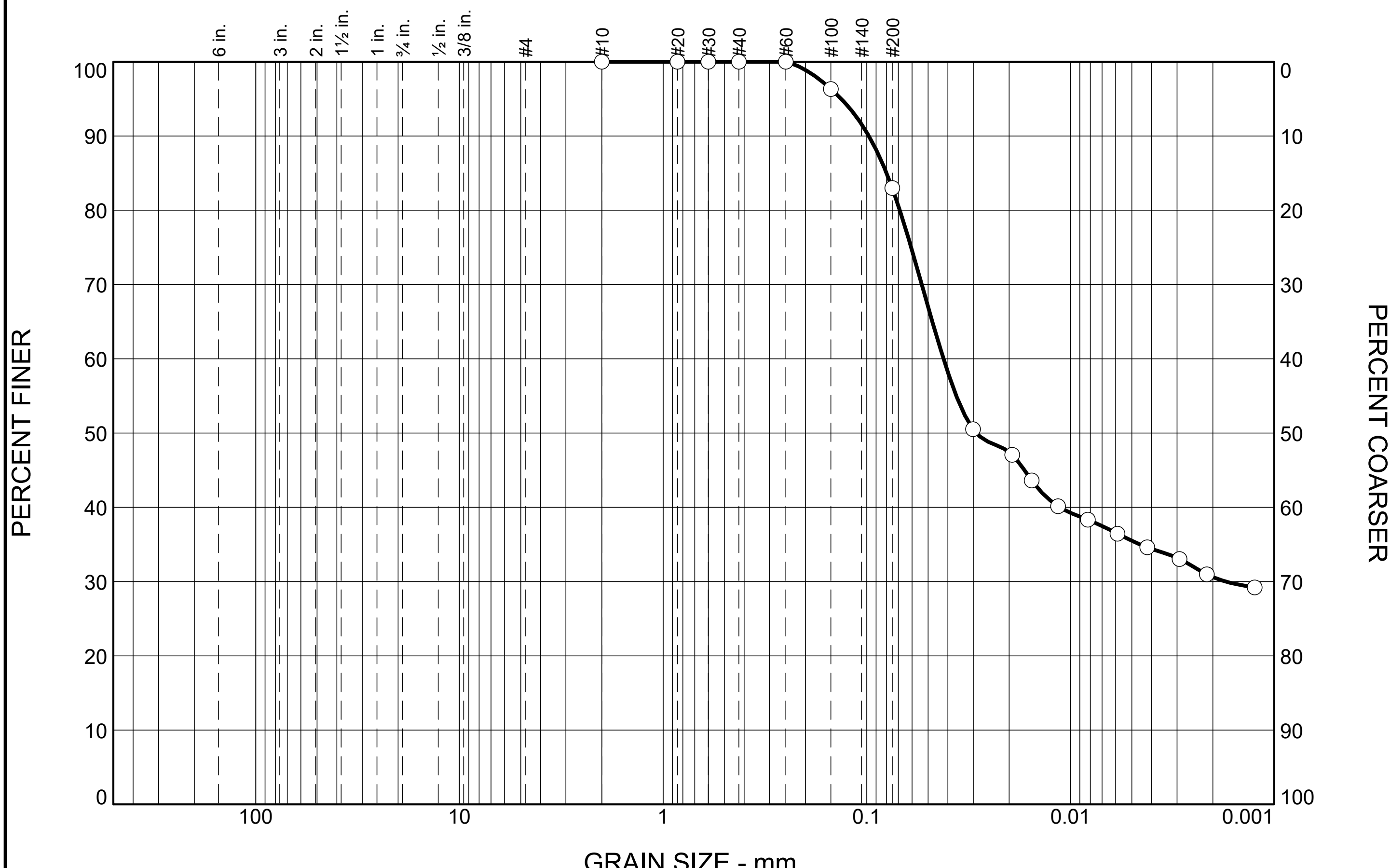
Tolunay-Wong Engineers, Inc.

Beaumont, TX

Client: Trans - Global Solutions, Inc.
Project: Cedar Bayou Deepening and Widening
Chambers County, Texas
Project No: 21.23.029 **Figure**

DRAFT

ASTM D7928



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	17.0	52.4	30.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#30	100.0		
#40	100.0		
#60	100.0		
#100	96.3		
#200	83.0		

* (no specification provided)

Material Description

Gray FAT CLAY with SAND (CH)

Atterberg Limits

PL= 27 LL= 66 PI= 39

Coefficients

D_{90}= 0.0977 D_{85}= 0.0800 D_{60}= 0.0420
D_{50}= 0.0290 D_{30}= 0.0017 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(36)

Remarks

Source of Sample: MB-9 Sediment Sample **Depth:** --

Date:

Tolunay-Wong Engineers, Inc.

Beaumont, TX

Client: Trans - Global Solutions, Inc.
Project: Cedar Bayou Deepening and Widening
Chambers County, Texas
Project No: 21.23.029 **Figure**

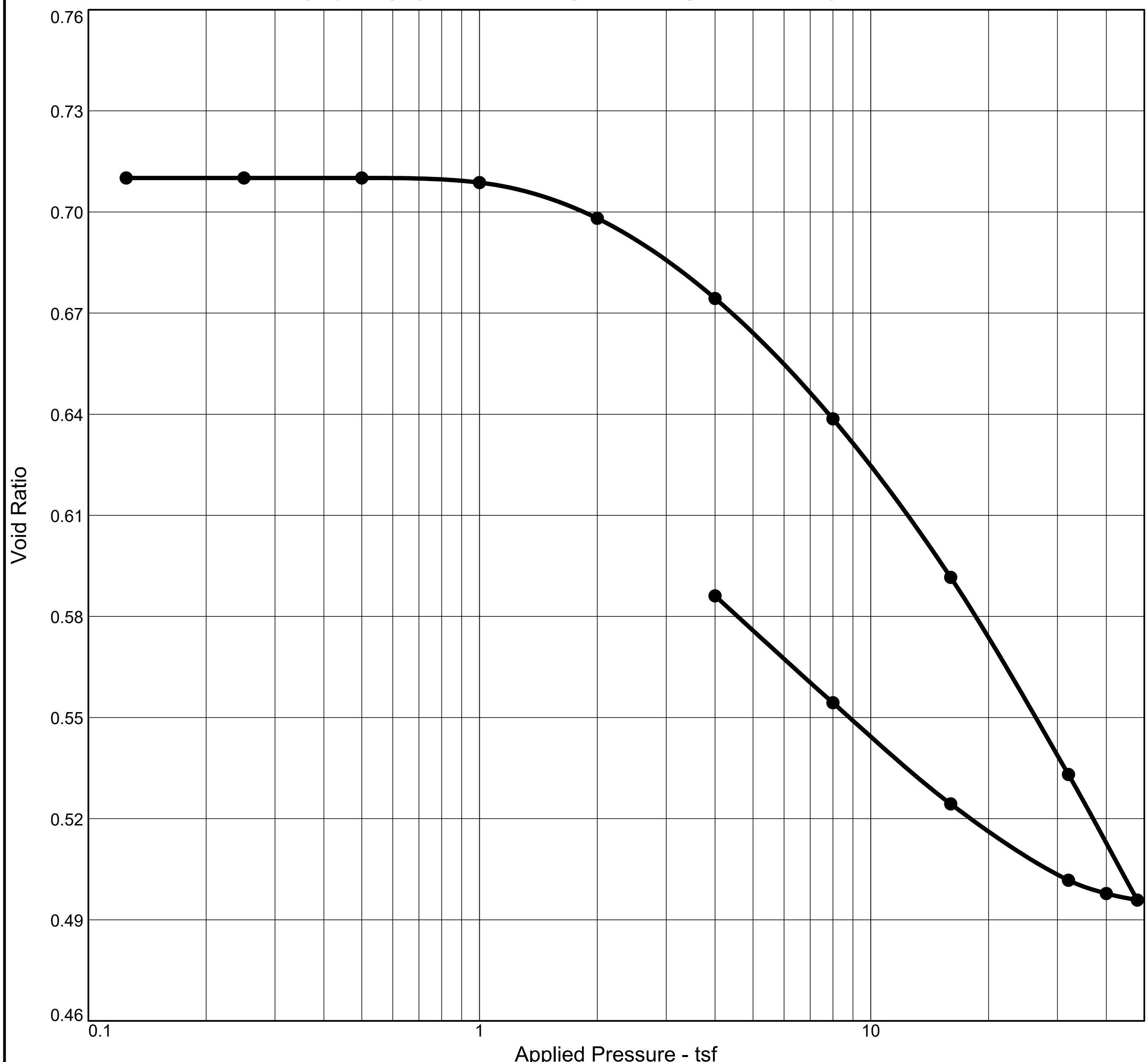
DRAFT

APPENDIX E

ONE-DIMENSIONAL CONSOLIDATION TEST REPORTS

DRAFT

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
97.6 %	25.7 %	98.6	79	50	2.70	CH		0.710

MATERIAL DESCRIPTION

Very stiff, tan and gray FAT CLAY (CH), with calcareous nodules and slickensides

Project No. 21.23.029 **Client:** Trans - Global Solutions, Inc.

Project: Cedar Bayou Deepening and Widening
Chambers County, Texas

Source of Sample: LB-1 **Depth:** 6-8

Tolunay-Wong Engineers, Inc.

Beaumont, TX

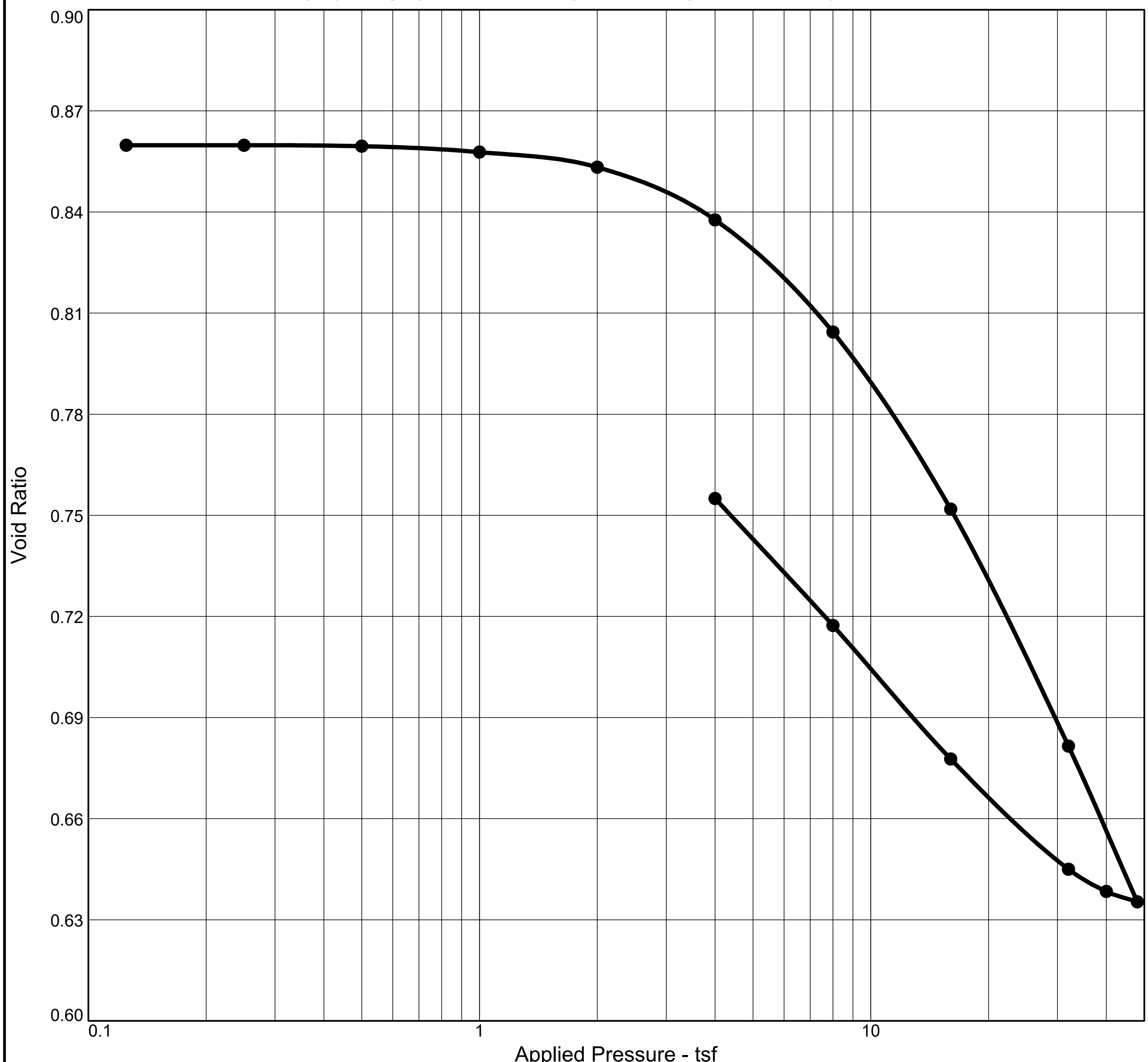
Remarks:
ASTM D2435 - Method B
Specific Gravity: Assumed

Figure

Tested By: Benjamin Moore

DRAFT

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
102.9 %	32.8 %	90.6	-	-	2.70	CH		0.860

MATERIAL DESCRIPTION

Very stiff, brown and tan FAT CLAY (CH), with calcareous nodules

Project No. 21.23.029 **Client:** Trans - Global Solutions, Inc.

Project: Cedar Bayou Deepening and Widening
Chambers County, Texas

Source of Sample: LB-1 **Depth:** 28-30

Tolunay-Wong Engineers, Inc.

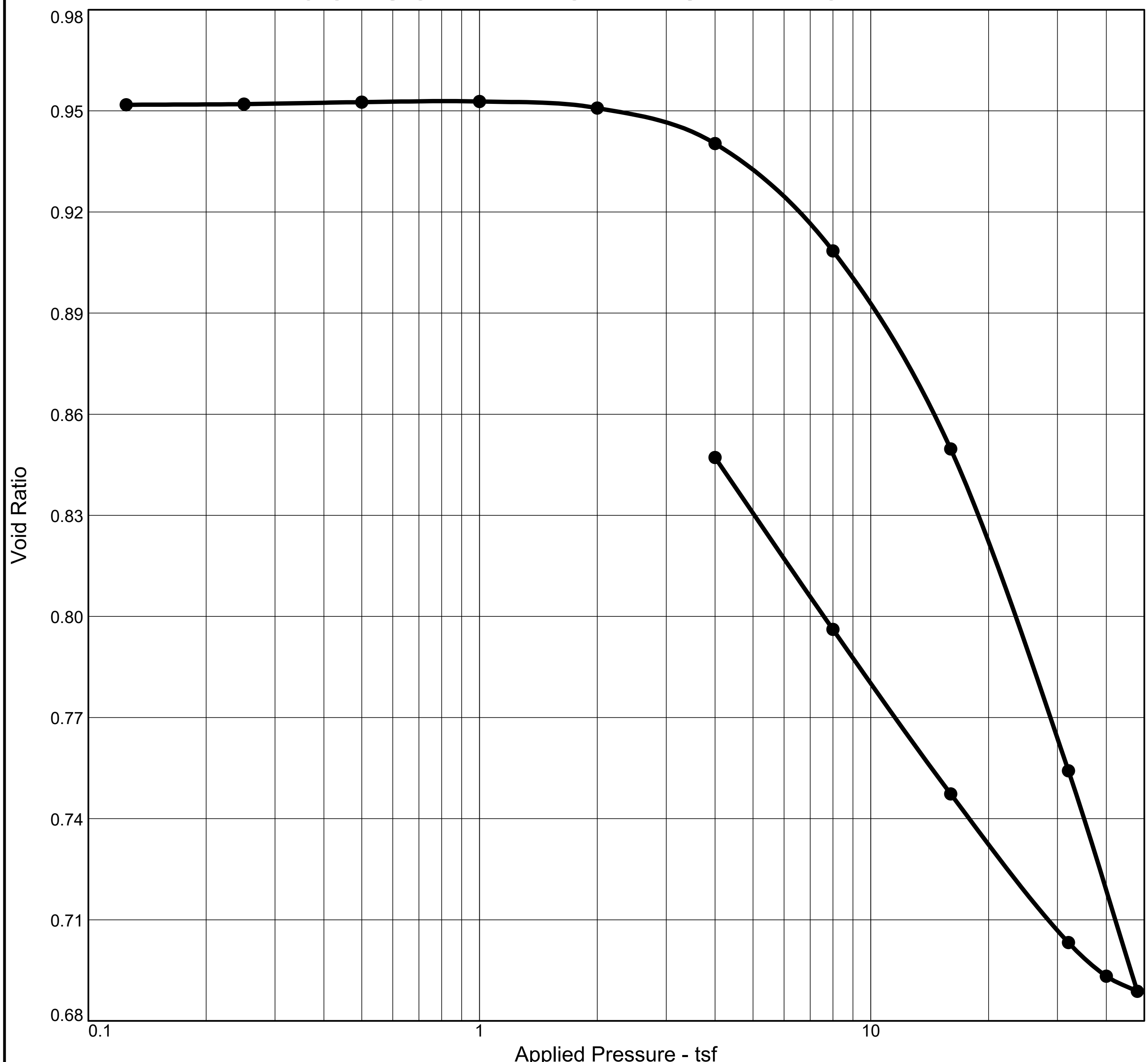
Beaumont, TX

Remarks:
ASTM D2435 - Method B
Specific Gravity: Assumed

Figure

Tested By: Benjamin Moore

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
102.9 %	36.3 %	86.3	89	60	2.70	CH		0.953

MATERIAL DESCRIPTION

Very stiff, brown and tan FAT CLAY (CH)

Project No. 21.23.029 **Client:** Trans - Global Solutions, Inc.

Project: Cedar Bayou Deepening and Widening
Chambers County, Texas

Source of Sample: LB-1 **Depth:** 48-50

Tolunay-Wong Engineers, Inc.

Beaumont, TX

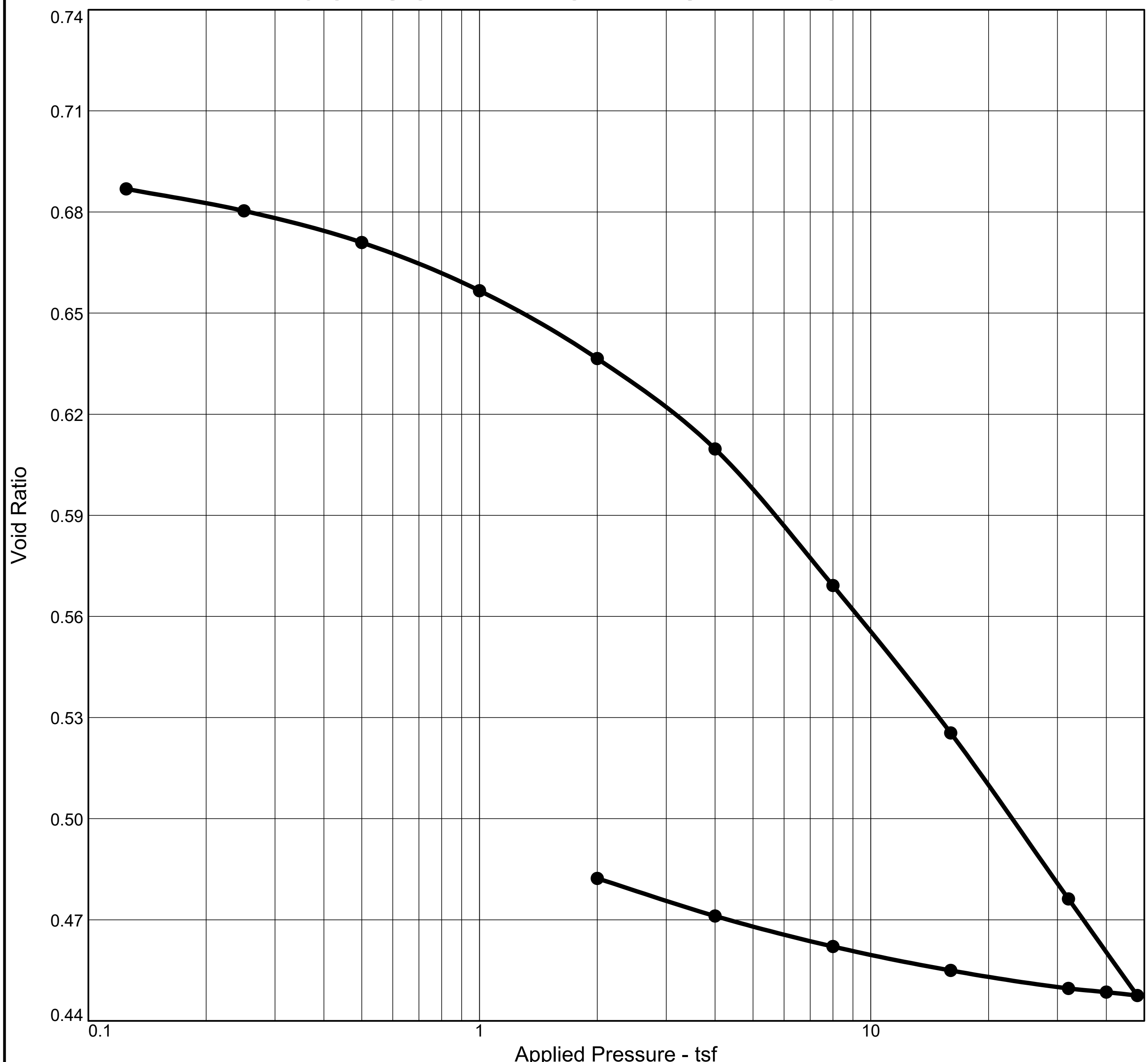
Remarks:
ASTM D2435 - Method B
Specific Gravity: Assumed

Figure

Tested By: Benjamin Moore

DRAFT

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
97.9 %	25.1 %	99.6	41	21	2.70	CL		0.692

MATERIAL DESCRIPTION

Stiff gray LEAN CLAY with SAND

Project No. 21.23.029 **Client:** Trans - Global Solutions, Inc.

Project: Cedar Bayou Deepening and Widening
Chambers County, Texas

Source of Sample: LB-2 **Depth:** 93-95

Tolunay-Wong Engineers, Inc.

Beaumont, TX

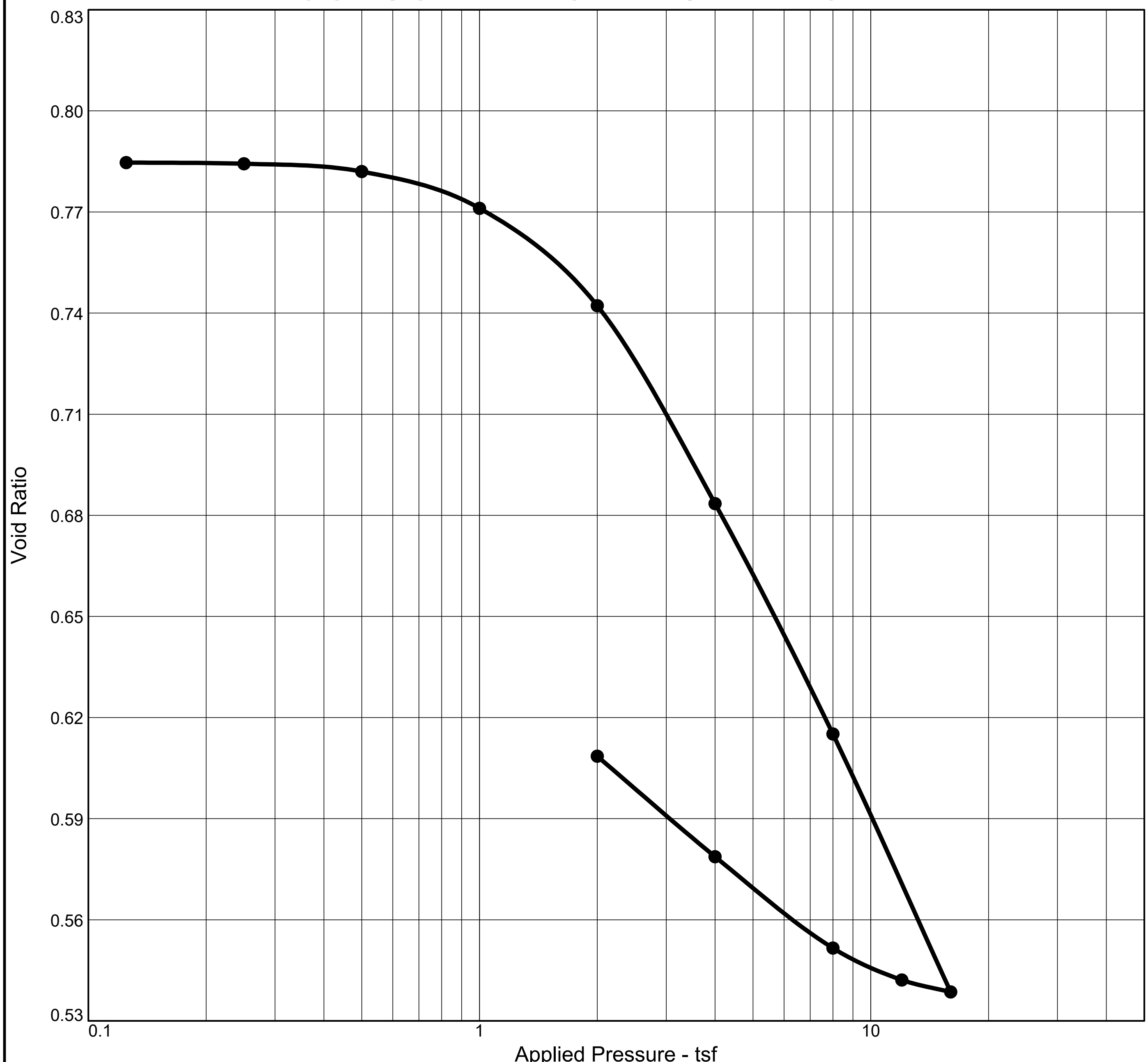
Remarks:
ASTM D2435 - Method B
Specific Gravity: Assumed

Figure

Tested By: Benjamin Moore

DRAFT

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
97.5 %	28.3 %	94.4	77	59	2.70	CH		0.785

MATERIAL DESCRIPTION

Stiff, gray and tan FAT CLAY (CH), with ferrous and calcareous nodules

Project No. 21.23.029 **Client:** Trans - Global Solutions, Inc.

Project: Cedar Bayou Deepening and Widening
Chambers County, Texas

Source of Sample: LB-3 **Depth:** 4-6

Remarks:
ASTM D2435 - Method B
Specific Gravity: Assumed

Tolunay-Wong Engineers, Inc.

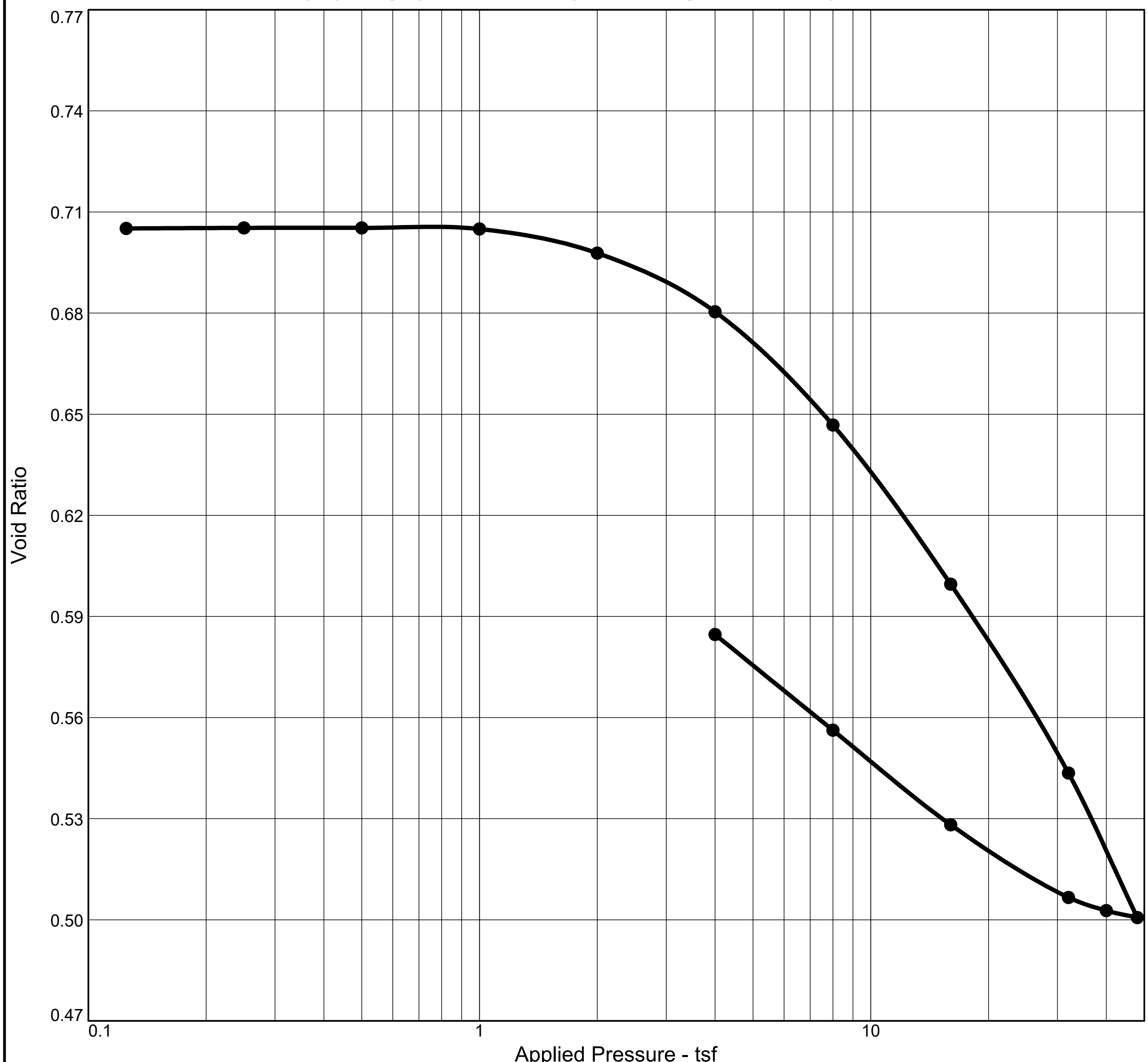
Beaumont, TX

Figure

Tested By: Benjamin Moore

DRAFT

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
103.6 %	27.1 %	98.8	73	49	2.70	CH		0.705

MATERIAL DESCRIPTION

Very stiff, brown and gray FAT CLAY (CH), with calcareous nodules

Project No. 21.23.029 **Client:** Trans - Global Solutions, Inc.

Project: Cedar Bayou Deepening and Widening
Chambers County, Texas

Source of Sample: LB-3 **Depth:** 23-25

Tolunay-Wong Engineers, Inc.

Beaumont, TX

Remarks:
ASTM D2435 - Method B
Specific Gravity: Assumed

Figure

Tested By: Benjamin Moore

DRAFT

APPENDIX F

CONSOLIDATED-UNDRAINED TRIAXIAL
COMPRESSION TEST REPORTS

DRAFT

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-1 / 38-40

TRI Log #: 63507.1
Test Method: ASTM D4767 Mod

Specimens				
Identification	1	2	3	4
Depth/Elev. (ft)	-	-	-	-
Eff. Consol. Stress (psi)	5.7	11.4	22.9	-
Initial Specimen Properties				
Avg. Diameter (in)	2.03	-	-	-
Avg. Height (in)	4.16	-	-	-
Avg. Water Content (%)	28.6	-	-	-
Bulk Density (pcf)	120.0	-	-	-
Dry Density (pcf)	93.4	-	-	-
Specific Gravity (Assumed)	2.75			
Saturation (%)	93.8	-	-	-
Void Ratio, n	0.84	-	-	-
B-Value, End of Saturation	0.96	-	-	-

Test Setup	
Specimen Condition	Undisturbed / Intact
Specimen Preparation	Trimmed
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear				
Void Ratio	0.83	0.81	0.78	-

Shear / Post-Shear				
Rate of Strain (%/hr)	1.00	1.00	1.00	-
Avg. Water Content (%)	-	-	30.6	-

At Failure								
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$				Ratio, $(\sigma_1'/\sigma_3')_{max}$			
Axial Strain at Failure (%), $\varepsilon_{a,f}$	-	-	-	-	1.0	3.8	9.7	-
Minor Effective Stress (psi), $\sigma_3'_f$	-	-	-	-	3.5	8.1	16.8	-
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	-	-	-	-	7.6	13.3	22.1	-
Pore Water Pressure, Δu_f (psi)	-	-	-	-	2.1	3.3	6.1	-
Major Effective Stress (psi), $\sigma_1'_f$	-	-	-	-	11.2	21.4	38.9	-
Secant Friction Angle (degrees)	-	-	-	-	31.2	26.7	23.4	-
Effective Friction Angle (degrees)	-				20.5			
Effective Cohesion (psi)	-				1.4			

Note: Multi-stage testing was performed for this sample. The first two stages were terminated in accordance with stress path tangency and/or peak principal stress ratio. The presented M-C parameters are based on a linear regression in modified stress space, across all assigned effective consolidation stresses. This fit does not purported to capture typical curvature of envelopes that may, in particular, be observed across broader range in effective stresses. Please note that the stresses associated with peak principal stress ratio are presented in tabular form on the first page of the report. There are alternate interpretations to this failure criterion including but not limited to peak principal stress difference and strain compatibility.

Jeffrey A. Kuhn , Ph.D., P.E., 6/4/2021
Analysis & Quality Review/Date

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-1 / 38-40

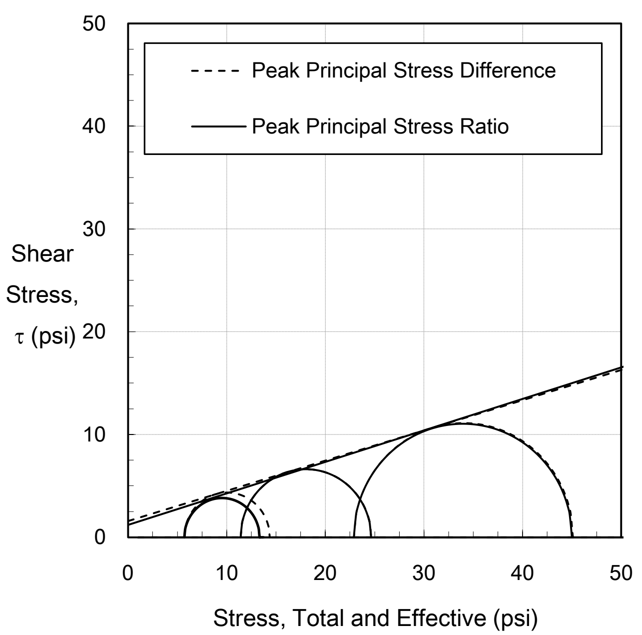
TRI Log #: 63507.1
Test Method: ASTM D4767 Mod

R / "Total Stress" Envelope			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	ϕ_R	16.4	17.0
Cohesion (psi)	c_R	1.6	1.2

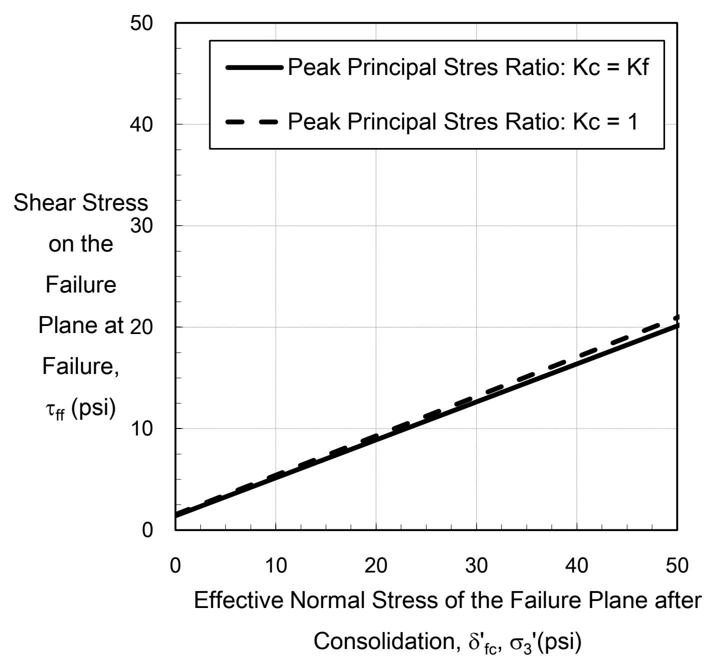
Kc = Kf Envelope, Effective Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	ϕ'	20.3	20.5
Effective Cohesion (psi)	c'	1.5	1.4

Kc = 1 (τ_{ff} vs σ'_{fc}) Envelope, Total Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	$d_{Kc=1}$	20.2	21.2
Cohesion (psi)	$\psi_{Kc=1}$	2.0	1.5

R / "Total Stress" Envelope



Three-Stage Rapid Drawdown Envelopes

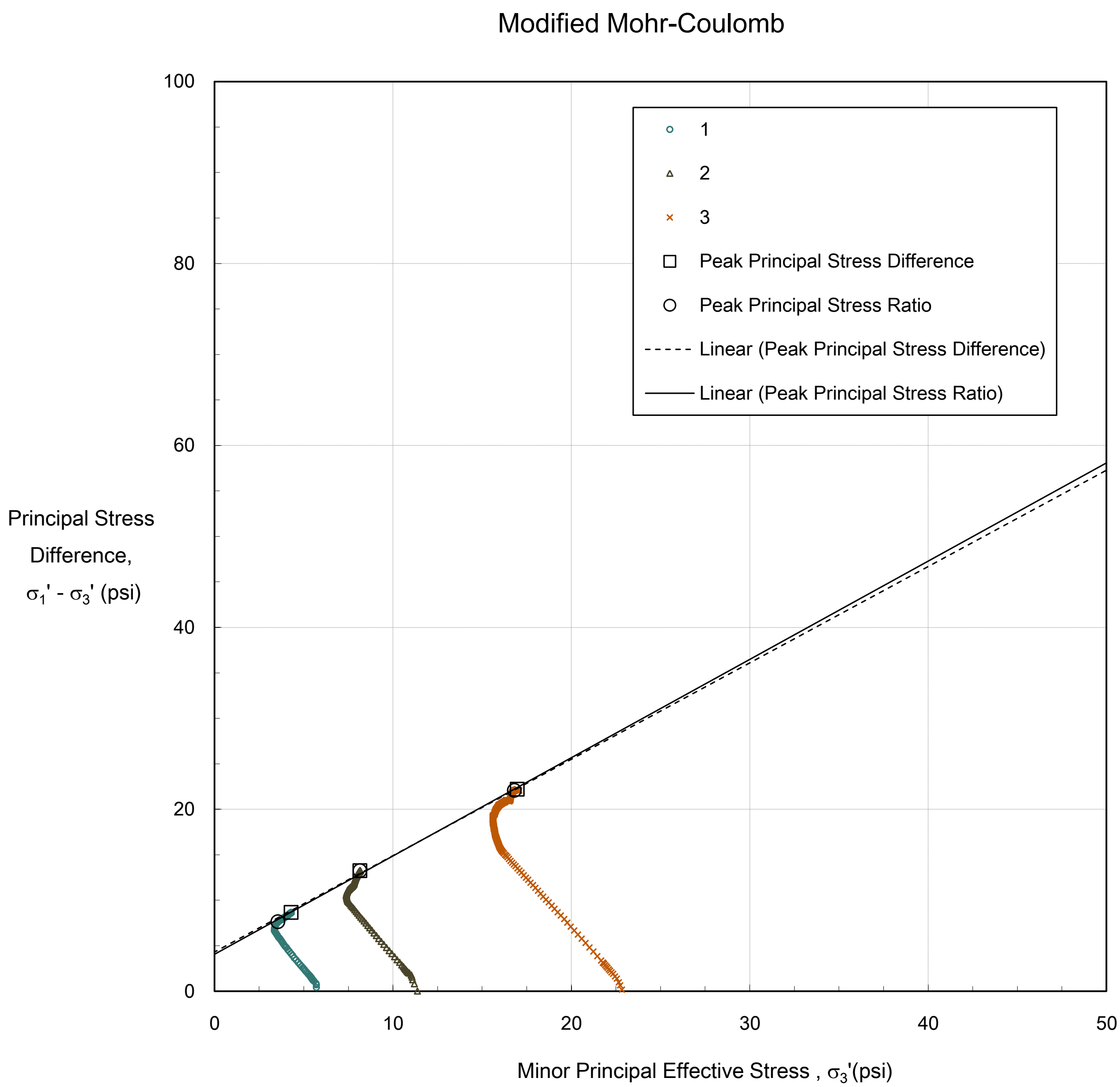


TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-1 / 38-40

TRI Log #: 63507.1
Test Method: ASTM D4767 Mod



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	20.5
Effective Cohesion (psi)	-	1.4

TRI Environmental, Inc.
9063 Bee Caves Rd. – Austin, TX 78733 – USA | Ph: 800.880.TEST or 512.263.2101

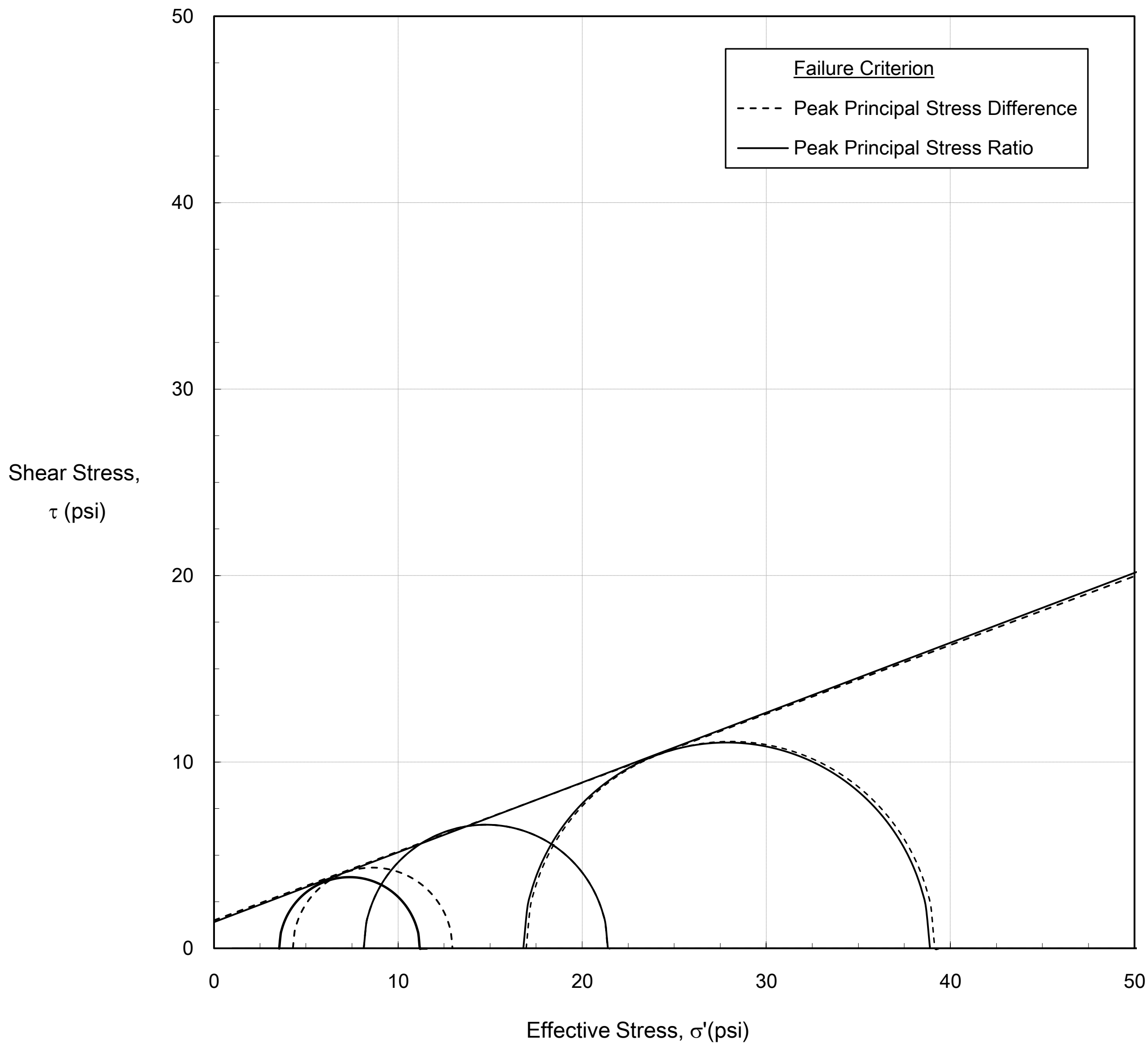
DRAFT

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-1 / 38-40

TRI Log #: 63507.1
Test Method: ASTM D4767 Mod

Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	20.5
Effective Cohesion (psi)	-	1.4

TRI Environmental, Inc.
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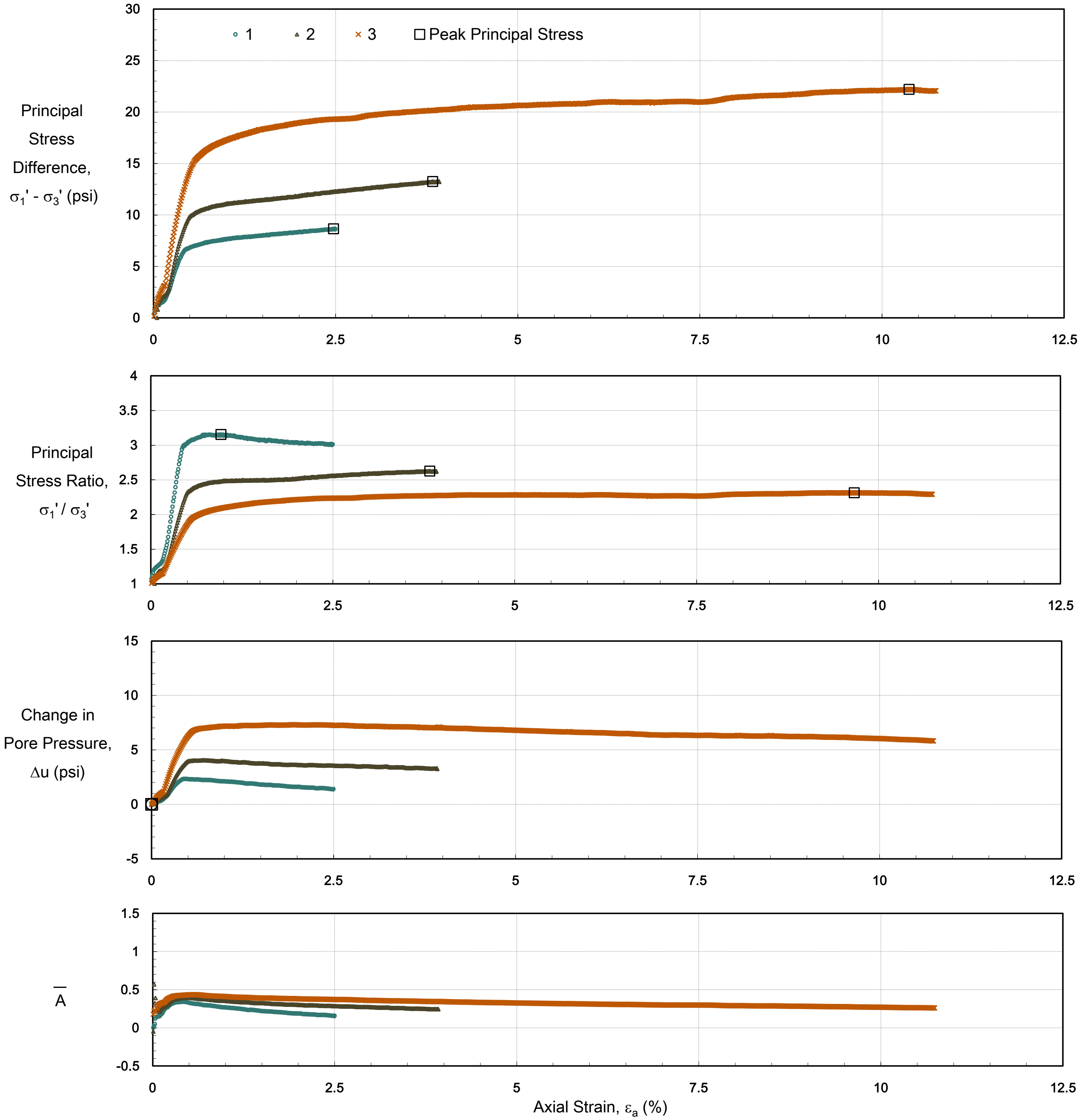
DRAFT

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-1 / 38-40

TRI Log #: 63507.1
Test Method: ASTM D4767 Mod



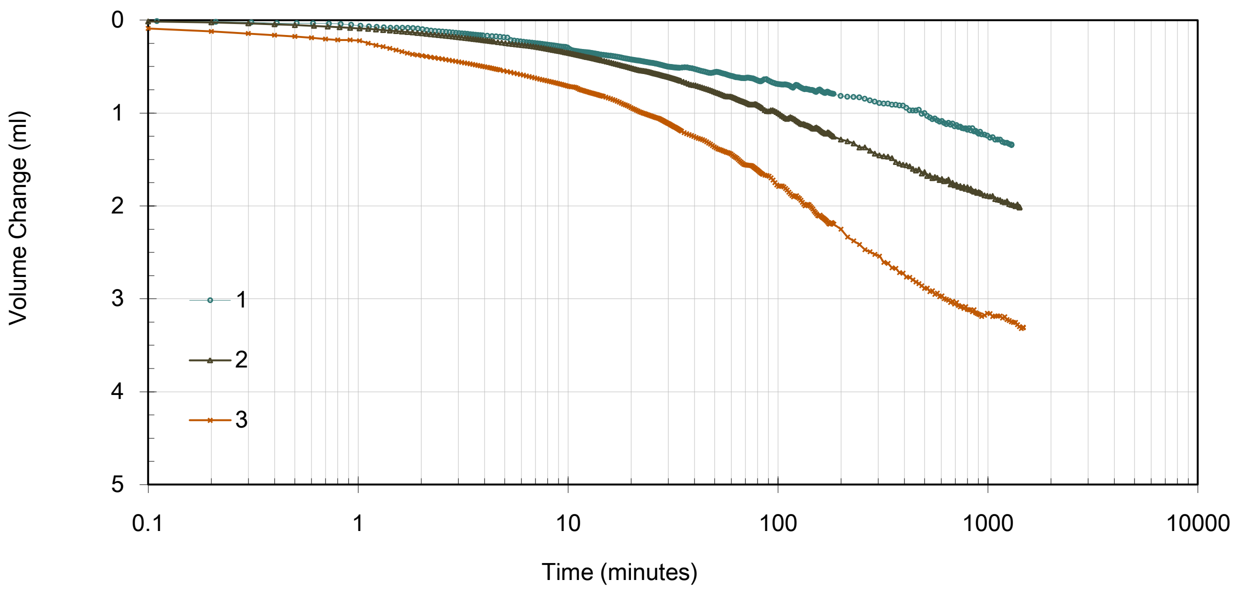
TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

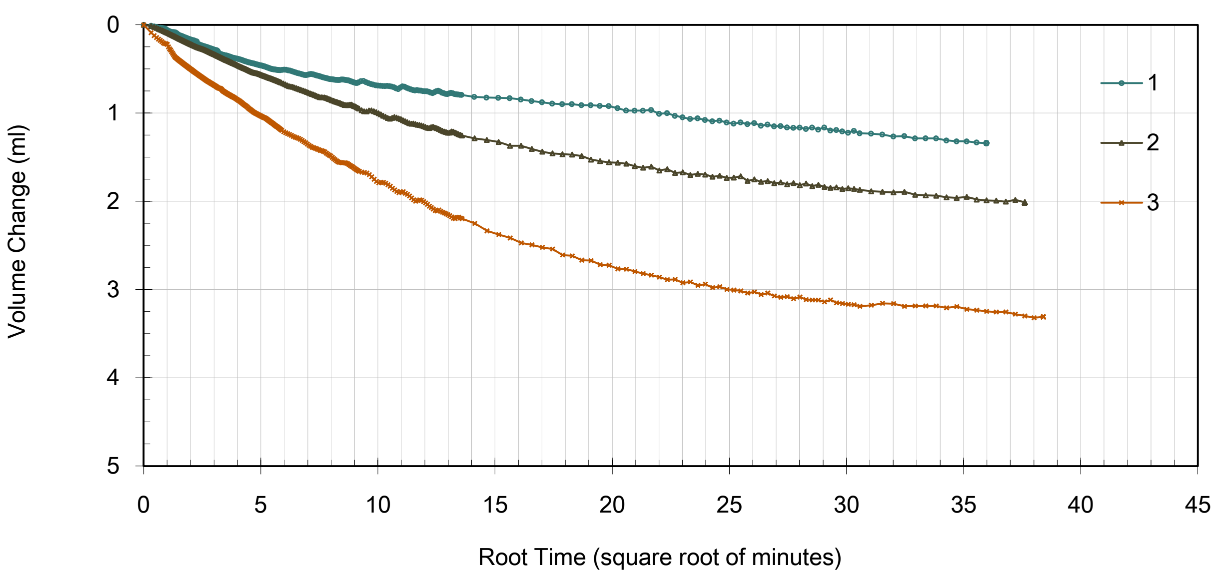
TESTING, RESEARCH, CONSULTING AND FIELD SERVICES DRAFT
Austin, TX - USA | CA - USA | SC - USA | Gold Coast - Australia | Suzhou - China | Sao Paulo, Brazil | Johannesburg - Africa

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc | TRI Log #: 63507.1
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project | Test Method: ASTM D4767 Mod
Sample: MB-1 / 38-40

Consolidation





TRI Environmental, Inc.
9063 Bee Caves Rd. – Austin, TX 78733 – USA | Ph: 800.880.TEST or 512.263.2101

DRAFT

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-2 / 30-32

TRI Log #: 63507.2
Test Method: ASTM D4767 Mod

Specimens				
Identification	1	2	3	4
Depth/Elev. (ft)	-	-	-	-
Eff. Consol. Stress (psi)	4.8	9.6	19.2	-
Initial Specimen Properties				
Avg. Diameter (in)	2.01	2.03	2.05	-
Avg. Height (in)	4.22	4.10	3.99	-
Avg. Water Content (%)	19.0	-	-	-
Bulk Density (pcf)	124.4	-	-	-
Dry Density (pcf)	104.5	-	-	-
Specific Gravity (Assumed)	2.75			
Saturation (%)	81.5	-	-	-
Void Ratio, n	0.64	0.63	0.60	-
B-Value, End of Saturation	0.95	-	-	-

Test Setup	
Specimen Condition	Undisturbed / Intact
Specimen Preparation	Trimmed
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear				
Void Ratio	0.63	0.60	0.57	-

Shear / Post-Shear				
Rate of Strain (%/hr)	1.00	1.00	1.00	-
Avg. Water Content (%)	-	-	19.3	-

At Failure								
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$				Ratio, $(\sigma_1'/\sigma_3')_{max}$			
Axial Strain at Failure (%), $\varepsilon_{a,f}$	-	-	-	-	2.8	2.9	3.0	-
Minor Effective Stress (psi), $\sigma_3'_f$	-	-	-	-	2.7	5.9	12.1	-
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	-	-	-	-	11.1	18.7	29.5	-
Pore Water Pressure, Δu_f (psi)	-	-	-	-	2.1	3.8	7.2	-
Major Effective Stress (psi), $\sigma_1'_f$	-	-	-	-	13.9	24.6	41.6	-
Secant Friction Angle (degrees)	-	-	-	-	42.1	37.8	33.4	-
Effective Friction Angle (degrees)	-				29.5			
Effective Cohesion (psi)	-				1.9			

Note: Multi-stage testing was performed for this sample. The first two stages were terminated in accordance with stress path tangency and/or peak principal stress ratio. The presented M-C parameters are based on a linear regression in modified stress space, across all assigned effective consolidation stresses. This fit does not purported to capture typical curvature of envelopes that may, in particular, be observed across broader range in effective stresses. Please note that the stresses associated with peak principal stress ratio are presented in tabular form on the first page of the report. There are alternate interpretations to this failure criterion including but not limited to peak principal stress difference and strain compatibility.

Jeffrey A. Kuhn , Ph.D., P.E., 6/4/2021
Analysis & Quality Review/Date

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

DRAFT

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-2 / 30-32

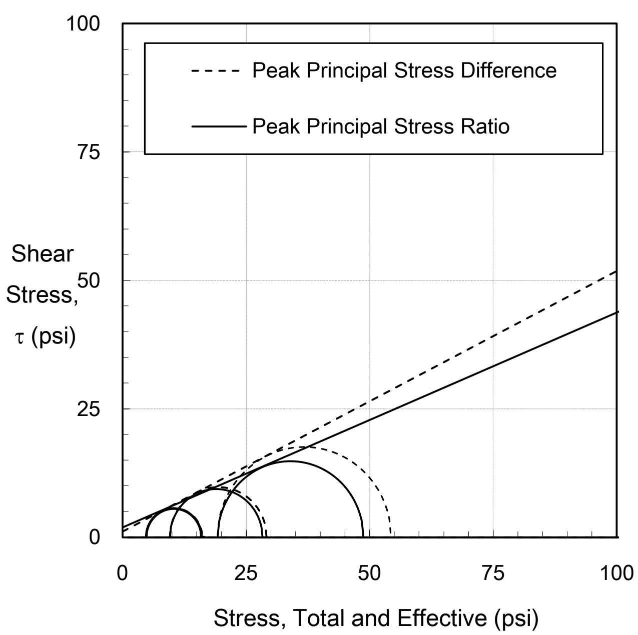
TRI Log #: 63507.2
Test Method: ASTM D4767 Mod

R / "Total Stress" Envelope			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	ϕ_R	26.9	22.7
Cohesion (psi)	c_R	1.1	1.9

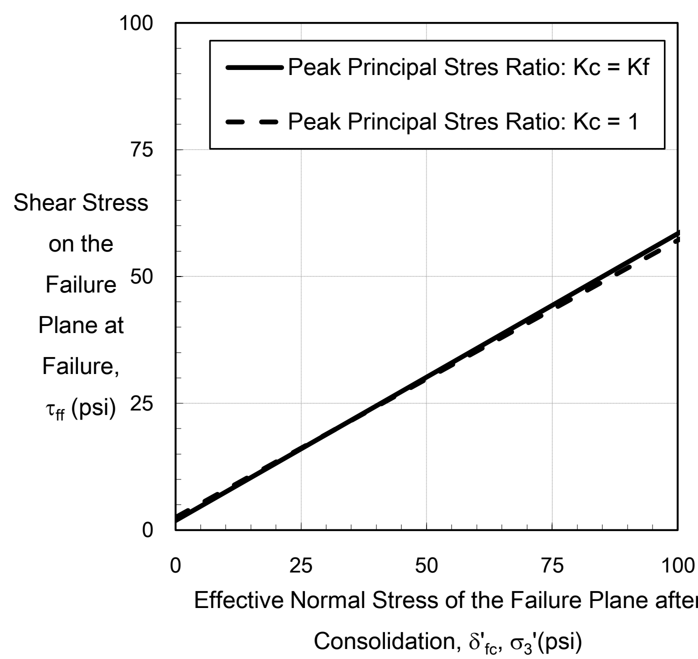
Kc = Kf Envelope, Effective Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	ϕ'	27.2	29.5
Effective Cohesion (psi)	c'	2.3	1.9

Kc = 1 (τ_{ff} vs σ'_{fc}) Envelope, Total Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	$d_{Kc=1}$	36.3	28.7
Cohesion (psi)	$\psi_{Kc=1}$	1.6	2.5

R / "Total Stress" Envelope



Three-Stage Rapid Drawdown Envelopes



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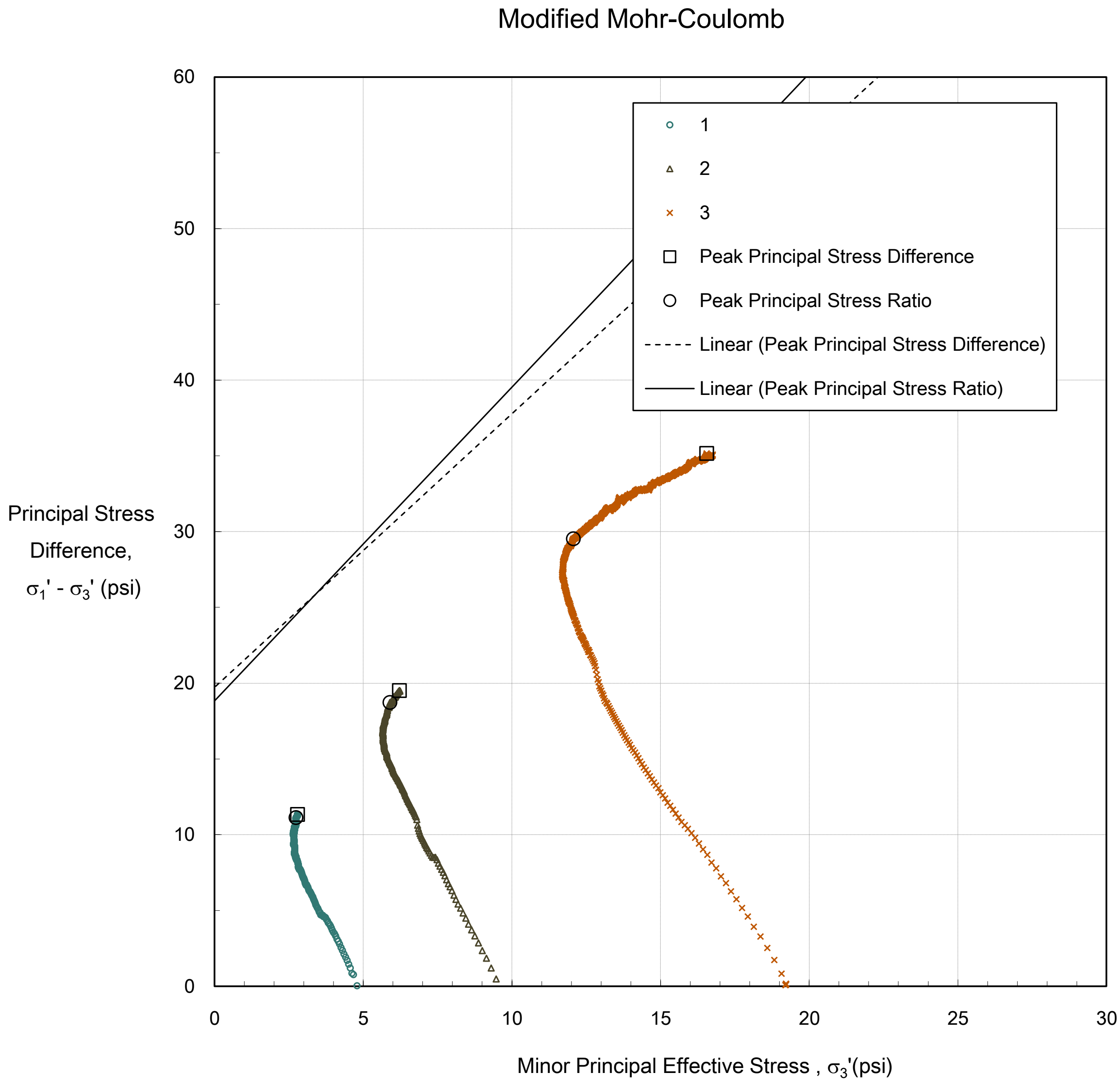
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-2 / 30-32

TRI Log #: 63507.2
Test Method: ASTM D4767 Mod



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	29.5
Effective Cohesion (psi)	-	1.9

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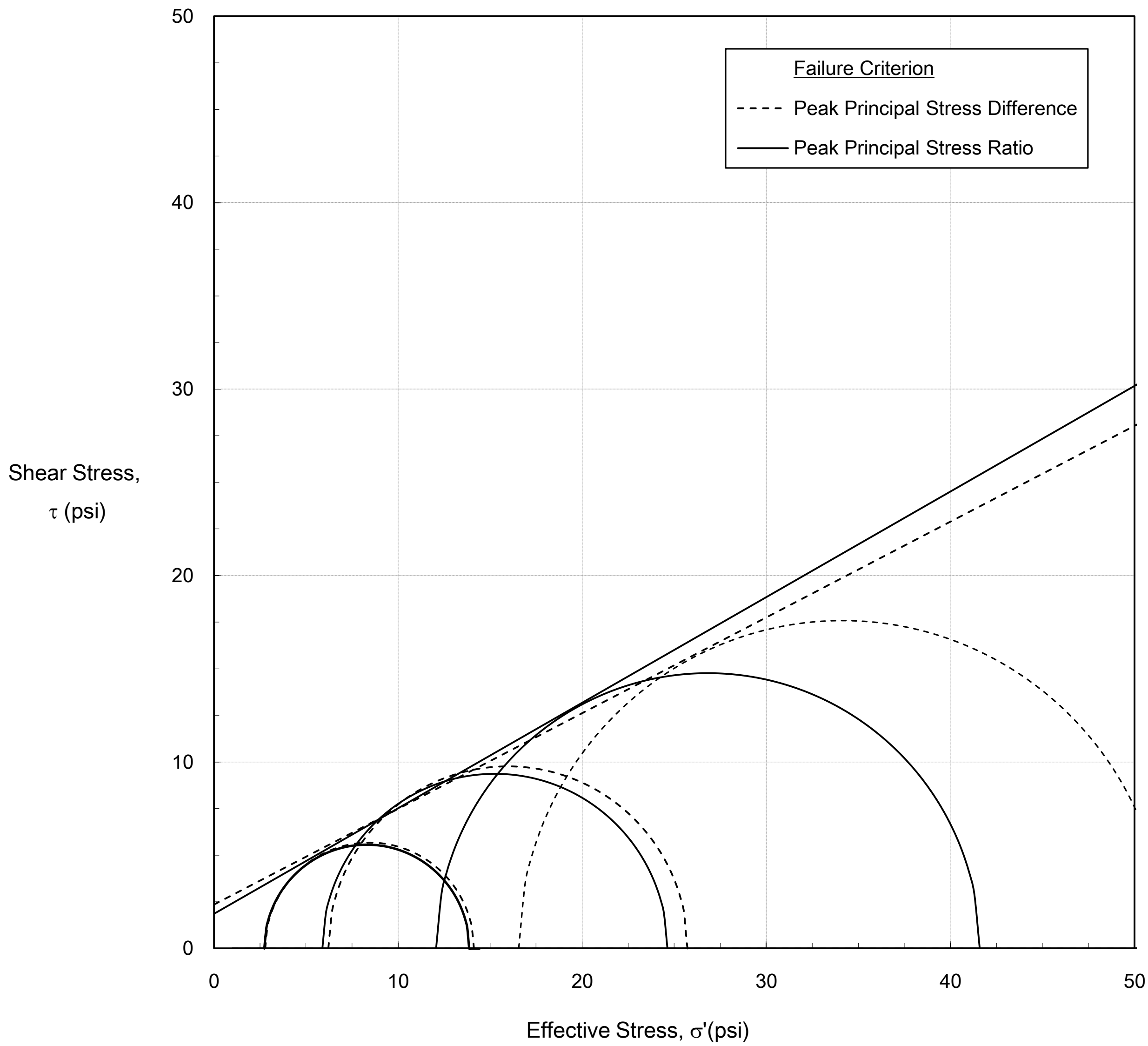
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
TRI Log #: 63507.2
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Test Method: ASTM D4767 Mod
Sample: MB-2 / 30-32

Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	29.5
Effective Cohesion (psi)	-	1.9

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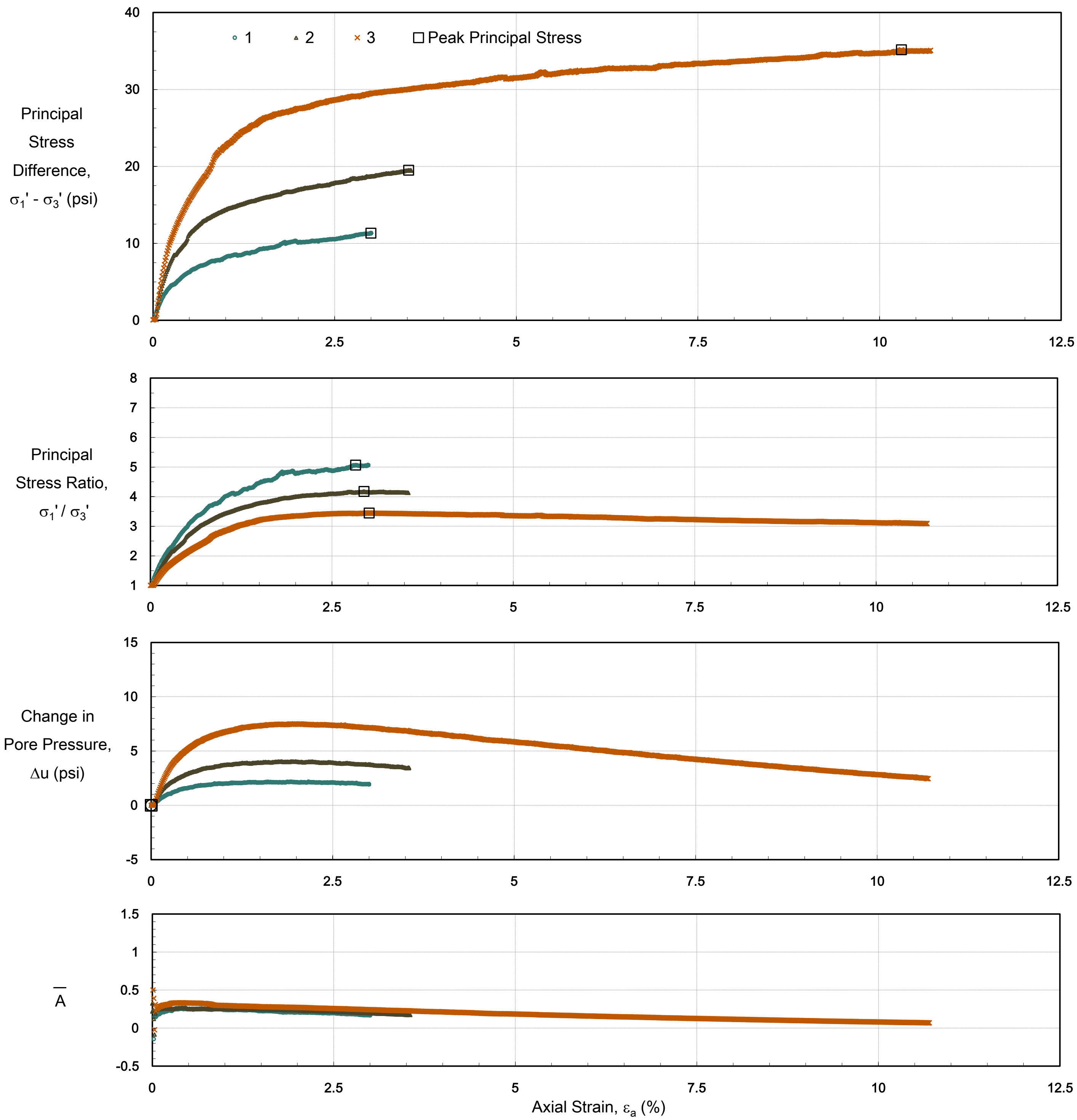
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-2 / 30-32

TRI Log #: 63507.2
Test Method: ASTM D4767 Mod



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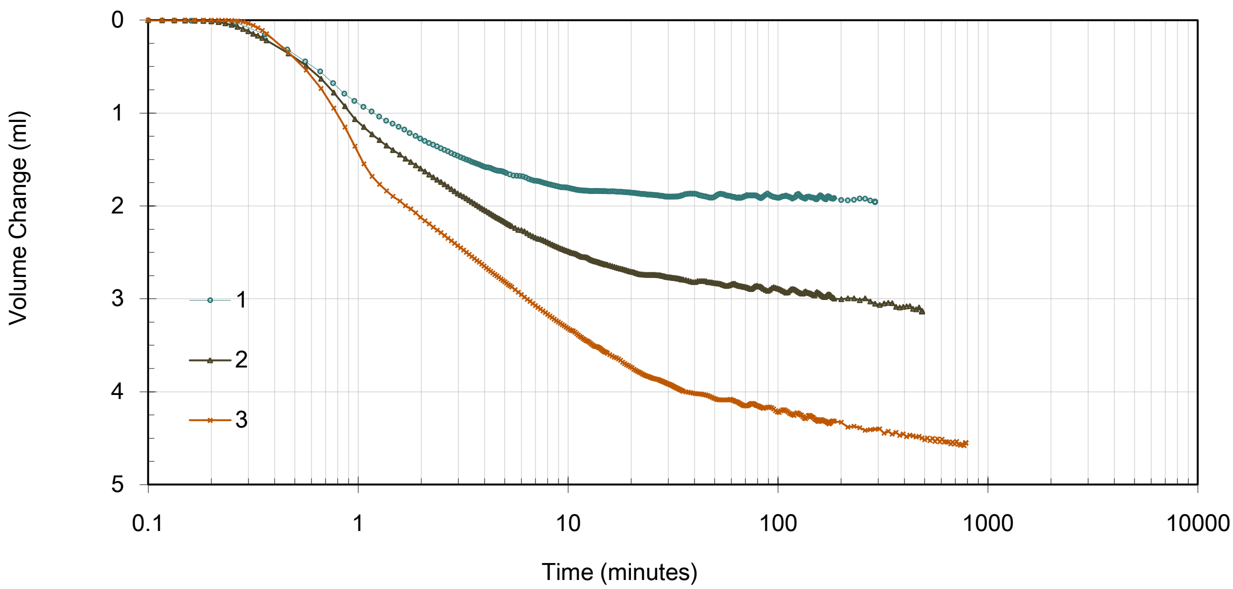
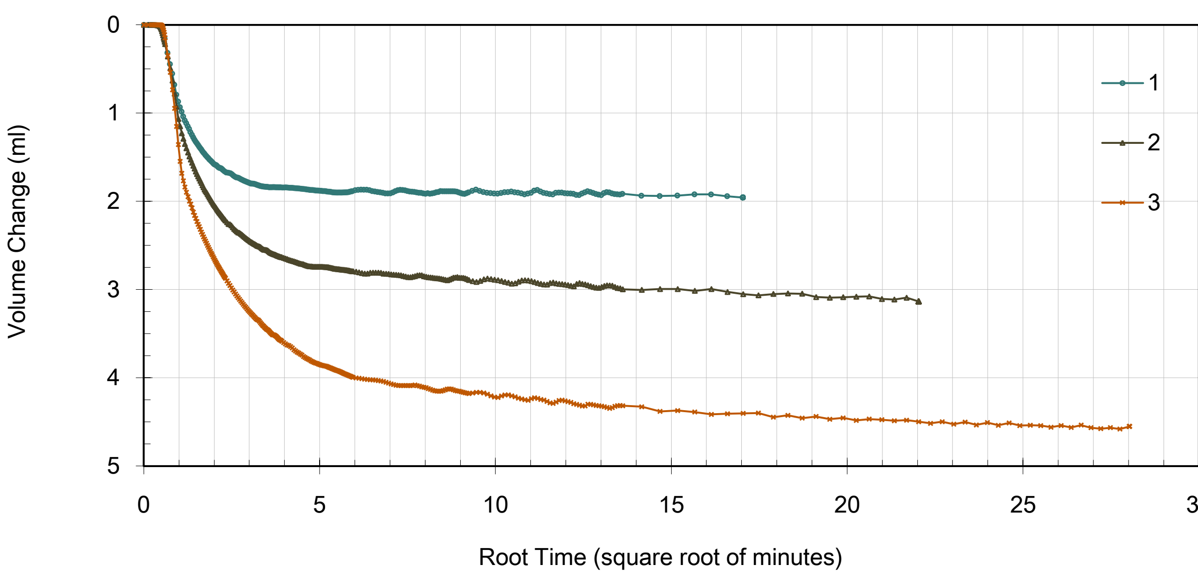
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-2 / 30-32

TRI Log #: 63507.2
Test Method: ASTM D4767 Mod

Consolidation





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Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-7 / 33-35

TRI Log #: 63508.1
Test Method: ASTM D4767 Mod

Specimens				
Identification	1	2	3	4
Depth/Elev. (ft)	-	-	-	-
Eff. Consol. Stress (psi)	6.1	12.2	24.4	-
Initial Specimen Properties				
Avg. Diameter (in)	2.03	2.05	2.05	-
Avg. Height (in)	4.80	4.70	4.61	-
Avg. Water Content (%)	20.8	-	-	-
Bulk Density (pcf)	126.9	-	-	-
Dry Density (pcf)	105.1	-	-	-
Specific Gravity (Assumed)	2.75			
Saturation (%)	90.2	-	-	-
Void Ratio, n	0.63	0.62	0.60	-
B-Value, End of Saturation	0.98	-	-	-

Test Setup	
Specimen Condition	Undisturbed / Intact
Specimen Preparation	Trimmed
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear				
Void Ratio	0.62	0.60	0.57	-

Shear / Post-Shear				
Rate of Strain (%/hr)	1.00	1.00	1.00	-
Avg. Water Content (%)	-	-	23.4	-

At Failure								
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$				Ratio, $(\sigma_1'/\sigma_3')_{max}$			
Axial Strain at Failure (%), $\varepsilon_{a,f}$	-	-	-	-	2.4	2.2	2.8	-
Minor Effective Stress (psi), $\sigma_3'_f$	-	-	-	-	4.4	8.4	16.1	-
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	-	-	-	-	14.8	24.1	39.1	-
Pore Water Pressure, Δu_f (psi)	-	-	-	-	1.7	3.8	8.3	-
Major Effective Stress (psi), $\sigma_1'_f$	-	-	-	-	19.2	32.5	55.2	-
Secant Friction Angle (degrees)	-	-	-	-	38.8	36.2	33.2	-
Effective Friction Angle (degrees)	-				30.5			
Effective Cohesion (psi)	-				1.8			

Note: Multi-stage testing was performed for this sample. The first two stages were terminated in accordance with stress path tangency and/or peak principal stress ratio. The presented M-C parameters are based on a linear regression in modified stress space, across all assigned effective consolidation stresses. This fit does not purported to capture typical curvature of envelopes that may, in particular, be observed across broader range in effective stresses. Please note that the stresses associated with peak principal stress ratio are presented in tabular form on the first page of the report. There are alternate interpretations to this failure criterion including but not limited to peak principal stress difference and strain compatibility.

Jeffrey A. Kuhn , Ph.D., P.E., 6/7/2021
Analysis & Quality Review/Date

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Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-7 / 33-35

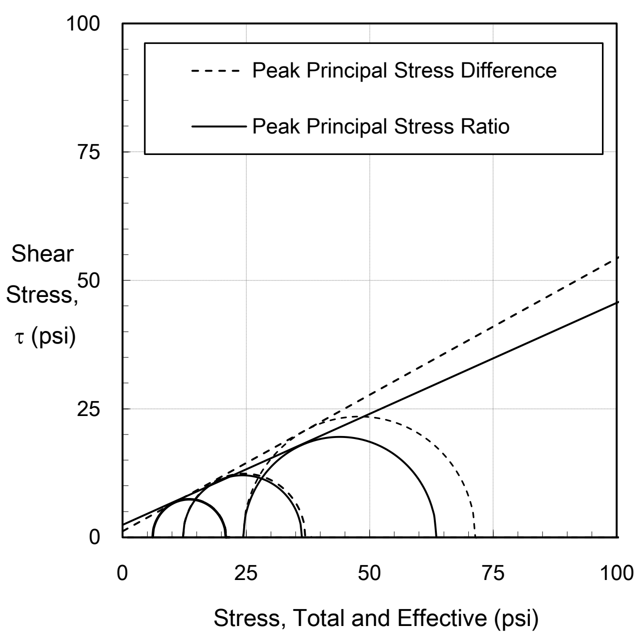
TRI Log #: 63508.1
Test Method: ASTM D4767 Mod

R / "Total Stress" Envelope			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	ϕ_R	28.0	23.4
Cohesion (psi)	c_R	1.1	2.4

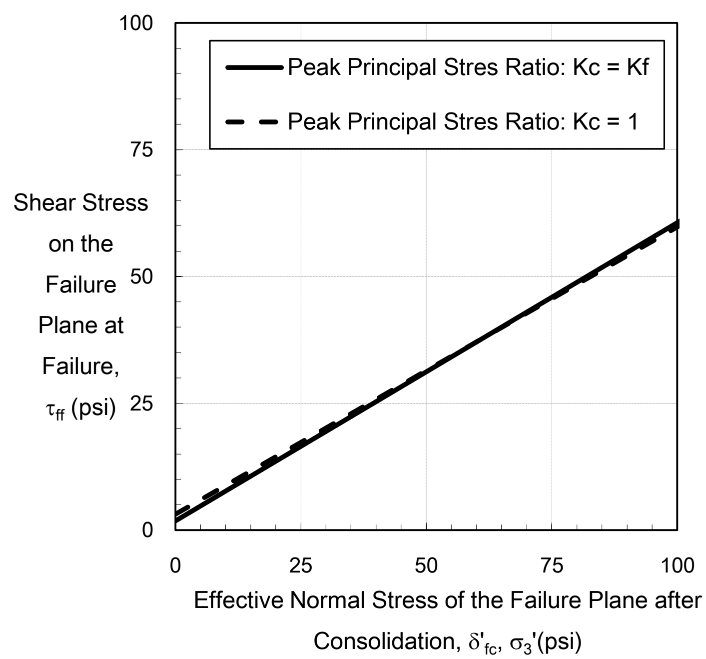
Kc = Kf Envelope, Effective Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	ϕ'	28.5	30.5
Effective Cohesion (psi)	c'	2.3	1.8

Kc = 1 (τ_{ff} vs σ'_{fc}) Envelope, Total Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	$d_{Kc=1}$	37.8	29.5
Cohesion (psi)	$\psi_{Kc=1}$	1.6	3.1

R / "Total Stress" Envelope



Three-Stage Rapid Drawdown Envelopes



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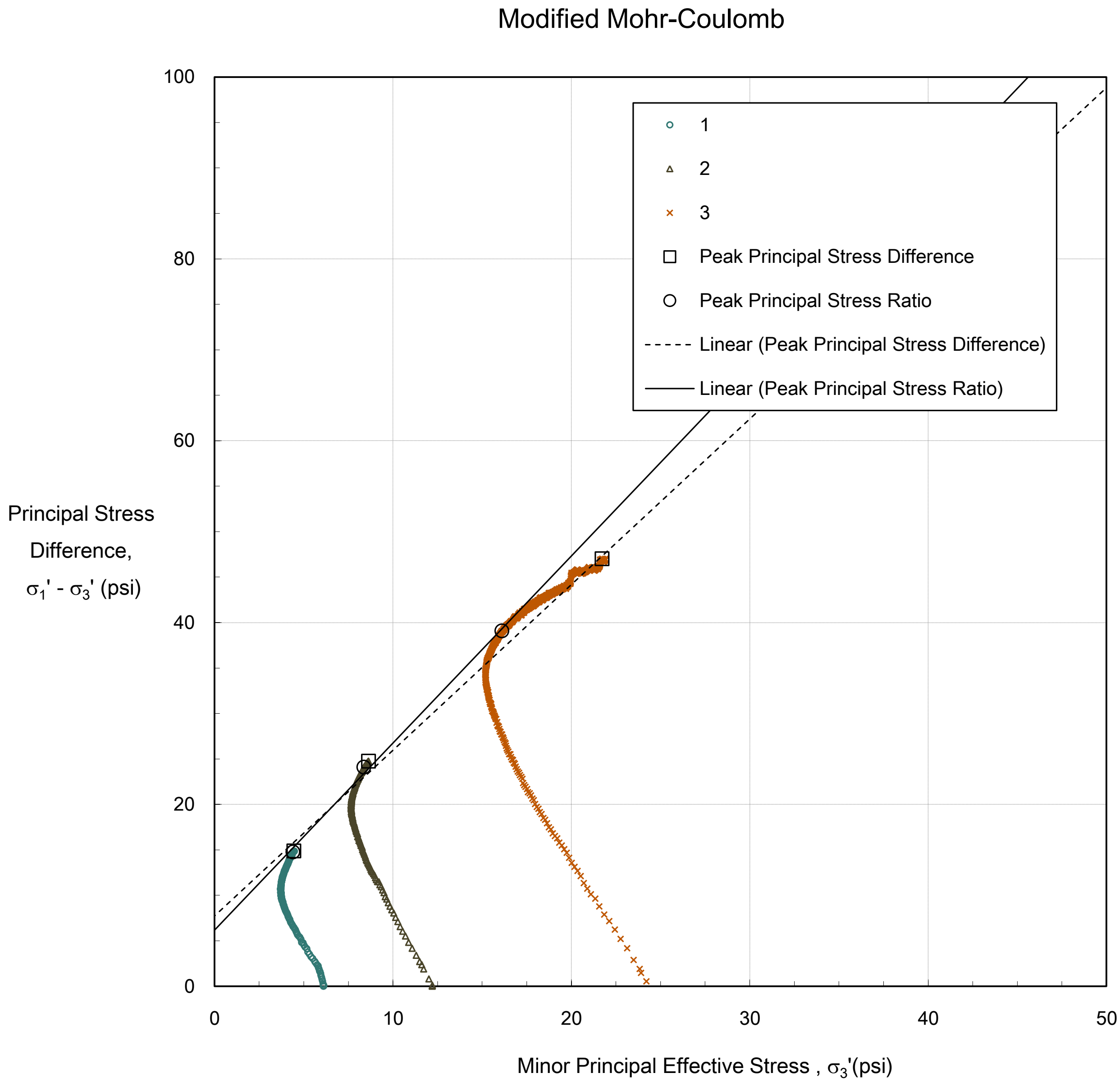
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-7 / 33-35

TRI Log #: 63508.1
Test Method: ASTM D4767 Mod



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	30.5
Effective Cohesion (psi)	-	1.8

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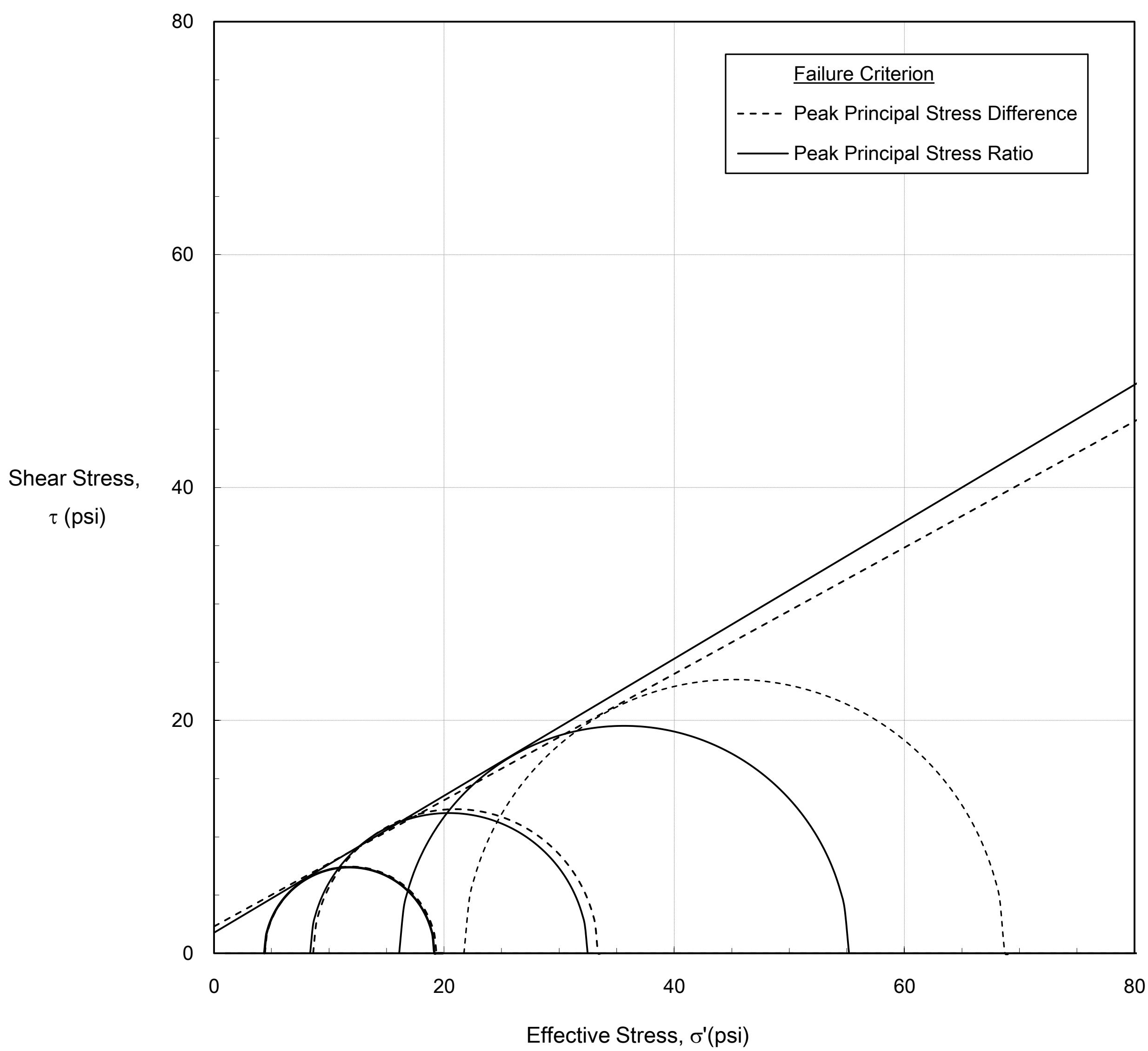
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc | TRI Log #: 63508.1
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project | Test Method: ASTM D4767 Mod
Sample: MB-7 / 33-35

Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	30.5
Effective Cohesion (psi)	-	1.8

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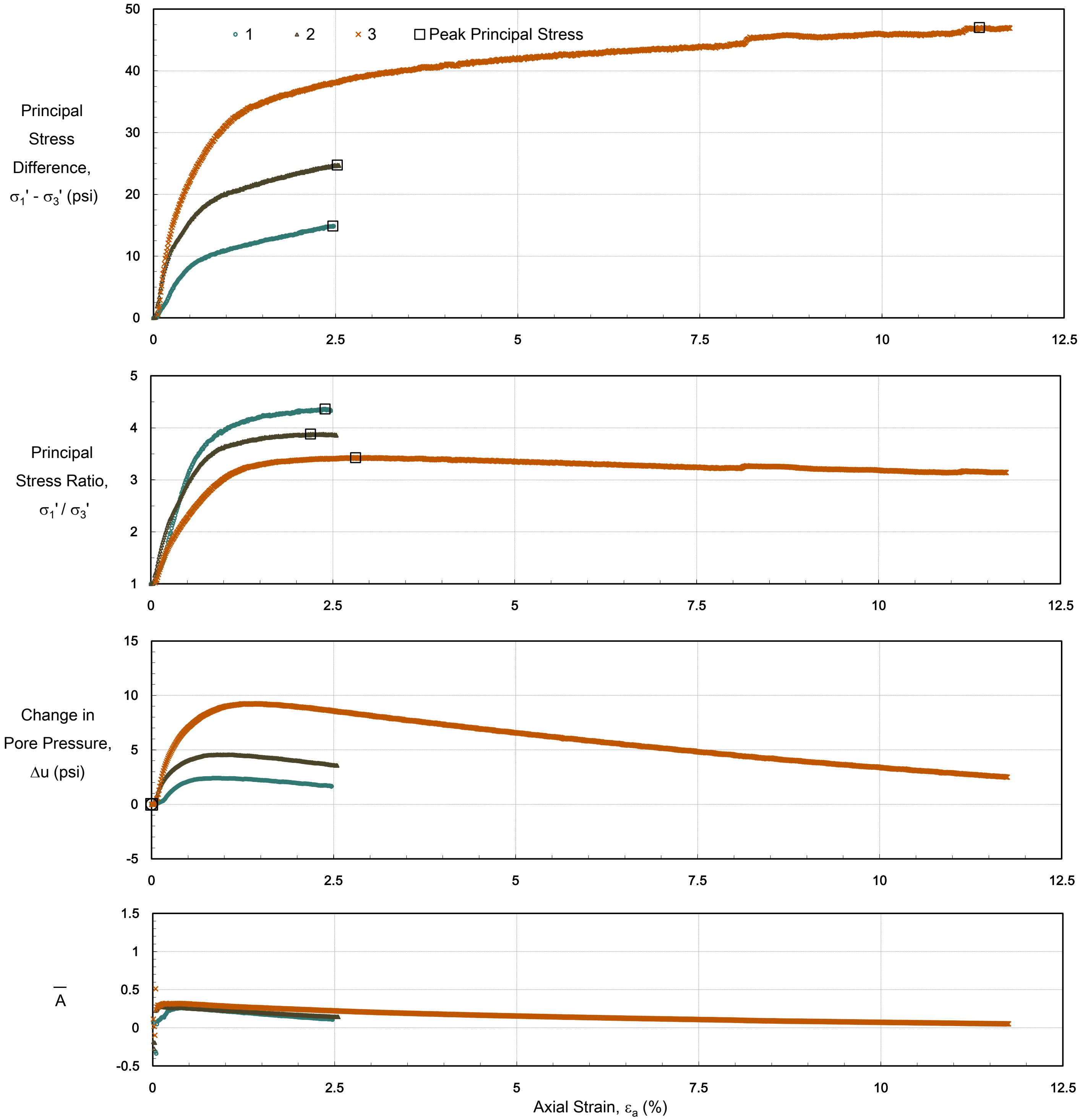
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc | TRI Log #: 63508.1
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project | Test Method: ASTM D4767 Mod
Sample: MB-7 / 33-35



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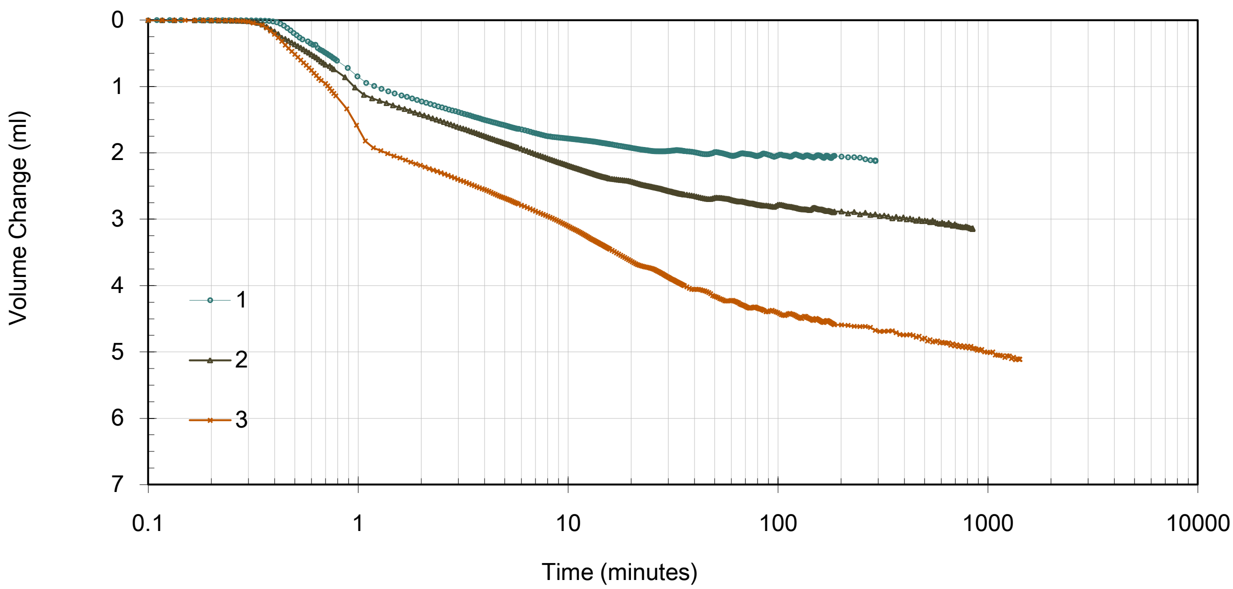
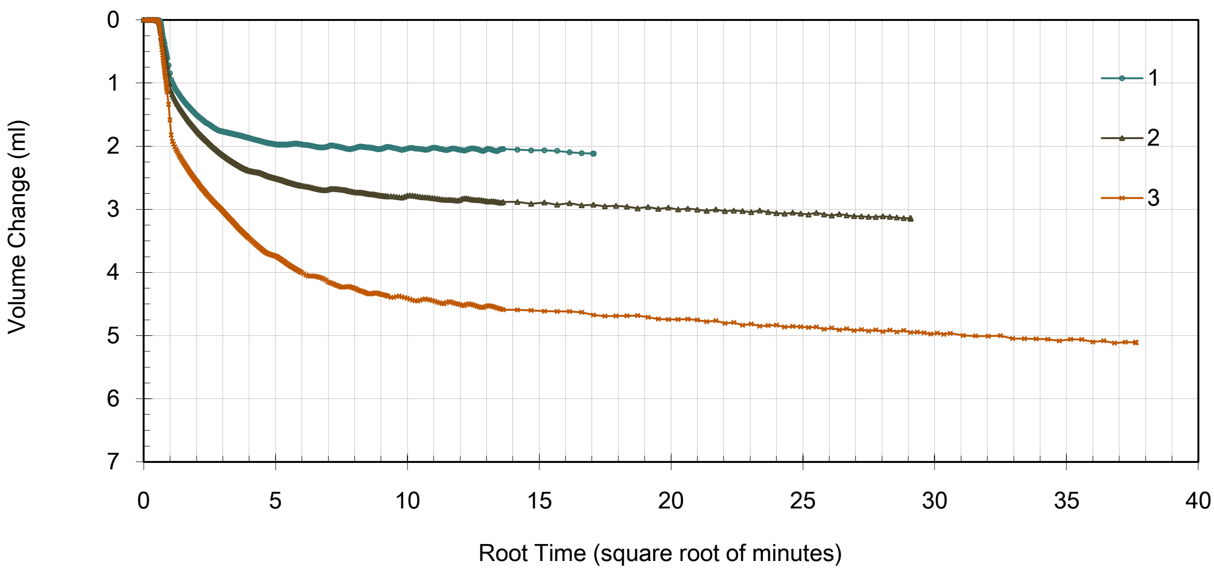
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-7 / 33-35

TRI Log #: 63508.1
Test Method: ASTM D4767 Mod

Consolidation





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Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-9 / 18-20

TRI Log #: 63508.2
Test Method: ASTM D4767 Mod

Specimens				
Identification	1	2	3	4
Depth/Elev. (ft)	-	-	-	-
Eff. Consol. Stress (psi)	3.0	5.9	11.9	-
Initial Specimen Properties				
Avg. Diameter (in)	2.02	2.04	2.05	-
Avg. Height (in)	4.05	3.98	3.92	-
Avg. Water Content (%)	32.2	-	-	-
Bulk Density (pcf)	117.8	-	-	-
Dry Density (pcf)	89.1	-	-	-
Specific Gravity (Assumed)	2.75			
Saturation (%)	95.7	-	-	-
Void Ratio, n	0.93	0.92	0.91	-
B-Value, End of Saturation	0.95	-	-	-

Test Setup	
Specimen Condition	Undisturbed / Intact
Specimen Preparation	Trimmed
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear				
Void Ratio	0.92	0.91	0.90	-

Shear / Post-Shear				
Rate of Strain (%/hr)	1.00	1.00	1.00	-
Avg. Water Content (%)	-	-	29.8	-

At Failure								
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$				Ratio, $(\sigma_1'/\sigma_3')_{max}$			
Axial Strain at Failure (%), $\varepsilon_{a,f}$	-	-	-	-	2.3	1.5	1.5	-
Minor Effective Stress (psi), $\sigma_3'_f$	-	-	-	-	1.0	2.3	5.6	-
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	-	-	-	-	12.1	16.7	21.1	-
Pore Water Pressure, Δu_f (psi)	-	-	-	-	2.0	3.7	6.3	-
Major Effective Stress (psi), $\sigma_1'_f$	-	-	-	-	13.1	18.9	26.7	-
Secant Friction Angle (degrees)	-	-	-	-	58.9	51.7	40.6	-
Effective Friction Angle (degrees)	-				28.3			
Effective Cohesion (psi)	-				3.4			

Note: Multi-stage testing was performed for this sample. The first two stages were terminated in accordance with stress path tangency and/or peak principal stress ratio. The presented M-C parameters are based on a linear regression in modified stress space, across all assigned effective consolidation stresses. This fit does not purported to capture typical curvature of envelopes that may, in particular, be observed across broader range in effective stresses. Please note that the stresses associated with peak principal stress ratio are presented in tabular form on the first page of the report. There are alternate interpretations to this failure criterion including but not limited to peak principal stress difference and strain compatibility.

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Analysis & Quality Review/Date

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-9 / 18-20

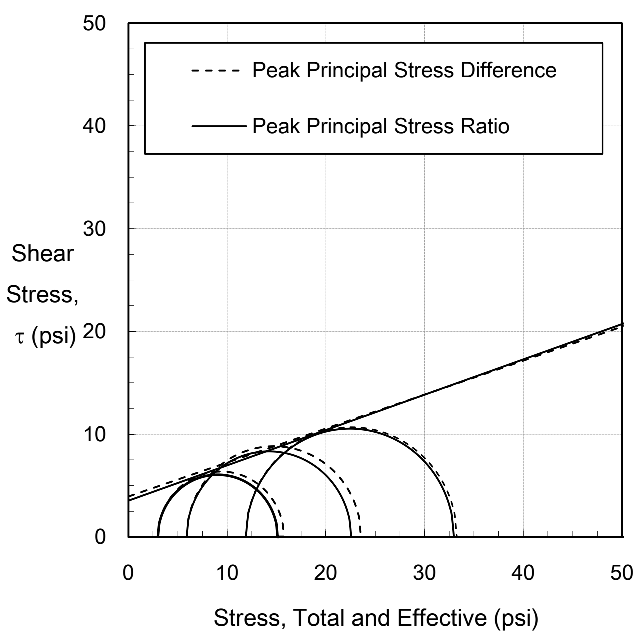
TRI Log #: 63508.2
Test Method: ASTM D4767 Mod

R / "Total Stress" Envelope			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	ϕ_R	18.3	19.0
Cohesion (psi)	c_R	3.9	3.5

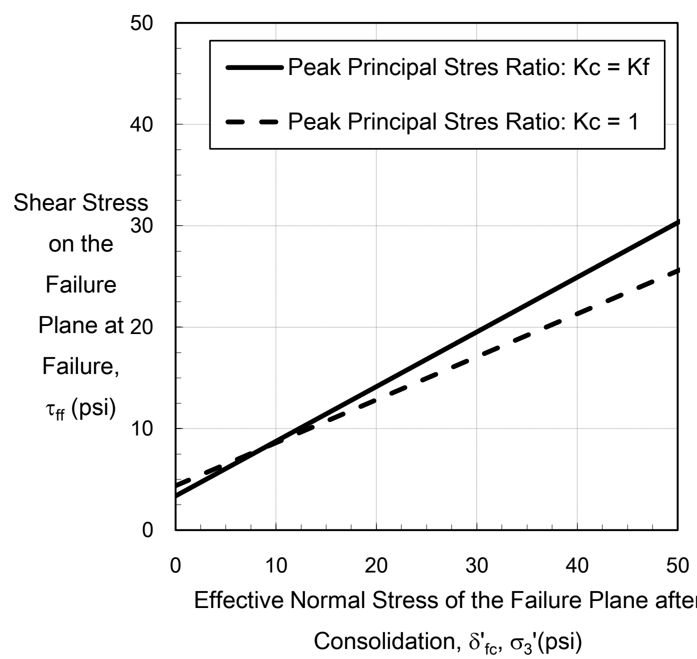
Kc = Kf Envelope, Effective Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	ϕ'	28.1	28.3
Effective Cohesion (psi)	c'	3.4	3.4

Kc = 1 (τ_{ff} vs σ'_{fc}) Envelope, Total Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	$d_{Kc=1}$	22.0	23.0
Cohesion (psi)	$\psi_{Kc=1}$	4.8	4.4

R / "Total Stress" Envelope



Three-Stage Rapid Drawdown Envelopes



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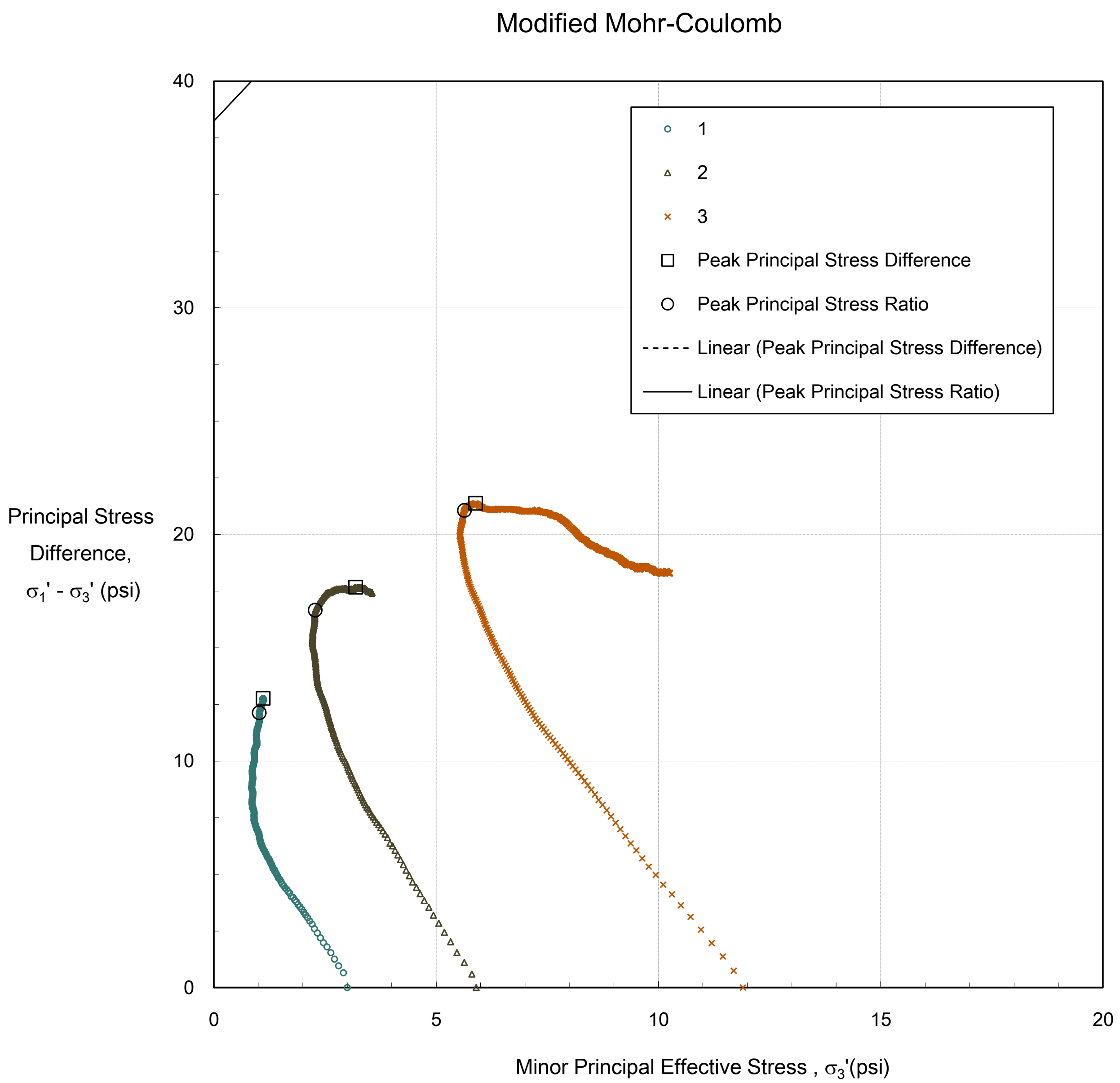
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-9 / 18-20

TRI Log #: 63508.2
Test Method: ASTM D4767 Mod



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	28.3
Effective Cohesion (psi)	-	3.4

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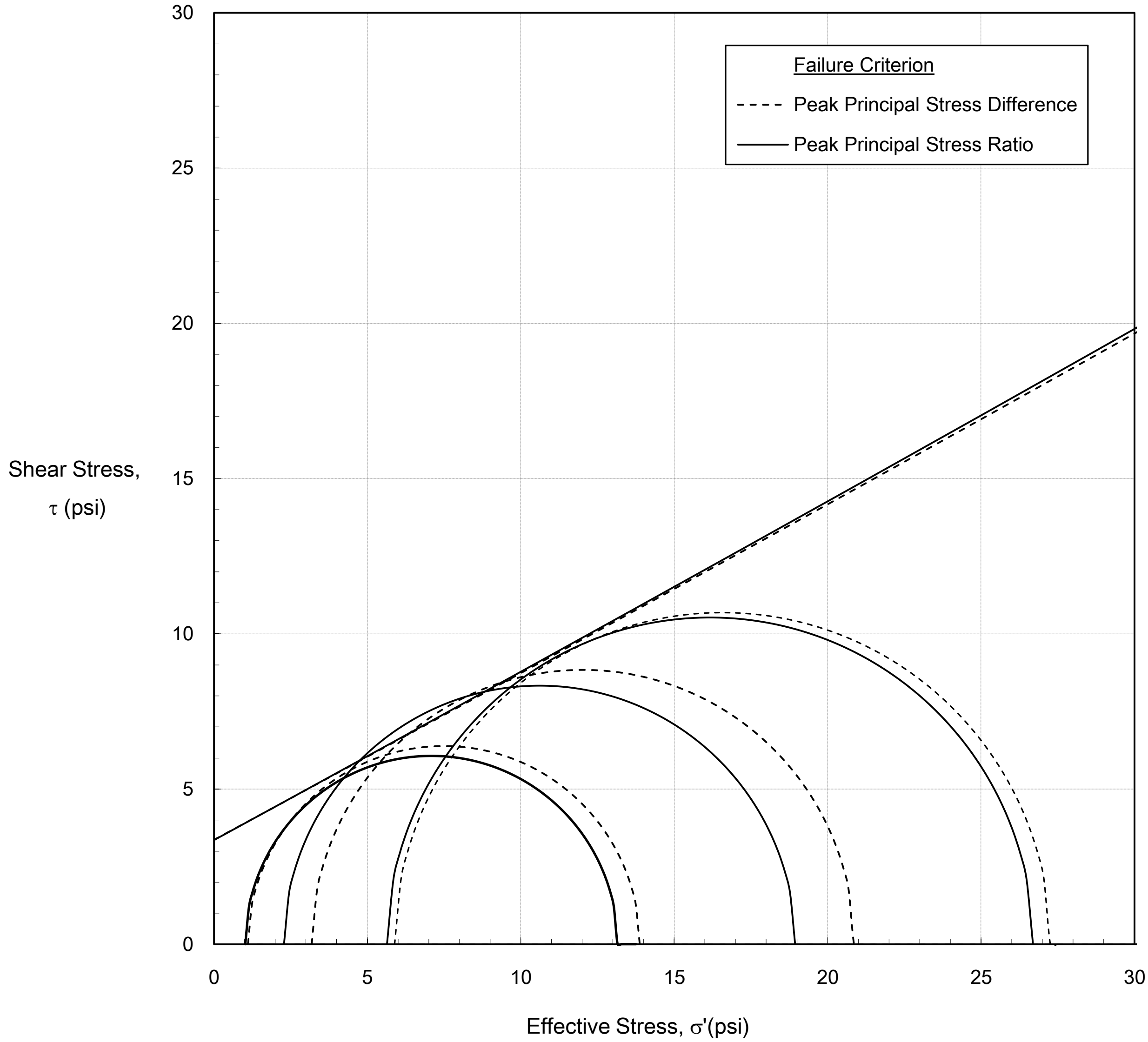
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-9 / 18-20

TRI Log #: 63508.2
Test Method: ASTM D4767 Mod

Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	28.3
Effective Cohesion (psi)	-	3.4

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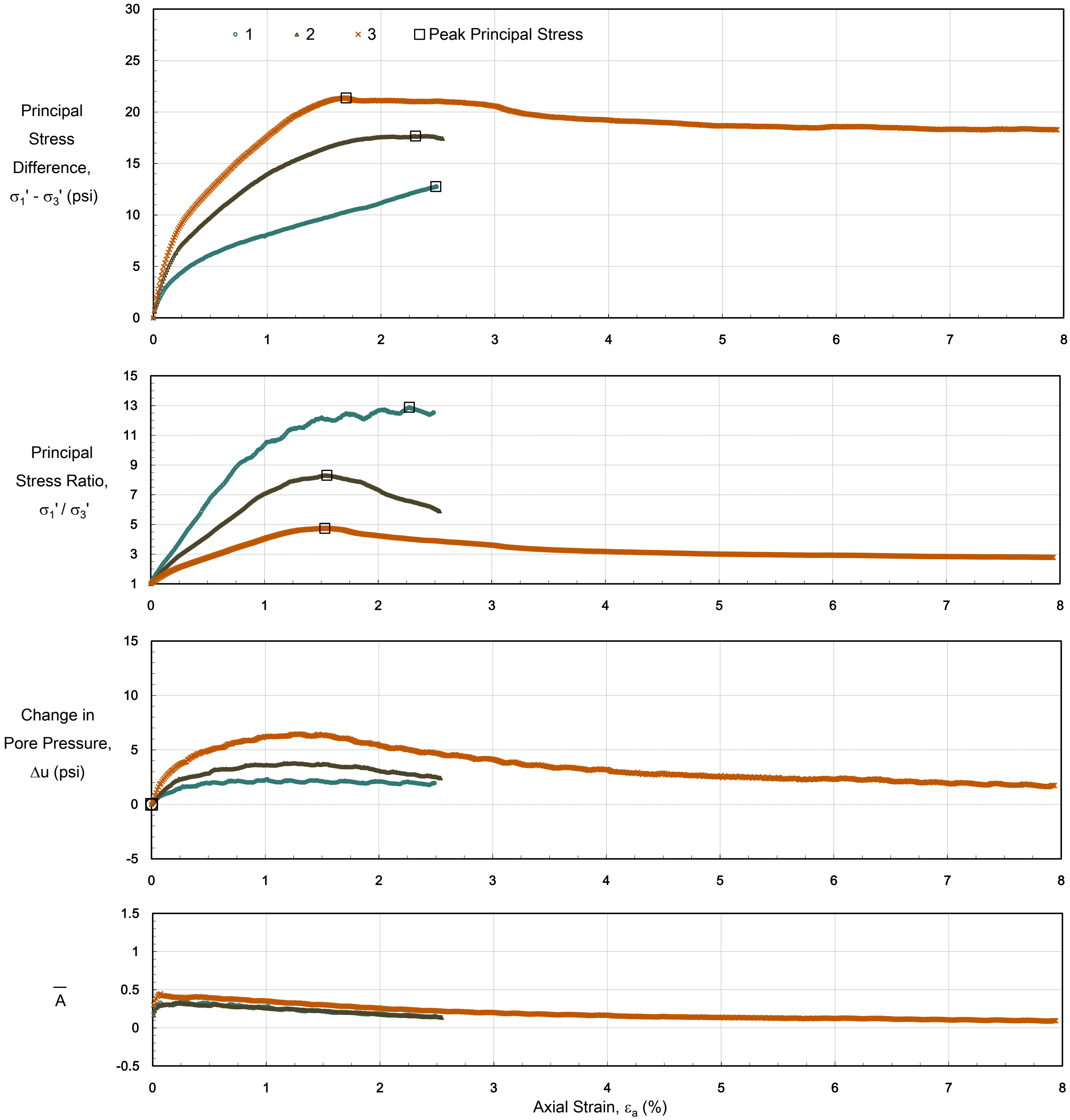
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-9 / 18-20

TRI Log #: 63508.2
Test Method: ASTM D4767 Mod



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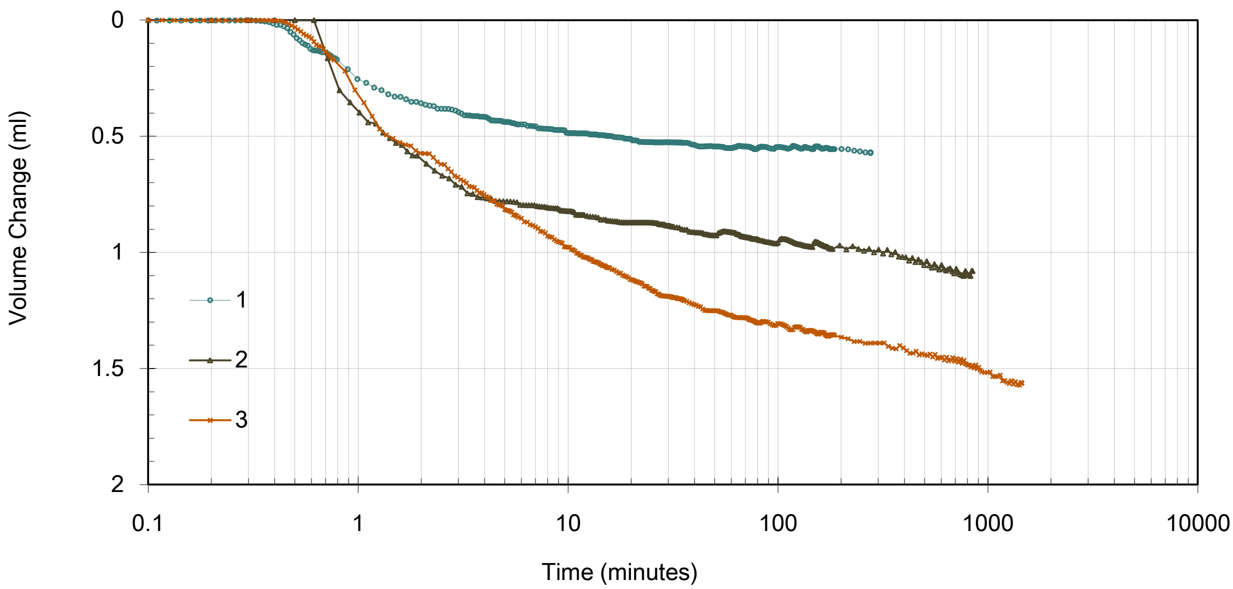
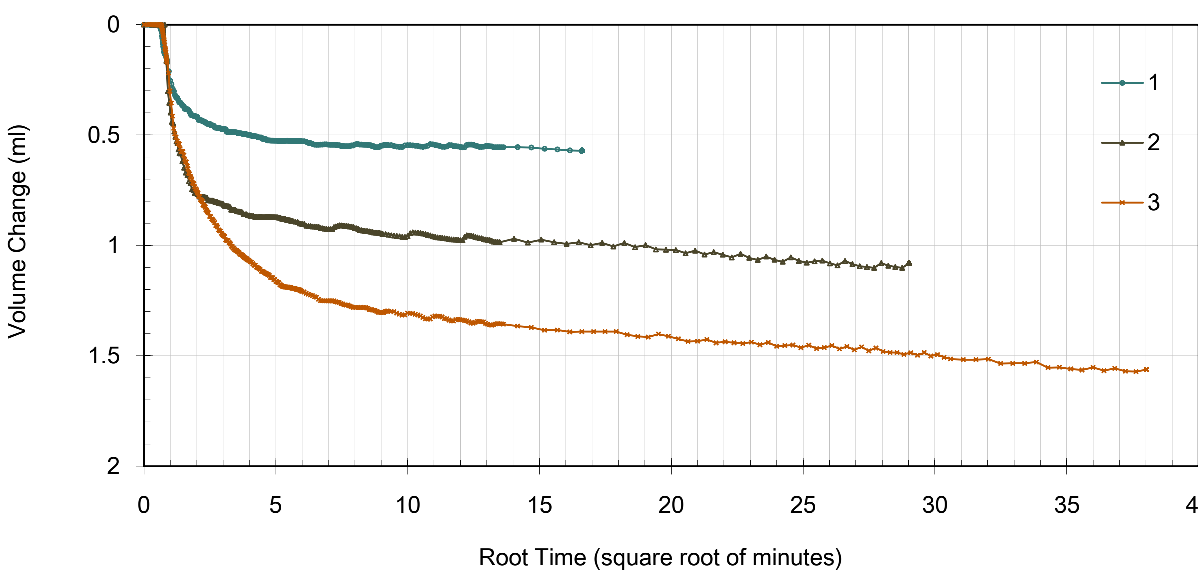
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: MB-9 / 18-20

TRI Log #: 63508.2
Test Method: ASTM D4767 Mod

Consolidation





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Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: LB-1 / 9-11

TRI Log #: 63508.3
Test Method: ASTM D4767 Mod

Specimens				
Identification	1	2	3	4
Depth/Elev. (ft)	-	-	-	-
Eff. Consol. Stress (psi)	3.5	7.1	14.1	-
Initial Specimen Properties				
Avg. Diameter (in)	2.03	2.05	2.06	-
Avg. Height (in)	4.21	4.10	4.01	-
Avg. Water Content (%)	26.9	-	-	-
Bulk Density (pcf)	119.5	-	-	-
Dry Density (pcf)	94.2	-	-	-
Specific Gravity (Assumed)	2.75			
Saturation (%)	90.0	-	-	-
Void Ratio, n	0.82	0.81	0.80	-
B-Value, End of Saturation	0.98	-	-	-

Test Setup	
Specimen Condition	Undisturbed / Intact
Specimen Preparation	Trimmed
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear				
Void Ratio	0.81	0.80	0.79	-

Shear / Post-Shear				
Rate of Strain (%/hr)	1.00	1.00	1.00	-
Avg. Water Content (%)	-	-	30.5	-

At Failure								
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$				Ratio, $(\sigma_1'/\sigma_3')_{max}$			
Axial Strain at Failure (%), $\varepsilon_{a,f}$	-	-	-	-	0.9	1.1	5.2	-
Minor Effective Stress (psi), $\sigma_3'_f$	-	-	-	-	2.2	4.6	9.3	-
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	-	-	-	-	7.6	11.8	17.3	-
Pore Water Pressure, Δu_f (psi)	-	-	-	-	1.3	2.4	4.7	-
Major Effective Stress (psi), $\sigma_1'_f$	-	-	-	-	9.8	16.4	26.7	-
Secant Friction Angle (degrees)	-	-	-	-	39.1	34.0	28.8	-
Effective Friction Angle (degrees)	-				23.7			
Effective Cohesion (psi)	-				1.6			

Note: Multi-stage testing was performed for this sample. The first two stages were terminated in accordance with stress path tangency and/or peak principal stress ratio. The presented M-C parameters are based on a linear regression in modified stress space, across all assigned effective consolidation stresses. This fit does not purported to capture typical curvature of envelopes that may, in particular, be observed across broader range in effective stresses. Please note that the stresses associated with peak principal stress ratio are presented in tabular form on the first page of the report. There are alternate interpretations to this failure criterion including but not limited to peak principal stress difference and strain compatibility.

Jeffrey A. Kuhn , Ph.D., P.E., 6/7/2021
Analysis & Quality Review/Date

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Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: LB-1 / 9-11

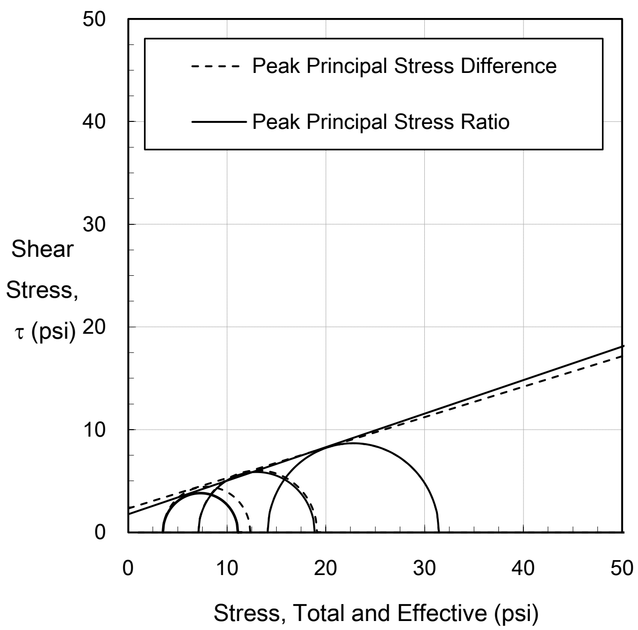
TRI Log #: 63508.3
Test Method: ASTM D4767 Mod

R / "Total Stress" Envelope			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	ϕ_R	16.5	18.1
Cohesion (psi)	c_R	2.3	1.7

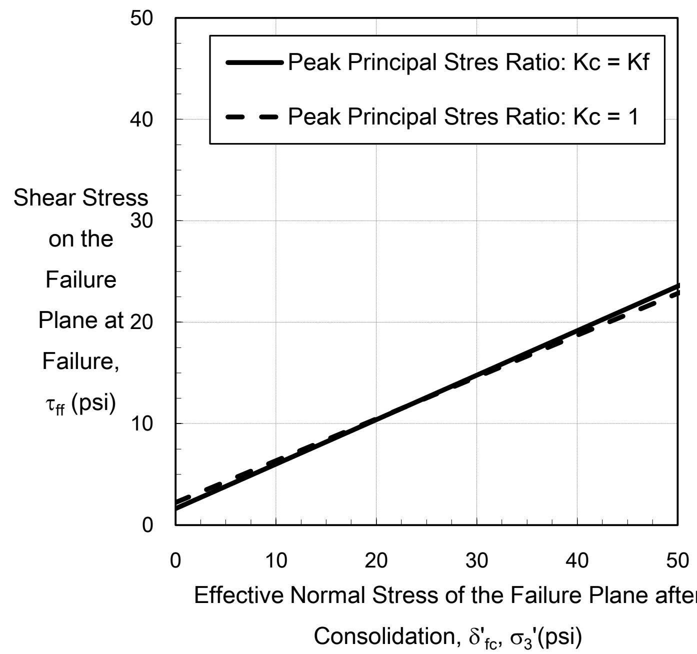
Kc = Kf Envelope, Effective Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	ϕ'	22.9	23.7
Effective Cohesion (psi)	c'	1.8	1.6

Kc = 1 (τ_{ff} vs σ'_{fc}) Envelope, Total Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	$d_{Kc=1}$	20.1	22.4
Cohesion (psi)	$\psi_{Kc=1}$	2.9	2.2

R / "Total Stress" Envelope



Three-Stage Rapid Drawdown Envelopes



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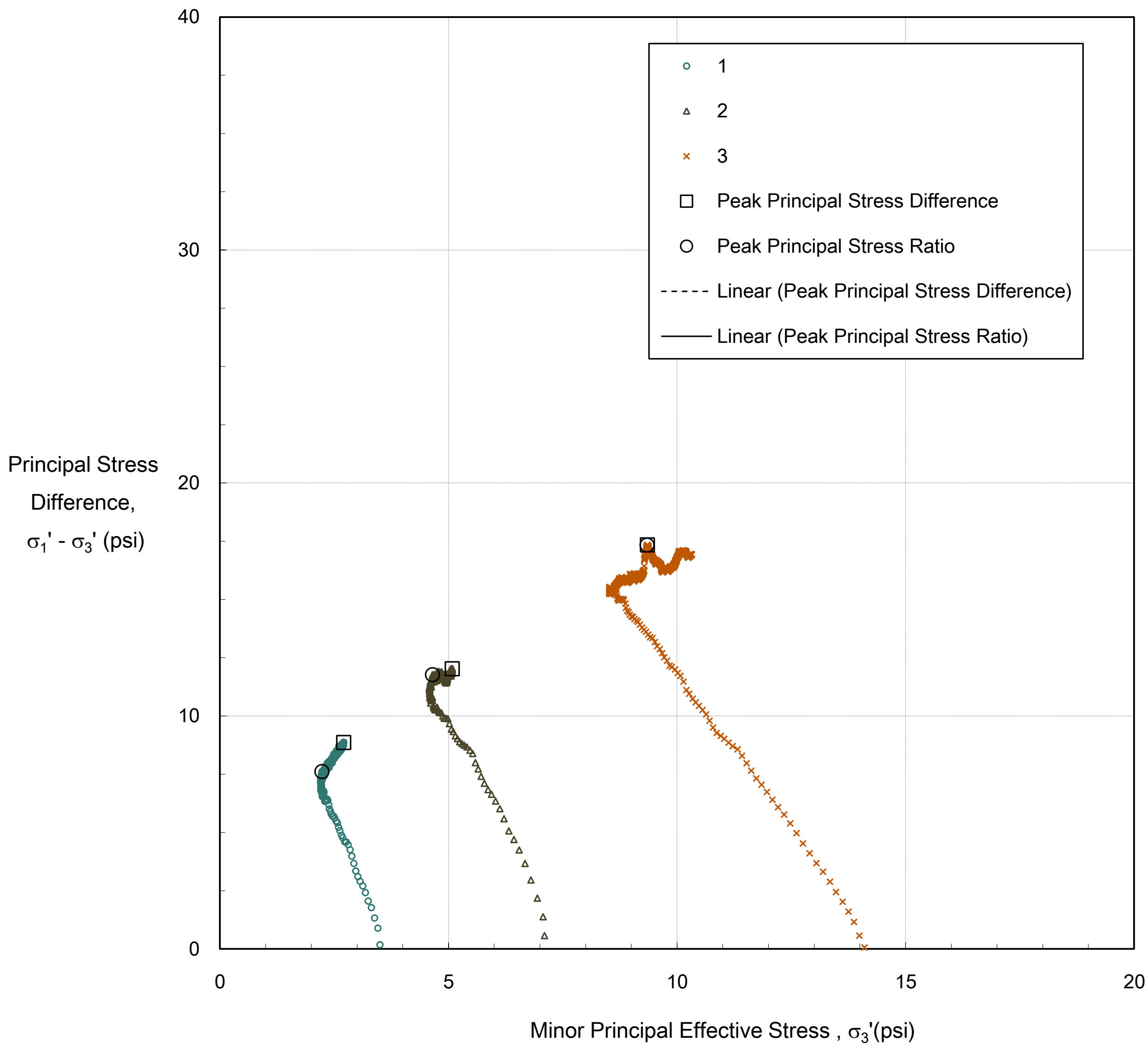
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: LB-1 / 9-11

TRI Log #: 63508.3
Test Method: ASTM D4767 Mod

Modified Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	23.7
Effective Cohesion (psi)	-	1.6

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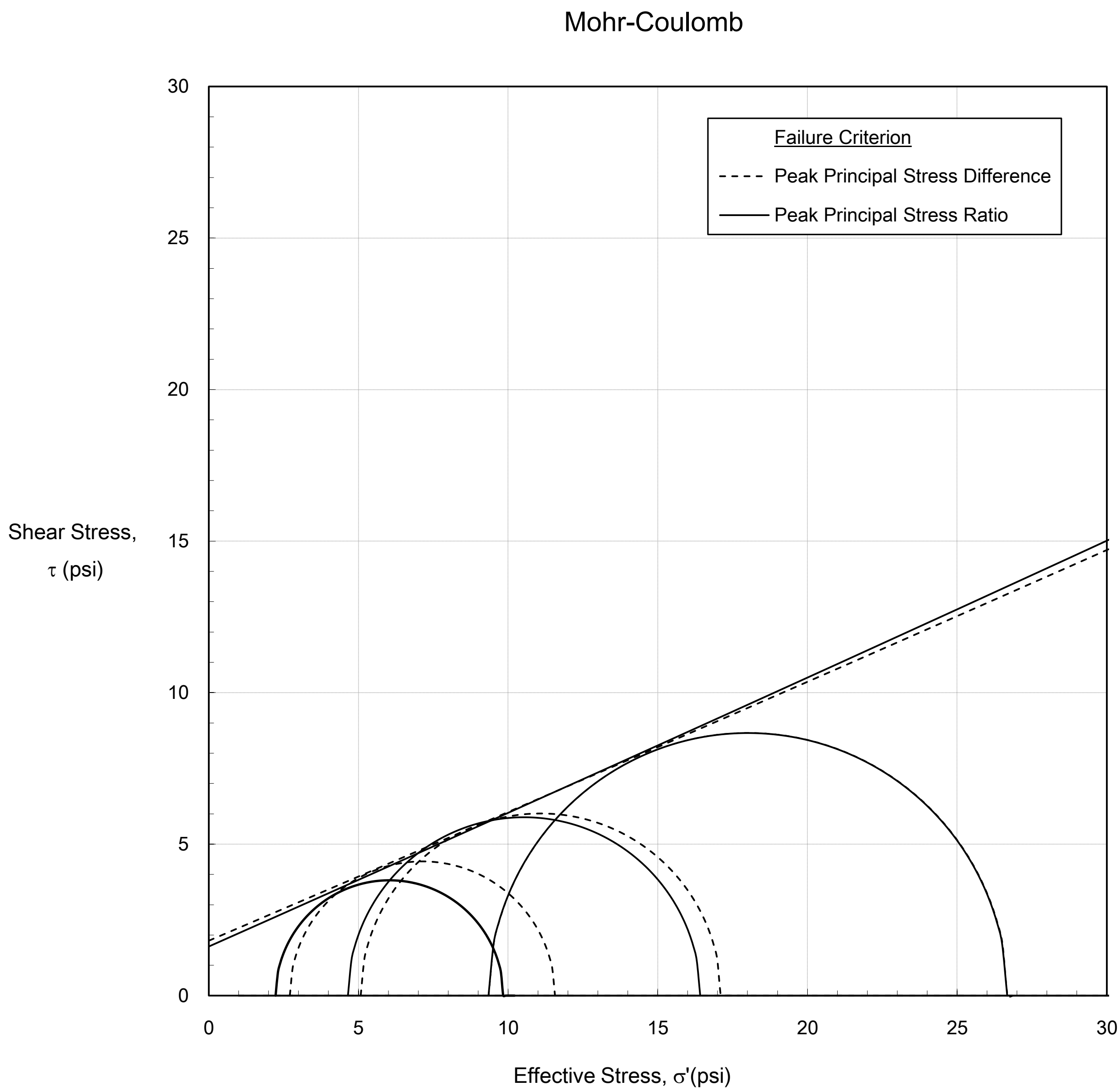
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: LB-1 / 9-11

TRI Log #: 63508.3
Test Method: ASTM D4767 Mod



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	23.7
Effective Cohesion (psi)	-	1.6

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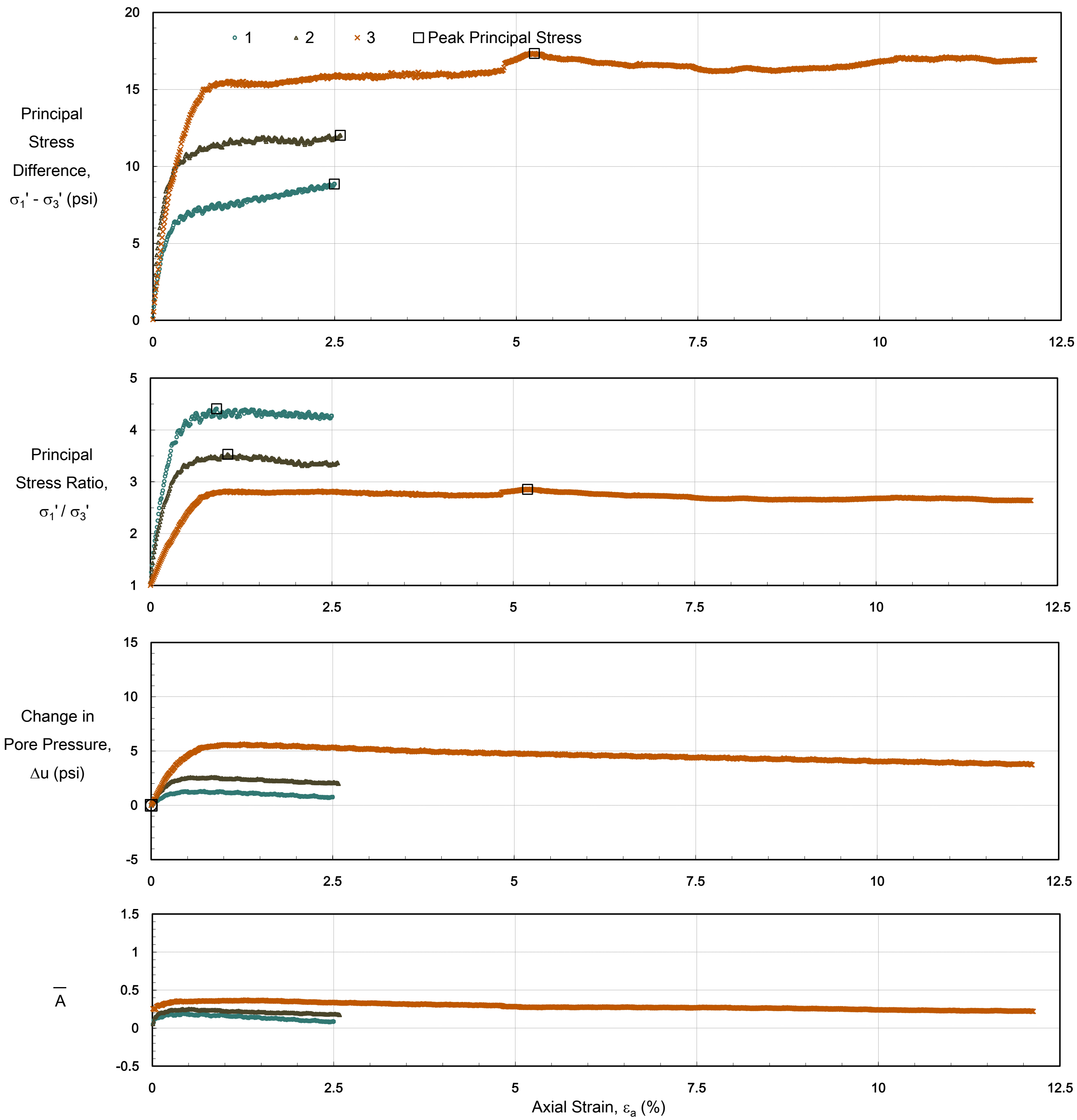
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: LB-1 / 9-11

TRI Log #: 63508.3
Test Method: ASTM D4767 Mod



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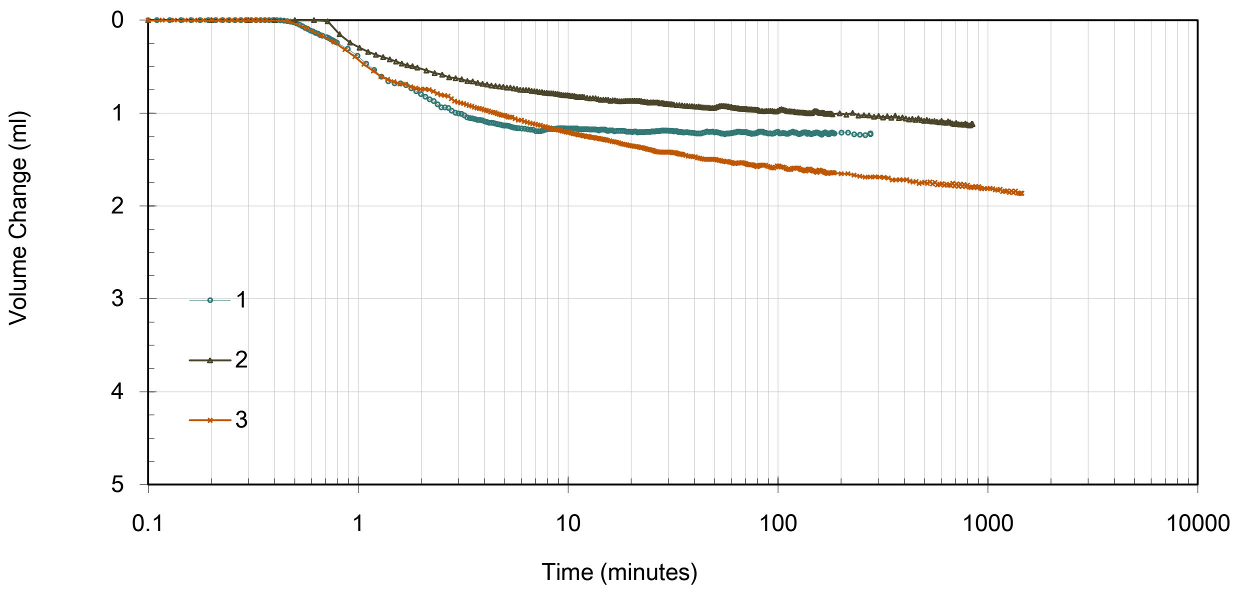
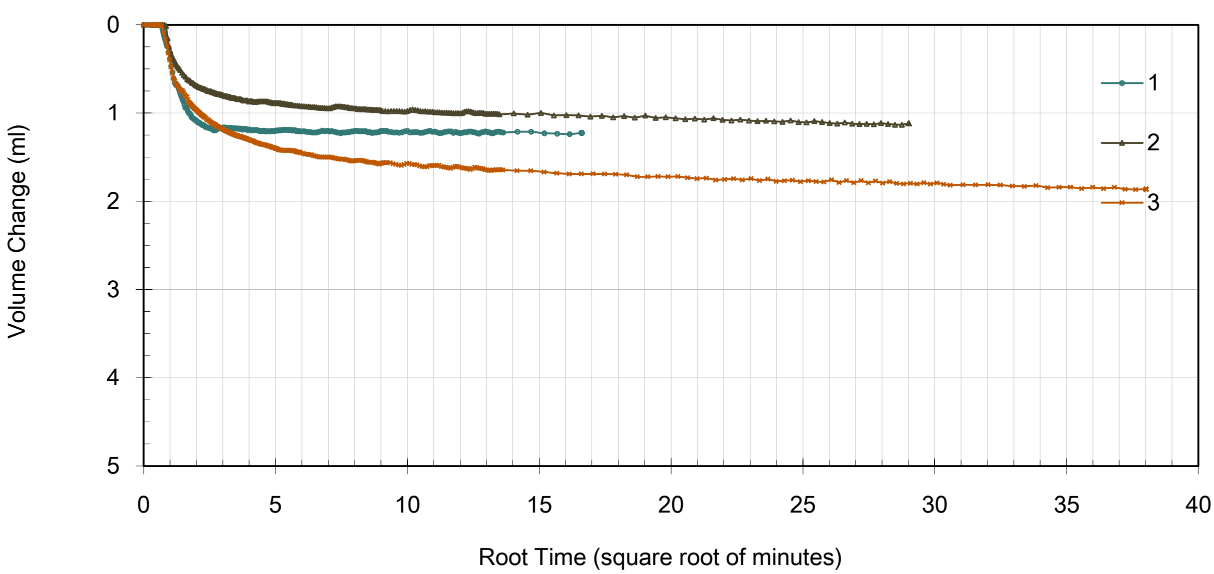
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: LB-1 / 9-11

TRI Log #: 63508.3
Test Method: ASTM D4767 Mod

Consolidation





Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: LB-1 / 23-25

TRI Log #: 63508.4
Test Method: ASTM D4767 Mod

Specimens				
Identification	1	2	3	4
Depth/Elev. (ft)	-	-	-	-
Eff. Consol. Stress (psi)	6.5	13.1	26.1	-
Initial Specimen Properties				
Avg. Diameter (in)	2.04	2.06	2.08	-
Avg. Height (in)	4.18	4.08	3.98	-
Avg. Water Content (%)	27.2	-	-	-
Bulk Density (pcf)	117.7	-	-	-
Dry Density (pcf)	92.6	-	-	-
Specific Gravity (Assumed)	2.75			
Saturation (%)	87.5	-	-	-
Void Ratio, n	0.85	0.85	0.84	-
B-Value, End of Saturation	0.95	-	-	-

Test Setup	
Specimen Condition	Undisturbed / Intact
Specimen Preparation	Trimmed
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear				
Void Ratio	0.85	0.84	0.83	-

Shear / Post-Shear				
Rate of Strain (%/hr)	1.00	1.00	1.00	-
Avg. Water Content (%)	-	-	29.3	-

At Failure								
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$				Ratio, $(\sigma_1'/\sigma_3')_{max}$			
Axial Strain at Failure (%), $\varepsilon_{a,f}$	-	-	-	-	1.3	2.1	2.2	-
Minor Effective Stress (psi), $\sigma_3'_f$	-	-	-	-	2.8	7.8	15.3	-
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	-	-	-	-	9.6	17.9	26.4	-
Pore Water Pressure, Δu_f (psi)	-	-	-	-	3.7	5.6	10.8	-
Major Effective Stress (psi), $\sigma_1'_f$	-	-	-	-	12.4	25.7	41.6	-
Secant Friction Angle (degrees)	-	-	-	-	38.9	32.4	27.6	-
Effective Friction Angle (degrees)	-				23.6			
Effective Cohesion (psi)	-				2.1			

Note: Multi-stage testing was performed for this sample. The first two stages were terminated in accordance with stress path tangency and/or peak principal stress ratio. The presented M-C parameters are based on a linear regression in modified stress space, across all assigned effective consolidation stresses. This fit does not purported to capture typical curvature of envelopes that may, in particular, be observed across broader range in effective stresses. Please note that the stresses associated with peak principal stress ratio are presented in tabular form on the first page of the report. There are alternate interpretations to this failure criterion including but not limited to peak principal stress difference and strain compatibility.

Jeffrey A. Kuhn , Ph.D., P.E., 6/7/2021
Analysis & Quality Review/Date

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Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: LB-1 / 23-25

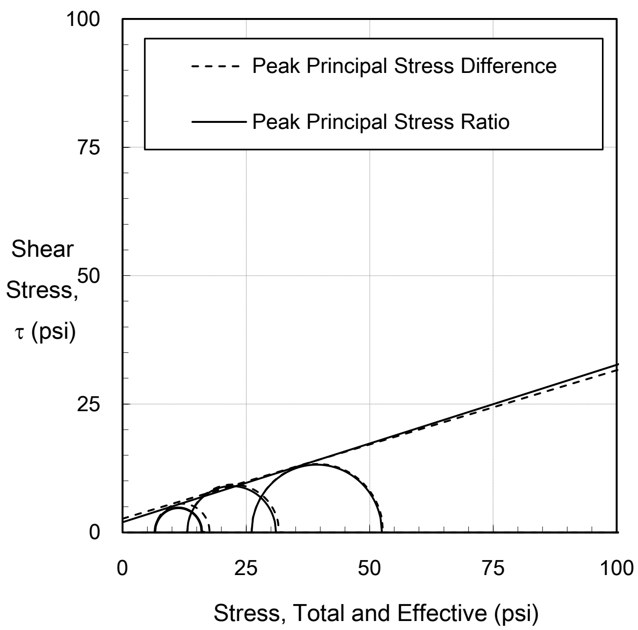
TRI Log #: 63508.4
Test Method: ASTM D4767 Mod

R / "Total Stress" Envelope			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	ϕ_R	16.1	17.0
Cohesion (psi)	c_R	2.7	2.0

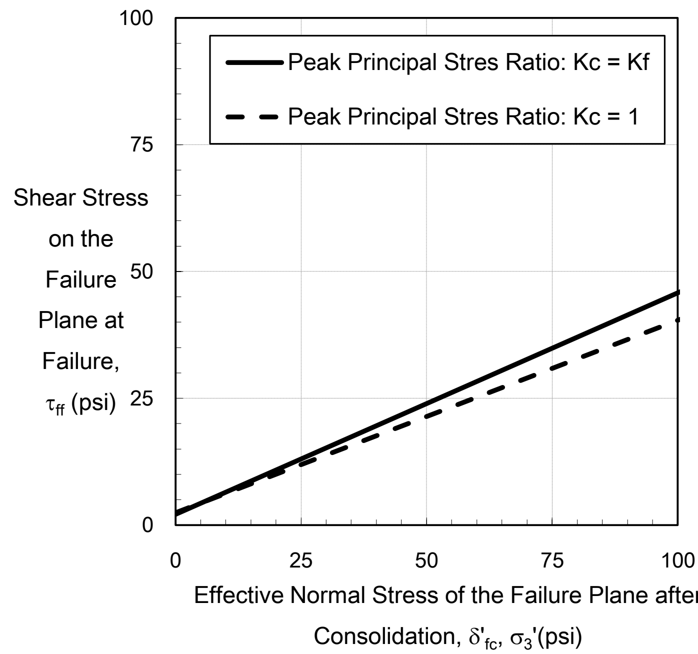
Kc = Kf Envelope, Effective Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	ϕ'	22.2	23.6
Effective Cohesion (psi)	c'	2.5	2.1

Kc = 1 (τ_{ff} vs σ'_{fc}) Envelope, Total Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	$d_{Kc=1}$	19.6	20.8
Cohesion (psi)	$\psi_{Kc=1}$	3.3	2.4

R / "Total Stress" Envelope



Three-Stage Rapid Drawdown Envelopes



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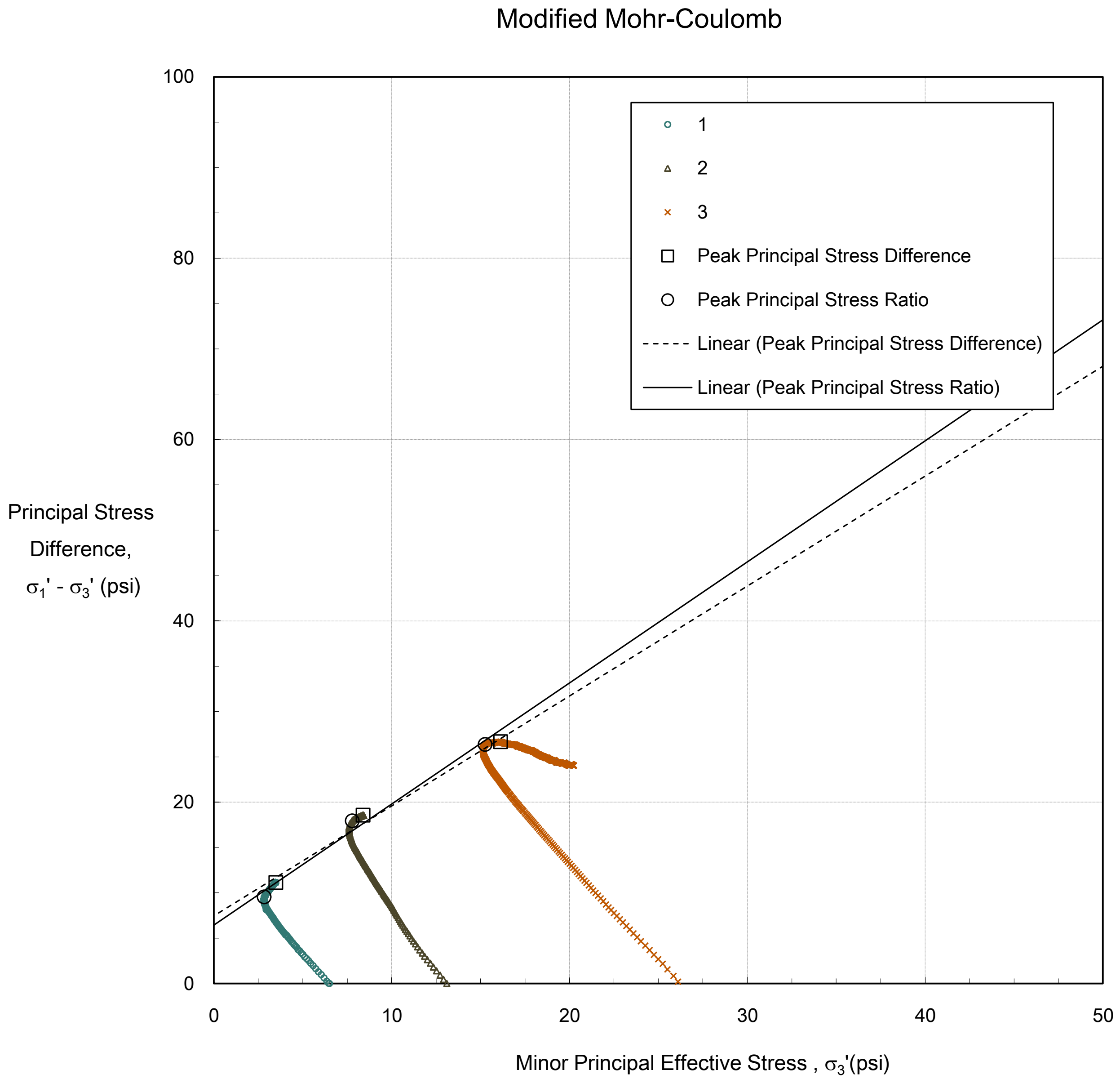
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: LB-1 / 23-25

TRI Log #: 63508.4
Test Method: ASTM D4767 Mod



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	23.6
Effective Cohesion (psi)	-	2.1

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Multi-Stage Consolidated-Undrained Triaxial Compression

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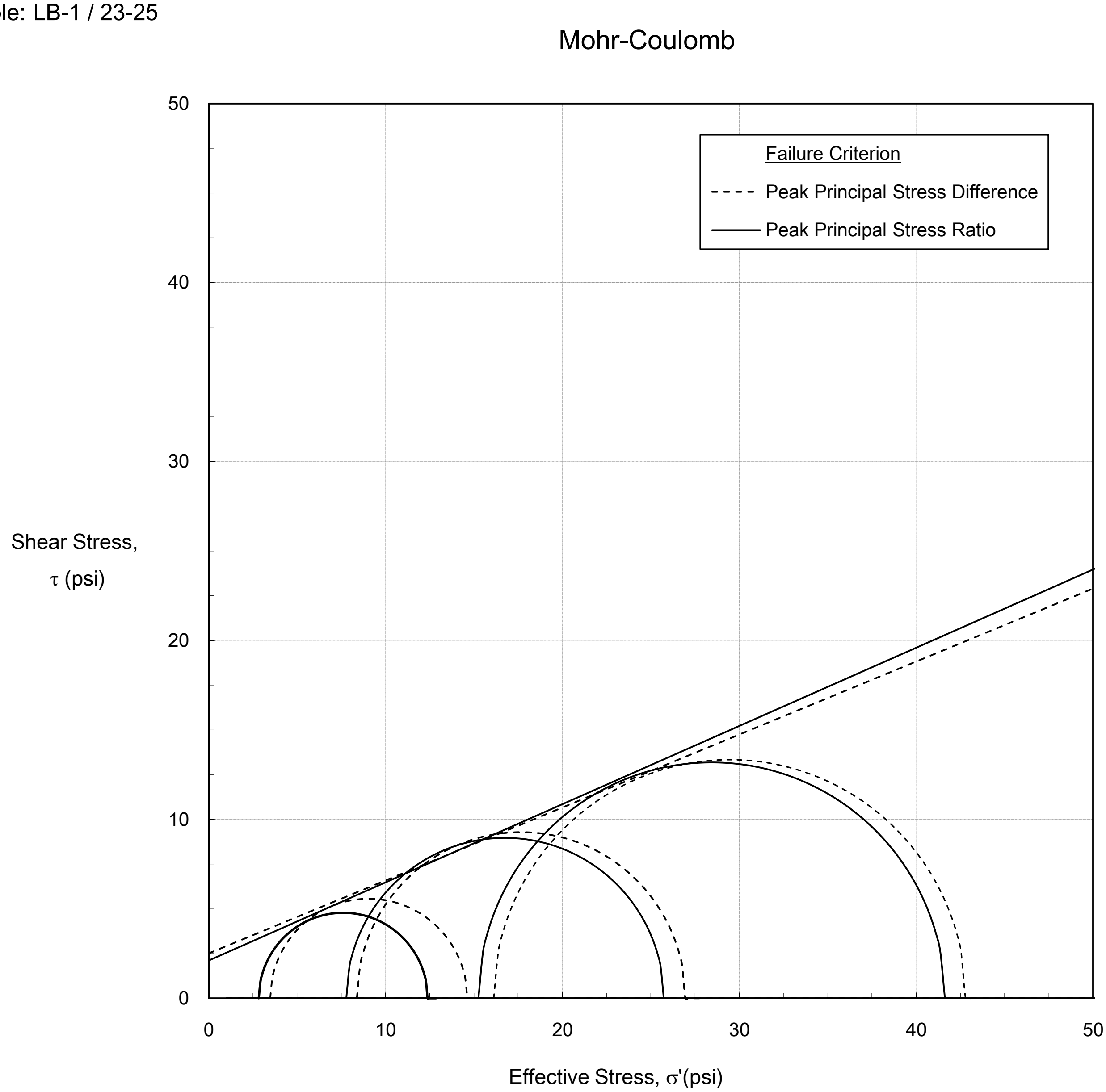

Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	-	23.6
Effective Cohesion (psi)	-	2.1

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Multi-Stage Consolidated-Undrained Triaxial Compression

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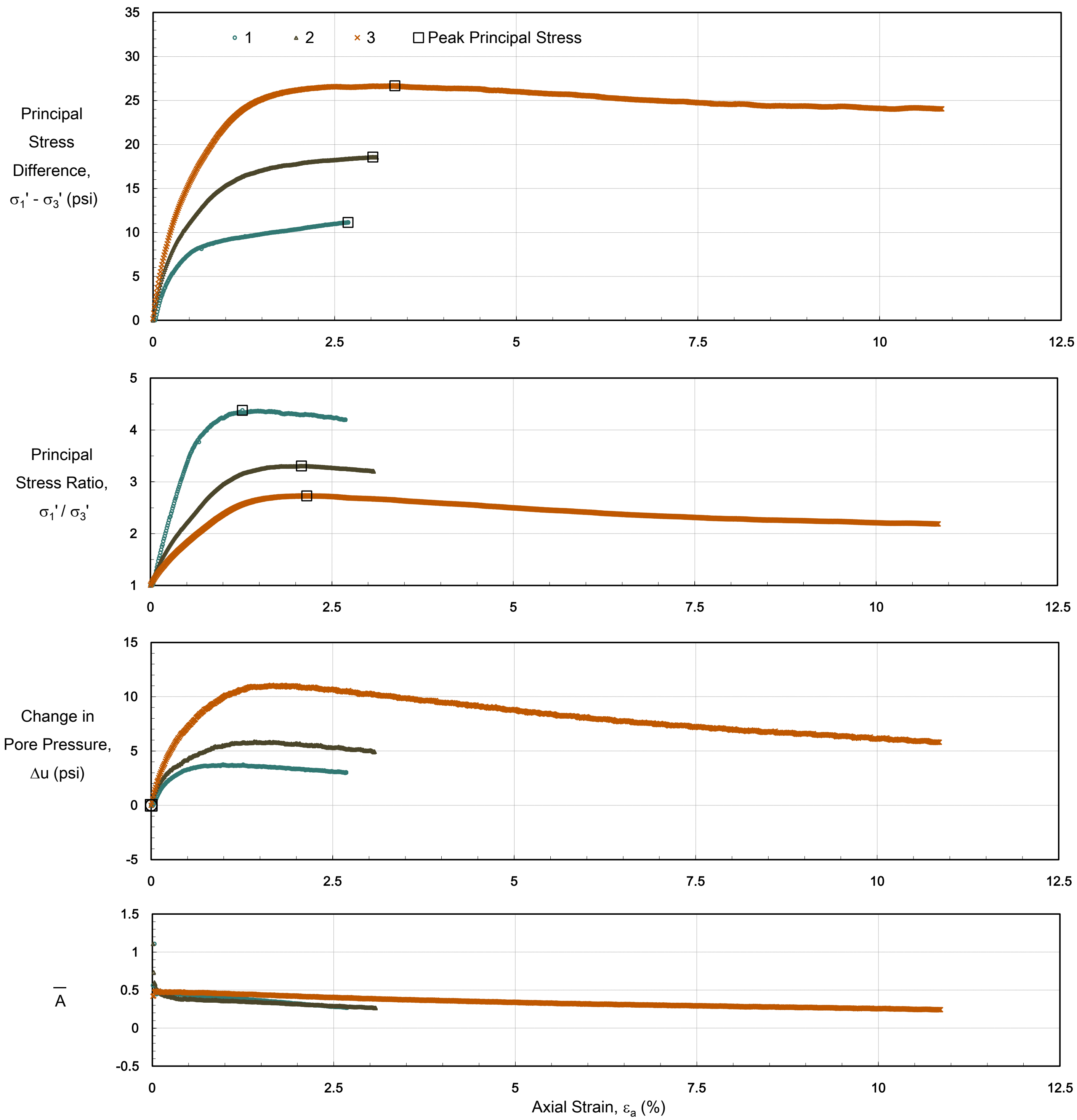
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Sample: LB-1 / 23-25

TRI Log #: 63508.4
Test Method: ASTM D4767 Mod



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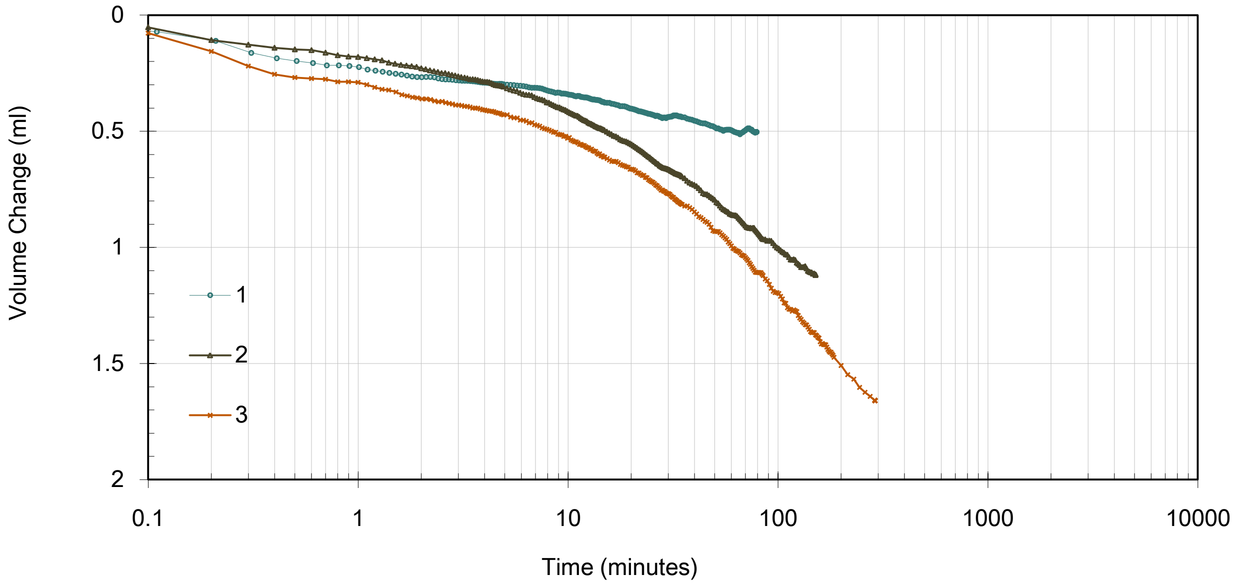
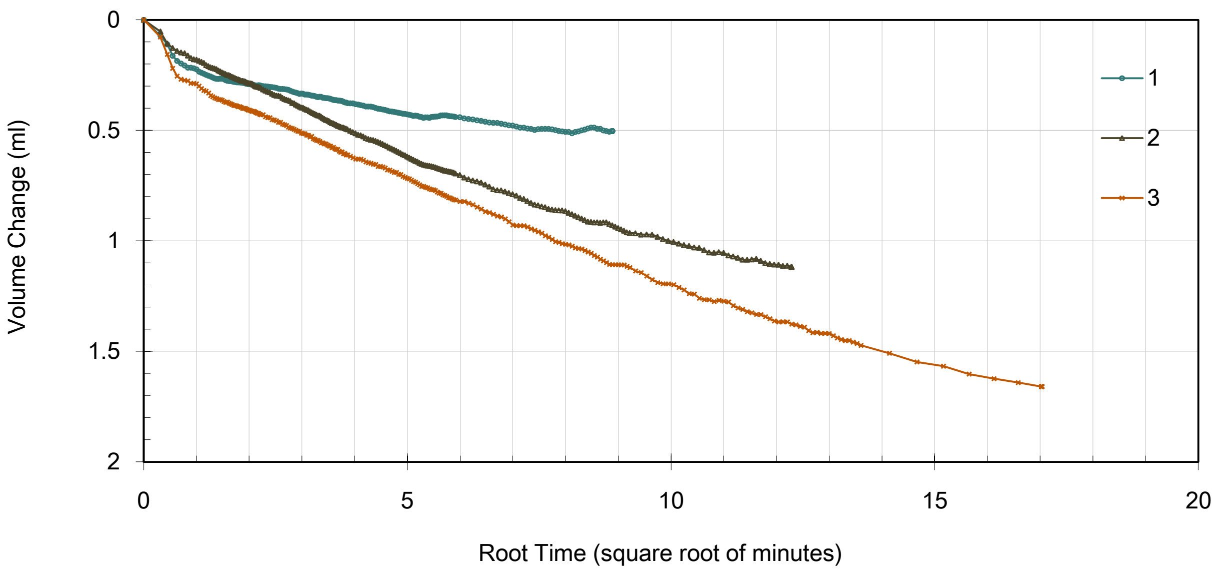
Multi-Stage Consolidated-Undrained Triaxial Compression

Client: Tolunay Wong Engineers, Inc
TRI Log #: 63508.4
Project: 21.23.029 - Cedar Bayou Deepening & Widening Project
Test Method: ASTM D4767 Mod
Sample: LB-1 / 23-25

Consolidation





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APPENDIX G

DESIGN SOIL PARAMETERS

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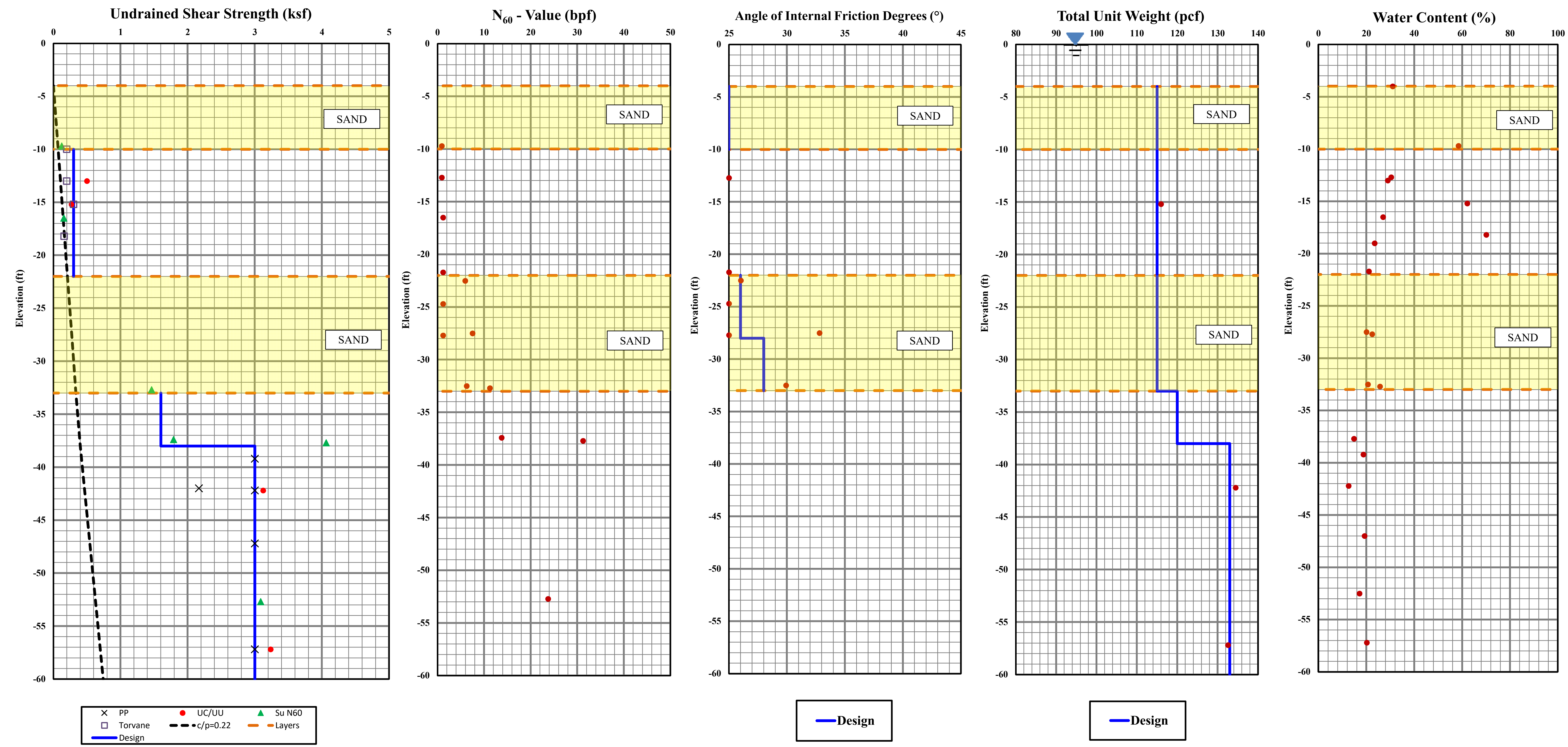

Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	Project Number: 21.23.029 Report Number: 120938
Trans-Global Solutions, Inc. Beaumont, Texas	**Design Soil Parameters** **MB-1 and MB-2**	Appendix G Figure 1

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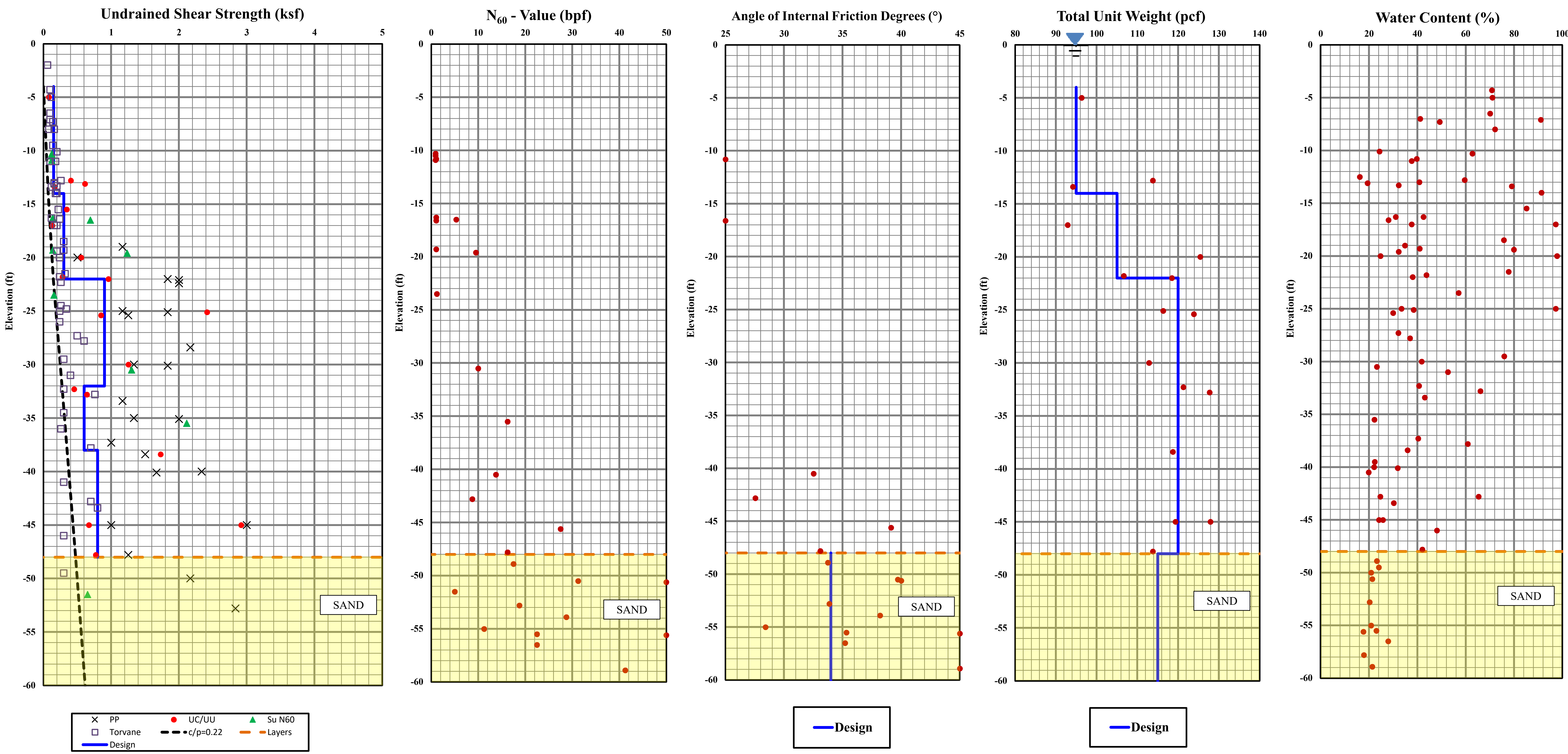

Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	Project Number: 21.23.029 Report Number: 120938
Trans-Global Solutions, Inc. Beaumont, Texas	**Design Soil Parameters** **MB-3 through MB-10**	Appendix G Figure 2

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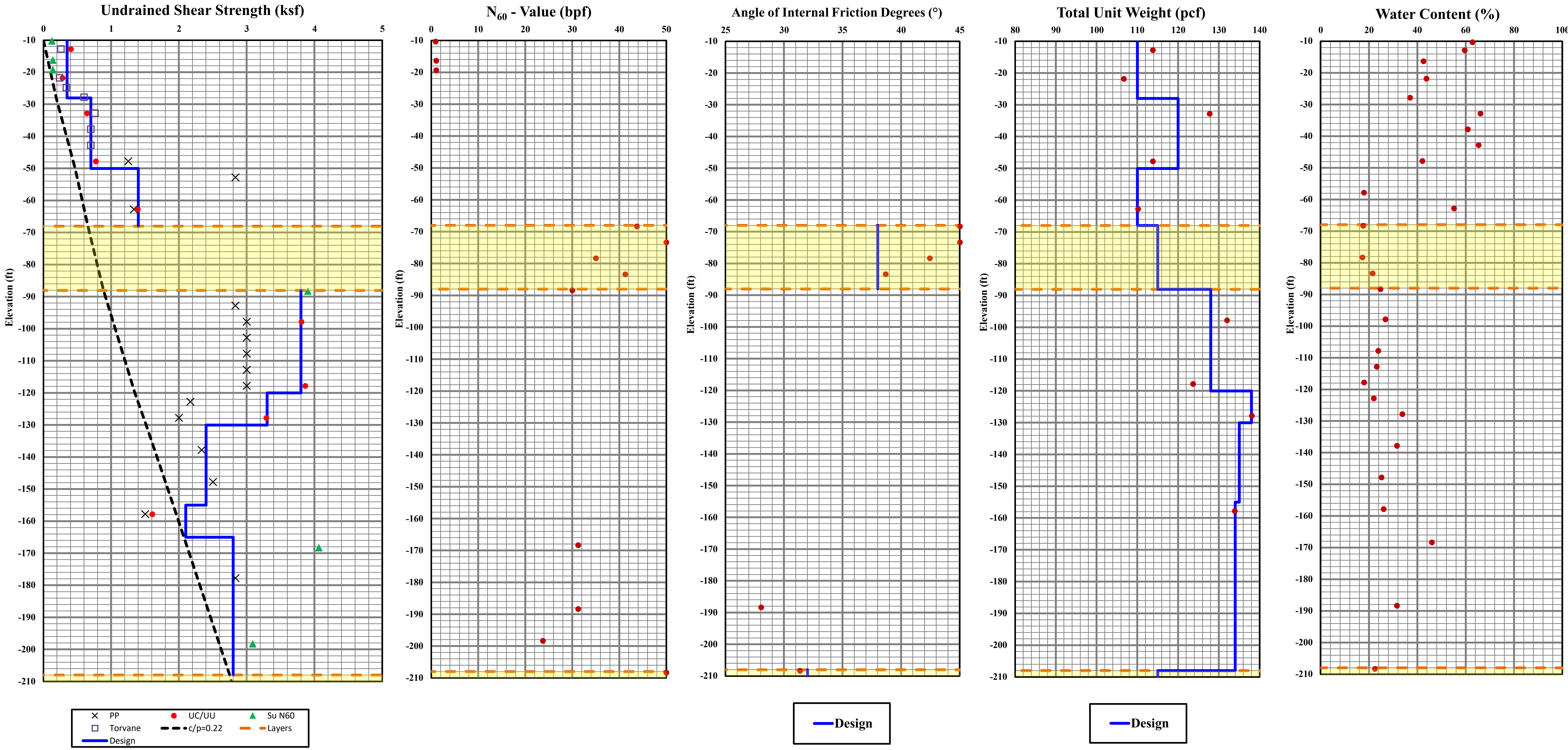

Cedar Bayou Deepening & Widening Project Chambers County, Texas	**Tolunay-Wong Engineers, Inc.**	Project Number: 21.23.029 Report Number: 120938
Trans-Global Solutions, Inc. Beaumont, Texas	**Design Soil Parameters - Dock Structures - Marine MB-10**	Appendix G Figure 3

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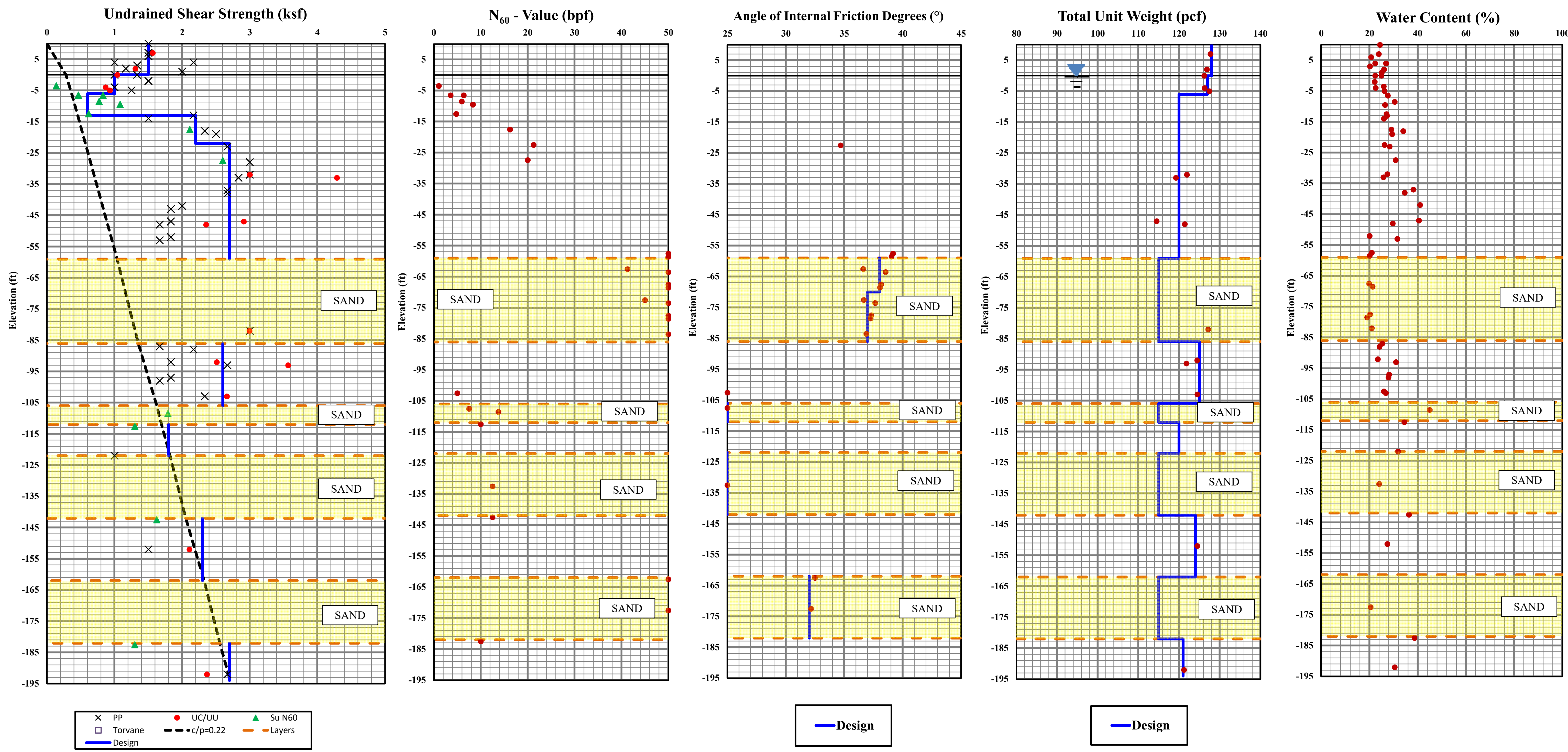

Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	Project Number: 21.23.029 Report Number: 120938
Trans-Global Solutions, Inc. Beaumont, Texas	**Design Soil Parameters - Dock Structures - Landside** **LB-1 through LB-3**	Appendix G Figure 4

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TABULATED DRAINED & UNDRAINED
SOIL PARAMETERS

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Soil Design Parameters								
Soil Layer	Soil Description	Elevation Range (ft)	γ (pcf)	γ' (pcf)	Undrained (Short-Term) Case		Drained (Long-Term) Case	
					c (psf)	φ (°)	c' (psf)	φ' (°)
1	Loose Sand	(-)4 to (-)10	115	53	0	25	0	25
2	Soft clay	(-)10 to (-)22	115	53	300	0	30	27
3	Loose Sand	(-)22 to (-)28	115	53	0	26	0	26
4	Loose Sand	(-)28 to (-)33	120	58	0	28	0	28
5	Stiff Clay	(-)33 to (-)38	120	58	1,600	0	160	28
6	Very Stiff Clay	(-)38 to (-)60	133	71	3,300	0	200	22

Legend:
γ = Total Unit Weight
φ = Friction Angle
γ' = Submerged Unit Weight
c = Cohesion

Cedar Bayou Deepening & Widening Project Chambers County, Texas	**Tolunay-Wong Engineers, Inc.**	**Project No.** 21.23.029 **Report No.** 120938
Trans-Global Solutions, Inc. Beaumont, Texas	**Soil Design Parameters MB-1 & MB-2**	**Appendix** G **Figure 4**

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Soil Design Parameters								
Soil Layer	Soil Description	Elevation Range (ft)	γ (pcf)	γ' (pcf)	Undrained (Short-Term) Case		Drained (Long-Term) Case	
					c (psf)	φ (°)	c' (psf)	φ' (°)
1	Very Soft Clay	(-)4 to (-)14	95	33	150	0	15	25
2	Soft Clay	(-)14 to (-)22	105	43	300	0	30	28
3	Firm Clay	(-)22 to (-)32	120	58	900	0	135	28
4	Firm Clay	(-)32 to (-)38	120	58	600	0	60	25
5	Firm Clay	(-)38 to (-)48	120	58	800	0	120	28
6	Loose to Very Dense Sand	(-)48 to (-)60	115	53	0	34	0	34

Legend:

γ = Total Unit Weight

γ' = Submerged Unit Weight

c = Cohesion

φ = Friction Angle

Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project No.** 21.23.029 **Report No.** 120938
Trans-Global Solutions, Inc. Beaumont, Texas	**Soil Design Parameters MB-3 to MB-10**	**Appendix** G **Figure** 5

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Soil Design Parameters - Sheet Pile Bulkhead												
Soil Layer	Soil Description	Elevation Range (ft)	γ (pcf)	γ' (pcf)	Undrained (Short-Term) Case				Drained (Long-Term) Case			
					c (psf)	φ (°)	δ (°)	a (psf)	c' (psf)	φ' (°)	δ (°)	a (psf)
1	Stiff Clay (Fill)	(+)10 to (+)0	120	120	1,000	0	0	750	0	28	14	0
2	Stiff Clay	(+)0 to (-)6	127	65	1,000	0	0	750	100	24	12	0
3	Firm Clay	(-)6 to (-)13	120	58	600	0	0	550	60	28	14	0
4	Very Stiff Clay	(-)13 to (-)22	120	58	2,200	0	0	950	300	24	12	0
5	Very Stiff Clay	(-)22 to (-)59	120	58	2,700	0	0	950	200	19	9	0
6	Dense to Very Dense Sand	(-)59 to (-)70	115	53	0	38	19	0	0	38	19	0
7	Dense to Very Dense Sand	(-)70 to (-)86	115	53	0	37	19	0	0	37	19	0
8	Stiff to Very Stiff Clay	(-)86 to (-)106	125	63	2,600	0	0	950	200	27	13	0

Notes:

(1) Plasticity index (PI) was used to estimate drained friction angle for cohesive soils.
(2) Effective cohesion values were estimated using published correlations and our experience with similar soils.
(3) Effective cohesion values for clays at shallow depths were neglected to account for weathering and strain softening effects.
(4) Design groundwater level estimated at El. 0-ft.

Legend:

γ = Total Unit Weight
γ' = Submerged Unit Weight
c = Cohesion
φ = Friction Angle
δ = Angle of Wall Friction, δ = (0.5) φ for steel
a = Adhesion

Cedar Bayou Deepening & Widening Project **Chambers County, Texas**	Tolunay-Wong Engineers, Inc.	**Project No.** 21.23.029 **Report No.** 120938
Trans-Global Solutions, Inc. **Beaumont, Texas**	**Soil Design Parameters - Sheet Pile Bulkhead** **LB-1 to LB-3**	**Appendix** G **Figure** 7

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APPENDIX H

RESULTS OF GLOBAL
STABILITY ANALYSES

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CHANNEL SIDE SLOPES GLOBAL STABILITY

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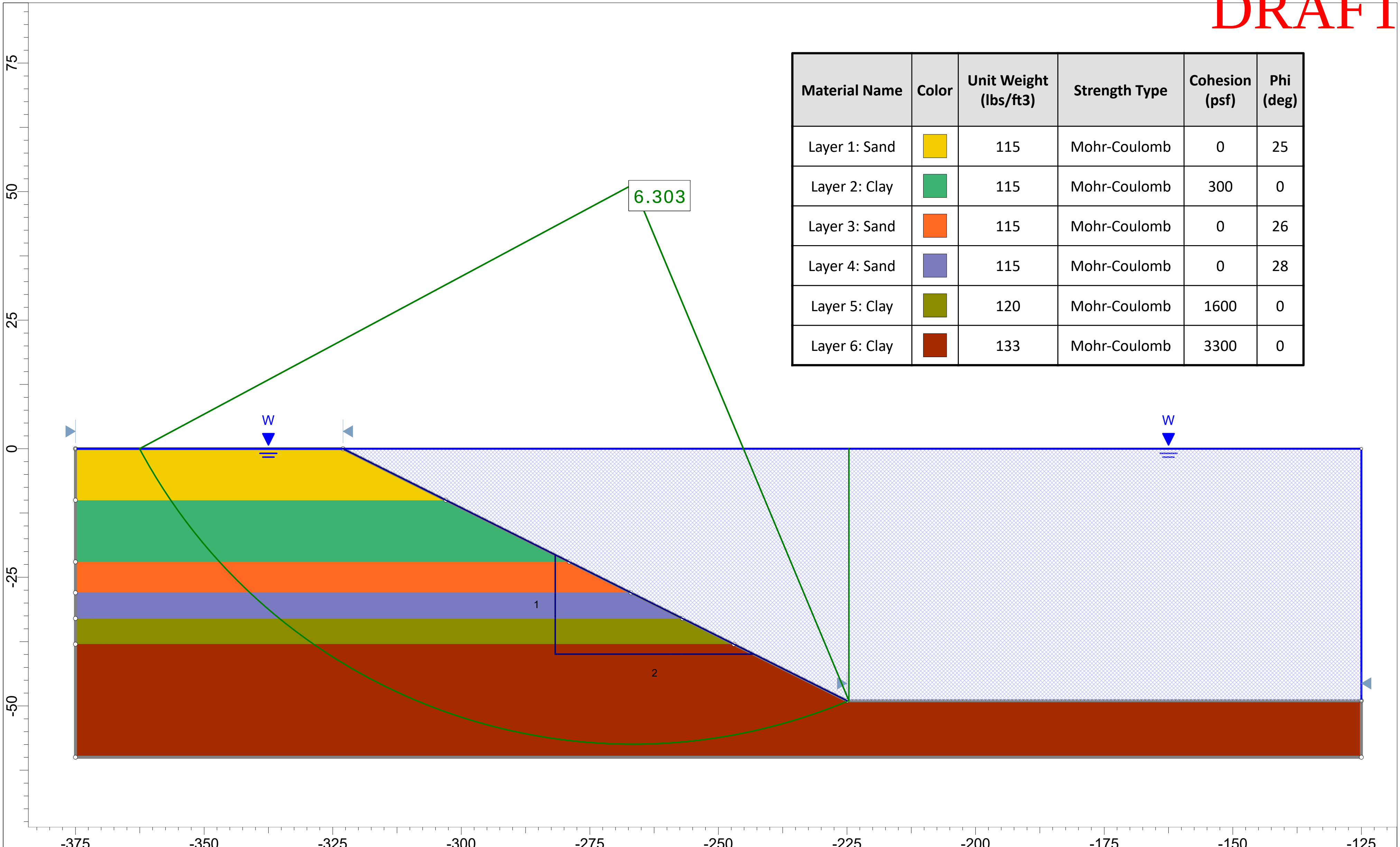
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Layer 1: Sand		115	Mohr-Coulomb	0	25
Layer 2: Clay		115	Mohr-Coulomb	300	0
Layer 3: Sand		115	Mohr-Coulomb	0	26
Layer 4: Sand		115	Mohr-Coulomb	0	28
Layer 5: Clay		120	Mohr-Coulomb	1600	0
Layer 6: Clay		133	Mohr-Coulomb	3300	0

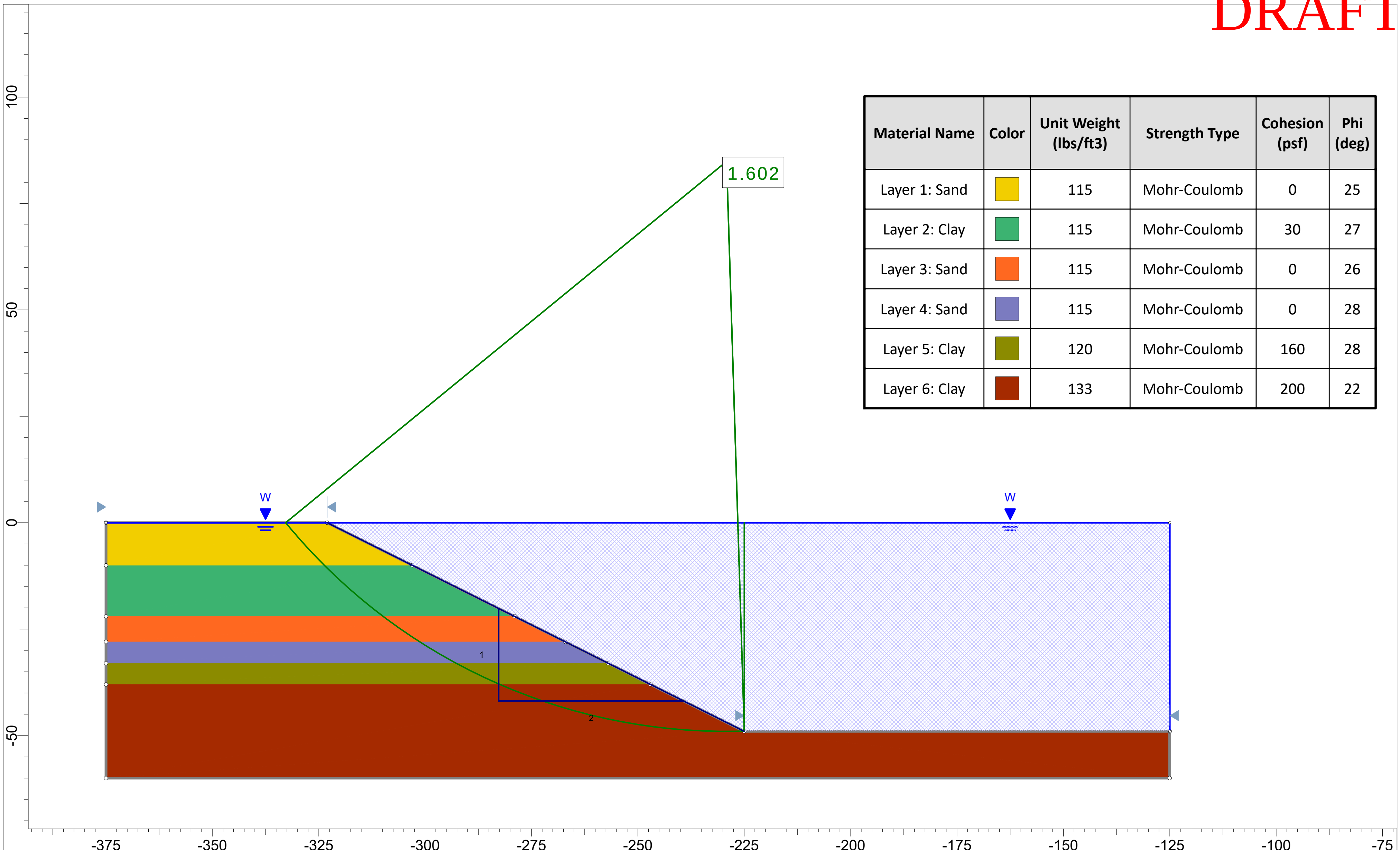


Tolunay-Wong Engineers, Inc.

SLIDEINTERPRET 8.028

Project	Cedar Bayou Deepening & Widening Project
Analysis Description	MB-1 & MB-2 - Short Term Conditions - Global Stability - 2H:1V
Drawn By	T. O'Connor
Scale	1:310
Client	Trans-Global Solutions, Inc.
Date	6/7/2021, 3:11:38 PM
	Figure 1

DRAFT



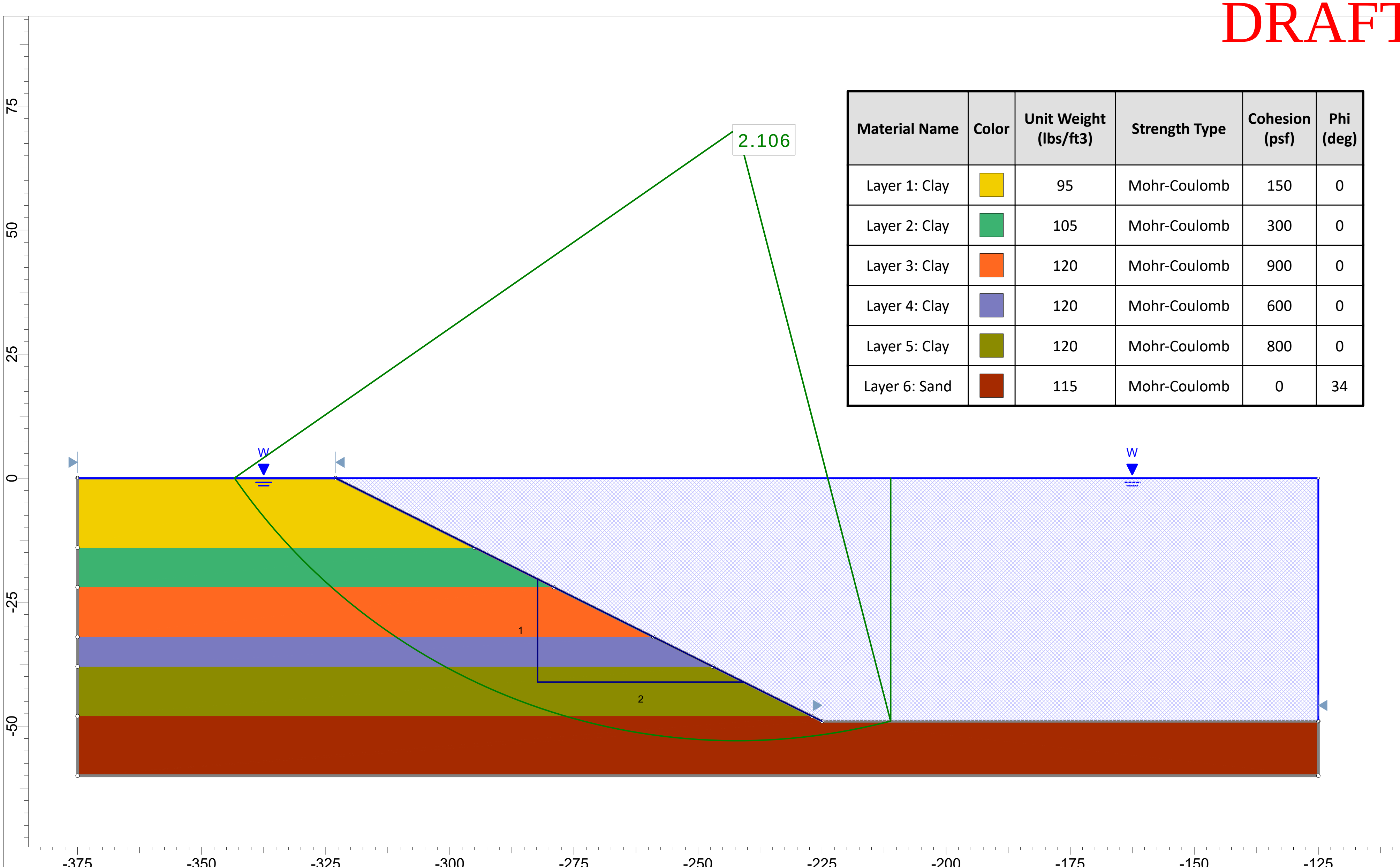
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Layer 1: Sand		115	Mohr-Coulomb	0	25
Layer 2: Clay		115	Mohr-Coulomb	30	27
Layer 3: Sand		115	Mohr-Coulomb	0	26
Layer 4: Sand		115	Mohr-Coulomb	0	28
Layer 5: Clay		120	Mohr-Coulomb	160	28
Layer 6: Clay		133	Mohr-Coulomb	200	22

Tolunay-Wong Engineers, Inc.

SLIDEINTERPRET 8.028

Project	Cedar Bayou Deepening & Widening Project		
Analysis Description	MB-1 & MB-2 - Long Term Conditions - Global Stability - 2H:1V		
Drawn By T. O'Connor	*Scale* 1:374	*Client*	Trans-Global Solutions, Inc.
Date	6/7/2021, 3:11:38 PM		Figure 2

DRAFT



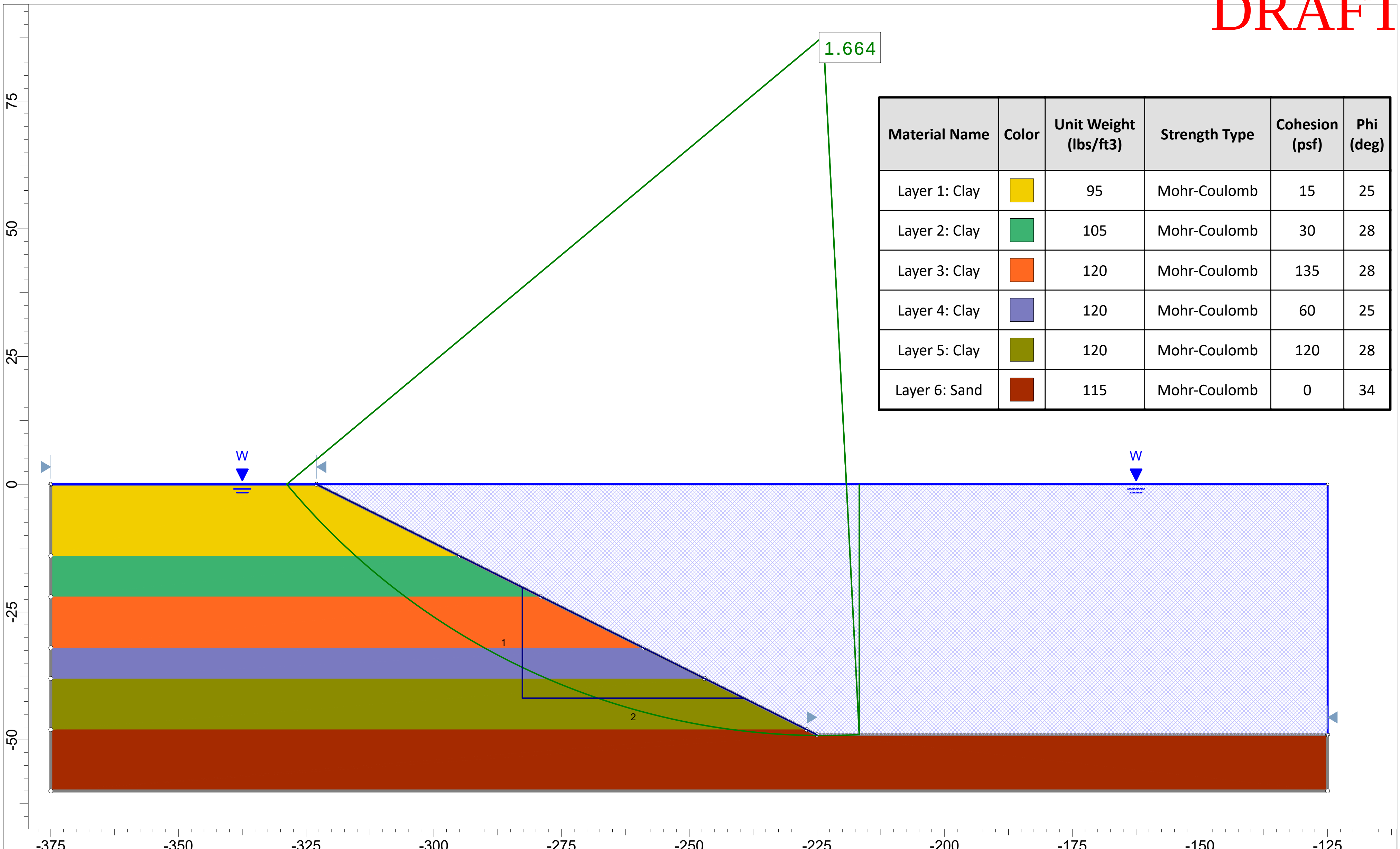
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Layer 1: Clay		95	Mohr-Coulomb	150	0
Layer 2: Clay		105	Mohr-Coulomb	300	0
Layer 3: Clay		120	Mohr-Coulomb	900	0
Layer 4: Clay		120	Mohr-Coulomb	600	0
Layer 5: Clay		120	Mohr-Coulomb	800	0
Layer 6: Sand		115	Mohr-Coulomb	0	34

Tolunay-Wong Engineers, Inc.

SLIDEINTERPRET 8.028

Project	Cedar Bayou Deepening & Widening Project		
Analysis Description	MB-3 to MB-10 - Short Term Conditions - Global Stability - 2H:1V		
Drawn By T. O'Connor	*Scale* 1:324	*Client*	Trans-Global Solutions, Inc.
Date	6/7/2021, 3:11:38 PM		Figure 3

DRAFT



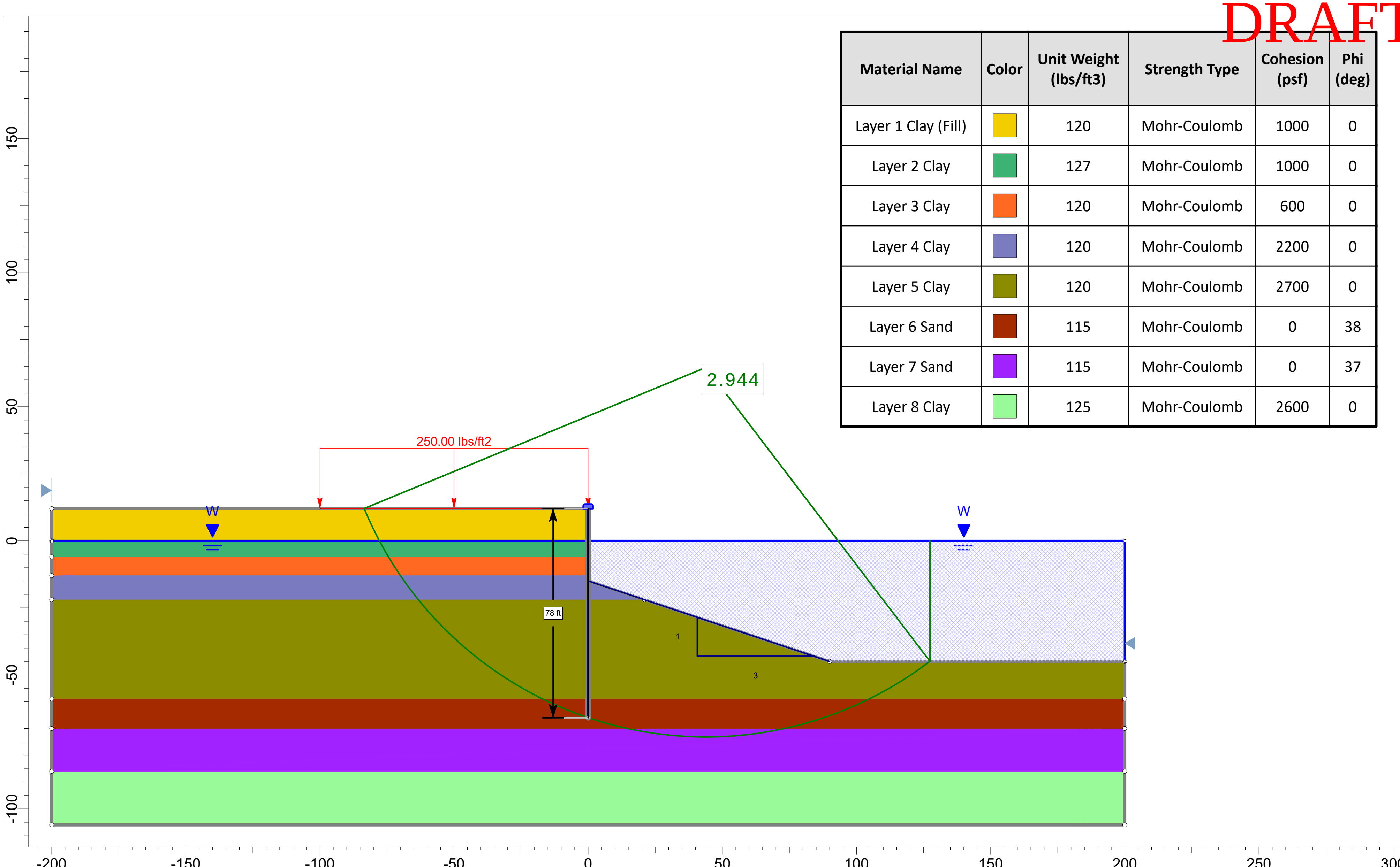
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Layer 1: Clay		95	Mohr-Coulomb	15	25
Layer 2: Clay		105	Mohr-Coulomb	30	28
Layer 3: Clay		120	Mohr-Coulomb	135	28
Layer 4: Clay		120	Mohr-Coulomb	60	25
Layer 5: Clay		120	Mohr-Coulomb	120	28
Layer 6: Sand		115	Mohr-Coulomb	0	34

Tolunay-Wong Engineers, Inc.	*Project* Cedar Bayou Deepening & Widening Project
	Analysis Description MB-3 to MB-10 - Long Term Conditions - Global Stability - 2H:1V
	Drawn By T. O'Connor · *Scale* 1:312 · *Client* Trans-Global Solutions, Inc.
SLIDEINTERPRET 8.028	*Date* 6/7/2021, 3:11:38 PM · Figure 4

DRAFT

SHEET PILE BULKHEAD GLOBAL STABILITY

DRAFT



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Layer 1 Clay (Fill)		120	Mohr-Coulomb	1000	0
Layer 2 Clay		127	Mohr-Coulomb	1000	0
Layer 3 Clay		120	Mohr-Coulomb	600	0
Layer 4 Clay		120	Mohr-Coulomb	2200	0
Layer 5 Clay		120	Mohr-Coulomb	2700	0
Layer 6 Sand		115	Mohr-Coulomb	0	38
Layer 7 Sand		115	Mohr-Coulomb	0	37
Layer 8 Clay		125	Mohr-Coulomb	2600	0

Tolunay-Wong Engineers, Inc.

SLIDEINTERPRET 8.028

Project Cedar Bayou Deepening & Widening Project

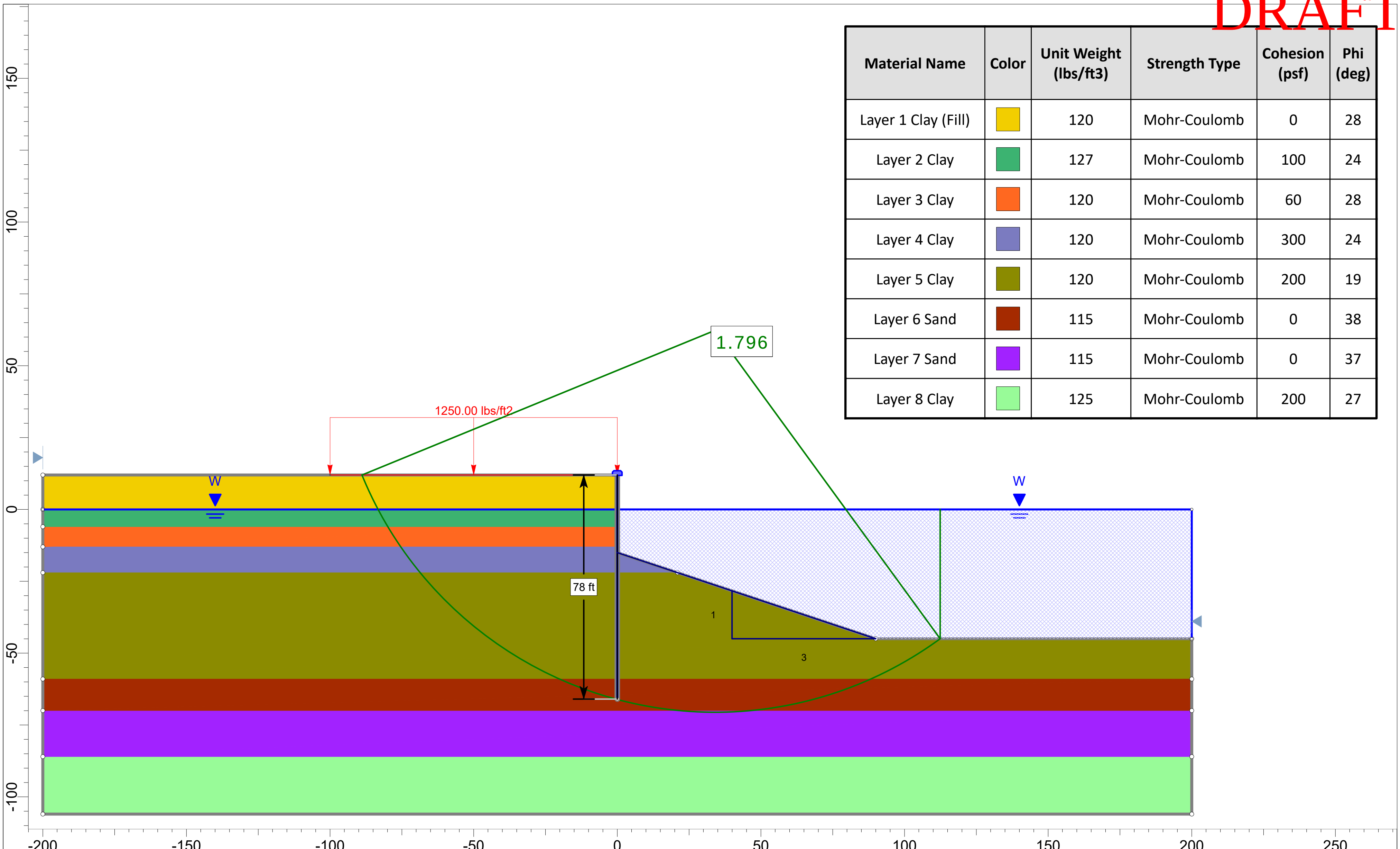
Analysis Description Sheet Pile Bulkhead - Short Term Conditions - Global Stability - Dock

Drawn By T. O'Connor | *Scale* 1:599 | *Client* Trans-Global Solutions, Inc.

Date

Figure 5

DRAFT



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Layer 1 Clay (Fill)		120	Mohr-Coulomb	0	28
Layer 2 Clay		127	Mohr-Coulomb	100	24
Layer 3 Clay		120	Mohr-Coulomb	60	28
Layer 4 Clay		120	Mohr-Coulomb	300	24
Layer 5 Clay		120	Mohr-Coulomb	200	19
Layer 6 Sand		115	Mohr-Coulomb	0	38
Layer 7 Sand		115	Mohr-Coulomb	0	37
Layer 8 Clay		125	Mohr-Coulomb	200	27

Tolunay-Wong Engineers, Inc.

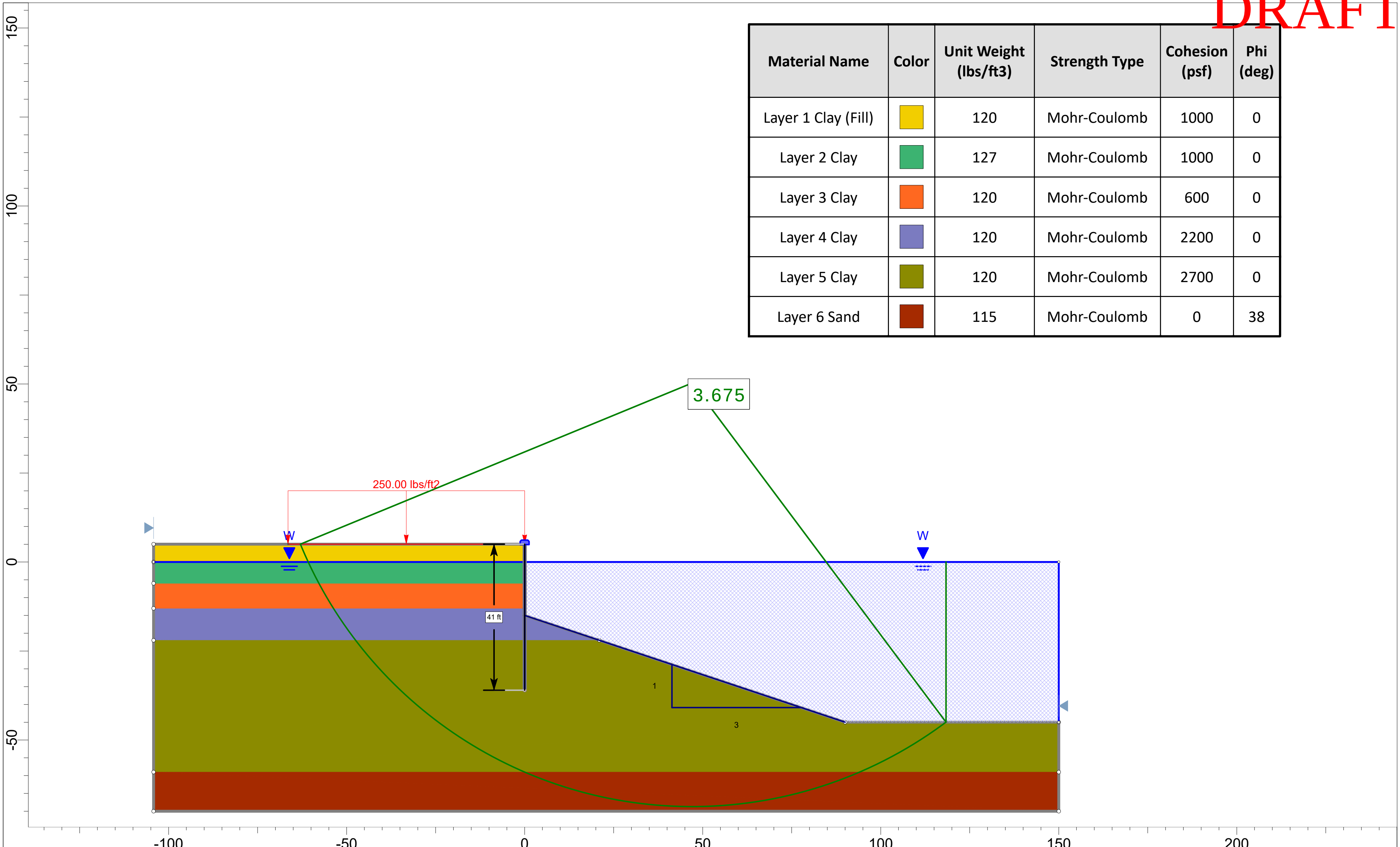
SLIDEINTERPRET 8.028

Project	Cedar Bayou Deepening & Widening Project
Analysis Description	Sheet Pile Bulkhead - Long Term Conditions - Global Stability - Dock
Drawn By	T. O'Connor
Scale	1:555
Client	Trans-Global Solutions, Inc.
Date	

Figure 6

DRAFT

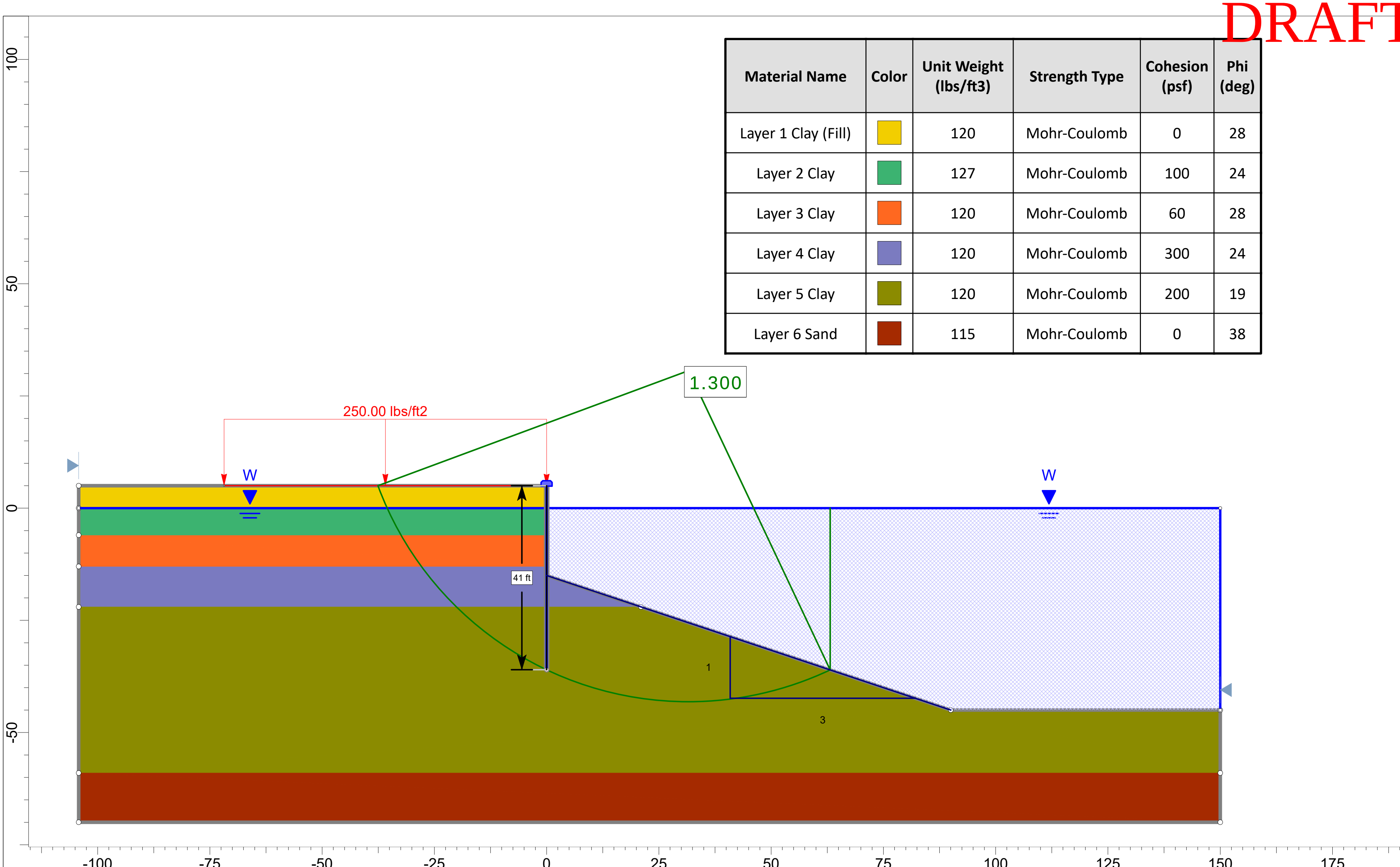
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Layer 1 Clay (Fill)		120	Mohr-Coulomb	1000	0
Layer 2 Clay		127	Mohr-Coulomb	1000	0
Layer 3 Clay		120	Mohr-Coulomb	600	0
Layer 4 Clay		120	Mohr-Coulomb	2200	0
Layer 5 Clay		120	Mohr-Coulomb	2700	0
Layer 6 Sand		115	Mohr-Coulomb	0	38



Tolunay-Wong Engineers, Inc.

Project	Cedar Bayou Deepening & Widening Project
Analysis Description	Sheet Pile Bulkhead - Short Term Conditions - Global Stability - RORO
Drawn By T. O'Connor	*Scale* 1:447
Client	Trans-Global Solutions, Inc.
Date	Figure 7

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Layer 1 Clay (Fill)	Yellow	120	Mohr-Coulomb	0	28
Layer 2 Clay	Green	127	Mohr-Coulomb	100	24
Layer 3 Clay	Orange	120	Mohr-Coulomb	60	28
Layer 4 Clay	Purple	120	Mohr-Coulomb	300	24
Layer 5 Clay	Olive	120	Mohr-Coulomb	200	19
Layer 6 Sand	Dark red	115	Mohr-Coulomb	0	38

Tolunay-Wong Engineers, Inc.

Project	Cedar Bayou Deepening & Widening Project
Analysis Description	Sheet Pile Bulkhead - Long Term Conditions - Global Stability - RORO
Drawn By	T. O'Connor
Scale	1:358
Client	Trans-Global Solutions, Inc.
Date	
	Figure 8

SLIDEINTERPRET 8.028

APPENDIX I

ULTIMATE AXIAL PILE CAPACITY CURVES

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MUDLINE ELEVATION EL. (-) 15-FT

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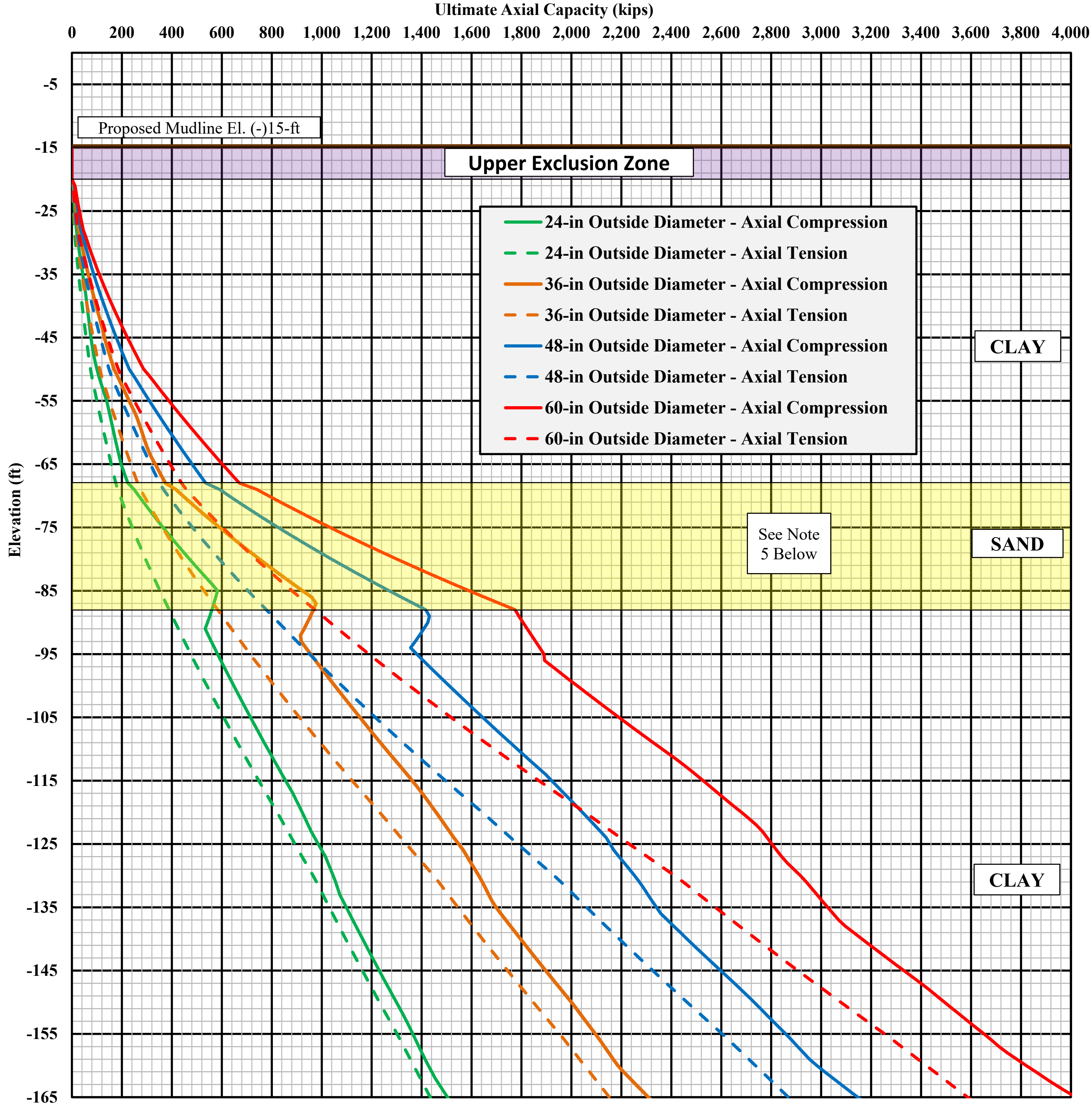
ULTIMATE AXIAL CAPACITY VERSUS ELEVATION
STEEL OPEN-ENDED PIPE PILES - MARINE - El. (-)15-ft

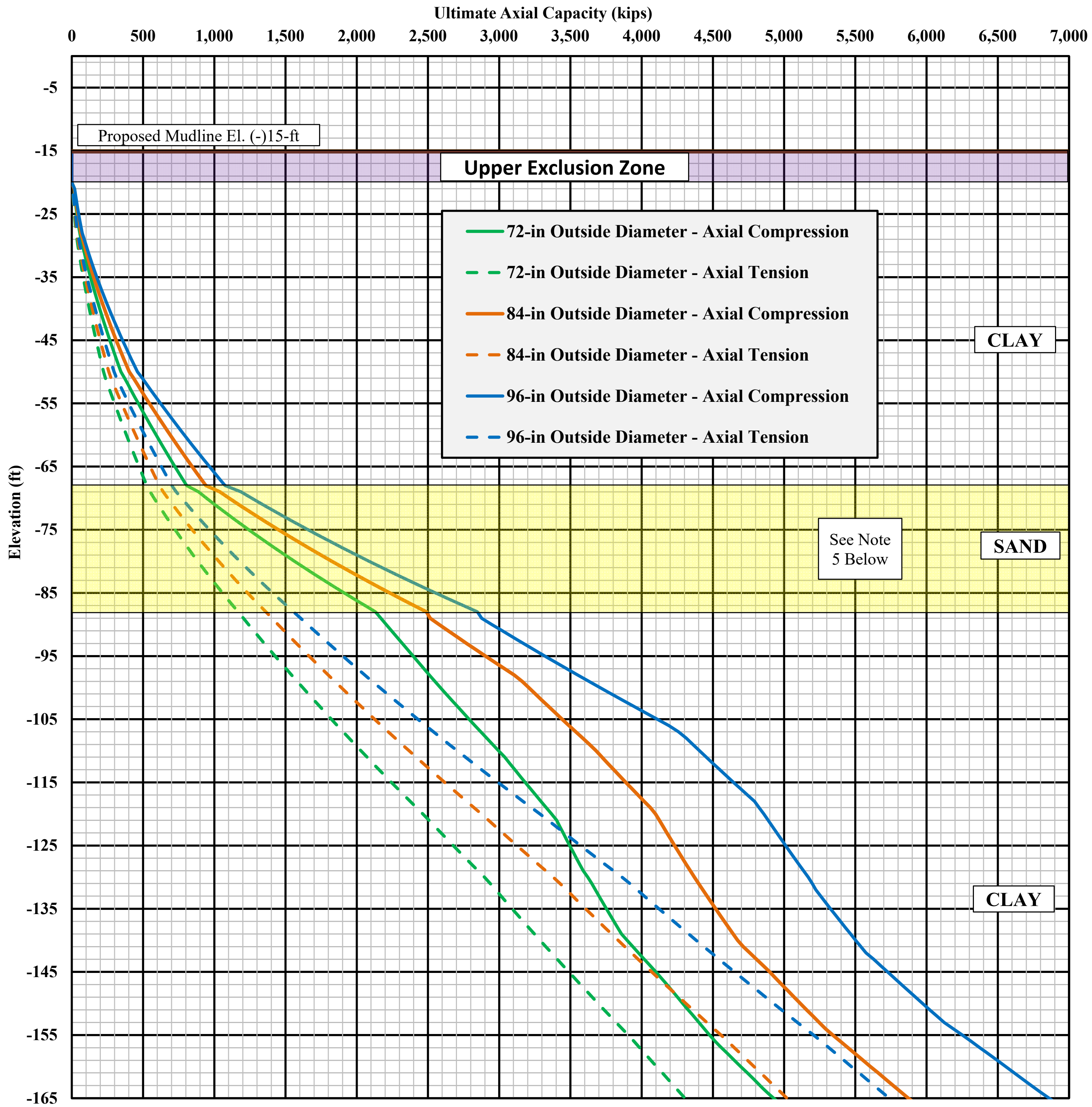


NOTES:
1) Center-to-center spacing of the pile should be at least three (3) times the pile diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.
6) Assumed pipe pile wall thickness of 3/8-in for 24-in pipe piles and 1/2-in for all other pipe pile diameters shown.

Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation** **Steel Open-Ended Pipe Piles** **Marine - El. (-)15-ft**	**Appendix:** I **Figure:** 1

DRAFT

ULTIMATE AXIAL CAPACITY VERSUS ELEVATION
STEEL OPEN-ENDED PIPE PILES - MARINE - El. (-)15-ft

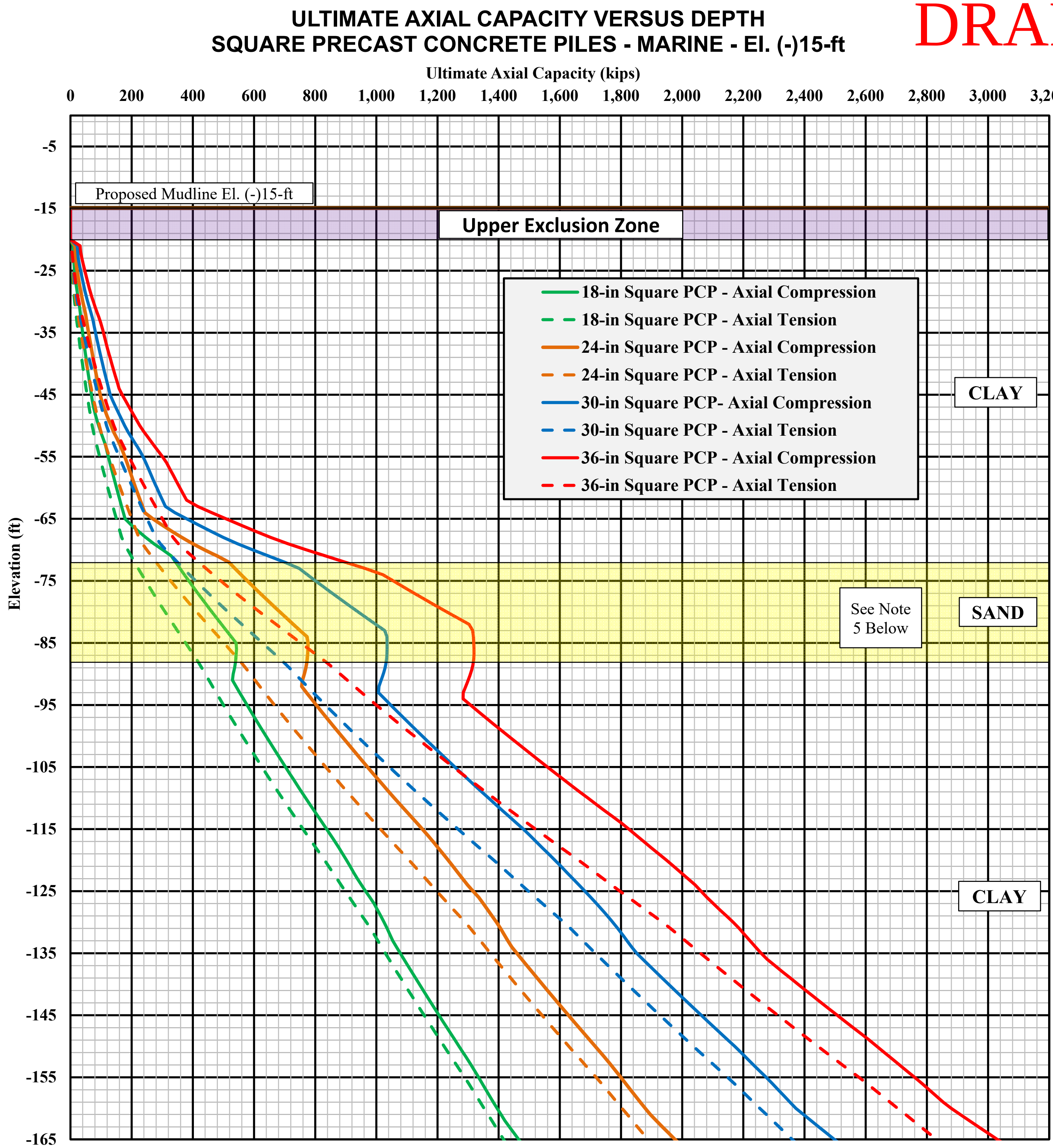


NOTES:

1) Center-to-center spacing of the pile should be at least three (3) times the pile diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.
6) Assumed pipe pile wall thickness of 1/2-in for all pipe pile diameters shown.

Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation** **Steel Open-Ended Pipe Piles** **Marine - El. (-)15-ft**	**Appendix:** I **Figure:** 2

DRAFT

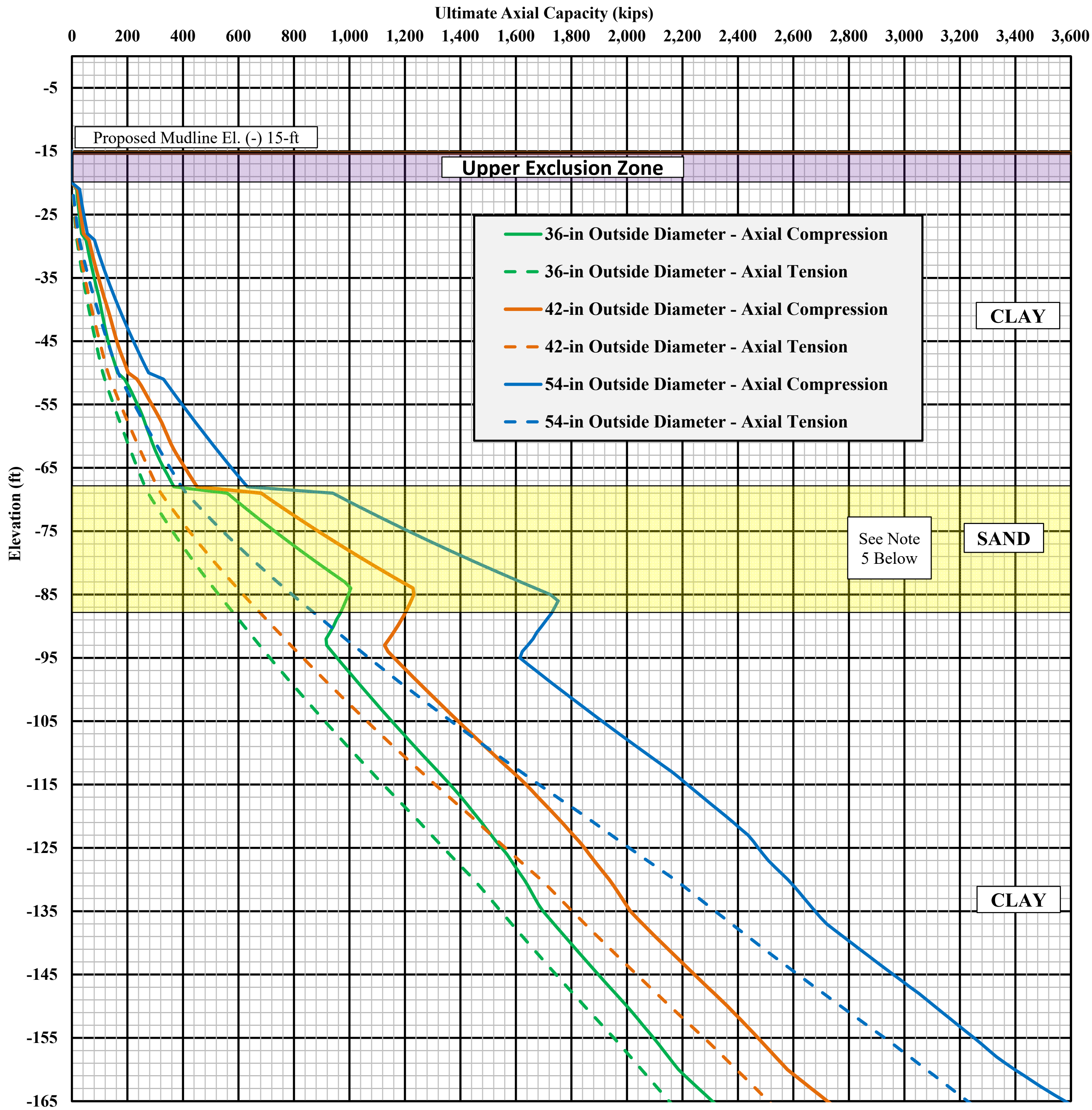


NOTES:
1) Center-to-center spacing of the pile should be at least three (3) times the pile width.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.

Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation** **Square Precast Concrete Piles** **Marine - El. (-)15-ft**	**Appendix:** I **Figure:** 3

DRAFT

ULTIMATE AXIAL CAPACITY VERSUS ELEVATION
CYLINDRICAL SPUN CAST CONCRETE PILES - MARINE - El. (-) 15-ft



NOTES:

1) Center-to-center spacing of the pile should be at least three (3) times the pile diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.
6) Assumed pile wall thickness of 6-in for all pile diameters shown.

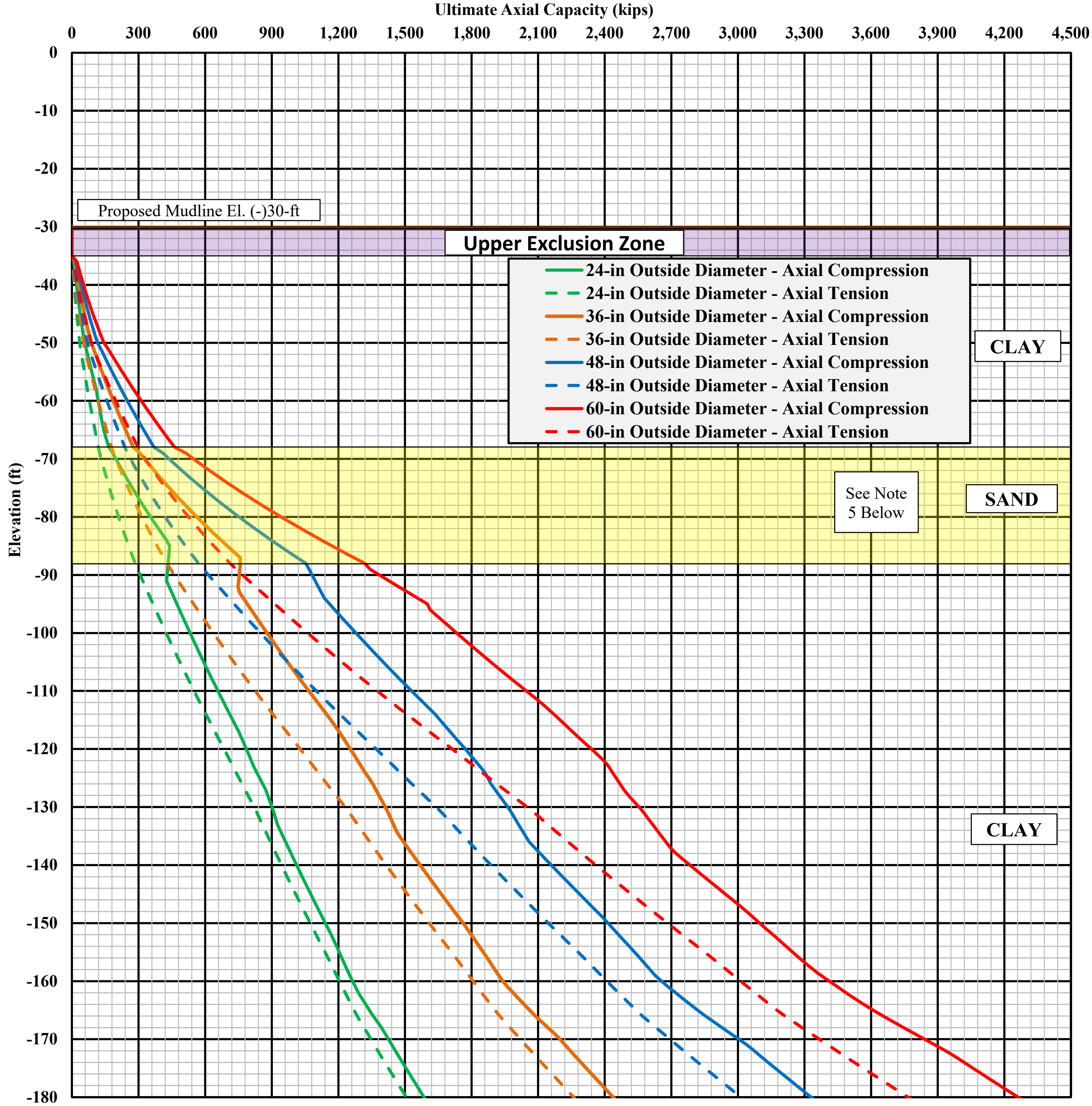
Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation** **Cylindrical Spun Cast Concrete Piles** **Marine - El. (-)15-ft**	**Appendix:** I **Figure:** 4

DRAFT

MUDLINE ELEVATION EL. (-) 30-FT

ULTIMATE AXIAL CAPACITY VERSUS ELEVATION
STEEL OPEN-ENDED PIPE PILES - MARINE - El. (-)30-ft

DRAFT



NOTES:
1) Center-to-center spacing of the pile should be at least three (3) times the pile diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.
6) Assumed pipe pile wall thickness of 3/8-in for 24-in pipe piles and 1/2-in for all other pipe pile diameters shown.

Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation Steel Open-Ended Pipe Piles Marine - El. (-)30-ft**	**Appendix:** I **Figure:** 5

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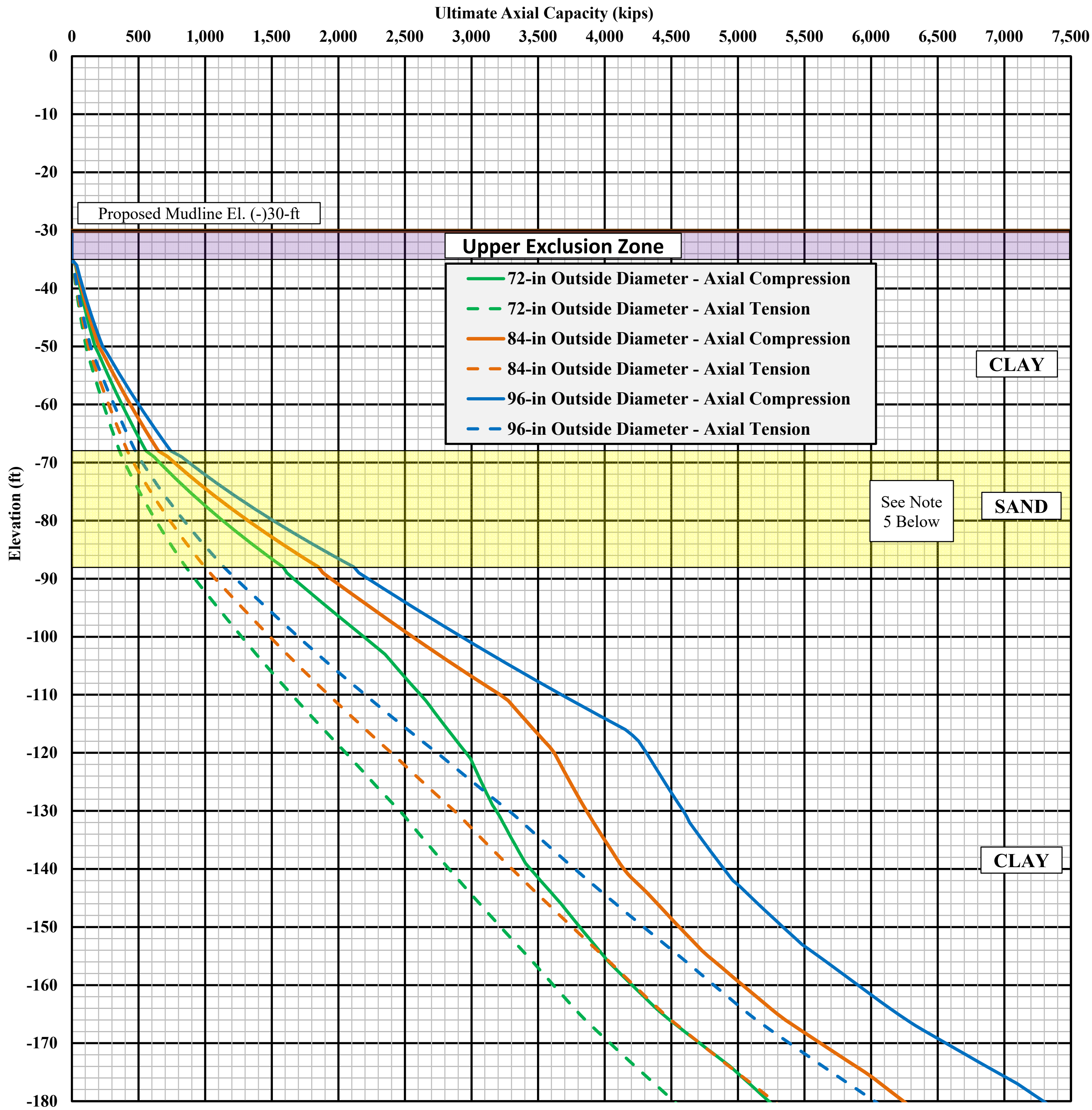
ULTIMATE AXIAL CAPACITY VERSUS ELEVATION
STEEL OPEN-ENDED PIPE PILES - MARINE - El. (-)30-ft



NOTES:

1) Center-to-center spacing of the pile should be at least three (3) times the pile diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.
6) Assumed pipe pile wall thickness of 1/2-in for all pipe pile diameters shown.

Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation** **Steel Open-Ended Pipe Piles** **Marine - El. (-)30-ft**	**Appendix:** I **Figure:** 6

ULTIMATE AXIAL CAPACITY VERSUS DEPTH
SQUARE PRECAST CONCRETE PILES - MARINE - El. (-)30-ft

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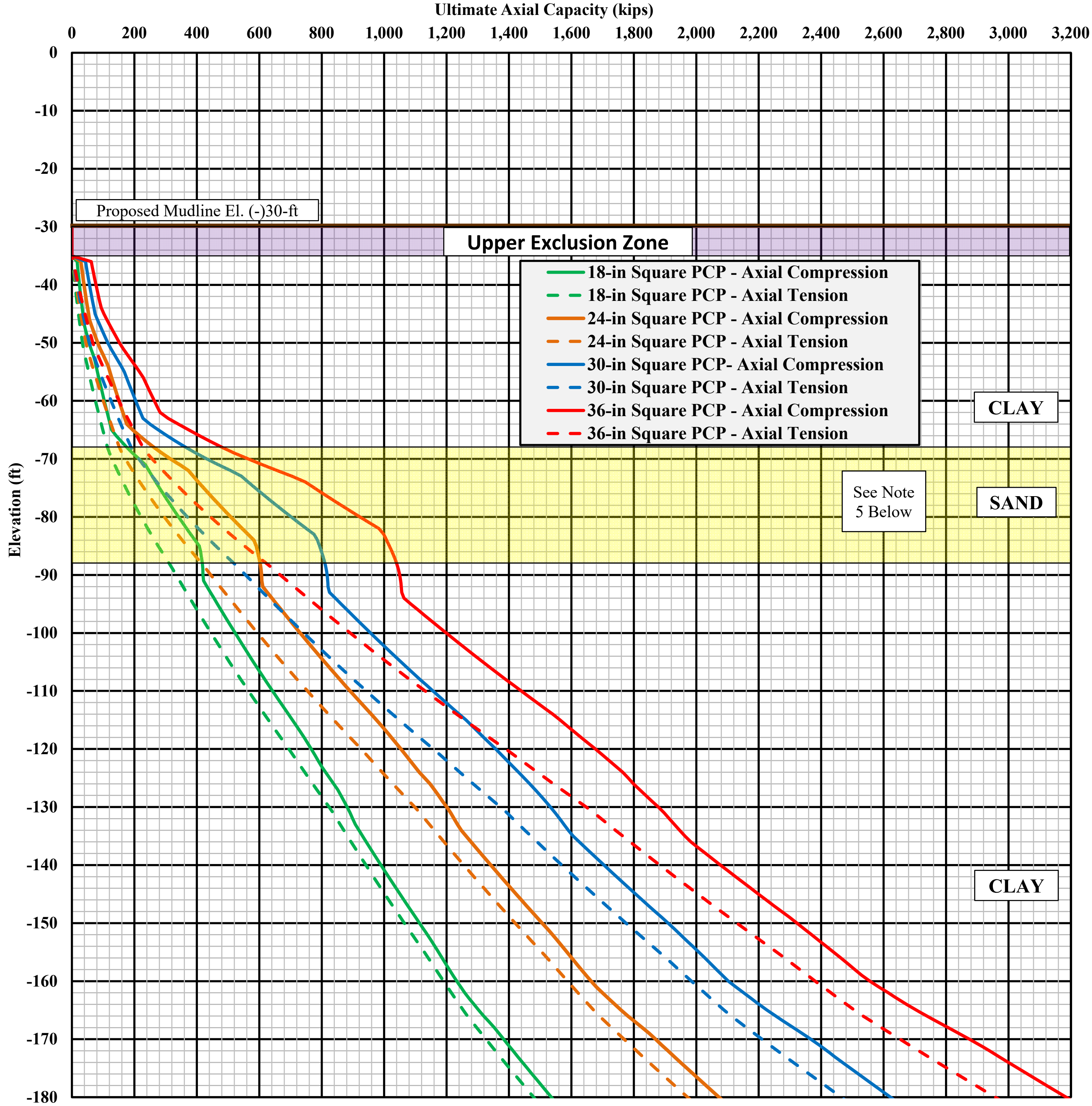

NOTES:

1) Center-to-center spacing of the pile should be at least three (3) times the pile width.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.

Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation Square Precast Concrete Piles Marine - El. (-)30-ft**	**Appendix:** I **Figure:** 7

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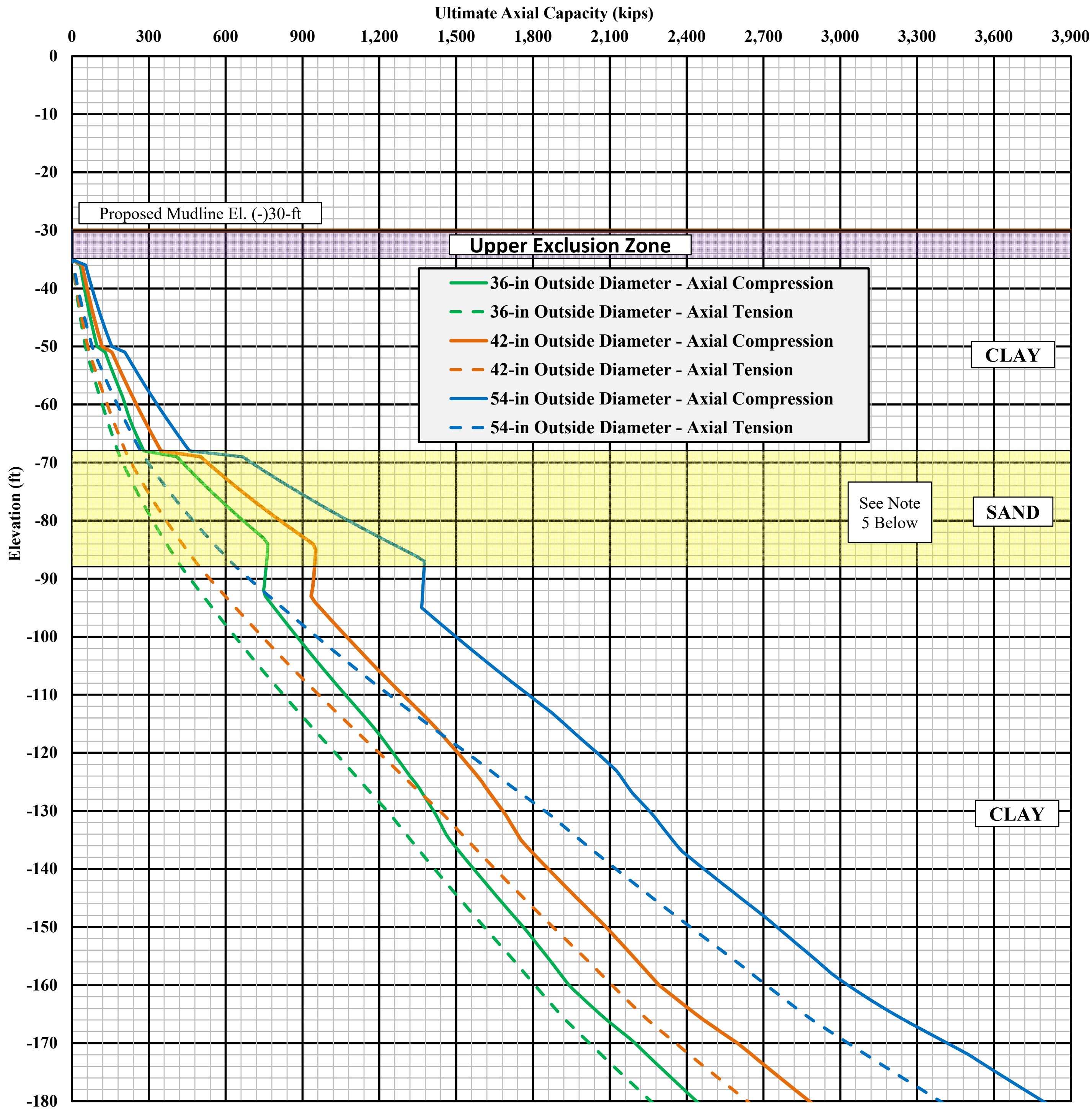
ULTIMATE AXIAL CAPACITY VERSUS ELEVATION
CYLINDRICAL SPUN CAST CONCRETE PILES - MARINE - El. (-)30-ft



NOTES:

1) Center-to-center spacing of the pile should be at least three (3) times the pile diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.
6) Assumed pile wall thickness of 6-in for all pile diameters shown.

Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation** **Cylindrical Spun Cast Concrete Piles** **Marine - El. (-)30-ft**	**Appendix:** I **Figure:** 8

MUDLINE ELEVATION EL. (-) 45-FT

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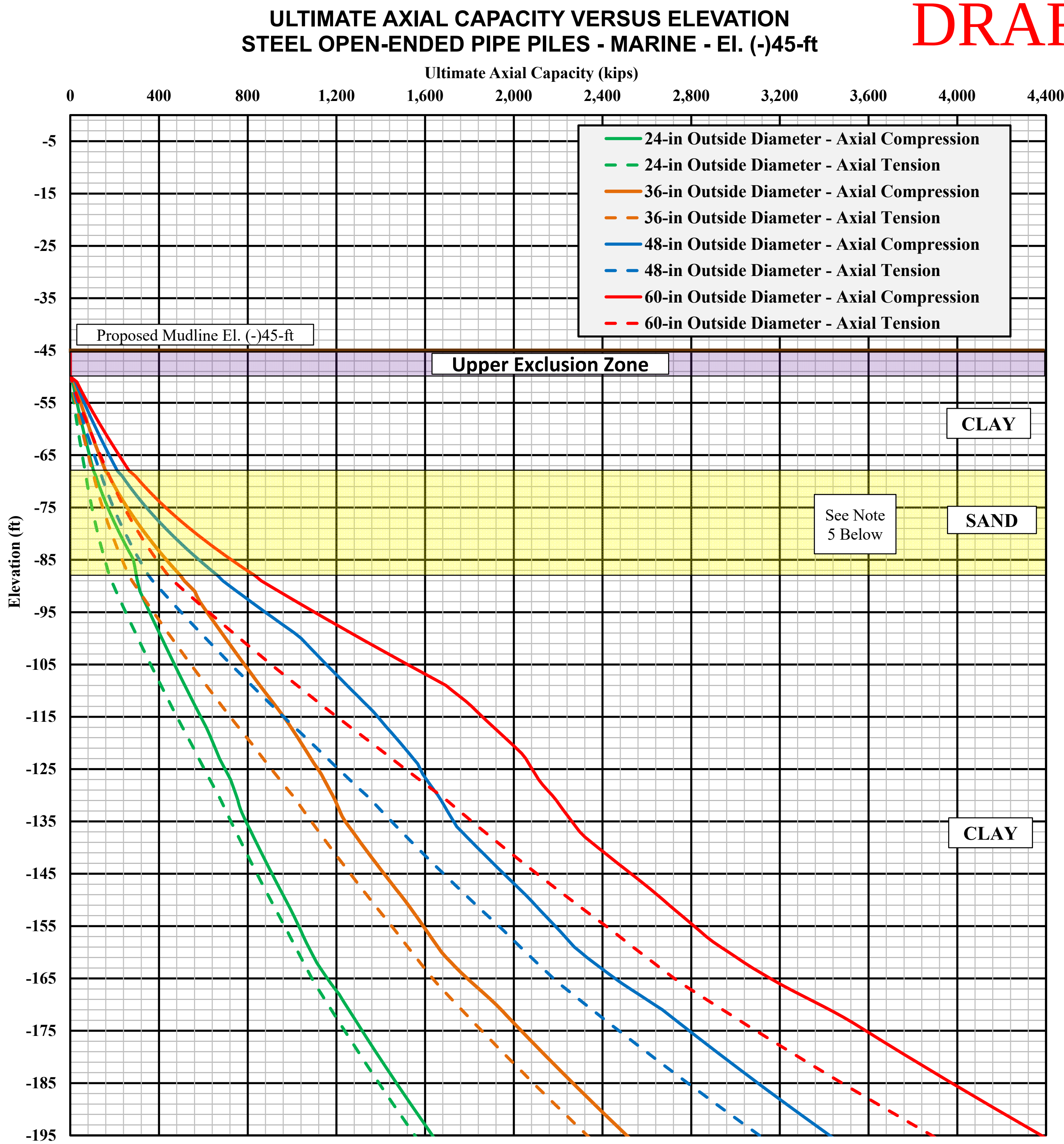
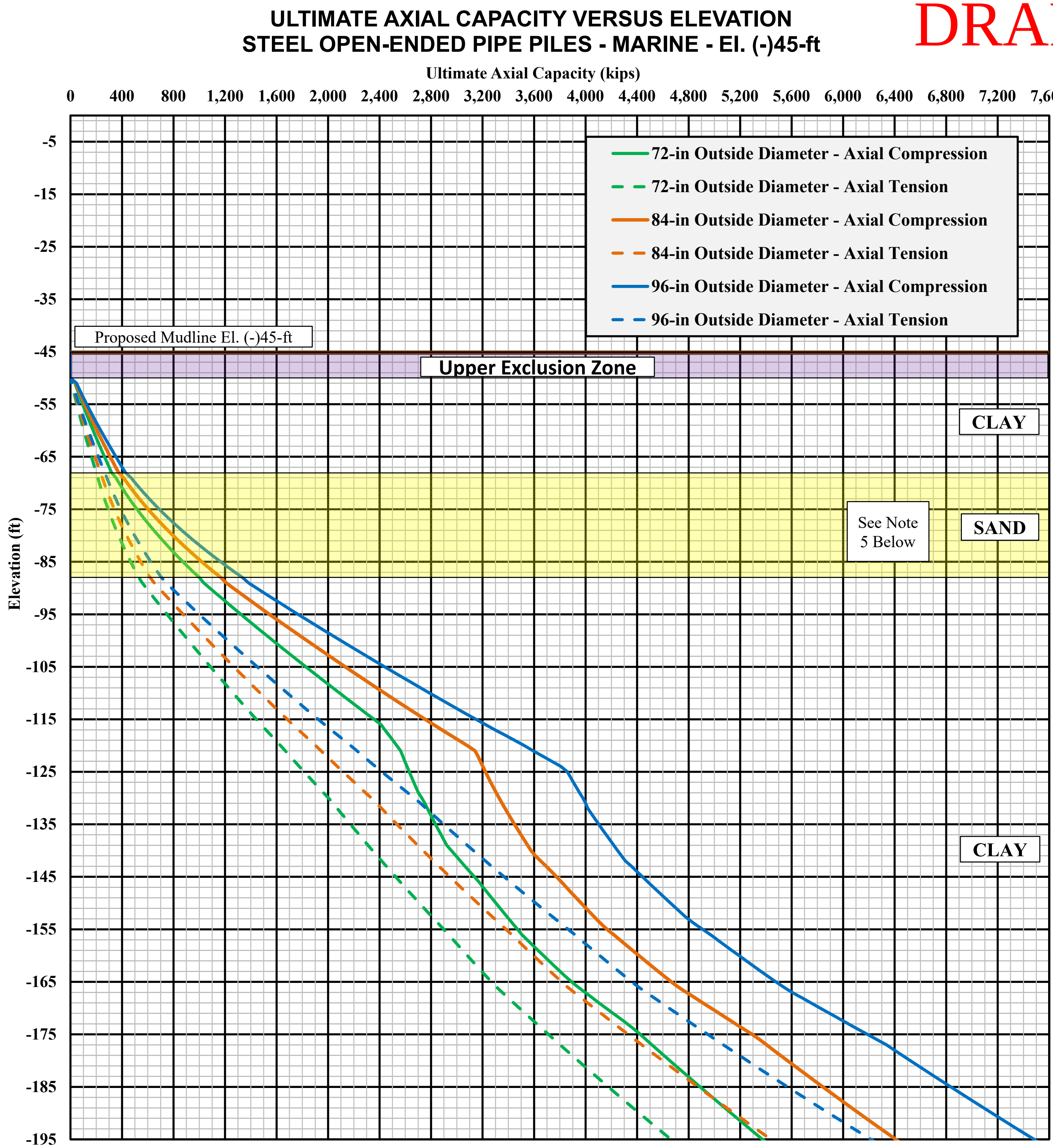


NOTES:

1) Center-to-center spacing of the pile should be at least three (3) times the pile diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.
6) Assumed pipe pile wall thickness of 3/8-in for 24-in pipe piles and 1/2-in for all other pipe pile diameters shown.

Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation** **Steel Open-Ended Pipe Piles** **Marine - El. (-)45-ft**	**Appendix:** I **Figure:** 9

DRAFT



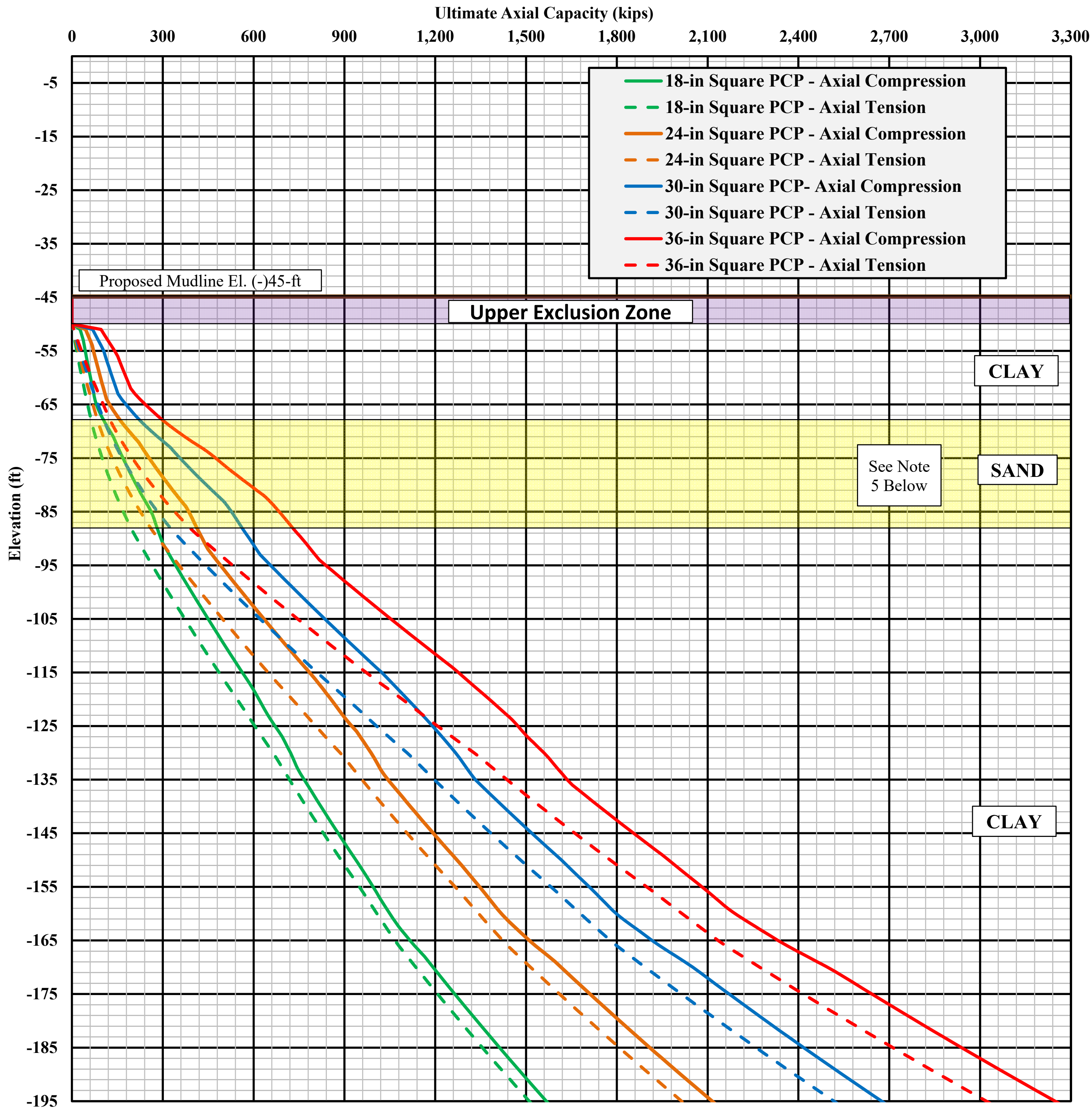
NOTES:

1) Center-to-center spacing of the pile should be at least three (3) times the pile diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.
6) Assumed pipe pile wall thickness of 1/2-in for all pipe pile diameters shown.

Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation** **Steel Open-Ended Pipe Piles** **Marine - El. (-)45-ft**	**Appendix:** I **Figure:** 10

DRAFT

ULTIMATE AXIAL CAPACITY VERSUS DEPTH
SQUARE PRECAST CONCRETE PILES - MARINE - El. (-)45-ft



NOTES:
1) Center-to-center spacing of the pile should be at least three (3) times the pile width.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.

Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation** **Square Precast Concrete Piles** **Marine - El. (-)45-ft**	**Appendix:** I **Figure:** 11

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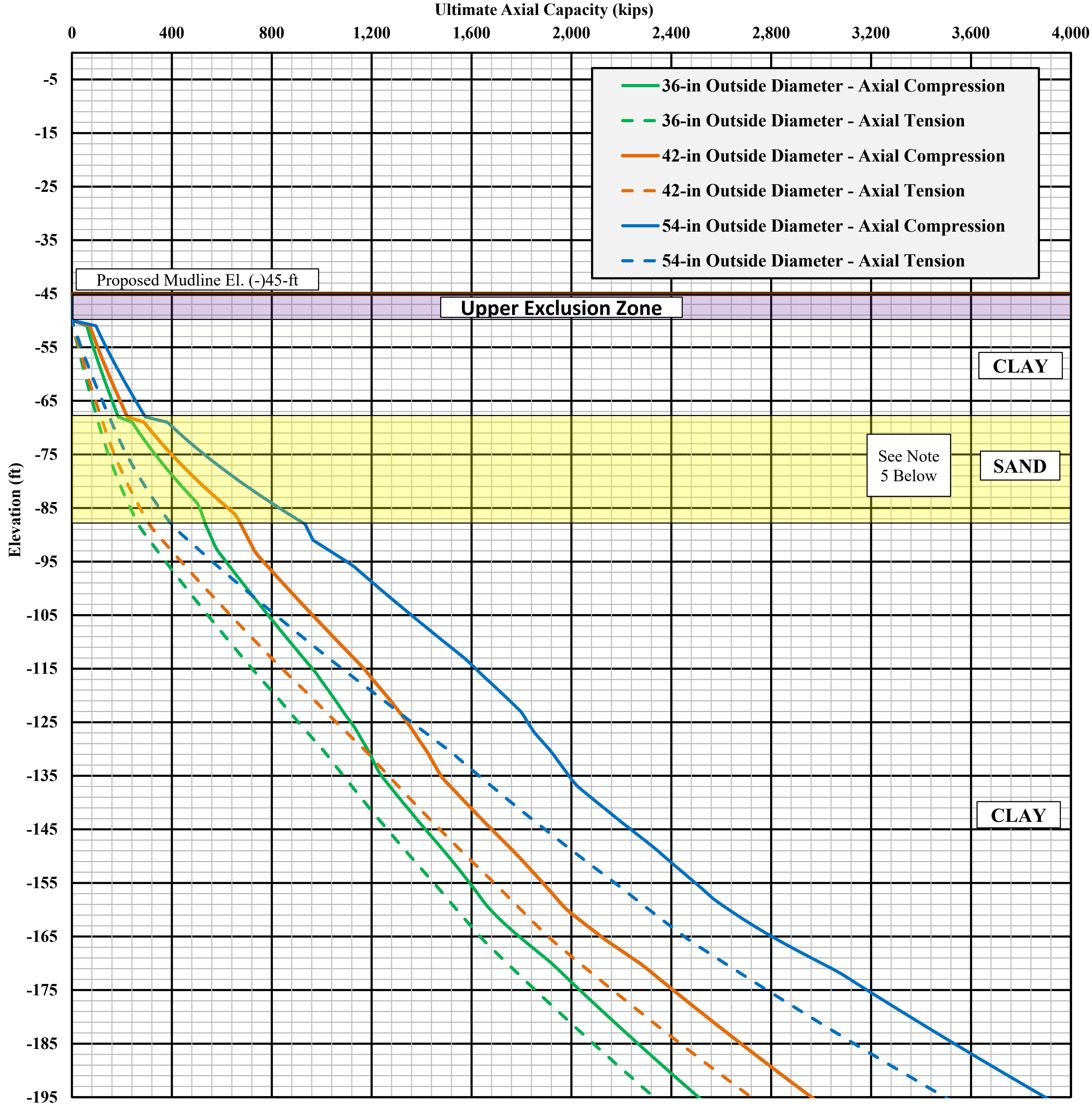
ULTIMATE AXIAL CAPACITY VERSUS ELEVATION
CYLINDRICAL SPUN CAST CONCRETE PILES - MARINE - El. (-)45-ft



NOTES:
1) Center-to-center spacing of the pile should be at least three (3) times the pile diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.
6) Assumed pile wall thickness of 6-in for all pile diameters shown.

Project		
Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation Cylindrical Spun Cast Concrete Piles Marine - El. (-)45-ft**	**Appendix:** I **Figure:** 12

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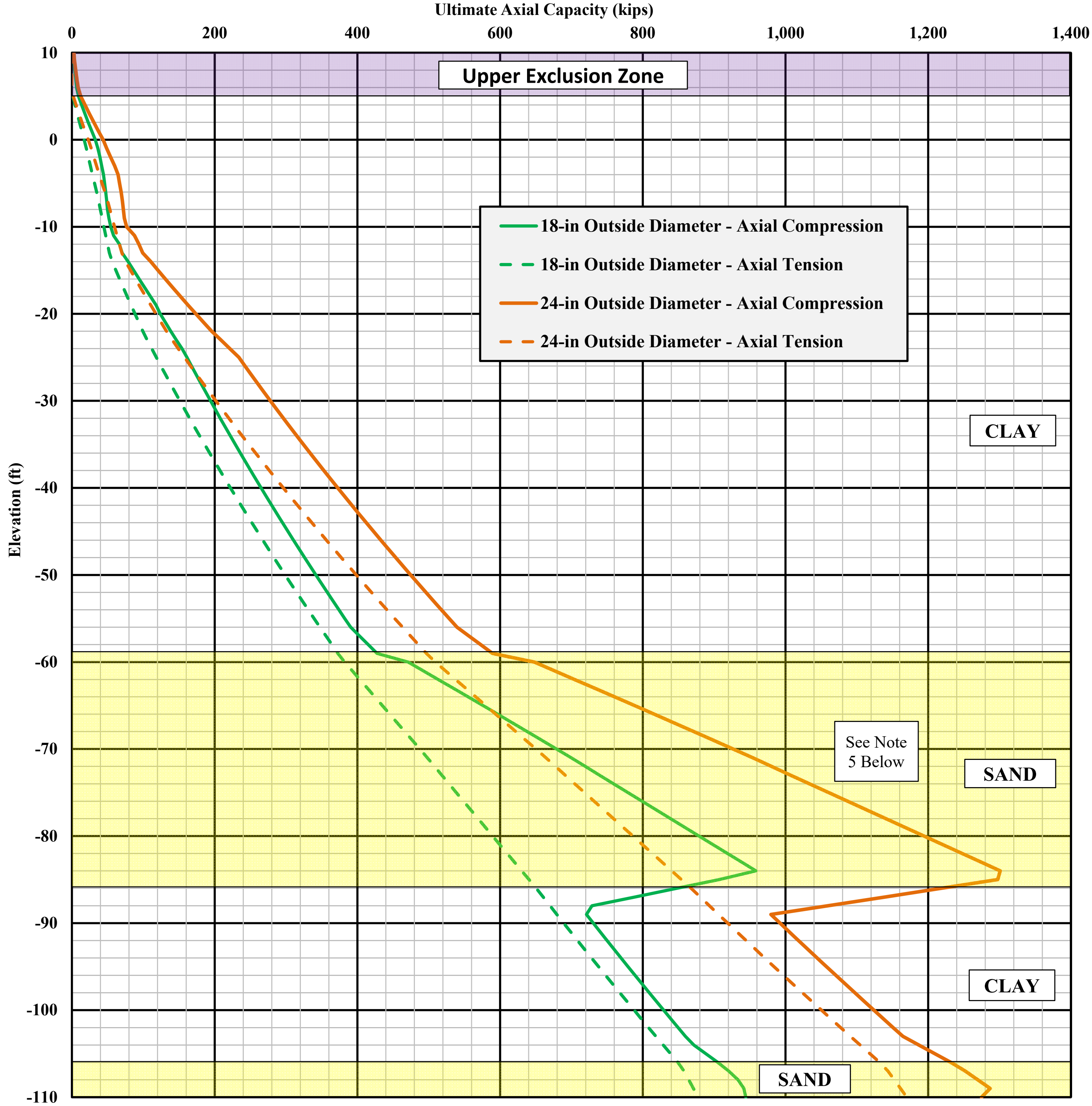
LANDSIDE

DRAFT

ULTIMATE AXIAL CAPACITY VERSUS ELEVATION
STEEL OPEN-ENDED PIPE PILES - LANDSIDE - El. (+)10-FT

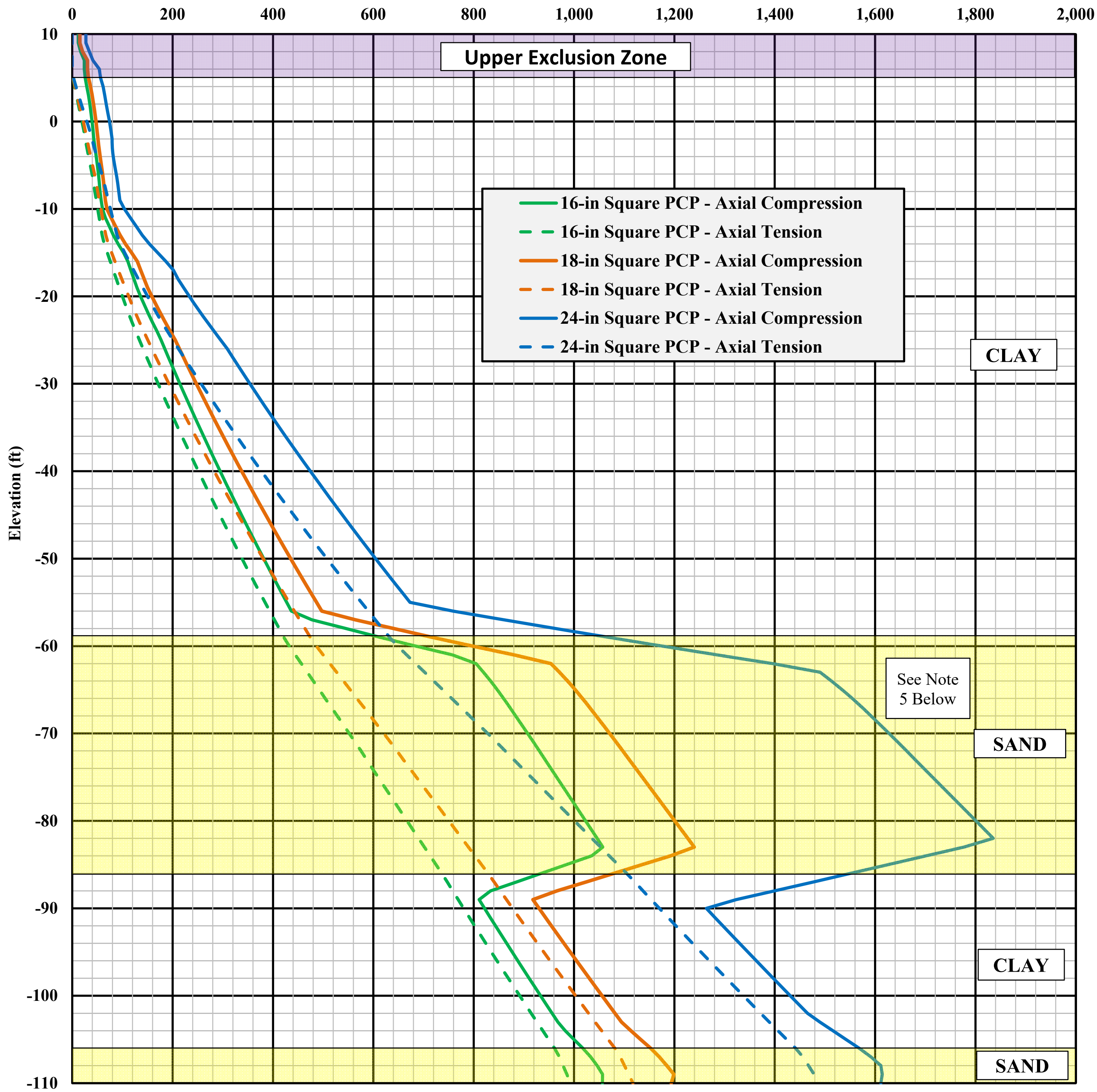


NOTES:
1) Center-to-center spacing of the pile should be at least three (3) times the pile diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.
6) Assumed pipe pile wall thickness of 3/8-in for all pipe pile diameters shown.

Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation Steel Open-Ended Pipe Piles Landside - El. (+)10-ft**	**Appendix:** I **Figure:** 13

DRAFT

ULTIMATE AXIAL CAPACITY VERSUS ELEVATION
SQUARE PRECAST CONCRETE PILES - LANDSIDE - El. (+)10-FT



NOTES:
1) Center-to-center spacing of the pile should be at least three (3) times the pile diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.

Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation Square Precast Concrete Piles Landside - El. (+)10-ft**	**Appendix:** I **Figure:** 14

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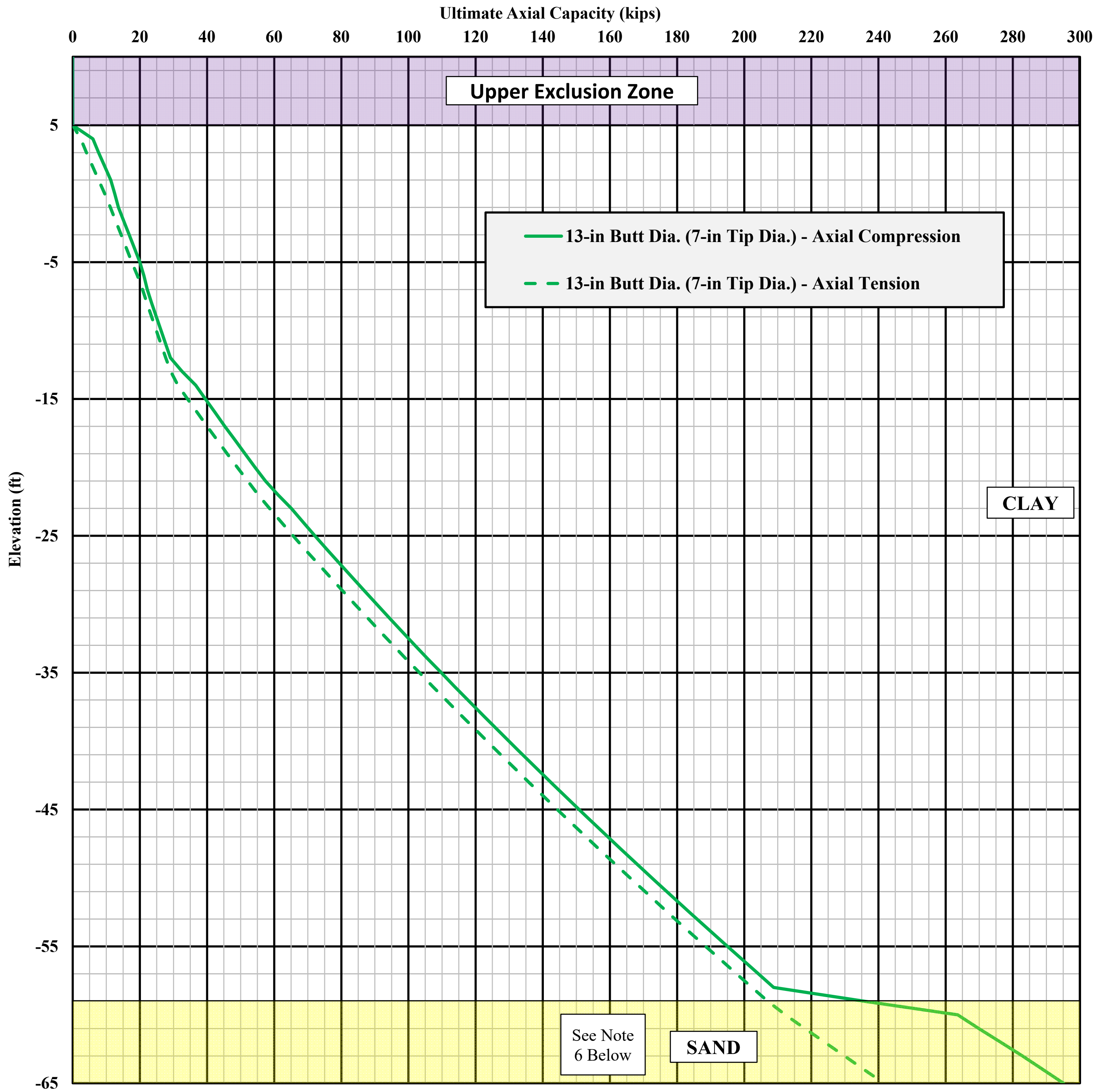
ULTIMATE AXIAL CAPACITY VERSUS ELEVATION
CLASS B TIMBER PILES - LANDSIDE - El. (+)10-FT



NOTES:

1) Center-to-center spacing of the pile should be at least three (3) times the butt diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Embedment depths for Class B timber pile sizes can be determined by commonly available Southern Pine Timber Pile lengths as presented in the Timber Piling Council (TPC) Timber Pile Design Manual (updated 2015).
6) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.

Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation** **Class B Timber Piles** **Landside - El. (+)10-ft**	**Appendix:** I **Figure:** 15

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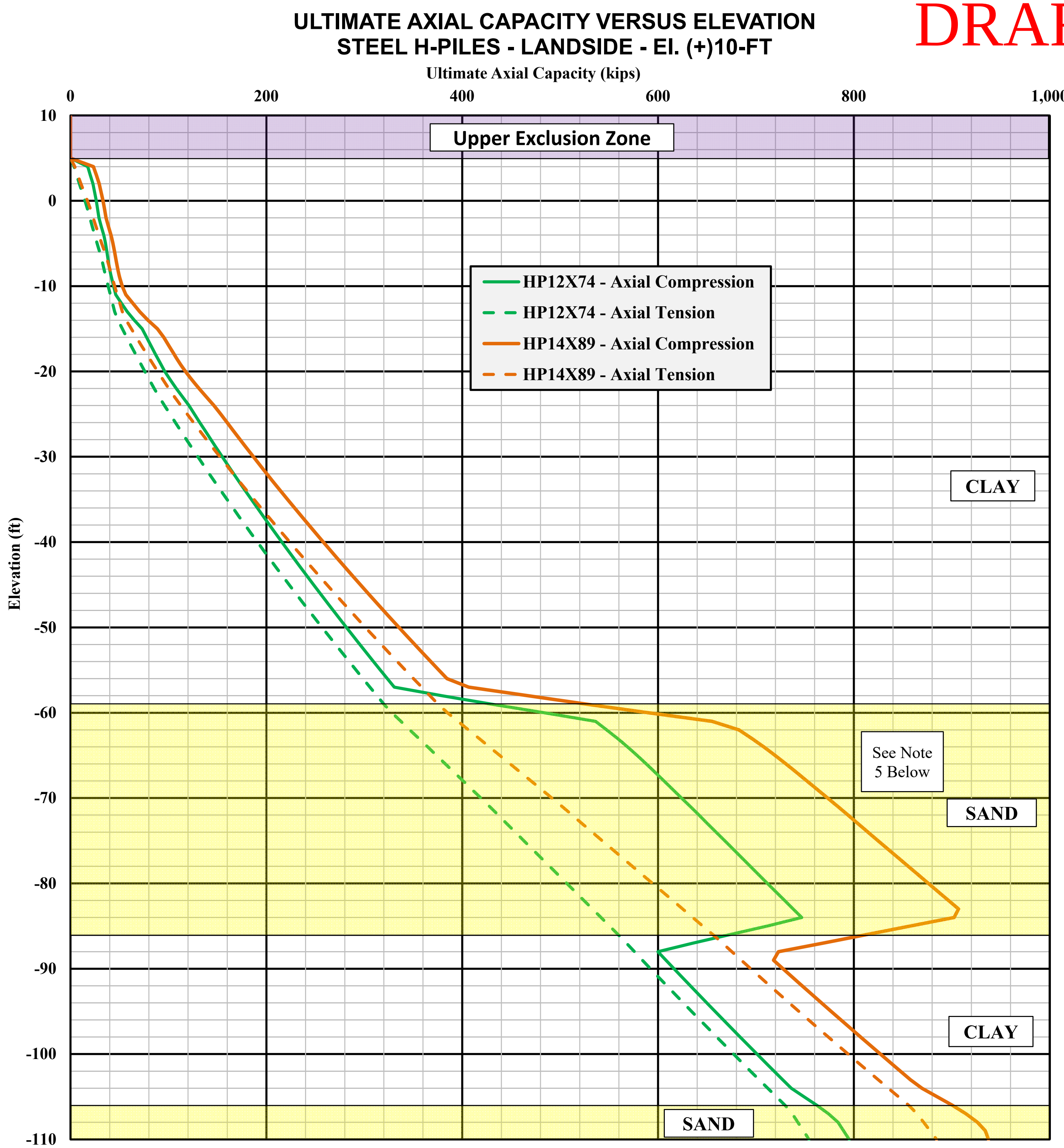


NOTES:

1) Center-to-center spacing of the pile should be at least three (3) times the pile diameter.
2) A factor of safety of 2.5 is recommended for allowable compression loads.
3) A factor of safety of 3.0 is recommended for allowable tension loads (does not include the weight of pile).
4) Reduced factors of safety can be considered if a pile load testing program (static, dynamic or combination) is performed.
5) Increased driving resistance and/or refusal could be encountered in the sand strata shown. See Section 11.3.

Project Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	**Project Number:** 21.23.029 **Report Number:** 120938
Client Lanier & Associates Consulting Engineers, Inc. Beaumont, Texas	**Ultimate Axial Capacity vs. Elevation** **Steel H-Piles** **Landside - El. (+)10-ft**	**Appendix:** I **Figure:** 16

APPENDIX J

PROCEDURE FOR COMPUTING CAPACITY
OF BATTERED PILES

PROCEDURE FOR COMPUTING APPROXIMATE AXIAL AND HORIZONTAL CAPACITY OF BATTERED PILES

NOMENCLATURE:

P_c = Compression Capacity of Vertical Pile

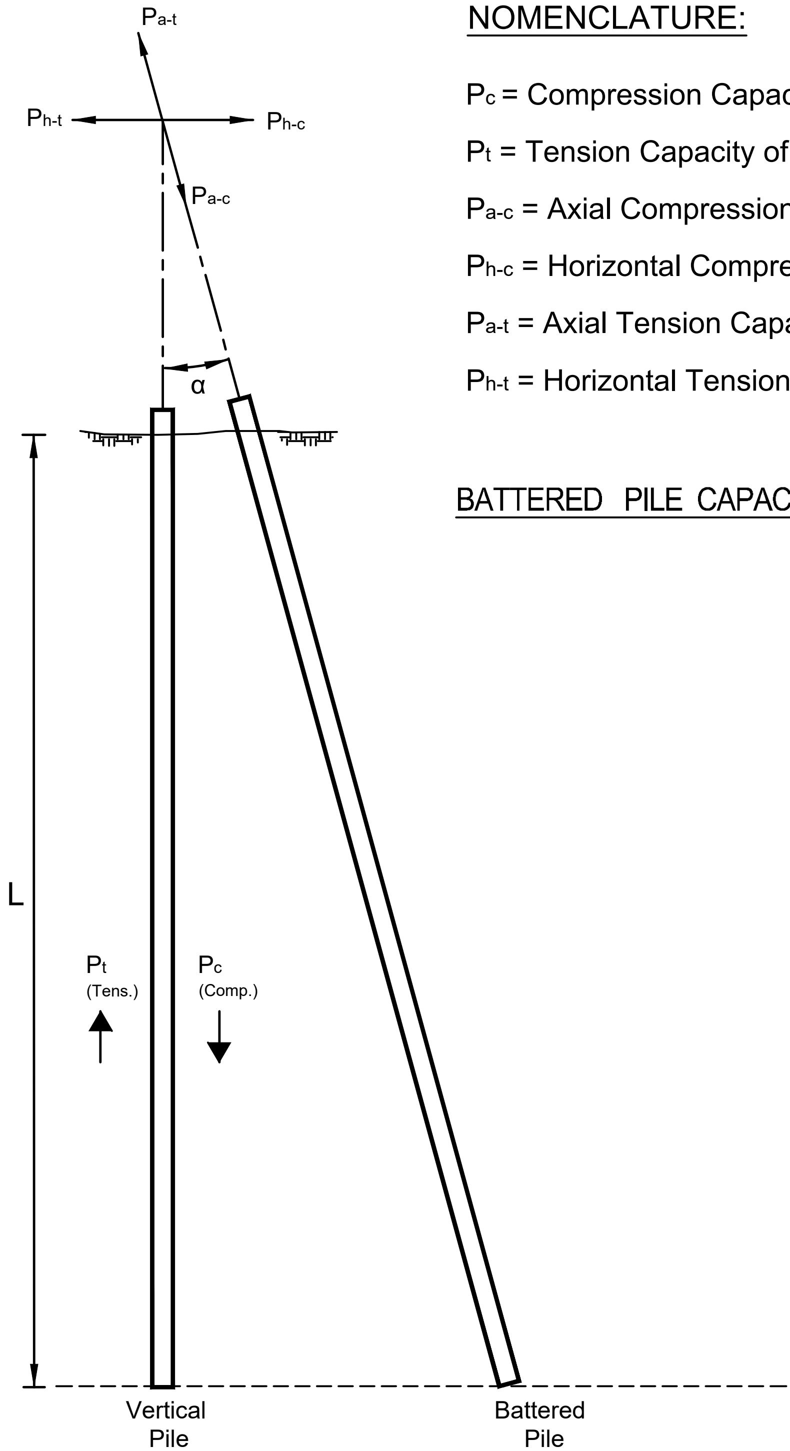
P_t = Tension Capacity of Vertical Pile

$P_{a\text{-}c}$ = Axial Compression Capacity of Battered Pile

$P_{h\text{-}c}$ = Horizontal Compression Capacity of Battered Pile

$P_{a\text{-}t}$ = Axial Tension Capacity of Battered Pile

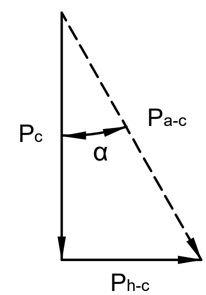
$P_{h\text{-}t}$ = Horizontal Tension Capacity of Battered Pile



BATTERED PILE CAPACITY CALCULATIONS:

$$P_{a\text{-}c} = \frac{P_c}{\cos(\alpha)}$$

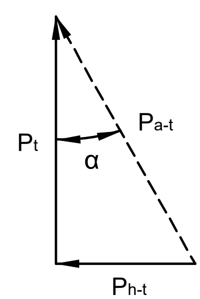
$$P_{h\text{-}c} = P_c\,[\tan(\alpha)]$$



Vertical Diagram For Compression

$$P_{a\text{-}t} = \frac{P_t}{\cos(\alpha)}$$

$$P_{h\text{-}t} = P_t\,[\tan(\alpha)]$$



Vertical Diagram For Tension

Notes:

(1) If Ultimate compression and tension capacity of vertical piles (Pc and Pt) are used to compute battered pile capacities, appropriate factors of safety should be applied.

(2) Vertical and angled piles must be penetrated to equal elevations for this method to be applicable.

(3) Bending stiffness of piles and soil bearing capacity against battered piles is not included in this method.

APPENDIX K

SOIL DESIGN PARAMETERS FOR
LATERAL PILE RESPONSE ANALYSIS

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Table: Lateral Analysis Soil Design Parameters - Marine Dock Structures							
LPILE Soil Type	**Elevation (ft)**		**Effective Unit Weight, γ' (pcf)**	**Cohesion, c (psf)**	**Friction Angle (°)**	**Static Lateral Modulus, *k* (pci)**	**Strain Factor, ε_{50}**
	Top	**Bottom**					
Soft Clay (Matlock)	-10	-28	48	350	--	30	0.020
Soft Clay (Matlock)	-28	-50	58	700	--	100	0.010
Stiff Clay without Free Water	-50	-68	48	1,400	--	500	0.007
Sand (Reese)	-68	-88	53	--	38	125	--
Stiff Clay without Free Water	-88	-120	66	3,800	--	1,000	0.005
Stiff Clay without Free Water	-120	-130	76	3,300	--	1,000	0.005
Stiff Clay without Free Water	-130	-155	73	2,400	--	1,000	0.005
Stiff Clay without Free Water	-155	-165	72	2,100	--	1,000	0.005
Stiff Clay without Free Water	-165	-208	72	2,800	--	1,000	0.005

Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	Project Number: 21.23.029 Report Number: 120938
Trans-Global Solutions, Inc. Beaumont, Texas	**Lateral Analysis Soil Design Parameters Marine Dock Structures**	Appendix K Figure 1

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Table: Lateral Analysis Soil Design Parameters - Landside Dock Structures							
LPILE Soil Type	**Elevation (ft)**		**Effective Unit Weight, γ' (pcf)**	**Cohesion, c (psf)**	**Friction Angle (°)**	**Static Lateral Modulus, *k* (pci)**	**Strain Factor, ε_{50}**
	Top	**Bottom**					
Stiff Clay without Free Water	10	0	128	1,500	--	500	0.007
Stiff Clay without Free Water	0	-6	65	1,000	--	100	0.010
Soft Clay (Matlock)	-6	-13	58	600	--	100	0.010
Stiff Clay without Free Water	-13	-22	58	2,200	--	1,000	0.005
Stiff Clay without Free Water	-22	-59	58	2,700	--	1,000	0.005
Sand (Reese)	-59	-70	53	--	38	125	--
Sand (Reese)	-70	-86	53	--	37	125	--
Stiff Clay without Free Water	-86	-106	63	2,600	--	1,000	0.005
Sand (Reese)	-106	-112	53	--	25	125	--

Cedar Bayou Deepening & Widening Project Chambers County, Texas	Tolunay-Wong Engineers, Inc.	Project Number: 21.23.029 Report Number: 120938
Trans-Global Solutions, Inc. Beaumont, Texas	**Lateral Analysis Soil Design Parameters Landside Dock Structures**	Appendix K Figure 2

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APPENDIX L

DISORBO CONSULTING, LLC PRE-DREDGE
ENVIRONMENTALFINDINGS REPORT (REDACTED)

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Findings Report
Pre-Dredge Environmental Testing
Cedar Bayou Channel Deepening/Widening
Cedar Port Industrial Park

TGS

Trans-Global Solutions Inc.
Chambers County, Texas

Tolunay-Wong Engineers, Inc.

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.

May 2021

DiSorbo
Environmental Consulting Firm

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Table of Contents

List of Tables

DRAFT

Table of Contents (continued)

List of Figures

List of Appendices

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Executive Summary

This report presents the findings of pre-dredge environmental testing in support of the Trans-Global Solutions Inc. (TGS) deepening/widening of the Cedar Bayou connecting channel between the Cedar Port Industrial Park and the Houston Ship Channel (see Figure 1 Site Location Map). The Cedar Port Industrial Park is located east of Houston, Texas in Chambers County. Dredge spoils will likely be relocated to a private placement area (PA).

Consistent with new cut dredging protocols, full-depth core sediment samples (4) were collected by a barge-mounted drilling rig within the new cut dredge footprint to represent the material to be removed. In addition, three (3) of these stations were selected for the collection of elutriate make-up materials for laboratory preparation and testing. Two (2) stations were selected for the collection of channel water column testing. Including the quality control blanks, there were a total of eleven (11) media samples tested for environmental parameters. Geotechnical testing was performed by others.

Lab analyses were completed by A&B Labs located in east Houston, Texas, which is a NELAP certified lab. The field collection activities were completed in March 2021 by DiSorbo Consulting, LLC in accordance with the sampling and analysis plan prepared specifically for this work.

In addition to physical characteristics (grain size distribution, water and solids content), sediment samples were comprehensively analyzed for volatile & semi-volatile organics, metals, ammonia, pH, total organic carbon, TPH, polychlorinated biphenyls (PCBs), and pesticides. Representative water and elutriate samples were analyzed for a similar comprehensive list. In addition, the sediment samples were subjected to waste characterization and classification testing as a contingency.

The results were compared to normal criteria utilized by the USACE Environmental Section and Real Estate Division for federal Placement Area and Beneficial Use Area disposition of dredged material.

Overall, based on this limited testing, the dredged sediment placement on land with subsequent dewatering by settling and the resulting discharge of return water will not have a negative or degrading impact on current environmental conditions at the placement area selected or Cedar Bayou (location of return water discharge) based on the normal criteria. The following paragraphs recount these findings in greater detail by the specific environmental media tested.

Sediment in the Dredge Footprint

Per USACE guidance, the primary reference criteria for sediment included (1) NOAA-Effects Range Low (ER-L) for Marine, (2) USEPA Region 6 published values, and (3) Texas Risk Reduction Program (TRRP) values for human health and ecological exposure. In addition, the sediment samples collected were subjected to volatiles analysis and RCI testing (reactivity, corrosivity, and ignitability), parameters which are over and above the normal USACE testing regime. Dioxins were not tested.

For the source area or dredging footprint (four full-depth core samples), all of the volatile organic analytes (VOAs), semi-volatile organic compounds (SVOCs), PCB, TPH, TOC, ammonia, pH, and pesticides results were either non-detect or within the primary screening and acceptable levels.

For metals, there were detections for virtually all of the analytes except silver which was non-detect. Among the detections, all were quantified at concentrations within the screening benchmark (NOAA ER-L), with the exception of the metal arsenic in the sediment sample from Station MB-9. However, this singular exceedance was lower than the secondary screening benchmark (NOAA ER-L) utilized by the USACE for evaluating sediment quality, and the elutriate sample taken from this same station had concentrations of all constituents, including arsenic, that were acceptable from a water quality perspective. Thus, the trace metals observed in the sediment do not disqualify the material from being transferred to and disposed of in a private land PA, beneficial use area, or in a federal PA on approval. In addition, the sediment material all met non-hazardous criteria under RCRA.

Site Water and Elutriate Findings

Benchmark criteria for the water matrix and elutriate included the (1) Texas Surface Water Quality Standards [TSWQS, 30 TAC §307, marine acute assuming water effect ratio of 1], (2) USEPA National Water Quality Criteria (WQC, marine acute), (3) NOAA Screening Quick Reference Tables (SQRT, marine acute water), and (4) USEPA Region 6 Watershed Standards (marine acute).

For the site water and elutriate samples, all of the metals, VOAs, SVOCs, TPH, pesticide, ammonia, and PCB concentrations were either non-detect or at levels well within applicable criteria.

Summary

Overall, the results of the source area testing indicate that the dredged material placement and subsequent settling with resulting discharge of return water will not have a negative or degrading impact on current environmental conditions at either the placement area selected or the receiving water (location of return water discharge) based on USACE and USEPA recognized or Texas adopted criteria. Placement could conceivably include private PA, beneficial use zone, or federal PAs.

Section 1
Project Information

1.1 Project Description and Background

The Cedar Port Industrial Park intends to perform new cut (hydraulic and/or mechanical) dredging of the Cedar Bayou waterway located between the Industrial Park and the Houston Ship Channel (see Figure 1 Site Location Map). The purpose of the current sampling effort was to test sediment and other media from within the dredge footprint to ensure suitability of the material for disposal. The placement area will discharge return water after settling into the same or a nearby waterway.

This report of findings documents the field sampling protocols (e.g., sample collection and field-testing methods and quality assurance/quality control measures) and laboratory methods of physical and chemical analyses for sediment, water, and elutriate media to determine dredge disposal site suitability. This report also presents an evaluation of the laboratory findings.

1.2 Sampling Objectives

The objectives of the bulk sediment and water sampling event included:

- Collection of sediment data from the footprint of the area to be dredged to determine if the source material contains concentrations of chemicals of concern that would indicate significant historical contamination; for this objective, the findings are primarily compared to recognized environmental benchmarks furnished by the USACE;
- Collection of site water to determine pre-existing concentrations of constituents in the water column and for comparison to applicable water quality standards; and
- Collection of elutriate phase testing data from the area to be dredged to evaluate return water compliance with water quality standards applicable to the receiving water.

1.3 Overview and Approach

The environmental sampling team from DiSorbo mobilized to the area in March 2021, alongside a separate crew (Tolunay-Wong Engineers, TWE) that concurrently collected geotechnical core samples from the same platform and rig. Decontamination protocols between these separately purposed core collections were strictly followed. In accordance with the environmental sampling plan specific to this project, four sampling stations were preselected in the marine environment, as shown on Figure 2 and in Table 2-1. The locations were selected in order to be representative of the footprint for new cut dredging to deepen and widen the existing barge channel (which is off the main federal Houston Ship Channel [HSC]) in order to accommodate ship traffic in the future (-45' MLLW is the reported nominal depth of the deepening and widening plan). The existing stretch of barge channel connects the mouth of Cedar Bayou with the HSC. The HSC is part of the San Jacinto River system that meets various bays before entering the Gulf of Mexico near Galveston, Texas.

Water, elutriate makeup, and sediment samples were collected from the dredge footprint areas for the purpose of laboratory testing to characterize the material to be dredged. An equipment blank and a trip blank were included in the testing program for quality control purposes. The laboratory utilized for the testing was A&B Labs of Houston, which is recognized by the National Environmental Laboratory Accreditation Program (NELAP). Their specialty subcontracted labs are also accredited.

In addition to physical characteristics (grain size distribution, water and solids content), sediment samples were comprehensively analyzed for volatile and semi-volatile organics, metals, ammonia, pH, total organic carbon, PCBs, TPH, and pesticides. Water samples were analyzed for a similar comprehensive list. Elutriate samples generated in the laboratory from field collected media were also analyzed. Dioxins were not included. Additionally, the sediments were subjected to waste characterization testing under Resource Conservation and Recovery Act (RCRA) and Texas waste classification testing protocols, as a contingency in the event that a suitable land-based placement area is determined to not available for use for this dredging project.

Results were then compared with media appropriate screening criteria recommended by the regulatory agencies. In some cases, in which screening benchmarks were not furnished in the USACE/USEPA guidance and yet analyte detections were made, DiSorbo sought and referenced other available media specific criteria from the literature or regulations for comparison.

1.4 Report Organization

This report is organized into five primary sections after the Executive Summary, including: Introduction, Methods, Results/Discussion, Conclusions, and References. Details of the plans and results are supplied in accompanying tables and figures. Supporting and additional information, such as the plan for sampling, comparison criteria, logs, and lab reports are given in appendices.

Section 2
Methods of Collection and Analysis

2.1 Overview of Sampling Program

The primary purpose of the pre-dredge sampling project was to evaluate sediment from within the deepening and widening footprint proposed for the existing barge channel that connects the mouth of Cedar Bayou with the HSC south of the Interstate 10 crossing of the San Jacinto River. The existing barge channel to be deepened and widened is located within an industrialized portion of Chambers County, Texas, immediately east of Harris County.

Water, elutriate, and sediment samples were collected from the proposed dredge area for the purpose of laboratory testing to characterize the material to be dredged. The sampled material was laboratory analyzed to determine whether unacceptable adverse environmental impacts could result from dredging and the subsequent dredge material placement operations, including the discharge of return water to the channel.

All sample collection activities and chemical analyses were conducted in accordance with guidance generally provided by USACE-SWG for new cut and maintenance dredging and per existing standard procedures outlined in the following reference documents.

- USEPA and USACE (1991). Evaluation of Dredged Material Proposed for Ocean Disposal (the "Green Book"). Testing Manual, Section 8, Collection and Preservation of Samples. EPA 503/8-01/001.
- USEPA and USACE (1995). QA/QC Guidance for Sampling and Analysis for Sediment, Water and Tissues for Dredged Material Evaluations (Chemical Evaluations). EPA-823- B-95-001.
- USEPA and USACE (1998). Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. Inland Testing Manual (the "ITM"). Section 8, EPA-823-B-98-004.

Copies of the Sampling & Analysis Plan (SAP), Health & Safety Plan (HASP), Job Safety Analysis (JSA), and relevant screening criteria for this work are included in Appendix A of this report.

Prior to the sampling activity, the new empty containers for sediment, site water, and elutriate sample collection were segregated into station specific sampling sets. The containers were placed into ice chests with packing material and labeled with sample type (Site Water, Sediment, Elutriate Makeup, Trip and Equipment Blanks). All other required information, such as the date and time, was added at the time of actual sample collection.

2.2 Sample Sites, Equipment and Team

A total of eleven (11) media samples were collected and analyzed by the contract laboratory, including four (4) full-depth core sediment samples (Stations MB-1, MB-5, MB-7, and MB-9).

The count included two water quality (channel water) samples plus one equipment blank; and sufficient additional sediment and site water were collected so that the laboratory could prepare three (3) elutriate samples from Stations MB-1, MB-5, and MB-9 for aqueous phase testing, based upon the Standard Elutriate Test (SET). A trip blank (water container unopened in the field) was analyzed as well for a limited subset of tests (metals only, per usual protocol). The purpose of the elutriate phase testing is to imitate, first, the settling and clarification of the dredge spoil and, secondly, the return water discharge quality for comparison with TSWQS or other health-based standards and screening levels, with or without mixing zone calculations, as appropriate.

Table 2-1 in combination with Figure 2 provides sample station information including the sample names, precise locations, and sample counts. The sampling location plan (Figure 2) illustrates the approximate footprint of the area to be dredged adjacent to the federal channel. The sample stations were spatially located to be representative of the entire footprint. Zones of minimal or incidental deposition or pre-existing deeper draft spots were avoided as usual. However, because the project involves extending the navigational channel depth from barge draft (-11’ MLLW nominal) to ship draft (-45’ to -50’ MLLW nominal), this factor was of practically no concern, that is, there was plenty of “new cut” column at all of the stations considered.

The coordination of efforts to complete the pre-dredge planning, mobilization, field sampling, laboratory analyses, tabulation of results, evaluation and interpretation of results, quality control review, reporting, technical review, and ultimate regulatory approval, if necessary, included/includes the following persons and organizations:

Title	Point of Contact (POC)	Contact Information
Project Manager	Bob Davis	DiSorbo Consulting – Austin Office 9737 Great Hills Trail, Suite 340 Austin, Texas 78759 O. 512-693-4184 | C. 512-970-9639 bdavis@disorboconsult.com
Task Manager / Safety (and Field Crew for Environ Sampling)	Allen Rienstra - lead James Reis - assist	DiSorbo Consulting – Austin Office 9737 Great Hills Trail, Suite 340 Austin, Texas 78759 C. 512-693-4185 | C. 409-504-6933 arienstra@disorboconsult.com jreis@disorboconsult.com
Additional Field Assist	Trey O'Connor, E.I.T. TWE Drilling Rig & Crew Spud-barge tug and support boat by Peninsula Marine	Tolunay-Wong Engineers 2455 W Cardinal Dr, Beaumont, TX 77705 409-840-4214
Subcontractor for Drilling	DiSorbo was a subcontractor to TWE for this project	Tolunay Wong Engineers 2455 W. Cardinal Drive Beaumont, TX 77705 O. 409-840-4214
Laboratory Contact	Clint Larison and Shantall Carpenter	A&B Environmental Services, Inc. 10100 East Freeway, Suite 100 Houston, Texas 77029 O. 713-453-6060 ext. 136 clarison@ablabs.com scarpenter@ablabs.com
Engineering Partner of Host Facility	Chris Guy, P.E. Lanier & Associates Consulting Engineers, Inc.	Lanier & Associates Beaumont Office 595 Orleans St, Suite 600 Beaumont, TX 77701 Ofc: (409) 212-1051 cguy@lanier-engineers.com
Host Facility and Project Owner	James Scott Cedar Port Industrial Park	James Scott Trans-Global Solutions, Inc. Office: 409-727-4801 Cell: 409-658-7959 jscott@tgsgroup.com

2.3 Sediment Sample Collection

Before the sampling event began, the new and clean sediment/soil, site water, and elutriate sample containers were segregated into station specific sampling sets. The sampling containers were labeled with the station identification number and all other required information except date and time, which was added just prior to collecting the sample. The containers were placed in ice chests designated with the station identification number and with packing material but no ice. Separate ice chests with ice to be used for sample preservation were transported to the collection station along with the station sample container ice chests. Sets of ice chests (containing the sampling containers and the ice) were placed on the water craft and transported to the designated sampling stations.

Sediment samples were collected from the four stations within the dredge footprint in order to spatially represent the entire area. Station locations were informed by an earlier depth survey conducted by Lanier & Associates. The actual locations of sampling were GPS-recorded for precision, and ended up being very close to the planned locations. Sediment samples were collected using a conventional rotary drilling rig positioned by truck on a spud barge for the marine stations. The maximum depth required is about -47' MLLW. The maximum length of cores was determined and continuously logged in several foot intervals, with an aliquot of material taken from each interval and the full core blended and composite sampled using a lined bucket for mixing.

Nitrile disposable gloves were worn before composite mixing and loading aliquots into the labeled and marked sample containers. New disposable gloves were used at each location. As the sample containers were filled, they were placed in Ziploc (or equivalent) bags, then placed into the assigned ice chest. The archive-intended sediment samples, if retained, were initially placed on ice and then transferred to a freezer once they reached their final destination. A small amount of headspace was allowed for the archived samples to prevent container breakage during freezing.

2.4 Water Sample Collection for Bulk Chemistry and Elutriate Testing

Two stations for water quality chemical analysis were identified (see Figure 2). Three standard elutriate test (SET) stations were identified as well. One equipment blank (deionized water pumped through clean tubing and/or over the sampling equipment) was also containerized for analysis. The trip blank was not opened during sampling operations.

Once the vessel was positioned and stabilized at each sampling station, a 12-volt submersible pump attached three feet from the bottom of a five feet long length of 3/8" rebar (vertical orientation) was lowered into the water. The rebar was fitted with a flat bottom to prevent it from penetrating into sediment, thus maintaining the pump intake within about three feet of the bottom. The weight of the assembly facilitated submersion and stabilization of the pump. The pump was attached to the rebar with tie wraps, and the rebar was suspended from its eyelet. The electrical and poly lines were attached to the cable from the pump to the surface. The sample tubing was flushed with at least ten times the tubing volume before samples were collected. The site water was field tested for pH, temperature, and conductivity. Immediately before each sample jar was filled, a collection time was assigned to the containers for that station and sample set. As the sample containers were filled, they were placed in their protective sleeves and then into the assigned ice chest. Once an ice chest received its containers, ice was added to maintain approximate 4°C until lab receipt and handling.

The pump was retrieved and then decontaminated by submersing it and the tubing in an Alconox soap rinse and then pumping a minimum of ten tubing volumes of the soap solution through the pump and tubing, followed by a tap water pumped rinse, then two deionized water pumped rinses. All decontamination rinsate was collected in containers and disposed of properly. After the decontamination procedures were completed, the pump, tubing, and rebar devices were placed into a clean plastic bag to prevent contamination from other activities on the vessel. Once the water sampling was completed, all sample ice chests were delivered to a staging area for loading to vehicle and transportation to the laboratory. A field log was kept during the sampling to record the time sequence, field conditions, weather conditions, and to make other observations or to note deviations from the plan and reasons for those deviations. A copy of the field log notes is in Appendix C.

2.5 Sample Preservation, Shipping, and Custody

As the sample containers were filled and marked, they were placed into their protective sleeves and then placed into the assigned ice chest. All samples were handled under chain of custody (COC) protocols beginning at the time of collection. The samples were transported to A&B Labs in Houston.

Samples were considered to be “in custody” if they were (1) in the custodian’s possession or view, (2) in a secured place (locked) with restricted access, or (3) in route via courier. Standard COC procedures were used for all samples collected, transferred, and analyzed as part of this project. COC forms were used to identify the samples, custodians, and dates of transfer. Each person who had custody of the samples signed the COC forms and ensured the samples were stored properly and not left unattended unless properly secured. The information on COC forms included:

- Sample Identification Number;
- Sample Collection Date and Time;
- Sample Matrix (e.g., marine sediment or water);
- Parameters to be Analyzed;
- Container Types;
- Sampler Identification;
- Dates of Transfer; and
- Names and Signatures of Persons with Successive Custody.

Copies of the original COC's are made at the laboratory upon delivery of the samples. In addition, COC records are included in the final report prepared by the analytical laboratory, and are also included here in Appendix D.

2.6 Physical and Chemical Analyses

Physical and chemical parameters were based on the USACE guidance regarding potential chemicals of concern in Texas waterways as well as area specific knowledge of chemicals detected in nearby projects. All of the analytical methods followed USEPA, Standard Methods (SMs) or ASTM protocols, and the test methods are listed in Table 2-2. The analytical laboratory contracted to perform the analyses maintains current NELAP accreditation for the prescribed methods, and the certificates are included in Appendix B. Samples were collected, prepared, and shipped to maintain compliance with appropriate holding times and temperatures for the prospective analytical methods as presented in the SAP and Table 2-2. Physical and chemical analyses for sediment samples included:

- Grain size analysis (gravel, sand, silt, clay);
- Water Content/Percent Solids;
- Total Organic Carbon (TOC) and pH;
- Volatile Organic Compounds (VOCs);
- Semi-Volatile Organic Compounds (SVOCs);
- Pesticides and Total PCB Aroclors;
- Total Metals (antimony, arsenic, cadmium, total chromium, copper, lead, mercury, nickel, silver, and zinc);
- Total Petroleum Hydrocarbons (TPH);
- Total Ammonia; and
- RCRA Characteristics of RCI (reactivity, corrosivity, ignitability).

Site water and elutriate analyses were conducted for the following constituents:

- Total Organic Carbon;
- pH and salinity;
- Volatile Organic Compounds (VOCs);
- Semi-Volatile Organic Compounds (SVOCs);
- Pesticides and Total PCB Aroclors,
- Dissolved Metals (antimony, arsenic, cadmium, total chromium, copper, lead, total mercury, nickel, silver, and zinc);
- Total Petroleum Hydrocarbons (TPH); and
- Total Ammonia.

Standard elutriate testing was conducted for three of the stations. Chemical analyses commenced as soon as practicable after laboratories took receipt of the samples. Analyses were conducted within method holding times (except pH) and accomplished with appropriate quality control measures. The current Texas laboratory certification is provided in Appendix B.

Standard elutriate test (SET) samples were prepared according to USACE procedures included in the USACE ITM. Sediment and site water were mixed at the default method conditions and ratios prior to agitation and aeration. This test is designed to conservatively mimic conditions indicative of water quality discharged from a confined disposal facility during active dredge disposal operations.

The laboratory standard operating procedure (SOP) for the SET is included here in Appendix B. In accordance with procedures outlined in the ITM and the UTM, elutriate phase analysis results were compared to Texas Surface Water Quality Criteria (30 Texas Administrative Code Chapter 307) to evaluate whether, after appropriate mixing zone boundaries have been applied if necessary, surface water quality criteria will be met in the return water that is discharged to the receiving water.

2.7 Variances from SAP

This section identifies modifications that were made in the field or laboratory and additionally reports discrepancies observed by the sampling team or laboratory on behalf of the applicant. While every effort was made to follow the details and intent of the SAP, the reality of field sampling and data collection is that sometimes variances are required or inadvertently occur. It is important to both describe and weigh the significance of such variances in the report of findings.

Holding Times

Holding times were not met for pH for the sediment samples in the laboratory. This was an expected occurrence due to the elapsed time from collection to analysis. There was reasonable agreement between the pH measurements of channel water obtained in the field versus the laboratory reported values of pH, and all were in the 5-9 standard units range.

Missing Lab Parameters

The lab inadvertently omitted the analysis of pH for the two water quality samples and the three elutriate samples. The sediment sample from Station MB-5 was supposed to receive RCRA RCI testing in addition to the usual USACE parameters, and these supplemental tests (RCI) were absent from the results. Th remaining three sediment samples did receive RCI testing, however, with the outcome determination of “non-hazardous” if disposed as a waste. The omissions of pH and RCI were determined to not be significant or critical omissions.

Over-extended Core Lengths

The field crew mistakenly added 50’ to the measured depth of water to arrive at the target depth for full-depth core samples. For example, if the water depth was determined to be 8’, the termination depth of core collected was 58’ below water surface at that station. In actuality, the dredging envelope depth is based on the datum of mean lower low water (MLLW). If the projected allowable dredge depth is -47’ MLLW and the water depth is 8’ (that is, the mudline occurs 8’ below the water surface), then the appropriate length for the full-depth core sample would be 39’ rather than 50’. On average, this discrepancy added about 25% of extra length to the cores. Because the sampling lab results were virtually all non-detect, this additional core length does not appreciably change the outcome of the evaluation. The crew has been instructed about this calculation for future collection activities.

Section 3
Results and Discussion

3.1 Sediment

The laboratory reported the chemical analyses of the sediment samples on a dry weight basis, as is the normal industry standard when direct comparisons with benchmark concentrations are to be made. The full set of results of sediment testing is tabulated in Table 3-1. Bold values represent detected concentrations. Yellow highlighted cells in this table represent findings that exceeded one or more but not all available benchmark criteria. A comparison of project-specific quantitation limits furnished by the laboratory with the target detection limits presented in the SAP was also made, and the laboratory-achieved reporting limits were acceptable in almost every instance.

Per USACE guidance, referenced numerical criteria for sediment included (1) NOAA-Effects Range Low (ER-L) for Marine; (2) USEPA Region 6 published values, and (3) Texas Risk Reduction Program (TRRP) Tier 1 Residential values for human health exposure. Other numerical criteria for sediment were also included as reference points in the tables, being available for some of the analytes which did not have numerical criteria published in the aforementioned sources.

For metals, there were detections for virtually all of the analytes except silver which was non-detect. Among the detections, all were quantified at concentrations within the screening benchmark (NOAA ER-L), with the exception of the metal arsenic in the sediment sample from Station MB-9. However, this singular exceedance was lower than the secondary screening benchmark (NOAA ER-L) utilized by the USACE for evaluating sediment quality, and the elutriate sample taken from this same station had concentrations of all constituents, including arsenic, that were acceptable from a water quality perspective. All other parameter results (VOCs, SVOCs, pesticides, PCBs, ammonia, TPH, TOC, pH, and RCI values) were either non-detect or acceptably low. Thus, none of the findings disqualify the material from being transferred to and disposed of in a private land PA, beneficial use area, or in a federal PA on approval. In addition, the reported sediment material results all met non-hazardous criteria under RCRA.

These findings indicate that the dredge material associated with this new cut event are acceptable for loading to a private or federal placement area (if requested), or to a qualified beneficial use area.

3.2 Water

Table 3-2 presents a summary of laboratory analytical results for the water quality samples collected (Stations MB-1 and MB-7) and the equipment blank. The complete analytical reports including QA/QC data can be found in Appendix E.

As mentioned earlier, benchmark criteria for the water matrix are primarily the Texas Surface Water Quality Standards (TSWQS, 30 TAC §307, marine acute assuming water effect ratio of 1), followed by the USEPA National Water Quality Criteria (WQC, marine acute), the NOAA Screening Quick Reference Tables (SQRT, marine acute water), and the USEPA Region 6 Watershed Standards (marine acute).

For the tested constituents (metals, VOCs, SVOCs, pesticides, TOC, pH, ammonia, TPH, and PCBs) in the water phase, sample results were either non-detect or at levels well below the identified criteria.

In all, the water column (Cedar Bayou barge channel) testing was as expected, with no significant environmental concerns.

3.3 Elutriate

The summary results of elutriate testing at the dredge footprint are presented in Table 3-3. Benchmark criteria for elutriate include the same ones as listed above for the water column samples.

Similar to the water column results, the elutriate phase testing for metals, VOCs, SVOCs, pesticides, TOC, pH, ammonia, TPH, and PCBs yielded results that were either non-detect or at levels below the identified criteria.

In summary, for elutriate produced by material from the dredging footprint as represented by these findings, the results appear to meet current standards of surface water quality, especially after mixing with ambient water.

3.4 Field Observations

As presented in Table 3-4, the physical characterizations of the sediments were consistent with the observation of low organic content (average of 0.4% OC), presumably naturally sourced and with about equal fractions of sand, silt, and clay, in the reported particle size distributions. Laboratory measured pH of sediment fell within the expected neutral to upper values for a clay rich bottom sediment associated with typical inland navigable waterways in the Texas Gulf Coast.

Section 4
Conclusions

This report documents the methodology and results of pre-dredge multimedia sample collection and analysis related to the Cedar Port Industrial Park access channel deepening/widening project.

Sediment in the Dredge Footprint

For the source area or dredging footprint (four full-depth core samples), all of the volatile organic analytes (VOAs), semi-volatile organic compounds (SVOCs), PCB, TPH, TOC, ammonia, pH, and pesticides results were either non-detect or within the primary screening and acceptable levels.

For metals, there were detections for virtually all of the analytes except silver which was non-detect. Among the detections, all were quantified at concentrations within the screening benchmark (NOAA ER-L), with the exception of the metal arsenic in the sediment sample from Station MB-9. However, this singular exceedance was lower than the secondary screening benchmark (NOAA ER-L) utilized by the USACE for evaluating sediment quality, and the elutriate sample taken from this same station had concentrations of all constituents, including arsenic, that were acceptable from a water quality perspective.

Thus, the trace metals or other constituents observed in the sediment do not disqualify the material from being transferred to and disposed of in a private land PA, beneficial use area, or in a federal PA on USACE approval. In addition, the sediment material all met non-hazardous criteria under RCRA.

Site Water and Elutriate Findings

For the site water (two samples) and elutriate phase (three samples), all of the metals, VOAs, SVOCs, TPH, TOC, pesticide, ammonia, and PCB concentrations were either non-detect or at levels well within applicable criteria.

Summary

Overall, the results of the source area testing indicate that the dredged material placement and subsequent settling with resulting discharge of return water will not have a negative or degrading impact on current environmental conditions at either the placement area selected or the receiving water (location of return water discharge) based on USACE and USEPA recognized or Texas adopted criteria. Placement could conceivably include private PA, beneficial use zone, or federal PAs.

Section 5
References

1. USEPA and USACE (Feb 1991). Evaluation of Dredged Material Proposed for Ocean Disposal (the "Green Book"). Testing Manual, Section 8, Collection and Preservation of Samples. EPA 503/8-01/001.

2. USEPA (April 1995). QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations (Chemical Evaluations). EPA-823-B-95-001.

3. USEPA and USACE (1998). Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. Inland Testing Manual (the "ITM"). Section 8. EPA-823-B-98-004.

4. USEPA and USACE (May 1981). Procedures for Handling and Chemical Analysis of Sediment and Water Samples, "Technical Report EPA / CE-81-1, prepared by R.H. Plumb, Jr. and colleagues Great Lakes Laboratory, State University College at Buffalo, NY for the USEPA / USCOE Technical Committee of Criteria for Dredged and Fill Material.

5. USEPA (Oct 2001). Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. EPA-823-B-01-002.

6. USEPA (1986). Test Methods for Evaluating Solid Waste (SW846): Physical/chemical Methods.

7. Buchman, M.F.(2008). NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages. http://response.restoration.noaa.gov/sites/default/files/SQuiRTs.pdf

8. EPA Region 6 Sediment Benchmark: based on Guidance for Conduction Ecological Risk Assessments at Remediation Sites in Texas, Toxicology and Risk Assessment Section, Texas Natural Resource Conservation Commission, Austin, TX (2001 RG-263, Revised)

9. TCEQ (2010) Texas Surface Water Quality Standards (TSWQS) Title 30 Texas Administrative Code (TAC) Section 307.6(c)(i) Table 1, Saltwater Acute Criteria.

10. Vicinie, A., Palermo, M., Matko, L. (2011) Proceedings of the Western Dredging Association (WEDA XXXI) Technical Conference and Texas A&M University (TAMU 41) Dredging Seminar, Nashville, Tennessee, June 5-8, 2011: A review of the various elutriate tests and refinements of the methodologies.

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Tables

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Table 2-1
Overview of Pre-Dredge Stations within Footprint
TWE Cedar Port – 2021 Pre-Dredge Testing in Support of Channel Dredging

Station	Collection Date	Location Coordinates Latitude / Longitude		Meas. Depth of Water (feet)	pH of Water		Other Metrics		Sediment Sample Collected	Site Water Collected	Elutriate Media Collected
					Field	Lab (Note 1)	Water Temp Field	Total Drilled Depth			
MW-1	03/16/2021	29.6874	-93.9807	6	--	NM	--	56’	●	●	●
MW-5	03/16/2021	29.6863	-93.9806	8	--	--	--	58’	●		●
MW-7	03/17/2021	29.6809	-93.9491	7	5.20	NM	21.09 C	57’	●	●	
MW-9	03/17/2021	29.6744	-93.9379	10	6.55	--	20.87 C	60’	●		●

NOTES:

1. Laboratory inadvertently omitted the measurement of pH of the water samples (NM = Not Measured).
2. See Figure 2 for the mapped locations of the sampling stations.

Table 2-2
Analytical Testing Program
TWE Cedar Port – 2021 Pre-Dredge Testing in Support of Channel Dredging

Parameter	*EPA or Other Recognized Method*	*Sediment Note 1 (4 samples)*	*Water Note 2 (2 samples + EqB & Trip Blk)*	*Elutriate Note 3 (3 samples)*
		Physical Testing		
Grain Size Distribution	ASTM 422-63	●		
Water Content/Solids	SM 2540G	●		
		Chemical Testing		
pH	SW-846 9040/9045	●	●	
TPH	TCEQ 1005	●	●	●
Ammonia	EPA 350.2	●	●	●
TOC	SW-846 9060A	●	●	●
9 Metals Plus Mercury	EPA 200.8/SW-846 7471B	●	●	●
Volatiles & Semi-volatiles	EPA 8260/8270D	●	●	●
Total PCBs	EPA 8082A	●	●	●
Salinity	SM 2520B		●	
Pesticides (OC)	EPA 8081B	●	●	●

Notes:

1. Sediment samples were taken at Stations MB-1, MB-5, MB-7, and MB-9. A duplicate was not taken.
2. Water Quality samples were taken at Stations MW-1, MW-7, and MW-9, plus Equipment Blank & Trip Blank.
3. Elutriate materials were taken at Stations MW-1, MW-5, and MW-9; the lab generated elutriate samples.
4. The laboratory inadvertently omitted the water sample pH measurements.
5. In addition to these analyses, the lab analyzed Sediment Samples MB-1, 7, and 9 for RCRA characteristics.

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Table 3-1: Sediment Analysis Results and Screening - TWE Cedar Port Pre-Dredge Testing 2021

				Screening Benchmarks																			Sediment: Data Evaluation	
														MB-1-SED 21031513.11 3/16/2021		MB-5-SED 21031513.13 3/16/2021		MB-7-SED 21031513.08 3/17/2021		MB-9-SED 21031513.09 3/17/2021		Average		
Analyte	Method	Units	Samp Count	NOAA ER-L (b)	NOAA ER-M (b)	EPA Reg 6 (c)	TCEQ TRRP Resi-dential (d)	Ecological Reference	(e) or (f)	Other	Ref	TDL	Lab RL	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Compare MAX/AVG to Preferred Bmark	Additional Comment
SVOCs																								
1,2,4-Trichlorobenzene	SW-846 8260C	mg/Kg	4				69,500	20,000	(e)	--		10	0.0044	< 0.00138		< 0.00138		< 0.00138		< 0.00138		< 0.00	Pass	--
1,2-Dichlorobenzene	SW-846 8260C	mg/Kg	4				389,000			--		20	0.0044	< 0.001		< 0.001		< 0.001		< 0.001		< 0.00	Pass	--
1,3-Dichlorobenzene	SW-846 8260C	mg/Kg	4				61,600			--		20	0.0044	< 0.00141		< 0.00141		< 0.00141		< 0.00141		< 0.00	Pass	--
1,4-Dichlorobenzene	SW-846 8260C	mg/Kg	4				253,000	20,000	(e)	--		20	0.0044	< 0.00144		< 0.00144		< 0.00144		< 0.00144		< 0.00	Pass	--
2,4-Dichlorophenol	SW-846 8270D	ug/Kg	4				200,000			--		120	0.04175	< 21.67		< 21.67		< 21.67		< 21.67		< 21.67	Pass	--
2,4-Dimethylphenol	SW-846 8270D	ug/Kg	4				1,330,000			--		20	0.04175	< 23.74		< 23.74		< 23.74		< 23.74		< 23.74	Pass	--
2,4-Dinitrophenol	SW-846 8270D	ug/Kg	4				133,000	20,000	(e)	--		500	0.04175	< 55.67		< 55.67		< 55.67		< 55.67		< 55.67	Pass	--
Acenaphthene	SW-846 8270D	ug/Kg	4	16	500	16	2,970,000	20,000	(e)	--		20	0.04175	< 15.32		< 15.32		< 15.32		< 15.32		< 15.32	Pass	--
Acenaphthylene	SW-846 8270D	ug/Kg	4	44	640	44	3,800,000			--		20	0.04175	< 23.74		< 23.74		< 23.74		< 23.74		< 23.74	Pass	--
Anthracene	SW-846 8270D	ug/Kg	4	85.3	1100	85.3	17,700,000			--		20	0.04175	< 18.12		< 18.12		< 18.12		< 18.12		< 18.12	Pass	--
Benzo(a)anthracene	SW-846 8270D	ug/Kg	4	261	1600	261	41,000			--		20	0.04175	< 28.26		< 28.26		< 28.26		< 28.26		< 28.26	Pass	
Benzo(a)pyrene	SW-846 8270D	ug/Kg	4	430	1600	430	4,100			--		20	0.04175	< 43.33		< 43.33		< 43.33		< 43.33		< 43.33	Pass	--
Benzo(b&k)fluoranthene	SW-846 8270D	ug/Kg	4				41,000			1800	AET	20	0.04175	< 46.97		< 46.97		< 46.97		< 46.97		< 46.97	Pass	--
Benzo(g,h,i)perylene	SW-846 8270D	ug/Kg	4				1,780,000			670	AET	20	0.04175	< 29.86		< 29.86		< 29.86		< 29.86		< 29.86	Pass	--
Chrysene	SW-846 8270D	ug/Kg	4	384	2800	384	4,100,000			--		20	0.04175	< 23.74		< 23.74		< 23.74		< 23.74		< 23.74	Pass	--
Dibenzo(a,h)anthracene	SW-846 8270D	ug/Kg	4	63.4	260	63.4	4,000			--		20	0.04175	< 49.42		< 49.42		< 49.42		< 49.42		< 49.42	Pass	--
Diethyl phthalate	SW-846 8270D	ug/Kg	4				53,300,000	100,000	(e)	530	D	50	0.04175	< 29.86		< 29.86		< 29.86		< 29.86		< 29.86	Pass	--
Fluoranthene	SW-846 8270D	ug/Kg	4	600	5100	600	2,320,000			--		20	0.04175	< 25.62		< 25.62		< 25.62		< 25.62		< 25.62	Pass	--
Fluorene	SW-846 8270D	ug/Kg	4	19	540	19	2,260,000	30,000	(e)	--		20	0.04175	< 11.87		< 11.87		< 11.87		< 11.87		< 11.87	Pass	--
Hexachlorobenzene	SW-846 8270D	ug/Kg	4				1,020			--		10	0.04175	< 39.94		< 39.94		< 39.94		< 39.94		< 39.94	Pass	--
Indeno(1,2,3-cd)pyrene	SW-846 8270D	ug/Kg	4				42,000			600	AET	20	0.04175	< 35.61		< 35.61		< 35.61		< 35.61		< 35.61	Pass	--
Naphthalene	SW-846 8260C	mg/Kg	4	160	2100	160	124,000			--		20	0.0044	< 0.00188		< 0.00188		< 0.00188		< 0.00188		< 0.00	Pass	--
Pentachlorophenol	SW-846 8270D	ug/Kg	4				730	500	(e)	--		100	0.04175	< 35.61		< 35.61		< 35.61		< 35.61		< 35.61	Pass	--
Phenanthrene	SW-846 8270D	ug/Kg	4	240	1500	240	1,710,000			--		20	0.04175	< 21.67		< 21.67		< 21.67		< 21.67		< 21.67	Pass	--
Phenol	SW-846 8270D	ug/Kg	4				950,000	30,000	(e)	--		100	0.04175	< 18.12		< 18.12		< 18.12		< 18.12		< 18.12	Pass	--
Pyrene	SW-846 8270D	ug/Kg	4	665	2600	665	1,700,000			--		20	0.04175	< 38.15		< 38.15		< 38.15		< 38.15		< 38.15	Pass	--

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Table 3-1: Sediment Analysis Results and Screening - TWE Cedar Port Pre-Dredge Testing 2021

				Screening Benchmarks																				Sediment: Data Evaluation	
														MB-1-SED 21031513.11 3/16/2021		MB-5-SED 21031513.13 3/16/2021		MB-7-SED 21031513.08 3/17/2021		MB-9-SED 21031513.09 3/17/2021		Average			
Analyte	Method	Units	Samp Count	NOAA ER-L (b)	NOAA ER-M (b)	EPA Reg 6 (c)	TCEQ TRRP Resi-dential (d)	Ecological Reference	(e) or (f)	Other	Ref	TDL	Lab RL	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result		Compare MAX/AVG to Preferred Bmark	Additional Comment
PESTICIDES AND PCBs																									
4,4-DDD	SW-846 8081B	ug/Kg	4	2	20	1.22	14,200	21	(f)	--		5	4.175	< 0.26		< 0.26		< 0.26		< 0.26		< 0.26		Pass	--
4,4-DDE	SW-846 8081B	ug/Kg	4	2.2	27	2.07	10,200	21	(f)	--		5	4.175	< 0.36		< 0.36		< 0.36		< 0.36		< 0.36		Pass	--
4,4-DDT	SW-846 8081B	ug/Kg	4	1	7	1.19	5,390	21	(f)	--		5	4.175	< 0.48		< 0.48		< 0.48		< 0.48		< 0.48		Pass	--
alpha-BHC	SW-846 8081B	ug/Kg	4				250			--		3	4.175	< 0.1		< 0.1		< 0.1		< 0.1		< 0.10		Pass	--
Alpha-Chlordane	SW-846 8081B	ug/Kg	4				13,000			--		3	4.175	< 0.25		< 0.25		< 0.25		< 0.25		< 0.25		Pass	--
Aldrin	SW-846 8081B	ug/Kg	4				50			--		3	4.175	< 0.2		< 0.2		< 0.2		< 0.2		< 0.20		Pass	--
beta-BHC	SW-846 8081B	ug/Kg	4				920			--		3	4.175	< 0.33		< 0.33		< 0.33		< 0.33		< 0.33		Pass	--
Chlordane	SW-846 8081B	ug/Kg	4		6		7,330			--		3	41.75	< 1.67		< 1.67		< 1.67		< 1.67		< 1.67		Pass	--
delta-BHC	SW-846 8081B	ug/Kg	4				2,850			--		3	4.175	< 0.34		< 0.34		< 0.34		< 0.34		< 0.34		Pass	--
Dieldrin	SW-846 8081B	ug/Kg	4	0.02	8	0.715	150	4.9	(f)	--		5	4.175	< 0.25		< 0.25		< 0.25		< 0.25		< 0.25		Pass	**RL > BM**
Endosulfan I	SW-846 8081B	ug/Kg	4				90,800			--		5	4.175	< 0.34		< 0.34		< 0.34		< 0.34		< 0.34		Pass	--
Endosulfan II	SW-846 8081B	ug/Kg	4				270,000			--		5	4.175	< 0.28		< 0.28		< 0.28		< 0.28		< 0.28		Pass	--
Endosulfan sulfate	SW-846 8081B	ug/Kg	4				380,000			--		5	4.175	< 0.25		< 0.25		< 0.25		< 0.25		< 0.25		Pass	--
Endrin	SW-846 8081B	ug/Kg	4				9,010			--		5	4.175	< 0.39		< 0.39		< 0.39		< 0.39		< 0.39		Pass	--
Endrin aldehyde	SW-846 8081B	ug/Kg	4				19,000			--		5	4.175	< 0.41		< 0.41		< 0.41		< 0.41		< 0.41		Pass	--
Endrin ketone	SW-846 8081B	ug/Kg	4				19,000			--		5	4.175	< 0.33		< 0.33		< 0.33		< 0.33		< 0.33		Pass	--
gamma-BHC (Lindane)	SW-846 8081B	ug/Kg	4				1,110			--		3	4.175	< 0.15		< 0.15		< 0.15		< 0.15		< 0.15		Pass	--
Heptachlor	SW-846 8081B	ug/Kg	4				130			--		3	4.175	< 0.33		< 0.33		< 0.33		< 0.33		< 0.33		Pass	--
Heptachlor epoxide	SW-846 8081B	ug/Kg	4				240			--		3	4.175	< 0.26		< 0.26		< 0.26		< 0.26		< 0.26		Pass	--
Toxaphene	SW-846 8081B	ug/Kg	4				1,240			--		50	41.75	< 1.67		< 1.67		< 1.67		< 1.67		< 1.67		Pass	--
g-Chlordane	SW-846 8081B	ug/Kg	4				7330			--		3	4.175	< 0.18		< 0.18		< 0.18		< 0.18		< 0.18		Pass	--
PCBs, Total	SW-846 8082A	ug/Kg	4	22.7		22.7	1,140	40,000	(e)	--		10	0.4175	< 1.52		< 1.52		< 1.52		< 1.52		< 1.52		Pass	--
METALS																									
Antimony	SW-846 6020B	mg/Kg	4		-		15	0.27	(f)	1	TX	2.5	0.5	0.11335	J	0.17724	J	0.14734	J	0.12636	J	< 0.14		Pass	--
Arsenic	SW-846 6020B	mg/Kg	4	8.2	70	8.2	24.2	18	(e)	5.9	TX	1.0	0.5	**1.83**		**3.11**		**3.73**		**16.37**		6.26		Pass	**See Text**
Cadmium	SW-846 6020B	mg/Kg	4	1.2	9.6	1.2	51.0	0.36	(f)	--		1.0	0.5	< 0.070		**0.079**	J	**0.079**	J	**0.08071**	J	0.08		Pass	--
Chromium, total	SW-846 6020B	mg/Kg	4	81	370	81	26,600	0.4	(e)	30	TX	1	0.5	**3.8**		**5.47**		**8.72**		**14.26**		8.06		Pass	--
Copper	SW-846 6020B	mg/Kg	4	34	270	34	1,300	28	(f)	15	TX	10	0.5	**3.15**		**5**		**6.73**		**11.99**		6.72		Pass	--
Lead	SW-846 6020B	mg/Kg	4	46.7	218	46.7	-	11	(f)	15	TX	10	0.5	**4.42**		**7.65**		**8.82**		**11.34**		8.06		Pass	--
Mercury	SW-846 7470A	mg/Kg	4	0.15	0.71	0.15	5.50	0.1	(e)	0.04	TX	0.1	0.01	**0.004**	J	**0.028**		**0.009**	J	**0.027**		0.02		Pass	--
Nickel	SW-846 6020B	mg/Kg	4	20.9	51.6	20.9	842	38	(e)	10	TX	10	0.5	**3.86**		**5.78**		**9.99**		**18.97**		9.65		Pass	**See Text**
Silver	SW-846 6020B	mg/Kg	4	1	3.7	1	96.7	4.2	(f)	--		1.0	0.5	< 0.13		< 0.13		< 0.13		< 0.13		0.13		Pass	--
Zinc	SW-846 6020B	mg/Kg	4	150	410	150	9,920	46	(f)	30	TX	10	1	**11.6**		**17.54**		**24.42**		**39.6**		23.29		Pass	--

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Table 3-1: Sediment Analysis Results and Screening - TWE Cedar Port Pre-Dredge Testing 2021

Analyte	Method	Units	Samp Count	Screening Benchmarks: NOAA ER-L (b)	NOAA ER-M (b)	EPA Reg 6 (c)	TCEQ TRRP Resi-dential (d)	Ecological Reference (e) or (f)	Other	Ref	TDL	Lab RL	MB-1-SED 21031513.11 3/16/2021 Result	Qual	MB-5-SED 21031513.13 3/16/2021 Result	Qual	MB-7-SED 21031513.08 3/17/2021 Result	Qual	MB-9-SED 21031513.09 3/17/2021 Result	Qual	Average Result	Sediment: Data Evaluation: Compare MAX/AVG to Preferred Bmark	Additional Comment
MISCELLANEOUS																							
Ammonia	SM4500NH3-Dm	mg/Kg	4				2500		--		0	1	6.07		20.8		3.53		11.27		10.42	Pass	--
Clay	D422	%	4						--		1	0.01	26.1		20.3		25.4		44.0		29.0	Pass	--
Sand	D423	%	4						--		1	0.01	46.2		32.6		24.8		16.8		30.1	Pass	--
Silt	D424	%	4						--		1	0.01	27.7		47.1		49.8		39.2		41.0	Pass	--
Solid Content (%)	SM 2540G	%	4						--		1		77.60		63.2		71.60		75.30		71.93	Pass	--
pH	SW-846 9045D	SU	4						--		-		8.8		- -	-	9.1		8.9		8.93	Pass	--
Total Organic Carbon	Walkley-Black	mg/Kg	4						--		-	267	3680		8760		3090		2280		4452.50	Pass	--
TPH	TX 1005	mg/Kg	4				1,070		--		5		< 6.88		< 6.88		< 6.88		< 6.88		< 6.88	Pass	--

NOTES:

0.29	Detected Results in **BOLD**
U	Non-detected compound.
Exceeds	Maximum or average value exceeds the benchmark
PASS	Maximum or average value is below the benchmark
(light blue)	Preferred criteria, per USACE SWG guidance
(yellow)	Results exceed some screening criteria but not others
(orange)	Results exceed ER-M criteria (Effects Range-Medium)
(red)	Results exceed all applicable screening criteria
BM-NA	Detected but benchmark is not available
RL > BM	Reporting limit exceeds one or more benchmarks
U	Undetected at SDL (Sample Detection Limit).
J	Estimation. Below calibration range but above MDL.
H3	Sample was received and analyzed past holding time
D1	Sample required dilution due to matrix effects.

(a) Sabine-Neches Nagivation District Placement Former Placement Criteria (NO LONGER IN EFFECT)

(b) NOAA - Effects Range - Low OR Median, Marine, from "Screening Quick Reference Tables for Organics-Sediments", NOAA 2008 OR & R Report

(c) USEPA Region 6 - http://rais.ornl.gov/tools/eco_search.php

(d) TCEQ Texas Risk Reduction Standards (TRRP) Protective Concentration Levels, Human Health, Residential, 30 TAC 350 (August 2018)

(e) TCEQ Ecological Guidance (2014)

(f) USEPA Eco-SSL: http://www.epa.gov/ecotox/ecossl/

7

Special Notes:

1. The sediment samples were additionally analyzed for Volatile Organic Compounds (Method 8260C) and none of the target compounds were found at detectable levels.
2. The sediment samples were additionally analyzed for RCRA Hazardous Waste Characteristics (RCI = Reactivity, Corrosivity, Ignitability); all were determined non-hazardous.

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Table 3-2: Water Analysis Results and Screening - TWE Cedar Port Pre-Dredge Testing 2021

Analyte	Method	Units	Samp Count	Screening Benchmarks: TSWQS (30TAC 307) Marine Acute Ref 1	Screening Benchmarks: Second-ary Ref Screen Criteria	Screening Benchmarks: Ref 2, 3, or 4	TDL	Lab RL	MB-1-WAT 21031513.01 3/17/2021 Result	MB-1-WAT Qual	MB-7-WAT 21031513.03 3/17/2021 Result	MB-7-WAT Qual	MB-EQB-WAT 21031513.05 3/17/2021 Result	MB-EQB-WAT Qual	MB-Trip-WAT 21031513.06 3/17/2021 Result	MB-Trip-WAT Qual	Average Result	Water: Data Evaluation: Compare MAX to Preferred Bmark	Water: Data Evaluation: Compare MEAN to Preferred Benchmark	Water: Data Evaluation: Additional Comment
SVOCs																				
Benzo[b&k]fluoranthene	EPA 625.1	ug/L	4		300	3	0.6	0.00125	< 0.57		< 0.57		< 0.57				< 0.570	Pass	Pass	--
1,2,4-Trichlorobenzene	EPA 625.1	ug/L	4		160	3	0.9	0.00125	< 0.53		< 0.53		< 0.53				< 0.530	Pass	Pass	--
1,2-Dichlorobenzene	EPA 624.1	mg/L	4		1970	3	0.8	0.005	< 0.001		< 0.001		< 0.001				< 0.001	Pass	Pass	--
1,3-Dichlorobenzene	EPA 624.1	mg/L	4		1970	3	0.9	0.005	< 0.001		< 0.001		< 0.001				< 0.001	Pass	Pass	--
1,4-Dichlorobenzene	EPA 624.1	mg/L	4		1970	3	1	0.01	< 0.001		< 0.001		< 0.001				< 0.001	Pass	Pass	--
2,4-Dichlorophenol	EPA 625.1	ug/L	4				0.8	0.00125	< 0.69		< 0.69		< 0.69				< 0.690	Pass	Pass	--
2,4-Dimethylphenol	EPA 625.1	ug/L	4				10	0.00125	< 0.53		< 0.53		< 0.53				< 0.530	Pass	Pass	--
2,4-Dinitrophenol	EPA 625.1	ug/L	4		4850	3	5	0.00125	< 1.41000		< 1.41000		< 1.41000				< 1.410	Pass	Pass	--
Acenaphthene	EPA 625.1	ug/L	4		970	3	0.75	0.00125	< 0.28		< 0.28		< 0.28				< 0.280	Pass	Pass	--
Acenaphthylene	EPA 625.1	ug/L	4		300	3	1	0.00125	< 0.47		< 0.47		< 0.47				< 0.470	Pass	Pass	--
Anthracene	EPA 625.1	ug/L	4		300	3	0.6	0.00125	< 0.35		< 0.35		< 0.35				< 0.350	Pass	Pass	--
Benzo[a]anthracene	EPA 625.1	ug/L	4		300	3	0.4	0.00125	< 0.38		< 0.38		< 0.38				< 0.380	Pass	Pass	--
Benzo[a]pyrene	EPA 625.1	ug/L	4		300	3	0.3	0.00125	< 0.85		< 0.85		< 0.85				< 0.850	Pass	Pass	--
Benzo[g,h,i]perylene	EPA 625.1	ug/L	4		300	3	1.2	0.00125	< 0.63		< 0.63		< 0.63				< 0.630	Pass	Pass	--
Chrysene	EPA 625.1	ug/L	4		300	3	0.3	0.00125	< 0.57		< 0.57		< 0.57				< 0.570	Pass	Pass	--
Dibenz(a,h)anthracene	EPA 625.1	ug/L	4		300	3	1.3	0.00125	< 0.69		< 0.69		< 0.69				< 0.690	Pass	Pass	--
Diethyl phthalate	EPA 625.1	ug/L	4		2944	3	1	0.00125	< 0.63		< 0.63		< 0.63				< 0.630	Pass	Pass	--
Fluoranthene	EPA 625.1	ug/L	4		40	3	0.9	0.00125	< 0.44		< 0.44		< 0.44				< 0.440	Pass	Pass	--
Fluorene	EPA 625.1	ug/L	4		300	3	0.6	0.00125	< 0.47		< 0.47		< 0.47				< 0.470	Pass	Pass	--
Hexachlorobenzene	EPA 625.1	ug/L	4		160	3	0.4	0.00125	< 0.69		< 0.69		< 0.69				< 0.690	Pass	Pass	--
Indeno[1,2,3-cd]pyrene	EPA 625.1	ug/L	4		300	3	1.2	0.00125	< 0.22		< 0.22		< 0.22				< 0.220	Pass	Pass	--
Naphthalene	EPA 625.1	ug/L	4		250	4	0.8	0.00125	< 0.31		< 0.31		< 0.31				< 0.310	Pass	Pass	--
Pentachlorophenol	EPA 625.1	ug/L	4	15.1	13	3	50	0.00125	< 0.5		< 0.5		< 0.5				< 0.500	Pass	Pass	--
Phenanthrene	EPA 625.1	ug/L	4	7.7	7.7	3	0.5	0.00125	< 0.44		< 0.44		< 0.44				< 0.440	Pass	Pass	--
Phenol	EPA 625.1	ug/L	4		5800	3	10	0.00125	< 0.44		< 0.44		< 0.44				< 0.440	Pass	Pass	--
Pyrene	EPA 625.1	ug/L	4		300	3	1.5	0.00125	< 0.57		< 0.57		< 0.57				< 0.570	Pass	Pass	--

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Table 3-2: Water Analysis Results and Screening - TWE Cedar Port Pre-Dredge Testing 2021

Analyte	Method	Units	Samp Count	Screening Benchmarks			TDL	Lab RL	Sample IDs and Concentrations									Water: Data Evaluation		
				TSWQS (30TAC 307) Marine Acute Ref 1	Second-ary Ref Screen Criteria	Ref 2, 3, or 4			MB-1-WAT 21031513.01 3/17/2021		MB-7-WAT 21031513.03 3/17/2021		MB-EQB-WAT 21031513.05 3/17/2021		MB-Trip-WAT 21031513.06 3/17/2021		Average	Compare MAX to Preferred Bmark	Compare MEAN to Preferred Benchmark	Additional Comment
									Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result			
PESTICIDES/PCBs																				
alpha-Chlordane	EPA 608.3	ug/L	4	0.09			0.03	0.125	< 0.002		< 0.002		< 0.002				< 0.002	Pass	Pass	--
g-Chlordane	EPA 608.3	ug/L	4	0.09			0.03	0.125	< 0.005		< 0.005		< 0.005				< 0.005	Pass	Pass	--
4,4'-DDD	EPA 608.3	ug/L	4	0.13	3.6	3	0.1	0.125	< 0.006		< 0.006		< 0.006				< 0.006	Pass	Pass	--
4,4'-DDE	EPA 608.3	ug/L	4		14	3	0.1	0.125	< 0.002		< 0.002		< 0.002				< 0.002	Pass	Pass	--
4,4'-DDT	EPA 608.3	ug/L	4		0.13	2	0.1	0.125	< 0.004		< 0.004		< 0.004				< 0.004	Pass	Pass	--
Aldrin	EPA 608.3	ug/L	4	1.3	1.3		0.03	0.125	< 0.003		< 0.003		< 0.003				< 0.003	Pass	Pass	--
alpha-BHC	EPA 608.3	ug/L	4				0.03	0.125	< 0.008		< 0.008		< 0.008				< 0.008	Pass	Pass	--
beta-BHC	EPA 608.3	ug/L	4				0.03	0.125	< 0.01		< 0.01		< 0.01				< 0.010	Pass	Pass	--
Chlordane (technical)	EPA 608.3	ug/L	4	0.09	0.09		0.03	1.25	< 0.025		< 0.025		< 0.025				< 0.025	Pass	Pass	--
delta-BHC (d-BHC)	EPA 608.3	ug/L	4				0.03	0.125	< 0.004		< 0.004		< 0.004				< 0.004	Pass	Pass	--
Dieldrin	EPA 608.3	ug/L	4	0.71	0.71	2	0.02	0.125	< 0.003		< 0.003		< 0.003				< 0.003	Pass	Pass	--
Endosulfan I	EPA 608.3	ug/L	4	0.034	0.034	2	0.1	0.125	< 0.003		< 0.003		< 0.003				< 0.003	Pass	Pass	--
Endosulfan II	EPA 608.3	ug/L	4	0.034			0.1	0.125	< 0.004		< 0.004		< 0.004				< 0.004	Pass	Pass	--
Endosulfan sulfate	EPA 608.3	ug/L	4	0.034			0.1	0.125	< 0.003		< 0.003		< 0.003				< 0.003	Pass	Pass	--
Endrin	EPA 608.3	ug/L	4	0.037	0.037	2	0.1	0.125	< 0.004		< 0.004		< 0.004				< 0.004	Pass	Pass	--
Endrin Aldehyde	EPA 608.3	ug/L	4	0.037	0.037	2	0.1	0.125	< 0.008		< 0.008		< 0.008				< 0.008	Pass	Pass	--
Endrin Ketone	EPA 608.3	ug/L	4	0.037	0.037	2	0.1	0.125	< 0.005		< 0.005		< 0.005				< 0.005	Pass	Pass	--
gamma-BHC (Lindane)	EPA 608.3	ug/L	4		0.16	2	0.1	0.125	< 0.005		< 0.005		< 0.005				< 0.005	Pass	Pass	--
Heptachlor	EPA 608.3	ug/L	4	0.053	0.053	2	0.1	0.125	< 0.005		< 0.005		< 0.005				< 0.005	Pass	Pass	--
Heptachlor epoxide	EPA 608.3	ug/L	4	0.053	0.053	2	0.1	0.125	< 0.002		< 0.002		< 0.002				< 0.002	Pass	Pass	--
Toxaphene	EPA 608.3	ug/L	4	0.21	90	2	0.5	1.25	< 0.10		< 0.10		< 0.10				< 0.100	Pass	Pass	--
PCBs, Total	#N/A	ug/L	4	10			0.01	0.05	< 0.01		< 0.01		< 0.01				< 0.013	Pass	Pass	--

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Table 3-2: Water Analysis Results and Screening - TWE Cedar Port Pre-Dredge Testing 2021

Analyte	Method	Units	Samp Count	Screening Benchmarks: TSWQS (30TAC 307) Marine Acute Ref 1	Screening Benchmarks: Second-ary Ref Screen Criteria	Screening Benchmarks: Ref 2, 3, or 4	TDL	Lab RL	MB-1-WAT 21031513.01 3/17/2021 Result	MB-1-WAT Qual	MB-7-WAT 21031513.03 3/17/2021 Result	MB-7-WAT Qual	MB-EQB-WAT 21031513.05 3/17/2021 Result	MB-EQB-WAT Qual	MB-Trip-WAT 21031513.06 3/17/2021 Result	MB-Trip-WAT Qual	Average Result	Water: Data Evaluation: Compare MAX to Preferred Bmark	Water: Data Evaluation: Compare MEAN to Preferred Benchmark	Water: Data Evaluation: Additional Comment
METALS																				
Antimony	EPA 200.8	ug/L	4		1500	3	3	0.00125	**2.09**		**1.48**		< 0.2000		< 0.2000		1.785	Pass	Pass	--
Arsenic	EPA 200.8	ug/L	4	149	69	2	1	0.00125	**2.62**		**2.38**		0.443		0.381		2.500	Pass	Pass	--
Cadmium	EPA 200.8	ug/L	4	40	40	2	1	0.00125	< 0.3	D1	< 0.3	D1	< 0.1		< 0.1		< 0.300	Pass	Pass	--
Chromium (total)	EPA 200.8	ug/L	4		103	4	1	0.00125	**0.61**	D1	< **0.3**	D1	< 0.1		< 0.1		0.457	Pass	Pass	--
Copper	EPA 200.8	ug/L	4	13.5	4.8	2	1	0.00125	**1.57**		**1.19**	D1	< 0.4		< 0.4		1.380	Pass	Pass	--
Lead	EPA 200.8	ug/L	4	133	210	2	1	0.00125	< 0.3	D1	< 0.3	D1	< 0.1		< 0.1		< 0.300	Pass	Pass	--
Nickel	EPA 200.8	ug/L	4	118	74	2	1	0.00125	**1.8**		**1.75**		< 0.1		< 0.1		1.775	Pass	Pass	--
Silver	EPA 200.8	ug/L	4	2	1.9	2	1	0.00125	< 0.5	D1	< 0.5	D1	< 0.2		< 0.2		< 0.500	Pass	Pass	--
Zinc	EPA 200.8	ug/L	4	92.7	90		1	0.005	**4.47**	D1	**4.23**	D1	**5.16**		< 1.1		< 4.4	Pass	Pass	--
Mercury	EPA 245.1	ug/L	4	2.1			0.2	0.0002	**0.09**		< 0.06		< 0.06		< 0.06		< 0.075	Pass	Pass	--
MISCELLANEOUS																				
Ammonia	SM 4500NH3D	mg/L	4				-	0.03	0.05		0.07		< 0.01				< 0.043	--	--	--
Salinity	SM 2520B	s.u.	4				-	2	11.3		8.6						9.950	--	--	--
Total Organic Carbon	SM 5310B	mg/L	4				-	1	4.4		4.7		< 0.35				3.150	--	--	--
TPH	TX 1005	mg/L	4				-	6.45	< 0.18		< 0.18		< 0.18				< 0.180	--	--	--

0.29	Detected Results in **BOLD**
U	Non-detected compound.
EXCEEDS	Maximum or average value exceeds the benchmark
PASS	Maximum or average value is below the benchmark
	Preferred or primary criteria, per USACE SWG guidance
44	Results exceed some screening criteria but not others
66	Results exceed all applicable screening criteria for that constituent
BM-NA	Detected but benchmark is not available
RL > BM	Reporting limit exceeds one or more benchmarks
ND or BDL	Analyte not detected
U	Undetected at SDL (Sample Detection Limit).
J	Estimation. Below calibration range but above MDL.
H3	Sample was received and analyzed past holding time
D1	Sample required dilution due to matrix effects.

Special Note: The water samples and equipment blank were additionally analyzed for VOCs by Method 8260, and no target compounds were detected.

Table 3-3: Elutriate Analysis Results and Screening - TWE Cedar Port Pre-Dredge Testing 2021

Analyte	Method	Units	Sample Count	Screening Benchmarks: TSWQS (30 TAC 307) Marine Acute Ref 1	Screening Benchmarks: Secon-dary Ref Screen Criteria	Screening Benchmarks: Ref 2, 3, or 4	Target DL	Method DL	MB-1-ELUT 21031513.15 3/17/2021 Result	MB-1-ELUT Qual	MB-5-ELUT 21031513.16 3/17/2021 Result	MB-5-ELUT Qual	MB-9-ELUT 21031513.17 3/17/2021 Result	MB-9-ELUT Qual	Average Result	Compare MAX to Preferred Bmark	With Mixing Zone Calcs	Additional Comment
SVOCs																		
Benzo[b&k]fluoranthene	SW846 8270D	ug/L	1		300	3	0.6	0.00125	< 0.57		< 0.57		< 0.57		< 0.5700	Pass	Pass	-
1,2,4-Trichlorobenzene	EPA 625.1	ug/L	1		160	3	0.9	0.00125	< 0.53		< 0.53		< 0.53		< 0.5300	Pass	Pass	-
1,2-Dichlorobenzene	EPA 625.1	ug/L	1		1970	3	0.8	0.00125	< 0.41		< 0.41		< 0.41		< 0.4100	Pass	Pass	-
1,3-Dichlorobenzene	EPA 625.1	ug/L	1		1970	3	0.9	0.00125	< 0.53		< 0.53		< 0.53		< 0.5300	Pass	Pass	-
1,4-Dichlorobenzene	EPA 625.1	ug/L	1		1970	3	1	0.00125	< 0.25		< 0.25		< 0.25		< 0.2500	Pass	Pass	-
2,4-Dichlorophenol	EPA 625.1	ug/L	1				0.8	0.00125	< 0.69		< 0.69		< 0.69		< 0.6900	Pass	Pass	-
2,4-Dimethylphenol	EPA 625.1	ug/L	1				10	0.00125	< 0.53		< 0.53		< 0.53		< 0.5300	Pass	Pass	-
2,4-Dinitrophenol	EPA 625.1	ug/L	1		4850	3	5	0.00125	< 1.41		< 1.41		< 1.41		< 1.4100	Pass	Pass	-
Acenaphthene	EPA 625.1	ug/L	1		970	3	0.75	0.00125	< 0.28		< 0.28		< 0.28		< 0.2800	Pass	Pass	-
Acenaphthylene	EPA 625.1	ug/L	1		300	3	1	0.00125	< 0.47		< 0.47		< 0.47		< 0.4700	Pass	Pass	-
Anthracene	EPA 625.1	ug/L	1		300	3	0.6	0.00125	< 0.35		< 0.35		< 0.35		< 0.3500	Pass	Pass	-
Benzo[a]anthracene	EPA 625.1	ug/L	1		300	3	0.4	0.00125	< 0.38		< 0.38		< 0.38		< 0.3800	Pass	Pass	-
Benzo[a]pyrene	EPA 625.1	ug/L	1		300	3	0.3	0.00125	< 0.85		< 0.85		< 0.85		< 0.8500	Pass	Pass	-
Benzo[g,h,i]perylene	EPA 625.1	ug/L	1		300	3	1.2	0.00125	< 0.63		< 0.63		< 0.63		< 0.6300	Pass	Pass	-
Chrysene	EPA 625.1	ug/L	1		300	3	0.3	0.00125	< 0.57		< 0.57		< 0.57		< 0.5700	Pass	Pass	-
Dibenz(a,h)anthracene	EPA 625.1	ug/L	1		300	3	1.3	0.00125	< 0.69		< 0.69		< 0.69		< 0.6900	Pass	Pass	-
Diethyl phthalate	EPA 625.1	ug/L	1		2944	3	1	0.00125	< 0.63		< 0.63		< 0.63		< 0.6300	Pass	Pass	-
Fluoranthene	EPA 625.1	ug/L	1		40	3	0.9	0.00125	< 0.44		< 0.44		< 0.44		< 0.4400	Pass	Pass	-
Fluorene	EPA 625.1	ug/L	1		300	3	0.6	0.00125	< 0.47		< 0.47		< 0.47		< 0.4700	Pass	Pass	-
Hexachlorobenzene	EPA 625.1	ug/L	1		160	3	0.4	0.00125	< 0.69		< 0.69		< 0.69		< 0.6900	Pass	Pass	-
Indeno[1,2,3-c,d]pyrene	EPA 625.1	ug/L	1		300	3	1.2	0.00125	< 0.22		< 0.22		< 0.22		< 0.2200	Pass	Pass	-
Naphthalene	EPA 625.1	ug/L	1		250	4	0.8	0.00125	< 0.31		< 0.31		< 0.31		< 0.3100	Pass	Pass	-
Pentachlorophenol	EPA 625.1	ug/L	1	15.1	13	3	50	0.00125	< 0.5		< 0.5		< 0.5		< 0.5000	Pass	Pass	-
Phenanthrene	EPA 625.1	ug/L	1	7.7	7.7	3	0.5	0.00125	< 0.44		< 0.44		< 0.44		< 0.4400	Pass	Pass	-
Phenol	EPA 625.1	ug/L	1		5800	3	10	0.00125	< 0.44		< 0.44		< 0.44		< 0.4400	Pass	Pass	-
Pyrene	EPA 625.1	ug/L	1		300	3	1.5	0.00125	< 0.57		< 0.57		< 0.57		< 0.570	Pass	Pass	-

Table 3-3: Elutriate Analysis Results and Screening - TWE Cedar Port Pre-Dredge Testing 2021

Analyte	Method	Units	Sample Count	Screening Benchmarks: TSWQS (30 TAC 307) Marine Acute Ref 1	Secondary Ref Screen Criteria	Ref 2, 3, or 4	Target DL	Method DL	Sample IDs and Concentrations: MB-1-ELUT 21031513.15 3/17/2021 Result	Qual	MB-5-ELUT 21031513.16 3/17/2021 Result	Qual	MB-9-ELUT 21031513.17 3/17/2021 Result	Qual	Average Result	Elutriate: Data Evaluation: Compare MAX to Preferred Bmark	With Mixing Zone Calcs	Additional Comment
PESTICIDES / PCBs																		
alpha-Chlordane	EPA 608.3	ug/L	1	0.09			0.03	0.125	< 0.002		< 0.002		< 0.002		< 0.002	Pass	Pass	-
y-Chlordane	EPA 608.3	ug/L	1	0.09				0.125	< 0.005		< 0.005		< 0.005		< 0.005	Pass	Pass	
4,4'-DDD	EPA 608.3	ug/L	1	0.13	3.6	3	0.003	0.125	< 0.006		< 0.006		< 0.006		< 0.006	Pass	Pass	
4,4'-DDE	EPA 608.3	ug/L	1		14	3	0.1	0.125	< 0.002		< 0.002		< 0.002		< 0.002	Pass	Pass	-
4,4'-DDT	EPA 608.3	ug/L	1		0.13	2	0.1	0.125	< 0.004		< 0.004		< 0.004		< 0.004	Pass	Pass	-
Aldrin	EPA 608.3	ug/L	1	1.3	1.3		0.03	0.125	< 0.003		< 0.003		< 0.003		< 0.003	Pass	Pass	-
alpha-BHC	EPA 608.3	ug/L	1			2	0.03	0.125	< 0.008		< 0.008		< 0.008		< 0.008	Pass	Pass	-
beta-BHC	EPA 608.3	ug/L	1				0.03	0.125	< 0.01		< 0.01		< 0.01		< 0.010	Pass	Pass	-
Chlordane (technical)	EPA 608.3	ug/L	1	0.09	0.09	2	0.1	1.25	< 0.025		< 0.025		< 0.025		< 0.025	Pass	Pass	-
delta-BHC (d-BHC)	EPA 608.3	ug/L	1					0.125	< 0.004		< 0.004		< 0.004		< 0.004	Pass	Pass	
Dieldrin	EPA 608.3	ug/L	1	0.71	0.71	2	0.03	0.125	< 0.003		< 0.003		< 0.003		< 0.003	Pass	Pass	-
Endosulfan I	EPA 608.3	ug/L	1	0.034	0.034		0.03	0.125	< 0.003		< 0.003		< 0.003		< 0.003	Pass	Pass	-
Endosulfan II	EPA 608.3	ug/L	1	0.034			0.03	0.125	< 0.004		< 0.004		< 0.004		< 0.004	Pass	Pass	-
Endosulfan sulfate	EPA 608.3	ug/L	1	0.034		2	0.02	0.125	< 0.003		< 0.003		< 0.003		< 0.003	Pass	Pass	-
Endrin	EPA 608.3	ug/L	1	0.037	0.037			0.125	< 0.004		< 0.004		< 0.004		< 0.004	Pass	Pass	
Endrin Aldehyde	EPA 608.3	ug/L	1	0.037	0.037	2	0.1	0.125	< 0.008		< 0.008		< 0.008		< 0.008	Pass	Pass	-
Endrin Ketone	EPA 608.3	ug/L	1	0.037	0.037		0.1	0.125	< 0.005		< 0.005		< 0.005		< 0.005	Pass	Pass	-
gamma-BHC (Lindane)	EPA 608.3	ug/L	1		0.16		0.1	0.125	< 0.005		< 0.005		< 0.005		< 0.005	Pass	Pass	-
Heptachlor	EPA 608.3	ug/L	1	0.053	0.053	2	0.1	0.125	< 0.005		< 0.005		< 0.005		< 0.005	Pass	Pass	-
Heptachlor epoxide	EPA 608.3	ug/L	1	0.053	0.053	2	0.1	0.125	< 0.002		< 0.002		< 0.002		< 0.002	Pass	Pass	-
Toxaphene	EPA 608.3	ug/L	1	0.21	90	2	0.1	1.25	< 0.100		< 0.100		< 0.100		< 0.100	Pass	Pass	--
PCBs, Total	EPA 608.3	ug/L	1	10			0.01	0.05	< 0.0129		< 0.0129		< 0.0129		< 0.013	Pass	Pass	-

Table 3-3: Elutriate Analysis Results and Screening - TWE Cedar Port Pre-Dredge Testing 2021

Analyte	Method	Units	Sample Count	Screening Benchmarks: TSWQS (30 TAC 307) Marine Acute Ref 1	Screening Benchmarks: Secon-dary Ref Screen Criteria	Screening Benchmarks: Ref 2, 3, or 4	Target DL	Method DL	MB-1-ELUT 21031513.15 3/17/2021 Result	MB-1-ELUT Qual	MB-5-ELUT 21031513.16 3/17/2021 Result	MB-5-ELUT Qual	MB-9-ELUT 21031513.17 3/17/2021 Result	MB-9-ELUT Qual	Average Result	Compare MAX to Preferred Bmark	With Mixing Zone Calcs	Additional Comment
METALS																		
Mercury	EPA 245.1	ug/L	1	2.1			0.2	0.0002	< 0.06		< 0.06		< 0.06		< 0.06	Pass	Pass	-
Antimony	EPA 200.8	ug/L	1		1500	3	3	0.00125	**1.82**		**0.984**	D1	**0.784**	D1	1.82	Pass	Pass	-
Arsenic	EPA 200.8	ug/L	1	149	69	2	1	0.00125	**5.07**		**3.35**		**2.56**		5.07	Pass	Pass	-
Cadmium	EPA 200.8	ug/L	1	40	40	2	1	0.00125	< 0.3	D1	< 0.3	D1	< 0.3	D1	< 0.30	Pass	Pass	-
Chromium (total)	EPA 200.8	ug/L	1		103	4	1	0.00125	**0.713**	D1	**0.344**	D1	< 0.3	D1	0.71	Pass	Pass	-
Copper	EPA 200.8	ug/L	1	13.5	4.8	2	1	0.00125	**1.5**		**1.21**	D1	**1.14**	D1	1.50	Pass	Pass	-
Lead	EPA 200.8	ug/L	1	133	210	2	1	0.00125	< 0.3	D1	< 0.3	D1	< 0.3	D1	< 0.30	Pass	Pass	-
Nickel	EPA 200.8	ug/L	1	118	74	2	1	0.00125	**1.93**		**2.17**		**1.9**		1.93	Pass	Pass	-
Silver	EPA 200.8	ug/L	1	2	1.9	2	1	0.00125	< 0.5	D1	< 0.5	D1	< 0.5	D1	< 0.50	Pass	Pass	-
Zinc	EPA 200.8	ug/L	1	92.7	90	2	1	0.005	**6.29**		**5.26**		**9.71**		6.29	Pass	Pass	-
MISCELLANEOUS																		
Ammonia	SM 4500NH3D	mg/L	1					0.03	0.85		0.71		1.37		0.850	--	--	-
Total Organic Carbon	SM 5310B	mg/L	1					1	4.7		4.8		4.6		4.700	--	--	-
TPH	TX 1005	mg/L	1					6.45	0.415	J	< 0.18		< 0.18		< 0.415	--	--	-

0.29	Detected Results in **BOLD**
U	Non-detected compound.
EXCEEDS	Maximum or average value exceeds the benchmark
PASS	Maximum or average value is below the benchmark
(blue shading)	Preferred criteria, per USACE SWG guidance
(yellow shading)	Results exceed some screening criteria but not others
(red shading)	Results exceed all applicable screening criteria for that constituent
RL > BM	Reporting limit exceeds one or more benchmarks
ND or BDL or <value	Analyte not detected at the indicated reporting limit
U	Undetected at SDL (Sample Detection Limit).
J	Estimation. Below calibration range but above MDL.
H3	Sample was received and analyzed past holding time
D1	Sample required dilution due to matrix effects.

1 Texas Surface Water Quality Criteria (30TAC307) saltwater marine acute criteria, water effect ratio is equal to 1.
2 USEPA National Water Quality Criteria (WQC, Marine Acute)
3 NOAA Screening Quick Reference Tables (SQRT, Marine Acute Water)
4 USEPA Region 6 Watershed Standards (Marine Acute)

Special Note: All three elutriate samples were also analyzed for VOCs by Method 8269; no target compounds were detected. See last appendix.

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Table 3-4
Sediment Physical Characterization
TWE Cedar Port – 2021 Channel Dredging

Fraction	Units	MW-1 03/16/2021	MW-5 03/16/2021	MW-7 03/17/2021	MW-9 03/17/2021
Clay	%	26.1	20.3	25.4	44.0
Silt	%	27.7	47.1	49.8	39.2
Sand	%	46.2	32.6	24.8	16.8
Gravel	%	0.0	0.0	0.0	0.0
Total	%	100.0	100.0	100.0	100.0

Figures

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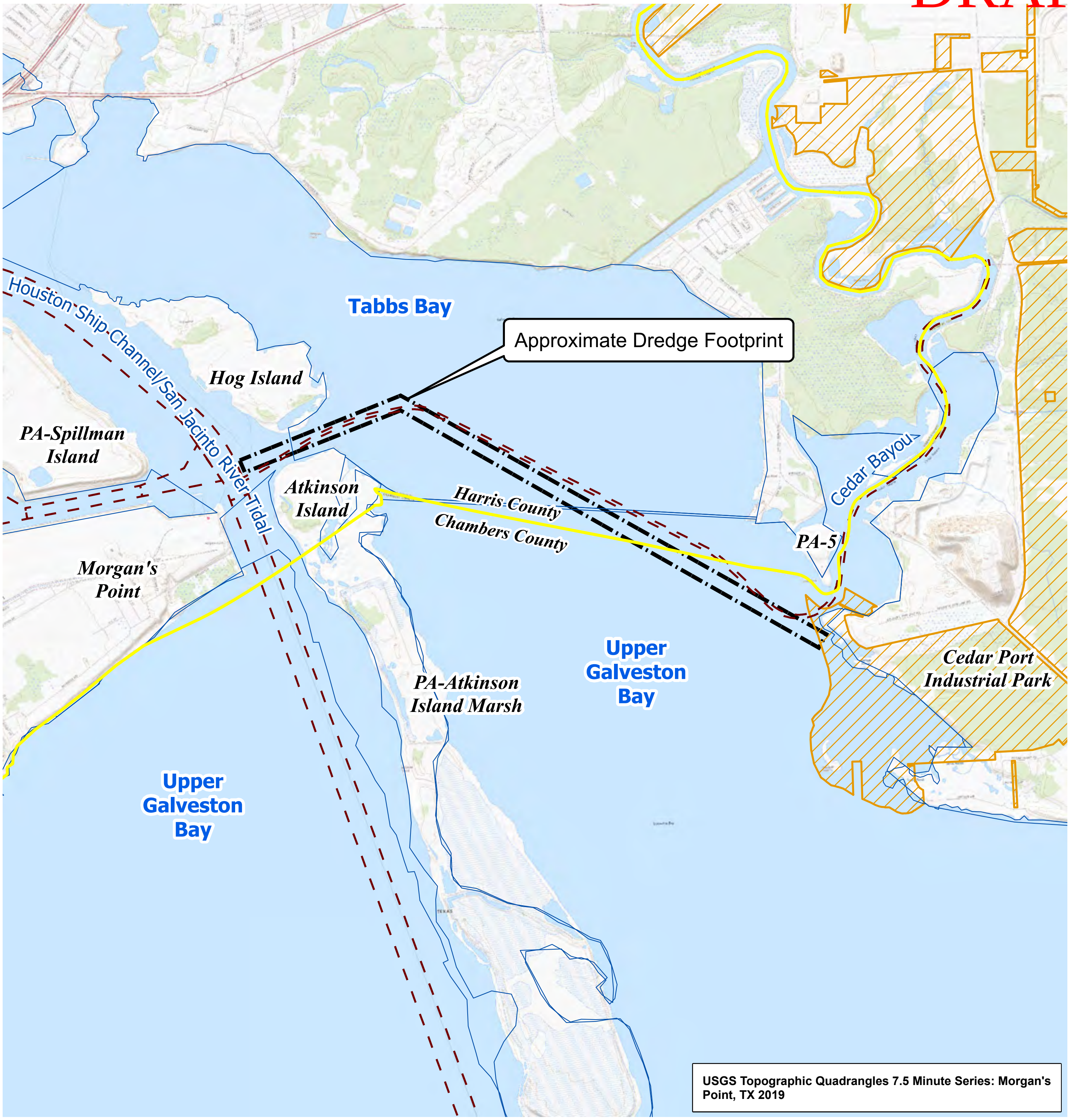
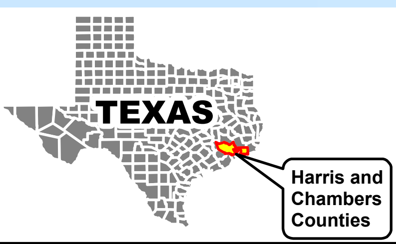




Legend

- Approximate Dredge Footprint
- TGS Cedar Port Partners LP Property Boundary
- USACE Federal Channel Framework
- County Line

N

0 2,000 4,000 FEET

1" = 4,000 FEET
1:48,000

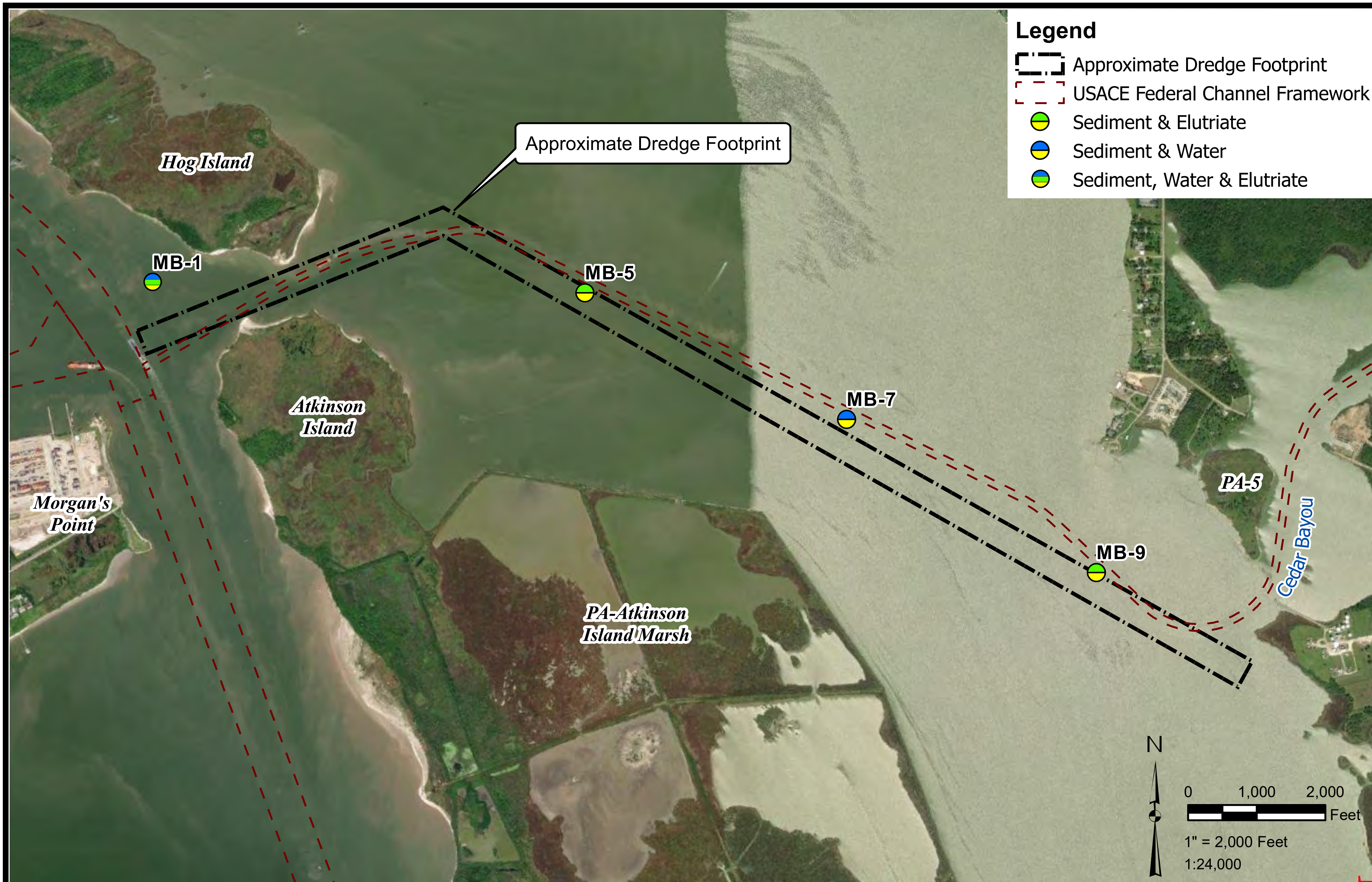
DiSorbo Environmental Consulting Firm | Lanier & Associates Consulting Engineers, Inc. | Tolunay-Wong Engineers, Inc. | TGS Trans-Global Solutions, Inc.

CEDAR PORT IND PARK CHANNEL PRE-DREDGE

FIGURE 1
SITE LOCATION MAP

DRAWN BY:	L WILSON
APPROVED BY:	B DAVIS
PROJECT NO:	SITE LOCATION
FILE NO.	Dredge Project 2021.mxd
DATE:	MARCH 2021

J:\Prj\TGS Cedar Port\Dredge Project 2021\Dredge Project 2021.aprx
Printed By: laurie on 3/1/2021



DiSorbo Environmental Consulting Firm

LANIER & ASSOCIATES CONSULTING ENGINEERS, INC.

Tolunay-Wong Engineers, Inc.

TGS Trans-Global Solutions, Inc.

CEDAR PORT INDUSTRIAL PARK
CHANNEL PRE-DREDGE

FIGURE 2
SITE PLAN AND SAMPLE LOCATIONS

DRAWN BY:	L WILSON
APPROVED BY:	B DAVIS
PROJECT NO:	SAMPLE LOCATIONS
FILE NO.	Dredge Project 2021.mxd
DATE:	APRIL 2021

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Printed By: laurie on 4/13/2021

USACE Tabulated Criteria

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Table 3: Target Detection Levels (TDLs), Screening Benchmarks and Analytical Methodology for Analysis of Common COCs and Parameters for Marine Water and Elutriate, Private Dredging Application

Chemical	CAS #	Units	TDL- Marine	Screening Benchmarks				Suggested Methods [f]
			Region 6 [a]	TSWQS (Marie Acute) [b] (1)	EPA WQC (Marine Acute) [c] (2)	NOAA (Marine Acute) [d] (3)	Region 6 (Marine Acute) [e] (4)	
Semivolatiles								
1,2,4-Trichlorobenzene	120-82-1	ug/L	0.9[h]	-	-	160	22	8270C, GC-MS SIM Mode; 1625C, 3510A, 3520A/8100, 8240A, 8250, 8260, 8270A, 8310
1,2-Dichlorobenzene	95-50-1	ug/L	0.8[h]	-	-	1,970	591	
1,3-Dichlorobenzene	541-73-1	ug/L	0.9[h]	-	-	1,970	142	
1,4-Dichlorobenzene	541-73-1	ug/L	1[h]	-	-	1,970	99	
2,4-Dichlorophenol	120-83-2	ug/L	0.8[h]	-	-	-	-	
2,4-Dimethylphenol	105-67-9	ug/L	10	-	-	-	-	
2,4-Dinitrophenol	51-28-5	ug/L	5[h]	-	-	4,850	1330	
Acenaphthene	83-32-9	ug/L	0.75[h]	-	-	970	40.4	
Acenaphthylene	208-96-8	ug/L	1.0[h]	-	-	300	-	
Anthracene	120-12-7	ug/L	0.6[h]	-	-	300	0. 18	
Benzo(a)anthracene	56-55-3	ug/L	0.4[h]	-	-	300	-	
Benzo(a)pyrene	50-32-8	ug/L	0.3[h]	-	-	300	-	
Benzo(b)fluoranthene	205-99-2	ug/L	0.6[h]	-	-	300	-	
Benzo(g,h,i)perylene	191-24-2	ug/L	1.2[h]	-	-	300	-	
Benzo(k)fluoranthene	207-08-9	ug/L	0.6[h]	-	-	300	-	
Chrysene	218-01-9	ug/L	0.3[h]	-	-	300	-	
Dibenzo(a,h)anthracene	53-70-3	ug/L	1.3[h]	-	-	300	-	
Diethyl Phthalate	84-66-2	ug/L	1[h]	-	-	2,944	884	
Fluoranthene	206-44-0	ug/L	0.9[h]	-	-	40	2.96	
Fluorene	86-73-7	ug/L	0.6[h]	-	-	300	50	
Hexachlorobenzene	118-74-1	ug/L	0.4[h]	-	-	160	-	
Indeno[1,2,3-c,d]pyrene	193-39-5	ug/L	1.2[h]	-		300	-	
Naphthalene	91-20-3	ug/L	0.8[h]	-	-	-	250	
Pentachlorophenol	87-86-5	ug/L	50	15.1	13	13	9.6	
Phenanthrene	85-01-8	ug/L	0.5[h]	7.7	-	7.7	4.6	
Phenol	108-95-2	ug/L	10	-	-	5,800	5,500	
Pyrene	129-00-0	ug/L	1.5[h]	-	-	300	0. 24	
Pesticides								
4,4'-DDD	72-54-8	ug/L	0.1	0.13	-	3.6	0. 025	608, 3510A, 3520A/8080, 8081A
4,4'-DDE	72-55-9	ug/L	0.1	-	-	14	0. 14	
4,4'-DDT	50-29-3	ug/L	0.1	-	0.13 (G, ii)	0.065	0. 001	
Aldrin	309-00-2	ug/L	0.03[h]	1.3	1.3 (G)	0.65	0. 13	

Table 3: Target Detection Levels (TDLs), Screening Benchmarks and Analytical Methodology for Analysis of Common COCs and Parameters for Marine Water and Elutriate, Private Dredging Application

Chemical	CAS #	Units	TDL- Marine	Screening Benchmarks				Suggested Methods [f]
			Region 6 [a]	TSWQS (Marie Acute) [b]	EPA WQC (Marine Acute) [c]	NOAA (Marine Acute) [d]	Region 6 (Marine Acute) [e]	
Alpha-BHC	319-84-6	ug/L	0.03	-	-	-	-	608, 3510A, 3520A/8080, 8081A
Beta-BHC	319-85-7	ug/L	0.03	-	-	-	-	
Chlordane and Derivatives	57-74-9	ug/L	0.03[h]	0.09	0.09 (G)	-	-	
Delta-BHC	319-86-8	ug/L	0.03	-	-	-	-	
Dieldrin	60-57-1	ug/L	0.03	0.71	0.71 (G)	0.355	0. 002	
Endosulfan and Derivatives	115-29-7	ug/L	0.1	0.034	0.034 (G, Y)	0.017	-	
Endrin and Derivatives	72-20-8	ug/L	0.1	0.037	0.037 (G)	0.0185	0. 002	
Gamma-BHC (lindane)	58-89-9	ug/L	0.1	-	0.16 (G)	0.08	-	
Heptachlor and Derivatives	76-44-8	ug/L	0.1	0.053	0.053 (G)	0.0265	0. 004	
Toxaphene	8001-35-2	ug/L	0.5	0.21	90 (D)	0.21	0. 0002	
Polychlorinated Biphenyls								
Total PCB	1336-36-3	ug/L	0.01	10	-	0.033	-	8082
Metals [g]								
Antimony	7440-36-0	ug/L	3 (0.03)[i]	-	-	1,500	500	200.8, 6010 or 6020
Arsenic	7440-38-2	ug/L	1 (0.011)[i]	149w	69 (A, D)	69	78	
Cadmium	7440-43-9	ug/L	1 (0.01)[i]	40w	40 (D)	40	-	
Chromium (total)	7440-47-3	ug/L	1	-	-	-	103	
Copper	7440-50-8	ug/L	1 (0.1)[i]	13.5w	4.8 (D, cc)	4.8	3.6	
Lead	7439-92-1	ug/L	1 (0.03)[i]	133w	210 (D)	210	5.3	
Mercury	7439-97-6	ug/L	0.2 (0.0003)[i]	2.1	-	1.8	1.1	7471, 7420, 245.1
Nickel	7440-02-0	ug/L	1 (0.1)[i]	118w	74 (D)	74	13.1	200.8, 6010 or 6020
Silver	7440-22-4	ug/L	1 (0.1)[i]	2w	1.9 (D)	0.95	-	
Zinc	7440-66-6	ug/L	1 (0.5)[i]	92.7w	90 (D)	90	84.2	
Miscellaneous Parameters								
Ammonia	NH3	mg/l	0.03	-	-	-	-	350.1, 350.2, 350.3
Total Organic Carbon	Q129	%	0.10%	-	-	-	-	9060, 415.1, APHA 5310D
Total Petroleum Hydrocarbons	8012-95-1	mg/l	0.1	-	-	-	NA	418.1, 8021, TNRCC 1005 & 1006

[green box] Selected Criteria

FOOTNOTES:

Table 3: Target Detection Levels (TDLs), Screening Benchmarks and Analytical Methodology for Analysis of Common COCs and Parameters for Marine Water and Elutriate, Private Dredging Application

Chemical	CAS #	Units	TDL- Marine	Screening Benchmarks				Suggested Methods [f]
			Region 6 [a]	TSWQS (Marie Acute) [b]	EPA WQC (Marine Acute) [c]	NOAA (Marine Acute) [d]	Region 6 (Marine Acute) [e]	

a) This list may include analyses and analytes not required for your site, or may not include site-specific requirements for your site. Consult with the Galveston District. The primary source of these TDLs was EPA 823-B-95-001, QA/QC Guidance for Sampling and Analysis of Sediments, Water and Tissues for Dredged Material Evaluations. (http://water.epa.gov/polwaste/sediments/cs/upload/evaluationguide.pdf)
b) TSWQS- https://www.tceq.texas.gov/waterquality/standards/2010standards.html
c) EPA WQC- http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm
d) NOAA- http://response.restoration.noaa.gov/cpr/sediment/squirt/squirt.html
e) Region 6- http://www.epa.gov/region6/water/ecopro/watershd/standard/index.htm
f) Suggested methods from USEPA, 1995, "QA/QC Guidance for Sediment and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations" (http://water.epa.gov/polwaste/sediments/cs/upload/evaluationguide.pdf), the SERIM (http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100FTIH.TXT), and the USEPA Region 6 RIA (http://www.epa.gov/region6/water/ecopro/em/ocean/text/ria.pdf). Any method that can achieve these TDLs is acceptable, provided the appropriate documentation of the method performance is generated for the project and the method is adequately identified and described in the SAP.
g) Metals shall be expressed as Dissolved values in water samples, except for mercury, which shall be reported as Total Recoverable Concentrations
h) These values are based on recommendations from the EPA Region 6 laboratory in Houston; these values were based on data or other technical basis.
i) The values in parentheses are based on EPA "clean techniques", (EPA 1600 series methods) which are applicable in instances where other TDLs are inadequate to assess EPA water quality criteria.

TSWQS footnotes (footnote letters from TCEQ, only footnotes for constituents of concern are retained in this table):
w) Indicates that a criterion is multiplied by a water-effect ratio (WER) in order to incorporate the effects of local water chemistry on toxicity. The WER is equal to 1 except where sufficient data is available to establish a site-specific WER.

EPA WQC footnotes (footnote letters from NRWRC, only footnotes for constituents of concern are retained in this table)
A) This recommended water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive. No data are known to be available concerning whether the toxicities of the forms of arsenic to aquatic organisms are additive. Please consult the criteria document for details.
D) Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. See "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic life Metals Criteria (PDF)," (49 pp, 3MB) October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for Water, available on NSCEP's web site and 40CFR§131.36(b)(1). Conversion Factors applied in the table can be found in Appendix A to the Preamble- Conversion Factors for Dissolved Metals.
G) This Criterion is based on 304(a) aquatic life criterion issued in 1980, and was issued in one of the following documents: Aldrin/Dieldrin (PDF) (153 pp, 7.3MB) (EPA 440/5-80-019), Chlordane (PDF) (68 pp, 3.1MB) (EPA 440/5-80-027), DDT (PDF) (175 pp, 8.3MB) (EPA 440/5-80-038), Endosulfan (PDF) (155 pp, 7.3MB) (EPA 440/5-80-046), Endrin (PDF) (103 pp, 4.6MB) (EPA 440/5-80-047), Heptachlor (PDF) (114 pp, 5.4MB) (EPA 440/5-80-052), Hexachlorocyclohexane (PDF) (109 pp, 4.8MB) (EPA 440/5-80-054), Silver (EPA 440/5-80-071). The Minimum Data Requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines (PDF) (104 pp, 3.3MB). If evaluation is to be done using an averaging period, the acute criteria values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines.
Y) This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.
cc) When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effect Ratios might be appropriate.
ii)This criterion applies to DDT and its metabolites (i.e., the total conc. DDT plus metabolites should not exceed this value).

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Table 4: Target Detection Levels (TDLs), Screening Benchmarks and Analytical Methodology for Bulk Analysis of Common COCs and Parameters for Marine Sediment (dry weight), Private Dredging Application

Chemical	CAS #	Units	TDL- Marine Region 6 [a]	Screening Benchmarks NOAA (Marine) [b] ERL	Screening Benchmarks NOAA (Marine) [b] ERM	Region 6 (Marine) [c]	Suggested Methods [d]
Semivolatiles							
1,2,4-Trichlorobenzene	120-82-1	ug/kg	10	-	-	-	8270C; GC-MS in SIM mode; 1625C, 3540A, 3550A/8100, 8240A, 8250, 8260, 8270A
1,2-Dichlorobenzene	95-50-1	ug/kg	20	-	-	-	
1,3-Dichlorobenzene	541-73-1	ug/kg	20	-	-	-	
1,4-Dichlorobenzene	541-73-1	ug/kg	20	-	-	-	
2,4-Dichlorophenol	120-83-2	ug/kg	120[f]	-	-	-	
2,4-Dimethylphenol	105-67-9	ug/kg	20	-	-	-	
2,4-Dinitrophenol	51-28-5	ug/kg	500[f]	-	-	-	
Acenaphthene	83-32-9	ug/kg	20	16	500	16	
Acenaphthylene	208-96-8	ug/kg	20	44	640	44	
Anthracene	120-12-7	ug/kg	20	85.3	1,100	85.3	
Benzo(a)anthracene	56-55-3	ug/kg	20	261	1,600	261	
Benzo(a)pyrene	50-32-8	ug/kg	20	430	1,600	430	
Benzo(b)fluoranthene	205-99-2	ug/kg	20	-	-	-	
Benzo(g,h,i)perylene	191-24-2	ug/kg	20	-	-	-	
Benzo(k)fluoranthene	207-08-9	ug/kg	20	-	-	-	
Chrysene	218-01-9	ug/kg	20	384	2,800	384	
Dibenzo(a,h)anthracene	53-70-3	ug/kg	20	63.4	260	63.4	
Diethyl Phthalate	84-66-2	ug/kg	50	-	-	-	
Fluoranthene	206-44-0	ug/kg	20	600	5,100	600	
Fluorene	86-73-7	ug/kg	20	19	540	19	
Hexachlorobenzene	118-74-1	ug/kg	10	-	-	-	
Indeno[1,2,3-c,d]pyrene	193-39-5	ug/kg	20	-	-	-	
Naphthalene	91-20-3	ug/kg	20	160	2,100	160	
Pentachlorophenol	87-86-5	ug/kg	100	-	-	-	
Phenanthrene	85-01-8	ug/kg	20	240	1,500	240	
Phenol	108-95-2	ug/kg	100	-	-	-	
Pyrene	129-00-0	ug/kg	20	665	2,600	665	
Pesticides							
4,4'-DDD	72-54-8	ug/kg	5[f]	2	20	1.22	3540A, 3550A/8080, 8081A
4,4'-DDE	72-55-9	ug/kg	5[f]	2.2	27	2.07	
4,4'-DDT	50-29-3	ug/kg	5[f]	1	7	1.19	
Aldrin	309-00-2	ug/kg	3[f]	-	-	-	
Alpha-BHC	319-84-6	ug/kg	3[f]	-	-	-	
Beta-BHC	319-85-7	ug/kg	3[f]	-	-	-	
Chlordane and Derivatives	57-74-9	ug/kg	3[f]	-	-	-	
Delta-BHC	319-86-8	ug/kg	3[f]	-	-	-	
Dieldrin	60-57-1	ug/kg	5[f]	0.02	8	0.715	
Endosulfan and Derivatives	115-29-7	ug/kg	5[f]	-	-	-	
Endrin and Derivatives	72-20-8	ug/kg	5[f]	-	-	-	
Gamma-BHC (Lindane)	58-89-9	ug/kg	3[f]	-	-	-	
Heptachlor and Derivatives	76-44-8	ug/kg	3[f]	-	-	-	
Toxaphene	8001-35-2	ug/kg	50	-	-	-	
Polychlorinated Biphenyls							
Total PCB	1336-36-3	ug/kg	1	22.7 (g)	180	22.7 (g)	8082
Metals [e]							
Antimony	7440-36-0	mg/kg	2.5	-	-	-	6010/6020, 3050A/7421, 7420, 3010A
Arsenic	7440-38-2	mg/kg	1	8.2	70	8.2	
Cadmium	7440-43-9	mg/kg	1	1.2	96	1.2	
Chromium (total)	7440-47-3	mg/kg	1	81	370	81	
Copper	7440-50-8	mg/kg	10	34	270	34	

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Table 4: Target Detection Levels (TDLs), Screening Benchmarks and Analytical Methodology for Bulk Analysis of Common COCs and Parameters for Marine Sediment (dry weight), Private Dredging Application

Chemical	CAS #	Units	TDL- Marine	Screening Benchmarks			Suggested Methods [d]
			Region 6 [a]	NOAA (Marine) [b]		Region 6 (Marine) [c]	
				ERL	ERM		
Lead	7439-92-1	mg/kg	10	46.7	218	46.7	6010/6020 , 3050A/7421, 7420, 3010A
Mercury	7439-97-6	mg/kg	0.1	0.15	0.71	0.15	7471
Nickel	7440-02-0	mg/kg	10	20.9	51.6	20.9	6010/6020, 3050A/7421, 7420, 3010A
Silver	7440-22-4	mg/kg	1	1	3.7	1	
Zinc	7440-66-6	mg/kg	10	150	410	150	
Miscellaneous Parameters							
Ammonia	NH3	mg/kg	0.1	-	-	-	350.1, 350.1
Grain Size (sand, silt, clay)	-	%	1%	-	-	-	Sieve & Hydrometer
Total Organic Carbon	Q129	%	0.10%	-	-	-	9060
Total Petroleum Hydrocarbons	8012-95-1	mg/kg	5	-	-	-	8021, 9070, 418.1, TRNCC 1005 & 1006
Total Solids/Dry Weight	-	%	0.10%	-	-	-	160.3

Selected Criteria

FOOTNOTES:

a) This list may include analyses and analytes not required for your site, or may not include site-specific requirements for your site. Consult with the Galveston District. The primary source of these TDLs was EPA 823-B-95-001, QA/QC Guidance for Sampling and Analysis of Sediments, Water and Tissues for Dredged Material Evaluations. (http://water.epa.gov/polwaste/sediments/cs/upload/evaluationguide.pdf)

b) NOAA- http://response.restoration.noaa.gov/cpr/sediment/squirt/squirt.html

c) Region 6- http://rais.ornl.gov/tools/eco_search.php

d) Suggested methods reported in USEPA, 1995, "QA/QC Guidance for Sediment and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations" (http://water.epa.gov/polwaste/sediments/cs/upload/evaluationguide.pdf). Any method that can achieve these TDLs is acceptable, provided the appropriate documentation of the method performance is generated for the project and the method is adequately identified and described in the SAP.

e) Metals shall be expressed as Dissolved values in water samples, except for mercury and selenium, which shall be reported as Total Recoverable

f) These values are based on recommendations from the EPA Region 6 Laboratory in Houston; these values were based on data or other technical basis.

g) Total PCBs for Region 6 from "Update to Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas" RG-263 (revised) January 2006; Total PCBs for NOAA from Squirt Table for Organics in Sediment

Table 5: Tier I Soil PCLs for Human Health Screening [Total Combined, Redidential and Commercial/Industrial] for Common COCs and Parameters, Private Dredging Application

Chemical	CAS #	Units	Screening Benchmarks[a]	
			Residential[b]	Commercial/Industrial[c]
Semivolatiles				
1,2,4-Trichlorobenzene	120-82-1	mg/kg	7.0E+01	1.1E+02
1,2-Dichlorobenzene	95-50-1	mg/kg	3.9E+02	5.7E+02
1,3-Dichlorobenzene	541-73-1	mg/kg	6.2E+01	8.8E+01
1,4-Dichlorobenzene	541-73-1	mg/kg	2.5E+02	1.2E+03
2,4-Dichlorophenol	120-83-2	mg/kg	2.0E+02	2.0E+03
2,4-Dimethylphenol	105-67-9	mg/kg	1.3E+03	1.4E+04
2,4-Dinitrophenol	51-28-5	mg/kg	1.3E+02	1.4E+03
Acenaphthene	83-32-9	mg/kg	3.0E+03	3.7E+04
Acenaphthylene	208-96-8	mg/kg	3.8E+03	3.7E+04
Anthracene	120-12-7	mg/kg	1.8E+04	1.9E+05
Benzo(a)anthracene	56-55-3	mg/kg	4.1E+01	1.7E+02
Benzo(a)pyrene	50-32-8	mg/kg	4.1E+00	1.7E+01
Benzo(b)flouranthene	205-99-2	mg/kg	4.1E+01	1.7E+02
Benzo(g,h,i)perylene	191-24-2	mg/kg	1.8E+03	1.9E+04
Benzo(k)fluoranthene	207-08-9	mg/kg	4.2E+02	1.7E+03
Chrysene	218-01-9	mg/kg	4.1E+03	1.7E+04
Dibenzo(a,,h)anthracene	53-70-3	mg/kg	4.0E+00	1.7E+01
Diethyl Phthalate	84-66-2	mg/kg	5.3E+04	5.5E+05
Fluoranthene	206-44-0	mg/kg	2.3E+03	2.5E+04
Fluorene	86-73-7	mg/kg	2.3E+03	2.5E+04
Hexachlorobenzene	118-74-1	mg/kg	1.0E+00	6.9E+00
Indeno[1,2,3-c,d]pyrene	193-39-5	mg/kg	4.2E+01	1.7E+02
Naphthalene	91-20-3	mg/kg	1.2E+02	1.9E+02
Pentachlorophenol	87-86-5	mg/kg	7.3E-01	3.2E+01
Phenanthrene	85-01-8	mg/kg	1.7E+03	1.9E+04
Phenol	108-95-2	mg/kg	9.5E+02	1.4E+03
Pyrene	129-00-0	mg/kg	1.7E+03	1.9E+04
Pesticides				
4,4'-DDD	72-54-8	mg/kg	1.4E+01	1.0E+02
4,4'-DDE	72-55-9	mg/kg	1.0E+01	7.3E+01
4,4'-DDT	50-29-3	mg/kg	5.4E+00	6.8E+01
Aldrin	309-00-2	mg/kg	5.0E-02	9.7E-01
Alpha-BHC	319-84-6	mg/kg	2.5E-01	2.9E+00
Alpha chlordane	5103-71-9	mg/kg	1.3E+01	5.4E+01
Beta-BHC	319-85-7	mg/kg	9.2E-01	1.1E+01
Beta chlordane	5103-74-2	mg/kg	-	-
Delta-BHC	319-86-8	mg/kg	2.9E+00	1.2E+01
Dieldrin	60-57-1	mg/kg	1.5E-01	1.1E+00
Endosulfan	115-29-7	mg/kg	4.0E+02	4.1E+03
Endosulfan I	959-98-8	mg/kg	9.1E+01	1.4E+03

Table 5: Tier I Soil PCLs for Human Health Screening [Total Combined, Redidential and Commercial/Industrial] for Common COCs and Parameters, Private Dredging Application

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Chemical	CAS #	Units	Screening Benchmarks[a]	
			Residential[b]	Commercial/Industrial[c]
Endosulfan II	33213-65-9	mg/kg	2.7E+02	4.1E+03
Endosulfan sulfate	1031-07-8	mg/kg	3.8E+02	4.1E+03
Endrin	72-20-8	mg/kg	9.0E+00	2.0E+02
Endrin aldehyde	7421-93-4	mg/kg	1.9E+01	2.0E+02
Endrin ketone	53494-70-5	mg/kg	1.9E+01	2.0E+02
Gamma-BHC (Lindane)	58-89-9	mg/kg	1.1E+00	1.8E+01
Gamma chlordane	5566-34-7	mg/kg	7.3E+00	5.1E+01
Heptachlor	76-44-8	mg/kg	1.3E-01	2.8E+00
Heptachlor epoxide	1024-57-3	mg/kg	2.4E-01	1.9E+00
Toxaphene	8001-35-2	mg/kg	1.2E+00	1.7E+01
Polychlorinated Biphenyls				
Total PCB	1336-36-3	mg/kg	1.1E+00	7.1E+00
Metals				
Antimony	7440-36-0	mg/kg	1.5E+01	3.1E+02
Arsenic	7440-38-2	mg/kg	2.4E+01	2.0E+02
Cadmium	7440-43-9	mg/kg	5.1E+01	7.7E+02
Chromium (total)	7440-47-3	mg/kg	2.7E+04	7.5E+04
Copper	7440-50-8	mg/kg	1.3E+03	9.4E+04
Lead	7439-92-1	mg/kg	-	-
Mercury (pH = 4.9)	7439-97-6	mg/kg	2.1E+00	3.3E+00
Mercury (pH = 6.8)	7439-97-6	mg/kg	5.5E+00	1.1E+01
Nickel	7440-02-0	mg/kg	8.4E+02	8.6E+03
Silver	7440-22-4	mg/kg	9.7E+01	2.3E+03
Zinc	7440-66-6	mg/kg	9.9E+03	2.5E+05
Metals				
Ammonia	NH3	mg/kg	2.5E+03	3.5E+03
Grain Size (sand, silt, clay)	-	%	-	-
Total Organic Carbon	Q129	%	-	-
Total Petroleum Hydrocarbons[d]	8012-95-1	mg/kg	1.1E+03	2.1E+03
Total Solids/Dry Weight	-	%	-	-

FOOTNOTES:

a) TCEQ Texas Risk Reduction Program (TRRP-http://tceq.texas.gov/remediation/trrp/guidance.html);lowest values are reported from 0.5 acre and 30 acre carinogenic and noncarcinogenic values.

b) Residential total soil combined include inhalation, ingestion, dermal, and vegetable consumption pathways.

c) Region 6- http://rais.ornl.gov/tools/eco_search.php

d) Suggested methods reported in USEPA, 1995, "QA/QC Guidance for Sediment and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations" (http://water.epa/gov/polwaste/sediments/cs/upload/evaluationguide.pdf). Any method that can achieve these TDLs is acceptable, provided the appropriate documentation of the method performance is generated for the project and the method is adequately

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Table 6: Ecological Benchmarks for Soil for Common COCs and Parameters, Private Dredging Application

Chemical	CAS #	Units	Median Background	Screening Benchmarks			
				TCEQ [a]		EcoSSL [b]	
				Earthworms	Plants	Avian	Mammal
Semivolatiles							
1,2,4-Trichlorobenzene	120-82-1	ug/kg	-	2.0E+04	-	-	-
1,2-Dichlorobenzene	95-50-1	ug/kg	-	-	-	-	-
1,3-Dichlorobenzene	541-73-1	ug/kg	-	-	-	-	-
1,4-Dichlorobenzene	541-73-1	ug/kg	-	2.0E+04	-	-	-
2,4-Dichlorophenol	120-83-2	ug/kg	-	-	-	-	-
2,4-Dimethylphenol	105-67-9	ug/kg	-	-	-	-	-
2,4-Dinitrophenol	51-28-5	ug/kg	-	-	2.0E+04	-	-
Acenaphthene	83-32-9	ug/kg	-	-	2.0E+04	-	-
Acenaphthylene	208-96-8	ug/kg	-	-	-	-	-
Anthracene	120-12-7	ug/kg	-	-	-	-	-
Benzo(a)anthracene	56-55-3	ug/kg	-	-	-	-	-
Benzo(a)pyrene	50-32-8	ug/kg	-	-	-	-	-
Benzo(b)fluoranthene	205-99-2	ug/kg	-	-	-	-	-
Benzo(g,h,i)perylene	191-24-2	ug/kg	-	-	-	-	-
Benzo(k)fluoranthene	207-08-9	ug/kg	-	-	-	-	-
Chrysene	218-01-9	ug/kg	-	-	-	-	-
Dibenzo(a,h)anthracene	53-70-3	ug/kg	-	-	-	-	-
Diethyl Phthalate	84-66-2	ug/kg	-	-	1.0E+05	-	-
Fluoranthene	206-44-0	ug/kg	-	-	-	-	-
Fluorene	86-73-7	ug/kg	-	3.0E+04	-	-	-
Hexachlorobenzene	118-74-1	ug/kg	-	-	-	-	-
Indeno[1,2,3-c,d]pyrene	193-39-5	ug/kg	-	-	-	-	-
Naphthalene	91-20-3	ug/kg	-	-	-	-	-
Pentachlorophenol	87-86-5	ug/kg	-	3.1E+04	5.0E+02	2.1E+03	2.8E+03
Phenanthrene	85-01-8	ug/kg	-	-	-	-	-
Phenol	108-95-2	ug/kg	-	3.0E+04	7.0E+04	-	-
Pyrene	129-00-0	ug/kg	-	-	-	-	-
Pesticides							
4,4'-DDD	72-54-8	ug/kg	-	-	-	9.3E+01	2.1E+01
4,4'-DDE	72-55-9	ug/kg	-	-	-	9.3E+01	2.1E+01
4,4'-DDT	50-29-3	ug/kg	-	-	-	9.3E+01	2.1E+01
Aldrin	309-00-2	ug/kg	-	-	-	-	-
Alpha-BHC	319-84-6	ug/kg	-	-	-	-	-
Alpha chlordane	5103-71-9	ug/kg	-	-	-	-	-
Beta-BHC	319-85-7	ug/kg	-	-	-	-	-
Beta chlordane	5103-74-2	ug/kg	-	-	-	-	-
Delta-BHC	319-86-8	ug/kg	-	-	-	-	-
Dieldrin	60-57-1	ug/kg	-	-	-	2.2E+01	4.9E+00
Endosulfan	115-29-7	ug/kg	-	-	-	-	-
Endosulfan I	959-98-8	ug/kg	-	-	-	-	-
Endosulfan II	33213-65-9	ug/kg	-	-	-	-	-
Endosulfan sulfate	1031-07-8	ug/kg	-	-	-	-	-
Endrin	72-20-8	ug/kg	-	-	-	-	-
Endrin aldehyde	7421-93-4	ug/kg	-	-	-	-	-
Endrin ketone	53494-70-5	ug/kg	-	-	-	-	-
Gamma-BHC (Lindane)	58-89-9	ug/kg	-	-	-	-	-
Gamma chlordane	5566-34-7	ug/kg	-	-	-	-	-
Heptachlor	76-44-8	ug/kg	-	-	-	-	-

Table 6: Ecological Benchmarks for Soil for Common COCs and Parameters, Private Dredging Application DRAFT

Chemical	CAS #	Units	Median Background	Screening Benchmarks			
				TCEQ [a]		EcoSSL [b]	
				Earthworms	Plants	Avian	Mammal
Heptachlor epoxide	1024-57-3	ug/kg	-	-	-	-	-
Toxaphene	8001-35-2	ug/kg	-	-	-	-	-
Polychlorinated Biphenyls							
Total PCB	1336-36-3	ug/kg	-	-	4.0E+04	-	-
Metals							
Antimony	7440-36-0	mg/kg	1.0E+00	7.8E+01	5.0E+00	-	2.7E-01
Arsenic	7440-38-2	mg/kg	5.9E+00	6.0E+01	1.8E+01	4.3E+01	4.6E+01
Cadmium	7440-43-9	mg/kg	-	1.4E+02	3.2E+01	7.7E-01	3.6E-01
Chromium (total)	7440-47-3	mg/kg	3.0E+01	4.0E-01	1.0E+00	-	-
Copper	7440-50-8	mg/kg	1.5E+01	8.0E+01	7.0E+01	2.8E+01	4.9E+01
Lead	7439-92-1	mg/kg	1.5E+01	1.7E+03	1.2E+02	1.1E+01	5.6E+01
Mercury	7439-97-6	mg/kg	4.0E-02	1.0E-01	3.0E-01	-	-
Nickel	7440-02-0	mg/kg	1.0E+01	2.8E+02	3.8E+01	2.1E+02	1.3E+02
Silver	7440-22-4	mg/kg	-	-	5.6E+02	4.2E+00	1.4E+01
Zinc	7440-66-6	mg/kg	3.0E+01	1.2E+02	1.6E+02	4.6E+01	7.9E+01
Miscellaneous Parameters							
Ammonia	NH3	mg/kg	-	-	-	-	-
Grain Size (sand, silt, clay)	-	%	-	-	-	-	-
Total Organic Carbon	Q129	%	-	-	-	-	-
Total Petroleum Hydrocarbons	8012-95-1	mg/kg	-	-	-	-	-
Total Solids/Dry Weight	-	%	-	-	-	-	-

Footnotes:

a) TCEQ: Conducting Ecological Risk Assessments at Remediation Sites in Texas (2014) (http://www.tceq.texas.gov/remediation/eco/eco.html)

b) USEPA Eco-SSL: http://www.epa.gov/ecotox/ecossl/

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Table 7: Target Detection Levels (TDLs), Screening Benchmarks and Analytical Methodology for Analysis of Special Land Use/History COCs and Parameters for Marine Water and Elutriate, Private Dredging Application

Chemical	CAS #	Units	TDL- Marine	Screening Benchmarks				Suggested Methods [f]
			Region 6 [a]	TSWQS (Marie Acute) [b]	EPA WQC (Marine Acute) [c]	NOAA (Marine Acute) [d]	Region 6 (Marine Acute) [e]	
Metals								
Chromium (3+)	7440-47-3 (III)	ug/L	1	-	-	103,000	-	6020
Chromium (6+)	7440-47-3 (Cr6+)	ug/L	1	1,090w	1,100 (D)	1,100	49.6	7196A, 7197, 218.5
Selenium [g]	7782-49-2	ug/L	2	564	290 (D, dd)	290	0.136	7740, 7741, 7742, 270.2, 270.2
Organotin								
Tributyltin	688-73-3	ug/L	0.01 [h]	-	-	-	-	Krone et al., 1989 (GC/FPD)
Miscellaneous Parameters								
Cyanides	57-12-5	mg/l	0.1 [i]	0.0056	1 (Q)	0.001	0.0056	335.2, 9010B/9012A

Footnotes:

a) This list may include analyses and analytes not required for your site, or may not include site-specific requirements for your site. Consult with the Galveston District. The primary source of these TDLs was EPA 823-B-95-001, QA/QC Guidance for Sampling and Analysis of Sediments, Water and Tissues for Dredged Material Evaluations. (http://water.epa.gov/polwaste/sediments/cs/upload/evaluationguide.pdf)

b) TSWQS- https://www.tceq.texas.gov/waterquality/standards/2010standards.html

c) EPA WQC- http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm

d) NOAA- http://response.restoration.noaa.gov/cpr/sediment/squirt/squirt.html

e) Region 6- http://www.epa.gov/region6/water/ecopro/watershd/standard/index.htm

f) Suggested methods from USEPA, 1995, "QA/QC Guidance for Sediment and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations" (http://water.epa.gov/polwaste/sediments/cs/upload/evaluationguide.pdf), the SERIM (http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100FTIH.TXT), and the USEPA Region 6 RIA (http://www.epa.gov/region6/water/ecopro/em/ocean/text/ria.pdf). Any method that can achieve these TDLs is acceptable, provided the appropriate documentation of the method performance is generated for the project and the method is adequately identified and described in the SAP.

g) Selenium shall be reported as Total Recoverable Concentrations

h) TDL value taken from Southeast Regional Implementation Manual (2008) (http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100FTIH.TXT)

i) This value recommended by Houston lab using colorimetric method. This value is based upon FREE cyanide, not complexed as the method is designed to analyze for. If free cyanide is expected, consult the laboratory as to the best method for quantifying free cyanide.

EPA WQC footnotes (footnote letters from NRWRC, only footnotes for constituents of concern are retained in this table)

D) Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. See "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic life Metals Criteria (PDF)," (49 pp, 3MB) October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for Water, available on NSCEP's web site and 40CFR§131.36(b)(1). Conversion Factors applied in the table can be found in Appendix A to the Preamble-Conversion Factors for Dissolved Metals.

dd) Selenium criteria document (EPA 440/5-87-006, September 1987)states that if selenium is as toxic to saltwater fishes in the field as it is to freshwater fishes in the field, the status of the fish community should be monitored whenever the conc.of selenium exceeds 5.0 µg/l in salt water because the saltwater CCC does not take into account uptake via the food chain.

Q) This recommended water quality criterion is expressed as ug free cyanide (as CN)/l.

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Table 8: Target Detection Levels (TDLs), Screening Benchmarks and Analytical Methodology for Analysis of Special Land Use/History COCs and Parameters for Marine Sediment (dry weight), Private Dredging Application

Chemical	CAS #	Units	TDL-Marine	Screening Benchmarks			Suggested Methods [d]
			Region 6 [a]	NOAA (Marine) [b]		Region 6 (Marine) [c]	
				ERL	ERM		
Polychlorinated Biphenyls [e]							
Polychlorinated Biphenyls-209 congeners	-	ug/kg	1	-	-	-	1668
Metals							
Chromium (3+)	7440-47-3 (III)	mg/kg	1	-	-	-	6010/6020
Chromium (6+)	7440-47-3	mg/kg	1	-	-	-	7196
Selenium [f]	7782-49-2	mg/kg	0.5	-	-	-	7741, 7740, 6010/6020
Organotin [g]							
Dibutyltin	1002-53-5	ug/kg	10	-	-	-	Krone et al., 1989 (GC/FPD)
Monobutyltin	78763-54-9	ug/kg	10	-	-	-	
Tributyltin	688-73-3	ug/kg	10	-	-	-	
Miscellaneous Parameters							
Cyanides	57-12-5	mg/kg	2	-	-	-	9010B/9012A
Volatile Organics							
Trichloroethene	79-01-6	ug/kg	5	-	-	-	P&T
Tetrachloroethene	127-18-4	ug/kg	0.1	-	-	-	
Ethylbenzene	100-41-4	ug/kg	1.5	-	-	-	
Total Xylene (sum of o-, m-, p-)	95-47-6 108-38-3 106-42-3	ug/kg	5	-	-	-	
Dioxins/Furans [h]							
2,3,7,8 - TCDD	1746-01-6	pg/g	0.1	-	-	-	1613B
1,2,3,7,8 - PeCDD	40321-76-4	pg/g	0.1	-	-	-	
1,2,3,4,7,8 - HxCDD	39227-28-6	pg/g	0.1	-	-	-	
1,2,3,6,7,8 - HxCDD	57653-85-7	pg/g	0.1	-	-	-	
1,2,3,7,8,9 - HxCDD	19408-74-3	pg/g	0.1	-	-	-	
1,2,3,4,6,7,8 - HpCDD	35822-46-9	pg/g	0.1	-	-	-	
OCDD	3268-87-9	pg/g	0.1	-	-	-	
2,3,7,8 - TCDF	51207-31-9	pg/g	0.1	-	-	-	
1,2,3,7,8 - PeCDF	57117-41-6	pg/g	0.1	-	-	-	
2,3,4,7,8 - PeCDF	57117-31-4	pg/g	0.1	-	-	-	
1,2,3,4,7,8 - HxCDF	70648-26-9	pg/g	0.1	-	-	-	
1,2,3,6,7,8 - HxCDF	57117-44-9	pg/g	0.1	-	-	-	
2,3,4,6,7,8 - HxCDF	60851-34-5	pg/g	0.1	-	-	-	
1,2,3,7,8,9 - HxCDF	72918-21-9	pg/g	0.1	-	-	-	
1,2,3,4,6,7,8 - HpCDF	67562-39-4	pg/g	0.1	-	-	-	
1,2,3,4,7,8,9 - HpCDF	55673-89-7	pg/g	0.1	-	-	-	
OCDF	39001-02-0	pg/g	0.1	-	-	-	
Total Dioxin TEQ	-	pg/g	20	-	-	-	-

FOOTNOTES:

a) This list may include analyses and analytes not required for your site, or may not include site-specific requirements for your site. Consult with the Galveston District. The primary source of these TDLs was EPA 823-B-95-001, QA/QC Guidance for Sampling and Analysis of Sediments, Water and Tissues for Dredged Material Evaluations. (http://water.epa.gov/polwaste/sediments/cs/upload/evaluationguide.pdf

b) NOAA- http://response/restoration.noaa.gov/cpr/sediment/squirt/squirt.html

c) Region 6- http://rais.ornl.gov/tools/eco_search.php

d) Suggested methods reported in USEPA, 1995, "QA/QC Guidance for Sediment and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations" (http://water.epa/gov/polwaste/sediments/cs/upload/evaluationguide.pdf). Any method that can achieve these TDLs is acceptable, provided the appropriate documentation of the method performance is generated for the project and the method is adequately identified and described in the SAP.

e) PCB congener TDLs are reported from the Southeast Regional Implementation Manual (2008) (http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100FTIH.TXT). Analysis of 209 congeners for fingerprinting.

f) Selenium shall be reported as Total Recoverable Concentrations

g) Organotin TDLs are reported from the Souteast Regional Implementation Manual (2008). For example, sites with historic sandblasting, shipbreaking, maintenance, and repair would warrant analysis of organotins.

h) Dioxins/Furans TDLs are reported from Galveston Harbor and Channel and HSC Table A-2

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Table 9: Tier I Soil PCLs for Human Health Screening [Total Combined, Residential and Commerical/Industrial] for Speical Land Use/History COCs and Parameters, Private Dredging Application

Chemical	CAS #	Units	Screening Benchmarks [a]	
			Residential [b]	Commercial/Industrial [c]
Polychlorinated Biphenyls [d]				
Polychlorinated Biphenyls- 209 congeners	-	ug/kg	1.14E+03	7.13E+03
Metals				
Chromium (3+)	7440-47-3 (III)	mg/kg	2.69E+04	7.46E+04
Chromium (6+)	7440-47-3 (Cr6+)	mg/kg	1.22E+02	1.01E+03
Selenium [e]	7782-49-2	mg/kg	3.09E+02	2.27E+03
Organotin				
Dibutyltin	1002-53-5	ug/kg	-	-
Monobutyltin	78763-54-9	ug/kg	-	-
Tributyltin	688-73-3	ug/kg	-	-
Miscellaneous Parameters				
Cyanides	57-12-S	mg/kg	4.80E+01	5.83E+02
Dioxins/Furans				
2,3,7,8 -TCDD	1746-01-6	pg/g	-	-
1,2,3,7,8 - PeCDD	40321-76-4	pg/g	-	-
1,2,3,4,7,8 - HxCDD	39227-28-6	pg/g	-	-
1,2,3,6,7,8 - HxCDD	57653-85-7	pg/g	-	-
1,2,3,7,8,9 - HxCDD	19408-74-3	pg/g	-	-
1,2,3,4,6,7,8 - HpCDD	35822-46-9	pg/g	-	-
OCDD	3268-87-9	pg/g	-	-
2,3,7,8 - TCDF	51207-31-9	pg/g	-	-
1,2,3,7,8 - PeCDF	57117-41-6	pg/g	-	-
2,3,4,7,8 - PeCDF	57117-31-4	pg/g	-	-
1,2,3,4,7,8 - HxCDF	70648-26-9	pg/g	-	-
1,2,3,6,7,8 - HxCDF	57117-44-9	pg/g	-	-
2,3,4,6,7,8 - HxCDF	60851-34-5	pg/g	-	-
1,2,3,7,8,9 - HxCDF	72918-21-9	pg/g	-	-
1,2,3,4,6,7,8 - HpCDF	67562-39-4	pg/g	-	-
1,2,3,4,7,8,9 - HpCDF	55673-89-7	pg/g	-	-
OCDF	39001-02-0	pg/g	-	-
Total Dioxin TEQ (2,3,7,8,-TCDD TEQ)	-	pg/g	1	S

Footnotes:

a) TCEQ Texas Risk Reduction Program (TRRP-http://www.tceq.texas.gov/remediation/trrp/guidance.html); lowest values are reported from 0.S acre and 30 acre carcinogenic and noncarcinogenic values.

b) TRRP Table 4- Residential total soil combined include inhalation, ingestion, dermal, and vegetable consumption pathways.

c) TRRP Table 5- Commercial/Industrial total soil combined include inhalation, ingestion, and dermal pathways.

d) Analysis of 209 congeners for fingerprinting.

e) Selenium shall be reported as Total Recoverable Concentrations

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Table 10: Ecological Benchmarks for Soil for Special Land Use/History COCs and Parameters, Private Dredging Application

Chemical	CAS #	Units	Median Background	Screening Benchmarks			
				TCEQ [a]		EcoSSL [b]	
				Earthworms	Plants	Avian	Mammal
Polychlorinated Biphenyls [c]							
Polychlorinated Biphenyls- 209 congeners	-	ug/kg	-	-	4.00E+01	-	-
Metals							
Chromium (3+)	7440-47-3 (III)	mg/kg	-	-	-	26	34
Chromium (6+)	7440-47-3 (Cr6+)	mg/kg	-	-	-	-	130
Selenium [d]	7782-49-2	mg/kg	3.00E-01	4.10E+00	5.20E-01	1.20E+00	6.30E-01
Organotin							
Dibutyltin	1002-53-5	ug/kg	-	-	-	-	-
Monobutyltin	78763-54-9	ug/kg	-	-	-	-	-
Tributyltin	688-73-3	ug/kg	-	-	-	-	-
Miscellaneous Parameters							
Cyanides	57-12-5	mg/kg	-	-	-	-	-
Dioxins/Furans							
2,3,7,8 -TCDD	1746-01-6	pg/g	-	-	-	-	-
1,2,3,7,8 - PeCDD	40321-76-4	pg/g	-	-	-	-	-
1,2,3,4,7,8 - HxCDD	39227-28-6	pg/g	-	-	-	-	-
1,2,3,6,7,8 - HxCDD	57653-85-7	pg/g	-	-	-	-	-
1,2,3,7,8,9 - HxCDD	19408-74-3	pg/g	-	-	-	-	-
1,2,3,4,6,7,8 - HpCDD	35822-46-9	pg/g	-	-	-	-	-
OCDD	3268-87-9	pg/g	-	-	-	-	-
2,3,7,8 - TCDF	51207-31-9	pg/g	-	-	-	-	-
1,2,3,7,8 - PeCDF	57117-41-6	pg/g	-	-	-	-	-
2,3,4,7,8 - PeCDF	57117-31-4	pg/g	-	-	-	-	-
1,2,3,4,7,8 - HxCDF	70648-26-9	pg/g	-	-	-	-	-
1,2,3,6,7,8 - HxCDF	57117-44-9	pg/g	-	-	-	-	-
2,3,4,6,7,8 - HxCDF	60851-34-5	pg/g	-	-	-	-	-
1,2,3,7,8,9 - HxCDF	72918-21-9	pg/g	-	-	-	-	-
1,2,3,4,6,7,8 - HpCDF	67562-39-4	pg/g	-	-	-	-	-
1,2,3,4,7,8,9 - HpCDF	55673-89-7	pg/g	-	-	-	-	-
OCDF	39001-02-0	pg/g	-	-	-	-	-
Total Dioxin TEQ (2,3,7,8,-TCDD TEQ)	-	pg/g	-	-	-	-	-

Footnotes:

a) TCEQ: Conducting Ecological Risk Assessments at Remediation Sites in Texas (2014) (http://www.tceq.texas.gov/remediation/eco/eco.html)

b) USEPA Eco-SSL: http://www.epa.gov/ecotox/ecossl/

c) Analysis of 209 congeners for fingerprinting.

d) Selenium shall be reported as Total Recoverable Concentrations

Texas-Specific Criteria

Texas-Specific Soil Background Concentrations milligrams per kilogram (mg/kg)[1]	
Metal	Median Background Concentration (mg/kg)
Aluminum	30,000
Antimony	1
Arsenic	5.9
Barium	300
Beryllium	1.5
Boron	30
Total Chromium	30
Cobalt	7
Copper	15
Fluoride	190
Iron	15,000
Lead	15
Manganese	300
Mercury	0.04
Nickel	10
Selenium	0.3
Strontium	100
Tin	0.9
Titanium	2,000
Thorium	9.3
Vanadium	50
Zinc	30

[1] Source: "Background Geochemistry of Some Rocks, Soils, Plants, and Vegetables in the Conterminous United States", by Jon J. Connor, Hansford T. Shacklette, et al., Geological Survey Professional Paper 574-F, US Geological Survey.

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TABLE 1

Criteria in Water for Specific Toxic Materials -
AQUATIC LIFE PROTECTION
(All values are listed or calculated in micrograms per liter)
(Hardness concentrations are input as milligrams per liter)

Parameter	CASRN	Freshwater	Freshwater	Saltwater	Saltwater
		Acute Criteria	Chronic Criteria	Acute Criteria	Chronic Criteria
Aldrin	309-00-2	3.0	---	1.3	---
Aluminum (d)	7429-90-5	991w	---	---	---
Arsenic (d)	7440-38-2	340 w	150 w	149w	78w
Cadmium (d)	7440-43-9	$1.136672-(\ln(hardness)(0.041838))\ (we^{(1.0166(\ln(hardness))-2.4743)})$	$1.101672-(\ln(hardness)(0.041838))\ (we^{(0.7409(\ln(hardness))-4.719)})$	40.0 w	8.75 w
Carbaryl	63-25-2	2.0	---	613	---
Chlordane	57-74-9 and 12789-03-6	2.4	0.004	0.09	0.004
Chlorpyrifos	2921-88-2	0.083	0.041	0.011	0.006
Chromium (Tri) (d)	16065-83-1	$0.316we^{(0.8190(\ln(hardness))+3.7256)}$	$0.860we^{(0.8190(\ln(hardness))+0.6848)}$	---	---
Chromium (Hex) (d)	18540-29-9	15.7w	10.6w	1,090w	49.6w
Copper (d)*	7440-50-8	$0.960m\ e^{(0.9422(\ln(hardness))-1.6448)}$	$0.960m\ e^{(0.8545(\ln(hardness))-1.6463)}$	13.5w	3.6w
Cyanide † (free)	57-12-5	45.8	10.7	5.6	5.6
4,4'- DDT	50-29-3	1.1	0.001	0.13	0.001
Demeton	8065-48-3	---	0.1	---	0.1

Diazinon	333-41-5	0.17	0.17	0.819	0.819
Dicofol	115-32-2	59.3	19.8	---	---
Dieldrin	60-57-1	0.24	0.002	0.71	0.002
Diuron	330-54-1	210	70	---	---
Endosulfan I (*alpha*)	959-98-8	0.22	0.056	0.034	0.009
Endosulfan II (*beta*)	33213-65-9	0.22	0.056	0.034	0.009
Endosulfan sulfate	1031-07-8	0.22	0.056	0.034	0.009
Endrin	72-20-8	0.086	0.002	0.037	0.002
Guthion	86-50-0	---	0.01	---	0.01
Heptachlor	76-44-8	0.52	0.004	0.053	0.004
Hexachloro-cyclohexane (*gamma*)(Lindane)	58-89-9	1.126	0.08	0.16	---
Lead (d)	7439-92-1	1.46203-(ln(hardness)(0.145712)) $(we^{(1.273(\ln(hardness))-1.460)})$	1.46203-(ln(hardness)(0.145712)) $(we^{(1.273(\ln(hardness))-4.705)})$	133w	5.3w
Malathion	121-75-5	---	0.01	---	0.01
Mercury	7439-97-6	2.4	1.3	2.1	1.1
Methoxychlor	72-43-5	---	0.03	---	0.03
Mirex	2385-85-5	---	0.001	---	0.001
Nickel (d)	7440-02-0	$0.998we^{(0.8460(\ln(hardness))+2.255)}$	$0.997we^{(0.8460(\ln(hardness))+0.0584)}$	118w	13.1w
Nonylphenol	84852-15-3 and 25154-	28	6.6	7	1.7

	52-3				
Parathion (ethyl)	56-38-2	0.065	0.013	---	---
Pentachlorophenol	87-86-5	$e^{(1.005(pH)-4.869)}$	$e^{(1.005(pH)-5.134)}$	15.1	9.6
Phenanthrene	85-01-8	30	30	7.7	4.6
Polychlorinated	1336-36-3	2.0	0.014	10	0.03
Biphenyls (PCBs) ‡					
Selenium	7782-49-2	20	5	564	136
Silver, as free ion	7440-22-4	0.8w	---	2w	---
Toxaphene	8001-35-2	0.78	0.0002	0.21	0.0002
Tributyltin (TBT)	688-73-3	0.13	0.024	0.24	0.0074
2,4,5 Trichlorophenol	95-95-4	136	64	259	12
Zinc (d)	7440-66-6	$0.978we^{(0.8473(\ln(hardness))+0.884)}$	$0.986we^{(0.8473(\ln(hardness))+0.884)}$	92.7w	84.2w

* In designated oyster waters, an acute saltwater copper criterion of 3.6 micrograms per liter applies outside of the mixing zone of permitted discharges, and specified mixing zones for copper do not encompass oyster reefs containing live oysters.

† Compliance will be determined using the analytical method for available cyanide.

(d) Indicates that the criteria for a specific parameter are for the dissolved portion in water. All other criteria are for total recoverable concentrations, except where noted.

‡ These criteria apply to the sum of all congener or all isomer or homolog or Arochlor analysis.

w Indicates that a criterion is multiplied by a water-effect ratio (WER) in order to incorporate the effects of local water chemistry on toxicity. The WER is equal to 1 except where sufficient data is available to establish a site-specific WER.

WERs for individual water bodies are listed in Appendix E when standards are revised. The number preceding the w in the freshwater criterion equation is an EPA conversion factor.

m Indicates that a criterion may be multiplied by a WER or a biotic ligand model result in order to incorporate the effects of local water chemistry on toxicity. The multiplier is equal to 1 except where sufficient data is available to establish a site-specific multiplier. Multipliers for individual water bodies are listed in Appendix E when standards are revised. The number preceding the m in the freshwater equation is an EPA conversion factor.

e The mathematical constant that is the basis of the natural logarithm. When rounded to four decimal points, *e* is equal to 2.7183.

Appendix C

Field Notes & Boring Logs

3/16/21 TWEI 21001
Marine Sampling & Analysis
San Jacinto River / North Bay

0730 Arrived @ Dock / Met w/ NE

WX: 70°F, Wind East @ 1mph
Fog, Overcast

0800 - Departed Dock w/ work boat. Arrived @ Jack-up rig
Set up equipment.

0830 - Moved rig to station MB-1. Water Depth 6'

Morgan's Point Tide
0.50' ↑

0905 Started Drilling MB-1

1200 Stopped Drilling MB-1

PHOTOS: 359-364

1210 Sampled MB-1-SED
MB-1-ELUT-SED

3/16/21 TWEI 21001

1230 Arrived @ Station MB-5
Water Depth: 8'

Morgan's Point Tide
1.00' ↓

1245 - Started Drilling MB-5

Photos:

1515 - Stopped Drilling MB-5

1530 - Sampled MB-5-ELT-SED
MB-5-SED

1600 - Set up @ MB-7
Alisha @ A&B LABS

1630 Arrived @ Dock

1713 - Dropped off samples @
A&B LABS

3/17/2021 ~~Howard~~ TWE ~~Shorty~~ -
Cedar Dredge project

0600 - Left Boat. Stopped for fuel & ICE.

0730 - Arrived @ Boat launch. Loaded equipment. Departed for Barrington to fuel truck boat.

0845 - Arrived @ Jack-up rig. Safety meeting.

Wx: Humid wind SE @ 11 mph 71°F, 80% precip.

GPS of MB-7 / 036

Water Depth:

0900 Sampled MB-7-WAT

0935 - Calibrated Horiba WQ meter

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WQ for Station MB-7
21.09°C
5.20 pH
201 ORP
13.7 ms/cm
71.3 NTU
8.24 ms/L DO

Morgan's Pt. Tide 0.80 ↑ @ 10:45

11:45 Stopped drilling MB-7

1150 - Sampled MB-7 - SED
1155 - Trip Blank WAT
1200 - Departed for MB-9 Arrived

12:22 Started drilling MB-9

1226 - Boat delay, ferry line moving through.

1310 - Started drilling MB-9

 3/17/21

TWE
Cooper Droge

MB-9 WQ
20.87°C
6.55 ph
134 ORP
14.2 ms/cm
92.9 NTU
5.61 mg/L DO

1300 Sampled MB-9-ELUT-WTR

1500 Stopped drilling MB-9

1520 Sampled MB-9-SED
MB-9-SED-ELUT

WX: clear, 70°F Winds N @ 10 mph. Received ~0.25" during front.

1530 Departed for Station MB-3 (will not sample)

1645 - MB-5-ELUT-WAT

1710 - MB-1-ELUT WAT
MB-1-WAT

1730 - Equipment blank sample

1745: Arrived @ Dock. Unloaded equipment

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Equipment Report Card

Ajax Environmental

Horiba U-52

Sonde- C1102

This equipment has been inspected prior to its shipment and the following items and general, observable condition have been described.

Please review this instrument upon its arrival to confirm the contents of this report. Should you recognize a deviation, please call 713-789-4149 to report your findings.

All items on this report will be reviewed upon the unit's return to AJAX Env. Any damage, lost items or unreasonable and unusual maintenance required to restore the unit to its reported condition will require additional charges to the customer.

1. Display: .... __x__
2. Sonde: .... __x__
3. Sonde Moisture Container: .... _____
4. Manual: .... __x__
5. Flow Thru Sampler (FTC): .... __x__
6. Calibration Cup: .... __x__
7. Small calibration solution: .... __x___

Auto Calibration Solution:
Lot 9082801
Exp. 09/30/21

1. calibrated pH reading: 4.01
2. Calibrated Conductivity reading: 4.50 mS/cm
3. Calibrated DO reading: 8.50 mg/l
4. Calibrated Turbidity reading: 0.0 NTU
5. Temperature reading for calibration: 24.15 C

Inspector: SNT **Date:** 03-15-21

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Ajax Environmental
10801 Hammerly Blvd., Suite 148
Houston, TX 77043

Certification of Calibration

Zero Reading

MFG: GasCo	Lot #: 305-401959890-1	Expiration: 11/10/24

Instrument S/N: **A1101** **Model:** **MiniRae Lite**

Span Reading

Span Concentration 100 ppm Isobutylene

Zero Reading 0.0 ppm Span Reading 100.1 ppm

Calibrated by: Nick Taylor

Signature: [signature]

Date completed: March 15, 2021

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Photographs During Collection of Media for Environmental Testing
TGS Cedar Port Industrial Park – Deepening/Widening Cedar Bayou Channel
Pre-Dredge Sampling Fieldwork – March 2021

1. Truck-mounted drill rig in braked position on work deck of Spud Barge.

2. Water Conditions Quiet for Portions of Full-Depth Core Collection Work.

3. Drilling Crew Performed Double Duty (Geotech and Envir Cores) during week.

4. Example of Brown and Gray Clays Encountered in Full-Depth Cores.

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Photographs During Collection of Media for Environmental Testing
TGS Cedar Port Industrial Park – Deepening/Widening Cedar Bayou Channel
Pre-Dredge Sampling Fieldwork – March 2021

5. Marine Core MB-7 at the
15-17 Foot Interval Sliced & Splayed

6. Typical Full-Depth Core Broken into
Lined Container for Forming Composite

7. Typical High-Clay Portion of a Full-Depth
Core Interval for Observation/Description

8. Closer-in View of Same Interval Splayed.

DiSorbo Environmental Consulting Firm

Cedar Port Industrial Park, Cedar Bayou
Tolunay-Wong Engineers
TWEI21001

Geologist	: James Reis
Drilling Company	: TWE
Driller	: S. Hernandez
Drilling Rig	: SIMCO 2500
Drilling Method	: 4" Wash Bin
Sampling Method	: 3"Shlby.Tb. & 2" Splt. Spn.
Water Depth	: 6'
Total Depth	: 56'
Start Date/Time	: 3/16/2021 09:00
Finish Date/Time	: 3/16/2021 12:00

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MB-1

(Sheet 1 of 3)

Latitude	: 29.68740
Longitude	: -94.98066
Comments	: Sediment samples were composites of full core.

Saturation

▼ Saturation

Completion Results

Depth (ft.)	PID (ppm)	Saturation	Lithology	USCS	Recovery (%)	Sample	DESCRIPTION
0	0.0			SP	55		SAND - Sulfide odor, brownish gray, shell fragments, low plasticity.
5	0.2			SP	90		SAND - Similar to above (STA).
	16.0			SL	90		CLAYEY SAND - Sulfide odor, gray, low plasticity.
10	6.0			SL	90		CLAYEY SAND - STA.
	0.0			SL	90		CLAYEY SAND - STA.
15	0.0			SP	100		SAND - No odor, light to dark gray, fine to coarse grain.
	0.0			SP			SAND - No odor, gray with some tan, fine grain.

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Cedar Port Industrial Park, Cedar Bayou
Tolunay-Wong Engineers
TWEI21001

Geologist	: James Reis
Drilling Company	: TWE
Driller	: S. Hernandez
Drilling Rig	: SIMCO 2500
Drilling Method	: 4" Wash Bin
Sampling Method	: 3"Shlby.Tb. & 2" Splt. Spn.
Water Depth	: 6'
Total Depth	: 56'
Start Date/Time	: 3/16/2021 09:00
Finish Date/Time	: 3/16/2021 12:00

MB-1

Latitude	: 29.68740
Longitude	: -94.98066
Comments	: Sediment samples were composites of full core.

Saturation
▼ Saturation

Completion Results

Depth (ft.)	PID (ppm)	Saturation	Lithology	USCS	Recovery (%)	Sample	DESCRIPTION
19	0.0			SP	100	X	
24	0.0			SP	50	X	SAND - No odor, coarse.
29	0.0			SP	100	X	SAND - STA, with clay inclusions
34	0.0			CH	100	X	CLAY - Gley, moderate plasticity, firm, no odor, 2.5 tons/cubic foot.

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Tolunay-Wong Engineers
TWEI21001

Geologist	: James Reis
Drilling Company	: TWE
Driller	: S. Hernandez
Drilling Rig	: SIMCO 2500
Drilling Method	: 4" Wash Bin
Sampling Method	: 3"Shlby.Tb. & 2" Splt. Spn.
Water Depth	: 6'
Total Depth	: 56'
Start Date/Time	: 3/16/2021 09:00
Finish Date/Time	: 3/16/2021 12:00

MB-1

Latitude	: 29.68740
Longitude	: -94.98066
Comments	: Sediment samples were composites of full core.

Saturation
▼ Saturation

Completion Results

Depth (ft.)	PID (ppm)	Saturation	Lithology	USCS	Recovery (%)	Sample	DESCRIPTION
38	0.0			CH	100	X	CLAY - Gray with some tan, no odor, very firm, moderate plasticity, 3.5 tons/cubic foot
43	0.0			CL	70	X	CLAY - Very gralley, gray to brown, firm, low plasticity, no odor, some shells, 3.5 tons/cubic foot.
48	0.0			CL	100	X	CLAY - STA.
53							

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Geologist	: James Reis
Drilling Company	: TWE
Driller	: S. Hernandez
Drilling Rig	: SIMCO 2500
Drilling Method	: 4" Wash Bin
Sampling Method	: 3"Shlby.Tb. & 2" Splt. Spn.
Water Depth	: 8'
Total Depth	: 58'
Start Date/Time	: 3/16/2021 12:35
Finish Date/Time	: 3/16/2021 15:40

MB-5

(Sheet 1 of 3)

Latitude	: 29.68635
Longitude	: -94.98086
Comments	: Sediment samples were composites of full core.

Saturation

▼ Saturation

Completion Results

Depth (ft.)	PID (ppm)	Saturation	Lithology	USCS	Recovery (%)	Sample	DESCRIPTION
0	0.0			CL	100	X	SANDY CLAY - No odor, gray, soft, moderate plasticity.
	0.0			CL	100	X	SANDY CLAY - Soft, gray, no odor, moderate plasticity, transitions to fat clay at 4.0'.
5	0.0			CL	100	X	SANDY CLAY - Similar to above (STA), sulfide odor.
10	0.0			CH	100	X	CLAY - Sand lenses throughout, gray, no odor, fat.
	0.0			CL	100	X	CLAY - STA.
15	0.0			CL	100	X	CLAY - STA.
	0.0			CL		X	CLAY - STA, 2-3" of shell fill material at top then into the fat clays.

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Geologist	: James Reis
Drilling Company	: TWE
Driller	: S. Hernandez
Drilling Rig	: SIMCO 2500
Drilling Method	: 4" Wash Bin
Sampling Method	: 3"Shlby.Tb. & 2" Splt. Spn.
Water Depth	: 8'
Total Depth	: 58'
Start Date/Time	: 3/16/2021 12:35
Finish Date/Time	: 3/16/2021 15:40

MB-5

Latitude	: 29.68635
Longitude	: -94.98086
Comments	: Sediment samples were composites of full core.

Saturation
▼ Saturation

Completion Results

Depth (ft.)	PID (ppm)	Saturation	Lithology	USCS	Recovery (%)	Sample	DESCRIPTION
19	0.0			CL	100	X	
24	0.0			CL	100	X	CLAY - STA.
29	0.0			CL	100	X	CLAY - STA.
34	0.0			CL	100	X	CLAY - STA.

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Geologist	: James Reis
Drilling Company	: TWE
Driller	: S. Hernandez
Drilling Rig	: SIMCO 2500
Drilling Method	: 4" Wash Bin
Sampling Method	: 3"Shlby.Tb. & 2" Splt. Spn.
Water Depth	: 8'
Total Depth	: 58'
Start Date/Time	: 3/16/2021 12:35
Finish Date/Time	: 3/16/2021 15:40

MB-5

DRAFT

Latitude	: 29.68635
Longitude	: -94.98086
Comments	: Sediment samples were composites of full core.

Saturation
▼ Saturation

Completion Results

Depth (ft.)	PID (ppm)	Saturation	Lithology	USCS	Recovery (%)	Sample	DESCRIPTION
38	0.0			CL	100	X	CLAY - Sand and shell inclusions.
43	0.0			CL	100	X	SANDY SILTY CLAY - No odor, low plasticity, soft.
48	0.0			CL	100	X	CLAY - Transitions to clayey sand at 49'.
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Geologist	: James Reis
Drilling Company	: TWE
Driller	: H. Willoughby
Drilling Rig	: SIMCO 2500
Drilling Method	: 4" Wash Bin
Sampling Method	: 3"Shlby.Tb. & 2" Splt. Spn.
Water Depth	: 7'
Total Depth	: 57'
Start Date/Time	: 3/17/2021 09:05
Finish Date/Time	: 3/17/2021 11:40

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MB-7

Latitude	: 29.68092
Longitude	: -94.94906
Comments	: Sediment samples were composites of full core.

Saturation
▼ Saturation

Completion Results

Depth (ft.)	PID (ppm)	Saturation	Lithology	USCS	Recovery (%)	Sample	DESCRIPTION
0				CL			CLAY - Moderate plasticity, sand inclusions, gray, sulfide odor.
	1.9			SC	100		CLAYEY SAND - Low plasticity, gray, soft, shell inclusions, sulfide odor.
5	0.0			SC	100		CLAYEY SAND - Similar to above (STA).
	0.0			CL	60		SILTY CLAY - Moderate plasticity, soft, shell inclusions, no odor.
10	0.0			CL	50		CLAY - Light brown, firm, moderate plasticity.
	0.0			CL	100		CLAY - Light brown, very firm, moderate plasticity, gray/reddish brown redox inclusions, 2.75 tons/cubic foot.
15	0.0			CH	70		CLAY - Dark reddish brown (redox), very firm, high plasticity, no odor, transitions to grayish yellow at bottom, 2.75 tons/cubic foot.
	0.0			CL			CLAY - Gray, very firm, moderate plasticity, small black inclusions, 2.0 tons/cubic foot

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Geologist	: James Reis
Drilling Company	: TWE
Driller	: H. Willoughby
Drilling Rig	: SIMCO 2500
Drilling Method	: 4" Wash Bin
Sampling Method	: 3"Shlby.Tb. & 2" Splt. Spn.
Water Depth	: 7'
Total Depth	: 57'
Start Date/Time	: 3/17/2021 09:05
Finish Date/Time	: 3/17/2021 11:40

MB-7

Latitude	: 29.68092
Longitude	: -94.94906
Comments	: Sediment samples were composites of full core.

Saturation

▼ Saturation

Completion Results

Depth (ft.)	PID (ppm)	Saturation	Lithology	USCS	Recovery (%)	Sample	DESCRIPTION
19	0.0			CL	100	X	
24	0.0			CL	80	X	CLAY - STA, crumbly, 2.5 tons/cubic foot.
29	0.0			CL	70	X	CLAY - Dark greenish gray, damp, low plasticity, crumbly, no odor
34	0.0			CL	60	X	CLAY - Light to dark gray, low plasticity, no odor, crumbly.

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Geologist	: James Reis
Drilling Company	: TWE
Driller	: H. Willoughby
Drilling Rig	: SIMCO 2500
Drilling Method	: 4" Wash Bin
Sampling Method	: 3"Shlby.Tb. & 2" Splt. Spn.
Water Depth	: 7'
Total Depth	: 57'
Start Date/Time	: 3/17/2021 09:05
Finish Date/Time	: 3/17/2021 11:40

MB-7

(Sheet 3 of 3)

Latitude	: 29.68092
Longitude	: -94.94906
Comments	: Sediment samples were composites of full core.

Saturation

▼ Saturation

Completion Results

Depth (ft.)	PID (ppm)	Saturation	Lithology	USCS	Recovery (%)	Sample	DESCRIPTION
38	0.0			SS	95	X	SAND - Gray, saturated, no odor, clayey sand until 39' into sand.
43	0.0			SS	40	X	SAND - With some clay, gray, firm, no odor
48	0.0			SS	40	X	SAND - STA.
53							

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TWEI21001

Geologist	: James Reis
Drilling Company	: TWE
Driller	: H. Willoughby
Drilling Rig	: SIMCO 2500
Drilling Method	: 4" Wash Bin
Sampling Method	: 3"Shlby.Tb. & 2" Splt. Spn.
Water Depth	: 10.3'
Total Depth	: 60.3'
Start Date/Time	: 3/17/2021 13:00
Finish Date/Time	: 3/17/2021 15:00

MB-9

(Sheet 1 of 3)

Latitude	: 29.67444
Longitude	: -94.93785
Comments	: Sediment samples were composites of full core.

Saturation

▼ Saturation

Completion Results

Depth (ft.)	PID (ppm)	Saturation	Lithology	USCS	Recovery (%)	Sample	DESCRIPTION
0	0.0			CH	30		CLAY - Unconsolidated, dark gray, no odor.
5	0.0			CH	100		CLAY - Gray, soft, no odor.
	0.0			CH	65		CLAY - Similar to above (STA), more firm than above.
10	0.0			CH	50		CLAY - STA.
	0.0			CH	50		CLAY - Reddish brown with gray, shells, crumbly, stiff, no odor.
15	0.0			CH	100		CLAY - STA.
	0.0			CH			CLAY - STA.

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Geologist	: James Reis
Drilling Company	: TWE
Driller	: H. Willoughby
Drilling Rig	: SIMCO 2500
Drilling Method	: 4" Wash Bin
Sampling Method	: 3"Shlby.Tb. & 2" Splt. Spn.
Water Depth	: 10.3'
Total Depth	: 60.3'
Start Date/Time	: 3/17/2021 13:00
Finish Date/Time	: 3/17/2021 15:00

MB-9

Latitude	: 29.67444
Longitude	: -94.93785
Comments	: Sediment samples were composites of full core.

Saturation

▼ Saturation

Completion Results

Depth (ft.)	PID (ppm)	Saturation	Lithology	USCS	Recovery (%)	Sample	DESCRIPTION
19	0.0			CH	70	X	
24	0.0			CH	75	X	CLAY - STA, more gray/gley than above.
29	0.0			CH	100	X	CLAY - STA.
34	0.0			CH	100	X	CLAY - Gley, some gravel, no odor, stiff, crumbly, 2.0 tons/cubic foot.

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Cedar Port Industrial Park, Cedar Bayou
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TWEI21001

Geologist : James Reis
Drilling Company : TWE
Driller : H. Willoughby
Drilling Rig : SIMCO 2500
Drilling Method : 4" Wash Bin
Sampling Method : 3"Shlby.Tb. & 2" Splt. Spn.
Water Depth : 10.3'
Total Depth : 60.3'
Start Date/Time : 3/17/2021 13:00
Finish Date/Time : 3/17/2021 15:00

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MB-9
(Sheet 3 of 3)

Latitude : 29.67444
Longitude : -94.93785
Comments : Sediment samples were composites of full core.

Saturation
▼ Saturation

Completion Results

Depth (ft.)	PID (ppm)	Saturation	Lithology	USCS	Recovery (%)	Sample	DESCRIPTION
38	0.0			SM	30	X	SAND - Gray, no odor.
43	0.0			SM	60	X	SAND - STA.
48	0.0			SP	50	X	SAND - Coarse.
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Client: Tolunay-Wong Engineers, Trans-Global Solutior	Project No. TWEI21001	Boring No. \ Well No.: MB-1
Project Name: Cedar Port Pre-Dredge 2021		Sheet 1 of 2
Water Depth: 6' / Target/Total Depth: 56' (H2O+TD)	GPS Coordinates: 29.68740, -94.98066	Logged By: James Reis
Drilling Methods \ Auger Size \ Bit Size: 4" Wash Bin	Drilling Rig: Simco 2500 / Driller: S. Hernandez	Drilling Company: TWE
Sampling Method \ Size of Sampler: 3" Shelby Tube, 2" Split Spoon		Drilling Start Date / Time: 3.16.21 0900
Comments:		Drilling Finish Date / Time: 3.16.21 1200

Field Screening: Depth (feet bgl)	PID (ppm)	Air Temp. (°F)	Lithologic Interval (feet bgl)	Symbol	% Recovery	Description of Lithology
	0.0	68	0-2	SP	55	SAND - sulfide odor, brownish grey, shell fragments, low plasticity
	0.2	69	3-5	SP	90	SAND - STA
	16.0	70	6-8	SL	90	CLAYEY SAND - sulfide odor, grey, low plasticity
	6.0	70	9-11	SL	90	CLAYEY SAND - STA
	0.0	70	12-14	SL	90	CLAYEY SAND - STA
	0.0	70	15-17	SP	100	SAND - no odor, light to dark grey, fine to coarse grain
	0.0	70	18-20	SP	100	SAND - no odor, gray w/ some tan, fine grain
	0.0	71	23-25	SP	50	SAND - no odor, coarse
	0.0	71	28-30	SP	100	SAND - STA w/ clay inclusions
	0.0	72	33-35	CH	100	CLAY - gley, mod. plasticity, firm, no odor 2.5 tons/ft³
	0.0	72	38-40	CH	100	CLAY - grey w/ some tan, no odor, very firm, mod. plasticity 3.5 tons/ft³

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Client: Tolunay-Wong Engineers, Trans-Global Solutior		Project No. TWEI21001	Boring No. \ Well No. MB-1
Project Name: Cedar Port Pre-Dredge 2021			Sheet 2 of 2
Water Depth	Target/Total Depth	GPS Coordinates	Logged By
Drilling Methods \ Auger Size \ Bit Size	Drilling Rig	Driller	Drilling Company
Sampling Method \ Size of Sampler			Drilling Start Date / Time
Comments			Drilling Finish Date / Time

See Pg 1

Field Screening: Depth (feet bgl)	PID (ppm)	Air Temp. (°F)	Lithologic Interval (feet bgl)	Symbol	% Recovery	Description of Lithology
	0.0	72	43-45	CL	70	CLAY - very gravelly, grey to brown, firm, low plasticity, no odor, some shells 3.5 tons/ft³
	0.0	72	48-50	CL	100	CLAY - STA
						★ Sample times:
						1210 MB-1-SED
						1210 MB-1-ELUT-SED
					3.17.21	17:10 MB-1-WAT
					3.17.21	17:10 MB-1-ELUT-WAT

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Client: Tolunay-Wong Engineers, Trans-Global Solutior	Project No. TWEI21001	Boring No. \ Well No. MB-5
Project Name: Cedar Port Pre-Dredge 2021		Sheet 1 of 1
Water Depth: 8' / Target/Total Depth: -58' (H2O→TD)	GPS Coordinates: 29.68635, -94.96086	Logged By: James Reis
Drilling Methods \ Auger Size \ Bit Size: 4" Wash Bit	Drilling Rig: SINCO 2500 / Driller: S. Hernandez	Drilling Company: TWE
Sampling Method \ Size of Sampler: 3" Shelby Tube / 2" Split Spoon		Drilling Start Date / Time: 3.16.21 1235
Comments		Drilling Finish Date / Time: 3.16.21 1540

Depth (feet bgl)	PID (ppm)	Air Temp. (°F)	Lithologic Interval (feet bgl)	Symbol	% Recovery	Description of Lithology
	Field Screening					
	0.0	72	0-2	CL	100	SANDY CLAY - Soft, gray, no odor, mod. plasticity
	0.0	72	3-5	CL	100	SANDY CLAY - gray, soft, no odor, mod. plasticity, transitions to fat clay @ 4.0'
	0.0	72	6-8	CL	100	SANDY CLAY - STA, sulfide odor
	0.0	73	9-11	CH	100	CLAY - w/ sand lenses, grey, no odor, fat
	0.0	73	12-14	CL	100	CLAY - STA
	0.0	73	15-17	CL	100	CLAY - STA
	0.0	73	18-20	CL	100	CLAY - STA, 2-3" of shell fill material @ top then into the fat clays
			23-25	* JR		
	0.0	73	~~21-23~~	CL	100	CLAY - STA
			~~25~~			
	0.0	74	28-30	CL	100	CLAY - STA
	0.0	74	33-35	CL	100	CLAY - STA
	0.0	74	38-40	CL	100	CLAY - Sand & shell inclusions, fines present
	0.0	74	43-45	CL	100	SANDY SILTY CLAY - no odor, low plasticity, soft
	0.0	75	48-50	CL	100	CLAY - transitions to clayey sand @ 49'

*Sample times: 1530 MB-5-SED
1530 MB-5-ELUT-SED
3.17.21 16:45 MB-5-ELUT-WAT

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Client: Tolunay-Wong Engineers, Trans-Global Solutior		Project No. TWEI21001	Boring No. \ Well No. MB-7
Project Name: Cedar Port Pre-Dredge 2021			Sheet 1 of 2
Water Depth 7'	Target/Total Depth 57' (H2O→TD)	GPS Coordinates 29.68092, -94.94906	Logged By James Reis
Drilling Methods \ Auger Size \ Bit Size ~~Shelby~~ 4" Wash Bin	Drilling Rig SIMCO 2500	Driller H. Willoughby	Drilling Company TWE
Sampling Method \ Size of Sampler 3" Shelby Tube / 2" Split Spoon			Drilling Start Date / Time 3.17.21 0905
Comments			Drilling Finish Date / Time 3.17.21 1140

Depth (feet bgl)	PID (ppm)	Air Temp. (°F)	Lithologic Interval (feet bgl)	Symbol	% Recovery	Description of Lithology
	0.0	72	0-6"	CL	100	CLAY - mod. plasticity, sand inclusions, grey, sulfide odor
	1.9	72	6"-2'	SC	100	CLAYEY SAND - low plasticity, grey, soft, shell inclusions, sulfide odor
	0.0	72	3-5	SC	100	CLAY SAND - STA
	0.0	73	6-8	CL	60	SILTY CLAY - mod. plasticity, soft, shell inclusions, no odor
	0.0	73	9-11	CL	50	CLAY - light brown, firm, mod. plasticity
	0.0	73	12-14	CL	100	CLAY - light brown, very firm, mod. plasticity, grey/reddish brown inclusions (redox) 2.75 tons/ft³
	0.0	73	15-17	CH	70	CLAY - Dark reddish brown (redox), very firm, high plasticity, no odor, transitions to greyish yellow @ bottom. 2.75 tons/ft³
	0.0	73	18-20	CL	100	CLAY - gray, very firm, high to mod. plasticity, small black inclusions. 2.0 tons/ft³
	0.0	73	~~21-23~~ 23-25	~~CL~~	80	CLAY - STA, crumbly 2.5 tons/ft³
	0.0	73	28-30	CL	70	CLAY - dark greenish gray, damp, low plasticity, crumbly, no odor

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Client: Tolunay-Wong Engineers, Trans-Global Solutior	Project No. TWEI21001	Boring No. \ Well No. MB-7
Project Name: Cedar Port Pre-Dredge 2021		Sheet 2 of 2
Water Depth	Target/Total Depth	GPS Coordinates	Logged By
Drilling Methods \ Auger Size \ Bit Size	Drilling Rig	Driller	Drilling Company
Sampling Method \ Size of Sampler		Drilling Start Date / Time
Comments		Drilling Finish Date / Time

See Page 1

Depth (feet bgl)	PID (ppm)	Air Temp. (°F)	Lithologic Interval (feet bgl)	Symbol	% Recovery	Description of Lithology
	0.0	73	33-35	CL	60	CLAY - light to dark gray, low plasticity, no odor, crumbly
	0.0	73	38-40	SS	95	SAND - gray, saturated, no odor, clayey sand until 39' into sand
	0.0	73	43-45	SS	40	SAND - w/ some clay, gray, firm, no odor
	0.0	73	48-50	SS	40	SAND - STA

* Sample times:
1150 MB-7-SED
0900 MB-7-WAT

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DiSorbo Consulting, LLC 1001 Louisiana Street, Suite 3250 | Houston, Texas 77002 713.955.1230 www.disorboconsult.com

Client: Tolunay-Wong Engineers, Trans-Global Solutior		Project No. TWEI21001	Boring No. \ Well No. MB-9
Project Name: Cedar Port Pre-Dredge 2021			Sheet 1 of 1
Water Depth: 10'4"	Target/Total Depth: 60'4" (H20->TD)	GPS Coordinates: 29.67444, -94.93785	Logged By: James Reis
Drilling Methods \ Auger Size \ Bit Size: 4" Wash Bm	Drilling Rig: SIMCO 2500	Driller: H. Willoughby	Drilling Company: TWE
Sampling Method \ Size of Sampler: 3" Shelby Tube / 2" Split Spoon			Drilling Start Date / Time: 3.17.21 1300
Comments:			Drilling Finish Date / Time: 3.17.21 1500

Depth (feet bgl)	Field Screening: PID (ppm)	Field Screening: Air Temp. (°F)	Lithologic Interval (feet bgl)	Symbol	% Recovery	Description of Lithology
	0.0	61	0-2	CH	30	CLAY - unconsolidated, dark gray, no odor
	0.0	61	3-5	CH	100	CLAY - gray, soft, no odor
	0.0	62	6-8	CH	65	CLAY - STA, more firm
	0.0	63	9-11	CH	50	CLAY - STA
	0.0	63	12-14	CH	50	CLAY - reddish brown w/ gray inclusions, shells, crumbly, stiff, no odor.
	0.0	63	15-17	CH	100	CLAY - STA
	0.0	63	18-20	CH	70	CLAY - STA
	0.0	70	23-25	CH	75	CLAY - STA, w/ more gray/gley
	0.0	70	28-30	CH	100	CLAY - STA
	0.0	71	33-35	CH	100	CLAY - Gley, some gravel, no odor, stiff, crumbly 2.0 tons/ft^3
	0.0	73	38-40	SM	30	SAND - gray, no odor, moist
	0.0	73	43-45	SM	60	SAND - STA
	0.0	73	48-50	SP	50	SAND - coarse, ~~F~~.
						* Sample time:
						15:20 MB-9-SED

13:20 MB-9-ELUT-SED
13:00 MB-9-ELUT-WAT

Appendix D
Chain of Custody Forms

The Chain of Custody is a Legal Document

Job ID: 21031513

TAT: 5 Days PM: Scarpenter

A&B

10100 East Freeway (I-10)
Houston, TX 77029

1. REPORT TO:
Company: DiSorbo Consulting
Address: 8501 N. MoPac, Ste. 300
Austin, TX 78759
Contact: Bob Davis
Phone: 512-970-9639
Email: bdavis@disorboconsult.com
CC:
CC:

2. INVOICE TO:
Company: DiSorbo Consulting
Address: 1010 Travis St., Ste 916
Houston, TX 77702
Contact: Accounts Payable
Phone: 713-955-1227
Email:
CC:
CC:

3. PO# / Qt210301205

4. Turnaround Time- Business Days
☐ 1 Day * ☑ 5 Days
☐ 2 Days * ☐ 7 Days
☐ 3 Days * ☐ Other ____
* Surcharge Applies

Day Zero is the day sample is received. Report due at 5pm on due day.

5. Project #

6. Project Name / Location
Cedar Port Pre-Dredge Sampling

7. Reporting Requirement
☐ TRRP Limits ☐ TRRP Rpt. Package ☐ Std Level II ☑ MDL Report ☐ EDD

8. Sampler's Name & Company: James Reis, DiSorbo
Sampler's Signature & Date: [signature] 3.17.21

Water List

9. Sample ID & Description	Lab Use Only	10. Sampling Date	Time	11. comp	grab	12. Matrix GW	Water	Soil	Sludge	Oil	13. TOTAL No. of Containers	NH3 (<0.03 RL), TOC	Salinity	Metals Dissolved ICPMS (ug/L)	Hg (ug/L)	TPH 1005	SVOC, SVOC SIM (ug/L)	PCBs	Pesticides	VOC	18. Comments
No. Containers												1	1	1	1	3	5	3	3	3	
14. Containers*												P	P	P	P	VOA	A/G	A/G	A/G	VOA	
15. Preservatives**																					
MB - 1 - WAT		3.17.21	1710		X		X				21	X	X	X	X	X	X	X	X	X	
MB - 1 - ELUT - WATER PART		↓	1716		↓		X				20	X		X	X	X	X	X	X	X	Comp w/SED PART
MB - 7 - WAT			0900				X				21	X	X	X	X	X	X	X	X	X	
MB - 9 - ELUT - WATER PART			1300				X				20	X		X	X	X	X	X	X	X	Comp w/SED PART
MB - EQB - WAT			1750				X				20	X		X	X	X	X	X	X	X	
MB - TRIP - WAT			1155				X				2			X	X						
MB-5 - ELUT - WATER PA		↓	1645		↓																

19. RELINQUISHED BY	DATE	TIME	20. RECEIVED BY	DATE	TIME	KNOWN HAZARDS / COMMENTS:
James Reis, DiSorbo	3-17-21	19:00	[signature]	3-17-21	1900	
						7.6°C [initials]

* Containers: VOA- 40 ml vial; 4 oz/8 oz- glass wide mouth; A/G- Amber/Glass 1 Liter; P/O- Plastic/other ____

Preservatives: C-Cool H- HCl N- HNO3 S-H2SO4 OH- NaOH T-Na2S2O3 X- Other ZnAcetate

Temperature: ____
Intact? ☑ Y ☐ N
Initials ____

BILL OF LADING/TRACKING #

METHOD OF SHIPMENT

Samples will be disposed of after 30 days. A&B reserves the right to return samples.

A&B CANNOT ACCEPT VERBAL CHANGES. PLEASE FAX WRITTEN CHANGES TO 713-453-6091 OR EMAIL THE NEW COC TO YOUR PROJECT MANAGER.

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The Chain of Custody is a Legal Document

Job ID: 21031513
TAT: 5 Days PM: Scarpenter

10100 East Freeway (I-10)
Houston, TX 77029

1. REPORT TO:	2. INVOICE TO:
Company: DiSorbo Consulting	Company: DiSorbo Consulting
Address: 8501 N. MoPac, Ste. 300, Austin, TX 78759	Address: 1010 Travis St., Ste 916, Houston, TX 77702
Contact: Bob Davis	Contact: Accounts Payable
Phone: 512-970-9639	Phone: 713-955-1227
Email:bdavis@disorboconsult.com	Email:
CC:	CC:
CC:	CC:

3.PO# / Qt210301205

4. Turnaround Time- Business Days
- ☐ 1 Day *
- ☐ 2 Days *
- ☐ 3 Days *
- ☑ 5 Days
- ☐ 7 Days
- ☐ Other ____

* Surcharge Applies

Day Zero is the day sample is received. Report due at 5pm on due day.

5. Project #

6. Project Name / Location
Cedar Port Pre-Dredge Sampling

7. Reporting Requirement
☐ TRRP Limits ☐ TRRP Rpt. Packag ☐ Std Level II ☑ MDL Report ☐ EDD

8. Sampler's Name & Company: James Reis, DiSorbo
Sampler's Signature & Date: [signature] 3.17.21

9. Sample ID & Description	Lab Use Only	10. Sampling Date	Time	11. comp	grab	12. Matrix GW	Water	Soil	Sludge	Oil	other	13. TOTAL No. of Containers	TOC_Sub	%Moisture, Particle Size_Sub	%Moisture, NH3 (<0.1 RL), Hg, Metals ICPMS, Pest, PCB (<1 RL), TPH SVOC, SVOC SIM (ug/Kg)	VOCs	RCI			18. Comments
No. Containers													1	1	4					
14. Containers*													G	G	G					
15. Preservatives**													C	C	C					Soil List
~~MB - 1 - SED~~ JR								X				6	X	X	X	X	X			
MB - 7 - SED		3-17-21	11:50	x				X				6	X	X	X	X	X			
MB - 9 - SED		3-17-21	15:20	x				X				6	X	X	X	X	X			
~~MB - 1 - ELUT - SED PART~~ JR								X				6	X	X	X	X				Lab to composite ELUT WTR and ELUT SED
MB - 9 - ELUT - SED PART		3-17-21	15:20	x				X				6	X	X	X	X				Lab to composite ELUT WTR and ELUT SED

19. RELINQUISHED BY	DATE	TIME	20. RECEIVED BY	DATE	TIME
James Reis, DiSorbo	3.17.21	19:00	[signature]	3-17-21	1900

KNOWN HAZARDS / COMMENTS:
1.6 °C 10 MM/23 [illegible]

* Containers: **VOA**- 40 ml vial **A/G**- Amber/Glass 1 Liter
4 oz/8 oz- glass wide mouth **P/O**- Plastic/other ________

Preservatives: **C**-Cool **H**- HCl **N**- HNO3
S-H2SO4 **OH**- NaOH **T**-Na2S2O3 **X**- Other *ZnAcetate*

Temperature: ____
Intact? ☐ Y ☐ N
Initials ________

BILL OF LADING/TRACKING #
METHOD OF SHIPMENT

A&B CANNOT ACCEPT VERBAL CHANGES. PLEASE FAX WRITTEN CHANGES TO 713-453-6091 OR EMAIL THE NEW COC TO YOUR PROJECT MANAGER.

Samples will be disposed of after 30 days. A&B reserves the right to return samples.

Appendix E

Laboratory Reports

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Laboratory Analysis Report

Total Number of Pages: 99

Job ID : 21031513

10100 East Freeway, Suite 100, Houston, TX 77029 tel: 713-453-6060, fax: 713-453-6091, http://www.ablabs.com

Client Project Name :
Cedar Port Pre-Dredge Sampling

Report To :	Client Name:	DiSorbo Consulting LLC	P.O.#.:
	Attn:	Bob Davis	Sample Collected By: James Reis
	Client Address:	8501 N. MoPac Expressway, Ste. 300	Date Collected: 03/16/21 - 03/17/21
	City, State, Zip:	Austin, Texas, 78759	

A&B Labs has analyzed the following samples...

Client Sample ID	Matrix	A&B Sample ID
MB-1-WAT	Water	21031513.01
MB-7-WAT	Water	21031513.03
MB-EQB-WAT	Water	21031513.05
MB-Trip-WAT	Water	21031513.06
MB-7-SED	Soil	21031513.08
MB-9-SED	Soil	21031513.09
MB-1-SED	Soil	21031513.11
MB-5-SED	Soil	21031513.13
MB-1-ELUT-WAT & SED Composite	Water	21031513.15
MB-5-ELUT-WAT & SED Composite	Water	21031513.16
MB-9-ELUT-WAT & SED Composite	Water	21031513.17

Released By: Shantall Carpenter
Title: Senior Project Manager
Date: 3/30/2021

This Laboratory is NELAP (T104704213) accredited. Effective: 04/01/2020; Expires: 3/31/2021
Scope: Non-Potable Water, Drinking Water, Air, Solid, Biological Tissue, Hazardous Waste

I am the laboratory manager, or his/her designee, and I am responsible for the release of this data package. This laboratory data package has been reviewed and is complete and technically compliant with the requirements of the methods used, except where noted in the attached exception reports. I affirm, to the best of my knowledge that all problems/anomalies observed by this laboratory (and if applicable, any and all laboratories subcontracted through this laboratory) that might affect the quality of the data, have been identified in the Laboratory Review Checklist, and that no information or data have been knowingly withheld that would affect the quality of the data.

Date Received : 03/16/2021 17:15

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Job ID : 21031513

Date: 3/30/2021

General Term Definition

Back-Wt	Back Weight	Post-Wt	Post Weight
BRL	Below Reporting Limit	ppm	parts per million
cfu	colony-forming units	Pre-Wt	Previous Weight
Conc.	Concentration	Q	Qualifier
D.F.	Dilution Factor	RegLimit	Regulatory Limit
Front-Wt	Front Weight	RPD	Relative Percent Difference
LCS	Laboratory Check Standard	RptLimit	Reporting Limit
LCSD	Laboratory Check Standard Duplicate	SDL	Sample Detection Limit
MS	Matrix Spike	surr	Surrogate
MSD	Matrix Spike Duplicate	T	Time
MW	Molecular Weight	TNTC	Too numerous to count
J	Estimation. Below calibration range but above MDL		

Qualifier Definition

D1	Sample required dilution due to matrix effects.
L1	Associated LCS and/or LCSD recovery is above acceptance limits for flagged analyte. Bias may be high.
L2	Associated LCS and/or LCSD recovery is below acceptance limits for flagged analyte. Bias may be low.
LO	Low level quantitation check does not meet recovery acceptance criteria.
M1	Matrix Spike and/or Matrix Spike Duplicate recovery is above laboratory control limits due to matrix interference.
M2	Matrix Spike and/or Matrix Spike Duplicate recovery is below laboratory control limits due to matrix interference."The sample randomly selected as QC for this batch was not part of your project. Therefore, this sample matrix is not applicable to your project samples."
S2	Surrogate recovery is below control limit. Results may be biased low.
V1	CCV recovery is above acceptance limits. This target analyte was not detected in the sample.
V11	CCV recovery is below acceptance limits.

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-1-WAT	Job Sample ID:	21031513.01
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	17:10	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SM 2520B	Salinity (Electrical Conductivity Method)								
	Salinity²	11.3	s.u.	1	0.52	2		03/23/21 16:00	LEB
SM 4500NH3D									
	Ammonia as N	0.05	mg/L	1		0.01		03/22/21 13:37	SG
SM 5310B	Total Organic Carbon								
	TOC	4.4	mg/L	1	0.35	1		03/22/21 13:00	AJ
EPA 200.8	Dissolved Metals								
	Antimony	2.09	ug/L	2.5	0.500	0.625		03/22/21 21:15	GG
	Arsenic	2.62	ug/L	2.5	0.250	0.625		03/22/21 21:15	GG
	Cadmium	< 0.3	ug/L	2.5	0.300	0.625	D1	03/22/21 21:15	GG
	Chromium	0.613	ug/L	2.5	0.300	0.625	J	03/22/21 21:15	GG
	Copper	1.57	ug/L	2.5	1.00	0.625		03/22/21 21:15	GG
	Lead	< 0.3	ug/L	2.5	0.300	0.625	D1	03/22/21 21:15	GG
	Nickel	1.80	ug/L	2.5	0.300	0.625		03/22/21 21:15	GG
	Silver	< 0.5	ug/L	2.5	0.500	0.625	D1	03/22/21 21:15	GG
	Zinc	4.47	ug/L	2.5	2.80	0.625	D1	03/22/21 21:15	GG
EPA 245.1	Total Metals - Mercury								
	Mercury	0.09	ug/L	1	0.0600	0.2	J	03/19/21 12:55	BDC
TX 1005	Total Petroleum Hydrocarbons								
	C6-C12	<0.35	mg/L	1.00	0.35	2.15		03/19/21 17:13	AK
	>C12-C28	<0.37	mg/L	1.00	0.37	2.15		03/19/21 17:13	AK
	>C28-C35	<0.18	mg/L	1.00	0.18	2.15		03/19/21 17:13	AK
	Total C6-C35	<0.18	mg/L	1.00	0.18			03/19/21 17:13	AK
	Chlorooctadecane(surr)	99.8	%	1.00		70-125		03/19/21 17:13	AK
	1-Chlorooctane(surr)	77.9	%	1.00		70-125		03/19/21 17:13	AK
EPA 608.3	Polychlorinated Biphenyls								
	Total PCBs	<0.0129	ug/L	1	0.0129	0.05		03/23/21 22:12	PS
	Decachlorobiphenyl(surr)	51	%	0.25		35-129		03/23/21 22:12	PS
	Tetrachloro-m-xylene(surr)	52	%	0.25		27-127		03/23/21 22:12	PS
EPA 608.3	Organochlorine Pesticides								
	Alpha-chlordane	< 0.002	ug/L	0.25	0.002	0.0025		03/23/21 19:00	PS
	Gamma-chlordane	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:00	PS
	4,4-DDD	< 0.006	ug/L	0.25	0.006	0.0025		03/23/21 19:00	PS
	4,4-DDE	<0.002	ug/L	0.25	0.002	0.0025		03/23/21 19:00	PS
	4,4-DDT	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:00	PS
	a-BHC	< 0.008	ug/L	0.25	0.008	0.0025		03/23/21 19:00	PS
	Aldrin	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:00	PS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-1-WAT	Job Sample ID:	21031513.01
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	17:10	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 608.3	Organochlorine Pesticides								
	b-BHC	< 0.010	ug/L	0.25	0.010	0.0025		03/23/21 19:00	PS
	Chlordane	<0.025	ug/L	0.25		0.025		03/23/21 19:00	PS
	d-BHC	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:00	PS
	Dieldrin	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:00	PS
	Endosulfan I	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:00	PS
	Endosulfan II	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:00	PS
	Endosulfan sulfate	<0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:00	PS
	Endrin	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:00	PS
	Endrin aldehyde	< 0.008	ug/L	0.25	0.008	0.0025		03/23/21 19:00	PS
	Endrin ketone	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:00	PS
	g-BHC	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:00	PS
	Heptachlor	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:00	PS
	Heptachlor epoxide	< 0.002	ug/L	0.25	0.002	0.0025		03/23/21 19:00	PS
	Toxaphene	<0.1	ug/L	0.25	0.1	0.025		03/23/21 19:00	PS
	Tetrachloro-m-xylene(surr)	38.9	%	0.25		24-127		03/23/21 19:00	PS
	Decachlorobiphenyl(surr)	25.6	%	0.25		34-120	S2	03/23/21 19:00	PS
EPA 624.1	Volatile Organic Compounds								
	1,1,1-Trichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	1,1,2,2-Tetrachloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	1,1,2-Trichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	1,1-Dichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	1,1-Dichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	1,2-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	1,2-Dichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	1,3-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	1,4-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	2-Butanone	<0.005	mg/L	1.00	0.005	0.005		03/18/21 16:34	RT
	Benzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Bromodichloromethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Bromoform	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Bromomethane	<0.002	mg/L	1.00	0.002	0.005		03/18/21 16:34	RT
	Carbon tetrachloride	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Chlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Chloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Chloroform	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Chloromethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	cis-1,3-Dichloropropene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC		Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-1-WAT	Job Sample ID:	21031513.01
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	17:10	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 624.1	Volatile Organic Compounds								
	Dibromochloromethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Ethylbenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Methylene chloride	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Tetrachloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Toluene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	trans-1,2-Dichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	trans-1,3-Dichloropropene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Trichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Trichlorofluoromethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Vinyl Chloride	<0.001	mg/L	1.00	0.001	0.005		03/18/21 16:34	RT
	Dibromofluoromethane(surr)	123	%	1.00		70-130		03/18/21 16:34	RT
	1,2-Dichloroethane-d4(surr)	128	%	1.00		70-130		03/18/21 16:34	RT
	Toluene-d8(surr)	98	%	1.00		70-130		03/18/21 16:34	RT
	p-Bromofluorobenzene(surr)	102	%	1.00		70-130		03/18/21 16:34	RT
EPA 625.1	Semivolatile Organic Compounds								
	1,2,4-Trichlorobenzene	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 18:20	MS
	1,2-Dichlorobenzene	< 0.41	ug/L	0.25	0.410	1.25		03/22/21 18:20	MS
	1,3-Dichlorobenzene	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 18:20	MS
	1,4-Dichlorobenzene	< 0.25	ug/L	0.25	0.250	1.25		03/22/21 18:20	MS
	2,4-Dichlorophenol	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 18:20	MS
	2,4-Dimethylphenol	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 18:20	MS
	2,4-Dinitrophenol	< 1.41	ug/L	0.25	1.41	1.25		03/22/21 18:20	MS
	Acenaphthene	< 0.28	ug/L	0.25	0.280	1.25		03/22/21 18:20	MS
	Acenaphthylene	< 0.47	ug/L	0.25	0.470	1.25		03/22/21 18:20	MS
	Anthracene	< 0.35	ug/L	0.25	0.350	1.25		03/22/21 18:20	MS
	Benzo(a)anthracene	< 0.38	ug/L	0.25	0.380	1.25		03/22/21 18:20	MS
	Benzo(a)pyrene	< 0.85	ug/L	0.25	0.850	1.25		03/22/21 18:20	MS
	Benzo(b)fluoranthene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 18:20	MS
	Benzo(g,h,i)perylene	< 0.63	ug/L	0.25	0.630	1.25		03/22/21 18:20	MS
	Benzo(k)fluoranthene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 18:20	MS
	Chrysene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 18:20	MS
	Dibenzo(a,h)anthracene	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 18:20	MS
	Diethyl phthalate	< 0.63	ug/L	0.25	0.630	1.25		03/22/21 18:20	MS
	Fluoranthene	< 0.44	ug/L	0.25	0.440	1.25		03/22/21 18:20	MS
	Fluorene	< 0.47	ug/L	0.25	0.470	1.25		03/22/21 18:20	MS
	Hexachlorobenzene	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 18:20	MS
	Indeno(1,2,3-cd)pyrene	< 0.22	ug/L	0.25	0.220	1.25		03/22/21 18:20	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-1-WAT	Job Sample ID:	21031513.01
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	17:10	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 625.1	Semivolatile Organic Compounds								
	Naphthalene	< 0.31	ug/L	0.25	0.310	1.25		03/22/21 18:20	MS
	Pentachlorophenol	< 0.5	ug/L	0.25	0.500	1.25		03/22/21 18:20	MS
	Phenanthrene	< 0.44	ug/L	0.25	0.440	1.25		03/22/21 18:20	MS
	Phenol	< 0.44	ug/L	0.25	0.440	1.25	L2	03/22/21 18:20	MS
	Pyrene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 18:20	MS
	2-Fluorophenol(surr)	28.5	%	0.25		15-115		03/22/21 18:20	MS
	Phenol-d6(surr)	21	%	0.25		10-130		03/22/21 18:20	MS
	Nitrobenzene-d5(surr)	61.1	%	0.25		23-120		03/22/21 18:20	MS
	2-Fluorobiphenyl(surr)	56.3	%	0.25		30-115		03/22/21 18:20	MS
	2,4,6-Tribromophenol(surr)	42.3	%	0.25		19-122		03/22/21 18:20	MS
	p-Terphenyl-d14(surr)	55	%	0.25		18-137		03/22/21 18:20	MS
EPA 625.1	Selected Ion Monitoring								
	Benzo(a)pyrene	< 0.025	ug/L	0.25	0.1	0.025		03/22/21 19:31	MS
	Chrysene	< 0.025	ug/L	0.25	0.1	0.025		03/22/21 19:31	MS
	2,4,6-Tribromophenol(surr)	41.4	%	0.25		19-122		03/22/21 19:31	MS
	2-Fluorobiphenyl(surr)	41.9	%	0.25		30-115		03/22/21 19:31	MS
	2-Fluorophenol(surr)	26.8	%	0.25		15-115		03/22/21 19:31	MS
	Nitrobenzene-d5(surr)	54.2	%	0.25		23-120		03/22/21 19:31	MS
	Phenol-d6(surr)	19.4	%	0.25		10-130		03/22/21 19:31	MS
	p-Terphenyl-d14(surr)	50.7	%	0.25		18-137		03/22/21 19:31	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-7-WAT	Job Sample ID:	21031513.03
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	09:00	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SM 2520B	Salinity (Electrical Conductivity Method)								
	Salinity²	8.6	s.u.	1	0.52	2		03/23/21 16:00	LEB
SM 4500NH3D									
	Ammonia as N	0.07	mg/L	1		0.01		03/22/21 13:37	SG
SM 5310B	Total Organic Carbon								
	TOC	4.7	mg/L	1	0.35	1		03/22/21 13:00	AJ
EPA 200.8	Dissolved Metals								
	Antimony	1.48	ug/L	2.5	0.500	0.625		03/22/21 21:35	GG
	Arsenic	2.38	ug/L	2.5	0.250	0.625		03/22/21 21:35	GG
	Cadmium	< 0.3	ug/L	2.5	0.300	0.625	D1	03/22/21 21:35	GG
	Chromium	< 0.3	ug/L	2.5	0.300	0.625	D1	03/22/21 21:35	GG
	Copper	1.19	ug/L	2.5	1.00	0.625	D1	03/22/21 21:35	GG
	Lead	< 0.3	ug/L	2.5	0.300	0.625	D1	03/22/21 21:35	GG
	Nickel	1.75	ug/L	2.5	0.300	0.625		03/22/21 21:35	GG
	Silver	< 0.5	ug/L	2.5	0.500	0.625	D1	03/22/21 21:35	GG
	Zinc	4.23	ug/L	2.5	2.80	0.625	D1	03/22/21 21:35	GG
EPA 245.1	Total Metals - Mercury								
	Mercury	< 0.06	ug/L	1	0.0600	0.2		03/19/21 12:58	BDC
TX 1005	Total Petroleum Hydrocarbons								
	C6-C12	<0.35	mg/L	1.00	0.35	2.15		03/19/21 18:40	AK
	>C12-C28	<0.37	mg/L	1.00	0.37	2.15		03/19/21 18:40	AK
	>C28-C35	<0.18	mg/L	1.00	0.18	2.15		03/19/21 18:40	AK
	Total C6-C35	<0.18	mg/L	1.00	0.18			03/19/21 18:40	AK
	Chlorooctadecane(surr)	94.4	%	1.00		70-125		03/19/21 18:40	AK
	1-Chlorooctane(surr)	82	%	1.00		70-125		03/19/21 18:40	AK
EPA 608.3	Polychlorinated Biphenyls								
	Total PCBs	<0.0129	ug/L	1	0.0129	0.05		03/23/21 22:26	PS
	Decachlorobiphenyl(surr)	45	%	0.25		35-129		03/23/21 22:26	PS
	Tetrachloro-m-xylene(surr)	58	%	0.25		27-127		03/23/21 22:26	PS
EPA 608.3	Organochlorine Pesticides								
	Alpha-chlordane	< 0.002	ug/L	0.25	0.002	0.0025		03/23/21 19:14	PS
	Gamma-chlordane	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:14	PS
	4,4-DDD	< 0.006	ug/L	0.25	0.006	0.0025		03/23/21 19:14	PS
	4,4-DDE	<0.002	ug/L	0.25	0.002	0.0025		03/23/21 19:14	PS
	4,4-DDT	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:14	PS
	a-BHC	< 0.008	ug/L	0.25	0.008	0.0025		03/23/21 19:14	PS
	Aldrin	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:14	PS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name: DiSorbo Consulting LLC   Attn: Bob Davis

Project Name: Cedar Port Pre-Dredge Sampling

Client Sample ID:	MB-7-WAT	Job Sample ID:	21031513.03
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	09:00	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 608.3	Organochlorine Pesticides								
	b-BHC	< 0.010	ug/L	0.25	0.010	0.0025		03/23/21 19:14	PS
	Chlordane	<0.025	ug/L	0.25		0.025		03/23/21 19:14	PS
	d-BHC	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:14	PS
	Dieldrin	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:14	PS
	Endosulfan I	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:14	PS
	Endosulfan II	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:14	PS
	Endosulfan sulfate	<0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:14	PS
	Endrin	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:14	PS
	Endrin aldehyde	< 0.008	ug/L	0.25	0.008	0.0025		03/23/21 19:14	PS
	Endrin ketone	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:14	PS
	g-BHC	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:14	PS
	Heptachlor	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:14	PS
	Heptachlor epoxide	< 0.002	ug/L	0.25	0.002	0.0025		03/23/21 19:14	PS
	Toxaphene	<0.1	ug/L	0.25	0.1	0.025		03/23/21 19:14	PS
	Tetrachloro-m-xylene(surr)	46.3	%	0.25		24-127		03/23/21 19:14	PS
	Decachlorobiphenyl(surr)	25	%	0.25		34-120	S2	03/23/21 19:14	PS
EPA 624.1	Volatile Organic Compounds								
	1,1,1-Trichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	1,1,2,2-Tetrachloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	1,1,2-Trichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	1,1-Dichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	1,1-Dichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	1,2-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	1,2-Dichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	1,3-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	1,4-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	2-Butanone	<0.005	mg/L	1.00	0.005	0.005		03/18/21 17:37	RT
	Benzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Bromodichloromethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Bromoform	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Bromomethane	<0.002	mg/L	1.00	0.002	0.005		03/18/21 17:37	RT
	Carbon tetrachloride	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Chlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Chloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Chloroform	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Chloromethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	cis-1,3-Dichloropropene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-7-WAT	Job Sample ID:	21031513.03
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	09:00	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 624.1	Volatile Organic Compounds								
	Dibromochloromethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Ethylbenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Methylene chloride	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Tetrachloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Toluene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	trans-1,2-Dichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	trans-1,3-Dichloropropene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Trichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Trichlorofluoromethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Vinyl Chloride	<0.001	mg/L	1.00	0.001	0.005		03/18/21 17:37	RT
	Dibromofluoromethane(surr)	119	%	1.00		70-130		03/18/21 17:37	RT
	1,2-Dichloroethane-d4(surr)	129	%	1.00		70-130		03/18/21 17:37	RT
	Toluene-d8(surr)	98.1	%	1.00		70-130		03/18/21 17:37	RT
	p-Bromofluorobenzene(surr)	102	%	1.00		70-130		03/18/21 17:37	RT
EPA 625.1	Semivolatile Organic Compounds								
	1,2,4-Trichlorobenzene	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 19:21	MS
	1,2-Dichlorobenzene	< 0.41	ug/L	0.25	0.410	1.25		03/22/21 19:21	MS
	1,3-Dichlorobenzene	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 19:21	MS
	1,4-Dichlorobenzene	< 0.25	ug/L	0.25	0.250	1.25		03/22/21 19:21	MS
	2,4-Dichlorophenol	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 19:21	MS
	2,4-Dimethylphenol	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 19:21	MS
	2,4-Dinitrophenol	< 1.41	ug/L	0.25	1.41	1.25		03/22/21 19:21	MS
	Acenaphthene	< 0.28	ug/L	0.25	0.280	1.25		03/22/21 19:21	MS
	Acenaphthylene	< 0.47	ug/L	0.25	0.470	1.25		03/22/21 19:21	MS
	Anthracene	< 0.35	ug/L	0.25	0.350	1.25		03/22/21 19:21	MS
	Benzo(a)anthracene	< 0.38	ug/L	0.25	0.380	1.25		03/22/21 19:21	MS
	Benzo(a)pyrene	< 0.85	ug/L	0.25	0.850	1.25		03/22/21 19:21	MS
	Benzo(b)fluoranthene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 19:21	MS
	Benzo(g,h,i)perylene	< 0.63	ug/L	0.25	0.630	1.25		03/22/21 19:21	MS
	Benzo(k)fluoranthene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 19:21	MS
	Chrysene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 19:21	MS
	Dibenzo(a,h)anthracene	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 19:21	MS
	Diethyl phthalate	< 0.63	ug/L	0.25	0.630	1.25		03/22/21 19:21	MS
	Fluoranthene	< 0.44	ug/L	0.25	0.440	1.25		03/22/21 19:21	MS
	Fluorene	< 0.47	ug/L	0.25	0.470	1.25		03/22/21 19:21	MS
	Hexachlorobenzene	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 19:21	MS
	Indeno(1,2,3-cd)pyrene	< 0.22	ug/L	0.25	0.220	1.25		03/22/21 19:21	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-7-WAT	Job Sample ID:	21031513.03
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	09:00	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 625.1	Semivolatile Organic Compounds								
	Naphthalene	< 0.31	ug/L	0.25	0.310	1.25		03/22/21 19:21	MS
	Pentachlorophenol	< 0.5	ug/L	0.25	0.500	1.25		03/22/21 19:21	MS
	Phenanthrene	< 0.44	ug/L	0.25	0.440	1.25		03/22/21 19:21	MS
	Phenol	< 0.44	ug/L	0.25	0.440	1.25	L2	03/22/21 19:21	MS
	Pyrene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 19:21	MS
	2-Fluorophenol(surr)	30.2	%	0.25		15-115		03/22/21 19:21	MS
	Phenol-d6(surr)	21.6	%	0.25		10-130		03/22/21 19:21	MS
	Nitrobenzene-d5(surr)	63.8	%	0.25		23-120		03/22/21 19:21	MS
	2-Fluorobiphenyl(surr)	58.4	%	0.25		30-115		03/22/21 19:21	MS
	2,4,6-Tribromophenol(surr)	40.5	%	0.25		19-122		03/22/21 19:21	MS
	p-Terphenyl-d14(surr)	52.8	%	0.25		18-137		03/22/21 19:21	MS
EPA 625.1	Selected Ion Monitoring								
	Benzo(a)pyrene	< 0.025	ug/L	0.25	0.1	0.025		03/22/21 20:01	MS
	Chrysene	< 0.025	ug/L	0.25	0.1	0.025		03/22/21 20:01	MS
	2,4,6-Tribromophenol(surr)	41	%	0.25		19-122		03/22/21 20:01	MS
	2-Fluorobiphenyl(surr)	44.9	%	0.25		30-115		03/22/21 20:01	MS
	2-Fluorophenol(surr)	28.1	%	0.25		15-115		03/22/21 20:01	MS
	Nitrobenzene-d5(surr)	56.7	%	0.25		23-120		03/22/21 20:01	MS
	Phenol-d6(surr)	20	%	0.25		10-130		03/22/21 20:01	MS
	p-Terphenyl-d14(surr)	48.3	%	0.25		18-137		03/22/21 20:01	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-EQB-WAT	Job Sample ID:	21031513.05
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	17:50	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SM 4500NH3D									
	Ammonia as N	<0.01	mg/L	1		0.01		03/22/21 13:37	SG
SM 5310B	Total Organic Carbon								
	TOC	<0.35	mg/L	1	0.35	1		03/22/21 13:00	AJ
EPA 200.8	Dissolved Metals								
	Antimony	< 0.2	ug/L	1	0.200	0.25		03/22/21 20:39	GG
	Arsenic	0.443	ug/L	1	0.100	0.25		03/22/21 20:39	GG
	Cadmium	< 0.1	ug/L	1	0.100	0.25		03/22/21 20:39	GG
	Chromium	< 0.1	ug/L	1	0.100	0.25		03/22/21 20:39	GG
	Copper	< 0.4	ug/L	1	0.400	0.25		03/22/21 20:39	GG
	Lead	< 0.1	ug/L	1	0.100	0.25		03/22/21 20:39	GG
	Nickel	< 0.1	ug/L	1	0.100	0.25		03/22/21 20:39	GG
	Silver	< 0.2	ug/L	1	0.200	0.25		03/22/21 20:39	GG
	Zinc	5.16	ug/L	1	1.10	0.25		03/22/21 20:39	GG
EPA 245.1	Total Metals - Mercury								
	Mercury	< 0.06	ug/L	1	0.0600	0.2		03/19/21 13:02	BDC
TX 1005	Total Petroleum Hydrocarbons								
	C6-C12	<0.35	mg/L	1.00	0.35	2.15		03/19/21 19:38	AK
	>C12-C28	<0.37	mg/L	1.00	0.37	2.15		03/19/21 19:38	AK
	>C28-C35	<0.18	mg/L	1.00	0.18	2.15		03/19/21 19:38	AK
	Total C6-C35	<0.18	mg/L	1.00	0.18			03/19/21 19:38	AK
	Chlorooctadecane(surr)	98.3	%	1.00		70-125		03/19/21 19:38	AK
	1-Chlorooctane(surr)	90	%	1.00		70-125		03/19/21 19:38	AK
EPA 608.3	Polychlorinated Biphenyls								
	Total PCBs	<0.0129	ug/L	1	0.0129	0.05		03/23/21 22:54	PS
	Decachlorobiphenyl(surr)	51	%	0.25		35-129		03/23/21 22:54	PS
	Tetrachloro-m-xylene(surr)	66	%	0.25		27-127		03/23/21 22:54	PS
EPA 608.3	Organochlorine Pesticides								
	Alpha-chlordane	< 0.002	ug/L	0.25	0.002	0.0025		03/23/21 19:27	PS
	Gamma-chlordane	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:27	PS
	4,4-DDD	< 0.006	ug/L	0.25	0.006	0.0025		03/23/21 19:27	PS
	4,4-DDE	<0.002	ug/L	0.25	0.002	0.0025		03/23/21 19:27	PS
	4,4-DDT	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:27	PS
	a-BHC	< 0.008	ug/L	0.25	0.008	0.0025		03/23/21 19:27	PS
	Aldrin	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:27	PS
	b-BHC	< 0.010	ug/L	0.25	0.010	0.0025		03/23/21 19:27	PS
	Chlordane	<0.025	ug/L	0.25		0.025		03/23/21 19:27	PS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-EQB-WAT	Job Sample ID:	21031513.05
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	17:50	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 608.3	Organochlorine Pesticides								
	d-BHC	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:27	PS
	Dieldrin	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:27	PS
	Endosulfan I	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:27	PS
	Endosulfan II	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:27	PS
	Endosulfan sulfate	<0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:27	PS
	Endrin	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:27	PS
	Endrin aldehyde	< 0.008	ug/L	0.25	0.008	0.0025		03/23/21 19:27	PS
	Endrin ketone	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:27	PS
	g-BHC	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:27	PS
	Heptachlor	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:27	PS
	Heptachlor epoxide	< 0.002	ug/L	0.25	0.002	0.0025		03/23/21 19:27	PS
	Toxaphene	<0.1	ug/L	0.25	0.1	0.025		03/23/21 19:27	PS
	Tetrachloro-m-xylene(surr)	49.8	%	0.25		24-127		03/23/21 19:27	PS
	Decachlorobiphenyl(surr)	34.9	%	0.25		34-120		03/23/21 19:27	PS
EPA 624.1	Volatile Organic Compounds								
	1,1,1-Trichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	1,1,2,2-Tetrachloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	1,1,2-Trichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	1,1-Dichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	1,1-Dichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	1,2-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	1,2-Dichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	1,3-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	1,4-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	2-Butanone	<0.005	mg/L	1.00	0.005	0.005		03/18/21 18:39	RT
	Benzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Bromodichloromethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Bromoform	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Bromomethane	<0.002	mg/L	1.00	0.002	0.005		03/18/21 18:39	RT
	Carbon tetrachloride	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Chlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Chloroethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Chloroform	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Chloromethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	cis-1,3-Dichloropropene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Dibromochloromethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Ethylbenzene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-EQB-WAT	Job Sample ID:	21031513.05
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	17:50	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 624.1	Volatile Organic Compounds								
	Methylene chloride	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Tetrachloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Toluene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	trans-1,2-Dichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	trans-1,3-Dichloropropene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Trichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Trichlorofluoromethane	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Vinyl Chloride	<0.001	mg/L	1.00	0.001	0.005		03/18/21 18:39	RT
	Dibromofluoromethane(surr)	125	%	1.00		70-130		03/18/21 18:39	RT
	1,2-Dichloroethane-d4(surr)	129	%	1.00		70-130		03/18/21 18:39	RT
	Toluene-d8(surr)	98.4	%	1.00		70-130		03/18/21 18:39	RT
	p-Bromofluorobenzene(surr)	102	%	1.00		70-130		03/18/21 18:39	RT
EPA 625.1	Semivolatile Organic Compounds								
	1,2,4-Trichlorobenzene	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 19:53	MS
	1,2-Dichlorobenzene	< 0.41	ug/L	0.25	0.410	1.25		03/22/21 19:53	MS
	1,3-Dichlorobenzene	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 19:53	MS
	1,4-Dichlorobenzene	< 0.25	ug/L	0.25	0.250	1.25		03/22/21 19:53	MS
	2,4-Dichlorophenol	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 19:53	MS
	2,4-Dimethylphenol	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 19:53	MS
	2,4-Dinitrophenol	< 1.41	ug/L	0.25	1.41	1.25		03/22/21 19:53	MS
	Acenaphthene	< 0.28	ug/L	0.25	0.280	1.25		03/22/21 19:53	MS
	Acenaphthylene	< 0.47	ug/L	0.25	0.470	1.25		03/22/21 19:53	MS
	Anthracene	< 0.35	ug/L	0.25	0.350	1.25		03/22/21 19:53	MS
	Benzo(a)anthracene	< 0.38	ug/L	0.25	0.380	1.25		03/22/21 19:53	MS
	Benzo(a)pyrene	< 0.85	ug/L	0.25	0.850	1.25		03/22/21 19:53	MS
	Benzo(b)fluoranthene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 19:53	MS
	Benzo(g,h,i)perylene	< 0.63	ug/L	0.25	0.630	1.25		03/22/21 19:53	MS
	Benzo(k)fluoranthene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 19:53	MS
	Chrysene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 19:53	MS
	Dibenzo(a,h)anthracene	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 19:53	MS
	Diethyl phthalate	< 0.63	ug/L	0.25	0.630	1.25		03/22/21 19:53	MS
	Fluoranthene	< 0.44	ug/L	0.25	0.440	1.25		03/22/21 19:53	MS
	Fluorene	< 0.47	ug/L	0.25	0.470	1.25		03/22/21 19:53	MS
	Hexachlorobenzene	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 19:53	MS
	Indeno(1,2,3-cd)pyrene	< 0.22	ug/L	0.25	0.220	1.25		03/22/21 19:53	MS
	Naphthalene	< 0.31	ug/L	0.25	0.310	1.25		03/22/21 19:53	MS
	Pentachlorophenol	< 0.5	ug/L	0.25	0.500	1.25		03/22/21 19:53	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-EQB-WAT	Job Sample ID:	21031513.05
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	17:50	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 625.1	Semivolatile Organic Compounds								
	Phenanthrene	< 0.44	ug/L	0.25	0.440	1.25		03/22/21 19:53	MS
	Phenol	< 0.44	ug/L	0.25	0.440	1.25	L2	03/22/21 19:53	MS
	Pyrene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 19:53	MS
	2-Fluorophenol(surr)	37.6	%	0.25		15-115		03/22/21 19:53	MS
	Phenol-d6(surr)	22.1	%	0.25		10-130		03/22/21 19:53	MS
	Nitrobenzene-d5(surr)	60.5	%	0.25		23-120		03/22/21 19:53	MS
	2-Fluorobiphenyl(surr)	58.9	%	0.25		30-115		03/22/21 19:53	MS
	2,4,6-Tribromophenol(surr)	57.1	%	0.25		19-122		03/22/21 19:53	MS
	p-Terphenyl-d14(surr)	59.8	%	0.25		18-137		03/22/21 19:53	MS
EPA 625.1	Selected Ion Monitoring								
	Benzo(a)pyrene	< 0.025	ug/L	0.25	0.1	0.025		03/22/21 20:31	MS
	Chrysene	< 0.025	ug/L	0.25	0.1	0.025		03/22/21 20:31	MS
	2,4,6-Tribromophenol(surr)	63.2	%	0.25		19-122		03/22/21 20:31	MS
	2-Fluorobiphenyl(surr)	43.1	%	0.25		30-115		03/22/21 20:31	MS
	2-Fluorophenol(surr)	35.4	%	0.25		15-115		03/22/21 20:31	MS
	Nitrobenzene-d5(surr)	54.4	%	0.25		23-120		03/22/21 20:31	MS
	Phenol-d6(surr)	20.7	%	0.25		10-130		03/22/21 20:31	MS
	p-Terphenyl-d14(surr)	52.2	%	0.25		18-137		03/22/21 20:31	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-Trip-WAT	Job Sample ID:	21031513.06
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	11:55	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 200.8	Dissolved Metals								
	Antimony	< 0.2	ug/L	1	0.200	0.25		03/22/21 20:51	GG
	Arsenic	0.381	ug/L	1	0.100	0.25		03/22/21 20:51	GG
	Cadmium	< 0.1	ug/L	1	0.100	0.25		03/22/21 20:51	GG
	Chromium	< 0.1	ug/L	1	0.100	0.25		03/22/21 20:51	GG
	Copper	< 0.4	ug/L	1	0.400	0.25		03/22/21 20:51	GG
	Lead	< 0.1	ug/L	1	0.100	0.25		03/22/21 20:51	GG
	Nickel	< 0.1	ug/L	1	0.100	0.25		03/22/21 20:51	GG
	Silver	< 0.2	ug/L	1	0.200	0.25		03/22/21 20:51	GG
	Zinc	< 1.1	ug/L	1	1.10	0.25		03/22/21 20:51	GG
EPA 245.1	Total Metals - Mercury								
	Mercury	< 0.06	ug/L	1	0.0600	0.2		03/19/21 13:05	BDC

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		
Client Sample ID:	MB-7-SED	Job Sample ID:	21031513.08
Date Collected:	03/17/21	Sample Matrix	Soil
Time Collected:	11:50	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 1010A	Ignitability (Flash Point) up to 150 degrees F								
	Ignitability	>150	°F	1				03/23/21 10:39	YSK
SM 2540G	% Moisture								
	% Moisture	28.4	%	1		0.1		03/19/21 08:15	SL
SM4500NH3-Dm									
	Ammonia as N[1]	3.53	mg/Kg	10	0.200	1		03/22/21 08:46	SG
SW-846 7.3	Reactive Cyanide								
	Reactive Cyanide[2]	<4.9	mg/Kg	1	4.9			03/23/21 11:51	YSK
SW-846 7.3	Reactive Sulfide								
	Reactive Sulfide[2]	<25	mg/Kg	1	25			03/23/21 12:05	YSK
SW-846 9045D	Corrosivity, pH								
	pH	9.1	s.u.					03/19/21 11:48	SL
	Temperature when read, °C[2]	22.1	s.u.					03/19/21 11:48	SL
SW-846 6020B	Metals by ICP/MS								
	Antimony	0.14734	mg/Kg	1	0.10	0.125		03/22/21 15:02	GG
	Arsenic	3.73	mg/Kg	1	0.08	0.125		03/22/21 15:02	GG
	Cadmium	0.07917	mg/Kg	1	0.07	0.125	J	03/22/21 15:02	GG
	Chromium	8.72	mg/Kg	1	0.11	0.125		03/22/21 15:02	GG
	Copper	6.73	mg/Kg	1	0.02	0.125		03/22/21 15:02	GG
	Lead	8.82	mg/Kg	1	0.11	0.125		03/22/21 15:02	GG
	Nickel	9.99	mg/Kg	1	0.02	0.125		03/22/21 15:02	GG
	Silver	<0.13	mg/Kg	1	0.13	0.125		03/25/21 16:11	GG
	Zinc	24.42	mg/Kg	1	0.57	0.5		03/22/21 15:02	GG
SW-846 7470A	Total Metals - Mercury								
	Mercury	0.00942	mg/Kg	2	0.00176	0.008	D1	03/19/21 14:29	BDC
TX 1005	Total Petroleum Hydrocarbons								
	C6-C12	<9.49	mg/Kg	1.00	9.49	25		03/19/21 01:49	AK
	>C12-C28	<13	mg/Kg	1.00	13.0	25		03/19/21 01:49	AK
	>C28-C35	<6.88	mg/Kg	1.00	6.88	25		03/19/21 01:49	AK
	Total C6-C35	<6.88	mg/Kg	1.00	6.88			03/19/21 01:49	AK
	Chlorooctadecane(surr)	103	%	1.00		60-150		03/19/21 01:49	AK
	1-Chlorooctane(surr)	96.4	%	1.00		60-143		03/19/21 01:49	AK
SW-846 8081B	Organochlorine Pesticides								
	Alpha-chlordane	< 0.25	ug/Kg	0.25	0.25	0.08325		03/23/21 21:40	PS
	Gamma-chlordane	< 0.18	ug/Kg	0.25	0.18	0.08325		03/23/21 21:40	PS
	4,4-DDD	< 0.26	ug/Kg	0.25	0.26	0.08325		03/23/21 21:40	PS
	4,4-DDE	<0.36	ug/Kg	0.25	0.36	0.4175		03/23/21 21:40	PS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-7-SED	Job Sample ID:	21031513.08
Date Collected:	03/17/21	Sample Matrix	Soil
Time Collected:	11:50	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8081B	Organochlorine Pesticides								
	4,4-DDT	< 0.48	ug/Kg	0.25	0.48	0.4175	L1	03/23/21 21:40	PS
	a-BHC	< 0.10	ug/Kg	0.25	0.10	0.08325		03/23/21 21:40	PS
	Aldrin	< 0.20	ug/Kg	0.25	0.20	0.08325		03/23/21 21:40	PS
	b-BHC	< 0.33	ug/Kg	0.25	0.33	0.08325		03/23/21 21:40	PS
	Chlordane	<1.67	ug/Kg	0.25	1.67	0.8325		03/23/21 21:40	PS
	d-BHC	< 0.34	ug/Kg	0.25	0.34	0.4175		03/23/21 21:40	PS
	Dieldrin	< 0.25	ug/Kg	0.25	0.25	0.08325		03/23/21 21:40	PS
	Endosulfan I	< 0.34	ug/Kg	0.25	0.34	0.4175		03/23/21 21:40	PS
	Endosulfan II	< 0.28	ug/Kg	0.25	0.28	0.08325		03/23/21 21:40	PS
	Endosulfan sulfate	<0.25	ug/Kg	0.25	0.25	0.08325		03/23/21 21:40	PS
	Endrin	< 0.39	ug/Kg	0.25	0.39	0.4175		03/23/21 21:40	PS
	Endrin aldehyde	< 0.41	ug/Kg	0.25	0.41	0.4175		03/23/21 21:40	PS
	Endrin ketone	< 0.33	ug/Kg	0.25	0.33	0.08325		03/23/21 21:40	PS
	g-BHC	< 0.15	ug/Kg	0.25	0.15	0.08325		03/23/21 21:40	PS
	Heptachlor	< 0.33	ug/Kg	0.25	0.33	0.08325		03/23/21 21:40	PS
	Heptachlor epoxide	< 0.26	ug/Kg	0.25	0.26	0.08325		03/23/21 21:40	PS
	Toxaphene	<1.67	ug/Kg	0.25	1.67	0.8325		03/23/21 21:40	PS
	Tetrachloro-m-xylene(surr)	34.9	%	0.25		20-131		03/23/21 21:40	PS
	Decachlorobiphenyl(surr)	18.9	%	0.25		30-134	S2	03/23/21 21:40	PS
SW-846 8082A	Polychlorinated Biphenyls								
	Total PCBs	< 1.52	ug/Kg	0.25	1.52	0.4175		03/24/21 03:03	PS
	Tetrachloro-m-xylene(surr)	60	%	0.25		42-128		03/24/21 03:03	PS
	Decachlorobiphenyl(surr)	44.9	%	0.25		42-130		03/24/21 03:03	PS
SW-846 8260C	Volatile Organic Compounds by GC/MS								
	1,1,1,2-Tetrachloroethane	<0.00085	mg/Kg	0.94	0.00085	0.0047		03/18/21 18:36	RT
	1,1,1-Trichloroethane	<0.00148	mg/Kg	0.94	0.00148	0.0047		03/18/21 18:36	RT
	1,1,2,2-Tetrachloroethane	<0.00132	mg/Kg	0.94	0.00132	0.0047		03/18/21 18:36	RT
	1,1,2-Trichloroethane	<0.00176	mg/Kg	0.94	0.00176	0.0047		03/18/21 18:36	RT
	1,1-Dichloroethane	<0.00157	mg/Kg	0.94	0.00157	0.0047		03/18/21 18:36	RT
	1,1-Dichloroethylene	<0.00173	mg/Kg	0.94	0.00173	0.0047		03/18/21 18:36	RT
	1,1-Dichloropropene	<0.00144	mg/Kg	0.94	0.00144	0.0047		03/18/21 18:36	RT
	1,2,3-trichlorobenzene	<0.00166	mg/Kg	0.94	0.00166	0.0047		03/18/21 18:36	RT
	1,2,3-Trichloropropane	<0.00151	mg/Kg	0.94	0.00151	0.0047		03/18/21 18:36	RT
	1,2,4-Trichlorobenzene	<0.00138	mg/Kg	0.94	0.00138	0.0047		03/18/21 18:36	RT
	1,2,4-Trimethylbenzene	<0.00122	mg/Kg	0.94	0.00122	0.0047		03/18/21 18:36	RT
	1,2-Dibromo-3-chloropropane	<0.00311	mg/Kg	0.94	0.00311	0.0047		03/18/21 18:36	RT
	1,2-Dibromoethane	<0.00113	mg/Kg	0.94	0.00113	0.0047		03/18/21 18:36	RT

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-7-SED	Job Sample ID:	21031513.08
Date Collected:	03/17/21	Sample Matrix	Soil
Time Collected:	11:50	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8260C	Volatile Organic Compounds by GC/MS								
	1,2-Dichlorobenzene	<0.001	mg/Kg	0.94	0.00100	0.0047		03/18/21 18:36	RT
	1,2-Dichloroethane	<0.00132	mg/Kg	0.94	0.00132	0.0047		03/18/21 18:36	RT
	1,2-Dichloropropane	<0.00113	mg/Kg	0.94	0.00113	0.0047		03/18/21 18:36	RT
	1,3,5-Trimethylbenzene	<0.00151	mg/Kg	0.94	0.00151	0.0047		03/18/21 18:36	RT
	1,3-Dichlorobenzene	<0.00141	mg/Kg	0.94	0.00141	0.0047		03/18/21 18:36	RT
	1,3-Dichloropropane	<0.00141	mg/Kg	0.94	0.00141	0.0047		03/18/21 18:36	RT
	1,4-Dichlorobenzene	<0.00144	mg/Kg	0.94	0.00144	0.0047		03/18/21 18:36	RT
	2,2-Dichloropropane	<0.0022	mg/Kg	0.94	0.00220	0.0047		03/18/21 18:36	RT
	2-Chlorotoluene	<0.00144	mg/Kg	0.94	0.00144	0.0047		03/18/21 18:36	RT
	4-Chlorotoluene	<0.00138	mg/Kg	0.94	0.00138	0.0047		03/18/21 18:36	RT
	4-Isopropyltoluene	<0.00141	mg/Kg	0.94	0.00141	0.0047		03/18/21 18:36	RT
	Benzene	<0.00107	mg/Kg	0.94	0.00107	0.0047		03/18/21 18:36	RT
	Bromobenzene	<0.00113	mg/Kg	0.94	0.00113	0.0047		03/18/21 18:36	RT
	Bromochloromethane	<0.00126	mg/Kg	0.94	0.00126	0.0047	L1	03/18/21 18:36	RT
	Bromodichloromethane	<0.00088	mg/Kg	0.94	0.00088	0.0047		03/18/21 18:36	RT
	Bromoform	<0.00072	mg/Kg	0.94	0.00072	0.0047		03/18/21 18:36	RT
	Bromomethane	<0.0017	mg/Kg	0.94	0.00170	0.0047		03/18/21 18:36	RT
	Carbon tetrachloride	<0.00151	mg/Kg	0.94	0.00151	0.0047		03/18/21 18:36	RT
	Chlorobenzene	<0.00148	mg/Kg	0.94	0.00148	0.0047		03/18/21 18:36	RT
	Chloroethane	<0.00242	mg/Kg	0.94	0.00242	0.0047		03/18/21 18:36	RT
	Chloroform	<0.00119	mg/Kg	0.94	0.00119	0.0047	L1	03/18/21 18:36	RT
	Chloromethane	<0.00226	mg/Kg	0.94	0.00226	0.0047		03/18/21 18:36	RT
	cis-1,2-Dichloroethylene	<0.00119	mg/Kg	0.94	0.00119	0.0047	L1	03/18/21 18:36	RT
	cis-1,3-Dichloropropene	<0.00113	mg/Kg	0.94	0.00113	0.0047		03/18/21 18:36	RT
	Dibromochloromethane	<0.0011	mg/Kg	0.94	0.00110	0.0047		03/18/21 18:36	RT
	Dibromomethane	<0.00138	mg/Kg	0.94	0.00138	0.0047		03/18/21 18:36	RT
	Dichlorodifluoromethane	<0.00135	mg/Kg	0.94	0.00135	0.0047		03/18/21 18:36	RT
	Ethylbenzene	<0.00138	mg/Kg	0.94	0.00138	0.0047		03/18/21 18:36	RT
	Isopropylbenzene	<0.00126	mg/Kg	0.94	0.00126	0.0047		03/18/21 18:36	RT
	m- & p-Xylenes	<0.00273	mg/Kg	0.94	0.00273	0.0094		03/18/21 18:36	RT
	MEK	<0.00267	mg/Kg	0.94	0.00267	0.0047		03/18/21 18:36	RT
	Methylene chloride	<0.00154	mg/Kg	0.94	0.00154	0.0047		03/18/21 18:36	RT
	Naphthalene	<0.00188	mg/Kg	0.94	0.00188	0.0047		03/18/21 18:36	RT
	n-Butylbenzene	<0.00179	mg/Kg	0.94	0.00179	0.0047		03/18/21 18:36	RT
	n-Propylbenzene	<0.00138	mg/Kg	0.94	0.00138	0.0047		03/18/21 18:36	RT
	o-Xylene	<0.00126	mg/Kg	0.94	0.00126	0.0047		03/18/21 18:36	RT
	sec-Butylbenzene	<0.0016	mg/Kg	0.94	0.00160	0.0047		03/18/21 18:36	RT

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-7-SED	Job Sample ID:	21031513.08
Date Collected:	03/17/21	Sample Matrix	Soil
Time Collected:	11:50	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8260C	Volatile Organic Compounds by GC/MS								
	Styrene	<0.00126	mg/Kg	0.94	0.00126	0.0047		03/18/21 18:36	RT
	t-butylbenzene	<0.00141	mg/Kg	0.94	0.00141	0.0047		03/18/21 18:36	RT
	Tetrachloroethylene	<0.00138	mg/Kg	0.94	0.00138	0.0047		03/18/21 18:36	RT
	Toluene	<0.00119	mg/Kg	0.94	0.00119	0.0047		03/18/21 18:36	RT
	trans-1,2-Dichloroethylene	<0.00144	mg/Kg	0.94	0.00144	0.0047	L1	03/18/21 18:36	RT
	trans-1,3-Dichloropropene	<0.00094	mg/Kg	0.94	0.00094	0.0047		03/18/21 18:36	RT
	Trichloroethylene	<0.00104	mg/Kg	0.94	0.00104	0.0047		03/18/21 18:36	RT
	Trichlorofluoromethane	<0.00198	mg/Kg	0.94	0.00198	0.0047	V1	03/18/21 18:36	RT
	Vinyl Chloride	<0.00185	mg/Kg	0.94	0.00185	0.0047		03/18/21 18:36	RT
	Dibromofluoromethane(surr)	111	%	0.94		70-130		03/18/21 18:36	RT
	1,2-Dichloroethane-d4(surr)	108	%	0.94		70-130		03/18/21 18:36	RT
	Toluene-d8(surr)	98.9	%	0.94		70-130		03/18/21 18:36	RT
	p-Bromofluorobenzene(surr)	113	%	0.94		70-130		03/18/21 18:36	RT
SW-846 8270D	Semivolatile Organic Compounds								
	1,2,4-Trichlorobenzene	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 19:02	MS
	1,2-Dichlorobenzene	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 19:02	MS
	1,3-Dichlorobenzene	< 30.65	ug/Kg	0.25	30.7	41.8		03/22/21 19:02	MS
	1,4-Dichlorobenzene	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 19:02	MS
	2,4-Dichlorophenol	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 19:02	MS
	2,4-Dimethylphenol	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 19:02	MS
	2,4-Dinitrophenol	< 55.67	ug/Kg	0.25	55.7	41.8		03/22/21 19:02	MS
	Acenaphthene	< 15.32	ug/Kg	0.25	15.3	41.8		03/22/21 19:02	MS
	Acenaphthylene	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 19:02	MS
	Anthracene	< 18.12	ug/Kg	0.25	18.1	41.8		03/22/21 19:02	MS
	Benzo(a)anthracene	< 28.26	ug/Kg	0.25	28.3	41.8		03/22/21 19:02	MS
	Benzo(a)pyrene	< 43.33	ug/Kg	0.25	43.3	41.8		03/22/21 19:02	MS
	Benzo(b)fluoranthene	< 29.86	ug/Kg	0.25	29.9	41.8		03/22/21 19:02	MS
	Benzo(g,h,i)perylene	< 29.86	ug/Kg	0.25	29.9	41.8		03/22/21 19:02	MS
	Benzo(k)fluoranthene	< 46.97	ug/Kg	0.25	47.0	41.8		03/22/21 19:02	MS
	Chrysene	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 19:02	MS
	Dibenzo(a,h)anthracene	< 49.42	ug/Kg	0.25	49.4	41.8		03/22/21 19:02	MS
	Diethyl phthalate	< 29.86	ug/Kg	0.25	29.9	41.8		03/22/21 19:02	MS
	Fluoranthene	< 25.62	ug/Kg	0.25	25.6	41.8		03/22/21 19:02	MS
	Fluorene	< 11.87	ug/Kg	0.25	11.9	41.8		03/22/21 19:02	MS
	Hexachlorobenzene	< 39.94	ug/Kg	0.25	39.9	41.8		03/22/21 19:02	MS
	Indeno(1,2,3-cd)pyrene	< 35.61	ug/Kg	0.25	35.6	41.8		03/22/21 19:02	MS
	Naphthalene	< 15.32	ug/Kg	0.25	15.3	41.8		03/22/21 19:02	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-7-SED	Job Sample ID:	21031513.08
Date Collected:	03/17/21	Sample Matrix	Soil
Time Collected:	11:50	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8270D	Semivolatile Organic Compounds								
	Pentachlorophenol	< 35.61	ug/Kg	0.25	35.6	41.8		03/22/21 19:02	MS
	Phenanthrene	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 19:02	MS
	Phenol	< 18.12	ug/Kg	0.25	18.1	41.8		03/22/21 19:02	MS
	Pyrene	< 38.15	ug/Kg	0.25	38.2	41.8		03/22/21 19:02	MS
	2-Fluorophenol(surr)	57.9	%	0.25		20-115		03/22/21 19:02	MS
	Phenol-d6(surr)	58	%	0.25		15-120		03/22/21 19:02	MS
	Nitrobenzene-d5(surr)	50.3	%	0.25		20-120		03/22/21 19:02	MS
	2-Fluorobiphenyl(surr)	56.8	%	0.25		30-115		03/22/21 19:02	MS
	2,4,6-Tribromophenol(surr)	81.1	%	0.25		10-120		03/22/21 19:02	MS
	p-Terphenyl-d14(surr)	71.7	%	0.25		30-140		03/22/21 19:02	MS
SW-846 8270D SIM	Selected Ion Monitoring								
	1,2,4-Trichlorobenzene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:03	MS
	1,3-Dichlorobenzene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:03	MS
	Benzo(b)fluoranthene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:03	MS
	Benzo(g,h,i)perylene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:03	MS
	Benzo(k)fluoranthene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:03	MS
	Dibenzo(a,h)anthracene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:03	MS
	Hexachlorobenzene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:03	MS
	Pyrene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:03	MS
	Nitrobenzene-d5(surr)	51.1	%	0.25		20-120		03/22/21 23:03	MS
	2-Fluorobiphenyl(surr)	44.4	%	0.25		30-115		03/22/21 23:03	MS
	2,4,6-Tribromophenol(surr)	64.9	%	0.25		10-120		03/22/21 23:03	MS
	p-Terphenyl-d14(surr)	57.3	%	0.25		30-140		03/22/21 23:03	MS
	2-Fluorophenol(surr)	50.6	%	0.25		20-115		03/22/21 23:03	MS
	Phenol-d6(surr)	49.3	%	0.25		15-120		03/22/21 23:03	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-9-SED	Job Sample ID:	21031513.09
Date Collected:	03/17/21	Sample Matrix	Soil
Time Collected:	15:20	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 1010A	Ignitability (Flash Point) up to 150 degrees F								
	Ignitability	>150	°F	1				03/23/21 10:39	YSK
SM 2540G	% Moisture								
	% Moisture	24.7	%	1		0.1		03/19/21 08:15	SL
SM4500NH3-Dm									
	Ammonia as N[1]	11.27	mg/Kg	10	0.200	1		03/22/21 08:46	SG
SW-846 7.3	Reactive Cyanide								
	Reactive Cyanide[2]	<4.9	mg/Kg	1	4.9			03/23/21 11:51	YSK
SW-846 7.3	Reactive Sulfide								
	Reactive Sulfide[2]	<25	mg/Kg	1	25			03/23/21 12:05	YSK
SW-846 9045D	Corrosivity, pH								
	pH	8.9	s.u.					03/19/21 11:48	SL
	Temperature when read, °C[2]	22	s.u.					03/19/21 11:48	SL
SW-846 6020B	Metals by ICP/MS								
	Antimony	0.12636	mg/Kg	1	0.10	0.125		03/22/21 15:10	GG
	Arsenic	16.37	mg/Kg	1	0.08	0.125		03/22/21 15:10	GG
	Cadmium	0.08071	mg/Kg	1	0.07	0.125	J	03/22/21 15:10	GG
	Chromium	14.26	mg/Kg	1	0.11	0.125		03/22/21 15:10	GG
	Copper	11.99	mg/Kg	1	0.02	0.125		03/22/21 15:10	GG
	Lead	11.34	mg/Kg	1	0.11	0.125		03/22/21 15:10	GG
	Nickel	18.97	mg/Kg	1	0.02	0.125		03/22/21 15:10	GG
	Silver	<0.13	mg/Kg	1	0.13	0.125		03/25/21 16:15	GG
	Zinc	39.60	mg/Kg	1	0.57	0.5		03/22/21 15:10	GG
SW-846 7470A	Total Metals - Mercury								
	Mercury	0.02716	mg/Kg	2	0.00176	0.008		03/19/21 13:59	BDC
TX 1005	Total Petroleum Hydrocarbons								
	C6-C12	<9.49	mg/Kg	1.00	9.49	25		03/19/21 02:18	AK
	>C12-C28	<13	mg/Kg	1.00	13.0	25		03/19/21 02:18	AK
	>C28-C35	<6.88	mg/Kg	1.00	6.88	25		03/19/21 02:18	AK
	Total C6-C35	<6.88	mg/Kg	1.00	6.88			03/19/21 02:18	AK
	Chlorooctadecane(surr)	99	%	1.00		60-150		03/19/21 02:18	AK
	1-Chlorooctane(surr)	94.1	%	1.00		60-143		03/19/21 02:18	AK
SW-846 8081B	Organochlorine Pesticides								
	Alpha-chlordane	< 0.25	ug/Kg	0.25	0.25	0.08325		03/23/21 22:07	PS
	Gamma-chlordane	< 0.18	ug/Kg	0.25	0.18	0.08325		03/23/21 22:07	PS
	4,4-DDD	< 0.26	ug/Kg	0.25	0.26	0.08325		03/23/21 22:07	PS
	4,4-DDE	<0.36	ug/Kg	0.25	0.36	0.4175		03/23/21 22:07	PS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-9-SED	Job Sample ID:	21031513.09
Date Collected:	03/17/21	Sample Matrix	Soil
Time Collected:	15:20	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8081B	Organochlorine Pesticides								
	4,4-DDT	< 0.48	ug/Kg	0.25	0.48	0.4175	L1	03/23/21 22:07	PS
	a-BHC	< 0.10	ug/Kg	0.25	0.10	0.08325		03/23/21 22:07	PS
	Aldrin	< 0.20	ug/Kg	0.25	0.20	0.08325		03/23/21 22:07	PS
	b-BHC	< 0.33	ug/Kg	0.25	0.33	0.08325		03/23/21 22:07	PS
	Chlordane	<1.67	ug/Kg	0.25	1.67	0.8325		03/23/21 22:07	PS
	d-BHC	< 0.34	ug/Kg	0.25	0.34	0.4175		03/23/21 22:07	PS
	Dieldrin	< 0.25	ug/Kg	0.25	0.25	0.08325		03/23/21 22:07	PS
	Endosulfan I	< 0.34	ug/Kg	0.25	0.34	0.4175		03/23/21 22:07	PS
	Endosulfan II	< 0.28	ug/Kg	0.25	0.28	0.08325		03/23/21 22:07	PS
	Endosulfan sulfate	<0.25	ug/Kg	0.25	0.25	0.08325		03/23/21 22:07	PS
	Endrin	< 0.39	ug/Kg	0.25	0.39	0.4175		03/23/21 22:07	PS
	Endrin aldehyde	< 0.41	ug/Kg	0.25	0.41	0.4175		03/23/21 22:07	PS
	Endrin ketone	< 0.33	ug/Kg	0.25	0.33	0.08325		03/23/21 22:07	PS
	g-BHC	< 0.15	ug/Kg	0.25	0.15	0.08325		03/23/21 22:07	PS
	Heptachlor	< 0.33	ug/Kg	0.25	0.33	0.08325		03/23/21 22:07	PS
	Heptachlor epoxide	< 0.26	ug/Kg	0.25	0.26	0.08325		03/23/21 22:07	PS
	Toxaphene	<1.67	ug/Kg	0.25	1.67	0.8325		03/23/21 22:07	PS
	Tetrachloro-m-xylene(surr)	32.4	%	0.25		20-131		03/23/21 22:07	PS
	Decachlorobiphenyl(surr)	22	%	0.25		30-134	S2	03/23/21 22:07	PS
SW-846 8082A	Polychlorinated Biphenyls								
	Total PCBs	< 1.52	ug/Kg	0.25	1.52	0.4175		03/24/21 03:30	PS
	Tetrachloro-m-xylene(surr)	56.3	%	0.25		42-128		03/24/21 03:30	PS
	Decachlorobiphenyl(surr)	46.7	%	0.25		42-130		03/24/21 03:30	PS
SW-846 8260C	Volatile Organic Compounds by GC/MS								
	1,1,1,2-Tetrachloroethane	<0.00085	mg/Kg	0.92	0.00085	0.0046		03/18/21 19:06	RT
	1,1,1-Trichloroethane	<0.00148	mg/Kg	0.92	0.00148	0.0046		03/18/21 19:06	RT
	1,1,2,2-Tetrachloroethane	<0.00132	mg/Kg	0.92	0.00132	0.0046		03/18/21 19:06	RT
	1,1,2-Trichloroethane	<0.00176	mg/Kg	0.92	0.00176	0.0046		03/18/21 19:06	RT
	1,1-Dichloroethane	<0.00157	mg/Kg	0.92	0.00157	0.0046		03/18/21 19:06	RT
	1,1-Dichloroethylene	<0.00173	mg/Kg	0.92	0.00173	0.0046		03/18/21 19:06	RT
	1,1-Dichloropropene	<0.00144	mg/Kg	0.92	0.00144	0.0046		03/18/21 19:06	RT
	1,2,3-trichlorobenzene	<0.00166	mg/Kg	0.92	0.00166	0.0046		03/18/21 19:06	RT
	1,2,3-Trichloropropane	<0.00151	mg/Kg	0.92	0.00151	0.0046		03/18/21 19:06	RT
	1,2,4-Trichlorobenzene	<0.00138	mg/Kg	0.92	0.00138	0.0046		03/18/21 19:06	RT
	1,2,4-Trimethylbenzene	<0.00122	mg/Kg	0.92	0.00122	0.0046		03/18/21 19:06	RT
	1,2-Dibromo-3-chloropropane	<0.00311	mg/Kg	0.92	0.00311	0.0046		03/18/21 19:06	RT
	1,2-Dibromoethane	<0.00113	mg/Kg	0.92	0.00113	0.0046		03/18/21 19:06	RT

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name: DiSorbo Consulting LLC Attn: Bob Davis

Project Name: Cedar Port Pre-Dredge Sampling

Client Sample ID: MB-9-SED Job Sample ID: 21031513.09

Date Collected: 03/17/21 Sample Matrix Soil

Time Collected: 15:20 % Moisture

Other Information:

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8260C	Volatile Organic Compounds by GC/MS								
	1,2-Dichlorobenzene	<0.001	mg/Kg	0.92	0.00100	0.0046		03/18/21 19:06	RT
	1,2-Dichloroethane	<0.00132	mg/Kg	0.92	0.00132	0.0046		03/18/21 19:06	RT
	1,2-Dichloropropane	<0.00113	mg/Kg	0.92	0.00113	0.0046		03/18/21 19:06	RT
	1,3,5-Trimethylbenzene	<0.00151	mg/Kg	0.92	0.00151	0.0046		03/18/21 19:06	RT
	1,3-Dichlorobenzene	<0.00141	mg/Kg	0.92	0.00141	0.0046		03/18/21 19:06	RT
	1,3-Dichloropropane	<0.00141	mg/Kg	0.92	0.00141	0.0046		03/18/21 19:06	RT
	1,4-Dichlorobenzene	<0.00144	mg/Kg	0.92	0.00144	0.0046		03/18/21 19:06	RT
	2,2-Dichloropropane	<0.0022	mg/Kg	0.92	0.00220	0.0046		03/18/21 19:06	RT
	2-Chlorotoluene	<0.00144	mg/Kg	0.92	0.00144	0.0046		03/18/21 19:06	RT
	4-Chlorotoluene	<0.00138	mg/Kg	0.92	0.00138	0.0046		03/18/21 19:06	RT
	4-Isopropyltoluene	<0.00141	mg/Kg	0.92	0.00141	0.0046		03/18/21 19:06	RT
	Benzene	<0.00107	mg/Kg	0.92	0.00107	0.0046		03/18/21 19:06	RT
	Bromobenzene	<0.00113	mg/Kg	0.92	0.00113	0.0046		03/18/21 19:06	RT
	Bromochloromethane	<0.00126	mg/Kg	0.92	0.00126	0.0046	L1	03/18/21 19:06	RT
	Bromodichloromethane	<0.00088	mg/Kg	0.92	0.00088	0.0046		03/18/21 19:06	RT
	Bromoform	<0.00072	mg/Kg	0.92	0.00072	0.0046		03/18/21 19:06	RT
	Bromomethane	<0.0017	mg/Kg	0.92	0.00170	0.0046		03/18/21 19:06	RT
	Carbon tetrachloride	<0.00151	mg/Kg	0.92	0.00151	0.0046		03/18/21 19:06	RT
	Chlorobenzene	<0.00148	mg/Kg	0.92	0.00148	0.0046		03/18/21 19:06	RT
	Chloroethane	<0.00242	mg/Kg	0.92	0.00242	0.0046		03/18/21 19:06	RT
	Chloroform	<0.00119	mg/Kg	0.92	0.00119	0.0046	L1	03/18/21 19:06	RT
	Chloromethane	<0.00226	mg/Kg	0.92	0.00226	0.0046		03/18/21 19:06	RT
	cis-1,2-Dichloroethylene	<0.00119	mg/Kg	0.92	0.00119	0.0046	L1	03/18/21 19:06	RT
	cis-1,3-Dichloropropene	<0.00113	mg/Kg	0.92	0.00113	0.0046		03/18/21 19:06	RT
	Dibromochloromethane	<0.0011	mg/Kg	0.92	0.00110	0.0046		03/18/21 19:06	RT
	Dibromomethane	<0.00138	mg/Kg	0.92	0.00138	0.0046		03/18/21 19:06	RT
	Dichlorodifluoromethane	<0.00135	mg/Kg	0.92	0.00135	0.0046		03/18/21 19:06	RT
	Ethylbenzene	<0.00138	mg/Kg	0.92	0.00138	0.0046		03/18/21 19:06	RT
	Isopropylbenzene	<0.00126	mg/Kg	0.92	0.00126	0.0046		03/18/21 19:06	RT
	m- & p-Xylenes	<0.00273	mg/Kg	0.92	0.00273	0.0092		03/18/21 19:06	RT
	MEK	<0.00267	mg/Kg	0.92	0.00267	0.0046		03/18/21 19:06	RT
	Methylene chloride	<0.00154	mg/Kg	0.92	0.00154	0.0046		03/18/21 19:06	RT
	Naphthalene	<0.00188	mg/Kg	0.92	0.00188	0.0046		03/18/21 19:06	RT
	n-Butylbenzene	<0.00179	mg/Kg	0.92	0.00179	0.0046		03/18/21 19:06	RT
	n-Propylbenzene	<0.00138	mg/Kg	0.92	0.00138	0.0046		03/18/21 19:06	RT
	o-Xylene	<0.00126	mg/Kg	0.92	0.00126	0.0046		03/18/21 19:06	RT
	sec-Butylbenzene	<0.0016	mg/Kg	0.92	0.00160	0.0046		03/18/21 19:06	RT

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L A B O R A T O R Y   T E S T   R E S U L T S

Job ID : 21031513

Date 3/30/2021

Client Name: DiSorbo Consulting LLC   Attn: Bob Davis
Project Name: Cedar Port Pre-Dredge Sampling

Client Sample ID: MB-9-SED
Date Collected: 03/17/21
Time Collected: 15:20
Other Information:

Job Sample ID: 21031513.09
Sample Matrix Soil
% Moisture

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8260C	Volatile Organic Compounds by GC/MS								
	Styrene	<0.00126	mg/Kg	0.92	0.00126	0.0046		03/18/21 19:06	RT
	t-butylbenzene	<0.00141	mg/Kg	0.92	0.00141	0.0046		03/18/21 19:06	RT
	Tetrachloroethylene	<0.00138	mg/Kg	0.92	0.00138	0.0046		03/18/21 19:06	RT
	Toluene	<0.00119	mg/Kg	0.92	0.00119	0.0046		03/18/21 19:06	RT
	trans-1,2-Dichloroethylene	<0.00144	mg/Kg	0.92	0.00144	0.0046	L1	03/18/21 19:06	RT
	trans-1,3-Dichloropropene	<0.00094	mg/Kg	0.92	0.00094	0.0046		03/18/21 19:06	RT
	Trichloroethylene	<0.00104	mg/Kg	0.92	0.00104	0.0046		03/18/21 19:06	RT
	Trichlorofluoromethane	<0.00198	mg/Kg	0.92	0.00198	0.0046	V1	03/18/21 19:06	RT
	Vinyl Chloride	<0.00185	mg/Kg	0.92	0.00185	0.0046		03/18/21 19:06	RT
	Dibromofluoromethane(surr)	117	%	0.92		70-130		03/18/21 19:06	RT
	1,2-Dichloroethane-d4(surr)	112	%	0.92		70-130		03/18/21 19:06	RT
	Toluene-d8(surr)	101	%	0.92		70-130		03/18/21 19:06	RT
	p-Bromofluorobenzene(surr)	108	%	0.92		70-130		03/18/21 19:06	RT
SW-846 8270D	Semivolatile Organic Compounds								
	1,2,4-Trichlorobenzene	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 19:34	MS
	1,2-Dichlorobenzene	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 19:34	MS
	1,3-Dichlorobenzene	< 30.65	ug/Kg	0.25	30.7	41.8		03/22/21 19:34	MS
	1,4-Dichlorobenzene	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 19:34	MS
	2,4-Dichlorophenol	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 19:34	MS
	2,4-Dimethylphenol	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 19:34	MS
	2,4-Dinitrophenol	< 55.67	ug/Kg	0.25	55.7	41.8		03/22/21 19:34	MS
	Acenaphthene	< 15.32	ug/Kg	0.25	15.3	41.8		03/22/21 19:34	MS
	Acenaphthylene	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 19:34	MS
	Anthracene	< 18.12	ug/Kg	0.25	18.1	41.8		03/22/21 19:34	MS
	Benzo(a)anthracene	< 28.26	ug/Kg	0.25	28.3	41.8		03/22/21 19:34	MS
	Benzo(a)pyrene	< 43.33	ug/Kg	0.25	43.3	41.8		03/22/21 19:34	MS
	Benzo(b)fluoranthene	< 29.86	ug/Kg	0.25	29.9	41.8		03/22/21 19:34	MS
	Benzo(g,h,i)perylene	< 29.86	ug/Kg	0.25	29.9	41.8		03/22/21 19:34	MS
	Benzo(k)fluoranthene	< 46.97	ug/Kg	0.25	47.0	41.8		03/22/21 19:34	MS
	Chrysene	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 19:34	MS
	Dibenzo(a,h)anthracene	< 49.42	ug/Kg	0.25	49.4	41.8		03/22/21 19:34	MS
	Diethyl phthalate	< 29.86	ug/Kg	0.25	29.9	41.8		03/22/21 19:34	MS
	Fluoranthene	< 25.62	ug/Kg	0.25	25.6	41.8		03/22/21 19:34	MS
	Fluorene	< 11.87	ug/Kg	0.25	11.9	41.8		03/22/21 19:34	MS
	Hexachlorobenzene	< 39.94	ug/Kg	0.25	39.9	41.8		03/22/21 19:34	MS
	Indeno(1,2,3-cd)pyrene	< 35.61	ug/Kg	0.25	35.6	41.8		03/22/21 19:34	MS
	Naphthalene	< 15.32	ug/Kg	0.25	15.3	41.8		03/22/21 19:34	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-9-SED	Job Sample ID:	21031513.09
Date Collected:	03/17/21	Sample Matrix	Soil
Time Collected:	15:20	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8270D	Semivolatile Organic Compounds								
	Pentachlorophenol	< 35.61	ug/Kg	0.25	35.6	41.8		03/22/21 19:34	MS
	Phenanthrene	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 19:34	MS
	Phenol	< 18.12	ug/Kg	0.25	18.1	41.8		03/22/21 19:34	MS
	Pyrene	< 38.15	ug/Kg	0.25	38.2	41.8		03/22/21 19:34	MS
	2-Fluorophenol(surr)	60.1	%	0.25		20-115		03/22/21 19:34	MS
	Phenol-d6(surr)	60.1	%	0.25		15-120		03/22/21 19:34	MS
	Nitrobenzene-d5(surr)	52.2	%	0.25		20-120		03/22/21 19:34	MS
	2-Fluorobiphenyl(surr)	58.3	%	0.25		30-115		03/22/21 19:34	MS
	2,4,6-Tribromophenol(surr)	86.3	%	0.25		10-120		03/22/21 19:34	MS
	p-Terphenyl-d14(surr)	76.7	%	0.25		30-140		03/22/21 19:34	MS
SW-846 8270D SIM	Selected Ion Monitoring								
	1,2,4-Trichlorobenzene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:33	MS
	1,3-Dichlorobenzene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:33	MS
	Benzo(b)fluoranthene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:33	MS
	Benzo(g,h,i)perylene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:33	MS
	Benzo(k)fluoranthene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:33	MS
	Dibenzo(a,h)anthracene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:33	MS
	Hexachlorobenzene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:33	MS
	Pyrene	< 0.825	ug/Kg	0.25	3.30	0.825		03/22/21 23:33	MS
	2,4,6-Tribromophenol(surr)	66.7	%	0.25		10-120		03/22/21 23:33	MS
	p-Terphenyl-d14(surr)	57.9	%	0.25		30-140		03/22/21 23:33	MS
	2-Fluorophenol(surr)	52.5	%	0.25		20-115		03/22/21 23:33	MS
	Phenol-d6(surr)	52	%	0.25		15-120		03/22/21 23:33	MS
	Nitrobenzene-d5(surr)	54	%	0.25		20-120		03/22/21 23:33	MS
	2-Fluorobiphenyl(surr)	44.8	%	0.25		30-115		03/22/21 23:33	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-1-SED	Job Sample ID:	21031513.11
Date Collected:	03/16/21	Sample Matrix	Soil
Time Collected:	12:10	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 1010A	Ignitability (Flash Point) up to 150 degrees F								
	Ignitability	>150	°F	1				03/23/21 10:39	YSK
SM 2540G	% Moisture								
	% Moisture	22.4	%	1		0.1		03/20/21 14:45	SL
SM4500NH3-Dm									
	Ammonia as N[1]	6.07	mg/Kg	10	0.200	1		03/22/21 08:46	SG
SW-846 7.3	Reactive Cyanide								
	Reactive Cyanide[2]	<4.9	mg/Kg	1	4.9			03/23/21 11:51	YSK
SW-846 7.3	Reactive Sulfide								
	Reactive Sulfide[2]	<25	mg/Kg	1	25			03/23/21 12:05	YSK
SW-846 9045D	Corrosivity, pH								
	pH	8.8	s.u.					03/22/21 10:50	SL
	Temperature when read, °C[2]	21.8	s.u.					03/22/21 10:50	SL
SW-846 6020B	Metals by ICP/MS								
	Antimony	0.11335	mg/Kg	1	0.10	0.125	J	03/22/21 15:26	GG
	Arsenic	1.83	mg/Kg	1	0.08	0.125		03/22/21 15:26	GG
	Cadmium	<0.07	mg/Kg	1	0.07	0.125		03/22/21 15:26	GG
	Chromium	3.80	mg/Kg	1	0.11	0.125		03/22/21 15:26	GG
	Copper	3.15	mg/Kg	1	0.02	0.125		03/22/21 15:26	GG
	Lead	4.42	mg/Kg	1	0.11	0.125		03/22/21 15:26	GG
	Nickel	3.86	mg/Kg	1	0.02	0.125		03/22/21 15:26	GG
	Silver	<0.13	mg/Kg	1	0.13	0.125		03/25/21 16:19	GG
	Zinc	11.60	mg/Kg	1	0.57	0.5		03/22/21 15:26	GG
SW-846 7470A	Total Metals - Mercury								
	Mercury	0.00363	mg/Kg	1	0.00088	0.004	J	03/22/21 14:43	BDC
TX 1005	Total Petroleum Hydrocarbons								
	C6-C12	<9.49	mg/Kg	1.00	9.49	25		03/22/21 11:29	AK
	>C12-C28	<13	mg/Kg	1.00	13.0	25		03/22/21 11:29	AK
	>C28-C35	<6.88	mg/Kg	1.00	6.88	25		03/22/21 11:29	AK
	Total C6-C35	<6.88	mg/Kg	1.00	6.88			03/22/21 11:29	AK
	Chlorooctadecane(surr)	106	%	1.00		60-150		03/22/21 11:29	AK
	1-Chlorooctane(surr)	95.5	%	1.00		60-143		03/22/21 11:29	AK
SW-846 8081B	Organochlorine Pesticides								
	Alpha-chlordane	< 0.25	ug/Kg	0.25	0.25	0.08325		03/23/21 22:20	PS
	Gamma-chlordane	< 0.18	ug/Kg	0.25	0.18	0.08325		03/23/21 22:20	PS
	4,4-DDD	< 0.26	ug/Kg	0.25	0.26	0.08325		03/23/21 22:20	PS
	4,4-DDE	<0.36	ug/Kg	0.25	0.36	0.4175		03/23/21 22:20	PS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-1-SED	Job Sample ID:	21031513.11
Date Collected:	03/16/21	Sample Matrix	Soil
Time Collected:	12:10	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8081B	Organochlorine Pesticides								
	4,4-DDT	< 0.48	ug/Kg	0.25	0.48	0.4175	L1	03/23/21 22:20	PS
	a-BHC	< 0.10	ug/Kg	0.25	0.10	0.08325		03/23/21 22:20	PS
	Aldrin	< 0.20	ug/Kg	0.25	0.20	0.08325		03/23/21 22:20	PS
	b-BHC	< 0.33	ug/Kg	0.25	0.33	0.08325		03/23/21 22:20	PS
	Chlordane	<1.67	ug/Kg	0.25	1.67	0.8325		03/23/21 22:20	PS
	d-BHC	< 0.34	ug/Kg	0.25	0.34	0.4175		03/23/21 22:20	PS
	Dieldrin	< 0.25	ug/Kg	0.25	0.25	0.08325		03/23/21 22:20	PS
	Endosulfan I	< 0.34	ug/Kg	0.25	0.34	0.4175		03/23/21 22:20	PS
	Endosulfan II	< 0.28	ug/Kg	0.25	0.28	0.08325		03/23/21 22:20	PS
	Endosulfan sulfate	<0.25	ug/Kg	0.25	0.25	0.08325		03/23/21 22:20	PS
	Endrin	< 0.39	ug/Kg	0.25	0.39	0.4175		03/23/21 22:20	PS
	Endrin aldehyde	< 0.41	ug/Kg	0.25	0.41	0.4175		03/23/21 22:20	PS
	Endrin ketone	< 0.33	ug/Kg	0.25	0.33	0.08325		03/23/21 22:20	PS
	g-BHC	< 0.15	ug/Kg	0.25	0.15	0.08325		03/23/21 22:20	PS
	Heptachlor	< 0.33	ug/Kg	0.25	0.33	0.08325		03/23/21 22:20	PS
	Heptachlor epoxide	< 0.26	ug/Kg	0.25	0.26	0.08325		03/23/21 22:20	PS
	Toxaphene	<1.67	ug/Kg	0.25	1.67	0.8325		03/23/21 22:20	PS
	Tetrachloro-m-xylene(surr)	22.9	%	0.25		20-131		03/23/21 22:20	PS
	Decachlorobiphenyl(surr)	13.6	%	0.25		30-134	S2	03/23/21 22:20	PS
SW-846 8082A	Polychlorinated Biphenyls								
	Total PCBs	< 1.52	ug/Kg	0.25	1.52	0.4175		03/24/21 03:44	PS
	Tetrachloro-m-xylene(surr)	41.8	%	0.25		42-128	S2	03/24/21 03:44	PS
	Decachlorobiphenyl(surr)	30.8	%	0.25		42-130	S2	03/24/21 03:44	PS
SW-846 8260C	Volatile Organic Compounds by GC/MS								
	1,1,1,2-Tetrachloroethane	<0.00085	mg/Kg	0.88	0.00085	0.0044		03/17/21 12:01	RT
	1,1,1-Trichloroethane	<0.00148	mg/Kg	0.88	0.00148	0.0044		03/17/21 12:01	RT
	1,1,2,2-Tetrachloroethane	<0.00132	mg/Kg	0.88	0.00132	0.0044		03/17/21 12:01	RT
	1,1,2-Trichloroethane	<0.00176	mg/Kg	0.88	0.00176	0.0044		03/17/21 12:01	RT
	1,1-Dichloroethane	<0.00157	mg/Kg	0.88	0.00157	0.0044		03/17/21 12:01	RT
	1,1-Dichloroethylene	<0.00173	mg/Kg	0.88	0.00173	0.0044		03/17/21 12:01	RT
	1,1-Dichloropropene	<0.00144	mg/Kg	0.88	0.00144	0.0044		03/17/21 12:01	RT
	1,2,3-trichlorobenzene	<0.00166	mg/Kg	0.88	0.00166	0.0044		03/17/21 12:01	RT
	1,2,3-Trichloropropane	<0.00151	mg/Kg	0.88	0.00151	0.0044		03/17/21 12:01	RT
	1,2,4-Trichlorobenzene	<0.00138	mg/Kg	0.88	0.00138	0.0044		03/17/21 12:01	RT
	1,2,4-Trimethylbenzene	<0.00122	mg/Kg	0.88	0.00122	0.0044		03/17/21 12:01	RT
	1,2-Dibromo-3-chloropropane	<0.00311	mg/Kg	0.88	0.00311	0.0044		03/17/21 12:01	RT
	1,2-Dibromoethane	<0.00113	mg/Kg	0.88	0.00113	0.0044		03/17/21 12:01	RT

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC		Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-1-SED	Job Sample ID:	21031513.11
Date Collected:	03/16/21	Sample Matrix	Soil
Time Collected:	12:10	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8260C	Volatile Organic Compounds by GC/MS								
	1,2-Dichlorobenzene	<0.001	mg/Kg	0.88	0.00100	0.0044		03/17/21 12:01	RT
	1,2-Dichloroethane	<0.00132	mg/Kg	0.88	0.00132	0.0044		03/17/21 12:01	RT
	1,2-Dichloropropane	<0.00113	mg/Kg	0.88	0.00113	0.0044		03/17/21 12:01	RT
	1,3,5-Trimethylbenzene	<0.00151	mg/Kg	0.88	0.00151	0.0044		03/17/21 12:01	RT
	1,3-Dichlorobenzene	<0.00141	mg/Kg	0.88	0.00141	0.0044		03/17/21 12:01	RT
	1,3-Dichloropropane	<0.00141	mg/Kg	0.88	0.00141	0.0044		03/17/21 12:01	RT
	1,4-Dichlorobenzene	<0.00144	mg/Kg	0.88	0.00144	0.0044		03/17/21 12:01	RT
	2,2-Dichloropropane	<0.0022	mg/Kg	0.88	0.00220	0.0044		03/17/21 12:01	RT
	2-Chlorotoluene	<0.00144	mg/Kg	0.88	0.00144	0.0044		03/17/21 12:01	RT
	4-Chlorotoluene	<0.00138	mg/Kg	0.88	0.00138	0.0044		03/17/21 12:01	RT
	4-Isopropyltoluene	<0.00141	mg/Kg	0.88	0.00141	0.0044		03/17/21 12:01	RT
	Benzene	<0.00107	mg/Kg	0.88	0.00107	0.0044		03/17/21 12:01	RT
	Bromobenzene	<0.00113	mg/Kg	0.88	0.00113	0.0044		03/17/21 12:01	RT
	Bromochloromethane	<0.00126	mg/Kg	0.88	0.00126	0.0044	L1	03/17/21 12:01	RT
	Bromodichloromethane	<0.00088	mg/Kg	0.88	0.00088	0.0044		03/17/21 12:01	RT
	Bromoform	<0.00072	mg/Kg	0.88	0.00072	0.0044		03/17/21 12:01	RT
	Bromomethane	<0.0017	mg/Kg	0.88	0.00170	0.0044		03/17/21 12:01	RT
	Carbon tetrachloride	<0.00151	mg/Kg	0.88	0.00151	0.0044		03/17/21 12:01	RT
	Chlorobenzene	<0.00148	mg/Kg	0.88	0.00148	0.0044		03/17/21 12:01	RT
	Chloroethane	<0.00242	mg/Kg	0.88	0.00242	0.0044		03/17/21 12:01	RT
	Chloroform	<0.00119	mg/Kg	0.88	0.00119	0.0044	L1	03/17/21 12:01	RT
	Chloromethane	<0.00226	mg/Kg	0.88	0.00226	0.0044		03/17/21 12:01	RT
	cis-1,2-Dichloroethylene	<0.00119	mg/Kg	0.88	0.00119	0.0044	L1	03/17/21 12:01	RT
	cis-1,3-Dichloropropene	<0.00113	mg/Kg	0.88	0.00113	0.0044		03/17/21 12:01	RT
	Dibromochloromethane	<0.0011	mg/Kg	0.88	0.00110	0.0044		03/17/21 12:01	RT
	Dibromomethane	<0.00138	mg/Kg	0.88	0.00138	0.0044		03/17/21 12:01	RT
	Dichlorodifluoromethane	<0.00135	mg/Kg	0.88	0.00135	0.0044		03/17/21 12:01	RT
	Ethylbenzene	<0.00138	mg/Kg	0.88	0.00138	0.0044		03/17/21 12:01	RT
	Isopropylbenzene	<0.00126	mg/Kg	0.88	0.00126	0.0044		03/17/21 12:01	RT
	m- & p-Xylenes	<0.00273	mg/Kg	0.88	0.00273	0.0088		03/17/21 12:01	RT
	MEK	<0.00267	mg/Kg	0.88	0.00267	0.0044		03/17/21 12:01	RT
	Methylene chloride	<0.00154	mg/Kg	0.88	0.00154	0.0044		03/17/21 12:01	RT
	Naphthalene	<0.00188	mg/Kg	0.88	0.00188	0.0044		03/17/21 12:01	RT
	n-Butylbenzene	<0.00179	mg/Kg	0.88	0.00179	0.0044		03/17/21 12:01	RT
	n-Propylbenzene	<0.00138	mg/Kg	0.88	0.00138	0.0044		03/17/21 12:01	RT
	o-Xylene	<0.00126	mg/Kg	0.88	0.00126	0.0044		03/17/21 12:01	RT
	sec-Butylbenzene	<0.0016	mg/Kg	0.88	0.00160	0.0044		03/17/21 12:01	RT

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-1-SED	Job Sample ID:	21031513.11
Date Collected:	03/16/21	Sample Matrix	Soil
Time Collected:	12:10	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8260C	Volatile Organic Compounds by GC/MS								
	Styrene	<0.00126	mg/Kg	0.88	0.00126	0.0044		03/17/21 12:01	RT
	t-butylbenzene	<0.00141	mg/Kg	0.88	0.00141	0.0044		03/17/21 12:01	RT
	Tetrachloroethylene	<0.00138	mg/Kg	0.88	0.00138	0.0044		03/17/21 12:01	RT
	Toluene	<0.00119	mg/Kg	0.88	0.00119	0.0044		03/17/21 12:01	RT
	trans-1,2-Dichloroethylene	<0.00144	mg/Kg	0.88	0.00144	0.0044	L1	03/17/21 12:01	RT
	trans-1,3-Dichloropropene	<0.00094	mg/Kg	0.88	0.00094	0.0044		03/17/21 12:01	RT
	Trichloroethylene	<0.00104	mg/Kg	0.88	0.00104	0.0044		03/17/21 12:01	RT
	Trichlorofluoromethane	<0.00198	mg/Kg	0.88	0.00198	0.0044	V1	03/17/21 12:01	RT
	Vinyl Chloride	<0.00185	mg/Kg	0.88	0.00185	0.0044		03/17/21 12:01	RT
	Dibromofluoromethane(surr)	110	%	0.88		70-130		03/17/21 12:01	RT
	1,2-Dichloroethane-d4(surr)	111	%	0.88		70-130		03/17/21 12:01	RT
	Toluene-d8(surr)	102	%	0.88		70-130		03/17/21 12:01	RT
	p-Bromofluorobenzene(surr)	111	%	0.88		70-130		03/17/21 12:01	RT
SW-846 8270D	Semivolatile Organic Compounds								
	1,2,4-Trichlorobenzene	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 20:05	MS
	1,2-Dichlorobenzene	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 20:05	MS
	1,3-Dichlorobenzene	< 30.65	ug/Kg	0.25	30.7	41.8		03/22/21 20:05	MS
	1,4-Dichlorobenzene	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 20:05	MS
	2,4-Dichlorophenol	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 20:05	MS
	2,4-Dimethylphenol	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 20:05	MS
	2,4-Dinitrophenol	< 55.67	ug/Kg	0.25	55.7	41.8		03/22/21 20:05	MS
	Acenaphthene	< 15.32	ug/Kg	0.25	15.3	41.8		03/22/21 20:05	MS
	Acenaphthylene	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 20:05	MS
	Anthracene	< 18.12	ug/Kg	0.25	18.1	41.8		03/22/21 20:05	MS
	Benzo(a)anthracene	< 28.26	ug/Kg	0.25	28.3	41.8		03/22/21 20:05	MS
	Benzo(a)pyrene	< 43.33	ug/Kg	0.25	43.3	41.8		03/22/21 20:05	MS
	Benzo(b)fluoranthene	< 29.86	ug/Kg	0.25	29.9	41.8		03/22/21 20:05	MS
	Benzo(g,h,i)perylene	< 29.86	ug/Kg	0.25	29.9	41.8		03/22/21 20:05	MS
	Benzo(k)fluoranthene	< 46.97	ug/Kg	0.25	47.0	41.8		03/22/21 20:05	MS
	Chrysene	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 20:05	MS
	Dibenzo(a,h)anthracene	< 49.42	ug/Kg	0.25	49.4	41.8		03/22/21 20:05	MS
	Diethyl phthalate	< 29.86	ug/Kg	0.25	29.9	41.8		03/22/21 20:05	MS
	Fluoranthene	< 25.62	ug/Kg	0.25	25.6	41.8		03/22/21 20:05	MS
	Fluorene	< 11.87	ug/Kg	0.25	11.9	41.8		03/22/21 20:05	MS
	Hexachlorobenzene	< 39.94	ug/Kg	0.25	39.9	41.8		03/22/21 20:05	MS
	Indeno(1,2,3-cd)pyrene	< 35.61	ug/Kg	0.25	35.6	41.8		03/22/21 20:05	MS
	Naphthalene	< 15.32	ug/Kg	0.25	15.3	41.8		03/22/21 20:05	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name: DiSorbo Consulting LLC

Attn: Bob Davis

Project Name: Cedar Port Pre-Dredge Sampling

Client Sample ID: MB-1-SED

Date Collected: 03/16/21

Time Collected: 12:10

Other Information:

Job Sample ID: 21031513.11

Sample Matrix Soil

% Moisture

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8270D	Semivolatile Organic Compounds								
	Pentachlorophenol	< 35.61	ug/Kg	0.25	35.6	41.8		03/22/21 20:05	MS
	Phenanthrene	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 20:05	MS
	Phenol	< 18.12	ug/Kg	0.25	18.1	41.8		03/22/21 20:05	MS
	Pyrene	< 38.15	ug/Kg	0.25	38.2	41.8		03/22/21 20:05	MS
	2-Fluorophenol(surr)	55.6	%	0.25		20-115		03/22/21 20:05	MS
	Phenol-d6(surr)	56	%	0.25		15-120		03/22/21 20:05	MS
	Nitrobenzene-d5(surr)	50.7	%	0.25		20-120		03/22/21 20:05	MS
	2-Fluorobiphenyl(surr)	56.8	%	0.25		30-115		03/22/21 20:05	MS
	2,4,6-Tribromophenol(surr)	76.4	%	0.25		10-120		03/22/21 20:05	MS
	p-Terphenyl-d14(surr)	67.9	%	0.25		30-140		03/22/21 20:05	MS
SW-846 8270D SIM	Selected Ion Monitoring								
	1,2,4-Trichlorobenzene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:04	MS
	1,3-Dichlorobenzene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:04	MS
	Benzo(b)fluoranthene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:04	MS
	Benzo(g,h,i)perylene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:04	MS
	Benzo(k)fluoranthene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:04	MS
	Dibenzo(a,h)anthracene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:04	MS
	Hexachlorobenzene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:04	MS
	Pyrene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:04	MS
	2-Fluorophenol(surr)	49.9	%	0.25		20-115		03/23/21 00:04	MS
	Phenol-d6(surr)	49.6	%	0.25		15-120		03/23/21 00:04	MS
	Nitrobenzene-d5(surr)	50.2	%	0.25		20-120		03/23/21 00:04	MS
	2-Fluorobiphenyl(surr)	42.5	%	0.25		30-115		03/23/21 00:04	MS
	2,4,6-Tribromophenol(surr)	61.8	%	0.25		10-120		03/23/21 00:04	MS
	p-Terphenyl-d14(surr)	52.5	%	0.25		30-140		03/23/21 00:04	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-5-SED	Job Sample ID:	21031513.13
Date Collected:	03/16/21	Sample Matrix	Soil
Time Collected:	15:30	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SM 2540G	% Moisture								
	% Moisture	36.8	%	1		0.1		03/20/21 14:45	SL
SM4500NH3-Dm									
	Ammonia as N[1]	20.8	mg/Kg	10	0.200	1		03/22/21 08:46	SG
SW-846 6020B	Metals by ICP/MS								
	Antimony	0.17724	mg/Kg	1	0.10	0.125		03/22/21 15:34	GG
	Arsenic	3.11	mg/Kg	1	0.08	0.125		03/22/21 15:34	GG
	Cadmium	0.07911	mg/Kg	1	0.07	0.125	J	03/22/21 15:34	GG
	Chromium	5.47	mg/Kg	1	0.11	0.125		03/22/21 15:34	GG
	Copper	5.00	mg/Kg	1	0.02	0.125		03/22/21 15:34	GG
	Lead	7.65	mg/Kg	1	0.11	0.125		03/22/21 15:34	GG
	Nickel	5.78	mg/Kg	1	0.02	0.125		03/22/21 15:34	GG
	Silver	<0.13	mg/Kg	1	0.13	0.125		03/25/21 16:23	GG
	Zinc	17.54	mg/Kg	1	0.57	0.5		03/22/21 15:34	GG
SW-846 7470A	Total Metals - Mercury								
	Mercury	0.02762	mg/Kg	1	0.00088	0.004		03/22/21 15:10	BDC
TX 1005	Total Petroleum Hydrocarbons								
	C6-C12	<9.49	mg/Kg	1.00	9.49	25		03/22/21 16:40	AK
	>C12-C28	<13	mg/Kg	1.00	13.0	25		03/22/21 16:40	AK
	>C28-C35	<6.88	mg/Kg	1.00	6.88	25		03/22/21 16:40	AK
	Total C6-C35	<6.88	mg/Kg	1.00	6.88			03/22/21 16:40	AK
	Chlorooctadecane(surr)	88.9	%	1.00		60-150		03/22/21 16:40	AK
	1-Chlorooctane(surr)	97.5	%	1.00		60-143		03/22/21 16:40	AK
SW-846 8081B	Organochlorine Pesticides								
	Alpha-chlordane	< 0.25	ug/Kg	0.25	0.25	0.08325		03/23/21 22:34	PS
	Gamma-chlordane	< 0.18	ug/Kg	0.25	0.18	0.08325		03/23/21 22:34	PS
	4,4-DDD	< 0.26	ug/Kg	0.25	0.26	0.08325		03/23/21 22:34	PS
	4,4-DDE	<0.36	ug/Kg	0.25	0.36	0.4175		03/23/21 22:34	PS
	4,4-DDT	< 0.48	ug/Kg	0.25	0.48	0.4175	L1	03/23/21 22:34	PS
	a-BHC	< 0.10	ug/Kg	0.25	0.10	0.08325		03/23/21 22:34	PS
	Aldrin	< 0.20	ug/Kg	0.25	0.20	0.08325		03/23/21 22:34	PS
	b-BHC	< 0.33	ug/Kg	0.25	0.33	0.08325		03/23/21 22:34	PS
	Chlordane	<1.67	ug/Kg	0.25	1.67	0.8325		03/23/21 22:34	PS
	d-BHC	< 0.34	ug/Kg	0.25	0.34	0.4175		03/23/21 22:34	PS
	Dieldrin	< 0.25	ug/Kg	0.25	0.25	0.08325		03/23/21 22:34	PS
	Endosulfan I	< 0.34	ug/Kg	0.25	0.34	0.4175		03/23/21 22:34	PS
	Endosulfan II	< 0.28	ug/Kg	0.25	0.28	0.08325		03/23/21 22:34	PS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-5-SED	Job Sample ID:	21031513.13
Date Collected:	03/16/21	Sample Matrix	Soil
Time Collected:	15:30	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8081B	Organochlorine Pesticides								
	Endosulfan sulfate	<0.25	ug/Kg	0.25	0.25	0.08325		03/23/21 22:34	PS
	Endrin	< 0.39	ug/Kg	0.25	0.39	0.4175		03/23/21 22:34	PS
	Endrin aldehyde	< 0.41	ug/Kg	0.25	0.41	0.4175		03/23/21 22:34	PS
	Endrin ketone	< 0.33	ug/Kg	0.25	0.33	0.08325		03/23/21 22:34	PS
	g-BHC	< 0.15	ug/Kg	0.25	0.15	0.08325		03/23/21 22:34	PS
	Heptachlor	< 0.33	ug/Kg	0.25	0.33	0.08325		03/23/21 22:34	PS
	Heptachlor epoxide	< 0.26	ug/Kg	0.25	0.26	0.08325		03/23/21 22:34	PS
	Toxaphene	<1.67	ug/Kg	0.25	1.67	0.8325		03/23/21 22:34	PS
	Tetrachloro-m-xylene(surr)	18.4	%	0.25		20-131	S2	03/23/21 22:34	PS
	Decachlorobiphenyl(surr)	14.9	%	0.25		30-134	S2	03/23/21 22:34	PS
SW-846 8082A	Polychlorinated Biphenyls								
	Total PCBs	< 1.52	ug/Kg	0.25	1.52	0.4175		03/24/21 03:58	PS
	Tetrachloro-m-xylene(surr)	40.7	%	0.25		42-128	S2	03/24/21 03:58	PS
	Decachlorobiphenyl(surr)	34.2	%	0.25		42-130	S2	03/24/21 03:58	PS
SW-846 8260C	Volatile Organic Compounds by GC/MS								
	1,1,1,2-Tetrachloroethane	<0.00085	mg/Kg	0.87	0.00085	0.00435		03/17/21 13:02	RT
	1,1,1-Trichloroethane	<0.00148	mg/Kg	0.87	0.00148	0.00435		03/17/21 13:02	RT
	1,1,2,2-Tetrachloroethane	<0.00132	mg/Kg	0.87	0.00132	0.00435		03/17/21 13:02	RT
	1,1,2-Trichloroethane	<0.00176	mg/Kg	0.87	0.00176	0.00435		03/17/21 13:02	RT
	1,1-Dichloroethane	<0.00157	mg/Kg	0.87	0.00157	0.00435		03/17/21 13:02	RT
	1,1-Dichloroethylene	<0.00173	mg/Kg	0.87	0.00173	0.00435		03/17/21 13:02	RT
	1,1-Dichloropropene	<0.00144	mg/Kg	0.87	0.00144	0.00435		03/17/21 13:02	RT
	1,2,3-trichlorobenzene	<0.00166	mg/Kg	0.87	0.00166	0.00435		03/17/21 13:02	RT
	1,2,3-Trichloropropane	<0.00151	mg/Kg	0.87	0.00151	0.00435		03/17/21 13:02	RT
	1,2,4-Trichlorobenzene	<0.00138	mg/Kg	0.87	0.00138	0.00435		03/17/21 13:02	RT
	1,2,4-Trimethylbenzene	<0.00122	mg/Kg	0.87	0.00122	0.00435		03/17/21 13:02	RT
	1,2-Dibromo-3-chloropropane	<0.00311	mg/Kg	0.87	0.00311	0.00435		03/17/21 13:02	RT
	1,2-Dibromoethane	<0.00113	mg/Kg	0.87	0.00113	0.00435		03/17/21 13:02	RT
	1,2-Dichlorobenzene	<0.001	mg/Kg	0.87	0.00100	0.00435		03/17/21 13:02	RT
	1,2-Dichloroethane	<0.00132	mg/Kg	0.87	0.00132	0.00435		03/17/21 13:02	RT
	1,2-Dichloropropane	<0.00113	mg/Kg	0.87	0.00113	0.00435		03/17/21 13:02	RT
	1,3,5-Trimethylbenzene	<0.00151	mg/Kg	0.87	0.00151	0.00435		03/17/21 13:02	RT
	1,3-Dichlorobenzene	<0.00141	mg/Kg	0.87	0.00141	0.00435		03/17/21 13:02	RT
	1,3-Dichloropropane	<0.00141	mg/Kg	0.87	0.00141	0.00435		03/17/21 13:02	RT
	1,4-Dichlorobenzene	<0.00144	mg/Kg	0.87	0.00144	0.00435		03/17/21 13:02	RT
	2,2-Dichloropropane	<0.0022	mg/Kg	0.87	0.00220	0.00435		03/17/21 13:02	RT
	2-Chlorotoluene	<0.00144	mg/Kg	0.87	0.00144	0.00435		03/17/21 13:02	RT

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name: DiSorbo Consulting LLC   Attn: Bob Davis
Project Name: Cedar Port Pre-Dredge Sampling

Client Sample ID:	MB-5-SED	Job Sample ID:	21031513.13
Date Collected:	03/16/21	Sample Matrix	Soil
Time Collected:	15:30	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8260C	Volatile Organic Compounds by GC/MS								
	4-Chlorotoluene	<0.00138	mg/Kg	0.87	0.00138	0.00435		03/17/21 13:02	RT
	4-Isopropyltoluene	<0.00141	mg/Kg	0.87	0.00141	0.00435		03/17/21 13:02	RT
	Benzene	<0.00107	mg/Kg	0.87	0.00107	0.00435		03/17/21 13:02	RT
	Bromobenzene	<0.00113	mg/Kg	0.87	0.00113	0.00435		03/17/21 13:02	RT
	Bromochloromethane	<0.00126	mg/Kg	0.87	0.00126	0.00435	L1	03/17/21 13:02	RT
	Bromodichloromethane	<0.00088	mg/Kg	0.87	0.00088	0.00435		03/17/21 13:02	RT
	Bromoform	<0.00072	mg/Kg	0.87	0.00072	0.00435		03/17/21 13:02	RT
	Bromomethane	<0.0017	mg/Kg	0.87	0.00170	0.00435		03/17/21 13:02	RT
	Carbon tetrachloride	<0.00151	mg/Kg	0.87	0.00151	0.00435		03/17/21 13:02	RT
	Chlorobenzene	<0.00148	mg/Kg	0.87	0.00148	0.00435		03/17/21 13:02	RT
	Chloroethane	<0.00242	mg/Kg	0.87	0.00242	0.00435		03/17/21 13:02	RT
	Chloroform	<0.00119	mg/Kg	0.87	0.00119	0.00435	L1	03/17/21 13:02	RT
	Chloromethane	<0.00226	mg/Kg	0.87	0.00226	0.00435		03/17/21 13:02	RT
	cis-1,2-Dichloroethylene	<0.00119	mg/Kg	0.87	0.00119	0.00435	L1	03/17/21 13:02	RT
	cis-1,3-Dichloropropene	<0.00113	mg/Kg	0.87	0.00113	0.00435		03/17/21 13:02	RT
	Dibromochloromethane	<0.0011	mg/Kg	0.87	0.00110	0.00435		03/17/21 13:02	RT
	Dibromomethane	<0.00138	mg/Kg	0.87	0.00138	0.00435		03/17/21 13:02	RT
	Dichlorodifluoromethane	<0.00135	mg/Kg	0.87	0.00135	0.00435		03/17/21 13:02	RT
	Ethylbenzene	<0.00138	mg/Kg	0.87	0.00138	0.00435		03/17/21 13:02	RT
	Isopropylbenzene	<0.00126	mg/Kg	0.87	0.00126	0.00435		03/17/21 13:02	RT
	m- & p-Xylenes	<0.00273	mg/Kg	0.87	0.00273	0.0087		03/17/21 13:02	RT
	MEK	<0.00267	mg/Kg	0.87	0.00267	0.00435		03/17/21 13:02	RT
	Methylene chloride	<0.00154	mg/Kg	0.87	0.00154	0.00435		03/17/21 13:02	RT
	Naphthalene	<0.00188	mg/Kg	0.87	0.00188	0.00435		03/17/21 13:02	RT
	n-Butylbenzene	<0.00179	mg/Kg	0.87	0.00179	0.00435		03/17/21 13:02	RT
	n-Propylbenzene	<0.00138	mg/Kg	0.87	0.00138	0.00435		03/17/21 13:02	RT
	o-Xylene	<0.00126	mg/Kg	0.87	0.00126	0.00435		03/17/21 13:02	RT
	sec-Butylbenzene	<0.0016	mg/Kg	0.87	0.00160	0.00435		03/17/21 13:02	RT
	Styrene	<0.00126	mg/Kg	0.87	0.00126	0.00435		03/17/21 13:02	RT
	t-butylbenzene	<0.00141	mg/Kg	0.87	0.00141	0.00435		03/17/21 13:02	RT
	Tetrachloroethylene	<0.00138	mg/Kg	0.87	0.00138	0.00435		03/17/21 13:02	RT
	Toluene	<0.00119	mg/Kg	0.87	0.00119	0.00435		03/17/21 13:02	RT
	trans-1,2-Dichloroethylene	<0.00144	mg/Kg	0.87	0.00144	0.00435	L1	03/17/21 13:02	RT
	trans-1,3-Dichloropropene	<0.00094	mg/Kg	0.87	0.00094	0.00435		03/17/21 13:02	RT
	Trichloroethylene	<0.00104	mg/Kg	0.87	0.00104	0.00435		03/17/21 13:02	RT
	Trichlorofluoromethane	<0.00198	mg/Kg	0.87	0.00198	0.00435	V1	03/17/21 13:02	RT
	Vinyl Chloride	<0.00185	mg/Kg	0.87	0.00185	0.00435		03/17/21 13:02	RT

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-5-SED	Job Sample ID:	21031513.13
Date Collected:	03/16/21	Sample Matrix	Soil
Time Collected:	15:30	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8260C	Volatile Organic Compounds by GC/MS								
	Dibromofluoromethane(surr)	119	%	0.87		70-130		03/17/21 13:02	RT
	1,2-Dichloroethane-d4(surr)	118	%	0.87		70-130		03/17/21 13:02	RT
	Toluene-d8(surr)	102	%	0.87		70-130		03/17/21 13:02	RT
	p-Bromofluorobenzene(surr)	109	%	0.87		70-130		03/17/21 13:02	RT
SW-846 8270D	Semivolatile Organic Compounds								
	1,2,4-Trichlorobenzene	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 20:37	MS
	1,2-Dichlorobenzene	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 20:37	MS
	1,3-Dichlorobenzene	< 30.65	ug/Kg	0.25	30.7	41.8		03/22/21 20:37	MS
	1,4-Dichlorobenzene	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 20:37	MS
	2,4-Dichlorophenol	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 20:37	MS
	2,4-Dimethylphenol	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 20:37	MS
	2,4-Dinitrophenol	< 55.67	ug/Kg	0.25	55.7	41.8		03/22/21 20:37	MS
	Acenaphthene	< 15.32	ug/Kg	0.25	15.3	41.8		03/22/21 20:37	MS
	Acenaphthylene	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 20:37	MS
	Anthracene	< 18.12	ug/Kg	0.25	18.1	41.8		03/22/21 20:37	MS
	Benzo(a)anthracene	< 28.26	ug/Kg	0.25	28.3	41.8		03/22/21 20:37	MS
	Benzo(a)pyrene	< 43.33	ug/Kg	0.25	43.3	41.8		03/22/21 20:37	MS
	Benzo(b)fluoranthene	< 29.86	ug/Kg	0.25	29.9	41.8		03/22/21 20:37	MS
	Benzo(g,h,i)perylene	< 29.86	ug/Kg	0.25	29.9	41.8		03/22/21 20:37	MS
	Benzo(k)fluoranthene	< 46.97	ug/Kg	0.25	47.0	41.8		03/22/21 20:37	MS
	Chrysene	< 23.74	ug/Kg	0.25	23.7	41.8		03/22/21 20:37	MS
	Dibenzo(a,h)anthracene	< 49.42	ug/Kg	0.25	49.4	41.8		03/22/21 20:37	MS
	Diethyl phthalate	< 29.86	ug/Kg	0.25	29.9	41.8		03/22/21 20:37	MS
	Fluoranthene	< 25.62	ug/Kg	0.25	25.6	41.8		03/22/21 20:37	MS
	Fluorene	< 11.87	ug/Kg	0.25	11.9	41.8		03/22/21 20:37	MS
	Hexachlorobenzene	< 39.94	ug/Kg	0.25	39.9	41.8		03/22/21 20:37	MS
	Indeno(1,2,3-cd)pyrene	< 35.61	ug/Kg	0.25	35.6	41.8		03/22/21 20:37	MS
	Naphthalene	< 15.32	ug/Kg	0.25	15.3	41.8		03/22/21 20:37	MS
	Pentachlorophenol	< 35.61	ug/Kg	0.25	35.6	41.8		03/22/21 20:37	MS
	Phenanthrene	< 21.67	ug/Kg	0.25	21.7	41.8		03/22/21 20:37	MS
	Phenol	< 18.12	ug/Kg	0.25	18.1	41.8		03/22/21 20:37	MS
	Pyrene	< 38.15	ug/Kg	0.25	38.2	41.8		03/22/21 20:37	MS
	2-Fluorophenol(surr)	55.6	%	0.25		20-115		03/22/21 20:37	MS
	Phenol-d6(surr)	54.4	%	0.25		15-120		03/22/21 20:37	MS
	Nitrobenzene-d5(surr)	49.1	%	0.25		20-120		03/22/21 20:37	MS
	2-Fluorobiphenyl(surr)	54.6	%	0.25		30-115		03/22/21 20:37	MS
	2,4,6-Tribromophenol(surr)	77.1	%	0.25		10-120		03/22/21 20:37	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-5-SED	Job Sample ID:	21031513.13
Date Collected:	03/16/21	Sample Matrix	Soil
Time Collected:	15:30	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SW-846 8270D	Semivolatile Organic Compounds								
	p-Terphenyl-d14(surr)	69	%	0.25		30-140		03/22/21 20:37	MS
SW-846 8270D SIM	Selected Ion Monitoring								
	1,2,4-Trichlorobenzene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:35	MS
	1,3-Dichlorobenzene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:35	MS
	Benzo(b)fluoranthene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:35	MS
	Benzo(g,h,i)perylene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:35	MS
	Benzo(k)fluoranthene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:35	MS
	Dibenzo(a,h)anthracene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:35	MS
	Hexachlorobenzene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:35	MS
	Pyrene	< 0.825	ug/Kg	0.25	3.30	0.825		03/23/21 00:35	MS
	Nitrobenzene-d5(surr)	49.8	%	0.25		20-120		03/23/21 00:35	MS
	2-Fluorobiphenyl(surr)	41.4	%	0.25		30-115		03/23/21 00:35	MS
	2,4,6-Tribromophenol(surr)	59.5	%	0.25		10-120		03/23/21 00:35	MS
	p-Terphenyl-d14(surr)	54.7	%	0.25		30-140		03/23/21 00:35	MS
	2-Fluorophenol(surr)	49.1	%	0.25		20-115		03/23/21 00:35	MS
	Phenol-d6(surr)	47.9	%	0.25		15-120		03/23/21 00:35	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-1-ELUT-WAT & SED Composite	Job Sample ID:	21031513.15
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	17:10	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SM 4500NH3D									
	Ammonia as N	0.85	mg/L	1		0.01		03/22/21 13:37	SG
SM 5310B	Total Organic Carbon								
	TOC	4.7	mg/L	1	0.35	1		03/22/21 17:00	AJ
EPA 200.8	Dissolved Metals								
	Antimony	1.82	ug/L	2.5	0.500	0.625		03/22/21 22:04	GG
	Arsenic	5.07	ug/L	2.5	0.250	0.625		03/22/21 22:04	GG
	Cadmium	< 0.3	ug/L	2.5	0.300	0.625	D1	03/22/21 22:04	GG
	Chromium	0.713	ug/L	2.5	0.300	0.625	D1	03/22/21 22:04	GG
	Copper	1.50	ug/L	2.5	1.00	0.625		03/22/21 22:04	GG
	Lead	< 0.3	ug/L	2.5	0.300	0.625	D1	03/22/21 22:04	GG
	Nickel	1.93	ug/L	2.5	0.300	0.625		03/22/21 22:04	GG
	Silver	< 0.5	ug/L	2.5	0.500	0.625	D1	03/22/21 22:04	GG
	Zinc	6.29	ug/L	2.5	2.80	0.625		03/22/21 22:04	GG
EPA 245.1	Total Metals - Mercury								
	Mercury	< 0.06	ug/L	1	0.0600	0.2		03/23/21 13:01	BDC
TX 1005	Total Petroleum Hydrocarbons								
	C6-C12	0.415	mg/L	1.00	0.35	2.15	J	03/22/21 23:51	AK
	>C12-C28	<0.37	mg/L	1.00	0.37	2.15		03/22/21 23:51	AK
	>C28-C35	<0.18	mg/L	1.00	0.18	2.15		03/22/21 23:51	AK
	Total C6-C35	0.415	mg/L	1.00	0.18			03/22/21 23:51	AK
	Chlorooctadecane(surr)	105	%	1.00		70-125		03/22/21 23:51	AK
	1-Chlorooctane(surr)	90.6	%	1.00		70-125		03/22/21 23:51	AK
EPA 608.3	Polychlorinated Biphenyls								
	Total PCBs	<0.0129	ug/L	1	0.0129	0.05		03/23/21 23:08	PS
	Decachlorobiphenyl(surr)	58	%	0.25		35-129		03/23/21 23:08	PS
	Tetrachloro-m-xylene(surr)	60	%	0.25		27-127		03/23/21 23:08	PS
EPA 608.3	Organochlorine Pesticides								
	Alpha-chlordane	< 0.002	ug/L	0.25	0.002	0.0025		03/23/21 19:53	PS
	Gamma-chlordane	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:53	PS
	4,4-DDD	< 0.006	ug/L	0.25	0.006	0.0025		03/23/21 19:53	PS
	4,4-DDE	<0.002	ug/L	0.25	0.002	0.0025		03/23/21 19:53	PS
	4,4-DDT	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:53	PS
	a-BHC	< 0.008	ug/L	0.25	0.008	0.0025		03/23/21 19:53	PS
	Aldrin	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:53	PS
	b-BHC	< 0.010	ug/L	0.25	0.010	0.0025		03/23/21 19:53	PS
	Chlordane	<0.025	ug/L	0.25		0.025		03/23/21 19:53	PS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-1-ELUT-WAT & SED Composite	Job Sample ID:	21031513.15
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	17:10	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 608.3	Organochlorine Pesticides								
	d-BHC	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:53	PS
	Dieldrin	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:53	PS
	Endosulfan I	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:53	PS
	Endosulfan II	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:53	PS
	Endosulfan sulfate	<0.003	ug/L	0.25	0.003	0.0025		03/23/21 19:53	PS
	Endrin	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 19:53	PS
	Endrin aldehyde	< 0.008	ug/L	0.25	0.008	0.0025		03/23/21 19:53	PS
	Endrin ketone	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:53	PS
	g-BHC	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:53	PS
	Heptachlor	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 19:53	PS
	Heptachlor epoxide	< 0.002	ug/L	0.25	0.002	0.0025		03/23/21 19:53	PS
	Toxaphene	<0.1	ug/L	0.25	0.1	0.025		03/23/21 19:53	PS
	Tetrachloro-m-xylene(surr)	43.9	%	0.25		24-127		03/23/21 19:53	PS
	Decachlorobiphenyl(surr)	32.5	%	0.25		34-120	S2	03/23/21 19:53	PS
EPA 624.1	Volatile Organic Compounds								
	1,1,1-Trichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	1,1,2,2-Tetrachloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	1,1,2-Trichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	1,1-Dichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	1,1-Dichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	1,2-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	1,2-Dichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	1,3-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	1,4-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	2-Butanone	<0.005	mg/L	1.00	0.005	0.005		03/23/21 13:52	RT
	Benzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Bromodichloromethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Bromoform	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Bromomethane	<0.002	mg/L	1.00	0.002	0.005		03/23/21 13:52	RT
	Carbon tetrachloride	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Chlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Chloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Chloroform	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Chloromethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	cis-1,3-Dichloropropene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Dibromochloromethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Ethylbenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name: DiSorbo Consulting LLC — Attn: Bob Davis

Project Name: Cedar Port Pre-Dredge Sampling

Client Sample ID:	MB-1-ELUT-WAT & SED Composite	Job Sample ID:	21031513.15
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	17:10	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 624.1	Volatile Organic Compounds								
	Methylene chloride	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Tetrachloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Toluene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	trans-1,2-Dichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	trans-1,3-Dichloropropene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Trichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Trichlorofluoromethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Vinyl Chloride	<0.001	mg/L	1.00	0.001	0.005		03/23/21 13:52	RT
	Dibromofluoromethane(surr)	120	%	1.00		70-130		03/23/21 13:52	RT
	1,2-Dichloroethane-d4(surr)	126	%	1.00		70-130		03/23/21 13:52	RT
	Toluene-d8(surr)	96.3	%	1.00		70-130		03/23/21 13:52	RT
	p-Bromofluorobenzene(surr)	101	%	1.00		70-130		03/23/21 13:52	RT
EPA 625.1	Semivolatile Organic Compounds								
	1,2,4-Trichlorobenzene	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 20:24	MS
	1,2-Dichlorobenzene	< 0.41	ug/L	0.25	0.410	1.25		03/22/21 20:24	MS
	1,3-Dichlorobenzene	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 20:24	MS
	1,4-Dichlorobenzene	< 0.25	ug/L	0.25	0.250	1.25		03/22/21 20:24	MS
	2,4-Dichlorophenol	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 20:24	MS
	2,4-Dimethylphenol	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 20:24	MS
	2,4-Dinitrophenol	< 1.41	ug/L	0.25	1.41	1.25		03/22/21 20:24	MS
	Acenaphthene	< 0.28	ug/L	0.25	0.280	1.25		03/22/21 20:24	MS
	Acenaphthylene	< 0.47	ug/L	0.25	0.470	1.25		03/22/21 20:24	MS
	Anthracene	< 0.35	ug/L	0.25	0.350	1.25		03/22/21 20:24	MS
	Benzo(a)anthracene	< 0.38	ug/L	0.25	0.380	1.25		03/22/21 20:24	MS
	Benzo(a)pyrene	< 0.85	ug/L	0.25	0.850	1.25		03/22/21 20:24	MS
	Benzo(b)fluoranthene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 20:24	MS
	Benzo(g,h,i)perylene	< 0.63	ug/L	0.25	0.630	1.25		03/22/21 20:24	MS
	Benzo(k)fluoranthene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 20:24	MS
	Chrysene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 20:24	MS
	Dibenzo(a,h)anthracene	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 20:24	MS
	Diethyl phthalate	< 0.63	ug/L	0.25	0.630	1.25		03/22/21 20:24	MS
	Fluoranthene	< 0.44	ug/L	0.25	0.440	1.25		03/22/21 20:24	MS
	Fluorene	< 0.47	ug/L	0.25	0.470	1.25		03/22/21 20:24	MS
	Hexachlorobenzene	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 20:24	MS
	Indeno(1,2,3-cd)pyrene	< 0.22	ug/L	0.25	0.220	1.25		03/22/21 20:24	MS
	Naphthalene	< 0.31	ug/L	0.25	0.310	1.25		03/22/21 20:24	MS
	Pentachlorophenol	< 0.5	ug/L	0.25	0.500	1.25		03/22/21 20:24	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-1-ELUT-WAT & SED Composite	Job Sample ID:	21031513.15
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:	17:10	% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 625.1	Semivolatile Organic Compounds								
	Phenanthrene	< 0.44	ug/L	0.25	0.440	1.25		03/22/21 20:24	MS
	Phenol	< 0.44	ug/L	0.25	0.440	1.25	L2	03/22/21 20:24	MS
	Pyrene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 20:24	MS
	2-Fluorophenol(surr)	31.8	%	0.25		15-115		03/22/21 20:24	MS
	Phenol-d6(surr)	23.1	%	0.25		10-130		03/22/21 20:24	MS
	Nitrobenzene-d5(surr)	64.8	%	0.25		23-120		03/22/21 20:24	MS
	2-Fluorobiphenyl(surr)	61.1	%	0.25		30-115		03/22/21 20:24	MS
	2,4,6-Tribromophenol(surr)	46.2	%	0.25		19-122		03/22/21 20:24	MS
	p-Terphenyl-d14(surr)	57.2	%	0.25		18-137		03/22/21 20:24	MS
EPA 625.1	Selected Ion Monitoring								
	Benzo(a)pyrene	< 0.025	ug/L	0.25	0.1	0.025		03/22/21 21:03	MS
	Chrysene	< 0.025	ug/L	0.25	0.1	0.025		03/22/21 21:03	MS
	2,4,6-Tribromophenol(surr)	47.2	%	0.25		19-122		03/22/21 21:03	MS
	2-Fluorobiphenyl(surr)	44.5	%	0.25		30-115		03/22/21 21:03	MS
	2-Fluorophenol(surr)	30.1	%	0.25		15-115		03/22/21 21:03	MS
	Nitrobenzene-d5(surr)	56.6	%	0.25		23-120		03/22/21 21:03	MS
	Phenol-d6(surr)	21.7	%	0.25		10-130		03/22/21 21:03	MS
	p-Terphenyl-d14(surr)	51.9	%	0.25		18-137		03/22/21 21:03	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-5-ELUT-WAT & SED Composite	Job Sample ID:	21031513.16
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:		% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SM 4500NH3D									
	Ammonia as N	0.71	mg/L	1		0.01		03/22/21 13:37	SG
SM 5310B	Total Organic Carbon								
	TOC	4.8	mg/L	1	0.35	1		03/22/21 17:00	AJ
EPA 200.8	Dissolved Metals								
	Antimony	0.984	ug/L	2.5	0.500	0.625	D1	03/22/21 22:24	GG
	Arsenic	3.35	ug/L	2.5	0.250	0.625		03/22/21 22:24	GG
	Cadmium	< 0.3	ug/L	2.5	0.300	0.625	D1	03/22/21 22:24	GG
	Chromium	0.344	ug/L	2.5	0.300	0.625	J	03/22/21 22:24	GG
	Copper	1.21	ug/L	2.5	1.00	0.625	D1	03/22/21 22:24	GG
	Lead	< 0.3	ug/L	2.5	0.300	0.625	D1	03/22/21 22:24	GG
	Nickel	2.17	ug/L	2.5	0.300	0.625		03/22/21 22:24	GG
	Silver	< 0.5	ug/L	2.5	0.500	0.625	D1	03/22/21 22:24	GG
	Zinc	5.26	ug/L	2.5	2.80	0.625		03/22/21 22:24	GG
EPA 245.1	Total Metals - Mercury								
	Mercury	< 0.06	ug/L	1	0.0600	0.2		03/23/21 13:04	BDC
TX 1005	Total Petroleum Hydrocarbons								
	C6-C12	<0.35	mg/L	1.00	0.35	2.15		03/23/21 00:21	AK
	>C12-C28	<0.37	mg/L	1.00	0.37	2.15		03/23/21 00:21	AK
	>C28-C35	<0.18	mg/L	1.00	0.18	2.15		03/23/21 00:21	AK
	Total C6-C35	<0.18	mg/L	1.00	0.18			03/23/21 00:21	AK
	Chlorooctadecane(surr)	91.5	%	1.00		70-125		03/23/21 00:21	AK
	1-Chlorooctane(surr)	80.5	%	1.00		70-125		03/23/21 00:21	AK
EPA 608.3	Polychlorinated Biphenyls								
	Total PCBs	<0.0129	ug/L	1	0.0129	0.05		03/23/21 23:21	PS
	Decachlorobiphenyl(surr)	55	%	0.25		35-129		03/23/21 23:21	PS
	Tetrachloro-m-xylene(surr)	60	%	0.25		27-127		03/23/21 23:21	PS
EPA 608.3	Organochlorine Pesticides								
	Alpha-chlordane	< 0.002	ug/L	0.25	0.002	0.0025		03/23/21 20:07	PS
	Gamma-chlordane	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 20:07	PS
	4,4-DDD	< 0.006	ug/L	0.25	0.006	0.0025		03/23/21 20:07	PS
	4,4-DDE	<0.002	ug/L	0.25	0.002	0.0025		03/23/21 20:07	PS
	4,4-DDT	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 20:07	PS
	a-BHC	< 0.008	ug/L	0.25	0.008	0.0025		03/23/21 20:07	PS
	Aldrin	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 20:07	PS
	b-BHC	< 0.010	ug/L	0.25	0.010	0.0025		03/23/21 20:07	PS
	Chlordane	<0.025	ug/L	0.25		0.025		03/23/21 20:07	PS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-5-ELUT-WAT & SED Composite	Job Sample ID:	21031513.16
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:		% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 608.3	Organochlorine Pesticides								
	d-BHC	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 20:07	PS
	Dieldrin	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 20:07	PS
	Endosulfan I	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 20:07	PS
	Endosulfan II	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 20:07	PS
	Endosulfan sulfate	<0.003	ug/L	0.25	0.003	0.0025		03/23/21 20:07	PS
	Endrin	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 20:07	PS
	Endrin aldehyde	< 0.008	ug/L	0.25	0.008	0.0025		03/23/21 20:07	PS
	Endrin ketone	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 20:07	PS
	g-BHC	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 20:07	PS
	Heptachlor	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 20:07	PS
	Heptachlor epoxide	< 0.002	ug/L	0.25	0.002	0.0025		03/23/21 20:07	PS
	Toxaphene	<0.1	ug/L	0.25	0.1	0.025		03/23/21 20:07	PS
	Tetrachloro-m-xylene(surr)	44.6	%	0.25		24-127		03/23/21 20:07	PS
	Decachlorobiphenyl(surr)	32.5	%	0.25		34-120	S2	03/23/21 20:07	PS
EPA 624.1	Volatile Organic Compounds								
	1,1,1-Trichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	1,1,2,2-Tetrachloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	1,1,2-Trichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	1,1-Dichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	1,1-Dichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	1,2-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	1,2-Dichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	1,3-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	1,4-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	2-Butanone	<0.005	mg/L	1.00	0.005	0.005		03/23/21 14:23	RT
	Benzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Bromodichloromethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Bromoform	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Bromomethane	<0.002	mg/L	1.00	0.002	0.005		03/23/21 14:23	RT
	Carbon tetrachloride	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Chlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Chloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Chloroform	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Chloromethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	cis-1,3-Dichloropropene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Dibromochloromethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Ethylbenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name: DiSorbo Consulting LLC   Attn: Bob Davis
Project Name: Cedar Port Pre-Dredge Sampling

Client Sample ID: MB-5-ELUT-WAT & SED Composite   Job Sample ID: 21031513.16
Date Collected: 03/17/21   Sample Matrix: Water
Time Collected: % Moisture
Other Information:

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 624.1	Volatile Organic Compounds								
	Methylene chloride	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Tetrachloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Toluene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	trans-1,2-Dichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	trans-1,3-Dichloropropene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Trichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Trichlorofluoromethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Vinyl Chloride	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:23	RT
	Dibromofluoromethane(surr)	116	%	1.00		70-130		03/23/21 14:23	RT
	1,2-Dichloroethane-d4(surr)	122	%	1.00		70-130		03/23/21 14:23	RT
	Toluene-d8(surr)	96.8	%	1.00		70-130		03/23/21 14:23	RT
	p-Bromofluorobenzene(surr)	102	%	1.00		70-130		03/23/21 14:23	RT
EPA 625.1	Semivolatile Organic Compounds								
	1,2,4-Trichlorobenzene	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 20:55	MS
	1,2-Dichlorobenzene	< 0.41	ug/L	0.25	0.410	1.25		03/22/21 20:55	MS
	1,3-Dichlorobenzene	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 20:55	MS
	1,4-Dichlorobenzene	< 0.25	ug/L	0.25	0.250	1.25		03/22/21 20:55	MS
	2,4-Dichlorophenol	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 20:55	MS
	2,4-Dimethylphenol	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 20:55	MS
	2,4-Dinitrophenol	< 1.41	ug/L	0.25	1.41	1.25		03/22/21 20:55	MS
	Acenaphthene	< 0.28	ug/L	0.25	0.280	1.25		03/22/21 20:55	MS
	Acenaphthylene	< 0.47	ug/L	0.25	0.470	1.25		03/22/21 20:55	MS
	Anthracene	< 0.35	ug/L	0.25	0.350	1.25		03/22/21 20:55	MS
	Benzo(a)anthracene	< 0.38	ug/L	0.25	0.380	1.25		03/22/21 20:55	MS
	Benzo(a)pyrene	< 0.85	ug/L	0.25	0.850	1.25		03/22/21 20:55	MS
	Benzo(b)fluoranthene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 20:55	MS
	Benzo(g,h,i)perylene	< 0.63	ug/L	0.25	0.630	1.25		03/22/21 20:55	MS
	Benzo(k)fluoranthene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 20:55	MS
	Chrysene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 20:55	MS
	Dibenzo(a,h)anthracene	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 20:55	MS
	Diethyl phthalate	< 0.63	ug/L	0.25	0.630	1.25		03/22/21 20:55	MS
	Fluoranthene	< 0.44	ug/L	0.25	0.440	1.25		03/22/21 20:55	MS
	Fluorene	< 0.47	ug/L	0.25	0.470	1.25		03/22/21 20:55	MS
	Hexachlorobenzene	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 20:55	MS
	Indeno(1,2,3-cd)pyrene	< 0.22	ug/L	0.25	0.220	1.25		03/22/21 20:55	MS
	Naphthalene	< 0.31	ug/L	0.25	0.310	1.25		03/22/21 20:55	MS
	Pentachlorophenol	< 0.5	ug/L	0.25	0.500	1.25		03/22/21 20:55	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-5-ELUT-WAT & SED Composite	Job Sample ID:	21031513.16
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:		% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 625.1	Semivolatile Organic Compounds								
	Phenanthrene	< 0.44	ug/L	0.25	0.440	1.25		03/22/21 20:55	MS
	Phenol	< 0.44	ug/L	0.25	0.440	1.25	L2	03/22/21 20:55	MS
	Pyrene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 20:55	MS
	2-Fluorophenol(surr)	27.5	%	0.25		15-115		03/22/21 20:55	MS
	Phenol-d6(surr)	18.8	%	0.25		10-130		03/22/21 20:55	MS
	Nitrobenzene-d5(surr)	54.2	%	0.25		23-120		03/22/21 20:55	MS
	2-Fluorobiphenyl(surr)	52	%	0.25		30-115		03/22/21 20:55	MS
	2,4,6-Tribromophenol(surr)	46.7	%	0.25		19-122		03/22/21 20:55	MS
	p-Terphenyl-d14(surr)	59.8	%	0.25		18-137		03/22/21 20:55	MS
EPA 625.1	Selected Ion Monitoring								
	Benzo(a)pyrene	< 0.025	ug/L	0.25	0.1	0.025		03/22/21 21:33	MS
	Chrysene	< 0.025	ug/L	0.25	0.1	0.025		03/22/21 21:33	MS
	Phenol-d6(surr)	16.8	%	0.25		10-130		03/22/21 21:33	MS
	p-Terphenyl-d14(surr)	54.3	%	0.25		18-137		03/22/21 21:33	MS
	2,4,6-Tribromophenol(surr)	48.9	%	0.25		19-122		03/22/21 21:33	MS
	2-Fluorobiphenyl(surr)	37.2	%	0.25		30-115		03/22/21 21:33	MS
	2-Fluorophenol(surr)	25	%	0.25		15-115		03/22/21 21:33	MS
	Nitrobenzene-d5(surr)	47.2	%	0.25		23-120		03/22/21 21:33	MS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis	
Project Name:	Cedar Port Pre-Dredge Sampling		

Client Sample ID:	MB-9-ELUT-WAT & SED Composite	Job Sample ID:	21031513.17
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:		% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
SM 4500NH3D									
	Ammonia as N	1.37	mg/L	5		0.05		03/22/21 13:37	SG
SM 5310B	Total Organic Carbon								
	TOC	4.6	mg/L	1	0.35	1		03/22/21 17:00	AJ
EPA 200.8	Dissolved Metals								
	Antimony	0.784	ug/L	2.5	0.500	0.625	D1	03/22/21 22:52	GG
	Arsenic	2.56	ug/L	2.5	0.250	0.625		03/22/21 22:52	GG
	Cadmium	< 0.3	ug/L	2.5	0.300	0.625	D1	03/22/21 22:52	GG
	Chromium	< 0.3	ug/L	2.5	0.300	0.625	D1	03/22/21 22:52	GG
	Copper	1.14	ug/L	2.5	1.00	0.625	D1	03/22/21 22:52	GG
	Lead	< 0.3	ug/L	2.5	0.300	0.625	D1	03/22/21 22:52	GG
	Nickel	1.9	ug/L	2.5	0.300	0.625		03/22/21 22:52	GG
	Silver	< 0.5	ug/L	2.5	0.500	0.625	D1	03/22/21 22:52	GG
	Zinc	9.71	ug/L	2.5	2.80	0.625		03/22/21 22:52	GG
EPA 245.1	Total Metals - Mercury								
	Mercury	< 0.06	ug/L	1	0.0600	0.2		03/23/21 13:07	BDC
TX 1005	Total Petroleum Hydrocarbons								
	C6-C12	<0.35	mg/L	1.00	0.35	2.15		03/23/21 00:50	AK
	>C12-C28	<0.37	mg/L	1.00	0.37	2.15		03/23/21 00:50	AK
	>C28-C35	<0.18	mg/L	1.00	0.18	2.15		03/23/21 00:50	AK
	Total C6-C35	<0.18	mg/L	1.00	0.18			03/23/21 00:50	AK
	Chlorooctadecane(surr)	98.2	%	1.00		70-125		03/23/21 00:50	AK
	1-Chlorooctane(surr)	86.5	%	1.00		70-125		03/23/21 00:50	AK
EPA 608.3	Polychlorinated Biphenyls								
	Total PCBs	<0.0129	ug/L	1	0.0129	0.05		03/23/21 23:25	PS
	Decachlorobiphenyl(surr)	58	%	0.25		35-129		03/23/21 23:35	PS
	Tetrachloro-m-xylene(surr)	60	%	0.25		27-127		03/23/21 23:35	PS
EPA 608.3	Organochlorine Pesticides								
	Alpha-chlordane	< 0.002	ug/L	0.25	0.002	0.0025		03/23/21 20:47	PS
	Gamma-chlordane	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 20:47	PS
	4,4-DDD	< 0.006	ug/L	0.25	0.006	0.0025		03/23/21 20:47	PS
	4,4-DDE	<0.002	ug/L	0.25	0.002	0.0025		03/23/21 20:47	PS
	4,4-DDT	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 20:47	PS
	a-BHC	< 0.008	ug/L	0.25	0.008	0.0025		03/23/21 20:47	PS
	Aldrin	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 20:47	PS
	b-BHC	< 0.010	ug/L	0.25	0.010	0.0025		03/23/21 20:47	PS
	Chlordane	<0.025	ug/L	0.25		0.025		03/23/21 20:47	PS

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-9-ELUT-WAT & SED Composite	Job Sample ID:	21031513.17
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:		% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 608.3	Organochlorine Pesticides								
	d-BHC	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 20:47	PS
	Dieldrin	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 20:47	PS
	Endosulfan I	< 0.003	ug/L	0.25	0.003	0.0025		03/23/21 20:47	PS
	Endosulfan II	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 20:47	PS
	Endosulfan sulfate	<0.003	ug/L	0.25	0.003	0.0025		03/23/21 20:47	PS
	Endrin	< 0.004	ug/L	0.25	0.004	0.0025		03/23/21 20:47	PS
	Endrin aldehyde	< 0.008	ug/L	0.25	0.008	0.0025		03/23/21 20:47	PS
	Endrin ketone	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 20:47	PS
	g-BHC	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 20:47	PS
	Heptachlor	< 0.005	ug/L	0.25	0.005	0.0025		03/23/21 20:47	PS
	Heptachlor epoxide	< 0.002	ug/L	0.25	0.002	0.0025		03/23/21 20:47	PS
	Toxaphene	<0.1	ug/L	0.25	0.1	0.025		03/23/21 20:47	PS
	Tetrachloro-m-xylene(surr)	46.3	%	0.25		24-127		03/23/21 20:47	PS
	Decachlorobiphenyl(surr)	33.1	%	0.25		34-120	S2	03/23/21 20:47	PS
EPA 624.1	Volatile Organic Compounds								
	1,1,1-Trichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	1,1,2,2-Tetrachloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	1,1,2-Trichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	1,1-Dichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	1,1-Dichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	1,2-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	1,2-Dichloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	1,3-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	1,4-Dichlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	2-Butanone	<0.005	mg/L	1.00	0.005	0.005		03/23/21 14:54	RT
	Benzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Bromodichloromethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Bromoform	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Bromomethane	<0.002	mg/L	1.00	0.002	0.005		03/23/21 14:54	RT
	Carbon tetrachloride	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Chlorobenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Chloroethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Chloroform	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Chloromethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	cis-1,3-Dichloropropene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Dibromochloromethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Ethylbenzene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT

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LABORATORY TEST RESULTS

Job ID : 21031513

Date 3/30/2021

Client Name: DiSorbo Consulting LLC   Attn: Bob Davis

Project Name: Cedar Port Pre-Dredge Sampling

Client Sample ID:	MB-9-ELUT-WAT & SED Composite	Job Sample ID:	21031513.17
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:		% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 624.1	Volatile Organic Compounds								
	Methylene chloride	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Tetrachloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Toluene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	trans-1,2-Dichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	trans-1,3-Dichloropropene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Trichloroethylene	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Trichlorofluoromethane	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Vinyl Chloride	<0.001	mg/L	1.00	0.001	0.005		03/23/21 14:54	RT
	Dibromofluoromethane(surr)	119	%	1.00		70-130		03/23/21 14:54	RT
	1,2-Dichloroethane-d4(surr)	125	%	1.00		70-130		03/23/21 14:54	RT
	Toluene-d8(surr)	96.9	%	1.00		70-130		03/23/21 14:54	RT
	p-Bromofluorobenzene(surr)	102	%	1.00		70-130		03/23/21 14:54	RT
EPA 625.1	Semivolatile Organic Compounds								
	1,2,4-Trichlorobenzene	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 21:25	MS
	1,2-Dichlorobenzene	< 0.41	ug/L	0.25	0.410	1.25		03/22/21 21:25	MS
	1,3-Dichlorobenzene	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 21:25	MS
	1,4-Dichlorobenzene	< 0.25	ug/L	0.25	0.250	1.25		03/22/21 21:25	MS
	2,4-Dichlorophenol	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 21:25	MS
	2,4-Dimethylphenol	< 0.53	ug/L	0.25	0.530	1.25		03/22/21 21:25	MS
	2,4-Dinitrophenol	< 1.41	ug/L	0.25	1.41	1.25		03/22/21 21:25	MS
	Acenaphthene	< 0.28	ug/L	0.25	0.280	1.25		03/22/21 21:25	MS
	Acenaphthylene	< 0.47	ug/L	0.25	0.470	1.25		03/22/21 21:25	MS
	Anthracene	< 0.35	ug/L	0.25	0.350	1.25		03/22/21 21:25	MS
	Benzo(a)anthracene	< 0.38	ug/L	0.25	0.380	1.25		03/22/21 21:25	MS
	Benzo(a)pyrene	< 0.85	ug/L	0.25	0.850	1.25		03/22/21 21:25	MS
	Benzo(b)fluoranthene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 21:25	MS
	Benzo(g,h,i)perylene	< 0.63	ug/L	0.25	0.630	1.25		03/22/21 21:25	MS
	Benzo(k)fluoranthene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 21:25	MS
	Chrysene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 21:25	MS
	Dibenzo(a,h)anthracene	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 21:25	MS
	Diethyl phthalate	< 0.63	ug/L	0.25	0.630	1.25		03/22/21 21:25	MS
	Fluoranthene	< 0.44	ug/L	0.25	0.440	1.25		03/22/21 21:25	MS
	Fluorene	< 0.47	ug/L	0.25	0.470	1.25		03/22/21 21:25	MS
	Hexachlorobenzene	< 0.69	ug/L	0.25	0.690	1.25		03/22/21 21:25	MS
	Indeno(1,2,3-cd)pyrene	< 0.22	ug/L	0.25	0.220	1.25		03/22/21 21:25	MS
	Naphthalene	< 0.31	ug/L	0.25	0.310	1.25		03/22/21 21:25	MS
	Pentachlorophenol	< 0.5	ug/L	0.25	0.500	1.25		03/22/21 21:25	MS

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L A B O R A T O R Y   T E S T   R E S U L T S

Job ID : 21031513

Date 3/30/2021

Client Name:	DiSorbo Consulting LLC	Attn: Bob Davis
Project Name:	Cedar Port Pre-Dredge Sampling	

Client Sample ID:	MB-9-ELUT-WAT & SED Composite	Job Sample ID:	21031513.17
Date Collected:	03/17/21	Sample Matrix	Water
Time Collected:		% Moisture	
Other Information:			

Test Method	Parameter/Test Description	Result	Units	DF	SDL	MQL	Q	Date Time	Analyst
EPA 625.1	Semivolatile Organic Compounds								
	Phenanthrene	< 0.44	ug/L	0.25	0.440	1.25		03/22/21 21:25	MS
	Phenol	< 0.44	ug/L	0.25	0.440	1.25	L2	03/22/21 21:25	MS
	Pyrene	< 0.57	ug/L	0.25	0.570	1.25		03/22/21 21:25	MS
	2-Fluorophenol(surr)	29.5	%	0.25		15-115		03/22/21 21:25	MS
	Phenol-d6(surr)	19	%	0.25		10-130		03/22/21 21:25	MS
	Nitrobenzene-d5(surr)	55.4	%	0.25		23-120		03/22/21 21:25	MS
	2-Fluorobiphenyl(surr)	51	%	0.25		30-115		03/22/21 21:25	MS
	2,4,6-Tribromophenol(surr)	39.8	%	0.25		19-122		03/22/21 21:25	MS
	p-Terphenyl-d14(surr)	50.2	%	0.25		18-137		03/22/21 21:25	MS
EPA 625.1	Selected Ion Monitoring								
	Benzo(a)pyrene	< 0.025	ug/L	0.25	0.1	0.025		03/22/21 22:03	MS
	Chrysene	< 0.025	ug/L	0.25	0.1	0.025		03/22/21 22:03	MS
	2,4,6-Tribromophenol(surr)	40.5	%	0.25		19-122		03/22/21 22:03	MS
	2-Fluorobiphenyl(surr)	37.9	%	0.25		30-115		03/22/21 22:03	MS
	2-Fluorophenol(surr)	27.3	%	0.25		15-115		03/22/21 22:03	MS
	Nitrobenzene-d5(surr)	49.6	%	0.25		23-120		03/22/21 22:03	MS
	Phenol-d6(surr)	17.6	%	0.25		10-130		03/22/21 22:03	MS
	p-Terphenyl-d14(surr)	45.5	%	0.25		18-137		03/22/21 22:03	MS

[1]-Parameter not covered by accreditation
[2]-Parameter not available for accreditation

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Total Petroleum Hydrocarbons **Method : TX 1005** **Reporting Units : mg/Kg**

QC Batch ID : Qb210318139 **Created Date :** 03/18/21 **Created By :** AKumar

Samples in This QC Batch : 21031513.08,09

Sample Preparation : PB21031858 **Prep Method :** TX 1005 **Prep Date :** 03/18/21 11:30 **Prep By :** AKumar

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
C6-C12	TPH-1005-1	< MDL	mg/Kg	1.00	25	9.49		
>C12-C28	TPH-1005-2	< MDL	mg/Kg	1.00	25	13.0		
>C28-C35	TPH-1005-4	< MDL	mg/Kg	1.00	25	6.88		
Total C6-C35		< MDL	mg/Kg	1.00	----	6.88		
Chlorooctadecane(surr)	3386-33-2	100	%	1.00				
1-Chlorooctane(surr)	111-85-3	94.7	%	1.00				

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
C6-C12	500	507	101	500	455	91.1	10.8	20	75-125	
>C12-C28	500	503	101	500	457	91.3	9.6	20	75-125	
>C28-C35	500	481	96.2	500	490	97.9	1.8	20	75-125	

QC Type: MS and MSD

QC Sample ID: 21031483.01

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
C6-C12	1.26	500	511	102	500	547	109	6.7	20	75-125	
>C12-C28	2.27	500	535	107	500	562	112	4.9	20	75-125	
>C28-C35	0.00	500	599	120	500	529	106	12.4	20	75-125	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Volatile Organic Compounds **Method : EPA 624.1** **Reporting Units : mg/L**

QC Batch ID : Qb21031931 **Created Date :** 03/18/21 **Created By :** Rajeev

Samples in This QC Batch : 21031513.01,03,05

Sample Preparation : PB21031941 **Prep Method :** EPA 624.1 **Prep Date :** 03/18/21 10:00 **Prep By :** Rajeev

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
1,1,1-Trichloroethane	71-55-6	< MDL	mg/L	1.00	0.005	0.001		
1,1,2,2-Tetrachloroethane	79-34-5	< MDL	mg/L	1.00	0.005	0.001		
1,1,2-Trichloroethane	79-00-5	< MDL	mg/L	1.00	0.005	0.001		
1,1-Dichloroethane	75-34-3	< MDL	mg/L	1.00	0.005	0.001		
1,1-Dichloroethylene	75-35-4	< MDL	mg/L	1.00	0.005	0.001		
1,2-Dichlorobenzene	95-50-1	< MDL	mg/L	1.00	0.005	0.001		
1,2-Dichloroethane	107-06-2	< MDL	mg/L	1.00	0.005	0.001		
1,3-Dichlorobenzene	541-73-1	< MDL	mg/L	1.00	0.005	0.001		
1,4-Dichlorobenzene	106-46-7	< MDL	mg/L	1.00	0.005	0.001		
2-Butanone	78-93-3	< MDL	mg/L	1.00	0.005	0.005		
Benzene	71-43-2	< MDL	mg/L	1.00	0.005	0.001		
Bromodichloromethane	75-27-4	< MDL	mg/L	1.00	0.005	0.001		
Bromoform	75-25-2	< MDL	mg/L	1.00	0.005	0.001		
Bromomethane	74-83-9	< MDL	mg/L	1.00	0.005	0.002		
Carbon tetrachloride	56-23-5	< MDL	mg/L	1.00	0.005	0.001		
Chlorobenzene	108-90-7	< MDL	mg/L	1.00	0.005	0.001		
Chloroethane	75-00-3	< MDL	mg/L	1.00	0.005	0.001		
Chloroform	67-66-3	< MDL	mg/L	1.00	0.005	0.001		
Chloromethane	74-87-3	< MDL	mg/L	1.00	0.005	0.001		
cis-1,3-Dichloropropene	10061-01-5	< MDL	mg/L	1.00	0.005	0.001		
Dibromochloromethane	124-48-1	< MDL	mg/L	1.00	0.005	0.001		
Ethylbenzene	100-41-4	< MDL	mg/L	1.00	0.005	0.001		
Methylene chloride	75-09-2	< MDL	mg/L	1.00	0.005	0.001		
Tetrachloroethylene	127-18-4	< MDL	mg/L	1.00	0.005	0.001		
Toluene	108-88-3	< MDL	mg/L	1.00	0.005	0.001		
trans-1,2-Dichloroethylene	156-60-5	< MDL	mg/L	1.00	0.005	0.001		
trans-1,3-Dichloropropene	10061-02-6	< MDL	mg/L	1.00	0.005	0.001		
Trichloroethylene	79-01-6	< MDL	mg/L	1.00	0.005	0.001		
Trichlorofluoromethane	75-69-4	< MDL	mg/L	1.00	0.005	0.001		
Vinyl Chloride	75-01-4	< MDL	mg/L	1.00	0.005	0.001		
Dibromofluoromethane(surr	1868-53-7	114	%	1.00				
1,2-Dichloroethane-d4(surr	17060-07-0	111	%	1.00				
Toluene-d8(surr)	2037-26-5	98.9	%	1.00				
p-Bromofluorobenzene(surr	460-00-4	103	%	1.00				

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Volatile Organic Compounds **Method : EPA 624.1** **Reporting Units : mg/L**

QC Batch ID : Qb21031931 **Created Date :** 03/18/21 **Created By :** Rajeev

Samples in This QC Batch : 21031513.01,03,05

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
1,1-Dichloroethylene	0.02	0.0235	118	0.02	0.0231	115	1.9	30	75.5-124	
Benzene	0.02	0.0215	107	0.02	0.0215	108	0.1	30	80-120	
Chlorobenzene	0.02	0.0210	105	0.02	0.0209	104	0.5	30	80-120	
Toluene	0.02	0.0214	107	0.02	0.0211	106	1.5	30	77.1-121	
Trichloroethylene	0.02	0.0211	106	0.02	0.0208	104	1.5	30	80-120	
1,1,1-Trichloroethane	0.02	0.0224	112	0.02	0.0221	111	1.4	30	80-120	
1,1,2,2-Tetrachloroethane	0.02	0.0185	92.3	0.02	0.0198	99.2	7	30	80-120	
1,1,2-Trichloroethane	0.02	0.0207	104	0.02	0.0215	107	3.7	30	80-120	
1,1-Dichloroethane	0.02	0.0227	114	0.02	0.0227	114	0.1	30	77.6-124	
1,2-Dichlorobenzene	0.02	0.0208	104	0.02	0.0204	102	1.7	30	83.2-121	
1,2-Dichloroethane	0.02	0.0219	110	0.02	0.0224	112	2.2	30	74.5-129	
1,3-Dichlorobenzene	0.02	0.0208	104	0.02	0.0206	103	1.1	30	80-120	
1,4-Dichlorobenzene	0.02	0.0210	105	0.02	0.0206	103	1.8	30	80-120	
Bromodichloromethane	0.02	0.0217	108	0.02	0.0217	108	0.1	30	80-119	
Bromoform	0.02	0.0194	96.9	0.02	0.0201	101	3.6	30	78.8-127	
Bromomethane	0.02	0.0208	104	0.02	0.0211	105	1.4	30	53-138	
Carbon tetrachloride	0.02	0.0218	109	0.02	0.0212	106	2.7	30	70-136	
Chloroethane	0.02	0.0208	104	0.02	0.0201	101	3.5	30	75.6-128	
Chloroform	0.02	0.0224	112	0.02	0.0226	113	0.9	30	79-123	
Chloromethane	0.02	0.0221	111	0.02	0.0222	111	0.4	30	69.6-125	
cis-1,3-Dichloropropene	0.02	0.0218	109	0.02	0.0218	109	0.2	30	80-120	
Dibromochloromethane	0.02	0.0206	103	0.02	0.0209	104	1.5	30	82.8-117	
Ethylbenzene	0.02	0.0214	107	0.02	0.0210	105	1.8	30	80-120	
Methylene chloride	0.02	0.0217	109	0.02	0.0217	109	0.1	30	69.4-131	
Tetrachloroethylene	0.02	0.0216	108	0.02	0.0208	104	3.8	30	40-168	
trans-1,2-Dichloroethylene	0.02	0.0229	115	0.02	0.0228	114	0.6	30	77.5-122	
trans-1,3-Dichloropropene	0.02	0.0213	107	0.02	0.0216	108	1.2	30	81.5-113	
Trichlorofluoromethane	0.02	0.0208	104	0.02	0.0213	106	2.4	30	80-132	
Vinyl Chloride	0.02	0.0214	107	0.02	0.0213	107	0.6	30	71.1-127	
2-Butanone	0.02	0.0219	109	0.02	0.0213	107	2.7	30	75-125	

QC Type: MS and MSD

QC Sample ID: 21031513.01

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
1,1-Dichloroethylene	BRL	0.02	0.0256	128						81-130	
Benzene	BRL	0.02	0.0225	113						84-132	
Chlorobenzene	BRL	0.02	0.0207	104						72-132	
Toluene	BRL	0.02	0.0218	109						72-136	
Trichloroethylene	BRL	0.02	0.0218	109						75-136	
1,1,1-Trichloroethane	BRL	0.02	0.0241	121						78-131	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis :	**Volatile Organic Compounds**	**Method :**	**EPA 624.1**	**Reporting Units :**	**mg/L**
QC Batch ID : Qb21031931	**Created Date :** 03/18/21	**Created By :**	Rajeev		
Samples in This QC Batch :	21031513.01,03,05				

QC Type: MS and MSD

QC Sample ID: 21031513.01

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
1,1,2,2-Tetrachloroethane	BRL	0.02	0.0256	128						66-145	
1,1,2-Trichloroethane	BRL	0.02	0.0241	120						69-138	
1,1-Dichloroethane	BRL	0.02	0.0248	124						84-128	
1,2-Dichlorobenzene	BRL	0.02	0.0205	103						73-138	
1,2-Dichloroethane	BRL	0.02	0.0264	132						65-154	
1,3-Dichlorobenzene	BRL	0.02	0.0201	100						74-136	
1,4-Dichlorobenzene	BRL	0.02	0.0201	101						71-136	
Bromodichloromethane	BRL	0.02	0.0238	119						83-134	
Bromoform	BRL	0.02	0.0232	116						68-135	
Bromomethane	BRL	0.02	0.0213	107						65-144	
Carbon tetrachloride	BRL	0.02	0.0262	131						70-136	
Chloroethane	BRL	0.02	0.0221	110						76-147	
Chloroform	BRL	0.02	0.0243	121						68-130	
Chloromethane	BRL	0.02	0.0227	113						73-127	
cis-1,3-Dichloropropene	BRL	0.02	0.0233	116						81-126	
Dibromochloromethane	BRL	0.02	0.0229	114						68-139	
Ethylbenzene	BRL	0.02	0.0212	106						75-133	
Methylene chloride	BRL	0.02	0.0238	119						74-126	
Tetrachloroethylene	BRL	0.02	0.0201	100						65-138	
trans-1,2-Dichloroethylene	BRL	0.02	0.0246	123						73-130	
trans-1,3-Dichloropropene	BRL	0.02	0.0232	116						73-129	
Trichlorofluoromethane	BRL	0.02	0.0236	118						78-143	
Vinyl Chloride	BRL	0.02	0.0225	113						58-135	
2-Butanone	BRL	0.02	0.0247	124						75-125	

ab-q213-0321

Refer to the Definition page for terms.

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Total Metals - Mercury **Method : EPA 245.1** **Reporting Units : mg/L**

QC Batch ID : Qb21031936 **Created Date :** 03/19/21 **Created By :** BChristofer

Samples in This QC Batch : 21031513.01,03,05,06

Digestion : PB21031937 **Prep Method :** EPA 245.1 **Prep Date :** 03/19/21 08:40 **Prep By :** JYou

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Mercury	7439-97-6T	< MDL	mg/L	1	0.0002	0.00006		

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Mercury	0.005	0.00543	109	0.005	0.00551	110	1.5	20	85-115	

QC Type: MS and MSD
QC Sample ID: 21031531.01

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
Mercury	BRL	0.005	0.00464	92.8						82-115	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Volatile Organic Compounds **Method : SW-846 8260C** **Reporting Units : mg/Kg**

QC Batch ID : Qb21031938 **Created Date :** 03/18/21 **Created By :** Rajeev

Samples in This QC Batch : 21031513.08,09,11,13

Sample Preparation :		**Prep Method :**		**Prep Date :**	**Prep By :**
	PB21031938		SW-846 5035A	03/17/21 11:00	Rajeev
	PB21031938		SW-846 5035A	03/18/21 15:10	Rajeev

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
1,1,1,2-Tetrachloroethane	630-20-6	< MDL	mg/Kg	1.00	0.005	0.00085		
1,1,1-Trichloroethane	71-55-6	< MDL	mg/Kg	1.00	0.005	0.00148		
1,1,2,2-Tetrachloroethane	79-34-5	< MDL	mg/Kg	1.00	0.005	0.00132		
1,1,2-Trichloroethane	79-00-5	< MDL	mg/Kg	1.00	0.005	0.00176		
1,1-Dichloroethane	75-34-3	< MDL	mg/Kg	1.00	0.005	0.00157		
1,1-Dichloroethylene	75-35-4	< MDL	mg/Kg	1.00	0.005	0.00173		
1,1-Dichloropropene	563-58-6	< MDL	mg/Kg	1.00	0.005	0.00144		
1,2,3-trichlorobenzene	87-61-6	< MDL	mg/Kg	1.00	0.005	0.00166		
1,2,3-Trichloropropane	96-18-4	< MDL	mg/Kg	1.00	0.005	0.00151		
1,2,4-Trichlorobenzene	120-82-1	< MDL	mg/Kg	1.00	0.005	0.00138		
1,2,4-Trimethylbenzene	95-63-6	< MDL	mg/Kg	1.00	0.005	0.00122		
1,2-Dibromo-3-chloropropa	96-12-8	< MDL	mg/Kg	1.00	0.005	0.00311		
1,2-Dibromoethane	106-93-4	< MDL	mg/Kg	1.00	0.005	0.00113		
1,2-Dichlorobenzene	95-50-1	< MDL	mg/Kg	1.00	0.005	0.00100		
1,2-Dichloroethane	107-06-2	< MDL	mg/Kg	1.00	0.005	0.00132		
1,2-Dichloropropane	78-87-5	< MDL	mg/Kg	1.00	0.005	0.00113		
1,3,5-Trimethylbenzene	108-67-8	< MDL	mg/Kg	1.00	0.005	0.00151		
1,3-Dichlorobenzene	541-73-1	< MDL	mg/Kg	1.00	0.005	0.00141		
1,3-Dichloropropane	142-28-9	< MDL	mg/Kg	1.00	0.005	0.00141		
1,4-Dichlorobenzene	106-46-7	< MDL	mg/Kg	1.00	0.005	0.00144		
2,2-Dichloropropane	594-20-7	< MDL	mg/Kg	1.00	0.005	0.00220		
2-Chlorotoluene	95-49-8	< MDL	mg/Kg	1.00	0.005	0.00144		
4-Chlorotoluene	106-43-4	< MDL	mg/Kg	1.00	0.005	0.00138		
4-Isopropyltoluene	99-87-6	< MDL	mg/Kg	1.00	0.005	0.00141		
Benzene	71-43-2	< MDL	mg/Kg	1.00	0.005	0.00107		
Bromobenzene	108-86-1	< MDL	mg/Kg	1.00	0.005	0.00113		
Bromochloromethane	74-97-5	< MDL	mg/Kg	1.00	0.005	0.00126		
Bromodichloromethane	75-27-4	< MDL	mg/Kg	1.00	0.005	0.00088		
Bromoform	75-25-2	< MDL	mg/Kg	1.00	0.005	0.00072		
Bromomethane	74-83-9	< MDL	mg/Kg	1.00	0.005	0.00170		
Carbon tetrachloride	56-23-5	< MDL	mg/Kg	1.00	0.005	0.00151		
Chlorobenzene	108-90-7	< MDL	mg/Kg	1.00	0.005	0.00148		
Chloroethane	75-00-3	< MDL	mg/Kg	1.00	0.005	0.00242		
Chloroform	67-66-3	< MDL	mg/Kg	1.00	0.005	0.00119		
Chloromethane	74-87-3	< MDL	mg/Kg	1.00	0.005	0.00226		
cis-1,2-Dichloroethylene	156-59-2	< MDL	mg/Kg	1.00	0.005	0.00119		
cis-1,3-Dichloropropene	10061-01-5	< MDL	mg/Kg	1.00	0.005	0.00113		

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Volatile Organic Compounds **Method : SW-846 8260C** **Reporting Units : mg/Kg**

QC Batch ID : Qb21031938 **Created Date :** 03/18/21 **Created By :** Rajeev

Samples in This QC Batch : 21031513.08,09,11,13

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Dibromochloromethane	124-48-1	< MDL	mg/Kg	1.00	0.005	0.00110		
Dibromomethane	74-95-3	< MDL	mg/Kg	1.00	0.005	0.00138		
Dichlorodifluoromethane	75-71-8	< MDL	mg/Kg	1.00	0.005	0.00135		
Ethylbenzene	100-41-4	< MDL	mg/Kg	1.00	0.005	0.00138		
Isopropylbenzene	98-82-8	< MDL	mg/Kg	1.00	0.005	0.00126		
m- & p-Xylenes	179601-23-1	< MDL	mg/Kg	1.00	0.01	0.00273		
MEK	78-93-3	< MDL	mg/Kg	1.00	0.005	0.00267		
Methylene chloride	75-09-2	< MDL	mg/Kg	1.00	0.005	0.00154		
Naphthalene	91-20-3	< MDL	mg/Kg	1.00	0.005	0.00188		
n-Butylbenzene	104-51-8	< MDL	mg/Kg	1.00	0.005	0.00179		
n-Propylbenzene	103-65-1	< MDL	mg/Kg	1.00	0.005	0.00138		
o-Xylene	95-47-6	< MDL	mg/Kg	1.00	0.005	0.00126		
sec-Butylbenzene	135-98-8	< MDL	mg/Kg	1.00	0.005	0.00160		
Styrene	100-42-5	< MDL	mg/Kg	1.00	0.005	0.00126		
t-butylbenzene	98-06-6	< MDL	mg/Kg	1.00	0.005	0.00141		
Tetrachloroethylene	127-18-4	< MDL	mg/Kg	1.00	0.005	0.00138		
Toluene	108-88-3	< MDL	mg/Kg	1.00	0.005	0.00119		
trans-1,2-Dichloroethylene	156-60-5	< MDL	mg/Kg	1.00	0.005	0.00144		
trans-1,3-Dichloropropene	10061-02-6	< MDL	mg/Kg	1.00	0.005	0.00094		
Trichloroethylene	79-01-6	< MDL	mg/Kg	1.00	0.005	0.00104		
Trichlorofluoromethane	75-69-4	< MDL	mg/Kg	1.00	0.005	0.00198		
Vinyl Chloride	75-01-4	< MDL	mg/Kg	1.00	0.005	0.00185		
Dibromofluoromethane(surr	1868-53-7	120	%	1.00				
1,2-Dichloroethane-d4(surr	17060-07-0	109	%	1.00				
Toluene-d8(surr)	2037-26-5	98.9	%	1.00				
p-Bromofluorobenzene(surr	460-00-4	111	%	1.00				

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
1,1,1,2-Tetrachloroethane	0.02	0.0222	111	0.02	0.0225	113	1.4	30	78-125	
1,1,1-Trichloroethane	0.02	0.0253	126	0.02	0.0257	128	1.6	30	70-130	
1,1,2,2-Tetrachloroethane	0.02	0.0215	107	0.02	0.0214	107	0.4	30	70-124	
1,1,2-Trichloroethane	0.02	0.0214	107	0.02	0.0213	106	0.3	30	78-121	
1,1-Dichloroethane	0.02	0.0237	118	0.02	0.0248	124	4.6	30	76-125	
1,1-Dichloroethylene	0.02	0.0240	120	0.02	0.0252	126	5	30	70-131	
1,1-Dichloropropene	0.02	0.0222	111	0.02	0.0227	113	2.2	30	76-125	
1,2,3-trichlorobenzene	0.02	0.0180	90.3	0.02	0.0202	101	11.2	30	66-130	
1,2,3-Trichloropropane	0.02	0.0217	109	0.02	0.0219	110	0.7	30	73-125	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Volatile Organic Compounds **Method : SW-846 8260C** **Reporting Units : mg/Kg**

QC Batch ID : Qb21031938 **Created Date :** 03/18/21 **Created By :** Rajeev

Samples in This QC Batch : 21031513.08,09,11,13

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
1,2,4-Trichlorobenzene	0.02	0.0185	92.6	0.02	0.0209	105	12.1	30	66-129	
1,2,4-Trimethylbenzene	0.02	0.0216	108	0.02	0.0227	113	4.8	30	75-123	
1,2-Dibromo-3-chloropropa	0.02	0.0194	96.9	0.02	0.0202	101	4.1	30	61-132	
1,2-Dibromoethane	0.02	0.0211	106	0.02	0.0211	106	0.2	30	78-122	
1,2-Dichlorobenzene	0.02	0.0214	107	0.02	0.0217	108	1.5	30	78-121	
1,2-Dichloroethane	0.02	0.0238	119	0.02	0.0238	119	0.2	30	71-128	
1,2-Dichloropropane	0.02	0.0217	109	0.02	0.0213	107	2	30	76-123	
1,3,5-Trimethylbenzene	0.02	0.0220	110	0.02	0.0224	112	1.8	30	73-124	
1,3-Dichlorobenzene	0.02	0.0212	106	0.02	0.0221	110	4	30	77-121	
1,3-Dichloropropane	0.02	0.0225	113	0.02	0.0229	114	1.7	30	77-121	
1,4-Dichlorobenzene	0.02	0.0216	108	0.02	0.0221	110	2.5	30	75-120	
2,2-Dichloropropane	0.02	0.0246	123	0.02	0.0256	128	4	30	67-133	
2-Chlorotoluene	0.02	0.0227	113	0.02	0.0230	115	1.4	30	75-122	
4-Chlorotoluene	0.02	0.0224	112	0.02	0.0228	114	1.6	30	72-124	
4-Isopropyltoluene	0.02	0.0216	108	0.02	0.0222	111	2.6	30	73-127	
Benzene	0.02	0.0219	110	0.02	0.0220	110	0.4	30	77-121	
Bromobenzene	0.02	0.0209	105	0.02	0.0205	103	2	30	78-121	
Bromochloromethane	0.02	0.0256	128	0.02	0.0251	126	2.1	30	75-125	L1
Bromodichloromethane	0.02	0.0236	118	0.02	0.0233	116	1.3	30	71-127	
Bromoform	0.02	0.0220	110	0.02	0.0218	109	1.1	30	67-132	
Bromomethane	0.02	0.0247	123	0.02	0.0239	119	3.2	30	55-140	
Carbon tetrachloride	0.02	0.0238	119	0.02	0.0235	117	1.1	30	69-135	
Chlorobenzene	0.02	0.0221	111	0.02	0.0218	109	1.4	30	79-120	
Chloroethane	0.02	0.0243	121	0.02	0.0241	121	0.7	30	59-139	
Chloroform	0.02	0.0243	122	0.02	0.0253	127	3.9	30	78-123	L1
Chloromethane	0.02	0.0229	115	0.02	0.0255	128	10.5	30	50-136	
cis-1,2-Dichloroethylene	0.02	0.0245	123	0.02	0.0251	126	2.3	30	77-123	L1
cis-1,3-Dichloropropene	0.02	0.0223	111	0.02	0.0218	109	2.2	30	74-126	
Dibromochloromethane	0.02	0.0226	113	0.02	0.0221	110	2.1	30	74-126	
Dibromomethane	0.02	0.0235	118	0.02	0.0226	113	4	30	78-125	
Dichlorodifluoromethane	0.02	0.0201	101	0.02	0.0223	112	10.2	30	29-149	
Ethylbenzene	0.02	0.0224	112	0.02	0.0220	110	2	30	76-122	
Isopropylbenzene	0.02	0.0222	111	0.02	0.0221	110	0.6	30	68-134	
m- & p-Xylenes	0.04	0.0453	113	0.04	0.0450	113	0.6	30	77-124	
MEK	0.02	0.0247	123	0.02	0.0213	107	14.7	30	51-148	
Methylene chloride	0.02	0.0195	97.7	0.02	0.0183	91.5	6.5	30	70-128	
Naphthalene	0.02	0.0164	82.1	0.02	0.0198	98.9	18.7	30	62-129	
n-Butylbenzene	0.02	0.0218	109	0.02	0.0227	114	4.1	30	70-128	
n-Propylbenzene	0.02	0.0221	111	0.02	0.0225	112	1.7	30	73-125	
o-Xylene	0.02	0.0222	111	0.02	0.0219	109	1.6	30	77-123	
sec-Butylbenzene	0.02	0.0219	109	0.02	0.0226	113	3.3	30	73-126	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Volatile Organic Compounds **Method : SW-846 8260C** **Reporting Units : mg/Kg**

QC Batch ID : Qb21031938 **Created Date :** 03/18/21 **Created By :** Rajeev

Samples in This QC Batch : 21031513.08,09,11,13

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Styrene	0.02	0.0223	112	0.02	0.0212	106	5.1	30	76-124	
t-butylbenzene	0.02	0.0202	101	0.02	0.0206	103	1.8	30	73-125	
Tetrachloroethylene	0.02	0.0224	112	0.02	0.0217	109	3.1	30	73-128	
Toluene	0.02	0.0228	114	0.02	0.0227	114	0.3	30	77-121	
trans-1,2-Dichloroethylene	0.02	0.0242	121	0.02	0.0254	127	5	30	74-125	L1
trans-1,3-Dichloropropene	0.02	0.0216	108	0.02	0.0223	112	3.4	30	71-130	
Trichloroethylene	0.02	0.0213	106	0.02	0.0216	108	1.5	30	77-123	
Trichlorofluoromethane	0.02	0.0263	131	0.02	0.0278	139	5.7	30	62-140	
Vinyl Chloride	0.02	0.0222	111	0.02	0.0239	120	7.3	30	56-135	

QC Type: MS and MSD
QC Sample ID: 21031513.09

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
1,1,1,2-Tetrachloroethane	BRL	0.019	0.0205	108						71.4-131	
1,1,1-Trichloroethane	BRL	0.019	0.0226	119						69.6-140	
1,1,2,2-Tetrachloroethane	BRL	0.019	0.0204	107						66.6-128	
1,1,2-Trichloroethane	BRL	0.019	0.0208	110						72.8-125	
1,1-Dichloroethane	BRL	0.019	0.0223	117						72.7-129	
1,1-Dichloroethylene	BRL	0.019	0.0226	119						71.4-131	
1,1-Dichloropropene	BRL	0.019	0.0205	108						75.9-132	
1,2,3-trichlorobenzene	BRL	0.019	0.0154	81						56.7-153	
1,2,3-Trichloropropane	BRL	0.019	0.0214	113						61.6-138	
1,2,4-Trichlorobenzene	BRL	0.019	0.0156	81.9						55.9-150	
1,2,4-Trimethylbenzene	BRL	0.019	0.0202	106						71.1-131	
1,2-Dibromo-3-chloropropa	BRL	0.019	0.0197	104						52.4-150	
1,2-Dibromoethane	BRL	0.019	0.0202	106						72.9-125	
1,2-Dichlorobenzene	BRL	0.019	0.0192	101						76.1-126	
1,2-Dichloroethane	BRL	0.019	0.0225	118						66.4-134	
1,2-Dichloropropane	BRL	0.019	0.0208	109						70.2-128	
1,3,5-Trimethylbenzene	BRL	0.019	0.0202	106						75.1-127	
1,3-Dichlorobenzene	BRL	0.019	0.0196	103						73.9-126	
1,3-Dichloropropane	BRL	0.019	0.0223	117						68.3-124	
1,4-Dichlorobenzene	BRL	0.019	0.0197	104						72.3-127	
2,2-Dichloropropane	BRL	0.019	0.0182	95.8						68.5-138	
2-Chlorotoluene	BRL	0.019	0.0206	109						71.7-128	
4-Chlorotoluene	BRL	0.019	0.0203	107						72.2-126	
4-Isopropyltoluene	BRL	0.019	0.0198	104						77.5-125	
Benzene	BRL	0.019	0.0207	109						74-126	
Bromobenzene	BRL	0.019	0.0192	101						73.3-129	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Volatile Organic Compounds **Method : SW-846 8260C** **Reporting Units : mg/Kg**

QC Batch ID : Qb21031938 **Created Date :** 03/18/21 **Created By :** Rajeev

Samples in This QC Batch : 21031513.08,09,11,13

QC Type: MS and MSD
QC Sample ID: 21031513.09

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
Bromochloromethane	BRL	0.019	0.0229	121						68.8-131	
Bromodichloromethane	BRL	0.019	0.0224	118						69-135	
Bromoform	BRL	0.019	0.0206	108						62-146	
Bromomethane	BRL	0.019	0.0222	117						58.7-139	
Carbon tetrachloride	BRL	0.019	0.0214	112						68.7-135	
Chlorobenzene	BRL	0.019	0.0198	104						73.3-129	
Chloroethane	BRL	0.019	0.0229	121						66.2-129	
Chloroform	BRL	0.019	0.0228	120						73.7-134	
Chloromethane	BRL	0.019	0.0209	110						51.4-135	
cis-1,2-Dichloroethylene	BRL	0.019	0.0219	115						72.4-132	
cis-1,3-Dichloropropene	BRL	0.019	0.0205	108						67.7-134	
Dibromochloromethane	BRL	0.019	0.0209	110						73.2-126	
Dibromomethane	BRL	0.019	0.0219	115						69.9-134	
Dichlorodifluoromethane	BRL	0.019	0.0159	83.7						36.8-144	
Ethylbenzene	BRL	0.019	0.0201	106						72.2-128	
Isopropylbenzene	BRL	0.019	0.0199	105						71.2-131	
m- & p-Xylenes	BRL	0.038	0.0405	107						70.7-131	
MEK	BRL	0.019	0.0169	88.8						52.5-152	
Methylene chloride	BRL	0.019	0.0177	93.1						70.6-129	
Naphthalene	BRL	0.019	0.0147	77.4						60.7-145	
n-Butylbenzene	BRL	0.019	0.0194	102						66.5-136	
n-Propylbenzene	BRL	0.019	0.0205	108						73.3-126	
o-Xylene	BRL	0.019	0.0203	107						71.6-130	
sec-Butylbenzene	BRL	0.019	0.0203	107						77.9-124	
Styrene	BRL	0.019	0.0193	101						71.1-131	
t-butylbenzene	BRL	0.019	0.0181	95.3						74.4-130	
Tetrachloroethylene	BRL	0.019	0.0208	109						62.6-157	
Toluene	BRL	0.019	0.0204	107						73.3-127	
trans-1,2-Dichloroethylene	BRL	0.019	0.0225	118						70-130	
trans-1,3-Dichloropropene	BRL	0.019	0.0196	103						71.5-124	
Trichloroethylene	BRL	0.019	0.0201	106						69.2-133	
Trichlorofluoromethane	BRL	0.019	0.0242	127						63.9-140	
Vinyl Chloride	BRL	0.019	0.0205	108						40.9-159	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Corrosivity, pH **Method : SW-846 9045D** **Reporting Units : s.u.**

QC Batch ID : Qb21031941 **Created Date :** 03/19/21 **Created By :** Surayah

Samples in This QC Batch : 21031513.08,09

QC Type: Duplicate

QC Sample ID: 21031463.01

Parameter	QCSample Result	Sample Result	Units	RPD	RPD CtrlLimit		Qual
pH	5.6	5.6	s.u.	0	5		

QC Type: LCS and LCSD

Parameter	LCS Assigned	LCS Result		LCSD Assigned	LCSD Result		RPD	RPD CtrlLimit	Tolerance	Qual
pH	4.0	4.05							98.75-101.25	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : % Moisture **Method : SM 2540G** **Reporting Units : %**

QC Batch ID : Qb21031943 **Created Date :** 03/19/21 **Created By :** Surayah

Samples in This QC Batch : 21031513.08,09

Sample Preparation : PB21031942 **Prep Method :** SM 2540G **Prep Date :** 03/19/21 08:10 **Prep By :** Surayah

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
% Moisture		< MDL	%	1	0.1			

QC Type: Duplicate

QC Sample ID: 21031600.01

Parameter	QCSample Result	Sample Result	Units	RPD	RPD CtrlLimit		Qual
% Moisture	2.63	3.06	%	15.1	20		

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Total Metals - Mercury **Method : SW-846 7470A** **Reporting Units : mg/Kg**

QC Batch ID : Qb21031950 **Created Date :** 03/19/21 **Created By :** BChristofer

Samples in This QC Batch : 21031513.08,09

Digestion : PB21031948 **Prep Method :** SW-846 7470A **Prep Date :** 03/19/21 08:30 **Prep By :** JYou

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Mercury	7439-97-6T	< MDL	mg/Kg	1	0.004	0.00088		

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Mercury	0.1	0.101	101	0.1	0.100	100	0.8	20	80-120	

QC Type: MS and MSD
QC Sample ID: 21031513.09

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
Mercury	0.0272	0.2	0.213	92.9						80-120	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Total Petroleum Hydrocarbons **Method : TX 1005** **Reporting Units : mg/L**

QC Batch ID : Qb21031988 **Created Date :** 03/19/21 **Created By :** AKumar

Samples in This QC Batch : 21031513.15,16,17

Sample Preparation : PB21031959 **Prep Method :** TX 1005 **Prep Date :** 03/19/21 15:00 **Prep By :** AKumar

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
C6-C12	TPH-1005-1	< MDL	mg/L	1.00	2.15	0.35		
>C12-C28	TPH-1005-2	< MDL	mg/L	1.00	2.15	0.37		
>C28-C35	TPH-1005-4	< MDL	mg/L	1.00	2.15	0.18		
Total C6-C35		< MDL	mg/L	1.00	----	0.18		
Chlorooctadecane(surr)	3386-33-2	94.2	%	1.00				
1-Chlorooctane(surr)	111-85-3	94.3	%	1.00				

QC Type: Duplicate

QC Sample ID: 21031658.10

Parameter	QCSample Result	Sample Result	Units	RPD	RPD CtrlLimit		Qual
>C12-C28	BRL	0.188	mg/L	0	+20		
>C28-C35	BRL	0.083	mg/L	0	+20		
C6-C12	BRL	0.425	mg/L	0	+20		
Total C6-C35	BRL	0.696	mg/L	0	+20		

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
C6-C12	43	42.1	97.9	43	43.1	100	2.3	20	75-125	
>C12-C28	43	45.0	105	43	46.8	109	4	20	75-125	
>C28-C35	43	43.2	101	43	46.5	108	7.3	20	75-125	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Total Petroleum Hydrocarbons **Method : TX 1005** **Reporting Units : mg/L**

QC Batch ID : Qb21031989 **Created Date :** 03/19/21 **Created By :** AKumar

Samples in This QC Batch : 21031513.01,03,05

Sample Preparation : PB21031958 **Prep Method :** TX 1005 **Prep Date :** 03/19/21 14:00 **Prep By :** AKumar

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
C6-C12	TPH-1005-1	< MDL	mg/L	1.00	2.15	0.35		
>C12-C28	TPH-1005-2	< MDL	mg/L	1.00	2.15	0.37		
>C28-C35	TPH-1005-4	< MDL	mg/L	1.00	2.15	0.18		
Total C6-C35		< MDL	mg/L	1.00	----	0.18		
Chlorooctadecane(surr)	3386-33-2	96.2	%	1.00				
1-Chlorooctane(surr)	111-85-3	93.9	%	1.00				

QC Type: Duplicate

QC Sample ID: 21031513.03

Parameter	QCSample Result	Sample Result	Units	RPD	RPD CtrlLimit		Qual
>C12-C28	BRL	0.170	mg/L	0	+20		
>C28-C35	BRL	0.023	mg/L	0	+20		
C6-C12	BRL	0.241	mg/L	0	+20		
Total C6-C35	BRL	0.434	mg/L	0	+20		

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
C6-C12	43	45.0	105	43	45.0	105	0	20	75-125	
>C12-C28	43	49.7	116	43	48.4	113	2.6	20	75-125	
>C28-C35	43	46.2	108	43	44.4	103	4	20	75-125	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Metals by ICP/MS **Method : SW-846 6020B** **Reporting Units : mg/Kg**

QC Batch ID : Qb210322104 **Created Date :** 03/22/21 **Created By :** Ggorane

Samples in This QC Batch : 21031513.08,09,11,13

Digestion : PB21032244 **Prep Method :** SW-846 3050B **Prep Date :** 03/19/21 12:30 **Prep By :** JYou

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Antimony	7440-36-0	< MDL	mg/Kg	1	0.125	0.10		
Arsenic	7440-38-2T	< MDL	mg/Kg	1	0.125	0.08		
Cadmium	7440-43-9	< MDL	mg/Kg	1	0.125	0.07		
Chromium	7440-47-3T	< MDL	mg/Kg	1	0.125	0.11		
Copper	7440-50-8	< MDL	mg/Kg	1	0.125	0.02		
Lead	7439-92-1T	< MDL	mg/Kg	1	0.125	0.11		
Nickel	7440-02-0	< MDL	mg/Kg	1	0.125	0.02		
Silver	7440-22-4	< MDL	mg/Kg	1	0.125	0.13		
Zinc	7440-66-6T	< MDL	mg/Kg	1	0.5	0.57		

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Antimony	25	24.7	98.8	25	25.3	101	2.4	20	80-120	
Arsenic	25	28.1	112	25	27.9	111	0.8	20	80-120	
Cadmium	25	24.5	97.9	25	24.5	98.1	0.1	20	80-120	
Chromium	25	23.4	93.6	25	23.5	93.8	0.4	20	80-120	
Copper	25	23.6	94.5	25	23.6	94.6	0.1	20	80-120	
Lead	25	24.6	98.2	25	25.0	100	1.8	20	80-120	
Nickel	25	24.4	97.5	25	24.4	97.5	0.1	20	80-120	
Silver	25	22.6	90.3	25	22.3	89.2	1.2	20	80-120	
Zinc	25	25.0	100	25	25.3	101	1.1	20	80-120	

QC Type: MS and MSD

QC Sample ID: 21031410.01

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
Antimony	BRL	25	9.39	37.6						75-125	M2
Arsenic	2.10	25	31.6	118						75-125	
Cadmium	BRL	25	26.6	106						75-125	
Chromium	5.60	25	33.4	111						75-125	
Copper	3.81	25	29.8	104						75-125	
Lead	5.21	25	29.6	97.6						75-125	
Nickel	4.86	25	31.6	107						75-125	
Silver	BRL	25	25.9	104						75-125	
Zinc	13.4	25	41.7	113						75-125	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Total Metals - Mercury **Method : SW-846 7470A** **Reporting Units : mg/Kg**

QC Batch ID : Qb210322108 **Created Date :** 03/22/21 **Created By :** BChristofer

Samples in This QC Batch : 21031513.11,13

Digestion : PB21032260 **Prep Method :** SW-846 7470A **Prep Date :** 03/22/21 08:45 **Prep By :** JYou

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Mercury	7439-97-6T	< MDL	mg/Kg	1	0.004	0.00088		

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Mercury	0.1	0.101	101	0.1	0.0961	96.1	4.9	20	80-120	

QC Type: MS and MSD
QC Sample ID: 21031513.13

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
Mercury	0.0276	0.1	0.118	90.5						80-120	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : % Moisture **Method : SM 2540G** **Reporting Units : %**

QC Batch ID : Qb21032212 **Created Date :** 03/22/21 **Created By :** Surayah

Samples in This QC Batch : 21031513.11,13

Sample Preparation : PB21032205 **Prep Method :** SM 2540G **Prep Date :** 03/20/21 14:30 **Prep By :** Surayah

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
% Moisture		< MDL	%	1	0.1			

QC Type: Duplicate

QC Sample ID: 21031562.01

Parameter	QCSample Result	Sample Result	Units	RPD	RPD CtrlLimit		Qual
% Moisture	17.9	17.5	%	2.3	20		

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Corrosivity, pH **Method : SW-846 9045D** **Reporting Units : s.u.**

QC Batch ID : Qb21032237 **Created Date :** 03/22/21 **Created By :** Surayah

Samples in This QC Batch : 21031513.11

QC Type: Duplicate

QC Sample ID: 21031513.11

Parameter	QCSample Result	Sample Result	Units	RPD	RPD CtrlLimit		Qual
pH	8.8	8.8	s.u.	0	5		

QC Type: LCS and LCSD

Parameter	LCS Assigned	LCS Result		LCSD Assigned	LCSD Result		RPD	RPD CtrlLimit	Tolerance	Qual
pH	4.0	3.98							98.75-101.25	

ab-q213-0321

Refer to the Definition page for terms.

DRAFT

QUALITY CONTROL CERTIFICATE

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Total Petroleum Hydrocarbons **Method : TX 1005** **Reporting Units : mg/Kg**

QC Batch ID : Qb21032269 **Created Date :** 03/22/21 **Created By :** AKumar

Samples in This QC Batch : 21031513.11

Sample Preparation : PB21032229 **Prep Method :** TX 1005 **Prep Date :** 03/22/21 11:00 **Prep By :** AKumar

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
C6-C12	TPH-1005-1	< MDL	mg/Kg	1.00	25	9.49		
>C12-C28	TPH-1005-2	< MDL	mg/Kg	1.00	25	13.0		
>C28-C35	TPH-1005-4	< MDL	mg/Kg	1.00	25	6.88		
Total C6-C35		< MDL	mg/Kg	1.00	----	6.88		
Chlorooctadecane(surr)	3386-33-2	114	%	1.00				
1-Chlorooctane(surr)	111-85-3	109	%	1.00				

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
C6-C12	500	533	107	500	526	105	1.4	20	75-125	
>C12-C28	500	581	116	500	581	116	0.1	20	75-125	
>C28-C35	500	504	101	500	520	104	3.2	20	75-125	

QC Type: MS and MSD

QC Sample ID: 21031513.11

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
C6-C12	5.37	500	506	100	500	507	100	0.1	20	75-125	
>C12-C28	5.22	500	548	109	500	529	105	3.6	20	75-125	
>C28-C35	0.35	500	549	110	500	532	106	3	20	75-125	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : **Method :** **SM4500NH3-Dm** **Reporting Units : mg/Kg**

QC Batch ID : Qb21032279 **Created Date :** 03/22/21 **Created By :** Sgarcia

Samples in This QC Batch : 21031513.08,09,11,13

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Ammonia as N	NH3-N	< MDL	mg/Kg	1	0.1	0.02		

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Ammonia as N	50	50.0	100	50	49.4	98.8	1.2		80-120	

QC Type: MS and MSD
QC Sample ID: 21031513.08

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
Ammonia as N	3.53	50	55.7	104	50	53.6	100	3.8		80-120	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : **Method :** **SM 4500NH3D** **Reporting Units : mg/L**

QC Batch ID : Qb21032282 **Created Date :** 03/22/21 **Created By :** Sgarcia

Samples in This QC Batch : 21031513.01,03,05,15,16,17

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Ammonia as N	NH3-N	< MDL	mg/L	1	0.01			

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Ammonia as N	0.5	0.48	96	0.5	0.49	98	2.1		87.1-115	

QC Type: MS and MSD
QC Sample ID: 21031513.01

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
Ammonia as N	0.05	0.5	0.52	94	0.5	0.52	94	0	20	85.2-121	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Total Organic Carbon **Method : SM 5310B** **Reporting Units : mg/L**

QC Batch ID : Qb21032284 **Created Date :** 03/22/21 **Created By :** Ajohn

Samples in This QC Batch : 21031513.01,03,05

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
TOC		< MDL	mg/L	1	1	0.35		

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
TOC	10	9.1	91						89.4-113	

QC Type: MS and MSD
QC Sample ID: 21031507.01

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
TOC	8.7	5	13.7	100	5	13.6	98	0.7	10	80-120	

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Total Organic Carbon **Method : SM 5310B** **Reporting Units : mg/L**

QC Batch ID : Qb21032286 **Created Date :** 03/22/21 **Created By :** Ajohn

Samples in This QC Batch : 21031513.15,16,17

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
TOC		< MDL	mg/L	1	1	0.35		

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
TOC	10	9.5	95						89.4-113	

QC Type: MS and MSD
QC Sample ID: 21031742.01

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
TOC	25.0	5	30.3	106	5	30.7	114	1.3	10	80-120	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Total Petroleum Hydrocarbons **Method : TX 1005** **Reporting Units : mg/Kg**

QC Batch ID : Qb21032297 **Created Date :** 03/22/21 **Created By :** AKumar

Samples in This QC Batch : 21031513.13

Sample Preparation : PB21032249 **Prep Method :** TX 1005 **Prep Date :** 03/22/21 15:00 **Prep By :** AKumar

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
C6-C12	TPH-1005-1	< MDL	mg/Kg	1.00	25	9.49		
>C12-C28	TPH-1005-2	< MDL	mg/Kg	1.00	25	13.0		
>C28-C35	TPH-1005-4	< MDL	mg/Kg	1.00	25	6.88		
Total C6-C35		< MDL	mg/Kg	1.00	----	6.88		
Chlorooctadecane(surr)	3386-33-2	125	%	1.00				
1-Chlorooctane(surr)	111-85-3	120	%	1.00				

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
C6-C12	500	532	106	500	539	108	1.2	20	75-125	
>C12-C28	500	570	114	500	589	118	3.2	20	75-125	
>C28-C35	500	554	111	500	566	113	2.2	20	75-125	

QC Type: MS and MSD

QC Sample ID: 21031513.13

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
C6-C12	1.06	500	569	114	500	567	113	0.5	20	75-125	
>C12-C28	1.14	500	602	120	500	577	115	4.3	20	75-125	
>C28-C35	0.05	500	503	101	500	513	103	2	20	75-125	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Salinity (Electrical Conductivity Method) **Method : SM 2520B** **Reporting Units : s.u.**

QC Batch ID : Qb210323105 **Created Date :** 03/23/21 **Created By :** LEBell

Samples in This QC Batch : 21031513.01,03

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Salinity		< MDL	s.u.	1	2	0.52		

QC Type: Duplicate

QC Sample ID: 21031513.01

Parameter	QCSample Result	Sample Result	Units	RPD	RPD CtrlLimit		Qual
Salinity	11.3	11.3		0	20		

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis :	**Semivolatile Organic Compounds**	**Method :**	**SW-846 8270D**	**Reporting Units : mg/Kg**

QC Batch ID : Qb21032315 **Created Date :** 03/22/21 **Created By :** MShah

Samples in This QC Batch : 21031513.08,09,11,13

Extraction : PB21032241 **Prep Method :** SW-846 3546 **Prep Date :** 03/22/21 12:30 **Prep By :** MMuteen

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
1,2,4-Trichlorobenzene	120-82-1	< MDL	mg/Kg	0.25	0.04175	0.02167		
1,2-Dichlorobenzene	95-50-1	< MDL	mg/Kg	0.25	0.04175	0.02167		
1,3-Dichlorobenzene	541-73-1	< MDL	mg/Kg	0.25	0.04175	0.03065		
1,4-Dichlorobenzene	106-46-7	< MDL	mg/Kg	0.25	0.04175	0.02374		
2,4-Dichlorophenol	120-83-2	< MDL	mg/Kg	0.25	0.04175	0.02167		
2,4-Dimethylphenol	105-67-9	< MDL	mg/Kg	0.25	0.04175	0.02374		
2,4-Dinitrophenol	51-28-5	< MDL	mg/Kg	0.25	0.04175	0.05567		
Acenaphthene	83-32-9	< MDL	mg/Kg	0.25	0.04175	0.01532		
Acenaphthylene	208-96-8	< MDL	mg/Kg	0.25	0.04175	0.02374		
Anthracene	120-12-7	< MDL	mg/Kg	0.25	0.04175	0.01812		
Benzo(a)anthracene	56-55-3	< MDL	mg/Kg	0.25	0.04175	0.02826		
Benzo(a)pyrene	50-32-8	< MDL	mg/Kg	0.25	0.04175	0.04333		
Benzo(b)fluoranthene	205-99-2	< MDL	mg/Kg	0.25	0.04175	0.02986		
Benzo(g,h,i)perylene	191-24-2	< MDL	mg/Kg	0.25	0.04175	0.02986		
Benzo(k)fluoranthene	207-08-9	< MDL	mg/Kg	0.25	0.04175	0.04697		
Chrysene	218-01-9	< MDL	mg/Kg	0.25	0.04175	0.02374		
Dibenzo(a,h)anthracene	53-70-3	< MDL	mg/Kg	0.25	0.04175	0.04942		
Diethyl phthalate	84-66-2	< MDL	mg/Kg	0.25	0.04175	0.02986		
Fluoranthene	206-44-0	< MDL	mg/Kg	0.25	0.04175	0.02562		
Fluorene	86-73-7	< MDL	mg/Kg	0.25	0.04175	0.01187		
Hexachlorobenzene	118-74-1	< MDL	mg/Kg	0.25	0.04175	0.03994		
Indeno(1,2,3-cd)pyrene	193-39-5	< MDL	mg/Kg	0.25	0.04175	0.03561		
Naphthalene	91-20-3	< MDL	mg/Kg	0.25	0.04175	0.01532		
Pentachlorophenol	87-86-5	< MDL	mg/Kg	0.25	0.04175	0.03561		
Phenanthrene	85-01-8	< MDL	mg/Kg	0.25	0.04175	0.02167		
Phenol	108-95-2	< MDL	mg/Kg	0.25	0.04175	0.01812		
Pyrene	129-00-0	< MDL	mg/Kg	0.25	0.04175	0.03815		
2-Fluorophenol(surr)	367-12-4	58	%	0.25				
Phenol-d6(surr)	13127-88-3	55	%	0.25				
Nitrobenzene-d5(surr)	4165-60-0	50.5	%	0.25				
2-Fluorobiphenyl(surr)	132-60-8	56.8	%	0.25				
2,4,6-Tribromophenol(surr)	118-79-6	78.5	%	0.25				
p-Terphenyl-d14(surr)	1718-51-0	68.2	%	0.25				

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Semivolatile Organic Compounds **Method : SW-846 8270D** **Reporting Units : mg/Kg**

QC Batch ID : Qb21032315 **Created Date :** 03/22/21 **Created By :** MShah

Samples in This QC Batch : 21031513.08,09,11,13

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
1,2,4-Trichlorobenzene	0.834	0.424	50.9	0.834	0.454	54.4	6.8	35	34-112	
1,2-Dichlorobenzene	0.834	0.442	53	0.834	0.453	54.3	2.5	35	33-113	
1,3-Dichlorobenzene	0.834	0.441	52.9	0.834	0.459	55	4	35	30-110	
1,4-Dichlorobenzene	0.834	0.446	53.5	0.834	0.462	55.4	3.5	35	31-111	
2,4-Dichlorophenol	0.834	0.516	61.9	0.834	0.556	66.7	7.5	35	40-118	
2,4-Dimethylphenol	1.67	0.882	52.8	1.67	0.942	56.4	6.6	35	30-115	
2,4-Dinitrophenol	0.834	0.571	68.5	0.834	0.606	72.7	6	35	6-101	
Acenaphthene	0.834	0.449	53.9	0.834	0.477	57.2	6	35	40-109	
Acenaphthylene	0.834	0.461	55.3	0.834	0.489	58.6	5.9	35	32-117	
Anthracene	0.834	0.534	64.1	0.834	0.572	68.5	6.9	35	47-117	
Benzo(a)anthracene	0.834	0.531	63.7	0.834	0.567	67.9	6.6	35	49-117	
Benzo(a)pyrene	0.834	0.575	69	0.834	0.614	73.7	6.6	35	45-117	
Benzo(b)fluoranthene	0.834	0.550	65.9	0.834	0.573	68.7	4.1	35	45-124	
Benzo(g,h,i)perylene	0.834	0.515	61.7	0.834	0.542	65	5.1	35	43-119	
Benzo(k)fluoranthene	0.834	0.551	66.1	0.834	0.619	74.2	11.6	35	47-121	
Chrysene	0.834	0.523	62.7	0.834	0.553	66.3	5.6	35	50-116	
Dibenzo(a,h)anthracene	0.834	0.534	64.1	0.834	0.567	67.9	6	35	45-122	
Diethyl phthalate	0.834	0.514	61.7	0.834	0.558	66.9	8.2	35	50-121	
Fluoranthene	0.834	0.544	65.2	0.834	0.590	70.7	8.1	35	50-124	
Fluorene	0.834	0.513	61.5	0.834	0.554	66.4	7.7	35	43-120	
Hexachlorobenzene	0.834	0.576	69	0.834	0.608	72.9	5.4	35	45-115	
Indeno(1,2,3-cd)pyrene	0.834	0.514	61.7	0.834	0.543	65.1	5.5	35	45-119	
Naphthalene	0.834	0.778	93.2	0.834	0.831	99.6	6.6	35	35-112	
Pentachlorophenol	0.834	0.700	83.9	0.834	0.725	87	3.5	35	25-125	
Phenanthrene	0.834	0.522	62.6	0.834	0.557	66.8	6.5	35	50-113	
Phenol	0.834	0.471	56.4	0.834	0.485	58.2	2.9	35	34-118	
Pyrene	0.834	0.528	63.4	0.834	0.564	67.6	6.6	35	47-115	

QC Type: MS and MSD

QC Sample ID: 21031513.13

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
1,2,4-Trichlorobenzene	BRL	0.834	0.417	50						32-126	
1,2-Dichlorobenzene	BRL	0.834	0.432	51.9						34-118	
1,3-Dichlorobenzene	BRL	0.834	0.425	51						34-118	
1,4-Dichlorobenzene	BRL	0.834	0.432	51.7						35-115	
2,4-Dichlorophenol	BRL	0.834	0.524	62.8						31-124	
2,4-Dimethylphenol	BRL	1.67	0.916	54.8						29-129	
2,4-Dinitrophenol	BRL	0.834	0.544	65.3						D-94	
2,4-Dinitrotoluene	BRL	0.834	0.576	69.1						42-134	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Semivolatile Organic Compounds **Method : SW-846 8270D** **Reporting Units : mg/Kg**

QC Batch ID : Qb21032315 **Created Date :** 03/22/21 **Created By :** MShah

Samples in This QC Batch : 21031513.08,09,11,13

QC Type: MS and MSD
QC Sample ID: 21031513.13

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
2-Chlorophenol	BRL	0.834	0.461	55.3						26-119	
4-Chloro-3-methylphenol	BRL	0.834	0.545	65.3						40-127	
4-Nitrophenol	BRL	0.834	0.472	56.6						14-138	
Acenaphthene	BRL	0.834	0.457	54.8						45-125	
Acenaphthylene	BRL	0.834	0.461	55.3						43-118	
Anthracene	BRL	0.834	0.541	64.8						53-119	
Benzo(a)anthracene	BRL	0.834	0.538	64.5						43-131	
Benzo(a)pyrene	BRL	0.834	0.581	69.7						43-126	
Benzo(b)fluoranthene	BRL	0.834	0.542	65						36-126	
Benzo(g,h,i)perylene	BRL	0.834	0.515	61.7						27-126	
Benzo(k)fluoranthene	BRL	0.834	0.582	69.8						36-134	
Chrysene	BRL	0.834	0.525	63						42-131	
Dibenzo(a,h)anthracene	BRL	0.834	0.540	64.7						33-122	
Diethyl phthalate	BRL	0.834	0.543	65.1						48-126	
Fluoranthene	BRL	0.834	0.558	66.9						51-125	
Fluorene	BRL	0.834	0.525	62.9						48-123	
Hexachlorobenzene	BRL	0.834	0.576	69						35-130	
Indeno(1,2,3-cd)pyrene	BRL	0.834	0.518	62.2						31-135	
Naphthalene	BRL	0.834	0.812	97.3						32-124	
N-nitroso-di-n-propylamine	BRL	0.834	0.459	55.1						30-128	
Pentachlorophenol	BRL	0.834	0.709	85.1						36-117	
Phenanthrene	BRL	0.834	0.528	63.3						45-125	
Phenol	BRL	0.834	0.479	57.5						22-118	
Pyrene	BRL	0.834	0.546	65.5						32-138	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : **Ignitability (Flash Point) up to 150 degrees F** **Method :** **SW-846 1010A** **Reporting Units :** **°F**

QC Batch ID : Qb21032322 **Created Date :** 03/23/21 **Created By :** SKYanduru

Samples in This QC Batch : 21031513.08,09,11

QC Type: Duplicate

QC Sample ID: 21031775.01

Parameter	QCSample Result	Sample Result	Units	RPD	RPD CtrlLimit		Qual
Ignitability	>150	>150	°F		12		

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Ignitability	85	86	101	85	86	101	0	12	96-104	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Dissolved Metals **Method : EPA 200.8** **Reporting Units : mg/L**

QC Batch ID : Qb21032324 **Created Date :** 03/22/21 **Created By :** Ggorane

Samples in This QC Batch : 21031513.01,03,05,06,15,16,17

Digestion : PB21032316 **Prep Method :** SW-846 3005A **Prep Date :** 03/22/21 12:30 **Prep By :** Ggorane

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Antimony	7440-36-0	< MDL	mg/L	1	0.00025	0.0002		
Arsenic	7440-38-2T	< MDL	mg/L	1	0.00025	0.0001		
Cadmium	7440-43-9	< MDL	mg/L	1	0.00025	0.0001		
Chromium	7440-47-3T	< MDL	mg/L	1	0.00025	0.0001		
Copper	7440-50-8	< MDL	mg/L	1	0.00025	0.0004		
Lead	7439-92-1T	< MDL	mg/L	1	0.00025	0.0001		
Nickel	7440-02-0	< MDL	mg/L	1	0.00025	0.0001		
Silver	7440-22-4	< MDL	mg/L	1	0.00025	0.0002		
Zinc	7440-66-6T	< MDL	mg/L	1	0.00025	0.0011		

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Antimony	0.05	0.0500	100	0.05	0.0503	101	0.6	20	85-115	
Arsenic	0.05	0.0527	105	0.05	0.0529	106	0.3	20	85-115	
Cadmium	0.05	0.0497	99.3	0.05	0.0499	99.9	0.5	20	85-115	
Chromium	0.05	0.0495	99.1	0.05	0.0488	97.7	1.5	20	85-115	
Copper	0.05	0.0496	99.3	0.05	0.0491	98.1	1.1	20	85-115	
Lead	0.05	0.0477	95.3	0.05	0.0486	97.1	2	20	85-115	
Nickel	0.05	0.0492	98.4	0.05	0.0492	98.3	0	20	85-115	
Silver	0.05	0.0473	94.6	0.05	0.0473	94.5	0	20	85-115	
Zinc	0.05	0.0494	98.7	0.05	0.0489	97.9	1	20	85-115	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis :	**Semivolatile Organic Compounds**	**Method :**	**EPA 625.1**	**Reporting Units :**	**mg/L**

QC Batch ID : Qb21032339 **Created Date :** 03/22/21 **Created By :** MShah

Samples in This QC Batch : 21031513.01,03,05,15,16,17

Extraction : PB21032243 **Prep Method :** EPA 625.1 **Prep Date :** 03/22/21 12:30 **Prep By :** MMuteen

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
1,2,4-Trichlorobenzene	120-82-1	< MDL	mg/L	0.25	0.00125	0.00053		
1,2-Dichlorobenzene	95-50-1	< MDL	mg/L	0.25	0.00125	0.00041		
1,3-Dichlorobenzene	541-73-1	< MDL	mg/L	0.25	0.00125	0.00053		
1,4-Dichlorobenzene	106-46-7	< MDL	mg/L	0.25	0.00125	0.00025		
2,4-Dichlorophenol	120-83-2	< MDL	mg/L	0.25	0.00125	0.00069		
2,4-Dimethylphenol	105-67-9	< MDL	mg/L	0.25	0.00125	0.00053		
2,4-Dinitrophenol	51-28-5	< MDL	mg/L	0.25	0.00125	0.00141		
Acenaphthene	83-32-9	< MDL	mg/L	0.25	0.00125	0.00028		
Acenaphthylene	208-96-8	< MDL	mg/L	0.25	0.00125	0.00047		
Anthracene	120-12-7	< MDL	mg/L	0.25	0.00125	0.00035		
Benzo(a)anthracene	56-55-3	< MDL	mg/L	0.25	0.00125	0.00038		
Benzo(a)pyrene	50-32-8	< MDL	mg/L	0.25	0.00125	0.00085		
Benzo(b)fluoranthene	205-99-2	< MDL	mg/L	0.25	0.00125	0.00057		
Benzo(g,h,i)perylene	191-24-2	< MDL	mg/L	0.25	0.00125	0.00063		
Benzo(k)fluoranthene	207-08-9	< MDL	mg/L	0.25	0.00125	0.00057		
Chrysene	218-01-9	< MDL	mg/L	0.25	0.00125	0.00057		
Dibenzo(a,h)anthracene	53-70-3	< MDL	mg/L	0.25	0.00125	0.00069		
Diethyl phthalate	84-66-2	< MDL	mg/L	0.25	0.00125	0.00063		
Fluoranthene	206-44-0	< MDL	mg/L	0.25	0.00125	0.00044		
Fluorene	86-73-7	< MDL	mg/L	0.25	0.00125	0.00047		
Hexachlorobenzene	118-74-1	< MDL	mg/L	0.25	0.00125	0.00069		
Indeno(1,2,3-cd)pyrene	193-39-5	< MDL	mg/L	0.25	0.00125	0.00022		
Naphthalene	91-20-3	< MDL	mg/L	0.25	0.00125	0.00031		
Pentachlorophenol	87-86-5	< MDL	mg/L	0.25	0.00125	0.00050		
Phenanthrene	85-01-8	< MDL	mg/L	0.25	0.00125	0.00044		
Phenol	108-95-2	< MDL	mg/L	0.25	0.00125	0.00044		
Pyrene	129-00-0	< MDL	mg/L	0.25	0.00125	0.00057		
2-Fluorophenol(surr)	367-12-4	38.9	%	0.25				
Phenol-d6(surr)	13127-88-3	22	%	0.25				
Nitrobenzene-d5(surr)	4165-60-0	61.5	%	0.25				
2-Fluorobiphenyl(surr)	132-60-8	60.1	%	0.25				
2,4,6-Tribromophenol(surr)	118-79-6	57.6	%	0.25				
p-Terphenyl-d14(surr)	1718-51-0	66.6	%	0.25				

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual

ab-q213-0321

Refer to the Definition page for terms.

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Semivolatile Organic Compounds **Method : EPA 625.1** **Reporting Units : mg/L**

QC Batch ID : Qb21032339 **Created Date :** 03/22/21 **Created By :** MShah

Samples in This QC Batch : 21031513.01,03,05,15,16,17

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
1,2,4-Trichlorobenzene	0.025	0.0118	47.3	0.025	0.0120	47.9	1.4	35	40-140	
1,2-Dichlorobenzene	0.025	0.0120	47.9	0.025	0.0119	47.5	0.6	35	40-140	
1,3-Dichlorobenzene	0.025	0.0120	48.1	0.025	0.0120	48.1	0.1	35	40-140	
1,4-Dichlorobenzene	0.025	0.0119	47.8	0.025	0.0119	47.6	0.4	35	40-140	
2,4-Dichlorophenol	0.025	0.0162	64.7	0.025	0.0163	65.3	0.8	35	40-140	
2,4-Dimethylphenol	0.05	0.0305	61	0.025	0.0298	119	2.3	35	40-140	
2,4-Dinitrophenol	0.025	0.0160	64	0.025	0.0169	67.5	5.5	35	40-140	
Acenaphthene	0.025	0.0141	56.3	0.025	0.0141	56.2	0.2	35	40-140	
Acenaphthylene	0.025	0.0145	58.2	0.025	0.0145	58.1	0.3	35	40-140	
Anthracene	0.025	0.0167	66.7	0.025	0.0168	67.1	0.8	35	40-140	
Benzo(a)anthracene	0.025	0.0170	67.9	0.025	0.0175	69.9	3.1	35	40-140	
Benzo(a)pyrene	0.025	0.0183	73.1	0.025	0.0183	73.2	0.2	35	40-140	
Benzo(b)fluoranthene	0.025	0.0166	66.4	0.025	0.0165	66	0.6	35	40-140	
Benzo(g,h,i)perylene	0.025	0.0163	65.2	0.025	0.0164	65.5	0.7	35	40-140	
Benzo(k)fluoranthene	0.025	0.0168	67.3	0.025	0.0165	66.1	2	35	40-140	
Chrysene	0.025	0.0166	66.4	0.025	0.0164	65.5	1.3	35	40-140	
Dibenzo(a,h)anthracene	0.025	0.0163	65.1	0.025	0.0164	65.6	0.8	35	40-140	
Diethyl phthalate	0.025	0.0157	62.7	0.025	0.0157	62.6	0.2	35	40-140	
Fluoranthene	0.025	0.0176	70.4	0.025	0.0175	70.1	0.6	35	40-140	
Fluorene	0.025	0.0158	63	0.025	0.0158	63	0.3	35	40-140	
Hexachlorobenzene	0.025	0.0164	65.6	0.025	0.0165	66.1	0.6	35	40-140	
Indeno(1,2,3-cd)pyrene	0.025	0.0167	66.8	0.025	0.0168	67	0.6	35	40-140	
Naphthalene	0.025	0.0221	88.5	0.025	0.0221	88.6	0.1	35	40-140	
Pentachlorophenol	0.025	0.0165	65.9	0.025	0.0167	67	1.4	35	40-140	
Phenanthrene	0.025	0.0160	64.1	0.025	0.0161	64.5	0.5	35	40-140	
Phenol	0.025	0.00662	26.5	0.025	0.00652	26.1	1.5	35	40-140	L2
Pyrene	0.025	0.0169	67.6	0.025	0.0170	68	0.6	35	40-140	

QC Type: MS and MSD
QC Sample ID: 21031513.01

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
1,2,4-Trichlorobenzene	0.00000	0.025	0.00970	38.8						15-120	
1,2-Dichlorobenzene	0.00000	0.025	0.00935	37.4						15-120	
1,3-Dichlorobenzene	0.00000	0.025	0.00920	36.8						15-120	
1,4-Dichlorobenzene	0.00000	0.025	0.00932	37.3						15-120	
2,4-Dichlorophenol	0.00000	0.025	0.0133	53.2						15-120	
2,4-Dimethylphenol	0.00000	0.05	0.0276	55.2						15-120	
2,4-Dinitrophenol	0.00000	0.025	0.00721	28.9						15-120	
Acenaphthene	0.00000	0.025	0.0130	51.9						15-120	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Semivolatile Organic Compounds **Method : EPA 625.1** **Reporting Units : mg/L**

QC Batch ID : Qb21032339 **Created Date :** 03/22/21 **Created By :** MShah

Samples in This QC Batch : 21031513.01,03,05,15,16,17

QC Type: MS and MSD
QC Sample ID: 21031513.01

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
Acenaphthylene	0.00000	0.025	0.0134	53.8						15-120	
Anthracene	0.00000	0.025	0.0159	63.6						15-120	
Benzo(a)anthracene	0.00000	0.025	0.0166	66.2						15-120	
Benzo(a)pyrene	0.00000	0.025	0.0175	70.1						15-120	
Benzo(b)fluoranthene	0.00000	0.025	0.0160	64						15-120	
Benzo(g,h,i)perylene	0.00000	0.025	0.0158	63.2						15-120	
Benzo(k)fluoranthene	0.00000	0.025	0.0155	61.9						15-120	
Chrysene	0.00000	0.025	0.0160	64						15-120	
Dibenzo(a,h)anthracene	0.00000	0.025	0.0158	63.4						15-120	
Diethyl phthalate	0.00000	0.025	0.0154	61.5						15-120	
Fluoranthene	0.00000	0.025	0.0168	67.3						15-120	
Fluorene	0.00000	0.025	0.0148	59.3						15-120	
Hexachlorobenzene	0.00000	0.025	0.0156	62.5						15-120	
Indeno(1,2,3-cd)pyrene	0.00000	0.025	0.0162	65						15-120	
Naphthalene	0.00000	0.025	0.0192	76.9						15-120	
Pentachlorophenol	0.00000	0.025	0.00674	27						15-120	
Phenanthrene	0.00000	0.025	0.0154	61.7						15-120	
Phenol	0.00000	0.025	0.00554	22.2						15-120	
Pyrene	0.00000	0.025	0.0164	65.5						15-120	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513

Date : 3/30/2021

Analysis : Reactive Cyanide **Method : SW-846 7.3** **Reporting Units : mg/Kg**

QC Batch ID : Qb21032349 **Created Date :** 03/23/21 **Created By :** SKYanduru

Samples in This QC Batch : 21031513.08,09,11

Sample Preparation : PB21032321 **Prep Method :** SW-846 7.3 **Prep Date :** 03/23/21 10:00 **Prep By :** SKYanduru

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Reactive Cyanide		< MDL	mg/Kg	1	----	4.9		

QC Type: Duplicate

QC Sample ID: 21031309.01

Parameter	QCSample Result	Sample Result	Units	RPD	RPD CtrlLimit		Qual
Reactive Cyanide	BRL	BRL	mg/Kg	0	20		

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Reactive Cyanide	5	2.04	40.7	5	2.04	40.7	0.2	20	40-120	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Selected Ion Monitoring **Method : EPA 625.1** **Reporting Units : mg/L**

QC Batch ID : Qb21032354 **Created Date :** 03/23/21 **Created By :** MShah

Samples in This QC Batch : 21031513.01,03,05,15,16,17

Extraction : PB21032246 **Prep Method :** EPA 625.1 **Prep Date :** 03/22/21 12:30 **Prep By :** MMuteen

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Benzo(a)pyrene	50-32-8	< MDL	mg/L	0.25	2.5E-05	0.0001		
Chrysene	218-01-9	< MDL	mg/L	0.25	2.5E-05	0.0001		
2,4,6-Tribromophenol(surr)	118-79-6	58.5	%	0.25				
2-Fluorobiphenyl(surr)	132-60-8	49.5	%	0.25				
2-Fluorophenol(surr)	367-12-4	39	%	0.25				
Nitrobenzene-d5(surr)	4165-60-0	49.5	%	0.25				
Phenol-d6(surr)	13127-88-3	21.5	%	0.25				
p-Terphenyl-d14(surr)	1718-51-0	60.5	%	0.25				

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Benzo(a)pyrene	0.0005	0.0002975	59.5	0.0005	0.0002775	55.5	7			
Chrysene	0.0005	0.0003025	60.5	0.0005	0.0002825	56.5	6.8			

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Selected Ion Monitoring **Method : SW-846 8270D SI** **Reporting Units : mg/Kg**

QC Batch ID : Qb21032355 **Created Date :** 03/22/21 **Created By :** MShah

Samples in This QC Batch : 21031513.08,09,11,13

Extraction : PB21032248 **Prep Method :** SW-846 3546 **Prep Date :** 03/22/21 12:30 **Prep By :** MMuteen

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
1,2,4-Trichlorobenzene	120-82-1	< MDL	mg/Kg	0.25	0.000825	0.0033		
1,3-Dichlorobenzene	541-73-1	< MDL	mg/Kg	0.25	0.000825	0.0033		
Benzo(b)fluoranthene	205-99-2	< MDL	mg/Kg	0.25	0.000825	0.0033		
Benzo(g,h,i)perylene	191-24-2	< MDL	mg/Kg	0.25	0.000825	0.0033		
Benzo(k)fluoranthene	207-08-9	< MDL	mg/Kg	0.25	0.000825	0.0033		
Dibenzo(a,h)anthracene	53-70-3	< MDL	mg/Kg	0.25	0.000825	0.0033		
Hexachlorobenzene	118-74-1	< MDL	mg/Kg	0.25	0.000825	0.0033		
Pyrene	129-00-0	< MDL	mg/Kg	0.25	0.000825	0.0033		
2,4,6-Tribromophenol(surr)	118-79-6	55	%	0.25				
2-Fluorobiphenyl(surr)	132-60-8	63	%	0.25				
2-Fluorophenol(surr)	367-12-4	59	%	0.25				
Nitrobenzene-d5(surr)	4165-60-0	58.5	%	0.25				
Phenol-d6(surr)	13127-88-3	55	%	0.25				
p-Terphenyl-d14(surr)	1718-51-0	78	%	0.25				

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
1,2,4-Trichlorobenzene	0.0166	0.00808	48.7	0.0166	0.00892	53.7	9.8	30	32-126	
1,3-Dichlorobenzene	0.0166	0.00800	48.2	0.0166	0.00850	51.2	6.1	30	34-118	
Benzo(b)fluoranthene	0.0166	0.00883	53.2	0.0166	0.0103	62.2	15.3	30	36-126	
Benzo(g,h,i)perylene	0.0166	0.00833	50.2	0.0166	0.00967	58.2	14.8	30	27-126	
Benzo(k)fluoranthene	0.0166	0.00908	54.7	0.0166	0.00983	59.2	7.9	30	36-134	
Dibenzo(a,h)anthracene	0.0166	0.00842	50.7	0.0166	0.00967	58.2	13.9	30	33-122	
Hexachlorobenzene	0.0166	0.00958	57.7	0.0166	0.0103	62.2	7.2	30	35-130	
Pyrene	0.0166	0.00933	56.2	0.0166	0.0102	61.7	8.9	30	32-138	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Reactive Sulfide **Method : SW-846 7.3** **Reporting Units : mg/Kg**

QC Batch ID : Qb21032359 **Created Date :** 03/23/21 **Created By :** SKYanduru

Samples in This QC Batch : 21031513.08,09,11

Sample Preparation : PB21032322 **Prep Method :** SW-846 7.3 **Prep Date :** 03/23/21 10:00 **Prep By :** SKYanduru

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Reactive Sulfide		< MDL	mg/Kg	1	----	25		

QC Type: Duplicate

QC Sample ID: 21031309.01

Parameter	QCSample Result	Sample Result	Units	RPD	RPD CtrlLimit		Qual
Reactive Sulfide	BRL	BRL	mg/Kg	0	20		

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Reactive Sulfide	1000	1000	100	1000	1000	100	0	20	91.9-108	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Total Metals - Mercury **Method : EPA 245.1** **Reporting Units : mg/L**

QC Batch ID : Qb21032378 **Created Date :** 03/23/21 **Created By :** BChristofer

Samples in This QC Batch : 21031513.15,16,17

Digestion : PB21032328 **Prep Method :** EPA 245.1 **Prep Date :** 03/23/21 08:40 **Prep By :** JYou

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Mercury	7439-97-6T	< MDL	mg/L	1	0.0002	0.00006		

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Mercury	0.005	0.00479	95.8	0.005	0.00476	95.2	0.6	20	85-115	

QC Type: MS and MSD
QC Sample ID: 21031832.01

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
Mercury	BRL	0.005	0.00461	92.2						82-115	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Volatile Organic Compounds **Method : EPA 624.1** **Reporting Units : mg/L**

QC Batch ID : Qb21032397 **Created Date :** 03/23/21 **Created By :** Rajeev

Samples in This QC Batch : 21031513.15,16,17

Sample Preparation : PB21032355 **Prep Method :** EPA 624.1 **Prep Date :** 03/23/21 10:00 **Prep By :** Rajeev

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
1,1,1-Trichloroethane	71-55-6	< MDL	mg/L	1.00	0.005	0.001		
1,1,2,2-Tetrachloroethane	79-34-5	< MDL	mg/L	1.00	0.005	0.001		
1,1,2-Trichloroethane	79-00-5	< MDL	mg/L	1.00	0.005	0.001		
1,1-Dichloroethane	75-34-3	< MDL	mg/L	1.00	0.005	0.001		
1,1-Dichloroethylene	75-35-4	< MDL	mg/L	1.00	0.005	0.001		
1,2-Dichlorobenzene	95-50-1	< MDL	mg/L	1.00	0.005	0.001		
1,2-Dichloroethane	107-06-2	< MDL	mg/L	1.00	0.005	0.001		
1,3-Dichlorobenzene	541-73-1	< MDL	mg/L	1.00	0.005	0.001		
1,4-Dichlorobenzene	106-46-7	< MDL	mg/L	1.00	0.005	0.001		
2-Butanone	78-93-3	< MDL	mg/L	1.00	0.005	0.005		
Benzene	71-43-2	< MDL	mg/L	1.00	0.005	0.001		
Bromodichloromethane	75-27-4	< MDL	mg/L	1.00	0.005	0.001		
Bromoform	75-25-2	< MDL	mg/L	1.00	0.005	0.001		
Bromomethane	74-83-9	< MDL	mg/L	1.00	0.005	0.002		
Carbon tetrachloride	56-23-5	< MDL	mg/L	1.00	0.005	0.001		
Chlorobenzene	108-90-7	< MDL	mg/L	1.00	0.005	0.001		
Chloroethane	75-00-3	< MDL	mg/L	1.00	0.005	0.001		
Chloroform	67-66-3	< MDL	mg/L	1.00	0.005	0.001		
Chloromethane	74-87-3	< MDL	mg/L	1.00	0.005	0.001		
cis-1,3-Dichloropropene	10061-01-5	< MDL	mg/L	1.00	0.005	0.001		
Dibromochloromethane	124-48-1	< MDL	mg/L	1.00	0.005	0.001		
Ethylbenzene	100-41-4	< MDL	mg/L	1.00	0.005	0.001		
Methylene chloride	75-09-2	< MDL	mg/L	1.00	0.005	0.001		
Tetrachloroethylene	127-18-4	< MDL	mg/L	1.00	0.005	0.001		
Toluene	108-88-3	< MDL	mg/L	1.00	0.005	0.001		
trans-1,2-Dichloroethylene	156-60-5	< MDL	mg/L	1.00	0.005	0.001		
trans-1,3-Dichloropropene	10061-02-6	< MDL	mg/L	1.00	0.005	0.001		
Trichloroethylene	79-01-6	< MDL	mg/L	1.00	0.005	0.001		
Trichlorofluoromethane	75-69-4	< MDL	mg/L	1.00	0.005	0.001		
Vinyl Chloride	75-01-4	< MDL	mg/L	1.00	0.005	0.001		
Dibromofluoromethane(surr	1868-53-7	117	%	1.00				
1,2-Dichloroethane-d4(surr	17060-07-0	112	%	1.00				
Toluene-d8(surr)	2037-26-5	97.5	%	1.00				
p-Bromofluorobenzene(surr	460-00-4	100	%	1.00				

DRAFT

QUALITY CONTROL CERTIFICATE

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Volatile Organic Compounds **Method :** EPA 624.1 **Reporting Units :** mg/L

QC Batch ID : Qb21032397 **Created Date :** 03/23/21 **Created By :** Rajeev

Samples in This QC Batch : 21031513.15,16,17

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
1,1-Dichloroethylene	0.02	0.0228	114	0.02	0.0222	111	2.6	30	75.5-124	
Benzene	0.02	0.0214	107	0.02	0.0213	106	0.3	30	80-120	
Chlorobenzene	0.02	0.0201	101	0.02	0.0202	101	0.4	30	80-120	
Toluene	0.02	0.0211	105	0.02	0.0207	103	1.8	30	77.1-121	
Trichloroethylene	0.02	0.0209	105	0.02	0.0206	103	1.6	30	80-120	
1,1,1-Trichloroethane	0.02	0.0227	114	0.02	0.0222	111	2.3	30	80-120	
1,1,2,2-Tetrachloroethane	0.02	0.0210	105	0.02	0.0204	102	2.7	30	80-120	
1,1,2-Trichloroethane	0.02	0.0210	105	0.02	0.0208	104	1.1	30	80-120	
1,1-Dichloroethane	0.02	0.0228	114	0.02	0.0224	112	2	30	77.6-124	
1,2-Dichlorobenzene	0.02	0.0205	102	0.02	0.0204	102	0.4	30	83.2-121	
1,2-Dichloroethane	0.02	0.0222	111	0.02	0.0219	110	1.3	30	74.5-129	
1,3-Dichlorobenzene	0.02	0.0203	102	0.02	0.0204	102	0.4	30	80-120	
1,4-Dichlorobenzene	0.02	0.0202	101	0.02	0.0202	101	0.2	30	80-120	
Bromodichloromethane	0.02	0.0212	106	0.02	0.0215	107	1.4	30	80-119	
Bromoform	0.02	0.0203	101	0.02	0.0199	99.7	1.9	30	78.8-127	
Bromomethane	0.02	0.0210	105	0.02	0.0211	105	0.3	30	53-138	
Carbon tetrachloride	0.02	0.0214	107	0.02	0.0212	106	0.9	30	70-136	
Chloroethane	0.02	0.0228	114	0.02	0.0224	112	2	30	75.6-128	
Chloroform	0.02	0.0223	112	0.02	0.0219	110	2	30	79-123	
Chloromethane	0.02	0.0201	101	0.02	0.0202	101	0.3	30	69.6-125	
cis-1,3-Dichloropropene	0.02	0.0217	108	0.02	0.0214	107	1.2	30	80-120	
Dibromochloromethane	0.02	0.0206	103	0.02	0.0203	102	1.5	30	82.8-117	
Ethylbenzene	0.02	0.0208	104	0.02	0.0205	103	1.5	30	80-120	
Methylene chloride	0.02	0.0249	124	0.02	0.0244	122	1.9	30	69.4-131	
Tetrachloroethylene	0.02	0.0204	102	0.02	0.0201	101	1.4	30	40-168	
trans-1,2-Dichloroethylene	0.02	0.0226	113	0.02	0.0223	111	1.5	30	77.5-122	
trans-1,3-Dichloropropene	0.02	0.0213	106	0.02	0.0207	103	2.7	30	81.5-113	
Trichlorofluoromethane	0.02	0.0227	114	0.02	0.0224	112	1.4	30	80-132	
Vinyl Chloride	0.02	0.0197	98.4	0.02	0.0196	98.2	0.4	30	71.1-127	
2-Butanone	0.02	0.0193	96.7	0.02	0.0213	106	9.7	30	75-125	

QC Type: MS and MSD

QC Sample ID: 21031755.02

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
1,1-Dichloroethylene	BRL	0.02	0.0227	114						81-130	
Benzene	BRL	0.02	0.0212	106						84-132	
Chlorobenzene	BRL	0.02	0.0202	101						72-132	
Toluene	BRL	0.02	0.0208	104						72-136	
Trichloroethylene	BRL	0.02	0.0221	111						75-136	
1,1,1-Trichloroethane	BRL	0.02	0.0223	111						78-131	

ab-q213-0321

Refer to the Definition page for terms.

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : **Volatile Organic Compounds** **Method :** **EPA 624.1** **Reporting Units :** **mg/L**

QC Batch ID : Qb21032397 **Created Date :** 03/23/21 **Created By :** Rajeev

Samples in This QC Batch : 21031513.15,16,17

QC Type: **MS and MSD**

QC Sample ID: **21031755.02**

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
1,1,2,2-Tetrachloroethane	BRL	0.02	0.0271	135						66-145	
1,1,2-Trichloroethane	BRL	0.02	0.0237	119						69-138	
1,1-Dichloroethane	BRL	0.02	0.0224	112						84-128	
1,2-Dichlorobenzene	BRL	0.02	0.0206	103						73-138	
1,2-Dichloroethane	0.0477	0.02	0.0646	84.4						65-154	
1,3-Dichlorobenzene	BRL	0.02	0.0203	102						74-136	
1,4-Dichlorobenzene	BRL	0.02	0.0202	101						71-136	
Bromodichloromethane	0.0206	0.02	0.0413	104						83-134	
Bromoform	BRL	0.02	0.0243	121						68-135	
Bromomethane	BRL	0.02	0.0214	107						65-144	
Carbon tetrachloride	BRL	0.02	0.0215	108						70-136	
Chloroethane	BRL	0.02	0.0226	113						76-147	
Chloroform	0.0378	0.02	0.0552	86.9						68-130	
Chloromethane	BRL	0.02	0.0246	123						73-127	
cis-1,3-Dichloropropene	BRL	0.02	0.0225	112						81-126	
Dibromochloromethane	BRL	0.02	0.0268	134						68-139	
Ethylbenzene	BRL	0.02	0.0207	103						75-133	
Methylene chloride	BRL	0.02	0.0204	102						74-126	
Tetrachloroethylene	BRL	0.02	0.0198	99						65-138	
trans-1,2-Dichloroethylene	BRL	0.02	0.0225	113						73-130	
trans-1,3-Dichloropropene	BRL	0.02	0.0227	114						73-129	
Trichlorofluoromethane	BRL	0.02	0.0243	121						78-143	
Vinyl Chloride	BRL	0.02	0.0202	101						58-135	
2-Butanone	BRL	0.02	0.0233	116						75-125	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Polychlorinated Biphenyls **Method : EPA 608.3** **Reporting Units : ug/L**

QC Batch ID : Qb21032568 **Created Date :** 03/23/21 **Created By :** PSunkara

Samples in This QC Batch : 21031513.01,03,05,15,16,17

Extraction : PB21032369 **Prep Method :** EPA 608.3 **Prep Date :** 03/23/21 10:00 **Prep By :** Msoria

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Total PCBs		< MDL	ug/L	1	0.05	0.0129		
Decachlorobiphenyl(surr)	2051-24-3	97	%	0.25				
Tetrachloro-m-xylene(surr)	877-09-8	80	%	0.25				

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Total PCBs	4	1.884	47.1	4	1.994	49.9	5.7	18	41-130	

QC Type: MS and MSD

QC Sample ID: 21031513.03

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
Total PCBs		4	1.698	42.5						40-140	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Polychlorinated Biphenyls **Method : SW-846 8082A** **Reporting Units : ug/Kg**

QC Batch ID : Qb21032570 **Created Date :** 03/23/21 **Created By :** PSunkara

Samples in This QC Batch : 21031513.08,09,11,13

Extraction : PB21032371 **Prep Method :** SW-846 3546 **Prep Date :** 03/23/21 14:30 **Prep By :** Msoria

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Total PCBs		< MDL	ug/Kg	0.25	0.4175	1.52		
Tetrachloro-m-xylene(surr)	877-09-8	98.3	%	0.25				
Decachlorobiphenyl(surr)	2051-24-3	128	%	0.25				

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Total PCBs	66.5	69.802	105	66.5	70.424	106	0.9	9	16.2-170	

QC Type: MS and MSD
QC Sample ID: 21031513.08

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
Total PCBs	0	66.5	42.997	64.7						40-140	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Organochlorine Pesticides **Method : EPA 608.3** **Reporting Units : ug/L**

QC Batch ID : Qb21032592 **Created Date :** 03/23/21 **Created By :** PSunkara

Samples in This QC Batch : 21031513.01,03,05,15,16,17

Extraction : PB21032370 **Prep Method :** EPA 608.3 **Prep Date :** 03/23/21 12:00 **Prep By :** Msoria

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Alpha-chlordane	5103-71-9	< MDL	ug/L	0.25	0.0025	0.002		
Gamma-chlordane	5103-74-2	< MDL	ug/L	0.25	0.0025	0.005		
4,4-DDD	72-54-8	< MDL	ug/L	0.25	0.0025	0.006		
4,4-DDE	72-55-9	< MDL	ug/L	0.25	0.0025	0.002		
4,4-DDT	50-29-3	< MDL	ug/L	0.25	0.0025	0.004		
a-BHC	319-84-6	< MDL	ug/L	0.25	0.0025	0.008		
Aldrin	309-00-2	< MDL	ug/L	0.25	0.0025	0.003		
b-BHC	319-85-7	< MDL	ug/L	0.25	0.0025	0.010		
Chlordane	57-74-9	< MDL	ug/L	0.25	0.025			
d-BHC	319-86-8	< MDL	ug/L	0.25	0.0025	0.004		
Dieldrin	60-57-1	< MDL	ug/L	0.25	0.0025	0.003		
Endosulfan I	959-98-8	< MDL	ug/L	0.25	0.0025	0.003		
Endosulfan II	33213-65-9	< MDL	ug/L	0.25	0.0025	0.004		
Endosulfan sulfate	1031-07-8	< MDL	ug/L	0.25	0.0025	0.003		
Endrin	72-20-8	< MDL	ug/L	0.25	0.0025	0.004		
Endrin aldehyde	7421-93-4	< MDL	ug/L	0.25	0.0025	0.008		
Endrin ketone	53494-70-5	< MDL	ug/L	0.25	0.0025	0.005		
g-BHC	58-89-9	< MDL	ug/L	0.25	0.0025	0.005		
Heptachlor	76-44-8	< MDL	ug/L	0.25	0.0025	0.005		
Heptachlor epoxide	1024-57-3	< MDL	ug/L	0.25	0.0025	0.002		
Toxaphene	8001-35-2	< MDL	ug/L	0.25	0.025	0.1		
Tetrachloro-m-xylene(surr)	877-09-8	33.9	%	0.25				
Decachlorobiphenyl(surr)	2051-24-3	37.4	%	0.25				

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Alpha-chlordane	0.1	0.0664	66.4	0.1	0.0631	63.1	5.1	23	29-135	
Gamma-chlordane	0.1	0.0639	63.9	0.1	0.0629	62.9	1.5	21	27-136	
4,4-DDD	0.1	0.0714	71.4	0.1	0.0719	71.9	0.7	24	27-147	
4,4-DDE	0.1	0.032	32	0.1	0.03218	32.2	0.6	21	30-136	
4,4-DDT	0.1	0.113	113	0.1	0.111	111	1.5	30	23-152	
a-BHC	0.1	0.049	48.8	0.1	0.050	49.6	2.5	25	23-125	
Aldrin	0.1	0.0575	57.5	0.1	0.0549	54.9	4.6	23	27-127	
b-BHC	0.1	0.0642	64.3	0.1	0.0626	62.6	2.6	24	29-132	
d-BHC	0.1	0.0734	73.4	0.1	0.0711	71.1	3.1	20	30-139	
Dieldrin	0.1	0.0571	57.1	0.1	0.0561	56.1	1.8	21	29-135	

ab-q213-0321

Refer to the Definition page for terms.

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Organochlorine Pesticides **Method : EPA 608.3** **Reporting Units : ug/L**

QC Batch ID : Qb21032592 **Created Date :** 03/23/21 **Created By :** PSunkara

Samples in This QC Batch : 21031513.01,03,05,15,16,17

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Endosulfan I	0.1	0.031	31	0.1	0.031	30.6	0	24	15-125	
Endosulfan II	0.1	0.040	39.6	0.1	0.039	38.9	1.6	21	20-133	
Endosulfan sulfate	0.1	0.037	37	0.1	0.0358	35.8	3.3	20	21-151	
Endrin	0.1	0.0608	60.8	0.1	0.0604	60.4	0.6	24	22-147	
Endrin aldehyde	0.1	0.0602	60.3	0.1	0.0588	58.8	2.4	33	14-136	
Endrin ketone	0.1	0.0808	80.8	0.1	0.0796	79.6	1.4	20	15-154	
g-BHC	0.1	0.0556	55.6	0.1	0.0564	56.4	1.4	25	23-132	
Heptachlor	0.1	0.0564	56.4	0.1	0.0569	56.9	0.9	20	27-134	
Heptachlor epoxide	0.1	0.0619	61.9	0.1	0.0612	61.3	1.1	24	32-132	

QC Type: MS and MSD
QC Sample ID: 21031513.05

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
Alpha-chlordane	0.000	0.1	0.0620	62						40-140	
Gamma-chlordane	0.000	0.1	0.0618	61.8						40-140	
4,4-DDD	0.000	0.1	0.122	122						40-140	
4,4-DDE	BRL	0.1	0.03481	34.8						40-140	M2
4,4-DDT	0.000	0.1	0.142	143						40-140	M1
a-BHC	0.000	0.1	0.047	47.4						40-140	
Aldrin	0.000	0.1	0.041	41.1						40-140	
b-BHC	0.000	0.1	0.0678	67.8						40-140	
d-BHC	0.000	0.1	0.0811	81.1						40-140	
Dieldrin	0.000	0.1	0.0582	58.3						40-140	
Endosulfan I	0.000	0.1	0.035	35.3						40-140	M2
Endosulfan II	0.000	0.1	0.0531	53.1						40-140	
Endosulfan sulfate	BRL	0.1	0.03956	39.6						40-140	M2
Endrin	0.000	0.1	0.0700	70						40-140	
Endrin aldehyde	0.000	0.1	0.0766	76.6						40-140	
Endrin ketone	0.000	0.1	0.0881	88.1						40-140	
g-BHC	0.000	0.1	0.0556	55.6						40-140	
Heptachlor	0.000	0.1	0.049	49.3						40-140	
Heptachlor epoxide	0.000	0.1	0.0666	66.6						40-140	

QUALITY CONTROL CERTIFICATE

DRAFT

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Organochlorine Pesticides **Method : SW-846 8081B** **Reporting Units : ug/Kg**

QC Batch ID : Qb21032593 **Created Date :** 03/23/21 **Created By :** PSunkara

Samples in This QC Batch : 21031513.08,09,11,13

Extraction : PB21032373 **Prep Method :** SW-846 3546 **Prep Date :** 03/23/21 13:30 **Prep By :** Msoria

QC Type: Method Blank

Parameter	CAS #	Result	Units	D.F.	MQL	MDL		Qual
Alpha-chlordane	5103-71-9	< MDL	ug/Kg	0.25	0.08325	0.25		
Gamma-chlordane	5103-74-2	< MDL	ug/Kg	0.25	0.08325	0.18		
4,4-DDD	72-54-8	< MDL	ug/Kg	0.25	0.08325	0.26		
4,4-DDE	72-55-9	< MDL	ug/Kg	0.25	0.4175	0.36		
4,4-DDT	50-29-3	< MDL	ug/Kg	0.25	0.4175	0.48		
a-BHC	319-84-6	< MDL	ug/Kg	0.25	0.08325	0.10		
Aldrin	309-00-2	< MDL	ug/Kg	0.25	0.08325	0.20		
b-BHC	319-85-7	< MDL	ug/Kg	0.25	0.08325	0.33		
Chlordane	57-74-9	< MDL	ug/Kg	0.25	0.8325	1.67		
d-BHC	319-86-8	< MDL	ug/Kg	0.25	0.4175	0.34		
Dieldrin	60-57-1	< MDL	ug/Kg	0.25	0.08325	0.25		
Endosulfan I	959-98-8	< MDL	ug/Kg	0.25	0.4175	0.34		
Endosulfan II	33213-65-9	< MDL	ug/Kg	0.25	0.08325	0.28		
Endosulfan sulfate	1031-07-8	< MDL	ug/Kg	0.25	0.08325	0.25		
Endrin	72-20-8	< MDL	ug/Kg	0.25	0.4175	0.39		
Endrin aldehyde	7421-93-4	< MDL	ug/Kg	0.25	0.4175	0.41		
Endrin ketone	53494-70-5	< MDL	ug/Kg	0.25	0.08325	0.33		
g-BHC	58-89-9	< MDL	ug/Kg	0.25	0.08325	0.15		
Heptachlor	76-44-8	< MDL	ug/Kg	0.25	0.08325	0.33		
Heptachlor epoxide	1024-57-3	< MDL	ug/Kg	0.25	0.08325	0.26		
Toxaphene	8001-35-2	< MDL	ug/Kg	0.25	0.8325	1.67		
Tetrachloro-m-xylene(surr)	877-09-8	55	%	0.25				
Decachlorobiphenyl(surr)	2051-24-3	70.6	%	0.25				

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Alpha-chlordane	3.34	3.01	90.1	3.34	2.57	76.9	15.8	25	52-135	
Gamma-chlordane	3.34	3.12	93.4	3.34	2.60	77.8	18.2	25	47-143	
4,4-DDD	3.34	3.20	95.8	3.34	3.01	90.1	6.1	24	56-152	
4,4-DDE	3.34	2.15	64.4	3.34	2.14	64.1	0.5	22	31-152	
4,4-DDT	3.34	4.85	145	3.34	4.72	141	2.7	27	38-144	L1
a-BHC	3.34	2.20	65.9	3.34	2.01	60.2	9	24	43-131	
Aldrin	3.34	2.33	69.8	3.34	2.22	66.5	4.8	24	45-133	
b-BHC	3.34	2.75	82.3	3.34	2.60	77.8	5.6	24	48-134	
d-BHC	3.34	3.02	90.4	3.34	2.72	81.4	10.5	24	38-156	
Dieldrin	3.34	2.33	69.8	3.34	2.30	68.9	1.3	21	58-136	

ab-q213-0321

Refer to the Definition page for terms.

DRAFT

QUALITY CONTROL CERTIFICATE

Job ID : 21031513 **Date :** 3/30/2021

Analysis : Organochlorine Pesticides **Method : SW-846 8081B** **Reporting Units : ug/Kg**

QC Batch ID : Qb21032593 **Created Date :** 03/23/21 **Created By :** PSunkara

Samples in This QC Batch : 21031513.08,09,11,13

QC Type: LCS and LCSD

Parameter	LCS Spk Added	LCS Result	LCS % Rec	LCSD Spk Added	LCSD Result	LCSD % Rec	RPD	RPD CtrlLimit	%Recovery CtrlLimit	Qual
Endosulfan I	3.34	1.12	33.5	3.34	1.19	35.6	6.1	22	19-132	
Endosulfan II	3.34	1.79	53.6	3.34	1.68	50.3	6.3	21	36-95	
Endosulfan sulfate	3.34	2.47	74	3.34	2.38	71.3	3.7	23	63-143	
Endrin	3.34	2.67	79.9	3.34	2.33	69.8	13.6	21	51-141	
Endrin aldehyde	3.34	2.66	79.6	3.34	2.55	76.3	4.2	23	42-150	
Endrin ketone	3.34	3.67	110	3.34	3.42	102	7	18	61-149	
g-BHC	3.34	2.56	76.6	3.34	2.28	68.3	11.6	22	49-135	
Heptachlor	3.34	2.52	75.4	3.34	2.24	67.1	11.8	24	52-124	
Heptachlor epoxide	3.34	2.60	77.8	3.34	2.50	74.9	3.9	23	57-129	

QC Type: MS and MSD
QC Sample ID: 21031513.08

Parameter	Sample Result	MS Spk Added	MS Result	MS % Rec	MSD Spk Added	MSD Result	MSD % Rec	RPD	RPD CtrlLimit	%Rec CtrlLimit	Qual
4,4-DDD	0.0000	3.34	2.98	89.2						56-152	
4,4-DDE	BRL	3.34	2.420	72.5						31-152	
4,4-DDT	0.0000	3.34	4.58	137						38-144	
a-BHC	0.0000	3.34	1.88	56.3						43-131	
Aldrin	0.0000	3.34	2.01	60.2						45-133	
b-BHC	0.0000	3.34	2.42	72.5						48-134	
d-BHC	0.0000	3.34	2.72	81.4						38-156	
Dieldrin	0.0000	3.34	2.09	62.6						58-136	
Endosulfan I	0.0000	3.34	0.862	25.8						19-132	
Endosulfan II	0.0000	3.34	1.46	43.7						36-95	
Endosulfan sulfate	BRL	3.34	2.828	84.7						63-143	
Endrin	0.0000	3.34	2.37	71						51-141	
Endrin aldehyde	0.0000	3.34	2.27	68						42-150	
Endrin ketone	0.0000	3.34	3.34	100						61-149	
g-BHC	0.0000	3.34	2.20	65.9						49-135	
Heptachlor	0.0000	3.34	2.07	62						52-124	
Heptachlor epoxide	0.0000	3.34	2.48	74.3						57-129	

The Chain of Custody is a Legal Document — Page 1 of 2

DRAFT

10100 East Freeway (I-10)
Houston, TX 77029

Job ID: 21031513

TAT: 5 Days — PM: Scarpenter

A&B -

1. REPORT TO:	2. INVOICE TO:	3.PO# / Qt210301205
Company: DiSorbo Consulting	Company: DiSorbo Consulting	4. Turnaround Time- Business Days
Address: 8501 N. MoPac, Ste. 300, Austin, TX 78759	Address: 1010 Travis St., Ste 916, Houston, TX 77702	☐ 1 Day * ☑ 5 Days; ☐ 2 Days * ☐ 7 Days; ☐ 3 Days * ☐ Other ___
Contact: Bob Davis	Contact: Accounts Payable	* Surcharge Applies
Phone: 512-970-9639	Phone: 713-955-1227	
Email: bdavis@disorboconsult.com	Email:	*Day Zero is the day sample is received. Report due at 5pm on due day.*
CC:	CC:	
CC:	CC:	

5. Project #

6. Project Name / Location
Cedar Port Pre-Dredge Sampling

7. Reporting Requirement
☐ TRRP Limits ☐ TRRP Rpt. Package ☐ Std Level II ☑ MDL Report ☐ EDD

8. Sampler's Name & Company — James Reis, DiSorbo
Sampler's Signature & Date — [signature] 3-17-21

9. Sample ID & Description	Lab Use Only	10. Sampling Date	Time	11. comp	grab	12. Matrix GW	Water	Soil	Sludge	Oil	13. TOTAL No. of Containers	NH3 (<0.03 RL), TOC	Salinity	Metals Dissolved ICPMS (ug/L)	Hg (ug/L)	TPH 1005	SVOC, SVOC SIM (ug/L)	PCBs	Pesticides	VOC	18. Comments
No. Containers												1	1	1	1	3	5	3	3	3	
14. Containers*												P	P	P	P	VOA	A/G	A/G	A/G	VOA	
15. Preservatives**																					Water List
MB - 1 - WAT	01AU	3-17-21	1710		X		X				21	X	X	X	X	X	X	X	X	X	
MB - 1 - ELUT - WATER PART	02AT	↓	1716		↓		X				20	X		X	X	X	X	X	X	X	Comp w/SED PART
MB - 7 - WAT	03AU	↓	0900		↓		X				21	X	X	X	X	X	X	X	X	X	
MB - 9 - ELUT - WATER PART	04AT	↓	1300		↓		X				20	X		X	X	X	X	X	X	X	Comp w/SED PART
MB - EQB - WAT	05AT	↓	1750		↓		X				20	X		X	X	X	X	X	X	X	
MB - TRIP - WAT	06AB	↓	1155		↓		X				2			X	X						
MB-5-ELUT-~~WATER~~	07AT	↓	1645		↓																

19. RELINQUISHED BY	DATE	TIME	20. RECEIVED BY	DATE	TIME	KNOWN HAZARDS / COMMENTS
James Reis, DiSorbo	3-17-21	19:00	[signature]	3.17.21	1900	
						1.6°C [illegible]

* Containers: VOA- 40 ml vial; 4 oz/8 oz- glass wide mouth; A/G- Amber/Glass 1 Liter; P/O- Plastic/other ______

Preservatives: C-Cool H- HCl N- HNO3 S-H2SO4 OH- NaOH T-Na2S2O3 X- Other *ZnAcetate*

Temperature: ____ Intact? ☐ Y ☐ N Initials ____

BILL OF LADING/TRACKING #

METHOD OF SHIPMENT

A&B CANNOT ACCEPT VERBAL CHANGES. PLEASE FAX WRITTEN CHANGES TO 713-453-6091 OR EMAIL THE NEW COC TO YOUR PROJECT MANAGER.

Samples will be disposed of after 30 days. A&B reserves the right to return samples.

DRAFT

The Chain of Custody is a Legal Document

Page 2 of 2

10100 East Freeway (I-10)
Houston, TX 77029

Job ID: 21031513

TAT: 5 Days PM: Scarpenter

1. REPORT TO:	2. INVOICE TO:	3.PO# / Q210301205
Company: DiSorbo Consulting	Company: DiSorbo Consulting	**4. Turnaround Time- Business Days**
Address: 8501 N. MoPac, Ste. 300 Austin, TX 78759	Address: 1010 Travis St., Ste 916 Houston, TX 77702	☐ 1 Day * ☑ 5 Days ☐ 2 Days * ☐ 7 Days ☐ 3 Days * ☐ Other ____
Contact: Bob Davis	Contact: Accounts Payable	* Surcharge Applies
Phone: 512-970-9639	Phone: 713-955-1227	
Email: bdavis@disorboconsult.com	Email:	*Day Zero is the day sample is received. Report due at 5pm on due day.*
CC:	CC:	
CC:	CC:	

5. Project #

6. Project Name / Location
Cedar Port Pre-Dredge Sampling

7. Reporting Requirement
☐ TRRP Limits ☐ TRRP Rpt. Packag ☐ Std Level II ☑ MDL Report ☐ EDD

8. Sampler's Name & Company
James Reis, DiSorbo

Sampler's Signature & Date
[signature] 3.17.21

9. Sample ID & Description	Lab Use Only	10. Sampling Date	10. Sampling Time	11. comp	11. grab	12. Matrix GW	Water	Soil	Sludge	Oil	other	13. TOTAL No. of Containers	TOC_Sub	%Moisture, Particle Size_Sub	%Moisture, NH3 (<0.1 RL), Hg, Metals ICPMS, Pest, PCB (<1 RL), TPH SVOC, SVOC SIM (ug/Kg)	VOCs	RCI			18. Comments
No. Containers													1	1	4					
14. Containers*													G	G	G					
15. Preservatives**													C	C	C					Soil List
~~MB - 1 - SED~~ QR								X				6	X	X	X	X	X			
MB - 7 - SED	08AF	3-17-21	11:50	x				X				6	X	X	X	X	X			
MB - 9 - SED	09AF	3-17-21	15:20	x				X				6	X	X	X	X	X			
~~MB - 1 - ELUT - SED PART~~ QR								X				6	X	X	X	X				Lab to composite ELUT WTR and ELUT SED
MB - 9 - ELUT - SED PART	10AF	3-17-21	15:20	x				X				6	X	X	X	X				Lab to composite ELUT WTR and ELUT SED

19. RELINQUISHED BY	DATE	TIME	20. RECEIVED BY	DATE	TIME	KNOWN HAZARDS / COMMENTS:
James Reis, DiSorbo	3.17.21	19:00	[signature]	3.17.21	1900	
						1.6 °C 10C01/3.4

* Containers: VOA- 40 ml vial A/G- Amber/Glass 1 Liter
4 oz/8 oz- glass wide mouth P/O- Plastic/other ________

Preservatives: C- Cool H- HCl N- HNO3
S-H2SO4 OH- NaOH T-Na2S2O3 X- Other *ZnAcetate*

BILL OF LADING/TRACKING #

METHOD OF SHIPMENT

Temperature: ____
Intact? ☐ Y ☐ N
Initials ________

A&B CANNOT ACCEPT VERBAL CHANGES. PLEASE FAX WRITTEN CHANGES TO 713-453-6091 OR EMAIL THE NEW COC TO YOUR PROJECT MANAGER.

Samples will be disposed of after 30 days. A&B reserves the right to return samples.

DRAFT

The Chain of Custody is a Legal Document

Page 2 of 2

Job ID:21031410 TA 3/19/21

21031513

A

10100 East Freeway (I-10) Houston, TX 77029	**1. REPORT TO:** Company: DiSorbo Consulting Address: 8501 N. MoPac, Ste. 300 Austin, TX 78759 Contact: Bob Davis Phone: 512-970-9639 Email: bdavis@disorboconsult.com CC: CC:	**2. INVOICE TO:** Company: DiSorbo Consulting Address: 1010 Travis St., Ste 916 Houston, TX 77702 Contact: Accounts Payable Phone: 713-955-1227 Email: CC CC

3.PO# / Qt210301205

4. Turnaround Time- Business Days

☐ 1 Day * ☑ 5 Days
☐ 2 Days * ☐ 7 Days
☐ 3 Days * ☐ Other ____

* Surcharge Applies

Day Zero is the day sample is received. Report due at 5pm on due day.

5. Project #

6. Project Name / Location
Cedar Port Pre-Dredge Sampling

7. Reporting Requirement
☐ TRRP Limits ☐ TRRP Rpt. Packag ☐ Std Level II ☑ MDL Report ☐ EDD

8. Sampler's Name & Company **Sampler's Signature & Date**

9. Sample ID & Description	Lab Use Only	10. Sampling Date	10. Sampling Time	11. comp	11. grab	12. Matrix GW	Water	Soil	Sludge	Oil	other	13. TOTAL No. of Containers	TOC_Sub	%Moisture, Particle Size_Sub	%Moisture, NH3 (0.1 RL), Hg, Metals ICPMS, Pest, PCB (<1 RL), TPH, SVOC, SVOC SIM (ug/Kg)	VOCs	RCI			18. Comments
No. Containers													1	1	4					Soil List
14. Containers*													G	G	G					
15. Preservatives**													C	C	C					
MB - 1 - SED	01AF	03/16/21	1210					X				6	X	X	X	X	X			
MB - 1 - ELUT - SED PART	02AF	↓	1210					X				6	X	X	X	X				Lab to composite ELUT WTR and ELUT SED
MB - 5 - SED	03AF		1530					X				6	X	X	X	X				
MB - 5 - ELUT - SED PART	04AF	↓	1530					X				6	X	X	X	X				Lab to composite ELUT WTR and ELUT SED

19. RELINQUISHED BY	DATE	TIME	20. RECEIVED BY	DATE	TIME	KNOWN HAZARDS / COMMENTS.
[signature]	03/16	1715	[signature]	3-16-21	1715	4.1 °C IR20230

* Containers: VOA- 40 ml vial; A/G- Amber/Glass 1 Liter; 4 oz/8 oz- glass wide mouth; P/O- Plastic/other ____

Preservatives C- Cool H- HCl N- HNO3 S-H2SO4 OH- NaOH T-Na2S2O3 X- Other ZnAcetate

Temperature ____ K101
Intact? ☑ Y ☐ N
Initials ____

BILL OF LADING/TRACKING #

METHOD OF SHIPMENT

A&B CANNOT ACCEPT VERBAL CHANGES. PLEASE FAX WRITTEN CHANGES TO 713-453-6091 OR EMAIL THE NEW COC TO YOUR PROJECT MANAGER.

Samples will be disposed of after 30 days. A&B reserves the right to return samples.

Sample Condition Checklist

DRAFT

A&B JobID : **21031513**	Date Received : **03/16/2021**	Time Received : **5:15PM**	
Client Name : **DiSorbo Consulting LLC**			
Temperature : **1.6°C**	Sample pH : **<2 nh3, hg**		
Thermometer ID : **102002320**	pH Paper ID : **81548**		
Perservative :			

	Check Points	Yes	No	N/A
1.	Cooler seal present and signed.		X	
2.	Sample(s) in a cooler.	X		
3.	If yes, ice in cooler.	X		
4.	Sample(s) received with chain-of-custody.	X		
5.	C-O-C signed and dated.	X		
6.	Sample(s) received with signed sample custody seal.		X	
7.	Sample containers arrived intact. (If no comment).	X		
8.	Matrix : Water ☐ Soil ☐ Liquid ☐ Sludge ☐ Solid ☐ Cassette ☐ Tube ☐ Bulk ☐ Badge ☐ Food ☐ Other ☐			
9.	Sample(s) were received in appropriate container(s).	X		
10.	Sample(s) were received with proper preservative	X		
11.	All samples were logged or labeled.	X		
12.	Sample ID labels match C-O-C ID's		X	
13.	Bottle count on C-O-C matches bottles found.	X		
14.	Sample volume is sufficient for analyses requested.	X		
15.	Samples were received within the hold time.	X		
16.	VOA vials completely filled.	X		
17.	Sample accepted.	X		
18	Has client been contacted about sub-out	X		

Comments : Include actions taken to resolve discrepancies/problem:

07= 'MB-4-ELUT-WATERPORT as sx ID. -VH 03-19-21

Received by : JMontemayor

Check in by/date : VHernandez / 03/18/2021

DRAFT

Laboratory Analysis Report

DRAFT

Job ID : 21031513

10100 East Freeway, Suite 100, Houston, TX 77029 tel: 713-453-6060, fax: 713-453-6091, http://www.ablabs.com

Client Project Name :
Cedar Port Pre-Dredge Sampling

Report To :	Client Name:	DiSorbo Consulting LLC	P.O.#.:
	Attn:	Bob Davis	Sample Collected By: James Reis
	Client Address:	8501 N. MoPac Expressway, Ste. 30	Date Collected: 03/16/21 - 03/17/21
	City, State, Zip:	Austin, Texas, 78759	

Client Sample ID	Matrix	A&B Sample ID
MB-7-SED	Soil	21031513.08
MB-9-SED	Soil	21031513.09
MB-1-SED	Soil	21031513.11
MB-5-SED	Soil	21031513.13

This analysis was subcontracted to :
Ana Lab, 2600 Dudley
Kilgore, Texas, 75662

Released By: Shantall Carpenter
Title: Senior Project Manager

Date: 04/19/2021

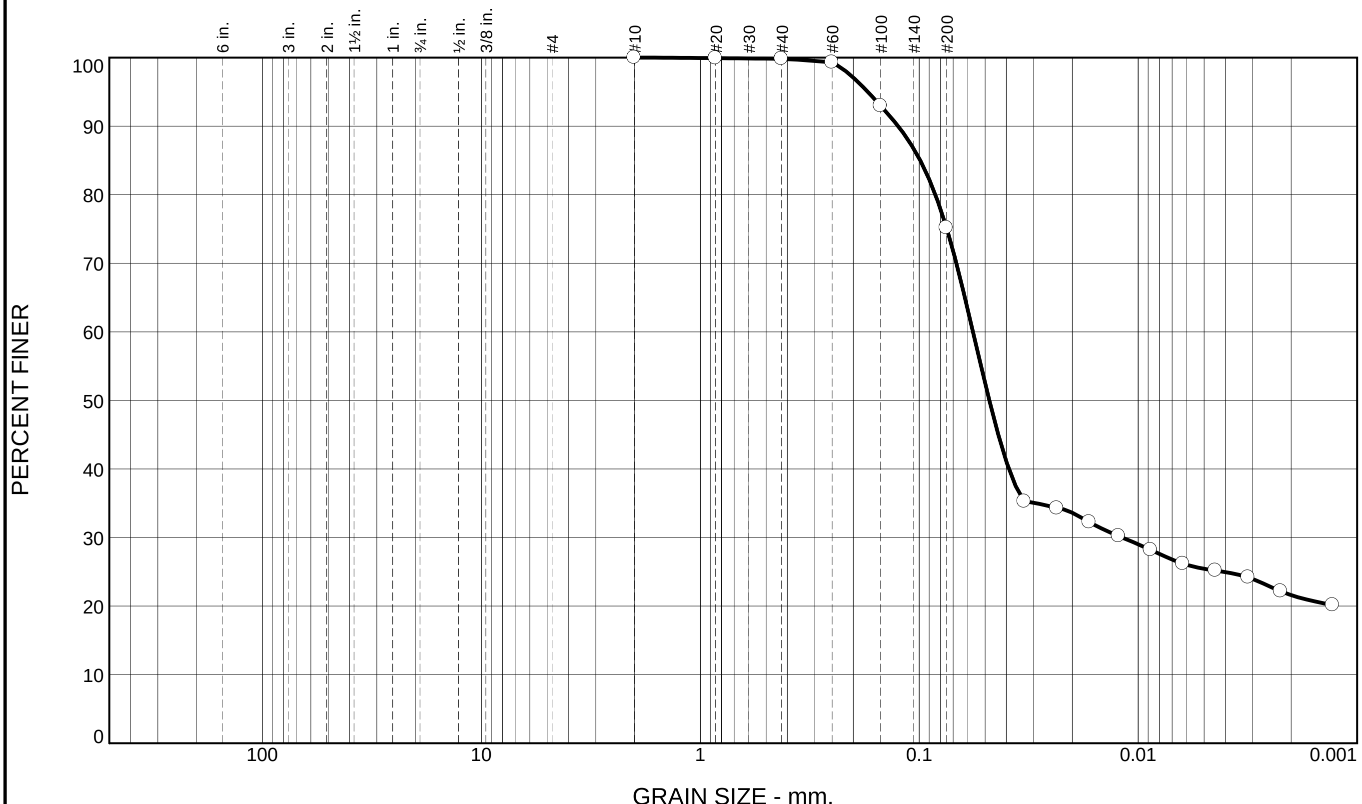
I am the laboratory manager, or his/her designee, and I am responsible for the release of this data package. This laboratory data package has been reviewed and is complete and technically compliant with the requirements of the methods used, except where noted in the attached exception reports. I affirm, to the best of my knowledge that all problems/anomalies observed by this laboratory (and if applicable, any and all laboratories subcontracted through this laboratory) that might affect the quality of the data, have been identified in the Laboratory Review Checklist, and that no information or data have been knowingly withheld that would affect the quality of the data.

ab-q210-0321

Date Received : 03/16/2021 17:15

DRAFT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	24.6	49.8	25.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	99.8		
#60	99.3		
#100	93.0		
#200	75.2		

* (no specification provided)

Material Description

MB-7-SED

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.1248 D_{85}= 0.0989 D_{60}= 0.0568
D_{50}= 0.0478 D_{30}= 0.0118 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample Number: MB-7-SED

Date: 04/01/2021

TOLUNAY-WONG ENGINEERS

Client: A & B Labs
Project:

Tested By: R Kowis **Checked By:** R Kowis

DRAFT

GRAIN SIZE DISTRIBUTION TEST DATA

4/8/2021

Client: A & B Labs
Project:
Project Number:
Sample Number: MB-7-SED
Material Description: MB-7-SED
Date: 04/01/2021
Tested by: R Kowis **Checked by:** R Kowis

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 244.24
Tare Wt. = 231.82
Minus #200 from wash = 75.2%

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
281.82	231.82	231.82	#10	231.82	100.0
			#20	231.86	99.9
			#40	231.91	99.8
			#60	232.18	99.3
			#100	235.34	93.0
			#200	244.24	75.2

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =50
Hygroscopic moisture correction:
Moist weight and tare = 44.00
Dry weight and tare = 43.77
Tare weight = 31.37
Hygroscopic moisture = 1.9%
Table of composite correction values:

Temp., deg. C:	20.8	21.3
Comp. corr.:	-5.0	-5.0

Meniscus correction only = 0.5
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
2.00	21.3	22.5	17.5	0.0132	23.0	12.5	0.0331	35.3
4.00	21.3	22.0	17.0	0.0132	22.5	12.6	0.0235	34.2
8.00	21.3	21.0	16.0	0.0132	21.5	12.8	0.0167	32.2
15.00	21.3	20.0	15.0	0.0132	20.5	12.9	0.0123	30.2
30.00	21.1	19.0	14.0	0.0133	19.5	13.1	0.0088	28.2
60.00	21.0	18.0	13.0	0.0133	18.5	13.3	0.0062	26.2
120.00	20.8	17.5	12.5	0.0133	18.0	13.3	0.0044	25.2
240.00	21.0	17.0	12.0	0.0133	17.5	13.4	0.0031	24.2
480.00	21.0	16.0	11.0	0.0133	16.5	13.6	0.0022	22.2
1440.00	21.3	15.0	10.0	0.0132	15.5	13.8	0.0013	20.1

Tolunay-Wong Engineers, Inc. in Texas City, TX

DRAFT

Fractional Components

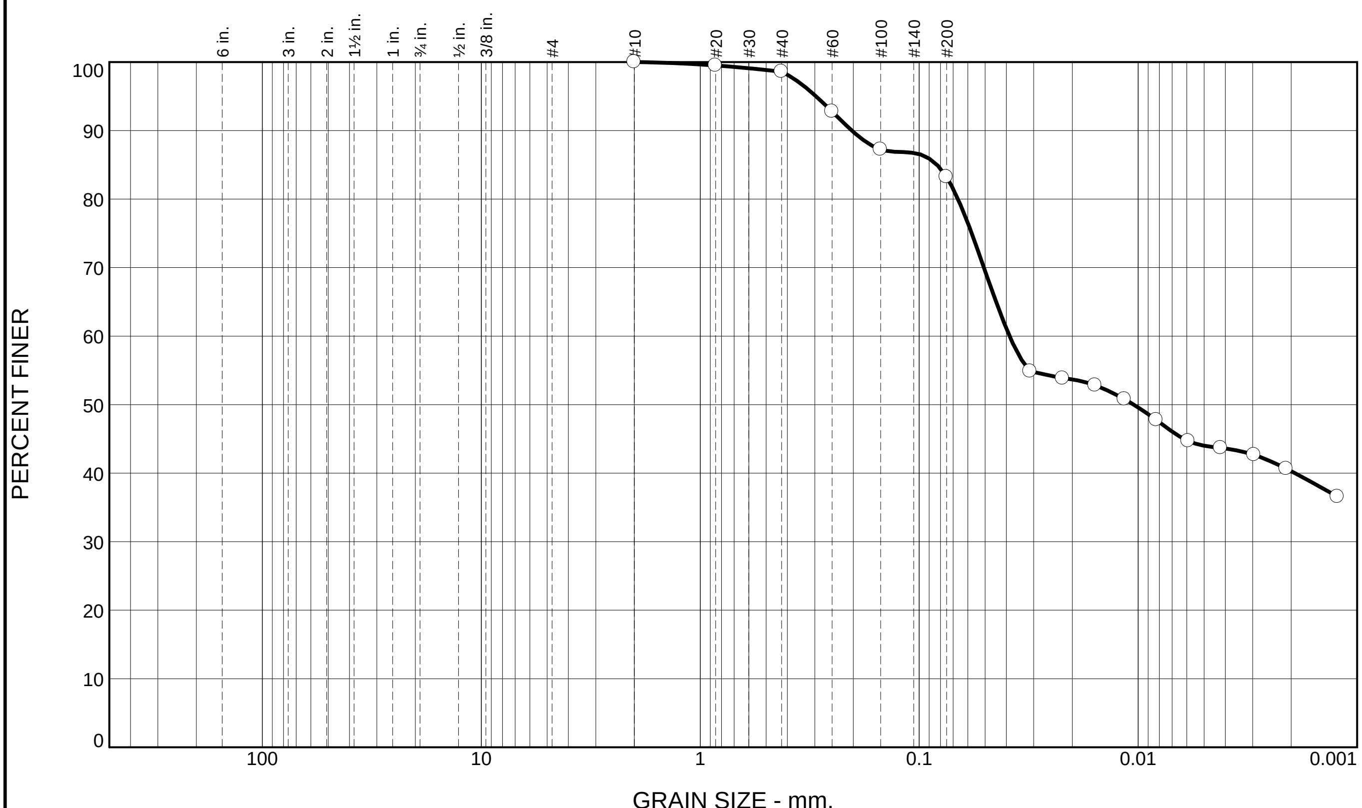
Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.2	24.6	24.8	49.8	25.4	75.2

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
				0.0118	0.0389	0.0478	0.0568	0.0843	0.0989	0.1248	0.1717

Fineness Modulus
0.08

DRAFT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.4	15.4	39.2	44.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.5		
#40	98.6		
#60	92.8		
#100	87.2		
#200	83.2		

* (no specification provided)

Material Description

MB-9-SED

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2030 D_{85}= 0.0829 D_{60}= 0.0387
D_{50}= 0.0105 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample Number: MB-9-SED

Date: 04/01/2021

TOLUNAY-WONG ENGINEERS

Client: A & B Labs
Project:

Tested By: R Kowis **Checked By:** R Kowis

DRAFT

GRAIN SIZE DISTRIBUTION TEST DATA

4/8/2021

Client: A & B Labs
Project:
Project Number:
Sample Number: MB-9-SED
Material Description: MB-9-SED
Date: 04/01/2021
Tested by: R Kowis **Checked by:** R Kowis

Sieve Test Data

Post #200 Wash Test Weights (grams): Dry Sample and Tare = 59.75
Tare Wt. = 51.36
Minus #200 from wash = 83.2%

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
101.36	51.36	51.36	#10	51.36	100.0
			#20	51.61	99.5
			#40	52.07	98.6
			#60	54.97	92.8
			#100	57.74	87.2
			#200	59.75	83.2

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =50
Hygroscopic moisture correction:
Moist weight and tare = 45.33
Dry weight and tare = 44.97
Tare weight = 31.76
Hygroscopic moisture = 2.7%
Table of composite correction values:

Temp., deg. C:	20.7	21.3
Comp. corr.:	-5.0	-5.0

Meniscus correction only = 0.5
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
2.00	20.9	32.0	27.0	0.0133	32.5	11.0	0.0311	54.9
4.00	20.9	31.5	26.5	0.0133	32.0	11.0	0.0221	53.8
8.00	20.8	31.0	26.0	0.0133	31.5	11.1	0.0157	52.8
15.00	20.8	30.0	25.0	0.0133	30.5	11.3	0.0115	50.8
30.00	20.8	28.5	23.5	0.0133	29.0	11.5	0.0083	47.7
60.00	20.7	27.0	22.0	0.0133	27.5	11.8	0.0059	44.7
120.00	20.7	26.5	21.5	0.0133	27.0	11.9	0.0042	43.7
240.00	21.2	26.0	21.0	0.0132	26.5	11.9	0.0030	42.7
480.00	21.2	25.0	20.0	0.0132	25.5	12.1	0.0021	40.6
1440.00	21.3	23.0	18.0	0.0132	23.5	12.4	0.0012	36.6

Tolunay-Wong Engineers, Inc. in Texas City, TX

DRAFT

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	1.4	15.4	16.8	39.2	44.0	83.2

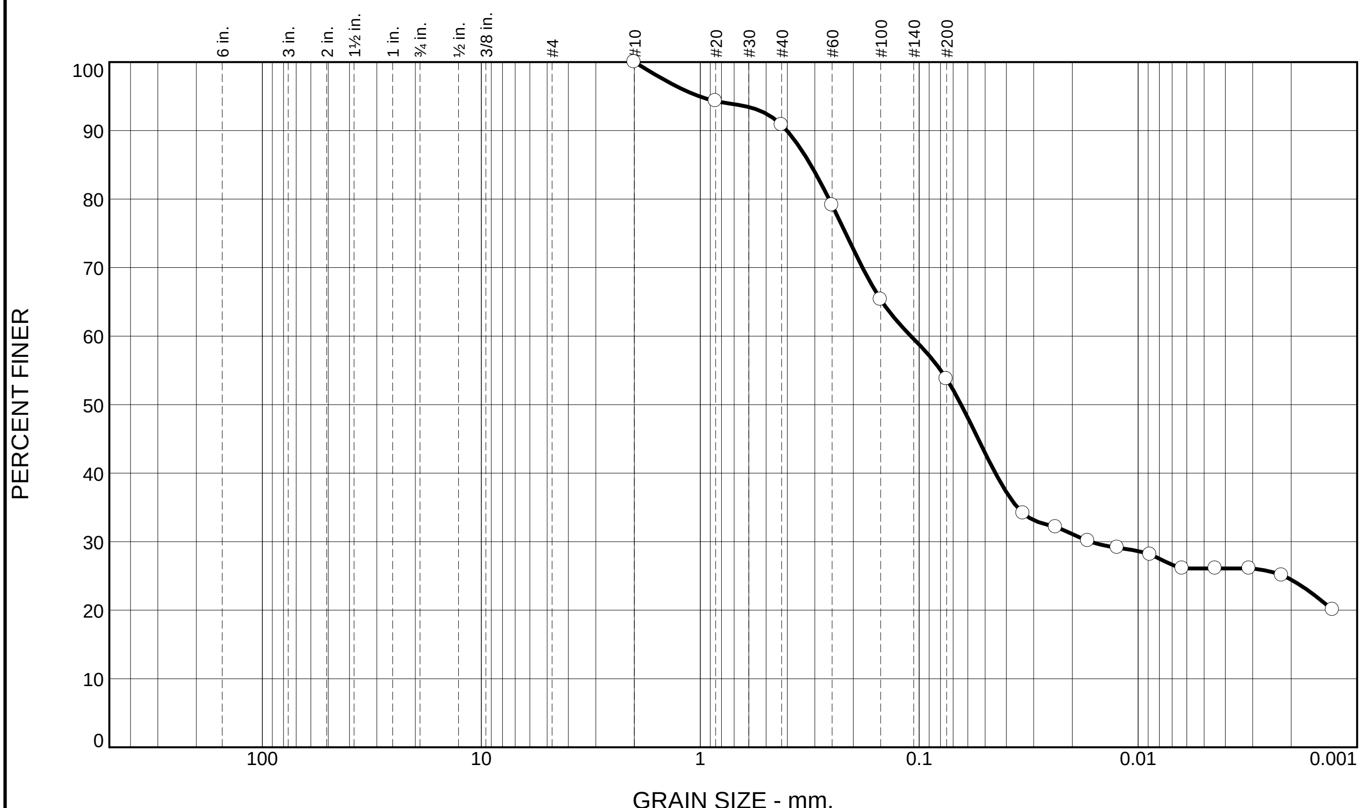
D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.0019	0.0105	0.0387	0.0665	0.0829	0.2030	0.2959

Fineness Modulus
0.19

Tolunay-Wong Engineers, Inc. in Texas City, TX

DRAFT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	9.2	37.0	27.7	26.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	94.3		
#40	90.8		
#60	79.1		
#100	65.3		
#200	53.8		

* (no specification provided)

Material Description

MB-1-SED

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4022 D_{85}= 0.3130 D_{60}= 0.1091
D_{50}= 0.0643 D_{30}= 0.0165 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample Number: MB-1-SED

Date: 04/01/2021

TOLUNAY-WONG ENGINEERS

Client: A & B Labs
Project:

Tested By: R Kowis **Checked By:** R Kowis

DRAFT

GRAIN SIZE DISTRIBUTION TEST DATA

4/8/2021

Client: A & B Labs
Project:
Project Number:
Sample Number: MB-1-SED
Material Description: MB-1-SED
Date: 04/01/2021
Tested by: R Kowis **Checked by:** R Kowis

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 75.72
Tare Wt. = 52.60
Minus #200 from wash = 53.8%

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
102.60	52.60	52.60	#10	52.60	100.0
			#20	55.45	94.3
			#40	57.20	90.8
			#60	63.04	79.1
			#100	69.93	65.3
			#200	75.72	53.8

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =50
Hygroscopic moisture correction:
Moist weight and tare = 42.45
Dry weight and tare = 42.24
Tare weight = 28.43
Hygroscopic moisture = 1.5%
Table of composite correction values:

Temp., deg. C:	20.6	21.3
Comp. corr.:	-5.0	-5.0

Meniscus correction only = 0.5
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
2.00	20.7	22.0	17.0	0.0133	22.5	12.6	0.0335	34.1
4.00	20.7	21.0	16.0	0.0133	21.5	12.8	0.0238	32.1
8.00	20.7	20.0	15.0	0.0133	20.5	12.9	0.0169	30.1
15.00	20.6	19.5	14.5	0.0133	20.0	13.0	0.0124	29.1
30.00	20.6	19.0	14.0	0.0133	19.5	13.1	0.0088	28.1
60.00	20.6	18.0	13.0	0.0133	18.5	13.3	0.0063	26.1
120.00	20.6	18.0	13.0	0.0133	18.5	13.3	0.0044	26.1
240.00	21.3	18.0	13.0	0.0132	18.5	13.3	0.0031	26.1
480.00	21.3	17.5	12.5	0.0132	18.0	13.3	0.0022	25.1
1440.00	21.3	15.0	10.0	0.0132	15.5	13.8	0.0013	20.1

Tolunay-Wong Engineers, Inc. in Texas City, TX

DRAFT

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	9.2	37.0	46.2	27.7	26.1	53.8

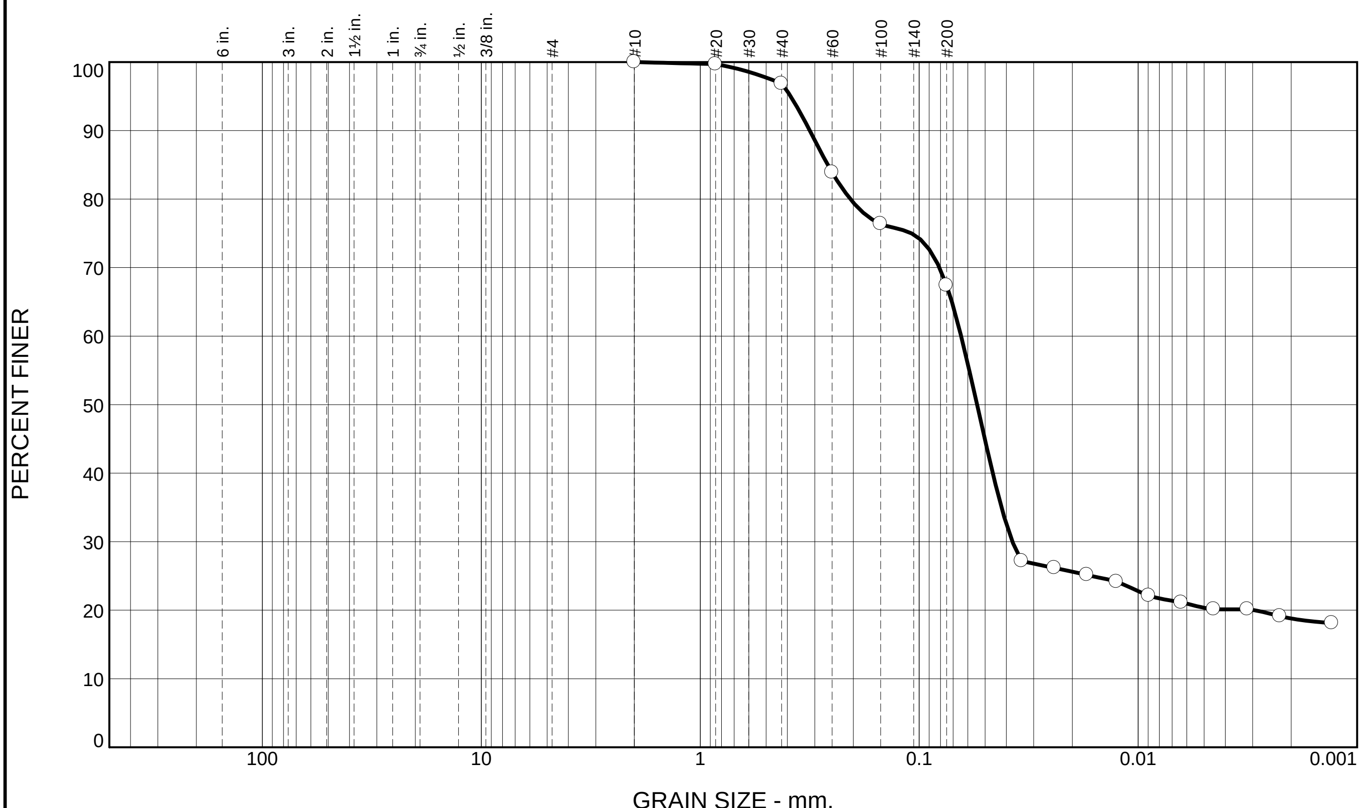
D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
				0.0165	0.0449	0.0643	0.1091	0.2580	0.3130	0.4022	1.0090

Fineness Modulus
0.61

Tolunay-Wong Engineers, Inc. in Texas City, TX

DRAFT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	3.1	29.5	47.1	20.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.7		
#40	96.9		
#60	83.9		
#100	76.4		
#200	67.4		

* (no specification provided)

Material Description

MB-5-SED

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3161 D_{85}= 0.2616 D_{60}= 0.0643
D_{50}= 0.0544 D_{30}= 0.0375 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample Number: MB-5-SED

Date: 04/01/2021

TOLUNAY-WONG ENGINEERS

Client: A & B Labs
Project:

Tested By: R Kowis **Checked By:** R Kowis

DRAFT

GRAIN SIZE DISTRIBUTION TEST DATA

4/8/2021

Client: A & B Labs
Project:
Project Number:
Sample Number: MB-5-SED
Material Description: MB-5-SED
Date: 04/01/2021
Tested by: R Kowis **Checked by:** R Kowis

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 245.51
Tare Wt. = 229.21
Minus #200 from wash = 67.4%

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
279.21	229.21	229.21	#10	229.21	100.0
			#20	229.36	99.7
			#40	230.78	96.9
			#60	237.26	83.9
			#100	241.02	76.4
			#200	245.51	67.4

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =50
Hygroscopic moisture correction:
Moist weight and tare = 40.42
Dry weight and tare = 40.21
Tare weight = 28.28
Hygroscopic moisture = 1.8%
Table of composite correction values:

Temp., deg. C:	20.8	21.2
Comp. corr.:	-5.0	-5.0

Meniscus correction only = 0.5
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
2.00	21.1	18.5	13.5	0.0133	19.0	13.2	0.0340	27.2
4.00	21.1	18.0	13.0	0.0133	18.5	13.3	0.0241	26.2
8.00	21.0	17.5	12.5	0.0133	18.0	13.3	0.0171	25.2
15.00	21.0	17.0	12.0	0.0133	17.5	13.4	0.0126	24.2
30.00	21.0	16.0	11.0	0.0133	16.5	13.6	0.0089	22.1
60.00	20.9	15.5	10.5	0.0133	16.0	13.7	0.0063	21.1
120.00	20.8	15.0	10.0	0.0133	15.5	13.8	0.0045	20.1
240.00	21.2	15.0	10.0	0.0132	15.5	13.8	0.0032	20.1
480.00	21.2	14.5	9.5	0.0132	15.0	13.8	0.0022	19.1
1440.00	21.2	14.0	9.0	0.0132	14.5	13.9	0.0013	18.1

Tolunay-Wong Engineers, Inc. in Texas City, TX

DRAFT

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	3.1	29.5	32.6	47.1	20.3	67.4

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
			0.0030	0.0375	0.0461	0.0544	0.0643	0.2062	0.2616	0.3161	0.3865

Fineness Modulus
0.37

Tolunay-Wong Engineers, Inc. in Texas City, TX

DRAFT

The Chain of Custody is a Legal Document — Page 1 of 2

Job ID: 21031513
TAT: 5 Days PM: Scarpenter

10100 East Freeway (I-10)
Houston, TX 77029

A&B -

1. REPORT TO:	2. INVOICE TO:	3.PO# / Q210301205
Company: DiSorbo Consulting	Company: DiSorbo Consulting	4. Turnaround Time- Business Days
Address: 8501 N. MoPac, Ste. 300, Austin, TX 78759	Address: 1010 Travis St., Ste 916, Houston, TX 77702	☐ 1 Day * ☑ 5 Days
Contact: Bob Davis	Contact: Accounts Payable	☐ 2 Days * ☐ 7 Days
Phone: 512-970-9639	Phone: 713-955-1227	☐ 3 Days * ☐ Other ___
Email: bdavis@disorboconsult.com	Email:	* Surcharge Applies
CC:	CC:	*Day Zero is the day sample is received. Report due at 5pm on due day.*
CC:	CC:	

5. Project #

6. Project Name / Location
Cedar Port Pre-Dredge Sampling

7. Reporting Requirement
☐ TRRP Limits ☐ TRRP Rpt. Package ☐ Std Level II ☑ MDL Report ☐ EDD

8. Sampler's Name & Company: James Reis, DiSorbo
Sampler's Signature & Date: [signature] 3-17-21

No. Containers												1	1	1	1	3	5	3	3	3	
14. Containers*												P	P	P	P	VOA	A/G	A/G	A/G	VOA	
15. Preservatives**																					Water List
9. Sample ID & Description	Lab Use Only	10. Sampling Date	Time	11. comp	grab	12. Matrix GW	Water	Soil	Sludge	Oil	13. TOTAL No. of Containers	NH3 (<0.03 RL), TOC	Salinity	Metals Dissolved ICPMS (ug/L)	Hg (ug/L)	TPH 1005	SVOC, SVOC SIM (ug/L)	PCBs	Pesticides	VOC	18. Comments
MB - 1 - WAT	01AU	3-17-21	1710		X		X				21	X	X	X	X	X	X	X	X	X	
MB - 1 - ELUT - WATER PART	02AT	↓	1716		↓		X				20	X		X	X	X	X	X	X	X	Comp w/SED PART
MB - 7 - WAT	03AU	↓	0900		↓		X				21	X	X	X	X	X	X	X	X	X	
MB - 9 - ELUT - WATER PART	04AT	↓	1300		↓		X				20	X		X	X	X	X	X	X	X	Comp w/SED PART
MB - EQB - WAT	05AT	↓	1750		↓		X				20	X		X	X	X	X	X	X	X	
MB - TRIP - WAT	06AB	↓	1155		↓		X				2			X	X						
MB-5-ELUT-WATER PA	07AT	↓	1645		↓																

19. RELINQUISHED BY	DATE	TIME	20. RECEIVED BY	DATE	TIME	KNOWN HAZARDS / COMMENTS
James Reis, DiSorbo	3-17-21	19:00	[signature]	3-17-21	1900	
						1.6°C [illegible]

* Containers: VOA- 40 ml vial; 4 oz/8 oz- glass wide mouth; A/G- Amber/Glass 1 Liter; P/O- Plastic/other ______

Preservatives: C-Cool H- HCl N- HNO3 S-H2SO4 OH- NaOH T-Na2S2O3 X- Other *ZnAcetate*

Temperature: ____ Intact? ☐ Y ☐ N Initials ____

BILL OF LADING/TRACKING #

METHOD OF SHIPMENT

A&B CANNOT ACCEPT VERBAL CHANGES. PLEASE FAX WRITTEN CHANGES TO 713-453-6091 OR EMAIL THE NEW COC TO YOUR PROJECT MANAGER.

Samples will be disposed of after 30 days. A&B reserves the right to return samples.

DRAFT

The Chain of Custody is a Legal Document

10100 East Freeway (I-10)
Houston, TX 77029

Job ID: 21031513

TAT: 5 Days PM: Scarpenter

1. REPORT TO:	2. INVOICE TO:	3. PO# / Q\210301205
Company: DiSorbo Consulting	Company: DiSorbo Consulting	4. Turnaround Time- Business Days
Address: 8501 N. MoPac, Ste. 300 Austin, TX 78759	Address: 1010 Travis St., Ste 916 Houston, TX 77702	☐ 1 Day * ☑ 5 Days ☐ 2 Days * ☐ 7 Days ☐ 3 Days * ☐ Other ____
Contact: Bob Davis	Contact: Accounts Payable	* Surcharge Applies
Phone: 512-970-9639	Phone: 713-955-1227	
Email: bdavis@disorboconsult.com	Email:	*Day Zero is the day sample is received. Report due at 5pm on due day.*
CC:	CC:	
CC:	CC:	

5. Project #

6. Project Name / Location: Cedar Port Pre-Dredge Sampling

7. Reporting Requirement: ☐ TRRP Limits ☐ TRRP Rpt. Packag ☐ Std Level II ☑ MDL Report ☐ EDD

8. Sampler's Name & Company: James Reis, DiSorbo

Sampler's Signature & Date: [signature] 3.17.21

9. Sample ID & Description	Lab Use Only	10. Sampling Date	Time	11. comp	grab	12. Matrix GW	Water	Soil	Sludge	Oil	other	13. TOTAL No. of Containers	TOC_Sub (1, G, C)	%Moisture, Particle Size_Sub (1, G, C)	%Moisture, NH3 (<0.1 RL), Hg, Metals ICPMS, Pest, PCB (<1 RL), TPH SVOC, SVOC SIM (ug/Kg) (4, G, C)	VOCs	RCI			18. Comments
~~MB - 1 - SED~~ QR								X				6	X	X	X	X	X			
MB - 7 - SED	08AF	3-17-21	11:50	X				X				6	X	X	X	X	X			
MB - 9 - SED	09AF	3-17-21	15:20	X				X				6	X	X	X	X	X			
~~MB - 1 - ELUT - SED PART~~ QR								X				6	X	X	X	X				Lab to composite ELUT WTR and ELUT SED
MB - 9 - ELUT - SED PART	10AF	3-17-21	15:20	X				X				6	X	X	X	X				Lab to composite ELUT WTR and ELUT SED

No. Containers / 14. Containers* / 15. Preservatives**

Soil List

19. RELINQUISHED BY	DATE	TIME	20. RECEIVED BY	DATE	TIME	KNOWN HAZARDS / COMMENTS:
James Reis, DiSorbo	3-17-21	19:00	[signature]	3/17/21	1900	
						1.6 °C 10CM/3[illegible]

* Containers: VOA- 40 ml vial; A/G- Amber/Glass 1 Liter; 4 oz/8 oz- glass wide mouth; P/O- Plastic/other ______

Preservatives: C-Cool H- HCl N- HNO3 S-H2SO4 OH- NaOH T-Na2S2O3 X- Other *ZnAcetate*

Temperature: ____ Intact? ☐ Y ☐ N Initials ____

BILL OF LADING/TRACKING #

METHOD OF SHIPMENT

A&B CANNOT ACCEPT VERBAL CHANGES. PLEASE FAX WRITTEN CHANGES TO 713-453-6091 OR EMAIL THE NEW COC TO YOUR PROJECT MANAGER.

Samples will be disposed of after 30 days. A&B reserves the right to return samples.

DRAFT

The Chain of Custody is a Legal Document

Page 2 of 2

	1. REPORT TO:	2. INVOICE TO:	3.PO# / QI210301205
10100 East Freeway (I-10) Houston, TX 77029 Job ID:21031410 TA 3/19/21 21031513 A	Company: DiSorbo Consulting Address: 8501 N. MoPac, Ste. 300 Austin, TX 78759 Contact: Bob Davis Phone: 512-970-9639 Email: bdavis@disorboconsult.com CC: CC:	Company: DiSorbo Consulting Address: 1010 Travis St., Ste 916 Houston, TX 77702 Contact: Accounts Payable Phone: 713-955-1227 Email: CC CC	4. Turnaround Time- Business Days ☐ 1 Day * ☑ 5 Days ☐ 2 Days * ☐ 7 Days ☐ 3 Days * ☐ Other ____ * Surcharge Applies *Day Zero is the day sample is received. Report due at 5pm on due day.*

5. Project #

6. Project Name / Location: Cedar Port Pre-Dredge Sampling

7. Reporting Requirement: ☐ TRRP Limits ☐ TRRP Rpt. Packag ☐ Std Level II ☑ MDL Report ☐ EDD

8. Sampler's Name & Company — Sampler's Signature & Date

No. Containers													1	1	4				
14. Containers*													G	G	G				
15. Preservatives**													C	C	C				Soil List
9. Sample ID & Description	Lab Use Only	10. Sampling Date	10. Sampling Time	11. comp	11. grab	12. Matrix GW	Water	Soil	Sludge	Oil	other	13. TOTAL No. of Containers	TOC_Sub	%Moisture, Particle Size_Sub	%Moisture, NH3 (0.1 RL), Hg, Metals ICPMS Pest, PCB (<1 RL), TPH SVOC, SVOC SIM (ug/Kg)	VOCs	RCI		18. Comments
MB - 1 - SED	01AF	03/16/21	1210					X				6	X	X	X	X	X		
MB - 1 - ELUT - SED PART	02AF	↓	1210					X				6	X	X	X	X			Lab to composite ELUT WTR and ELUT SED
MB - 5 - SED	03AF		1530					X				6	X	X	X	X			
MB - 5 - ELUT - SED PART	04AF	↓	1530					X				6	X	X	X	X			Lab to composite ELUT WTR and ELUT SED

19. RELINQUISHED BY	DATE	TIME	20. RECEIVED BY	DATE	TIME	KNOWN HAZARDS / COMMENTS
[signature]	03/16	1715	[signature]	3-16-21	1715	4.1°C IR0020

* Containers: VOA- 40 ml vial 4 oz/8 oz- glass wide mouth	A/G- Amber/Glass 1 Liter P/O- Plastic/other ____	Preservatives C-Cool H- HCl N- HNO3 S-H2SO4 OH- NaOH T-Na2S2O3 X- Other ZnAcetate	Temperature ____ K101 Intact? ☑ Y ☐ N Initials ____
BILL OF LADING/TRACKING #		METHOD OF SHIPMENT	

A&B CANNOT ACCEPT VERBAL CHANGES. PLEASE FAX WRITTEN CHANGES TO 713-453-6091 OR EMAIL THE NEW COC TO YOUR PROJECT MANAGER.

Samples will be disposed of after 30 days. A&B reserves the right to return samples.

Sample Condition Checklist

DRAFT

A&B JobID : **21031513**	Date Received : **03/17/2021**	Time Received : **7:00PM**
Client Name : **DiSorbo Consulting LLC**		
Temperature : **1.6**	Sample pH : **<2 nh3, hg**	
Thermometer ID : **102002320**	pH Paper ID : **81548**	
Perservative :		

	Check Points	Yes	No	N/A
1.	**Cooler seal present and signed.**		X	
2.	**Sample(s) in a cooler.**	X		
3.	**If yes, ice in cooler.**	X		
4.	**Sample(s) received with chain-of-custody.**	X		
5.	**C-O-C signed and dated.**	X		
6.	**Sample(s) received with signed sample custody seal.**		X	
7.	**Sample containers arrived intact. (If no comment).**	X		
8.	**Matrix :** **Water** ☐ **Soil** ☐ **Liquid** ☐ **Sludge** ☐ **Solid** ☐ **Cassette** ☐ **Tube** ☐ **Bulk** ☐ **Badge** ☐ **Food** ☐ **Other** ☐			
9.	**Sample(s) were received in appropriate container(s).**	X		
10.	**Sample(s) were received with proper preservative**	X		
11.	**All samples were logged or labeled.**	X		
12.	**Sample ID labels match C-O-C ID's**		X	
13.	**Bottle count on C-O-C matches bottles found.**	X		
14.	**Sample volume is sufficient for analyses requested.**	X		
15.	**Samples were received within the hold time.**	X		
16.	**VOA vials completely filled.**	X		
17.	**Sample accepted.**	X		
18	**Has client been contacted about sub-out**	X		

Comments : Include actions taken to resolve discrepancies/problem:

07= 'MB-4-ELUT-WATERPORT as sx ID. -VH 03-19-21

Received by : JMontemayor

Check in by/date : VHernandez / 03/18/2021

DRAFT

Laboratory Analysis Report

Total Number of Pages: 29

DRAFT

Job ID : 21031513

10100 East Freeway, Suite 100, Houston, TX 77029 tel: 713-453-6060, fax: 713-453-6091, http://www.ablabs.com

Client Project Name :
Cedar Port Pre-Dredge Sampling

Report To :	Client Name:	DiSorbo Consulting LLC	P.O.#.:
	Attn:	Bob Davis	Sample Collected By: James Reis
	Client Address:	8501 N. MoPac Expressway, Ste. 30	Date Collected: 03/16/21 - 03/17/21
	City, State, Zip:	Austin, Texas, 78759	

Client Sample ID	Matrix	A&B Sample ID
MB-7-SED	Soil	21031513.08
MB-9-SED	Soil	21031513.09
MB-1-SED	Soil	21031513.11
MB-5-SED	Soil	21031513.13

This analysis was subcontracted to :
Ana Lab, 2600 Dudley
Kilgore, Texas, 75662

Released By: Shantall Carpenter
Title: Senior Project Manager

Date: 04/19/2021

I am the laboratory manager, or his/her designee, and I am responsible for the release of this data package. This laboratory data package has been reviewed and is complete and technically compliant with the requirements of the methods used, except where noted in the attached exception reports. I affirm, to the best of my knowledge that all problems/anomalies observed by this laboratory (and if applicable, any and all laboratories subcontracted through this laboratory) that might affect the quality of the data, have been identified in the Laboratory Review Checklist, and that no information or data have been knowingly withheld that would affect the quality of the data.

ab-q210-0321

Date Received : 03/16/2021 17:15

2600 Dudley Rd. Kilgore, Texas 75662
R: 3306 State Highway 135 N, Kilgore, TX 75662
Office: 903-984-0551 * Fax: 903-984-5914

ANA LAB DRAFT
Testing the Limits of Science and Service

Project
959316

ABL2-G

A & B Labs
Shantall Carpenter
10100 East Freeway
Suite 100
Houston, TX 77029

Printed 04/06/2021 14:23

TABLE OF CONTENTS

This report consists of this Table of Contents and the following pages:

2600 Dudley Rd. Kilgore, Texas 75662
R: 3306 State Highway 135 N, Kilgore, TX 75662
*Office: 903-984-0551 * Fax: 903-984-5914*

ANA LAB DRAFT 1

Testing the Limits of Science and Service

ABL2-G

A & B Labs
Shantall Carpenter
10100 East Freeway
Suite 100
Houston, TX 77029

Project
959316

Printed: 04/06/2021

RESULTS

Sample Results

1973820 MB-7-SED — *Received:* 03/30/2021

Solid & Chemical Materials — *Collected by:* Client — A & B Labs — *PO:* 45151/21031513

Taken: 03/17/2021 11:50:00

SM2540 G-1997 /MOD — *Prepared:* 945096 03/31/2021 07:45:00 — *Analyzed* 945096 03/31/2021 07:45:00 TH2

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	**Total Solids for Dry Wt**	**75.1**	**%**	0.010			01

*Walkley-Black *MOD* — *Prepared:* 945077 04/01/2021 07:30:00 — *Analyzed* 945077 04/01/2021 07:30:00 ESG

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	**Organic Carbon**	**3090 ***	**mg/kg**	266			01

* Dry Weight Basis

1973821 MB-9-SED — *Received:* 03/30/2021

Solid & Chemical Materials — *Collected by:* Client — A & B Labs — *PO:* 45151/21031513

Taken: 03/17/2021 15:20:00

SM2540 G-1997 /MOD — *Prepared:* 945096 03/31/2021 07:45:00 — *Analyzed* 945096 03/31/2021 07:45:00 TH2

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	**Total Solids for Dry Wt**	**70.1**	**%**	0.010			01

*Walkley-Black *MOD* — *Prepared:* 945340 04/02/2021 08:15:00 — *Analyzed* 945340 04/02/2021 08:15:00 ESG

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	**Organic Carbon**	**2280 ***	**mg/kg**	285			01

* Dry Weight Basis

2600 Dudley Rd. Kilgore, Texas 75662
R: 3306 State Highway 135 N, Kilgore, TX 75662
Office: 903-984-0551 * Fax: 903-984-5914

ANA LAB DRAFT 1
Testing the Limits of Science and Service

ABL2-G

Project 959316

A & B Labs
Shantall Carpenter
10100 East Freeway
Suite 100
Houston, TX 77029

Printed: 04/06/2021

1973822 **MB-1-SED** Received: 03/30/2021

Solid & Chemical Materials Collected by: Client A & B Labs PO: 45151/21031513
Taken: 03/16/2021 12:10:00

SM2540 G-1997 /MOD Prepared: 945413 04/01/2021 15:40:00 Analyzed 945413 04/01/2021 15:40:00 TH2

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	Total Solids for Dry Wt	74.8	%	0.010			01

*Walkley-Black *MOD* Prepared: 945340 04/02/2021 08:15:00 Analyzed 945340 04/02/2021 08:15:00 ESG

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	Organic Carbon	3680 *	mg/kg	267			01

* Dry Weight Basis

1973823 **MB-5-SED** Received: 03/30/2021

Solid & Chemical Materials Collected by: Client A & B Labs PO: 45151/21031513
Taken: 03/16/2021 15:30:00

SM2540 G-1997 /MOD Prepared: 945752 04/05/2021 15:25:00 Analyzed 945752 04/05/2021 15:25:00 TH2

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	Total Solids for Dry Wt	66.1	%	0.010			01

*Walkley-Black *MOD* Prepared: 945340 04/02/2021 08:15:00 Analyzed 945340 04/02/2021 08:15:00 ESG

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	Organic Carbon	8760 *	mg/kg	303			01

* Dry Weight Basis

Sample Preparation

1973820 **MB-7-SED** Received: 03/30/2021

45151/21031513

03/17/2021

NELAP-accredited #T104704201-21-18

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Testing the Limits of Science and Service

ABL2-G

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Houston, TX 77029

Project 959316

Printed: 04/06/2021

1973820 MB-7-SED — Received: 03/30/2021 — 45151/21031513

03/17/2021

		Prepared:		03/31/2021	13:01:24	Calculated		03/31/2021	13:01:24	CAL
z	Environmental Fee (per Project)	Verified								
	Calculation	Prepared:		04/01/2021	13:59:13	Calculated		04/01/2021	13:59:13	CAL
	As Received to Dry Weight Basis	Calculated								
	SM 2540 G-1997	Prepared:	944622	03/31/2021	07:45:00	Analyzed	944622	03/31/2021	07:45:00	TH2
NELAC	Total Solids Start Code	Started								

1973821 MB-9-SED — Received: 03/30/2021 — 45151/21031513

03/17/2021

	Calculation	Prepared:		04/02/2021	11:46:17	Calculated		04/02/2021	11:46:17	CAL
	As Received to Dry Weight Basis	Calculated								
	SM 2540 G-1997	Prepared:	944622	03/31/2021	07:45:00	Analyzed	944622	03/31/2021	07:45:00	TH2
NELAC	Total Solids Start Code	Started								

1973822 MB-1-SED — Received: 03/30/2021 — 45151/21031513

03/16/2021

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A & B Labs
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Printed: 04/06/2021

1973822 **MB-1-SED** *Received:* 03/30/2021
45151/21031513
03/16/2021

Calculation		*Prepared:*		*04/02/2021*	*15:46:34*	*Calculated*		*04/02/2021*	*15:46:34*	*CAL*
	As Received to Dry Weight Basis	**Calculated**								
SM 2540 G-1997		*Prepared:*	*945168*	*04/01/2021*	*15:40:00*	*Analyzed*	*945168*	*04/01/2021*	*15:40:00*	*TH2*
NELAC	**Total Solids Start Code**	**Started**								

1973823 **MB-5-SED** *Received:* 03/30/2021
45151/21031513
03/16/2021

Calculation		*Prepared:*		*04/06/2021*	*14:22:18*	*Calculated*		*04/06/2021*	*14:22:18*	*CAL*
	As Received to Dry Weight Basis	**Calculated**								
SM 2540 G-1997		*Prepared:*	*945666*	*04/05/2021*	*15:25:00*	*Analyzed*	*945666*	*04/05/2021*	*15:25:00*	*TH2*
NELAC	**Total Solids Start Code**	**Started**								

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Qualifiers:

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RESULTS

Sample Results

1973820 MB-7-SED — Received: 03/30/2021

Solid & Chemical Materials — Collected by: Client — A & B Labs — PO: 45151/21031513

Taken: 03/17/2021 11:50:00

SM2540 G-1997 /MOD — *Prepared:* 945096 03/31/2021 07:45:00 — *Analyzed* 945096 03/31/2021 07:45:00 TH2

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	Total Solids for Dry Wt	75.1	%	0.010			01

*Walkley-Black *MOD* — *Prepared:* 945077 04/01/2021 07:30:00 — *Analyzed* 945077 04/01/2021 07:30:00 ESG

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	Organic Carbon	3090 *	mg/kg	266			01

* Dry Weight Basis

Sample Preparation for Sample 1973820

1973820 MB-7-SED — Received: 03/30/2021

45151/21031513

03/17/2021

Prepared: 03/31/2021 13:01:24 — *Calculated* 03/31/2021 13:01:24 CAL

z — Environmental Fee (per Project) — Verified

Calculation — *Prepared:* 04/01/2021 13:59:13 — *Calculated* 04/01/2021 13:59:13 CAL

As Received to Dry Weight Basis — Calculated

SM 2540 G-1997 — *Prepared:* 944622 03/31/2021 07:45:00 — *Analyzed* 944622 03/31/2021 07:45:00 TH2

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1973820 MB-7-SED

Received: 03/30/2021

45151/21031513

03/17/2021

SM 2540 G-1997 *Prepared: 944622 03/31/2021 07:45:00 Analyzed 944622 03/31/2021 07:45:00 TH2*

NELAC	**Total Solids Start Code**	**Started**

Qualifiers:

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Bill Peery

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RESULTS

Sample Results

1973821 **MB-9-SED** *Received:* 03/30/2021

Solid & Chemical Materials *Collected by:* Client A & B Labs *PO:* 45151/21031513
Taken: 03/17/2021 15:20:00

SM2540 G-1997 /MOD *Prepared:* 945096 03/31/2021 07:45:00 *Analyzed* 945096 03/31/2021 07:45:00 TH2

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	**Total Solids for Dry Wt**	**70.1**	**%**	0.010			01

*Walkley-Black *MOD* *Prepared:* 945340 04/02/2021 08:15:00 *Analyzed* 945340 04/02/2021 08:15:00 ESG

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	**Organic Carbon**	**2280 ***	**mg/kg**	285			01

* Dry Weight Basis

Sample Preparation for Sample 1973821

1973821 **MB-9-SED** *Received:* 03/30/2021

45151/21031513

03/17/2021

Calculation *Prepared:* 04/02/2021 11:46:17 *Calculated* 04/02/2021 11:46:17 CAL

As Received to Dry Weight Basis **Calculated**

SM 2540 G-1997 *Prepared:* 944622 03/31/2021 07:45:00 *Analyzed* 944622 03/31/2021 07:45:00 TH2

NELAC **Total Solids Start Code** **Started**

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Qualifiers:

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RESULTS

Sample Results

1973822 **MB-1-SED** Received: 03/30/2021

Solid & Chemical Materials Collected by: Client A & B Labs PO: 45151/21031513

Taken: 03/16/2021 12:10:00

SM2540 G-1997 /MOD Prepared: 945413 04/01/2021 15:40:00 Analyzed 945413 04/01/2021 15:40:00 TH2

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	**Total Solids for Dry Wt**	**74.8**	**%**	0.010			01

*Walkley-Black *MOD* Prepared: 945340 04/02/2021 08:15:00 Analyzed 945340 04/02/2021 08:15:00 ESG

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	**Organic Carbon**	**3680 ***	**mg/kg**	267			01

* Dry Weight Basis

Sample Preparation for Sample 1973822

1973822 **MB-1-SED** Received: 03/30/2021

45151/21031513

03/16/2021

Calculation Prepared: 04/02/2021 15:46:34 Calculated 04/02/2021 15:46:34 CAL

As Received to Dry Weight Basis **Calculated**

SM 2540 G-1997 Prepared: 945168 04/01/2021 15:40:00 Analyzed 945168 04/01/2021 15:40:00 TH2

NELAC **Total Solids Start Code** **Started**

NELAP-accredited #T104704201-21-18

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1
2
3
4

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RESULTS

Sample Results

1973823 **MB-5-SED** — Received: 03/30/2021

Solid & Chemical Materials — Collected by: Client — A & B Labs — PO: 45151/21031513

Taken: 03/16/2021 15:30:00

SM2540 G-1997 /MOD — Prepared: 945752 04/05/2021 15:25:00 — Analyzed 945752 04/05/2021 15:25:00 TH2

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	Total Solids for Dry Wt	66.1	%	0.010			01

*Walkley-Black *MOD* — Prepared: 945340 04/02/2021 08:15:00 — Analyzed 945340 04/02/2021 08:15:00 ESG

	Parameter	Results	Units	RL	Flags	CAS	Bottle
NELAC	Organic Carbon	8760 *	mg/kg	303			01

* Dry Weight Basis

Sample Preparation for Sample 1973823

1973823 **MB-5-SED** — Received: 03/30/2021

45151/21031513

03/16/2021

Calculation — Prepared: 04/06/2021 14:22:18 — Calculated 04/06/2021 14:22:18 CAL

	As Received to Dry Weight Basis	Calculated

SM 2540 G-1997 — Prepared: 945666 04/05/2021 15:25:00 — Analyzed 945666 04/05/2021 15:25:00 TH2

NELAC	Total Solids Start Code	Started

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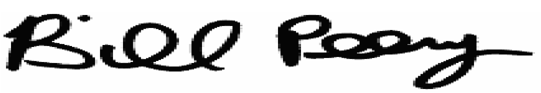

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3
4
5
6

RESULTS

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CAS	Parameter	Results	MDL	SDL	MQL	MQLAdj	Flag	Units	Target	Bottle	Dilute
Solid & Chemical Materials	Gravimetrics								SM2540 G-1997 /MOD		
1973820	MB-7-SED										
		Collection:	03/17/2021	11:50:00	Client				*Received:*	03/30/2021	
	Prepared: 945096										
				Analyzed:	945096		3/31/21	07:45:00			
	Total Solids for Dry Wt	**75.1**	0.010	0.010	0.010	0.010		**%**		01	1.00
1973821	MB-9-SED										
		Collection:	03/17/2021	15:20:00	Client				*Received:*	03/30/2021	
	Prepared: 945096										
				Analyzed:	945096		3/31/21	07:45:00			
	Total Solids for Dry Wt	**70.1**	0.010	0.010	0.010	0.010		**%**		01	1.00
1973822	MB-1-SED										
		Collection:	03/16/2021	12:10:00	Client				*Received:*	03/30/2021	
	Prepared: 945413										
				Analyzed:	945413		4/1/21	15:40:00			
	Total Solids for Dry Wt	**74.8**	0.010	0.010	0.010	0.010		**%**		01	1.00
1973823	MB-5-SED										

Email: projectmanger@ana-lab.com

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SOIL

CAS	Parameter	Results	MDL	SDL	MQL	MQLAdj	Flag	Units	Target	Bottle	Dilute
Solid & Chemical Materials	Gravimetrics								SM2540 G-1997 /MOD		
		Collection:	03/16/2021	15:30:00	Client				*Received:*	03/30/2021	
Prepared:	945752										
				Analyzed:	945752		4/5/21		15:25:00		
	Total Solids for Dry Wt	**66.1** **Dup: 65.2** **Mean: 65.65**	0.010	0.010	0.010	0.010		**%**		01	1.00

MDL is Method Detection Limit (40 CFR 136 Appendix B)

SDL is Sample Detection Limit and is the adjusted MDL (sample specific dilutions, dry weight)

MQL is the Method Quantitation Limit and corresponds to a low standard

MQLADJ is the Adjusted Method Quantitation Limit (dilutions, dry weight)

Qualifiers:

We report results on an As Received or wet basis unless marked Dry Weight. Unless otherwise noted, testing was performed at Ana-labs corporate laboratory that holds the following Federal and State certificates: EPA Lab Number TX00063, US Department of Agriculture Soil Import Permit P330-18-00178, Texas Commission on Environmental Quality Commercial Drinking Water Lab Approval (Lab ID: TX219), Texas Commission on Environmental Quality NELAP T104704201-21-18, Louisiana Department of Environmental Quality Laboratory Certification (NELAP, LELAP) #02008, Louisiana Department of Health Drinking Water Certificate No LA026, Oklahoma Department of Environmental Quality TNI Laboratory Accreditation Program Certificate No. 2020-097, Arkansas Department of Environmental Quality Certification #18-068-0. The Accredited column designates accreditation by N -- NELAC, or z -- not covered under NELAC scope of accreditation.

These analytical results relate to the sample tested. This report may NOT be reproduced EXCEPT in FULL without written approval of Ana-Lab Corp. Unless otherwise specified, these test results meet the requirements of NELAC.

Email: projectmanger@ana-lab.com

NELAP-accredited #T104704201-21-18

2600 Dudley Rd. Kilgore, Texas 75662
R: 3306 State Highway 135 N, Kilgore, TX 75662
*Office: 903-984-0551 * Fax: 903-984-5914*

ANA LAB DRAFT
Testing the Limits of Science and Service

RESULTS

Project
959316

ABL2

Printed 04/06/2021

SOIL

A & B Labs
Shantall Carpenter
10100 East Freeway
Suite 100
Houston, TX 77029

Bill Peery, MS, VP Technical Services

Email: projectmanger@ana-lab.com

NELAP-accredited #T104704201-21-18

2600 Dudley Rd. Kilgore, Texas 75662
R: 3306 State Highway 135 N, Kilgore, TX 75662
Office: 903-984-0551 * Fax: 903-984-5914

ANA-LAB DRAFT
Testing the Limits of Science and Service

1
2
3
4
5
6
7

RESULTS

Project 959316

ABL2

Printed 04/06/2021

SOIL

A & B Labs
Shantall Carpenter
10100 East Freeway
Suite 100
Houston, TX 77029

CAS	Parameter	Results	MDL	SDL	MQL	MQLAdj	Flag	Units	Target	Bottle	Dilute
Solid & Chemical Materials	Wet Bench								Walkley-Black *MOD		
1973820	MB-7-SED										
		Collection:	03/17/2021	11:50:00	Client				Received:	03/30/2021	
	Prepared: 945077										
				Analyzed:	945077		4/1/21		07:30:00		
	Organic Carbon	3090 *	200	266	200	266		mg/kg		01	1.00
* Dry Weight Basis											
1973821	MB-9-SED										
		Collection:	03/17/2021	15:20:00	Client				Received:	03/30/2021	
	Prepared: 945340										
				Analyzed:	945340		4/2/21		08:15:00		
	Organic Carbon	2280 *	200	285	200	285		mg/kg		01	1.00
* Dry Weight Basis											
1973822	MB-1-SED										
		Collection:	03/16/2021	12:10:00	Client				Received:	03/30/2021	
	Prepared: 945340										
				Analyzed:	945340		4/2/21		08:15:00		
	Organic Carbon	3680 *	200	267	200	267		mg/kg		01	1.00
* Dry Weight Basis											

Email: projectmanger@ana-lab.com

NELAP-accredited #T104704201-21-18

2600 Dudley Rd. Kilgore, Texas 75662
R: 3306 State Highway 135 N, Kilgore, TX 75662
Office: 903-984-0551 * Fax: 903-984-5914

DRAFT

ANA-LAB
Testing the Limits of Science and Service

RESULTS

Project
959316

ABL2

Printed 04/06/2021

SOIL

A & B Labs
Shantall Carpenter
10100 East Freeway
Suite 100
Houston, TX 77029

CAS	Parameter	Results	MDL	SDL	MQL	MQLAdj	Flag	Units	Target	Bottle	Dilute
Solid & Chemical Materials	Wet Bench								Walkley-Black *MOD		
1973823	MB-5-SED										
		Collection:	03/16/2021		15:30:00	Client			Received:	03/30/2021	
	Prepared: 945340										
				Analyzed:	945340		4/2/21		08:15:00		
	Organic Carbon	8760 *	200	303	200	303		mg/kg		01	1.00

* Dry Weight Basis

MDL is Method Detection Limit (40 CFR 136 Appendix B)

SDL is Sample Detection Limit and is the adjusted MDL (sample specific dilutions, dry weight)

MQL is the Method Quantitation Limit and corresponds to a low standard

MQLADJ is the Adjusted Method Quantitation Limit (dilutions, dry weight)

Qualifiers:

We report results on an As Received or wet basis unless marked Dry Weight. Unless otherwise noted, testing was performed at Ana-labs corporate laboratory that holds the following Federal and State certificates: EPA Lab Number TX00063, US Department of Agriculture Soil Import Permit P330-18-00178, Texas Commission on Environmental Quality Commercial Drinking Water Lab Approval (Lab ID: TX219), Texas Commission on Environmental Quality NELAP T104704201-21-18, Louisiana Department of Environmental Quality Laboratory Certification (NELAP, LELAP) #02008, Louisiana Department of Health Drinking Water Certificate No LA026, Oklahoma Department of Environmental Quality TNI Laboratory Accreditation Program Certificate No. 2020-097, Arkansas Department of Environmental Quality Certification #18-068-0. The Accredited column designates accreditation by N -- NELAC, or z -- not covered under NELAC scope of accreditation.

Email: projectmanger@ana-lab.com

NELAP-accredited #T104704201-21-18

2600 Dudley Rd. Kilgore, Texas 75662
R: 3306 State Highway 135 N, Kilgore, TX 75662
*Office: 903-984-0551 * Fax: 903-984-5914*

DRAFT 1

ANA LAB
Testing the Limits of Science and Service 2

RESULTS 3

 4

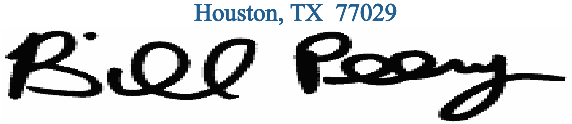
Project 5
959316 6

ABL2 7

Printed 04/06/2021

SOIL

A & B Labs
Shantall Carpenter
10100 East Freeway
Suite 100
Houston, TX 77029



Bill Peery, MS, VP Technical Services

Email: projectmanger@ana-lab.com

NELAP-accredited #T104704201-21-18

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4
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6
7
8

ABL2-G

A & B Labs
Shantall Carpenter
10100 East Freeway
Suite 100
Houston, TX 77029

Project 959316

Printed 04/06/2021

Analytical Set 945096 — SM2540 G-1997 /MOD

ControlBlk

Parameter	PrepSet	Reading	MDL	MQL	Units	File
Total Solids for Dry Wt	945096	0.0003			grams	122163592

Duplicate

Parameter	Sample	Result	Unknown	Unit	RPD	Limit%
Total Solids for Dry Wt	1973463	81.7	84.6	%	3.49	20.0
Total Solids for Dry Wt	1973686	3.60	3.57	%	0.837	20.0
Total Solids for Dry Wt	1973768	0.795	0.808	%	1.62	20.0

Analytical Set 945413 — SM2540 G-1997 /MOD

ControlBlk

Parameter	PrepSet	Reading	MDL	MQL	Units	File
Total Solids for Dry Wt	945413	0			grams	122169079

Duplicate

Parameter	Sample	Result	Unknown	Unit	RPD	Limit%
Total Solids for Dry Wt	1974169	99.9	99.9	%	0	20.0
Total Solids for Dry Wt	1974188	0.570	0.566	%	0.704	20.0

Analytical Set 945752 — SM2540 G-1997 /MOD

ControlBlk

Parameter	PrepSet	Reading	MDL	MQL	Units	File
Total Solids for Dry Wt	945752	0.0003			grams	122175696

Duplicate

Parameter	Sample	Result	Unknown	Unit	RPD	Limit%
Total Solids for Dry Wt	1973823	65.2	66.1	%	1.37	20.0
Total Solids for Dry Wt	1974768	72.0	70.8	%	1.68	20.0

Analytical Set 945077 — Walkley-Black *MOD

Blank

Parameter	PrepSet	Reading	MDL	MQL	Units	File
Organic Carbon	945077	ND	200	200	mg/kg	122163330

LCS Dup

Parameter	PrepSet	LCS	LCSD	Known	Limits%	LCS%	LCSD%	Units	RPD	Limit%
Organic Carbon	945077	323	314	300	85.0 - 115	108	105	mg/kg	2.83	20.0

MSD

Parameter	Sample	MS	MSD	UNK	Known	Limits	MS%	MSD%	Units	RPD	Limit%
Organic Carbon	1973694	13100	14300	1850	10500	70.0 - 130	110	122	mg/kg	10.1	20.0

Analytical Set 945340 — Walkley-Black *MOD

QUALITY CONTROL

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ANALAB
Testing the Limits of Science and Service

1 2 3 4 5 6 7 8

ABL2-G

A & B Labs
Shantall Carpenter
10100 East Freeway
Suite 100
Houston, TX 77029

Project
959316

Printed 04/06/2021

Blank

Parameter	PrepSet	Reading	MDL	MQL	Units	File
Organic Carbon	945340	ND	200	200	mg/kg	122167844

LCS Dup

Parameter	PrepSet	LCS	LCSD	Known	Limits%	LCS%	LCSD%	Units	RPD	Limit%
Organic Carbon	945340	310	314	300	85.0 - 115	103	105	mg/kg	1.28	20.0

MSD

Parameter	Sample	MS	MSD	UNK	Known	Limits	MS%	MSD%	Units	RPD	Limit%
Organic Carbon	1973821	12000	12100	1600	9520	70.0 - 130	113	114	mg/kg	0.957	20.0

* Out RPD is Relative Percent Difference: abs(r1-r2) / mean(r1,r2) * 100%   Recover% is Recovery Percent: result / known * 100%

Blank - Method Blank

DRAFT

Subcontract Laboratory Chain-of-Custody

A & B Labs	Send To:	Report To:	Turnaround Time:
10100 East Freeway	Company: Ana-Labs	Company: A&B Labs	STD: X
Suite 100	Address: 2600 Dudley Road	Address: 10100 East Frwy Suite 100	
Houston, TX 77029	City: Kilgore, TX 75663	Houston, TX 77029	
713-453-6060	Contact: Skeeter Ludwig	Contact: Shantall Carpenter/Alisha Hughes	PO# 45151 / 21031513
713-453-6091 fax	Phone: 903-984-0551	Phone: 713-453-6060 xt 127	
info@ablabs.com	Email: skeeter@ana-lab.com	Email: alishar@ablabs.com	
		CC: scarpenter@ablabs.com	Preservatives

PLEASE EMAIL INVOICE TO: ACCOUNTSPAYABLE@ABLABS.COM

Special Instructions or Comments:

Please report wet weight.

Lab #	Item	Sample ID / Name	Collection Date	Collection Time	Comp	Grab	Matrix	# of Containers	Container Types	TOC					Remarks:
21031513.08	1	MB-7-SED	3/17/2021	11:50		X	Sed	1		X					1973Y20
21031513.09	2	MB-9-SED	3/17/2021	15:20		X	Sed	1		X					1973Y21
21031513.11	3	MB-1-SED	3/16/2021	1210		X	Sed	1		X					1973Y22
21031513.13	4	MB-5-SED	3/16/2021	15:30		X	Sed	1		X					1973Y23
	5														
	6														
	7														
	8														
	9														
	10														
	11														
	12														

Matrix: WW-Wastewater W-Water DW-Drinking Water S-Soil SD-Solid L-Liquid SL-Sludge O-Oil A-Air Bag Can-Air Canister B-OVM Badge T-Tube

Preservatives: C-Cool Ice H-HCl N-Nitric Acid S-Sulfuric Acid OH-NaOH T-Sodium Thiosulfate O- Other (specify)______

Containers: VOA-40 ml vial A-amber 1 liter G-glass 1 liter 4oz or 8oz - 4 8 ounce glass P-Plastic

Relinquished By:	Date:	Time	Received By:	Date	Time
Fed Ex	3/30/21	1225	Fed Ex / Kathy Tarver Ana-Lab	3/30/21	1225

ab-s004-0309

See Attached for Tracking # and Temp

DRAFT

959316 CoC Print Group 001 of 001

3/29/2021 FedEx Ship Manager - Print Your Label(s)

ORIGIN ID:HBYA (713) 453-6060
ASHLEY ARNETT
A&B ENVIRONMENTAL SERVICES
10100 EAST FWY STE 100

HOUSTON, TX 77029
UNITED STATES US

SHIP DATE: 29MAR21
ACTWGT: 10.00 LB
CAD: 251130614/INET4340

BILL SENDER

TO SAMPLE RECEIVINGSKEETER
ANA-LABS
2600 DUDLEY RD.

KILGORE TX 75663
(903) 984-0551 REF: 15000078
INV:
PO: DEPT:

56DJ2/5E F2/FE4A

TRK# 0201 7732 9775 6303

TUE - 30 MAR 10:30A
PRIORITY OVERNIGHT

AH GGGA

75663
TX-US SHV

Date 3/30 Time 1235 Tech [illegible]
Temp: 3.5/3.4 C
Therm#: 8448 Corr Fact: -0.1 C

After printing this label:
1. Use the 'Print' button on this page to print your label to your laser or inkjet printer.
2. Fold the printed page along the horizontal line.
3. Place label in shipping pouch and affix it to your shipment so that the barcode portion of the label can be read and scanned.

Warning: Use only the printed original label for shipping. Using a photocopy of this label for shipping purposes is fraudulent and could result in additional billing charges, along with the cancellation of your FedEx account number.
Use of this system constitutes your agreement to the service conditions in the current FedEx Service Guide, available on fedex.com.FedEx will not be responsible for any claim in excess of $100 per package, whether the result of loss, damage, delay, non-delivery,misdelivery,or misinformation, unless you declare a higher value, pay an additional charge, document your actual loss and file a timely claim.Limitations found in the current FedEx Service Guide apply. Your right to recover from FedEx for any loss, including intrinsic value of the package, loss of sales, income interest, profit, attorney's fees, costs, and other forms of damage whether direct, incidental,consequential, or special is limited to the greater of $100 or the authorized declared value. Recovery cannot exceed actual documented loss.Maximum for items of extraordinary value is $1,000, e.g. jewelry, precious metals, negotiable instruments and other items listed in our ServiceGuide. Written claims must be filed within strict time limits, see current FedEx Service Guide.

DRAFT

The Chain of Custody is a Legal Document

Page 1 of 2

Job ID: 21031513

TAT: 5 Days PM: Scarpenter

A&B

10100 East Freeway (I-10)
Houston, TX 77029

1. REPORT TO:	2. INVOICE TO:	3.PO# / Q210301205
Company: DiSorbo Consulting	Company: DiSorbo Consulting	4. Turnaround Time- Business Days
Address: 8501 N. MoPac, Ste. 300 Austin, TX 78759	Address: 1010 Travis St., Ste 916 Houston, TX 77702	☐ 1 Day * ☑ 5 Days ☐ 2 Days * ☐ 7 Days ☐ 3 Days * ☐ Other ___
Contact: Bob Davis	Contact: Accounts Payable	* Surcharge Applies
Phone: 512-970-9639	Phone: 713-955-1227	
Email: bdavis@disorboconsult.com	Email:	*Day Zero is the day sample is received. Report due at 5pm on due day.*
CC:	CC:	
CC:	CC:	

5. Project #

6. Project Name / Location
Cedar Port Pre-Dredge Sampling

7. Reporting Requirement
☐ TRRP Limits ☐ TRRP Rpt. Package ☐ Std Level II ☑ MDL Report ☐ EDD

8. Sampler's Name & Company James Reis, DiSorbo
Sampler's Signature & Date [signature] 3.17.21

											No. Containers	1	1	1	1	3	5	3	3	3	No. Containers
												P	P	P	P	VOA	A/G	A/G	A/G	VOA	14. Containers*
																					15. Preservatives**
9. Sample ID & Description	Lab Use Only	10. Sampling Date	Time	11. comp	grab	12. Matrix GW	Water	Soil	Sludge	Oil	13. TOTAL No. of Containers	NH3 (<0.03 RL), TOC	Salinity	Metals Dissolved ICPMS (ug/L)	Hg (ug/L)	TPH 1005	SVOC, SVOC SIM (ug/L)	PCBs	Pesticides	VOC	Water List 18. Comments
MB - 1 - WAT	01AU	3-17-21	1710		X		X				21	X	X	X	X	X	X	X	X	X	
MB - 1 - ELUT - WATER PART	02AT	↓	1716		↓		X				20	X		X	X	X	X	X	X	X	Comp w/SED PART
MB - 7 - WAT	03AU		0900				X				21	X	X	X	X	X	X	X	X	X	
MB - 9 - ELUT - WATER PART	04AT		1300				X				20	X		X	X	X	X	X	X	X	Comp w/SED PART
MB - EQB - WAT	05AT		1750				X				20	X		X	X	X	X	X	X	X	
MB - TRIP - WAT	06AB		1155				X				2			X	X						
MB-5 - ELUT - WATER PA	07AT	↓	1645		↓																

19. RELINQUISHED BY	DATE	TIME	20. RECEIVED BY	DATE	TIME	KNOWN HAZARDS / COMMENTS
James Reis, DiSorbo	3-17-21	19:00	[signature]	3.17.21	1900	
						1.6°C [illegible]

* Containers: VOA- 40 ml vial; 4 oz/8 oz- glass wide mouth; A/G- Amber/Glass 1 Liter; P/O- Plastic/other ____

Preservatives: C-Cool H- HCl N- HNO3 S-H2SO4 OH- NaOH T-Na2S2O3 X- Other *ZnAcetate*

Temperature: ____ Intact? ☐ Y ☐ N Initials ____

BILL OF LADING/TRACKING #

METHOD OF SHIPMENT

A&B CANNOT ACCEPT VERBAL CHANGES. PLEASE FAX WRITTEN CHANGES TO 713-453-6091 OR EMAIL THE NEW COC TO YOUR PROJECT MANAGER.

Samples will be disposed of after 30 days. A&B reserves the right to return samples.

DRAFT

The Chain of Custody is a Legal Document

10100 East Freeway (I-10)
Houston, TX 77029

Job ID: 21031513

TAT: 5 Days PM: Scarpenter

1. REPORT TO:	2. INVOICE TO:	3. PO# / Q#210301205
Company: DiSorbo Consulting	Company: DiSorbo Consulting	4. Turnaround Time- Business Days
Address: 8501 N. MoPac, Ste. 300, Austin, TX 78759	Address: 1010 Travis St., Ste 916, Houston, TX 77702	☐ 1 Day * ☑ 5 Days ☐ 2 Days * ☐ 7 Days ☐ 3 Days * ☐ Other ____
Contact: Bob Davis	Contact: Accounts Payable	* Surcharge Applies
Phone: 512-970-9639	Phone: 713-955-1227	
Email: bdavis@disorboconsult.com	Email:	*Day Zero is the day sample is received. Report due at 5pm on due day.*
CC:	CC:	
CC:	CC:	

5. Project #

6. Project Name / Location
Cedar Port Pre-Dredge Sampling

7. Reporting Requirement
☐ TRRP Limits ☐ TRRP Rpt. Packag ☐ Std Level II ☑ MDL Report ☐ EDD

8. Sampler's Name & Company: James Reis, DiSorbo
Sampler's Signature & Date: [signature] 3.17.21

9. Sample ID & Description	Lab Use Only	10. Sampling Date	10. Sampling Time	11. comp	11. grab	12. Matrix GW	Water	Soil	Sludge	Oil	other	13. TOTAL No. of Containers	TOC_Sub	%Moisture, Particle Size_Sub	%Moisture, NH3 (<0.1 RL), Hg, Metals ICPMS, Pest, PCB (<1 RL), TPH SVOC, SVOC SIM (ug/Kg)	VOCs	RCI			18. Comments
No. Containers													1	1	4					
14. Containers*													G	G	G					
15. Preservatives**													C	C	C					Soil List
~~MB - 1 - SED~~ QR								X				6	X	X	X	X	X			
MB - 7 - SED	06AF	3-17-21	11:50	X				X				6	X	X	X	X	X			
MB - 9 - SED	07AF	3-17-21	15:20	X				X				6	X	X	X	X	X			
~~MB - 1 - ELUT - SED PART~~ QR								X				6	X	X	X	X				Lab to composite ELUT WTR and ELUT SED
MB - 9 - ELUT - SED PART	10AF	3-17-21	15:20	X				X				6	X	X	X	X				Lab to composite ELUT WTR and ELUT SED

19. RELINQUISHED BY	DATE	TIME	20. RECEIVED BY	DATE	TIME	KNOWN HAZARDS / COMMENTS:
James Reis, DiSorbo	3.17.21	19:00	[signature]	3.17.21	1900	
						1.6 °C 10CM/3.1

* Containers: VOA- 40 ml vial; A/G- Amber/Glass 1 Liter; 4 oz/8 oz- glass wide mouth; P/O- Plastic/other ____

Preservatives: C-Cool H- HCl N- HNO3 S-H2SO4 OH- NaOH T-Na2S2O3 X- Other *ZnAcetate*

Temperature: ____ Intact? ☐ Y ☐ N Initials [initials]

BILL OF LADING/TRACKING #

METHOD OF SHIPMENT

A&B CANNOT ACCEPT VERBAL CHANGES. PLEASE FAX WRITTEN CHANGES TO 713-453-6091 OR EMAIL THE NEW COC TO YOUR PROJECT MANAGER.

Samples will be disposed of after 30 days. A&B reserves the right to return samples.

DRAFT

The Chain of Custody is a Legal Document

Page 2 of 2

Job ID:21031410 (TA 3/19/21) 21031513 A 10100 East Freeway (I-10) Houston, TX 77029	**1. REPORT TO:** Company: DiSorbo Consulting Address: 8501 N. MoPac, Ste. 300 Austin, TX 78759 Contact: Bob Davis Phone: 512-970-9639 Email: bdavis@disorboconsult.com CC: CC:	**2. INVOICE TO:** Company: DiSorbo Consulting Address: 1010 Travis St., Ste 916 Houston, TX 77702 Contact: Accounts Payable Phone: 713-955-1227 Email: CC: CC:	**3.PO#** / Qt210301205 **4. Turnaround Time- Business Days** ☐ 1 Day * ☑ 5 Days ☐ 2 Days * ☐ 7 Days ☐ 3 Days * ☐ Other ____ * Surcharge Applies *Day Zero is the day sample is received. Report due at 5pm on due day.*

5. Project #

6. Project Name / Location
Cedar Port Pre-Dredge Sampling

7. Reporting Requirement
☐ TRRP Limits ☐ TRRP Rpt. Packag ☐ Std Level II ☑ MDL Report ☐ EDD

8. Sampler's Name & Company — **Sampler's Signature & Date**

9. Sample ID & Description	Lab Use Only	10. Sampling Date	Time	11. comp	grab	12. Matrix GW	Water	Soil	Sludge	Oil	other	13. TOTAL No. of Containers	TOC_Sub	%Moisture, Particle Size_Sub	%Moisture, NH3 (0.1 RL), Hg, Metals ICPMS, Pest, PCB (<1 RL), TPH, SVOC, SVOC SIM (ug/Kg)	VOCs	RCI			18. Comments
No. Containers													1	1	4					
14. Containers*													G	G	G					
15. Preservatives**													C	C	C					Soil List
MB - 1 - SED	01AF	03/16/21	1210					X				6	X	X	X	X	X			
MB - 1 - ELUT - SED PART	02AF	↓	1210					X				6	X	X	X	X				Lab to composite ELUT WTR and ELUT SED
MB - 5 - SED	03AF	↓	1530					X				6	X	X	X	X				
MB - 5 - ELUT - SED PART	04AF	↓	1530					X				6	X	X	X	X				Lab to composite ELUT WTR and ELUT SED

19. RELINQUISHED BY	DATE	TIME	20. RECEIVED BY	DATE	TIME	KNOWN HAZARDS / COMMENTS
[signature]	03/16	1715	[signature]	3-16-21	1715	4.1°C IR0023C

* Containers: VOA- 40 ml vial 4 oz/8 oz- glass wide mouth	A/G- Amber/Glass 1 Liter P/O- Plastic/other ____	Preservatives C-Cool H- HCl N- HNO3 S-H2SO4 OH- NaOH T-Na2S2O3 X- Other ZnAcetate	Temperature ____ K104 Intact? ☑ Y ☐ N Initials ____
BILL OF LADING/TRACKING #		METHOD OF SHIPMENT	

A&B CANNOT ACCEPT VERBAL CHANGES. PLEASE FAX WRITTEN CHANGES TO 713-453-6091 OR EMAIL THE NEW COC TO YOUR PROJECT MANAGER.

Samples will be disposed of after 30 days. A&B reserves the right to return samples.

Sample Condition Checklist

DRAFT

A&B JobID : **21031513**	Date Received : **03/17/2021**	Time Received : **7:00PM**	
Client Name : **DiSorbo Consulting LLC**			
Temperature : **1.6**	Sample pH : **<2 nh3, hg**		
Thermometer ID : **102002320**	pH Paper ID : **81548**		
Perservative :			

	Check Points	Yes	No	N/A
1.	Cooler seal present and signed.		X	
2.	Sample(s) in a cooler.	X		
3.	If yes, ice in cooler.	X		
4.	Sample(s) received with chain-of-custody.	X		
5.	C-O-C signed and dated.	X		
6.	Sample(s) received with signed sample custody seal.		X	
7.	Sample containers arrived intact. (If no comment).	X		
8.	Matrix : Water ☐ Soil ☐ Liquid ☐ Sludge ☐ Solid ☐ Cassette ☐ Tube ☐ Bulk ☐ Badge ☐ Food ☐ Other ☐			
9.	Sample(s) were received in appropriate container(s).	X		
10.	Sample(s) were received with proper preservative	X		
11.	All samples were logged or labeled.	X		
12.	Sample ID labels match C-O-C ID's		X	
13.	Bottle count on C-O-C matches bottles found.	X		
14.	Sample volume is sufficient for analyses requested.	X		
15.	Samples were received within the hold time.	X		
16.	VOA vials completely filled.	X		
17.	Sample accepted.	X		
18	Has client been contacted about sub-out	X		

Comments : Include actions taken to resolve discrepancies/problem:

07= 'MB-4-ELUT-WATERPORT as sx ID. -VH 03-19-21

Received by : JMontemayor

Check in by/date : VHernandez / 03/18/2021

Attachment C-2

Coastal Engineering Report

October 2024
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

Attachment C-2: Coastal Engineering Report

Prepared for Cedar Port Navigation and Improvement District

October 2024
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

Attachment C-2: Coastal Engineering Report

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Project Number: 232823-01.01
https://anchorqea.sharepoint.com/sites/CPNDDeepwater-Portal/AQ Internal Documents/3. Draft FS_EIS/Appendix C Engineering Report/3. Appendix C-2 Coastal Engineering Report.docx

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENT

ABBREVIATIONS

ADCIRC+STWAVE	ADCIRC and STWAVE modeling system
AdH	Adaptive Hydraulics
AEP	annual exceedance probability
CTXS	Coastal Texas Protection and Restoration Feasibility Study
CUDEM	Continuously Updated Digital Elevation Model
DMPA	dredged material placement area
ECIP	Expansion Channel Improvement Project
EIS	environmental impact statement
ERDC	U.S. Army Engineer Research and Development Center
FEMA	Federal Emergency Management Agency
fps	foot per second
FS	feasibility study
FS-EIS	*Integrated Feasibility Report-Environmental Impact Statement*
FS/EIS	*Feasibility Study/Environmental Impact Statement*
FWOP	Future Without Project
FWP	Future with Project
HSC	Houston Ship Channel
MHHW	mean higher high water
MLLW	mean lower low water
NAVD88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
ppt	part per thousand
POA	period of analysis
PWOP	Present Without Project
PWP	Present with Project
SLAT	Sea Level Analysis Tool
SLR	sea level rise
study	new deepwater federal navigation channel planned to connect the Houston Ship Channel and a new terminal for the Cedar Port Industrial Park in Baytown, Texas
TSP	tentatively selected plan
TWDB	Texas Water Development Board
USACE	U.S. Army Corps of Engineers
WOP	Without Project
WP	With Project

WRDA	Water Resources Development Act of 2022

1 Introduction

The Cedar Port Navigation and Improvement District is seeking to develop a new deepwater federal navigation channel planned to connect the Houston Ship Channel (HSC) and a new terminal for the Cedar Port Industrial Park in Baytown, Texas (study) while enhancing efficient, safe, and reliable navigation in the Cedar Bayou Navigation Channel and HSC to existing stakeholder terminals.

As a water resources development project seeking to improve rivers and harbors of the United States, the study is subject to the requirements of Water Resources Development Act of 2022 (WRDA) through a feasibility study (FS). The Cedar Port Navigation and Improvement District is serving as the nonfederal sponsor under Section 203 of the WRDA. Federal interest in the study also requires compliance with the National Environmental Policy Act (NEPA). Consistent with the requirements of the WRDA and NEPA, an FS/environmental impact statement (EIS), called the *Feasibility Study/Environmental Impact Statement* (FS/EIS), is being completed to evaluate the feasibility and environmental effects of the study and assess alternatives.

As part of the FS/EIS, numerical modeling was performed to evaluate effects of the Without Project (WOP) and With Project (WP) alternatives on aspects of the physical environment. The numerical modeling approach followed and was consistent with recent U.S. Army Corps of Engineers (USACE) studies of similar projects in the study vicinity. Particularly, in the evaluation of typical annual hydrodynamics, salinity, and sediment transport, the study was modeled in the same manner as the recent USACE *Houston Ship Channel Expansion Channel Improvement Project (ECIP) Integrated Feasibility Report-Environmental Impact Statement* (McAlpin et al. 2019a). In the evaluation of storm surge and waves, the study was modeled in the same manner as the recent Coastal Texas Protection and Restoration Feasibility Study (CTXS; Massey et al. 2019). Furthermore, to achieve the greatest consistency with these recent USACE methodologies, the study modeling team used the same models as the USACE evaluations, updated with site-specific data as needed for the study evaluations.

The purpose of this report is to present the methodology and results of the numerical modeling evaluations as part of the FS/EIS evaluations for the study prepared in compliance with NEPA and Section 203.

1.1 Background

The Cedar Port Industrial Park is located adjacent to the shoreline of upper Galveston Bay in Baytown, Texas, approximately 30 miles southeast of Houston (Figure 1). Comprised of approximately 15,000 acres of industrial facilities, the park is situated between Cedar Bayou and Trinity and Galveston Bays, less than 5 miles east of the HSC. To the west of the park, across from the mouth of Cedar Bayou, Atkinson Island, adjacent marsh cells, and adjacent USACE dredged material placement areas (DMPAs) act as a physical land barrier that separates the HSC from the waters of upper Galveston Bay that border the park.

Tides in upper Galveston Bay can be both diurnal, with one daily high and one daily low, and semidiurnal, with two daily highs and two daily lows. Upper Galveston Bay is considered a microtidal environment with a mean tide range of 1.1 feet, as published at the National Oceanic and Atmospheric Administration (NOAA) tidal station 8770613, Morgans Point, Barbours Cut, Texas (NOAA 2024a). Tidal datum elevations published at this NOAA station are as follows:

- Mean higher high water (MHHW) is 1.34 feet North American Vertical Datum of 1988 (NAVD88).
- Mean high water is 1.27 feet NAVD88.
- Mean tide level is 0.70 foot NAVD88.
- Mean low water is 0.14 foot NAVD88.
- Mean lower low water (MLLW) is 0.01 foot NAVD88.

Elevated water levels can occur in the study vicinity as a result of spring tides and storms. The highest water level recorded at NOAA station 8770613 during its 30-year period of operation from 1995 to present was 9.1 feet NAVD88, measured on September 13, 2008, during Hurricane Ike.

Water circulation and currents in upper Galveston Bay are the result of tides, freshwater inflows, and wind. Near the western shoreline of Cedar Port Industrial Park, local currents are particularly influenced by Cedar Bayou. Based on long-term estimates of freshwater inflows in Cedar Bayou calculated by the Texas Water Development Board (TWDB) from 1977 to 2018 (TWDB 2024), average discharge from Cedar Bayou into Galveston Bay is approximately 600 cubic feet per second, and the average annual peak discharge is approximately 13,000 cubic feet per second.

The largest quantities of freshwater enter Galveston Bay from the San Jacinto and Trinity rivers. Combined, these rivers discharge an average of approximately 11 million acre-feet annually into Galveston Bay, based on long-term estimates from 1977 to 2018 computed by TWDB. During the same period, all other tributaries of Galveston Bay were estimated to discharge a combined average of approximately 4 million acre-feet annually (TWDB 2024). Along with freshwater, the tributaries of Galveston Bay discharge suspended sediment into the bay system. Sediment in the bay system routinely accumulates in the HSC and needs to be dredged to maintain navigability of the channel. From fiscal year 2010 to 2013, approximately $20 million was allocated annually for the maintenance of the HSC by the USACE, Galveston District (USACE 2012).

The prevailing wind directions in the vicinity of the study area, as determined from historical measurements at NOAA station 8770613, are from the southeast and south. Sustained winds from the prevailing southeast and south directions can result in elevated water levels in upper Galveston Bay and can produce countercurrent eddies in the nearshore areas (USACE SWG 2019).

Galveston Bay is typically a low-energy wave environment due to its shallow water depths and bathymetry and its limited connectivity to the Gulf of Mexico through three inlets. The barrier islands that enclose Galveston Bay to the south effectively separate it from the waters of the Gulf of Mexico and block wave energy from entering the bay. Field measurements of locally-generated waves near the middle of Trinity Bay from August 2004 to May 2005 found significant wave heights ranging 0 to 2.8 feet (Dupuis and Anis 2013). Larger waves can impact the study area during tropical storms and hurricanes, due to higher winds and increased water depth from storm surge.

The main source of salinity in Galveston Bay is the HSC, which provides a pathway for saltwater to enter the bay from the Gulf of Mexico. The highest salinities in the HSC are concentrated in the bottom of the channel because saltwater is denser than freshwater. The high concentration of downstream bottom salinity from the Gulf of Mexico creates a density gradient that generates an upstream flow of saltwater along the bed of the channel, forming what is known as a salt wedge. High seasonal freshwater inflows into Galveston Bay can result in increased vertical stratification of freshwater and saltwater in the HSC, making the wedge effect more pronounced. Salinities typically decrease in Galveston Bay in May and June, due to high freshwater inflows from the Mississippi, Sabine-Neches, Atchafalaya, and other northern Gulf of Mexico river systems, which freshen the entire northern Gulf of Mexico region (McAlpin et al. 2019a).

1.2 Objective

Numerical modeling was used to address the following study questions as part of the FS/EIS evaluations:

1. What are the potential effects of the study alternatives on salinities in Galveston Bay, Trinity Bay, and the HSC?
2. What are the potential effects of the study alternatives on circulation patterns in upper Galveston Bay?
3. What are the predicted shoaling volumes in the study alternative channels?
4. What are the potential effects of study alternatives on storm surge and storm waves at adjacent shorelines in Galveston Bay and Trinity Bay?
5. What are the potential effects of the study alternatives on adjacent shorelines in Galveston Bay and Trinity Bay as a result of ship waves (wakes)?

1.3 Approach

To address the study questions, a numerical modeling approach was developed that followed and was consistent with recent USACE studies of similar projects in the study vicinity and used the same modeling tools where applicable. The approach was developed in coordination with the USACE, Galveston District, through a draft memorandum submitted on January 9, 2023 (Anchor QEA 2023) and further refined during a follow-up meeting with USACE, Galveston District on January 31, 2023.

The modeling approach used three distinct numerical modeling tools to simulate three physical processes needed to address the study questions. These three physical process and associated modeling tools are described in the following subsections.

1.3.1 Annual Hydrodynamics, Salinity, and Sediment Transport

Consistent with the methodology presented in the numerical modeling appendix to the USACE HSC ECIP *Integrated Feasibility Report-Environmental Impact Statement* (FS-EIS; McAlpin et al. 2019a), the 3D Adaptive Hydraulics (AdH) modeling suite was used to simulate coupled hydrodynamics, salinity, and sediment transport within Galveston Bay and the HSC and to address Study Questions 1, 2, and 3.

For consistency with the HSC ECIP FS-EIS simulations, the same 3D AdH model previously calibrated, validated, and used by the U.S. Army Engineer Research and Development Center (ERDC) for the HSC ECIP FS-EIS evaluations was provided to Anchor QEA for the study evaluations by ERDC, through coordination with the USACE, Galveston District. Upon receipt, the HSC ECIP model files were updated by Anchor QEA for the study evaluations as described in Subsection 3.1 and executed on the ERDC high-performance computing system.

1.3.2 Storm Surge and Waves

Consistent with the methodology of the CTXS (Massey et al. 2019), the 2D coupled ADCIRC and STWAVE modeling system (ADCIRC+STWAVE) was used to simulate coupled storm surge and storm waves within Galveston Bay and the HSC and to address Study Question 4.

For consistency with the CTXS, the same 2D ADCIRC+STWAVE model previously used for the CTXS storm surge evaluations was used as a starting point for the study evaluations. Using site-specific data provided by Anchor QEA, the ERDC storm surge modeling team updated the CTXS 2D ADCIRC+STWAVE model as needed for the study evaluations and executed a subset of the CTXS storm simulations, which were selected through collaboration among Anchor QEA, ERDC, and the USACE, Galveston District. Details of the model updates and storm selection are provided in Subsection 3.2 and Attachment 1 to this report.

1.3.3 Vessel Wakes

To evaluate potential vessel wakes associated with the study alternative channel routes and the effects on adjacent shorelines, the 2D XBeach modeling suite was used. At the time of the study evaluations, there was not an existing numerical model for the calculation of ship wakes developed by USACE for Galveston Bay. Upon review of available software suites, the XBeach modeling platform was selected by Anchor QEA, in agreement with the USACE, Galveston District, as an appropriate tool for the simulation of ship wakes associated with the study.

XBeach is an open-source numerical modeling suite developed by Delft University of Technology and Deltares. Originally developed to simulate waves, mean flows, and morphodynamics of sandy coasts during storms, XBeach has since been expanded to include capabilities for additional coastal processes (de Ridder 2023). One expansion was the development of a two-layer nonhydrostatic mode, which is a phase-resolving module capable of simulating individual waves (de Ridder et al. 2021). This module includes the relevant processes for generation and propagation of vessel wakes and has been shown to reproduce the primary and secondary wave fields produced by transiting vessels (Alstrom et al. 2021, Bluteau et al. 2023).

The phase-resolving two-layer nonhydrostatic mode of XBeach was used in all study simulations. Model simulations were developed by Anchor QEA as described in Subsection 3.3, using the same site-specific data as the AdH and ADCIRC+STWAVE models and vessel characteristics consistent with the vessel navigation simulations described in Appendix C, Attachment C-3.

2 Plan Alternatives

As fully detailed in Section 3 of the draft Integrated FS/EIS, a plan formulation process identified an array of study alternatives to establish a new deepwater channel directly from the HSC to the deepwater container terminal planned for the Cedar Port Industrial Park. Fifteen alternatives (identified by a mixture of location names and route labels [i.e., A, B, C, D, and E]) were initially considered, with most being rejected based on significant impacts related to navigational constraints, utility infrastructure, and habitats. Following the initial feasibility evaluation, three study alternatives (Alternatives B, D, and E) and the No Action Alternative were evaluated as part of the draft Integrated FS/EIS. All study alternatives include new built infrastructure and nature-based solution elements consistent with USACE guidelines and procedures.

2.1 No Action Alternative

The No Action Alternative, or WOP, which is required as part of an EIS analysis, represents what would reasonably be expected to occur in the foreseeable future if a proposed project were not approved. Under this alternative, no new channel would be developed, and deep-draft vessels could not access the Cedar Port Industrial Park.

For the numerical modeling evaluations, the geometry of the No Action Alternative consists of existing conditions, plus any new projects reasonably expected to be implemented by others at the time horizons of the evaluations.[1] Through discussions with the USACE, Galveston District, it was determined that the reasonable expectation of a future project by others would be based on the project being both authorized and funded at the time of plan formulation. Through further coordination with the USACE, Galveston District, it was determined the No Action Alternative would include the fully implemented HSC ECIP project, which was partially under construction at the time of the study plan formulation process. Other third-party projects considered for inclusion in the No Action Alternative were the USACE Coastal Spine and the Texas A&M University at Galveston's Ike Dike projects (USACE and GLO 2021), both of which include storm surge protection measures aimed at reducing coastal flooding risk along Galveston Bay and the HSC. However, neither of these two projects were ultimately included in the No Action Alternative, due to neither being both authorized and funded at the time of the plan formulation.

The fully implemented HSC ECIP project features included in the No Action Alternative were based on the 95% design documents available on the study website (Port Houston 2024). These features are shown in Figure 2 and consist of the following components.

- Widening and deepening of eight reaches in the HSC, as described in Table 1
- Construction of two new oyster reef sites near San Leon and Dollar Bay

[1] The time horizons for the numerical modeling evaluations are described in Subsection 2.5.

- Construction of two new bird islands
- Construction of two new DMPAs adjacent to Atkinson Island

Table 1
HSC ECIP Widening and Deepening of HSC Reaches (95% Design)

HSC Reach	Approximate Length (miles)	Description
Bolivar Roads to Redfish	11.5	Widening of channel to 700 feet, with bend easings
Redfish to Bayport Ship Channel	8.3	Widening of channel to a minimum of 700 feet, with bend easings
Bayport Ship Channel to Barbours Cut	5.0	Widening of channel to 700 feet
Bayport Ship Channel	4.0	Widening of channel to approximately 455 feet and modification of channel entrance
Barbours Cut Ship Channel	1.6	Widening of channel to approximately 455 feet and modification of channel entrance
Boggy Bayou to Sims Bayou	4.8	Widening of channel to approximately 530 feet through Greens Bayou confluence; deepening of channel to 46.5 feet MLLW from Boggy Bayou to Huntington Bayou
Sims Bayou to Interstate Highway 610	1.0	Deepening of channel to 41.5 feet MLLW
Interstate Highway 610 to Turning Basin	2.6	Deepening of channel to 39 feet MLLW; increase of Brady Island Turning Basin

Through coordination with USACE, Galveston District, it was determined that local hydrographic and topographic surveying was needed to establish existing bathymetry and topography conditions in the vicinity of the Cedar Port Industrial Park and the study alternative channel routes for use in the No Action numerical modeling scenarios. A hydrographic and topographic survey was performed in July and August 2023 along the corridors of the four tentative alternative channel routes under consideration at that time. The limits of the survey and survey elevations are shown in Figure 3. Surveyed bathymetric elevations of the bay bottom generally ranged between -2 and -10 feet NAVD88. Surveyed elevations on Atkinson Island measured as high as +33 feet NAVD88. In overlapping areas, the site survey was found to be consistent with other publicly available elevation datasets of upper Galveston Bay, Cedar Bayou, the HSC, and Atkinson Island (NOAA 2023; USACE 2023).

2.2 Alternative E

Alternative E, the tentatively selected plan (TSP), involves excavating a new, deep channel from the HSC through Atkinson Island and portions of adjacent DMPA marsh cells (Figure 4). The channel continues east into upper Galveston Bay and terminates adjacent to the Cedar Port Industrial Park. A turning basin is located within the bendway of the channel's final approach to the Cedar Port

Industrial Park to allow for ships to be maneuvered as needed for docking and departure. The new channel would be up to 400 feet wide at its base and maintained at -46.5 feet MLLW. However, for the purpose of the numerical modeling evaluations, the channel bed elevation was assumed to be -50.5 feet MLLW (-50.5 feet NAVD88[2]), which represents the maintained elevation of -46.5 feet MLLW, plus 2 feet of allowable advanced maintenance depth, plus 2 feet of allowable overdredge depth. Inclusion of the advanced maintenance and overdredge depths is consistent with the methodology of the HSC ECIP evaluations (McAlpin et al. 2019a) and represents the lower limit of dredge elevations associated with the baseline maintenance depth, for the evaluation of greatest potential effects of the study on the modeled processes. As part of this alternative, a portion of the dredged material from the Route E channel will be used to build a beneficial use island, which will include oysters, wetlands, and upland vegetation habitat created to offset any habitat losses incurred as part of the channel dredging. Future beneficial use islands will be built to accept the material from 50 years' worth of maintenance dredging. The beneficial use islands will be designed with gentle slopes to provide suitable depths to support oyster habitat and low to high marsh. The beneficial use islands will also promote resiliency by protecting the adjacent shoreline against storm surge and wave action.

2.3 Alternative B

Alternative B would differ from Alternative E in the location and length of the channel, but it would also include the construction of beneficial use islands. Under Alternative B, a new federal deep-draft channel connecting the HSC to the Cedar Port Industrial Park would be dredged through a portion of the existing DMPA site south of Atkinson Island eastward into upper Galveston Bay, terminating adjacent to the park (Figure 5). A turning basin is located within the bendway of the channel's final approach to the Cedar Port Industrial Park to allow for ships to be maneuvered as needed for docking and departure. As with Alternative E, the new channel width would be up to 400 feet wide at its base and assumed to have a bottom elevation of -50.5 feet NAVD88 for the purpose of the numerical modeling evaluations.

2.4 Alternative D

Like Alternative B, Alternative D would differ from the TSP in location and channel length and include beneficial use islands. But, under Alternative D, a new federal deep-draft channel would be excavated from south of Blue Water Atoll through upper Galveston Bay to connect the HSC and Cedar Port Industrial Park (Figure 6). The new channel would terminate at a turning basin adjacent to the Cedar Port Industrial Park, and, like Alternatives E and B, it would be up to 400 feet wide at its base,

[2] According to the local tidal datum elevations presented in Subsection 1.1, -50.5 MLLW = -50.5 NAVD88. This conversion is consistent with the USACE tidal datum conversions for the HSC north of Redfish Reef provided in the 95% design plans of the HSC ECIP (Port Houston 2024).

and the bottom elevation is assumed to be -50.5 feet NAVD88 for the purpose of the numerical modeling evaluations.

2.5 Time Horizons

As stated in Subsection 2.1.4 of Appendix C, the period of analysis (POA) for the study FS/EIS evaluations is 50 years, which matches the POA for the HSC ECIP FS-EIS (USACE SWG 2019). Consistent with the methodology of the HSC ECIP FS-EIS evaluations, the study alternatives were evaluated with the numerical models at two time horizons within the POA. The first time horizon represents the beginning of the POA—a time in the future immediately at the completion of study construction, which is hereafter referred to as Year 0 of the study. Relative to the completion of construction, Year 0 is considered the present condition for the study. The second time horizon represents the end of the POA—50 years after the completion of construction, during which time the Galveston Bay system would be expected to undergo environmental changes in the form of sea level rise (SLR) and reduced freshwater inflows; this time horizon is hereafter referred to as Year 50 of the study. Relative to the completion of construction, Year 50 is considered the future condition for the study.

Estimated construction schedules were developed for Alternatives B, D, and E as part of the Dredged Material Management Plan presented in Appendix D. The lengthiest duration of construction (corresponding to Alternative Route D) was estimated to be completed in 2035. Therefore, 2035 was selected as Year 0 for the study because any of the alternatives would be expected to be completed by then, making Year 50 of the study 2085. These two time horizons are summarized in Table 2.

Table 2
Time Horizons Used in the Numerical Modeling Evaluations

Study Year	Calendar Year
Year 0	2035
Year 50	2085

3 Model Setup

This section describes the simulations and setup steps performed for the three numerical models described in Subsection 1.3.

3.1 Annual Hydrodynamics, Salinity, and Sediment Transport

For the FS/EIS evaluation of annual hydrodynamics, salinity, and sediment transport associated with the study alternatives, the USACE 3D AdH model previously calibrated, validated, and used for the HSC ECIP FS-EIS evaluations (McAlpin et al. 2019a, 2019b) was provided to Anchor QEA by ERDC through coordination with the USACE, Galveston District. The model includes Galveston Bay, nine adjacent tributaries that discharge freshwater and sediment into the bay, and a portion of the Gulf of Mexico. The model domain is shown in Figure 5, with the locations of the nine model tributaries of Galveston Bay labeled (San Jacinto River, Trinity River, Buffalo Bayou, Cedar Bayou, Double Bayou, Clear Creek, Oyster Bayou, Dickinson Bayou, and Chocolate Bayou).

As described by McAlpin et al. (2019a), the 3D AdH model simulated 1 year of hydrodynamics, salinity, and sediment transport for the HSC ECIP FS-EIS evaluations of each scenario.[3] This year is referred to as the analysis year and was preceded by an additional spin-up year for each scenario, which was simulated to establish initial salinity and bed conditions for the analysis year. The input conditions for the analysis year simulations are based on 2010 conditions, which were determined by the USACE, Galveston District to be a suitable base for the HSC ECIP FS-EIS evaluations (McAlpin et al. 2019a).[4] After updating the model for the study evaluations (as described in Subsection 3.1.1), the same spin-up and analysis year simulations used in the HSC ECIP FS-EIS evaluations were performed for each study WOP and WP scenario and time horizon described in Section 2. The resulting study simulation list is shown in Table 3. The last column of Table 3 contains shorthand names for the simulations that are used in the remainder of this report when referring to the model scenarios.

[3] The model scenarios for the HSC ECIP FS/EIS evaluations included WOP and WP alternatives at present and future conditions.

[4] 2010 was also a validation year for the AdH model, in which the model was shown to perform well in predicting field conditions (McAlpin et al. 2019b).

Table 3
Study AdH Simulations

Simulation No.	Study Alternative	Time Horizon	Simulation Type	Simulation Shorthand Name
1	No Action	Year 0 (present condition)	Spin-up year	PWOP
2			Analysis year	
3	Alternative B	Year 0 (present condition)	Spin-up year	PWP-B
4			Analysis year	
5	Alternative D	Year 0 (present condition)	Spin-up year	PWP-D
6			Analysis year	
7	Alternative E	Year 0 (present condition)	Spin-up year	PWP-E
8			Analysis year	
9	No Action	Year 50 (future condition)	Spin-up year	FWOP
10			Analysis year	
11	Alternative B	Year 50 (future condition)	Spin-up year	FWP-B
12			Analysis year	
13	Alternative D	Year 50 (future condition)	Spin-up year	FWP-D
14			Analysis year	
15	Alternative E	Year 50 (future condition)	Spin-up year	FWP-E
16			Analysis year	

Updates to the HSC ECIP FS-EIS model for use in the study evaluations are described in the following subsection, along with summaries of the model forcing conditions for the study simulations.

3.1.1 HSC ECIP Model Updates

As a starting point for the study model simulations, ERDC provided all the simulation files from the HSC ECIP FS-EIS evaluations to Anchor QEA. To adapt them for use in the study FS/EIS evaluations, updates to the model grid and tidal boundary conditions were required.

3.1.1.1 Grid Updates

The HSC ECIP model grid was developed for suitability in evaluating the specific project features in the HSC ECIP FS-EIS study. To render it suitable for evaluation of the study alternatives, several updates to the HSC ECIP model grid were required.[5] These updates are described in the following subsections and were performed collaboratively and in close communication with ERDC, which provided technical assistance to Anchor QEA throughout the AdH modeling effort.

[5] The study grid updates used the HSC ECIP Present with study (PWP) model grid as the base grid, as it represented conditions most like those of the study No Action scenario.

3.1.1.1.1 Inclusion of HSC ECIP 95% Design Features

The HSC ECIP FS-EIS simulations evaluated the preliminary design of the project elements, which were later refined in the 95% design. To meet the requirements of the study No Action alternative (Subsection 2.1), the HSC ECIP model grid was updated to include all the elements of HSC ECIP 95% design.

3.1.1.1.2 Local Study Area Refinements and Elevation Updates

The study area in the vicinity of the Cedar Port Industrial Park was not an area of interest requiring high spatial resolution for the HSC ECIP FS-EIS evaluations. Local grid refinement in this area was, therefore, required to resolve the geometries of the new channel alternatives, beneficial use areas, and the existing Cedar Bayou for the study evaluations. In the new channels, the grid was refined to a node spacing of approximately 100 feet in the cross-channel direction and a node spacing of approximately 300 feet in the streamwise direction. Along the perimeters of the new beneficial use areas, the grid was refined to a minimum node spacing of approximately 175 feet. In Cedar Bayou, the grid was refined to a node spacing of approximately 200 feet.

For consistency among the study simulations, the 2D geometries of the grid elements were kept identical among the model grids for all the alternatives. Only the grid node elevations and the designation and removal of dry elements were varied among the study alternative model grids.[6] Figure 6 shows a comparison of the HSC ECIP model grid for the Present with Project (PWP) scenario (left panel) and the study model grid for the Present Without Project (PWOP) model scenario (right panel) in the vicinity of the Cedar Port Industrial Park after the inclusion of the HSC ECIP 95% project features and the local study refinements.

Within the local refinement area, the No Action scenario required the most recent elevation data to define model bathymetry conditions in the vicinity of the study (Section 2.1). To that end, the model grid bathymetry within the local refinement area was updated with the following data sources. Figure 7 shows an overlay of these datasets, along with their coverage areas:

- The site survey data collected in July and August 2023 were used to define the model bathymetry within the survey coverage area.
- USACE hydrographic survey data of Cedar Bayou collected in May 2023 were used to define the model bathymetry within Cedar Bayou.
- The NOAA Continuously Updated Digital Elevation Model (CUDEM) was used to define the model bathymetry within the remainder of the local refinement area outside of the site survey and USACE hydrographic survey coverage areas.

[6] As described by McAlpin et al. (2019a), 3D AdH cannot include dry areas in the model domain. Therefore, any areas of the model grid that would be dry at any time during the simulation (such as the new beneficial use areas) were removed from the model grid for each simulation.

In areas of overlap, the elevations of these datasets were found to be generally consistent. This can be seen, for example, in the consistency of the color contours of the site survey and CUDEM elevations in the vicinity of the site survey limits shown in Figure 7. Furthermore, at the limits of the local refinement area, Figure 7 shows that the site survey and CUDEM elevations are consistent with the adjacent AdH model grid node elevations immediately outside of the refinement area, resulting in a smooth elevation transition from the local refinement area to the rest of the AdH grid.

Because 3D AdH does not have the ability to wet and dry, adjustment of some of the updated grid node elevations within the local refinement area was required to ensure that they remained wet throughout the simulations. To this end, any grid nodes with elevations higher than -3.3 feet NAVD88 after the grid elevation updates described above were assigned an elevation of -3.3 feet NAVD88.

After creation of the Project No Action model grid geometry and elevations through the steps described above, each WP model grid was created by doing the following:

- Assigning an elevation of -50.5 feet NAVD88 to the bottom of each channel alternative
- Removing the model grid elements within the beneficial use areas of each alternative

Within the new channels, the model grid elements were assigned the same physical properties (e.g., bed roughness and constituent diffusion rates) as those of the HSC used in the HSC ECIP FS-EIS evaluations (McAlpin et al. 2019a, 2019b). Within the remainder of the local grid refinement area outside of the new channels, the physical properties of the refined grid elements were not changed from the properties of the unrefined grid elements in the HSC ECIP model grid.

Figures 8 through 11 show the study model grids for the four alternatives resulting from the updates to the HSC ECIP model grid.

During initial testing, the study model simulations were found to produce numerical instabilities related to the constituent transport near the model boundaries in four locations: Dickinson Bayou, Clear Creek, the Industrial Canal, and the San Jacinto River. Through collaboration with ERDC, it was determined that the best option for addressing these instabilities was to locally increase the constituent diffusion rates at these locations. The constituent diffusion rates were, therefore, increased in the portions of these four tributaries located near the boundaries and outside Galveston Bay, which resolved the numerical instabilities and resulted in the successful completion of the model simulations.

3.1.1.2 SLR Updates

As described by McAlpin et al. (2019a), the AdH model simulations include tidal forcing at the Gulf of Mexico boundary based on tidal constituents and measurements at NOAA stations 8772447 (Freeport, Texas) and 8770822 (Texas Point, Sabine Pass, Texas). In the HSC ECIP FS-EIS evaluations, the tidal forcing for Year 0 was based on estimated sea level in 2029, and the tidal forcing at Year 50 was based on estimated sea level at Year 2079. To adjust the tidal forcings for potential SLR at study Year 0 (2035) and study Year 50 (2085), SLR projections were calculated using the USACE (2019) Intermediate curve consistent with the methodology of the HSC ECIP FS-EIS evaluations. The SLR calculations were performed using the online USACE Sea Level Analysis Tool (SLAT) implementation of the USACE (2019) SLR formulas (USACE 2024) with corrections for vertical land movement. For the SLAT calculations, data from NOAA station 8771450, Galveston Pier 21, Texas (NOAA 2024b), were used because it is the station closest to the study site where data were collected for at least the minimum duration recommended for SLAT projections. Table 4 presents the results of the SLAT SLR projections used to adjust the tidal boundary conditions for the study model simulations.

Table 4
SLR Projections Used to Adjust AdH Model Boundary Conditions at Year 0 and Year 50

Period	Calculated SLR
2029–2035	0.18 foot
2035–2085	1.72 feet

Figure 12 shows the resulting tidal boundary conditions for the study simulations obtained after applying the SLR adjustments in Table 4 to the tidal boundary conditions of the HSC ECIP FS-EIS simulations. The blue lines in Figure 12 are the Year 0 timeseries, and the red lines are the Year 50 timeseries. The top panel corresponds to the spin-up year, and the bottom panel corresponds to the analysis year.

Due to the model grid updates discussed in Subsection 3.1.1.1 and the SLR adjustments presented above, the study WOP scenarios represent different geometric and environmental conditions than the HSC ECIP FS-EIS WP scenarios. Given these differences, the model results of these scenarios were expected to differ somewhat but were expected to be similar overall.

3.1.2 Freshwater Inflow

As described by McAlpin et al. (2019a), freshwater inflows into the AdH model were applied at nine tributaries of Galveston Bay based on flow estimates obtained from TWDB. For consistency with the HSC ECIP FS-EIS simulations, the same inflow rates were used for the study FS/EIS evaluations (Figures 14 and 15). However, as a result of the grid updates described in Subsection 3.1.1.1, the location of the Cedar Bayou inflows into the AdH grid was updated from its location in the HSC ECIP simulations as follows:

- In the HSC ECIP model grid, Cedar Bayou was a sub-grid-scale feature that was, therefore, not directly resolved in the grid geometry. Its inflows into the Galveston Bay system were, therefore, accounted for by applying them at nearby Goose Lake, approximately 3 miles west of Cedar Bayou, which, due to its larger scale, was directly included in the HSC ECIP model grid.

- As a result of the study grid refinements described in Subsection 3.1.1.1 and shown in Figure 6, Cedar Bayou was directly included in the study model grids. Therefore, for the study simulations, the location of the Cedar Bayou inflows was transferred from Goose Lake to Cedar Bayou at the location shown in Figure 15.

3.1.3 Salinity, Wind, Meteorological Conditions, and Sediment

The input conditions for salinity, wind, meteorology, and sediment in the AdH model are described by McAlpin et al. (2019a). For consistency with the HSC ECIP FS-EIS simulations, all these same conditions were used for the study FS/EIS evaluations.

3.2 Storm Surge and Waves

For the FS/EIS evaluation of storm surge and waves associated with the study alternatives, the USACE 2D ADCIRC+STWAVE model previously used for the CTXS storm surge evaluations was used as a starting point for the study evaluations (Massey et al. 2019). Updates to the CTXS model for use in the study evaluations are summarized in the following subsection, along with the selection of storm events and the resulting simulations used for the study evaluations. These items are described in more detail in Attachment 1.

3.2.1 CTXS Model Updates

As the basis for updating the CTXS model for use in the study evaluations, Anchor QEA provided ERDC with the following datasets:

- A geospatial file of the HSC ECIP 95% design features, digitized from the 95% design documents available on the study website (Port Houston 2024)
- The July and August 2023 site survey data, May 2023 USACE Cedar Bayou survey data, and NOAA CUDEM data
- Geospatial files of the study alternative channel routes and beneficial use areas
- SLR projections for study Year 0 and Year 50

Updates to the CTXS model performed by ERDC using these datasets are summarized in the following subsections and described in more detail in Attachment 1.

3.2.1.1 Grid Updates

Using the geospatial and elevation datasets provided by Anchor QEA, ERDC performed local refinements and bathymetry/topography updates to the ADCIRC+STWAVE model grids to obtain

WOP and WP model grids for the study simulations. Details of the model grid updates are provided in Attachment 1.

3.2.1.2 SLR Updates

As described in Attachment 1, sea level conditions for the CTXS simulations represented year 2017. To adjust the sea level conditions in the study simulations for potential SLR at study Year 0 (2035) and study Year 50 (2085), SLR projections were calculated using the USACE (2019) Intermediate curve, consistent with the methodology described in Subsection 3.1.1.2 for SLR adjustments in the AdH simulations.

As described in Attachment 1, the SLR calculations were performed using the online USACE SLAT implementation of the USACE (2019) SLR formulas (USACE 2024) with corrections for vertical land movement. For the SLAT calculations, data from NOAA station 8771450, Galveston Pier 21, Texas (NOAA 2024b), were used because it is the station closest to the study site where data were collected for at least the minimum duration recommended for SLAT projections. Table 5 presents the results of the SLAT SLR projections used to adjust the sea level conditions for the study ADCIRC+STWAVE simulations.

Table 5
SLR Projections Used to Adjust ADCIRC+STWAVE Sea Level Conditions at Year 0 and Year 50

Period	Calculated SLR
2017–2035	0.51 foot
2035–2085	1.72 feet

3.2.2 Storm Selection

As described by Massey et al. (2019), the CTXS included the development and simulation of 660 synthetic tropical storms across coastal Texas and Louisiana. For the purposes of the study FS/EIS evaluations, three of the CTXS storms that represented a range of extreme events at the study area were selected for the study simulations. Specifically, three CTXS storms with return periods of approximately 10, 100, and 500 years (in terms of peak storm surge elevation) were selected for use. These return periods were considered to represent a reasonable range of storm magnitudes appropriate for assessing the potential effects of the alternative study features on storm surge and waves in upper Galveston Bay for the purposes of the FS/EIS evaluations. The selection of CTXS storms meeting the target return periods was performed collaboratively and in close communication with ERDC and the USACE, Galveston District.

As described in Attachment 1, stormwater level statistics for annual exceedance probabilities (AEPs) with confidence limits were computed as part of the CTXS (Nadal-Caraballo et al. 2019) at more than

18,000 save point locations across the Texas and Louisiana coastal areas. As a starting point for the study storm selection, ERDC provided Anchor QEA with the CTXS storm tracks and storm parameters[7], as well as the timeseries stillwater elevations and AEP statistics for the CTXS storms at requested save points throughout Galveston Bay. Figure 16 shows the CTXS storm tracks that pass within the vicinity of Galveston Bay.

Using the CTXS data provided by ERDC, storms were screened for consideration at save point 15651, located in the study vicinity in upper Galveston Bay between the mouth of Cedar Bayou and the Atkinson Island marsh complex. At this save point, the screening analysis was performed by comparing the timeseries stillwater elevations from all 660 CTXS synthetic storms to the best-estimate AEP values at the target return periods (i.e., 10, 100, and 500 years). Storms with peak stillwater elevations within 0.5 foot of the target return period AEP values were considered for potential selection. Of the considered storms, focus was given to the upper range of events at each return period and individually examined in terms of its storm track relative to the study area. Storm tracks with landfalls to the west of and near the study area were given the largest focus, as they were considered most likely to have the greatest direct impacts to the study area, as their counterclockwise rotations would generate southerly surges and waves directed into upper Galveston Bay.

Upon examination of the screened storms at each target return period using the methodology described above, the following CTXS storms were selected for the study storm surge simulations. Upon selection, the peak stillwater elevation for each storm was compared with the Federal Emergency Management Agency (FEMA) AEP estimate[8] at the CTXS save point 15651 location to assess the consistency of the selected storm magnitude with that of the local FEMA Flood Insurance Study estimates.

- 10-year storm
  - CTXS storm 458 was selected to represent an approximate 10-year return period storm at the study area.
  - The peak stillwater elevation at save point 15651 for this storm was 8.0 feet NAVD88, which was within 0.5 foot of both the CTX and FEMA 10-year AEP stillwater elevations.
  - The location of this storm's peak stillwater elevation on the USACE AEP curve is shown in Figure 17a, along with those of 19 other CTXS storms screened for potential consideration.
  - Based on the Holland B parameter for this storm at landfall, the peak windspeed at landfall equated to a Category 2 hurricane.

[7] Key parameters included translation speed, radius of maximum winds, central pressure difference, and Holland B parameter.

[8] FEMA AEP values of stillwater elevation at CTXS save point 15651 were taken from the latest Chambers County Flood Insurance Study, Coastal Transect No. 4 (FEMA 2018).

- This storm followed CTXS Track 61 with a northwest heading immediately west of Galveston Bay. This track is shown as the dotted green line in Figure 16.

- 100-year storm
  - CTXS storm 521 was selected to represent an approximate 100-year return period storm at the study area.
  - The peak stillwater elevation at save point 15651 for this storm was 13.5 feet NAVD88, which was within 0.5 foot of both the CTX and FEMA 100-year AEP stillwater elevations.
  - The location of this storm's peak stillwater elevation on the USACE AEP curve is shown in Figure 17b, along with those of three other CTXS storms that were screened for potential consideration.
  - Based on the Holland B parameter for this storm at landfall, the peak windspeed at landfall equated to a Category 4 hurricane.
  - This storm followed Track 70, with a north heading immediately west of Galveston Bay. This track is shown as the dotted yellow-orange line in Figure 16.
- 500-year storm
  - CTXS storm 523 was selected to represent an approximate 500-year return period storm at the study area.
  - The peak stillwater elevation at save point 15651 for this storm was 16.8 feet NAVD88, which was within 0.5 foot of both the CTX and FEMA 100-year AEP stillwater elevations.
  - The location of this storm's peak stillwater elevation on the USACE AEP curve is shown in Figure 17c. This was the only CTXS storm that met the screening criteria for consideration as an approximate 500-year event.
  - Based on the Holland B parameter for this storm at landfall, the peak windspeed at landfall equated to a Category 3 hurricane.
  - This storm followed Track 70, with a north heading immediately west of Galveston Bay. This track is shown as the dotted yellow-orange line in Figure 16.
  - It is worth noting that, in terms of windspeed, this approximately 500-year storm is one category lower than the approximately 100-year storm (CTXS storm 521), even though both storms follow the same track. However, as described in Attachment 1, the translational speed of the approximately 500-year storm is slower than the approximately 100-year storm,and its size is larger—both of which appear to be responsible for the larger storm surge levels of storm 523 compared to storm 521.

It is worth noting that, in Figures 17a through 17c, the FEMA AEP curves are plotted in addition to the USACE CTXS AEP curves. As shown in these figures, the two curves are very similar in the region of overlap. This shows good agreement between the CTX and FEMA Flood Insurance Study statistics at the study area; therefore, both are shown to support the storm selection at each target return period.

3.2.3 *Study Simulations*

The study storm surge simulation list for the evaluation of the study alternatives for each selected storm at the present and future time horizons is shown in Table 6.

Table 6
Study ADCIRC+STWAVE Simulations

Simulation No.	Study Alternative	Time Horizon	CTXS Storm ID	Approximate Return Period at Study Area
1	No Action	Year 0 (present condition)	458	10 years
2			521	100 years
3			523	500 years
4	Alternative B	Year 0 (present condition)	458	10 years
5			521	100 years
6			523	500 years
7	Alternative D	Year 0 (present condition)	458	10 years
8			521	100 years
9			523	500 years
10	Alternative E	Year 0 (present condition)	458	10 years
11			521	100 years
12			523	500 years
13	No Action	Year 50 (future condition)	458	10 years
14			521	100 years
15			523	500 years
16	Alternative B	Year 50 (future condition)	458	10 years
17			521	100 years
18			523	500 years
19	Alternative D	Year 50 (future condition)	458	10 years
20			521	100 years
21			523	500 years
22	Alternative E	Year 50 (future condition)	458	10 years
23			521	100 years
24			523	500 years

These simulations were executed by ERDC on the ERDC high-performance computing system and are described in more detail in Attachment 1.

3.3 Vessel Wakes

For the FS/EIS evaluation of vessel wakes associated with ships transiting the study channel alternatives, the 2D XBeach modeling software was used to simulate nearshore water levels and bed shear stresses produced by passing vessels. This subsection includes details on the vessel wake model development and simulations.

3.3.1 Model Grids

An XBeach model grid was developed for each WP alternative using the same following datasets used in the study AdH and ADCIRC+STWAVE model grids:

- A geospatial file of the HSC ECIP 95% design features digitized from the 95% design documents available on the study website (Port Houston 2024)
- The July and August 2023 site survey data, May 2023 USACE Cedar Bayou survey data, and NOAA CUDEM data
- Geospatial files of the study alternative channel routes and beneficial use areas

Each model grid covered the same region of upper Galveston Bay from north of Smith Point to the Fred Hartman Bridge, including bay areas from west of the HSC to the eastern limit of the study beneficial use areas. The study model grids are shown in Figures 18 through 20. The resolution of each model grid was spatially uniform and composed of 23- by 23-foot grid cells. This resolution was considered adequate for representing the nearshore bathymetry and study features, as well as the details of the simulated vessel wakes.

3.3.2 Design Vessel Characteristics

As described in Subsection 4.1 of Appendix C, the study design vessel is a container ship with dimensions of 1,202 feet (overall length) by 158 feet (beam) by 49.8 feet (maximum draft). This vessel matches what was used in the navigation simulations for both the study (Appendix C, Attachment C-3) and the HSC ECIP and is the largest ship anticipated to use the study channel. Consistent with the navigation simulations presented in Appendix C, Attachment C-3, the transiting speed of the design vessel along each alternative channel route was assumed to be 6 knots at an operating draft of 46.6 feet.

3.3.3 Model Vessel Hull Geometry

A traveling vessel is simulated in XBeach as a moving pressure field, represented as a spatially varied grid of draft depths along the vessel's length and width, superimposed onto the model hydrodynamic grid at the vessel's transit speed at each timestep. The vessel draft depths correspond to the bottom of its hull.

Prototype vessel hull geometry for the design ship was obtained from the vessel hull database available through the DELFTship maritime software (DELFTship 2023). A prototype container ship that most closely matched the overall dimensions of the study design ship was selected from the DELFTship database. The selected prototype hull was then geometrically scaled in each direction to match the design vessel dimensions.

After geometrically scaling the prototype vessel hull geometry to match the design vessel dimensions, the block coefficient of the resulting scaled vessel hull geometry was computed and compared to vessel class-specific literature values to verify its reasonableness. The block coefficient is the ratio of the volume occupied by the submerged portion of the vessel hull to the volume occupied by a block with dimensions equal to the maximum length of each respective submerged vessel hull dimension. A vessel hull's block coefficient is, therefore, an index of water displacement and an important parameter in the generation of vessel wakes.

Table 7 summarizes the scaling factors used to scale each dimension of the prototype vessel hull geometry to obtain the model vessel hull geometry, as well as the block coefficients for the prototype and scaled model hulls. As shown in Table 7, the prototype vessel hull geometry was scaled up in each dimension by factors ranging approximately 15% to 30% to obtain the model hull geometry. The scaling of the prototype hull did not significantly alter the block coefficient, which was within 1% of the block coefficient of mariner class cargo ships reported by USACE (Sorensen 1997). The scaled model vessel hull geometry was, therefore, considered reasonable for use in this model evaluation.

Table 7
Model Scaling of Prototype Vessel Hull Geometry

Parameter	Length Overall	Beam	Draft	Block Coefficient, (C_b)
Prototype vessel	1,032 feet	122 feet	36 feet	0.5292
Model vessel	1,202 feet	158 feet	46.6 feet	0.5291
Model scaling factor	+16.5%	+29.5%	+29.4%	-0.02%

Note:
Block coefficients of both the prototype and scaled model hull geometries are within 1% of the block coefficient of marine-class cargo ships of 0.526 given in Table 1 of Sorensen (1997).

An isometric view of the prototype container ship geometry is shown in Figure 21a. Plan and profile views of the model ship geometry, after being scaled to the design vessel dimensions, are shown in Figures 21b and 21c.

For use in XBeach, the scaled model vessel geometry was discretized onto a 2D vessel grid with uniform resolution of 1.6 by 1.6 feet, which was considered adequate for representing the hull details. Bottom depths of the model vessel hull geometry were interpolated to the 2D vessel grid for use in the XBeach simulations.

3.3.4 Model Water Levels

As stated in Section 1, the primary purpose of the vessel wake modeling was to evaluate the potential effects of vessel wakes at adjacent shorelines generated by ships transiting the study alternative channel routes. Because elevated water levels result in the encroachment of bay waters into larger nearshore areas, the use of elevated water levels in the XBeach simulations was considered appropriate for evaluating the potential propagation of vessel wakes into adjacent nearshore areas. However, extreme water levels associated with storm events were considered outside the range of vessel operating conditions due to local safety practices of port closures and suspended vessel transit during storms (Houston Pilots 2021). Extreme water levels, therefore, were not considered realistic for use in the XBeach simulations.

Figure 22 shows a cumulative frequency distribution of the available 6-minute water level measurements at the NOAA Barbours Cut station (NOAA station 8770613) from December 1995 through January 2024. The location of this NOAA station relative to the study area is shown in Figure 1. As shown in Figure 22, the 85th-percentile value (i.e., the water level higher than 85% of the recorded 6-minute values) is 1.8 feet NAVD88. The 85th-percentile value is approximately 0.5 foot above MHHW and was considered an appropriate basis for the water levels used in the vessel wake simulations due to it representing an elevated water level above typical tides that could occur when vessels would be transiting the channel.

To adjust the selected water level (representing the 85th-percentile of historical water levels in 2024) for potential SLR at study Year 0 (2035) and study Year 50 (2085), SLR projections were calculated consistent with the methodology described in Subsections 3.1.1.2 and 3.2.1.2 for SLR adjustments in the AdH and ADCIRC+STWAVE simulations. The SLR calculations were performed using the online USACE SLAT implementation of the USACE (2019) SLR formulas (USACE 2024) with corrections for vertical land movement. For the SLAT calculations, data from NOAA station 8771450, Galveston Pier 21, Texas (NOAA 2024b), were used because that station is the closest to the study site where data were collected for at least the minimum duration recommended for SLAT projections. Table 8 presents the results of the SLAT SLR projections used to adjust the sea level conditions for the study XBeach simulations.

Table 8
SLR Projections Used to Adjust XBeach Model Initial Conditions at Year 0 and Year 50

Period	Calculated SLR
2024–2035	0.32 foot
2035–2085	1.72 feet

3.3.5 Model Simulations

The study vessel wake simulation list is shown in Table 9 for the evaluation of both inbound and outbound vessel trips in each alternative channel route at the present and future time horizons. For each simulation, the path of the vessel was the centerline of the channel.

Table 9
Study XBeach Simulations

Simulation No.	Study Alternative	Time Horizon	Transit Direction
1	Alternative B	Year 0 (present condition)	Inbound
2			Outbound
3	Alternative D	Year 0 (present condition)	Inbound
4			Outbound
5	Alternative E	Year 0 (present condition)	Inbound
6			Outbound
7	Alternative B	Year 50 (future condition)	Inbound
8			Outbound
9	Alternative D	Year 50 (future condition)	Inbound
10			Outbound
11	Alternative E	Year 50 (future condition)	Inbound
12			Outbound

4 Model Results and Discussion

This section describes the results of the numerical model simulations described in Section 3 for the WP and WOP scenarios and the two time horizons. Present condition simulations represent calendar year 2035, and future condition simulations represent calendar year 2085.

4.1 Annual Hydrodynamics, Salinity, and Sediment Transport

The four study alternatives (No Action and Alternative Routes B, D, and E) were simulated at the present and future time horizons using 3D AdH as described in the previous sections. The results include comparisons of salinities throughout the model domain, comparisons of velocities and flow patterns in the vicinity of the alternative study features, and comparisons of shoaling volumes in the alternative channels.

As described by McAlpin et al. (2019b), it is recommended that comparison of WP and WOP results be done on the present conditions and the future conditions separately, except where discussed otherwise, to isolate impacts due to the study alternatives alone. Due to the variability in several input parameters for the present and future conditions, direct comparison of present and future results may be misleading unless careful consideration is given to understanding the difference in the present and future input parameters.

4.1.1 Salinity

This subsection describes the 3D AdH salinity results. Results are presented through four types of analyses. The point analysis, cross-sectional analysis, and HSC profile analysis follow the methodology presented in the HSC ECIP FS-EIS evaluations of salinity (McAlpin 2019a). Spatial distribution of salinities in the area of interest surrounding the Cedar Port Industrial Park are also presented.

4.1.1.1 Salinity Point Analysis

Consistent with the methodology of the HSC ECIP FS-EIS evaluations (McAlpin 2019a), several locations within the model domain were selected for analysis of time history, maximum/minimum/average, vertical profiles, and cumulative frequency distributions of salinity. The locations selected for these point analyses are shown in Figure 23a and listed in Table 10. Points 1 through 29 match the locations of the point analysis performed for the HSC ECIP FS-EIS evaluations. Points 30 through 35 are new points, corresponding to key locations in the study vicinity.

Table 10
Salinity Point Analysis Locations

Point Number	Name	Point Number	Name
1	HSC at Morgans Point	19	Offatts Bayou
2	HSC at Atkinson Island	20	Dickinson
3	HSC at Middle Bay Marsh	21	Clear Creek
4	HSC at Red Fish Reef	22	Smith Point
5	HSC at Lower Galveston Bay	23	Middle East Bay
6	HSC at Bolivar Roads	24	HSC at Fred Hartman Bridge
7	HSC at Entrance	25	HSC at Goat Island
8	HSC at Gulf	26	HSC at Carpenters Bayou
9	Upper Galveston Bay 1	27	HSC at Greens Bayou
10	Upper Galveston Bay 2	28	HSC at Sims Bayou
11	Lower Galveston Bay	29	HSC at Turning Basin
12	Lower Trinity Bay	30	North of Beneficial Use Shoreline
13	Middle Trinity Bay	31	South of Beach City Shoreline
14	Upper Trinity Bay	32	West of Proposed Channel
15	Western East Bay	33	Center of Proposed Channel
16	Eastern East Bay	34	East of Proposed Channel
17	Eastern West Bay	35	Near Bay Oaks
18	Middle West Bay		

The point analysis plots for the 35 locations are shown in Figures 23b through 23j1. The top left panels show timeseries line charts of salinities for the analysis year for each study alternative and time horizon scenario. The top right panels show bar charts of the maximum, mean, and minimum salinity values during the analysis year for each scenario. The bottom left panels show line charts of the average annual vertical salinity profile during the analysis year for each scenario. The bottom right panels show salinity cumulative frequency distributions during the analysis year for each scenario. The percentile values in the x axis represent the percentage of time during the analysis year when salinities were below the y-axis values for each plotted line. For all the charts except the vertical profiles, the plotted values are the bottom salinity values, which will be larger than or equal to the surface salinity values due to larger salt concentrations being denser than fresher concentrations.

For points 1 through 29, comparison of Figures 23b through 23d1 to the corresponding figures in the HSC ECIP FS-EIS numerical modeling report (McAlpin 2019a) show that the trends are consistent for both sets of results and that the salinity values for the HSC ECIP WP scenario are close to the values of the study WOP scenarios. These comparisons provide confirmation that, outside of the local study area, the results of the study simulations are consistent with those of the HSC ECIP FS-EIS evaluations.

Throughout the model domain, the results indicate that mean salinities are mostly higher for the future conditions than the present due to the higher Gulf of Mexico water levels resulting from SLR driving increased salinities into Galveston Bay, combined with future reductions in freshwater inflows.

At points 1 through 29, the model results show small differences in salinities between the WOP and WP alternatives, with differences generally less than 2 parts per thousand (ppt). These results indicate that outside of the immediate study area, the study alternatives have a small effect on salinities in the wider HSC and Galveston Bay area. At points 30 through 32 and 34, the model results show slightly larger (up to 3 ppt) increases in salinities for the WP alternatives compared to the WOP alternative in the vicinity of the study area but outside of the new channels. In these areas, the largest salinity increases are generally associated with Alternative Route D. At point 33, located in the new channels, the results show similar increases in bottom salinities of approximately 10 ppt for all the WP alternatives compared to the WOP alternative.[9] At point 35, located north of Cedar Bayou near the shoreline of Bay Oaks, salinities are slightly lower (by approximately 2 ppt) for all WP alternatives compared to the WOP alternative. These lower nearshore salinities in the WP scenarios appear to be the result of fresher water traveling close to the shoreline in the vicinity of Bay Oaks.

4.1.1.2 Spatial Distribution Salinity Analysis

Figures 24a through 24d show maps of annual average surface and bottom salinities in the study area of interest in the vicinity of the Cedar Port Industrial Park. These figures show that salinities are generally increased in the area south of Cedar Bayou and east of the Atkinson Island DMPA and marsh complex in the WP scenarios compared to the WOP scenarios. Consistent with the point analysis in Subsection 4.1.1.1, these figures show general increases of approximately 3 ppt outside of the new channels in this area and increases of up to 10 ppt inside of the new channels. Also apparent in these figures is the typical lateral distribution of saltwater in Galveston Bay common to most of the simulation results, in which freshwater tends to travel closest to the shorelines when entering the bay from the tributaries. This tendency is most evident in these figures for the freshwater discharges from Cedar Bayou immediately north of the Bay Oaks area and for the freshwater discharges from the Trinity River in northeast Trinity Bay.

4.1.1.3 Cross-Sectional Salinity Analysis

Consistent with the methodology of the HSC ECIP FS-EIS evaluations, several locations within the model domain were selected for cross-sectional analysis of annual average salinities. The locations of

[9] These increases are only within the new channels, which provide a pathway for the salinities of HSC channel bottoms to migrate into the study area along the bottoms of the new channels. The resulting salinities in the bottoms of the new channels are like those in the adjacent reaches of the HSC and are confined to the bottoms of the new channels within the study area.

the selected cross sections are shown in Figure 25a. Cross sections 1 through 11 match the locations of the cross-sectional analysis performed for the HSC ECIP evaluations. Cross sections 12 through 14 are new cross sections corresponding to key locations in the study vicinity. The cross-sectional results are shown in Figures 25b through 25c1.

For cross sections 1 through 11 in the HSC, comparison of Figures 25b through 25w to the corresponding figures in the HSC ECIP FS-EIS numerical modeling report (McAlpin 2019a) show consistency between both sets of results, confirming that outside of the local study area, the results of the study simulations are consistent with those of the HSC ECIP FS-EIS evaluations. Overall, the trends and magnitudes of salinities in the HSC cross sections are similar for the WP and WOP scenarios, with the Alternative Route D results appearing to show slightly lower salinities than the other scenarios. Interpreted in light of the point analysis and spatial distribution analysis presented in the previous subsections, these results indicate that Alternative D may divert slightly larger quantities of saltwater from the HSC into the study area, resulting in slightly larger salinities in the vicinity of Cedar Port Industrial Park and slightly lower salinities in the HSC compared to the other WP and WOP scenarios.

For cross sections 12 through 14 (Figures 25x through 25c1), the results are consistent with those of the point analysis and spatial distribution analysis within the study area discussed in the previous subsections. South of Cedar Bayou (in cross sections 12 and 13), salinities are generally increased within the study area, with slightly higher salinities associated with Alternative Route D. In the vicinity of Bay Oaks (cross section 14), nearshore waters remain fresher (less than 10 ppt) for approximately 500 additional feet offshore in the PWP scenarios compared to the PWOP scenario.

4.1.1.4 HSC Profile Analysis

Consistent with the methodology of the HSC ECIP FS-EIS evaluations, a profile of annual average salinities along the centerline of the HSC from the Gulf of Mexico to the HSC Turning Basin was generated for each WOP and WP scenario. These profile plots allow for the comparison of the salinity wedge migration along the HSC for each scenario.

Figure 26a shows a plan view map of the profile route, along with reference locations labeled as black dots. Figures 26b and 26c show the profile results. Consistent with the salinity results previously discussed, these figures show overall similar trends and magnitudes of annual average salinity in the HSC for the WP compared to the WOP scenarios at each time horizon, with HSC salinities for the Route D scenarios appearing slightly less saline than the others.

4.1.2 Velocity

Consistent with the methodology of the HSC ECIP FS-EIS evaluations, velocity comparisons of the WOP and WP scenarios will focus on residual velocities. Residual velocity is the velocity obtained by time averaging the full velocity record to yield the net magnitude and direction of all the time-varied values. This vector defines the net flow direction and speed of a particle of water. Although water particles within the Galveston Bay system move back and forth due to tides, there is generally a prevailing flow direction that moves the water particle along a certain path. Typically, in tidally dominated systems with deep draft channels, such as Galveston Bay, the dominant flow path is in the upstream/flood direction along the water bottom and in the downstream/ebb direction along the water surface.

Figures 27a through 27d show the residual surface and bottom velocity magnitudes and directions in the study area of interest in the vicinity of the Cedar Port Industrial Park for the WOP and WP model scenarios. Comparison of these figures with the corresponding figures in the HSC ECIP FS-EIS numerical modeling report (McAlpin 2019a) show consistency of overall flow patterns between both sets of results. These comparisons provide confirmation that, aside from localized velocity differences due to study features, the results of the study simulations are consistent with those of the HSC ECIP FS-EIS evaluations.

The results show that the overall flow patterns are similar for the WOP and WP scenarios at each time horizon except for localized differences in the WP scenarios that include the following:

- Residual surface velocities increase by approximately 0.5 to 1.0 foot per second (fps) along the edges of the new beneficial use sites and the northern tip of Bird Island in the WP compared to the WOP scenarios in both the present and future conditions. These trends are similar for residual bottom velocities, but the magnitudes of the changes are less.
- Residual surface and bottom velocities increase by up to 0.5 fps within and near the boundaries of the new channels in the WP compared to the WOP scenarios for both the present and future conditions.
- Residual surface and bottom velocity fields around the mouth of Cedar Bayou increase by approximately 0.2 fps in the WP compared to the WOP scenarios in both the present and future conditions. The spatial extents of these increases are largest for the Alternative Route E scenario.
- Residual surface velocities decrease slightly (by 0.1 to 0.2 fps) between beneficial use areas and the shoreline of the Beach City community in the WP compared to the WOP scenarios for both the present and future conditions.
- For Alternative Route D, residual current velocities decrease slightly (by approximately 0.2 fps) within the turning basin of the channel.

4.1.3 Shoaling

For the study evaluations, the purpose of the sediment transport component of the AdH model simulations was to estimate annual shoaling volumes in the new channel alternatives as part of the evaluation of future maintenance and sediment management efforts. To that end, shoaling volumes in the new channel alternatives were computed from the study AdH model results using the same methodology described in the HSC ECIP FS-EIS numerical modeling report (McAlpin et al. 2019a) for the calculation of shoaling volumes by reach in the HSC.

As described by McAlpin et al. (2019a, 2019b), the methodology for the shoaling volume calculations applies reach-specific scaling factors to the AdH-computed sedimentation volumes to obtain scaled shoaling volumes. The purpose of the scaling factors is to account for sources of shoaling not specifically included in the AdH model, such as sediment loads from ungagged freshwater inflows, wind-generated wave erosion in shallow regions of the bay system, and vessel-induced erosion.

The HSC ECIP FS-EIS model evaluations used a historical scaling method whereby model-computed shoaling quantities from a simulation of 2005 were scaled to annually averaged dredging records in the HSC from 2006 through 2016. The maintained dimensions of the HSC during the period of the annualized dredging records was 45 feet deep by 530 feet wide (which matched the HSC channel dimensions of the WOP scenario in the HSC ECIP evaluations). The scale factor obtained through this process for each HSC segment was then applied to the HSC ECIP FS-EIS model results to yield the predicted shoaling volumes for the study alternatives (McAlpin et al. 2019a, 2019b).

Recent ERDC estimates of shoaling volumes in the HSC include a scenario for a 700-foot channel width, similar to the 95% ECIP design reflected in the study PWOP scenario (McAlpin and Ross 2021). As the most recent estimates of shoaling volumes in the HSC most closely resembling the fully implemented ECIP 95% design (which the study PWOP scenario represents), the shoaling volumes for the "PWP700" scenario provided in Figure 57 of McAlpin and Ross (2021) were used as the basis of scaling the model-computed HSC shoaling volumes for the study PWOP scenario. The scale factors obtained through this process were then used to scale the model-computed shoaling volumes in the study alternative channels for each PWP scenario using the nearest HSC reach(es) to each channel. For Alternative Routes B and E, the scaling factor for the HSC reach from Bayport to Morgans Point was used. For Alternative Route D, an average of the scaling factors for the HSC reaches from Red Fish to Bayport and from Bayport to Morgans Point was used.

Figure 28 shows the unscaled cumulative bed displacement (i.e., vertical accretion) values within each of the alternative channel routes at the end of the analysis year from the respective PWP model simulation. As shown in the top right panel, the location with the largest magnitude of shoaling is the turning basin of Alternative Route D. It is possible that the turning basin of Route D shoals is at a higher rate than those of Alternative Routes B and E because it is located at the end of the channel and traps deposited sediment compared to the in-channel configuration of the turning basins for Alternative Routes B and E. The larger shoaling volumes in the turning basin of Route D are consistent with local velocity decreases noted in Subsection 4.1.2.

The scaled annual shoaling volumes obtained from the analysis are shown in Table 11. As expected, the shoaling volume for the Route D channel is the largest among three because it is the longest channel, and its turning basin has the highest rates of observed vertical accretion of the three alternatives. The shoaling volume for Alternative D is similar to (20% lower than) the estimated rate for the adjacent Bayport to Morgans Point reach of the HSC based on the recent estimates from the HSC PWP700 scenario (McAlpin and Ross 2021). The shoaling volumes for Alternatives B and E are similar (with the Route B estimate being approximately 30% lower than that of Route E) and are close to the estimated rate for the nearby Barbours Cut reach of the HSC based on the recent estimates from the HSC PWP700 scenario simulated (McAlpin and Ross 2021).

Table 11
Estimated Annual Shoaling Volumes for New Channel Alternatives

Alternative Channel Route	Annual Shoaling Volume (cubic yards per year)
B	160,000
D	490,000
E	220,000

Comparing the results of the PWOP and PWP scenarios, the model results indicate that the new channels do not increase shoaling in the HSC. Results of the future condition simulations indicate that, in general and similar to the findings of the HSC ECIP FS-EIS evaluations, shoaling is predicted to decrease over time due to long-term changes.

4.2 Storm Surge and Waves

Results of the storm surge and wave model simulations of the study alternatives are detailed in Attachment 1. A summary of the key findings follows:

- For all simulated storm events (10-, 100-, and 500- year events) and sea level conditions (present and future), the difference in maximum water surface elevations in the WP compared to the WOP scenarios were less than 1 foot, and those differences were mostly contained in and around the beneficial use areas associated with each alternative, where land elevations had been raised to create the islands. The vast majority of the study area showed less than 0.5 foot of difference in maximum water surface elevations in the WP compared to the WOP scenarios.
- The differences in maximum significant wave heights in the WP compared to WOP scenarios were of a larger magnitude and for a larger area. The sheltering around and the depth-limited waves over the beneficial use islands associated with the study alternatives generally reduced the maximum significant wave heights by 1 to 4 feet along the shoreline. Higher maximum significant wave heights were observed in and around the new channels for each alternative.

4.3 Vessel Wakes

Figures 29a through 29l show water level results for the inbound and outbound design vessel trips along each proposed route under present and future conditions. These results are presented as a sequence of panel plots showing snapshots of the model water levels at key times throughout each simulation. When viewed in sequence, these maps depict the progression of water level fluctuations and wave propagations resulting from the simulated vessel movements.

In general, the model results show water level fluctuations throughout the study vicinity resulting from passing vessel drawdown and wakes generated by the simulated ship traffic along all new channel routes. Based on the simulations, the following areas within the study vicinity are considered particularly vulnerable to potential effects from the vessel wakes:

- The Bay Oaks area north of Cedar Bayou, which contains a community of residents along its shores
- The Beach City area south of the Cedar Port Industrial Park, which contains a community of residents along its shores
- The banks of the portions of alternative channel routes B and E that pass through the Atkinson Island complex, which will experience focused effects of vessel wakes due to the confined nature of those channel reaches

Figures 30a through 30k show line plots of time histories of the simulated water levels at representative locations of these three areas for each model scenario. For the Bay Oaks area, time histories are plotted near the southern point of Bay Oaks Harbor; the model results show that the water level fluctuations caused by the simulated ships at this location continue to propagate northward along the entire Bay Oaks shoreline. For the Beach City area, time histories are plotted near Cedar Point; the model results show that the water level fluctuations caused by the simulated ships at this location continue to propagate eastward along the Beach City shoreline.

The time history results show that the largest water level fluctuations incident to the Bay Oaks area occur for outbound vessels transiting Route E, with a maximum fluctuation of 1.3 feet peaking at a water level of 3.1 feet NAVD88 for the present condition; this peak water level corresponds to water being pushed northward by the design ship as it turns west from Cedar Port toward the HSC. At Cedar Point, water level fluctuations incident to the Beach City area are largest for outbound vessels transiting Route B, with a maximum fluctuation of 0.9 foot peaking at a water level of 2.4 feet NAVD88; this peak water level corresponds to water being pushed eastward by the design ship as it turns west from Cedar Port toward the HSC. Within the confined portions of the Route B and Route E channels, the time history results show primary wave heights ranging 1.3 to 1.6 feet for the present condition; the wave heights are slightly less in the future condition, albeit at the elevated water level.

Figures 31a through 31l show bed shear stress results for the inbound and outbound design vessel trips along each proposed route under present and future conditions. These results are presented as a sequence of panel plots showing snapshots of the model bed shear stresses at the same times shown in the water level results of Figures 29a through 29l. The results show that bed shear stresses generally follow the paths of the water level fluctuations and could result in resuspension of bay sediments in the shallow areas and shoreline in the vicinity of the study. For example, excluding turning maneuvers, bed shear stresses range from 0.1 to 1.0 pascals in the area in the area surrounding the ship as it travels along each channel (Figures 31a through 31l). According to critical bed shear stress values published by the U.S. Geological Survey, these simulated bed shear stress field could mobilize material classes ranging from coarse silt to very coarse sand (USGS 2013).

5 Sensitivity Analysis of Channel Width for the Tentatively Selected Plan

As described in Subsection 2.2, the geometric design of the TSP includes a minimum bottom channel width of 400 feet; this width is typical along its length, except where it becomes wider at the turning basin. However, to evaluate the potential effects of design refinements to the channel width in the future Preliminary Engineering and Design phase, sensitivity simulations were performed using a widened version of the TSP channel. The sensitivity simulations were used to evaluate salinities, velocities, shoaling volumes, and vessel wakes associated with a wider channel. Specifically, the PWP Route E scenarios were re-simulated in the AdH and XBeach models after modifying the model grids to increase the bottom channel width by 50 feet (i.e., by 25 feet on each side). Results of these sensitivity simulations, comparing the PWP Route E Widened to the PWP Route E (TSP) scenario, are presented in the following subsections.

5.1 Salinity

Figure 32 shows model results of annual average surface and bottom salinities in the study area of interest in the vicinity of the Cedar Port Industrial Park for the PWP Route E (TSP) and PWP Route E Widened scenarios. These figures show that salinities are slightly increased in and adjacent to the channel due to the channel widening. However, the differences are less than 2 ppt and localized to the channel and its immediate vicinity.

Figures 33a through 33n show cross sections of annual average salinities at the 14 locations in the HSC and the study vicinity shown in Figure 25a. These cross sections show no discernible differences between the PWP Route E and PWP Route E Widened scenarios.

Figure 34 compares annual average salinity profiles in the HSC for the PWP Route E and PWP Route E Widened scenarios. The alignment of this profile is shown in Figure 26a. These profiles show no discernible differences between the PWP Route E and PWP Route E Widened scenarios.

5.2 Velocity

Figure 35 shows the residual surface and bottom velocity magnitudes and directions in the study area of interest in the vicinity of the Cedar Port Industrial Park for the PWP Route E (TSP) and PWP Route E Widened scenarios. These results do not show significant differences in residual velocities due to the channel widening.

5.3 Shoaling

Annual shoaling volumes were estimated from the AdH results for the PWP Route E Widened scenario using the same methodology as for the PWP Route E (TSP) scenario described in Subsection 4.1.3. The results show an increase in the annual shoaling volume due to the channel widening, which increases the shoaling volume from 220,000 cubic yards per year in the PWP Route E scenario to 440,000 cubic yards per year in the PWP Route E Widened scenario.

5.4 Vessel Wakes

Figures 36a and 36b show maps of water level results for the inbound and outbound design vessel trips for the PWP Route E Widened scenario. Figures 37a through 37d show line plots of time histories of the simulated water levels at the locations of proposed shoreline stabilization described in Subsection 4.3. Figures 38a and 38b show maps of bed shear stress results for the inbound and outbound design vessel trips at the same times shown in the water level results of Figures 36a and 36b. Compared to the PWP Route E (TSP) scenario, these results show that the wake patterns are similar in the PWP Route E Widened scenario, but the magnitudes of water level fluctuations and associated bed shear stresses decrease slightly due to the widened channel.

6 Summary

As part of the FS/EIS evaluations for a new deepwater federal navigation channel planned to connect the HSC and a new terminal at the Cedar Port Industrial Park, numerical modeling was performed to evaluate the effects of WOP and WP alternatives on aspects of the physical environment in Galveston Bay. Annual hydrodynamics, salinity, and sediment transport were simulated using USACE's 3D AdH model used in the HSC ECIP FS-EIS evaluations, updated with site-specific data as needed for the study evaluations. Three hurricane events (representing 10-, 100-, and 500-year return period events at the study site in terms of storm surge elevation) were simulated using USACE's ADCIRC+STWAVE model used in the CTXS, updated with site-specific data as needed for the study evaluations, to evaluate the effects of WOP and WP alternatives on storm surge and waves. Vessel wake simulations were performed with the nonhydrostatic XBeach model to evaluate water level fluctuations and bed shear stresses associated with ship transit in the WP channel alternatives and the effects on adjacent shorelines. All model simulations were performed at Year 0 and Year 50 time horizons.

The model results show that salinities are generally increased in the area south of Cedar Bayou and east of the Atkinson Island DMPA and marsh complex in the WP scenarios compared to the WOP scenarios. Increases in annual average salinities range up to 3 ppt outside the new channels in this area and up to 10 ppt inside the new channels. The largest increases correspond to Alternative Route D, which is also associated with slight decreases in salinity in the HSC.

Results of residual current velocities show that overall flow patterns are similar for the WOP and WP scenarios in the vicinity of the study area, with localized differences in and around the study features.

Estimated shoaling volumes for the WP alternatives are summarized as follows:

- Alternative Route B: 160,000 cubic yards per year
- Alternative Route D: 490,000 cubic yards per year
- Alternative Route E: 220,000 cubic yards per year

The model results indicate that the largest shoaling volumes within the new channel alternatives occur in the turning basin of Alternative Route D. Results of the storm surge simulations generally showed differences in maximum water surface elevations of less than 0.5 foot in the WP compared to the WOP scenarios for all simulated events; localized differences of up to 1 foot were observed, mostly in and around the beneficial use areas associated with each alternative. The model results show that the beneficial use islands associated with the study alternatives provide sheltering of the surrounding area from storm waves; the sheltering around and the depth-limited waves over the beneficial use islands generally reduced the maximum significant wave heights by 1 to 4 feet. Increases in maximum significant wave heights were observed in and around the new channels for each alternative.

In general, the model results show water level fluctuations throughout the study vicinity resulting from passing vessel drawdown and wakes generated by the simulated ship traffic along all the new channel routes. Based on the simulations, the following areas within the study vicinity are considered particularly vulnerable to potential effects from the vessel wakes:

- The Bay Oaks area north of Cedar Bayou, which contains a community of residents along its shores
- The Beach City area south of the Cedar Port Industrial Park, which contains a community of residents along its shores
- The banks of the portions of channel routes B and E that pass through the Atkinson Island complex, which will experience focused effects of vessel wakes due to the confined nature of those channel reaches

The model results show that bed shear stresses caused by the simulated vessel wakes could result in resuspension of bay sediments in the shallow areas and shoreline in the vicinity of the study.

The geometric design of the TSP (Alternative Route E) includes a minimum bottom channel width of 400 feet; this width is typical along its length, except where it becomes wider at the turning basin. However, to evaluate the potential effects of design refinements to the channel width in the future Preliminary Engineering and Design phase, sensitivity simulations were performed using a widened version of the TSP channel. The sensitivity simulations were used to evaluate salinities, velocities, shoaling volumes, and vessel wakes associated with a wider channel. Specifically, the PWP Route E scenarios were re-simulated in the AdH and XBeach models after modifying the model grids to increase the bottom channel width by 50 feet (i.e., by 25 feet on each side).

- Results of the sensitivity simulations show that salinities are slightly increased in and adjacent to the channel due to the channel widening; however, the differences appear small (2 ppt or less) and localized to the channel and its immediate vicinity. Away from the channel, there are no discernible differences due to the channel widening.
- Results of residual surface and bottom velocity magnitudes and directions in the vicinity of the Cedar Port Industrial Park do not show significant differences due to the channel widening.
- Widening of the channel resulted in an increase in the estimated annual shoaling volume from 220,000 cubic yards per year in the TSP scenario to 440,000 cubic yards per year in the widened channel scenario.
- Results of the vessel wake simulations show that the wake patterns are similar for the widened channel scenario compared to the TSP, but the magnitudes of water level fluctuations and associated bed shear stresses decrease slightly due to the widened channel.

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Figures

Notes: Basemap Source: Bing Satellite Imagery, HSC: Houston Ship Channel, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

- HSC Centerline
- Cedar Bayou Centerline
- National Oceanic and Atmospheric Administration Station 8770613: Morgans Point, Barbours Cut, Texas
- Atkinson Island
- Atkinson Island Marsh Cells
- Existing Dredge Material Placement Areas in Upper Galveston Bay, South of Cedar Bayou

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Figure 1
Project Location
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

Notes: Basemap Source: Bing Satellite Imagery, ECIP: Expansion Channel Improvement Project, HSC: Houston Ship Channel, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

- HSC Bolivar Roads to Redfish
- HSC Redfish to Bayport Ship Channel
- HSC Bayport Ship Channel to Barbours Cut
- Bayport Ship Channel
- Barbours Cut Ship Channel
- HSC Boggy Bayou to Sims Bayou
- HSC Sims Bayou to Interstate Highway 610
- HSC Interstate Highway 610 to Turning Basin
- San Leon Oyster Reef
- Dollar Oyster Reef
- Bird Island
- Long Bird Island
- Dredge Material Placement Area M11
- Dredge Material Placement Area M12

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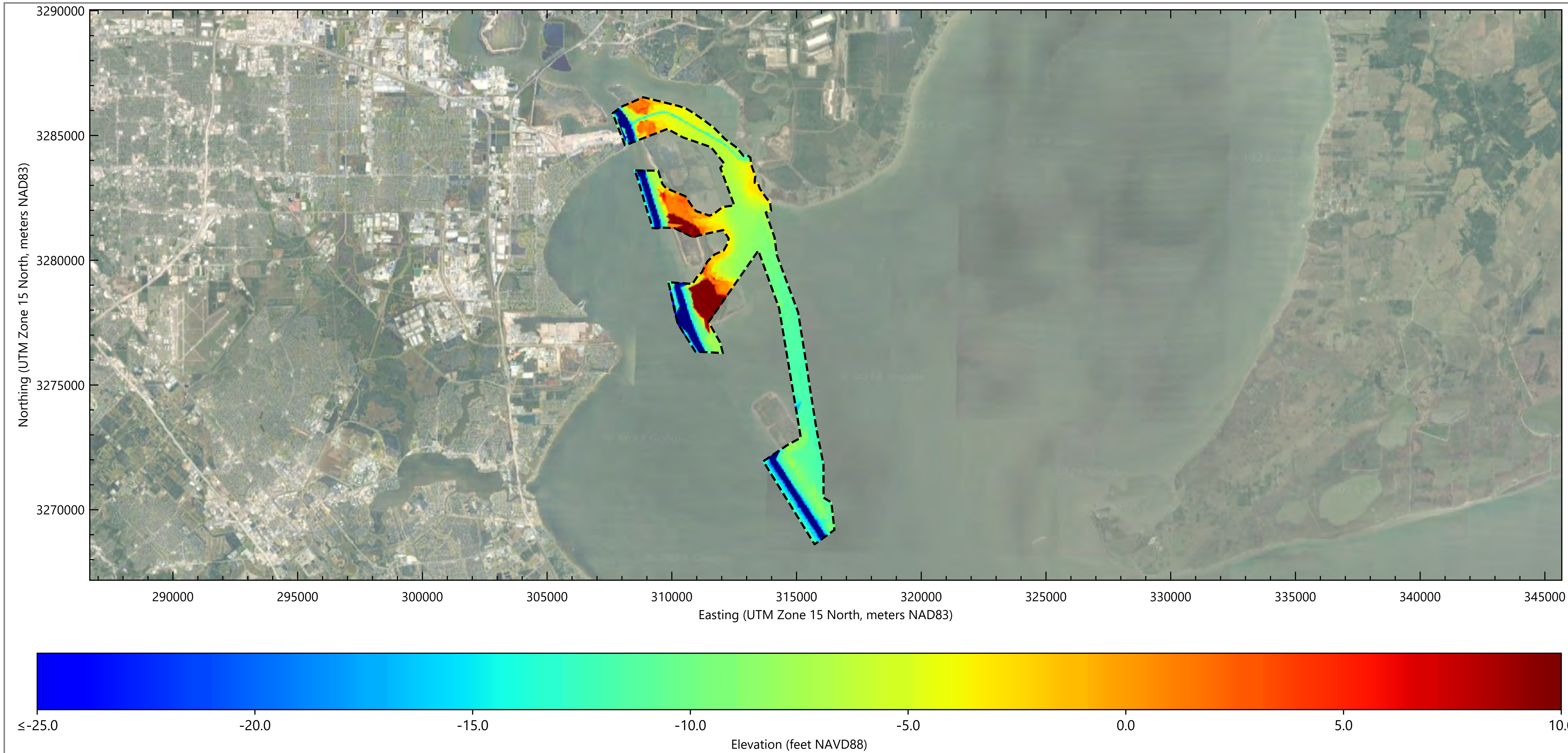
Figure 2
HSC ECIP 95% Design Features
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Survey data collected by Lanier & Associates Consulting Engineers, Inc., in July and August 2023. Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983,NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

- - July through August 2023 Site Survey Limits

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Figure 3
Site Survey Data

Notes: Basemap Source: Bing Satellite Imagery, BU: Beneficial Use, HSC: Houston Ship Channel, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

- HSC Centerline
- Cedar Bayou Centerline
- Alternative Route E Channel Footprint
- Alternative Route E BU Footprint

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Figure 4a
Project Alternative Route E Features
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

DRAFT

Notes: Basemap Source: Bing Satellite Imagery, BU: Beneficial Use, HSC: Houston Ship Channel, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

- HSC Centerline
- Cedar Bayou Centerline
- Alternative Route B Channel Footprint
- Alternative Route B BU Footprint

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Figure 4b
Project Alternative Route B Features

Notes: Basemap Source: Bing Satellite Imagery, BU: Beneficial Use, HSC: Houston Ship Channel, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

- HSC Centerline
- Cedar Bayou Centerline
- Alternative Route D Channel Footprint
- Alternative Route D BU Footprint

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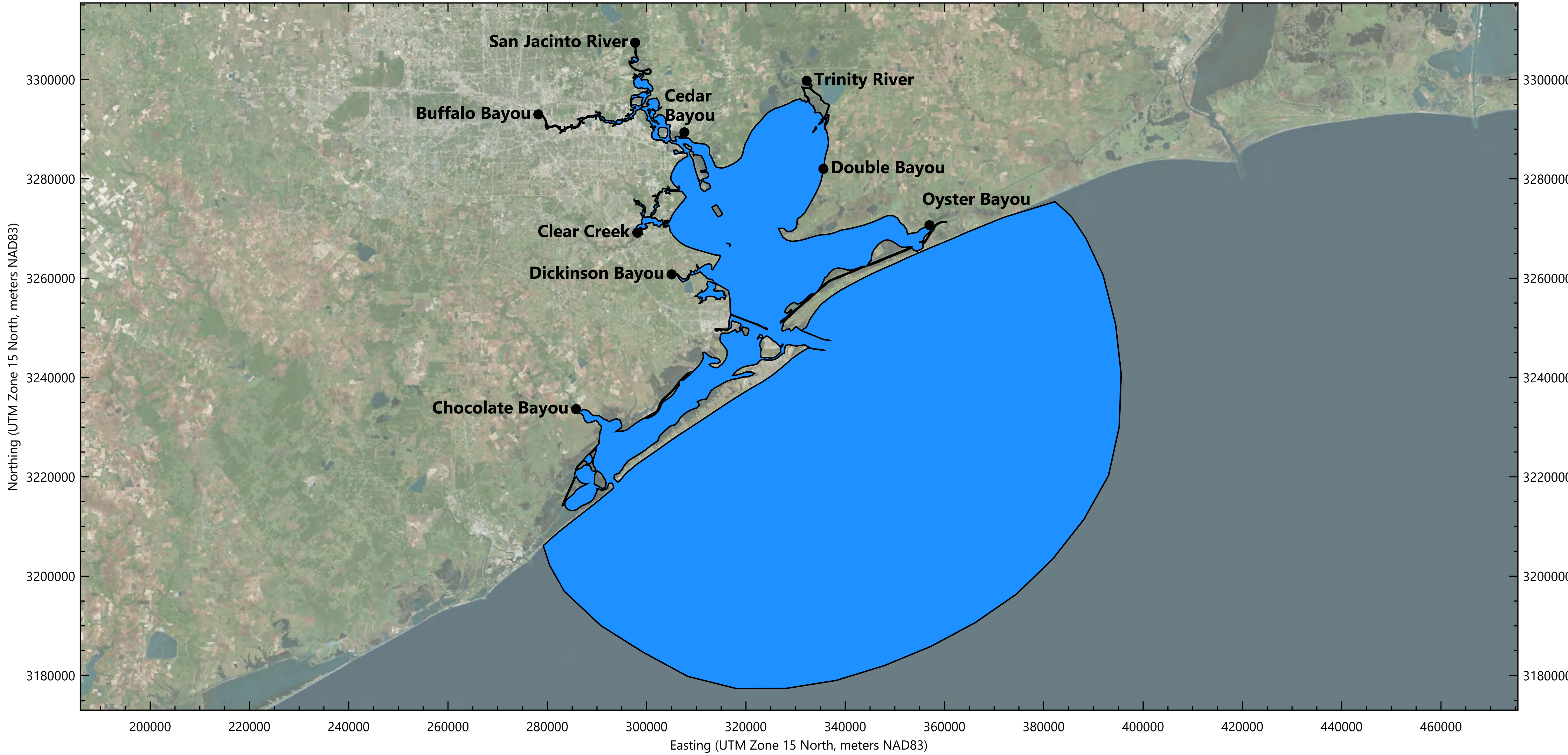
Figure 4c
Project Alternative Route D Features
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Bing Satellite Imagery, AdH: Adaptive Hydraulics, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

- AdH Model Domain (Without Project Scenarios)
- Freshwater Inflow Location

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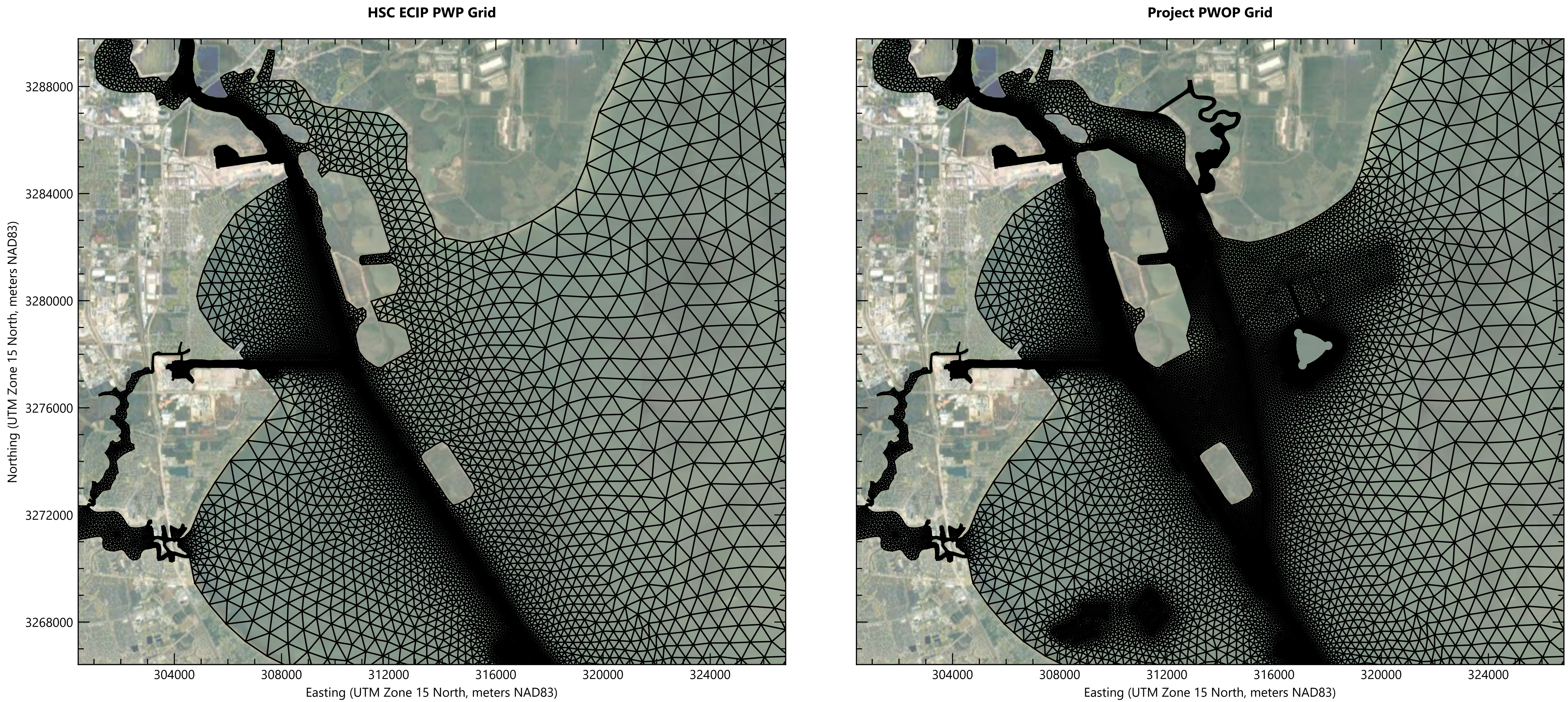
Figure 5
HSC ECIP AdH Model Domain and Locations of Freshwater Inflow



Notes: Basemap Source: Bing Satellite Imagery, AdH: Adaptive Hydraulics, ECIP: Expansion Channel Improvement Project, HSC: Houston Ship Channel, NAD83: North American Datum of 1983, PWOP: Present Without Project, PWP: Present with Project, UTM: Universal Transverse Mercator

Grid Element Edge

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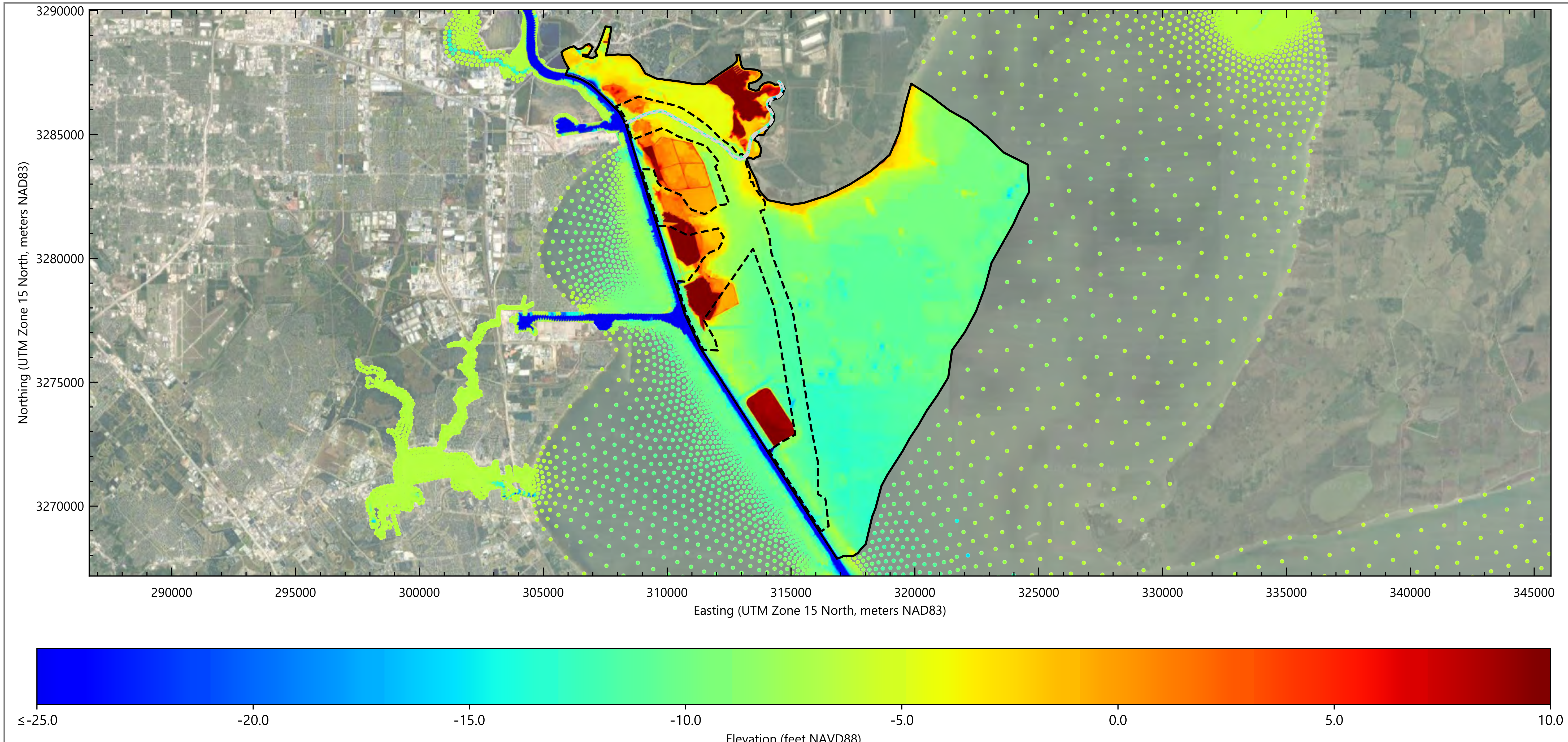
Figure 6
Local AdH Model Grid Refinements in the Vicinity of Cedar Port Industrial Park
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: This plan view shows a composite of three elevation surfaces overlaid in the following order (from top to bottom): 1) July through August 2023 Site Survey, 2) May 2023 USACE Cedar Bayou Survey, and 3) NOAA CUDEM. Basemap Source: Google Satellite Imagery, AdH: Adaptive Hydraulics, CUDEM: Continuously Updated Digital Elevation Model, ECIP: Expansion Channel Improvement Project, HSC: Houston Ship Channel, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, NOAA: National Oceanic and Atmospheric Administration, USACE: U.S. Army Corps of Engineers, UTM: Universal Transverse Mercator

- AdH Model Grid Project Refinement Area
- July through August 2023 Site Survey Limits
- May 2023 USACE Cedar Bayou Hydrographic Survey Limits
- AdH HSC ECIP Model Grid Node Outside of Refinement Area

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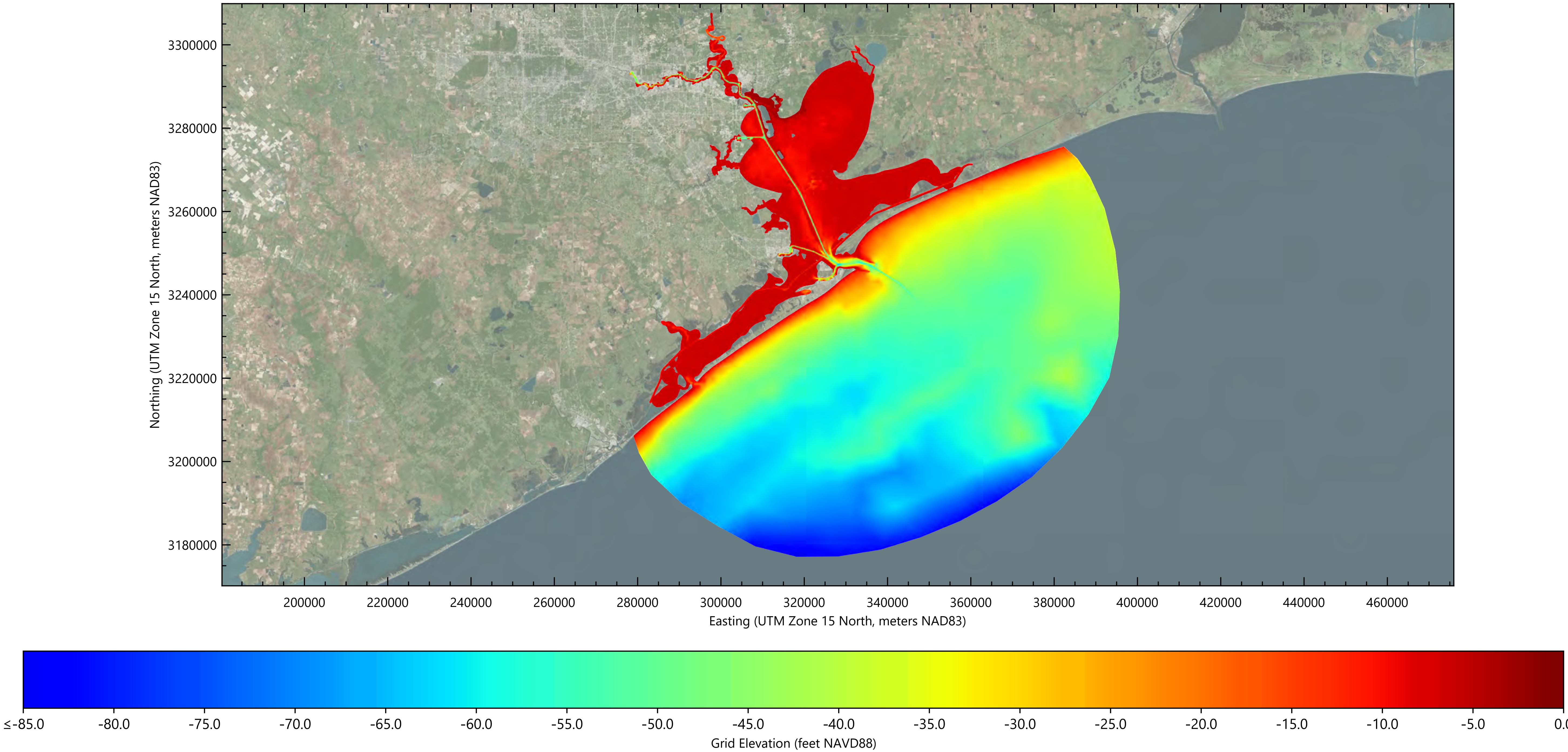
Figure 7
Model Elevation Data



Notes: Basemap Source: Bing Satellite Imagery, AdH: Adaptive Hydraulics, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

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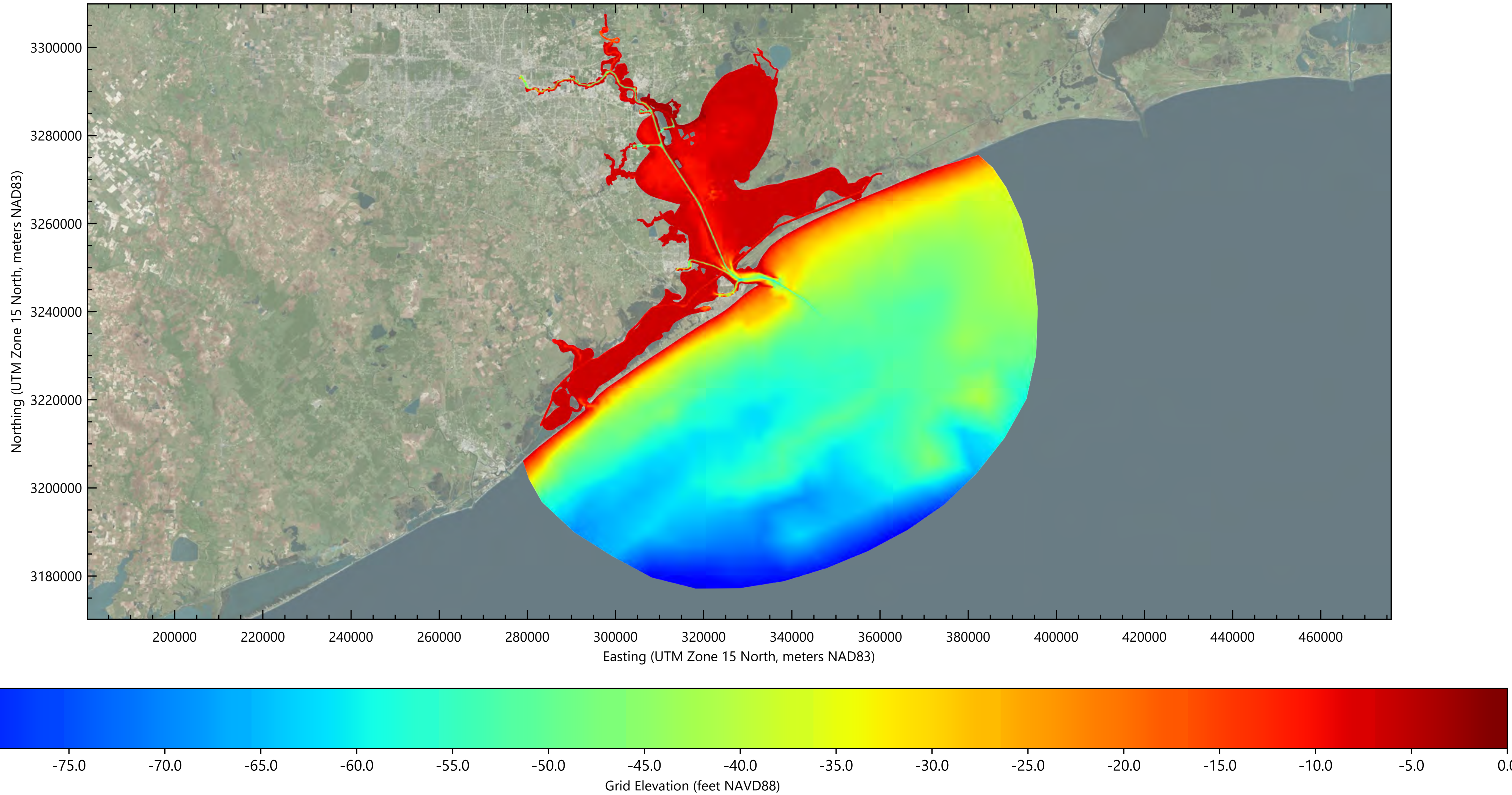
Figure 8
AdH Model Grid: Without Project



Notes: Basemap Source: Bing Satellite Imagery, AdH: Adaptive Hydraulics, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

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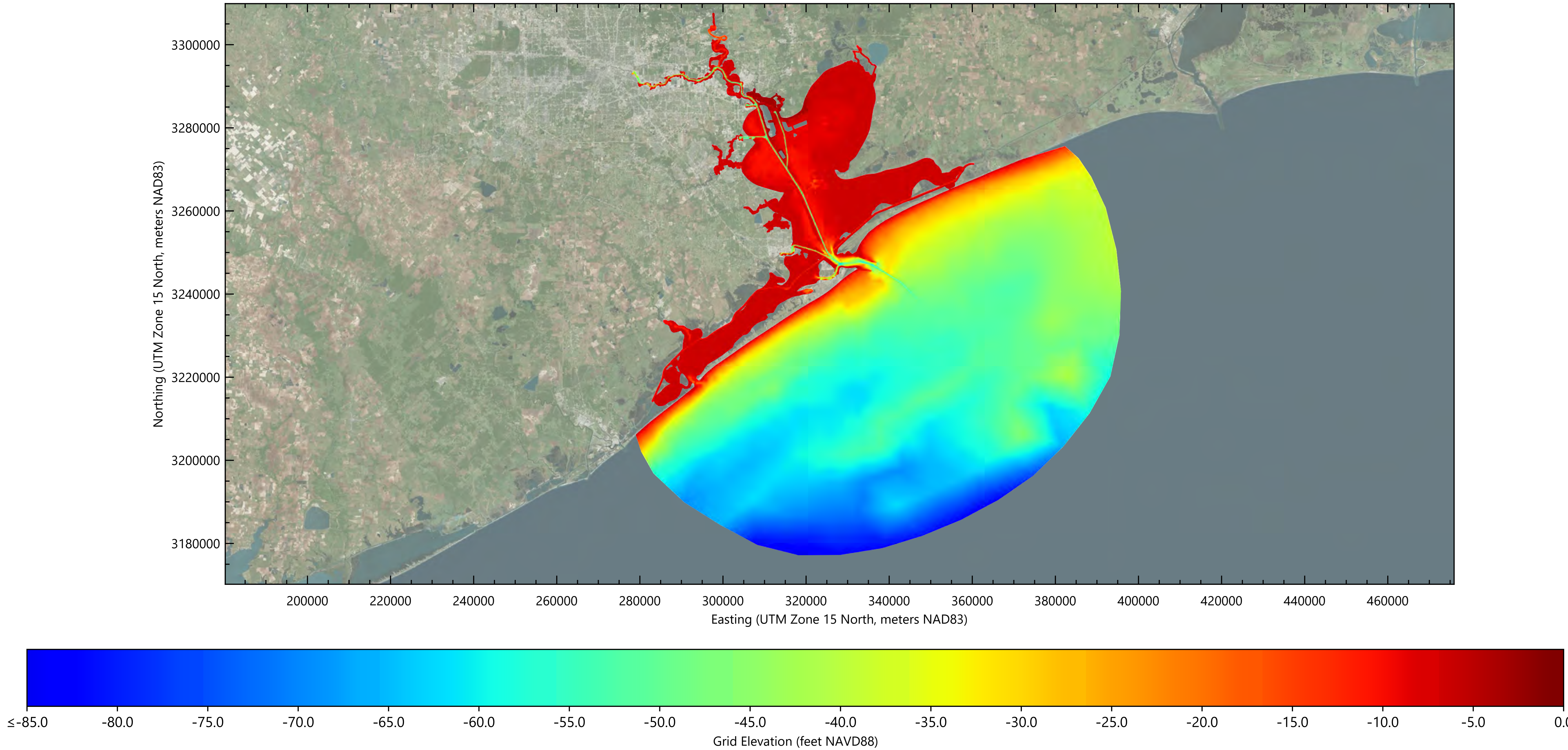
Figure 9
AdH Model Grid: With Project, Alternative Route B



Notes: Basemap Source: Bing Satellite Imagery, AdH: Adaptive Hydraulics, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

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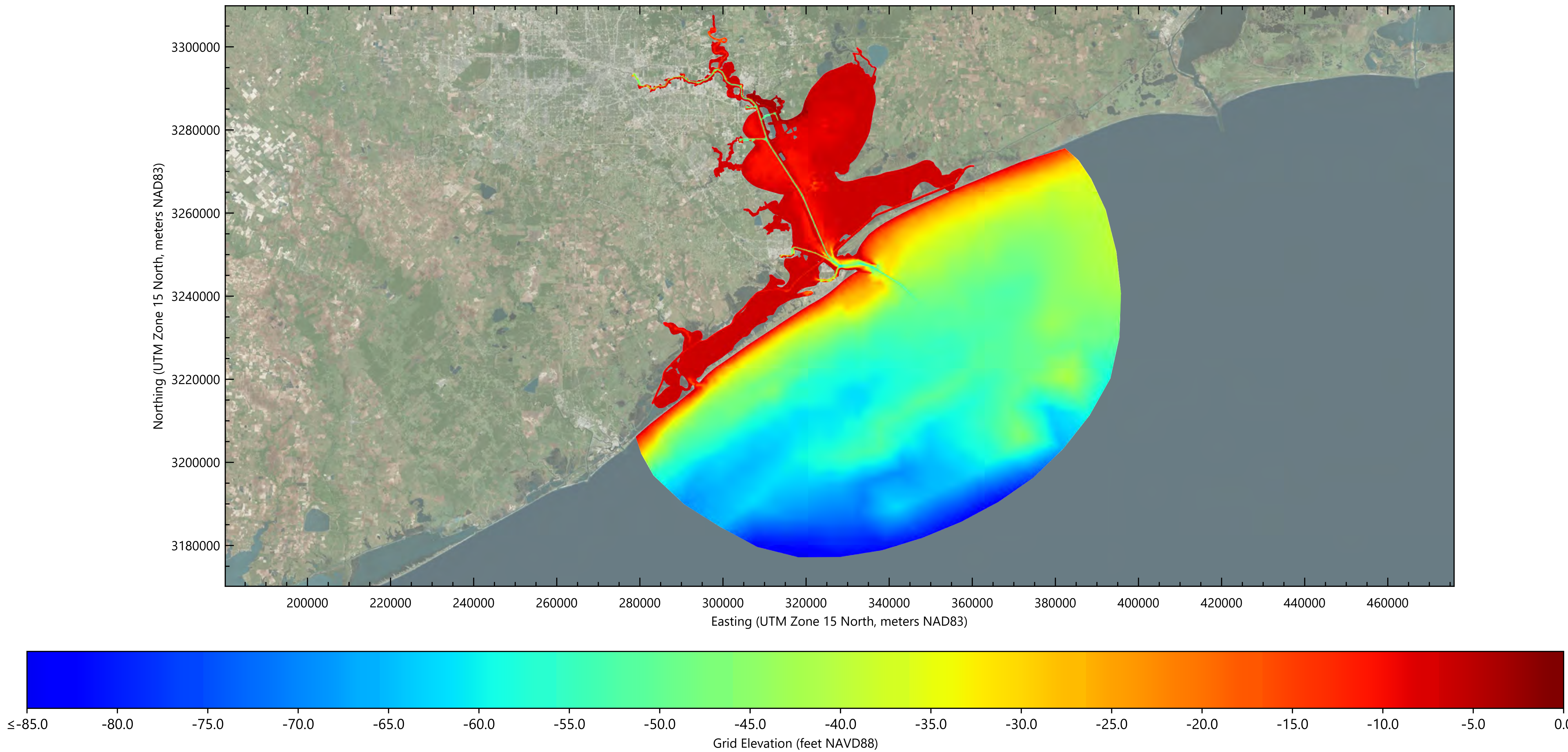
Figure 10
AdH Model Grid: With Project, Alternative Route D



Notes: Basemap Source: Bing Satellite Imagery, AdH: Adaptive Hydraulics, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

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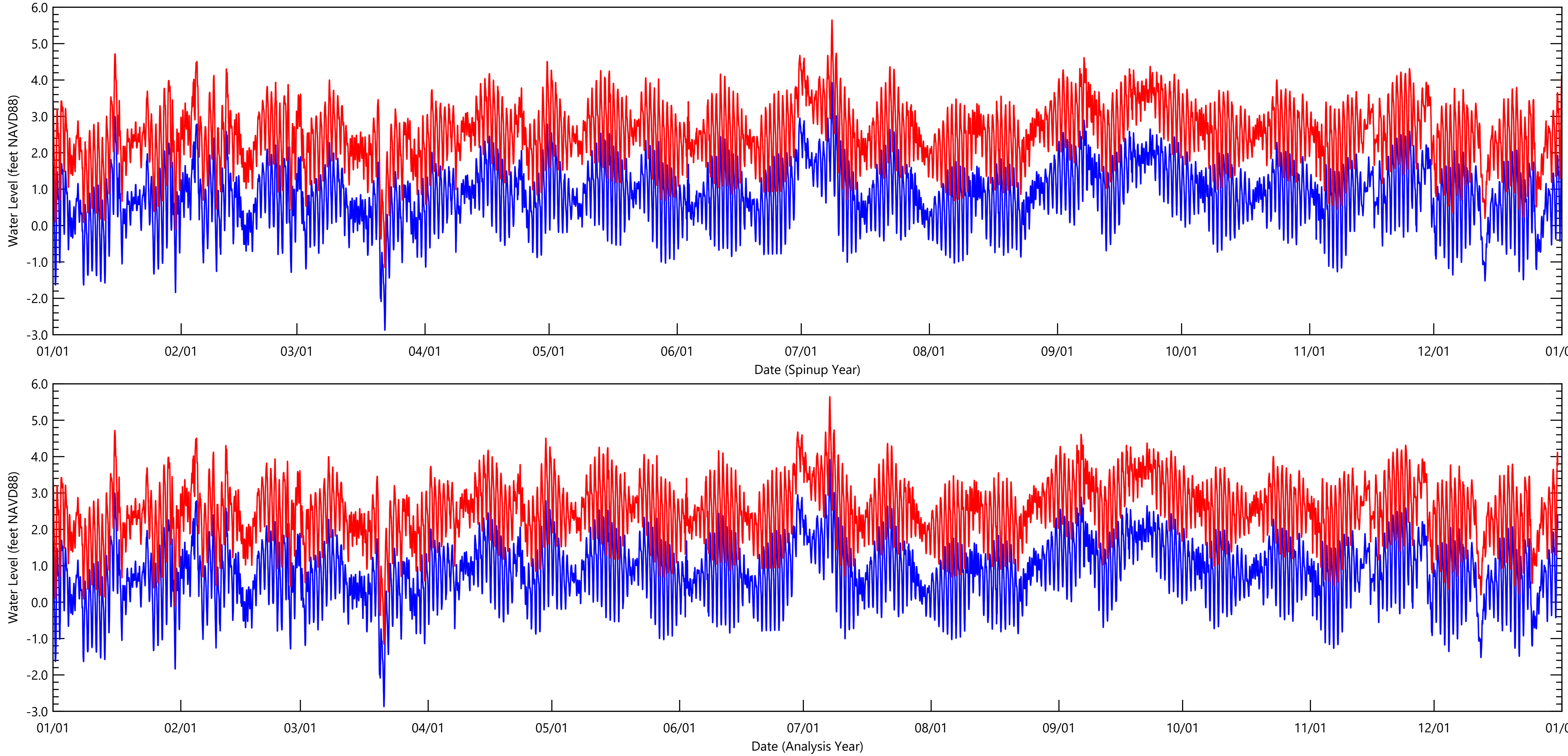
Figure 11
AdH Model Grid: With Project, Alternative Route E
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: AdH: Adaptive Hydraulics, NAVD88: North American Vertical Datum of 1988

Year 0

Year 50

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Figure 12
AdH Year 0 and Year 50 Tidal Boundary Conditions
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

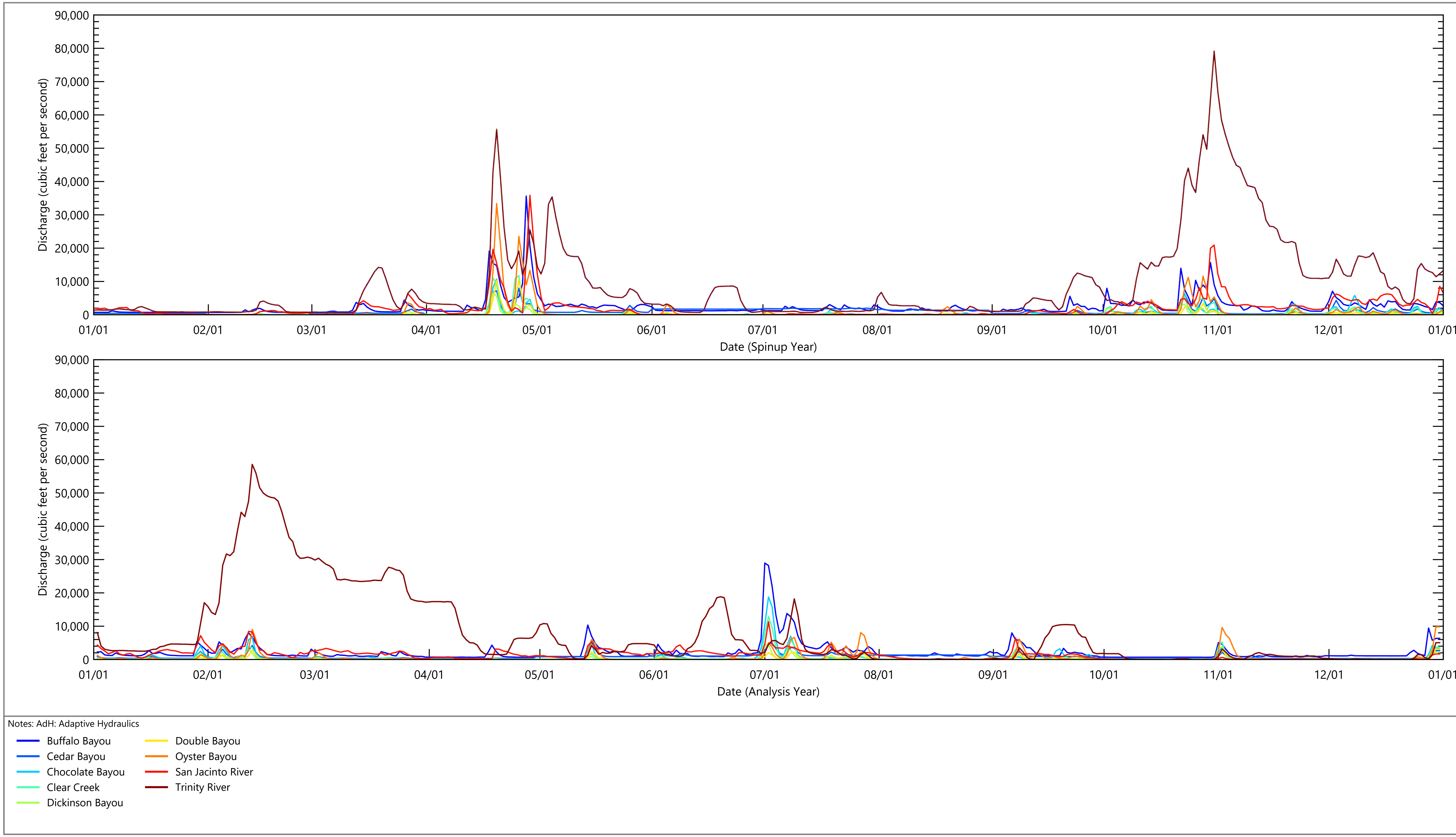

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Figure 13
AdH Year 0 Freshwater Inflow Boundary Conditions
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

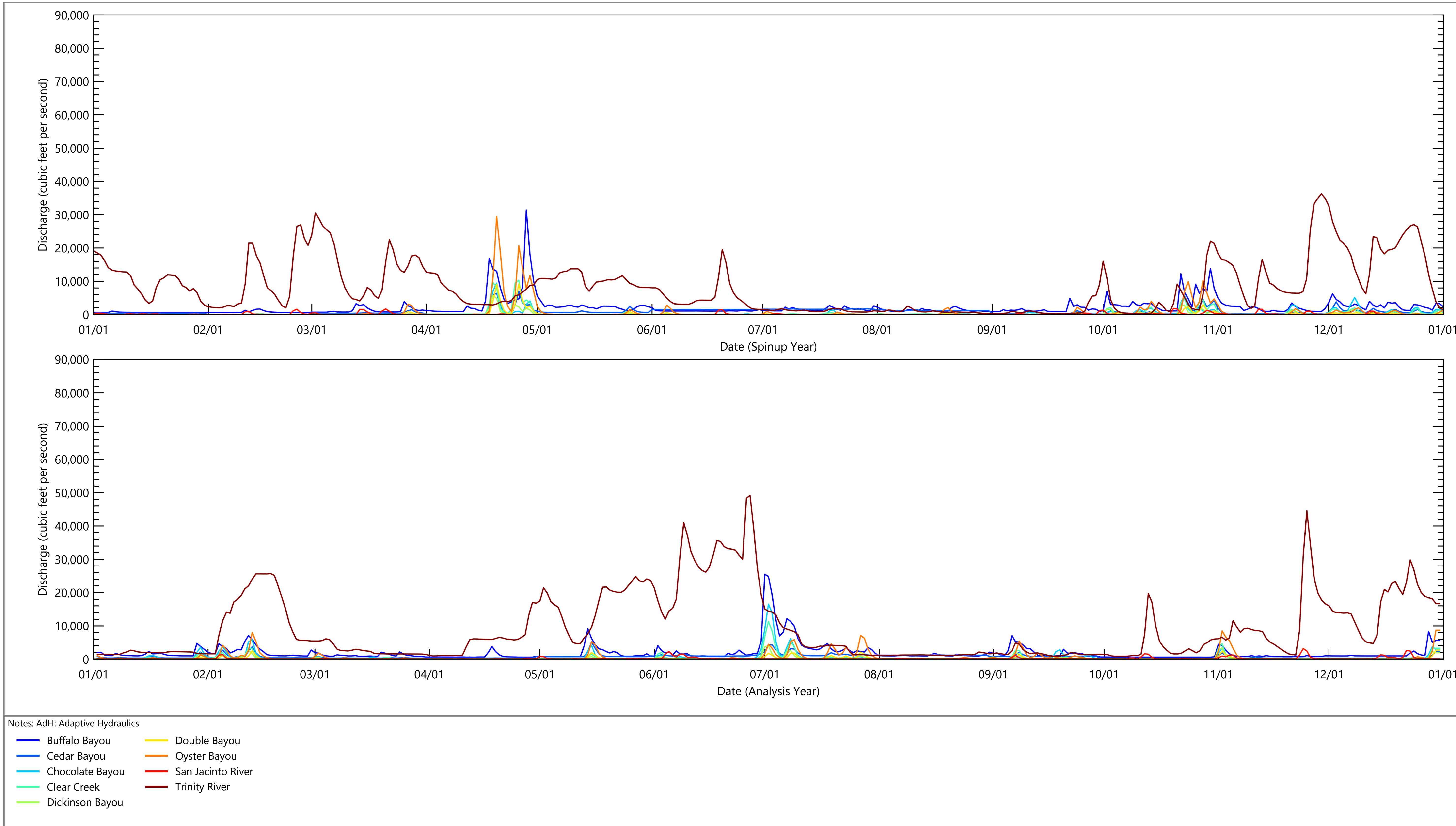

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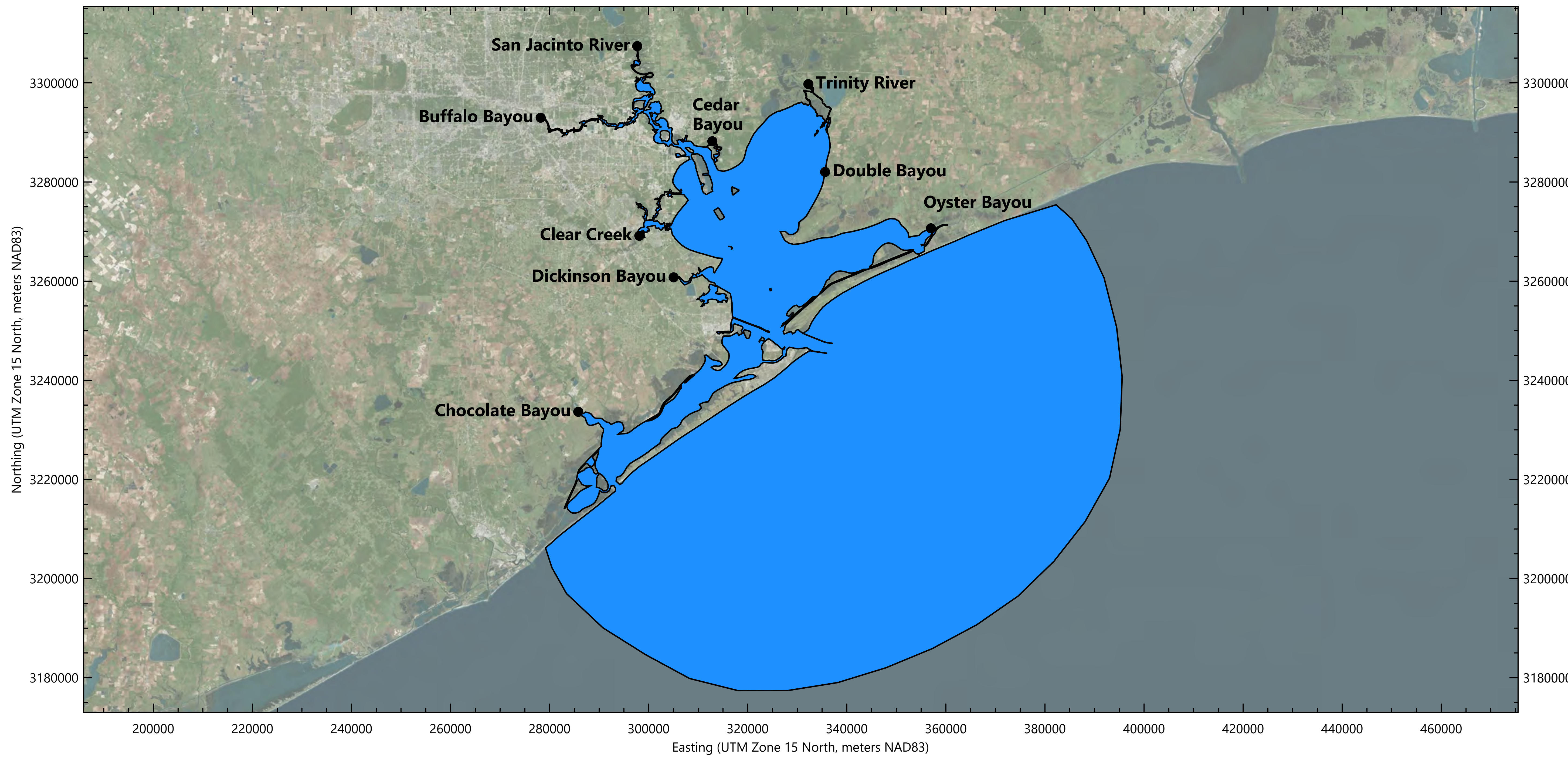
Figure 14
AdH Year 50 Freshwater Inflow Boundary Conditions
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Bing Satellite Imagery, AdH: Adaptive Hydraulics, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

- AdH Model Domain (Without Project Scenarios)
- Freshwater Inflow Location

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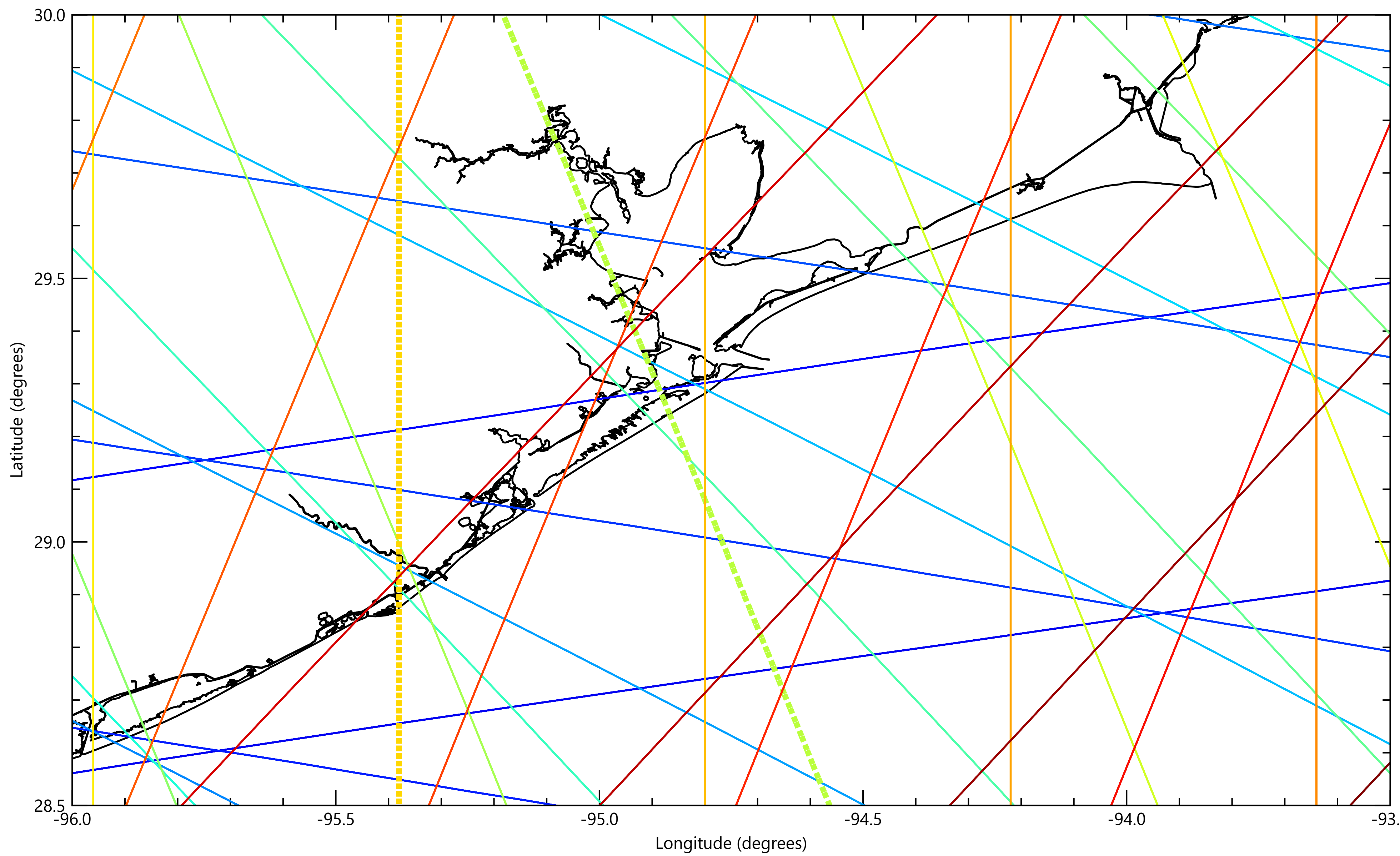
Figure 15
Project AdH Model Domain and Locations of Freshwater Inflow
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: CTXS: Coastal Texas Protection and Restoration Feasibility Study, TxDOT: Texas Department of Transportation

TxDOT Coastline	Storm Track 23	Storm Track 46	Storm Track 60	Storm Track 71	Storm Track 80
Storm Track 9	Storm Track 33	Storm Track 47	Storm Track 61	Storm Track 72	Storm Track 81
Storm Track 10	Storm Track 34	Storm Track 48	Storm Track 62	Storm Track 73	Storm Track 84
Storm Track 20	Storm Track 35	Storm Track 49	Storm Track 63	Storm Track 77	Storm Track 85
Storm Track 21	Storm Track 36	Storm Track 50	Storm Track 69	Storm Track 78	Storm Track 86
Storm Track 22	Storm Track 37	Storm Track 59	Storm Track 70	Storm Track 79	Storm Track 87

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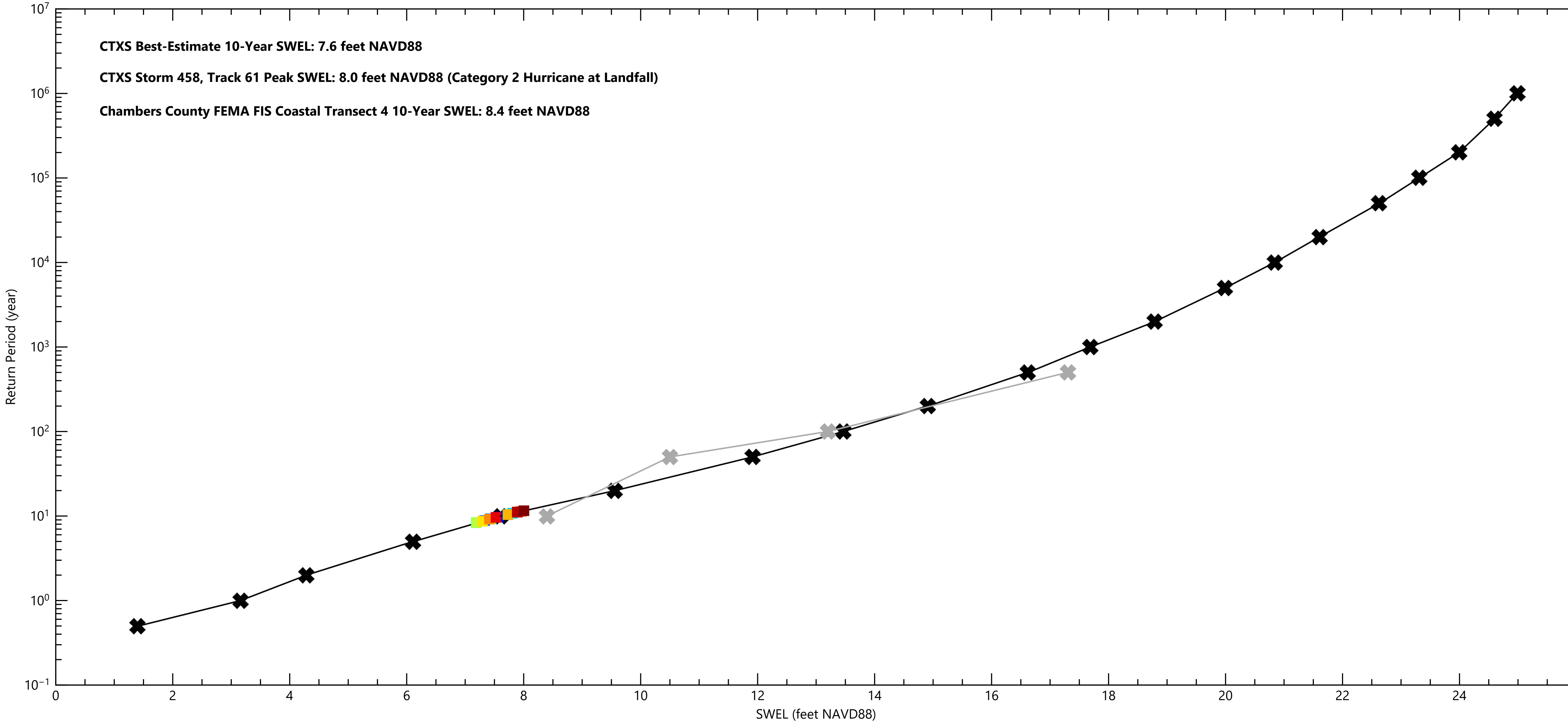
Figure 16
CTXS Storm Tracks Near Galveston Bay, Texas
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: AEP: Annual Exceedance Probability, CTXS: Coastal Texas Protection and Restoration Feasibility Study, FEMA: Federal Emergency Management Agency, FIS: Flood Insurance Study, NAVD88: North American Vertical Datum of 1988, SWEL: Stillwater Elevation

CTXS AEP Value	Storm 253, Track 34	Storm 330, Track 44	Storm 423, Track 57
CTXS AEP Curve	Storm 255, Track 34	Storm 333, Track 45	Storm 434, Track 58
FEMA AEP Value	Storm 257, Track 34	Storm 338, Track 45	Storm 458, Track 61
FEMA AEP Curve	Storm 260, Track 35	Storm 341, Track 46	Storm 509, Track 68
Storm 44, Track 6	Storm 261, Track 35	Storm 352, Track 47	Storm 570, Track 77
Storm 146, Track 20	Storm 323, Track 43	Storm 358, Track 48	Storm 631, Track 84

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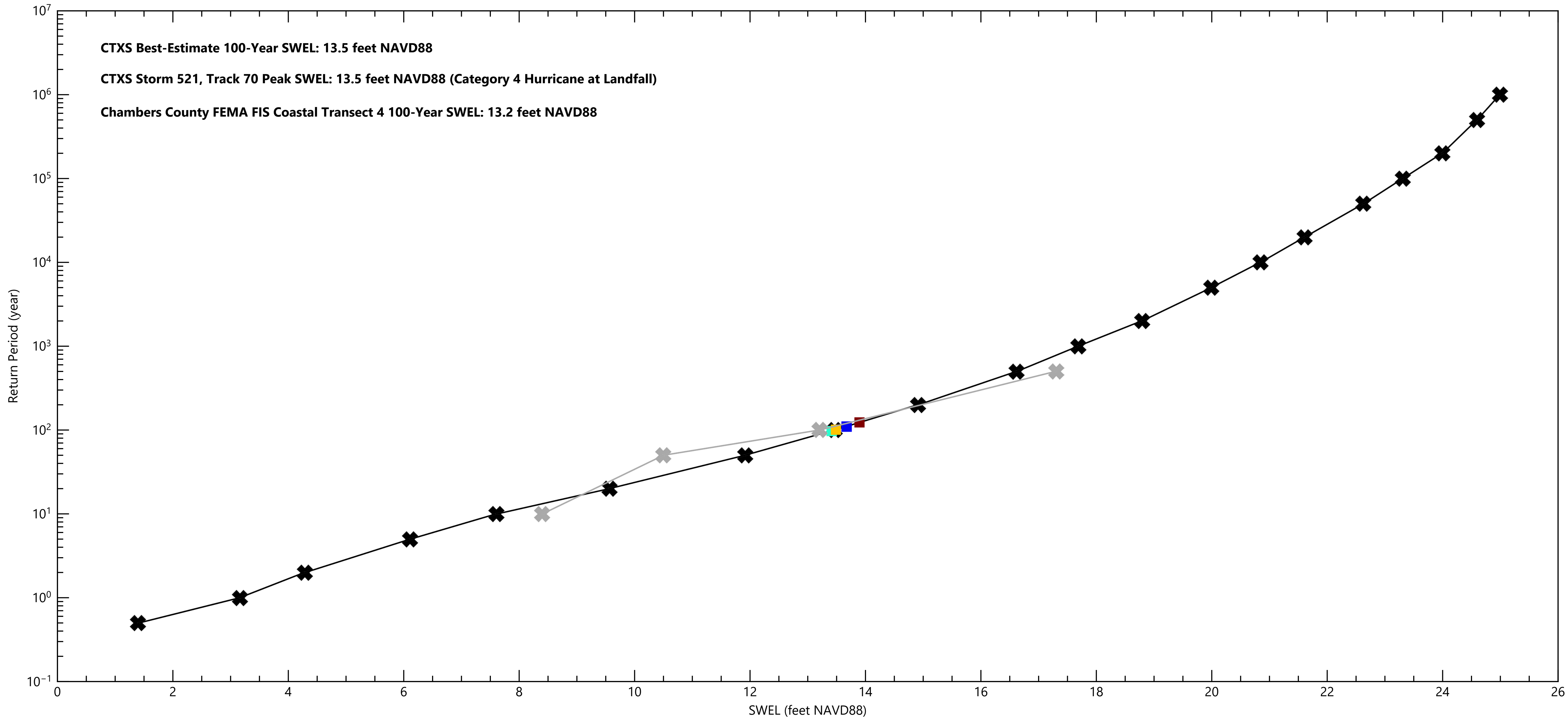
Figure 17a
10-Year CTXS Storm Selection



Notes: AEP: Annual Exceedance Probability, CTXS: Coastal Texas Protection and Restoration Feasibility Study, FEMA: Federal Emergency Management Agency, FIS: Flood Insurance Study, NAVD88: North American Vertical Datum of 1988, SWEL: Stillwater Elevation

CTXS AEP Value
CTXS AEP Curve
FEMA AEP Value
FEMA AEP Curve
Storm 247, Track 33
Storm 456, Track 61
Storm 521, Track 70
Storm 525, Track 70

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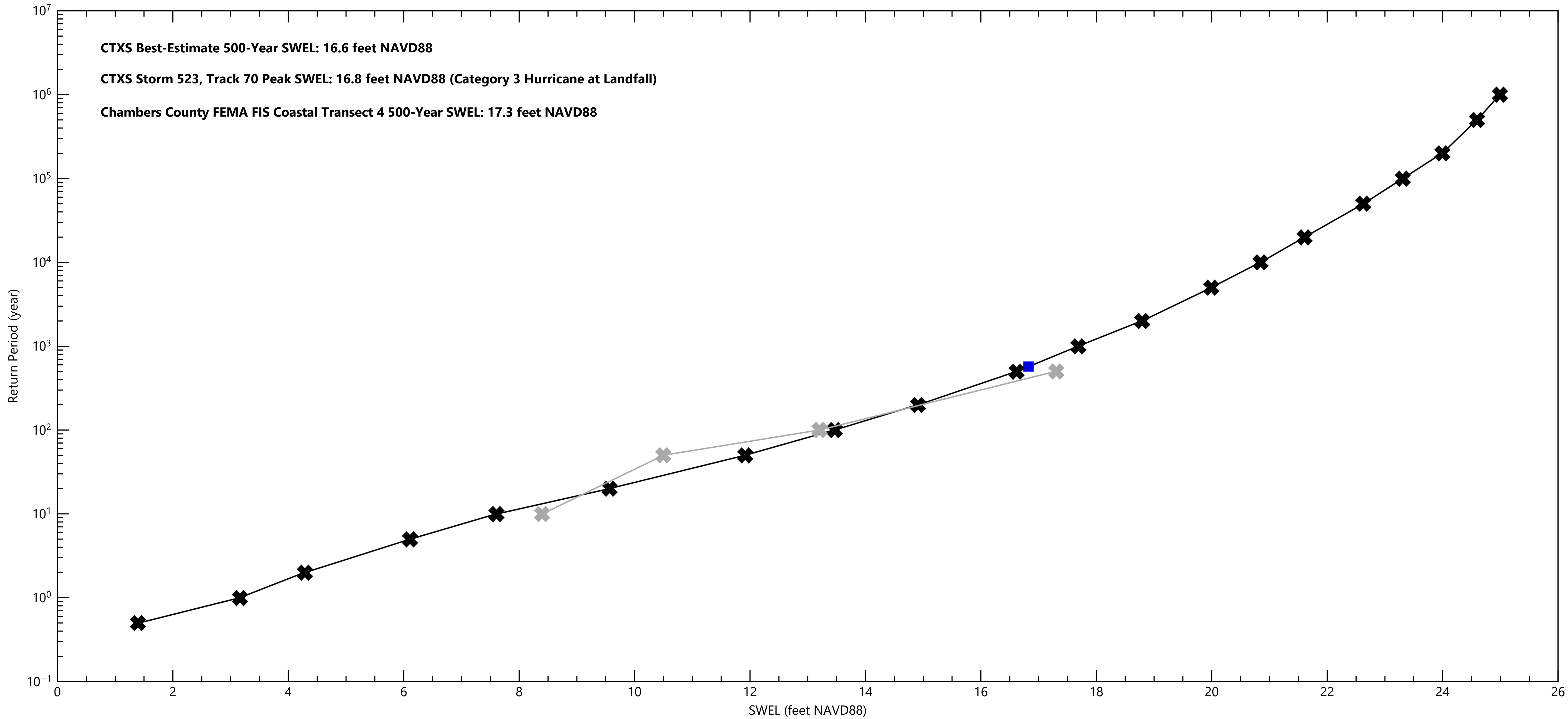
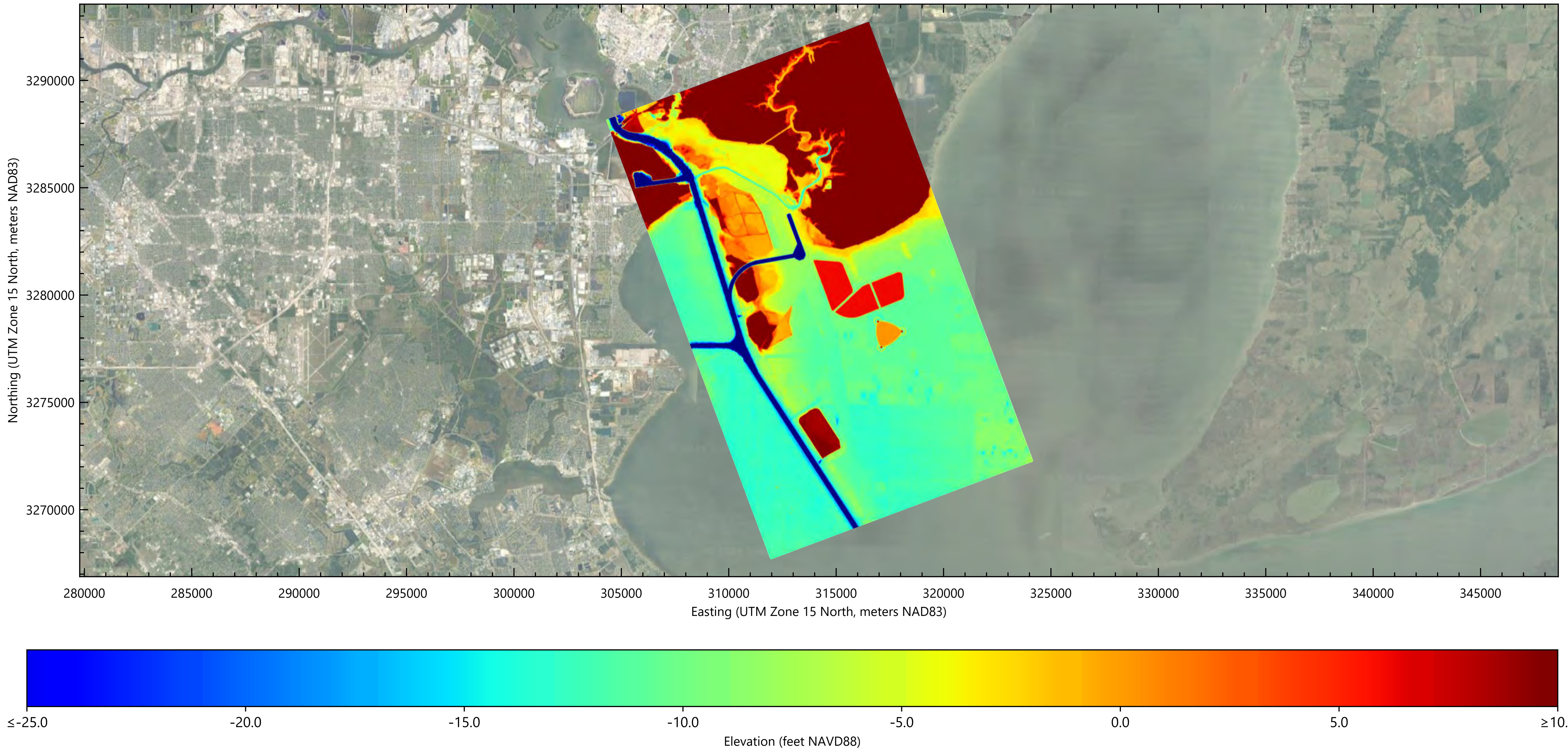
Figure 17b
100-Year CTXS Storm Selection
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: AEP: Annual Exceedance Probability, CTXS: Coastal Texas Protection and Restoration Feasibility Study, FEMA: Federal Emergency Management Agency, FIS: Flood Insurance Study, NAVD88: North American Vertical Datum of 1988, SWEL: Stillwater Elevation

Figure 17c
500-Year CTXS Storm Selection



Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

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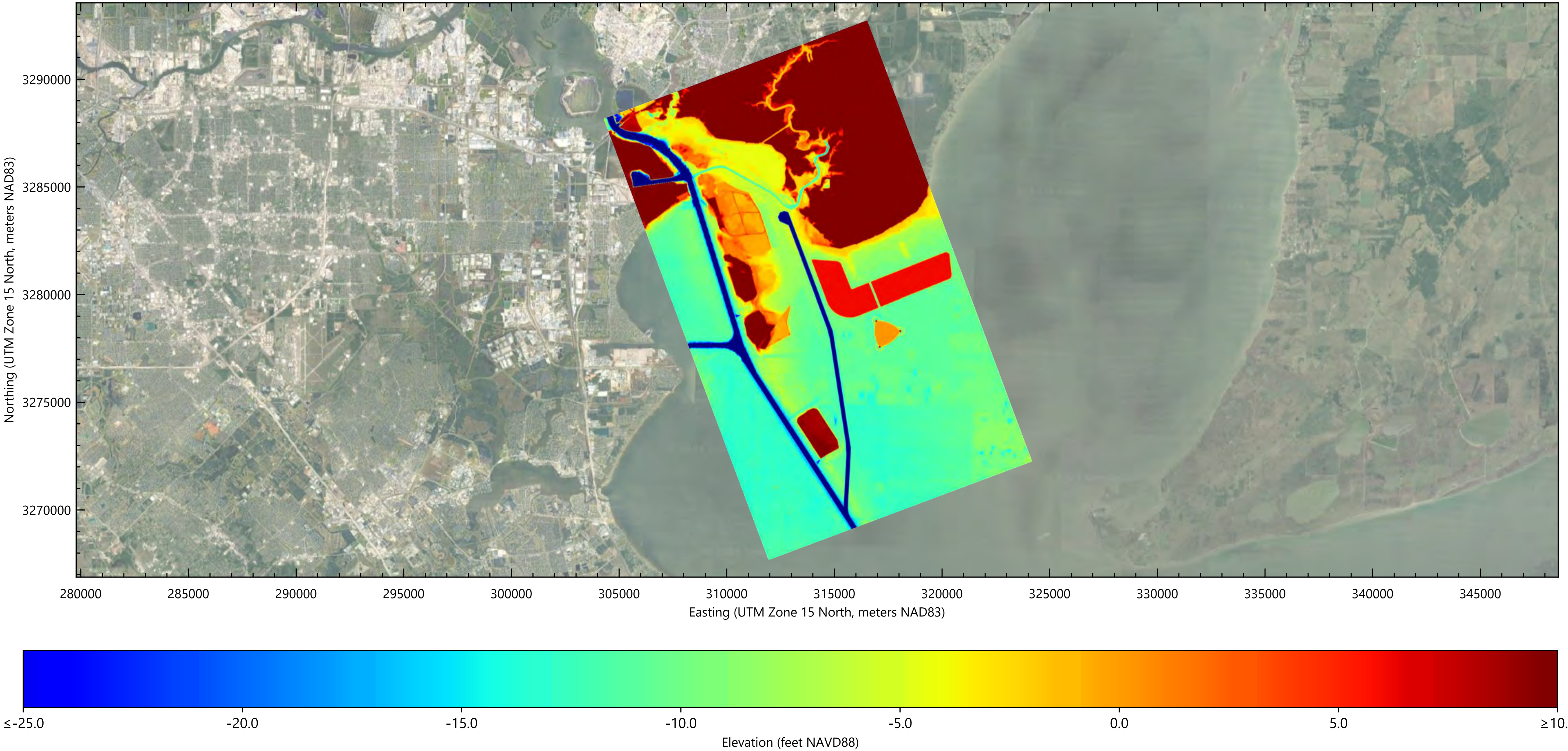
Figure 18
Project Alternative Route B XBeach Model Grid
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

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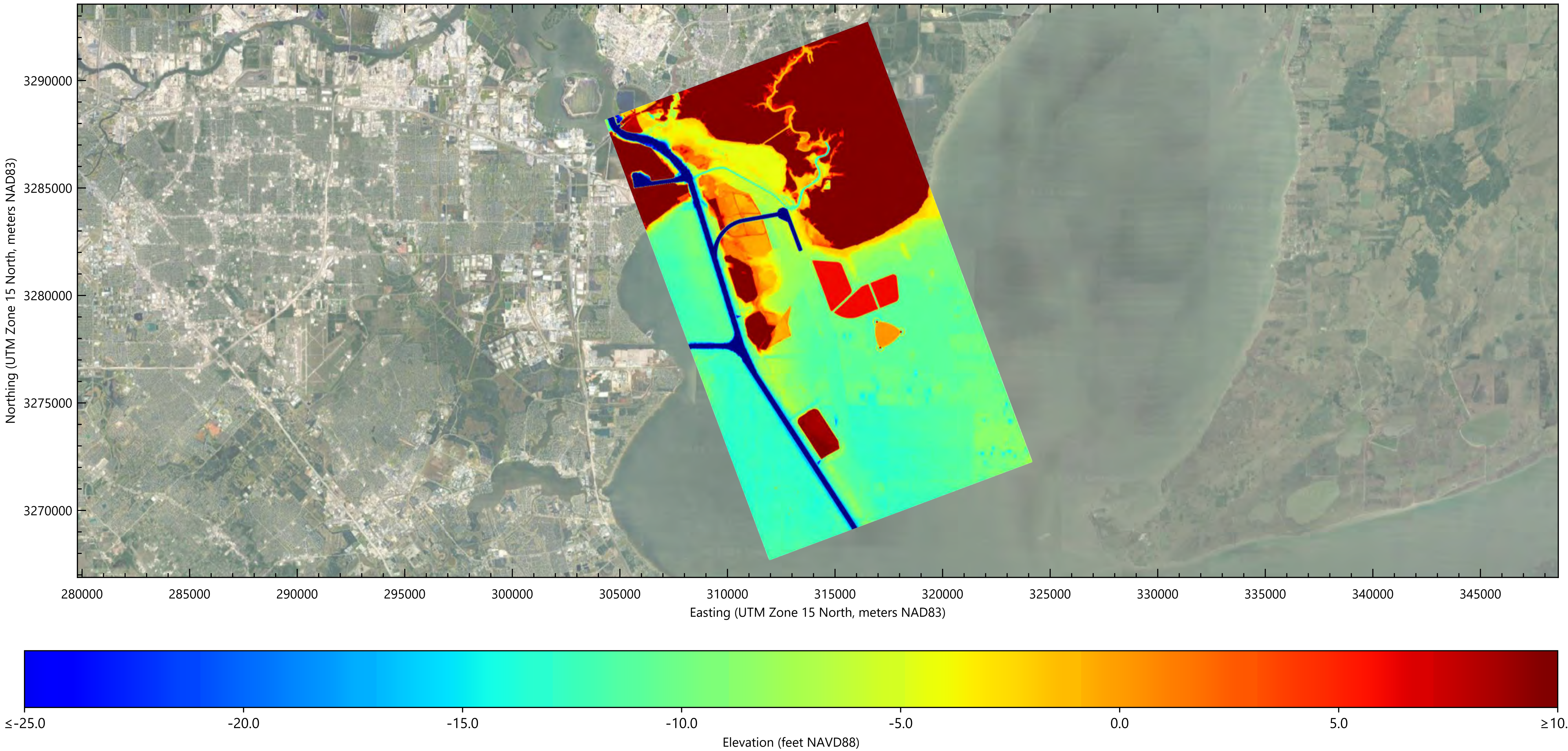
Figure 19
Project Alternative Route D XBeach Model Grid
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

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Figure 20
Project Alternative Route E XBeach Model Grid
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

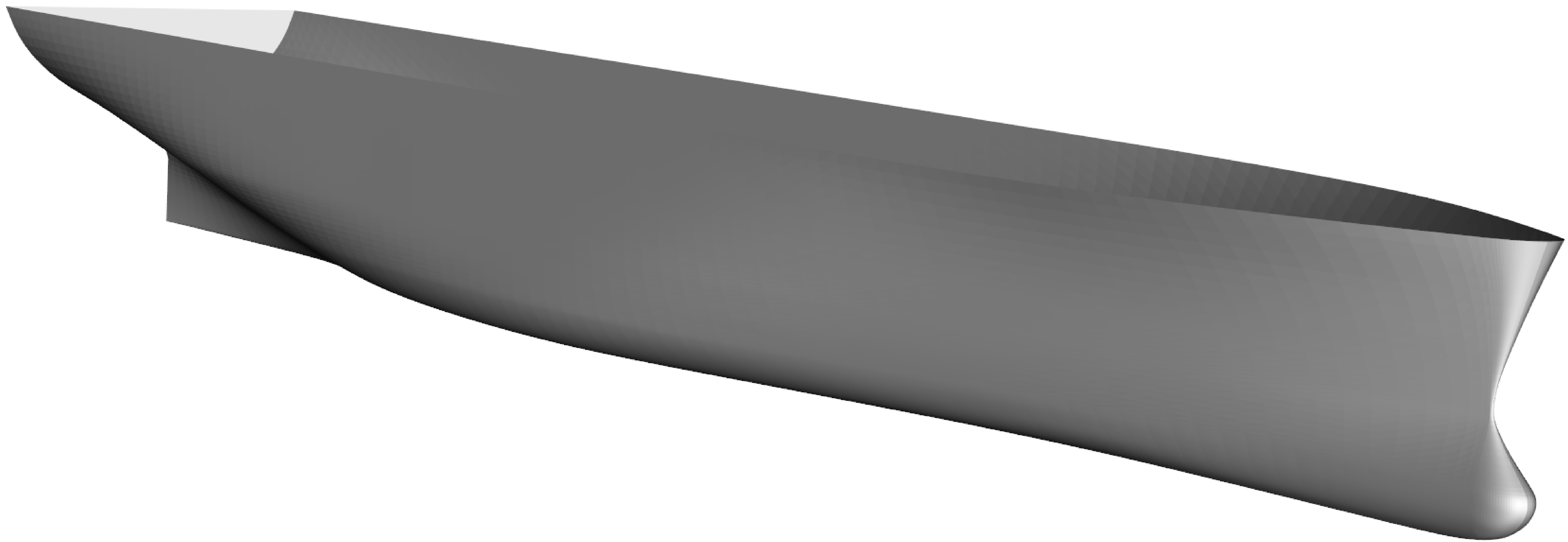

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Figure 21a

Isometric View of Prototype Container Ship Geometry

Appendix C-2: Coastal Engineering Report

Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

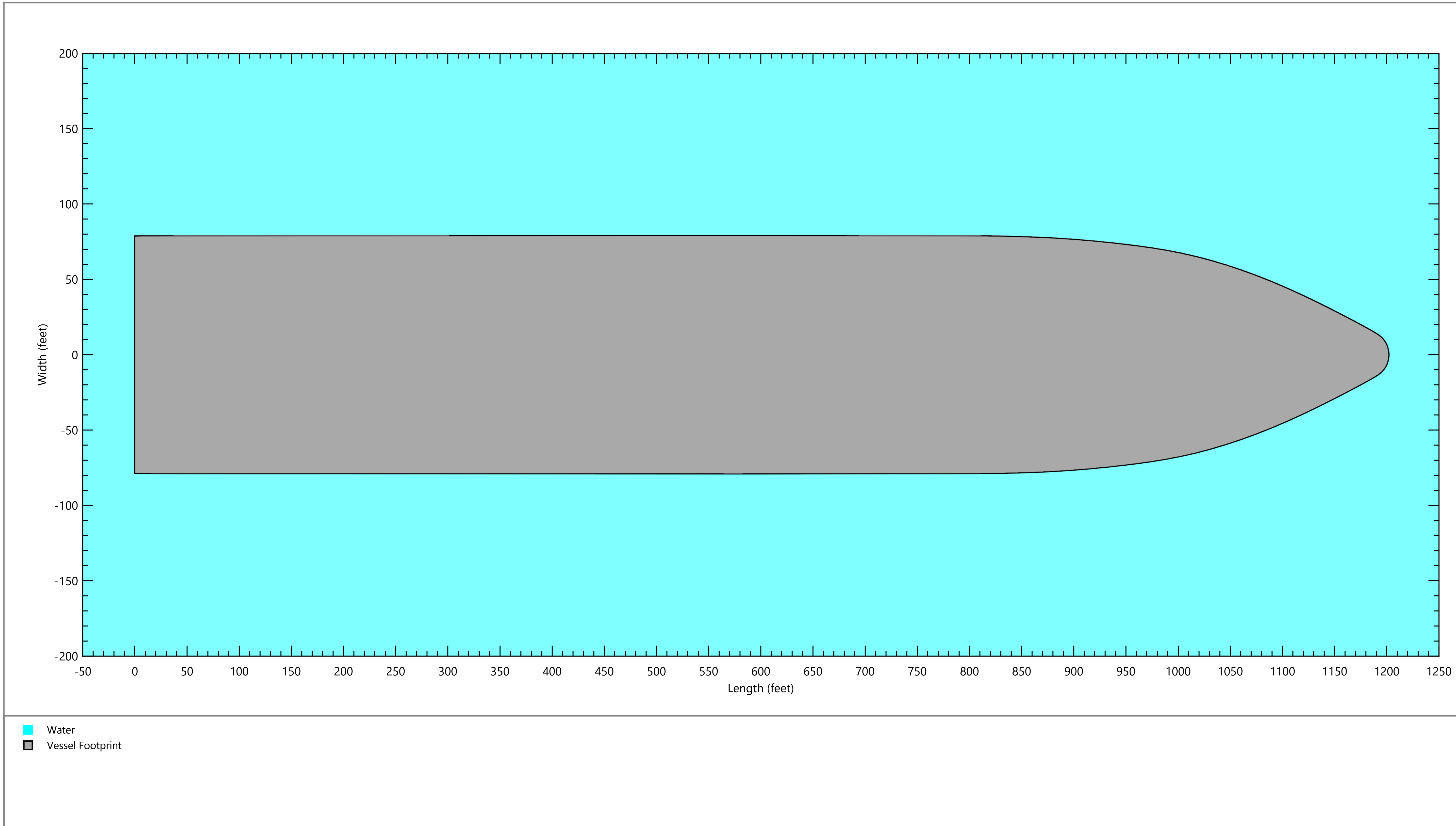

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Figure 21b
Plan View of Scaled Container Ship Geometry
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

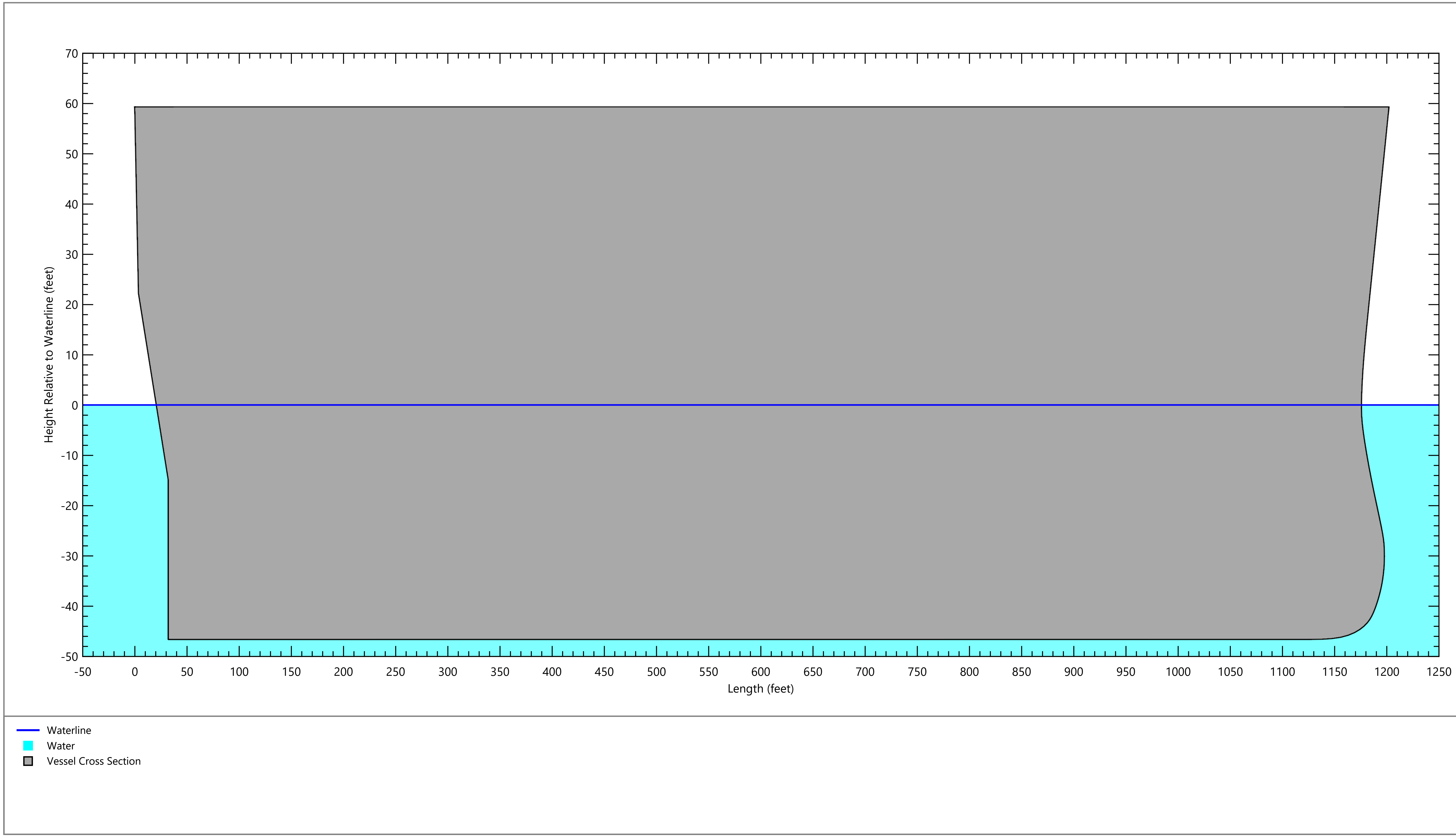

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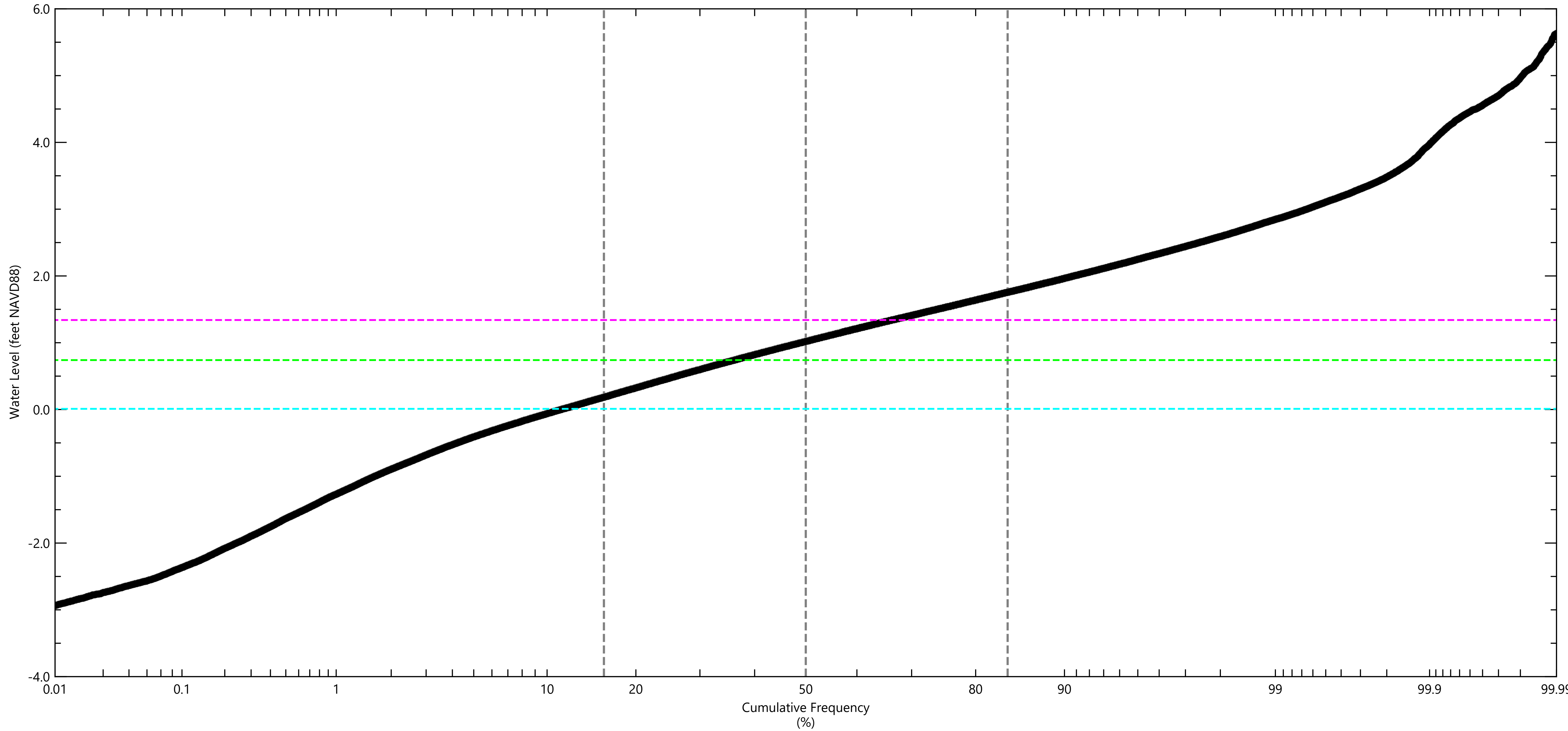
Figure 21c
Profile View of Scaled Container Ship Geometry
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: CTXS: Coastal Texas Protection and Restoration Feasibility Study, MHHW: Mean Higher High Water, MLLW: Mean Lower Low Water, MSL: Mean Sea Level, NAVD88: North American Vertical Datum of 1988, NOAA: National Oceanic and Atmospheric Administration

- Measured Six-Minute Water Levels at NOAA Station 8770613 (Dec 1995 through Jan 2024, 85th Percentile: 1.8 feet NAVD88)
- MHHW at NOAA Station 8770613 (1.3 feet NAVD88)
- MSL at NOAA Station 8770613 (0.7 feet NAVD88)
- MLLW at NOAA Station 8770613 (0.0 feet NAVD88)

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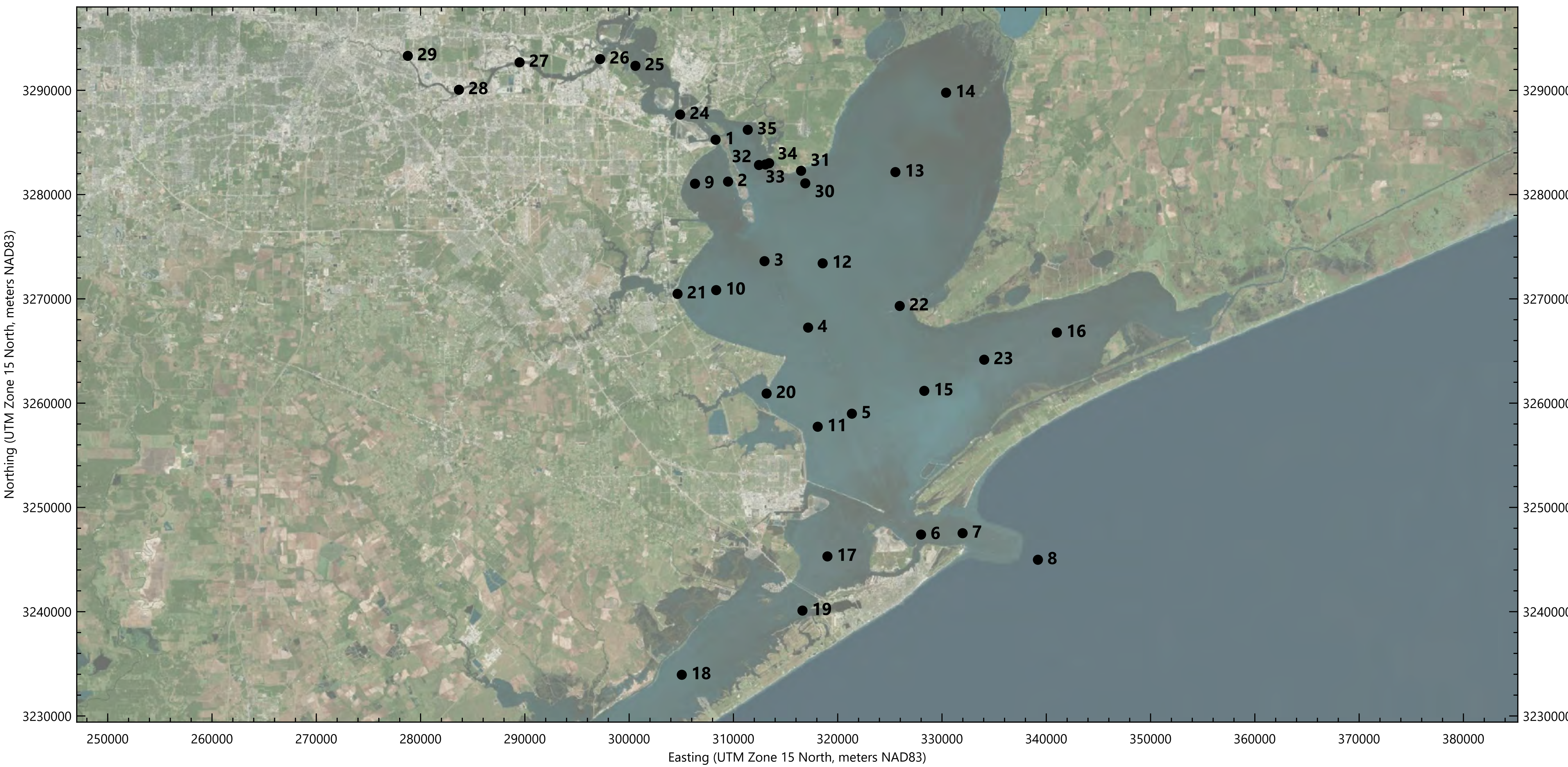
Figure 22
Cumulative Frequency Distribution of Measured Water Levels at NOAA Station 8770613



Notes: Basemap Source: Bing Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

● Salinity Point Analysis Location

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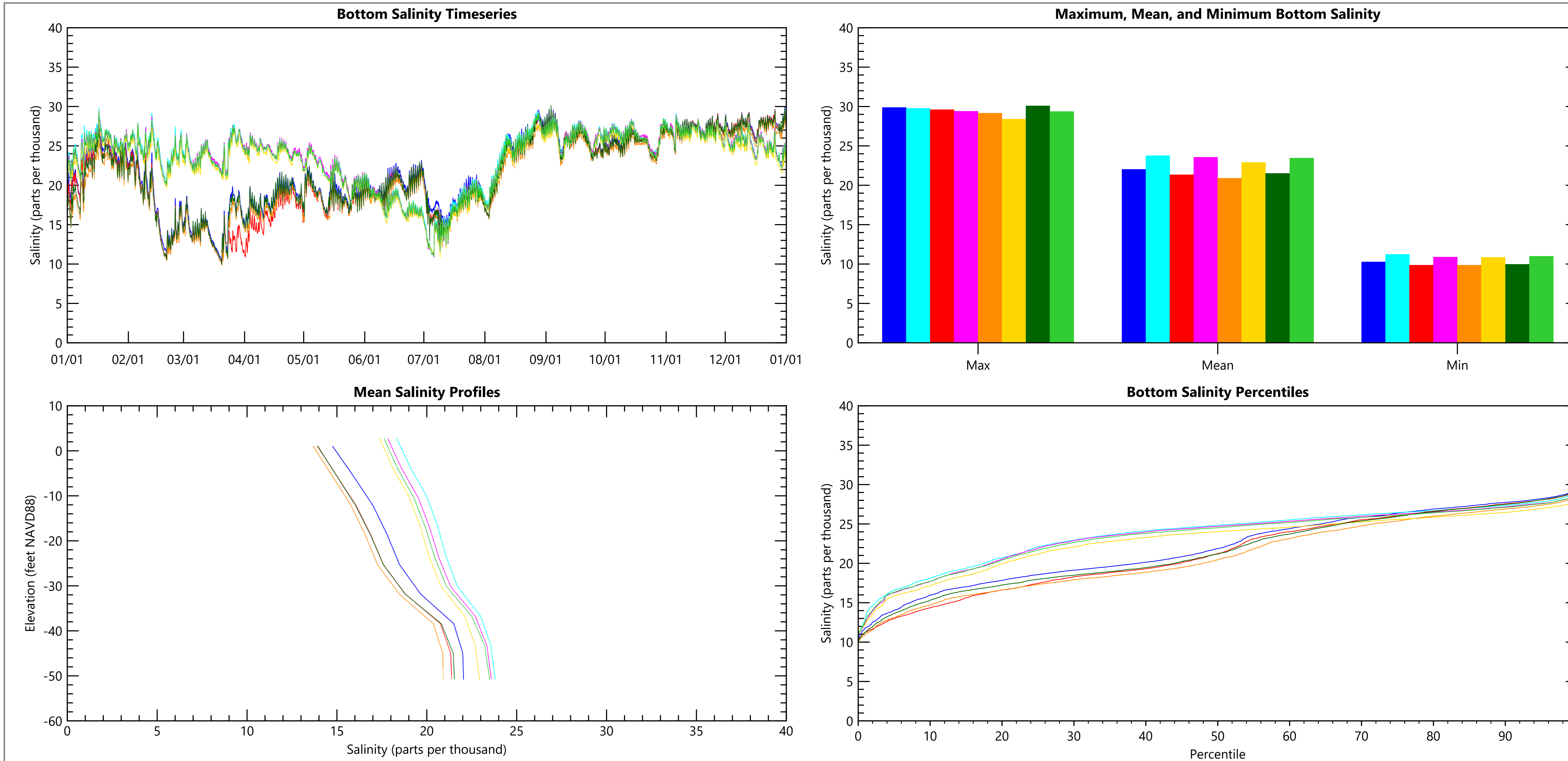
Figure 23a
Salinity Point Analysis Reference Map
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWOP: Future Without Project, FWP: Future with Project, HSC: Houston Ship Channel, NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

- PWOP
- FWOP
- PWP Route B
- FWP Route B
- PWP Route D
- FWP Route D
- PWP Route E
- FWP Route E

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Figure 23b
Salinity Point Analysis at Point 1: HSC at Morgans Point

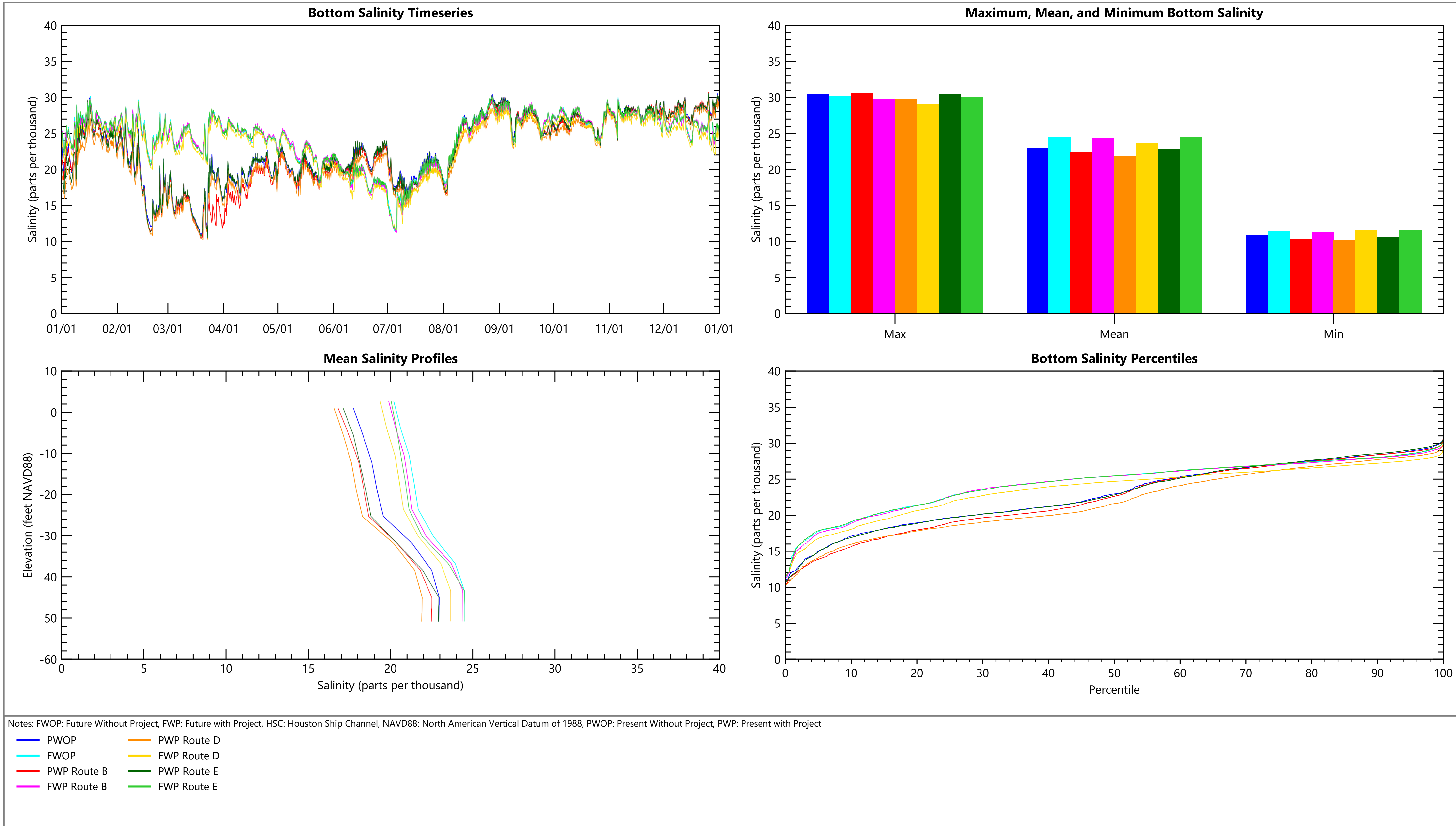

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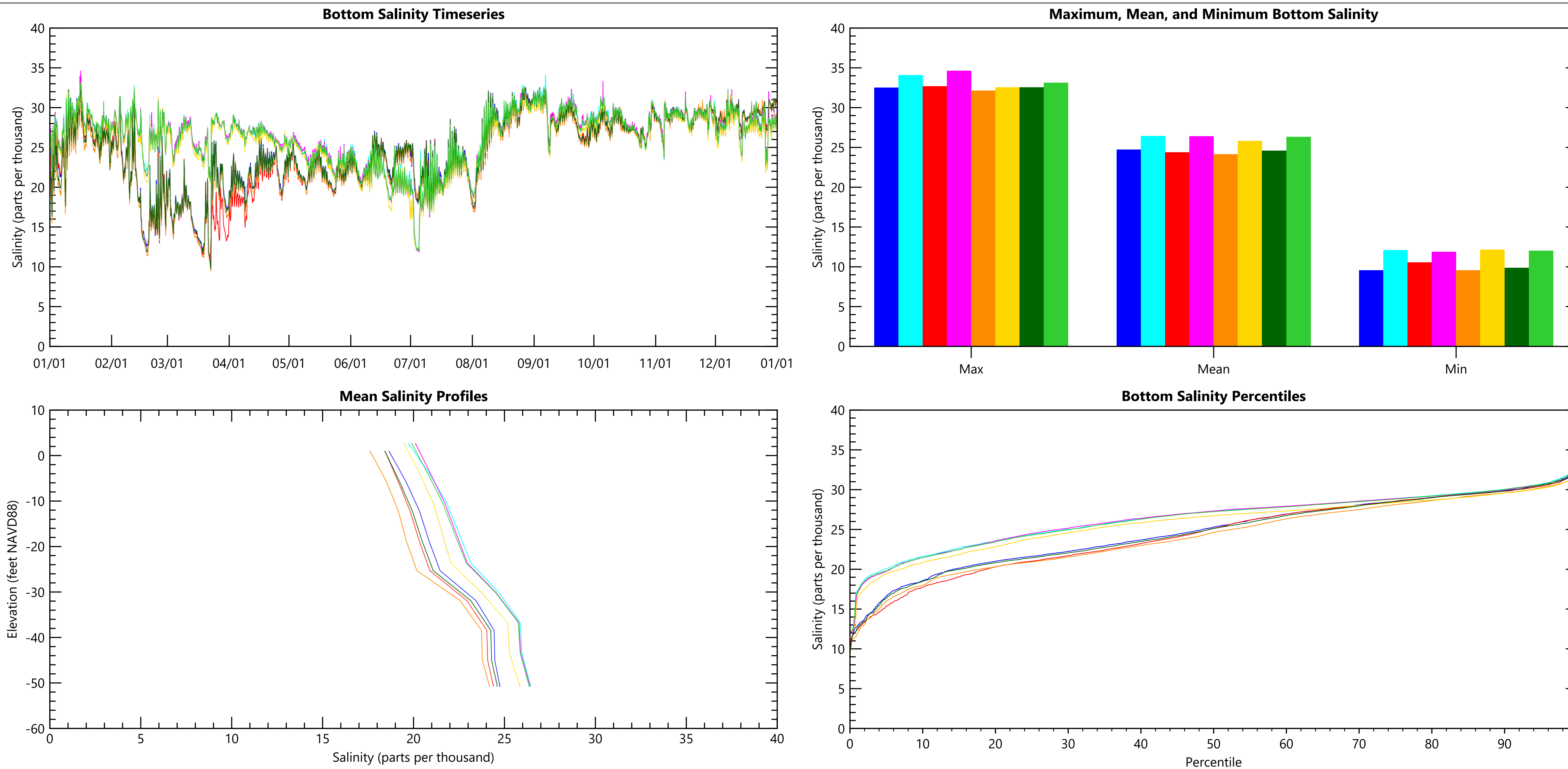
Figure 23c
Salinity Point Analysis at Point 2: HSC at Atkinson Island
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWOP: Future Without Project, FWP: Future with Project, HSC: Houston Ship Channel, NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

PWOP
FWOP
PWP Route B
FWP Route B
PWP Route D
FWP Route D
PWP Route E
FWP Route E

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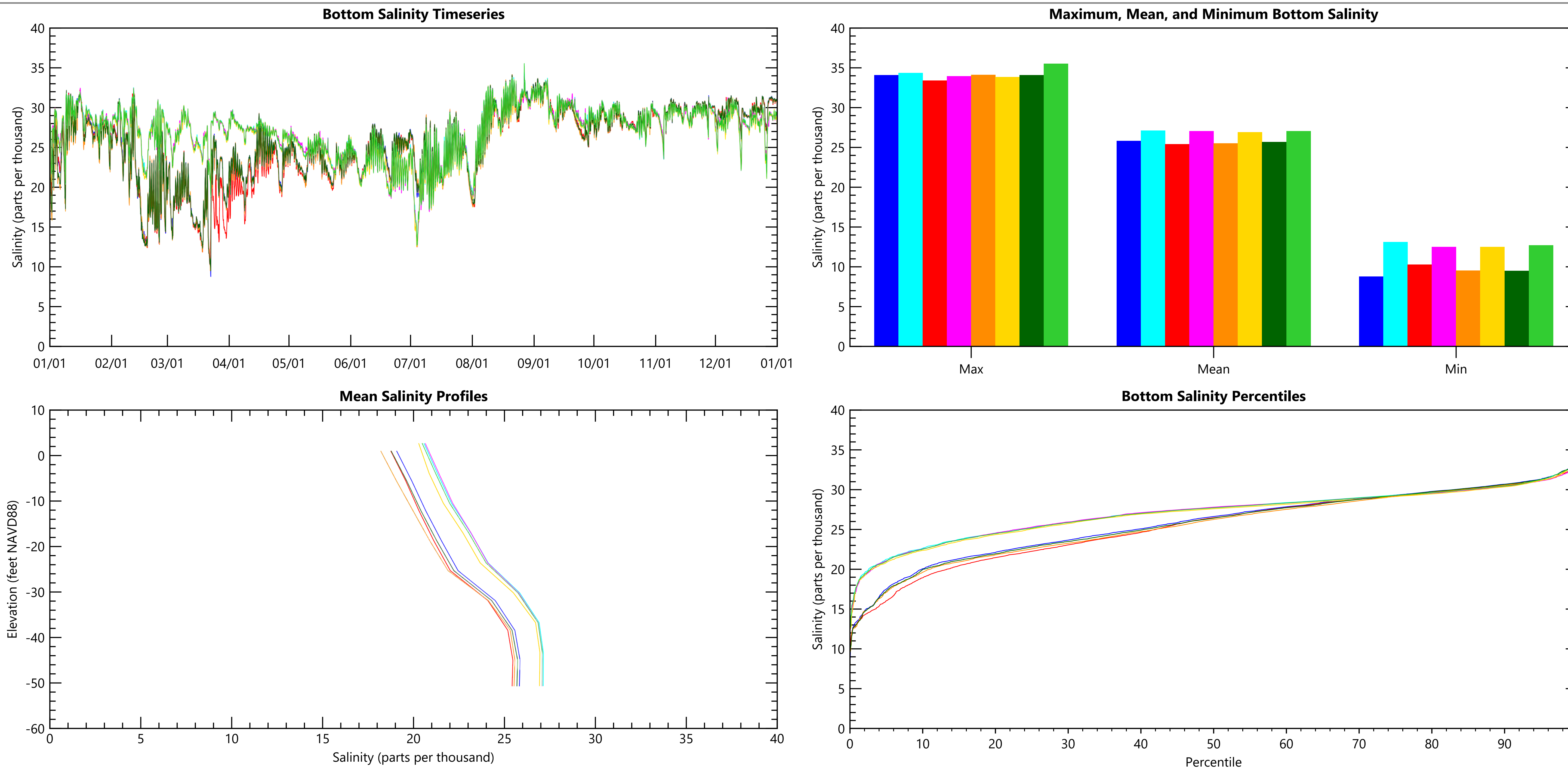
Figure 23d
Salinity Point Analysis at Point 3: HSC at Middle Bay Marsh



Notes: FWOP: Future Without Project, FWP: Future with Project, HSC: Houston Ship Channel, NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

- PWOP
- FWOP
- PWP Route B
- FWP Route B
- PWP Route D
- FWP Route D
- PWP Route E
- FWP Route E

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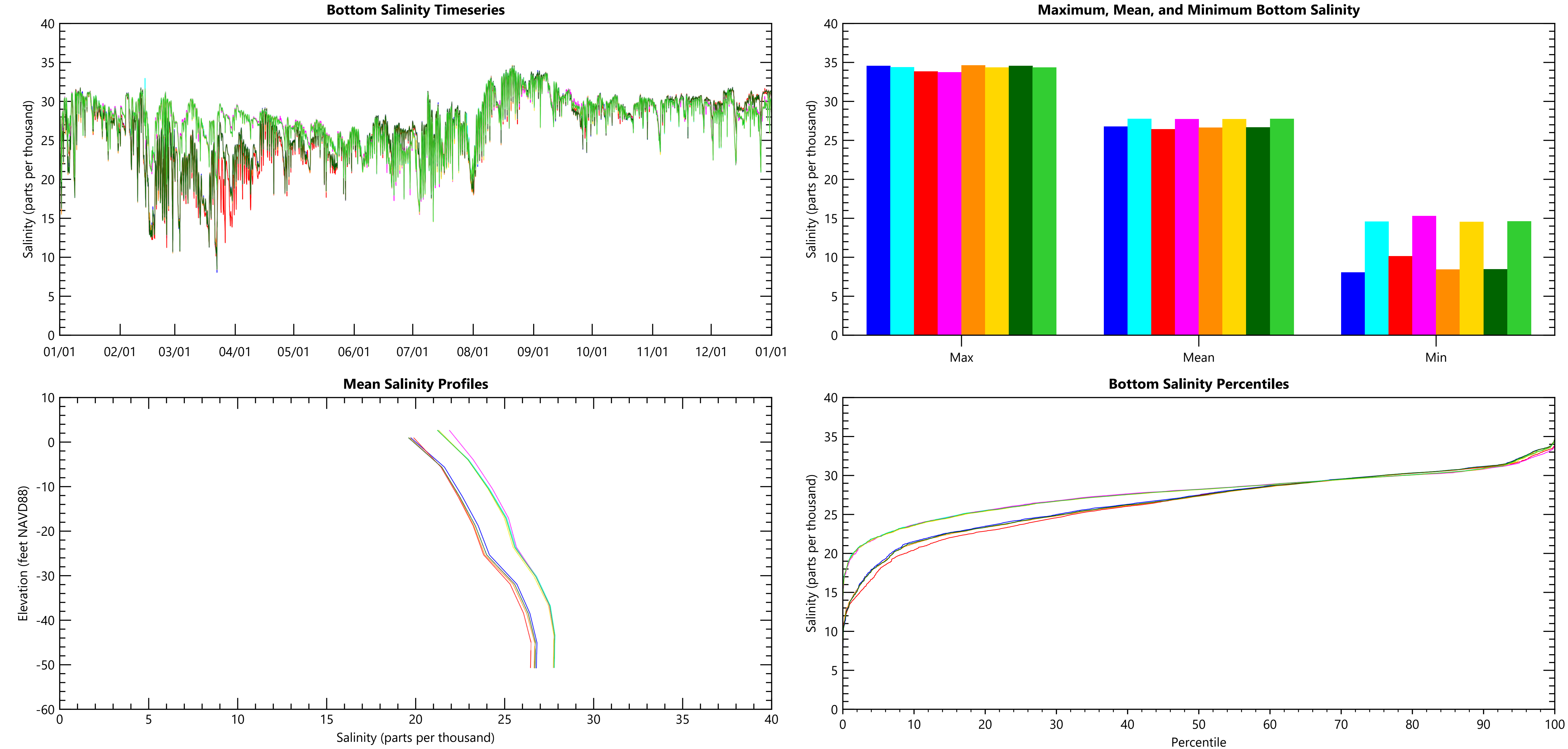
Figure 23e
Salinity Point Analysis at Point 4: HSC at Red Fish Reef
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWOP: Future Without Project, FWP: Future with Project, HSC: Houston Ship Channel, NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

- PWOP
- FWOP
- PWP Route B
- FWP Route B
- PWP Route D
- FWP Route D
- PWP Route E
- FWP Route E

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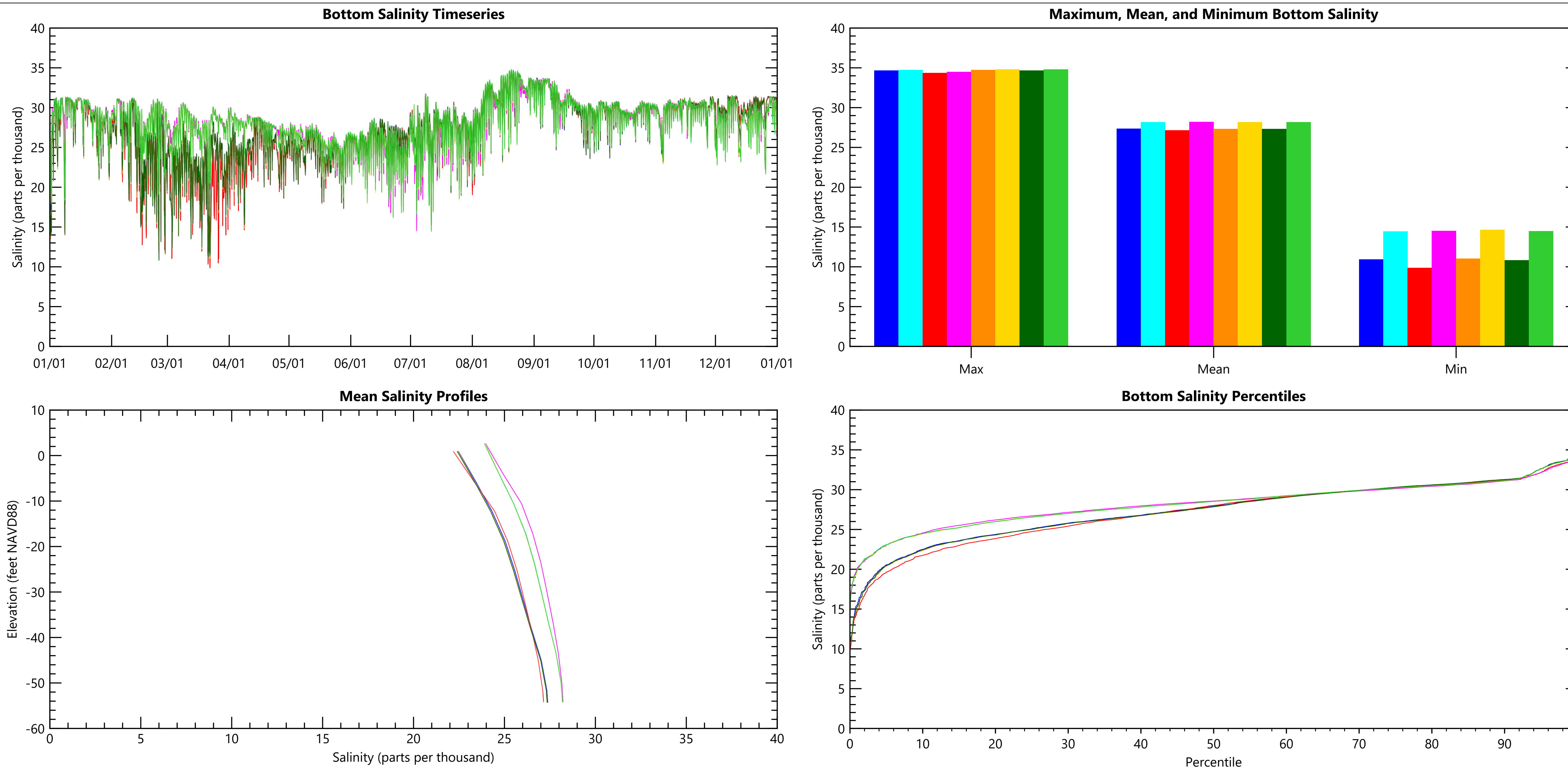
Figure 23f
Salinity Point Analysis at Point 5: HSC at Lower Galveston Bay



Notes: FWOP: Future Without Project, FWP: Future with Project, HSC: Houston Ship Channel, NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

- PWOP
- FWOP
- PWP Route B
- FWP Route B
- PWP Route D
- FWP Route D
- PWP Route E
- FWP Route E

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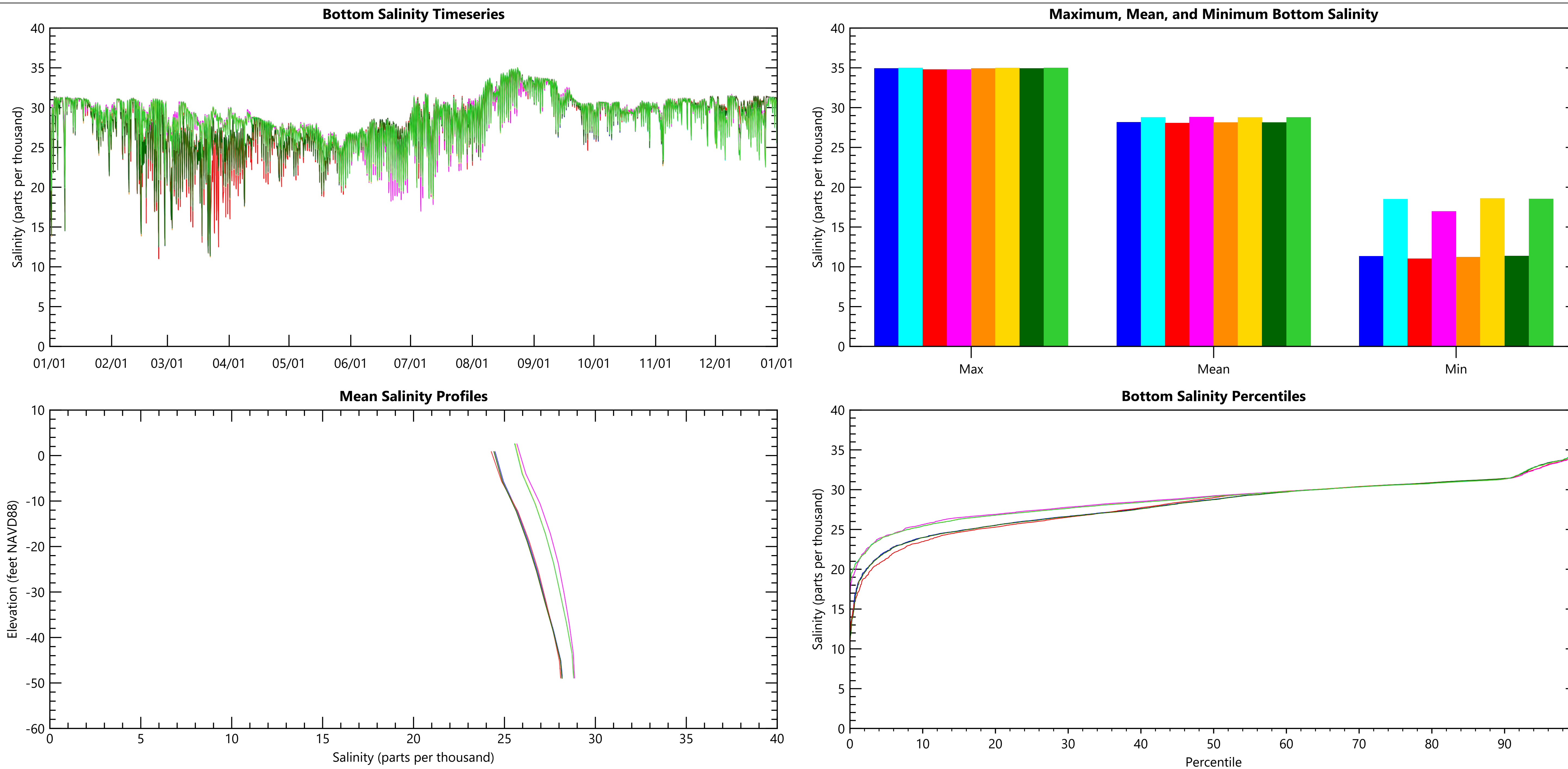
Figure 23g
Salinity Point Analysis at Point 6: HSC at Bolivar Roads



Notes: FWOP: Future Without Project, FWP: Future with Project, HSC: Houston Ship Channel, NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

PWOP
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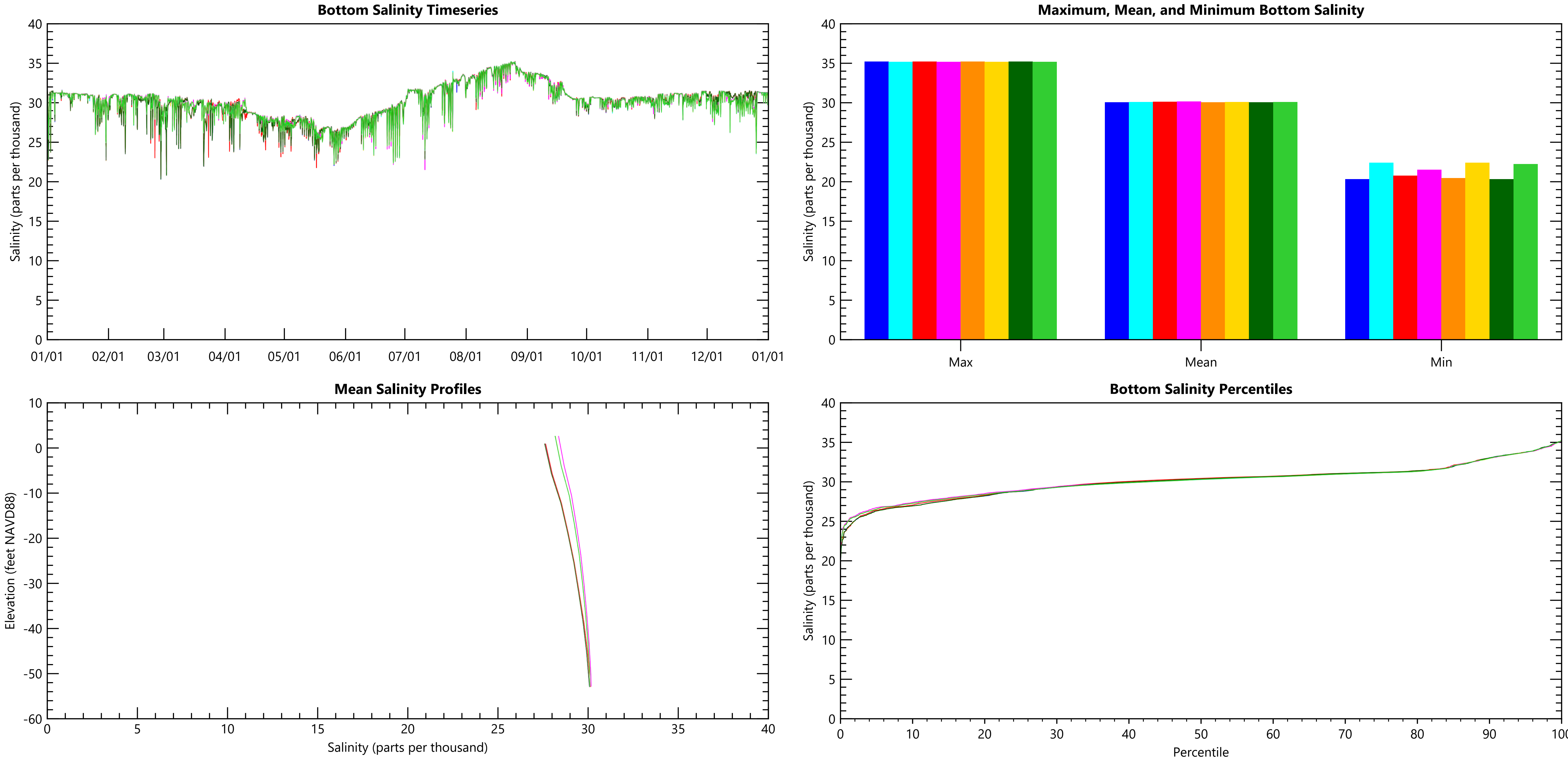
Figure 23h
Salinity Point Analysis at Point 7: HSC at Entrance
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



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- FWP Route E

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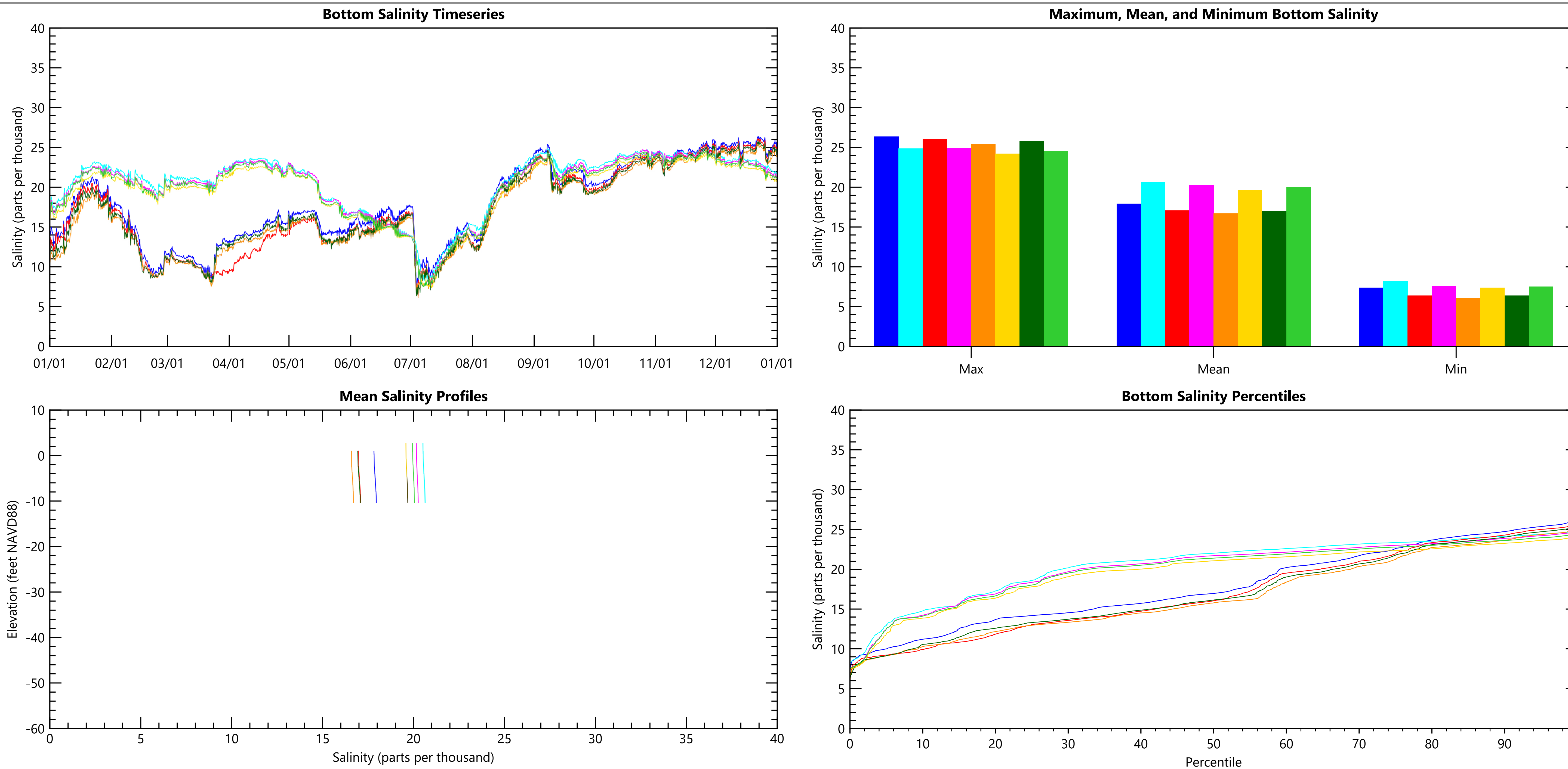
Figure 23i
Salinity Point Analysis at Point 8: HSC at Gulf
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



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- FWP Route E

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Figure 23j
Salinity Point Analysis at Point 9: Upper Galveston Bay 1
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

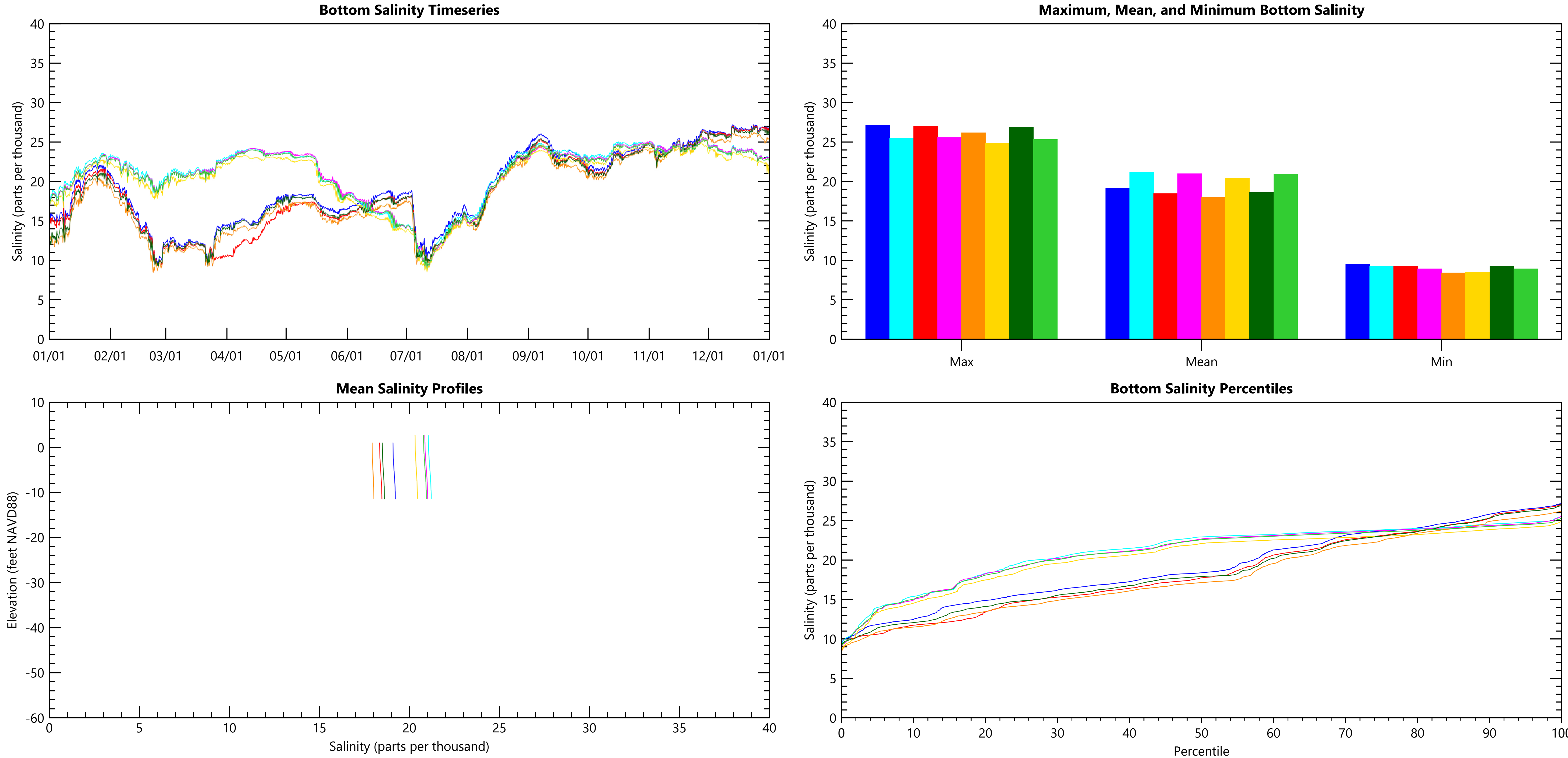

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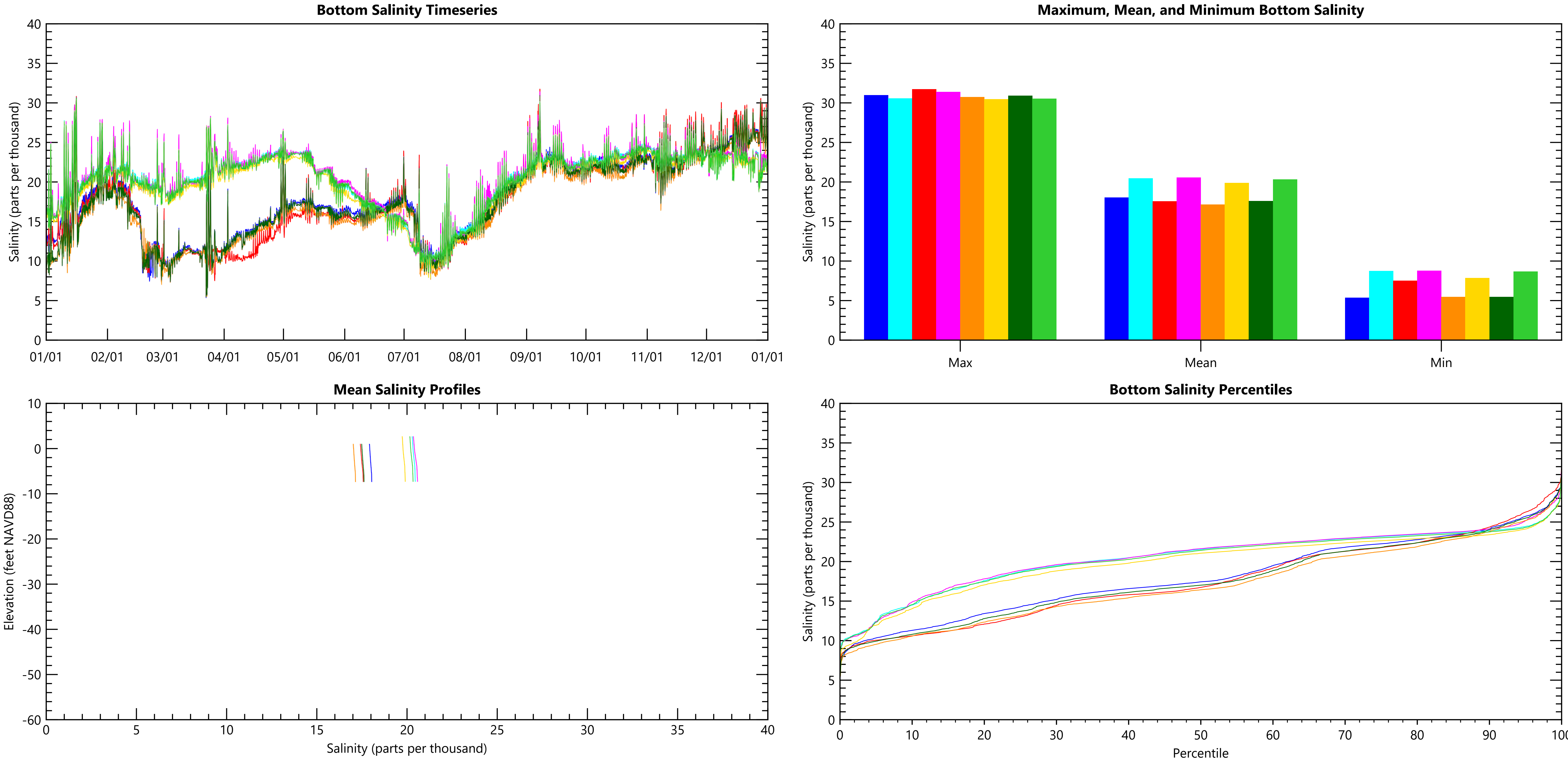
Figure 23k
Salinity Point Analysis at Point 10: Upper Galveston Bay 2
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



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- PWP Route E
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Figure 23l
Salinity Point Analysis at Point 11: Lower Galveston Bay

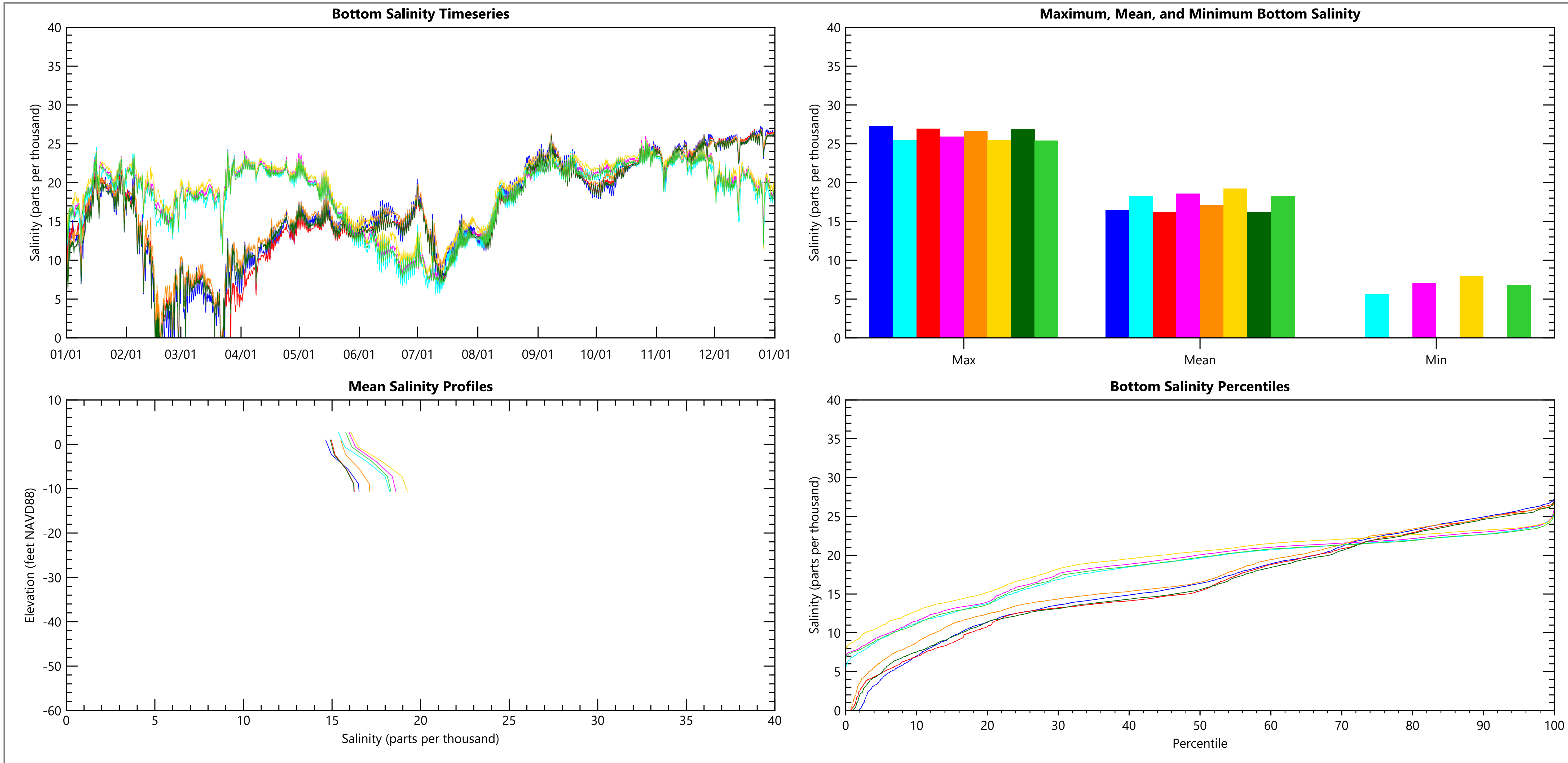

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Figure 23m
Salinity Point Analysis at Point 12: Lower Trinity Bay
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

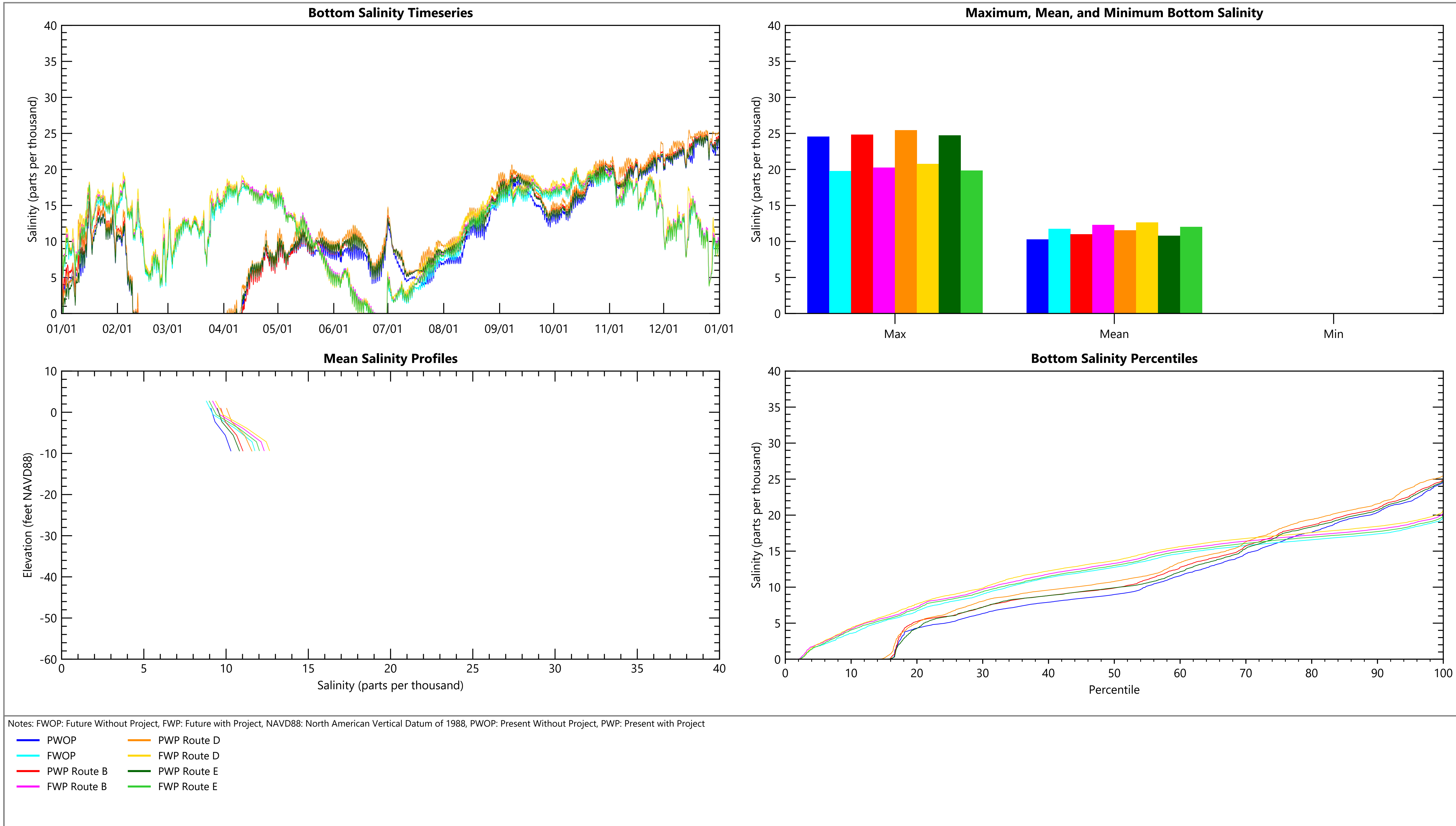

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Figure 23n
Salinity Point Analysis at Point 13: Middle Trinity Bay
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

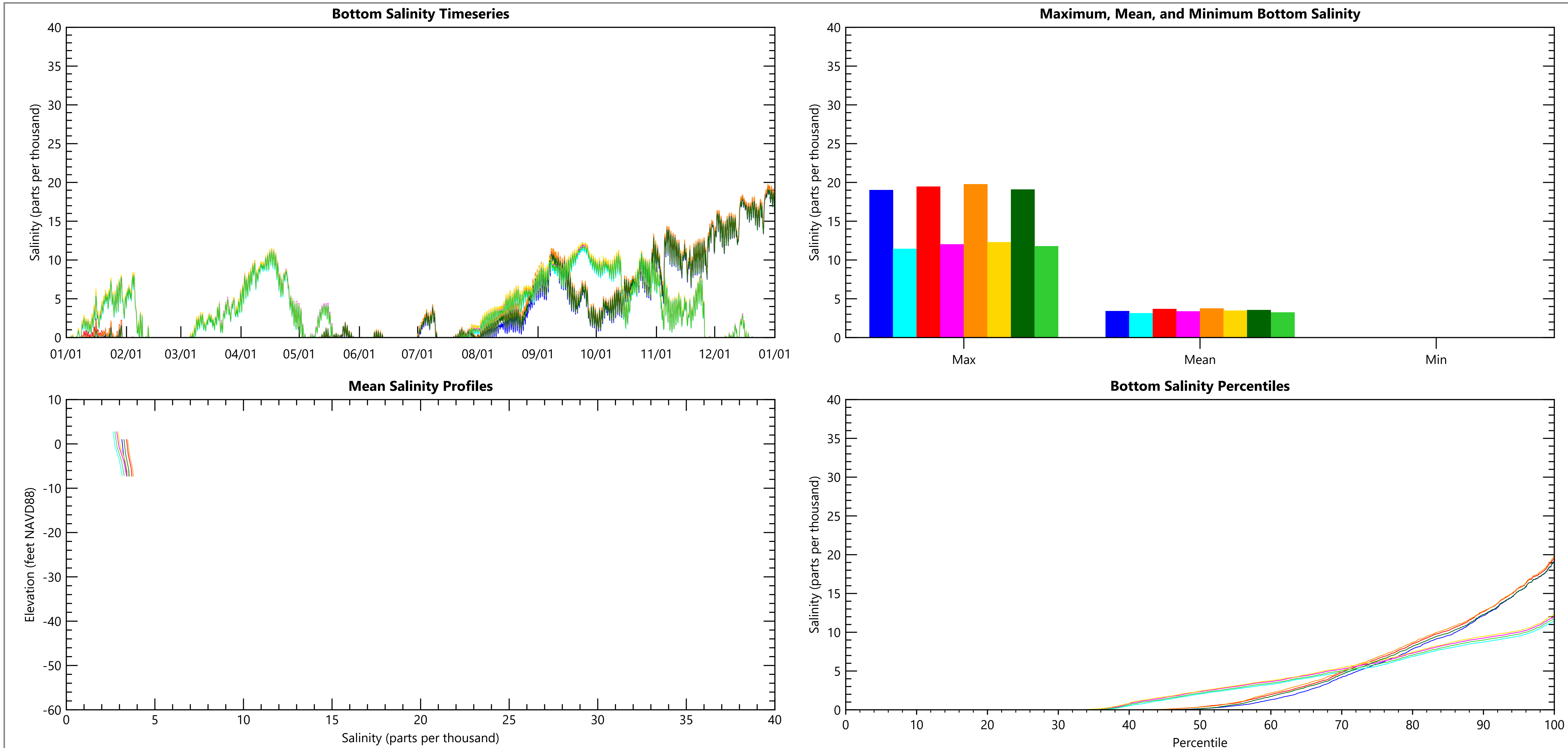

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Figure 23o
Salinity Point Analysis at Point 14: Upper Trinity Bay
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

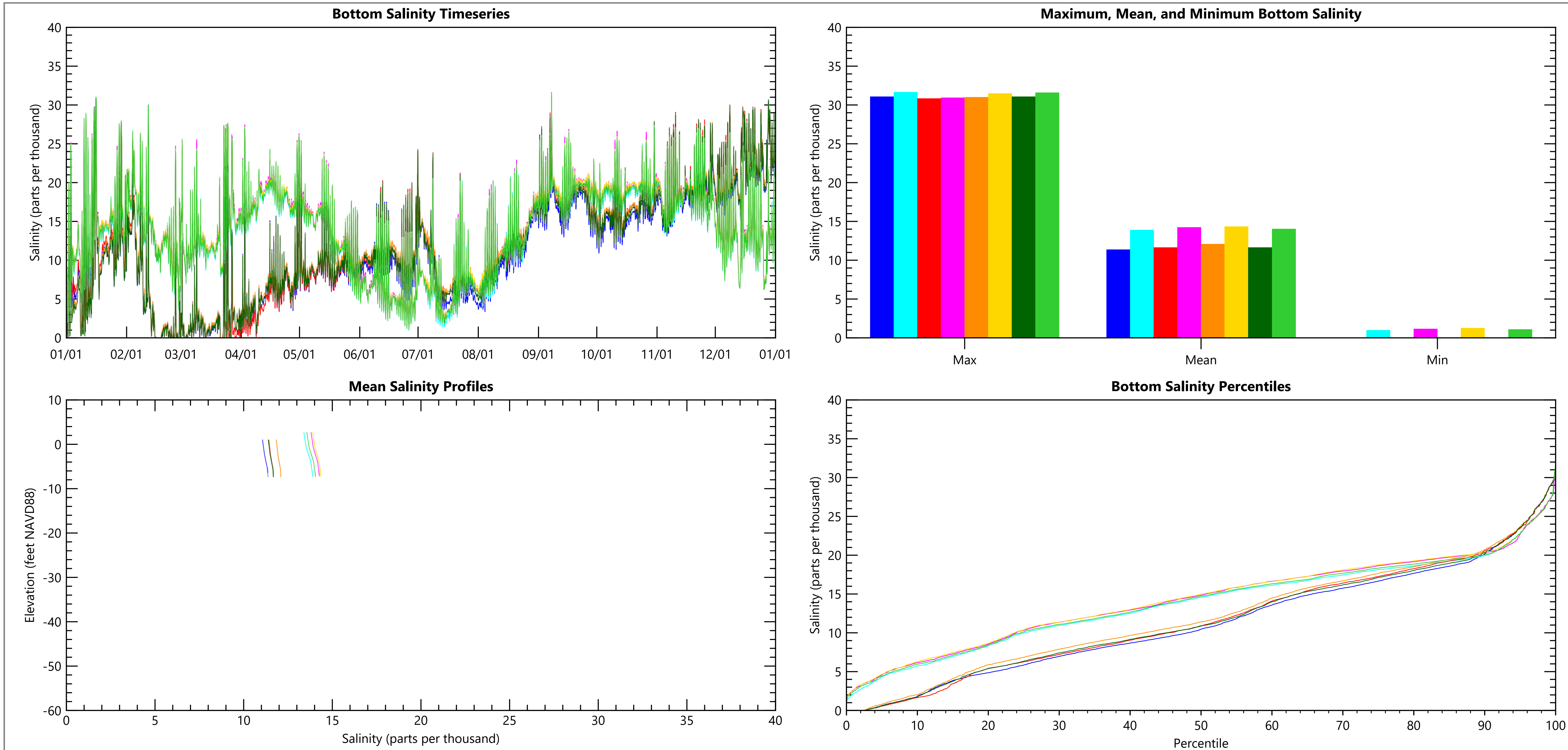

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Figure 23p
Salinity Point Analysis at Point 15: Western East Bay
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

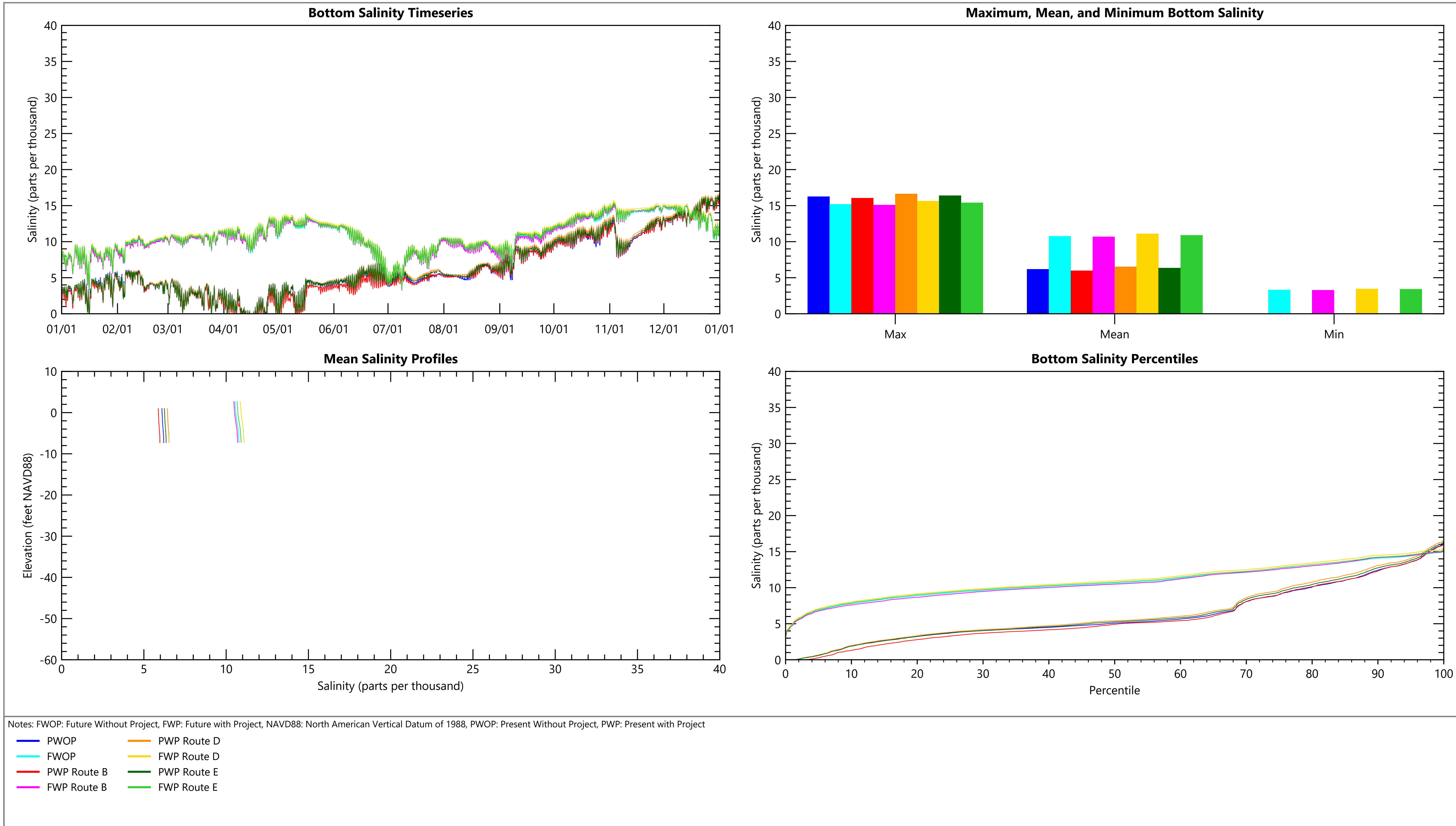

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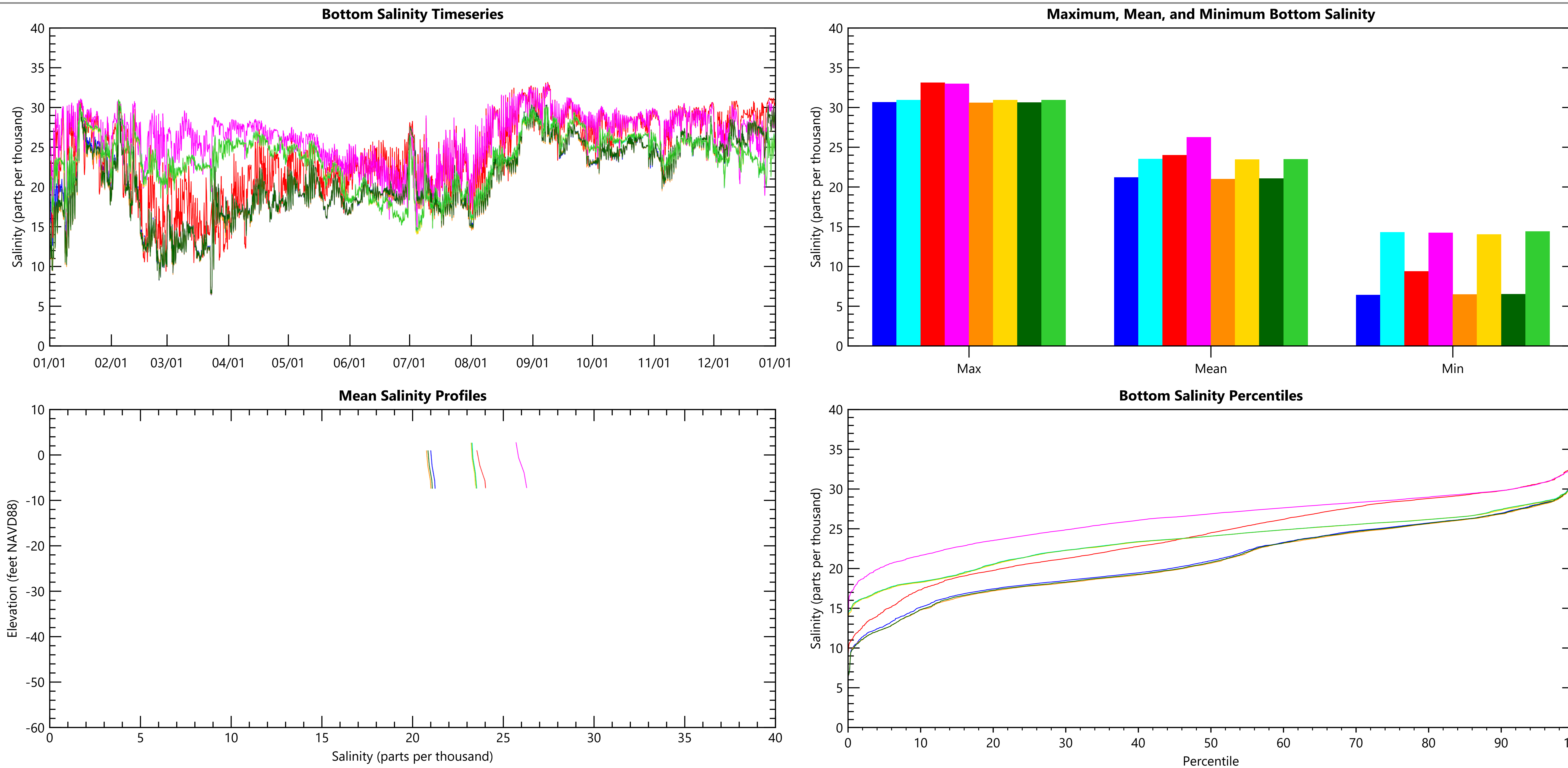
Figure 23q
Salinity Point Analysis at Point 16: Eastern East Bay
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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- PWP Route D
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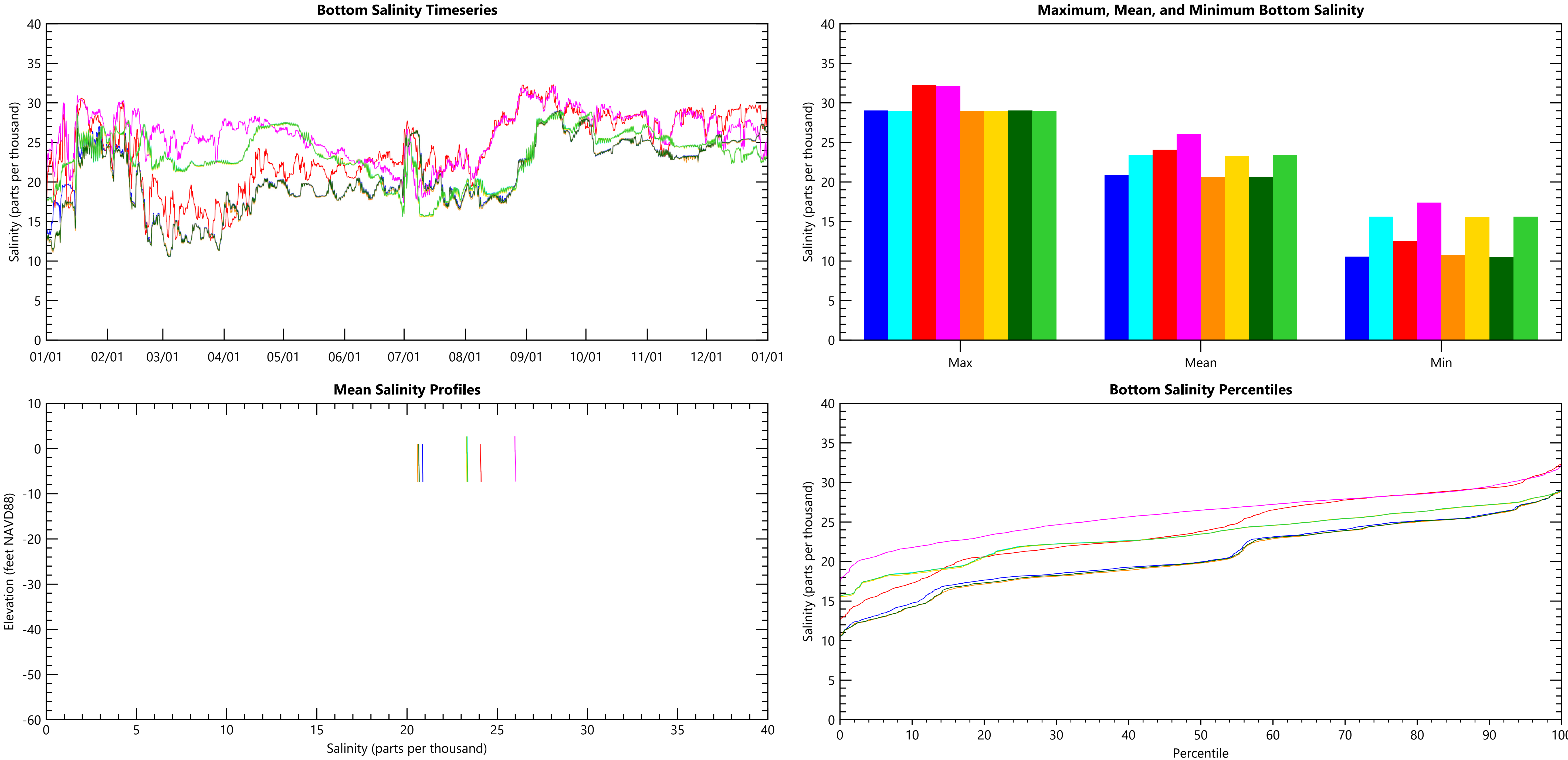
Figure 23r
Salinity Point Analysis at Point 17: Eastern West Bay



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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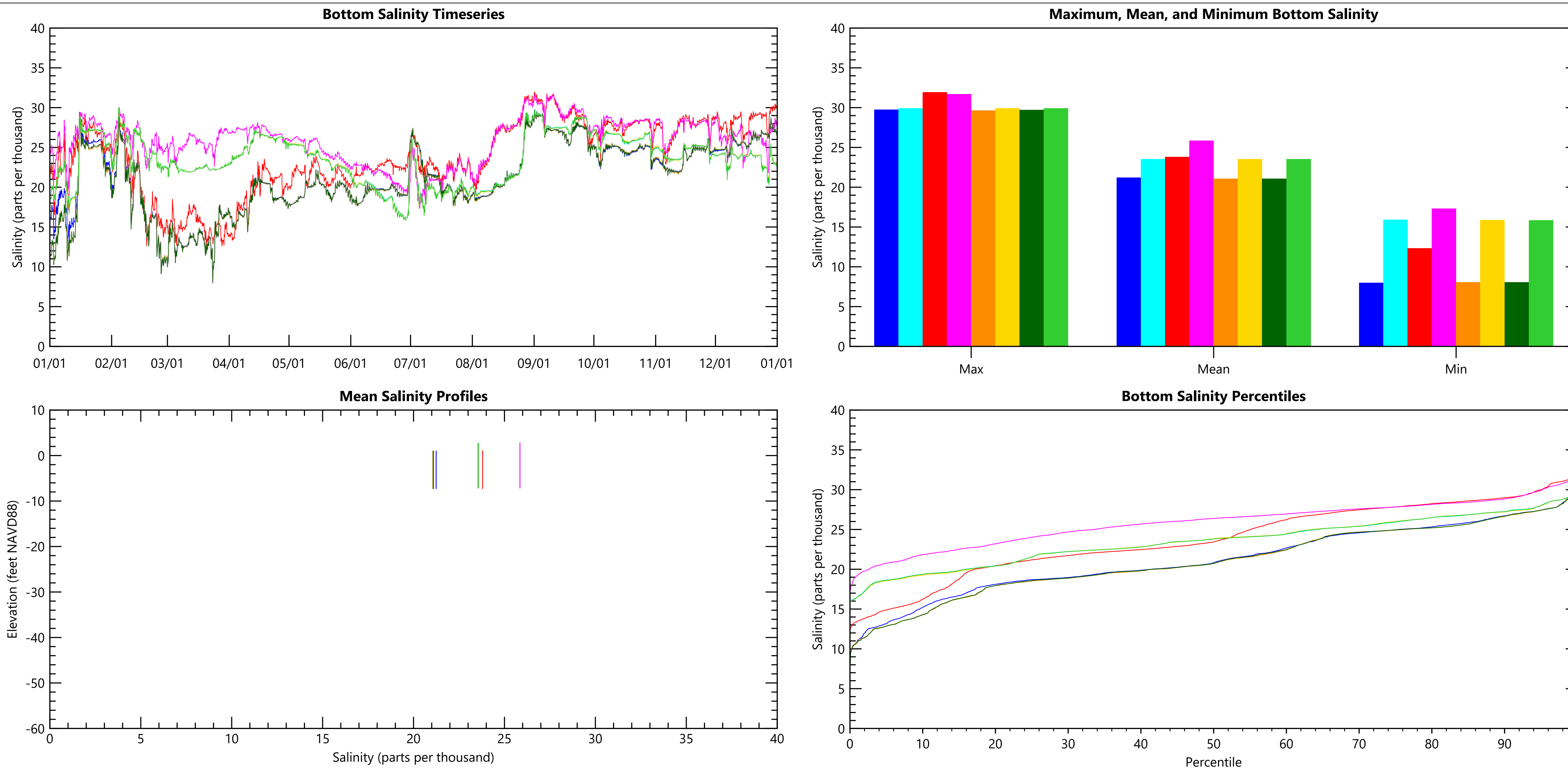
Figure 23s
Salinity Point Analysis at Point 18: Middle West Bay



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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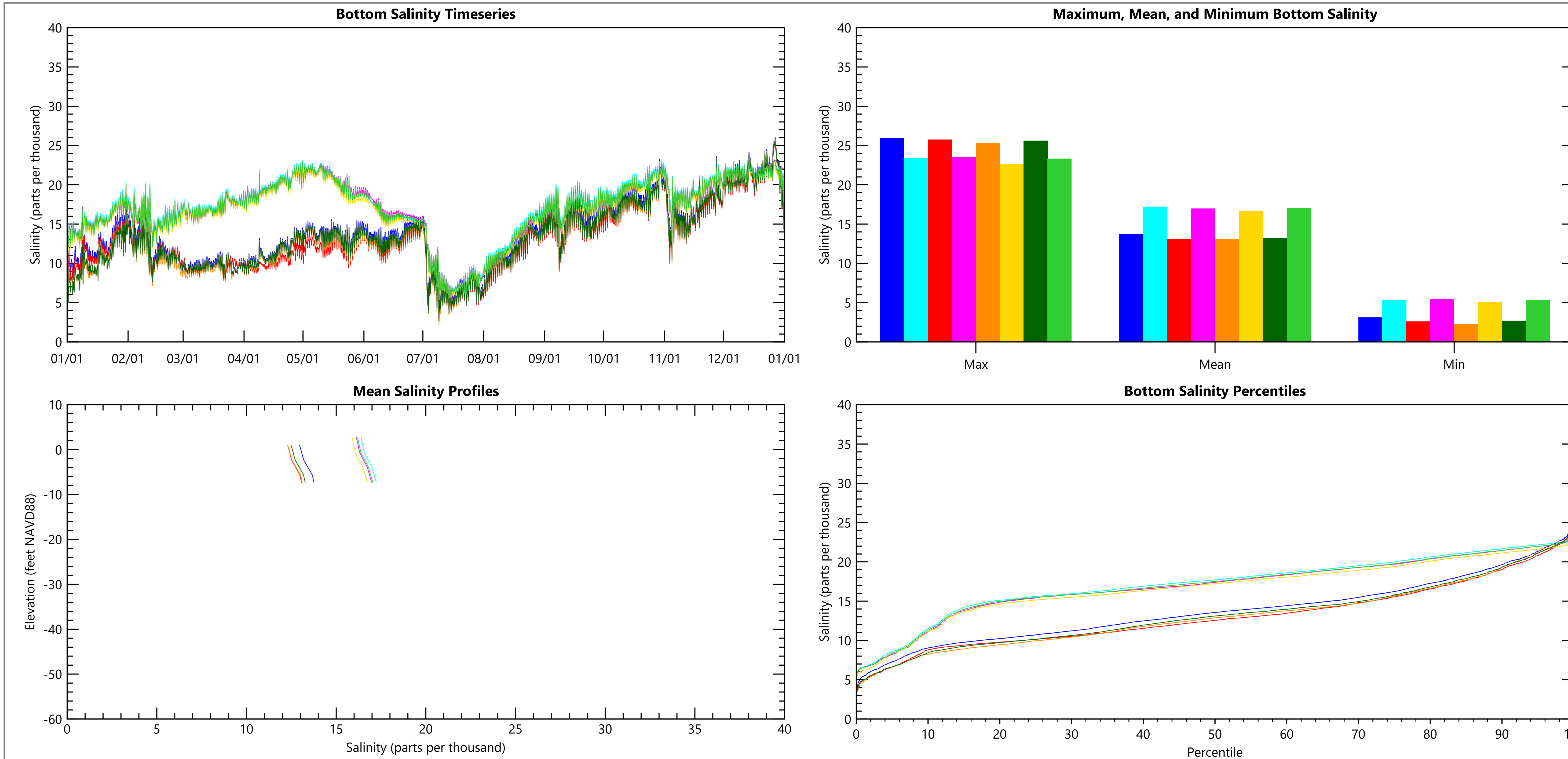
Figure 23t
Salinity Point Analysis at Point 19: Offatts Bayou
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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Figure 23u
Salinity Point Analysis at Point 20: Dickinson

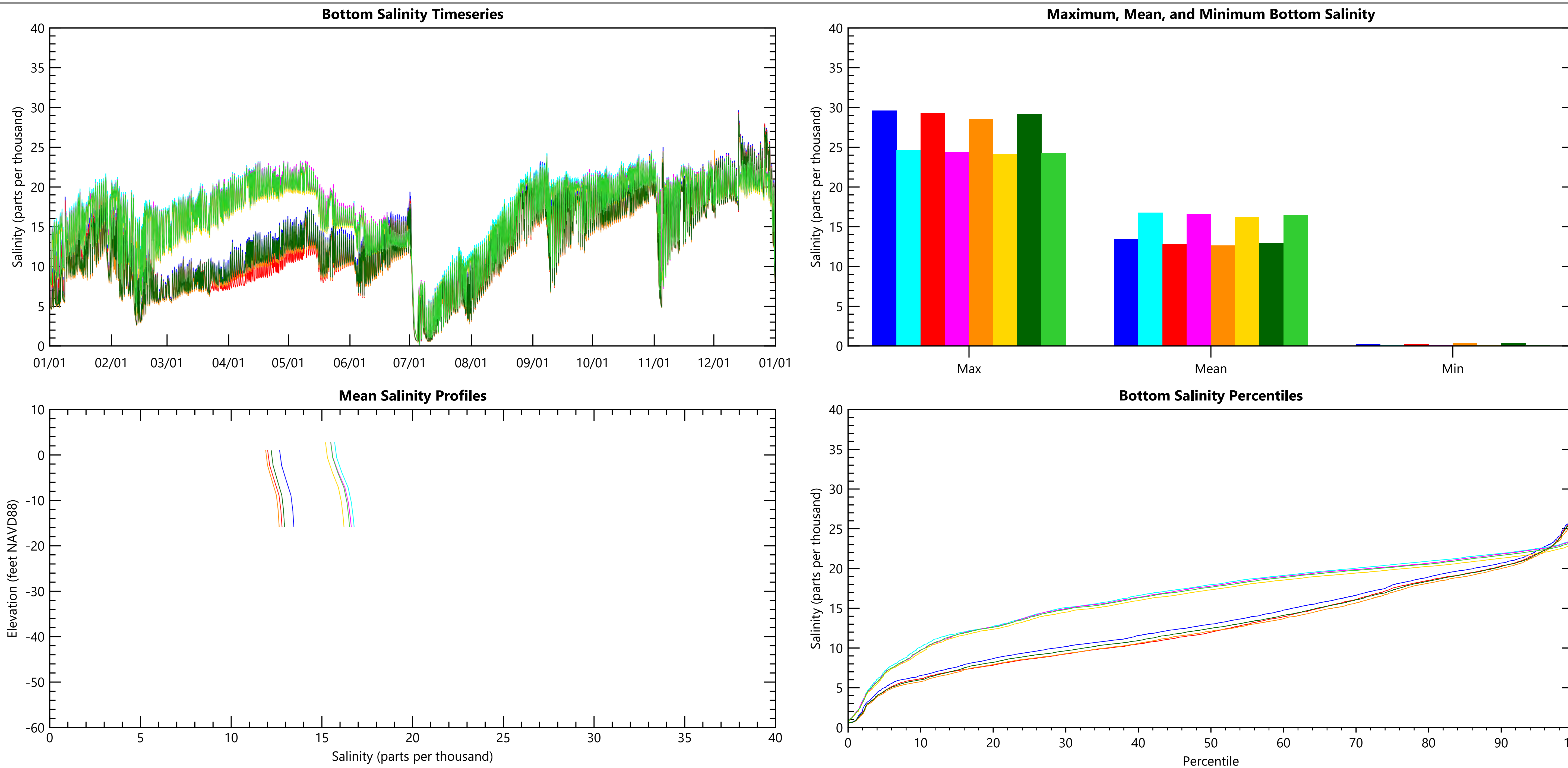

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Figure 23v
Salinity Point Analysis at Point 21: Clear Creek

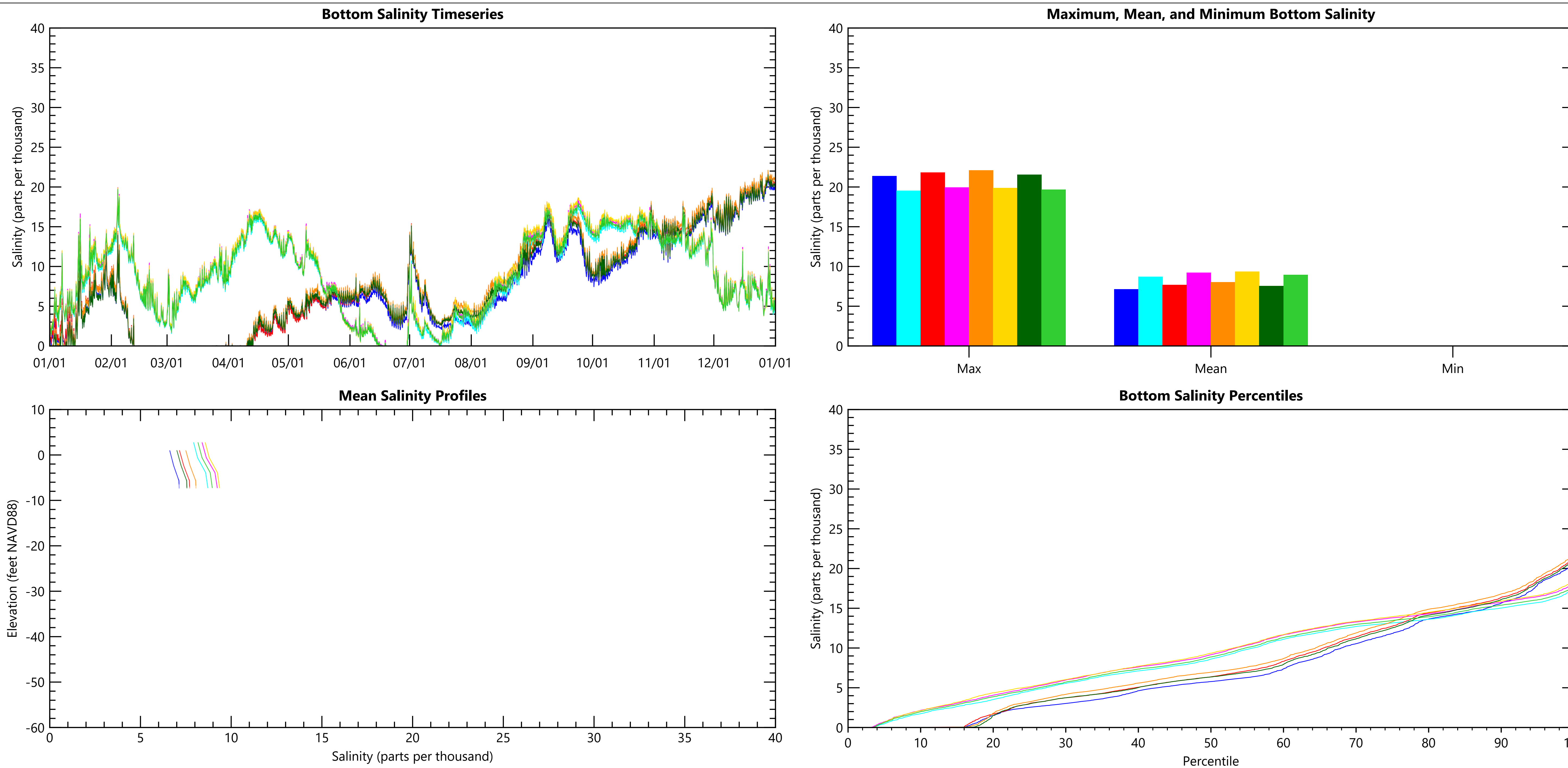

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Figure 23w
Salinity Point Analysis at Point 22: Smith Point
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

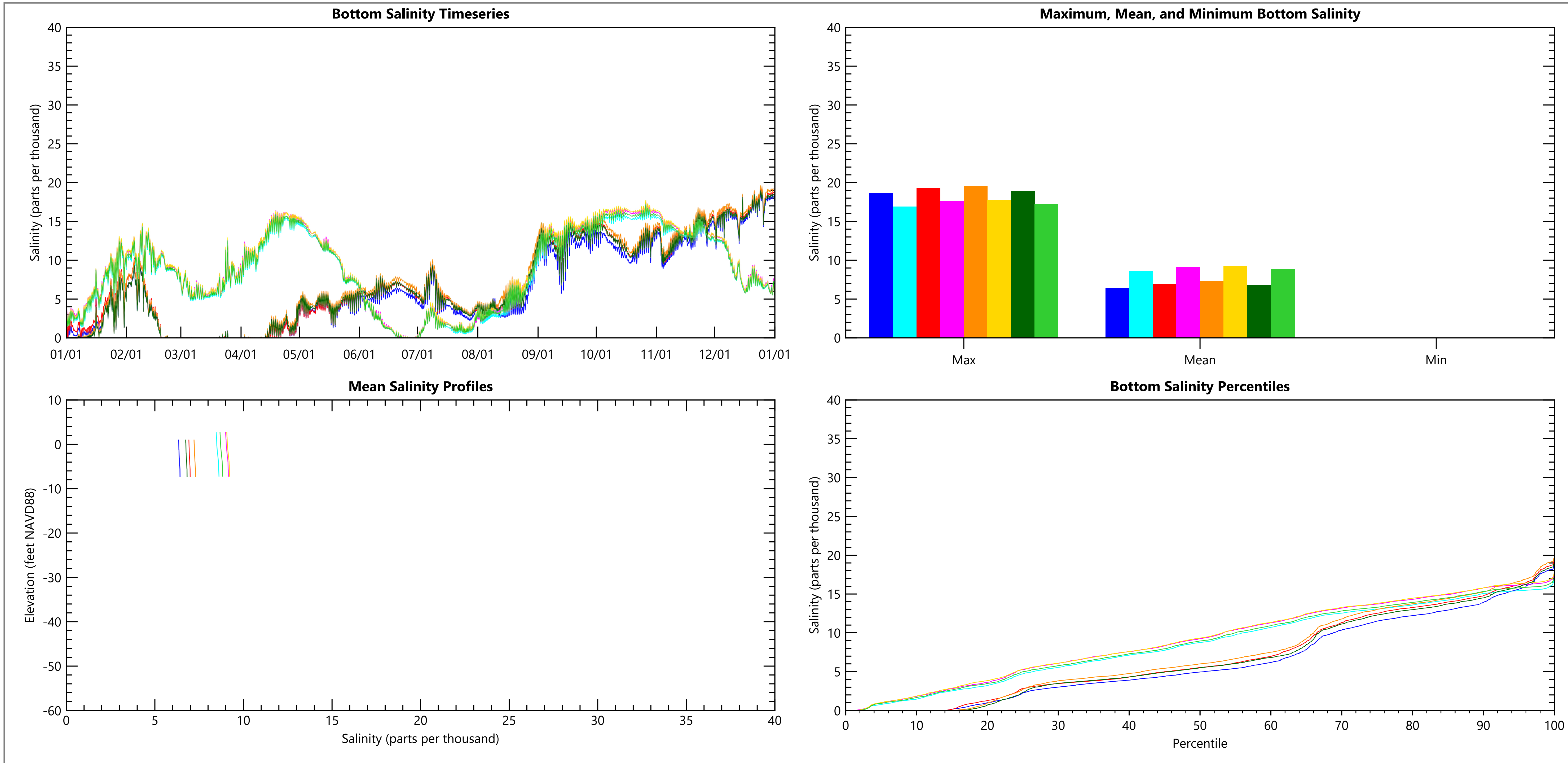

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Figure 23x
Salinity Point Analysis at Point 23: Middle East Bay
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

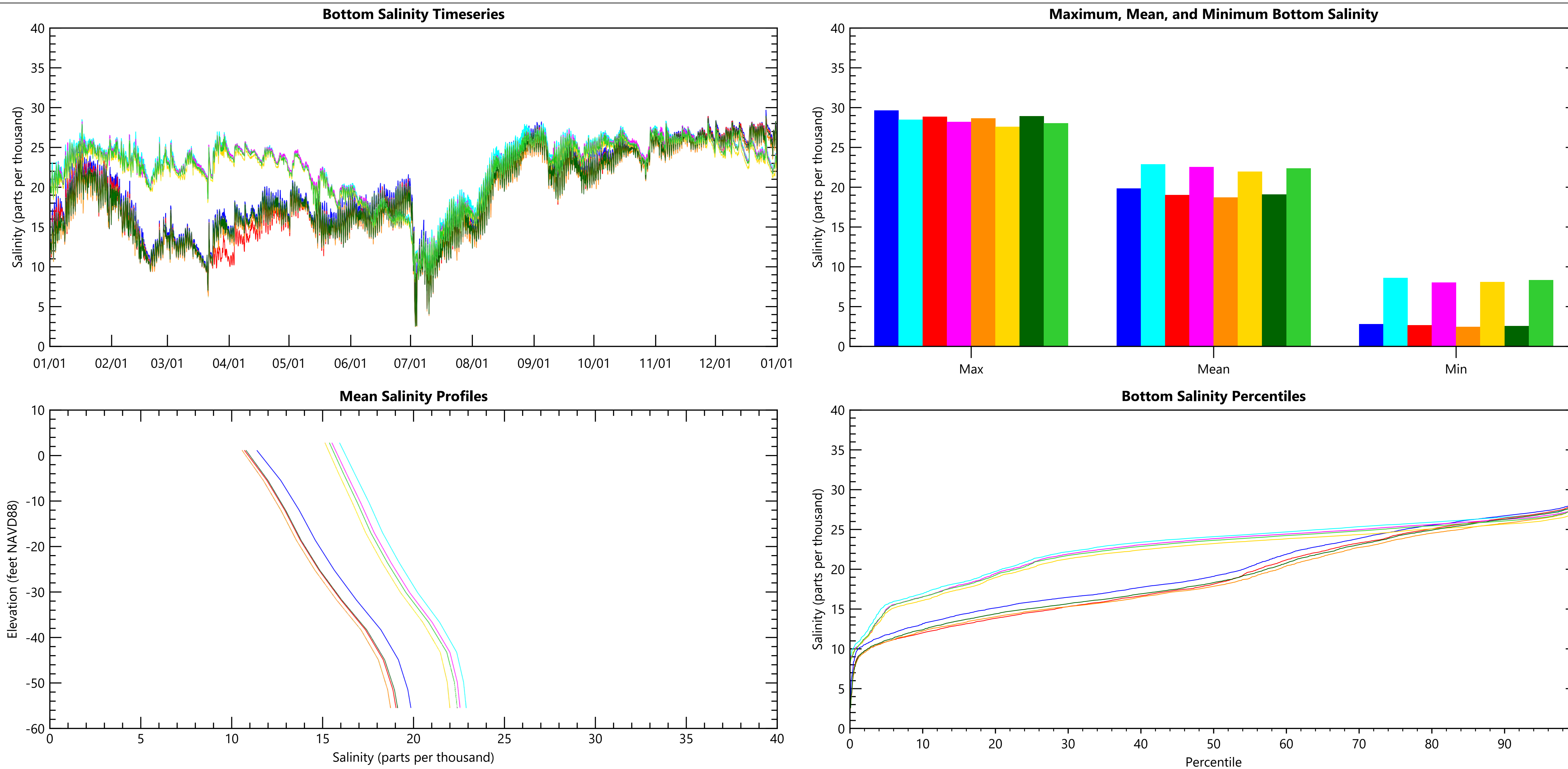

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Figure 23y
Salinity Point Analysis at Point 24: HSC at Fred Hartman Bridge
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

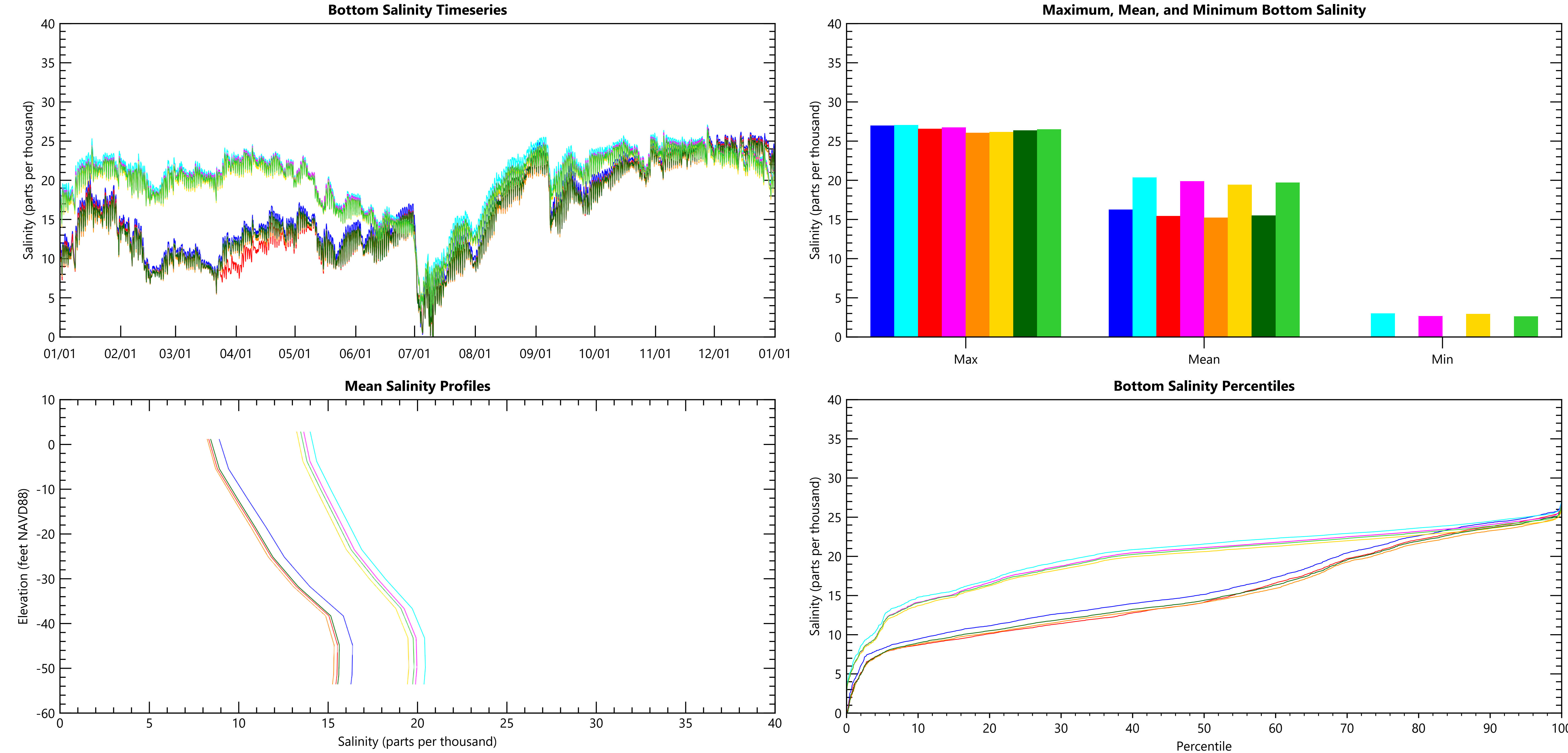

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Figure 23z
Salinity Point Analysis at Point 25: HSC at Goat Island
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

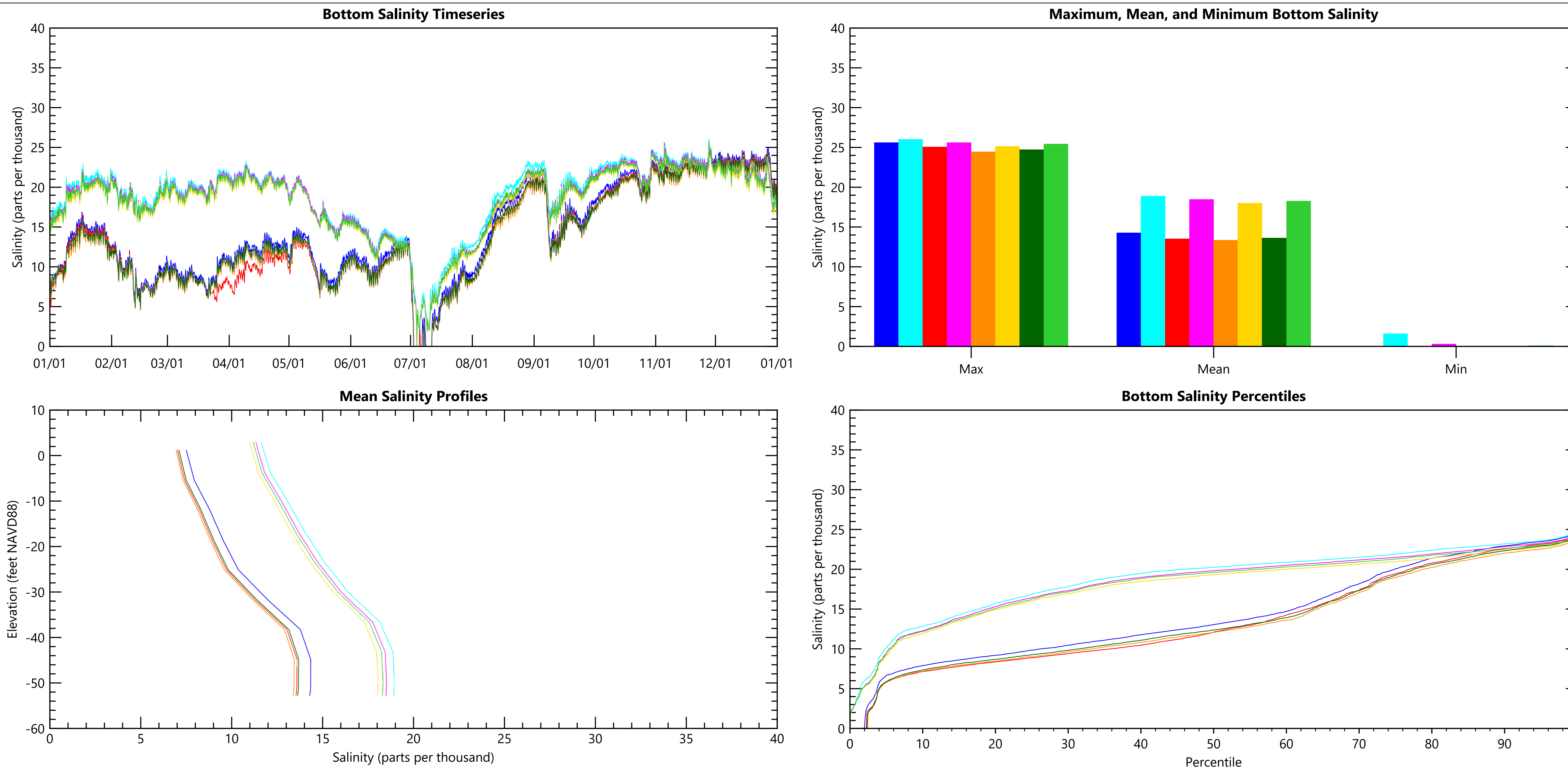

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Figure 23a1
Salinity Point Analysis at Point 26: HSC at Carpenters Bayou
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

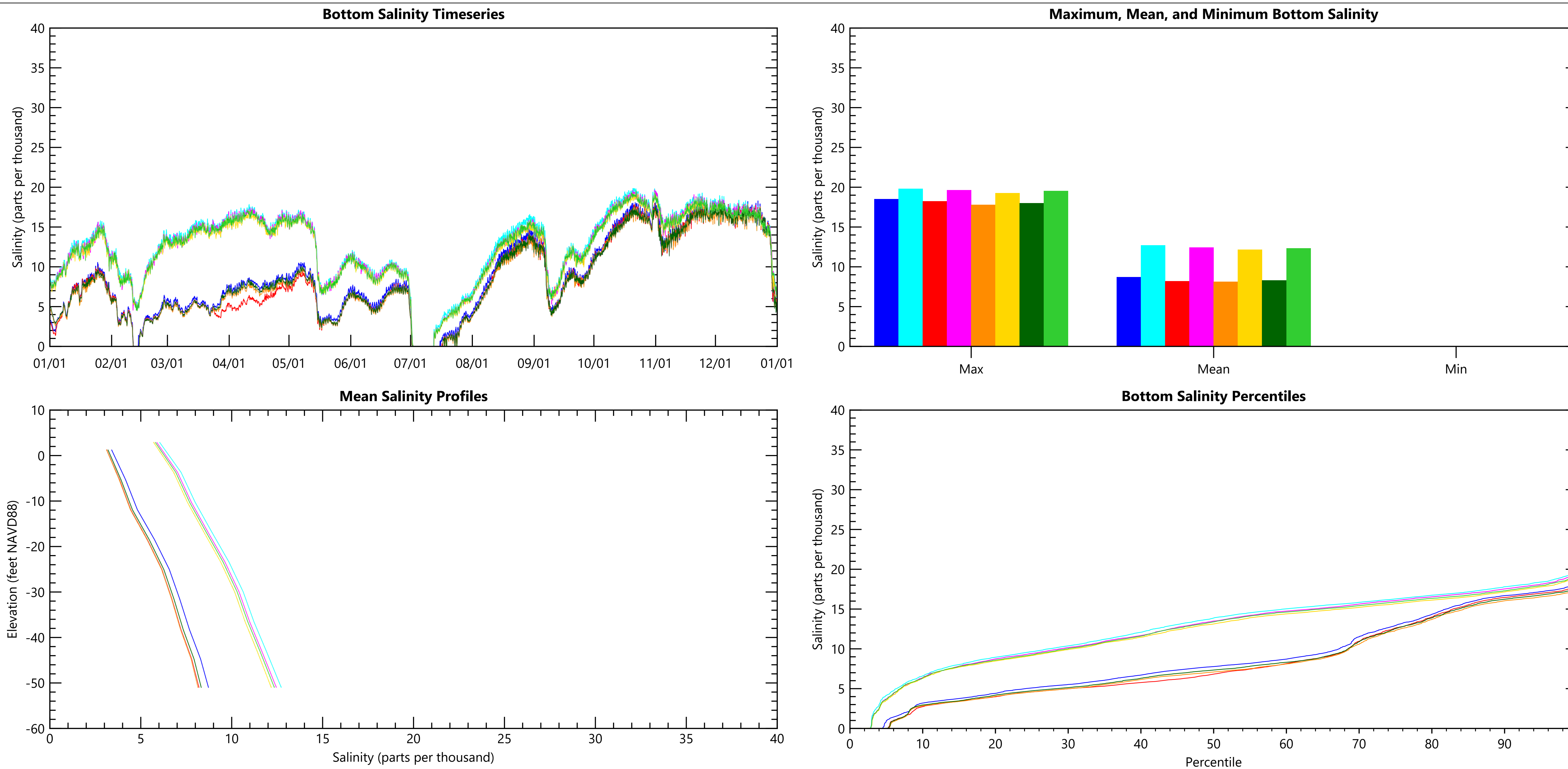

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Figure 23b1
Salinity Point Analysis at Point 27: HSC at Greens Bayou

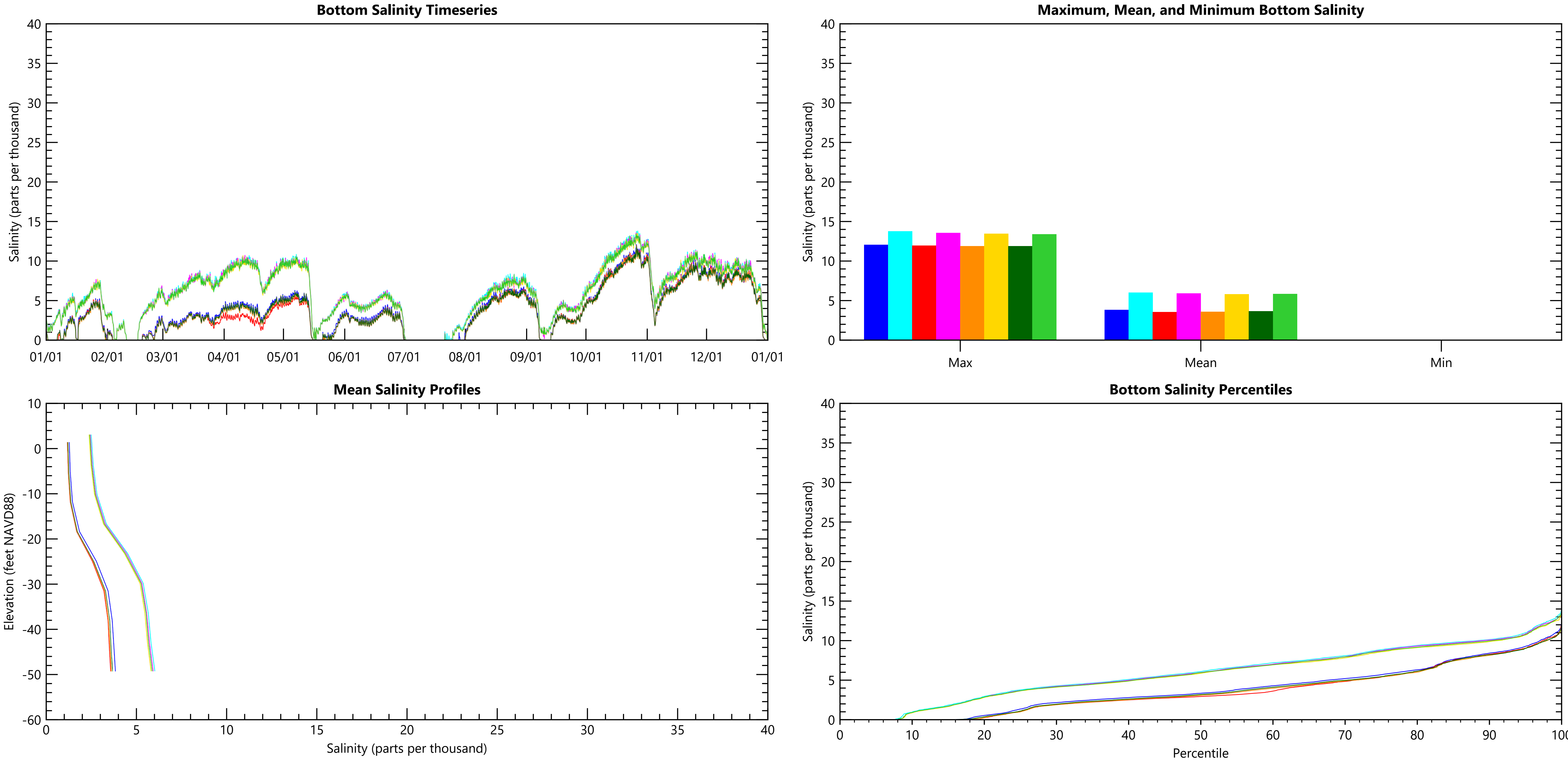

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Figure 23c1
Salinity Point Analysis at Point 28: HSC at Sims Bayou

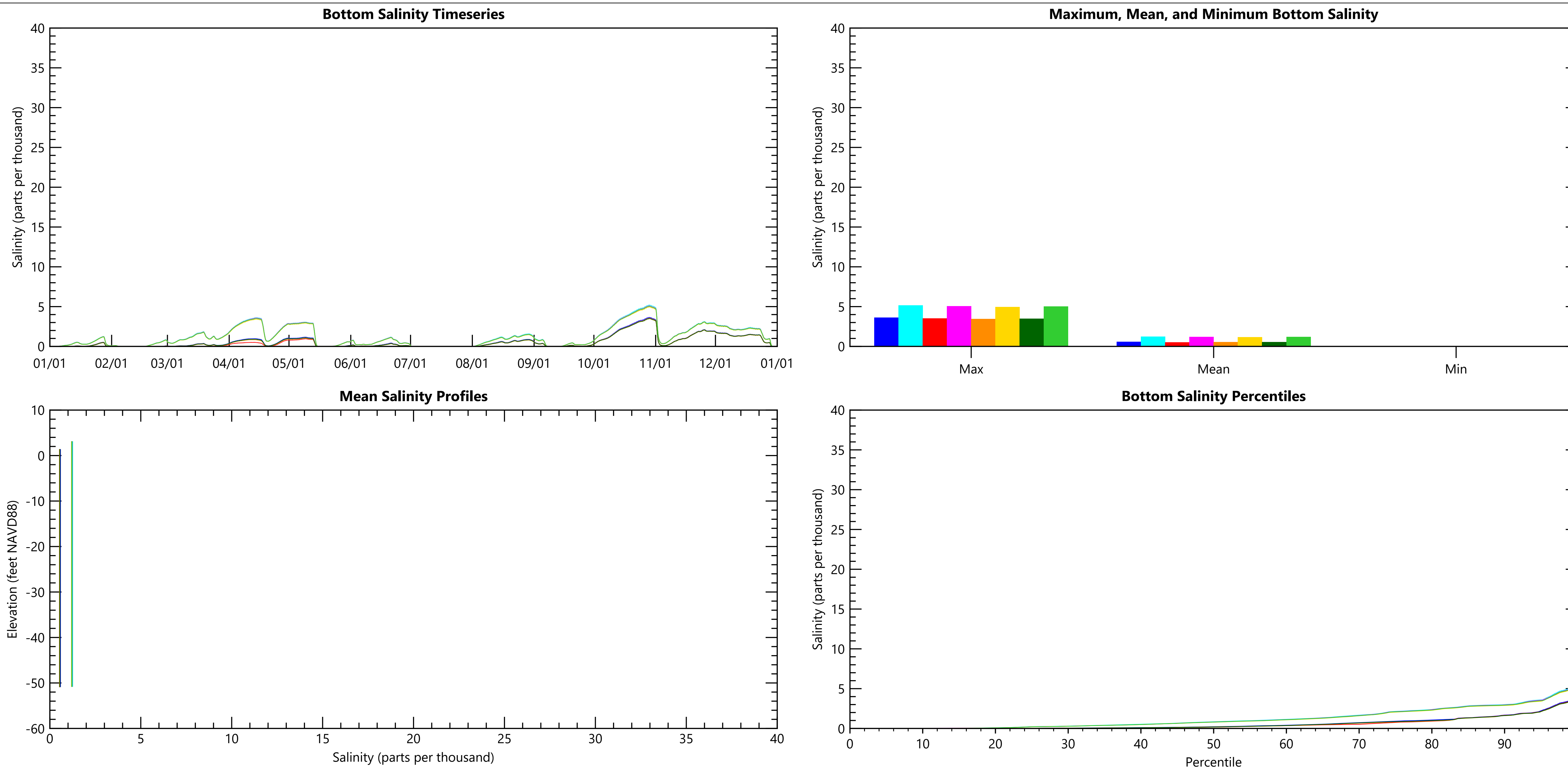

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Figure 23d1
Salinity Point Analysis at Point 29: HSC at Turning Basin
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

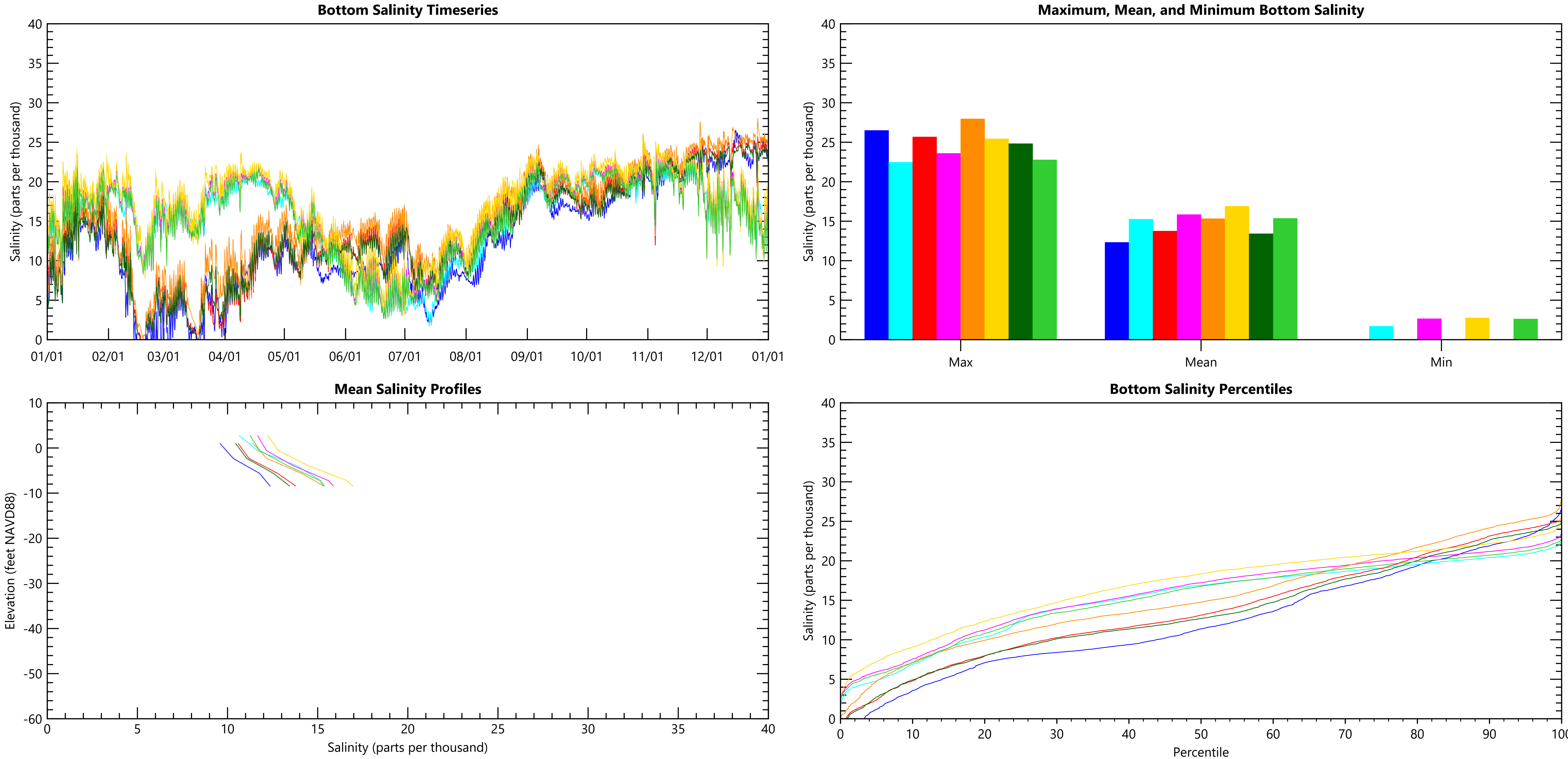

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Figure 23e1
Salinity Point Analysis at Point 30: North of BU Shoreline
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

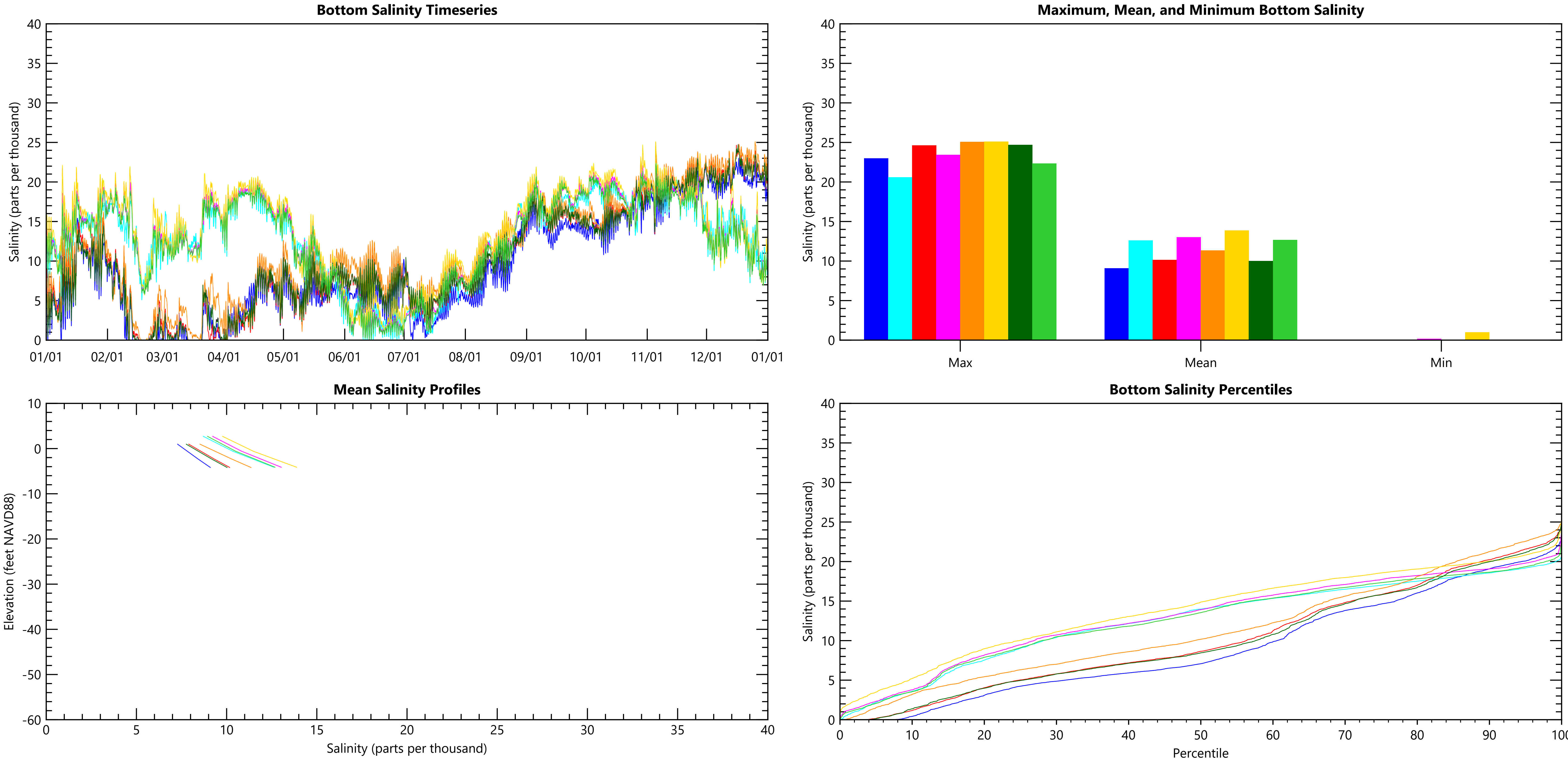

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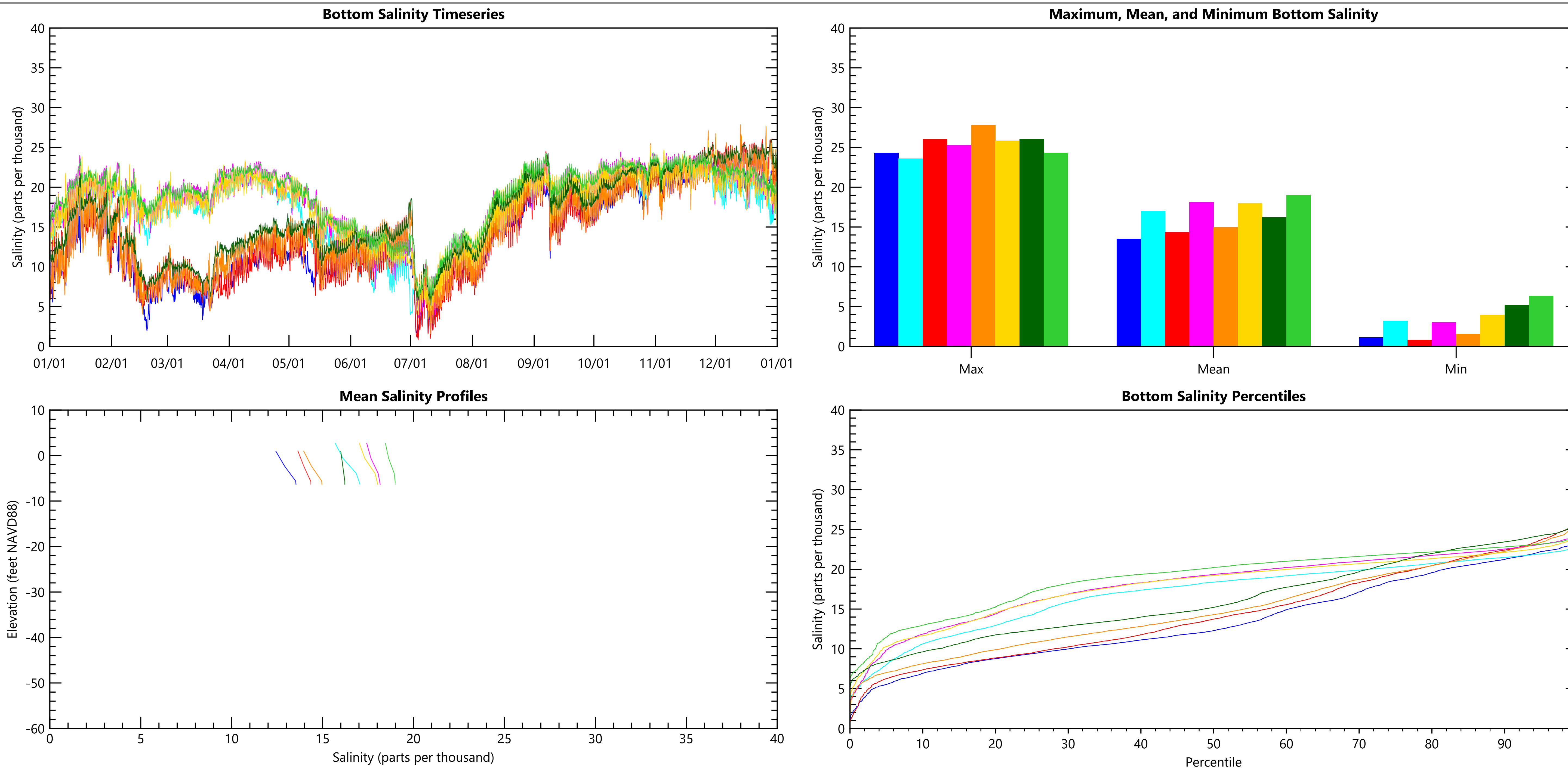
Figure 23f1
Salinity Point Analysis at Point 31: South of Beach City Shoreline



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- FWP Route E

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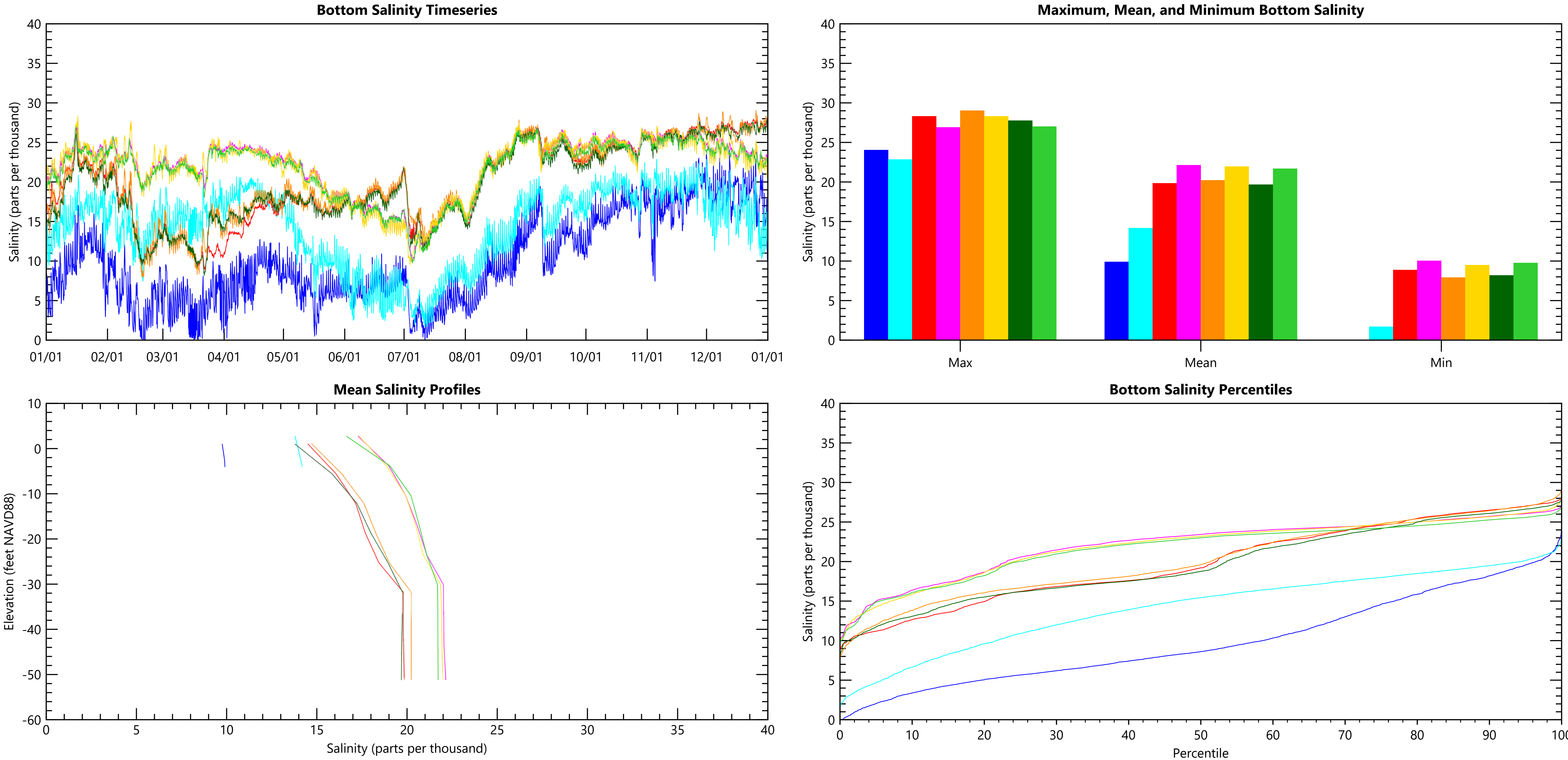
Figure 23g1
Salinity Point Analysis at Point 32: West of Proposed Channel



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

- PWOP
- FWOP
- PWP Route B
- FWP Route B
- PWP Route D
- FWP Route D
- PWP Route E
- FWP Route E

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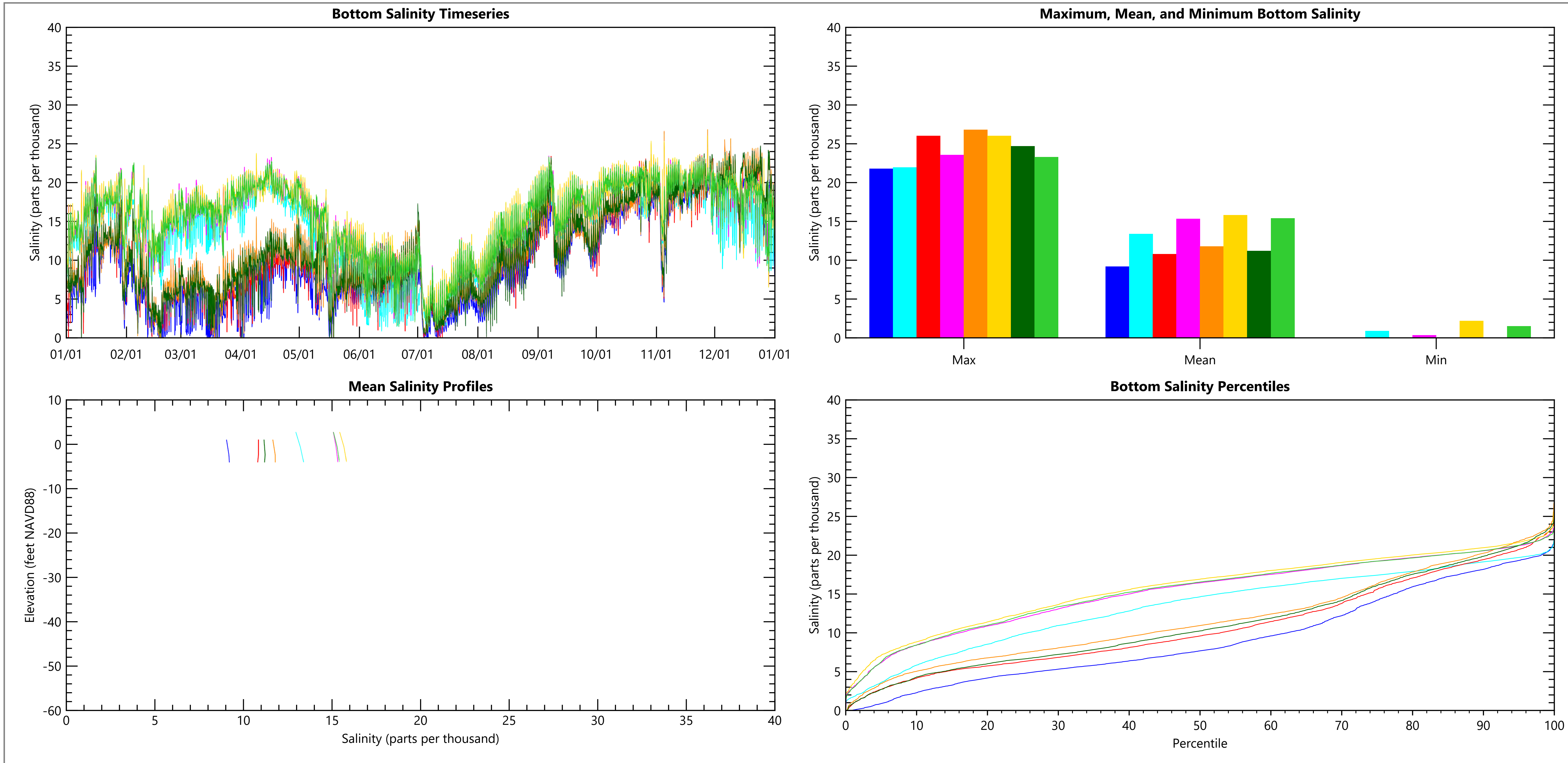
Figure 23h1
Salinity Point Analysis at Point 33: Center of Proposed Channel



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

- PWOP
- FWOP
- PWP Route B
- FWP Route B
- PWP Route D
- FWP Route D
- PWP Route E
- FWP Route E

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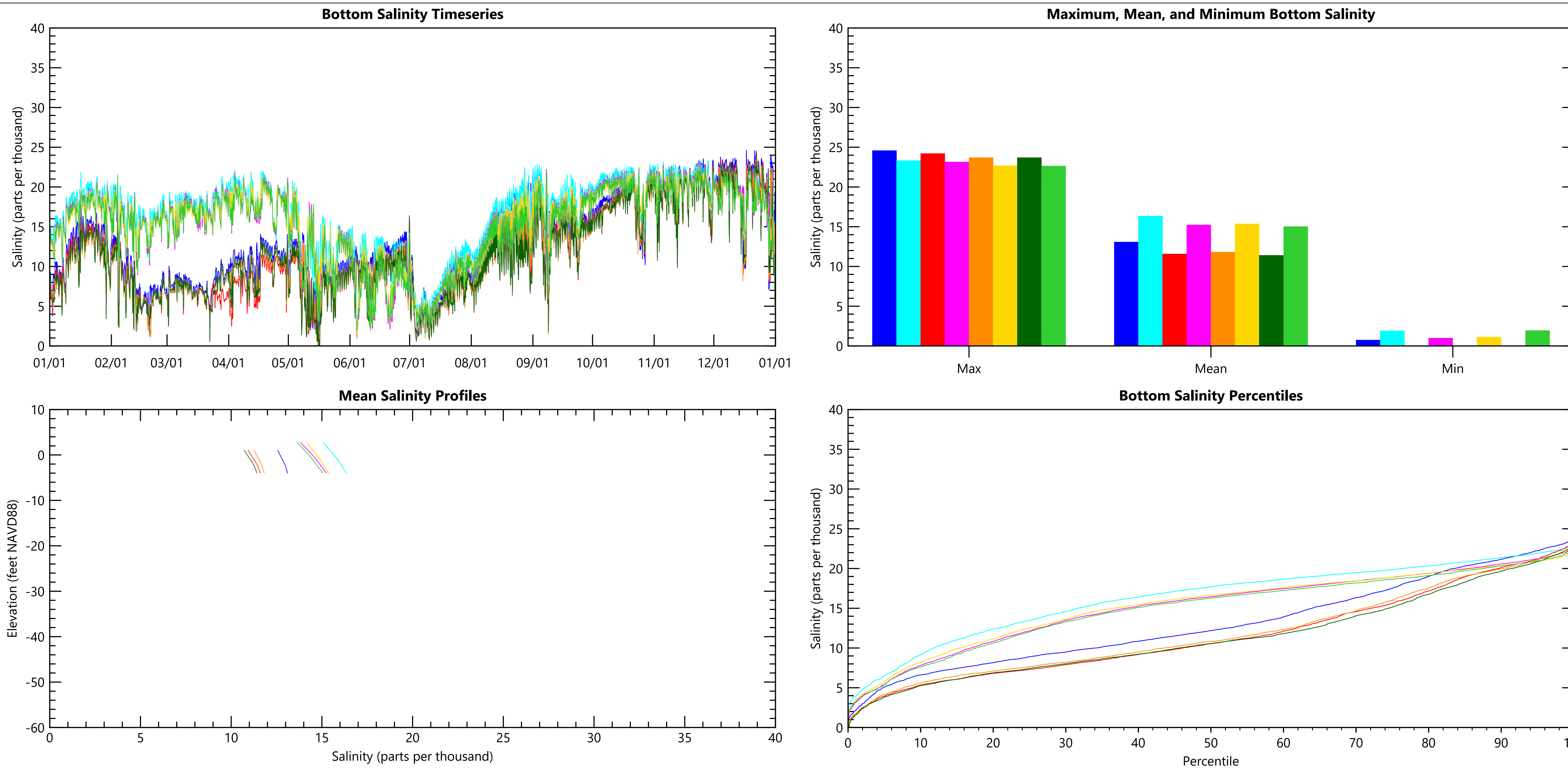
Figure 23i1
Salinity Point Analysis at Point 34: East of Proposed Channel
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

- PWOP
- FWOP
- PWP Route B
- FWP Route B
- PWP Route D
- FWP Route D
- PWP Route E
- FWP Route E

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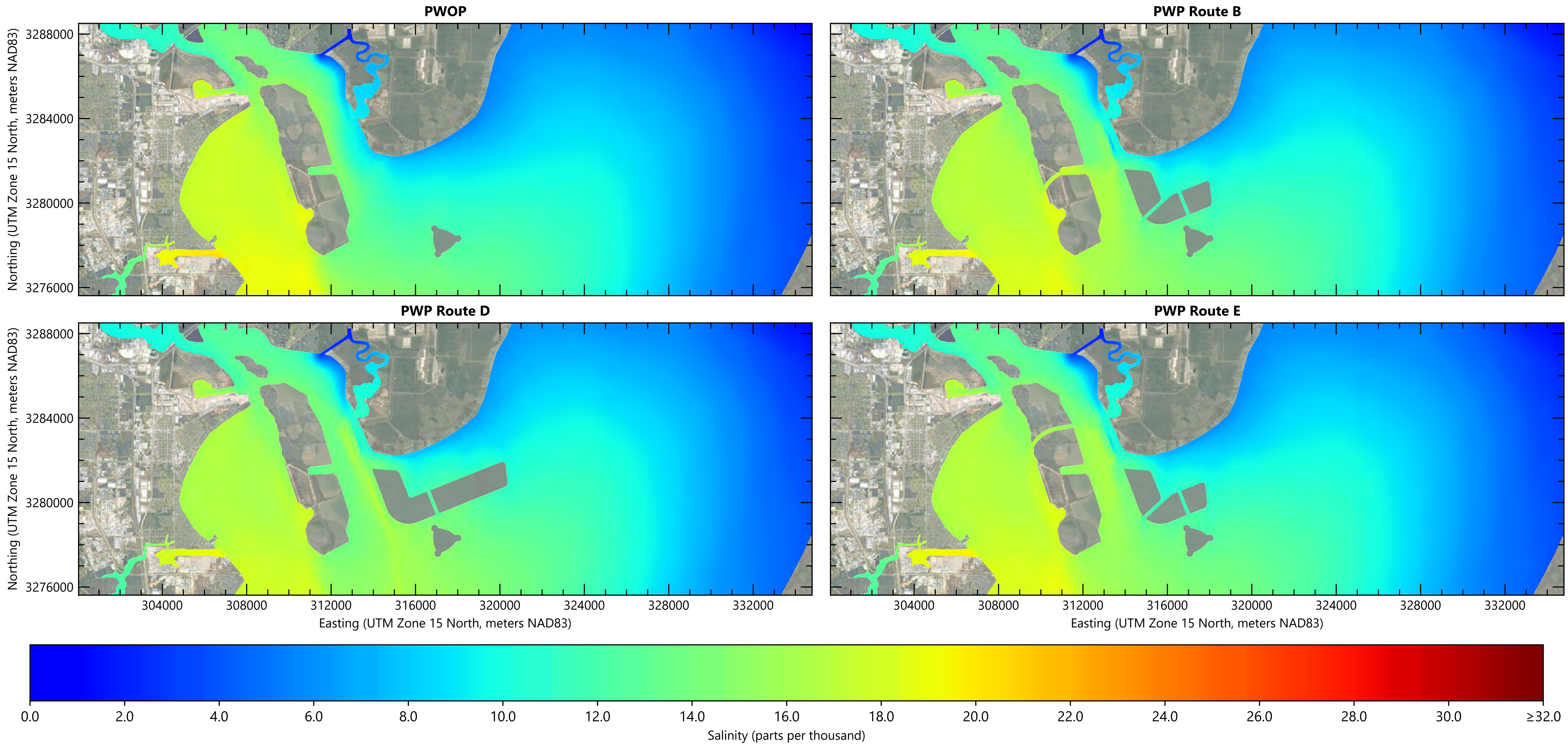
Figure 23j1
Salinity Point Analysis at Point 35: Near Bay Oaks
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, PWOP: Present Without Project, PWP: Present with Project, UTM: Universal Transverse Mercator

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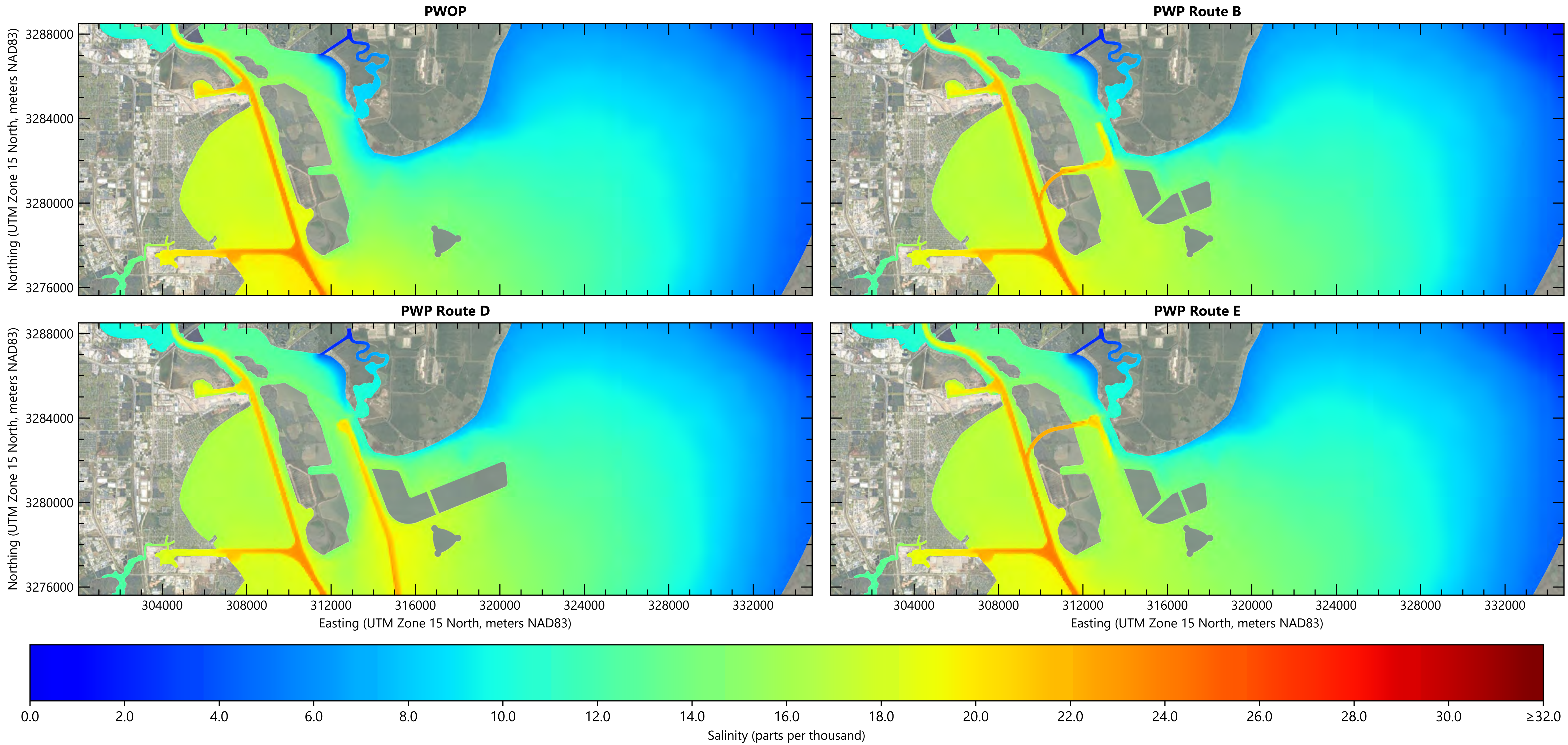
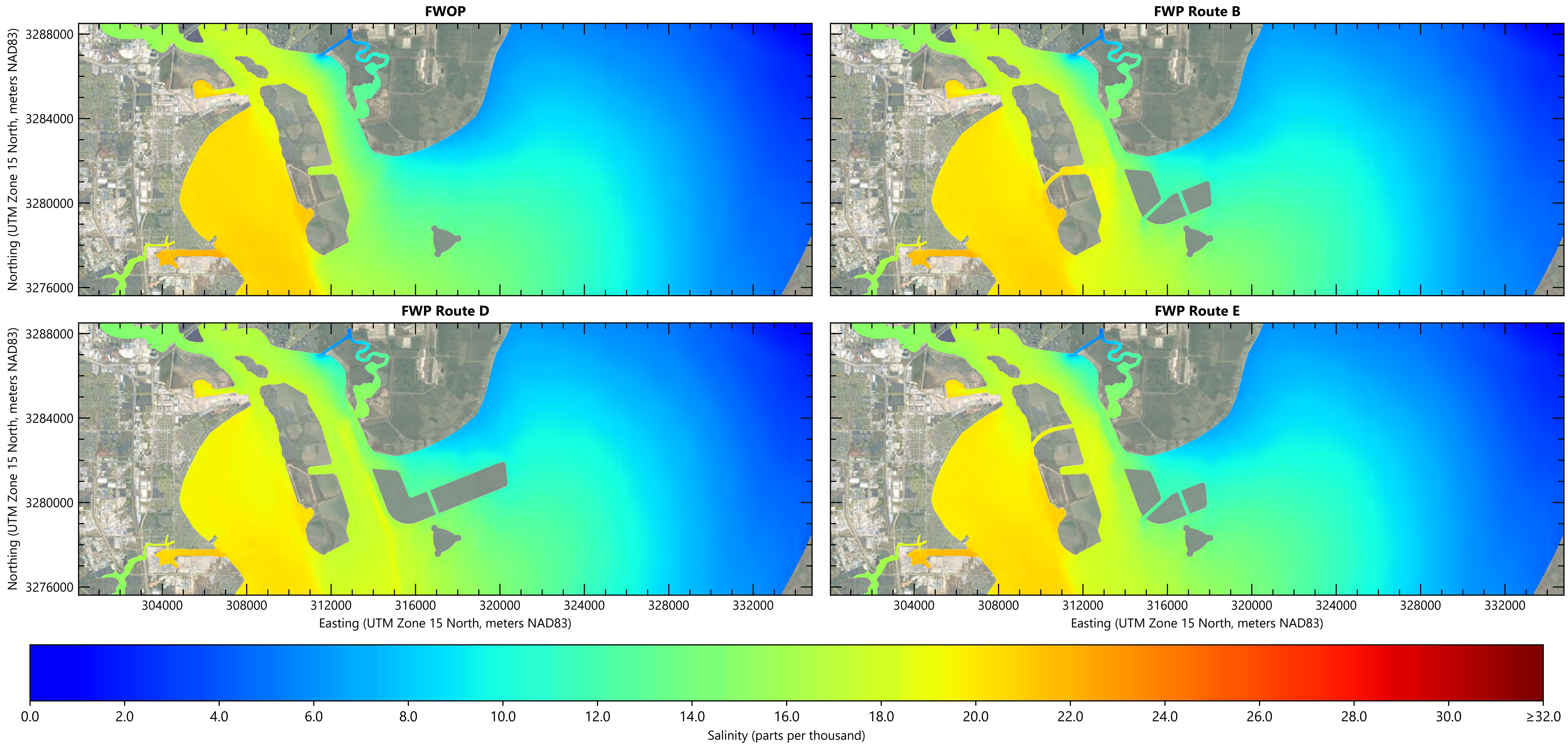
Figure 24a
Comparison of Annual Average Surface Salinities at Area of Interest: Year 0 Scenarios
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, PWOP: Present Without Project, PWP: Present with Project, UTM: Universal Transverse Mercator

Figure 24b

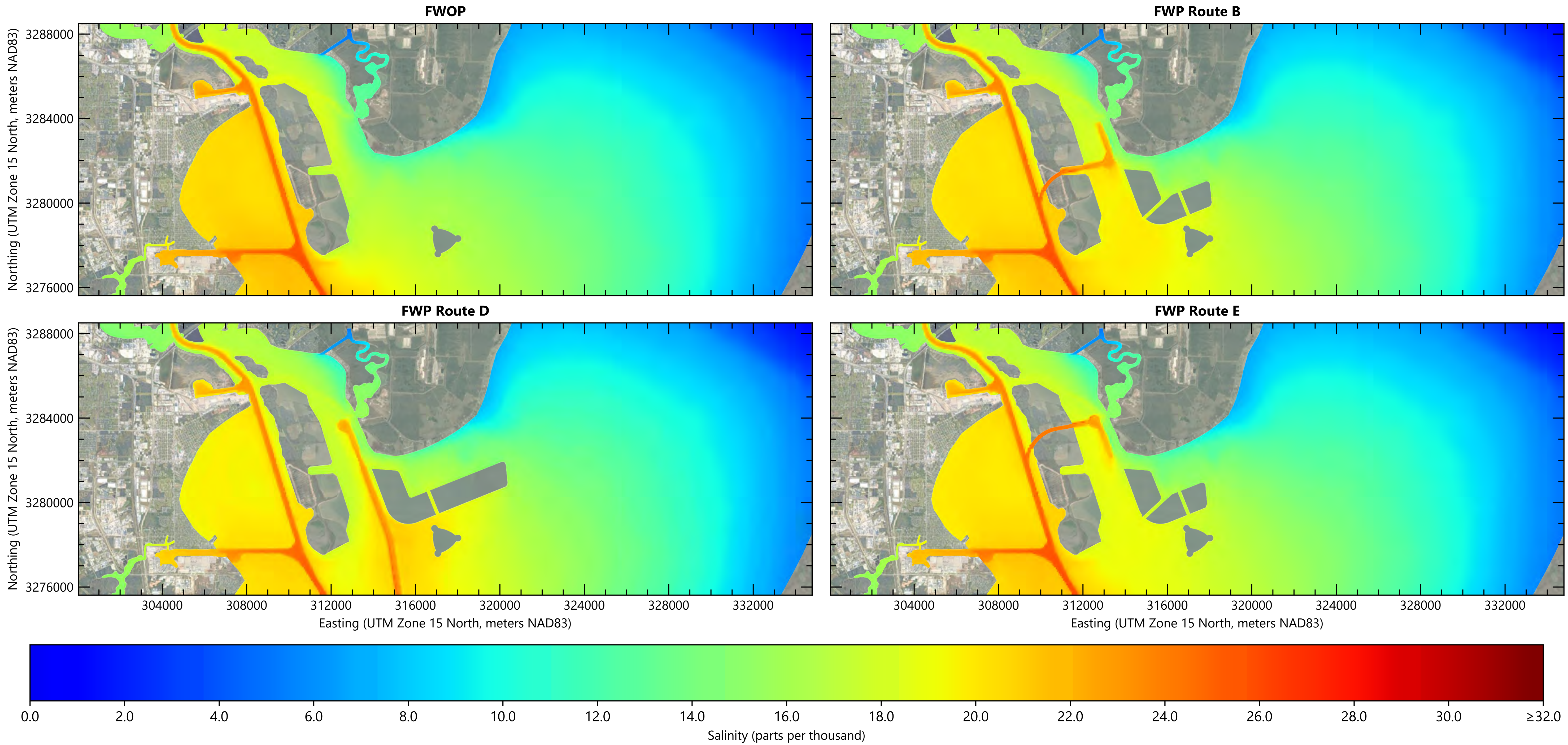
Comparison of Annual Average Bottom Salinities at Area of Interest: Year 0 Scenarios



Notes: Basemap Source: Google Satellite Imagery, FWOP: Future Without Project, FWP: Future with Project, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

Figure 24c

Comparison of Annual Average Surface Salinities at Area of Interest: Year 50 Scenarios



Notes: Basemap Source: Google Satellite Imagery, FWOP: Future Without Project, FWP: Future with Project, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

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Figure 24d
Comparison of Annual Average Bottom Salinities at Area of Interest: Year 50 Scenarios
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

Notes: Basemap Source: Bing Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

○ Cross Section Starting Location and Designation

— Cross Section Line

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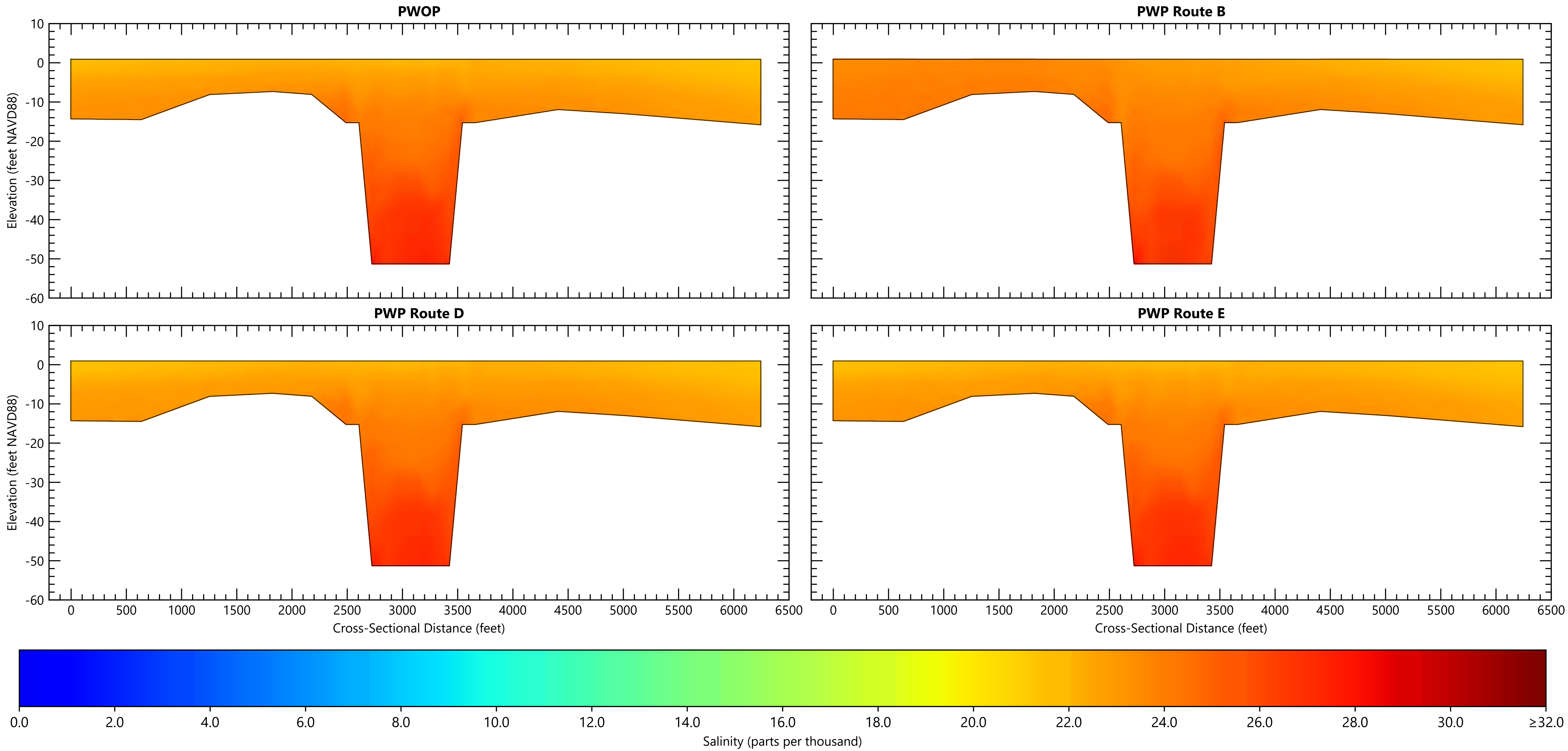
Figure 25a
Salinity Cross-Sectional Analysis Reference Map
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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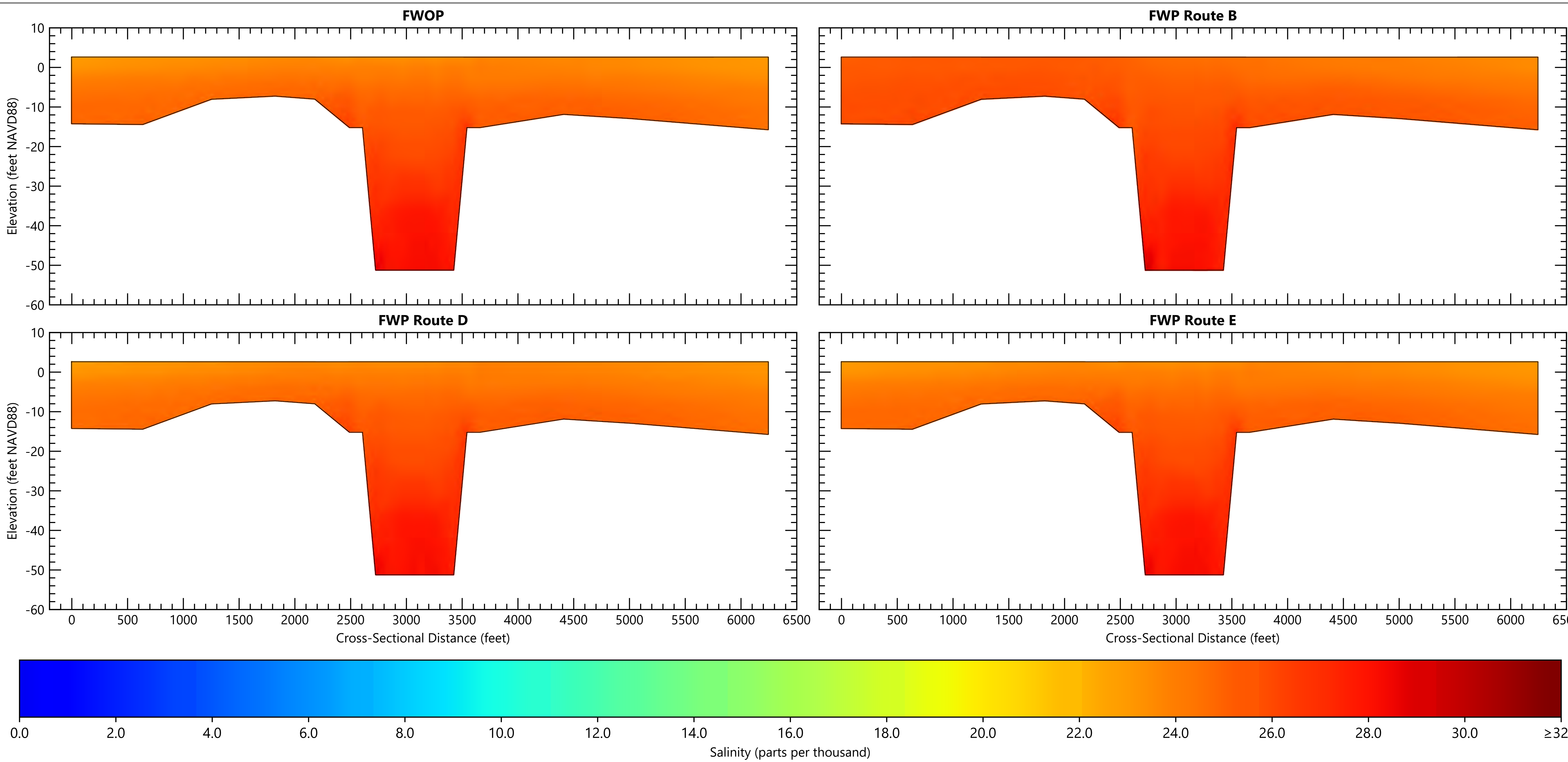
Figure 25b
Cross Section 1 Annual Average Salinity: Year 0 Scenarios
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988

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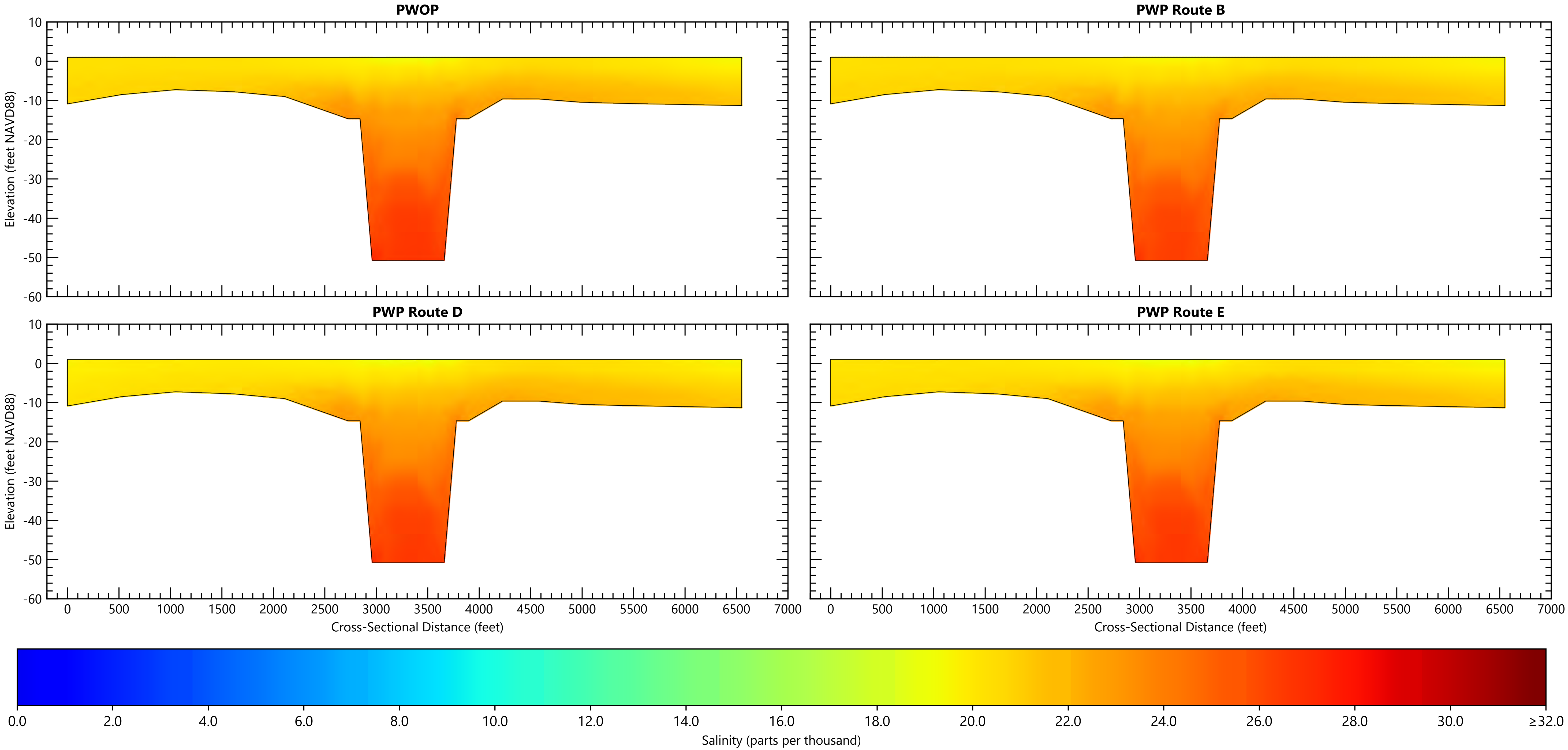
Figure 25c
Cross Section 1 Annual Average Salinity: Year 50 Scenarios



Notes: NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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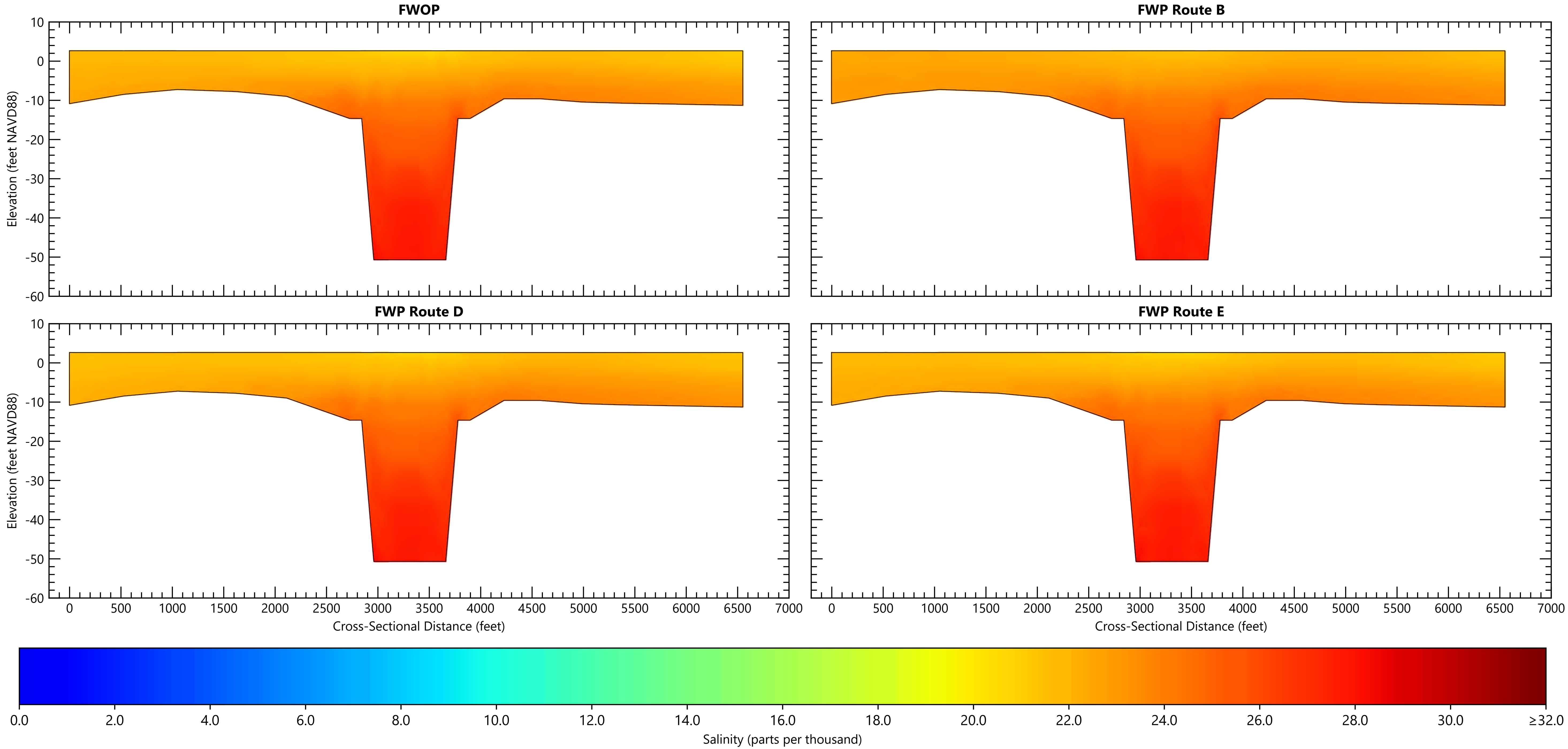
Figure 25d
Cross Section 2 Annual Average Salinity: Year 0 Scenarios
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988

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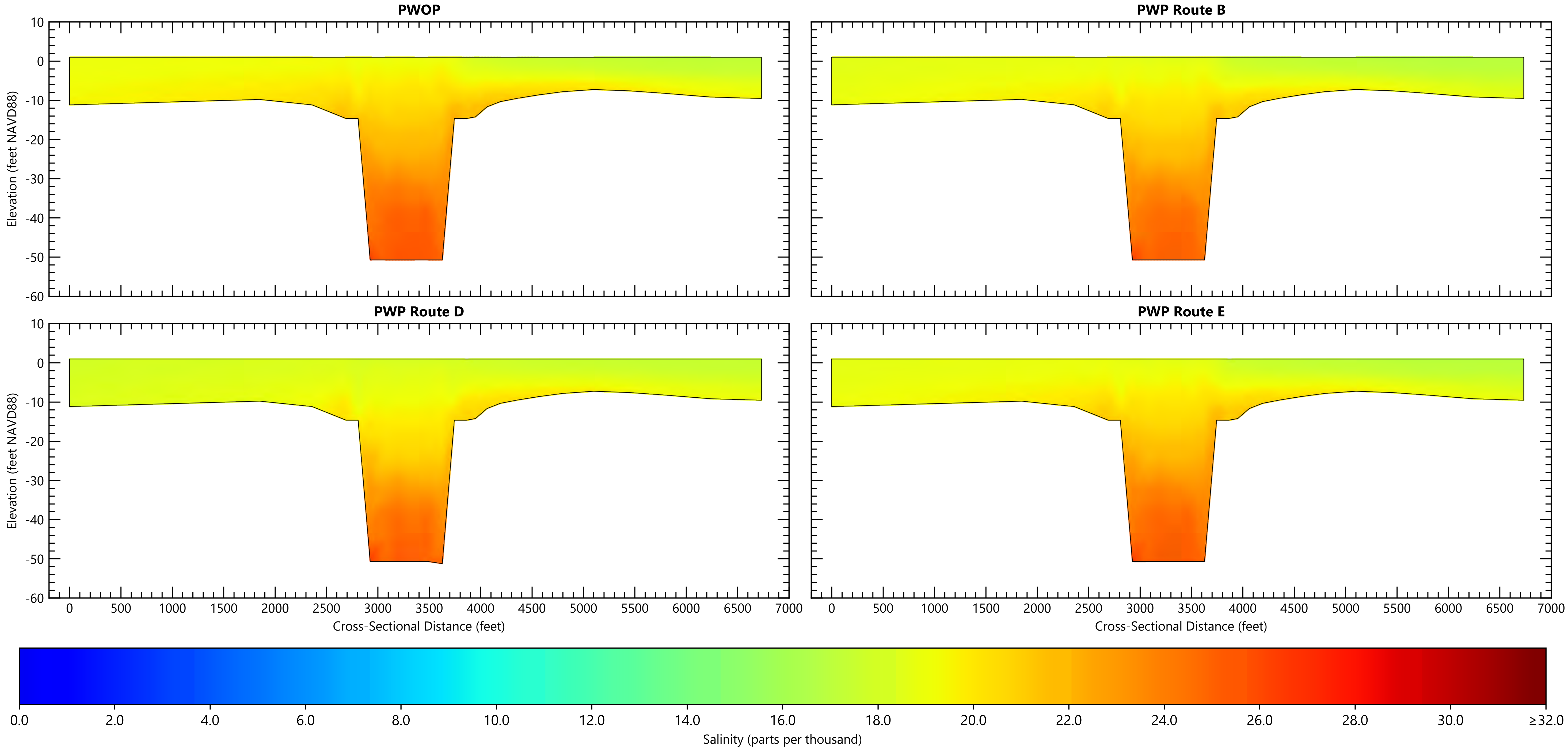
Figure 25e
Cross Section 2 Annual Average Salinity: Year 50 Scenarios



Notes: NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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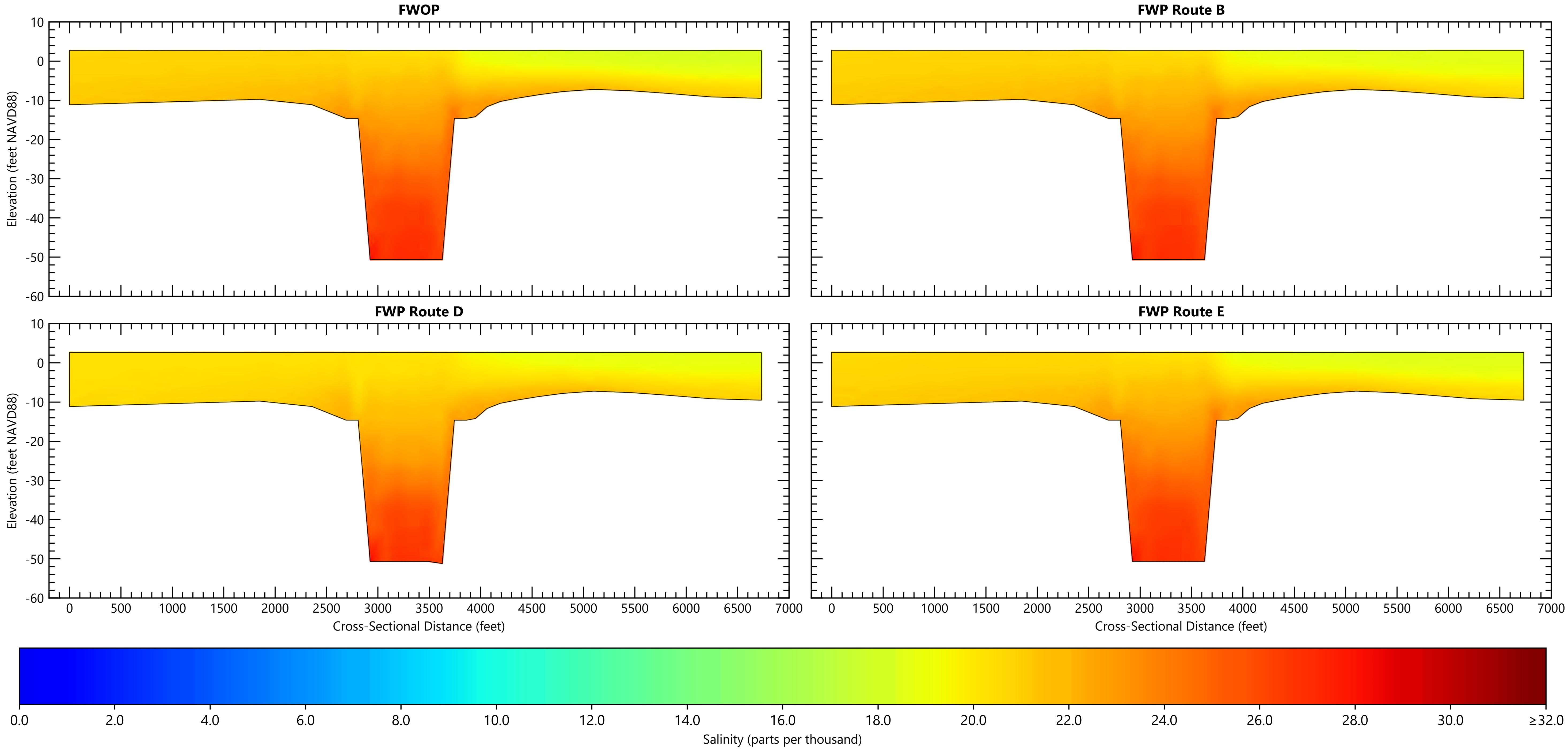
Figure 25f
Cross Section 3 Annual Average Salinity: Year 0 Scenarios
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988

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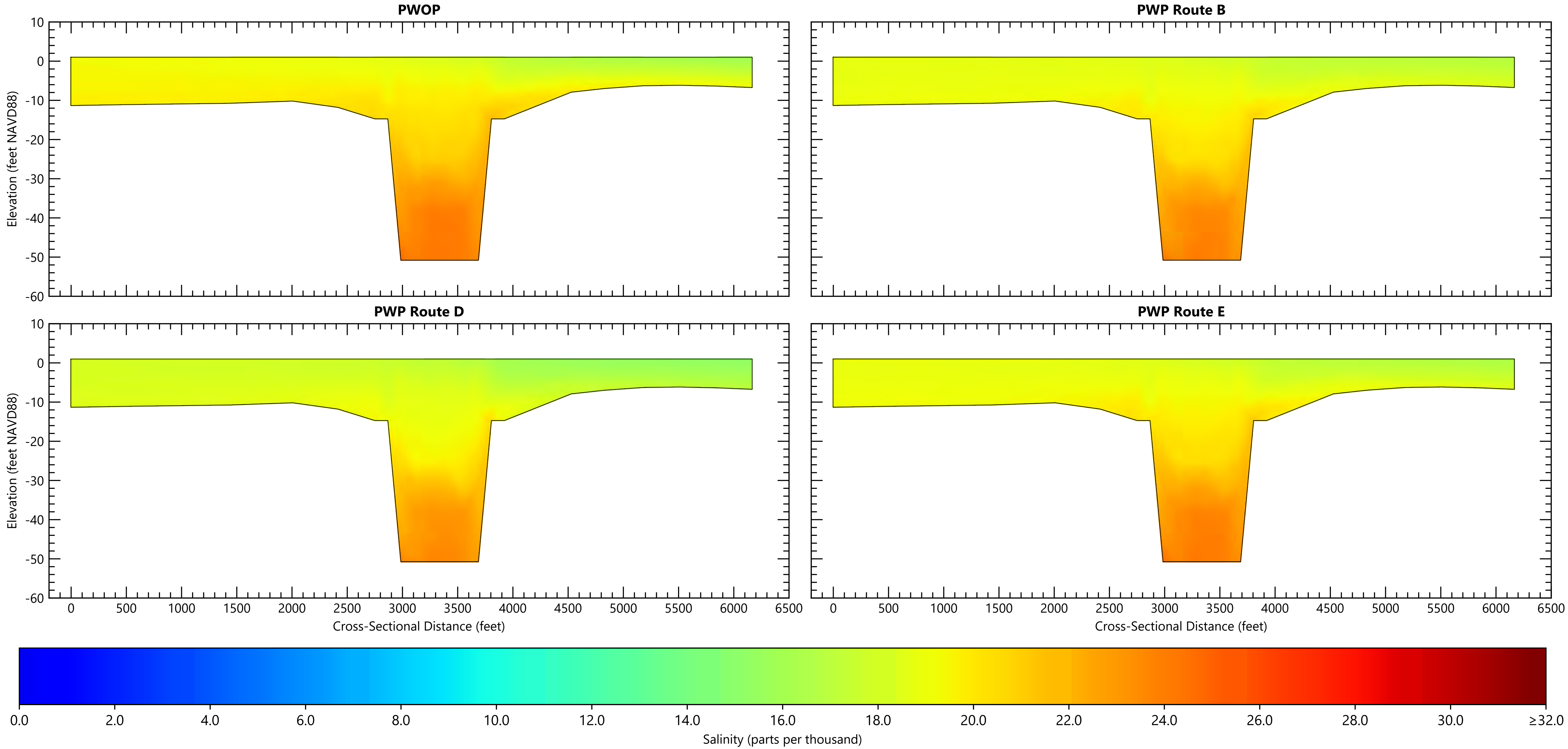
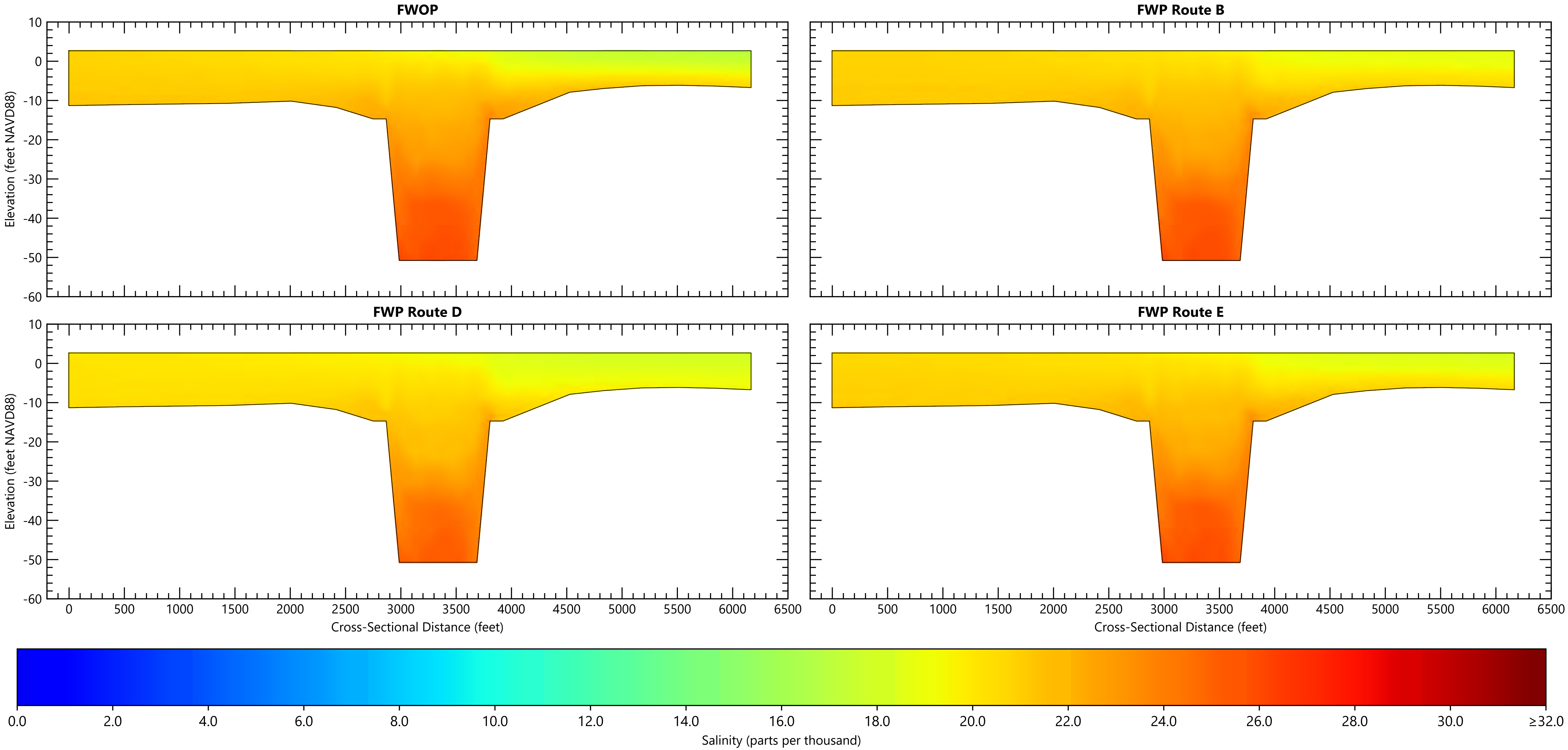
Figure 25g
Cross Section 3 Annual Average Salinity: Year 50 Scenarios



Notes: NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

Figure 25h
Cross Section 4 Annual Average Salinity: Year 0 Scenarios



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988

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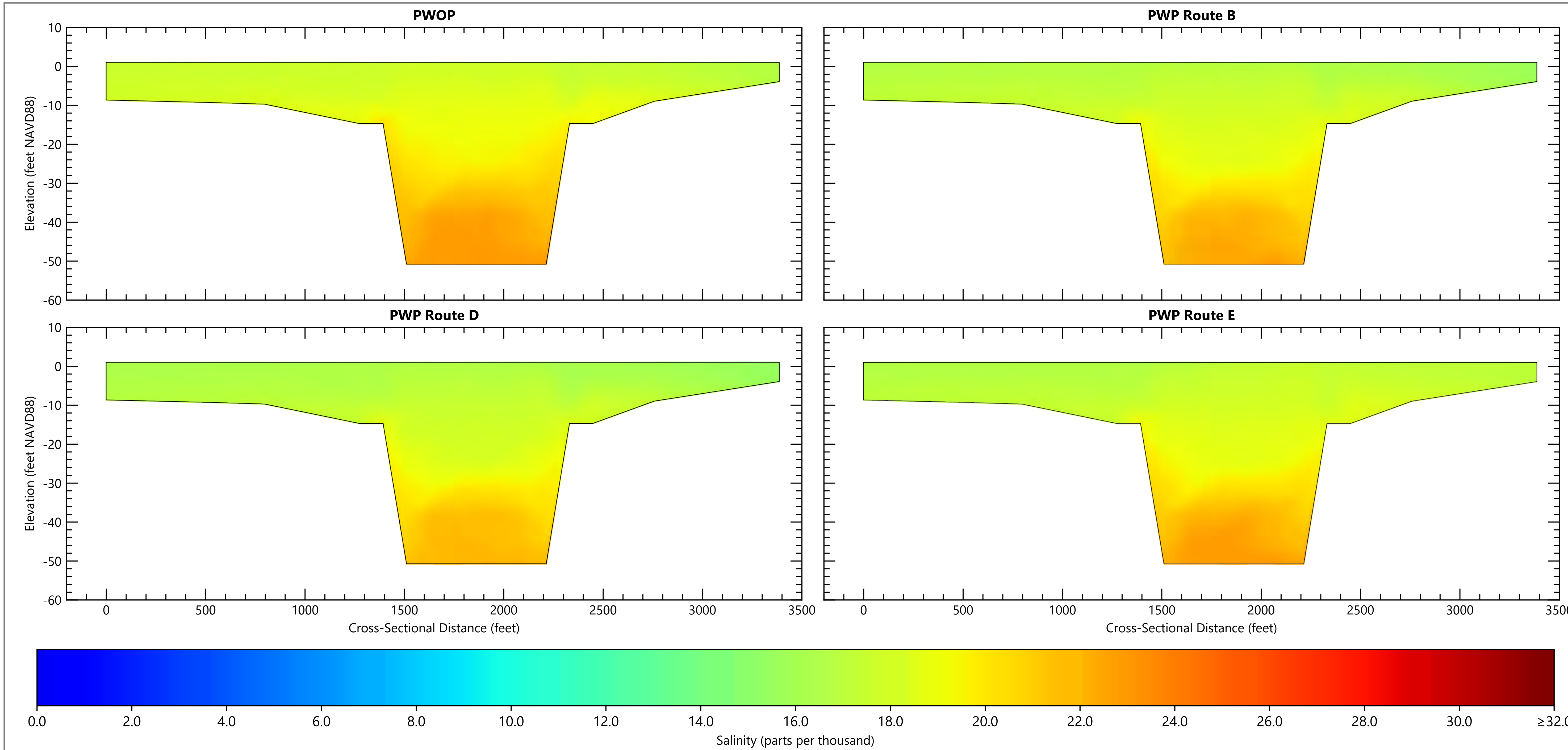
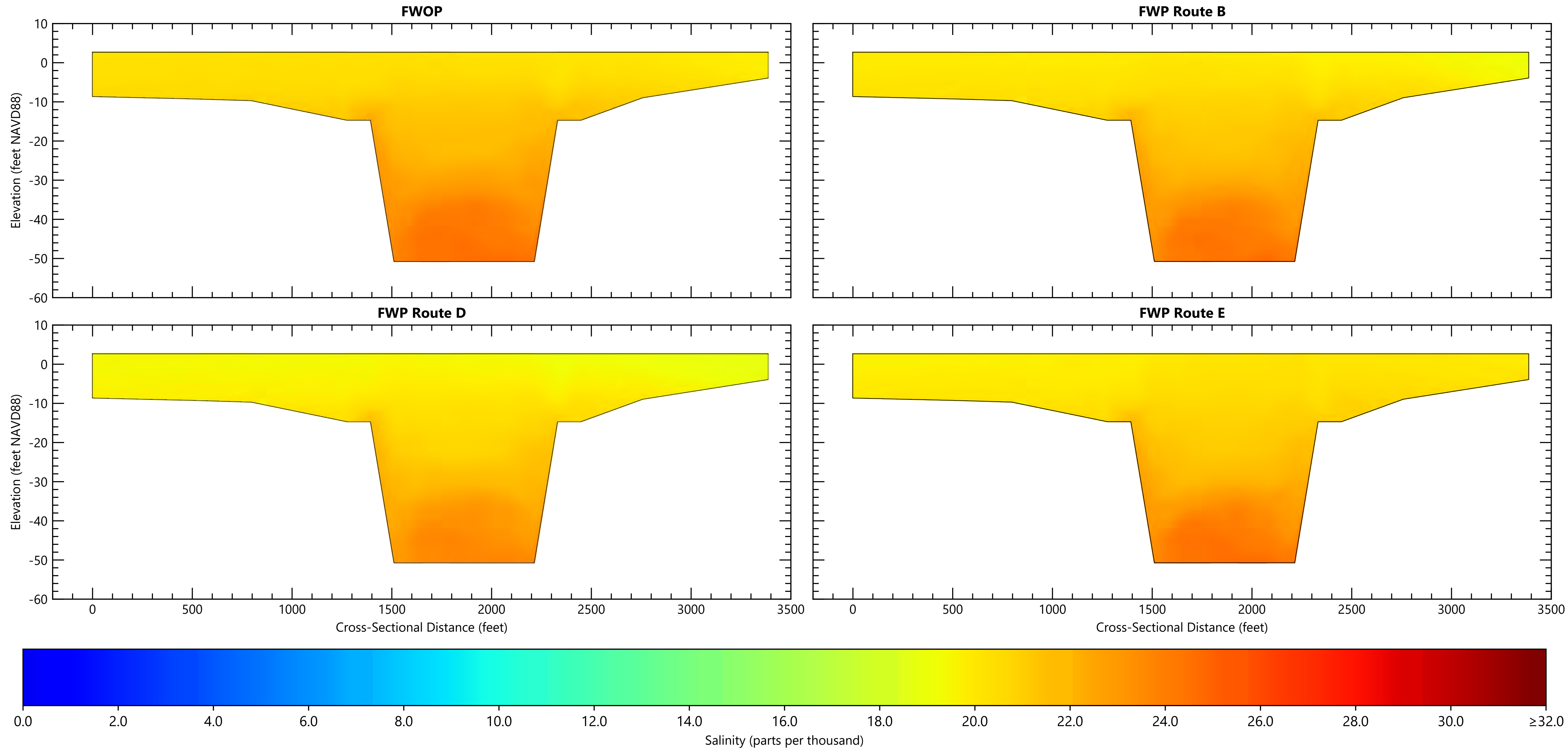
Figure 25i
Cross Section 4 Annual Average Salinity: Year 50 Scenarios



Notes: NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

Figure 25j
Cross Section 5 Annual Average Salinity: Year 0 Scenarios



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988

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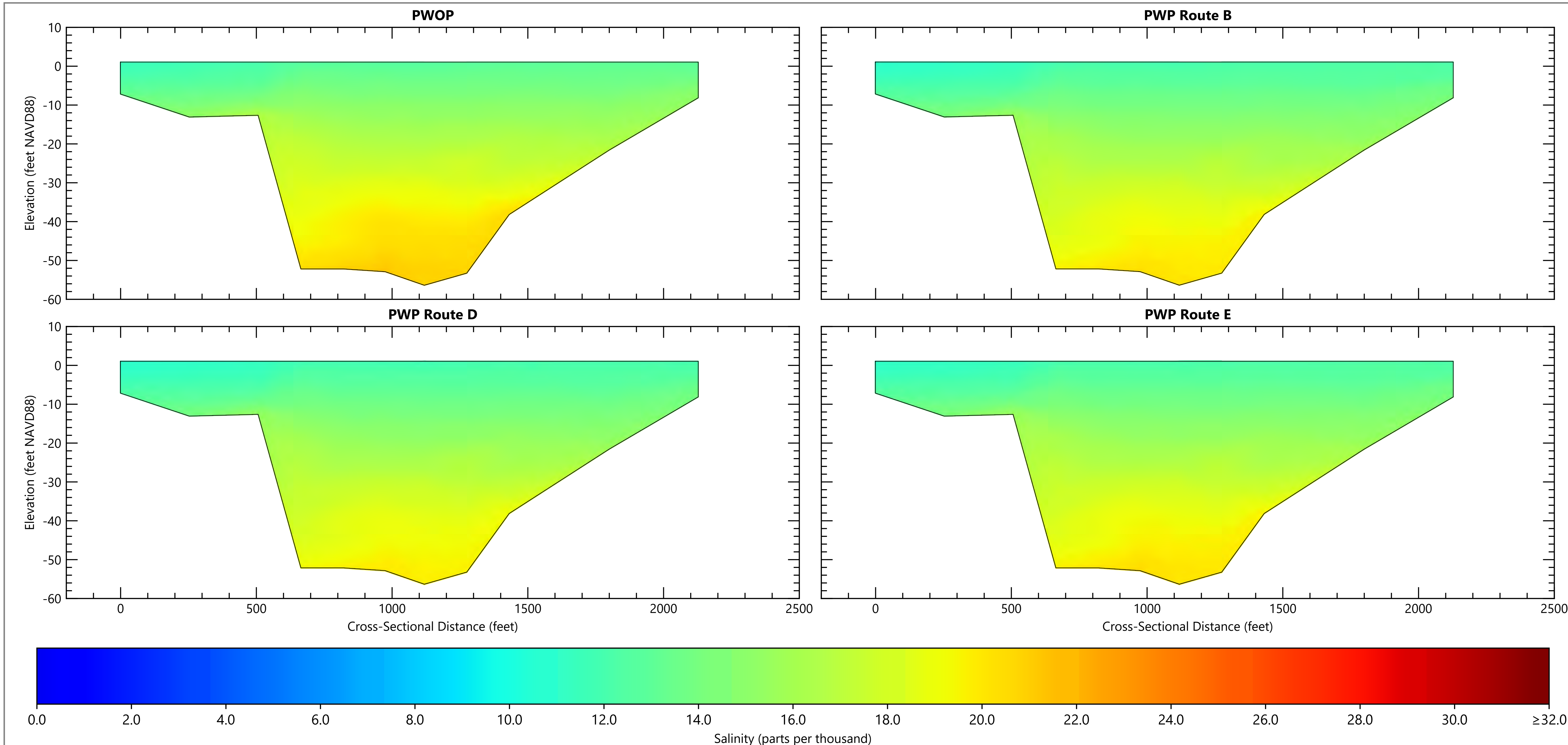
Figure 25k
Cross Section 5 Annual Average Salinity: Year 50 Scenarios



Notes: NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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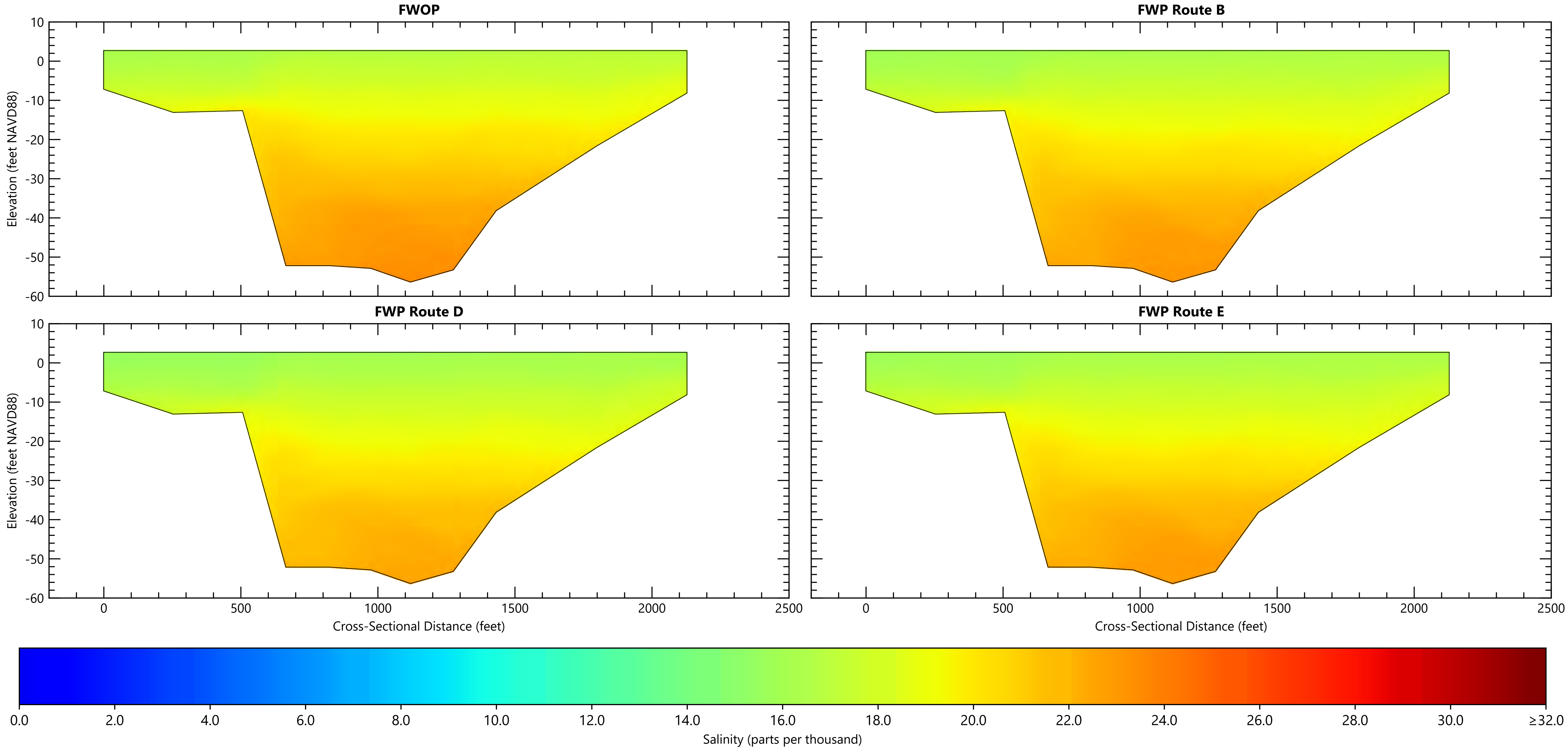
Figure 25l
Cross Section 6 Annual Average Salinity: Year 0 Scenarios
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988

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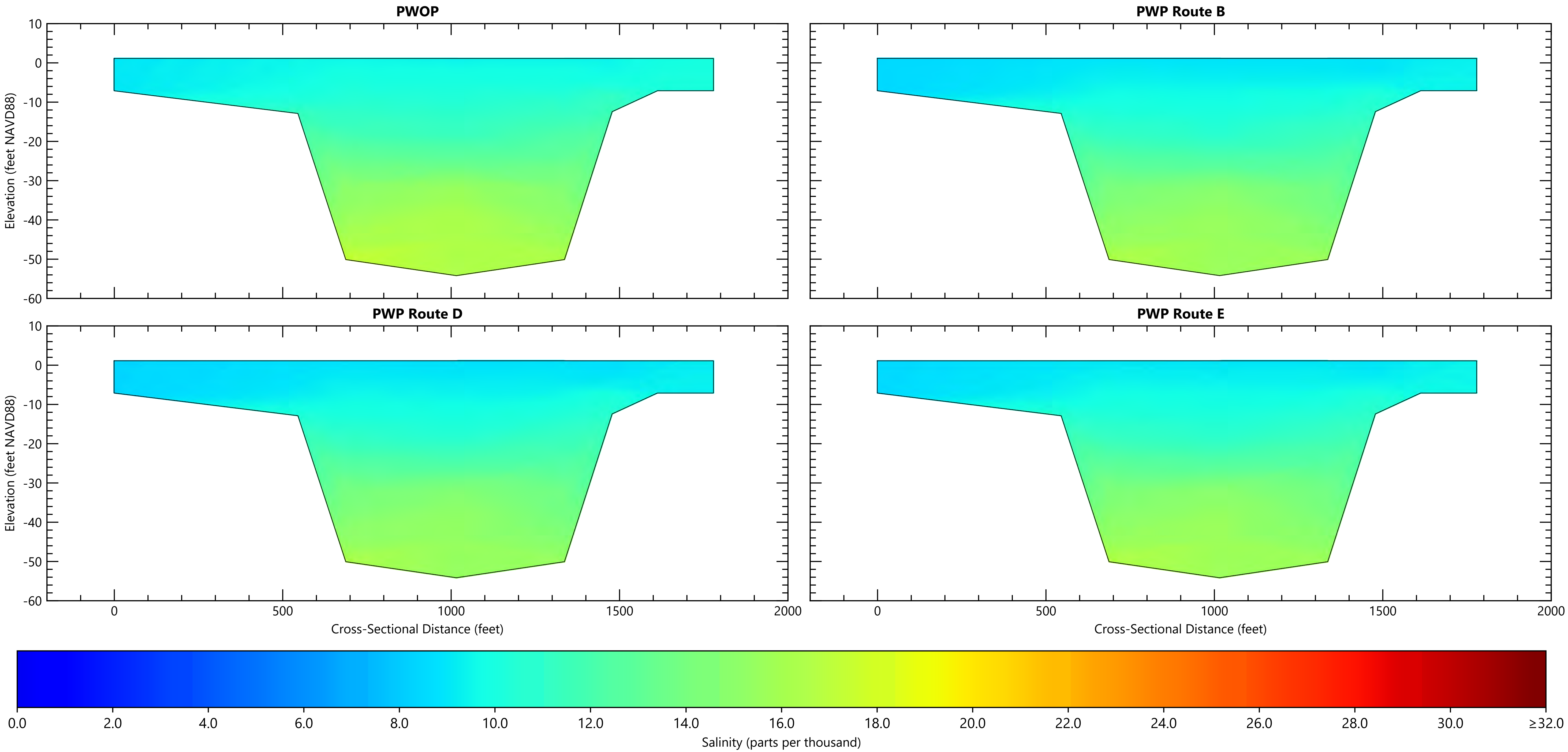
Figure 25m
Cross Section 6 Annual Average Salinity: Year 50 Scenarios
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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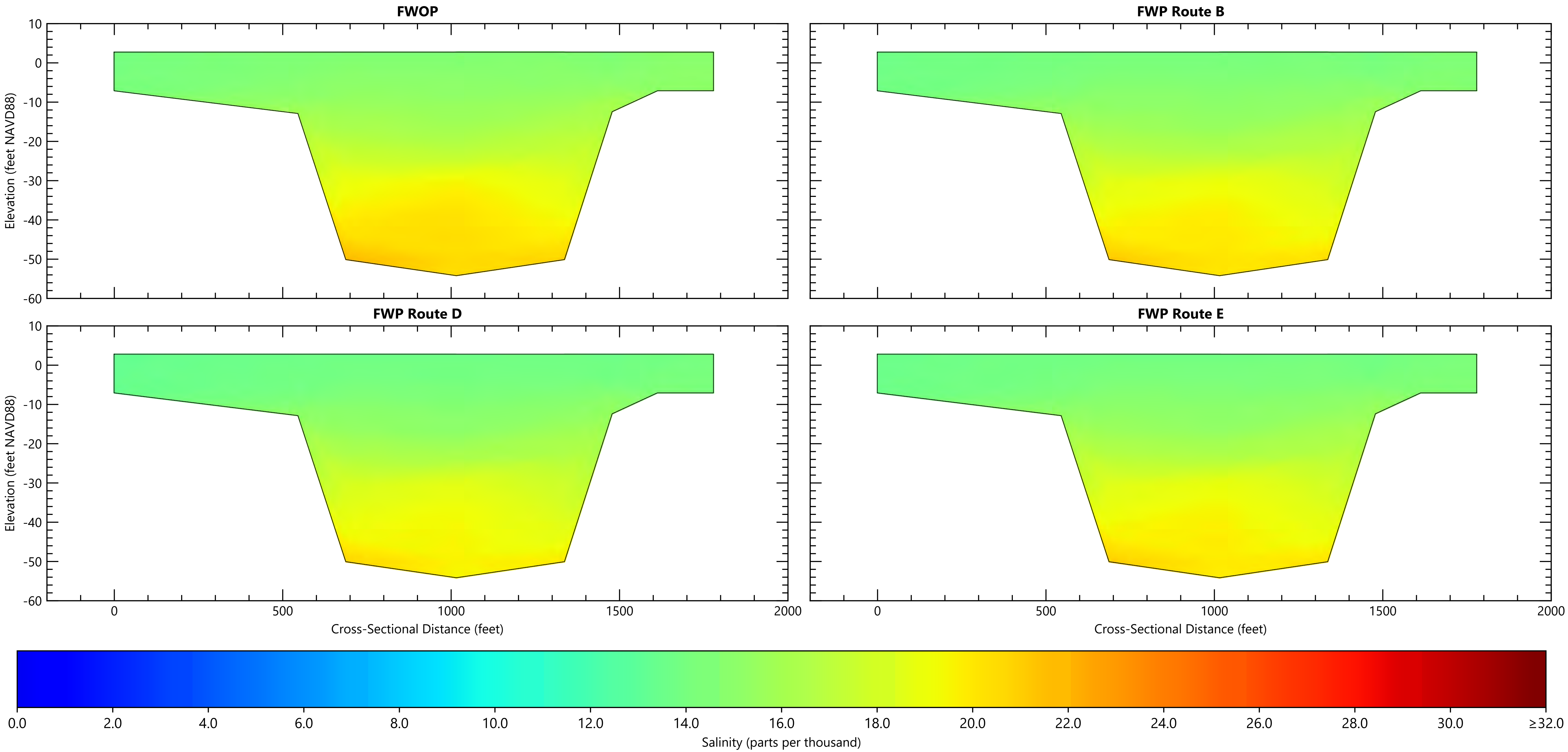
Figure 25n
Cross Section 7 Annual Average Salinity: Year 0 Scenarios



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988

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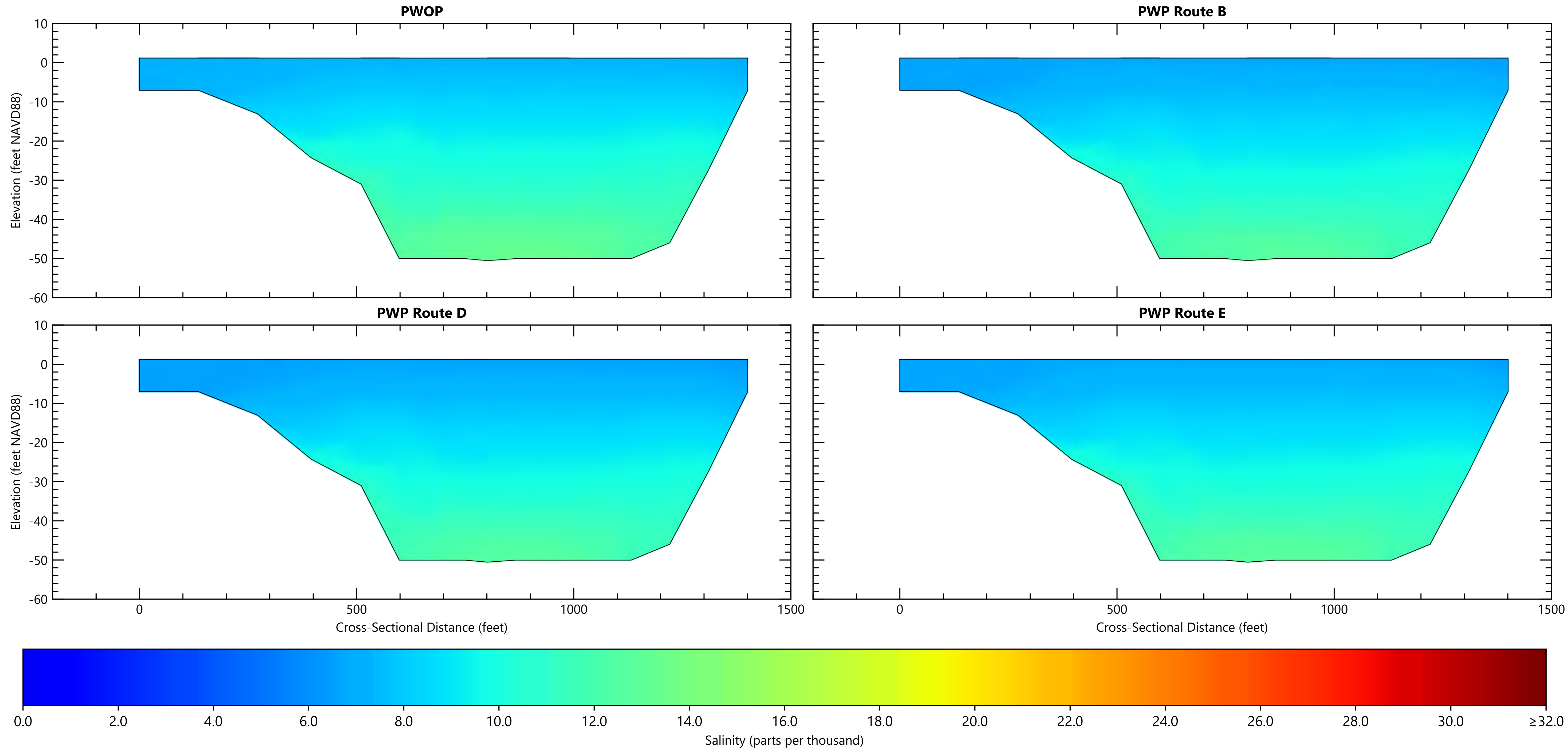
Figure 25o
Cross Section 7 Annual Average Salinity: Year 50 Scenarios
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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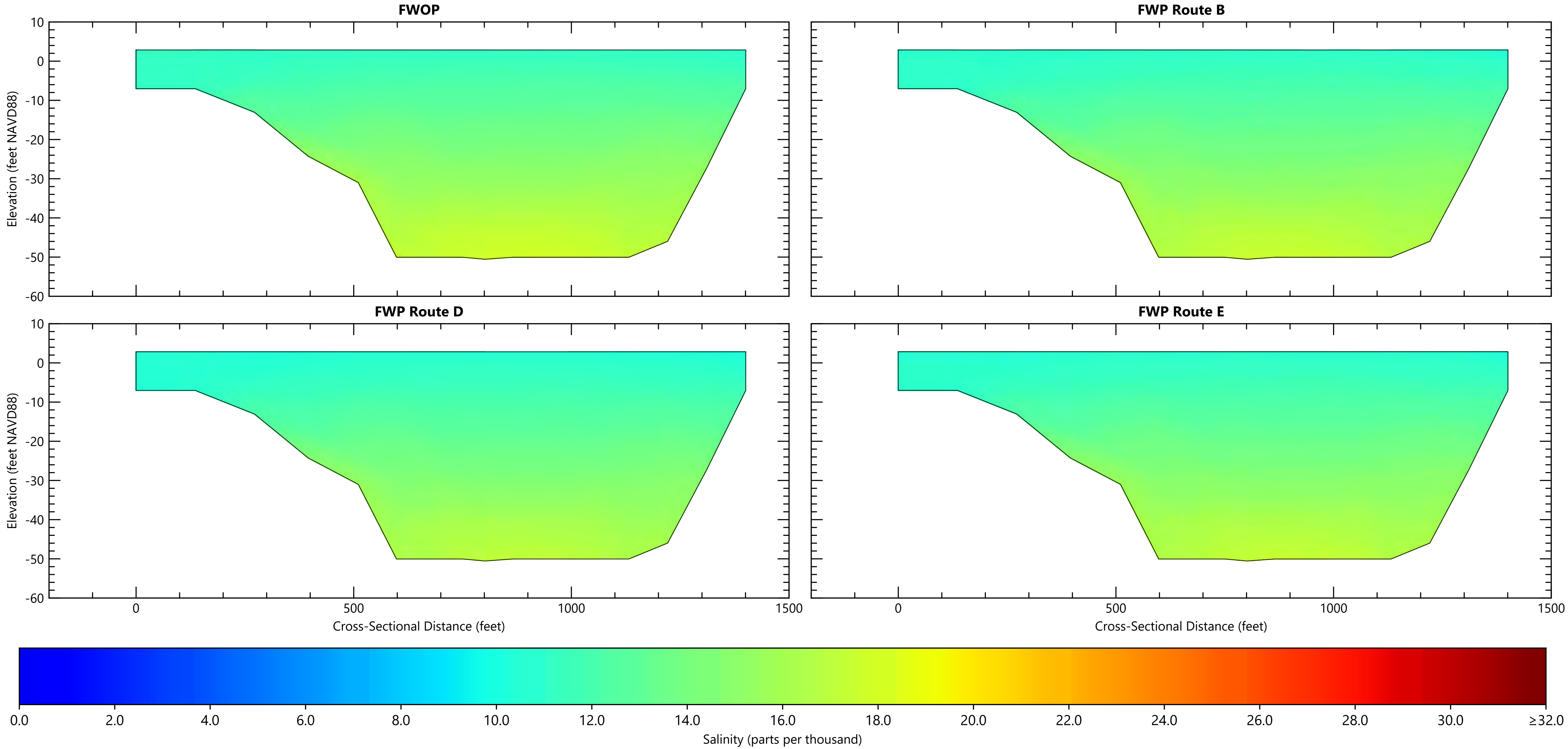
Figure 25p
Cross Section 8 Annual Average Salinity: Year 0 Scenarios



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988

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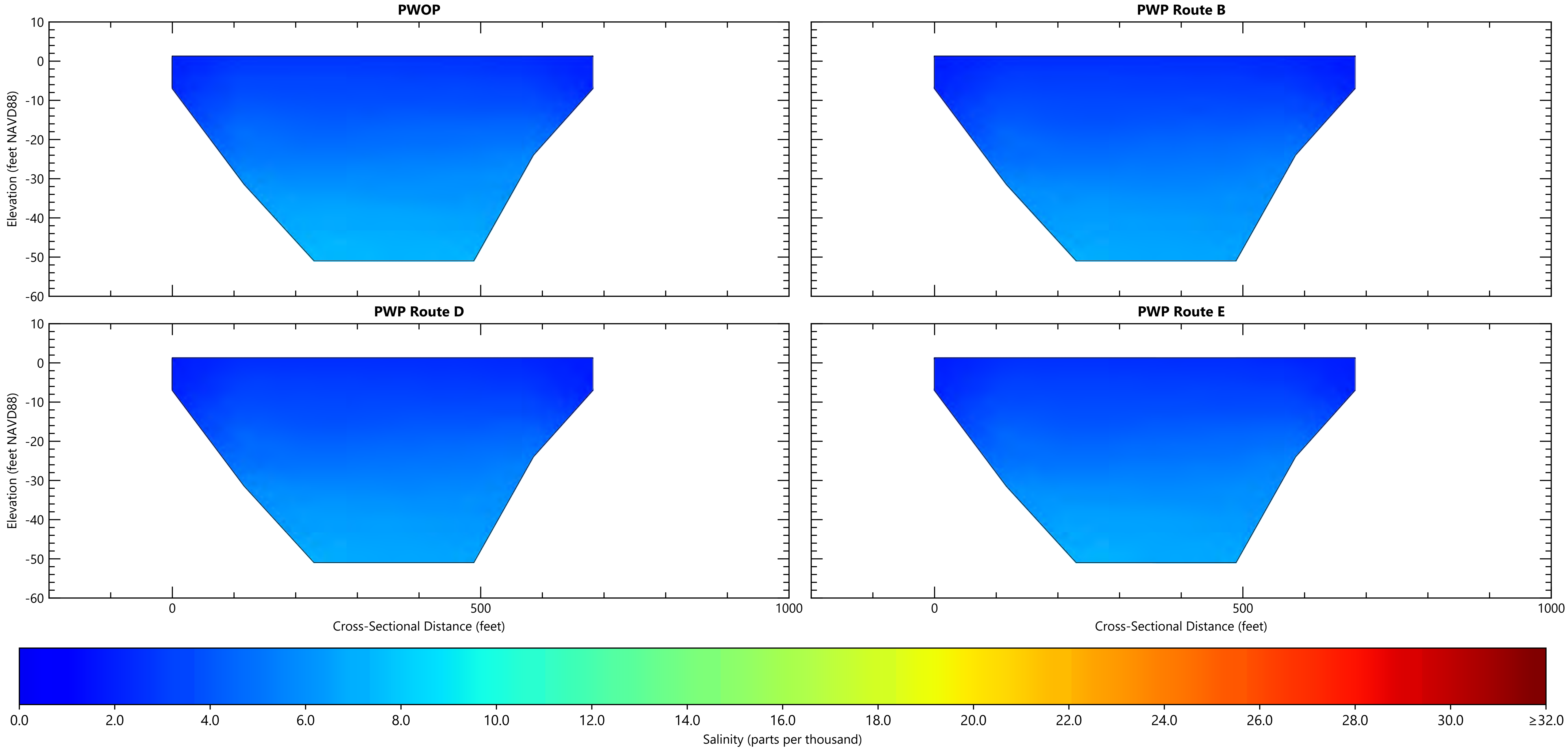
Figure 25q
Cross Section 8 Annual Average Salinity: Year 50 Scenarios



Notes: NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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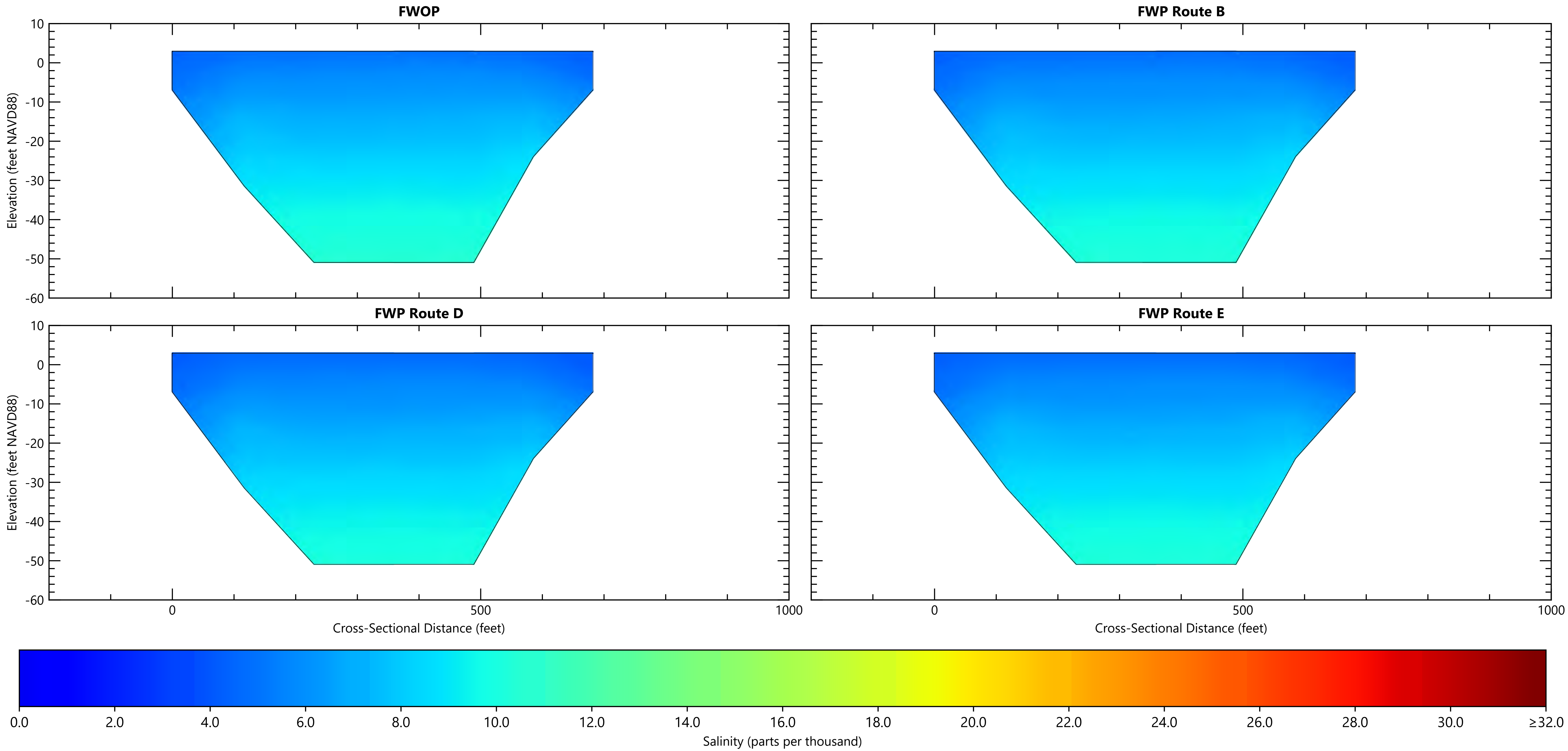
Figure 25r
Cross Section 9 Annual Average Salinity: Year 0 Scenarios
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988

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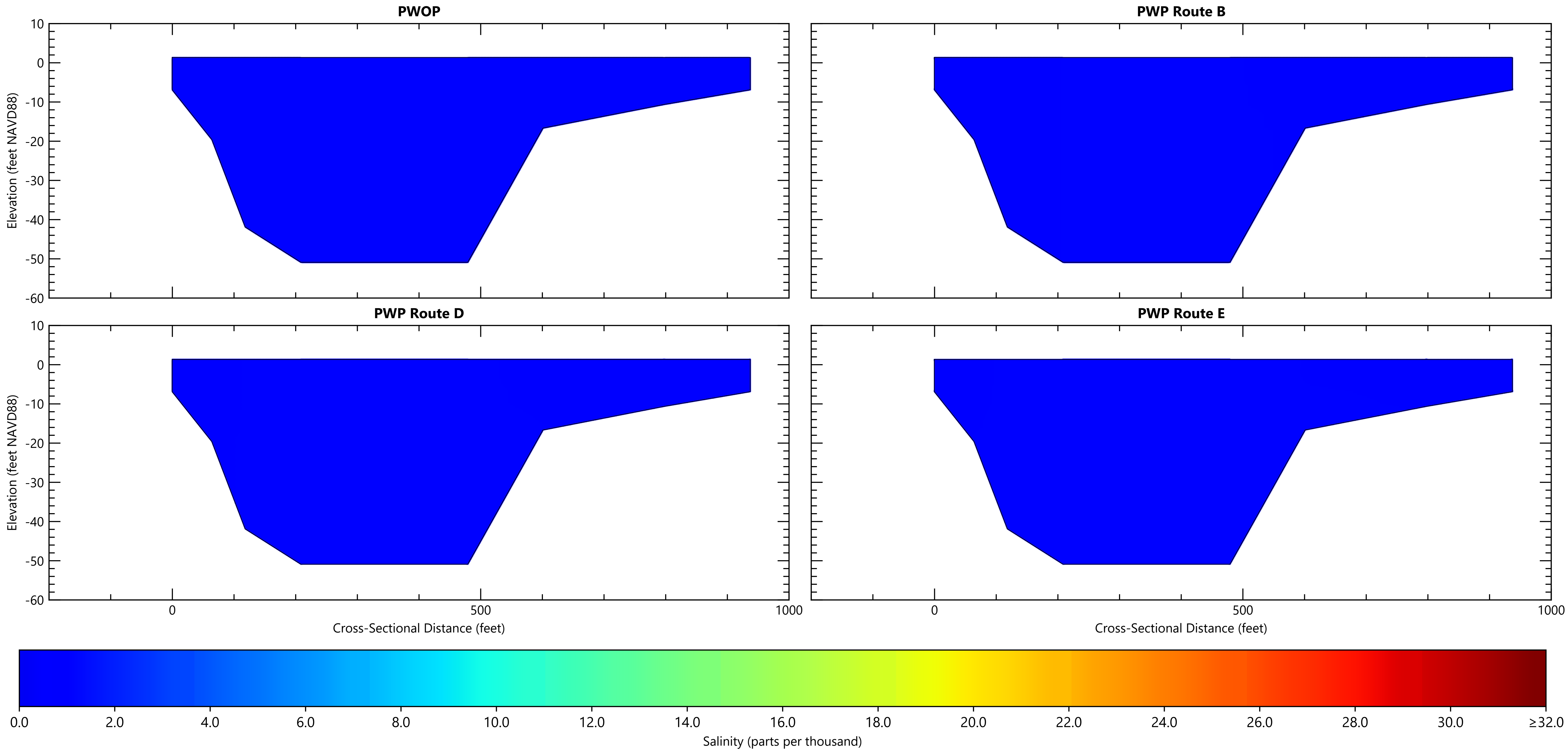
Figure 25s
Cross Section 9 Annual Average Salinity: Year 50 Scenarios
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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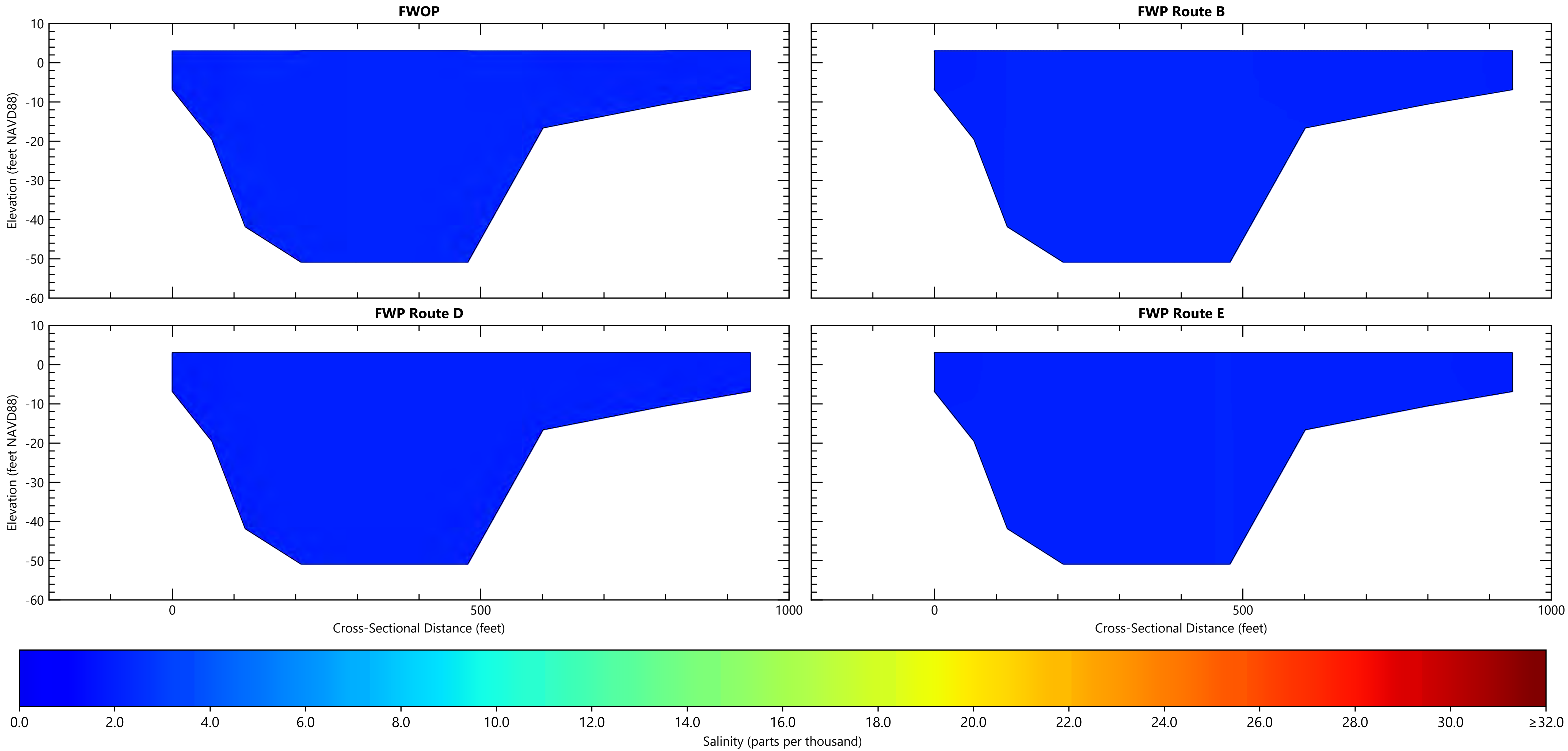
Figure 25t
Cross Section 10 Annual Average Salinity: Year 0 Scenarios



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988

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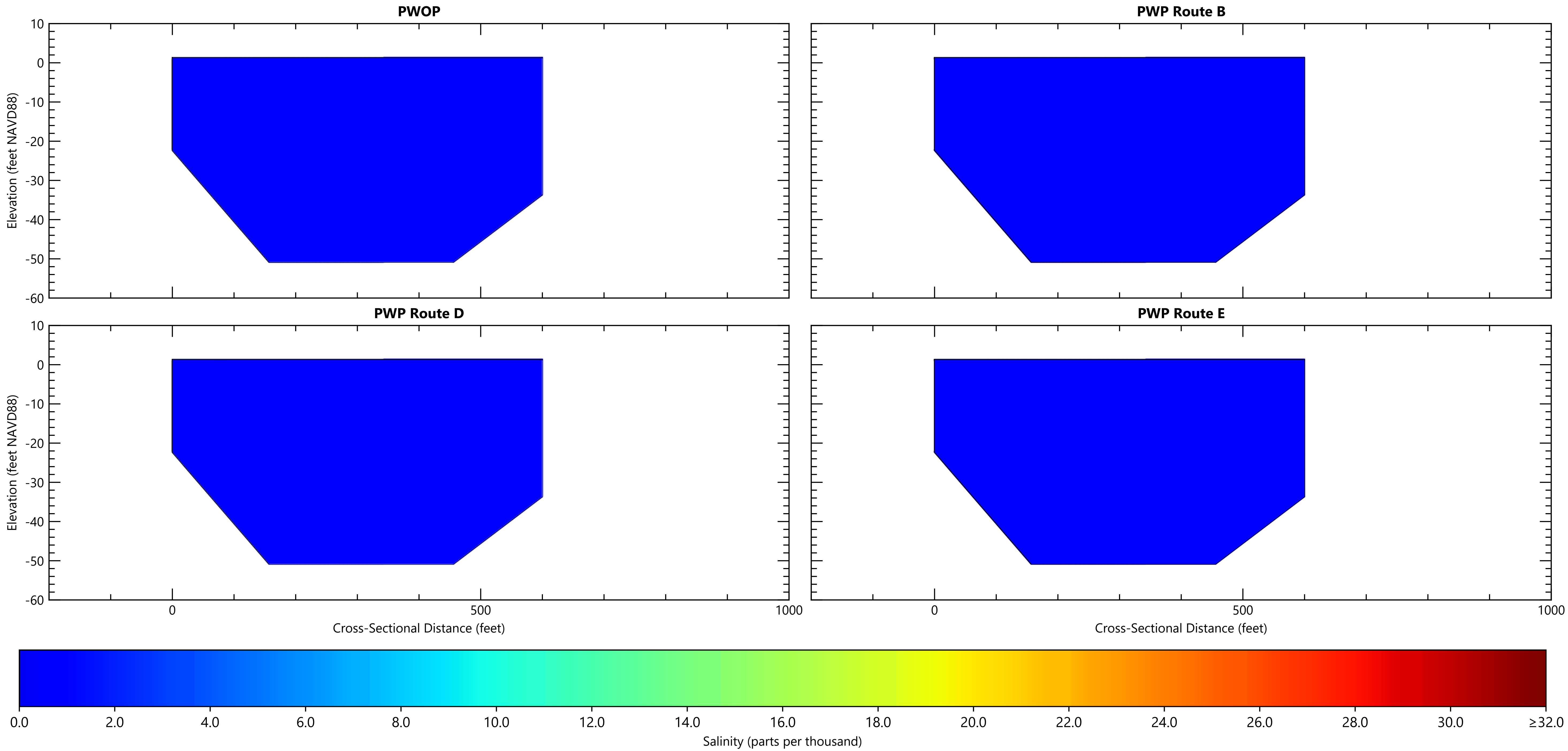
Figure 25u
Cross Section 10 Annual Average Salinity: Year 50 Scenarios
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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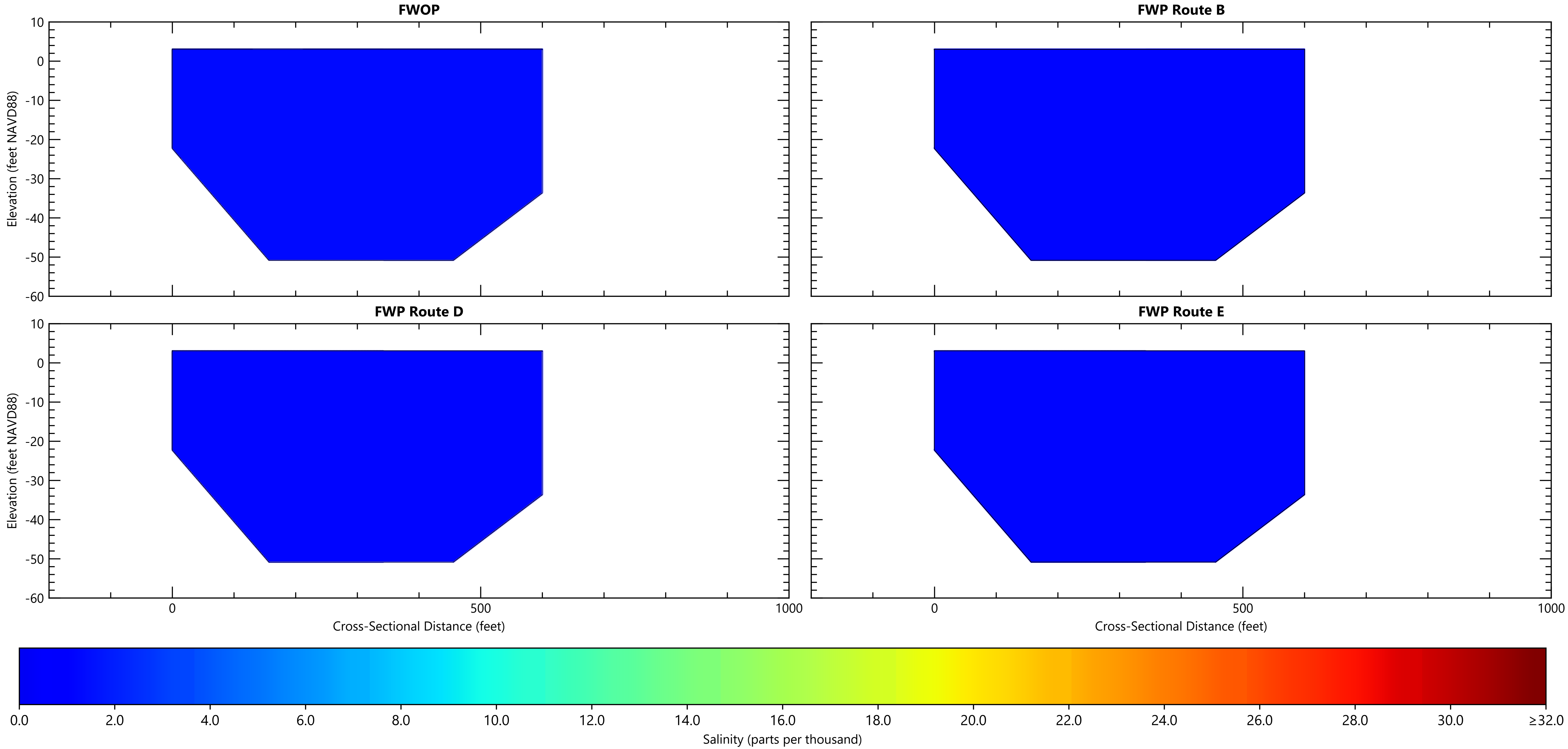
Figure 25v
Cross Section 11 Annual Average Salinity: Year 0 Scenarios



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988

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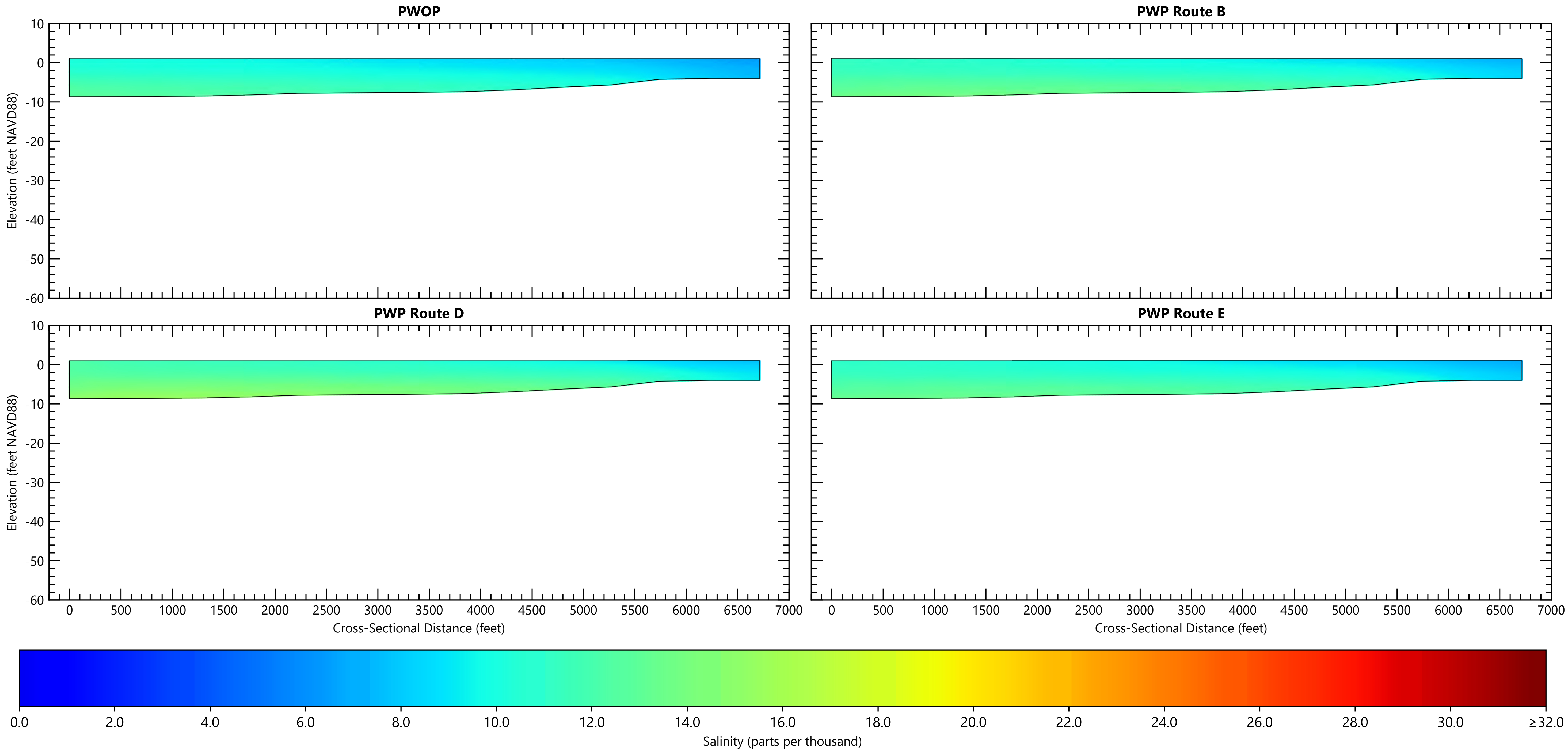
Figure 25w
Cross Section 11 Annual Average Salinity: Year 50 Scenarios



Notes: NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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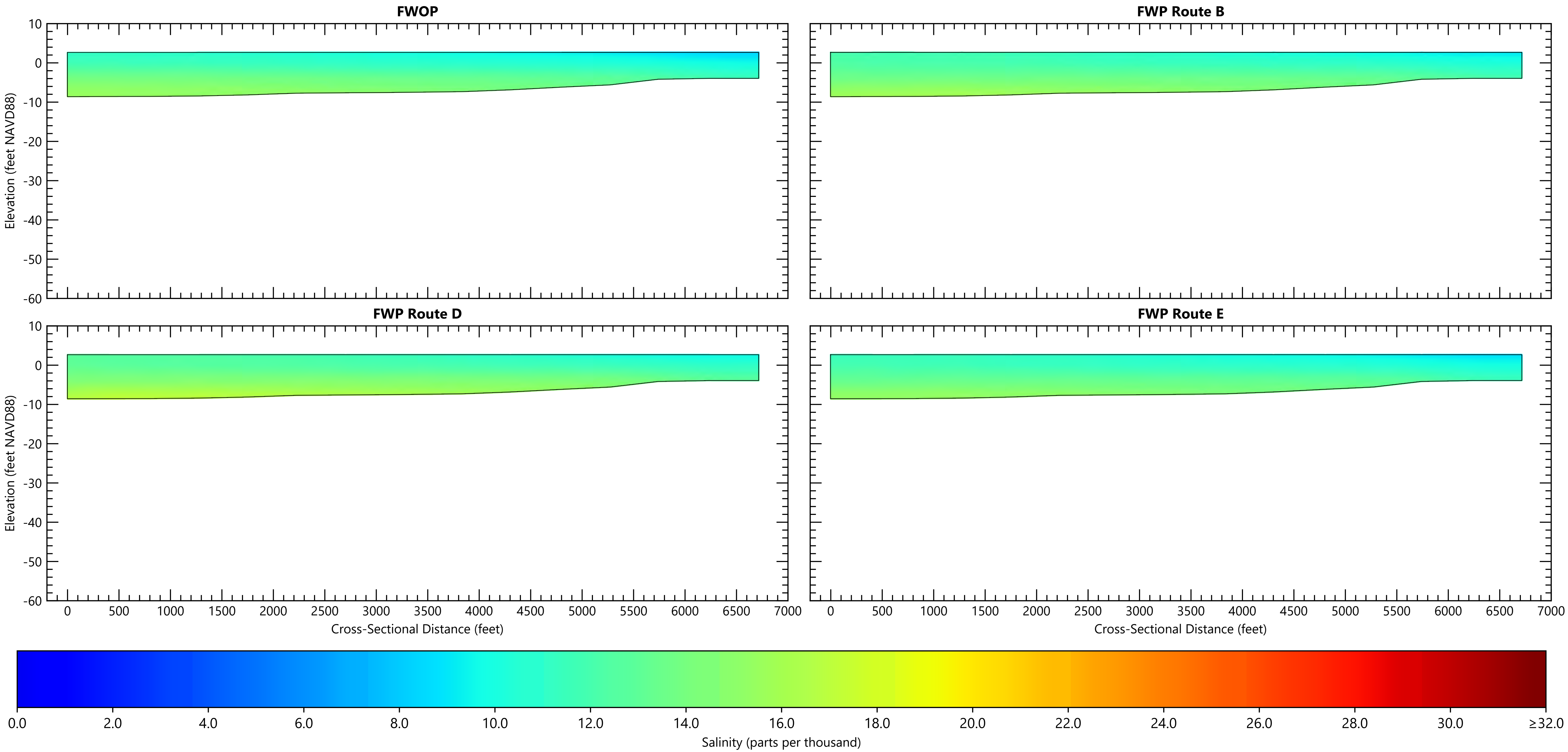
Figure 25x
Cross Section 12 Annual Average Salinity: Year 0 Scenarios



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988

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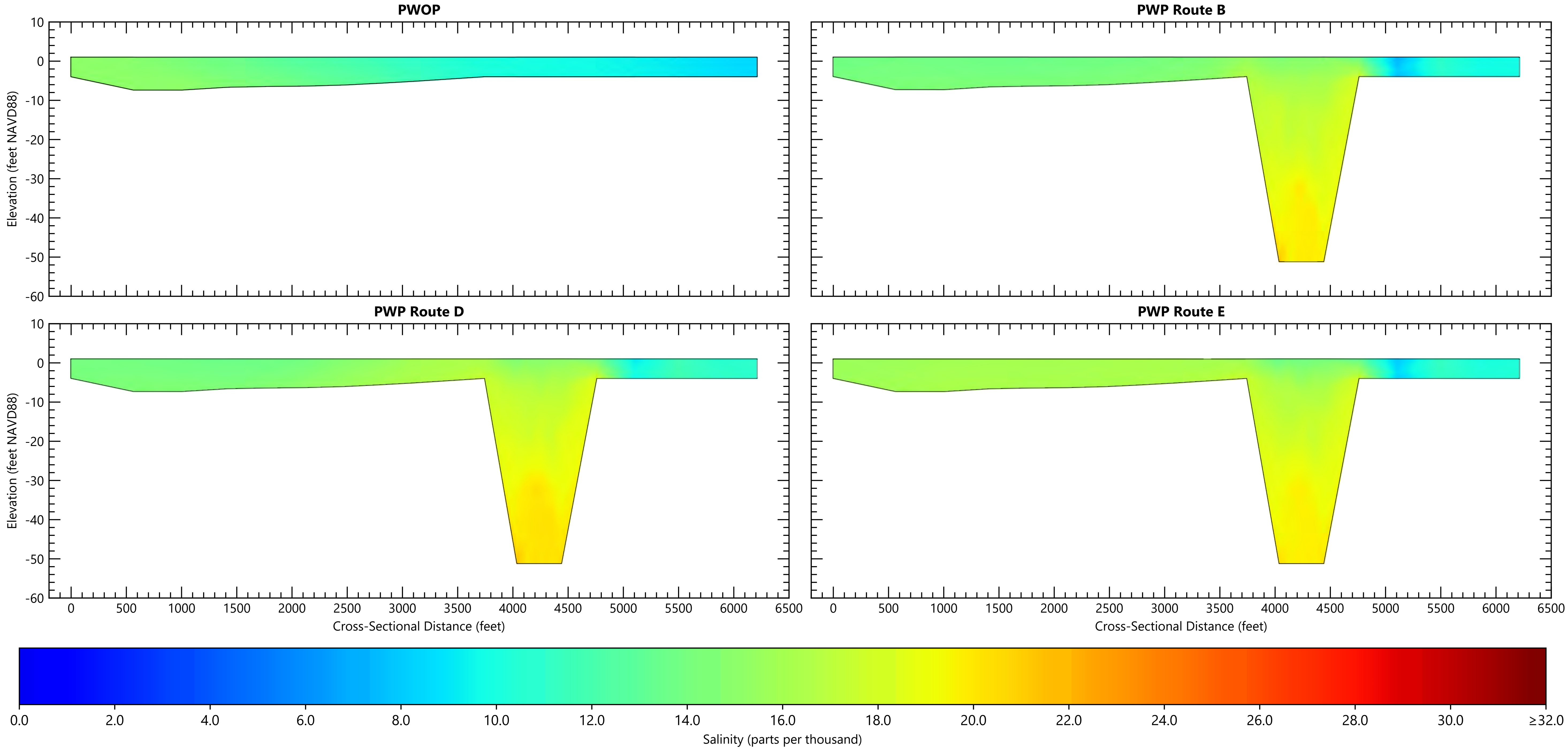
Figure 25y
Cross Section 12 Annual Average Salinity: Year 50 Scenarios



Notes: NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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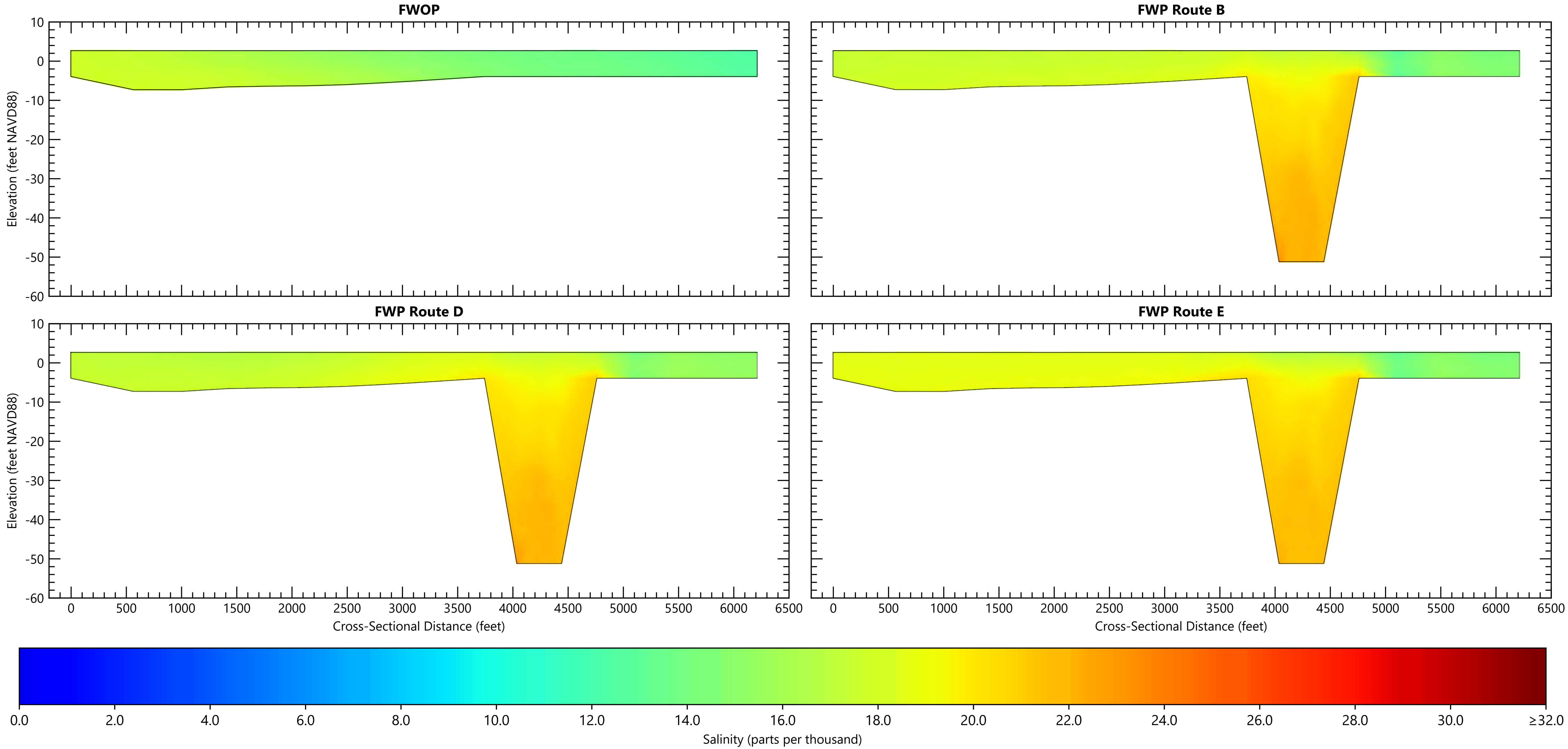
Figure 25z
Cross Section 13 Annual Average Salinity: Year 0 Scenarios



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988

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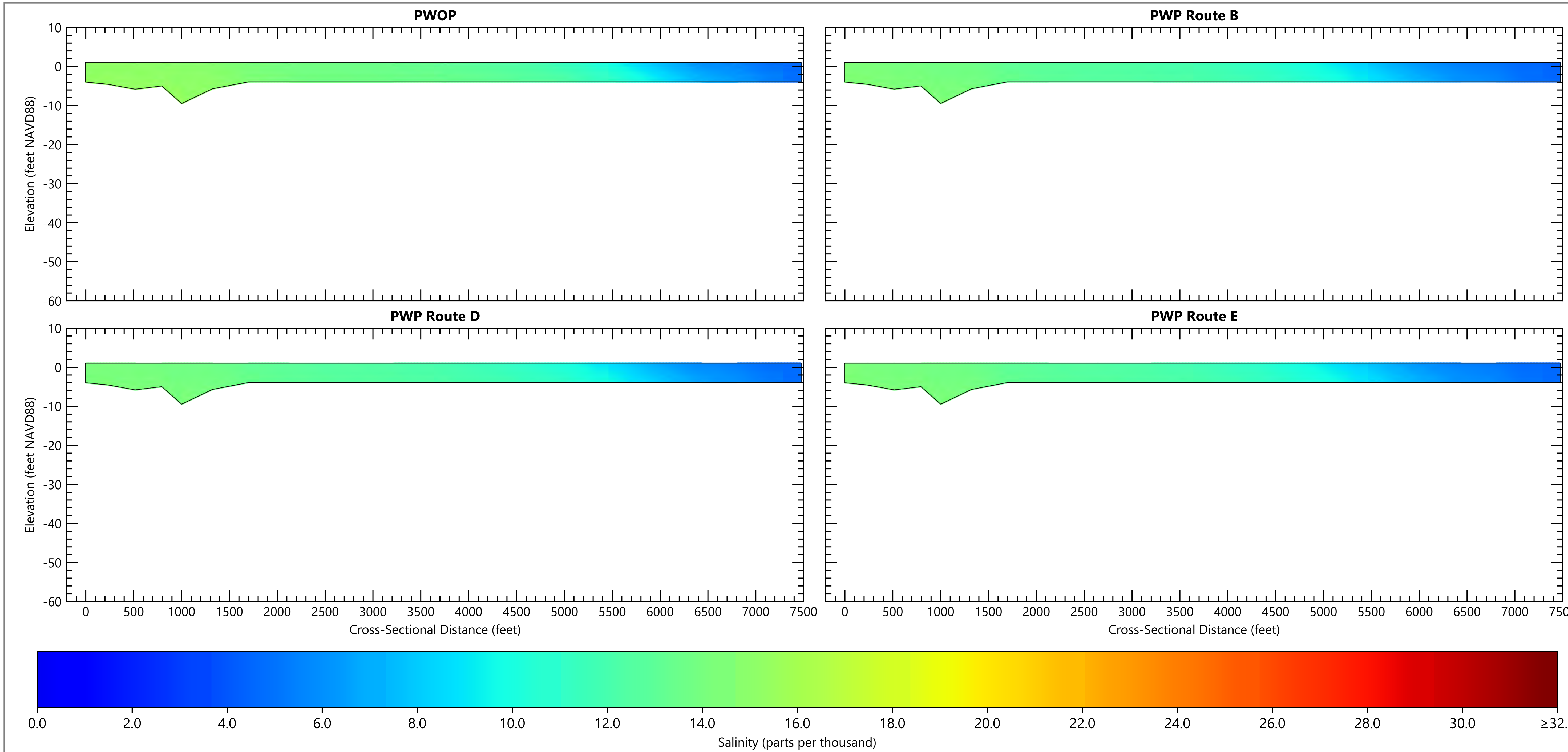
Figure 25a1
Cross Section 13 Annual Average Salinity: Year 50 Scenarios



Notes: NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project

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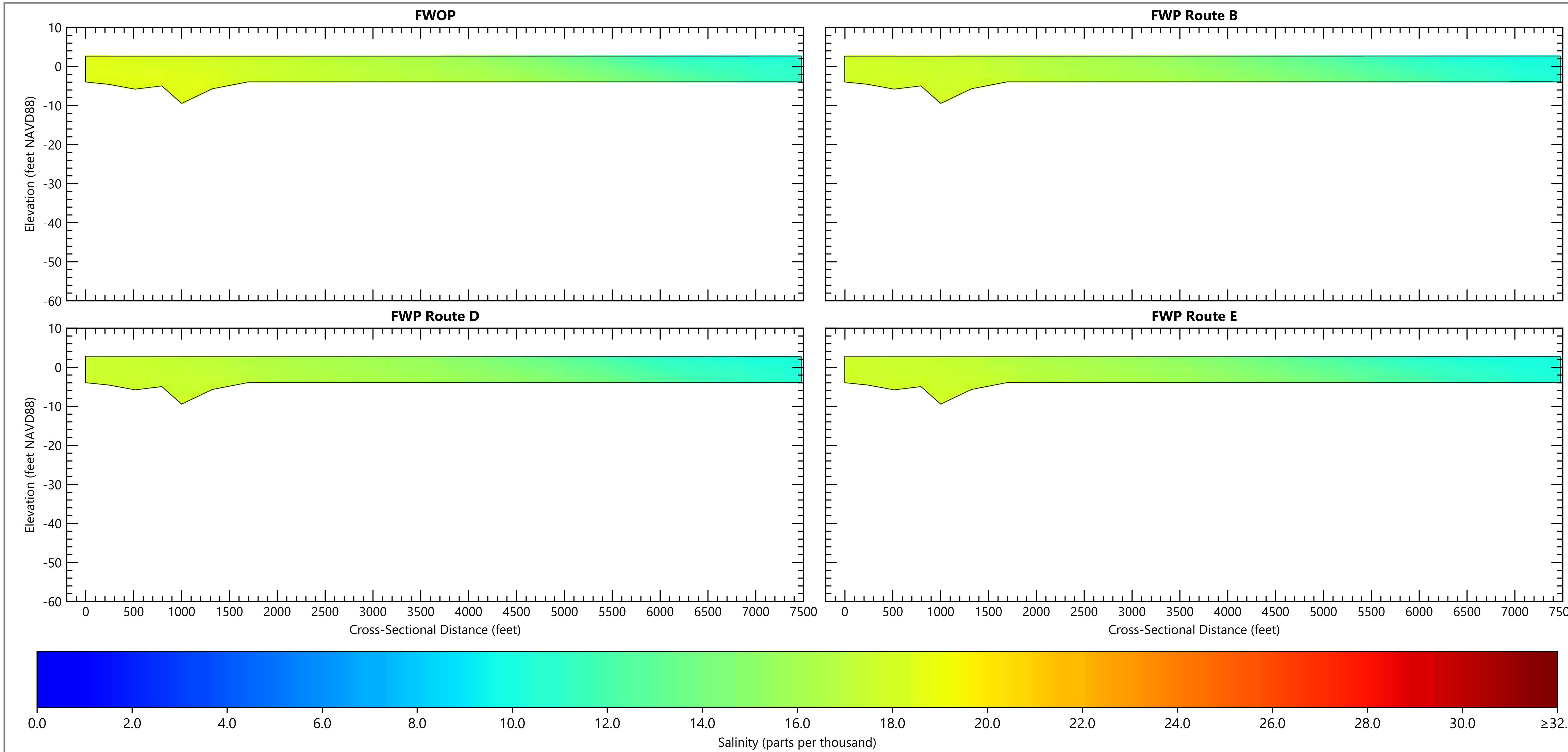
Figure 25b1
Cross Section 14 Annual Average Salinity: Year 0 Scenarios



Notes: FWOP: Future Without Project, FWP: Future with Project, NAVD88: North American Vertical Datum of 1988

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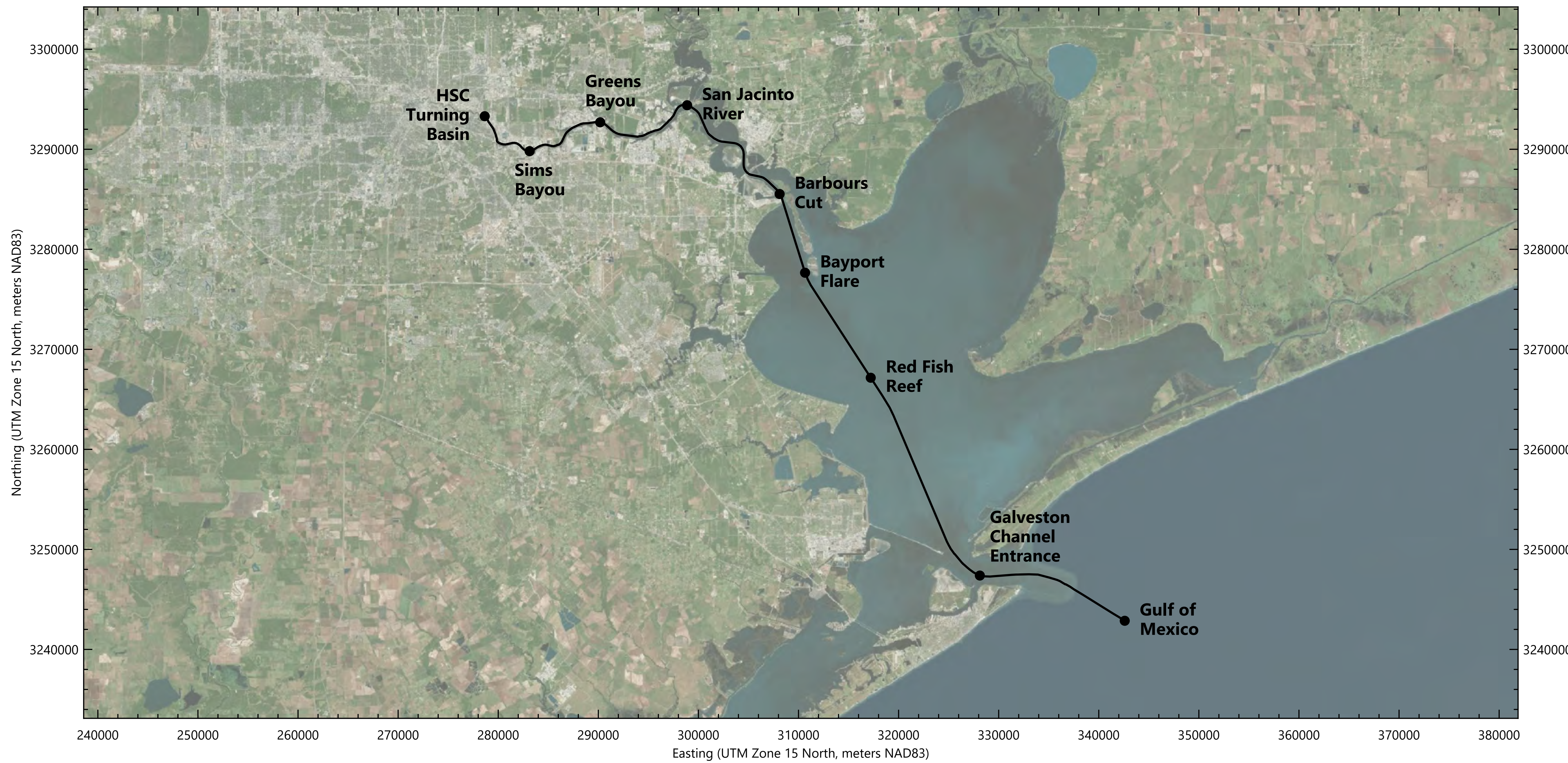
Figure 25c1
Cross Section 14 Annual Average Salinity: Year 50 Scenarios
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Bing Satellite Imagery, HSC: Houston Ship Channel, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

HSC Profile

Reference Locations

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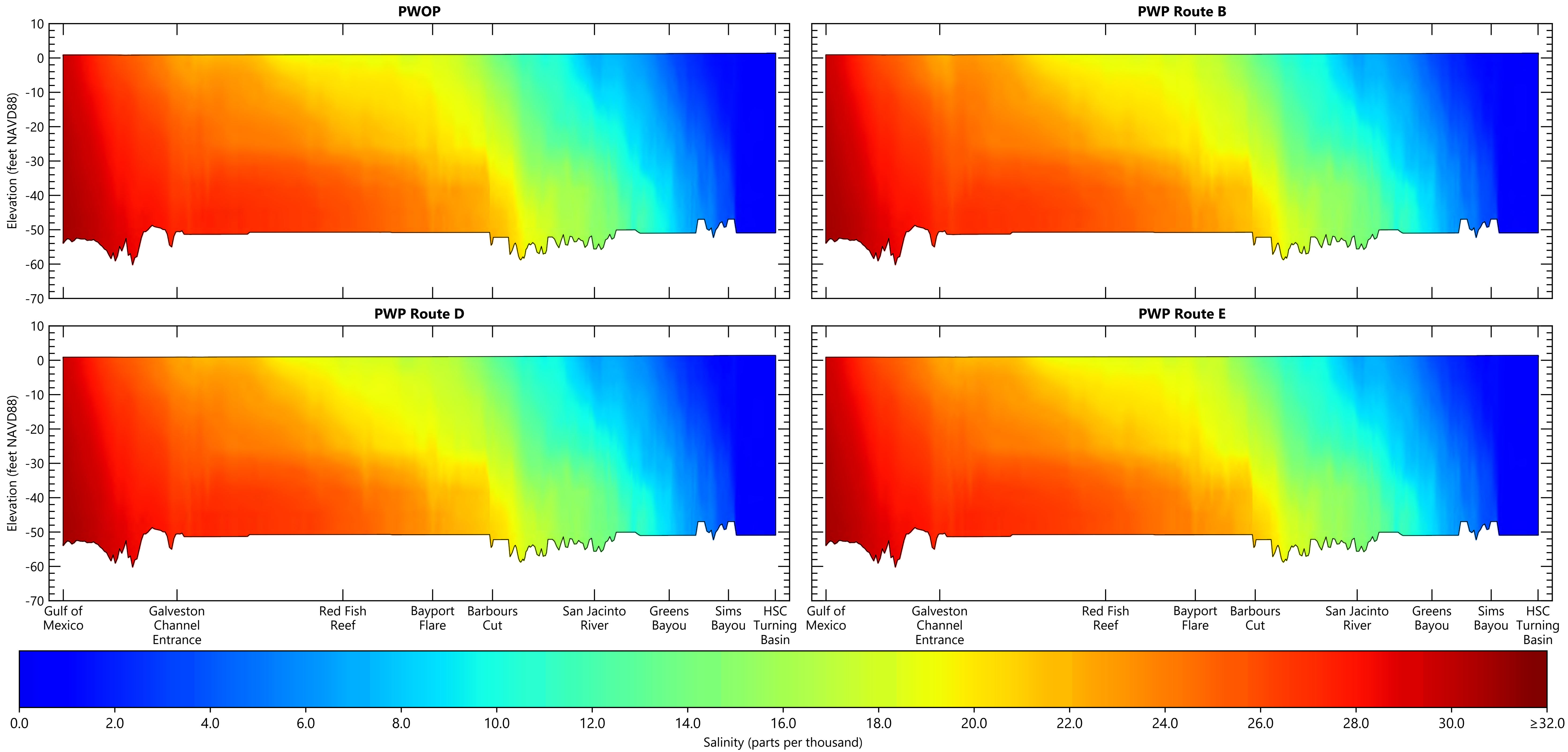
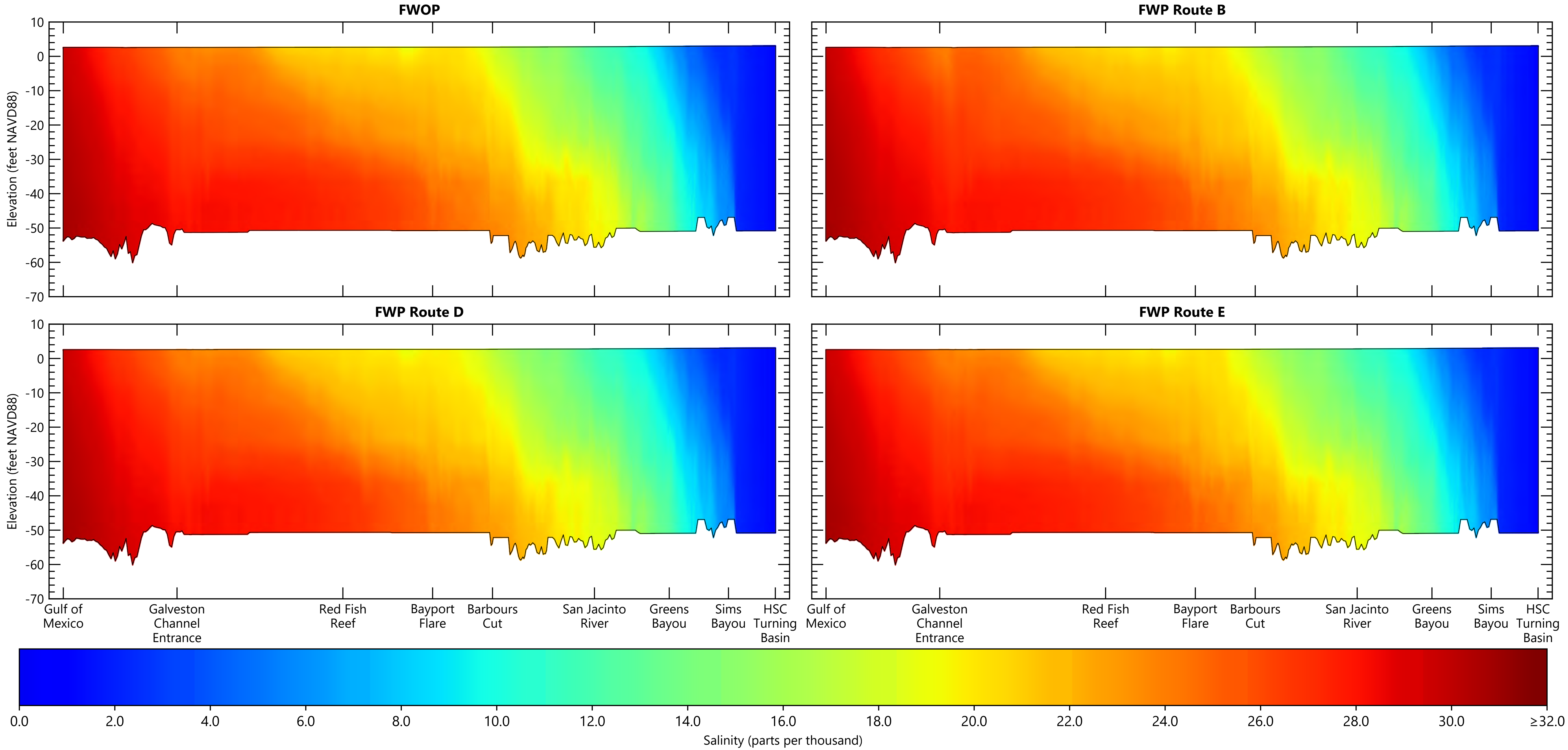
Figure 26a
HSC Salinity Profile Reference Map
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: HSC: Houston Ship Channel, NAVD88: North American Vertical Datum of 1988, PWOP: Present Without Project, PWP: Present with Project



Notes: FWOP: Future Without Project, FWP: Future with Project, HSC: Houston Ship Channel, NAVD88: North American Vertical Datum of 1988

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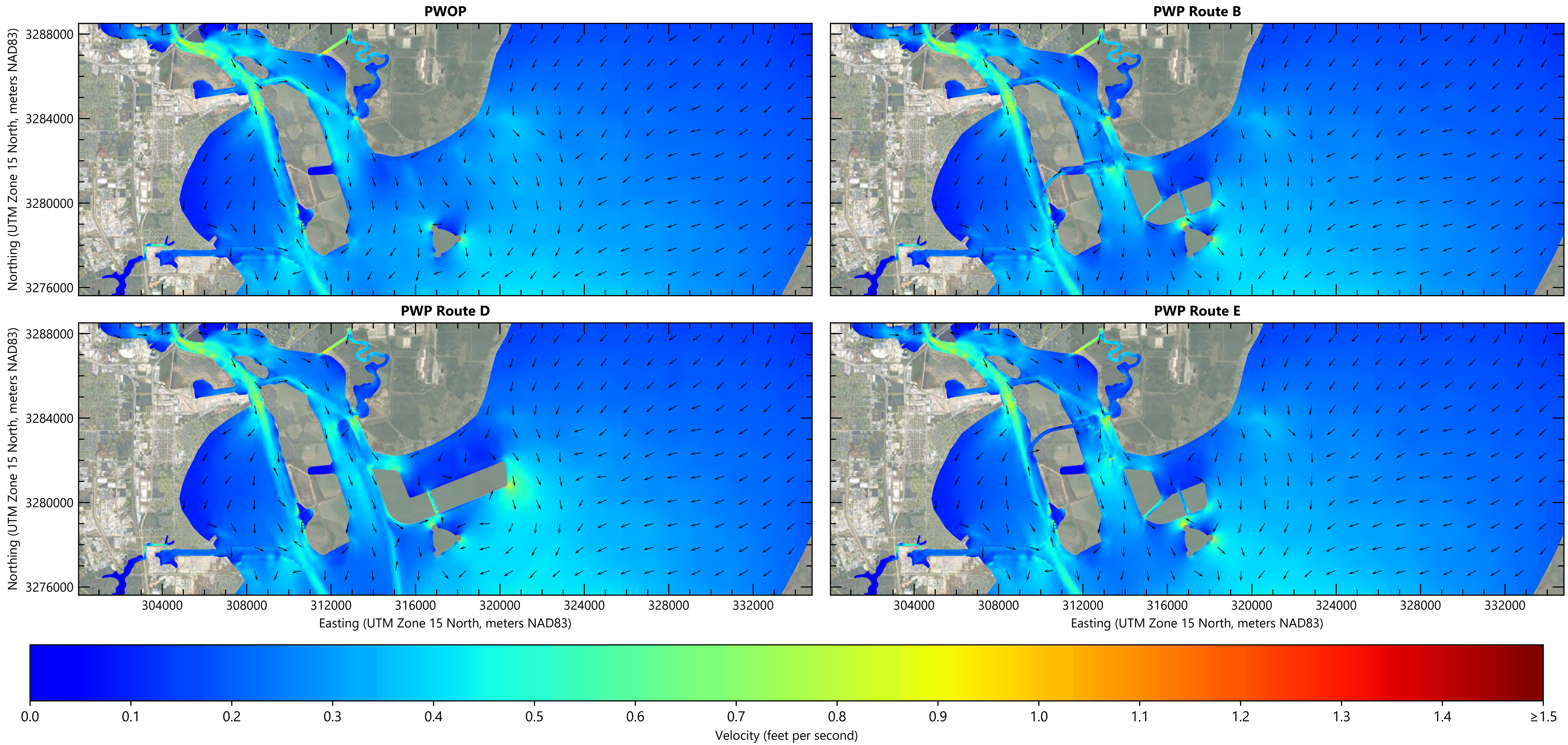
Figure 26c
HSC Annual Average Salinity Profiles: Year 50 Scenarios



Notes: Arrows denote residual velocity direction. Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, PWOP: Present Without Project, PWP: Present with Project, UTM: Universal Transverse Mercator

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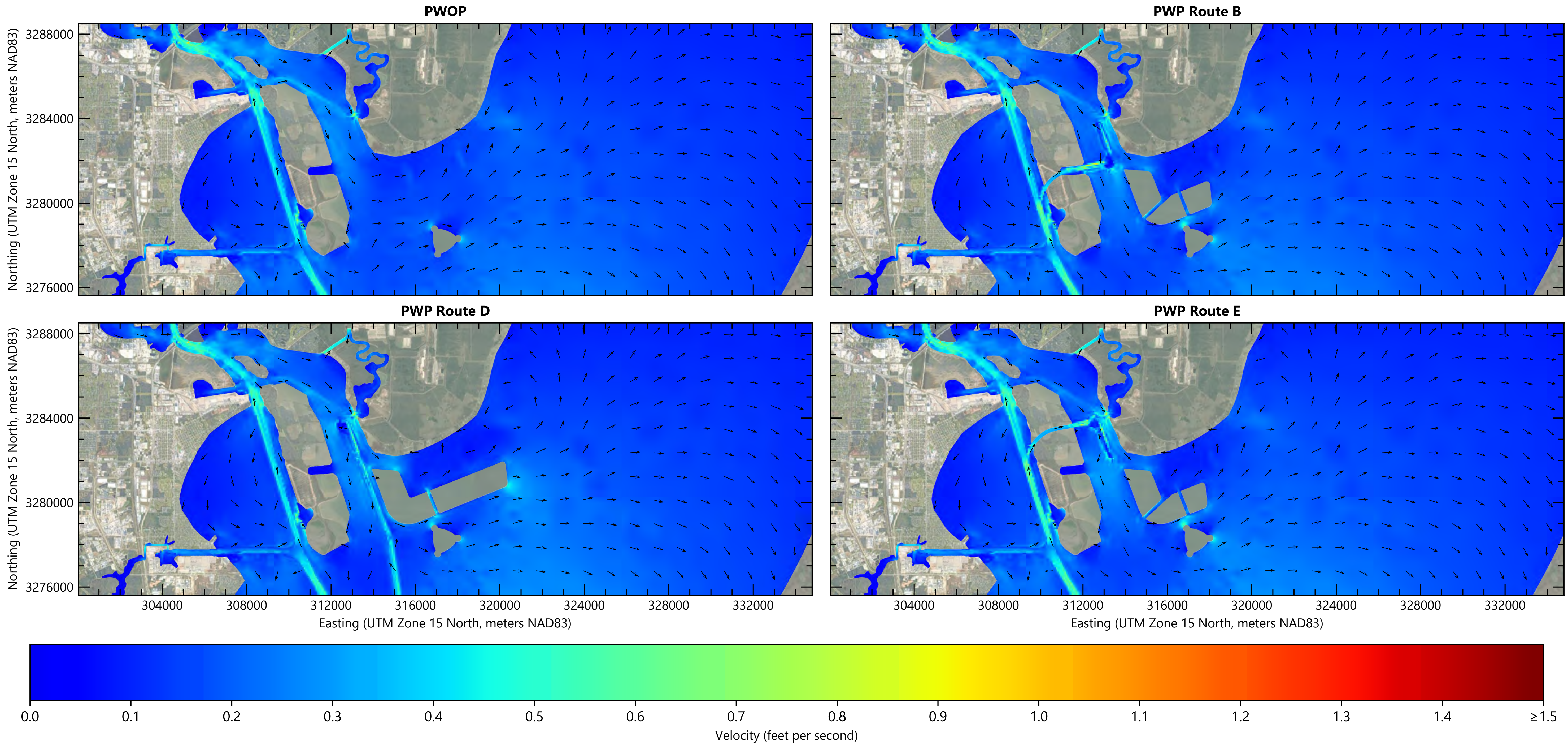
Figure 27a
Comparison of Residual Surface Velocities at Area of Interest: Year 0 Scenarios



Notes: Arrows denote residual velocity direction. Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, PWOP: Present Without Project, PWP: Present with Project, UTM: Universal Transverse Mercator

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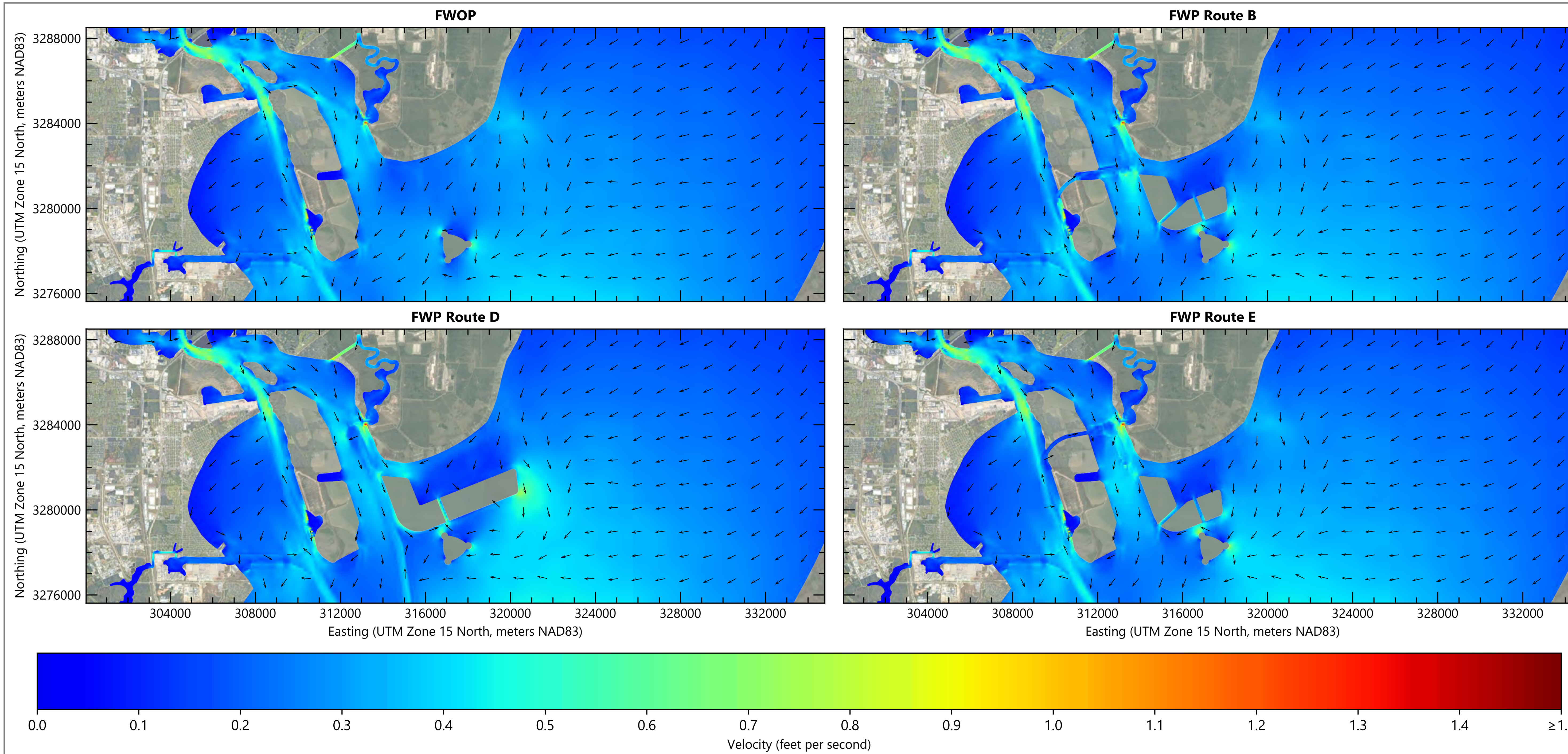
Figure 27b
Comparison of Residual Bottom Velocities at Area of Interest: Year 0 Scenarios
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Arrows denote residual velocity direction. Basemap Source: Google Satellite Imagery, FWOP: Future Without Project, FWP: Future with Project, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

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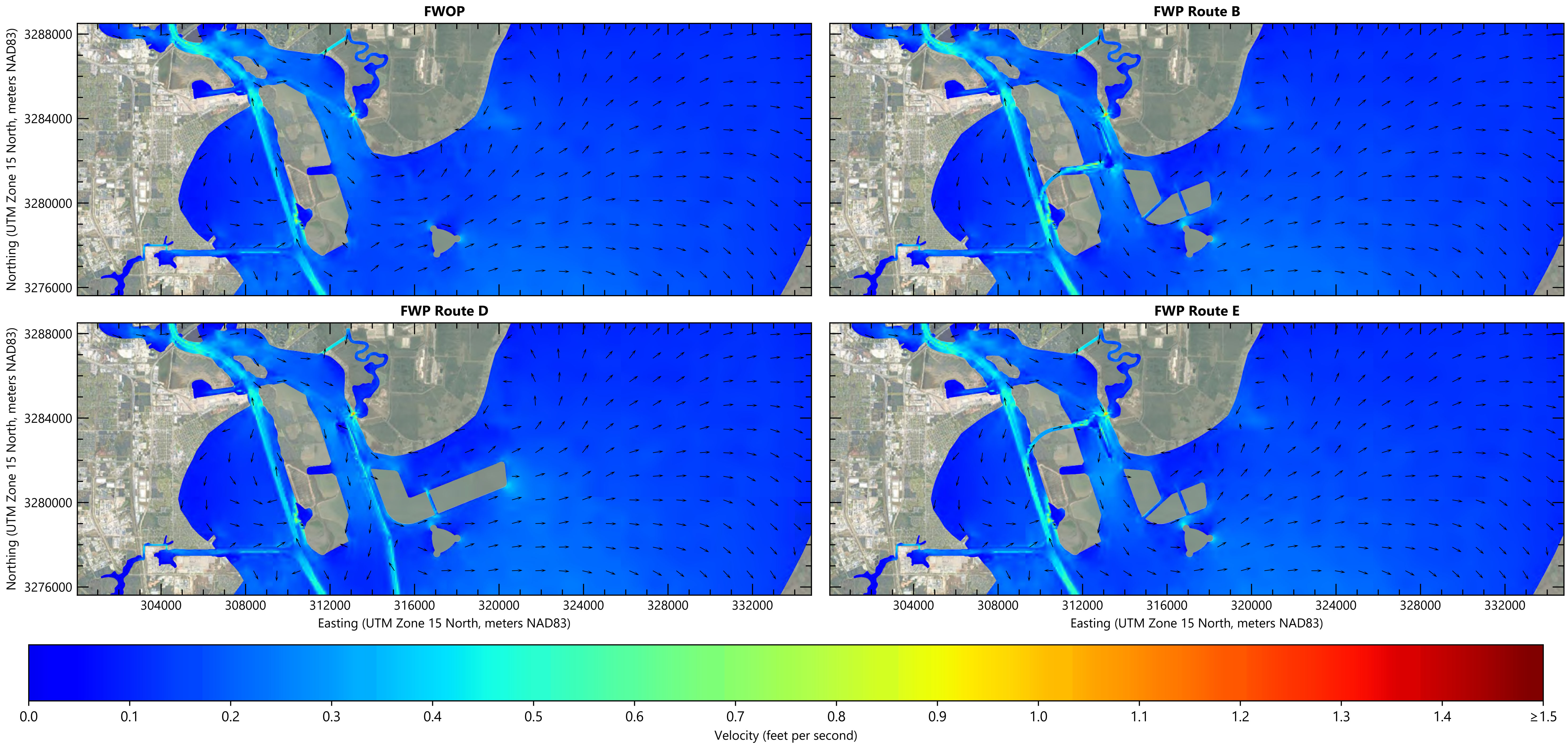
Figure 27c
Comparison of Residual Surface Velocities at Area of Interest: Year 50 Scenarios

Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Arrows denote residual velocity direction. Basemap Source: Google Satellite Imagery, FWOP: Future Without Project, FWP: Future with Project, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

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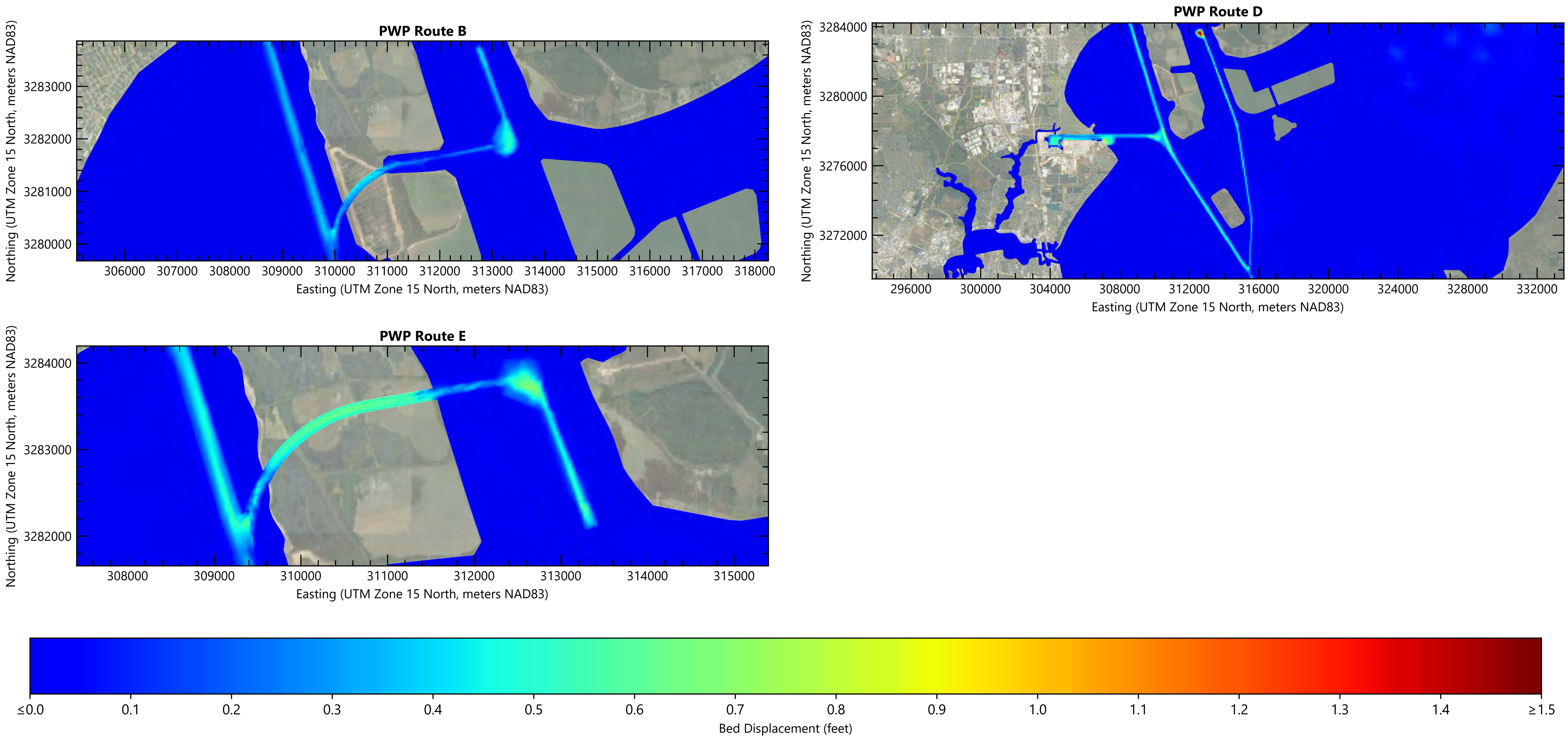
Figure 27d
Comparison of Residual Bottom Velocities at Area of Interest: Year 50 Scenarios
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, PWP: Present with Project, UTM: Universal Transverse Mercator

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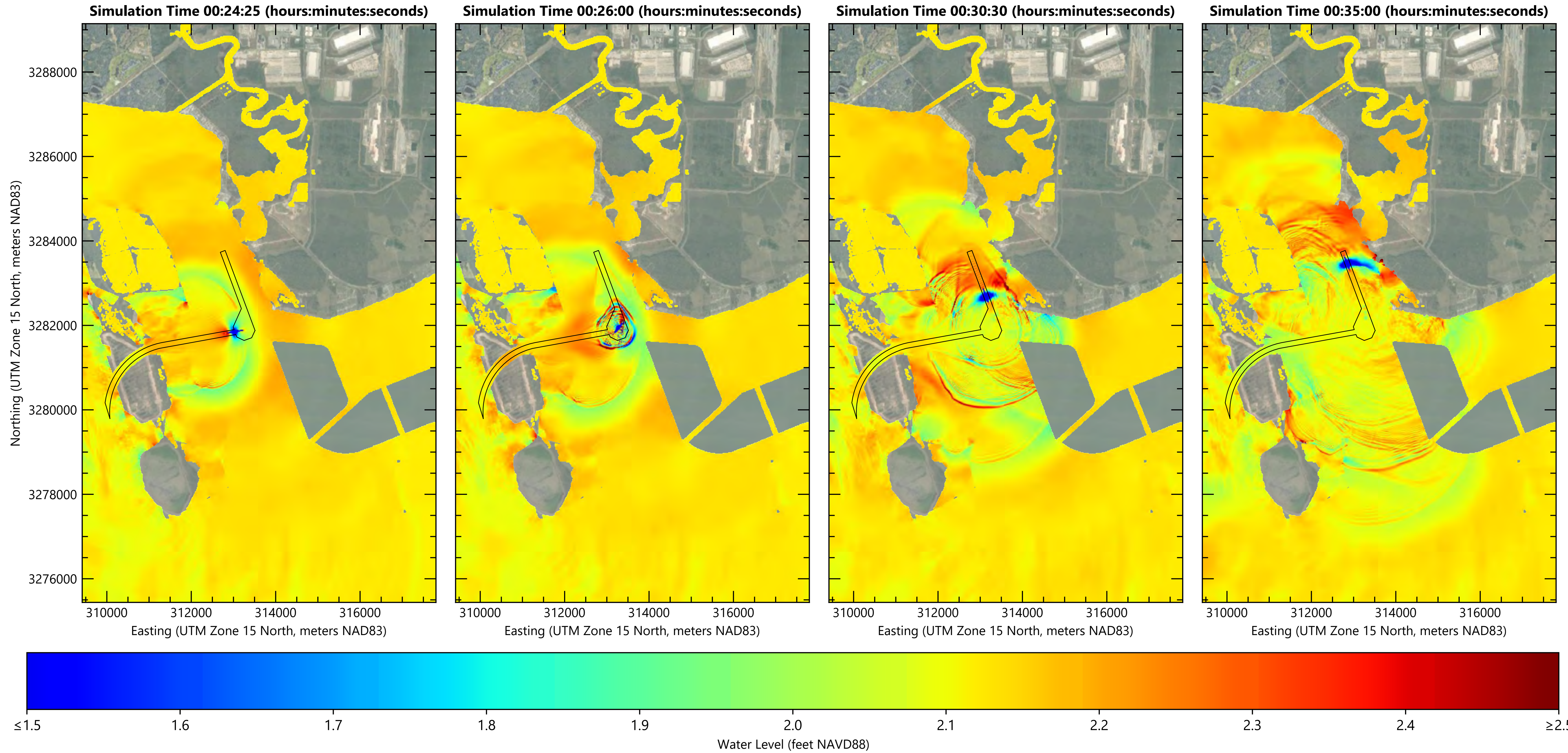
Figure 28
Comparison of Predicted Bed Displacements in Alternative Channel Routes
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

Channel Footprint

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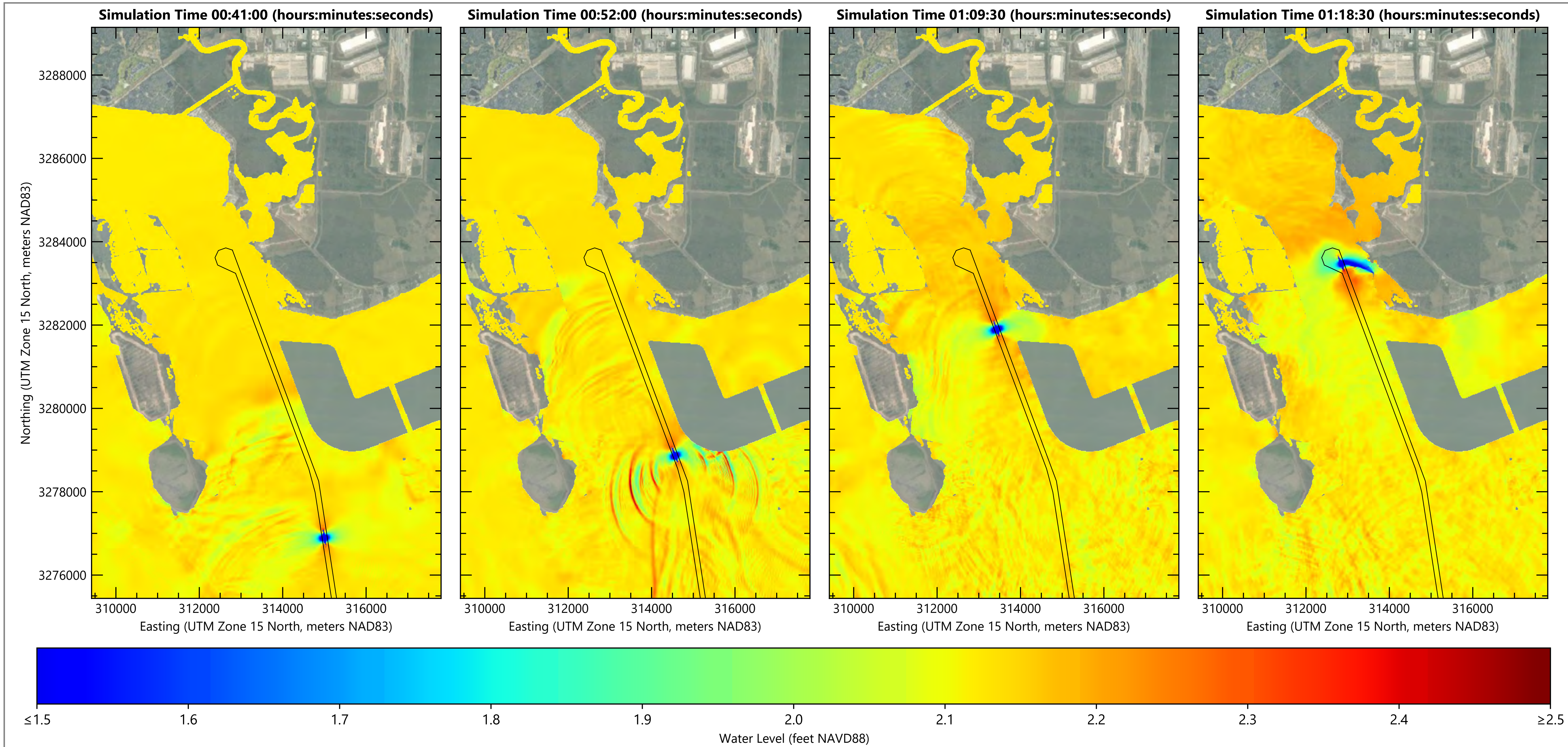
Figure 29a
Vessel Wake Water Level Results: Route B Inbound, Year 0
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

Channel Footprint

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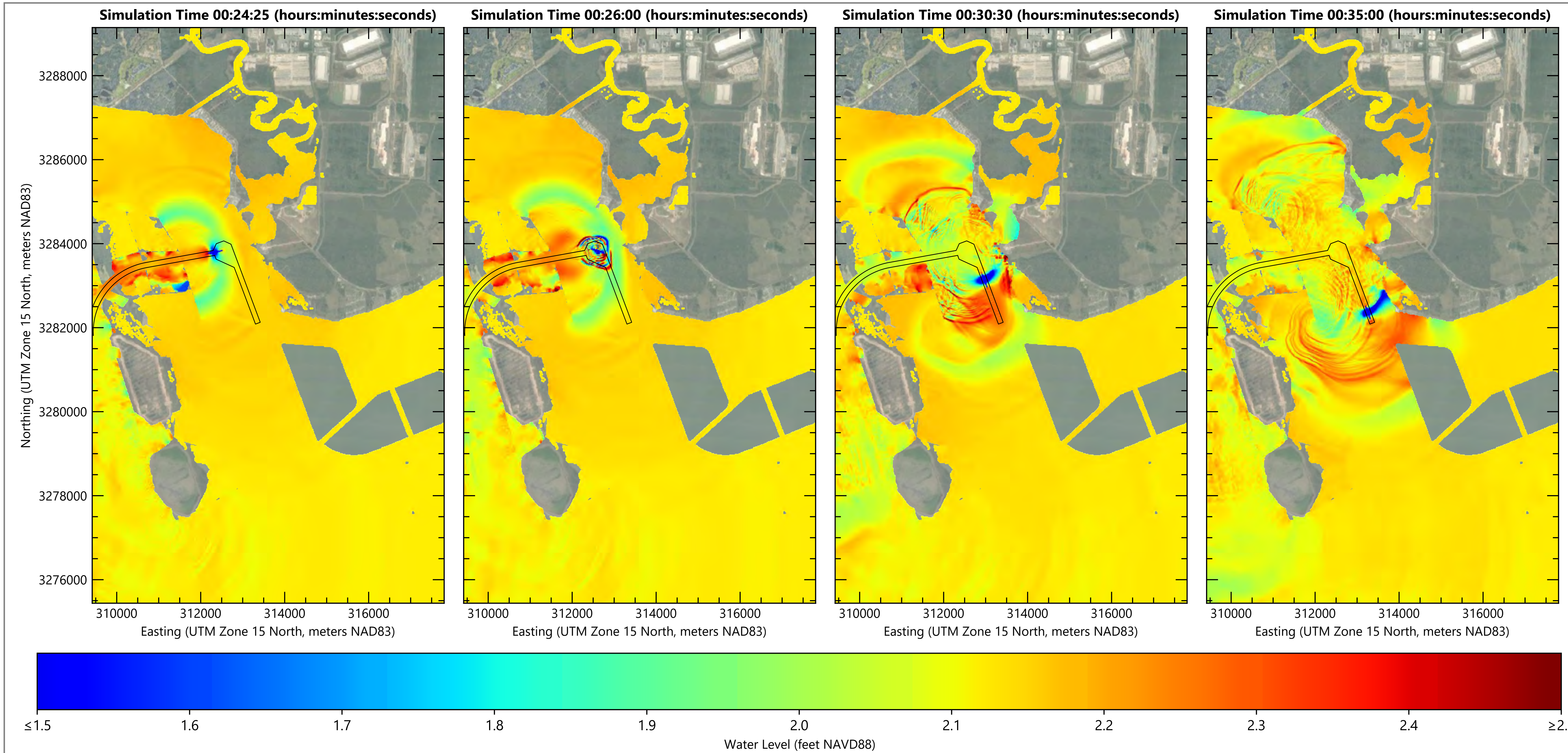
Figure 29b
Vessel Wake Water Level Results: Route D Inbound, Year 0
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

Channel Footprint

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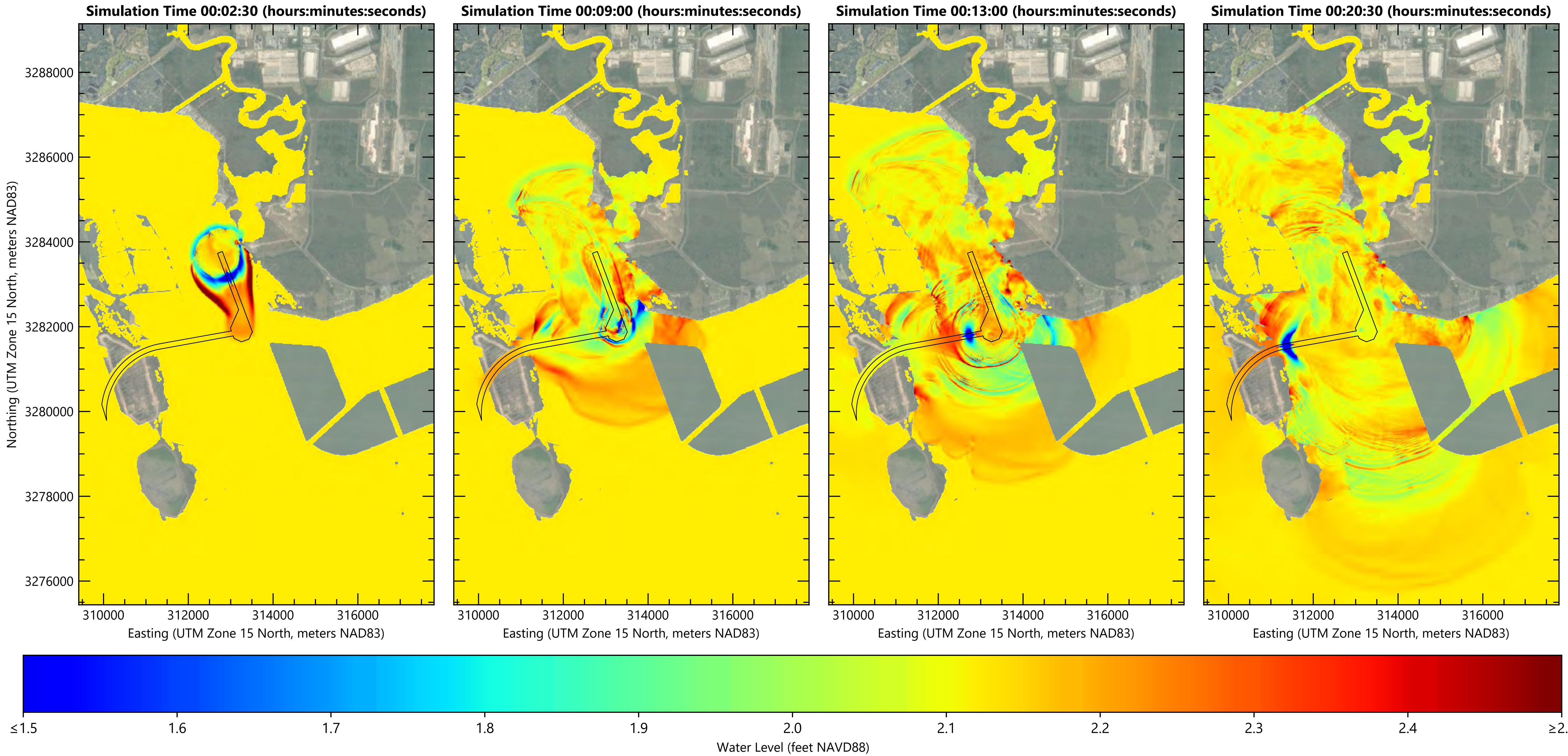
Figure 29c
Vessel Wake Water Level Results: Route E Inbound, Year 0
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

Channel Footprint

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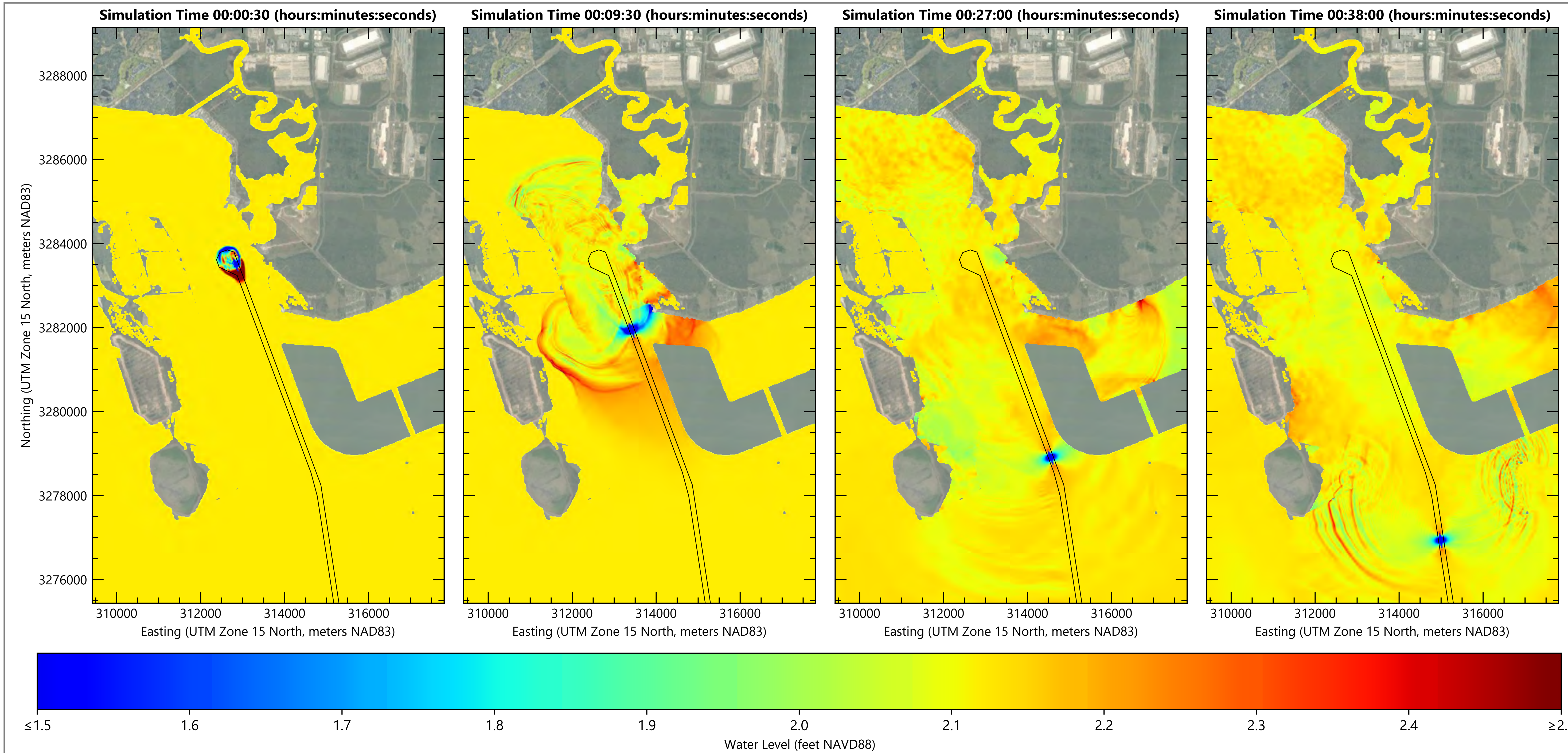
Figure 29d
Vessel Wake Water Level Results: Route B Outbound, Year 0



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

Channel Footprint

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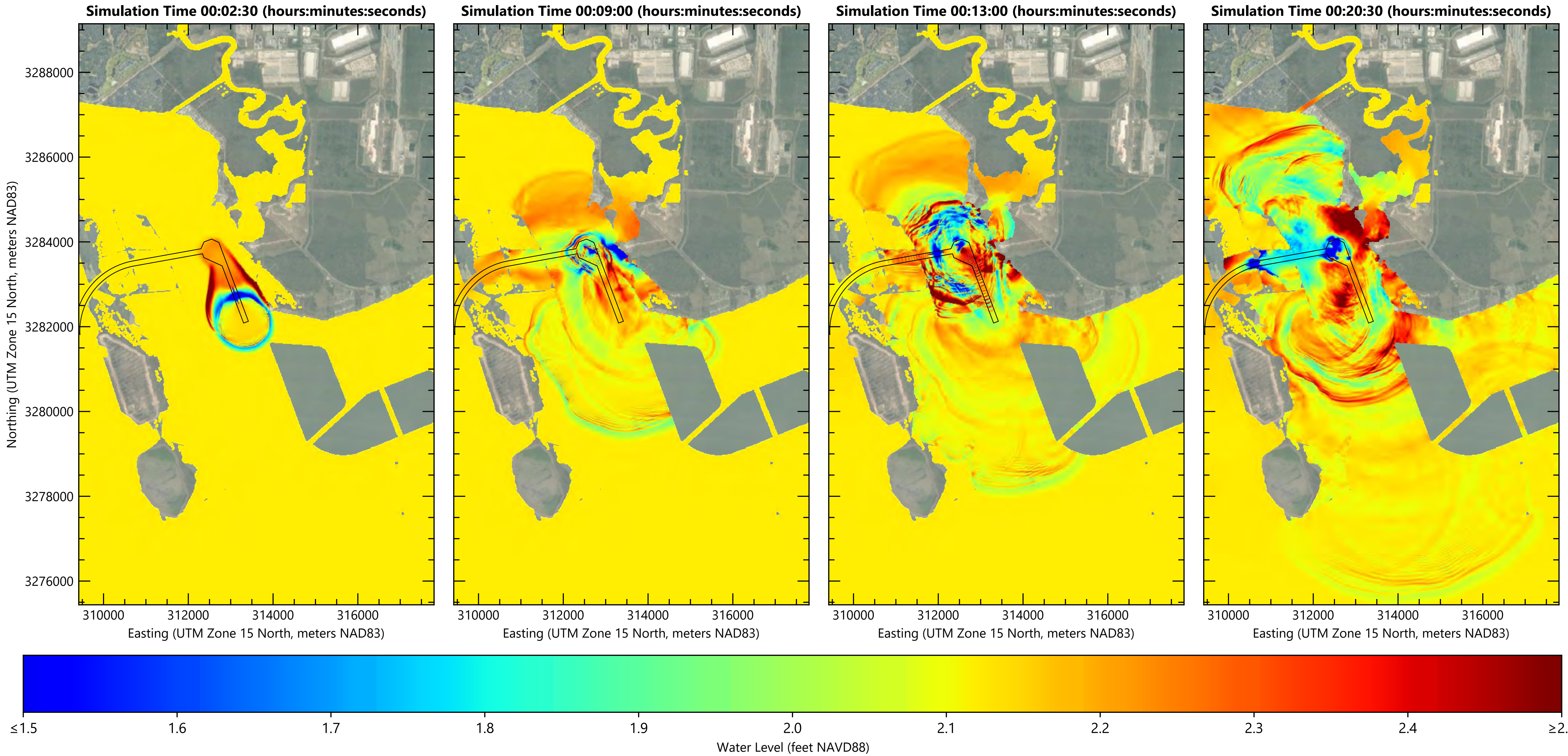
Figure 29e
Vessel Wake Water Level Results: Route D Outbound, Year 0

Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

Channel Footprint

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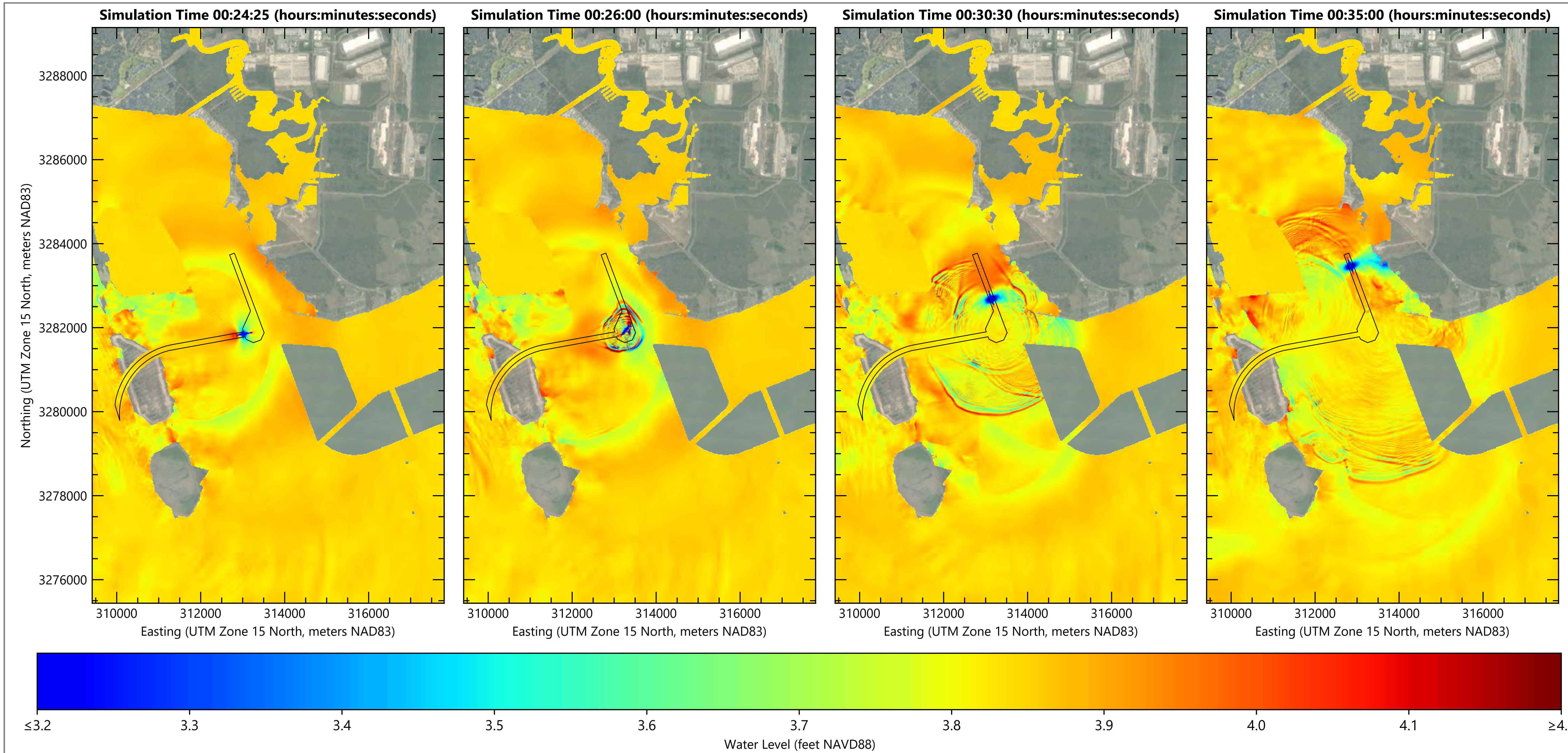
Figure 29f
Vessel Wake Water Level Results: Route E Outbound, Year 0



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

Channel Footprint

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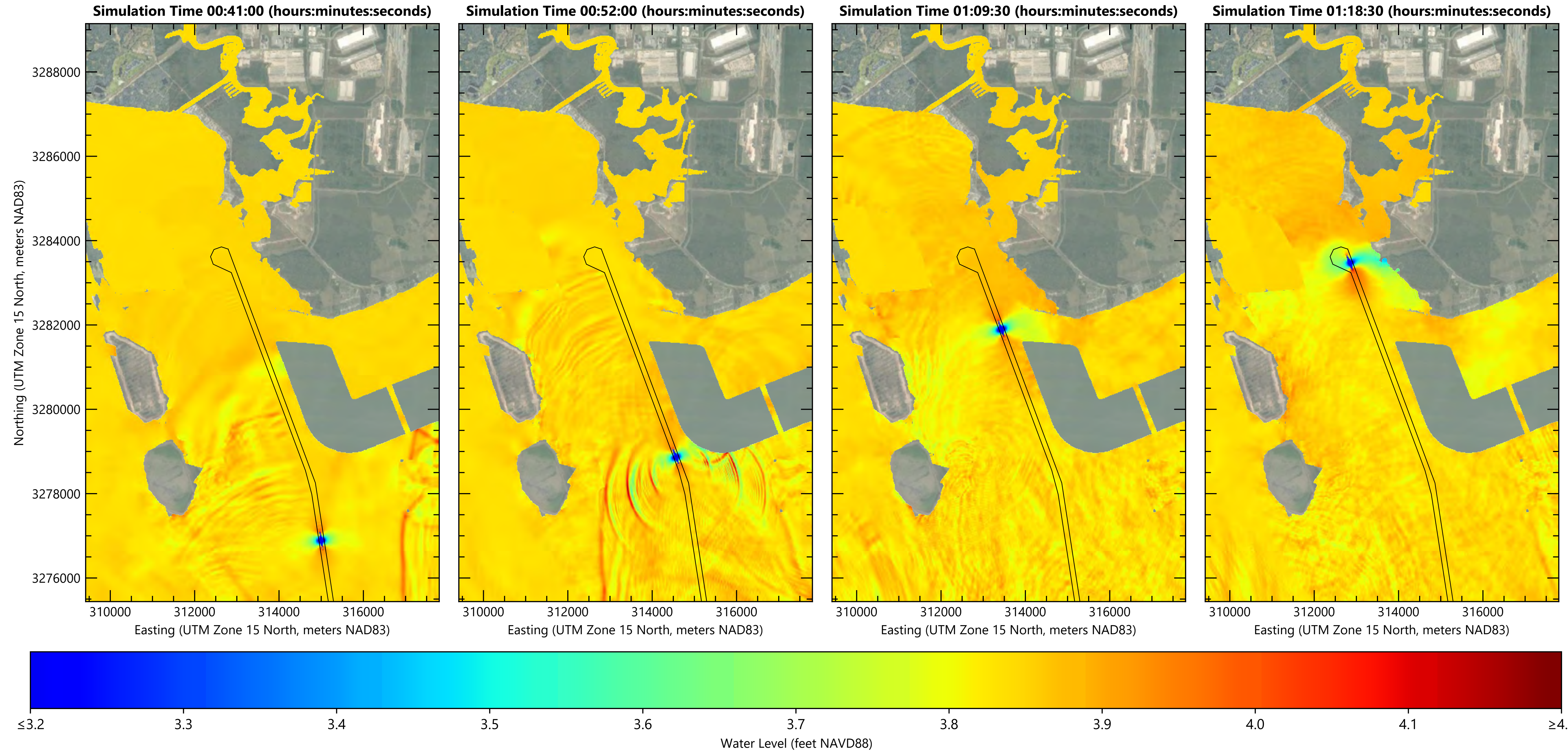
Figure 29g
Vessel Wake Water Level Results: Route B Inbound, Year 50



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

Channel Footprint

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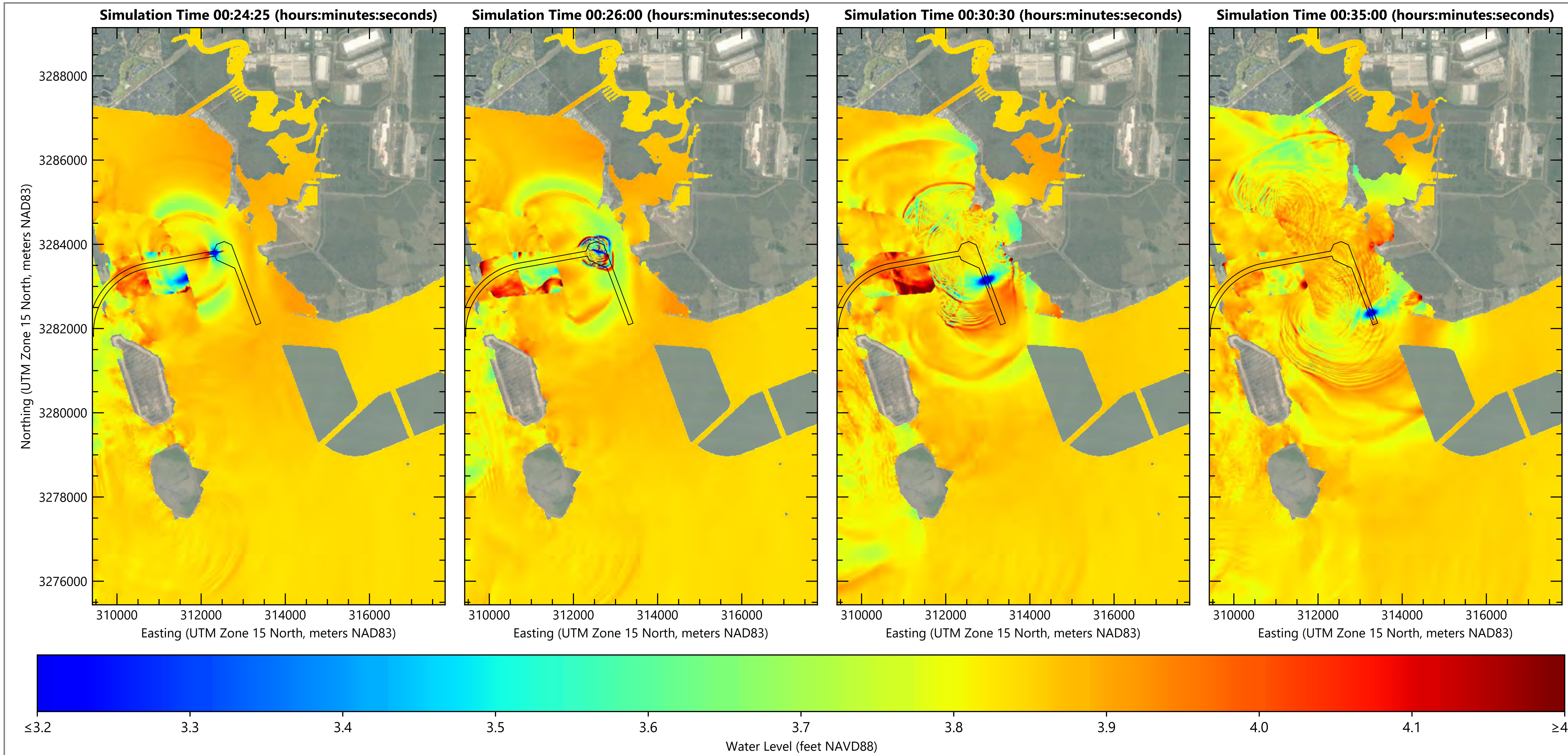
Figure 29h
Vessel Wake Water Level Results: Route D Inbound, Year 50
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

Channel Footprint

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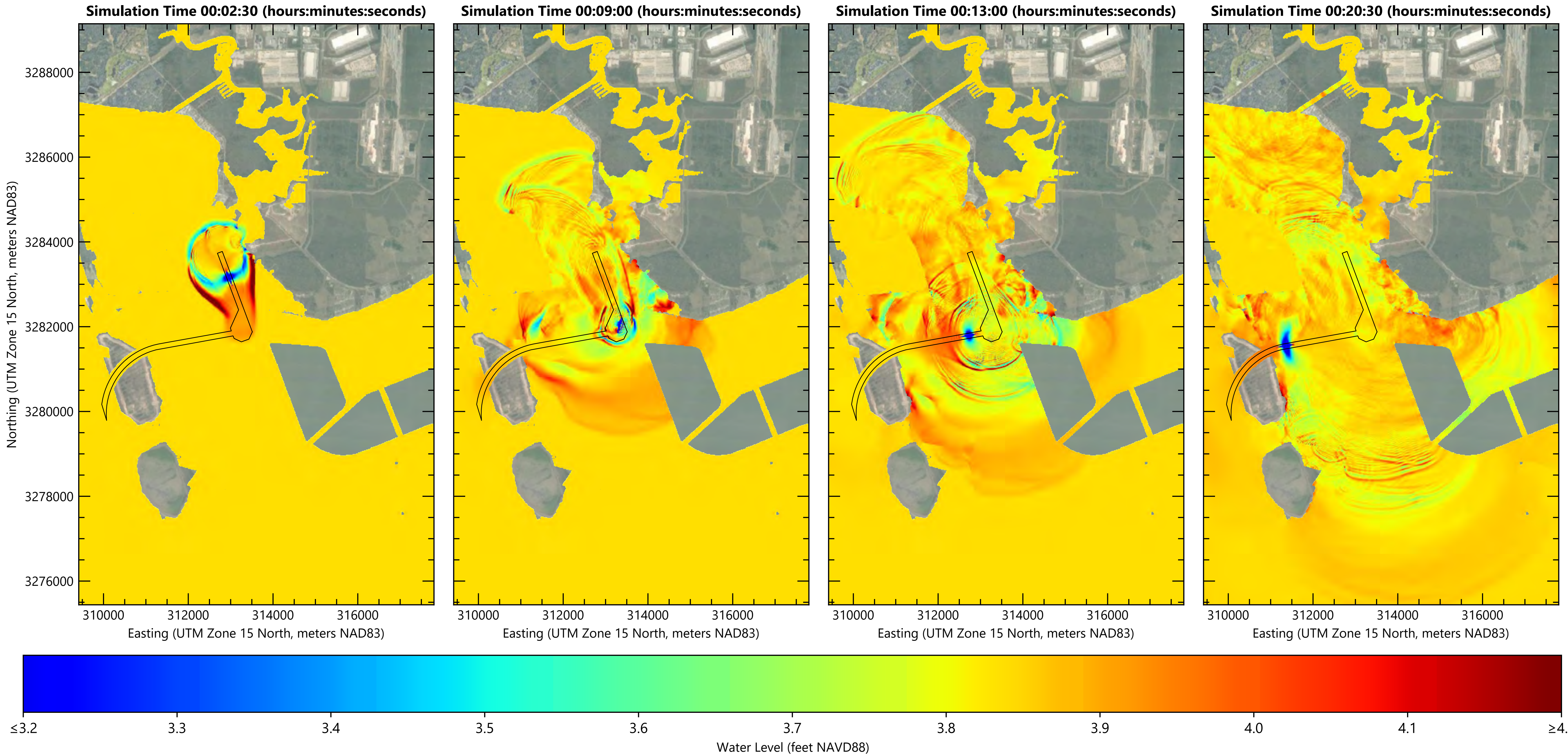
Figure 29i

Vessel Wake Water Level Results: Route E Inbound, Year 50



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

Channel Footprint

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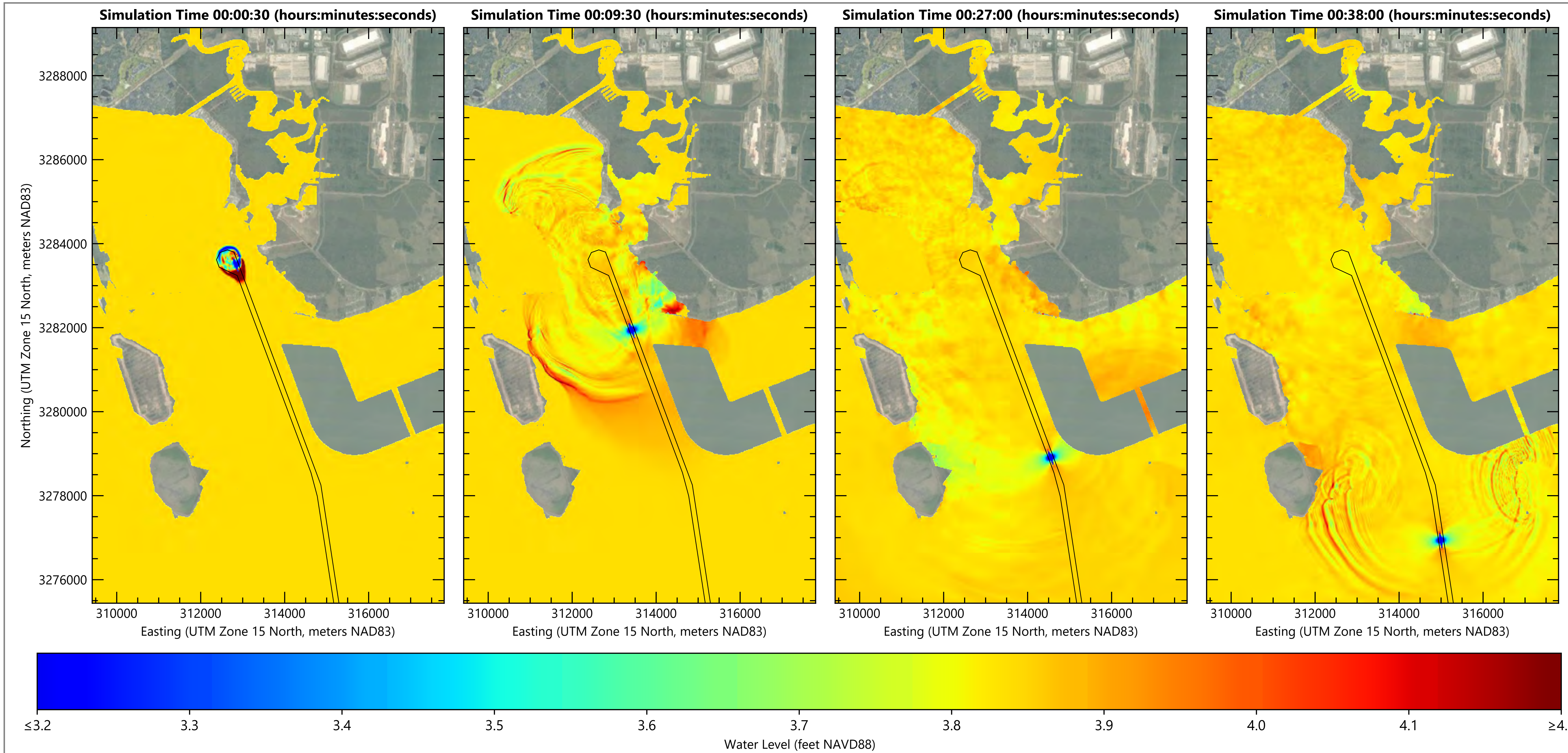
Figure 29j
Vessel Wake Water Level Results: Route B Outbound, Year 50



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

Channel Footprint

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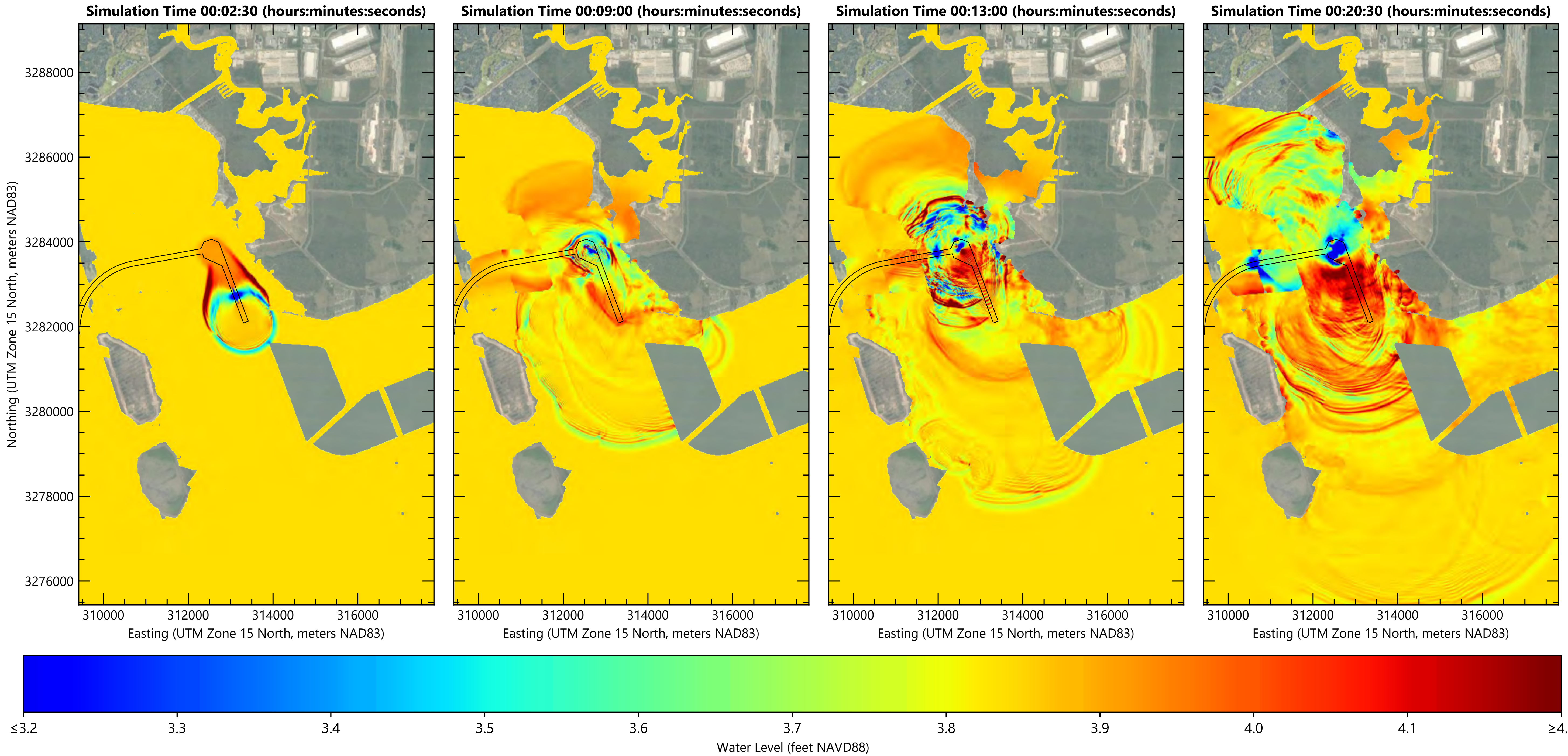
Figure 29k
Vessel Wake Water Level Results: Route D Outbound, Year 50
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

— Channel Footprint

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Figure 29l
Vessel Wake Water Level Results: Route E Outbound, Year 50
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

Notes: Basemap Source: Bing Satellite Imagery, BU: Beneficial Use, HSC: Houston Ship Channel, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

- Vessel Wake Point Analysis Location
- HSC Centerline
- Cedar Bayou Centerline
- Alternative Route B Channel Footprint
- Alternative Route B BU Footprint

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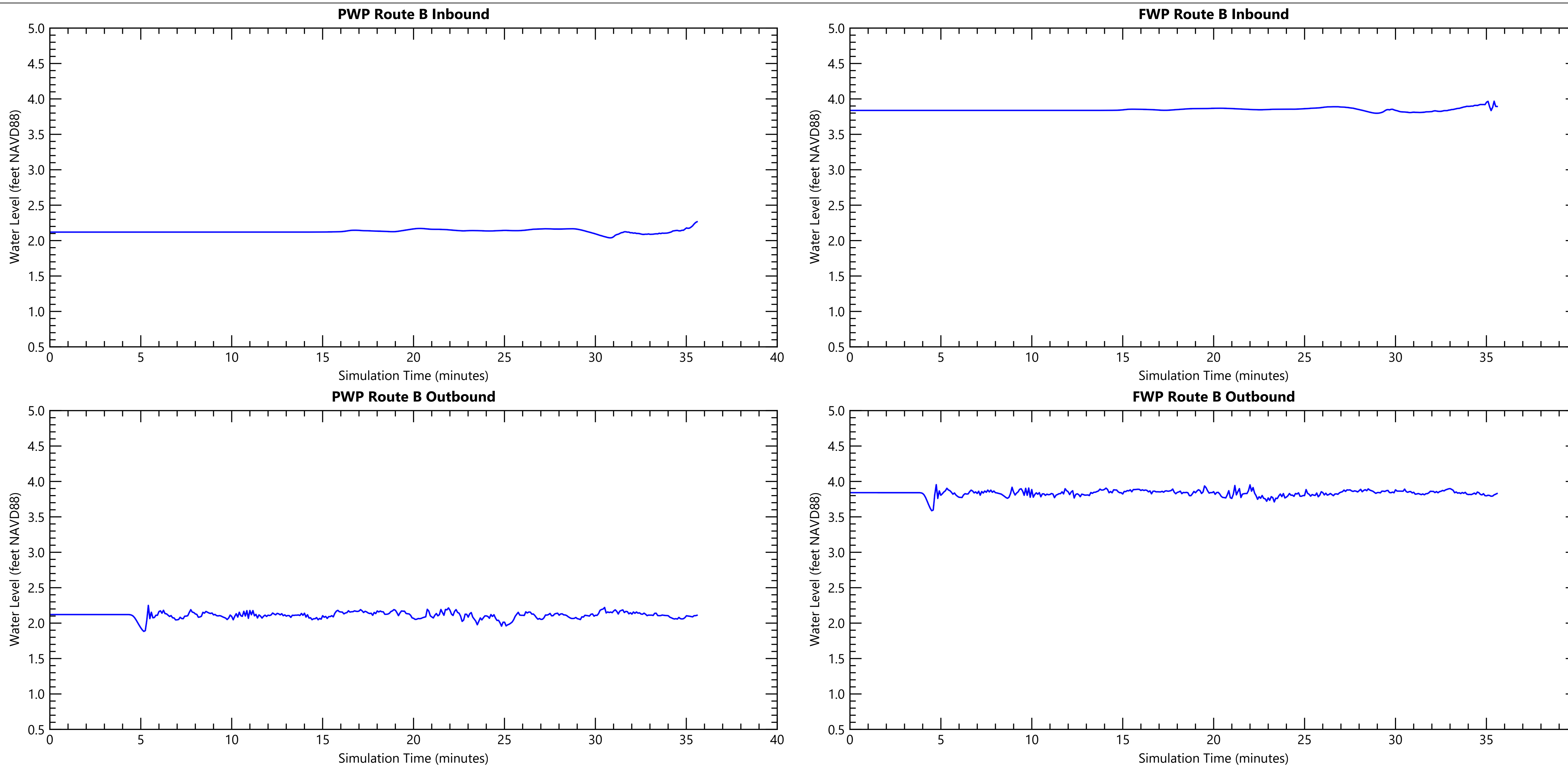
Figure 30a
Vessel Wake Point Analysis Reference Map: Alternative Route B



Notes: FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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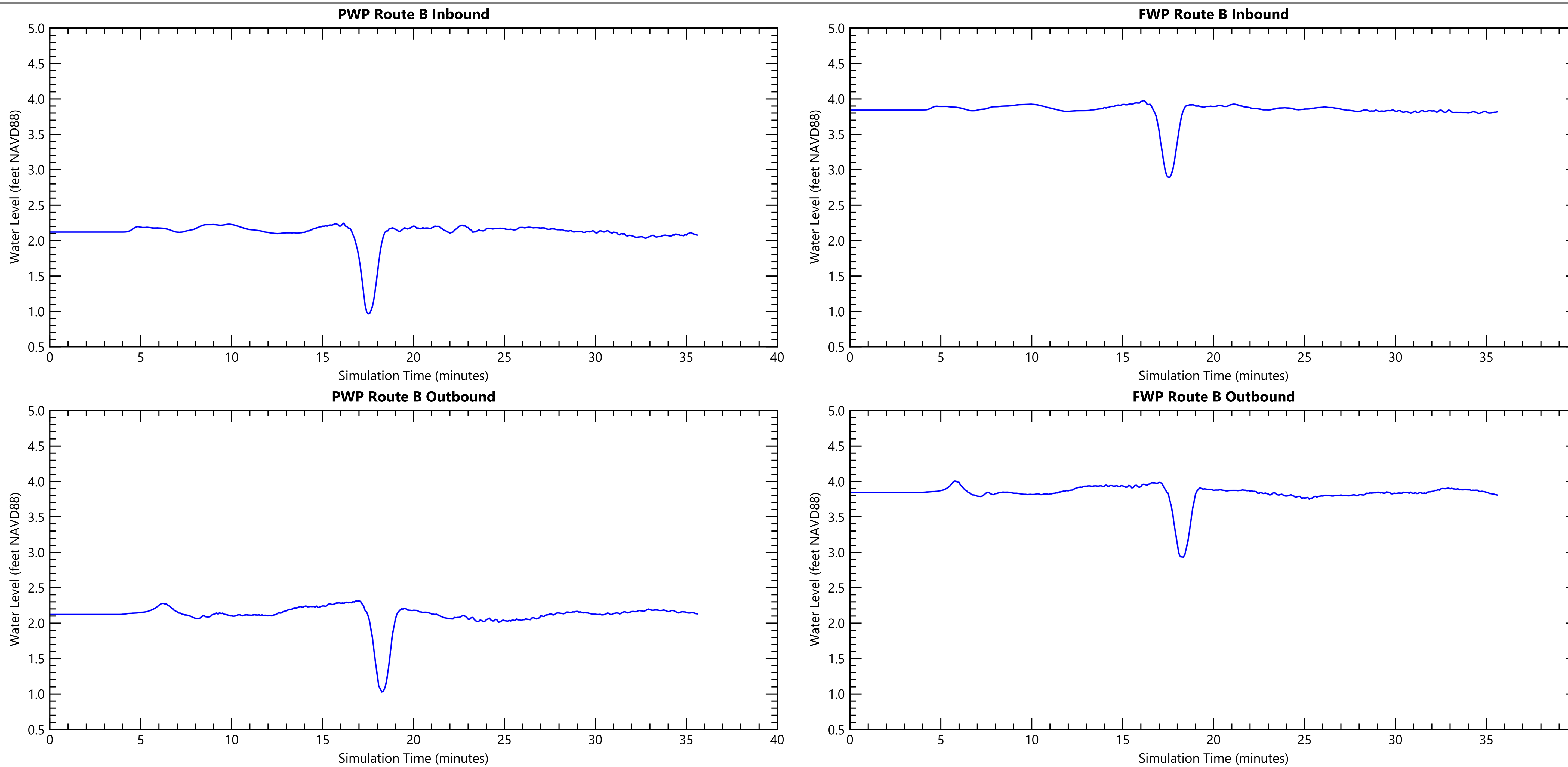
Figure 30b

Vessel Wake Point Analysis: Route B, Point 1 (Near Bay Oaks)



Notes: FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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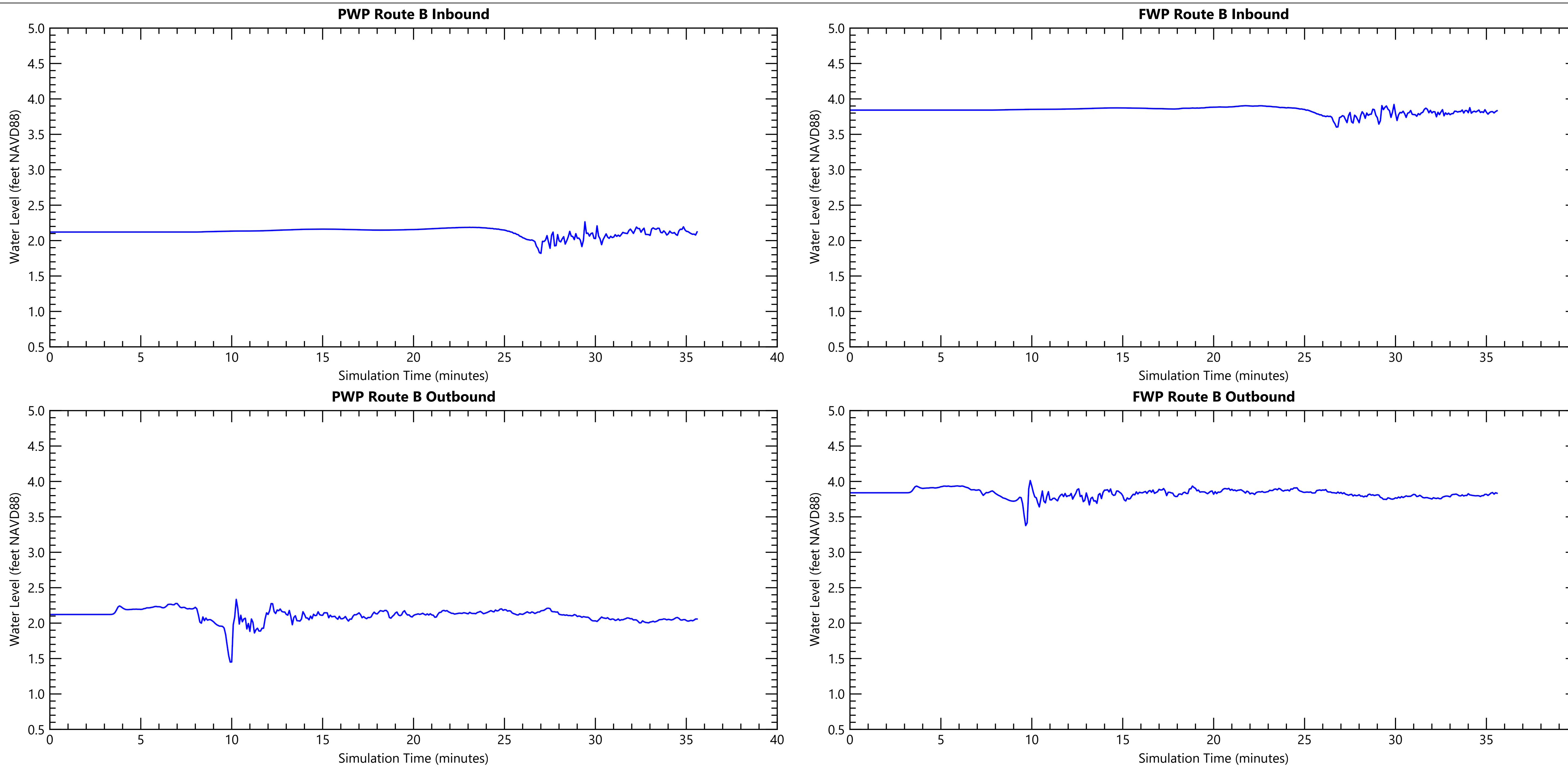
Figure 30c
Vessel Wake Point Analysis: Route B, Point 2 (South Bank of Channel Through Atkinson Island)
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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Figure 30d
Vessel Wake Point Analysis: Route B, Point 3 (Near Cedar Point)

Notes: Basemap Source: Bing Satellite Imagery, BU: Beneficial Use, HSC: Houston Ship Channel, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

- Vessel Wake Point Analysis Location
- HSC Centerline
- Cedar Bayou Centerline
- Alternative Route D Channel Footprint
- Alternative Route D BU Footprint

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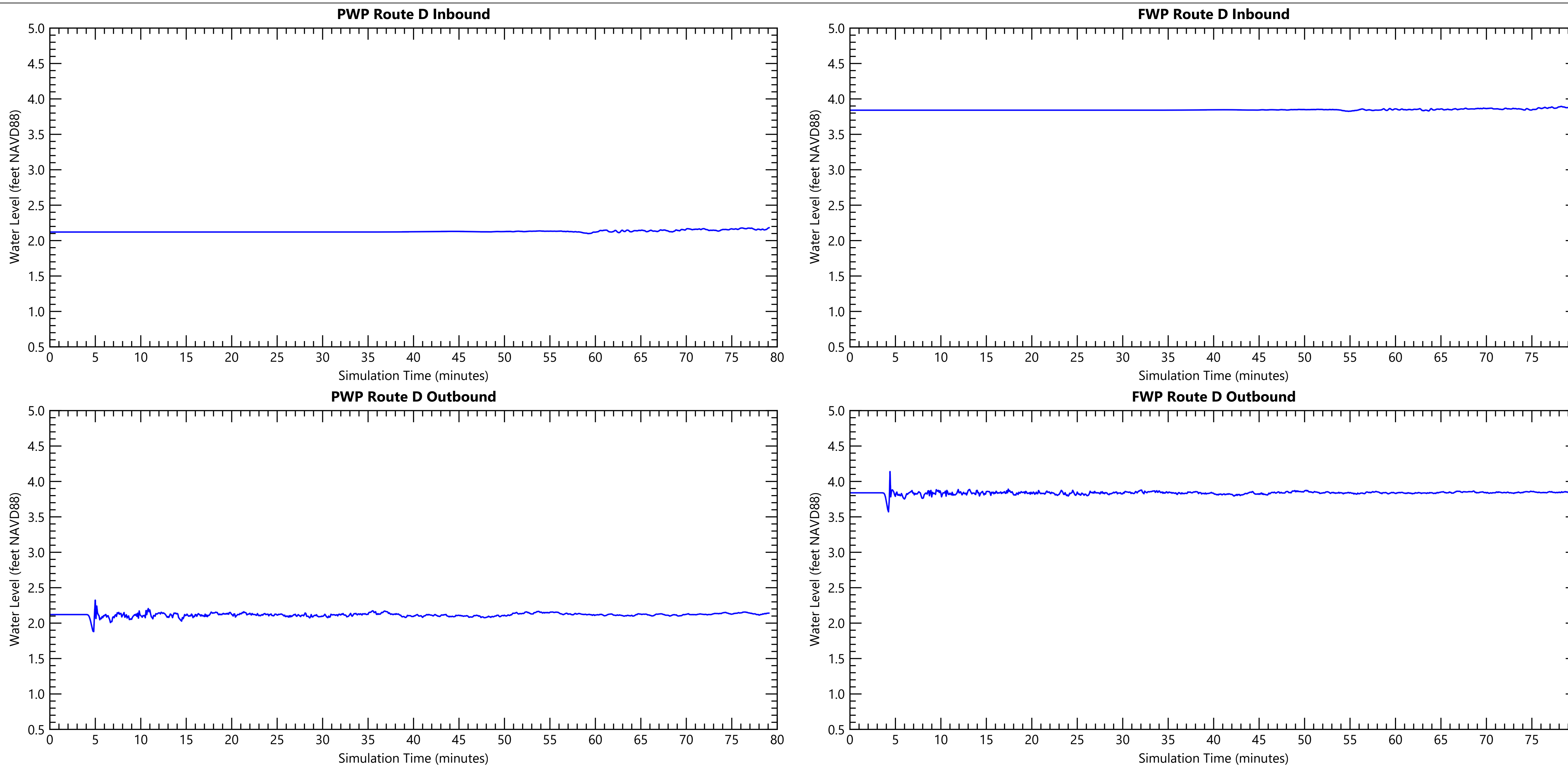
Figure 30e
Vessel Wake Point Analysis Reference Map: Alternative Route D



Notes: FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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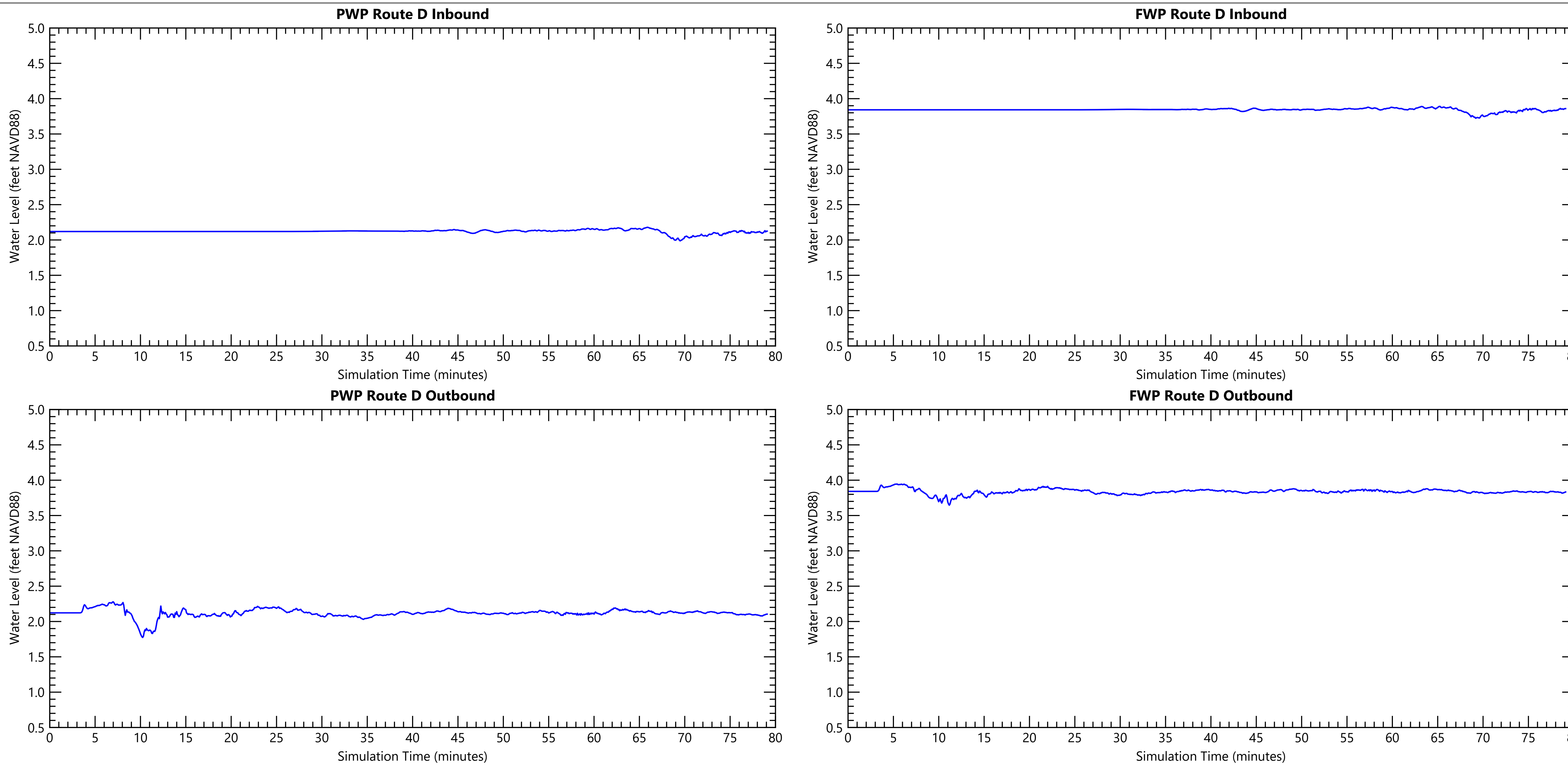
Figure 30f
Vessel Wake Point Analysis: Route D, Point 1 (Near Bay Oaks)
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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Figure 30g
Vessel Wake Point Analysis: Route D, Point 2 (Near Cedar Point)
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

Notes: Basemap Source: Bing Satellite Imagery, BU: Beneficial Use, HSC: Houston Ship Channel, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

- Vessel Wake Point Analysis Location
- HSC Centerline
- Cedar Bayou Centerline
- Alternative Route E Channel Footprint
- Alternative Route E BU Footprint

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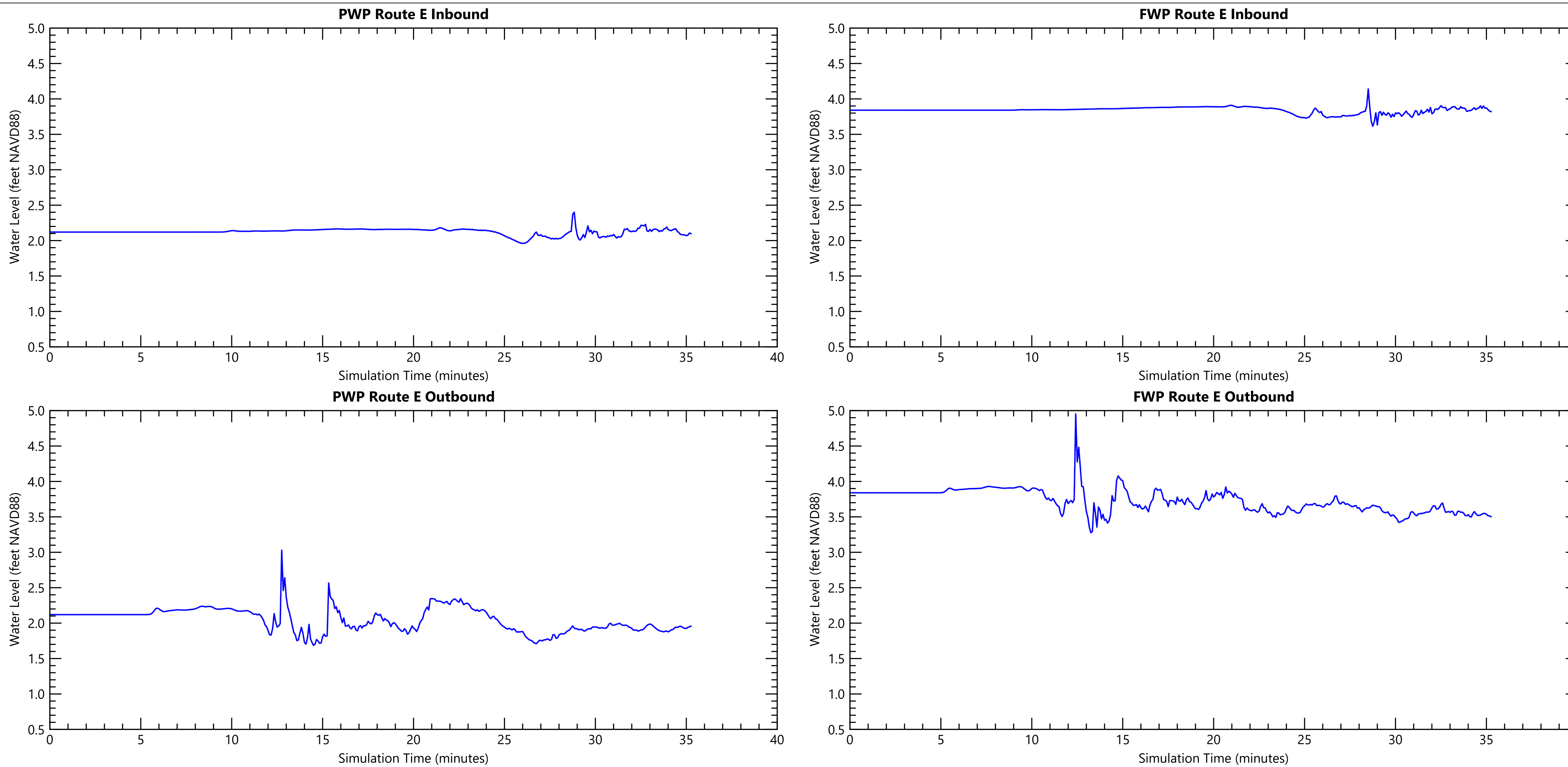
Figure 30h
Vessel Wake Point Analysis Reference Map: Alternative Route E
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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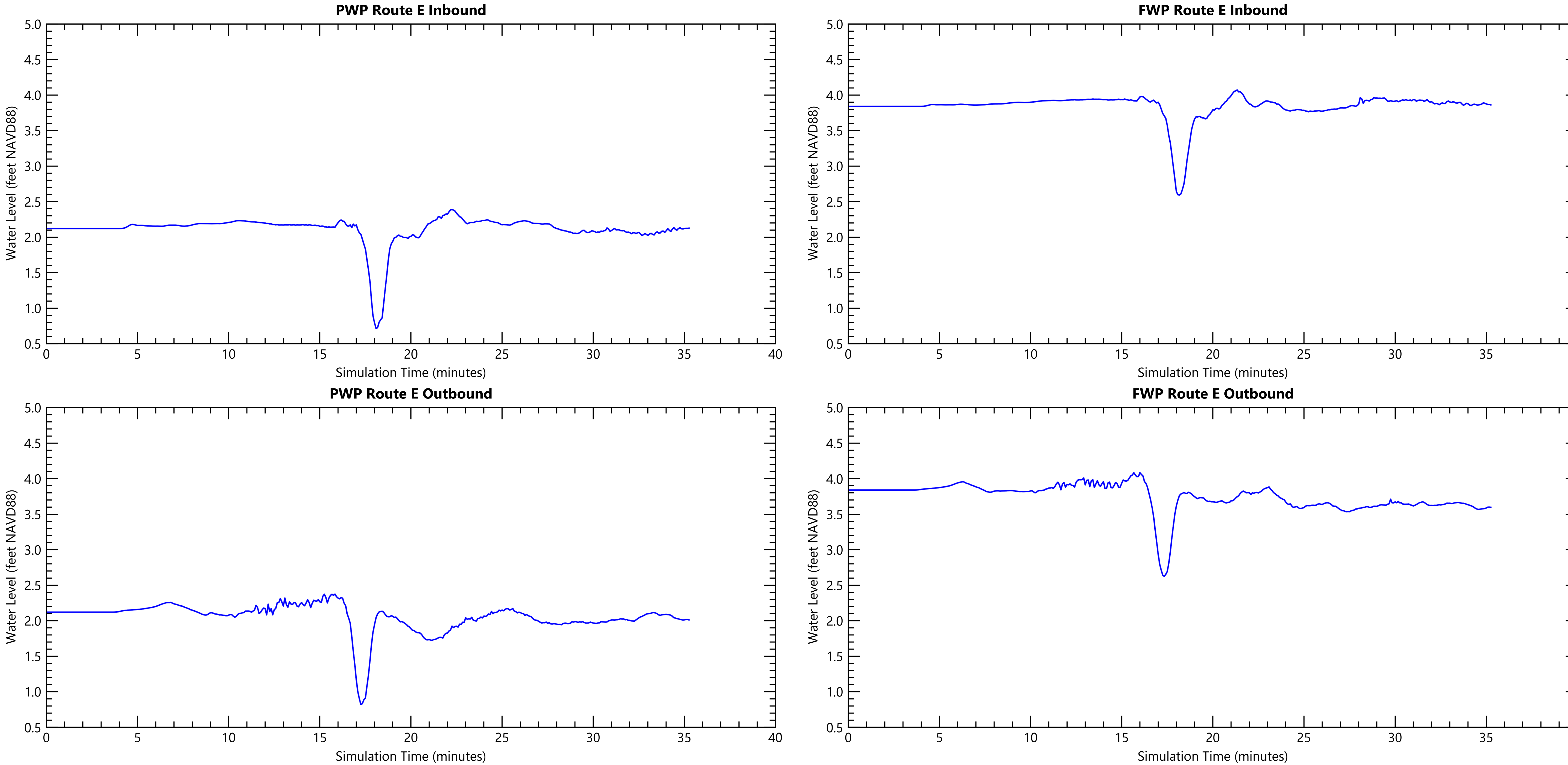
Figure 30i
Vessel Wake Point Analysis: Route E, Point 1 (Near Bay Oaks)
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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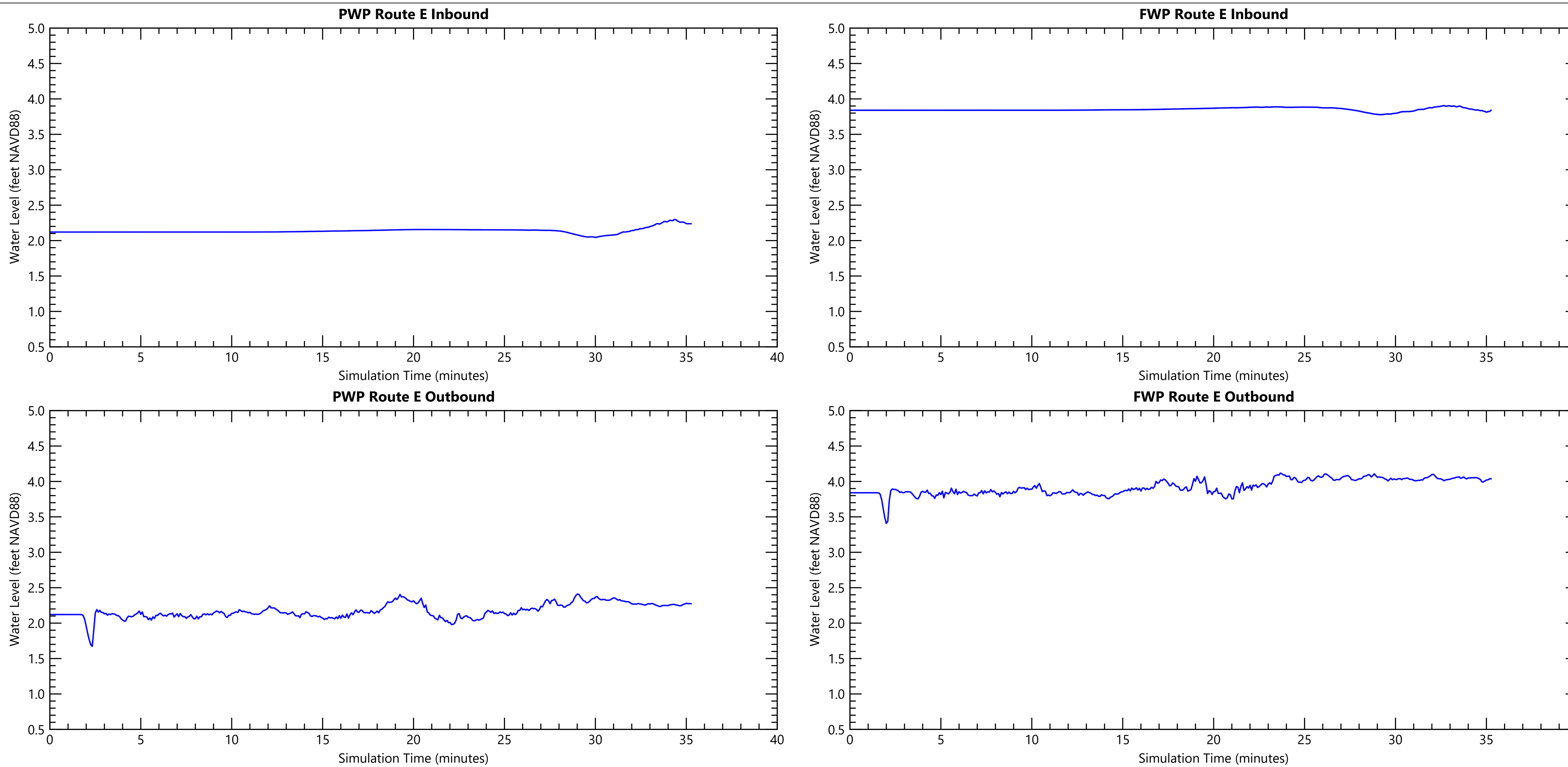
Figure 30j

Vessel Wake Point Analysis: Route E, Point 2 (South Bank of Channel Through Atkinson Island)



Notes: FWP: Future with Project, NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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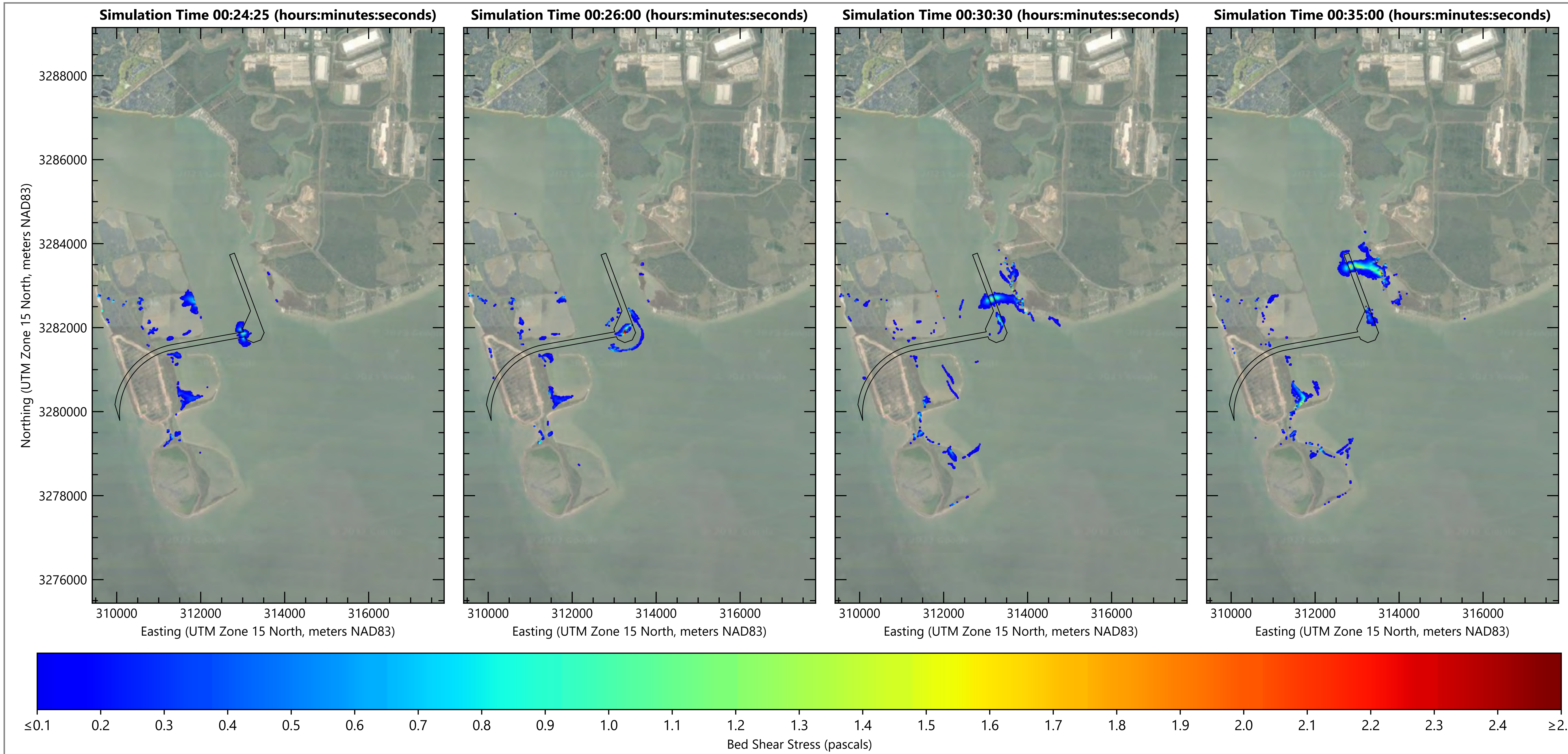
Figure 30k
Vessel Wake Point Analysis: Route E, Point 3 (Near Cedar Point)



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

Channel Footprint

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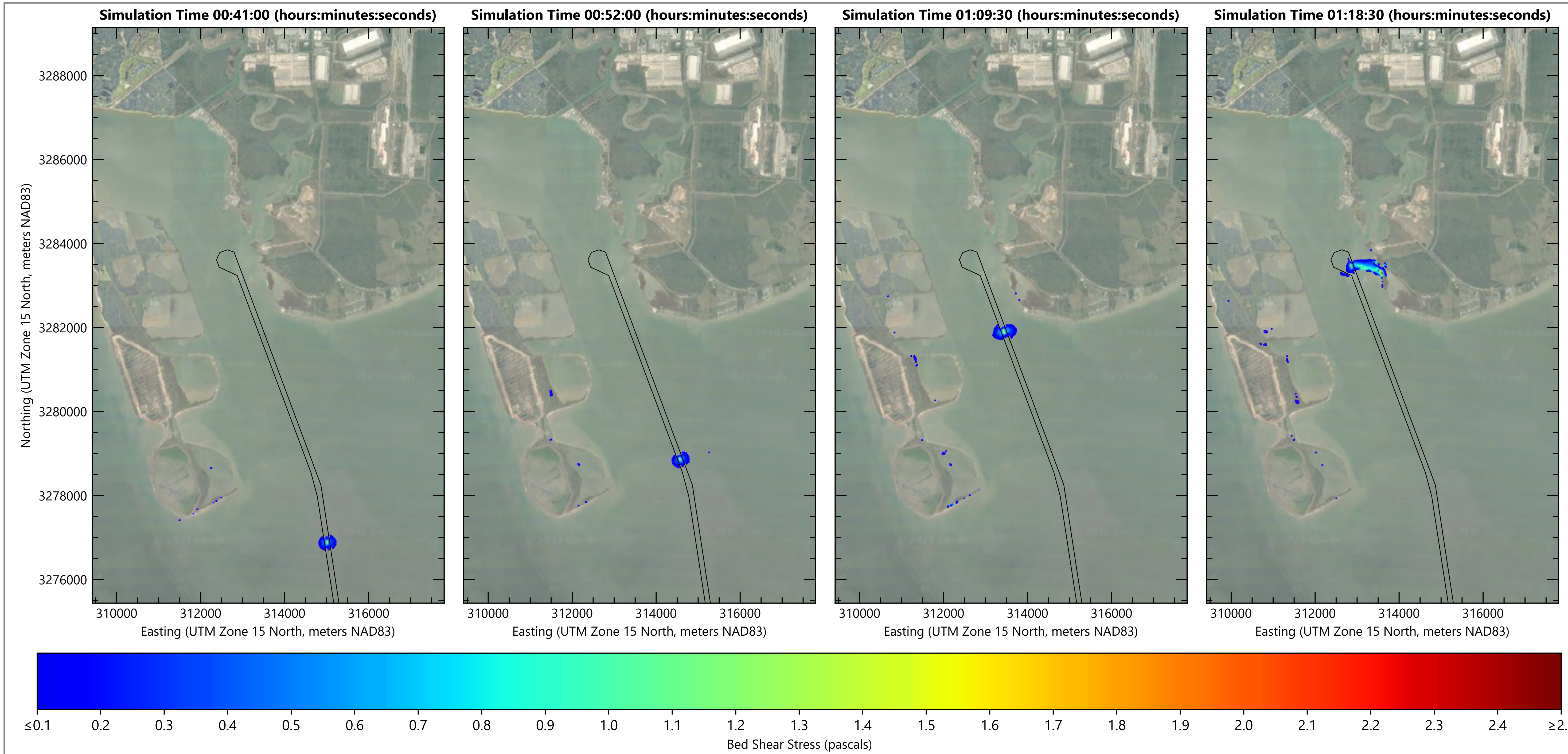
Figure 31a
Vessel Wake Bed Shear Stress Results: Route B Inbound, Year 0
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

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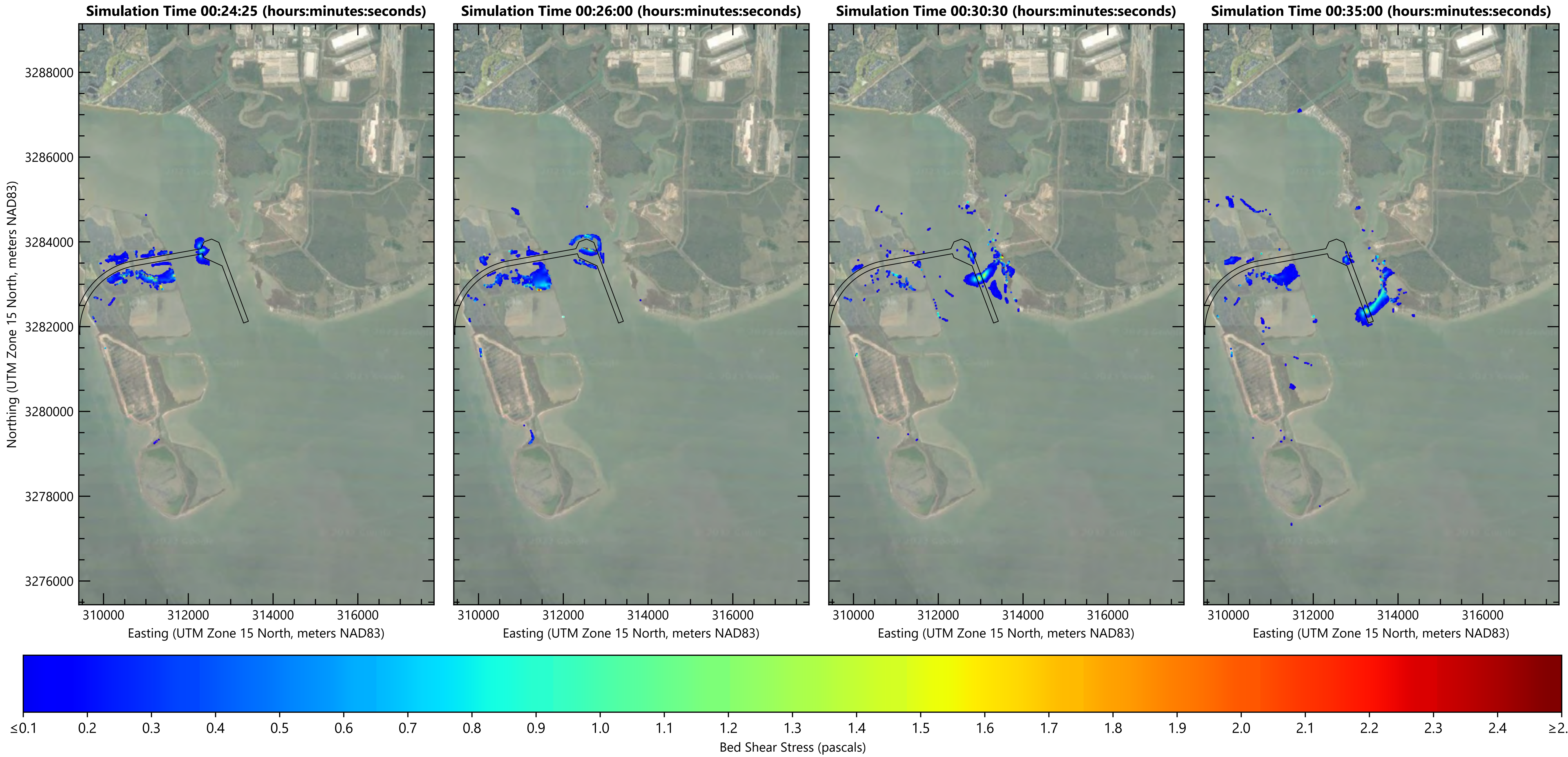
Figure 31b
Vessel Wake Bed Shear Stress Results: Route D Inbound, Year 0
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

Channel Footprint

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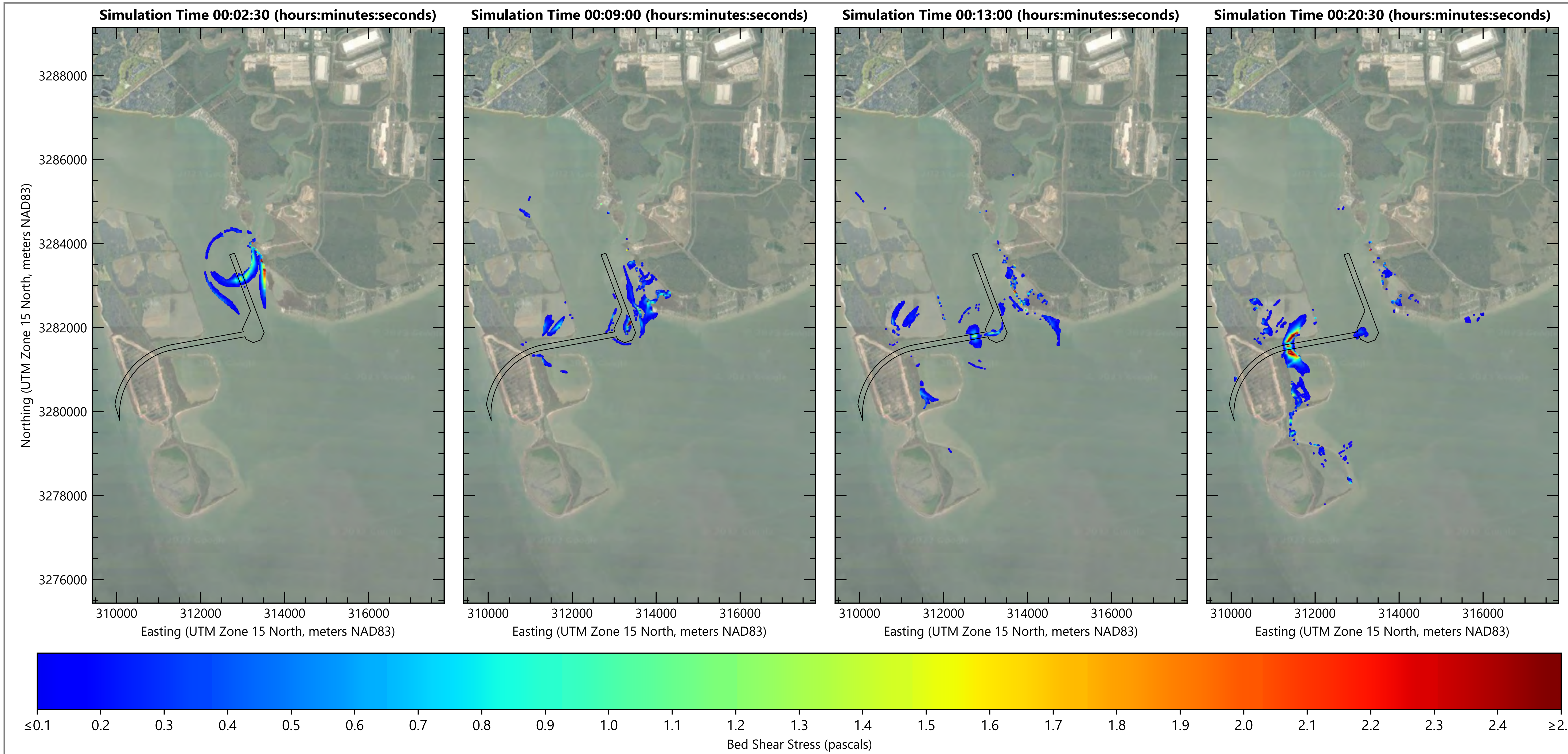
Figure 31c
Vessel Wake Bed Shear Stress Results: Route E Inbound, Year 0
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

Channel Footprint

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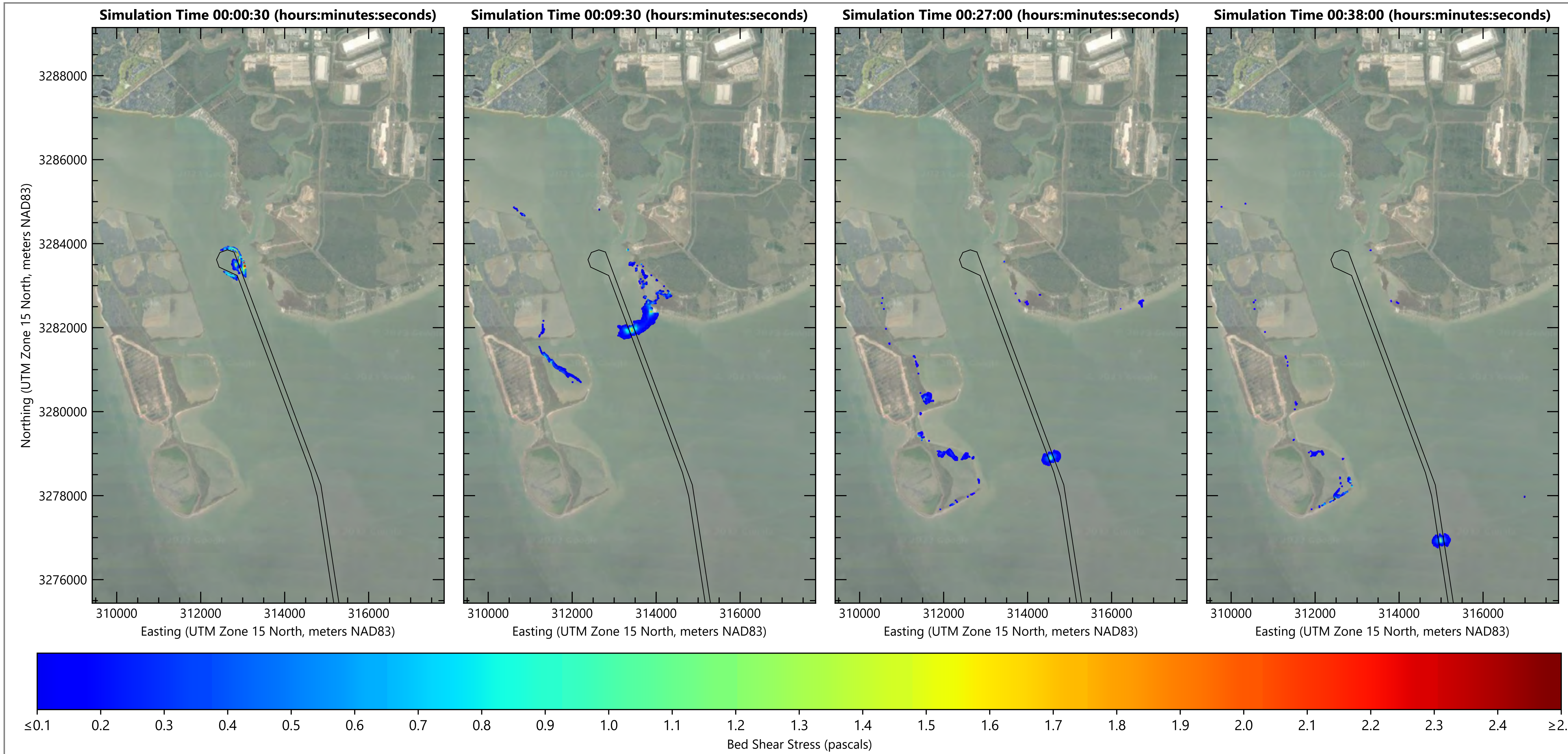
Figure 31d
Vessel Wake Bed Shear Stress Results: Route B Outbound, Year 0
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

— Channel Footprint

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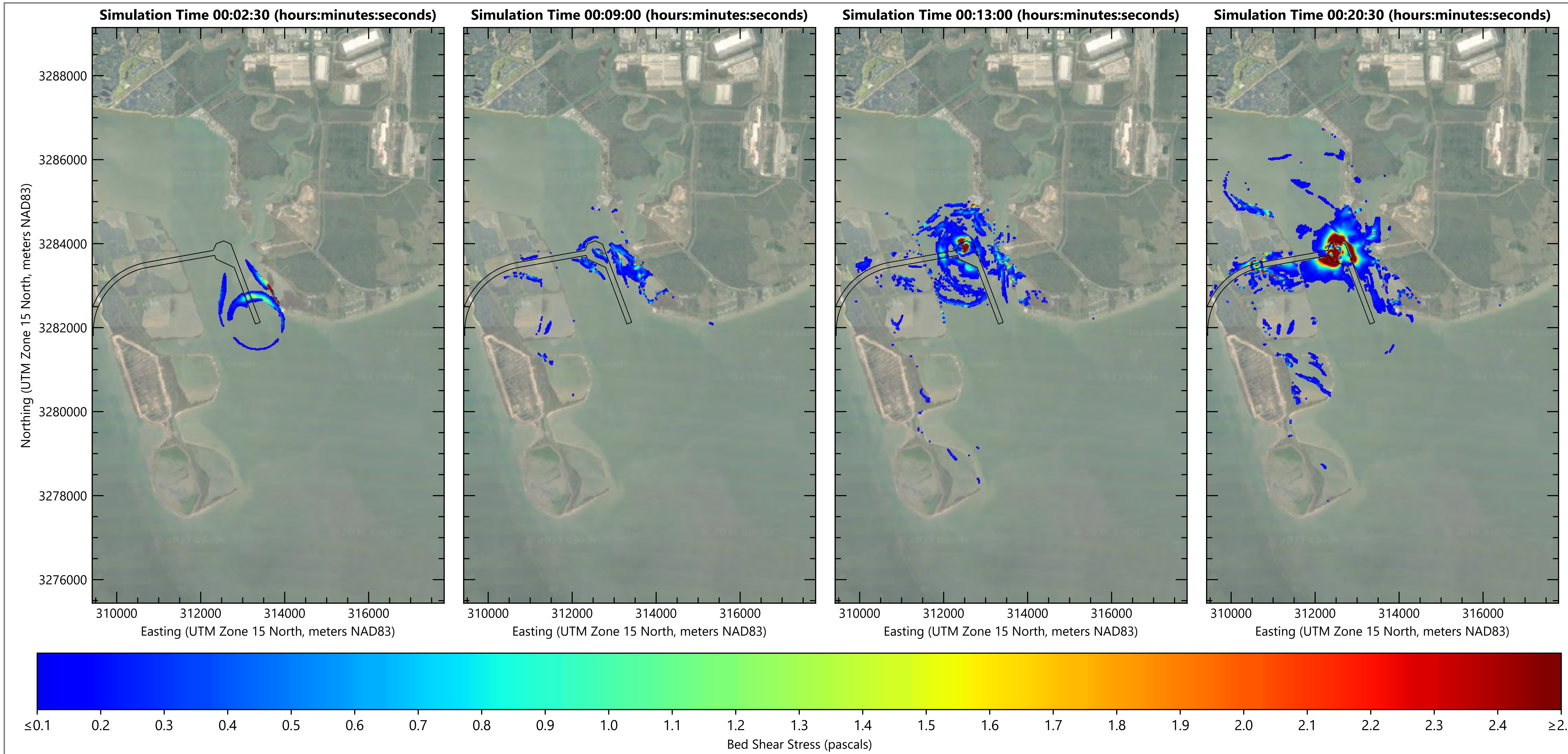
Figure 31e
Vessel Wake Bed Shear Stress Results: Route D Outbound, Year 0



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

Channel Footprint

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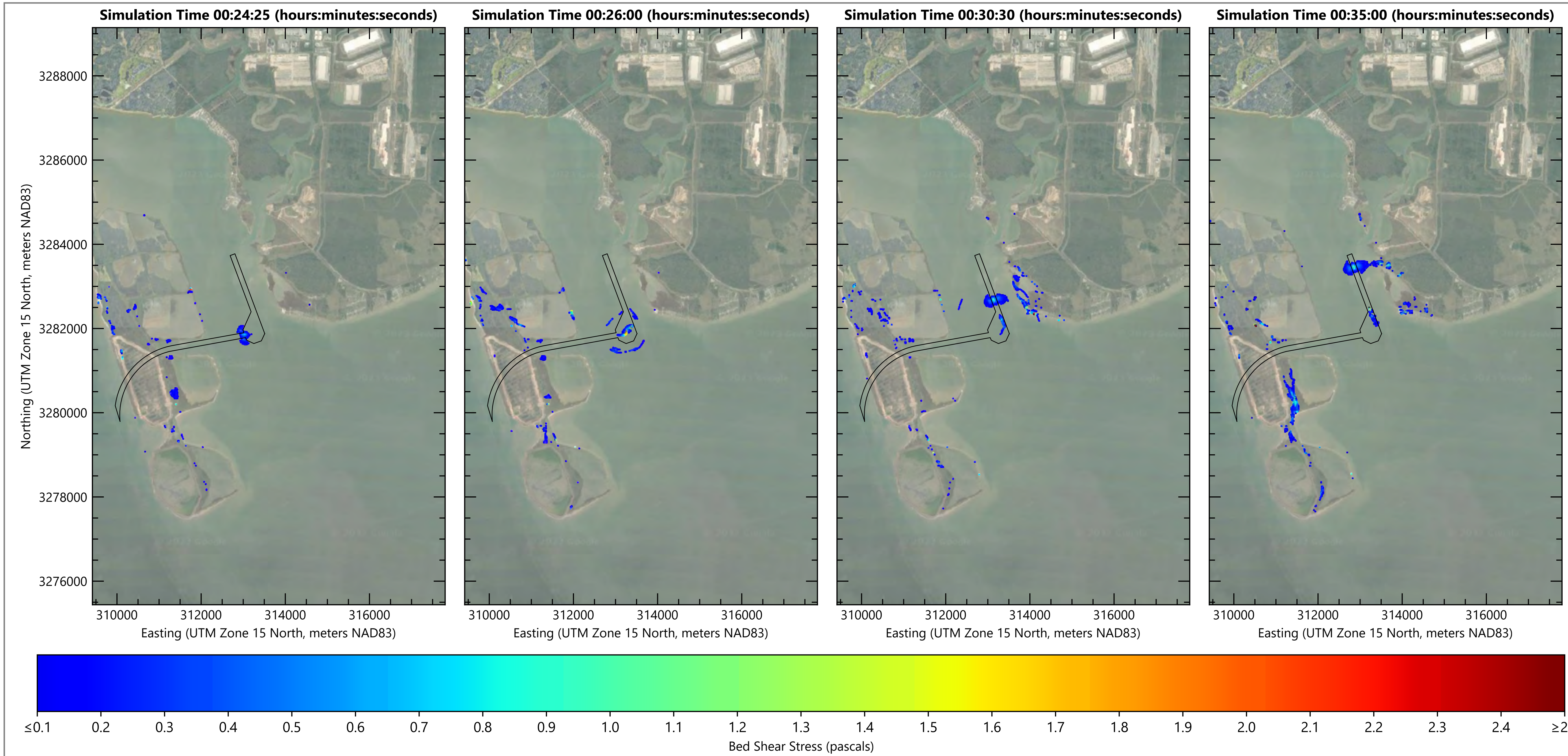
Figure 31f
Vessel Wake Bed Shear Stress Results: Route E Outbound, Year 0



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

Channel Footprint

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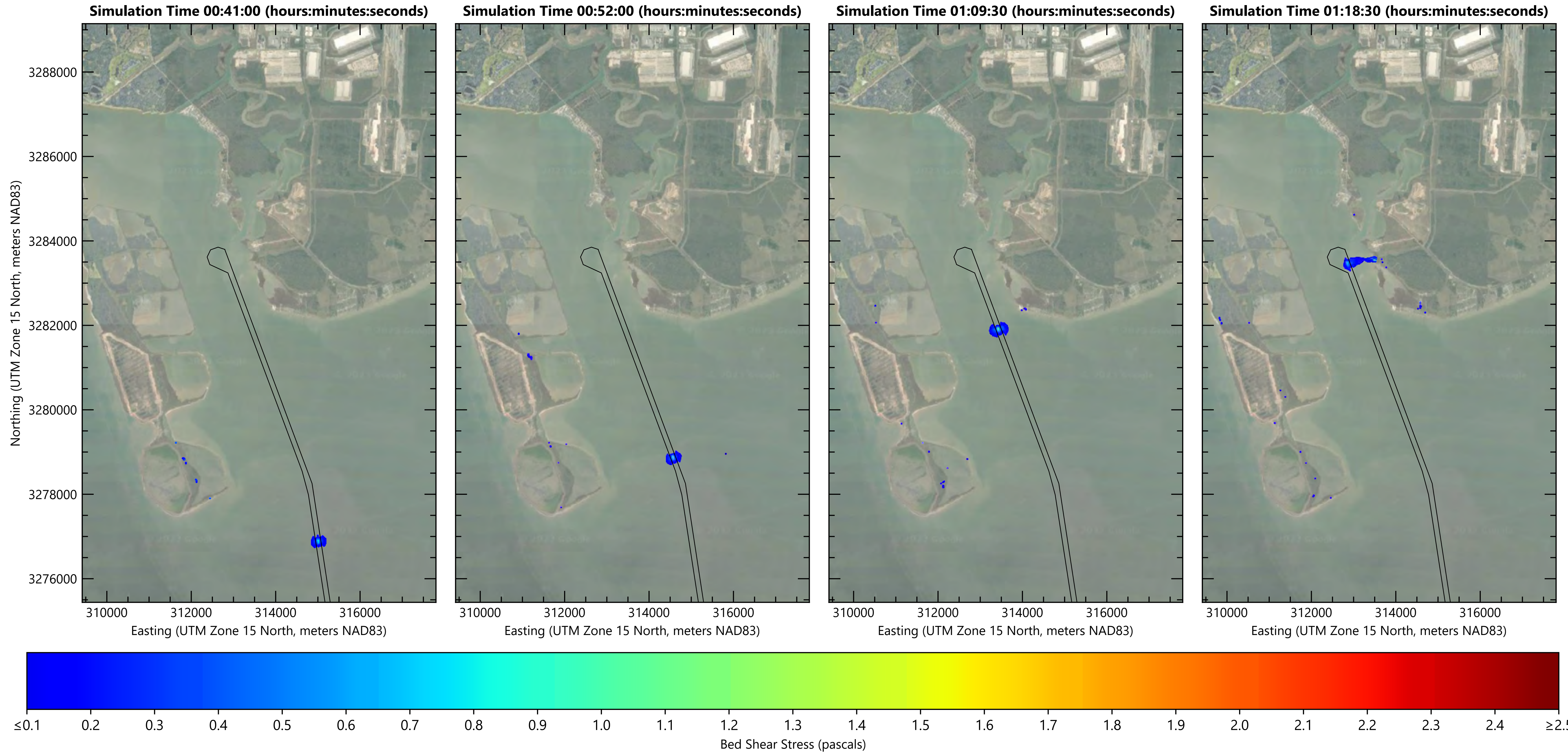
Figure 31g
Vessel Wake Bed Shear Stress Results: Route B Inbound, Year 50
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

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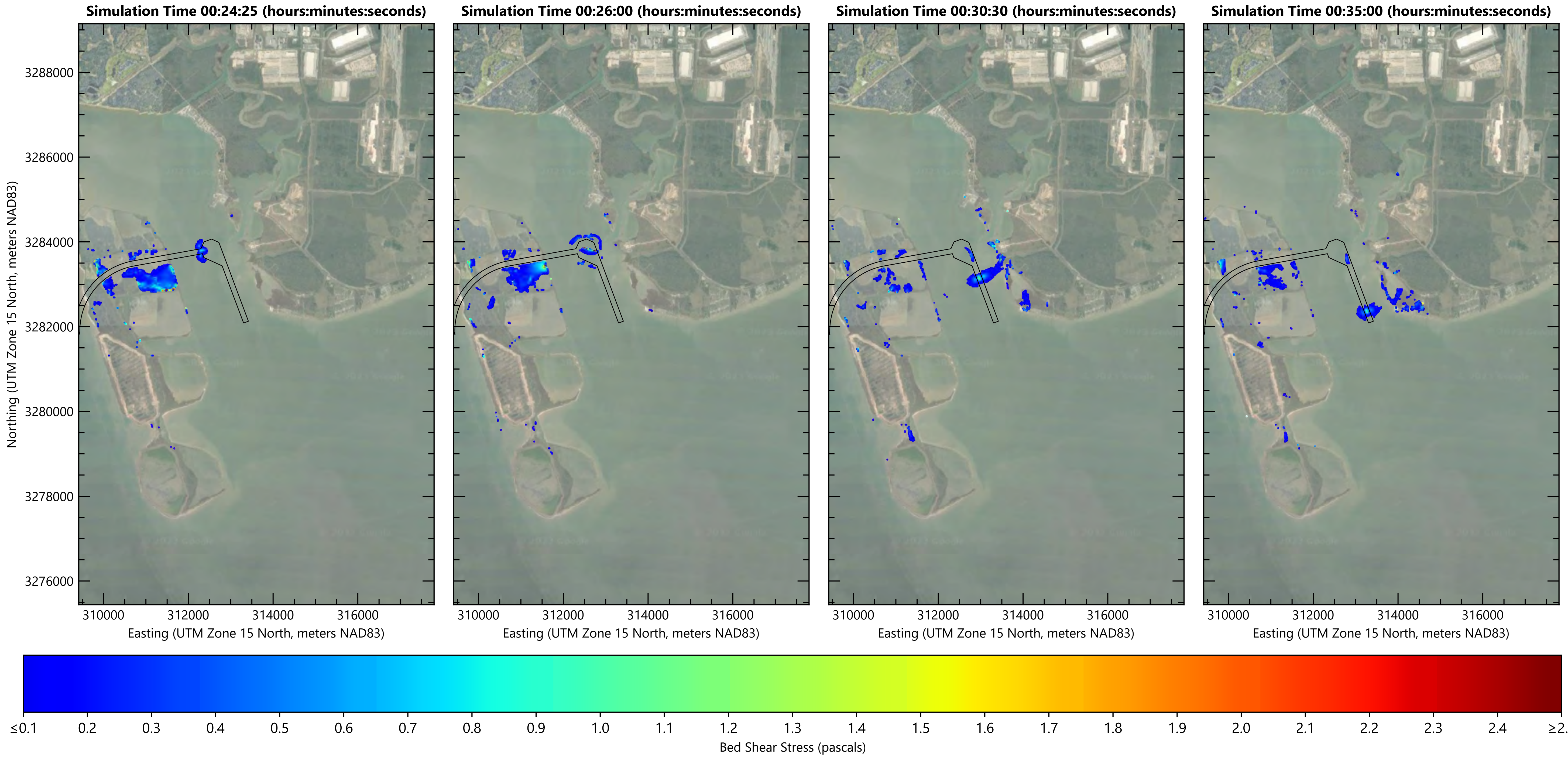
Figure 31h
Vessel Wake Bed Shear Stress Results: Route D Inbound, Year 50
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

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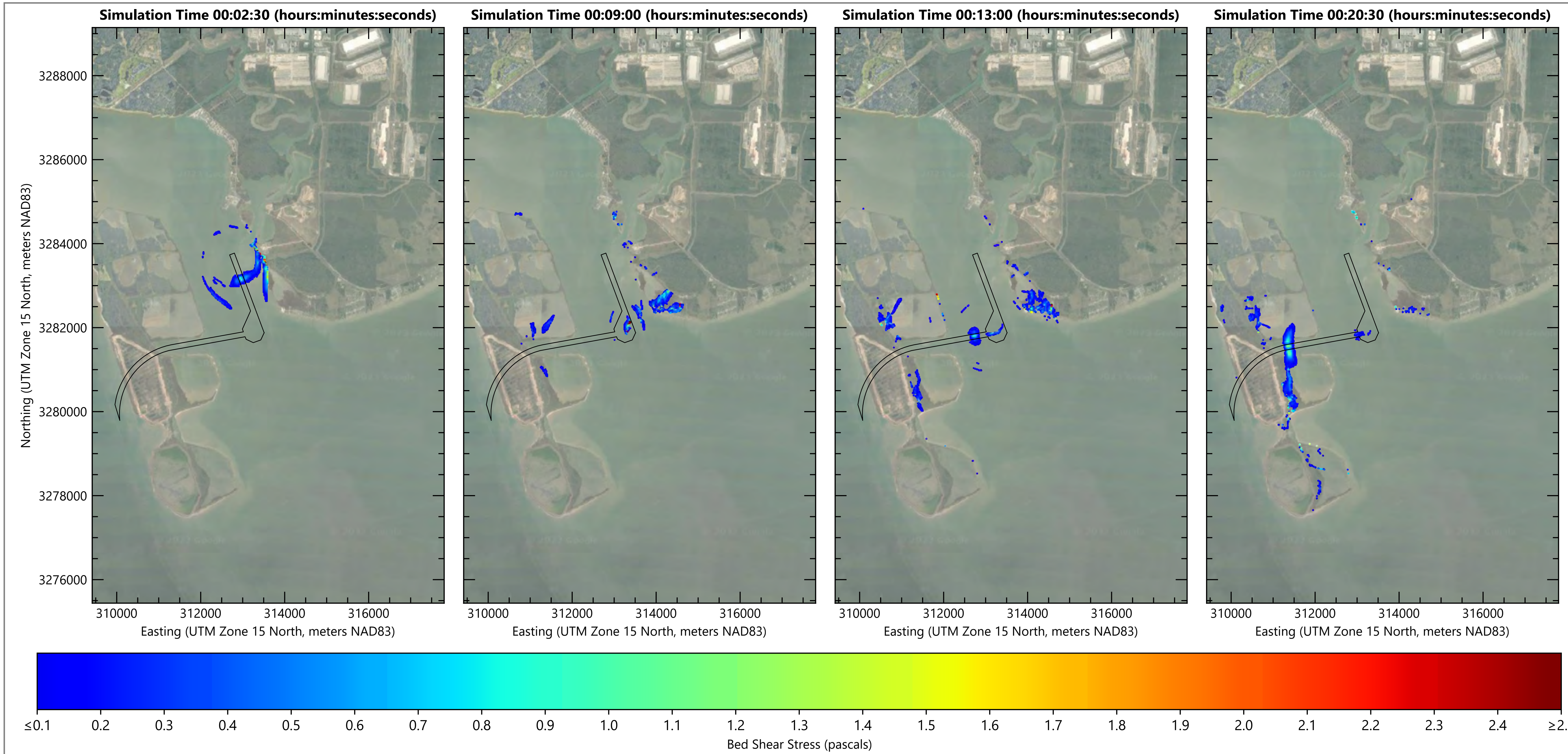
Figure 31i
Vessel Wake Bed Shear Stress Results: Route E Inbound, Year 50



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

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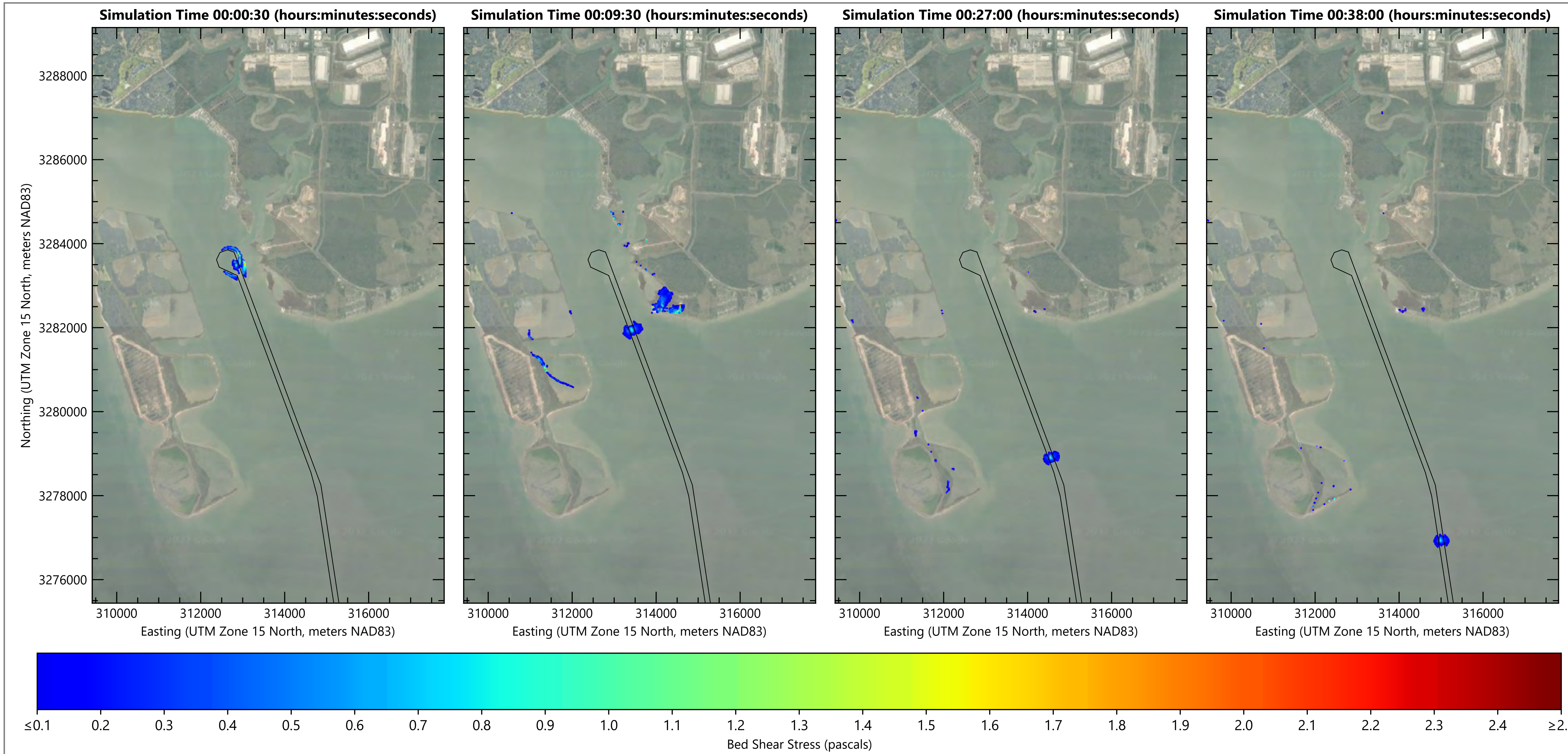
Figure 31j
Vessel Wake Bed Shear Stress Results: Route B Outbound, Year 50
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

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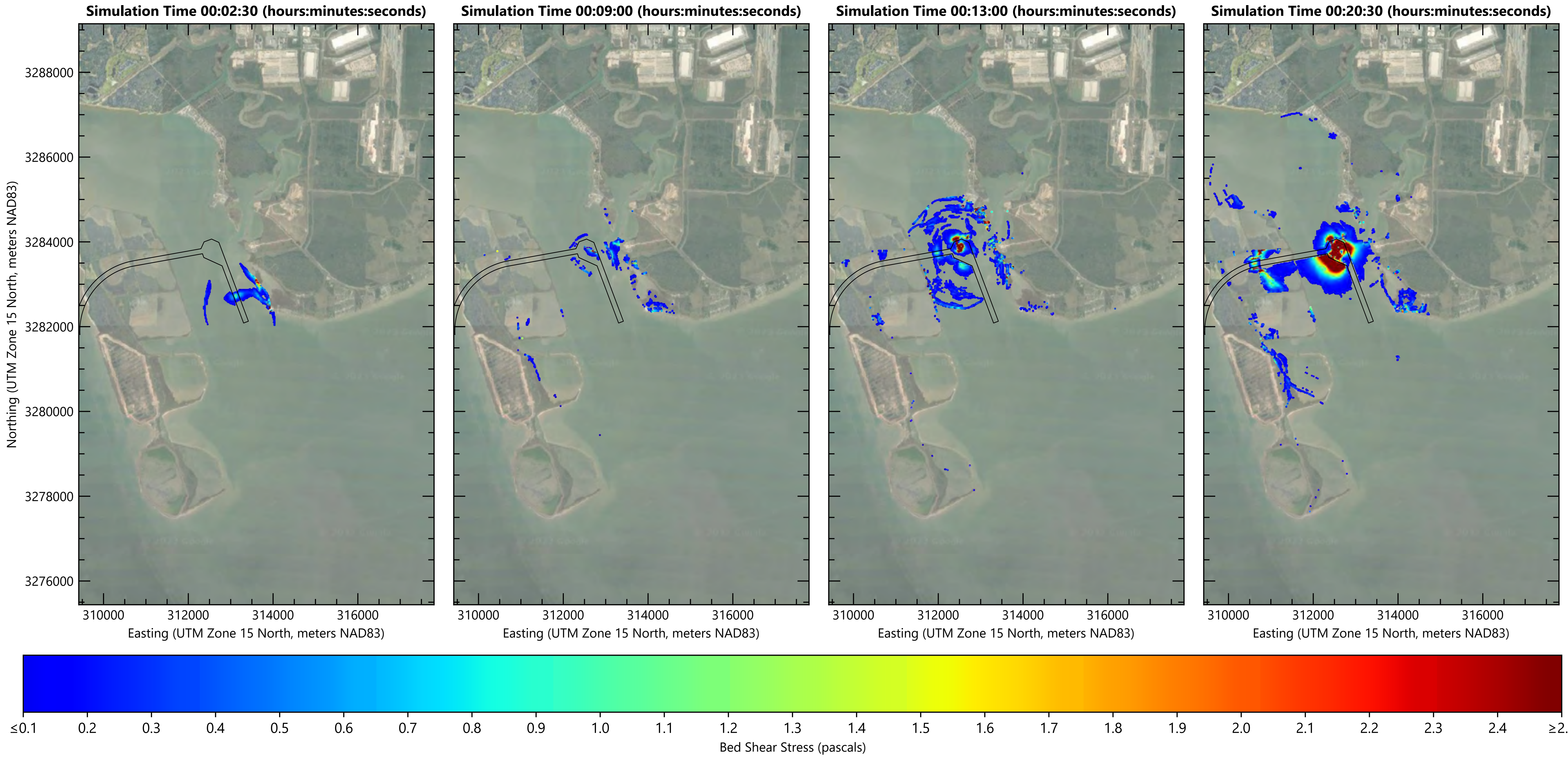
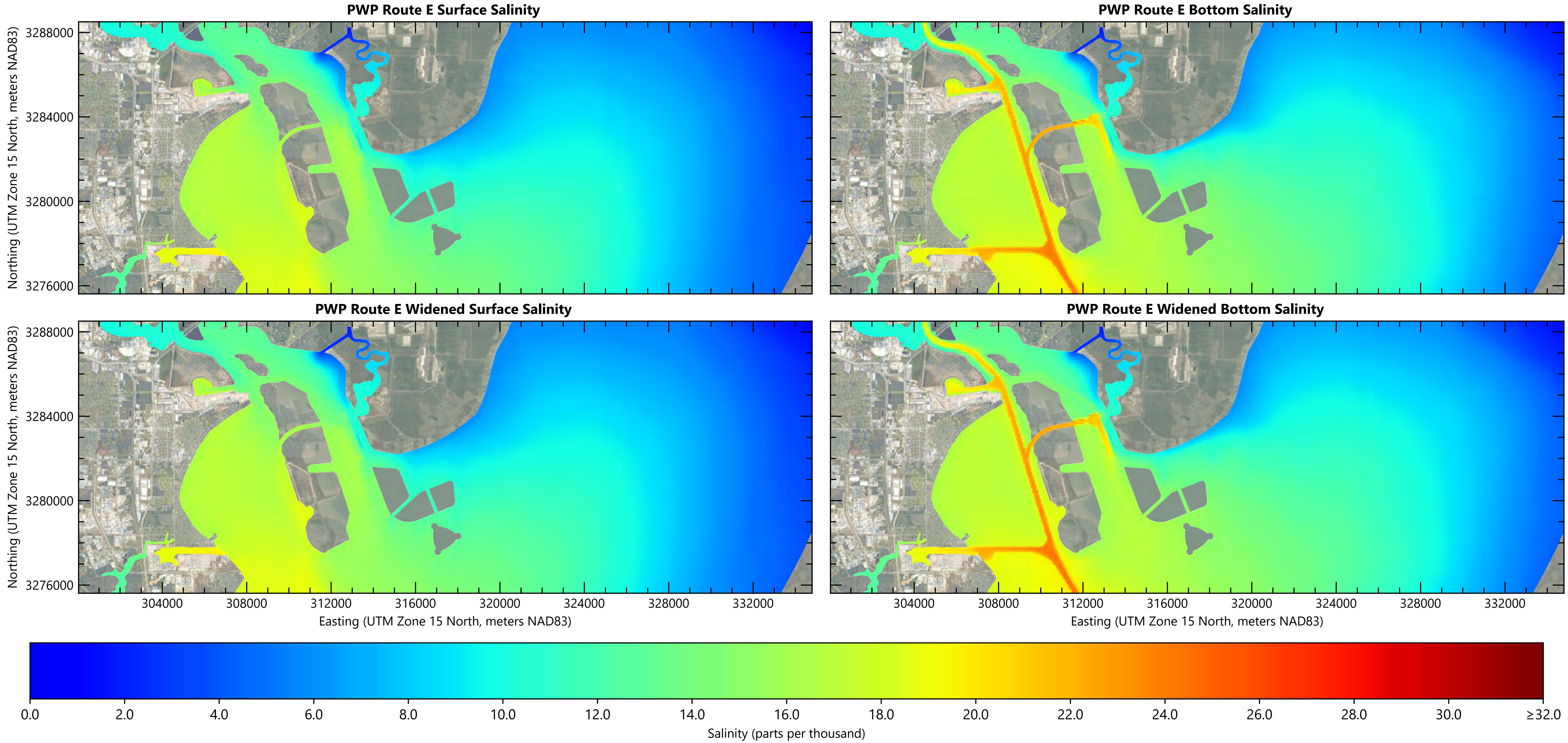
Figure 31k
Vessel Wake Bed Shear Stress Results: Route D Outbound, Year 50
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

— Channel Footprint

Figure 31l
Vessel Wake Bed Shear Stress Results: Route E Outbound, Year 50



Notes: Basemap Source: Google Satellite Imagery, PWP: Present with Project, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

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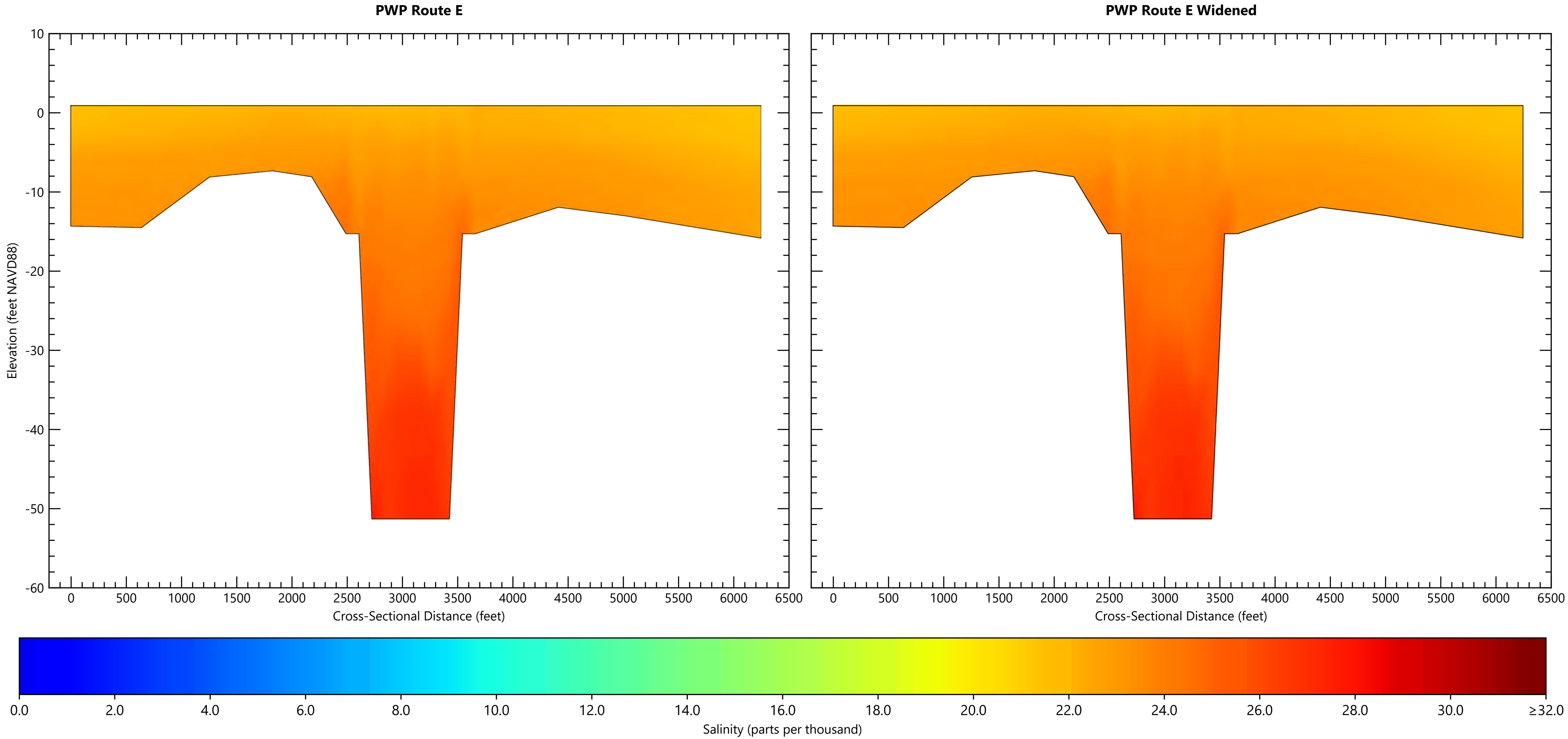
Figure 32

Comparison of Annual Average Surface and Bottom Salinities at Area of Interest: PWP Route E Versus PWP Route E Widened



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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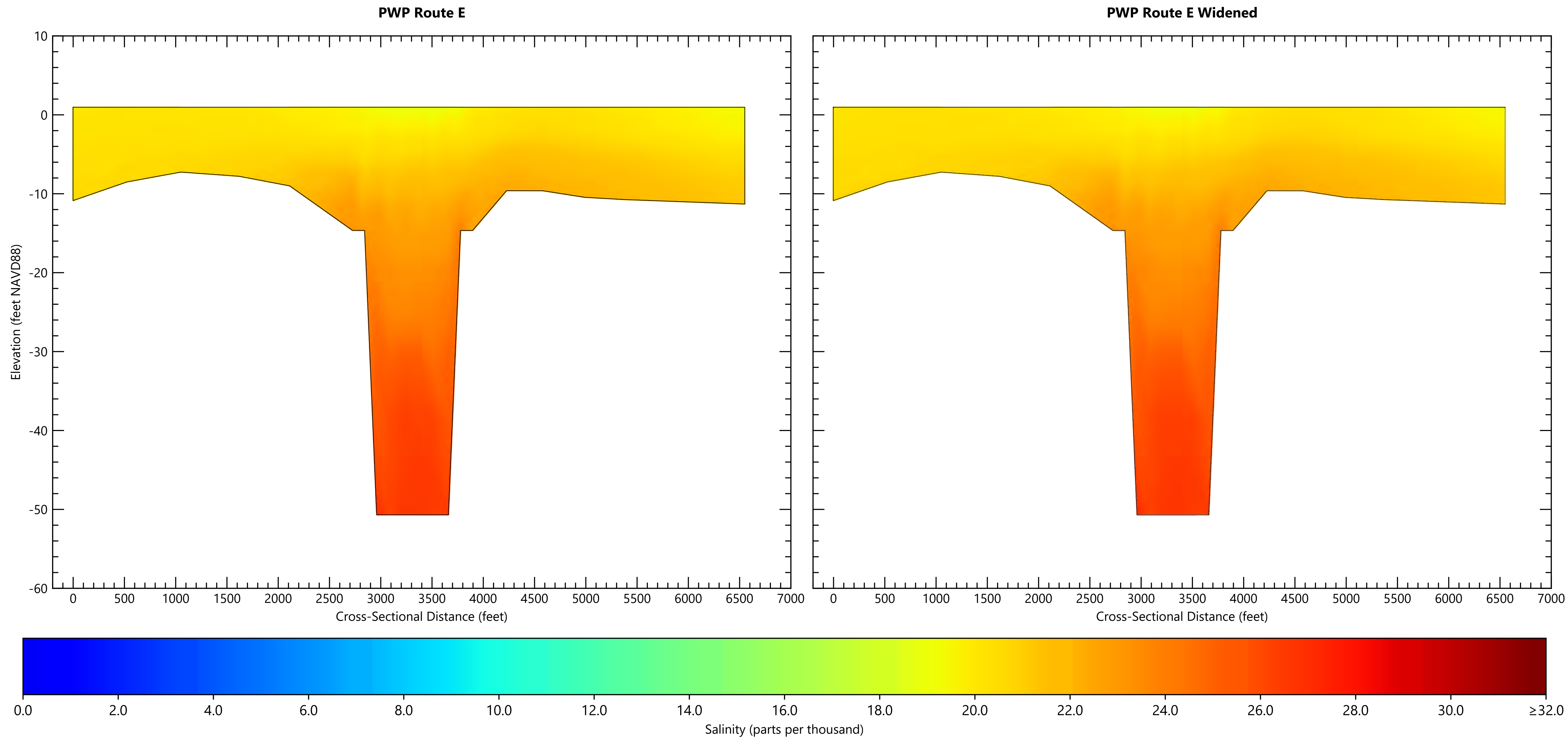
Figure 33a
Cross Section 1 Annual Average Salinity: PWP Route E Versus PWP Route E Widened



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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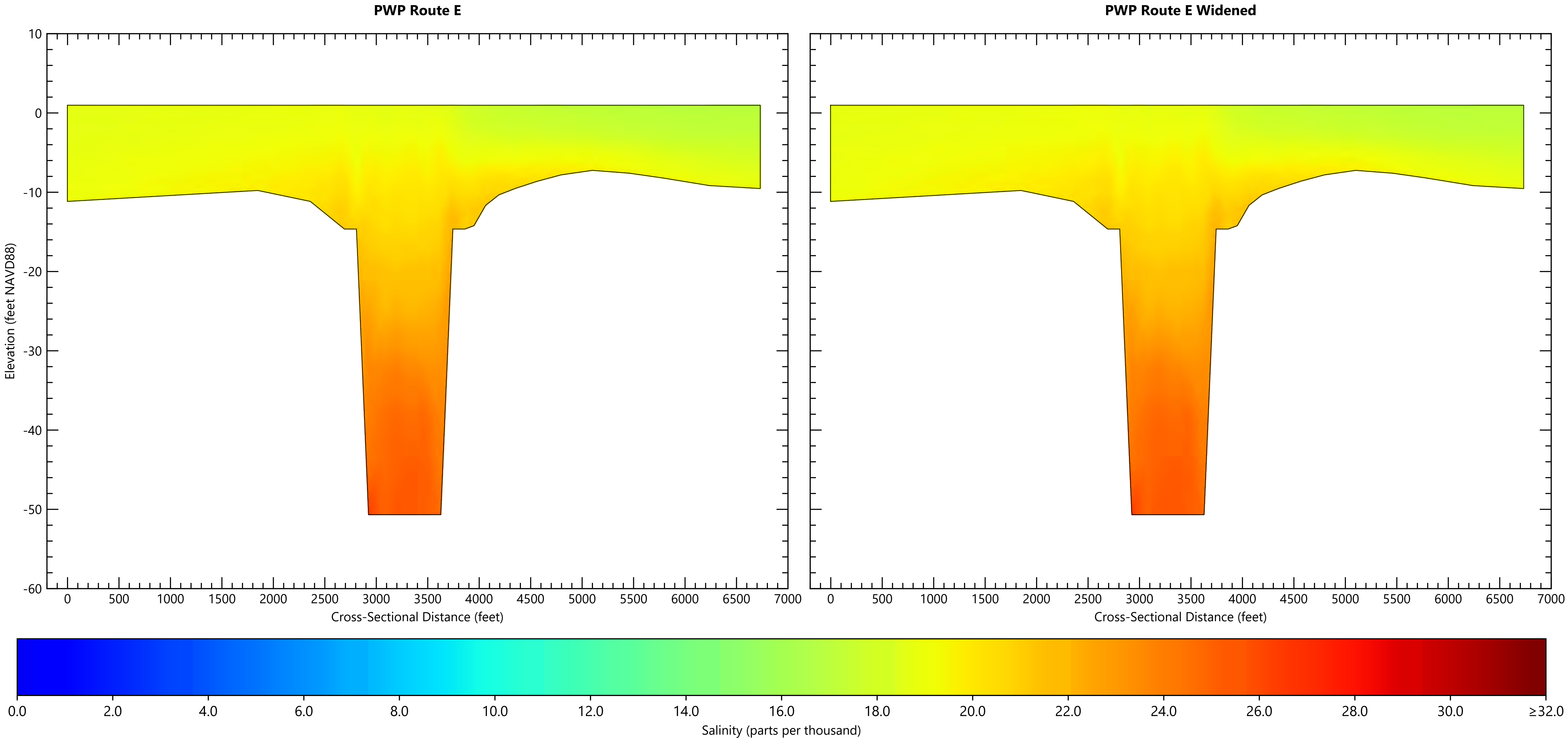
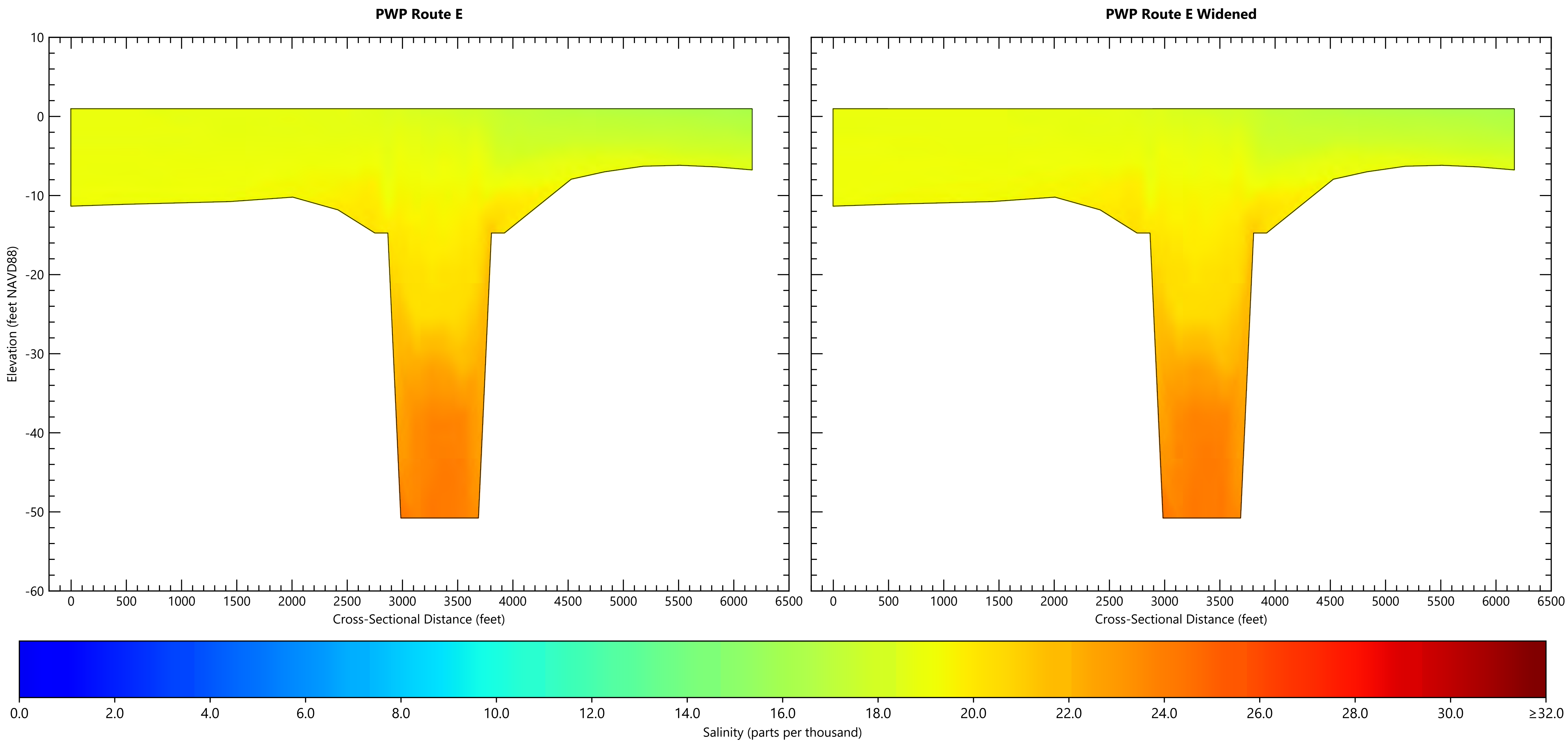
Figure 33b
Cross Section 2 Annual Average Salinity: PWP Route E Versus PWP Route E Widened
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

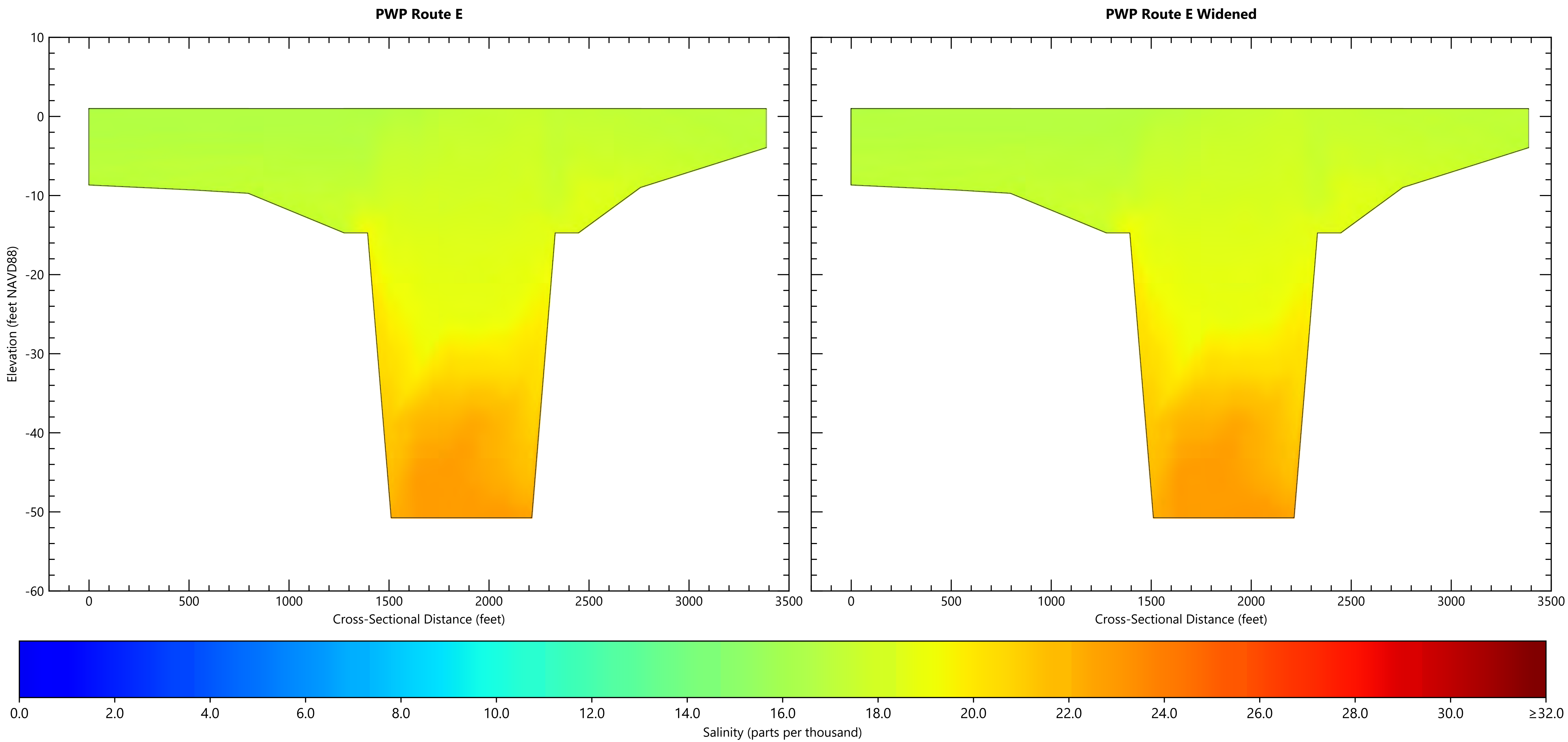
Figure 33c
Cross Section 3 Annual Average Salinity: PWP Route E Versus PWP Route E Widened



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

Figure 33d

Cross Section 4 Annual Average Salinity: PWP Route E Versus PWP Route E Widened



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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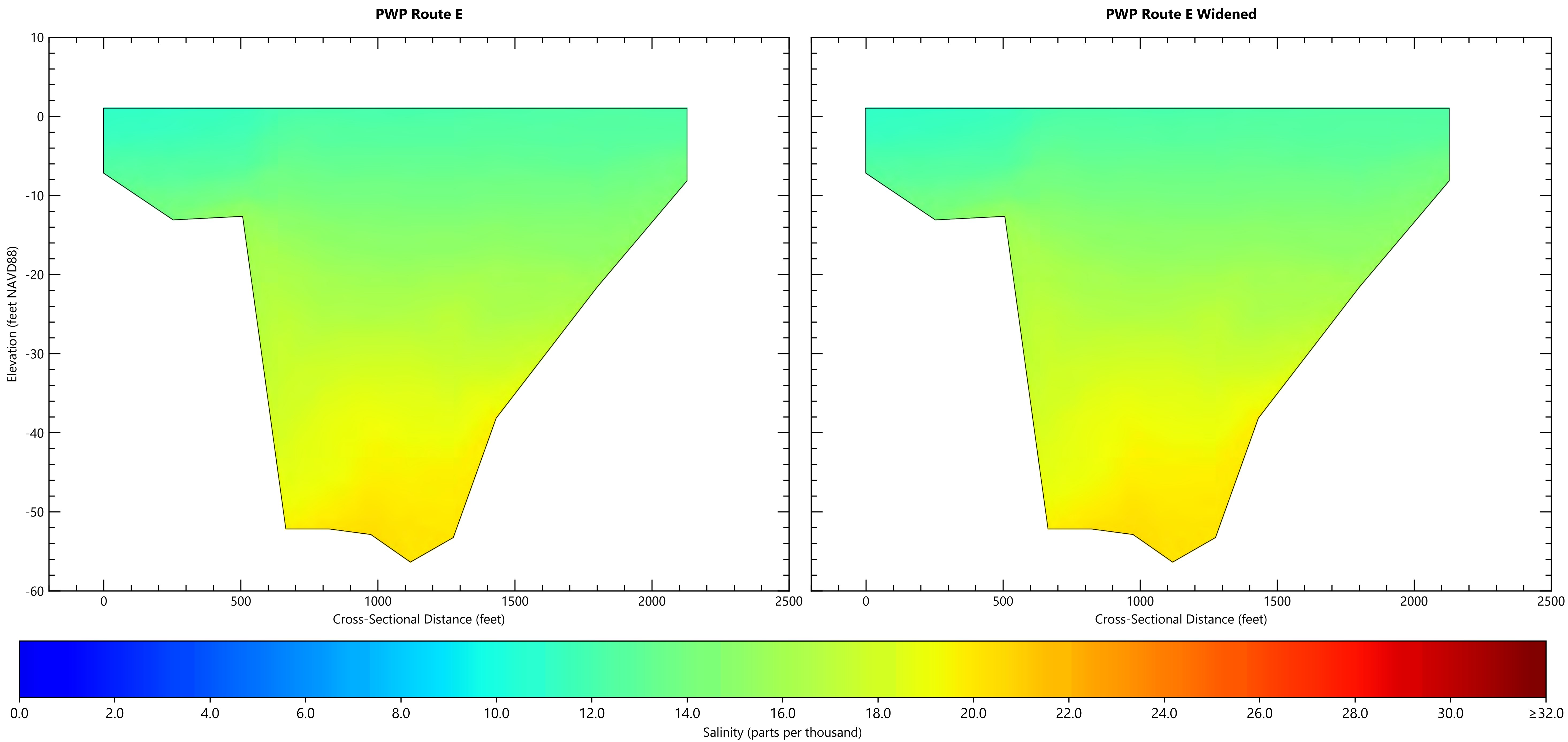
Figure 33e

Cross Section 5 Annual Average Salinity: PWP Route E Versus PWP Route E Widened



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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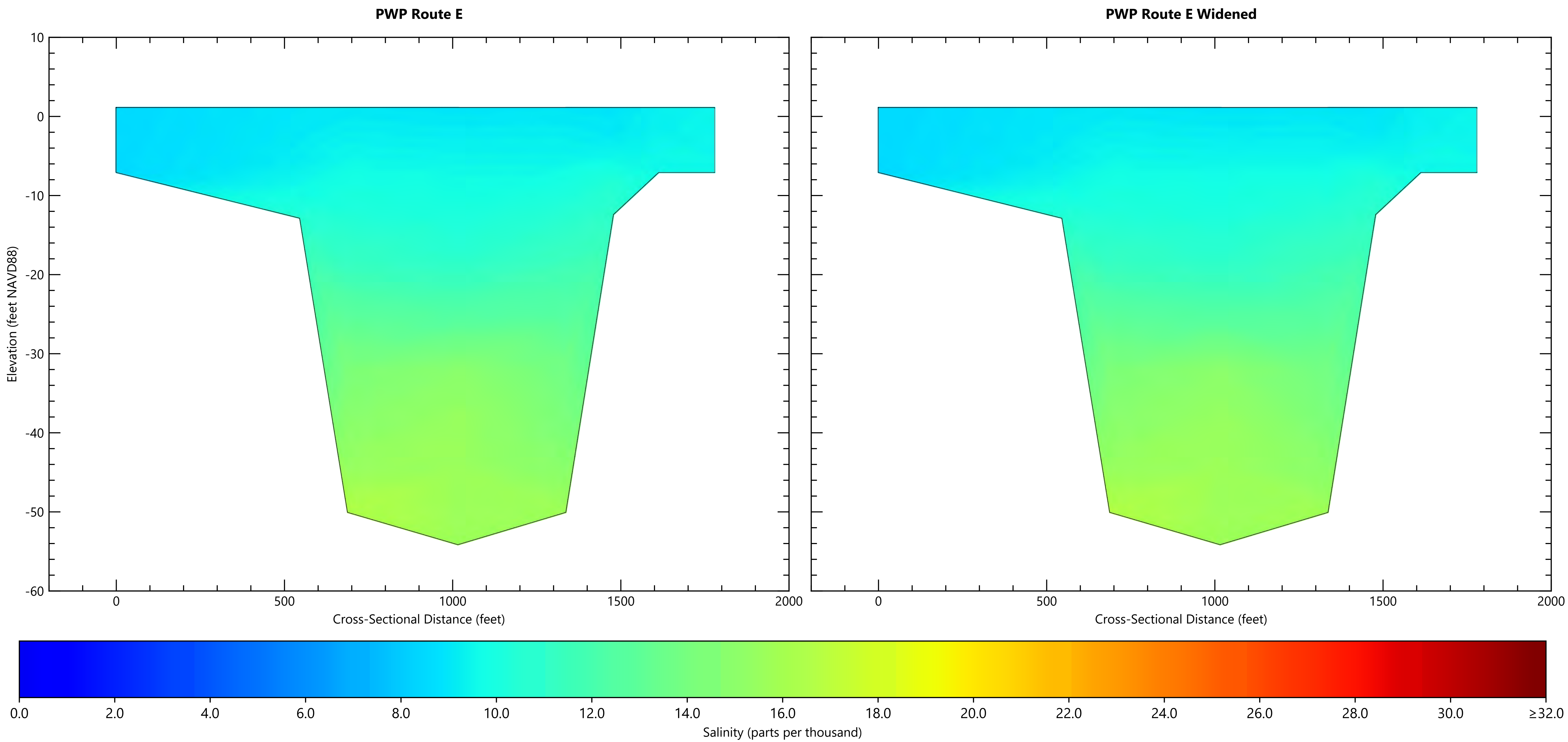
Figure 33f

Cross Section 6 Annual Average Salinity: PWP Route E Versus PWP Route E Widened



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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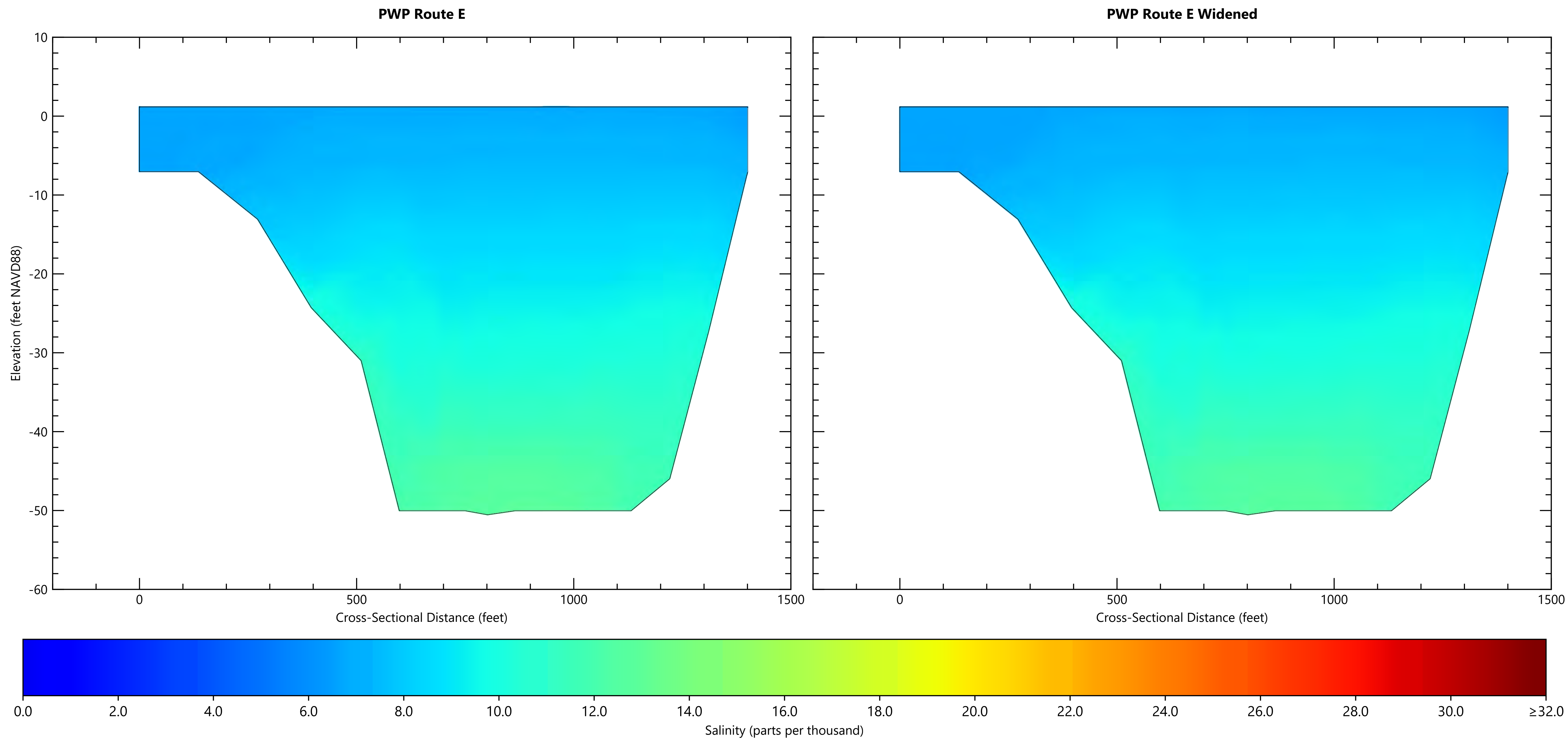
Figure 33g
Cross Section 7 Annual Average Salinity: PWP Route E Versus PWP Route E Widened



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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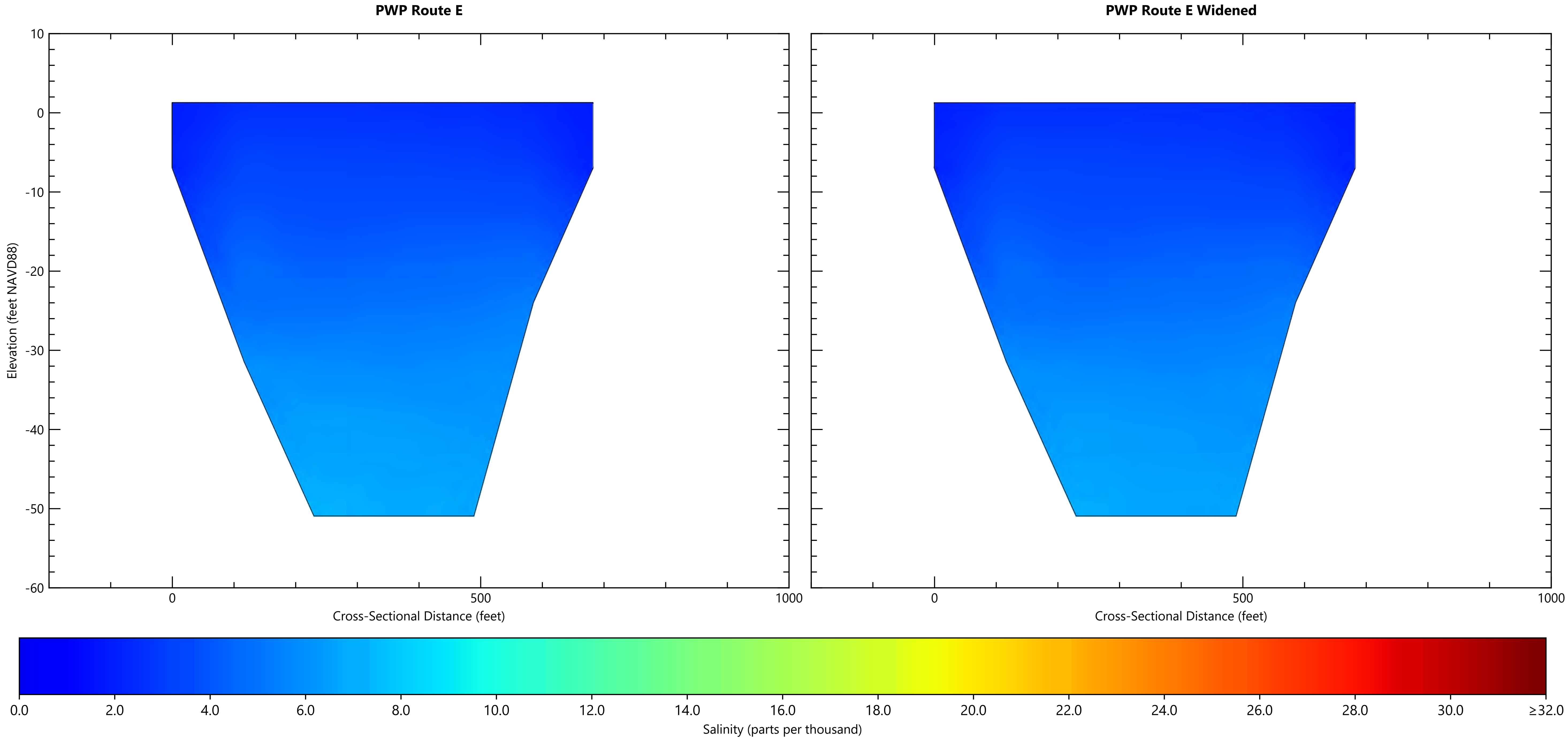
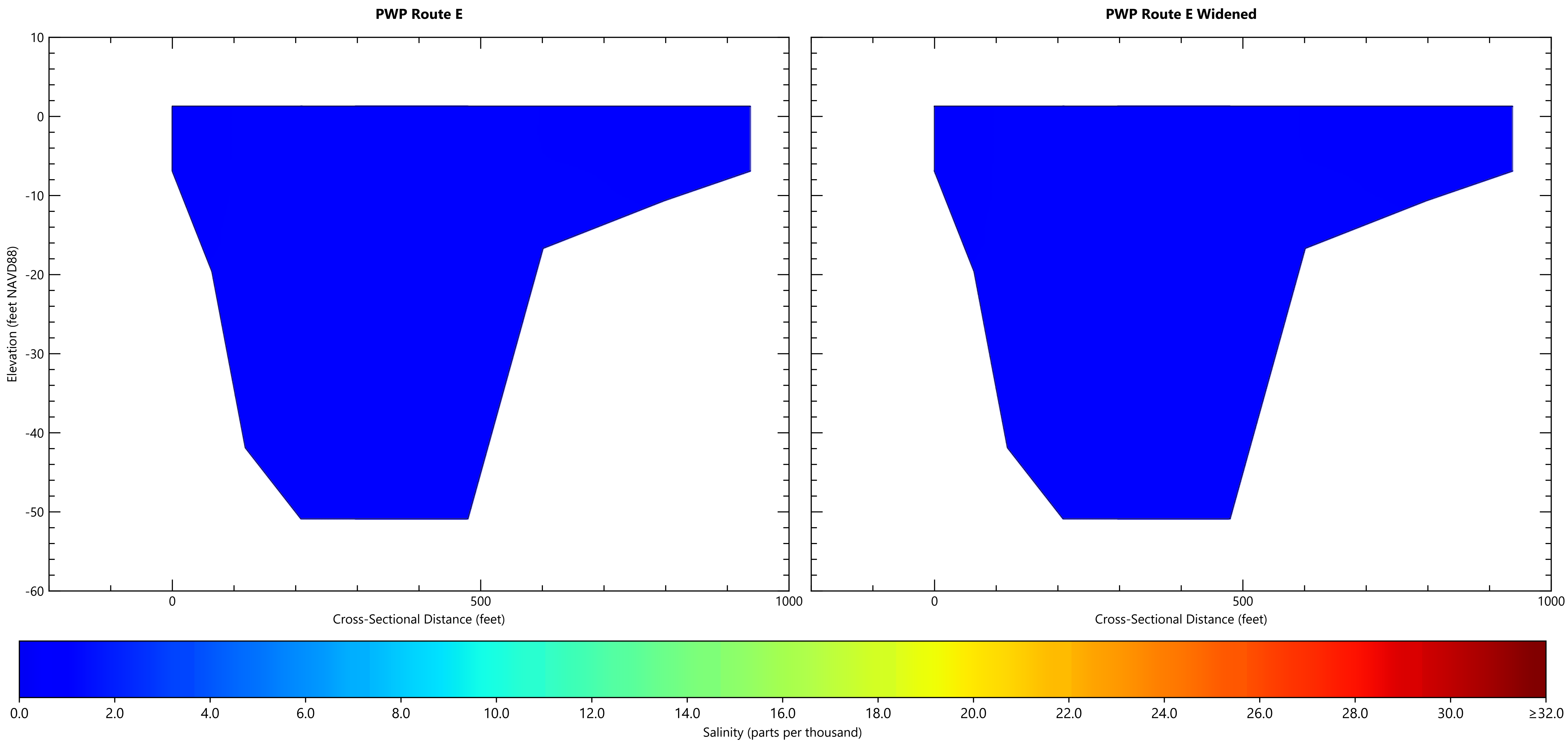
Figure 33h
Cross Section 8 Annual Average Salinity: PWP Route E Versus PWP Route E Widened



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

Figure 33i
Cross Section 9 Annual Average Salinity: PWP Route E Versus PWP Route E Widened



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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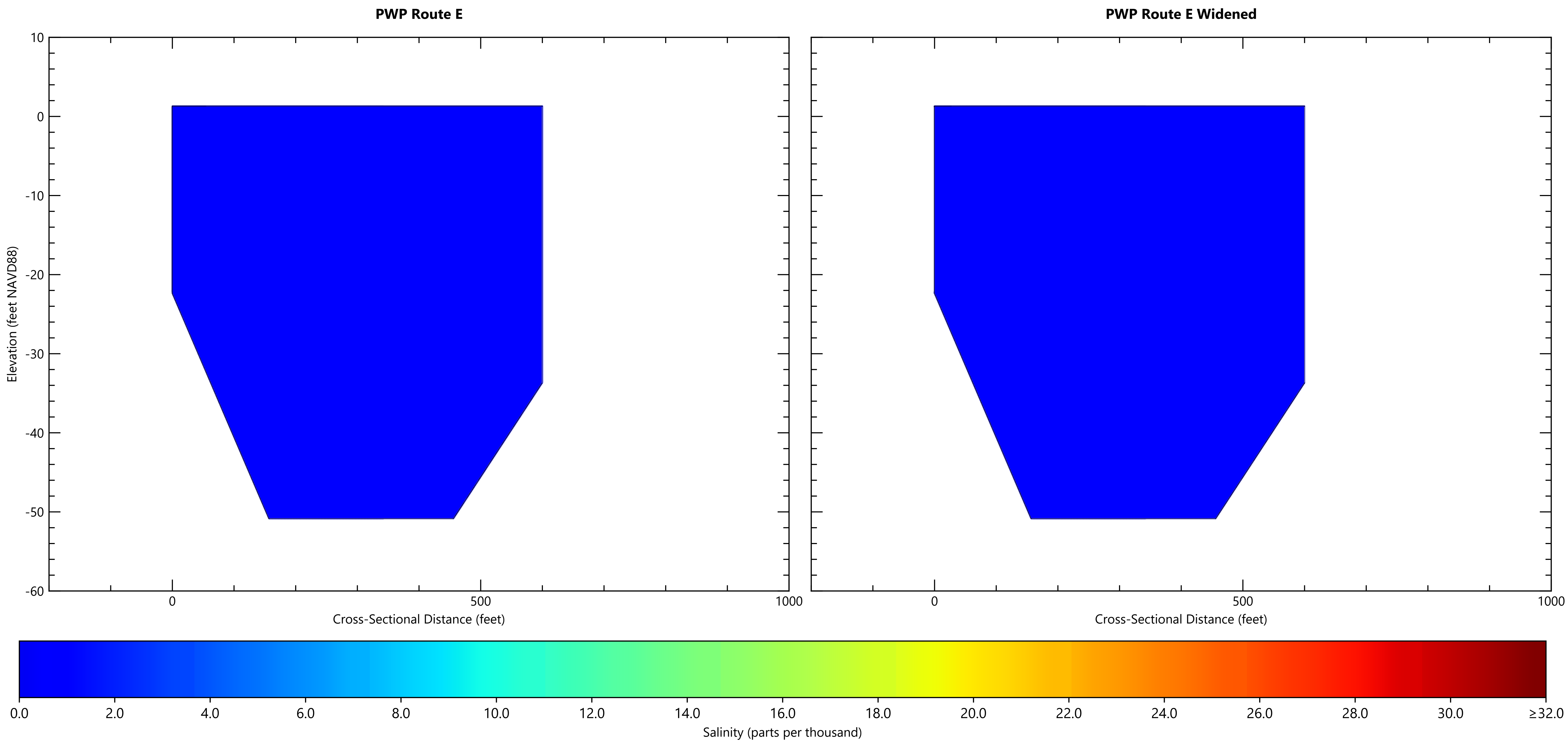
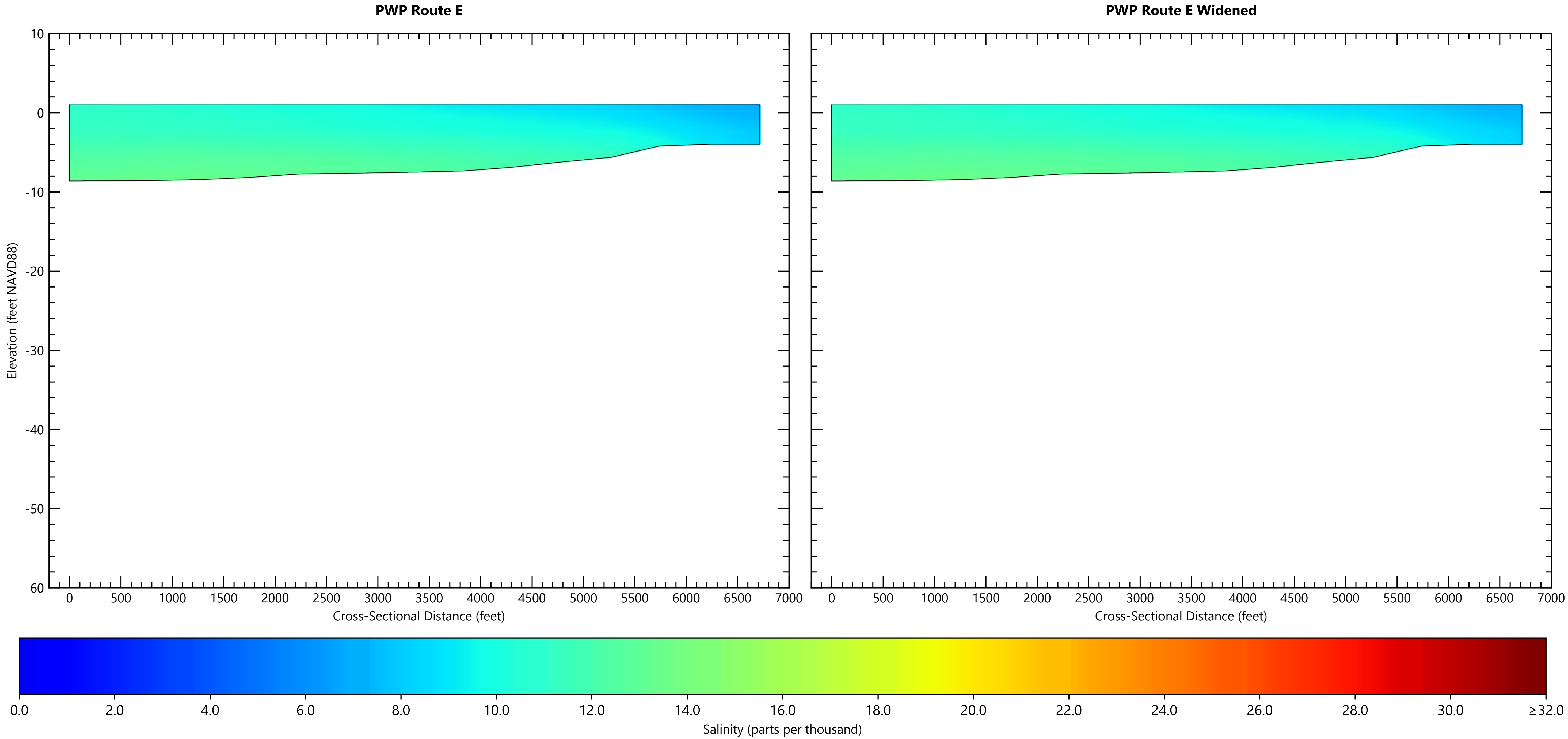
Figure 33j
Cross Section 10 Annual Average Salinity: PWP Route E Versus PWP Route E Widened
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

Figure 33k
Cross Section 11 Annual Average Salinity: PWP Route E Versus PWP Route E Widened



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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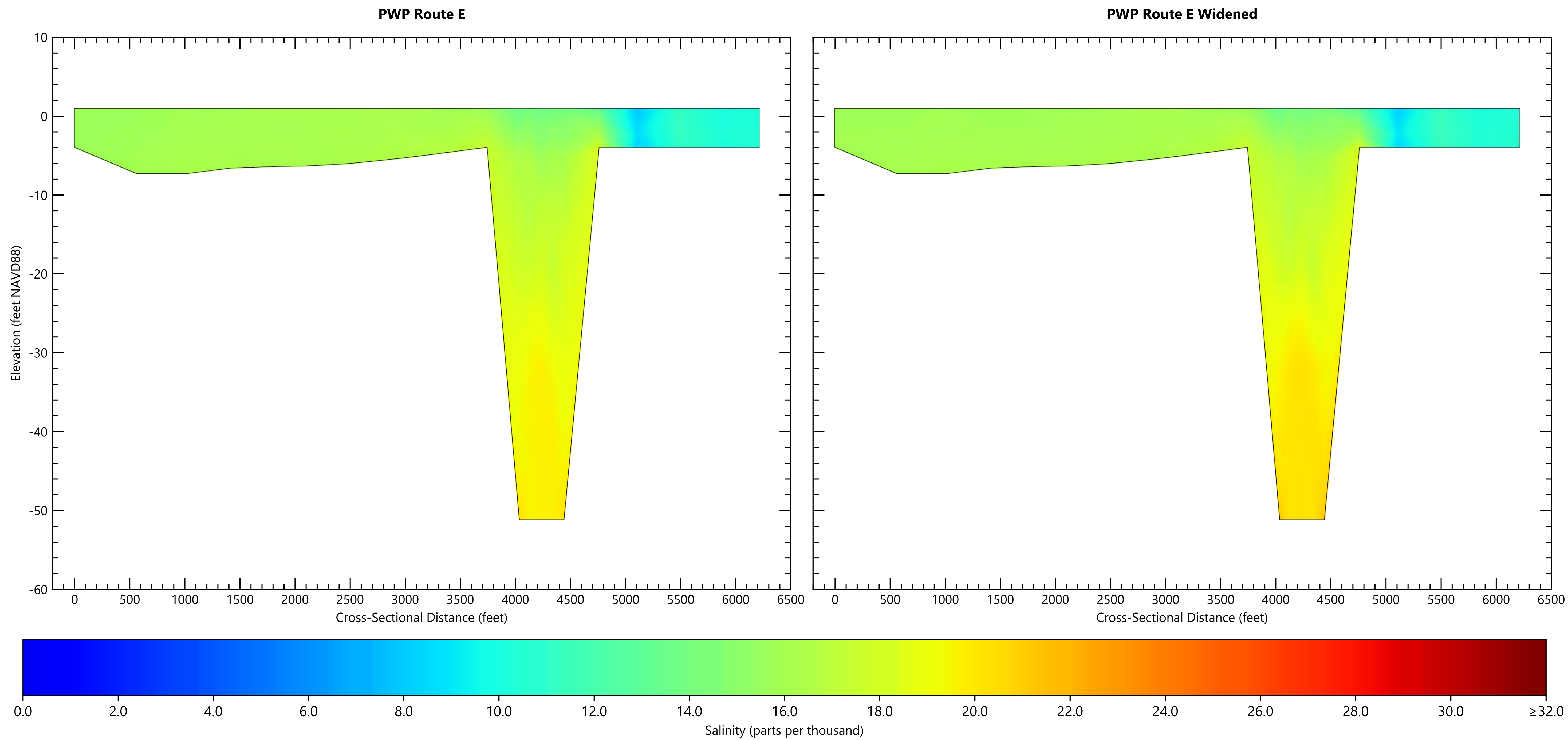
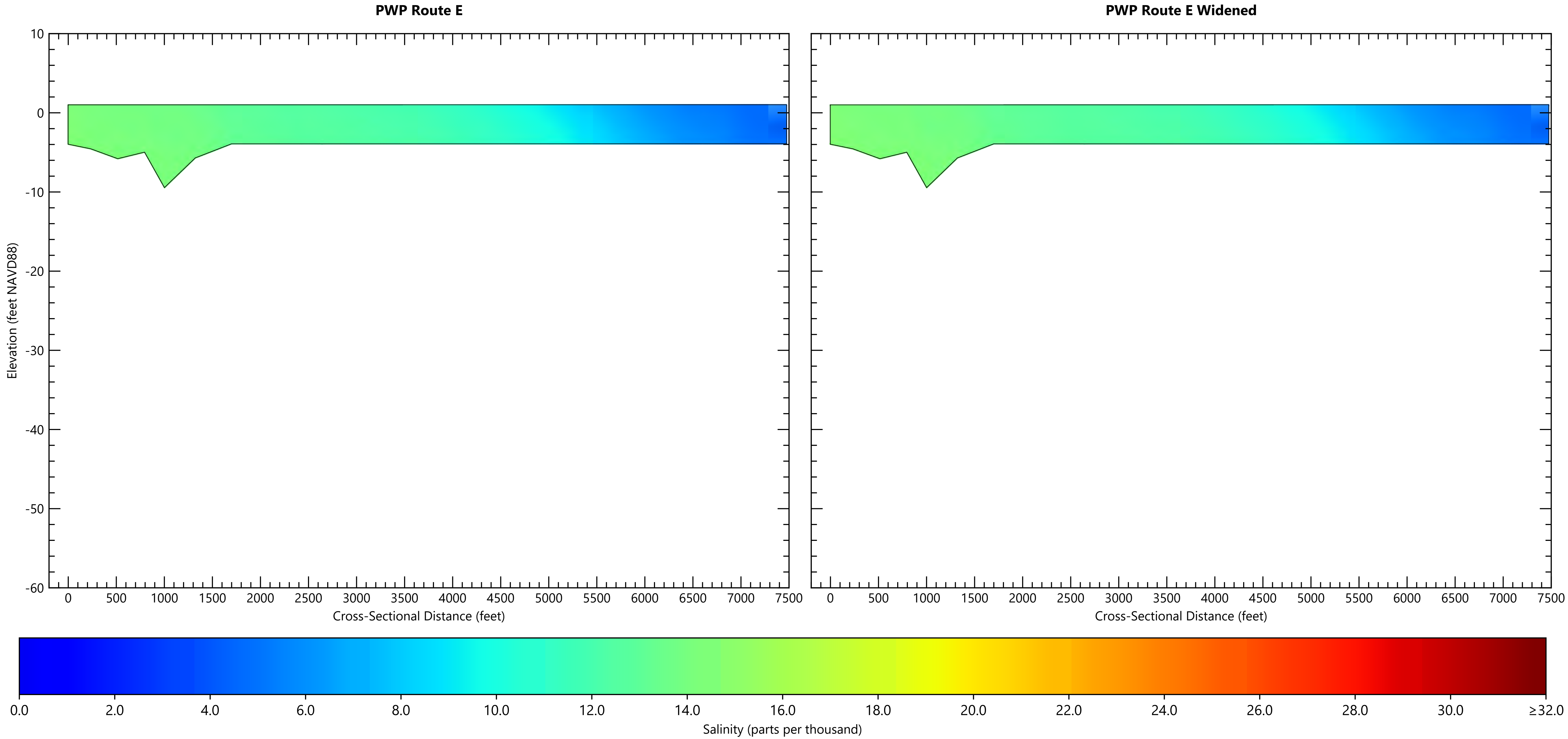
Figure 33l
Cross Section 12 Annual Average Salinity: PWP Route E Versus PWP Route E Widened
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

Figure 33m

Cross Section 13 Annual Average Salinity: PWP Route E Versus PWP Route E Widened



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

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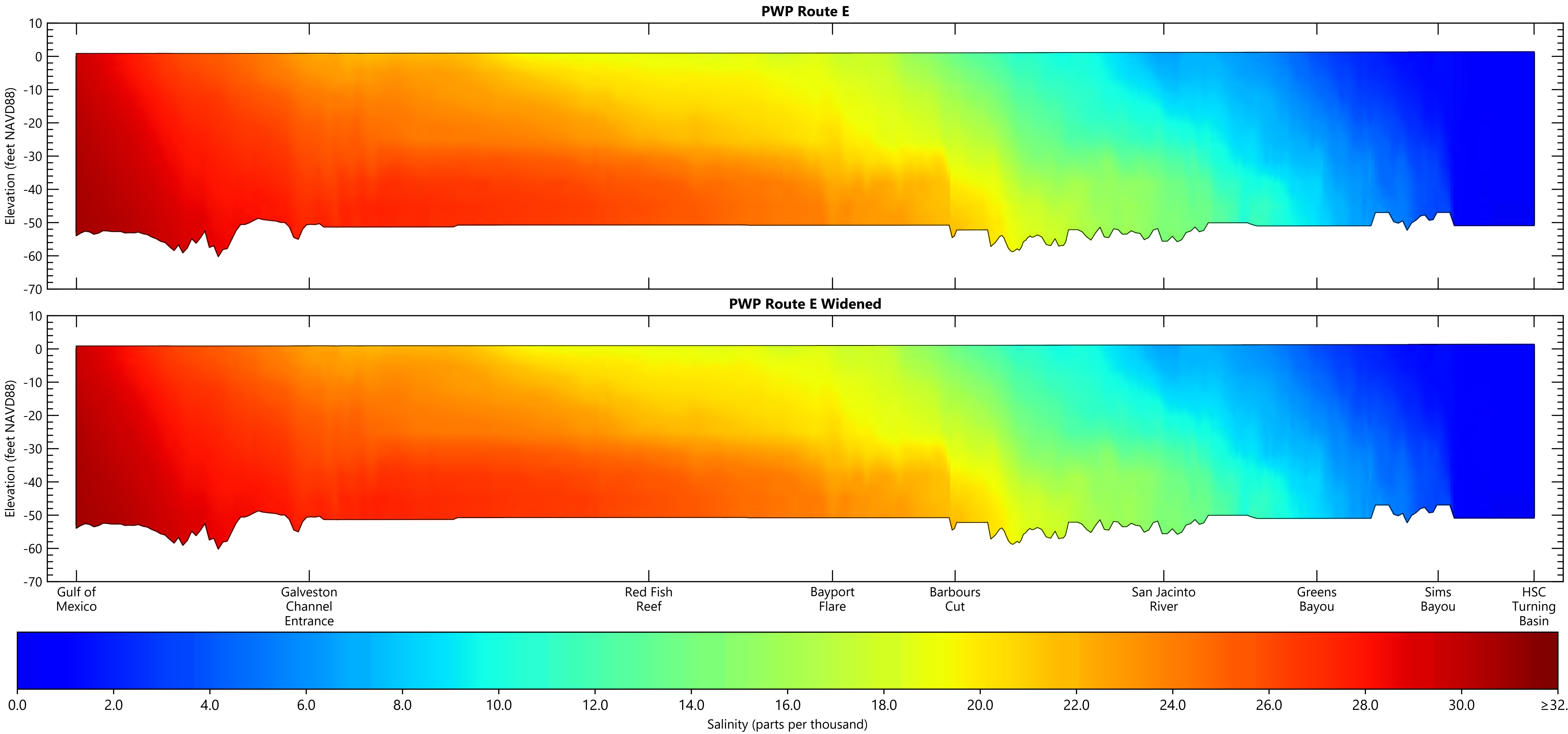
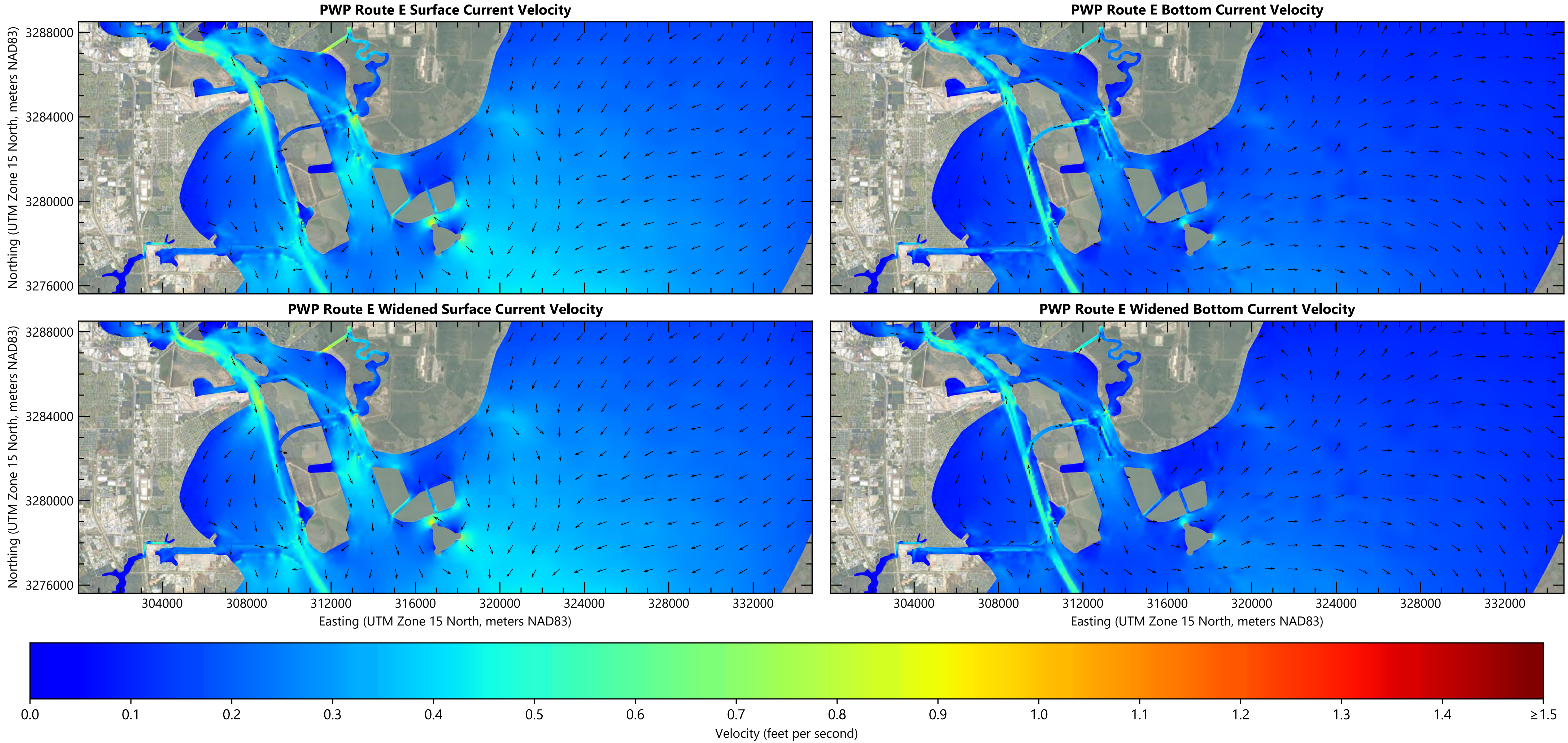
Figure 33n
Cross Section 14 Annual Average Salinity: PWP Route E Versus PWP Route E Widened



Notes: HSC: Houston Ship Channel, NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

Figure 34
HSC Annual Average Salinity Profiles: PWP Route E Versus PWP Route E Widened



Notes: Arrows denote residual velocity direction. Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, PWP: Present with Project, UTM: Universal Transverse Mercator

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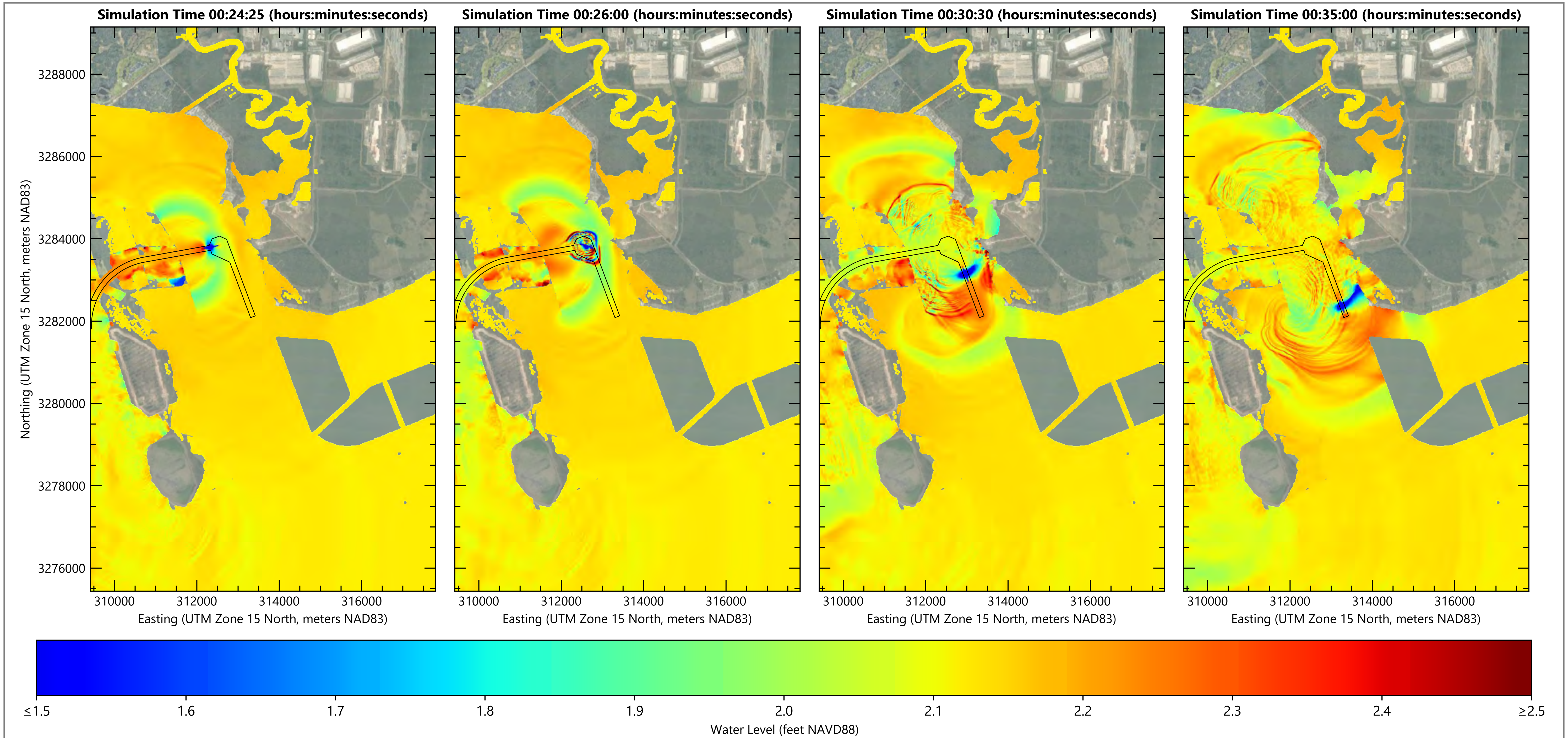
Figure 35
Comparison of Residual Surface and Bottom Current Velocities at Area of Interest: PWP Route E Versus PWP Route E Widened



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

Channel Footprint

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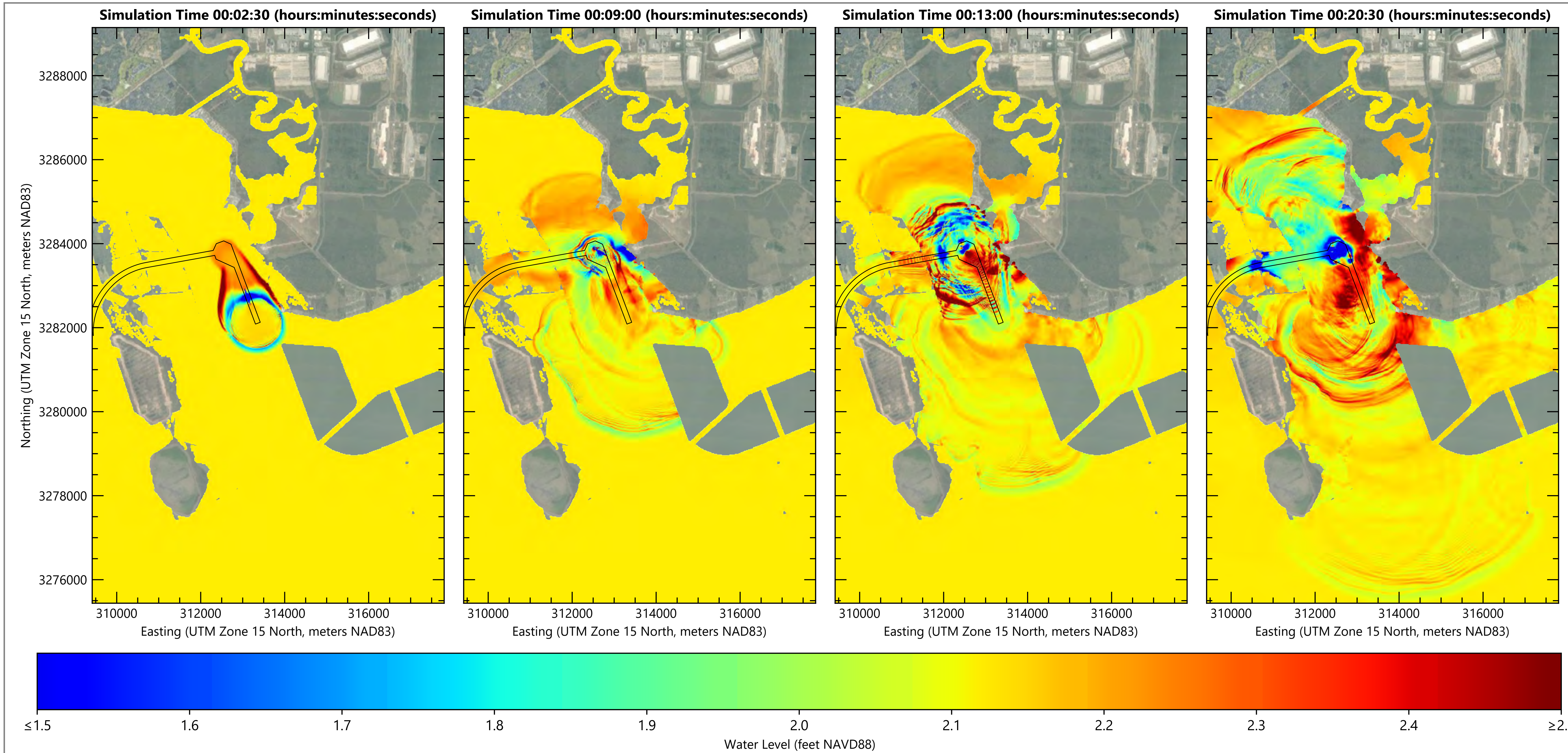
Figure 36a
Vessel Wake Water Level Results: Route E Widened Inbound, Year 0
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, NAVD88: North American Vertical Datum of 1988, UTM: Universal Transverse Mercator

— Channel Footprint

Publish Date: 08/21/2024 12:25 PM | User: JH
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ANCHOR QEA

Figure 36b
Vessel Wake Water Level Results: Route E Widened Outbound, Year 0

Notes: Basemap Source: Bing Satellite Imagery, BU: Beneficial Use, HSC: Houston Ship Channel, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

- Vessel Wake Point Analysis Location
- HSC Centerline
- Cedar Bayou Centerline
- Alternative Route E Widened Channel Footprint
- Alternative Route E BU Footprint

Publish Date: 08/21/2024 11:53 AM | User: JH
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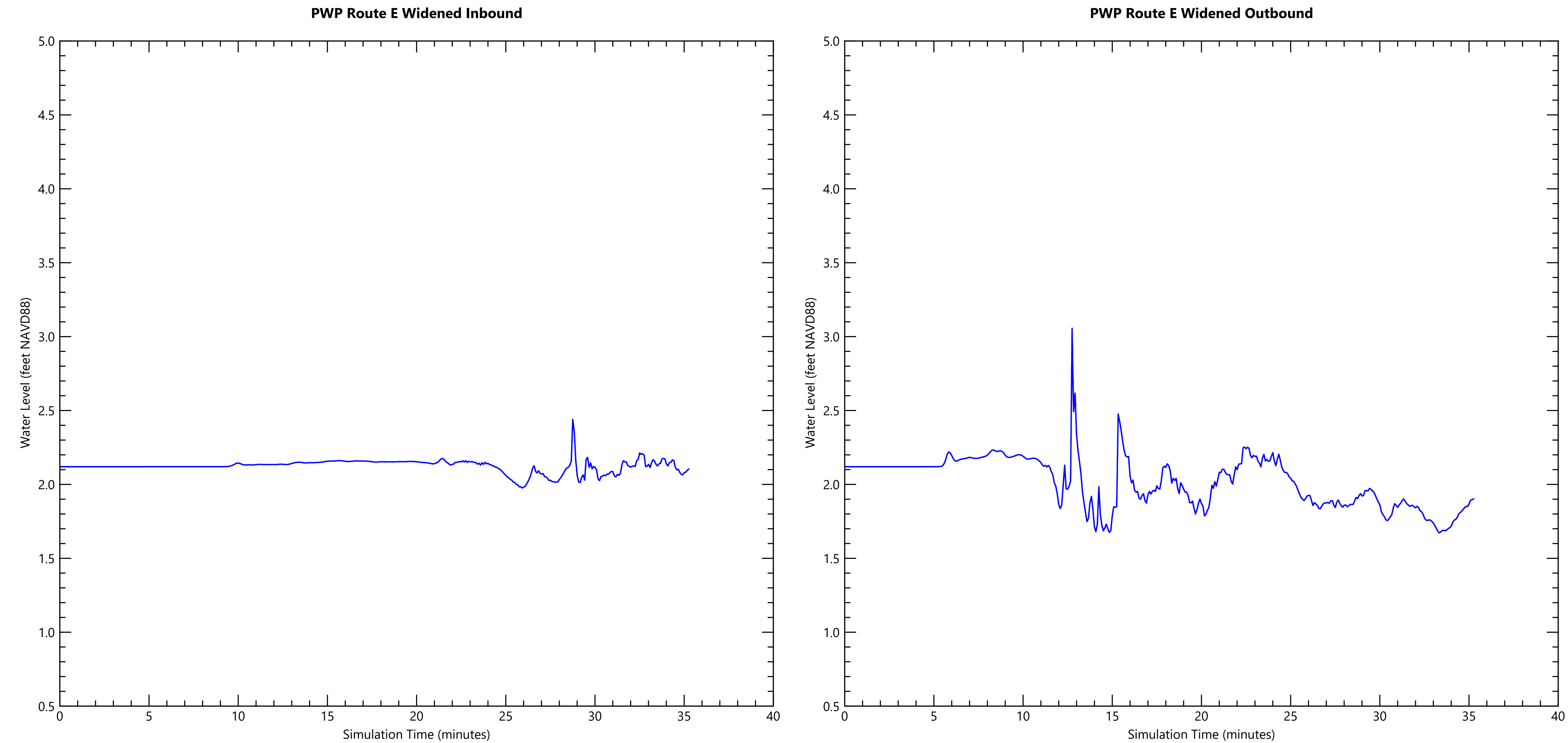
ANCHOR QEA

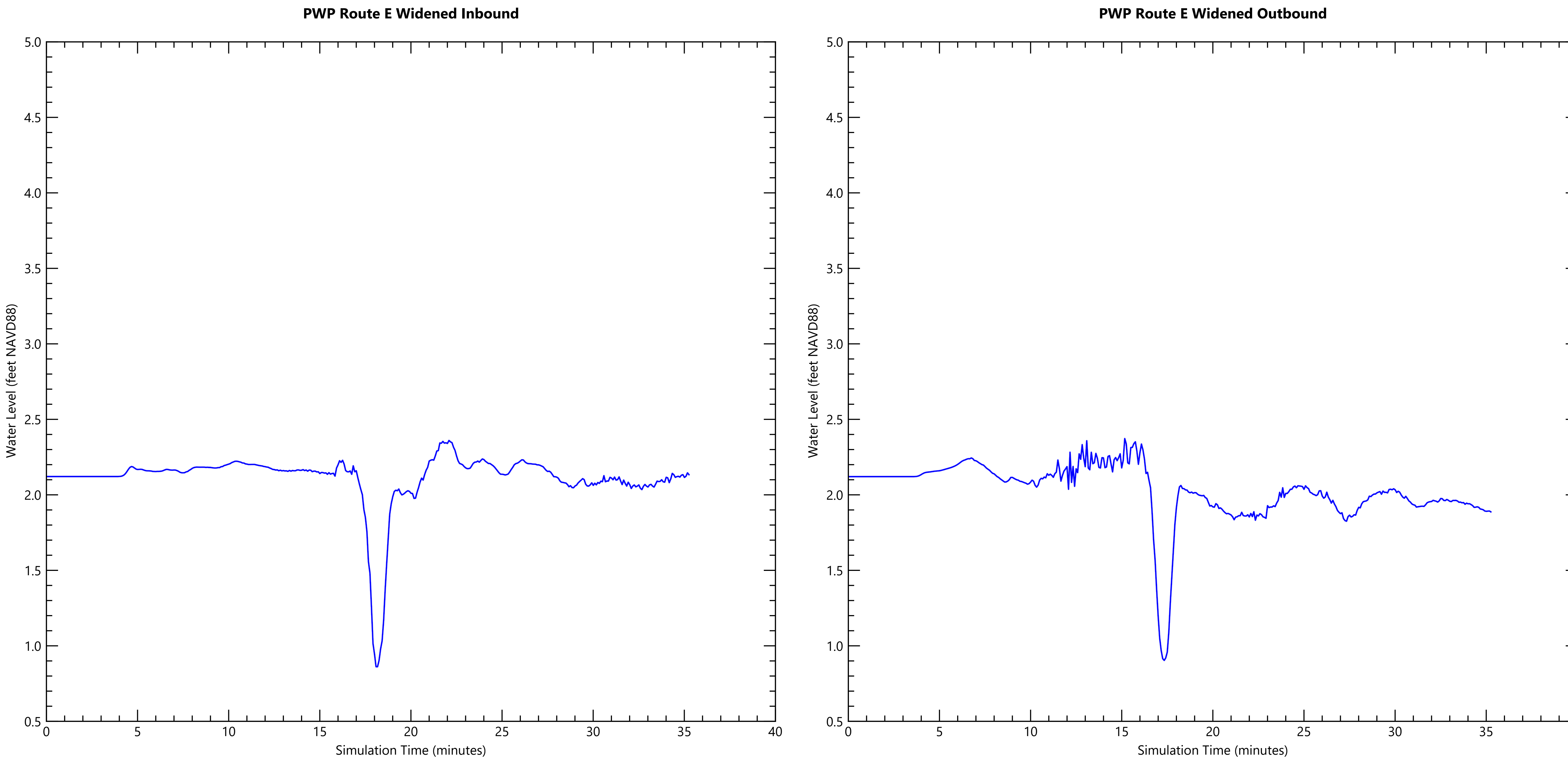
Figure 37a
Vessel Wake Point Analysis Reference Map: Alternative Route E Widened
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

ANCHOR QEA

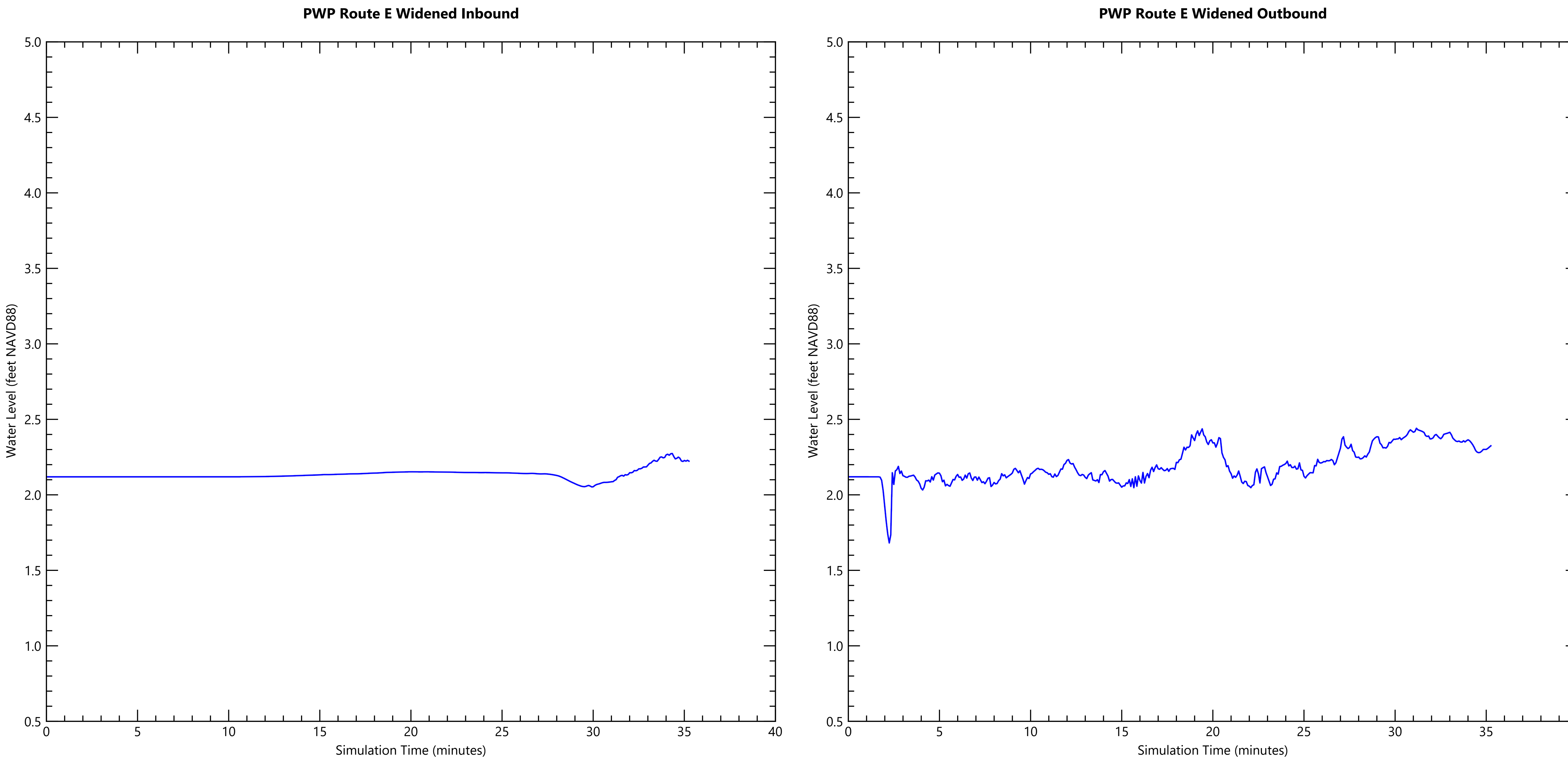
Figure 37b
Vessel Wake Point Analysis: Route E Widened, Point 1 (Near Bay Oaks)
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

Figure 37c

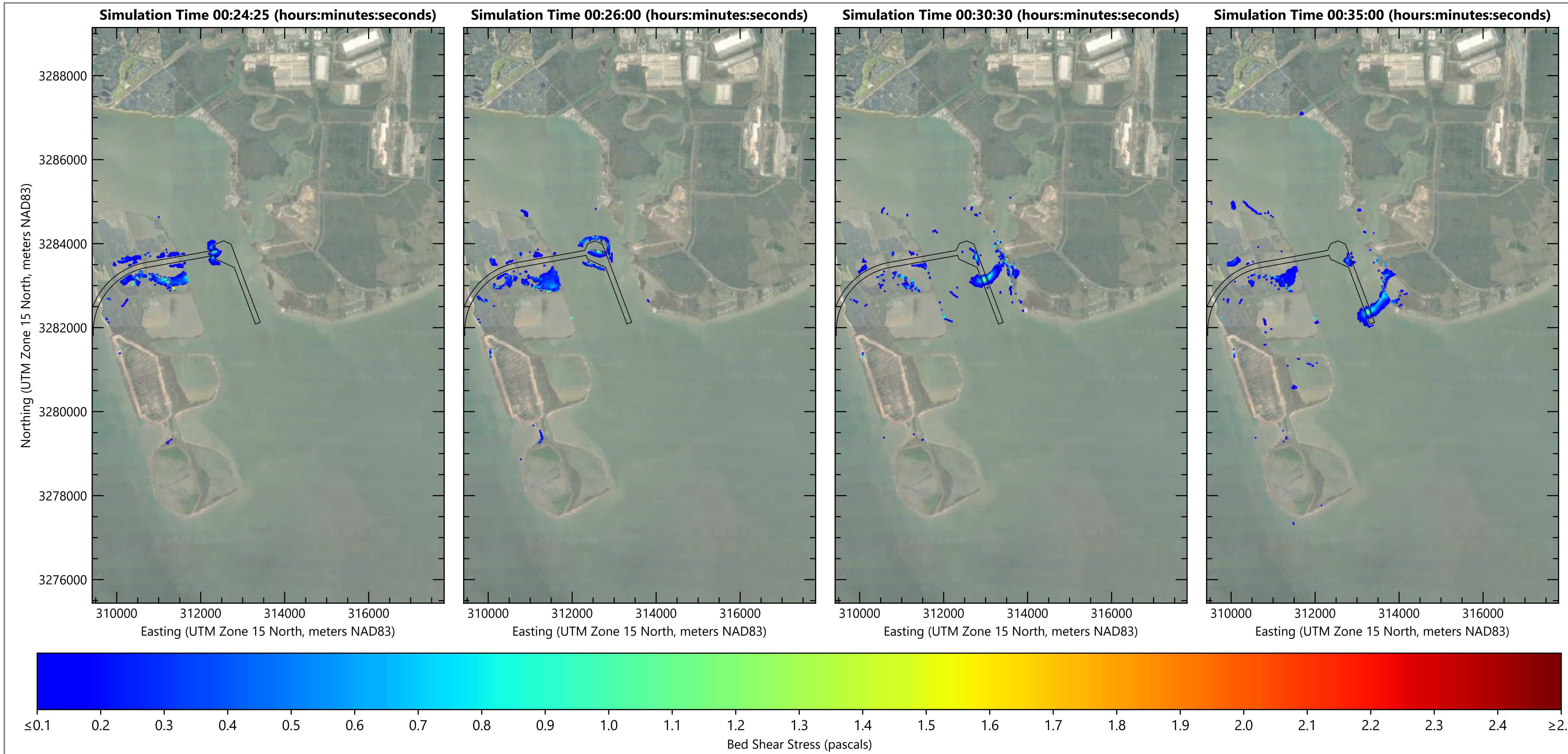
Vessel Wake Point Analysis: Route E Widened, Point 2 (South Bank of Channel Through Atkinson Island)



Notes: NAVD88: North American Vertical Datum of 1988, PWP: Present with Project

ANCHOR QEA

Figure 37d
Vessel Wake Point Analysis: Route E Widened, Point 3 (Near Cedar Point)
Appendix C-2: Coastal Engineering Report
Cedar Port Navigation District Channel Deepening Project, Baytown, Texas



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

Channel Footprint

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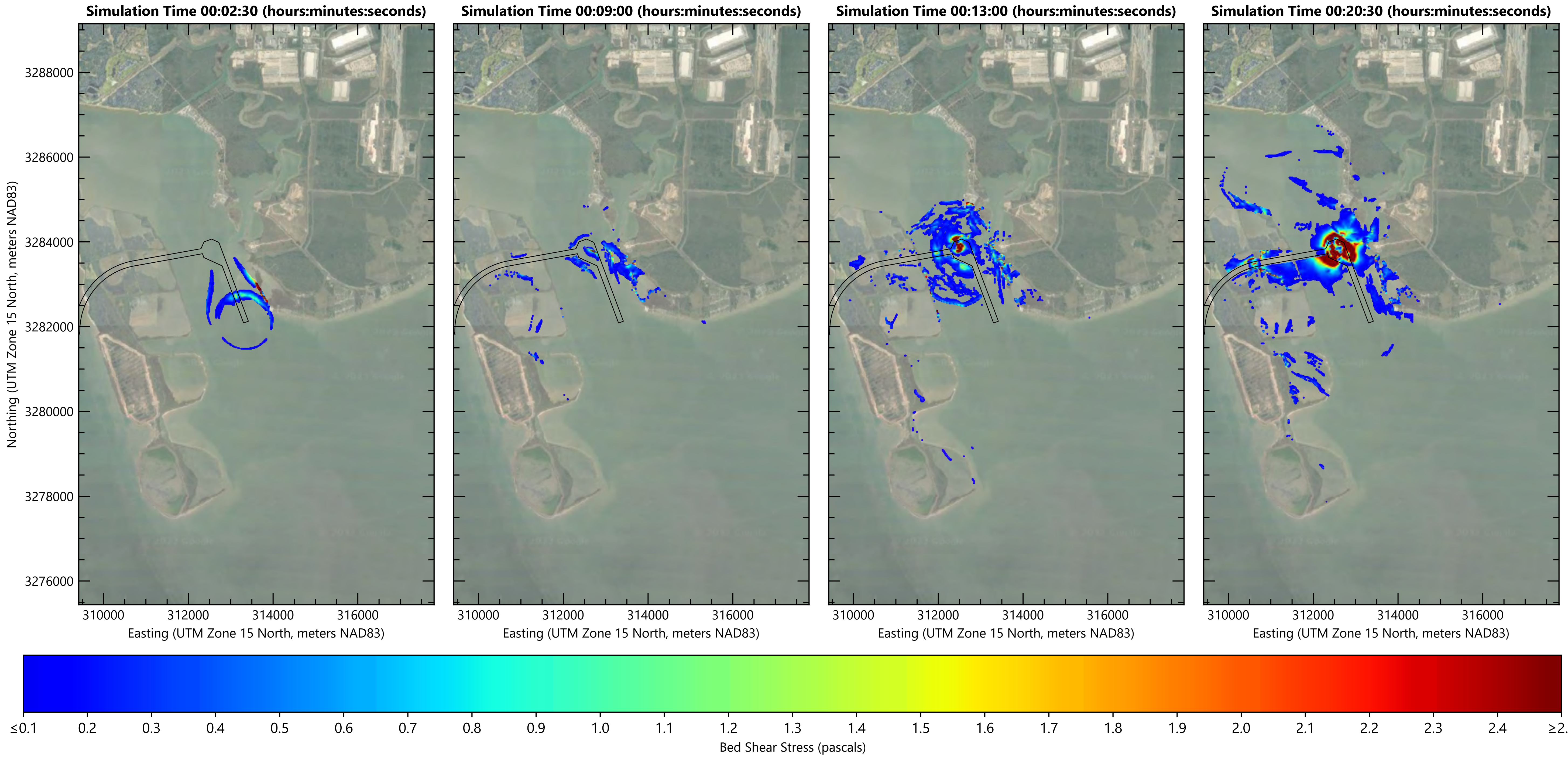
ANCHOR QEA

Figure 38a
Vessel Wake Bed Shear Stress Results: Route E Widened Inbound, Year 0



Notes: Basemap Source: Google Satellite Imagery, NAD83: North American Datum of 1983, UTM: Universal Transverse Mercator

— Channel Footprint

Publish Date: 08/21/2024 12:29 PM | User: JH
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ANCHOR QEA

Figure 38b

Vessel Wake Bed Shear Stress Results: Route E Widened Outbound, Year 0

Appendix C-2: Coastal Engineering Report

Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

Attachment 1
Screening Level Application of the Coastal Storm Modeling System (CSTORM-MS) for Storm Surge and Wave Conditions for the Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

Draft ERDC/CHL LR-XX-X
July 2024

Screening Level Application of the Coastal Storm Modeling System (CSTORM-MS) for Storm Surge and Wave Conditions for the Cedar Port Navigation District Channel Deepening Project, Baytown, Texas

By Thomas C. Massey[1], Josef Hoffmann[2], Matthew Henderson[2], Jacob Garrett[3], and Sydney Crisanti[1]

ABSTRACT: The U.S. Army Corps of Engineers Galveston District (SWG) is currently engaged in a feasibility study of the Cedar Port Navigation and Improvement District Channel Deepening Project near Baytown, Texas. This letter report provides an overview of the application of Coastal Storm Modeling System (CSTORM) coupled Advanced Circulation (ADCIRC) and Steady-State Wave (STWAVE) models for this project. This study leverages the Coastal Texas Protection and Restoration Feasibility Study (CTXS) storm surge and wave modeling (Massey et.al, 2019, Melby et al., 2021) setup for initial ADCIRC and STWAVE models, as well as a subset of synthetic storms and computed statistics for annual exceedance probabilities (Nadal-Caraballo et.al 2019). Four new ADCIRC meshes and STWAVE grids were created to represent without-project conditions and three alternative with-project conditions. Two different sea-level scenarios were used for the modeling to represent the year 2035 and the yearfl 2085. Statistical water level data from the CTXS in the project area was used to select three synthethic tropical storm events to serve as proxy storms for producing the 10-yr, 100-yr, and 500-yr water levels in the project area.

INTRODUCTION: The U.S. Army Corps of Engineers Galveston District (SWG) is currently engaged in a feasibility-level study of the Cedar Port Navigation and Improvement District Channel Deepening Project located near Baytown, Texas (Figure 1). The study will identify and evaluate the feasibility of providing a deep-water connection between the Houston Ship Channel (HSC) and a planned deepwater terminal facility at Cedar Port Industrial Park while supporting efficient, safe, and reliable navigation in the Cedar Bayou Navigation Channel and HSC to existing stakeholder terminals (USACE 2023). As stated in the background material on the Federal Register website regarding this project, “The potential project area includes Cedar Bayou Navigation Channel, and portions of Tabbs Bay, Trinity Bay and Galveston Bay (Galveston Bay System) adjacent to the HSC in Chambers and Harris Counties, Texas. The project area also includes the existing Cedar Port terminal at Cedar Port Industrial Park in Baytown, Texas. The Cedar Bayou Navigation Channel is a federally authorized 5-mile shallow water barge channel that supports more than 1.5 million tons of cargo per year. (USACE 2023).” The study considers several different channel configurations from which three configurations were

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selected for simulating storm condition water levels and wave heights using the CSTORM modeling system (Massey et al. 2011). Coastal Texas Protection and Restoration Feasibility Study (hereafter referred to as “the Coastal Texas Study” or “CTXS”) modeling (Massey et al. 2019) and statistics results (Nadal-Caraballo et al. 2019) were used as starting points for this work. The Advanced Circulation (ADCIRC) (Luettich et al. 1992, Westerink et.al. 1992) mesh and Steady-State Wave (STWAVE) (Massey et al. 2011; Smith et.al 2001) grids from the CTXS were used and updated to enhance resolution in the project area. In addition, the mesh was updated ensure alignment with the channel and other new structures resulting from beneficial use of dredged materials for both with and without-project conditions. Three of the 660 synthetic tropical storms from the CTXS were selected to produce representative 10-yr, 100-yr, and 500-yr water levels in the project area based on existing data from the CTXS.

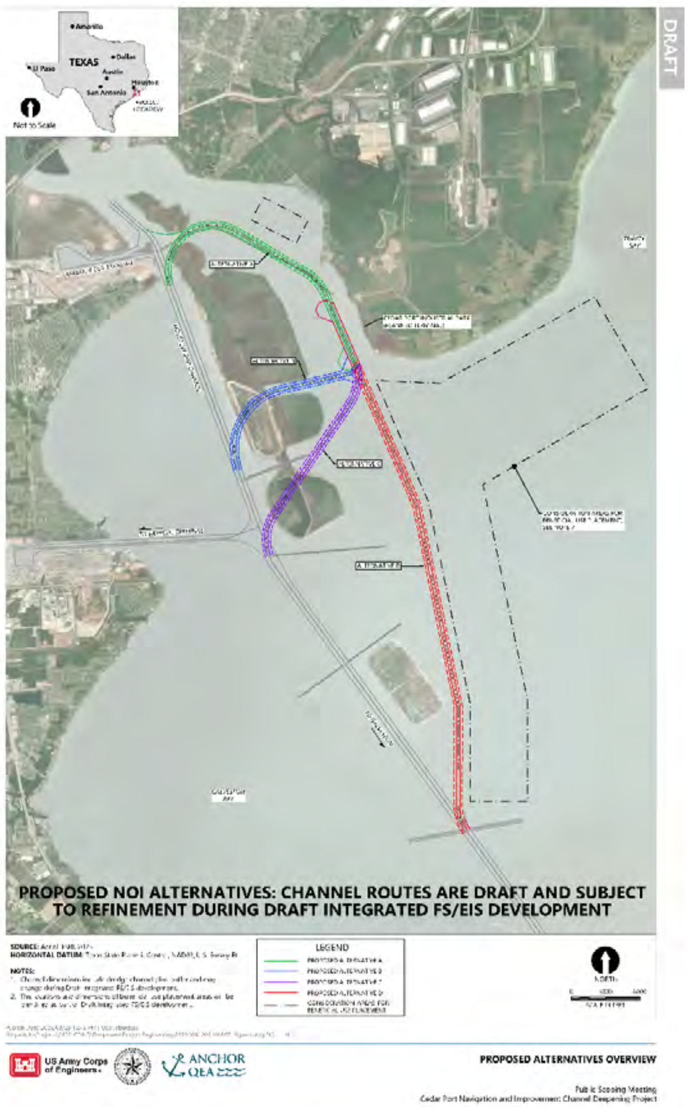
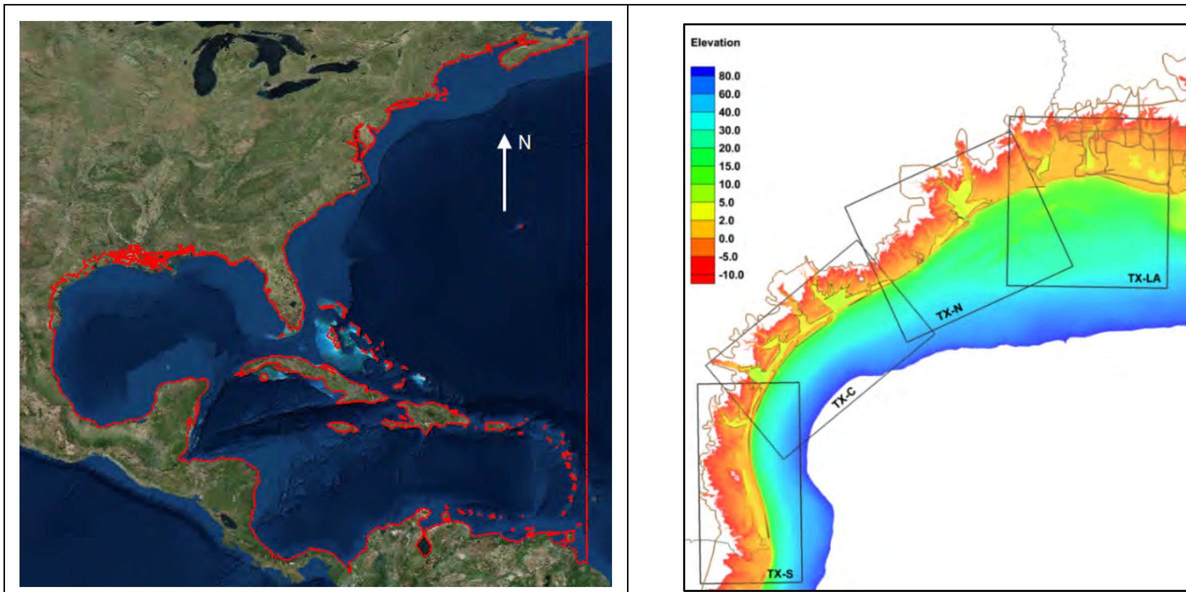


Figure 1 Map showing the Cedar Port project area near Baytown, TX area and draft alternative designs for the channel.

The remaining sections of this report detail the mesh updates and the storm selection process for representative water levels, followed by the presentation of modeling results for maximum water levels and maximum significant wave heights in the study area.

ADCIRC Mesh and STWAVE Grid Modification Details

The numerical modeling inputs, storm conditions, and statistics from the CTXS served as the foundation for this effort. For modeling details from the CTXS, see Massey et al. 2019. For details on the storms and statistical calculations from CTXS, see Nadal et al. 2019. The CTXS ADCIRC and STWAVE numerical modeling domains for the CTXS study area (Figure 2) are resolved sufficiently for large-scale regional studies but need to be further resolved to include enhanced resolution in the project area to more accurately represent the proposed with-project alternative features. Figure 3 presents 2D color contour plots of mesh resolution for the (a) CTXS mesh and the (b) updated Cedar Port without-project (WOP) mesh. Mesh resolution is defined as the diameter of the circle that circumscribes an element. In the CTXS mesh, resolution in the project area ranged from approximately 60 feet in the Houston Ship Channel (HSC) to over 2000 feet in the Trinity Bay area. The updated Cedar Port meshes were designed to have a minimum resolution of approximately 36 feet and a maximum of approximately 500 feet in the project area. The extent of the ADCIRC mesh remained consistent between the CTXS and the Cedar Port meshes. Shapefiles depicting each of the project alternatives, Alternative B (AltB), Alternative D, (AltD), and Alternative E (AltE) were provided to ERDC-CHL, by Anchor QEA LLC, for use in developing the meshes. These three alternative plans were overlaid simultaneously and used to create a single without-project (WOP) mesh that had element sizes consistently set between alternative features and had element edges aligned with alternative features, such as the channel sides and the local island areas. In addition to the Cedar Port alternatives, all the updated meshes also contained updates to the HSC for width and depth. Once all features were set in the WOP mesh, the three with-project meshes were developed from it, by changing the topography, bathymetry and Manning's n frictional values to represent the different features with only minimal changes to element edge locations. This minimal change between all the meshes allows for more consistent comparisons and increases the certainty that any solution differences observed between the different configurations are due to project features alone, and not resolution changes. Figure 4 shows a close-up view of a 2D color contour plot of the topography and bathymetry values for a portion of the Cedar Port Alternative B with the element edges displayed as gray lines, with red lines overlaid showing the element edges of the CTXS ADCIRC mesh for comparison. Similarly, Figure 5 shows a close-up view of the 2D color contours of the topography and bathymetry values for the Cedar Port Alternative D with the element edges drawn in gray and red lines overlaid to show the element edges of the CTXS ADCIRC mesh.



(a) (b)

Figure 2 Map showing the (a) extents of the ADCIRC mesh, red lines, used in the CTXS along with the (b) extents of the STWAVE domains overlayed on the 2D color contours of bathymetry (meters) from the CTXS ADCIRC. Note that the Cedar Port projects are located in the TX-N STWAVE domain.

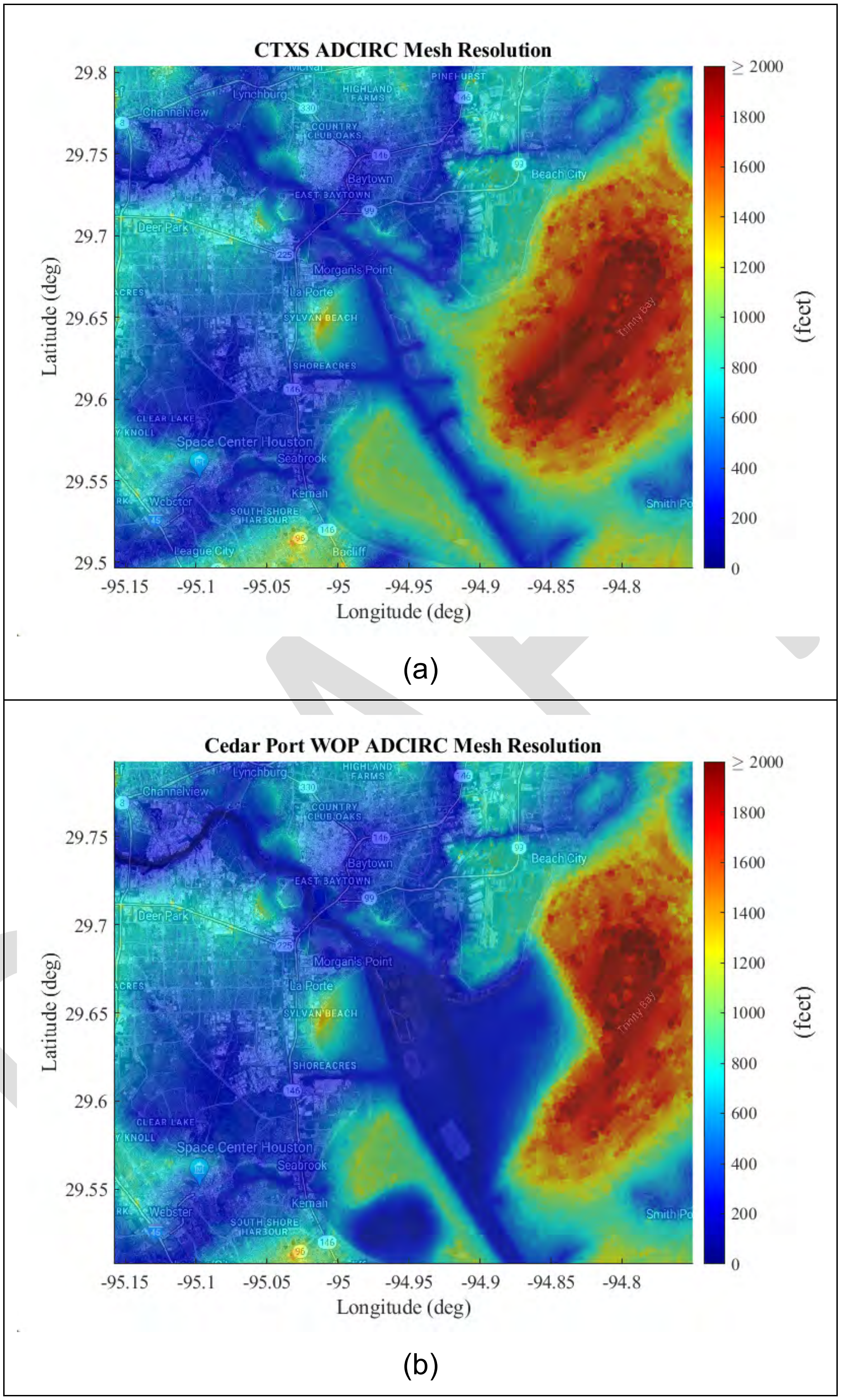


Figure 3 Maps with 2D color contour plots of the ADCIRC mesh resolution. Regional views for the (a) CTXS mesh and (b) updated without-project conditions Cedar Port mesh are shown.

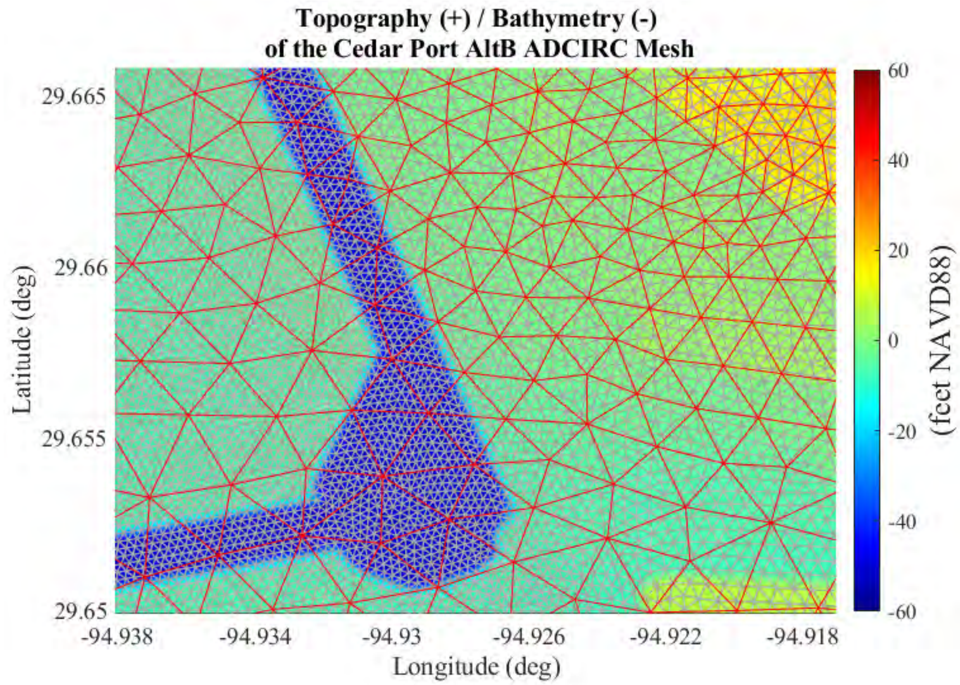


Figure 4 Map overlaid with 2D color contour plots of topography and bathymetry for the with-project Alternative B (AltB) condition ADCIRC mesh, with gray lines showing the AltB element edges and red lines showing the CTXS element edges for comparison.

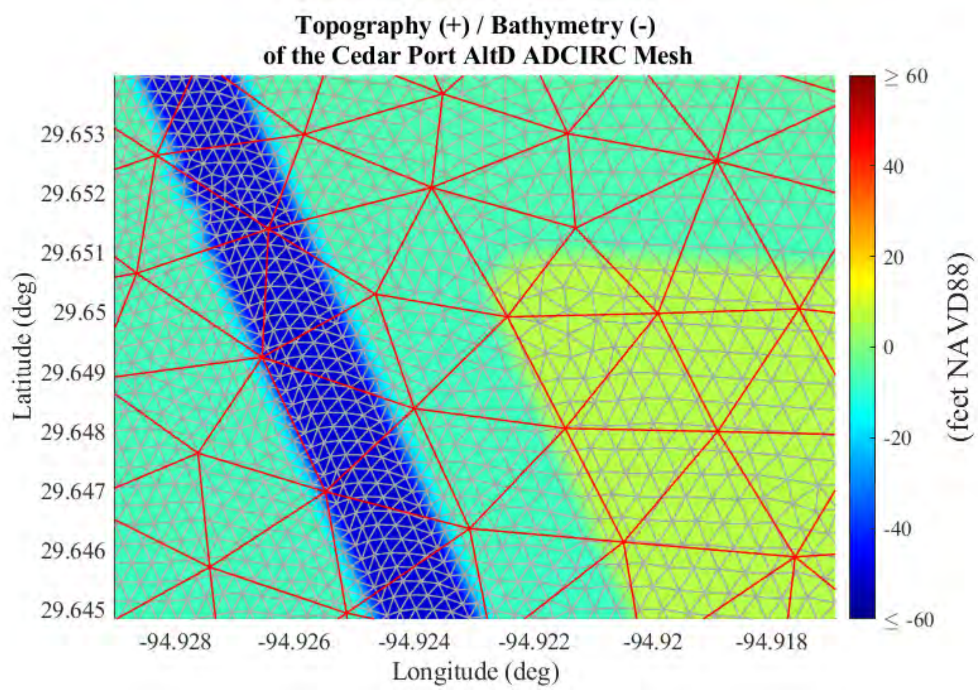


Figure 5 Map overlaid with 2D color contour plots of topography and bathymetry for the with-project Alternative B (AltB) condition ADCIRC mesh, with gray lines showing the AltD element edges and red lines showing the CTXS element edges for comparison.

Figure 6 shows a 2D color contour plots of topography and bathymetry for the CTXS ADCIRC mesh for the north western portion of Galveston Bay. The HSC is shown with the darkest blue colors. In addition to the mesh resolution changes for the Cedar Port meshes and the HSC deepening and widening updates, updated topography and bathymetry values were provided by Anchor QEA in the immediate project areas and were used on the updated mesh. Figure 7 shows the updated topography and bathymetry values for the WOP Cedar Port ADCIRC mesh for the same area as shown in Figure 6. Figure 8 through Figure 11 show 2D color contour plots of topography and bathymetry with a slightly closer view of the project area. Figure 8 is the updated WOP mesh, Figure 9 is for the Alternative B conditions, Figure 10 is for the Alternative D conditions and Figure 11 is for the Alternative E conditions. The different Cedar Port channel alternative routes are clearly visible in these plots as are the different footprints of the islands to be created. Similarly Figure 12 to Figure 15 show 2D color contour plots of Manning's n friction coefficient values in the project areas. Figure 8 is the updated WOP mesh, Figure 13 is for the Alternative B conditions, Figure 14 is for the Alternative D conditions and Figure 15 is for the Alternative E conditions. Manning's n values are set to 0.02 in the channels and deeper water. The Manning's n value for the Cedar Port alternatives created islands is set to 0.05 and the Manning's n values in the marsh areas that are part of the HSC updated conditions are set to 0.08.

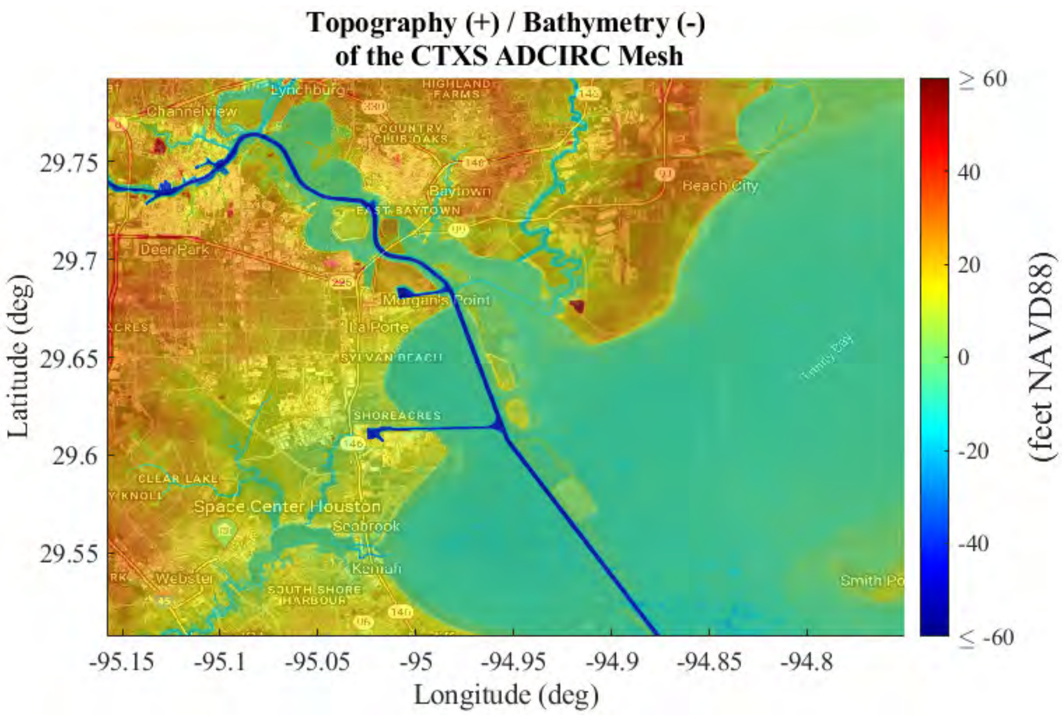


Figure 6 Color contour map showing the topography and bathymetry values from the CTXS ADCIRC mesh in the greater project area.

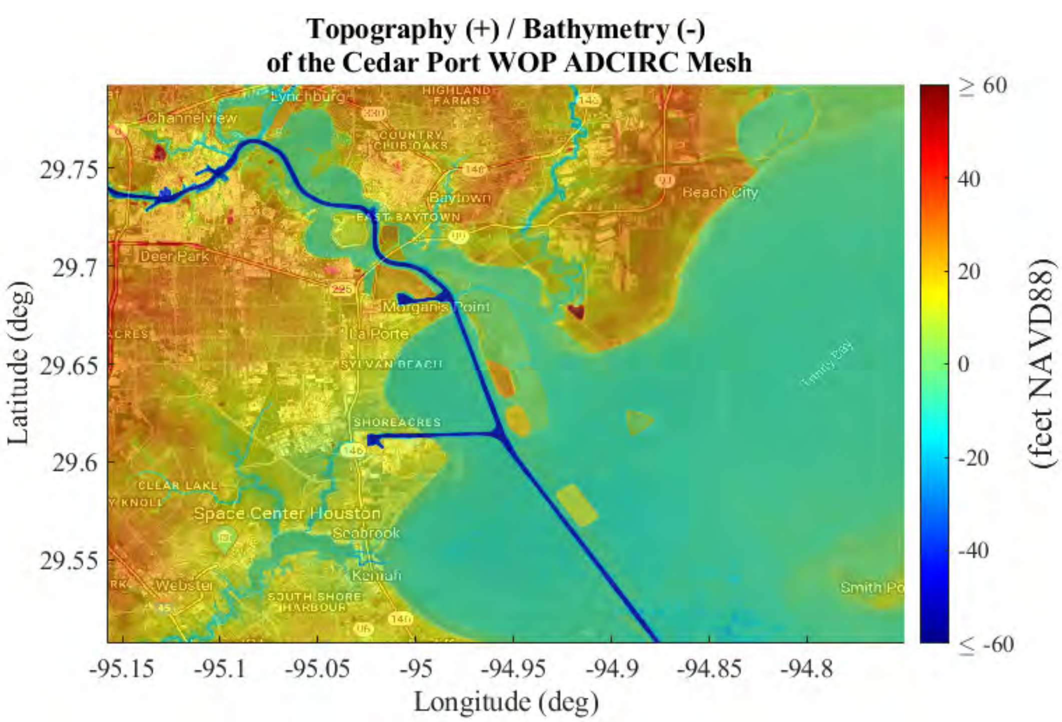


Figure 7 Color contour map showing the topography and bathymetry values from the Cedar Port without-project (WOP) ADCIRC mesh in the greater project area.

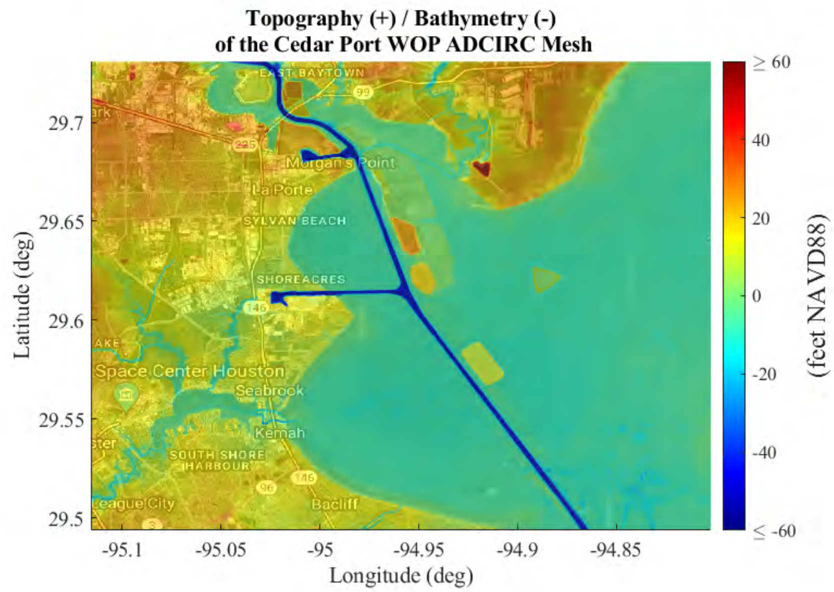


Figure 8 Map overlaid with 2D color contour plots of topography and bathymetry for the updated without-project (WOP) conditions ADCIRC mesh.

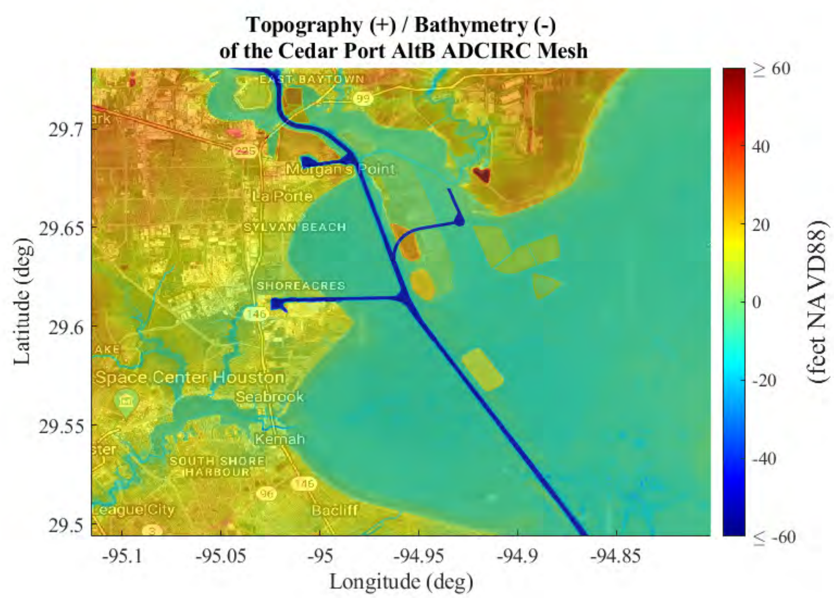


Figure 9 Map overlaid with 2D color contour plots of topography and bathymetry for the Cedar Port with-project Alternative B (AltB) conditions ADCIRC mesh.

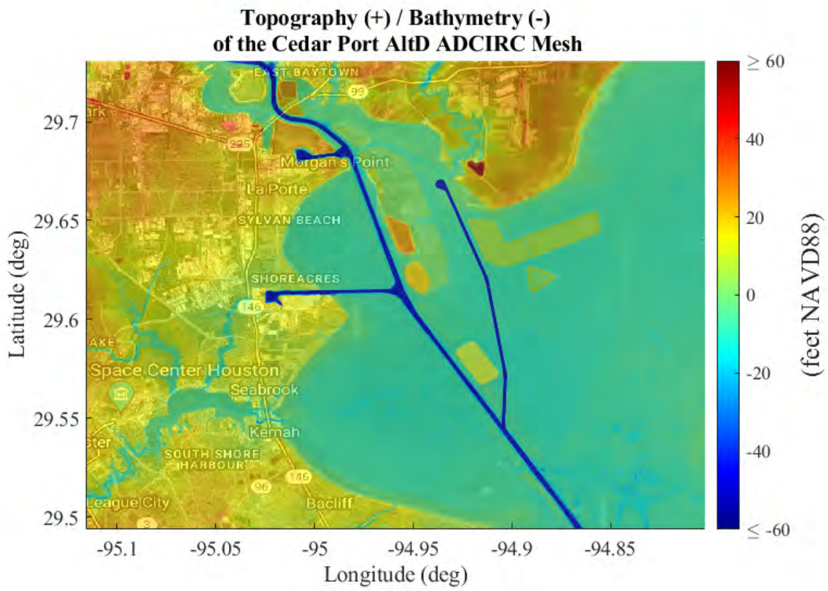


Figure 10 Map overlaid with 2D color contour plots of topography and bathymetry for the Cedar Port with-project Alternative D (AltD) conditions ADCIRC mesh.

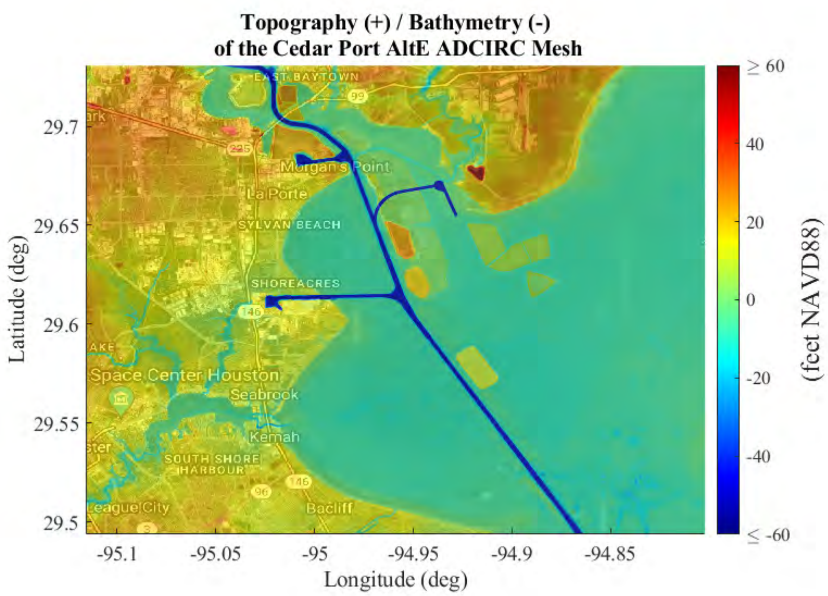


Figure 11 Map overlaid with 2D color contour plots of topography and bathymetry for the Cedar Port with-project Alternative E (AltE) conditions ADCIRC mesh.

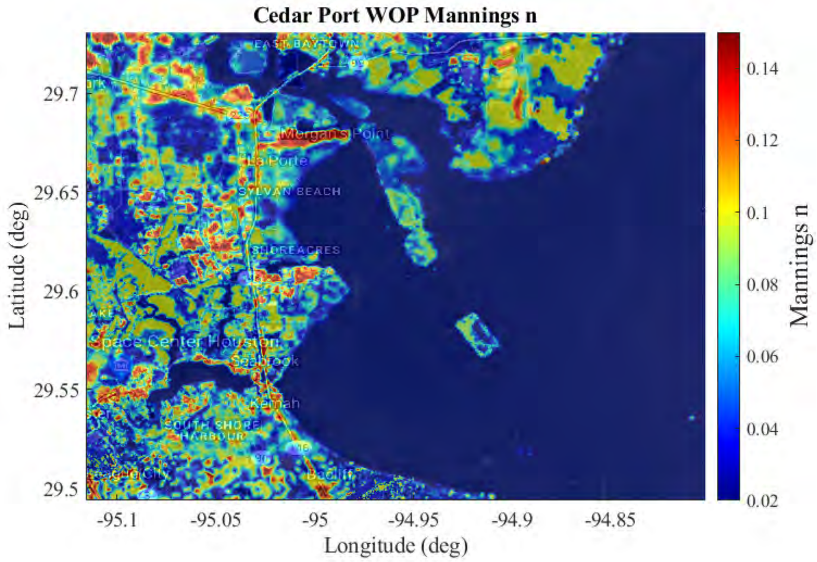


Figure 12 Map overlaid with 2D color contour plots of Manning's n values for the updated without-project (WOP) condition ADCIRC mesh.

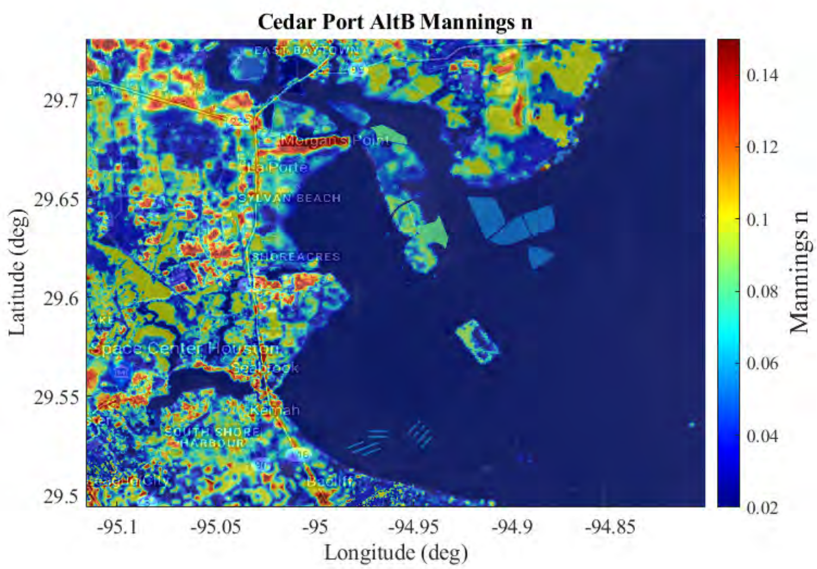


Figure 13 Map overlaid with 2D color contour plots of Manning's n values for the Cedar Port with-project Alternative B (AltB) condition ADCIRC mesh.

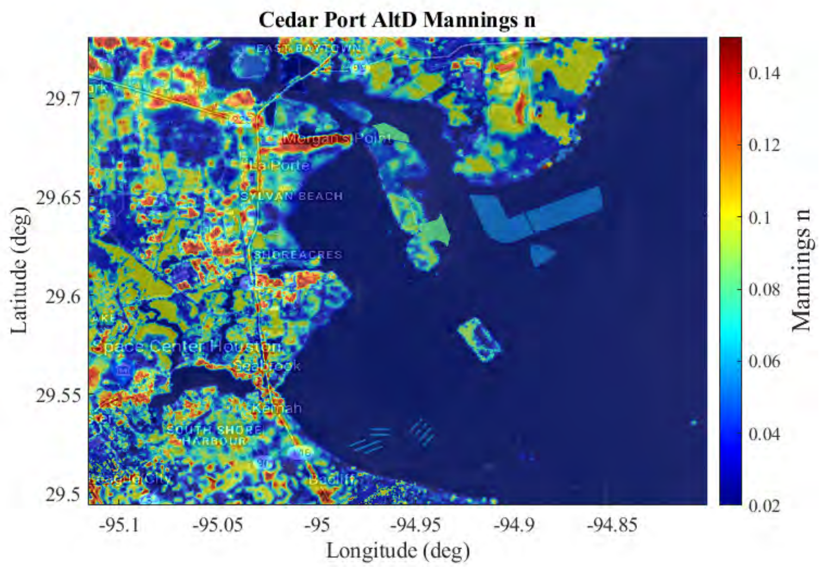


Figure 14 Map overlaid with 2D color contour plots of Manning's n values for the Cedar Port with-project Alternative D (AltD) condition ADCIRC mesh.

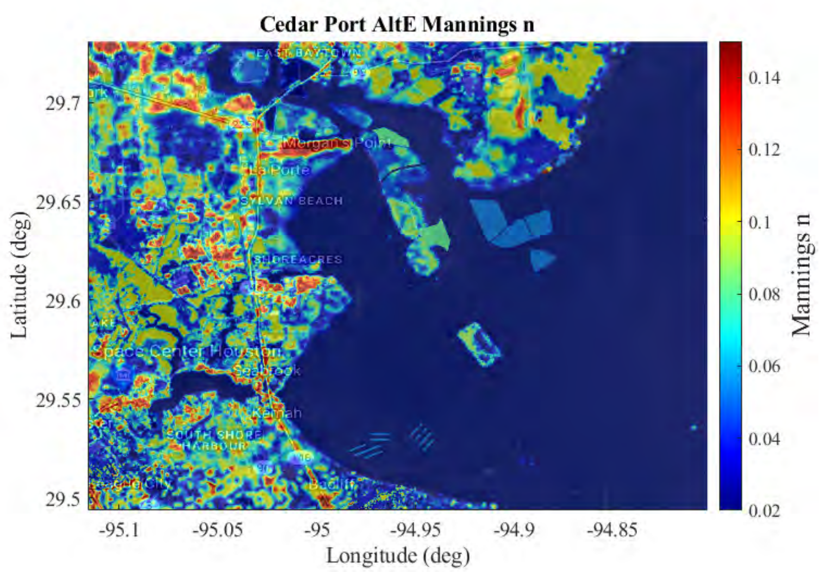


Figure 15 Map overlaid with 2D color contour plots of Manning's n values for the Cedar Port with-project Alternative E (AltE) condition ADCIRC mesh..

The STWAVE grid domain (TX-N) from the CTXS study, shown in Figure 2(b), was also updated. The original CTXS TX-N grid used a grid spacing of 656.16 feet (200 meter) which was refined to 328.08 feet (100 meters). The grid extents and azimuth of rotation of the updated grid remained unchanged from the CTXS. The STWAVE (x0,y0) location is (1132495.0, 4123323.0) within the StatePlane Coordinate System, Zone 4204 in meters. The azimuth of rotation for the STWAVE grid is 115.0 degrees. The updated grid consists of 1721 cells in the i-direction and 2111 cells in the j-direction. The corresponding topography and bathymetry changes and Manning's n friction values for each of the with- and without-project conditions set in the ADCIRC meshes were linearly interpolated onto the new STWAVE grids. No other changes to the STWAVE grid or model settings were made from the original CTXS.

Storm Selection

Stormwater level statics for annual exceedance probabilities (AEP) with confidence limits were computed as part of the CTXS (Nadal-Caraballo et al. 2019) at over 18,000 save point locations across the Texas and Louisiana coastal areas. Anchor performed an analysis of the CTXS still water elevations AEP's at save point number 15,651 which is located near the project area. Based on the AEP values at that save point, 10-yr still water level AEP is approximately 7.6 feet NAVD88, the 100-yr still water level AEP is about 13.5 feet, and the 500-yr still water level AEP is about 16.6 feet. After determining the different AEP values for still water levels, the maximum still water level model results from all 660 storms were examined at save point 15,651 to see which storms produced values with +/- 0.5 feet of the stated AEP values. Figure 16 shows a map of the project area overlaid with different CTXS storm tracks crossing through the area. After all the storms that produced maximum still water levels close to the AEP's the storm list was further restricted to those storms that had tracks with the potential for greater impacts in the vicinity of the project site, as compared to a very large and powerful storm that was way offshore but produced the 10-year still water level value.

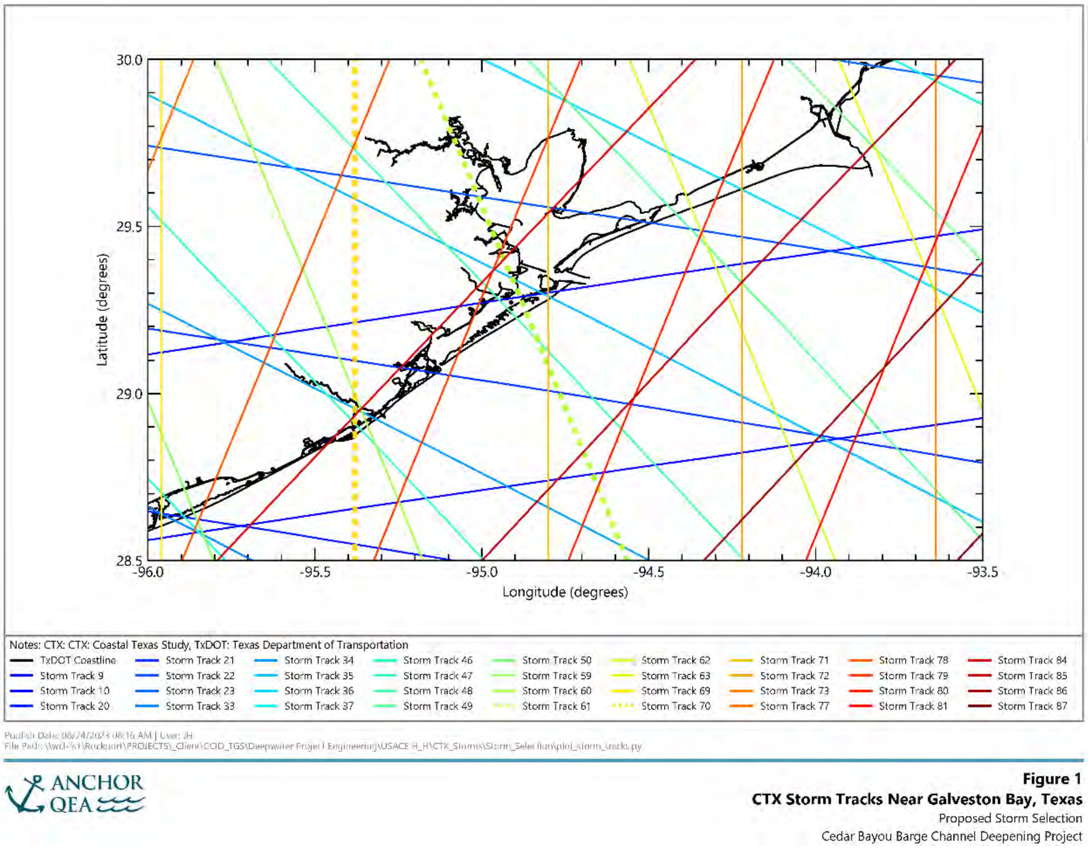


Figure 16 Map showing the greater Galveston Bay coastline as black lines, overlaid with storm tracks from the CTXS as colored lines. Dashed colored lines indicate the storm tracks selected for use as proxy storms.

Based on this analysis and storm selection criteria, CTXS storms 458, 521, and 523 were selected for use as proxy storms for this study. The peak stillwater elevation at the site for storm 458 is 8.0 feet NAVD88, which is within 0.5 foot of both the CTXS and FEMA 10-year stillwater elevations. This information is noted on Figure 17. Based on the Holland B parameter, set as 1.16 for this storm at landfall, the peak windspeed at landfall equates to a Category 2 hurricane. The minimum sea level pressure at landfall is 963.7 mb (13.977 psi) and the radius of maximum winds is 20.7 nautical miles decreasing slightly 20 20.5 nautical miles at landfall. The translational speed is approximately 10 knots. This storm follows Track 61 of the CTXS, with a NW heading immediately west of Galveston Bay, and the track is shown as the dotted green line in Figure 17.

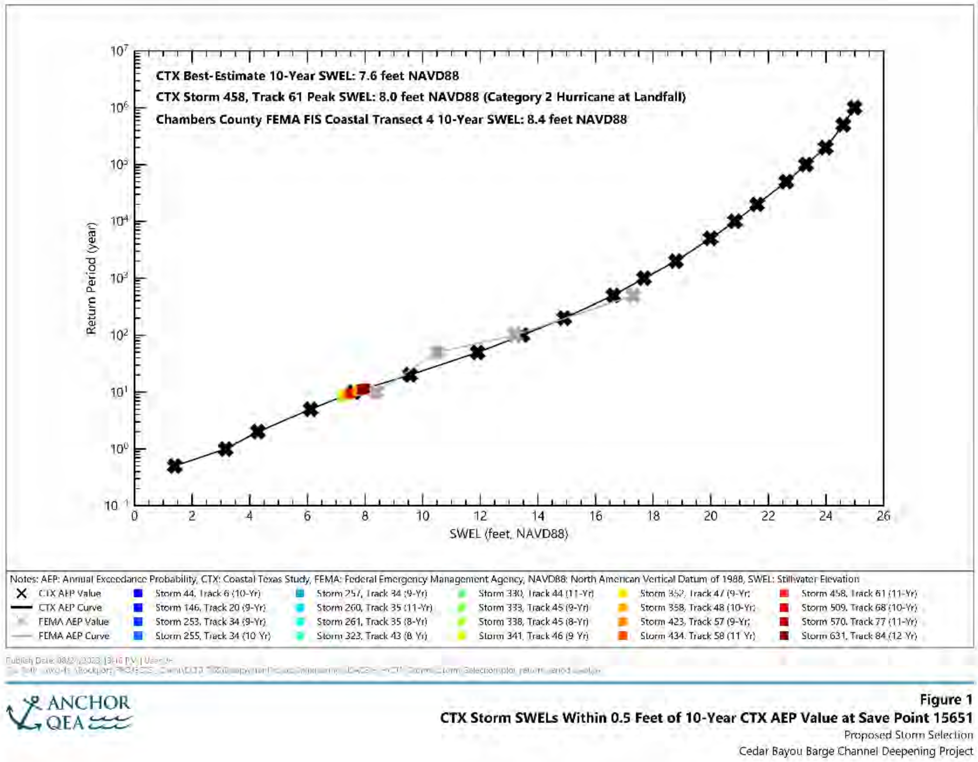


Figure 17 CTXS still water level AEP values and storms producing peak water levels within +/- 0.5 feet of the 10-year AEP at save point 15,651.

The peak stillwater elevation at the site for storm 521 is 13.5 feet NAVD88, which is within 0.5 foot of both the CTXS and FEMA 100-year stillwater elevations. This information is noted on Figure 19. Based on the Holland B parameter for this storm at landfall which is set to 1.33, the peak windspeed at landfall equates to a Category 4 hurricane. The minimum sea level pressure is 875 mb (12.691 psi) but increased to 905.2 mb (13.129 psi) at landfall and the radius of maximum winds increased from 12.4 nautical miles to 17.6 nautical miles at landfall. The translational speed is approximately 15-knots. This storm follows Track 70 of the CTXS, with a north heading west of Galveston Bay. This track is shown as the dotted yellow-orange line line Figure 19.

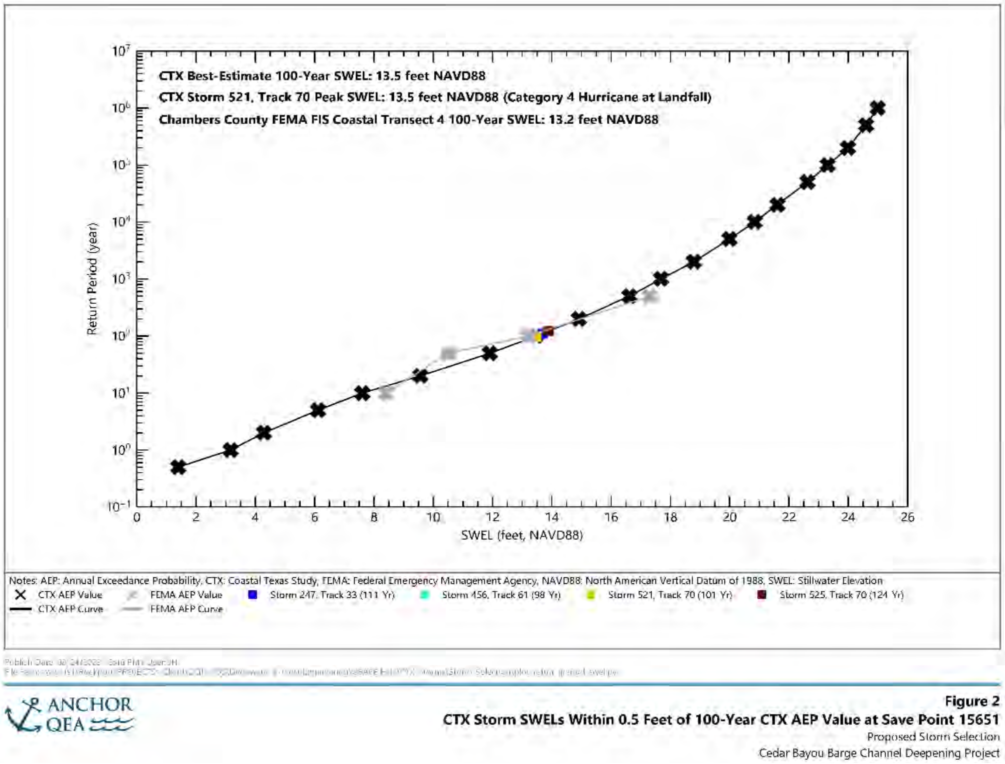


Figure 18 CTXS still water level AEP values and storms producing peak water levels within +/- 0.5 feet of the 100-year AEP at save point 15,651.

The peak stillwater elevation at the site for storm 523 is 16.8 feet NAVD88, which is within 0.5 foot of both the CTXS and FEMA 500-year stillwater elevations. This information is noted on Figure 19. Based on the Holland B parameter for this storm at landfall which is set to 1.06, the peak windspeed at landfall equates to a Category 3 hurricane. The minimum sea level pressure is 915 mb (13.271 psi) and increased to 927.3 mb (13.449 psi) at landfall and the radius of maximum winds is 23.5 nautical miles which increased to 25.9 nautical miles at landfall. The translational speed is approximately 5-knots. This storm also follows Track 70 of the CTXS, with a north heading west of Galveston Bay. This track is shown as the dotted yellow-orange line line Figure 19. Note that while the wind speed for storm 523 is lower than that of 521 on the same track, the translational speed is slower and the storm size is larger, both of which appear to be increasing the storm's still water levels higher than the intense but faster moving and smaller storm 521.

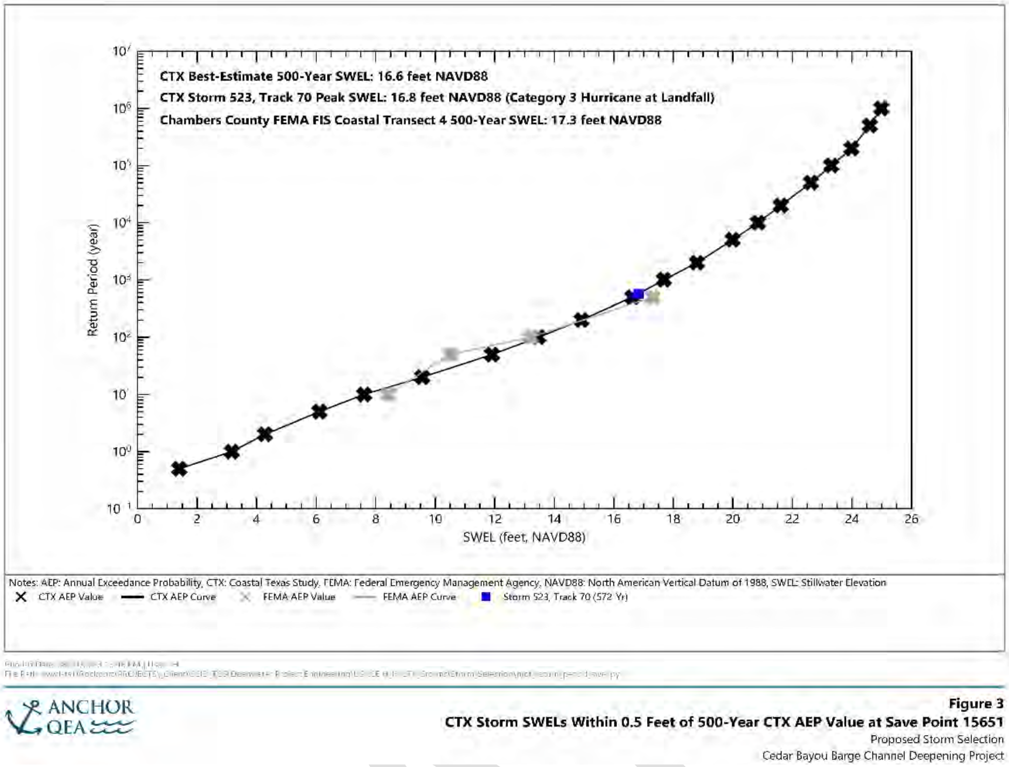


Figure 19 CTXS still water level AEP values and storms producing peak water levels within +/- 0.5 feet of the 500-year AEP at save point 15,651.

Vertical Datum, Steric Adjustment, and Sea Level Rise

The ADCIRC mesh topography/bathymetry values being used for the CTXS are referenced relative to the NAVD88 datum which is a geodetic equipotential surface and is referenced to a given epoch, in this case the 2004.65 epoch. Since ADCIRC is a barotropic model it is not formulated to model intra-annual mean sea surface variability caused by thermal expansion of the water and other baroclinic effects. The magnitude of these effects is typically estimated by analyzing the long-term tidal constituents, such as the solar annual (Sa) and solar semiannual (Ssa) constituents, which are available from long-term NOAA tide gauges. This adjustment to water levels is known as steric adjustment. Furthermore, when accounting for sea-level change (SLC) scenarios, geoid offset values are used to make adjustments. It is convenient to decompose the geoid offset into two parts, the first part to account for steric effects not captured by the model, and the second part for a sea-level change:

$$\text{Geoid\_Offset} = \text{Steric Adjustment} + \text{SLC} \qquad (1)$$

The base geoid offset used for synthetic tropical events for the CTXS was set to 1 foot (0.3048 meters) and represents an averaged value over the entire coast of Texas and included adjustments for SLC for the year 2017. For this study, the values were adjusted to account for sea level rise for the years 2035 for SLC_0 and 2085 for SLC_1 using the USACE Sea Level Analysis Tool (SLAT) (SLAT 2024) for locations near Cedar Port. The

USACE 2013 Intermediate Sea Level Rise Curve, (USACE 2019), which is computed from the modified National Research Council (NRC) Curve I, (NRC 2012) considers both the most recent intergovernmental panel on climate change (IPCC) projections, (IPCC 2007) and modified NRC projections with the local rate of vertical land movement added was used to calculate sea level adjustments. For the SLAT, NOAA Tidal Station 8771450, Galveston Pier 21, TX, was used as the closest station to the project site with the minimum length of data record recommended for the SLAT projections. The sea level increases from the CTX base year (2017) to Cedar Port Year 0 (2035), was 0.51 feet. Thus for all, SLC_0 simulations, the geoid offset value was set to 1.51 feet (0.46025 m). For the period 2017 to 2085, the calculated sea level increase is 2.23 feet which represents the Year 50 Cedar Port simulations. For all, SLC_1 simulations, the geoid offset value was set to 2.23 feet (0.6797 m). No separate adjustments were made for possibly varying steric effects into the future.

CSTORM Model Results: Maximum Water Surface Elevation Comparisons between Without- and With-Project Cases

CSTORM coupled ADCIRC + STWAVE simulations were performed for each of the three selected proxy storms using sea level conditions 0 and 1, SLC_0 and SLC_1, for the without project (WOP), with-project Alternative B (AltB), with-project Altnerative D (AltD) and with-project Altneative E (AltE) configurations. Two-dimensional color contour plots of maximum water surface elevation (WSE) relative to NAVD88 are provided for each storm for the without-project scenario along with 2D color contour plots showing the difference in maximum WSE between the with-project alternatives and the without-project conditions. Results are grouped by sea level condition for all three storms and provided in the next subsections.

Maximum WSE for SLC_0

Color contour plots of maximum water surface elevations given in feet and relative to NAVD88 for sea level condition 0, SLC_0 are provided in the top left-hand blocks of Figure 20, Figure 21, and Figure 22. In each figure, the top right-hand block shows the difference in maximum water surface elevations between Alternative B minus without-project (AltB-Base). The bottom left-hand block shows the difference in maximum WSE between Alternative D minus without-project (AltD-Base) and the bottom right block shows the difference in maximum WSE between Alternative E minus without-project (AltE-Base).

Storm 458 results are shown in Figure 20 where the maximum water surface elevations in the upper western area of Galveston Bay range from about 6 feet to 12 feet. Differences in maximum water surface elevation are generally nearly zero with areas not zero being less than 0.4 feet higher for with-project conditions except the areas where the new with-project islands are included, where the maximum water surface elevations are between 0.5 and 1.0 feet higher. For Alternative E, there is a slight decrease in maximum water surface elevation observed around the northern extent of the islands and wetlands (around -94.97 degrees longitude and 29.68 degrees latitude).

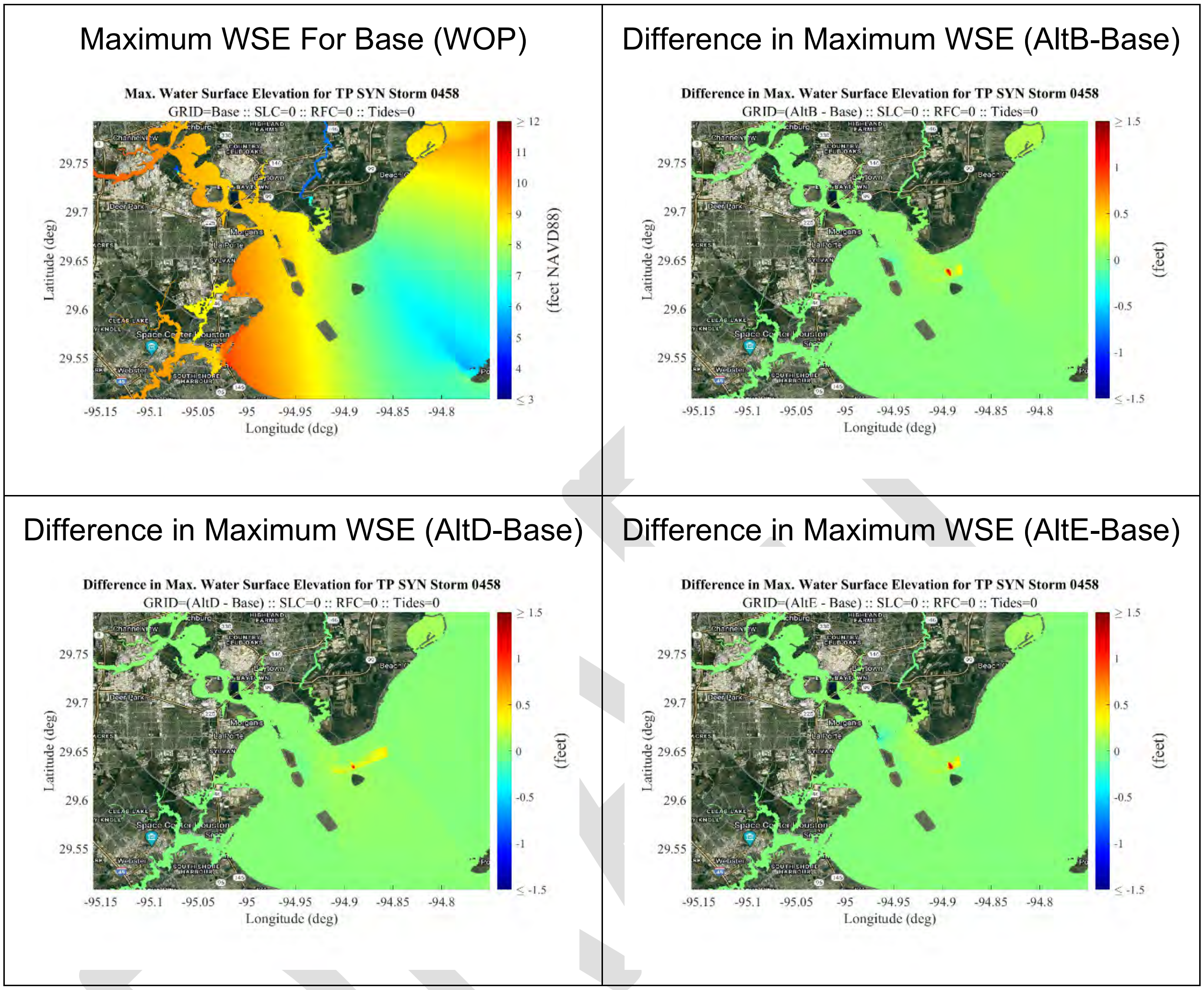


Figure 20 Comparison of maximum water surface elevation results for Storm 458 and SLC0.

Storm 521 results are shown in Figure 21 where the maximum water surface elevations in the upper western area of Galveston Bay range from about 10 feet to over 22 feet. With the higher WSE than from storm 458, there is more area inundated as well. Differences in maximum water surface elevation are generally negligiable, with areas showing variations of less than 0.5 feet. There are nearly equal areas showing higher maximum WSE and lower maximum WSE around the with-project island areas. Differences in maximum WSE between all three with-project conditions and the without-project are insignificant. Difference for AltD do have a slightly higher value and more area of difference than AltB and AltE, this is due to the larger size of the with-project island for AltD.

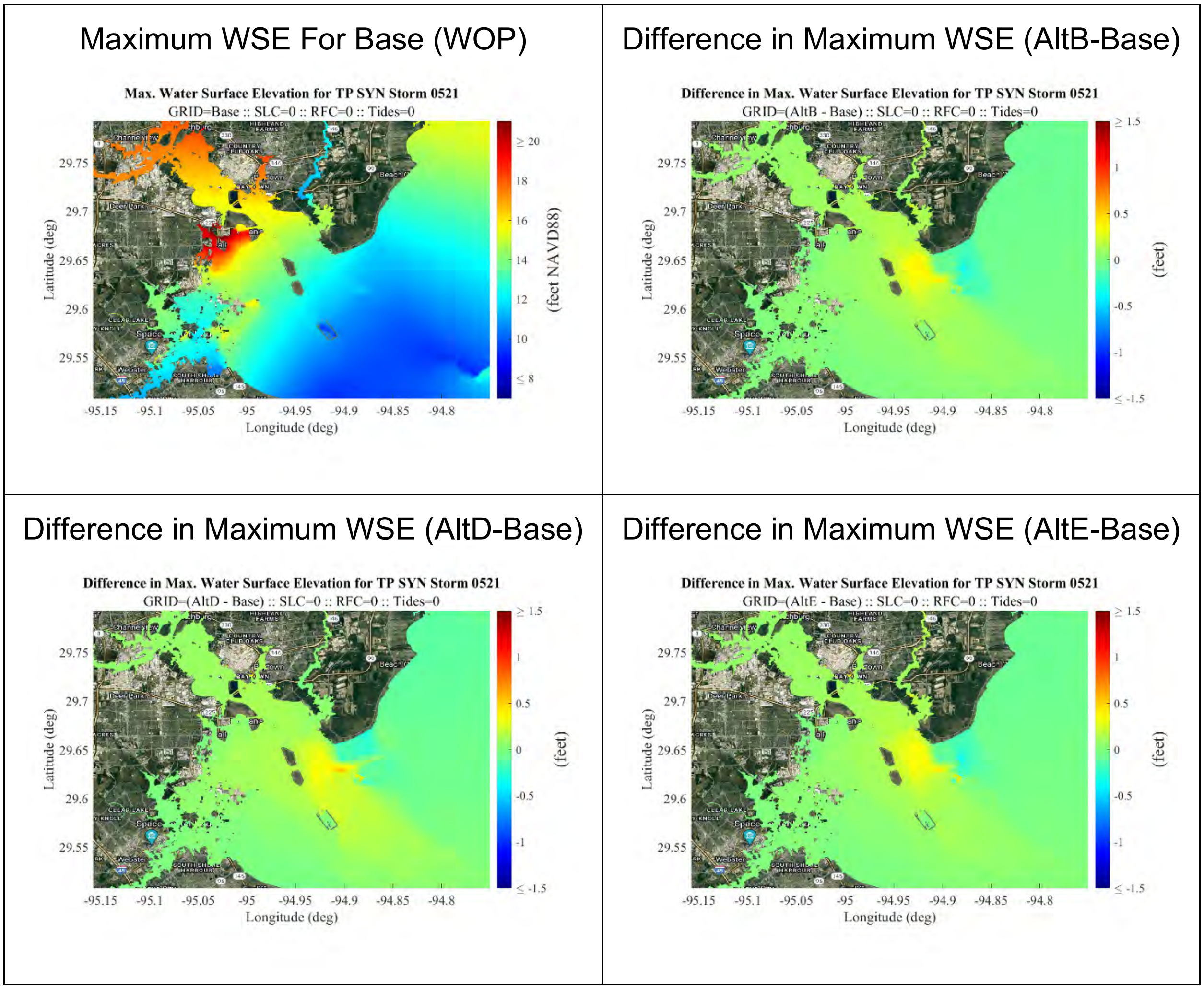


Figure 21 Comparison of maximum water surface elevation results for Storm 521 and SLC0.

Storm 523 results are shown in Figure 22 where the maximum water surface elevations in the upper western area of Galveston Bay range from about 14 feet to over 24 feet. With a higher maximum WSE than either storm 458 or 521, there is more area inundated as well. Differences in maximum water surface elevation are generally nearly zero with areas not zero being less than 0.3 feet higher for the with-project conditions. AltD shows a slightly larger area where differences in maximum WSE are about 0.3 feet than the AltB and AltE.

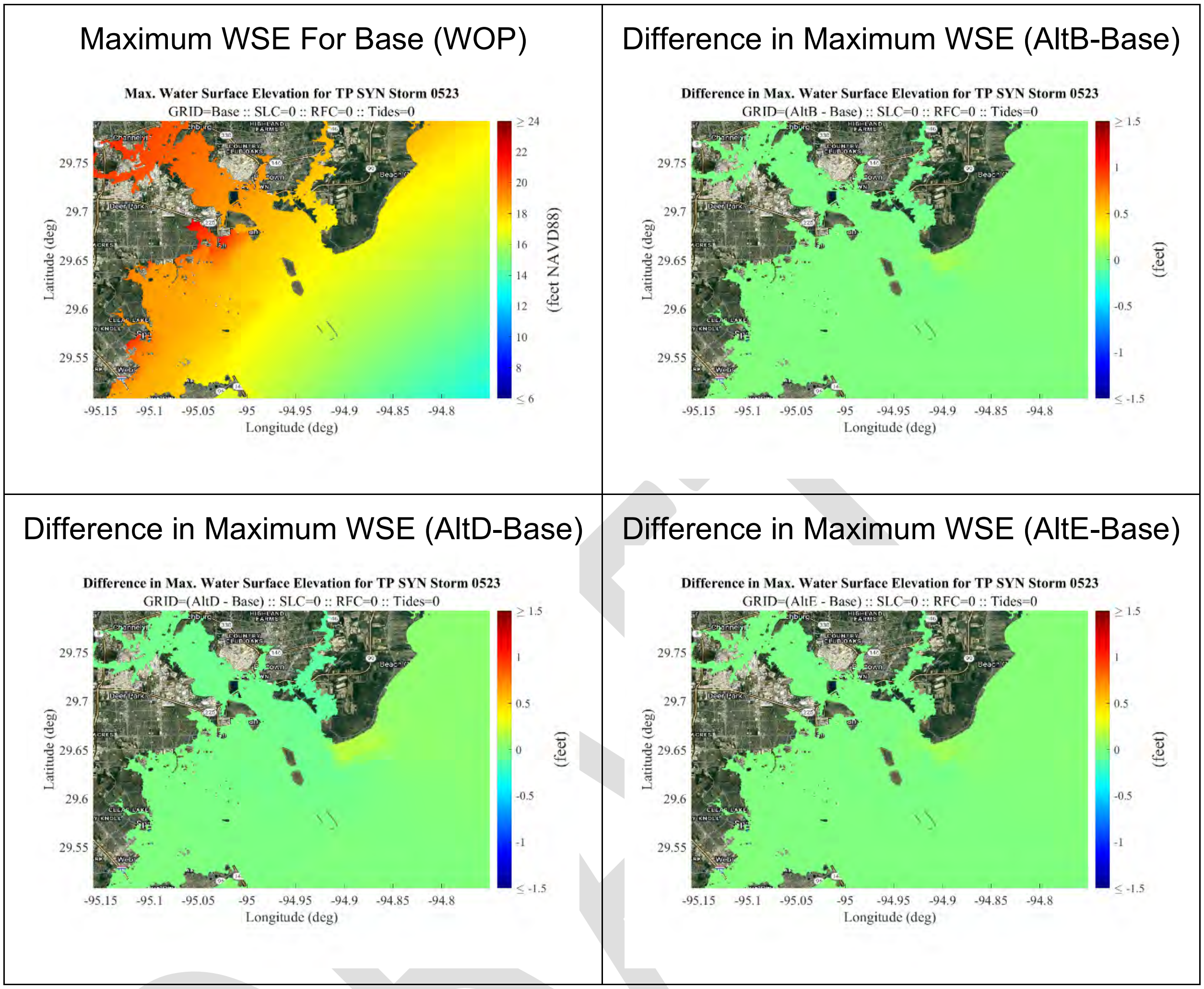


Figure 22 Comparison of maximum water surface elevation results for Storm 523 and SLC0.

Maximum WSE for SLC_1

Color contour plots of maximum water surface elevtions given in feet and relative to NAVD88 for sea level condition 1, SLC_1, are provided in the top left hand blocks of Figure 23, Figure 24, and Figure 25. In each figure, the top right hand block shows the difference in maximum water surface elevations between Alternative B minus without-project (AltB-Base). The bottom left hand block shows the difference in maximum WSE between Alternative D minus without-project (AltD-Base) and the bottom right block shows the difference in maximum WSE between Alternative E minus without-project (AltE-Base). Under the SLC_1 condition, the differences in maximum water surface elevation between without-project and with-project conditions are nearly zero for all projects and storms. Results for storm 521 show isolated areas around the island and wetland areas of the projects where differences range from being about 0.3 feet lower to 0.3 feet higher and then a slight increase of around 0.2 feet visible on the northern portions near the Houston Ship Channel for Alternative D. There is also a slight lowering of maximum WSE, around 0.2 feet, for storm 521 that is visible near -95.05 degrees longitude and 29.68 degrees latitude.

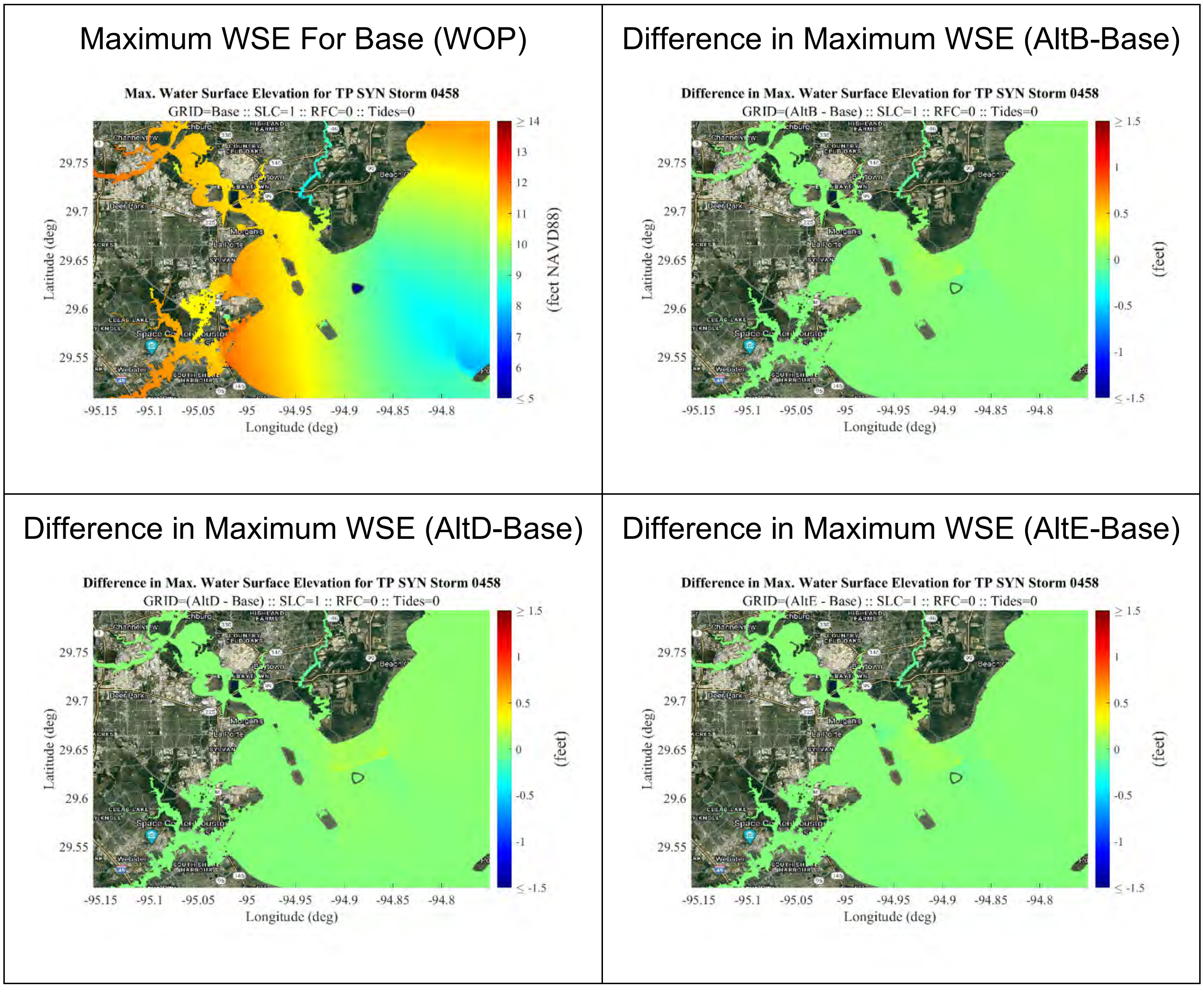


Figure 23 Comparison of maximum water surface elevation results for Storm 458 and SLC1.

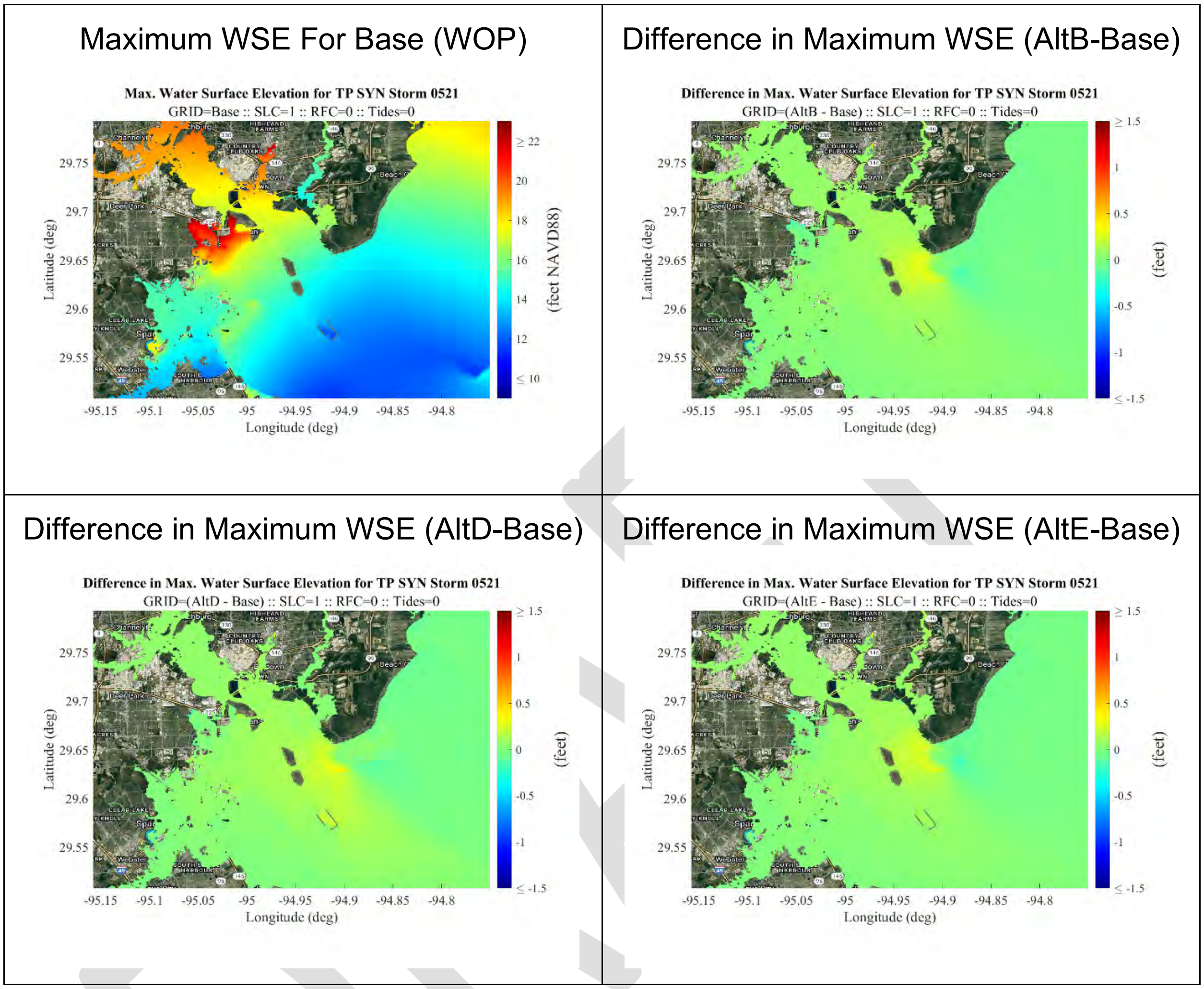


Figure 24 Comparison of maximum water surface elevation results for Storm 521 and SLC1.

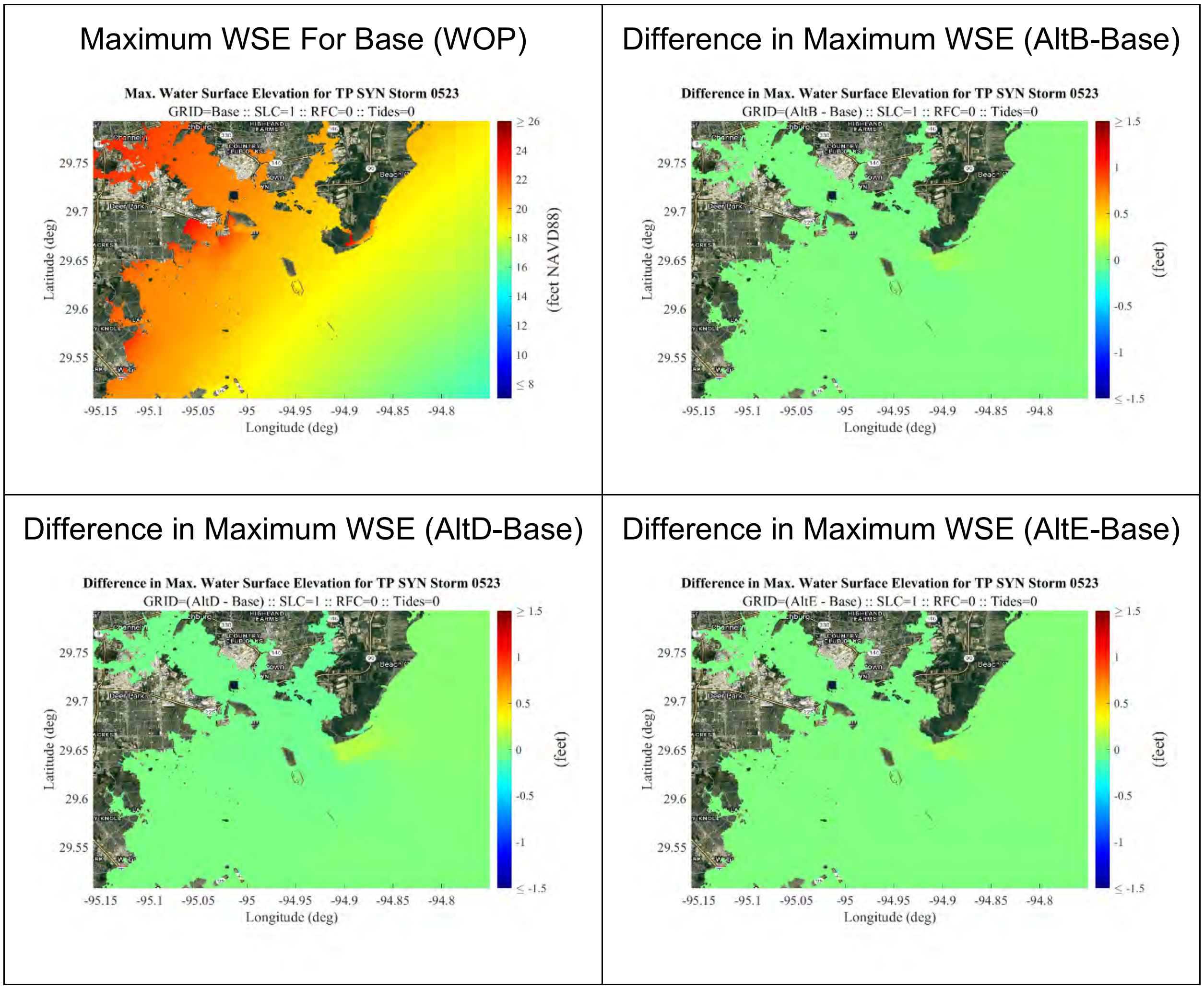
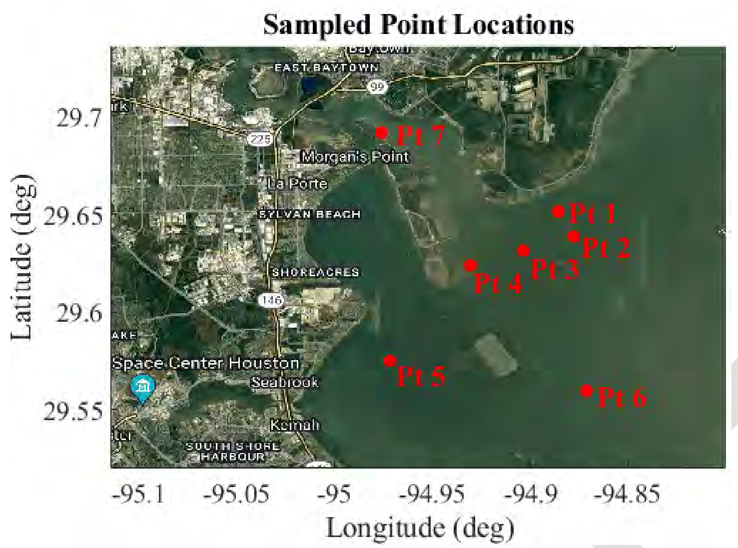


Figure 25 Comparison of maximum water surface elevation results for Storm 523 and SLC1.

Comparison of Maximum Water Surface Elevations at Selected Point Locations

Table 1 shows the location of seven (7) point locations selected around the main project areas including near the with-project islands and the channels. Table 2 provides the maximum water surface elevation values for each of the three storms and 4 model simulation geometrys for sea level condition 0 (SLC_0). Table 3 provides the maximum water surface elevation values for each of the three storms and 4 model simulation geometrys for sea level condition 1 (SLC_1).



Location Name	Longitude (Degrees)	Latitude (Degrees)
Pt 1	-94.8858100	29.6511180
Pt 2	-94.8779390	29.6384460
Pt 3	-94.9037350	29.6314280
Pt 4	-94.9308230	29.6240730
Pt 5	-94.9714590	29.5763790
Pt 6	-94.8707980	29.5602500
Pt 7	-94.9762550	29.6918490

Table 1 Location of selected point locations for comparison of modeling results.

Maximum WSE (feet NAVD88) Sea Level Condition 0 (SLC_0)								
Storm #	**Geometry**	**Pt 1**	**Pt 2**	**Pt 3**	**Pt 4**	**Pt 5**	**Pt 6**	**Pt 7**
458	Base	7.43	7.23	7.81	8.32	9.19	7.35	8.96
	AltB	7.47	7.18	7.93	8.37	9.20	7.36	8.99
	AltD	7.48	7.52	8.03	8.37	9.21	7.39	8.99
	AltE	7.45	7.18	7.93	8.37	9.20	7.35	8.99
521	Base	11.88	11.40	11.89	12.24	12.50	9.94	15.46
	AltB	11.72	11.06	12.18	12.56	12.53	10.02	15.57
	AltD	11.67	11.46	12.30	12.59	12.54	10.09	15.57
	AltE	11.69	11.13	12.17	12.55	12.53	10.01	15.58
523	Base	16.87	16.60	16.81	17.03	16.93	15.37	18.36
	AltB	16.95	16.64	16.79	17.01	16.92	15.36	18.35
	AltD	17.03	16.64	16.83	16.98	16.90	15.37	18.32
	AltE	16.94	16.64	16.79	17.01	16.92	15.36	18.35

Table 2 Maximum WSE at slected point locations around the main project areas for SLC_0 for all 4 geometry conditions and all 3 storms.

Maximum WSE (feet NAVD88) Sea Level Condition 1 (SLC_1)								
Storm #	**Geometry**	**Pt 1**	**Pt 2**	**Pt 3**	**Pt 4**	**Pt 5**	**Pt 6**	**Pt 7**
458	Base	9.44	9.27	9.76	10.22	10.99	9.32	10.81
	AltB	9.48	9.23	9.85	10.27	11.00	9.33	10.84
	AltD	9.54	9.39	9.93	10.27	11.00	9.36	10.84
	AltE	9.46	9.23	9.85	10.26	11.00	9.33	10.84
521	Base	14.20	13.80	13.97	14.25	14.26	12.15	17.25
	AltB	14.16	13.67	14.17	14.47	14.29	12.20	17.35
	AltD	14.22	13.79	14.25	14.47	14.29	12.25	17.35
	AltE	14.13	13.67	14.15	14.44	14.29	12.19	17.35
523	Base	18.86	18.61	18.83	19.06	19.00	17.46	20.31
	AltB	18.95	18.64	18.80	19.04	19.00	17.45	20.30
	AltD	19.01	18.63	18.82	19.01	18.98	17.46	20.28
	AltE	18.93	18.64	18.79	19.05	19.00	17.45	20.30

Table 3 Maximum WSE at slected point locations around the main project areas for SLC_1 for all 4 geometry conditions and all 3 storms.

CSTORM Model Results: Maximum Significant Wave Height Comparisons between Without- and With-Project Cases

This section provides details on the maximum significant wave height, H_{m0}, results from the CSTORM coupled ADCIRC + STWAVE simulations. As in the previous section, results are presented grouped first by sea level condition, SLC_0 and SLC_1, and then by storm, 458, 521, and 523. For each sea level condtion and storm, two-dimensional color contour plots are produced showing maximum H_{m0} results for the without-project (Base) along with differences in maximum H_{m0} for between the alternatives (AltB, AltD, and AltE) minus the Base conditions. Results are grouped by sea level condition for all three storms and provided in the next two subsections.

Maximum H_{m0} for SLC_0

Color contour plots of maximum significant wave height, H_{m0}, given in feet and relative to NAVD88 for sea level condition 0, SLC_0, are provided in the top left hand blocks of Figure 26, Figure 27, and Figure 28. In each figure, the top right-hand block shows the difference in maximum H_{m0} between Alternative B minus without-project (AltB-Base). The bottom left-hand block shows the difference in maximum H_{m0} between Alternative D minus without-project (AltD-Base) and the bottom right block shows the difference in maximum H_{m0} between Alternative E minus without-project (AltE-Base).

Storm 458 results are shown in Figure 26 where the maximum H_{m0} in the upper western area of Galveston Bay range from about 6 feet to 7 feet. Differences in maximum H_{m0} are generally nearly zero in the bay with larger differences occurring mainly near the with-project islands and wetland. Over and around the islands and wetland areas there is a lessening of maximum significant wave height between 2 and 4 feet. In Alternative B a small area of higher H_{m0} is observed where the project channel cuts through the island and wetland areas, near -94.95 degrees longitude and 29.65 degrees latitude. Alternative D also shows a slightly larger area of differences in maximum H_{m0} on the order of less than 1 foot that occur along the with-project channel south of the project island.

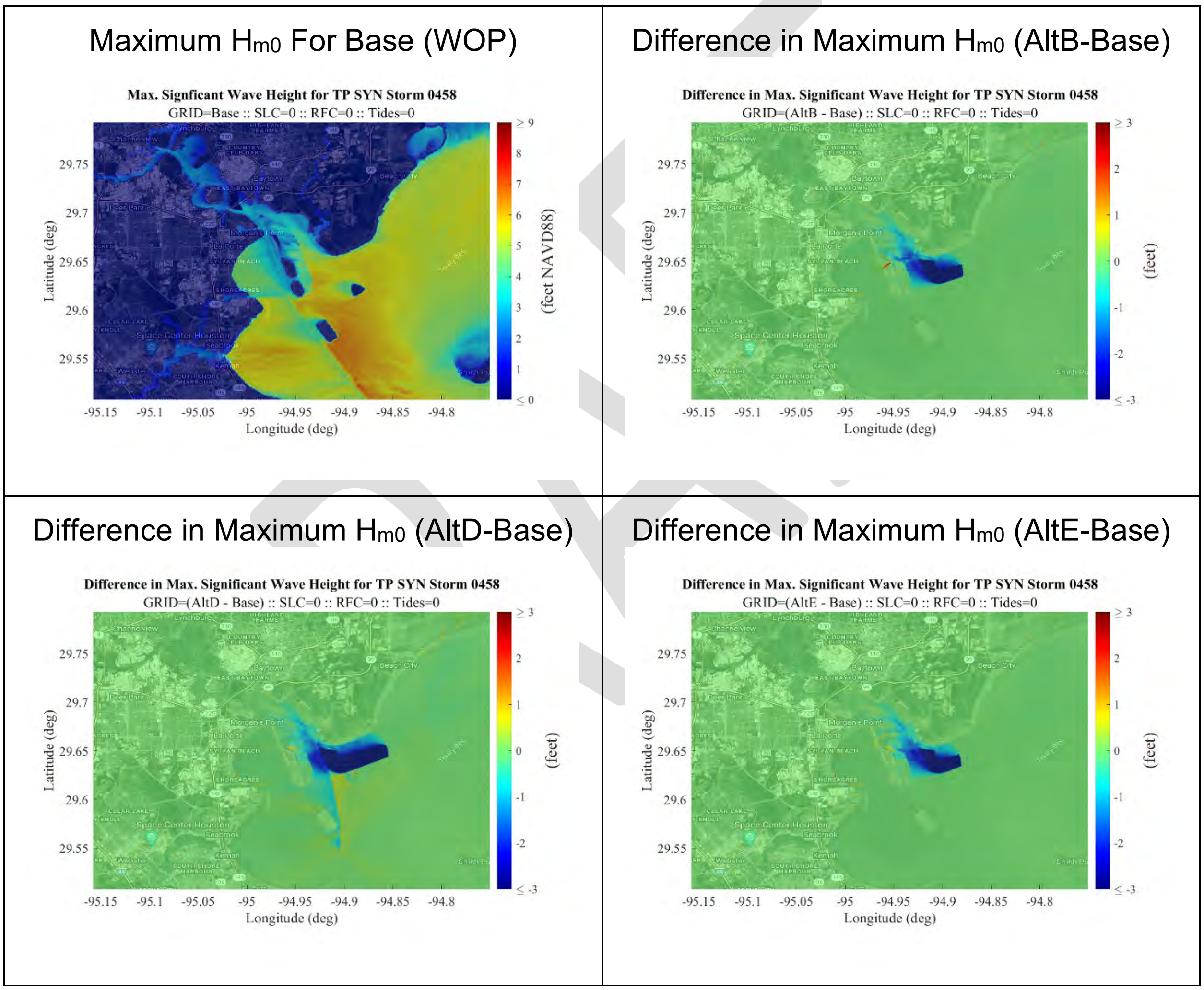


Figure 26 Comparison of maximum signficant wave height (H_{m0}) results for Storm 458 and SLC0.

Storm 521 results are shown in Figure 27 where the maximum H_{m0} in the majority of Galveston Bay range from about 7 feet to over 12 feet with the largest waves on the western side of the Houston Ship Channel. Differences in maximum H_{m0} are generally nearly zero in the bay away from the immediate project areas. Larger differences in the maximum Hm0 are observed near the with-project islands and wetland. Over and around the islands and wetland areas there is a lessening of maximum significant wave height between 4 and 6 feet. In Alternative B a small area of higher H_{m0}, greater than 3 feet, is observed where the project channel cuts through the island and wetland areas, near -94.95 degrees longitude and 29.65 degrees latitude. Alternative D also shows a slightly larger area of differences in maximum H_{m0} with values ranging from 1 to 2 feet lower on the western side of the with-project channel and 1 to 2 feet higher on the eastern side of the channel, all south of the project island.

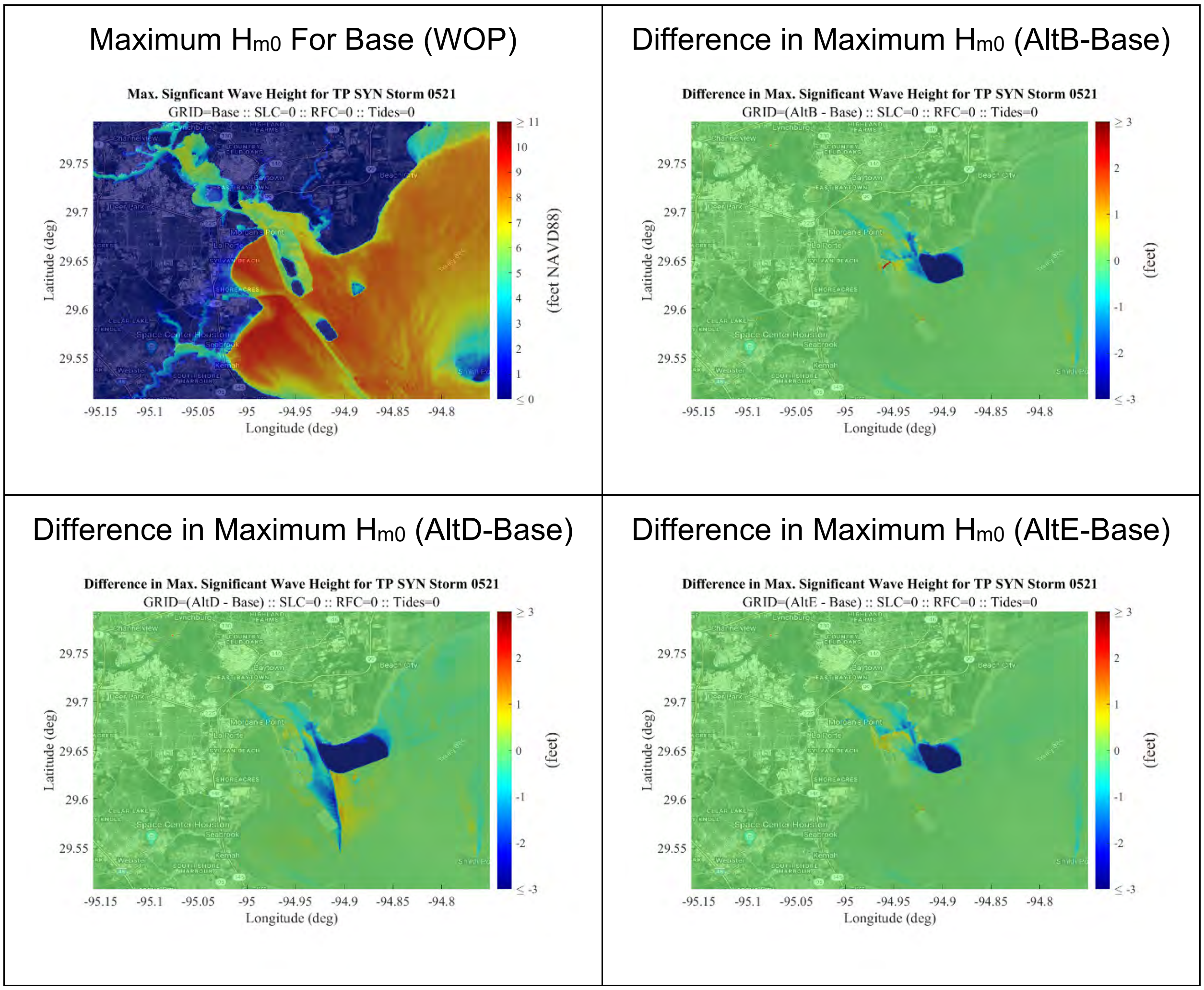


Figure 27 Comparison of maximum signficant wave height (H_{m0}) results for Storm 521 and SLC0.

Storm 523 results are shown in Figure 28 where the maximum H_{m0} in the majority of Galveston Bay range from about 7 feet to around 11 feet with the large waves occurring along and to the east of the Houston Ship Channel. Differences in maximum H_{m0} are generally nearly zero in the bay away from the immediate project areas. Larger differences in the maximum Hm0 are observed near the with-project islands and wetland. Over and around the islands and wetland areas there is a lessening of maximum significant wave height between 1.5 and 2.5 feet. In Alternative B a small area of higher H_{m0}, greater than 3 feet, is observed where the project channel cuts through the island

and wetland areas, near -94.95 degrees longitude and 29.65 degrees latitude. Alternative D also shows a slightly larger area of differences in maximum H_{m0} with values less than 1 foot lower on the western side of the with-project channel and 1 to 2 feet higher on the eastern side of the channel, all south of the project island.

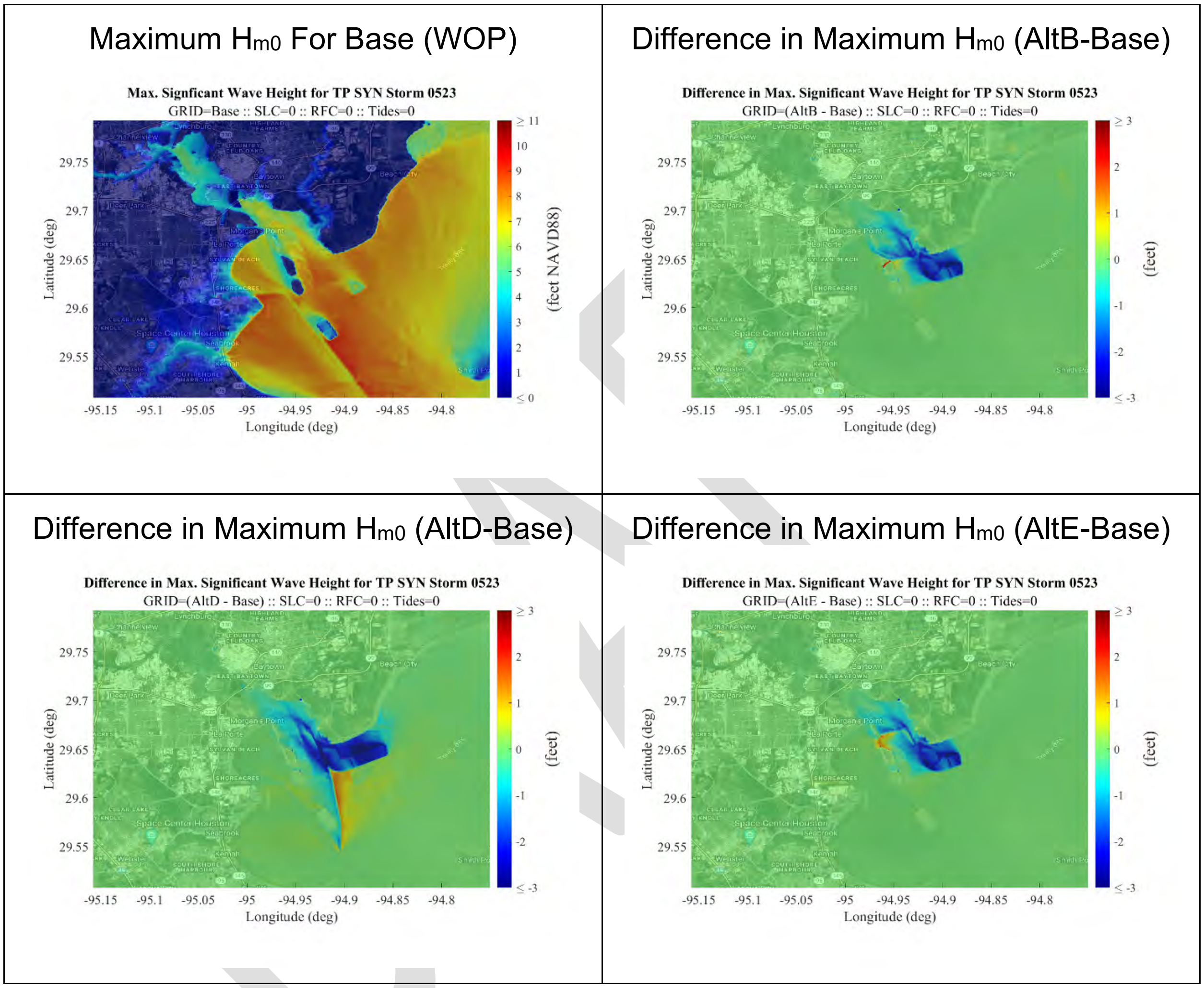


Figure 28 Comparison of maximum signficant wave height (H_{m0}) results for Storm 523 and SLC0.

Maximum H_{m0} for SLC_1

Color contour plots of maximum significant wave height, H_{m0}, given in feet and relative to NAVD88 for sea level condition 1, SLC_1, are provided in the top left hand blocks of Figure 29, Figure 30, and Figure 31. In each figure, the top right hand block shows the difference in maximum H_{m0} between Alternative B minus without-project (AltB-Base). The bottom left hand block shows the difference in maximum H_{m0} between Alternative D minus without-project (AltD-Base) and the bottom right block shows the difference in maximum H_{m0} between Alternative E minus without-project (AltE-Base).

Storm 458 results are shown in Figure 29 where the maximum H_{m0} in the upper western area of Galveston Bay range from about 6 feet to 8 feet. Differences in maximum H_{m0} are generally nearly zero in the bay with greater differences occurring mainly near the with-project islands and wetland. Over and around the islands and wetland areas there is a lessening of maximum significant wave height between 2 and 4 feet. In Alternative B a small area of higher H_{m0}, greater than 3 feet, is observed where the project channel cuts through the island and wetland areas, near -94.95 degrees longitude and 29.65 degrees latitude. Alternative D also shows a slightly larger area of differences in maximum H_{m0} on the order of 0.5 feet that occurs along the with-project channel south of the project island.

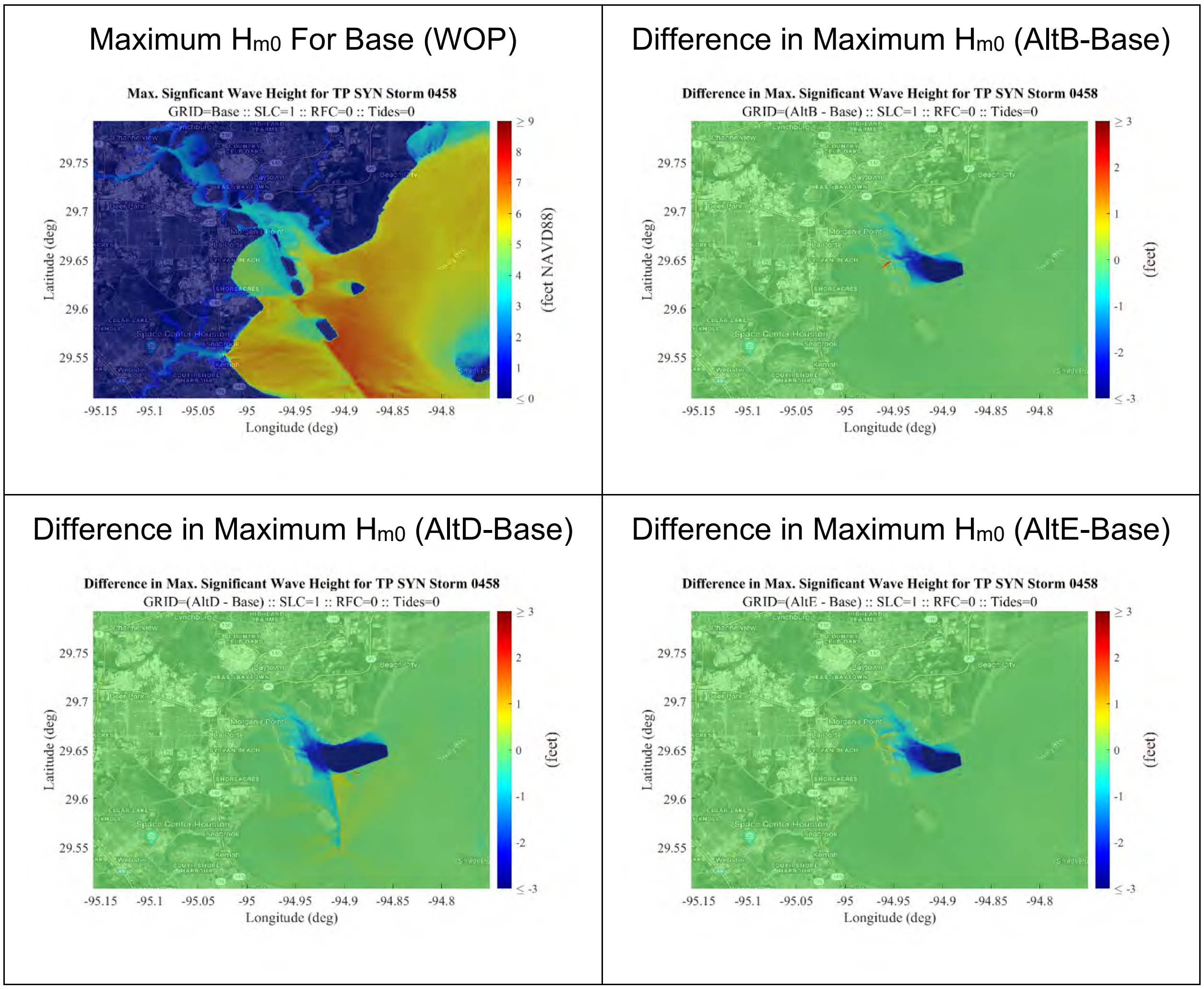


Figure 29 Comparison of maximum signficant wave height (H_{m0}) results for Storm 458 and SLC1.

Storm 521 results are shown in Figure 30 where the maximum H_{m0} in the majority of Galveston Bay range from about 8 feet to over 12 feet with the largest waves on the western side of the Houston Ship Channel. Differences in maximum H_{m0} are generally nearly zero in the bay away from the immediate project areas. Larger differences in the maximum Hm0 are observed near the with-project islands and wetland. Over and around the islands and wetland areas there is a lessening of maximum significant wave height between 4 and 6 feet. In Alternative B a small area of higher H_{m0}, greater than 3 feet, is observed where the project channel cuts through the island and wetland areas, near -94.95 degrees longitude and 29.65 degrees latitude. Alternative D also shows a slightly larger area of differences in maximum H_{m0} with values around 2 feet lower on the western side of the with-project channel and 1.5 feet higher on the eastern side of the channel, all south of the project island. There are small pockets of significant differences observed between AltB and AltE, with Hm0 being approximately 1 foot higher.

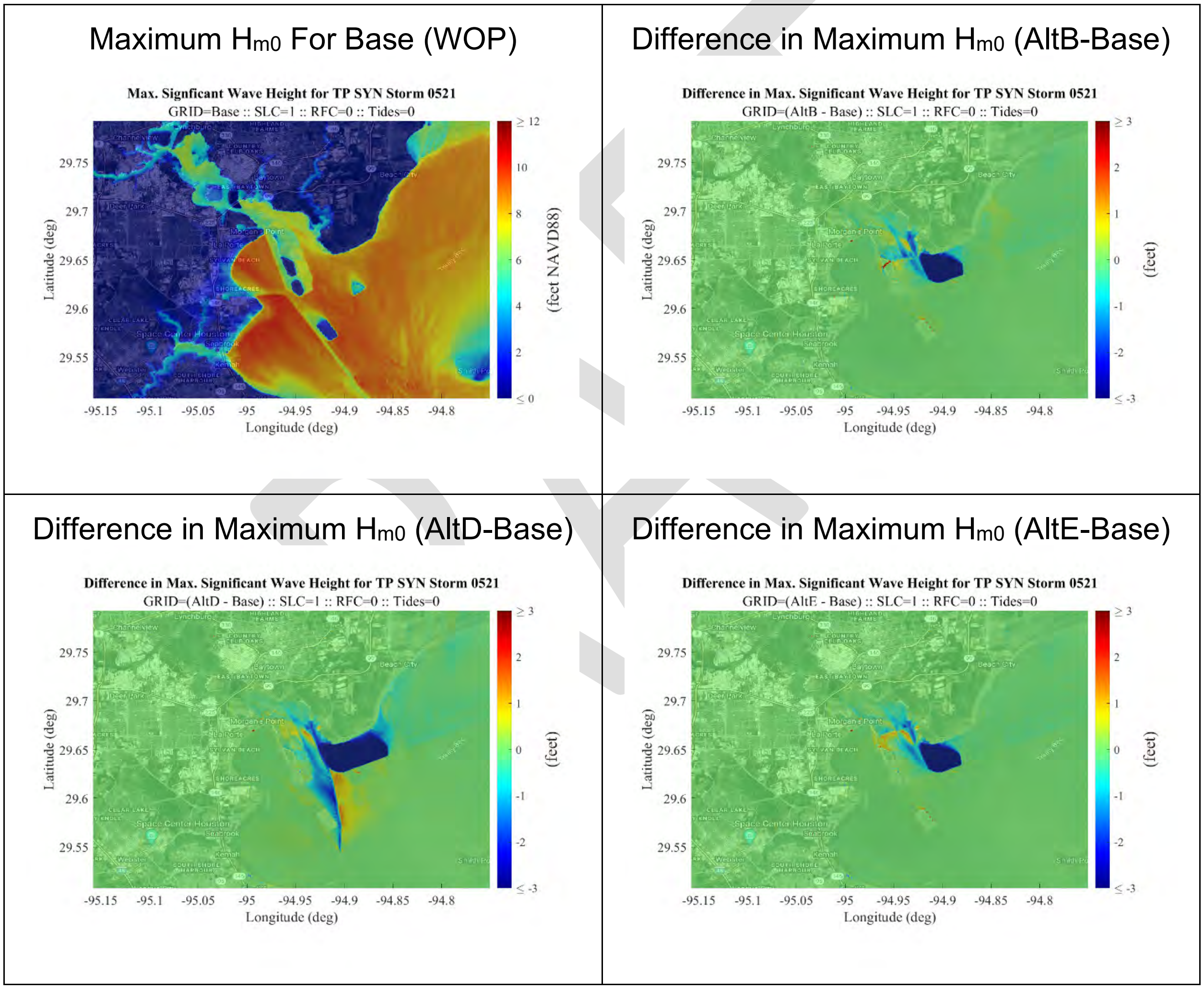


Figure 30 Comparison of maximum signficant wave height (H_{m0}) results for Storm 521 and SLC1.

Storm 523 results are shown in Figure 31 where the maximum H_{m0} in the majority of Galveston Bay range from about 8 feet to around 12 feet with the larger waves occurring along and to the east of the Houston Ship Channel. Differences in maximum H_{m0} are generally nearly zero in the bay away from the immediate project areas. Higher differences in the maximum Hm0 are observed near the with-project islands and wetland. Nearthe islands and wetland areas there is a lessening of maximum significant wave height between 1 and 2 feet. In Alternative B a small area of higher H_{m0}, greater than 3 feet, is observed where the project channel cuts through the island and wetland areas, near -94.95 degrees longitude and 29.65 degrees latitude. Alternative D also shows a slightly larger area of differences in maximum H_{m0} with values less than 1 foot lower on the western side of the with-project channel and 1.5 to 2 feet higher on the eastern side of the channel, all south of the project island.

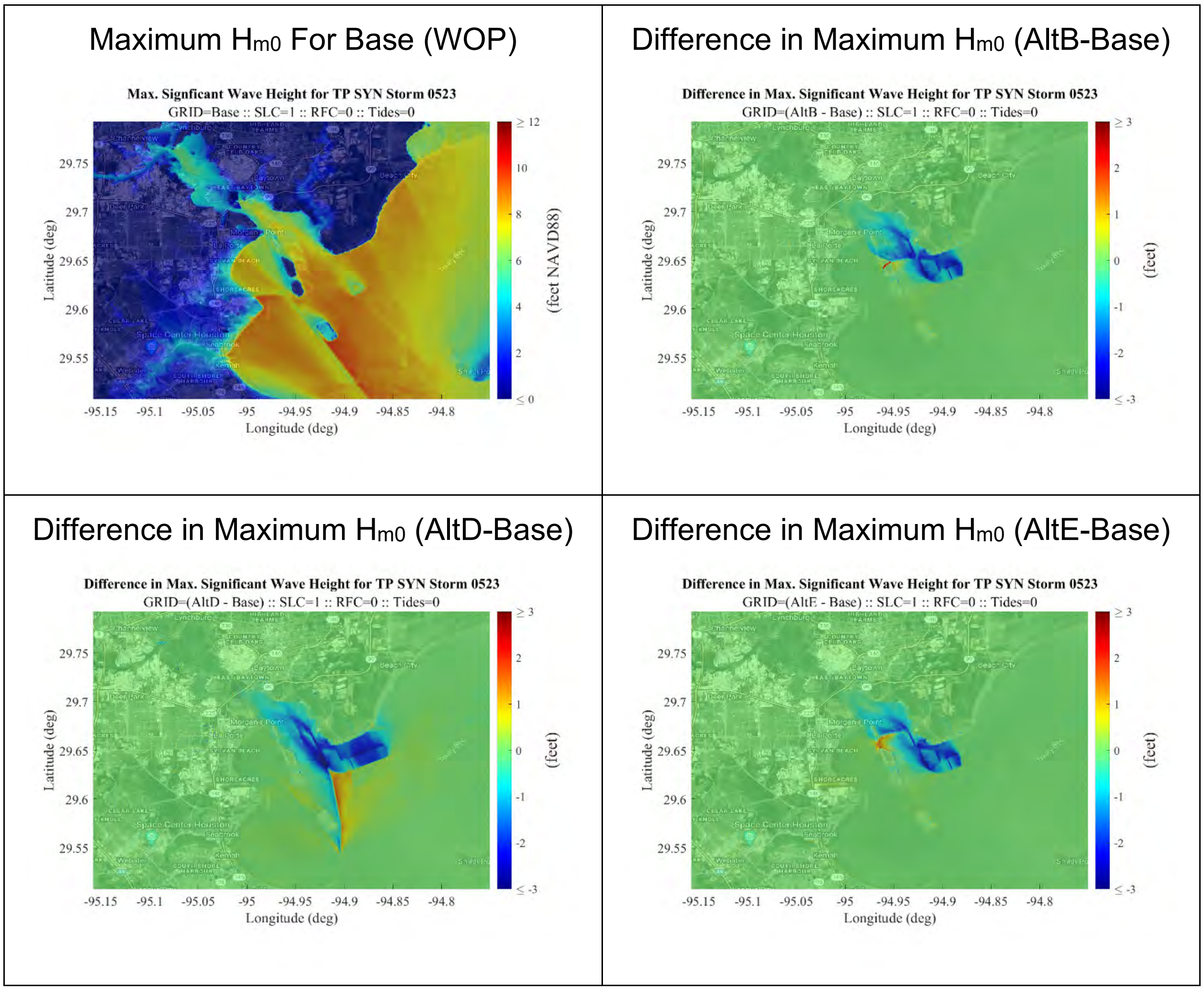
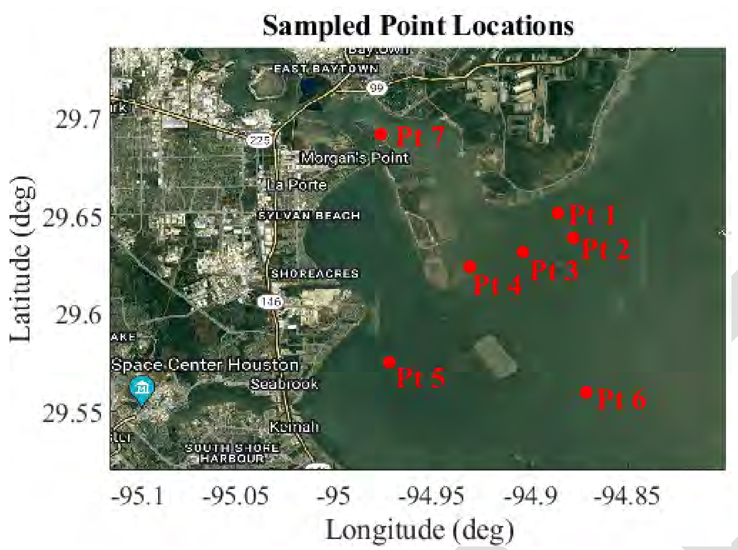


Figure 31 Comparison of maximum signficant wave height (H_{m0}) results for Storm 523 and SLC1.

Comparison of Maximum Significant Wave Heights at Selected Point Locations

Table 4 shows the location of seven (7) point locations selected around the main project areas including near the with-project islands and the channels. These are the same point locations as provided earlier in Table 1 and are included here for ease of reference. Table 5 provides the maximum significant wave height (H_{m0}) values for each of the three storms and 4 model simulation geometrys for sea level condition 0 (SLC_0). Table 6 provides the maximum H_{m0} values for each of the three storms and 4 model simulation geometrys for sea level condition 1 (SLC_1).



Location Name	Longitude (Degrees)	Latitude (Degrees)
Pt 1	-94.8858100	29.6511180
Pt 2	-94.8779390	29.6384460
Pt 3	-94.9037350	29.6314280
Pt 4	-94.9308230	29.6240730
Pt 5	-94.9714590	29.5763790
Pt 6	-94.8707980	29.5602500
Pt 7	-94.9762550	29.6918490

Table 4 Location of selected point locations for comparison of modeling results.

Maximum H_{m0} (feet NAVD88) Sea Level Condition 0 (SLC_0)								
Storm #	**Geometry**	**Pt 1**	**Pt 2**	**Pt 3**	**Pt 4**	**Pt 5**	**Pt 6**	**Pt 7**
458	Base	5.79	5.86	5.59	6.09	5.32	6.27	2.41
	AltB	5.14	5.77	0.77	5.66	5.32	6.27	2.37
	AltD	3.65	0.39	0.75	5.29	5.31	6.28	2.36
	AltE	5.48	5.86	0.76	5.65	5.32	6.27	2.39
521	Base	8.23	8.55	7.94	8.95	9.68	8.56	5.54
	AltB	6.19	7.87	3.27	8.93	9.69	8.57	5.59
	AltD	4.01	2.93	3.31	8.00	9.75	8.60	5.58
	AltE	7.08	8.58	3.26	8.93	9.68	8.57	5.56
523	Base	8.27	8.26	7.60	8.60	8.43	8.41	6.31
	AltB	6.81	7.88	5.61	8.29	8.45	8.42	6.06
	AltD	5.31	5.64	5.72	7.86	8.51	8.46	5.72
	AltE	7.46	8.27	5.64	8.29	8.46	8.42	6.05

Table 5 Maximum $\mathbf{H_{m0}}$ at slected point locations around the main project areas for SLC_0 for all 4 geometry conditions and all 3 storms.

Maximum H_{m0} (feet NAVD88) Sea Level Condition 1 (SLC_1)								
Storm #	**Geometry**	**Pt 1**	**Pt 2**	**Pt 3**	**Pt 4**	**Pt 5**	**Pt 6**	**Pt 7**
458	Base	6.34	6.34	6.11	6.52	5.52	6.85	2.94
	AltB	5.68	6.24	1.93	6.04	5.53	6.85	2.92
	AltD	2.70	1.71	1.97	5.64	5.53	6.87	2.88
	AltE	6.01	6.33	1.93	6.03	5.53	6.85	2.94
521	Base	8.53	8.75	8.50	9.57	10.07	9.43	6.26
	AltB	6.96	8.40	4.30	9.48	10.09	9.43	6.29
	AltD	4.52	4.12	4.34	8.45	10.17	9.47	6.17
	AltE	7.92	8.77	4.29	9.56	10.09	9.43	6.30
523	Base	8.73	8.66	7.78	8.79	8.80	8.76	6.97
	AltB	7.08	8.22	6.50	8.75	8.82	8.76	6.64
	AltD	6.44	6.57	6.66	8.43	8.90	8.80	6.24
	AltE	7.88	8.67	6.53	8.75	8.83	8.76	6.64

Table 6 Maximum $\mathbf{H_{m0}}$ at slected point locations around the main project areas for SLC_1 for all 4 geometry conditions and all 3 storms.

Conclusions:

A screening level coastal storm surge and wave modeling study has been completed for the Cedar Port feasibility project using the Coastal Storm Modeling System (CSTORM-MS). Three representative synthetic storms from the 660 storms used for the CTX study were simulated and served as proxy storms for the 10-year, 100-year, and 500-year water level annual return interval. Four different geometric mesh configurations were examined: the without-project condition (Base) and three with-project conditions—AltB, AltD, and AltE. The three selected proxy storms and four mesh configurations were simulated using two sea level conditions. The first sea level conditions was set to represent the mean sea level state in the year 2035, which is consistent with the expected completion date of construction. The second sea level conditions represents the 50-year project life date, in year 2085. The 2035 water level including historical steric water level effects was 1.51 feet and the 2085 water level was 2.23 feet. The 24 simulations were then intercompared between the Base conditions and the three with-project alternatives on a storm by storm bases and for each sea level condition (SLC_0 and SLC_1). Comparions were made for maximum water surface elevations and maximum significant wave height results. For all storm events and sea level conditions, the difference in maximum water surface elevations were less than 1 foot and those difference were mostly contained in and around the with-project islands where land elevations had been raised to create the islands. The vast majority of the project area showed less than 0.5 feet of difference in maximum water surface elevations.

The differences in maximum significant wave heights between with- and without-project conditions were of a larger magnitude and for a larger area. The sheltering around and the depth-limited waves over the with-project islands, generally reduced the maximum significant wave heights by between 1 to 4 feet. Higher maximum significant wave heights were observed through the with-project channel cutting through the existing islands and wetlands east of the Houston Ship Channel for alternative D.

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Attachment C-3
Feasibility-Level Ship Simulation Study of Alternative Channels for Cedar Port

Feasibility-Level Ship Simulation Study of Alternative Channels for Cedar Port

Report: May 3, 2024

Prepared for:

Cedar Port Navigation Improvement District (CPNID)

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Simulations Conducted at the Maritime Pilots Institute, Covington, LA

& at the San Jacinto College Maritime Campus, La Porte, TX

Executive Summary

Purpose and Scope

This feasibility-level ship simulation study aims to evaluate the feasibility of alternative ship channels connecting the Houston Ship Channel (HSC) to a proposed container terminal in Cedar Bayou (Cedar Port). Additionally, it seeks to identify potential hazards to ship navigation. The scope of this feasibility study includes five alternative corridors: Alpha, Bravo, Charlie, Delta, and Echo. Each corridor has multiple variations of ship channels that were evaluated for feasibility of navigation. The design test vessel was a loaded Ultra Large Container Vessel (ULCV) with a length overall of 1,202' (366.5m) and a beam of 158' (48.2m) (ULCV 366m). The ULCV 366m is the same ship model as the ULCV test vessel used during the Houston Ship Channel's Project 11 (HSC Project 11).

Methodology

Eight ship pilots took part in this study. They performed 41 ship simulation risk scenarios or runs using a K-Sim Kongsberg Full Mission Bridge ship simulator. The runs focused on arrivals and sailings of the ULCV 366m using various ship channels connecting Cedar Port and the HSC. Environmental conditions were slack water, daylight visibility, and some runs included sustained winds of 15 to 20 knots from the southeast or the north/northwest. Screenshots during each run were taken, and the pilot was debriefed afterward. During the debrief, the pilot was asked to describe how they felt about the run, identify potential hazards to navigation, and assess the overall run on a Green-Amber-Red (GAR) risk assessment scale. Additionally, roundtable discussions with the pilots, research team members, and attendees led to multiple iterative rounds of channel design changes. These discussions also led to the conclusions and recommendations made in this report.

Results

Corridor Echo is feasible for connecting the HSC to Cedar Port. Multiple ship channels were found to be feasible for navigating the ULCV 366m. The feasible ship channels were Echo #1, Echo #2, Bravo #3 Final, as well as Delta 400' and 455' wide variations. Corridor Alpha did not have any ship channels (Alpha 400' or 455' width) that were feasible for navigation by the ULCV 366m. Similarly, Bravos #1, #2, and #3 were also found not to be feasible for safe navigation of the ULCV 366m. Finally, during roundtable discussions with the research team and the pilots, Charlie was found unfeasible for navigation before ship simulations transpired.

Conclusions

The primary conclusion is that a ship channel design in the Echo corridor can be feasible for navigating the ULCV 366m between the HSC and Cedar Port. The pilots found that ship channel Echo #1 was feasible but required cautious and alert ship handling. Multiple potential hazards were identified associated with Echo #1 that need to be addressed during the Preconstruction, Engineering Design phase (PED). The primary hazards were having a constant 5,300' radius turn of 96° in an arcing channel that is 400' wide. Despite navigational challenges and research limitations, the Echo corridor can be feasibly navigated using the ULCV 366m connecting the HSC to Cedar Port.

This research had multiple limitations that should be addressed during the PED phase. This research did not test the following: bathymetry and currents, limited visibility scenarios, other HSC vessel traffic, as well as not testing cargo vessels of various sizes and types other than the ULCV 366m that could call on Cedar Port. This is because the feasibility-level research focused on the geometric space available for navigating a ULCV 366m inside each ship channel.

The following conclusions were based on discussions among and between the pilots, the research team, and attendees. These conclusions are to inform the Cedar Port project going forward into PED.

Channel Design and Layout

1. Echo is a feasible corridor for designing a ship channel connecting HSC to Cedar Port for navigating a ULCV 366m.
2. Alternative ship channels Echo #1, Echo #2, Bravo #3 Final, and Delta (both 400' and 455' wide versions) are all feasible for navigation from the HSC to Cedar Port.
3. Each feasible ship channel has multiple potential hazards that need to be addressed during the PED phase when developing the optimum ship channel. The results section of this report identifies these potential hazards, which are reflected in the GAR scores associated with each run.

Tugboats (Tugs)

4. The tugboats used in this research had 75 tons of bollard pull. Even with all four tugs assisting, they were underpowered in 15kn sustained winds when attempting to turn the ULCV 366m in the turning basin, as well as undocking the vessel from the berths.
5. To effectively work at 90° from the ULCV 366m, tugs require at least 75' of hawser.
6. Tugs will have limited capability to assist the ULCV 366m in a 400' wide ship channel. This issue is especially evident for channel layouts with a 400' wide continuous arcing turn.

Piloting Operations

7. The maximum sustained wind for safe navigation of the ULCV 366m was 15kn. A 20kn wind is over the HPA's guidelines for this vessel size.
8. The Houston Pilots currently back vessels to the dock at Barbours Cut from Morgan's Point, which is 0.5 to 0.6 nautical miles (nm). Thus, Cedar Port's proposed Berths #3 and #4, with a distance of 0.7 nm, are similar in backing distance.

Echo Corridor

9. The proposed turning basin for Corridor Echo on the north side of Cedar Port has a diameter of 1,500' (457m). The turning basin for Bayport is 100' wider with a diameter of 1,600' (488m) and has extra water at the LBC 5 area to assist the turn.
10. For Corridor Echo, the Berthing Area is 300' wide, and the Berthing Area Access Channel is 400' wide, for a total of 700' between the berthing fenders and the parallel bank. When the tugs worked on a 90° while backing down or driving out of the terminal basin design, they often crossed the bank parallel to the berths.
11. The runs in Echo #1 required a high cognitive load from the pilots, requiring constant and alert ship handling to navigate the channel safely.
12. For Echo #1, arrivals using the ULCV 366m from the HSC to a berth in Cedar Port took about 60 minutes. This includes up to 15 minutes in the constant arcing turn and up to 15 minutes to turn the ship in the turning basin. Sailings took about 40 minutes to complete. Thus, the pilots reported mental fatigue after piloting Echo #1, especially after an arrival.

13. A ULCV 366m loitering in Echo #1 while waiting for piloted vessels to transit the HSC was feasible, but a wider channel would make this practice safer.
14. Echo #1's best practices for piloting required a constant 6° rate of turn per minute for the continual 5,300' arc radius turn for approximately 15 minutes as the complete turn is 96° from the HSC.
15. Echo #1 is 400' wide and requires the pilot to drive the ULCV 366m's pivot point on the centerline rather than the bow due to the leeway or drift angle of the ship. This is especially the case when experiencing 15kn sustained winds that can increase the drift angle of the ULCV 366m.
16. In Echo #2, a ship attempting to turn at the widener connecting the two legs could require tug assistance.

Delta Corridor

17. For Delta, the 455' wide alternative channel was rated safer and preferred by the pilots over the 400' wide version.

Recommendations

Channel Design and Layout

1. The optimization of a ship channel during PED should explore various navigation philosophies, such as straightaways, turn wideners, and other geometry of the channel's turns. Additionally, adjustments to the proposed turning basin, including flares, siting, and diameter, should be considered.
2. The flared entrance from HSC to Echo #1 needs to be widened.
3. The entrance from Echo #1 to the turning basin needs to be widened.
4. The channel design should allow a piloted ship to lay alongside a bank when experiencing an emergency aboard the vessel (such as losing power) or during adverse weather conditions, such as 20kn winds.
5. Federal Aids to Navigation (ATONs), including buoys, lights, and especially ranges, are necessary to demarcate the channel and assist in navigation.
6. The turning basin must be wide enough for the ULCV 366m to safely maneuver using "back and fill" to control their pivot point.
7. Delta's 400' wide version requires wideners to make the turns safer.

Tugs

8. A tug shelf along the edge of the ship channel should be considered to allow the tugs to work alongside the ship and assist with turns inside the channel.
9. For Echo #2, the design of a turn widener should have enough space for tugs to provide direct/indirect pull in both inbound and outbound directions.
10. The terminal basin should be wide enough so that there is sufficient room for the tugs to work on a 90° while the ULCV 366m is backing down or driving out.
11. Tugboats with up to 100 tons of bollard pull should be considered, particularly during winds of 15kn, to safely assist the ULCV 366m.

Pilot Operations

12. Two pilots are required for arrivals or sailings of the ULCV 366m.
13. Arrivals and departures will require the utilization of a Portable Pilot Unit for navigating the ULCV 366m.

Disclaimer

Locus conducted this feasibility-level research for the Cedar Port Navigation Improvement District (CPNID). as an independent study assessing the piloted navigation of alternative corridors and ship channel designs connecting the HSC to Cedar Port. This is feasibility-level research. Due to limited time, resources, and budget, only six days of ship simulations were conducted to evaluate the various corridors and alternative ship channels. This feasibility-level research did not consider many factors, such as bathymetry, currents, existing HSC piloted and non-piloted vessel traffic, limited visibility, and types of vessels other than the ULCV 366m. Also, most of the runs did not include wind. The assumptions made for the testing program are consistent with U.S. Army Corps of Engineers policy for Feasibility-Level Ship Simulations. This is explained further in the report.

This research aimed to inform, stimulate, and solicit pilot input on the proposed corridors and channel alternatives utilizing various risk scenarios tested in a ship simulator and during roundtable discussions. The ship pilots who participated in this research included retired pilots who were private contractors to Locus as well as members of the Houston Pilots Association (HPA) Safety Committee. The opinions and recommendations shared in this report do not represent the official opinion of the HPA Safety Committee nor the policy of the HPA. This report and other information are anticipated to be used to inform and advise the HPA Safety Committee in their policy advisement to the HPA concerning Cedar Port.

Table of Contents

Table of Figures

Locus

Table of Ship Simulation Runs

Introduction

This feasibility-level ship simulation study aims to evaluate the feasibility of alternative ship channels connecting the Houston Ship Channel (HSC) to a proposed container terminal in Cedar Bayou (Cedar Port). Additionally, it seeks to identify potential hazards to ship navigation. The scope of this feasibility study includes five alternative navigation corridors: Alpha, Bravo, Charlie, Delta, and Echo. Each navigation corridor has multiple variations of ship channels that were evaluated for feasibility of navigation. The design test vessel for this study was a loaded Ultra Large Container Vessel (ULCV) with a length overall of 1,202' (366.5m) and a beam of 158' (48.2m) (ULCV 366m). The ULCV 366m is the same ship model as the ULCV test vessel used during the Houston Ship Channel's Project 11 (HSC Project 11).

A research team was organized by Locus LLC (Locus), commissioned by CPNID to conduct this study. The study utilizes risk scenarios to reflect real-life circumstances that ship pilots could encounter when piloting a ULCV 366m in the alternative corridors and ship channels connecting the HSC to Cedar Port. These scenarios were tested using the K-Sim Kongsberg Full Mission Bridge ship simulator at the Maritime Pilots Institute in Covington, Louisiana, and the three interactive ship simulators at the San Jacinto Maritime College in LaPorte, Texas (SJCC). Each risk scenario was assessed based on empirical protocols developed before the ship simulations and with additional input from the pilots during the ship simulations. The assessments of the risk scenarios, along with roundtable discussions with the pilots, led to the conclusions and recommendations in this report.

Study Overview

The study was conducted iteratively and collaboratively in two parts over one year. The first part of the feasibility-level ship simulation study was the ship simulations conducted in August 2023 at the Maritime Pilots Institute in Covington, Louisiana (Covington simulations). This research was conducted over four days to evaluate the feasibility of alternative corridors Alpha, Bravo, and Delta, including alternative ship channels in each corridor. The two contracted pilots were instructors for the Maritime

Pilots Institute. They were both involved in training Houston Pilots for handling a 366m class ULCV as part of the Houston Ship Channel's Project 11 (HSC Project 11).

The primary finding of the Covington simulations was that the ship channel alternative Bravo #3 Final was feasible for navigating the ULCV 366m from the HSC to Cedar Port. This information was reported to CPNID in September 2023. However, in subsequent conversations with USACE regarding the Bravo #3 Final findings, the USACE requested the project to study a different corridor connecting the HSC to Cedar Port. What was proposed was moving the layout of Bravo #3 Final to the north into a different corridor, which led to the development of Echo #1. Echo #1 was explored and discussed during tabletop meetings with the USACE, government agencies, and stakeholders, as well as with members of the Houston Pilots Association (HPA).

The second part of the study focused on ship simulations to evaluate the feasibility of an Echo Corridor, including alternative ship channels, Echo #1 and Echo #2. This feasibility-level research took place in 2024. It involved a roundtable meeting with CPNID, research team members, and HPA's leadership in February 2024. This informed the development of the ship simulation feasibility study conducted in April 2024 at the San Jacinto College Maritime Campus in La Porte, TX (San Jacinto simulations). Current members of the HPA Safety Committee took part in two days of ship simulations, testing the feasibility of Echo #1 and Echo #2. Both parts of the study were feasibility-level ship simulations.

Feasibility-Level Ship Simulations

Locus conducted Feasibility-Level Ship Simulations (FLSS) to evaluate alternative ship channels (Alpha, Bravo, Delta, and Echo) connecting the HSC to Cedar Port. FLSS was implemented by the U.S. Army Corps of Engineers (USACE) Engineering and Development Center (ERDC) in 2016 to provide a means of screening proposed channel improvements before the Preconstruction Engineering Design (PED) phase. This process is described by Webb, Shelton, and Martin (2019)[1] and Martin et al (2021)[2].

FLSS is consistent with USACE's SMART Planning, which was introduced in 2012 for conducting feasibility-level studies.[3] USACE SMART Planning is a streamlined approach for project development and decision-making intended to improve and streamline feasibility studies. SMART is an acronym for Specific, Measurable, Attainable, Risk-informed, and Timely. This planning methodology aims to deliver feasibility studies and projects more efficiently and effectively, focusing on clear goals and feasible outcomes within constrained timelines and budgets. FLSS was developed to allow sponsors, USACE districts, and stakeholders the ability to screen or vet alternative projects. According to the Water Resources Development Act of 2018 Section 1152, "which authorizes non-Federal interests to undertake feasibility studies of water resources development projects for submission to the Secretary" (USACE Memo, May 2019)[4]. Thus, Locus, working with CPNID and other research team members, conducted an FLSS to evaluate alternative ship channels connecting the HSC to Cedar Port.

FLSS was not developed to replace robust simulation testing of design alternatives, which will occur during the PED phase. FLSS is simplified ship simulation testing to vet

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[1] Webb, Dennis W., Shelton, Timothy W., and S. Keith Martin. (2019). "SMART Planning Requires Smart Modeling: Getting the Most Value for Your Ship Simulation Dollar." Paper presented at ASCE Ports Conference, Pittsburgh, PA. Retrieved from: https://ascelibrary.org/doi/10.1061/9780784482629.019

[2] Martin, S. Keith, Johnston, Morgan M., Pazan, Kiara I., Sanchez, Mario J., Allison, Mary Claire, and Gary Lynch. (2021). "Screening Channel Design Alternatives Using Ship Simulation." *Journal of Waterway, Port, Coastal, and Ocean Engineering,* Volume 147, Issue 5. Retrieved from: https://ascelibrary.org/doi/abs/10.1061/%28ASCE%29WW.1943-5460.0000659

[3] Webb, Shelton, Martin (2019).

[4] USACE. (May 2019). "Implementation Guidance for Section 1152 of the Water Resources Development Act of 2018, Studies of Water Resources Development Projects by Non-Federal Interests." Retrieved from: https://planning.erdc.dren.mil/toolbox/guidance.cfm?Option=WRDALaw&Side=No&Type=WRDA%20Implementation

navigation design alternatives. Simplifying the simulations occurs in three key areas: inputs to the ship simulator, the focus of the simulation testing, and results and reporting. The assumptions made for the Cedar Port FLSS in these three areas are as follows.

Inputs to the Ship Simulator

The inputs to the ship simulator for FLSS purposes were simplified, and multiple assumptions were made concerning pilots, visual databases, bathymetry, and currents. Additional inputs to the ship simulator, such as the ship models, assist tugboats and environmental conditions, are described in this report's methodology section.

Pilots: Typically, pilots licensed for the project area are used for FLSS research. However, no pilots have experience bringing ships to Cedar Port as it is currently only designed for barge traffic. Instead, during the Covington simulations, the feasibility of Corridors Alpha, Bravo, and Delta and their various channel alternatives were evaluated using two recently retired pilots who are instructors at the Maritime Pilots Institute. Both pilots have decades of experience piloting cargo and other ships in channels and are familiar with the HSC. They both took part in the training of Houston Pilots to utilize the design test vessel, 366m class ULCV, for HSC Project 11. While neither pilot was an active Houston Ship Pilot, the Houston Ship Pilots were informed and accepted their participation in the study. The two pilots were Captain Jim Concagh, who retired from the Houston Ship Pilots in 2022 after 24 years of service, and Captain Stuart Lilly, who retired from the Biscayne Bay (Miami) Pilots in 2017 after 25 years of service. Six active members of the HPA Safety Committee participated in the ship simulations during the San Jacinto simulations.

Visual Databases: The visual scene used for the HSC Project 11 study was modified to include the proposed container terminal, Cedar Port, and various alternative channels with accompanying proposed Federal Aids to Navigation (ATONS). The ATON layouts were developed by Locus to mark each channel and were used by the pilots.

Bathymetry: Detailed bathymetry was not included in the simulation databases. However, basic bank forces were added alongside each alternative channel. The bottom depths in the channels were adapted using tidal water to accommodate the design test vessel, the 366m class ULCV. This is because the bottom depth used in HSC Project 11 was 46.6' (14.2m), but the loaded ULCV 366m draft is 49.8' (15.2m). For HSC Project 11, +4.9' (+1.5m) of tidal water was added to accommodate the ULCV 366m. The table below shows the project bottom depths used in the databases and the amount of added tidal water for the total water depth. This is consistent with the HSC Project 11 ship simulations using the ULCV 366m.[5]

Table 1. Project Bottom Depths Used

Ship Simulations Database	Bottom Depth	Tidal Water	Total Water Depth
HSC Project 11	46.6' (14.2m)	+ 4.9' (+1.5m)	51.5' (15.7m)
Covington Simulations (Part 1)	46.6' (14.2m)	+ 4.9' (+1.5m)	51.5' (15.7m)
San Jacinto Simulations (Part 2)	46.6' (14.2m)	+ 4.9' (+1.5m)	51.5' (15.7m)

Currents: No currents were included in the FLSS simulations. During multiple meetings, members of the HPA indicated that the currents in the project area are small and that they are not highly concerned about tidal currents. Therefore, slack tide, with no currents, was used as this realistic condition occurs twice daily in Galveston Bay. Running at slack tide provides a realistic and consistent condition for comparing alternative channels. If an alternative channel does not provide adequate navigation during slack tide, it is highly unlikely that adding currents will improve the feasibility of navigation.

Simulation Testing

The ship simulation testing for an FLSS does not follow the more rigorous methodology used during the PED phase. During FLSS testing, a ship simulation run is conducted and then discussed among the pilots and researchers. A simulation matrix was developed as a basic guide for Cedar Port. However, it is typical for a FLSS testing program

[5] Martin, S. Keith, Johnston, Morgan M., Pazan, Kiara I. Sanchez, Mario J., Allison, Mary C., Daggett, Larry L., Hewlett, Chris, Webb, Dennis W., and George Burkley. (October 2021). "Houston Ship Channel Expansion Improvement Project – Navigation Channel Improvement Study." Retrieved from: http://dx.doi.org/10.21079/11681/42342

to deviate from the matrix if deemed appropriate. This was the approach as the testing program was modified iteratively daily with input from the pilots, engineers, and research team and informing the client throughout.

Results and Reporting

Consistent with the USACE's FLSS process, engineering, and statistical data were not collected during and after each run. Instead, only qualitative data was collected and analyzed, along with some clearance distances. Qualitative data includes images of a vessel's path taken from the ship simulator instructor's station during and immediately after each run, which are included in the analysis of each individual run in this report. As stated in Martin et al. (2021), the analysis and recommendations come from two sources: notes taken throughout the testing program and elicitation from the mariners participating in the study.

Research team member Dennis Webb presented the FLSS approach for Cedar Port described above to the USACE Galveston District and ERDC on August 16, 2023. At the meeting, Kiara Paza and Shannon Stever represented ERDC, Mohammed Islam and Himangshu Das represented USACE Galveston District, and Clayton Henderson represented the sponsor CPNID. All participants agreed with the FLSS approach. ERDC's Shannon Stever attended in person and observed two days of the FLSS on-site at the Maritime Pilots Institute in Covington, Louisiana.

Methodology

This study used mixed methods. Qualitative empirical data and local subject matter experts' opinions were collected and assessed to evaluate the navigational feasibility of the alternative channels. The research team members, the pilots and tug masters who participated in the ship simulations, and those who attended the ship simulations are listed below, along with their organizational affiliations and roles.

Table 2. Research Team Members, Ship Simulation Participants and Attendees

Research Team Members		
Name	**Organizational Affiliation**	**Role**
George Burkley, MSc	Locus	Project Manager, Facilitator
Fernando Lagunes	Locus	Simulator Technician and Modeler
Anderson Russell	Locus	Simulator Operator
Dennis Webb, PE, DNE	Webb Simulation Consulting LLC, USACE (Retired)	Channel Design Engineer
Bryan Elliott	San Jacinto College, Maritime Campus	Simulator Technician and Operator
John Gregg	San Jacinto College, Maritime Campus	Simulator Operator
Jonathan Pierce, PhD	Alaska Safeguard Marine LLC	Research Lead
Pilots and Tug Masters		
Capt. Matt Glass	Second Officer, HPA Safety Committee	Pilot
Houston Ship Pilot	HPA Safety Committee	Pilot
Houston Ship Pilot	HPA Safety Committee	Pilot
Houston Ship Pilot	HPA Safety Committee	Pilot
Houston Ship Pilot	HPA Safety Committee	Pilot
Houston Ship Pilot	HPA Safety Committee	Pilot
Capt. Jim Concagh	Locus, Retired Houston Ship Pilots	Pilot
Capt. Stuart Lilly	Locus, Retired Biscayne Bay (Miami) Pilots	Pilot
G&H Tug Master	G&H Towing	Tug Master
G&H Tug Master	G&H Towing	Tug Master
Charles Mitchell	Port Captain, G&H Towing	Tug Master
Ship Simulation Attendees		
Clayton Henderson	CPNID	Client
Shannon Stever	ERDC, USACE	Observer
Michael Curtiss	HPA	Observer
JJ Plunkett	Chief Operating Officer, HPA	Observer
Chris Guy	Lanier Engineering	Engineer
Richard Mestayer	Lanier Engineering	Engineer
Steve Cappellino	AnchorQEA	Engineer

Alternative Corridors and Ship Channels

Five alternative corridors (Alpha, Bravo, Charlie, Delta, and Echo) were developed for the FLSS to connect the HSC to Cedar Port. Each corridor had a unique layout and included multiple variations of ship channels, except for Charlie. Chris Guy and the engineers at Lanier & Associates Consulting Engineering (Lanier Engineering) provided the alternative corridors and ship channels to the research team. Each corridor had at least one ship channel with 400' wide alignments.

Additionally, 455' wide alignments for Alpha, Bravo, Delta, and Echo were developed. The wider 455' alignments for Alpha and Delta were tested during ship simulations but not for Bravo and Echo. For the 455' versions, Mr. Dennis Webb widened the 400' channel alternatives created by Lanier Engineering and modified how each alternative channel transitioned into the HSC. In the figures of each channel, the blue identifies the 400' wide and the orange the 455' wide version. The 400' width was based on input from the Houston Pilots during a preparatory meeting as the minimum feasible width for the ULCV 366m. At the same time, the 455' was selected because that is the existing width of the Bayport "Land Cut" channel leading to the Bayport Container Terminal in Bayport, TX. The Bayport Land Cut channel was planned and designed for 366m class ULCVs. Figure 1 represents the basic layout of the five navigation corridors. This figure does not include the channels developed and tested for Bravo (Bravos #1, #2, #3, and #3 Final) or Echo (Echo #1, Echo #2) developed iteratively during the study.

Each alternative channel was submitted to LOCUS's ship simulator modeler and research team member, Mr. Fernando Lagunes. Mr. Lagunes formatted each alternative channel for the K-Sim Kongsberg ship simulators in Covington, LA, and La Porte, TX. He also took part in the vetting and troubleshooting of the databases, along with other research team members, to ensure the channel databases were valid and operational.

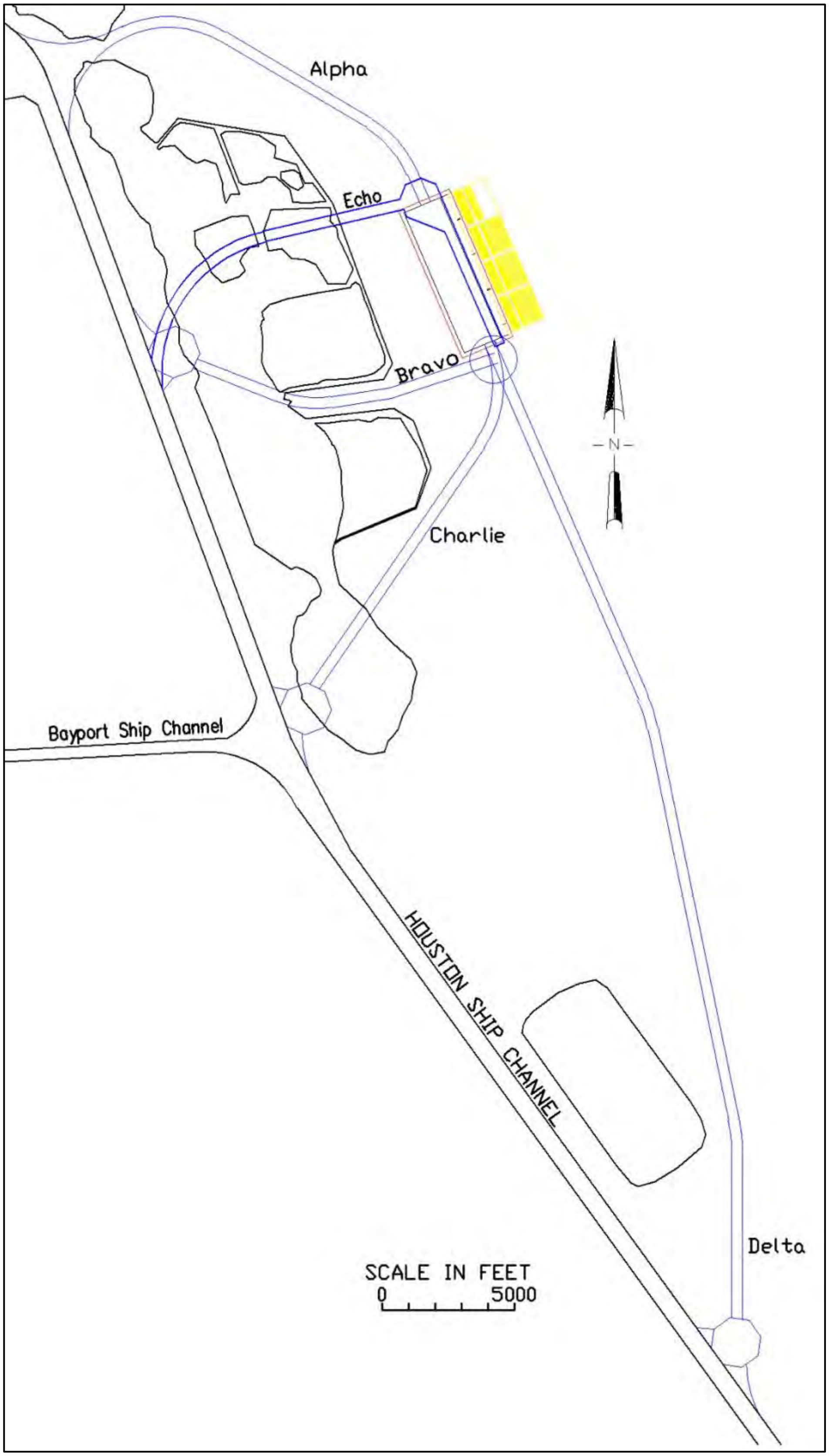


Figure 1. Five Alternative Corridors Connecting the HSC to Cedar Port

The alternative corridors from north to south have the following basic layout:

- **Alpha:** Alpha is the furthest north across from Barbours Cut along the HSC. It has a flared entrance entering a long arcing turn to the east, a straightaway, and a second turn before entering the terminal basin from the north. It is about 4 miles long.
- **Echo**: Echo cuts through Atkinson Island about 3 miles north of Bayport. It requires a turn to the northeast, then a straightaway entering a turning basin to the north of the terminal basin. It is about 2.5 miles long.
- **Bravo:** Bravo intersects Atkinson Island along the HSC. It requires a turn to the southeast, then a straightaway entering a turning basin south of the terminal basin. It is about 3 miles long.
- **Charlie:** Charlie (not tested) is across from the Bayport Ship Channel along the HSC. It has a turning basin, then a long straightaway to the northeast, and then a turn into a turning basin to the south of the terminal basin. It is about 3 miles long.
- **Delta**: Delta is the furthest south, starting near the South Boat Cut Channel on the HSC. It has a turning basin leading to three straightaways connected by two bends connecting to the south end of the terminal basin. It is about 8 miles long.

Below is a more detailed description of each channel and figures of the channel's design and charted route.

Alpha

The layout of Corridor Alpha is across from Barbours Cut in the HSC. Two alternative ship channels were developed: a 400' wide alignment and a 455' wide alignment. Both versions of Alpha are 3.9 miles long. The description of the turns and distances are based on a route from the HSC on the centerline to Cedar Port: HSC entry into the channel requires a continuous motion turn of 140° (from heading 342° to 122°) over about 2 miles. The straightaway in the channel is 1.3 miles long and requires a course correction of 5° (from heading 122° to 127°). The final turn in the channel requires a 29°

turn (from heading 127° to 156°) in just 2,100'. Then, it is a straightaway of 0.4 miles from the last turn into the terminal basin at heading 156°. This is depicted in the figures below.

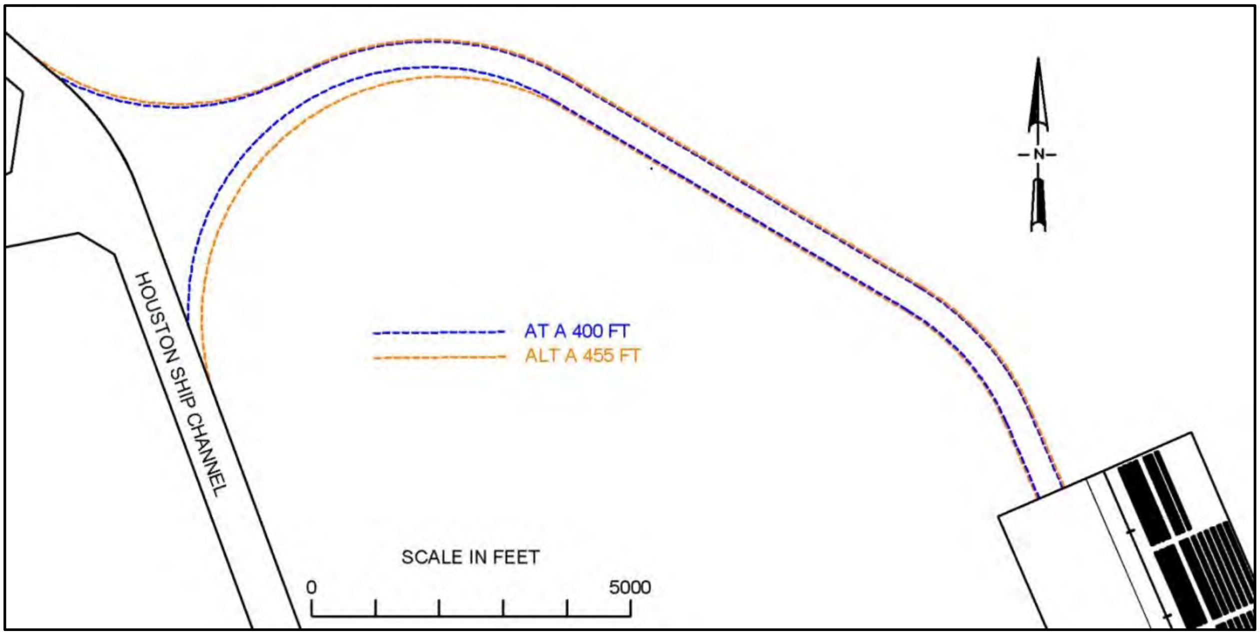


Figure 2. Corridor Alpha with ship channels 400' and 455'

Figure 3. Alpha Charted Route

Echo

The Corridor Echo layout cuts through Atkinson Island between the HSC and Cedar Port. Two alternative ship channels were developed: Echo #1 and Echo #2. Echo #1 is about 3 miles north of Bayport and approximately 6,700' north of the previously tested Bravo #3 Final. The description of the turns and distances are based on a route from the HSC on the centerline to Cedar Port: Echo #1 is designed with a 5,300' radius to turn from a heading of 342° in the HSC to a heading of 078° in the channel's straightaway heading into the turning basin. This requires a constant arcing turn of 96° over approximately one mile (5,300'). The channel is 400' wide. It has a turning basin that is 1,500' in diameter and connects to the terminal basin from the north. Bravo #3 Final had a similar arcing turn but entered the terminal basin from the south. It should also be noted that the proposed Container Terminal has been shifted approximately 70' to the east compared to what was tested during the Covington simulations.

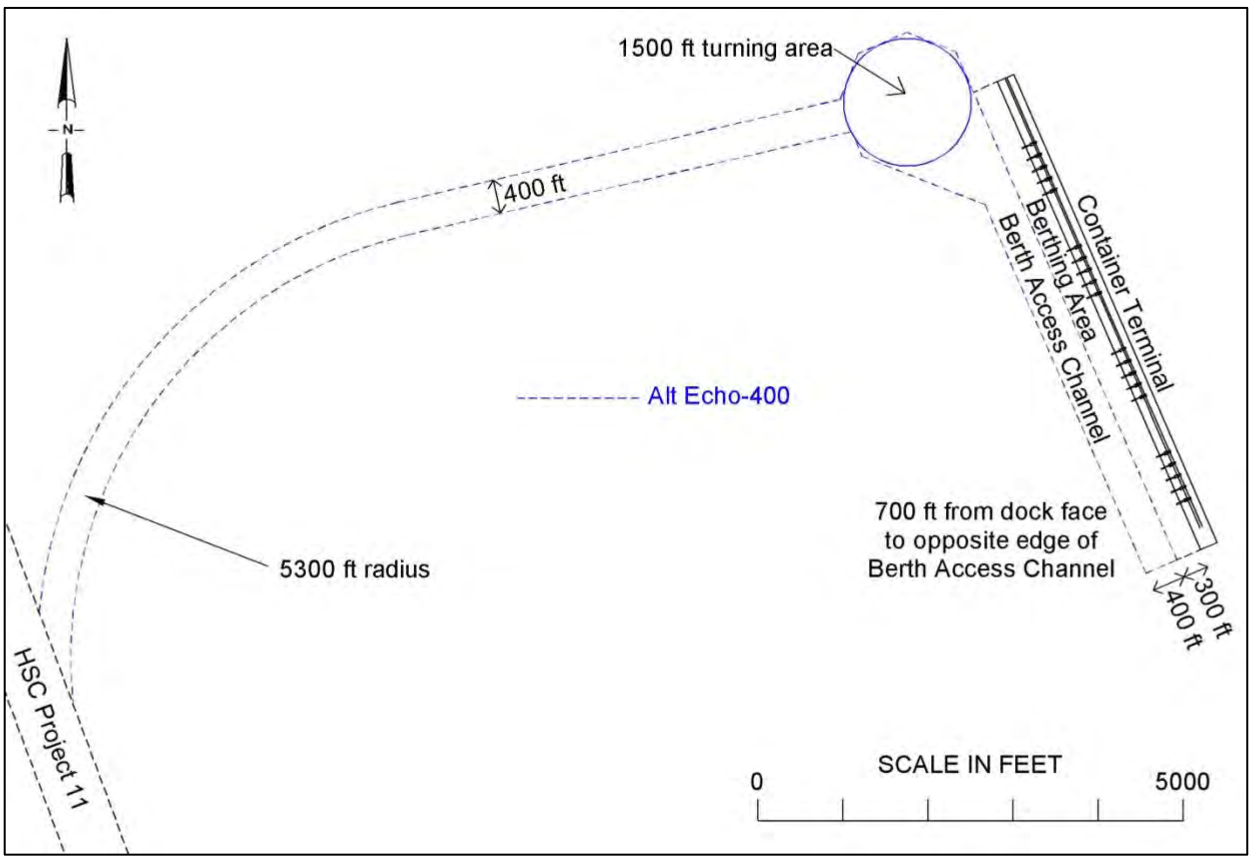


Figure 4. Echo #1, with 5,300' radius turn

At the end of the second day of San Jacinto simulations, the research team working with the pilots and attendees, including the client and engineers, discussed alternative philosophies for navigating the HSC and Cedar Port corridor. One idea was to change the continuous arcing turn into two straightaway courses connected by a turn widener. This alternative design approach was called Echo #2. It allows the ULCV 366m to depart the HSC using a single assist tug engaged in active escort astern, passing through a short navigation flare while turning to align the ship on a set of ranges with a northeast heading (024° true). The ship then proceeds on heading 024°T for approximately two ship lengths from the HSC flare into a 400' channel, then into a turn widener. In the turn widener, the pilot turns the ship to the east to heading 078°T into the final 400' wide channel straightway leading to the turning basin north of Cedar Port. The purpose of Echo #2 was to provide an alternative navigation philosophy from the continuous arcing turn of Echo #1.

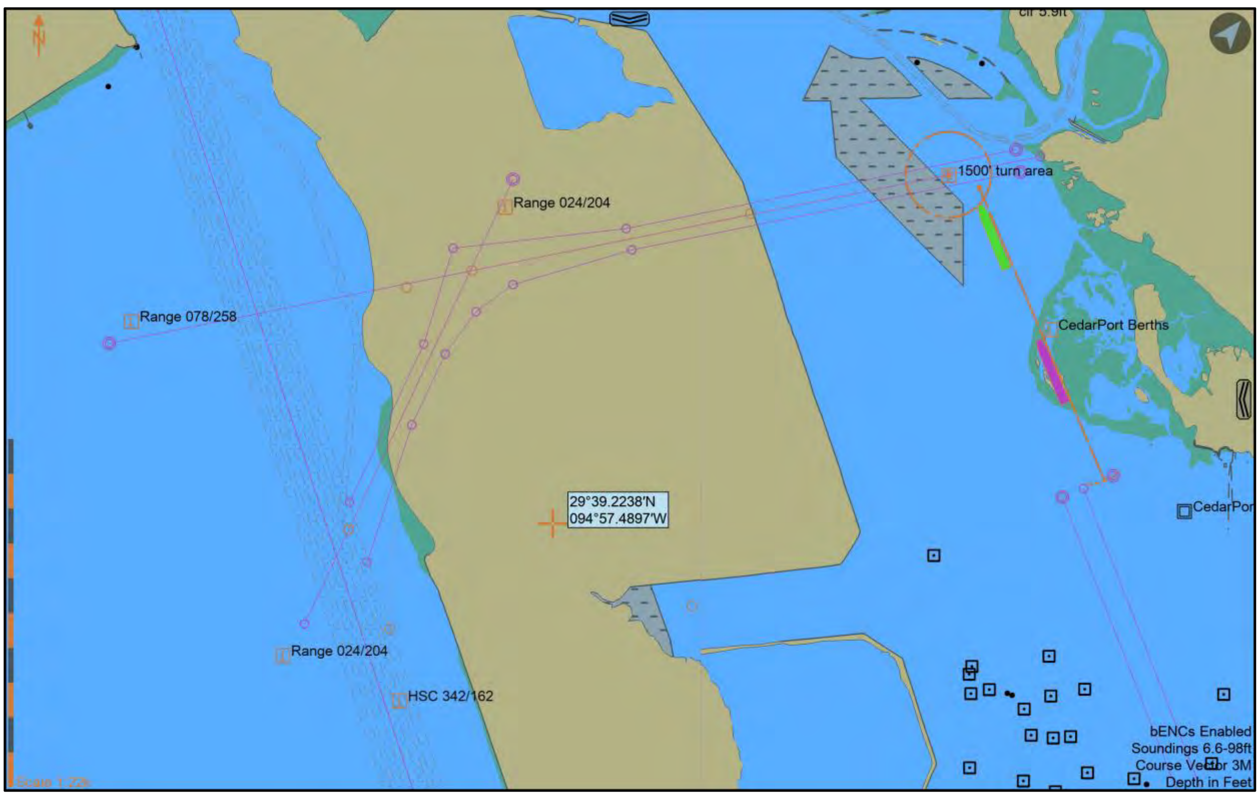


Figure 5. Echo #2 Charted Route with ranges on heading 024° and 078°

Bravo #1

Bravo #1 is 2.8 miles long. The centerline route from the HSC entry into the channel requires a 132° turn (from heading 342° to 114°) in 0.4 miles. Once a ship enters the channel, there is a continuous motion turn of 31° over about 1.5 miles. Then, there was one final course correction of 9° (from heading 083° to 074°) in 0.4 miles to enter the turning basin at heading 074°. Once the ship entered the turning basin to the south of the terminal, the ship needed to use tugboats to make a 95° turn (from heading 074° to 339°) to enter the terminal basin. Only the 400' version of the channel was tested.

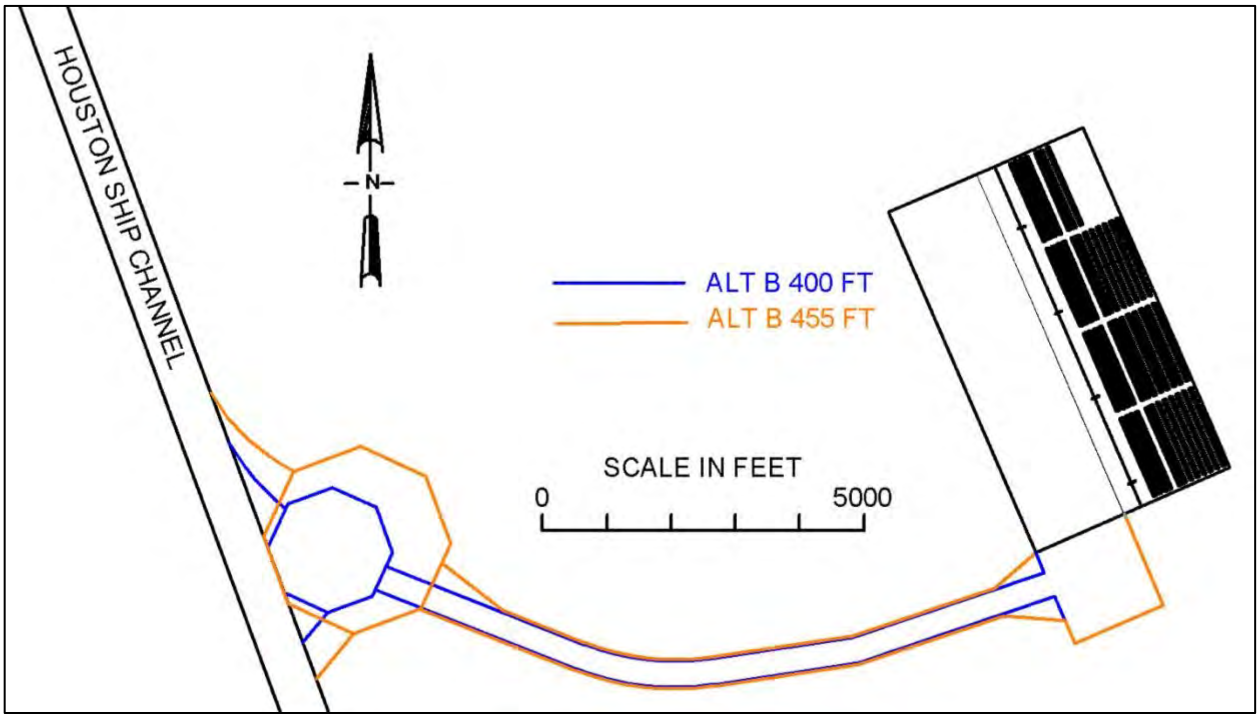


Figure 6. Bravo #1 with 400' and 455' options

Figure 7. Bravo #1 Charted Route

Bravo #2

Bravo #1 is 2.2 miles long and was adapted into Bravo #2 to reduce the 122° turn from the HSC to the channel and remove the 31° turn inside the channel. These turns were identified as potential hazards to the feasible navigation of a ULCV 366m. Instead, the channel was designed to be straight from the HSC to a turning basin south of the terminal basin. Bravo #2 requires a 91° turn (heading from 342° to 073°) from the HSC to the channel. Once inside the channel, it is straightaway for 2 miles before ending in the turning basin. Only the 400' wide version of this channel was tested.

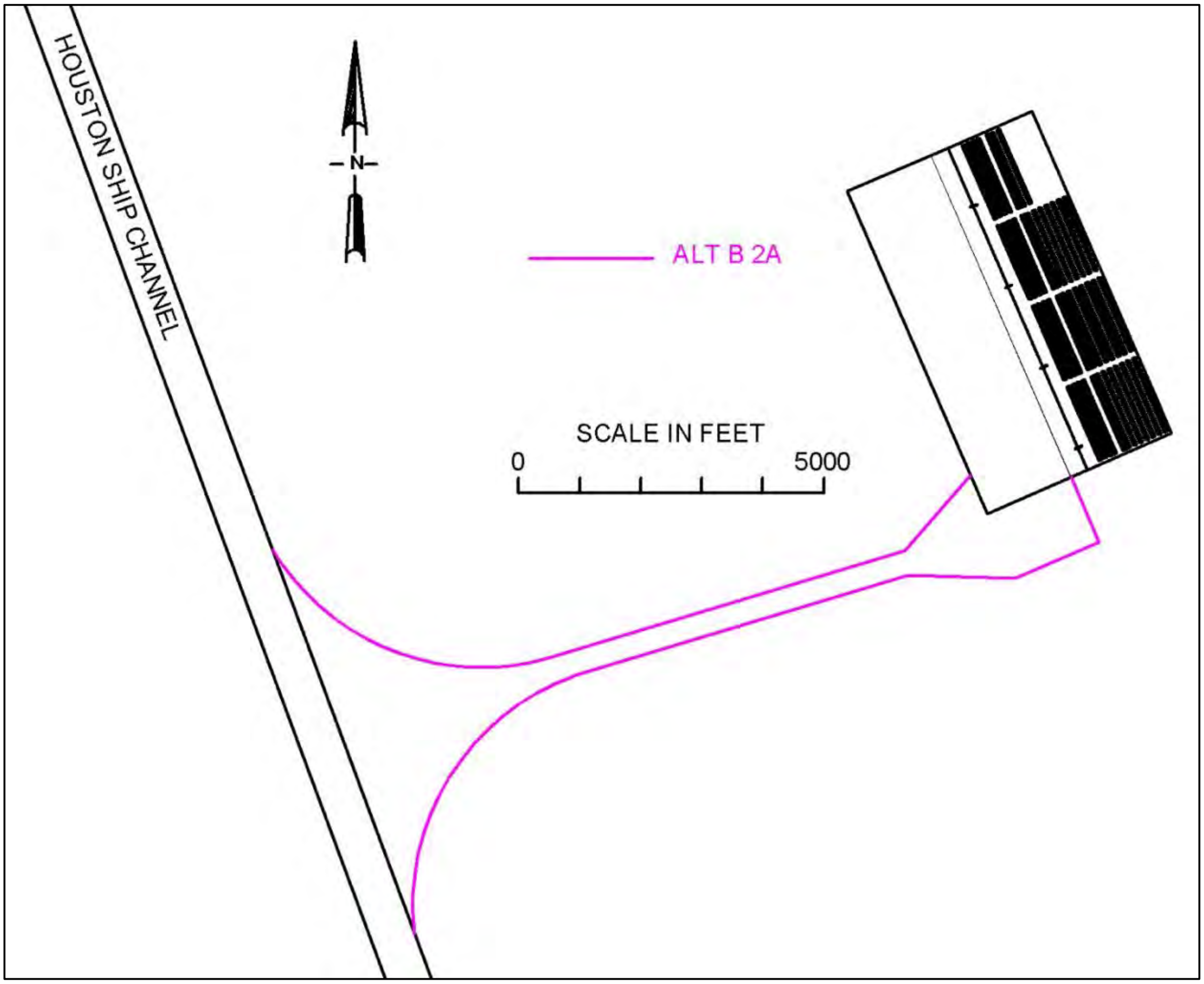


Figure 8. Bravo #2 Design

Figure 9. Bravo #2 Charted Route

Bravo #3

Like Bravo #2, the straightened channel was designed to prevent the ship from encountering the banks due to the long, continuous, arcing turns requiring sustained rates of turn from the HSC to the Cedar Port channel. Bravo #3 was 2.4 miles long, requiring a turn of 66° from heading 342° in the HSC to heading 048° in the channel. This turn is similar to the 57° turn into Bayport from the HSC. However, Bayport benefits from a large flare and a widener of the HSC, with a bank on only one side of the ship, which allows pilots to get the ship to a better angle when transiting into or out of the Bayport Ship Channel. Only the 400’ wide version of the Bravo #3 channel was tested.

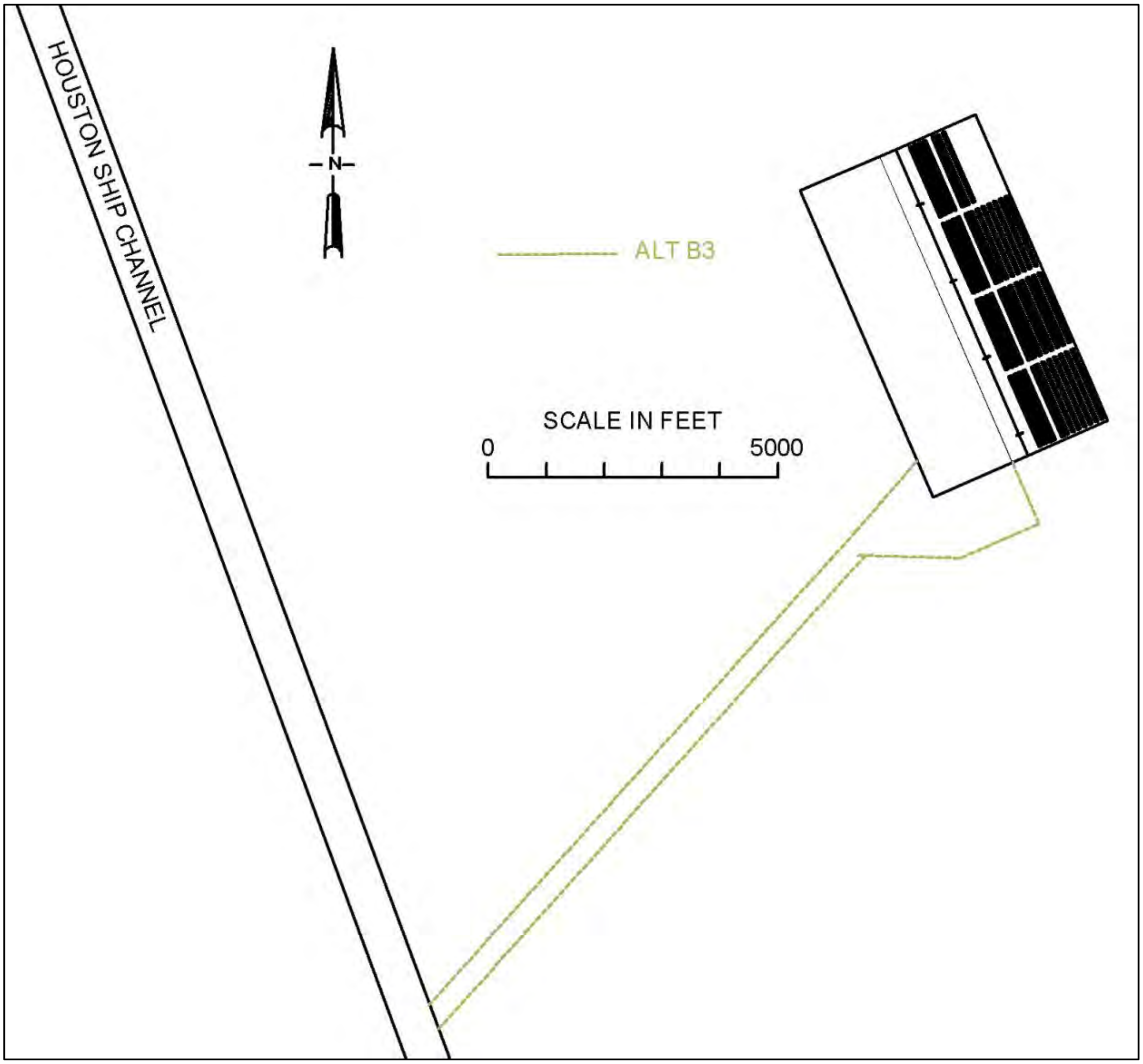


Figure 10. Bravo #3 Design

Figure 11. Bravo #3 Charted Route

Bravo #3 Final

Bravo #3 Final was the last iteration of trying to develop alternative channels in the Bravo Corridor. Bravo #3 Final is about 3.6 miles long. The continuous motion turn from the HSC into the channel was divided into three segments. The first segment from the HSC into the flared entrance of the channel requires a 15° turn (from heading 342° to heading 357°) in 0.9 miles. Then, the second segment requires a 66° turn (from heading 357° to heading 063°) in 0.9 miles. This is the same degree turn as Bravo #3 but is less acute, allowing a ship to complete the turn more easily under its own power and rudder rather than needing to stop the ship and turn the vessel using tugboats. Then, the final straightaway segment into the turning basin south of the terminal basin requires a 12° course correction (from heading 063° to heading 075°) in 1.2 miles. Only the 400' wide version of this channel was tested.

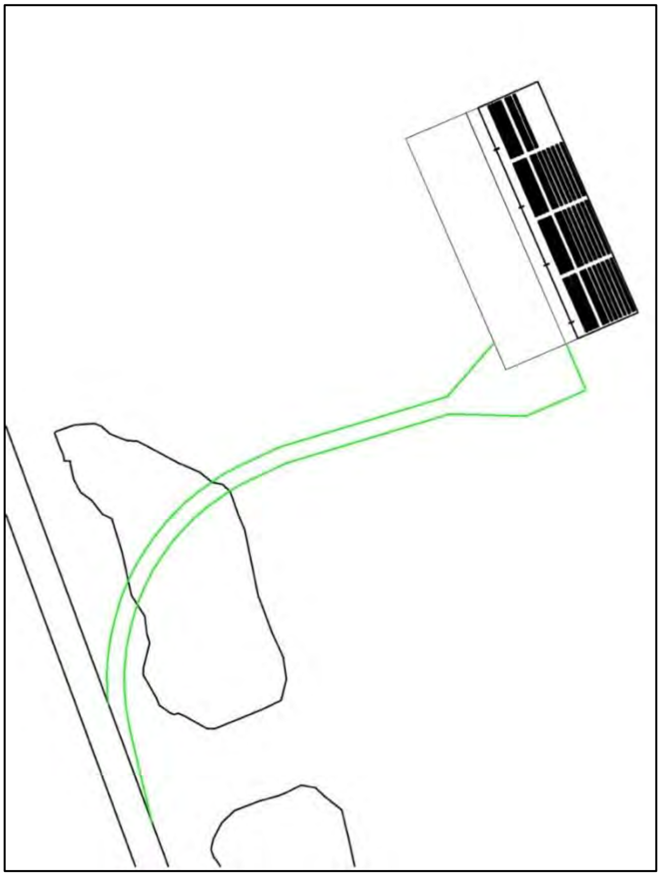


Figure 12. Bravo #3 Final Design

Figure 13. Bravo #3 Final Charted Route

Charlie

Charlie is 3.3 miles long. The centerline route from the HSC entry into the channel requires a 55° turn (from heading 342° to 037°) made in a turning basin off of the HSC across from the Bayport Ship Channel flared entrance. Once a ship enters Charlie, it is about 2.6 miles to the turn into the terminal basin. The turn is 39° turn (from heading 037° to 358°) from the channel into the terminal basin. While this channel was developed, its feasibility was not assessed using the ship simulator. This was based on a conversation between the client and the pilots. The channel was deemed unfeasible due to joining the HSC across from the Bayport Ship Channel, which is a potential hazard to ship traffic. Additionally, there is a requirement for a large turning basin at the HSC intersection along with its difficult turns. Only the 400' wide version of this channel was considered.

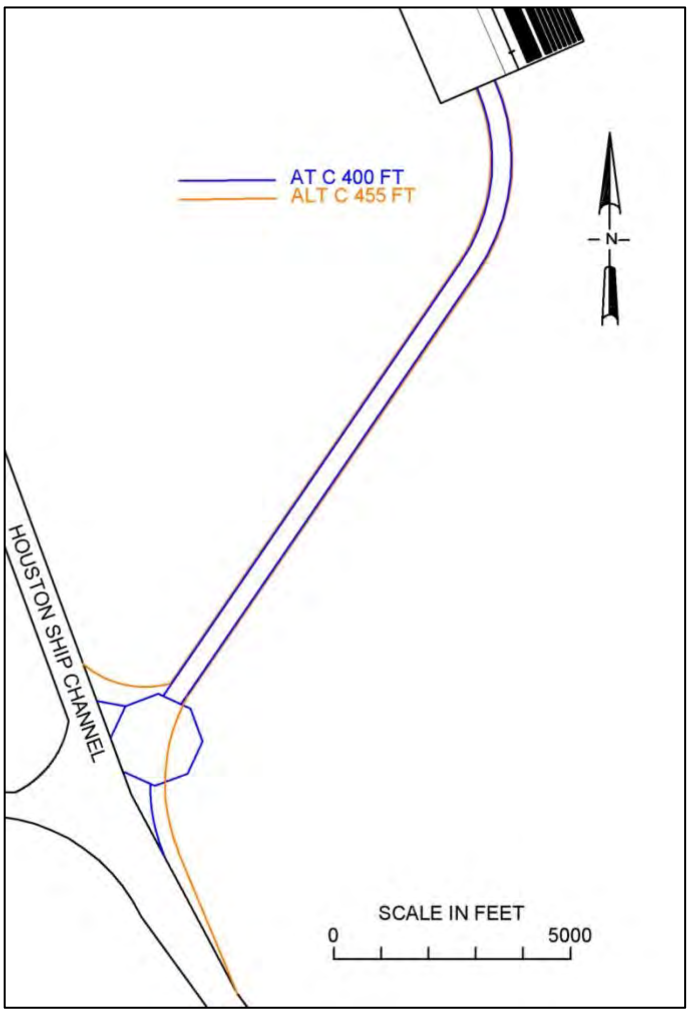


Figure 14. Charlie Design

Figure 15. Charlie Charted Route

Delta

Delta is ~8 miles long. Two alternative ship channels were tested with 400’ and 455’ wide alignments. The route from the HSC on the centerline: HSC entry into the channel is a 36° turn (from heading 326° to 002°) that must be completed in 0.6 miles. Then, there are three straightaways connected by two turns. The first straightaway is ~1.9 miles long at heading 002°. The first in-channel turn is 12° (Inset B), going from heading 002 ° to 350°. The second straightaway is ~3.10 miles long on heading 350°. The second in-channel turn is 11° (Inset C), going from heading 350° to 339°. Then, a third straightaway on heading 339° for ~2.9 miles until the ship enters the southern entrance to the terminal basin.

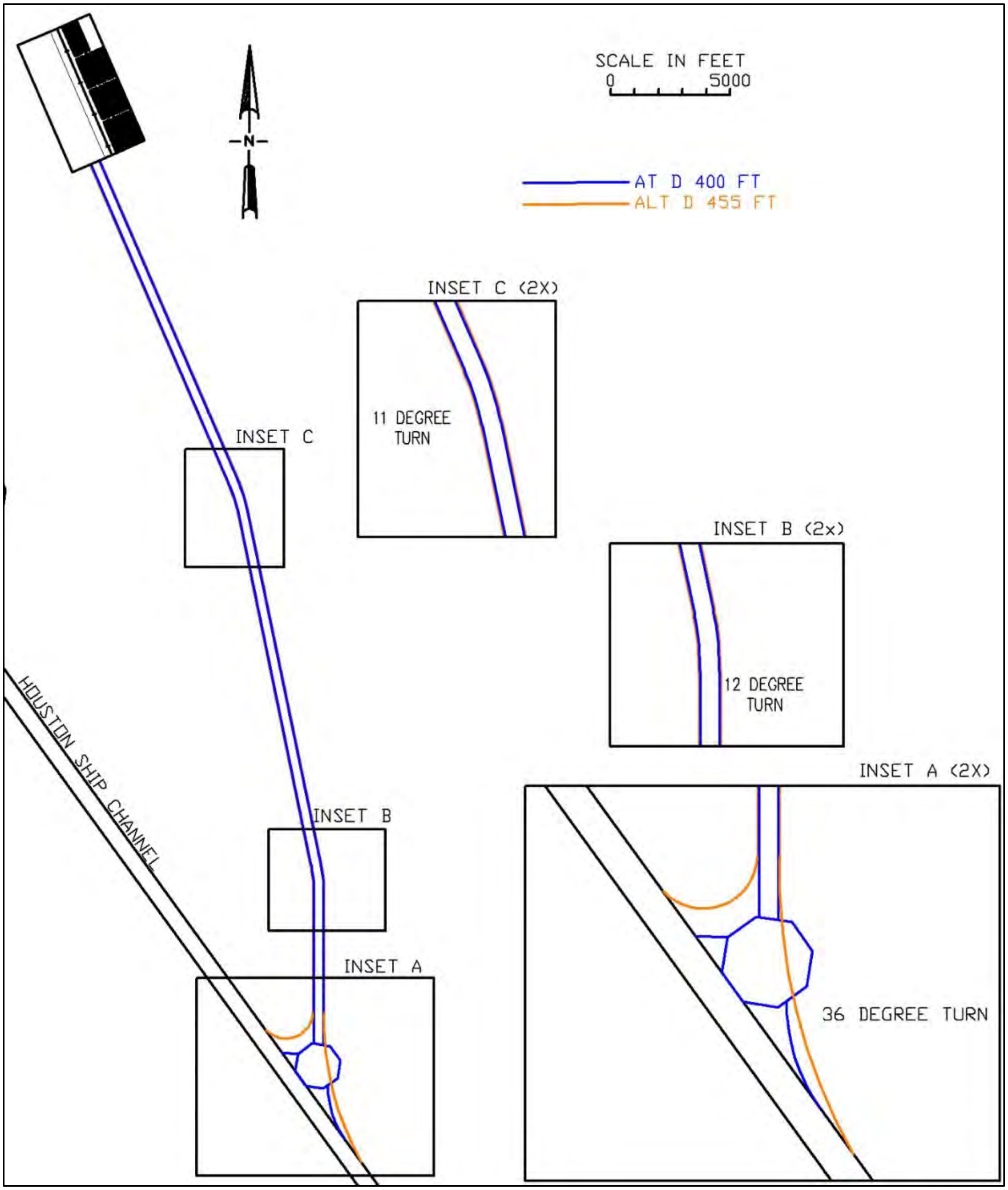


Figure 16. Delta Design

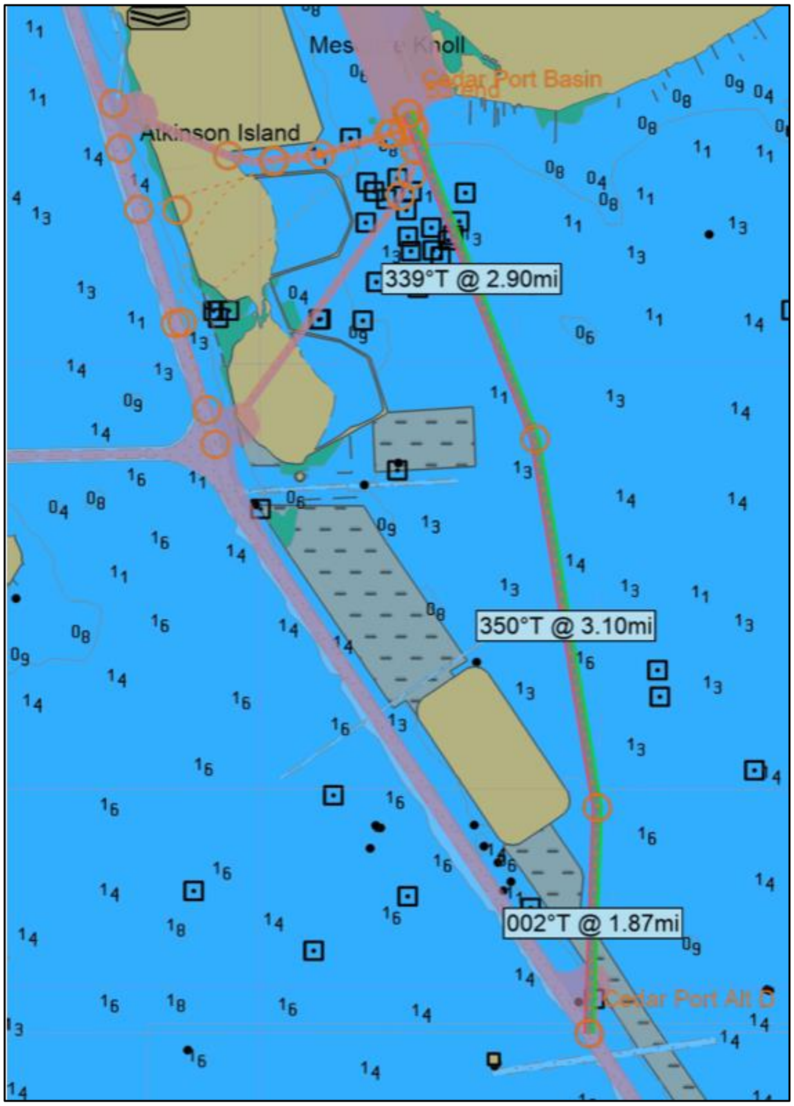


Figure 17. Delta Charted Route

Design Test Vessels

The same design test vessel, 366m class ULCV with 15,000 TEU capacity (ULCV 366m), was used for the Cedar Port FLSS as was used for the HSC Project 11 study. HSC Project 11 only utilized a loaded version of the 366m class ULCV, but the pilots for the Cedar Port FLSS wanted to test a ballast version as well. Therefore, during the Covington simulations, three ship simulation runs used a similar ship model (CNTNR35) with the same overall length and beam as the ULCV 366m model but slightly less draft. For the San Jacinto simulations, Locus had a ballast version of the 366m class ULCV developed (ULCV 366m Ballast) tested during two ship simulation runs. Therefore, 35 / 41 ship simulation runs used the loaded ULCV 366m.

Members of the HPA have vetted all three ship models, and the pilots participating in this study described the models as “very realistic.” The table below lists the ship models and describes their dimensions. The pilot cards for each model are below.

Table 3. Test Vessel Models’ Dimensions

Ship Model	LOA	Beam	Draft	Displacement
ULCV 366m (Loaded)	1,202’ (366.5m)	158’ (48.2m)	49.8’ (15.2m)	178,766 tons
ULCV 366m (Ballast)	1,202’ (366.5m)	158’ (48.2m)	32’ fore & 34’ aft (9.8m fore & 10.4m aft)	127,000 tons
CNTNR35	1,202’ (366.5m)	158’ (48.2m)	49.3’ (15m)	176,400 tons

PILOT CARD

ULCV366
Version 1

Ship's name 366 ULCV 14K **Date** ____

Call Sign ____ **Deadweight** 133500 tonnes **Year built** ____

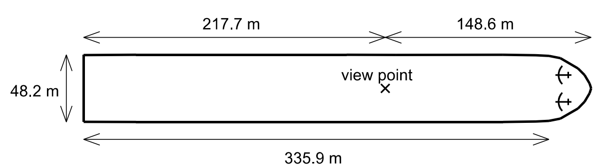
Draught aft 15.2 m / 49 ft 10 in **Forward** 15.2 m / 49 ft 10 in **Displacement** 178766 tonnes

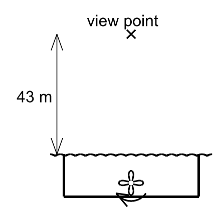
SHIP'S PARTICULARS

Length overall 366.5 m **Anchor chain:** **Port** 28.0 shackles **Starboard** 28.0 shackles

Breadth 48.2 m **Stern** ____ shackles

Bulbous bow Yes **(1 shackle = 27.432 m = 15 fathoms)**





PROPULSION PARTICULARS

Type of engine Diesel **Maximum power** 67699 kW (92045 hp)

Manoeuvring engine order		RPM	Pitch	Speed (knots) Loaded	Speed (knots) Ballast
Full sea speed	**1**	102.0		24.5	
Full Ahead	**0.8**	90.0		22.2	
Half Ahead	**0.5**	60.0		15.1	
Slow Ahead	**0.25**	31.0		7.2	
Dead Slow Ahead	**0.125**	20.0		4.8	
Dead Slow Astern	**-0.125**	-20.0			
Slow Astern	**-0.25**	-31.0			
Half Astern	**-0.5**	-51.0			
Full Astern	**-1**	-67.0			

Time limit astern ____ min:sec

Full ahead to full astern ____ min:sec

Max. No. of consecutive starts ____

Minimum RPM ____ ____ knots

Astern power ____ % ahead

Figure 18. Pilot Card of ULCV 366m, Loaded Condition

PILOT CARD

ULCV36B
Version 1

Ship's name 366 ULCV 14K **Date** ______

Call Sign ______ **Deadweight** 0 tonnes **Year built** ______

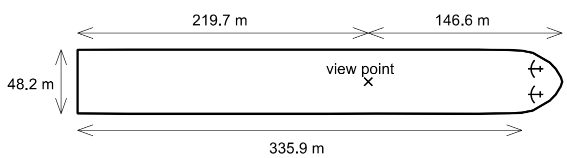
Draught aft 10.36 m / 33 ft 12 in **Forward** 9.75 m / 31 ft 12 in **Displacement** 127000 tonnes

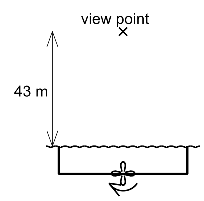
SHIP'S PARTICULARS

Length overall 366.5 m **Anchor chain:** **Port** 28.0 shackles **Starboard** 28.0 shackles

Breadth 48.2 m **Stern** ______ shackles

Bulbous bow Yes **(1 shackle = 27.432 m = 15 fathoms)**





PROPULSION PARTICULARS

Type of engine Diesel **Maximum power** 67699 kW (92045 hp)

Manoeuvring engine order		RPM	Pitch	Speed (knots) Loaded	Speed (knots) Ballast
Full sea speed	**1**	102.0			24.6
Full Ahead	**0.8**	90.0			22.1
Half Ahead	**0.5**	60.0			15.0
Slow Ahead	**0.25**	31.0			7.2
Dead Slow Ahead	**0.125**	20.0			4.8
Dead Slow Astern	**-0.125**	-20.0			
Slow Astern	**-0.25**	-31.0			
Half Astern	**-0.5**	-51.0			
Full Astern	**-1**	-67.0			

Time limit astern ______ min:sec

Full ahead to full astern ______ min:sec

Max. No. of consecutive starts ______

Minimum RPM ______ ______ knots

Astern power ______ % ahead

Figure 19. Pilot Card of ULCV 366m, Ballast Condition

PILOT CARD

CNTNR35
Version 10

Ship's name Maersk Edinburgh

Call Sign V7UE9 **Deadweight** 133500 tonnes **Year built** 2010

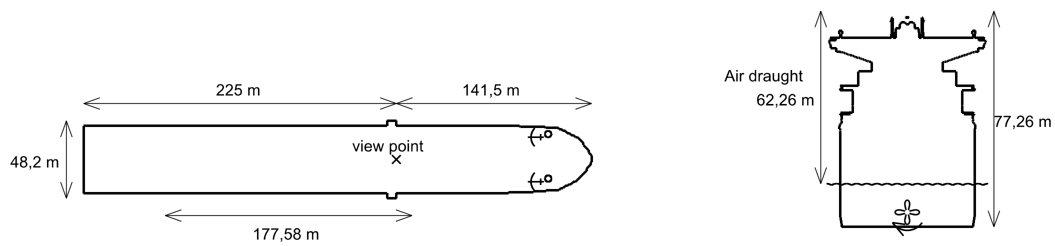
Draught aft 15 m / 49 ft 3 in **Forward** 15 m / 49 ft 3 in **Displacement** 176400 tonnes

SHIP'S PARTICULARS

Length overall 366.5 m **Anchor chain: Port** 28.0 shackles **Starboard** 28.0 shackles

Breadth 48.2 m

Bulbous bow Yes **(1 shackle = 27,432 m = 15 fathoms)**



PROPULSION PARTICULARS

Type of engine Diesel **Maximum power** 67699 kW (92045 hp)

Manoeuvring engine order		RPM	Pitch	Speed (knots)	
				Loaded	Ballast
Full sea speed	**1**	102.0	N/A	24.6	N/A
Full Ahead	**0.8**	90.0	N/A	22.2	N/A
Half Ahead	**0.5**	60.0	N/A	15.1	N/A
Slow Ahead	**0.25**	31.0	N/A	7.2	N/A
Dead Slow Ahead	**0.125**	20.0	N/A	4.8	N/A
Dead Slow Astern	**-0.125**	-20.0	N/A		
Slow Astern	**-0.25**	-31.0	N/A		
Half Astern	**-0.5**	-51.0	N/A		
Full Astern	**-1**	-67.0	N/A		

Figure 20. Pilot Card of CNTNR35

Tugs

Tug assistance was provided using both interactive and vector tugs. During all ship simulations, the pilots had four assist tugs available. For the single-bridge Covington simulations, one ship simulator and vector tugs were used. The vector tug model had a maximum bollard pull of 80 tons and was the same tug model used during the research for HSC Project 11. During the San Jacinto simulations, there were three interactive ship simulators available. At SJCC, two of the ship simulator bridges were used as interactive tugs controlled by tug masters from G&H Towing, along with two vector tugs. During the San Jacinto simulations, the tug models were representations of G&H Towing's 7500 series tractor tugs (LOA 27.6m X Beam 12m) with 75 tons of bollard pull were used. These were used because of the G&H Towing master's familiarity with the tugs. The simulator operator controlled the vector tugs and, like the interactive tugs, followed the orders given by the pilots via the radio for direction and force.

Environmental Conditions

For a majority of the runs (26/41), calm conditions were used. Winds were only added after the pilots successfully completed the runs without wind. When winds were added, they were sustained velocity and from one of three directions: Southeast (135°), North (000°), or Northwest (315°). The winds from the Southeast and the North were the exact wind directions used during HSC Project 11. A Northwest wind was used three times during the San Jacinto simulations, as requested by the Houston Pilots. The wind velocity was 15kn for all directions, except for one run performed using a Southeast wind at 20kn during the San Jacinto simulations. The Houston Pilots requested this wind velocity even though a 20kn wind exceeds the HPA's guidelines for this vessel size. There was no tidal current, as slack water was used during all simulations. Clear daylight visibility was also used during all simulations.

Scenario Objectives

The risk scenarios were developed by the research team with input from the pilots and the client. This was done to create a realistic scenario for the pilots to assess each channel alternative's feasibility and identify potential navigation hazards. There were primarily two types of scenarios, but additional ones were added. The scenarios either focused on the ULCV 366m arriving from the HSC to Cedar Port via an alternative channel or sailing from Cedar Port to the HSC via an alternative channel.

The arrivals generally started in the HSC at two to four ship lengths (depending on the pilot's request) to the south below the alternative channel’s entrance, with a typical starting speed of about 6 knots. During the San Jacinto simulations, we also started multiple runs with the ship already in the ship channel about one to two ship lengths before entering the turning basin. These runs were set up to focus on entering and turning the ULCV 366m in the turning basin, backing past the berthed ULCV 366m, and then docking on the starboard side alongside an open berth at the container terminal.

Departure, “Sailing” simulations in the Covington simulator used an own-ship starting position of about one ship length inside the terminal basin, headed towards the channel’s entrance, with a starting speed of about 3 knots. In the San Jacinto simulations, the starting position for sailings was starboard side alongside a berth (Berth #2 or #3) at the container terminal. Additionally, for two runs in Delta, the ship started north of the channel entrance in the HSC with a southbound heading. These two runs were assessed as unrealistic and not feasible; accordingly, no other southbound arrival runs were attempted.

Scenario Assessments

Both qualitative empirical data and subject matter experts' opinions were collected and analyzed after each run. Before this ship simulation study, the pilots were briefed about the project and the feasibility assessment process. The following protocols were established to identify “failed” runs: (1) if the ship left the channel or had an allision; (2) if

50% or more of a tug was forced out of the channel. These standards are widely used in other research performed by the research team with the Houston Ship Pilots.

A risk assessment was performed after each run using a semi-structured private interview process debriefing the pilot who performed the run. The risk assessment included two components. First is a potential hazard identification, followed by a GAR score. The hazard identification focused on the width of the channel (400’ or 455’), the capability to safely turn into the channel, performing in-channel turns, and whether the tugboats were sufficient. During the San Jacinto simulations, a question was added based on a request by the pilots to ask whether a portable pilot unit (PPU) for navigation was necessary. At the end of each debrief, the pilot was asked to assess the entire run using a Green-Amber-Red (GAR) risk assessment scoring system modified for this project. Assessing risk levels using GAR is consistent with qualitative risk assessments performed by the USACE.[6] The hazard identification and the GAR scores for the runs are reported in the results.

Table 4. Green-Amber-Red Risk Assessment Scale with Maritime Interpretation for Cedar Port FLSS

Score	GAR	Risk Scale	Maritime Interpretation
1	Green	Safe: Low Risk	Normal, routine ship handling; Required some of my skills and resources as a pilot
2	Amber	Caution: Moderate Risk	Cautious, alert ship handling was required; Required many or most of my skills and resources as a pilot
3	Red	Unsafe: High Risk	The maneuver could not be performed; Emergency ship handling; Required all of my skills and resources as a pilot

[6] Also, by reference at USCG, COMDTINST 3500.3A05, March 2018

Results

The results are divided into two sections. The overall analysis evaluates the feasibility of each corridor along with its alternative ship channels. The second section analyzes each run performed by a pilot individually grouped by ship channel.

Overall Results

The run matrix below reports all 41 runs completed for testing alternative ship channels in the Alpha, Bravo, Delta, and Echo navigational corridors. Runs included both sailings and arrivals. The wind was primarily only used after the pilots found the channel feasible for navigating a ULCV 366m. Testing corridors Alpha and Delta focused only on the 400' and 455' wide alignment channel alternatives. Multiple alternative channels were developed and tested for testing navigational corridors Bravo and Echo, but only with the 400' wide alignment. The pilots could request up to four tugboats at any point during the run. All runs used at least one tug over the stern to begin, and then the additional tugboats were available as the vessel approached the turning basin or terminal basin.

The table below describes each run performed. The table includes the run number, channel, ship model, run objective, winds, results, whether the run passed or failed, and the pilot's GAR score for the run. Overall, 27/41 runs passed (65% pass rate).

Table 5. Run Matrix Listing Channel, Ship Model, Objective, Wind, and Assessment

Run#	Channel	Ship Model	Objective	Wind	Pass	GAR
1	Delta 400’	ULCV 366m	Arrival	None	Yes	1
2	Delta 400’	ULCV 366m	Sailing	135° @15kn	Yes	1
3	Delta 400’	ULCV 366m	Sailing	000° @15kn	Yes	1
4	Delta 400’	ULCV 366m	Arrival	135° @15kn	No	3
5	Delta 400’	ULCV 366m	Arrival	135° @15kn	Yes	1
6	Delta 400’	ULCV 366m	Arrival Southbound	000° @15kn	No	3
7	Delta 400’	ULCV 366m	Arrival Southbound	000° @15kn	Yes	2
8	Delta 455'	ULCV 366m	Arrival	None	Yes	1
9	Delta 455'	ULCV 366m	Sailing	None	Yes	1
10	Alpha 400’	ULCV 366m	Arrival	None	No	3
11	Alpha 400’	ULCV 366m	Sailing	None	Yes	2
12	Alpha 400’	ULCV 366m	Sailing	000° @15kn	No	3
13	Alpha 400’	ULCV 366m	Arrival	135° @15kn	Yes	1
14	Alpha 400’	CNTR35	Arrival	None	No	3
15	Alpha 400’	CNTR35	Sailing	None	No	3
16	Alpha 400’	ULCV 366m	Arrival	000° @15kn	No	3
17	Alpha 455'	ULCV 366m	Arrival	None	No	3
18	Alpha 455'	ULCV 366m	Sailing	None	Yes	2
19	Bravo #1	ULCV 366m	Arrival	None	No	3
20	Bravo #1	ULCV 366m	Arrival	None	Yes	2
21	Bravo #1	ULCV 366m	Sailing	None	No	3
22	Bravo #2	CNTR35	Arrival	None	No	3
23	Bravo #3	ULCV 366m	Arrival	None	No	3
24	Bravo #3	ULCV 366m	Arrival	None	Yes	2
25	Bravo #3	ULCV 366m	Sailing	None	Yes	2
26	Bravo #3 Final	ULCV 366m	Arrival	None	Yes	1
27	Bravo #3 Final	ULCV 366m	Arrival	None	Yes	1
28	Bravo #3 Final	ULCV 366m	Sailing	None	Yes	1
29	Bravo #3 Final	ULCV 366m	Arrival	None	Yes	1
30*	Echo #1	ULCV 366m	Arrival	None	Yes	2
31*	Echo #1	ULCV 366m	Arrival	None	Yes	2
32*	Echo #1	ULCV 366m	Sailing	None	No	NA
33*	Echo #1	ULCV 366m	Sailing	None	Yes	2
34*	Echo #1	ULCV 366m	Arrival	135° @15kn	Yes	2
35*	Echo #1	ULCV 366m	Sailing	135° @15kn	Yes	3
36*	Echo #1	ULCV 366m	Arrival	135° @20kn	Yes	3
37*	Echo #1	ULCV 366m	Sailing	315° @15kn	Yes	2
38*	Echo #1	ULCV 366m (Ballast)	Arrival	315° @15kn	Yes	2
39*	Echo #1	ULCV 366m (Ballast)	Arrival	315° @15kn	Yes	2
40*	Echo #2	ULCV 366m	Arrival	None	No	NA
41*	Echo #2	ULCV 366m	Arrival	None	Yes	1

Notes: * indicates ship simulations performed at SJCC with members of the Houston Pilots

Bravo #3 Final

Bravo #3 Final was feasible for safe navigation as per the pilots from the part-one Covington simulations. It had a 100% pass rate and a GAR score of Green /Safe for all four runs. The pilots concluded it was the safest channel among the ones tested (channels in Corridors Alpha, Bravo, and Delta). The pilots did state that the continuous motion turn in Bravo #3 Final posed a potential hazard. To mitigate this potential hazard, they recommended that two tugboats should be required and that the pilot should maintain speed control over the vessel at approximately 6 to 7kn and not exceeding a rate of turn per minute (ROT) of 14 degrees. However, in subsequent meetings with the USACE, project clients and engineers discussed Bravo #3 Final and found that it faced concerns over the layout and location. The USACE suggested a different corridor than Bravo for a ship channel connecting the HSC to Cedar Port. What was proposed was moving Bravo #3 Final to the north, which led to the development of the Echo Corridor and eventually Echo #1 and Echo #2.

Echo

During the San Jacinto simulations, the pilots found that Echo #1 is feasible for successful navigation. This was demonstrated by the fact that the pilots were able to navigate the ULCV 366m into Echo from the HSC, perform the continuous arcing ~96° turn with a 5,300’ radius, enter and turn the vessel in the turning basin, and come alongside the starboard side to the terminal’s berths, as well as perform these same maneuvers outbound.

During the ship simulations, the pilots found that Alt Echo potentially possessed multiple hazards to safe navigation. The primary hazards were having a constant 5,300’ radius turn of 96° and a channel 400’ wide. The continual arc turn inbound requires the pilots to slow down their approach from the HSC to around 6-7kn to make the entry turn into Alt Echo. Then, once in the channel, the design test vessel must make a constant 5,300’ radius turn of 96°. This requires the pilot to make constant course corrections with only a stern assist tug of approximately six degrees per minute at 6kn for about 15 minutes to complete the turn. This assist tug is limited in its maneuverability space as it cannot maneuver outside the ship's form due to the channel's narrowness. This turn is naturally provided without the benefit of a set of ranges for the pilot to line up on visually, so they have to rely on their electronic chart PPU for navigation.

Echo is 400’ (~122m) wide throughout. The design test vessel is LOA 366.5m (1,202’) X Beam 48.2m (158’) and, with an expected drift angle of 4°, creates a swept path or effective beam of 71.6m or 235’ (See Figure 21 Below).[7] This swept path matters because the channel is 400’ wide. The ULCV, with 4° of drift angle in an arcing 400’ channel, leaves 82.5’ from the side shell of the vessel to the channel bank. It was observed that if the ship's bow was on the centerline while experiencing a substantial drift angle, the stern could end up near the bank. Additionally, this proximity to the bank effectively prevents a tug from working outside the form of the ship within this channel. The G&H tugs were 90’ LOA and require 75’ of hawser to assist the ship when working at 90°.

$$\text{Swept Path} = \left(\sqrt{L^2+B^2}\right)\left(\sin\left(\frac{1}{\tan\left(\frac{L}{B}\right)}+a\right)\right)$$

Spreadsheet Prepared by: George B. Burkley, Maritime Pilots Institute

	Length	Beam	L^2	B^2	Cubic Factor	(B/L)	Tan^ -1 (B/L)	
Vessel Effective Beam Due to Swept Path	336.5	48.2	113232.3	2323.24	339.9345378	6.9813	8.166347211	M
								FT

Swept Bath-Effective Beam (m) per Crab Angle (d)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
M	54.2	60.0	65.8	71.6	77.4	83.2	88.9	94.6	100.3	106.0	111.6	117.2	122.7	128.3
FT	177.7	196.9	216.0	235.0	254.0	272.9	291.8	310.5	329.2	347.7	366.2	384.5	402.7	420.8

Swept Bath-Effective Beam (m) per Crab Angle (d)

Single Calculation from Entered Data	71.6414

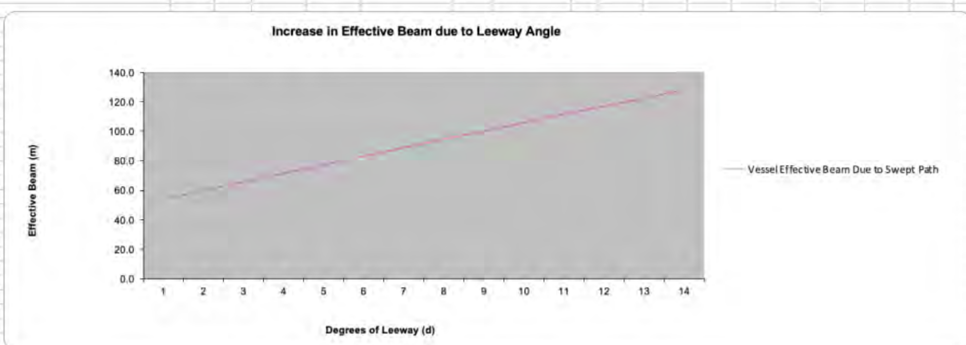


Figure 21. Swept path analysis for the ULCV 366m in 15kn of wind

The results show that the pilots rated Echo #1 as an Amber / Caution on the GAR scale. There were some exceptions, as the pilots rated Runs 35 and 36 as Red / High Risk.

[7] Swept path estimate: SP = (√(L^2+B^2) x (Sin(1/(L/B))+a) where “a” equals drift angle., F. Lagunes, G. Burkley

Both of these runs had a southeast wind, with Run #35 using 15kn and Run #36 increasing the velocity to 20kn. The 20kn wind is over the HPA guidelines for this ULCV class. These results demonstrate that Echo #1 is feasible for successful navigation but requires caution and could be high risk in certain circumstances.

Runs #40 and 41 tested the feasibility of Echo #2. The first run failed due to non-design or layout issues. The second run was successful, and the pilot rated it as Green / Low Risk. Echo #2 uses a two-leg course turn with a connecting widener, which was successful. The pilots commented they had navigation options in the channel layout to either proceed at a constant speed through the connecting turn or to slow and join with tugs for a slower "harbor-turn" maneuver. It was suggested that this two-course system with a connecting widener philosophy is an option to evaluate in future preconstruction channel design. Additionally, the combined results of Echo #1 and Echo #2 show that a corridor can be feasibly navigated using the ULCV 366m connecting the HSC to Cedar Port.

Delta

The 400' wide and 455' wide alignment channels in the Delta Corridor were feasible for navigation. The Delta 455' wide version had two runs, both of which passed and had a GAR score of Green / Low Risk. The pilots liked Delta 455' but identified the turns as a potential hazard. To mitigate this hazard, they suggested turn wideners. They also recommended using two tugboats at all times and speed control of 7kn on the straightaways and 6kn on the turns.

Not Feasible Channels

Ship channel alternatives Alpha (400' and 455' wide) and Bravos #1, #2, and #3 are not feasible for navigation. These alternatives are too risky, with the primary hazard associated with the entry turn from the HSC. The majority of the runs led to failures.

Analysis of Each Individual Run with Screenshots

Channel Delta (Runs #1 – 9)

Channel Description: Channel Delta is ~8 miles long and takes about 70 minutes to transit from the terminal basin to the HSC. The 400' (Run #1-7) and 455' (Run #8-9) channel widths were tested. Based on a route from the HSC on the centerline, the project established the turns and distances as follows: HSC entry into the channel is a 36° turn (from heading 326° to 002°) that must be completed in 0.6 miles, In-Channel Turn #1 is 12° and in Channel Turn #2 is 11°. Both of these turns are nearly two miles apart from each other.

Channel Assessment: For Delta, both the 400' and 455' versions require wideners for the turns, but wideners were not tested as they were unavailable. The 400' channel is feasible but requires at least one tug escort, and the ship needs to control its speed at a maximum of 7kn. The turn into the channel from the HSC heading northbound, turning 36° at about 6kn, was performed safely using one tug. Heading southbound on the HSC requires the ship to come to a complete stop and use three tugs to perform a 216° turn to enter the channel. Such a maneuver was judged unsafe to perform while underway at 4kn or greater, and requiring the ship to stop in the HSC is a hazard.

Run 1. Delta 400’, Arrival ULCV 366m, No Wind, GAR 1

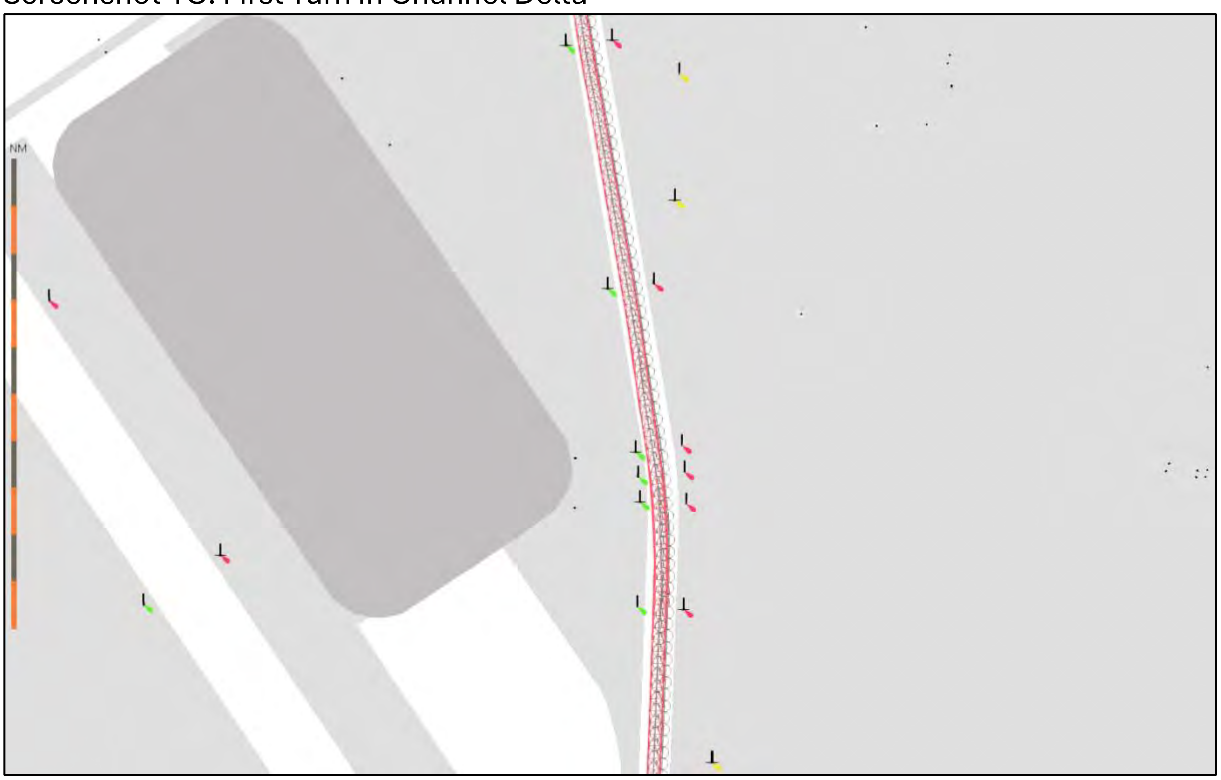
Run Description: On the first turn (Screenshot 1H), the ship got within 30’ of the bank. Twenty feet from the bank was the minimum distance for a successful run.

Pilot Comments: The pilot reported that this run was good and not highly difficult. The 400’ width of the channel on the straightaways is good for one-way traffic with no tow traffic, but the turns need wideners. The two tugs were sufficient during the channel work, and a third tug was used in the terminal basin to maneuver the ship into position (Screenshot 1G). The pilot stated that the dimensions of the terminal basin were good for turning the ship around.

List of Screenshots:

Screenshot 1B. Ship inbound from HSC turning into Channel Delta

Screenshot 1C. First Turn in Channel Delta

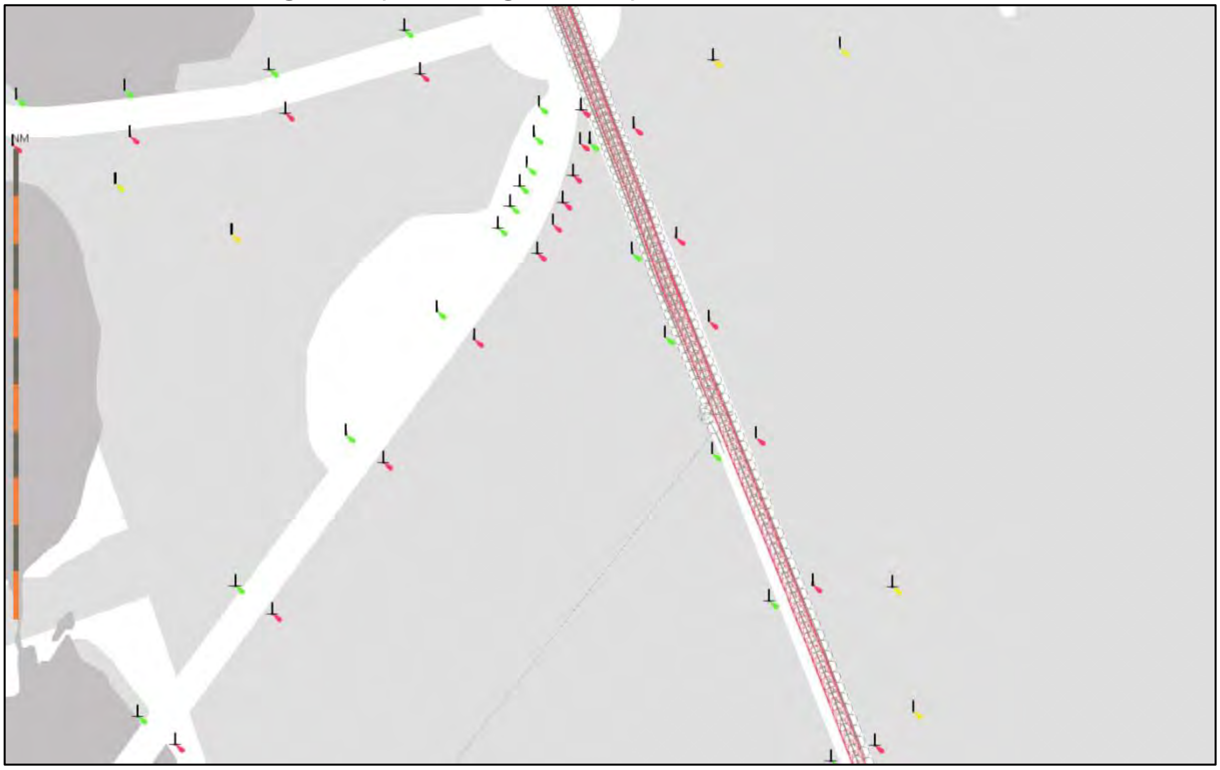


Locus

Screenshot 1D. Straightaway in Channel Delta

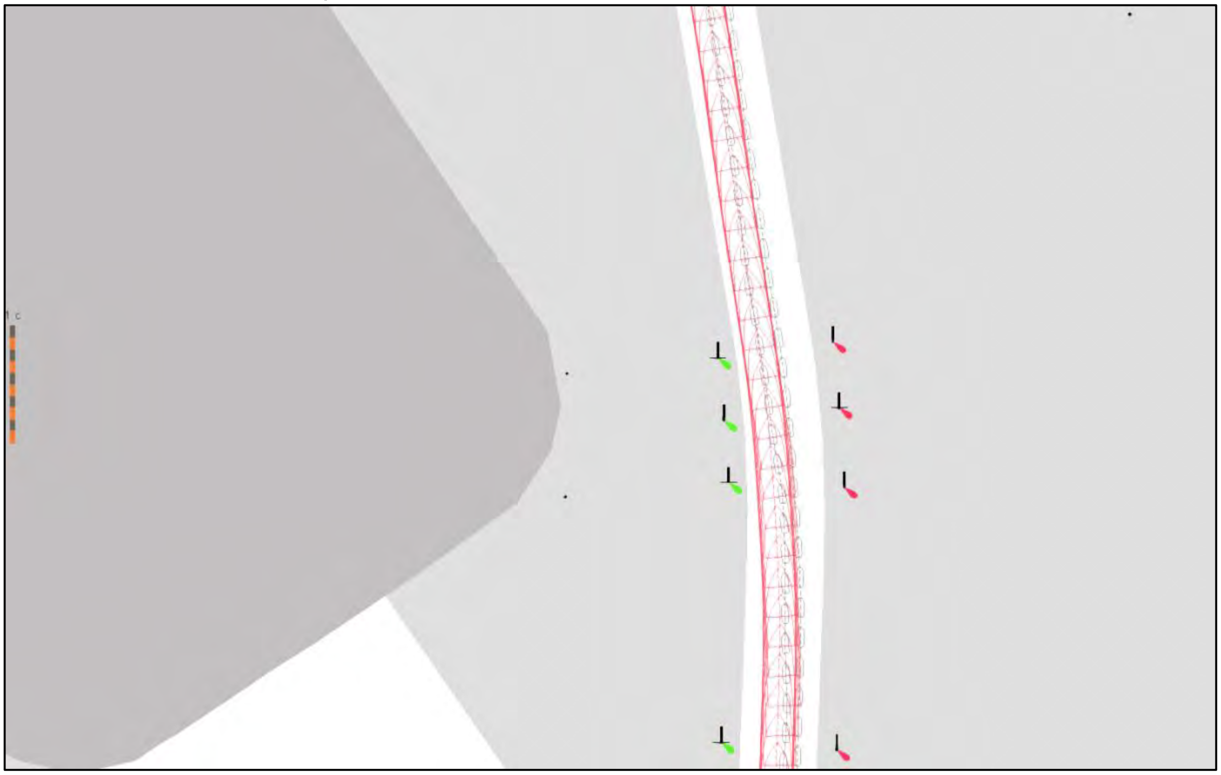
Screenshot 1E. Second Turn in Channel Delta

Screenshot 1F. Straightaway entering the Entry to the Terminal Basin in Channel Delta



Screenshot 1G. Turning the Ship in the Terminal Basin After Transiting Channel Delta

Screenshot 1H. Closeup of 30-feet from the Bank on the First Turn in Channel Delta



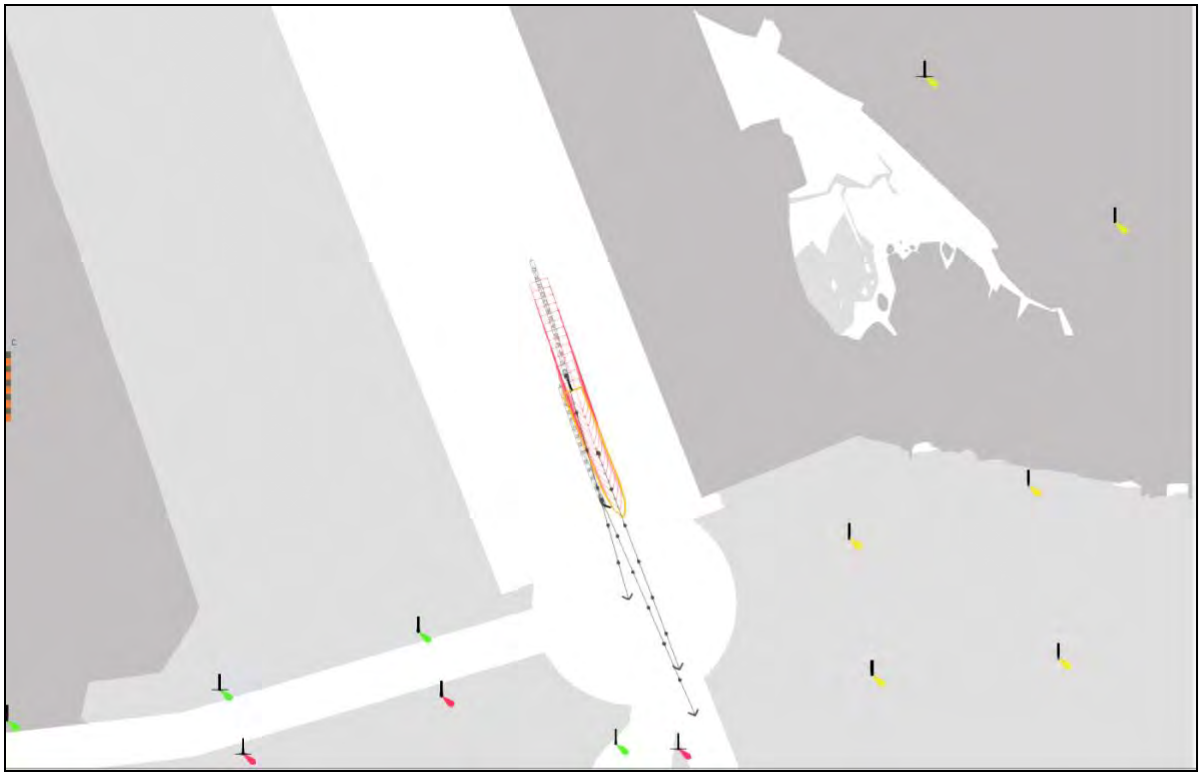
Run 2. Delta 400', Arrival ULCV 366m, Wind 135° @15kn, GAR 1

Run Description: On the first turn (Screenshot 2C), the ship got within 33' of the bank. Twenty feet from the bank was the minimum distance for a successful run.

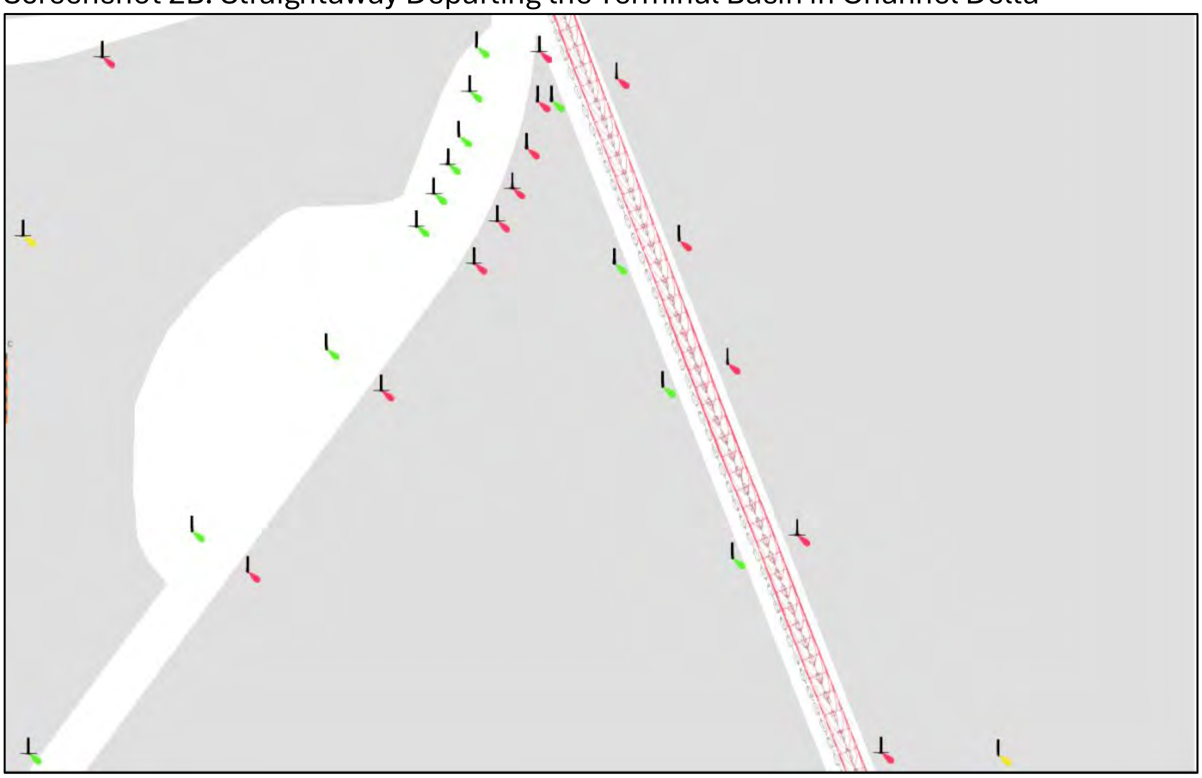
Pilot Comments: The pilot reported that this run was good, and the ship was controlled throughout. When transiting the channel, the speed must be kept to 7 knots or less, or the ship will pick up too much squat and scrape the bottom. The 400' width of the channel on the straightaways is good, but the turns need wideners. The two tugs are necessary during the channel work.

List of Screenshots:

Screenshot 2A. Sailing from the Terminal Basin Heading Towards Channel Delta

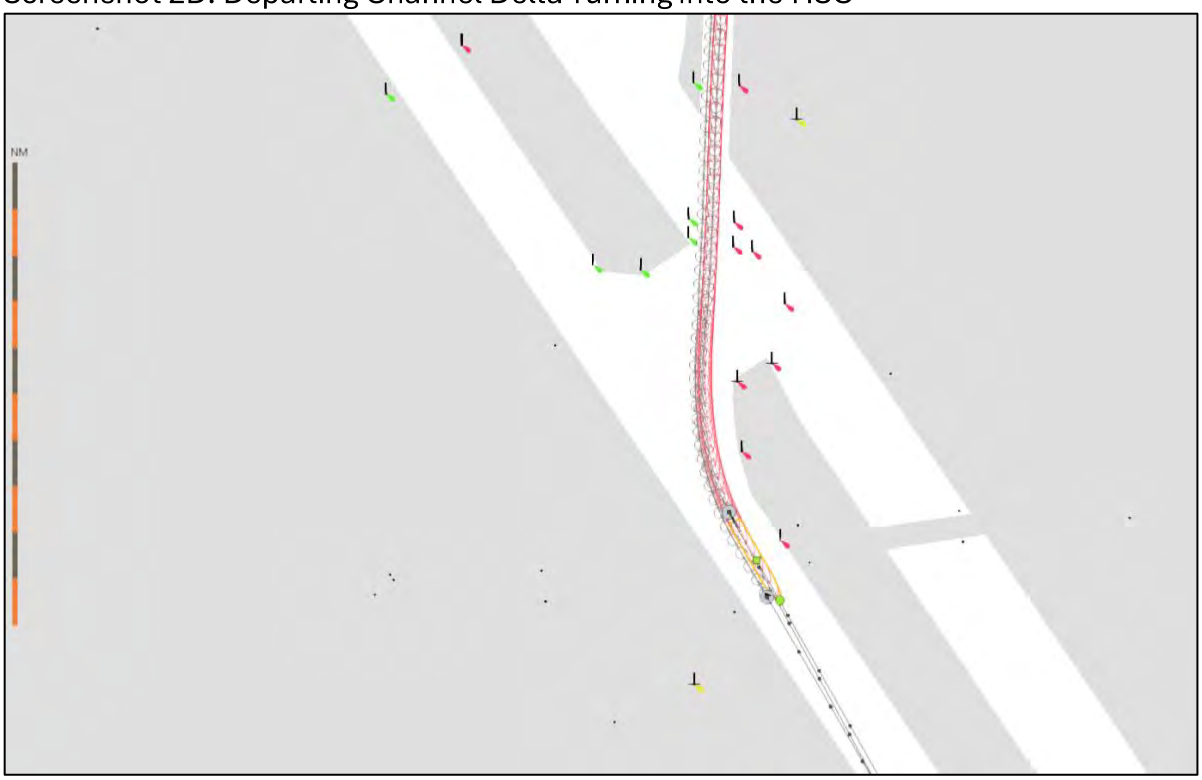


Screenshot 2B. Straightaway Departing the Terminal Basin in Channel Delta



Screenshot 2C. First Turn Outbound on Channel Delta

Screenshot 2D. Departing Channel Delta Turning into the HSC



Run 3. Delta 400', Sailing ULCV 366m, Wind 000° @15kn, GAR 1

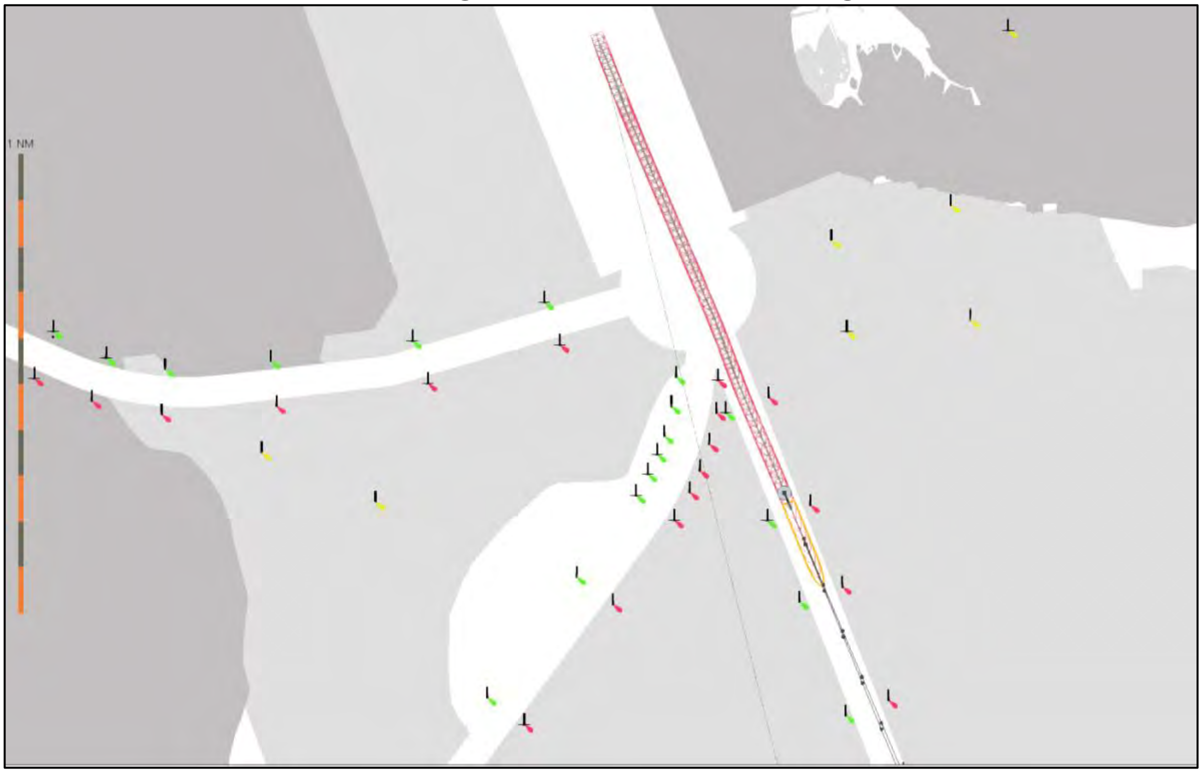
Run Description: When transiting the channel, the speed was 6.5kn, and the pilot did not experience substantial forces from either the bank or the wind. Did not get close to the bank on either turn (Screenshots 3A & 3B).

Pilot Comments: The pilot reported that this run was good, and the ship was controlled throughout. The pilot stated that at least one tug is necessary for this large of a ship to transit this narrow channel.

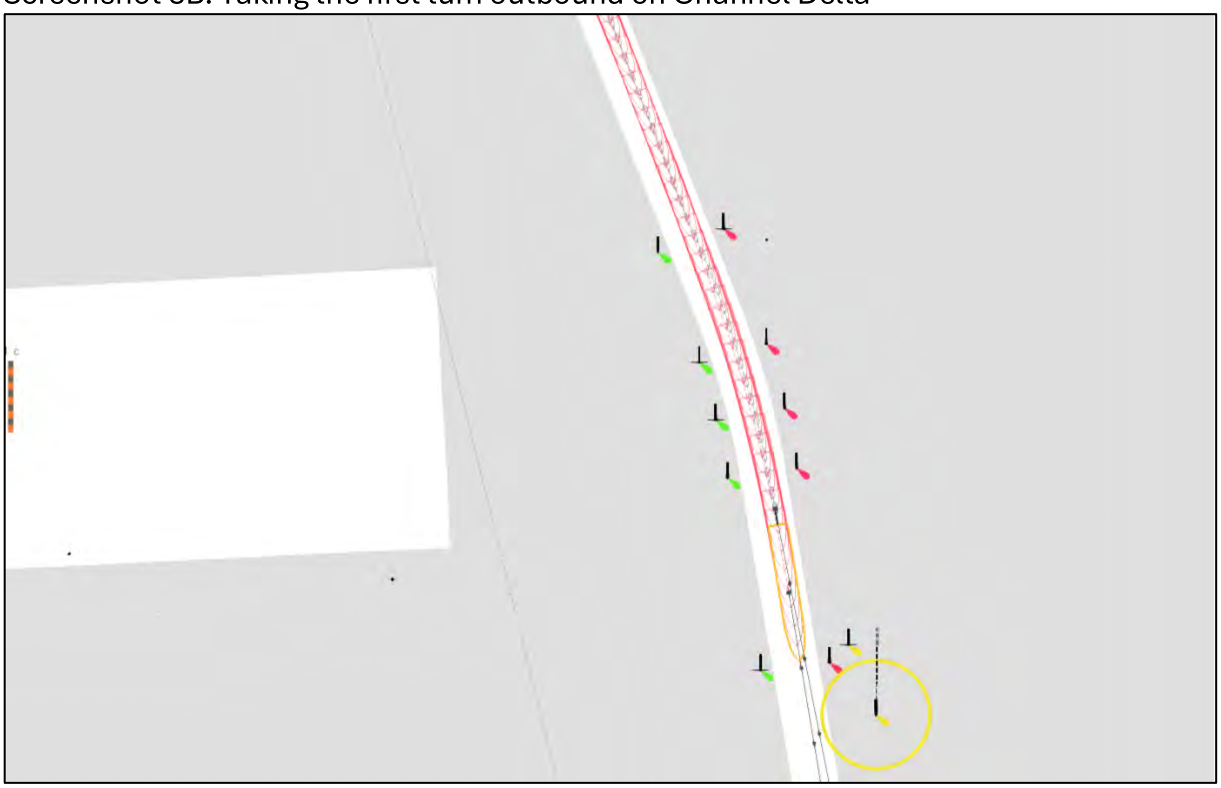
List of Screenshots:

Screenshot 3A. Outbound Leaving the Terminal Basin Entering Channel Delta
Screenshot 3B. Taking the first turn outbound on Channel Delta
Screenshot 3C. Straightaway on Channel Delta
Screenshot 3D. Second Turn on Channel Delta
Screenshot 3E. Departing Channel Delta into the HSC

Screenshot 3A. Outbound Leaving the Terminal Basin Entering Channel Delta



Screenshot 3B. Taking the first turn outbound on Channel Delta



Locus

Screenshot 3C. Straightaway on Channel Delta

Screenshot 3D. Second Turn on Channel Delta

Screenshot 3E. Departing Channel Delta into the HSC

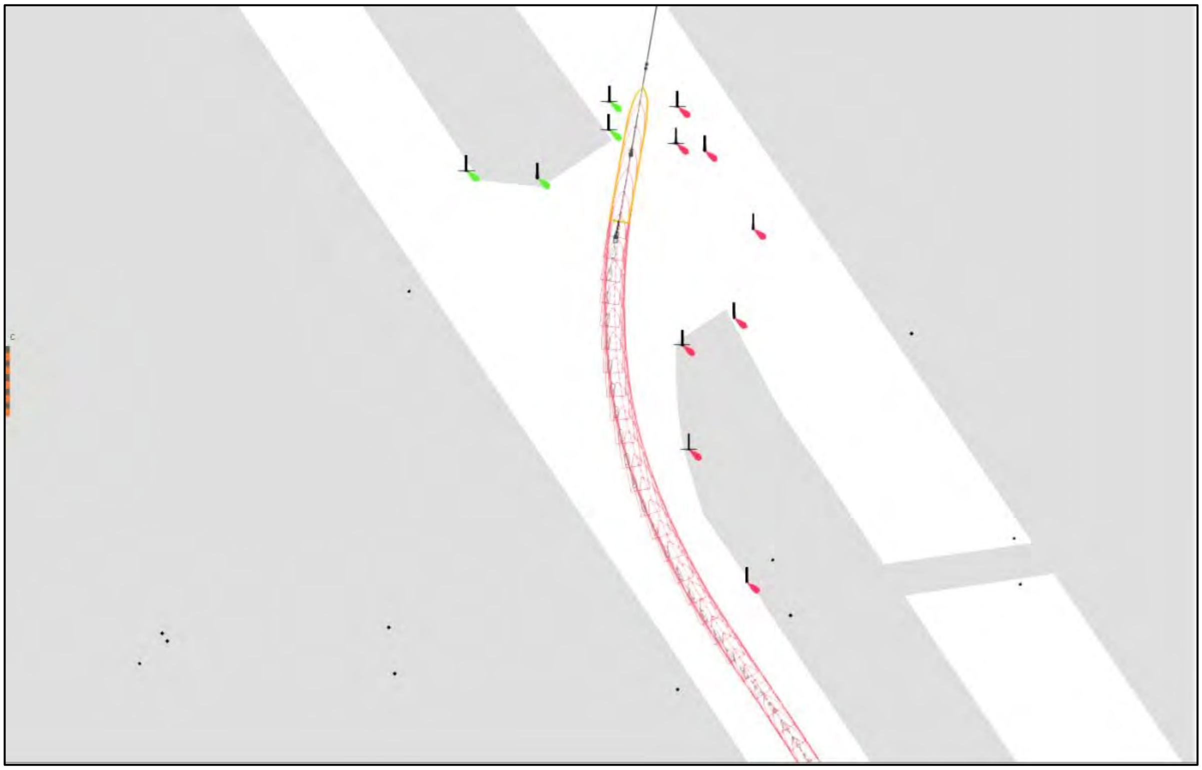
Run 4. Delta 400’, Arrival ULCV 366m, Wind 135° @15kn, GAR 3 - FAILED

Run Description: The simulation started with the ship picking up speed northbound on the HSC, increasing from a starting speed of 6kn to 8kn when beginning the turn into the Delta channel and up to 8.5kn during and exiting the turn into Channel Delta. The result was a gutter-ball effect of the ship entering too fast and coming close to the inner portside bank on the entrance. Due to the bank effect and over-correction, the ship was pushed across the channel to nearly strike the outer starboard side bank. The Under Keel Clearance (UKC) due to squat at this higher speed was 0.5m. The ship listed in the turn, and the outer corner of the ship’s bottom was scraping the channel bottom during the turn. The pilot used emergency ship handling and got within 12’ of the outer starboard side bank (Screenshot 4B). This is a failed maneuver as the ship struck the bank multiple times.

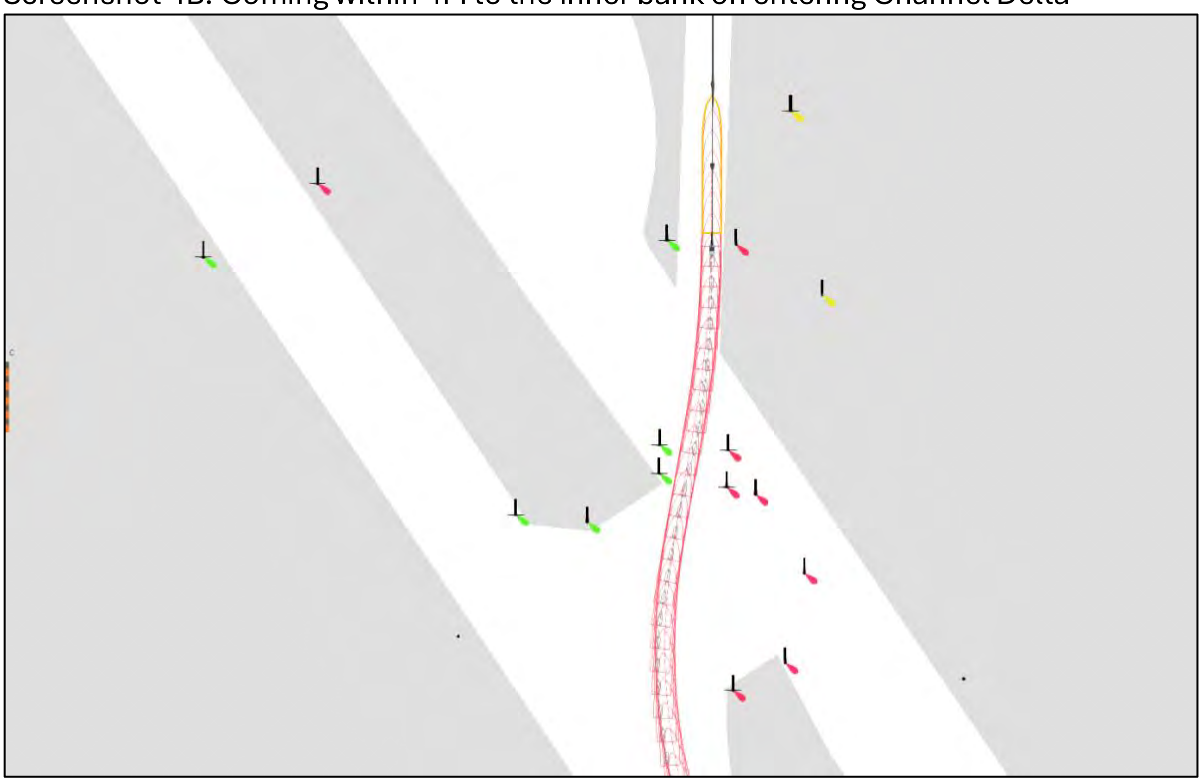
Pilot Comments: The pilot stated that the problems were because they started too late and went too fast. According to the pilot, the turn must be done at 7kn or less, entering Channel Delta from the HSC, similar to Bayport. Also similar to Bayport, the tugs must be made fast at the beginning of the run, well before starting the turn.

List of Screenshots:
Screenshot 4A. Inbound from HSC into Channel Delta
Screenshot 4B. Coming within 12’ to the inner bank on entering Channel Delta
Screenshot 4C. First Turn Inbound on Channel Delta

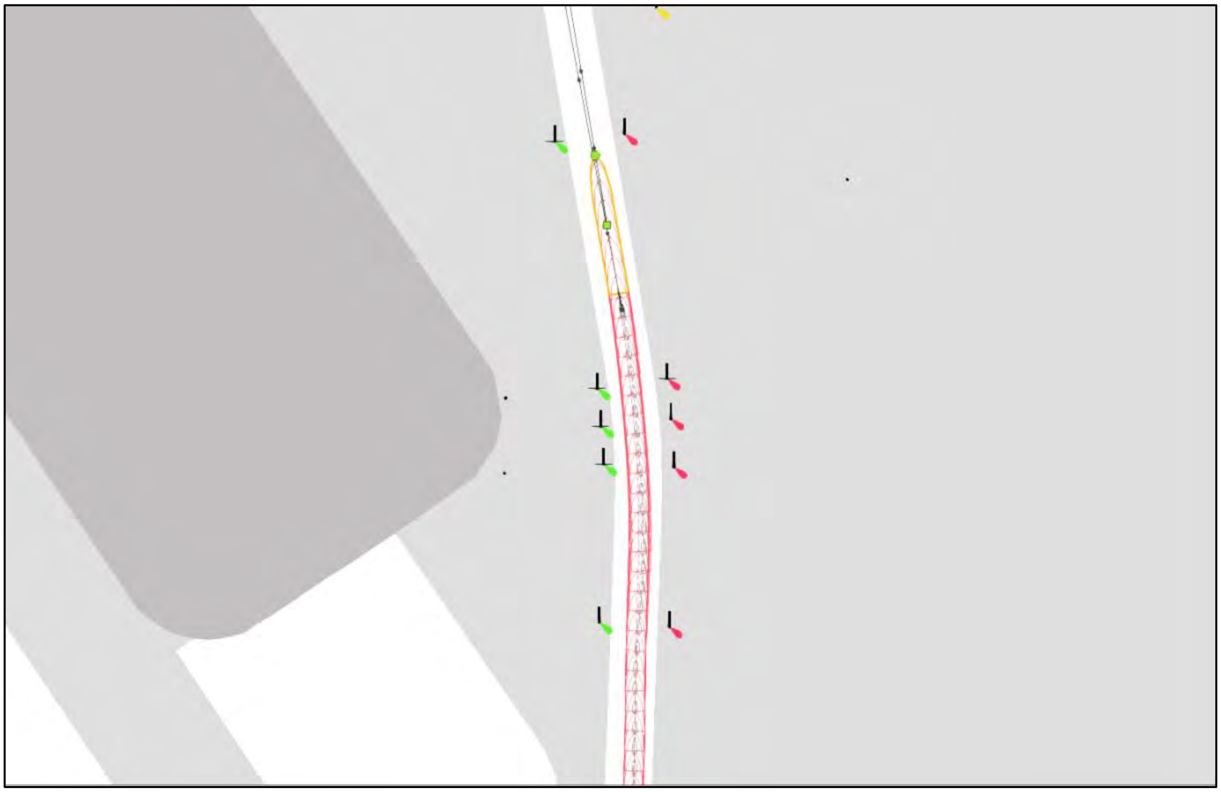
Screenshot 4A. Inbound from HSC into Channel Delta



Screenshot 4B. Coming within 4M to the inner bank on entering Channel Delta



Screenshot 4C. First Turn Inbound on Channel Delta



Run 5. Delta 400’, Arrival ULCV 366m, Wind 135° @15kn, GAR 1

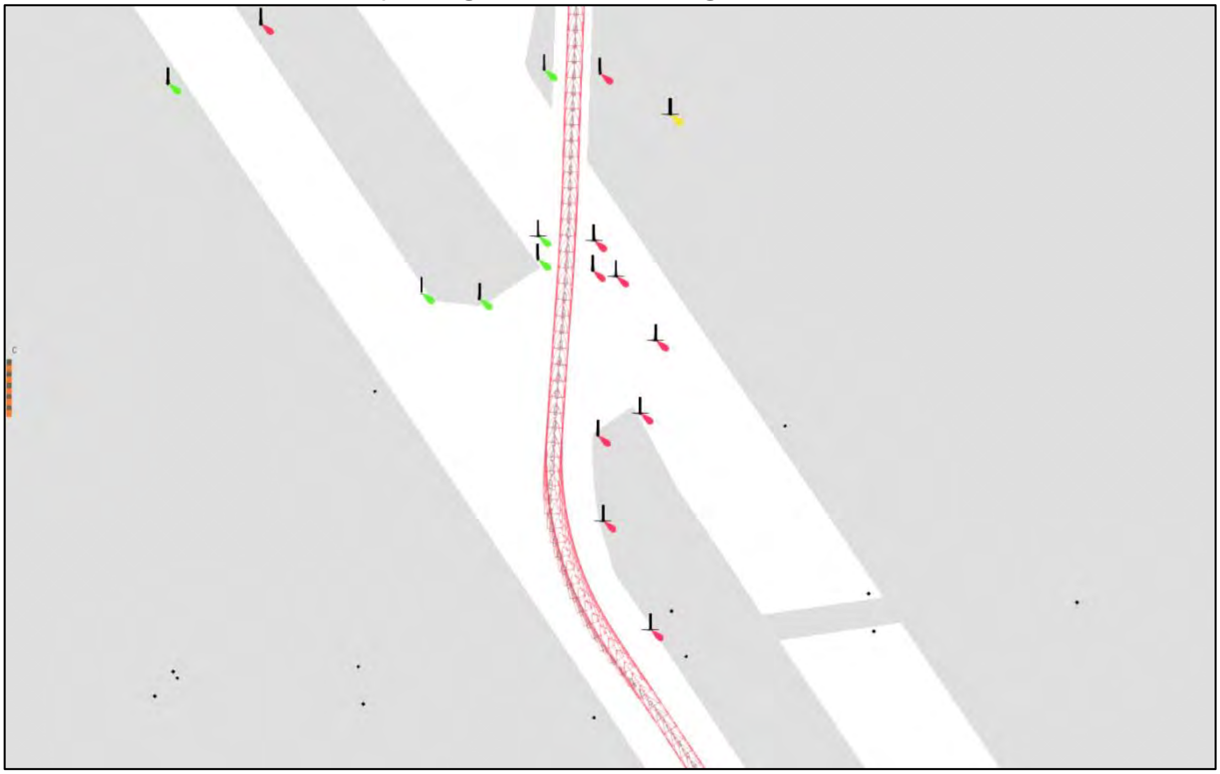
Run Description: As Run #4 failed, an alternative pilot performed the same maneuver for this run. This time, the pilot performed the turn at 6kn and increased to 7kn once the turn was completed inside Channel Delta (Screenshot 5B). The maneuver was then paused and assessed before completing the entire run, as the focus was on the first inbound turn.

Pilot Comments: The pilot stated that 6 to 7kn is required to have the right speed to keep the ship under control. The width of 400’ for the channel is good but requires at least one tug assist. Also, the turns should require wideners to increase the margin of safety.

List of Screenshots:

Screenshot 5A. Inbound Departing the HSC Entering Channel Delta
Screenshot 5B. Inbound First Turn in Channel Delta

Screenshot 5A. Inbound Departing the HSC Entering Channel Delta



Screenshot 5B. Inbound First Turn in Channel Delta

Run 6. Delta 400’, Arrival but Southbound HSC ULCV 366m, Wind 000° @15kn, GAR 3 - FAILED

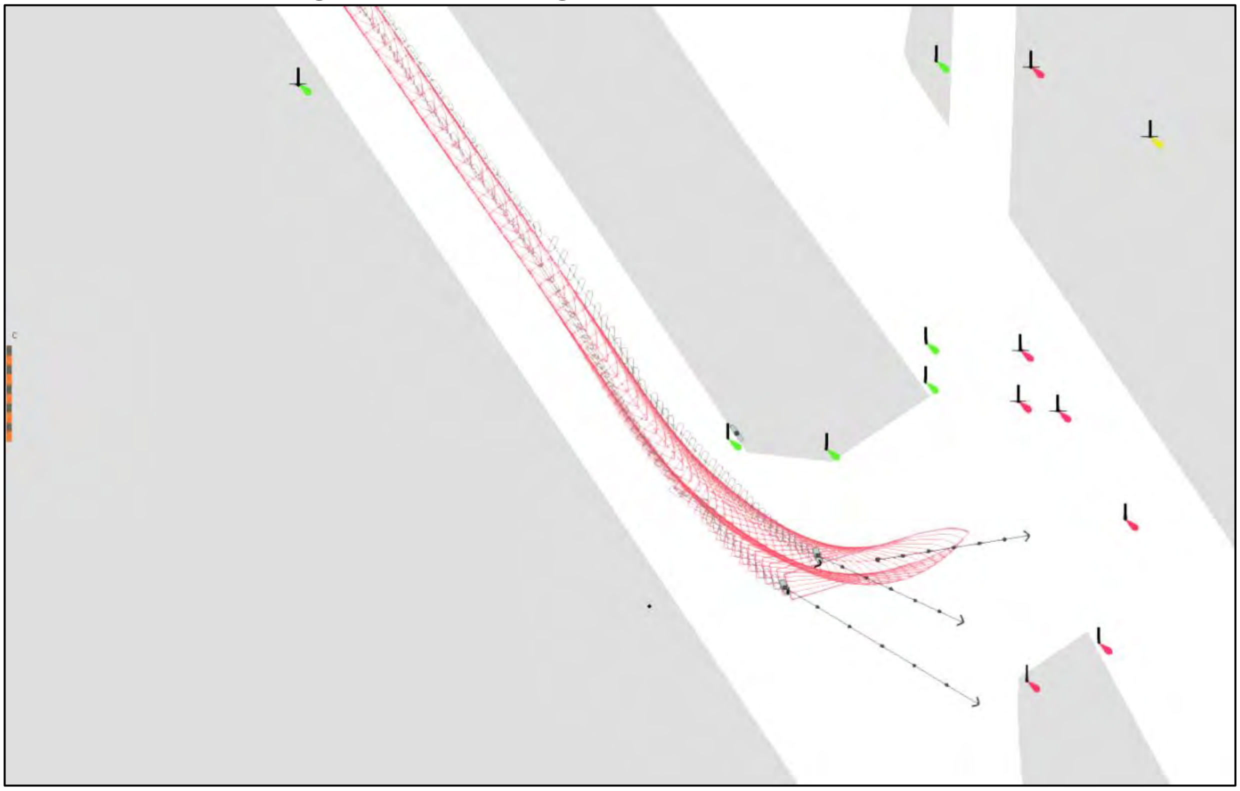
Run Description: For this run, the approach was changed from northbound up the HSC to southbound down the HSC. The ship was unable to make the turn into Delta. The pilot used the two tugs and a bow thruster to make the turn. The pilot decreased the ship's speed during the approach and even stopped the engines while still in the HSC. The turn was done at 3.7kn with a slowly increasing ROT using the rudder, tugs, and bow thruster. The pilot tried to get the ROT up to 15 to 18 degrees but ended up grounding the ship (Screenshot 6A). As the ship ran aground and could not turn into Delta, it is considered a failed maneuver.

Pilot Comments: The ship struck the bottom due to the amount of wind and tug force on a ship this large, listing the ship in the turn, along with an inability to achieve the required turn rate.

List of Screenshots:

Screenshot 6A. Grounding Inbound Heading South Down the HSC to Turn into Delta

Screenshot 6A. Starting Inbound Heading South Down the HSC to Turn into Delta



Run 7. Delta 400', Arrival but Southbound, ULCV 366m, Wind 000° @15kn, GAR 2

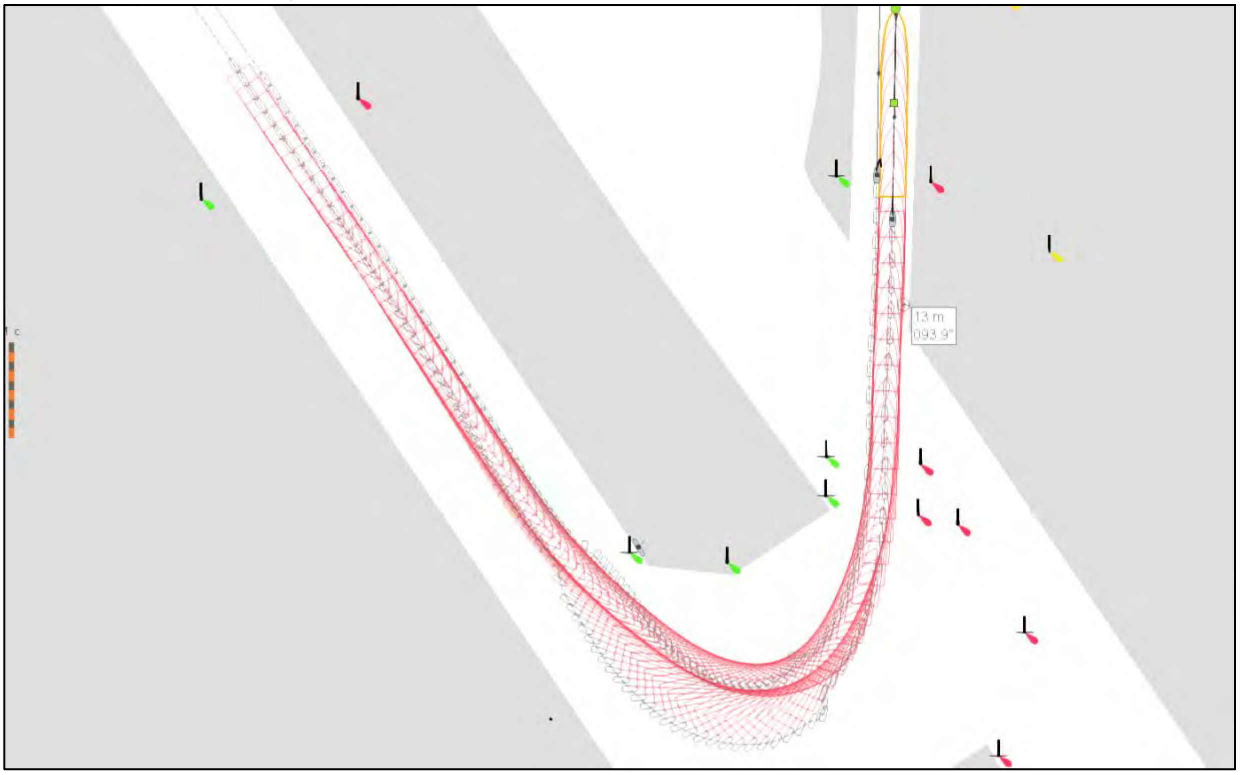
Run Description: Run #7 was a re-run of Run #6 using an alternative pilot. Tidal water was added, +5' (+1.5m), to increase the UKC of the ship when it performs the inbound turn. The approach is from the north, heading down the HSC and trying to make the turn inbound to Cedar Port. The pilot turned off the ship's engine while in the HSC to try to slow down the ship and used the rudder, tugs, and thrusters to turn the ship. Due to the forces on the ship in the maneuver, the ship was listing substantially over 2 degrees and had a ROT of about 20 degrees. At one point, the ship was within 40' of the outer starboard side bank of the channel. The maneuver required hard over rudder, thrusters, and tug power to complete the turn.

Pilot Comments: The pilot reported that they took the ROT off too quickly and ended up too close to the bank. This type of maneuver is highly difficult and, in a loaded ship, probably would require coming to a complete stop in the HSC and using the tugs and thrusters to make a harbor-style turn into Channel Delta.

Screenshots List:

Screenshot 7B. Completed Inbound Turn into Delta from the HSC

Screenshot 7B. Completed Inbound Turn into Delta from the HSC



Run 8. Delta 455', Arrival ULCV 366m, No Wind, GAR 1

Run Description: The ship completed the turn into the channel from the HSC. The ship maintained about 6.5kn and a ROT of 6 degrees to make the turn using the ship's rudder and engines. During the first turn, the ship got 100' from the centerline, which would be within 20' in the 400' channel, but in the 455' channel, the ship was still at a safer distance of 45' from the bank. Similarly, on the second turn, the ship got 110' from the centerline but maintained a safe distance of about 35'. The pilot was able to complete the maneuver safely.

Pilot Comments:

"As a former Houston Ship Pilot, I feel that the Houston Ship Pilots will require a 455' channel for a ship this size, similar to Bayport. On the long Channel Delta, you can travel up to 7kn, but on the HSC, we can take a ship this size up to 8kn. On the 455' channel, there is greater safety as it's easier to keep the ship on the centerline."

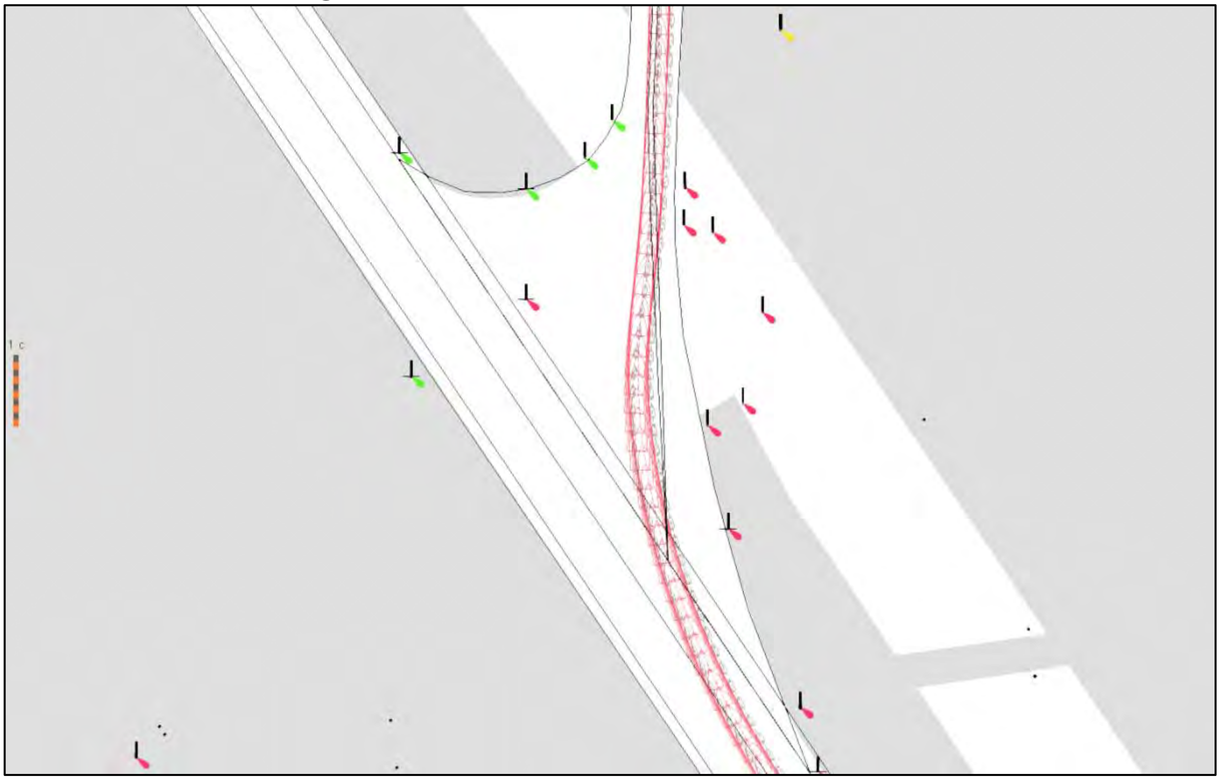
Capt. Jim Concaugh, Houston Pilot (ret.)

In addition to the above quote, the pilot felt they could drive directly into the channel without tugs assisting, but the tugs were there in case. The pilot reported always having plenty of reserve power, whether the tugs or the engines, and was able to keep the rate of turn low. The pilot concluded that Channel Delta is much safer than Channel Alpha as there is a margin for error allowed in Delta but none in Alpha.

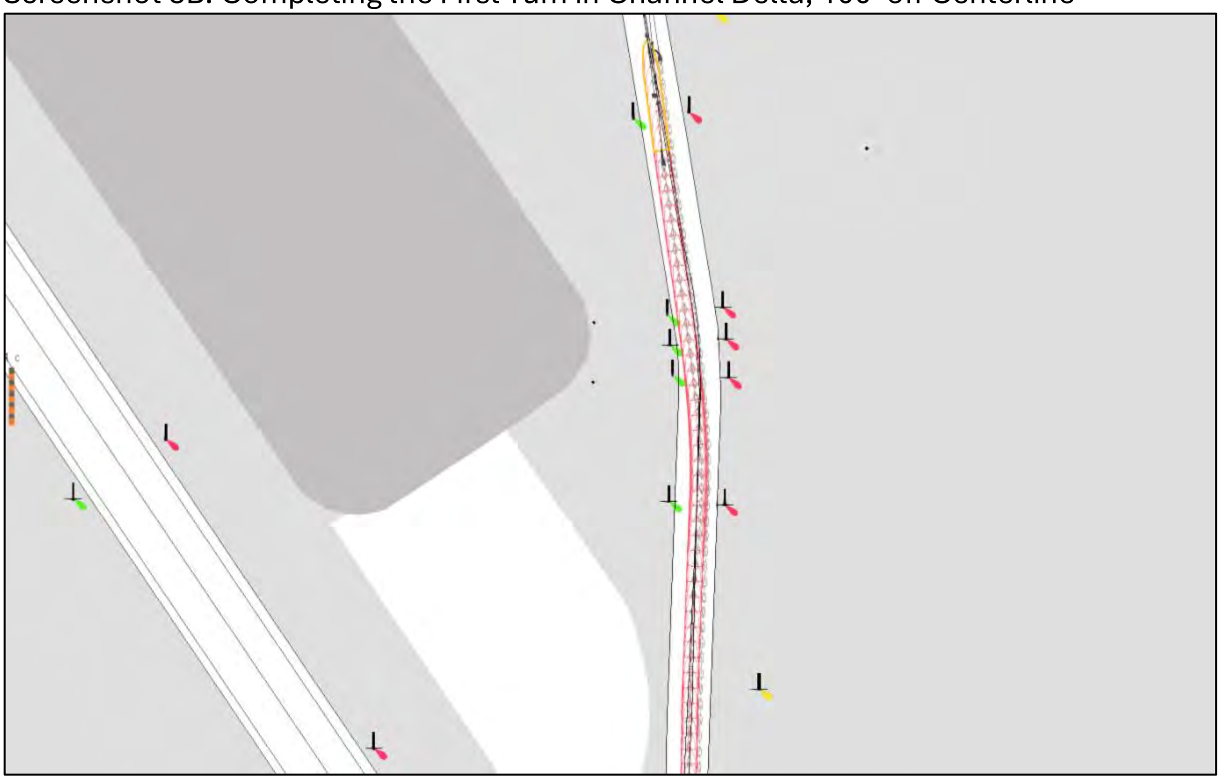
Screenshots List:

Screenshot 8A. Entering Channel Delta from the HSC
Screenshot 8B. Completing the First Turn in Channel Delta, 100' off Centerline
Screenshot 8C. Completing the Second Turn in Channel Delta, 110' off Centerline

Screenshot 8A. Entering Channel Delta from the HSC



Screenshot 8B. Completing the First Turn in Channel Delta, 100’ off Centerline



Screenshot 8C. Completing the Second Turn in Channel Delta, 110’ off Centerline

Run 9. Delta 455', Sailing ULCV 366m, No Wind, GAR 1

Run Description: This was not a complete run from the terminal basin to the HSC. Rather, this was the last run of the day, and due to lack of time, the run included just the two in-channel turns. The ship headed outbound down the channel, starting before the first turn. The turn was successful at about 6kn, and the pilot kept the ROT down to less than 4 degrees. The second turn was similar, with the pilot keeping the ship on the centerline at 6.4kn with a ROT reaching 5 degrees.

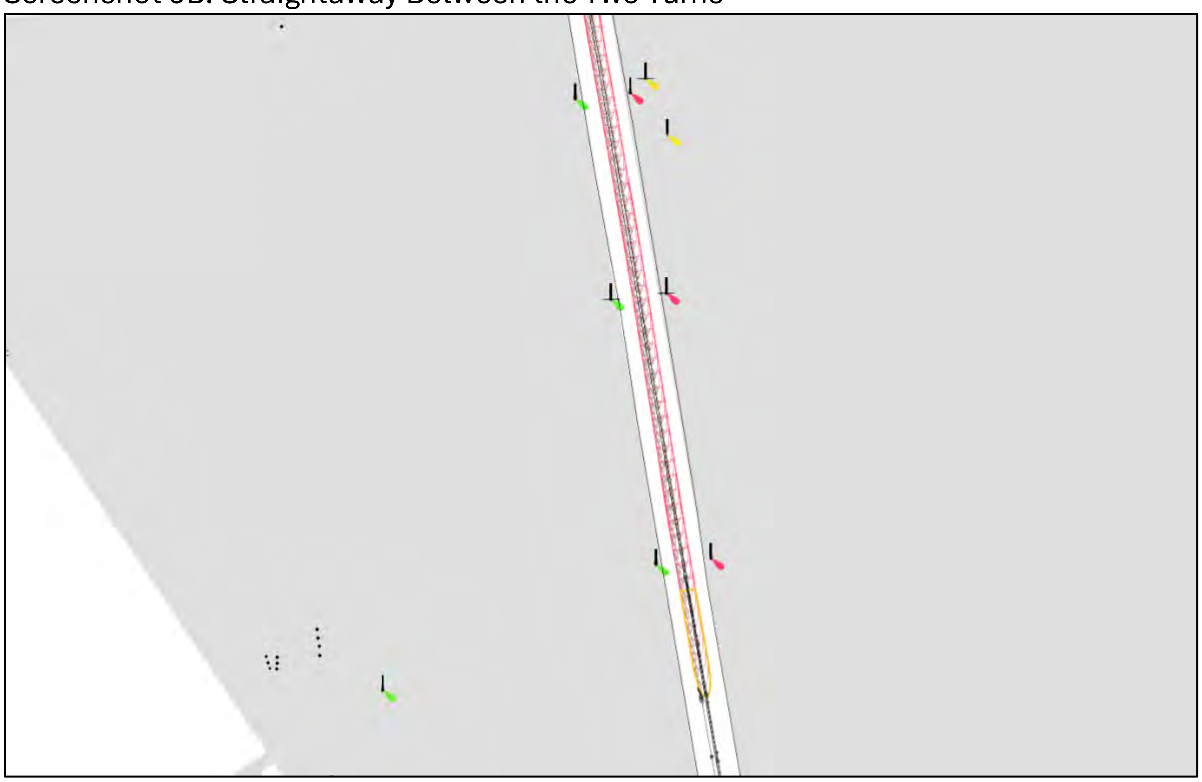
Pilot Comments: This was a straightforward, routine ship-handling maneuver. The 455' channel is better because there is a greater margin for error. It is easier to keep the ROT lower and more power in reserve. In the 455' channel, I can also drive right into the channel much easier than in a narrower channel. Wideners for the turns would still be beneficial as it would make them safer.

Screenshots List:

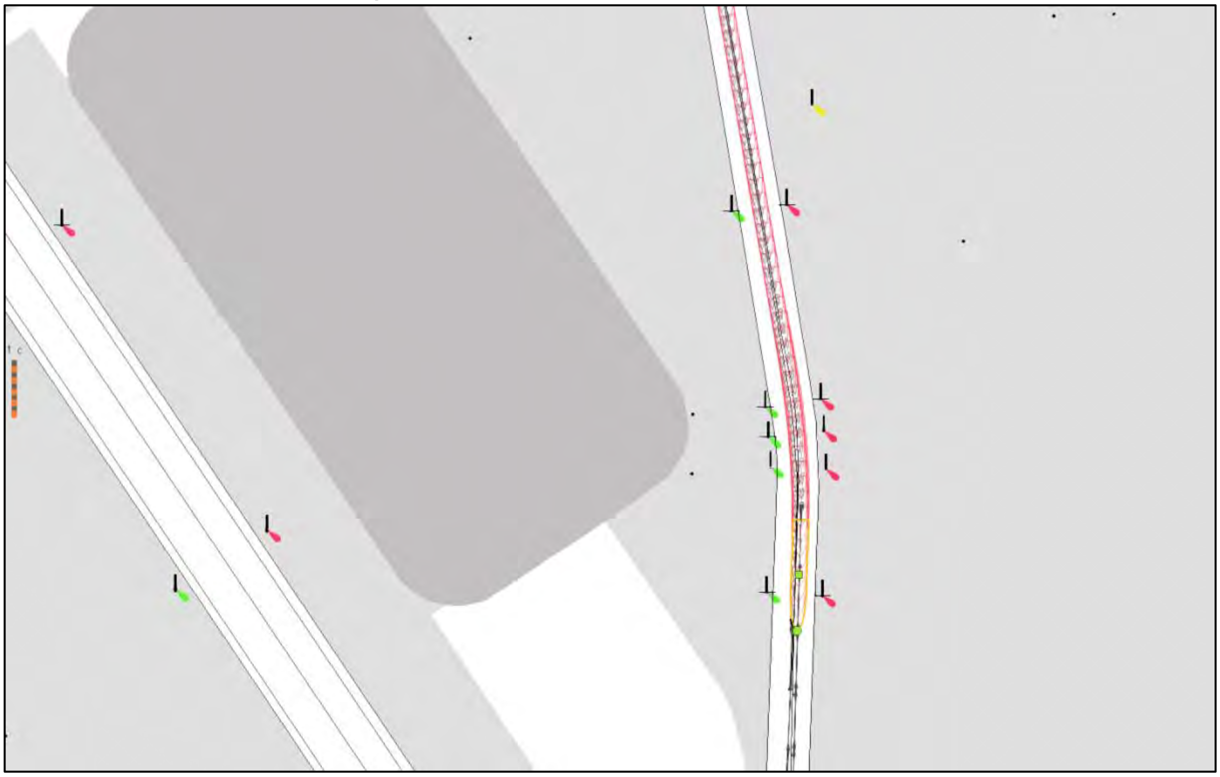
Screenshot 9A. Heading Outbound Entering the First Turn
Screenshot 9B. Straightaway Between the Two Turns
Screenshot 9C. Completing the Second Outbound Turn

Screenshot 9A. Heading Outbound Entering the First Turn

Screenshot 9B. Straightaway Between the Two Turns



Screenshot 9C. Completing the Second Outbound Turn



Channel Alpha (Runs #10 – 18)

Channel Description: Channel Alpha is 3.9 miles long and takes about 50 minutes to transit from the terminal basin to the HSC. Alternative channels 400’ (Runs #10 – 16) and 455’ (Runs #17 – 18) wide alignments were tested. Based on a route from the HSC on the centerline, the following turns and distances were established: HSC entry into the channel requires a continuous motion turn of 143° (from heading 339° to 122°) over about 2 miles that was broken into several segments. The first segment is a turn of 85° (from heading 339° to heading 064°) in 0.7 miles, the second segment is a turn of 9° (from heading 064° to 073°) in 0.7 miles, the third segment is a turn of 23° (from heading 073° to 096°) in 1,200’, the fourth segment is a turn of 17° (from heading 096° to 113°) in 1,400’ and the final segment is a turn of 9° (from heading 113° to 122°) in 900’. The straightaway in the channel is 1.3 miles long and requires a course correction of 5° (from heading 122° to 127°). The final turn in the channel requires a 29° turn (from heading 127° to 156°) in just 2,100’. This turn was broken into two segments. The first segment is a 13° turn (from heading 127° to 140°) in 900’, and the second segment is a 16° turn (from heading 140° to 156°) in 1,200’. These turns are both acute, given the ship is 1,200’ long. It is a straightaway of 0.4 miles from the last turn into the terminal basin at heading 156°.

Channel Assessment: Channel Alpha is not feasible for safe navigation. The pilots could not reliably and safely make the continuous arcing turn into the channel's entrance from the HSC and vice versa. The in-channel turn of 29° near the terminal basin also posed a hazard. There were multiple allisions on both sides of the bank, inbound and outbound. The issues were similar in the 455’ wide channel as well.

Run 10. Alpha 400', Arrival ULCV 366m, No Wind, GAR 3 - FAILED

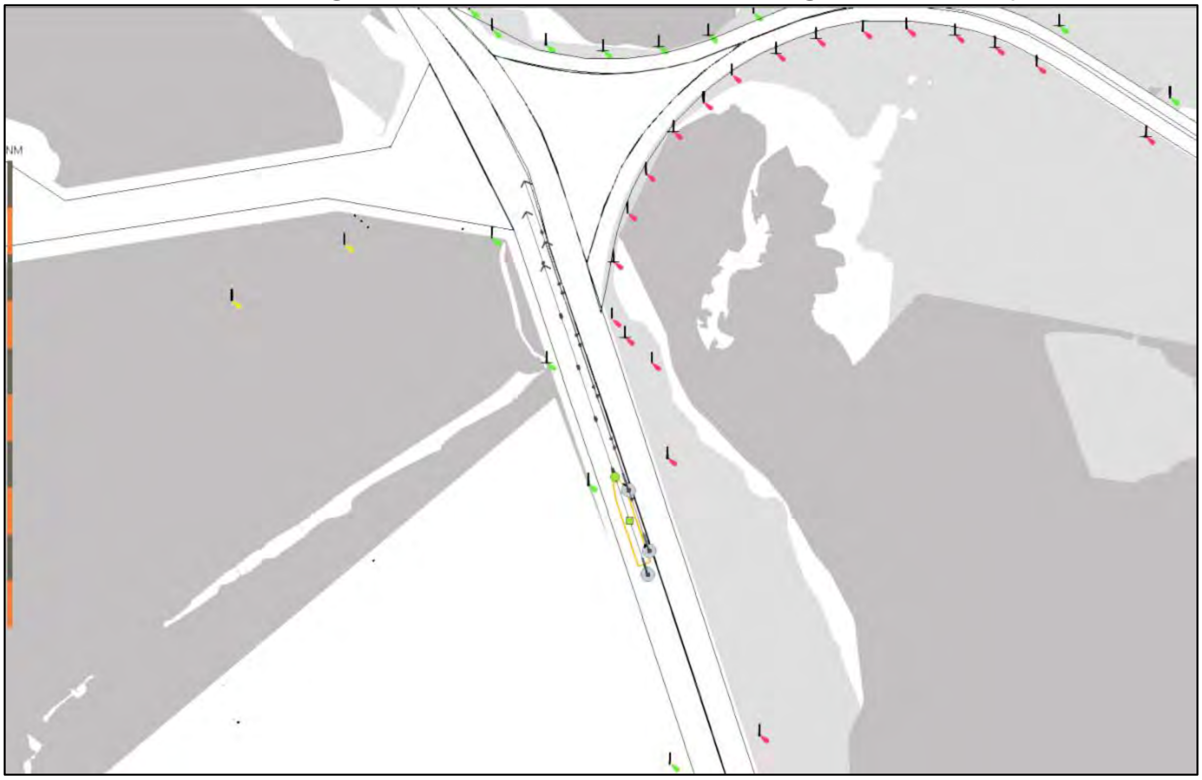
Run Description: The pilot could not safely navigate the ship through the continuous motion turn and subsequent in-channel turn, striking the bank twice, requiring pausing the simulation and repositioning the ship back on the centerline. During the entrance from the HSC to the channel, the pilot turned off the ship's engines to begin the turn, trying to reduce the ship's speed from 5kn. The pilot relied on the tugboats and rudder, at a slow speed of 4kn, attempting to make the 143° continuous motion turn. However, the ship came too close to the inner starboard side bank (Screenshot 10B) then, due to bank forces and over-correction, the ship ran uncontrolled across the channel, striking the outer portside bank (Screenshots 10C & 10D). The ship's speed was 6.5kn and began to scrape across the bottom due to listing greater than 2 degrees. To continue the run, the simulation was paused, and the ship was moved back to the centerline. The pilot then transited the channel at about 6kn until the final 29° turn was reached before entering the terminal basin. During this turn, the pilot reduced the ship's speed to less than 4kn, making the ship difficult to maneuver and requiring the tugs. The ship struck the inner portside bank (Screenshots 10E & 10F). This was a failed maneuver as the ship struck the bank in multiple locations.

Pilot Comments: The pilot stated that there were multiple incidents of the ship striking the banks. They felt they had a good starting speed and turn but encountered some problems. They were unable to recover the ship on the turns. This channel requires complete precision and perfect timing.

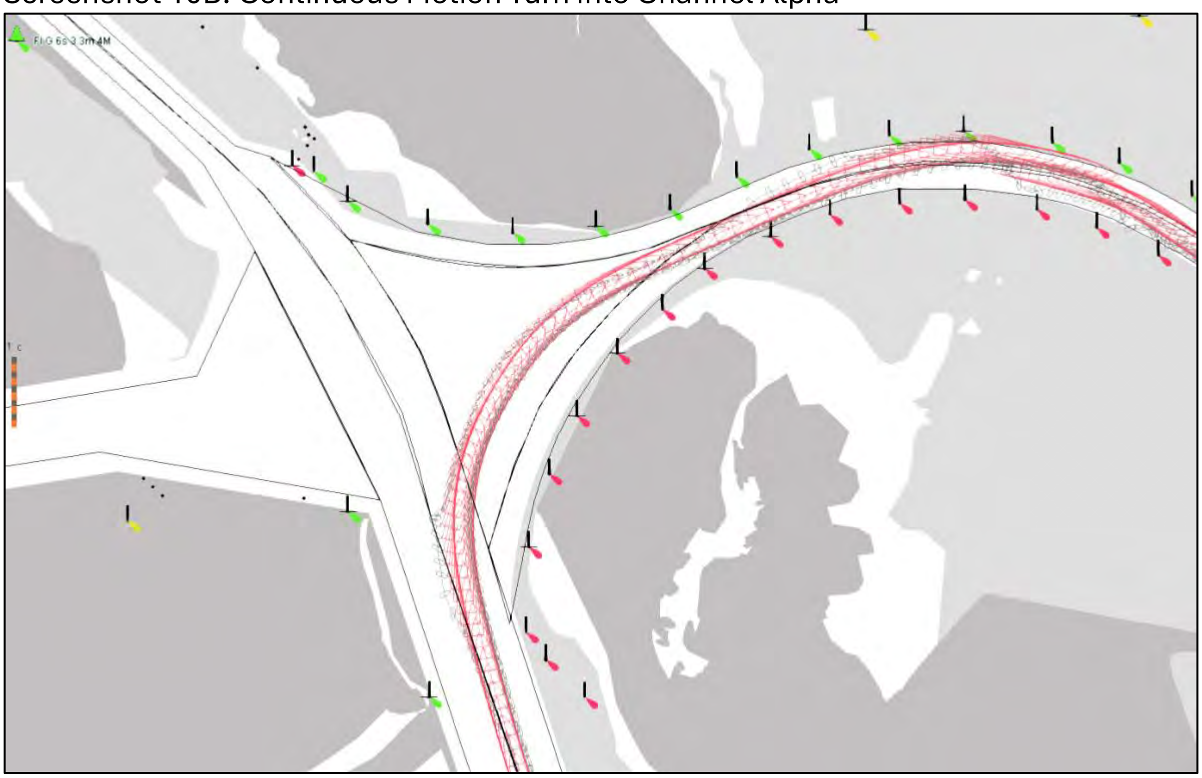
List of Screenshots:

Screenshot 10A. Starting Position Inbound on HSC Heading to Channel Alpha Screenshot
Screenshot 10B. Continuous Motion Turn into Channel Alpha
Screenshot 10C. Completed Continuous Motion Turn and Straightaway in Channel Alpha
Screenshot 10D. Close-up of Continuous Turn at Channel Alpha
Screenshot 10E. Second Turn and Entrance into Terminal Basin from Channel Alpha
Screenshot 10F. Close-up of Hitting Bank Entering Terminal Basin from Channel Alpha

Screenshot 10A. Starting Position Inbound on HSC Heading to Channel Alpha

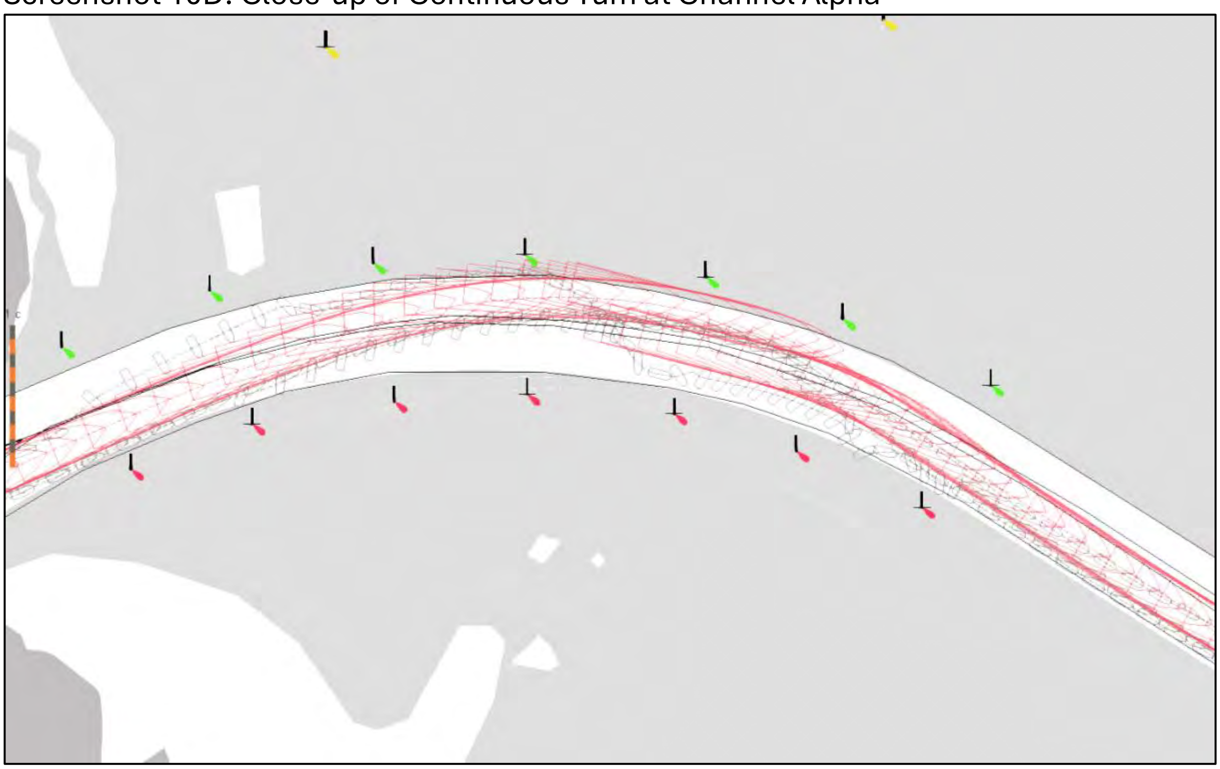


Screenshot 10B. Continuous Motion Turn into Channel Alpha



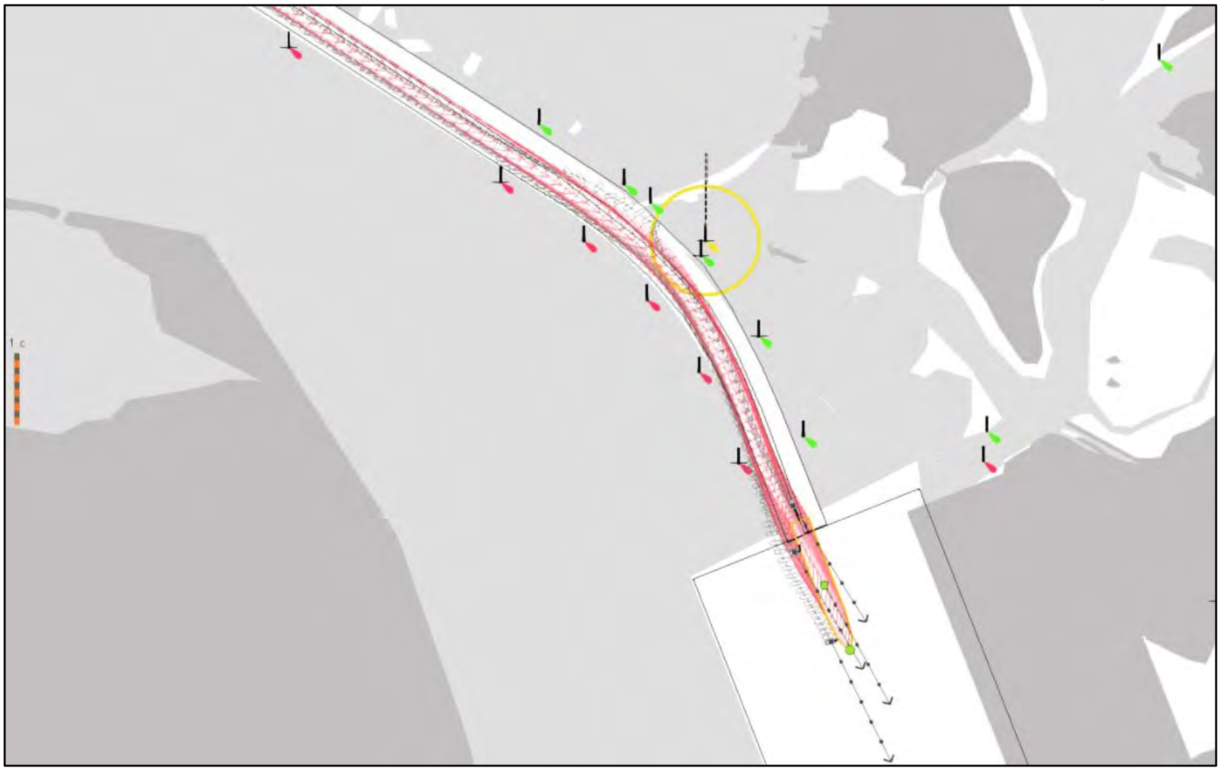
Screenshot 10C. Completed Continuous Motion Turn and Straightaway in Channel Alpha

Screenshot 10D. Close-up of Continuous Turn at Channel Alpha



Locus

Screenshot 10E. Second Turn and Entrance into Terminal Basin from Channel Alpha



Screenshot 10F. Close-up of Hitting Bank Entering Terminal Basin from Channel Alpha

Run 11. Alpha 400’, Sailing ULCV 366m, No Wind, GAR 2

Run Description: The run began at the terminal basin's exit and the channel's entrance. The pilot maintained positive control of the vessel throughout the in-channel turns and transit using speeds of 3.5 to 5.5kn. During the continuous motion of the turn into the HSC, the stern of the ship was within 20’ of the outer starboard side bank (Screenshot 11D). Upon entering the HSC, the ship was going 8kn with a ROT of 7 degrees, causing it to list and scrape along the bottom of the HSC.

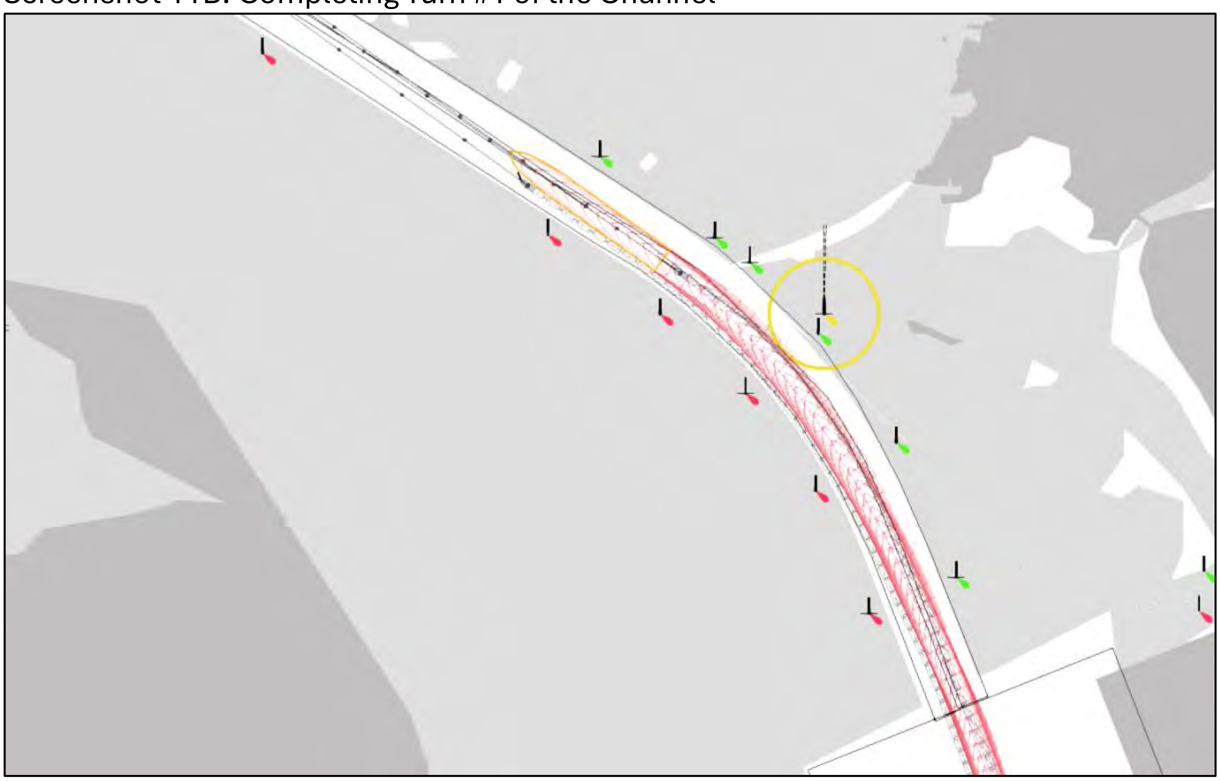
Pilot Comments: The pilot stated that he was too fast to exit the channel and should have been doing around 5kn. The channel’s width at 400’ was not an issue, and the straightaways were safe to transit. The problem was the continuous motion turn, which must be flared or cut back to reduce the ROT.

List of Screenshots:

Screenshot 11A. Outbound of Terminal Basin Entering Channel Alpha
Screenshot 11B. Completing Turn #1 of the Channel
Screenshot 11C. Beginning the Continuous Motion Turn into the HSC
Screenshot 11D. Entering the HSC from the Continuous Motion Turn – Stern 20’ from Bank
Screenshot 11E. Ship Turning into HSC at 8kn scraping along the bottom of the HSC

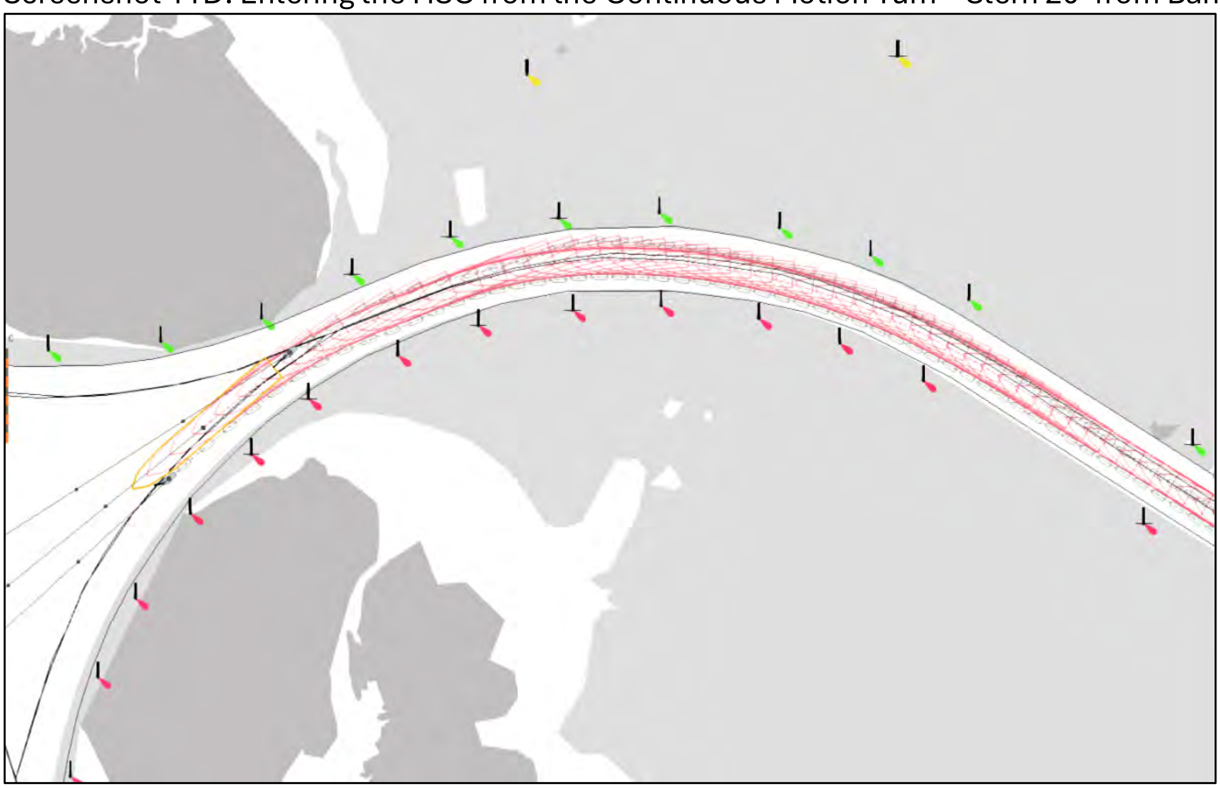
Screenshot 11A. Outbound of Terminal Basin Entering Channel Alpha

Screenshot 11B. Completing Turn #1 of the Channel

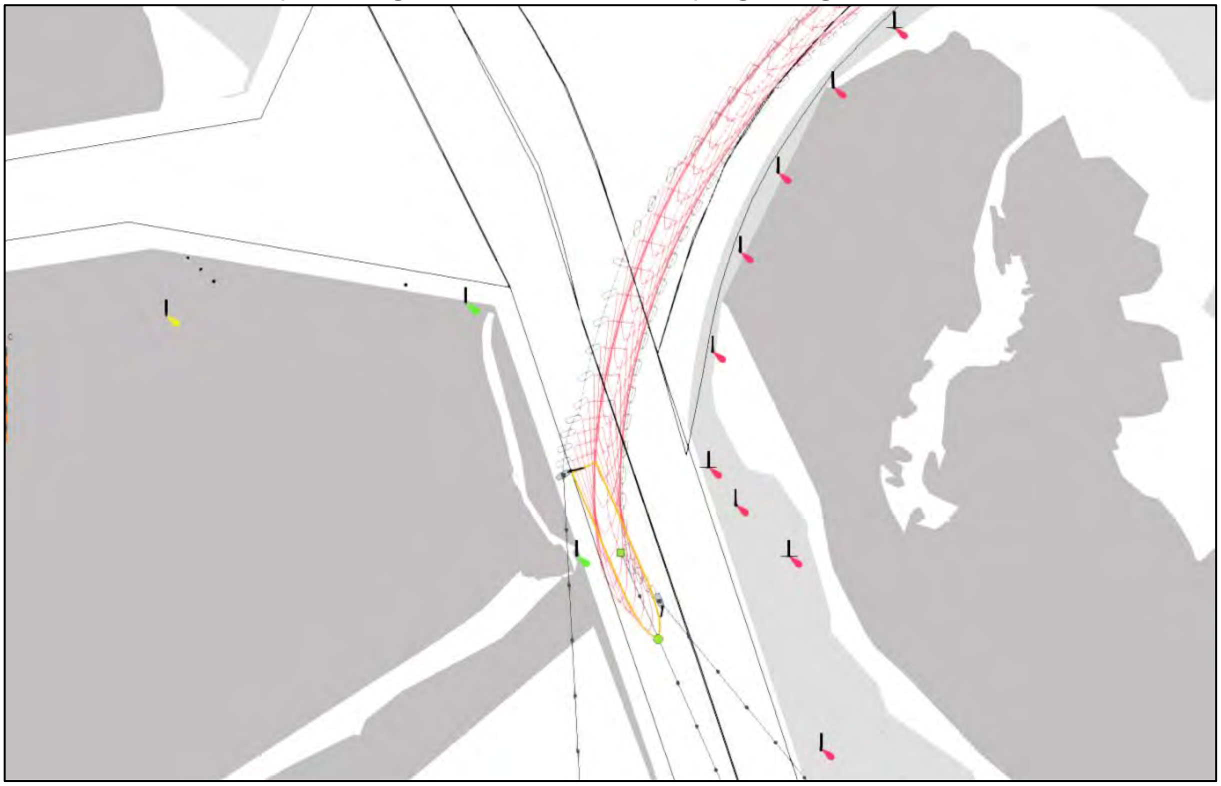


Screenshot 11C. Beginning the Continuous Motion Turn into the HSC

Screenshot 11D. Entering the HSC from the Continuous Motion Turn – Stern 20' from Bank



Screenshot 11E. Ship Turning into HSC at 8kn scraping along the bottom of the HSC



Run 12. Alpha 400', Sailing ULCV 366m, Wind 000° @15kn, GAR 3 - FAILED

Run Description: To further assess Channel Alpha 400' outbound, the wind was added from the north (000° @ 15kn). The run started heading out of the terminal basin at 3kn with increasing velocity up to 4.5kn to make the first turn. This first turn was successful, along with the straightaway transit leading up to the continuous motion turn. The pilot started the turn at 5.6kn, trying to turn the ship to port, but the ship got sucked into the outer starboard side bank. This led to the stern alliding with the bank while the ship was underway at 5kn. The pilot could not get separated from the bank as there was not enough room to turn away (Screenshots 12C & 12D). After departing the channel at about 5kn, the pilot attempted to complete the turn into the HSC. However, as the ROT increased to 17 degrees per minute, the ship began to list and roll at greater than 2 degrees, causing the ship to scrape along the bottom of the HSC.

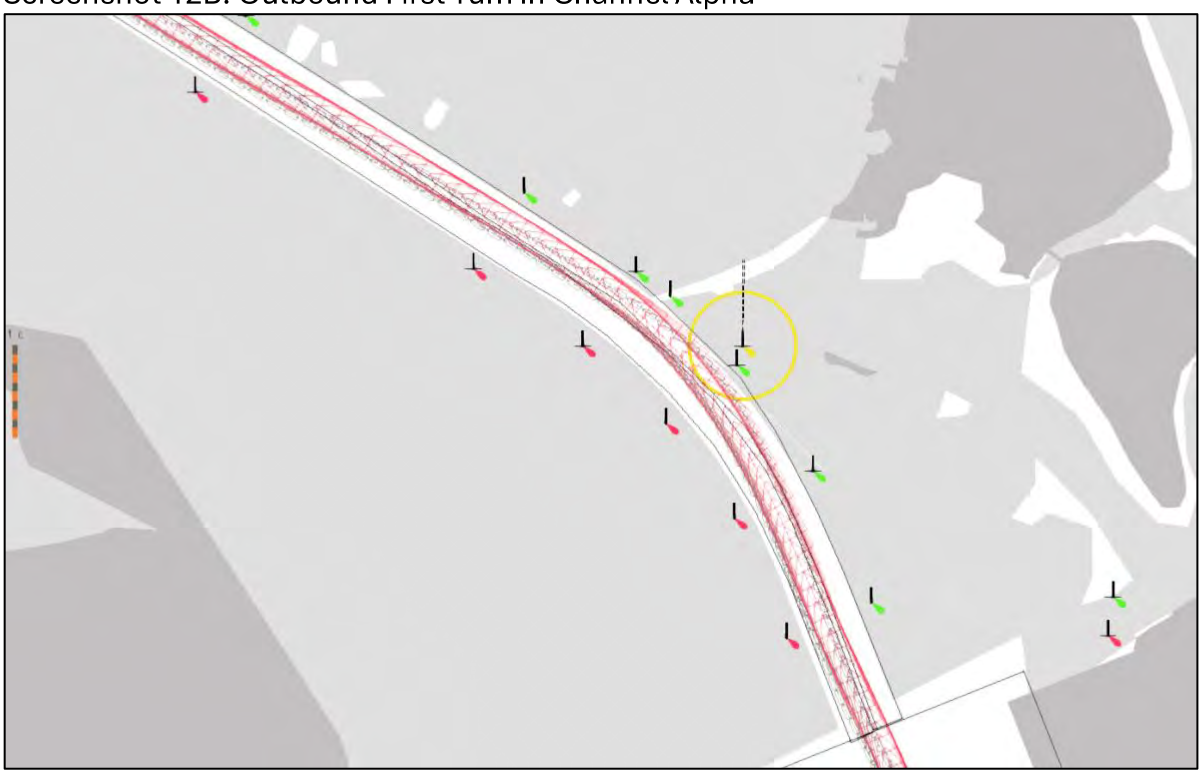
Pilot Comments: The pilot commented that in this channel, "there is zero recovery room. You cannot be early or late." The pilot used the analogy that this channel requires riding on rails to keep on the centerline through these turns. The pilot had to utilize all three tugs and still struck the bank.

List of Screenshots:

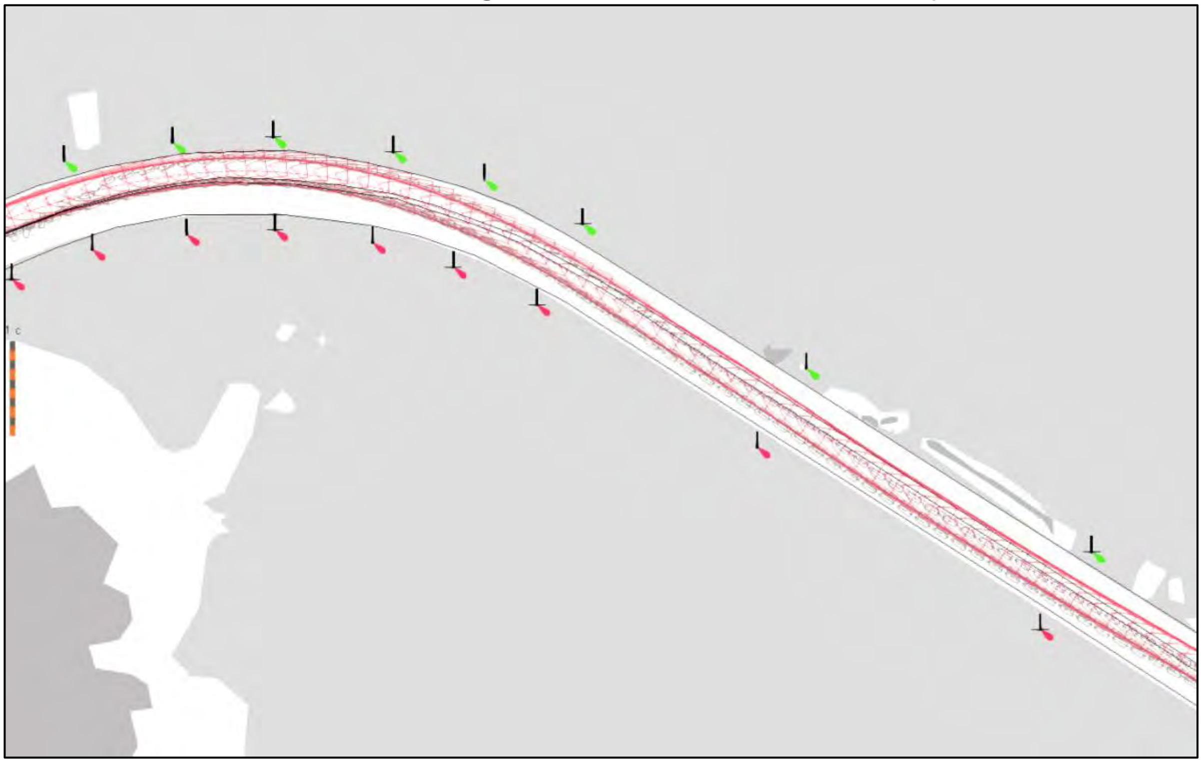
Screenshot 12A. Outbound from Terminal Basin into Channel Alpha
Screenshot 12B. Outbound First Turn in Channel Alpha
Screenshot 12C. Outbound Starting Continuous Turn on Channel Alpha
Screenshot 12D. Completing Continuous Turn on Channel Alpha
Screenshot 12E. Entering HSC from Channel Alpha

Screenshot 12A. Outbound from Terminal Basin into Channel Alpha

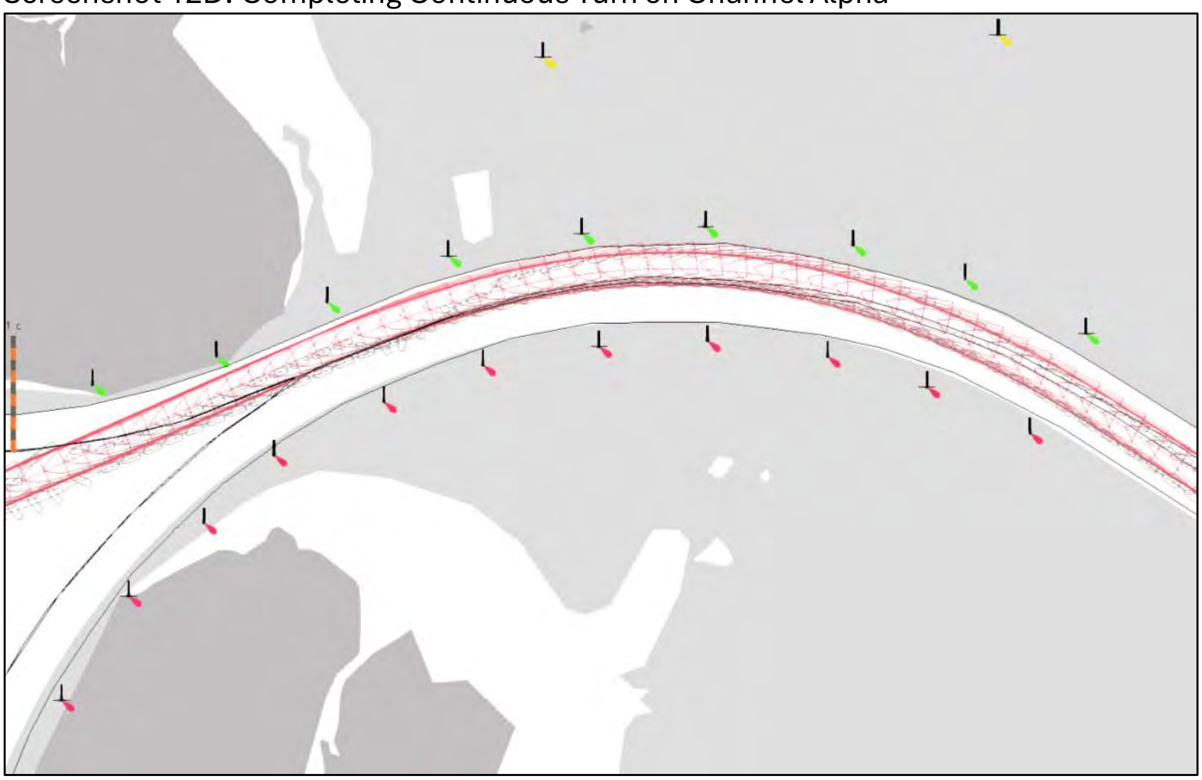
Screenshot 12B. Outbound First Turn in Channel Alpha



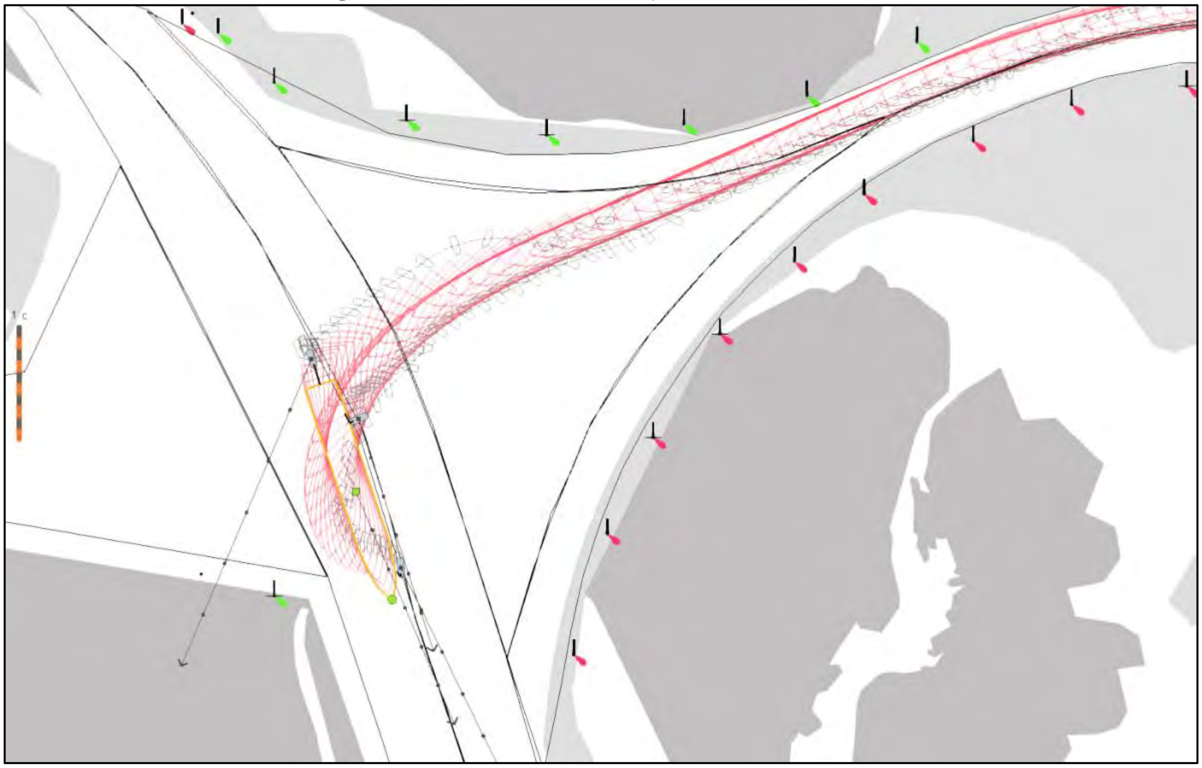
Screenshot 12C. Outbound Starting Continuous Turn on Channel Alpha



Screenshot 12D. Completing Continuous Turn on Channel Alpha



Screenshot 12E. Entering HSC from Channel Alpha



Run 13. Alpha 400', Arrival ULCV 366m, Wind SE 135°@15kn, GAR 1

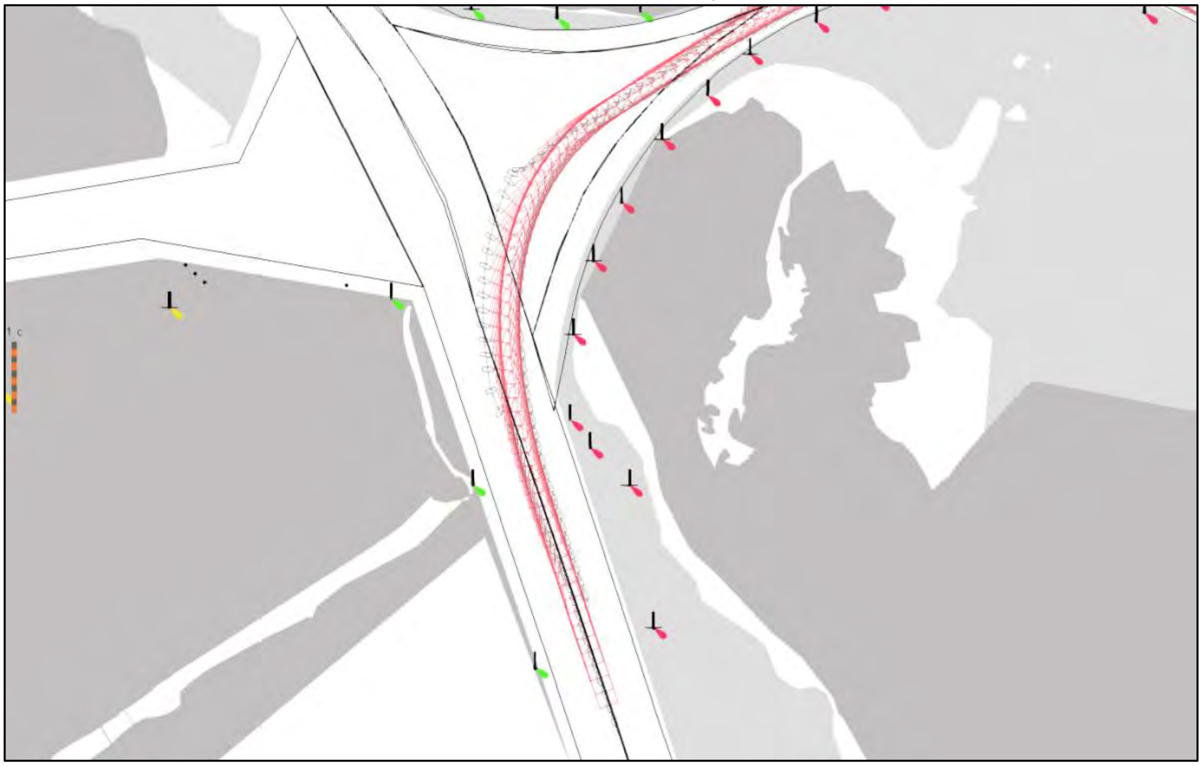
Run Description: To assess the inbound navigability of Alpha 400', the southeast wind was added at 15kn, along with two tugs. This was the first maneuver that was completely successful, not striking any of the banks and not coming close nor scraping the bottom of the channel due to the ship listing. The pilot maintained positive control over the ship and regulated its speed to 4.5 and 5.8kn. The ROT on the continuous motion turn reached 14 degrees per minute at one point, but the pilot was able to quickly take off the ROT to maintain control of the ship.

Pilot Comments: The pilot attributed this to using two tugs and keeping on the inside of the turn, stating that on the outside of the turn, you cannot correct (Screenshot 13B). The pilot stated that you must stay on the centerline the entire time on this channel as there is little to no room for error.

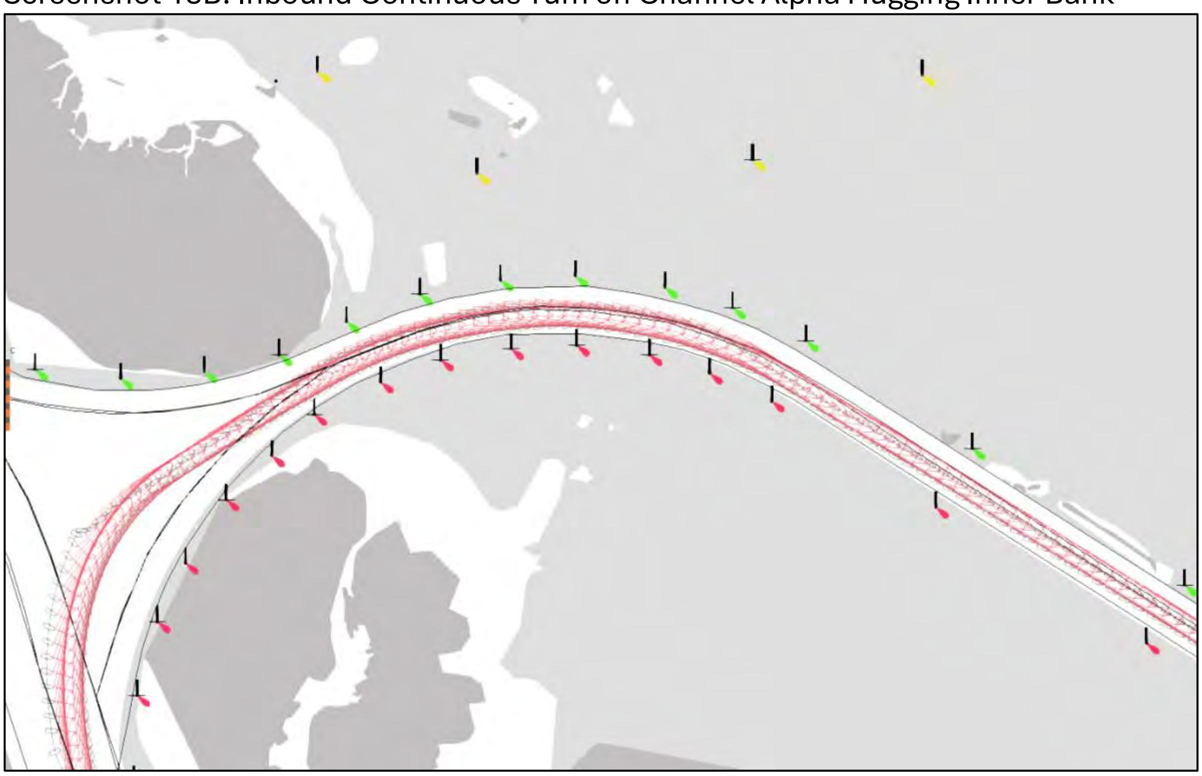
List of Screenshots:

Screenshot 13A. Inbound from HSC into Channel Alpha
Screenshot 13B. Inbound Continuous Turn on Channel Alpha Hugging Inner Bank
Screenshot 13C. Second Turn and Entering the Terminal Basin from Channel Alpha

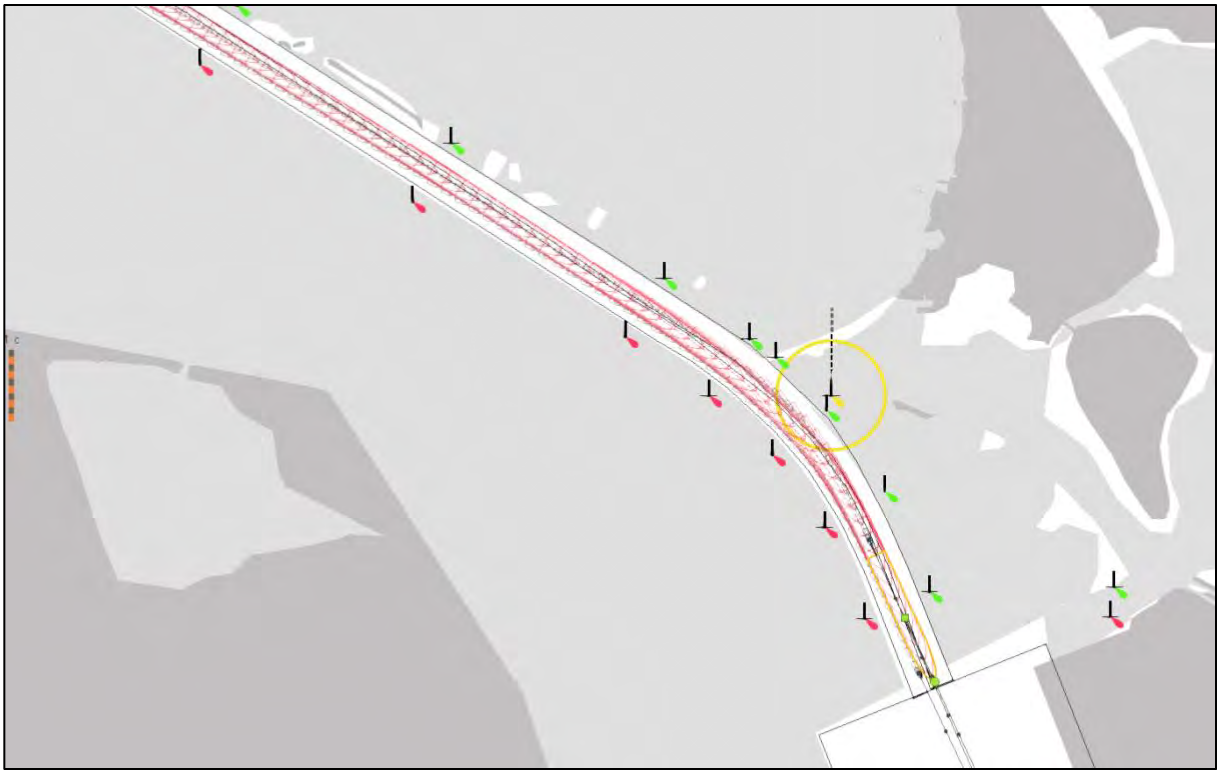
Screenshot 13A. Inbound from HSC into Channel Alpha



Screenshot 13B. Inbound Continuous Turn on Channel Alpha Hugging Inner Bank



Screenshot 13C. Second Turn and Entering the Terminal Basin from Channel Alpha



Run 14. Alpha 400’, Arrival CNTR35, No Wind, GAR 3 – FAILED

Run Description: One of the hazards encountered in testing the Channel Alpha was the ships would scrape along the bottom when listing at 2 degrees or greater. This listing would occur at a high ROT. This listing resulted from a great amount of force on the ship, such as three tugs and a hard over rudder, and/or if the ship was going too fast during a turn such as 7kn or greater, and the pressure of the wind. To counter this problem, it was decided to increase the water under the ship’s keel using a similar container ship model with the same LOA and Beam but 0.5’ less draft.

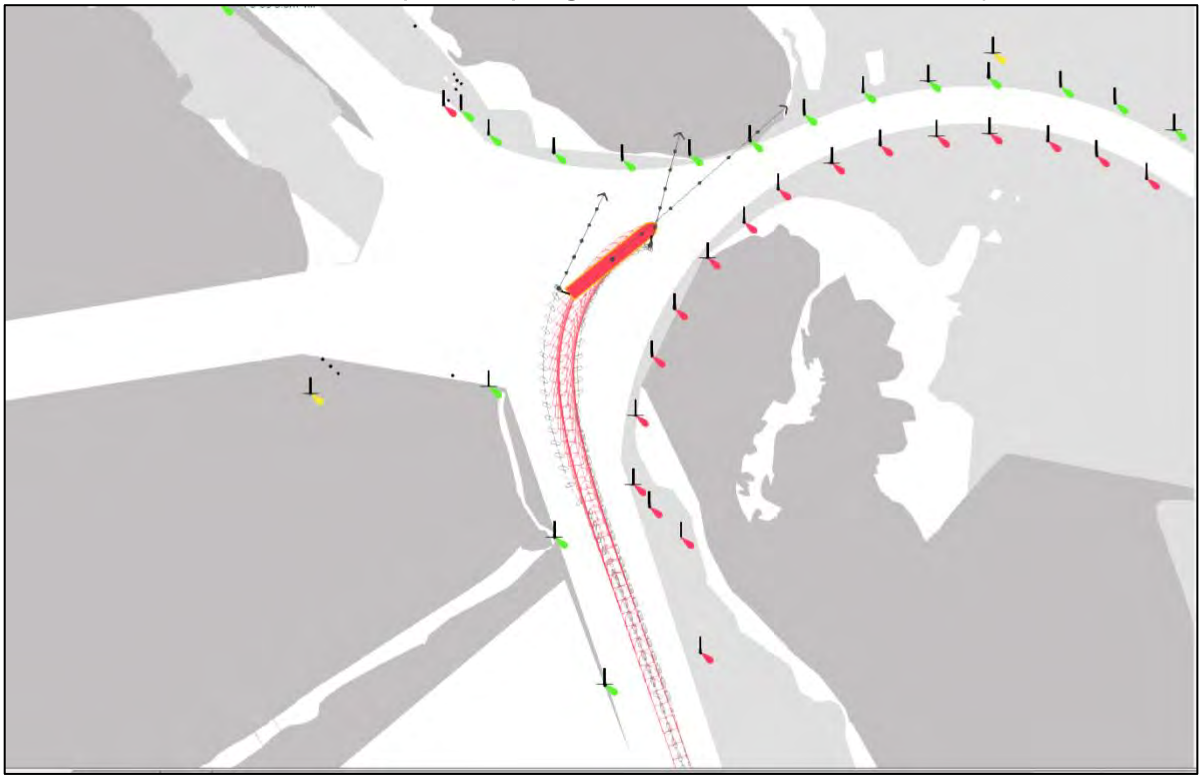
During the simulation run, the arriving ship started the continuous motion turn into Channel Alpha at 4.8kn, and the ROT quickly got up to 15 degrees per minute. The ROT on the ship continued to increase to 18 degrees per minute when the pilot began to check the turn with orders of hard over on the rudder and tug orders. Using a power indirect maneuver with the center-lead aft tug, the pilot was able to reduce the ROT quickly to 10 degrees; then, it kept coming down to 4 degrees per minute. The pilot could not control the ship during the turn (Screenshot 14B), and it struck the southern or starboard side bank after the ship hit the port bank and ran across the channel, hitting the opposite northern bank as well (Screenshot 14C).

Pilot Comments: The pilot commented that performing the continuous motion turn to get and maintain the perfect rate of turn and ship speed is highly difficult. The pilot stated that the typical ROT at Bayport is 12 to 13 degrees, while this continuous motion turn requires a 14- or 15-degree ROT, which is highly difficult to control along with speed on a ship this size. This is a failed maneuver, striking multiple banks and being unable to complete the turn into the channel.

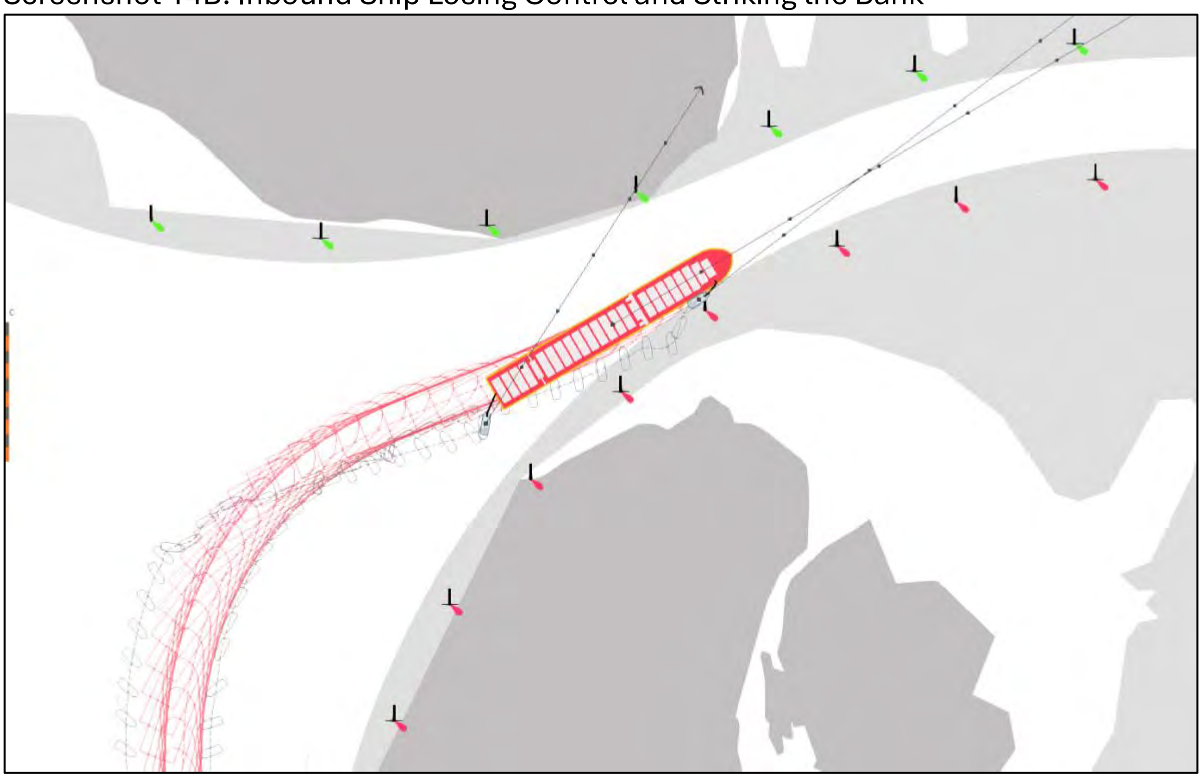
List of Screenshots:

Screenshot 14A. Inbound Ship Attempting Turn from HSC to Channel Alpha
Screenshot 14B. Inbound Ship Losing Control and Striking the Bank
Screenshot 14C. The Ship Veering from One Bank to Another

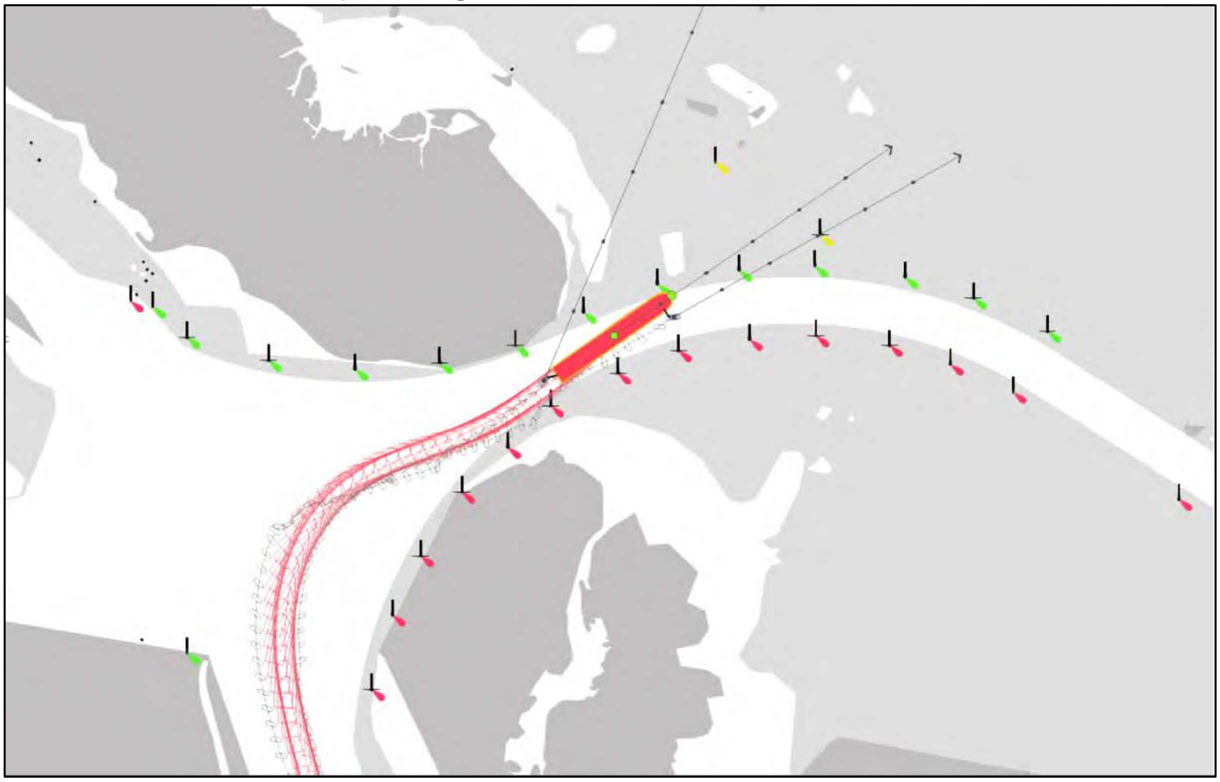
Screenshot 14A. Inbound Ship Attempting Turn from HSC to Channel Alpha



Screenshot 14B. Inbound Ship Losing Control and Striking the Bank



Screenshot 14C. The Ship Veering from One Bank to Another



Run 15. Alpha 400’, Sailing CNTR35, No Wind, GAR 3 - FAILED

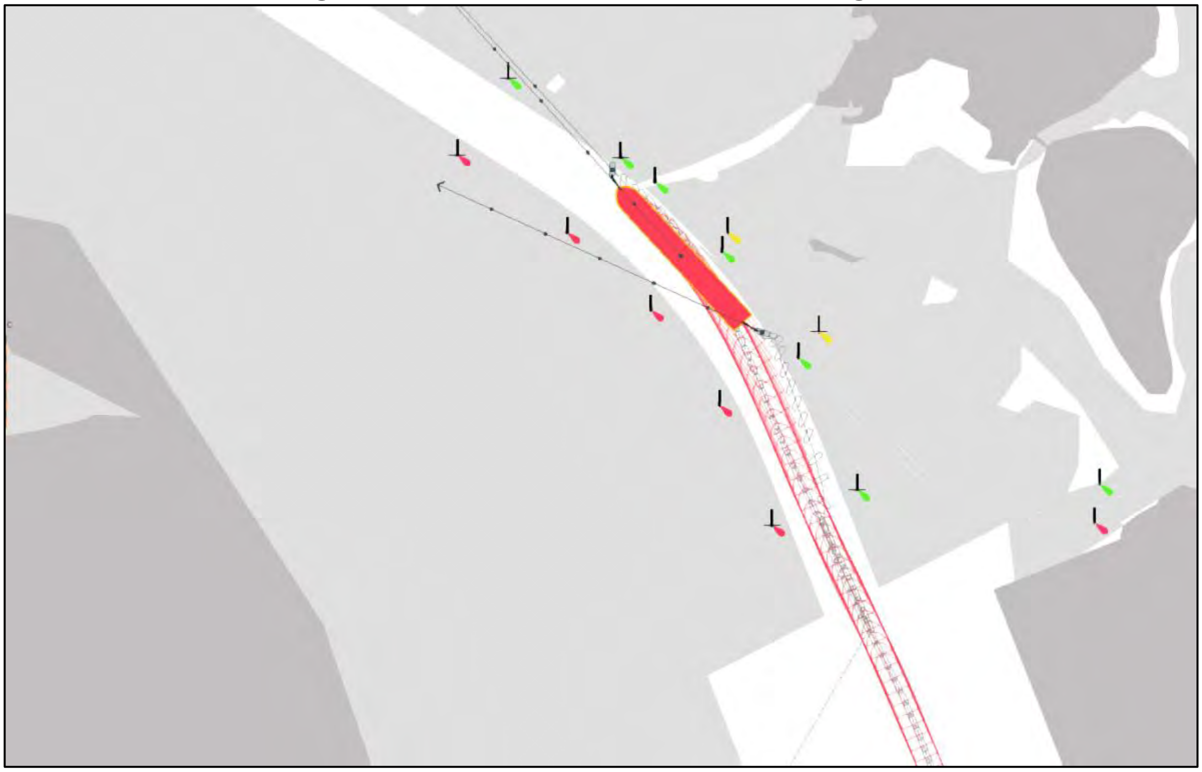
Run Description: The outbound ship headed into the channel from the terminal basin. During the first outbound 29° turn, the ship got up to 12 degrees per minute, but the pilot was still unable to prevent the ship’s stern from striking the bank on the outer starboard side bank along with the tugs working outside the channel (Screenshot 15A). The pilot was able to recover the ship and continue the transit. Reaching the continuous motion turn, the pilot began the turn at 5kn on the centerline. He could control the speed at about 5 knots and maintain about 4 to 6 degrees ROT throughout (Screenshot 15C). After reaching the flared entrance to the HSC, the pilot safely increased the ROT to 11 degrees while increasing the ship’s speed to 7kn (Screenshot 15D).

Pilot Comments: The pilot commented that two tugs were necessary to recover the ship on the turns but that the straightaway 400’ channel was “comfortable.” The pilot added that in a 400’ channel, two tugboats would be required to recover the ship if it got off the centerline.

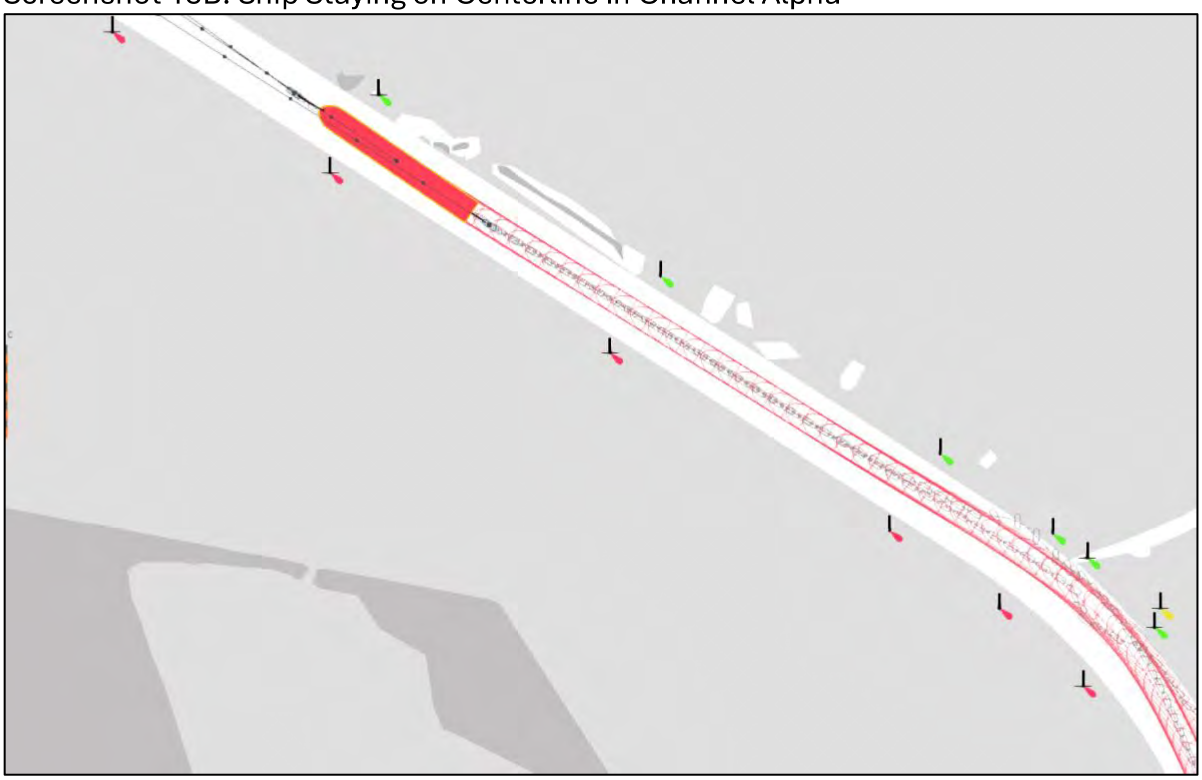
Screenshots List:

Screenshot 15A. Sailing from Terminal Basin with Stern Striking the Bank on the First Turn
Screenshot 15B. Ship Staying on Centerline in Channel Alpha
Screenshot 15C. Ship Performing the Continuous Motion Turn
Screenshot 15D. Ship Completing the Continuous Motion Turn Entering the HSC

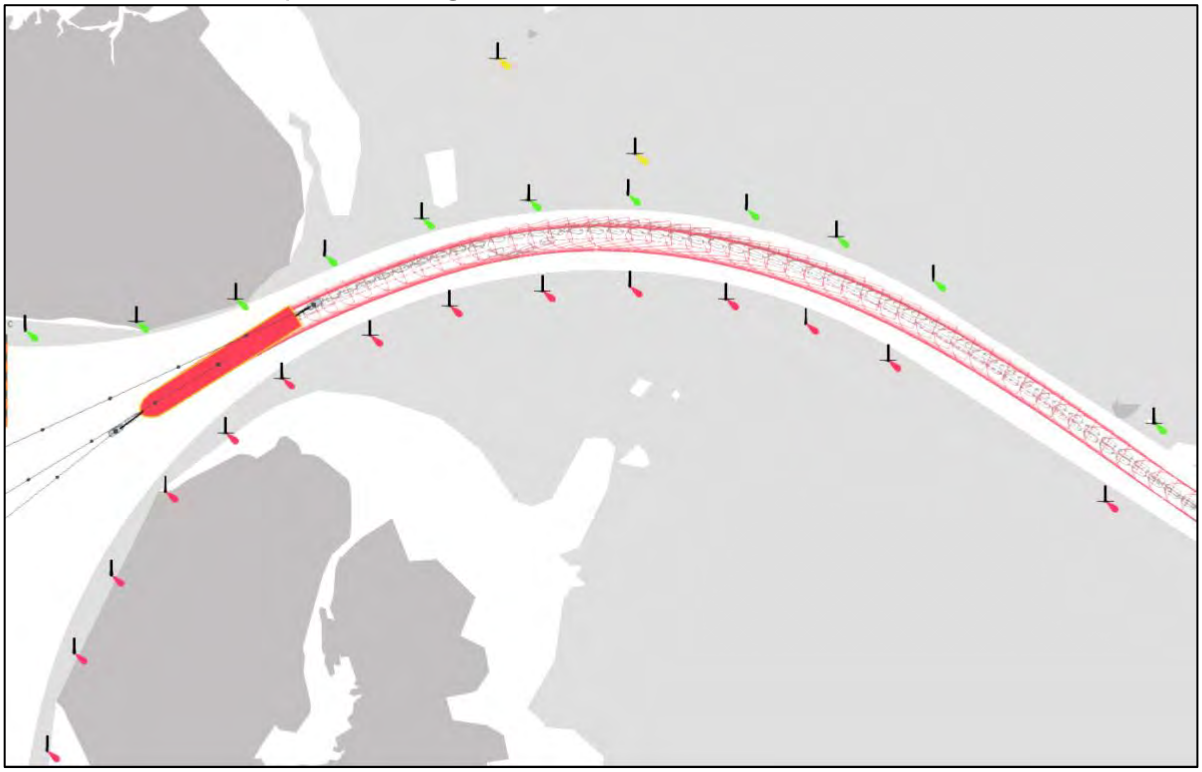
Screenshot 15A. Sailing from Terminal Basin with Stern Striking the Bank on the First Turn



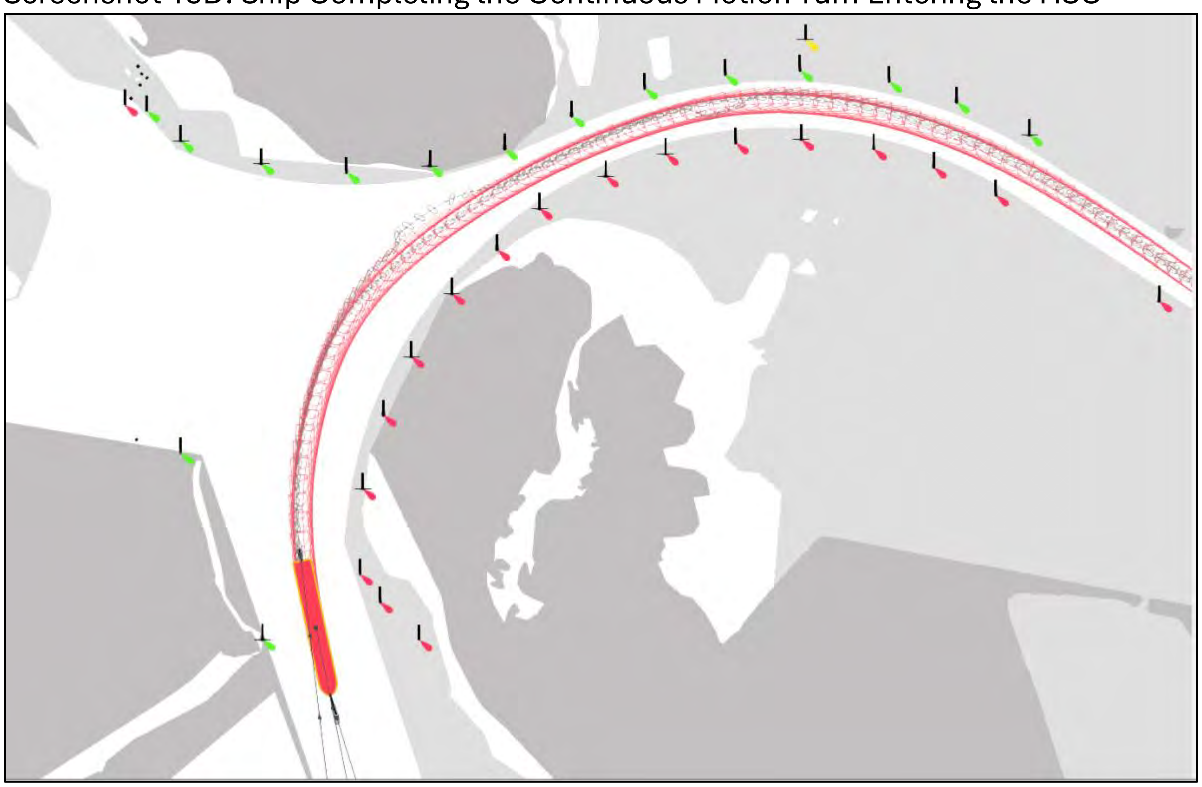
Screenshot 15B. Ship Staying on Centerline in Channel Alpha



Screenshot 15C. Ship Performing the Continuous Motion Turn



Screenshot 15D. Ship Completing the Continuous Motion Turn Entering the HSC



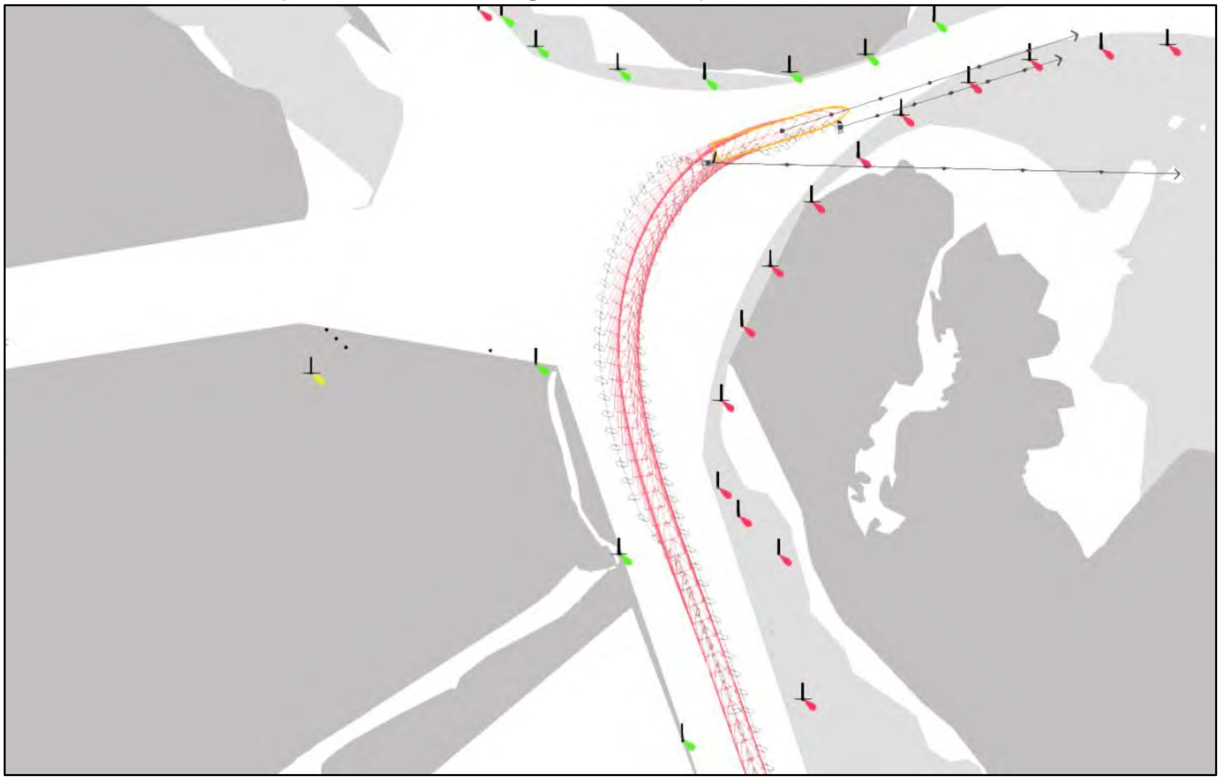
Run 16. Alpha 400', Arrival ULCV 366m, Wind 000° @15kn, GAR 3 - FAILED

Run Description: The pilots reported that the ULCV 366m ship model handled better than the CTNR33 ship model. The run failed as the ship struck the bank twice. First, the ship struck the bank on the continuous motion turn inbound on the inner portside of the bank. The pilot tried to keep the ship's speed at 5kn and quickly increased the ROT to 14 degrees per minute. However, the pilot started the turn too late and too fast, causing them to increase the ROT too quickly and too much (Screenshot 16B). The pilot said they attempted to keep the ROT to 10-12 degrees. However, they still struck the bank. On the second turn that struck the bank near the terminal basin, the ship began the turn at 5.8kn, and the ROT quickly increased from 3 to 6 to 8 degrees. The pilot could not keep the ship on the centerline during the turn, and the stern struck the outer starboard side bank (Screenshot 16E).

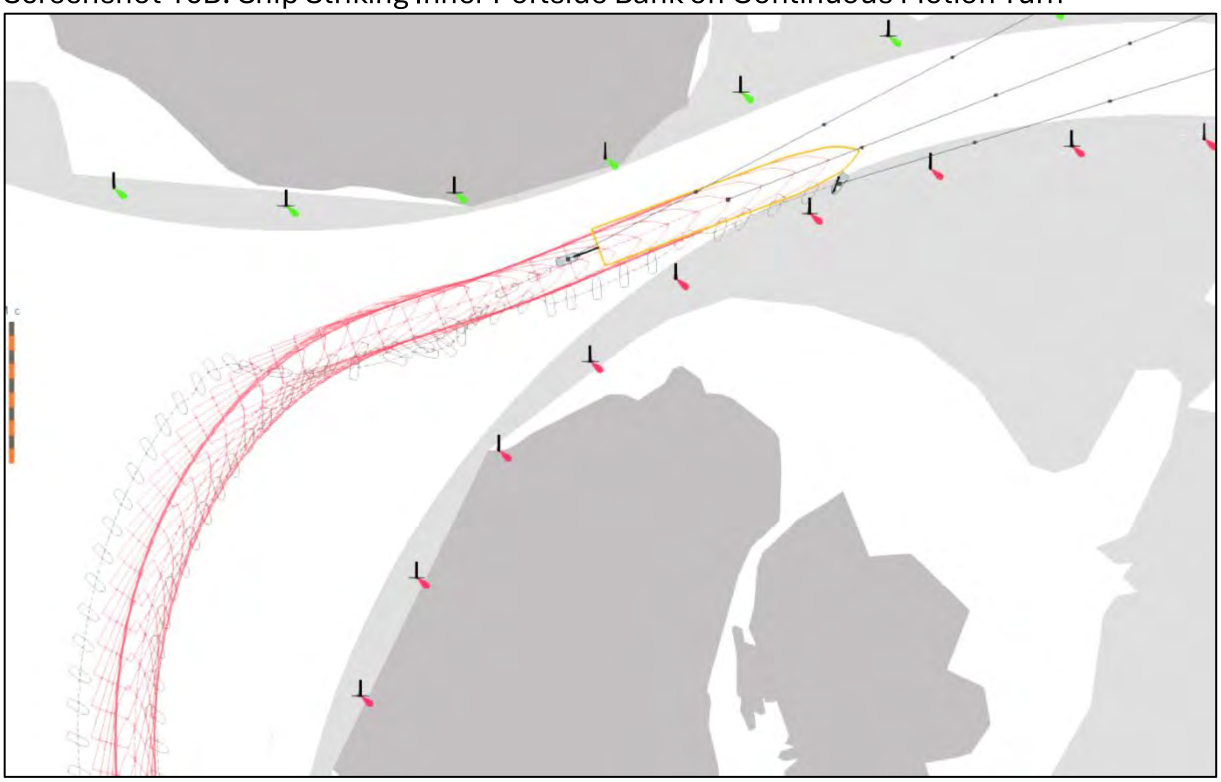
Pilot Comments: The pilot commented that on the turns in this channel, there is zero margin of error on this ship. That turns require perfect timing and control over the ship's speed and other forces. The margin of error on the continuous motion turn is not enough. It requires perfection every time, and I have to hold it. Two tugboats are a requirement for this channel.

List of Screenshots:

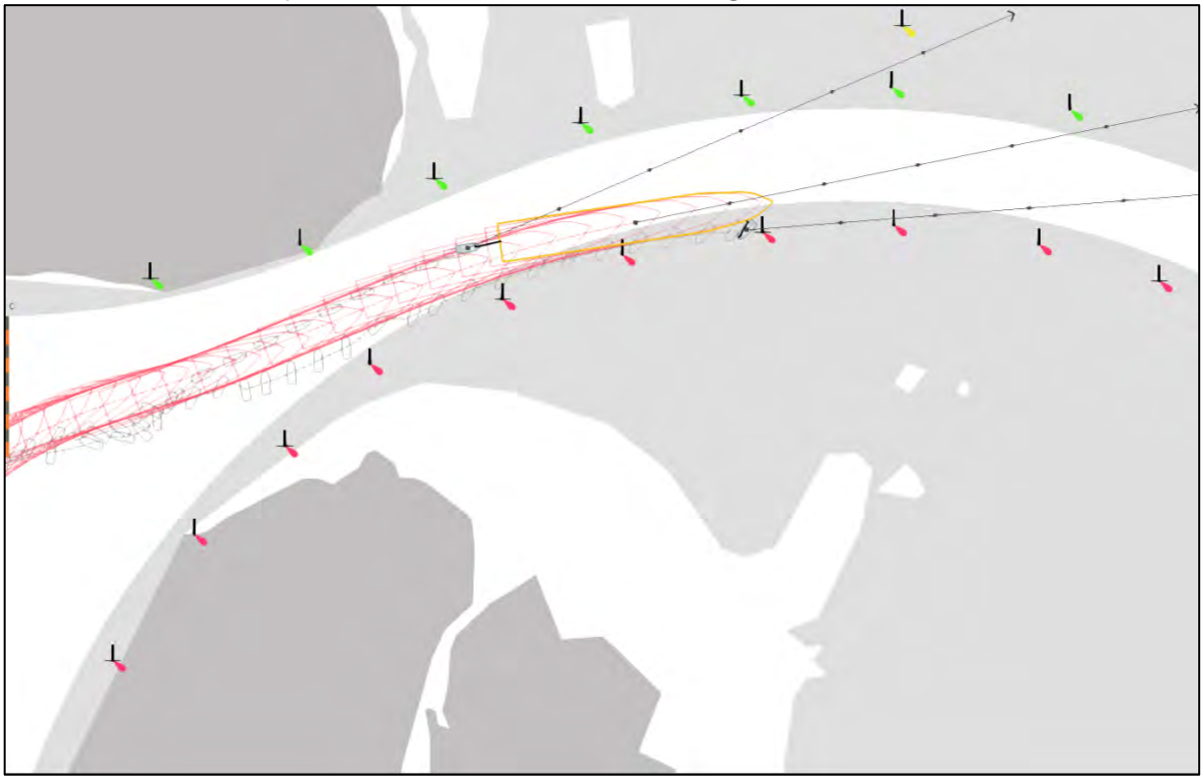
Screenshot 16A. Ship Inbound Entering Channel Alpha from the HSC



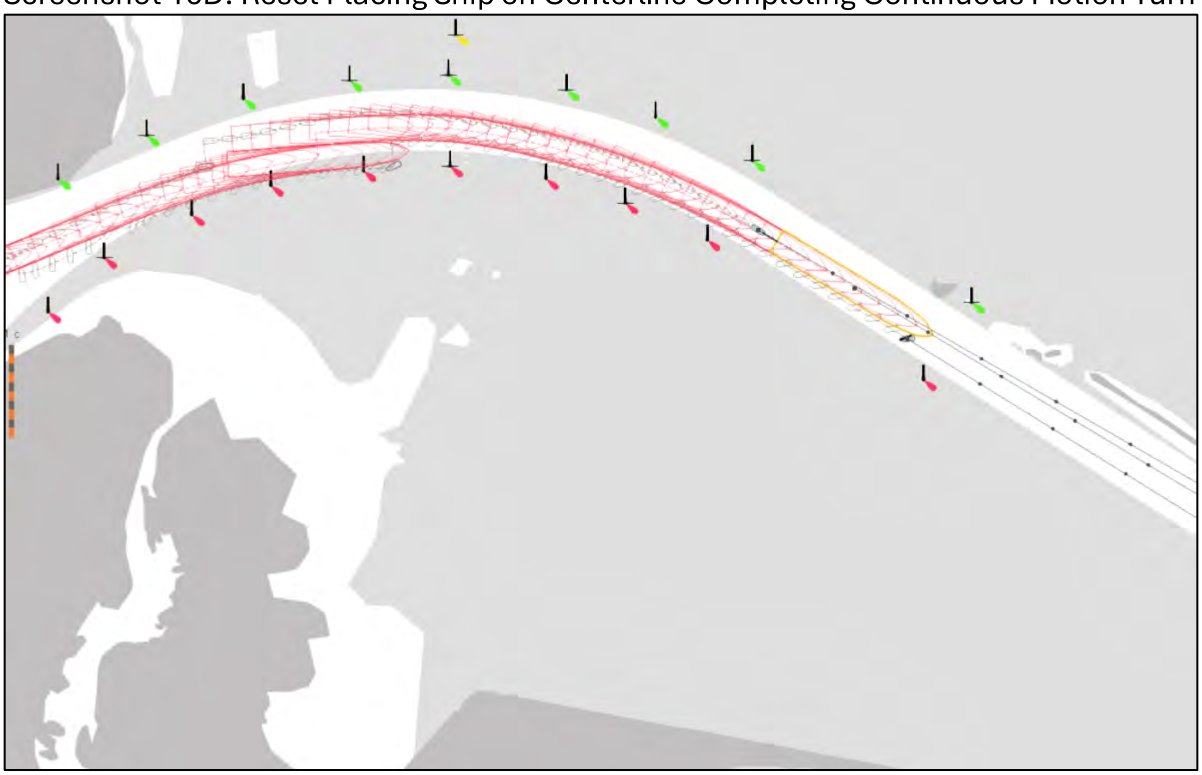
Screenshot 16B. Ship Striking Inner Portside Bank on Continuous Motion Turn



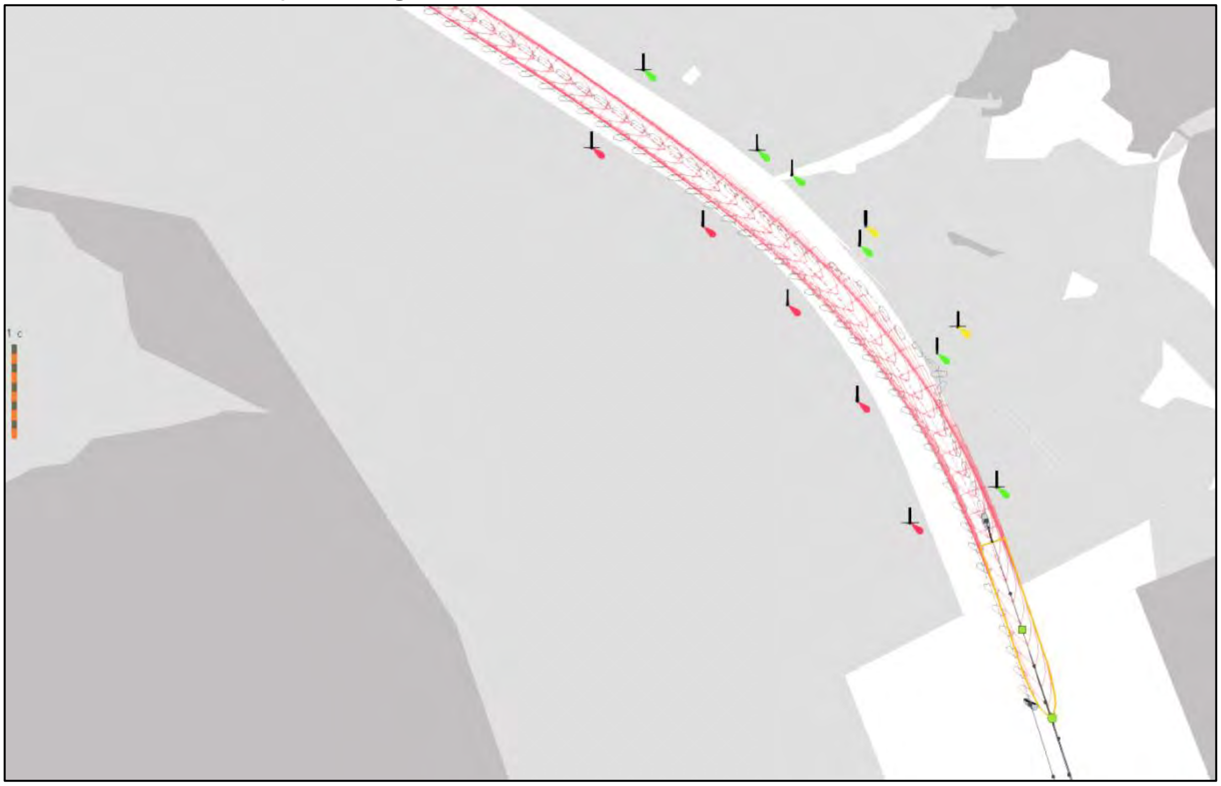
Screenshot 16C. Ship Unable to Recover after Striking the Bank on the Continuous Turn



Screenshot 16D. Reset Placing Ship on Centerline Completing Continuous Motion Turn



Screenshot 16E. Ship Striking the Outer Starboard Bank on Final Turn



Run 17. Alpha 455', Arrival ULCV 366m, No Wind, GAR 3 - FAILED

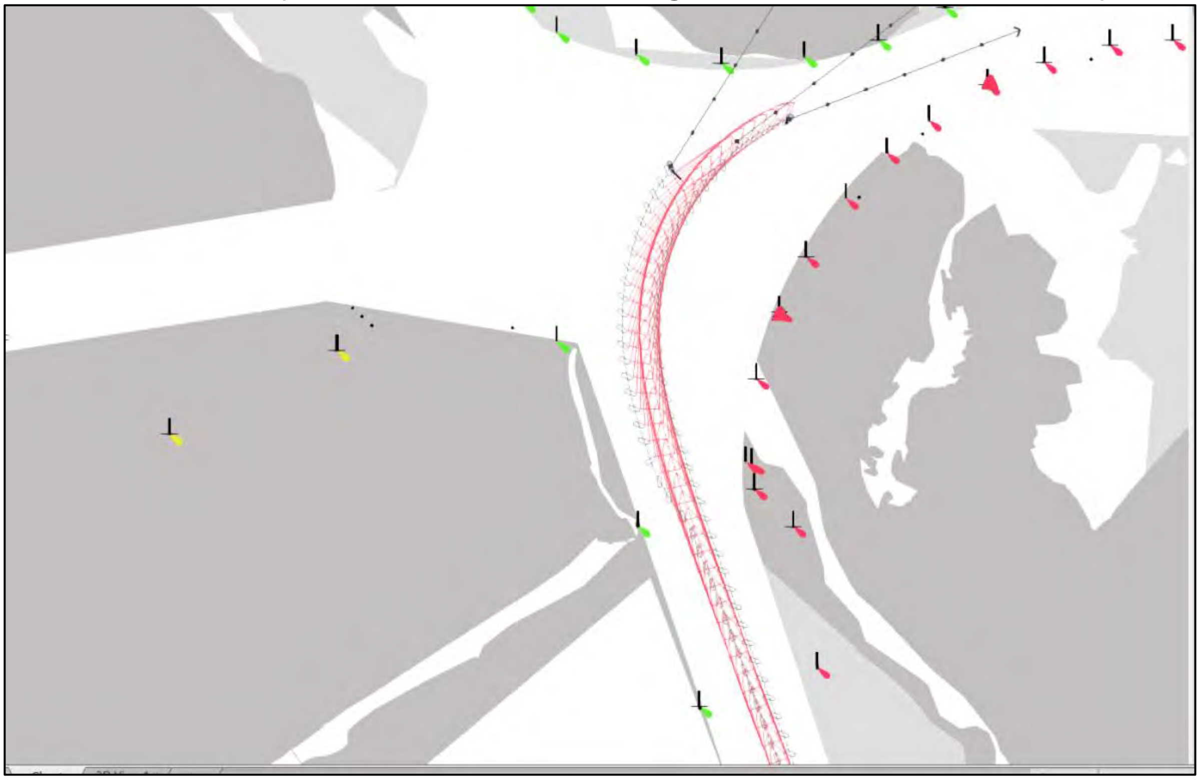
Run Description: This run failed as the ship struck the bank on the second turn when approaching the terminal basin. On the second turn, the ship approached at 6kn, and the pilot tried to use the tugs to reduce the ROT. However, the ship came too close to the inner portside of the bank. On the continuous motion turn, the pilot was more successful. This turn was safely performed by entering the flared entrance at 5.5kn and slowly increasing the ROT. The ROT steadily increased from 7 degrees to 12 degrees to 14 degrees. The pilot stated they did not want to reach a 15-degree ROT. The ship slowed down and used the tugs to assist the turn. To make the turn, the pilot had to use all the forces available, including tugs, hard over rudder, and thrusters.

Pilot Comments: This channel option poses a hazard that the others do not; there is no bail-out area available in an emergency, either inbound or outbound. You have to commit completely to the continuous motion turn. The 455' channel is much safer and better than the 400' channel because I could recover using the tugboats on the continuous motion turn. In the wider channel, there is greater room for recovery, and staying on the channel's centerline is easier. The pilot still needed two tugboats to perform the maneuver. The pilot stated, "This requires all of the tools of piloting. There is a point when you need more, and nothing is there." The channel design "should not require all the forces to be applied to make a normal transit."

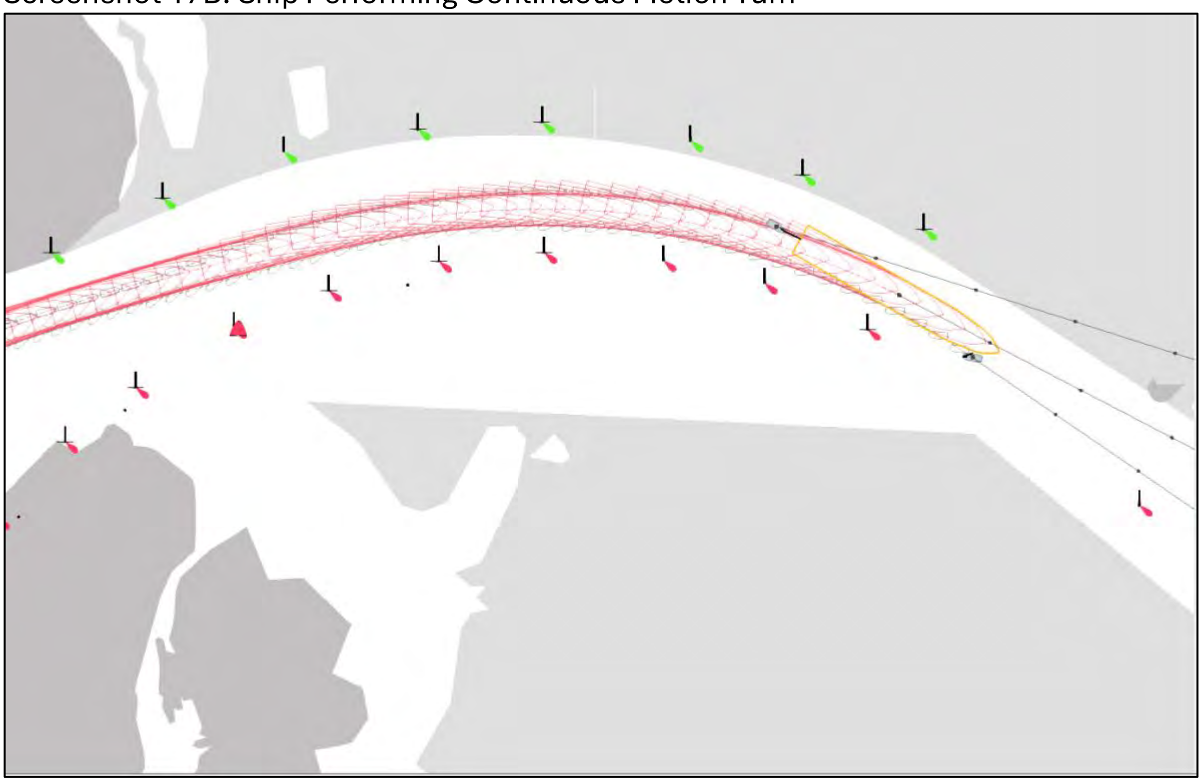
Screenshots List:

Screenshot 17A. Ship Inbound from HSC Entering Flared Entrance of Channel Alpha
Screenshot 17B. Ship Performing Continuous Motion Turn
Screenshot 17C. Ship Striking the Inner Portside of the Bank on the Second Turn

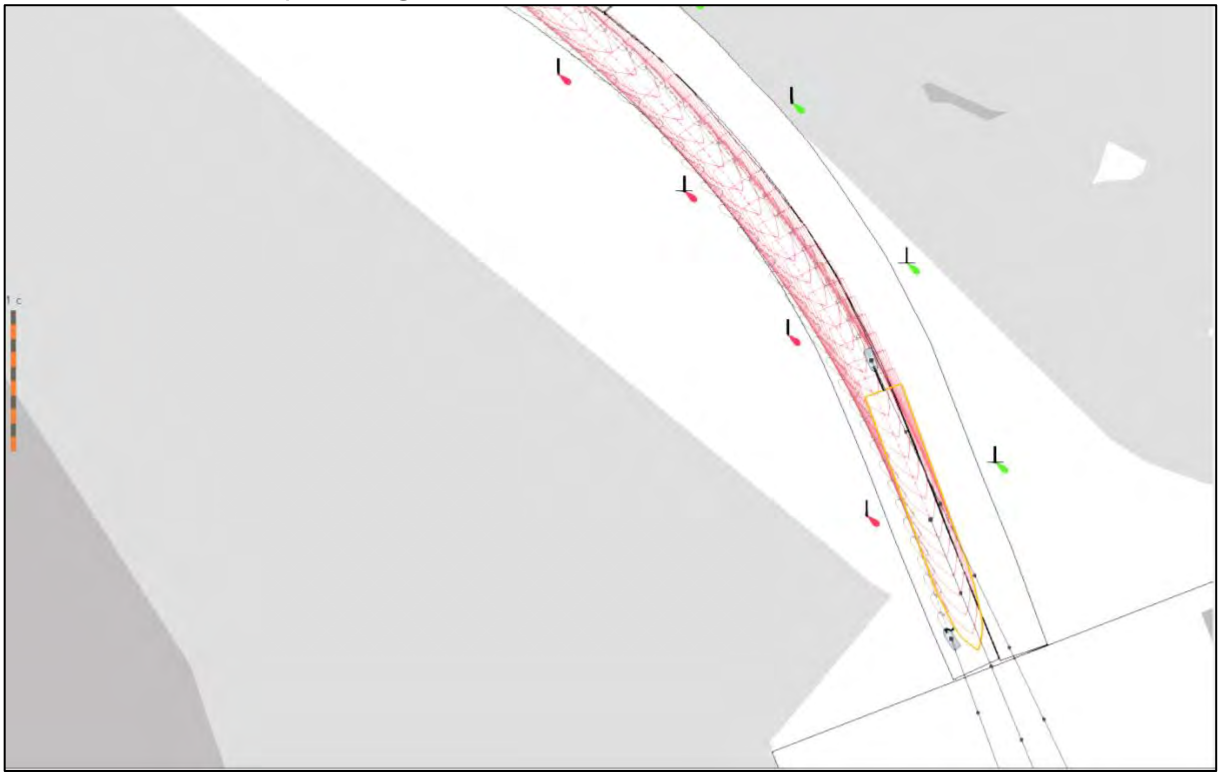
Screenshot 17A. Ship Inbound from HSC Entering Flared Entrance of Channel Alpha



Screenshot 17B. Ship Performing Continuous Motion Turn



Screenshot 17C. Ship Striking the Inner Portside of the Bank on the Second Turn



Run 18. Alpha 455', Sailing ULCV 366m, No Wind, GAR 2

Run Description: This run was successful because the ship did not strike any banks. The pilot successfully navigated the first turn at about 5.6kn using an 8 to 9-degree ROT. The tugs were used throughout. On the 455' channel, it was easier for the pilot to maintain the center line. The pilot could keep the ship at 5.4kn and 7 degrees ROT on the constant motion turn. The ship was 100' from the centerline, meaning that in the 400' channel, the ship would be equal to or within 20' of the bank. But on the 455' channel, the pilot maintained a safe distance from the bank while hugging the buoys inside to complete the turn. As the ship completed the turn into the HSC, the ROT reached 14 degrees, at which time the pilot began to check the turn using tugs and rudder, eventually turning hard over. The pilot was successful but used all of their resources.

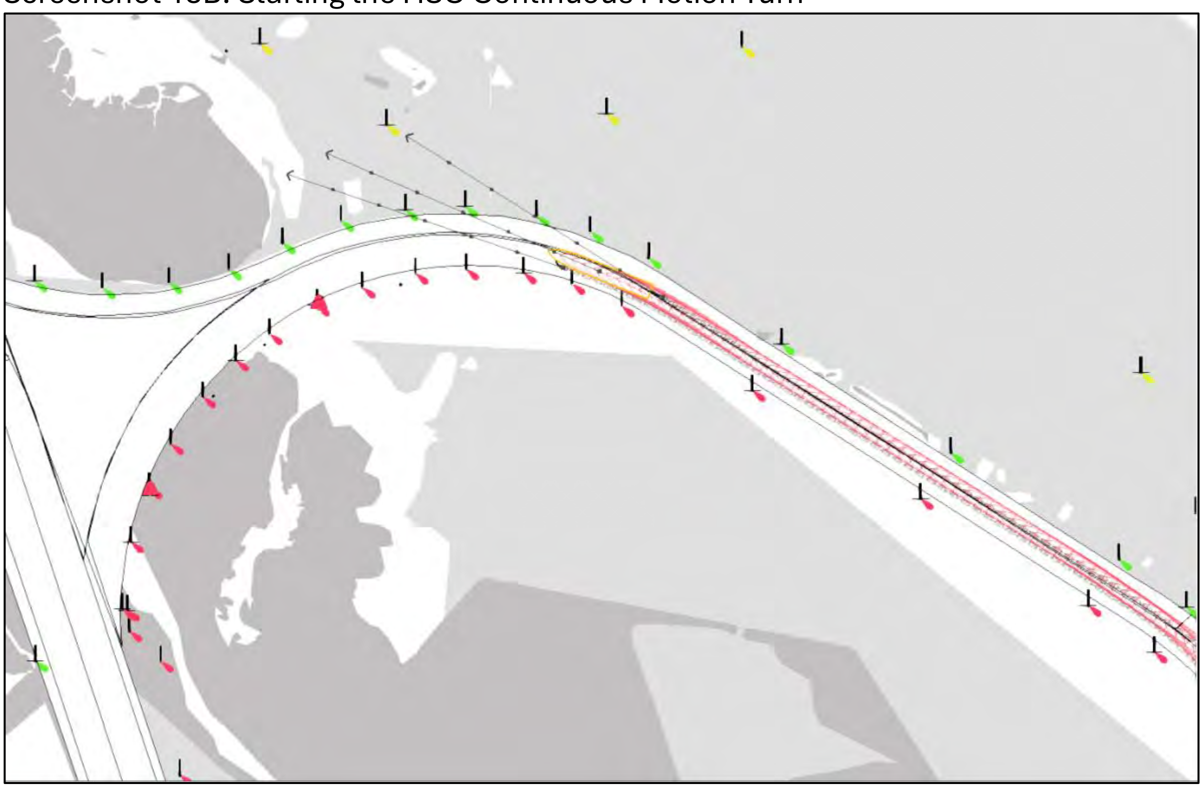
Pilot Comments: The two tugs are necessary. The continuous turn seems easier in the 455' channel than in the 400' channel. I can get a better angle on the turn, as you need to be inside the turn to succeed. With the 455', it is easier to set up inside and get the right angle. Even in the 455', there is no place for errors. Having the greater UKC makes a big difference in being successful on these turns. The pilot needs to be alert, and it requires your full attention. "It is a two-pilot job for sure. A second "resource" pilot is necessary. It will require all the attention of both pilots."

Screenshots List:

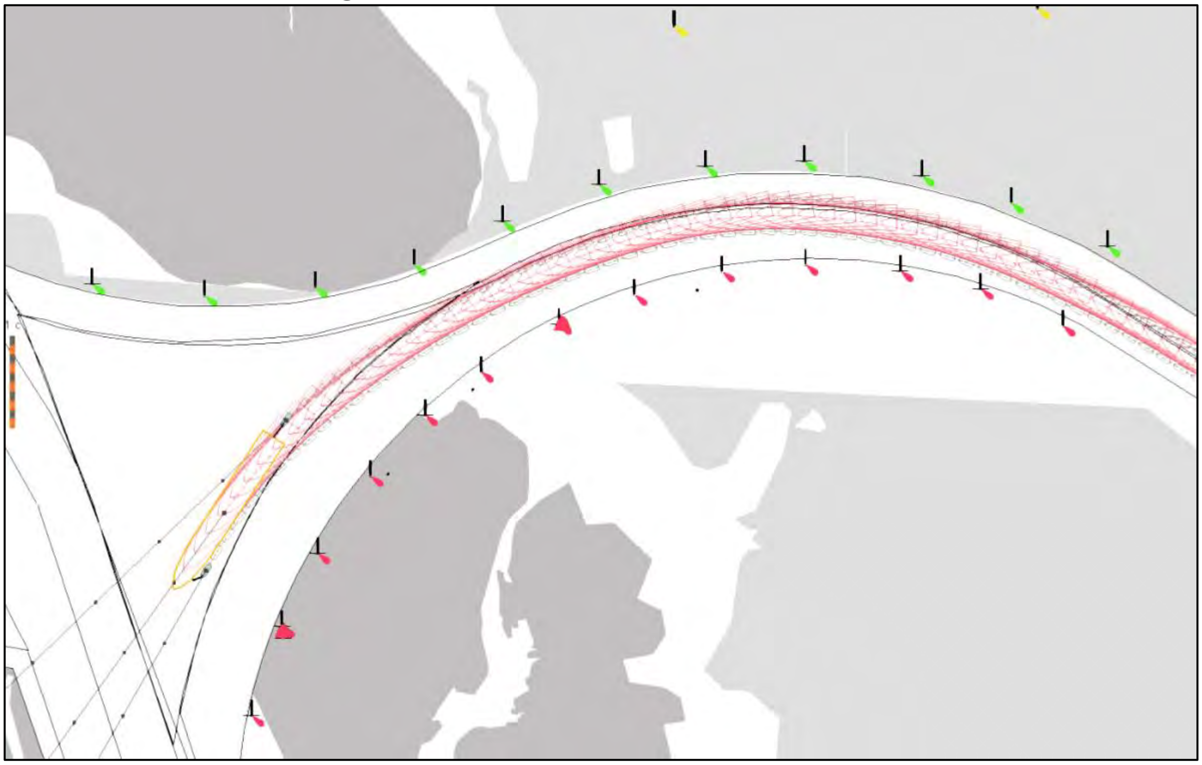
Screenshot 18A. Departing the Terminal Basin and Completing the First Turn
Screenshot 18B. Starting the HSC Continuous Motion Turn
Screenshot 18C. Entering the Flared Entrance to the HSC
Screenshot 18D. Completing the Flared Entrance and Entering the HSC

Screenshot 18A. Departing the Terminal Basin and Completing the First Turn

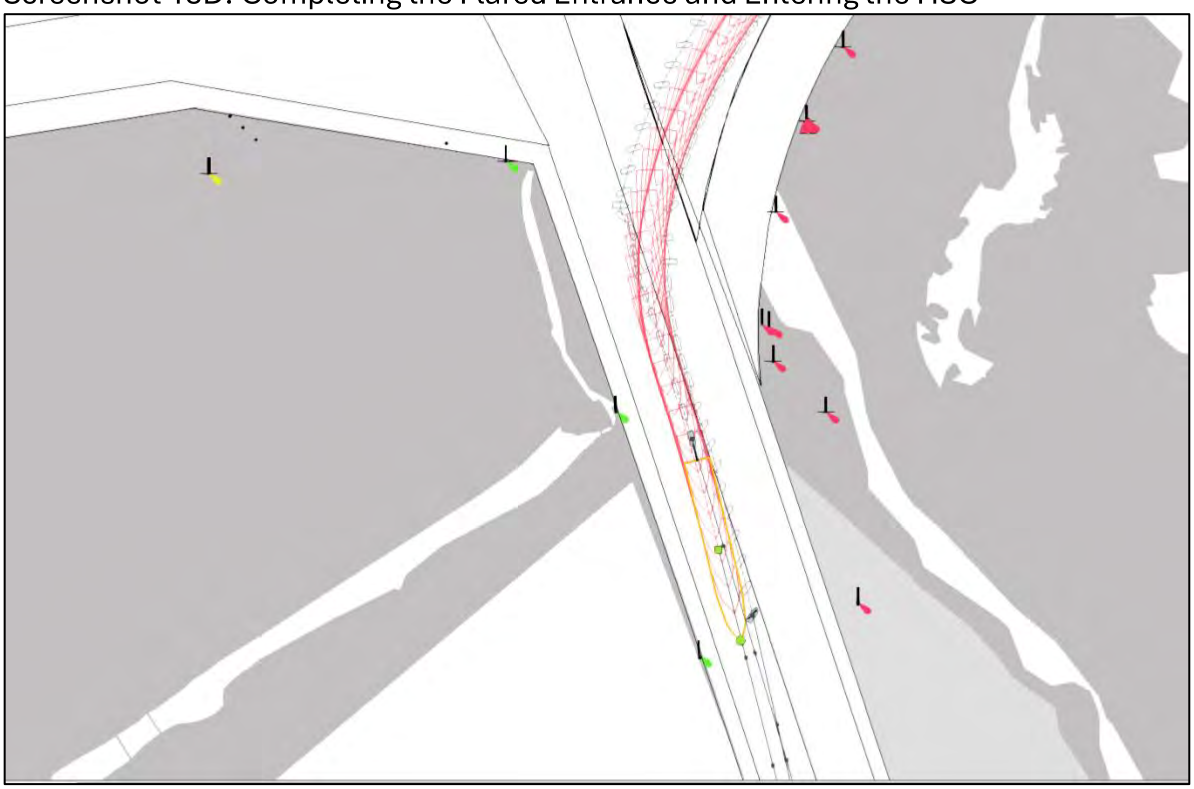
Screenshot 18B. Starting the HSC Continuous Motion Turn



Screenshot 18C. Entering the Flared Entrance to the HSC



Screenshot 18D. Completing the Flared Entrance and Entering the HSC



Channel Bravo #1 (Runs #19 – 21)

Channel Description: Channel Bravo #1 is 2.8 miles long and takes about 60 minutes to transit from the terminal basin to the HSC. The centerline route from the HSC entry into the channel requires a 122° turn (from heading 352° to 114°) in 0.4 miles. Once a ship enters the channel, there is a continuous motion turn of 31° over about 1.5 miles. Then, there was one final course correction of 9° (from heading 083° to 074°) in 0.4 miles to enter the turning basin at heading 074°. Once the ship entered the turning basin outside the terminal, the ship needed to use tugboats to make a 95° turn (from heading 074° to 339°) to enter the terminal basin.

Channel Assessment: Only the 400' channel was tested, as it failed due to the turn into or out of HSC rather than the channel's width. The ship cannot safely make the 122° turn into or out of the HSC entrance without stopping and using tugs to complete the turn. This turn should not be performed to or from the HSC as it's a hazard to the ship and other traffic.

Run 19. Bravo #1, ULCV 336m, No Wind, GAR 3 - FAILED

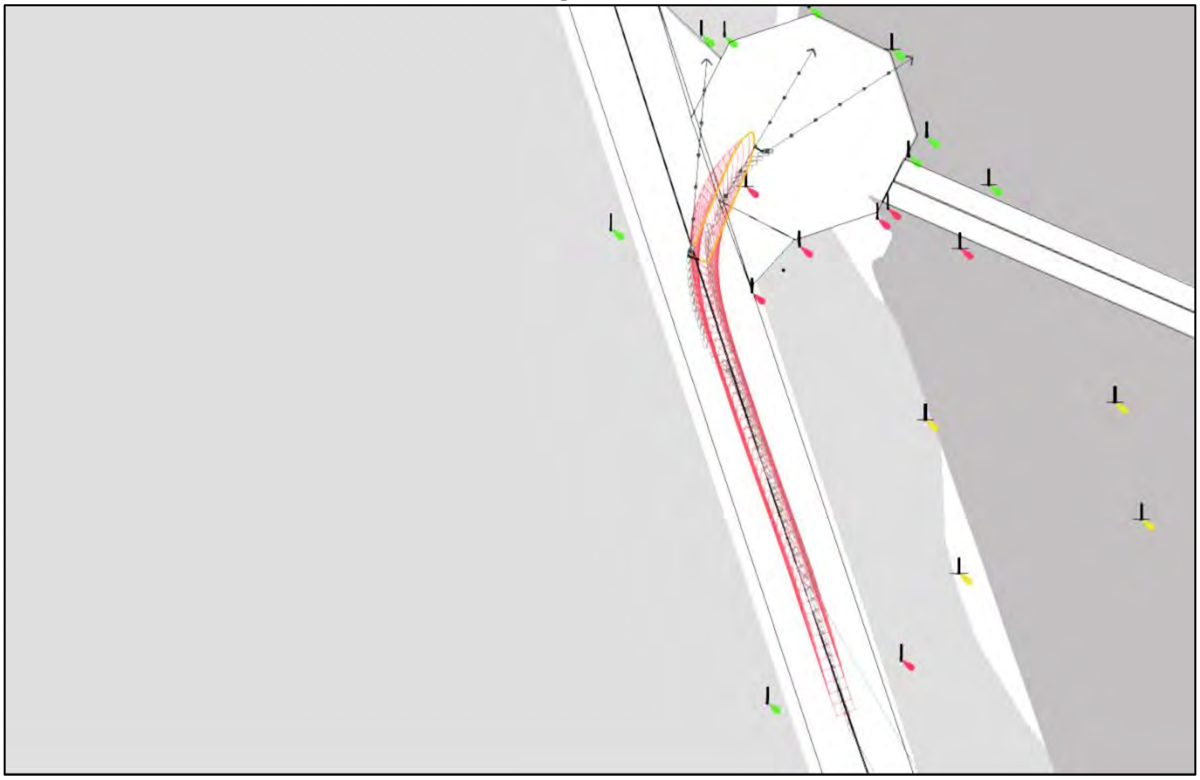
Run Description: The ship could not turn from the HSC into Bravo #1 (Screenshot 19B). It required the ship to stop its engines and use the tugs and rudder at 100% even to attempt the turn, but that still failed.

Pilot Comments: The pilot stated that they do not like this option because you cannot turn into the channel with at least 4kn of speed to control the ship while underway. This awful turn requires the ship to stop in the HSC. You cannot have headway entering the channel, and the turn must be done using a full-over rudder, tugs, and thrusters. This is not a channel turn but a harbor turn. An analogy is that the HSC is a highway; instead of the channel being an off-ramp, this is a stop sign on the highway.

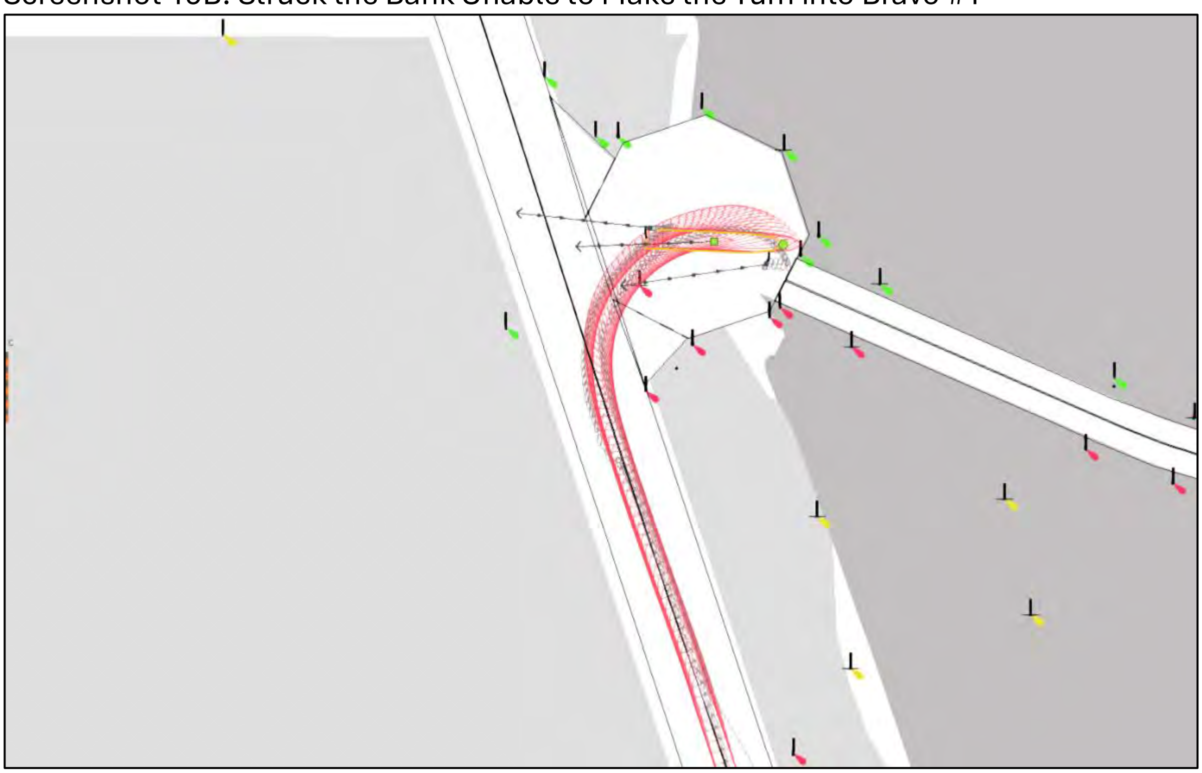
List of Screenshots:

Screenshot 19A. Inbound on HSC Turning into Bravo #1
Screenshot 19B. Struck the Bank, Unable to Make the Turn into Bravo #1

Screenshot 19A. Inbound on HSC Turning into Bravo #1



Screenshot 19B. Struck the Bank Unable to Make the Turn into Bravo #1



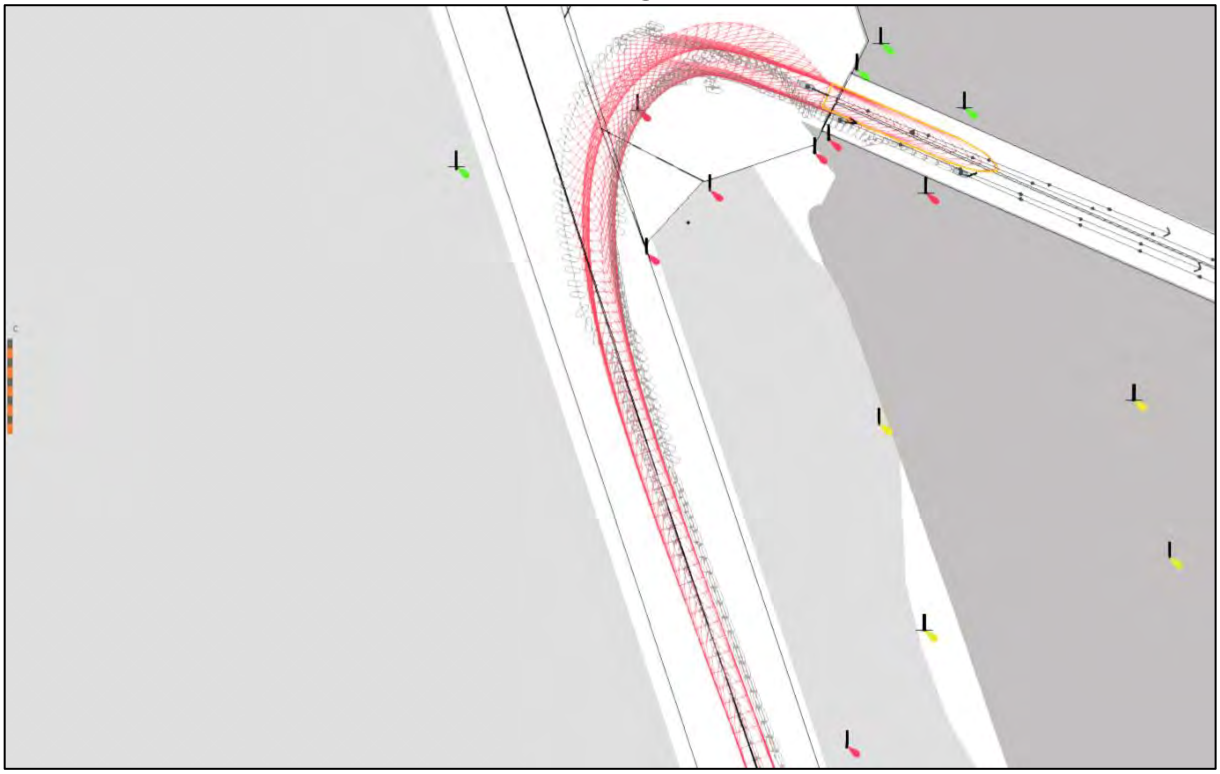
Run 20. Bravo #1, ULCV 366m, No Wind, GAR 2

Run Description: This was a re-run of Run #19. It was successful, but the tugboat nearly left the channel during the first turn-in the channel (Screenshot 20C), and the tugboat was well outside of the channel during the turn into the terminal basin. Still, it is assumed in PED that the area will be flared out for ship entry.

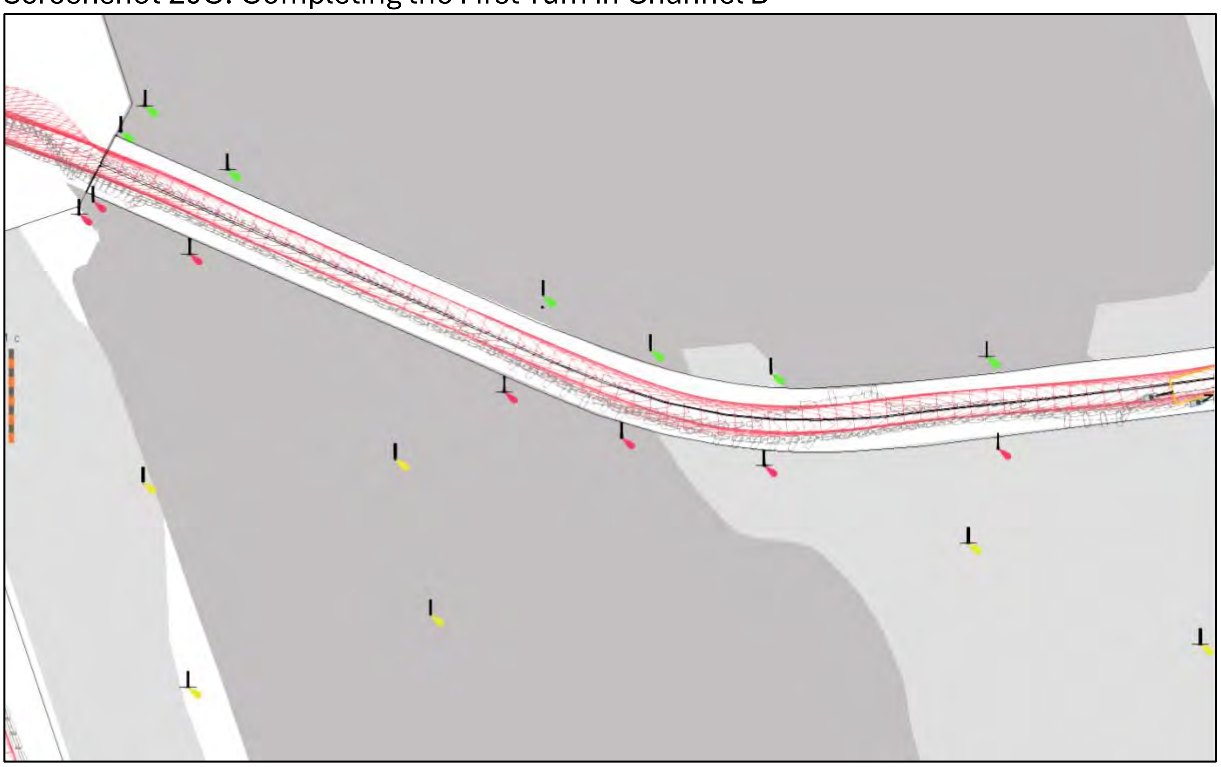
Pilot Comments: The pilot commented that this channel will restrict traffic in the HSC. Even if the ship were turned further toward the island, the ship would still need to stop in the HSC as entering at 3kn was still too fast for this ship. Wideners are needed on all the in-channel turns. The entire maneuver requires multiple tugboats to assist. To get the ship to turn into Channel Bravo #1 successfully, the ship must stop and use all three tugs to perform the turn. All turns required tug assist during transit, and going 5kn was too fast. This channel would be limited to 4kn maximum. The ROT in the basin was an issue as it took too long to reduce the ship's momentum once it got greater than 15° ROT.

List of Screenshots:

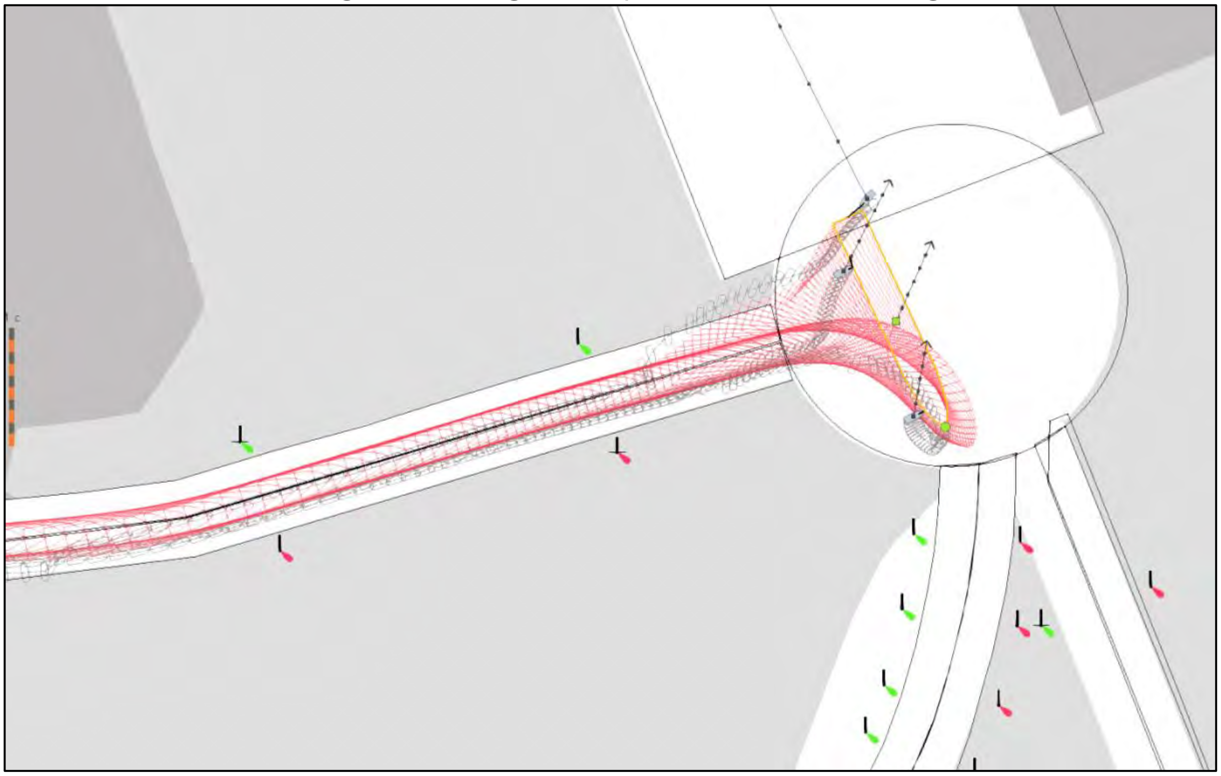
Screenshot 20B. Inbound from the HSC Turning into Channel B



Screenshot 20C. Completing the First Turn in Channel B



Screenshot 20D. Entering and Turning the Ship Around in the Turning Basin



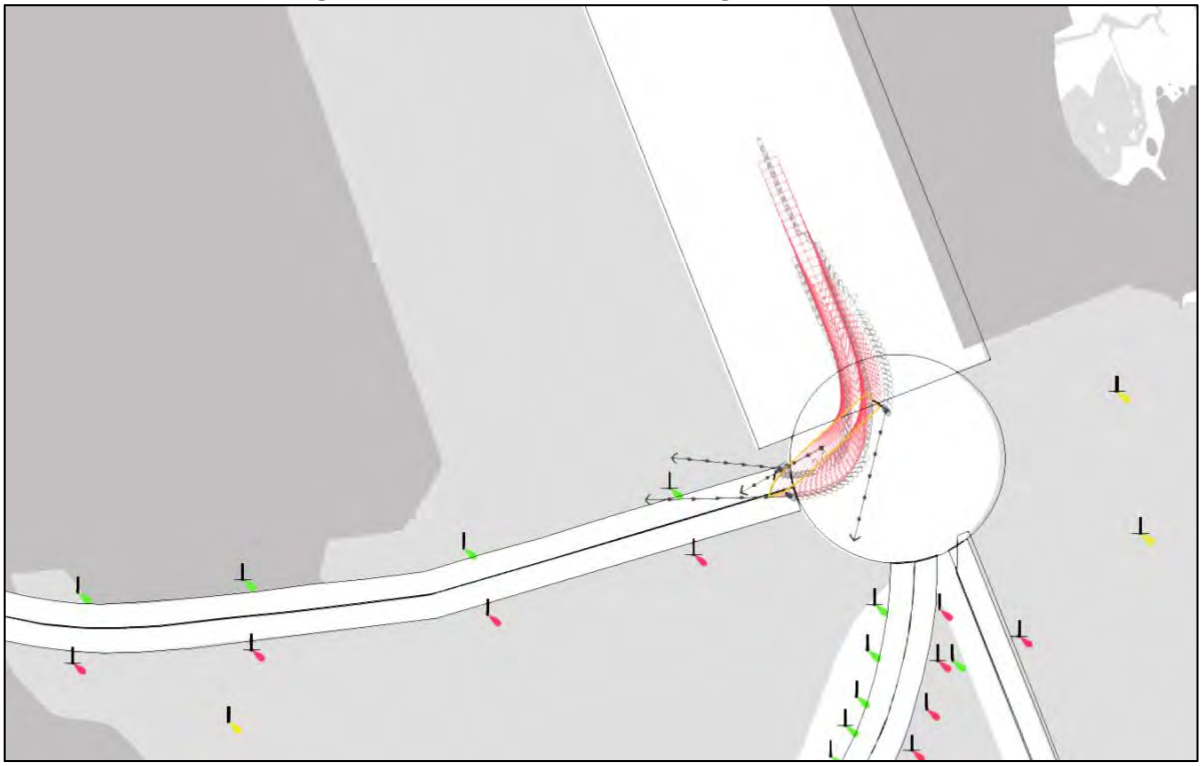
Run 21. Bravo #1, Sailing ULCV 366m, No Wind, GAR 3 – FAILED

Run Description: Bravo #1 was tested using an outbound ship from the terminal basin to the HSC. The pilot safely navigated the ship until it reached the turn for the HSC. The ship's port bow hit the buoy on the HSC entrance and hit the bottom of the channel due to the ship listing too far over (Screenshot 21E).

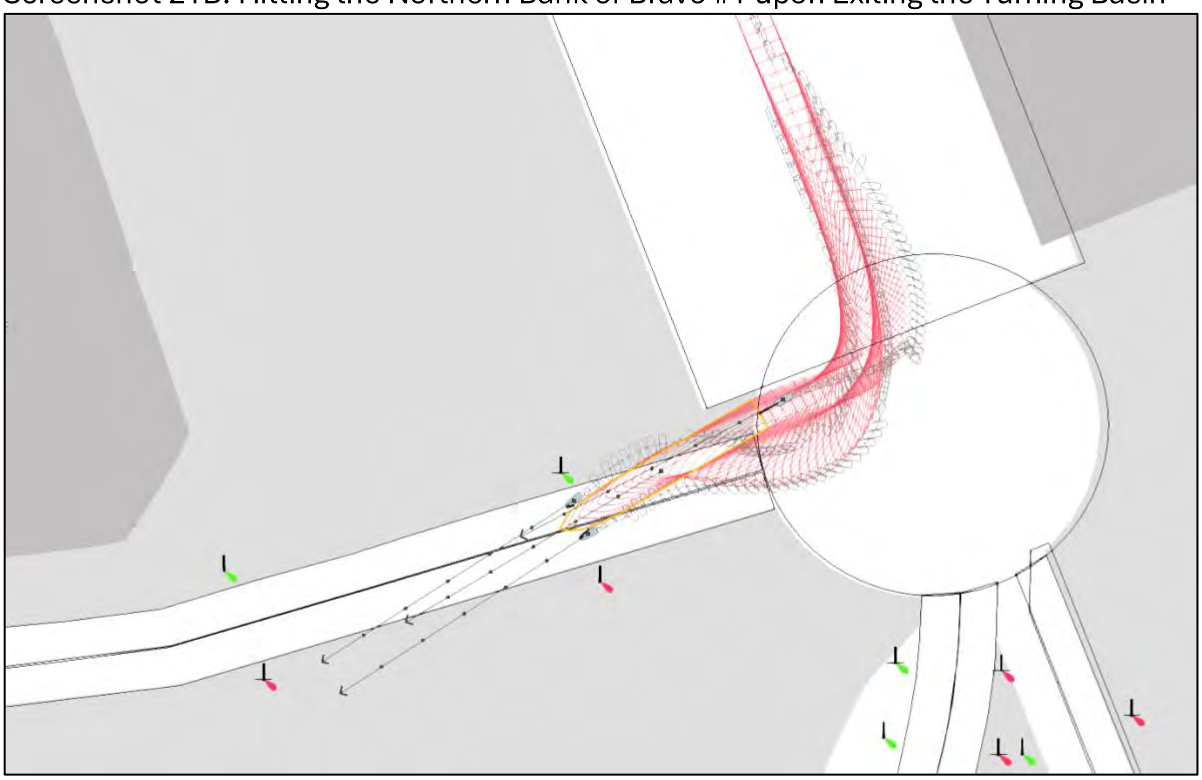
Pilot Comments: The pilot stated that the channel needs wideners for the turns. The turn outbound of the terminal basin was also hazardous and should not be done while underway, and it requires the ship to come to a complete stop and use the tugs, the rudder, and thrusters to turn the ship into place. The turning basin should have 45-degree flares, making it safer to bring the ship in and out while under its power (Screenshot 21B). The pilot reported that they made the turn into the HSC going too fast, which was about 2kn, and then tried to increase the rate of turn up to 15 degrees per minute using a hard over rudder, three tugs, and the thrusters. The pilot was still unable to complete a safe turn into the HSC. The ship hit the bottom because it was rolling too far, and the ship should not be attempting to enter the HSC from a stopped position, which is required to stop and turn the ship.

List of Screenshots:

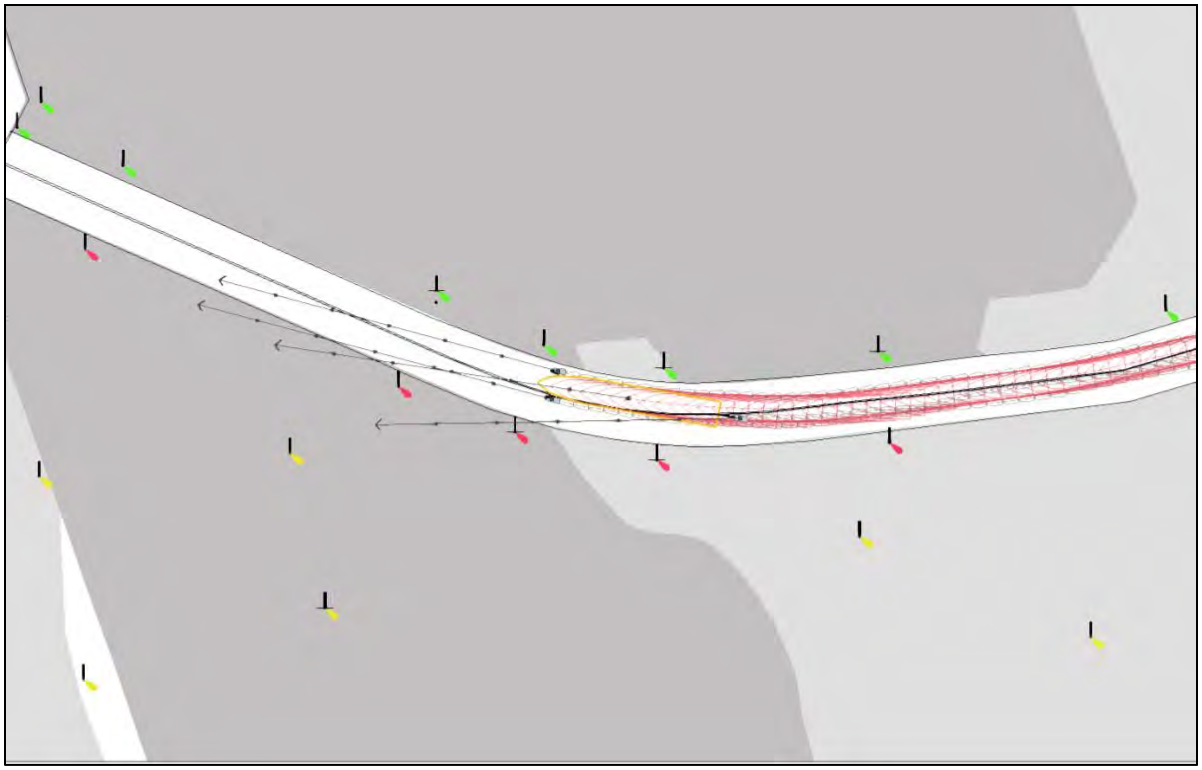
Screenshot 21A. Sailing from Terminal Basin Entering Bravo #1



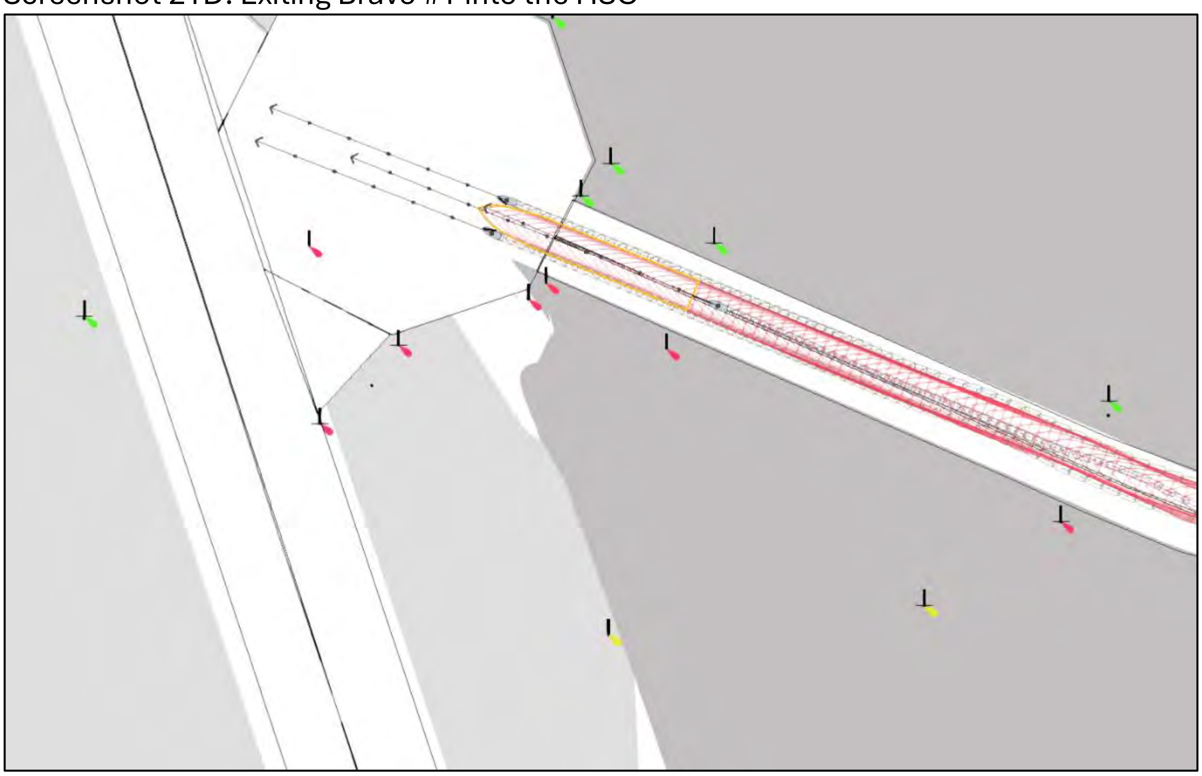
Screenshot 21B. Hitting the Northern Bank of Bravo #1 upon Exiting the Turning Basin



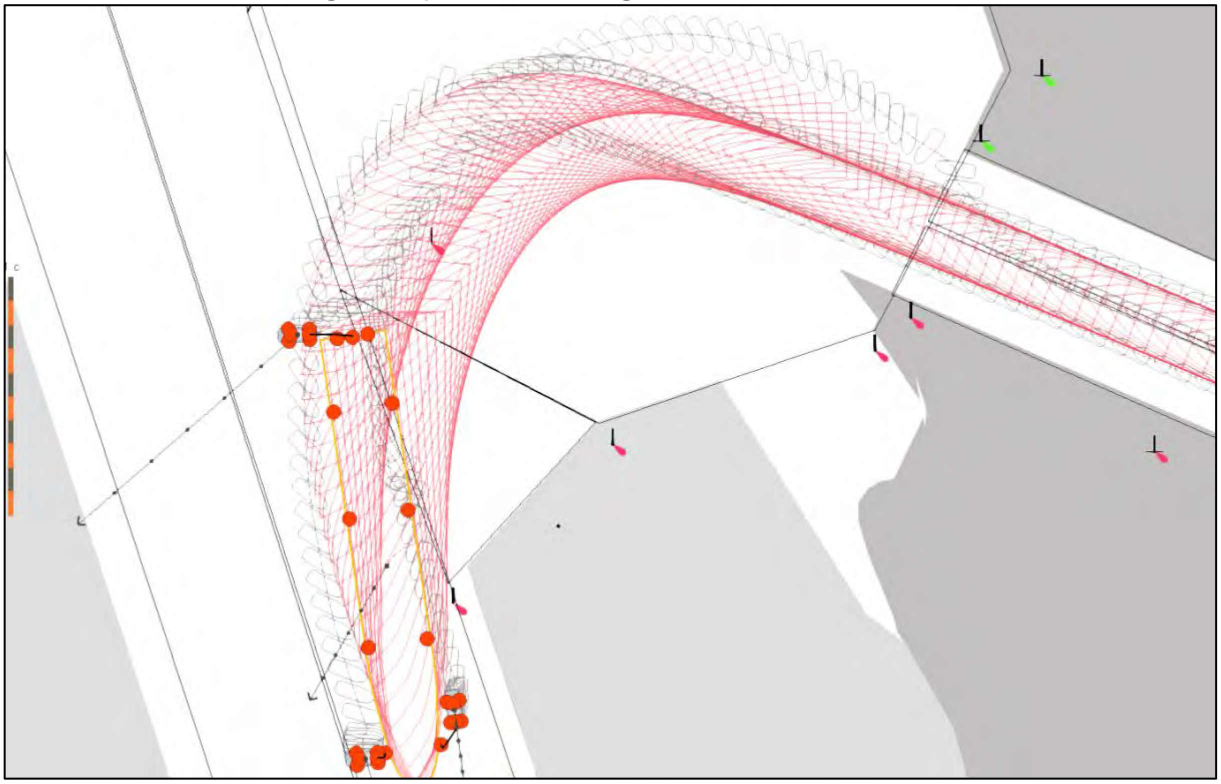
Screenshot 21C. First Turn in Bravo #1



Screenshot 21D. Exiting Bravo #1 into the HSC



Screenshot 21E. Striking a Buoy When Turning into the HSC from Bravo #1



Channel Bravo #2 (Run #22)

Channel Description: Bravo #1 was adapted into Bravo #2 to reduce the 122° turn from the HSC to the channel, along with removing the 31° turn in the channel. Instead, the channel was designed to be straight from the HSC to the terminal basin, allowing the ship to turn using tugs before entering. Bravo #2 requires a 91° turn (heading from 342° to 073°) with an insufficient flare. The channel is a straightaway of 2.2 miles long before ending outside the terminal basin.

Channel Assessment: The ULCV 366m could not turn from the HSC into the channel. The flare needed to be less acute, given the width of the HSC. The ship ran aground as the turn rate required was too great for the ship to make while underway.

Run 22. Bravo #2, Arrival CNTR35, No Wind, GAR 3 – FAILED

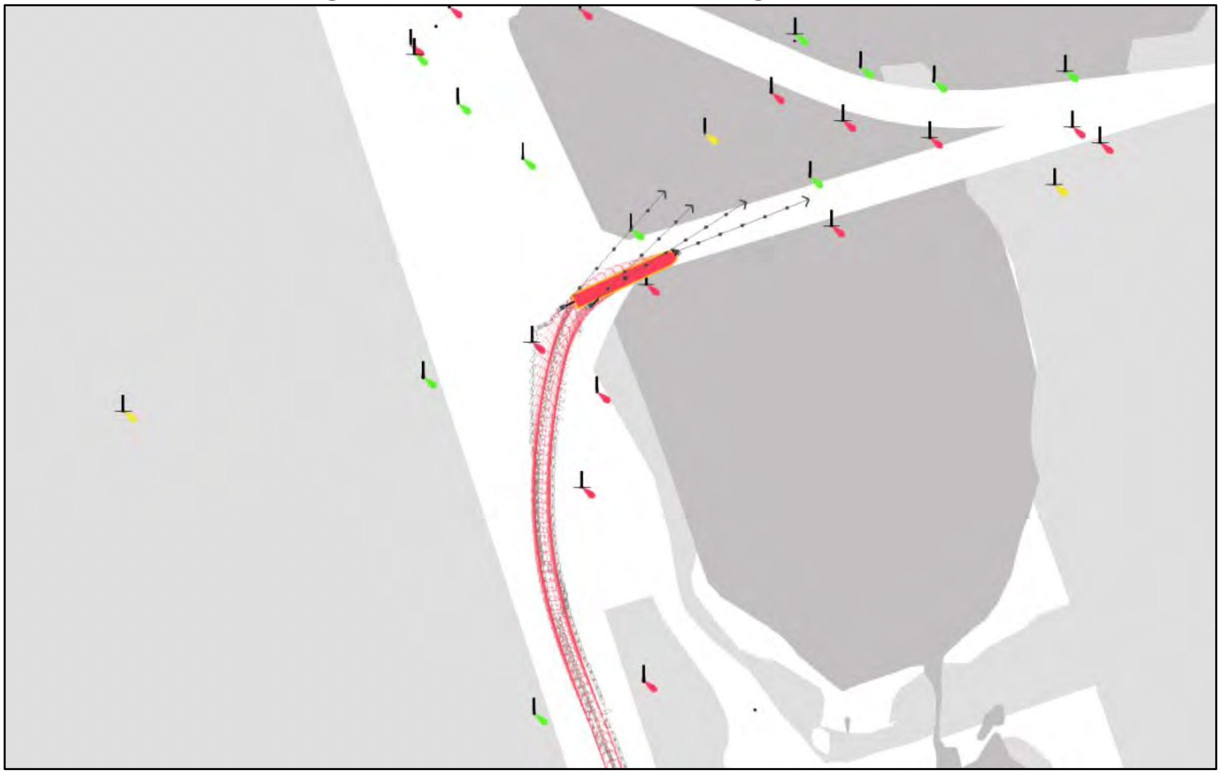
Run Description: To assess Channel Bravo #2, a CNTR35 ship model was used, and it was piloted inbound with three tugs and no wind. During the maneuver, the pilot could not make the continuous motion turn required to enter Channel Bravo #2 from the HSC. The pilot attempted the turn starting at 4kn, then stopped the engines in the HSC to completely depend on the rudder, three tugs, and thrusters to make the turn. Stopping the ship's engines in the HSC can pose a hazard to other traffic. Also, note that there is a risk of stopping a ship's engine, as it may not re-engage. It is more prudent to run the engine at its slowest and use other methods, such as tugs, to slow the ship. The pilot used hard over rudder and maximum tug forces. The ship reached a 20° ROT, but the pilot could not safely control the turn, causing the ship to strike the inner starboard side bank. This maneuver was a failure.

Pilot Comments: The pilot stated that such a turn required perfect piloting and could not be done without stopping the ship first. There was a group discussion about the channel design, as it was similar to the turn at Bayport. However, after reviewing the charts, it was clear that Bayport benefited from a widener in the HSC south of its flared turn, allowing ships more space to complete the turn. According to one of the pilots, the turn at Bayport is done at 12 to 13 degrees ROT. This turn at Channel Bravo #2 required nearly 20 degrees ROT, which is too great for this size of ship.

List of Screenshots:

Screenshot 22B. Turning Inbound into Channel Bravo #2, Striking the Southern Bank

Screenshot 22B. Turning Inbound into Bravo #2, Striking the Southern Bank



Channel Bravo #3 (Runs #23 – 25)

Channel Description: Similar to Bravo #2, the straightened channel was designed to prevent the ship from striking the banks due to turns that required too great ROT. This version of the channel was 2.4 miles long, and it required a turn of 66° (from heading 342° in the HSC to heading 048° in the channel) to enter the channel from the HSC. This turn is similar to the turn into Bayport from the HSC, which requires a 57° turn. However, Bayport benefits from a large flare and a widener of the HSC, allowing pilots to get the ship on a better angle to make the turn into or out of Bayport.

Channel Assessment: The pilots could not reliably and safely complete the 66° turn into or out of the channel from the HSC. The flare to the channel was too narrow. Bayport benefits from a widener in the HSC, allowing ships to get a better angle upon approach. This design lacks such a widener, and the ROT to enter the channel is too great to perform safely.

Run 23. Bravo #3, Arrival ULCV 366m, No Wind, GAR 3 - FAILED

Run Description: This was the first run in the new Channel Bravo #3. The simulation was paused once it became clear that the ship would strike the bank and could not safely complete the turn into the channel. The pilot began the turn using the rudder and the tugs while the ship was doing 6.3kn. The ship quickly gained a ROT up to 9 degrees at 6.3kn, and to decrease the ship's speed, the pilot ordered the tugs to use power indirect and back full. The pilot began using full thrusters, tugs, and rudder as the ship rolled over 2 degrees. The pilot attempted to keep a 12-degree ROT on the ship, but it kept increasing. Soon, the ROT reached 15 degrees at 5.1kn. To prevent slamming into the bank, the pilot started emergency ship handling using half astern while the tugs were already backing. At this point, the simulation was stopped.

Pilot Comments: This required emergency ship handling. I was trying to keep my speed above 6kn and the ROT around 13 degrees. I was already in bad shape once I started reducing the turn rate. With this type of turn, finding the right speed and ROT is difficult. We should not be using this channel.

Screenshots List:

Screenshot 23A. Inbound Ship About to Hit the Bank at Bravo #3

Screenshot 23A. Inbound Ship About to Hit the Bank at Bravo #3

Run 24. Bravo #3, Arrival ULCV 366m, No Wind, GAR 2

Run Description: The pilot completed this maneuver safely, but it required 100% of the resources and forces to prevent the ship from hitting the bank. The pilot had to use all three tugs and hard over the rudder to control the speed and ROT on the ship to turn from the HSC into the channel safely. The ROT was constantly at 15 degrees while the ship was going 5.2kn. The pilot could check the turn and quickly reduce the turn rate while still aiming at the opposite bank. This required hard over the rudder and the tugs. When turning into the terminal basin, the pilot stopped the ship's engines and relied on the tugs and hard-over rudder to turn the ship. Astern engines were necessary to perform the turn and enter the terminal basin safely. In the terminal basin, the pilot used the rudder and tugs to turn the ship 180° to represent a portside docking.

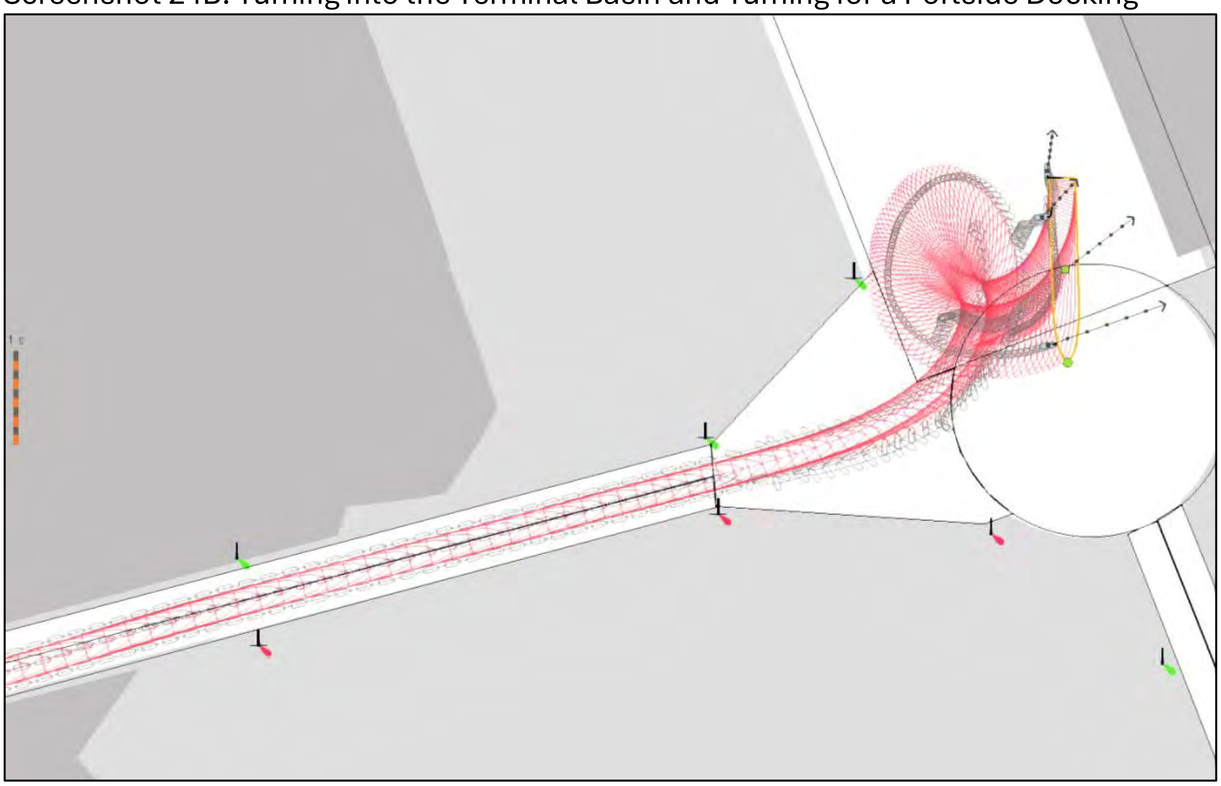
Pilot Comments: Completing the turn from the HSC into the channel requires a full rudder and all three tugs. I need all three tugs to control the speed and to generate the ROT early when starting the turn. Even with all three tugs, there is still a tendency to over-rotate. The ROT must be kept to 15 degrees maximum to be safe. Currently, at Bayport, the largest ships we are bringing are cargo ships LOA 1,096' Beam 150', which require 100% of the forces every time to make the turn.

Screenshots List:

Screenshot 24A. Turning Inbound from the HSC into Bravo #3
Screenshot 24B. Turning into the Terminal Basin and Turning for a Portside Docking

Screenshot 24A. Turning Inbound from the HSC into Bravo #3

Screenshot 24B. Turning into the Terminal Basin and Turning for a Portside Docking



Run 25. Bravo #3, Sailing ULCV 366m, No Wind, GAR 2

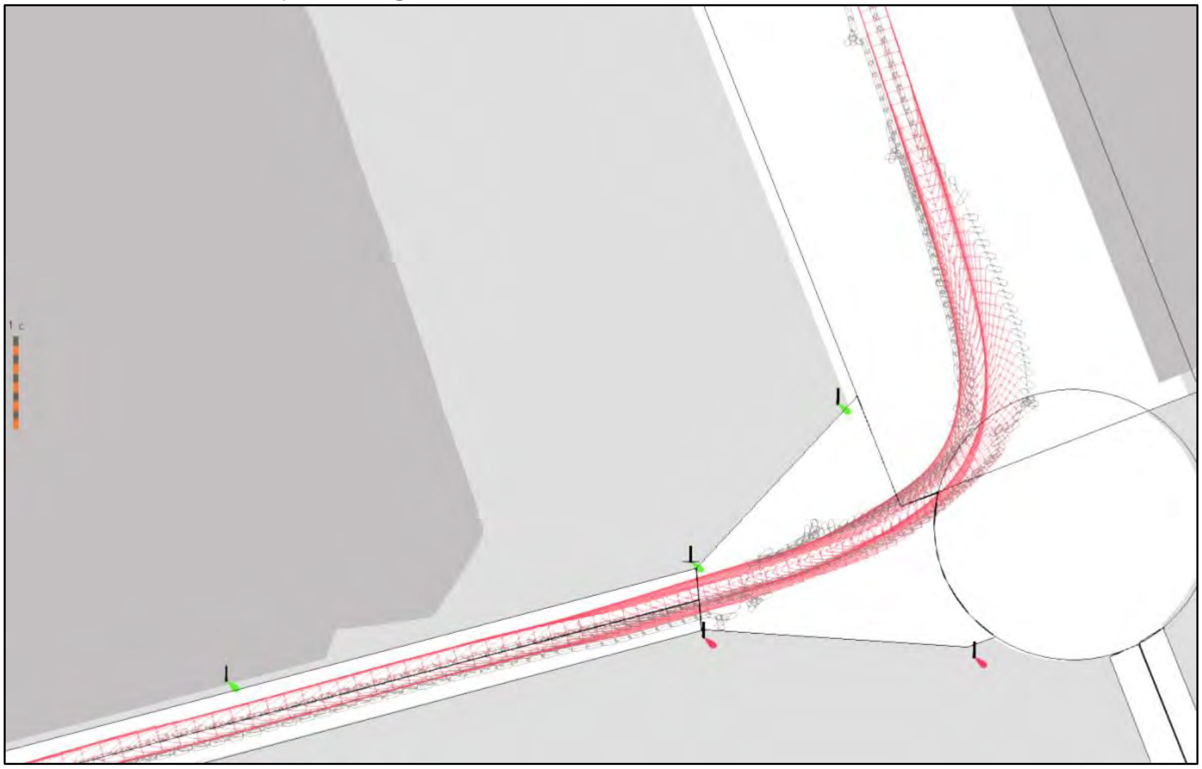
Run Description: The pilot completed both the turns out of the terminal basin into the channel and from the channel into the HSC. However, both turns required 100% of the forces available using all three tugs, and even then, the maneuvers were dangerous. The turn from the channel into the HSC was a 16-degree, and the ship was rolling at 3.5 degrees. This channel requires three tugs and 100% of the forces available to complete multiple risky turns.

Pilot Comments: This required my total focus and attention. All three tugs were required to turn from the channel into the HSC. Three tugs are necessary for this job. We rolled 3.5 degrees coming out of the channel into the HSC as our ROT was 16 degrees and using full tug forces. That was hazardous. Coming out of the terminal basin, I did not do a proper flare turn but instead did a 90-degree turn using all three tugs.

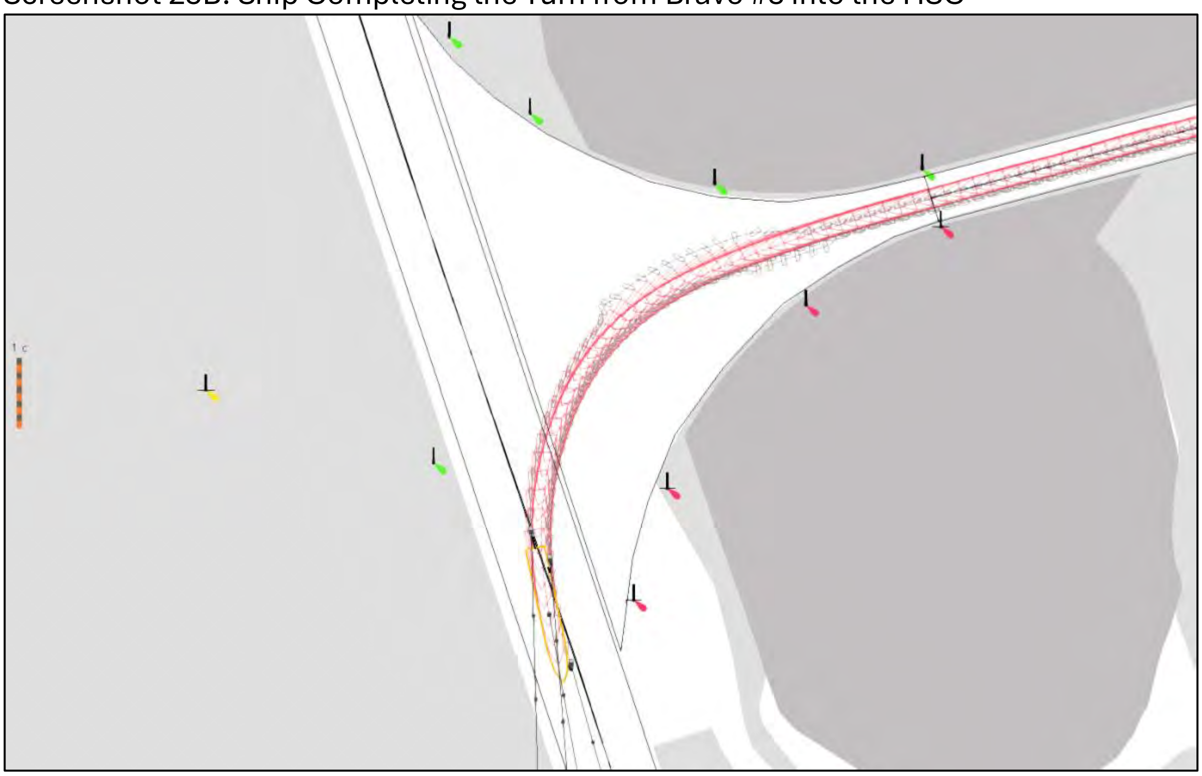
Screenshots List:

Screenshot 25A. Ship Turning Outbound from the Terminal Basin into Bravo #3
Screenshot 25B. Ship Completing the Turn from Bravo #3 into the HSC

Screenshot 25A. Ship Turning Outbound from the Terminal Basin into Bravo #3



Screenshot 25B. Ship Completing the Turn from Bravo #3 into the HSC



Channel Bravo #3 Final (Runs #26 – 29)

Channel Description: Channel Bravo #3 Final's route divided the continuous turn into three segments. The first segment from the HSC into the flared entrance of the channel requires a 15° turn (from heading 342° to heading 357°) in 0.9 miles. Then, the second segment requires a 66° turn (from heading 357° to heading 063°) in 0.9 miles. This is the same degree turn as Bravo #3 but is less acute, allowing for a ship to complete the turn more easily under its power rather than needing to stop and turn the vessel using tugboats. Then, the final straightaway segment into the area adjacent to the terminal basin requires a 12° turn (from heading 063° to heading 075°) in 1.2 miles. The segment widths for Bravo #3 Final were 400 ft.

Channel Assessment: The pilots selected this channel as feasible for the first part of the study.

Run 26. Bravo #3 Final, Arrival ULCV 366m, No Wind, GAR 1

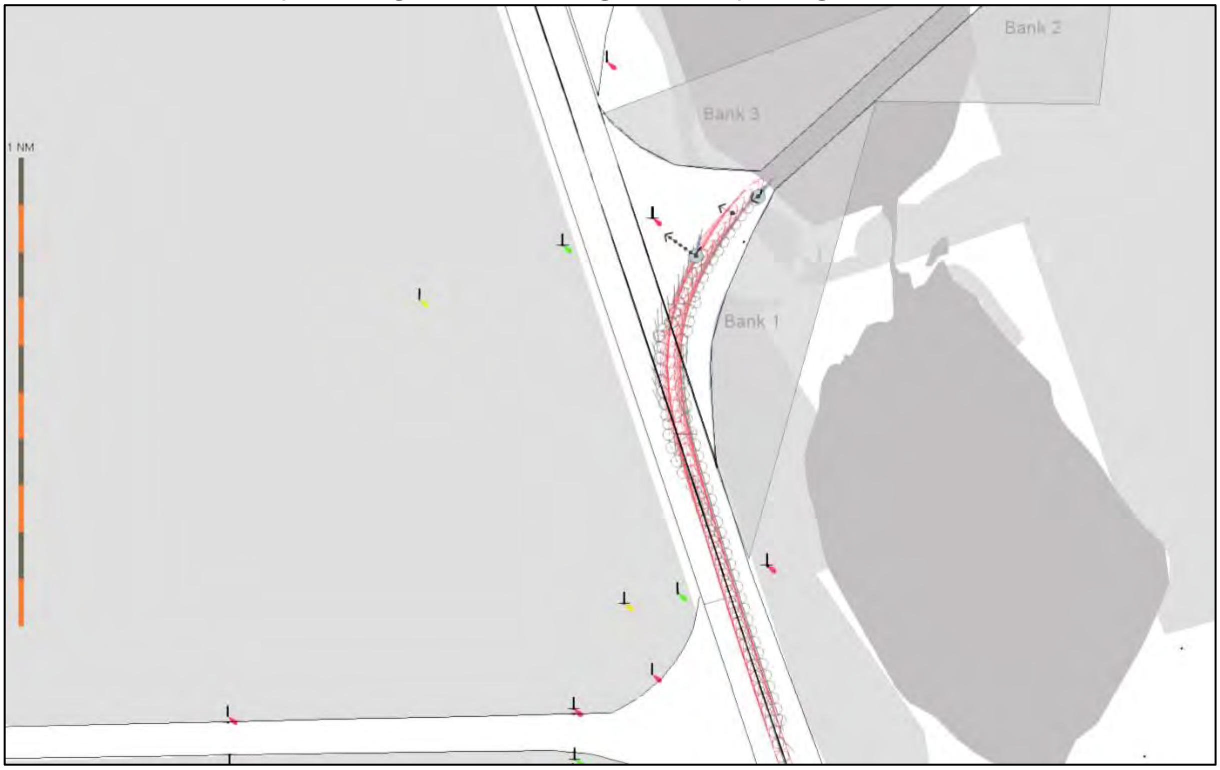
Run Description: The objective of the simulation was to evaluate the entry turn from the HSC into the Bravo #3 channel. The run stopped once the turn was completed. The pilot safely completed the turn from the HSC into the flared channel entrance. The pilot kept a speed of about 6kn entering the turn, and the ship came down slightly during the turn to 5.5kn. The pilot used the rudder and both tugs, including one doing a power indirect to make the turn. The ROT slowly increased to 13 degrees per minute, and then the pilot started to check the turn. The pilot was able to use the rudder and tugs in a normal fashion to reduce the ship's ROT to 9 degrees and get back to midship with the ship stable and in control before pausing the run.

Pilot Comments: This was a good turn into the HSC. I had control throughout. The turn was the easiest besides Delta. I got the ROT up to 13 degrees but felt in control. This is much safer than Alpha or the other versions of Bravo.

Screenshots List:

Screenshot 26A. Ship Turning Inbound Using Flared Opening from HSC into Bravo #3 Final

Screenshot 26A. Ship Turning Inbound Using Flared Opening from HSC into Bravo #3 Final



Run 27. Bravo #3 Final, Arrival ULCV 366m, No Wind, GAR 1

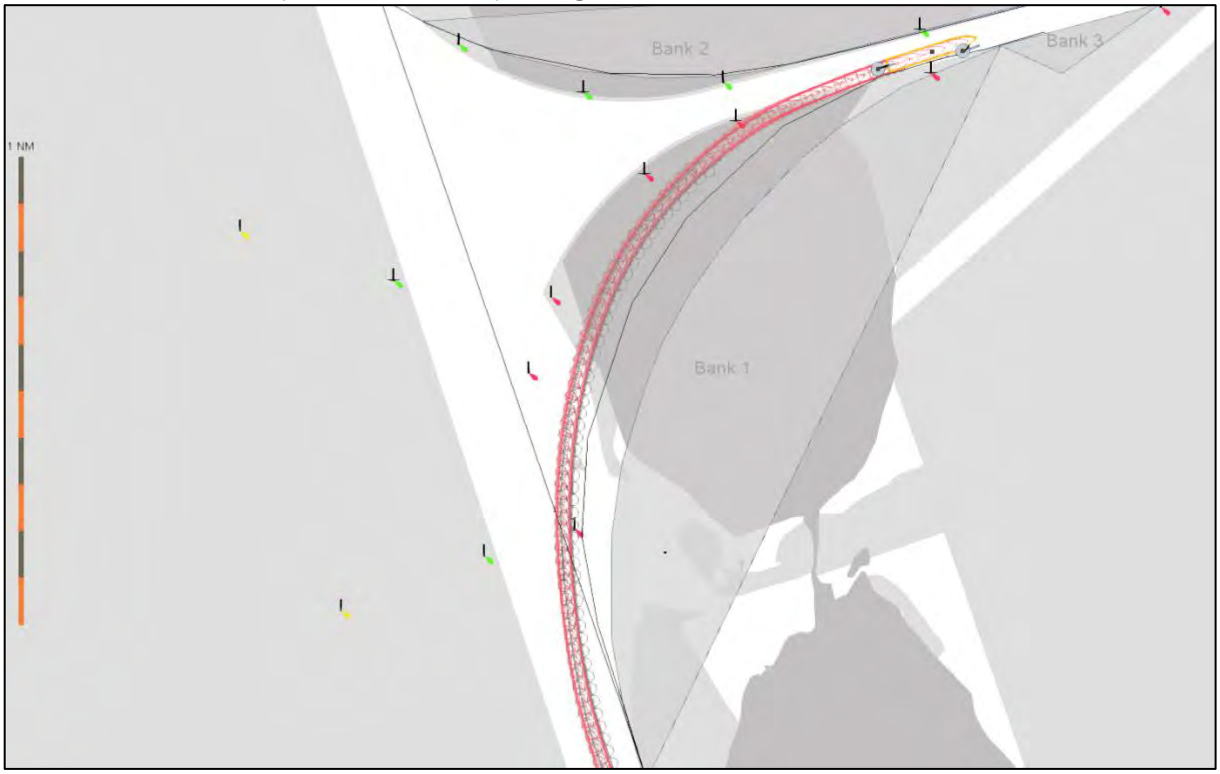
Run Description: This was a complete run from the HSC through Bravo #3 Final into the terminal basin. The pilot had positive control of the vessel throughout, with the maximum ROT reaching 9 degrees, but 7 degrees ROT was the norm.

Pilot Comments: This turn is much easier and does not require hard over rudder and indirect full on the tugs. “This is a dream channel compared to the others.” I had plenty of power in reserve throughout. This was routine and normal ship handling. I never had to use hard over rudder and could use the ship to check up on the turn. On this channel, 400’ wide is acceptable because the flares for the turns are so wide.

Screenshots List:

Screenshot 27A. Ship Inbound Completing Turn from HSC into Bravo #3 Final

Screenshot 27A. Ship Inbound Completing Turn from HSC into Bravo #3 Final



Run 28. Bravo #3 Final, Sailing ULCV 366m, No Wind, GAR 1

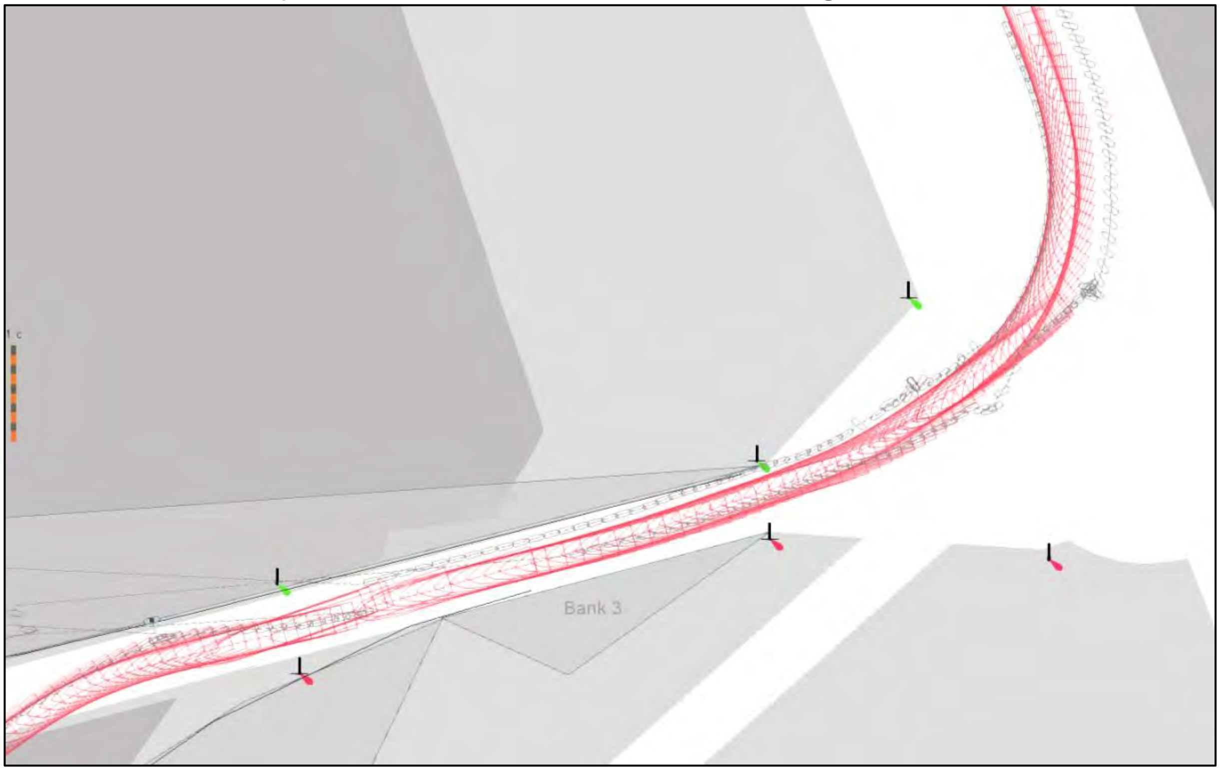
Run Description: The ship exited the terminal basin and turned into the Bravo #3 channel. This turn required the tugs and was done at 3kn. Once the ship got into the channel, they could increase to slow ahead, keeping on the center line. The turn into the HSC was safe and was done at 3 to 4kn. Once most of the turn was completed, the pilot gave the ship a kick, increasing the speed to 6kn along with the ROT. The pilot kept the ROT at 7 degrees to complete the turn safely.

Pilot Comments: Coming out of the terminal basin, I was going slow and needed to use the tugs to turn into the channel. Coming out of the terminal is similar to Bayport, as the tugs are needed to turn the ship. Overall, this is the best channel. From a piloting perspective, this has the best navigation and poses the least number of hazards to navigation.

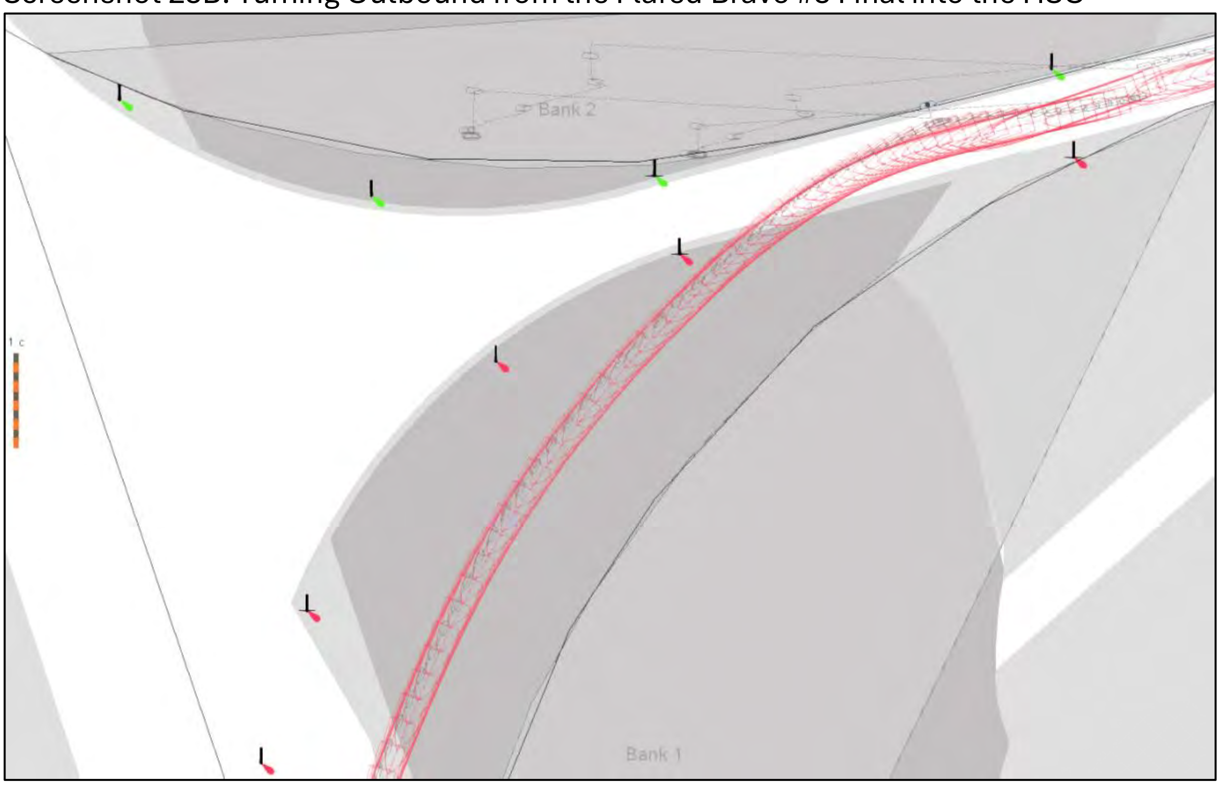
Screenshots List:

Screenshot 28A. Ship Outbound from Terminal Basin Turning into Bravo #3 Final
Screenshot 28B. Turning Outbound from the Flared Bravo #3 Final into the HSC
Screenshot 28C. Ship Completing the Turn into the HSC
Screenshot 28D. Entire Run in Bravo #3 Final

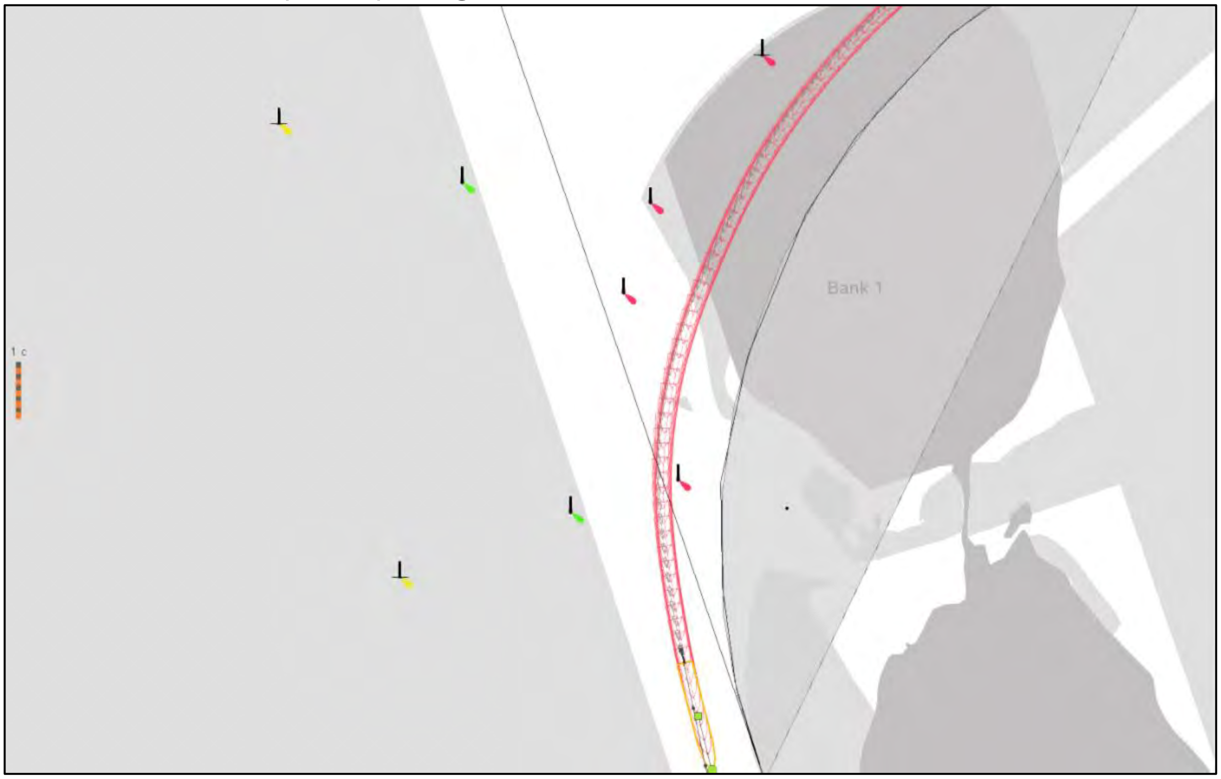
Screenshot 28A. Ship Outbound from Terminal Basin Turning into Bravo #3 Final



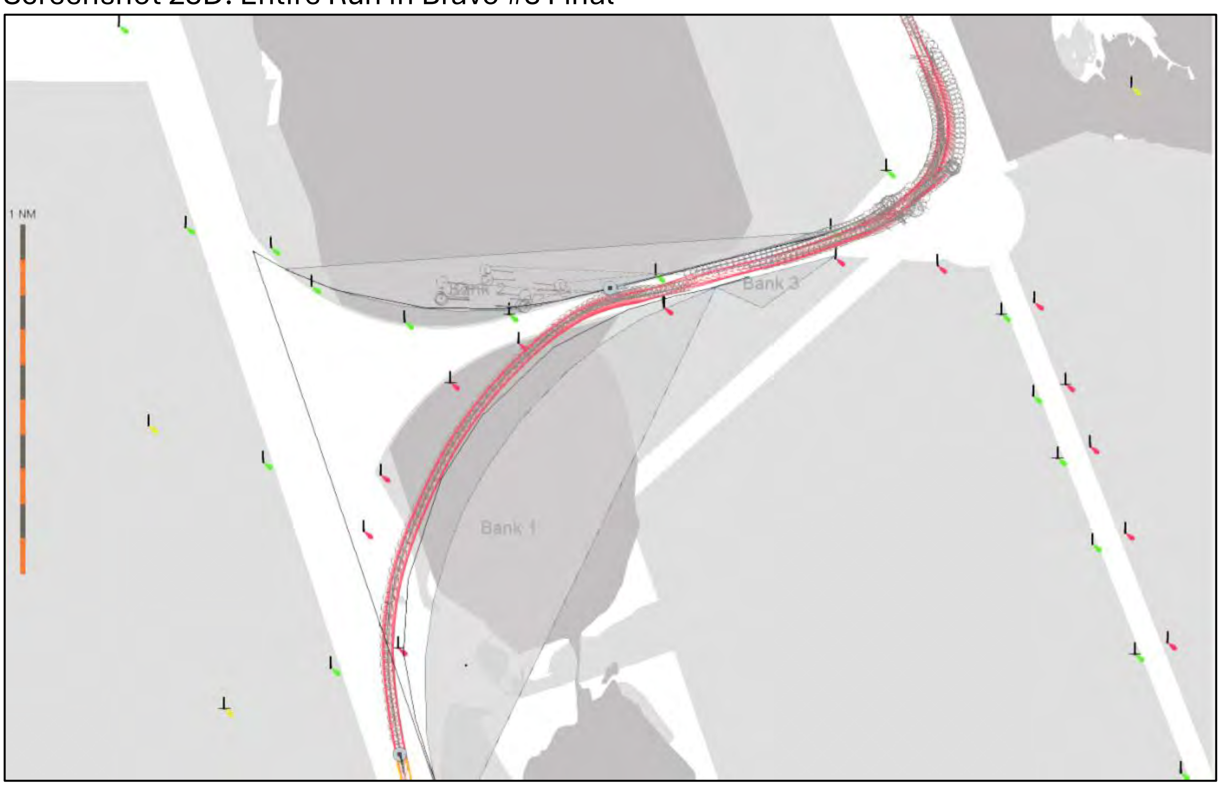
Screenshot 28B. Turning Outbound from the Flared Bravo #3 Final into the HSC



Screenshot 28C. Ship Completing the Turn into the HSC



Screenshot 28D. Entire Run in Bravo #3 Final



Run 29. Bravo #3 Final, Arrival ULCV 366m, No wind, GAR 1

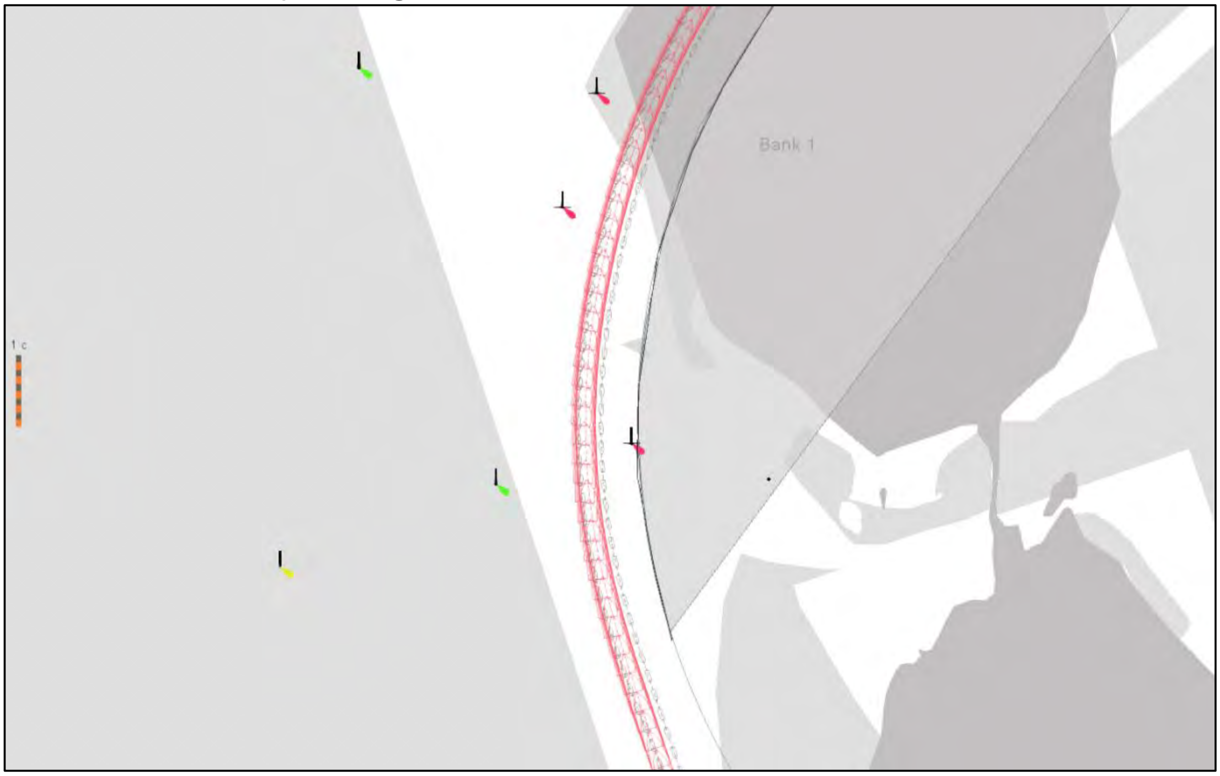
Run Description: To test an inbound turn with a smaller turn radius, the project modified Bravo #3 Final's flared entrance turn from the HSC to 5,100'. This was not a complete run, just a test of the reduced turn radius. The pilot had positive control over the vessel the entire time. The tugs were used to control the vessel's speed, helping keep it around 6 to 6.5kn through the turn. The ROT was steady at around 5 to 6 degrees until the end, when the pilot used the rudder and no tugs to increase the ROT to 10 degrees. Once an ROT of 10 degrees was reached, the pilot checked the turn using the rudder, quickly reducing the ROT to 4 degrees while entering the HSC channel.

Pilot Comments: The reduced radius turn did not increase the risks posed by this channel. I completed the turn into the channel safely from the HSC using little rudder and two tugs. The two tugs should be required in case of weather. I had plenty of reserve power to turn into the channel and felt comfortable. It does require laser focus, but this was my first time making this turn. I understood I could turn too early or late because I had enough space and the tugs. That is different from Alpha or the other Bravo options. I was able to control my speed and the ROT throughout. The channel is acceptable at 400' wide mostly because of the short distance and due to the large flares. However, a beam wind could pose a hazard on this channel. This channel is similar to Bayport, and when we experience a 15kn beam wind, it can be done, but it's working on the edge of safety.

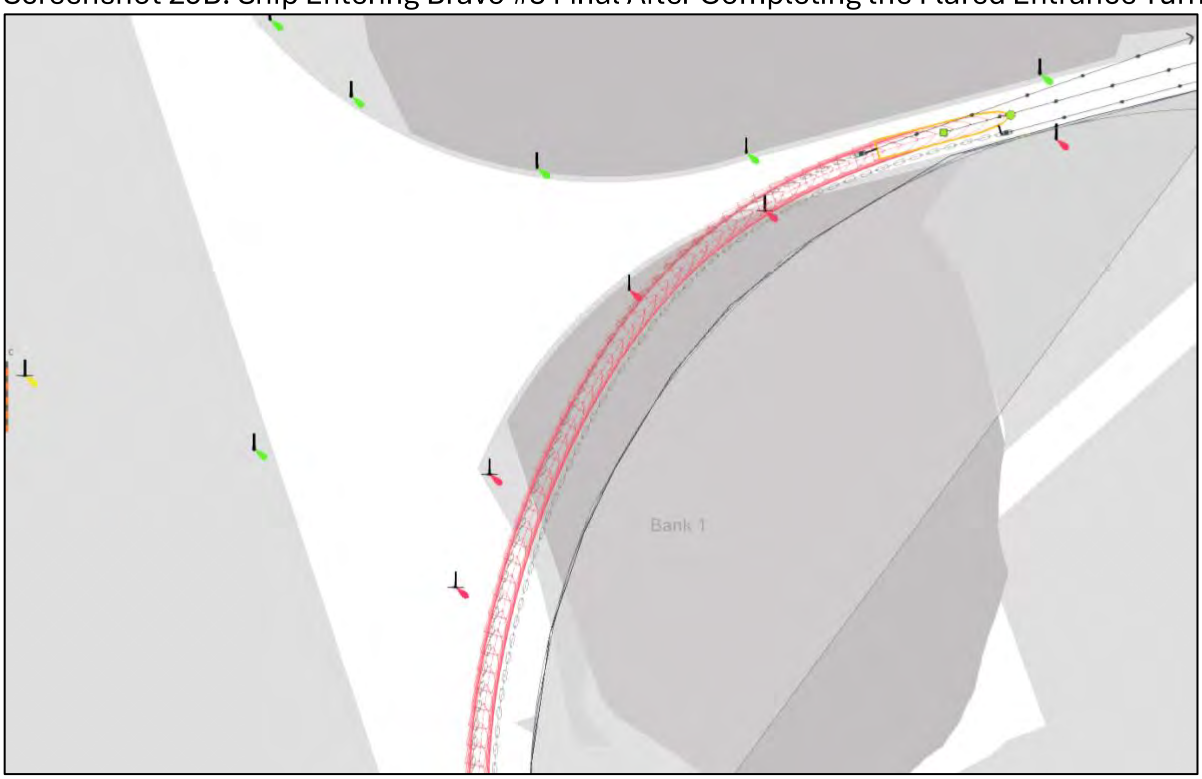
Screenshots List:

Screenshot 29A. Ship Turning Inbound from HSC into the Flared Entrance of Bravo #3 Final
Screenshot 29B. Ship Entering Bravo #3 Final After Completing the Flared Entrance Turn
Screenshot 29C. Entire Run in Bravo #3 Final

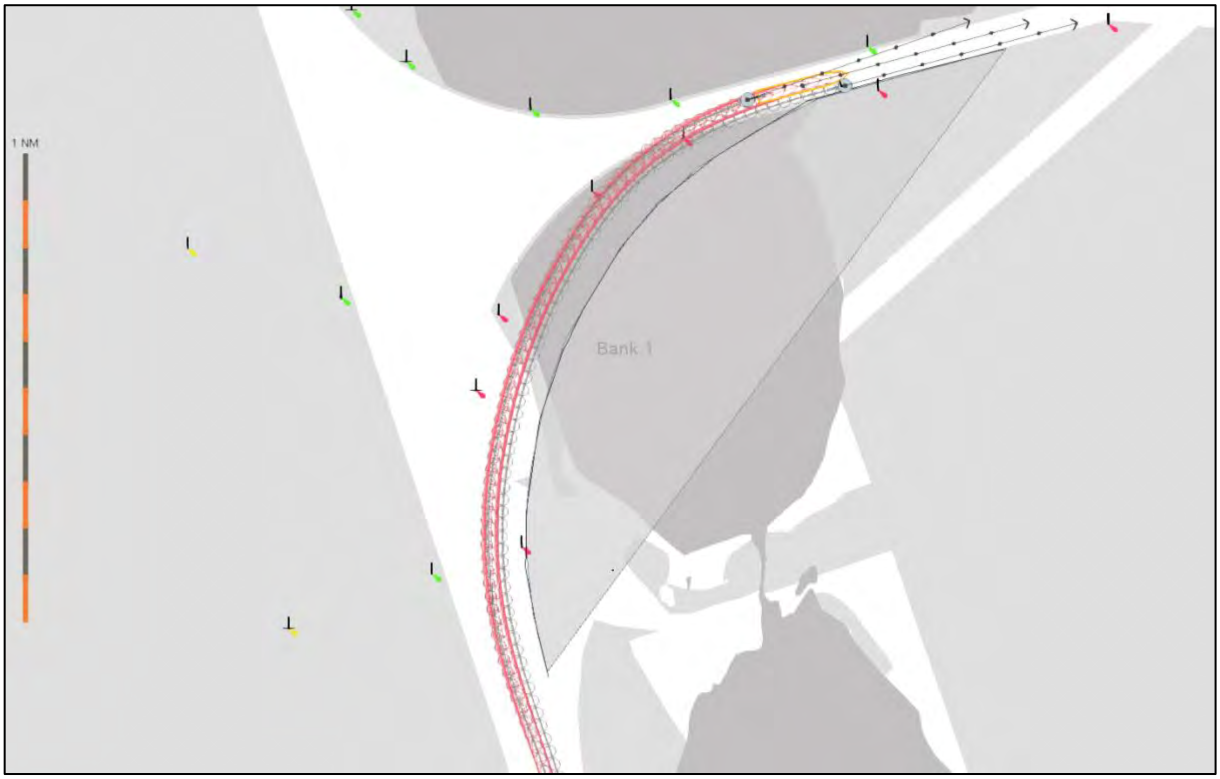
Screenshot 29A. Ship Turning Inbound from HSC into the Flared Entrance of Bravo #3 Final



Screenshot 29B. Ship Entering Bravo #3 Final After Completing the Flared Entrance Turn



Screenshot 29C. Entire Run in Bravo #3 Final



Channel Echo #1 (Runs #30 - 39)

Channel Description: Echo #1 is within a corridor cutting through Atkinson Island between the HSC and Cedar Port. It is about 3 miles north of the Bayport Ship Channel and approximately 6,700' north of the previously tested Bravo #3 Final. Echo #1 is designed with a 5,300' radius to turn from a heading of 342° in the HSC to a heading of 078° in the channel's straightaway heading into the turning basin. This requires a constant arcing turn of 96° over approximately one mile. The proposed channel is 400' wide. It terminates in a turning basin that is 1,500' in diameter and connects to the Cedar Port terminal from the north. Bravo #3 Final had a similar arcing turn (5,100' radius) but entered the Cedar Port terminal basin from the south. The proposed Container Terminal dock has been shifted approximately 70' to the east compared to what was tested during the first part of the study.

Channel Assessment: This channel is feasible for successful navigation, but the pilots did identify multiple potential hazards.

Run 30. Echo #1, Arrival ULCV 366m, No wind, GAR 2

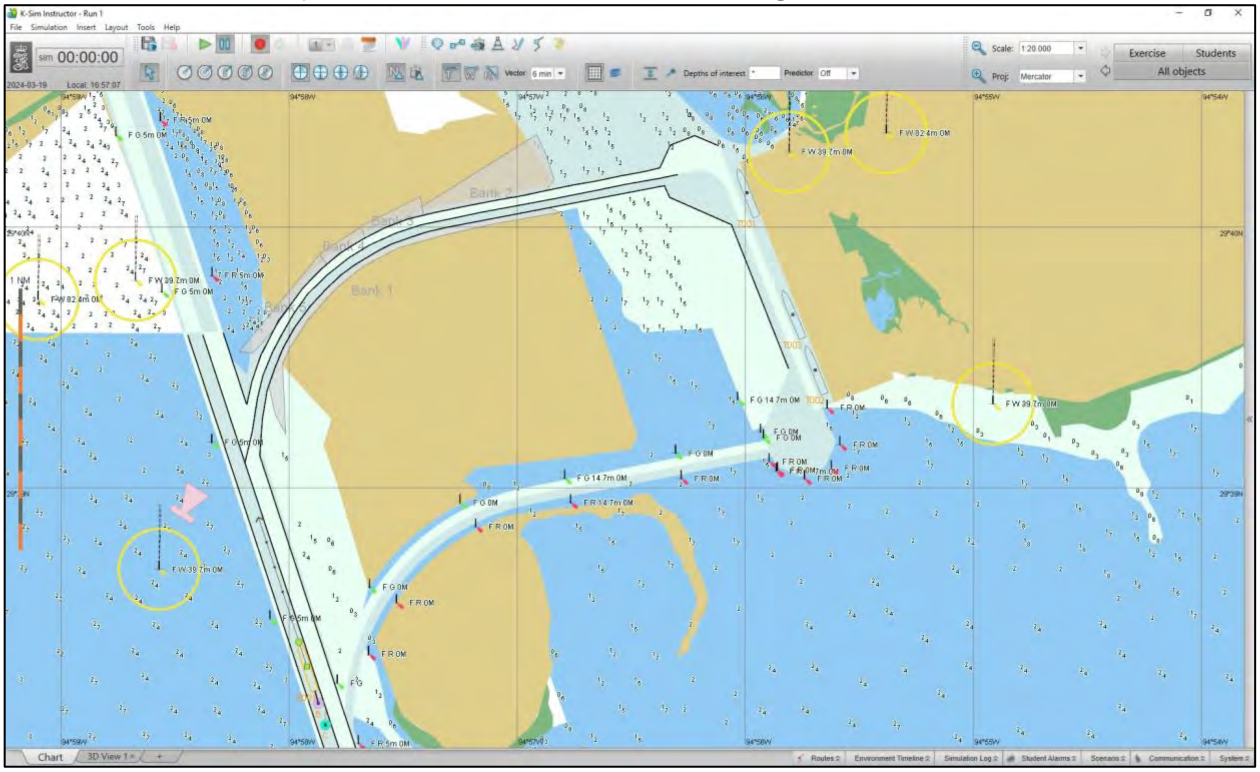
Run Description: The run started with the ship at 6kn, four ship lengths below the entrance to Echo and ½ a beam left of the centerline in the HSC, along with an assist tug with a line on the stern. The pilot had to use the tug and rudder to "muscle" the ship into the channel's entrance. The speed of the ship in the turn and channel was consistently 6kn. The ROT was about 6° in the continuous arcing turn with a maximum ROT of 15°. The ship simulator run froze due to a technical error after the turn in and while the ship was in the straight-away about two ship lengths before entering the turning basin. A vector tug was tied up to the ship during the turn-in to assist. The run was considered completed, and a debriefing was conducted.

Pilot Comments: This job will require two pilots. A PPU is necessary to make this maneuver. Entering Echo is difficult because we go from a 700' channel to exiting into a 400' channel. The pilot described a small margin for error when entering the channel and making the continuous arcing turn. The pilot had to get up to 15° ROT as he started the turn late into the run. The pilot had to constantly maintain and monitor course corrections to keep the ship from over or under-rotating. This maneuver did not require emergency ship handling but was difficult to perform and required cautious alert ship handling.

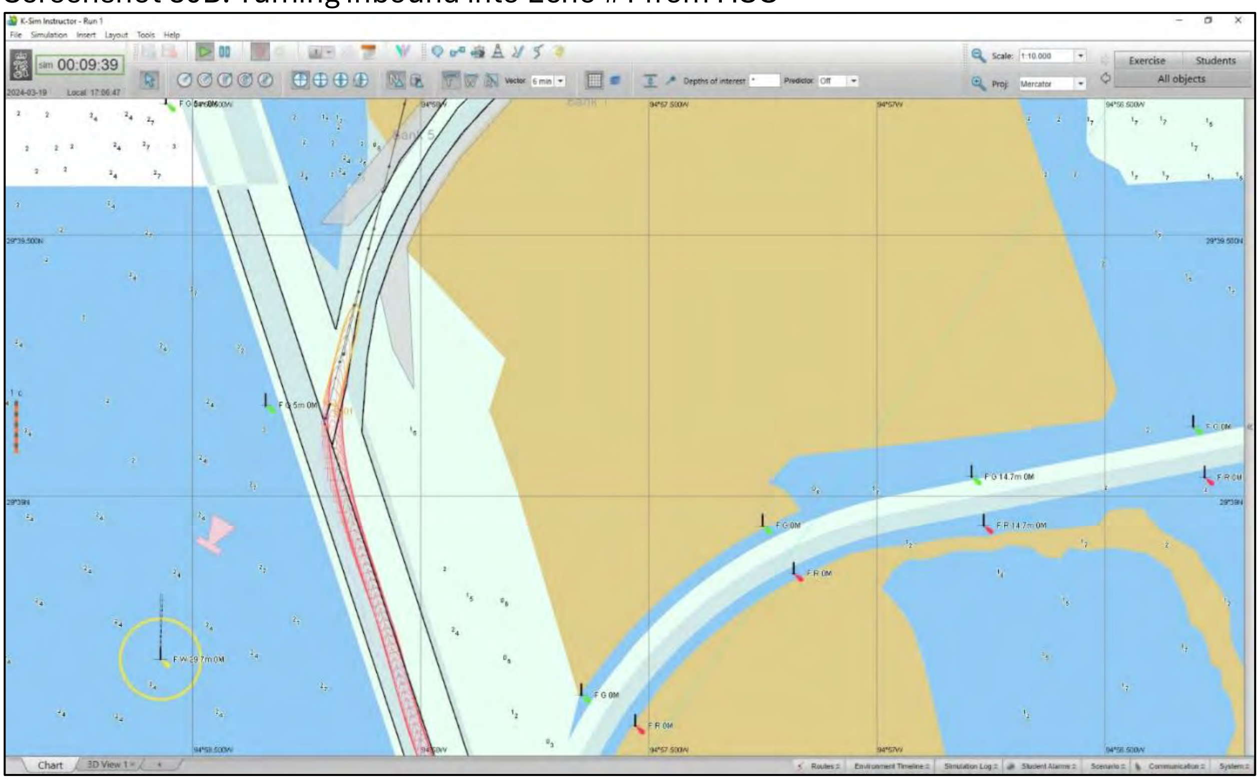
Screenshots List:

Screenshot 30A. Setup arrival from HSC into Echo #1, tug on the stern, no wind
Screenshot 30B. Turning inbound into Echo #1 from HSC
Screenshot 30C. Completed continuous arcing turn Echo #1
Screenshot 30D. Completed run, simulator froze when ship neared turning basin

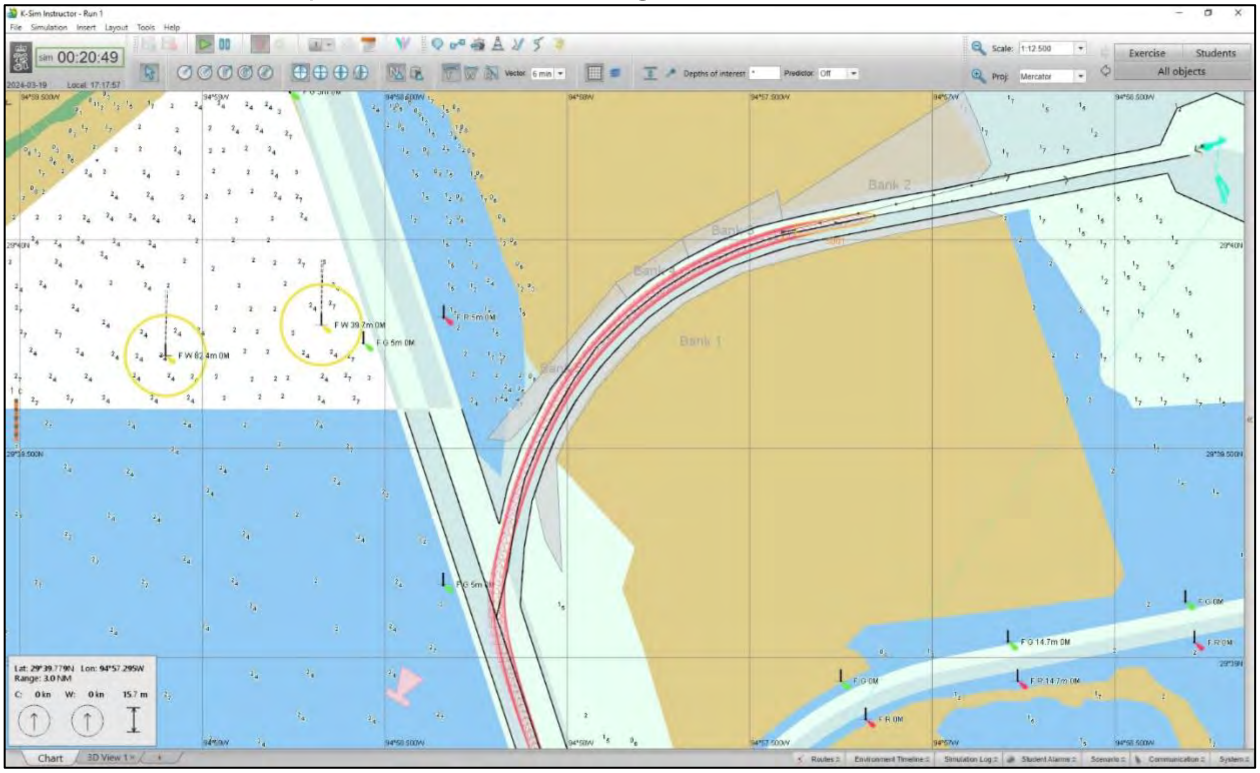
Screenshot 30A. Setup arrival from HSC into Echo #1, tug on the stern, no wind



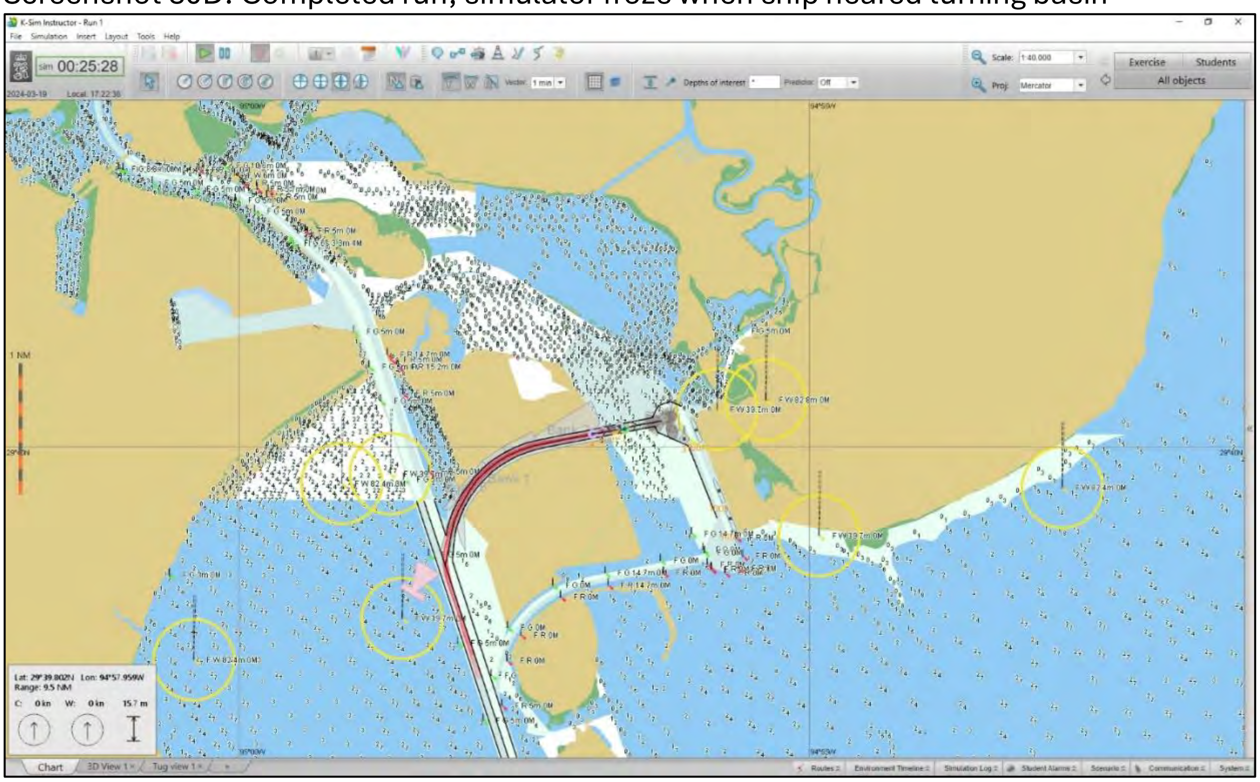
Screenshot 30B. Turning inbound into Echo #1 from HSC



Screenshot 30C. Completed continuous arcing turn Echo #1



Screenshot 30D. Completed run, simulator froze when ship neared turning basin



Run 31. Echo #1, Arrival ULCV 366m, No wind, GAR 2

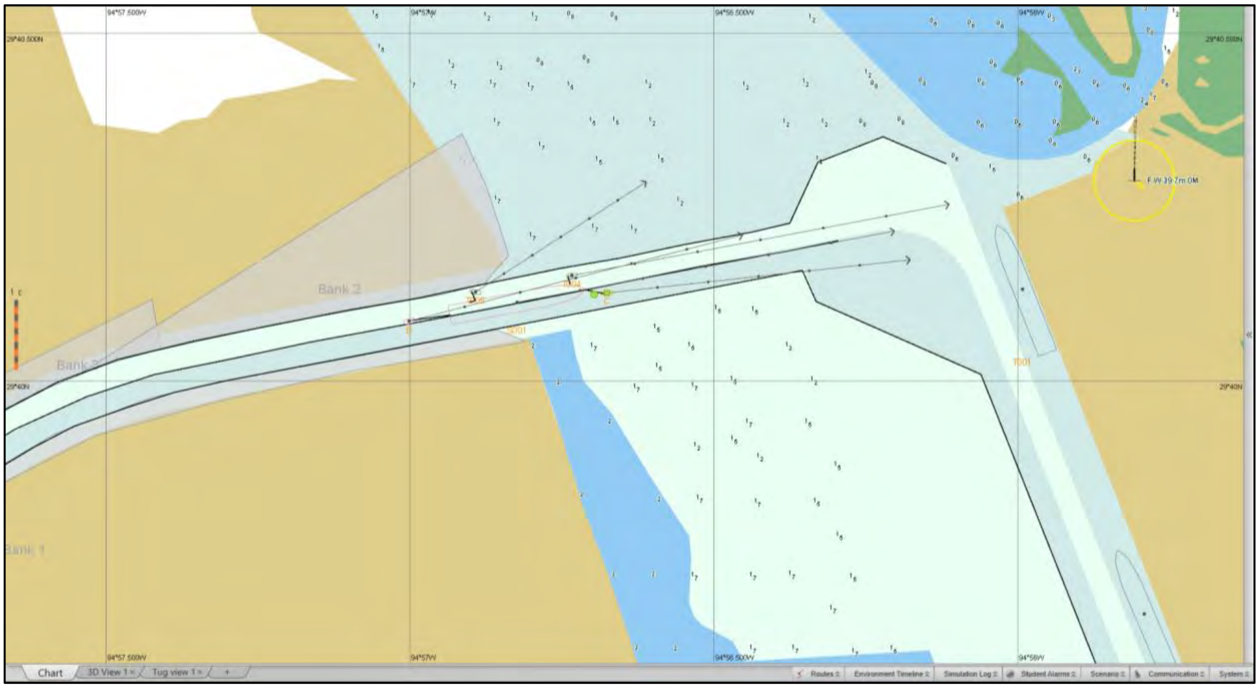
Run Description: This run began when the previous run froze with the inbound ship at about two ship lengths before the entrance of the turning basin at about 4kn. All four tugs were arranged on the center lead bow and stern, as well as on the port should and quarter. The pilot quickly slowed the ship to about 1kn as it entered the turning basin using slow astern. The pilot was able to turn the ship in the turning basin using the tugs and rudder with a maximum 17° ROT that took 14 minutes to complete. The pilot was able to back the ship down past the ship at Berth #1 and parallel with Berth #2. This was done using dead slow at 1.2kn.

Pilot Comments: The bow and stern tug worked outside the boundaries of the turning basin. The pilot believes this could have been prevented. A maximum ROT of 17° should be the maximum, and we do not advise going beyond that in the turning basin. I had positive control throughout the maneuver but was very cautious. I had to micromanage my pivot point. These ships are large, and the basin required a tight maneuver with the tugs working along the basin's edges.

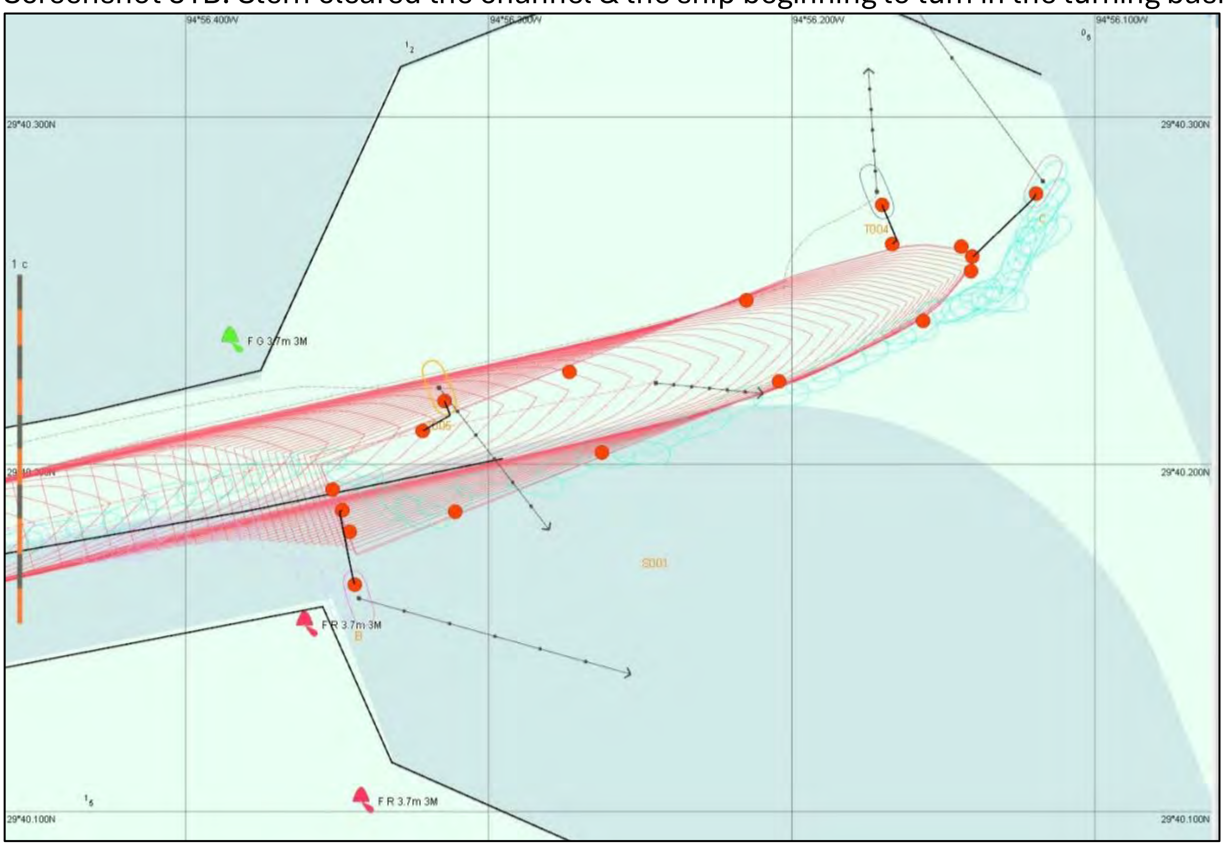
Screenshots List:

Screenshot 31A. Setup inbound into Echo #1's turning basin, all four tugs on the stern, bow, portside shoulder & quarter, zero wind
Screenshot 31B. Stern cleared the channel & the ship beginning to turn in the turning basin
Screenshot 31C. Ship completed turn in turning basin beginning to back
Screenshot 31D. Ship completed inbound run docking at Berth 3

Screenshot 31A. Setup inbound into Echo #1's turning basin, all four tugs on the stern, bow, portside shoulder & quarter, zero wind

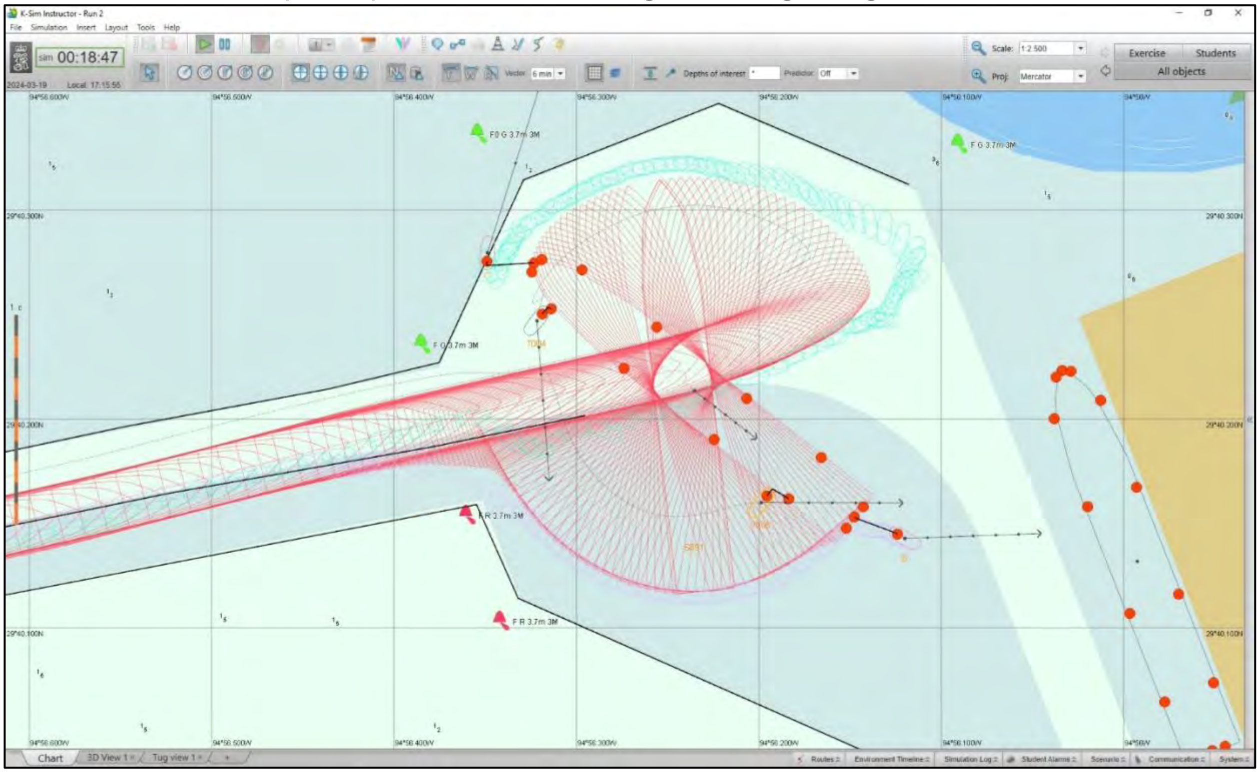


Screenshot 31B. Stern cleared the channel & the ship beginning to turn in the turning basin

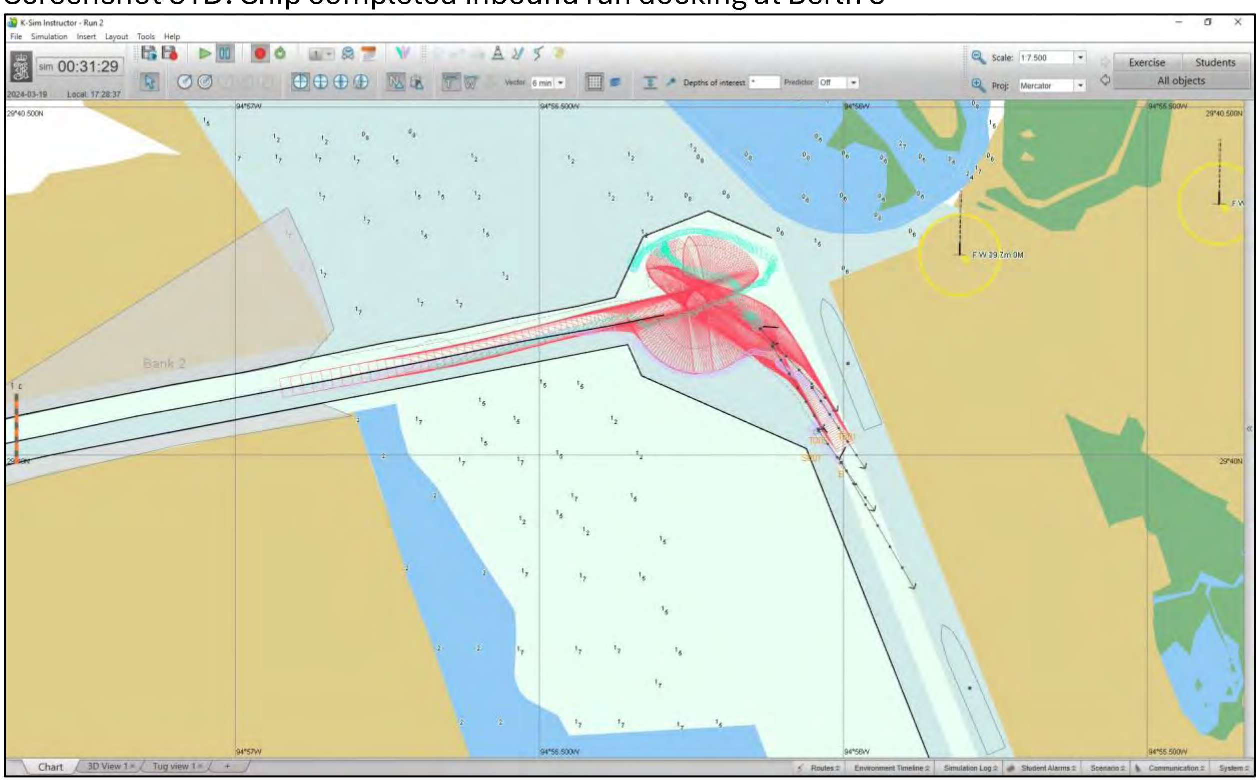


Locus

Screenshot 31C. Ship completed turn in turning basin beginning to back



Screenshot 31D. Ship completed inbound run docking at Berth 3



Run 32. Echo, Sailing ULCV 366m, No wind, FAILED, Not Applicable

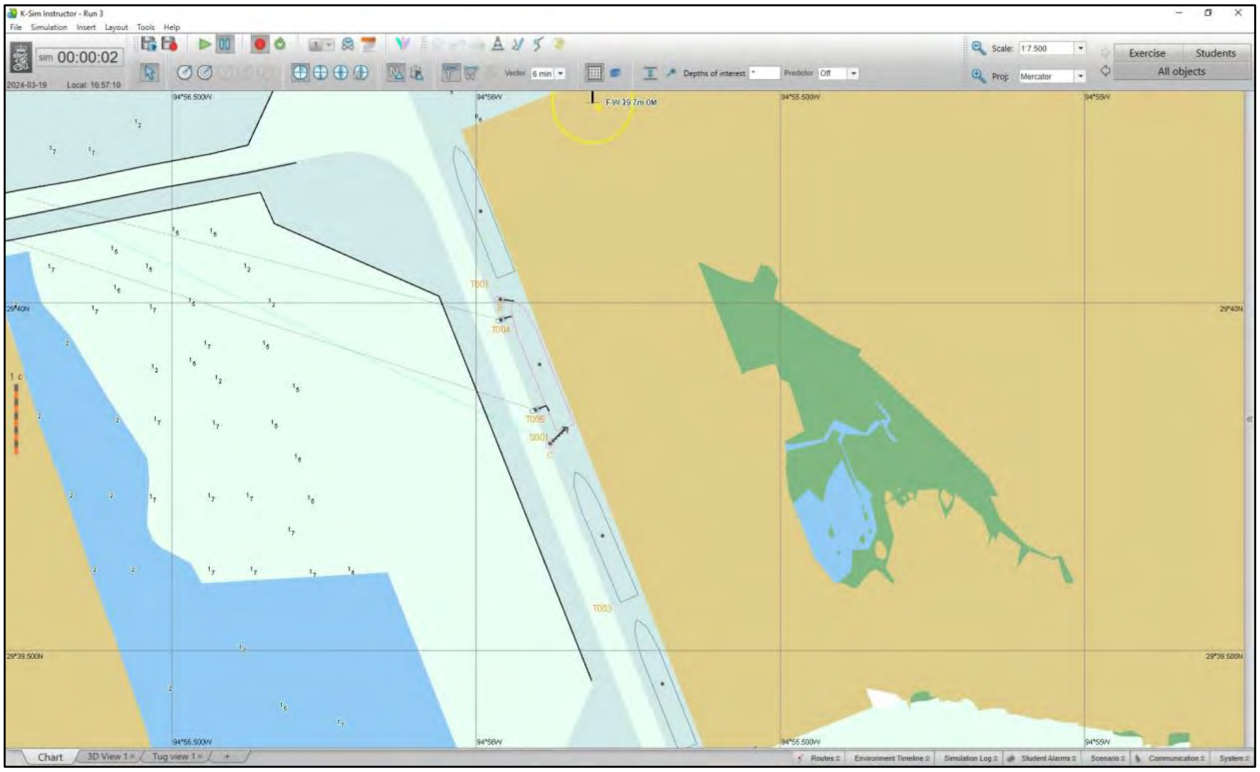
Run Description: Undocking from Berth #2 using four tugs arranged on the center lead bow, stern, as well as port shoulder and quarter. When attempting to pull the ship off the berth and into the terminal basin, the pilot lost track of communications due to too many distractions in the ship simulator. This resulted in the port quarter tug completely leaving the terminal basin and failing the run.

Pilot Comments: There was too much going on when we started. I did not see what happened with the tug; it was a communication failure.

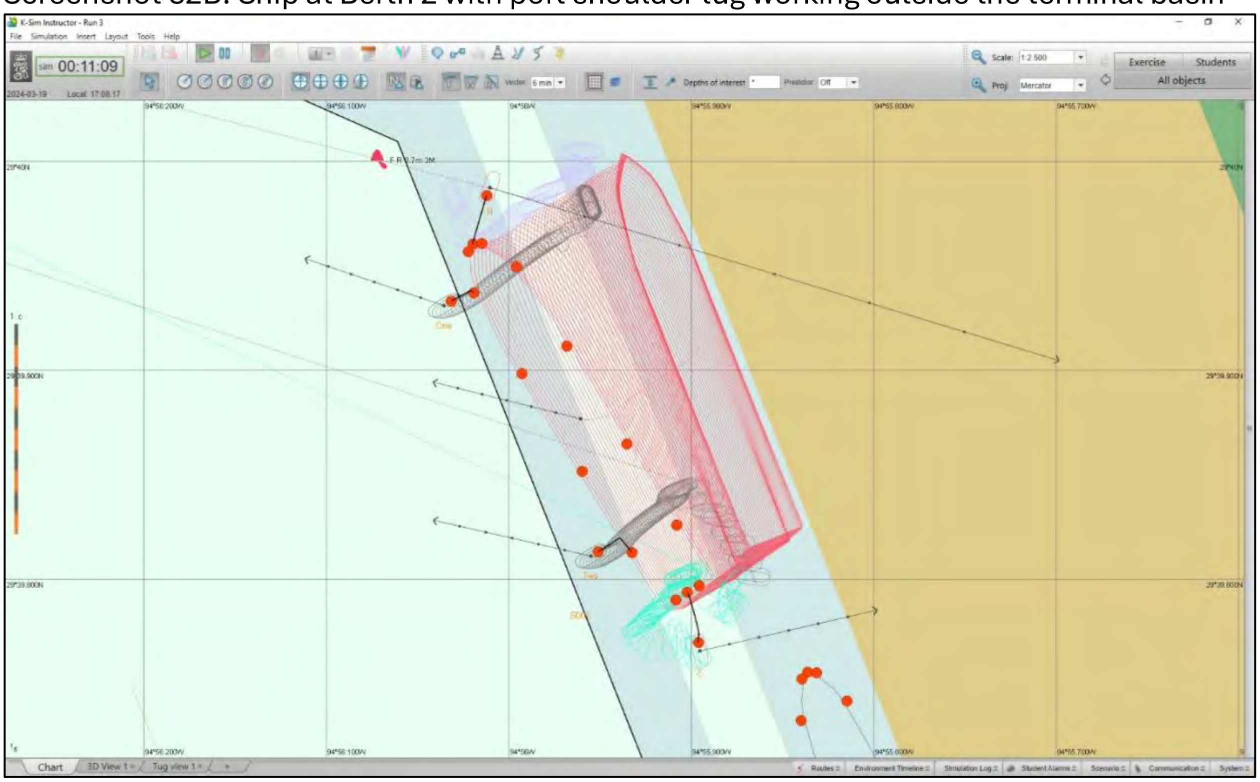
Screenshots List:

Screenshot 32A. Setup sailing and undocking from Berth #2, all four tugs on the stern, bow, portside shoulder & quarter, zero wind.
Screenshot 32B. Ship at Berth 2 with port shoulder tug working outside the terminal basin
Screenshot 32C. Completion ship left berthing pocket, All four tugs on the stern, bow, portside shoulder & port quarter

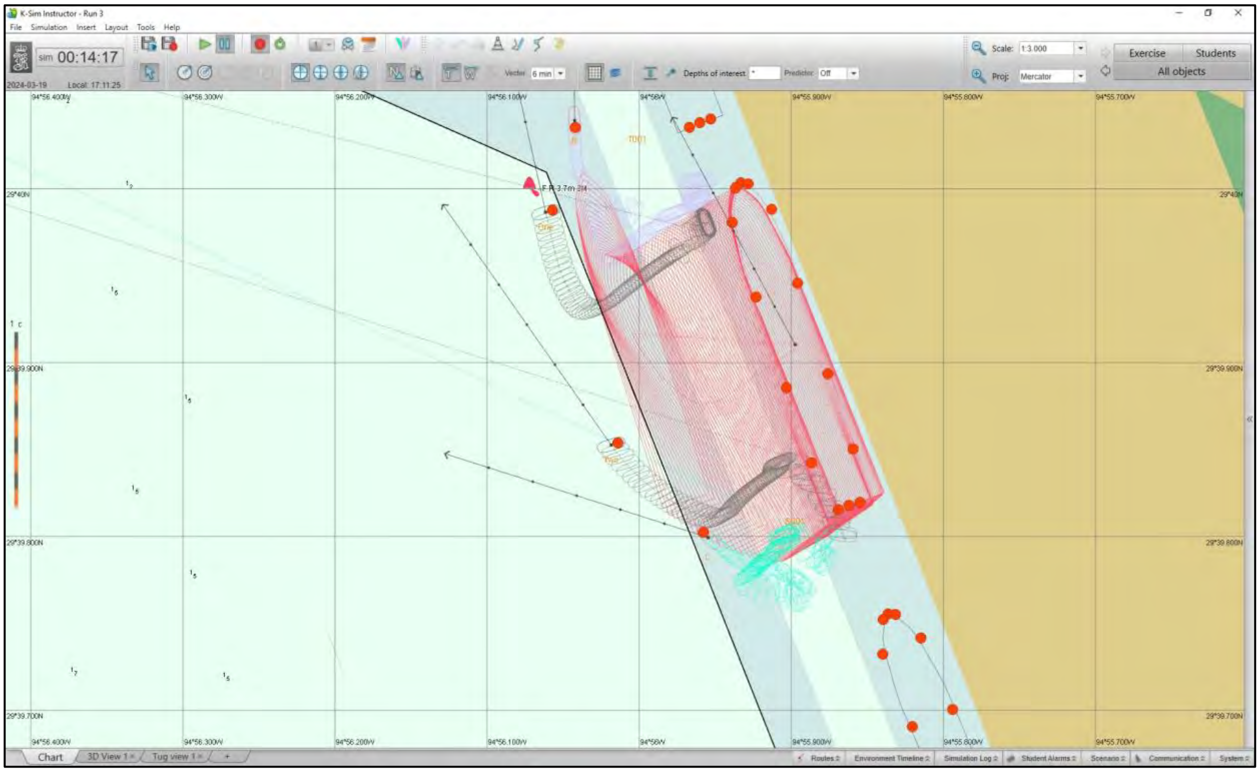
Screenshot 32A. Setup sailing and undocking from Berth #2, all four tugs on the stern, bow, portside shoulder & quarter, zero wind.



Screenshot 32B. Ship at Berth 2 with port shoulder tug working outside the terminal basin



Screenshot 32C. Completion ship left berthing pocket, All four tugs on the stern, bow, portside shoulder & quarter



Run 33. Echo #1, Sailing ULCV 366m, No wind, GAR 2

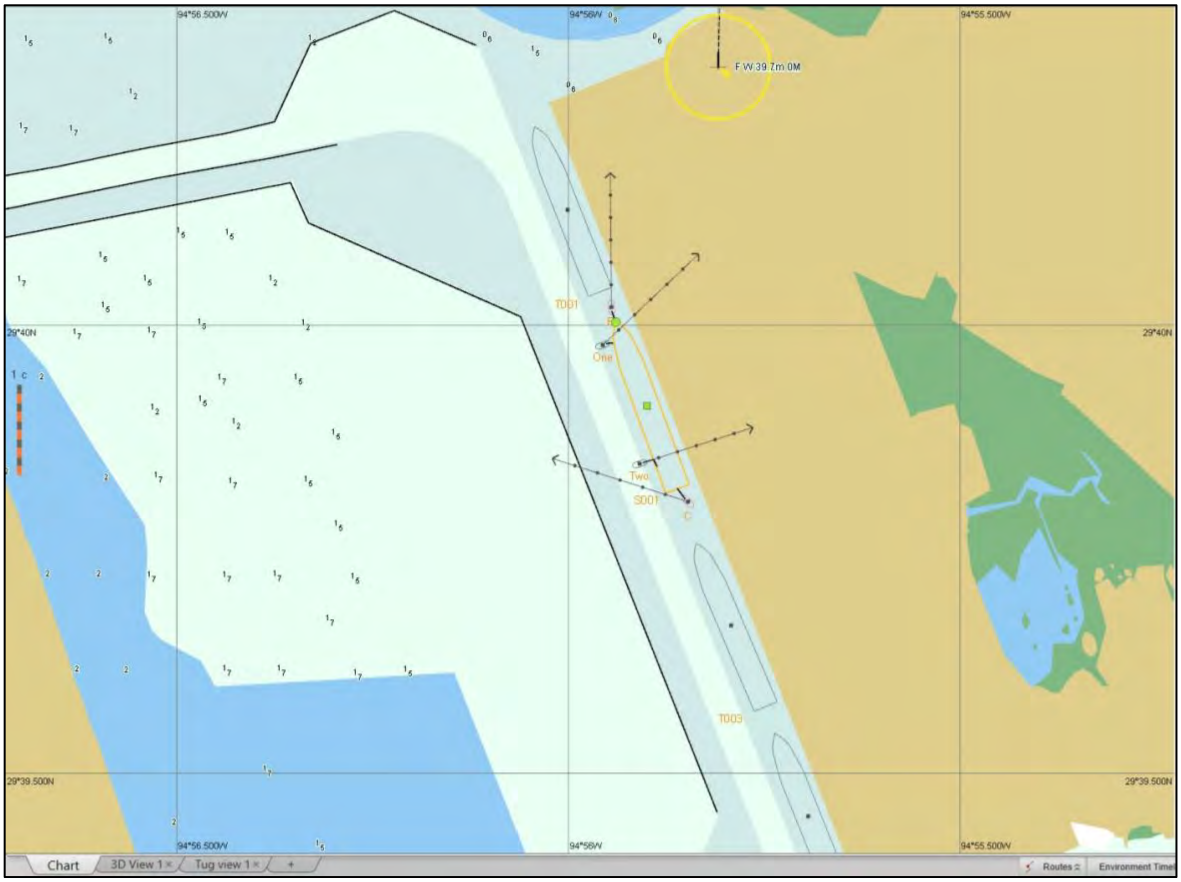
Run Description: Undocking from Berth #2 using four tugs arranged on the center lead bow, stern, as well as port shoulder and quarter. Once the pilot got the ship out of the berth, the port quarter tug needed to lay flat alongside to avoid going outside the terminal basin. Rather than turning the ship in the turning basin, the pilot hugged the outside bank of the turning basin and turned out, entering Echo #1 at about 6kn. The maximum ROT during the continuous arcing turn was about 9° per minute. The turn and exit into the HSC did not require emergency ship handling, and the ship was up to 8kn when entering the HSC. The entire run took about 38 minutes to complete.

Pilot Comments: Getting off the dock and lined up for the outbound turn is difficult. The ship needs to be far enough over to make the turn. I was cautious about swinging the stern past the ship at Berth #1. My goal was to drive out, but I had to hug the outer bank to make sure my stern cleared the ship at Berth #1. This was not a routine maneuver and required great precision. A major issue was ensuring the tugs stayed inside the terminal basin.

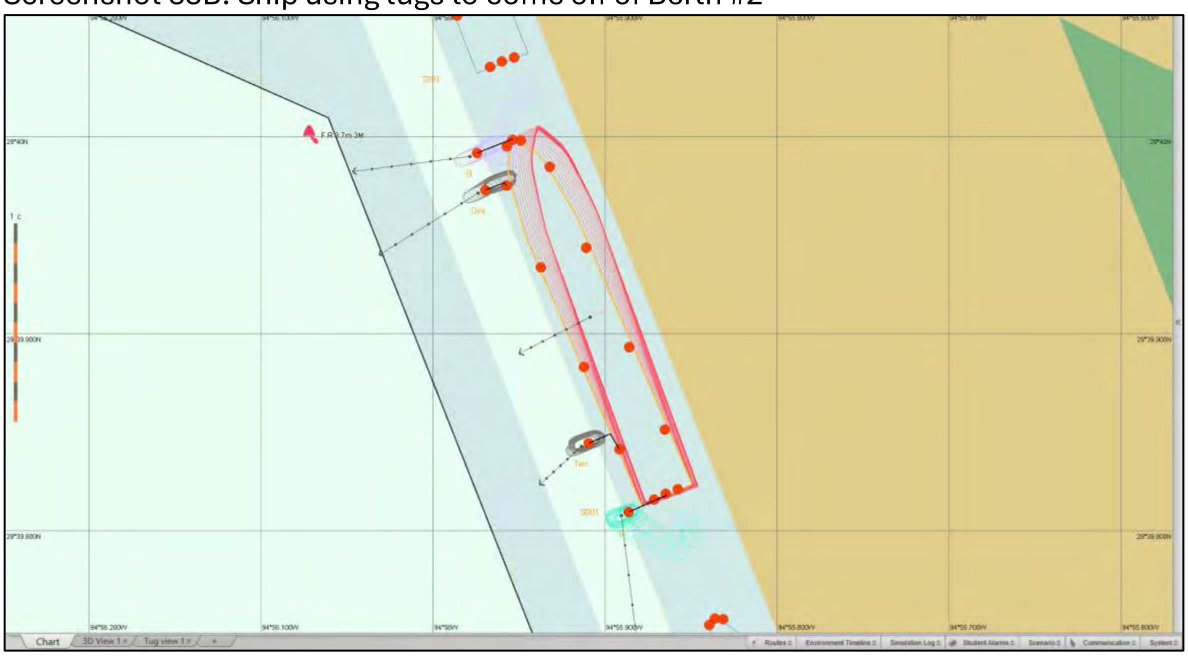
Screenshots List:

Screenshot 33A. Setup outbound and undocking from Berth 2, all four tugs on the stern, bow, portside shoulder & quarter, zero wind
Screenshot 33B. Ship using tugs to come off of Berth #2
Screenshot 33C. Ship enters Echo #1 after driving out of turning basin
Screenshot 33D. Ship in Echo #1 making the continuous arcing turn outbound
Screenshot 33E. Ship in Echo #1 exiting into the HSC
Screenshot 33F. Completion outbound entering HSC from Echo #1

Screenshot 33A. Setup outbound and undocking from Berth 2, all four tugs on the stern, bow, portside shoulder & quarter, zero wind

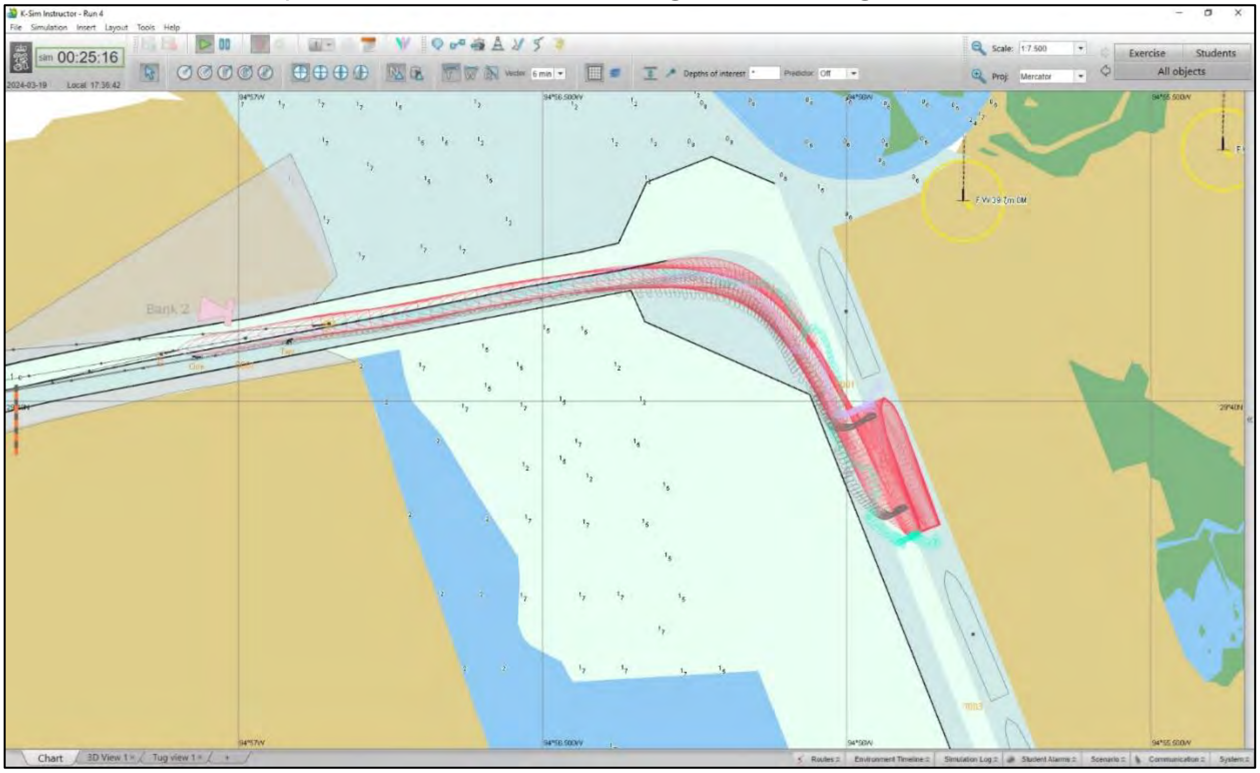


Screenshot 33B. Ship using tugs to come off of Berth #2

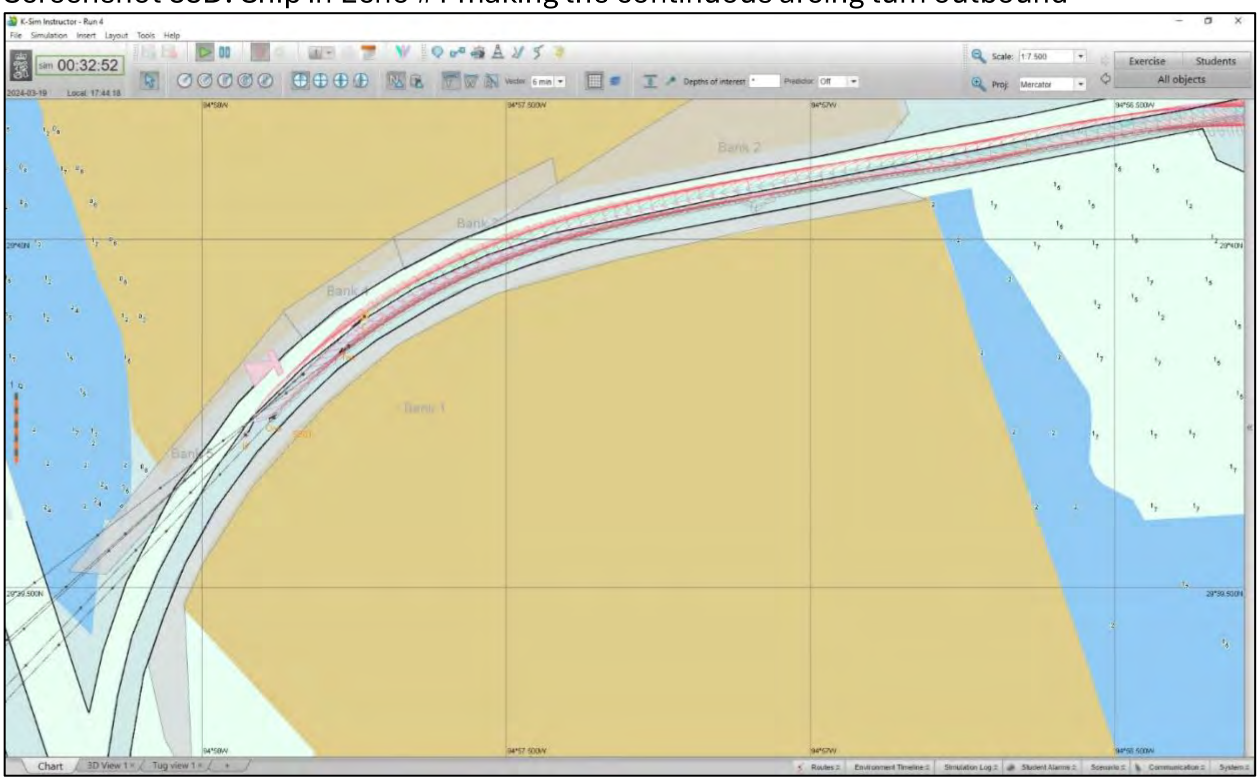


Locus

Screenshot 33C. Ship enters Echo #1 after driving out of turning basin

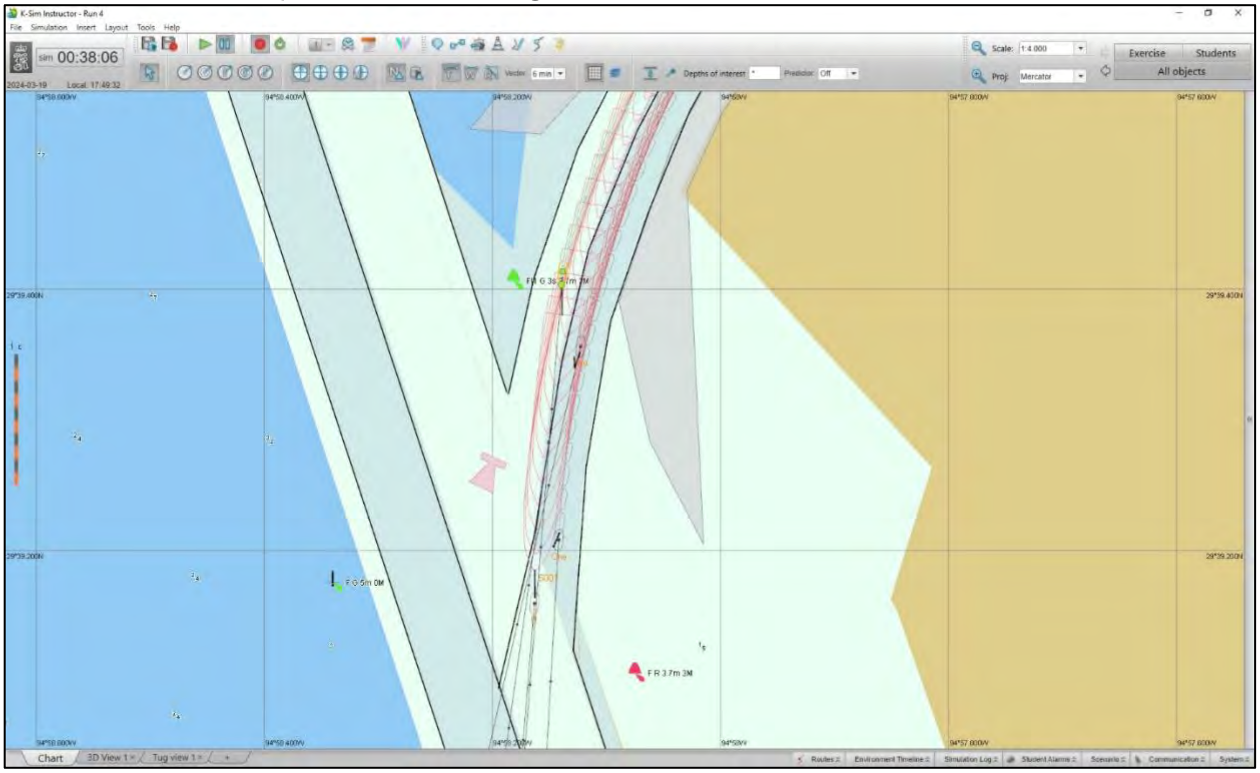


Screenshot 33D. Ship in Echo #1 making the continuous arcing turn outbound

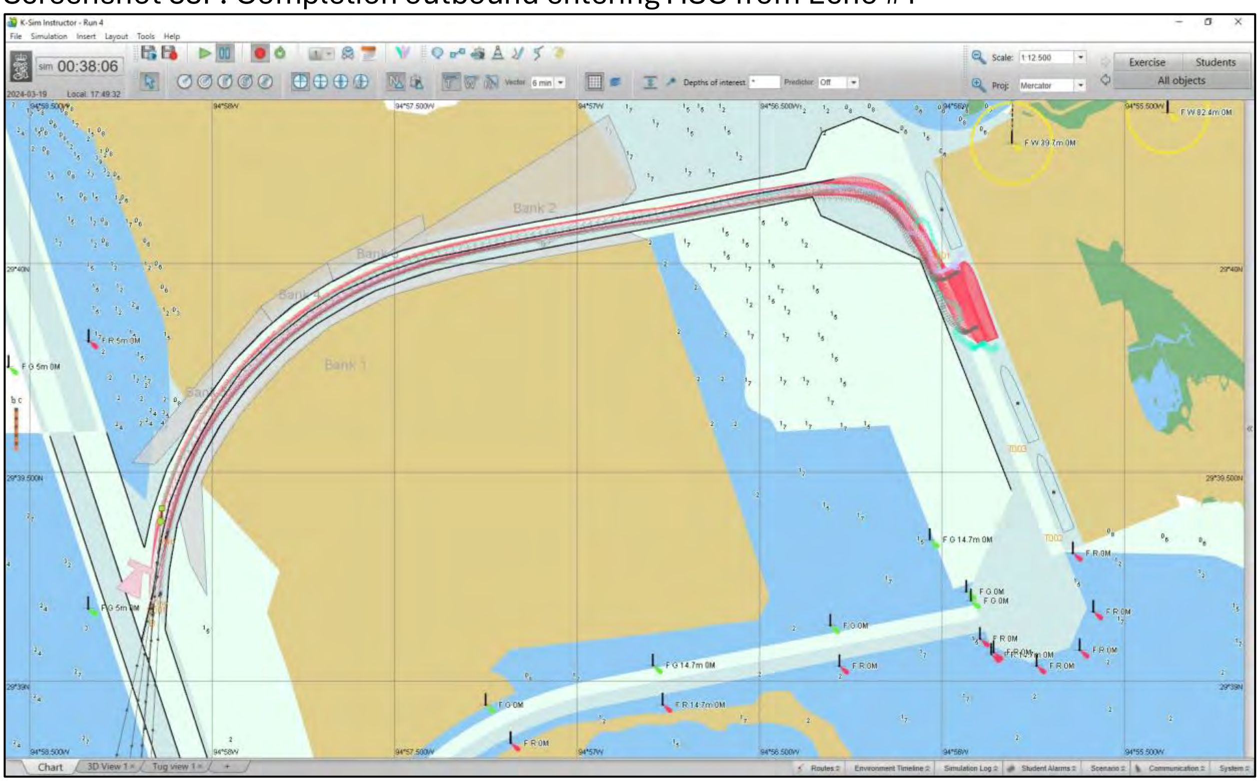


Locus

Screenshot 33E. Ship in Echo #1 exiting into the HSC



Screenshot 33F. Completion outbound entering HSC from Echo #1



Run 34. Echo, Inbound ULCV 366m, 135° @ 15kn, GAR 2

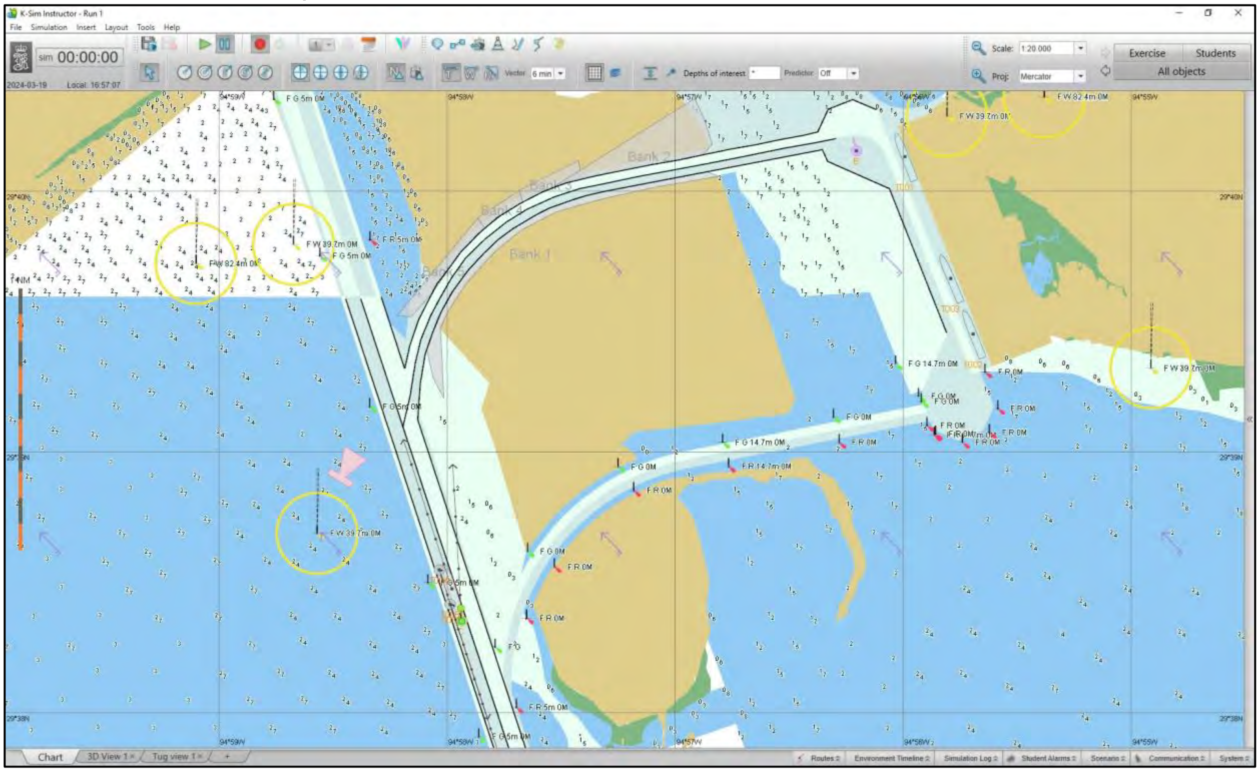
Run Description: The run started with the ship at 6kn, three ship lengths below the entrance to Echo and ½ a beam left of the centerline in the HSC, along with an assist tug with a line on the stern. The pilot could maneuver the ship into Echo from HSC, entering at about 6kn. The continuous arcing turn required about 12 minutes to perform at 5 to 6kn with a constant ROT of about 6°. The ship entered the turning basin at about 3kn and performed the turn at about 2kn, reaching a maximum ROT of 16°. The time to turn the ship in the turning basin was about 10 minutes. The pilot then backed the ship into place until it was parallel with Berth #2. The entire run took about 60 minutes to complete.

Pilot Comments: I felt fully engaged and alert during the entire run. This requires a high cognitive load, and I feel fatigued. Once I got into the constant arcing turn, I kept my ROT per minute to 6-10°. I could feel the wind the most during the final turn into the HSC. I was concerned about my crab angle of 2° when I was at 6kn, but this increased to 4° when I went down to 2kn to enter the turning basin. The basin is small for this size of a ship, and I used all the water in it. I did not need emergency ship handling, but it did require full tug orders in the turning basin. With wind, I want bigger tugs. Also, the PPU was necessary. Also, we need a flare for the turning basin. The red buoy is very close to the tugs. An arc and a flare would be very beneficial for entering the turning basin. Backing down into the berth, I was trying to keep as close to the ships as possible to keep the tugs safe as I backed the stern into the wind.

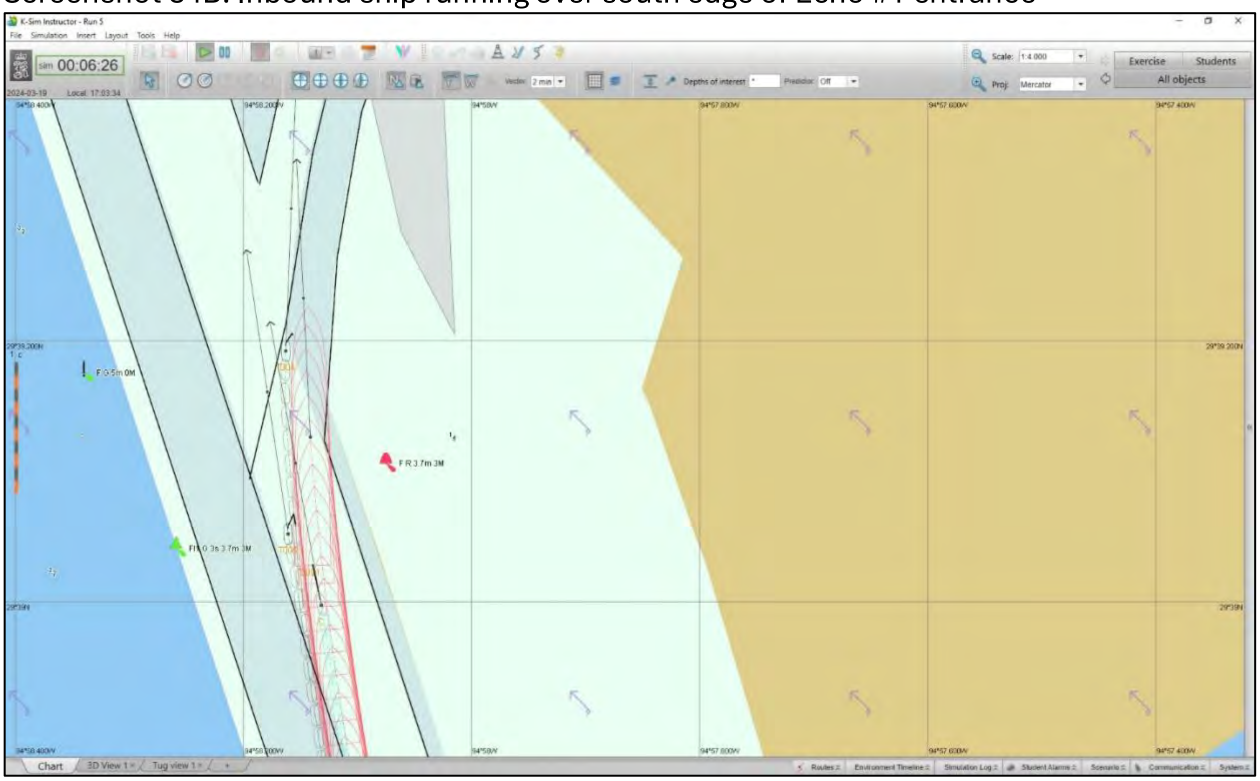
Screenshots List:

Screenshot 34A. Setup inbound from HSC towards Echo #1, Wind SE 135 @15kn
Screenshot 34B. Inbound ship running over south edge of Echo #1 entrance
Screenshot 34C. Inbound ship making the continuous arcing turn in Echo #1
Screenshot 34D. Inbound ship stopping in turning basin and beginning to turn
Screenshot 34E. Inbound ship completing turn in turning basin and beginning to back
Screenshot 34F. Ship backing down the terminal basin getting into parallel docking position for Berth #2, ship is 30' from the stern of the ship at Berth #1
Screenshot 34G. In position at the berth with complete turning basin turn
Screenshot 34H. Completion of arrival and docking at Berth 2, Wind SE 135° @15kn

Screenshot 34A. Setup inbound from HSC towards Echo #1, Wind SE 135 @15kn

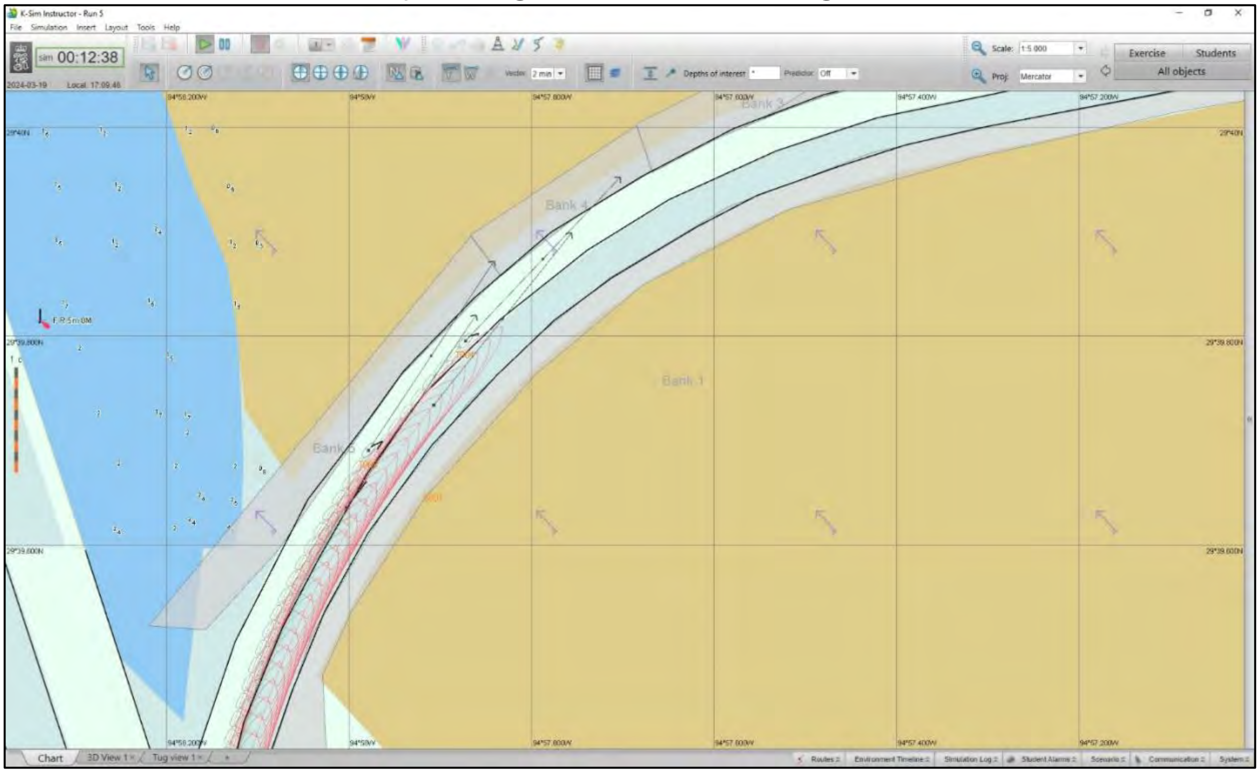


Screenshot 34B. Inbound ship running over south edge of Echo #1 entrance

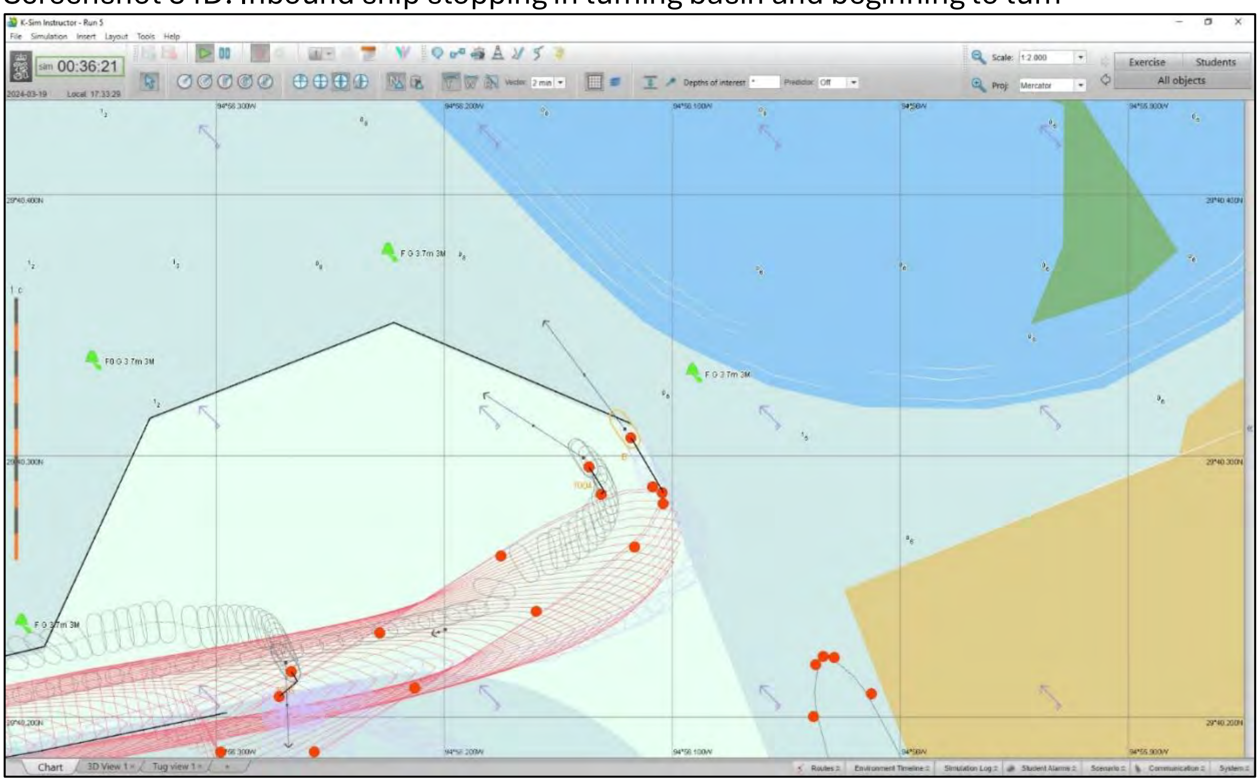


Locus

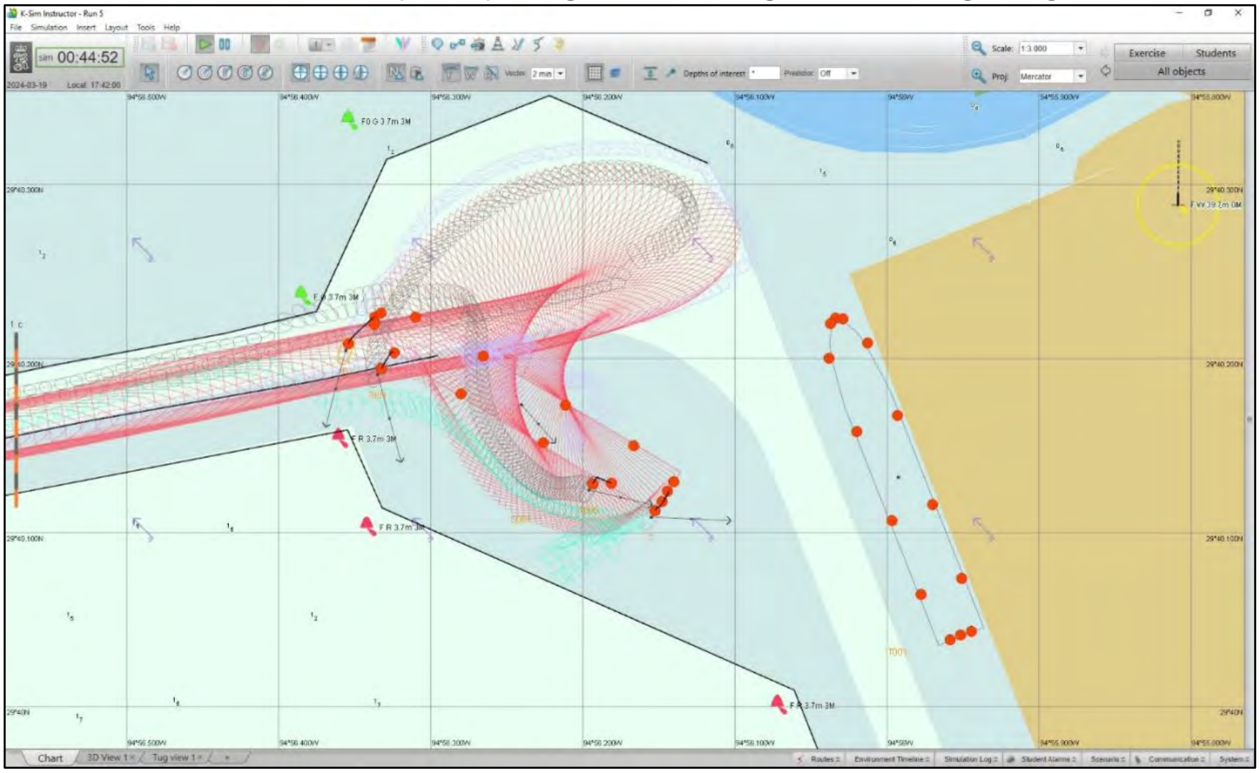
Screenshot 34C. Inbound ship making the continuous arcing turn in Echo #1



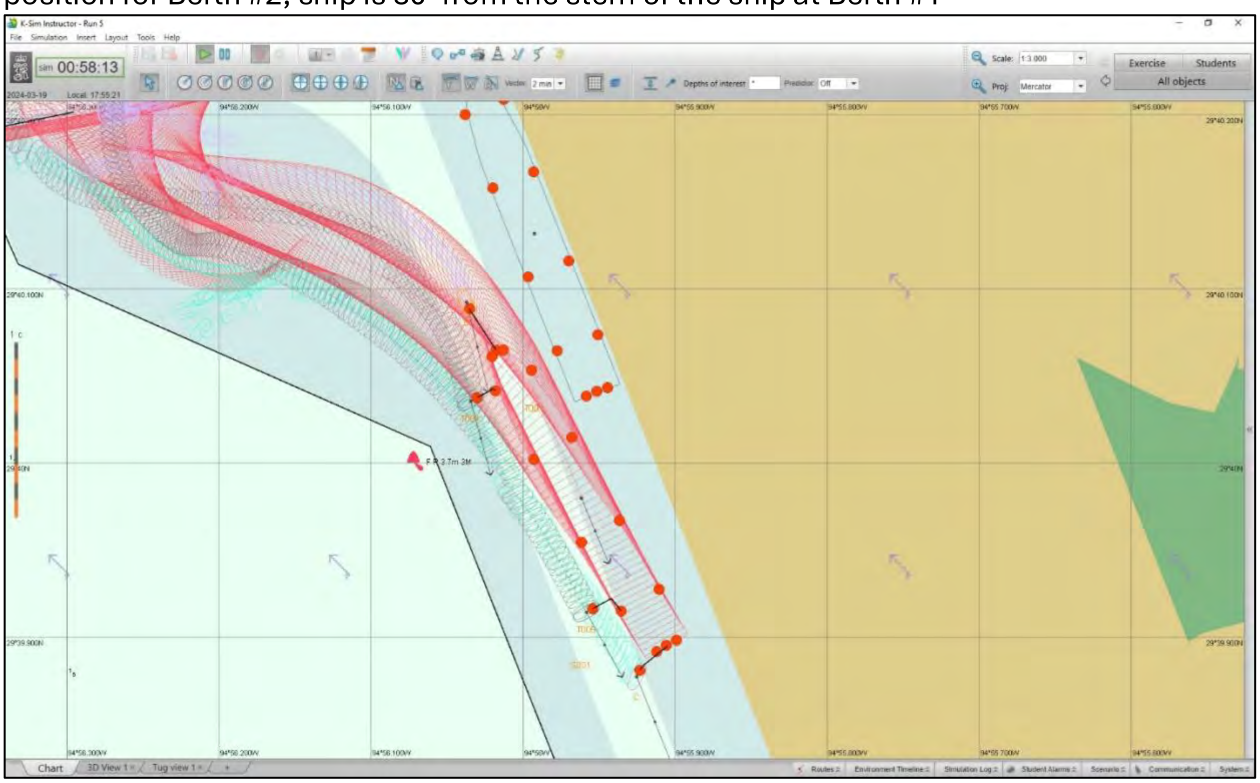
Screenshot 34D. Inbound ship stopping in turning basin and beginning to turn



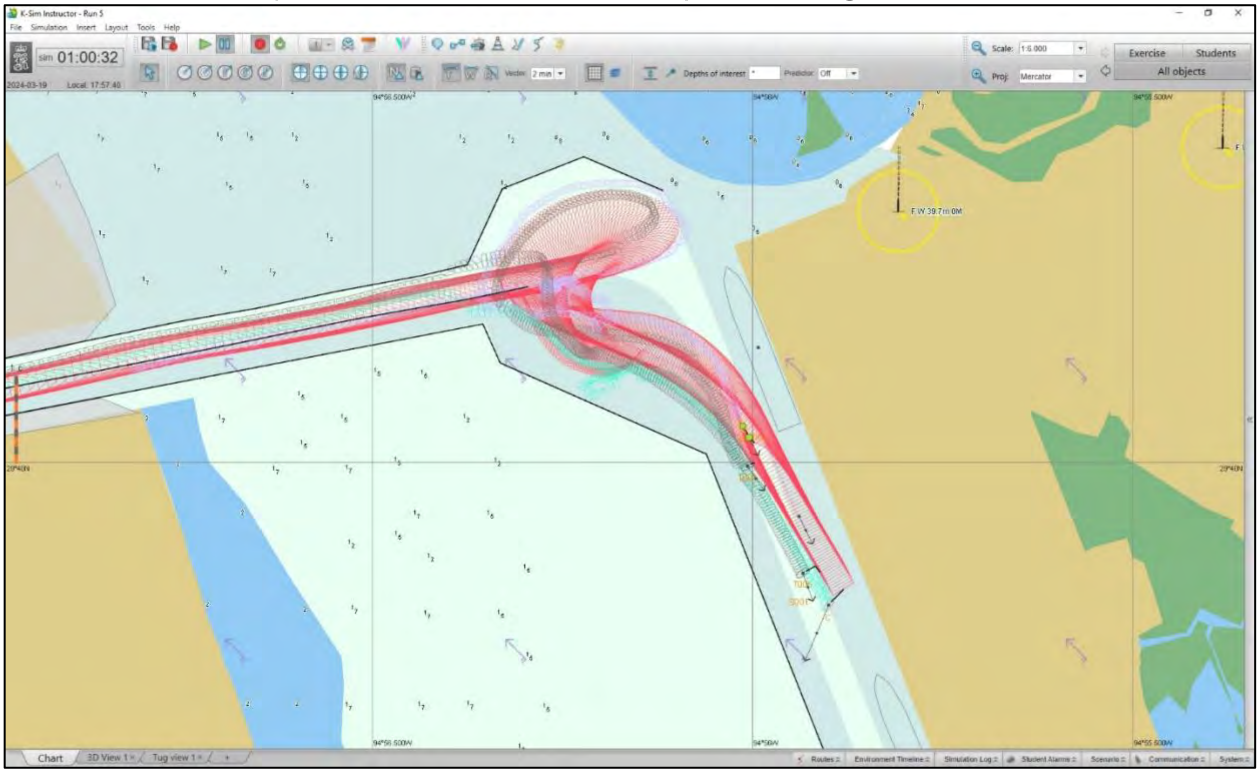
Screenshot 34E. Inbound ship completing turn in turning basin and beginning to back



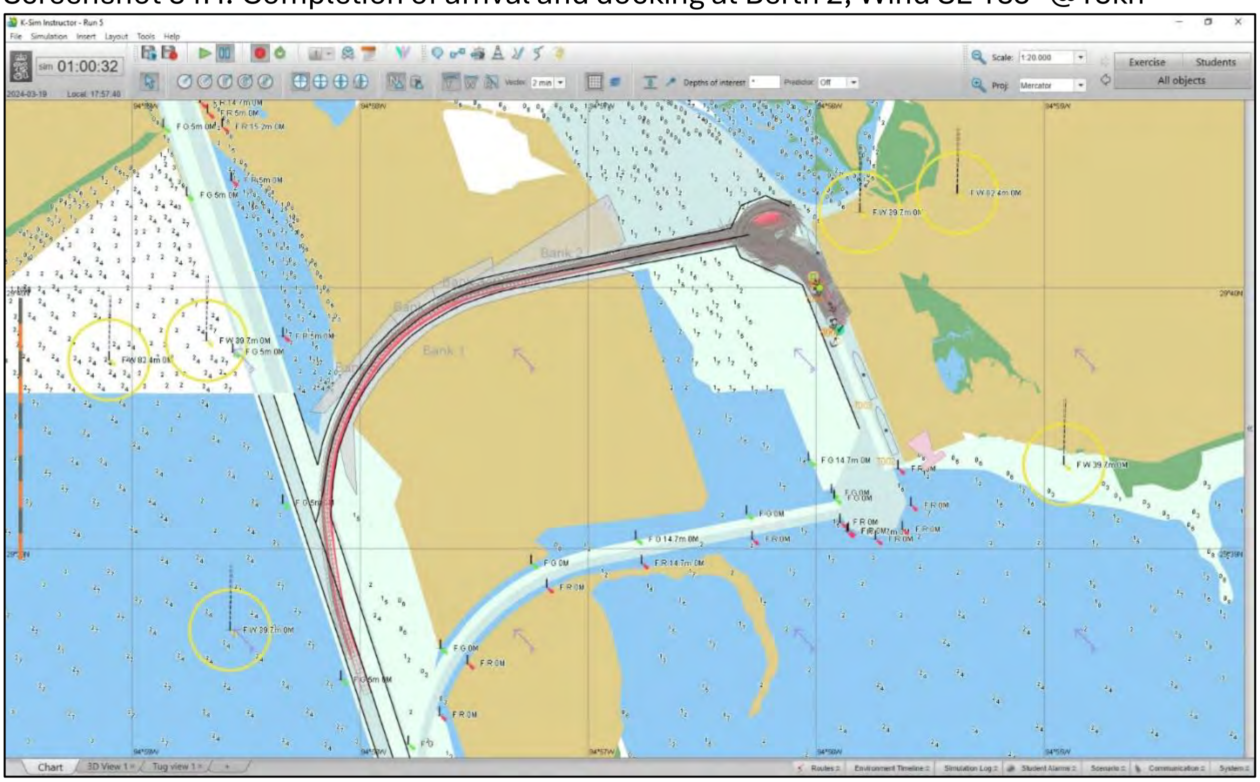
Screenshot 34F. Ship backing down the terminal basin getting into parallel docking position for Berth #2, ship is 30' from the stern of the ship at Berth #1



Screenshot 34G. In position at the berth with complete turning basin turn



Screenshot 34H. Completion of arrival and docking at Berth 2, Wind SE 135° @15kn



Run 35. Echo #1, Sailing ULCV 366m, 135° @ 15kn, GAR 3

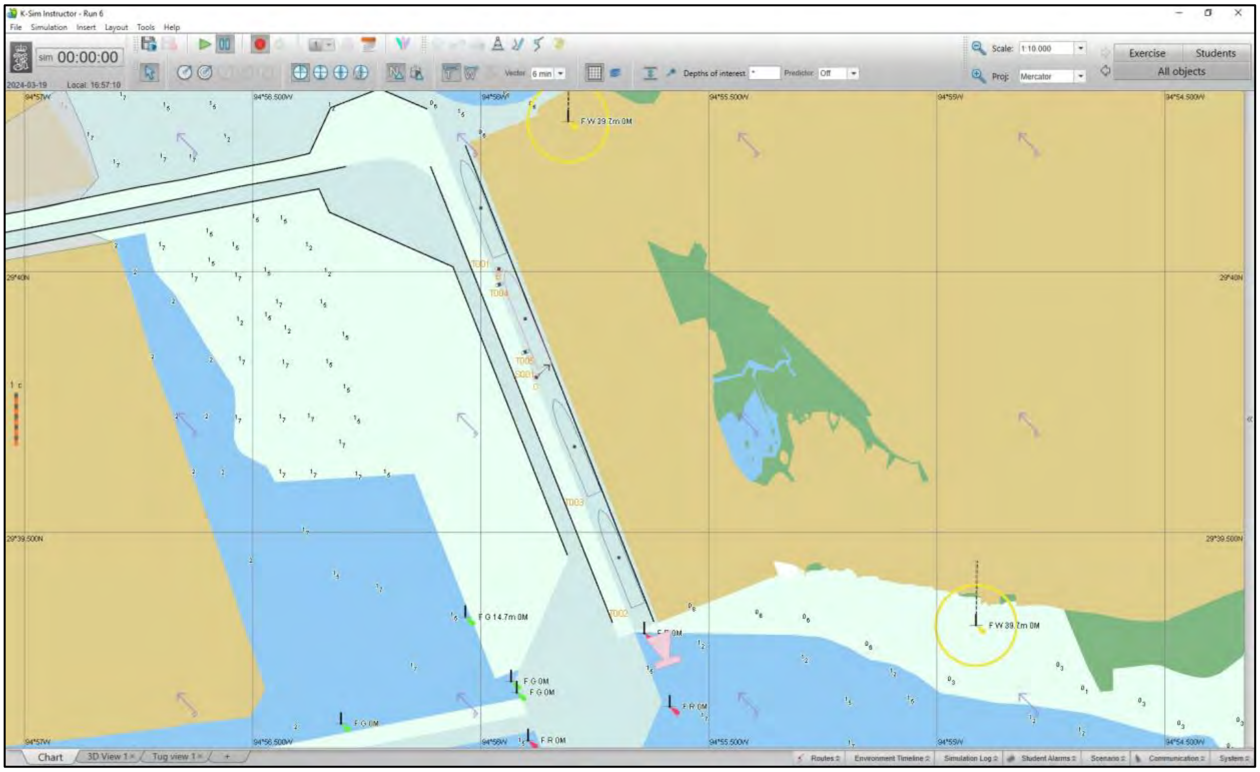
Run Description: Undocking from Berth #2 using four tugs arranged on the center lead bow, stern, as well as port shoulder and quarter. The port quarter ship needs to fall in line outbound and not work at 90° from the ship to prevent it from leaving the terminal basin. The pilot was able to turn the ship and drive out even with a ship at Berth #1. The ship entered the turning basin at about 2kn, and the turn took only about 8 minutes to complete. Once in Echo, the pilot brought the ship up to about 6kn. The continuous arcing turn took about 10 minutes for the pilot to complete at about 6kn with a constant ROT of 6-7°. However, at the top of the turn, the ship had a crab angle in part due to the wind and the size of the ship in this continuous arcing turn. It caused the stern of the ship to allide with the north bank on the starboard side. This occurred while the ship's bow was on the centerline of the turn in the channel. The pilot continued to complete the run and entered the HSC at 7kn, which took about 41 minutes.

Pilot Comments: This was not a safe maneuver. I am not happy with the width of the channel as the stern was dragging along the bank. I had enough tug power to come off the dock. I used my engines and the tugs to drive out, and I felt the wind when making the turn into Echo. The angle of the turning basin needs to be shaved off, creating a flared entrance. The width of the channel (400’) is not safe. A had a loaded vessel with the bow on the centerline and was in control of the ship at 6kn with a ROT 6°, but the bow and the stern were on different sides of the channel. This 100% requires a PPU. In a perfect world, this maneuver would have been safe. But we do not live in a perfect world, so this run was unsafe.

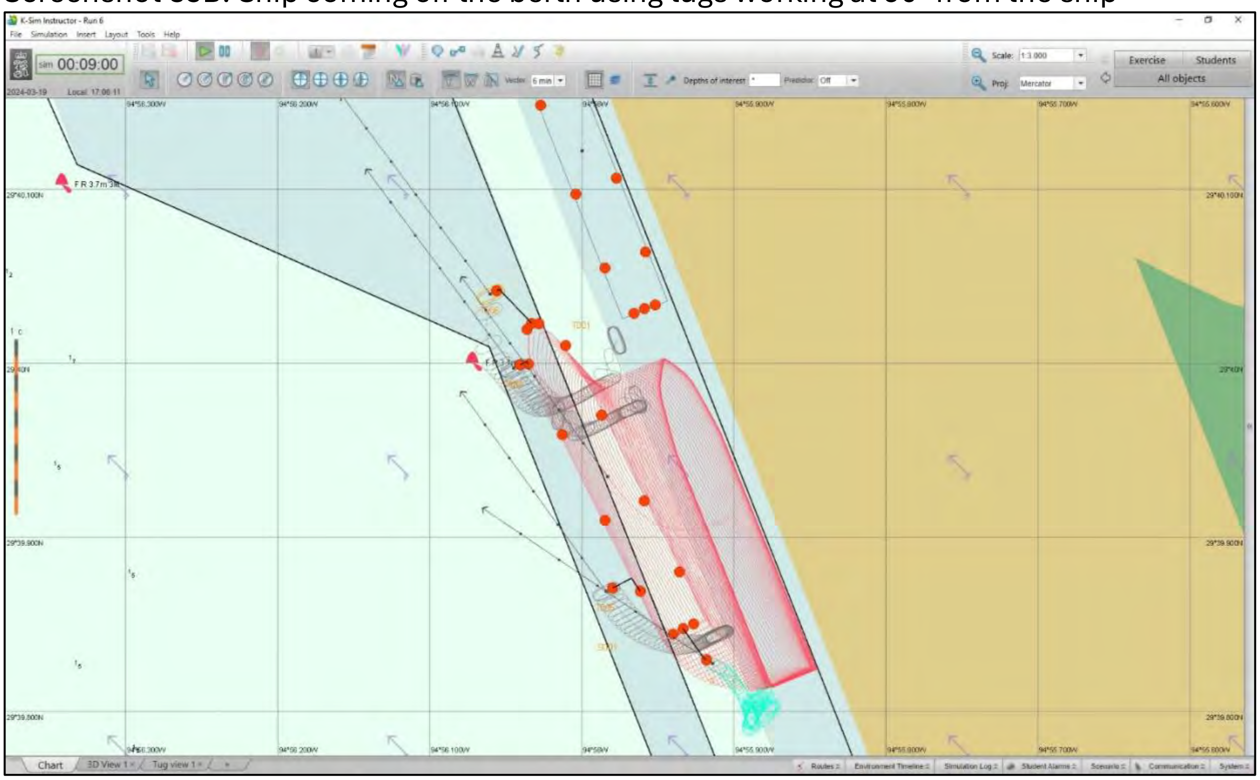
Screenshots List:

Screenshot 35A. Setup Outbound and undocking from Berth 2, all four tugs on the stern, bow, portside shoulder & quarter, Wind SE 135 @15kn
Screenshot 35B. Ship coming off the berth using tugs working at 90° from the ship
Screenshot 35C. Ship driving in the turning basin using tugs to assist the turn
Screenshot 35D. Ship driving into the continuous arcing turning in Echo #1
Screenshot 35E. Ship exiting Echo #1 into HSC
Screenshot 35F. Completed run sailing with ship’s stern in the north bank during the continuous arcing turning in Echo #1

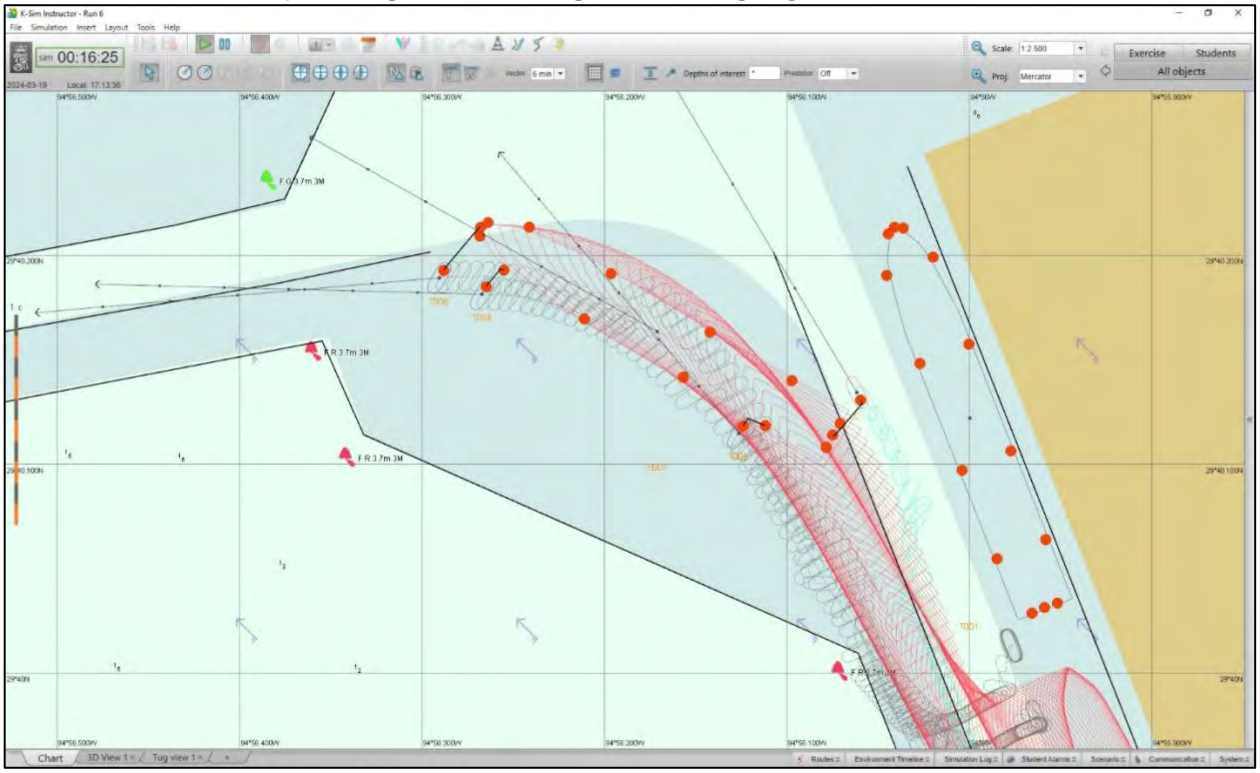
Screenshot 35A. Setup Outbound and undocking from Berth 2, all four tugs on the stern, bow, portside shoulder & quarter, Wind SE 135 @15kn



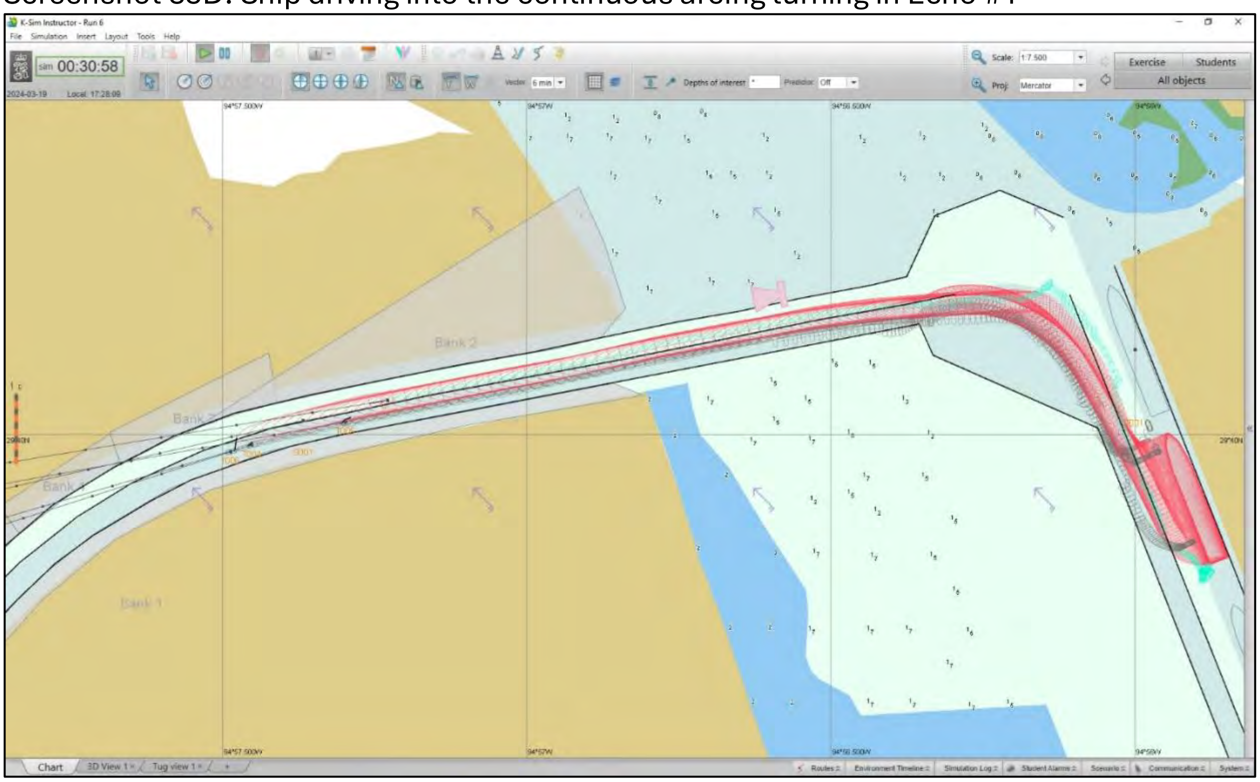
Screenshot 35B. Ship coming off the berth using tugs working at 90° from the ship



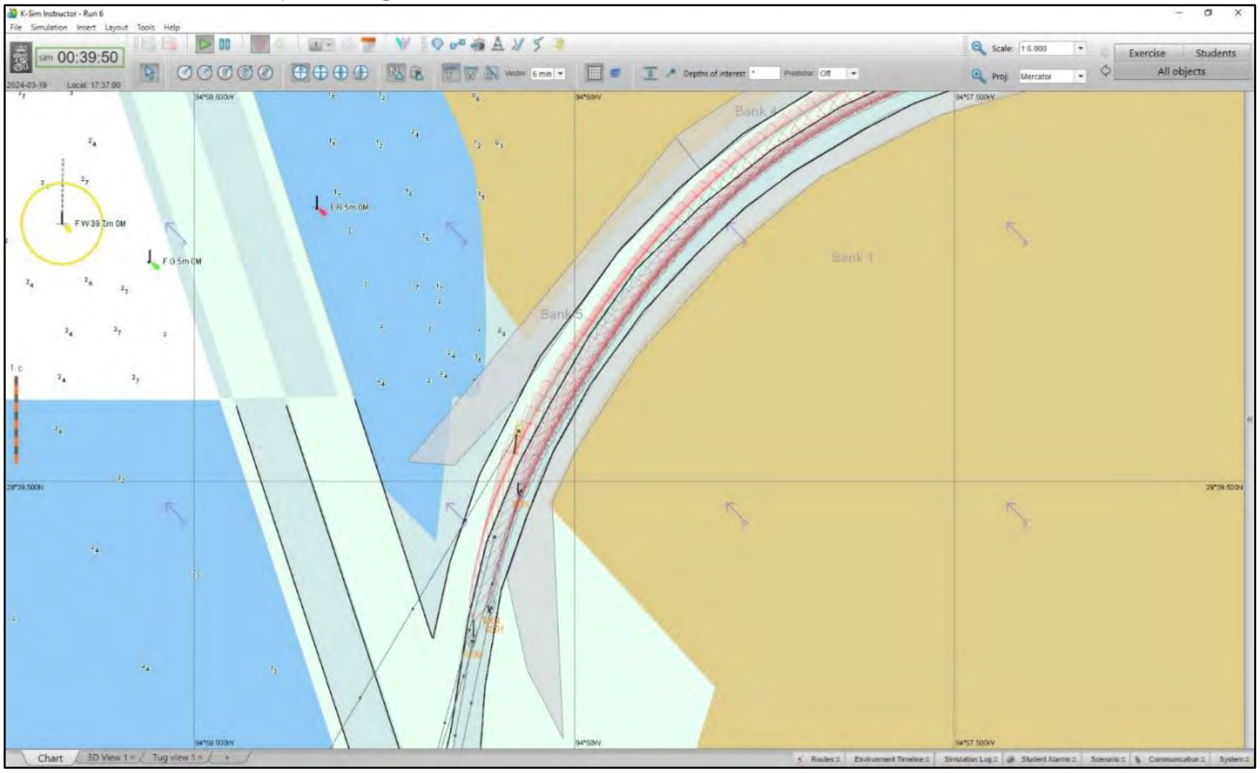
Screenshot 35C. Ship driving in the turning basin using tugs to assist the turn



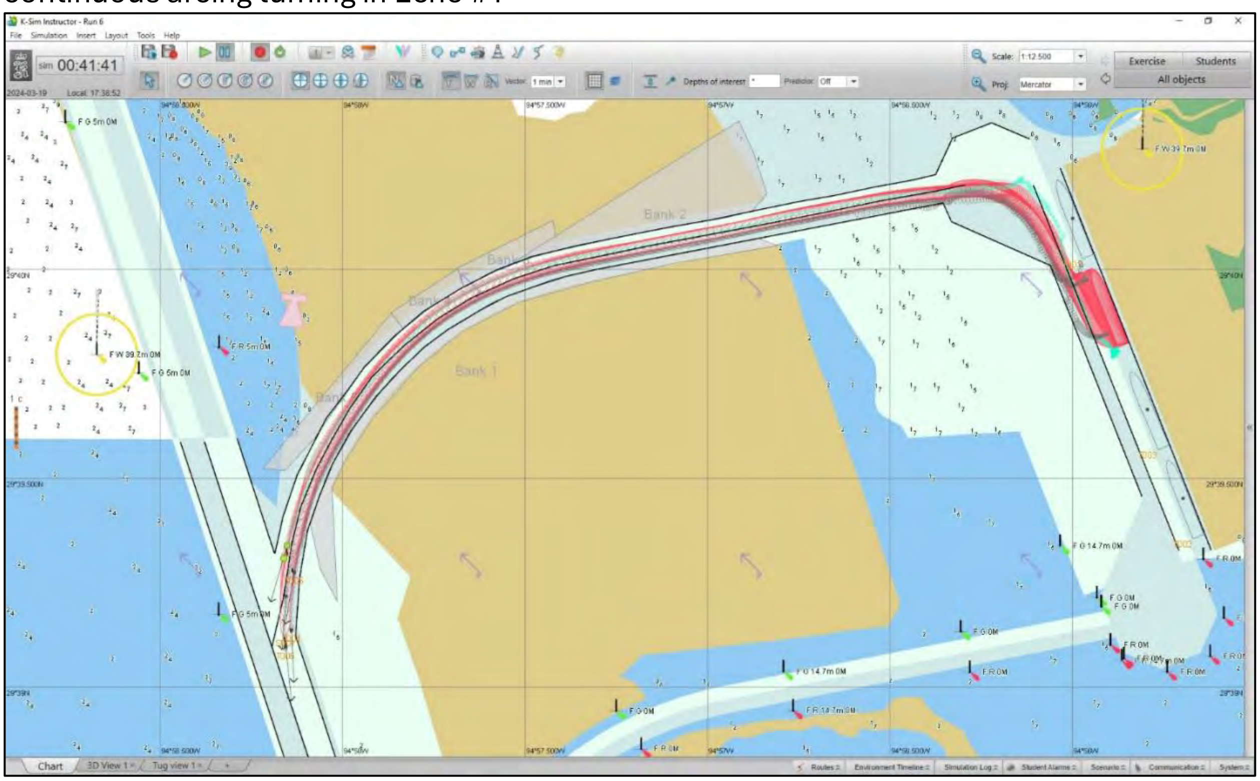
Screenshot 35D. Ship driving into the continuous arcing turning in Echo #1



Screenshot 35E. Ship exiting Echo #1 into HSC



Screenshot 35F. Completed run sailing with ship's stern in the north bank during the continuous arcing turning in Echo #1



Run 36. Echo, Arrival ULCV 366m, 135° @ 20kn, GAR 3

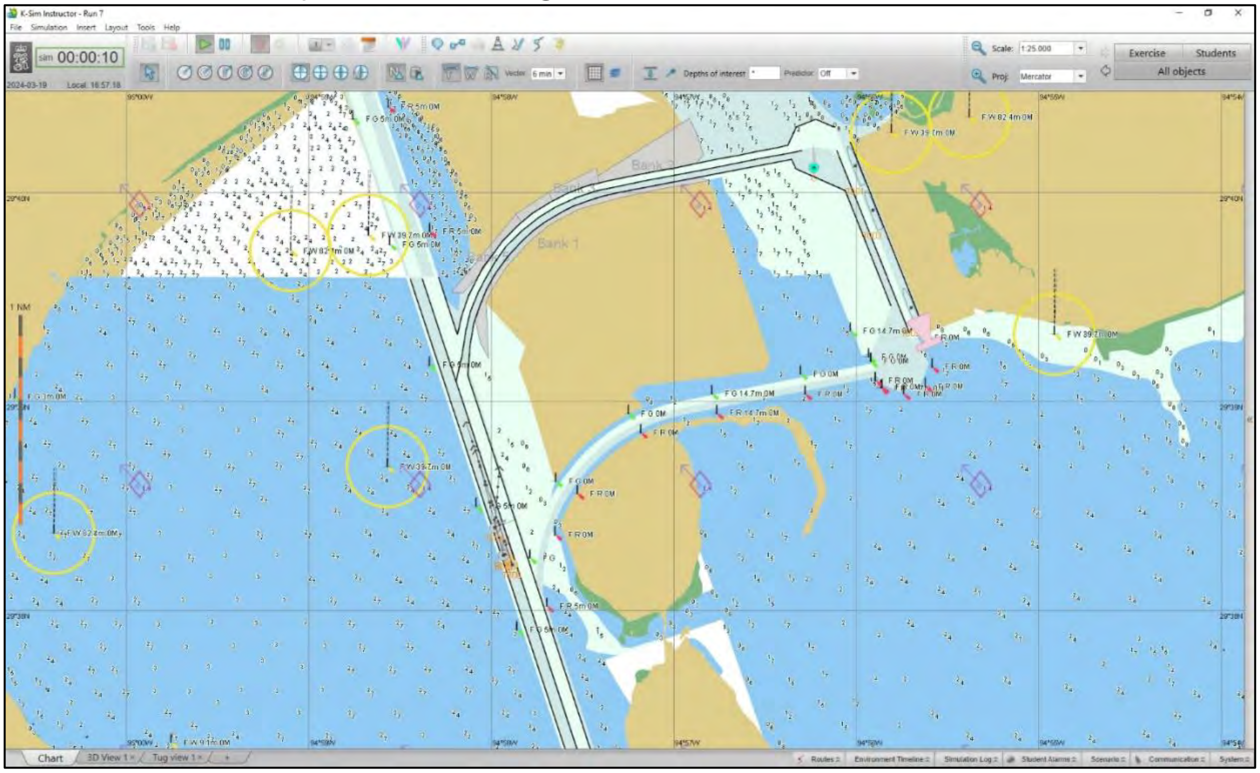
Run Description: The run started with the ship at 6kn, four ship lengths below the entrance to Echo and ½ a beam left of centerline in the HSC along with an assist tug with a line on the stern. The ship entered Echo #1 at 6.5kn and continued to accelerate into the turn reaching 7.4kn and called for an indirect assist from the stern tug to help make the turn. However, the emergency maneuver with the tug was not successful. During the turn into Echo #1, the ship's port shoulder allied (made contact with) the northern bank. During the allision, the ship was at 7kn with a ROT of 14° per minute. After alliding with the bank, the ship's speed was reduced to 3kn, and it bumped and rolled in a realistic manner off the bank. The run continued, and the continuous arcing turn took about 11 minutes to navigate, reaching a maximum speed of 7kn with a maximum ROT of 14°. The ship entered the turning basin, and the pilot slowed down the ship to 0.4kn when the bow reached the basin's edge. The pilot used two tugs to push full to try to turn the ship in the 20kn winds. It was not successful. The pilot ordered a third tug to push full near the stern as the ship was stuck "in irons" in the wind. The third tug made the difference, and the ship was able to complete the turn in about 15 minutes. The ship then backed down along the terminal basin to Berth #3. The entire run took about 75 minutes.

Pilot Comments: There was not enough room in the channel to safely perform this turn in 20kn winds. There is barely enough room in ideal conditions. At 20kn, this maneuver should not be done. Furthermore, there should be a place for the ship to lay up in the channel in case of winds pickup to 20kn, as the ship should not come into the terminal basin where it can collide with and damage other ships or the terminal. The entrance to the turning basin is a potential hazard for tugs on the stern or starboard side. The entrance should be flared. The 75-ton tugs were not sufficient in this wind. I needed 100-ton tugs. There was not much room for the tugs in the turning basin or terminal basin, meaning there was not much room for error. I was able to maintain positive control once I was in the terminal basin. I could have done this maneuver better, but any mistakes in the channel or turning basin are extremely difficult to recover from, especially with a 20kn wind. These ULCVs have a 15kn wind restriction from the HPA for a reason.

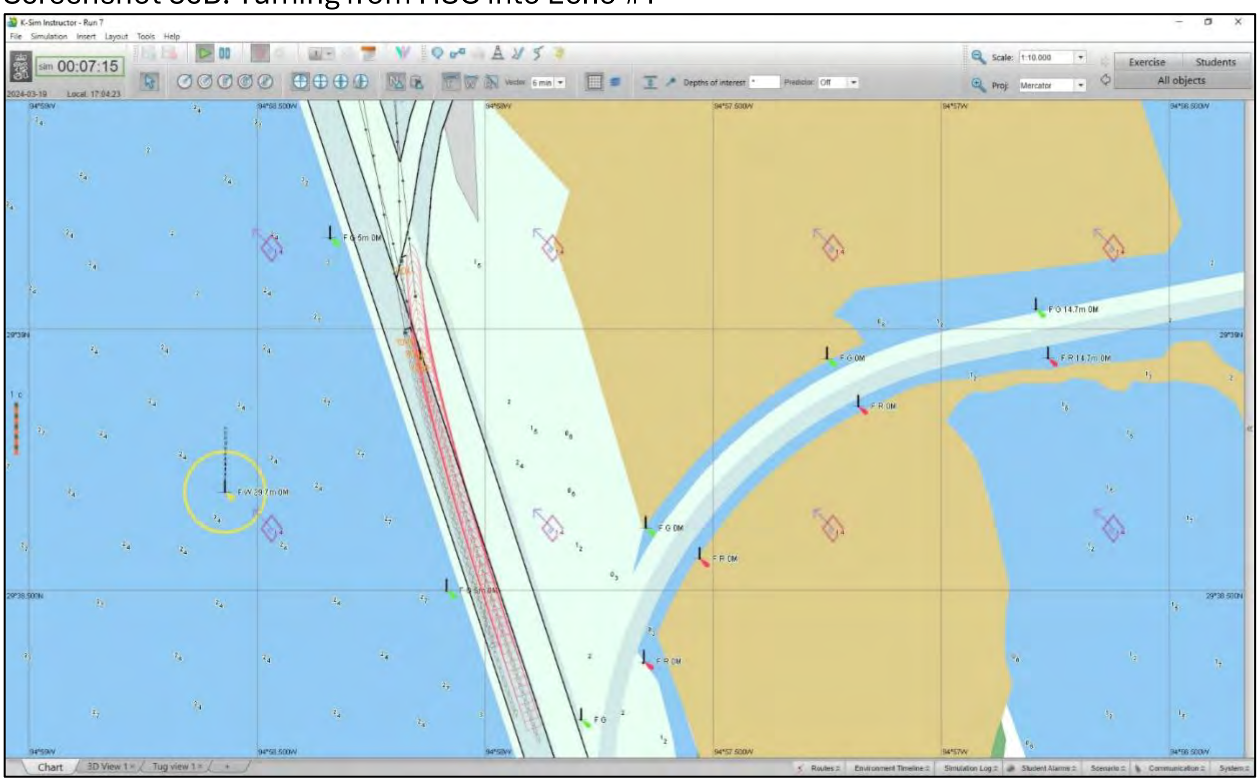
Screenshots List:

Screenshot 36A. Setup Echo #1, one tug on stern, SE 135 @20kn
Screenshot 36B. Turning from HSC into Echo #1
Screenshot 36C. Making continuous arc turn, alliding with northern bank
Screenshot 36D. Stern cleared the channel and starting to turn into turning basin, stern tug almost alliding with red buoy at entrance to turning basin
Screenshot 36E. Backing into the terminal basin after performing turn in turning basin
Screenshot 36F. Completed run of docking at Berth #3, Wind SE 135° @20kn

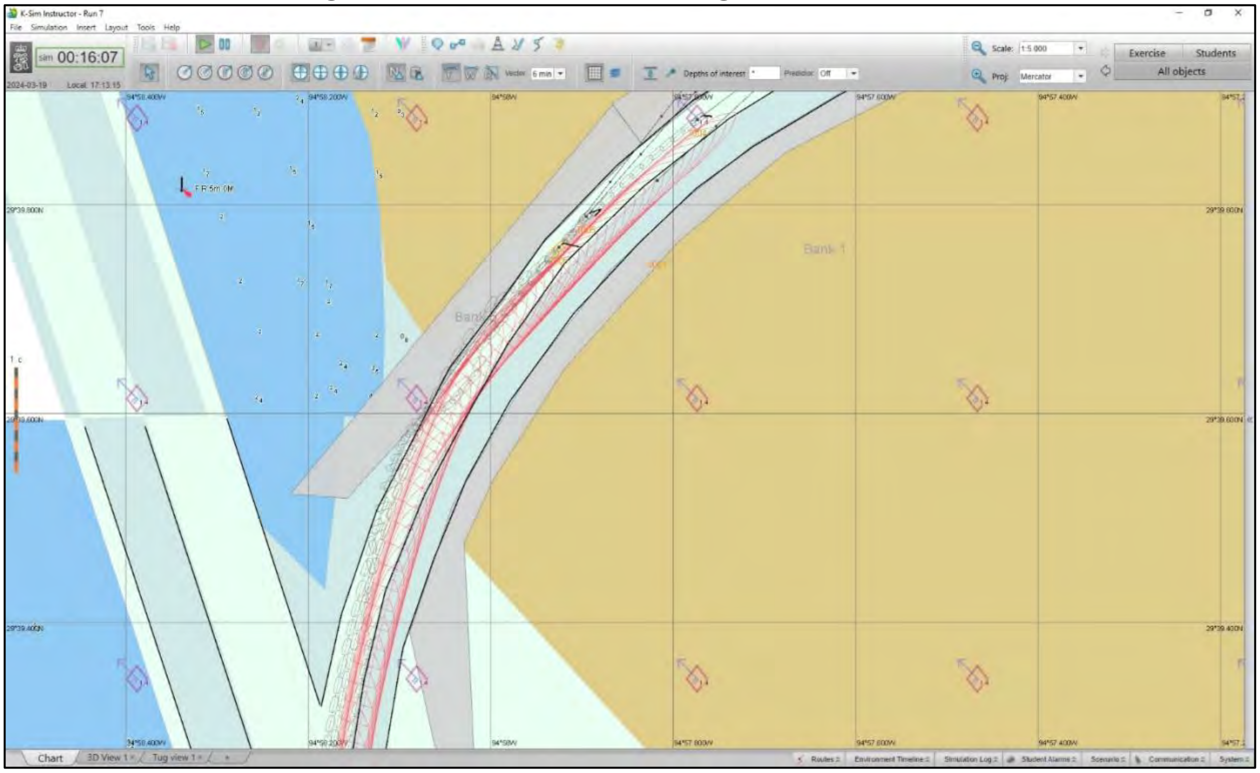
Screenshot 36A. Setup Echo #1, one tug on stern, SE 135 @20kn



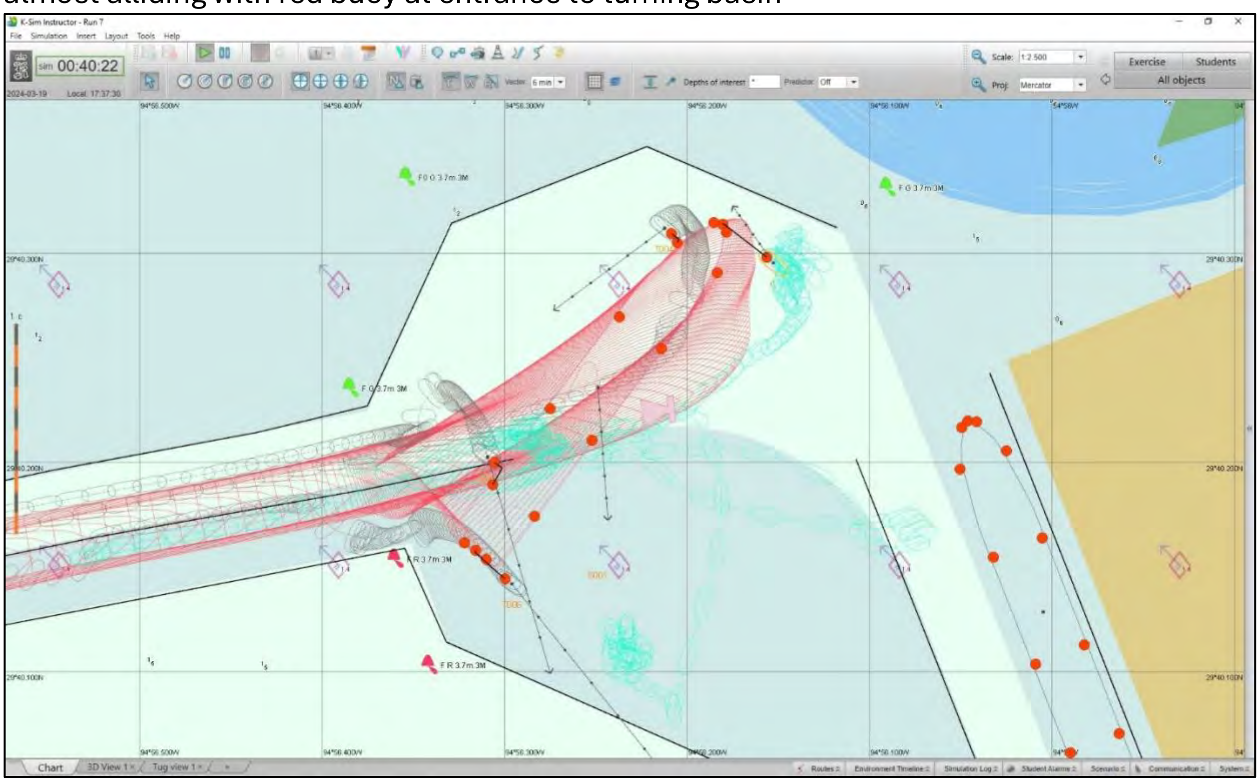
Screenshot 36B. Turning from HSC into Echo #1



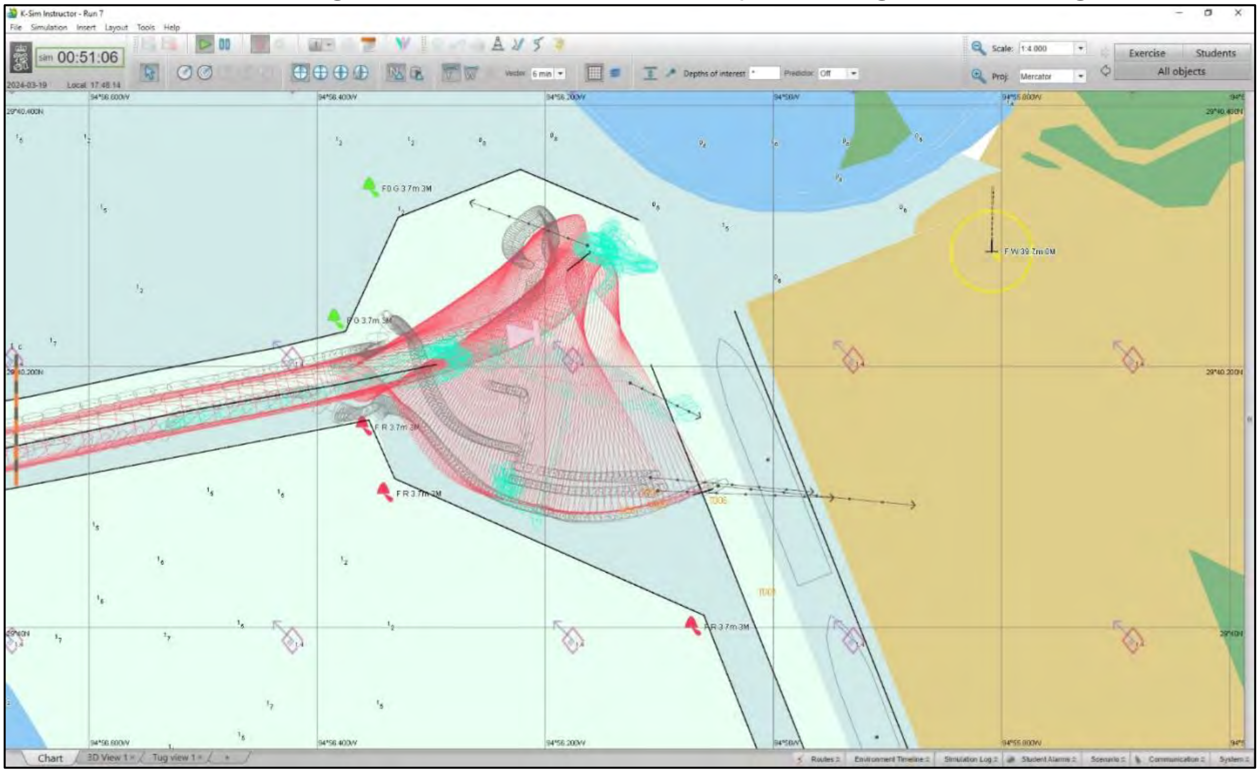
Screenshot 36C. Making continuous arc turn, alliding with northern bank



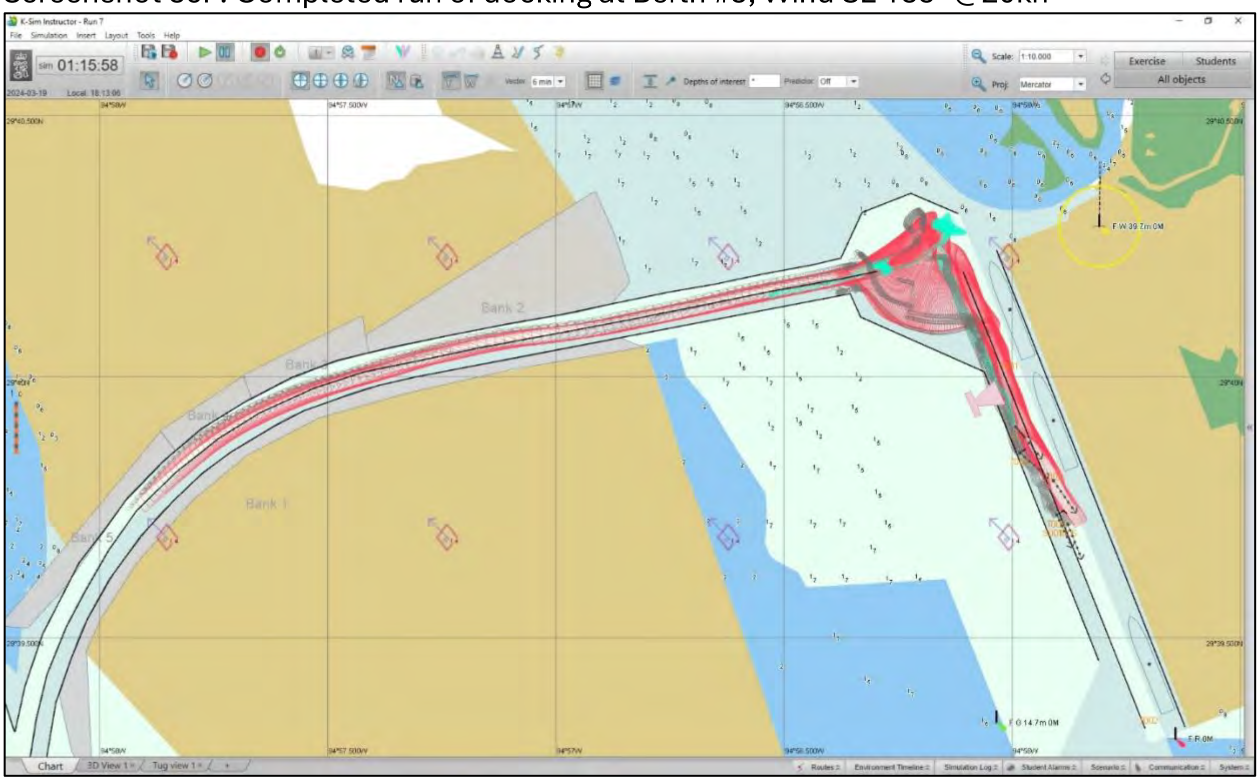
Screenshot 36D. Stern cleared the channel and starting to turn into turning basin, stern tug almost alliding with red buoy at entrance to turning basin



Screenshot 36E. Backing into the terminal basin after performing turn in turning basin



Screenshot 36F. Completed run of docking at Berth #3, Wind SE 135° @20kn



Run 37. Echo #1, Sailing ULCV 366m, 315° @ 15kn, GAR 2

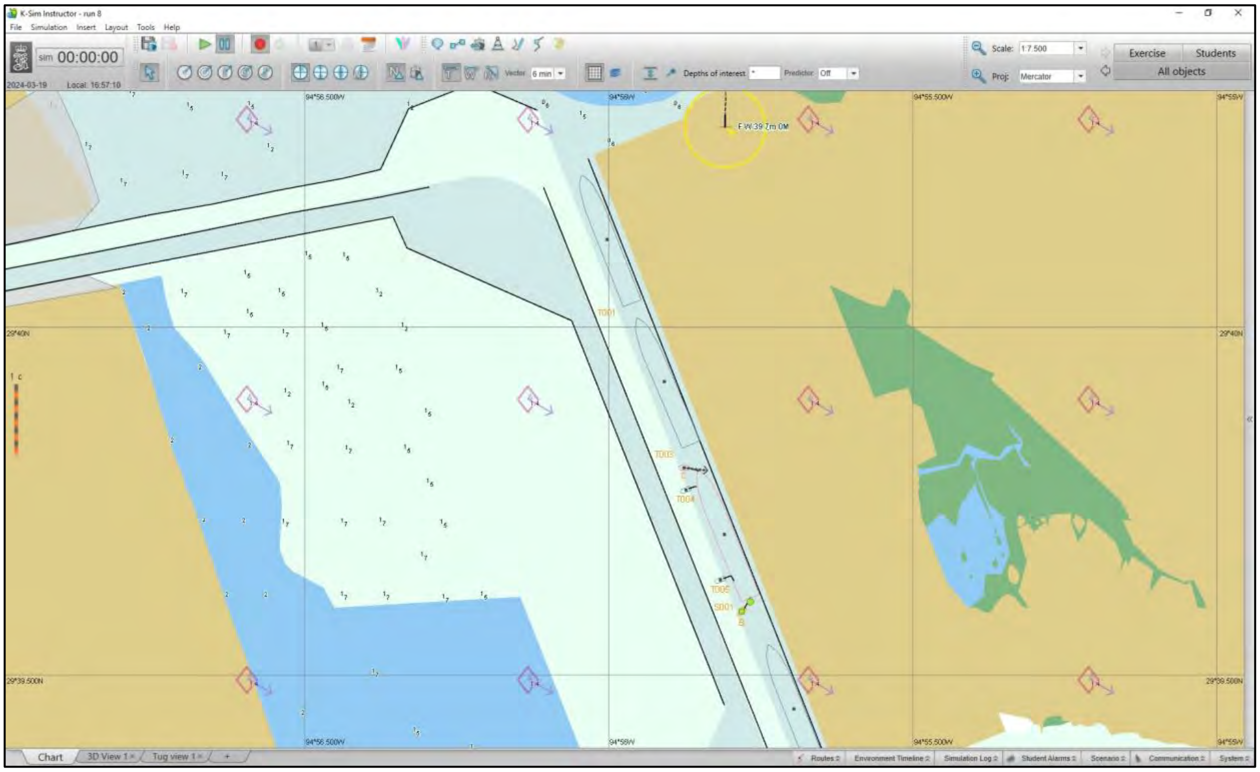
Run Description: Undocking from Berth #3 using four tugs arranged on the center lead bow, stern, as well as port shoulder and quarter. An objective in this run was to see if the ship could safely decelerate then accelerate in Echo #1 to accommodate other HSC piloted ship traffic. This was done from the simulator operator station using a radio to represent other ship traffic in the HSC. The pilot did not drive out but instead drove into the turning basin and used the tugs to turn the ship. This took about 10 minutes to complete, and the ship reached a maximum ROT 17° per minute. The ship entered Echo at about 6kn and then received a message via the radio of another outbound ship in the HSC. The pilot used the tug to slow down the ship down to about 3kn in the continuous arcing turn. The pilot was able to make the turn at 3-4kn with ROT 6° per minute and did not have a drift angle during the turn. The pilot was then able to accelerate, increasing their speed to 7kn when entering the HSC. The entire run took about 50 minutes to complete.

Pilot Comments: It is hard to get off the dock. I had to use the tugs to muscle it off with the NW wind. I went full astern in the turning basin to maintain positive control when turning the ship. I performed a harbor turn in the turning basin. I was able to go as little as 2kn in the channel and maintain a drift angle of less than one degree. As my speed increased, so did not ROT. I was engaged and alert and under control the entire time. This work is not routine and requires caution. There are no options for failure as there are no outs. Due to the size of the ship, this is a tight squeeze.

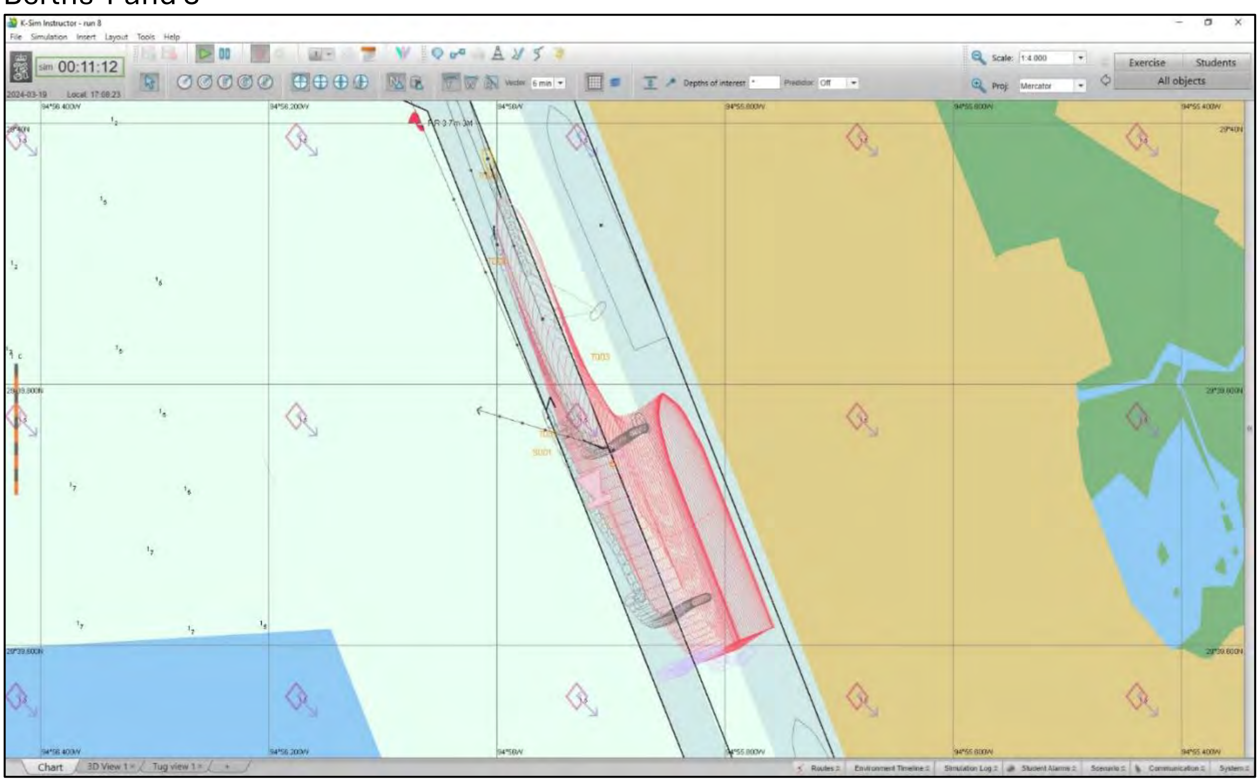
Screenshots List:

Screenshot 37A. Setup Outbound and undocking from Berth 3, four tugs on the stern, bow, portside shoulder & quarter, NW 315 @15kn
Screenshot 37B. Ship coming off the berth using tugs working at 90° and passing ships at Berths 1 and 3
Screenshot 37C. Ship turning in turning basin using tugs to lineup to enter Echo #1
Screenshot 37D. Ship in Echo #1 entering continuous arcing turn beginning to decelerate
Screenshot 37E. Ship departing Echo #1 and entering HSC
Screenshot 37F. Completed run sailing with Wind NW 315 @15kn, includes decelerating and accelerating in Echo #1 to coordinate with HSC piloted ship traffic

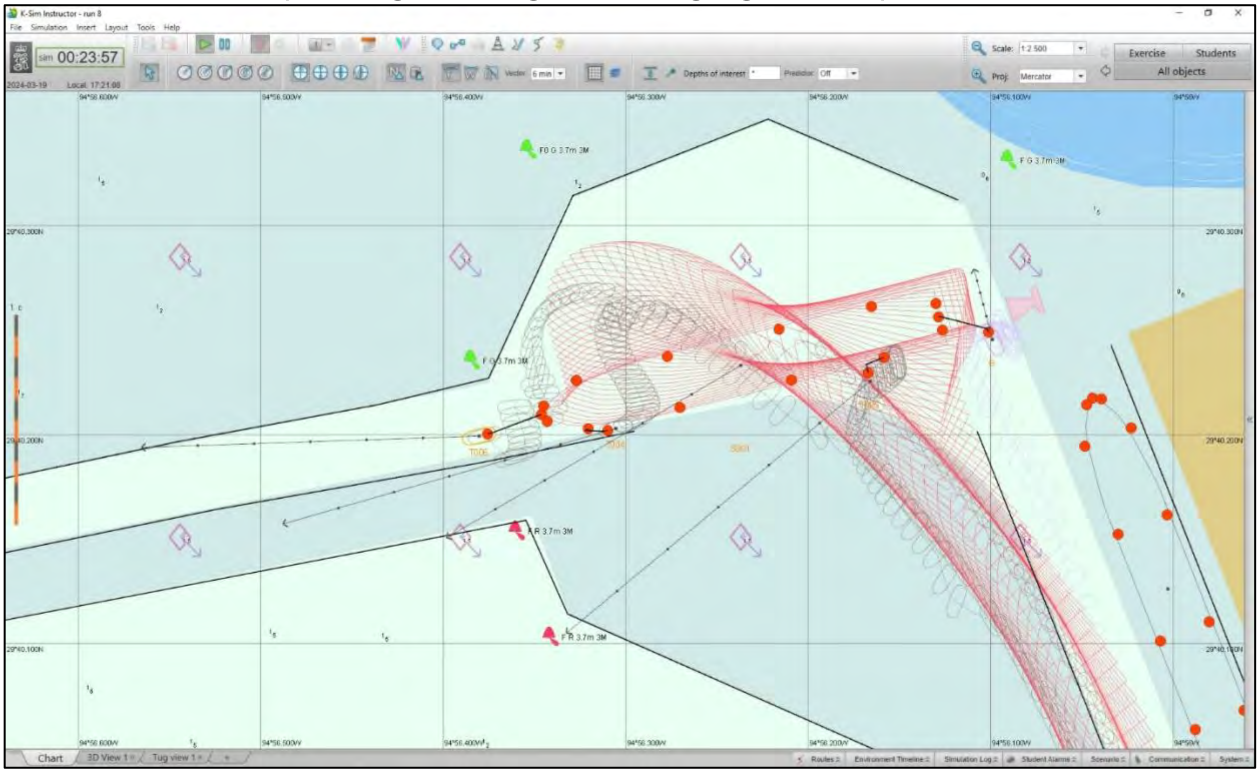
Screenshot 37A. Setup Outbound and undocking from Berth 3, four tugs on the stern, bow, portside shoulder & quarter, NW 315 @15kn



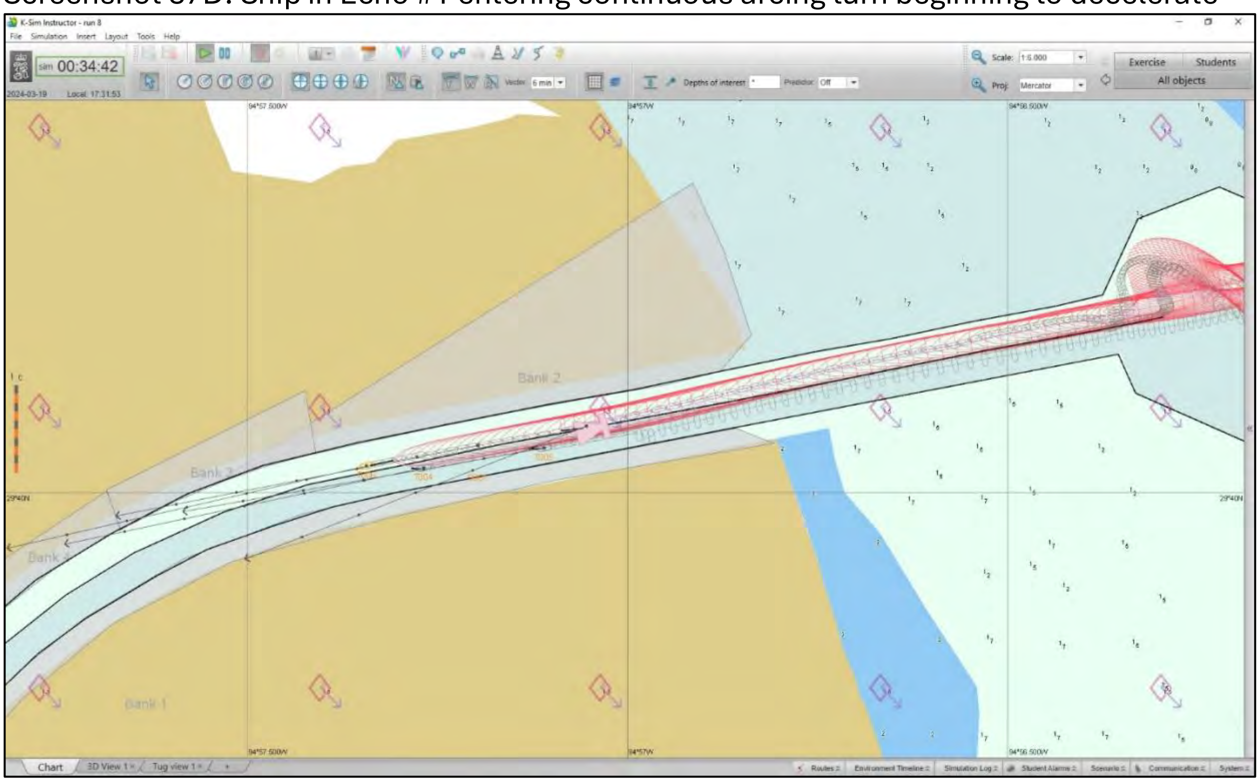
Screenshot 37B. Ship coming off the berth using tugs working at 90° and passing ships at Berths 1 and 3



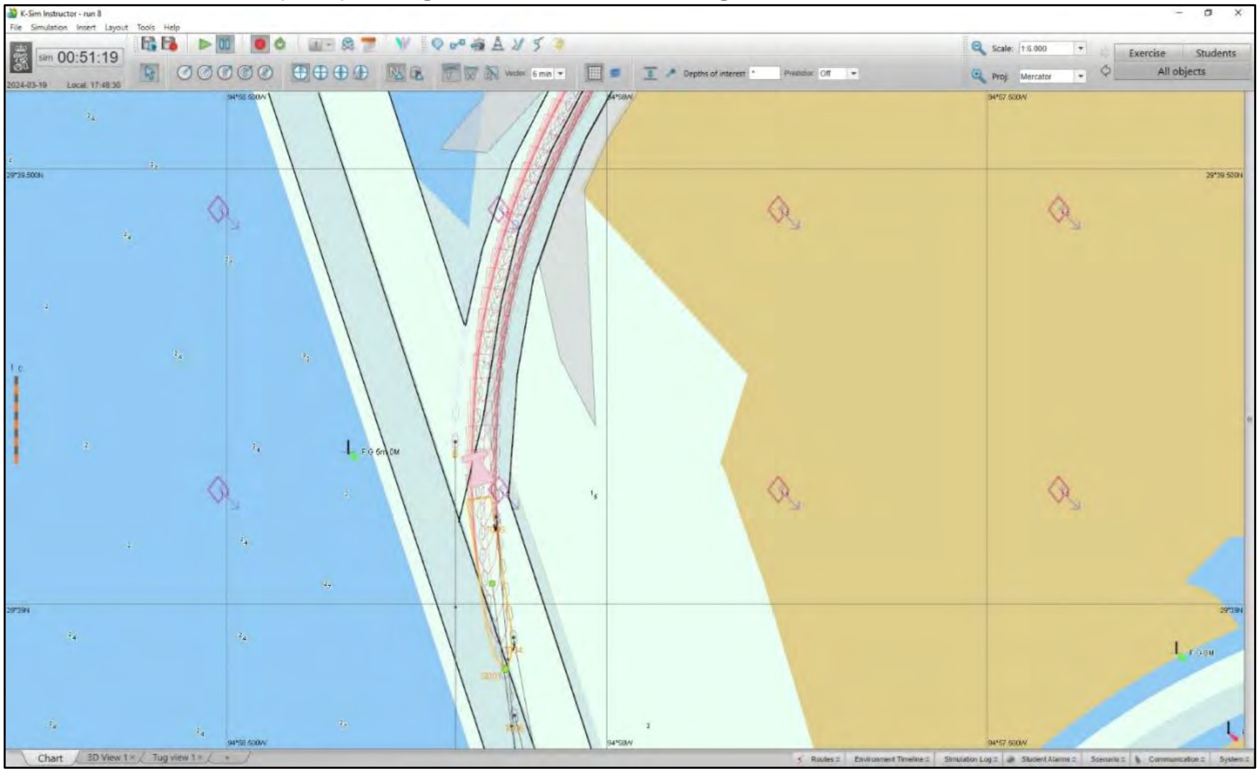
Screenshot 37C. Ship turning in turning basin using tugs to lineup to enter Echo #1



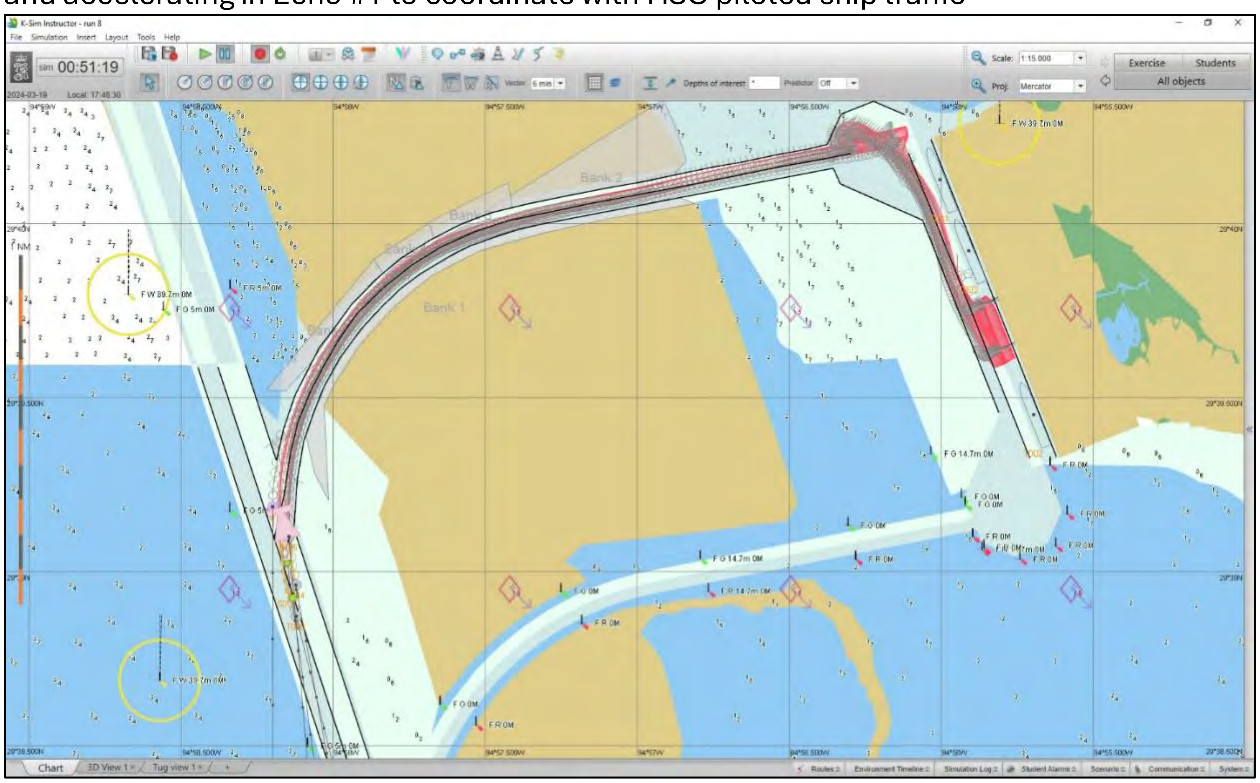
Screenshot 37D. Ship in Echo #1 entering continuous arcing turn beginning to decelerate



Screenshot 37E. Ship departing Echo #1 and entering HSC



Screenshot 37F. Completed run sailing with Wind NW 315 @15kn, includes decelerating and accelerating in Echo #1 to coordinate with HSC piloted ship traffic



Run 38. Echo #1, Arrival ULCV 366m Ballast, 315° @ 15kn, GAR 2

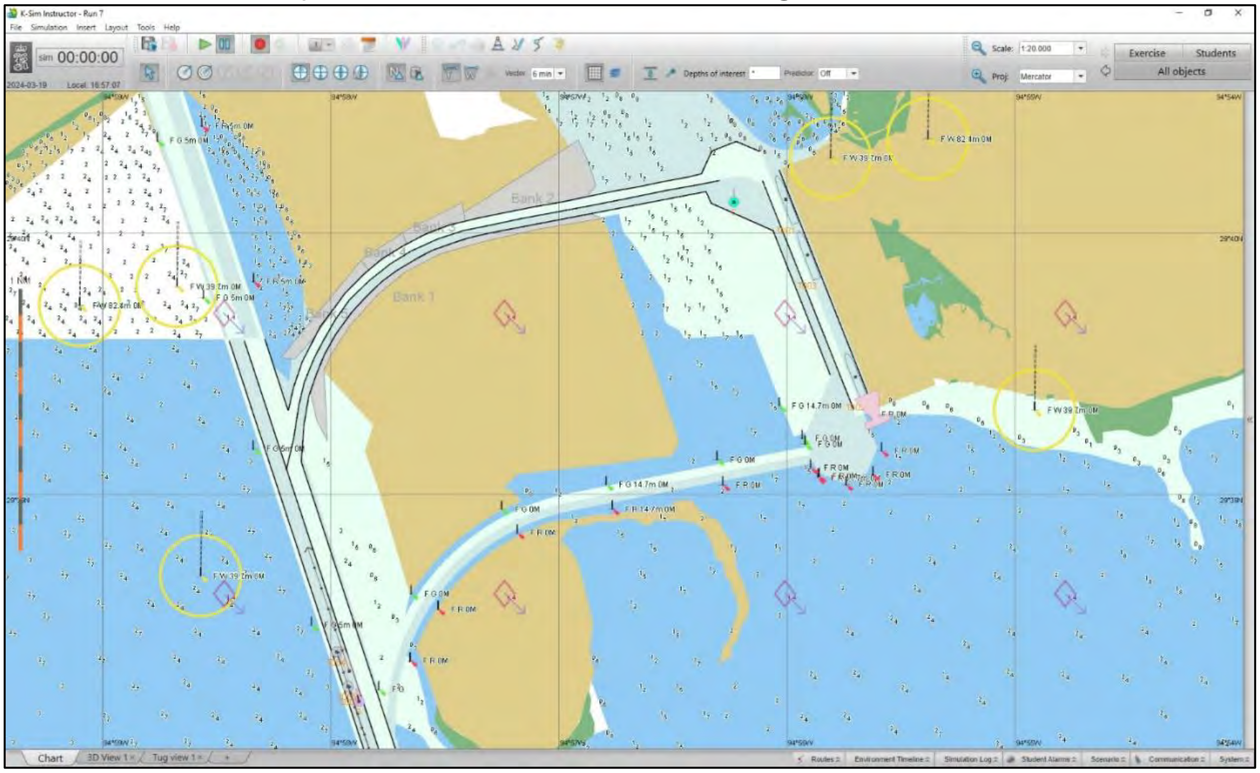
Run Description: The run started with the ship at 6kn, four ship lengths below the entrance to Echo #1 and ½ a beam left of centerline in the HSC along with an assist tug with a line on the stern. The pilot started the turn into Echo #1 at 7kn, and the pilot was hugging the starboard side (south bank). The ship moved onto the centerline and maintained 7kn with a ROT of 7-8° per minute and a crab angle of 2°. The continuous arcing turn took 10 minutes to complete. In the straightaway, the ship maintained 7kn and approached the turning basin on the high side of the channel entering. The ship entered the turning basin at 3.5kn, but the simulator froze when the vector tugs were tied up to assist with the turn.

Pilot Comments: The visibility is poor as there are not sufficient ranges to line up when turning into Echo or making the continuous arcing turn. The channel length and continuous arcing turn require alert ship handling and cause fatigue over time. I was able to maintain positive control throughout the channel. The pilot is highly reliant on their PPU to make this turn. It is a potential hazard if the PPU goes out; there are no ranges to line-up on to make the turn. “If you are planning a channel that can only be performed using technology, you are planning for failure.” We need better visuals and ranges.

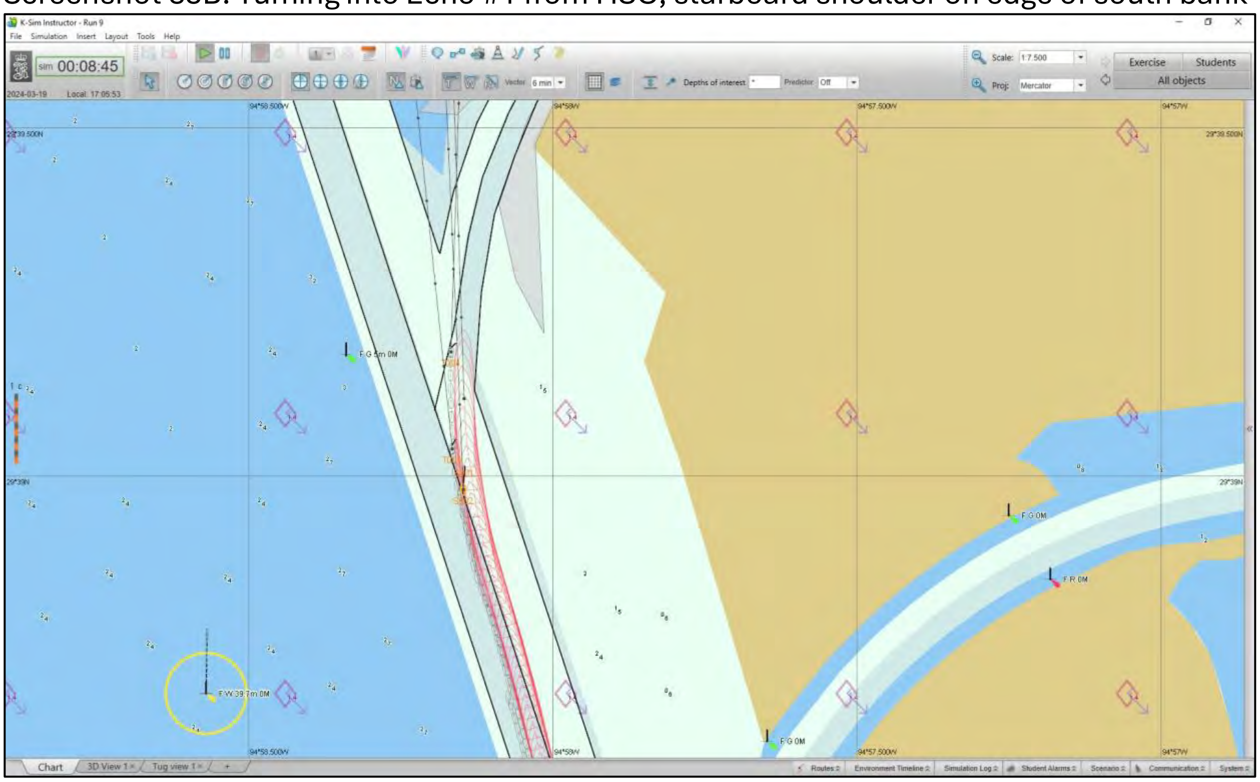
Screenshots List:

Screenshot 38A. Setup inbound from HSC to Echo #1, tug on stern, Wind NW 315 @15kn
Screenshot 38B. Turning into Echo #1 from HSC, starboard shoulder on edge of south bank
Screenshot 38C. Completing continuous arcing turn in Echo #1, ship’s quarter and stern are near the north bank during turn
Screenshot 38D. Completed run as simulator froze when entering the turning basin

Screenshot 38A. Setup inbound from HSC to Echo #1, tug on stern, Wind NW 315 @15kn

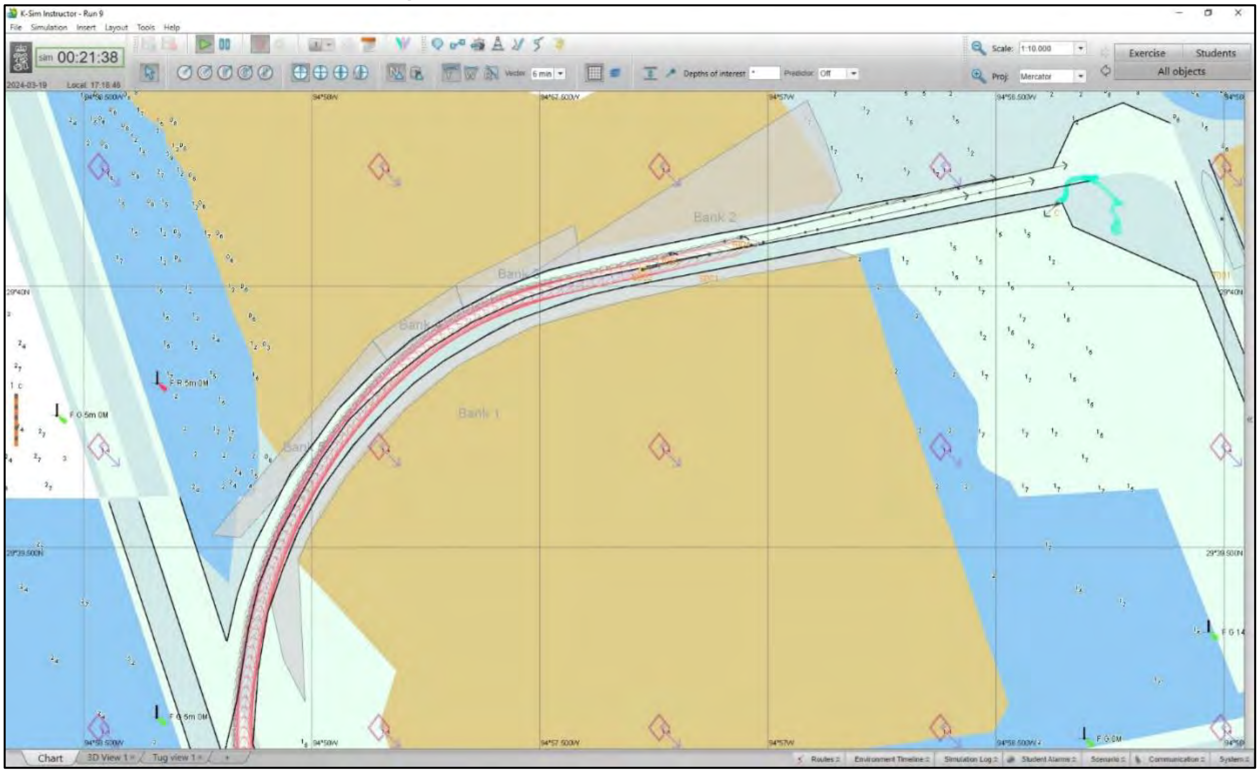


Screenshot 38B. Turning into Echo #1 from HSC, starboard shoulder on edge of south bank

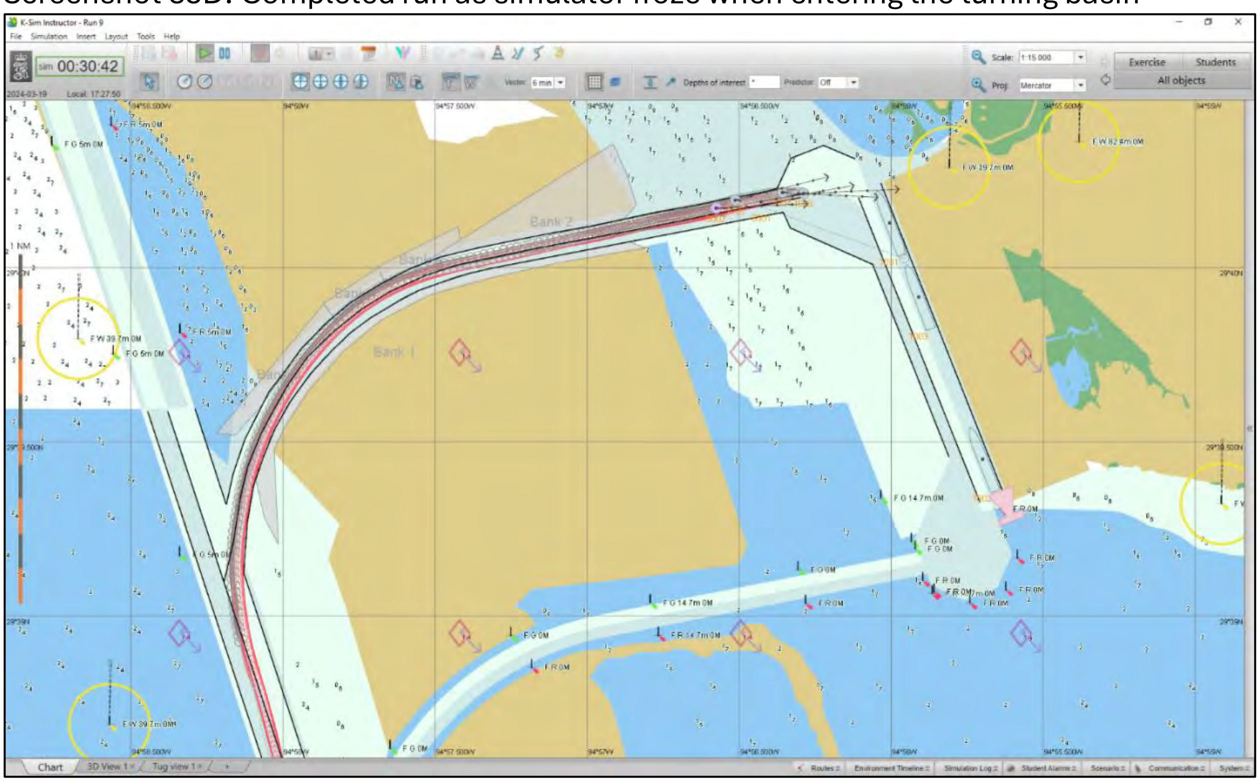


Locus

Screenshot 38C. Completing continuous arcing turn in Echo #1, ship's quarter and stern are near the north bank during turn



Screenshot 38D. Completed run as simulator froze when entering the turning basin



Run 39. Echo #1, Arrival ULCV 366m Ballast, 315° @ 15kn, GAR 2

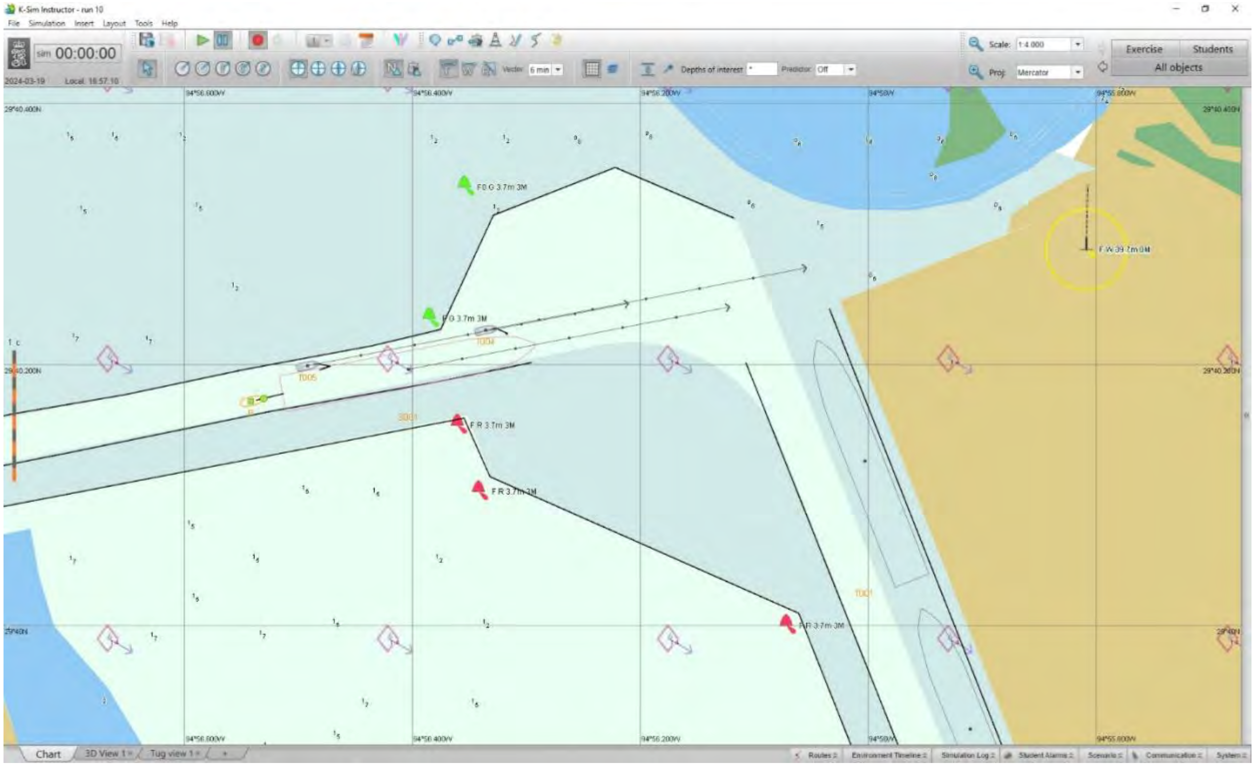
Run Description: This is a continuation of Run 38. The run started with the ship's bow entering the turning basin at 2.5kn with all three tugs arranged portside shoulder and quarter and a tug on the stern. Making the turn in the turning basin, the ship maintained about 0.5kn of headway and reached a maximum ROT of 13° per minute. It took 17 minutes to complete the turn in the turning basin. Making the turn required full engines and full tug orders. The ship backed down into place parallel to Berth #3.

Pilot Comments: A safe channel would have a range, then a wider area to turn, then another range, and repeat. Would rather have ranges prior to every turn and be aware of their surroundings, as the ranges would supplement that experience. Having four tugs, given that power, there should be no hazards doing this unless you have a north / northwest wind. The issue is that to be comfortable, we compensate for the tugs to be allowed outside the channel. You may run your tug into the dirt if an angle is created trying to dock. To avoid that, you would have to keep the vessel in the middle and evenly push the ship directly into the berth (#3) without any turn. Had to stop the engines to help the tug get on a 90° earlier in run. Ships are too big for these maneuvers. It's a tight maneuver for a 700ft channel, and an additional 50 ft would help assist in a turn like this. SE or S wind placement may cause even more concern while maneuvering.

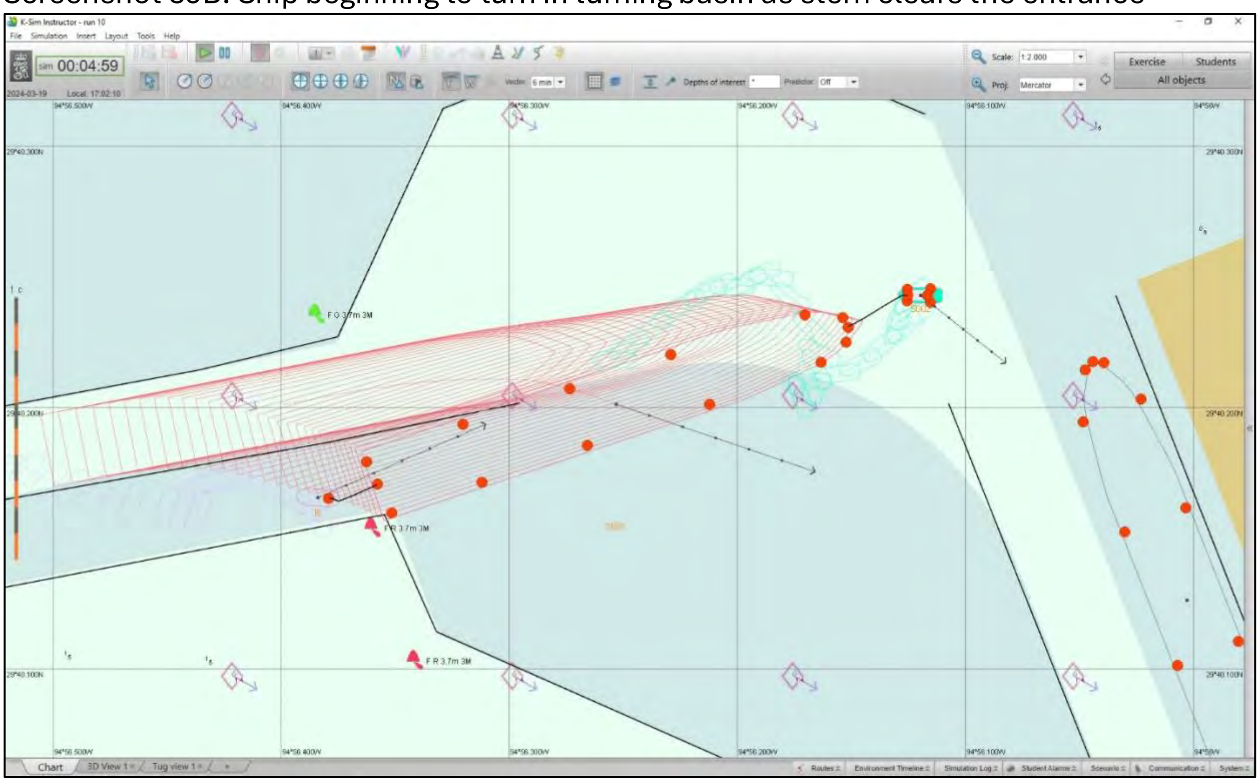
Screenshots List:

Screenshot 39A. Setup inbound from channel Echo #1 into turning basin, three tugs on the stern, portside shoulder & quarter, Wind NW 315 @15kn
Screenshot 39B. Ship beginning to turn in turning basin as stern clears the entrance
Screenshot 39C. Ship turning in turning basin trying to keep tugs inside project's limits
Screenshot 39D. Ship completed turn in turning basin begins to back into terminal basin
Screenshot 39E. Ship backing in parallel to ships at Berths 1 and 2, working on the centerline with tugs laying alongside because they cannot work at a 90° from the ship
Screenshot 39F: Completed docking at Berth 3, assisted by three tugs on the stern, portside shoulder & quarter, zero wind

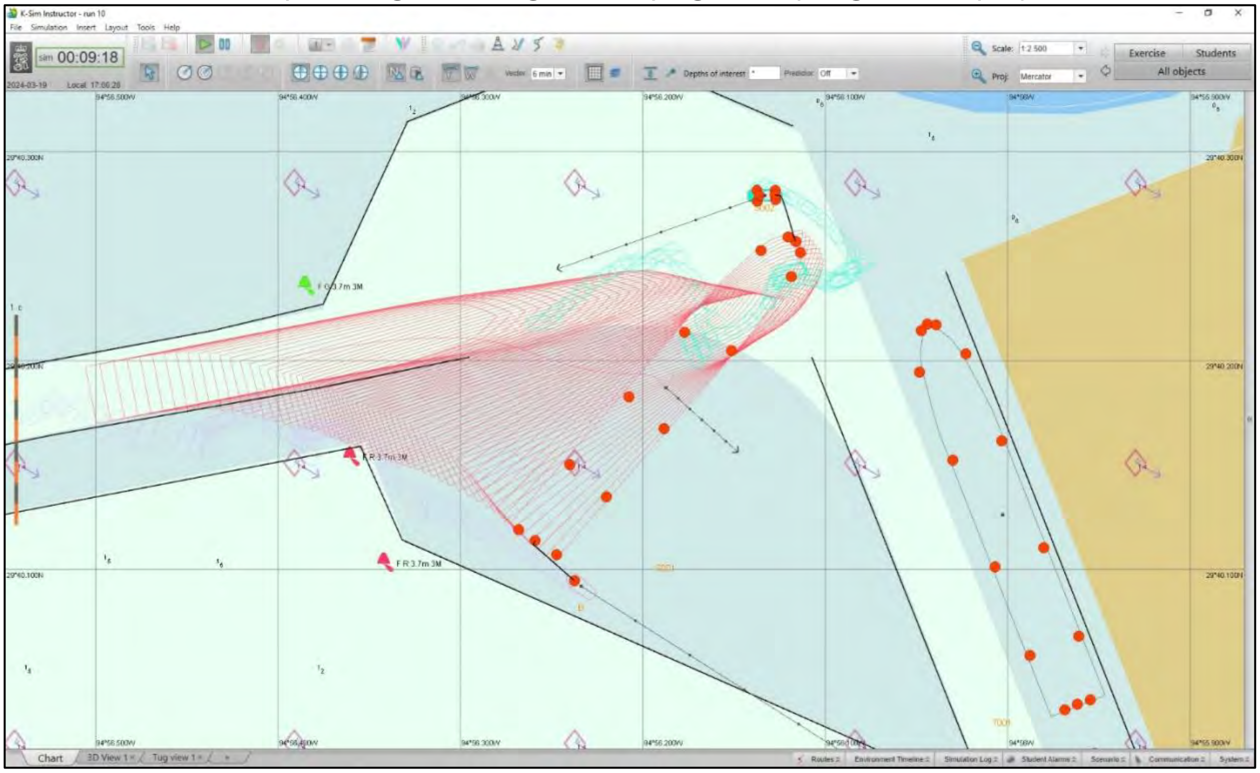
Screenshot 39A. Setup inbound from channel Echo #1 into turning basin, three tugs on the stern, portside shoulder & quarter, Wind NW 315 @15kn



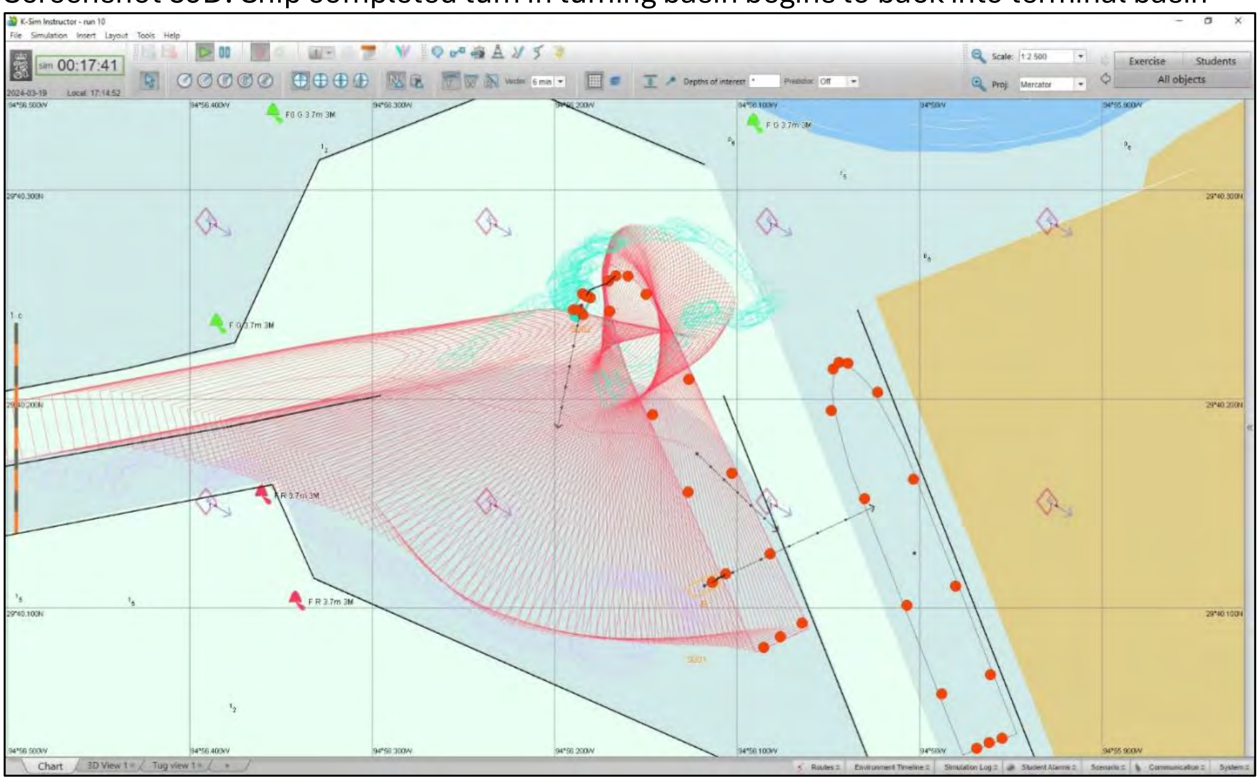
Screenshot 39B. Ship beginning to turn in turning basin as stern clears the entrance



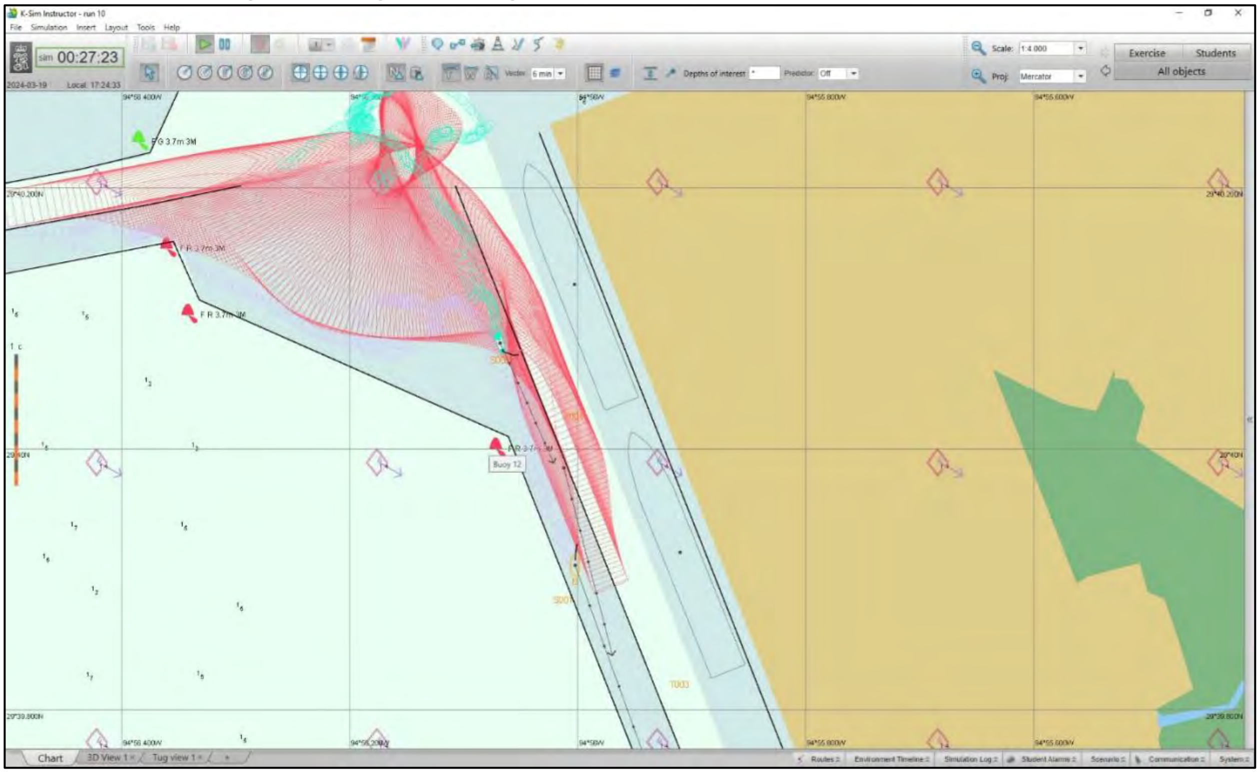
Screenshot 39C. Ship turning in turning basin trying to keep tugs inside project's limits



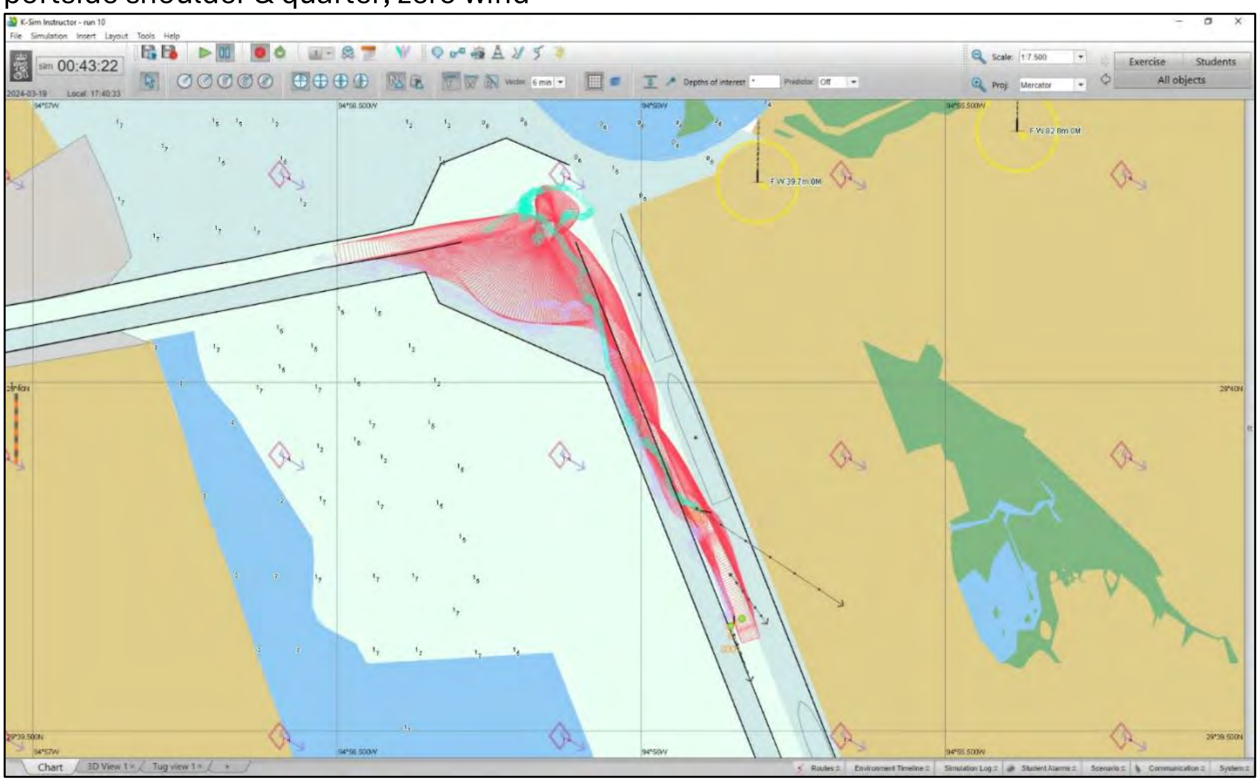
Screenshot 39D. Ship completed turn in turning basin begins to back into terminal basin



Screenshot 39E. Ship backing in parallel to ships at Berths 1 and 2, working on the centerline with tugs working at an angle because they cannot work at a 90° from the ship



Screenshot 39F: Completed docking at Berth 3, assisted by three tugs on the stern, portside shoulder & quarter, zero wind



Channel Echo #2 (Runs #40 - 41)

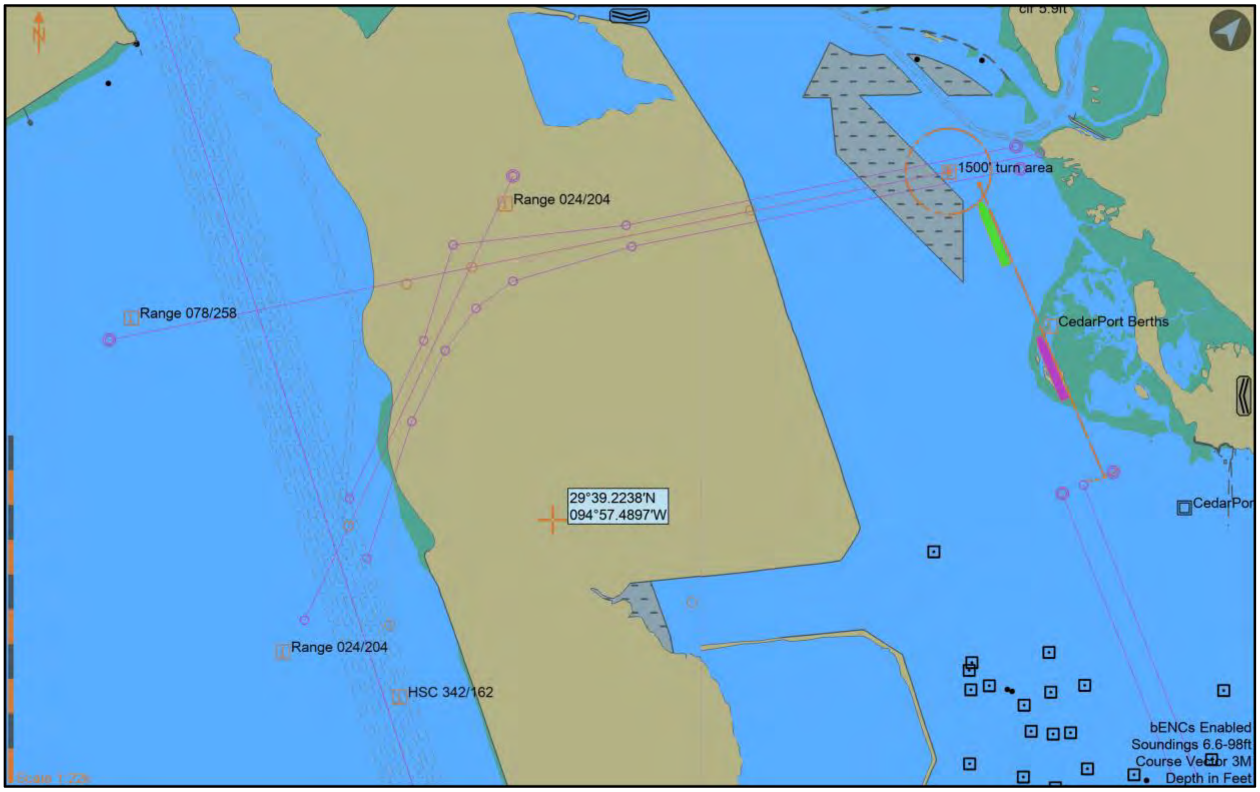


Figure 22: Layout of Channel Echo #2

Channel Description: Echo #2 allowed pilots to depart the HSC using a single assist tug engaged in active escort astern, passing through a short navigation flare, while turning to align the ship on a set of ranges (024° True). The pilot then proceeded on heading 024°T approximately two ship lengths from the HSC/short flare into a 400' channel, then into a standard turn widener. In the turn widener, the pilots turned the ship into the final 400' channel leading to the berth turn basin (078°T). This design using a two-leg course turn with a connecting widener was successful. The pilots commented they had navigation options in the channel layout to either proceed at a constant speed through the connecting turn or to slow and join with tugs for a slower, "harbor-turn" maneuver. It was suggested that this two-course system with a connecting widener philosophy is an option to evaluate in future detailed channel design.

Channel Assessment: This channel is feasible for navigation.

Run 40. Echo #2, Arrival ULCV 366m, None, Not Available

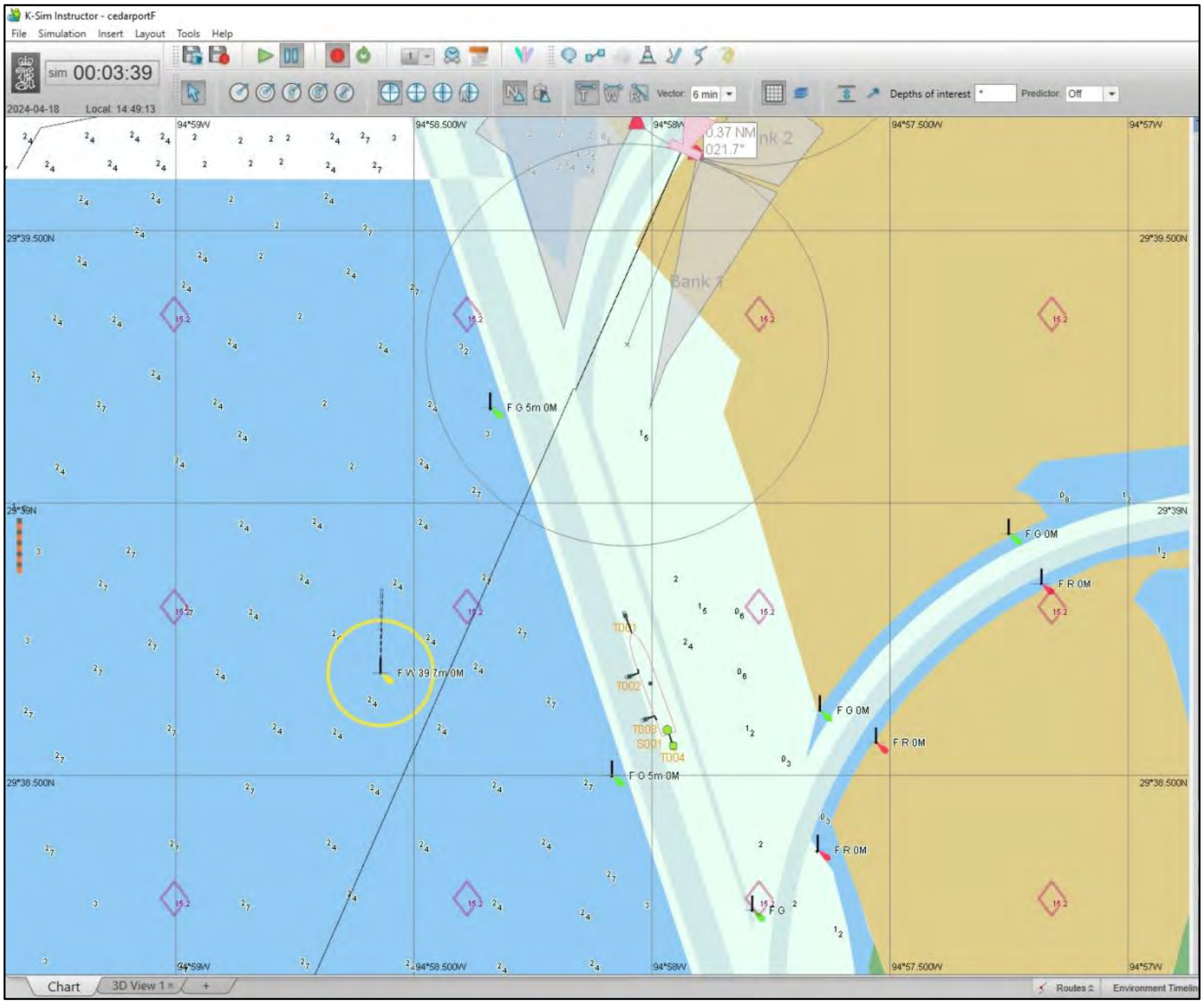
Run Description: This was the first alternative channel Echo #2 run. The research team developed it with input from the pilots and attendees. The goal was to set up multiple straightaways with ranges and a widener for the ship to turn. The run started with the ship at 6kn, three ship lengths below the entrance to Echo and ½ a beam left of centerline in the HSC along with four assist tugs arranged center lead bow and stern as well as two tugs on the port shoulder and quarter. The ship got up to 7kn in the HSC, and the pilot started the turn late into Echo #2. To compensate for the late, turn the pilot accelerated to 9kn. The pilot was not able to safely complete the turn, and the simulation was paused before the ship collided with the northern bank.

Pilot Comments: The run failed because I turned too late. While the run failed, I felt much safer than in Echo #1. I had a straight line I could use to line up on to enter Echo #2. It was easier to exit the HSC than it was with the previous turning bend. I need to keep my speed at 7kn maximum within the turn to prevent what happened. That will allow me to maintain positive control over the turn.

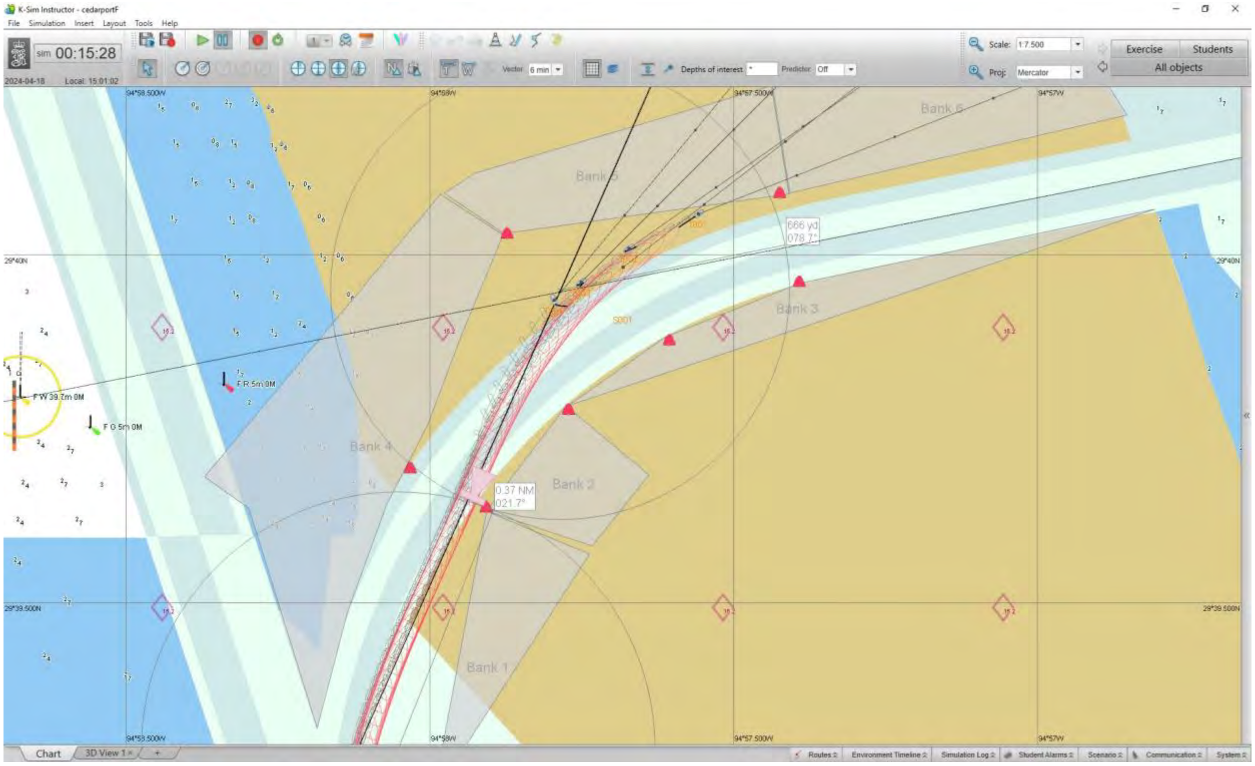
Screenshots List:

Screenshot 40A. Setup inbound ship from HSC to Echo #2, assisted by four tugs on the stern, bow, portside shoulder & quarter, with zero wind
Screenshot 40B. Completed run as simulation was paused as the pilot started the turn late and could not successfully make the turn in Echo #2

Screenshot 40A. Setup inbound ship from HSC to Echo #2, assisted by four tugs on the stern, bow, portside shoulder & quarter, with zero wind



Screenshot 40B. Completed run as simulation was paused as the pilot started the turn late and could not successfully make the turn in Echo #2



Run 41. Echo #2, Arrival ULCV 366m, None, GAR 1

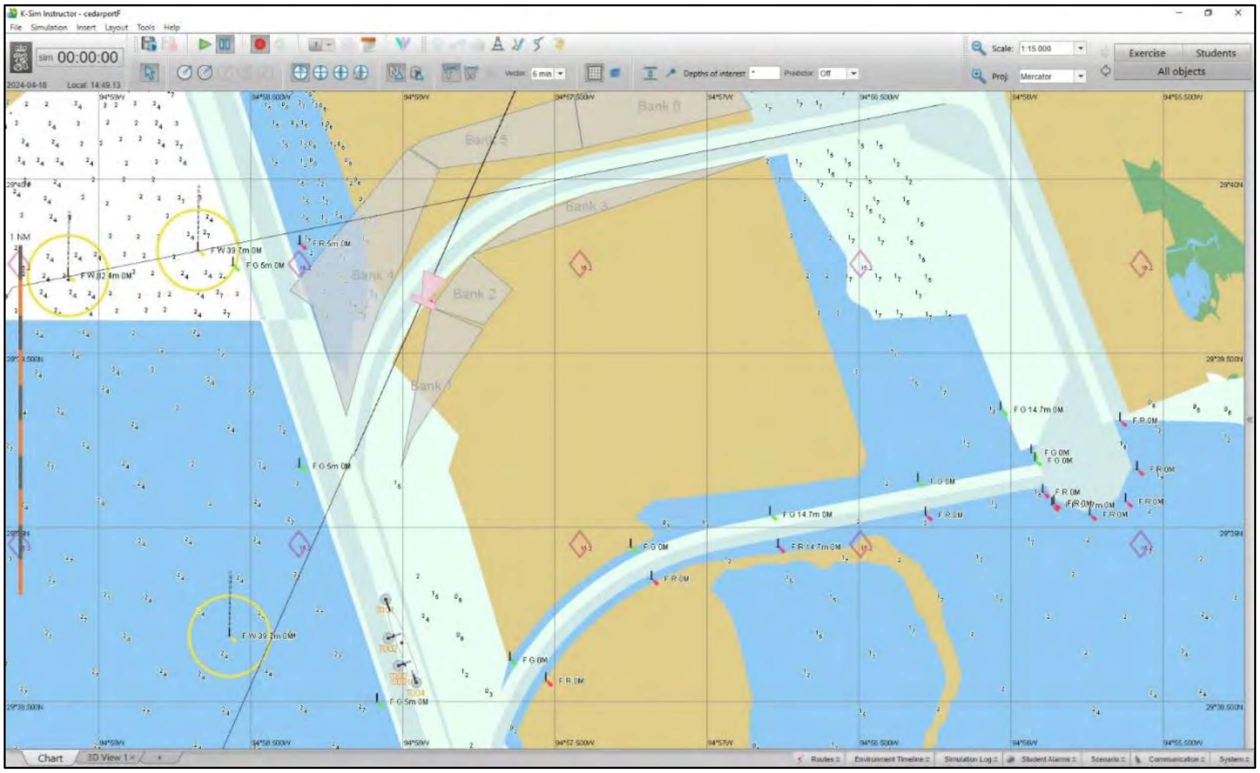
Run Description: This was the second run for Echo #2. The run started with the ship at 6kn, three ship lengths below the entrance to Echo and ½ a beam left of centerline in the HSC along with four assist tugs arranged center lead bow and stern as well as two tugs on the port shoulder and quarter. This run was performed by the same pilot who did Run #40. They reduced their speed and timed the turn into Echo #2 better than the previous run. They were able to maintain about 6kn and completed the turns to get on the straightaway heading towards the turning basin. The simulation was paused due to time constraints after the ship was on the ranges for the straightaway at heading 078° inbound to the basin.

Pilot Comments: This run felt good. I had the ability to turn into the channel and steady my course heading. I was able to get on a range and then drive to the widener. The ability to turn in and steady up on a range makes this much safer. Because of the widener, you do not need to be perfect to make the turn, especially with tugs assisting. This allows me to set a heading rather than constantly turning and trying to balance all the forces to make the continuous arcing turn. A straight line into the widener allows the pilots to fix any problems that could have developed during the initial turn into the channel from the HSC. However, you don't have the security to make the same recovery without that straight turn. If you hit a straight line, you can get the ship into a better position, even when mistakes are made. With an arc, you have to maintain an offset pivot point throughout the entire arc while battling the wind and bank effect. With the changes made, this turn will feel more familiar and less stressful, as these two straightaways create a larger margin for error. Having a set heading will also relieve some of the cognitive stress, as it simplifies what the pilot must focus on. Also, it allows for a flare and extra room within the turning basin.

Screenshots List:

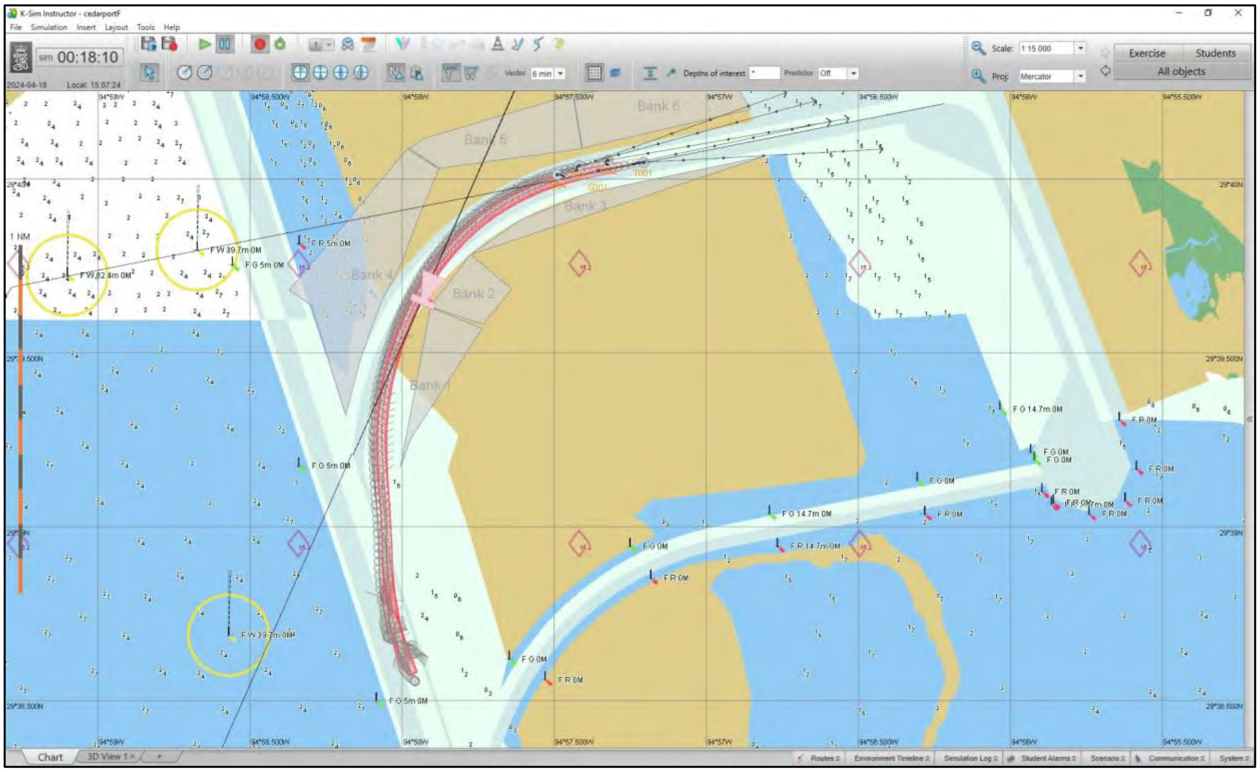
Screenshot 41A. Setup inbound from HSC to channel Echo #2, assisted by all four tugs on the stern, bow, portside shoulder & quarter, with zero wind
Screenshot 41B. Ship after performing arcing turn onto second set of ranges at 078° headed into turning basin
Screenshot 41C. Completion cleared turn into channel Echo #2, assisted by all four tugs on the stern, bow, portside shoulder & quarter, with zero wind

Screenshot 41A. Setup inbound from HSC to channel Echo #2, assisted by all four tugs on the stern, bow, portside shoulder & quarter, with zero wind



Screenshot 41B. Ship after performing arcing turn onto second set of ranges at 078° headed into turning basin

Screenshot 41C. Completion cleared turn into channel Echo #2, assisted by all four tugs on the stern, bow, portside shoulder & quarter, with zero wind



End of Report

Attachment C-4

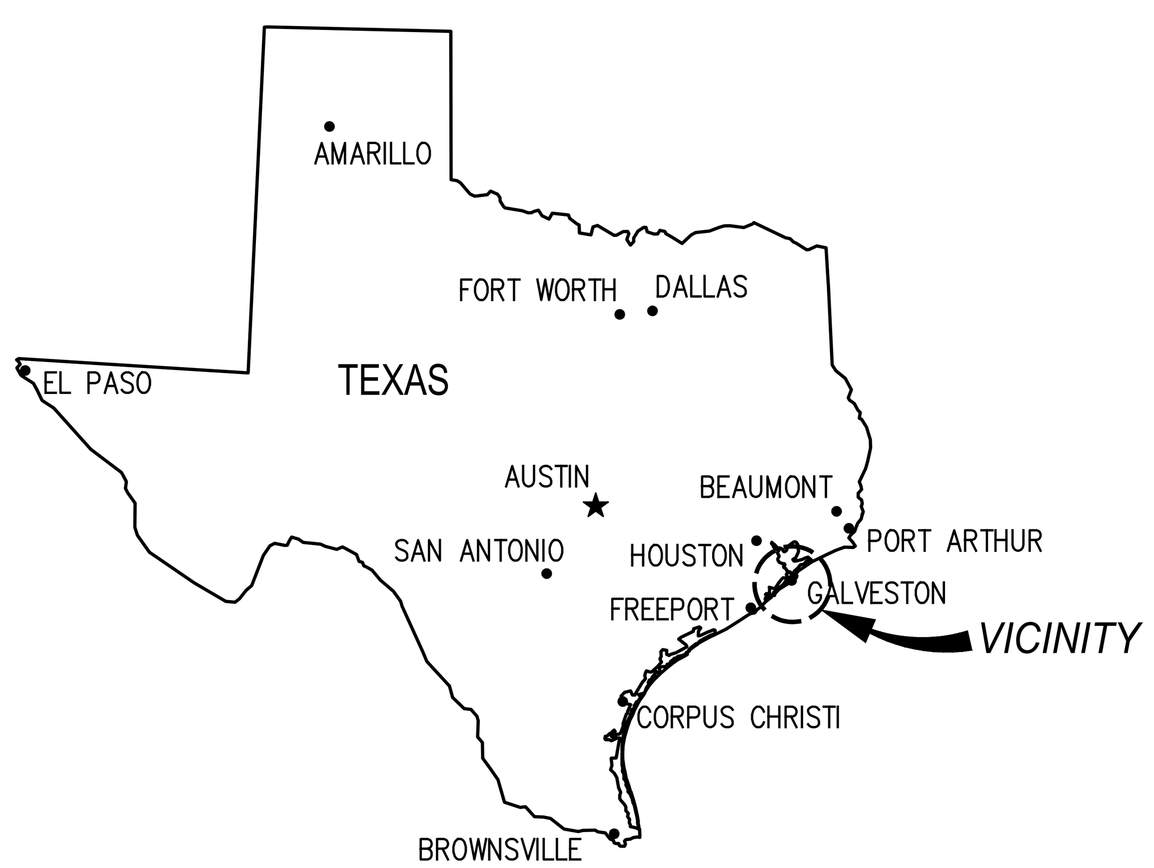
Drawings

5/6/2024 4:42 PM

CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT

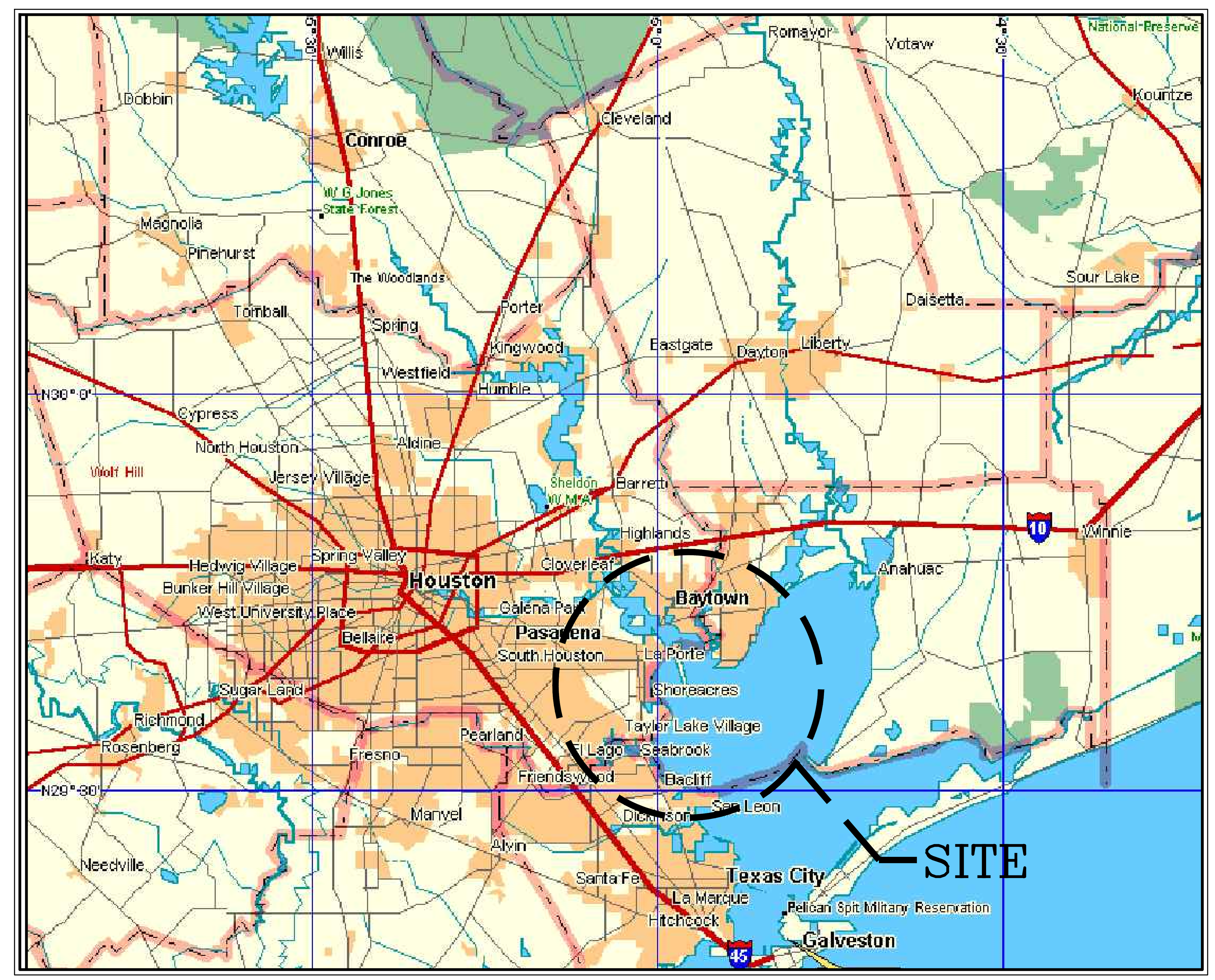
CEDAR BAYOU, TEXAS

PROPOSED NEW SHIP CHANNEL STUDY



AREA MAP

N



VICINITY MAP

N.T.S.

PROJECT SITE LOCATION:
29°39'45"N
94°56'01"W

DRAWING INDEX		
DWG. NO.	REV.	TITLE
CS1	C	TITLE SHEET, VICINITY MAP & DRAWING INDEX
ALTERNATIVE ROUTE A		
GA1A	C	GENERAL ARRANGEMENT & SITE PLAN
C1A	A	STA. 1000+00 TO 1045+00
C2A	A	STA. 1045+00 TO 1110+00
C3A	A	STA. 1100+00 TO 1170+00
C4A	A	STA. 1170+00 TO 1230+00
C5A	A	STA. 1230+00 TO 1258+95
X1A	A	CROSS SECTIONS
X2A	A	CROSS SECTIONS
X3A	A	CROSS SECTIONS
ALTERNATIVE ROUTE B		
GA1B	C	GENERAL ARRANGEMENT & SITE PLAN
C1B	A	STA. 2000+00 TO 2060+00
C2B	A	STA. 2060+00 TO 2105+00
C3B	A	STA. 2105+00 TO 2185+00
C4B	A	STA. 2185+00 TO 2220+12
X1B	A	CROSS SECTIONS
X2B	A	CROSS SECTIONS
X3B	A	CROSS SECTIONS
ALTERNATIVE ROUTE C		
GA1C	C	GENERAL ARRANGEMENT & SITE PLAN
C1C	A	STA. 3000+00 TO 3055+00
C2C	A	STA. 3055+00 TO 3115+00
C3C	A	STA. 3115+00 TO 3170+00
C4C	A	STA. 3170+00 TO 3230+00
C5C	A	STA. 3230+00 TO 3248+82
X1C	A	CROSS SECTIONS
X2C	A	CROSS SECTIONS
X3C	A	CROSS SECTIONS
ALTERNATIVE ROUTE D		
GA1D	C	GENERAL ARRANGEMENT & SITE PLAN
C1D	A	STA. 4000+00 TO 4065+00
C2D	A	STA. 4065+00 TO 4130+00
C3D	A	STA. 4130+00 TO 4190+00
C4D	A	STA. 4190+00 TO 4250+00
C5D	A	STA. 4250+00 TO 4310+00
C6D	A	STA. 4310+00 TO 4370+00
C7D	A	STA. 4370+00 TO 4430+00
C8D	A	STA. 4430+00 TO 4483+73
X1D	A	CROSS SECTIONS
X2D	A	CROSS SECTIONS
X3D	A	CROSS SECTIONS
ALTERNATIVE ROUTE E		
GA1E	C	GENERAL ARRANGEMENT & SITE PLAN
C1E	B	STA. 5000+00 TO 5060+00
C2E	B	STA. 5060+00 TO 5105+00
C3E	B	STA. 5105+00 TO 5165+00
C4E	B	STA. 5165+00 TO 5214+95
X1E	B	CROSS SECTIONS
X2E	B	CROSS SECTIONS
X3E	B	CROSS SECTIONS

PRELIMINARY
MAY 03, 2024

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

REV	DATE	BY	DESCRIPTION
*			

REV	DATE	BY	DESCRIPTION
C	05/03/24	RRM	UPDATED DRAWING INDEX
B	01/17/24	CSG	UPDATED DRAWING INDEX
A	11/01/23	CSG	PRELIMINARY – FOR REVIEW ONLY

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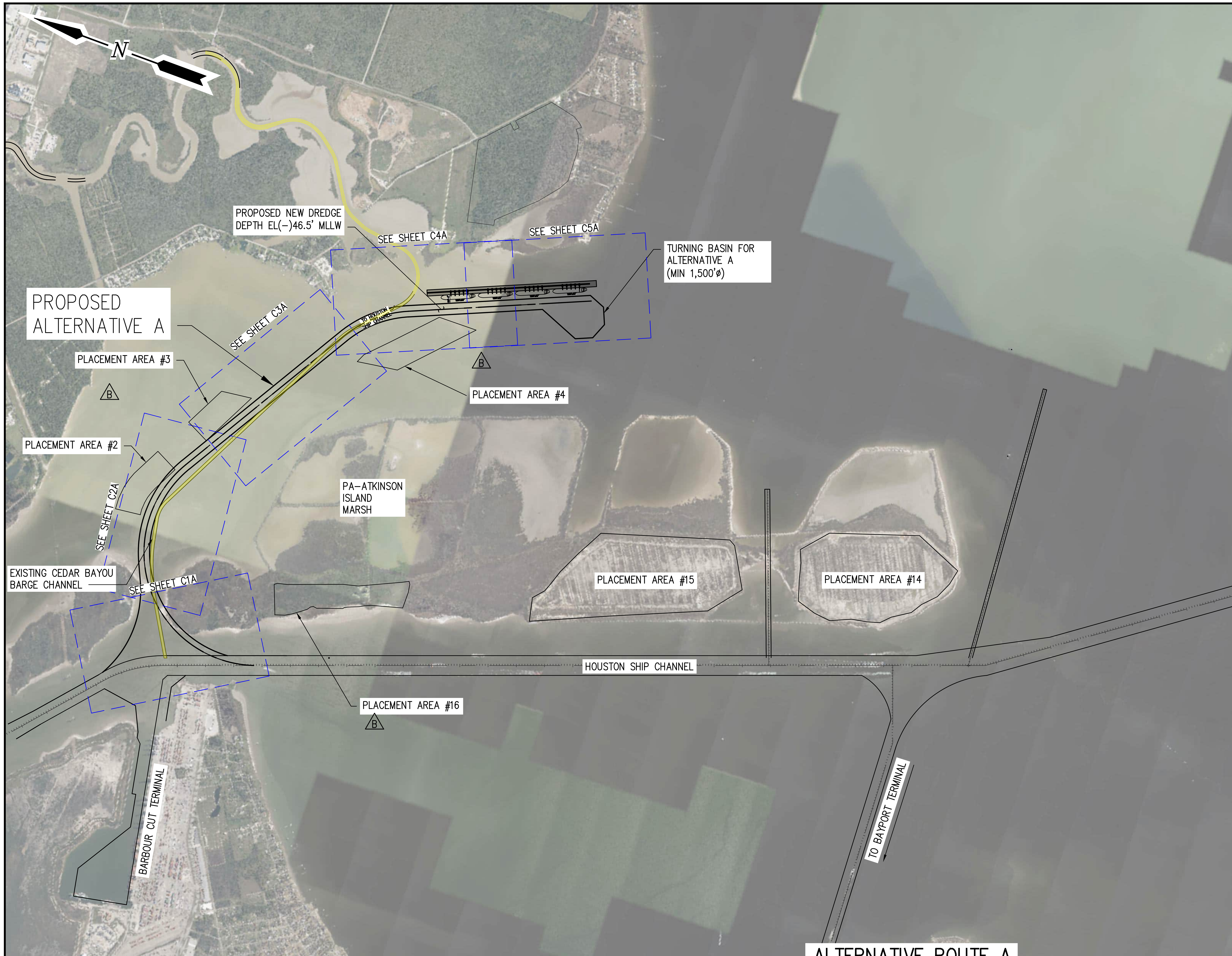
DATE NOV. '23
SHT SIZE 22"x34"
DESIGN *
DRAWN PJC
CHECK JEL
APPR'D RRM
JOB NO 11612

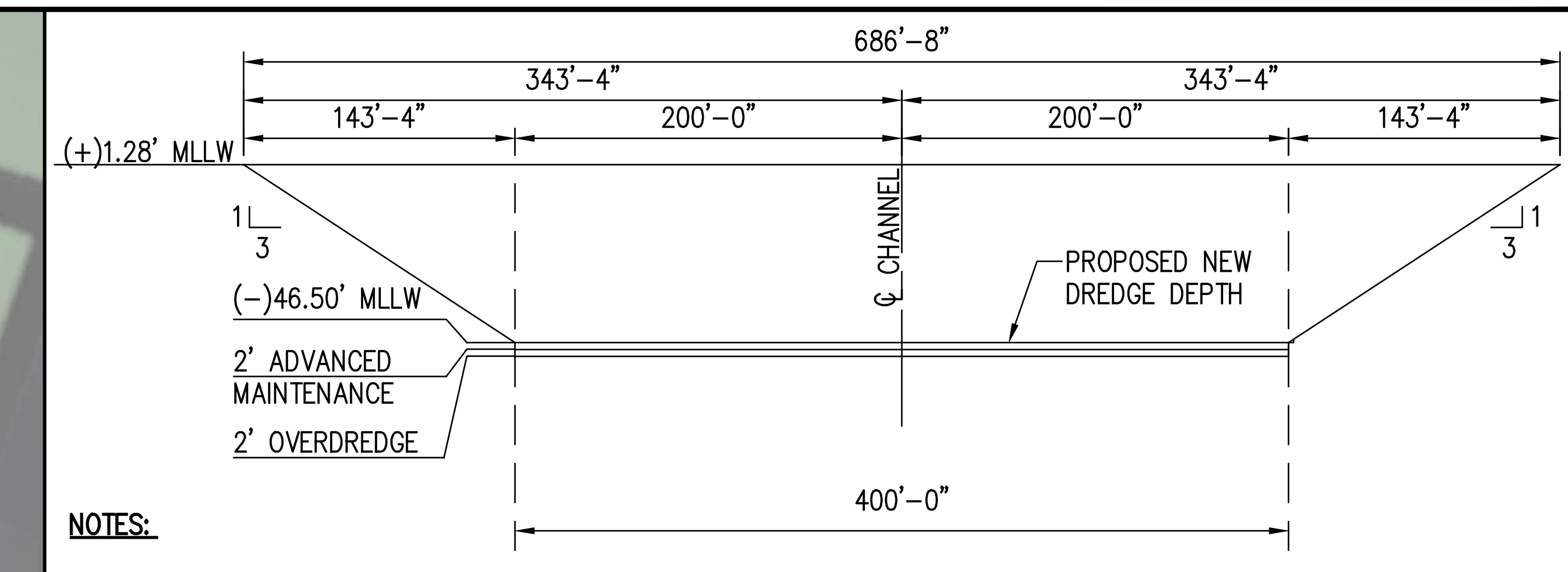
CEDAR PORT IMPROVEMENT & NAVIGATION DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTES
TITLE SHEET, VICINITY MAP & DRAWING INDEX

SHEET NO.
CS1

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\11612-CS1.DWG



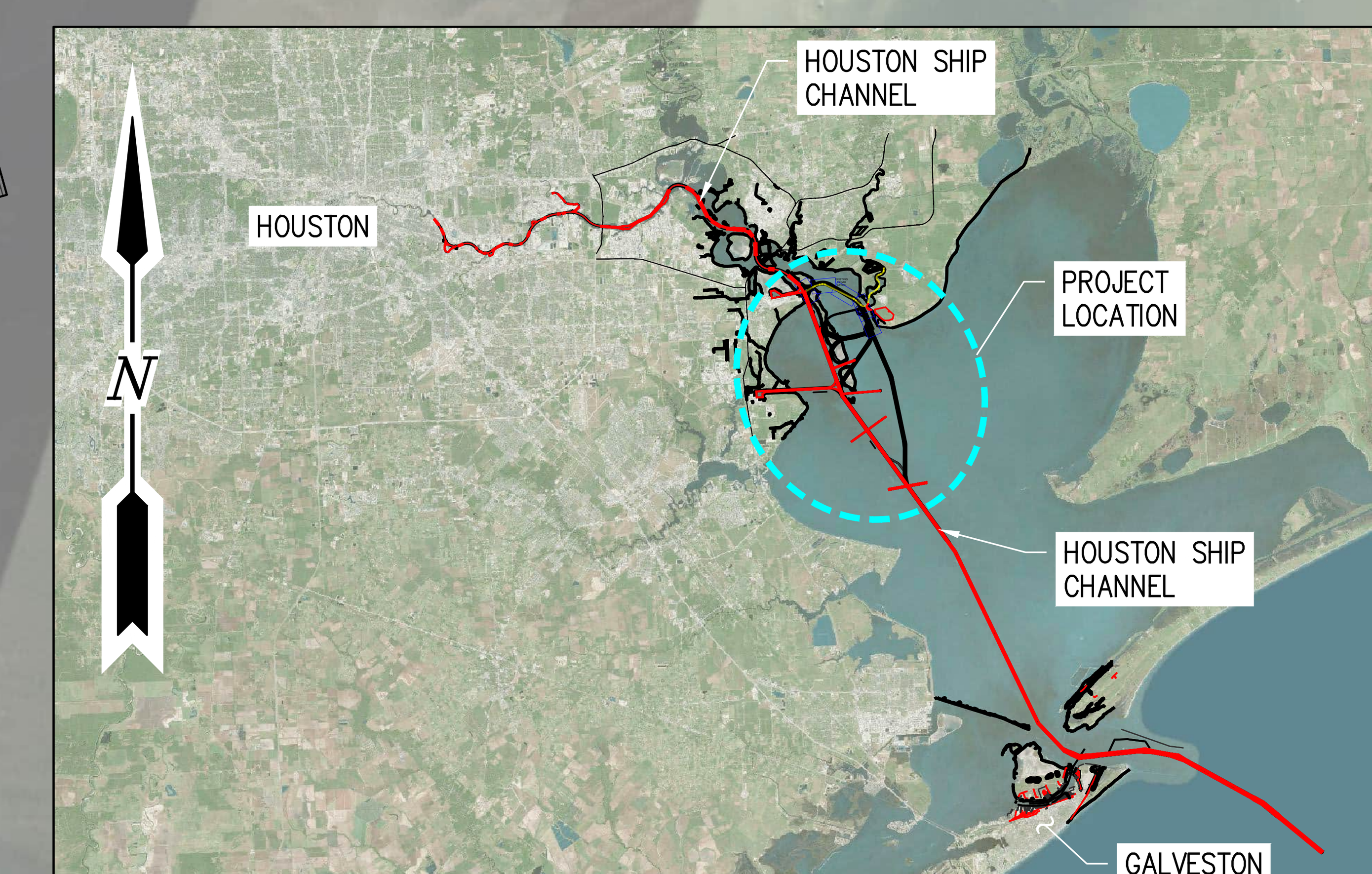


NOTES:

1. DESIGN VESSEL LOA = 1200 FEET AND BEAM = 158 FEET.
2. SLOPES ARE TO BE CONFIRMED.
3. MEAN HIGH WATER = EL.(+)1.28' MLLW.

TYPICAL CROSS SECTION

SCALE: N.T.S.



ALTERNATIVE ROUTE A
GENERAL ARRANGEMENT & SITE PLAN

SCALE: 1" = 2000'

2000 0 1000 2000 4000

(IN FEET)

PRELIMINARY

APRIL 24, 2024

LOCATION MAP

SCALE: 1"= 5 MILES

8 0 4 8 16

(IN MILES)

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LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
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REV	DATE	BY	DESCRIPTION
*			

REV	DATE	BY	DESCRIPTION
C	04/24/24	CSG	UPDATED BEAM LENGTH
B	01/17/24	CSG	ADDED ADDITIONAL DMPAS
A	11/01/23	CSG	PRELIMINARY

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DATE OCT. '23
SHT SIZE 22"x34"
DESIGN *
DRAWN PJC
CHECK TRD
APPR'D RRM
JOB NO 11612

CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE A
GENERAL ARRANGEMENT & SITE PLAN

SHEET NO.
GA1A

5/6/2024 4:43 PM

NOTES:

1. HYDROGRAPHIC SURVEY PERFORMED BY LANIER & ASSOCIATES ON JUNE 26 THROUGH 28, 2023.
2. HORIZONTAL DATUM REFERENCED TO TEXAS STATE PLANE (SOUTH CENTRAL) NAD 83.
3. ALL ELEVATIONS ARE EXPRESSED IN FEET AND TENTHS AND ARE REFERENCED TO MEAN LOWER LOW WATER (M.L.L.W.) DATUM
4. DATUM FOR THE WATER SURFACE AT THE TIME OF THE SURVEY WAS PROVIDED BY THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) MORGAN'S POINT TIDE GAGE, ID 87706113.
5. SEE DRAWING GA1A FOR SITE MAP.

ALTERNATIVE ACCESS ROUTE A 1000+00 TO 1045+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

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CONSULTING ENGINEERS, INC.
LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
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REV	DATE	BY	DESCRIPTION
*			

REV	DATE	BY	DESCRIPTION
A	11/01/23	CSG	PRELIMINARY

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DESIGN *
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CHECK TRD
APPR'D RRM
JOB NO 11612

CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE A
STA. 1000+00 TO 1045+00

SHEET NO.
C1A

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION A\23-07-C1A-C5A.DWG

5/6/2024 4:43 PM

NOTES:

1. HYDROGRAPHIC SURVEY PERFORMED BY LANIER & ASSOCIATES ON JUNE 26 THROUGH 28, 2023.
2. HORIZONTAL DATUM REFERENCED TO TEXAS STATE PLANE (SOUTH CENTRAL) NAD 83.
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4. DATUM FOR THE WATER SURFACE AT THE TIME OF THE SURVEY WAS PROVIDED BY THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) MORGAN'S POINT TIDE GAGE, ID 87706113.
5. SEE DRAWING GA1A FOR SITE MAP.

ALTERNATIVE ACCESS ROUTE A 1045+00 TO 1110+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

PRELIMINARY
NOVEMBER 1, 2023

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CONSULTING ENGINEERS, INC.
LA: EF-1120 TX: F-2981
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REV	DATE	BY	DESCRIPTION
*			

REV	DATE	BY	DESCRIPTION
A	11/01/23	CSG	PRELIMINARY

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DATE OCT. '23
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DESIGN *
DRAWN PJC
CHECK TRD
APPR'D RRM
JOB NO 11612

CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE A
STA. 1045+00 TO 1110+00

SHEET NO.
C2A

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION A\23-07-C1A-C5A.DWG

5/6/2024 4:43 PM

NOTES:

1. HYDROGRAPHIC SURVEY PERFORMED BY LANIER & ASSOCIATES ON JUNE 26 THROUGH 28, 2023.
2. HORIZONTAL DATUM REFERENCED TO TEXAS STATE PLANE (SOUTH CENTRAL) NAD 83.
3. ALL ELEVATIONS ARE EXPRESSED IN FEET AND TENTHS AND ARE REFERENCED TO MEAN LOWER LOW WATER (M.L.L.W.) DATUM
4. DATUM FOR THE WATER SURFACE AT THE TIME OF THE SURVEY WAS PROVIDED BY THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) MORGAN'S POINT TIDE GAGE, ID 87706113.
5. SEE DRAWING GA1A FOR SITE MAP.

ALTERNATIVE ACCESS ROUTE A 1110+00 TO 1170+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

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LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
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REV	DATE	BY	DESCRIPTION
*			

REV	DATE	BY	DESCRIPTION
A	11/01/23	CSG	PRELIMINARY

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DATE OCT. '23
SHT SIZE 22"x34"
DESIGN *
DRAWN PJC
CHECK TRD
APPR'D RRM
JOB NO 11612

CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE A
STA. 1100+00 TO 1170+00

SHEET NO.
C3A

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION A\23-07-C1A-C5A.DWG

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NOTES:

1. HYDROGRAPHIC SURVEY PERFORMED BY LANIER & ASSOCIATES ON JUNE 26 THROUGH 28, 2023.
2. HORIZONTAL DATUM REFERENCED TO TEXAS STATE PLANE (SOUTH CENTRAL) NAD 83.
3. ALL ELEVATIONS ARE EXPRESSED IN FEET AND TENTHS AND ARE REFERENCED TO MEAN LOWER LOW WATER (M.L.L.W.) DATUM
4. DATUM FOR THE WATER SURFACE AT THE TIME OF THE SURVEY WAS PROVIDED BY THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) MORGAN'S POINT TIDE GAGE, ID 87706113.
5. SEE DRAWING GA1A FOR SITE MAP.

ALTERNATIVE ACCESS ROUTE A 1170+00 TO 1230+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

REV	DATE	BY	DESCRIPTION
*			

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A	11/01/23	CSG	PRELIMINARY

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DATE OCT. '23
SHT SIZE 22"x34"
DESIGN *
DRAWN PJC
CHECK TRD
APPR'D RRM
JOB NO 11612

CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE A
STA. 1170+00 TO 1230+00

SHEET NO.
C4A

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION A\23-07-C1A-C5A.DWG

5/6/2024 4:44 PM

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION A\23-07-C1A-C5A.DWG

NOTES:

1. HYDROGRAPHIC SURVEY PERFORMED BY LANIER & ASSOCIATES ON JUNE 26 THROUGH 28, 2023.
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5. SEE DRAWING GA1A FOR SITE MAP.

ALTERNATIVE ACCESS ROUTE A 1230+00 TO 1258+95

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE A
STA. 1230+00 TO 1258+95

SHEET NO.
C5A

5/6/2024 4:44 PM

NOTES:

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ALTERNATIVE ACCESS ROUTE A STA. 1020+00 (C1A)

SCALE: 1" = 50'

50 0 25 50 100 (IN FEET)

PRELIMINARY
NOVEMBER 1, 2023

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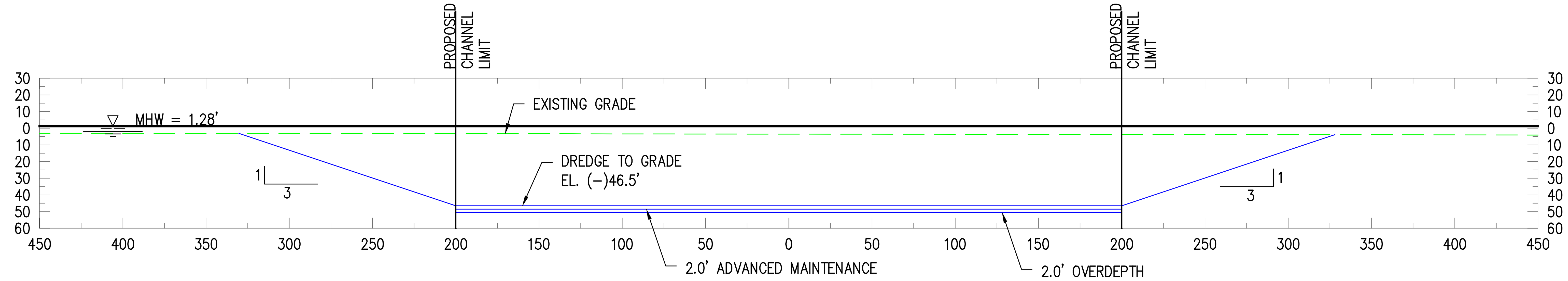
CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE A
CROSS SECTIONS

SHEET NO.
X1A

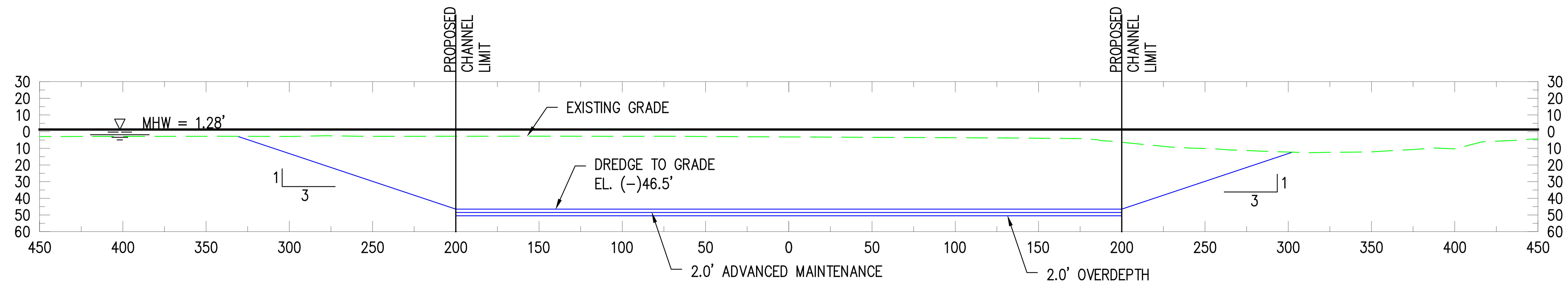
J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION A\23-07-X1A-X3A.DWG



ALTERNATIVE ACCESS ROUTE A STA. 1210+00

C4A

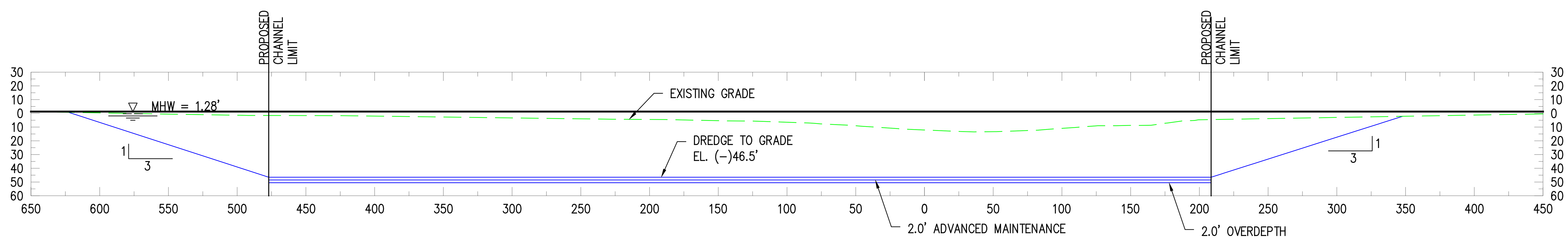
SCALE: 1" = 50'



ALTERNATIVE ACCESS ROUTE A STA. 1115+00

C3A

SCALE: 1" = 50'



ALTERNATIVE ACCESS ROUTE A STA. 1045+00

C1A

SCALE: 1" = 50'

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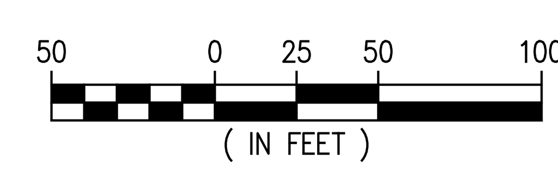

PRELIMINARY
NOVEMBER 1, 2023

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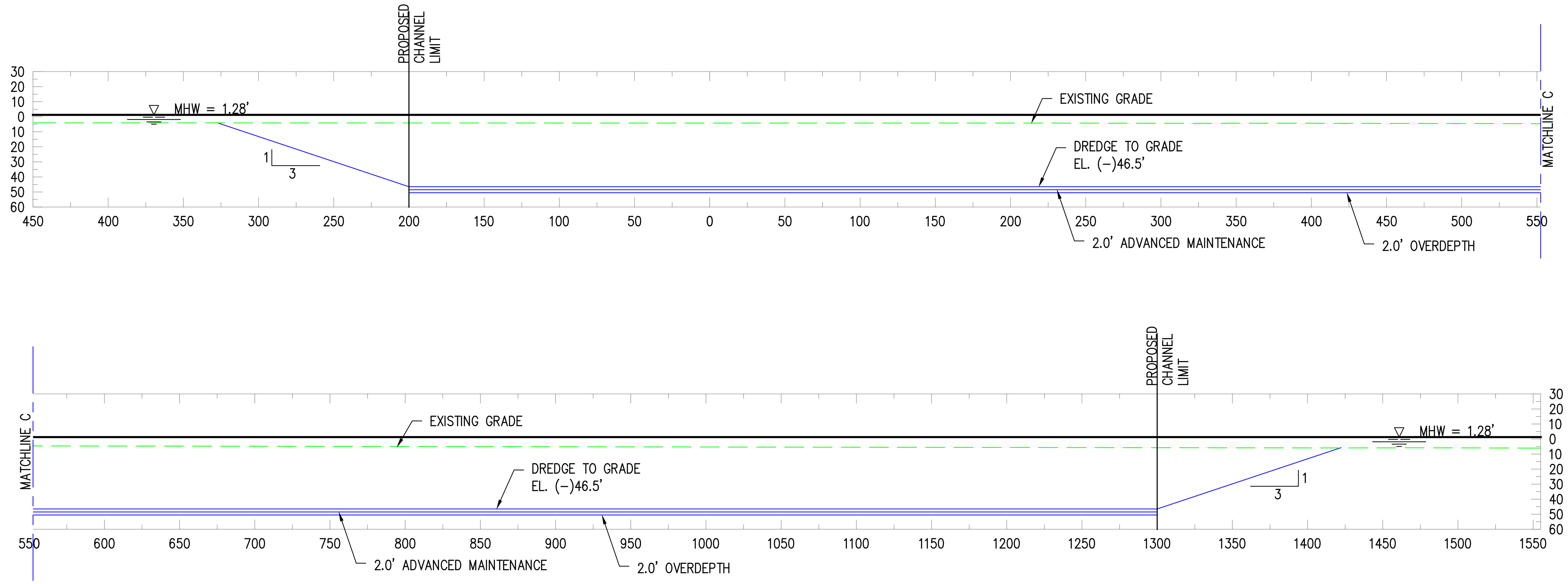
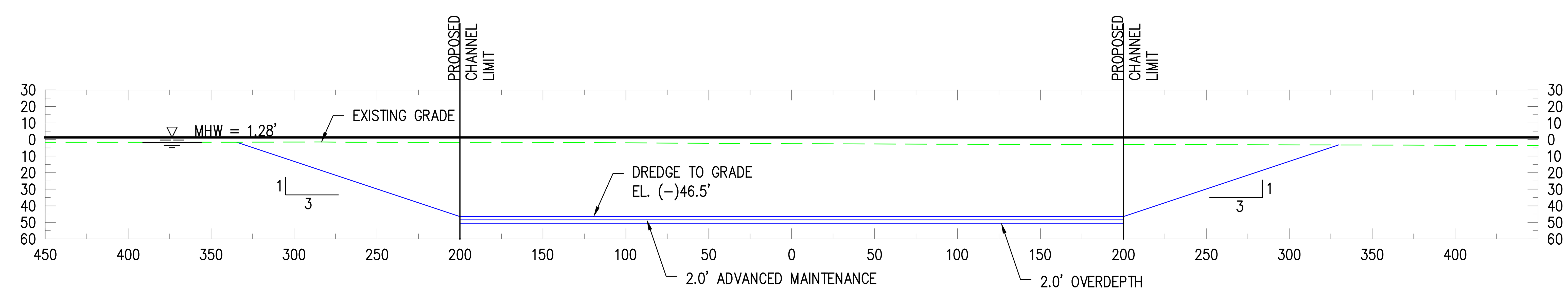
CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE A
CROSS SECTIONS

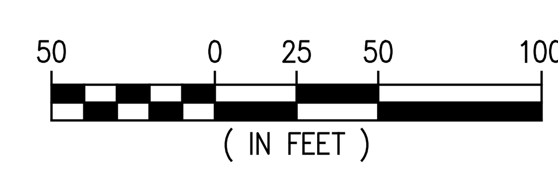
SHEET NO.
X2A



ALTERNATIVE ACCESS ROUTE A STA. 1255+00 (C5A)
SCALE: 1" = 50'



ALTERNATIVE ACCESS ROUTE A STA. 1230+00 (C4A)
SCALE: 1" = 50'



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NOVEMBER 1, 2023

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VF-185 LSF-10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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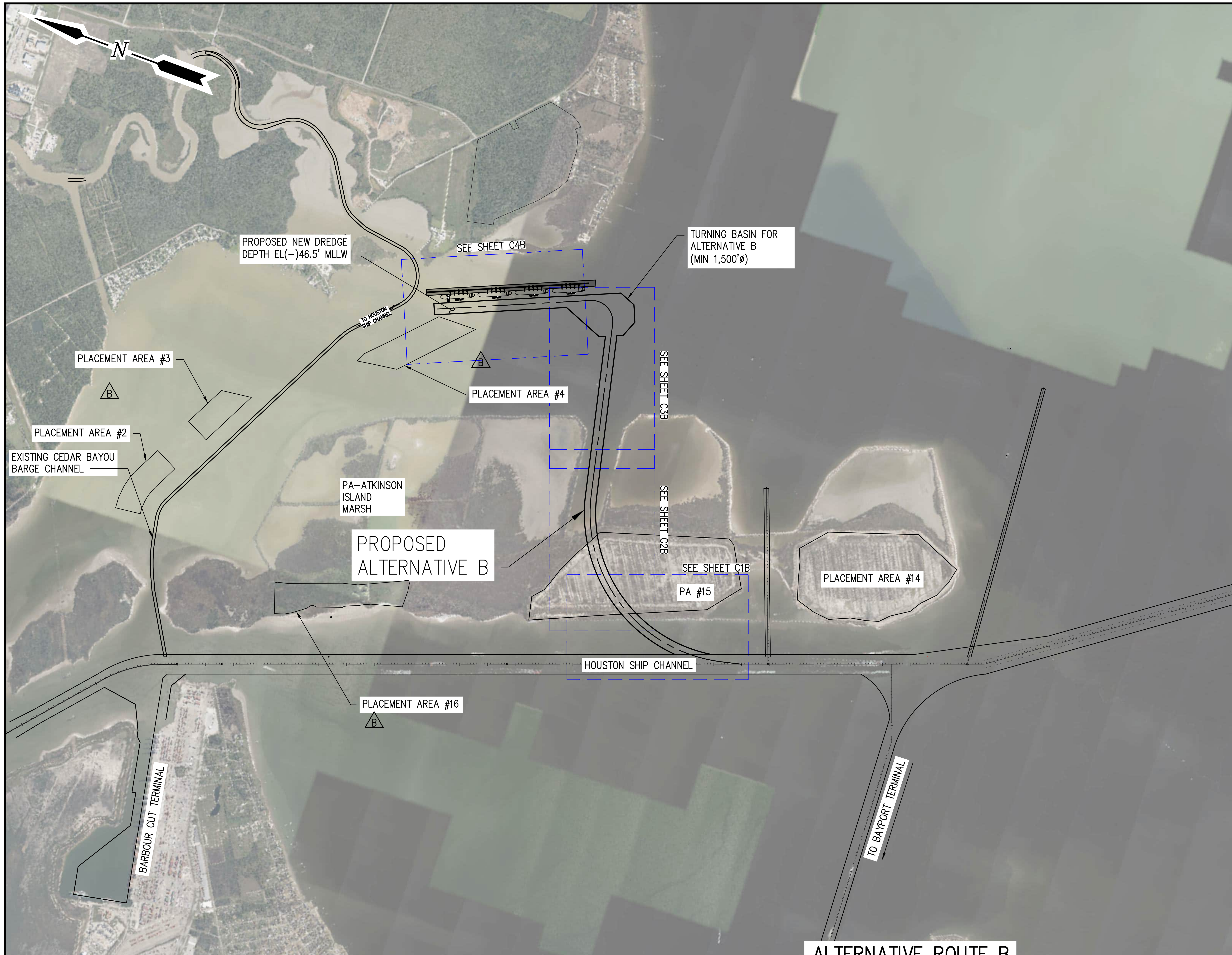
CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

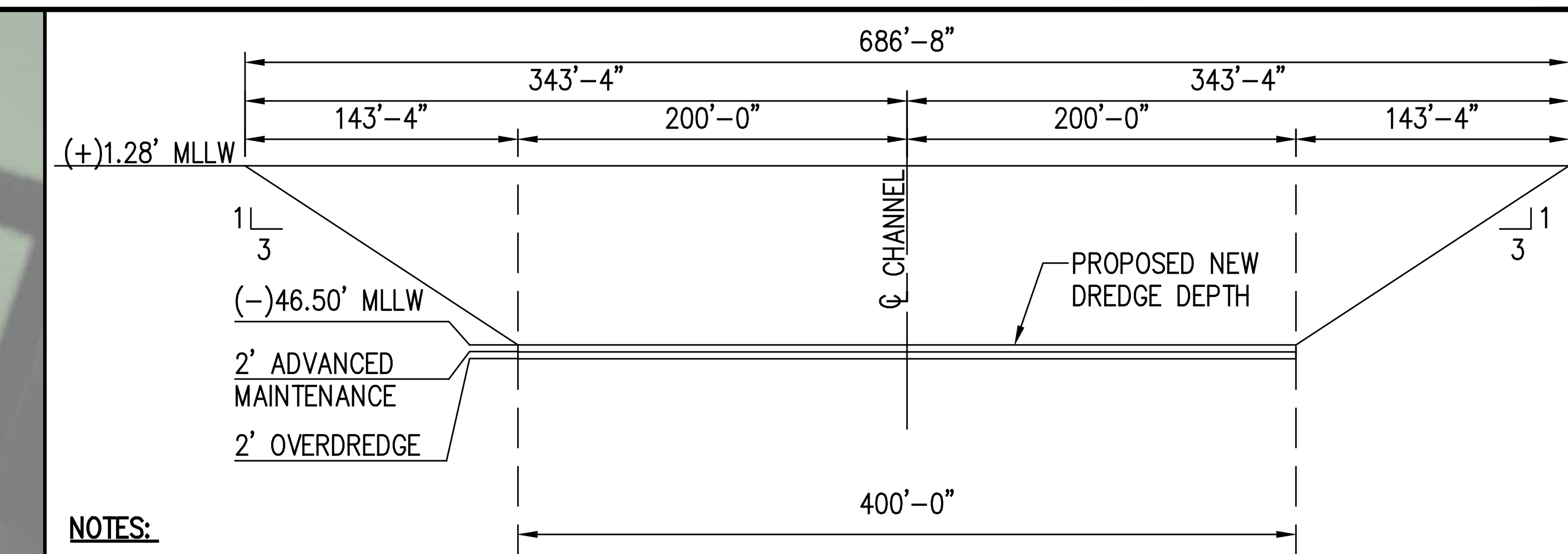
CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE A
CROSS SECTIONS

SHEET NO.
X3A

5/6/2024 4:44 PM

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION B-3\23-07-GA1B.DWG



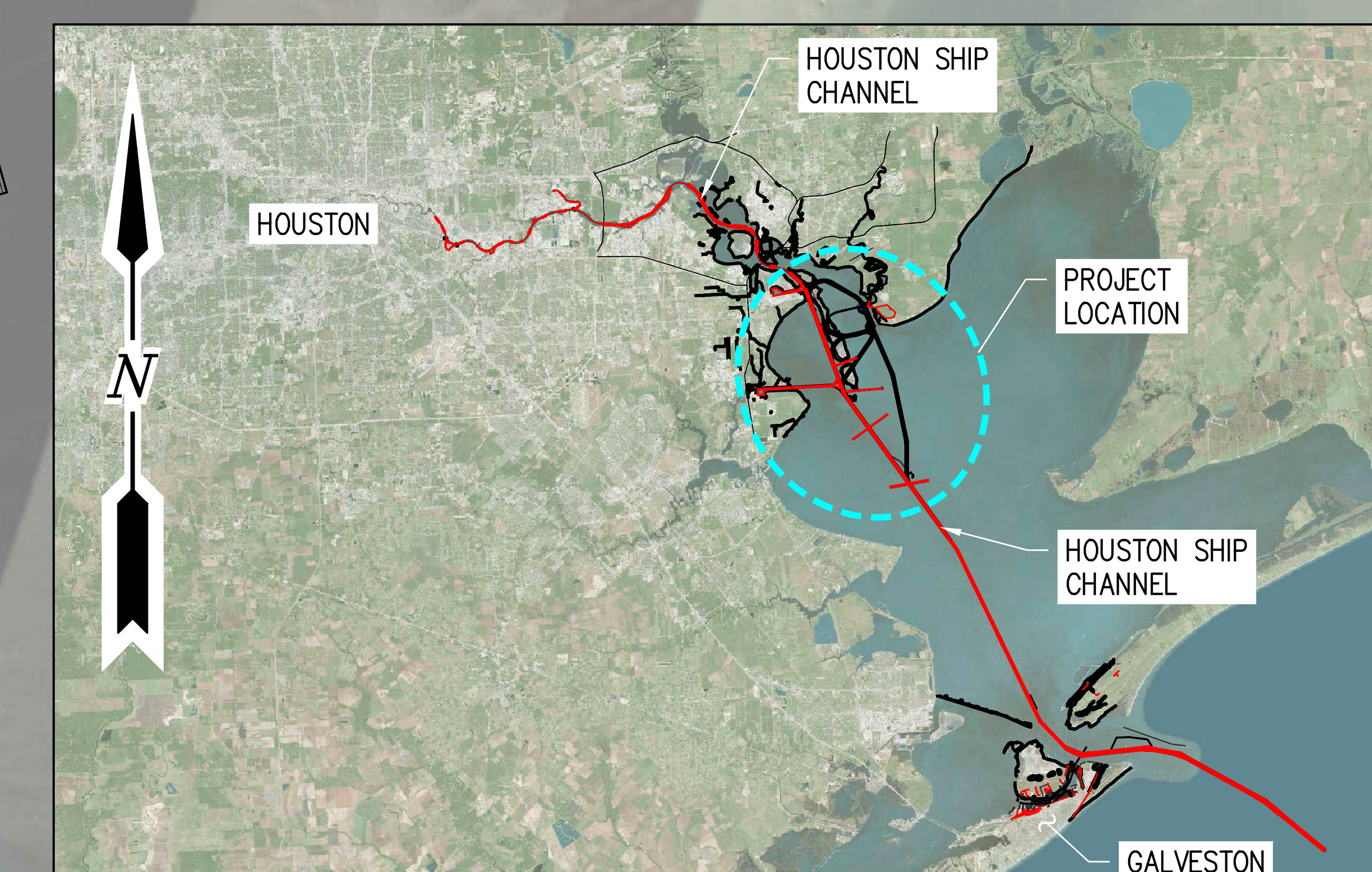


NOTES:

1. DESIGN VESSEL LOA = 1200 FEET AND BEAM = 158 FEET.
2. SLOPES ARE TO BE CONFIRMED.
3. MEAN HIGH WATER = EL.(+)1.28' MLLW.

TYPICAL CROSS SECTION

SCALE: N.T.S.



ALTERNATIVE ROUTE B
GENERAL ARRANGEMENT & SITE PLAN

SCALE: 1" = 2000'

2000 0 1000 2000 4000 (IN FEET)

PRELIMINARY
APRIL 24, 2024

LOCATION MAP

SCALE: 1"= 5 MILES

8 0 4 8 16 (IN MILES)

LANIER & ASSOCIATES
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LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

REV	DATE	BY	DESCRIPTION
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REV	DATE	BY	DESCRIPTION
C	04/24/24	CSG	UPDATED BEAM LENGTH
B	01/17/24	CSG	ADDED ADDITIONAL DMPAS
A	11/01/23	CSG	PRELIMINARY

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CHECK DLC
APPR'D RRM
JOB NO 11612

CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE B
GENERAL ARRANGEMENT & SITE PLAN

SHEET NO.
GA1B

NOTES:

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5. SEE DRAWING GA1B FOR SITE MAP.

LANIER & ASSOCIATES
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VF-185 LSF-10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE B
STA. 2000+00 TO 2060+00

SHEET NO.
C1B

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ALTERNATIVE ACCESS ROUTE B 2060+00 TO 2105+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
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NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE B
STA. 2060+00 TO 2105+00

SHEET NO.
C2B

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION B-3\23-07-C1B-C4B.DWG

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NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE B
STA. 2105+00 TO 2185+00

SHEET NO.
C3B

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ALTERNATIVE ACCESS ROUTE B 2185+00 TO 2220+12

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

5/6/2024 4:46 PM

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION B-3\23-07-C1B-C4B.DWG

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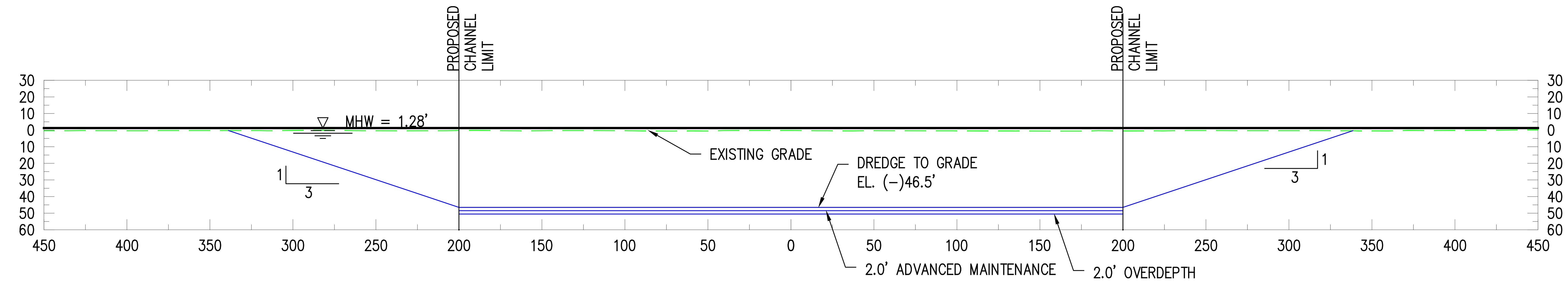
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE B
STA. 2185+00 TO 2220+12

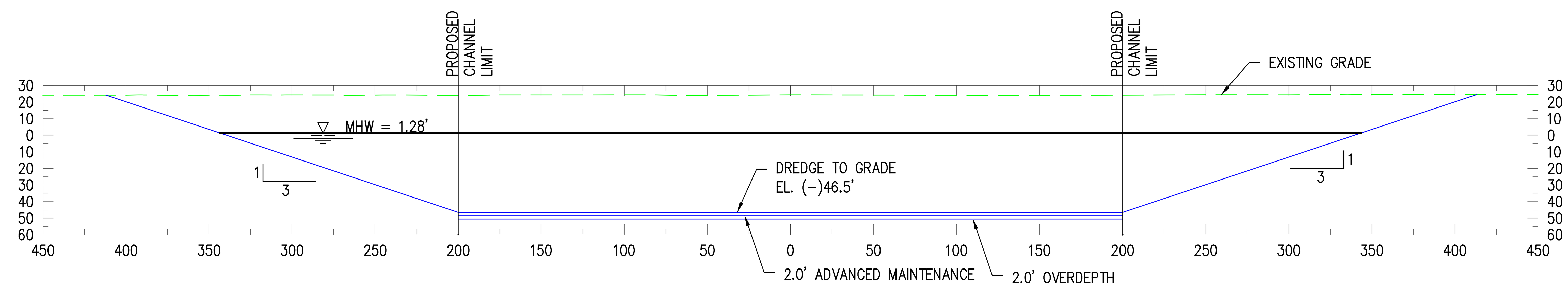
SHEET NO.
C4B



ALTERNATIVE ACCESS ROUTE B STA. 2085+00

SCALE: 1" = 50'

C2B



ALTERNATIVE ACCESS ROUTE B STA. 2060+00

SCALE: 1" = 50'

C2B

ALTERNATIVE ACCESS ROUTE B STA. 2030+00

SCALE: 1" = 50'

C1B

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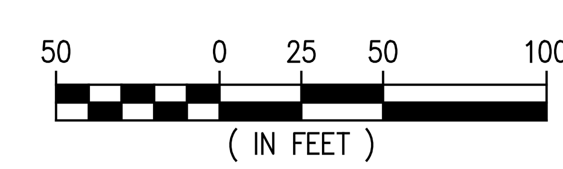

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NOVEMBER 1, 2023

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ALTERNATIVE ROUTE B
CROSS SECTIONS

SHEET NO.
X1B

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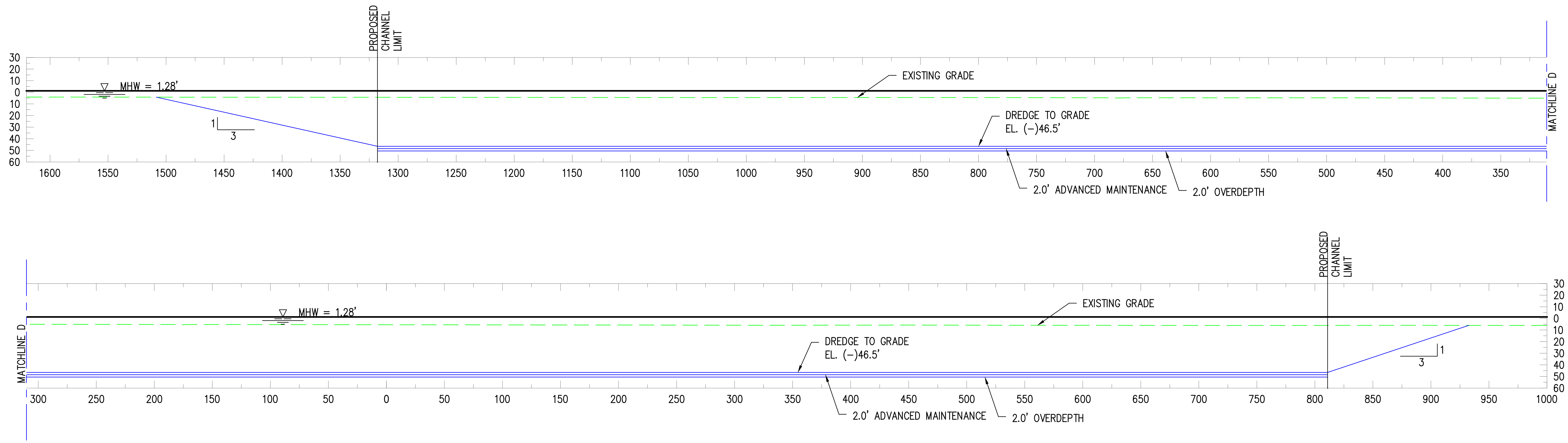
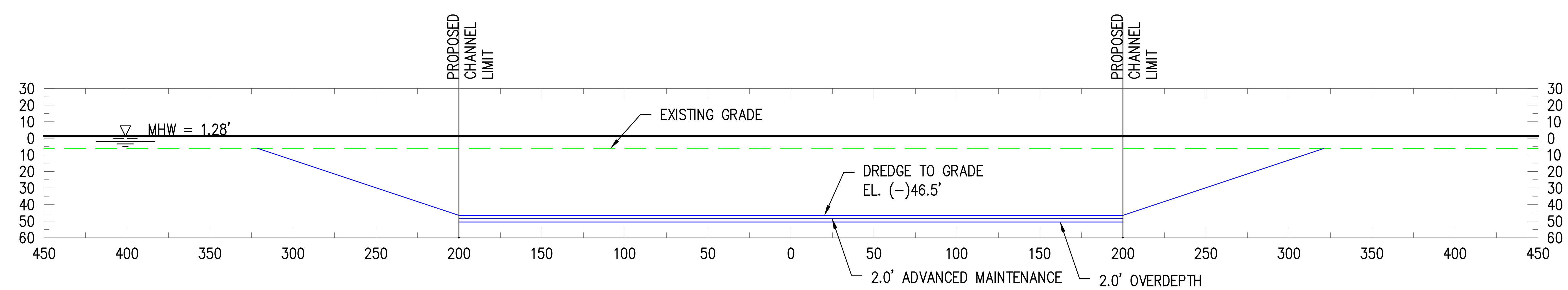


ALTERNATIVE ACCESS ROUTE B STA. 2155+00

SCALE: 1" = 50'

C3B



ALTERNATIVE ACCESS ROUTE B STA. 2135+00

SCALE: 1" = 50'

C3B

NOTES:

1. HYDROGRAPHIC SURVEY PERFORMED BY LANIER & ASSOCIATES ON JUNE 26 THROUGH 28, 2023.
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4. DATUM FOR THE WATER SURFACE AT THE TIME OF THE SURVEY WAS PROVIDED BY THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) MORGAN'S POINT TIDE GAGE, ID 87706113.
5. SIDE SLOPE ARE TO BE CONFIRMED.

50 0 25 50 100
(IN FEET)

PRELIMINARY
NOVEMBER 1, 2023

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

REV	DATE	BY	DESCRIPTION
*			

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A	11/01/23	CSG	PRELIMINARY

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DATE OCT. '23
SHT SIZE 22"x34"
DESIGN *
DRAWN PJC
CHECK TRD
APPR'D RRM
JOB NO 11612

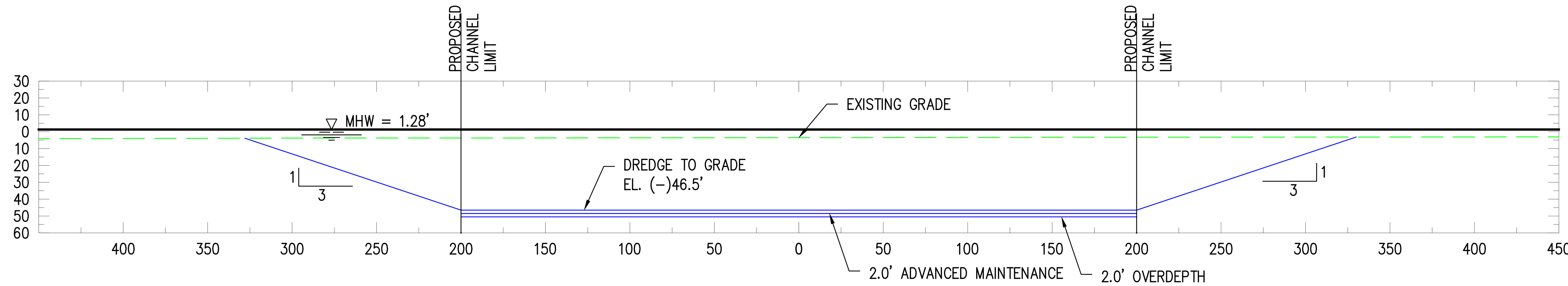
CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE B
CROSS SECTIONS

SHEET NO.
X2B

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION B-3\23-07-X1B-X3B.DWG

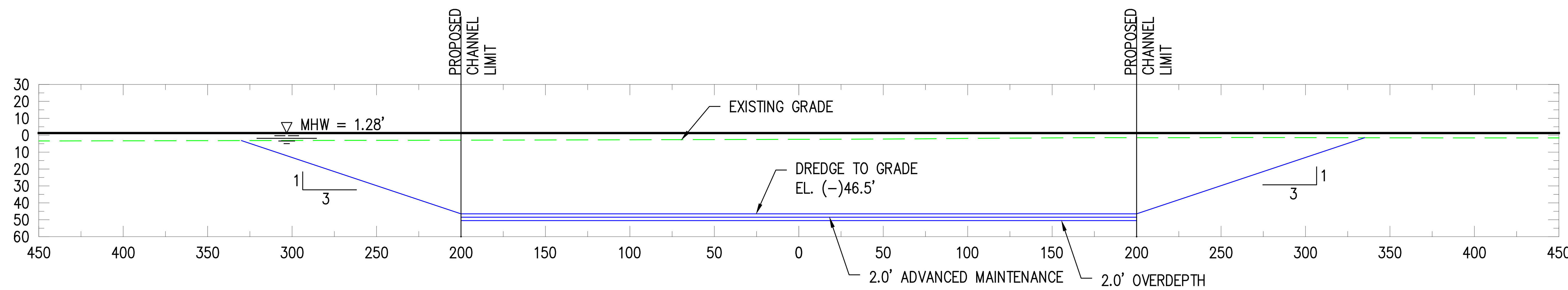
5/6/2024 4:46 PM



ALTERNATIVE ACCESS ROUTE B STA. 2215+00

SCALE: 1" = 50'

C4B



ALTERNATIVE ACCESS ROUTE B STA. 2193+00

SCALE: 1" = 50'

C4B

ALTERNATIVE ACCESS ROUTE B STA. 2167+00

SCALE: 1" = 50'

C3B

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5. SIDE SLOPE ARE TO BE CONFIRMED.

50 0 25 50 100
(IN FEET)

PRELIMINARY
NOVEMBER 1, 2023

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
LA: EF−1120 TX: F−2981
VF−185 LSF−10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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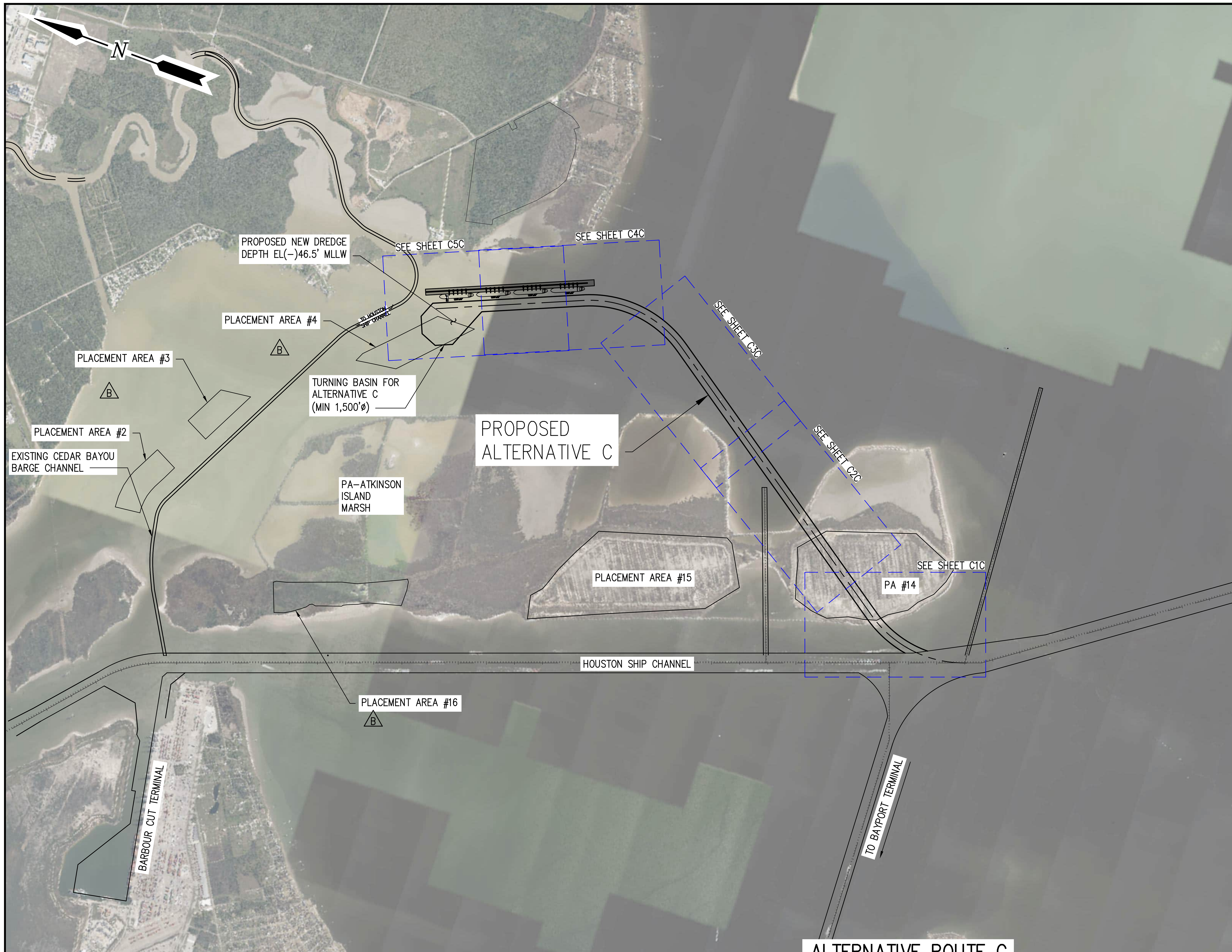
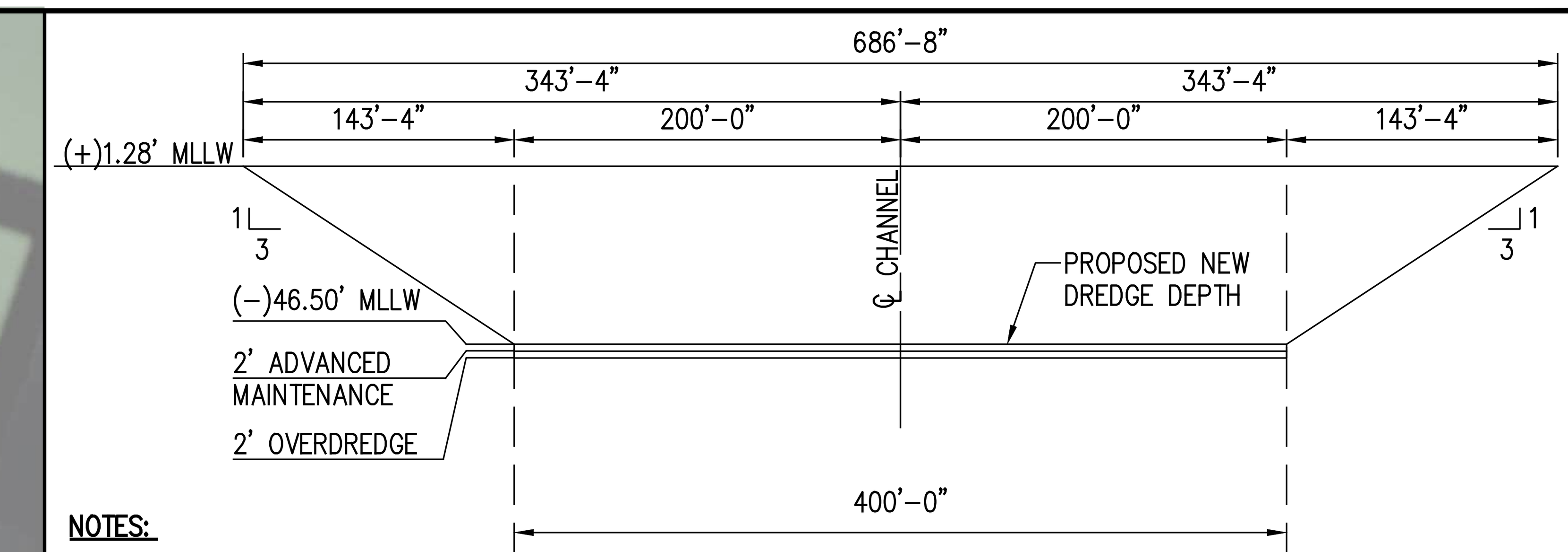
CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE B
CROSS SECTIONS

SHEET NO.
X3B

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION B-3\23-07-X1B-X3B.DWG



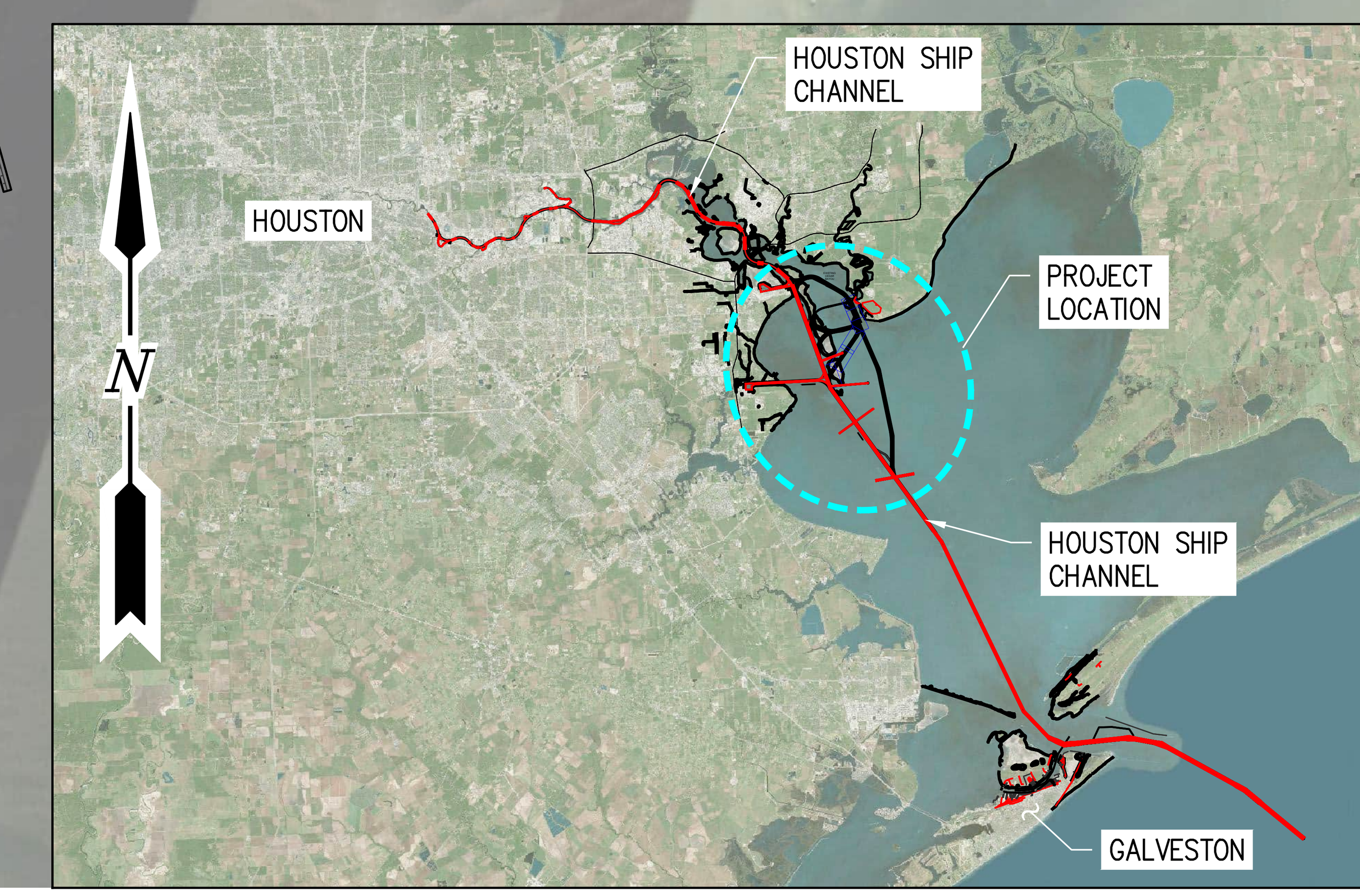


NOTES:

1. DESIGN VESSEL LOA = 1200 FEET AND BEAM = 158 FEET. C
2. SLOPES ARE TO BE CONFIRMED.
3. MEAN HIGH WATER = EL.(+)1.28' MLLW.

TYPICAL CROSS SECTION

SCALE: N.T.S.



ALTERNATIVE ROUTE C

GENERAL ARRANGEMENT & SITE PLAN

SCALE: 1" = 2000'

2000 0 1000 2000 4000 (IN FEET)

PRELIMINARY

APRIL 24, 2024

LOCATION MAP

SCALE: 1"= 5 MILES

8 0 4 8 16 (IN MILES)

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
LA: EF–1120 TX: F–2981
VF–185 LSF–10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

REV	DATE	BY	DESCRIPTION
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REV	DATE	BY	DESCRIPTION
C	04/24/24	CSG	UPDATED BEAM LENGTH
B	01/17/24	CSG	ADDED ADDITIONAL DMPAS
A	11/01/23	CSG	PRELIMINARY

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CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ACCESS ROUTE C
GENERAL ARRANGEMENT & SITE PLAN

SHEET NO.
GA1C

5/6/2024 4:47 PM

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION C\23–07–GA1C.DWG

5/6/2024 4:47 PM

NOTES:

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5. SEE DRAWING GA1C FOR SITE MAP.

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
LA: EF-1120 TX: F-2981
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NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE C
STA. 3000+00 TO 3055+00

SHEET NO.
C1C

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION C\23-07-C1C-C4C.DWG

5/6/2024 4:47 PM

ALTERNATIVE ACCESS ROUTE C 3065+00 TO 3125+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

NOTES:

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CONSULTING ENGINEERS, INC.
LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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JOB NO 11612

CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE C
STA. 3055+00 TO 3115+00

SHEET NO.
C2C

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION C\23-07-C1C-C4C.DWG

ALTERNATIVE ACCESS ROUTE C 3115+00 TO 3170+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

NOTES:

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NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE C
STA. 3115+00 TO 3170+00

SHEET NO.
C3C

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5. SEE DRAWING GA1C FOR SITE MAP.

ALTERNATIVE ACCESS ROUTE C 3170+00 TO 3230+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

PRELIMINARY
NOVEMBER 1, 2023

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION C\23-07-C1C-C4C.DWG

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CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE C
STA. 3170+00 TO 3230+00

SHEET NO.
C4C

ALTERNATIVE ACCESS ROUTE C 3230+00 TO 3248+82

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

PRELIMINARY
NOVEMBER 1, 2023

NOTES:

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LANIER & ASSOCIATES
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NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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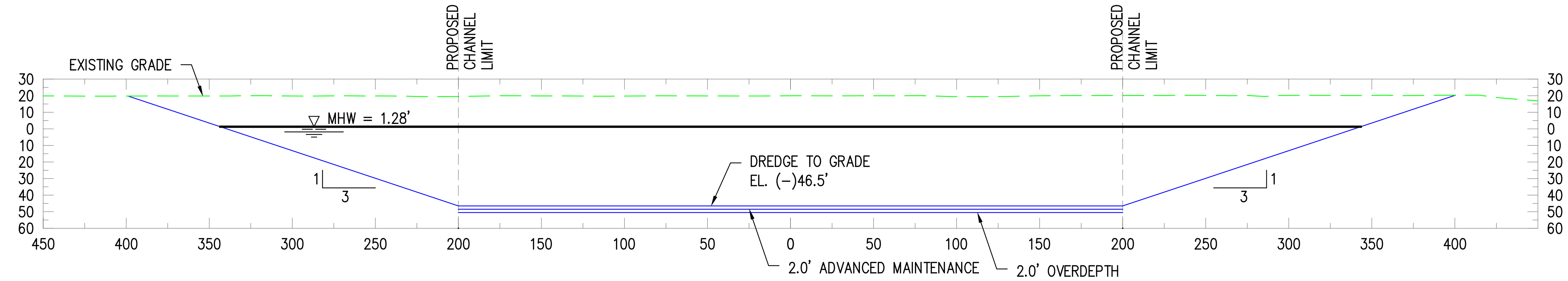
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE C
STA. 3230+00 TO 3248+82

SHEET NO.
C5C

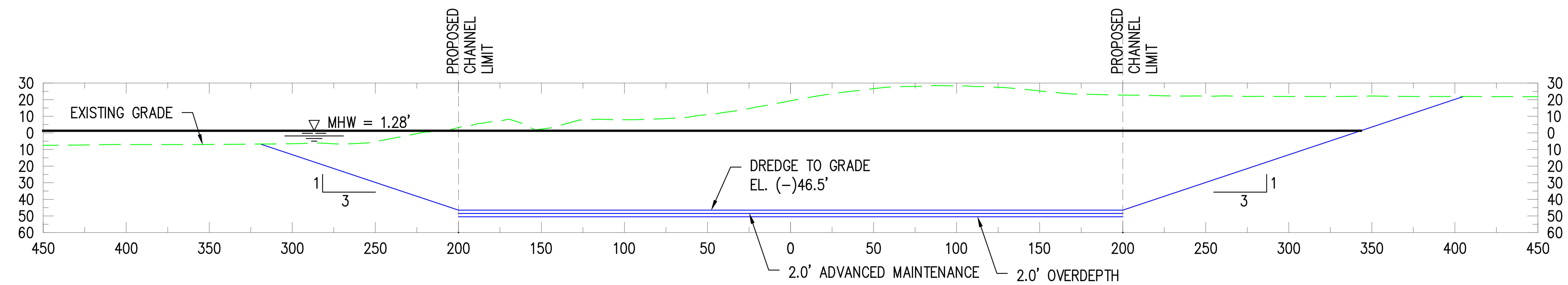
5/6/2024 4:49 PM
J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION C\23-07-C1C-C4C.DWG



ALTERNATIVE ACCESS ROUTE C STA. 3055+00

SCALE: 1" = 50'

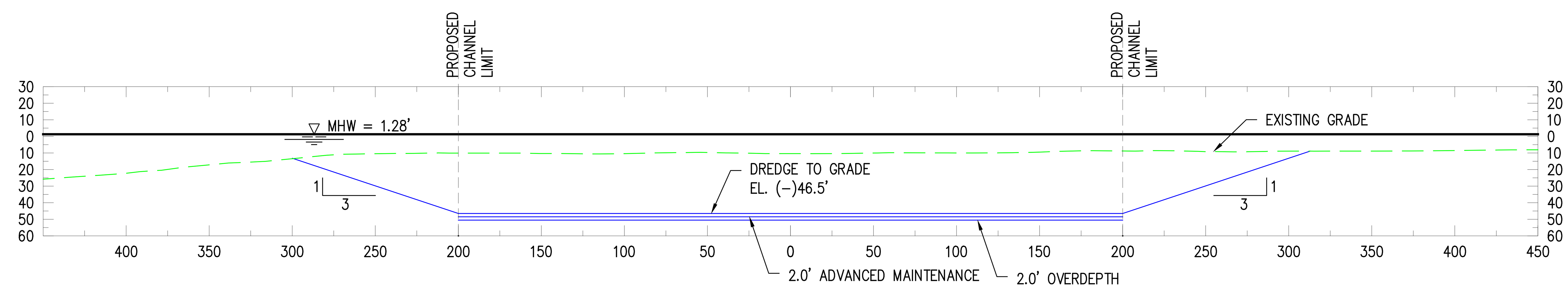
C2C



ALTERNATIVE ACCESS ROUTE C STA. 3035+00

SCALE: 1" = 50'

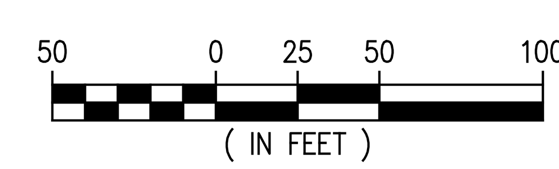
C1C



ALTERNATIVE ACCESS ROUTE C STA. 3025+00

SCALE: 1" = 50'

C1C



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NOVEMBER 1, 2023

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NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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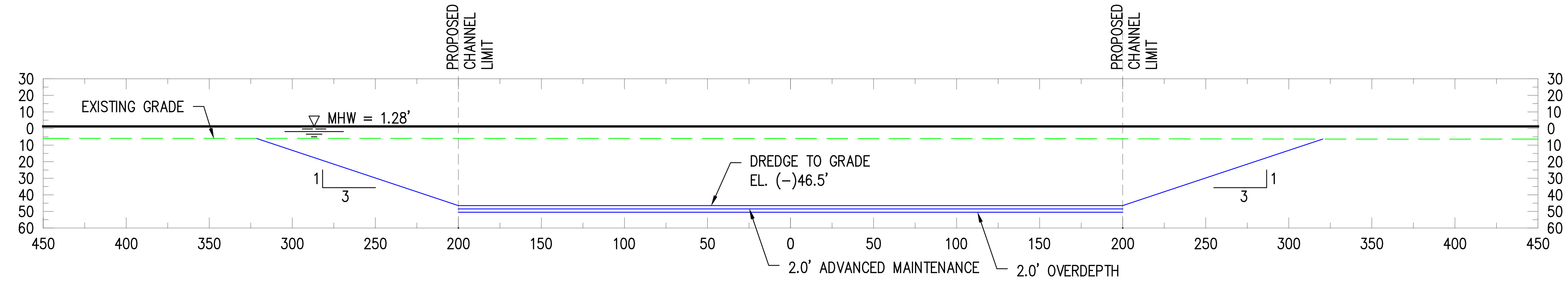
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE C
CROSS SECTIONS

SHEET NO.
X1C

5/6/2024 4:49 PM

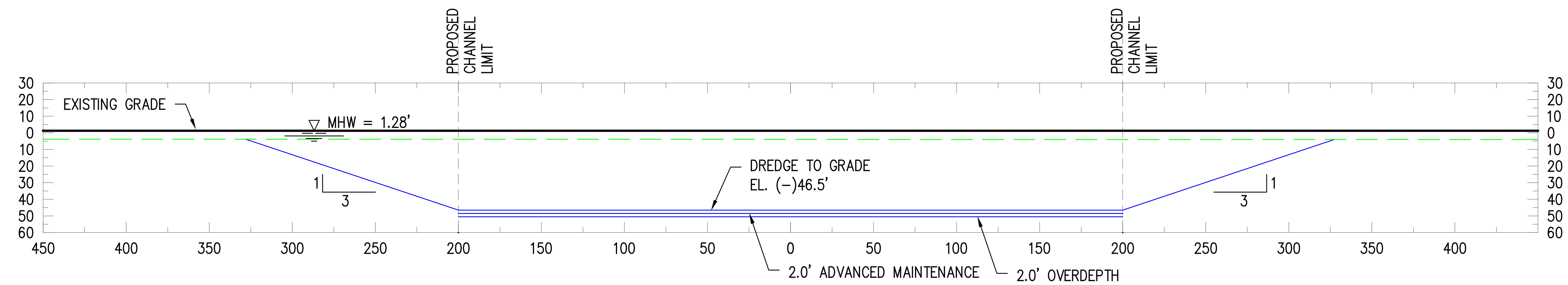


SCALE = 50H:50V

ALTERNATIVE ACCESS ROUTE C STA. 3140+00

SCALE: 1" = 50'

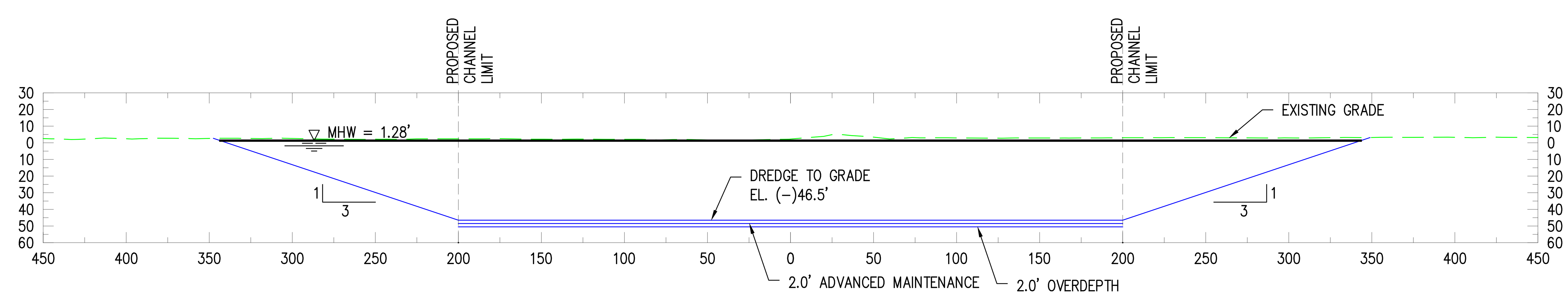
C3C



ALTERNATIVE ACCESS ROUTE C STA. 3090+00

SCALE: 1" = 50'

C2C



ALTERNATIVE ACCESS ROUTE C STA. 3075+00

SCALE: 1" = 50'

C2C

50 0 25 50 100

(IN FEET)

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LANIER & ASSOCIATES
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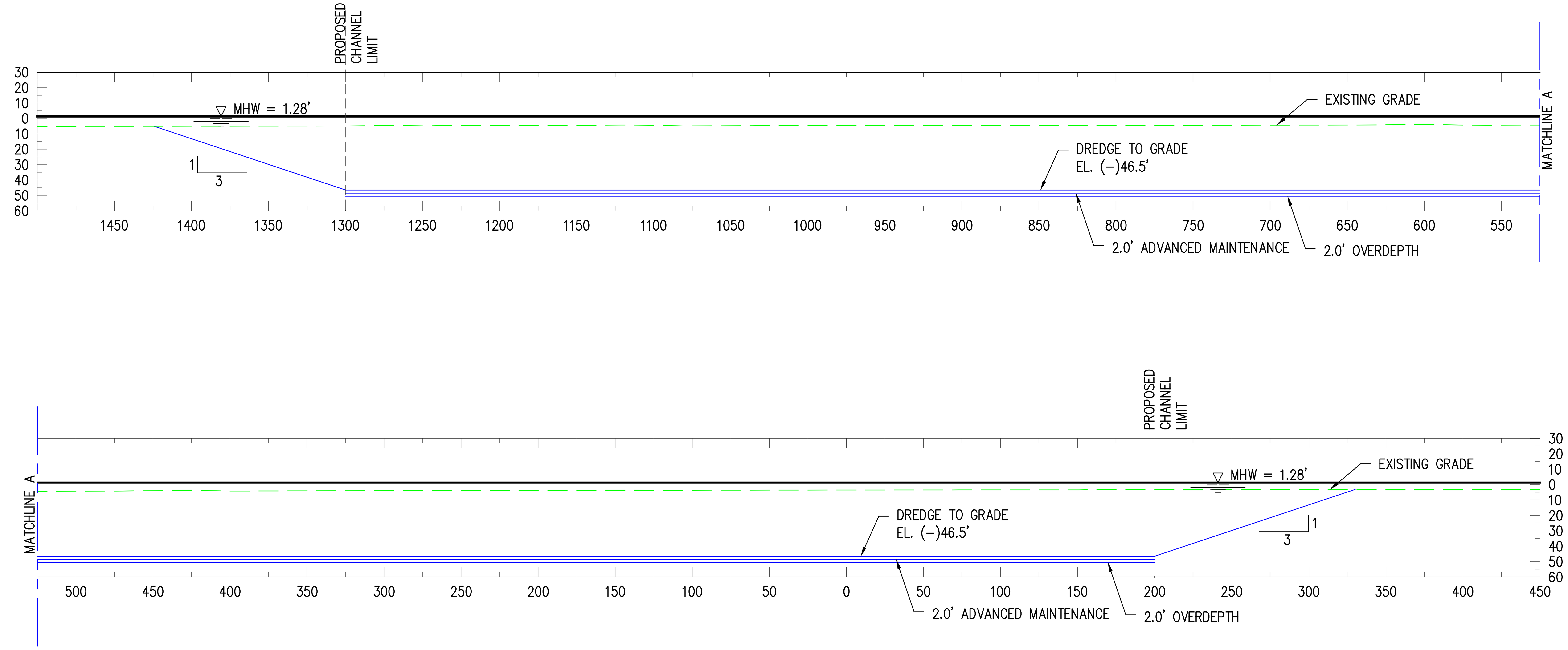
CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE C
CROSS SECTIONS

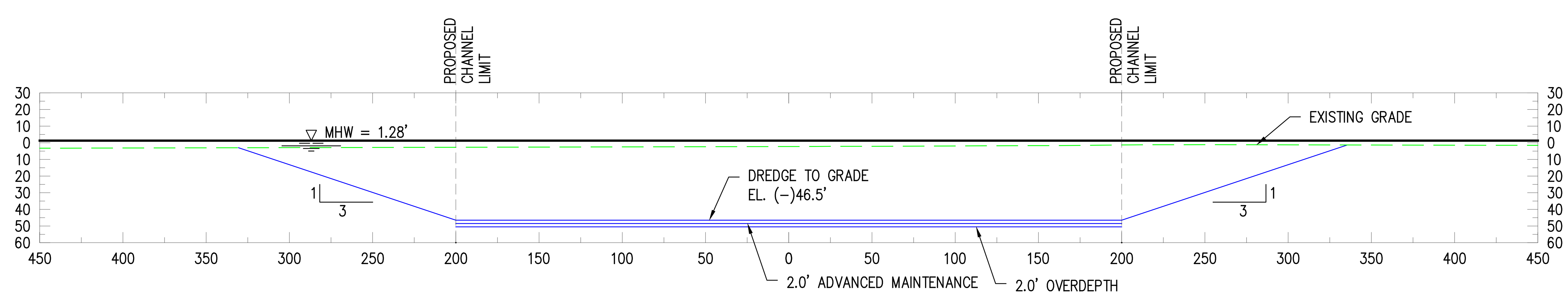
SHEET NO.
X2C



ALTERNATIVE ACCESS ROUTE C STA. 3245+00

SCALE: 1" = 50'

C4C



ALTERNATIVE ACCESS ROUTE C STA. 3220+00

SCALE: 1" = 50'

C4C

50 0 25 50 100

(IN FEET)

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SHT SIZE 22"x34"
DESIGN *
DRAWN PJC
CHECK TRD
APPR'D RRM
JOB NO 11612

CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE C
CROSS SECTIONS

SHEET NO.
X3C

ALTERNATIVE ROUTE D
GENERAL ARRANGEMENT & SITE PLAN

SCALE: 1" = 2000'

2000 0 1000 2000 4000 (IN FEET)

PRELIMINARY
APRIL 24, 2024

LOCATION MAP

SCALE: 1"= 5 MILES

8 0 4 8 16 (IN MILES)

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
LA: EF−1120 TX: F−2981
VF−185 LSF−10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

REV	DATE	BY	DESCRIPTION
C	04/24/24	CSG	UPDATED BEAM LENGTH
B	01/17/24	CSG	ADDED ADDITIONAL DMPAS
A	11/01/23	CSG	PRELIMINARY

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DATE OCT. '23
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DESIGN *
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CHECK DLC
APPR'D RRM
JOB NO 11612

CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE D
GENERAL ARRANGEMENT & SITE PLAN

SHEET NO.
GA1D

5/6/2024 4:49 PM
J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION D\23−07−GA1D.DWG

5/6/2024 4:49 PM

ALTERNATIVE ACCESS ROUTE D 4000+00 TO 4065+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

NOTES:

1. HYDROGRAPHIC SURVEY PERFORMED BY LANIER & ASSOCIATES ON JUNE 26 THROUGH 28, 2023.
2. HORIZONTAL DATUM REFERENCED TO TEXAS STATE PLANE (SOUTH CENTRAL) NAD 83.
3. ALL ELEVATIONS ARE EXPRESSED IN FEET AND TENTHS AND ARE REFERENCED TO MEAN LOWER LOW WATER (M.L.L.W.) DATUM
4. DATUM FOR THE WATER SURFACE AT THE TIME OF THE SURVEY WAS PROVIDED BY THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) MORGAN'S POINT TIDE GAGE, ID 87706113.
5. SEE DRAWING GA1D FOR SITE MAP.

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

REV	DATE	BY	DESCRIPTION
*			

REV	DATE	BY	DESCRIPTION
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CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE D
STA. 4000+00 TO 4065+00

SHEET NO.
C1D

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION D\23-07-C1D-C8D.DWG

5/6/2024 4:50 PM

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ALTERNATIVE ACCESS ROUTE D 4065+00 TO 4130+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
LA: EF–1120 TX: F–2981
VF–185 LSF–10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

REV	DATE	BY	DESCRIPTION
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CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE D
STA. 4065+00 TO 4130+00

SHEET NO.
C2D

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION D\23-07-C1D-C8D.DWG

NOTES:

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5. SEE DRAWING GA1D FOR SITE MAP.

ALTERNATIVE ACCESS ROUTE D 4130+00 TO 4190+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

PRELIMINARY
NOVEMBER 1, 2023

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
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CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE D
STA. 4130+00 TO 4190+00

SHEET NO.
C3D

5/6/2024 4:51 PM

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION D\23-07-C1D-C8D.DWG

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ALTERNATIVE ACCESS ROUTE D 4190+00 TO 4250+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

PRELIMINARY
NOVEMBER 1, 2023

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NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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JOB NO 11612

CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE D
STA. 4190+00 TO 4250+00

SHEET NO.
C4D

NOTES:

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ALTERNATIVE ACCESS ROUTE D 4250+00 TO 4310+00

SCALE: 1" = 200'

200 0 100 200 400 (IN FEET)

5/6/2024 4:51 PM

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION D\23-07-C1D-C8D.DWG

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CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE D
STA. 4250+00 TO 4310+00

SHEET NO.
C5D

5/6/2024 4:51 PM
J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION D\23-07-C1D-C8D.DWG

ALTERNATIVE ACCESS ROUTE D 4310+00 TO 4370+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

NOTES:

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CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE D
STA. 4310+00 TO 4370+00

SHEET NO.
C6D

ALTERNATIVE ACCESS ROUTE D 4370+00 TO 4430+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

NOTES:

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5. SEE DRAWING GA1D FOR SITE MAP.

LANIER & ASSOCIATES
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VF-185 LSF-10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE D
STA. 4370+00 TO 4430+00

SHEET NO.
C7D

NOTES:

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ALTERNATIVE ACCESS ROUTE D 4430+00 TO 4483+73

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

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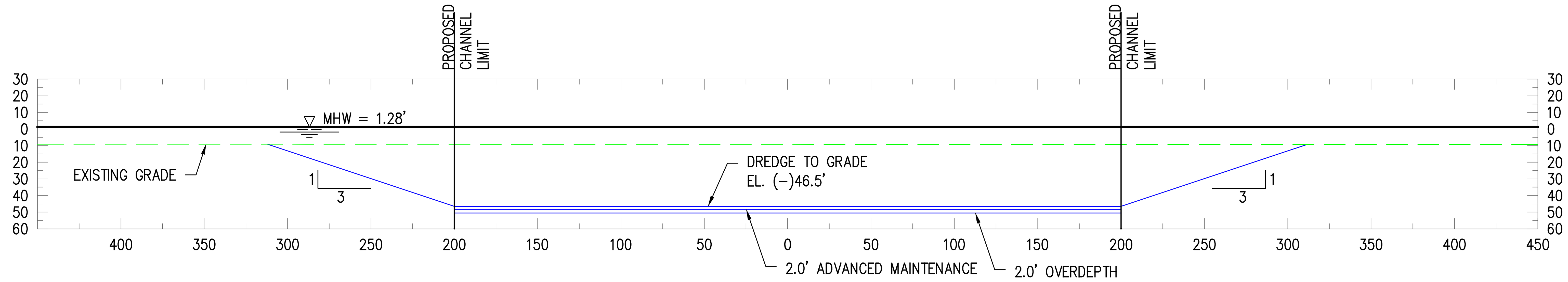
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE D
STA. 4430+00 TO 4483+73

SHEET NO.
C8D

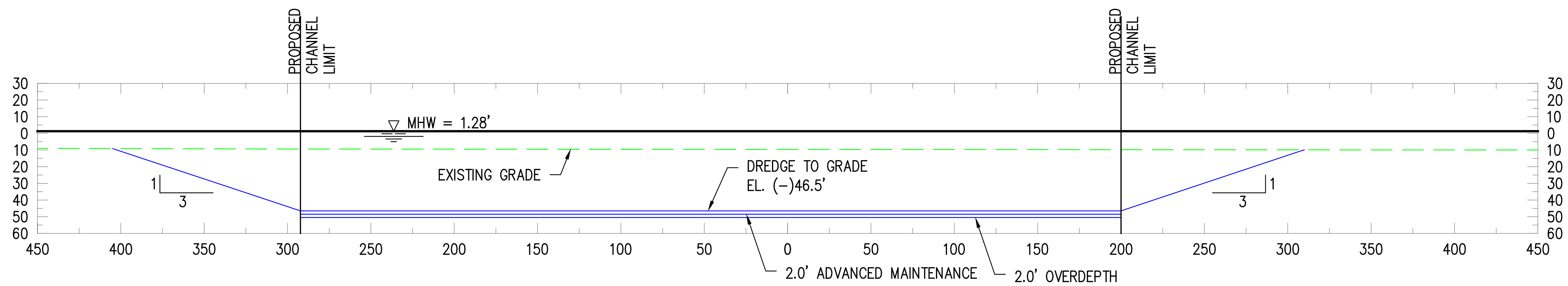
5/6/2024 4:53 PM



ALTERNATIVE ACCESS ROUTE D STA. 4273+00

SCALE: 1" = 50'

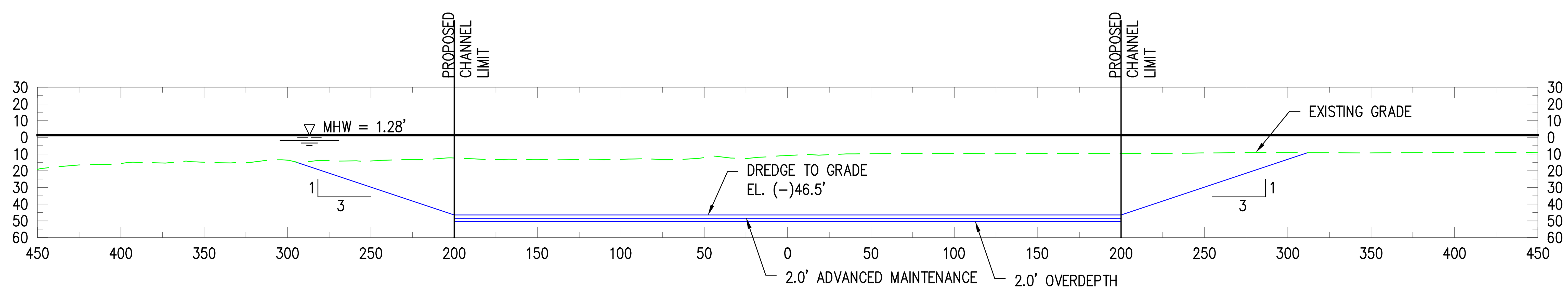
C5D



ALTERNATIVE ACCESS ROUTE D STA. 4113+00

SCALE: 1" = 50'

C2D



ALTERNATIVE ACCESS ROUTE D STA. 4025+00

SCALE: 1" = 50'

C1D

NOTES:

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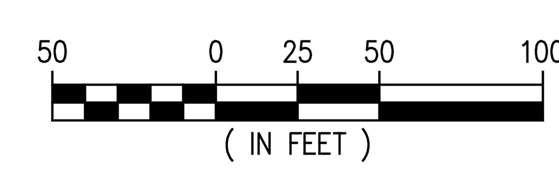

PRELIMINARY
NOVEMBER 1, 2023

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION D\23-07-X1D-X3D.DWG

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
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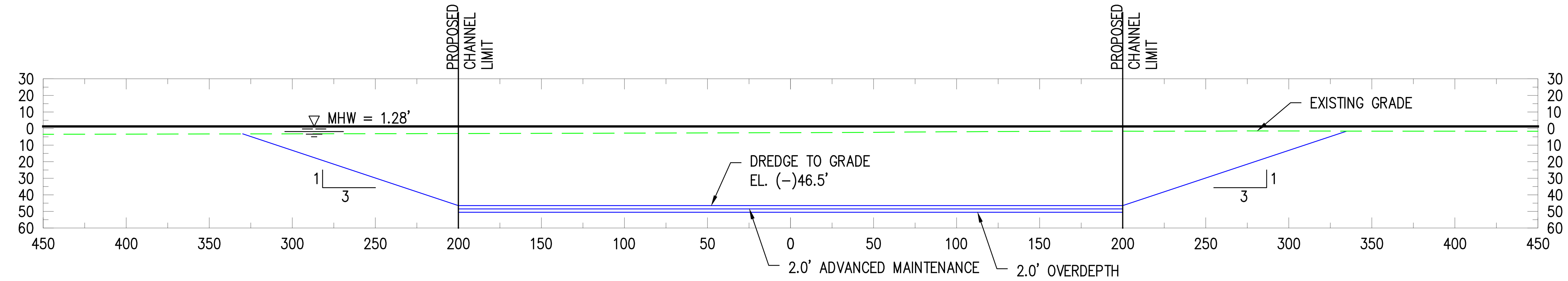
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE D
CROSS SECTIONS

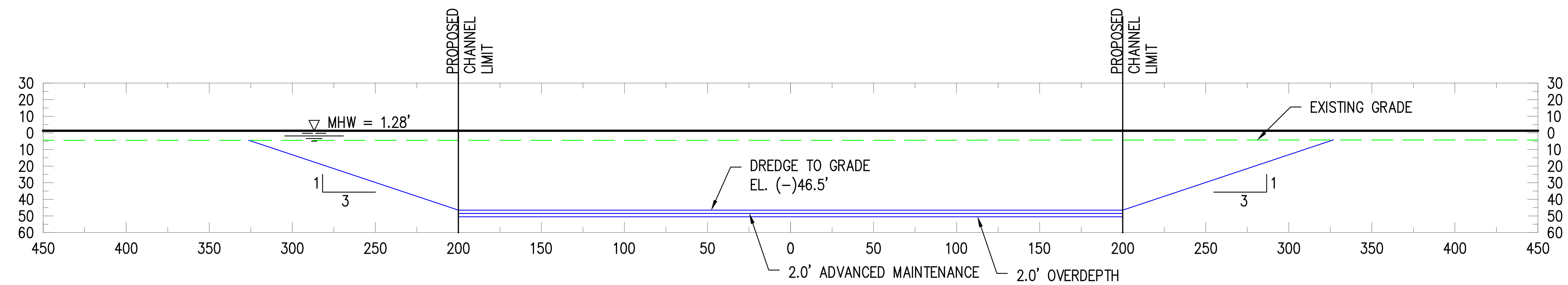
SHEET NO.
X1D

5/6/2024 4:53 PM



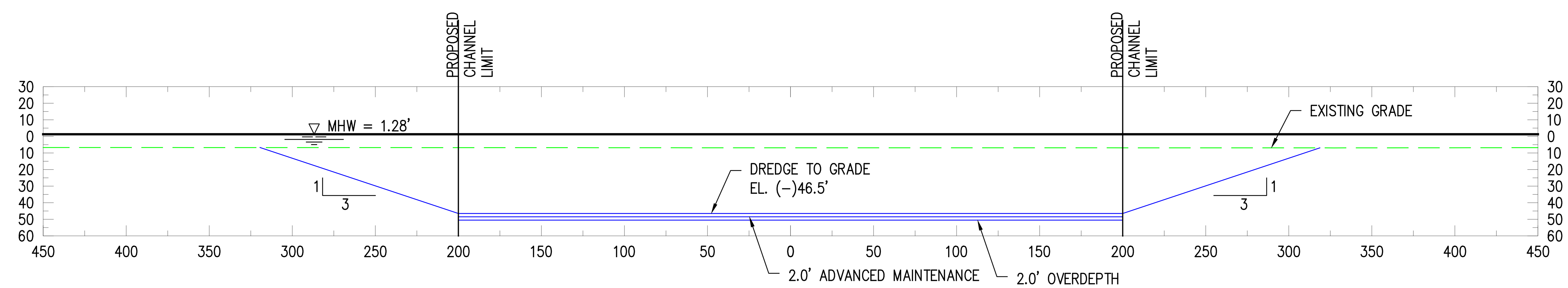
ALTERNATIVE ACCESS ROUTE D STA. 4457+00 — C8D

SCALE: 1" = 50'



ALTERNATIVE ACCESS ROUTE D STA. 4430+00 — C7D

SCALE: 1" = 50'



ALTERNATIVE ACCESS ROUTE D STA. 4392+00 — C7D

SCALE: 1" = 50'

NOTES:

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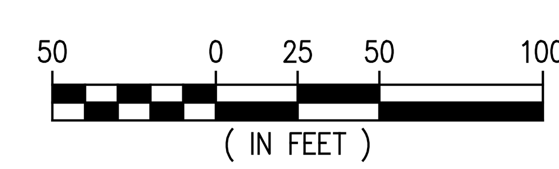

PRELIMINARY
NOVEMBER 1, 2023

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CONSULTING ENGINEERS, INC.
LA: EF-1120 TX: F-2981
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NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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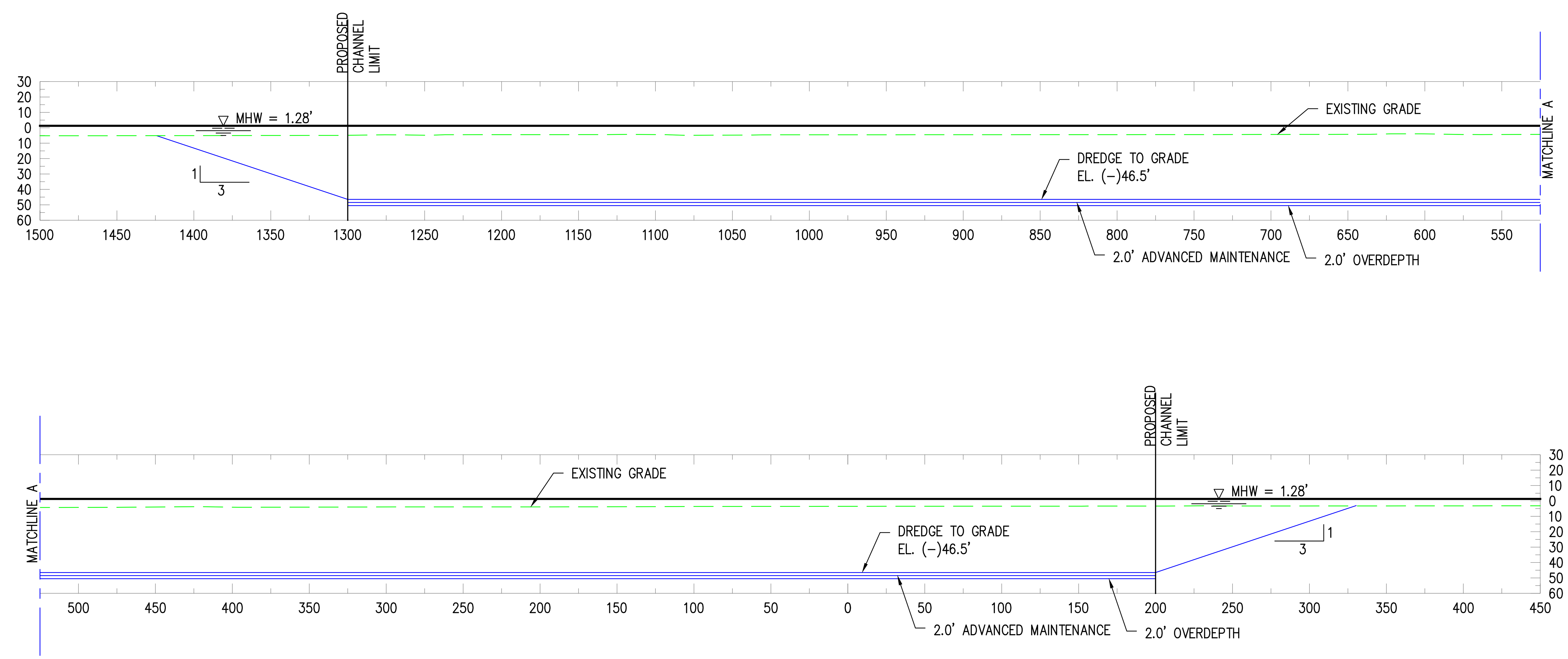
CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE D
CROSS SECTIONS

SHEET NO.
X2D

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION D\23-07-X1D-X3D.DWG



ALTERNATIVE ACCESS ROUTE D STA. 4480+00

SCALE: 1" = 50'

C8D

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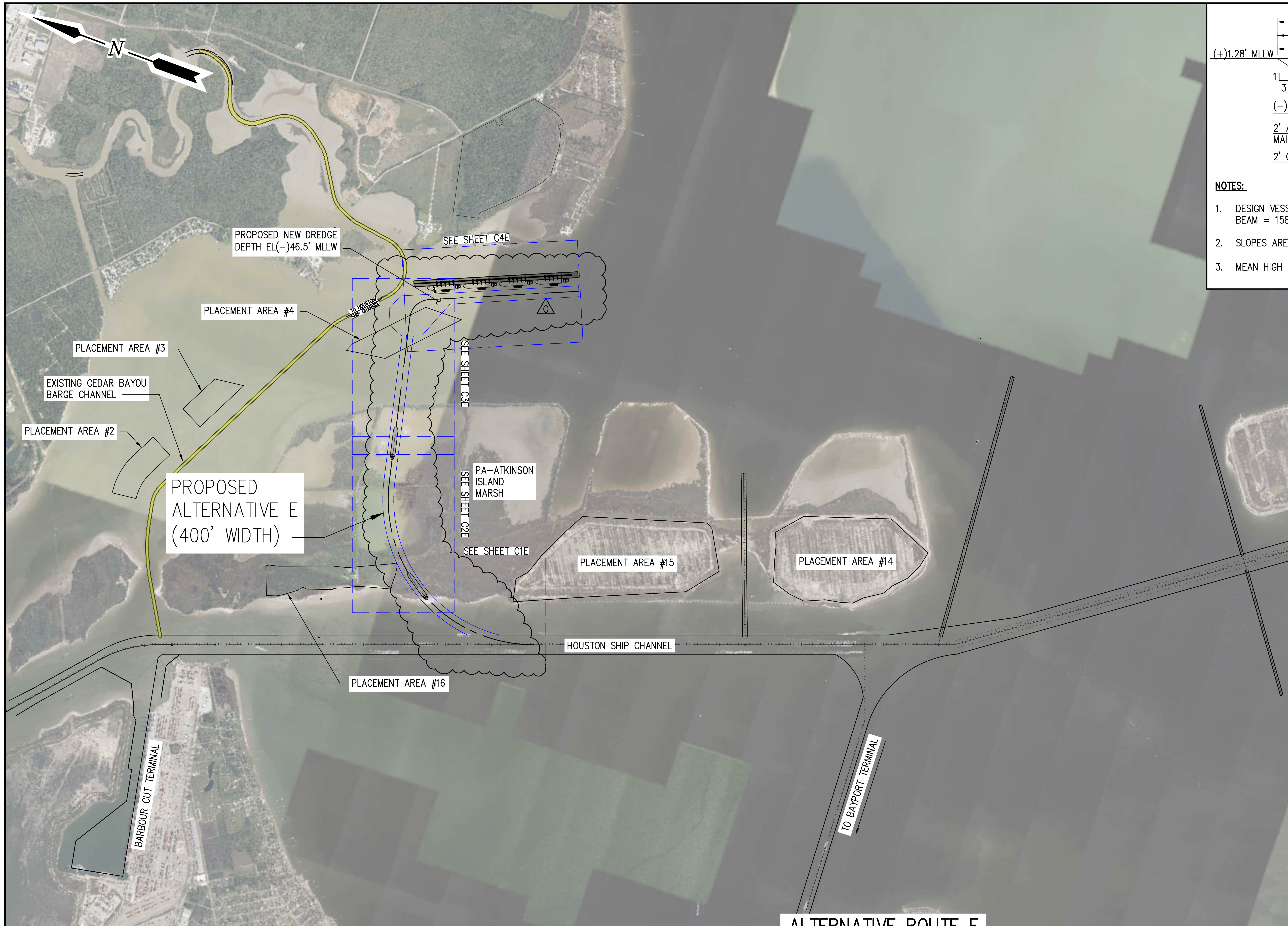
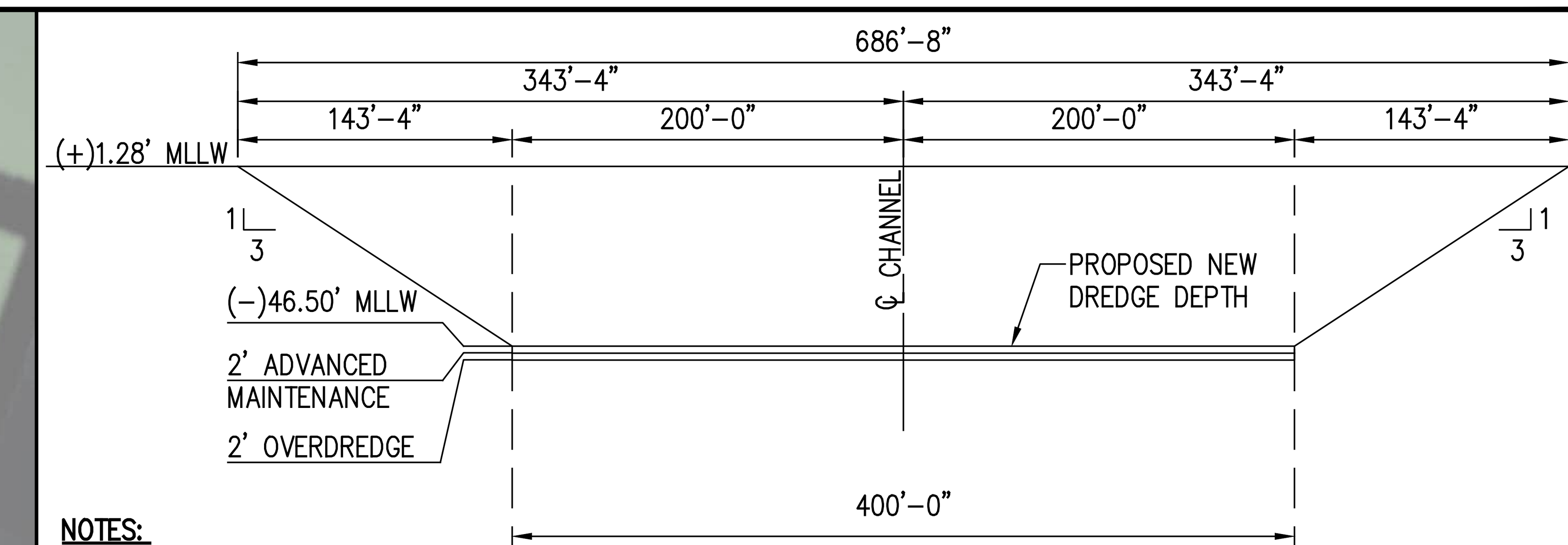
CHECK TRD
APPR'D RRM
JOB NO 11612

CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE D
CROSS SECTIONS

SHEET NO.
X3D



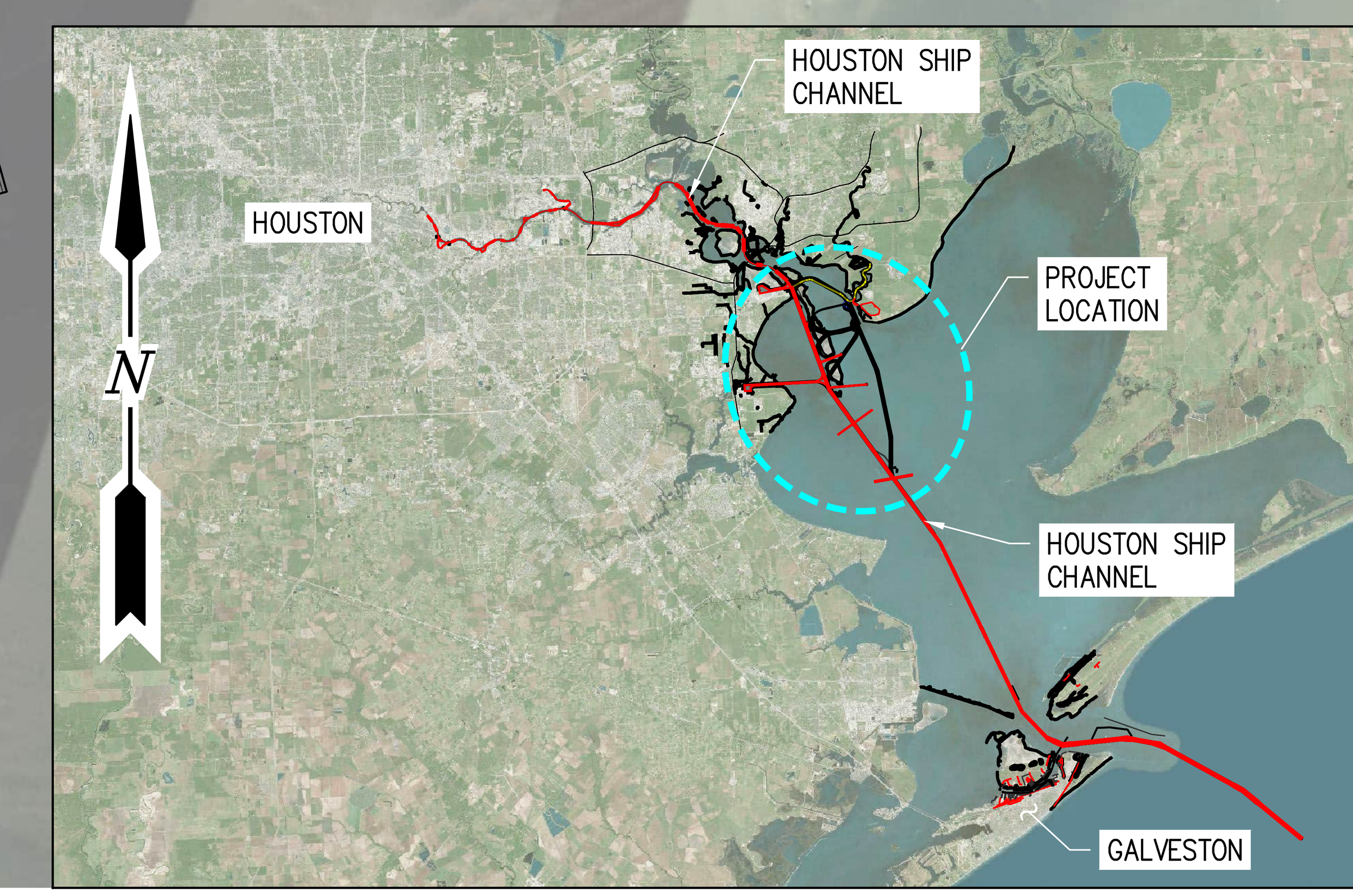


NOTES:

1. DESIGN VESSEL LOA = 1200 FEET AND BEAM = 158 FEET. B
2. SLOPES ARE TO BE CONFIRMED.
3. MEAN HIGH WATER = EL.(+)1.28' MLLW.

TYPICAL CROSS SECTION

SCALE: N.T.S.



ALTERNATIVE ROUTE E
GENERAL ARRANGEMENT & SITE PLAN

SCALE: 1" = 2000'

2000 0 1000 2000 4000

(IN FEET)

PRELIMINARY
MAY 03, 2024

LOCATION MAP

SCALE: 1"= 5 MILES

8 0 4 8 16

(IN MILES)

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
LA: EF−1120 TX: F−2981
VF−185 LSF−10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

REV	DATE	BY	DESCRIPTION
*			

REV	DATE	BY	DESCRIPTION
C	05/03/24	RRM	UPDATED ALIGNMENT
B	04/24/24	CSG	UPDATED BEAM LENGTH
A	04/04/24	CSG	PRELIMINARY

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DATE DEC. '23
SHT SIZE 22"x34"
DESIGN *
DRAWN PJC
CHECK DLC
APPR'D RRM
JOB NO 11612

CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE E
GENERAL ARRANGEMENT & SITE PLAN

SHEET NO.
GA1E

5/6/2024 4:53 PM

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION E\23-12-GA1E.DWG

NOTES:

1. HYDROGRAPHIC SURVEY PERFORMED BY LANIER & ASSOCIATES ON JUNE 26 THROUGH 28, 2023.
2. HORIZONTAL DATUM REFERENCED TO TEXAS STATE PLANE (SOUTH CENTRAL) NAD 83.
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4. DATUM FOR THE WATER SURFACE AT THE TIME OF THE SURVEY WAS PROVIDED BY THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) MORGAN'S POINT TIDE GAGE, ID 87706113.
5. SEE DRAWING GA1E FOR SITE MAP.

ALTERNATIVE ACCESS ROUTE E 5000+00 TO 5060+00

SCALE: 1" = 200'

200 0 100 200 400 (IN FEET)

PRELIMINARY MAY 03, 2024

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION E\23-12-C1E-C4E.DWG

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CONSULTING ENGINEERS, INC.
LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
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REV	DATE	BY	DESCRIPTION
*			

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B	05/03/24	RRM	UPDATED ALIGNMENT
A	01/11/24	CSG	PRELIMINARY

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DATE DEC. '23
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CHECK TRD
APPR'D RRM
JOB NO 11612

CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE E
STA. 5000+00 TO 5060+00

SHEET NO.
C1E

NOTES:

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5. SEE DRAWING GA1E FOR SITE MAP.

ALTERNATIVE ACCESS ROUTE E 5060+00 TO 5105+00

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

B

5/6/2024 4:54 PM

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION E\23-12-C1E-C4E.DWG

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LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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*			

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DATE OCT. '23
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CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE E
STA. 5060+00 TO 5105+00

SHEET NO.
C2E

5/6/2024 4:54 PM

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION E\23-12-C1E-C4E.DWG

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NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE E
STA. 5105+00 TO 5165+00

SHEET NO.
C3E

ALTERNATIVE ACCESS ROUTE E 5165+00 TO 5215+96

SCALE: 1" = 200'

200 0 100 200 400

(IN FEET)

NOTES:

1. HYDROGRAPHIC SURVEY PERFORMED BY LANIER & ASSOCIATES ON JUNE 26 THROUGH 28, 2023.
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5. SEE DRAWING GA1E FOR SITE MAP.

5/6/2024 4:55 PM

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION E\23-12-C1E-C4E.DWG

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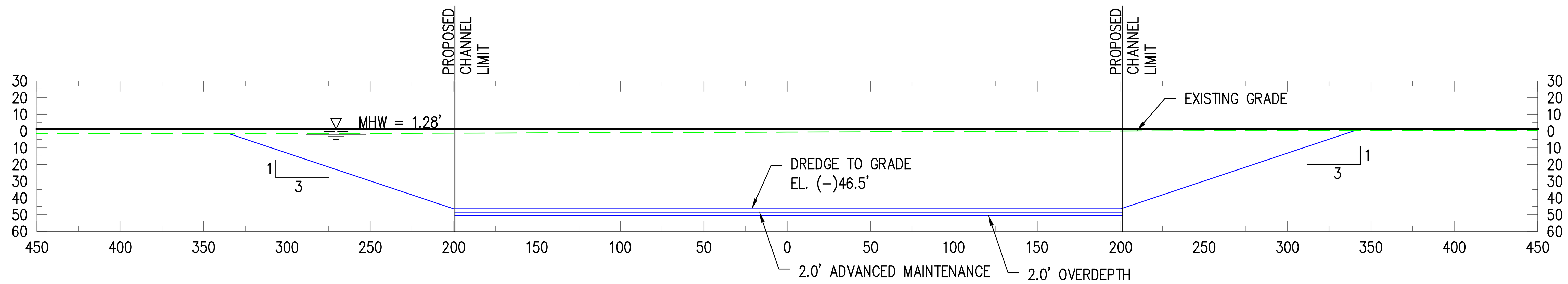
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE E
STA. 5165+00 TO 5215+96

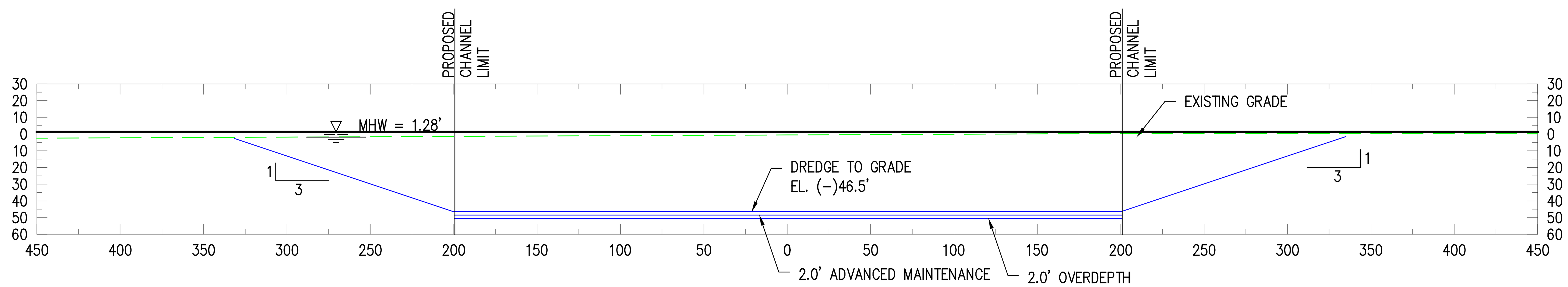
SHEET NO.
C4E



ALTERNATIVE ACCESS ROUTE E STA. 5085+00

SCALE: 1" = 50'

C2E



ALTERNATIVE ACCESS ROUTE E STA. 5060+00

SCALE: 1" = 50'

C2E

ALTERNATIVE ACCESS ROUTE E STA. 5030+00

SCALE: 1" = 50'

C1E

NOTES:

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5. SEE DRAWING GA1E FOR SITE MAP.

50 0 25 50 100
(IN FEET)

PRELIMINARY
MAY 03, 2024

5/6/2024 4:55 PM

J:\11000S\11612 CEDAR BAYOU DEEPENING PERMIT\DRAWINGS\ALTERNATIVE ACCESS ROUTES\OPTION E\23-12-X1E-X3E.DWG

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CONSULTING ENGINEERS, INC.
LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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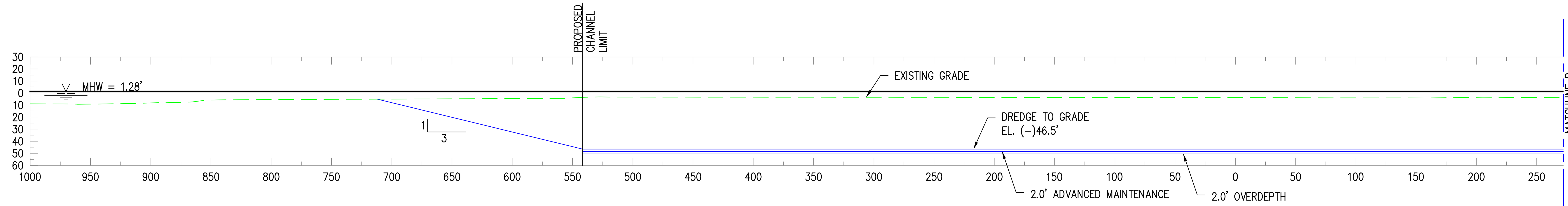
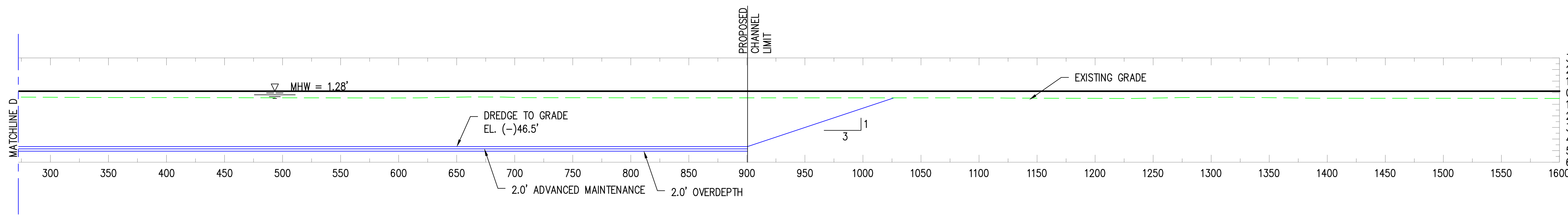
CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE E
CROSS SECTIONS

SHEET NO.
X1E

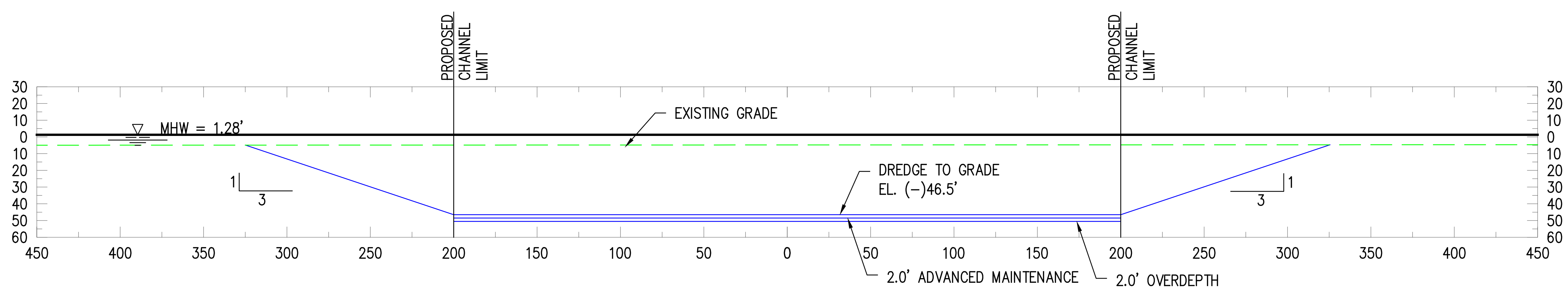




ALTERNATIVE ACCESS ROUTE B STA. 5155+00

SCALE: 1" = 50'

C3E



ALTERNATIVE ACCESS ROUTE E STA. 5135+00

SCALE: 1" = 50'

C3E

NOTES:

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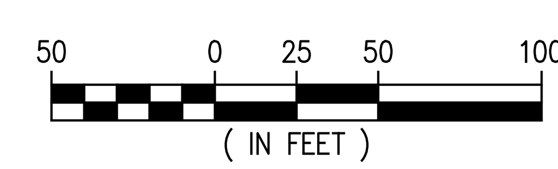

B

PRELIMINARY
MAY 03, 2024

LANIER & ASSOCIATES
CONSULTING ENGINEERS, INC.
LA: EF-1120 TX: F-2981
VF-185 LSF-10194817
NEW ORLEANS • BEAUMONT • CORPUS CHRISTI • HOUSTON • MANDEVILLE

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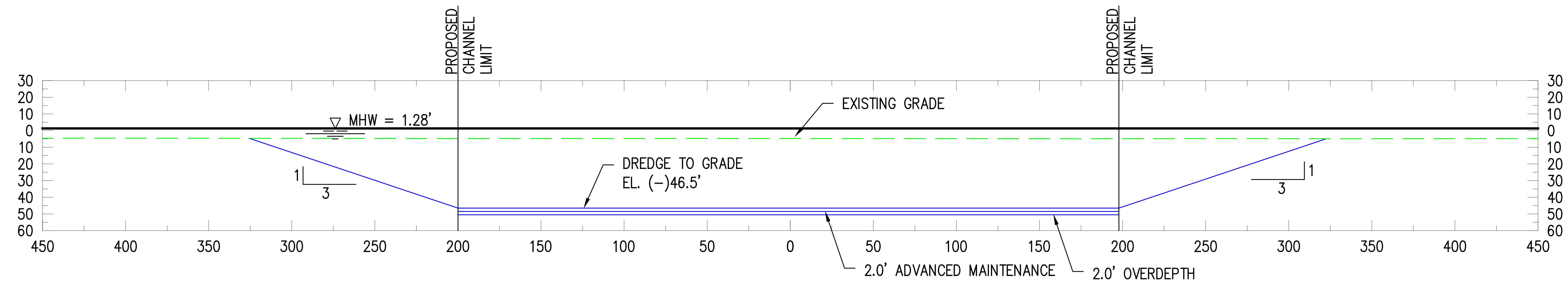
CEDAR PORT NAVIGATION & IMPROVEMENT DISTRICT
CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE E
CROSS SECTIONS

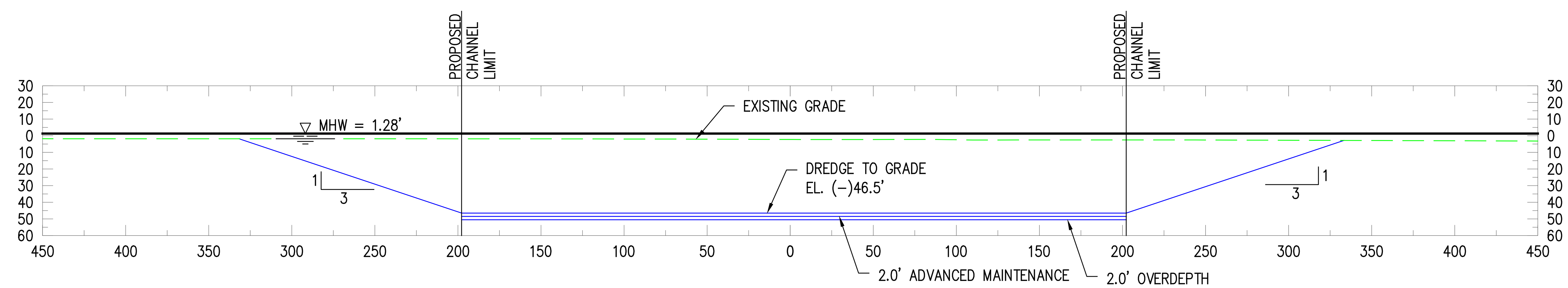
SHEET NO.
X2E



ALTERNATIVE ACCESS ROUTE E STA. 5215+00

SCALE: 1" = 50'

C4E



ALTERNATIVE ACCESS ROUTE E STA. 5193+00

SCALE: 1" = 50'

C4E

ALTERNATIVE ACCESS ROUTE E STA. 5167+00

SCALE: 1" = 50'

C3E

NOTES:

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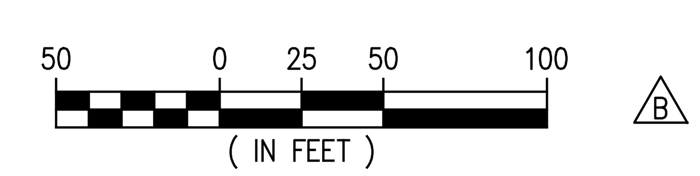

PRELIMINARY
MAY 03, 2024

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CEDAR BAYOU TEXAS

CEDAR BAYOU PROPOSED NEW SHIP CHANNEL STUDY
ALTERNATIVE ROUTE E
CROSS SECTIONS

SHEET NO.
X3E