INDIVIDUAL PERMIT APPLICATION

Harbor Island Seawater Desalination Facility
Corpus Christi, Texas

Prepared for:

The Port of Corpus Christi Authority

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Project No. TXE10785

February 2025

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ACRONYMS AND ABBREVIATIONS

-	minus
AEP	American Electric Power
AJD	approved jurisdictional determination
BA	Biological Assessment
BMP	best management practice
CCSC	Corpus Christi Ship Channel
CFR	Code of Federal Regulations
CWA	Clean Water Act
EFH	essential fish habitat
ELS	early life stage
ESA	Endangered Species Act
ft/s	feet per second
Geosyntec	Geosyntec Consultants, Inc.
Gulf	Gulf of Mexico (Gulf of America)
HDD	horizontal directional drilling
I&E	impingement and entrainment
IP	individual permit
IPAC	Information for Planning and Consultation
LEDPA	Least Environmentally Damaging Practicable Alternative
LF	linear feet
MGD	million gallons per day
NAVD88	North American Vertical Datum of 1988
NMFS	National Marine Fisheries Service
NLAA	May Affect, Not Likely to Adversely Affect
NPDES	National Pollutant Discharge Elimination System
PCCA	Port of Corpus Christi Authority

PEM	palustrine emergent
ppt	part(s) per thousand
SPM	single point mooring
SPMWD	San Patricio Municipal Water District
SWPPP	stormwater pollution prevention plan
T&E	threatened and endangered
TBM	tunnel boring machine
TCEQ	Texas Commission on Environmental Quality
TGLO	Texas General Land Office
THC	Texas Historical Commission
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TWDB	Texas Water Development Board
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WOTUS	Waters of the United States

1. PROJECT DETAILS

The Port of Corpus Christi Authority (PCCA or Port) is applying to the United States Army Corps of Engineers (USACE) for an Individual Permit (IP) for a Clean Water Act (CWA) Section 404 and Section 10 authorization to construct a 100-million-gallon-per-day (MGD) marine seawater desalination facility and associated infrastructure (the Project), aimed at providing a reliable, drought-resilient water supply. Additionally, the Project is scalable to support the long-term water needs of the region, which is heavily reliant on surface water and experiencing more frequent and more severe droughts.

The Project will include the construction of an upland Desalination Facility (the Desalination Facility), as well as a seawater intake structure, two outfall structures, product freshwater pipelines, and other appurtenances (together, the Supporting Infrastructure). The Desalination Facility is proposed to be located on Harbor Island, near Port Aransas, Nueces County, Texas (the Desalination Facility Site). It is bounded on the south and southeast by the Corpus Christi Ship Channel (Humble Basin); on the west by Highway 361 (Redfish Bay Causeway); and on the east and northeast by Harbor Island Road, Aransas Channel, and Inner Basin (Figure 1). The proposed 31-acre Desalination Facility Site and the associated pipelines and other infrastructure will collectively be referred to as the Project area.

The Project requires proximity to the Gulf of Mexico (Gulf of America) (the "Gulf") for appropriate intake and outfall structure siting for the Supporting Infrastructure. It is anticipated that the project construction will not include constructing all elements of the Project at once but sequenced. Sequencing will depend on final engineering design, which will define the order of construction.

1.1 Project Contacts:

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1.2 Directions to Project Area

From Aransas Pass, Texas, take the Red Fish Bay Causeway (Highway 361) west to the Desalination Facility Site, which is located on Harbor Island. The causeway terminates and becomes a ferry. The Desalination Facility Site is located north of the causeway, before arriving at the ferry port when traveling on Highway 361.

2. PURPOSE AND NEED

The Project proposes a new water supply for the Coastal Bend Region, which struggles with persistent drought conditions that severely constrain existing surface-water supplies. As the region enters the year 2025, combined reservoir storage levels for the Choke Canyon Reservoir and Lake Corpus Christi—the predominate water supplies for the region—have dipped below 20%, triggering "critical water shortage" restrictions for residents, businesses, and industry. Recurring droughts are common, with significant drought periods occurring in the 1950s, 1960s, 1980s, 1990s, and 2010s, as well as the current decade. Concerningly, average annual inflows to the region's surface water supplies continue to trend lower with each successive drought. The need for a reliable, drought-proof water supply exists now—not years in the future.

These water needs are expected to increase. The Coastal Bend Region's water planning group (Region N) projects in its most recent water plan (2021 Region N Water Plan) that total water use for the region will increase by 47.2 percent between 2010 and 2070. Because this plan did not account for several large projects announced for the Coastal Bend Region in recent years (for example, a lithium refining plant in Robstown announced in 2023), the water shortages identified in the 2026 planning cycle are expected to increase.

Additionally, the 2021 Region N Water Plan notes that water sources for municipal and industrial users require "a very high degree of reliability." Existing supplies for the region "may not be fully reliable" during extended droughts. On the other hand, the 2021 Region N Water Plan remarks that the Port's proposed Project is "highly reliable."

The Project can efficiently establish this new water supply through existing state authorizations. The Project maximizes optionality, reliability, and environmental protectiveness through two distinct outfall locations. And finally, the Project is scalable to meet increasing water supply needs of the region and the state over the coming decades.

2.1 Project Purpose

2.1.1 Basic Purpose

USACE's 404(b)(1) Guidelines rely on a project's "basic purpose" to evaluate whether the project is "water dependent." A project is "water dependent" when it "require[s] access or proximity to siting within [a] special aquatic site to fulfill its basic purpose." (40 CFR§ 230.10(a)(3)). Basic purpose is the fundamental or essential purpose of the proposed project.

The Project's basic purpose is to provide a drought-proof water supply through marine desalination. The Project is "water dependent" because desalination necessitates access to seawater, and that access implicates proximity to special aquatic sites such as tidal wetlands and vegetated shallows.[1] Notably, the Project—through the Preferred Alternative—does not propose impacts to any special aquatic site despite proximity to those sites.

2.1.2 Overall Purpose

USACE's 404(b)(1) Guidelines rely on a project's "overall purpose" to evaluate practicable alternatives and determine the LEDPA. An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics "in light of overall project purposes." (40 CFR § 230.10(a)(2)).

The Project's overall purpose is to efficiently establish a reliable, drought-proof water supply for the Coastal Bend Region through scalable marine desalination.

2.2 USACE Individual Permit Application Forms and Affected Waters of the United States

The IP Application form for the Project is included in Appendix A. Design Drawings are also included as an attachment to this application.

The Desalination Facility site is proposed at the location of former oil export facilities that have since been demolished and the property remediated. USACE authorized PCCA's new export terminal (SWG-2019-00245) on November 14, 2024, which includes an approved jurisdictional determination (AJD; SWG-2019-00245) for the Desalination Facility Site. The AJD was provided on February 25, 2022, by USACE for the Harbor Island property, including the entirety of the Desalination Facility Site, and identified wetlands and waters, which are presented in Figures 2.1–2.4.

Non-jurisdictional waterbodies resulting from the deconstruction of former export facilities are present within the Desalination Facility Site, as well as USACE-indicated, non-tidal jurisdictional wetlands. Construction of the Desalination Facility will fill several of these non-jurisdictional waterbodies but will not impact jurisdictional wetlands.

For the Supporting Infrastructure, construction of the finished water pipelines will involve unavoidable, temporary impacts to less than three acres of jurisdictional wetlands, as described in further detail in Section 5.1 and Appendix B. Construction of the intake structure, outfall structures, and related pipes avoids impacts to jurisdictional wetlands and special aquatic sites, with only minor impact.

[1] A project that is not "water dependent" must overcome the presumption that practicable alternatives are available that do *not* involve a special aquatic site. Because this Project is water dependent, this presumption does not apply.

In November 2024, a formal verification delineation was completed for the Waters of the United States (WOTUS)—including wetlands, ditches, tidal waters, and other non-jurisdictional waters. The verification delineation confirmed the type and boundaries of the WOTUS and are presented in Table 1. This verification focused on jurisdictional waters identified in the AJD associated with the Blue Water Texas Terminal project. During the assessment, the Project area was surveyed using the methodology provided in the *Corps of Engineers Wetland Delineation Manual* (USACE 1987) and the 2010 *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0*; USACE 2010*)* to identify wetlands. Wetlands were delineated within the proposed Project area and assigned a classification code using the Cowardin classification system (Cowardin et al 1979). Delineated wetlands are classified as palustrine emergent (PEM). PEM wetlands are characterized by erect, rooted, herbaceous hydrophytic vegetation present for all, or most, of the growing season, in most years. A detailed summary of proposed impacts is provided in Section 5.1. Additional delineation for portions of the Project Area outside of Harbor Island and the footprint of the treated water pipelines was not required since construction of the intake and outfall structures, as well as their attendant pipes, will occur through tunnelling methods that will avoid impacts to WOTUS.

The presence of an ordinary high watermark for ditches or riverine wetlands was determined based on the definition of "ordinary high watermark" as stated in 33 Code of Federal Regulations (CFR) 328.3(e) and as directed within the USACE Regulatory Guidance Letter dated December 7, 2005 (USACE 2005). Appendix B includes a Wetland and Waters Delineation—including delineation forms and associated photos from the survey—and will be referenced as the Wetland Report elsewhere in this document.

Table 1: Summary of Delineated Wetlands and Other Waters

Feature ID	Size (ac.)	Type	Jurisdictional?	Latitude	Longitude
PA001	0.09	Pond, Man Made	Yes	27.87974	-97.0986
PB001	0.20	Perennial Stream, Inlet from Bay	Yes	27.87543	-97.0938
PB002	0.05	Pond, Man Made	Yes	27.87782	-97.0966
SA005	0.02	Excavated Ditch	No	27.85274	-97.0735
SA007	0.37	Excavated Ditch	No	27.85194	-97.0734
WA004	1.13	Scrub-Scrub Wetland	Yes	27.89574	-97.1306
WA005	1.96	Emergent Wetland	Yes	27.89545	-97.1308
WA006	18.61	Scrub-Scrub Wetland	Yes	27.89412	-97.1238
WA007	0.56	Emergent Wetland	Yes	27.88976	-97.1106
WA008	0.46	Emergent Wetland	Yes	27.89341	-97.1221
WA009	0.06	Emergent Wetland	Yes	27.87997	-97.0989
WA010	0.29	Emergent Wetland	Yes	27.8792	-97.098
WA011	0.67	Nontidal Depression	No	27.85148	-97.0736
WA012	2.15	Nontidal Depression	No	27.85125	-97.068

Feature ID	Size (ac.)	Type	Jurisdictional?	Latitude	Longitude
WA014	0.21	Scrub-Scrub Wetland	Yes	27.85185	-97.0675
WA015	1.97	Emergent Wetland	Yes	27.87624	-97.0944
WA016	0.48	Emergent Wetland	Yes	27.89457	-97.1267
WA018	0.25	Nontidal Depression	No	27.85291	-97.078
WA020	0.02	Scrub-Scrub Wetland	Yes	27.85155	-97.0672
WB002	0.51	Nontidal Depression	No	27.85052	-97.068
WB004	0.03	Emergent Wetland	Yes	27.86272	-97.0794
WB005	0.59	Scrub-Scrub Wetland	Yes	27.86223	-97.0798
WB007	0.06	Emergent Wetland	Yes	27.86275	-97.0812
WB008	0.09	Emergent Wetland	Yes	27.86258	-97.081
WB009	0.04	Emergent Wetland	Yes	27.86297	-97.0804
WB010	0.01	Emergent Wetland	Yes	27.86468	-97.0836
WB011	0.08	Emergent Wetland	Yes	27.86496	-97.0828
WB012	0.13	Emergent Wetland	Yes	27.86512	-97.0834
WB013	0.30	Emergent Wetland	Yes	27.86665	-97.0837
WB014	2.72	Scrub-Scrub Wetland	Yes	27.86697	-97.0839
WB015	0.43	Emergent Wetland	Yes	27.87406	-97.0924
WB016	0.07	Emergent Wetland	Yes	27.87867	-97.0974
WET-01	0.06	Tidal Marsh	Yes	27.84515	-97.0697
WET-02	0.05	Tidal Marsh	Yes	27.84525	-97.0672
WET-03	0.01	Tidal Marsh	Yes	27.84522	-97.067
WET-04	0.12	Tidal Marsh	Yes	27.84511	-97.0665
WET-05	0.25	Tidal Marsh	Yes	27.84496	-97.0651
WET-07	0.13	Tidal Marsh	Yes	27.84511	-97.0639
WET-08	0.02	Tidal Marsh	Yes	27.84496	-97.0638
WET-09	0.00	Tidal Marsh	Yes	27.84503	-97.0634
WET-10	0.01	Tidal Marsh	Yes	27.84547	-97.0627
WET-11	0.00	Tidal Marsh	Yes	27.8455	-97.0626
WET-12	0.01	Tidal Marsh	Yes	27.84553	-97.0625
WET-13	0.01	Nontidal Depression	No	27.84553	-97.0671
WET-14	0.08	Nontidal Depression	No	27.8461	-97.0646
WET-15	0.07	Nontidal Depression	No	27.84615	-97.0638
WET-16	0.00	Nontidal Depression	No	27.84615	-97.0665
WET-17	0.15	Nontidal Depression	No	27.84636	-97.0638
WET-18	0.03	Nontidal Depression	No	27.84642	-97.0664
WET-19	0.08	Nontidal Depression	No	27.84643	-97.0643
WET-20	0.01	Nontidal Depression	No	27.84647	-97.0668
WET-21	0.18	Nontidal Depression	No	27.84656	-97.0649

Feature ID	Size (ac.)	Type	Jurisdictional?	Latitude	Longitude
WET-22	0.03	Nontidal Depression	No	27.84666	-97.067
WET-23	0.06	Nontidal Depression	No	27.84676	-97.0681
WET-24	0.06	Nontidal Depression	No	27.84682	-97.0654
WET-25	0.36	Nontidal Depression	No	27.84691	-97.0649
WET-26	0.53	Nontidal Depression	No	27.84711	-97.0666
WET-27	0.02	Nontidal Depression	No	27.84737	-97.066
WET-28	0.05	Nontidal Depression	No	27.84758	-97.0724
WET-29	3.26	Nontidal Depression	No	27.84778	-97.0697
WET-30	0.65	Nontidal Depression	No	27.84794	-97.0732
WET-31	2.17	Nontidal Depression	No	27.84803	-97.0663
WET-32	0.78	Nontidal Depression	No	27.8481	-97.0717
WET-33	0.12	Nontidal Depression	No	27.84833	-97.0671
WET-34	0.40	Nontidal Depression	No	27.84834	-97.0647
WET-35	0.02	Nontidal Depression	No	27.84855	-97.0677
WET-36	1.33	Nontidal Depression	No	27.84933	-97.0714
WET-37	0.13	Nontidal Depression	No	27.84986	-97.0719
WET-38	0.86	Nontidal Depression	No	27.84995	-97.0664
WET-39	1.40	Nontidal Depression	No	27.85078	-97.0734
WET-40	0.02	Nontidal Depression	No	27.85081	-97.0747
WET-41	0.71	Nontidal Depression	No	27.85299	-97.0754
Wet-43	0.20	Nontidal Depression	No	27.8544	-97.0787
WET-43	0.00	Nontidal Depression	No	27.85316	-97.0781
Wet-44	2.33	Nontidal Depression	No	27.85423	-97.0789
WET-44	0.02	Nontidal Depression	No	27.85308	-97.0782
WET-45	5.47	Nontidal Depression	No	27.85482	-97.0774
Wet-49	0.24	Nontidal Depression	No	27.85499	-97.0792
Wet-50	2.61	Tidal Marsh	Yes	27.85543	-97.0789
WET-51	23.68	Estuarine and Marine Wetland	Yes	27.85869	-97.0788
WET-52	13.00	Tidal Wetland, Open Water	Yes	27.85889	-97.0791
Wet-53	2.87	Tidal Marsh	Yes	27.8611	-97.0805
Wet-54	0.44	Tidal Marsh	Yes	27.86154	-97.0808
Wet-55/WB006	0.56	Tidal Marsh	Yes	27.86168	-97.0807
Wet-58	0.01	Excavated Ditch	No	27.84581	-97.0686
Wet 1	0.12	Emergent Wetland	Yes	27.85108	-97.0664
Wet 2	0.07	Emergent Wetland	Yes	27.85139	-97.0661

2.3 Construction Information

The proposed Project footprint will include construction of the following:

- Intake structure (*Gulf*)
- Intake pipe (*Gulf to Harbor Island*)
- Marine Life Handling System (*Harbor Island*)
- Desalination Facility (*Harbor Island*)
- Corpus Christi Ship Channel Outfall and Diffuser (*Ship Channel*)
- Gulf Outfall Discharge Tunnel Pipe and Diffuser (*Gulf*)
- Final product water pipelines (*Harbor Island to Aransas Pass*)

The sections below summarize the construction approaches.

2.3.1 Intake

2.3.1.1 Intake Structure

The intake structure will be located 1.3 miles offshore of San Jose Island in the Gulf at a depth of -35 feet NAVD88. The intake structure will have a manifold arrangement with approximately four to five branches to the velocity caps. All the branches will be evenly spread approximately 30 feet apart to obtain even flow distribution without interference from each other. The intake opening will be approximately 5 to 10 feet above the seabed to minimize the potential withdrawal of sediments or benthic organisms. The velocity cap opening will be designed to have an entrance velocity of ≤0.5 feet per second (ft/s) to reduce the intake of fish and other marine organisms into the intake. The velocity caps redirect the gravity-fed intake flow horizontally, which allows marine life to easily detect the low-flow entrance velocity and swim away. A three-inch mesh bar screen will be installed around the velocity caps to exclude larger marine organisms. A further discussion of methods used to avoid and minimize impingement and entrainment (I&E) of marine species can be found in Appendix E.

It is anticipated that all intake pipes will be placed underground with only the velocity caps and riser pipes above the seabed and nepheloid zone. The riser pipes from each velocity cap tie into a common discharge box and convey water flow to Harbor Island through a large-diameter gravity pipe. Temporary sediment redistribution within its footprint may occur as a result of the structure’s installation. The volume and rate of intake are necessary for PCCA to meet the Project’s purpose of producing 100 MGD of finished water.

Through tunneling construction methods, the intake structure avoids all impacts to jurisdictional wetlands and special aquatic sites. Construction of the intake structure will involve permanent but insignificant impacts to the Gulf seafloor through the placement of stone around the structure.

2.3.1.2 Intake Pipe

Seawater will be delivered to the Harbor Island facility by means of a large-diameter pipe of approximately 14 feet outer diameter and 12 feet inner diameter. The pipe route and alignment are proposed to follow the alignment of the “Bluewater Texas Terminal” project (SWG-2019-00174). The Bluewater Texas Terminal project has a published Draft Environmental Impact Statement and provided extensive and detailed survey information for all elements of the Project. The alignment travels roughly due east from Harbor Island, near the proposed Project facility location. The Harbor Island intake pipe will traverse for approximately 2.7 miles of its total 3.1 miles before separating from the Blue Water Texas Terminal project alignment, approximately 0.4 miles from the intake, as shown in Figure 3 and discussed in Appendix C. The proposed alignment runs beneath two maritime channels, a privately owned island, and the Gulf seabed. The pipe will be constructed by trenchless construction (tunnel boring), a common construction method for large-diameter pipes below the seabed. At sea, the trenchless construction method generally recommends that the tunnel be constructed at least two tunnel diameters below the seabed in potentially unstable substrates. The seabed elevation at the intake location is approximately minus (-) 35 feet North American Vertical Datum of 1988 (NAVD88). Pending the completion of a geotechnical survey, the top of the 14-foot tunnel is expected to be at approximately -64 feet NAVD88. Additionally, USACE requires a minimum clearance of 50 feet below the authorized project depth of 12 feet below mean lower-low water in the Lydia Ann Channel, a segment of the Gulf Intracoastal Waterway, infrastructure maintained by USACE. The influent intake pipe main tunneling shaft entrance is located upland on Harbor Island and the exit at the 35-foot contour in the Gulf.

The intake pipe will be installed via a subterranean tunnel boring machine (TBM) beginning at Harbor Island. This methodology creates no disturbance aboveground for intake pipe installation. Soil spoil (i.e., muck) produced from tunneling excavation must be removed from the tunnel and temporarily stored outside the launch shaft for dewatering. PCCA will utilize the dewatered excavated materials as fill for the upland Desalination Facility to be constructed on Harbor Island. A dewatered caisson, or similar structure, will be temporarily placed around the intake footprint prior to the TBM exiting the shaft location in the Gulf. All materials to construct the tunnel interior support and the conveying pipe will be inserted at the main tunneling shaft entrance on Harbor Island. Construction equipment will include heavy work trucks and equipment, TBM, shields, cutter heads, offshore platform, jack-up barge, and dewatered caisson or similar structure. For additional information regarding the TBM construction methodology, see Appendix D.

Because it is anticipated that soft soils will be encountered for the entirety of the tunnel profile, the proposed method for tunnel construction is an earth pressure balance TBM. TBMs for soft ground have a cylindrical shield to support the soil strata being mined through, as well as a bi-rotational cutter head equipped with cutting tools to remove the intact ground and draw the loosened material into the cutter head. The excavated soils are captured and removed from a chamber behind the cutter wheel.

Because it is anticipated that soft soils will be encountered for the entirety of the tunnel profile, the proposed method for tunnel construction is an earth pressure balance Tunnel Boring Machine (TBM) TBMs for soft ground have a cylindrical shield to support the soil strata being mined through, as well as a bi-rotational cutter head equipped with cutting tools to remove the intact ground and draw the loosened material into the cutter head. The excavated soils are captured and removed from a chamber behind the cutter wheel.

Pressurization of the face of the excavation is required in permeable soil under unbalanced hydrostatic pressure, given the expected tunnel condition under the seabed. If the face of the excavation were not pressurized, the unbalanced water pressure could allow soils to flow through the gaps in the cutter head and into the TBM and resulting excavation, filling the tunnel with soil. Such conditions may cause sinkholes and excessive settlement at the ground or seabed and may cause damage to existing infrastructure (e.g., adjacent oil pipelines).

Earth pressure balance TBMs function by maintaining a pressurized environment in a void just behind the cutter head and excavation face called a “muck chamber.” The face pressure is continuously monitored by operators in the TBM. The muck is a mixture of fragmented excavated spoils and soil conditioning additives (if any) to improve the material handling properties of the excavated material. The muck chamber is created by a bulkhead separating the construction crew from the pressurized environment at the face. Soil is removed from this pressurized environment by removing it through a helicoidal screw contained in a long steel cylinder. The helicoidal screw turns to slowly remove soil from behind the pressurized bulkhead while maintaining the appropriate face pressure. At the rear of the screw auger is a slide gate, where excavated soils are discharged onto a conveyor belt and then into muck cars near the end of the TBM shield. The muck cars/belt conveyor transport the muck to the primary work shaft, where they are hoisted to the surface by muck boxes or a vertical conveyor and into a temporary stockpile area/surge pile. The muck will be maintained onsite during the construction and will be dewatered similarly to dredge material, with an outfall structure adjacent to Aransas Channel. Dewatering muck will be permitted as part of the Texas Commission on Environmental Quality (TCEQ) 401 permit, discussed below. Once the material is sufficiently dewatered, it will be spread onsite.

The TBM shield is a cylindrical steel shell that is pushed forward along the tunnel, while the ground is excavated inside the shield. The main shield and tail shield support the ground as the tunnel lining is installed and fully protects workers within the tunnel. The shields fully encapsulate the excavation, never exposing the ground or leaving any area unsupported. The shield is propelled using hydraulic jacks installed within the shield tail that thrust against the tunnel lining system. The shield is designed to withstand the pressure of the surrounding ground and hydrostatic pressure.

To support the excavated bore in the soft soils at depths below sea level, a precast concrete segmented liner is proposed. This lining type has become the industry-standard lining for large-diameter, soft-ground, TBM-mined tunnels and is designed to meet Project requirements for durability and watertightness. The liner helps maintain the pressure the machine is exerting on the ground and provides a solid base against which the thrust jacks in the TBM propulsion system can push the cutterhead forward. For this reason, the TBM is used in conjunction with a prefabricated ground support system, which most commonly consists of precast concrete segments that are bolted and gasketed to form a watertight lining. This watertight lining must be designed to withstand construction, ground, seismic, and hydrostatic loads.

The main advantage of the TBM method is that temporary surface disturbance would occur in only two locations: the vertical work shafts at the discharge point in the Gulf, and the desalination facility on Harbor Island.

Construction of the intake pipe avoids all permanent impacts to jurisdictional wetlands, navigable waters, and special aquatic sites. The intake pipe is planned under existing Federally-authorized and maintained infrastructure, therefore, a minimum clearance of 50’ below Corps infrastructure is proposed.

2.3.2 Desalination Facility

2.3.2.1 Marine Life Handling System

As seawater arrives from the intake pipe to the Desalination Facility Site, it will first flow into an intake bay, which will feed the seawater to two-to-four screen channels. Each screen will be approximately 8 to 10 feet wide and will be equipped with a traveling screen. The screens will have revolving wire mesh panels with 2-to-6-millimeter (mm) openings to capture larvae along with any aquatic life and debris that make it in through the intake (less than 2 mm in size). The screens will collect and remove larvae, fish, and debris as the wire mesh panels rise out of the seawater. Trays will be installed on the screens to humanely capture marine organisms as they are lifted from the seawater. The screens will be equipped with low-pressure jet sprays to gently discharge the screened marine organisms to a fish trough that returns them to the Aransas Channel. After the marine organisms are transferred to the fish trough, high-pressure jet sprays eject debris from the screens. Figure 4 shows the preliminary configuration of the screening facility. The final design of approach velocity, width, depth, and number of screens will be conducted at a later stage of the Project.

Construction of the Marine Life Handling System will not impact jurisdictional wetlands, navigable waters, or special aquatic sites.

2.3.2.2 Desalination Facility – Treatment

A pump station will be installed downstream of the Marine Life Handling System to pump the seawater to the treatment facility. The individual capacity and number of pumps will be selected during the engineering design phase based on the location, configuration, and any design requirements of the facility. The pumps will be constructed of materials able to handle seawater and will include engineered redundancy. The pumps will discharge to a common force main that will deliver screened seawater to the desalination treatment systems. The seawater will be treated using reverse osmosis. It occupies approximately 31 acres and will be situated on Harbor Island in the location depicted on Drawing 1. Reverse osmosis results in a product water recovery rate of 40%–50%, and the concentrate effluent produced from the desalination process will discharge into the Corpus Christi Ship Channel (CCSC) or to an outfall in the Gulf via high-rate diffusers, which is further described below. Once the seawater is treated and stabilized (i.e., made noncorrosive), product water will be stored onsite in tanks prior to distribution.

Construction of the Desalination Facility will not impact jurisdictional wetlands, navigable waters, or special aquatic sites.

2.3.3 Outfalls

2.3.3.1 Corpus Christi Ship Channel Outfall

The Corpus Christi Ship Channel outfall or CCSC outfall is actually located adjacent to the Corpus Ship Channel and not within the Federally-authorized channel.

A pipe will connect to a reverse osmosis, concentrate-effluent holding tank at the southeast corner of the Seawater Desalination Facility (Appendix F). From that connection, a buried/submerged 60-inch pipe will transport stored effluent water to a multiport high-rate diffuser (port exit minimum velocity ≥ 3 meters per second) approximately 230 feet offshore of Harbor Island. Diffuser port exit velocities ≥ 3 meters per second generate sufficient momentum and energy in the effluent discharge to assure rapid mixing of the effluent and receiving water.

The buried line will be installed via horizonal directional drilling (HDD) or microtunnel boring machine. The top of the pipe will be submerged approximately 6 feet below the authorized depth of -54 feet mean lower-low water and run approximately 0.7 miles southeast from the product water tanks. The outfall construction equipment will include heavy work trucks, HDD rig and equipment, or microtunnel boring machine. The diffuser will be comprised of a 48-inch-diameter barrel with 20 180-millimeter-diameter ports, each at a 1.5-meter spacing, resulting in total diffuser length of 30 meters. In order to install the diffuser barrel, a bench must be excavated in the channel side slope (outside the channel template). This bench will result in the removal of approximately 903 cubic yards (24,381 cubic feet) of sediment. This dredged material will be stockpiled upland, dewatered, and spread as fill in the Desalination Facility Site.

The installation of the diffuser and connection to the tunnel may temporarily disturb up to approximately 0.6 acres (300 x 90 ft) of seafloor, or smaller. The volume of sediments displaced by trench and shaft construction may be up to 1,000 CY. The engineered armor rock layer over the diffuser barrel may be up to 3-ft thick and include up to 500 CY of rock graded in dimensions for stability to withstand the maximum velocities expected at the site.

Effluent will pass through the diffuser that is installed perpendicular to the outfall pipe and parallel to the shoreline before mixing with the water column of the CCSC. The TCEQ authorized the discharge from this outfall on December 22, 2022 (Texas Pollutant Discharge Elimination System [TPDES] Permit WQ0005253000, United States Environmental Protection Agency [USEPA] ID No. TX0138347). For further discussions on water quality, see Section 6.13 of this document.

Construction of the CCSC outfall will not impact jurisdictional wetlands or special aquatic sites. Construction of the outfall with create temporary disturbances to WOTUS (through turbidity and sediment displacement) and permanent but insignificant impacts to the unvegetated bay bottom through the placement of up to 500 CY of rock around the diffuser barrel. The outfall's location is adjacent to the CCSC and avoids the footprint of the Federally authorized channel.

2.3.3.2 Gulf Outfall

Another pipe will connect to the reverse osmosis, concentrate-effluent holding tank at the southeast corner of the desalination facility (Appendix F). From that connection, a buried/submerged 14-foot-outside-diameter and 12-foot-inside-diameter pipe will transport stored effluent water to a multiport high-rate diffuser (port exit minimum velocity ≥ 3 meters/second) approximately 1.8 miles offshore of San Jose Island and 0.5 miles further offshore from the intake. The pipe route and alignment are proposed to follow the alignment of the intake pipe, which also follows the “Bluewater Texas Terminal” project (SWG-2019-00174). The Bluewater Texas Terminal project has a published Draft Environmental Impact Statement and provided extensive and detailed survey information for all elements of the Project. The discharge pipe will be offset from the intake to the south by about 30-feet.

The conceptual design is a 50-port diffuser with 160-millimeter (6.3-inch) diameter ports. The ports will discharge at a minimum centerline depth of -7.5 meters (24.6 feet) at mean lower-low water. The total water depth at the center of the diffuser barrel will be approximately 37 feet (~11.3 meters) NAVD88. The high-rate diffuser port exit velocities ≥ 3 meters per second generate sufficient momentum and energy in the effluent discharge to assure rapid mixing of the effluent and receiving water.

The diffuser will have 25 risers with 2 ports per riser oriented at 180° to each other.[2] The ports on each riser will point in the prevailing direction of the ambient current: north-northeast and

[2] A design alternative with an elevated diffuser barrel with ports drilled on either side at the

south-southwest (Texas Automated Buoy System [TABS] Buoy D [1995–2022] at 2-meter depth).[3] The risers will be spaced at 6.25-meter intervals on the diffuser barrel, which results in a diffuser length of 150 meters (first riser to last riser). The diffuser barrel will have a removable plug (or equivalent opening) at its far end to allow it to be pigged to remove settled solids if necessary. The diffuser ports will discharge at a vertical angle of 60° to the water surface (i.e., angled toward the surface). The port and riser configuration is shown schematically in Figure 6 of Appendix F. Permit Drawings Diffuser Layout shows the diffuser orientation in the Gulf and a section view of the diffuser along with the riser from the discharge tunnel pipe (Figure 9 of Appendix F).

At the proposed discharge location and with the 50-port design, the Gulf salinity at a horizontal distance of 100 meters from the diffuser will be < 2 parts per thousand (ppt) above the ambient salinity at any given time.

Construction of the Gulf outfall avoids all impacts to jurisdictional wetlands and special aquatic sites. Construction of the outfall will create temporary disturbances to WOTUS (through turbidity and sediment displacement) and permanent but insignificant impacts to the Gulf seafloor through the placement of 500 CY rock around the diffuser barrel. TCEQ will authorize the discharge at this location concurrently with the USACE review of this individual permit.

2.3.3.3 Gulf Discharge Pipe

The proposed discharge pipe measures approximately 3.6 miles long and would run parallel to the intake tunnel to a point approximately 0.5 miles beyond the intake structure (Figure 3), where a multiport diffuser will be installed (Appendix G). The distance between the intake pipe and discharge pipe will be determined at a later phase of design based on geotechnical evaluation, but two tunnel diameters, or approximately 25 feet, is considered a recommended distance. The Gulf Discharge pipe will be constructed utilizing the same methodology of the intake pipe, to limit surface disturbance. Construction methods would be like those described for the intake pipe installation (see Appendix D).

The resulting flow velocity for the discharge design flow rate of 191.2 MGD is 2.6 ft/s, which results in a head loss through the pipeline of only 3 to 4 feet. The velocity is low enough that significant flow transients will not occur as discharge rates change. The major sources of head loss occur within the diffuser.

Construction of the Gulf discharge pipe avoids all impacts to jurisdictional wetlands, navigable waters, and special aquatic sites. The discharge pipe is planned under existing Federally-

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appropriate horizontal angle, spacing, and minimum depth below the water surface will provide equal dilution.

[3] The prevailing longshore current is to the north-northeast most of the year. During summer months it shifts to the south-southwest.

authorized and maintained infrastructure, therefore, a minimum clearance of 50-feet below Corps infrastructure is proposed.

2.3.4 Finished/Treated Water Pipeline(s)

The finished water pipelines (treated water pipelines or finished water pipelines) transport the treated water from the Desalination Facility to Aransas Pass, where it will connect into existing water distribution lines to meet the needs of the Coastal Bend Region. In general, the pipelines will run alongside the Redfish Bay Causeway (Highway 361) to the community of Aransas Pass. The scope of this construction methodology does not include distribution pipelines beyond the initial treated water line from the Desalination Facility to the City of Aransas Pass. The distribution lines within the City of Aransas Pass are considered separate and distinct from this project, since the Port has no authority or control over the construction of municipal waterlines. The pipelines from the Desalination Facility to the mainland are described below and illustrated in Figure 5. The construction methodology document for the finished water pipelines is included in Appendix I.

The finished water will be transported by up to two pipelines proposed to be 48 to 52 inches in diameter, constructed of steel, prestressed concrete cylinder pipe (PCCP) material, or high-density polyethylene (HDPE) material. The material type will be selected after geotechnical information is collected and subsurface trenching methodology has been finalized. The pipelines will total approximately 30,500 linear feet (LF) and comprise 21,500 LF of buried pipelines within the PCCA property. Approximately 9,000 LF of the buried pipelines will be installed below waters or wetlands along the route utilizing HDD or similar trenchless construction technology.

Additionally, Harbor Island has existing tie-in infrastructure with Nueces County Water Control & Improvement District 4 (NCWCID #4) that leads to Port Aransas and Mustang Island. The NCWCID #4 12-inch pipeline runs parallel to Highway 361 within the Texas Department of Transportation right-of-way, immediately adjacent to the proposed Desalination Facility illustrated in Figure 2. Therefore, the interconnect will not impact WOTUS, cultural resources or sensitive species. The existing NCWCID #4 connection can serve to deliver water to Port Aransas and Mustang Island (a portion of the Coastal Bend Region). Use of the existing NCWCID #4 infrastructure will not require additional construction or authorizations under the CWA or RHA.

Product water will ultimately be transmitted as wholesale water. The pipelines to Aransas Pass will be HDD drilled to avoid special aquatic resources. The proposed Aransas Pass tie-in will be located off of Highway 361 and S. Atlantic Street (Figure 1) using existing San Patricio Municipal Water District infrastructure. Figure 5 shows the location of the future interconnect. No off-takers have been identified at this phase of the Project, and, while these two locations are the only proposed tie-in locations, future/additional interconnects will be appropriately authorized prior to construction.

Construction of the finished water pipelines will involve unavoidable, temporary impacts to less than three acres of jurisdictional wetlands. This is described in further detail in Section 5.1 and in Appendix B.

2.4 Watersheds and Hydrologic Unit Codes

The Project area is located within the Aransas Bay Watershed, identified with the 8-digit Hydrologic Unit Code (HUC) 121004050400, as well as within the Gulf. The Project will be located in Redfish Bay, Aransas Bay, and the Gulf. The natural topography of the Project area is relatively flat with some dunes present on San Jose Island. The property for the Desalination Facility Site was formerly an oil export facility. The northern portion of Harbor Island and San Jose Island (in Aransas County) are undeveloped.

2.5 Property Owners

All of the parcels where the facility will be constructed are in Nueces County and owned by PCCA. These include parcel numbers 241473 (187.14 acres); 241506 (75.13 acres); 200083388 (6.51 acres); 241524 (10.73 acres); 241474 (26.07 acres); and 241523 (2.41 acres).

The finished product water pipelines will be constructed along Port-owned property in Nueces County. The following parcels are collocated with the proposed finished water pipelines easement (Table 2).

Table 2: Adjacent Property Owners

Property ID	Owner Name	Mailing Address
528783	2418 STATE HIGHWAY 361 LLC	PO Box 2369 , Boerne, TX 78006
200113456	BADOVINUS NICK	642 County Road 1700 , Clifton, TX 76634
523079	BAYES ERIC DOUGLAS & JENNIFER	30719 Riverlake Rd , Fulshear, TX 77441
586305	BAYES ERIC DOUGLAS & JENNIFER	30719 Riverlake Rd , Fulshear, TX 77441
200113462	BORDES TIARE & SANCHA PROPERTIES LLC	PO Box 270664 , Corpus Christi, TX 78427
378108	BORDES TIARE AND	STEVE J COUCHMAN P O BOX 2115 , ARANSAS PASS, TX 78335
382342	BORDES TIARE AND	STEVE J COUCHMAN P O BOX 2115 , ARANSAS PASS, TX 78335
513303	BUCK RAWLSTON ETUX SUSAN BUCK	PO Box 2332 , Aransas Pass, TX 78335
523078	CAMLEY LP	1353 W 2nd St , Taylor, TX 76574
529450	DILLEY DARLENE & DENNIS DILLEY	139 Ammann Rd , Boerne, TX 78015
528785	DILLEY DENNIS E AND WF, DARLENE L DILLEY	139 AMMANN RD , BOERNE, TX 78015
513566	HAHN MONTY I & WF JACKIE H	1010 Lois St , Kerrville, TX 78028

513305	HUDDLESTON JOHN & CAROL HUDDLESTON	PO Box 223 , Hungerford, TX 77448
523081	KNOX DAVID LUKE	2422 State Highway 361 , Aransas Pass, TX 78336
528784	LOT 7 LLC	1353 W 2nd St , Taylor, TX 76574
529451	MACCALLUM PETER S III	PO Box 627 , Lakehills, TX 78063
529453	MACCALLUM PETER S III	PO Box 627 , Lakehills, TX 78063
200113460	MARCUS COURTNEY S AND ETALS	C/O GERRY A. SOLCHER 111 W CASTLE LN , SAN ANTONIO, TX 78213
513302	NUGENT MIKE	BOX 321 , ARANSAS PASS, TX 78335
513304	RAUB PROPERTIES LLC	113 Lost Creek Dr , Portland, TX 78374
241481	RED FISH BAY PROPERTIES LTD	PO BOX 5454 , AUSTIN, TX 78763
382343	REEH JOE JR	850 Sidney Baker St , Kerrville, TX 78028
528782	STUART GRIFFIN PERLITZ RANCH LTD	PO Box 2369 , Boerne, TX 78006
200113458	WHEELESS BRIAN & CYNTHIA WHEELESS	704 W Loomis St , Ludington, MI 49431

The Gulf intake and outfall pipes will be installed across property owned by PCCA, Bass Brothers Enterprises, Inc. and the State of Texas. The installation of the pipes from Harbor Island under the Aransas Channel to the Lydia Ann Channel is on property owned by the Port of Corpus Christi. The installation of the pipes under the Lydia Ann Channel is on property owned by the State of Texas. The installation of the pipes under the barrier island (San Jose Island) are on properties in Aransas County. Parcel 48591 (San Jose Island) is owned by Bass Brothers Enterprises Inc. The installation of the pipes in the Gulf is on property owned by the State of Texas. PCCA has a Miscellaneous Easement with the Texas General Land Office for installation of the intake pipe and intake structure on State-owned lands. An amendment to the agreement for the outfall pipe and outfall structure is being requested concurrently with this request for authorization. PCCA has begun conversations with Bass Brothers Enterprises Inc. for crossing San Jose Island and concurrently will pursue access to this property, as well.

2.6 Project Authorizations

2.6.1 Federal Authorizations and Approvals

Section 404/10 Authorization

The proposed Project will temporarily impact 2.5 acres of PEM wetlands, one pond, and one stream along the finished water pipelines route. Special aquatic sites, as defined in Section 404 CWA, will not be impacted. PCCA sited both the intake and outfall structures in deep, open water, avoiding impacts to special aquatic sites. The upland Desalination Facility will only impact non-jurisdictional features, which were created as a result of the deconstruction of the former oil export facilities at Harbor Island.

Additionally, this project will include the removal of approximately 1,000 CY of sediments for the CCSC outfall and the placement of up to 500 CY of rock around the diffuser barrel. Construction of this outfall diffuser in the CCSC will impact approximately 400 square feet of unvegetated bay bottom. Additionally, the construction of the Gulf intake structure and outfall diffuser will impact approximately 11,300 square feet and 55,000 square feet of seafloor, respectively, through the placement of approximately 15,300 CY of stone.

<u>ESA Consultation</u>

The purpose of the Endangered Species Act (ESA) is to provide a means to conserve the ecosystems upon which endangered and threatened species depend and provide a program for the conservation of such species. Federal agencies must consult with the U.S. Fish and Wildlife Service (USFWS) when any project or action they permit may affect a listed species or designated critical habitat.

To evaluate potential impacts to federally listed threatened and endangered (T&E) species and their habitats, a Biological Assessment (BA) was completed for sensitive species with the potential to occur within the Project area (Appendix N). BA findings are summarized in Section 5.2.7 and the full BA is attached as Appendix M. The full BA will be provided during Section 7 consultation between the USACE and the USFWS Texas Coastal Ecological Services field office.

PCCA plans to deliver this permit application to interested resource agencies—especially the USFWS, National Marine Fisheries Service (NMFS), and the Texas Parks and Wildlife Department (TPWD)—to share full Project details.

2.6.2 State and Local Authorizations

<u>National Historic Preservation Act §106 Consultation</u>

The National Historic Preservation Act is meant to protect historic properties and cultural resources, including National Park Service (NPS) National Register of Historic Places (NRHP) eligible structures and historic properties; historic cemeteries; state antiquities landmarks; and historic highways. The National Historic Preservation Act Section 106 requires federal agencies to consult on the Section 106 process with State Historic Preservation Offices, and Tribal Historic Preservation Offices and Indian Tribes, if applicable, as part of the Federal permitting process.

The Texas Historical Commission (THC) review staff, led by state underwater archaeologist Amy Borgens, completed its review and has allowed the proposed Project to rely on the 2019 BOB Hydrographics, LLC, underwater archaeological survey conducted under Texas Antiquities Permit No. 8672 where the Project coincides with the 2019 survey area. Three remote-sensing contacts were located and marked for avoidance. Two of the contacts are within the planned Project Area of Potential Effect and must be avoided by at least 50 meters.

The currently planned desalination intake and outfall pipes will avoid these targets by the required 50-meter buffers. Additional archeological investigation will be required if these targets cannot be avoided. If the Project Area of Potential Effect shifts outside the current footprint, additional consultation with the THC may be required.

The construction on Harbor Island is within the limits of disturbance of the former oil export facilities that have since been demolished and the property remediated. This area is considered previously disturbed.

Clean Water Act, NPDES, and 401 Water Quality Certification

Federal regulations require that a proposed intake structure must have an associated outfall that is authorized by and complies with the NPDES permit program. TCEQ is responsible for the State of Texas' implementation of the NPDES program (Texas Pollutant Discharge Elimination System [TPDES]). On December 22, 2022, TCEQ authorized the discharge of effluent to the CCSC from the proposed desalination facility on Harbor Island with TPDES permit WQ0005253000 (USEPA ID No. TX0138347). Discharges from the outfall will comply with the issued TPDES permit. The proposed activity will also comply with any conditions of the state's CWA section 401 certification.

The CWA Section 401 Certification Rule (40 CFR §121) requires state water quality certifications prior to the issuance of federal permits and licenses to ensure that proposed projects will not violate state water quality standards. PCCA is submitting an application to TCEQ for CWA 401 Certification concurrently with this application.

Additionally, an application for a discharge in the Gulf is being submitted to the TCEQ to authorize the discharge at this location concurrently with the USACE review of this individual permit.

Water Rights

PCCA has previously submitted a Water Rights application to TCEQ on February 13, 2023, which is currently under review (Water Rights No. 13902).

State Lands

PCCA has received a Miscellaneous Easement to the Texas General Land Office (for the intake and intake pipe). Concurrently, an amendment for the outfall and discharge pipe will be requested from Texas General Land Office with review of this application.

Academia

PCCA participated in several local meetings, including meetings on December 3, 2024, at both the University of Texas Marine Science Center and the Harte Research Institute.

Stormwater Pollution Prevention

Under the National Pollutant Discharge Elimination System (NPDES), TCEQ requires a Construction General Permit No. TXR150000 for large construction activities (5 acres or greater) that discharge stormwater associated with ground surface disturbance.

To comply with Construction General Permit requirements for projects disturbing more than 1 acre of soil, a stormwater pollution prevention plan (SWPPP) is required to address construction phase discharges that will reach WOTUS, which includes wetlands, discharges to Municipal Separate Storm Sewer Systems (MS4s), and privately owned storm sewer systems. The SWPPP describes the implementation of practices that will be used to minimize the discharge of pollutants in stormwater associated with construction activity and permissible non-stormwater discharges. The SWPPP will also identify potential sources of pollution that have potential to violate water quality standards and the management practices used to prevent the pollutants from being discharged into surface water in the state or WOTUS. The SWPPP is a road map for how construction operators will comply with effluent limits and other permit conditions.

Because the Project is anticipated to disturb soil within an area greater than 5 acres, TCEQ will require both a SWPPP and Notice of Intent to be submitted to their online e-permit portal, the State of Texas Environmental Electronic Reporting System (STEERS), prior to Project implementation. This will occur upon design of the project and prior to commencing construction to accurately capture all phases and elements of construction.

3. ALTERNATIVES ANALYSIS

In accordance with 40 CFR 230.10, PCCA conducted an extensive alternatives analysis for the Project (Appendix J). This analysis concludes that the Project, as proposed herein, is the least environmentally damaging practicable alternative (the LEDPA). The alternatives analysis outlines the screening criteria PCCA considered and presents a comparative analysis of three additional alternatives, as well as a no-action alternative. The Project, as proposed herein, reflects PCCA's preferred alternative, meeting the Coastal Bend Region's well-documented need for a drought-proof water supply while avoiding and minimizing environmental impacts.

4. EXISTING CONDITIONS

4.1 Geology

The Project area lies within the Western Gulf Coastal Plain, an area formed by the deposition and uplift of sediment during the end of the Cretaceous period to the Pleistocene. Pleistocene to Holocene clays, silts, and sands underlay most of the region.

4.2 Soils

According to the Natural Resource Conservation Series (NRCS) Web Soil Survey database, the predominant soil units are Ijam clay loam, Mustang fine sand, and Psamments. The slope ranges from 0% to 3%, and the depth to water table may be 0 to 80 inches. The Ijam Series is typical of flats and poorly drained. The Mustang Series setting is barrier flats and poorly drained soils. The Psamments Unit setting is barrier flats with a drainage class of poorly drained.

4.3 Topography

Currently, the topography of the proposed Project area is relatively flat. Redfish Bay, the CCSC, and the Gulf border the Project area. Most of the Project area has been disturbed by industrialization.

4.4 Ecosystem and Habitat

The Project area is located within the Mid-Coast Barrier Islands and Coastal Marshes of the Western Gulf Coastal Plain and is more specifically located in Major Land Resource Area (MLRA) 150B (Gulf Coast Saline Prairies). The original (pre-European settlement) floodplain forests and grasslands of the Western Gulf Coast Plain have been replaced over the centuries through agricultural expansion and urbanization.

The aquatic environment, including inshore and offshore waters and habitats, are discussed below.

5. AFFECTED ENVIRONMENT AND ENVIRONMENTAL FACTORS

5.1 Proposed Aquatic Impacts

5.1.1 Jurisdictional Impacts: Wetlands and Other Waters

Construction of the proposed Project will result in unavoidable, temporary impacts to less than 3 acres of WOTUS due to temporary wetland filling during Project construction. Additionally, the Project will result in unavoidable impacts to the Gulf seabed at the intake and outfall locations, as well as at the unvegetated bay bottom at the CCSC outfall location.

To evaluate the potential for impacts to wetlands in considering each alternative, a review of the USFWS National Wetlands Inventory (NWI) database was performed (Table 3), and a verification of the current AJDs extending across the Project was conducted. Based on the results of the wetland verification, temporary impacts are anticipated by the proposed Project within the finished water pipelines' construction footprint. The impacts are defined as temporary, since the pipelines will be installed in these areas using open trench construction and restored to pre-existing contours immediately following construction. These temporary impacts include approximately 2.5 acres of jurisdictional PEM wetland, 0.09 acres of stream impact, 0.017 acres of impact to a pond, and 0.25 acres of jurisdictional palustrine shrub scrub (PSS) wetland located along the finished water pipelines. Wetland data sheets are provided in Appendix B and associated maps are provided as Figures 2.2-2.4.

Construction of the outfall diffuser in the CCSC will impact approximately 400 square feet of unvegetated bay bottom and include the removal of approximately 1,000 CY of sediments for the CCSC outfall and the placement of up to 500 CY of rock around the diffuser barrel. Additionally, construction of the Gulf intake structure and outfall diffuser will impact approximately 11,300 square feet and 55,000 square feet of seafloor, respectively through the placement of approximately 15,300 cubic yards of stone.

Table 3: Project Impacts to Jurisdictional Wetlands and Other Waters

Feature ID	Type	Impact Area (acres)	Temporary (Yes/No)	Latitude	Longitude
WA009	Emergent Wetland	0.006	Yes	27.87997	-97.0989
PA001	Pond, Man Made	0.017	Yes	27.87974	-97.0986
WB016	Emergent Wetland	0.04	Yes	27.87867	-97.0974
WB015	Emergent Wetland	0.07	Yes	27.87406	-97.0924
PB001	Perennial Stream, Inlet from Bay	0.09	Yes	27.87543	-97.0938
WA004	Scrub-Scrub Wetland[1]	0.12	Yes	27.89574	-97.1306
WA006	Scrub-Scrub Wetland[1]	0.14	Yes	27.8949	-97.1277

WA008	Emergent Wetland	0.14	Yes	27.89341	-97.1221
WA010	Emergent Wetland	0.14	Yes	27.8792	-97.098
WA016	Emergent Wetland	0.21	Yes	27.89457	-97.1267
WA005	Emergent Wetland	0.30	Yes	27.89545	-97.1308
WA015	Emergent Wetland	0.52	Yes	27.87624	-97.0944
WA006	Emergent Wetland	1.06	Yes	27.89318	-97.1198

[1] Shrub Scrub wetlands will be crossed utilizing HDD methods and included here for ingress/egress potential for temporary impacts until detailed design is completed for the project.

5.1.2 Section 10 Waters

Any tidally influenced waters are classified as a Section 10 waterway and will be minimally affected by the proposed Project construction and use of the intake and outfalls. The locations for intake and outfall structures have been selected to avoid impact on navigation and the course, location, condition, or capacity of all navigable waters located within the Project area (see Section 6.10). Further to support this Section 10 authorization, PCCA also conducted modeling to evaluate diffuser design for adequate mixing at the outfalls and to determine the best location of the outfalls. This is discussed further in the alternative analysis (Appendix I).

5.1.3 COASTAL ZONE MANAGEMENT

PCCA is aware that the proposed Project is located within the boundary of the Texas Coastal Management Program, as designated by the Texas General Land Office (TGLO), and will abide by all applicable coastal zone management plans. A statement of Consistency with the Coastal Management Program is attached (Appendix J).

5.2 404(b)(1) Guidelines Technical Evaluation Factors

5.2.1 Substrate (§230.20)

Substrate in the Project area is primarily sand with some silt and clay. During construction of the intake and outfall structures, temporary impacts from siltation could occur to the natural substrate present in the Gulf and the dredged substrate present in the CCSC. Benthic invertebrates would be temporarily affected by the siltation but would recolonize the area after construction. Small permanent impacts would occur from the placement of the intake structure and diffuser at the outfall locations; however, these substrate impacts would not adversely affect substrate functions or services after construction.

5.2.2 Suspended Particles/Turbidity (§230.21)

A temporary and localized increase in suspended particulates and turbidity levels is expected within the Project area during construction of the intake and outfall structures. Decreased light penetration would occur during periods of elevated turbidity that may reduce primary production and a temporary reduction in dissolved oxygen. Suspended particles resulting during construction would not result in detrimental effects to chemical and physical properties of the water column based on TCEQ water quality assessments and on the sediment, water, and elutriate sampling for the CCSC (Montgomery and Bourne 2018).

Implementing an appropriate SWPPP and minimizing activities that would resuspend bottom sediments while constructing the intake and outfall structures will reduce the potential increase in localized turbidity. During construction of the proposed intake and outfall structures, impacts associated with suspended particulates and turbidity would be minimized through mitigation measures to control the movement of suspended sediment particles, including silt screens, weighted turbidity curtains, and other appropriate methods specifically designed to minimize impacts.

No effect from suspended particles or turbidity is expected during operations: the slow water intake velocity of ≤ 0.5 ft/s will not create turbulence and therefore assures no effects to water quality by sediment resuspension in the immediate area of the proposed intake structure, as well as no effect on more distant seagrass beds. Additionally, the intake structure will be raised off the seafloor 5-10 feet to avoid potentially impacting the nepheloid layer present on the Texas Continental Shelf or negatively influencing the important role in sediment transport or the unique plant growth within the layer.

Regarding the discharge structures, the diffuser ports are on risers that will extend approximately 12 feet off the seafloor and be angled 60 degrees toward the water's surface. This will ensure proper mixing within the water column, avoid stirring up sediments on the seafloor during operation, and avoid any potential impacts on the function of the nepheloid layer.

5.2.3 Water (§230.22)

During construction of the intake and outfall structures, localized and temporary increases in turbidity, as described above, may temporarily impact water clarity and color.

Water clarity is expected to return to normal background levels shortly after the completion of construction activities. Temporary and localized depression of dissolved oxygen levels may occur because of increased sedimentation and turbidity during construction of the intake and outfall structures but are expected to quickly return to normal after completion of the construction activities. Additionally, no changes are expected due to nutrients and general chemical content of water. TCEQ has determined that Segment 2481 (Corpus Christi Bay), which contains the area of the proposed discharge in the CCSC, is not impaired with chemical contaminants. TCEQ Segment 2501_06 (Gulf, Port Aransas Area) is only impaired for limited fish consumption use for mercury in edible fish tissue.

5.2.4 Current Patterns and Water Circulation (§230.23)

Minimal alterations of the seafloor of the Gulf and the unvegetated bay bottom of the CCSC will result from the construction of the outfall structures and intake structure. Outfall discharges will be from the bottom of the channel and the Gulf seafloor, and the volume discharged and velocity of that discharge will be minor in comparison to the receiving waters of the Gulf and CCSC. Existing current patterns and water circulation will not be substantially impacted.

5.2.5 Normal Water Fluctuations (§230.24)

Alterations to the normal water fluctuations in the Project area are not expected. The comparative volume of the receiving waters of the Gulf and the CCSC is sufficiently high that the construction and operation of the Project would not impact daily, seasonal, or annual tidal fluctuations.

5.2.6 Salinity Gradients (§230.25)

Because of the marine and estuarine habitats present, natural salinity fluctuations characteristic of estuaries occur in the Project area, specifically in the CCSC area and in the Gulf area. For the CCSC location, large fluctuations in salinity occur naturally in this system on a day-to-day basis and throughout the year. Daily salinities can fluctuate from < 1 ppt to > 5 ppt, as well as experience large up or down changes over periods of days or weeks in response to droughts, excessive rainfall, or seasonal changes. Construction and operation of the Project will not obstruct or restrict the flow of freshwater into the Project area or otherwise reduce the volume of freshwater introduction that is already occurring.

The Gulf diffuser will allow discharge of up to 191.2 MGD to the Gulf through the high-rate diffuser. The hydrodynamic conditions in the Gulf (median ambient current is 0.27 meters per second) would result in rapid dilution of the proposed discharge, which would mix with the ambient tidal flow.

The CCSC diffuser will allow discharge of up to 95 MGD of brine through a high-rate diffuser to the CCSC. The hydrodynamic conditions in the CCSC near the Aransas Pass consist of high tidal velocities that generate high turbulence and maintain a deep channel turning into the Corpus Christi Bay. Average tidal flow measured in the CCSC has been estimated at 47,000 MGD (Parsons Environmental and Infrastructure, Inc. 2021). The proposed discharge of 95 MGD is 0.2% of that tidal flow and would be expected to rapidly mix in with the ambient tidal flow. Consequently, higher salinity around the CCSC diffuser represents only a small fraction of the total aquatic habitat area available in the ship channel.

The CORMIX Mixing Zone Model was used to predict salinity concentrations and includes worst-case scenarios (e.g., summer drought conditions, 95th percentile salinity and temperature inputs, slack tide) to estimate salinity. It is important to note that the CORMIX model output represents centerline concentrations and that concentrations decrease away from the centerline according to a Gaussian (normal) distribution.

At both outfall discharge locations, the initial effluent salinity is expected to rapidly dilute in the surrounding water column as a result of PCCA's installation of high-rate diffusers. Salinity modeling indicates that the maximum increase in receiving water salinity will be less than or equal to 2 ppt at a distance of 100 meters from the diffuser ports at the critical hydrologic condition.

The relatively small salinity increase from operation of the CCSC and/or Gulf diffusers falls well within the natural salinity fluctuations measured in the estuarine environment of Corpus Christi Bay and Gulf. Although the CCSC Outfall is located in the CCSC and not in the bay system (Nueces Estuary), tidal exchange will result in transport of a portion of the desalination facility effluent into the Corpus Christi Bay system. A SUNTANS hydrodynamic model of the Corpus Christi Bay system (LREWater, LLC 2019) was developed by PCCA to evaluate the CCSC discharge location. Results suggest that a maximum of 1 ppt salinity could result in the system away from the outfall, a highly saline water layer along the channel bottom will not occur, and salinity increases will be mitigated by the strong tidal force constantly driving water movement within the vicinity of the discharge (Appendix K). Based on modeling results, effluent discharges will not cause estuary-wide shifts of salinity gradients in view of the wide range of natural salinity variations that occur continuously in the Nueces Estuary.

The predicted changes in salinity will not be of sufficient magnitude or duration to cause effects on existing salinity gradients. Higher salinity from the effluent will be rapidly dispersed in the water column of the CCSC and Gulf. A localized area of elevated salinity will occur at a limited distance from the diffusers before dispersion to background salinity concentrations.

5.2.7 Threatened and Endangered Species (§230.30)

The following species effects determinations are based on species-specific habitat requirements for potentially occurring federally listed threatened and endangered (T&E) species, coupled with onsite habitat assessment and the proposed Project scope. Species presented below were identified as those with the potential to overlap Project area boundaries based on the USFWS Information for Planning and Consultation (IPaC) tool and NMFS Southeast Region ESA Section 7 and Essential Fish Habitat mapping applications. Effect determination definitions are listed below:

- **No effect**: The appropriate conclusion when the action agency determines its proposed action will not affect a listed species or designated critical habitat.
- **May affect, not likely to adversely affect**: The appropriate conclusion when effects on listed species are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any

adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgement, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.

- **May affect, likely to adversely affect**: The appropriate finding in a BA (or conclusion during informal consultation) if any adverse effects to a listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not discountable, insignificant, or beneficial. In the event the overall effect of the proposed action is beneficial to the listed species, but is also likely to cause some adverse effects, the proposed action "is likely to adversely affect" the listed species. If incidental take is anticipated to occur as a result of the proposed action, an "is likely to adversely affect" determination should be made. An "is likely to adversely affect" determination requires the initiation of formal section 7 consultation, under the ESA.

Qualified Geosyntec biologists conducted onsite protected species habitat assessments on November 5, 2024, in accordance with ESA Section 7(a) requirements. Prior to onsite habitat assessments, Geosyntec requested a USFWS IPaC Official Species List (Appendix M) and reviewed the NMFS mapping applications referenced above. The desktop review returned 16 T&E species with the potential to be found within the limits of the proposed Project. A summary of the assessed species and the anticipated effect determination is provided below in Table 4. Detailed discussion of the species' habitats and assessment of potential Project effects is included in the BA (Appendix M). The assessments determined that for every listed or proposed threatened or engaged species with potential to occur in the Project area, the anticipated effect was either No Effect or May Affect, Not Likely to Adversely Affect.

Table 4: Listed or Proposed Threatened and Endangered Species with Potential to Occur at the Project Site

Common Name	Scientific Name	ESA Status[1]	Critical Habitat in Action Area	Anticipated Effect Determination[2]
Birds				
Rufa red knot	*Calidris canutus rufa*	T	No	NLAA
Piping plover	*Charadrius melodus*	T	Yes, Final	NLAA
Northern aplomado falcon	*Falco femoralis septentrionalis*	E	No	NLAA
Whooping crane	*Grus americana*	E	No	NLAA
Eastern black rail	*Latterallus jamaicensis ssp. Jamaicensis*	T	No	NLAA
Attwater's greater prairie-chicken	*Tymanuchus cupido attwateri*	E	No	No Effect
Cartilaginous Fish				

Common Name	Scientific Name	ESA Status[1]	Critical Habitat in Action Area	Anticipated Effect Determination[2]
Giant manta ray	*Mobula birostris*	T	No	NLAA
Mammals				
Tricolored bat	*Perimyotis subflavus*	PE	No	No Effect
West Indian manatee	*Trichechus manatus*	T	No	NLAA
Plants				
South Texas ambrosia	*Ambrosia cheiranthifolia*	E	No	No Effect
Slender rush-pea	*Hoffmannseggia tenella*	E	No	No Effect
Reptiles				
Loggerhead sea turtle	*Caretta caretta*	T	NMFS: Yes, Final USFWS: No	NMFS: NLAA USFWS: No Effect
Green sea turtle	*Chelonia mydas*	T	NMFS: Yes, Final USFWS: No	NMFS: NLAA USFWS: No Effect
Leatherback sea turtle	*Dermochelys coriacea*	E	No	NMFS: NLAA USFWS: No Effect
Hawksbill sea turtle	*Eretmochelys imbricata*	E	No	NMFS: NLAA USFWS: No Effect
Kemp's Ridley sea turtle	*Lepidochelys kempii*	E	No	NMFS: NLAA USFWS: No Effect

[1] T = Threatened E = Endangered PE = Proposed Endangered

[2] NLAA = May Affect, Not Likely to Adversely Affect

5.2.7.1 Impacts to T&E Species

The two most significant sources of potential impacts that a desalination facility can have on the aquatic ecosystem are (1) impingement and entrainment (I&E) of aquatic life associated with the intake structure and (2) brine effluent from the outfall discharge. The Project's design and location accounts for and minimizes those impacts.

T&E species (sea turtles) and highly migratory species (e.g., sharks and whales) are not expected to be affected by the intake structure due to a combination of the following factors: lack of presence in the Project area, strong swimming abilities, large body sizes, birthing of fully formed neonates (e.g., shark pups and whale calves, instead of eggs and larvae), the design of the intake velocity caps, the presence of 3-inch bar screens, the depth of intake, and the distance of the intake from shore.

Juvenile and adult sea turtles are present in the vicinity of the Project area and have the potential to interact with the intake structure; however, the potential for neritic juvenile sea turtles to interact with the velocity caps is minimal. The design of the intake structure includes adding a 3-inch mesh bar screens at the entrances of the velocity caps to eliminate any potential for accidental "take" of juvenile turtles. This mitigation measure will also prevent adult sea turtles or larger fish from entering the velocity caps. A further discussion of impingement and entrainment of marine species can be found in Appendix E.

T&E species are not expected to be affected by the localized increases in salinity that will not exceed a salinity limit of 2.0 ppt (TPWD 2018a), which is considered protective of the marine environment, aquatic life, and wildlife, including spawning eggs and larval migration. Increased salinity is also within the range of natural salinity fluctuations that occur continuously in the Nueces Estuary.

5.2.8 Fish, Crustaceans, Mollusks, and Other Aquatic Organisms in Food Web (§230.31)

PCCA completed a verification survey of the oyster beds that could potentially be impacted within the inshore areas of the Project. This included an assessment of the CCSC outfall structure location and the finished water pipelines route from the facility to Aransas Pass. Due to the number of potential oyster beds, the finished water pipelines will be installed utilizing HDD and tunnel boring methods to avoid impacts (Figure 5).

During construction of the outfall diffusers and intake structure above the seafloor, temporary and localized impacts to nonmotile individual benthic organisms may occur, but long-term impacts to the benthic community are not expected. EFH present in the Project area include red drum, shrimp, reef fish, and coastal migratory pelagics. Highly migratory species in the Project area include tunas, swordfishes, sharks, and billfishes. Adverse effects to EFH are considered to be minor and will be temporary and localized within the footprints of the constructed outfall and intake structures. Sensitive habitats such as sea grasses are not present at the location of the structures due to water depth, and recolonization (including benthic colonization of the intake and outfall structures) would be likely after construction is complete. Construction activities would have a minor temporary localized impact on plankton due to increased turbidity levels. Potential reductions in primary productivity from turbidity would be localized around the immediate area of construction and would be limited to the time required for construction of the structures. The Project's construction and operation is expected to have minimal impacts on all life stages of aquatic organisms including fish, crustaceans, mollusks, plankton, and other food web organisms.

5.2.8.1 Impingement and Entrainment Evaluation

The following considerations indicate that the potential effects of I&E to Fish, Crustaceans, Mollusks, and Other Aquatic Organisms in Food Web, as well as other aquatic species, are expected to be minor:

- The design intake flow velocity at the entrance to the intake structure will fall below the USEPA-established limit of ≤0.5 ft/s (0.34 miles per hour) for power plants in other contexts, which is expected to drastically reduce the amount of marine life entering the velocity caps (and therefore greatly reduce I&E). USEPA (2011) reports that 96% of studied fish can avoid an intake structure when the entrance velocity is ≤ 0.5 ft/s. USEPA (2014) also reports that impingement mortality is reduced by 96% when the entrance velocity is ≤0.5 ft/s.

- The prevailing tidal velocities in the Gulf are generally higher than the entrance velocity of 0.5 ft/s at the intake structure. This combination suggests that, on average, eggs and larvae are more likely to pass by the velocity caps instead of being drawn in by them.
- The location of the intake structure is approximately 1.3 miles offshore of San Jose Island, away from shallow shoreline habitat (including seagrass beds) that comprises areas that may be used more widely by smaller species or for spawning and nursery habitat.
- The intake structure will be submerged at depth with approximately 20 to 25 feet of water overlying the velocity caps. This deeper placement will greatly limit or eliminate the withdrawal of positively buoyant eggs found at or near the surface of the Gulf.
- The intake structure entrances will be at least 5 feet above the seabed. This design feature will greatly limit or eliminate the withdrawal of demersal eggs and other benthic marine life species.
- I&E of eggs and larvae will be highly localized and will represent a small fraction of the total number of eggs and larvae present in the local aquatic ecosystem. Also, the vast majority of eggs and larvae would never encounter the proposed intake structure.
- Many estuarine species have high fecundities because > 99.9% of the nonadult life stages perish from natural causes without affecting the adult population structure; hence, these species have high built-in resiliencies to the loss of younger life stages.
- Because phytoplankton and zooplankton populations grow quickly, the small amount of biomass removed daily by the proposed water intake structures is expected to be replaced in a short amount of time. The proposed volume of desalination water withdrawal is very low relative to the total volume of the Gulf source water, and, therefore, any impacts to phytoplankton and zooplankton are too low to be demonstrable.
- The number of marine species potentially affected by I&E is further reduced by applying current technology, including bar screens that prevent certain marine life from entering the intake structure and traveling screens at the proposed desalination facility on Harbor Island that return marine life to a natural habitat.

The overwhelming majority of early life stages (ELSs) of the aquatic species present in the Gulf will not be impacted. In addition, none of the adult aquatic species or adult wildlife will be adversely affected.

As shown by decades of research on the effects of I&E, the impacts caused by I&E on fish populations and communities are small compared to other environmental impacts, such as overfishing, habitat destruction, pollution, or the introduction of invasive species. Specifically, reducing I&E has not been shown to result in measurable improvements in recreational or commercial fish populations (Barnthouse 2013).

A further discussion of impingement and entrainment of marine species can be found in Appendix E**.**

5.2.8.2 Salinity Effects

Similarly, the Project is expected to have little to no effect on fish, crustaceans, mollusks, and other aquatic organisms in food web related to brine discharge from the outfalls. Salinity modeling indicates that the maximum increase in receiving water salinity will be less than or equal to 2 ppt at a distance of 100 meters from the diffuser ports at the critical hydrologic condition. A salinity increase of no more than 2 ppt over ambient concentrations measured at 100 meters from the outfall has been recommended by TPWD and Texas General Land Office (TPWD 2018a), as approved during the State Office of Administrative Hearings (SOAH) hearing and the issued TPDES permit (No. WQ0005253000). This salinity increase of 2 ppt has been considered protective of the marine environment, aquatic life, and wildlife, including spawning eggs and larval migration. Additionally, marine organisms are adapted to the large natural salinity fluctuations characteristic of estuaries in the Project area, and a salinity tolerance range of 28 to 42 ppt has been reported (Stunz and Montagna 2015). Laboratory studies of salinity tolerance have reported tolerance greater than 45 ppt for sensitive larval stages.

The CCSC discharge location in the vicinity of the diffuser represents a deep, dredged navigational waterway under tidal influence that generally lacks the kinds of habitats favored by ELS estuarine aquatic species (e.g., extensive shallows, tidal wetlands, seagrass beds). Potential for salinity impacts will also be limited due to the typical exposure durations (which are considered to be short) to increased salinity over ambient concentrations in the immediate vicinity of the diffuser by ELS estuarine aquatic species moving through the water column, on the order of a few minutes to less than 35 minutes (during slack tide). Based on the general shape and depth of the effluent plume, as well as the spatial extent of the zone of initial dilution and the chronic aquatic life mixing zone in front of the diffuser, it is estimated that only a small fraction (< 1%) of ELS of the target aquatic species moving through the ship channel at any one time has the potential of contacting the elevated salinity from the effluent for even this limited amount of time. Finally, the width of the zone of initial dilution represents a small fraction of the total width of the CCSC.

Similarly, for the Gulf discharge location, potential for salinity impacts will also be limited by natural Gulf stream currents and diffuser design. Natural fluctuations in Gulf salinity levels vary to approximately 10 ppt or more throughout any given year (Appendix G). Although salinity effects will occur in localized portions of the water column around the outfall, these effects fall within ranges that reflect acceptable changes in salinity for the protection of habitats and estuarine organisms. Additionally, the zone of initial dilution (100 m) represents a miniscule fraction of the total volume of the Gulf.

Impacts to fish, crustaceans, mollusks, and other aquatic organisms are expected to be minimal in nature, as very little aquatic habitat will be impacted. Impacts could occur to benthic organisms during in-channel installation of the outfall pipe but are expected to be temporary and minimal in nature and not impact the species as a whole.

5.2.9 Other Wildlife (§230.32)

5.2.9.1 Migratory Birds

A species report of the Project area, requested through the Avian Knowledge Network (AKN) online phenology tool, included 350 species (AKN 2024). The AKN compiles data derived from survey, banding, and community science datasets. Critical nesting and foraging habitats were not identified within the Project area, and permanent impacts to migratory birds are not expected. Based on the review of federally maintained species listed for the Project area, species habitat requirements, and onsite assessment, impacts to migratory birds are unlikely. To minimize potential impacts to migratory species with the potential to nest within upland areas within the Desalination Facility Site, vegetation removal will be limited to periods outside the March–June nesting season. Should clearing be required during the nesting season, a nest clearance survey will be conducted to locate and buffer active nests until such a time as the nest fails or chicks fledge. Migratory birds have the potential to forage in the Project area; however, because of the mobile nature of these species, impacts are unlikely.

Adverse effects to migratory birds will not occur due to the water depth of the intake and outfall structures, which will prevent impacts. The localized increases in salinity will not exceed 2 ppt (TPWD 2018a), which is considered protective of the marine environment, aquatic life, and wildlife, including spawning eggs and larval migration. Increased salinity is also within the range of natural salinity fluctuations that occur continuously in the Nueces Estuary and the Gulf.

5.2.9.2 Reptiles and Amphibians

According to the iNaturalist community science online tool, which compiles ecological observations from its nationwide system of users, 75 species of reptile and amphibian have been observed within Nueces County, Texas. Twenty-six species of herptiles have been identified within the Port Aransas Nature Preserve, with four comprising introduced species. However, no reptiles or amphibians were identified by the iNaturalist website as observed within the Project area. Three introduced species were recorded by the iNaturalist community immediately south of the Project area, across the ship channel, within Port Aransas proper. Herptiles were not observed during the onsite assessment. Based on the historic disturbance and current vegetation maintenance within the proposed facility location, poor onsite habitat, and Project adherence to avoidance/conservation measures, impacts to native or sensitive reptile and amphibian species are unlikely.

The localized increases in salinity will not exceed a salinity of 2 ppt (TPWD 2018a), which is considered protective of the marine environment, aquatic life, and wildlife, including spawning eggs and larval migration. Increased salinity is also within the range of natural salinity fluctuations that occur continuously in the Nueces Estuary and the Gulf.

5.2.9.3 Mammals

Marine mammals are known to occur in the vicinity of the Project area. Also, all these species have large body sizes and give birth to live offspring with strong swimming abilities. Covering the openings of the velocity caps with 3-inch mesh bar screens to prevent entrance by neritic juvenile sea turtles will also preclude any possibility of entrance by marine mammals. Marine mammals are not expected to be affected by I&E.

The localized increases in salinity will not exceed 2 ppt (TPWD 2018a), which is considered protective of the marine environment, aquatic life, and wildlife, including spawning eggs and larval migration. Increased salinity is also within the range of natural salinity fluctuations that occur continuously in the Nueces Estuary and the Gulf.

5.2.10 Sanctuaries and Refuges (§230.40)

Review of the Integrated Biodiversity Assessment Tool Data Map identified the Port Aransas Nature Preserve and the Mission-Aransas National Estuarine Research Reserve near the proposed Project location, but not within the Project area. The Port Aransas Nature Preserve, managed by City of Port Aransas, is located across the CCSC from the Project Site and is situated on Mustang Island adjacent to the City of Port Aransas. The Mission-Aransas National Estuarine Research Reserve, managed by the University of Texas, is a large marine protected area comprising portions of Redfish Bay and South Bay east of the Project area. Both areas are separated from the Project area by dredged channels maintained by USACE (Figure 6).

In June 2000, Redfish Bay was designated a state scientific area by the Texas Parks and Wildlife Commission to protect and study native seagrasses. The Redfish Bay State Scientific Area contains the northernmost extensive stands of seagrass on the Texas coast. This includes 14,000 acres of submerged seagrass beds, with all five species of seagrass found in Texas present. The Redfish Bay State Scientific Area is a component of both the Aransas and Corpus Christi ecosystems. In three shallow and popular fishing areas, voluntary “prop-up” zones were marked with posts and signs visible to boaters in the area from 2000 through 2005. However, these zones were largely ineffective in reducing seagrass damage (TPWD 2018c).

Portions of the proposed Project area are located within the Redfish Bay State Scientific Area since the boundary extends around the upland area of Harbor Island and Light Lakes upland areas. However, no impacts will occur to this area due to the location of the discharge in adjacent to the CCSC and separation from Redfish Bay by upland areas and the intake and outfall structures in the Gulf and CCSC. While the Project is located in proximity to special aquatic sites (as is required to fulfill its basic purpose), it proposes no impacts to those sites.

5.2.11 Wetlands (§230.41)

Construction of the proposed Project will result in the temporary impacts to WOTUS through construction of Supporting Infrastructure in wetlands, specifically the finished water pipelines. Wetland impacts for the finished water pipelines will be minimized by utilizing HDD and/or tunnel boring methods. After Project completion, wetlands impacted by temporary construction measures will be returned to pre-construction conditions. The top 12 inches of soil within disturbed wetlands will be segregated from other excavated soils to preserve the existing seed bank. When construction ceases in wetland areas, soils will be returned, and the segregated seed soils will be returned to the surface.

The habitat that occurs at the CCSC discharge location is estuarine and marine deep-water habitat classified as an Estuarine (E) Subtidal (1) Unconsolidated Bottom (UB) Subtidal (L) (E1UBL). This deep-water tidal habitat has an unconsolidated bottom that lacks substantial shallows or seagrass beds, contains armored shoreline, and is characterized by the substantial depth (about 60 feet) and width (about 1,200 feet) of the CCSC. At the proposed Gulf discharge and intake location, the WOTUS are characterized as Marine (M) Subtidal (1) Unconsolidated Bottom (UB) Subtidal (L) (M1UBL).

No sensitive wetland vegetation (e.g., seagrass beds) is present in the area of the intake and discharge locations. Extensive wetlands, seagrass beds, and other shallow estuarine habitats are present in the surrounding bays. Unavoidable temporary impacts to wetlands will result during construction of the proposed Project. The primary impacts during construction for the intake and discharge locations will be to deep open water habitats.

5.2.12 Mud flats (§230.42)

There are no mud flats in the Project area.

5.2.13 Vegetated shallows (§230.43)

No vegetated shallows such as seagrass are present at the location of the intake and outfall structures. Seagrass habitat is present along the route of the finished water pipelines, but impacts will be minimized by utilizing HDD methods.

5.2.14 Coral and Oyster Reefs (§230.44)

Coral reefs are not present in the Project area. Oyster reef habitat is not present at the location of the intake and outfall structures. Oyster reefs are present along the route of the finished water pipelines, but impacts will be minimized by utilizing HDD methods.

5.2.15 Riffle and Pool Complexes (§230.45)

No riffle or pool complexes are present in the Project area.

5.2.16 Municipal and Private Water Supplies (§230.50)

Review of TWDB data showed no private or public or groundwater well sources within 5 miles of the proposed Desalination Facility Site boundary. No impacts to groundwater or public/private supply wells are anticipated. The proposed Project would create a 100-million-gallon-per-day marine seawater desalination facility to produce a reliable and droughtproof finished water supply, which would be additive to current supplies, thus creating a positive impact.

5.2.17 Recreational and Commercial Fisheries (§230.51)

The Project area is between Corpus Christi Bay and Redfish Bay. These bays are utilized by commercial fisheries, recreational fishing, and fish processing facilities adjacent to the Project area. Construction of the Project, including construction of the intake and outfall structures, as well as temporary impacts to wetlands along the finished product water pipelines, are not expected to have more than short-term impacts to recreational or commercial fisheries.

In Texas, commercial and recreational fishing is regulated by TPWD and by the Magnuson-Stevens Fishery Conservation and Management Act. TPWD maintains regulatory authority of recreational fisheries, which includes fish and other aquatic organisms, habitat, and “users” of the fisheries. This applies to anglers, boaters, birdwatchers, and any other party that uses an aquatic resource (TPWD 2018b). Additionally, TPWD regulates commercial fishing, which is defined as any activity that involves taking or handling fresh or saltwater aquatic resources/products for pay or purpose of barter, sale, or exchange. TPWD manages marine waters extending 9 nautical miles (10 statute-miles) off the coast of Texas (TPWD 2018b).

The distribution of species differs based on multiple ecological factors, including salinity, season, primary productivity, and bottom substrate. These factors differ widely across the Gulf and between the inshore, nearshore, and offshore waters. The proposed Project area encompasses estuarine, and marine waters within the immediate vicinity of the inshore pipelines and offshore pipelines and are utilized for commercial and recreational fisheries.

Recreational fishing occurs within Corpus Christi Bay and Redfish Bay. Effects to recreational and commercial fisheries are not anticipated as there are minimal impacts to the marine food web that are not expected to result in significant population level effects.

An evaluation of I&E includes species of commercial and recreational importance and the potential for I&E is species- and life-stage specific. Both minimal and high impact potential for I&E of eggs and larvae may occur depending on the species. However, when viewed within the context of all of the eggs and larvae present in the vicinity of the Project area, the potential for I&E would be considered to be minor when viewed on a larger population level scale.

As shown by decades of research on the effects of I&E, the impacts caused by I&E on fish populations and communities are small compared to other environmental impacts, such as overfishing, habitat destruction, pollution, or the introduction of invasive species. Specifically, reducing I&E has not been shown to result in measurable improvements in recreational or commercial fish populations (Barnthouse 2013).

The increases in salinity will not exceed 2 ppt at a distance of 100 meters from the diffusers (TPWD 2018a), which is considered protective of the marine environment, aquatic life, and wildlife, including spawning eggs and larval migration. Increased salinity is also within the range of natural salinity fluctuations that occur continuously in the Nueces Estuary and the Gulf. Therefore, impacts to recreational and commercial fisheries are not expected.

The proposed Project inshore treated waterline will be constructed in estuarine and marine waters between Harbor Island and Aransas Pass. The proposed Project offshore intake and outfall pipes will be constructed in the marine waters of the Gulf. The Redfish Bay State Scientific Area, which includes Redfish Bay, South Bay, and intersecting channels, supports many recreational fishing opportunities due to its varied habitat (TPWD 2018b).

The inshore treated water pipelines will cross the Redfish Bay State Scientific Area (RBSSA) for a total of about 4.2 miles; however, all open water and environmentally sensitive areas will be crossed using HDD. Impacts on commercial and recreational fisheries are not expected to be significant or result in a significant reduction in populations for any commercially and/or recreationally important species that occur in the proposed Project area. Although inshore pipeline installation will result in impacts on the islands through trenching and HDD placement, aquatic habitats will be crossed using the HDD methodology, which avoids impacts on the crossed features. Further, temporary impacts on the island will be restored upon completion of the construction. Offshore pipe installation impacts will be limited to the above seabed intake and outfall structures, as well as the navigational aids. These impacts are considered negligible.

5.2.18 Water-Related Recreation (§230.52)

The nearest public recreational facility is the Roberts Point Park Pavilion and launch, approximately 0.42 miles south of the proposed CCSC outfall location. An active port channel separates the boat ramp from the proposed outfall. Due to the proposed locations of the Desalination Facility Site, the intake and outfall structures, the finished water pipelines, and associated Project infrastructure, and the construction methodologies for each, no impacts to current recreational use, such as kayaking, or other activities, are anticipated.

5.2.19 Aesthetics (§230.53)

The proposed Project will be constructed within a disturbed area previously used as former oil export facilities. During construction of the pipelines and inshore/offshore pipes, the view shed for areas directly adjacent to the construction area would be disrupted by the presence of trucks, dust, temporary employees, and other construction activities. The Project area is mostly undeveloped and is unoccupied, consisting mostly of low relief uplands with ditches and wetlands limited to the edge of the bay. Some standing facilities are present within the Project area boundaries. Redfish Bay borders the Project area on the north and west with Aransas Channel to the east and CCSC to the south. Potential impacts to the view shed will be managed through detailed requirements in the construction documents, for such things as controlling dust and limiting work hours. Discharge of dredged or fill material during construction of the Project is not expected to impact the aesthetics of the aquatic ecosystem or the larger Project area.

5.2.20 Parks, National and Historical Monuments, National Seashores, Wilderness Aesthetics (§230.54)

Roberts Point Park and Port Aransas Nature Preserve are located across the CCSC from Harbor Island. The Mission-Aransas National Estuarine Research Reserve is located approximately 0.4 miles north of the Project area. The Aransas National Wildlife Refuge is located approximately 21 miles northeast of the Project area. The Padre Island National Seashore is approximately 28 miles southwest of the Project area. No impacts are anticipated.

6. PUBLIC-INTEREST REVIEW FACTORS

Evaluating the public-interest criteria for the Project involves three overarching considerations: (1) the relative extent of the public and private need for the Project; (2) the practicability of using alternative locations and methods to accomplish the objective; and (3) the extent and permanence of beneficial or detrimental effects on uses to which the area is suited. (33 CFR § 320.4(a)(2)).

First, the relative need for the Project is dire. The Coastal Bend Region has experienced—and is currently experiencing—recurring drought, with each successive drought reducing water supplies on a long-term basis. At the same time, long-term water demand is projected to grow.

Second, as described in the Alternatives Analysis (Appendix J), the Project, as proposed, demonstrates practicability and maximum environmental effectiveness for accomplishing the Project's objective.

And third, the permanence of the beneficial effects from the Project—namely, a reliable, drought-proof water supply—greatly outweigh any adverse effects from construction and operation of the Project.

6.1 Conservation [§320.4(a)]

The proposed Project largely avoids and minimizes impacts to WOTUS, T&E species (or habitat), or cultural resources. WOTUS impacts will be avoided or considered *de minimis* per CWA Section 10, 401, 402 and 404. Impacts to special aquatic sites will be temporary or otherwise avoided, and the impacts to the Gulf seafloor and unvegetated bay bottom are *de minimis*. The Project incorporates extensive HDD and tunneling efforts to avoid areas of environmental and cultural sensitivity.

The Project aims to meet critical water needs for the Coastal Bend Region while also conserving the region's important environmental resources. The Project's design incorporates the best technology available to minimize effects on the aquatic ecosystem. Design and location of the intake structure minimize effects related to I&E of aquatic life, and design and locations of the outfall structures minimize effects related to salinity from brine discharge. Despite spanning a large area, the Project proposes less than three acres of temporary wetland impacts, as well as minimal WOTUS impacts related to the construction of the intake and outfalls. The two most significant potential sources of impacts that a desalination facility can have on the aquatic ecosystem are (1) I&E of aquatic life associated with the intake structure and (2) brine effluent from the outfall discharge. The proposed Project is not expected to have significant direct or cumulative adverse impacts on the aquatic environment.

The use of the best technology available to minimize effects on the aquatic environment for the intake structure and diffusers at the outfall is included in the Project design. For example, submerged jet diffusers, which have the least environmental impact, are proposed for discharge of the brine effluent, and intake engineering design is consistent with power plants with regard to Section 316(B) of the CWA rules (although not required for desalination plants) to minimize I&E. Although some intake of marine life is inevitable with the intake structure for the Project Area in the Gulf, the potential effects to marine species and their local populations are expected to be minor due to the addition of technology to deter marine life from entering the intake and the addition of the marine life control system for the marine life that does enter the system. The recommendations provided by TPWD (2018a) to protect marine organisms for diversions have been incorporated into the design of the intake structure. Similarly, to protect marine life from brine effluent discharges, a salinity increase of 2 ppt at 100 meters from the diffusers (i.e., at the boundary of the mixing zone) recommended by TPWD (2018a) will be utilized for the TPDES water discharge permit.

6.2 Economics [§320.4(a) & (q)]

Once constructed, the Project will provide substantial economic benefits through a reliable supply of drought-proof water for the region. During construction, it will create jobs for local workers and opportunities for contractors and suppliers, providing a boost to the local economy. Once operational, the desalination facility will support long-term employment and contribute to sustained economic growth. By improving water reliability, the Project will reduce costs for businesses and attract new industries to the area. This will expand the regional tax base, strengthen economic stability, and encourage further development.

Adverse impacts to socioeconomics during the phases of the proposed Project will be negligible. The proposed Project is not being constructed in any portion of a major navigational fairway; as such, routine maritime activity is expected to continue undisturbed during construction and operation.

6.3 Aesthetics [§320.4(a)]

The proposed Project will be constructed within a previously disturbed area used for former oil export facilities. During construction of the pipes, the view shed for areas directly adjacent to the construction area would be disrupted by the presence of trucks, dust, temporary employees, and other construction activities. The Project area is mostly undeveloped and is unoccupied, consisting mostly of low relief uplands with ditches and wetlands limited to the edge of the bay. Some standing facilities are present within the Project area boundaries. Redfish Bay borders the Project area on the north and west with Aransas Channel to the east and CCSC to the south. Potential impacts to the view shed will be managed through detailed requirements in the construction documents, for such things as controlling dust, limiting work hours, etc. Supporting Infrastructure for the Project is largely buried underground or located many feet below the water surface.

6.4 General Environmental Concerns [§320.4(a)]

The proposed Project will have minimal impacts to wetlands and no adverse impacts to receiving streams, T&E species (or habitat), or cultural resources. WOTUS impacts are temporary or insignificant, and impacts to the Gulf are *de minimus* per Sections 10, 401, 402 and 404 of the CWA. The two most commonly cited environmental concerns associated with desalination projects—I&E and brine effluent—have been thoroughly addressed through design and site location in order to minimize any adverse effects to the aquatic environment.

6.5 Wetlands [§320.4(a) & (b)]

Relying on tunneling and HDD technologies, the Project proposes less than three acres of temporary impacts to wetlands, as well as minimal permanent impacts to ”other water” from placing rock around the intake and outfall structures for erosion protection, and impacting small areas of unvegetated Gulf seafloor and bay bottom.

6.6 Historic, Cultural, Scenic, and Recreational Values [§320.4(a) & (e)]

6.6.1 Cultural Resources

This Project will not impact any known cultural resources. The National Register of Historic Places lists the Tarpon Inn (0.9 miles) and the Aransas Pass Light House (1.2 miles) within the vicinity of Harbor Island. The proposed Project will not affect either of these locations. Additionally, extensive cultural resource reviews, especially marine archaeology surveys, were conducted for several Environmental Impact Statements (mainly Bluewater Texas and the Channel Deepening Project), as well as cultural resource surveys related to the Project, in this vicinity. A review of the THC online database was also performed. The proposed Project will not affect any resources documented in these surveys.

6.6.2 Tribal Trust

No impacts to Tribal resources are anticipated. Tribal coordination will be completed as part of the National Historic Preservation Act Section 106 coordination for the proposed Project.

6.7 Fish and Wildlife Values [§320.4(a) & (c)]

Long-term impacts to fish and wildlife or their habitats will not result from the construction of the Project and its discharge and intake structures. Temporary impacts will result during construction of the discharge and intake structures.

No effects are expected for wildlife species based on the lack of suitable habitat (e.g., Estuarine and Marine Deepwater habitat) and the state- and federal-listed species are highly mobile or transitory and, if present, could avoid the small area of elevated salinity, which mimic natural ambient fluctuations.

Potential exposure to effluent-related increased salinity via direct contact or ingestion/uptake represents only a minor pathway to aquatic-dependent wildlife species (including T&E species); hence, no impacts to birds and mammals are expected due to isolated small areas of elevated salinity (i.e., mixing zones), which mimic natural fluctuations. Aquatic-dependent wildlife species are not likely to use the deep-water habitats, do not forage in deep water sediments, and would not be exposed by direct contact or dietary intake, as salt is not a bioaccumulative substance.

Impacts to fish and wildlife are not expected because localized increases in salinity will not exceed 2 ppt (TPWD 2018a), which is considered protective of the marine environment, aquatic life, and wildlife, including spawning eggs and larval migration. Increased salinity is also within the range of natural salinity fluctuations that occur continuously in the Nueces Estuary and the Gulf.

As shown by decades of research on the effects of I&E, the impacts caused by I&E on fish populations and communities are small compared to other environmental impacts, such as overfishing, habitat destruction, pollution, or the introduction of invasive species. Specifically, reducing I&E has not been shown to result in measurable improvements in recreational or commercial fish populations (Barnthouse 2013).

6.8 Floodplain Hazards, Values, and Management [§320.4(a) & (l)]

The entirety of the proposed Project is within the Texas Coastal Management Zone. Use of tunneling and HDD construction methods will avoid any sensitive shallow water and shoreline habitat, as well as surface impacts, because the pipes will be relatively deep. PCCA has completed a storm surge analysis including the potential impact of sea level rises in Texas due to climate change, as needed. For simulating storm surge events of 50-, 100-, 250-, and 500-year return periods, PCCA will update the model as required.

6.9 Land Use [§ 320.4(a)]

Currently, the Project area is mostly undeveloped with some residential/commercial properties and was historically constrained to industrial land use. Surrounding land use is comprised largely of Aransas terminal company and residential land.

6.9.1 Recreational Use

The Project area is comprised of several parcels, mainly owned by PCCA and Redfish Bay Properties, with some parcels privately owned with restricted access. No recreational use takes place within the upland limits of the Project area, although recreational fishing does occur near the Project area. Impacts on commercial and recreational fisheries from the Proposed Project would be avoided, with minimal impacts located at the outfall and intake structures.

6.9.2 Special Management Areas

Portions of the proposed Project area are located within the Redfish Bay State Scientific Area. However, no impacts will occur to this area due to the location of the intake and outfall structures in the Gulf and CCSC.

6.10 Navigation [§320.4(a) & (o)]

In general, the Project is designed to avoid impacts to navigation from the subsea intake and outfall structures. The rules in Title 33 CFR (33 CFR Part 149 Subpart E), prescribe the aids to navigation. The rules also prescribe standards for optional aids, primarily buoys, which might be used to mark maneuvering lanes and the anchorage. Shipping and navigation resources within the vicinity of the proposed Project include anchorages areas, dredged navigation channels, intracoastal waterways, recreational fishing areas, and ports. PCCA is in discussions with the United States Coast Guard (USCG) on suitable private aids to navigation to mark the locations of the structures above the seabed. The proposed aids to navigation will be installed through coordination with the USCG following project authorization by USACE.

For the Project's offshore components (13.3 miles of subsea pipe) and a Gulf intake structure and outfall structure), locations were chosen to avoid anchorage areas offshore of Port Aransas that allow vessels to anchor while waiting to enter port.

For the Project's inshore components (finished water pipelines and the CCSC diffuser), construction methodology and location choice will minimize any impacts to navigation. Additional navigation aids developed with the USCG will further minimize impacts.

6.11 Shore Erosion and Accretion [§320.4(a)]

The outfall adjacent to the CCSC will be constructed using best management practices (BMPs) utilizing riprap to prevent shoreline erosion and scour. No other portion of the Project is expected to cause shore erosion and accretion.

6.12 Water Supply and Conservation [§320.4(a) & (m)]

No water supply wells or intakes are on or within close proximity to the Project area.

Construction activities associated with the proposed Project are not expected to have a significant impact on regional groundwater flow patterns. Shallow aquifers would quickly reestablish equilibrium if disturbed, and turbidity levels would rapidly subside. Impacts on deeper aquifers are not anticipated.

No impacts to public water supplies are anticipated. The nearest designated public water supply well is a groundwater well operated by the City of Aransas Pass located approximately 6 miles northwest of the Project area. Texas Water Development Board well data indicates that this well is maintained on standby for emergency purposes.

6.13 Water Quality [§320.4(a) & (d)]

Water quality involves the existing water quality conditions within the vicinity of the proposed Project and the anticipated potential environmental impacts associated with the construction and operation of the proposed Project to water quality of onshore, inshore, and offshore groundwater and waterbodies. Potential impacts to water quality include impacts from construction and operation of the desalination facility and the intake and outfall pipes. Temporary, minor impacts on groundwater quality and flow could occur during construction for the onshore pipes and pipelines; however, water levels will likely reestablish equilibrium, and total dissolved solid levels will subside shortly after construction. Dewatering of the drilling mud from the tunneling operation could lead to temporary minor impacts to turbidity in the bay along Aransas Channel.

HDD installation of inshore pipeline water crossings will minimize the impact of construction on suspended sediment and water quality. Offshore structures may result in temporary, minor turbidity increases due to suspension of seafloor sediments in the immediate vicinity; however, impacts will subside quickly. Normal operation of the onshore, inshore, and offshore components will not result in impacts on surface water quality.

Localized resuspension of sediments resulting in elevated turbidity will occur during construction of the intake and outfall structures. Impacts on the water quality of the surrounding area will be temporary and minimal. BMPs such as silt screens and weighted turbidity curtains may be utilized to reduce suspended sediments if determined to be appropriate or necessary.

No concerns with contaminated sediments have been documented in the Project area. Several published evaluations of historical sediment quality data show that researchers and regulatory authorities do not consider the substrate in Corpus Christi Bay to be impacted by contaminants at levels of regulatory concern. TCEQ sets state-wide water quality standards based on a series of pollutants. TCEQ has determined that Segment 2481 (Corpus Christi Bay), which contains the area of the proposed discharge in the CCSC, is not impaired with chemical contaminants. TCEQ Segment 2501_06 (Gulf, Port Aransas Area) is only impaired for limited fish consumption use for mercury in edible fish tissue.

Sediment, water, and elutriate sampling for the CCSC has been conducted in accordance with Marine Protection Research and Sanctuaries Act Section 103 to evaluate potential environmental effects associated with dredging and open water ocean placement. No potential for adverse bioaccumulation effects were reported for sediments (Montgomery and Bourne 2018). Sediment quality will likely not be impaired, and the resuspension of bioaccumulative compounds from such a small spatial scale are not likely to cause adverse effects on aquatic life or wildlife species.

Submerged jet diffusers, designed to rapidly mix the brine effluent with ambient seawater, are proposed for the discharge locations, and this technology has the least environmental impact. Salinity modeling indicates that the maximum increase in receiving water salinity will be less than or equal to 2 ppt at a distance of 100 meters from the diffuser ports at the critical hydrologic condition. A salinity increase of 2 ppt over ambient measured at 100 meters from the outfall has been recommended by TPWD and Texas General Land Office (TPWD 2018a). This salinity increase of 2 ppt has been considered protective of the marine environment, aquatic life, and wildlife, including spawning eggs and larval migration. Additionally, marine organisms are adapted to the large natural salinity fluctuations characteristic of estuaries in the project area, and a salinity tolerance range of 28 to 42 ppt has been reported (Stunz and Montagna 2015). Laboratory studies of salinity tolerance have reported tolerance greater than 45 ppt for sensitive larval stages. Potential for salinity impacts will also be limited due to the typical exposure durations (which are considered to be short) to increased salinity over ambient concentrations in the immediate vicinity of the diffuser by ELS estuarine aquatic species moving through the water column, on the order of a few minutes to less than 35 minutes (during slack tide). Modeling results also indicate that the proposed effluent discharge would not exceed the applicable Texas surface water quality standards for temperature.

Notably, the TCEQ issued TPDES Permit No. WQ0005253000 for the CCSC Outfall, deeming it protective of water quality, the marine ecosystem, and aquatic life.

6.14 Energy Needs, Energy Conservation and Development [§320.4(a) & (n)]

The PCCA environmental policy includes promoting pollution prevention and environmental awareness by taking steps to conserve resources through energy conservation and recycling. AEP Texas, a unit of American Electric Power (AEP), operates a 69-kilovolt overhead power line that runs from the City of Aransas Pass to Port Aransas. PCCA will coordinate with AEP to upgrade the existing service or install a parallel service and substation to support the Project. Through initial discussions with AEP, the routing, permitting and construction of the electric transmission line would be under the sole control of AEP and is therefore considered a separate project.

6.15 Safety [§320.4(a)]

In case of an emergency during construction of the proposed Project, the public services closest to the incident would be most likely to respond. There are numerous police and other emergency responders in the Project area, including the USCG Corpus Christi that would be available to respond to emergencies during construction of the proposed Project. It is anticipated that compliance with safety BMPs and standard practices would avoid emergency incidents, but should they occur, available responders in the study area have adequate capacity and skills to respond appropriately.

Safety measures will be taken to avoid increasing the current safety risk associated with any construction traffic and equipment deliveries on local public roadways.

6.16 Consideration of Property Ownership [§320.4(a) & (g)]

The proposed Project takes into consideration property ownership, relying on Port-owned parcels for the Desalination Facility Site and choosing locations and construction methodologies that minimize impacts to property owners. Overall, the Project will result in a positive effect on property ownership resulting from increased commercial value of the Harbor Island property.

In 2024, an easement was obtained from the Texas General Land Office for the placement of structures and pipes on State owned lands. An amendment for the diffuser in the Gulf is being sought concurrently with this authorization.

6.17 Needs and Welfare of the People [§320.4(a)]

The Project's overall purpose addresses a critical need of the people of the Coastal Bend Region—a reliable, drought-proof water supply. Without this reliable water supply, the residents, businesses, and industry of the region will continue to be negatively impacted by worsening drought conditions and responsive measures. The Project will create a new, drought-proof water supply for the entire region as it continues to grow.

6.18 Other Federal, State, or Local Requirements [§320.4(j)]

Required federal, state, and local permits or authorizations necessary for construction are currently pending or will be obtained prior to construction.

6.19 Environmental Benefits [§320.4(p)]

Desalination is a proven technology converting saltwater resources into freshwater to meet water needs in a region. The United States uses desalination plants to supplement water supplies; for example, San Diego, California, gets approximately 10% of the usable water from desalination. The PCCA Project will assist with the local water supply needs in a manner that is consistent with the Texas Water Development Board State Water Plan. In addition, by reducing the freshwater resources removed from the natural streams and rivers, the additional natural flows will flow into Nueces Bays and inshore areas.

6.20 Invasive Species

Introduction of new invasive species is unlikely and will be further managed through use of typical BMPs associated with vegetation restoration in disturbed areas, as required by the TCEQ

Construction General Permit for stormwater discharges (i.e., no planting of invasive species, use of certified seed mixes, onsite monitoring, and treatment of existing invasive species).

7. DETERMINATION OF CUMULATIVE EFFECTS ON AQUATIC ECOSYSTEMS [§230.11(G)]

Cumulative effects to the aquatic ecosystem are the collective result from changes attributable to a number of individual discharges of dredge and fill material from multiple activities that occur in a particular waterbody that persist over time. Cumulative effects may occur when there are repetitive permitted activities in a specific waterbody and the resources in that waterbody are not able to fully recover between each occurrence of a permitted activity.

The cumulative effects analysis for the aquatic ecosystem considers potential cumulative impacts to the offshore and adjacent shoreline area, which may be influenced by the proposed Project. Potential contributing activities considered in this analysis include other planned seawater desalination facilities. There are four proposed seawater desalination plants in the Corpus Christi, Texas, area that have submitted environmental permit applications and are under review by TCEQ. These include the City of Corpus Christi Inner Harbor, City of Corpus Christi La Quinta Channel, Port of Corpus Christi La Quinta Channel, and the proposed action at Harbor Island. A fifth desalination plant, Corpus Christi Polymers, located on the upper reaches of the Inner Harbor, is already permitted but not yet operational. These proposed plants (Figure 7) are located in Corpus Christi Bay, at minimum 12 miles away from the proposed Project area located in the Gulf.

The proposed Project is not expected to have significant adverse impacts on the aquatic environment when considering the cumulative effects of other planned seawater desalination facilities. Most impacts will be temporary and localized within the construction areas of the intake and outfalls. The proposed Project in combination with other planned projects, either recently completed, ongoing, or proposed within the Project area, are not expected to result in significant cumulative effects to the aquatic ecosystem. Along with bathymetry and freshwater inflows, water circulation and salinity levels are largely dictated by the tidal forcing, which governs the exchange of water between the bay systems and the Gulf. The SUNTANS model indicates that the increase in ambient salinity (resulting from the Harbor Island desalination brine discharge) will not continuously increase over time in the vicinity of the discharge. The tidal forcing near the discharge location is sufficiently strong to result in near constant water column mixing, which minimizes any increases in salinity resulting from the brine discharge. Given that the other desalination facilities are approximately 12 miles away, mixing of effluent levels is unlikely (Appendix L).

The majority of effects are anticipated to be negligible to minorly adverse regarding habitats present within the construction areas.

Currently, no other offshore seawater desalination facilities are proposed within the region. Each of the proposed desalination facilities would be required to comply with applicable CWA, ESA, TCEQ Water Quality and other regulatory requirements designed to protect the aquatic ecosystem, which would minimize impacts. Although each of the desalination projects considered may have different impacts based on their location and project design, the proposed Project, in conjunction with other desalination projects, would not contribute to a significant cumulative effect on the aquatic ecosystem due to its distance from the other facilities and offshore components (Appendix L).

7.1 Determination of Secondary Effects on the Aquatic Ecosystem

Secondary impacts from the Project—such as I&E and salinity analyses—have been discussed thoroughly throughout this application. No other known secondary impacts exist, such as additional infrastructure or fluctuating water levels, that would contribute to secondary effects.

8. MITIGATION [§320.4(r)]

The Project does not propose any significant resources losses that are specifically identifiable, reasonably likely to occur, and of importance to the human or aquatic environment. No mitigation is required.

8.1 Avoidance and Minimization

Instead, to the greatest extent practicable, the Project has been designed to avoid impacts to jurisdictional wetlands and other waters. The Project layout was adjusted multiple times to achieve this objective.

Impacts have been avoided and minimized, to the extent practicable, by utilizing the most efficient construction techniques to reduce the temporary impacts to wetlands, as well as the use of tunneling and HDDs to reduce the impacts to the bay, Gulf, and sensitive receptors.

As part of Project restoration plans, portions of the pipeline right-of-way (ROW) temporarily impacted, including wetlands and floodplains, will be restored to pre-construction conditions and contours. The applicant will work with USACE and other state and local agencies during the permitting process to ensure wetlands are protected during construction and operation of the Project.

The proposed Project has been designed to limit impacts to sensitive receptors and habitats to the greatest extent possible. The following BMPs have also been incorporated into the proposed Project to reduce impacts:

- Implement tunneling or HDD methodology for the Intake, outfalls, and finished water pipelines within WOTUS.
- Design outfall diffusers to minimize salinity concerns.
- Vessel Strike Avoidance and Injured/Dead Protected Species Reporting will be followed by all Project construction and support vessels per NMFS guidance.
- Plan construction to avoid sea turtle nesting season.
- Environmental monitors may be employed during construction of inshore and offshore Project components, as necessary or as a condition of the permits.
- Mapped sensitive features (e.g., cultural resources, seagrass beds, wetlands and oyster beds) will be marked and avoided during construction and operation.
- Plan construction to avoid migratory bird nesting, and follow seasonal restrictions applied by the NMFS to marine species.

- Follow standard best management practices to avoid impacts to waters of the US. Segregate the topsoil of the wetlands to be replaced after the pipelines have been trenched in.

8.2 Compensatory Mitigation

No Compensatory Mitigation is proposed for the project. The project was designed to avoid impacts to WOTUS. The two outfall structures and the Intake structure are proposed for placement in “Other Waters” (Section 10 Tidal waters); however, they were placed to avoid submerged aquatic vegetation and oyster beds and sensitive features. Impacts from the finished water pipelines in WOTUS, will be temporary.

9. CONCLUSION

The Project proposes to meet the Coastal Bend Region's immediate and ongoing need for a reliable, drought-proof water supply through the Harbor Island Desalination Facility and its Supporting Infrastructure. The Project comprises a seawater intake structure in the Gulf, outfall locations and diffusers in the Gulf and adjacent to the CCSC and treated water pipelines that connect to existing water distribution infrastructure.

As proposed, the Project incorporates innovative designs and construction methodologies to avoid and minimize impacts to WOTUS and the aquatic ecosystem. By incorporating HDD and tunneling technology, the Project proposes temporary impacts to less than three acres of wetlands, no impacts to special aquatic resources, and minimal impacts to small portions of the Gulf seafloor and unvegetated bay bottom for rock placement around the intake and outfall structures.

The Project aims to meet well-documented regional water supply needs through its overall purpose: to efficiently establish a reliable, drought-proof water supply for the Coastal Bend Region through scalable marine desalination. The proposed Project maximizes efficiency by incorporating existing authorizations (*e.g.*, the CCSC TPDES permit), promotes reliability through a dual-outfall system (*e.g.*, continued operation during maintenance of one outfall), and emphasizes scalability with two outfalls that can accommodate the region's growing water needs.

The Port looks forward to working with USACE to develop this important regional water-supply resource. Please do not hesitate to contact us with any questions.

10. LITERATURE CITED

Avian Knowledge Network (AKN). 2024. Avian Knowledge Network: An online databae of bird distribution and abundance [web application]. Ithaca, New York. Available at: avianknowledge.net. Accessed: November 2024.

Barnthouse, L.W. 2013. "Impacts of entrainment and impingement on fish populations: A review of the scientific evidence." *Environmental Science & Policy* 31, 149–156.

Coastal Bend Regional Planning Group. 2020. *Coastal Bend Regional Water Planning Area: Region N 2021 Regional Water Plan.*

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. FWS/OBS-79/31. Washington, D.C.: United States Fish and Wildlife Service.

Executive Order 12898. 1994. "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." 59 Federal Register 7629.

LREWater, LLC. 2019. Desalination Brine Discharge Modeling – Corpus Christi Bay System.

Montgomery C.R., and E.M. Bourne. 2018. Sampling, Chemical Analysis, and Bioassessment in Accordance with MPSRA Section 103 Corpus Christi Ship Channel (CCSC) Improvement Project, Entrance Channel and Extension Corpus Christi, TX. USACE Engineer Research and Development Center, Environmental Laboratory, Vicksburg, Mississippi. February 26, 2018.

Parsons Environment and Infrastructure, Inc. June 24, 2021. Field Sampling Technical Memorandum for Port of Corpus Christi Draft TPDES Permit No. WQ0005253000. Technical Memorandum.

Stunz, G.W., and P.A. Montagna. 2015. TM 2.1–Identification and Characterization of Potential Environmental Impacts Mitigation Measures Related to Intake and Discharge Facilities of Seawater Desalination Plants. Variable Salinity Desalination Demonstration Project, City of Corpus Christi. July 10.

Texas Parks and Wildlife Department (TPWD). 2018a. Marine Seawater Desalination Diversion and Discharge Zone Study. 84th Texas Legislature. HB 2031.

TPWD. 2018b. Commercial Fishing General Information. Accessed Online at: https://tpwd.texas.gov/fishboat/fish/commercial/. Accessed March 2018.

TPWD. 2018c. Fishing in Federal Waters. Outdoor Annual. Texas Hunting and Fishing Regulations. Available Online at: https://tpwd.texas.gov/regulations/outdoor-annual/fishing/saltwater-fishing/fishing-in-federal-waters Accessed 2024

U.S. Army Corps of Engineers (USACE). 1987. *Corps of Engineers Wetlands Delineation Manual*. Technical Report Y-87-1. Vicksburg, Mississippi: U.S. Army Engineers Waterways Experiment Station Environmental Laboratory.

USACE. 2005. Ordinary High Water Mark Identification. Regulatory Guidance Letter 05-05. December 07.

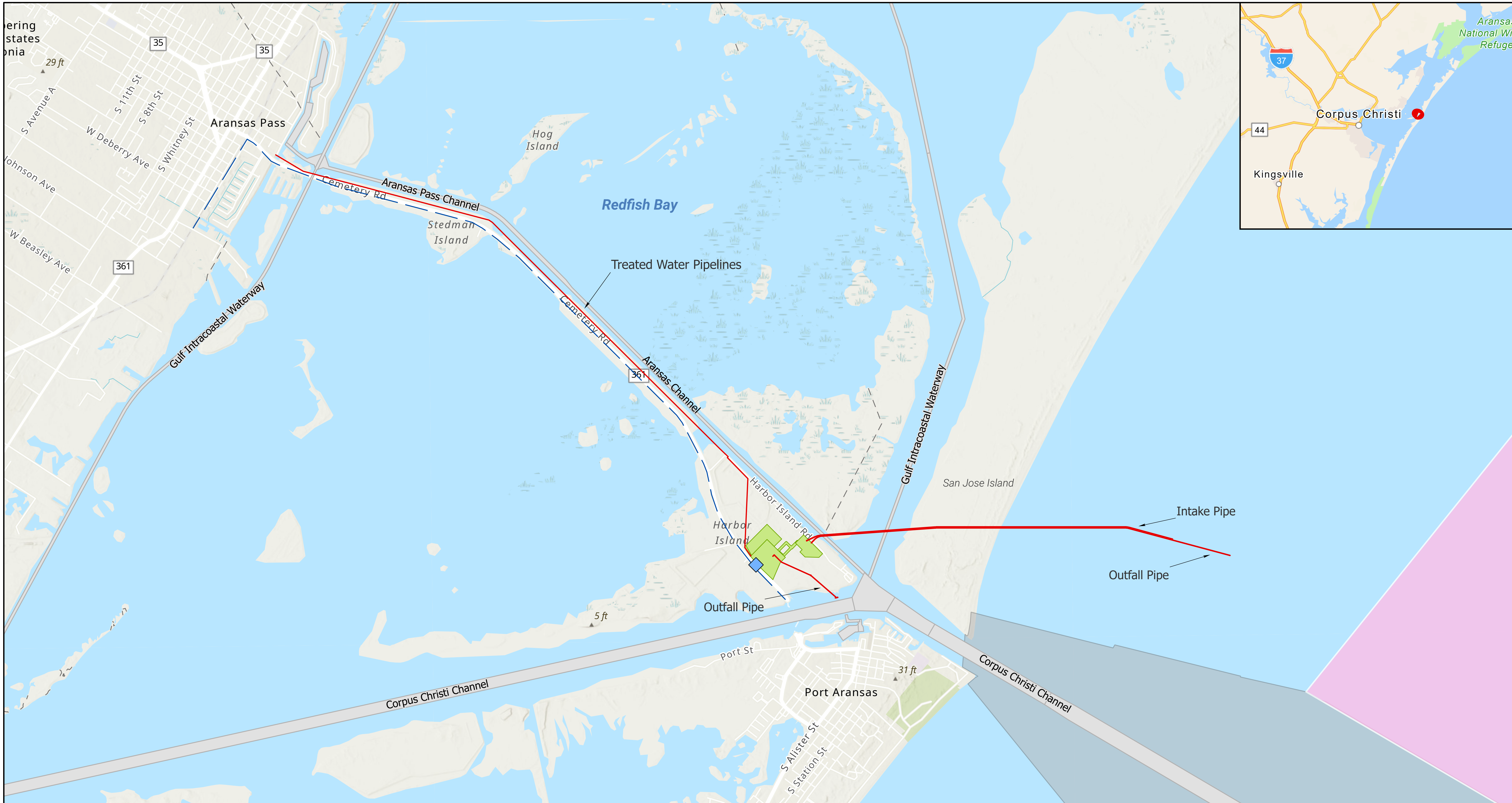
USACE. 2010. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0)*. ERDC/EL TR-10-20. Vicksburg, Mississippi: U.S. Army Engineer Research and Development Center.

United States Environmental Protection Agency (USEPA). (1986). Quality criteria for water. Environmental Protection Agency, Washington, DC: EPA 440/5-86-001.

USEPA. 2011. Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Rule. EPA-821-R-11-001. United States Environmental Protection Agency.

USEPA. 2014. Technical Development Document for the Final Section 316 (b) Phase II Existing Facilities Rule (Final). Vol. 7. EPA 821-R-04, 2004. U.S. Environmental Protection Agency.

FIGURES



- Proposed Pipelines and Pipes
- Existing Nueces County Water Conservation District #4 Water Line
- Desalination Plant Footprint
- Navigation Channel
- Shipping Fairway Lanes and Zones
- Anchorage
- Waterline Tie In (Approximate)

Harbor Island Desalination Plant Project Overview

Corpus Christi, Texas

Geosyntec consultants

Figure 1

TXE10785 | February 2025

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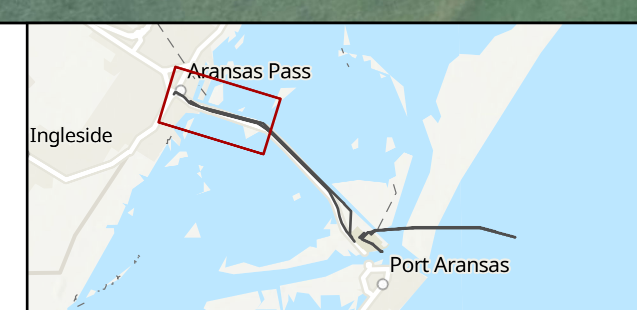
Proposed Pipeline
Navigation Channel
Onshore Pipeline Construction Footprint
Sensitive Area

Delineated Wetland
Jurisdictional
Impacted Jurisdictional Wetland



Harbor Island Desalination Plant Sensitive Areas

Corpus Christi, Texas

Geosyntec consultants

Figure 2.1

TXE10785 | February 2025

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Proposed Pipeline

Navigation Channel

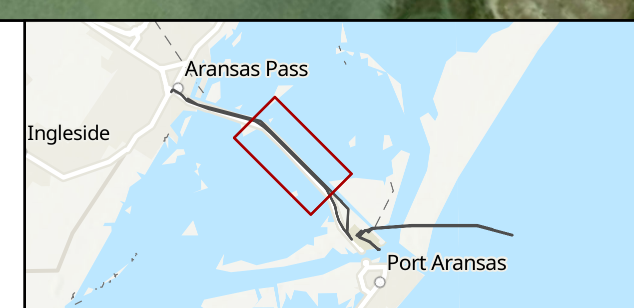
Onshore Pipeline Construction Footprint

Sensitive Area

Delineated Wetland

Jurisdictional

Impacted Jurisdictional Wetland



Harbor Island Desalination Plant
Sensitive Areas

Corpus Christi, Texas

Geosyntec consultants

Figure

2.2

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February 2025

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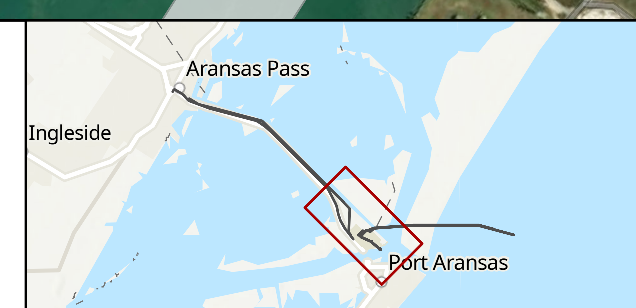
- Proposed Pipeline
- Navigation Channel
- Onshore Pipeline Construction Footprint
- Desalination Plant
- Property Boundary
- Staging Area
- Sensitive Area

Delineated Wetland

- Jurisdictional
- Non-jurisdictional
- Impacted Jurisdictional Wetland



Harbor Island Desalination Plant
Sensitive Areas

Corpus Christi, Texas

Geosyntec consultants

TXE10785	February 2025	Figure 2.3

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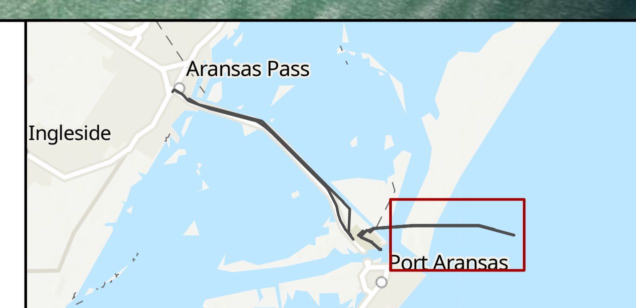
Proposed Pipeline
Navigation Channel
Sensitive Area



Harbor Island Desalination Plant
Sensitive Areas

Corpus Christi, Texas

Geosyntec consultants

TXE10785 | February 2025

Figure
2.4

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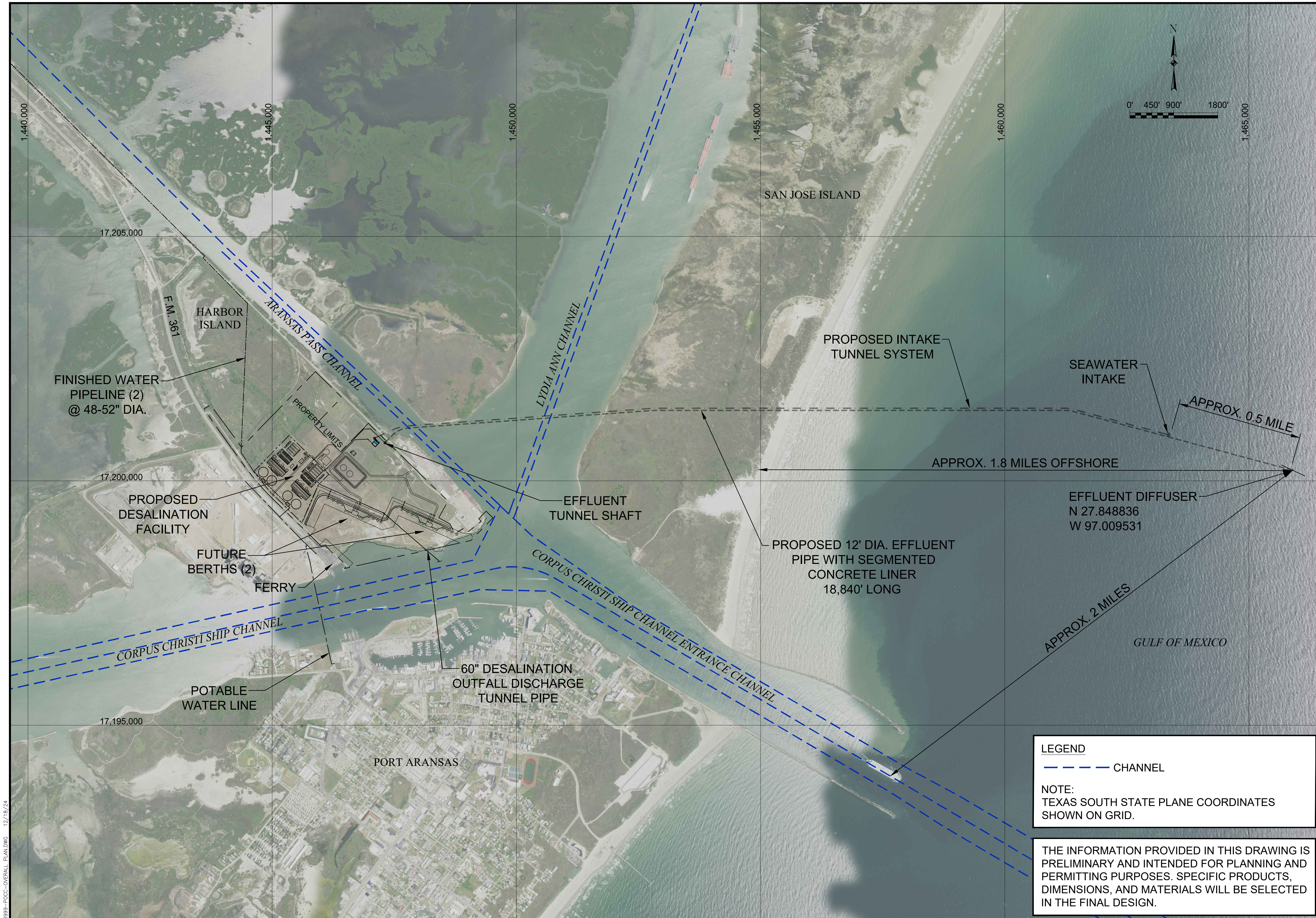

LEGEND

— — — CHANNEL

NOTE:
TEXAS SOUTH STATE PLANE COORDINATES SHOWN ON GRID.

THE INFORMATION PROVIDED IN THIS DRAWING IS PRELIMINARY AND INTENDED FOR PLANNING AND PERMITTING PURPOSES. SPECIFIC PRODUCTS, DIMENSIONS, AND MATERIALS WILL BE SELECTED IN THE FINAL DESIGN.

Rev	Date	Description	By

Issue Certification

PARSONS
TBPE REG. NO. F-8008
9101 BURNET RD
SUITE #210
AUSTIN, TX
(512) 719-6000

PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY
PROPOSED HARBOR ISLAND DESALINATION FACILITY

INTAKE AND DISCHARGE ALIGNMENTS

DRAWING NO. 3

REV.

453999--POCC--OVERALL PLAN.DWG 12/18/24

451565-CCHI-PERMIT-INTAKE PLAN.DWG 1/12/23

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(512) 719-6000

PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY
PROPOSED HARBOR ISLAND DESALINATION FACILITY

MARINE LIFE RETURN FACILITY CONFIGURATION

Figure 4

REV.

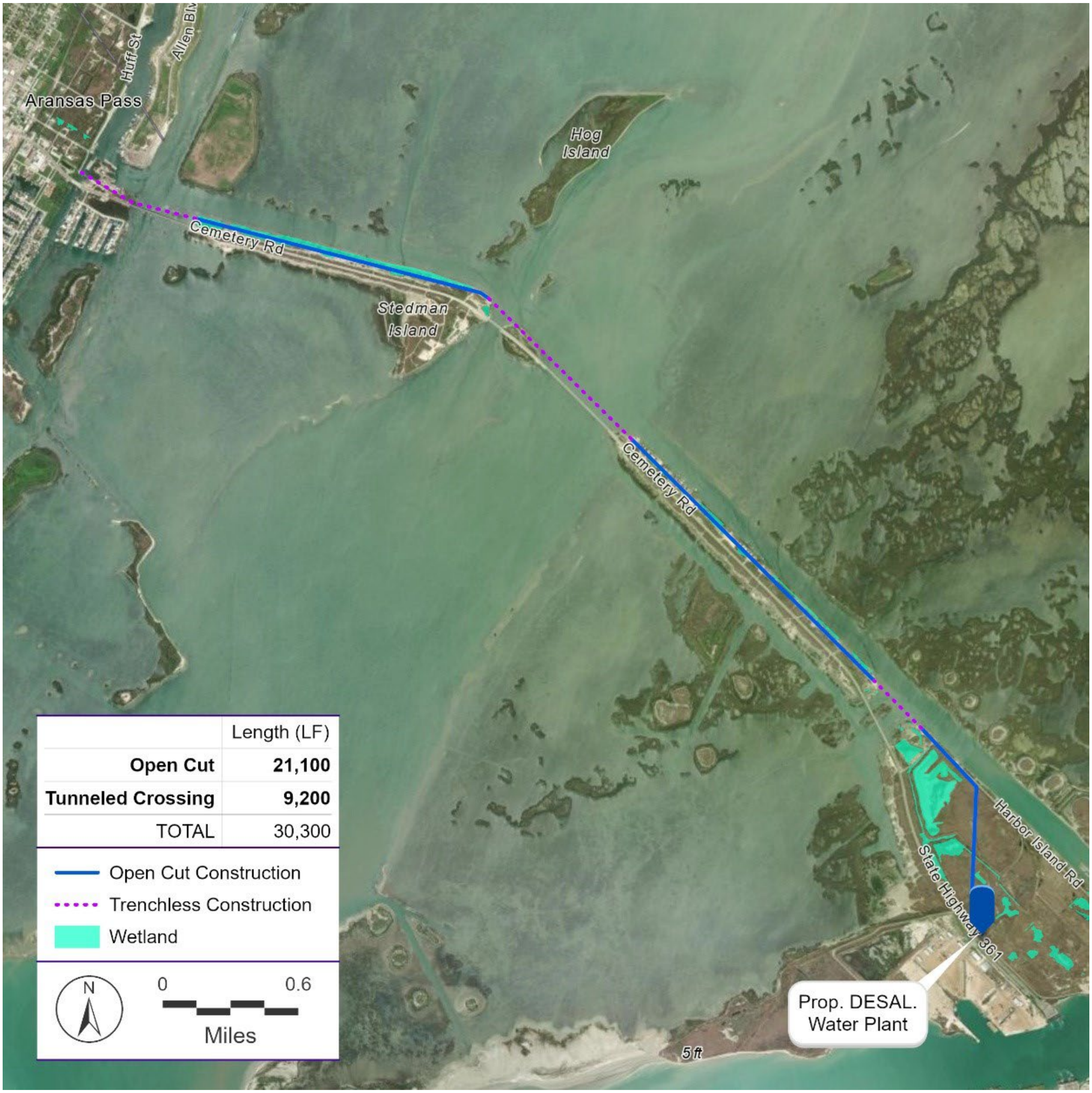


FIGURE 5: Finished Water Pipelines

Project Disturbance Footprint
Redfish Bay Scientific Area

Other Protected Areas
Local Conservation Area
Local Park
Local Recreation Area
Marine Protected Area
Private Conservation

Harbor Island Desalination Plant Protected Lands

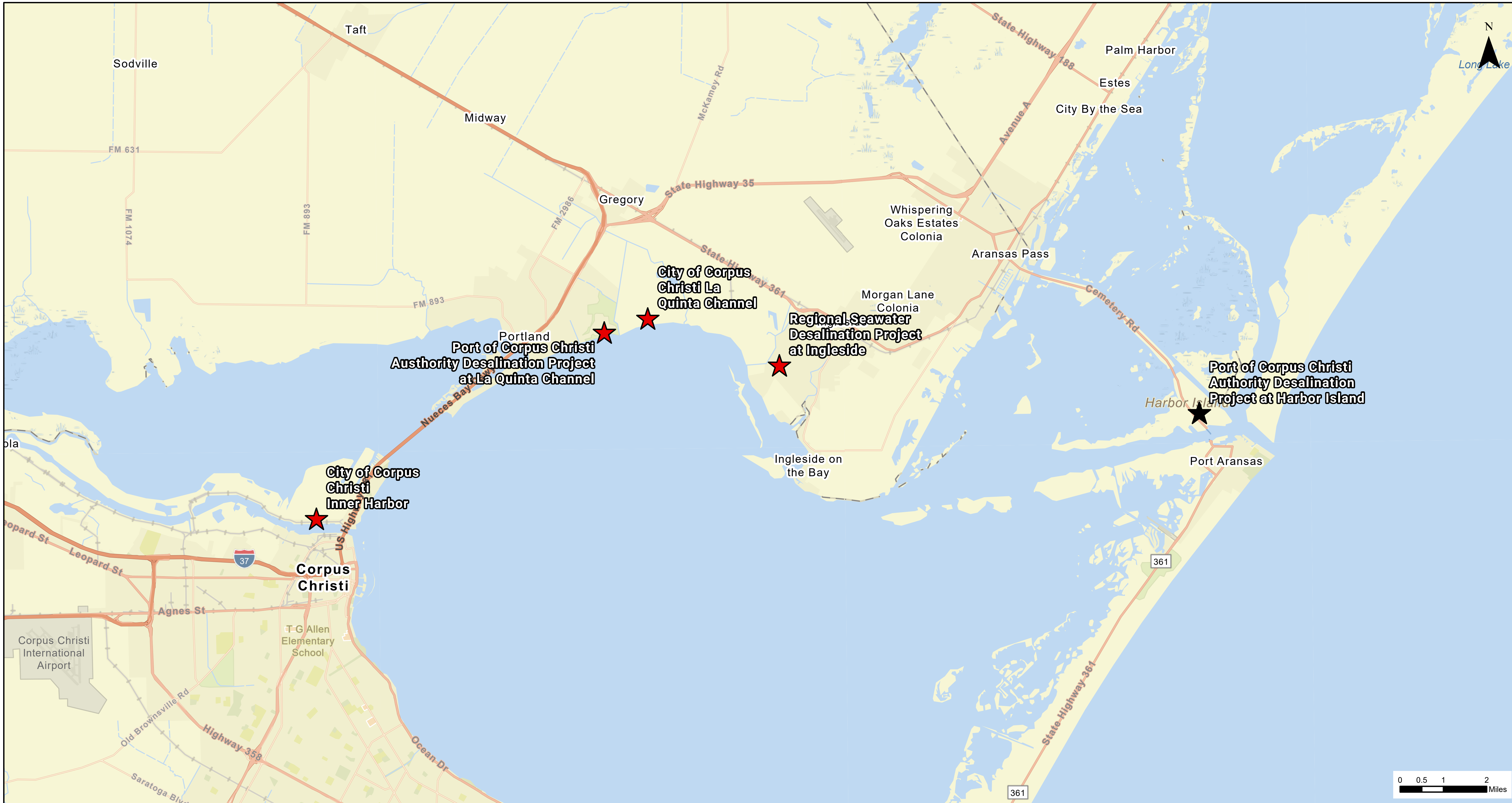
Corpus Christi, Texas

Geosyntec consultants

Figure 6

TXE10785 | February 2025

Z:\AUSTIN\Port_Corpus\Pro_Corpus_Christi\Pro_POCC_IP.aprx\Protected Areas 2/3/2025 6:10 PM (JGillespie)



Harbor Island Desalination Plant
Proposed Desalination Plants within Corpus Christi Area

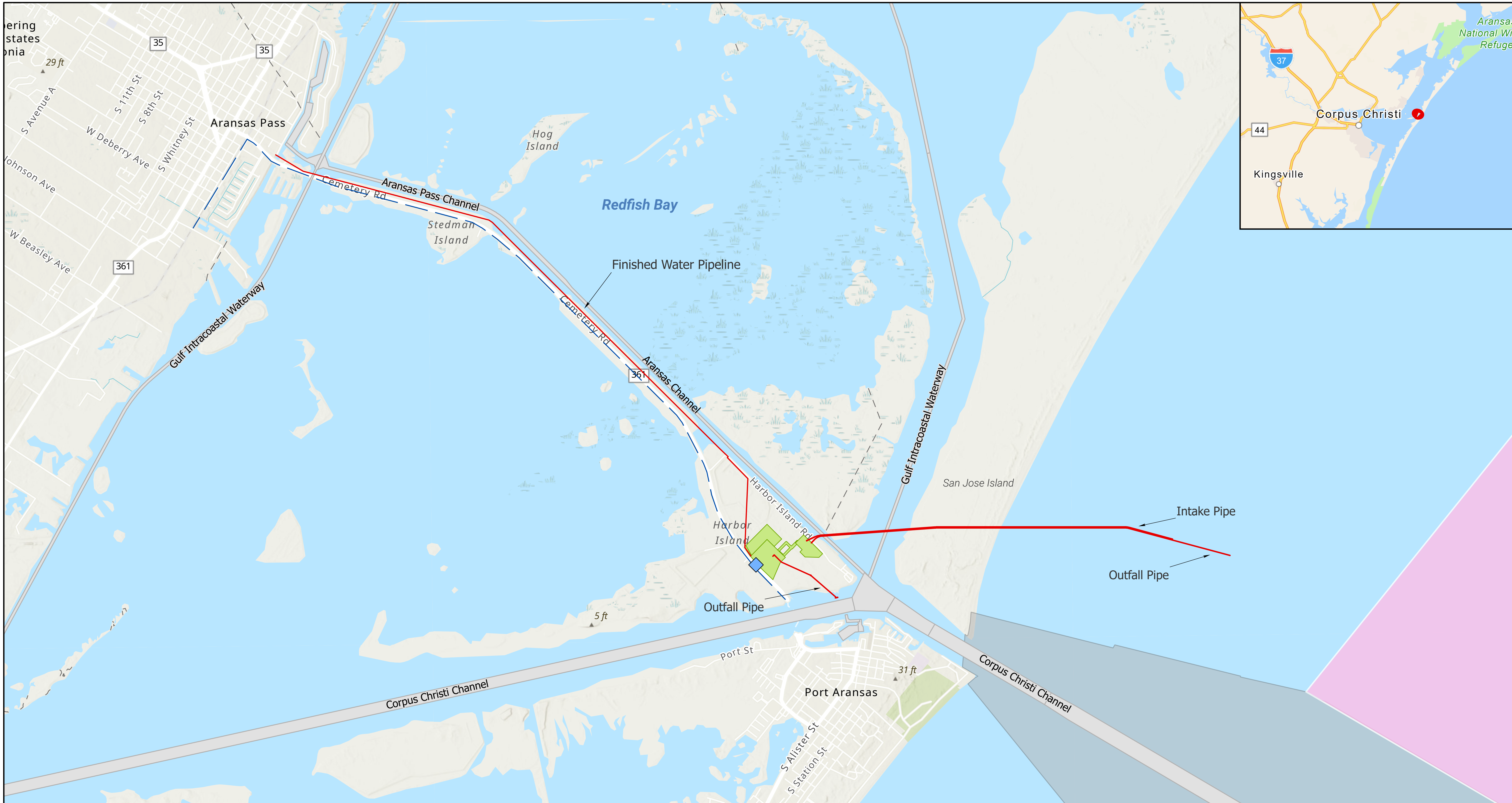
Corpus Christi, Texas

Geosyntec consultants

TXE10785	November 2024	Figure 7

Z:\AUSTIN\Port_Corpus\Pro_Corpus_Christi\Pro_POCC_IP.aprx\Desal Plants 11/22/2024 10:08 PM (JGillespie)

PERMIT DRAWINGS



- Proposed Pipeline and Pipes
- Existing Nueces County Water Conservation District #4 Water Line
- Desalination Plant Footprint
- Navigation Channel
- Shipping Fairway Lanes and Zones
- Anchorage
- Waterline Tie In (Approximate)

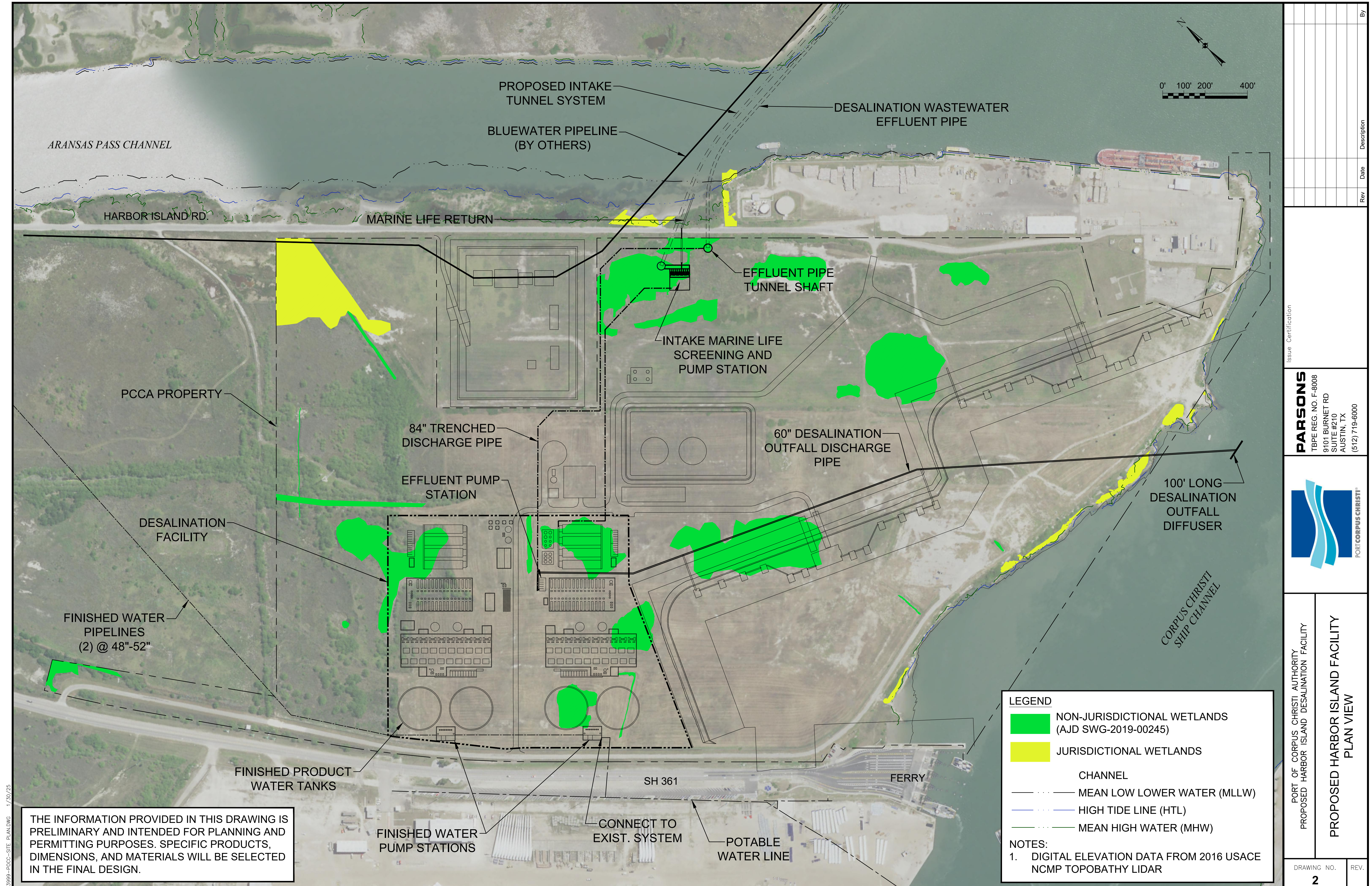
Harbor Island Desalination Plant Overall Layout

Corpus Christi, Texas

Geosyntec consultants

TXE10785	February 2025	Drawing 1

Z:\AUSTIN\Port_Corpus\Pro_Corpus_Christi\Pro_POCC_IP.aprx\Project Overview_nueces 2/24/2025 10:23 PM (JGillespie)



ARANSAS PASS CHANNEL
PROPOSED INTAKE TUNNEL SYSTEM
BLUEWATER PIPELINE (BY OTHERS)
DESALINATION WASTEWATER EFFLUENT PIPE
0' 100' 200' 400'
N
HARBOR ISLAND RD.
MARINE LIFE RETURN
EFFLUENT PIPE TUNNEL SHAFT
INTAKE MARINE LIFE SCREENING AND PUMP STATION
PCCA PROPERTY
84" TRENCHED DISCHARGE PIPE
60" DESALINATION OUTFALL DISCHARGE PIPE
EFFLUENT PUMP STATION
100' LONG DESALINATION OUTFALL DIFFUSER
DESALINATION FACILITY
FINISHED WATER PIPELINES (2) @ 48"-52"
CORPUS CHRISTI SHIP CHANNEL
FINISHED PRODUCT WATER TANKS
SH 361
FERRY
FINISHED WATER PUMP STATIONS
CONNECT TO EXIST. SYSTEM
POTABLE WATER LINE
LEGEND
NON-JURISDICTIONAL WETLANDS (AJD SWG-2019-00245)
JURISDICTIONAL WETLANDS
CHANNEL
MEAN LOW LOWER WATER (MLLW)
HIGH TIDE LINE (HTL)
MEAN HIGH WATER (MHW)
NOTES:
1. DIGITAL ELEVATION DATA FROM 2016 USACE NCMP TOPOBATHY LIDAR
THE INFORMATION PROVIDED IN THIS DRAWING IS PRELIMINARY AND INTENDED FOR PLANNING AND PERMITTING PURPOSES. SPECIFIC PRODUCTS, DIMENSIONS, AND MATERIALS WILL BE SELECTED IN THE FINAL DESIGN.
453999-POCC-SITE PLAN.DWG 1/30/25
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TBPE REG. NO. F-8008
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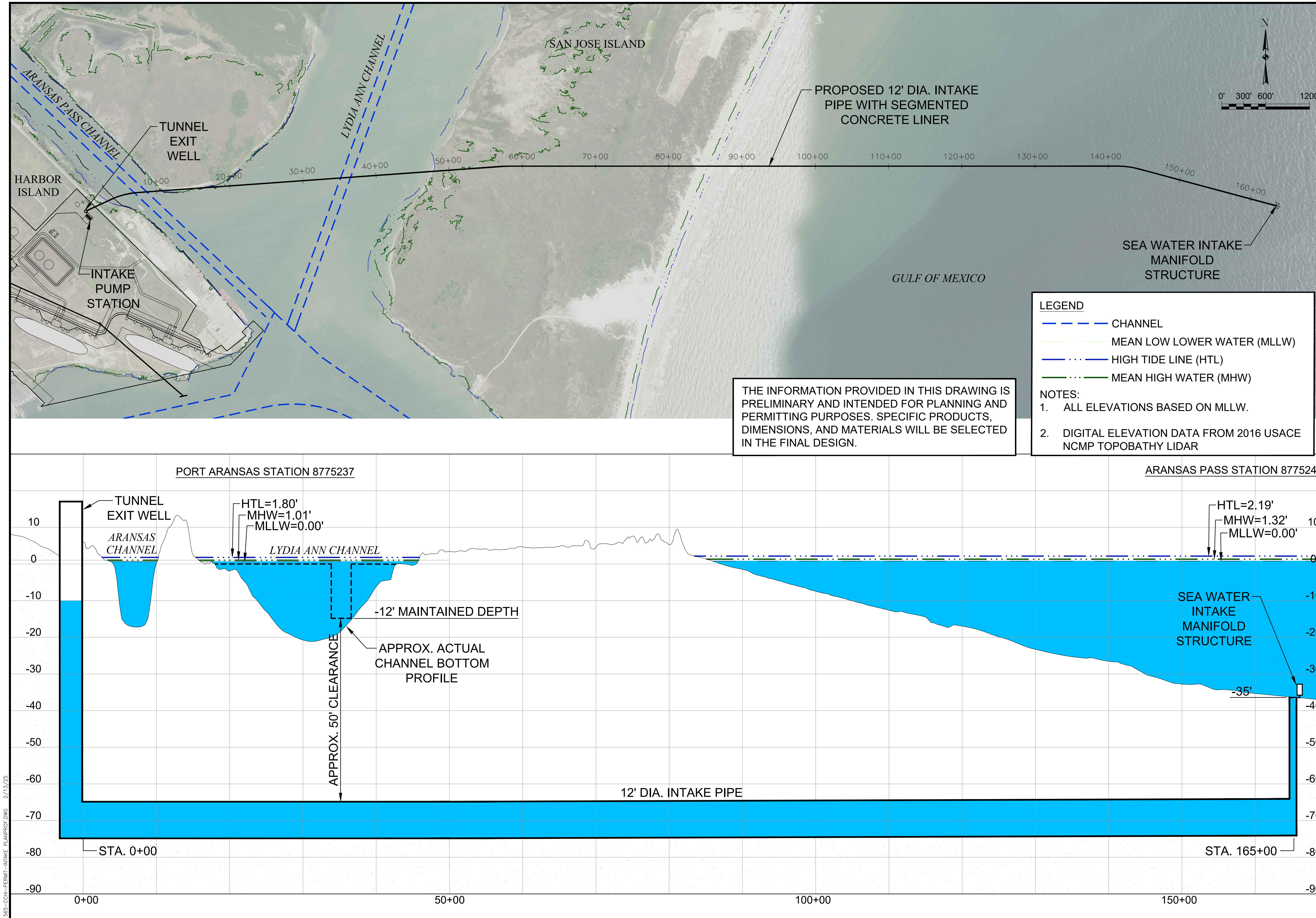
AUSTIN, TX
(512) 719-6000
PORT CORPUS CHRISTI
PORT OF CORPUS CHRISTI AUTHORITY
PROPOSED HARBOR ISLAND DESALINATION FACILITY
PROPOSED HARBOR ISLAND FACILITY
PLAN VIEW
DRAWING NO. 2
REV.



Rev | Date | Description | By

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PORT CORPUS CHRISTI

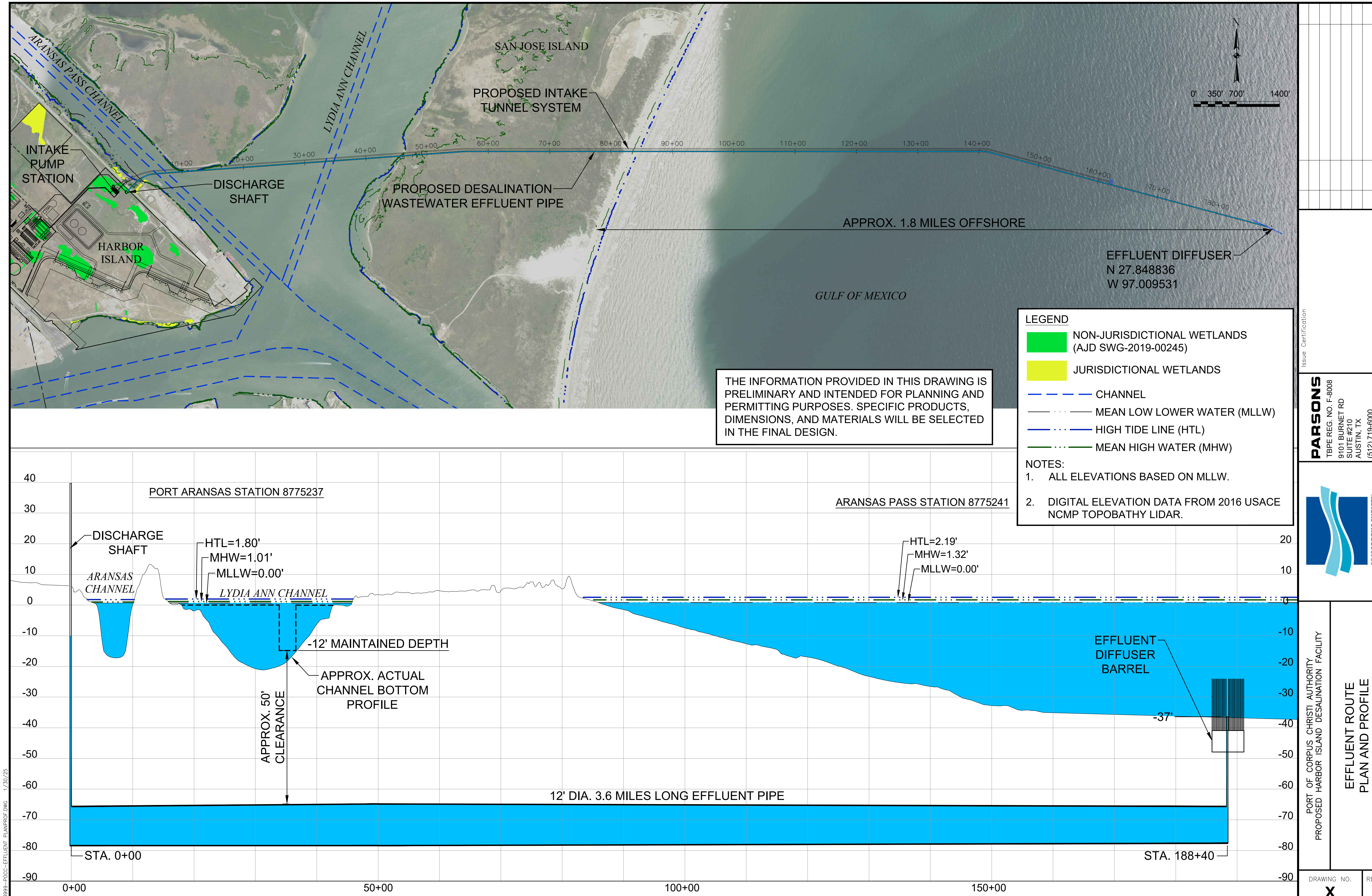
PORT OF CORPUS CHRISTI AUTHORITY
PROPOSED HARBOR ISLAND DESALINATION FACILITY

INTAKE ROUTE
PLAN AND PROFILE

DRAWING NO. 3

REV.

451565-CCHI-PERMIT-INTAKE PLANPROF.DWG 2/13/25



SAN JOSE ISLAND
ARANSAS PASS CHANNEL
LYDIA ANN CHANNEL
PROPOSED INTAKE TUNNEL SYSTEM
INTAKE PUMP STATION
DISCHARGE SHAFT
PROPOSED DESALINATION WASTEWATER EFFLUENT PIPE
HARBOR ISLAND
APPROX. 1.8 MILES OFFSHORE
EFFLUENT DIFFUSER
N 27.848836
W 97.009531
GULF OF MEXICO
0' 350' 700' 1400'
N
THE INFORMATION PROVIDED IN THIS DRAWING IS PRELIMINARY AND INTENDED FOR PLANNING AND PERMITTING PURPOSES. SPECIFIC PRODUCTS, DIMENSIONS, AND MATERIALS WILL BE SELECTED IN THE FINAL DESIGN.
LEGEND
NON-JURISDICTIONAL WETLANDS (AJD SWG-2019-00245)
JURISDICTIONAL WETLANDS
CHANNEL
MEAN LOW LOWER WATER (MLLW)
HIGH TIDE LINE (HTL)
MEAN HIGH WATER (MHW)
NOTES:
1. ALL ELEVATIONS BASED ON MLLW.
2. DIGITAL ELEVATION DATA FROM 2016 USACE NCMP TOPOBATHY LIDAR.
PORT ARANSAS STATION 8775237
ARANSAS PASS STATION 8775241
DISCHARGE SHAFT
HTL=1.80'
MHW=1.01'
MLLW=0.00'
ARANSAS CHANNEL
LYDIA ANN CHANNEL
-12' MAINTAINED DEPTH
APPROX. ACTUAL CHANNEL BOTTOM PROFILE
APPROX. 50' CLEARANCE
HTL=2.19'
MHW=1.32'
MLLW=0.00'
EFFLUENT DIFFUSER BARREL
-37'
12' DIA. 3.6 MILES LONG EFFLUENT PIPE
STA. 0+00
STA. 188+40
0+00
50+00
100+00
150+00
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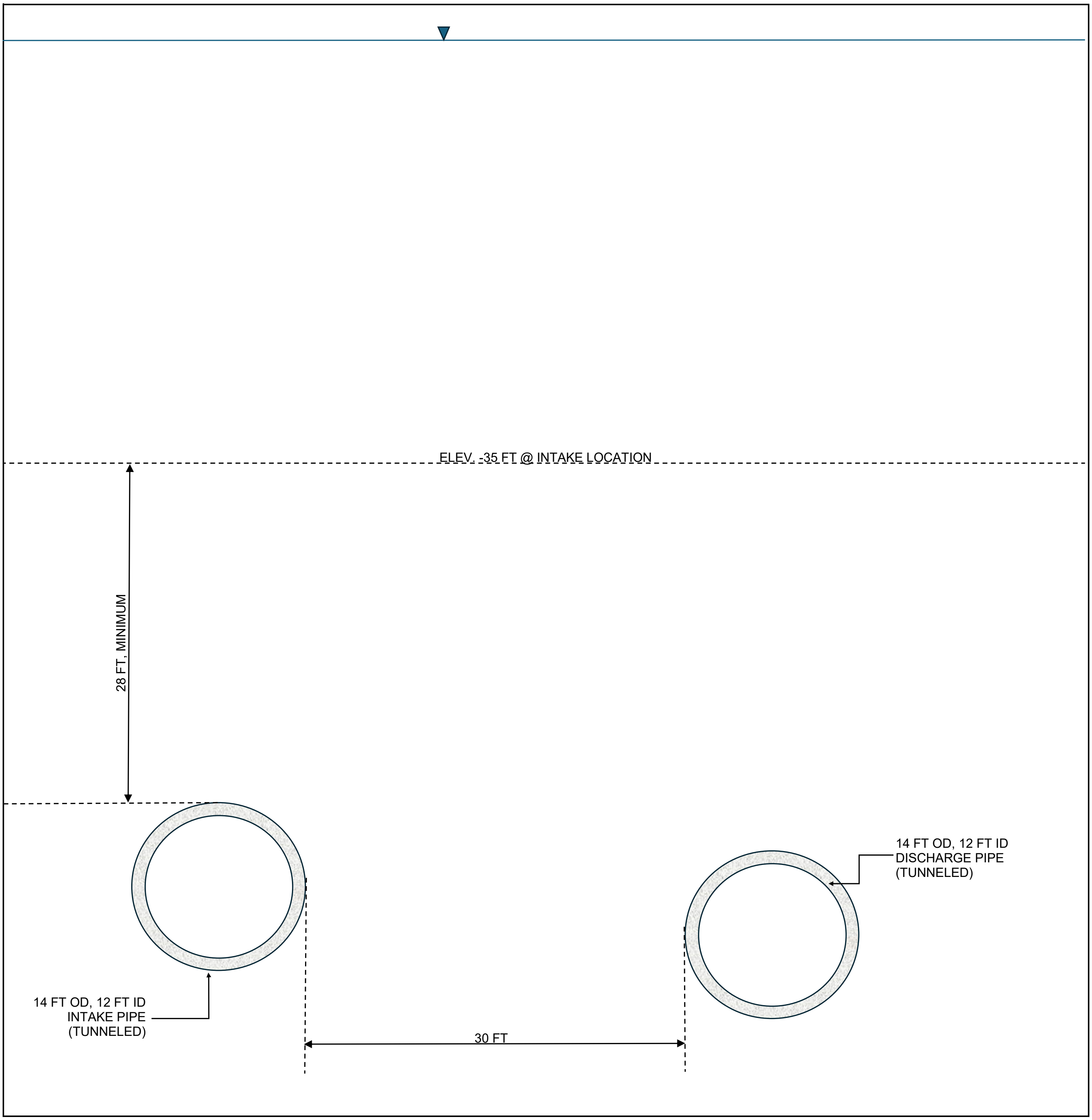
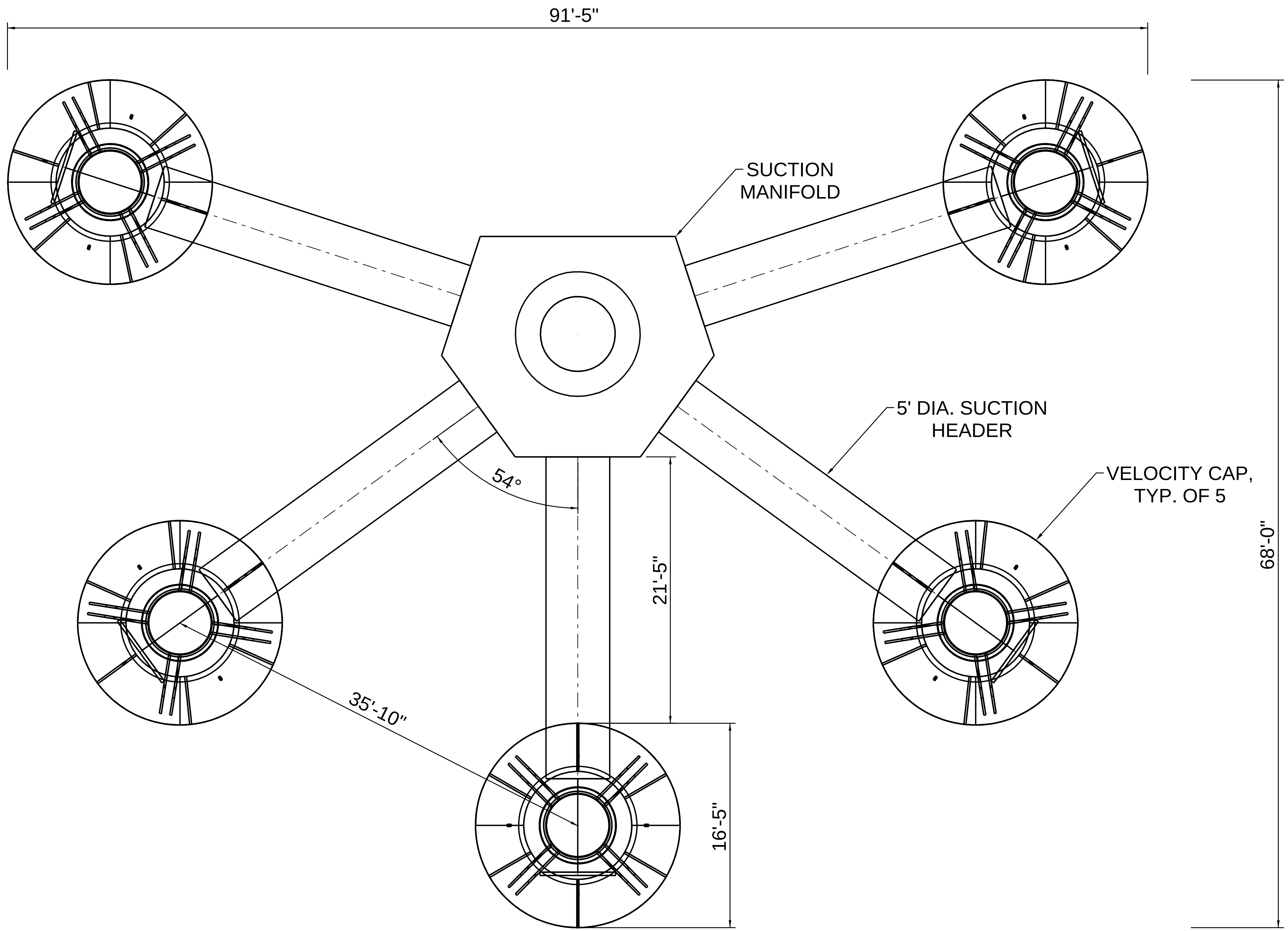
PROPOSED HARBOR ISLAND DESALINATION FACILITY
EFFLUENT ROUTE PLAN AND PROFILE
DRAWING NO.
X
REV.
Rev
Date
Description
By
Issue Certification



DRAWING NO. **5**: Intake and Diffuser Tunnels Section



TYPICAL INTAKE STRUCTURE PLAN

NOT TO SCALE

NOTES:
1. DIMENSIONS PRESENTED FOR PRELIMINARY LAYOUT AND APPROXIMATE SIZING ONLY. NOT INTENDED FOR CONSTRUCTION.

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KIT
Innovative Solutions. Trusted Experts.
2000 W. Sam Houston Pkwy S.,
Suite 1400
Houston, Texas 77042
Phone: (713) 783-8700
TBPE Firm Registration No. F-4991

451565-CCHI-KIT PLAN.DWG 2/2/23

Rev	Date	Description	By

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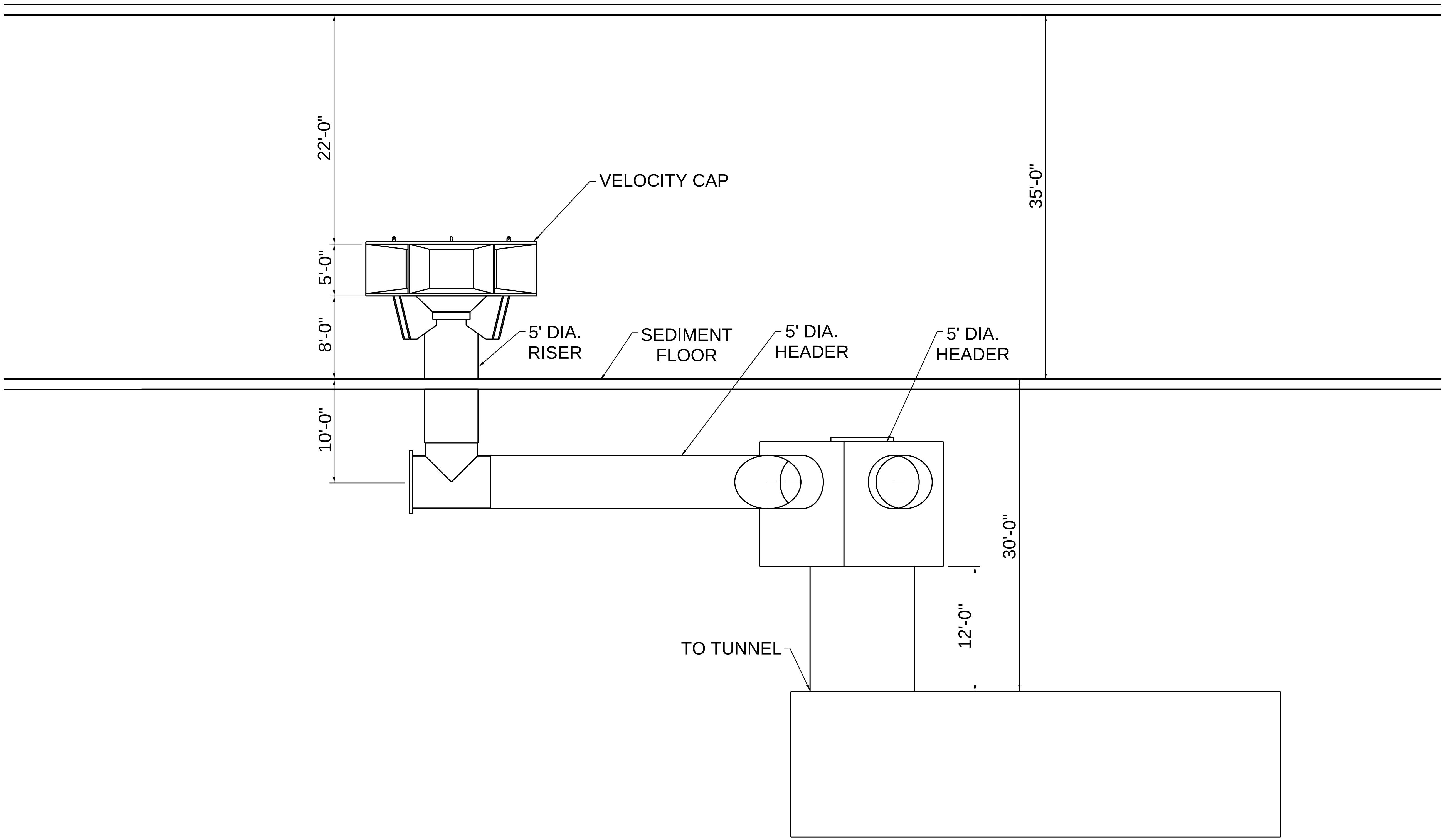
PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY
PROPOSED HARBOR ISLAND DESALINATION FACILITY

TYPICAL INTAKE STRUCTURE PLAN

DRAWING NO. 6

REV.



INTAKE STRUCTURE SECTION

NOT TO SCALE

NOTES:
1. DIMENSIONS PRESENTED FOR PRELIMINARY LAYOUT AND APPROXIMATE SIZING ONLY. NOT INTENDED FOR CONSTRUCTION.

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2000 W. Sam Houston Pkwy S.,
Suite 1400
Houston, Texas 77042
Phone: (713) 783-8700
TBPE Firm Registration No. F-4991

451565–CCHI–KIT SECTION.DWG 2/2/23

Rev	Date	Description	By

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AUSTIN, TX
(512) 719-6000

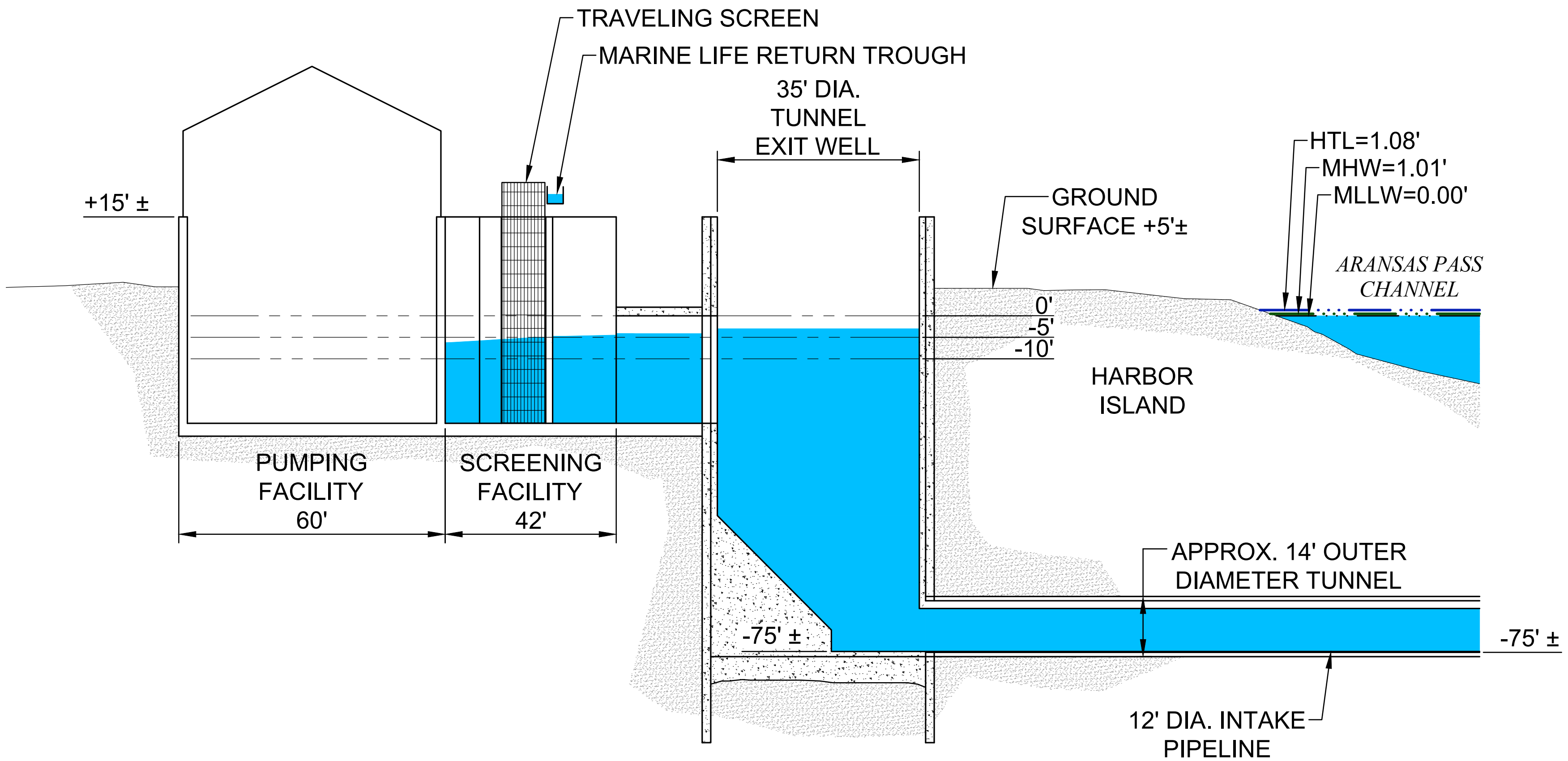
PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY
PROPOSED HARBOR ISLAND DESALINATION FACILITY

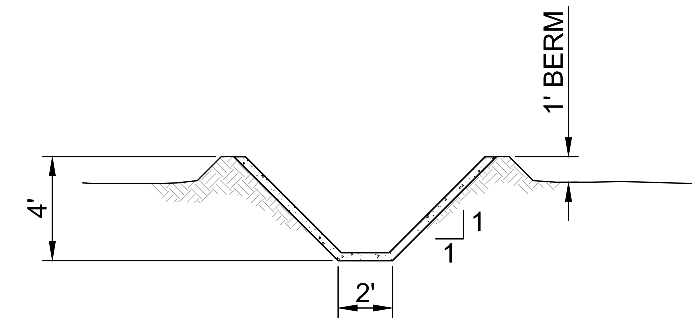
INTAKE STRUCTURE SECTION

DRAWING NO. 7

REV.



SCHEMATIC CROSS-SECTION OF SCREEN AND PUMPING FACILITY A / 2



TYPICAL MARINE LIFE RETURN CHANNEL DETAIL 1 / -

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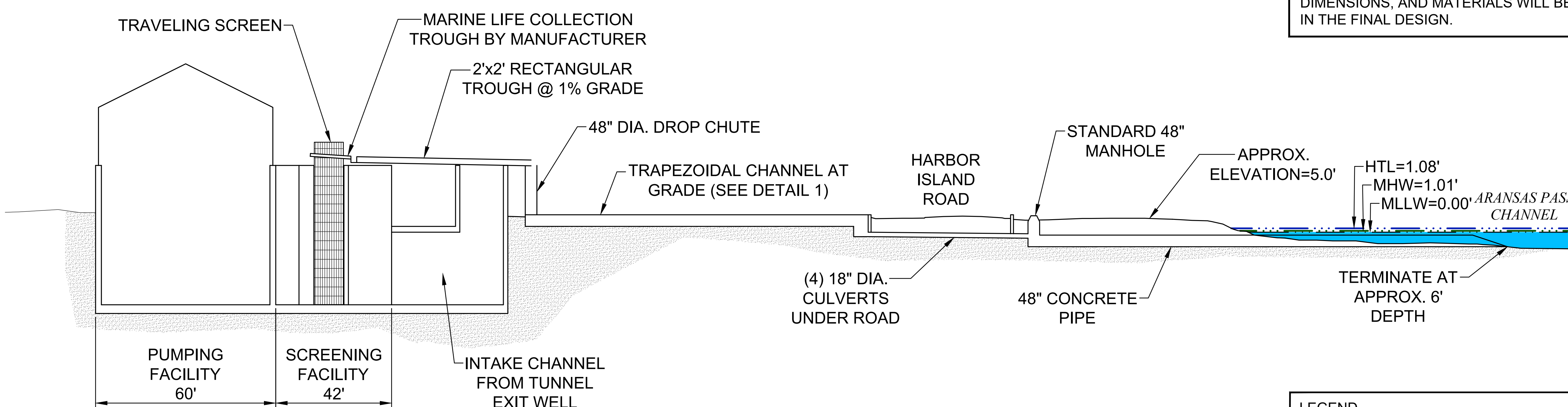

SCHEMATIC TYPICAL CROSS-SECTION OF MARINE LIFE RETURN CHANNEL B / 2

0' 10' 20' 40'

LEGEND

- MEAN LOW LOWER WATER (MLLW)
- HIGH TIDE LINE (HTL)
- MEAN HIGH WATER (MHW)

NOTES:

1. ALL DIMENSIONS PRELIMINARY.
2. ALL ELEVATIONS BASED ON MLLW.

Rev	Date	Description	By

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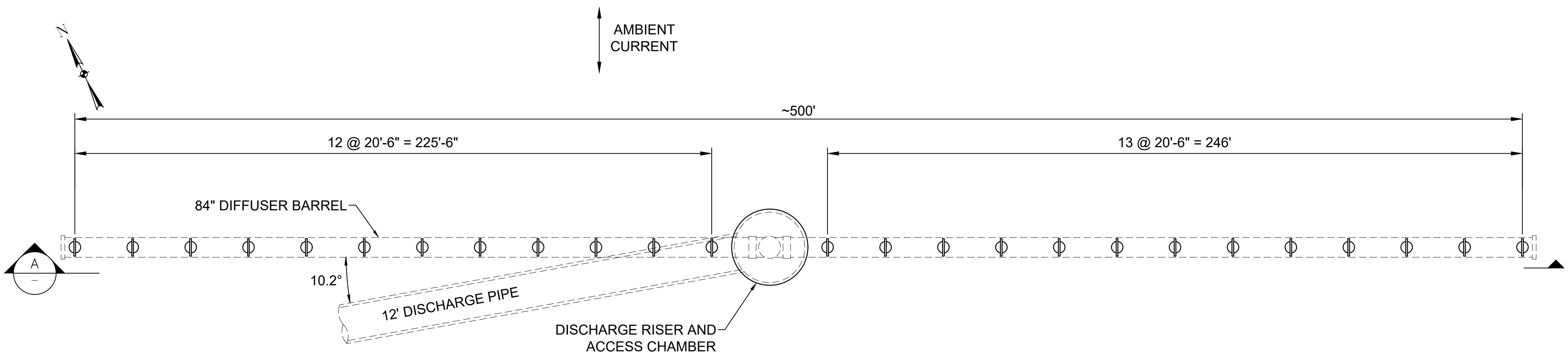
PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY
PROPOSED HARBOR ISLAND DESALINATION FACILITY

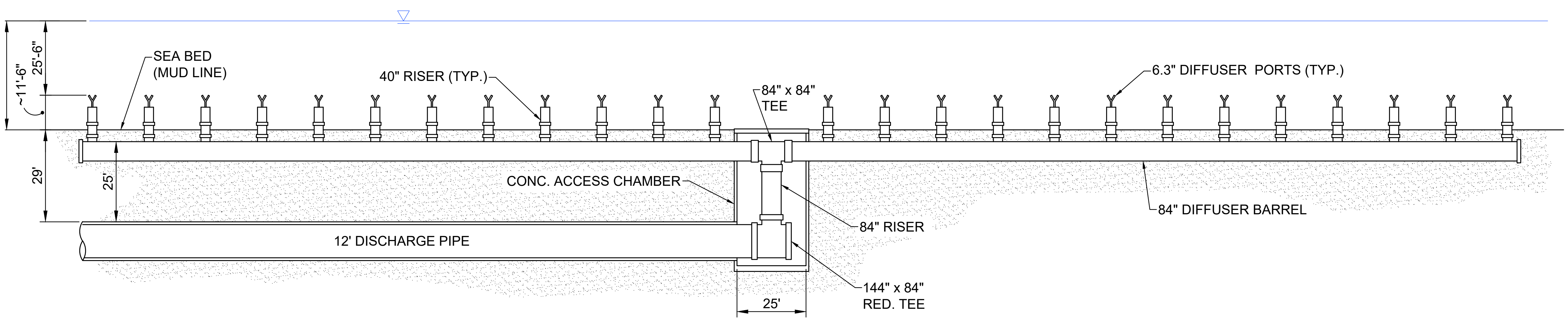
INTAKE SECTION - MARINE LIFE RETURN

DRAWING NO. 8 REV.

451565-CCHI-PERMIT-INTAKE SECTION.DWG 2/13/25



DIFFUSER PLAN VIEW



DIFFUSER SECTION A –

NOTE:
DIFFUSER BARRELS AND PORTS SHOWN ROTATED TO BE ALIGNED WITH DISCHARGE TUNNEL FOR CLARITY.

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Rev	Date	Description	By

Issue Certification

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SUITE #210
AUSTIN, TX
(512) 719-6000

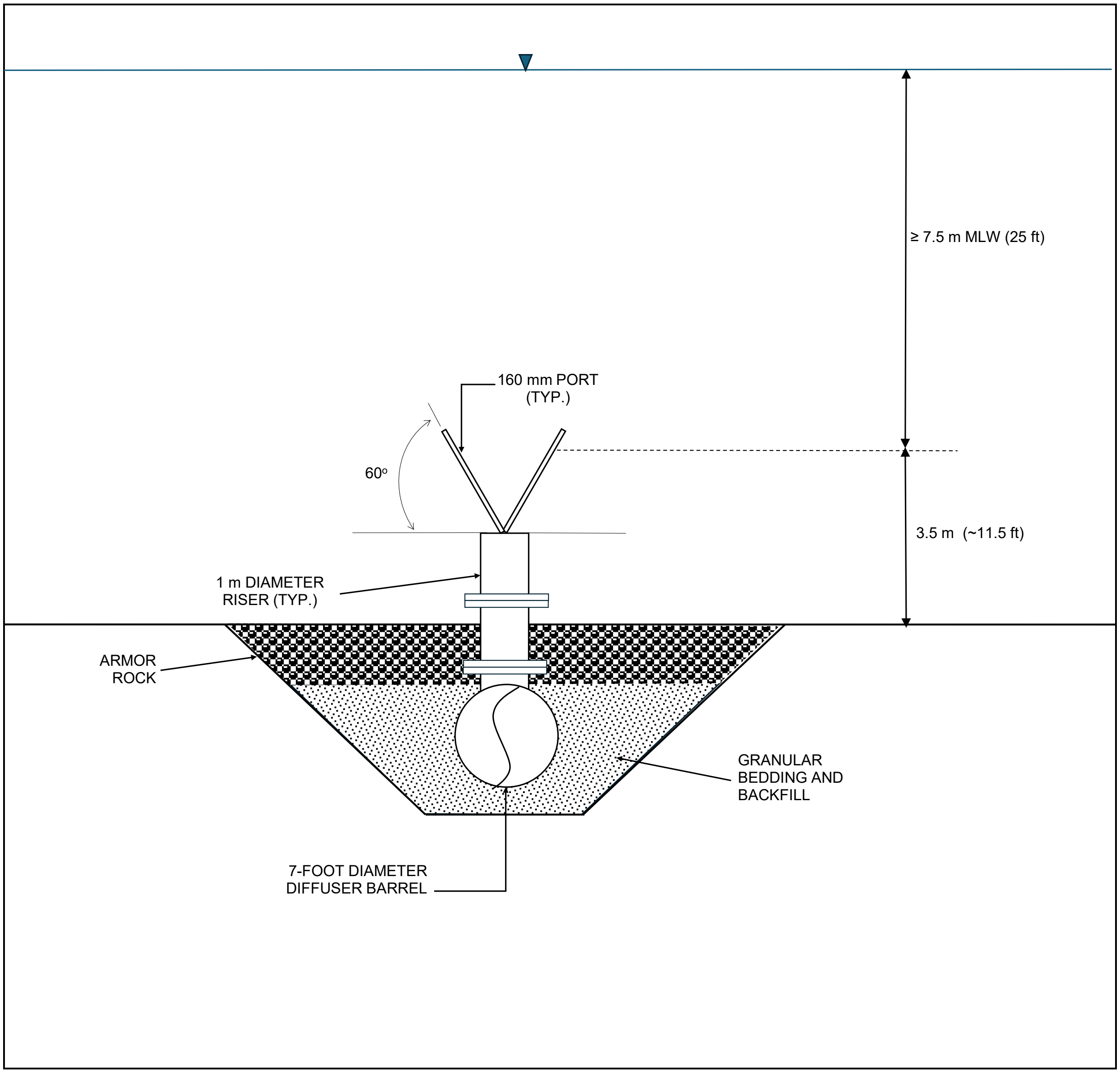
PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY
PROPOSED HARBOR ISLAND DESALINATION FACILITY

EFFLUENT DIFFUSER

DRAWING NO. 9

REV.



DRAWING **10**: High-rate Diffuser Port and Riser Schematic

Rev	Date	Description	By

Issue Certification

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(512) 719-6000

PORT CORPUS CHRISTI

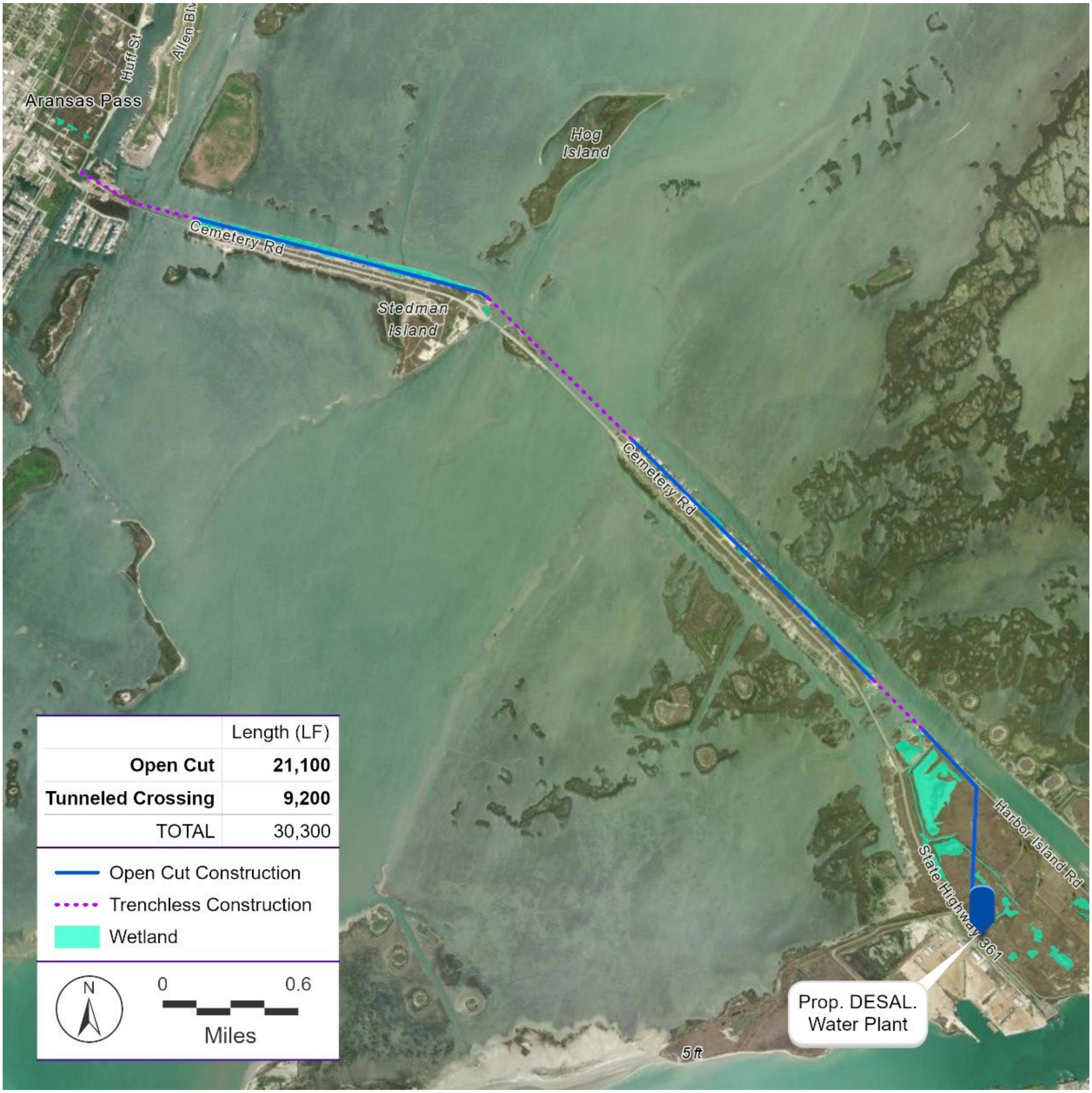
PORT OF CORPUS CHRISTI AUTHORITY
PROPOSED HARBOR ISLAND DESALINATION FACILITY

CORPUS CHRISTI SHIP CHANNEL
OUTFALL PLAN

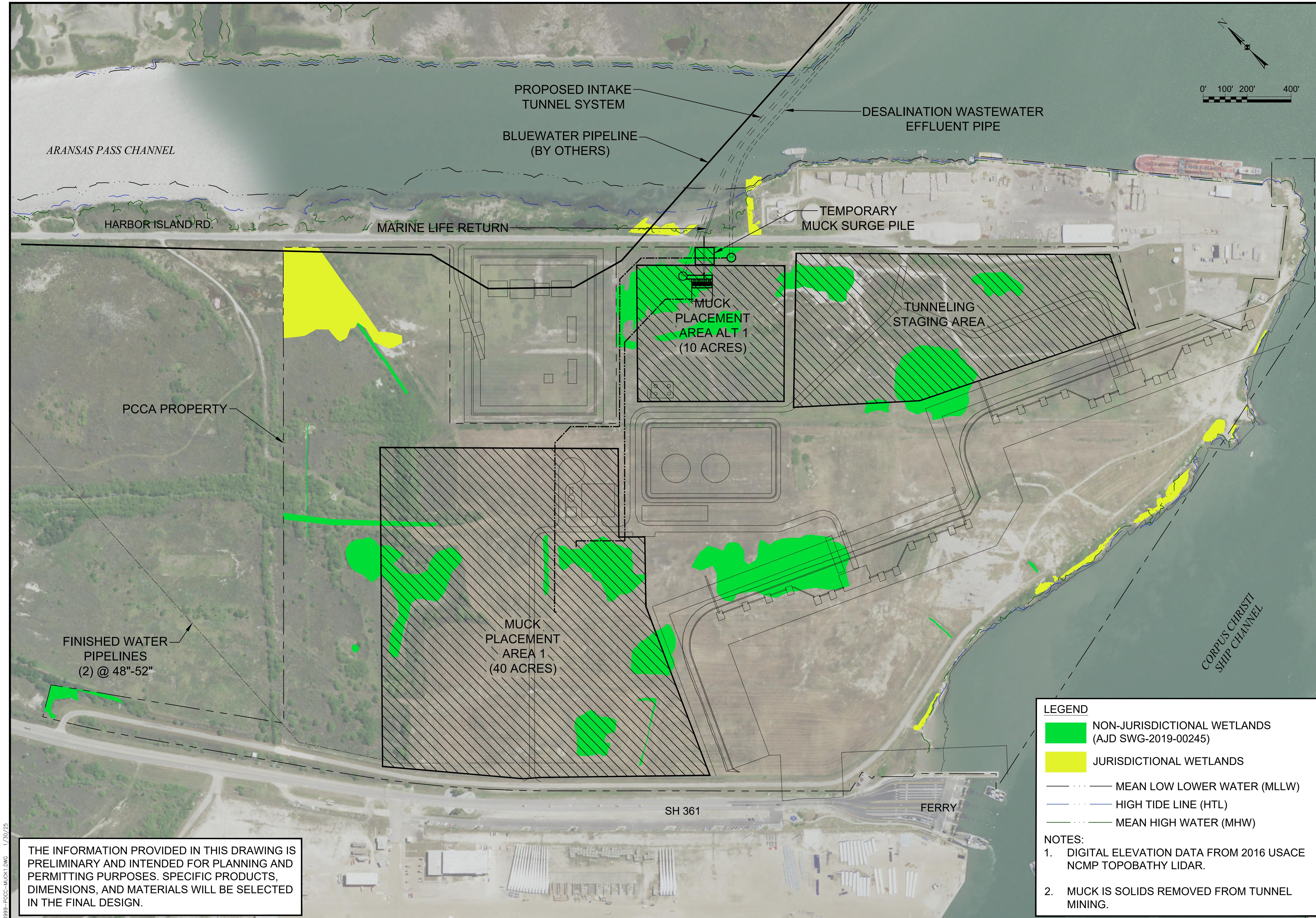
DRAWING NO. 11

REV.

451565-CCHI-PERMIT-OUTFALL PLAN.DWG 1/6/23



DRAWING NO. **12**: Treated Water Pipeline



453999–PCCC–MUCK1.DWG 1/30/25

Rev	Date	Description	By

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9101 BURNET RD
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AUSTIN, TX
(512) 719-6000

PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI AUTHORITY
PROPOSED HARBOR ISLAND DESALINATION FACILITY

PROPOSED HARBOR ISLAND DESALINATION FACILITY DURING TUNNEL CONSTRUCTION

DRAWING NO. 13
REV.

APPENDIX A

USACE Individual Permit Application Form 4345

U.S. Army Corps of Engineers (USACE) **APPLICATION FOR DEPARTMENT OF THE ARMY PERMIT** For use of this form, see 33 CFR 325. The proponent agency is CECW-COR.	***Form Approved - OMB No. 0710-0003 Expires: 2027-10-31***

The public reporting burden for this collection of information, OMB Control Number 0710-0003, is estimated to average 11 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or burden reduction suggestions to the Department of Defense, Washington Headquarters Services, at whs.mc-alex.esd.mbx.dd-dod-information-collections@mail.mil. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR APPLICATION TO THE ABOVE EMAIL.

PRIVACY ACT STATEMENT

Authorities: Rivers and Harbors Act, Section 10, 33 USC 403; Clean Water Act, Section 404, 33 USC 1344; Marine Protection, Research, and Sanctuaries Act, Section 103, 33 USC 1413; Regulatory Programs of the Corps of Engineers; Final Rule 33 CFR 320-332. Principal Purpose: Information provided on this form will be used in evaluating the application for a permit. Routine Uses: This information may be shared with the Department of Justice and other federal, state, and local government agencies, and the public and may be made available as part of a public notice as required by Federal law. Submission of requested information is voluntary, however, if information is not provided the permit application cannot be evaluated nor can a permit be issued. One set of original drawings or good reproducible copies which show the location and character of the proposed activity must be attached to this application (see sample drawings and/or instructions) and be submitted to the District Engineer having jurisdiction over the location of the proposed activity. An application that is not completed in full will be returned. System of Record Notice (SORN). The information received is entered into our permit tracking database and a SORN has been completed (SORN #A1145b) and may be accessed at the following website: http://dpcld.defense.gov/Privacy/SORNsIndex/DOD-wide-SORN-Article-View/Article/570115/a1145b-ce.aspx

(ITEMS 1 THRU 4 TO BE FILLED BY THE CORPS)

1. APPLICATION NO.	2. FIELD OFFICE CODE	3. DATE RECEIVED	4. DATE APPLICATION COMPLETE

(ITEMS BELOW TO BE FILLED BY APPLICANT)

5. APPLICANT'S NAME	8. AUTHORIZED AGENT'S NAME AND TITLE (agent is not required)
First - Sarah Middle - Last - Garza	First - Scott Middle - Last - Walker
Company - Port of Corpus Christi Authority	Company - Geosyntec Consultants
E-mail Address - sarah@pocca.com	E-mail Address - scott.walker@geosyntec.com
6. APPLICANT'S ADDRESS:	9. AGENT'S ADDRESS:
Address- 400 Charles Zahn, Jr. Drive	Address- 8627 N. Mopac Expy, Ste 300
City - Corpus Christi State - TX Zip - 78401 Country - USA	City - Austin State - TX Zip - 78759 Country - USA
7. APPLICANT'S PHONE NOs. w/AREA CODE	10. AGENTS PHONE NOs. w/AREA CODE
a. Residence b. Business 361.885.6163 c. Fax	a. Residence b. Business 361-443-9454 c. Fax

STATEMENT OF AUTHORIZATION

11. I hereby authorize, Scott Walker to act in my behalf as my agent in the processing of this application and to furnish, upon request, supplemental information in support of this permit application.

Sarah L Garza Digitally signed by Sarah L Garza Date: 2025.02.25 09:19:16 -06'00' 2025-02-25

SIGNATURE OF APPLICANT DATE

NAME, LOCATION, AND DESCRIPTION OF PROJECT OR ACTIVITY

12. PROJECT NAME OR TITLE (see instructions)
Harbor Island Seawater Desalination Facility

13. NAME OF WATERBODY, IF KNOWN (if applicable) Gulf of Mexico, Corpus Christi Ship Channel	14. PROJECT STREET ADDRESS (if applicable) Address Harbor Island
15. LOCATION OF PROJECT Latitude: °N 27.847348 Longitude: °W 97.069298	City - Port Aransas State- TX Zip- 78373

16. OTHER LOCATION DESCRIPTIONS, IF KNOWN (see instructions)

State Tax Parcel ID see full permit application Municipality

Section - Township - Range -

17. DIRECTIONS TO THE SITE
From Aransas Pass, Texas, take the Red Fish Bay Causeway (Highway 361) west to the Site, which is located on Harbor Island. The causeway terminates and becomes a ferry. The Project Site is located north of the causeway, before arriving at the ferry port when traveling on Highway 361.

18. Nature of Activity (Description of project, include all features)
The Port of Corpus Christi Authority (PCCA or Port) is applying for a Clean Water Act (CWA) Section 404 and Section 10 application to the United States Army Corps of Engineers (USACE) for an Individual Permit to construct a 100-million-gallon-per-day (MGD) marine seawater desalination facility (Project) and associated infrastructure, aimed at providing a sustainable and drought-resilient water supply. The Project will include the construction of a seawater intake structure, two outfall structures, an upland desalination facility, a product freshwater pipeline, and other appurtenances (together, "Site"). The Site is located on Harbor Island, near Port Aransas, Nueces County, Texas. It is bounded on the south and southeast by the Corpus Christi Ship Channel (Humble Basin); on the west by Highway 361 (Redfish Bay Causeway); and on the east and northeast by Harbor Island Road, Aransas Channel, and Inner Basin (Figure 1). The proposed 31-acre desalination facility and the associated pipelines and other infrastructure will collectively be referred to as the Project Area. While the Project requires proximity to the Gulf of Mexico (GOM) for appropriate intake and outfall structure siting, efforts were made to avoid impacting special aquatic sites wherever feasible.

19. Project Purpose (Describe the reason or purpose of the project, see instructions)
In 2017, PCCA began pursuing regulatory permits for a desalination facility on Harbor Island. The Project purpose is to efficiently establish a reliable, drought-proof water supply for the Coastal Bend Region through scalable marine desalination. The Project's purpose is tailored to the current and ongoing need for a drought-proof water supply for the region, which is vulnerable to persistent drought conditions. At the time PCCA submits this application, the City of Corpus Christi is currently in Stage 3 "critical water shortage" restrictions because primary water reservoirs are below 20% capacity. Average annual inflows to the region's surface water supplies continue to trend lower with each successive drought. Conversely, PCCA's Harbor Island project is included in the 2021 Region N Water Plan and noted as a "highly reliable" water source. PCCA's proposed project will meet the region's well-documented water needs through 100 MGD of desalinated water in a manner that is both consistent with regional planning and existing permits, while also avoiding and minimizing environmental impacts.

USE BLOCKS 20-23 IF DREDGED AND/OR FILL MATERIAL IS TO BE DISCHARGED

20. Reason(s) for Discharge
Construction of the proposed Project will result in temporary impacts to WOTUS during facility construction (2.5 ac PEM; 0.25 ac PSS; 0.017 ac pond; 0.09 ac stream). Additionally, the Project will impact the GOM seabed at the intake location and the CCSC at the outfall locations. Construction of the outfall diffuser in the CCSC will impact approximately 400 square feet of un-vegetated bay bottom. Additionally, construction of the GOM intake structure and outfall diffuser will impact approximately 11,300 square feet and 55,000 square feet of seafloor, respectively through the placement of approximately 15,300 cubic yards of stone.

21. Type(s) of Material Being Discharged and the Amount of Each Type in Cubic Yards:

Type Amount in Cubic Yards	Type Amount in Cubic Yards	Type Amount in Cubic Yards
15,300 Rip rap		

22. Surface Area in Acres of Wetlands or Other Waters Filled (see instructions)

Acres 400 ft of bay un-vegetated bottom and 1.53 acres of GOM seafloor
or
Linear Feet

23. Description of Avoidance, Minimization, and Compensation (see instructions)
The Site layout was adjusted multiple times to limit impacts to special aquatic sites. No special aquatic sites will be permanently impacted. Impacts have been avoided and minimized, to the extent practicable, by utilizing the most efficient construction techniques to reduce the temporary impacts to wetlands, as well as the use of tunneling and HDDs to reduce the impacts to the bay, GOM, and sensitive receptors. Mitigation measures proposed to minimize impacts to wetlands and WOTUS for the proposed Project include use of soil erosion and sediment controls, site restoration, and storm water management.

As part of Project restoration plans, portions of the pipeline ROW impacted, including wetlands and floodplains, will be restored to preconstruction conditions and contours.

24. Is Any Portion of the Work Already Complete? ☐ Yes ☒ No IF YES, DESCRIBE THE COMPLETED WORK

25. Addresses of Adjoining Property Owners, Lessees, Etc., Whose Property Adjoins the Waterbody (if more than can be entered here, please attach a supplemental list).

a. Address- See Section 2.5 of the Individual Permit for the adjoining land owners.

City - State - Zip -

b. Address-

City - State - Zip -

c. Address-

City - State - Zip -

d. Address-

City - State - Zip -

e. Address-

City - State - Zip -

26. List of Other Certificates or Approvals/Denials received from other Federal, State, or Local Agencies for Work Described in This Application.

AGENCY	TYPE APPROVAL*	IDENTIFICATION NUMBER	DATE APPLIED	DATE APPROVED	DATE DENIED
TCEQ	TPDES	WQ0005253000		December 22, 2022	

* Would include but is not restricted to zoning, building, and flood plain permits

27. Application is hereby made for permit or permits to authorize the work described in this application. I certify that this information in this application is complete and accurate. I further certify that I possess the authority to undertake the work described herein or am acting as the duly authorized agent of the applicant.

Sarah L Garza Digitally signed by Sarah L Garza Date: 2025.02.25 09:19:00 -06'00'	2025-02-25	Scott Walker Digitally signed by Scott Walker Date: 2025.02.25 08:17:21 -06'00'	2025-02-25
SIGNATURE OF APPLICANT	DATE	SIGNATURE OF AGENT	DATE

The Application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in block 11 has been filled out and signed.

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals, or covers up any trick, scheme, or disguises a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statements or entry, shall be fined not more than $10,000 or imprisoned not more than five years or both.

APPENDIX B

Wetland and Waters Delineation Data Sheets and Photos

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 29, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA008_PSS
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Marsh, Saltwater Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.895962 Long: -97.131164 Datum: North American Datum 1983
Soil Map Unit Name: Water NWI Classification: E2USN
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No ____
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes **X**	No ____
Hydric Soil Present?	Yes **X**	No ____
Wetland Hydrology Present?	Yes **X**	No ____

Is the Sampled Area within a Wetland? **Yes** **X** **No** ____

Remarks:

This point was determined to be within a wetland due to the presence of all 3 wetland criteria.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ____ Surface Water (A1)
- ____ High Water Table (A2)
- ____ Saturation (A3)
- ____ Water Marks (B1)
- ____ Sediment Deposits (B2)
- ____ Drift Deposits (B3)
- ____ Algal Mat or Crust (B4)
- ____ Iron Deposits (B5)
- ____ Inundation Visible on Aerial Imagery (B7)
- ____ Water-Stained Leaves (B9)
- ____ Aquatic Fauna (B13)
- ____ Marl Deposits (B15) **(LRR U)**
- **X** Hydrogen Sulfide Odor (C1)
- ____ Oxidized Rhizospheres on Living Roots(C3)
- ____ Presence of Reduced Iron (C4)
- ____ Recent Iron Reduction in Tilled Soils (C6)
- ____ Thin Muck Surface (C7)
- **X** Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ____ Surface Soil Cracks (B6)
- ____ Sparsely Vegetated Concave Surface (B8)
- ____ Drainage Patterns (B10)
- ____ Moss Trim Lines (B16)
- ____ Dry-Season Water Table (C2)
- ____ Crayfish Burrows (C8)
- ____ Saturation Visible on Aerial Imagery (C9)
- ____ Geomorphic Position (D2)
- ____ Shallow Aquitard (D3)
- **X** FAC-Neutral Test (D5)
- ____ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ____	No **X**	Depth (inches): **N/A**
Water Table Present?	Yes ____	No **X**	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes ____	No **X**	Depth (inches): **>20**

Wetland Hydrology Present? **Yes** **X** **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

A positive indication of wetland hydrology was observed (at least one primary indicator).

Other: Coastal inundation.

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: DPA008_PSS

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Sapling Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Shrub Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *Avicennia germinans*	50	Yes	OBL
2.			
3.			
4.			
5.			
6.			
	50 = Total Cover		
50% of total cover:	25	20% of total cover:	10

Herb Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *Spartina alterniflora*	30	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	30 = Total Cover		
50% of total cover:	15	20% of total cover:	6

Woody Vine Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)

Total Number of Dominant Species Across All Strata: **2** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**80**	x 1 =	**80**
FACW species	**0**	x 2 =	**0**
FAC species	**0**	x 3 =	**0**
FACU species	**0**	x 4 =	**0**
UPL species	**0**	x 5 =	**0**
Column Totals:	**80** (A)		**80** (B)

Prevalence Index = B/A = **1.00**

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤ 3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

SOIL

Sampling Point: DPA008_PSS

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-16	N 4	100	None	—	—	—	Sandy Clay	Shell hash mixed with matrix

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ____ Histosol (A1)
- ____ Histic Epipedon (A2)
- ____ Black Histic (A3)
- ____ Hydrogen Sulfide (A4)
- ____ Stratified Layers (A5)
- ____ Organic Bodies (A6) **(LRR P, T, U)**
- ____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ____ Muck Presence (A8) **(LRR U)**
- ____ 1 cm Muck (A9) **(LRR P, T)**
- ____ Depleted Below Dark Surface (A11)
- ____ Thick Dark Surface (A12)
- ____ Coast Prairie Redox (A16) **(MLRA 150A)**
- ____ Sandy Mucky Mineral (S1) **(LRR O, S)**
- _X_ Sandy Gleyed Matrix (S4)
- ____ Sandy Redox (S5)
- ____ Stripped Matrix (S6)
- ____ Dark Surface (S7) **(LRR P, S, T, U)**
- ____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ____ Thin Dark Surface (S9) **(LRR S, T, U)**
- ____ Loamy Mucky Mineral (F1) **(LRR O)**
- ____ Loamy Gleyed Matrix (F2)
- ____ Depleted Matrix (F3)
- ____ Redox Dark Surface (F6)
- ____ Depleted Dark Surface (F7)
- ____ Redox Depressions (F8)
- ____ Marl (F10) **(LRR U)**
- ____ Depleted Ochric (F11) **(MLRA 151)**
- ____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ____ Umbric Surface (F13) **(LRR P, T, U)**
- ____ Delta Ochric (F17) **(MLRA 151)**
- ____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ____ 1 cm Muck (A9) **(LRR O)**
- ____ 2 cm Muck (A10) **(LRR S)**
- ____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ____ Red Parent Material (TF2)
- ____ Very Shallow Dark Surface (TF12)
- ____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes _X_ **No** ____

Remarks:

A positive indication of hydric soil was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 29, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA009_PSS
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Marsh, Saltwater Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.895456 Long: -97.129560 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: E2USN
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No ____
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes **X** No ____
Hydric Soil Present? Yes **X** No ____
Wetland Hydrology Present? Yes **X** No ____

Is the Sampled Area within a Wetland? **Yes** **X** **No** ____

Remarks:

This point was determined to be within a wetland due to the presence of all 3 wetland criteria.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- **X** Surface Water (A1)
- ____ High Water Table (A2)
- ____ Saturation (A3)
- ____ Water Marks (B1)
- ____ Sediment Deposits (B2)
- ____ Drift Deposits (B3)
- ____ Algal Mat or Crust (B4)
- ____ Iron Deposits (B5)
- ____ Inundation Visible on Aerial Imagery (B7)
- ____ Water-Stained Leaves (B9)
- **X** Aquatic Fauna (B13)
- ____ Marl Deposits (B15) **(LRR U)**
- **X** Hydrogen Sulfide Odor (C1)
- ____ Oxidized Rhizospheres on Living Roots(C3)
- ____ Presence of Reduced Iron (C4)
- ____ Recent Iron Reduction in Tilled Soils (C6)
- ____ Thin Muck Surface (C7)
- ____ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ____ Surface Soil Cracks (B6)
- **X** Sparsely Vegetated Concave Surface (B8)
- ____ Drainage Patterns (B10)
- ____ Moss Trim Lines (B16)
- ____ Dry-Season Water Table (C2)
- ____ Crayfish Burrows (C8)
- ____ Saturation Visible on Aerial Imagery (C9)
- ____ Geomorphic Position (D2)
- ____ Shallow Aquitard (D3)
- **X** FAC-Neutral Test (D5)
- ____ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present? Yes **X** No ____ Depth (inches): **3**
Water Table Present? Yes ____ No **X** Depth (inches): **>20**
Saturation Present? (includes capillary fringe) Yes ____ No **X** Depth (inches): **>20**

Wetland Hydrology Present? **Yes** **X** **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

A positive indication of wetland hydrology was observed (at least one primary indicator).

A positive indication of wetland hydrology was observed (at least two secondary indicators).

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: **DPA009_PSS**

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0
Sapling Stratum (Plot size: 30 ft.)			
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0
Shrub Stratum (Plot size: 30 ft.)			
1. *Avicennia germinans*	50	Yes	OBL
2.			
3.			
4.			
5.			
6.			
	50 = Total Cover		
50% of total cover:	25	20% of total cover:	10
Herb Stratum (Plot size: 30 ft.)			
1. *Salicornia depressa*	5	Yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	5 = Total Cover		
50% of total cover:	2.5	20% of total cover:	1
Woody Vine Stratum (Plot size: 30 ft.)			
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)

Total Number of Dominant Species Across All Strata: **2** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:			Multiply by:
OBL species	**55**	x 1 =	**55**
FACW species	**0**	x 2 =	**0**
FAC species	**0**	x 3 =	**0**
FACU species	**0**	x 4 =	**0**
UPL species	**0**	x 5 =	**0**
Column Totals:	**55** (A)		**55** (B)

Prevalence Index = B/A = **1.00**

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- **X** 2 - Dominance Test is >50%
- **X** 3 - Prevalence Index is ≤ 3.0[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

SOIL

Sampling Point: DPA009_PSS

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-3	N 2.5	100	None	—	—	—	Organic Soil Layer	
3-16	10Y 5/1	100	None	—	—	—	Clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

____ Histosol (A1)
____ Histic Epipedon (A2)
____ Black Histic (A3)
____ Hydrogen Sulfide (A4)
____ Stratified Layers (A5)
____ Organic Bodies (A6) **(LRR P, T, U)**
____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
____ Muck Presence (A8) **(LRR U)**
____ 1 cm Muck (A9) **(LRR P, T)**
____ Depleted Below Dark Surface (A11)
____ Thick Dark Surface (A12)
____ Coast Prairie Redox (A16) **(MLRA 150A)**
____ Sandy Mucky Mineral (S1) **(LRR O, S)**
____ Sandy Gleyed Matrix (S4)
____ Sandy Redox (S5)
____ Stripped Matrix (S6)
____ Dark Surface (S7) **(LRR P, S, T, U)**
____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
____ Thin Dark Surface (S9) **(LRR S, T, U)**
____ Loamy Mucky Mineral (F1) **(LRR O)**
__X__ Loamy Gleyed Matrix (F2)
____ Depleted Matrix (F3)
____ Redox Dark Surface (F6)
____ Depleted Dark Surface (F7)
____ Redox Depressions (F8)
____ Marl (F10) **(LRR U)**
____ Depleted Ochric (F11) **(MLRA 151)**
____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
____ Umbric Surface (F13) **(LRR P, T, U)**
____ Delta Ochric (F17) **(MLRA 151)**
____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

____ 1 cm Muck (A9) **(LRR O)**
____ 2 cm Muck (A10) **(LRR S)**
____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
____ Red Parent Material (TF2)
____ Very Shallow Dark Surface (TF12)
____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes __X__ **No** ______

Remarks:

A positive indication of hydric soil was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 29, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA011_PEM
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Beach Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.895292 Long: -97.130171 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: E2EM1N
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No ____
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes **X**	No ____		
Hydric Soil Present?	Yes **X**	No ____	**Is the Sampled Area**	
Wetland Hydrology Present?	Yes **X**	No ____	**within a Wetland?**	**Yes** **X** **No** ____

Remarks:

This point was determined to be within a wetland due to the presence of all 3 wetland criteria.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

X	Surface Water (A1)	X	Aquatic Fauna (B13)
X	High Water Table (A2)		Marl Deposits (B15) **(LRR U)**
	Saturation (A3)	X	Hydrogen Sulfide Odor (C1)
	Water Marks (B1)		Oxidized Rhizospheres on Living Roots(C3)
	Sediment Deposits (B2)		Presence of Reduced Iron (C4)
	Drift Deposits (B3)		Recent Iron Reduction in Tilled Soils (C6)
	Algal Mat or Crust (B4)		Thin Muck Surface (C7)
	Iron Deposits (B5)		Other (Explain in Remarks)
	Inundation Visible on Aerial Imagery (B7)		
	Water-Stained Leaves (B9)		

Secondary Indicators (minimum of two required)

	Surface Soil Cracks (B6)
X	Sparsely Vegetated Concave Surface (B8)
	Drainage Patterns (B10)
	Moss Trim Lines (B16)
	Dry-Season Water Table (C2)
	Crayfish Burrows (C8)
	Saturation Visible on Aerial Imagery (C9)
	Geomorphic Position (D2)
	Shallow Aquitard (D3)
X	FAC-Neutral Test (D5)
	Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes **X**	No ____	Depth (inches): **3**
Water Table Present?	Yes **X**	No ____	Depth (inches): **8**
Saturation Present? (includes capillary fringe)	Yes ____	No **X**	Depth (inches): **>20**

Wetland Hydrology Present? **Yes** **X** **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

A positive indication of wetland hydrology was observed (at least one primary indicator).

A positive indication of wetland hydrology was observed (at least two secondary indicators).

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: **DPA011_PEM**

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Sapling Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Shrub Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Herb Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *Avicennia germinans*	70	Yes	OBL
2. *Salicornia depressa*	40	Yes	OBL
3. *Spartina alterniflora*	10	No	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	120 = Total Cover		
50% of total cover: 60		20% of total cover: 24	

Woody Vine Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)

Total Number of Dominant Species Across All Strata: **2** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:			Multiply by:	
OBL species	**120**	x 1 =	**120**	
FACW species	**0**	x 2 =	**0**	
FAC species	**0**	x 3 =	**0**	
FACU species	**0**	x 4 =	**0**	
UPL species	**0**	x 5 =	**0**	
Column Totals:	**120**	(A)	**120**	(B)

Prevalence Index = B/A = **1.00**

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- **X** 2 - Dominance Test is >50%
- **X** 3 - Prevalence Index is ≤ 3.0[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, <u>and</u> woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

SOIL

Sampling Point: **DPA011_PEM**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-12	10Y 4/1	98	10YR 5/8	2	C	M	Clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ____ Histosol (A1)
- ____ Histic Epipedon (A2)
- ____ Black Histic (A3)
- ____ Hydrogen Sulfide (A4)
- ____ Stratified Layers (A5)
- ____ Organic Bodies (A6) **(LRR P, T, U)**
- ____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ____ Muck Presence (A8) **(LRR U)**
- ____ 1 cm Muck (A9) **(LRR P, T)**
- ____ Depleted Below Dark Surface (A11)
- ____ Thick Dark Surface (A12)
- ____ Coast Prairie Redox (A16) **(MLRA 150A)**
- ____ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ____ Sandy Gleyed Matrix (S4)
- ____ Sandy Redox (S5)
- ____ Stripped Matrix (S6)
- ____ Dark Surface (S7) **(LRR P, S, T, U)**
- ____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ____ Thin Dark Surface (S9) **(LRR S, T, U)**
- ____ Loamy Mucky Mineral (F1) **(LRR O)**
- X Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- ____ Redox Dark Surface (F6)
- ____ Depleted Dark Surface (F7)
- ____ Redox Depressions (F8)
- ____ Marl (F10) **(LRR U)**
- ____ Depleted Ochric (F11) **(MLRA 151)**
- ____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ____ Umbric Surface (F13) **(LRR P, T, U)**
- ____ Delta Ochric (F17) **(MLRA 151)**
- ____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ____ 1 cm Muck (A9) **(LRR O)**
- ____ 2 cm Muck (A10) **(LRR S)**
- ____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ____ Red Parent Material (TF2)
- ____ Very Shallow Dark Surface (TF12)
- ____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes X **No** ____

Remarks:

A positive indication of hydric soil was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 29, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA012_U
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Beach Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.895072 Long: -97.130517 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No ___
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ___ No **X**
Hydric Soil Present? Yes ___ No **X**
Wetland Hydrology Present? Yes ___ No **X**

Is the Sampled Area within a Wetland? **Yes** ___ **No** **X**

Remarks:

This point was determined not to be within a wetland due to the lack of all three wetland criteria.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15) **(LRR U)**
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots(C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

	Yes	No	Depth (inches):
Surface Water Present?		**X**	**N/A**
Water Table Present?		**X**	**>20**
Saturation Present? (includes capillary fringe)		**X**	**>20**

Wetland Hydrology Present? **Yes** ___ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

No positive indication of wetland hydrology was observed.

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: **DPA012_U**

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0	= Total Cover	
50% of total cover:	0	20% of total cover:	0
Sapling Stratum (Plot size: 30 ft.)			
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0	= Total Cover	
50% of total cover:	0	20% of total cover:	0
Shrub Stratum (Plot size: 30 ft.)			
1. *Schinus terebinthifolia*	20	Yes	FAC
2. *Tamarix ramosissima*	15	Yes	FACW
3.			
4.			
5.			
6.			
	35	= Total Cover	
50% of total cover:	17.5	20% of total cover:	7
Herb Stratum (Plot size: 30 ft.)			
1. *Opuntia engelmannii*	15	Yes	UPL
2. *Trifolium repens*	10	Yes	FACU
3. *Cynodon dactylon*	15	Yes	FACU
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	40	= Total Cover	
50% of total cover:	20	20% of total cover:	8
Woody Vine Stratum (Plot size: 30 ft.)			
1. *None Observed*			
2.			
3.			
4.			
5.			
	0	= Total Cover	
50% of total cover:	0	20% of total cover:	0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)

Total Number of Dominant Species Across All Strata: **5** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **40%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	15	x 2 =	30
FAC species	20	x 3 =	60
FACU species	25	x 4 =	100
UPL species	15	x 5 =	75
Column Totals:	75 (A)		265 (B)

Prevalence Index = B/A = **3.53**

Hydrophytic Vegetation Indicators:

____ 1 - Rapid Test for Hydrophytic Vegetation
____ 2 - Dominance Test is >50%
____ 3 - Prevalence Index is ≤ 3.0[1]
____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** ____ **No** **X**

Remarks: (if observed, list morphological adaptations below).

No positive indication of hydrophytic vegetation was observed (≥50% of dominant species indexed as FAC− or drier).

SOIL

Sampling Point: DPA012_U

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-8	10YR 4/2	100	None	—	—	—	Sandy Clay	Shovel Restriction

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

____ Histosol (A1)
____ Histic Epipedon (A2)
____ Black Histic (A3)
____ Hydrogen Sulfide (A4)
____ Stratified Layers (A5)
____ Organic Bodies (A6) **(LRR P, T, U)**
____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
____ Muck Presence (A8) **(LRR U)**
____ 1 cm Muck (A9) **(LRR P, T)**
____ Depleted Below Dark Surface (A11)
____ Thick Dark Surface (A12)
____ Coast Prairie Redox (A16) **(MLRA 150A)**
____ Sandy Mucky Mineral (S1) **(LRR O, S)**
____ Sandy Gleyed Matrix (S4)
____ Sandy Redox (S5)
____ Stripped Matrix (S6)
____ Dark Surface (S7) **(LRR P, S, T, U)**
____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
____ Thin Dark Surface (S9) **(LRR S, T, U)**
____ Loamy Mucky Mineral (F1) **(LRR O)**
____ Loamy Gleyed Matrix (F2)
____ Depleted Matrix (F3)
____ Redox Dark Surface (F6)
____ Depleted Dark Surface (F7)
____ Redox Depressions (F8)
____ Marl (F10) **(LRR U)**
____ Depleted Ochric (F11) **(MLRA 151)**
____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
____ Umbric Surface (F13) **(LRR P, T, U)**
____ Delta Ochric (F17) **(MLRA 151)**
____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

____ 1 cm Muck (A9) **(LRR O)**
____ 2 cm Muck (A10) **(LRR S)**
____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
____ Red Parent Material (TF2)
____ Very Shallow Dark Surface (TF12)
____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: Gravel/Concrete
Depth (inches): 8

Hydric Soil Present? Yes ________ No X

Remarks:

No positive indication of hydric soils was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 29, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA013_PEM
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Beach Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.895233 Long: -97.128663 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: E2USP
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation No ,Soil No ,or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation No ,Soil No ,or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No
Hydric Soil Present?	Yes X	No
Wetland Hydrology Present?	Yes X	No

Is the Sampled Area within a Wetland? **Yes X** **No**

Remarks:

This point was determined to be within a wetland due to the presence of all 3 wetland criteria.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

	Surface Water (A1)	X	Aquatic Fauna (B13)
	High Water Table (A2)		Marl Deposits (B15) **(LRR U)**
	Saturation (A3)	X	Hydrogen Sulfide Odor (C1)
	Water Marks (B1)		Oxidized Rhizospheres on Living Roots(C3)
	Sediment Deposits (B2)		Presence of Reduced Iron (C4)
	Drift Deposits (B3)		Recent Iron Reduction in Tilled Soils (C6)
	Algal Mat or Crust (B4)		Thin Muck Surface (C7)
	Iron Deposits (B5)	X	Other (Explain in Remarks)
	Inundation Visible on Aerial Imagery (B7)		
	Water-Stained Leaves (B9)		

Secondary Indicators (minimum of two required)

	Surface Soil Cracks (B6)
X	Sparsely Vegetated Concave Surface (B8)
	Drainage Patterns (B10)
	Moss Trim Lines (B16)
	Dry-Season Water Table (C2)
	Crayfish Burrows (C8)
	Saturation Visible on Aerial Imagery (C9)
	Geomorphic Position (D2)
	Shallow Aquitard (D3)
X	FAC-Neutral Test (D5)
	Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes	No X	Depth (inches): **N/A**
Water Table Present?	Yes	No X	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes	No X	Depth (inches): **>20**

Wetland Hydrology Present? **Yes X** **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

A positive indication of wetland hydrology was observed (at least one primary indicator).

A positive indication of wetland hydrology was observed (at least two secondary indicators).

Other: Coastal inundation.

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: **DPA013_PEM**

Tree Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Sapling Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Shrub Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Herb Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *Avicennia germinans*	50	Yes	OBL
2. *Salicornia depressa*	10	No	OBL
3. *Spartina alterniflora*	10	No	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	70 = Total Cover		
50% of total cover:	35	20% of total cover:	14

Woody Vine Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **1** (A)

Total Number of Dominant Species Across All Strata: **1** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	70	x 1 =	70
FACW species	0	x 2 =	0
FAC species	0	x 3 =	0
FACU species	0	x 4 =	0
UPL species	0	x 5 =	0
Column Totals:	70 (A)		70 (B)

Prevalence Index = B/A = **1.00**

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤ 3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes **X** No ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

SOIL

Sampling Point: **DPA013_PEM**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-16	10Y 4/1	98	10YR 4/6	2	C	M	Clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

____ Histosol (A1)
____ Histic Epipedon (A2)
____ Black Histic (A3)
____ Hydrogen Sulfide (A4)
____ Stratified Layers (A5)
____ Organic Bodies (A6) **(LRR P, T, U)**
____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
____ Muck Presence (A8) **(LRR U)**
____ 1 cm Muck (A9) **(LRR P, T)**
____ Depleted Below Dark Surface (A11)
____ Thick Dark Surface (A12)
____ Coast Prairie Redox (A16) **(MLRA 150A)**
____ Sandy Mucky Mineral (S1) **(LRR O, S)**
____ Sandy Gleyed Matrix (S4)
____ Sandy Redox (S5)
____ Stripped Matrix (S6)
____ Dark Surface (S7) **(LRR P, S, T, U)**
____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
____ Thin Dark Surface (S9) **(LRR S, T, U)**
____ Loamy Mucky Mineral (F1) **(LRR O)**
__X__ Loamy Gleyed Matrix (F2)
__X__ Depleted Matrix (F3)
____ Redox Dark Surface (F6)
____ Depleted Dark Surface (F7)
____ Redox Depressions (F8)
____ Marl (F10) **(LRR U)**
____ Depleted Ochric (F11) **(MLRA 151)**
____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
____ Umbric Surface (F13) **(LRR P, T, U)**
____ Delta Ochric (F17) **(MLRA 151)**
____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

____ 1 cm Muck (A9) **(LRR O)**
____ 2 cm Muck (A10) **(LRR S)**
____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
____ Red Parent Material (TF2)
____ Very Shallow Dark Surface (TF12)
____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes __X__ **No** ______

Remarks:

A positive indication of hydric soil was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 29, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA014_U
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Beach Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.894971 Long: -97.127965 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No ____
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ____	No **X**		
Hydric Soil Present?	Yes ____	No **X**	**Is the Sampled Area**	
Wetland Hydrology Present?	Yes ____	No **X**	**within a Wetland?**	**Yes** ____ **No X**

Remarks:

This point was determined not to be within a wetland due to the lack of all three wetland criteria.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ____ Surface Water (A1)
- ____ High Water Table (A2)
- ____ Saturation (A3)
- ____ Water Marks (B1)
- ____ Sediment Deposits (B2)
- ____ Drift Deposits (B3)
- ____ Algal Mat or Crust (B4)
- ____ Iron Deposits (B5)
- ____ Inundation Visible on Aerial Imagery (B7)
- ____ Water-Stained Leaves (B9)
- ____ Aquatic Fauna (B13)
- ____ Marl Deposits (B15) **(LRR U)**
- ____ Hydrogen Sulfide Odor (C1)
- ____ Oxidized Rhizospheres on Living Roots(C3)
- ____ Presence of Reduced Iron (C4)
- ____ Recent Iron Reduction in Tilled Soils (C6)
- ____ Thin Muck Surface (C7)
- ____ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ____ Surface Soil Cracks (B6)
- ____ Sparsely Vegetated Concave Surface (B8)
- ____ Drainage Patterns (B10)
- ____ Moss Trim Lines (B16)
- ____ Dry-Season Water Table (C2)
- ____ Crayfish Burrows (C8)
- ____ Saturation Visible on Aerial Imagery (C9)
- ____ Geomorphic Position (D2)
- ____ Shallow Aquitard (D3)
- ____ FAC-Neutral Test (D5)
- ____ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ____	No **X**	Depth (inches): **N/A**
Water Table Present?	Yes ____	No **X**	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes ____	No **X**	Depth (inches): **>20**

Wetland Hydrology Present? **Yes** ____ **No X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

No positive indication of wetland hydrology was observed.

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: **DPA014_U**

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Sapling Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Shrub Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Herb Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *Opuntia engelmannii*	15	Yes	UPL
2. *Borrichia frutescens*	15	Yes	OBL
3. *Thelesperma filifolium*	15	Yes	UPL
4. *Oxalis stricta*	10	No	UPL
5. *Muhlenbergia schreberi*	30	Yes	FAC
6.			
7.			
8.			
9.			
10.			
11.			
	85 = Total Cover		
50% of total cover: 42.5		20% of total cover: 17	

Woody Vine Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)

Total Number of Dominant Species Across All Strata: **4** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **50%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**15**	x 1 =	**15**
FACW species	**0**	x 2 =	**0**
FAC species	**30**	x 3 =	**90**
FACU species	**0**	x 4 =	**0**
UPL species	**40**	x 5 =	**200**
Column Totals:	**85** (A)		**305** (B)

Prevalence Index = B/A = **3.59**

Hydrophytic Vegetation Indicators:

____ 1 - Rapid Test for Hydrophytic Vegetation
____ 2 - Dominance Test is >50%
____ 3 - Prevalence Index is ≤ 3.0[1]
____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** ____ **No** **X**

Remarks: (if observed, list morphological adaptations below).

No positive indication of hydrophytic vegetation was observed (≥50% of dominant species indexed as FAC− or drier).

Sampling Point: **DPA014_U**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-8	10YR 3/3	100	None	—	—	—	Sandy Clay Loam	Shovel Restriction

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ____ Histosol (A1)
- ____ Histic Epipedon (A2)
- ____ Black Histic (A3)
- ____ Hydrogen Sulfide (A4)
- ____ Stratified Layers (A5)
- ____ Organic Bodies (A6) **(LRR P, T, U)**
- ____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ____ Muck Presence (A8) **(LRR U)**
- ____ 1 cm Muck (A9) **(LRR P, T)**
- ____ Depleted Below Dark Surface (A11)
- ____ Thick Dark Surface (A12)
- ____ Coast Prairie Redox (A16) **(MLRA 150A)**
- ____ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ____ Sandy Gleyed Matrix (S4)
- ____ Sandy Redox (S5)
- ____ Stripped Matrix (S6)
- ____ Dark Surface (S7) **(LRR P, S, T, U)**
- ____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ____ Thin Dark Surface (S9) **(LRR S, T, U)**
- ____ Loamy Mucky Mineral (F1) **(LRR O)**
- ____ Loamy Gleyed Matrix (F2)
- ____ Depleted Matrix (F3)
- ____ Redox Dark Surface (F6)
- ____ Depleted Dark Surface (F7)
- ____ Redox Depressions (F8)
- ____ Marl (F10) **(LRR U)**
- ____ Depleted Ochric (F11) **(MLRA 151)**
- ____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ____ Umbric Surface (F13) **(LRR P, T, U)**
- ____ Delta Ochric (F17) **(MLRA 151)**
- ____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ____ 1 cm Muck (A9) **(LRR O)**
- ____ 2 cm Muck (A10) **(LRR S)**
- ____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ____ Red Parent Material (TF2)
- ____ Very Shallow Dark Surface (TF12)
- ____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: Pavement from old, buried road

Depth (inches): 8

Hydric Soil Present? Yes ____ No X

Remarks:

No positive indication of hydric soils was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 29, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA015_U
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Beach Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.894310 Long: -97.127297 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation No ,Soil No ,or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation No ,Soil No ,or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No X
Hydric Soil Present?	Yes ___	No X
Wetland Hydrology Present?	Yes ___	No X

Is the Sampled Area within a Wetland? **Yes** ___ **No** X

Remarks:

This point was determined not to be within a wetland due to the lack of all three wetland criteria.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15) **(LRR U)**
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots(C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches): **N/A**
Water Table Present?	Yes ___	No X	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches): **>20**

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

No positive indication of wetland hydrology was observed.

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: **DPA015_U**

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Sapling Stratum (Plot size: 30 ft.)			
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Shrub Stratum (Plot size: 30 ft.)			
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Herb Stratum (Plot size: 30 ft.)			
1. *Opuntia engelmannii*	10	No	UPL
2. *Schizachyrium scoparium*	30	Yes	FACU
3. *Yucca treculeana*	10	No	UPL
4. *Cynodon dactylon*	30	Yes	FACU
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	80 = Total Cover		
50% of total cover: 40		20% of total cover: 16	

Woody Vine Stratum (Plot size: 30 ft.)			
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **0** (A)

Total Number of Dominant Species Across All Strata: **2** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **0** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x 1 =	**0**
FACW species	**0**	x 2 =	**0**
FAC species	**0**	x 3 =	**0**
FACU species	**60**	x 4 =	**240**
UPL species	**20**	x 5 =	**100**
Column Totals:	**80** (A)		**340** (B)

Prevalence Index = B/A = **4.25**

Hydrophytic Vegetation Indicators:

____ 1 - Rapid Test for Hydrophytic Vegetation

____ 2 - Dominance Test is >50%

____ 3 - Prevalence Index is ≤ 3.0[1]

____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes ____ No __X__

Remarks: (if observed, list morphological adaptations below).

No positive indication of hydrophytic vegetation was observed (≥50% of dominant species indexed as FAC− or drier).

SOIL

Sampling Point: DPA015_U

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-16	10YR 5/3	98	10YR 5/6	2	C	M	Sandy Clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

____ Histosol (A1)
____ Histic Epipedon (A2)
____ Black Histic (A3)
____ Hydrogen Sulfide (A4)
____ Stratified Layers (A5)
____ Organic Bodies (A6) **(LRR P, T, U)**
____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
____ Muck Presence (A8) **(LRR U)**
____ 1 cm Muck (A9) **(LRR P, T)**
____ Depleted Below Dark Surface (A11)
____ Thick Dark Surface (A12)
____ Coast Prairie Redox (A16) **(MLRA 150A)**
____ Sandy Mucky Mineral (S1) **(LRR O, S)**
____ Sandy Gleyed Matrix (S4)
____ Sandy Redox (S5)
____ Stripped Matrix (S6)
____ Dark Surface (S7) **(LRR P, S, T, U)**

____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
____ Thin Dark Surface (S9) **(LRR S, T, U)**
____ Loamy Mucky Mineral (F1) **(LRR O)**
____ Loamy Gleyed Matrix (F2)
____ Depleted Matrix (F3)
____ Redox Dark Surface (F6)
____ Depleted Dark Surface (F7)
____ Redox Depressions (F8)
____ Marl (F10) **(LRR U)**
____ Depleted Ochric (F11) **(MLRA 151)**
____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
____ Umbric Surface (F13) **(LRR P, T, U)**
____ Delta Ochric (F17) **(MLRA 151)**
____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

____ 1 cm Muck (A9) **(LRR O)**
____ 2 cm Muck (A10) **(LRR S)**
____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
____ Red Parent Material (TF2)
____ Very Shallow Dark Surface (TF12)
____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ________ **No** X

Remarks:

No positive indication of hydric soils was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 29, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA016_PEM
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Beach Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.892485 Long: -97.117486 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No ____
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes **X**	No ____
Hydric Soil Present?	Yes **X**	No ____
Wetland Hydrology Present?	Yes **X**	No ____

Is the Sampled Area within a Wetland? **Yes X** **No ____**

Remarks:

This point was determined to be within a wetland due to the presence of all 3 wetland criteria.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

X	Surface Water (A1)	X	Aquatic Fauna (B13)
	High Water Table (A2)		Marl Deposits (B15) **(LRR U)**
	Saturation (A3)	X	Hydrogen Sulfide Odor (C1)
	Water Marks (B1)		Oxidized Rhizospheres on Living Roots(C3)
	Sediment Deposits (B2)		Presence of Reduced Iron (C4)
	Drift Deposits (B3)		Recent Iron Reduction in Tilled Soils (C6)
	Algal Mat or Crust (B4)		Thin Muck Surface (C7)
	Iron Deposits (B5)		Other (Explain in Remarks)
	Inundation Visible on Aerial Imagery (B7)		
	Water-Stained Leaves (B9)		

Secondary Indicators (minimum of two required)

	Surface Soil Cracks (B6)
X	Sparsely Vegetated Concave Surface (B8)
	Drainage Patterns (B10)
	Moss Trim Lines (B16)
	Dry-Season Water Table (C2)
	Crayfish Burrows (C8)
	Saturation Visible on Aerial Imagery (C9)
	Geomorphic Position (D2)
	Shallow Aquitard (D3)
X	FAC-Neutral Test (D5)
	Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes **X**	No ____	Depth (inches): **3**
Water Table Present?	Yes ____	No **X**	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes ____	No **X**	Depth (inches): **>20**

Wetland Hydrology Present? **Yes X** **No ____**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

A positive indication of wetland hydrology was observed (at least one primary indicator).

A positive indication of wetland hydrology was observed (at least two secondary indicators).

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: **DPA016_PEM**

Tree Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Sapling Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Shrub Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Herb Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *Avicennia germinans*	50	Yes	OBL
2. *Salicornia depressa*	10	No	OBL
3. *Spartina alterniflora*	15	Yes	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	75 = Total Cover		
50% of total cover: 37.5	20% of total cover: 15		

Woody Vine Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)

Total Number of Dominant Species Across All Strata: **2** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**75**	x 1 =	**75**
FACW species	**0**	x 2 =	**0**
FAC species	**0**	x 3 =	**0**
FACU species	**0**	x 4 =	**0**
UPL species	**0**	x 5 =	**0**
Column Totals:	**75** (A)		**75** (B)

Prevalence Index = B/A = **1.00**

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- **X** 2 - Dominance Test is >50%
- **X** 3 - Prevalence Index is ≤ 3.0[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

SOIL

Sampling Point: **DPA016_PEM**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-16	10Y 4/1	100	None	—	—	—	Clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ____ Histosol (A1)
- ____ Histic Epipedon (A2)
- ____ Black Histic (A3)
- ____ Hydrogen Sulfide (A4)
- ____ Stratified Layers (A5)
- ____ Organic Bodies (A6) **(LRR P, T, U)**
- ____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ____ Muck Presence (A8) **(LRR U)**
- ____ 1 cm Muck (A9) **(LRR P, T)**
- ____ Depleted Below Dark Surface (A11)
- ____ Thick Dark Surface (A12)
- ____ Coast Prairie Redox (A16) **(MLRA 150A)**
- ____ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ____ Sandy Gleyed Matrix (S4)
- ____ Sandy Redox (S5)
- ____ Stripped Matrix (S6)
- ____ Dark Surface (S7) **(LRR P, S, T, U)**
- ____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ____ Thin Dark Surface (S9) **(LRR S, T, U)**
- ____ Loamy Mucky Mineral (F1) **(LRR O)**
- _X_ Loamy Gleyed Matrix (F2)
- ____ Depleted Matrix (F3)
- ____ Redox Dark Surface (F6)
- ____ Depleted Dark Surface (F7)
- ____ Redox Depressions (F8)
- ____ Marl (F10) **(LRR U)**
- ____ Depleted Ochric (F11) **(MLRA 151)**
- ____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ____ Umbric Surface (F13) **(LRR P, T, U)**
- ____ Delta Ochric (F17) **(MLRA 151)**
- ____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ____ 1 cm Muck (A9) **(LRR O)**
- ____ 2 cm Muck (A10) **(LRR S)**
- ____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ____ Red Parent Material (TF2)
- ____ Very Shallow Dark Surface (TF12)
- ____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes _X_ **No** ____

Remarks:

A positive indication of hydric soil was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 29, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA020_PEM
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Beach Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.893408 Long: -97.122001 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No ____
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes **X**	No ____
Hydric Soil Present?	Yes **X**	No ____
Wetland Hydrology Present?	Yes **X**	No ____

Is the Sampled Area within a Wetland? **Yes X** **No** ____

Remarks:

This point was determined to be within a wetland due to the presence of all 3 wetland criteria.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

X	Surface Water (A1)	X	Aquatic Fauna (B13)
	High Water Table (A2)		Marl Deposits (B15) **(LRR U)**
	Saturation (A3)	X	Hydrogen Sulfide Odor (C1)
	Water Marks (B1)		Oxidized Rhizospheres on Living Roots(C3)
	Sediment Deposits (B2)		Presence of Reduced Iron (C4)
	Drift Deposits (B3)		Recent Iron Reduction in Tilled Soils (C6)
	Algal Mat or Crust (B4)		Thin Muck Surface (C7)
	Iron Deposits (B5)		Other (Explain in Remarks)
	Inundation Visible on Aerial Imagery (B7)		
	Water-Stained Leaves (B9)		

Secondary Indicators (minimum of two required)

	Surface Soil Cracks (B6)
X	Sparsely Vegetated Concave Surface (B8)
	Drainage Patterns (B10)
	Moss Trim Lines (B16)
	Dry-Season Water Table (C2)
	Crayfish Burrows (C8)
	Saturation Visible on Aerial Imagery (C9)
	Geomorphic Position (D2)
	Shallow Aquitard (D3)
X	FAC-Neutral Test (D5)
	Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes **X**	No ____	Depth (inches): **3**
Water Table Present?	Yes ____	No **X**	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes ____	No **X**	Depth (inches): **>20**

Wetland Hydrology Present? **Yes X** **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

A positive indication of wetland hydrology was observed (at least one primary indicator).

A positive indication of wetland hydrology was observed (at least two secondary indicators).

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: **DPA020_PEM**

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Sapling Stratum (Plot size: 30 ft.)			
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Shrub Stratum (Plot size: 30 ft.)			
1. *Avicennia germinans*	20	Yes	OBL
2.			
3.			
4.			
5.			
6.			
	20 = Total Cover		
50% of total cover: 10		20% of total cover: 4	

Herb Stratum (Plot size: 30 ft.)			
1. *Avicennia germinans*	10	Yes	OBL
2. *Borrichia frutescens*	15	Yes	OBL
3. *Batis maritima*	15	Yes	OBL
4. *Salicornia depressa*	10	Yes	OBL
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	50 = Total Cover		
50% of total cover: 25		20% of total cover: 10	

Woody Vine Stratum (Plot size: 30 ft.)			
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover: 0		20% of total cover: 0	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **5** (A)

Total Number of Dominant Species Across All Strata: **5** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:		
OBL species	**70**	x 1 =	**70**	
FACW species	**0**	x 2 =	**0**	
FAC species	**0**	x 3 =	**0**	
FACU species	**0**	x 4 =	**0**	
UPL species	**0**	x 5 =	**0**	
Column Totals:	**70**	(A)	**70**	(B)

Prevalence Index = B/A = **1.00**

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤ 3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

SOIL

Sampling Point: DPA020_PEM

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-16	5Y 5/1	95	10YR 6/8	5	C	M	Sandy Clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

____ Histosol (A1)
____ Histic Epipedon (A2)
____ Black Histic (A3)
____ Hydrogen Sulfide (A4)
____ Stratified Layers (A5)
____ Organic Bodies (A6) **(LRR P, T, U)**
____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
____ Muck Presence (A8) **(LRR U)**
____ 1 cm Muck (A9) **(LRR P, T)**
____ Depleted Below Dark Surface (A11)
____ Thick Dark Surface (A12)
____ Coast Prairie Redox (A16) **(MLRA 150A)**
____ Sandy Mucky Mineral (S1) **(LRR O, S)**
____ Sandy Gleyed Matrix (S4)
X Sandy Redox (S5)
____ Stripped Matrix (S6)
____ Dark Surface (S7) **(LRR P, S, T, U)**

____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
____ Thin Dark Surface (S9) **(LRR S, T, U)**
____ Loamy Mucky Mineral (F1) **(LRR O)**
____ Loamy Gleyed Matrix (F2)
____ Depleted Matrix (F3)
____ Redox Dark Surface (F6)
____ Depleted Dark Surface (F7)
____ Redox Depressions (F8)
____ Marl (F10) **(LRR U)**
____ Depleted Ochric (F11) **(MLRA 151)**
____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
____ Umbric Surface (F13) **(LRR P, T, U)**
____ Delta Ochric (F17) **(MLRA 151)**
____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

____ 1 cm Muck (A9) **(LRR O)**
____ 2 cm Muck (A10) **(LRR S)**
____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
____ Red Parent Material (TF2)
____ Very Shallow Dark Surface (TF12)
____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ________

Depth (inches): ________

Hydric Soil Present? Yes X **No** ____

Remarks:

A positive indication of hydric soil was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 29, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA021_U
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Beach Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.893042 Long: -97.121818 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **Yes** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No ____
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ____	No **X**
Hydric Soil Present?	Yes **X**	No ____
Wetland Hydrology Present?	Yes ____	No **X**

Is the Sampled Area within a Wetland? **Yes** ____ **No** **X**

Remarks:

This point was determined not to be within a wetland due to the lack of hydrophytic vegetation and wetland hydrology.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ____ Surface Water (A1)
- ____ High Water Table (A2)
- ____ Saturation (A3)
- ____ Water Marks (B1)
- ____ Sediment Deposits (B2)
- ____ Drift Deposits (B3)
- ____ Algal Mat or Crust (B4)
- ____ Iron Deposits (B5)
- ____ Inundation Visible on Aerial Imagery (B7)
- ____ Water-Stained Leaves (B9)
- ____ Aquatic Fauna (B13)
- ____ Marl Deposits (B15) **(LRR U)**
- ____ Hydrogen Sulfide Odor (C1)
- ____ Oxidized Rhizospheres on Living Roots(C3)
- ____ Presence of Reduced Iron (C4)
- ____ Recent Iron Reduction in Tilled Soils (C6)
- ____ Thin Muck Surface (C7)
- ____ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ____ Surface Soil Cracks (B6)
- ____ Sparsely Vegetated Concave Surface (B8)
- ____ Drainage Patterns (B10)
- ____ Moss Trim Lines (B16)
- ____ Dry-Season Water Table (C2)
- ____ Crayfish Burrows (C8)
- ____ Saturation Visible on Aerial Imagery (C9)
- ____ Geomorphic Position (D2)
- ____ Shallow Aquitard (D3)
- ____ FAC-Neutral Test (D5)
- ____ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ____	No **X**	Depth (inches): **N/A**
Water Table Present?	Yes ____	No **X**	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes ____	No **X**	Depth (inches): **>20**

Wetland Hydrology Present? **Yes** ____ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

No positive indication of wetland hydrology was observed.

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: DPA021_U

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Sapling Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Shrub Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Herb Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *Nassella leucotricha*	30	Yes	UPL
2. *Calyptocarpus vialis*	10	Yes	FAC
3. *Sonchus asper*	10	Yes	FACU
4. *Tamarix ramosissima*	10	Yes	FACW
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	60 = Total Cover		
50% of total cover: 30	20% of total cover: 12		

Woody Vine Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)

Total Number of Dominant Species Across All Strata: **4** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **50%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x 1 =	**0**
FACW species	**10**	x 2 =	**20**
FAC species	**10**	x 3 =	**30**
FACU species	**10**	x 4 =	**40**
UPL species	**30**	x 5 =	**150**
Column Totals:	**60** (A)		**240** (B)

Prevalence Index = B/A = **4.00**

Hydrophytic Vegetation Indicators:

____ 1 - Rapid Test for Hydrophytic Vegetation

____ 2 - Dominance Test is >50%

____ 3 - Prevalence Index is ≤ 3.0[1]

____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** ____ **No** X

Remarks: (if observed, list morphological adaptations below).

No positive indication of hydrophytic vegetation was observed (≥50% of dominant species indexed as FAC− or drier).

SOIL

Sampling Point: DPA021_U

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-16	10YR 6/2	98	10YR 6/8	2	C	M	Loamy Sand	Disturbed soils

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

____ Histosol (A1)
____ Histic Epipedon (A2)
____ Black Histic (A3)
____ Hydrogen Sulfide (A4)
____ Stratified Layers (A5)
____ Organic Bodies (A6) **(LRR P, T, U)**
____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
____ Muck Presence (A8) **(LRR U)**
____ 1 cm Muck (A9) **(LRR P, T)**
____ Depleted Below Dark Surface (A11)
____ Thick Dark Surface (A12)
____ Coast Prairie Redox (A16) **(MLRA 150A)**
____ Sandy Mucky Mineral (S1) **(LRR O, S)**
____ Sandy Gleyed Matrix (S4)
X Sandy Redox (S5)
____ Stripped Matrix (S6)
____ Dark Surface (S7) **(LRR P, S, T, U)**
____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
____ Thin Dark Surface (S9) **(LRR S, T, U)**
____ Loamy Mucky Mineral (F1) **(LRR O)**
____ Loamy Gleyed Matrix (F2)
____ Depleted Matrix (F3)
____ Redox Dark Surface (F6)
____ Depleted Dark Surface (F7)
____ Redox Depressions (F8)
____ Marl (F10) **(LRR U)**
____ Depleted Ochric (F11) **(MLRA 151)**
____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
____ Umbric Surface (F13) **(LRR P, T, U)**
____ Delta Ochric (F17) **(MLRA 151)**
____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

____ 1 cm Muck (A9) **(LRR O)**
____ 2 cm Muck (A10) **(LRR S)**
____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
____ Red Parent Material (TF2)
____ Very Shallow Dark Surface (TF12)
____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes X **No** ____________

Remarks:

A positive indication of hydric soil was observed.

Soils disturbed due to nearby road.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 29, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA022_PEM
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Beach Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.879957 Long: -97.098903 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes **X**	No		
Hydric Soil Present?	Yes **X**	No	**Is the Sampled Area**	
Wetland Hydrology Present?	Yes **X**	No	**within a Wetland?**	**Yes X No**

Remarks:

This point was determined to be within a wetland due to the presence of all 3 wetland criteria.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

X	Surface Water (A1)	X	Aquatic Fauna (B13)
	High Water Table (A2)		Marl Deposits (B15) **(LRR U)**
	Saturation (A3)		Hydrogen Sulfide Odor (C1)
	Water Marks (B1)		Oxidized Rhizospheres on Living Roots(C3)
	Sediment Deposits (B2)		Presence of Reduced Iron (C4)
	Drift Deposits (B3)		Recent Iron Reduction in Tilled Soils (C6)
	Algal Mat or Crust (B4)		Thin Muck Surface (C7)
	Iron Deposits (B5)		Other (Explain in Remarks)
	Inundation Visible on Aerial Imagery (B7)		
	Water-Stained Leaves (B9)		

Secondary Indicators (minimum of two required)

	Surface Soil Cracks (B6)
X	Sparsely Vegetated Concave Surface (B8)
	Drainage Patterns (B10)
	Moss Trim Lines (B16)
	Dry-Season Water Table (C2)
	Crayfish Burrows (C8)
	Saturation Visible on Aerial Imagery (C9)
	Geomorphic Position (D2)
	Shallow Aquitard (D3)
X	FAC-Neutral Test (D5)
	Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes **X**	No	Depth (inches): **6**
Water Table Present?	Yes	No **X**	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes	No **X**	Depth (inches): **>20**

Wetland Hydrology Present? Yes X No

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

A positive indication of wetland hydrology was observed (at least one primary indicator).

A positive indication of wetland hydrology was observed (at least two secondary indicators).

Aquatic Fauna: crabs.

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: **DPA022_PEM**

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Sapling Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Shrub Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Herb Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *Typha latifolia*	70	Yes	OBL
2. *Andropogon glomeratus*	10	No	FACW
3. *Borrichia frutescens*	5	No	OBL
4. *Schoenoplectus pungens*	15	No	OBL
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	100 = Total Cover		
50% of total cover:	50	20% of total cover:	20

Woody Vine Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **1** (A)

Total Number of Dominant Species Across All Strata: **1** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**90**	x 1 =	**90**
FACW species	**10**	x 2 =	**20**
FAC species	**0**	x 3 =	**0**
FACU species	**0**	x 4 =	**0**
UPL species	**0**	x 5 =	**0**
Column Totals:	**100** (A)		**110** (B)

Prevalence Index = B/A = **1.10**

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- X 3 - Prevalence Index is ≤ 3.0[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

SOIL

Sampling Point: **DPA022_PEM**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-16	10Y 5/1	100	None	—	—	—	Clay	Shell hash mixed with matrix

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ____ Histosol (A1)
- ____ Histic Epipedon (A2)
- ____ Black Histic (A3)
- ____ Hydrogen Sulfide (A4)
- ____ Stratified Layers (A5)
- ____ Organic Bodies (A6) **(LRR P, T, U)**
- ____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ____ Muck Presence (A8) **(LRR U)**
- ____ 1 cm Muck (A9) **(LRR P, T)**
- ____ Depleted Below Dark Surface (A11)
- ____ Thick Dark Surface (A12)
- ____ Coast Prairie Redox (A16) **(MLRA 150A)**
- ____ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ____ Sandy Gleyed Matrix (S4)
- ____ Sandy Redox (S5)
- ____ Stripped Matrix (S6)
- ____ Dark Surface (S7) **(LRR P, S, T, U)**
- ____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ____ Thin Dark Surface (S9) **(LRR S, T, U)**
- ____ Loamy Mucky Mineral (F1) **(LRR O)**
- X Loamy Gleyed Matrix (F2)
- ____ Depleted Matrix (F3)
- ____ Redox Dark Surface (F6)
- ____ Depleted Dark Surface (F7)
- ____ Redox Depressions (F8)
- ____ Marl (F10) **(LRR U)**
- ____ Depleted Ochric (F11) **(MLRA 151)**
- ____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ____ Umbric Surface (F13) **(LRR P, T, U)**
- ____ Delta Ochric (F17) **(MLRA 151)**
- ____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ____ 1 cm Muck (A9) **(LRR O)**
- ____ 2 cm Muck (A10) **(LRR S)**
- ____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ____ Red Parent Material (TF2)
- ____ Very Shallow Dark Surface (TF12)
- ____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes X **No** ____

Remarks:

A positive indication of hydric soil was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 29, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA023_U
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Beach Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.879913 Long: -97.098992 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No ____
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes **X**	No ____
Hydric Soil Present?	Yes **X**	No ____
Wetland Hydrology Present?	Yes ____	No **X**

Is the Sampled Area within a Wetland? **Yes** ____ **No** **X**

Remarks:

This point was determined not to be within a wetland due to the lack of wetland hydrology.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

____ Surface Water (A1)
____ High Water Table (A2)
____ Saturation (A3)
____ Water Marks (B1)
____ Sediment Deposits (B2)
____ Drift Deposits (B3)
____ Algal Mat or Crust (B4)
____ Iron Deposits (B5)
____ Inundation Visible on Aerial Imagery (B7)
____ Water-Stained Leaves (B9)
____ Aquatic Fauna (B13)
____ Marl Deposits (B15) **(LRR U)**
____ Hydrogen Sulfide Odor (C1)
____ Oxidized Rhizospheres on Living Roots(C3)
____ Presence of Reduced Iron (C4)
____ Recent Iron Reduction in Tilled Soils (C6)
____ Thin Muck Surface (C7)
____ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

____ Surface Soil Cracks (B6)
____ Sparsely Vegetated Concave Surface (B8)
____ Drainage Patterns (B10)
____ Moss Trim Lines (B16)
____ Dry-Season Water Table (C2)
____ Crayfish Burrows (C8)
____ Saturation Visible on Aerial Imagery (C9)
____ Geomorphic Position (D2)
____ Shallow Aquitard (D3)
X FAC-Neutral Test (D5)
____ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ____	No **X**	Depth (inches): **N/A**
Water Table Present?	Yes ____	No **X**	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes ____	No **X**	Depth (inches): **>20**

Wetland Hydrology Present? **Yes** ____ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

No positive indication of wetland hydrology was observed.

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: **DPA023_U**

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Sapling Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Shrub Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Herb Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *Borrichia frutescens*	10	No	OBL
2. *Muhlenbergia schreberi*	30	Yes	FAC
3. *Distichlis spicata*	30	Yes	OBL
4. *Cynodon dactylon*	15	No	FACU
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	85 = Total Cover		
50% of total cover:	42.5	20% of total cover:	17

Woody Vine Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)

Total Number of Dominant Species Across All Strata: **2** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**40**	x 1 =	**40**
FACW species	**0**	x 2 =	**0**
FAC species	**30**	x 3 =	**90**
FACU species	**15**	x 4 =	**60**
UPL species	**0**	x 5 =	**0**
Column Totals:	**85** (A)		**190** (B)

Prevalence Index = B/A = **2.24**

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤ 3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes X** **No** ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

SOIL

Sampling Point: DPA023_U

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-16	10YR 6/1	98	10YR 6/6	2	C	M	Sandy Clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ____ Histosol (A1)
- ____ Histic Epipedon (A2)
- ____ Black Histic (A3)
- ____ Hydrogen Sulfide (A4)
- ____ Stratified Layers (A5)
- ____ Organic Bodies (A6) **(LRR P, T, U)**
- ____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ____ Muck Presence (A8) **(LRR U)**
- ____ 1 cm Muck (A9) **(LRR P, T)**
- ____ Depleted Below Dark Surface (A11)
- ____ Thick Dark Surface (A12)
- ____ Coast Prairie Redox (A16) **(MLRA 150A)**
- ____ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ____ Sandy Gleyed Matrix (S4)
- X Sandy Redox (S5)
- ____ Stripped Matrix (S6)
- ____ Dark Surface (S7) **(LRR P, S, T, U)**
- ____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ____ Thin Dark Surface (S9) **(LRR S, T, U)**
- ____ Loamy Mucky Mineral (F1) **(LRR O)**
- ____ Loamy Gleyed Matrix (F2)
- ____ Depleted Matrix (F3)
- ____ Redox Dark Surface (F6)
- ____ Depleted Dark Surface (F7)
- ____ Redox Depressions (F8)
- ____ Marl (F10) **(LRR U)**
- ____ Depleted Ochric (F11) **(MLRA 151)**
- ____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ____ Umbric Surface (F13) **(LRR P, T, U)**
- ____ Delta Ochric (F17) **(MLRA 151)**
- ____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ____ 1 cm Muck (A9) **(LRR O)**
- ____ 2 cm Muck (A10) **(LRR S)**
- ____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ____ Red Parent Material (TF2)
- ____ Very Shallow Dark Surface (TF12)
- ____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____

Depth (inches): ____

Hydric Soil Present? Yes X **No** ____

Remarks:

A positive indication of hydric soil was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 30, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA024_PEM
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Marsh, Saltwater Local relief (concave, convex, none): Concave Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.879434 Long: -97.098251 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation No ,Soil No ,or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation No ,Soil No ,or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No
Hydric Soil Present?	Yes X	No
Wetland Hydrology Present?	Yes X	No

Is the Sampled Area within a Wetland? **Yes** X **No**

Remarks:

This point was determined to be within a wetland due to the presence of all 3 wetland criteria.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

	Surface Water (A1)	X	Aquatic Fauna (B13)
	High Water Table (A2)		Marl Deposits (B15) **(LRR U)**
X	Saturation (A3)		Hydrogen Sulfide Odor (C1)
	Water Marks (B1)		Oxidized Rhizospheres on Living Roots(C3)
	Sediment Deposits (B2)		Presence of Reduced Iron (C4)
	Drift Deposits (B3)		Recent Iron Reduction in Tilled Soils (C6)
X	Algal Mat or Crust (B4)		Thin Muck Surface (C7)
	Iron Deposits (B5)		Other (Explain in Remarks)
	Inundation Visible on Aerial Imagery (B7)		
	Water-Stained Leaves (B9)		

Secondary Indicators (minimum of two required)

	Surface Soil Cracks (B6)
	Sparsely Vegetated Concave Surface (B8)
	Drainage Patterns (B10)
	Moss Trim Lines (B16)
	Dry-Season Water Table (C2)
	Crayfish Burrows (C8)
	Saturation Visible on Aerial Imagery (C9)
	Geomorphic Position (D2)
	Shallow Aquitard (D3)
X	FAC-Neutral Test (D5)
	Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes	No X	Depth (inches): **N/A**
Water Table Present?	Yes	No X	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes X	No	Depth (inches): **0**

Wetland Hydrology Present? Yes X **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

A positive indication of wetland hydrology was observed (at least one primary indicator).

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: DPA024_PEM

Tree Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Sapling Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Shrub Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Herb Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *Borrichia frutescens*	30	Yes	OBL
2. *Schoenoplectus pungens*	40	Yes	OBL
3. *Distichlis spicata*	25	Yes	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	95 = Total Cover		
50% of total cover:	47.5	20% of total cover:	19

Woody Vine Stratum (Plot size: 30 ft.)

	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **3** (A)

Total Number of Dominant Species Across All Strata: **3** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**95**	x 1 =	**95**
FACW species	**0**	x 2 =	**0**
FAC species	**0**	x 3 =	**0**
FACU species	**0**	x 4 =	**0**
UPL species	**0**	x 5 =	**0**
Column Totals:	**95** (A)		**95** (B)

Prevalence Index = B/A = **1.00**

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤ 3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes **X** No ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

SOIL

Sampling Point: **DPA024_PEM**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-16	10YR 6/2	96	10YR 6/6	4	C	M	Sandy Clay	Shell hash and gravel mixed with matrix.

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ____ Histosol (A1)
- ____ Histic Epipedon (A2)
- ____ Black Histic (A3)
- ____ Hydrogen Sulfide (A4)
- ____ Stratified Layers (A5)
- ____ Organic Bodies (A6) **(LRR P, T, U)**
- ____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ____ Muck Presence (A8) **(LRR U)**
- ____ 1 cm Muck (A9) **(LRR P, T)**
- ____ Depleted Below Dark Surface (A11)
- ____ Thick Dark Surface (A12)
- ____ Coast Prairie Redox (A16) **(MLRA 150A)**
- ____ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ____ Sandy Gleyed Matrix (S4)
- X Sandy Redox (S5)
- ____ Stripped Matrix (S6)
- ____ Dark Surface (S7) **(LRR P, S, T, U)**
- ____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ____ Thin Dark Surface (S9) **(LRR S, T, U)**
- ____ Loamy Mucky Mineral (F1) **(LRR O)**
- ____ Loamy Gleyed Matrix (F2)
- ____ Depleted Matrix (F3)
- ____ Redox Dark Surface (F6)
- ____ Depleted Dark Surface (F7)
- ____ Redox Depressions (F8)
- ____ Marl (F10) **(LRR U)**
- ____ Depleted Ochric (F11) **(MLRA 151)**
- ____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ____ Umbric Surface (F13) **(LRR P, T, U)**
- ____ Delta Ochric (F17) **(MLRA 151)**
- ____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ____ 1 cm Muck (A9) **(LRR O)**
- ____ 2 cm Muck (A10) **(LRR S)**
- ____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ____ Red Parent Material (TF2)
- ____ Very Shallow Dark Surface (TF12)
- ____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes X **No** ____

Remarks:

A positive indication of hydric soil was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 30, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA025_U
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Prairie Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.879336 Long: -97.098303 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **Yes** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No ____
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes **X**	No ____
Hydric Soil Present?	Yes ____	No **X**
Wetland Hydrology Present?	Yes ____	No **X**

Is the Sampled Area within a Wetland? **Yes** ____ **No** **X**

Remarks:

This point was determined not to be within a wetland due to the lack of hydric soils and wetland hydrology.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ____ Surface Water (A1)
- ____ High Water Table (A2)
- ____ Saturation (A3)
- ____ Water Marks (B1)
- ____ Sediment Deposits (B2)
- ____ Drift Deposits (B3)
- ____ Algal Mat or Crust (B4)
- ____ Iron Deposits (B5)
- ____ Inundation Visible on Aerial Imagery (B7)
- ____ Water-Stained Leaves (B9)
- ____ Aquatic Fauna (B13)
- ____ Marl Deposits (B15) **(LRR U)**
- ____ Hydrogen Sulfide Odor (C1)
- ____ Oxidized Rhizospheres on Living Roots(C3)
- ____ Presence of Reduced Iron (C4)
- ____ Recent Iron Reduction in Tilled Soils (C6)
- ____ Thin Muck Surface (C7)
- ____ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ____ Surface Soil Cracks (B6)
- ____ Sparsely Vegetated Concave Surface (B8)
- ____ Drainage Patterns (B10)
- ____ Moss Trim Lines (B16)
- ____ Dry-Season Water Table (C2)
- ____ Crayfish Burrows (C8)
- ____ Saturation Visible on Aerial Imagery (C9)
- ____ Geomorphic Position (D2)
- ____ Shallow Aquitard (D3)
- **X** FAC-Neutral Test (D5)
- ____ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ____	No **X**	Depth (inches): **N/A**
Water Table Present?	Yes ____	No **X**	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes ____	No **X**	Depth (inches): **>20**

Wetland Hydrology Present? **Yes** ____ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

No positive indication of wetland hydrology was observed.

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: DPA025_U

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. None Observed			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Sapling Stratum (Plot size: 30 ft.)			
1. None Observed			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Shrub Stratum (Plot size: 30 ft.)			
1. None Observed			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Herb Stratum (Plot size: 30 ft.)			
1. *Muhlenbergia schreberi*	40	Yes	FAC
2. *Distichlis spicata*	30	Yes	OBL
3. *Borrichia frutescens*	15	No	OBL
4. *Solidago canadensis*	10	No	FACU
5. *Ambrosia psilostachya*	5	No	FAC
6.			
7.			
8.			
9.			
10.			
11.			
	100 = Total Cover		
50% of total cover:	50	20% of total cover:	20

Woody Vine Stratum (Plot size: 30 ft.)			
1. None Observed			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)

Total Number of Dominant Species Across All Strata: **2** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:			Multiply by:	
OBL species	45	x 1 =	45	
FACW species	0	x 2 =	0	
FAC species	45	x 3 =	135	
FACU species	10	x 4 =	40	
UPL species	0	x 5 =	0	
Column Totals:	100	(A)	220	(B)

Prevalence Index = B/A = **2.20**

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤ 3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

SOIL

Sampling Point: DPA025_U

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]		
0-3	10YR 6/2	100	None	—	—	—	Sandy Clay	Disturbed Soils
								Shovel Restriction

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

____ Histosol (A1)
____ Histic Epipedon (A2)
____ Black Histic (A3)
____ Hydrogen Sulfide (A4)
____ Stratified Layers (A5)
____ Organic Bodies (A6) **(LRR P, T, U)**
____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
____ Muck Presence (A8) **(LRR U)**
____ 1 cm Muck (A9) **(LRR P, T)**
____ Depleted Below Dark Surface (A11)
____ Thick Dark Surface (A12)
____ Coast Prairie Redox (A16) **(MLRA 150A)**
____ Sandy Mucky Mineral (S1) **(LRR O, S)**
____ Sandy Gleyed Matrix (S4)
____ Sandy Redox (S5)
____ Stripped Matrix (S6)
____ Dark Surface (S7) **(LRR P, S, T, U)**
____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
____ Thin Dark Surface (S9) **(LRR S, T, U)**
____ Loamy Mucky Mineral (F1) **(LRR O)**
____ Loamy Gleyed Matrix (F2)
____ Depleted Matrix (F3)
____ Redox Dark Surface (F6)
____ Depleted Dark Surface (F7)
____ Redox Depressions (F8)
____ Marl (F10) **(LRR U)**
____ Depleted Ochric (F11) **(MLRA 151)**
____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
____ Umbric Surface (F13) **(LRR P, T, U)**
____ Delta Ochric (F17) **(MLRA 151)**
____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

____ 1 cm Muck (A9) **(LRR O)**
____ 2 cm Muck (A10) **(LRR S)**
____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
____ Red Parent Material (TF2)
____ Very Shallow Dark Surface (TF12)
____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: Gravel/Shell Hash
Depth (inches): 3

Hydric Soil Present? Yes ____ No X

Remarks:

No positive indication of hydric soils was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: January 30, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPA026_PEM
Investigator(s): E. Munscher and J. Mitchell Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Marsh, Saltwater Local relief (concave, convex, none): Concave Slope (%): 0-5
Subregion (LRR or MLRA): T Lat: 27.851561 Long: -97.073445 Datum: North American Datum 1983
Soil Map Unit Name: Mustang fine sand, 0 to 1 percent slopes, occasionally flooded, frequently ponded NWI Classification: PEM1Ah
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) No (if no, explain in Remarks.)
Are Vegetation No ,Soil No ,or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation No ,Soil No ,or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ____	
Hydric Soil Present?	Yes X	No ____	**Is the Sampled Area**
Wetland Hydrology Present?	Yes X	No ____	**within a Wetland?** **Yes** X **No** ____

Remarks:

This point was determined to be within a wetland due to the presence of all 3 wetland criteria.

The survey area was determined to be wetter than normal at the time of survey.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

X Surface Water (A1)	X Aquatic Fauna (B13)	
____ High Water Table (A2)	____ Marl Deposits (B15) **(LRR U)**	
____ Saturation (A3)	X Hydrogen Sulfide Odor (C1)	
____ Water Marks (B1)	____ Oxidized Rhizospheres on Living Roots(C3)	
____ Sediment Deposits (B2)	____ Presence of Reduced Iron (C4)	
____ Drift Deposits (B3)	____ Recent Iron Reduction in Tilled Soils (C6)	
____ Algal Mat or Crust (B4)	____ Thin Muck Surface (C7)	
____ Iron Deposits (B5)	____ Other (Explain in Remarks)	
____ Inundation Visible on Aerial Imagery (B7)		
____ Water-Stained Leaves (B9)		

Secondary Indicators (minimum of two required)

- ____ Surface Soil Cracks (B6)
- X Sparsely Vegetated Concave Surface (B8)
- ____ Drainage Patterns (B10)
- ____ Moss Trim Lines (B16)
- ____ Dry-Season Water Table (C2)
- ____ Crayfish Burrows (C8)
- ____ Saturation Visible on Aerial Imagery (C9)
- ____ Geomorphic Position (D2)
- ____ Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)
- ____ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes X	No ____	Depth (inches): 10
Water Table Present?	Yes ____	No X	Depth (inches): >20
Saturation Present? (includes capillary fringe)	Yes ____	No X	Depth (inches): >20

Wetland Hydrology Present? Yes X **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

A positive indication of wetland hydrology was observed (at least one primary indicator).

A positive indication of wetland hydrology was observed (at least two secondary indicators).

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: **DPA026_PEM**

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Sapling Stratum (Plot size: 30 ft.)			
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Shrub Stratum (Plot size: 30 ft.)			
1. *Schinus terebinthifolia*	20	Yes	FAC
2.			
3.			
4.			
5.			
6.			
	20 = Total Cover		
50% of total cover: 10	20% of total cover: 4		

Herb Stratum (Plot size: 30 ft.)			
1. *Borrichia frutescens*	10	No	OBL
2. *Spartina spartinae*	60	Yes	OBL
3. *Andropogon glomeratus*	10	No	FACW
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	80 = Total Cover		
50% of total cover: 40	20% of total cover: 16		

Woody Vine Stratum (Plot size: 30 ft.)			
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)

Total Number of Dominant Species Across All Strata: **2** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**70**	x 1 =	**70**
FACW species	**10**	x 2 =	**20**
FAC species	**20**	x 3 =	**60**
FACU species	**0**	x 4 =	**0**
UPL species	**0**	x 5 =	**0**
Column Totals:	**100** (A)		**150** (B)

Prevalence Index = B/A = **1.50**

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤ 3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-16	7.5YR 5/1	98	10YR 4/6	2	C	PL	Sandy Clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

____ Histosol (A1)
____ Histic Epipedon (A2)
____ Black Histic (A3)
____ Hydrogen Sulfide (A4)
____ Stratified Layers (A5)
____ Organic Bodies (A6) **(LRR P, T, U)**
____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
____ Muck Presence (A8) **(LRR U)**
____ 1 cm Muck (A9) **(LRR P, T)**
____ Depleted Below Dark Surface (A11)
____ Thick Dark Surface (A12)
____ Coast Prairie Redox (A16) **(MLRA 150A)**
____ Sandy Mucky Mineral (S1) **(LRR O, S)**
____ Sandy Gleyed Matrix (S4)
_X_ Sandy Redox (S5)
____ Stripped Matrix (S6)
____ Dark Surface (S7) **(LRR P, S, T, U)**
____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
____ Thin Dark Surface (S9) **(LRR S, T, U)**
____ Loamy Mucky Mineral (F1) **(LRR O)**
____ Loamy Gleyed Matrix (F2)
____ Depleted Matrix (F3)
____ Redox Dark Surface (F6)
____ Depleted Dark Surface (F7)
____ Redox Depressions (F8)
____ Marl (F10) **(LRR U)**
____ Depleted Ochric (F11) **(MLRA 151)**
____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
____ Umbric Surface (F13) **(LRR P, T, U)**
____ Delta Ochric (F17) **(MLRA 151)**
____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

____ 1 cm Muck (A9) **(LRR O)**
____ 2 cm Muck (A10) **(LRR S)**
____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
____ Red Parent Material (TF2)
____ Very Shallow Dark Surface (TF12)
____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes _X_ **No** ____

Remarks:

A positive indication of hydric soil was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: February 5, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPB048_U
Investigator(s): C. Bailey and N. Trivino Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Beach Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.873819 Long: -97.092048 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) YES (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No ____
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ____	No **X**
Hydric Soil Present?	Yes ____	No **X**
Wetland Hydrology Present?	Yes ____	No **X**

Is the Sampled Area within a Wetland? **Yes** ____ **No** **X**

Remarks:

This point was determined not to be within a wetland due to the lack of all three wetland criteria.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

____ Surface Water (A1)
____ High Water Table (A2)
____ Saturation (A3)
____ Water Marks (B1)
____ Sediment Deposits (B2)
____ Drift Deposits (B3)
____ Algal Mat or Crust (B4)
____ Iron Deposits (B5)
____ Inundation Visible on Aerial Imagery (B7)
____ Water-Stained Leaves (B9)
____ Aquatic Fauna (B13)
____ Marl Deposits (B15) **(LRR U)**
____ Hydrogen Sulfide Odor (C1)
____ Oxidized Rhizospheres on Living Roots(C3)
____ Presence of Reduced Iron (C4)
____ Recent Iron Reduction in Tilled Soils (C6)
____ Thin Muck Surface (C7)
____ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

____ Surface Soil Cracks (B6)
____ Sparsely Vegetated Concave Surface (B8)
____ Drainage Patterns (B10)
____ Moss Trim Lines (B16)
____ Dry-Season Water Table (C2)
____ Crayfish Burrows (C8)
____ Saturation Visible on Aerial Imagery (C9)
____ Geomorphic Position (D2)
____ Shallow Aquitard (D3)
____ FAC-Neutral Test (D5)
____ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ____	No **X**	Depth (inches): **N/A**
Water Table Present?	Yes ____	No **X**	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes ____	No **X**	Depth (inches): **>20**

Wetland Hydrology Present? **Yes** ____ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

No positive indication of wetland hydrology was observed.

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: DPB048_U

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Sapling Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Shrub Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Herb Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Woody Vine Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **0** (A)

Total Number of Dominant Species Across All Strata: **0** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **0** (A/B)

Prevalence Index Worksheet:

Total % Cover of:			Multiply by:	
OBL species	**0**	x 1 =	**0**	
FACW species	**0**	x 2 =	**0**	
FAC species	**0**	x 3 =	**0**	
FACU species	**0**	x 4 =	**0**	
UPL species	**0**	x 5 =	**0**	
Column Totals:	**0**	(A)	**0**	(B)

Prevalence Index = B/A = **N/A**

Hydrophytic Vegetation Indicators:

____ 1 - Rapid Test for Hydrophytic Vegetation

____ 2 - Dominance Test is >50%

____ 3 - Prevalence Index is ≤ 3.0[1]

____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** ____ **No** X

Remarks: (if observed, list morphological adaptations below).

No positive indication of hydrophytic vegetation was observed (≥50% of dominant species indexed as FAC− or drier).

No vegetation present.

SOIL

Sampling Point: DPB048_U

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-20	10YR 5/1	100	None	—	—	—	Sandy Loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

____ Histosol (A1)
____ Histic Epipedon (A2)
____ Black Histic (A3)
____ Hydrogen Sulfide (A4)
____ Stratified Layers (A5)
____ Organic Bodies (A6) **(LRR P, T, U)**
____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
____ Muck Presence (A8) **(LRR U)**
____ 1 cm Muck (A9) **(LRR P, T)**
____ Depleted Below Dark Surface (A11)
____ Thick Dark Surface (A12)
____ Coast Prairie Redox (A16) **(MLRA 150A)**
____ Sandy Mucky Mineral (S1) **(LRR O, S)**
____ Sandy Gleyed Matrix (S4)
____ Sandy Redox (S5)
____ Stripped Matrix (S6)
____ Dark Surface (S7) **(LRR P, S, T, U)**
____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
____ Thin Dark Surface (S9) **(LRR S, T, U)**
____ Loamy Mucky Mineral (F1) **(LRR O)**
____ Loamy Gleyed Matrix (F2)
____ Depleted Matrix (F3)
____ Redox Dark Surface (F6)
____ Depleted Dark Surface (F7)
____ Redox Depressions (F8)
____ Marl (F10) **(LRR U)**
____ Depleted Ochric (F11) **(MLRA 151)**
____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
____ Umbric Surface (F13) **(LRR P, T, U)**
____ Delta Ochric (F17) **(MLRA 151)**
____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

____ 1 cm Muck (A9) **(LRR O)**
____ 2 cm Muck (A10) **(LRR S)**
____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
____ Red Parent Material (TF2)
____ Very Shallow Dark Surface (TF12)
____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____

Depth (inches): ____

Hydric Soil Present? Yes ____ No X

Remarks:

No positive indication of hydric soils was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: February 5, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPB049_PEM
Investigator(s): C. Bailey and N. Trivino Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Marsh, Saltwater Local relief (concave, convex, none): Concave Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.873851 Long: -97.092148 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) YES (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No ____
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes **X**	No ____
Hydric Soil Present?	Yes **X**	No ____
Wetland Hydrology Present?	Yes **X**	No ____

Is the Sampled Area within a Wetland? **Yes** **X** **No** ____

Remarks:

This point was determined to be within a wetland due to the presence of all 3 wetland criteria.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

X	Surface Water (A1)	____	Aquatic Fauna (B13)
____	High Water Table (A2)	____	Marl Deposits (B15) **(LRR U)**
____	Saturation (A3)	____	Hydrogen Sulfide Odor (C1)
____	Water Marks (B1)	____	Oxidized Rhizospheres on Living Roots(C3)
____	Sediment Deposits (B2)	____	Presence of Reduced Iron (C4)
____	Drift Deposits (B3)	____	Recent Iron Reduction in Tilled Soils (C6)
X	Algal Mat or Crust (B4)	____	Thin Muck Surface (C7)
____	Iron Deposits (B5)	____	Other (Explain in Remarks)
____	Inundation Visible on Aerial Imagery (B7)		
____	Water-Stained Leaves (B9)		

Secondary Indicators (minimum of two required)

____	Surface Soil Cracks (B6)
____	Sparsely Vegetated Concave Surface (B8)
____	Drainage Patterns (B10)
____	Moss Trim Lines (B16)
____	Dry-Season Water Table (C2)
____	Crayfish Burrows (C8)
____	Saturation Visible on Aerial Imagery (C9)
____	Geomorphic Position (D2)
____	Shallow Aquitard (D3)
X	FAC-Neutral Test (D5)
____	Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes **X**	No ____	Depth (inches): **0**
Water Table Present?	Yes ____	No **X**	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes ____	No **X**	Depth (inches): **>20**

Wetland Hydrology Present? **Yes** **X** **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

A positive indication of wetland hydrology was observed (at least one primary indicator).

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: **DPB049_PEM**

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Sapling Stratum (Plot size: 30 ft.)			
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Shrub Stratum (Plot size: 30 ft.)			
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Herb Stratum (Plot size: 30 ft.)			
1. *Distichlis littoralis*	80	Yes	OBL
2. *Salicornia depressa*	10	No	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	90 = Total Cover		
50% of total cover:	45	20% of total cover:	18

Woody Vine Stratum (Plot size: 30 ft.)			
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **1** (A)

Total Number of Dominant Species Across All Strata: **1** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**90**	x 1 =	**90**
FACW species	**0**	x 2 =	**0**
FAC species	**0**	x 3 =	**0**
FACU species	**0**	x 4 =	**0**
UPL species	**0**	x 5 =	**0**
Column Totals:	**90** (A)		**90** (B)

Prevalence Index = B/A = **1.00**

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤ 3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes **X** No ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

SOIL

Sampling Point: **DPB049_PEM**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-3	2.5Y 5/1	100	None	—	—	—	Sandy Loam	
3-20	N 4	98	10YR 5/4	2	C	PL	Sandy Loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

____ Histosol (A1)
____ Histic Epipedon (A2)
____ Black Histic (A3)
____ Hydrogen Sulfide (A4)
____ Stratified Layers (A5)
____ Organic Bodies (A6) **(LRR P, T, U)**
____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
____ Muck Presence (A8) **(LRR U)**
____ 1 cm Muck (A9) **(LRR P, T)**
____ Depleted Below Dark Surface (A11)
____ Thick Dark Surface (A12)
____ Coast Prairie Redox (A16) **(MLRA 150A)**
____ Sandy Mucky Mineral (S1) **(LRR O, S)**
X Sandy Gleyed Matrix (S4)
X Sandy Redox (S5)
____ Stripped Matrix (S6)
____ Dark Surface (S7) **(LRR P, S, T, U)**
____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
____ Thin Dark Surface (S9) **(LRR S, T, U)**
____ Loamy Mucky Mineral (F1) **(LRR O)**
____ Loamy Gleyed Matrix (F2)
____ Depleted Matrix (F3)
____ Redox Dark Surface (F6)
____ Depleted Dark Surface (F7)
____ Redox Depressions (F8)
____ Marl (F10) **(LRR U)**
____ Depleted Ochric (F11) **(MLRA 151)**
____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
____ Umbric Surface (F13) **(LRR P, T, U)**
____ Delta Ochric (F17) **(MLRA 151)**
____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

____ 1 cm Muck (A9) **(LRR O)**
____ 2 cm Muck (A10) **(LRR S)**
____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
____ Red Parent Material (TF2)
____ Very Shallow Dark Surface (TF12)
____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ________
Depth (inches): ________

Hydric Soil Present? Yes X **No** ____

Remarks:

A positive indication of hydric soil was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: February 5, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPB052_PEM
Investigator(s): C. Bailey and N. Trivino Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Beach Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.875722 Long: -97.093804 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) YES (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No ____
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes **X**	No ____
Hydric Soil Present?	Yes **X**	No ____
Wetland Hydrology Present?	Yes **X**	No ____

Is the Sampled Area within a Wetland? **Yes X** **No** ____

Remarks:

This point was determined to be within a wetland due to the presence of all 3 wetland criteria.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- X Surface Water (A1)
- ____ High Water Table (A2)
- ____ Saturation (A3)
- ____ Water Marks (B1)
- ____ Sediment Deposits (B2)
- ____ Drift Deposits (B3)
- ____ Algal Mat or Crust (B4)
- ____ Iron Deposits (B5)
- ____ Inundation Visible on Aerial Imagery (B7)
- ____ Water-Stained Leaves (B9)
- X Aquatic Fauna (B13)
- ____ Marl Deposits (B15) **(LRR U)**
- ____ Hydrogen Sulfide Odor (C1)
- ____ Oxidized Rhizospheres on Living Roots(C3)
- ____ Presence of Reduced Iron (C4)
- ____ Recent Iron Reduction in Tilled Soils (C6)
- ____ Thin Muck Surface (C7)
- ____ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ____ Surface Soil Cracks (B6)
- ____ Sparsely Vegetated Concave Surface (B8)
- ____ Drainage Patterns (B10)
- ____ Moss Trim Lines (B16)
- ____ Dry-Season Water Table (C2)
- ____ Crayfish Burrows (C8)
- ____ Saturation Visible on Aerial Imagery (C9)
- ____ Geomorphic Position (D2)
- ____ Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)
- ____ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes **X**	No ____	Depth (inches): **2**
Water Table Present?	Yes ____	No **X**	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes ____	No **X**	Depth (inches): **>20**

Wetland Hydrology Present? **Yes X** **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

A positive indication of wetland hydrology was observed (at least one primary indicator).

Aquatic Fauna: fish, crabs.

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: DPB052_PEM

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Sapling Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Shrub Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Herb Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *Salicornia depressa*	15	Yes	OBL
2. *Spartina alterniflora*	10	Yes	OBL
3. *Avicennia germinans*	5	No	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	30 = Total Cover		
50% of total cover:	15	20% of total cover:	6

Woody Vine Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)

Total Number of Dominant Species Across All Strata: **2** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:			Multiply by:
OBL species	**30**	x 1 =	**30**
FACW species	**0**	x 2 =	**0**
FAC species	**0**	x 3 =	**0**
FACU species	**0**	x 4 =	**0**
UPL species	**0**	x 5 =	**0**
Column Totals:	**30** (A)		**30** (B)

Prevalence Index = B/A = **1.00**

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤ 3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

SOIL

Sampling Point: **DPB052_PEM**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-3	2.5Y 5/1	100	None	—	—	—	Sand	Gravel mixed with matrix.
3-20	N 4	98	10YR 5/4	2	C	PL	Sand	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Organic Bodies (A6) **(LRR P, T, U)**
- ___ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ___ Muck Presence (A8) **(LRR U)**
- ___ 1 cm Muck (A9) **(LRR P, T)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Coast Prairie Redox (A16) **(MLRA 150A)**
- ___ Sandy Mucky Mineral (S1) **(LRR O, S)**
- X Sandy Gleyed Matrix (S4)
- X Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7) **(LRR P, S, T, U)**
- ___ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ___ Thin Dark Surface (S9) **(LRR S, T, U)**
- ___ Loamy Mucky Mineral (F1) **(LRR O)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Marl (F10) **(LRR U)**
- ___ Depleted Ochric (F11) **(MLRA 151)**
- ___ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ___ Umbric Surface (F13) **(LRR P, T, U)**
- ___ Delta Ochric (F17) **(MLRA 151)**
- ___ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ___ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) **(LRR O)**
- ___ 2 cm Muck (A10) **(LRR S)**
- ___ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ___ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ___ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ___

Depth (inches): ___

Hydric Soil Present? Yes X **No** ___

Remarks:

A positive indication of hydric soil was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: February 5, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPB053_U
Investigator(s): C. Bailey and N. Trivino Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Marsh, Saltwater Local relief (concave, convex, none): Concave Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.875774 Long: -97.093841 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) YES (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No ___
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No **X**
Hydric Soil Present?	Yes ___	No **X**
Wetland Hydrology Present?	Yes ___	No **X**

Is the Sampled Area within a Wetland? **Yes** ___ **No** **X**

Remarks:

This point was determined not to be within a wetland due to the lack of all three wetland criteria.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)	___ Aquatic Fauna (B13)
___ High Water Table (A2)	___ Marl Deposits (B15) **(LRR U)**
___ Saturation (A3)	___ Hydrogen Sulfide Odor (C1)
___ Water Marks (B1)	___ Oxidized Rhizospheres on Living Roots(C3)
___ Sediment Deposits (B2)	___ Presence of Reduced Iron (C4)
___ Drift Deposits (B3)	___ Recent Iron Reduction in Tilled Soils (C6)
___ Algal Mat or Crust (B4)	___ Thin Muck Surface (C7)
___ Iron Deposits (B5)	___ Other (Explain in Remarks)
___ Inundation Visible on Aerial Imagery (B7)	
___ Water-Stained Leaves (B9)	

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Moss Trim Lines (B16)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ___	No **X**	Depth (inches): **N/A**
Water Table Present?	Yes ___	No **X**	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes ___	No **X**	Depth (inches): **>20**

Wetland Hydrology Present? **Yes** ___ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

No positive indication of wetland hydrology was observed.

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: DPB053_U

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Sapling Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Shrub Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Herb Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Woody Vine Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover:	0	20% of total cover:	0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **0** (A)

Total Number of Dominant Species Across All Strata: **0** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **0** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x 1 =	**0**
FACW species	**0**	x 2 =	**0**
FAC species	**0**	x 3 =	**0**
FACU species	**0**	x 4 =	**0**
UPL species	**0**	x 5 =	**0**
Column Totals:	**0** (A)		**0** (B)

Prevalence Index = B/A = **N/A**

Hydrophytic Vegetation Indicators:

____ 1 - Rapid Test for Hydrophytic Vegetation
____ 2 - Dominance Test is >50%
____ 3 - Prevalence Index is ≤ 3.0[1]
____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** ____ **No** **X**

Remarks: (if observed, list morphological adaptations below).

No positive indication of hydrophytic vegetation was observed (≥50% of dominant species indexed as FAC− or drier).

No vegetation present.

SOIL

Sampling Point: DPB053_U

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-20	10YR 5/1	100	None	—	—	—	Sandy Loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

____ Histosol (A1)
____ Histic Epipedon (A2)
____ Black Histic (A3)
____ Hydrogen Sulfide (A4)
____ Stratified Layers (A5)
____ Organic Bodies (A6) **(LRR P, T, U)**
____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
____ Muck Presence (A8) **(LRR U)**
____ 1 cm Muck (A9) **(LRR P, T)**
____ Depleted Below Dark Surface (A11)
____ Thick Dark Surface (A12)
____ Coast Prairie Redox (A16) **(MLRA 150A)**
____ Sandy Mucky Mineral (S1) **(LRR O, S)**
____ Sandy Gleyed Matrix (S4)
____ Sandy Redox (S5)
____ Stripped Matrix (S6)
____ Dark Surface (S7) **(LRR P, S, T, U)**
____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
____ Thin Dark Surface (S9) **(LRR S, T, U)**
____ Loamy Mucky Mineral (F1) **(LRR O)**
____ Loamy Gleyed Matrix (F2)
____ Depleted Matrix (F3)
____ Redox Dark Surface (F6)
____ Depleted Dark Surface (F7)
____ Redox Depressions (F8)
____ Marl (F10) **(LRR U)**
____ Depleted Ochric (F11) **(MLRA 151)**
____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
____ Umbric Surface (F13) **(LRR P, T, U)**
____ Delta Ochric (F17) **(MLRA 151)**
____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

____ 1 cm Muck (A9) **(LRR O)**
____ 2 cm Muck (A10) **(LRR S)**
____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
____ Red Parent Material (TF2)
____ Very Shallow Dark Surface (TF12)
____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______________

Depth (inches): ______________

Hydric Soil Present? Yes ______ No __X__

Remarks:

No positive indication of hydric soils was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: February 5, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPB057_PEM
Investigator(s): C. Bailey and N. Trivino Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Beach Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.878633 Long: -97.097256 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) YES (if no, explain in Remarks.)
Are Vegetation No ,Soil No ,or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation No ,Soil No ,or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No
Hydric Soil Present?	Yes X	No
Wetland Hydrology Present?	Yes X	No

Is the Sampled Area within a Wetland? Yes X No

Remarks:

This point was determined to be within a wetland due to the presence of all 3 wetland criteria.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- X Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15) **(LRR U)**
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots(C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)
- ___ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes X	No	Depth (inches): 2
Water Table Present?	Yes	No X	Depth (inches): >20
Saturation Present? (includes capillary fringe)	Yes	No X	Depth (inches): >20

Wetland Hydrology Present? **Yes** X **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

A positive indication of wetland hydrology was observed (at least one primary indicator).

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: **DPB057_PEM**

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Sapling Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Shrub Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Herb Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *Eleocharis palustris*	60	Yes	OBL
2. *Axonopus fissifolius*	10	No	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	70 = Total Cover		
50% of total cover: 35	20% of total cover: 14		

Woody Vine Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **1** (A)

Total Number of Dominant Species Across All Strata: **1** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**60**	x 1 =	**60**
FACW species	**10**	x 2 =	**20**
FAC species	**0**	x 3 =	**0**
FACU species	**0**	x 4 =	**0**
UPL species	**0**	x 5 =	**0**
Column Totals:	**70** (A)		**80** (B)

Prevalence Index = B/A = **1.14**

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤ 3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

SOIL

Sampling Point: **DPB057_PEM**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-3	2.5Y 5/1	100	None	—	—	—	Sandy Loam	
3-20	N 4	98	10YR 5/4	2	C	PL	Sandy Loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

____ Histosol (A1)
____ Histic Epipedon (A2)
____ Black Histic (A3)
____ Hydrogen Sulfide (A4)
____ Stratified Layers (A5)
____ Organic Bodies (A6) **(LRR P, T, U)**
____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
____ Muck Presence (A8) **(LRR U)**
____ 1 cm Muck (A9) **(LRR P, T)**
____ Depleted Below Dark Surface (A11)
____ Thick Dark Surface (A12)
____ Coast Prairie Redox (A16) **(MLRA 150A)**
____ Sandy Mucky Mineral (S1) **(LRR O, S)**
X Sandy Gleyed Matrix (S4)
X Sandy Redox (S5)
____ Stripped Matrix (S6)
____ Dark Surface (S7) **(LRR P, S, T, U)**
____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
____ Thin Dark Surface (S9) **(LRR S, T, U)**
____ Loamy Mucky Mineral (F1) **(LRR O)**
____ Loamy Gleyed Matrix (F2)
____ Depleted Matrix (F3)
____ Redox Dark Surface (F6)
____ Depleted Dark Surface (F7)
____ Redox Depressions (F8)
____ Marl (F10) **(LRR U)**
____ Depleted Ochric (F11) **(MLRA 151)**
____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
____ Umbric Surface (F13) **(LRR P, T, U)**
____ Delta Ochric (F17) **(MLRA 151)**
____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

____ 1 cm Muck (A9) **(LRR O)**
____ 2 cm Muck (A10) **(LRR S)**
____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
____ Red Parent Material (TF2)
____ Very Shallow Dark Surface (TF12)
____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____

Depth (inches): ____

Hydric Soil Present? Yes X **No** ____

Remarks:

A positive indication of hydric soil was observed.

WETLAND DETERMINATION DATA FORM - Atlantic and Gulf Coastal Plain Region

Project/Site: Bluewater SPM County: Nueces Sampling Date: February 5, 2019
Applicant/Owner: Lloyd Engineering State: Texas Sample Point: DPB058_PEM
Investigator(s): C. Bailey and N. Trivino Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Beach Local relief (concave, convex, none): None Slope (%): 0-5
Subregion (LRR or MLRA): None Lat: 27.878822 Long: -97.097612 Datum: North American Datum 1983
Soil Map Unit Name: Ijam clay loam, rarely flooded NWI Classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? (Yes / No) YES (if no, explain in Remarks.)
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** significantly disturbed? Are "Normal Circumstances" present? Yes **X** No
Are Vegetation **No** ,Soil **No** ,or Hydrology **No** naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes **X**	No
Hydric Soil Present?	Yes **X**	No
Wetland Hydrology Present?	Yes **X**	No
Is the Sampled Area within a Wetland?	**Yes X**	**No**

Remarks:

This point was determined to be within a wetland due to the presence of all 3 wetland criteria.

HYDROLOGY

Wetland hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- X Surface Water (A1)
- High Water Table (A2)
- Saturation (A3)
- Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- Algal Mat or Crust (B4)
- Iron Deposits (B5)
- Inundation Visible on Aerial Imagery (B7)
- Water-Stained Leaves (B9)
- Aquatic Fauna (B13)
- Marl Deposits (B15) **(LRR U)**
- Hydrogen Sulfide Odor (C1)
- Oxidized Rhizospheres on Living Roots(C3)
- Presence of Reduced Iron (C4)
- Recent Iron Reduction in Tilled Soils (C6)
- Thin Muck Surface (C7)
- Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- Surface Soil Cracks (B6)
- Sparsely Vegetated Concave Surface (B8)
- Drainage Patterns (B10)
- Moss Trim Lines (B16)
- Dry-Season Water Table (C2)
- Crayfish Burrows (C8)
- Saturation Visible on Aerial Imagery (C9)
- Geomorphic Position (D2)
- Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)
- Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes **X**	No	Depth (inches): **2**
Water Table Present?	Yes	No **X**	Depth (inches): **>20**
Saturation Present? (includes capillary fringe)	Yes	No **X**	Depth (inches): **>20**

Wetland Hydrology Present? **Yes X** **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

A positive indication of wetland hydrology was observed (at least one primary indicator).

VEGETATION (Five Strata) - Use scientific names of plants.

Sampling Point: DPB058_PEM

Tree Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Sapling Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Shrub Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Herb Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *Eleocharis palustris*	60	Yes	OBL
2. *Axonopus fissifolius*	10	No	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	70 = Total Cover		
50% of total cover: 35	20% of total cover: 14		

Woody Vine Stratum (Plot size: 30 ft.)	Absolute % cover	Dominant Species?	Indicator Status
1. *None Observed*			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **1** (A)

Total Number of Dominant Species Across All Strata: **1** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**60**	x 1 =	**60**
FACW species	**10**	x 2 =	**20**
FAC species	**0**	x 3 =	**0**
FACU species	**0**	x 4 =	**0**
UPL species	**0**	x 5 =	**0**
Column Totals:	**70** (A)		**80** (B)

Prevalence Index = B/A = **1.14**

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤ 3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (if observed, list morphological adaptations below).

A positive indication of hydrophytic vegetation was observed (>50% of dominant species indexed as OBL, FACW, or FAC).

A positive indication of hydrophytic vegetation was observed (Prevalence Index is ≤ 3.00).

SOIL

Sampling Point: **DPB058_PEM**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-3	2.5Y 5/1	100	None	—	—	—	Sandy Loam	
3-20	N 4	98	10YR 5/4	2	C	PL	Sandy Loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soils Indicators: (Applicable to all LRRs, unless otherwise noted.)

____ Histosol (A1)
____ Histic Epipedon (A2)
____ Black Histic (A3)
____ Hydrogen Sulfide (A4)
____ Stratified Layers (A5)
____ Organic Bodies (A6) **(LRR P, T, U)**
____ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
____ Muck Presence (A8) **(LRR U)**
____ 1 cm Muck (A9) **(LRR P, T)**
____ Depleted Below Dark Surface (A11)
____ Thick Dark Surface (A12)
____ Coast Prairie Redox (A16) **(MLRA 150A)**
____ Sandy Mucky Mineral (S1) **(LRR O, S)**
_X_ Sandy Gleyed Matrix (S4)
_X_ Sandy Redox (S5)
____ Stripped Matrix (S6)
____ Dark Surface (S7) **(LRR P, S, T, U)**

____ Polyvalue Below Surface (S8) **(LRR S, T, U)**
____ Thin Dark Surface (S9) **(LRR S, T, U)**
____ Loamy Mucky Mineral (F1) **(LRR O)**
____ Loamy Gleyed Matrix (F2)
____ Depleted Matrix (F3)
____ Redox Dark Surface (F6)
____ Depleted Dark Surface (F7)
____ Redox Depressions (F8)
____ Marl (F10) **(LRR U)**
____ Depleted Ochric (F11) **(MLRA 151)**
____ Iron-Manganese Masses (F12) **(LRR O, P, T)**
____ Umbric Surface (F13) **(LRR P, T, U)**
____ Delta Ochric (F17) **(MLRA 151)**
____ Reduced Vertic (F18) **(MLRA 150A, 150B)**
____ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

____ 1 cm Muck (A9) **(LRR O)**
____ 2 cm Muck (A10) **(LRR S)**
____ Reduced Vertic (F18) **(outside MLRA 150A,B)**
____ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
____ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
____ Red Parent Material (TF2)
____ Very Shallow Dark Surface (TF12)
____ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes _X_ **No** ____

Remarks:

A positive indication of hydric soil was observed.

Photo 1. Palustrine emergent wetland WA011 as viewed from DPA026_PEM; view facing north.

Photo 2. Estuarine intertidal emergent wetland WA012 as viewed from DPA029_PEM; view facing east.

Photo 3. Palustrine emergent wetland WA019 as viewed from DPA044_PEM; view facing east.

Photo 4. Estuarine intertidal emergent wetland WB007 as viewed from DPB018_PEM; view facing west.

Photo 5. Palustrine emergent wetland WA018 as viewed from DPA049_PEM; view facing north.

Photo 6. Estuarine intertidal emergent wetland WB013 as viewed from DPB040_PEM; view facing north.

Wetland Vegetation Communities –Scrub-Shrub Wetlands

Photo 7. Palustrine scrub-shrub wetland WB003 as viewed from DPB007_PSS; view facing west.

Photo 8. Estuarine intertidal scrub-shrub wetland WB005 as viewed from DPB011_PSS; view facing east.

Photo 9. Estuarine intertidal scrub-shrub wetland WB006 as viewed from DPB017_PSS; view facing south.

Photo 10. Estuarine intertidal scrub-shrub wetland WB013 as viewed from DPB039_PSS; view facing south.

Photo 11. Estuarine intertidal scrub-shrub wetland WA006 as viewed from DPB017_PSS; view facing north.

Non-wetland Vegetation Communities – Herbaceous Uplands

Photo 12. An herbaceous upland as viewed from DPA027_U; view facing north.

Photo 13. An herbaceous upland as viewed from DPA028_U; view facing south.

Photo 14. An herbaceous upland as viewed from DPA038_U; view facing east.

Photo 15. An herbaceous upland as viewed from DPB061_U; view facing south.

Photo 16. An herbaceous upland as viewed from DPB060_U; view facing west.

Photo 17. An herbaceous upland as viewed from DPB012_U; view facing east.

Non-wetland Vegetation Communities – Scrub-Shrub Uplands

Photo 18. A scrub-shrub upland as viewed from DPA033_U; view facing east.

Photo 19. A scrub-shrub upland as viewed from DPB006_U; view facing west.

Waterbodies – Stream Waterbodies

Photo 20. Ephemeral ditch SA005; view facing west.

Photo 21. Intermittent stream SA006; view facing west.

Photo 22. Perennial stream SA007; view facing north.

Waterbodies – Ponded Waterbodies and Coastal Inlets

Photo 23. Coastal inlet waterbody PB001; view facing west.

Photo 24. Ponded waterbody PB003; view facing west.

Photo 25. Ponded waterbody PA001; view facing north.

APPENDIX C

Port of Corpus Christi Authority Proposed Intake for Desalination Plant
Basis of Design Report

PORT OF CORPUS CHRISTI
PROPOSED INTAKE FOR DESALINATION PLANT
BASIS OF DESIGN REPORT
HARBOR ISLAND, CORPUS CHRISTI, TEXAS

Prepared for:

Port of Corpus Christi

400 Harbor Drive

Corpus Christi, TX 78401

Prepared by:

Parsons Environment & Infrastructure Group Inc.

Texas Registered Engineering Firm F-8008

KIT Professionals Inc.

Texas Registered Engineering Firm F-4991

February 2023

1 Introduction

The Port of Corpus Christi Authority of Nueces County, Texas (Port Authority) intends to construct a desalination facility (the "Facility) on Harbor Island to produce reliable wholesale water for the Coastal Bend region beyond its current freshwater sources. Lake Corpus Christi, Choke Canyon Reservoir, Lake Texana and the Colorado River currently provide raw water to the region. The recent (2021-2022) drought with increased water demand has emphasized the continued need to find additional drought-proof water sources for the Coastal Bend region. The Port Authority requests authorization to divert up to 350,000 acre-ft/year (maximum diversion rate of 217,000 gallons/minute (gpm)) of State Water from the Gulf of Mexico (State Water') to the Facility. The Facility will initially use 175,000 acre-ft/year (maximum diversion rate of 109,000 gpm) of State Water to produce 50 million gallons per day (mgd) (56,000 acre-ft/year) of desalinated product water. Product water will be distributed on a wholesale basis to municipal and industrial entities. The requested authorization allows for expansion of the desalination plant to produce 100 mgd (112,000 acre-ft/year) of desalinated product water if future water requirements justify the additional capacity.

The purpose of this report is to provide a Basis of Design for the water intake structure, tunnel and intake screens in sufficient detail to support the Texas Commission on Environmental Quality (TCEQ) Water Rights Permit Application. Numeric measurements and values referenced in this document rely upon preliminary design considerations which are subject to confirmation or revision during the final engineering-design phase. Specific design, location, and operation inputs (based on the use of the InvisiHead technology and the use of five velocity caps) were used solely for the purposes of assessing potential impingement and entrainment from operation of the intake structure. Other technologies and/or products may be selected during the final engineering-design phase to meet or exceed the referenced performance criteria.

1.1 Water Supply Need and Applicability

The following statements demonstrate the need and applicability for the water right requested in the application and addressed in this report.

- "Since 1957, the Texas Water Development Board ('TWDB') has been charged with preparing a comprehensive and flexible long-term plan for the development, conservation, and management of the State's water resources." *See* Coastal Bend Regional Water Planning Area, Region N, by Coastal Bend Regional Water Planning Group, "2021 Regional Water Plan" at p. 1 (hereinafter "Regional Plan")
- The Coastal Bend Region (Region N) encompasses 11 counties of Texas -- including Aransas, Nueces, and San Patricio Counties. (Regional Plan at pp. 1-2, 5, including Figure ES 1)
- Chapter 5 of the Regional Plan entitled "Water Management Strategies," and subchapter 5D.10 fully discuss "Seawater Desalination" as a specific water management strategy. (Regional Plan at pp. 5.10-1 to 5.10-46)
- Section 5D.10.7 of the Regional Plan specifically discusses the Harbor Island desalination facility as a management strategy (Regional Plan at 5.D.10-33 to 5D.10-39).
- "If projected future water needs are not met, the TWDB has forecast that Region N will suffer combined lost income of $1.9 billion by 2030 and $6.9 billion by 2070; a loss of 13,000 jobs by 2030 and loss of 48,000 jobs by 2070; and consumer surplus losses of $163 million by 2030 and $172 million by 2070 (and related population losses and school enrollment losses)." (Regional Plan at p. 30, and Appendix B at p. 2)

Accordingly, this application addresses a known "water supply need in a manner that is consistent with the state water plan..." and addresses a "water supply need" specific to the Region N plan. Seawater desalination is expressly addressed in the Regional Plan as a water management strategy. Diversion of State Water for purposes of desalination is expressly considered in the Regional Plan for the proposed Facility (at Harbor Island). The requested diversion of 156 mgd (175,000 acre-ft/year) is appropriately scaled to the 50 mgd potable water production fully discussed in the Regional Plan while the requested diversion of 312 mgd (350,000 acre-ft/year) is scaled to address potential growth given more recent trends.

2 Site Selection / Area of Influence

The Port Authority has determined that a possible location for the Harbor Island Facility intake is offshore in the Gulf of Mexico (GOM). Locating the intake in the GOM will require routing the intake tunnel under the Aransas Pass Channel, the Lydia Ann Channel, and San Jose Island. Siting the intake in the GOM will be a substantial cost; however, the Port Authority concluded that the offshore location could reduce potential environmental impacts from impingement and entrainment of marine life related to the proposed diversion of seawater. It was also determined that the intake will be located at an approximate depth of 35 ft of water (-35 ft NAVD88). This depth allows the entrances to the intake system to be located at least 20 ft below the water surface and approximately 5 to 10 ft above the sea bed. Locating the intake 5 to 10 ft off the sea bed minimizes the potential for sediments or benthic organisms to be drawn into the intake structure. At 20 ft below the water surface, the intake depth is well below depths where marine organisms in the GOM are most abundant, including sensitive stages of eggs and larval fish, such as red drum. It has been documented that viable red drum eggs are buoyant at salinities over 25 parts per thousand (ppt) (Holt et al. 1981). With naturally occurring salinity in the area of the intake of above 31 ppt, red drum eggs float near the surface and thus will not come into the hydraulic zone of influence of the intake. Furthermore, this intake is being located approximately 1.5 miles from the entrance to the Aransas Pass Jetty, which will reduce any potential impact on GOM species which may migrate in and out of the bays through Aransas Pass.

3 Fish Protection Standards

In May 2020, the Port Authority passed a resolution recommending placement of the intake structure for the Harbor Island Facility in the GOM. The Port Authority has also included several additional design features to further minimize any potential adverse environmental effects related to the diversion of state water. This report identifies and describes these design features including: the use of a velocity cap intake system, intake location selected based on available scientific information, and the use of a marine life handling system. Each of these design features are briefly explained below and discussed in further detail throughout this report.

1. The velocity cap intake system will have an entrance velocity of ≤0.5 feet per second (ft/sec). This intake system is described in greater detail below. The United States Environmental Protection Agency (USEPA) considers that offshore water intakes fitted with velocity caps meet the impingement performance requirements of the Clean Water Act 316(b) 2014 Phase II Rule for Existing Facilities, defined as an annual reduction in impingement mortality of 76% or greater (see 40 CFR § 125.94(C)(4)). While not directly applicable to desalination, USEPA's regulatory framework for cooling water intake structures provides useful guidance for evaluating the potential for impingement and entrainment at the proposed desalination facility. The USEPA has determined that most marine organisms can easily swim away from the 0.5 ft/sec intake velocity and thus avoid the intake (40 CFR 125.92(v)). In addition, as distance from the entrance increases, water velocity rapidly declines to less than the typical natural current velocity. The InvisiHead seawater intake velocity cap is referenced in the USEPA 316(b) Technical Document (USEPA 2006) as a system meeting the impingement performance requirement. The manufacturer states that the velocity drops to a maximum of 0.009 ft/sec only 5 meters away from the entrance. The Port Authority expects the final engineering design of the intake to be similar to the performance of the InvisiHead product. Furthermore, a three-inch mesh bar screen will be installed around the velocity caps to exclude larger marine organisms.

2. The intake will be located at an approximate sea bed depth of 35 ft (-35 ft NAVD88) and approximately 1.3 miles offshore; both characteristics will reduce the potential intake of marine organisms that are found in shallower water in more productive environments.

3. The intake opening will be located approximately 5 to 10 ft above the sea bed, which will minimize the potential for sediments or benthic organisms to be drawn into the intake structure.

4. The top of the intake structure will be at least 20 ft below the surface of the water to reduce potential intake of buoyant eggs and larvae that are associated with the upper reaches of the water column.

5. The Port Authority will utilize traveling water screens with marine life handling features to support the return of marine life to its natural habitat. This marine life return system will operate on large rotating screens at the Facility intake bay (immediately adjacent to the exit well of the intake tunnel), which are designed to catch marine organisms and redirect them into a return trough that transports them into the Aransas Channel.

The Port Authority will use these technologies and design features to minimize potential environmental concerns with the intake for the Harbor Island Facility. These systems are described in greater detail below.

4 Proposed Units

The intake structure will consist of a system of pipes and protected openings secured to the sea bed. The openings are located approximately 5 to 10 ft above the sea bed, and will be equipped with a velocity cap. The intake system will also include pumps at an intake bay on Harbor Island to draw water by gravity flow through an intake tunnel and deliver seawater to the Facility. Rotating screens will be used at the Harbor Island Facility intake bay to remove any marine life and debris from the system to prevent them from entering the initial treatment works, including pumps, of the Facility. The screens will function as a marine life protection measure that catches marine organisms and returns them to the Aransas Channel.

4.1 Location

The proposed seawater intake structure will be located approximately 1.3 miles offshore in the GOM. The intake tunnel will be routed approximately 3.1 miles from the offshore intake structure in the GOM to the tunnel exit well on Harbor Island, and then through marine life protection screens in the adjacent Facility intake bay. The tunnel exit well, marine life protection screens, and intake bay will be located on the east side of Harbor Island adjacent to the Aransas Channel. Figure 1a presents the plan of the intake tunnel route, and Figure 1b presents a profile view of the intake tunnel.

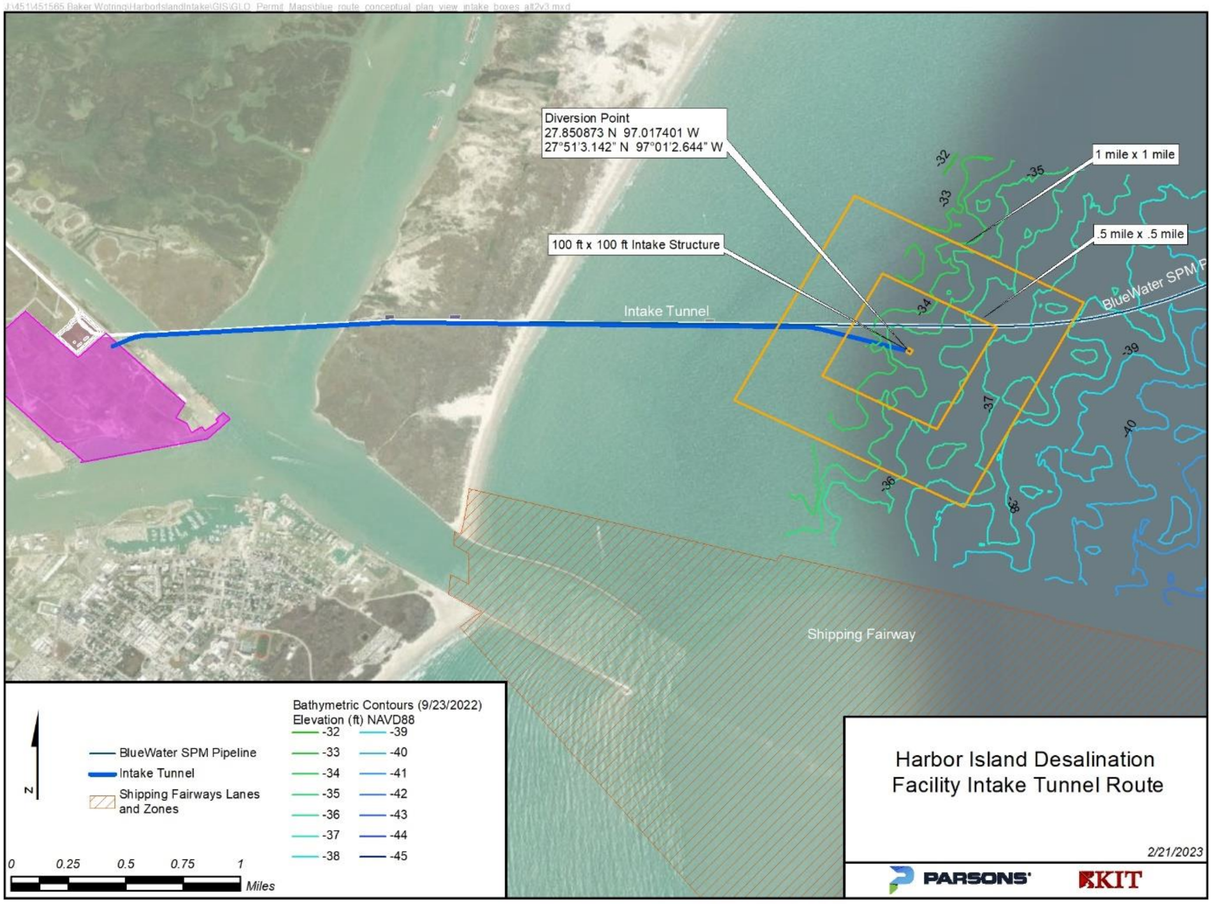


Figure 1a. Proposed Intake Location and Tunnel Route

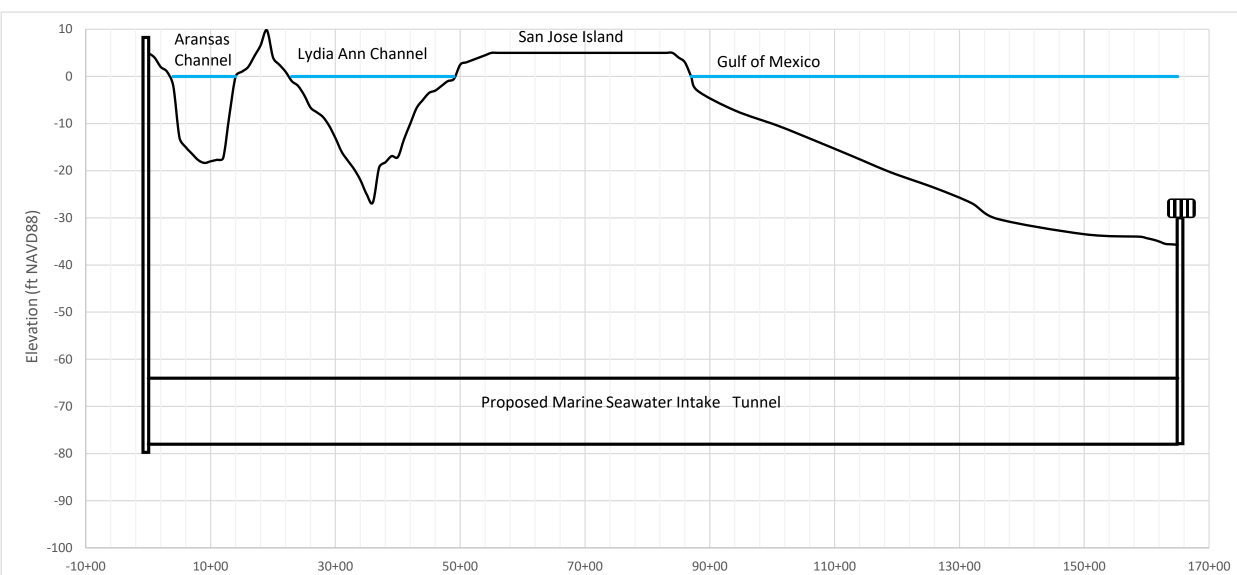


Figure 1b. Profile of Proposed Seawater Intake Tunnel

4.2 Seawater Intake Structure

For an initial production of 50 mgd, the intake structure will have a manifold arrangement with approximately four to five branches[1] to the velocity caps. All the branches will be evenly spread approximately 30 ft apart to obtain even flow distribution without interference from each other. The intake opening will be approximately 5 to 10 ft above the sea bed to minimize the potential for sediments or benthic organisms to be drawn into the intake structure. The velocity cap opening will be designed to have ≤0.5 ft/sec entrance velocity to reduce the intake of fish and other marine organisms into the intake and mitigate impingement. Figure 2 shows the typical structure of a single velocity cap. Figures 3 and 4 show the plan and section of the velocity cap array, respectively. It is anticipated that all intake piping will be placed underground with only the velocity caps and a riser pipe above the sea bed. The riser pipes from each velocity cap tie-in to a common discharge box and convey water flow to Harbor Island through a large-diameter gravity tunnel as explained in Section 4.3.

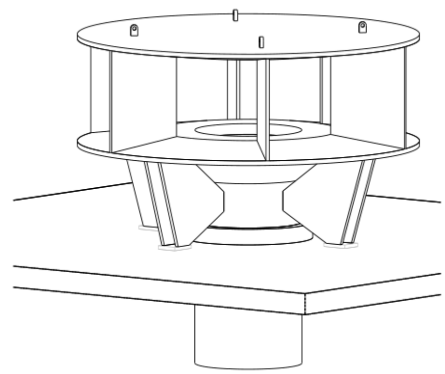


Figure 2. Velocity Cap

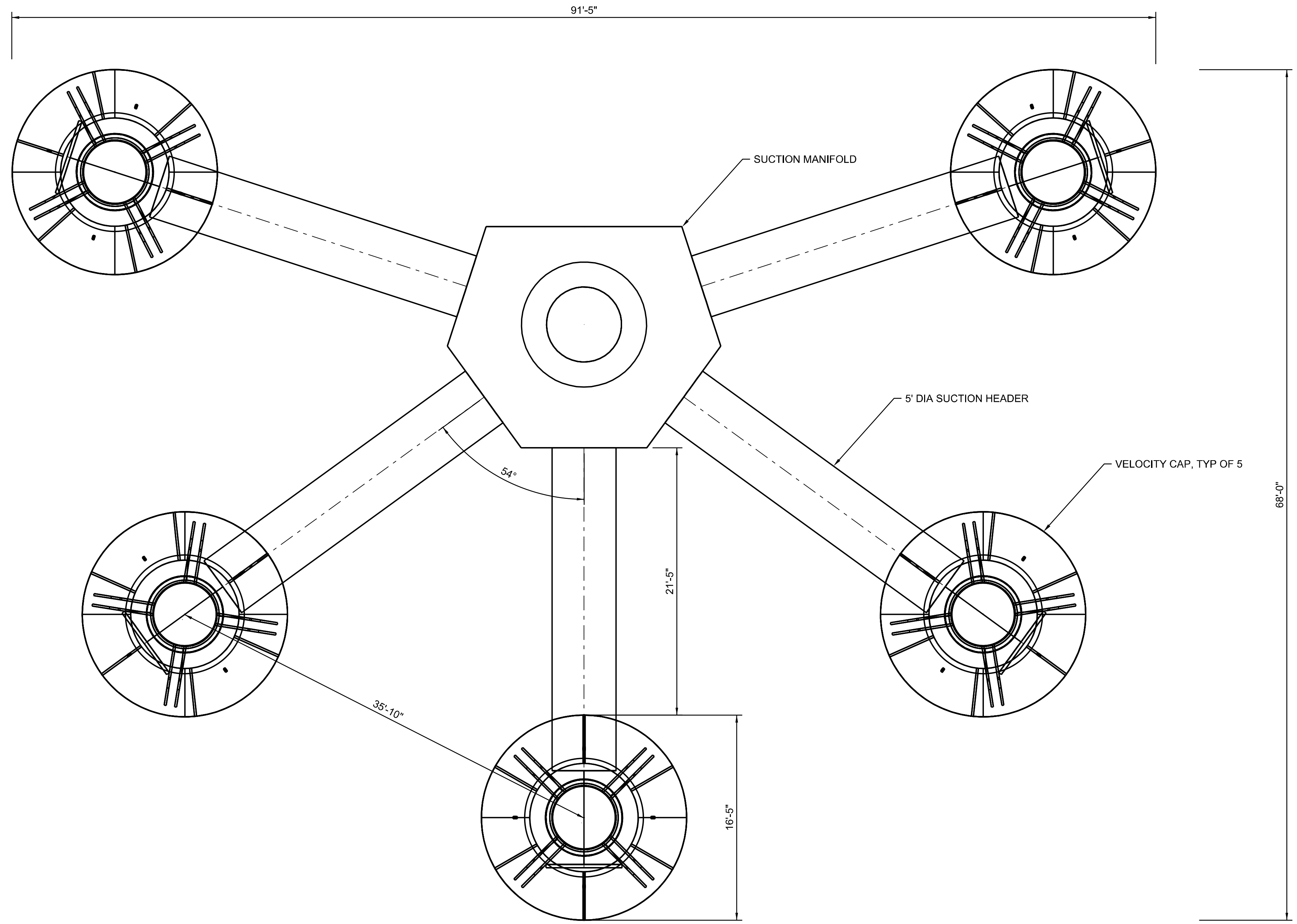
For the potential expansion that would increase the intake capacity to 312 mgd, a second manifold structure would be constructed in parallel. Having two intake structures each of approximately 156 mgd capacity will provide redundancy and make maintenance more efficient.

---

[1] The number, size, and spacing of velocity caps may be adjusted to meet the design velocity requirement and prevent flow interference. The final design will be based on manufacturer's specifications and recommendations.

GENERAL NOTES

1. DIMENSIONS PRESENTED FOR PRELIMINARY LAYOUT AND APPROXIMATE SIZING ONLY. NOT INTENDED FOR CONSTRUCTION.



PLAN
3/16"=1'-0"

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

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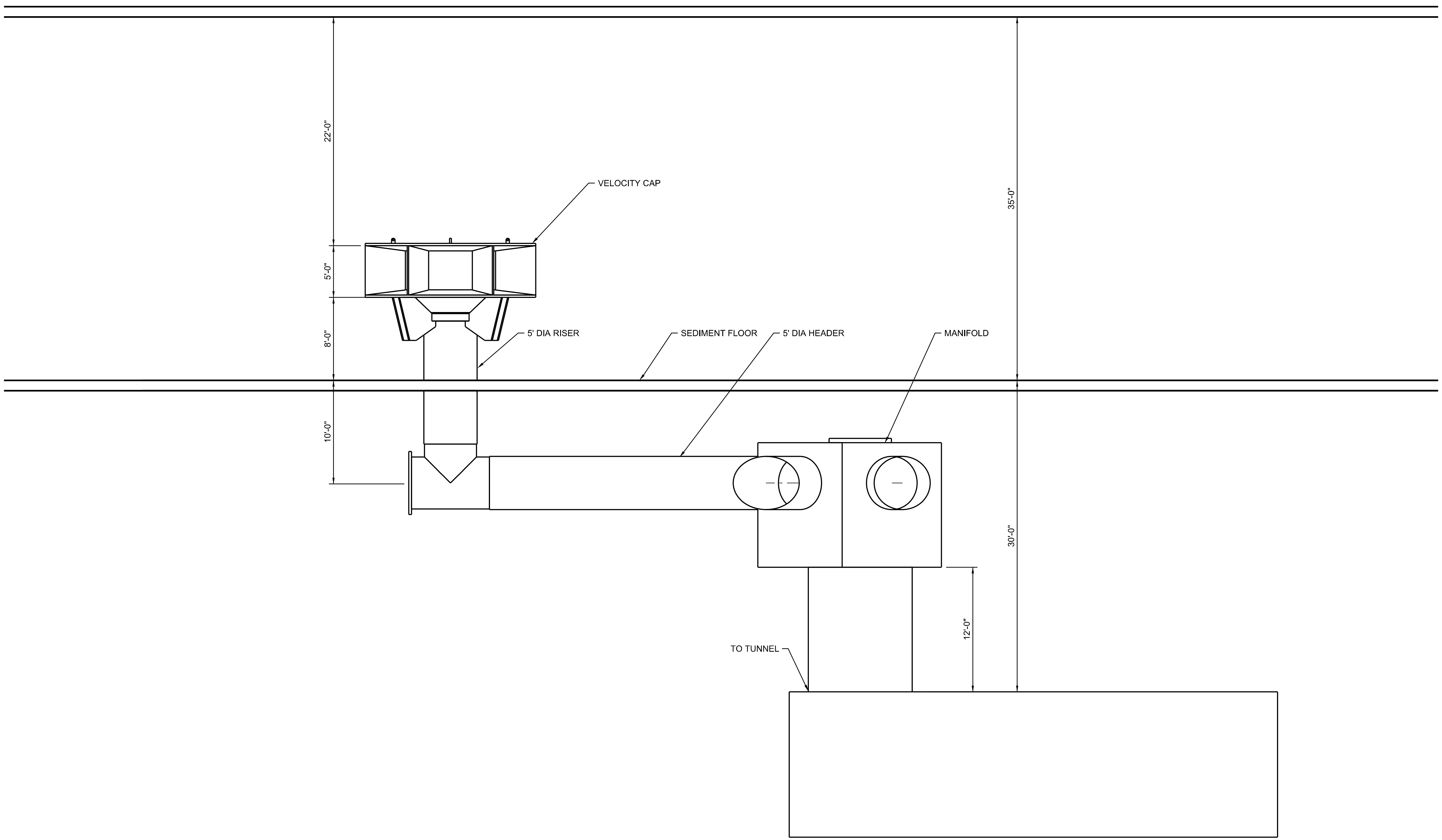
PORT OF CORPUS CHRISTI
PROPOSED INTAKE FOR DESALINATION PLANT
BASIS OF DESIGN REPORT
HARBOR ISLAND, CORPUS CHRISTI, TEXAS

FIGURE 3
INTAKE AND MANIFOLD PLAN

OCT 2022

GENERAL NOTES

1. DIMENSIONS PRESENTED FOR PRELIMINARY LAYOUT AND APPROXIMATE SIZING ONLY. NOT INTENDED FOR CONSTRUCTION.



SECTION
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IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

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PORT OF CORPUS CHRISTI
PROPOSED INTAKE FOR DESALINATION PLANT

BASIS OF DESIGN REPORT
HARBOR ISLAND, CORPUS CHRISTI, TEXAS

FIGURE 4
INTAKE AND MANIFOLD SECTION

OCT 2022

4.3 Intake Tunnel

Seawater will be delivered to the Harbor Island Facility by means of a large-diameter tunnel of approximately 14 ft tunnel outer diameter and 12 ft inner diameter.

4.3.1 Tunnel Geometry

The tunnel route and alignment are proposed to follow the alignment of the pipeline project called "Bluewater Texas Terminal" (Bluewater). The Bluewater alignment travels roughly due east from Harbor Island, very near the proposed Facility. The Harbor Island intake tunnel will follow the Bluewater alignment for approximately 2.7 of its total 3.1 miles before the alignments separate approximately 0.4 miles from the intake, as shown in Figure 1a. The proposed alignment runs beneath two maritime channels, a privately owned island, and the GOM sea bed. The tunnel will be constructed by trenchless construction (tunnel boring), a common construction method for large diameter pipelines below the sea bed.

At sea, the trenchless construction method generally recommends that the tunnel be constructed at least two tunnel diameters below the sea bed in potentially unstable substrates. The sea bed elevation at the intake location is approximately -35 ft NAVD88. Pending completion of a geotechnical survey, the top of the 14-ft tunnel is expected to be at approximately –64 ft NAVD88[2]. Additionally, the Army Corps of Engineers recommends a minimum clearance of 20 feet below the authorized project depth of 12 feet below mean lower-low water (MLLW) in the Lydia Ann Channel, a segment of the Gulf Intracoastal Waterway. At the proposed top of tunnel elevation of approximately -64 ft NAVD88, the tunnel will easily meet that clearance.

4.3.2 Flowrate

To produce 50 mgd of desalinated water, the desalination process requires a source water intake flowrate of 150.7 mgd. To produce 100 mgd at 40% recovery, the desalination process requires 301.4 mgd of source water. The tables below illustrate the mass balance calculation utilized to estimate the flowrates of the intake and the discharge.

In addition to the flows required for the desalination processes, additional flow is required to operate the marine life protection screens, return systems and debris removal off the screens. These operations require an additional 5.3 mgd for production of 50 mgd of desalinated water and 10.6 mgd for production of 100 mgd.

Characteristics – 50 mgd product water	Desalination Plant Intake	Desalination Production	Desalination Plant Effluent	Units
Total required intake flowrate:	150.7			mgd
Marine life screening and return	5.3			mgd
Total intake tunnel flowrate	156			mgd
Production flowrate (desalinated water):		50.0		mgd
Recovery rate of desalination process:		40		%
Reject flowrate:			75.0	mgd
Other waste flows:			20.6	mgd
Permitted Outfall flowrate:			95.6	mgd

[2] If geotechnical sampling along the entire alignment indicates that the substrate does not pose risks, the tunnel elevation may be adjusted to be slightly shallower,

The design flow rate for initial production of 50 mgd is 156 mgd, or 175,000 acre-ft/year. Various units for this flow rate are used for different calculations and in different fields in the water rights permit application. 156 mgd is equivalent to 109,000 gpm which is equal to 242 cubic feet per second (cfs).

An expansion to 100 mgd production would require an intake flow rate double of that described above, as shown below.

Characteristics – 100 mgd product water	Desalination Plant Intake	Desalination Production	Desalination Plant Effluent	Units
Total required intake flowrate:	301.4			mgd
Marine life screening and return	10.6			mgd
Total intake tunnel flowrate	312			mgd
Production flowrate (desalinated water):		100.0		mgd
Recovery rate of desalination process:		40		%
Reject flowrate:			150.0	mgd
Other waste flows:			41.2	mgd
Permitted Outfall flowrate:			191.2	mgd

The intake flow would be 312 mgd (350,000 acre-ft/year), a flow whose equivalent values are 217,000 gpm and 484 cfs.

4.4 Intake Screen System

The tunnel will convey State Water from the GOM to the Harbor Island Facility. To protect marine life and minimize impingement and entrainment, a traveling marine life screen and return system will be installed at Harbor Island. The screen and return structure will consist of troughs on the traveling screens and a seawater spray system to gently wash any marine organisms, including fish, off the screens and return them to the Aransas Channel. A schematic of the screens with seawater spray system is shown in Figure 5.

4.4.1 Traveling Screens with Marine Life Handling System

The intake tunnel conveys seawater into the tunnel exit well, from which seawater flows to an intake bay. The intake bay then feeds the seawater to 2 to 4 screen channels. Each screen will be approximately 8 to 10 ft wide and will be equipped with a traveling screen. Figures 6a and 6b show the preliminary configuration of the screening facility. Final design of approach velocity, width, depth, and number of screens will be conducted at a later stage of the project.

The screens will have revolving wire mesh panels with 2 to 6 mm openings to capture larvae along with any juvenile or larger fish as well as debris. The screens collect and remove fish and debris as the wire mesh panels rise out of the seawater. Fish trays are installed on the screens to humanely capture marine organisms as they are lifted from the seawater. The screens will be equipped with low pressure jet sprays to gently discharge the screened marine organisms to a fish trough that returns them back to the Aransas Channel. After the marine organisms are transferred to the fish trough, high-pressure jet sprays eject debris from the screens.

Additional screen channels and equipment will be added as needed for expansion for production of 100 mgd of desalinated water.

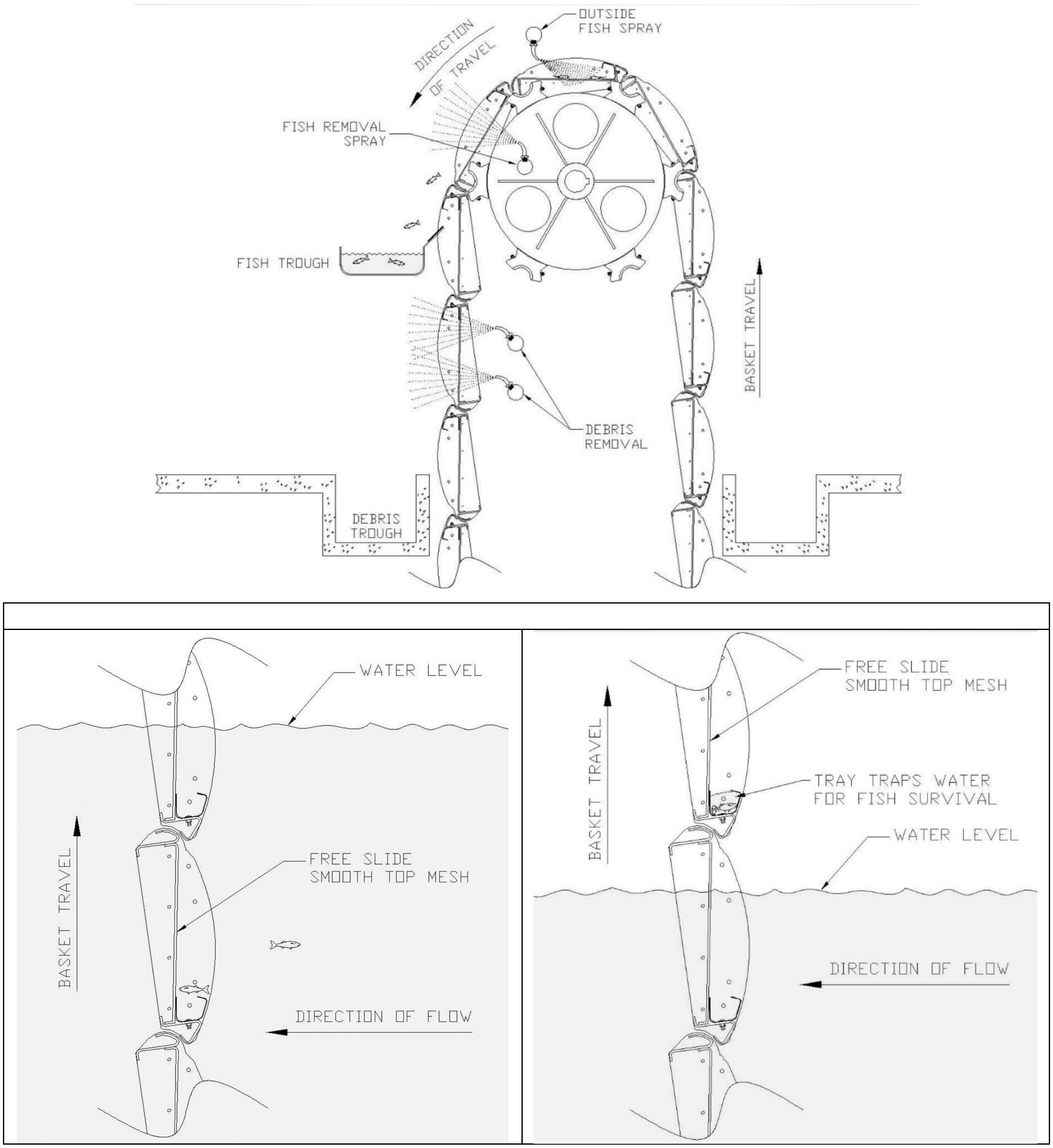

Figure 5. Traveling screen sketch and illustration of fish removal

4.4.2 Transfer Pumps & Controls

A pump station will be installed downstream of the screens to pump the seawater to the Facility. The individual capacity and number of pumps will be selected during the design based on the location, configuration, and any design requirements of the Facility. The pumps will be constructed of materials able to handle seawater. The pumps will discharge to a common force main that will deliver screened seawater to the desalination treatment systems.

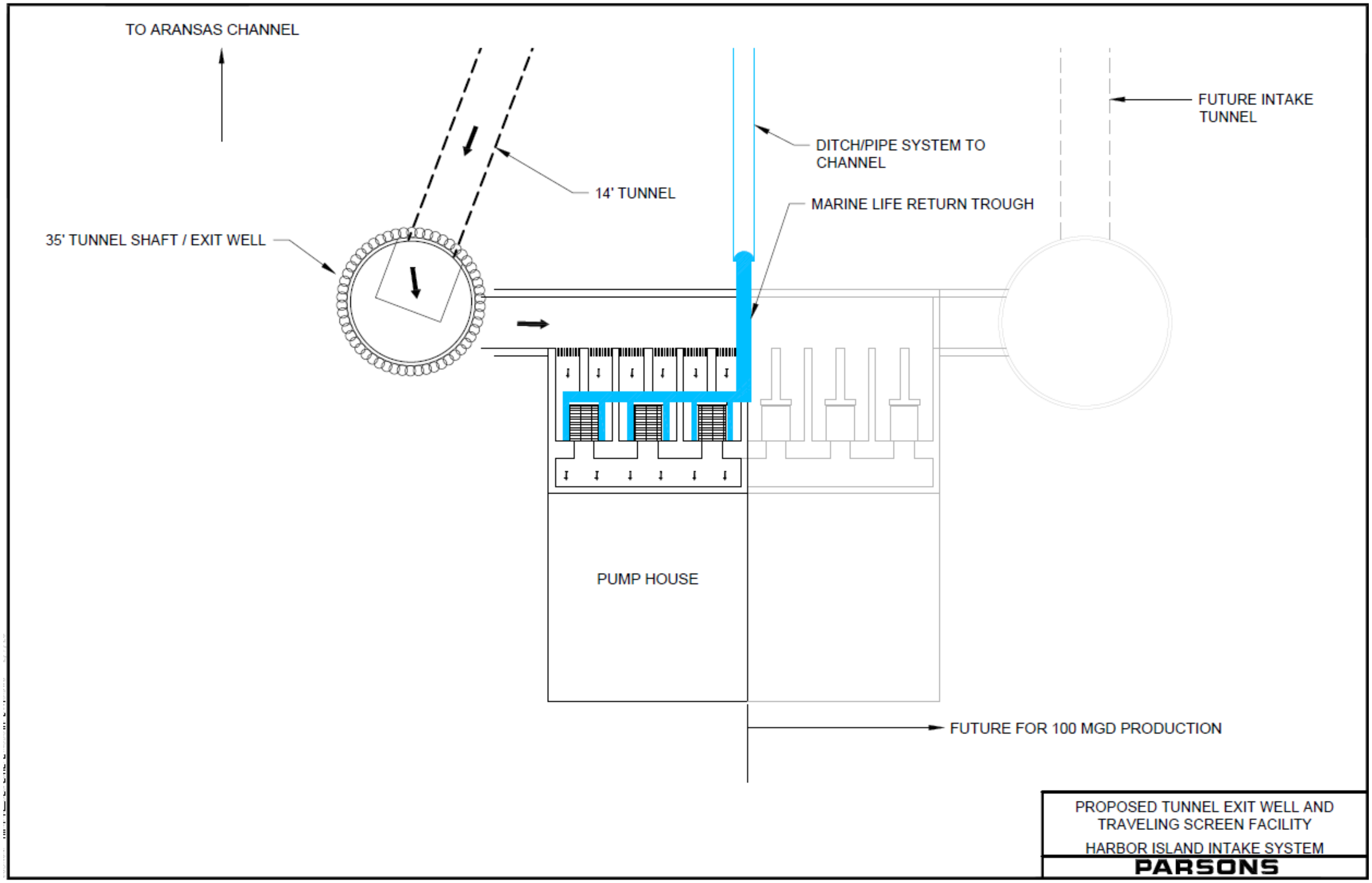

Figure 6a. Plan View of Proposed Marine Life Screening Facility

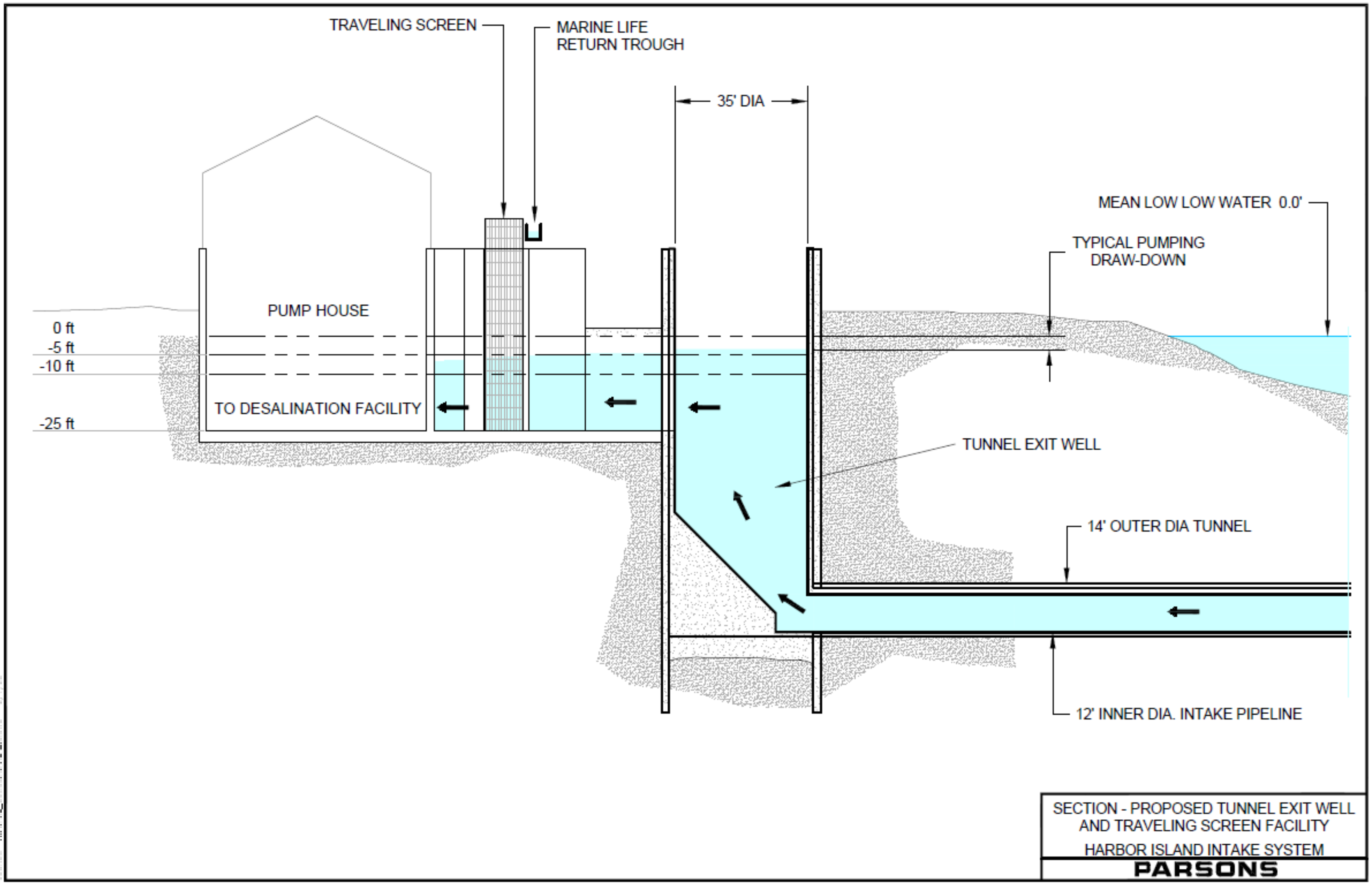

Figure 6b. Cross-Section of Proposed Marine Life Screening Facility

5 Conclusion

The offshore intake system will divert 175,000 acre-ft/year (156 mgd) of State Water to the proposed 50 mgd production capacity desalination Facility on Harbor Island and will be expandable up to 350,000 acre-ft/year (312 mgd). The intake system consists of a manifold of velocity cap intakes, a large diameter gravity intake tunnel to the on-shore screen structure, traveling screens with marine life return system, and transfer pumps. The intake structure will be designed to minimize impingement and entrainment of marine life. The information provided in this memo is preliminary and intended for planning and permitting purposes. Specific products, dimensions, and materials will be selected in the final design. The final design philosophy plans and specifications will be consistent with the assumptions and descriptions in this report.

6 References

Holt, J., R. Godbout, and C.R. Arnold. 1981a. Effects of temperature and salinity on egg hatching and larval survival of red drum, *Sciaenops ocellata*. Fishery Bulletin United States, National Marine Fisheries Service. (2012) v.79 (3): 569-573.

U.S. Environmental Protection Agency (USEPA). 2006. Technical Development Document for the Final Section 316(b) Phase III Existing Facilities Rule. EPA-821-R-06-003. Office of Water, Washington, DC.

APPENDIX D

Proposed Construction Methods for the Harbor Island Desalination Facility Intake Tunnel

Proposed Construction Methods for the Harbor Island Desalination Facility Intake Tunnel

Introduction

This document describes methods of construction for a proposed intake tunnel extending from a proposed seawater desalination facility located on Harbor Island, outside of Aransas Pass, Texas, to a point in the Gulf of Mexico (GOM) approximately 3.1 miles east of the desalination facility. The proposed tunnel would be constructed via a tunnel boring machine (TBM) such that surface disturbance would occur in only two locations—the vertical work shafts at the intake point in the GOM and at the desalination facility on Harbor Island. The remainder of the construction would occur deep within the ground and under the sea bed, undetectable to marine life, flora, fauna or humans above ground.

Numeric measurements and values referenced in this document rely upon preliminary design considerations which are subject to confirmation or revision during the final engineering-design phase.

Preliminary Routing

The proposed intake tunnel measures approximately 3.1 miles long, shown in blue in Figure 1 below. A profile of the tunnel is provided in Figure 2.

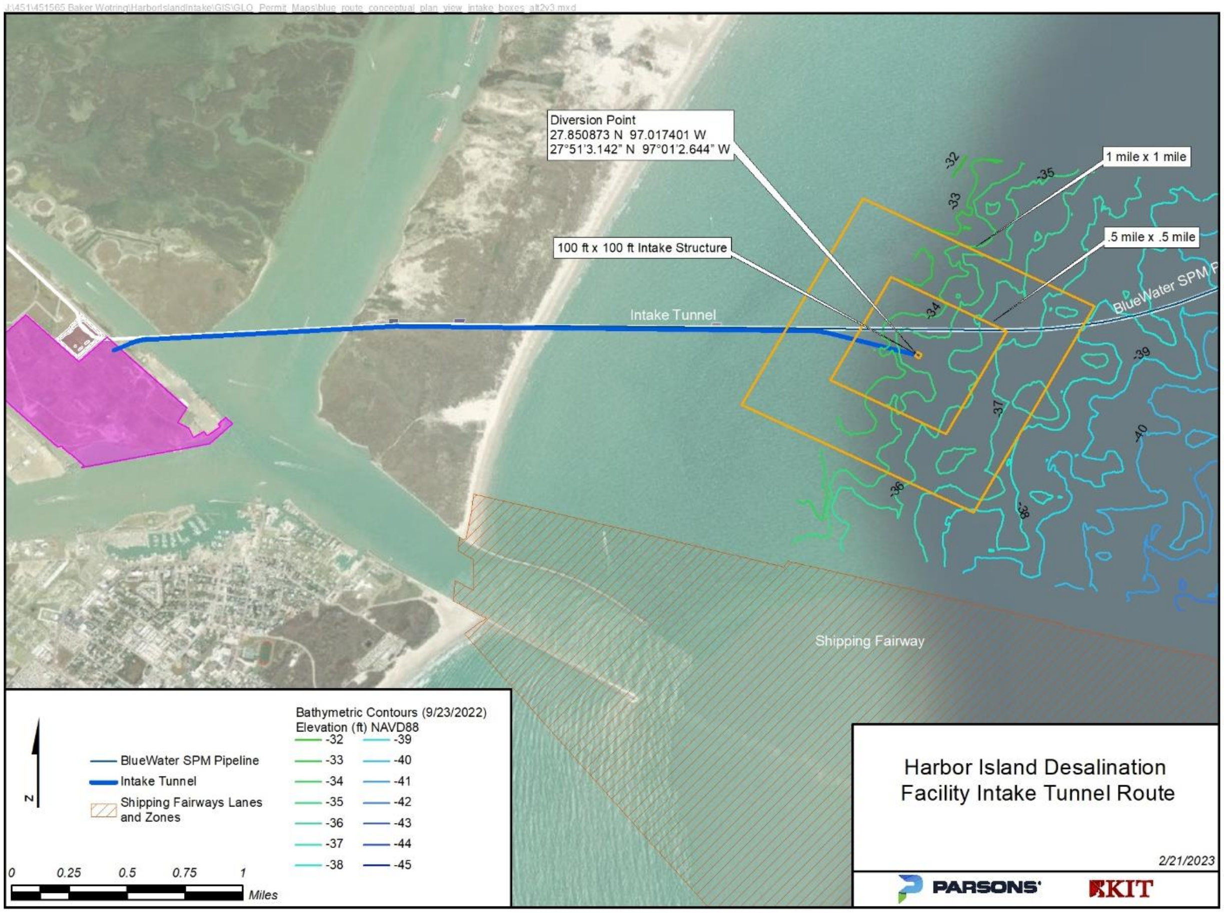

Figure 1. Alignment of Proposed Seawater Intake Tunnel

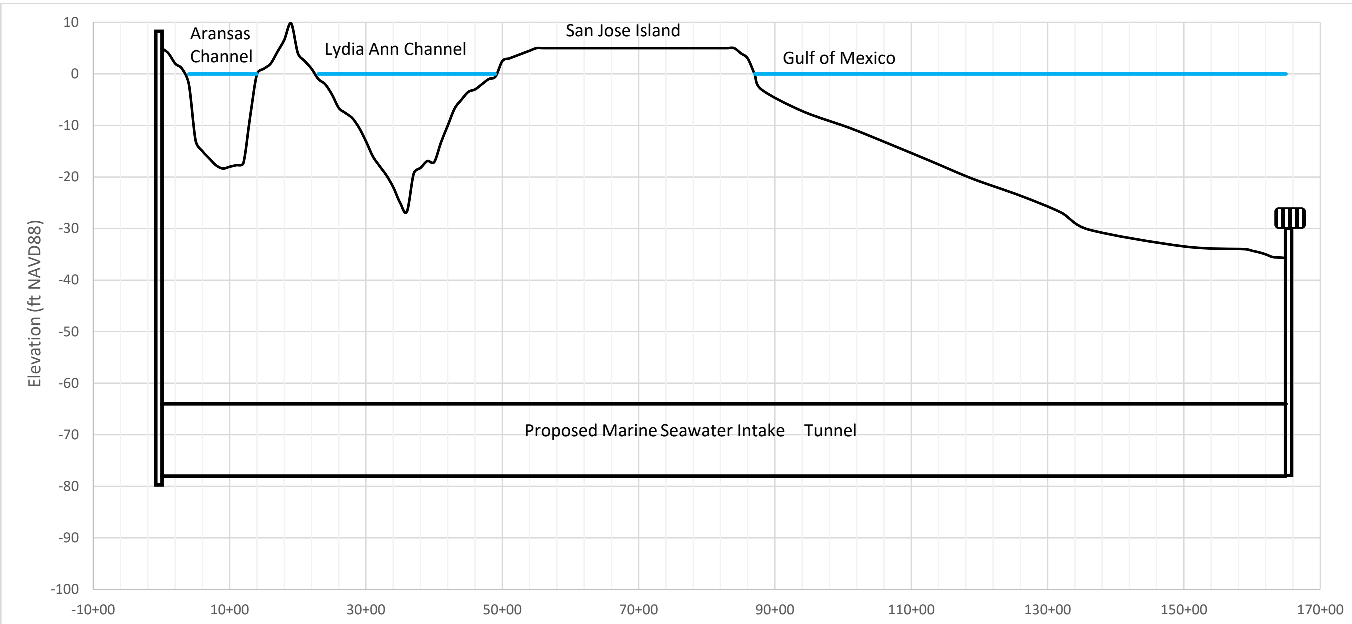

Figure 2. Profile of Proposed Seawater Intake Tunnel

The main work shaft (also known as the TBM launch shaft) is the vertical shaft planned for the Harbor Island site on the left side of Figure 2. A second shaft will be excavated in the Gulf of Mexico at the terminus of the tunnel, where the intake structure will be installed on the right side of Figure 2.

Assumed Geotechnical Conditions

A project-specific geotechnical investigation has not yet been performed along the alignment; however, some geotechnical data for inshore portions of the alignment have been reported in Appendix J to the license application for the Bluewater Texas Terminal Deepwater Port project to the Army Corps of Engineers (available at regulations.gov/docket/MARAD-2019-0094). The data available indicate soils at the elevation of the proposed tunnel include medium dense to very dense silty sands, and soft to very stiff lean and fat clays. Available boring logs and a generalized understanding of the geology in the Corpus Christi area suggest that only sands and clays are present at the elevations at which the tunnel will be constructed. These conditions are characterized as “soft ground”, that is, in laymen’s terms, soils and not rock. All tunneling will occur at elevations well below sea level. The top of the tunnel is proposed to be at an elevation of approximately -64 feet NAVD88.

A geotechnical investigation will be performed prior to final design that will influence many aspects of the design. The ultimate configuration and methods will be determined during final design after the geotechnical investigation is completed. Presented below is a generalized version of typical construction methods for a tunnel.

Proposed Tunnel Method

Because it is anticipated that soft soils will be encountered for the entirety of the tunnel profile, the proposed method for tunnel construction is an earth pressure balance TBM (Figure 3). TBMs for soft ground have a cylindrical shield to support the soil strata being mined through, and a bi-rotational cutterhead equipped with cutting tools to remove the intact ground and draw the loosened material into the cutterhead. The excavated soils are captured and removed from a chamber behind the cutter wheel.

Pressurization of the face of the excavation is required in permeable soil under unbalanced hydrostatic pressure, given the expected tunnel condition under the sea. If the face of the excavation were not pressurized, the unbalanced water pressure could allow soils to flow through the gaps in the cutter head and into the TBM and resulting excavation, filling the tunnel with soil. Such conditions may cause sinkholes and excessive settlement at the ground or sea bed and may cause damage to existing infrastructure (e.g., adjacent oil pipelines).

Earth pressure balance TBMs function by maintaining a pressurized environment in a void just behind the cutter head and excavation face called a "muck chamber." The face pressure is continuously monitored by operators in the TBM. The muck is a mixture of fragmented excavated spoils and soil conditioning additives (if any) to improve the material handling properties of the excavated material. The muck chamber is created by a bulkhead separating the construction crew from the pressurized environment at the face. Soil is removed from this pressurized environment by removing it through a helicoidal screw contained in a long steel cylinder. The helicoidal screw turns to slowly remove soil from behind the pressurized bulkhead while maintaining the appropriate face pressure. At the rear of the screw auger is a slide gate, where excavated soils are discharged onto a conveyor belt and then into muck cars near the end of the TBM shield. The muck cars/belt conveyor transport the muck to the primary work shaft, where they are hoisted to the surface by muck boxes or a vertical conveyor and into a temporary stockpile area/surge pile.

The TBM shield is a cylindrical steel shell that is pushed forward along the tunnel, while the ground is excavated inside the shield. The main shield and tail shield support the ground as the tunnel lining is installed and fully protects workers within the tunnel. The shields fully encapsulate the excavation, never exposing the ground or leaving any area unsupported. The shield is propelled using hydraulic jacks that thrust against the tunnel lining system installed within tail shield. The shield is designed to withstand the pressure of the surrounding ground and hydrostatic pressure.

To support the excavated bore in the soft soils at depths below sea level, a precast concrete segmented liner is proposed. This lining type has become the industry standard lining for large diameter soft ground TBM mined tunnels and is designed to meet project requirements for durability and watertightness. The liner helps to maintain the pressure the machine is exerting on the ground and provides a solid base against which the thrust jacks in the TBM propulsion system can push the cutterhead forward. For this reason, the TBM is used in conjunction with a prefabricated ground support system, which most commonly consists of pre-cast concrete segments that are bolted and gasketed to form a watertight lining, like that shown in Figure 4. This watertight lining must be designed to withstand construction, ground, seismic and hydrostatic loads.

The concrete segments are erected in the tail shield of the TBM (Figure 5), bolted and gasketed together to form a continuous ring. Thus, a TBM advance cycle consists of excavation and then ring erection and grouting during the next TBM excavation cycle so that a continuous lining is built behind the TBM. The faces of the segments are usually tapered, so that when assembled they can be rotated to accommodate horizontal and vertical curvature of the alignment.

For corrosion protection, handling strength, and production needs, precast concrete tunnel segments are cast with a dense high strength concrete. Dense concrete is accomplished by using fine filler materials to fill the microscopic pores and voids between the cement particles. Concrete segments are usually reinforced by either steel reinforcing bars or steel fibers.

Precast concrete linings are fully capable of providing a structurally adequate and long-lasting tunnel lining in the presumed soil materials to depths beyond those of the proposed tunnel.

It should be noted however, that if geologic faults exist, the faults can create active shear zones which, when severe enough, could distort and shear a typical precast concrete lining. Accordingly, these fault zones must be given special design consideration details. Future geotechnical investigations will verify whether fault movement is a potential concern along the tunnel alignment.

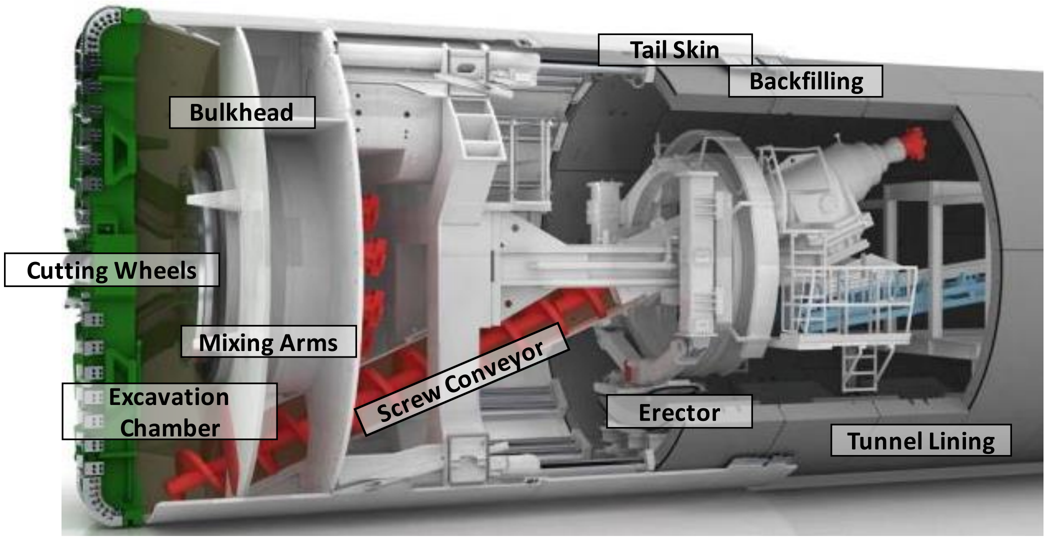

Figure 3. Earth Pressure Balanced (EPB) TBM
(Modified from https://www.herrenknecht.com/en/products/core-products/tunnelling/epb-shield.html)

Figure 4. Example Pre-cast Concrete Segmental Lining

Figure 5. EPB TBM Erecting a Pre-cast Concrete Segment

Shaft Construction

Shafts are the most important component of most water-conveying tunnel projects because these are the only locations of construction activities notable at the ground surface. The shafts contemplated for the intake tunnel system include two very distinct types of shafts. The main work shaft is where the TBM is launched and serves as the main access point for tunneling activities. This shaft will be located on the Harbor Island site, with a diameter large enough for optimal tunnel activities, and nearly all the at-grade construction activities will occur here.

The second shaft will be located offshore in the GOM and is where the TBM may be retrieved and will serve to install the pipe connection between the tunnel and the intake structure above the sea bed. The configuration of this shaft and the methods required to construct it are far different from the primary shaft. Both shafts are discussed further below.

Main Shaft Support System

The shaft excavation support system currently considered most feasible for the proposed main tunnel shaft based on the assumed soil conditions is secant piles (Figure 6). Secant piles provide a water-tight, rigid excavation support system. Secant piles are installed by drilling a series of overlapping circular shafts that form a concrete cylinder. A secant pile shaft support system is also designed to act as a compression ring, accounting for installation tolerances and the irregularities of the individual round columns.

The individual drilled shafts are constructed using typical drilled shaft foundation techniques. The shaft excavation walls are supported using drilling slurry, drilled temporary steel casing, or both. The use of temporary steel casing helps maintain a tighter vertical tolerance and helps when biting into adjacent primary concrete shafts. Each secant pile shaft will be 80 to 100 feet deep. The final diameter of the main shaft at Harbor Island will be approximately 35 feet.

A secant pile support system can be constructed in very challenging ground and groundwater conditions to cut off groundwater flow so that only a sump in the excavation bottom is required for groundwater control.

For shafts where the TBM break-in location is beneath the groundwater table in unstable/flowing ground, ground improvement may be performed to create a zone of modified ground (e.g., jet grouting) around the planned penetration location. This zone acts as a seal and has several advantages, including: 1) the zone allows the contractor to pressurize the TBM face to the required full pressure upon leaving the shaft, and 2) it reduces the risk of overmining, which could lead to settlement or sinkholes to the ground surface. In addition, special seals surrounding the TBM shield are designed for ingress of the TBM into the shaft wall.

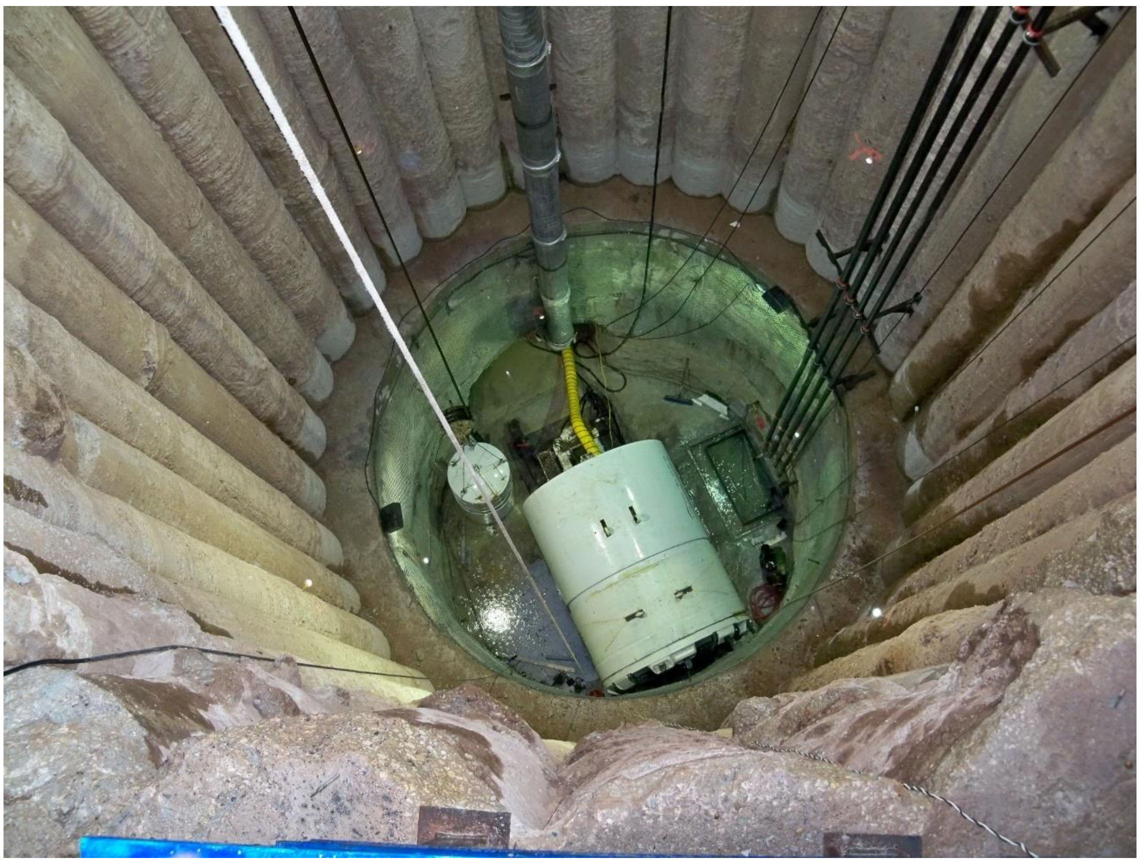

Figure 6. Example of Secant Pile Shaft with 10 ft diameter TBM

Offshore Intake Shaft

The proposed tunnel will terminate approximately 1.3 miles offshore, in the open waters of the Gulf of Mexico, at a sea bed elevation of approximately -35 feet NAVD88. The top of the proposed tunnel is at an elevation of approximately -64 feet NAVD88, so there is approximately 29 feet of separation between the top of the tunnel and the sea bed. The precise construction methods and details of an offshore shaft can be very complicated and subject to the Contractor's means and methods. We again note that the ultimate configuration and methods will be determined during final design after the geotechnical investigation is completed.

The offshore shaft connection will be constructed from platforms mounted above the offshore shaft location. Well before the TBM arrives to the offshore shaft location, a large caisson is lowered to the sea bed, anchored into the sea bed, and dewatered. Ground improvements may be performed on sea bed sediments in the space between the tunnel and the sea bed. These may include jet grouting or excavation via tremie concrete. A shaft will be constructed down to the level of the tunnel inside the caisson, excavating vertically down through the grouted/concreted plug. The TBM bores horizontally through the same grouted/concreted material to arrive at the shaft site.

After the spaces are safely excavated, a vertical conveyance pipe, or riser, is installed between the top of the tunnel up to an elevation near the sea bed, where the prefabricated intake system manifold is installed on the riser, and velocity caps connected to the manifold. Eventually, the portion of the caisson above the sea bed is removed, and the connection between the manifold and tunnel is completed. Connection of the intake riser to the intake tunnel is completed by remotely operated vehicles and robotic “sea horses”. Some operations may be performed by divers.

Figure 7. Example of a Vertical Conveyance Shaft Being Lowered Toward a Tunnel at Sea

Main Work Shaft Site Considerations

Main Shaft Site Characteristics

The main work shaft site on Harbor Island is the primary construction site for the tunneling project. The proposed shaft site location is in a currently undeveloped coastal zone, officially an island, that was historically used for industrial oil and gas operations. The developed properties near the site are industrial or dedicated to commercial shipping. The nearest residences are more than 1.2 miles from the site. The site is served by Harbor Island Road and then Texas State Highway 361.

Activities at the main work shaft site may include:

- Site lighting at night
- Lifting of tunnel muck from tunnel to ground surface with heavy cranes
- Lowering of supplies from ground surface to tunnel
- Compressor for ventilation system
- Heavy earth moving equipment to remove and dispose of excavated muck
- Other large construction equipment (cranes, front end loaders, etc.)
- Concrete plant to produce concrete segments for tunnel lining segments
- Batch plant for grout
- Precast concrete lining segment storage areas
- Temporary laydown for TBM components and other major equipment

- Other laydown space for materials and supplies
- Storage facilities
- Workshops
- Power substation or generators
- Project offices and employee facilities, including employee parking
- Arrival of supply trucks
- Storage of stripped topsoil for future site reclamation

The existing property provides enough space to store the entire inventory of the pre-cast tunnel lining segments. The TBM major components will be delivered to the Harbor Island TBM launch shaft site with very large truck-trailers. The disposal location for the tunnel spoils and truck haul routes will be developed during design.

Shaft Size

The main work shaft will be large enough so the TBM components can be lowered into the shaft, and muck cars can be lifted out, while also allowing room for additional construction equipment, ventilation, laborers, and other project and construction needs. Figure 8 shows an example of the main head of a TBM system being lowered into the main work shaft and shows typical cranes that would be utilized for tunneling operations, albeit the machine shown is significantly larger than required for the Harbor Island project.

The top of the shaft will include personnel safety measures that meet OSHA requirements. Often, the excavation support system (secant piles) is constructed so it simply extends above the ground surface a sufficient distance to create a wall or barrier to act as fall protection. Shaft flood protection from storm surges during construction will be a project requirement, and the safety barrier will be constructed so that it can support the design flood event.

Figure 8. Example of a Large-diameter TBM Cutterhead and Shield Being Lowered into a Main Work Shaft

Muck Handling and Disposal

Excavated material (i.e., muck) produced from tunneling excavation must be removed from the tunnel, temporarily stored outside the main work shaft, dewatered, and placed on site as fill material.

The main work shaft site will accommodate a temporary muck pile (surge pile) and allow for seamless removal of muck to upland areas needing fill. Tunnel muck will be removed from the tunnel using a rail muck wagon that is raised and lowered using a crane through the shaft site

It is anticipated that the tunnel will be excavated at a rate of 60 to 120 feet per day, including a multi-shift, 24-hr workday. This equates to 350 to 700 cubic yards (CY) per day of material. At this rate, the 3.1mile tunnel would be completed in approximately 190 days. The entire 3.1-mile tunnel is expected to produce approximately 100,000 CY of muck.

The main work shaft site will accommodate a muck pile that results from at least two days of mining. This would allow for an entire weekend of tunneling without requiring fill material management over the weekend.

All site entry and exit at the site will follow all required state, local, and federal rules for surface water protection and avoidance of construction nuisances.

Power Requirements

For a tunnel diameter up to 25 feet, the power required to run the TBM may be around 6 to 10 MW. Additional power is required for other project activities, such as: muck conveyor system and boosters, shaft and tunnel ventilation systems, lighting, and other ancillary equipment. For a large tunnel project such as this proposed seawater intake tunnel, a power substation may be required.

Site Restoration

After completion of tunneling construction activities at the site, the main work shaft will be converted into the exit well for the desalination facility intake tunnel. A marine life screening structure and pump station will be constructed at an intake bay adjacent to the exit well. Much of the remainder of the Harbor Island property will be used for the construction of the desalination facility and a future shipping terminal.

Geotechnical Instrumentation and Control of Ground Movements

Prior to actual construction, an extensive preconstruction survey is conducted of the area within the potential influence of the tunnel alignment and surface works. This is done over the entire alignment with a typical width of hundreds of feet. The condition of all structures and facilities, including surface features like roadways, and buried utilities are examined and documented. Given the location and alignment of this project, the instrumentation and control will be minimal. The tunnel will pass beneath an on-site road and possibly some utilities near the main work shaft before crossing beneath channels and the GOM. Instrumentation may be required if there are any crossings beneath petroleum pipelines.

APPENDIX E

Evaluation of Potential Impingement and Entrainment Associated with the Intake Structure for the Proposed Harbor Island Desalination Facility

Evaluation of Potential Impingement and Entrainment Associated with the Intake Structure for the Proposed Harbor Island Desalination Facility

Prepared for

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February 9, 2023

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ACRONYMS AND ABBREVIATIONS

AUF	area use factor
bgd	billion gallons per day
CCSC	Corpus Christi Ship Channel
CWIS	cooling water intake structure
EFH	essential fish habitat
ELS	early life stages
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
GCOOS	Gulf Coast Ocean Observing System
GMFMC	Gulf of Mexico Fishery Management Council
GOM	Gulf of Mexico
HMS	highly migratory species
HYCOM	Hybrid Coordinate Ocean Model
I&E	impingement and entrainment
IPAC	Information for Planning and Consultation
IQR	interquartile range
MFS	managed fish species
mgd	million gallons per day
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NAVD88	North American Vertical Datum of 1988
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
Port Authority	Port of Corpus Christi Authority of Nueces County, Texas
PINS	Padre Island National Seashore
ppt	part per thousand
SCL	straight carapace length
SEAMAP	Southeast Area Monitoring and Assessment Program
T&E	threatened and endangered

TABS	Texas Automated Buoy System
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TL	total length
TPWD	Texas Parks and Wildlife Department
TXGLO	Texas General Land Office
TXNDD	Texas Natural Diversity Database

EXECUTIVE SUMMARY

This report evaluates the potential for impingement and entrainment (I&E) of marine life due to the operation of a State Water from Gulf of Mexico[1] intake structure ("intake structure" or "project area") located in the Gulf of Mexico (GOM) approximately 1.3 miles from San Jose Island in Nueces County, Texas. This intake structure will provide feed water to a proposed desalination facility to be built on Harbor Island adjacent to the Corpus Christi Ship Channel (CCSC). Prior to entering the desalination facility, this feed water will flow through traveling screens designed to collect marine life before returning them to the Aransas Channel. The evaluation of potential I&E for this facility is, by default, qualitative because the facility does not yet exist and site-specific I&E data are not available. The evaluation proceeds as follows:

- Describe the major physical variables and salinities in the GOM Offshore[2] of San Jose Island. These variables consist of depth, substrate composition, seasonal water temperature profiles, and the prevailing direction and intensity of the tidal currents. These features determine the kinds of marine species that may live, feed, migrate, or spawn in the vicinity of the project area. (Note: "the vicinity of the project area" is defined for the purpose of this report as a 1.5- by 1.5-mile square centered on the location of the intake structure).
- Describe the intake structure located in the GOM. This intake structure is comprised of four or five velocity caps, risers and lateral pipes, and a manifold connecting the caps to a sub-sea intake tunnel to Harbor Island. The description covers major operational considerations regarding height of the water intakes, height of the velocity caps above the GOM sea bed and below the GOM surface, volume of State Water to be diverted, velocity of the State Water at the velocity caps' entrances, hydraulic zone of influence, and the proposed screening system at the proposed Harbor Island facility. The evaluation includes a simple volumetric comparison to provide a broader perspective on the potential intake of ichthyoplankton when viewed on a larger spatial scale. The analysis shows that the number of ichthyoplankton in the vicinity of the project area is anticipated to be between 100,000 and 1,000,000 times higher than the ichthyoplankton that may be present within the velocity caps. This analysis should be viewed as conservative for those species with positively buoyant or demersal early life stages that are unlikely to interact with the intake structure due to their position at the top or the bottom of the water column. The conclusion is that any incidental withdrawal of ichthyoplankton by the intake structure

[1] For purposes of this report, the term State Water from Gulf of Mexico ("State Water") means water derived from the Gulf of Mexico or a bay or arm of the Gulf of Mexico. This term may differ from the same or similar terms as used in the Texas Water Code, Texas Administrative Code, or other laws or rules.

[2] For purposes of this report, the term "Offshore" means the area of the Gulf of Mexico beyond the Texas Gulf shoreline, excluding a bay or arm of the Gulf of Mexico. This term may differ from the same or similar terms as used in the Texas Water Code, Texas Administrative Code, or other laws or rules.

should be considered minor relative to the vastly greater numbers of fish eggs and larvae in the vicinity of the project area.

- Identify and describe the species and their life stages likely to be in the GOM Offshore of San Jose Island. This process describes not only what species may occur (over 600), but also particular species of concern; including threatened and endangered species, highly migratory species, managed fish species, commercially important species, and recreationally important species. Eleven target species of fish and invertebrates were selected to provide a more detailed evaluation of the intake structure's potential impacts, if any, upon these selected groups of species. Finally, the information is combined to perform an evaluation on the potential for I&E of these various groups of species.
- The results of this assessment can be summarized as follows:
  - Of the 28 threatened and endangered species that may be in proximity of the velocity caps, the neritic (i.e., residing over the shallow continental shelf) juveniles of the five species of endangered sea turtles have some increased relative potential for I&E in the absence of mitigating measures. This potential is estimated to be minimal based on an area use factor (AUF) approach that considers the relatively large home range of the neritic sea turtles as compared to the small area occupied by the velocity caps.
  - Because of the sea turtles' protected status, the velocity cap openings will be shielded with bar screens to prevent juvenile turtles from entering the intake structure. This solution will also preclude adult sea turtles from entering the intake structure.
  - Only 1 of the 10 highly migratory species (i.e., sailfish) has eggs and larvae that might potentially be drawn into the intake structure, but those early life stages do not occur in the vicinity of the project area. The remaining nine highly migratory species that may be present in the vicinity of the project area are all sharks that give birth to fully formed and strongly swimming pups that are unlikely to experience I&E.
  - The majority of the 17 managed fish species that may potentially be present in the vicinity of the project area, as well as all of the 11 target species of fish and invertebrates, have one or more early life stages that show potential for I&E. However, withdrawals of these life stages into the intake structure will be relatively small compared to the great number of eggs and larvae (several orders of magnitude higher) present in the vicinity of the project area that will not interact at all with the intake structure.

The following components will be implemented based on all these considerations: a) place the water intake structure approximately 1.3 miles in the GOM at 5 to 10 ft above the sea bed in approximately 35 ft of water to limit interaction with marine life, b) set the entrance velocity at the velocity caps to ≤0.5 ft/s to reduce the potential withdrawal of eggs and larvae, c) enclose the velocity caps with 3-in. mesh size bar screens to prevent incidental entrance by juvenile and adult sea turtles (as well as larger fish), and d) use traveling screens at the proposed desalination facility to support survival.

1 INTRODUCTION

This report describes the potential for impingement and entrainment (I&E) of marine life that may occur due to the operation of a State Water from Gulf of Mexico ("State Water")[3] intake structure ("intake structure" or "project area") located in the Gulf of Mexico (GOM) approximately 1.3 miles Offshore[4] from San Jose Island in Nueces County, Texas. The intake structure will divert State Water to a proposed desalination facility to be built on Harbor Island adjacent to the Corpus Christi Ship Channel (CCSC). The evaluation of the potential for I&E for this proposed facility is, by default, qualitative because the facility does not yet exist and site-specific I&E data are therefore not available.

This report uses the U.S. Environmental Protection Agency (EPA) cooling water intake structure (CWIS) regulatory framework, and the scientific rationale used to develop that framework, to assess the I&E potential at the proposed Harbor Island facility. The reason is the similarities that exist between CWIS in marine environments and the anticipated infrastructure that will be deployed at the facility. It is understood that EPA's CWIS regulations do not apply to the proposed Harbor Island facility, but they provide a useful analytical framework due to similarities in the way the intake structures operate. This report also uses the more generic term "I&E" when addressing the consequences of all fauna that may potentially be withdrawn by the intake structure in the GOM.

Though not directly applicable to the proposed intake structure in the GOM, EPA regulations pertaining to CWIS provide the following definitions for I&E:

- **Impingement**: The entrapment of any life stages of fish and shellfish on the outer part of an intake structure or against a screening device during periods of intake water withdrawal.[5]
- **Entrainment**: Any life stages of fish and shellfish in the intake water flow entering and passing through a CWIS and into a cooling water system, including the condenser or heat exchanger.[6] (Note: this definition calls out specific CWIS infrastructure, but the principles of entrainment—i.e., passage through a screening device—are the same for desalination facilities.)

[3] For purposes of this report, the term "State Water" means water derived from the Gulf of Mexico or a bay or arm of the Gulf of Mexico. This term may differ from the same or similar terms as used in the Texas Water Code, Texas Administrative Code, or other laws or rules.
[4] For purposes of this report, the term "Offshore" means the area of the Gulf of Mexico beyond the Texas Gulf shoreline, excluding a bay or arm of the Gulf of Mexico. This term may differ from the same or similar terms as used in the Texas Water Code, Texas Administrative Code, or other laws or rules.
[5] 40 CFR 125.92(n)
[6] 40 CFR 125.92(h)

This section describes the general site location, the overall approach used to assess the potential for I&E by marine life in the GOM, and the report outline.

1.1 GENERAL SITE LOCATION

The Port of Corpus Christi Authority (Port Authority) is proposing to build a State Water desalination facility on Harbor Island adjacent to the CCSC across from Port Aransas, Nueces County, Texas. The Port Authority is also working to obtain a water rights permit from the Texas Commission on Environmental Quality (TCEQ) to gain permission to divert 156 million gallons per day (mgd) (expandable to 312 mgd in the future) of State Water from an area in the GOM located approximately 1.5 miles to the northeast of the entrance to the Aransas Inlet jetty for use in desalination. **Figure 1-1** shows the general location of the proposed Harbor Island desalination facility, the intake structure (also defined as "the project area"), the vicinity of the project area (note: "the vicinity of the project area" is defined for the purpose of this report as a 1.5- by 1.5-mile square centered on the location of the intake structure), and the intake tunnel that will bring State Water from the intake structure to the desalination facility.

This report characterizes the potential for I&E of marine life that may be present in the vicinity of the project area. Such an evaluation requires detailed information on key components, such as salinity, major physical characteristics of the proposed location (e.g., water temperature, depth, substrate composition, tidal currents), general biological diversity, commercial and recreational fisheries, life stage considerations (e.g., reproductive strategies), and presence of state or federal listed species. An additional line of evidence consists of reviewing I&E data reported by other facilities located in Texas in or near the GOM that withdraw surface water for cooling purposes. All of this information is publicly available online.

The goal of this effort is to describe the potential for and extent of I&E that might occur as a result of the proposed diversion of State Water from the project area for use in desalination. That assessment is based on a review of broad environmental conditions, the life histories of target species with sensitive life stages (e.g., presence of ichthyoplankton in the GOM), and a general understanding of the design and operation of the intake structure itself.

1.2 REPORT OUTLINE

The remainder of the report is organized as follows:

- Section 2 describes the major physical characteristics, salinities, and the prevailing hydrology and geomorphology expected in the GOM Offshore of San Jose Island.
- Section 3 describes the intake structure in terms of its location, various design features, and expected function. It also assesses the hydraulic zone of influence of the intake structure's velocity caps, and evaluates that information in a broader biological context.

- Section 4 describes the major biological characteristics of marine life that may be present in the vicinity of the project area. This information includes a list of expected species of zooplankton, other invertebrates, and fish; the presence of threatened and endangered (T&E) species and species of special concern; and 11 targeted species of invertebrates and fish specifically selected for a detailed life history analysis to assess their potential for I&E.
- Section 5 evaluates the potential for I&E by the various groups of species presented in the previous section.
- Section 6 lists the references cited in this report.

2 SOURCE WATER DATA

This section describes the physical characteristics, range of salinities, and hydrological and geomorphological conditions of the coastal waters at or near the project area.

The National Oceanic and Atmospheric Administration (NOAA) collects water-level data from monitoring Station 8775241 located in the GOM at the Aransas Inlet. TCEQ collects salinity and water temperature data from monitoring Station 13468, also located in the GOM at the Aransas Inlet. Additional data were obtained from metocean Buoy D of the Texas Automated Buoy System (TABS) maintained by Texas A&M University in partnership with the Texas General Land Office (TXGLO) (see **Figure 2-1** for the buoy locations). Data from the TABS buoy was sourced through the Gulf Coast Ocean Observing System (GCOOS[7]). Aransas Inlet with the NOAA and TCEQ monitoring stations lies approximately 1.5 miles to the southwest of the project area. The TABS Buoy D is found approximately 12 miles to the northeast of the project area and 6.3 miles Offshore in the GOM. Of note, the depth of the salinity sensor on the TABS buoy is unknown, but is assumed to be located at the same depth as the temperature sensor, which is placed 6.6 ft below the surface. Both the salinity and temperature data collected from the TABS buoy are referred to below as surface salinities and surface temperatures.

2.1 PHYSICAL CONDITIONS AND SALINITIES

The following sections outline the range of physical conditions and salinities observed around the project area based on field-collected data.

2.1.1 Depth

The mean depth at the location of the intake structure is approximately 35 ft. Tides and storm events will cause the ocean surface elevations to vary. Stated tidal datums extend +0.49 ft at mean high water to −0.62 ft at mean low water relative to the North American Vertical Datum of 1988 (NAVD88).[8] The graph on the left in **Figure 2-2** shows the available raw water levels from NOAA monitoring Station 8775241 in the GOM at Aransas Inlet relative to the mean surface level for measurements taken every 6 minutes between 2016 and 2022.[9] The measured water elevations highlight the range of water levels experienced in the vicinity of the project area. These data indicate that water levels tend to be above the mean sea level elevation. This apparent deviation from the norm could be due to localized winds creating a water level set-up. The panel on the right in **Figure 2-2** is a box-and-whisker chart showing the median level;

[7] https://data.gcoos.org/

[8] https://tidesandcurrents.noaa.gov/datums.html?datum=MSL&units=0&epoch=0&id=8775241&name=Aransas%2C+Aransas+Pass&state=TX

[9] https://tidesandcurrents.noaa.gov/stationhome.html?id=8775241

elevations of the 25th and 75th quartile, between which 50% of the data fall; outliers; and minimum and maximum values (shown by the whiskers) that are not considered outliers. The difference between the 75th and 25th quartile is called the interquartile range (IQR). Outliers are defined as either greater than 1.5*IQR+75th percentile or less than 25th percentile-1.5*IQR.

2.1.2 Salinity

TCEQ collected 380 salinity measurements from monitoring Station 13468 in the GOM at the Aransas Inlet at uneven time intervals from 1989 through 2022. TCEQ obtained readings both at the surface and as profiles within the water column, depending on the prevailing conditions at the time of measurement. The reported salinities (individual and profile combined) range from a low of 14 parts per thousand (ppt) in February of 2003 to a high of 42.2 ppt in August of 2001. The mean salinity across depth over the 42-year monitoring period is 30.14 ppt, with a median of 30.75 ppt. The large salinity variations may be attributed to the influence of tidally-driven water exchanges between the Corpus Christi Bay/Aransas Bay system and the nearby GOM via the Aransas Inlet. By itself, this salinity profile may not fully reflect the actual conditions at the project area. **Figure 2-3** summarizes the monthly variations in the surface water salinities in the GOM at the Aransas Inlet between 1989 and 2022.

The TABS Buoy D farther out in the GOM measured surface salinities between 2011 and 2019 at 30-minute intervals, but with intermittent disruptions that produced data gaps of various lengths. Surface salinities ranged from below 20 ppt to above 36 ppt (**Figure 2-4**). Low surface salinities that far out in the GOM could be due to periodic heavy rainfalls that temporarily dilute the prevailing salinity levels near the surface. Regardless, the data show marked seasonal fluctuations, with the highest surface salinities systematically measured during the summer months. **Figure 2-5** presents ranges of monthly surface salinities at TABS Buoy D. The box and whiskers are derived from the data for each month across the 10+ year record. Spurious outliers were removed from the data set during the data quality review process.

The salinity data collected in the GOM both at Aransas Inlet and 6.3 miles from shore bound the project area to the north and the south and indicate that salinities could range from below 20 ppt to above 40 ppt, but with average salinities in the low- to mid-30 ppt.

2.1.3 Temperature

TCEQ obtained 536 water temperature readings intermittently between 1969 and 2022 from the same station in the GOM at the Aransas Inlet as the salinity measurements. **Figure 2-6** summarizes the monthly variations in the surface water temperatures over the monitoring period in the GOM at the Aransas Inlet. Depending on site conditions, these values represent a composite of single-point measurements or vertical profiles throughout the water column. Based on the data set, the water temperatures across all depths ranged from a low of 10.1°C in January 2010 to a high of 31.3°C in August 2007. The mean water temperature equals 22.5°C, with a median temperature of 22.8°C. These large temperature ranges at the Aransas Inlet may not fully reflect the actual conditions around the project area.

TABS Buoy D farther out in the GOM has collected water temperatures at 30-minute intervals since 1995, but with periodic disruptions. The sensor is located about 6.6 ft below the surface. Therefore, for this report, the data are considered to represent water temperatures at the surface. The data show a strong seasonal pattern, with the highest summer temperatures reaching above 30°C (86°F) and the lowest winter temperatures dropping close to or below 10°C (50°F) (**Figures 2-7** and **2-8**). Data are not presented for 2010 and 2011 and were removed along with outliers deemed to be caused by instrument failure or aberrant data patterns identified during the quality control process.

The TCEQ and TABS temperature data sets suggest that the GOM water temperatures experience similar seasonal ranges, with maximum values at both locations exceeding 30°C and minimum values around 10°C.

2.2 HYDROLOGICAL AND GEOMORPHOLOGICAL CONDITIONS IN THE GULF OF MEXICO AROUND THE PROJECT AREA

The prevailing tidal currents and substrate composition are two important variables that can affect the movement of zooplankton through the water column and the presence or absence of certain species of fish or invertebrates that have specific habitat requirements. These two variables are further discussed below.

2.2.1 Hydrology

Researchers from Texas A&M University collected hydrodynamic data from the Bob Hall Pier located in the GOM across from North Padre Island to characterize tidal currents along the coast (Tissott et al. 2015). These researchers deployed acoustic doppler current profilers to capture a range of velocities extending away from the pier. Johnson (2008) also characterized current patterns within the GOM; however, at the time of this writing, access to the data collected and characterized in those studies was not available to make inferences about the project area.

Hydrodynamic conditions are governed by tides and regional circulation patterns. The project area will be located approximately 1.3 miles from the shore. This proximity to the coast limits the direction that currents can travel in that general area and causes the internal mixing processes to produce relatively uniform properties within the water column. Tidal conditions in the project area are predominantly alongshore following the angle of the coast.

Hydrodynamic current data from the TABS Buoy D, located to the northeast of the project site, were analyzed for this study and indicate predominant directions aligning with the coast northeast (50°) or southwest (217°) (**Figure 2-9**). The TABS Buoy D current data are collected 6.6 ft below the surface and have been reported every 30 minutes over a 27-year period. Velocities ranged in magnitude from 0 m/s during slack tide to greater than 0.8 m/s, and in outlier cases exceed 1 m/s. Median current speeds varied by month (**Figure 2-10**). Median values exceeded the intake velocity in all months but August. **Figure 2-11** shows that current direction also varied by month. The predominant current direction is to the southwest in the winter, transitioning to the northeast in the summer and back to the southwest in the fall. As with the temperature and salinity data, the velocity data went through a quality control process to remove anomalous data prior to analysis.

2.2.2 Geomorphology

The location of the intake structure is approximately 1.3 miles from shore, in an area of the GOM characterized as relatively flat, with gradual bathymetric change as distance from shore increases. Bed sediment is predominantly sand in the vicinity of the project area (**Figure 2-12**). For reference, sand has a nominal grain size of 62.4 to 2,000 microns whereas silts and clays have grain sizes below 62.4 microns. In deeper areas beyond the project area, bed conditions transition to a mixture of sand and finer materials, including silt and clay.

3 STATE WATER INTAKE STRUCTURE

This section describes the intake structure that will be used to divert State Water from the GOM for treatment in the proposed desalination facility on Harbor Island. Even though the final design is not yet available, the performance is expected to be consistent with the following descriptions.

3.1 GENERAL DESCRIPTION

The proposed desalination facility on Harbor Island will require up to 156 mgd of State Water initially, and could be expanded to up to 312 mgd in the future. The intake structure provides entrances for State Water diversion from the GOM. That water is then drawn through an intake tunnel to a pipeline exit well near the Harbor Island desalination facility to serve as feed stock to produce fresh water. As shown in **Figure 1-1**, the project area will be located approximately 1.3 miles from shore, and approximately 1.5 miles to the northeast of the Aransas Inlet jetty. The sea bed at the proposed location is approximately 35 ft deep below mean lower low water, and the intake structure placement will allow for about 20 to 25 ft of water overlying the velocity caps, depending on the final height of the five vertical riser pipes.

EPA considers water intakes placed 410 ft outside of the littoral zone to be a good engineering practice to reduce I&E (USEPA 2000, 2014). The littoral zone extends 600 ft from the shore, resulting in a distance of at least 1,010 ft from the shore available to help reduce environmental impacts (USEPA 2000, 2014; WateReuse Association 2011). Installing intakes to depths that have lower abundance of marine life has also been suggested to decrease environmental impacts associated with intake operations (USEPA 2014; WateReuse Association 2011). The proposed intake structure would be located well beyond 1,010 ft from shore and at depths that will help reduce interaction with marine life.

3.2 OPERATION

Based on available design considerations and calculations, the intake structure is planned to have the following general features.

- Water will be diverted from the GOM via four or five evenly spread, 5-ft-diameter vertical riser pipes (each affixed with a velocity cap), located a minimum of 30 ft apart and organized in a radial arrangement to generate an even flow distribution without interference from each other. All the water will converge via individual 5-ft-diameter suction headers into a common suction manifold (see **Figure 3-1**). From the common manifold, the State Water will flow via a single, large-diameter, 3.1-mile-long intake tunnel to the proposed desalination facility. All the intake piping is planned to be placed underground with only the velocity caps and 5 to 10 ft of vertical riser above the sea bed.

- The water velocity at the point of entrance into the velocity caps will be ≤0.5 ft/s. The water in the intake tunnel will flow at a maximum volume of approximately 242 ft^3/s and an estimated speed of between 2 and 4 ft/s at full capacity. At these velocities, and based on the 3.1-mile length of the intake tunnel, the State Water will take between 1 hour and 8 minutes and 2 hours and 16 minutes to travel from the location of the velocity caps to the pipeline exit well on Harbor Island.
- The entrances of the velocity caps will be placed from 5 to 10 ft above the sea bed to minimize the withdrawal of sediment particles or benthic marine life from below.
- Each vertical riser pipe will be fitted with a velocity cap approximately 16 ft in diameter and 5 ft in height. This structure is designed to minimize the withdrawal of juvenile and adult life stages of marine life present in the water column. A velocity cap is a horizontal cover placed over an intake pipe that redirects vertical flow into a more horizontal flow (USEPA 2011). Juvenile and adult fish have difficulty detecting, and therefore avoiding, vertically oriented currents but readily perceive horizontal flows. Hence, fish can easily swim away from a horizontal current field, thereby reducing the probability of being withdrawn by a water intake. Early life stages (ELS) of free-floating eggs and larvae cannot distinguish flow characteristics and also lack the swimming ability to avoid being withdrawn by the intake. However, a velocity cap minimizes the withdrawal of eggs and larvae that may be present above or below the entrances by changing the flow direction so that water is not pulled vertically. EPA considers that water intakes located away from shore and fitted with velocity caps meet the impingement performance requirements of the Clean Water Act Section 316(b) 2014 Phase II Rule for Existing Facilities, defined as an annual reduction in impingement mortality of 76% or greater (see 40 CFR § 125.94(C)(4)). While not directly applicable to the proposed desalination facility, EPA's regulatory framework for CWIS provides useful guidance for evaluating the potential for I&E at the proposed desalination facility.
- The withdrawal velocity at each velocity cap entrance will be engineered to be ≤0.5 ft/s in order to be consistent with EPA regulatory requirements for I&E for similar facilities in other contexts.[10]
- Three-inch mesh bar screens will be installed at the velocity cap entrances to prevent neritic juvenile sea turtles from entering the intake structure (see Sections 4 and 5 for more details on this subject). These bars will also prevent adult sea turtles and large fish from entering the velocity caps.

[10] https://www.ecfr.gov/current/title-40/chapter-I/subchapter-D/part-125/subpart-J/section-125.94

- Some of the small marine life entering the intake structure may be carried through the intake tunnel to the pipeline exit well that supplies feed State Water to the proposed Harbor Island desalination facility.
- On Harbor Island, all incoming State Water will pass through a system designed to collect marine life and debris before the State Water is processed for desalination. This system may consist of up to four vertical traveling screens containing revolving wire mesh panels with 2- to 6-mm openings. The screens collect and remove marine life and debris as the wire mesh panels rise out of the water. Fish baskets are installed on the screens to humanely capture marine life as they are lifted from the State Water. The screens will be equipped with low-pressure jet sprays to gently discharge marine life to the fish baskets and troughs from where they are sluiced to Aransas Channel. After the marine life is collected, high-pressure jet sprays remove any debris from the screens in a separate follow-up process.

3.3 HYDRAULIC ZONE OF INFLUENCE

3.3.1 Regional Perspective

It is important to place the intake structure, and the potential withdrawal of eggs and larvae by this structure, in a broader context.

Figure 3-2 shows the location of the intake structure in the GOM at 27.850873 N, 97.017401 W in the form of a 100- by 100-ft square, which generically represents the footprint of this intake structure. To provide scale, this figure includes three larger defined areas centered on the project area, with the following dimensions: a) 0.5- by 0.5-mile, b) 1 by 1-mile, and c) 1.5- by 1.5-mile squares. All four squares are rotated 27° from the state plane grid to run parallel to the shoreline.

At any one point in time, the volume of water (and its associated marine life) available to enter the intake structure is the volume of water present within each of the five velocity caps.[11] In other words, only the water present within the five velocity caps is the volume of interest. Each velocity cap represents a cylinder 5 ft high and 16 ft, 5 in. (= 16.42 ft) in diameter, with a radius of 8.21 ft.[12] The volume of a cylinder is calculated using the following formula:

[11] In support of the calculations presented in this section, it is assumed that the intake structure will consist of five velocity caps.
[12] The size of a velocity cap may change slightly because the final design has not yet been completed.

$$V_{cylinder} = \pi * r^2 * h$$

Where:

$\pi = 3.141593$
r = radius (8.21 ft)
h = height (5 ft)

Using this formula, the volume of each velocity cap equals 1,058.7812 ft^3, for a total volume of 5,293.906 ft^3 (rounded to 5,294 ft^3) across the five velocity caps. This calculation represents the volume of water that may contain marine life capable of entering the five intake pipes at any one point in time.

The estimated volume of water associated with the larger squares (referred to here as volumetric boxes 1, 2, and 3 for the 0.5- by 0.5-mile, 1- by 1-mile, and 1.5- by 1.5-mile squares, respectively) around the intake structure was calculated in the ArcGIS software environment using the "Polygon Volume" tool of the 3D Analyst extension. The volumes represent the area enclosed within the plane of the squares, referenced at mean sea level (0.93 ft NAVD88), and the sea bed beneath them, referenced to NOAA's continuously updated digital elevation model bathymetry (accessed in September 2022).[13] These estimated volumes are as follows (see **Table 3-1**): volumetric box 1 = 251,085,200 ft^3, volumetric box 2 = 996,730,233 ft^3, and volumetric box 3 = 2,176,520,647 ft^3.

Based on this information, one can determine how the total static volume of water present in the five velocity caps (i.e., 5,294 ft^3) compares to the volume of water present in volumetric boxes 1, 2, and 3 by dividing the latter into the former. These calculations yield the following ratios (see **Table 3-1**):

- Volume in the velocity caps vs. box 1: 5,294 ft^3 ÷ 251,085,200 ft^3 = 0.000021084
- Volume in the velocity caps vs. box 2: 5,294 ft^3 ÷ 996,730,233 ft^3 = 0.000005311
- Volume in the velocity caps vs. box 3: 5,294 ft^3 ÷ 2,176,520,647 ft^3 = 0.000002432.

These ratios can generically be interpreted as follows: for every one egg or larva that may be present in the velocity caps, the following number of eggs and larvae may be present in the three volumetric boxes (assuming homogeneous distribution of the ichthyoplankton throughout the water column):

- Volumetric box 1: 47,429 eggs or larvae (i.e., 1/0.000021084)

[13] Site-specific bathymetric data are available for the area around the location of the intake structure. However, these data could not be used in the calculations because they did not extend shoreward enough to provide all the required depth readings for the 1- × 1-mile and the 1.5- × 1.5-mile volumetric boxes.

- Volumetric box 2: 188,288 eggs or larvae (i.e., 1/0.000005311)
- Volumetric box 3: 411,184 eggs or larvae (i.e., 1/0.000002432).

In other words, assuming an even distribution of eggs and larvae throughout the water column and strictly based on volumetric proportions, the intake structure would contain 1 egg or larva for every 411,184 eggs or larvae found within volumetric box 3. The conclusion is that the effects of any incidental withdrawal of eggs and larvae by the intake structure will be minor given the vastly larger numbers of ichthyoplankton in the vicinity of the project area.

Measured ichthyoplankton density data are required to put these ratios into a more site-specific context. The ichthyoplankton assessment presented in Appendix U of the Deepwater Port license application for the Bluewater SPM Project (Bluewater Texas Terminals LLC 2021b) uses location-specific ichthyoplankton tow data provided by the NOAA National Marine Fisheries Service's (NMFS) Southeast Area Monitoring and Assessment Program (SEAMAP) to estimate the average number of fish eggs and fish larvae present at Station B233 from June through November. This station, which is represented by a 30- by 30-nautical mile block in the GOM off Port Aransas, includes the proposed location for the intake structure. The summer-fall sampling period broadly corresponds with much spawning activity in this area. Fish egg and larvae catch for each sample were aggregated, and divided by the sample VOL FILT parameter to create the sample catch per cubic meter of water filtered (i.e., catch per unit effort or density). For each taxon, larval densities were estimated as arithmetic means across the 24-year time series (1986 to 2014, excepting years where no sampling occurred at Station B233). A statistical distribution was estimated from which the average, as well as the 2.5 and 97.5 percentiles, were identified as the lower confidence limit and upper confidence limit.

Based on the SEAMAP ichthyoplankton surveys conducted by NMFS between 1986 and 2014, the average density of fish eggs and fish larvae at Station B233 equals 0.1388 eggs/ft^3 and 0.2152 larvae/ft^3, respectively. These numbers compare favorably with values presented by Hernandez et al. (2011) who collected fish eggs and larvae in the GOM approximately 10.6 miles off the coast of Alabama in 66 ft of water between April and August 2005. These authors reported an average fish egg density of 0.0697 eggs/ft^3 and an average fish larvae density of 0.203 larvae/ft^3 (note: both the SEAMAP and the Hernandez et al. 2011 studies used 0.333-mm mesh size).

To quantitatively illustrate relative densities, it is assumed that the Bluewater Texas Terminals LLC (2021b) values represent the average fish egg and larvae densities that may be present throughout the water column during spawning season in the vicinity of the project area. The amount of water in the intake structure, in which ichthyoplankton have the potential to be withdrawn from the water column via the velocity caps at any point in time, equals 5,294 ft^3. As outlined earlier, the amount of water in volumetric boxes 1, 2, and 3 equals 251,085,200 ft^3, 996,730,233 ft^3, and 2,176,520,647 ft^3, respectively. Using the ichthyoplankton density data presented above (i.e., 0.1388 eggs/ft^3 and 0.2152 larvae/ft^3; Bluewater Texas Terminals LLC 2021b), and assuming even distribution of eggs and larvae throughout the water column, one can estimate the number of ichthyoplankton that may be present in the velocity caps and the three volumetric boxes at a particular point in time.

Table 3-2 summarizes the outcome of the calculations. As an example, at average ichthyoplankton densities between June and November, and assuming an equal distribution throughout the water column in the vicinity of the project area, the number of eggs in volumetric box 3 would equal 302,101,066 (i.e., 0.1388 eggs/ft^3 × 2,176,520,647 ft^3), whereas the number of eggs in the five velocity caps would equal 735 eggs (i.e., 0.1388 eggs/ft^3 × 5,294 ft^3). Hence, the number of eggs in volumetric box 3 will exceed the number of eggs in the five velocity caps by 411,022 to 1 (i.e., 302,101,066 ÷ 735). The same calculations apply for the other volumetric boxes, and for the larvae.

This general approach represents another way to show that withdrawal of ichthyoplankton by the intake structure will be extremely minor compared to the high number of fish eggs and larvae present in the vicinity of the project area that will never encounter this structure. Obviously, the GOM is much larger than the 1.5- by 1.5-mile grid used in this example. Eggs and larvae found within this much larger area move into the Aransas Inlet to support recruitment into the bays.

Of note, this analysis is overly conservative for ichthyoplankton that are not evenly distributed within the water column. For example, eggs of red drum and spotted seatrout are positively buoyant at salinities above >25 ppt (Holt et al. 1981a,b). These eggs are therefore expected to float near the surface of the water column in the higher saline GOM, with little or no interaction with the velocity caps located 20+ ft below the surface.

This simplified analysis also does not consider the fact that not all of the eggs and larvae present in the GOM outside of the Aransas Inlet are expected to move through this inlet and into the estuaries for recruitment (Brown et al. 2000, 2004, 2005). The ichthyoplankton that do not enter the inlet and remain in the GOM are not recruited into their respective populations because they will not survive long term or reach reproductive age. This issue is further addressed in Section 5 of this report.

Consideration of the same general information, but in a more dynamic context, provides an alternative perspective, as outlined below.

The initial volume of State Water flowing through the velocity caps on a daily basis equals 156 mgd (or 20,854,167 ft^3/d). The volume of State Water passing through the CCSC near Harbor Island on a daily basis equals 47,000 mgd (or 6,283,007,000 ft^3/d).[14] The 47,000 mgd represents

[14] See Dr. Craig Jones' testimony filed with the State Office of Administrative Hearings on January 12, 2022 (pertaining to the TPDES effluent permit for the proposed desalination facility on Harbor Island), at p. 10 (" ...the average measured tidal flow from the [CCSC] transects is 47,000 million gallons per day" near Harbor Island).

60% of the total volume of water passing through the Aransas Inlet on a daily basis,[15] which equals 78,333 mgd (or 10,471,633,770 ft^3/d).

The volumetric ratio of the daily flow of water through the velocity caps vs. the daily flow of water passing through the Aransas Inlet is calculated as follows:

$$20{,}854{,}167 \text{ ft}^3/\text{d} \div 10{,}471{,}633{,}770 \text{ ft}^3/\text{d} = 0.00199149$$

This ratio can generically be interpreted as follows: on average, for every gallon of water that passes through the intake structure, 502 gallons of water (i.e., 1/0.00199149) will pass through the Aransas Inlet, which represents the recruitment corridor linking the GOM to the seagrass beds in the shallow bays. That ratio represents 0.2% of water that moves through the intake structure compared to the volume passing thru the Aransas Inlet.

3.3.2 Additional Considerations

The hydraulic zone of influence is a loosely defined term, but generally represents an area of the source water body around an intake structure that is directly affected by the water withdrawal or diversion process. Zooplankton, including ichthyoplankton, have minimal swimming abilities and therefore mostly move passively with the prevailing currents. For this marine life, the hydraulic zone of influence represents the area around a water intake with increased likelihood that zooplankton may be withdrawn with the diverted water.

The hydraulic zone of influence for older life stages of invertebrates and fish with stronger swimming capabilities is expected to be substantially smaller than for passively moving life stages. For older non-planktonic life stages, the hydraulic zone of influence represents the point at which an organism will enter the water intake, even if it actively attempts to swim away, because it can no longer overcome the force of the withdrawn water. Even under this general scenario, the hydraulic zone of influence for actively swimming fish and invertebrates will depend on the size/life stage of the marine life (i.e., smaller sizes are less capable swimmers than larger sizes), the species-specific swimming capabilities, and the general health conditions of the marine life.

The intake structure for the proposed Harbor Island desalination facility will be designed such that the velocity at the point of entrance to the velocity caps will be ≤0.5 ft/s, which represents a very slow speed (note 0.5 ft/sec = 0.34 miles per hour). As noted earlier, a facility that reduces its entrance velocity to this speed meets the performance for similar structures in other regulated contexts. Based on earlier studies by Sonnichsen et al. (1973), Christianson et al. (1973), and Boreman (1977), USEPA (2011) reports that 96% of studied fish can avoid an intake structure

[15] See Brown et al. (2000) at p. 24,247 (*approximately 60% of flow entering Aransas Inlet is toward Corpus Christi Bay via CCSC, 30% towards Aransas Bay via Lydia Ann Channel, and 10% towards Redfish Bay via Aransas Channel*); see also Brown et al. (2005) at p. 38 (*division of flow is 60% to CCSC, 30% to Lydia Ann Channel, and 10% to Aransas Channel*).

when the entrance velocity is ≤0.5 ft/s. In addition, USEPA (2014) reports that the impingement mortality is reduced by 96% when the entrance velocity is ≤0.5 ft/s.

The 0.5 ft/s velocity contour (if detectable) represents the outer boundary of the hydraulic zone of influence (EPRI 2007) and would be confined to the edge of the velocity cap. EPRI (2007) also reports that 0.5 ft/s velocity contours generally could not be measured in the field. This suggests that healthy, free-swimming fish may either swim past the intake structure or enter it before sensing the current and turning around. EPRI (2007) concluded that the hydraulic zone of influence concept may have limited biological relevance and that swimming capabilities and health condition of the species, as well as life stage, influence the potential for I&E more than this somewhat amorphous concept.

4 SOURCE WATER BIOLOGICAL CHARACTERIZATION

The following key steps need to be considered to assess the potential for the intake structure to withdraw marine life: a) identify the species of fish, invertebrates, reptiles, and mammals known to be present in the project area; b) select species that should be the focus for further evaluation because they are abundant, have high commercial and/or recreational value, are listed by Texas or the federal government, and/or are considered particularly sensitive to I&E; and c) describe the general life histories of selected target species to identify life stages that may have a higher potential for I&E. These issues are further discussed below.

This section of the report is organized as follows:

- Section 4.1 identifies the species present in the vicinity of the project area in the GOM based on trawl and plankton surveys, occurrence of listed species in the area, benthic survey data, and published data on the presence of phytoplankton and zooplankton.
- Section 4.2 describes the occurrence of highly migratory species (HMS) and managed fish species (MFS) in the vicinity of the project area that are specifically managed by NOAA.
- Section 4.3 describes the process used to select a small subset of target species potentially susceptible to I&E. The criteria used to identify such species consist of T&E species with the potential to be present in the vicinity of the project area, "fragile species" identified in 316(b) regulations as having a low likelihood to survive any form of impingement, species that are abundant in Texas GOM waters, species reported to be frequently impinged at cooling water intake structures elsewhere in coastal Texas, and species of commercial or recreational importance. This section also pays special attention to the five listed sea turtle species.
- Section 4.4 summarizes the life histories of the target species of fish and invertebrate species in terms of reproduction, larval recruitment, and period of peak abundance.
- Section 4.5 documents the correspondence with state and federal agencies in support of this report.

4.1 SPECIES PRESENCE IN THE VICINITY OF THE PROJECT AREA

The following sources were reviewed to prepare a list of marine species that may occur in the vicinity of the project area:

- Bottom trawl survey data collected from the Gulf States Marine Fisheries Commission via NOAA[16]
- Location-specific ichthyoplankton survey data subsets obtained from SEAMAP for Station B233 in the GOM and provided by NMFS in November 2022
- Fisheries survey data provided by the Texas Parks and Wildlife Department (TPWD)[17]
- State and federally threatened, potentially threatened, and endangered species known to occur in the vicinity of the project area
- Benthic species data presented in Appendix L (Benthic Survey Report) of the Deepwater Port License Application for the Bluewater Texas Terminal Project (Bluewater Texas Terminals LLC 2021a)
- Phytoplankton and zooplankton species from Holland et al. (1973, 1974) known to occur in nearby marine and coastal areas.

This analysis yielded 606 species of plankton, invertebrates, and vertebrates (**Appendix A**). This list provides a robust enumeration of marine life identified in the GOM Offshore of San Jose Island.

4.2 SPECIALLY MANAGED FISH SPECIES

This section describes the HMS and MFS managed by NOAA, and the associated fisheries management plans and essential fish habitats (EFHs), in order to determine which of these species may occur in the vicinity of the project area.

The 1976 Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (NOAA 2007) regulates marine fisheries management in U.S. federal waters**.** The MSFCMA requires federal agencies to consult with the Secretary of Commerce, through NOAA, with respect to "any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any essential fish habitat identified under this Act."[18] Each fishery management plan must identify and describe EFHs required by the managed fishery. The MSFCMA defines EFH as "those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity."[19] NOAA's regulations further define this term by specifying that "necessary" means "the habitat required to support a sustainable fishery and the managed species contribution to a healthy ecosystem."[20]

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[16] NOAA Fisheries. 2022. DisMAP data records. Retrieved from apps-st.fisheries.noaa.gov/dismap/DisMAP.html. Accessed August 2022.
[17] TPWD, Coastal Fisheries Division, Correspondence dated August 30, 2022
[18] 16 U.S.C. § 1855(2)
[19] 16 U.S.C. § 1853(a)(7) and § 1802(10)
[20] 50 C.F.R. § 600.10

The Gulf of Mexico Fishery Management Council (GMFMC) is one of eight regional councils established by the MSFCMA and managed by NOAA. The GMFMC has developed fisheries management plans (GMFMC 2016) for the following categories of species of interest: Coastal Migratory Pelagics; Red Drum; Reef Fish; Shrimp; Spiny Lobster; and Corals. The coastal waters in the GOM Offshore of San Jose Island also fall under the Atlantic HMS fisheries management plan administered by NOAA. Atlantic HMS include tunas, swordfishes, sharks, and billfishes. Management of HMS is outlined in the 2006 Consolidated Atlantic HMS Fishery Management Plan and its amendments (NMFS 2017).

Both the GMFMC and NMFS manage fisheries within the federal waters in the vicinity of the project area. TPWD is responsible for managing the marine recreational and commercial fishing in Texas state waters, located within 9 nautical miles [~10 statute-miles] of the coastline. However, because EFH is defined as those waters and substrates needed by fish to spawn, breed, feed, or grow to maturity, the management of federal fish species can extend into state waters. In the estuarine component, EFH encompasses all estuarine waters and substrates (mud, sand, shell, rock, and associated biological communities), including the sub-tidal vegetation (seagrasses and algae) and nearby inter-tidal vegetation (marshes and mangroves). In marine waters, EFH encompasses all marine waters and substrates (mud, sand, shell, rock, hard bottom, and associated biological communities) from the shoreline to the seaward limit of the exclusive economic zone.[21]

Figure 4-1 shows the EFHs in the GOM Offshore of San Jose Island published by NMFS. An apparent inconsistency exists between NMFS and GMFMC in the EFH designation for the red drum: the data layer for the red drum EFH obtained from NMFS only identifies estuarine habitat as EFH for this species, but not the nearby GOM, whereas the GMFMC fisheries management plan states that three life stages of the red drum (specifically, early juveniles, late juveniles, and adults) occur in the nearshore habitats of the GOM (GMFMC 2016; **Table 4-1**). This discrepancy has no impact on the current evaluation because the intake structure will be located in the GOM, and it is assumed that the project area represents EFH for the red drum.

EFH for spiny lobster and corals is absent in the GOM Offshore of San Jose Island and is therefore not considered further in this report.

In the GOM, virtually all marine waters and substrates (mud, sand, shell, rock) and their associated biological communities from the shoreline to the seaward limit of the exclusive economic zone are recognized as EFH. Therefore, the water and substrate in the project area fall under the purview of several federal fisheries management plans.

Managed species are included under the following fisheries management plans:

[21] https://gulfcouncil.org/wp-content/uploads/EFH-5-Year-Revew-plus-App-A-and-B_Final_12-2016.pdf

- Shrimp Fishery of the GOM, U.S. Waters
- Red Drum Fishery of the GOM
- Reef Fish of the GOM
- Coastal Migratory Pelagic Resources in the GOM and South Atlantic
- Atlantic HMS.

The above fisheries management plans, as well as GMFMC's and NMFS' online EFH mappers[22,23] were reviewed to determine which species may occur in the vicinity of the project area. The vicinity of the project area falls within GMFMC Ecoregion 5 in nearshore habitat. Ecoregion 5 encompasses the area from Freeport, Texas, to the U.S./Mexico border. It is understood that this area covers a substantially larger region than the space in the vicinity of the project area. GMFMC defines nearshore habitat as marine waters less than 59.1 ft deep. Excluded from further consideration were any life stage of species that did not occur in less than 35 ft of water, if specific depth intervals were defined for a species' life stage.

EFH for all the above fisheries management plans, except for HMS, is classified in terms of five life stages, namely eggs, larvae, juveniles, adults, and spawning adults. EFH for HMS is classified in terms of three life stage categories, namely spawning adults, eggs, and larvae; juveniles and subadults; and adults.

Tables 4-1 and 4-2 summarize the managed species (MFS and HMS, respectively), and their specific life stages, that may occur in the vicinity of the project area. GMFMC (2016) and NMFS (2017) provide the full life history information for all federally managed species in the GOM. In summary, it was determined that 17 species of MFS and 10 species of HMS may be present in the vicinity of the project area.

Eleven of the 17 MFS included in **Table 4-1** have sensitive life stages (i.e., eggs and larvae). Seven of the 10 HMS included in **Table 4-2** give birth to neonates ("pups"). These characteristics are further evaluated in Section 5 in terms of potential for I&E.

4.3 SELECTING TARGET SPECIES POTENTIALLY SUSCEPTIBLE TO I&E

Over 600 marine and estuarine species live in the GOM Offshore of San Jose Island (**Appendix A**). It would be unwieldy and inefficient to assess the potential for I&E for all of these species. Instead, a smaller subset of target species was identified to better focus the evaluation. The general criteria for selecting these target species, using EPA 316(b) CWIS regulations as general guidance, are as follows:

[22] https://portal.gulfcouncil.org/EFHreview.html Accessed September 7, 2022
[23] https://www.habitat.noaa.gov/apps/efhmapper/?page=page_1 Accessed September 7, 2022

- T&E species with potential to be present in the vicinity of the project area
- Fragile species known to be present in Texas GOM waters[24]
- Species that are abundant in Texas GOM waters
- Species reported to frequently impinge at cooling water intake structures in Texas
- Species that are commercially and/or recreationally important in Texas GOM waters.

This section presents the approach used to identify the target species that may have a potential for I&E.

4.3.1 T&E Species

Species of conservation concern may be listed as T&E under the U.S. Endangered Species Act (ESA) and/or under the authority of state law. Additionally, the Marine Mammal Protection Act of 1972 protects all cetaceans (whales, porpoise, and dolphins) and pinnipeds (seals and sea lions, but excluding walruses). The species of conservation concern that are protected by these regulatory programs were evaluated to determine which may occur in the vicinity of the project area and which may have a potential for I&E.

Texas state regulations are enforced by TPWD under Sections 65.171–65.177 (Threatened and Endangered Nongame Species) of Title 31 of the Texas Administrative Code (TAC) for animal species, and under Sections 69.01–69.09 (Endangered, Threatened, and Protected Native Plants) of Title 31 of the TAC for protected plant species. Under the TAC, TPWD prohibits the take, possession, transportation, or sale of any state-protected species listed as T&E without a permit. The ESA protects species that are T&E throughout all or a significant portion of their range. The ESA also requires the federal government to designate "critical habitat" for listed species. Critical habitat consists of the geographic areas containing the physical or biological features essential to conserve the listed species and therefore may need special management or protection. Critical habitat may also include areas that are not occupied by the species at the time of listing but are considered essential to its protection.

The following steps were taken to determine which T&E species or designated critical habitat may occur in the vicinity of the project area in the GOM:

- Compile all species listed in 31 TAC §65.175–65.176 for animal species, and in 31 TAC §69.8 for plant species.
- Perform a search using the Information for Planning and Consultation (IPAC) website[25] to compile a list of species and critical habitats known or expected to be present in the vicinity of the project area. The area was entered as a polygon of approximately

[24] See Section 4.3.2 in this report for additional details about "fragile species."
[25] https://ipac.ecosphere.fws.gov/

130 square miles centered around the Aransas Inlet, which ran 13 miles along the shore of the barrier beaches to 10 miles Offshore. This large area ensured that the search would identify all of the listed turtle and mammal species, all of which have extensive home ranges, that might be present in this portion of the GOM.

- Compile all species listed as protected by the Southeast Region Office of NOAA. This office maintains lists of protected corals, sea turtles, whales, dolphins and porpoises, fish, shark, and rays that may occur in the southeastern United States. The Southeast Region covers the area from Texas to North Carolina.
- Review each species for its potential to occur in the vicinity of the project area, which was defined as marine habitat occurring across from San Jose Island approximately 1.5 miles to the east from the Aransas Inlet jetty, at a depth of approximately 35 ft and with substrate consisting entirely of sand. This approach eliminated all birds and freshwater fish, as well as all terrestrial species of plants, reptiles, amphibians, and mammals.
- The remaining species of marine and estuarine fish, marine mammals, marine turtles, wetland plants, corals, and critical habitats were each individually assessed to determine if their published habitat characteristics and ranges included the vicinity of the project area. Additionally, the historical trawl data and species occurrence data provided by TPWD were reviewed to determine if a listed species has been observed in the vicinity of the project area.

Table 4-3 identifies the T&E species. This list contains 7 fish species, 16 mammal species, and 5 turtle species, which are further discussed below. **Figure 4-2** shows the locations of reported sightings of T&E species in the area Offshore of San Jose Island.

4.3.1.1 Listed Fish Species

Four of the listed fish species do not occur in the vicinity of the project area. Both the large-tooth sawfish and small-tooth sawfish were historically present, but are now considered extirpated from the region. The Nassau grouper is not known to occur in the region. The current range of the gulf sturgeon does not include the vicinity of the project area. By their absence, these four fish species would not experience I&E and are therefore removed from further consideration.

The oceanic whitetip shark, shortfin mako shark, and the giant ray have populations that may occur in or near the vicinity of the project area. These three species are all viviparous, giving birth to fully-formed pups. These characteristics are further evaluated in Section 5 in terms of potential for I&E.

4.3.1.2 Listed Sea Turtle Species

A generalized life history of sea turtles involves the following stages:

- The life cycle starts with egg laying on coastal nesting beaches. Hatchlings emerge from their nest, crawl towards the water, and quickly swim away from the coast to reach oceanic areas (typically depths greater than 650 ft).
- Post-hatchlings to juveniles remain for several years in the oceanic habitat typically associated with Sargassum (algae mats in open ocean) habitats.
- After growing to a larger body size, several species of sea turtles (Kemp's Ridley, green, hawksbill, and loggerhead; but not leatherback) recruit to shallower habitats throughout the continental shelf (neritic).
- Once the adults reach sexual maturity (the timing of which varies among species), they perform breeding migrations that can be across oceanic habitats to find mates, and often return to the nesting areas where they were born.

The Kemp's Ridley, green, hawksbill, and loggerhead turtles (i.e., all species except for the leatherback) experience an ontological shift, with a distinct post-natal oceanic phase, followed by recruitment as juveniles back over the continental shelf. The leatherback lives in the general pelagic habitat (both neritic and oceanic) and does not experience a distinct ontological shift.

Four of the five T&E sea turtle species that have the potential to occur in the GOM Offshore of San Jose Island (i.e., loggerhead, green, hawksbill, and Kemp's Ridley) have been observed in that area (**Figure 4-2**). **Table 4-4** provides detailed life history information on the five listed sea turtle species. This information is summarized below:

- **Loggerhead sea turtle (*Caretta caretta*)**
  These turtles live in the GOM and are known visitors to the Texas coast. Juveniles and young adults spend their lives in the open ocean before migrating onshore to breed and nest. Some nesting occurs in Texas between April and September, preferably on coarse-grained, narrow, and deeply-sloping sand beaches. Hatchlings depend on floating algae/seaweed for protection and foraging, which eventually transports them into the open ocean (TPWD 2022).[26] Foraging areas for neritic juveniles and adults include shallow continental shelf waters. Nesting in the GOM occurs from Florida to Texas. In Texas, occurrences have been documented at the Padre Island National Seashore (PINS),[27] located south of the project area. Hatchlings of this species may be briefly present in the vicinity of the project area when they enter the water after emerging from their nests and while migrating to oceanic waters away from shore. In addition, neritic juveniles and adults may be present nearshore for longer periods of time.

[26] https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/nongame/listed-species/
[27] National Park Service. 2022. Loggerhead Sea Turtle (*Caretta caretta*) species page. Retrieved from https://www.nps.gov/pais/learn/nature/loggerhead.htm. Accessed September 8, 2022.

- **Green sea turtle (*Chelonia mydas*)**
  The green sea turtle occurs in the GOM. Adults and juveniles occupy inshore and nearshore areas, including bays and lagoons with reefs and seagrass. Green sea turtles are largely herbivorous, consuming seagrasses and algae. The Texas Natural Diversity Database (TXNDD) reported several occurrences within 5 miles of the project area in 2004 and 2008 (TXNDD 2019). Nesting in the GOM occurs from June through September. In 2022, green turtle nests were observed on Mustang Island (approximately 8 miles south of Port Aransas, Texas; 1 nest), North Padre Island north of PINS (8 nests) and PINS (20–25 miles south of Port Aransas; 20 nests) in Texas.[28] It is therefore possible that hatchlings of this species may be briefly present in the vicinity of the project area when they enter the water after emerging from their nests and quickly migrate out to open water away from shore areas. In addition, neritic juveniles and adults may be present in the vicinity of the project area for longer periods of time.

- **Kemp's Ridley sea turtle *(Lepidochelys kempii*)**
  The Kemp's Ridley sea turtle is the smallest and most critically-endangered sea turtle species. In Texas, they occur in nearshore GOM waters, as well as bays and passes, where they feed mostly on crabs, and occasionally fish, sea jellies, and mollusks.[29] Currently, nesting occurs on GOM beaches from Bolivar Peninsula, Texas, to Vera Cruz, Mexico. Ninety-five percent of worldwide nesting occurs in Tamaulipas, Mexico. Each year, a few nests are found in other U.S. states. In the U.S., PINS represents primary nesting grounds for this species, with nesting occurring from April through August. In 2022, 8 nests were reported on San Jose Island (northwest of the project area), 14 nests on Mustang Island, 16 nests on North Padre Island (just south of Mustang Island), and 132 nests at PINS.[30] It is therefore possible that hatchlings from this species may be briefly present in the vicinity of the project area when they enter the water after emerging from their nests and quickly migrate to open oceanic waters away from nearshore areas. In addition, neritic juveniles, as small as 20 cm (7.8 in.) and as young as 1 to 2 years old, may be present in the vicinity of the project area and remain in the neritic habitat until they reach maturity.

- **Hawksbill sea turtle (*Eretmochelys imbricata*)**
  This species is found in the GOM, including Texas. Following the oceanic juvenile life stage, juveniles then migrate to shallower, coastal areas, mainly coral reefs and rocky areas, and also in bays and estuaries near mangroves when reefs are absent, but seldom in water deeper than 65 ft. They feed on sponges, jellyfish, sea urchins, mollusks, and crustaceans. Nesting occurs from April to November high up on the beach where

[28] National Park Service. 2022. Green Sea Turtle (*Chelonia mydas*) species page. Retrieved from https://www.nps.gov/pais/learn/nature/green.htm. Accessed September 8, 2022.
[29] National Park Service. 2022. Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) species page. Retrieved from https://www.nps.gov/pais/learn/nature/kridley.htm. Accessed September 8, 2022.
[30] https://www.nps.gov/pais/learn/nature/current-nesting-season.htm. Accessed September 9, 2022.

vegetation is available for cover. According to TXNDD, the last recorded observation near Port Aransas occurred in 1958 (TXNDD 2019). However, the National Park Service reports that juveniles occur in the nearshore waters of GOM and the waters near the Aransas Inlet jetty.[31] Post-hatchlings (approximately 7.6 cm [3 in.] long) have been found alive washed ashore in Sargassum seaweed, and juveniles (approximately 30.5 cm [12 in.] long) have been found alive washed ashore and entangled in mesh sacs.[31] Only one hawksbill nest has been documented in Texas, specifically at PINS.[31] It appears unlikely that hatchlings from this species would be present in the vicinity of the project area. However, neritic juveniles and adults may be present in the vicinity of the project area for longer periods of time.

- **Leatherback sea turtle (*Dermochelys coriacea*)**
  This species is found in the GOM. It is the most pelagic of the sea turtle species and performs the longest migrations. It is an omnivore that prefers feeding on jellyfish. The leatherback is usually found in the deeper, open ocean rather than closer to shore. This highly mobile turtle is unlikely to be present in the vicinity of the project area even though the area contains habitat that may be used by this species. TXNDD has not recorded the presence of leatherbacks in the GOM Offshore of San Jose Island (TXNDD 2019). Nesting is not common in Texas; however, a leatherback nest was reported in 2008 at PINS.[32]

The possible presence of recently emerged sea turtle hatchlings, juveniles, and adults in the project area is further evaluated in Section 5 in terms of potential for I&E.

4.3.1.3 Listed Marine Mammal Species

Several of the 16 species of T&E marine mammals are not known to occur in the vicinity of the project area. Also, all of these species have large body sizes and give birth to live offspring with strong swimming abilities. Covering the openings of the velocity caps with 3-in. mesh bar screens to prevent entrance by neritic juvenile sea turtles will also preclude any possibility of entrance by marine mammals. Hence, no further evaluation of these species is needed because marine mammals are not expected to be affected by I&E.

4.3.2 Fragile Species

"Fragile species" is a term that EPA defines as follows in 40 CFR 125.92(m)[33]:

[31] National Park Service. 2022. Hawksbill Sea Turtle (*Eretmochelys imbricata*) species page. Retrieved from https://www.nps.gov/pais/learn/nature/hawksbill.htm, Accessed September 9, 2022.
[32] https://www.nps.gov/pais/learn/nature/leatherback.htm
[33] https://www.ecfr.gov/current/title-40/chapter-I/subchapter-D/part-125

> **Fragile species** means those species of fish and shellfish that are least likely to survive any form of impingement. For purposes of this subpart, fragile species are defined as those with an impingement survival rate of less than 30 percent, including but not limited to alewife, American shad, Atlantic herring, Atlantic long-finned squid, Atlantic menhaden, bay anchovy, blueback herring, bluefish, butterfish, gizzard shad, grey snapper, hickory shad, menhaden, rainbow smelt, round herring, and silver anchovy.

Not all the fragile species mentioned above are expected to be present in the GOM Offshore of San Jose Island. This report used a combination of published literature on intake structures (Stunz and Montagna 2015) and I&E (WCM Group Inc. 2020; GBNEP 1993; Shepherd et al. 2016) in coastal Texas to identify the subset of fragile species expected to occur in the vicinity of the project area. The following four species fit this criterion:

- Bay anchovy
- Bluefish
- Gizzard shad
- Gulf menhaden.

Review of the life history information of these four species identified the gizzard shad as primarily a freshwater/brackish species that would be unlikely to occur in the vicinity of the project area out in the GOM. This species was therefore removed from further evaluation.

The three remaining fragile species were retained as target species.

4.3.3 Abundant, Frequently Impinged, and Commercially and/or Recreationally Important Species

The following sources were used to identify a subset of species to evaluate regarding potential to interact with the intake structure:

- The NOAA and TPWD trawl surveys
- Species identified as "potentially impacted" by intake structures in coastal Texas (Stunz and Montagna 2015)
- Species considered in the permit renewal for the Nueces Bay Power Station in Corpus Christi (WCM Group Inc. 2020)
- "Species comprising 1% or more of the total impinged during each study" of coastal Texas power plant intake structures, species frequently impinged, and species considered commercially and recreationally important (GBNEP 1993)

- Species impinged at the Barney M. Davis Power Plant in Corpus Christi (Shepherd et al. 2016)
- Species of commercial and recreational importance in the GOM as identified by the NMFS (2012)
- The three "fragile" species identified in Section 4.3.2 above.

Abundant species from the trawl surveys were determined using data from NOAA (weight catch per unit effort) and TPWD (sum catch per hour) to identify the species that are more likely to be present. The resulting list from the NOAA surveys consisted of 40 invertebrate and 70 vertebrate species (**Appendix B, Table B-1**), and the list from the TPWD surveys consisted of 121 invertebrate and 163 vertebrate species (**Appendix B, Table B-2**). These numbers were further condensed by selecting the 15[34] most-abundant species of invertebrates and vertebrates identified in the NOAA and TPWD surveys, respectively, which yielded the following results:

- **Table 4-5** shows that the 15 most-abundant invertebrate species from the NOAA surveys consist of 2 cnidarian species, 8 decapod species (4 crab and 4 shrimp), 2 echinoderm species, and 3 squid species. The 15 most-abundant vertebrate species from the NOAA data consist of 2 elasmobranch species (1 shark and 1 ray), 4 benthopelagic species of ray-finned fish, 5 species of demersal ray-finned fish, and 4 species of pelagic ray-finned fish.
- **Table 4-6** shows that the 15 most-abundant invertebrate species from the TPWD surveys consist of 3 cephalopod species, 3 cnidarian species, 7 decapod species (2 crab and 5 shrimp), and 2 echinoderm species. The 15 most-abundant vertebrate species from the TPWD surveys are all ray-finned fish and consist of 3 benthopelagic species, 10 demersal species, and 2 pelagic species.

These lists were incorporated into the selection of species susceptible to I&E to highlight those species that are abundant in the GOM Offshore of San Jose Island**.**

Table 4-7 presents an initial list of 63 species based on the criteria and sources outlined above. From this initial list, species were selected that fell into the following categories:

- Representative/target species already identified (WCM Group Inc. 2020)
- Species that are locally abundant (**Tables 4-5 and 4-6)** and/or frequently impinged (Galveston Bay NEP 1993)
- Commercially- and recreationally-important species (Galveston Bay NEP 1993; NMFS 2012)
- The three "fragile" species identified in Section 4.3.2 above.

[34] This number is based on professional judgment and simply represents a smaller set of species available to select the final target species.

This reductive process yielded 14 fish species and 6 invertebrate species. These 20 species are shaded in **Table 4-7**.

This interim list of 20 species was used to select the final 6 target fish species[35] (i.e., bay anchovy, bluefish, Gulf menhaden, Atlantic croaker, red drum and spotted seatrout) and 5 target invertebrate species[36] (i.e., blue crab, lesser blue crab/gulf crab, brown shrimp, pink shrimp, and white shrimp). All fragile species, except for gizzard shad, which is not expected in the GOM, were retained as target species. For the remaining species, preference was given to those species falling into more than one of the aforementioned categories and consideration was given to reflect a variety of life histories. Based on the best available information and the authors' best professional judgment, these 11 target species are broadly representative of the large species assemblages that occur in the GOM around the project area.

4.4 REPRODUCTION, LARVAL RECRUITMENT, AND PERIOD OF PEAK ABUNDANCE FOR TARGET SPECIES

The 11 target species may experience I&E depending on the life history traits of each species. The attributes of the different life stages present different methods of interaction that may occur during one or more critical life stages. For example, adults may occur in the vicinity of the project area, but due to their ability to swim at velocities faster than the proposed intake speed (i.e., ≤0.5 ft/s), the potential for I&E would be lower or non-existent. However, other life stages (planktonic or nektonic) may not have the ability to divert away from the velocity caps and may have a higher potential of entering the intake structures.

Table 4-8 summarizes the general life histories of the 11 target species. This information shows that many of the 11 target species selected for further evaluation have one or more sensitive life stages with a potential for I&E. This issue is further discussed in Section 5.

4.5 DOCUMENTATION OF CORRESPONDENCE WITH STATE AND FEDERAL AGENCIES

The Coastal Fisheries Division of the TPWD was contacted via email to obtain species occurrence data for the vicinity of the project area (**Appendix C**). In an email dated August 30, 2022, TPWD provided lists of vertebrate and invertebrate species that were collected using otter trawls from TPWD Major Area 20, which overlaps with the vicinity of the project area. These data are summarized in **Table 4-6**. In an email dated September 14, 2022, TPWD provided a list of sea

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[35] This number represents a manageable set of fish species with various characteristics of interest described earlier in this section.

[36] This number represents a manageable set of invertebrate species with various characteristics of interest described earlier in this section.

turtle occurrences and measured lengths from estuaries, designated as TPWD Major Area 5 (Aransas Bay), Major Area 6 (Corpus Christi Bay), and TPWD Major Area 20 (**Appendix C**).

Ichthyoplankton survey data collected in the GOM around the project area were obtained through direct email with the Southeast Fisheries Science Center of the NMFS. On December 13, 2022, NMFS provided ichthyoplankton trawl data for SEAMAP Station B233, the closest SEAMAP station to the project area. Species present in the ichthyoplankton data set that were absent in the bottom trawl survey data are noted in **Appendix A**, which also describes data use and analysis.

5 EVALUATION OF I&E POTENTIAL

This section evaluates how the physical conditions and salinities that prevail in the vicinity of the project area (Section 2), the general design features of the intake structure (Section 3), and the various species of marine life present in the vicinity of the project area (Section 4) may interact with the velocity caps and result in potential I&E at the proposed desalination facility.

5.1 INTRODUCTION

The main observations about the physical conditions and salinities prevalent in the project area are that it is mostly uniform in terms of bathymetry (approximately 35 ft deep, with minimal variation), has a predictable substrate composition (mostly sand), and the tidal currents are well defined (relatively faster than the intake velocity of ≤0.5 f/sec and typically moving parallel to the shoreline but in opposite directions depending on the seasons). The field-collected salinity and temperature profiles reflect the prevailing conditions in the GOM.

The major observations about the intake structure are that it will be located approximately 1.3 miles in the GOM, will divert 156 mgd (with the ability to expand in the future to 312 mgd) of State Water via four or five velocity caps to ensure an entrance velocity ≤0.5 ft/s and thereby relatively minimize withdrawal of eggs and larvae into the intake tunnel. Another important feature appropriately considered are the traveling fish screens proposed for the intake bay on Harbor Island to help remove marine life that may enter the intake structure from the GOM and be transported to Harbor Island through the intake tunnel.

The major observations about the biology in the GOM across from San Jose Island are that a) some MFS and HMS marine species, along with T&E marine species, may pass in the vicinity of the project area but are not expected to be adversely impacted by the State Water diversion process due to their large size and strong swimming abilities; b) smaller juvenile neritic sea turtles will be prevented from moving into the velocity caps by 3-in. mesh bar screens added at the entrances of these intake structures; and c) multiple species of marine and estuarine fish and invertebrates (including MFS and HMS) may reside and/or spawn in the vicinity of the area during different periods of the year.

The remainder of this section evaluates the sources of information used to determine the potential for I&E of local marine species.

5.2 SPECIFIC POTENTIAL FOR I&E

This section describes the specific potential of I&E for various species groups and life stages that may be present in the vicinity of the project area.

5.2.1 Potential I&E of MFS and HMS

Managed Fish Species

Table 4-1 summarizes the species and life stages of MFS that may be present in the GOM Offshore of San Jose Island. Of note, 4 of the 17 MFS shown in this table (namely, brown shrimp, pink shrimp, white shrimp, and red drum) are also evaluated as part of the 11 target species selected based on other considerations (see **Table 4-7**).

Of the 17 MFS, 8 species may have eggs and 11 species may have larvae in the vicinity of the project area at some time during the year. The velocity caps that define the entrance of the intake structure will minimize the number of juvenile and adult fish that may enter the intake structure because these older life stages are larger and can actively swim away upon sensing any horizontal intake currents. Eggs are passive and larvae have limited swimming capacity. Hence, these younger life stages do not have the ability to actively escape the current moving through the entrance and thus may be withdrawn by the velocity caps. Some plankton can be expected to enter the intake structure, even though the entrance velocity of ≤0.5 ft/s, and the depth of the velocity caps (i.e., 5 to 10 ft above the sea bed in at least 35 ft of water), will minimize this process. Of note, eggs and/or larvae that are positively buoyant (i.e., located close to the surface) or demersal (i.e., located on or close to the sea bed) are not expected to be withdrawn by the velocity caps, and therefore have a limited potential to experience I&E.

Highly Migratory Species

As shown in **Table 4-2**, of the 10 HMS, none are expected to have eggs or larvae in the vicinity of the project area. Although sailfish are an HMS that spawn eggs and form planktonic larvae, available data show that sailfish egg and larvae are not found in the vicinity of the project area. The remaining 9 species listed as HMS in **Table 4-2** are all shark species that have neonates (pups) born viviparously—fully formed swimmers that, unlike larvae, can avoid the intake structure current. Two of the shark species are also not found in the vicinity of the project area. The low entrance velocity of ≤0.5 ft/s at the velocity caps is expected to allow the highly-mobile shark pups, the only early life stage HMS in the vicinity of the project area, to avoid I&E.

In summary, the available information shows that 11 of the 17 MFS may have early life stages in the vicinity of the project area that have a potential to be drawn through the entrance of the velocity caps. Of the 10 HMS that may be present in the vicinity of the project area, only the sailfish spawn eggs and form planktonic larvae, but both of these life stages are not expected to be present in the vicinity of the project area, based on information presented in NMFS (2017). The remaining nine HMS all represent highly migratory shark species that give birth to fully-formed and actively-swimming pups. Two of these shark species are not found in the vicinity of the project area. The potential for shark pups to be captured by the water intakes is estimated to be minimal because they are capable swimmers and their large body size would prevent passage through the 3-in. mesh bar screen and into the intake tunnel.

5.2.2 Potential I&E of T&E Species

Tables 4-3 and 4-4 summarize the T&E species and their life stages that have the potential to be present in the vicinity of the project area. As indicated by **Table 4-3**, some T&E species are not found in the project area.

Listed Fish Species

The seven listed fish species are either not present in the vicinity of the project area or may be present but give birth to fully-formed neonates with strong swimming abilities. Absent species cannot experience I&E. Species with fully-formed neonates do not have a larval life stage that would be susceptible to I&E. The approach velocity of ≤0.5 ft/s at the entrance of the velocity caps is expected to allow all life stages of sharks and rays to swim away. Additionally, the relatively large body size of shark pups would prevent passage through the 3-in. mesh bar screen covering the velocity caps.

The three listed fish species that have the potential to occur in the area (i.e., the giant manta ray, the shortfin mako shark, and the oceanic whitetip shark) were evaluated for their pup sizes:

- At birth, the width (disc width) of a giant manta ray pup ranges from 91 to 182 cm (35.8 to 71.7 in.) (Miller and Klimovich 2017; Rambahiniarison et al. 2018). Neonates of that size cannot enter velocity caps protected by 3-in. mesh bar screens.
- Sharks are typically measured in total length (TL), which runs from the tip of the nose to the end of tail. Measured pup lengths for shortfin mako sharks ranged from 70 to 80 cm TL (27.6 to 31.5 in. TL) (Miller et al. 2022). To estimate the height of the shortfin mako pup, the ratio of TL to height (top of dorsal fin to bottom of belly) was measured from a scaled image published in Duffy and Francis (2001), and then the ratio (19.32 cm [7.6 in.] width to 74.5 cm [29.3 in.] length) used to calculate height estimates from published data of shortfin pup length published in Miller et al. 2022. Using this approach, shortfin mako shark pups could range from 18.0 to 20.6 cm (7.1 to 8.1 in.) in height (dorsal fin to belly). Pups of that size cannot enter velocity caps protected by 3-in. mesh bar screens.
- Oceanic whitetip sharks inhabit oceanic habitat. Measured pup lengths for this species ranged from 55 to 77 cm TL (21.7 to 30.3 in. TL) (Miller et al. 2022). Published measurements of the height or widths of oceanic whitetip shark pups could not be located. Historically, the oceanic whitetip shark grew up to 350 cm TL (137.8 in.); however, measurements from recent specimens of the shark rarely exceed 200 cm TL (78.7 in.) (Lessa et al. 1999; Young et al. 2017). The oceanic whitetip is a pelagic shark species, generally remaining in the open ocean, on the outer continental shelf, or around oceanic

islands in water over 184 m deep, and occurring from the surface to at least 152 m depth (Compagno 1984; Bonfil et al. 2008; Young et al. 2017). The locations of the nursery grounds are not well known but are believed to be in oceanic areas (Young et al. 2017). Growth rates for this species are reported as 25.2 cm per year (9.9 in.) in the first free-living year (Lessa et al. 1999; Young et al. 2017). Based on published pup TLs, growth rates, and habitat preferences, it is unlikely that this species would be present in the vicinity of the project area or would be able to pass through a 3-in. mesh bar screen.

Based on these considerations, the three listed species of manta ray and shark species will not be affected by I&E.

Listed Mammal Species

The 16 listed mammal species (i.e., whales, dolphin, and manatee) are large, powerful swimmers that are either not present in the vicinity of the project area or give birth to large, fully-formed young with strong swimming abilities. The presence of 3-in. mesh bar screens at the entrance of the velocity caps will preclude the entry of listed mammals into the intake structure. Hence, these species will not be affected by I&E.

Listed Sea Turtle Species

All five listed sea turtle species are present in the vicinity of the project area as juveniles and adults, and three of the five listed sea turtle species are known to have nested recently on nearby beaches. The presence of turtle hatchlings in nearshore waters of the GOM is inferred by this recorded nesting activity.

Table 4-4 summarizes the species-specific lengths of the turtle hatchlings, which vary from 3.8 to 9.9 cm (1.5 to 3.8 in.).

A review shows that the marine turtle nesting season can start as early as April and continues through September, with hatching occurring as late as November. The hatchlings usually come out of their nests in early evening, although they have also been documented to emerge at daybreak or during daytime. Nests can contain up to 170 eggs, and 20 to 120 hatchlings can emerge all at once (Witherington 1992, as cited in Lutz and Musick 1997).

The "hatchling frenzy" period starts right after emergence. It represents a period of high activity during which the hatchlings will enter the GOM and quickly swim away from shore. They begin to swim vigorously as soon as their flippers no longer contact the sand or substrate. Diving behavior during the initial swim has been observed, where the hatchlings dive under breaking waves, position in the undertow, and guide themselves seaward (Wyneken et al. 1990; Lohmann et al. 1995; Wang et al. 1998). The hatchlings continue to swim away from shore, resurfacing from the shallow short dives under the shore breakers, and with brief paddling near the surface for air (1 to 5 seconds), alternating with power stroking (2 to 10 seconds) below the surface (Salmon and Wyneken 1987; Witherington 1995). Green sea turtles were observed to power stroke for 10 to 40 minutes to cross a 2,000 ft wide, nearshore reef habitat (Booth 2009). The frenzied green sea turtle hatchlings reached speeds up to 1 mile per hour (1.47 ft/s) (Booth 2009).

The frenzy period is believed to increase survival as hatchlings cross predator-rich nearshore habitat. The continuous and direct swimming can last for 20 to 30 hours (Carr and Ogren 1960; Carr 1962, 1982; Wyneken and Salmon 1992; Witherington 1995). Swimming effort declines as time increases since entering the water (Wyneken 1997; Booth et al. 2004; Burgess et al. 2006). Booth (2009) showed that the green sea turtles put maximum effort into the first few minutes of swimming, and once beyond the nearshore reef habitat and into deeper water, the swimming effort eases. The residual egg yolk supplies enough energy for continuous swimming without feeding for at least 10 days. Following the frenzied phase, post-hatchlings likely become passive migrants in oceanic currents and use the Sargassum community as developmental habitat (Shaver 1991; NMFS et al. 2011).

Listed sea turtle hatchlings have only a minimal potential for interaction with the intake structure. Hatchlings swim directly and continuously towards the pelagic habitat past the continental shelf. They do not linger close to shore. Furthermore, observations of the initial swimming phase show that following their diving behavior from breaking shore waves, sea turtle hatchlings swim near the surface as they head seaward. Therefore, hatchlings will not occur 20 to 25 ft deep approximatively 1.3 miles Offshore.

The juvenile to adult life stages may occur in the vicinity of the project area for longer periods of time. Some juvenile and adult turtles may therefore interact with the entrances of the velocity caps. Recruitment to neritic habitat occurs at the juvenile life stage and is associated with the following straight carapace length (SCL): loggerhead = 41.6 to 79.7 cm (16.4 to 31.4 in.); Kemp's Ridley = 20 to 60 cm (7.9 to 23.6 in.); green turtle = 26.6 to 52 cm (10.5 to 20.5 in.); and hawksbill = 20 to 69 cm (7.9 to 27.2 in.) (**Table 4-4)**. Based on the data presented in **Table 4-4**, the smallest neritic juveniles would measure 7.9 in. (Kemp's Ridley and hawksbill). The foraging grounds for these species include the entire water column and benthic habitats. All juvenile and adult sea turtles are highly mobile and strong swimmers.

Sea turtle uptake is documented at the Port St. Lucie Nuclear Power Plant, located on Hutchinson Island on the east coast of Florida. The information presented below was obtained from NMFS (2016). The plant has operated since 1976, and maintains detailed records of captured sea turtles. Cooling water is obtained via three submerged intake structures: two measuring 12 ft in diameter and one measuring 16 ft in diameter. The intake structures are found in shallow water approximately 1,200 ft from shore, with the tops of the intake structures located about 7 ft below the surface at mean low water. Each intake structure is equipped with a velocity cap that restricts flow to less than 1 ft/s without any bar screens. The intake pipes are buried under the beach. They convey cooling water into an open intake canal approximately 1 mile long. The facility has installed barrier nets (5-, 8-, and 9-in. mesh) at the end of the canal to reduce impingement. This water intake arrangement (e.g., relatively close to shore, shallow), and the surrounding environmental setting, is quite different from the proposed water intake in the GOM for the Harbor Island desalination facility. However, the turtle uptake at the Port St. Lucie Nuclear Power Plant is included in the discussion as a point of reference.

Sea turtles at the Port St. Lucie Nuclear Power Plant enter the intake structure through the intake pipes and become entrapped in the open intake canal. Travel time through the pipes is approximately 5 minutes. This power plant entrapped 16,619 sea turtles between 2001 and 2016. The facility uses observers to capture and release the turtles. All five listed sea turtle species have been found in the intake canal, with loggerheads making up more than half of the total, green sea turtles making up slightly less than half of the total, and Kemp's Ridleys, hawksbills, and leatherbacks combined making up less than 1% of the total. From earlier records (1976 to 1985), the smallest turtle recorded was a 7.8-in. green sea turtle (NRC 1985). Overall, sub-adults were the most abundant age class found in the canal (NRC 1985). Of the 16,619 sea turtles captured, 297 (1.8%) resulted in mortality. The facility did not report a single instance of entrainment of sea turtle hatchlings.

Based on this case study, it is reasonable to deduct that neritic sea turtles as small as 7.9-in. SCL and larger may have a potential to enter unprotected velocity caps at the project area in the GOM, and move into the intake tunnel. Because of the turtles' protected status, and despite the low entrance velocity, the velocity caps will be enclosed by 3-in. mesh bar screens to prevent the entrance of sea turtle juveniles and adults into the intake structure.

An additional way to evaluate the potential for juvenile sea turtles to interact with the velocity caps in the project area is to derive an area use factor (AUF). EPA (USEPA 1997) states that the AUF represents the ratio of an area under investigation to the area used by the animal in terms of its home range, breeding range, or feeding/foraging range. In addition, the smallest area used by each animal should be retained to calculate AUFs in order to remain conservative

In the context of the current evaluation, the five velocity caps represent the area under investigation because this defined space represents the area that has the potential to allow turtles to enter the intake structure.[37]

Calculating a species-specific AUF requires two separate pieces of information: a) the combined surface area of the five velocity caps (in square miles), and b) conservative estimates of the home ranges of the neritic juvenile turtles (also in square miles). A species-specific AUF is then

[37] The calculations presented below are entirely for illustrative purposes only because 3-in. mesh size bar screens will be placed in front of the entrances of the velocity caps to prevent any juvenile or adult turtles from entering the intake structure.

calculated by dividing the combined surface area of the five velocity caps by a conservative estimate of the species-specific home range.

The velocity caps are circular structures with a diameter of 16 ft, 5 in. (see **Figure 3-1**), and therefore a radius of 8 ft, 2.5 in. (98.5 in.). The area of a circle is calculated as $\pi * r^2$, or 3.14 * (98.5 in.)^2, which equals 30,465.065 in.^{2}, or 211.563 ft^2 (1 ft^2 = 144 in.^{2}). The total surface area of the five velocity caps equals 1,057.82 ft^2, which represents 0.000038 mi^2 (1 mi^2 = 27,878,400 ft^2).

Valverde and Holzwart (2017) provide the following home ranges for juvenile neritic sea turtles in the GOM: Kemp's Ridley (1.9 to 11.6 mi^2); loggerhead (35 to 1,652 mi^2); hawksbill (0.008 mi^2 (average nighttime home range) to 0.048 mi^2 (average daytime home range): and green (>7.5 mi^2) (note: the authors do not provide home ranges for the leatherbacks).

These two pieces of information are then used to calculate conservative species-specific AUFs, as follows:

- Kemp's Ridley $AUF_{juvenile}$ = 0.000038 mi^2/1.9 mi^2 = 0.0000200
- Loggerhead $AUF_{juvenile}$ = 0.000038 mi^2/35 mi^2 = 0.000001086
- Hawksbill $AUF_{juvenile}$ = 0.000038 mi^2/0.008 mi^2 = 0.0047500
- Green $AUF_{juvenile}$ = 0.000038 mi^2/7.5 mi^2 = 0.0000051.

These AUFs show that the surface area of the velocity caps represents a tiny fraction of the surface area of the species-specific home ranges. At one extreme, the home range of the hawksbill turtle is 211 times larger than the surface area of the velocity caps (i.e., 1/0.00475). At the other extreme, the home range of the loggerhead turtle is 920,810 times larger than the surface area of the velocity cap (i.e., 1/0.000001086). These AUFs should be considered conservative because they are obtained using the lowest-reported home range for each species. Even so, these values are minute and emphasize the low likelihood that juvenile neritic sea turtles would interact with the velocity caps during their foraging activities in the GOM.

In conclusion, while several T&E marine species are known to be present or have the potential to be present in the vicinity of the project area, most are deemed unlikely to experience I&E due to larger body sizes, viviparity, swimming abilities, and the slow intake velocities of ≤0.5 ft/s at the entrances of the velocity caps. The five sea turtle species require in-depth consideration. The "hatching frenzy" phenomenon, rate of water withdrawal at the velocity cap entrances (≤0.5 ft/s), velocity caps' depth below surface (20+ ft), and the velocity caps' distance from shore (beyond surf) assure that turtle hatchlings emerging from nests on beaches in the surrounding region have minimal potential for I&E. However, sea turtle juveniles and adults that use neritic habitat do have a potential for interacting with the intake structure. The small AUFs of juvenile sea turtles greatly limit any chance of encountering these structures. Furthermore, placing bar screens across the entrances of the velocity caps to exclude juveniles and adults will eliminate the potential for interaction.

5.2.3 Potential I&E of the 11 Target Species

Table 4-7 identified for further evaluation 11 target species of fish and invertebrates of special interest based on their a) local abundance, b) life history characteristics, c) recognition as "fragile" species, d) reported impingement potential at other water intake facilities in the region, and e) recreational and/or commercial value. For each species, the general life history information was obtained for eggs, larvae, juveniles, and adults. The potential for each of these life stages to be withdrawn from the GOM and experience I&E due to the operation of the intake structure was then determined.

Table 5-1 summarizes the outcome of this process. For purpose of this evaluation, the potential for I&E is divided into the following four categories: minimal, low, medium, and high. These groupings are qualitative and assigned based on review of the available information and best professional judgement. The term "minimal" refers to the fact that the potential for passage through the intake structure, followed by I&E, is considered minor to none.

The table is also color coded to help visualize the potential for I&E, as follows: minimal is green, low is yellow, medium is orange, and high is blue.

When reviewing this body of information, it is important to keep in mind that the analysis is not a quantitative prediction of harm, but a qualitative evaluation of the potential for various life stages to be withdrawn by the intake structure in the GOM. Several factors not incorporated in the assessment need to be considered when reviewing this information:

- The evaluation does not predict mortality.
- The 3-in. mesh bar screens will prevent entry into the intake structure by larger life stages of some fish species.
- The traveling screens at the proposed desalination facility will collect and return to Aransas Channel a portion of the marine life withdrawn from the GOM.
- As presented in Section 3.3.2 of this report, any intake of marine life should not be viewed in absolute terms but must be considered within a broader ecological context. Specifically, for every egg or larva potentially withdrawn by the intake structure, vastly larger numbers of eggs and larvae in the surrounding area will not encounter this structure. So, for example, even though the potential for I&E of bay anchovy larvae is estimated to be "high" because they are found throughout the water column, it is only so for the 1 in almost 50,000 larvae within a quarter mile in any direction that potentially come into contact with the intake structure. Hence, when viewed within the context of <u>all</u> of the bay

anchovy larvae present in the vicinity of the project area, the potential for I&E should best be considered minor.

The results of the evaluation are as follows:

- **Atlantic Croaker (*Micropogonias undulatas*)**
  The potential I&E of eggs is estimated as low because they are pelagic and positively buoyant. The potential I&E of larvae is estimated as low because they only spend a short amount of time as plankton before becoming primarily demersal at depths commonly greater than that of the intake structure. The potential I&E of juveniles is estimated as minimal because they seek out shallow habitats in estuaries. The potential I&E of adults is estimated as low because this life stage may be present in nearshore areas of the GOM but adults are expected to swim at speeds substantially higher than the entrance velocity of ≤0.5 ft/s.
- **Bay Anchovy (*Anchoa mitchilli*)**
  The potential I&E of eggs is estimated as medium because they are buoyant until near hatching before they gradually sink into the water column. The potential I&E of larvae is estimated as high because they are found throughout the water column. The potential I&E of juveniles and adults is estimated as low because both are expected to swim at speeds substantially higher than the entrance velocity of ≤0.5 ft/s.
- **Bluefish (*Pomatomus saltatrix*)**
  The potential I&E of eggs is estimated as low because spawning occurs Offshore over the continental shelf. The potential I&E of larvae is estimated as high because larvae are pelagic and planktonic, and are dispersed throughout the water column when they move inshore. The potential I&E of juveniles and adults is estimated as low because both are expected to swim at speeds substantially higher than the entrance velocity of ≤0.5 ft/s.
- **Gulf Menhaden (*Brevoortia patronus*)**
  The potential I&E of eggs is estimated as high because they are planktonic and pelagic. The potential I&E of larvae is estimated as medium because they are planktonic (with diurnal vertical movements) but are more commonly found in Offshore environments before moving close to shore to enter the estuaries. The potential I&E of juveniles is estimated as minimal because they are predominantly found in estuarine environments and therefore are not in the vicinity of the intake structure. The potential I&E of adults is estimated as low because they are expected to swim at speeds substantially higher than the entrance velocity of ≤0.5 ft/s.
- **Red Drum (*Sciaenops ocellatus*)**
  The potential I&E of eggs is estimated as low because they are pelagic and positively buoyant, which will tend to keep them higher up in the water column than the depth of the intake structure. The potential I&E of larvae is estimated as high because they are

planktonic and dispersed throughout the water column. The potential I&E of juveniles is estimated as minimal because they seek out shallow estuarine habitats and are therefore not expected to be present in the vicinity of the intake structure. The potential I&E of adults is estimated as low because they are expected to swim at speeds substantially higher than the entrance velocity of ≤0.5 ft/s.

- **Spotted Seatrout (*Cynoscion nebulosus*)**
  The potential I&E of eggs is estimated as low because spawning occurs mainly in coastal bays, estuaries, and lagoons, but also close to shore in the GOM. Eggs are positively buoyant at salinities >25 ppt and are therefore expected to remain near the surface. The potential I&E of larvae is estimated as medium because they are planktonic for a short duration before settling to the sea bed. The potential I&E of juveniles is estimated as minimal because juveniles seek out shallow habitat ≤7.2 ft and are therefore not anticipated to be in the vicinity of the intake structure. The potential I&E of adults is estimated as low because they are demersal and are expected to swim at speeds substantially higher than the entrance velocity of ≤0.5 ft/s at the water intakes.

- **Blue Crab (*Callinectes sapidus*)**
  The potential I&E of eggs is estimated as minimal because the gravid females are external brooders, and the eggs attach to females' pleopods and are held against their abdomens until hatching. The potential I&E of larvae is estimated as high because the larval stages are planktonic forms that disperse throughout the water column. The potential I&E of juveniles is estimated as minimal because they are demersal and seek out estuarine habitats and are unlikely to occur in the vicinity of the intake structure. The potential I&E of adults is estimated as low because they are demersal and unlikely to spend much time in the upper water column.

- **Gulf Crab (*Callinectes similis*)**
  The potential I&E of eggs is estimated as minimal because the gravid females are external brooders, and the eggs are attached to the females' pleopods and are held against their abdomens until hatching. The potential I&E of larvae is estimated as high because all larval stages are planktonic forms that disperse throughout the water column. The potential I&E of juveniles is estimated as minimal because they are demersal, seek out estuarine habitats, and are therefore unlikely to occur in the vicinity of the intake structure, except as older juveniles. The potential I&E of adults is estimated as low because they are benthopelagic and unlikely to spend much time in the upper water column.

- **Brown Shrimp (*Penaeus aztecus*)**
  The potential I&E of eggs is estimated as minimal because they are demersal and found at depths greater than the proposed location of the intake structure. The potential I&E of larvae is estimated as high because they are planktonic and follow diurnal migrations throughout the water column. The potential I&E of juveniles is estimated as low because they reside in estuarine habitats with only some older juveniles migrating into the

nearshore GOM. The potential I&E of adults is estimated as low because they are demersal, are capable of swimming at speeds higher than the entrance velocity, and prefer areas deeper than 35 ft.

- **Pink Shrimp (*Penaeus duorarum*)**
  The potential I&E of eggs is estimated as low because they are demersal and are released at depths equivalent to or greater than the proposed location of the intake structure. The potential I&E of larvae is estimated as high because they are planktonic and found dispersed throughout the water column. The potential I&E of juveniles is estimated as low because juveniles are commonly found in estuaries over seagrass at depths <9.8 ft but subadults occur at depths ranging from 3.3 to 213 ft. The potential I&E of adults is estimated as low because they are demersal and are capable of swim speeds above the entrance velocity of ≤0.5 ft/s.

- **White Shrimp (*Penaeus setiferus*)**
  The potential I&E of eggs is estimated as low because they are demersal and found at depths equal to or greater than the proposed location of the intake structure. The potential I&E of larvae is estimated as high because they are planktonic and dispersed throughout the water column. The potential I&E of juveniles and subadults is estimated as low because they are demersal and found over soft-bottom habitats in estuaries. Older juveniles migrate out into the GOM to mature. The potential I&E of adults is estimated as low because they are demersal and are capable of swim speeds above the entrance velocity of ≤0.5 ft/s.

The available information suggests that eggs and larvae are the life stages with the highest potential for I&E. This finding is not surprising considering that eggs are unable to swim independently, and larvae only have limited swimming capabilities, particularly in the planktonic stage. Even though the entrance velocity of the velocity caps will be engineered to withdraw water at ≤0.5 ft/s, some eggs and larvae present in the water column that passively enter the intake structure can be expected to be drawn in.

It is important to note that the potential for I&E is species- and life-stage specific. For example, blue crab eggs are not expected to be withdrawn by the velocity caps because females carry their eggs until hatching. As a result, blue crab eggs have a minimal potential for withdrawal. Red drum post-larvae are carried by tidal currents out of the GOM, through the Aransas Inlet, and into the extensive estuarine seagrass beds beyond. Therefore, juvenile red drum are not expected to be present in the GOM approximately 1.3 miles Offshore and have a minimal potential for I&E. Other species, such as the bay anchovy and bluefish, have eggs and larvae that are present throughout the water column in the GOM, and therefore have a higher potential to be withdrawn by the velocity caps. But, as mentioned earlier, for every egg or larva that may be withdrawn by the intake structure, large numbers of eggs and larvae in the surrounding area will not encounter this structure. Hence, even though the potential for I&E by life stages of certain species is estimated to be "high" because they are found throughout the water column, it is only so for a tiny fraction of the total number of ichthyoplankton present in the larger area around the intake structure. So, when viewed within the context of all of the eggs and larvae present in the vicinity of the project area, the potential for I&E should best be considered to be minor when viewed on a larger scale.

5.2.4 I&E Studies in Texas

The proposed Harbor Island desalination facility and its associated intake structure are under design but have not yet been constructed. Hence, I&E data specific to this facility are not available for evaluation. By default, any assessment of the potential effect to biota from the proposed desalination facility and its intake structure is qualitative and based on extrapolated data and assumptions. Published monitoring information from several power plants operating in Texas was reviewed to support the current assessment and develop a realistic understanding of the potential for causing measurable population-level effects.

Table 5-2 summarizes I&E data collected from power stations in Texas that withdraw large volumes of cooling water from nearby water bodies. The facilities with quantitative information retained for this evaluation are the Barney M. Davis Power Plant in Corpus Christi, Texas (near Corpus Christi Bay), the P.H. Robinson Generating Station in Bacliff, Texas (Galveston Bay), the Sam Bertron Station in Strand, Texas (Houston Ship Channel), and the Cedar Bayou Generating Station in Baytown, Texas (Cedar Bayou). This section of the report focuses specifically on the data provided for these power facilities. For the sake of completeness, **Table 5-2** also provides monitoring data for several other power generating facilities in Texas. However, information from these other power generating facilities is not discussed below because it lacks actual counts of the number of impinged marine life during the monitoring period.

Several key factors must be considered when evaluating and interpreting this kind of facility-specific information:

- The power stations do not withdraw their cooling waters from the GOM 1.3 miles away from shore but instead from nearby shallow estuaries or other water bodies that have habitats, physical characteristics, salinities, and species assemblages that are expected to be quite different than those found in the GOM.
- It is unlikely that the power stations encounter the same mix of species and life stages as the intake structure in the GOM. For example, older demersal life stages of the blue crab will be more prevalent in the estuaries because of their habitat requirements, whereas planktonic life stages of the blue crab will be more prevalent in the GOM where this species spawns. Older larvae and juveniles of red drum are found in estuaries, whereas adults are also found in the GOM.
- The seasonal timing for the presence of different life stages will vary between the GOM and the other water bodies. For example, in the fall, red drum eggs are expected to be

present in the nearshore waters of the GOM where the adults spawn but not within estuaries where widespread spawning by this species is not expected to occur.

- The number of the smallest marine life that might have been entrained through the traveling screens has not been counted, and therefore is unknown.
- All else being equal, the potential for I&E also depends on a number of facility-specific factors, such as water intake capacity (mgd versus billions of gallons per day [bgd]), average intake velocities, depth of the intakes, any additional avoidance technologies, the type of fish screen technology implemented at the facility, and other engineering considerations. These variables inevitably cause existing power plants to differ substantially in their I&E performance. With full consideration of known variables and improved technologies, I&E performance is expected to be significantly improved with the more modern facilities proposed for the Harbor Island intake structure, particularly since most of the previous monitoring studies occurred before implementation of the 316(b) CWIS rules.

Notwithstanding these important caveats and unknowns, the available impingement information from the Texas power stations is summarized below:

- The *Barney M. Davis Power Plant in Corpus Christi, Texas,* performed a monitoring study over a period of 11 months, between March 14, 2006, and February 21, 2007 (estimated total of 345 days). During that time frame, the facility impinged 42,286 fish and 28,418 invertebrates, for a total of 70,704 organisms, or around 205 organisms per day. This total is equivalent to 0.38 organisms per day per million gallons of intake water based on the water intake capacity at this facility of 540 mgd.[38] Eleven species made up 92% of the impinged marine life during the study period. Five of those 11 species (specifically, Atlantic croaker, bay anchovy, Gulf menhaden, blue crab, and brown shrimp) also represent the target species outlined in Section 4 of this report.
- The *P.H. Robinson Generating Station in Bacliff, Texas,* performed a monitoring study over a 13-month period, from February 1969 to March 1970 (estimated total of up to 395 days). During that time frame, the facility impinged 68,518 organisms representing 83 species, or around 173 organisms per day. This total is equivalent to 0.0012 organisms per million gallons of intake water based on the water intake capacity at this facility of 138.6 bgd. The reported injury rates of the impinged marine life varied by species (10 species were assessed), and ranged from a high of 34.2% for bay anchovies to a low of 2.6% for Atlantic croakers and spotted seatrout.
- The *Sam Bertron Generating Station in Strand, Texas,* performed a monitoring study over a 12-month period, from January 12, 1978, to January 2, 1979 (estimated total of 356 days).

[38] The flow rate at this facility was variable. The highest flow occurred at ~492 mgd (20.52 million gallons per hour) for 7.5% of the time during the study. The flows fell below ~233 mgd (9.72 million gallons/hour) for 70% of the time during the study.

During that time frame, the facility impinged 479,448 fish and 132,450 invertebrates, for a total of 611,898 organisms, or around 1,719 organisms per day. This total is equivalent to 0.007 organisms per million gallons of intake water based on the water intake capacity at this facility of 241.1 bgd. Brown shrimp, white shrimp, and blue crab accounted for 96.2% of the invertebrate impingement. These three species are target species outlined in Section 4 of this report. Also, close to 90% of all impinged fish species consisted of Gulf menhaden, threadfin shad, bay anchovy, sand seatrout, spotted seatrout, Atlantic croaker, red drum, and southern flounder. Five of those eight species are target species outlined in Section 4 of this report.

- The *Cedar Bayou Generating Station in Baytown, Texas* (Cedar Bayou) performed a monitoring study over an 11-month period (estimated total of 334 days). During that time frame, the facility impinged 11,556 organisms, or around 35 organisms per day. It is not possible to calculate the number of organisms impinged per million gallons of intake water because the reference does not report the water intake capacity of this facility.

Galveston Bay NEP (1993) analyzed the I&E data for five power generating stations around Galveston Bay (note: the monitoring data collected at several of these stations are summarized above). The overall conclusions of those various monitoring studies were as follows:

- Small or weak-swimming larvae, post-larvae, and young fish were susceptible to I&E when intake velocities averaged >1.1 ft/s.
- Species most frequently subjected to I&E consisted of white shrimp, blue crab, Gulf menhaden, bay anchovy, sand seatrout, spot, and Atlantic croaker.
- Species less frequently subjected to I&E consisted of brown shrimp, sea catfish, and striped mullet.
- Larval fish found to be susceptible to entrainment included the naked goby, juvenile Gulf menhaden, bay anchovy, larval comb-tooth blennies, and Atlantic croaker.
- Generally, members of commercially or recreationally important fish species were not impinged in large numbers with respect to the most-abundant species.
- The overall probabilities of survival for impinged fish were much lower than for crustaceans.
- More crustaceans were impinged by number and weight compared to finfish, other than menhaden.

The available Texas I&E studies show that the number of marine life that may be retained on traveling fish screens at the proposed Harbor Island desalination facility is expected to be relatively minor when considered within a larger ecosystem context. **Table 5-3** provides fecundity information for 5 of the 11 target species. A recurring theme is the extraordinary fecundity of these species, with each female laying from tens of thousands to many millions of eggs each year. This reproductive strategy releases untold number of eggs in the GOM based on the evolutionary premise that the vast majority of early life stages will perish before they reach adulthood. This general pattern is also described in Section 3.3.2 of this report.

5.3 POTENTIAL FOR POPULATION-LEVEL EFFECTS

The potential I&E impacts to area marine life caused by the intake structure supplying State Water to the proposed Harbor Island desalination facility will be minor based on the following considerations: a) a review of the physical variables and salinities in the GOM in the vicinity of the intake structure, b) the general engineering details and components that combine to deliver a state-of-the-art State Water diversion system, and c) review of representative and relevant marine species at all life stages for the intake structure location. This conclusion is primarily due to the relatively low numbers of marine life expected to be drawn through the intake structure as compared to the high numbers of marine life present in the vicinity of the project area.

Entrainment impacts of planktonic larvae are typically assessed indirectly based on modeling. From a population biology perspective, the spatial scale of the proposed State Water diversion is very minor when considering the substantially larger amount of source water containing eggs and planktonic larvae in the vicinity of the project area. Depending on site-specific factors, such as withdrawal volume, velocity, and density of planktonic larvae, the range of potential larval entrainment losses derived from modeling results have been estimated as 0.02% to 0.33% of the source water populations for the Huntington Beach Desalination Facility in California, which had a proposed intake volume of 152 mgd (Tenera Environmental 2010a). Modeled species-specific losses of 0.01% to 0.063% were calculated by Tenera Environmental (2010b) for another facility in California with a proposed intake flow rate of 7 mgd. These losses were not considered significant because of the high fluctuations in population levels from changing environmental conditions, other stressors, and natural sources of mortality, which reach 99.9% (Tenera Environmental 2010b).

Several studies have modeled the movement of passive particles, representing red drum eggs and larvae, from the GOM into the Aransas Inlet by accounting for various environmental forces (e.g., tides and wind) and biological factors (e.g., egg or larval development and settlement) (Brown et al. 2000, 2004, 2005). These modeling studies found that between 39% and 55% of all the passive particles present in the GOM immediately outside of the Aransas Inlet at the start of the simulations were not anticipated to enter the inlet and were therefore effectively "lost" to the ecosystem. This type of large-scale loss is normal and expected. It emphasizes that the relatively small numbers of eggs and larvae that may be withdrawn by the intake structure at a more remote location in the GOM, when compared to the total number of eggs and larvae present in the vicinity of the project area (Section 3.3.1) and for many miles beyond in all directions, is not expected to affect local populations.

5.4 SUMMARY AND CONCLUSIONS

The analysis presented in this report suggests that the proposed water intake structure for the Harbor Island desalination plant has the potential to interact with planktonic life stages and weakly swimming older life stages of fish and invertebrates present in the GOM, as well as sea turtle juveniles. The numbers, kinds, and sizes of fish and invertebrates that interact with the intake structure will depend on life history considerations (e.g., spawning close to shore vs. pelagic areas; floating and demersal eggs vs. neutrally buoyant eggs; organism size; swimming abilities), seasonal considerations (e.g., fall spawners vs. year-round spawners), and intake structure considerations (e.g., average intake velocities, structure and function of velocity caps), among others. These topics have been discussed above.

Although some intake of marine life is inevitable with the intake structure for the project area in the GOM, the following considerations indicate that the potential effects to marine species and their local populations are expected to be minor:

- The design intake flow velocity at the entrance to the intake structure will fall below the EPA-established limit of ≤0.5 ft/s for power plants in other contexts, and is expected to drastically reduce the amount of marine life entering the velocity caps (and therefore greatly reduce I&E).
- The prevailing tidal velocities in the GOM are generally higher than the entrance velocity of 0.5 ft/s at the intake structure (see **Figure 2-10**). This combination suggests that, on average, eggs and larvae are more likely to pass through the velocity caps instead of being withdrawn by them.
- The location of the intake structure is approximately 1.3 miles Offshore, away from shallow habitat that comprises areas that may be used more widely by smaller species or for spawning.
- The intake structure will be submerged at depth with approximately 20 to 25 ft of water overlying the velocity caps. This deeper placement will greatly limit or eliminate the withdrawal of positively buoyant eggs found at or near the surface of the GOM.
- The intake structure entrances will be at least 5 ft above the sea bed. This design feature will greatly limit or eliminate the withdrawal of demersal eggs and other benthic marine life species.
- The number of those marine species potentially affected by I&E is further reduced by application of current technology, including bar screens that prevent certain marine life from entering the intake structure, and traveling screens at the proposed desalination facility on Harbor Island that return marine life to a natural habitat.

Based on volumetric considerations, and assuming even distribution throughout the water column, any withdrawal of eggs and larvae by the intake structure will represent a very small fraction of the total number of eggs and larvae expected to be present in the vicinity of the project area. If ELS are not evenly distributed in the water column (e.g., the eggs of red drum and spotted seatrout have positive buoyancy in the salty waters of the GOM), then the potential for withdrawal of such marine life is reduced even further.

The survival potential of marine life impinged on the traveling screens likely depends on the species (e.g., early life stages of fish have lower survival rates than invertebrates, “fragile” fish species are more affected than other fish species) and the proposed efficiency and efficacy of the steps used to remove the impinged marine life from the traveling screens for return to the nearby aquatic habitat.

An important consideration is the high fecundity of the 11 target species evaluated in this report. Their reproductive strategy presupposes that the vast majority of eggs and larvae will not survive to adulthood. Such a strong, built-in resiliency helps mitigate any impacts that might be associated with any potential withdrawal of these early life stages by the intake structure.

Finally, T&E species (sea turtles) and HMS are not expected to be affected by the intake structure due to a combination of the following factors: lack of presence in the project area, strong swimming abilities, large body sizes, birthing of fully formed neonates (e.g., shark pups and whale calves, instead of eggs and larvae), the design of the intake velocity caps, the presence of 3-in. bar screens, the depth of intake, and the distance of the intake from shore.

Turtle hatchlings have the potential to be present in the project area in the GOM for short periods of time based on the recorded presence of sea turtle nests on several regional beaches. However, nesting activity does not appear to be widespread (i.e., dozens of nests, not thousands), and the potential for withdrawal of sea turtle hatchlings by the intake structure is anticipated to be rare based on behavioral considerations (e.g., “frenzied” swimming close to the GOM surface towards the open ocean to minimize mortality from nearshore predators). Juvenile and adult sea turtles are present in the vicinity of the project area and have the potential to interact with the intake structure, as has been shown to occur at the Port St. Lucie Nuclear Power Plant in Florida. However, the potential for neritic juvenile sea turtles to interact with the velocity caps is demonstrably minimal using an AUF approach. The design of the intake structure will include adding 3-in. mesh size bar screens at the entrances of the velocity caps to eliminate any potential for accidental “take” of juvenile turtles. This mitigation measure will also prevent adult sea turtles or larger fish from entering the velocity caps.

The following components will be implemented based on all these considerations: a) place the water intake structure approximatively 1.3 miles Offshore at 5 to 10 ft above the sea bed in approximately 35 ft of water to limit interaction with marine life, b) set the entrance velocity at the velocity caps to ≤0.5 ft/s to reduce the potential withdrawal of eggs and larvae, c) enclose the velocity caps with 3-in. mesh size bar screens to prevent incidental entrance by juvenile and adult sea turtles, and d) use traveling screens at the proposed desalination facility to support survival.

6 REFERENCES

Blanchet, H. et al. 2001. The spotted seatrout fishery of the Gulf of Mexico, United States: A regional management plan. Van der Kooy (ed.). Gulf States Marine Fisheries Commission, Publication No. 87. March.

Bluewater Texas Terminals LLC. 2021a. Appendix L: Benthic Survey Report in Deepwater Port License Application for the Bluewater SPM Project, Volume II: Environmental Evaluation. Available at: https://downloads.regulations.gov/MARAD-2019-0094-0004/attachment_32.pdf

Bluewater Texas Terminals LLC. 2021b. Appendix U: Ichthyoplankton Assessment, Volume II: Environmental Evaluation. Available at: https://downloads.regulations.gov/MARAD-2019-0094-0004/attachment_41.pdf

Bonfil, R., S. Clarke, and H. Nakano. 2008. The biology and ecology of the oceanic whitetip shark, *Carcharhinus longimanus*. pp. 128-139. In *Sharks of the Open Ocean: Biology, Fisheries and Conservation*. M.D. Camhi, E.K. Pikitch, and E.A. Babcock (eds). Blackwell Publishing Ltd, Oxford, UK.

Booth, D.T. 2009. Swimming for your life: Locomotor effort and oxygen consumption during the green turtle (*Chelonia mydas*) hatchling frenzy. *J. Exp. Biol*. 212: 50–55. 10.1242/jeb.019778

Booth, D.T., E. Burgess, J. McCosker, and J.M. Lanyon. 2004. The influence of incubation temperature on posthatchling fitness characteristics of turtles. International Congress Series 1275:226–233.

Boreman. J. 1977. Impacts of power plant intake velocities on fish. Power Plant Team. U.S. Fish and Wildlife Service.

Brown, C.A., G.A. Jackson, and D.A. Brooks. 2000. Particle transport through a narrow tidal inlet due to tidal forcing and implications for larval transport. *J. Geophys. Res.* 105(C10): 24,141-24,156.

Brown, C.A., S.A. Holt, G.A. Jackson, D.A. Brooks, and G.J. Holt. 2004. Simulating larval supply to estuarine nursery areas: How important are physical processes to the supply of larvae to the Aransas Pass Inlet? *Fish. Oceanogr.* 13(3):181-196.

Brown, C.A., G.A. Jackson, S.A. Holt, and G.J. Holt. 2005. Spatial and temporal patterns in modeled particle transport to estuarine habitat with comparisons to larval fish settlement patterns. *Estuar. Coast. Shelf Sci.* 64(1): 33–46.

Burgess, E.A., Booth, D.T. and Lanyon, J.M. 2006. Swimming performance of hatchling green turtles is affected by incubation temperature. *Coral Reefs* 25:341–349.

Carr, A. 1962. Orientation problems in the high seas travel and terrestrial movements of marine turtles. *American Scientist* 50(3):358-374. (as cited in NMFS et al. 2011)

Carr, A. 1982. Notes on the behavioral ecology of sea turtles. In: Biology and conservation of sea turtles. K.A. Bjorndal (ed). Smithsonian Institution Press, Washington, DC. pp. 19–26. (as cited in NMFS et al. 2011).

Carr, A., and Ogren, L. 1960. The ecology and migrations of sea turtles. 4. The green turtle in the Caribbean Sea, American Museum of Natural History Bulletin, 121, 1, 1960. (as cited in NMFS et al. 2011).

Christianson. A. G.. F. H. Rainwater. M.A, Shirazi, and B.A. Tichenor. 1973. Reviewing environmental impact statements: power plant cooling systems, engineering aspects. U.S. Environmental Protection Agency (EPA), Pacific Northwest Environmental Research Laboratory. Corvallis. Oregon. Technical Series Report EPA-660/2-73-016

Compagno, L.J.V. 1984. Part 1 - Hexanchiformes to Lamniformes. FAO Fish. Synop. 125(4/1). FAO Species Catalogue. Vol. 4. Sharks of the World. An annotated and illustrated catalogue of shark species known to date. FAO, Rome, Italy, pp. 1-249.

Duffy, C., and M.P. Francis. 2001. Evidence of summer parturition in shortfin mako (*Isurus oxyrinchus*) sharks from New Zealand waters. *NZ J Mar Freshwater Res* 35:319-324.

EPRI (Electric Power Research Institute). 2007. Cooling Water Intake Structure Area-of-Influence Evaluations for Ohio River Ecological Research Program Facilities. 1015322. Electric Power Research Institute, Palo Alto, CA.

Froeschke, J.T., and B.F. Froeschke. 2011. Spatio-temporal predictive model based on environmental factors for juvenile spotted seatrout in Texas estuaries using boosted regression trees. *Fisheries Research* 111(3):131-138.

Froese, R., and D. Pauly (eds). 2022. FishBase. World Wide Web electronic publication. www.fishbase.org, version (06/2022).

Galveston Bay NEP. 1993. Non-fishing-human induced mortality of fisheries resources in Galveston Bay. Galveston Bay National Estuary Program. May.

Gibson, K.J., M.K. Streich, T.S. Topping, and G.W. Stunz. 2021. New insights into the seasonal movement patterns of shortfin mako sharks in the GOM. *Front. Mar. Sci.* 8:623104. doi: 10.3389/fmars.2021.623104

GMFMC. 2004. Final environmental impact statement for the generic amendment to the following fishery management plans of the Gulf of Mexico: Shrimp Fishery of the Gulf of Mexico, United States Waters; Red Drum Fishery of the Gulf of Mexico; Reef Fish Fishery of the Gulf of Mexico; Coastal Migratory Pelagic Resources (Mackerels) in the Gulf of Mexico and South Atlantic; Stone Crab Fishery of the Gulf of Mexico; Spiny Lobster in the Gulf of Mexico and South Atlantic; Coral and Coral Reefs of the Gulf of Mexico. Gulf of Mexico Fishery Management Council. Tampa, FL.

GMFMC. 2016. Final Report 5-Year Review of Essential Fish Habitat Requirements. Available online at: http://gulfcouncil.org/wp-content/uploads/EFH-5-Year-Revew-plus-App-A-and-B_Final_12-2016.pdf. Accessed September 2022. Gulf of Mexico Fishery Management Council. December.

Greene, G.N., et al. 1979. Impingement Monitoring Studies, Sam Bertron Generating Station, Houston Lighting and Power Company, Environmental Protection Division, HL&P, Houston, TX. 84 pp. (as cited in GBNEP 1993)

Greene, G.N., et al. 1980. Impingement Monitoring Studies, P.H. Robinson. Houston Lighting and Power Company, Environmental Protection Division. 138 pp. (as cited in GBNEP 1993)

Hernandez, F.J., L. Carassou, S. Muffelman, S.P. Powers, and W.M. Graham. 2011. Comparison of two plankton net mesh sizes for ichthyoplankton collection in the northern Gulf of Mexico. *Fisheries Research* 108:327-335.

Holland, J.S., N.J. Maciolek, R.D. Kalke, and C.H. Oppenheimer. 1973. A benthos and plankton study of the Corpus Christi, Copano and Aransas Bay systems. I: Report on the methods used and data collected during the period September 1972-June 1973. First Annual Report to the Texas Water Development Board December 1973. University of Texas Marine Science Institute at Port Aransas.

Holland, J.S., N.J. Maciolek, R.D. Kalke, and C.H. Oppenheimer. 1974. A benthos and plankton study of the Corpus Christi, Copano and Aransas Bay systems. II: Report on the data collected during the period July, 1973-April, 1974. Second Annual Report to the Texas Water Development Board December 1973. University of Texas Marine Science Institute at Port Aransas.

Holt, J., R. Godbout, and C.R. Arnold. 1981a. Effects of temperature and salinity on egg hatching and larval survival of red drum, Sciaenops ocellata [USA]. Fishery bulletin United States, National Marine Fisheries Service.

Holt, J., A.G. Johnson, C.R. Arnold, W.A. Fable Jr., and T.D. Williams. 1981b. Description of eggs and larvae of laboratory reared red drum, Sciaenops ocellata. Copeia, 751-756.

Jobe, W.D., et al. 1980. Studies on Survival of Nektonic Organisms after Passage through the Fish Pump System and Exposure to Thermal Shock at the Cedar Bayou Generating Station, Houston Lighting and Power Company. Final Report, Project No. 01-5169. Southwest Research Institute, Houston, TX. 25 pp. (as cited in GBNEP 1993)

Johnson, D.R. 2008. Ocean surface current climatology on the northern Gulf of Mexico. Published by the Gulf Coast Research Laboratory, Ocean Springs, MS. Project funded by the Marine Fisheries Initiative (MARFIN) program of the NMFS/NOAA.

Joung, S.J., N.F. Chen, H.H. Hsu, and K.M. Liu. 2016. Estimates of life history parameters of the oceanic whitetip shark, *Carcharhinus longimanus*, in the western north Pacific Ocean. *Mar Biol Res* 12:758-768.

Landry, A.M. 1977. Life History and Susceptibility of Fish in Galveston Bay, Texas to Power-Plant Cooling-Water Operations. Ph.D. Dissertation. Texas A&M University, Wildlife and Fisheries Sciences. College Station, Texas. 546 pp. (as cited in GBNEP 1993)

Lassuy, D.R. 1983a. Species profiles: life histories and environmental requirements (Gulf of Mexico) - Atlantic croaker. U.S. Fish and Wildlife Service, Division of Biological Services. FWS/OBS-82/11.3. U.S. Army Corps of Engineers, TR EL-82-4. 12 pp.

Lassuy, D.R. 1983b. Species profiles: life histories and environmental requirements (Gulf of Mexico) - spotted seatrout. U.S. Fish and Wildlife Service, Division of Biological Services. FWS/OBS-82/11.4. U.S. Army Corps of Engineers, TR EL-82-4. 14 pp.

Lessa, R., F.M. Santana, and R. Paglerani. 1999. Age, growth and stock structure of the oceanic whitetip shark, *Carcharhinus longimanus*, from the southwestern equatorial Atlantic. *Fish Res* 42:21-30.

Lohmann, K., A.W. Swartz, and C. Lohmann. 1995. Perception of ocean wave direction by sea turtles. *J. Exp. Biol*. 198:1079-85. 10.1242/jeb.198.5.1079.

Lutz, P.L., and J.A. Musick (eds). 1997. *The biology of sea turtles*. CRC Press LLC, New York, NY.

Miller, E., C. Wails, and J. Sulikowski. 2022. It's a shark-eat-shark world, but does that make for bigger pups? A comparison between oophagous and non-oophagous viviparous sharks. *Reviews in Fish Biology and Fisheries*. 32. 10.1007/s11160-022-09707-w.

Miller, M.H., and C. Klimovich. 2017. Endangered Species Act Status Review Report: Giant Manta Ray (*Manta birostris*) and Reef Manta Ray (*Manta alfredi*). Report to National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD. September 2017. 128 pp.

Moulton, D.L., M.A. Dance, J.A. Williams, M.Z. Sluis, G.W. Stunz, and J.R. Rooker. 2017. Habitat partitioning and seasonal movement of red drum and spotted seatrout. *Estuaries and Coasts* 40(3):905-916.

NMFS. 2012. Fisheries Economics of the United States, 2011. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-F/SPO-128. Available at: https://www.fisheries.noaa.gov/resource/document/fisheries-economics-united-states-2011-full-report. National Marine Fisheries Service. 175 pp.

NMFS. 2016. Endangered Species Act - section 7 consultation biological opinion on U.S. Nuclear Regulatory Commission's continued operation of the St. Lucie Nuclear Power Plant's circulating seawater cooling system, Jensen Beach, Hutchinson Island, Florida. SER-2006-832, Southeast Region, NMFS, NOAA, U.S. Department of Commerce, St. Petersburg, Florida.

NMFS. 2017. Final Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan: Essential Fish Habitat and Environmental Assessment. National Marine Fisheries Service. National Oceanic and Atmospheric Administration. Office of Sustainable Fisheries. Atlantic Highly Migratory Species Management Division.

NMFS, USFWS, and SEMARNAT. 2011. Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*), Second Revision. National Marine Fisheries Service. Silver Spring, Maryland 156 pp. + appendices. https://repository.library.noaa.gov/view/noaa/4368

NOAA. 2007. Magnuson-Stevens Fishery Conservation and Management Act. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Public Law 94-265. As amended by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (P.L. 109-479).

NOAA. 2022. Threatened and Endangered Species and Critical Habitats under National Oceanic and Atmospheric Administration (NOAA) Fisheries Jurisdiction. https://www.fisheries.noaa.gov/species-directory/threatened-endangered. Accessed September 2022. Last updated by Southeast Regional Office on 9/1/2021.

NRC. 1985. Sea Turtle Intake Entrapment Studies. Available at: https://www.nrc.gov/docs/ML1721/ML17215A861.pdf. Nuclear Regulatory Commission.

Olsen, Z. 2022. Personal communication (email correspondence between M. Abbene, Integral Consulting Inc., and Z. Olsen, Texas Parks and Wildlife Department, RE: Request for Texas Coastal Fisheries Data, dated August 30, 2022.

Pattillo, M.E., T.E. Czapla, D.M. Nelson, and M.E. Monaco. 1997. Distribution and abundance of fishes and invertebrates in Gulf of Mexico estuaries, Volume II: Species life history summaries. ELMA Rep. No. 11. NOAA/ NOS Strategic Environmental Assessments Division, Silver Spring, MD. 377 pp.

Perry, H.M., and T.D. McIlwain. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Gulf of Mexico): blue crab. U.S. Fish and Wildlife Service Biological Report 82(11.55). U.S. Army Corps of Engineers, TR EL-82-4. 21 pp.

Rambahiniarison J.M., M.J. Lamoste, C.A. Rohner, R. Murray, S. Snow, J. Labaja, et al. 2018. Life history, growth, and reproductive biology of four mobulid species in the Bohol Sea, Philippines. *Frontiers in Marine Science*. 5:269. doi: 10.3389/fmars.2018.00269.

Reagan, R.E. 1985. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Gulf of Mexico) - red drum. U.S. Fish and Wildlife Service Biological Report 82(11.36). U.S. Army Corps of Engineers, TR EL-82-4. 17 pp.

Reich, K.J., K.A. Bjorndal, and A.B. Bolten. 2007. The 'lost years' of green turtles: Using stable isotopes to study cryptic lifestages. *Biol Lett* 3:712–714. https://doi.org/10.1098/rsbl.2007.0394

Salmon, M., and J. Wyneken. 1987. Orientation and swimming behavior of hatchling loggerhead turtles *Caretta caretta L.* during their offshore migration. Journal of Experimental Marine Biology and Ecology. 109. 137-153. 10.1016/0022-0981(87)90012-8.

Schmidly, D.J., and R. D. Bradley. 2016. *The Mammals of Texas*. Seventh Edition. University of Texas Press. Available at: https://www.depts.ttu.edu/nsrl/mammals-of-texas-online-edition/

Shaver, D.J. 1991. Feeding ecology of Kemp's Ridley in south Texas waters. *Journal of Herpetology* 25:327–334

Shepherd, M.A., A. Labay, P.J. Shea, R. Rautiainen, and C. Achutan. 2016. Operational, water quality and temporal factors affecting impingement of fish and shellfish at a Texas coastal power plant. *Global Ecology and Conservation* 5:48-57.

Sink, T., R. Vega, and J. Butler. 2018. Red drum: Reproductive biology, brood stock management, and spawning. Southern Regional Aquaculture Center. Publication No. 0320.

Sonnichsen, J.C.. Bentley. G.F. Bailey, and R.E. Nakatani. 1973. A review of thermal power plant intake structure designs and related environmental considerations. Hanford Engineering Development Laboratory, Richland. Washington. HEDL-TME 73-24. UC-12.

Southwest Research Institute (SRI) (unpublished impingement study data; as cited in GBNEP 1993)

Stunz, G.W., and P.A. Montagna. 2015. TM 2.1–Identification and Characterization of Potential Environmental Impacts Mitigation Measures Related to Intake and Discharge Facilities of

Seawater Desalination Plants. Variable Salinity Desalination Demonstration Project, City of Corpus Christi. July 10.

Tenera Environmental. 2010a. Entrainment and impingement effects from operation of the Huntington Beach Desalination Facility in standalone mode. Prepared for Poseidon Resources Corporation. Tenera Environmental. February. 158 pp.

Tenera Environmental. 2010b. Open Ocean Intake Effects Study. Prepared for City of Santa Cruz. Tenera Environmental. December. 319 pp.

Tissot, P.E., J. Rizzo, and D.D. Williams. 2015. Nearshore wave and current measurements/ predictions on the Texas coast. 95th American Meteorological Society Annual Meeting, 13th Symposium on the Coastal Environment. July 2015. Phoenix, AZ.

TPWD. 2022. Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. https://tpwd.texas.gov/gis/rtest/. Accessed 8/18/2022. Last Updated 7/12/2022.

TXNDD. 2019. Element Occurrence data export. Wildlife Diversity Program of Texas Parks & Wildlife Department, Texas Natural Diversity Database. Available at https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/txndd/.

USEPA. 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. EPA-540-R-97-006. U.S. Environmental Protection Agency.

USEPA. 2000. Economic and Engineering Analyses of the Proposed New Facility Rule. EPA-821-R-00-019. U.S. Environmental Protection Agency.

USEPA. 2011. Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Rule. EPA-821-R-11-001. U.S. Environmental Protection Agency.

USEPA. 2014. Technical Development Document for the Final Section 316 (b) Phase II Existing Facilities Rule (Final). Vol. 7. EPA 821-R-04, 2004. U.S. Environmental Protection Agency.

Valverde R.A., and K.R. Holzwart. 2017. Sea Turtles of the Gulf of Mexico. In: Habitats and Biota of the Gulf of Mexico: Before the Deepwater Horizon Oil Spill. C. Ward (ed.). Springer, New York, NY. pp. 1189–1351.

Wang, J.H., J.K. Jackson, and K.J. Lohmann. 1998. Perception of wave surge motion by hatchling sea turtles. *J. Exp. Mar. Biol. Ecol*. 229:177-186. (as cited in NMFS et al. 2011)

Ward, G.H. 2012. The blue crab: a survey with application to San Antonio Bay. Center for Research in Water Resources.

Ward-Geiger, L.I., A.R. Knowlton, A.F. Amos, T.D. Pitchford, B. Mase-Guthrie, and B.J. Zoodsma. 2011. Recent Sightings of the North Atlantic Right Whale in the Gulf of Mexico. Gulf of Mexico Science 29 (1). Retrieved from https://aquila.usm.edu/goms/vol29/iss1/6

WateReuse Association. 2011. Desalination Plant Intakes: Impingement and Entrainment Impacts and Solutions. https://watereuse.org/wp-content/uploads/2015/10/IE_White_Paper.pdf

WCM Group Inc. 2020. Cooling Alternatives and Appendix A, Impingement and Entrainment Monitoring Study, in Texas Commission on Environmental Quality, Permit renewal with changes to discharge, deposit or dispose of waste(s) into or adjacent to water in the state. Permit No. WQ0001244000. March 2020 (downloadable at www.wcmgroup.com or via Google Search).

Witherington, B.E. 1992. Unpublished data, as cited in Lutz and Musick 1997.

Witherington, B.E. 1995. Observations of hatchling loggerhead turtles during the first few days of the lost year(s). pp. 154–157. In: Proceedings of the 12th Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-361. (as cited in NMFS et al. 2011)

Wyneken, J. 1997. Sea turtle locomotion: Mechanics, behavior, and energetics. In: The Biology of Sea Turtles. P.L. Lutz and J.A. Musick (eds.). CRC Press, Boca Raton, FL. pp. 165-198.

Wyneken, J., and M. Salmon. 1992. Frenzy and postfrenzy swimming activity in loggerhead, green, and leatherback hatchling sea turtles. *Copeia* 1992:478−484. (as cited in NMFS et al. 2011)

Wyneken, J., M. Salmon, and K. Lohmann. 1990. Orientation by hatchling loggerhead sea turtles Caretta caretta L. in a wave tank. *J. Exp. Mar. Biol. Ecol*. 139:43-50. 10.1016/0022-0981(90)90037-D.

Young, C.N., J. Carlson, M. Hutchinson, C. Hutt, D. Kobayashi, C.T McCandless, J. Wraith. 2017. Status review report: Oceanic whitetip shark (*Carcharhinus longimanus*). Final Report to the National Marine Fisheries Service, Office of Protected Resources. December 2017. 170 pp.

Figures

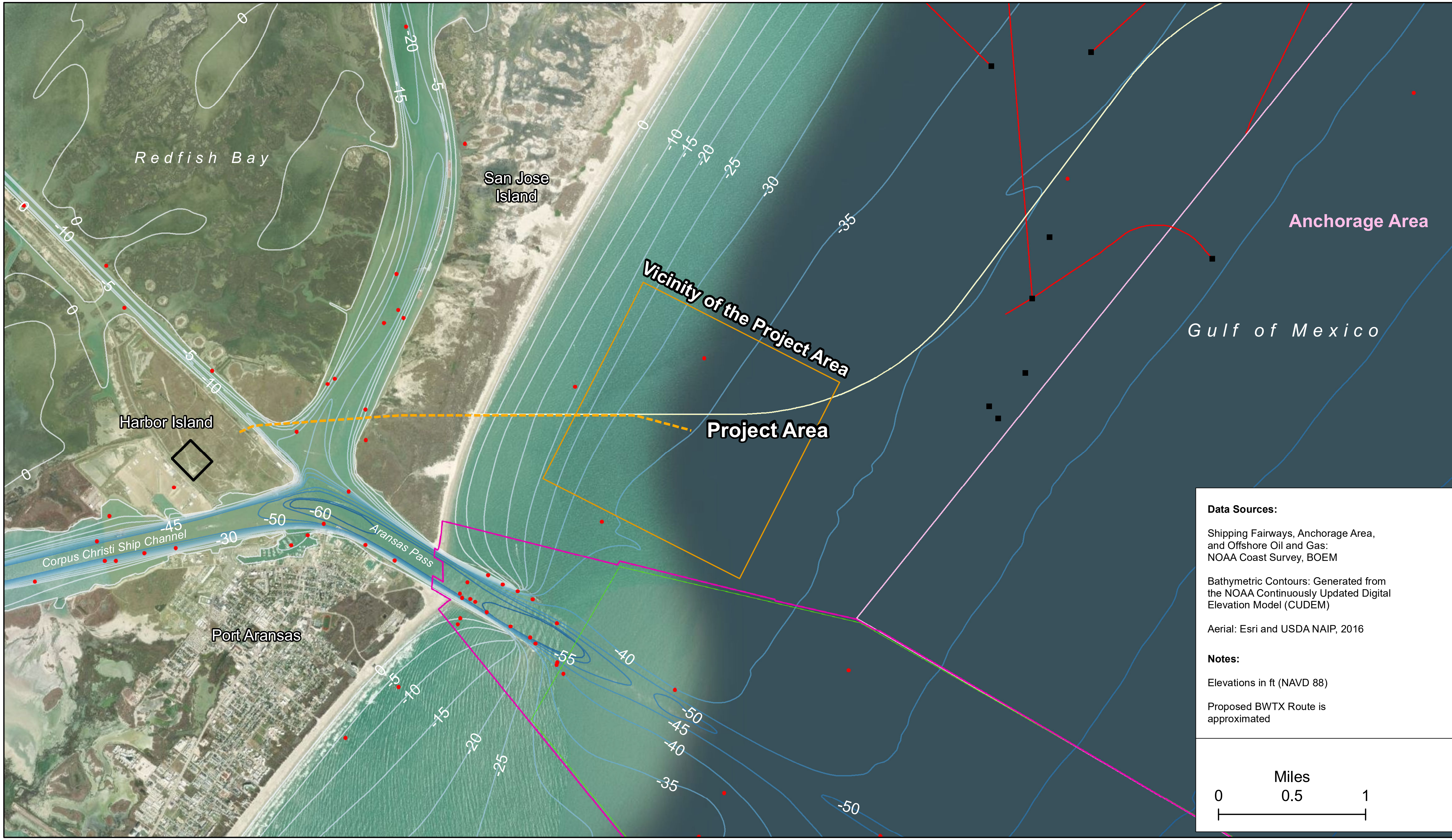

Figure 1-1
Approximate Locations of the Proposed Desalination Facility, the State Water Intake Structure, and the Intake Tunnel

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Legend

Proposed Desalination Facility Features

- Proposed Location of the Intake Tunnel
- Proposed Location of the Intake Structure
- Approximate Location of the Proposed Desalination Facility
- Anchorage Area
- Shipping Fairways
- Proposed BWTX Route
- Offshore Oil & Gas Pipelines
- Wrecks and Obstructions
- Offshore Oil & Gas Feature

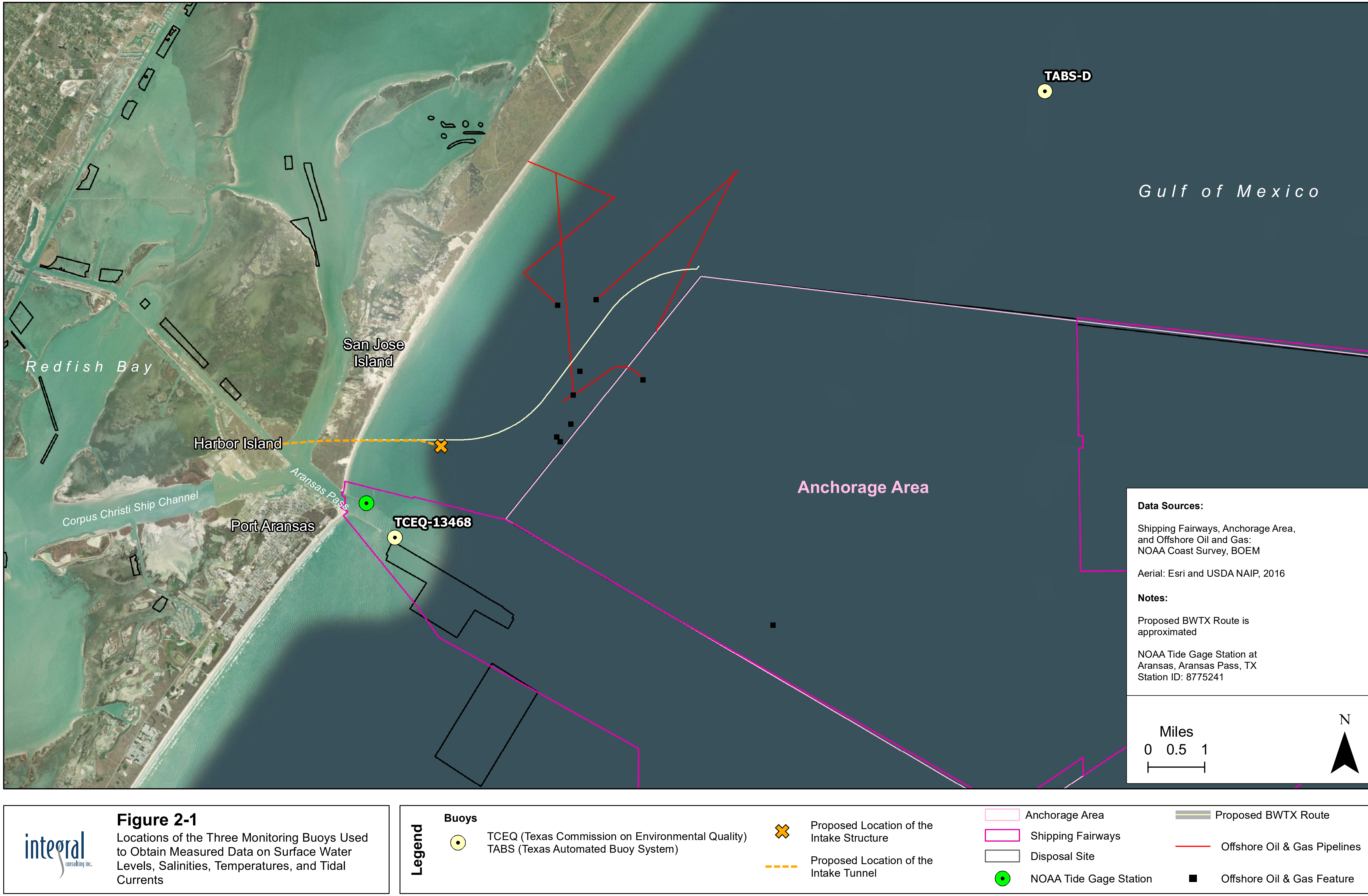

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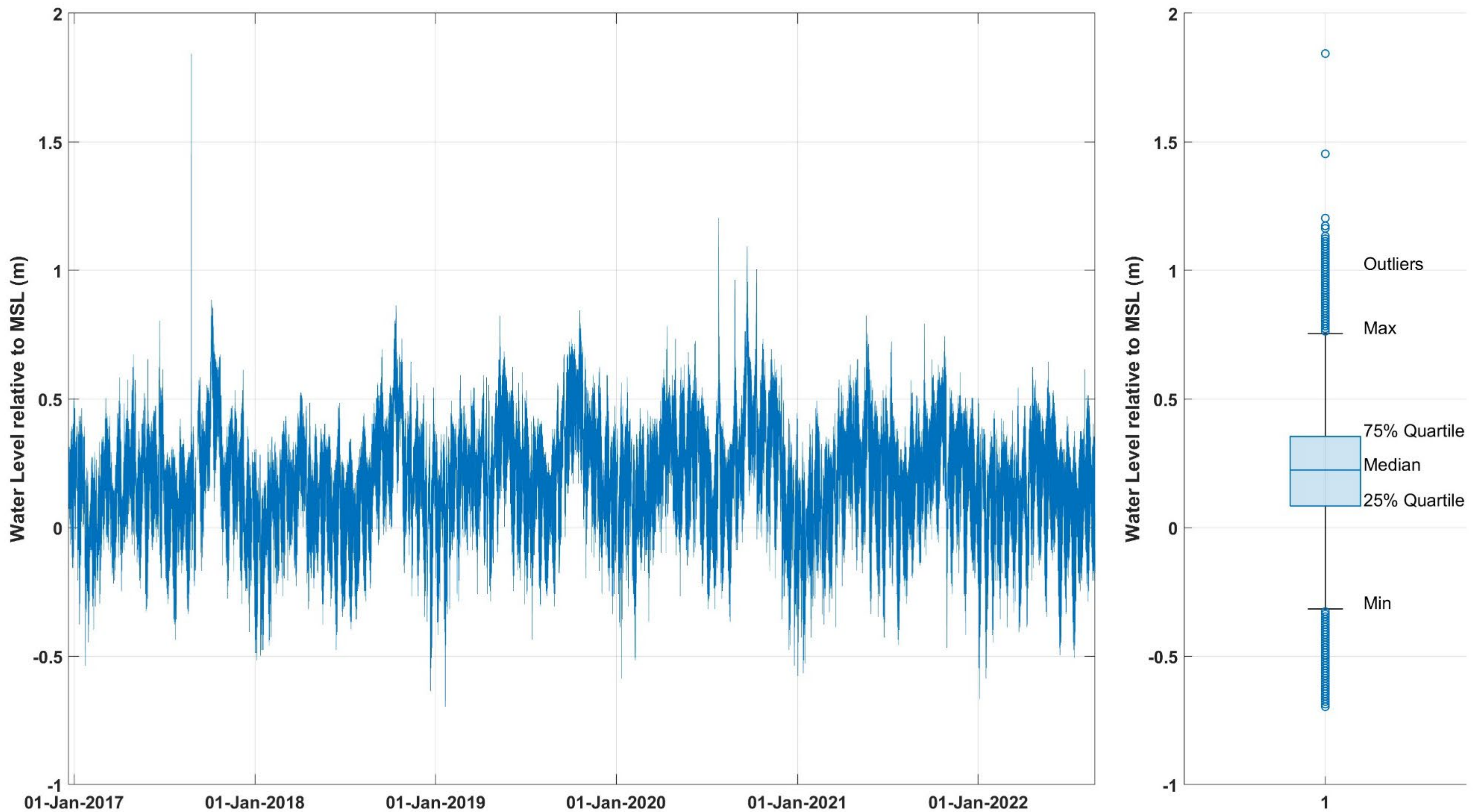
Figure 2-1
Locations of the Three Monitoring Buoys Used to Obtain Measured Data on Surface Water Levels, Salinities, Temperatures, and Tidal Currents



Notes: Data source: https://tidesandcurrents.noaa.gov/stationhome.html?id=8775241
Box and whisker plots indicate the median, 25th and 75th quartile, statistical minimum and maximum, and outlier points. Outliers are defined as either greater than 1.5*IQR+75th percentile value or less than 25th percentile-1.5*IQR.

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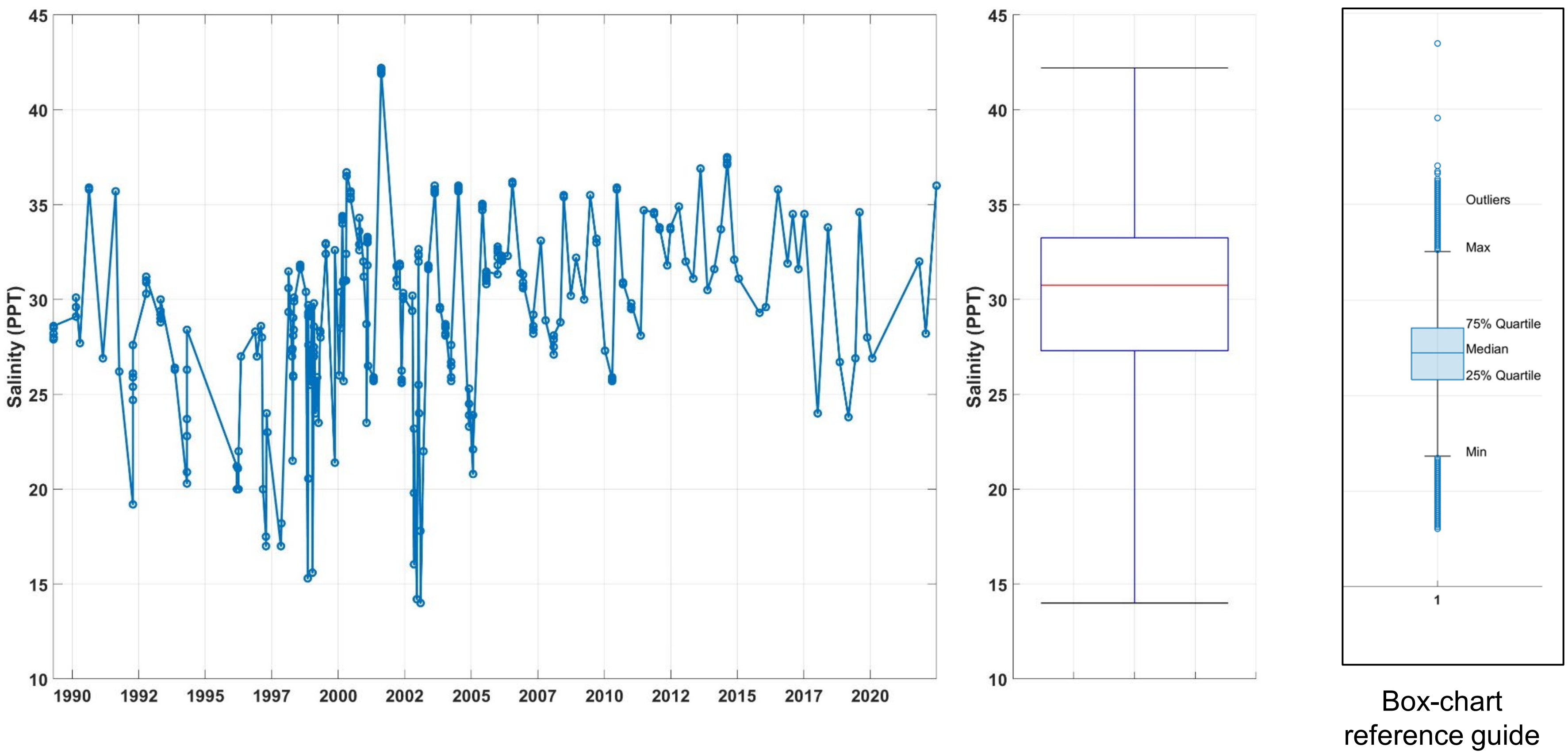
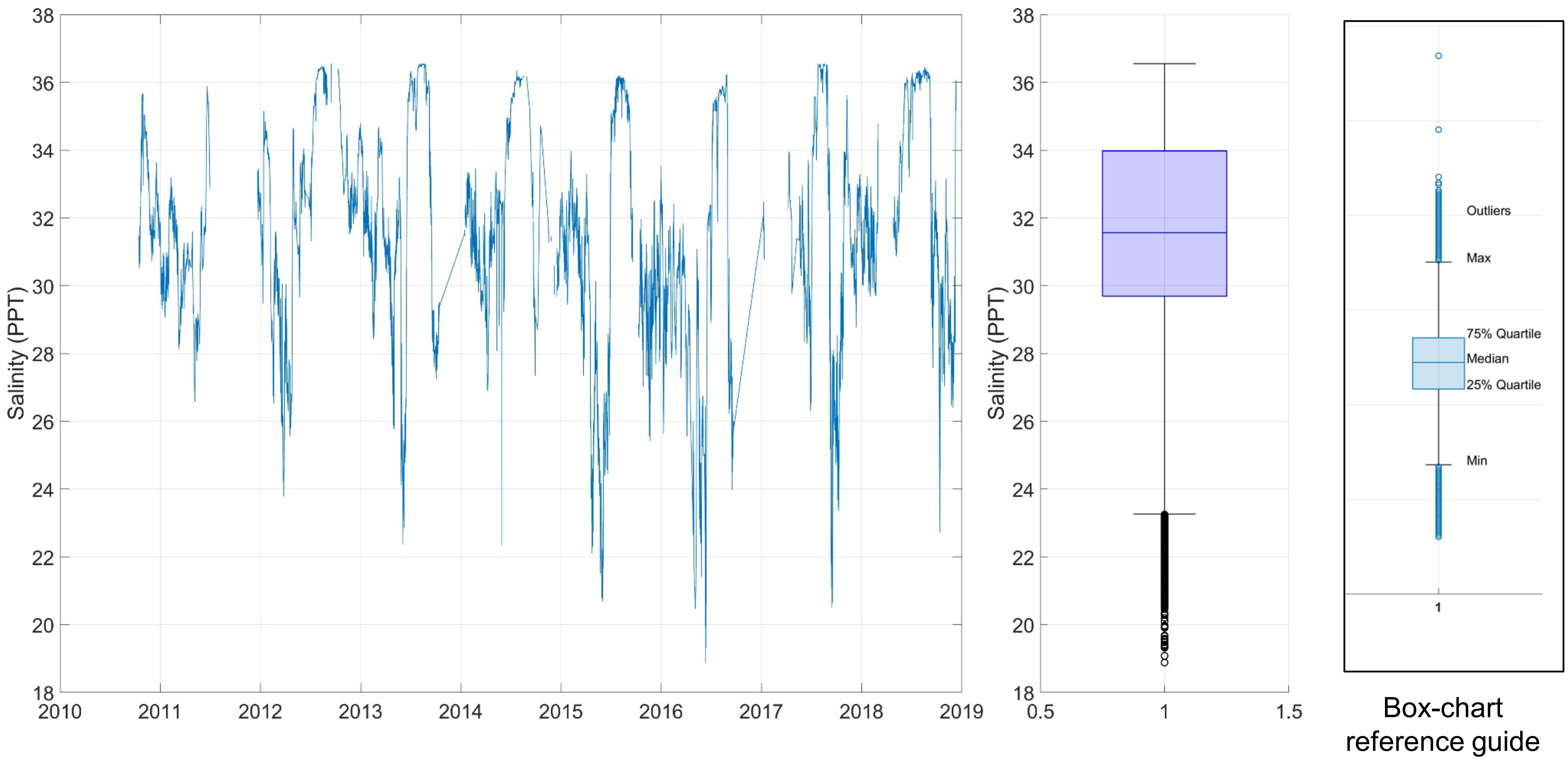
Figure 2-2.
Surface Water Levels Measured in the Gulf of Mexico at Aransas Inlet between 2017 and 2022



Notes: : Data sourced from the measurements collected by the Texas Commission on Environmental Quality at monitoring station 13468
Box and whisker plots indicate the median, 25th and 75th quartile, statistical minimum and maximum, and outlier points. Outliers are defined as either greater than 1.5*IQR+75th percentile value or less than 25th percentile-1.5*IQR (note: this salinity dataset does not contain any outliers)

Figure 2-3.
Monthly Variations in the Surface Water Salinities Measured in the Gulf of Mexico at Aransas Inlet between 1989 and 2022



Notes: Data were sourced through GCOOS for TABS Buoy D. https://tabs.gerg.tamu.edu/tglo/ven.php?buoy=D. The data were filtered to remove outliers that fell outside of the physical ranges.

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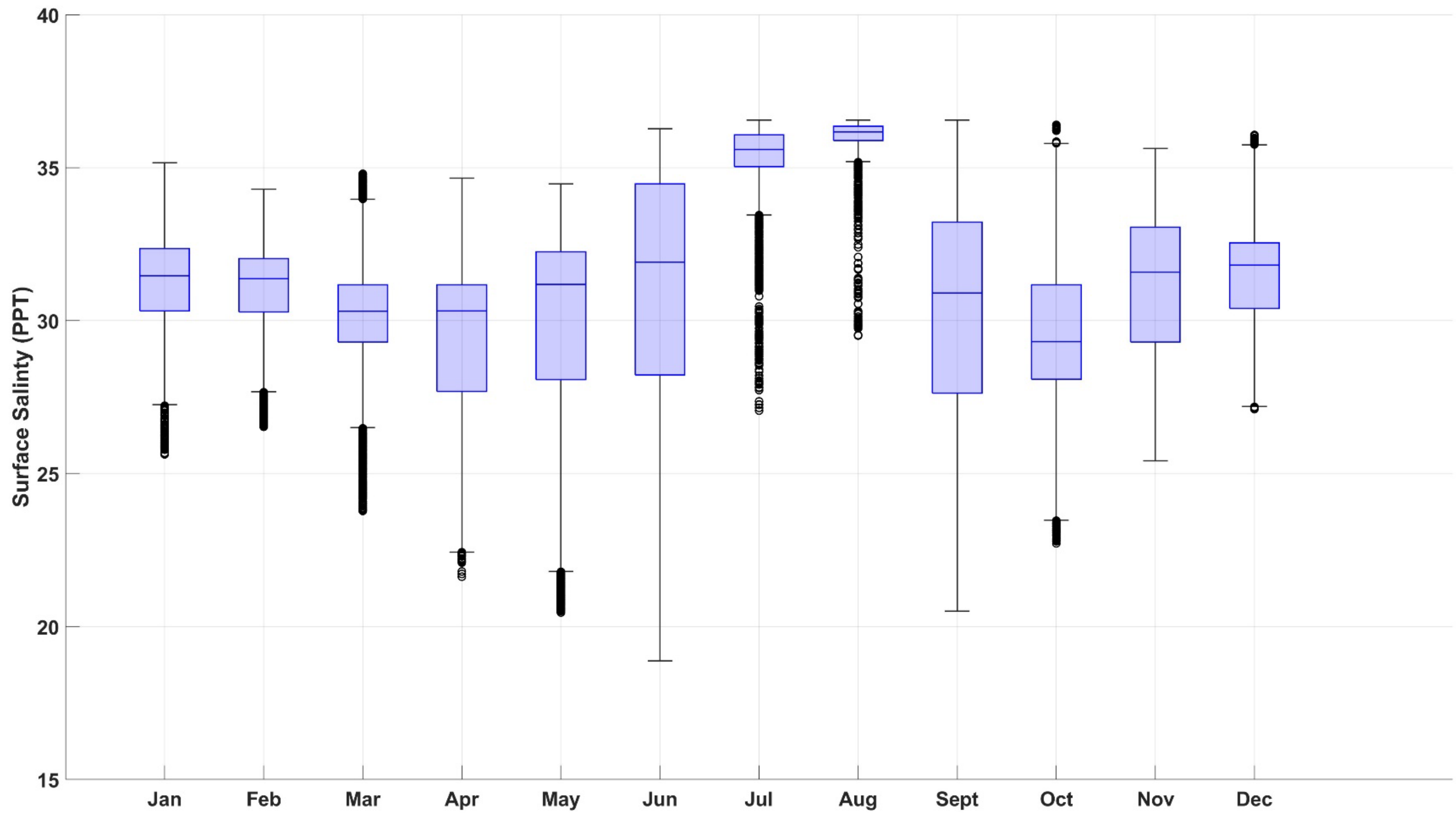
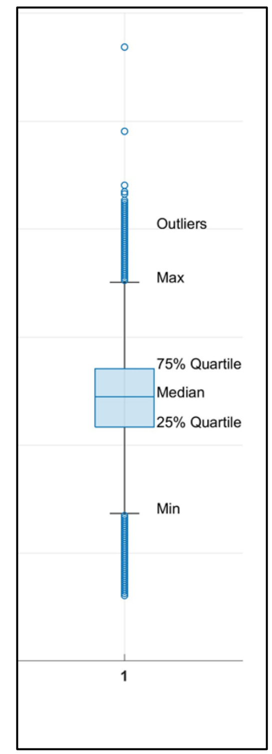
Figure 2-4.
Surface Salinities Measured in the Gulf of Mexico at the TABS Buoy D between 2010 and 2019





Box-chart reference guide

Notes: Data were sourced through GCOOS for TABS Buoy D. https://tabs.gerg.tamu.edu/tglo/ven.php?buoy=D. The data were filtered to remove outliers that fell outside of physical ranges.

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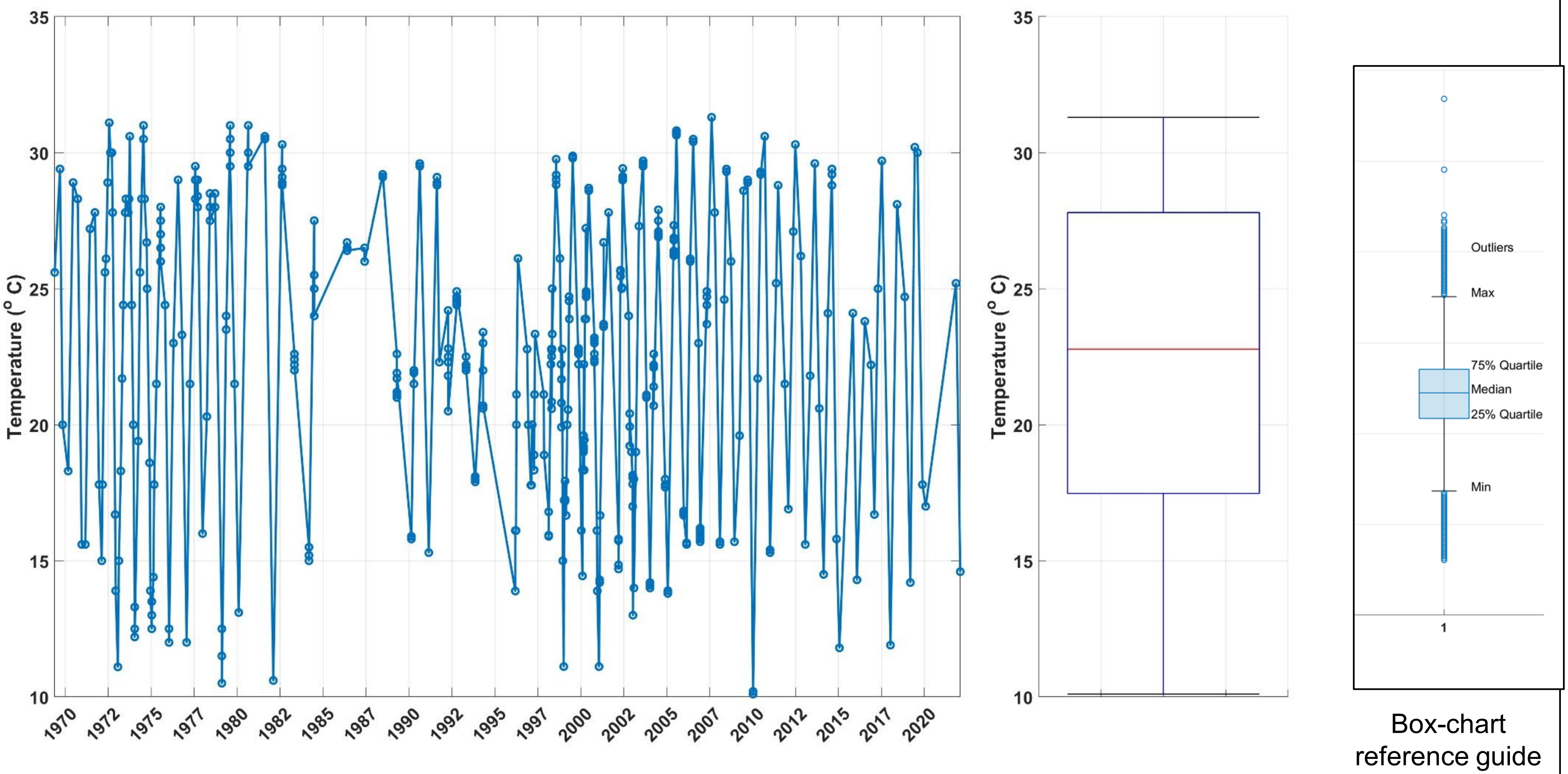
Figure 2-5.
Range of Monthly Surface Salinities Measured in the Gulf of Mexico at TABS buoy D between 2011 and 2019



Notes: Data sourced from the measurements collected by Texas Commission on Environmental Quality at monitoring station 13468.
Box and whisker plots indicate the median, 25th and 75th quartile, statistical minimum and maximum, and outlier points. Outliers are defined as either greater than 1.5*IQR+75th percentile value or less than 25th percentile-1.5*IQR (note: this surface water temperature data set does not contain any outliers).

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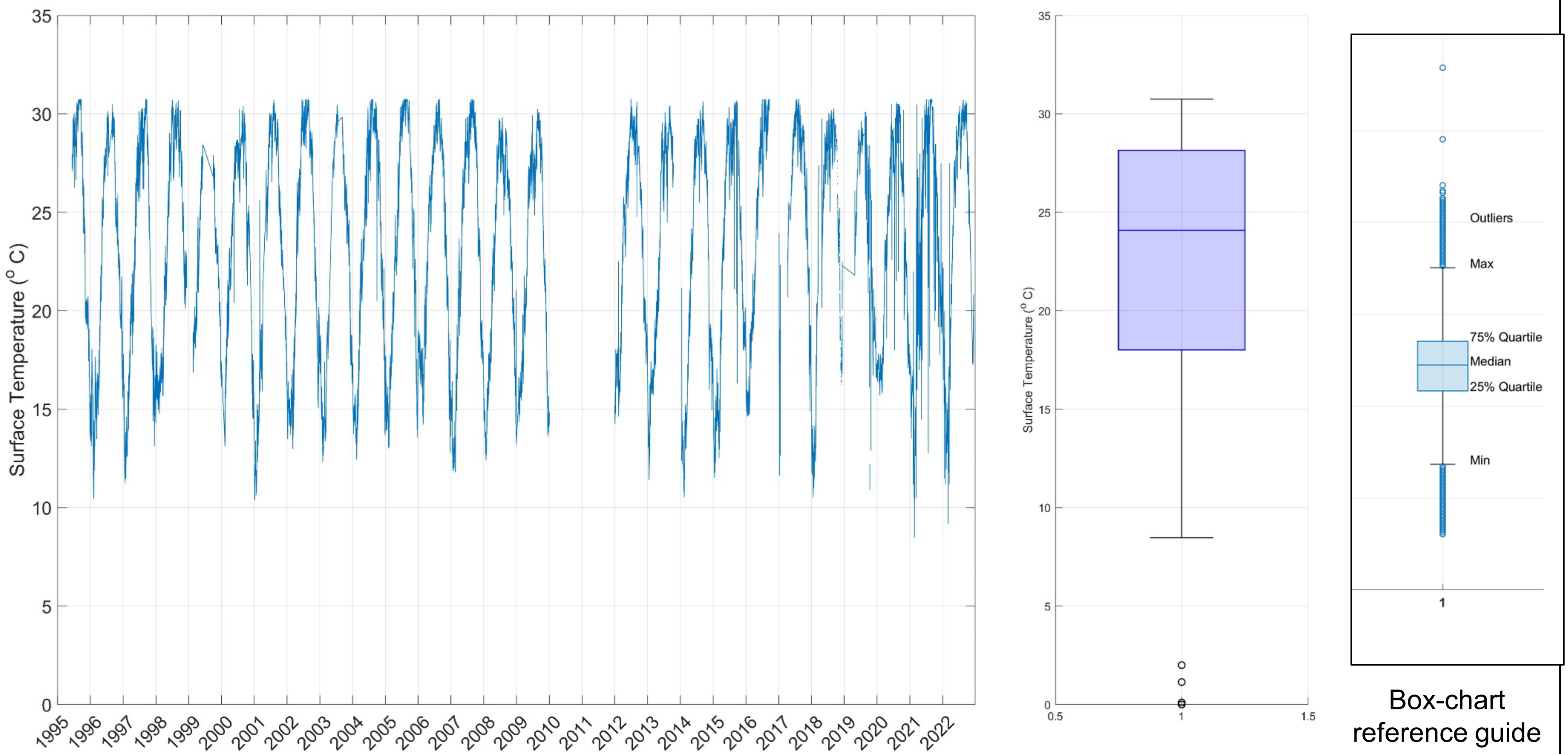
Figure 2-6.
Monthly Variations in Surface Water Temperatures Measured in the Gulf of Mexico at Aransas Inlet between 1989 and 2022



Notes: Data were sourced through GCOOS for TABS Buoy D. https://tabs.gerg.tamu.edu/tglo/ven.php?buoy=D. The data were filtered to remove outliers that fell outside of the physical ranges.

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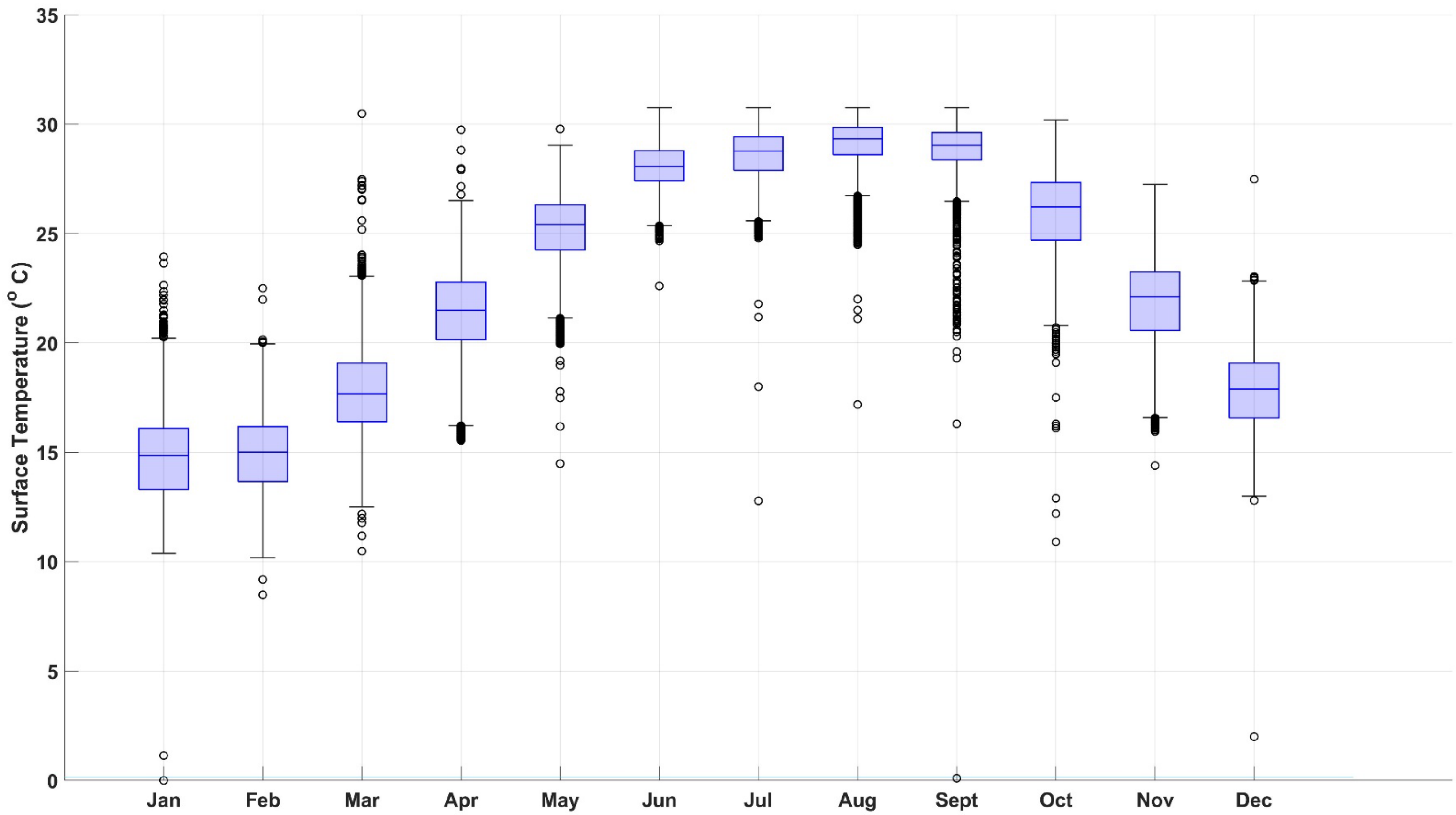
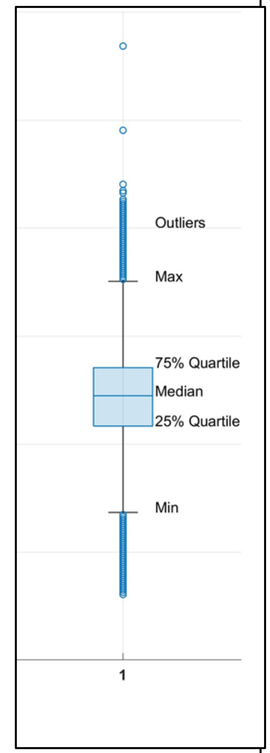
Figure 2-7.
Surface Temperatures Measured in the Gulf of Mexico at the TABS Buoy D between 2010 and 2019





Box-chart reference guide

Notes: Data were sourced through GCOOS for TABS Buoy D. https://tabs.gerg.tamu.edu/tglo/ven.php?buoy=D. Timeseries data were filtered prior to analysis to remove outliers deemed outside physical ranges.

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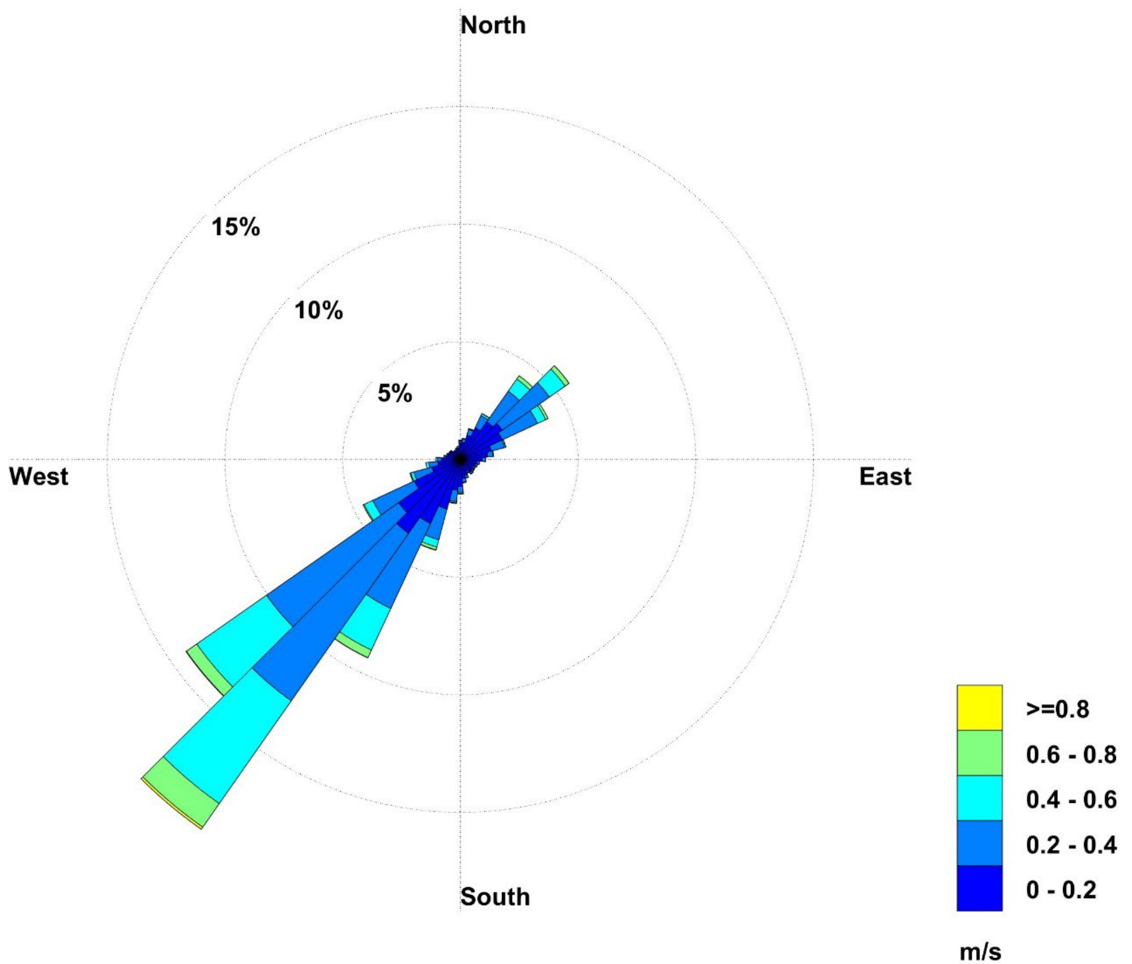
Figure 2-8.
Range of Monthly Surface Temperatures Measured in the Gulf of Mexico at TABS Buoy D between 2011 and 2019



Notes: Data were sourced through GCOOS for TABS Buoy D. https://tabs.gerg.tamu.edu/tglo/ven.php?buoy=D. Timeseries data were filtered to remove outliers deemed outside physical ranges prior to analysis. Percentage rings represent occurrence of that directional bin. Intake velocity is a constant 0.5 ft/s (0.15 m/s).

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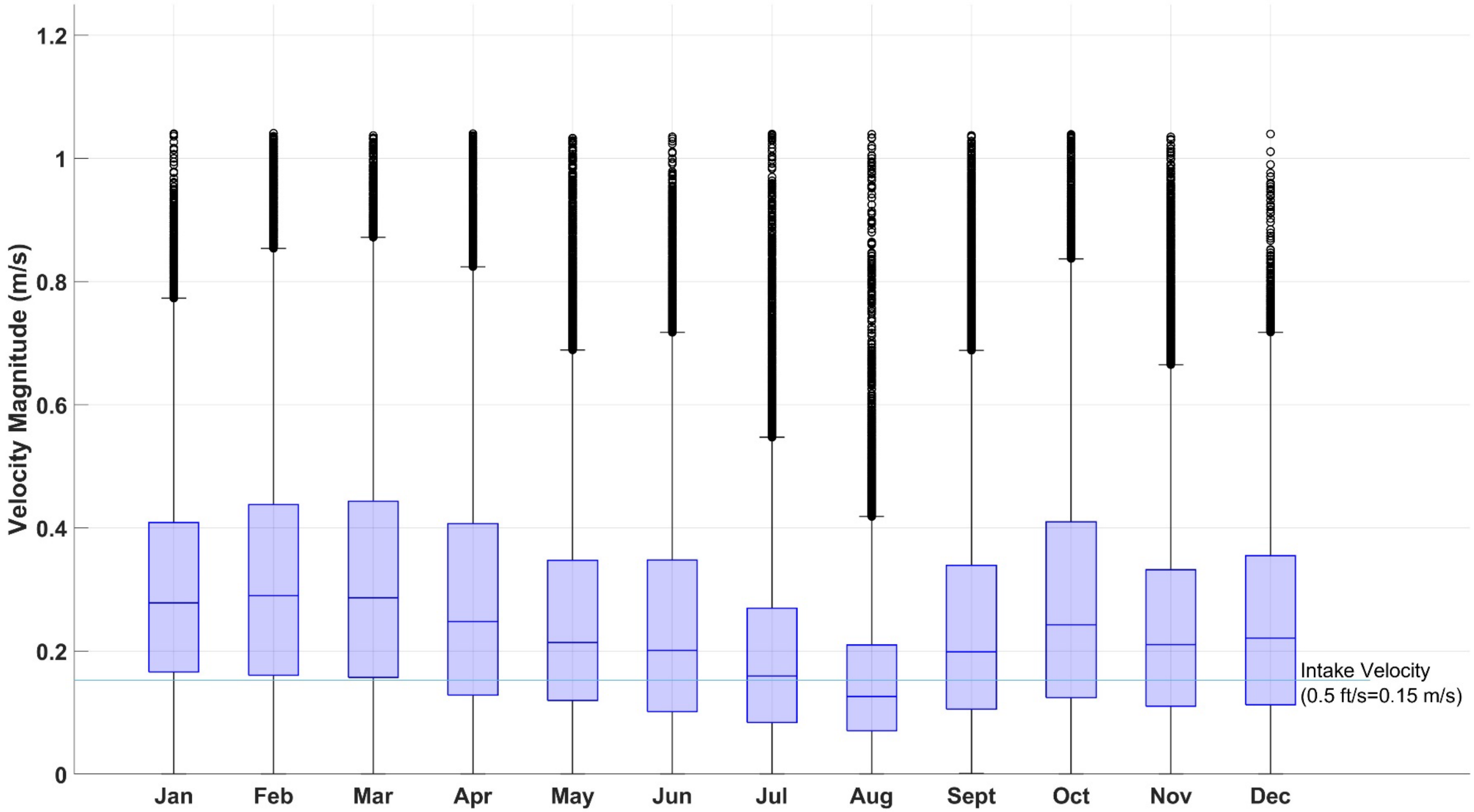
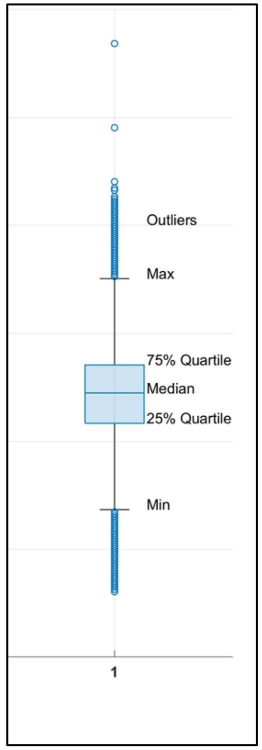
Figure 2-9.
Velocity Rose Showing Variations in the Speed, Magnitude, and Flow Direction of the Tidal Currents Measured in the Gulf of Mexico at the TABS-D Buoy over a 27-year Period





Box-chart reference guide

Notes: Data were sourced through GCOOS for TABS Buoy D. https://tabs.gerg.tamu.edu/tglo/ven.php?buoy=D. The data were filtered to remove outliers that fell outside the physical ranges. The intake velocity of 0.5 ft/s (0.15 m/s) at the velocity caps is included for comparison.

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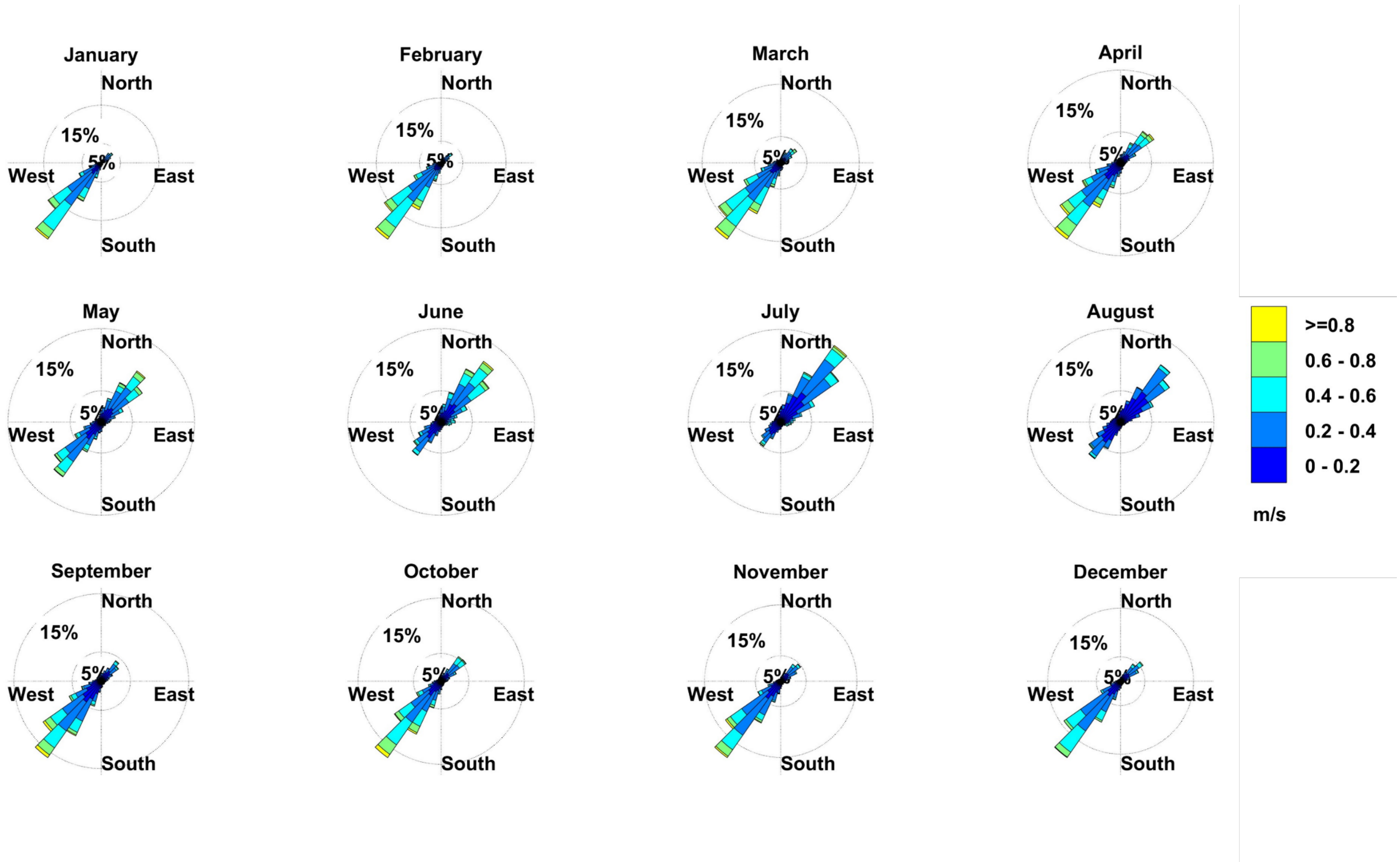
Figure 2-10.
Range of Monthly Velocity Magnitudes Measured in the Gulf of Mexico at TABS Buoy D over a 27-year period



Notes: Data were sourced through GCOOS for TABS Buoy D. https://tabs.gerg.tamu.edu/tglo/ven.php?buoy=D. Timeseries data were filtered to remove outliers deemed outside physical ranges prior to analysis. Percentage rings represent occurrence of that directional bin. Intake velocity is a constant 0.5 ft/s (0.15 m/s).

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Figure 2-11.
Monthly variations in the Speed, Magnitude, and Direction of the Tidal Currents Measured in the Gulf of Mexico at the TABS-D Buoy over a 27-year period

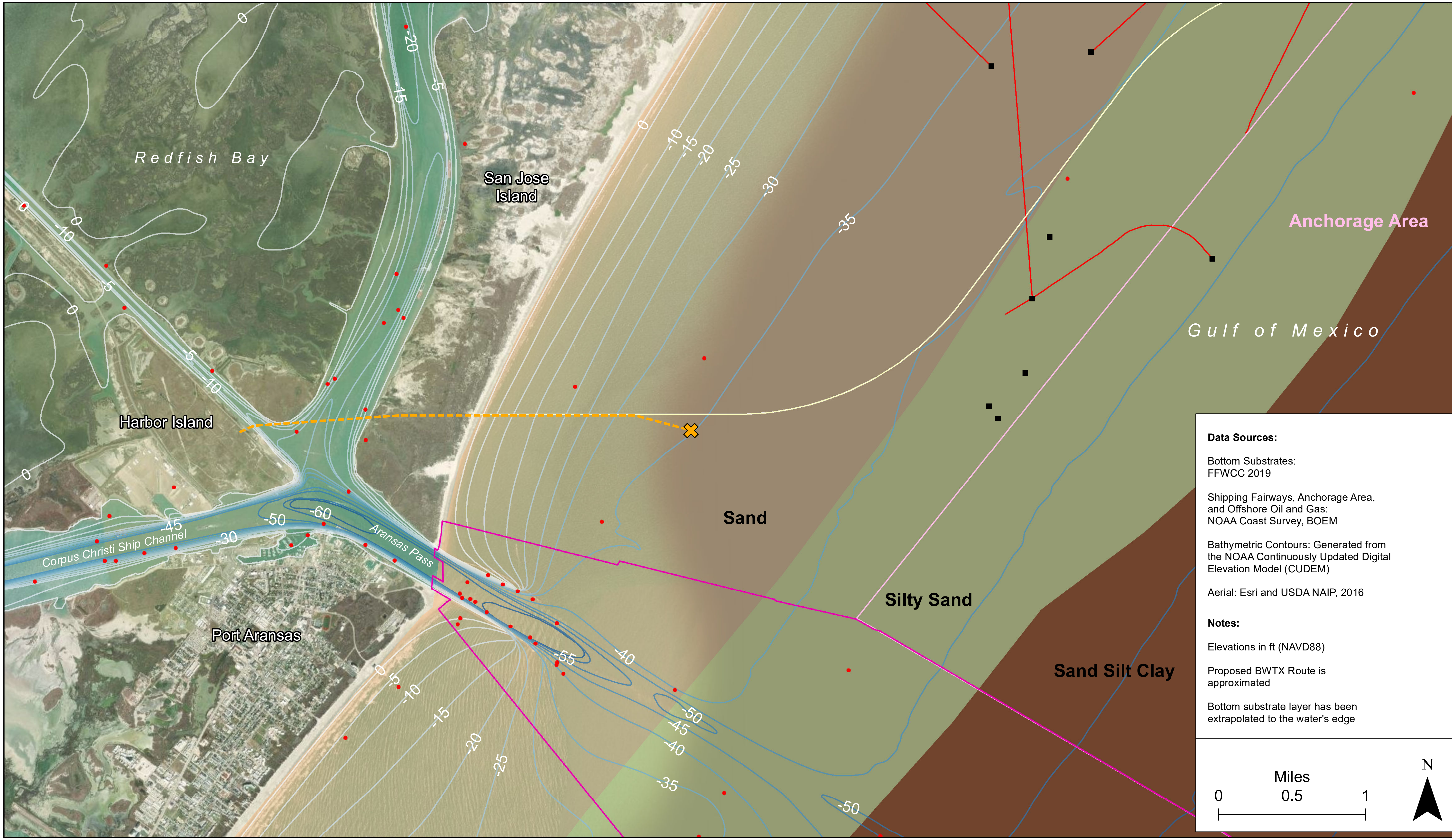
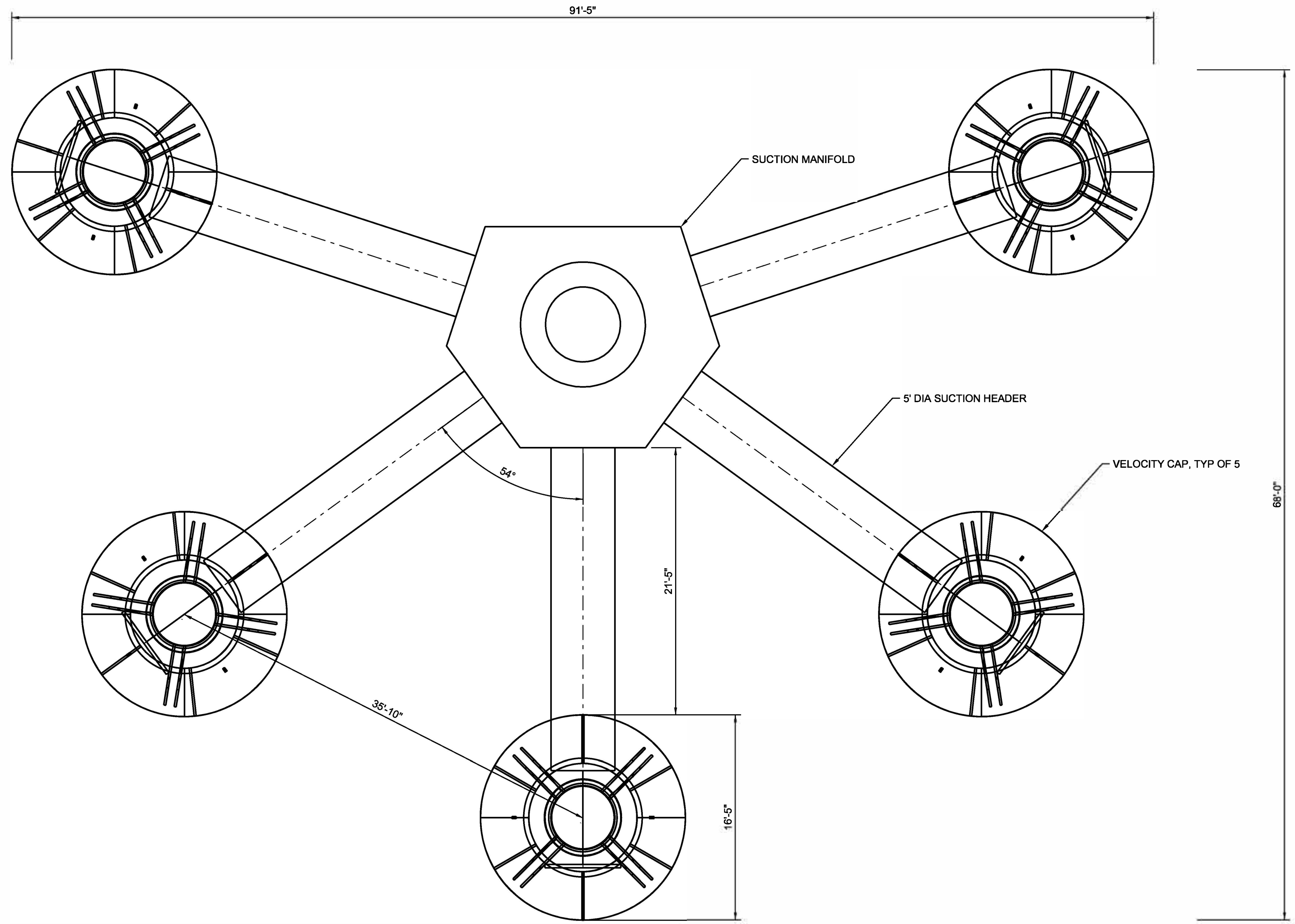


Figure 2-12
General Substrate Composition in the Gulf of Mexico Outside of the Aransas Inlet

GENERAL NOTES

1. DIMENSIONS PRESENTED FOR PRELIMINARY LAYOUT AND APPROXIMATE SIZING ONLY. NOT INTENDED FOR CONSTRUCTION.



PLAN
3/16"=1'-0"

WARNING
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

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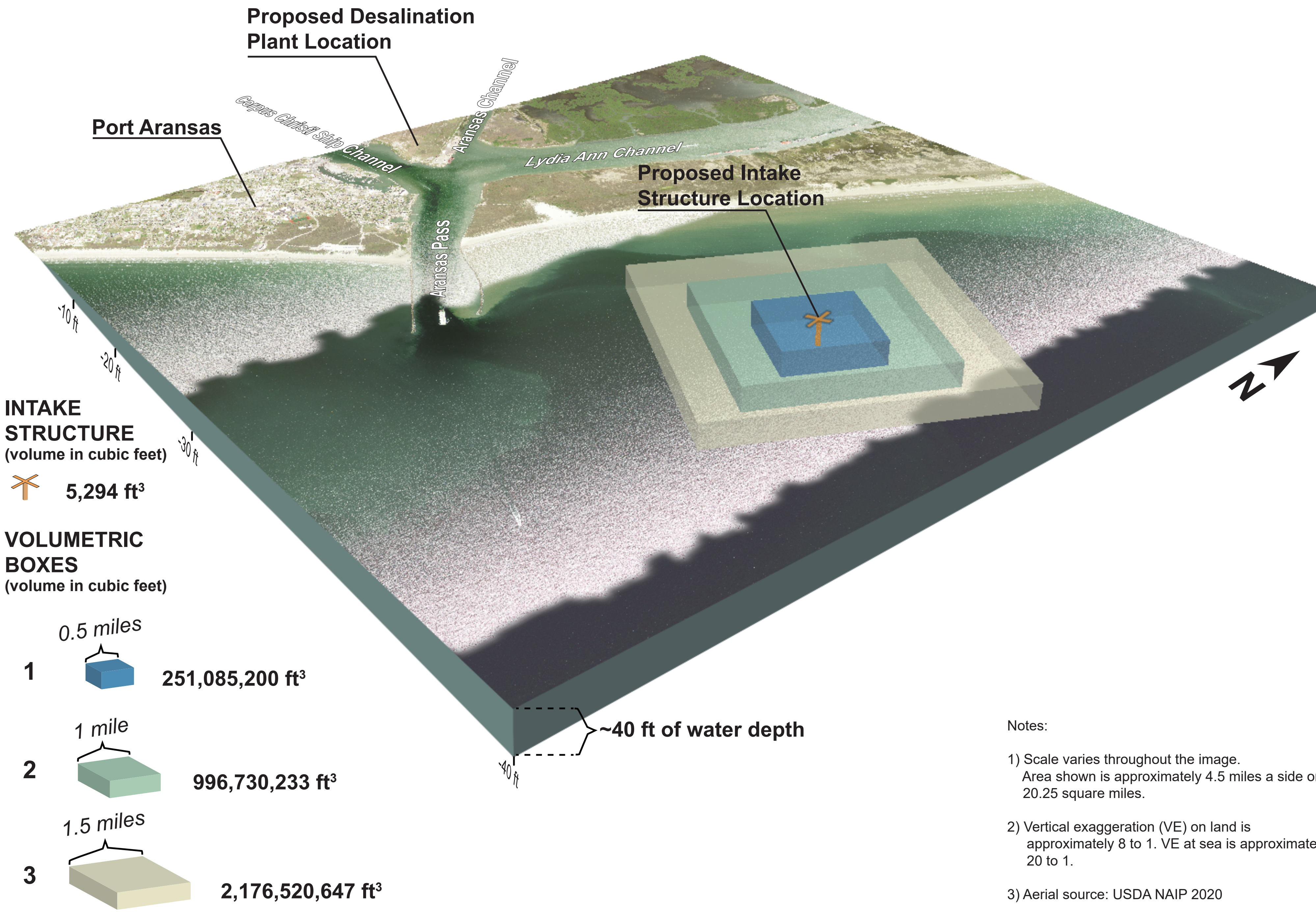
PORT CORPUS CHRISTI

PORT OF CORPUS CHRISTI
PROPOSED INTAKE FOR DESALINATION FACILITY
BASIS OF DESIGN REPORT
HARBOR ISLAND, CORPUS CHRISTI, TEXAS

FIGURE 3-1
INTAKE AND MANIFOLD PLAN

OCT 2022



Notes:

1) Scale varies throughout the image. Area shown is approximately 4.5 miles a side or 20.25 square miles.

2) Vertical exaggeration (VE) on land is approximately 8 to 1. VE at sea is approximately 20 to 1.

3) Aerial source: USDA NAIP 2020

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Figure 3-2.
Location of the Proposed State Water Intake Structure with the Three Volumetric Boxes

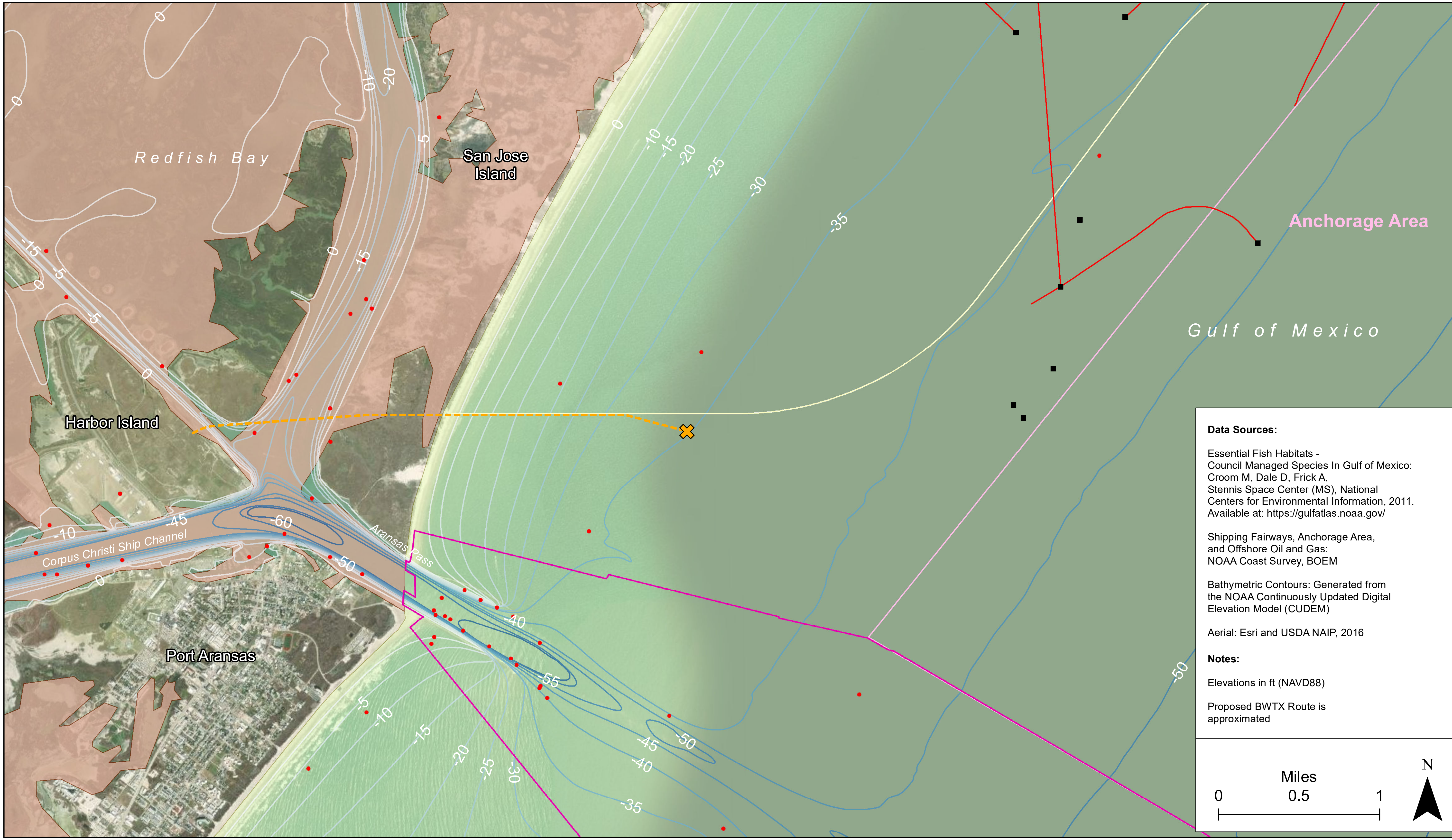

Figure 4-1
Essential Fish Habitat, Harbor Island Desalination Facility, Port Aransas, TX

Legend

Essential Fish Habitat (EFH) Species Occurrence Areas
- Red Drum, Shrimp, Reef Fish, Coastal Migratory Pelagics
- Shrimp, Reef Fish, Coastal Migratory Pelagics
- Proposed Location of the Intake Structure
- Proposed Location of the Intake Tunnel
- Anchorage Area
- Shipping Fairways
- Proposed BWTX Route
- Offshore Oil & Gas Pipelines
- Wrecks and Obstructions
- Offshore Oil & Gas Feature

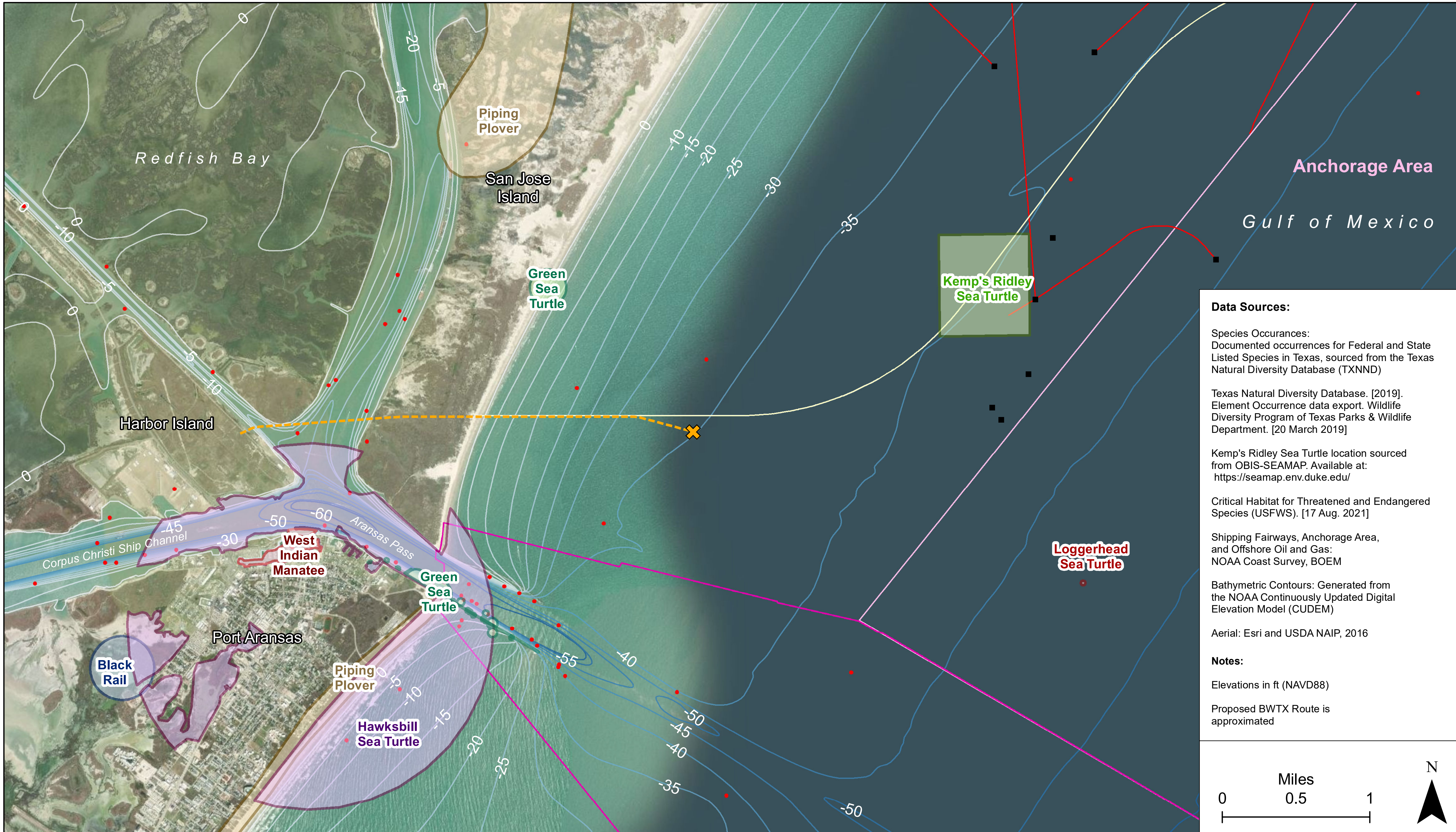

Figure 4-2
Reported Presence of Threatened and Endangered Marine Species, Harbor Island Desalination Plant, Port Aransas, TX

Legend

Species Occurances
- Black Rail
- Piping Plover (Last obs. year: 1991)
- Kemp's Ridley Sea Turtle (Last obs. year: 2013)
- West Indian Manatee (Last obs. year: 2016)
- Green Sea Turtle (Last obs. year: 2008)
- Hawksbill Sea Turtle (Last obs. year: 1958)
- Loggerhead Sea Turtle (Last obs. year: 2004)

- Proposed BWTX Route
- Proposed Location of the Intake Tunnel
- Proposed Location of the Intake Structure
- Anchorage Area
- Shipping Fairways
- Offshore Oil & Gas Pipelines
- Wrecks and Obstructions
- Offshore Oil & Gas Feature

Tables

Table 3-1. Volumetric Calculations

Volumetric Box	Shape	Length (ft)	Length (mi)	Surface Area (ft^2)	Surface Area (acres)	Surface Area (mi^2)	Volume (ft^3)[a]	Volume (U.S. gal)	Volume (acre feet)	Ratio of Intake Volume	Method
	Intake structure	--	--	--	--	--	5,294	39,602	0.1	--	--
1	Square box	2,640	0.50	6,969,600	160	0.25	251,085,200	1,878,247,862	5,764.1	0.000021084	Polygon over TIN
2	Square box	5,280	1.00	27,878,400	640	1.0	996,730,233	7,456,060,441	22,881.8	0.000005311	Polygon over TIN
3	Square box	7,920	1.50	62,726,400	1,440	2.25	2,176,520,647	16,281,506,232	49,966.2	0.000002432	Polygon over TIN

Notes:

See Figure 3-2 in this report for details on location.

TIN = triangulated irregular network

[a] See the report text for calculating the volume of water present in the five velocity caps of the intake structure. The estimated volume of water associated with each volumetric box was calculated in the ArcGIS software environment using the "Polygon Volume" tool of the 3D Analyst extension. The volumes represent the area enclosed within the plane of the squares, referenced at mean sea level (0.93 ft NAVD 88), and the sea bed underneath them, referenced to NOAA's continuously updated digital elevation model bathymetry.

Table 3-2. Ichthyoplankton Density Comparisons among Volumetric Boxes

Life Stage	Average Ichthyo-plankton Density[a] (organisms/ft^3)	Estimated Number of Ichthyoplankton in Intake Structure and Volumetric Boxes[b]			
		Intake Structure	Volumetrix Boxes 1	Volumetrix Boxes 2	Volumetrix Boxes 3
Eggs	0.1388	7.35E+02	3.49E+07	1.38E+08	3.02E+08
Larvae	0.2152	1.14E+03	5.40E+07	2.14E+08	4.68E+08

Notes:

[a] Bluewater Texas Terminals LLC. 2021. Appendix U: Ichthyoplankton Assessment, Volume II: Environmental Evaluation. Available at: https://downloads.regulations.gov/MARAD-2019-0094-0004/attachment_41.pdf

[b] See Figure 3-2 in this report.

Example calculation for eggs in the intake structure: volume = 5,294 ft^3; estimated number of eggs = 5,294 ft^3 X 0.1388 eggs/ft^3 = 735 eggs

Table 4-1. Managed Fish Species in the Vicinity of the Project Area by Life Stage

		Life Stage				
Scientific Name	Common Name	Eggs	Larvae	Juveniles	Adults	Spawning Adults
Shrimp						
Farfantepenaeus aztecus	Brown shrimp	--	x	x	--	--
Farfantepenaeus duorarum	Pink shrimp	x	x	x	x	x
Litopenaeus setiferus	White shrimp	x	x	x	x	x
Red Drum						
Sciaenops ocellatus	Red drum	--	x	x	x	--
Reef Fish						
Balistes capriscus	Gray triggerfish	x	x	x	x	x
Epinephelus itajara	Goliath grouper	--	--	x	x	x
Hyporthodus flavolimbatus	Yellowedge grouper	--	--	x	--	--
Lutjanus campechanus	Red snapper	--	--	--	x	--
Lutjanus griseus	Gray (mangrove) snapper	--	--	--	x	x
Lutjanus synagris	Lane snapper	x	x	x	x	x
Mycteroperca microlepis	Gag	--	--	--	x	--
Seriola dumerili	Greater amberjack	x	x	x	x	x
Seriola fasciata	Lesser amberjack	x	x	--	--	--
Seriola rivoliana	Almaco jack	x	x	x	x	x
Coastal Migratory Pelagic Fishes						
Scomberomorus cavalla	King mackerel	--	--	x	x	--
Scomberomorus maculatus	Spanish mackerel	--	x	--	--	--
Rachycentron canadum	Cobia	x	x	x	x	x

Source:
GMFMC (2016)

Notes:
The proposed project area is approximately 1.5 miles from the Aransas Inlet Jetty, Texas, in approximately 35 ft (10.7 m) of water. This area corresponds to GMFMC nearshore habitat in Ecoregion 5.

This list includes all the GMFCM-managed species for which at least one life stage occurs in GMFMC Ecoregion 5 and that are known to reside in water depths shallower than the 55 ft (17 m).

GMFCM = Gulf of Mexico Fishery Management Council

-- = the species is not identified as occurring in Ecoregion 5 for the indicated life stage

x = the species is identified as occurring in Ecoregion 5 for the indicated life stage

Table 4-2. Highly Migratory Fish Species in the Vicinity of the Project Area by Life Stage

Common Name	Scientific Name	Spawning/ Eggs/ Larvae[a]	Neonates[a]	Juveniles	Adults
Sailfish	*Istiophorus platypterus*	--	N/A	x	x
Scalloped hammerhead shark	*Sphyrna lewini*	N/A	x	--	--
Blacktip shark	*Carcharhinus limbatus*	N/A	x	x	x
Bull shark	*Carcharhinus leucas*	N/A	--	x	x
Lemon shark	*Negaprion brevirostris*	N/A	x	x	--
Spinner shark	*Carcharhinus brevipinna*	N/A	x	x	x
Bonnethead shark	*Sphyrna tiburo*	N/A	x	x	x
Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	N/A	x	x	x
Blacknose shark	*Carcharhinus acronotus*	N/A	--	x	x
Finetooth shark	*Carcharhinus isodon*	N/A	x	x	x

Sources:

NMFS (2017)

NOAA Essential Fish Habitat (EFH) Mapper. www.habitat.noaa.gov/apps/efhmapper. Accessed September 2022.

Notes:

The proposed project area is approximately 1.5 miles from the Aransas Inlet Jetty in approximately 35 ft (10.7 m) of water.

The list shows species managed by the Consolidated Atlantic Highly Migratory Species Fishery Management Plan, and known to occur within the project area.

-- = the species is not identified as occurring in the project area for the indicated life stage

X = the species is identified as occurring in the project area for the indicated life stage

N/A = data are not available for the species at the indicated life stage

[a] The earliest life stages for the sailfish, a type of billfish, are eggs and larvae; the earliest life stage for most sharks is the fully-formed newborn pup.

Table 4-3. Threatened and Endangered Marine Species that May Occur in the Vicinity of the Project Area

Scientific Name	Common Name	Federal Status	State Status	Source[a]	Range & Habitat Requirements[b]	Potential of Occurrence in Project Area[b]	Potential for I&E
Fish							
Acipenser oxyrinchus desotoi	Gulf sturgeon	T, Protected Fish		NOAA	Historically, this species occurred from the Mississippi River east to Tampa Bay. Sporadic occurrences were recorded as far west as the Rio Grande River in Texas and Mexico, and to Florida Bay in the east. Their present range extends from Lake Pontchartrain and the Pearl River system in Louisiana and Mississippi, respectively, east to the Suwannee River in Florida. Based on current data, populations continue to reproduce in seven river systems (Pearl, Pascagoula, Escambia, Yellow/Blackwater, Choctawhatchee, Apalachicola, and Suwannee rivers). In addition to the seven spawning riverine populations, Gulf sturgeon are also known to inhabit the Mobile and Ochlocknee rivers (NOAA 2022).	The gulf sturgeon is not likely to occur in the project area because its range is farther east. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in the project area.
Carcharhinus longimanus	Oceanic whitetip shark	T, Protected Fish	T	TPWD, NOAA	This pelagic species lives throughout tropical and sub-tropical waters. It generally prefers offshore habitats in the open ocean along the outer continental shelf or near ocean islands in waters with depths above 600 ft (182.9 m; NOAA 2022). The oceanic whitetip shark is protected throughout its range.	The location of the proposed water intake structure is at a depth of about 35 ft, which is not the preferred depth for the oceanic whitetip shark. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species lacks a larval phase (young are born fully formed), and pups measure between 55 and 77 cm (21.7 and 30.3 in.) at birth. Pups are too large to fit through 3-inch mesh bar screens.
Epinephelus striatus	Nassau grouper	T, Protected Fish		NOAA	This species is found in tropical and subtropical waters of the western North Atlantic. The Nassau grouper is considered a reef fish, but it transitions as it grows through a series of shifts in both habitat and diet. The larvae are planktonic. The juveniles are found in nearshore shallow waters in macroalgal and seagrass habitats, and shift deeper as they grow, to predominantly reef habitat (forereef and reef crest) (NOAA 2022).	The Nassau grouper does not occur in this region. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in the project area.
Isurus oxyrinchus	Shortfin mako shark	Candidate	T	TPWD	This pelagic, fast-swimming species is found in tropical and temperate waters circumglobally. Mako sharks use a variety of habitats during their long-distance migrations, including open-ocean and more shallow waters along the continental shelf. Although rare, recreational anglers have reported catching large, mature mako sharks from shore (Gibson et al 2021).	The shortfin mako shark may occur in the project area because it has been caught recreationally in inshore areas. However, this species is highly mobile and its preferred habitat is much further off-shore.	No potential for I&E. This species lacks a larval phase (young are born fully formed), and pups measure between 70 and 80 cm (27.6 and 31.5 in.) at birth. Pups are too large to fit through 3-inch mesh bar screens.
Manta birostris	Giant manta ray	T, Protected Fish		NOAA	This species is a migratory pelagic species that prefers sparse, highly-fragmented habitats within tropical, sub-tropical, and temperate marine waters. Populations within the GOM are small and sparsely distributed; however, a population of this species occurs within the Flower Garden Banks National Marine Sanctuary, located 100 nautical miles offshore of Galveston, Texas, in the northwestern GOM. These filter feeders are known to occur near the Yucatan Peninsula as well as other areas of the GOM (NOAA 2022). This species is protected throughout its range.	A known population of this species lives within the GOM and could transit through the area of the proposed water intake structure. However, given the distance of known populations of this species from Port Aransas and their general habitat preferences, it is unlikely that they would be impacted by the proposed project. The Texas Natural Diversity Database does not record the presence of giant manta rays in the project area (TXNDD 2019).	No potential for I&E. This species lacks a larval phase (young are born fully formed), and newborn pups have wingspans measuring between 91 and 183 cm (36 and 72 in.) Pups are too large to fit through 3-inch mesh bar screens.
Pristis pectinata	Smalltooth sawfish	E, Protected Fish		NOAA	The entire U.S. population of smalltooth sawfish is protected. These fish live in tropical seas and estuaries, feeding on a variety of fish and invertebrates such as shrimp and crabs. This species historically occurred in the Gulf Coast from Texas to Florida, but is now only found near Florida. It is extirpated from the Texas coast due to habitat loss and accidental captures (NOAA 2022).	The smalltooth sawfish does not occur in the project area. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in the project area.
Pristis pristis	Largetooth sawfish	E, Protected Fish		NOAA	This species was historically found in tropical and subtropical waters of all the oceans around the globe. However, they are now considered extirpated or extremely rare in portions of their former range (NOAA 2022).	The largetooth sawfish is considered extirpated from the region. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.

Table 4-3. Threatened and Endangered Marine Species that May Occur in the Vicinity of the Project Area

Scientific Name	Common Name	Federal Status	State Status	Source[a]	Range & Habitat Requirements[b]	Potential of Occurrence in Project Area[b]	Potential for I&E
Mammals							
Balaenoptera borealis	Sei whale	E	E	IPaC, NOAA, TPWD	This species has a wide distribution and lives in subtropical, temperate, and subpolar waters around the world. These whales prefer temperate waters in the mid-latitudes, and can be found in the Atlantic, Indian, and Pacific Oceans. During the summer, they are commonly found in the Gulf of Maine, and on Georges Bank and Stellwagen Bank off the U.S. coast in the western North Atlantic. The movement patterns of sei whales are not well known, but they are typically observed in deeper waters far from the coastline (NOAA 2022).	The sei whale is unlikely to occur in the project area because of habitat limitations. This species prefers deeper habitats. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.
Balaenoptera musculus	Blue whale	E	E	IPaC, NOAA, TPWD	This species Inhabits tropical, subtropical, temperate, and subpolar waters worldwide, but is infrequently sighted in the GOM. The whales migrate seasonally between summer feeding grounds and winter breeding grounds, but specifics vary. They are commonly observed at the surface in open ocean (Schmidly and Bradley 2016; NOAA 2022).	The blue whale is unlikely to occur in the project area because of the shallow water depth. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.
Balaenoptera ricei [c]	Rice's whale[c]	E	E	IPaC, NOAA, TPWD	The historical distribution of this species may have once encompassed the northern and southern GOM. For the past 25 years, Rice's whales in U.S. waters of the GOM have been consistently located in the northeastern GOM along the continental shelf between roughly 100 and 400 m depth. A single Rice's whale was observed in the western GOM off the coast of Texas, suggesting that their distribution may occasionally include waters elsewhere in the GOM (Schmidly and Bradley 2016; NOAA 2022).	The Bryde's whale is unlikely to occur in the project area because of habitat limitations. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.
Eubalaena glacialis	North Atlantic right whale	E	E	IPaC, NOAA, TPWD	This species inhabits subtropical and temperate waters in the northern Atlantic. The north-Atlantic right whale is very rare in the GOM, and the few reported sightings are likely vagrants (Ward-Geiger et al. 2011). They are known in Texas from a single individual that beached in February 1972 at Surfside Beach near Freeport, Brazoria County (Schmidly and Bradley 2016).	The north Atlantic right whale is unlikely to occur in the project area because its preferred habitat is much farther east. This species occurs only accidentally in the GOM, and this is certainly one of the rarest of cetaceans in these waters. The central Gulf may have been a whaling ground for right whales in the 1880s, but nothing is known of that reputed whaling effort. Only one stranding has been reported along the Texas coast. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.
Globicephala macrorhynchus	Short-finned pilot whale	MMPA Protected	T	NOAA	This species is found in warm temperate to tropical waters worldwide, generally in deep offshore areas. Short-finned pilot whales are common in the GOM, with numerous stranding and sighting records available from Texas. They are seen inshore at infrequent intervals and occasionally become stranded by severe storms. They are among the most frequently stranded of cetaceans and often mass strand. These cetaceans have mass stranded 15 times in the GOM, although none of the events occurred in Texas (Schmidly and Bradley 2016). Their main foraging habitats consist of areas with high squid densities.	The short-finned pilot whale is unlikely to occur in the project area because of habitat limitations. This species typically prefers deeper waters. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.
Kogia breviceps	Pygmy sperm whale	MMPA Protected	T	NOAA, TPWD	This species has a wide distribution. Pigmy sperm whales live in tropical, subtropical, and temperate waters in oceans and seas around the world. They are most common off coasts and along continental shelves. In the U.S., these whales live off the coasts of Hawai'i, the Pacific Northwest, the North Atlantic, and the northern GOM (NOAA 2022).	The pygmy sperm whale is unlikely to occur in the project area because of habitat limitations. It is a highly mobile species that prefers deeper waters. A local population is unknown, and recorded observations are mostly from strandings along beaches in the GOM. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.

Table 4-3. Threatened and Endangered Marine Species that May Occur in the Vicinity of the Project Area

Scientific Name	Common Name	Federal Status	State Status	Source[a]	Range & Habitat Requirements[b]	Potential of Occurrence in Project Area[b]	Potential for I&E
Kogia simus	Dwarf sperm whale	MMPA Protected	T	NOAA, TPWD	In the western North Atlantic, these whales are known from Virginia to the Lesser Antilles and the GOM. They strand fairly frequently. The most recent stranding period (2002–2014) included 10 strandings from six counties along the Texas coast (Schmidly and Bradley 2016; NOAA 2022).	The dwarf sperm whale is unlikely to occur in the project area, even though it contains potentially suitable habitat. However, this species is highly mobile and prefers deeper habitats. Local population are unknown, and the observations represent strandings along the coastline in GOM. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.
Megaptera novaeangliae	Humpback whale	E		IPaC, NOAA, TPWD	This species inhabits tropical, subtropical, temperate, and subpolar waters world wide, but is rare in the GOM. Humpback whales migrate up to 5,000 miles between colder water (feeding grounds) and warmer water (calving grounds) each year (NOAA 2022). They use both open ocean and coastal waters, sometimes including inshore areas such as bays, and are often found near the surface. The northwest Atlantic/GOM distinct population segment is not considered at risk of extinction and is not listed as Endangered on the Endangered Species Act.	The humpback whale is unlikely to occur in the project area because of habitat limitations. Historically in the GOM, humpback whales were occasionally hunted near the Florida Keys, but they are uncommon in the Gulf proper. Only seven confirmed records have been reported in the GOM. Sightings have been made off the west coast of Florida and near Alabama in the eastern Gulf and off the jetties in Galveston, Texas. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.
Mesoplodon europaeus	Gervais beaked whale	MMPA Protected	T	NOAA	This species is known primarily from the western North Atlantic, but members fairly commonly strand themselves in the GOM. Almost nothing is known about the life history of these whales. They are believed to inhabit deep waters close to shore, but little information is available on movements. They feed on squid and fish. This species prefers deep tropical, subtropical, and warm temperate waters of the Atlantic Ocean but is occasionally found in colder temperate seas (NOAA 2022). Strandings of Gervais's beaked whales are believed to be associated with calving, which probably takes place in shallow waters. A pregnant female with a near-term fetus stranded along the Texas coast (Schmidly and Bradley 2016). Specific data on their reproductive habits are not available.	The Gervais beaked whale is unlikely to occur in the project area because of unsuitable habitat. Several strandings have been reported in the northern GOM, including on Texas beaches, and this is considered the most abundant of the Mesoplodon species in the region. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.
Orcinus orca	Killer whale	MMPA Protected	T	NOAA	Killer whales live throughout all oceans and contiguous seas, from equatorial regions to polar pack-ice zones, but they are more numerous in nearshore cold temperate to subpolar waters. They are rare in the GOM, although sightings have increased in recent years. They are known in Texas based on one stranding on South Padre Island and one sighting in waters off Port Aransas (Schmidly and Bradley 2016).	The killer whale is unlikely to occur in the project area because of habitat limitations. The species is also uncommon in the area. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.
Physeter macrocephalus	Sperm whale	E	E	IPaC, NOAA, TPWD	This species inhabits tropical, subtropical, and temperate waters world wide, avoiding icy waters. Distribution is highly dependent on the sperm whale's food source (squids, sharks, skates, and fish), breeding, and pod composition. In general, this species migrates from north to south in the winter and south to north in the summer; however, individuals in tropical and temperate waters don't seem to migrate at all. They routinely dive to catch their prey (2,000-10,000 f) and generally occupy water at least 3,300 ft deep near ocean trenches (NOAA 2022).	The sperm whale is unlikely to occur in the project area because of habitat limitations. This species prefers deeper waters. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.
Pseudorca crassidens	False killer whale	E	T	NOAA	False killer whales are found globally in all tropical and subtropical oceans and generally in deep offshore waters. They generally prefer offshore tropical to subtropical waters deeper than 3,300 ft. Numerous strandings and sightings have occurred in the GOM, including a few strandings from the upper Texas coast (Schmidly and Bradley 2016).	The false killer whale is not likely to occur in the project area because it lacks the deeper off-shore habitat preferred by this species. No local population are known to occur and the observations represent strandings on beaches in the GOM. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.

Table 4-3. Threatened and Endangered Marine Species that May Occur in the Vicinity of the Project Area

Scientific Name	Common Name	Federal Status	State Status	Source[a]	Range & Habitat Requirements[b]	Potential of Occurrence in Project Area[b]	Potential for I&E
Stenella frontalis	Atlantic spotted dolphin	T	T	TPWD	This pelagic species is found in 65-820 ft deep water near the continental shelf but is also found in coastal waters. It is a common offshore dolphin of the GOM that only rarely strands along the Texas coast (Schmidly and Bradley 2016). The species has been observed from about the 20- to the 200-m (66–656 ft) depth curves (Schmidly and Bradley 2016).	The Atlantic spotted dolphin may occur on the project area because it contains habitat that may be used by this species. However, this common dolphin is mostly pelagic and highly mobile. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.
Steno bredanensis	Rough-toothed dolphin	MMPA Protected	T	NOAA	This species occurs in tropical and warm temperate waters around the world. Although rough-toothed dolphins are not very common in the GOM, they can occur at any time of the year. Their presence in Texas is known based on two historical strandings near Galveston and four more in the recent stranding record (2002–2014) from three counties (Kleberg, Brazoria, and Kennedy) (Schmidly and Bradley 2016). These are generally offshore, deep-water dolphins.	The rough-toothed dolphin is unlikely to occur on the project area because of habitat limitations. It is an uncommon species and recorded observations are mostly from strandings along beaches in the GOM. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.
Trichecus manatus	West Indian Manatee	T	T	IPaC, TPWD	This species rarely occurs as far north as Texas. Manatees frequent warm waters in large rivers, brackish bays, and coastal areas. They are very sensitive to cold water and feed opportunistically on aquatic plants. This species migrates seasonally to adapt to changing water temperature.	The West Indian manatee is unlikely to occur in the project area, even though it contains habitat that might be used by this species. Manatees rarely occur in Texas. The last recorded occurrence was in 2004 near Port Aransas Inlet (TXNDD 2019).	No potential for I&E. This species does not occur in project area.
Ziphius cavirostris	Goose-beaked whale	MMPA Protected	T	NOAA	This species is found in all tropical and temperate waters around the world. Several strandings and sightings have occurred in the northern GOM. There is a stranding recorded in Calhoun County, Texas, in 2004 (Schmidly and Bradley 2016).	The goose-beaked whale is unlikely to occur in the project area because of habitat limitations. 19 strandings have been recorded, mostly from the eastern part of the GOM, with very few from Texas. The TXNDD does not record the presence of this species in the project area (TXNDD 2019).	No potential for I&E. This species does not occur in project area.
Reptiles							
Caretta caretta	Loggerhead sea turtle	T	T	IPaC, NOAA, TPWD	This species is found in the GOM and are occasional visitors to the Texas coast. They migrate from feeding grounds to nesting beaches/barrier islands, and some nesting does occur in Texas (April to September). Beaches that are narrow, steeply sloped, with coarse-grain sand are preferred for nesting. Newly-hatched turtles depend on floating algae/seaweed for protection and foraging, which eventually transport them offshore and into open ocean. Juveniles and young adults spend their lives in open ocean, offshore before migrating to coastal areas to breed and nest. Foraging areas for adults include shallow continental shelf waters (TPWD 2022).	The highly-mobile loggerhead sea turtle is known to occur in the project area because it contains habitat that may be used by this species. The last recorded observation of this species near project area was in 2010 (Olsen 2022). Although uncommon, a green sea turtle nest was documented on Mustang Island (just to the south of Port Aransas) in 2008.	Minimal potential for I&E for all life stages: hatchlings stay close to the surface during the "hatchling frenzy period" when they rapidly swim from shore to their oceanic habitat; 3-inch mesh size bar screens will prevent neritic juveniles and adults from entering the intake structure.
Chelonia mydas	Green sea turtle	T	T	IPaC, NOAA, TPWD	This species is found in the GOM. Adults and juveniles occupy inshore and nearshore areas, including bays and lagoons with reefs and seagrass. Dependent upon life history stage, the green sea turtle has been documented using a variety of habitats. Adults spend most of their time within shallow coastal waterways with large sea grass beds (Reich et al. 2007). Juvenile turtles will spend most of their time within deep pelagic waters (Reich et al. 2007).	The highly-mobile green sea turtle is known to occur in the project area because it contains habitat that may be used by this species. Several occurrences were reported within 5 miles of the project area in 2004 and 2008 (TXNDD 2019). No recent nesting activity has been reported by this species along the beaches in the vicinity of the project area. However, this evaluation assumes that unreported nesting activity might occur and that hatchlings may therefore be present at certain times of the year.	Minimal potential for I&E for all life stages: hatchlings stay close to the surface during the "hatchling frenzy period" when they rapidly swim from shore to their oceanic habitat; 3-inch mesh size bar screens will prevent neritic juveniles and adults from entering the intake structure.
Dermochelys coriacea	Leatherback sea turtle	E	E	IPaC, NOAA, TPWD	This species is found in the GOM. It is the most pelagic of the sea turtle species and performs the longest migrations. It is an omnivore that prefers jellyfish, and nests between February and August. Nesting is not common in Texas (TPWD 2022).	The highly-mobile leatherback sea turtle is unlikely to occur on the project area even though it contains habitat that may be used by this species. The leatherback sea turtle is usually found in the deeper, open ocean rather than nearshore regions. The TXNDD does not record the presence of this species in the project area (TXNDD 2019). However, a leatherback nest was reported on Padre Island in 2008.[d] This evaluation assumes that unreported nesting activity might occur and that hatchlings may therefore be present at certain times of the year.	Minimal potential for I&E for all life stages: hatchlings stay close to the surface during the "hatchling frenzy period" when they rapidly swim from shore to their oceanic habitat; 3-inch mesh size bar screens will prevent neritic juveniles and adults from entering the intake structure.

Table 4-3. Threatened and Endangered Marine Species that May Occur in the Vicinity of the Project Area

Scientific Name	Common Name	Federal Status	State Status	Source[a]	Range & Habitat Requirements[b]	Potential of Occurrence in Project Area[b]	Potential for I&E
Eretmochelys imbricata	Hawksbill sea turtle	E	E	IPaC, NOAA, TPWD	This species is found in the GOM, including Texas. Hatchlings and juveniles are found in open, pelagic ocean and closely associated with floating algae/seagrass mats. Juveniles then migrate to shallower, coastal areas, mainly coral reefs and rocky areas, but also in bays and estuaries near mangroves when reefs are absent, seldom in water more than 65 ft deep. They feed on sponges, jellyfish, sea urchins, mollusks, and crustaceans. Nesting occurs from April to November high up on the beach where there is vegetation for cover and little or no sand. Some migrate, but others stay close to foraging areas (TPWD 2022). In the vicinity of the project area, juveniles occur in the nearshore waters of GoM and the waters near Aransas jetty.	The highly-mobile hawksbill sea turtle has the potential to occur in the project area. According to the TXNDD, the last recorded observation near port Aransas occurred in 1958 (TXNDD 2019). However, the National Park Service reports that juveniles occur in the nearshore waters of GOM and the waters near Aransas jetty. Post-hatchlings about 7.6 cm (3 in.) long have been found washed ashore alive in Sargassum seaweed, and juveniles about 30.5 cm (12 in.) long have been found washed ashore alive and entangled in mesh sacs.[e] Only one hawksbill nest has ever been documented in Texas, which was located at Padre Island National Seashore.[e] However, the project area lacks the coral reef habitat preferred by this species.	Minimal potential for I&E for all life stages: hatchlings stay close to the surface during the "hatchling frenzy period" when they rapidly swim from shore to their oceanic habitat; 3-inch mesh size bar screens will prevent neritic juveniles and adults from entering the intake structure.
Lepidochelys kempii	Kemp's Ridley sea turtle	E	E	IPaC, NOAA, TPWD	This species is found in the GOM. Adults are found in coastal waters with muddy or sandy bottoms. Some males migrate between feeding grounds and breeding grounds, but some don't. Females migrate between feeding and nesting areas, often returning to the same destinations. Nesting in Texas occurs on a smaller scale compared to other areas (i.e., Mexico). Hatchlings are quickly swept out to open water and are rarely found near shore. Similarly, juveniles often congregate near floating algae/seagrass mats off shore, and move into nearshore, coastal, neritic areas after 1-2 years and remain until they reach maturity. They feed primarily on crabs, but also snails, clams, other crustaceans and plants; juveniles feed on sargassum and its associated fauna. This species nests April through August.	The highly-mobile Kemp's Ridley sea turtle is known to occur in the project area because it contains habitat that may be used by this species. The last recorded presence was in 2016 when a Kemp's Ridley sea turtle was observed about 2 miles northeast and 3 miles southeast of the project area (TXNDD 2019). In 2022, a number of Kemp's Ridley nests were reported on beaches close to the project area.[e]	Minimal potential for I&E for all life stages: newborns stay close to the surface during the "hatchling frenzy period" when they rapidly swim from shore to their oceanic habitat; 3-inch mesh size bar screens will prevent neritic juveniles and adults from entering the intake structure.

Notes:

Table includes Federal and State Listed Threatened & Endangered Species that may occur near the proposed location of the intake (Project Area). The habitat of the project area is classified by the FWS as M1UBL, Marine Deepwater, Subtidal, Unconsolidated Bottom.

The following Taxonomic Groups were excluded from the table because they do not occur in Marine Deepwater habitat: All Birds, All Terrestrial species of Reptiles, Amphibians, and Mammals; All Freshwater Fish.

E = Endangered

I&E = impingement and entrainment
GOM = Gulf of Mexico
MMPA = Marine Mammal Protection Act
T = Threatened
TXNDD = Texas Natural Diversity Database

[a]Data Sources:

TPWD = Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. https://tpwd.texas.gov/gis/rtest/. Last Update 7/12/2022. Accessed 8/18/2022.

IPaC = U.S. Fish & Wildlife Service (FWS) Information for Planning and Conservation FWS IPaC Resource list generated 8/18/2022, based on intake location (Informal- Not for Consultation)

NOAA = Threatened and Endangered Species and Critical Habitats Under National Oceanic and Atmospheric Administration (NOAA) Fisheries Jurisdiction. https://www.fisheries.noaa.gov/species-directory/threatened-endangered. Last updated by Southeast Regional Office on 9/1/2021. Accessed September 2022.

[b]Local Habitat Descriptions adapted from TPWD, NOAA, and cited references.

[c]Rice's whale was formerly known as GOM Bryde's whale and listed in 2019 as an endangered subspecies. In 2021, NOAA revised the name and it is now called Rice's whale, *Balaenoptera ricei.*

[d]NPS 2022. https://www.nps.gov/pais/learn/nature/current-nesting-season.htm. Accessed September 9, 2022.

[e]NPS 2022. https://www.nps.gov/pais/learn/nature/hawksbill.htm Accessed September 9, 2022.

NPS 2022. https://www.nps.gov/pais/learn/nature/leatherback.htm. Accessed September 9, 2022.

https://www.seaturtlestatus.org/online-map-data

Table 4-4. Summary of Sea Turtle Life Histories

	Kemp's Ridley (*Lepidochelys kempii*)	Loggerhead (*Caretta caretta*)	Hawksbill (*Eretmochelys imbricata*)	Green (*Chelonia mydas*)	Leatherback (*Dermochelys coriacea*)
Hatchlings					
Size	Mean: 3.8 to 4.4 cm SCL	Mean: 5.4 cm SCL Range: 4.6 to 6.3 cm SCL	Range: 5 to 21 cm SCL	Mean: 5 cm SCL Range: 4.4 to 5.8 cm SCL	Mean: 5.91 to 9.07 cm SCL Range: 7.91 to 9.90 cm SCL
Diet	Not reported	Not reported	*Sargassum* , manatee grass, crab chela, eggs of flying fish, half-beaks, and needlefish	Not reported	Not reported
Post-Hatchlings					
Size	Not reported	Range: 3.9 to 7.8 cm SCL	Not reported	Not reported	Not reported
Duration	Not reported	Estimated value: <1 year	Not reported	Not reported	Estimated value: 1 year
Oceanic Juveniles					
Size	Range: 5 to 19 cm SCL	Estimated range: 15 to 63 cm SCL	Range: 20.1 to 29.1 cm SCL	Mean: 20 cm SCL Range: 15 to 6.3 cm SCL	Range: 10 to 134.7 cm SCL
Duration	Mean: 2 years Estimated maximum: 4 years	Estimated range: 7 to 11.5 years	Not reported	Estimated mean: 2 years	Estimated range: 11 to 13 years
Diet	Marine mollusks associated with the pelagic *Sargassum* community, including brown janthinas, *Cavolinalon girostris* , Sargassum snails, and unidentifiable crabs, *Sargassum* , hardhead catfish, blue crabs, stone crabs, and mottled purse crabs	*Sargassum* , pelagic crustaceans, and mollusks	*Sargassum* , manateegrass, crab chela, eggs of flying fish, half-beaks, and needlefish	Marine animals related to pelagic *Sargassum* , including hydroids, bryozoans, *Membranipora sp.* , portunid crabs, gastropods, serpulid polychaetes, *Porpita sp.* , *Sargassum* nudibranchs, *Vellela sp.,* *Sargassum* snails, *Pyrosoma sp.* ; plane head filefish; *Sargassum* ; and coralline and cladophora algae	*Aurelia sp.* , *Ocryopsis sp.* , warty comb jellyfish, and tunicates
Neritic Juveniles					
Size	Range: 20 to 60 cm SCL	Range: 41.6 to 79.7 cm SCL	Range: 20 to 69 cm SCL	Mean: 34.2 cm SCL Range: 26.6 to 52 cm SCL	Not reported
Duration	Range: 7 to 9 years	Estimated value: 20 years	Not reported	Estimated range: 17 to 19 years	Not reported
Diet	Speckled swimming crabs, blue crabs, longnose spider crabs, mottled purse crabs, *Libinia sp.* , calico crabs, surf hermits, Gulf stone crabs, bruised nassas, sharp nassas, moon snails, concentric nut clams, oysters, *Ovalipes sp.* , flat-clawed hermit crabs, blood ark clams, transverse ark clams, *Anadara sp.* , *Bittium sp.* , angelwing clams, *Epitonium sp.* , dwarf surf clams, *Terebra sp.* , annelids, common sand dollars, mullet American star drums, spot croakers, *Sargassum* , shoal grass, *Gracilaria sp.* , turtle grass, brown shrimp, and white shrimp	Pipe cleaner sea pens, calico crabs, *Libinia sp* ., blue crabs, *Persephona sp.* , bivalves, gastropods, and carrion from fisheries bycatch	Sponges, including *Chondrilla sp.* , *Dictyopteris sp.* , *Hypnea sp.* , *Jania sp.* , *Laurencia sp.* , *Ceramium sp.* , *Codium sp.* , and *Gracilaria sp.*	Turtle grass, shoalgrass, manatee grass, *Laurencia sp.* , and *Entermorpha sp* .	Not reported

Table 4-4. Summary of Sea Turtle Life Histories

	Kemp's Ridley (*Lepidochelys kempii*)	Loggerhead (*Caretta caretta*)	Hawksbill (*Eretmochelys imbricata*)	Green (*Chelonia mydas*)	Leatherback (*Dermochelys coriacea*)
Sexually Mature Adults					
Size	Range: 60 cm SCL	Mean: 79.7 to 92.4 cm SCL Range: 73.7 to 108 cm SCL	Mean: 90 to 99.6 cm SCL Range: 82.7 to 98.6 cm SCL	Mean: 100.3 to 101.8 cm SCL Range: 69.2 to 114 cm SCL	Mean: 147.7 cm SCL Range: 127.4 to 172.7 cm SCL
Age at Sexual Maturity	Mean: 10 years Range 10 to 20 years	Estimated value: 27 years	Minimum: 14 years Mean: 24 to 31.2 years	Estimated range: 18 to 27 years	Range: 12 to 29 years
Diet	Speckled swimming crabs, blue crabs, mottled purse crabs, Libinia sp., calico crabs, surf hermits, Gulf stone crabs, bruised nassas, sharp nassas, moon snails, concentric nut clams, oysters, star drums, spot croakers, Sargassum, shoalgrass, Gracilaria sp., turtle grass, brown shrimp, and white shrimp	Pipe cleaner sea pens, calico crabs, Libinia sp., blue crabs, Persephona sp., bivalves, gastropods, and carrion from fisheries bycatch	Sponges, including chicken liver sponge, demosponges, and button polyp, *Ricordea florida, Ancorina sp., Geodia sp., Placospongia sp., Suberites sp., Myriastra sp., Ecionemia sp., Chondrosia sp., Aaptos sp*., and *Tethya actinia*	Turtle grass, star grass, shoalgrass, manatee grass, eelgrass, algae, jellyfish, sponges, and sea pens	Cannonball jellyfish

Source:
Table adapted from Valverde and Holzwart (2017)

Notes:
SCL = straight carapace length

Table 4-5. Abundant and Common Species in the Vicinity of the Project Area Based on NOAA Catch Data

Organism Type		Zone	Species	Scientific Name	WTCPUE Max
Invertebrate	Cnidarian	Demersal	Sea pansy	*Renilla mulleri*	0.0719
		Pelagic	Sea nettle	*Chrysaora quinquecirrha*	0.2168
	Decapod (Crab)	Demersal	Lesser blue crab	*Callinectes similis*	9.2384
			Blue crab	*Callinectes sapidus*	0.1670
			Longspine swimming crab	*Achelous spinicarpus*	0.1535
			Stilt spider crab	*Anasimus latus*	0.1263
	Decapod (shrimp)	Demersal	Brown shrimp	*Penaeus aztecus*	6.3835
			Northern white shrimp	*Litopenaeus setiferus*	2.3997
			Mantis shrimp	*Squilla empusa*	0.4950
			Mantis shrimp	*Squilla neglecta*	0.0656
	Echinoderm	Demersal		*Astropecten cingulatus*	0.1486
			Lined sea star	*Luidia clathrata*	0.0879
	Cephalopod	Demersal	Atlantic brief squid	*Lolliguncula brevis*	0.8126
		Epipelagic	Longfin inshore squid	*Loligo pealeii*	0.5261
		Pelagic	Slender inshore squid	*Loligo pleii*	1.1673
Vertebrate	Elasmobranch	Benthopelagic	Lesser electric ray	*Narcine brasiliensis*	2.0418
			Bonnethead	*Sphyrna tiburo*	1.4581
	Fish	Benthopelagic	Atlantic moonfish	*Selene setapinnis*	4.6274
			Atlantic cutlassfish	*Trichiurus lepturus*	4.4652
			Hardhead catfish	*Ariopsis felis*	2.7242
			Rough scad	*Trachurus lathami*	2.3260
		Demersal	Atlantic croaker	*Micropogonias undulatus*	65.3385
			Spot	*Leiostomus xanthurus*	6.1754
			Banded drum	*Larimus fasciatus*	5.8619
			Southern kingfish	*Menticirrhus americanus*	3.8297
			Longspine porgy	*Stenotomus caprinus*	1.9661
		Pelagic	Gulf butterfish	*Peprilus burti*	9.9523
			Atlantic thread herring	*Opisthonema oglinum*	5.4062
			Atlantic bumper	*Chloroscombrus chrysurus*	2.3295
			Gulf menhaden	*Brevoortia patronus*	2.0250

Source: https://apps-st.fisheries.noaa.gov/dismap/
Species selected based on the 15 highest weight catch per unit effort (WTCPUE) for both intertebrates and vertebrates.

Table 4-6. Abundant and Common Species in the Vicinity of the Project Area Based on TPWD Catch Data

Organism Type		Zone	Species	Scientific Name	Sum Catch per Hour
Invertebrate	Cnidarian	Demersal	Sea pansy	*Renilla mulleri*	653,139
	Cephalopod	Demersal	Atlantic brief squid	*Lolliguncula brevis*	340,750
	Decapod (shrimp)	Demersal	Roughback shrimp	*Trachycaris rugosa*	249,347
	Cnidarian	Pelagic	Moon jelly	*Aurelia aurita*	170,918
	Decapod (shrimp)	Demersal	Brown shrimp	*Penaeus aztecus*	158,258
	Decapod (crab)	Demersal	Lesser blue crab	*Callinectes similis*	137,300
	Echinoderm	Demersal	Striped sea star	*Luidia clathrata*	105,644
	Decapod (shrimp)	Demersal	White shrimp	*Litopenaeus setiferus*	104,092
	Cephalopod	pelagic	Slender inshore squid	*Loligo pleii*	57,605
	Decapod (shrimp)	Demersal	(Common mantis shrimp)	*Stomatopoda*	51,206
	Cephalopod	Epipelagic	Longfin inshore squid	*Loligo pealeii*	50,509
	Decapod (crab)	Benthopelagic	Iridescent swimming crab	*Portunus gibbesii*	45,812
	Echinoderm	Demersal	Five-holed sand dollar	*Mellita quinquiesperforata*	45,409
	Decapod (shrimp)	Demersal	(Rimapenaeid shrimp - unidentified)	*Rimapenaeus sp.*	38,929
	Cnidarian	Demersal	Order anemones	*Actiniaria*	29,557
Vertebrate	Fish	Pelagic	Atlantic bumper	*Chloroscombrus chrysurus*	672,642
		Demersal	Atlantic croaker	*Micropogonias undulatus*	610,649
			Silver seatrout	*Cynoscion nothus*	376,080
		Pelagic	Gulf butterfish	*Peprilus burti*	238,298
		Demersal	Sand seatrout	*Cynoscion arenarius*	198,466
			Spot	*Leiostomus xanthurus*	142,321
			Shoal flounder	*Syacium gunteri*	123,128
			Banded drum	*Larimus fasciatus*	110,602
		Benthopelagic	Atlantic moonfish	*Selene setapinnis*	81,108
		Demersal	Star drum	*Stellifer lanceolatus*	74,068
			Longspine porgy	*Stenotomus caprinus*	69,609
			Atlantic threadfin	*Polydactylus octonemus*	42,953
			Pinfish	*Lagodon rhomboides*	41,275
		Benthopelagic	Red snapper	*Lutjanus campechanus*	35,873
			Atlantic cutlassfish	*Trichiurus lepturus*	33,440

Source:
Olson, Z. 2022. Email correspondence between M. Abbene (Integral Consulting Inc.) and Z. Olsen (TPWD), August 30, 2022.
Species selected based on the 15 highest sum catch per hour for both invertebrates and vertebrates.

Table 4-7. Abundant, Frequently Impinged, and Commercially and/or Recreationally Important Species

		Stunz and Montagna (2015)	Neuces Bay Power Station Permit Renewal (WCM Group Inc. 2020)		GBNEP (1993)			Barney M. Davis Power Plant (Shepherd et al. 2016)	National Marine Fisheries Service (2012)	NOAA and TPWD (Appendix B)	40 CFR 125.92(m)
Scientific Name	Common Name	Potentially Impacted	Species Collected from Power Station	Representative Species for Impingement Analysis	Species Comprising ≥1% of Total Impinged during Each Study	Abundant and Frequently Impinged	Commercially and Recreationally Important	Species Impinged	Commercially and Recreationally Important	Abundant Species	Fragile Species [a]
Hyporhamphus meeki	American halfbeak	x									
Lolliguncula brevis	Atlantic brief squid	x								x	
Chloroscombrus chrysurus	Atlantic bumper	x			x					x	
Micropogonias undulatas	Atlantic croaker	x	x	x	x	x		x	x	x	
Trichiurus lepturus	Atlantic cutlassfish				x					x	
Porichthys porosissimus	Atlantic midshipman				x						
Chaetodipterus faber	Atlantic spadefish				x						
Polydactylus octonemus	Altantic threadfin				x						
Anchoa mitchilli	Bay anchovy	x	x		x	x		x			x
Prinotus tribulus	Bighead searobin				x						
Pogonias cromis	Black drum	x			x		x				
Symphurus plagiusa	Blackcheek tonguefish				x						
Ictalurus furcatus	Blue catfish		x								
Pomatomus saltatrix	Bluefish	x									x
Gobiosoma robustum	Code coby	x									
Ctenogobius boleosoma	Darter goby	x									
Hypsoblennius hentz	Feather blenny	x									
Dorosoma cepedianum [b]	Gizzard shad				x						x
Microgobius thalassinus	Green goby	x									
Peprilus burtri	Gulf butterfish				x					x	
Paralichthys albigutta	Gulf flounder	x									
Fundulus grandis	Gulf killifish		x		x						
Brevoortia patronus	Gulf menhaden	x	x		x	x		x	x	x	x
Peprilus alephidotus	Harvestfish				x						
Trinectes maculatas	Hogchoaker	x									
Synodus foetens	Inshore lizardfish	x									
Elops saurus	Ladyfish	x						x			
Sphoeroides parvus	Least puffer				x						
Achirus lineatus	Lined sole		x		x						
Synodontidae sp.	Lizardfish	x									
Gobiosoma bosc	Naked goby	x	x	x							
Lagodon rhomboides	Pinfish	x	x					x		x	
Syngnathidae sp.	Pipefish	x									
Tetradontidae sp.	Puffer fish	x									
Sciaenops ocellatus	Red drum	x	x	x	x		x		x		
Cynoscion arenarius	Sand seatrout		x		x	x			x	x	
Arius felis	Sea catfish				x						
Triglidae sp.	Sea robin	x									

Table 4-7. Abundant, Frequently Impinged, and Commercially and/or Recreationally Important Species

		Stunz and Montagna (2015)	Neuces Bay Power Station Permit Renewal (WCM Group Inc. 2020)		GBNEP (1993)			Barney M. Davis Power Plant (Shepherd et al. 2016)	National Marine Fisheries Service (2012)	NOAA and TPWD (Appendix B)	40 CFR 125.92(m)
Scientific Name	Common Name	Potentially Impacted	Species Collected from Power Station	Representative Species for Impingement Analysis	Species Comprising ≥1% of Total Impinged during Each Study	Abundant and Frequently Impinged	Commercially and Recreationally Important	Species Impinged	Commercially and Recreationally Important	Abundant Species	Fragile Species [a]
Archosargus probatocephalus	Sheepshead		x								
Cyprinodon variegatus	Sheepshead minnow		x		x						
Ophichthus gomesii	Shrimp eel	x			x						
Bairdiella chrysoura	Silver perch	x	x	x							
Menidia sp.	Silversides	x	x								
Gobiesox strumosus	Skilletfish	x	x								
Paralichthys lethostigma	Southern flounder	x			x		x		x		
Leiostomus xanthurus	Spot croaker	x	x		x	x		x		x	
Eucinostomus argenteus	Spotfin mojarra	x									
Cynoscion nebulosus	Spotted seatrout	x	x	x	x		x		x		
Stellifer lanceolatus	Star drum				x						
Chasmodes bosquianus	Striped blenny		x								
Chilomycterus schoepfi	Striped burrfish	x									
Mugil cephalus	Striped mullet	x			x				x		
Megalops atlanticus	Tarpon	x									
Dorosoma petenese	Threadfin shad				x						
Callinectes sapidus	Blue crab	x	x	x	x	x		x	x	x	
Callinectes similis	Gulf crab (lesser blue crab)	x	x	x	x					x	
Penaeus aztecus	Brown shrimp	x	x	x	x	x		x	x	x	
Penaeus duorarum	Pink shrimp	x	x	x					x		
Penaeus setiferus	White shrimp	x	x	x	x	x			x	x	
Hippolytidae	Cleaner shrimp	x							x		
Palaemonidae	Grass shrimp	x						x			
Mysidae	Mysid shrimp	x						x			
Aurelia aurita	Moon jelly		x							x	

Notes:

Shading identifies potential target species, reflecting those required in 316b (fragile species, abundant species, and commercially and recreationally important species), except for T&E species, which are addressed separately in this report. Shaded species fell into at least one of these categories. Species shaded in dark gray were selected as target species (up to six invertebrate and six vertebrates). All fragile species, except for gizzard shad (see note b), were also retained as target species. For the remaining species, preference was given to those species falling into more than one of the aforementioned categories and consideration was given to reflect a variety of life histories.

[a] Fragile species identified in the cited impingement and entrainment studies.

[b] Although gizzard shad is a fragile species mentioned in GBNEP (1993), this species spends its entire life in fresh to brackish water and is therefore not expected to be present in the Gulf of Mexico.

Table 4-8. General Life History Traits of the 11 Target Fish and Invertebrate Species Susceptible to Impingement and Entrainment

			General Habitat					
Species Name	Scientific Name	Range	Eggs	Larvae	Juveniles	Adults	Source	Notes
Atlantic Croaker	*Micropogonias undulatas*	Marine; brackish; demersal; depth range up to 100 m	* Eggs are pelagic and buoyant in the GOM. * Incubation time is 29–32 hours at 23˚C and 26–30 hours at 25˚C.	* Larvae are pelagic and may spend time in the plankton but soon become demersal. * Early larvae are found in the mid- to outer continental shelf at depths ranging from 15 to 115 m located 20 to 200 km offshore.	* Juveniles become even more demersal than post-larvae and move into tidal creeks and other headwater areas. * They occur in estuarine to riverine environments where they seek out soft substrate.	* Adults are demersal and move between estuarine and oceanic waters. * They have seasonal inshore and offshore migrations, although some appear to remain in offshore waters year round. * They have been collected from depths ranging between 1 and 90 m over soft substrate. * Adults move up bays and estuaries in the spring, randomly in the summer, and seaward in the fall. * Spawning occurs in the open GOM near the mouths of the passes that lead into the shallow bays and lagoons. Spawning is reported to occur within a depth range of 7.8 to 81 m.	fishbase.org; Lassuy (1983a); Patillo et al. (1997)	Non-fragile
Bay Anchovy	*Anchoa mitchilli*	Marine; freshwater; brackish; pelagic-neritic; amphidromous; depth range 1–70 m, usually 1–36 m	* Buoyant when fresh, demersal at 12–16 hours	* Pelagic and occurs throughout the water column.	* Pelagic and occurs throughout the water column.	* Shallow tidal areas with muddy bottoms and brackish waters.	fishbase.org; Patillo et al. (1997)	Fragile
Bluefish	*Pomatomus saltatrix*	Marine; brackish; pelagic-oceanic; oceanodromous; depth range 0–200 m	* Pelagic and planktonic	* Planktonic	* Shallow coastal waters at least 2 m depth, in schools pursuing small fish	* Oceanic and coastal waters. * Most common along surf beaches and rock headlands in clean, high energy waters, although adults can also be found in estuaries and into brackish water.	fishbase.org	Fragile
Gulf Menhaden	*Brevoortia patronus*	Marine; pelagic-neritic; depth range 0–50 m	* Eggs are planktonic and pelagic in the GOM.	* Larvae stay in offshore waters 3–5 weeks as currents carry them into estuaries.	* Nektonic, estuaries	* Inshore, offshore, pelagic	fishbase.org; Patillo et al. (1997)	Fragile
Red Drum	*Sciaenops ocellatus*	Marine; brackish; demersal; oceanodromous	* Buoyant eggs are released in nearshore and inshore waters, typically inside the 20- m depth contour of the GOM. * Eggs float at salinities >25 ppt but sink at salinities <20 ppt. * Freshly-spawned eggs were recovered during one investigation in water depths ranging from 1.5 to 2.1 m. * Eggs are transported by tides into bays and estuaries. * The eggs are planktonic and pelagic. * Optimum hatching & survival conditions: 25°C and 30 ppt. * Hatching occurs in 18 to 30 hours, depending on surface water temperature and dissolved oxygen levels. * Duration: mid-August to December/early January --> see adult spawning.	* The embryo-larvae are planktonic and pelagic. * Larvae are carried by tidal currents into the shallow inside waters of bays and estuaries. * Larvae move through the passes in mid-channel surface water with the tidal currents and tend to seek shallow slack water along the sides of the channels to avoid being carried offshore during periods of ebb tide. * Once in estuaries, larvae seek grassy quiet coves, tidal flats, and lagoons among vegetation over sandy/muddy bottoms for protection from predation and currents. * Size range: 4–6 mm	* Tend to migrate from primary bays, which open to the sea, into secondary bays , which open into the primary bays. * Seek out structured habitat (e.g., seagrass meadows, oyster reefs, and habitat edges) in shallow waters (<0.5 m), but also deeper (3.05 m). * Intra-bay movement occurs, but with minimal inter-bay movement (i.e., high residency). * Juveniles can also move into the GOM or deeper water in or near passes in the winter. * Older juveniles (40–120 mm) tend to move in slightly deeper and more open waters and into primary bays in somewhat deeper waters (>1.8 m). * As juveniles approach 200 mm during their first spring , they may remain in deep-water areas of bays, or congregate near passes, usually in large aggregations. * Size range: 15–300 mm	* Relatively non-migratory but with broad random movements. * Occasionally found in shallow bays, but tend to spend more time in marine habitats after their first spawning. * Adults spawn in deeper waters at the mouths of bays. * Typically found in the GOM in littoral and shallow nearshore waters off beaches. * Migrating fish may use salinity gradients as predictive cues for directed movements from estuarine to oceanic habitats and back.	Moulton et al. (2017); Reagan (1985); Brown et al. (2005); Pattillo et al. (1997); Sink et al. (2018)	

Table 4-8. General Life History Traits of the 11 Target Fish and Invertebrate Species Susceptible to Impingement and Entrainment

			General Habitat					
Species Name	Scientific Name	Range	Eggs	Larvae	Juveniles	Adults	Source	Notes
Spotted Seatrout	*Cynoscion nebulosus*	Marine; brackish; demersal; non-migratory.	* Eggs can be either buoyant/pelagic (≥30 ppt) or demersal (≤25 ppt). * Eggs are found from marine to estuarine environments. * Eggs are generally associated with grass beds at or near barrier-island passes. * Hatching occurs in 16 to 40 hours at 25˚C. * Duration: February to October; see adult spawning.	* Can be transported on flood tides through passes connecting the GOM to inside waters. * Size range: 1.3 to 10–12 mm * Upon hatching, larvae can swim upwards into the water column but move towards the bottom after 4 to 7 days (depths not reported). * Duration of embryo-larval lifestage not found. * Seek out shallow, vegetated (i.e., seagrass beds) estuarine areas, but may also occur abundantly in areas without extensive seagrass beds (depths not reported). * Larvae are demersal in deep channels (depths not provided) with shell rubble, or in bottom vegetation. * The deep channels near grass beds may serve as their initial habitat, before moving into the grass beds as juveniles. * Duration of post-larval lifestage not found.	* Prefer bare substrate over deeper water (0.5–1.5 m) but also occur over sea grass meadows and habitat edges in shallower waters (<0.5 m). * Juveniles in FL have been reported from a water depth ranging between 0.5 m and 2.2 m. * May occur abundantly in areas without extensive seagrass beds, such as backwaters (e.g., bayous, tidal creeks, slow-moving rivers, mangrove-lined depressions), or marshes. * Intra-bay movement occurs, but with minimal inter-bay movement (i.e., high residency). * Juveniles remain in the estuarine nursery areas at least through the summer months, but may move to deeper water in the winter (depth range not specified) in response to lower water temperatures. * They rarely migrate into the GOM until they are mature. * Juveniles range in size from 10 to 12 mm to 180 to 200 mm.	* Seagrass beds are the preferred habitat, but adults also occur in mangrove-lined depressions, and in relatively-deep basins, tidal river mouths, channels, and canals. * Adults linger around the entrance of the passes year-round but may also occur in the surf zone of barrier islands, particularly in the fall. * Adults migrate very little, with most movements occurring seasonally in association with thermal and salinity tolerances, and with spawning activities. * Fall emigration to the deeper warmer waters of the bays or the GOM is apparent. * Spawning occurs in deeper holes and scour channels in seagrass meadows in depths of 3–4.6 m within estuaries, but may also occur in lower regions of estuaries, near passes between barrier islands, or even outside of estuaries. * Duration: spawning occurs from February to October (peak spawning from April to July.	Moulton et al. (2017); Froeschke and Froeschke (2011); Lassuy (1983b); Pattillo et al. (1997); fishbase.org	Non-fragile
Blue Crab	*Callinectes sapidus*	Benthopelagic; freshwater; brackish; depth range 0–90 m	* Eggs are carried externally by the female for approximately 2 weeks * Hatching occurs in mouths of estuaries and shallow marine waters	* Development of larvae progresses in the ocean. * Zoeae are planktonic, and remain in offshore waters for up to 1 month. Re-entry to estuarine waters occurs during the megalopal stage.	* Migration of megalopae and young crabs back into estuarine waters, demersal and estuarine.	* Active and abundant in shallow habitats. * Demersal and estuarine.	sealifebase.org; Patillo at al. (1997)	Non-fragile
Gulf Crab (lesser blue crab)	*Callinectes similis*	Benthopelagic; depth range 0– 379 m	* External brooder	* Planktonic		* Benthopelagic * Inhabits marine littoral water, seldom in estuaries.	sealifebase.org	
Brown Shrimp	*Penaeus aztecus*	Benthic; depth range 110 m (GMFMC 2004) (0–200 m sealifebase.org)	* Eggs are denser than seawater and are demersal * Commonly found fall to spring (18–110 m) in soft bottom habitats (sand, shell)	* Larval stages are planktonic; their position in the water column is dependent on time of day, water temperature and clarity. * Post-larvae spawned in the fall may burrow into the sediments to escape cooler temperatures and overwinter. * Post-larvae move into estuaries and transform into juveniles.	* Estuarine and marine, benthic, pelagic * Juveniles are common in estuarine waters at <1 m depth; juveniles emigrate from shallow estuaries to deeper waters. * Sub-adults common in 1–18 m of water.	* Marine, benthic, associated with soft substrates (silt, mud, sand).	sealifebase.org; Patillo et al (1997); GMFMC (2004)	Non-fragile
Pink Shrimp	*Penaeus duorarum*	Benthic; depth range 0–110 m (GMFMC 2004) (0–330 m sealifebase.org)	* Benthic, commonly found in offshore waters 9–48 m on soft bottom habitat (sand, shell)	* Estuarine, marine, planktonic * Commonly found at depths of 1–50 m	* Estuarine, late post-larvae and juveniles commonly found <3 m. * Sub-adult individuals can be found at depths of 1–65 m.	* Adults are demersal. * Spawning adults commonly found at depths of 9–48 m spring through fall (TX). * Non-spawning adults common at depths of 1–110 m, year-round.	sealifebase.org; GMFMC (2004)	
White Shrimp	*Penaeus setiferus*	Benthic; brackish; depth range 0–82 m (GMFMC 2004) (0–119 m sealifebase.org)	* Benthic, offshore, nearshore, and estuarine waters * Common spring to fall	* Planktonic, post-larvae become benthic upon reaching the nursery areas of estuaries.	* Estuarine waters <1 m. * Sub-adults common 1–30 m on soft bottom habitat (sand, shell). * Migration from estuaries is common during August and September.	* Benthic (diurnal activity). * Common in estuarine, nearshore, and offshore waters in soft bottom habitats. * Commonly found <27 m, spawning adults commonly found 9–34 m from June to July.	sealifebase.org; Patillo et al. (1997); GMFMC (2004)	

Table 5-1. Potential for Impingement and Entrainment by Four Key Life Stages of the 11 Target Fish and Invertebrate Species

Species	Scientific Name	Egg		Larvae		Juvenile		Adult		Source
		I&E Potential	Reason for Ranking	I&E Potential	Reason for Ranking	I&E Potential	Reason for Ranking	I&E Potential	Reason for Ranking	
Atlantic Croaker	*Micropogonias undulatas*	Low	Eggs are pelagic and positively buoyant.	Low	Larvae are free floating but quickly become demersal. Larvae are also more common at depths greater than the proposed intake structure, and farther offshore.	Minimal	Juveniles become even more demersal than post-larvae and move into tidal creeks and other headwater areas. They frequently occur in estuarine to riverine environments where they seek out soft substrate.	Low	Adults are demersal and capable swimmers that move between estuarine and oceanic waters.	fishbase.org; Lassuy (1983a); Patillo et al. (1997)
Bay Anchovy	*Anchoa mitchilli*	Medium	Fresh eggs are pelagic and positively buoyant at first but then sink into the water column before hatching; eggs become demersal after 12-16 hours.	High	Larvae are free-floating and planktonic.	Low	Juveniles are pelagic and swim throughout the water column. Juveniles are capable swimmers.	Low	Adult are pelagic and capable swimmers.	fishbase.org; Patillo et al. (1997)
Bluefish	*Pomatomus saltatrix*	Low	Eggs are pelagic and planktonic and are laid offshore over the continental shelf.	High	Larvae are free-floating and planktonic and move inshore as they mature.	Low	Juvenile are capable swimmers and form schools to hunt.	Low	Lifestage more common near high energy coastal habitat; potentially found in nearshore waters. Adults are capable swimmers.	fishbase.org; Patillo et al. (1997)
Gulf Menhaden	*Brevoortia patronus*	High	Spawning occurs in inshore and offshore waters. Eggs are planktonic and pelagic.	Medium	Larvae are free-floating and planktonic. They are found at greatest densities near the surface but sink at night. They are most common offshore but move inshore before entering estuaries.	Minimal	Juveniles develop in estuarine environments. This lifestage is absent from the area of the proposed water intake structure.	Low	Adults are pelagic and capable swimmers.	fishbase.org; Patillo et al. (1997)
Red Drum	*Sciaenops ocellatus*	Low	Eggs are pelagic and buoyant, and more likely found higher in the water column in the salty GOM. Eggs sink only in salinity <25 ppt.	High	Larvae consist of a free-floating planktonic stage found throughout water column.	Minimal	Juveniles move into shallow estuaries to mature. They are absent from the area of the proposed water intake structure.	Low	Adults are demersal and strong, capable swimmers.	Moulton et al. (2017); Reagan (1985); Brown et al. (2005); Pattillo et al. (1997); Sink et al. (2018)
Spotted Seatrout	*Cynoscion nebulosus*	Low	Eggs are pelagic and are positively buoyant at salinities $\geq$30 ppt. Spawning habitat mainly associated with coastal bays, estuaries, and lagoons, but also in inshore GOM.	Medium	Larvae are planktonic for a short duration before settling to the sea bed	Minimal	Juveniles seek out shallow habitat <2.2 m associated with seagrass.	Low	Adults are demersal and strong, capable swimmers. Low probability of presence in the area of the proposed water intake structure due to habitat preferences.	Moulton et al. (2017); Froeschke and Froeschke (2011); Lassuy (1983b); Patillo et al. (1997); fishbase.org
Blue Crab	*Callinectes sapidus*	Minimal	Blue crabs are external brooders; eggs are attached to female's pleopods until hatching.	High	All larval stages are planktonic and occur throughout the water column.	Minimal	Juveniles are benthopelagic. Young individuals prefer estuarine habitat.	Low	Adults are demersal.	sealifebase.org; Patillo et al. (1997)

Table 5-1. Potential for Impingement and Entrainment by Four Key Life Stages of the 11 Target Fish and Invertebrate Species

		Egg		Larvae		Juvenile		Adult		
Species	Scientific Name	I&E Potential	Reason for Ranking	I&E Potential	Reason for Ranking	I&E Potential	Reason for Ranking	I&E Potential	Reason for Ranking	Source
Gulf Crab	*Callinectes similis*	Minimal	Gulf crabs are external brooders; eggs are attached to female's pleopods until hatching.	High (based on blue crab)	All larval stages are planktonic and occur throughout the water column.	Minimal	Juveniles are benthopelagic and capable swimmers. Young individuals prefer estuarine habitat.	Low	Adults are benthopelagic and capable swimmers.	sealifebase.org
Brown Shrimp	*Penaeus aztecus*	Minimal	Eggs are demersal and are released in offshore spawning grounds at depths of 46 to 450 ft.	High	Larval stages are planktonic and follow vertical diurnal migrations throughout the water column.	Low	Early juveniles enter estuarine habitats from the GOM to mature. Older juveniles migrate out into nearshore GOM but prefer shallow marsh areas and estuarine bays.	Low	Adults are demersal and capable swimmers. Low likelihood of presence near proposed water intake structure because they prefer greater depths (46 to 361 ft).	sealifebase.org; Patillo et al. (1997); GMFMC (2004)
Pink Shrimp	*Penaeus duorarum*	Low	Spawning occurs in the GOM at depths ranging from 13 to 157 ft. Eggs are demersal. The proposed depth for the intake structure is close to the upper limit recorded for egg presence.	High	Larval stages are planktonic and can be found over the continental shelf throughout the water column, with strong diurnal movements.	Low	Juveniles are commonly found at depths of <10 ft in estuarine nursery areas associated with seagrasses. Sub-adults can be found at depths of 3 to 213 ft	Low	Adults are demersal. May be present near the proposed water intake structure, but can swim at speeds greater than intake velocity. Also, unlikely to be within water column due to demersal habits.	sealifebase.org; GMFMC (2004); Patillo et al. (1997)
White Shrimp	*Penaeus setiferus*	Low	Spawning occurs in nearshore marine waters at depths ranging from 30 to 112 ft. Eggs are demersal. The proposed depth for intake structure is at the upper limit recorded for egg presence.	High	Larval stages are planktonic and can be found throughout the water column.	Low	Juveniles seek out estuarine habitats over soft bottom (sand, shell) but migrate out into the GOM when they get older. Juveniles are primarily demersal.	Low	Adults are demersal. May be present near the proposed water intake structure, but can swim at speeds greater than intake velocity. Also, unlikely to be within water column due to demersal life history.	sealifebase.org; Patillo et al. (1997); GMFMC (2004)

Table 5-2. Summary of Coastal Texas Impingement Studies

Plant Name	Location	Capacity	Intake Velocity	Screen Type	Screen Size	Other Impingement/ Entrainment Technology	Major Findings	Reference
Barney M. Davis Power Plant	Corpus Christi (water is withdrawn from Laguna Madre)	540 MGD	Not stated	Passavant traveling drum screens with nylon mesh	1×2 mm	Fish return	-Monthly monitoring occurred from March 14, 2006 to February 21, 2007. -42,286 fish and 28,418 invertebrates were impinged, for a total of 70,834 organisms. -11 taxa comprised 92% of the impinged organisms. -Species impinged included spot, bay anchovy, brown shrimp, grass shrimp, blue crab, mysid shrimp, ladyfish, *Clupeidae spp.* , Atlantic croaker, Gulf menhaden, and pinfish. -Spot were impinged in the greatest numbers, whereas bay anchovy appeared most frequently. -May had the highest number of impinged taxa while October had the lowest. -The decrease in shrimp impingement from 6:00 to 18:00 h was likely related to nocturnal activity patterns. -Number of impinged individuals was highest from January to March and decreased approximately 20% for each successive month from January through December. -The number of impinged invertebrates increased slightly in July and September. -Total impingement was most associated with dissolved oxygen, sampling month and sampling time.	Shepherd et al. (2016)
P.H. Robinson Generating Station	Bacliff	138.6 BGD	Calculated approach velocity @ mean low water Unit 1: 1.05 f/sec Unit 2: 1.04 f/sec Unit 3: 1.14 f/sec Unit 4: 1.19 f/sec	Revolving mesh screen, square clear opening	9.5 mm (3/8 in.)	Not stated	Screen samples contained 68,518 organisms and 83 species from February 1969 through March 1970. **Gulf menhaden** Entrainment: < 30 mm SL, peaked March and April 1969 and January through March 1970. Impingement: 14 to 200 mm SL, highest at 35 to 85 mm SL and peaked February to June 1969 when the number of juveniles peaked; Injury rates: 5.8%. Peak abundance had low injury rates. **Bay anchovy** Entrainment: <20 mm SL, enhanced 20 to 50 mm, peaked from May to September 1969. Impingement: 20 to 65 mm SL; 50 to 70 mm SL were impinged mostly from March to April 1969, and December 1969; Injury rates: 34.2%. Highest injury rates were observed during low abundance. **Sea catfish** Entrainment: 35 to ~50 mm SL, peaked April 1969 and September 1969. Impingement: 42 to 248 mm SL, peaked during the late summer; Injury rates: 11.6%. Highest injury rates were observed during low impingement. **Sand seatrout** Impingement: 35 to 175 mm SL, peaked May to August 1969; Injury rates: 9.6%. Months with peak impingement had low injury rates. **Spot** Entrainment: <30 mm SL and peaked in March 1969. Impingement: 28 to 142 mm SL and peaked from later summer to early winter; Injury rates: 5%. **Atlantic croaker** Entrainment: <30 mm SL, peaked during recruitment from March to April 1969 and January to March 1970. Impingement: 15 to 223 SL, highest from 30 to 65 mm and peaked February to April 1969; Injury rates: 2.6% **Spotted seatrout** Impingement: 48 to 169 mm SL peaked during the fall through winter; Injury rate: 2.6% **Black drum** Impingement: 40 to 283 mm SL, highest 40 to 84 mm SL, peaked during June; Injury rate: 4.8% **Red drum** Impingement: 41 to 94 mm SL **Southern flounder** Impingement: 29 to 272 mm SL; Injury rate: 11.7%	Landry (1977) in GBNEP (1993)

Table 5-2. Summary of Coastal Texas Impingement Studies

Plant Name	Location	Capacity	Intake Velocity	Screen Type	Screen Size	Other Impingement/ Entrainment Technology	Major Findings	Reference
							-81 species of fish, 23 species of crustaceans, and 1 species of mollusc were collected from April 1978 to March 1979. A total of 79,337 organisms (33,622 fish and 45,715 invertebrates) were collected during the study period. -The organisms impinged in this study and Landry (1977) had six species in common. For Units 1 and 2, Landry's (1977) projections were an order of magnitude higher for Gulf menhaden, sea catfish, sand seatrout, and spot. Estimates for bay anchovy and Atlantic croaker were also higher. -This study concluded that the estimates of total annual impingement weight for finfish between the two studies were of the same order of magnitude.	Greene et al. (1980a) in GBNEP 1993
Sam Bertron Generating Station	Houston Ship Channel	241.1 BGD	Calculated approach velocity @ mean low water Unit 1: 1.05 f/sec Unit 2: 1.04 f/sec Unit 3: 1.14 f/sec Unit 4: 1.19 f/sec	Revolving mesh screen, square clear opening	9.5 mm (3/8 in.)	Not stated	-479,448 fish and 132,450 invertebrates were collected. 68 species of fish, 17 species of crustaceans, and 1 species of mollusc were captured from January 12, 1978, to January 2, 1979. -10 species comprised >1% of the total. -Brown shrimp, white shrimp, and blue crab accounted for 96.2% of the impinged invertebrates. -Major forage species including Gulf menhaden, threadfin shad, and bay anchovy accounted for 68.3% of the projected fish impingement. -Other commercially or recreationally important fish impinged included sand seatrout, spotted seatrout, Atlantic croaker, red drum, and southern flounder, which made up 20.7% of all fish. -Two other species taken in large numbers were spot and striped mullet, which composed 6.1% of all fish. Impingement Results by Species (size range and peak abundance) **Brown shrimp**: mid-May to end of June **White shrimp**: end of June to end of September, November 1 to January **Blue crab**: 5 to 210 mm **Gulf menhaden**: 20 to 230 mm, November 1 to mid-December **Sand seatrout**: 5 to 325 mm, November 1 to January 1 **Spotted seatrout**: 65 to 280 mm, November 1 to end of March **Atlantic croaker**: 5 to 245 mm, end of March to mid-May **Red drum**: 40 to 380 mm, most end of January to end of February **Southern flounder**: 40 to 290 mm, mid-April to June 1	Greene et al. (1979) in GBNEP 1993

Table 5-2. Summary of Coastal Texas Impingement Studies

Plant Name	Location	Capacity	Intake Velocity	Screen Type	Screen Size	Other Impingement/ Entrainment Technology	Major Findings	Reference
Webster Generating Station	southern Harris County on the north side of Clear Creek, 3.5 miles upstream from its mouth on Clear Lake	138.6 BGD	Max Actual velocities Unit 1: 1.48 f/sec Unit 2: 1.48 f/sec Unit 3: 2.56 f/sec	Revolving mesh screen	9.5 mm (3/8 in.)	Not stated	-62 species od fish, 1 amphibian, 13 species of crustaceans, and 1 species of mollusc were impinged from December 8, 1977, to November 28, 1978. -Brown shrimp, white shrimp, and blue crab composed 47.3% of organisms impinged. -Gulf menhaden, threadfin shad, and bay anchovy accounted for 28.7% of organisms impinged. -9 species of commercial or recreational importance were impinged, including sand seatrout, spotted seatrout, Atlantic croaker, black drum, red drum, and southern flounder. Only the Atlantic croaker made up a significant portion of the organisms impinged. -Brown shrimp were abundant in late May and early June, and again in November. -White shrimp had a minor peak in late August and early September, and a major peak from the end of November to early January. The winter peak had smaller shrimp. -Gulf menhaden were abundant in December and January and again in late November 1978. A peak of small menhaden occurred in early April. -Atlantic croaker were most abundant in spring and early summer and least abundant in late summer and fall. -10 fish taxa were taken in entrainment samples, but 4 species (bay anchovy, naked goby, Gulf menhaden, and Atlantic croaker) accounted for 98.9% of total fish. -Bay anchovy and naked goby larvae and juveniles were present from April through November 1978. -Young Gulf menhaden and Atlantic croaker were present only from February through mid-April 1978.	Greene (1980) in GBNEP (1993)
Cedar Bayou Generating Station	Baytown, Texas (withdraws water from Cedar Bayou)	Not stated	Calculated Approach Velocity and Average Low Water: Unit 1: 0.830 f/sec Unit 2: 0.830 f/sec Unit 3: 0.783 f/sec Design and Confirmed Approach Velocities at Mean Sea Level at time of SRI study: Unit 1: 1.0 f/sec Unit 2: 1.0 f/sec Unit 3: 0.5 f/sec	Revolving mesh screen, square clear opening	12.7 mm (1/2 in.) or 9.5 mm (3/8 in.) for all units	Fish pump	-9,355 fish and 2,201 crustaceans were collected at the intake screens from June 1978 through May 1979. -91% of the fish and 95% of the crustaceans were alive when collected. -The following organisms were impinged in the largest numbers during the study: Gulf menhaden, Atlantic croaker, white shrimp, blue crab, brown shrimp, bay anchovy, sand seatrout, and spot. -The recreationally- or commercially-important species (i.e., spotted seatrout, southern flounder, black drum, and red drum) composed 0.3% of the total number of organisms impinged on the intake screens. -The most-abundant organisms that were impinged and passed through the fish pump were Gulf menhaden, white shrimp, Atlantic croaker, brown shrimp, blue crab, blackcheek tonguefish, sand seatrout, bay anchovy, least puffer, and spot. -The recreationally or commercially important species (i.e., spotted seatrout, southern flounder, black drum, and red drum) made up <0.4% of the total organisms impinged on intake screens and passed through the fish pump. Size ranges (mm SL) and survival (%) immediately after impingement: **Bay anchovy**: 82% **Gulf menhaden**: 96% **Sand seatrout**: 32 mm to 171 mm; 88% **Spotted seatrout**: 84% **Spot**: 32 mm to 127 mm; 97% **Atlantic croaker**: 20 mm to 120 mm; 78% **Southern flounder**: 91% **Black drum**: 100% (1 individual) **Red drum**: 100% (1 individual) **Least puffer**: 44% **Blackcheek tonguefish**: 76% **Blue crab**: 87 mm, and 15 mm to 196 mm; 97% **Brown shrimp**: 45 mm to 122 mm; 95% **White shrimp**: 41 mm to 147 mm; 96%	Jobe et al. (1980b) in GBNEP (1993)

Table 5-2. Summary of Coastal Texas Impingement Studies

Plant Name	Location	Capacity	Intake Velocity	Screen Type	Screen Size	Other Impingement/ Entrainment Technology	Major Findings	Reference
							-A total of 5,225,116 organisms were collected with 168 taxonomic groups identified, including fish, crustaceans, amphibians, and reptiles, from April 1973 to December 1980. -12 species of fish or crustaceans comprised more than 1% of the total number of organisms collected. -These species comprised approximately 93% of the total number of organisms collected. Impingement results (size range plus peak impingement period) **Bay anchovy**: 15 to 90 mm, March to May **Gulf menhaden**: 5 to 105 mm, November to April **Blue crab**: NA, May to September **Sand seatrout**: 20 to 285 mm, May to July **Spotted seatrout**: 30 to 285 mm, November to April **Gizzard shad**: 30 to 310 mm, April to July **Atlantic croaker**: 10 to 300 mm, February to June **Striped mullet**: 20 to 390 mm, March to April **Grass shrimp**: NA, April to July **Southern flounder**: 20 to 340 mm, May to June **Brown shrimp**: NA, May to July **White shrimp**: NA, September to December **Black drum**: 40 to 280 mm, March to November **Atlantic threadfin**: 45 to 150 mm, April to August **Red drum**: 40 to 325 mm, January to March **Atlantic cutlassfish**: 40 to 705 mm, March to July	SRI (unpublished) in GBNEP (1993)
Deepwater	Houston Ship Channel	45.3 BGD (1978) 39.9 BGD (1979)	Max Present Screen Approach Velocity 0.76 f/sec (all units)	Revolving mesh screen	9.5 mm (3/8 in.)	Not stated	-Revolving screens were sampled once per month in 1978 and 1979. -No animals were impinged June through October in both 1978 and 1979, and May 1979 when the maximum flows occurred. -17 species of fish and 2 species of invertebrates were captured. A total of 146 invertebrates and 327 finfish were impinged over both years. The most abundant species were blue crab, sand seatrout, Atlantic croaker, bay anchovy, and white shrimp. Impingement results 1979 (size range and peak abundance) **White shrimp**: 30 to 60 mm, December **Blue crab**: 10 to 60 mm, January to March, November to December **Bay anchovy**: 20 to 30 mm, November to December **Sand seatrout**: 70 mm, November **Atlantic croaker**: 20 to 60 mm, November	Greene (1980) in GBNEP (1993)

Notes:
BGD= billion gallons per day
f/sec = feet per second
MGD = million gallons per day
SL = standard length

Table 5-3. Fecundity of Several Target Species

Target Species	References
Blue Crab	
• In south Texas, blue crab females may spawn year-round in years with mild winters, with the highest activity occurring in spring and summer. • A single female may carry one to six million eggs in her external egg mass (called a “sponge” or “berry”). • Females may produce up to eight broods per year.	Pattillo et al. (1997); Perry and McIlwain (1986); Ward (2012)
White Shrimp	
• Females lay their eggs in offshore waters of the Gulf of Mexico from March to October (peak activity is June and July). • Females that spawn early in the spring may spawn a second time in late summer or fall, and possibly up to four times per year. • A large female is estimated to produce half a million to one million eggs during each spawning event.	Pattillo et al. (1997)
Red Drum	
• Red drum spawning in the Gulf of Mexico occurs from mid-August to December/early January, with peaks in mid-September through October, and then declining. • The females are “batch spawners,” meaning that they ovulate and expel their eggs in two or more large batches during the course of the spawning season. • Wild females produce between 160,000 and 3,270,000 eggs per batch depending on their size, with a mean batch fecundity of 1,540,000 eggs among fish of all sizes. • In one experiment, 10 to 12 spawns per fish over 90 to 100 days were typical, with one captive fish spawning 31 times over 90 days. Another experiment reported three females spawning 52 times in 76 days, producing an estimated total of 60 million eggs. • Captive fish released about 1 million eggs per spawn during the first 45 days, dropping to 10,000 to 100,000 eggs thereafter. • The maximum-recorded spawn was 2,058,000 eggs per fish during one night. • A maximum individual annual fecundity is estimated as 30 million eggs for females weighing between 9 and 14 kg. • The total annual fecundity of a wild 75.7 cm (29.8-inch) female has been reported to be as high as 62 million eggs (measured via volumetric displacement) or 95 million eggs (measured via the gravimetric [i.e., mass] method).	Pattillo et al. (1997); Reagan (1985); Sink et al. (2018)

Table 5-3. Fecundity of Several Target Species

Target Species	References
Atlantic Croaker	
• The Atlantic croaker has a protracted spawning season in the Gulf of Mexico that stretches from September/October to March/May, with a peak in October and possibly November (note: these ranges are generic to the Gulf of Mexico, not the area around Aransas Inlet). • Pattillo et al. (1997) reported fecundities for females from the Gulf of Mexico ranging between 27,000 eggs for a female measuring 136 mm SL and 1,075,000 eggs for a female measuring 318 mm SL. Lassuy (1983) reported the fecundity of a 395 mm female as 180,000 eggs (from one paper) and 41,200 eggs (from another paper).	Pattillo et al. (1997); Lassuy (1983a)
Spotted Trout	
• Spotted seatrout females are “batch spawners” capable of releasing eggs many times during the reproductive season. Spawning frequency appears to be high and is estimated to occur every 3.6 days, but this frequency is probably not sustained throughout the entire spawning season. • In Texas, the spawning season extends from April to October, with spawning occurring during all these months. • The percentage of females spawning at any given time is difficult to determine. It is also a challenge to estimate the fecundity of a species that spawns in batches and has a protracted spawning season. Finally, the frequency of spawning reported in the literature may cause fecundity to be poorly estimated. • Having said that, a 2 lb spotted seatrout spawning eight times in a season would produce about 3 million eggs. • Forty-five captive broodfish maintained at a state-operated fish hatchery in Texas spawned 251 million eggs over a 9-month period. • Estimates of fecundity range from a mean of 14,000 eggs from 28.3 cm (11.14 in.) TL age I females to 1.1 million eggs for age IV females averaging 50.4 cm (19.84 in.) TL. Annual fecundity may average greater than 10 million eggs per female.	Pattillo et al. (1997); Blanchet et al. (2001)

Notes:
SL = standard length
TL = total length

Appendix A

Comprehensive List of Fish and Invertebrate Species that May Occur in the Gulf of Mexico around the Project Area

Appendix A

The following marine taxa were included in Appendix A as taxa that may occur in the vicinity of the project area:

- All taxa identified in bottom trawl survey data collected from the Gulf States Marine Fisheries Commission via NOAA (NOAA 2022).
- All taxa identified in fisheries survey data provided by the Texas Parks and Wildlife Department (TPWD 2022).
- All state and federally threatened, potentially threatened, and endangered species known to occur in the vicinity of the project area.
- All benthic species data presented in Appendix L (Benthic Survey Report) of the Deepwater Port License Application for the Bluewater Texas Terminal Project (Bluewater Texas Terminals LLC 2021a).
- A subset of phytoplankton and zooplankton taxa from Holland et al. (1973, 1974) which are known to occur in marine and coastal areas. Holland et al. (1973, 1974) conducted phytoplankton tows in the Texas Bay systems and compiled extensive lists of the taxa identified. However, because specific locations where these taxa were caught were not provided, they were cross-referenced with a number of studies on phytoplankton and zooplankton salinity tolerance (Cervetto and Pagano 1999; Brand 1984; Gilabert 2001; Hopper 1960; Gaillard et al. 2021; Miller and Kamykowski 1986; Rai and Rajashekhar 2014; Isinibilir et al. 2011; Nagasathya and Thajuddin 2008; Tundisi and Tundisi 1968) to identify species known to inhabit coastal and marine environments.
- Species from location-specific ichthyoplankton survey data subsets obtained from the Southeast Area Monitoring and Assessment Program (SEAMAP) for station B233 in the GOM and provided by NMFS in November 2022, which were not identified in the NOAA and TPWD surveys. This station covers the area that includes the proposed water intake structure and includes 186 sampling events between 1984 and 2019. Larvae classified at higher taxonomic levels (e.g., genus or family) in the SEAMAP data that also have one or more related species identified in the adult catch data sets from NOAA or TPWD are considered to be included in both the adult and ichthyoplankton survey data.

This data set includes different taxonomic groups because not all organisms could be identified down to species level. This analysis yielded 606 unique taxa of plankton, invertebrates, and vertebrates.

References

Bluewater Texas Terminals LLC. 2021a. Appendix L: Benthic Survey Report in Deepwater Port License Application for the Bluewater SPM Project, Volume II: Environmental Evaluation.

Brand, L.E. (1984). The salinity tolerance of forty-six marine phytoplankton isolates. Estuarine, *Coastal and Shelf Science* 18(5): 543-556.

Cervetto, G., R. Gaudy, and M. Pagano. 1999. Influence of salinity on the distribution of *Acartia tonsa* (Copepoda, Calanoida). *Journal of Experimental Marine Biology and Ecology* 239(1): 33-45.

Gaillard, S., D. Réveillon, C. Danthu, F.Hervé, M. Sibat, L. Carpentier, H. Hégaret, V. Séchet, and P. Hess. 2021. Effect of a short-term salinity stress on the growth, biovolume, toxins, osmolytes and metabolite profiles on three strains of the *Dinophysis acuminata*-complex (*Dinophysis cf. sacculus*). *Harmful Algae* 107, 102009.

Gilabert, J. 2001. Seasonal plankton dynamics in a Mediterranean hypersaline coastal lagoon: the Mar Menor. *Journal of Plankton Research* 23(2): 207-218.

Holland, J.S. 1973. A benthos and plankton study of the Corpus Christi, Copano and Aransas Bay systems. I, Report on the methods used and data collected during the period September 1972-June 1973.

Holland, J.S. 1974. A benthos and plankton study of the Corpus Christi, Copano and Aransas Bay systems. II, Report on the data collected during the period July, 1973-April, 1974.

Hopper, A.F. 1960. The resistance of marine zooplankton of the caribbean and South Atlantic to changes in salinity 1. Limnology and Oceanography, 5(1), 43-47.

Isinibilir, M., L. Svetlichny, E. Hubareva, I.N. Yilmaz, F. Ustun, G. Belmonte, and B. Toklu-Alicli. 2011. Adaptability and vulnerability of zooplankton species in the adjacent regions of the Black and Marmara Seas. Journal of Marine Systems, 84(1-2), 18-27.

Miller, R.L., and D.L. Kamykowski. 1986. Effects of temperature, salinity, irradiance and diurnal periodicity on growth and photosynthesis in the diatom nitzschia americana; light-saturated growth. *Journal of Phycology* 22(3): 339-348.

Nagasathya, A., and N. Thajuddin. 2008. Diatom diversity in hypersaline environment. *Journal of Fisheries and Aquatic Science* 3(5): 328-333.

NOAA Fisheries. 2022. DisMAP data records. Retrieved from apps-st.fisheries.noaa.gov/dismap/DisMAP.html. Accessed August 2022

Rai, S.V., and M. Rajashekhar. 2014. Effect of pH, salinity and temperature on the growth of six species of marine phytoplankton. *Journal of Algal Biomass Utilization* 5(4): 55-59.

TPWD, Coastal Fisheries Division, Correspondence dated August 30, 2022

Tundisi, J., and T.M. Tundisi. 1968. Plankton studies in a mangrove environment: V. Salinity tolerances of some planktonic crustaceans. *Boletim do Instituto Oceanográfico* 17: 57-65.

Appendix A. Comprehensive List of All Fish and Invertebrate Species That May Occur in the Gulf of Mexico around the Project Area

Species	Scientific Name	Notes
Sargent major	*Abudefduf saxatilis* [g]	
Gladiator box crab	*Acanthocarpus alexandri* [a]	
Scrawled cowfish	*Acanthostracion quadricornis* [a,b]	
NA	*Acartia tonsa* [e]	Zooplankton species
Longspine swimming crab	*Achelous spinicarpus* [a]	
Blotched swimming crab	*Achelous spinimanus* [a,b]	
Lined sole	*Achirus lineatus* [b]	
Gulf Sturgeon	*Acipenser oxyrinchus desotoi* [a]	T, Protected Fish (Federal)
Order anemones	*Actiniaria* [b,d]	
Mossy scallop	*Aequipecten muscosus* [a]	
Many-ribbed papillaed jellyfish	*Aequorea forskalea* [b]	
Texas venus	*Agriopoma texasiana* [b]	
African pompano	*Alectis ciliaris* [b]	
Family snapping shrimps	*Alpheidae* [b]	
Estuarine snapping shrimp	*Alpheus estuariensis* [b]	
Sand snapping shrimp	*Alpheus floridanus* [b]	
Bigclaw snapping shrimp	*Alpheus heterochaelis* [b]	
Dotterel filefish	*Aluterus heudelotii* [a]	
Orange filefish	*Aluterus schoepfii* [a,b]	
Scribbled leatherjacket filefish (or Scrawled filefish)	*Aluterus scriptus* [a,b]	
Many-colored tellin	*Ameritella versicolor* [d]	
NA	*Ampelisca vadorum* [d]	Amphipod species
Paper scallop	*Amusium papyraceum* [a]	
Skewed ark	*Anadara baughmani* [a]	
Blood ark	*Anadara ovalis* [b]	
Stilt spider crab	*Anasimus latus* [a]	
Sea hare - unidentified	*Anaspidea* [b]	
Striped anchovy	*Anchoa hepsetus* [a,b]	
Dusky anchovy	*Anchoa lyolepis* [b]	

Appendix A. Comprehensive List of All Fish and Invertebrate Species That May Occur in the Gulf of Mexico around the Project Area

Species	Scientific Name	Notes
Bay anchovy	*Anchoa mitchilli* [a,b]	
Three-eye flounder	*Ancylopsetta dilecta* [a]	
Ocellated flounder	*Ancylopsetta ommata* [a,b]	
Ocellated frogfish	*Antennarius ocellatus* [a]	
Singlespot frogfish	*Antennarius radiosus* [a,b]	
Striated frogfish	*Antennarius striatus* [a]	
Sea star	*Anthenoides peircei* [a]	
Fangtooth snake-eel	*Aplatophis chauliodus* [g]	
Mottled sea hare	*Aplysia fasciata* [b]	
Bigtooth cardinalfish	*Apogon affinis* [a]	
Bridle cardinalfish	*Apogon aurolineatus* [a]	
Twospot cardinalfish	*Apogon pseudomaculatus* [a]	
Sawcheek cardinalfish	*Apogon quadrisquamatus* [a]	
Purple-spined sea urchin	*Arbacia punctulata* [a]	
Turkey wing	*Arca zebra* [a]	
Common sundial	*Architectonica perspectiva* [b]	
Sheepshead	*Archosargus probatocephalus* [b]	
Speckled swimming crab	*Arenaeus cribrarius* [a,b]	
Calico scallop	*Argopecten gibbus* [a]	
Western bay scallop	*Argopectin irradians amplicostatus* [b]	
NA	*Ariomma* [g]	Genus of deepwater, marine ray-finned fishes
Hardhead catfish	*Ariopsis felis* [a,b]	
Brazilian armina	*Armina mulleri* [b]	
Sea squirt	*Ascidiacea* [b]	
Class starfishes	*Asteroidea* [b]	
Brittle star	*Asteroporpa annulata* [a]	
Bronze cardinalfish	*Astrapogon alutus* [a]	
Royal sea star	*Astropecten articulatus* [a]	
Sea star species	*Astropecten cingulatus* [a]	

Appendix A. Comprehensive List of All Fish and Invertebrate Species That May Occur in the Gulf of Mexico around the Project Area

Species	Scientific Name	Notes
Two-spined star fish	*Astropecten duplicatus* [a,b]	
Giant basket star	*Astrophyton muricatum* [a]	
Southern stargazer	*Astroscopus y-graecum* [b]	
Sawtooth penshell	*Atrina serrata* [a]	
Moon jelly	*Aurelia aurita* [b]	
NA	*Auxis* [g]	Frigate tuna genus
Gafftopsail catfish	*Bagre marinus* [a,b]	
Silver perch	*Bairdiella chrysoura* [a,b]	
sei whale	*Balaenoptera borealis* [c]	E (Federal), E (TX State)
blue whale	*Balaenoptera musculus* [c]	E (Federal), E (TX State)
Gulf of Mexico Bryde's whale	*Balaenoptera ricei* [c]	E (Federal), E (TX State)
Gray triggerfish	*Balistes capriscus* [a,b]	
Sooty eel	*Bascanichthys bascanium* [b]	
Yellowtail bass	*Bathyanthias mexicanus* [a]	
Horned searobin	*Bellator militaris* [a]	
NA	*Biddulphia sp.* [f]	Phytoplankton species
Ragged goby	*Bollmannia communis* [a,b]	
Antenna codlet	*Bregmaceros atlanticus* [a]	
Finescale menhaden	*Brevoortia gunteri* [b]	
Gulf menhaden	*Brevoortia patronus* [a,b]	
Atlantic menhaden	*Brevoortia tyrannus* [g]	
Bearded brotula	*Brotula barbata* [a,b]	
Pearwhelk	*Busycotypus spiratus* [b]	
Grass porgy	*Calamus arctifrons* [a]	
Jolthead porgy	*Calamus bajonado* [a]	
Whitebone porgy	*Calamus leucosteus* [a]	
Knobbed porgy	*Calamus nodosus* [a]	
Sheepshead porgy	*Calamus penna* [a]	
Littlehead porgy	*Calamus proridens* [a]	

Appendix A. Comprehensive List of All Fish and Invertebrate Species That May Occur in the Gulf of Mexico around the Project Area

Species	Scientific Name	Notes
Flame box crab	*Calappa flammea* [a,b]	
Yellow box crab	*Calappa sulcata* [a,b]	
Hermit anemone	*Calliactis tricolor* [a]	
Blue crab	*Callinectes sapidus* [a,b]	
Lesser blue crab	*Callinectes similis* [a,b]	
Cancellate cantharus	*Cantharus cancellarius* [a,b]	
Orangespotted filefish	*Cantherhines pullus* [b]	
Rough triggerfish	*Canthidermis maculatus* [g]	
Caribbean sharpnose-puffer	*Canthigaster rostrata* [a]	
Family jacks	*Carangidae* [b]	
Remora	*Carangiformes* [b]	
Blue runner	*Caranx crysos* [a,b]	
Crevalle jack	*Caranx hippos* [a,b]	
Blacknose shark	*Carcharhinus acronotus* [a]	
Blacktip shark	*Carcharhinus limbatus* [b]	
Oceanic Whitetip Shark	*Carcharhinus longimanus* [a,b]	T, Protected Fish (Federal), T (TX State)
Loggerhead Sea Turtle	*Caretta caretta* [c]	T (Federal), T (TX State)
NA	*Caryocorbula* [d]	Saltwater clam species
Blackline tilefish	*Caulolatilus cyanops* [a]	
Anchor tilefish	*Caulolatilus intermedius* [a]	
Bank sea bass	*Centropristis ocyurus* [a]	
Rock sea bass	*Centropristis philadelphica* [a,b]	
Black sea bass	*Centropristis striata* [a]	
NA	*Ceratioidea* [g]	Deep-sea angler fish family
NA	*Ceratioidei* [g]	Deep-sea angler fish suborder
NA	*Ceratium furca* [e]	Phytoplankton species
Atlantic spadefish	*Chaetodipterus faber* [a,b]	
Spotfin butterflyfish	*Chaetodon ocellatus* [a]	
Reef butterflyfish	*Chaetodon sedentarius* [a]	

Appendix A. Comprehensive List of All Fish and Invertebrate Species That May Occur in the Gulf of Mexico around the Project Area

Species	Scientific Name	Notes
Green Sea Turtle	*Chelonia mydas* [c]	T (Federal), T (TX State)
Flowery lace murex	*Chicoreus florifer-dilectus* [a]	
Striped burrfish	*Chilomycterus schoepfii* [a,b]	
Unknown bivalve	*Chione clenchii* [a]	Species *Chione clenchii* could not be verified but this record appears to be for a bivalve belonging to the Chione genus. Naming conventions likely have changed since data were collected.
Florida cross-barred venus	*Chione elevata* [b]	
Sea wasp	*Chironex fleckeri* [b]	
Atlantic bumper	*Chloroscombrus chrysurus* [a,b]	
Yellowtail reeffish	*Chromis enchrysura* [a]	
Sea nettle	*Chrysaora quinquecirrha* [a,b]	
Horned whiff	*Citharichthys cornutus* [a]	
Anglefin whiff	*Citharichthys gymnorhinus* [a]	
Spotted whiff	*Citharichthys macrops* [a,b]	
Bay whiff	*Citharichthys spilopterus* [a,b]	
Thinstripe hermit	*Clibanarius vittatus* [b]	
Menhaden and Herrings- unidentified	*Clupeidae* [b]	
Robust crab	*Collodes robustus* [a]	
Barred grunt	*Conodon nobilis* [b]	
NA	*Corycaeus sp.* [e]	Zooplankton species
Common dolphinfish	*Coryphaena hippurus* [g]	
NA	*Coryphaena* [g]	Dolphinfish family
NA	*Cossura soyeri* [d]	Polychaete species
Bluelip parrotfish	*Cryptotomus roseus* [a]	
Darter goby	*Ctenogobius boleosoma* [b]	
Four-tentacle box jelly	*Cubozoa* [b]	
Mexican flounder	*Cyclopsetta chittendeni* [a,b]	
Spotfin flounder	*Cyclopsetta fimbriata* [a,b]	

Appendix A. Comprehensive List of All Fish and Invertebrate Species That May Occur in the Gulf of Mexico around the Project Area

Species	Scientific Name	Notes
NA	*Cyclotella sp.* [f]	Phytoplankton species
NA	*Cyclothone* [g]	Bristlefish genus
Sand seatrout	*Cynoscion arenarius* [b]	
Spotted seatrout	*Cynoscion nebulosus* [b]	
Silver seatrout	*Cynoscion nothus* [b]	
Flamingo tongue	*Cyphoma gibbosum* [b]	
Intermediate cyphoma	*Cyphoma intermedium* [b]	
Yellow prickly cockle	*Dallocardia muricata* [b]	
Bareye hermit	*Dardanus fucosus* [a]	
Red brocade hermit	*Dardanus insignis* [a]	
Atlantic stingray	*Dasyatis sabina* [b]	
Bluntnose stingray	*Dasyatis say* [b]	
Round scad	*Decapterus punctatus* [a,b]	
Red hogfish	*Decodon puellaris* [a]	
Leatherback Sea Turtle	*Dermochelys coriacea* [c]	E (Federal), E (TX State)
NA	*Diaphus* [g]	Lanternfish genus
Irish pompano	*Diapterus auratus* [b]	
Atlantic giant cockle	*Dinocardium robustum* [b]	
NA	*Dinophysis sp.* [f]	Phytoplankton species
Dwarf sand perch	*Diplectrum bivittatum* [a,b]	
Sand perch	*Diplectrum formosum* [a,b]	
Atlantic diplodon	*Diplodonta punctata* [d]	
Spottail seabream	*Diplodus holbrookii* [a]	
Atlantic distorsio	*Distorsio clathrata* [a,b]	
NA	*Ditylum brightwellii* [e]	Phytoplankton species
Threadfin shad	*Dorosoma petenense* [b]	
Hairy sponge crab	*Dromidia antillensis* [a,b]	
Gulf grassflat crab	*Dyspanopeus texanus* [b]	
Sharksucker	*Echeneis naucrates* [a]	

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Species	Scientific Name	Notes
Whitefin sharksucker	*Echeneis neucratoides* [a]	
NA	*Echinodermata* [d]	Echinoderm species
Spotted spoon-nose eel	*Echiophis intertinctus* [a]	
Rainbow runner	*Elagatis bipinnulatus* [g]	
Ladyfish	*Elopidae* [b]	
Puerto Rican sand crab	*Emerita portoricensis* [b]	
Beach mole crab	*Emerita* spp. [b]	
Sand dollar	*Encope aberrans* [a]	
Notched sand dollar	*Encope michelini* [a]	
Family anchovies	*Engraulidae* [b]	
Spiny flounder	*Engyophrys senta* [a]	
Red grouper	*Epinephelus morio* [a]	
Nassau Grouper	*Epinephelus striatus* [a]	T, Protected Fish (Federal)
Jackknife-fish	*Equetus lanceolatus* [a]	
Hawksbill Sea Turtle	*Eretmochelys imbricata* [c]	E (Federal), E (TX State)
Broadback sumo crab	*Ethusa microphthalma* [a]	
Fringed flounder	*Etropus crossotus* [a,b]	
Shelf flounder	*Etropus cyclosquamus* [a]	
Smallmouth flounder	*Etropus microstomus* [g]	
Gray flounder	*Etropus rimosus* [a]	
Round herring	*Etrumeus teres* [a,b]	
North Atlantic right whale	*Eubalaena glacialis* [c]	E (Federal), E (TX State)
NA	*Eucalanus sp.* [e]	Zooplankton species
Slate pencil urchin	*Eucidaris tribuloides* [a]	
Silver mojarra (or spotfin mojarra)	*Eucinostomus argenteus* [a,b]	
Silver jenny	*Eucinostomus gula* [a,b]	
Tidewater mojarra	*Eucinostomus harengulus* [a]	
Flagfin mojarra	*Eucinostomus melanopterus* [b]	
NA	*Eudorella* [d]	Species of marine hooded shrimp

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Species	Scientific Name	Notes
Craggy bathyal crab	*Euphrosynoplax clausa* [a]	
Little tunny	*Euthynnus alletteratus* [b]	
Redleg humpback shrimp	*Exhippolysmata oplophoroides* [b]	
NA	*Exocoetidae* [g]	Flying fish family
Pink shrimp	*Farfantepenaeus duorarum* [b]	
Atlantic figsnail	*Ficus communis* [a]	
Red cornetfish	*Fistularia petimba* [a]	
NA	*Gadiformes* [g]	Cod order
Shrimp flounder	*Gastropsetta frontalis* [a]	
Lesser mantis shrimp	*Gibbesia neglecta* [b]	
Short-finned pilot whale	*Globicephala macrorhynchus* [a]	MMPA Protected (Federal), T (TX State)
NA	*Glycinde multidens* [d]	Polychaete species
Skilletfish	*Gobiesox strumosus* [a]	
Family gobies	*Gobiidae* [b]	
Highfin goby	*Gobionellus oceanicus* [b]	
Naked goby	*Gobiosoma bosc* [b]	
Code goby	*Gobiosoma robustum* [b]	
Giant sunfish	*Goniaster tesselatus* [a]	
Split-Thumb mantis shrimp	*Gonodactylus bredini* [a]	
NA	*Gonostomatidae* [g]	Bristlemouth family
Naked sole	*Gymnachirus melas* [a]	
Fringed sole	*Gymnachirus texae* [a,b]	
Blacktail moray	*Gymnothorax kolpos* [a]	
Blackedge moray	*Gymnothorax nigromarginatus* [a,b]	
Honeycomb moray	*Gymnothorax saxicola* [a]	
Smooth butterfly ray	*Gymnura micrura* [b]	
Tomtate	*Haemulon aurolineatum* [a]	
White grunt	*Haemulon plumieri* [a]	
Striped grunt	*Haemulon striatum* [a]	

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Species	Scientific Name	Notes
Slippery dick	*Halichoeres bivittatus* [b]	
Pancake batfish	*Halieutichthys aculeatus* [a,b]	
Scaled sardine	*Harengula jaguana* [a,b]	
Bluntnose jack	*Hemicaranx amblyrhynchus* [a,b]	
NA	*Hemiramphidae* [g]	Halfbeaks family
Giant mantis shrimp	*Hemisquilla ensigera* [b]	
Calico box crab	*Hepatus epheliticus* [a,b]	
Bearded fireworms	*Hermodice carunculata* [a]	
Smooth elbow crab	*Heterocrypta granulata* [b]	
Lined seahorse	*Hippocampus erectus* [a,b]	
Dwarf seahorse	*Hippocampus zosterae* [b]	
Family elongate squids	*Histioteuthidae* [b]	
Sargassumfish	*Histrio histrio* [b]	
Blue angelfish	*Holacanthus bermudensis* [a]	
Deepwater squirrelfish	*Holocentrus bullisi* [a]	
Sea cucumber	*Holothuroidea* [b]	
Blacktail pikeconger	*Hoplunnis diomediana* [a]	
Freckled pike-conger	*Hoplunnis macrura* [a]	
Southern stingray	*Hypanus americanus* [b]	
NA	*Hyperia sp.* [e]	Zooplankton species
Warsaw grouper	*Hyporthodus nigritus* [b]	
Feather blenny	*Hypsoblennius hentz* [b]	
NA	*Iliacantha liodactylus* [a]	Species of purse crab
Longfinger purse crab	*Iliacantha subglobosa* [a]	
Chocolate chip sea cucumber	*Isostichopus badionotus* [a]	
Indo-Pacific sailfish	*Istiophorus platypterus* [g]	
shortfin mako shark	*Isurus oxyrinchus* [b]	Candidate (Federal), T (TX State)
Lancer stargazer	*Kathetostoma albigutta* [a]	
Skipjack tuna	*Katsuwonus pelamis* [g]	

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Species	Scientific Name	Notes
Pygmy sperm whale	*Kogia breviceps* [a,b]	MMPA Protected (Federal), T (TX State)
Dwarf sperm whale	*Kogia simus* [a,b]	MMPA Protected (Federal), T (TX State)
NA	*Kyphosus* [g]	Sea chub genus
NA	*Labidocera acutifrons* [e]	Zooplankton species
NA	*Labridae* [g]	Wrasse family
Hogfish	*Lachnolaimus maximus* [a]	
Honeycomb cowfish	*Lactophrys polygonia* [a]	
Eggcockle	*Laevicardium laevigatum* [a]	
Yellow eggcockle	*Laevicardium mortoni* [a]	
Smooth puffer	*Lagocephalus laevigatus* [a,b]	
Pinfish	*Lagodon rhomboides* [a,b]	
Banded drum	*Larimus fasciatus* [a,b]	
Brown grass shrimp	*Leander tenuicornis* [b]	
White elbow crab	*Leiolambrus nitidus* [a,b]	
Spot	*Leiostomus xanthurus* [a,b]	
Kemp's Ridley Sea Turtle	*Lepidochelys kempii* [c]	E (Federal), E (TX State)
Blackedge cusk-eel	*Lepophidium brevibarbe* [a,b]	
Mottled cusk-eel	*Lepophidium jeannae* [a]	
White synapta	*Leptosynapta tenuis* [d]	
NA	*Levinsenia gracilis* [d]	Polychaete species
Longnose spider crab	*Libinia dubia* [b]	
Portly spider crab	*Libinia emarginata* [a,b]	
Clenchs thick-ringed venus	*Lirophora clenchi* [b]	
Northern white shrimp	*Litopenaeus setiferus* [a,b]	
Areolated hairy crab	*Lobopilumnus agassizii* [a]	
Tripletail	*Lobotes surinamensis* [g]	
Longfin inshore squid	*Loligo pealeii* [a,b]	
Slender inshore squid	*Loligo pleii* [a,b]	
Atlantic brief squid	*Lolliguncula brevis* [a,b]	

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Species	Scientific Name	Notes
Swordtail jawfish	*Lonchopisthus micrognathus* [a]	
Banded sea star	*Luidia alternata* [a,b]	
Lined sea star (or striped sea star)	*Luidia clathrata* [a,b]	
Mutton snapper	*Lutjanus analis* [g]	
Red snapper	*Lutjanus campechanus* [a,b]	
Gray snapper	*Lutjanus griseus* [a]	
Lane snapper	*Lutjanus synagris* [a,b]	
Peppermint shrimp	*Lysmata boggess* [b]	
Green sea urchin	*Lytechinus variegatus* [a]	
Short macoma	*Macoma brevifrons* [a]	
Delta macoma	*Macoma pulleyi* [a]	
Spongy decorator crab	*Macrocoeloma trispinosum* [a]	
NA	*Magelona uebelackerae* [d]	Polychaete species
NA	*Maldanidae* [d]	Polychaete species
NA	*Malmgreniella taylori* [d]	Polychaete species
Giant Manta Ray	*Manta birostris* [a]	T, Protected Fish (Federal)
NA	*Mediomastus* [d]	Polychaete species
humpback whale	*Megaptera novaeangliae* [c]	E (Federal)
Five-holed sand dollar	*Mellita quinquiesperforata* [b]	
Rough silverside	*Membras martinica* [b]	
Inland silverside	*Menidia beryllina* [b]	
Silverside - unidentified	*Menidia sp.* [b]	
Gulf stone crab	*Menippe adina* [b]	
Southern kingfish	*Menticirrhus americanus* [a,b]	
Gulf kingfish	*Menticirrhus littoralis* [b]	
Texas quahog	*Mercenaria texana* [b]	
Salmon shrimp	*Mesopenaeus tropicalis* [a]	
Gervais beaked whale	*Mesoplodon europaeus* [a]	MMPA Protected (Federal), T (TX State)
Carribean velvet shrimp	*Metapenaeopsis goodei* [a]	

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Species	Scientific Name	Notes
False arrow crab	*Metoporhaphis calcarata* [a,b]	
Atlantic croaker	*Micropogonias undulatus* [a,b]	
Red ridged clinging crab	*Mithrax forceps* [a]	
Coral clinging crab	*Mithrax hispidus* [a]	
Shaggy clinging crab	*Mithrax pleuracanthus* [a]	
Fringed filefish	*Monacanthus ciliatus* [a]	
Pygmy filefish	*Monacanthus setifer* [g]	
NA	*Moringuidae* [g]	Spaghetti eel, worm eel family
Striped mullet	*Mugil cephalus* [b]	
White mullet	*Mugil curema* [b]	
Red goatfish	*Mullus auratus* [a,b]	
NA	*Munida forceps* [a]	Species of squat lobster
Common squat lobster	*Munida pusilla* [a]	
Giant eastern murex	*Muricanthus fulvescens* [a]	
Smooth dogfish	*Mustelus canis* [a]	
Gag	*Mycteroperca microlepis* [a]	
Scamp	*Mycteroperca phenax* [a]	
NA	*Myctophidae* [g]	Lanternfish family
NA	*Myrophinae* [g]	Worm eel subfamily
Speckled worm-eel	*Myrophis punctatus* [g]	
Fivespine purse crab	*Myropsis quinquespinosa* [a]	
Batfish - unidentified	*NA* [b]	
Lesser electric ray	*Narcine brasiliensis* [a,b]	
NA	*Narcissia trigonaria* [a]	Echinoderm/sea star species
Moonsnail - unidentified	*Naticidae* [b]	
Twospot brotula	*Neobythites gilli* [a]	
Spinycheek scorpionfish	*Neomerinthe hemingwayi* [a]	
NA	*Nephtys incisa* [d]	Polychaete species
NA	*Nettastomatidae* [g]	Duckbilled eels family

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Species	Scientific Name	Notes
False shark eye	*Neverita delessertiana* [b]	
Shark eye	*Neverita duplicata* [b]	
Emerald parrotfish	*Nicholsina usta* [a]	
NA	*Nitzschia americana* [e]	Phytoplankton species
NA	*Nitzschia closterium* [e]	Phytoplankton species
Ponderous ark	*Noetia ponderosa* [b]	
NA	*Nostoc sp.* [e]	Phytoplankton species
NA	*Notomastus* [d]	Polychaete species
Order nudibranchs and sea slugs	*Nudibranchia* [b]	
Pygmy octopus	*Octopus joubini* [a]	
Common octopus	*Octopus vulgaris* [a,b]	
Family batfishes	*Ogcocephalidae* [b]	
Longnose batfish	*Ogcocephalus corniger* [a]	
Slantbrow batfish	*Ogcocephalus declivirostris* [a]	
Spotted batfish	*Ogcocephalus pantostictus* [a,b]	
Roughback batfish	*Ogcocephalus parvus* [a,b]	
Polka-dot batfish	*Ogcocephalus radiatus* [a,b]	
NA	*Oikopleura sp.* [e]	Zooplankton species
NA	*Oithona nana* [f]	Zooplankton species
Leatherjack	*Oligoplites saurus* [b]	
Lettered olive	*Oliva sayana* [b]	
NA	*Ophichthidae* [g]	Snake eel family
NA	*Ophichthinae* [g]	Snake eel subfamily
Shrimp eel	*Ophichthus gomesii* [a,b]	
Blackpored eel	*Ophichthus melanoporus* [g]	
Palespotted eel	*Ophichthus puncticeps* [a,b]	
King snake eel	*Ophichthus rex* [g]	
NA	*Ophichthus* [g]	Snake eel genus
Longnose cusk-eel	*Ophidion beani* [a]	

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Species	Scientific Name	Notes
Blotched cusk-eel	*Ophidion grayi* [a,b]	
Bank cusk-eel	*Ophidion holbrookii* [a]	
Mooneye cusk-eel	*Ophidion selenops* [a]	
Crested cusk-eel	*Ophidion welshi* [a,b]	
Harlequin brittle star	*Ophioderma appressa* [a]	
Brittle star	*Ophioderma brevispinum* [a]	
Elegant brittle star	*Ophiolepis elegans* [a]	
Angular brittle star	*Ophiothrix angulata* [a]	
Class brittle stars	*Ophiuroidea* [b]	
Atlantic thread herring	*Opisthonema oglinum* [a,b]	
Beach flea	*Orchestia* spp. [b]	
Killer whale	*Orcinus orca* [a]	MMPA Protected (Federal), T (TX State)
Cushioned star	*Oreaster reticulatus* [a]	
Pigfish	*Orthopristis chrysoptera* [a,b]	
NA	*Ostraciidae* [g]	Boxfish family
Polka-dot cusk-eel	*Otophidium omostigma* [a]	
Florida lady crab	*Ovalipes floridanus* [a,b]	
NA	*Oxydromus obscurus* [d]	Polychaete species
Red porgy	*Pagrus pagrus* [a]	
Family right-handed hermit crabs	*Paguridae* [b]	
Blue-eyed hermit	*Paguristes sericeus* [a]	
Hermit crab	*Paguristes triangulatus* [a]	
Hermit crab	*Pagurus bullisi* [a]	
Dimpled hermit	*Pagurus impressus* [b]	
Longwrist hermit	*Pagurus longicarpus* [b]	
Flatclaw hermit	*Pagurus pollicaris* [b]	
Grass shrimp - unidentified	*Palaemonetes* [b]	
Labile stilt crab	*Palicus alternatus* [a]	
Oystershell mud crab	*Panopeus simpsoni* [b]	

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Species	Scientific Name	Notes
Seaweed blenny	*Parablennius marmoreus* [a]	
Margintail conger	*Paraconger caudilimbatus* [a]	
Gulf flounder	*Paralichthys albigutta* [a,b]	
Southern flounder	*Paralichthys lethostigma* [a,b]	
Broad flounder	*Paralichthys squamilentus* [a]	
Rose shrimp	*Parapenaeus politus* [a]	
NA	*Paraprionospio pinnata* [d]	Polychaete species
Blackbar drum	*Pareques iwamotoi* [a]	
Cubbyu	*Pareques umbrosus* [a]	
Elbow crab	*Parthenope agonus* [a]	
Elbow crab	*Parthenope fraterculus* [a]	
Ravenel scallop	*Pecten ravenelli* [a]	
NA	*Pectinaria gouldii* [d]	Polychaete species
Family penaeid shrimps	*Penaeidae* [b]	
Brown shrimp	*Penaeus aztecus* [a,b]	
Northern pink shrimp	*Penaeus duorarum* [a]	
Giant hermit	*Pentrochirus diogenes* [a,b]	
Gulf butterfish	*Peprilus burti* [a,b]	
Harvestfish	*Peprilus paru* [a,b]	
Slender searobin	*Peristedion gracile* [a]	
Pink purse crab	*Persephona crinita* [a,b]	
Mottled purse crab	*Persephona mediterranea* [a,b]	
Green porcelain crab	*Petrolisthes armatus* [b]	
Sponge cardinalfish	*Phaeoptyx xenus* [a]	
Scotch bonnet	*Phalium granulatum* [b]	
Sperm whale	*Physeter macrocephalus* [c]	E (Federal), E (TX State)
Hakeling	*Physiculus fulvus* [a]	
Spineback hairy crab	*Pilumnus sayi* [a]	
Family pea crabs	*Pinnotheridae* [b]	

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Species	Scientific Name	Notes
Schwengel pitar	*Pitar cordatus* [a]	
Bladetooth elbow crab	*Platylambrus granulata* [a]	
Shrimp	*Plesionika longicauda* [a]	
Shortfinger neck crab	*Podochela sidneyi* [a,b]	
Sailfin molly	*Poecilia latipinna* [b]	
Black drum	*Pogonias cromis* [b]	
Atlantic threadfin	*Polydactylus octonemus* [b]	
White giant-turris	*Polystira albida* [a]	
Delicate giant-turris	*Polystira tellea* [a]	
Gray angelfish	*Pomacanthus arcuatus* [a]	
Cocao damselfish	*Pomacentrus variabilis* [a]	
Bluefish	*Pomatomus saltatrix* [a,b]	
Longspine scorpionfish	*Pontinus longispinis* [a]	
Spotted porcelain crab	*Porcellana sayana* [a,b]	
Striped porcelain crab	*Porcellana sigsbeiana* [a]	
Atlantic midshipman	*Porichthys plectrodon* [a,b]	
Phylum Sponges	*Porifera* [b]	
Family mud crabs and swimming crabs	*Portunidae* [b]	
Iridescent swimming crab	*Portunus gibbesii* [a,b]	
Redhair swimming crab	*Portunus ordwayii* [a]	
Sargassum swimming crab	*Portunus sayi* [a,b]	
Atlantic bigeye	*Priacanthus arenatus* [a]	
Spiny searobin	*Prionotus alatus* [a]	
Bigeye searobin	*Prionotus longispinosus* [a,b]	
Gulf of mexico barred searobin	*Prionotus martis* [a]	
Bandtail searobin	*Prionotus ophryas* [a,b]	
Mexican searobin	*Prionotus paralatus* [a]	
Bluespotted searobin	*Prionotus roseus* [a,b]	
Blackfin searobin (also Blackwing searobin)	*Prionotus rubio* [a,b]	

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Species	Scientific Name	Notes
Leopard searobin	*Prionotus scitulus* [a,b]	
Shortwing searobin	*Prionotus stearnsi* [a]	
Bighead searobin	*Prionotus tribulus* [a,b]	
Short bigeye	*Pristigenys alta* [a]	
Wenchman	*Pristipomoides aquilonaris* [a,b]	
Smalltooth Sawfish	*Pristis pectinata* [a]	E, Protected Fish (Federal)
Largetooth Sawfish	*Pristis pristis* [a]	E, Protected Fish (Federal)
NA	*Prorocentrum micans* [f]	Phytoplankton species
NA	*Psenes* [g]	Driftfishes genus
Rough rubble crab	*Pseudomedaeus agassizii* [a]	
Diminutive worm eel	*Pseudomyrophis fugesae* [g]	
False killer whale	*Pseudorca crassidens* [a]	E (Federal), T (TX State)
Flecked squareback crab	*Pseudorhombila quadridentata* [a]	
Spotted goatfish	*Pseudupeneus maculatus* [a]	
Atlantic wing-oyster	*Pteria colymbus* [a]	
Red lionfish	*Pterois volitans* [a]	
Cobia	*Rachycentron canadum* [b]	
Clearnose skate	*Raja eglanteria* [a]	
Roundel skate	*Raja texana* [a,b]	
Gulf frog crab	*Raninoides louisianensis* [a,b]	
Sea pansy	*Renilla mulleri* [a,b]	
Atlantic guitarfish	*Rhinobatos lentiginosus* [a]	
Cownose ray	*Rhinoptera bonasus* [a,b]	
Harris mud crab	*Rhithropanopeus harrisii* [d]	
Atlantic sharpnose shark	*Rhizoprionodon terraenovae* [a,b]	
Vermilion snapper	*Rhomboplites aurorubens* [a]	
Mushroom jellyfish	*Rhopilema verrilli* [b]	
Yellow conger	*Rhynchoconger flavus* [a,b]	
Roughneck shrimp	*Rimapenaeus constrictus* [b]	

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Species	Scientific Name	Notes
Rimapenaeid shrimp - unidentified	*Rimapenaeus* spp. [b]	
Benthic bobtail squid	*Rossia* spp.[a]	
Freckled soapfish	*Rypticus bistrispinus* [a]	
Whitespotted soapfish	*Rypticus maculatus* [a]	
NA	*Sagitta sp.* [e]	Zooplankton species
Spanish sardine	*Sardinella aurita* [a,b]	
Largescale lizardfish	*Saurida brasiliensis* [a,b]	
Smallscale lizardfish	*Saurida caribbaea* [b]	
Shortjaw lizardfish	*Saurida normani* [a]	
Seatrout - unidentified	*Sciaenidae* [b]	
Red Drum	*Sciaenops ocellatus* [b]	
NA	*Scoletoma verrilli* [d]	Polychaete species
King mackerel	*Scomberomorus cavalla* [a,b]	
Spanish mackerel	*Scomberomorus maculatus* [a,b]	
Royal bonnet	*Sconsia striata* [a]	
Longfin scorpionfish	*Scorpaena agassizii* [a]	
Barbfish	*Scorpaena brasiliensis* [a,b]	
Smoothhead scorpionfish	*Scorpaena calcarata* [a]	
Spotted scorpionfish	*Scorpaena Mystes* [b]	
Sargassum nudibranch	*Scyllaea pelagica* [b]	
Ridged slipper lobster	*Scyllarides nodifer* [a]	
Chace slipper lobster	*Scyllarus chacei* [a]	
Scaled slipper lobster	*Scyllarus depressus* [a]	
Bigeye scad	*Selar crumenophthalmus* [a,b]	
Atlantic moonfish	*Selene setapinnis* [a,b]	
Lookdown	*Selene vomer* [a,b]	
Greater amberjack	*Seriola dumerili* [a,b]	
Banded rudderfish	*Seriola zonata* [a]	
Pygmy sea bass	*Serraniculus pumilio* [a,b]	

Appendix A. Comprehensive List of All Fish and Invertebrate Species That May Occur in the Gulf of Mexico around the Project Area

Species	Scientific Name	Notes
Blackear bass	*Serranus atrobranchus* [a]	
Saddle bass	*Serranus notospilus* [a]	
Tattler	*Serranus phoebe* [a]	
Belted sandfish	*Serranus subligarius* [a,b]	
Brown rock shrimp	*Sicyonia brevirostris* [a,b]	
Spiny rock shrimp	*Sicyonia burkenroadi* [a]	
Lesser rock shrimp	*Sicyonia dorsalis* [a,b]	
Kinglet rock shrimp	*Sicyonia typica* [a]	
Lightning whelk	*Sinistrofulgur perversum* [b]	
White baby ear	*Sinum perspectivum* [b]	
NA	*Skeletonema costatum* [f]	Phytoplankton species
NA	*Soleidae* [g]	True sole family
Heart urchin	*Spatangoida* [b]	
Gulf squareback crab	*Speocarcinus lobatus* [a,b]	
Marbled puffer	*Sphoeroides dorsalis* [a]	
Southern puffer	*Sphoeroides nephelus* [a]	
Least puffer	*Sphoeroides parvus* [a,b]	
Bandtail puffer	*Sphoeroides spengleri* [a]	
Great barracuda	*Sphyraena barracuda* [b]	
Northern sennet	*Sphyraena borealis* [a]	
Guachanche barracuda	*Sphyraena guachancho* [a,b]	
Family barracudas	*Sphyraenidae* [b]	
Bonnethead	*Sphyrna tiburo* [a,b]	
NA	*Spirulina sp.* [e]	Phytoplankton species
Atlantic thorny oyster	*Spondylus americanus* [a]	
Sand devil	*Squatina dumeril* [a]	
Offshore mantis shrimp	*Squilla chydaea* [a,b]	
Mantis shrimp	*Squilla deceptrix* [a]	
Mantis shrimp	*Squilla empusa* [a]	

Appendix A. Comprehensive List of All Fish and Invertebrate Species That May Occur in the Gulf of Mexico around the Project Area

Species	Scientific Name	Notes
Mantis shrimp	*Squilla neglecta* [a]	
Mantis shrimp	*Squilla rugosa* [a]	
Luminous hake	*Steindachneria argentea* [a]	
Star drum	*Stellifer lanceolatus* [a,b]	
Atlantic Spotted Dolphin	*Stenella frontalis* [b]	T (Federal), T (TX State)
Rough-toothed dolphin	*Steno bredanensis* [a]	MMPA Protected (Federal), T (TX State)
Furcate spider crab	*Stenocionops coelata* [a]	
Furcate spider crab	*Stenocionops furcatus* [a]	
Prickly spider crab	*Stenocionops spinimanus* [a]	
Yellowline arrow crab	*Stenorhynchus seticornis* [a,b]	
Longspine porgy	*Stenotomus caprinus* [a,b]	
Planehead filefish	*Stephanolepis hispidus* [a,b]	
Common mantis shrimp	*Stomatopoda* [b]	
Cannonball jelly or cabbagehead	*Stomolophus meleagris* [b]	
Hays' rocksnail	*Stramonita canaliculata* [b]	
Florida rocksnail	*Stramonita haemastoma* [b]	
Florida fighting conch	*Strombus alatus* [b]	
Wrinkled sea squirt	*Styela plicata* [a]	
Pencil urchin	*Stylocidaris affinis* [a]	
Shoal flounder	*Syacium gunteri* [a,b]	
Dusky flounder	*Syacium papillosum* [a]	
Offshore tonguefish	*Symphurus civitatum* [a]	
Spottedfin tonguefish	*Symphurus diomedeanus* [a]	
Blackcheek tonguefish	*Symphurus plagiusa* [a,b]	
Spottail tonguefish	*Symphurus urospilus* [a]	
Chain pipefish	*Syngnathus louisianae* [b]	
Sargassum pipefish	*Syngnathus pelagicus* [b]	
Gulf pipefish	*Syngnathus scovelli* [b]	
Inshore lizardfish	*Synodus foetens* [a,b]	

Appendix A. Comprehensive List of All Fish and Invertebrate Species That May Occur in the Gulf of Mexico around the Project Area

Species	Scientific Name	Notes
Sand diver	*Synodus intermedius* [a]	
Offshore lizardfish	*Synodus poeyi* [a,b]	
Box jelly	*Tamoya haplonema* [a]	
NA	*Temora stylifera* [e]	Zooplankton species
Sea star	*Tethyaster grandis* [a]	
Atlantic bluefin tuna	*Thunnus thynnus* [g]	
NA	*Thunnus* [g]	True tuna genus
Giant tun	*Tonna galea* [a,b]	
Arrow shrimp	*Tozeuma carolinense* [b]	
Snakefish	*Trachinocephalus myops* [a]	
Florida pompano	*Trachinotus carolinus* [b]	
Permit	*Trachinotus falcatus* [b]	
Rough scad	*Trachurus lathami* [a,b]	
Roughback shrimp	*Trachycaris rugosa* [b]	
West Indian Manatee	*Trichecus manatus* [c]	T (Federal), T (TX State)
Atlantic cutlassfish	*Trichiurus lepturus* [a,b]	
Sash flounder	*Trichopsetta ventralis* [a]	
Family searobins	*Triglidae* [b]	
Hogchoker	*Trinectes maculatus* [b]	
Horse conch	*Triplofusus giganteus* [b]	
Squatter pea crab	*Tumidotheres maculatus* [b]	
Dwarf goatfish	*Upeneus parvus* [a,b]	
Gulf hake	*Urophycis cirrata* [a]	
Southern hake	*Urophycis floridana* [a,b]	
Spotted hake	*Urophycis regia* [a]	
Olive Nerite	*Vitta usnea* [d]	
Atlantic seabob	*Xiphopenaeus kroyeri* [a,b]	
Pearly razorfish	*Xyrichtys novacula* [a]	
Goose-beaked whale	*Ziphius cavirostris* [a]	MMPA Protected (Federal), T (TX State)

Appendix A. Comprehensive List of All Fish and Invertebrate Species That May Occur in the Gulf of Mexico around the Project Area

Species	Scientific Name	Notes

Notes:

NA = not available, no common name currently available or not enough information to determine scientific name

[a] Data source: NOAA Fisheries. 2022. DisMAP data records. Retrieved from apps-st.fisheries.noaa.gov/dismap/DisMAP.html. Accessed August 2022

[b] Data source: TPWD, Coastal Fisheries Division, Correspondence dated August 30, 2022

[c] Data source: IPaC, NOAA and/or TPWD

[d] Data source: Bluewater Benthic Survey Report (Appendix L) - stations 10 and 14.

[e] Data source: Holland et al. 1973, subset known to occur in marine and coastal areas

[f] Data source: Holland et al. 1974, subset known to occur in marine and coastal areas

[g] Data source: SEAMAP ichthyoplankton dataset

Appendix B

Abundant Species Based on Catch Data

Appendix B

Appendix B includes the abundant species noted in either the National Oceanic and Atmospheric Administration (NOAA) bottom trawl survey data (Table B-1) or the Texas Parks and Wildlife Department (TPWD) survey data (Table B-2). Selection criteria for inclusion from the survey data followed similar methods for each data source. Both the NOAA and TPWD data sets included species name, common name, a relative measure of abundance, and various other data columns. For this analysis, we were interested in identifying the most abundant species from each data set and used either the weight catch per unit effort ("WTCPUE") column for the NOAA data, or the sum catch per hour ("Sum_Catch_Per_Hour") column from the TPWD data set.

We applied the following data processing steps for the NOAA data set:

- Exclude rows with WTCPUE < 0.
- For species with multiple WTCPUE values > 0, keep maximum recorded value.
- Check species name and common name for accuracy.
- Identify major taxonomic group (e.g., invertebrate, vertebrate, family) using publicly available databases (e.g., fishbase.org, noaa.gov/species-directory).
- Identify habitat preference (e.g., demersal, pelagic) using above listed resources.
- Sort by species group (invertebrate, vertebrate), and WTCPUE.

We applied the following data processing steps for the TPWD data set:

- Exclude rows with Sum_Catch_Per_Hour < 0.
- Merge species scientific names from Appendix B-1 with common names from TPWD data set. TPWD data did not include scientific names.
- Identify major species taxonomic group (invertebrate, vertebrate).
- Sort by species group (invertebrate, vertebrate), and WTCPUE.

Table B-1. Abundant and Common Fish and Invertebrate Species Captured in the General Vicinity of the Proposed Water Intake Structure from NOAA Bottom Trawl Data

Organism Type	Species	Scientific Name	WTCPUE Max
Invertebrate	Lesser blue crab	*Callinectes similis*	9.23843
Invertebrate	Brown shrimp	*Penaeus aztecus*	6.38353
Invertebrate	Northern white shrimp	*Litopenaeus setiferus*	2.39969
Invertebrate	Slender inshore squid	*Loligo pleii*	1.16730
Invertebrate	Atlantic brief squid	*Lolliguncula brevis*	0.81260
Invertebrate	Longfin inshore squid	*Loligo pealeii*	0.52610
Invertebrate	Mantis shrimp	*Squilla empusa*	0.49496
Invertebrate	Sea nettle	*Chrysaora quinquecirrha*	0.21683
Invertebrate	Blue crab	*Callinectes sapidus*	0.16698
Invertebrate	Longspine swimming crab	*Achelous spinicarpus*	0.15353
Invertebrate	Sea star species	*Astropecten cingulatus*	0.14861
Invertebrate	Stilt spider crab	*Anasimus latus*	0.12630
Invertebrate	Lined sea star	*Luidia clathrata*	0.08792
Invertebrate	Sea pansy	*Renilla mulleri*	0.07192
Invertebrate	Mantis shrimp	*Squilla neglecta*	0.06561
Invertebrate	Portly spider crab	*Libinia emarginata*	0.06266
Invertebrate	Northern pink shrimp	*Penaeus duorarum*	0.04535
Invertebrate	Rose shrimp	*Parapenaeus politus*	0.04298
Invertebrate	Schwengel pitar	*Pitar cordatus*	0.04199
Invertebrate	Speckled swimming crab	*Arenaeus cribrarius*	0.04039
Invertebrate	Atlantic seabob	*Xiphopenaeus kroyeri*	0.03290
Invertebrate	Paper scallop	*Amusium papyraceum*	0.02985
Invertebrate	Calico box crab	*Hepatus epheliticus*	0.02460
Invertebrate	Yellow box crab	*Calappa sulcata*	0.01842
Invertebrate	Iridescent swimming crab	*Portunus gibbesii*	0.01807
Invertebrate	Two-spined star fish	*Astropecten duplicatus*	0.01669
Invertebrate	Blotched swimming crab	*Achelous spinimanus*	0.01542
Invertebrate	Mottled purse crab	*Persephona mediterranea*	0.01509
Invertebrate	Offshore mantis shrimp	*Squilla chydaea*	0.01311
Invertebrate	Gulf frog crab	*Raninoides louisianensis*	0.00820
Invertebrate	White elbow crab	*Leiolambrus nitidus*	0.00681
Invertebrate	Pink purse crab	*Persephona crinita*	0.00591
Invertebrate	Skewed ark	*Anadara baughmani*	0.00354
Invertebrate	Hermit anemone	*Calliactis tricolor*	0.00285
Invertebrate	Flecked squareback crab	*Pseudorhombila quadridentata*	0.00164
Invertebrate	NA	*Iliacantha liodactylus*	0.00164
Invertebrate	Fivespine purse crab	*Myropsis quinquespinosa*	0.00164
Invertebrate	Lesser rock shrimp	*Sicyonia dorsalis*	0.00098
Invertebrate	Sargassum swimming crab	*Portunus sayi*	0.00095
Invertebrate	Spotted porcelain crab	*Porcellana sayana*	0.00033

Table B-1. Abundant and Common Fish and Invertebrate Species Captured in the General Vicinity of the Proposed Water Intake Structure from NOAA Bottom Trawl Data

Organism Type	Species	Scientific Name	WTCPUE Max
Vertebrate	Atlantic croaker	*Micropogonias undulatus*	65.33847
Vertebrate	Gulf butterfish	*Peprilus burti*	9.95229
Vertebrate	Spot	*Leiostomus xanthurus*	6.17542
Vertebrate	Banded drum	*Larimus fasciatus*	5.86193
Vertebrate	Atlantic thread herring	*Opisthonema oglinum*	5.40618
Vertebrate	Atlantic moonfish	*Selene setapinnis*	4.62739
Vertebrate	Atlantic cutlassfish	*Trichiurus lepturus*	4.46523
Vertebrate	Southern kingfish	*Menticirrhus americanus*	3.82975
Vertebrate	Hardhead catfish	*Ariopsis felis*	2.72419
Vertebrate	Atlantic bumper	*Chloroscombrus chrysurus*	2.32954
Vertebrate	Rough scad	*Trachurus lathami*	2.32600
Vertebrate	Lesser electric ray	*Narcine brasiliensis*	2.04183
Vertebrate	Gulf menhaden	*Brevoortia patronus*	2.02497
Vertebrate	Longspine porgy	*Stenotomus caprinus*	1.96605
Vertebrate	Bonnethead	*Sphyrna tiburo*	1.45809
Vertebrate	Striped anchovy	*Anchoa hepsetus*	1.27155
Vertebrate	Pinfish	*Lagodon rhomboides*	1.01366
Vertebrate	Bluntnose jack	*Hemicaranx amblyrhynchus*	0.93856
Vertebrate	Inshore lizardfish	*Synodus foetens*	0.88576
Vertebrate	Scaled sardine	*Harengula jaguana*	0.82900
Vertebrate	Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	0.79718
Vertebrate	Bigeye searobin	*Prionotus longispinosus*	0.57787
Vertebrate	Red snapper	*Lutjanus campechanus*	0.55059
Vertebrate	Red snapper	*Lutjanus campechanus*	0.55059
Vertebrate	Shoal flounder	*Syacium gunteri*	0.51216
Vertebrate	Star drum	*Stellifer lanceolatus*	0.45427
Vertebrate	Mexican flounder	*Cyclopsetta chittendeni*	0.40618
Vertebrate	Harvestfish	*Peprilus paru*	0.35791
Vertebrate	Rock sea bass	*Centropristis philadelphica*	0.25228
Vertebrate	Summer flounder (Southern flounder)	*Paralichthys lethostigma*	0.19657
Vertebrate	Gafftopsail catfish	*Bagre marinus*	0.18535
Vertebrate	Ocellated flounder	*Ancylopsetta ommata*	0.17846
Vertebrate	Dwarf sand perch	*Diplectrum bivittatum*	0.17620
Vertebrate	Crested cusk-eel	*Ophidion welshi*	0.15878
Vertebrate	Dwarf goatfish	*Upeneus parvus*	0.15550
Vertebrate	Fringed flounder	*Etropus crossotus*	0.14369
Vertebrate	Atlantic midshipman	*Porichthys plectrodon*	0.13385
Vertebrate	Blue runner	*Caranx crysos*	0.12775
Vertebrate	Spottedfin tonguefish	*Symphurus diomedeanus*	0.12007
Vertebrate	Bighead searobin	*Prionotus tribulus*	0.11719

Table B-1. Abundant and Common Fish and Invertebrate Species Captured in the General Vicinity of the Proposed Water Intake Structure from NOAA Bottom Trawl Data

Organism Type	Species	Scientific Name	WTCPUE Max
Vertebrate	Smooth puffer	*Lagocephalus laevigatus*	0.09283
Vertebrate	Spanish mackerel	*Scomberomorus maculatus*	0.09047
Vertebrate	Blackedge cusk-eel	*Lepophidium brevibarbe*	0.07677
Vertebrate	Gray triggerfish	*Balistes capriscus*	0.07529
Vertebrate	Mexican searobin	*Prionotus paralatus*	0.06069
Vertebrate	Largescale lizardfish	*Saurida brasiliensis*	0.05067
Vertebrate	Blackcheek tonguefish	*Symphurus plagiusa*	0.04641
Vertebrate	Bay whiff	*Citharichthys spilopterus*	0.04298
Vertebrate	Blackfin searobin	*Prionotus rubio*	0.02723
Vertebrate	Slantbrow batfish	*Ogcocephalus declivirostris*	0.02268
Vertebrate	Sash flounder	*Trichopsetta ventralis*	0.01936
Vertebrate	King mackerel	*Scomberomorus cavalla*	0.01867
Vertebrate	Offshore tonguefish	*Symphurus civitatum*	0.01701
Vertebrate	Spiny flounder	*Engyophrys senta*	0.00992
Vertebrate	Shortwing searobin	*Prionotus stearnsi*	0.00949
Vertebrate	Wenchman	*Pristipomoides aquilonaris*	0.00886
Vertebrate	Bigeye scad	*Selar crumenophthalmus*	0.00886
Vertebrate	Striped burrfish	*Chilomycterus schoepfii*	0.00755
Vertebrate	Planehead filefish	*Stephanolepis hispida*	0.00696
Vertebrate	Ragged goby	*Bollmannia communis*	0.00525
Vertebrate	Bearded brotula	*Brotula barbata*	0.00425
Vertebrate	Silver jenny	*Eucinostomus gula*	0.00316
Vertebrate	Bay anchovy	*Anchoa mitchilli*	0.00295
Vertebrate	Least puffer	*Sphoeroides parvus*	0.00230
Vertebrate	Fringed sole	*Gymnachirus texae*	0.00213
Vertebrate	Spiny searobin	*Prionotus alatus*	0.00142
Vertebrate	Antenna codlet	Bregmaceros atlanticus	0.000354302

Source: NOAA Fisheries. 2022. DisMAP data records. Retrieved from apps-st.fisheries.noaa.gov/dismap/DisMAP.html. Accessed August 2022

Notes:

WTCPUE = weight catch per unit effort

Table B-2. Abundant and Common Fish and Invertebrate Species Captured in the General Vicinity of the Proposed Water Intake Structure from TPWD Data

Organism Type	Species	Scientific Name	Sum Catch Per Hour
Invertebrate	Sea pansy	*Renilla mulleri*	653139
Invertebrate	Atlantic brief squid	*Lolliguncula brevis*	340750
Invertebrate	Roughback shrimp	*Trachycaris rugosa*	249347
Invertebrate	Moon jelly	*Aurelia aurita*	170918
Invertebrate	Brown shrimp	*Penaeus aztecus*	158258
Invertebrate	Lesser blue crab	*Callinectes similis*	137300
Invertebrate	Lined sea star (or striped sea star)	*Luidia clathrata*	105644
Invertebrate	Northern white shrimp	*Litopenaeus setiferus*	104092
Invertebrate	Slender inshore squid	*Loligo pleii*	57605
Invertebrate	Common mantis shrimp	*Stomatopoda*	51206
Invertebrate	Longfin inshore squid	*Loligo pealeii*	50509
Invertebrate	Iridescent swimming crab	*Portunus gibbesii*	45812
Invertebrate	Five-holed sand dollar	*Mellita quinquiesperforata*	45409
Invertebrate	Rimapenaeid shrimp - unidentified	*Rimapenaeus* spp.	38929
Invertebrate	Order anemones	*Actiniaria*	29557
Invertebrate	Pink shrimp	*Farfantepenaeus duorarum*	22739
Invertebrate	Lesser rock shrimp	*Sicyonia dorsalis*	15535
Invertebrate	Roughneck shrimp	*Rimapenaeus constrictus*	13449
Invertebrate	Two-spined star fish	*Astropecten duplicatus*	12457
Invertebrate	Sea nettle	*Chrysaora quinquecirrha*	10120
Invertebrate	Pink purse crab	*Persephona crinita*	9078
Invertebrate	Atlantic seabob	*Xiphopenaeus kroyeri*	8459
Invertebrate	Longnose spider crab	*Libinia dubia*	7208
Invertebrate	Cannonball jelly or cabbagehead	*Stomolophus meleagris*	7028
Invertebrate	Cancellate cantharus	*Cantharus cancellarius*	5060
Invertebrate	Flatclaw hermit	*Pagurus pollicaris*	4948
Invertebrate	Blue crab	*Callinectes sapidus*	4110
Invertebrate	Speckled swimming crab	*Arenaeus cribrarius*	3957
Invertebrate	Florida lady crab	*Ovalipes floridanus*	3918
Invertebrate	Banded sea star	*Luidia alternata*	3204
Invertebrate	Blotched swimming crab	*Achelous spinimanus*	2451
Invertebrate	Calico box crab	*Hepatus epheliticus*	2429
Invertebrate	Yellow box crab	*Calappa sulcata*	2206
Invertebrate	Mottled purse crab	*Persephona mediterranea*	1970
Invertebrate	Heart urchin	*Spatangoida*	1862
Invertebrate	Lesser mantis shrimp	*Gibbesia neglecta*	1796
Invertebrate	Moonsnail - unidentified	*Naticidae*	1567
Invertebrate	Lightning whelk	*Sinistrofulgur perversum*	1381
Invertebrate	Blood ark	*Anadara ovalis*	950
Invertebrate	Many-ribbed papillaed jellyfish	*Aequorea forskalea*	922
Invertebrate	Family mud crabs and swimming crabs	*Portunidae*	695
Invertebrate	Yellowline arrow crab	*Stenorhynchus seticornis*	669
Invertebrate	Sargassum swimming crab	*Portunus sayi*	573
Invertebrate	False arrow crab	*Metoporhaphis calcarata*	429
Invertebrate	Shark eye	*Neverita duplicata*	407
Invertebrate	Estuarine snapping shrimp	*Alpheus estuariensis*	405
Invertebrate	Florida rocksnail	*Stramonita haemastoma*	381
Invertebrate	White elbow crab	*Leiolambrus nitidus*	377
Invertebrate	Giant hermit	*Pentrochirus diogenes*	359
Invertebrate	Sea hare - unidentified	*Anaspidea*	311
Invertebrate	Spotted porcelain crab	*Porcellana sayana*	303

Table B-2. Abundant and Common Fish and Invertebrate Species Captured in the General Vicinity of the Proposed Water Intake Structure from TPWD Data

Organism Type	Species	Scientific Name	Sum Catch Per Hour
Invertebrate	False shark eye	*Neverita delessertiana*	269
Invertebrate	Mottled sea hare	*Aplysia fasciata*	234
Invertebrate	Order nudibranchs and sea slugs	*Nudibranchia*	210
Invertebrate	Green porcelain crab	*Petrolisthes armatus*	204
Invertebrate	Class brittle stars	*Ophiuroidea*	198
Invertebrate	Brown rock shrimp	*Sicyonia brevirostris*	174
Invertebrate	Gulf grassflat crab	*Dyspanopeus texanus*	168
Invertebrate	Thinstripe hermit	*Clibanarius vittatus*	168
Invertebrate	Longwrist hermit	*Pagurus longicarpus*	156
Invertebrate	Offshore mantis shrimp	*Squilla chydaea*	150
Invertebrate	Gulf squareback crab	*Speocarcinus lobatus*	132
Invertebrate	Portly spider crab	*Libinia emarginata*	124
Invertebrate	Arrow shrimp	*Tozeuma carolinense*	102
Invertebrate	Brazilian armina	*Armina mulleri*	102
Invertebrate	Pearwhelk - unidentified	*Busycotypus sp.*	102
Invertebrate	White baby ear	*Sinum perspectivum*	98
Invertebrate	Mushroom jellyfish	*Rhopilema verrilli*	90
Invertebrate	Family elongate squids	*Histioteuthidae*	84
Invertebrate	Common sundial	*Architectonica perspectiva*	82
Invertebrate	Florida fighting conch	*Strombus alatus*	78
Invertebrate	Oystershell mud crab	*Panopeus simpsoni*	78
Invertebrate	Class starfishes	*Asteroidea*	66
Invertebrate	Giant tun	*Tonna galea*	66
Invertebrate	Bigclaw snapping shrimp	*Alpheus heterochaelis*	60
Invertebrate	Scotch bonnet	*Phalium granulatum*	54
Invertebrate	Sargassum crab	*Portunus sayi*	48
Invertebrate	Smooth elbow crab	*Heterocrypta granulata*	48
Invertebrate	Squatter pea crab	*Tumidotheres maculatus*	48
Invertebrate	Beach mole crab	*Emerita* spp.	46
Invertebrate	Beach flea	*Orchestia* spp.	42
Invertebrate	Family penaeid shrimps	*Penaeidae*	42
Invertebrate	Family right-handed hermit crabs	*Paguridae*	42
Invertebrate	Flamingo tongue	*Cyphoma gibbosum*	42
Invertebrate	Pearwhelk	*Busycotypus spiratus*	42
Invertebrate	Peppermint shrimp	*Lysmata boggess*	42
Invertebrate	Gulf stone crab	*Menippe adina*	36
Invertebrate	Hairy sponge crab	*Dromidia antillensis*	36
Invertebrate	Ponderous ark	*Noetia ponderosa*	36
Invertebrate	Sea wasp	*Chironex fleckeri*	36
Invertebrate	Family pea crabs	*Pinnotheridae*	30
Invertebrate	Gulf frog crab	*Raninoides louisianensis*	30
Invertebrate	Lettered olive	*Oliva sayana*	30
Invertebrate	Common octopus	*Octopus vulgaris*	24
Invertebrate	Sargassum nudibranch	*Scyllaea pelagica*	24
Invertebrate	Shortfinger neck crab	*Podochela sidneyi*	24
Invertebrate	Dimpled hermit	*Pagurus impressus*	18
Invertebrate	Family snapping shrimps	*Alpheidae*	18
Invertebrate	Family swimming crabs	*Portunidae*	18
Invertebrate	Four-tentacle box jelly	*Cubozoa*	18
Invertebrate	Hays' rocksnail	*Stramonita canaliculata*	18
Invertebrate	Puerto Rican sand crab	*Emerita portoricensis*	18

Table B-2. Abundant and Common Fish and Invertebrate Species Captured in the General Vicinity of the Proposed Water Intake Structure from TPWD Data

Organism Type	Species	Scientific Name	Sum Catch Per Hour
Invertebrate	Sand snapping shrimp	*Alpheus floridanus*	18
Invertebrate	Western bay scallop	*Argopectin irradians amplicostatus*	18
Invertebrate	Yellow prickly cockle	*Dallocardia muricata*	18
Invertebrate	Atlantic giant cockle	*Dinocardium robustum*	16
Invertebrate	Atlantic distorsio	*Distorsio clathrata*	12
Invertebrate	Brown grass shrimp	*Leander tenuicornis*	12
Invertebrate	Clenchs thick-ringed venus	*Lirophora clenchi*	12
Invertebrate	Flame box crab	*Calappa flammea*	12
Invertebrate	Florida cross-barred venus	*Chione elevata*	12
Invertebrate	Giant mantis shrimp	*Hemisquilla ensigera*	12
Invertebrate	Grass shrimp - unidentified	*Palaemonetes*	12
Invertebrate	Horse conch	*Triplofusus giganteus*	12
Invertebrate	Intermediate cyphoma	*Cyphoma intermedium*	12
Invertebrate	Redleg humpback shrimp	*Exhippolysmata oplophoroides*	12
Invertebrate	Sea cucumber	*Holothuroidea*	12
Invertebrate	Sea squirt	*Ascidiacea*	12
Invertebrate	Swimming crab	*Portunidae*	12
Invertebrate	Texas quahog	*Mercenaria texana*	12
Invertebrate	Texas venus	*Agriopoma texasiana*	12
Vertebrate	Atlantic bumper	*Chloroscombrus chrysurus*	672642
Vertebrate	Atlantic croaker	*Micropogonias undulatus*	610649
Vertebrate	Silver seatrout	*Cynoscion nothus*	376080
Vertebrate	Gulf butterfish	*Peprilus burti*	238298
Vertebrate	Sand seatrout	*Cynoscion arenarius*	198466
Vertebrate	Spot	*Leiostomus xanthurus*	142321
Vertebrate	Shoal flounder	*Syacium gunteri*	123128
Vertebrate	Banded drum	*Larimus fasciatus*	110602
Vertebrate	Atlantic moonfish	*Selene setapinnis*	81108
Vertebrate	Star drum	*Stellifer lanceolatus*	74068
Vertebrate	Longspine porgy	*Stenotomus caprinus*	69609
Vertebrate	Atlantic threadfin	*Polydactylus octonemus*	42953
Vertebrate	Pinfish	*Lagodon rhomboides*	41275
Vertebrate	Red snapper	*Lutjanus campechanus*	35873
Vertebrate	Atlantic cutlassfish	*Trichiurus lepturus*	33440
Vertebrate	Hardhead catfish	*Ariopsis felis*	31195
Vertebrate	Striped anchovy	*Anchoa hepsetus*	27479
Vertebrate	Harvestfish	*Peprilus paru*	26158
Vertebrate	Blackfin searobin (also Blackwing searobin)	*Prionotus rubio*	23655
Vertebrate	Bay anchovy	*Anchoa mitchilli*	20367
Vertebrate	Southern kingfish	*Menticirrhus americanus*	18658
Vertebrate	Blackcheek tonguefish	*Symphurus plagiusa*	17674
Vertebrate	Scaled sardine	*Harengula jaguana*	16861
Vertebrate	Fringed flounder	*Etropus crossotus*	15510
Vertebrate	Gafftopsail catfish	*Bagre marinus*	10096
Vertebrate	Bay whiff	*Citharichthys spilopterus*	9703
Vertebrate	Pigfish	*Orthopristis chrysoptera*	8779
Vertebrate	Dwarf goatfish	*Upeneus parvus*	8771
Vertebrate	Gulf menhaden	*Brevoortia patronus*	7509
Vertebrate	Least puffer	*Sphoeroides parvus*	6795
Vertebrate	Bigeye searobin	*Prionotus longispinosus*	6790

Table B-2. Abundant and Common Fish and Invertebrate Species Captured in the General Vicinity of the Proposed Water Intake Structure from TPWD Data

Organism Type	Species	Scientific Name	Sum Catch Per Hour
Vertebrate	Atlantic spadefish	*Chaetodipterus faber*	6032
Vertebrate	Southern hake	*Urophycis floridana*	5824
Vertebrate	Rough scad	*Trachurus lathami*	5369
Vertebrate	Greater amberjack	*Seriola dumerili*	4952
Vertebrate	Silver perch	*Bairdiella chrysoura*	4950
Vertebrate	Lookdown	*Selene vomer*	4553
Vertebrate	Smooth puffer	*Lagocephalus laevigatus*	4549
Vertebrate	Silver mojarra (or spotfin mojarra)	*Eucinostomus argenteus*	4144
Vertebrate	Bighead searobin	*Prionotus tribulus*	4056
Vertebrate	Lane snapper	*Lutjanus synagris*	4036
Vertebrate	Pancake batfish	*Halieutichthys aculeatus*	4010
Vertebrate	Gray triggerfish	*Balistes capriscus*	3988
Vertebrate	Inshore lizardfish	*Synodus foetens*	3200
Vertebrate	Bluntnose jack	*Hemicaranx amblyrhynchus*	2816
Vertebrate	Dwarf sand perch	*Diplectrum bivittatum*	2637
Vertebrate	Barred grunt	*Conodon nobilis*	2130
Vertebrate	Silver jenny	*Eucinostomus gula*	2102
Vertebrate	Atlantic stingray	*Dasyatis sabina*	1815
Vertebrate	Lesser electric ray	*Narcine brasiliensis*	1713
Vertebrate	Planehead filefish	*Stephanolepis hispidus*	1671
Vertebrate	Largescale lizardfish	*Saurida brasiliensis*	1539
Vertebrate	King mackerel	*Scomberomorus cavalla*	1537
Vertebrate	Gulf kingfish	*Menticirrhus littoralis*	1485
Vertebrate	Mexican flounder	*Cyclopsetta chittendeni*	1449
Vertebrate	Atlantic thread herring	*Opisthonema oglinum*	1315
Vertebrate	Ocellated flounder	*Ancylopsetta ommata*	1260
Vertebrate	Rock sea bass	*Centropristis philadelphica*	1232
Vertebrate	Menhaden and Herrings- unidentified	*Clupeidae*	1156
Vertebrate	Lined seahorse	*Hippocampus erectus*	952
Vertebrate	Lined sole	*Achirus lineatus*	920
Vertebrate	Striped burrfish	*Chilomycterus schoepfii*	802
Vertebrate	Spanish mackerel	*Scomberomorus maculatus*	749
Vertebrate	Round herring	*Etrumeus teres*	731
Vertebrate	Threadfin shad	*Dorosoma petenense*	629
Vertebrate	Atlantic midshipman	*Porichthys plectrodon*	617
Vertebrate	Spanish sardine	*Sardinella aurita*	477
Vertebrate	Offshore lizardfish	*Synodus poeyi*	473
Vertebrate	Guachanche barracuda	*Sphyraena guachancho*	461
Vertebrate	Crevalle jack	*Caranx hippos*	449
Vertebrate	Leatherjack	*Oligoplites saurus*	383
Vertebrate	White mullet	*Mugil curema*	293
Vertebrate	Hogchoker	*Trinectes maculatus*	293
Vertebrate	Round scad	*Decapterus punctatus*	287
Vertebrate	Spotted batfish	*Ogcocephalus pantostictus*	281
Vertebrate	Crested cusk-eel	*Ophidion welshi*	264
Vertebrate	Orange filefish	*Aluterus schoepfii*	254
Vertebrate	Blue runner	*Caranx crysos*	228
Vertebrate	Red goatfish	*Mullus auratus*	216
Vertebrate	Southern flounder	*Paralichthys lethostigma*	204
Vertebrate	Ladyfish	*Elopidae*	204
Vertebrate	Family anchovies	*Engraulidae*	204

Table B-2. Abundant and Common Fish and Invertebrate Species Captured in the General Vicinity of the Proposed Water Intake Structure from TPWD Data

Organism Type	Species	Scientific Name	Sum Catch Per Hour
Vertebrate	Family herrings	*Clupeidae*	192
Vertebrate	Polka-dot batfish	*Ogcocephalus radiatus*	192
Vertebrate	Bluespotted searobin	*Prionotus roseus*	186
Vertebrate	Highfin goby	*Gobionellus oceanicus*	180
Vertebrate	Gulf flounder	*Paralichthys albigutta*	174
Vertebrate	Finescale menhaden	*Brevoortia gunteri*	168
Vertebrate	Bonnethead	*Sphyrna tiburo*	168
Vertebrate	Fringed sole	*Gymnachirus texae*	160
Vertebrate	Black drum	*Pogonias cromis*	154
Vertebrate	Yellow conger	*Rhynchoconger flavus*	138
Vertebrate	Roughback batfish	*Ogcocephalus parvus*	138
Vertebrate	Southern stargazer	*Astroscopus y-graecum*	130
Vertebrate	Barbfish	*Scorpaena brasiliensis*	126
Vertebrate	Spotted seatrout	*Cynoscion nebulosus*	118
Vertebrate	Blackedge cusk-eel	*Lepophidium brevibarbe*	112
Vertebrate	Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	108
Vertebrate	Gulf pipefish	*Syngnathus scovelli*	102
Vertebrate	Bluefish	*Pomatomus saltatrix*	96
Vertebrate	Smooth butterfly ray	*Gymnura micrura*	96
Vertebrate	Chain pipefish	*Syngnathus louisianae*	90
Vertebrate	Ragged goby	*Bollmannia communis*	78
Vertebrate	Blotched cusk-eel	*Ophidion grayi*	72
Vertebrate	Cobia	*Rachycentron canadum*	72
Vertebrate	Family batfishes	*Ogcocephalidae*	72
Vertebrate	Scrawled cowfish	*Acanthostracion quadricornis*	72
Vertebrate	Florida pompano	*Trachinotus carolinus*	66
Vertebrate	Inland silverside	*Menidia beryllina*	66
Vertebrate	Striped mullet	*Mugil cephalus*	66
Vertebrate	Dusky anchovy	*Anchoa lyolepis*	60
Vertebrate	Cownose ray	*Rhinoptera bonasus*	60
Vertebrate	Red Drum	*Sciaenops ocellatus*	60
Vertebrate	Roundel skate	*Raja texana*	60
Vertebrate	Sailfin molly	*Poecilia latipinna*	60
Vertebrate	Silverside - unidentified	*Menidia spp.*	60
Vertebrate	Southern stingray	*Hypanus americanus*	60
Vertebrate	Bigeye scad	*Selar crumenophthalmus*	52
Vertebrate	Spotted whiff	*Citharichthys macrops*	50
Vertebrate	Darter goby	*Ctenogobius boleosoma*	48
Vertebrate	Rough silverside	*Membras martinica*	48
Vertebrate	Shrimp eel	*Ophichthus gomesii*	48
Vertebrate	Bearded brotula	*Brotula barbata*	42
Vertebrate	Great barracuda	*Sphyraena barracuda*	42
Vertebrate	Palespotted eel	*Ophichthus puncticeps*	42
Vertebrate	Sargassumfish	*Histrio histrio*	42
Vertebrate	Warsaw grouper	*Hyporthodus nigritus*	34
Vertebrate	Blackedge moray	*Gymnothorax nigromarginatus*	30
Vertebrate	Code goby	*Gobiosoma robustum*	30
Vertebrate	Little tunny	*Euthynnus alletteratus*	30
Vertebrate	Permit	*Trachinotus falcatus*	30
Vertebrate	Pygmy sea bass	*Serraniculus pumilio*	30
Vertebrate	Singlespot frogfish	*Antennarius radiosus*	30

Table B-2. Abundant and Common Fish and Invertebrate Species Captured in the General Vicinity of the Proposed Water Intake Structure from TPWD Data

Organism Type	Species	Scientific Name	Sum Catch Per Hour
Vertebrate	Sooty eel	*Bascanichthys bascanium*	30
Vertebrate	Spotted scorpionfish	*Scorpaena Mystes*	30
Vertebrate	Batfish - unidentified	NA	24
Vertebrate	Blacktip shark	*Carcharhinus limbatus*	24
Vertebrate	Bluntnose stingray	*Dasyatis say*	24
Vertebrate	Family jacks	*Carangidae*	24
Vertebrate	Leopard searobin	*Prionotus scitulus*	24
Vertebrate	Naked goby	*Gobiosoma bosc*	24
Vertebrate	Spotfin flounder	*Cyclopsetta fimbriata*	24
Vertebrate	Dwarf seahorse	*Hippocampus zosterae*	20
Vertebrate	African pompano	*Alectis ciliaris*	18
Vertebrate	Flagfin mojarra	*Eucinostomus melanopterus*	18
Vertebrate	Irish pompano	*Diapterus auratus*	18
Vertebrate	Loggerhead Sea Turtle	*Caretta caretta*	18
Vertebrate	Remora	*Carangiformes*	18
Vertebrate	Sand perch	*Diplectrum formosum*	18
Vertebrate	Sargassum pipefish	*Syngnathus pelagicus*	18
Vertebrate	Seatrout - unidentified	*Sciaenidae*	18
Vertebrate	Smallscale lizardfish	*Saurida caribbaea*	18
Vertebrate	Bandtail searobin	*Prionotus ophryas*	12
Vertebrate	Belted sandfish	*Serranus subligarius*	12
Vertebrate	Family barracudas	*Sphyraenidae*	12
Vertebrate	Family gobies	*Gobiidae*	12
Vertebrate	Family searobins	*Triglidae*	12
Vertebrate	Feather blenny	*Hypsoblennius hentz*	12
Vertebrate	Orangespotted filefish	*Cantherhines pullus*	12
Vertebrate	Scribbled leatherjacket filefish (or Scrawled filefish)	*Aluterus scriptus*	12
Vertebrate	Sheepshead	*Archosargus probatocephalus*	12
Vertebrate	Slippery dick	*Halichoeres bivittatus*	12
Vertebrate	Wenchman	*Pristipomoides aquilonaris*	12

Source: TPWD, Coastal Fisheries Division, Correspondence dated August 30, 2022

Appendix C

Correspondence with State Agency

Michele Abbene

From: Zachary Olsen <Zachary.Olsen@tpwd.texas.gov>
Sent: Tuesday, August 30, 2022 11:20 AM
To: Michele Abbene
Subject: RE: Request for Texas Coastal Fisheries Data
Attachments: CF-Mar-Res-Mon-Ops-Manual-2018.pdf; TRAWL_MA20_INVERTS.xlsx; TRAWL_MA20_VERTS.xlsx

[CAUTION: External email. Think before you click links or open attachments.]
Michele,
Attached is your requested data. You will find invertebrate data in the "…INVERTS.xlsx" file and vertebrates in the "…VERTS.xlsx" file.

A couple details on the sampling methodology. These samples were collected using otter trawls inside our Gulf sampling area MA20 ("Major Area 20")--this roughly corresponds to your request (i.e., adjacent to San Jose and Mustang Islands). Latitude and longitude are provided for each sample. This area does cover out to 10 miles, though with the lat and long information you should be able to coarse out data within 5 miles (as you requested). I've attached SOPs for TPWDs Fisheries Independent sampling program. This data was collected as part of the "Gulf Trawl" program that begins on page 35 of the attached document. Included in this document is gear specs of the sampling gear.

Some metadata for the attached excel spreadsheets:

- Data was available in this sampling area from 1985-present. The most recent data that you will see if from June 2022—we have not completed the editing process for data collected later than this and so it is not yet ready for public release.
- All trawl data is given as CPUE (catch/hour)—"ELASPED_TIME" is the time (in decimal hours) that was used to calculated the CPUE.
- Blanks in species column for CPUE indicate zero catch for that sample.
- Latitude and longitude is given relative to NAD83.
- All species are given by common names, but if you need clarification on any of these just let me know
- In an effort to make this a bit more manageable, I've removed all entries that only had a single record in the time series. I have also removed any entries that did not identify catch (taxonomically) below Class (e.g., I removed unidentified fishes that were entered at Class Ray Finned Fishes—Actinopterygii)

Please let me know if you have any questions on any of this.
Thanks,
Zach

Zachary Olsen
Texas Parks and Wildlife Department – Coastal Fisheries Division
Aransas Bay Ecosystem Leader
824 S. Fuqua St.
Rockport, Texas 78382
Office: 361.729.5429

From: Michele Abbene <mabbene@integral-corp.com>
Sent: Friday, August 26, 2022 10:08 AM
To: Zachary Olsen <Zachary.Olsen@tpwd.texas.gov>
Subject: Re: Request for Texas Coastal Fisheries Data

ALERT: This email came from an external source. Do not open attachments or click on links in unknown or unexpected emails.

Great, thank you!

MICHELE ABBENE
Tel: 225.346.9534 | Cell: 631.680.4650
INTEGRAL CONSULTING INC.

From: Zachary Olsen <Zachary.Olsen@tpwd.texas.gov>
Sent: Friday, August 26, 2022 10:07:00 AM
To: Michele Abbene <mabbene@integral-corp.com>
Subject: RE: Request for Texas Coastal Fisheries Data

[CAUTION: External email. Think before you click links or open attachments.]
Hi Michele,
I ran this by our Science Director and he approved the request—I'll start compiling this data for you ASAP.
Zach

Zachary Olsen
Texas Parks and Wildlife Department – Coastal Fisheries Division
Aransas Bay Ecosystem Leader
824 S. Fuqua St.
Rockport, Texas 78382
Office: 361.729.5429

From: Michele Abbene <mabbene@integral-corp.com>
Sent: Thursday, August 25, 2022 2:46 PM
To: Zachary Olsen <Zachary.Olsen@tpwd.texas.gov>
Subject: Request for Texas Coastal Fisheries Data

ALERT: This email came from an external source. Do not open attachments or click on links in unknown or unexpected emails.

Hi Zach,

Thanks for chatting with me yesterday. I am looking for fisheries data and benthic invertebrate data (if available) for the following:

Location: Aransas Pass area. Along Mustang Island and San Jose Island to 5 miles offshore.
Project Type: environmental assessment for intake structure (specifically impingement and entrainment)
Time Frame: all data (you mentioned as far back as 70s or 80s through present).

Please let me know if you have any additional questions.

Regards,
Michele

MICHELE ABBENE | Project Scientist
Tel: 225.346.9534 | Cell: 631.680.4650
8550 United Plaza Blvd., Suite 702 | Baton Rouge | LA 70809
mabbene@integral-corp.com | www.integral-corp.com

integral INSIGHT FOR AN EVOLVING WORLD

Michele Abbene

From:	Zachary Olsen <Zachary.Olsen@tpwd.texas.gov>
Sent:	Wednesday, September 14, 2022 4:12 PM
To:	Michele Abbene
Subject:	RE: Request for Texas Coastal Fisheries Data
Attachments:	SEATURTLES_MA5_MA6_MA20.xlsx

[CAUTION: External email. Think before you click links or open attachments.]

Michele,

Attached is the requested data.

- Data is from 1980-present (when available) and for Major Area 5 (MA; Aransas Bay), MA 6 (Corpus Christi Bay), and MA 20 (Gulf of Mexico adjacent to these bay). These areas include all of the estuaries you mention below. The most recent data queried was from June 2022—we have not completed the editing process for data collected later than this and so it is not yet ready for public release.
- Data are from three different sampling gears (indicated in the "GEAR" column). Please refer to the SOP manual that I sent with the previous data request.
- Each row of data represents a single specimen.
- When length is available, it is given as mm.
- Latitude and longitude is given relative to NAD83.
- All species are given by common names, but if you need clarification on any of these, just let me know.

Please let me know if you have any questions here.

Zach

Zachary Olsen
Texas Parks and Wildlife Department – Coastal Fisheries Division
Aransas Bay Ecosystem Leader
824 S. Fuqua St.
Rockport, Texas 78382
Office: 361.729.5429

From: Michele Abbene <mabbene@integral-corp.com>
Sent: Monday, September 12, 2022 11:06 AM
To: Zachary Olsen <Zachary.Olsen@tpwd.texas.gov>
Subject: RE: Request for Texas Coastal Fisheries Data

Hi Zach,

I have an additional request for the same project.

I would like to see records of all sea turtles that have been observed/caught in the estuary complex (e.g., Corpus Christi Bay, Redfish Bay, Aransas Bay, Copano Bay, Nueces Bay). Do you have information on the size or life stage of the turtles as well?

I did see a few turtles reported in the previous dataset. If there are additionally sea turtle records from the Gulf of Mexico area (besides the ones in the trawl data you already sent) or size information, please include those as well.

Please let me know if you require additional information to complete this request.

Thank you,
Michele

MICHELE ABBENE
Tel: 225.346.9534 | Cell: 631.680.4650
INTEGRAL CONSULTING INC.

From: Michele Abbene
Sent: Tuesday, August 30, 2022 1:34 PM
To: Zachary Olsen <Zachary.Olsen@tpwd.texas.gov>
Subject: RE: Request for Texas Coastal Fisheries Data

Received, thank you!

Regards,

From: Zachary Olsen <Zachary.Olsen@tpwd.texas.gov>
Sent: Tuesday, August 30, 2022 11:20 AM
To: Michele Abbene <mabbene@integral-corp.com>
Subject: RE: Request for Texas Coastal Fisheries Data

Michele,
Attached is your requested data. You will find invertebrate data in the "…INVERTS.xlsx" file and vertebrates in the "…VERTS.xlsx" file.

A couple details on the sampling methodology. These samples were collected using otter trawls inside our Gulf sampling area MA20 ("Major Area 20")--this roughly corresponds to your request (i.e., adjacent to San Jose and Mustang Islands). Latitude and longitude are provided for each sample. This area does cover out to 10 miles, though with the lat and long information you should be able to coarse out data within 5 miles (as you requested). I've attached SOPs for TPWDs Fisheries Independent sampling program. This data was collected as part of the "Gulf Trawl" program that begins on page 35 of the attached document. Included in this document is gear specs of the sampling gear.

Some metadata for the attached excel spreadsheets:

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- All species are given by common names, but if you need clarification on any of these just let me know
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Please let me know if you have any questions on any of this.
Thanks,
Zach

Zachary Olsen
Texas Parks and Wildlife Department – Coastal Fisheries Division
Aransas Bay Ecosystem Leader
824 S. Fuqua St.
Rockport, Texas 78382
Office: 361.729.5429

From: Michele Abbene <mabbene@integral-corp.com>
Sent: Friday, August 26, 2022 10:08 AM
To: Zachary Olsen <Zachary.Olsen@tpwd.texas.gov>
Subject: Re: Request for Texas Coastal Fisheries Data

Great, thank you!

MICHELE ABBENE
Tel: 225.346.9534 | Cell: 631.680.4650
INTEGRAL CONSULTING INC.

From: Zachary Olsen <Zachary.Olsen@tpwd.texas.gov>
Sent: Friday, August 26, 2022 10:07:00 AM
To: Michele Abbene <mabbene@integral-corp.com>
Subject: RE: Request for Texas Coastal Fisheries Data

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Zach

Zachary Olsen
Texas Parks and Wildlife Department – Coastal Fisheries Division
Aransas Bay Ecosystem Leader
824 S. Fuqua St.
Rockport, Texas 78382
Office: 361.729.5429

From: Michele Abbene <mabbene@integral-corp.com>
Sent: Thursday, August 25, 2022 2:46 PM
To: Zachary Olsen <Zachary.Olsen@tpwd.texas.gov>
Subject: Request for Texas Coastal Fisheries Data

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Hi Zach,

Thanks for chatting with me yesterday. I am looking for fisheries data and benthic invertebrate data (if available) for the following:

Location: Aransas Pass area. Along Mustang Island and San Jose Island to 5 miles offshore.
Project Type: environmental assessment for intake structure (specifically impingement and entrainment)
Time Frame: all data (you mentioned as far back as 70s or 80s through present).

Please let me know if you have any additional questions.

Regards,
Michele

MICHELE ABBENE | **Project Scientist**
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8550 United Plaza Blvd., Suite 702 | Baton Rouge | LA 70809
mabbene@integral-corp.com | www.integral-corp.com

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Major A 5 = Aransas Bay; Major A 6 = Corpus Christi Bay, Major A 20 = Gulf of Mexico next to these bays

MAJOR_AR	MINOR_AR	STATION_CODE	GEAR	YEAR	MONTH	COMPLETION_DTTM	Y	X	COMMON_NAME	NUMBER_CAPTURED	LENGTH
6	260	4	Bag Seine	2009	10	10/26/2009 9:56	27.8842	-97.3447	Hawksbill seaturtle	1	46
6	130	114	Gill Net	2021	6	6/1/2021 10:26	27.8167	-97.1636	Green seaturtle	1	405
6	130	114	Gill Net	2021	6	6/1/2021 10:26	27.8167	-97.1636	Green seaturtle	1	399
6	130	212	Gill Net	2021	6	6/10/2021 7:34	27.7196	-97.3329	Green seaturtle	1	426
6	130	207	Gill Net	2020	11	11/4/2020 7:39	27.7413	-97.1605	Green seaturtle	1	374
6	130	207	Gill Net	2020	11	11/4/2020 7:39	27.7413	-97.1605	Green seaturtle	1	308
6	130	111	Gill Net	2020	9	9/23/2020 8:35	27.8215	-97.2155	Green seaturtle	1	459
6	130	94	Gill Net	2015	10	10/7/2015 8:49	27.8489	-97.1383	Green seaturtle	1	445
6	130	191	Gill Net	2016	5	5/25/2016 8:54	27.7633	-97.1647	Green seaturtle	1	580
6	130	156	Gill Net	2016	6	6/16/2016 8:45	27.7878	-97.1211	Green seaturtle	1	
6	130	156	Gill Net	2019	4	4/23/2019 8:39	27.7939	-97.1203	Green seaturtle	1	365
6	130	156	Gill Net	2019	4	4/23/2019 8:39	27.7939	-97.1203	Green seaturtle	1	367
6	130	159	Gill Net	2017	10	10/30/2017 9:03	27.7689	-97.3864	Green seaturtle	1	328
6	130	111	Gill Net	2017	10	10/23/2017 8:43	27.8217	-97.2158	Green seaturtle	1	442
6	130	227	Gill Net	2014	10	10/29/2014 8:10	27.7053	-97.2908	Green seaturtle	1	380
6	130	221	Gill Net	2014	10	10/8/2014 8:58	27.7289	-97.1828	Green seaturtle	1	369
6	130	116	Gill Net	2013	5	5/7/2013 7:28	27.8214	-97.1306	Green seaturtle	1	525
6	130	238	Gill Net	2013	5	5/6/2013 7:48	27.6969	-97.2519	Green seaturtle	1	268
6	130	90	Gill Net	2010	4	4/13/2010 7:56	27.8431	-97.2469	Green seaturtle	1	365
6	130	90	Gill Net	2009	10	10/6/2009 8:23	27.8364	-97.2417	Green seaturtle	1	300
6	130	173	Gill Net	2001	4	4/10/2001 10:44	27.7692	-97.1514	Loggerhead seaturtle	1	250
6	260	9	Gill Net	2019	5	5/28/2019 8:30	27.8731	-97.4547	Green seaturtle	1	284
6	284	55	Gill Net	2016	4	4/27/2016 8:35	27.8858	-97.1178	Green seaturtle	1	435
6	284	54	Gill Net	2016	4	4/27/2016 7:25	27.8919	-97.1339	Green seaturtle	1	
6	284	94	Gill Net	2015	6	6/10/2015 9:07	27.8492	-97.1414	Green seaturtle	1	370
6	284	93	Gill Net	2015	10	10/7/2015 7:48	27.8489	-97.1594	Green seaturtle	1	382
6	284	55	Gill Net	2017	5	5/16/2017 7:06	27.8914	-97.1331	Green seaturtle	1	415
6	284	54	Gill Net	2017	10	10/10/2017 8:30	27.8919	-97.1339	Green seaturtle	1	320
6	284	54	Gill Net	2017	10	10/10/2017 8:30	27.8919	-97.1339	Green seaturtle	1	325
6	284	54	Gill Net	2017	10	10/10/2017 8:30	27.8919	-97.1339	Green seaturtle	1	310
6	284	95	Gill Net	2017	9	9/26/2017 7:31	27.8442	-97.125	Green seaturtle	1	295
6	284	95	Gill Net	2017	9	9/26/2017 7:31	27.8442	-97.125	Green seaturtle	1	353
6	284	63	Gill Net	2011	4	4/26/2011 9:28	27.8697	-97.1539	Green seaturtle	1	285
6	284	65	Gill Net	2010	11	11/4/2010 7:40	27.8692	-97.1319	Green seaturtle	1	343
6	284	65	Gill Net	2011	10	10/26/2011 7:47	27.8681	-97.1328	Green seaturtle	1	450
6	284	77	Gill Net	2007	5	5/23/2007 6:57	27.8531	-97.1611	Green seaturtle	1	290
6	284	92	Gill Net	2001	4	4/20/2001 7:40	27.8364	-97.17	Green seaturtle	1	394

Major A 5 = Aransas Bay; Major A 6 = Corpus Christi Bay, Major A 20 = Gulf of Mexico next to these bays

MAJOR_AR	MINOR_AR	STATION_CODE	GEAR	YEAR	MONTH	COMPLETION_DTTM	Y	X	COMMON_NAME	NUMBER_CAPTURED	LENGTH
6	284	55	Gill Net	2000	4	4/27/2000 8:25	27.8894	-97.1303	Green seaturtle	1	280
5	20	262	Gill Net	2020	10	10/13/2020 7:29	28.0047	-97.057	Green seaturtle	1	404
5	20	152	Gill Net	2017	9	9/12/2017 10:59	28.1161	-96.9222	Green seaturtle	1	550
5	20	152	Gill Net	2017	9	9/12/2017 10:59	28.1161	-96.9222	Green seaturtle	1	562
5	20	95	Gill Net	2018	9	9/18/2018 8:45	28.1375	-97.0006	Green seaturtle	1	344
5	20	200	Gill Net	2011	4	4/21/2011 7:50	28.0667	-96.9625	Green seaturtle	1	386
5	20	178	Gill Net	2013	9	9/19/2013 8:36	28.0953	-96.9156	Green seaturtle	1	434
5	20	262	Gill Net	2001	5	5/10/2001 8:55	28.0042	-97.0561	Green seaturtle	1	344
5	20	323	Gill Net	1994	11	11/2/1994 6:44	27.9056	-97.0583	Green seaturtle	1	397
5	20	316	Gill Net	1993	5	5/25/1993 7:08	27.9181	-97.0181	Green seaturtle	1	280
5	120	248	Gill Net	2014	9	9/17/2014 8:13	28.0283	-97.125	Green seaturtle	1	353
5	250	81	Gill Net	2016	4	4/21/2016 7:36	28.1542	-96.8161	Green seaturtle	1	344
5	250	158	Gill Net	2017	5	5/11/2017 7:00	28.1136	-96.8247	Green seaturtle	1	274
5	250	132	Gill Net	2001	9	9/19/2001 9:43	28.1181	-96.8194	Green seaturtle	1	332
5	280	320	Gill Net	2015	10	10/19/2015 10:15	27.9006	-97.1064	Green seaturtle	1	332
5	280	284	Gill Net	2019	5	5/6/2019 8:38	27.9711	-97.0856	Green seaturtle	1	261
5	280	303	Gill Net	2019	4	4/29/2019 8:25	27.9339	-97.0864	Green seaturtle	1	287
5	280	321	Gill Net	2019	10	10/23/2019 8:33	27.9111	-97.0844	Green seaturtle	1	291
5	285	330	Gill Net	2019	10	10/23/2019 7:33	27.8967	-97.0872	Green seaturtle	1	286
6	130	241	Trawl	2008	2	2/7/2008 12:10	27.6925	-97.2064	Green seaturtle	1	
20	994	2075	Trawl	2010	10	10/18/2010 8:09	27.8428	-96.9858	Loggerhead seaturtle	1	
20	994	1968	Trawl	2010	7	7/6/2010 9:35	27.9722	-96.8878	Loggerhead seaturtle	1	890
20	994	2076	Trawl	2004	4	4/27/2004 9:15	27.8356	-96.9744	Loggerhead seaturtle	1	690
20	994	2148	Trawl	1997	7	7/16/1997 12:15	27.7417	-97.0583	Kemp's ridley seaturtle	1	600
5	120	186	Trawl	2019	9	9/6/2019 12:10	28.0781	-97.2058	Green seaturtle	1	350
5	250	79	Trawl	2020	12	12/7/2020 10:34	28.1561	-96.8404	Green seaturtle	1	376
5	250	56	Trawl	2013	8	8/21/2013 9:50	28.1722	-96.8411	Green seaturtle	1	500

APPENDIX F

Port of Corpus Christi Proposed Corpus Christi Ship Channel Outfall Pipe Construction Methodology

PORT OF CORPUS CHRISTI
CORPUS CHRISTI SHIP CHANNEL OUTFALL PIPE
CONSTRUCTION METHODOLOGY
HARBOR ISLAND, CORPUS CHRISTI, TEXAS

Prepared **for:**

Port of Corpus Christi

400 Charles Zahn, Jr. Drive

Corpus Christi, TX 78401

Prepared by:

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Texas Registered Engineering Firm F-4991

Parsons Environnent & Infrastructure Group Inc.
Texas Registered Engineering Firm F-7652

February 12, 2025

1 Introduction

The Port of Corpus Christi Authority of Nueces County, Texas (Port Authority) intends to construct a desalination facility (the "Facility) on Harbor Island to create optionality for the region in the face of the mounting need for a drought-proof water supply. Lake Corpus Christi, Choke Canyon Reservoir, Lake Texana and the Colorado River currently provide raw water to the region. The recent (2021-2024) drought with increased water demand has emphasized the continued need to find additional drought-proof water sources for the Coastal Bend region. The Port Authority has requested authorization to divert up to 350,000 acre-ft/year (maximum diversion rate of 217,000 gallons/minute (gpm)) of State Water from the Gulf of Mexico ('State Water') to the Facility to produce 100 million gallons per day (MGD) (112,000 acre-ft/year) of desalinated product water.

The purpose of this document is to provide the Construction Methodology for the Harbor Island 50 MGD discharge pipe and outfall structures which will allow for discharge of reject water. This report will provide the construction details in sufficient detail to support the various permit applications required. Numeric measurements and values referenced in this document rely upon preliminary design considerations which are subject to confirmation or revision during the final engineering-design phase. Specific design, location, and operation inputs were used for the purposes of assessing potential impacts to the environment and avoiding sensitive areas. Other technologies and/or products may be selected during the engineering-design phase due to geotechnical or related information that will meet or exceed the referenced performance criteria.

2 Preliminary Routing

The 50 MGD pipe connects to the Seawater Desalination Facility and heads southwest across Harbor Island, connecting to the outfall structure, which is located adjacent to the Corpus Christi Ship Channel. This is detailed in Figure 1 below.

The discharge pipe will connect to a reverse osmosis, concentrate-effluent holding tank at the southeast corner of the Seawater Desalination Facility. From that connection, a buried/submerged 60-inch pipe will transport stored effluent water to a multiport high-rate diffuser (port exit minimum velocity ≥ 3 meters per second) approximately 230 feet offshore of Harbor Island. Diffuser port exit velocities ≥ 3 meters per second generate sufficient momentum and energy in the effluent discharge to assure rapid mixing of the effluent and receiving water.

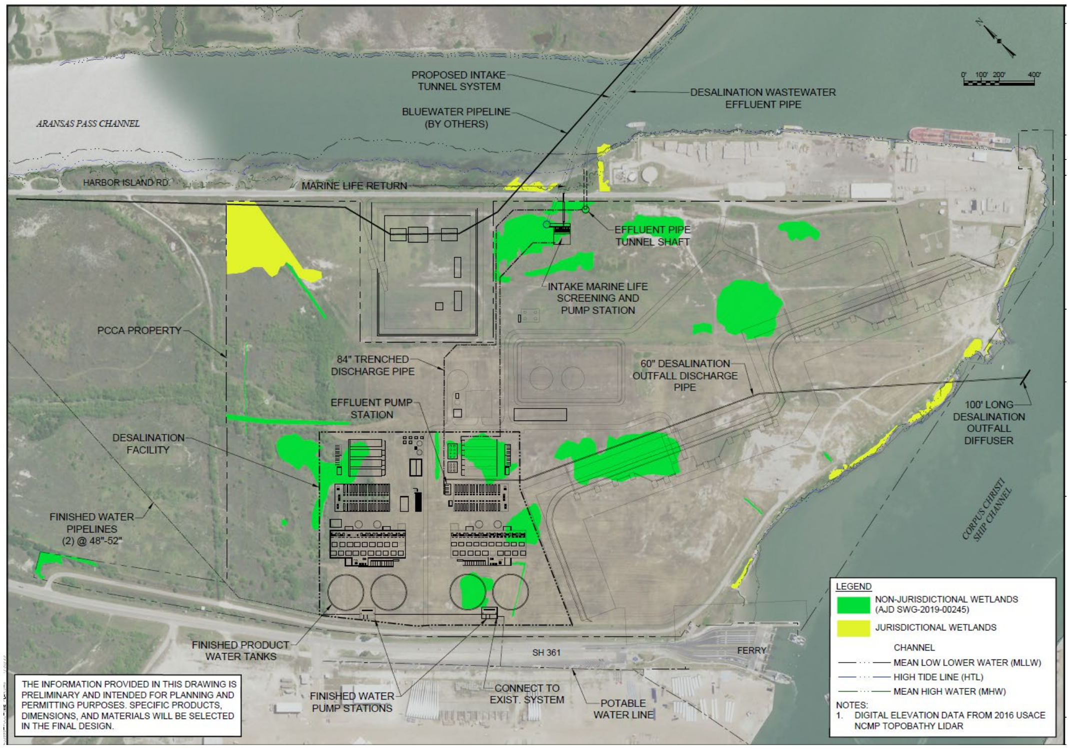

Figure 1: Location of 50 MGD Discharge

3 Assumed Geotechnical Conditions

A project-specific geotechnical investigation has not yet been performed on Harbor Island. Available boring logs and a generalized understanding of the geology in the Corpus Christi area suggests that only sands and silty clays are present. These conditions are characterized as “soft ground”, that is, in laymen’s terms, soil and not rock. The top of the tunnel is proposed to be at an elevation of approximately -60 feet NAVD88.

A geotechnical investigation will be performed prior to final design that will influence many aspects of the design. The ultimate configuration and methods will be determined during final design after the geotechnical investigation is completed. Presented below is a generalized version of typical construction methods for a tunnel.

4 Proposed Tunnel Method

4.1 Microtunneling

Microtunneling is a specialized pipejacking method that can be used to construct the outfall pipe by sequentially jacking pipes horizontally from a jacking shaft to a reception shaft. It uses a remote-controlled, guided self-excavating tunnel boring machine (MTBM) (which means non-man entry, remote steering/controlled, and controlled face tunneling according to the American Public Works Association Greenbook). Controlled face tunneling means providing pressure equal and opposite to the earth and water pressures at the “tunnel heading” or “excavation face” to prevent uncontrolled inflow of soils and water. Microtunneling has been successfully used to install pipelines with a diameter of 10 to 136 inches, with lengths between 200 ft to 1.5 miles. With a precise automated guidance, microtunneling can be used in a wide variety of soil conditions while maintaining very close tolerances to line and grade. MTMB methods are used when line and grade are critical.

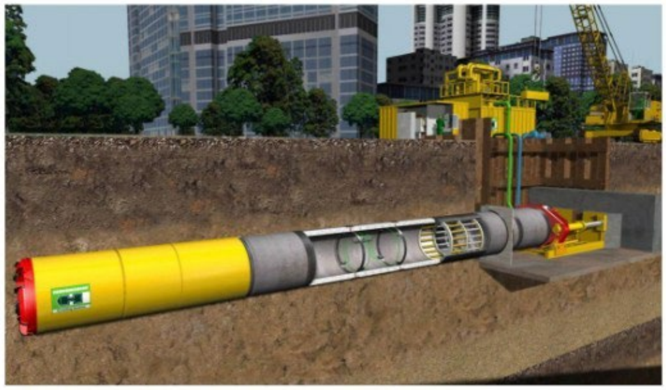

Figure 1: Microtunneling[1]

4.2 Horizontal Directional Drilling

Alternatively, Horizontal Directional Drilling (HDD) may also be used. HDD is a trenchless construction method whereby a pipeline is installed along an arcing drill path, beginning and ending at the ground surface, and passing under the conflicting feature in-between, without requiring deep shafts. A drill rig is set up on one end of the installation and begins by drilling a pilot bore to the exit point. The alignment typically begins with a 5-to-20-degree tangent section that transitions to a vertical curve with a radius between 600 and 6,000 ft, depending on drill size, product pipe diameter, product pipe material, and required alignment. At the end of the bore, the alignment raises to the surface at a typical angle of 5 to 18 degrees. The pilot bore is then reamed in one or more passes to obtain the required diameter needed for pullback of the product pipe string and a diameter larger than the product pipe diameter. Once the reaming is complete, the drill pipe is connected to the product pipe's outer diameter with a swivel and pulling head at the exit side of the alignment and pulled into place in one continuous operation. HDD is usually a cheaper and faster method than micro tunneling.

Based on industry experience, the maximum HDD diameter is typically 60 inches with a maximum drive length of 3,500 feet. Given the length of HDD drive for a 60" pipe, HDD may be used.

[1] https://www.linkedin.com/pulse/what-microtunneling-maged-ghoweba/

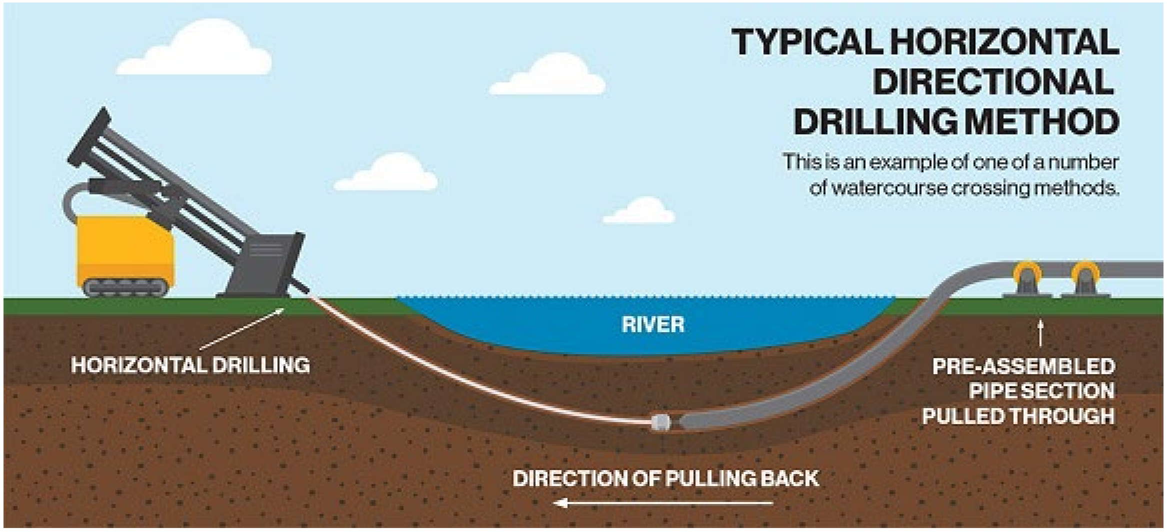

Figure 2: Horizontal Directional Drilling (HDD) Example[2]

4.3 Preferred Construction Method

For the overall CCSC outfall pipe, either micro tunnelling or HDD is the preferred methods.

[2] https://www.slurrytreatmentplant.com/news/company-news/88.html

APPENDIX G

Port of Corpus Christi Proposed Gulf of Mexico Outfall for Desalination Plant Basis of Design Report

PORT OF CORPUS CHRISTI
PROPOSED GULF OF MEXICO OUTFALL FOR DESALINATION PLANT
BASIS OF DESIGN REPORT
HARBOR ISLAND, CORPUS CHRISTI, TEXAS

Prepared for:

Port of Corpus Christi
400 Charles Zahn, Jr. Drive
Corpus Christi, TX 78401

Prepared by:

Parsons Environment & Infrastructure Group Inc.
Texas Registered Engineering Firm F-7652

Civitas Engineering Group, Inc.
Texas Registered Engineering Firm F-4991

With attached Appendix from:

Tischler/Kocurek
Texas Registered Engineering Firm F-3277

January 28. 2025

1 Introduction

The Port of Corpus Christi Authority of Nueces County, Texas (Port Authority) intends to construct a desalination facility (the “Facility) on Harbor Island to create optionality for the region in the face of mounting need for a drought-proof water supply. Lake Corpus Christi, Choke Canyon Reservoir, Lake Texana and the Colorado River currently provide raw water to the region. The recent (2021-2022) drought with increased water demand has emphasized the continued need to find additional drought-proof water sources for the Coastal Bend region. The Port Authority has requested authorization to divert up to 350,000 acre-ft/year (maximum diversion rate of 217,000 gallons/minute (gpm)) of State Water from the Gulf of Mexico (‘State Water’) to the Facility to produce 100 million gallons per day (MGD) (112,000 acre-ft/year) of desalinated product water. Product water will be distributed on a wholesale basis to municipal and industrial entities.

The purpose of this report is to provide a Basis of Design for the discharge of the facility’s wastewater to the Gulf of Mexico (GOM) (see Figure 1) in sufficient detail to support the various permit applications required for construction. Numeric measurements and values referenced in this document rely upon preliminary design considerations which are subject to confirmation or revision during the final engineering-design phase. Specific design, location, and operation inputs were used for the purposes of assessing potential impacts to the environment. Other technologies and/or products may be selected during the final engineering-design phase to meet or exceed the referenced performance criteria.

2 Facility Characteristics

The proposed desalination facility is expected to operate with a desalination recovery rate from 40 to 50%, meaning that 40% to 50% of the pre-treated seawater that enters the reverse osmosis (RO) units becomes desalinated product water, with the balance of the water (called RO retentate or RO reject) as a higher salinity brine wastewater. Other wastewater flows are generated as reject from the pre-treatment system; they are combined with the RO retentate to produce the expected total of 191.2 MGD of wastewater at 40% recovery, or 132.9 MGD at 50% recovery. The salt content of the other wastewater flows is essentially the same as the source seawater; water treatment chemicals are dosed at concentrations in the low milligram per liter (mg/L) range and will not significantly impact salinity. The water balances for the facility operating at 40% and 50% recovery are shown in Table 1 and 2, respectively.

Table 1. Water balance for the proposed 100 MGD desalination facility operating at a 40% recovery rate.

Characteristics	Desalination Plant Intake	Desalination Production	Desalination Plant Effluent	Units
Total required intake flowrate:	301.4			MGD
Marine life screening and return	10.6			MGD
Total intake tunnel flowrate	312			MGD
Production flowrate (desalinated water):		100.0		MGD
Recovery rate of desalination process:		40		%
RO retentate flowrate:			150.0	MGD
Other waste flows:			41.2	MGD
Permitted Outfall flowrate:			191.2	MGD

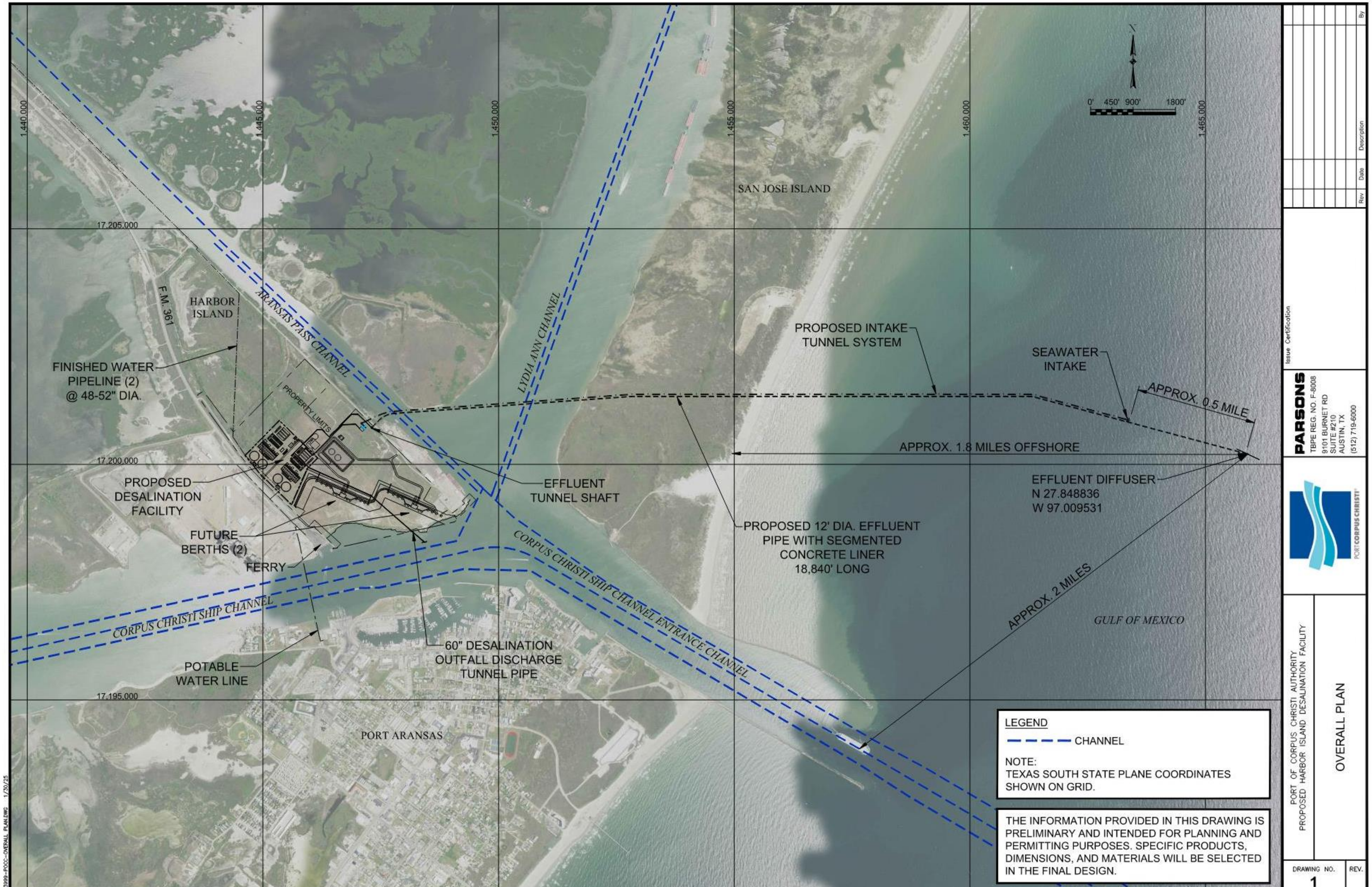

Figure 1. Overall Plan

Table 2. Water balance for the proposed 100 MGD desalination facility operating at a 50% recovery rate.

Characteristics	Desalination Plant Intake	Desalination Production	Desalination Plant Effluent	Units
Total required intake flowrate:	241.2			MGD
Marine life screening and return	10.6			MGD
Total intake tunnel flowrate	251.8			MGD
Production flowrate (desalinated water):		100.0		MGD
Recovery rate of desalination process:		50		%
RO Retentate flowrate:			100.0	MGD
Other waste flows:			32.9	MGD
Permitted Outfall flowrate:			132.9	MGD

3 Wastewater Pump Station

3.1 Introduction

This section provides the design approach and recommendations for the effluent discharge pump station for the proposed 100 MGD Harbor Island Desalination Facility including an overview of a preliminary conceptual layout of the discharge piping and discharge pump station. The discharge pump station shall pump the brine reject water from the treatment processes via a large diameter tunnel to the discharge point in the GOM. The discharge into the GOM will be via a multi-port diffuser on a riser pipe extending from the tunnel as detailed in Section 4.

3.2 Discharge Location and Piping Layout

Figure 2 details the location of the discharge pump station and layout of the discharge piping to the beginning of the tunneled discharge pipe on Harbor Island. The discharge pump station is situated next to the ultrafiltration unit in the desalination facility as shown in Figure. A seven-foot (ft) diameter discharge pipe will carry the desalination plant brine effluent from the discharge pump station to the shoreline, where a 12-ft diameter tunnel will transport the brine effluent to the discharge diffuser located in the GOM.

3.3 Discharge Pump Station

The discharge pump station will be designed to handle 191.2 MGD of brine reject for the 100 MGD production facility at 40% recovery. The design features a two-compartment wet well measuring 50 ft by 60 ft each and equipped with seven pumps (six duty and one standby).

All wastewaters in the plant, including the reject water from the RO membranes and other wastewaters from the desalination processes will flow into a manhole located upstream of the discharge pump station and then to the discharge pump station wet well via a large gravity line. To ensure adequate cycle time for the pumps and to prevent surcharging of upstream units, a wet well depth of approximately 70 ft is proposed.

The suction and discharge piping for each pump will have a diameter of 42 inches, and the common discharge pipe from the pump station will be 7 ft in diameter. Each pump’s 42-inch discharge pipe will be fitted with a swing-check valve and an isolation valve. A combination air/vacuum release valve and a surge relief valve will be installed on the 7-ft common discharge pipe. Please refer to Figure 4 for visual context of the design.

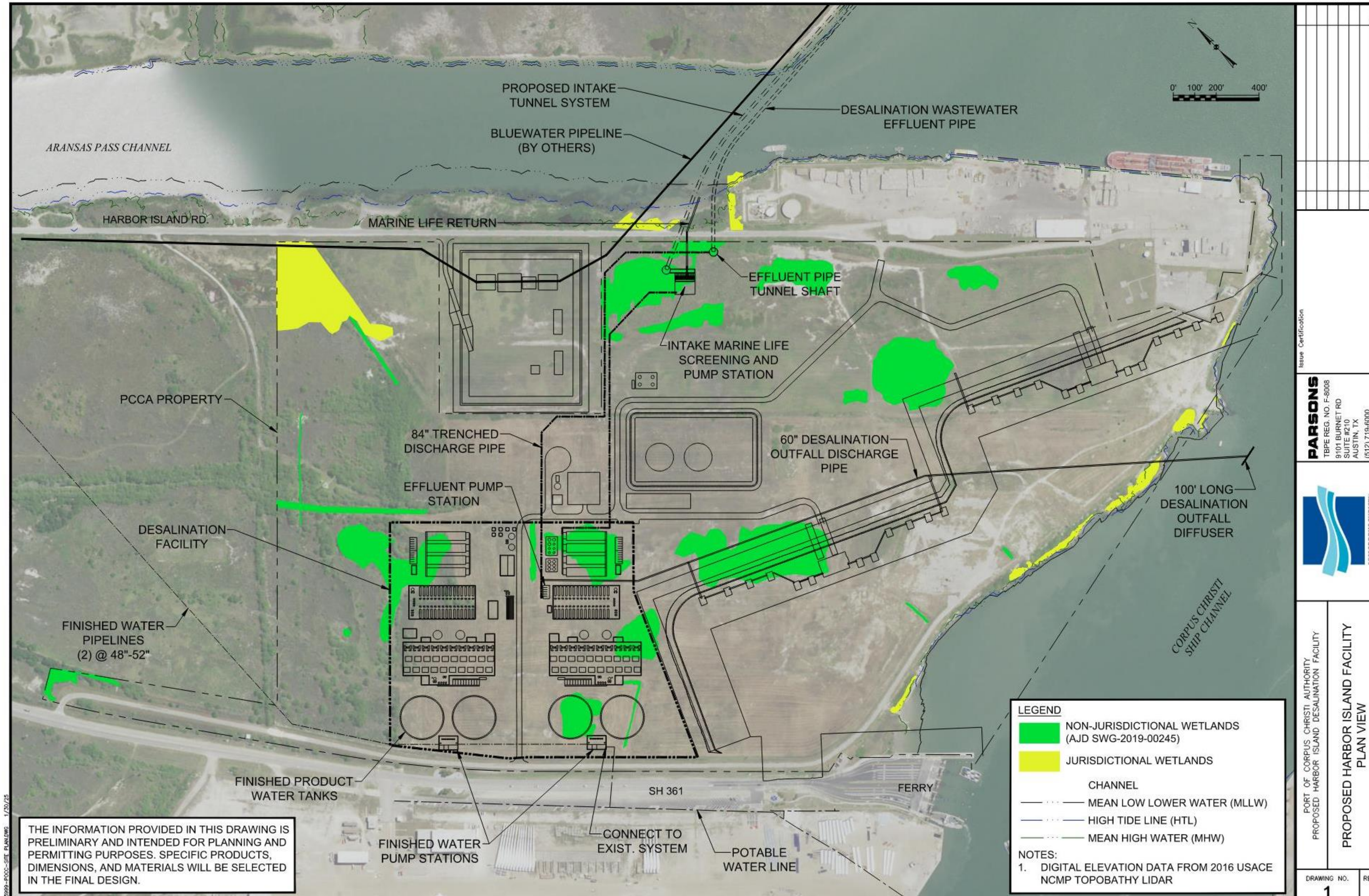

Figure 2. Facility Layout on Harbor Island

Figure 3. Discharge Pump Station Location – Plan View

3.3.1 Pump Information

It is recommended that vertical turbine pumps are used for this application. For the design capacity of 191.2 MGD, a discharge head of approximately 70 ft is recommended. This will be more than sufficient to overcome the static head required to overcome the elevation difference, seawater pressure at the discharge location, diffuser head loss, and friction and minor losses through the approximately 18,840 ft long tunnel. Several manufacturers were contacted for pump recommendations and the information provided in this section is based on Patterson Vertical Turbine Pumps. The pump system parameters are summarized in Table 3. System curves for several head conditions and the manufacturer pump curves are shown in Figure 5.

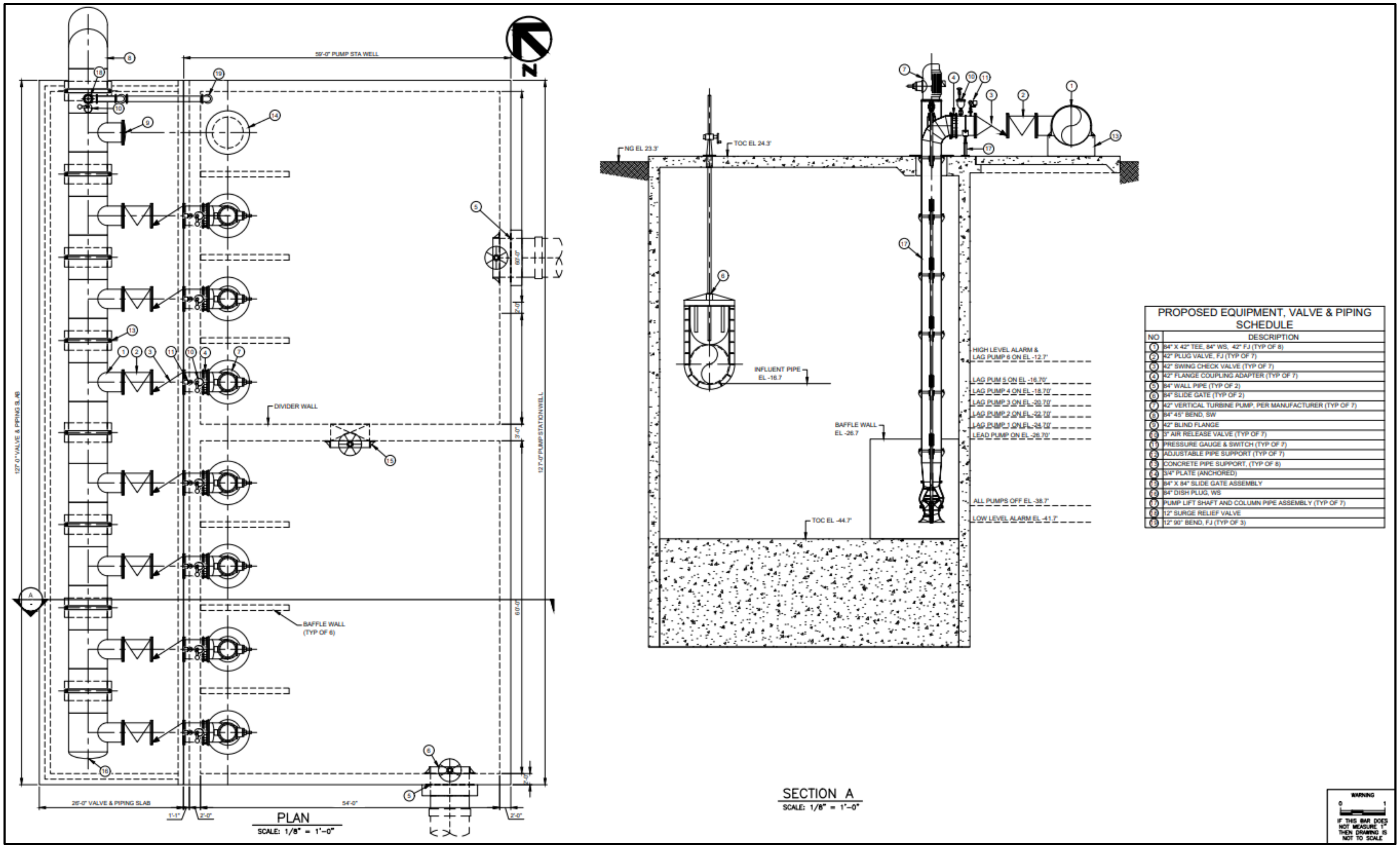

Figure 4. Effluent Discharge Pump Station Layout

Various materials for the pump body were evaluated. The plant's effluent will have elevated salinity, with an expected potential range from approximately 42 to 64 ppt based on the historical range of salinity at the intake, the expected range of desalinated water recoveries, and the facility water balance (see Appendix A). Therefore, the pump material must be highly resistant to corrosion. Austenitic Stainless Steel, Duplex Stainless Steel, Super Austenitic Stainless Steel, Super Duplex Stainless Steel and Hyper Duplex Stainless-Steel materials were evaluated. Among these options, Austenitic Stainless Steel, Duplex Stainless Steel, and Super Austenitic Stainless Steel are not suitable for the reject water's salinity concentrations, while Hyper Duplex Stainless Steel is excessively robust and costly. Therefore, Super Duplex Stainless Steel has been selected for the pump material due to its corrosion resistance and cost-effectiveness compared to the other alternatives.

Table 3. Summary of Recommended Pump System

Parameter	**Value**
Total No. of Pumps	7 (6 duty + 1 standby)
Discharge Head (ft)	70
Firm Pumping Capacity (MGD)	191.2
Individual Pump Capacity (MGD)	45
Motor Speed (rpm)	720
Pump Motor (horsepower)	496

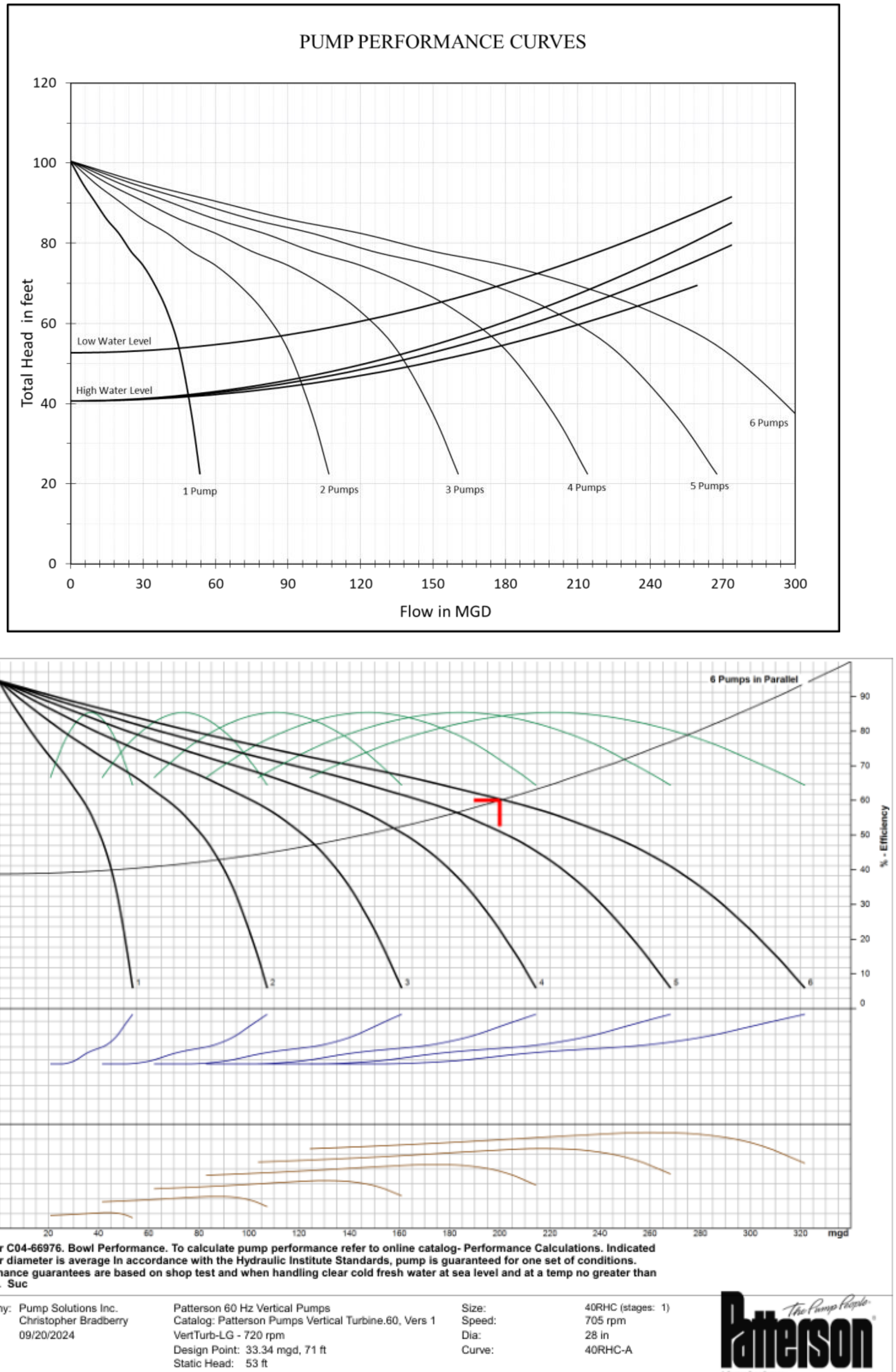

Figure 5. System Curves and Manufacturer Pump Curves

4 Wastewater Outfall

This section provides a summary description of the outfall. The outfall is addressed in greater detail, including the mixing evaluation, in Appendix A.

4.1 Diffuser Location

Locating the outfall in the GOM will require routing the effluent pipe under the Aransas Pass Channel, the Lydia Ann Channel, and San Jose Island (Figure 1). The location selected is outside of areas designated for navigation and anchorage. The center of the diffuser will be approximately 9,800 ft (2,987 meters [m]) from shore at its nearest point, and approximately one-half mile (810 m) from the Harbor Island Desalination Facility intake to avoid entrainment of the diluted brine plume. The anticipated latitude/longitude of the center of the diffuser is 27.848836°N, 97.009531°W. The coordinates could shift slightly during the detailed design phase based on a more detailed bathymetric survey and geotechnical study.

4.2 Diffuser Configuration

The outfall design uses for a high-rate diffuser that will discharge at port exit velocities ≥ 3 meters/second (m/s) at the estimated maximum monthly average effluent flows. Diffuser port exit velocities ≥ 3 m/s generate sufficient momentum and energy in the effluent discharge to assure rapid mixing of the effluent and receiving water.

The conceptual design is a 50-port diffuser with 160-millimeter (mm) (6.3-inch) diameter ports. The ports will discharge at a minimum centerline depth of –7.5 m (24.6 ft) at mean lower low water (MLLW). The total water depth at the center of the diffuser barrel will be ~ 37 ft (~11.3 m) below MLLW (Figure 1).

The diffuser will have 25 risers with 2 ports per riser oriented at 180° to each other.[1] The ports on each riser will point in the prevailing direction of the ambient current: north-northeast (NNE) and south-southwest (SSW)[TABS Buoy D (1995-2022) @ 2m depth][2]. The risers will be spaced at 6.25-m intervals on the diffuser barrel which results in a diffuser length of 150 m (first riser to last riser). The diffuser barrel will have a removable plug (or equivalent opening) at its far end to allow it to be pigged to remove settled solids if necessary. The diffuser ports will discharge at a vertical angle of 60° to the water surface (i.e., angled toward the surface). The port and riser configuration is shown schematically in Figure 6. Figure 7 shows the diffuser orientation in the GOM and a section view of the diffuser along with the riser from the discharge pipe.

At the proposed discharge location and with the 50-port design, the maximum increase in ambient GOM salinity at a horizontal distance of 100 m from the diffuser will be < 2 ppt.

Please see Appendix A for additional information on the design of the diffuser to minimize water quality impacts.

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[1] A design alternative with an elevated diffuser barrel with ports drilled on either side at the appropriate horizontal angle, spacing, and minimum depth below the water surface will provide equal dilution.

[2] The prevailing longshore current is to the NNE most of the year. During summer months it shifts to the SSW.

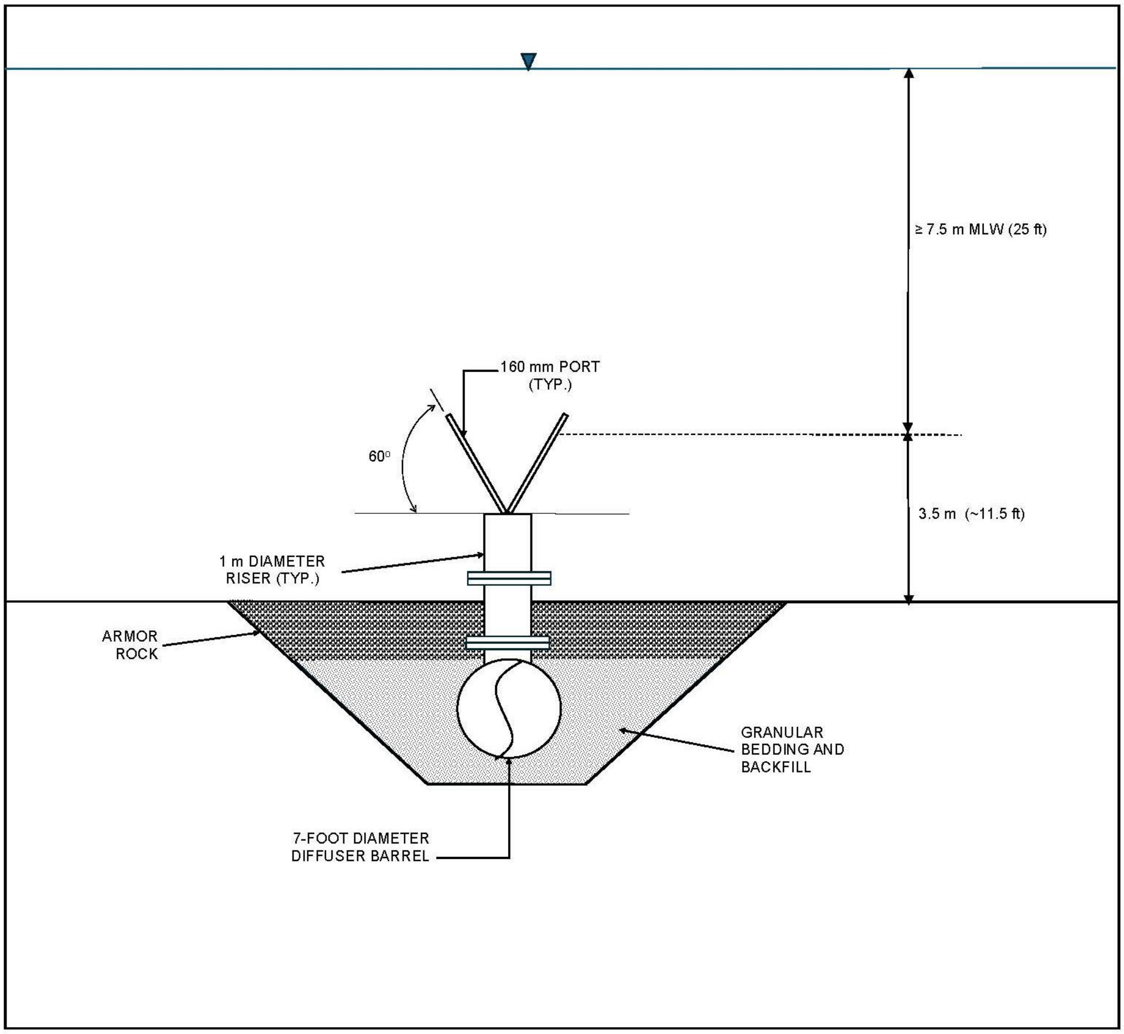

Figure 6. Diffuser Port and Riser Schematic

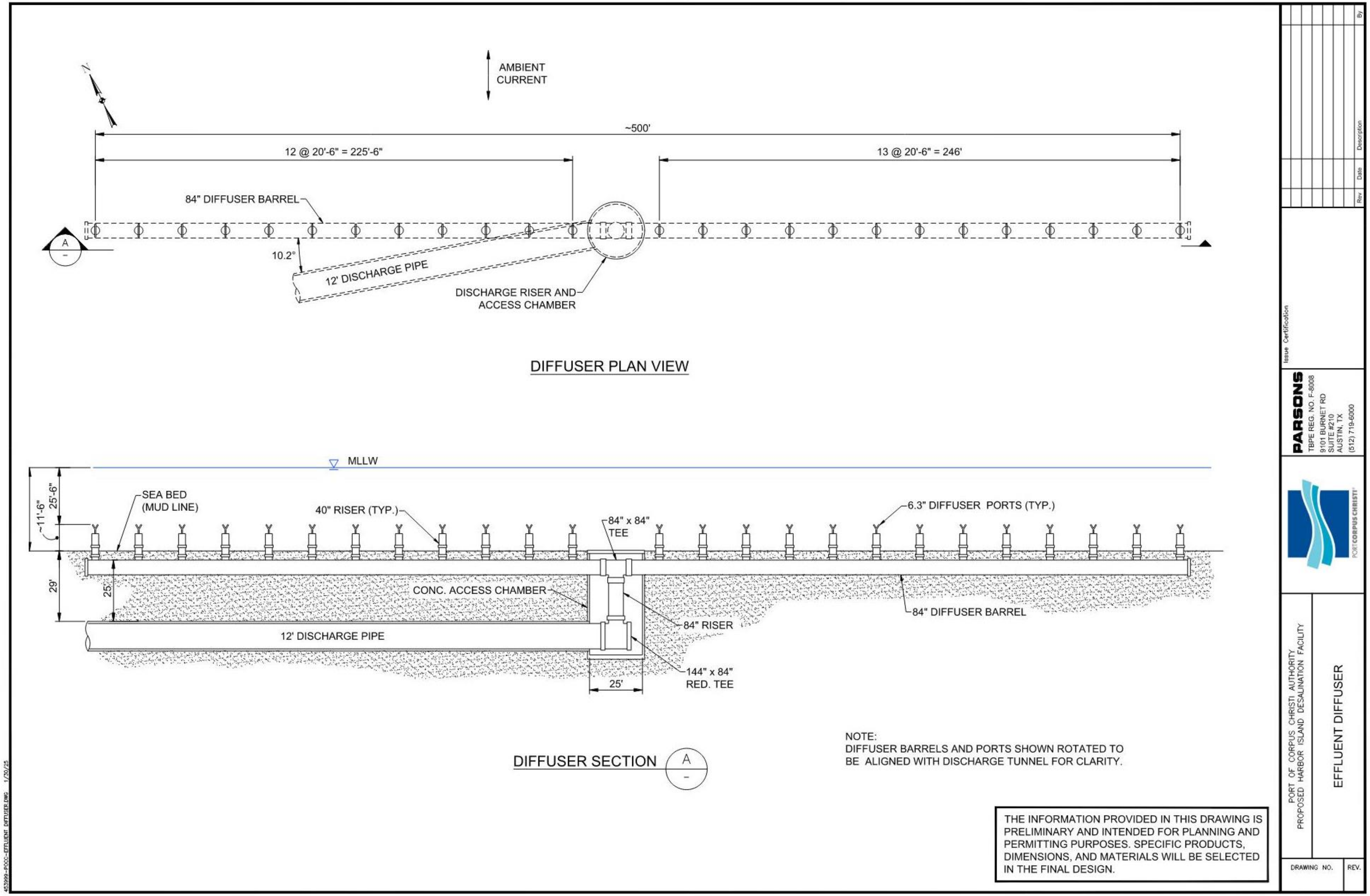

Figure 7. Outfall Diffuser

5 Pipe Conveyance

5.1 Route

The proposed pipe route follows the Bluewater Texas Terminal pipeline and the proposed Harbor Island Intake pipe tunnel. The Bluewater Texas Terminal pipeline extends roughly due east from Harbor Island and passes very near the proposed Facility. Both the Harbor Island intake pipe tunnel and discharge pipe will follow the Bluewater alignment for approximately 2.7 miles before they deviate slightly to the south, as shown in Figure 1. The discharge pipe will run parallel to the intake pipe, approximately 30 ft south of it. The 30 ft distance will provide more than two tunnel diameters of distance between the tunnels at their closest point, but not require an excessively wide easement. Further, the close distance will potentially reduce the amount of required geotechnical characterization of the underground substrate. The proposed alignment runs beneath two maritime channels, a privately owned island, and the GOM seabed.

5.2 Construction Methods

The U.S. Army Corps of Engineers' required clearance below the Lydia Ann Channel results in trenchless construction (tunneling, microtunneling, horizontal directional drilling, etc.) being required for the channel crossings. This rules out jetting and trenching construction methods which are not feasible for placement of a pipe significantly below the channel bottom. Both trenchless and trenching/jetting construction methods can be considered for the rest of the pipe.

5.2.1 Evaluation of Trenchless Construction Methodologies

Trenchless construction methods considered potentially feasible for the discharge pipe are evaluated in the following. Depending on the technology, they may be feasible for all or part of the pipe construction.

5.2.1.1 Horizontal Directional Drilling

Horizontal Directional Drilling (HDD) is a trenchless construction method whereby a pipe is installed along an arcing drill path, beginning and ending at the ground surface, and passing under the conflicting feature in between, without requirement for deep shafts. A drill rig is set up on one side of crossing and begins by drilling a pilot bore to the exit point. The alignment typically begins with a 5-to-20-degree tangent section that transitions to a vertical curve with a radius between 600 and 6,000 ft, depending on drill size, product pipe diameter, product pipe material, and required alignment. At the end of the bore, the alignment raises to the surface at a typical angle of 5 to 18 degrees. The pilot bore is then reamed in one or more passes to obtain the required diameter needed for pullback of the product pipe string. The bore is reamed to a diameter larger than the product pipe diameter. Once the reaming is complete, the drill pipe is connected to the product pipe outer diameter with a swivel and pulling head at the exit side of the alignment, and pulled into place in one continuous operation.

Based on industry experience, the maximum HDD diameter is typically 60 inches with a maximum drive length of 3,500 feet. To maintain a maximum velocity of 8 ft/s, two 60-inch pipes would need to be installed in parallel. Given the length of HDD drive for a 60" pipe, HDD is considered only for the channel crossing portion of the discharge pipe.

5.2.1.2 Microtunneling

Microtunneling is a specialized pipejacking method that can be used to install a pipe by sequentially jacking pipes horizontally from a jacking shaft to a reception shaft. It uses a remote-controlled, guided self-excavating tunnel boring machine (MTBM) (which means non-man entry, remote steering/controlled, and controlled face tunneling according to the American Public Works Association Greenbook). Controlled face tunneling means providing pressure equal and opposite to the earth and water pressures at the “tunnel heading” or “excavation face” to prevent uncontrolled inflow of soils and water. Microtunneling has been successfully used to install pipes from 10 to 136 inches, with lengths between 200 ft to 1.5 miles. With a precise automated guidance, microtunneling can be used in a wide variety of soil conditions while maintaining very close tolerances to line and grade. MTMB methods are used when line and grade are critical, which is not the case for this discharge pipe. The main limitation of MTBM for this project is the maximum jacking drive length, which is typically 1,500 feet. This means that a total of 12 shafts would need to be constructed, seven of which would be at offshore locations. The precise construction methods and details of an offshore shaft can be very complicated and subject to the Contractor’s means and methods. Shaft construction methods would be similar to those described below for the tunnel alternative. Also, microtunneling would likely not be capable of a drive length sufficient for the channel crossing.

5.2.1.3 Controlled-Face Tunnel Boring Machine

Because it is anticipated that soft soils will be encountered for the entirety of the tunnel profile, the proposed method for tunnel construction is an earth pressure balance (EPB) tunnel boring machine (TBM). TBMs for soft ground have a cylindrical shield to support the soil strata being mined through, and a bi-rotational cutterhead equipped with cutting tools to remove the intact ground and draw the loosened material into the cutterhead. The excavated soils are captured and removed from a chamber behind the cutter wheel.

Pressurization of the face of the excavation is required in permeable soil under unbalanced hydrostatic pressure, given the expected tunnel condition under the sea. If the face of the excavation were not pressurized, the unbalanced water pressure could allow soils to flow in through the gaps in the cutter head and into the TBM and resulting excavation, filling the tunnel with soil. Such conditions may cause sinkholes and excessive settlement at the ground or sea bed and may cause damage to existing infrastructure (e.g., adjacent oil pipelines).

Earth pressure balance TBMs function by maintaining a pressurized environment in the space just behind the cutter head and excavation face called a “muck chamber.” The face pressure is continuously monitored by operators in the TBM. The muck is a mixture of fragmented excavated spoils and soil conditioning additives (if any) to improve the material handling properties of the excavated material. The muck chamber is created by a bulkhead separating the construction crew from the pressurized environment at the face. Soil is removed from this pressurized environment through a helicoidal screw contained in a long steel cylinder. The helicoidal screw turns to slowly remove soil from behind the pressurized bulkhead while maintaining the appropriate face pressure. At the rear of the screw auger is a slide gate, where excavated soils are discharged onto a conveyor belt and then into muck cars near the end of the TBM shield. The muck cars/belt conveyor transport the soil to the primary work shaft, where it is hoisted to the surface by muck boxes or a vertical conveyor and into a temporary stockpile area/surge pile. The soils are de-watered in a designated facility and can later be used as upland fill material.

The TBM shield is a cylindrical steel shell that is pushed forward along the tunnel, while the ground is excavated inside the shield. The main shield and tail shield support the ground as the tunnel lining is installed and fully protects workers within the tunnel. The shields fully encapsulate the excavation, never exposing the ground or leaving any area unsupported. The shield is propelled using hydraulic jacks that thrust against the tunnel lining system installed within tail shield. The shield is designed to withstand the pressure of the surrounding ground and hydrostatic pressure.

To support the excavated bore in the soft soils at depths below sea level, a precast concrete segmented liner is proposed. This lining type has become the industry standard for large diameter soft ground TBM mined tunnels and is designed to meet project requirements for durability and watertightness. The liner helps to maintain the pressure the machine is exerting on the ground and provides a solid base against which the thrust jacks in the TBM propulsion system can push the cutterhead forward. For this reason, the TBM is used in conjunction with a prefabricated ground support system, which most commonly consists of pre-cast concrete segments that are bolted and gasketed to form a watertight lining. This watertight lining must be designed to withstand construction, ground, seismic and hydrostatic loads.

The smallest practical finished diameter for a tunnel of this length is approximately 12 ft. This size allows space for the ventilation ducts and muck handling system needed to avoid intermediate construction shafts.

The main advantage of the TBM method is that surface disturbance would be limited to the two shaft locations: the vertical work shafts at the discharge point in the GOM and at the desalination facility on Harbor Island. There are various ways the shafts can be constructed depending on a contractor's preferred mean and methods, but the following provides a brief explanation of common methods applicable to the Harbor Island work shaft and the offshore riser shaft.

The Harbor Island shaft could be constructed using secant piles. Secant piles provide a water-tight, rigid excavation support system. Secant piles are installed by drilling a series of overlapping small diameter shafts that are backfilled with concrete to form a rigid, water-tight cylinder. Once the ring of secant piles is complete, the soil within the cylinder is excavated to form the shaft. Depending on the soil and groundwater conditions, ground improvement may be necessary for the bottom of the shaft and/or for the TBM breakout location.

The offshore shaft would be constructed from a platform stationed over the shaft location. Well before the TBM arrives at the offshore shaft location, a large caisson is lowered, keyed into the seabed, and dewatered. Ground improvements may be performed on seabed sediments in the space between the tunnel and the seabed. A shaft will be constructed down to the level of the tunnel inside the caisson, excavating vertically down through a grouted/concreted plug. The TBM bores horizontally through the same grouted/concreted material to arrive at the shaft site. The riser is then constructed within the shaft, and the portion of the caisson above the seabed is removed.

5.2.2 Trenched Construction

Trenched construction methods are potentially applicable for construction of the discharge pipe, except for the channel crossings. Appropriate construction methods depend on whether the location is onshore, in the beach/surf zone, or offshore. The following describes typical construction methods for the discharge pipe that are appropriate for the expected conditions. There are other trenched construction methods a contractor could select based on their preferred means and methods.

Standard trenched construction would be appropriate for the pipe from the pump station to the point trenchless construction begins for the channel crossing (shaft for TBM tunneling or pit for HDD), but groundwater control may be necessary depending on the depth/elevation of the pipe.

Trenched pipe construction in the beach zone would likely include using sheet piling to hold the trench open and allowing water to enter the trench. The pipe would be constructed/installed "in the wet". This type of construction would transition into the surf zone. In the surf zone, it is anticipated sheet piling would continue to be used to hold the trench open, but excavation and pipe installation would be done from a temporary trestle constructed through the surf zone.

Outside the surf zone, it is anticipated the pipe would be constructed from a barge that excavates the trench, installs the pipe, and backfills the pipe. Sheet piling would not be feasible for this construction, so a significantly wider trench would be excavated to provide an adequate width for pipe installation. The pipe would be fully trenched into the seabed to protect it from wave forces, and it is anticipated that armor rock would be placed above the pipe to protect it from anchors and fishing gear.

5.2.3 Hybrid vs. Trenchless Comparison

Trenchless construction will be required for crossing the channels and standard onshore trenched construction would be used to connect the pump station to the point where trenchless construction begins.

5.2.3.1 Hybrid Alternative

The hybrid alternative would include trenchless construction to install the pipe between Harbor Island and San Jose Island. On San Jose Island, the installation would transition to trenched beach/surf zone construction, followed by offshore trenched construction. At the outfall site, the diffuser would be installed on a riser connected to the crown of the pipe. There would be a high point in the pipe on San Jose Island. This would require a permanent structure for an air release valve to prevent air accumulation at the high point that could restrict the hydraulic capacity of the pipe. This air release valve would require periodic maintenance.

This construction would involve temporary dock facilities and heavy earth construction on San Jose Island. Trenching would also disrupt the seabed through the surf zone, and over a relatively large width offshore. Trenching across San Jose Island and offshore, would be vulnerable to storms with the potential to damage construction equipment and partially constructed pipe sections. Surface easements would be required for trenched construction.

5.2.3.2 Trenchless Alternative

The tunneled portion of the pipe would start at a shaft on Harbor Island located at the end of the trenched pipe from the pump station. Figure 8 is a profile view of the finished Harbor Island shaft. The majority of the surface construction impacts would be limited to the area around the shaft – materials and equipment to construct the tunnel would enter and excavated spoils would exit at this location. The tunnel would be constructed well below the Aransas Channel and Lydia Ann Channel and would have a gentle upward slope out to the diffuser location to facilitate removal of any water that enters the tunnel during construction. The tunnel would be kept at least two tunnel diameters below the seabed (Figure 9), and two tunnel diameters distant from the parallel intake tunnel (Figure 10). The concrete segment tunnel liner that is installed as the tunnel advances would serve as the discharge pipe. The tunnel would terminate in a shaft at the diffuser location. This would include a vertical riser to just below the seabed, and would tee into the barrel for the diffuser. The diffuser barrel would be trenched into the seabed and covered with armor rock to protect against anchors and fishing gear. The low point of the pipe would be at this shaft, so any accumulated air could be released from the pipe on Harbor Island or through the diffuser.

Tunneling the pipe would have surface impacts on Harbor Island and at the diffuser site, but would have none on the seabed or San Jose Island in between. The pipe would be well below the seabed protected from wave forces, anchors, and fishing gear. Additionally, subterranean easements are typically easier to obtain and cost less than surface easements. In the event of a gulf storm, tunnel work would be paused so the Harbor Island shaft and site could be secured, but the major construction equipment or constructed works would not be expected to be subject to damage. Construction of the riser shaft, riser, and diffuser would be vulnerable to damage from storms.

5.2.3.3 Preferred Construction Method

While both a hybrid construction using trenchless and trenched construction and an entirely trenchless (tunneled) construction would be capable of installing the pipe, tunneling is the preferred method. It minimizes environmental impacts, does not require a permanent structure on San Jose Island, would have less construction risk, and would result in a pipe less susceptible to damage from waves, ships and fishing. With the exception of the pipe from the discharge pump station to the tunnel shaft, all on Harbor Island, the reminder of the discharge pipe will be tunneled.

5.3 Pipe Hydraulics

The finished tunnel diameter of 12 feet results in a flow velocity of 2.6 ft/s at the discharge design flow rate of 191.2 MGD. The velocity is low enough that significant flow transients will not occur as discharge rates change and high enough to limit the deposition of suspended solids. The trenched portion of the pipe on Harbor Island could have a smaller diameter to reduce construction cost.

The proposed diameter of the riser between the tunnel and diffuser is 7 feet. The flow velocity in the riser will be 7.7 ft/s, which is high enough to help transport any solids up and out of the tunnel portion of the pipe and low enough to avoid significant hydraulic transients.

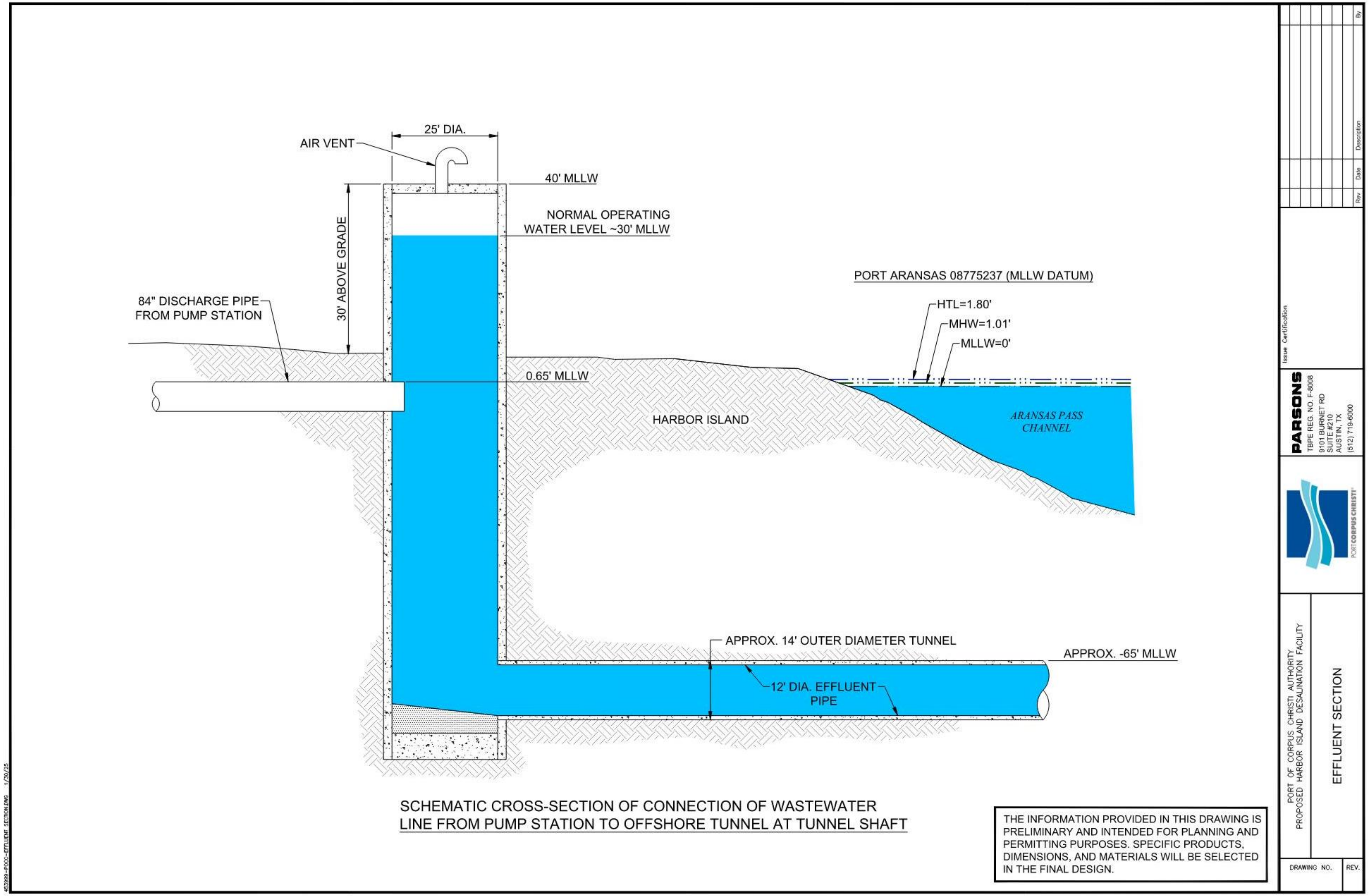

Figure 8. Schematic Cross-Section of Connection of Wastewater Pipe from Pump Station to Offshore Tunnel

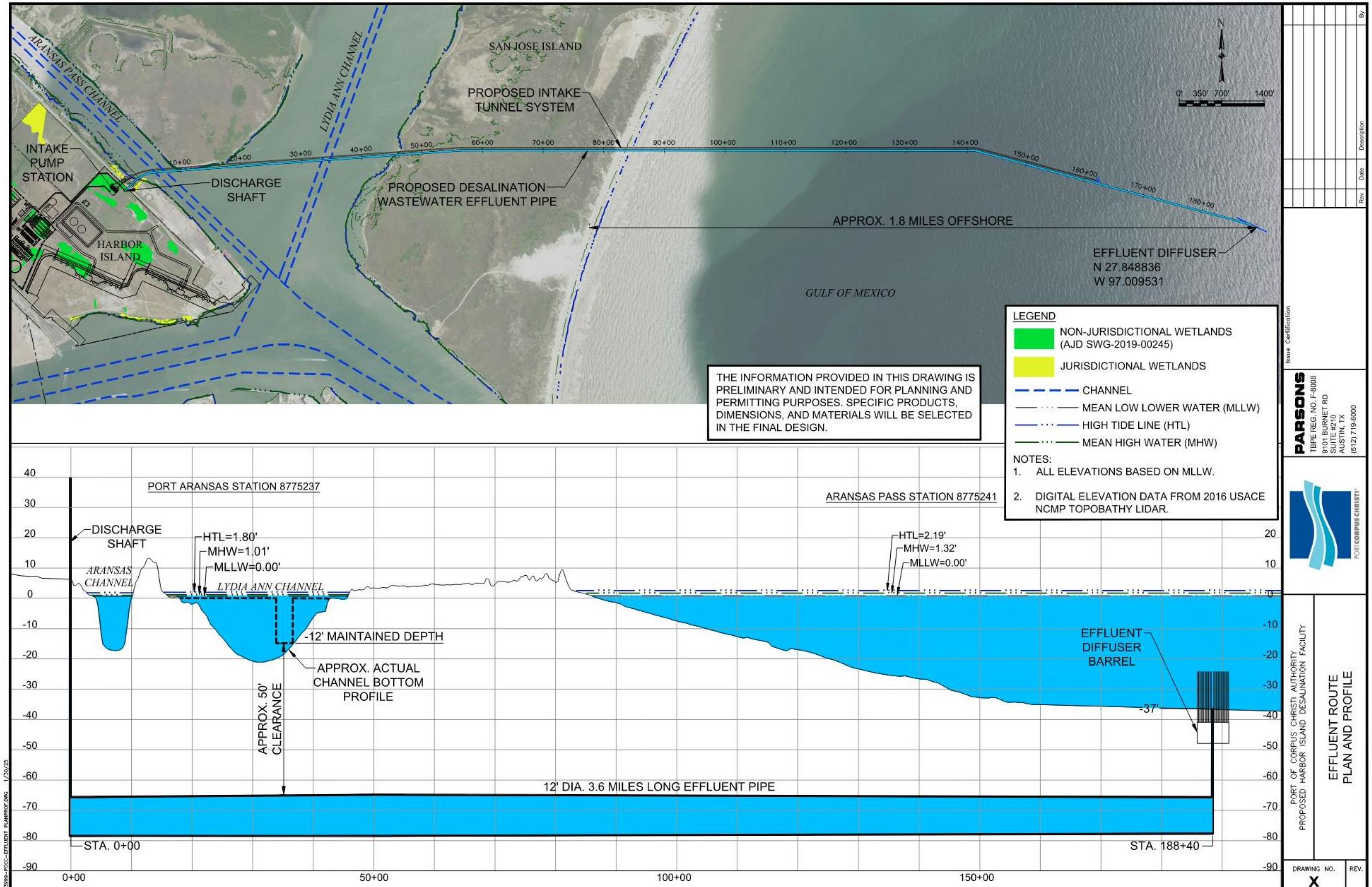

Figure 9. Effluent Pipe Plan and Profile

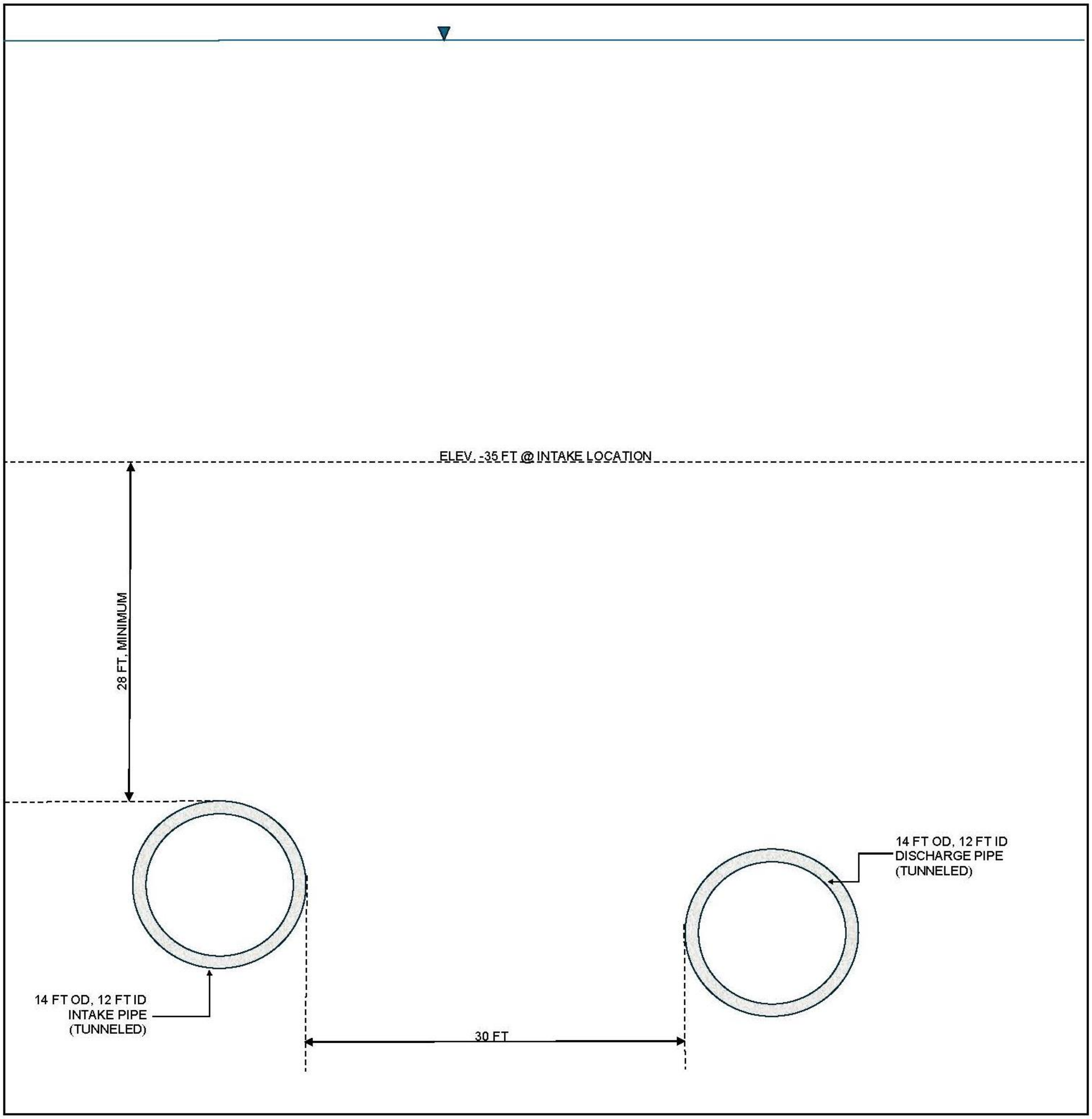

Figure 10. Parallel Intake and Discharge Pipes Section near Seawater Intake Location

For this preliminary assessment, the head loss through the discharge pipe is estimated using the Hazen-Williams Equation:

$$H = \frac{4.72 * L * Q^{1.85}}{C^{1.85} * d^{4.87}}$$

Where:

H = head loss (ft)
L = length of pipe (ft)
d = diameter of pipe (ft)
Q = flow rate in the pipe (cfs)
C = Hazen-Williams coefficient (conservatively use 100 for rough concrete pipe)

The estimated head loss through the discharge pipe and riser is approximately 6 feet. This coupled with a 23-ft head loss through the diffuser gives a total head loss of approximately 30 feet from the Harbor Island shaft through the diffuser.

APPENDIX 1

High-Rate Diffuser Conceptual Design
Harbor Island Desalination Facility

High-Rate Diffuser Conceptual Design
Harbor Island Desalination Facility

Prepared for

Port of Corpus Christi Authority
Corpus Christi, Texas

Under Contract to
Parsons Environment & Infrastructure Group, Inc.

by

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965

January 2025

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Units	
°C	degrees Celsius
cm	centimeter
°F	degrees Fahrenheit
ft	feet
ft/s	feet per second
in	inch
kg/m^3	kilogram per cubic meter
MGD	million gallons per day
mg/L	milligram per liter
m/s	meters per second
m^3/s	cubic meters per second
ppt	parts per thousand

1. Introduction

The Port of Corpus Christi Authority (POCCA) is planning to construct a marine seawater desalination facility with a design capacity of 100 million gallons/day (MGD) of finished desalted product water to provide a drought proof, sustainable water supply for the region. The Harbor Island Desalination Facility (HIDF) includes options for an intake structure and a high-rate diffuser for the HIDF effluent to be constructed in the Gulf of Mexico (GOM). The proposed locations of the GOM intake and diffuser and the pipes connecting them to the HIDF are shown in Figure 1.

This report presents the conceptual design of the proposed high-rate effluent diffuser proposed for the GOM. The design is based on a modeling evaluation performed by Tischler/Kocurek (T/K) to assure that the effluent discharge has no adverse effects on the Gulf of Mexico water quality, aquatic biota, and other designated uses.

Water Quality Standards

The Gulf of Mexico (GOM) is identified as Segment 2501 in the Surface Water Quality Standards adopted by the Texas Commission on Environmental Quality (TCEQ) at 30 Texas Administrative Code Chapter 307 (30 TAC 307). Segment 2501 has numeric water quality standards (WQS) for dissolved oxygen, pH, indicator bacteria, and temperature. There are no numeric criteria for salinity or total dissolved solids (TDS) because the GOM is seawater with naturally elevated concentrations of sea salts. The applicable Chapter 307 General Criteria narrative WQS for salinity is at 30 TAC 307.4(g)(1) and states that: “Concentrations and the relative ratios of dissolved minerals such as chloride, sulfate, and total dissolved solids must be maintained such that existing, designated, presumed, and attainable uses are not impaired.”

Water Quality Standards adopted by TCEQ for toxic pollutants at 30 TAC 307.6 are applicable to the HIFD discharge and are used to develop WQBELs, as necessary, based on evaluation of the constituents of a discharge, using three mixing zone categories:

1. Zone of initial dilution (ZID) where standards to protect aquatic life from acute toxicity are applied.
2. Mixing zone (MZ) where standards to protect aquatic life from chronic toxicity are applied.
3. Human health mixing zone (HHMZ) where standards to protect human health through the fish/shellfish tissue consumption pathway are applied.

The WQS specify maximum allowable ambient temperatures (30 TAC 307.10, Appendix A) in designated stream segments. The maximum allowable ambient temperature standard for Segment No. 2501 is 95 °F (35.0 °C)[1] (30 TAC 307.10, Appendix A). The temperature standards also specify allowable increases over ambient temperatures for discharges to water in the state. In

[1] Because the output of the mixing model used in this study is in SI (metric) units, SI units will be used in the report with English units shown as needed for interpretation.

Segment 2501 the maximum allowable temperature rise is 1.5 °F (0.83 °C) in summer (June, July, and August) and 4 °F (2.22 °C) during the spring, fall, and winter (30 TAC 307.4(f)(3)).

The Texas surface water quality standards apply at the boundary of an authorized thermal mixing zone. The standards do not establish a maximum size for such mixing zones, but state that the temperature shall be maintained so as not to interfere with reasonable uses of such waters (30 TAC 307.4(f)).

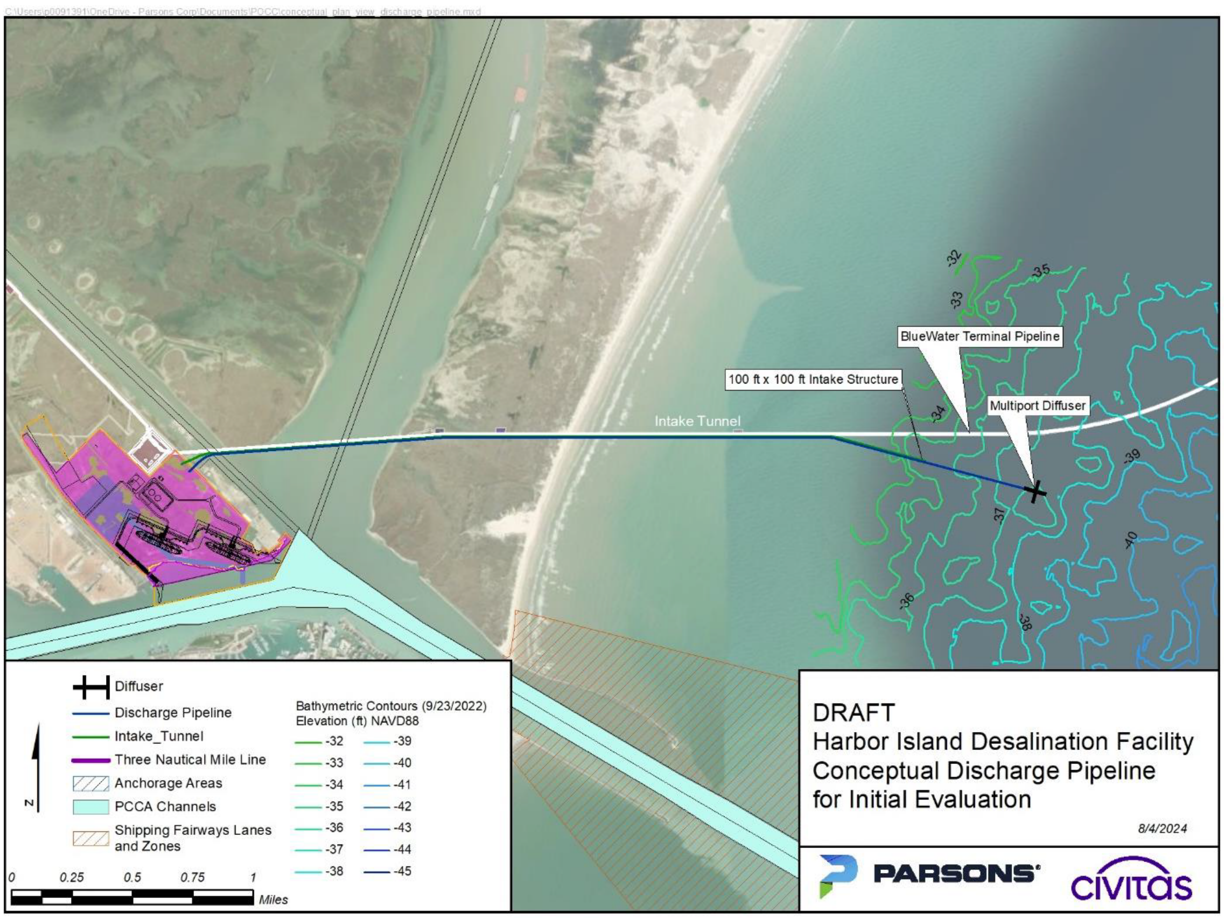

Figure 1. Proposed HIDF Intake and Diffuser Locations

There is no Texas WQS specifying the allowable salinity increase in the receiving water resulting from the discharge of desalination facility brine effluent. This diffuser conceptual design is based on achieving a maximum increase in receiving water salinity less than or equal to 2 parts/thousand (ppt) at a distance of 100 meters (m) from the diffuser ports at the critical hydrologic condition.

2. Diffuser Design

The design is for a high-rate diffuser that will discharge at port exit velocities ≥ 3 meters/second (m/s) at the estimated maximum monthly average effluent flows. Diffuser port exit velocities ≥ 3 m/s generate sufficient momentum and energy in the effluent discharge to assure rapid mixing of the effluent and receiving water.

Diffuser Location

The diffuser is proposed in the GOM at the location shown on Figure 1. The location is outside of areas designated for navigation and anchorage and the diffuser riser/port closest to the shoreline will be approximately 10,000 feet (3,300 m) offshore. The approximate latitude/longitude of the mid-point of the 150 m long diffuser barrel is 27.848836°N and 97.009531°W. This location is approximately one-half mile (805 m) southeast from the HIDF intake and in deeper water to avoid entrainment of the diluted brine plume. The precise latitude/longitude of the diffuser will be determined upon completion of a bathymetric study will be provided to TCEQ when this work is completed.

Diffuser Configuration

The conceptual design is a 50-port diffuser with 160-millimeter (mm) (6.3-inch) diameter ports. The ports will discharge at a minimum centerline depth of –7.5 m at mean low water (MLW). The total water depth at the center of the diffuser barrel will be ≥ 37 feet (~11.3 m) NAVD88 (Figure 1).

The diffuser will have 25 risers with 2 ports/riser oriented at 180° to each other.[2] The ports on each riser will point in the prevailing direction of the ambient current: north-northeast (NNE) and south-southwest (SSW)[TABS Buoy D (1995-2022) @ 2m depth][3]. The risers will be spaced at 6.25-m intervals on the diffuser barrel which results in a diffuser length of 150 m (first riser to last riser). The diffuser barrel will have a removable plug (or equivalent opening) at its far end to allow it to be pigged to remove settled solids if necessary. The diffuser ports will discharge at vertical angle of 60° to the water surface (i.e., angled toward the surface). The port and riser configuration is shown schematically in Figure 2. Figure 3 shows the diffuser orientation in the GOM relative to the ambient current as simulated by the CORMIX2 model.

The diffuser ports may be fitted with Tideflex™ or equivalent duckbill valves[4] to prevent backflow when there is no effluent discharge. The decision to add duckbill valves or use the

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[2] A design alternative with an elevated diffuser barrel with ports drilled on either side at the appropriate horizontal angle, spacing, and minimum depth below the water surface will provide equal dilution.

[3] The prevailing longshore current is to the NNE most of the year. During summer months it shifts to the SSW.

[4] Duckbill valves are made of an elastomer that pinches closed the port opening when there is no flow and prevents backflow of seawater into the diffuser barrel. The valve opens gradually as flows increase due to the increasing pressure of the water and becomes equivalent to a conventional open port at the design flow.

designed open ports will be made when the final design is prepared. The CORMIX2 modeling does not consider these valves to be present – it assumes conventional ports. The addition of duckbill valves will increase the port exit velocities at lower effluent flows (below the design flow) that will increase dilution above the values predicted for this conceptual design.

Effluent Characteristics

The proposed effluent flow rates for the diffuser are shown in Table 1. POCCA has estimated these flows based on the HIDF reverse osmosis membrane process freshwater production capacity for two operating scenarios: (1) 50% recovery; and (2) 40% recovery. The percent recovery is the percentage by volume of produced water (desalinated seawater) recovered from the intake seawater volume. The effluent flow is the volume of water that contains the sea salts that are removed by the reverse osmosis system and water generated during pretreatment of the sea water to prepare it for reverse osmosis.

The effluent flow rates for these two operating conditions are used to design the diffuser and calculate the dilution achieved in the GOM.

Table 1. HIDF Design Effluent Flow

Averaging Period	Flow (MGD)	Flow (m^3/s)
Max. Monthly Average (50% recovery)	152.9	6.701
Max. Monthly Average (40% recovery)	191.2	8.375

Parsons Environment & Infrastructure Group, Inc. (Parsons) developed thirty-two combinations of HIDF temperatures, densities, and salinity for development of the diffuser design. These combinations include the 5th, 50th, and 95th percentiles of temperature, salinity, and density of the GOM at the discharge location during the spring, summer, fall and winter, and the predicted HIDF effluent values for each of these properties at the two design flows shown in Table 1. Parsons also provided the 5th, 50th, and 95th percentiles of the GOM ambient currents at the proposed diffuser location.

Thirty-six combinations, representing the highest and lowest effluent densities predicted at each of the three ambient currents and at the two effluent flows, were selected to develop the diffuser design. Table 2 shows the predicted effluent temperatures and densities that are used in the diffuser design. The relationship between density, salinity and temperature is:

Density = (1+(0.001*((28.14-0.0735*T-0.00469*T^2) + (0.802-0.002*T)*(S-35))))*1000

where: S = salinity in parts/thousand (ppt); T = temperature (°C).

Table 2. HIDF Outfall Temperatures, Salinities and Densities

Condition	Temperature (°C)	Salinity (ppt)**	Density (kg/m^3)**
Summer – T5, S95	26.59	63.77/55.46	1044.41/1038.19
Summer – T95, S5	30.41	45.42/39.52	1029.29/1024.92
Fall – T5, S95	25.57	62.62/54.46	1045.9/1039.68
Spring – T5, S5	15.26	42.31/36.81	1031.57/1027.32
Winter – T5, S95	12.02	59.46/51.72	1045.61/1039.59
Spring – T95, S5	26.78	42.31/36.81	1028.28/1024.16

*T5 – 5th percentile temperature; S95 – 95th percentile salinity, etc.

**50% recovery/40% recovery. Salinity in parts per thousand.

The diffuser design evaluates operation at 40% and 50% recovery because of the discharge flow rate and density/salinity differences at the different recovery rates. The resulting conceptual diffuser design will assure that the design effluent dilution at critical hydrologic conditions will be achieved when the HIDF operates at all product water recoveries from 40% to 50%.

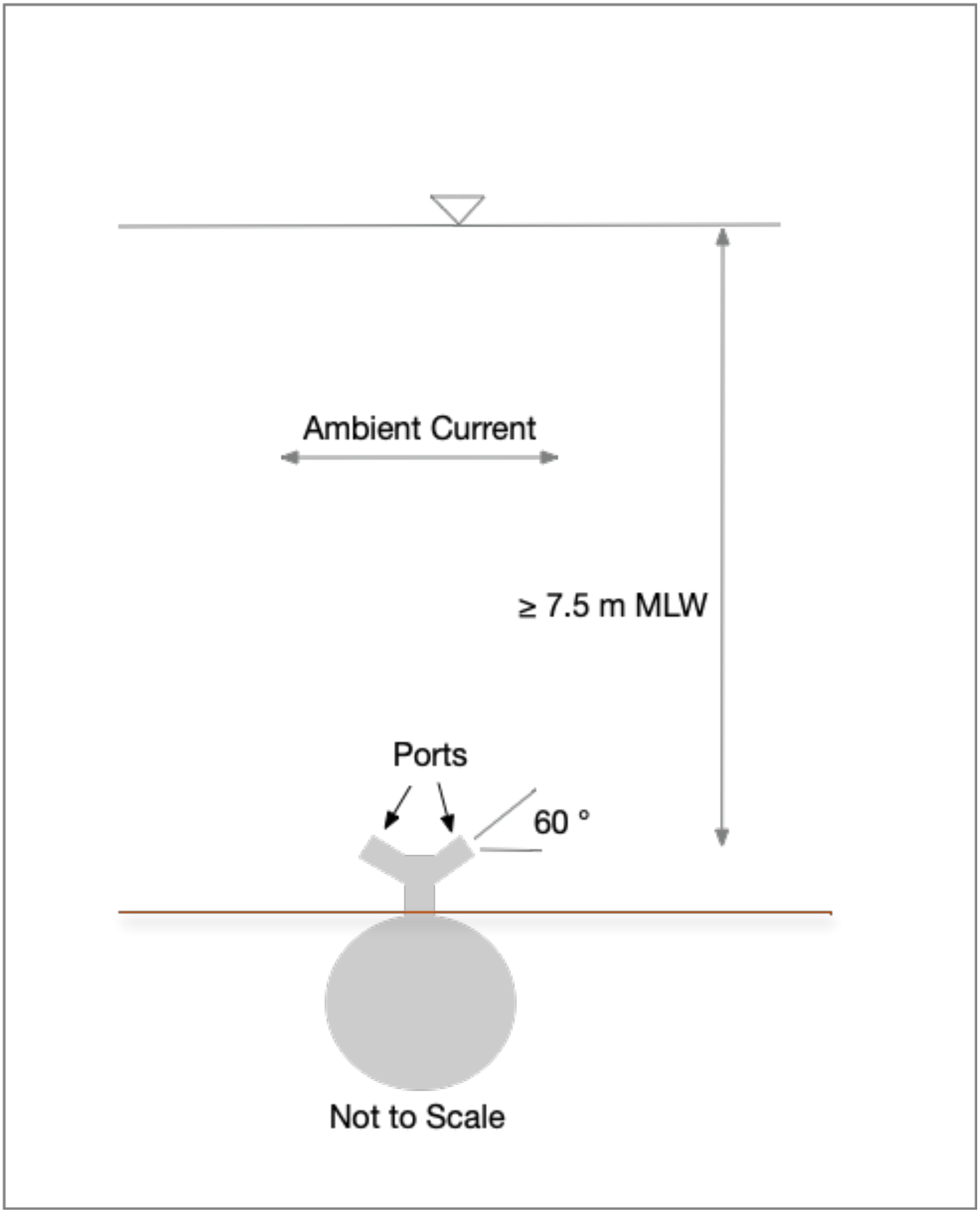

Figure 2. Port and Riser Configuration

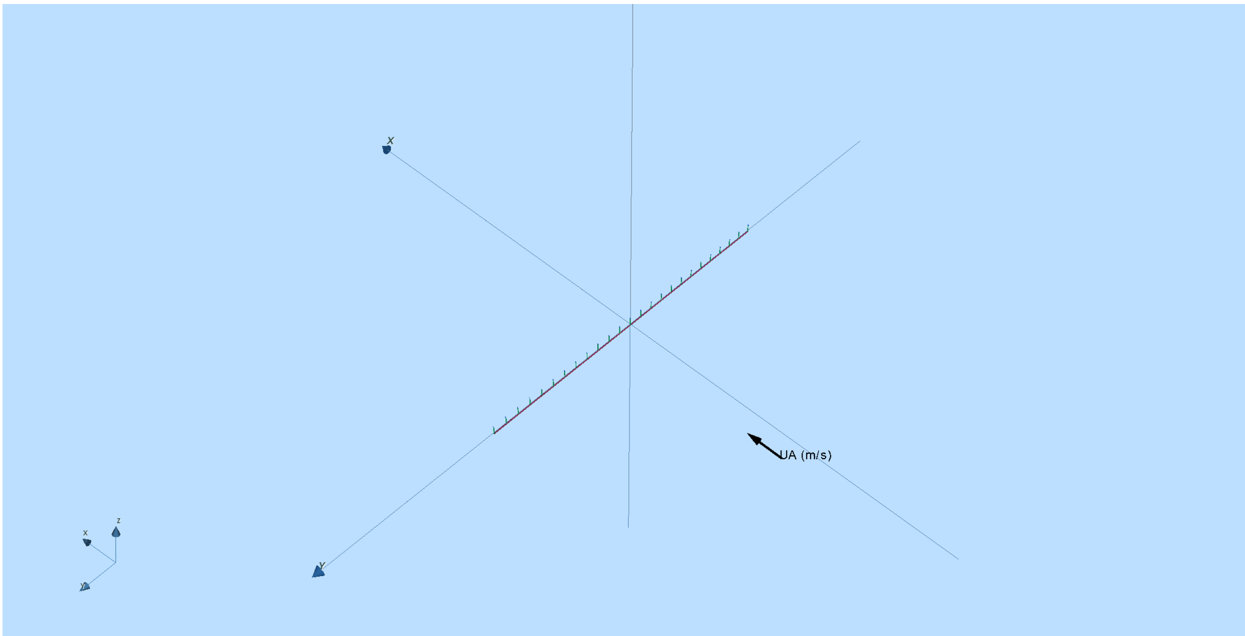

Figure 3. Diffuser Orientation

3. Dilution Analysis

The dilution that is achieved with the 50-port diffuser was simulated using the mixing zone model CORMIX2[5]. CORMIX2 simulates the mixing of a positively or negatively buoyant discharge plume from a multiple port diffuser into a receiving water that may be density stratified or unstratified. The model includes the effect of ambient currents on mixing. The output from CORMIX2 is the centerline dilution factor and plume dimensions as a function of distance from the discharge ports. The highest predicted effluent concentration is at the plume centerline and decreases to background concentrations at the edges of the plume. The model can simulate both near-field[6] and far-field mixing.

An effluent plume is buoyant when it has a lower salinity and higher temperature than the receiving water; therefore, the worst case for mixing with a positively buoyant plume is usually when the density difference between the effluent and the receiving water is the greatest. Under these conditions, after jet momentum is dissipated the plume rises toward the water surface due to its buoyancy. Additional dilution occurs during this plume rise as it entrains surface water from the surrounding area. Once the plume surfaces, it spreads across the water surface due to its retained momentum and the ambient current velocity.

Negatively buoyant effluents sink to the bottom of the receiving water. Diffusers for negatively buoyant plumes orient the ports toward the water surface. When the initial jet dilution achieved by the port exit velocity dissipates, if the density of the plume exceeds that of the receiving water the plume will sink to the bottom of the waterbody and then flow with the ambient current along the bottom of the water body. Mixing of the plume with the surrounding water continues and dispersion generated by the ambient current results in the continuing decrease of salinity until the plume becomes indistinguishable from the surrounding seawater salinity and temperature.

The effluent from the HIDF diffuser will be negatively buoyant under all ambient conditions because the intake water and the effluent discharge are taken from essentially the same location in the GOM and the salt content of the effluent discharge is increased by the desalination process, resulting in an effluent discharge that is always of a greater density than that of the seawater at the discharge location. Temperature increases during the desalination process, if any, are insufficient to have any measurable effect on the density of the effluent.

[5] Doneker, R.L. and Jirka, G.H., December 2007 (updated February 2017). CORMIX Users Manual: A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters, EPA-823-K-07-001, U.S. Environmental Protection Agency, Washington, D.C.

[6] Near-field mixing occurs in the region near the diffuser where the momentum of the plume induced by the high port exit velocity is the dominant force affecting mixing. Far-field mixing is a result of the ambient current speed, plume-receiving water density difference, and natural dispersion (including wind-induced mixing).

Ambient Conditions

The physical dimensions of the GOM at the proposed discharge location are shown in Table 3. This location is in shallow water outside of designated navigation and anchorage areas. The precise geographical coordinates of the diffuser location cannot be identified until the final design is completed.

Table 3. GOM Physical/Hydrologic Parameters

	Physical Parameter		Reference
Distance from shoreline	~10,000 ft	~3,050 m	Google Earth™
Average depth near discharge	~37 ft	~11.3 m	NAVD88[7]
Depth at diffuser location	~37 ft	~11.3 m	NAVD88

The ambient temperature, salinity and current data are from the TABS Buoy D of the Texas Automated Buoy System[8]. Records for the monitoring period 1995-2022 (272,990 observations) were analyzed by Parsons to determine the 5th, 50th, and 95th percentile values for each of these parameters.

The relationship between density and salinity and temperature is:

Density = (1+(0.001*((28.14-0.0735*T-0.00469*T^2) + (0.802-0.002*T)*(S-35))))*1000

where: S = salinity in parts/thousand (ppt); T = temperature (°C).

Table 4 presents the GOM ambient conditions used for the diffuser design.

Table 4. GOM Ambient Water Quality*

Density Condition	Temperature (°C)	Salinity (ppt)	Density (kg/m^3)
Summer – T5, S95	26.59	36.50	1023.99
Summer – T95, S5	30.41	26.03	1014.92
Fall – T5, S95	19.81	35.84	1025.48
Winter – T5, S95	12.02	34.04	1025.83
Spring – T95, S5	26.78	24.25	1014.76
Spring – T5, S5	15.26	24.25	1017.63

*TABS Buoy D (2019-2022)

These densities are based on combinations of the 95th and 5th percentile temperatures (T5, T95) and salinities (S5, S95) in the data for TABS Buoy D and represent the conditions that will maximize the density difference between the effluent discharge and the ambient water. The maximum density difference between effluent and receiving typically water results in the minimum achievable dilution for a buoyant (positive or negative) plume.

Ambient current statistics from 1995-2022 were calculated for TABS Buoy 5. The 50th percentile (median) current of 0.27 m/s, the 5th percentile current of 0.11 m/s, and the 95th percentile current of 0.65 m/s were used to develop the diffuser design. The median current of 0.27 m/s is representative of the 24-hour long-term average current and is the best estimate of the daily average available dilution at the diffuser site.

[7] https://geodesy.noaa.gov/datums/vertical/north-american-vertical-datum-1988.shtml

[8] Texas Automated Buoy System (TABS), https://tabs.gerg.tamu.edu/Tglo/

Modeling Results

The plume centerline dilution factor at the edge of the hydrodynamic mixing zone (near-field region), which is the point at which momentum-induced mixing ceases, is predicted by the CORMIX2 model. The model calculates the plume width and thickness at the distance from the diffuser ports at each output interval where the model generates a predicted centerline dilution factor and percent effluent.

Additional mixing of the diluted effluent with the receiving water outside of the near-field region occurs due to density differences, wind, and ambient currents. This dilution is termed far-field dilution and is also predicted by CORMIX2.

Mixing Zone Definition

TCEQ has a consistent policy for establishing mixing zones for high-rate diffusers. TCEQ designates 3 categories of mixing zone: (1) the zone of initial dilution (ZID), which is the acute aquatic life protection mixing zone; (2) the chronic aquatic life mixing zone that is identified as the mixing zone (MZ); and (3) the human health mixing zone (HHMZ). The mixing zone policy is intended to address the specific language at 30 TAC 307.8(b), which defines the size of the zone of initial dilution (ZID). The regulatory language specifies the size of the ZID and indicates that for diffusers, the ZID will have an area or volume equivalent to the size specified in the regulation.

The TCEQ mixing zone policy for multi-port diffusers is as follows:

- The ZID and mixing zones for the diffuser are based on an equivalent volume representing the following dimensions: ZID = 50 foot radius (15.2 metres); MZ = 200 foot radius (60.5 m); and HHMZ = 400 foot radius (121 m) extending over the local water depth.
- The shape of the equivalent mixing zone for a multi-port diffuser is a rectangular box extending from the channel bottom to water surface.

This diffuser design, with a 150-m distance between the inner and outermost risers, has the following mixing zone dimensions:

MZ: x = 76.4 m; y = 55 m where x is measured along the diffuser axis (x=0 at the center of the diffuser barrel) and y is the distance from the ports measured on either side of the diffuser in the direction (s) of the ambient current.

HHMZ: x = 130 m; y = 130 m using the same coordinates as the MZ.

The ZID is at x = 14.1 m and y = 6.5 m using the same coordinates as the MZ.

Diffuser Dilution Calculations

A total of 36 combinations of effluent and ambient density were examined to determine the critical ambient and effluent conditions in terms of critical initial dilution that are achieved with the diffuser design. Effluent and ambient conditions that represent the maximum density difference were used to screen potential diffuser configurations at the 50% recovery design flow (maximum monthly average, 6.701 m^3/s) – number of ports, distance between ports, and port exit velocity. The initial configuration choice(s) were then evaluated at the 40% recovery flow rate (8.375 m^3/s). The screening analysis results were used to configure the conceptual diffuser design.

The performance of the selected design was then evaluated for 36 representative combinations of effluent flow and density and receiving water density and ambient current.

Table 5 presents the results of the 36 diffuser mixing simulations. Table 6 presents the salinity and the rise (Δ) above ambient salinity at 100 m from the ports.

Table 5. Predicted Effluent Dilution

Effluent Flow (m^3/s)*	Effluent Density (kg/m^3)	Ambient Density (Percentile)	Ambient Current (m/s)	ZID Percent Effluent	MZ Percent Effluent	100 m Percent Effluent	HHMZ Percent Effluent
6.701	1044.41	1023.99	0.27	13.12	6.95	4.65	3.69
6.701	1029.29	1014.92	0.27	11.65	5.91	3.85	3.01
6.701	1045.9	1025.48	0.27	13.11	6.95	4.64	3.69
6.701	1031.57	1017.63	0.27	11.51	5.84	3.81	2.97
6.701	1045.61	1025.83	0.27	12.87	6.85	4.57	3.63
6.701	1028.28	1014.76	0.27	11.50	5.77	3.76	2.93
6.701	1044.41	1023.99	0.11	12.65	8.47	7.23	6.73
6.701	1029.29	1014.92	0.11	11.36	7.83	6.89	6.34
6.701	1045.9	1025.48	0.11	12.59	8.60	7.42	6.87
6.701	1031.57	1017.63	0.11	10.81	7.66	6.56	6.20
6.701	1045.61	1025.83	0.11	12.47	8.45	7.04	6.74
6.701	1028.28	1014.76	0.11	10.67	7.63	6.71	6.18
6.701	1044.41	1023.99	0.65	11.14	1.84	0.78	0.72
6.701	1029.29	1014.92	0.65	9.01	2.02	1.11	0.70
6.701	1045.9	1025.48	0.65	9.03	1.84	0.78	0.72
6.701	1031.57	1017.63	0.65	9.03	2.04	1.12	0.70
6.701	1045.61	1025.83	0.65	9.47	1.86	0.78	0.72
6.701	1028.28	1014.76	0.65	8.68	2.06	1.13	0.70
8.375	1038.19	1023.99	0.27	10.02	5.72	4.04	3.28
8.375	1024.92	1014.92	0.27	8.81	5.02	3.48	2.81
8.375	1039.68	1025.48	0.27	10.10	5.72	4.03	3.27
8.375	1027.32	1017.63	0.27	8.69	4.95	3.44	2.76
8.375	1039.59	1025.83	0.27	10.00	5.65	3.97	3.22
8.375	1024.16	1014.76	0.27	10.00	4.90	3.39	2.73
8.375	1038.19	1023.99	0.11	100.0**	3.40	3.16	3.07
8.375	1024.92	1014.92	0.11	100.0**	3.26	3.40	3.27
8.375	1039.68	1025.48	0.11	100.0**	3.42	3.15	3.05
8.375	1027.32	1017.63	0.11	100.0**	3.22	3.43	3.29
8.375	1039.59	1025.83	0.11	100.0**	3.40	3.18	3.09
8.375	1024.16	1014.76	0.11	100.0**	3.16	3.45	3.31
8.375	1038.19	1023.99	0.65	10.00	5.27	3.14	2.41
8.375	1024.92	1014.92	0.65	9.08	4.94	3.30	2.73
8.375	1039.68	1025.48	0.65	10.00	5.27	3.14	2.41
8.375	1027.32	1017.63	0.65	4.75	4.91	3.32	2.76
8.375	1039.59	1025.83	0.65	9.92	5.23	3.15	2.44
8.375	1024.16	1014.76	0.65	8.96	2.16	1.24	0.66

*6.701 m3/s = 50% recovery; 8.375 m3/s = 40% recovery
**Near field instability due to low ambient current and high port exit velocity

Table 6. Predicted Salinity Increases at 100 m from Diffuser

Effluent Flow (m^3/s)*	Effluent Density (kg/m^3)	Ambient Density (Percentile)	Ambient Current (m/s)	Ambient Salinity (ppt)	Effluent Salinity (ppt)	Δ Salinity @ 100 m (ppt)	Salinity @ 100 m (ppt)
6.701	1044.41	1023.99	0.27	36.5	63.77	1.27	37.77
6.701	1029.29	1014.92	0.27	26.03	45.42	0.75	26.78
6.701	1045.9	1025.48	0.27	35.84	62.62	1.24	37.08
6.701	1031.57	1017.63	0.27	24.25	42.31	0.69	24.94
6.701	1045.61	1025.83	0.27	34.04	59.46	1.16	35.20
6.701	1028.28	1014.76	0.27	24.25	42.31	0.68	24.93
6.701	1044.41	1023.99	0.11	36.5	63.77	1.97	38.47
6.701	1029.29	1014.92	0.11	26.03	45.42	1.34	27.37
6.701	1045.9	1025.48	0.11	35.84	62.62	1.99	37.83
6.701	1031.57	1017.63	0.11	24.25	42.31	1.18	25.43
6.701	1045.61	1025.83	0.11	34.04	59.46	1.79	35.83
6.701	1028.28	1014.76	0.11	24.25	42.31	1.21	25.46
6.701	1044.41	1023.99	0.65	36.5	63.77	0.21	36.71
6.701	1029.29	1014.92	0.65	26.03	45.42	0.21	26.24
6.701	1045.9	1025.48	0.65	35.84	62.62	0.21	36.05
6.701	1031.57	1017.63	0.65	24.25	42.31	0.20	24.45
6.701	1045.61	1025.83	0.65	34.04	59.46	0.20	34.24
6.701	1028.28	1014.76	0.65	24.25	42.31	0.20	24.45
8.375	1038.19	1023.99	0.27	36.5	55.46	1.82	38.32
8.375	1024.92	1014.92	0.27	26.03	39.52	1.11	27.14
8.375	1039.68	1025.48	0.27	35.84	54.46	1.78	37.62
8.375	1027.32	1017.63	0.27	24.25	36.81	1.01	25.26
8.375	1039.59	1025.83	0.27	34.04	51.72	1.67	35.71
8.375	1024.16	1014.76	0.27	24.25	36.81	1.00	25.25
8.375	1038.19	1023.99	0.11	36.5	55.46	1.70	38.20
8.375	1024.92	1014.92	0.11	26.03	39.52	1.29	27.32
8.375	1039.68	1025.48	0.11	35.84	54.46	1.66	37.50
8.375	1027.32	1017.63	0.11	24.25	36.81	1.21	25.46
8.375	1039.59	1025.83	0.11	34.04	51.72	1.60	35.64
8.375	1024.16	1014.76	0.11	24.25	36.81	1.22	25.47
8.375	1038.19	1023.99	0.65	36.5	55.46	1.34	37.84
8.375	1024.92	1014.92	0.65	26.03	39.52	1.08	27.11
8.375	1039.68	1025.48	0.65	35.84	54.46	1.31	37.15
8.375	1027.32	1017.63	0.65	24.25	36.81	1.02	25.27
8.375	1039.59	1025.83	0.65	34.04	51.72	1.26	35.30
8.375	1024.16	1014.76	0.65	24.25	36.81	0.24	24.49

*6.701 m3/s = 50% recovery; 8.375 m3/s = 40% recovery

The critical condition with respect to the increase in the ambient (background) salinity at 100 m from the diffuser occurs at the 50% recovery rate and corresponds to the greatest difference between ambient salinity (which is the intake salinity for the HIDF) and the effluent salinity. This occurs at the Fall (T5, S95) ambient condition and the 5th percentile ambient current. The maximum salinity concentration is predicted to be 37.83 ppt at 100 m from the diffuser (1.99 ppt greater than the ambient salinity under these conditions). This predicted concentration is at the centerline of the plume. At this location (100 m from the ports), CORMIX2 predicts that the salinity plume will be attached to the bottom and 2.4 m thick and 337.4 m wide. At the boundaries of the plume the salinity concentration decreases to the ambient salinity. The predicted width of the plume – 337.4 m – assures that it will not interact with the HIDF intake that will be located over 800 m from the closest diffuser port pair (first riser). The joint probability of occurrence of this combination of ambient conditions is 0.000125 (0.05^3) assuming that there is no correlation between the three conditions. The CORMIX2 model output and a schematic of the plume for the critical case are provided in the appendix.

As shown in Table 6, at the ambient/effluent conditions associated with the 40% recovery HIDF operation the increases in ambient salinity at the 100 m distance from the diffuser are less than for the 50% recovery operation. There are two reasons for this: (1) the effluent salinity concentrations are lower at 40% recovery rate so the difference in salinity between the effluent and ambient is lower; and (2) the higher effluent flow rate at 40% recovery results in an increased discharge velocity at the 50 ports which in turn results in more rapid mixing due to the greater momentum and energy of the discharged effluent.

The dilution at the ZID (6.5 m from the ports) is essentially zero (100% effluent) at the 8.375 m^3/s flow rate when the ambient current is at the 5^{th} percentile (0.11 m/s). Because the momentum of the discharge is high compared to the ambient current, local instability occurs near the diffuser and the model predicts the area close to the ports to be approximately 100% effluent. Under all other effluent/ambient conditions the dilution at the ZID is ≤ 12.87% effluent.

Alternative Discharge Scenarios

One potential alternative for the discharge design was identified. The diffuser could be located further offshore at a greater distance from the intake structure. This alternative would locate the diffuser in deeper water and provide an additional safety factor with respect to intake entrainment of HIDF effluent.

Extending the pipeline offshore from the proposed location by an additional 1,000 m would increase the average water depth at the center of the diffuser to approximately 45 feet (NAVD88)(13.7 m). Modeling of the critical case scenario [Fall (T5, S95)] at a 13.7 m water depth (at two different riser heights above the bottom) with CORMIX2 did not provide any increase in the predicted effluent dilution or reduce the salinity concentration at the 100 m distance from the diffuser. The additional costs and impacts associated with extending the diffuser to an average water depth of 45 feet will not improve the achievable dilution/salinity or reduce the risk of entrainment at the intake of HIDF effluent.

Another alternative that would locate the diffuser closer to the shore, in shallower water, was rejected because of the lower dilution potential, possible intake entrainment of the plume, and possible interference with recreational activity. The GOM bottom has a downward slope toward the center of the gulf so there will be a tendency for the bottom-attached plume to move downgradient toward the HIDF intake and potentially be entrained. The shallower water decreases the available volume of ambient water flowing across the diffuser thus decreasing the dilution that can be achieved. Locating the diffuser closer to the shoreline at shallower depths near shore may also interfere with recreational activities.

Temperature Analysis

The Texas surface water quality standards apply at the boundary of an authorized thermal mixing zone. The standards do not establish a maximum size for such mixing zones, but state that that the temperature shall be maintained so as not to interfere with reasonable uses of such waters [30 TAC 307.4(f)]. The Texas surface water quality standards rule and the TCEQ mixing zone policy do not establish a maximum size for thermal mixing zones so they are determined by a case-by-case TCEQ evaluation. The HIDF is not a thermal discharge[9] and this analysis is performed only for the purpose of documenting that the GOM water temperature standard will not be exceeded by the effluent discharge.

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[9] Any heating of the seawater during the pretreatment and desalination process is incidental and a result of ambient air temperature, solar radiation, and wind that heats and cools the treatment equipment. There is no thermal “process” that adds heat to the intake water used by the HIDF.

For simplicity, this temperature analysis uses the MZ dimensions described above for toxic pollutants, but this assumption is made only to demonstrate that the surface water quality standards for temperature are achieved rapidly in the GOM. This assumption of the mixing zone dimensions is not T/K's conclusion or recommendation that the MZ dimensions are the appropriate physical dimensions for a thermal mixing zone that achieves the Texas water quality standard for temperature.

The statistical analysis of the ambient data (Table 4) show that the 95th percentile water temperature at the intake/discharge location is 30.41 °C (87 °F) which is 4.59 °C (8.26 °F) below the 35 °C (95 °F) water quality standard for Segment 2501.

A simplified heat budget analysis was performed using the methodology developed by Argaman and Adams for wastewater treatment tanks[10]. An approximation of the surface area and perimeter of the tanks/equipment used by the desalination process was estimated from the draft plot plan of the HIDF. Based on Port Aransas meteorologic data a daily high temperature of 95 °F and wind speed of 10 miles/hour were used to calculate the equilibrium temperature in the water treatment system. This calculation indicates that there will be an approximately 0.26 °C maximum temperature rise across the desalination process under these ambient conditions at mid-day. The increase in temperature above intake water temperature will negligible during the rest of the daylight hours and at night.

The discharge will also be diluted to a concentration of 8.60 percent effluent or less at the edge of the mixing zone (Table 5). This amount of dilution would allow an increase in effluent temperature of 9.65 °C above ambient at the edge of the MZ, based on the water quality standard maximum allowable summer temperature increase above ambient temperature of 0.83 °C (30 TAC 307.4(f)(3)). The predicted maximum temperature increase from the intake to the effluent at the HIDF is ~21.6% of the allowable 0.83 °C. Therefore, the proposed HIDF discharge does not have a reasonable potential to cause or contribute to an exceedance of the applicable temperature standards.

[10] Argaman, Y. and Adams, C. (1977) *Comprehensive temperature model for aerated biological systems*, Prog. Water Technology, V9, pp. 397-409, Pergamon Press. Note: the terms in the heat balance equations for aeration and biological heat generation are removed for this analysis.

4. Conclusions

The CORMIX2 modeling analysis demonstrates that a 50-port high-rate diffuser can be effectively used to enhance mixing of the HIDF effluent with the GOM receiving waters. At the proposed discharge location and with the 50-port design, the maximum increase in ambient GOM salinity at a horizontal distance of 100 m from the diffuser will be < 2 ppt. The plume will be bottom attached at this distance from the diffuser and will be 2.4 m thick and 337 m wide. The appendix provides a schematic of the plume shape and dimensions at this effluent/ambient condition.

The key components of the diffuser design are as follows:

minimum bottom elevation	≥11.3	m MLLW
port depth below surface (center of diffuser)	≥7.5	m MLLW
number of risers	25	
distance between risers	6.25	m
total length of diffuser barrel	150	m
number of ports per riser	2	
orientation of ports on risers	180° (opposing)	
port diameter	160	mm
port angle to horizontal (water surface)	60°	
port angle to ambient current	0º-180° (~NNE, SSW)	

The detailed engineering design of the diffuser will be prepared following approval of the diffuser critical dilutions by TCEQ and issuance of a TPDES permit based on the dilution achieved by the proposed diffuser.

Appendix

CORMIX Output File and Plume Schematic

Critical Condition

```
CORMIX2 PREDICTION FILE:
22222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
                       CORMIX MIXING ZONE EXPERT SYSTEM
               Subsystem CORMIX2: Multiport Diffuser Discharges
                             CORMIX Version 12.0GTD
                     HYDRO2 Version 12.0.1.0 August 2021
CASE DESCRIPTION
 Site name/label:   POCCA Gulf Diffuser
 Design case:       pocca_9
 FILE NAME:         \\M...ice Projects\pocca gulf diffuser\pocca_2024_9.prd
 Time stamp:        08/29/2024-11:05:23

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =     11.00  HD    =     11.00
 UA    =      0.110 F     =      1.412 USTAR =0.4622E-01
 UW    =      2.000 UWSTAR=0.2198E-02
 Uniform density environment
 STRCND=  U         RHOAM = 1025.4800

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= alternating_perpendicular
 BANK  =  LEFT      DISTB =   2475.00  YB1   =   2400.00  YB2   =   2550.00
 LD    =    150.00  NOPEN =   50       NRISER=   25       SPAC  =      6.25    NPPERR =    2
 D0    =      0.160 A0    =      0.020 H0    =      3.50  SUB0  =      7.50
 D0INP =      0.160 CR0   =      1.000 B0    =0.6434E-02
 Nozzle/port arrangement:   alternating_without_fanning
 GAMMA =     90.00  THETA =     60.00  SIGMA =      0.00  BETA  =     90.00
 U0    =      6.666 Q0    =      6.701 Q0A   =0.6701E+01
 RHO0  = 1045.9000  DRHO0 =-.2042E+02  GP0   =-.1953E+00
 C0    =0.1000E+03  CUNITS=  %
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0    =0.4467E-01         SIGNJ0=     -1.0
 m0 =U0^2*B0 =0.2859E+00   j0 =U0*GP0*B0 =-.8375E-02   (based on slot width B0)
 m0 =U0*q0   =0.2978E+00   j0 =q0*GP0    =-.8724E-02   (based on volume flux q0)
 Associated 2-d length scales (meters)
 lQ=B  =      0.007 lM    =      6.92  lm    =     24.61
 lmp   =  99999.00  lbp   =  99999.00  la    =  99999.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0    =0.6701E+01  M0    =0.4288E+02  J0    =-.1256E+01
 Associated 3-d length scales (meters)
 LQ    =      0.14  LM    =     14.95  Lm    =     60.76  Lb    =    983.13
                                       Lmp   =  99999.00  Lbp   =  99999.00

NON-DIMENSIONAL PARAMETERS
 FR0   =    188.05  FRD0  =     37.71  R     =     60.60  PL    =  140.00
 (slot)             (port/nozzle)

RECOMPUTED SOURCE CONDITIONS FOR ALTERNATING JETS OR RISER GROUPS:
 Momentum fluxes:   m0    =0.2476E+00  M0    =0.3713E+02
 lQ=B  =      0.008 lM    =      5.99  lm    =     21.31  lmp   =  99999.00
 LQ    =      0.933 LM    =     13.42  Lm    =     56.54  Lmp   =  99999.00
 Properties of riser group with  2 ports/nozzles each:
 U0    =      5.773 D0    =      0.243 A0    =      0.046 THETA =     90.00
 FR0   =    151.56  FRD0  =     26.49  R     =     52.48
 (slot)             (riser group)

FLOW CLASSIFICATION
 222222222222222222222222222222222222222222222222
 2  Flow class (CORMIX2)      =    MNU1         2
 2  Applicable layer depth HS =    11.00        2
 222222222222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.1000E+03  CUNITS=  %
 NTOX  =  0
 NSTD  =  0
```

```
 REGMZ =  1
 REGSPC=  1         XREG  =    100.00  WREG  =      0.00  AREG  =      0.00
 XINT  =  10000.00  XMAX  =  10000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
      2475.00 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP = 100 display intervals per module
```

```
BEGIN MOD201: DIFFUSER DISCHARGE MODULE

 Due to complex near-field motions:  EQUIVALENT SLOT DIFFUSER (2-D) GEOMETRY

 Profile definitions:
   BV = Gaussian 1/e (37%) width, in vertical plane normal to trajectory
   BH = top-hat half-width, in horizontal plane normal to trajectory
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)
   Uc = Local centerline excess velocity (above ambient)
   TT = Cumulative travel time

      X        Y       Z        S       C       BV       BH       Uc        TT
     0.00     0.00    3.50     1.0 0.100E+03   0.01    75.00     6.666   .00000E+00

END OF MOD201: DIFFUSER DISCHARGE MODULE
```

```
BEGIN MOD224: NEGATIVELY BUOYANT LINE PLUME

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

  Control volume inflow:
      X        Y       Z        S       C       BV       BH        TT
     0.00     0.00    3.50     1.0 0.100E+03   0.01    75.00   .00000E+00

  Control volume outflow:
      X        Y       Z        S       C       BV       BH        TT
     3.00     0.00    0.00     7.5 0.133E+02   0.90    75.90   .11809E+02
 Cumulative travel time =          11.8093 sec  (    0.00 hrs)

END OF MOD224: NEGATIVELY BUOYANT LINE PLUME
```

```
BEGIN MOD232: LAYER BOUNDARY IMPINGEMENT/UPSTREAM SPREADING

  Vertical angle of layer/boundary impingement    =     -90.00 deg
  Horizontal angle of layer/boundary impingement  =       0.00 deg

 UPSTREAM INTRUSION PROPERTIES:
        Upstream intrusion length               =     146.37 m
        X-position of upstream stagnation point =    -143.37 m
        Thickness in intrusion region           =       0.70 m
        Half-width at downstream end            =     168.67 m
        Thickness at downstream end             =       2.35 m

 In this case, the upstream INTRUSION IS VERY LARGE, exceeding 10 times
   the local water depth.
 This may be caused by a very small ambient velocity, perhaps in
   combination with large discharge buoyancy.
 If the ambient conditions are strongly transient (e.g. tidal), then the
   CORMIX steady-state predictions of upstream intrusion are probably
   unrealistic.
 The plume predictions prior to boundary impingement and wedge formation
   will be acceptable, however.

  Control volume inflow:
      X        Y       Z        S       C       BV       BH        TT
```

```
     3.00     0.00     0.00     7.5 0.133E+02   0.90    75.90   .11809E+02

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

       X        Y        Z        S        C        BV       BH       ZU       ZL        TT
   -143.37     0.00     0.00  9999.9 0.000E+00   0.00     0.00     0.00     0.00   .13424E+04
   -138.76     0.00     0.00    33.8 0.296E+01   0.16    23.85     0.16     0.00   .13005E+04
   -116.15     0.00     0.00    14.0 0.714E+01   0.37    57.94     0.37     0.00   .10950E+04
    -93.54     0.00     0.00    10.5 0.950E+01   0.50    78.39     0.50     0.00   .88942E+03
    -70.93     0.00     0.00     9.0 0.111E+02   0.59    94.52     0.59     0.00   .68388E+03
    -48.32     0.00     0.00     8.1 0.123E+02   0.64   108.27     0.64     0.00   .47835E+03
    -25.71     0.00     0.00     7.7 0.130E+02   0.68   120.46     0.68     0.00   .27281E+03
     -3.10     0.00     0.00     7.5 0.133E+02   0.70   131.52     0.70     0.00   .67270E+02
     19.50     0.00     0.00     8.3 0.121E+02   0.93   163.19     0.93     0.00   .16189E+03
     42.11     0.00     0.00    10.7 0.935E+01   1.65   165.12     1.65     0.00   .36742E+03
     64.72     0.00     0.00    12.4 0.808E+01   2.16   166.95     2.16     0.00   .57296E+03
     87.33     0.00     0.00    13.0 0.768E+01   2.35   168.67     2.35     0.00   .77850E+03
 Cumulative travel time =         778.4989 sec  (    0.22 hrs)

END OF MOD232: LAYER BOUNDARY IMPINGEMENT/UPSTREAM SPREADING
** End of NEAR-FIELD REGION (NFR) **
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BEGIN MOD241: BUOYANT AMBIENT SPREADING

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

 Plume Stage 1 (not bank attached):
       X        Y        Z        S        C        BV       BH       ZU       ZL        TT
     87.33     0.00     0.00    13.0 0.768E+01   2.35   168.67     2.35     0.00   .77850E+03
 ** REGULATORY MIXING ZONE BOUNDARY **
 In this prediction interval the plume DOWNSTREAM distance meets or exceeds
 the regulatory value =   100.00 m.
 This is the extent of the REGULATORY MIXING ZONE.
    100.64     0.00     0.00    13.5 0.741E+01   2.41   170.26     2.41     0.00   .89944E+03
    113.94     0.00     0.00    14.0 0.716E+01   2.47   171.86     2.47     0.00   .10204E+04
    127.24     0.00     0.00    14.4 0.692E+01   2.54   173.46     2.54     0.00   .11413E+04
    140.55     0.00     0.00    14.9 0.669E+01   2.60   175.06     2.60     0.00   .12623E+04
    153.85     0.00     0.00    15.4 0.647E+01   2.66   176.67     2.66     0.00   .13832E+04
    167.16     0.00     0.00    16.0 0.627E+01   2.73   178.29     2.73     0.00   .15042E+04
    180.46     0.00     0.00    16.5 0.607E+01   2.79   179.91     2.79     0.00   .16251E+04
    193.76     0.00     0.00    17.0 0.588E+01   2.86   181.53     2.86     0.00   .17461E+04
    207.07     0.00     0.00    17.6 0.569E+01   2.92   183.16     2.92     0.00   .18670E+04
    220.37     0.00     0.00    18.1 0.552E+01   2.99   184.78     2.99     0.00   .19879E+04
    233.67     0.00     0.00    18.7 0.535E+01   3.05   186.42     3.05     0.00   .21089E+04
    246.98     0.00     0.00    19.2 0.519E+01   3.12   188.05     3.12     0.00   .22298E+04
    260.28     0.00     0.00    19.8 0.504E+01   3.18   189.69     3.18     0.00   .23508E+04
    273.59     0.00     0.00    20.4 0.490E+01   3.25   191.34     3.25     0.00   .24717E+04
    286.89     0.00     0.00    21.0 0.475E+01   3.32   192.98     3.32     0.00   .25927E+04
    300.19     0.00     0.00    21.6 0.462E+01   3.39   194.63     3.39     0.00   .27136E+04
    313.50     0.00     0.00    22.3 0.449E+01   3.46   196.28     3.46     0.00   .28346E+04
    326.80     0.00     0.00    22.9 0.436E+01   3.53   197.93     3.53     0.00   .29555E+04
    340.11     0.00     0.00    23.6 0.424E+01   3.60   199.59     3.60     0.00   .30764E+04
    353.41     0.00     0.00    24.2 0.413E+01   3.67   201.25     3.67     0.00   .31974E+04
    366.71     0.00     0.00    24.9 0.402E+01   3.74   202.91     3.74     0.00   .33183E+04
    380.02     0.00     0.00    25.6 0.391E+01   3.81   204.57     3.81     0.00   .34393E+04
    393.32     0.00     0.00    26.3 0.381E+01   3.88   206.23     3.88     0.00   .35602E+04
    406.63     0.00     0.00    27.0 0.371E+01   3.95   207.90     3.95     0.00   .36812E+04
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419.93	0.00	0.00	27.7	0.361E+01	4.02	209.56	4.02	0.00	.38021E+04
433.23	0.00	0.00	28.4	0.352E+01	4.10	211.23	4.10	0.00	.39231E+04
446.54	0.00	0.00	29.1	0.343E+01	4.17	212.90	4.17	0.00	.40440E+04
459.84	0.00	0.00	29.9	0.334E+01	4.24	214.58	4.24	0.00	.41650E+04
473.15	0.00	0.00	30.7	0.326E+01	4.32	216.25	4.32	0.00	.42859E+04
486.45	0.00	0.00	31.4	0.318E+01	4.39	217.92	4.39	0.00	.44068E+04
499.75	0.00	0.00	32.2	0.310E+01	4.47	219.60	4.47	0.00	.45278E+04
513.06	0.00	0.00	33.0	0.303E+01	4.55	221.28	4.55	0.00	.46487E+04
526.36	0.00	0.00	33.8	0.296E+01	4.62	222.96	4.62	0.00	.47697E+04
539.66	0.00	0.00	34.7	0.289E+01	4.70	224.64	4.70	0.00	.48906E+04
552.97	0.00	0.00	35.5	0.282E+01	4.78	226.32	4.78	0.00	.50116E+04
566.27	0.00	0.00	36.3	0.275E+01	4.86	228.00	4.86	0.00	.51325E+04
579.58	0.00	0.00	37.2	0.269E+01	4.93	229.69	4.93	0.00	.52535E+04
592.88	0.00	0.00	38.1	0.263E+01	5.01	231.37	5.01	0.00	.53744E+04
606.18	0.00	0.00	39.0	0.257E+01	5.09	233.06	5.09	0.00	.54953E+04
619.49	0.00	0.00	39.9	0.251E+01	5.17	234.74	5.17	0.00	.56163E+04
632.79	0.00	0.00	40.8	0.245E+01	5.25	236.43	5.25	0.00	.57372E+04
646.10	0.00	0.00	41.7	0.240E+01	5.34	238.12	5.34	0.00	.58582E+04
659.40	0.00	0.00	42.7	0.234E+01	5.42	239.81	5.42	0.00	.59791E+04
672.70	0.00	0.00	43.6	0.229E+01	5.50	241.50	5.50	0.00	.61001E+04
686.01	0.00	0.00	44.6	0.224E+01	5.58	243.19	5.58	0.00	.62210E+04
699.31	0.00	0.00	45.6	0.220E+01	5.67	244.88	5.67	0.00	.63420E+04
712.62	0.00	0.00	46.6	0.215E+01	5.75	246.57	5.75	0.00	.64629E+04
725.92	0.00	0.00	47.6	0.210E+01	5.84	248.27	5.84	0.00	.65838E+04
739.22	0.00	0.00	48.6	0.206E+01	5.92	249.96	5.92	0.00	.67048E+04
752.53	0.00	0.00	49.6	0.202E+01	6.01	251.65	6.01	0.00	.68257E+04
765.83	0.00	0.00	50.7	0.197E+01	6.09	253.35	6.09	0.00	.69467E+04
779.13	0.00	0.00	51.7	0.193E+01	6.18	255.04	6.18	0.00	.70676E+04
792.44	0.00	0.00	52.8	0.189E+01	6.27	256.74	6.27	0.00	.71886E+04
805.74	0.00	0.00	53.9	0.185E+01	6.35	258.44	6.35	0.00	.73095E+04
819.05	0.00	0.00	55.0	0.182E+01	6.44	260.13	6.44	0.00	.74305E+04
832.35	0.00	0.00	56.1	0.178E+01	6.53	261.83	6.53	0.00	.75514E+04
845.65	0.00	0.00	57.3	0.175E+01	6.62	263.53	6.62	0.00	.76723E+04
858.96	0.00	0.00	58.4	0.171E+01	6.71	265.23	6.71	0.00	.77933E+04
872.26	0.00	0.00	59.6	0.168E+01	6.80	266.93	6.80	0.00	.79142E+04
885.57	0.00	0.00	60.8	0.164E+01	6.89	268.63	6.89	0.00	.80352E+04
898.87	0.00	0.00	62.0	0.161E+01	6.98	270.33	6.98	0.00	.81561E+04
912.17	0.00	0.00	63.2	0.158E+01	7.08	272.03	7.08	0.00	.82771E+04
925.48	0.00	0.00	64.4	0.155E+01	7.17	273.73	7.17	0.00	.83980E+04
938.78	0.00	0.00	65.7	0.152E+01	7.26	275.43	7.26	0.00	.85190E+04
952.09	0.00	0.00	66.9	0.149E+01	7.36	277.13	7.36	0.00	.86399E+04
965.39	0.00	0.00	68.2	0.147E+01	7.45	278.83	7.45	0.00	.87608E+04
978.69	0.00	0.00	69.5	0.144E+01	7.55	280.53	7.55	0.00	.88818E+04
992.00	0.00	0.00	70.8	0.141E+01	7.64	282.24	7.64	0.00	.90027E+04
1005.30	0.00	0.00	72.1	0.139E+01	7.74	283.94	7.74	0.00	.91237E+04
1018.60	0.00	0.00	73.5	0.136E+01	7.83	285.64	7.83	0.00	.92446E+04
1031.91	0.00	0.00	74.8	0.134E+01	7.93	287.34	7.93	0.00	.93656E+04
1045.21	0.00	0.00	76.2	0.131E+01	8.03	289.05	8.03	0.00	.94865E+04
1058.52	0.00	0.00	77.6	0.129E+01	8.13	290.75	8.13	0.00	.96075E+04
1071.82	0.00	0.00	79.0	0.127E+01	8.23	292.46	8.23	0.00	.97284E+04
1085.12	0.00	0.00	80.4	0.124E+01	8.33	294.16	8.33	0.00	.98493E+04
1098.43	0.00	0.00	81.9	0.122E+01	8.43	295.86	8.43	0.00	.99703E+04
1111.73	0.00	0.00	83.3	0.120E+01	8.53	297.57	8.53	0.00	.10091E+05
1125.04	0.00	0.00	84.8	0.118E+01	8.63	299.27	8.63	0.00	.10212E+05
1138.34	0.00	0.00	86.3	0.116E+01	8.73	300.98	8.73	0.00	.10333E+05
1151.64	0.00	0.00	87.8	0.114E+01	8.83	302.68	8.83	0.00	.10454E+05
1164.95	0.00	0.00	89.3	0.112E+01	8.94	304.39	8.94	0.00	.10575E+05
1178.25	0.00	0.00	90.8	0.110E+01	9.04	306.10	9.04	0.00	.10696E+05
1191.56	0.00	0.00	92.4	0.108E+01	9.14	307.80	9.14	0.00	.10817E+05
1204.86	0.00	0.00	94.0	0.106E+01	9.25	309.51	9.25	0.00	.10938E+05
1218.16	0.00	0.00	95.6	0.105E+01	9.35	311.21	9.35	0.00	.11059E+05
1231.47	0.00	0.00	97.2	0.103E+01	9.46	312.92	9.46	0.00	.11180E+05
1244.77	0.00	0.00	98.8	0.101E+01	9.56	314.63	9.56	0.00	.11301E+05
1258.08	0.00	0.00	100.4	0.996E+00	9.67	316.33	9.67	0.00	.11422E+05
1271.38	0.00	0.00	102.1	0.979E+00	9.78	318.04	9.78	0.00	.11543E+05
1284.68	0.00	0.00	103.8	0.964E+00	9.89	319.75	9.89	0.00	.11664E+05
1297.99	0.00	0.00	105.5	0.948E+00	9.99	321.45	9.99	0.00	.11784E+05
1311.29	0.00	0.00	107.2	0.933E+00	10.10	323.16	10.10	0.00	.11905E+05
1324.60	0.00	0.00	108.9	0.918E+00	10.21	324.87	10.21	0.00	.12026E+05
1337.90	0.00	0.00	110.7	0.903E+00	10.32	326.58	10.32	0.00	.12147E+05

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  1351.20     0.00     0.00   112.5 0.889E+00  10.43   328.28   10.43    0.00   .12268E+05
  1364.51     0.00     0.00   114.2 0.875E+00  10.55   329.99   10.55    0.00   .12389E+05
  1377.81     0.00     0.00   116.1 0.862E+00  10.66   331.70   10.66    0.00   .12510E+05
  1391.12     0.00     0.00   117.9 0.848E+00  10.77   333.41   10.77    0.00   .12631E+05
  1404.42     0.00     0.00   119.7 0.835E+00  10.88   335.11   10.88    0.00   .12752E+05
  1417.72     0.00     0.00   121.6 0.822E+00  11.00   336.82   11.00    0.00   .12873E+05
 Cumulative travel time =       12872.9629 sec  (    3.58 hrs)

END OF MOD241: BUOYANT AMBIENT SPREADING
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BEGIN MOD261: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

  Vertical diffusivity (initial value)   = 0.102E+00 m^2/s
  Horizontal diffusivity (initial value) = 0.352E+01 m^2/s

 Profile definitions:
   BV = Gaussian s.d.*sqrt(pi/2) (46%) thickness, measured vertically
      = or equal to layer depth, if fully mixed
   BH = Gaussian s.d.*sqrt(pi/2) (46%) half-width,
        measured horizontally in Y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)
   TT = Cumulative travel time

 Plume Stage 1 (not bank attached):
      X        Y        Z        S       C       BV       BH      ZU      ZL       TT
  1417.72     0.00     0.00   121.6 0.822E+00  11.00   336.82   11.00    0.00   .12873E+05
 Plume interacts with SURFACE.
 The passive diffusion plume becomes VERTICALLY FULLY MIXED within this
   prediction interval.
  1503.55     0.00     0.00   126.3 0.792E+00  11.00   349.69   11.00    0.00   .13653E+05
  1589.37     0.00     0.00   131.0 0.763E+00  11.00   362.72   11.00    0.00   .14433E+05
  1675.19     0.00     0.00   135.8 0.737E+00  11.00   375.91   11.00    0.00   .15214E+05
  1761.01     0.00     0.00   140.6 0.711E+00  11.00   389.26   11.00    0.00   .15994E+05
  1846.84     0.00     0.00   145.5 0.688E+00  11.00   402.76   11.00    0.00   .16774E+05
  1932.66     0.00     0.00   150.4 0.665E+00  11.00   416.41   11.00    0.00   .17554E+05
  2018.48     0.00     0.00   155.4 0.644E+00  11.00   430.21   11.00    0.00   .18334E+05
  2104.30     0.00     0.00   160.4 0.623E+00  11.00   444.16   11.00    0.00   .19115E+05
  2190.13     0.00     0.00   165.5 0.604E+00  11.00   458.26   11.00    0.00   .19895E+05
  2275.95     0.00     0.00   170.6 0.586E+00  11.00   472.51   11.00    0.00   .20675E+05
  2361.77     0.00     0.00   175.8 0.569E+00  11.00   486.90   11.00    0.00   .21455E+05
  2447.60     0.00     0.00   181.1 0.552E+00  11.00   501.43   11.00    0.00   .22235E+05
  2533.42     0.00     0.00   186.4 0.537E+00  11.00   516.11   11.00    0.00   .23016E+05
  2619.24     0.00     0.00   191.7 0.522E+00  11.00   530.92   11.00    0.00   .23796E+05
  2705.06     0.00     0.00   197.1 0.507E+00  11.00   545.88   11.00    0.00   .24576E+05
  2790.89     0.00     0.00   202.6 0.494E+00  11.00   560.97   11.00    0.00   .25356E+05
  2876.71     0.00     0.00   208.1 0.481E+00  11.00   576.20   11.00    0.00   .26136E+05
  2962.53     0.00     0.00   213.6 0.468E+00  11.00   591.57   11.00    0.00   .26917E+05
  3048.35     0.00     0.00   219.2 0.456E+00  11.00   607.06   11.00    0.00   .27697E+05
  3134.18     0.00     0.00   224.9 0.445E+00  11.00   622.70   11.00    0.00   .28477E+05
  3220.00     0.00     0.00   230.6 0.434E+00  11.00   638.46   11.00    0.00   .29257E+05
  3305.82     0.00     0.00   236.3 0.423E+00  11.00   654.35   11.00    0.00   .30038E+05
  3391.65     0.00     0.00   242.1 0.413E+00  11.00   670.38   11.00    0.00   .30818E+05
  3477.47     0.00     0.00   247.9 0.403E+00  11.00   686.53   11.00    0.00   .31598E+05
  3563.29     0.00     0.00   253.8 0.394E+00  11.00   702.81   11.00    0.00   .32378E+05
  3649.11     0.00     0.00   259.7 0.385E+00  11.00   719.22   11.00    0.00   .33158E+05
  3734.94     0.00     0.00   265.7 0.376E+00  11.00   735.75   11.00    0.00   .33939E+05
  3820.76     0.00     0.00   271.7 0.368E+00  11.00   752.41   11.00    0.00   .34719E+05
  3906.58     0.00     0.00   277.8 0.360E+00  11.00   769.19   11.00    0.00   .35499E+05
  3992.41     0.00     0.00   283.9 0.352E+00  11.00   786.10   11.00    0.00   .36279E+05
  4078.23     0.00     0.00   290.0 0.345E+00  11.00   803.13   11.00    0.00   .37059E+05
  4164.05     0.00     0.00   296.2 0.338E+00  11.00   820.27   11.00    0.00   .37840E+05
  4249.87     0.00     0.00   302.5 0.331E+00  11.00   837.54   11.00    0.00   .38620E+05
  4335.70     0.00     0.00   308.7 0.324E+00  11.00   854.93   11.00    0.00   .39400E+05
  4421.52     0.00     0.00   315.1 0.317E+00  11.00   872.44   11.00    0.00   .40180E+05
  4507.34     0.00     0.00   321.4 0.311E+00  11.00   890.06   11.00    0.00   .40960E+05
  4593.16     0.00     0.00   327.8 0.305E+00  11.00   907.80   11.00    0.00   .41741E+05
  4678.99     0.00     0.00   334.3 0.299E+00  11.00   925.66   11.00    0.00   .42521E+05
  4764.81     0.00     0.00   340.8 0.293E+00  11.00   943.63   11.00    0.00   .43301E+05
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4850.63	0.00	0.00	347.3	0.288E+00	11.00	961.72	11.00	0.00	.44081E+05
4936.46	0.00	0.00	353.9	0.283E+00	11.00	979.93	11.00	0.00	.44861E+05
5022.28	0.00	0.00	360.5	0.277E+00	11.00	998.24	11.00	0.00	.45642E+05
5108.10	0.00	0.00	367.2	0.272E+00	11.00	1016.67	11.00	0.00	.46422E+05
5193.92	0.00	0.00	373.9	0.267E+00	11.00	1035.21	11.00	0.00	.47202E+05
5279.75	0.00	0.00	380.6	0.263E+00	11.00	1053.86	11.00	0.00	.47982E+05
5365.57	0.00	0.00	387.4	0.258E+00	11.00	1072.63	11.00	0.00	.48762E+05
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5623.04	0.00	0.00	407.9	0.245E+00	11.00	1129.57	11.00	0.00	.51103E+05
5708.86	0.00	0.00	414.9	0.241E+00	11.00	1148.77	11.00	0.00	.51883E+05
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9828.36	0.00	0.00	790.0	0.127E+00	11.00	2187.52	11.00	0.00	.89333E+05
9914.19	0.00	0.00	798.6	0.125E+00	11.00	2211.43	11.00	0.00	.90114E+05
10000.01	0.00	0.00	807.3	0.124E+00	11.00	2235.42	11.00	0.00	.90894E+05

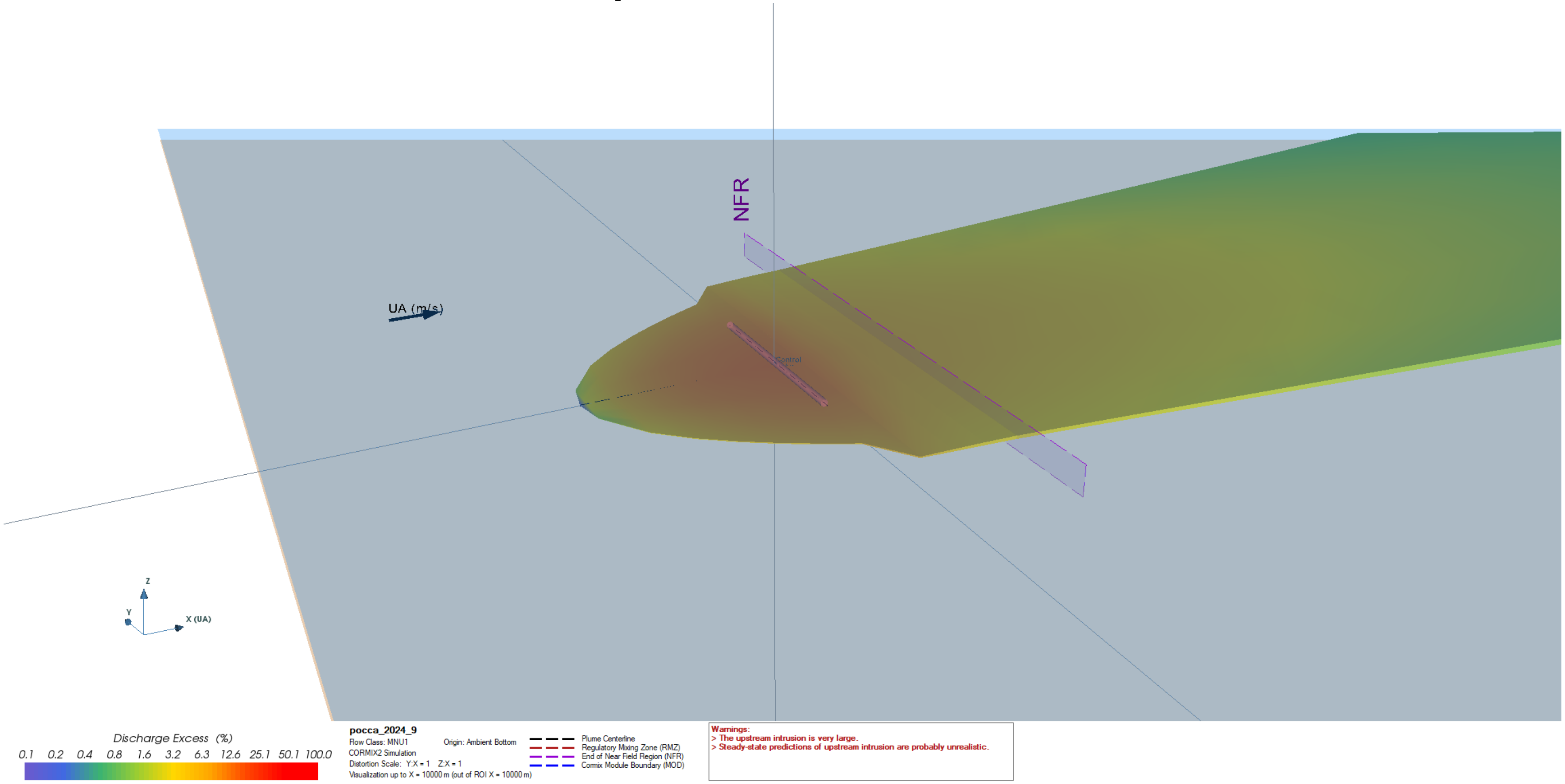
Cumulative travel time = 90893.6641 sec (25.25 hrs)

Simulation limit based on maximum specified distance = 10000.00 m.
This is the REGION OF INTEREST limitation.

END OF MOD261: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

CORMIX2: Multiport Diffuser Discharges End of Prediction File
2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222

Plume Shape and Dimensions at Critical Dilution



APPENDIX H

Port of Corpus Christi Proposed Gulf of Mexico Outfall for Desalination Plant Construction Methodology

PORT CORPUS CHRISTI®

PORT OF CORPUS CHRISTI
PROPOSED GULF OF MEXICO OUTFALL FOR DESALINATION PLANT
CONSTRUCTION METHODOLOGY
HARBOR ISLAND, CORPUS CHRISTI, TEXAS

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January 28. 2025

Proposed Construction Methods for the Harbor Island Desalination Facility Gulf of Mexico Discharge

Introduction

This document describes a general approach and methods of construction for a proposed effluent pump station, discharge pipe, and outfall diffuser extending from a proposed seawater desalination facility located on Harbor Island, outside of Aransas Pass, Texas, to a point in the Gulf of Mexico (GOM) approximately 3.6 miles east of the desalination facility. The discharge pipe would include trenched construction on Harbor Island and a tunneled section from Harbor Island to the offshore outfall. The proposed tunnel section would be constructed via a tunnel boring machine (TBM) such that surface disturbance would occur in only two locations – the vertical work shafts at the outfall diffuser point in the GOM and near the desalination facility on Harbor Island. The remainder of the tunnel construction would occur deep within the ground and under the seabed, undetectable to marine life, flora, fauna or humans above ground.

This construction methodology has been developed for the concept design stage for permitting purposes. Numeric measurements and values referenced in this document rely upon preliminary design considerations which are subject to confirmation or revision during the final engineering-design phase.

Preliminary Tunnel Routing

The proposed effluent discharge tunnel measures approximately 3.6 miles long. A plan and profile of the tunnel is provided in Figure 1. The main work shaft (also known as the TBM launch shaft) is the vertical shaft planned for the Harbor Island site on the left side of Figure 1. A second shaft will be excavated in the GOM at the terminus of the tunnel, where the outfall diffuser will be installed on the right side of Figure 1.

Assumed Geotechnical Conditions

A project-specific geotechnical investigation has not yet been performed along the alignment; however, some geotechnical data for inshore portions of the alignment have been reported in Appendix J to the license application for the Bluewater Texas Terminal Deepwater Port project to the Army Corps of Engineers (available at regulations.gov/docket/MARAD-2019-0094). The data available indicate soils at the elevation of the proposed tunnel include medium dense to very dense silty sands, and soft to very stiff lean and fat clays. Available boring logs and a generalized understanding of the geology in the Corpus Christi area suggest that only sands and clays are present at the elevations at which the tunnel will be constructed. These conditions are characterized as "soft ground", that is, in laymen's terms, soils and not rock. All tunneling will occur at elevations well below sea level. The top of the tunnel is proposed to be at an elevation of approximately -65 feet MLLW[1].

A geotechnical investigation will be performed prior to final design that will influence many aspects of the design. The ultimate configuration and methods will be determined during final design after the geotechnical investigation is completed. Presented below is a generalized version of typical construction methods for a tunnel.

Proposed Tunneling Method

Because it is anticipated that soft soils will be encountered for the entirety of the tunnel profile, the proposed method for tunnel construction is an earth pressure balance TBM (Figure 2). TBMs for soft ground have a cylindrical shield to support the soil strata being mined through, and a bi-rotational cutterhead equipped with cutting tools to remove the intact ground and draw the loosened material into the cutterhead. The excavated soils are captured and removed from a chamber behind the cutter wheel.

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[1] mean lower low water at Port Aransas

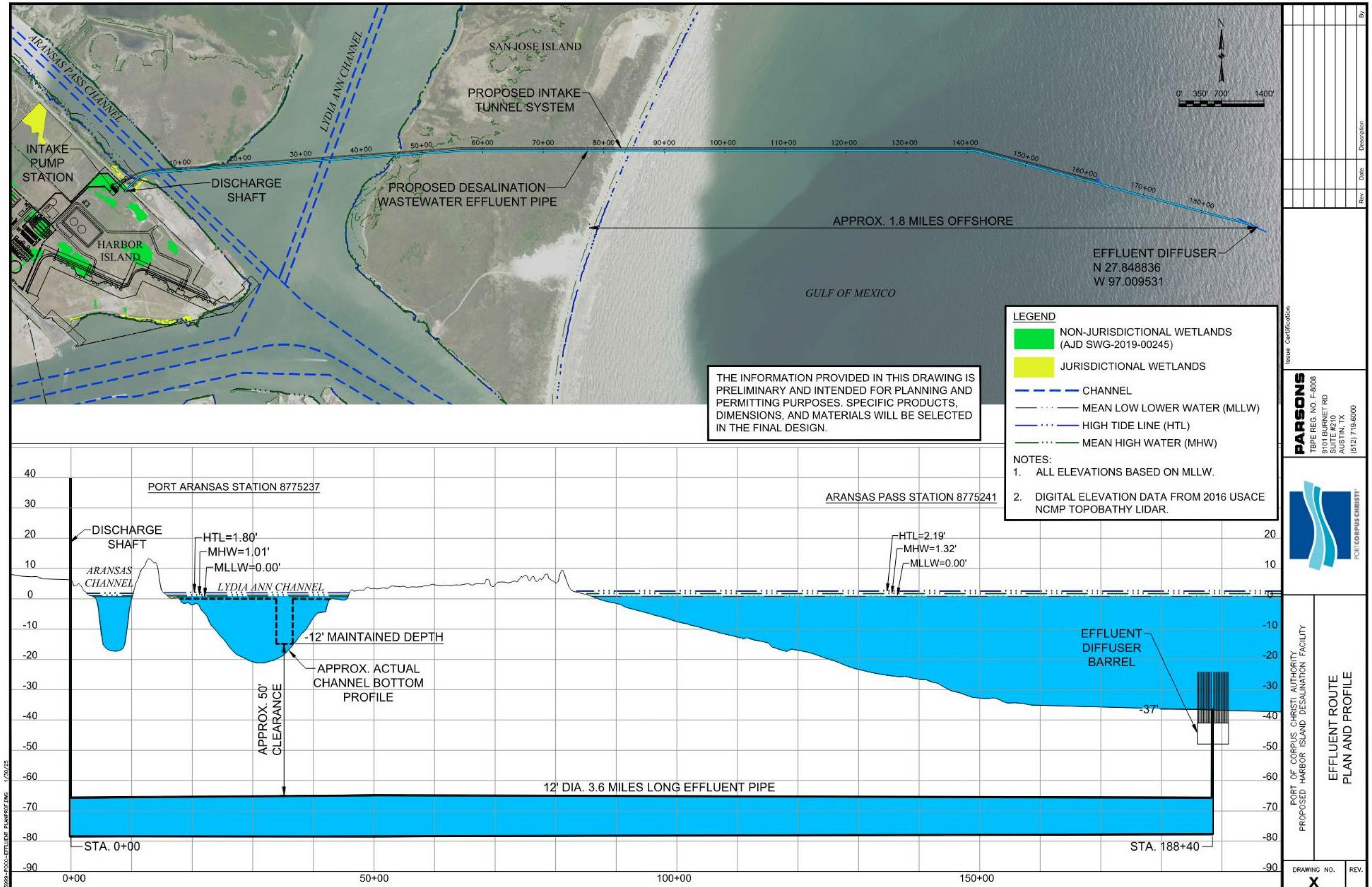


Figure 1. Plan and Profile of Proposed Discharge Tunnel

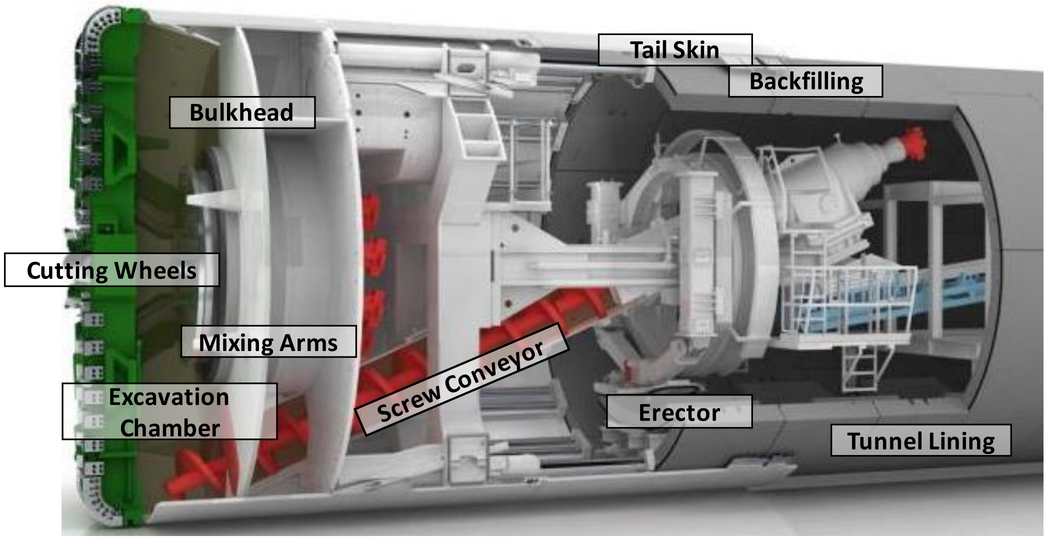


Figure 2. Earth Pressure Balance Tunnel Boring Machine
(Modified from https://www.herrenknecht.com/en/products/core-products/tunnelling/epb-shield.html)

Pressurization of the face of the excavation is required in permeable soil under unbalanced hydrostatic pressure, given the expected tunnel condition under the sea. If the face of the excavation were not pressurized, the unbalanced water pressure could allow soils to flow through the gaps in the cutter head and into and through the TBM, filling the tunnel with soil. Such conditions may cause sinkholes and excessive settlement at the ground or sea bed and may cause damage to existing infrastructure (e.g., adjacent pipes).

Earth pressure balance TBMs function by maintaining a pressurized environment in a void just behind the cutter head and excavation face called a "muck chamber." The face pressure is continuously monitored by operators in the TBM. The muck is a mixture of fragmented excavated spoils and soil conditioning additives (if any) to improve the material handling properties of the excavated material. The muck chamber is created by a bulkhead separating the construction crew from the pressurized environment at the face. Soil is removed from this pressurized environment by removing it through a helicoidal screw contained in a long steel cylinder. The helicoidal screw turns to slowly remove soil from behind the pressurized bulkhead while maintaining the appropriate face pressure. At the rear of the screw auger is a slide gate, where excavated soils are discharged onto a conveyor belt and then into muck cars near the end of the TBM shield. The muck cars/belt conveyor transport the muck to the primary work shaft, where they are hoisted to the surface and emptied into a temporary stockpile area/surge pile. Alternately, muck can be lifted to the surface by a vertical conveyor system.

The TBM shield is a cylindrical steel shell that is pushed forward along the tunnel, while the ground is excavated inside the shield. The main shield and tail shield support the ground as the tunnel lining is installed and fully protect workers within the tunnel. The shields fully support the excavation, never exposing the ground or leaving any area unsupported. The shield is propelled using hydraulic jacks that thrust against the tunnel lining system installed within the tail shield. The shield is designed to withstand the pressure of the surrounding ground and hydrostatic pressure.

To support the excavated bore in the soft soils at depths below sea level, a precast concrete segmented liner is proposed. This lining type has become the industry standard for large diameter soft ground TBM mined tunnels and is designed to meet project requirements for durability and watertightness. The liner helps to maintain the pressure the machine exerts on the ground and provides a solid base against which the thrust jacks in the TBM propulsion system can push the cutterhead forward. The pre-cast concrete segments are bolted and gasketed to form a watertight lining, like that shown in Figure 3. This watertight lining is designed to withstand construction, ground, seismic and hydrostatic loads.

The concrete segments are erected in the tail shield of the TBM (Figure 4), bolted and gasketed together to form a continuous ring. Thus, a TBM advance cycle consists of excavation and then ring erection and grouting during the next

TBM excavation cycle so that a continuous lining is built behind the TBM. The faces of a ring of segments are usually tapered, so when assembled the ring can be rotated to accommodate horizontal and vertical curvature of the alignment.

For corrosion protection, handling strength, and production needs, precast concrete tunnel segments are cast with a dense high strength concrete. Dense concrete is accomplished by using fine filler materials to fill the microscopic pores and voids between the cement particles. Concrete segments are usually reinforced by either steel reinforcing bars or steel fibers.

Precast concrete linings are fully capable of providing a structurally adequate and long-lasting tunnel lining in the presumed soil materials to depths beyond those of the proposed tunnel.

It should be noted however, that if geologic faults exist, the faults can create active shear zones which, when severe enough, could distort and shear a typical precast concrete lining. Accordingly, these fault zones must be given special design consideration details. Future geotechnical investigations will verify whether fault movement is a potential concern along the tunnel alignment.

Figure 3. Example Pre-Cast Concrete Segmental Lining

Figure 4. Erecting a Pre-Cast Concrete Segment in Tail of Tunnel Boring Machine

Shaft Construction

Shafts are the most important component of most water-conveying tunnel projects because these are the only locations of construction activities notable at the ground surface. The shafts contemplated for the discharge tunnel system include two very distinct types of shafts. The main work shaft is where the TBM is launched and serves as the main access point for tunneling activities. This shaft will be located on the Harbor Island site, with a diameter large enough for optimal tunnel activities, and nearly all the at-grade construction activities will occur here.

The second shaft will be located offshore in the GOM and is where the TBM may be retrieved and will serve to install the pipe connection between the tunnel and the diffuser above the sea bed. The configuration of this shaft and the methods required to construct it are far different from the primary shaft. Both shafts are discussed further below.

MAIN SHAFT SUPPORT SYSTEM

Based on the assumed soil conditions at the site, the shaft excavation support system currently considered most feasible for the proposed main tunnel shaft is secant piles (Figure 5). Secant piles provide a water-tight, rigid excavation support system. Secant piles are installed by drilling a series of overlapping circular concrete-filled shafts that together form a rigid, watertight cylinder. A secant pile shaft support system is designed to act as a compression ring, accounting for installation tolerances and the irregularities of the individual round columns.

The individual drilled shafts are constructed using typical drilled shaft/pile foundation techniques. The shaft excavation walls are supported using drilling slurry, drilled temporary steel casing, or both. The use of temporary steel casing helps maintain a tighter vertical tolerance and helps when biting into adjacent primary concrete shafts. Each secant pile shaft will be 80 to 100 feet deep. The final diameter of the main shaft at Harbor Island will be approximately 35 feet. Once the ring of secant piles is complete, the soil within the cylinder is excavated to create the shaft.

A secant pile support system can be constructed in very challenging ground and groundwater conditions to cut off groundwater flow so that only a sump in the excavation bottom is required for groundwater control.

Since the TBM breakout location (where the TBM exits the shaft to begin tunneling) is below the groundwater table in potentially unstable/flowing ground, ground improvement (e.g., jet grouting) may be performed to create a zone of modified ground around the planned penetration location. This zone acts as a seal and has several advantages, including: 1) the zone allows the contractor to pressurize the TBM face to the required full pressure upon leaving the shaft, and 2) it reduces the risk of overmining, which could lead to settlement or sinkholes to the ground surface. In addition, special seals surrounding the TBM shield are designed for exit of the TBM through the shaft wall.

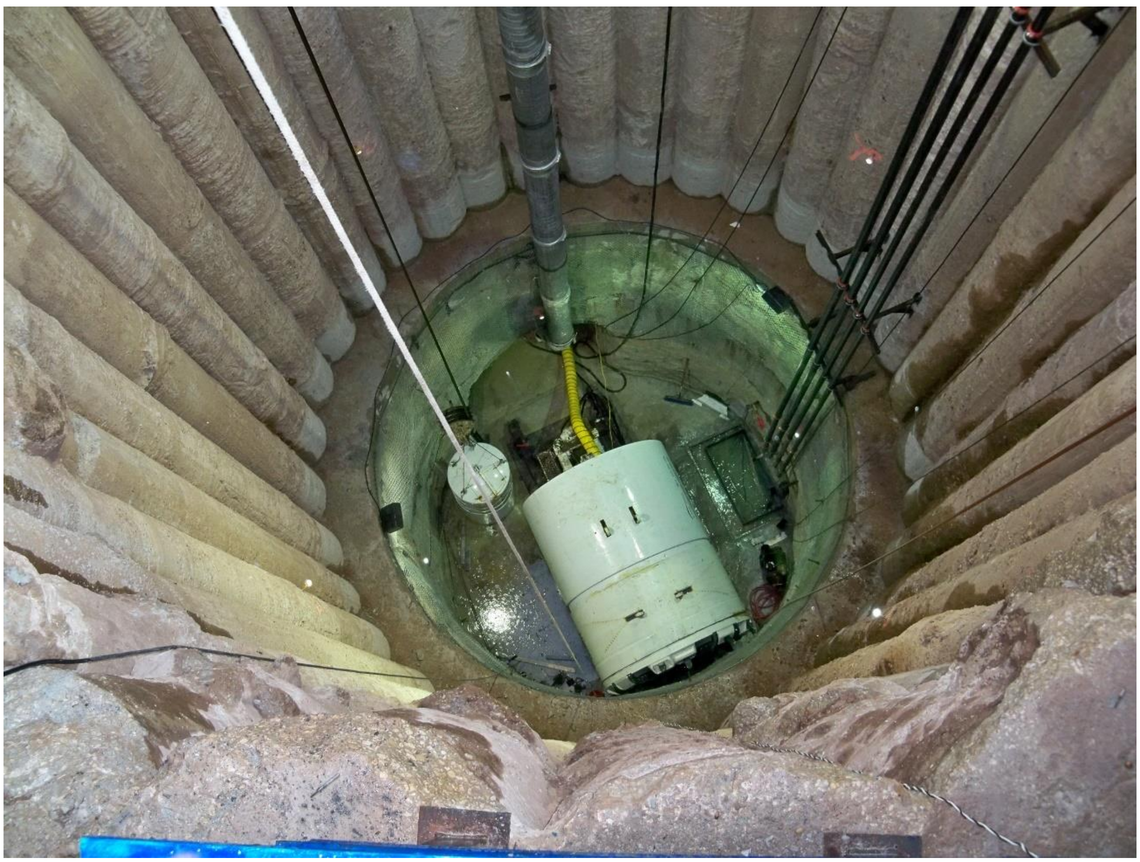


Figure 5. Example of Secant Pile Shaft with TBM

OFFSHORE DISCHARGE SHAFT

The proposed tunnel will terminate approximately two miles offshore, in the open waters of the GOM, at a sea bed elevation of approximately -37 feet MLLW. The top of the proposed tunnel is at an elevation of approximately -65 feet MLLW, so there is approximately 29 feet of separation between the top of the tunnel and the sea bed. The precise construction methods and details of an offshore shaft can be very complicated and subject to the Contractor's means and methods. We again note that the ultimate configuration and methods will be determined during final design after the geotechnical investigation is completed.

The offshore shaft connection will be constructed from platforms mounted above the offshore shaft location (figure 6). Well before the TBM arrives to the offshore shaft location, a large caisson is lowered to the sea bed, keyed into the sea bed, and dewatered. Ground improvements may be performed on sea bed sediments in the space between where the tunnel will enter and the sea bed. These may include jet grouting or excavation via tremie concrete. A shaft will be constructed down to the level of the tunnel inside the caisson, excavating vertically down through the grouted/concreted plug. The TBM bores horizontally through the same grouted/concreted material to arrive at the shaft site.

Figure 6. Example of a Vertical Conveyance Shaft Being Lowered Toward a Tunnel at Sea

After the TBM is removed and spaces are safely excavated, a vertical conveyance pipe, or riser, is installed between the top of the tunnel up to an elevation near the seabed, where it will connect to the diffuser. The diffuser structure consists of an approximately 7-ft diameter barrel almost 500-ft long with 25 vertical risers that terminate with two diffuser ports per riser (figure 7). The diffuser barrel is roughly centered on the riser from the tunnel, and laid in a trench constructed by typical marine trenching or jetting techniques such that the crown of the barrel is a few feet below the seabed. The diffuser barrel will be assembled on site from pipe sections, with stubs for attachment of risers to ports. The port risers are installed on the diffuser barrel and extend upwards from the crown of the barrel to the design depth for the diffuser ports (figure 8). The diffuser ports are at the tip of risers that extend from the barrel through the sediment and above the seabed. The diffuser barrel trench is backfilled with the excavated sediment to match the surrounding sediment elevation and armored with rock over the barrel. The portion of the caisson above the seabed is removed, and the connections between the diffuser barrel, riser, and tunnel are completed by remotely operated vehicles and robotic “sea horses”. Some operations may be performed by divers.

The installation of the diffuser and connection to the tunnel may temporarily disturb up to approximately 1.25 acres (600 x 90 ft) of sea bed. The volume of sediments displaced by trench and shaft construction may be up to 16,000 CY. The engineered armor rock layer over the diffuser barrel may be up to 3-ft thick and include up to 2,000 CY of rock graded in dimensions for stability to withstand the maximum velocities expected at the site. Navigational markers and beacons will be installed around the diffuser to add protection from ship strikes and trawling. Additional details will be determined during the detailed design phase.

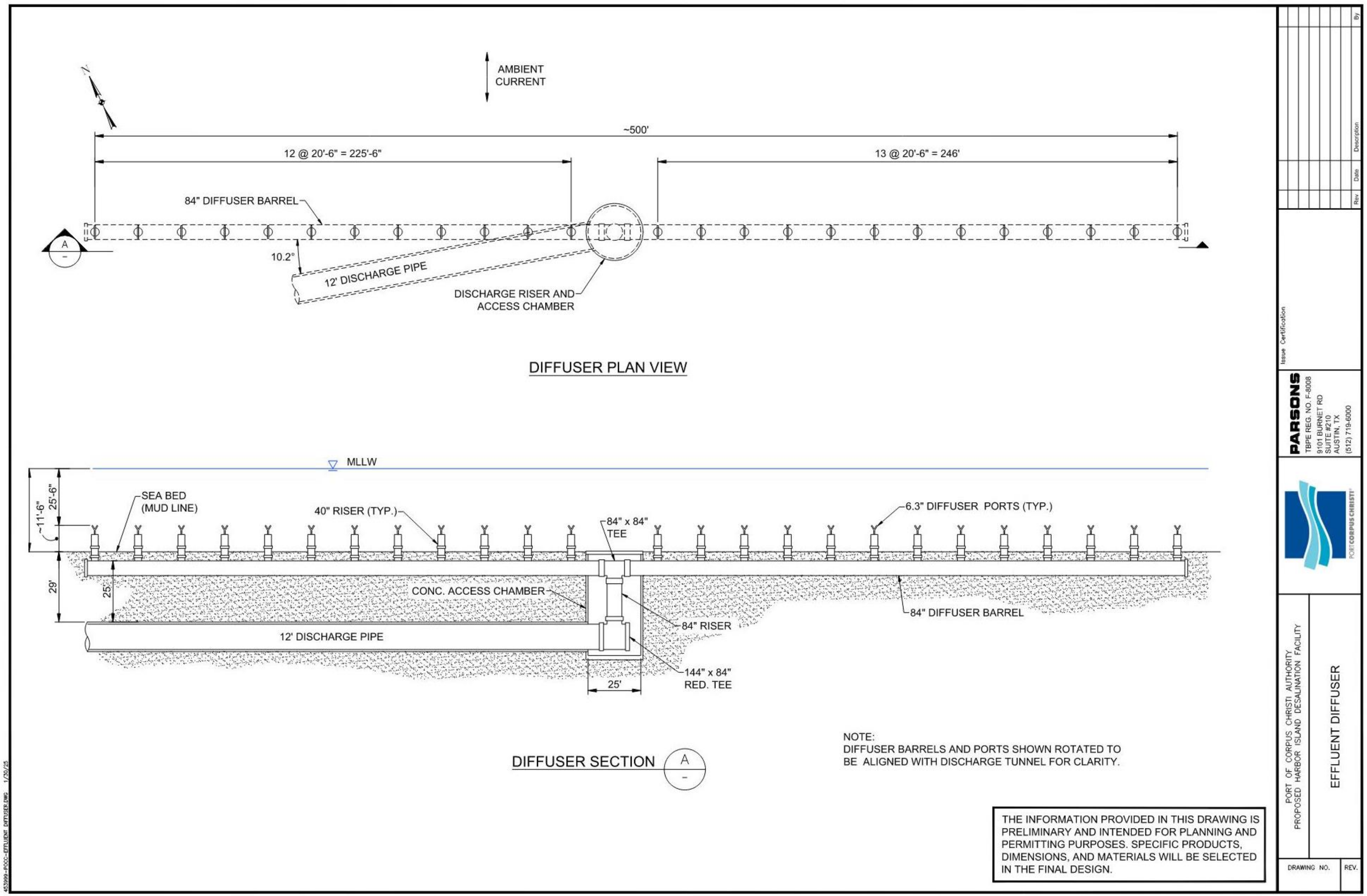


Figure 7. Plan and Profile of Outfall Diffuser

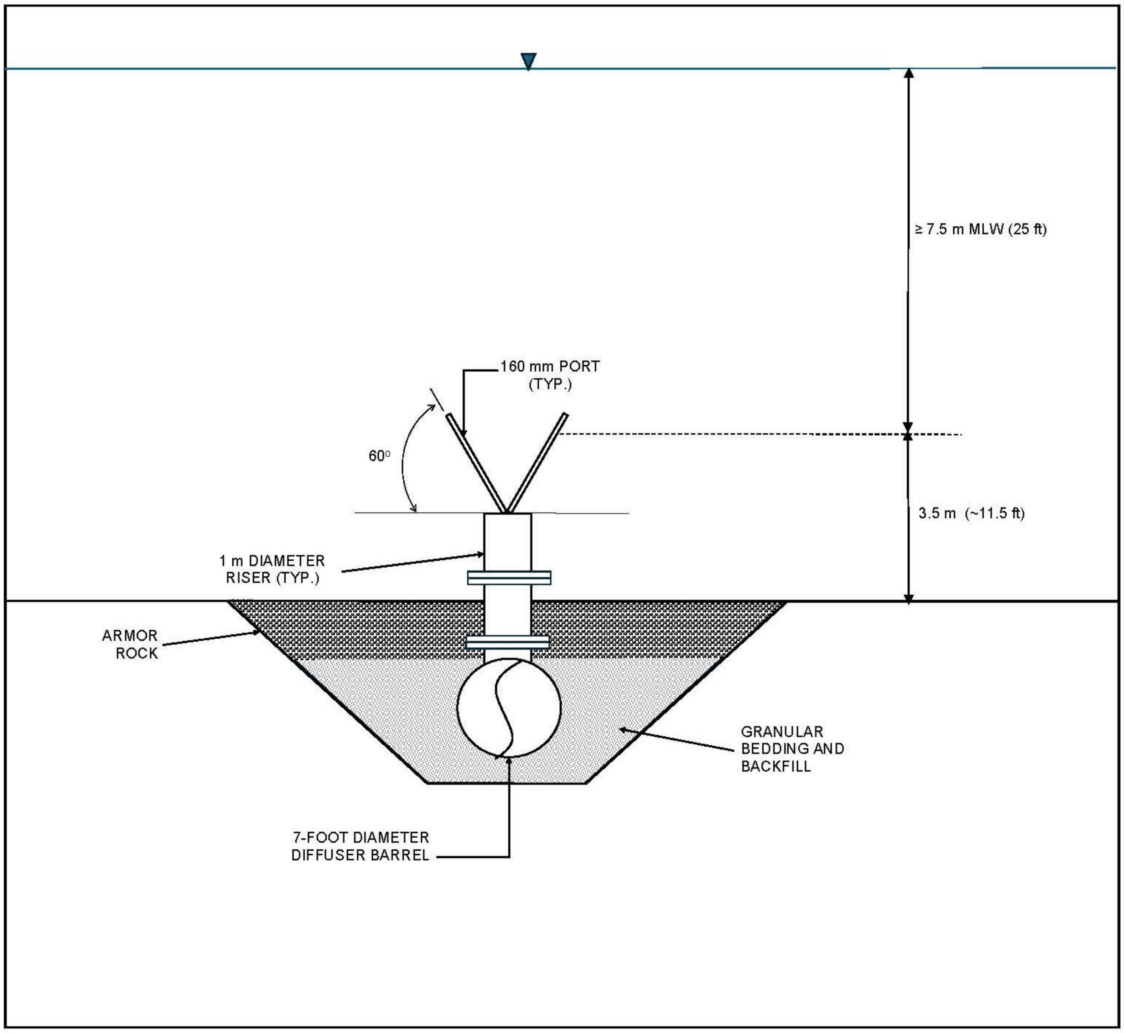


Figure 8. Diffuser Riser and Port Schematic

Main Work Shaft Site Considerations

MAIN SHAFT SITE CHARACTERISTICS

The main work shaft site on Harbor Island is the primary construction site for the tunneling project. The proposed shaft site location is in a currently undeveloped coastal zone, officially an island, that was historically used for industrial oil and gas operations. The developed properties near the site are industrial or dedicated to commercial shipping. The nearest residences are more than 1.2 miles from the site. The site is served by Harbor Island Road and then Texas State Highway 361.

Activities at the main work shaft site may include:

- Site lighting at night
- Lifting of tunnel muck from tunnel to ground surface with heavy cranes
- Lowering of supplies from ground surface to tunnel
- Compressor for ventilation system

- Heavy earth moving equipment to remove and dispose of excavated muck
- Other large construction equipment (cranes, front end loaders, etc.)
- Concrete plant to produce concrete segments for tunnel lining segments
- Batch plant for grout
- Precast concrete lining segment storage areas
- Temporary laydown for TBM components and other major equipment
- Other laydown space for materials and supplies
- Storage facilities
- Workshops
- Power substation or generators
- Project offices and employee facilities, including employee parking
- Arrival of supply trucks
- Storage of stripped topsoil for future site reclamation

The existing property provides enough space to store the entire inventory of the pre-cast tunnel lining segments. A tunneling staging area is depicted in figure 9. The TBM major components will be delivered to the Harbor Island TBM main work shaft site with very large truck-trailers. Final use or disposal for the tunnel spoils and truck haul routes will be determined during design.

SHAFT SIZE

The main work shaft will be large enough so the TBM components can be lowered into the shaft, and muck cars can be lifted out, while also allowing room for additional construction equipment, ventilation, laborers, and other project and construction needs. Figure 10 shows an example of the main head of a TBM system being lowered into the main work shaft and shows typical cranes that would be utilized for tunneling operations, albeit the machine shown is significantly larger than required for the Harbor Island project.

The top of the shaft will include personnel safety measures that meet OSHA requirements. Often, the excavation support system (secant piles) is constructed so it simply extends above the ground surface a sufficient distance to create a wall or barrier to act as fall protection. Shaft flood protection from storm surges during construction will be a project requirement, and the safety barrier will be constructed so that it can support the design flood event.

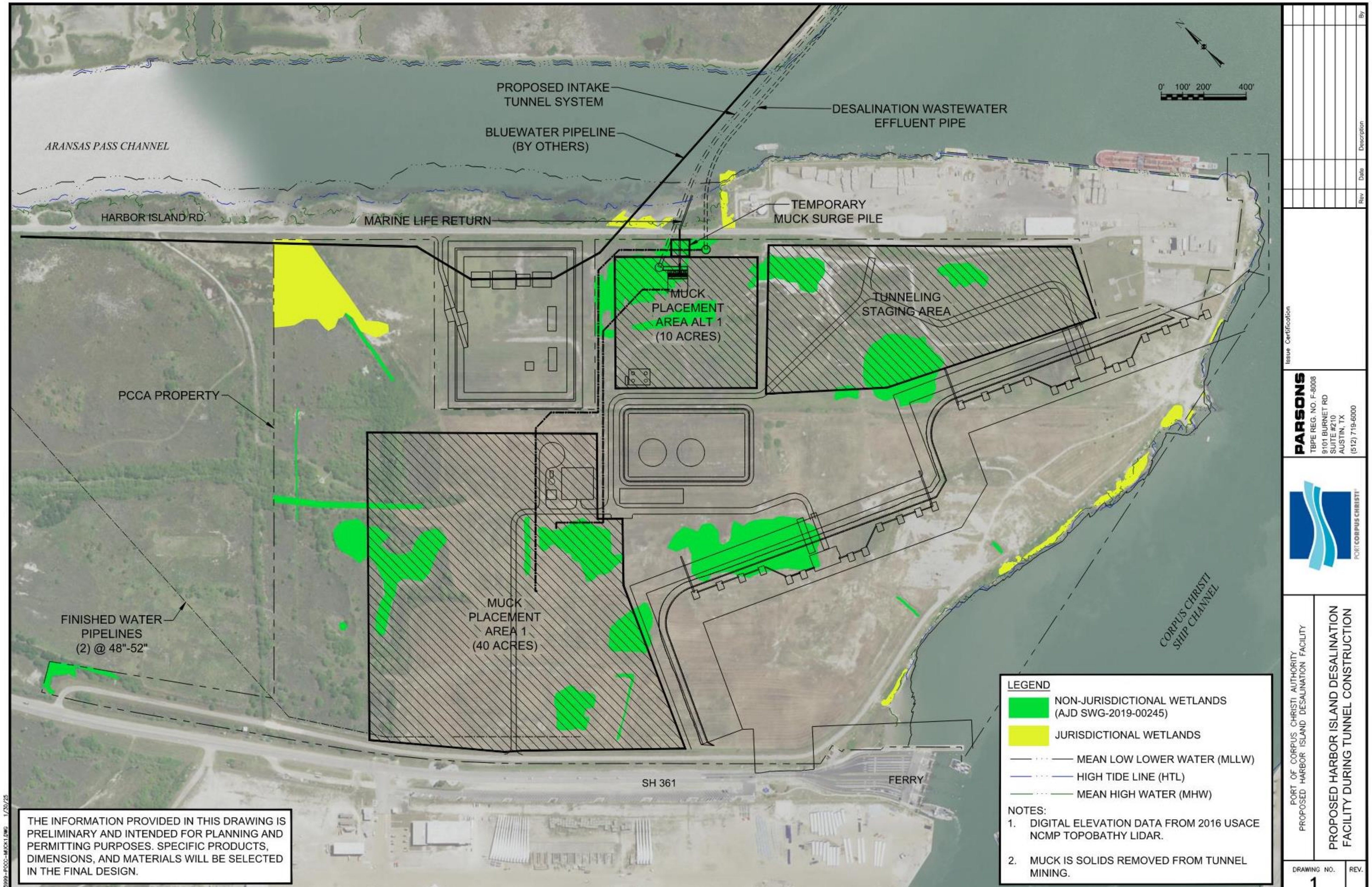


Figure 9. Proposed Muck Fill and Staging Area during Tunnel Construction

Figure 10. Example of a Large-diameter TBM Being Lowered into a Main Work Shaft

MUCK HANDLING AND DISPOSAL

Excavated material (i.e., muck) produced from tunneling excavation must be removed from the tunnel, temporarily stored outside the main work shaft, dewatered, and potentially placed on site as fill material.

The main work shaft site will accommodate a temporary muck pile (surge pile) and allow for seamless removal of muck to upland areas needing fill. Tunnel muck will be removed from the tunnel using a rail muck wagon that is raised and lowered using a crane through the shaft.

It is anticipated that the tunnel will be excavated at a rate of 60 to 120 feet per day, including a multi-shift, 24-hr workday. This equates to 350 to 700 cubic yards (CY) per day of material. At this rate, the 3.6-mile tunnel would be completed in approximately 220 days. The entire 3.6-mile tunnel is expected to produce approximately 116,000 CY of muck. The 3.1-mile seawater intake tunnel is expected to produce approximately another 85,000 CY of muck.

The main work shaft site will accommodate a muck surge pile that results from at least two days of mining. This would allow for an entire weekend of tunneling without requiring fill material management over the weekend. Given a maximum day of mining of 700 CY, and applying a bulking factor of 1.4, a maximum loose volume of 980 CY per day is expected. The muck surge pile will be surrounded on three sides and divided into two cells using mafia blocks (concrete barrier blocks 2-ft high by 2-ft wide by 6-ft long), stacked three high to form walls 6-ft high. The base of the muck cells could be either compacted road base and gravel or a concrete pad. Each cell will accommodate 980 CY, and be approximately 51-ft x 51-ft with 6-ft high walls. The muck piles would extend above the tops of the walls at a slope of 2:1 horizontal: vertical. A full cell would have a pile extending approximately 12.5-ft above the top of the walls.

The muck residence time in each cell will allow the muck conditioning additives (if any) to break down. Under normal conditions, large amounts of free water are not expected to drain from the surge pile, and normal construction erosion/sediment best management practices should be adequate to protect surface waters.

After the conditioning additives have broken down, the muck would be spread in the fill areas. It would be wet, but without free water. It would be spread in an 8” loose lift, and fill placement areas would be rotated to allow 7 days of drying before compacting it, at which point it would be ready for placement of the next layer.

Figure 9 illustrates the locations of the potential permanent muck placement areas for elevation augmentation. Muck placement area 1 is the primary fill area, covering approximately 40 acres and including the anticipated location of the proposed desalination facility; it. Fill from the discharge tunnel mining would raise the land surface of this placement area by approximately 2 feet. Fill from the intake tunnel mining could raise the land surface of this placement area by another 1.5 feet. Alternate muck placement area 1 may be utilized for muck with properties that are not as desirable as substrates for structures, such as fat clays, or during particularly rainy periods when muck drying rates lag behind production rates.

All site entry and exit will follow all required state, local, and federal rules for surface water protection and avoidance of construction nuisances.

POWER REQUIREMENTS

For a tunnel diameter up to 25 feet, the power required to run the TBM may be around 6 to 10 megawatts. Additional power is required for other project activities, such as: muck conveyor system and boosters, shaft and tunnel ventilation systems, lighting, and other ancillary equipment. For a large tunnel project such as this proposed brine discharge tunnel, a power substation may be required.

SITE RESTORATION

After completion of tunneling construction activities at the site, the main work shaft will be converted into the exit well for the brine discharge pump station, as shown in Figure 11. Much of the remainder of the Harbor Island property will be used for the construction of the proposed desalination facility and a proposed future shipping terminal.

GEOTECHNICAL INSTRUMENTATION AND CONTROL OF GROUND MOVEMENTS

Prior to actual construction, an extensive pre-construction survey is conducted of the area within the potential influence of the tunnel alignment and surface works. This is done over the entire alignment with a typical width of hundreds of feet. The condition of all structures and facilities, including surface features like roadways, and buried utilities are examined and documented. Given the location and alignment of this project, the instrumentation and control will be minimal. The tunnel will pass beneath an on-site road and possibly some utilities near the main work shaft before crossing beneath channels and the GOM. Instrumentation may be required if there are any crossings beneath petroleum pipelines.

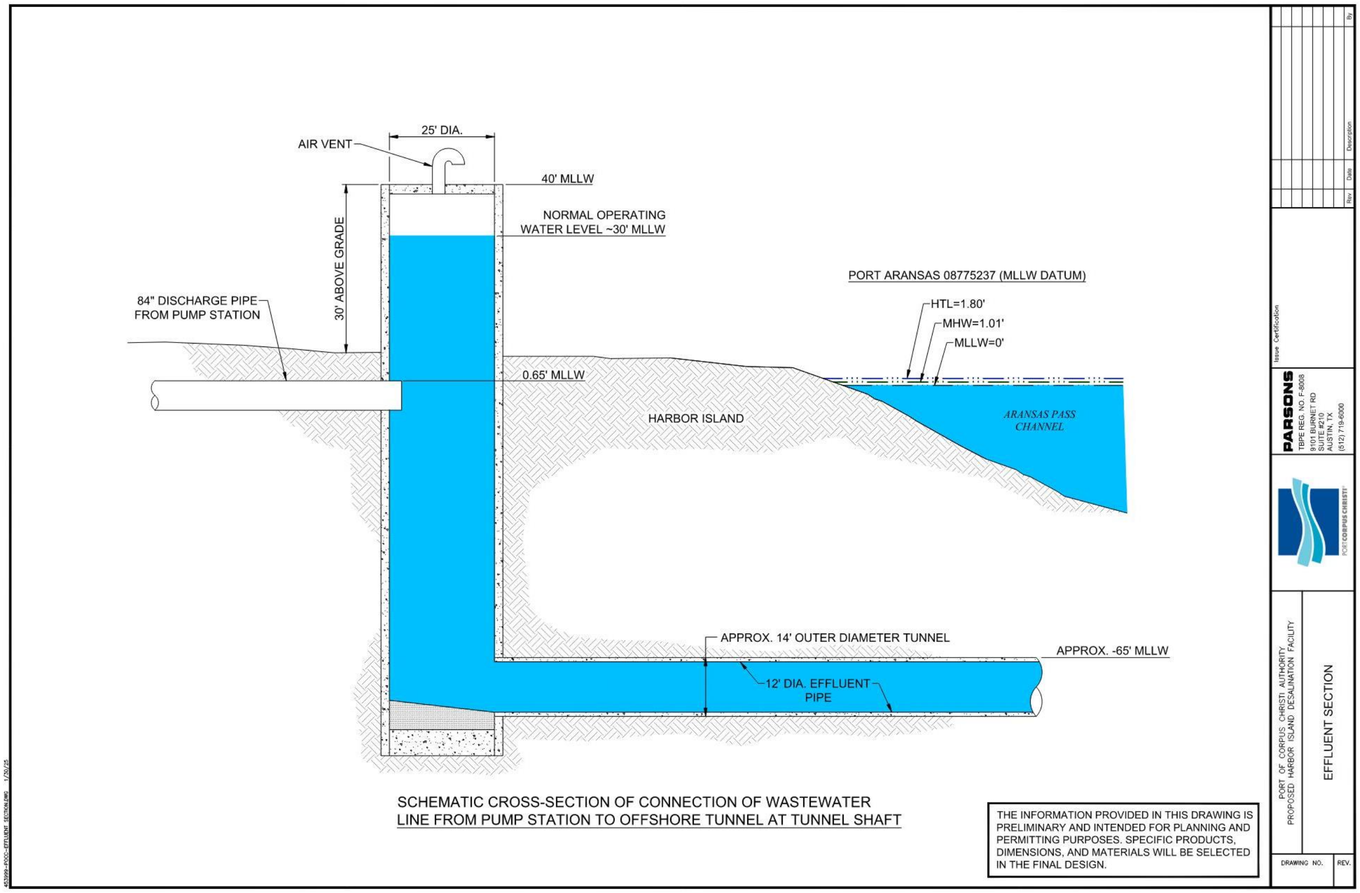


Figure 11. Schematic Cross-Section of Wastewater Pipe from Pump Station to Offshore Tunnel at Tunnel Shaft

Onsite Trenched Discharge Wastewater Pipe

DISCHARGE WASTEWATER PIPE GENERAL LAYOUT

The trenched section of the effluent discharge pipe acts as the connection between the discharge pump station with the discharge wastewater outfall shaft and tunnel which transports the brine effluent offshore to the GOM. The proposed layout of the trenched section of the discharge pipe is depicted in figure 12.

At this stage service conflicts are anticipated to be very minimal in this area as it is largely greenfield, however any service conflicts will be found and considered as part of the design as the design progresses.

The discharge pipe leaving the pump station is proposed to be approximately 7-ft (84-inch) diameter steel pipe. The steel pipe will be installed in sections and the sections may be either sealed bell and spigot joints, welded joints, or flanged joints. The exact type of joint will be determined in later design stages.

DISCHARGE WASTEWATER PIPE INSTALLATION METHODOLOGY

The discharge pipe will be constructed after the discharge shaft and tunnel has been completed. This is because typical pipe construction starts at the obvert (downstream) and works their way to the invert (at the pump station). However, due to the time required for tunnel construction, the discharge pipe to the pump station could be completed simultaneously with the tunnel, after the main work shaft has been completed.

A trench is to be excavated for the discharge pipe and the pipe placed in it. Due to the pipe's large diameter, the trench should be at least 12 feet deep. Once excavated, the trench shall be backfilled with a minimum of 12 inches of compacted bedding material (cement stabilized sand or bank sand) upon which the pipe sections shall be laid in accordance with approved crane lift procedures. Design of final pipe depths will occur at a later date once geotechnical information is completed.

Once the pipe has been placed and joints established, the pipe trench will be backfilled to the haunch area with the specified backfill material, and compacted.

The above pipe cover requirements are to be a minimum of 4 feet above the pipe where the pipe is subject to no significant loads, however if the pipe is subject to traffic loads, or any other significant load, the cover required is at least 6 feet.

Harbor Island Effluent Pump Station

DISCHARGE PUMP STATION GENERAL LAYOUT

The discharge pump station location is identified in figure 12, adjacent to the start of the 84-in trenched discharge pipe. The discharge pump station consists of seven (7) pumps, six (6) of which are duty pumps and a one (1) is for standby backup purposes. A slot for an eighth pump has been included for future capacity expansion as necessary. Further information on the general layout of the pump station can be found in figure 13, and in the Basis of Design Report.

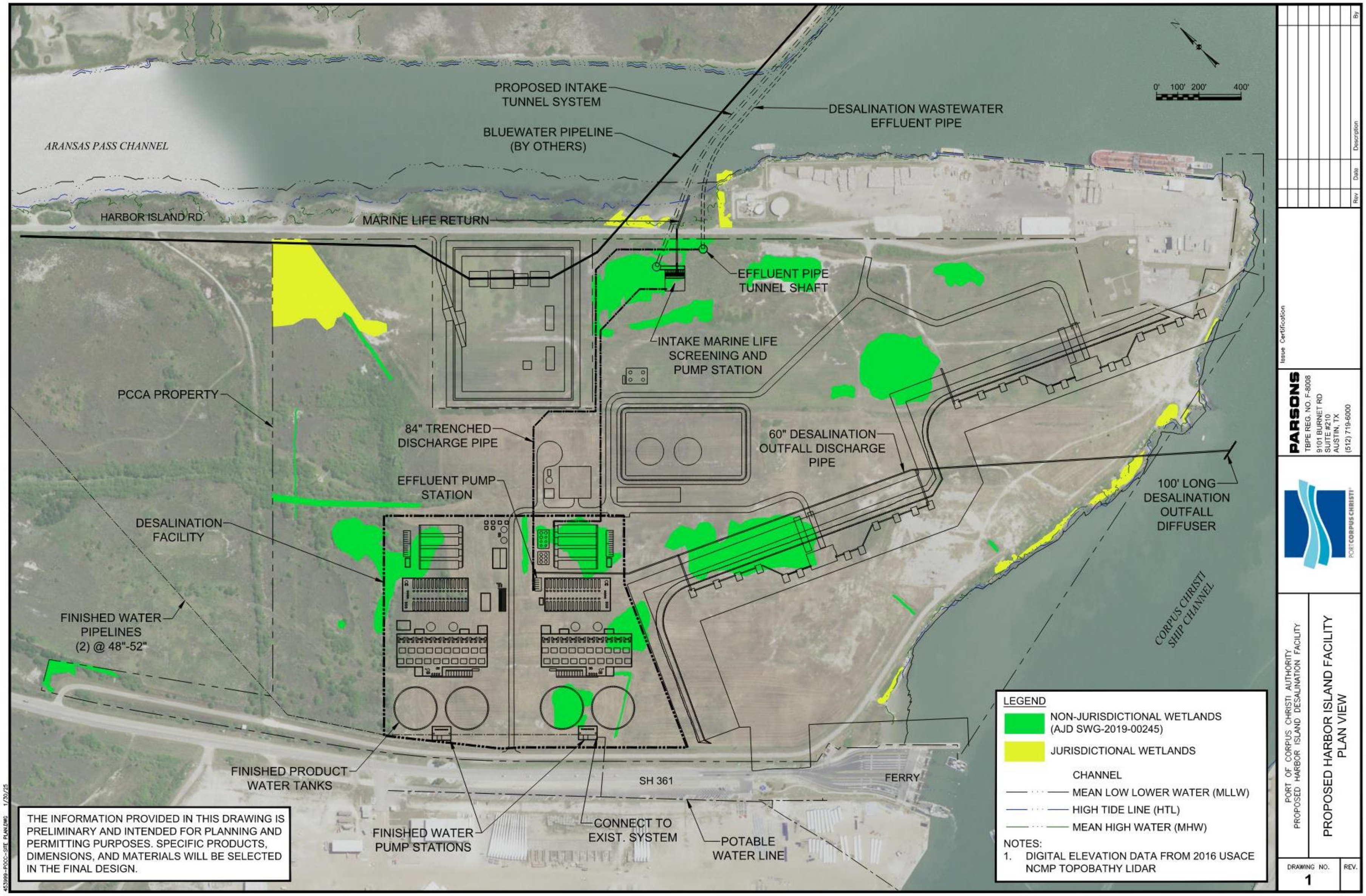


Figure 12. Proposed Facility Layout with Alignment of the Trenched Section of the Effluent Discharge Pipe on Harbor Island

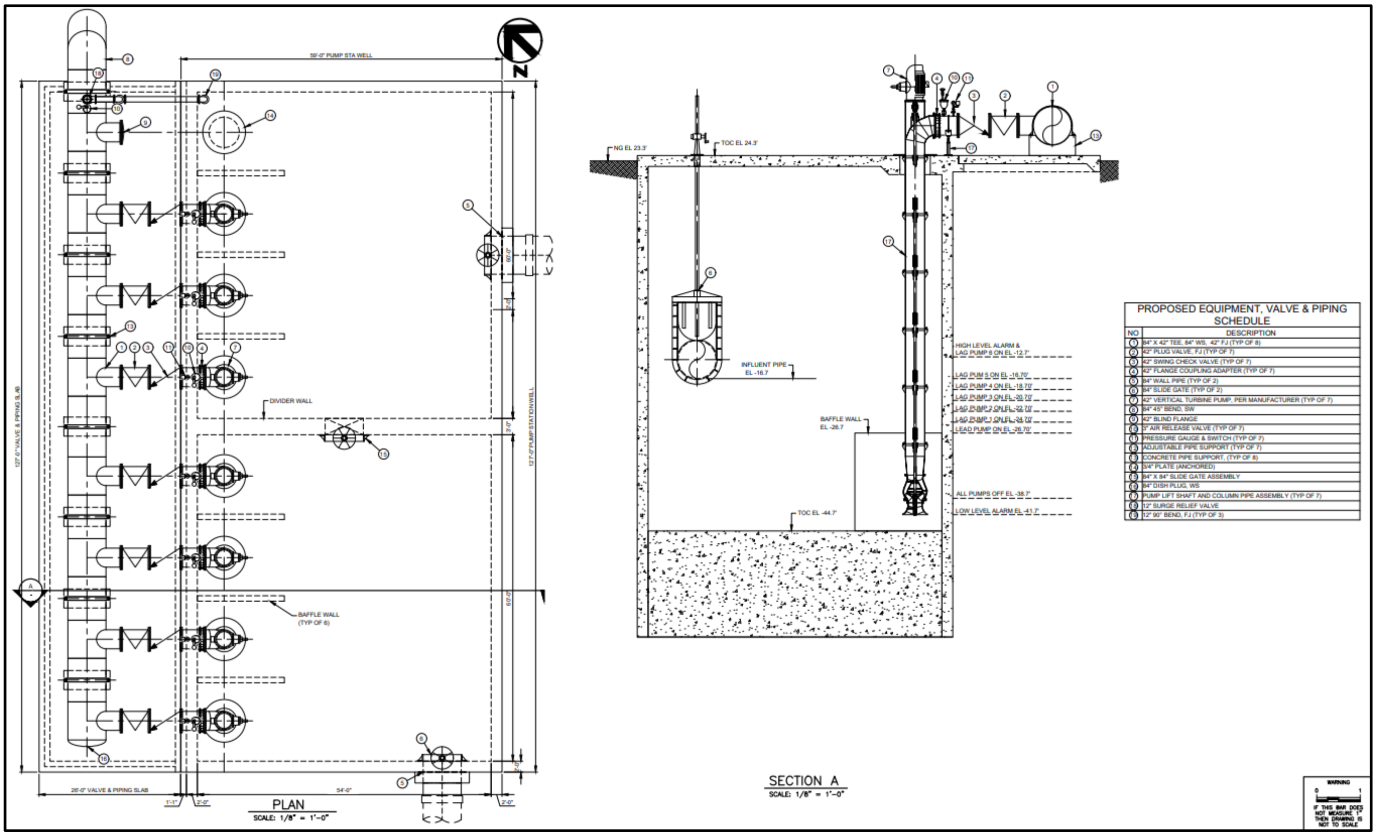


Figure 13. Discharge Pump Station General Layout

PUMP STATION MATERIALS AND CAPACITY

The pump station is proposed to have a capacity to pump approximately 191 million gallons per day (MGD) of effluent from the facility to the outfall diffuser in the GOM. To accommodate this, each pump will have swing-check valves and an isolation valve and each pump will have a capacity of pumping 45 MGD, with a motor speed of 720 rpm and have 496 HP of power. Lastly, as discussed in the basis of design report, the proposed wet well depth is 70 feet.

CONSTRUCTION SEQUENCE

The construction of the discharge pump station facility will commence with excavating the approximately 59-ft x 127-ft x 70-ft deep well for the pump station (as measured from the concept design level drawings). Since the excavation will be deep, proper care and safety measures, such as exclusion zoning and barricades, shall be used to prevent workers from falling into the excavation.

A potential construction methodology has been described below; however, other methods may be used depending on specific geotechnical information. The pit shall be excavated similar to the intake/discharge tunnel's vertical shafts and may be constructed with secant pile walls. The secant pile walls will require a shallow reinforced concrete guide wall (example figure 14) to be installed prior to constructing the preliminary piles. The size of the secant piles will be determined at later design stages, especially as more geotechnical information becomes available.

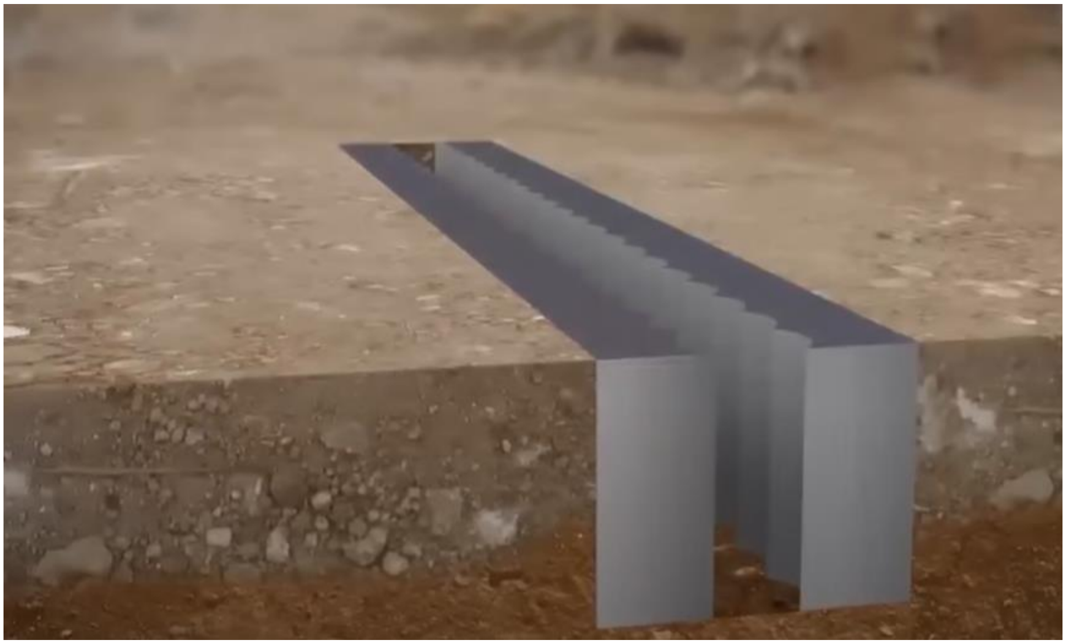


Figure 14. Secant Pile Guide Wall Example[2]

The exact methodology surrounding the installation of the preliminary (un-reinforced) piles will be subject to the geotechnical ground conditions. Generally, the preliminary piles will be constructed in an alternating fashion (figure 15). Then the preliminary piles between the alternate preliminary piles will be constructed (figure 16).

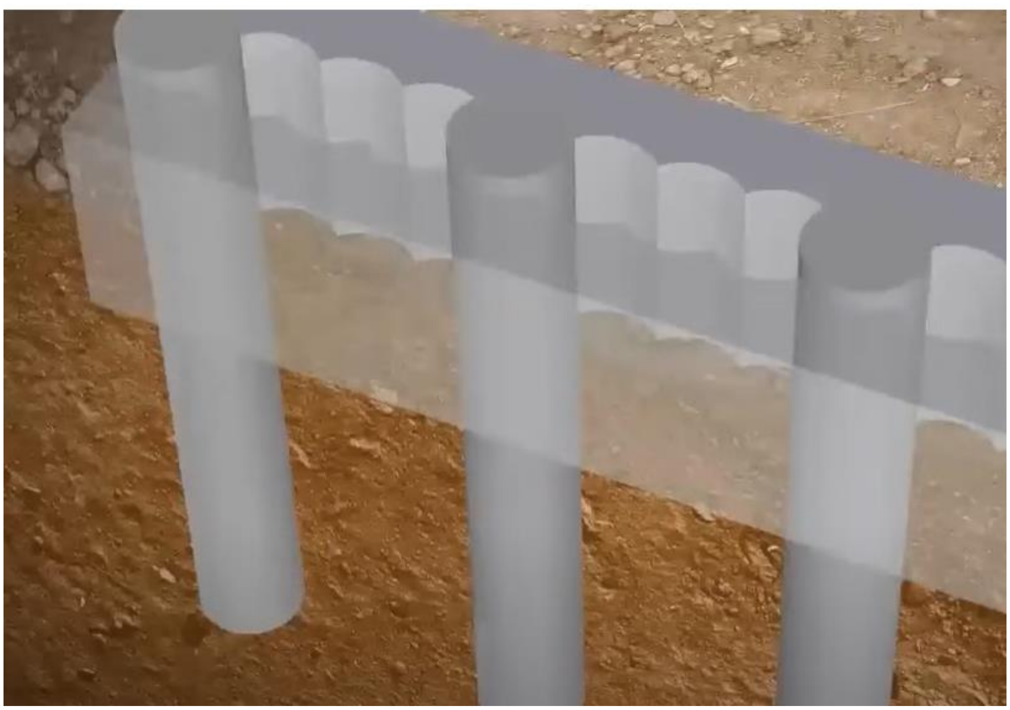


Figure 15. Preliminary Piles, Alternate Piles First Pass

[2] Figure from https://www.youtube.com/watch?v=UF9FLUioZv8&ab_channel=PilingContractors

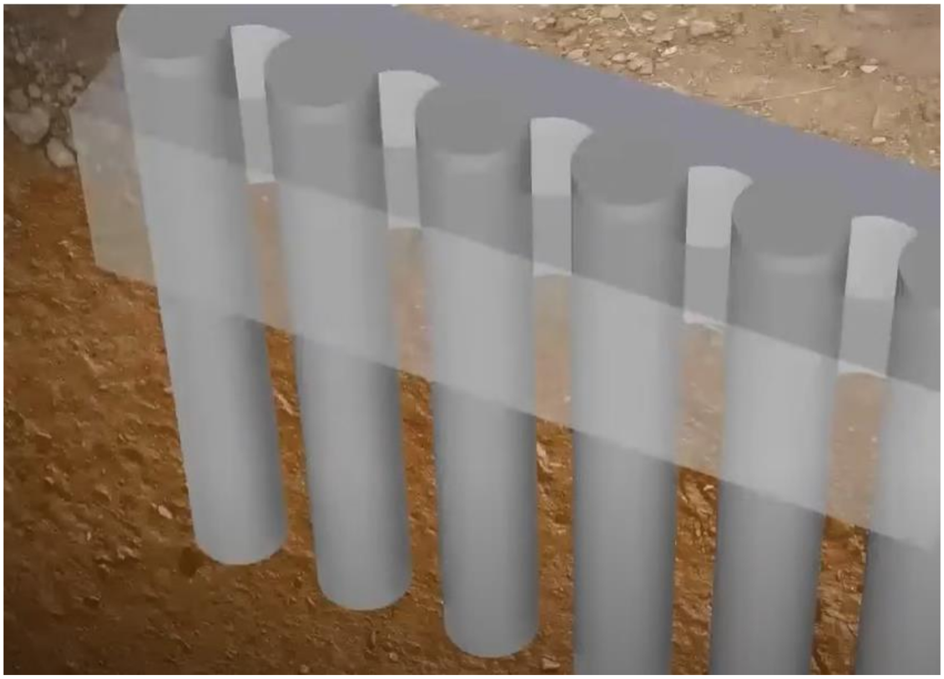


Figure 16. Preliminary Piles, Alternate Piles 2nd Pass

During withdrawal of the auger, the concrete will be poured to form the unreinforced preliminary piles (figure 17).

Figure 17. Casting Concrete Through Auger During Withdrawal[3]

[3] https://www.youtube.com/watch?v=APszwmbeGas&ab_channel=AarsleffGroundEngineeringLtd

Secondary piles will be then drilled between the preliminary piles in a similar 1st pass and 2nd pass fashion. The reinforcement cage will be placed and poured after the pile is drilled (figure 18).

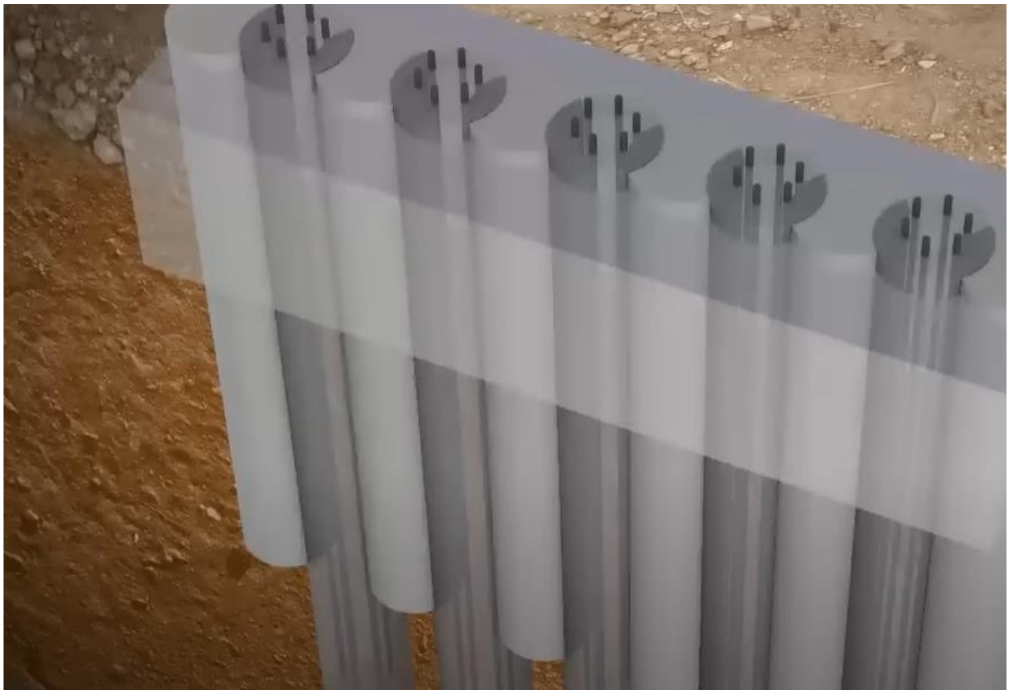


Figure 18. Secondary Piles

As the excavation progresses, temporary supports in the form of whalers, props, or anchors are often used (figure 19). Due to the nature of the area being in close proximity to the marine waters, it is expected that the water table may be shallow and thus the excavation may need to be dewatered appropriately during construction.

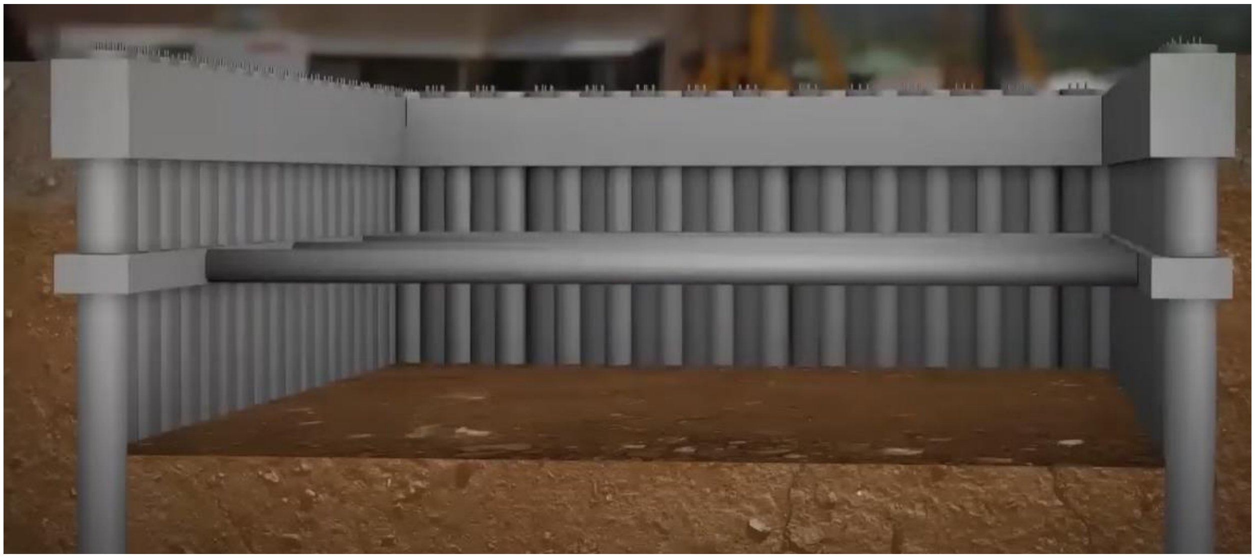


Figure 19. Temporary Props or Anchors During Excavation

The bottom of excavation will be covered in reinforced concrete. According to the concept design exhibit, the thickness of this reinforced concrete slab is to be approximately 10-ft thick to ensure adequate watertightness of the excavation for future works. The exact thickness of this slab may be changed as geotechnical data is available and as the design progresses.

If desired or specified in the engineering drawings, concrete may then be added to the secant pile wall to provide for a smooth interior surface.

After the excavation and secant pile wall is safe, the pump foundations, pumps, piping, and associated other equipment (i.e. valves) will be installed in the pit. An appropriate crane and lifting procedure must be followed on site during installation of these various parts, and support for any part not at the bottom of excavation will be needed.

APPENDIX I

Port of Corpus Christi Proposed Gulf of Mexico Finished Water Line for Desalination Construction Methodology

PORT CORPUS CHRISTI®

PORT OF CORPUS CHRISTI

PROPOSED GULF OF MEXICO FINISHED WATER LINE FOR DESALINATION PLANT

CONSTRUCTION METHODOLOGY

HARBOR ISLAND, CORPUS CHRISTI, TEXAS

Prepared **for:**

Port of Corpus Christi

400 Charles Zahn, Jr. Drive

Corpus Christi, TX 78401

Prepared by:

civitas

Civitas Engineering Group, Inc.

Texas Registered Engineering Firm F-4991

PARSONS

Parsons Environnent & Infrastructure Group Inc.

Texas Registered Engineering Firm F-7652

February 6, 2025

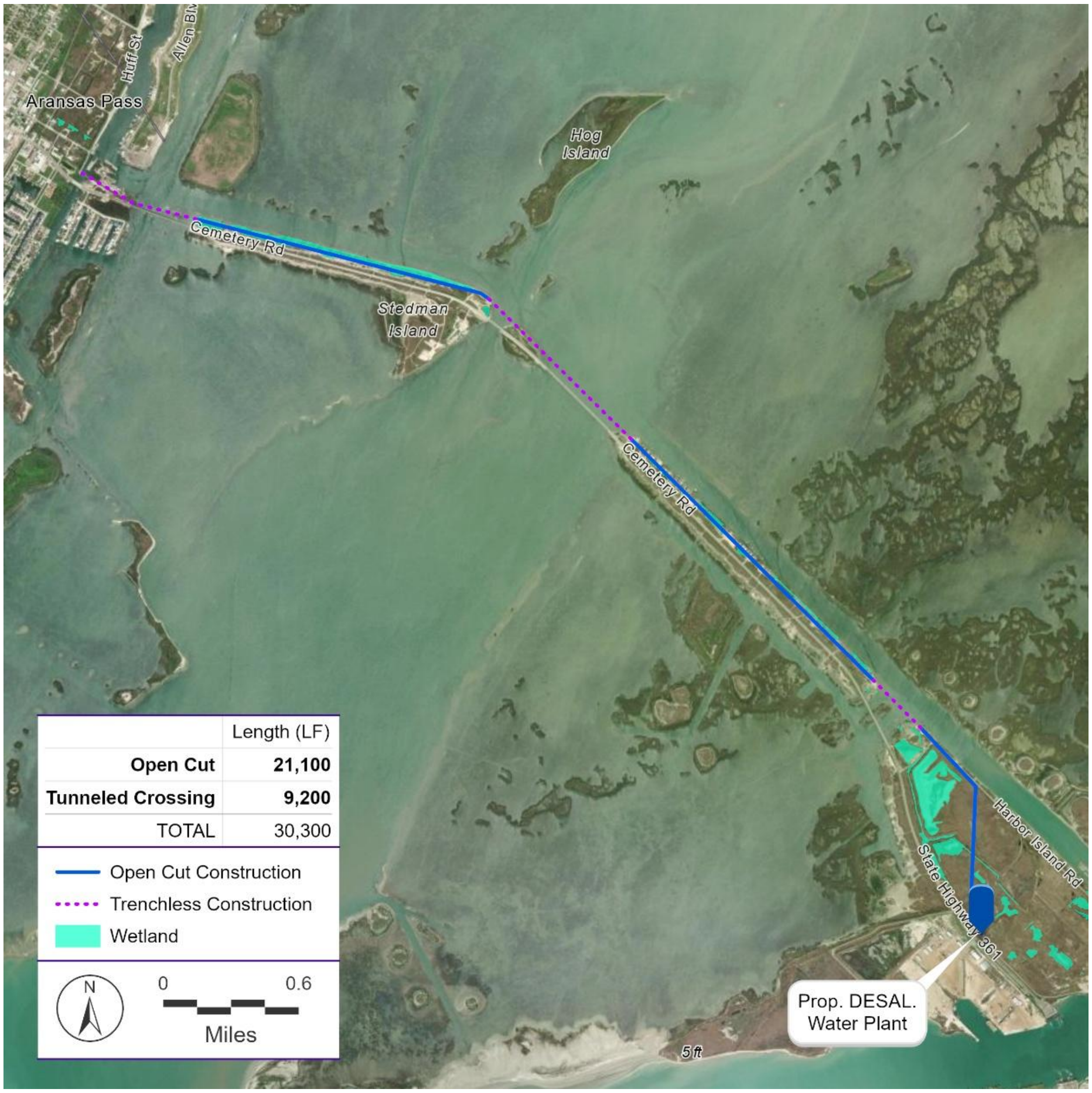
1 Introduction

The Port of Corpus Christi Authority of Nueces County, Texas (Port Authority) intends to construct a desalination facility (the "Facility) on Harbor Island to create optionality for the region in the face of the mounting need for a drought-proof water supply. Lake Corpus Christi, Choke Canyon Reservoir, Lake Texana and the Colorado River currently provide raw water to the region. The recent (2021-2024) drought with increased water demand has emphasized the continued need to find additional drought-proof water sources for the Coastal Bend region. The Port Authority has requested authorization to divert up to 350,000 acre-ft/year (maximum diversion rate of 217,000 gallons/minute (gpm)) of State Water from the Gulf of Mexico ('State Water') to the Facility to produce 100 million gallons per day (MGD) (112,000 acre-ft/year) of desalinated product water.

The purpose of this document is to provide the Construction Methodology for the Harbor Island 100 MGD finished water pipelines which will transport the water to the mainland in Aransas Pass, Texas. This report will provide the facility's treated water line in sufficient detail to support the various permit applications required. Numeric measurements and values referenced in this document rely upon preliminary design considerations which are subject to confirmation or revision during the final engineering-design phase. Specific design, location, and operation inputs were used for the purposes of assessing potential impacts to the environment and avoiding sensitive areas. Other technologies and/or products may be selected during the engineering-design phase due to geotechnical or related information which will meet or exceed the referenced performance criteria.

2 Finished Water Pipeline General Layout

The finished water pipeline transports the finished water from the desalination water treatment plant to Aransas Pass. In general, it will run alongside the Redfish Bay Causeway (TX-361) to the community of Aransas Pass. The scope of this construction methodology does not include distribution pipelines beyond Port owned property as additional upgrades or new construction would be completed by others. Therefore, only the pipeline to the mainland in Aransas Pass is included, as depicted in the figure below.



Figures 1: Finished Water Pipeline proposed Transmission Corridor

3 Finished Water Pipeline Materials and Dimensions

The finished water pipeline is proposed to include parallel pipes of 48 - 52" diameter constructed of steel, PCCP, or HDPE material. The material type will be selected after geotechnical information is collected and subsurface trenching methodology has been finalized. The pipeline is a total of approximately 30,300 LF, comprised of 21,100 LF of buried pipeline adjacent to Highway 361 and approximately 9,200 LF of which would be various water crossings along the route. Options considered for water crossing were trenchless technology, such as micro tunneling and/or horizonal directional drilling (HDD), jetting of the pipeline, or a pipe bridge. Due to the size and weight of the pipeline, for a 100 MGD facility, attaching the pipeline(s) to an existing state highway bridge structure was not deemed feasible. Therefore, if a pipeline bridge was to be utilized, it would require a new stand-alone structure for these crossings. Therefore, the pipeline bridge was ruled out due to the height required over the Gulf Intercoastal Waterway (GIWW) and potential placement of bridge structures in wetland or below mean high tide areas, which may result in potential negative environmental impacts. Jetting was also ruled out due to the COE depth requirements below the GIWW and potential negative environmental impacts. Thus, it was determined that subsurface crossings using trenchless techniques would be the least damaging from an environmental standpoint for the marine crossings.

4 Finished Water Pipeline Installation Methodology

4.1 Open Cut Excavation – Upland Environments

The portions of the 48 - 52" pipeline that are on land and not in a sensitive environment are proposed to be constructed in a similar fashion to the on-site discharge pipe. This will be by traditional trench technology with appropriate cover and bedding for a large diameter pipeline as required for the site-specific geotechnical conditions.

4.2 Trenchless Construction – Marine Environments

The U.S. Army Corps of Engineers' Galveston District requirements for clearance below navigable channels such as the intercoastal waterways and other shallow draft project channels is 15 ft below the dredged depth of the channel or a minimum of 25 ft below mean lower low water (MLLW), whichever is greater. (SWG-1998-02413 General Permit for HDD or DD under Navigable Waters of the US, effective June 1, 2020). Therefore, trenchless construction (tunneling, micro tunneling, horizontal directional drilling, etc.) will be required for the channel/marine crossings.

4.3 Micro tunneling

To span the water crossings, micro tunneling is proposed as one possible means. Micro tunneling is a specialized pipejacking method that can be used to construct a pipeline by sequentially jacking pipes horizontally from a jacking shaft to a reception shaft. It uses a remote-controlled, guided self-excavating tunnel boring machine (MTBM) (which means non-man entry, remote steering/controlled, and controlled face tunneling according to the American Public Works Association Greenbook). Controlled face tunneling means providing pressure equal and opposite to the earth and water pressures at the "tunnel heading" or "excavation face" to prevent uncontrolled inflow of soils and water. Micro tunneling has been successfully used to install pipelines with a diameter of 10 to 136 inches, with lengths between 200 ft to 1.5 miles. With a precise automated guidance, micro tunneling can be used in a wide variety of soil conditions while maintaining very close tolerances to line and grade. MTMB methods are used when line and grade are critical. Micro tunneling will be considered only for the marine crossing areas.

Figure 2: Microtunneling[1]

[1] https://www.linkedin.com/pulse/what-microtunneling-maged-ghoweba/

4.4 Horizontal Directional Drilling

Alternatively, Horizontal Directional Drilling (HDD) may also be used. HDD is a trenchless construction method whereby a pipeline is installed along an arcing drill path, beginning and ending at the ground surface, and passing under the conflicting feature in-between, without requiring deep shafts. A drill rig is set up on one side of the crossing and begins by drilling a pilot bore to the exit point. The alignment typically begins with a 5-to-20-degree tangent section that transitions to a vertical curve with a radius between 600 and 6,000 ft, depending on drill size, product pipe diameter, product pipe material, and required alignment. At the end of the bore, the alignment raises to the surface at a typical angle of 5 to 18 degrees. The pilot bore is then reamed in one or more passes to obtain the required diameter needed for pullback of the product pipe string and a diameter larger than the product pipe diameter. Once the reaming is complete, the drill pipe is connected to the product pipe outer diameter with a swivel and pulling head at the exit side of the alignment, and pulled into place in one continuous operation. HDD is usually a cheaper and faster method than micro tunneling.

Based on industry experience, the maximum HDD diameter is typically 60 inches with a maximum drive length of 3,500 feet. Given the length of HDD drive for a 48 - 52" pipe, HDD is considered only for the marine crossing portion of the pipeline. In some situations, a hybrid method of micro tunneling and HDD may be used.

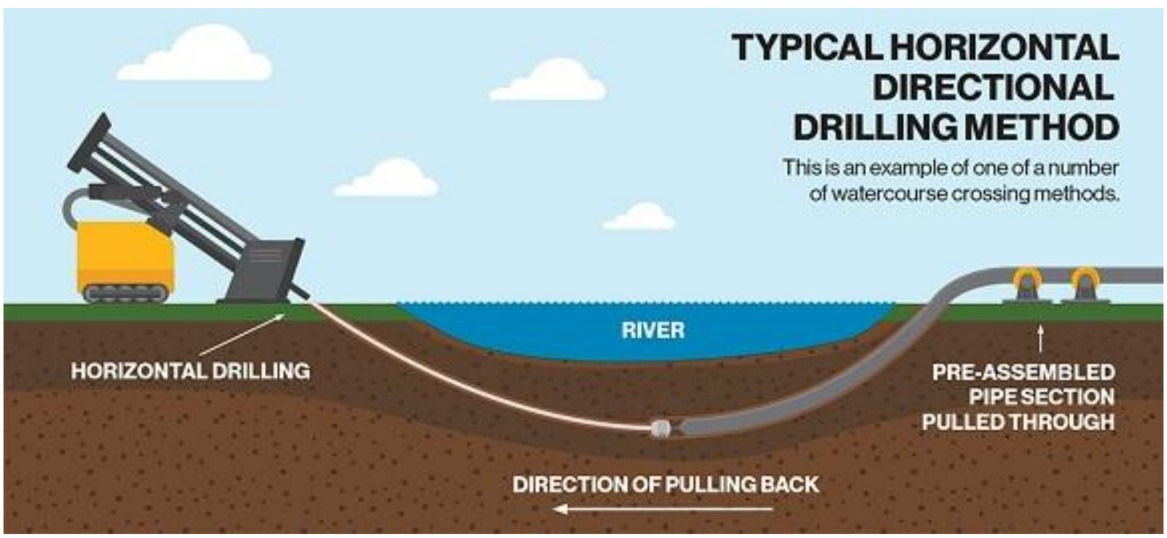


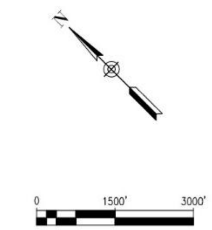
Figure 3: Horizontal Directional Drilling (HDD) Example[2]

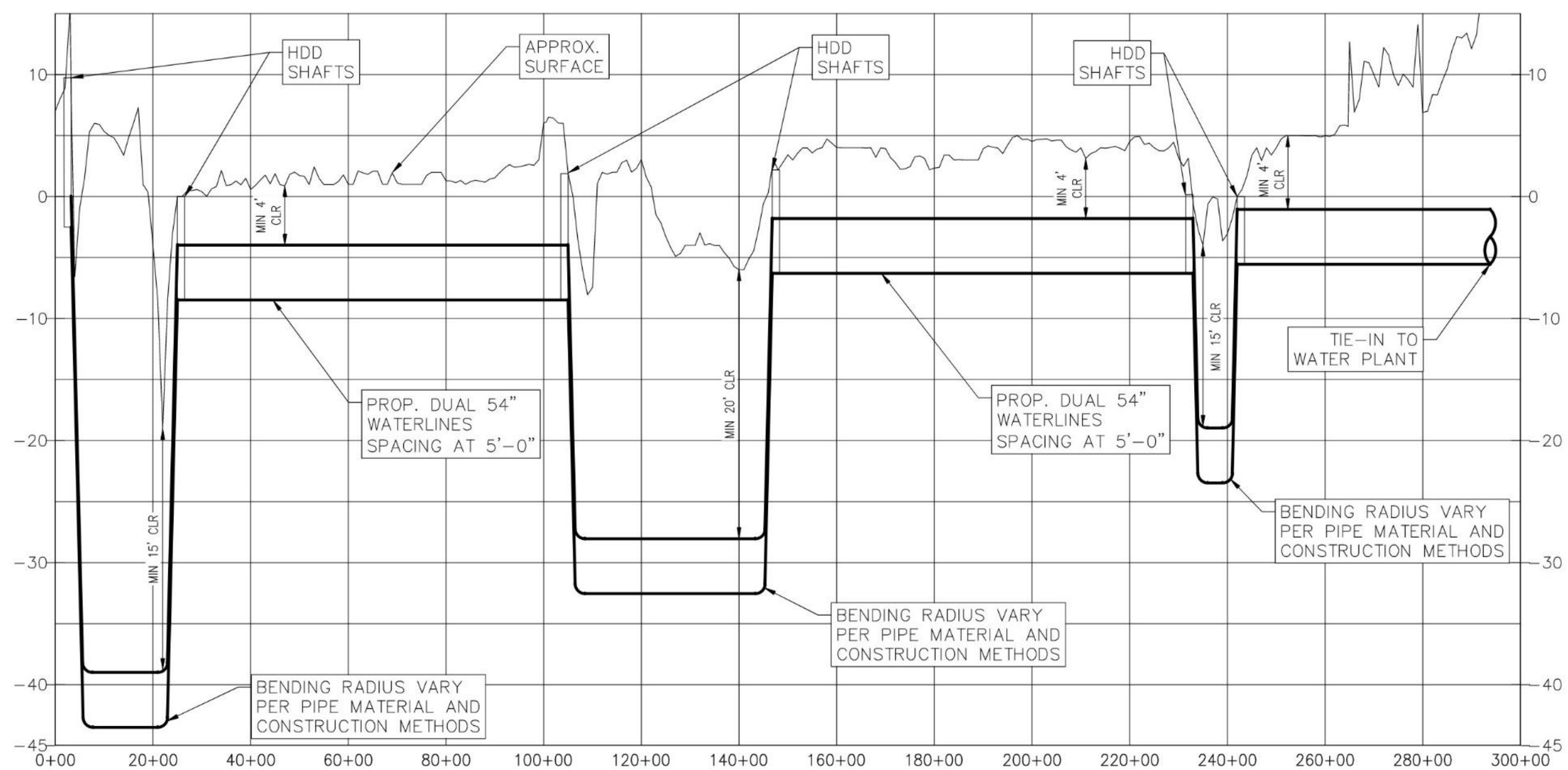
4.5 Preferred Construction Method

For the overall finished water pipeline, a combined method of using open cut excavation installation for the land segments and either micro tunnelling or HDD for the marine crossings is the preferred methods. This is because the combined methods avoid potential environmental impacts, do not require permanent structures within the mean high tide or wetland areas, and, would have less construction risk. The attached figures provide an aerial and profile view of the three marine crossings. Note that the x and y axis are not the same due to the length of the crossing.

[2] https://www.slurrytreatmentplant.com/news/company-news/88.html

PROJECT LOCATION





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TBPE Firm Registration No. F-4491

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ENGINEER: Yongki Shim, PhD, PE
DATE: JANUARY 2024

OVERALL LAYOUT

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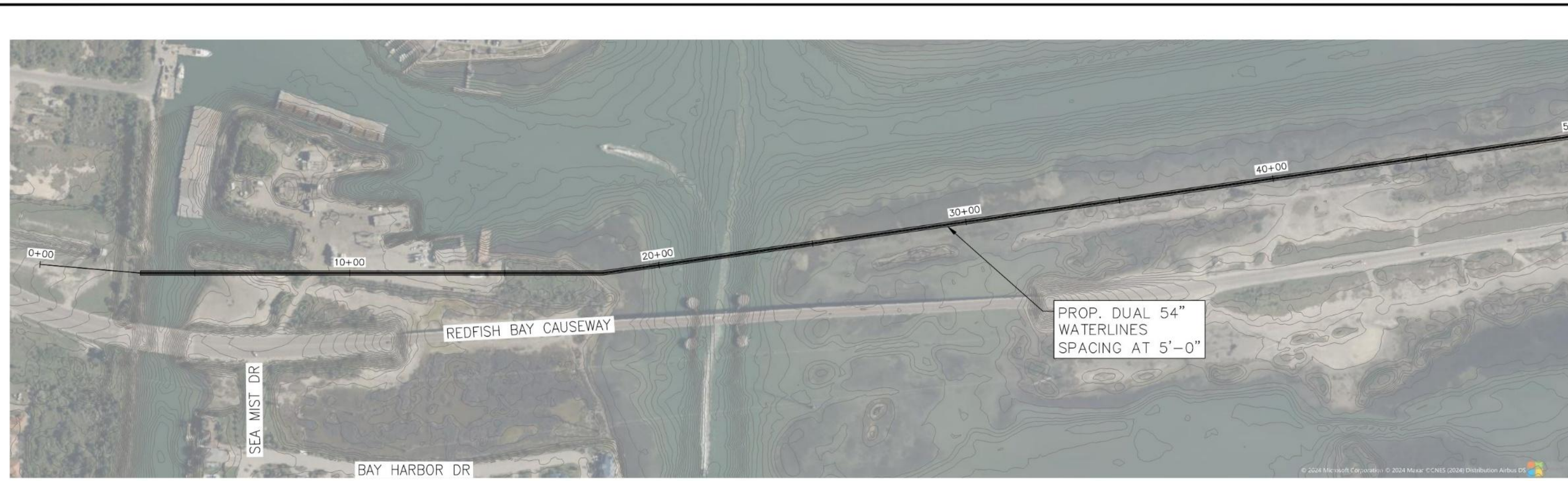

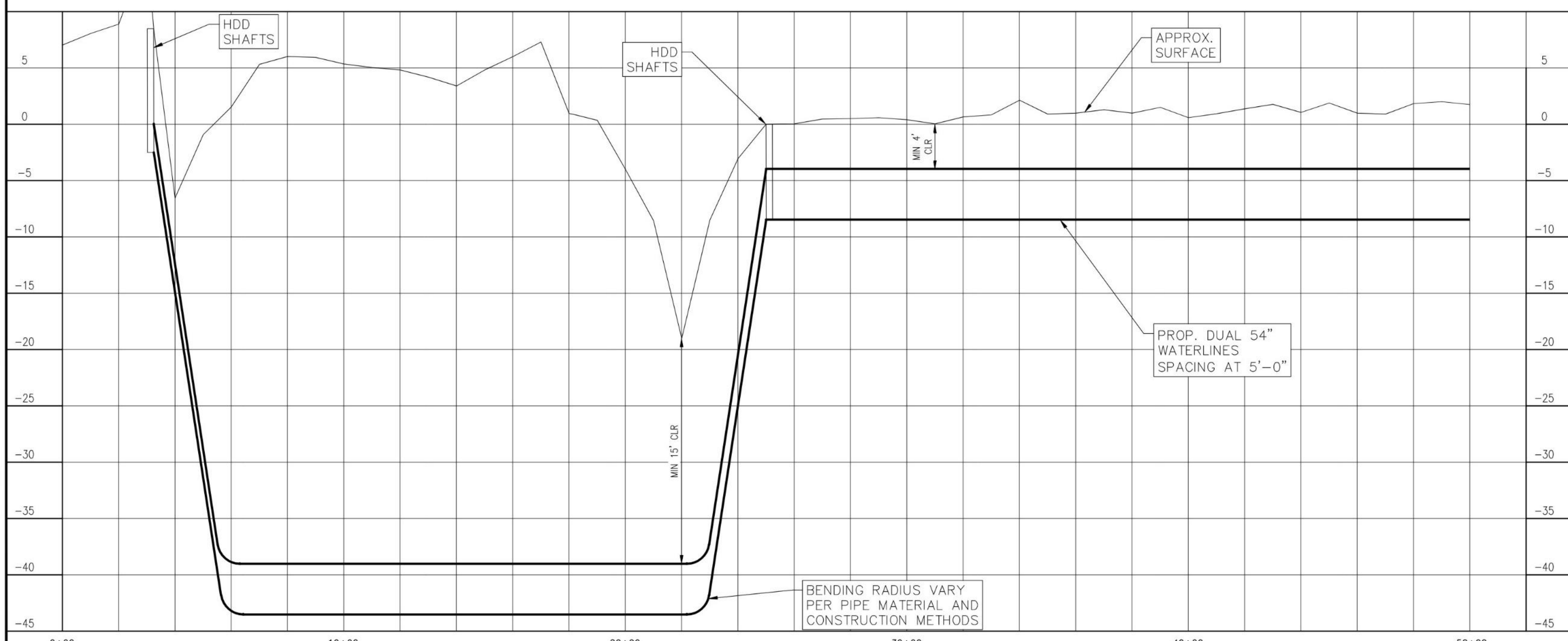

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ENGINEER: Yongki Shim, PhD, PE
DATE: JANUARY 2024

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SOUTH BAY
REDFISH BAY CAUSEWAY
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PROP. DUAL 54" WATERLINES SPACING AT 5'–0"
© 2024 Microsoft Corporation © 2024 Maxar ©CNES (2024) Distribution Airbus DS
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HDD SHAFTS
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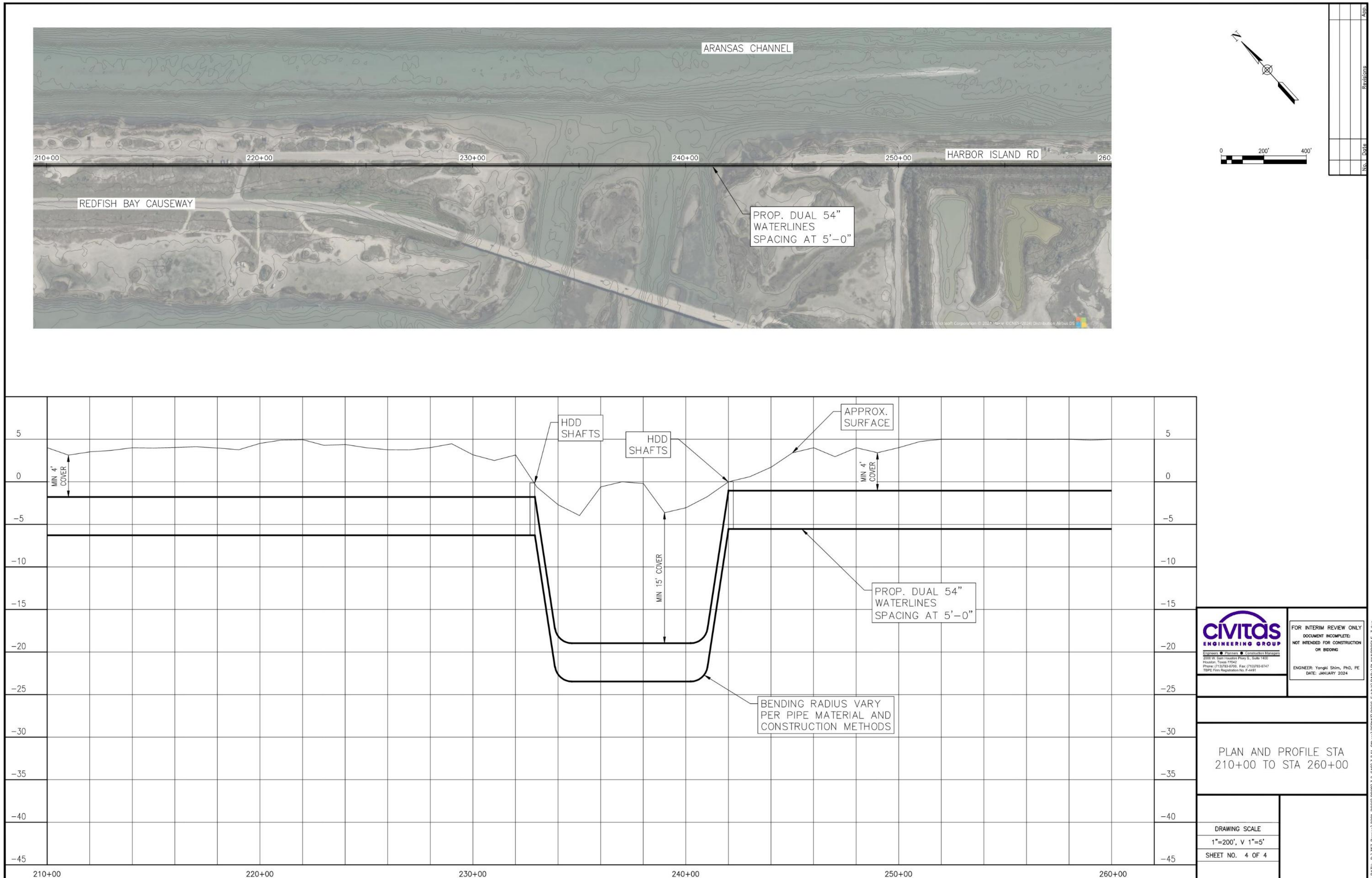

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HARBOR ISLAND RD
REDFISH BAY CAUSEWAY
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PROP. DUAL 54" WATERLINES SPACING AT 5'-0"
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PLOTTED DATE: 1/8/25

APPENDIX J

Alternatives Analysis

Geosyntec consultants

engineers | scientists | innovators

ALTERNATIVES ANALYSIS

Harbor Island Seawater Desalination Facility

Prepared for

The Port of Corpus Christi Authority

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Corpus Christi, Texas 78401

Prepared by

Geosyntec Consultants, Inc.

8627 N Mopac Expy, Ste 300

Austin, Texas 78759

Project TXE10785

February 2025

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1. EXECUTIVE SUMMARY

The Port of Corpus Christi Authority (PCCA or the Port) proposes to construct a 100-million-gallons-per-day (MGD) marine seawater desalination facility to produce a reliable, drought-proof water supply for the Coastal Bend Region (the Project). Currently, the region primarily relies on surface water sources for municipal and industrial use. Persistent drought conditions have caused—and are currently causing—severe strain on these surface water supplies, negatively impacting the region's residents, businesses, and industry. Projected residential and industrial growth in the Coastal Bend will further drive demands on water resources in the coming decades.

The Project aims to meet the Coastal Bend Region's need for a reliable, drought-proof water supply. To do so, the Project requires authorization for the discharge of dredged or fill material into waters of the United States (WOTUS) under Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act of 1899 (RHA). USACE cannot issue a Section 404 permit if a practicable alternative exists that would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. (40 CFR § 230.10(a)). Practicable means the alternative is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall project purpose. Similarly, reasonable alternatives for National Environmental Policy Act (NEPA) review consider project purpose as well as technology, economics, and common sense.

The Port developed this Alternatives Analysis to address these CWA requirements and the United States Army Corps of Engineers' (USACE) Section 404(b)(1) Guidelines. This analysis incorporates best available technologies and innovative construction methodologies to evaluate alternatives that avoid and minimize environmental impacts.

The alternatives in this document reflect the overall Project purpose: **to efficiently establish a reliable, drought-proof water supply for the Coastal Bend Region through scalable marine desalination**. Alternative 4, the Port's Preferred Alternative, meets that purpose and is the least environmentally damaging practicable alternative (the LEDPA), minimizing impacts to the aquatic ecosystem without other significant adverse environmental consequences. The Preferred Alternative proposes a seawater intake structure in the Gulf of Mexico (Gulf of America) (the "Gulf"), outfall structures and diffusers in the Gulf and adjacent to the Corpus Christi Ship Channel (CCSC), intake and outfall pipes, an upland desalination facility, and treated water pipelines. Notably, the Texas Commission on Environmental Quality (TCEQ) has already authorized discharge from the CCSC outfall in compliance with Texas Pollutant Discharge Elimination System (TPDES) water-quality requirements.

This document presents a comparative analysis of three alternatives in addition to the Preferred Alternative (together, the "Siting Alternatives"), as well as a No-Action Alternative. The Siting Alternatives contemplate differing configurations for intake and outfall locations, as well as differing construction options for the treated water pipelines. The location of the upland desalination facility—Harbor Island—remains constant throughout the Siting Alternatives because it meets all screening criteria for practicability when considering cost, existing technology, and logistics in light of the overall Project purpose.

The Project, as proposed in the Port's individual permit (IP) application, reflects the Preferred Alternative and constitutes the LEDPA. Issuance of an IP pursuant to the application and this Alternatives Analysis will authorize a Project that addresses the Coastal Bend Region's critical need for a reliable, drought-proof water supply.

2. PURPOSE AND NEED

The Project proposes a new water supply for the Coastal Bend Region, which struggles with persistent drought conditions that severely constrain existing surface-water supplies. As the region enters the year 2025, combined reservoir storage levels for the Choke Canyon Reservoir and Lake Corpus Christi—the predominate water supplies for the region—have dipped below 20%, triggering "critical water shortage" restrictions for residents, businesses, and industry. Recurring droughts are common, with significant drought periods occurring in the 1950s, 1960s, 1980s, 1990s, and 2010s, as well as the current decade. Concerningly, average annual inflows to the region's surface water supplies continue to trend lower with each successive drought. The need for a reliable, drought-proof water supply exists now—not years in the future.

These water needs are expected to increase. The Coastal Bend Region's water planning group (Region N) projects in its most recent water plan (2021 Region N Water Plan) that total water use for the region will increase by 47.2 percent between 2010 and 2070. Because this plan did not account for several large projects announced for the Coastal Bend Region in recent years (for example, a lithium refining plant in Robstown announced in 2023), the water shortages identified in the 2026 planning cycle are expected to increase.

Additionally, the 2021 Region N Water Plan notes that water sources for municipal and industrial users require "a very high degree of reliability." Existing supplies for the region "may not be fully reliable" during extended droughts. On the other hand, the 2021 Region N Water Plan remarks that the Port's proposed Project is "highly reliable."

The Project can efficiently establish this new water supply through existing state authorizations. The Project maximizes optionality, reliability, and environmental protectiveness through two distinct outfall locations. And finally, the Project is scalable to meet increasing water supply needs of the region and the state over the coming decades.

2.1 Project Purpose

Basic Purpose

USACE's 404(b)(1) Guidelines rely on a project's "basic purpose" to evaluate whether the project is "water dependent." A project is "water dependent" when it "require[s] access or proximity to siting within [a] special aquatic site [] to fulfill its basic purpose." (40 CFR§ 230.10(a)(3)). Basic purpose is the fundamental or essential purpose of the proposed project.

The Project's basic purpose is to provide a drought-proof water supply through marine desalination. The Project is "water dependent" because desalination necessitates access to seawater, and that access implicates proximity to special aquatic sites such as tidal wetlands and vegetated shallows.[1] Notably, the Project—through the Preferred Alternative—does not propose impacts to any special aquatic site despite proximity to those sites.

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[1] A project that is not "water dependent" must overcome the presumption that practicable alternatives are available that do *not* involve a special aquatic site. Because this Project is water dependent, this presumption does not apply.

Overall Purpose

USACE's 404(b)(1) Guidelines rely on a project's "overall purpose" to evaluate practicable alternatives and determine the LEDPA. An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics "in light of overall project purposes." (40 CFR § 230.10(a)(2)).

The Project's overall purpose is to efficiently establish a reliable, drought-proof water supply for the Coastal Bend Region through scalable marine desalination.

3. PROJECT DESCRIPTION

Desalination allows communities to use a broader variety of water sources than conventional treatment techniques, improving the resilience of water-stressed communities. Reverse osmosis is the most common membrane technology for desalination—more than two-thirds of desalination facilities nationwide are brackish water reverse osmosis facilities.

The primary components of the desalination process include:

- Intake pipe and structure
- The desalination facility
    - Preliminary screening
    - Pre-treatment and desalination plant
    - Brine holding tank
    - Pump station
- Outfall pipe(s) and diffuser(s)
- Treated water pipelines

4. SCREENING CRITERIA

USACE Guidance recommends initial screening to eliminate clearly impracticable and unreasonable alternatives. Larger projects may incorporate several levels of screening, with coarser screens applied at the outset and more refined screens as the range of alternatives narrows. Ultimately, only practicable alternatives may be considered as the LEDPA.

4.1 Screening Criteria for Location of the Desalination Facility

To meet the Project's overall purpose, the proposed Project requires construction of a desalination facility (the Desalination Facility), as well as a seawater intake structure, outfall structure(s), product treated water pipelines, and other appurtenances (Supporting Infrastructure).

Several aspects of the Project's overall purpose inform the screening criteria for the location of the Desalination Facility. Because the Project's purpose is to meet water needs in the Coastal Bend Region, the Desalination Facility must be sited such that it can practicably tie into existing water distribution lines that serve the Coastal Bend Region. Additionally, the Project seeks to *efficiently* meet the Coastal Bend Region's critical water needs, and alternatives that incorporate existing authorizations best serve this purpose. The Project's purpose is to establish a *reliable*, drought-proof water supply, and alternatives that incorporate two outfall locations (which allow for continued water production during times of maintenance) best serve this purpose. Multiple outfall locations also support the Project's overall purpose by allowing for *scalability*. Incorporating two outfalls also increases the projects overall resilience. The USACE looks at resilience as four key actions: prepare, absorb, recover, and adapt to successfully address future adversities.

PCCA designated the following screening criteria to locate the Desalination Facility in a manner that achieves the Project's overall purpose:

1. Property located in practicable proximity to an established water distribution system that serves the Coastal Bend Region;
2. Property located in practicable proximity to the Gulf and its accompanying bays to support seawater intake and outfall(s);
3. Property sufficiently large to accommodate the Desalination Facility and the Supporting Infrastructure;
4. Property owned or could be practicably and efficiently acquired by the Port;
5. Property with land-use compatibility and availability of existing infrastructure (such as road, pipelines, high voltage electricity, and other utilities); areas with an established/existing industrial presence are preferred, due to safety and security standards; adjacency to residences and third-party public-access buildings is not preferred;
6. Property with adequate space for temporary construction facilities, including construction offices and construction laydown area;
7. Property with limited or no WOTUS;

8. Strong preference for property with adequate space to accommodate expansions of Desalination Facility and Supporting Infrastructure in the future if market demand and economic conditions support such additions.

Considering these screening criteria, the Port was able to eliminate as impracticable locations with conflicting land-use compatibility—for example, Lighthouse Lakes and San Jose Island have extensive WOTUS that would impact cost and logistics; Mustang Island has minimal industrial presence and many residences; Aransas Pass, Ingleside, and Rockport have large residential presences and impracticable access to the Gulf. Additionally, these other locations cannot be reasonably obtained, utilized, expanded, or managed to fulfill the overall purpose of the Project.

Harbor Island is a practicable option to site the Desalination Facility, meeting all screening criteria listed above. Harbor Island is uniquely located along the Corpus Christi Ship Channel (CCSC) and with close proximity to the Gulf. The Harbor Island configuration in the Preferred Alternative (Figure 5) provided sufficient space and land-use compatibility and avoided WOTUS. In narrowing this Desalination Facility configuration, PCCA analyzed potential desalination design configurations, including location, size, layout, and anticipated operations of a facility, as well as access to suitable intake, discharge, and water supply infrastructure.

Accordingly, the Siting Alternatives discussed herein are centered around Harbor Island, near Port Aransas, Nueces County, Texas. The 100 MGD Desalination Facility is proposed to occupy approximately 31 acres of Harbor Island. The relevant portion of Harbor Island is bounded on the south and southeast by the Corpus Christi Ship Channel (Humble Basin); on the southwest by Highway 361 (Redfish Bay Causeway/Cemetery Road); and on the east, northeast and north by Harbor Island Road, and Aransas Pass Channel (Figure 5). No additional practicable alternatives met the screening criteria to in light of the Project's overall purpose.

4.1.1 Outfall and Intake Location Screening Criteria

To achieve the Project's overall purpose, the seawater intake system and brine discharge (outfall) system should be designed and constructed to ensure sufficient seawater in terms of quantity and quality for both intake and mixing. Seawater intake systems are a fundamental part of a desalination plant and, to meet the Project's overall purpose, necessitate designs that limit the intake of biomass and sediments. Outfall systems also require siting and design that adhere to the Project's overall purpose. The intake and outfall siting criteria focused on the following features:

1. Avoiding navigability concerns such as shipping fairways and anchorage areas;
2. Avoiding aboveground disturbances in connecting the intake and outfall structures to the Desalination Facility;
3. Placing the outfalls in large aquatic systems with natural flows to minizine impacts from brine discharge;
4. Placing the seawater intake structure in approximately 35 ft of water and 5 to 10 ft above the bed to limit interaction with marine life and vessels;
5. Avoiding densely populated areas;

6. Maintaining a sufficiently large intake pipe and intake structure design to minimize intake velocity and reduce the potential withdrawal of eggs and larvae from the marine environment while fulfilling volume requirements;

7. Avoiding culturally or environmentally sensitive areas; and

8. Following existing rights of way.

Considering these screening criteria, PCCA was able to eliminate many routes and siting locations for the intake and outfall system locations. For example, locations too close to the barrier island would involve potential impacts to culturally or environmentally sensitive areas (such as shoreline nursery and spawning habitats) that would undermine intake and outfall designs, and locations too far offshore or in designated navigation areas would undermine practicability through cost and potentially interfere with established anchorages. PCCA identified three practicable locations for the intake system and associated pipes and three practicable locations for the outfall system and associated pipes (see Figures 1–4).

4.1.2 Treated Water Pipelines Screening Criteria

Finally, the proposed Project requires construction of treated water pipelines to transport the treated water from the Desalination Facility. PCCA considered the following screening criteria for siting the pipelines:

1. Ability to connect to an existing water distribution system that serves the Coastal Bend Region;

2. Land-use compatibility; and

3. Existing rights of ways (*e.g.*, pipeline or utility).

Considering these screening criteria, PCCA identified only one practicable alternative to connect into an existing water distribution system with access to the Coastal Bend Region: a tie-in to existing San Patricio Municipal Water District (SPMWD) infrastructure in Aransas Pass, utilizing an existing right-of-way (ROW) owned by PCCA. This tie-in location (1) provides broader connection to the Coastal Bend Region; (2) can be accessed through compatible land (Highway 361 and the Redfish Bay Causeway connecting Harbor Island and Aransas Pass); and (3) involves existing PCCA rights of way that minimize cost and logistical issues.

Additionally, Harbor Island has existing tie-in infrastructure with Nueces County Water Control & Improvement District 4 (NCWCID #4) that leads to Port Aransas and Mustang Island. The existing NCWCID #4 connection can serve to deliver water to Port Aransas and Mustang Island (a portion of the Coastal Bend Region), but it cannot function as the *only* tie-in or treated water pipeline for the Project because (1) the existing infrastructure does not connect back to the greater Coastal Bend Region and instead functions as a terminus; and (2) even if such a connection to the greater Coastal Bend Region existed, the existing infrastructure cannot support the volume of treated water produced by the proposed Desalination Facility. Use of the existing NCWCID #4 infrastructure will not require additional construction or authorizations under the CWA or RHA.

Accordingly, constructing treated water pipelines to the Aransas Pass tie-in location, in addition to use of the existing NCWCID #4 infrastructure, provides the only practicable alternative that meets the screening criteria and the Project's overall purpose.

The connection to SPMWD's existing system is proposed to occur just under 7 miles northwest of the Desalination Facility. In general, the pipelines would run alongside the Redfish Bay Causeway (Highway 361) to the mainland in the community of Aransas Pass (Figure 1). Highway 361 (also labeled as Cemetery Road) provides a land bridge between the Desalination Facility and the mainland distribution system. PCCA has a somewhat parallel ROW that ranges from 40 to 50 ft wide generally north of and in the vicinity of Highway 361. The existing ROW provides a route to water distribution system that connects Harbor Island and Stedman Island and avoids crossing open bay areas and potential impacts to special aquatic resources.

The treated water will be transported by up to two parallel pipelines proposed to be 48 to 52 inches in diameter, constructed of steel, prestressed concrete cylinder pipe (PCCP) material, or high-density polyethylene (HDPE) material. The material type will be selected after geotechnical information is collected and subsurface trenching methodology has been finalized. The pipelines will total approximately 30,500 linear feet (LF) in length of which approximately 21,500 LF is planned to be trenched and buried within the PCCA property and uplands.

The treated water pipelines would likely be installed in an on-land trench, with two options for crossing tidal waters and wetlands. Therefore, the practicable alternatives considered for the treated water pipelines are related to construction techniques.

The two practicable construction alternatives, following the only practicable route, include:

- Horizontal directional drill (HDD) crossing of all the tidal areas and sensitive upland areas such as shrub/scrub wetlands; or
- Installing piers or pilings to bridge the tidal waters and sensitive upland areas.

Both of these construction methods are considered in Section 6 below in evaluating the environmental impacts of each Siting Alternative.

5. ALTERNATIVES CONSIDERED – PRACTICABILITY

After consideration of the above screening criteria, the alternatives for the proposed Project include (1) differing configurations of the intake and outfall system locations and (2) differing construction techniques for the treated water pipelines. This analysis evaluates four Siting Alternatives and a No-Action Alternative.

5.1 No-Action Alternative

Under the No-Action Alternative, the Port would not construct the Project. The minimal impacts associated with the Project would be avoided; however, selection of the No-Action Alternative would also mean that the purpose and need of the Project would not be fulfilled. The Coastal Bend Region's critical need for a reliable, drought-proof water supply would continue, and the benefits of the Project would not be realized. If the Project is not constructed, other proposed desalination projects may be considered, but the Project is the only such marine desalination facility proposed that incorporates offshore seawater intake and brine discharge, making it unique amongst other proposed desalination projects. The No-Action Alternative could therefore result in any environmental impact being transferred to another project site within the Coastal Bend, and none of those proposed sites currently contemplate offshore intake and discharge, as this Project does.

5.2 Framework for Evaluating Practicability

Under the USACE 404(b)(1) Guidelines and related guidance, PCCA considered the following criteria in evaluating identified alternatives for practicability:

Cost

Identification of differences among the alternatives that could result in substantial capital cost differences that would make the alternative unfeasible.

Existing Technology

Technologies for each alternative required consideration of the following criteria: proximity to seawater, water depth, natural flows of water, outside of shipping lanes and anchorages, utilities (water, electric, natural gas, sewage), and construction support facilities.

Logistics

Logistics for each alternative considered: proximity of access to construction materials, source materials, and labor; proximity to water distribution lines; raw and potable water sources; and utility and energy availability critical to facility operations. Additional logistical considerations include:

- Ability to maximize optionality, scalability, and reliability;
- Transportation/Infrastructure Availability

The alternatives will require reliable access to deep-water channels. Construction of the proposed pipes and pipelines requires access for construction materials and heavy equipment.

- Synergy and Integration

  Building near existing infrastructure channels is key to taking advantage of the potential synergies and access to existing docks.

- Physical Site Characteristics

  The physical site characteristics refer to the routes for the intake and outfall pipes, and the required temporary facilities needed to support construction. Characteristics include land availability and adequate laydown space to implement construction methods. They also include identification of adverse features that could potentially limit construction and use, including channels; soil conditions; presence of existing above-ground structures; any other restrictions affecting movement of people and equipment for construction.

- Constructability

  The relative constructability of the intake and outfall pipes, as well as the treated water pipelines, is a critical component of the analysis. Although the key criteria evaluated for constructability features overlap with other factors referenced above, the focus of this analysis is the ability to construct the pipes while minimizing the impact of construction activities on existing and adjacent land uses. Example criteria include: site accessibility, space, leases, and suitability of site conditions; accessibility of the site for large cranes and other heavy construction equipment; and effects of potential congestion in the region.

- Timing Constraints/Regulatory Uncertainties

  The analysis of each alternative considered the constraints posing a risk to the Project schedule (in light of the Project's overall purpose), such as regulatory uncertainties, ROW acquisition, and existing and necessary state authorizations (*e.g.*, water-right authorizations, water-quality authorizations).

5.3 Alternative 1: (50 MGD) Inshore Only – Aransas Pass Channel Intake and CCSC Outfall

This alternative includes an intake within the Aransas Pass channel and an outfall directly adjacent to the CCSC southeast of the proposed desalination facility (Figure 2). Importantly, this configuration allows for only half of the proposed Project size, and results in the ability to produce only 50 MGD of treated water, as opposed to 100 MGD.

The intake pipe would be 470 feet long and the structure would be placed immediately northeast of the facility adjacent to Aransas Channel. A discharge pipe would connect to a reverse osmosis, concentrate-effluent holding tank at the southeast corner of the desalination facility. From that connection, a buried/submerged 60-inch pipe will transport stored effluent water to a multiport high-rate diffuser (port exit minimum velocity ≥ 3 meters per second) approximately 230 feet offshore of Harbor Island. Diffuser port exit velocities ≥ 3 meters per second generate sufficient momentum and energy in the effluent discharge to assure rapid mixing of the effluent and receiving water. Based on the design, this outfall would accommodate only up to 50 MGD treated water produced from the Desalination Facility. Effluent will pass through the diffuser that is installed perpendicular to the outfall pipe and parallel to the shoreline before mixing with the water column of the CCSC.

This alternative was determined to be a practicable alternative because it is available and satisfies criteria related to cost, technology, and logistics in light of the overall Project Purpose. Notably, however, this alternative is not scalable for growing regional needs and does not allow for offshore seawater intake and discharge. The Port did not select Alternative 1 as its preferred alternative (see Table 1).

Cost

The Harbor Island site for the Desalination Facility has sufficient room and is adjacent to CCSC, where the only outfall for this alternative is proposed. Due to the close proximity to the proposed Desalination Facility for the intake and outfall structures, this option has a substantially lower cost than Alternatives 2, 3, and 4.

Existing Technology

The buried pipes for the intake and outfall systems would be installed via HDD or microtunnel boring machine. The location supports intake and outfall structure technology that is practicable in light of the overall Project purpose.

Logistics

The alternative would have access to existing major highways and ports for delivery of construction equipment and materials.

Physical Site Characteristics

In order to install the diffuser barrel for the outfall system, a bench must be excavated in the CCSC side slope (outside boundary of the channel). This bench will result in the removal of approximately 1,000 cubic yards (30,000 cubic feet) of sediment. The pipe will be submerged approximately 6 feet below the USACE-authorized channel depth of -54 feet mean lower-low water and run approximately 0.7 miles southeast from the effluent water tanks. The location of the outfall system for Alternative 1 is the dredged bottom between Harbor Island and the CCSC, away from seagrass beds, SAV, or other areas of environmental or cultural significance.

Constructability

The outfall construction equipment will include heavy work trucks, HDD rig and equipment, or a microtunnel boring machine. The diffuser will be comprised of a 48-inch-diameter barrel with 20 180-millimeter-diameter ports, each at a 1.5-meter spacing, resulting in total diffuser length of 30 meters.

Timing Constraints/Regulatory Uncertainties

The TCEQ authorized the discharge from the CCSC outfall on December 22, 2022 (TPDES Permit WQ0005253000, United States Environmental Protection Agency [USEPA] ID No. TX0138347). Using this existing permit adds to the Project's overall purpose by maximizing efficiency, expediting timelines, and providing regulatory certainty. The Coastal Bend Region's need for a reliable, drought-proof water supply is now—not years in the future—and this need is expected to only increase in coming years. Incorporating existing authorizations such as WQ0005253000 meets the Project's overall purpose of *efficiently* establishing a drought-proof water supply to meet the critical need of the region.

5.4 Alternative 2: (100MGD) Offshore Only – North Gulf Intake and Outfall

Alternative 2 comprises a full 100MGD of treated water capacity, with both intake and outfall systems located in the Gulf, north of the Aransas Pass Channel (Figure 3). Intake and outfall pipes would be installed through tunnel boring technology, described below.

The proposed Gulf intake and outfall pipes follow the Bluewater Texas Terminal pipeline. The intake and outfall pipes will run parallel to each other and the Bluewater Texas Terminal pipeline, extending roughly due east from Harbor Island for approximately 2.7 miles before the route bends slightly to the south, as shown in Figure 3. The proposed alignment runs beneath two maritime channels, a privately owned island, and the Gulf seabed. The intake and outfall pipes would be approximately 30 ft apart, providing more than two tunnel diameters of distance between the tunnels at their closest point, but would not require an excessively wide easement.

The intake pipe (a total of 3.1 miles long) would connect the intake structure to the Desalination Facility. The intake structure would be located 1.3 miles offshore of San Jose Island in the Gulf at a depth of -35 feet NAVD88.

The discharge pipe (a total of 3.6 miles long) would connect to the reverse osmosis, concentrate-effluent holding tank at the southeast corner of the desalination facility. From that connection, a buried/submerged 14-foot-outside-diameter and 12-foot-inside-diameter pipe would transport stored effluent water to a multiport high-rate diffuser (port exit minimum velocity $\geq$ 3 meters/second) approximately 1.8 miles offshore of San Jose Island, 0.5 miles further offshore than the intake structure.

This alternative was determined to be a practicable alternative because it is available to the applicant and satisfies the criteria related to cost, existing technology, and logistics in light of the overall Project Purpose. Notably, however, this alternative (1) is scalable only to 100MGD with one outfall; (2) only one outfall does not allow for enhanced reliability during times of maintenance, as two outfalls would; and (3) the Gulf outfall is not yet permitted, which undermines Project efficiency through regulatory uncertainty in the absence of no other permitted outfall. The Port did not select Alternative 2 as its preferred alternative (see Table 1).

Cost

Siting the outfall in the Gulf will be a substantial cost; however, the optionality of a Gulf outfall for brine discharge will add to reliability and environmental protectiveness.

Existing Technology

The Gulf intake structure will have a manifold arrangement with approximately four to five branches to the velocity caps. All the branches will be evenly spread approximately 30 feet apart to obtain even flow distribution without interference from each other. The intake opening will be approximately 5 to 10 feet above the seabed to minimize the potential withdrawal of sediments or benthic organisms. The velocity cap opening will be designed to have an entrance velocity of ≤0.5 feet per second (ft/s) to reduce the intake of fish and other marine organisms into the intake. The velocity caps redirect the gravity-fed intake flow horizontally, which allows marine life to easily detect the low-flow entrance velocity and swim away. A three-inch mesh bar screen will be installed around the velocity caps to exclude larger marine organisms.

Diffuser port exit velocities ≥ 3 meters per second generate sufficient momentum and energy in the effluent discharge to assure rapid mixing of the effluent and receiving water. The conceptual design is a 50-port diffuser with 160-millimeter (6.3-inch) diameter ports. The ports will discharge at a minimum centerline depth of -7.5 meters (24.6 feet) at mean lower-low water. The total water depth at the center of the diffuser barrel will be approximately 37 feet (~11.3 meters) NAVD88.

The diffuser will have 25 risers with 2 ports per riser oriented at 180° to each other. The ports on each riser will point in the prevailing direction of the ambient current: north-northeast and south-southwest (Texas Automated Buoy System [TABS] Buoy D [1995–2022] at 2-meter depth). The risers will be spaced at 6.25-meter intervals on the diffuser barrel, which results in a diffuser length of 150 meters (first riser to last riser). The diffuser barrel will have a removable plug (or equivalent opening) at its far end to allow it to be pigged to remove settled solids if necessary. The diffuser ports will discharge at a vertical angle of 60° to the water surface (i.e., angled toward the surface).

At the proposed discharge location and with the 50-port design, the Gulf salinity at a horizontal distance of 100 meters from the diffuser will be < 2 parts per thousand (ppt) above the ambient salinity at any given time.

Logistics

The location selected is outside of areas designated for navigation and anchorage. The alternative would have access to existing major highways and ports for delivery of construction equipment and materials.

Physical Site Characteristics

The center of the diffuser will be approximately 9,800 ft (2,987 meters [m]) from shore at its nearest point, and approximately one-half mile (810 m) from the intake structure to avoid entrainment of the diluted brine plume.

The data available indicate soils at the elevation of the proposed tunnel include medium dense to very dense silty sands, and soft to very stiff lean and fat clays. Available boring logs and a generalized understanding of the geology in the Corpus Christi area suggest that only sands and clays are present at the elevations at which the tunnel will be constructed.

These conditions are characterized as "soft ground", that is, in laymen's terms, soils and not rock. All tunneling will occur at elevations well below sea level. The top of the tunnel is proposed to be at an elevation of approximately -64 feet NAVD88.

Constructability

Because it is anticipated that soft soils will be encountered for the entirety of the tunnel profile, the proposed method for tunnel construction is an earth pressure balance (EPB) tunnel boring machine (TBM). TBMs for soft ground have a cylindrical shield to support the soil strata being mined through, and a bi-rotational cutterhead equipped with cutting tools to remove the intact ground and draw the loosened material into the cutterhead. The excavated soils are captured and removed from a chamber behind the cutter wheel. Pressurization of the face of the excavation is required, given the expected permeable soils and hydrostatic pressure tunnel condition under the sea.

Earth pressure balance TBMs function by maintaining a pressurized environment in the space just behind the cutter head and excavation face called a "muck chamber." The face pressure is continuously monitored by operators in the TBM. The muck is a mixture of fragmented excavated spoils and soil conditioning additives (if any) to improve the material handling properties of the excavated material. Soil is removed from this pressurized environment through a helicoidal screw contained in a long steel cylinder. The helicoidal screw turns to slowly remove soil from behind the pressurized bulkhead while maintaining the appropriate face pressure. At the rear of the screw auger is a slide gate, where excavated soils are discharged onto a conveyor belt and then into muck cars near the end of the TBM shield. The muck cars/belt conveyor transport the soil to the primary work shaft, where it is hoisted to the surface by muck boxes or a vertical conveyor and into a temporary stockpile area/surge pile. The soils are de-watered in a designated facility and can later be used as upland fill material.

The TBM shield is a cylindrical steel shell that is pushed forward along the tunnel, while the ground is excavated inside the shield. The main shield and tail shield support the ground as the tunnel lining is installed and fully protects workers within the tunnel. The shields fully encapsulate the excavation, never exposing the ground or leaving any area unsupported. The shield is designed to withstand the pressure of the surrounding ground and hydrostatic pressure.

To support the excavated bore in the soft soils at depths below sea level, a precast concrete segmented liner is proposed. This lining type has become the industry standard for large diameter soft ground TBM mined tunnels and is designed to meet project requirements for durability and watertightness. TBM is used along with pre-cast concrete segments that are bolted and gasketed to form a watertight lining. This watertight lining must be designed to withstand construction, ground, seismic and hydrostatic loads.

The smallest practical finished diameter for a tunnel of this length is approximately 12 ft. This size allows space for the ventilation ducts and muck handling system needed to avoid intermediate construction shafts. The main advantage of the TBM method is that surface disturbance would be limited to the two shaft locations: the vertical work shafts at the discharge point in the Gulf and at the desalination facility on Harbor Island.

The Harbor Island shaft could be constructed using secant piles. Secant piles provide a water-tight, rigid excavation support system.

The offshore shaft would be constructed from a platform stationed over the shaft location. A shaft will be constructed down to the level of the tunnel inside a caisson. The TBM bores horizontally to arrive at the shaft site. A riser is then constructed within the shaft, and the portion of the caisson above the seabed is removed.

Timing Constraints/Regulatory Uncertainties

The proposed intake and outfall route follows the Bluewater Texas Terminal pipeline. Evaluation of this proposed pipeline route provided extensive details for this analysis, which has expedited field studies and preparation for the Section 10/404 permit.

However, the TCEQ would still need to authorize the discharge from the Gulf outfall for Alternative 2, which imposes regulatory uncertainty and would delay the Project's ability to meet the Coastal Bend Region's existing water needs. While this north-of-Aransas-Channel outfall location provides slightly more regulatory certainty than Alternative 3's Gulf outfall (which is south of the Aransas Channel), the multi-year timeline involved with obtaining a TPDES permit—without the benefit using the existing permit for the CCSC outfall—would considerably delay the Project and undermine the Project's purpose of *efficiently* establishing a reliable, drought-proof water supply.

5.5 Alternative 3. (100MGD) Offshore Only – South Gulf Intake and Outfall

Alternative 3 comprises a full 100MGD of treated production capacity, with both intake and outfall systems located in the Gulf, south of the Aransas Pass Channel (Figure 4). However, as described in further detail below, the cost and logistics associated with tunnel boring beneath north Mustang Island and Port Aransas are such that this alternative is deemed impracticable based on cost and logistics.

The proposed intake and outfall pipes would traverse under the CCSC, multiple privately owned lots in Port Aransas, and the Gulf seabed, extending roughly due southeast from Harbor Island (Figure 4). The intake and outfall pipes would run parallel, approximately 30 ft feet apart. The 30 ft distance would provide more than two tunnel diameters of distance between the pipes at their closest point, but not require an excessively wide easement.

The intake pipe (a total of 2.7 miles long) would connect the intake structure to the Desalination Facility. The intake structure would be located 1 mile offshore of Port Aransas in the Gulf at a depth of -35 feet NAVD88.

The discharge pipe (a total of 3.6 miles long) would connect to the reverse osmosis, concentrate-effluent holding tank at the southeast corner of the desalination facility. From that connection, a buried/submerged 14-foot-outside-diameter and 12-foot-inside-diameter pipe would transport stored effluent water to a multiport high-rate diffuser (port exit minimum velocity $\geq$ 3 meters/second) located approximately 1.9 miles offshore of Port Aransas. The outfall structure would be placed 0.9 miles further offshore than the intake structure.

This alternative was determined to *not* be a practicable alternative based on cost and logistics in light of the overall Project Purpose (see Table 1).

Cost

Siting the outfall in the Gulf will be a substantial cost; however, the optionality of a Gulf outfall for brine discharge will add to reliability and environmental protectiveness. However, this alternative becomes prohibitively costly when considering the additional costs for the construction of the pipes 50 feet below the CCSC and the leases required to install the pipes under private lots.

Existing Technology

The technology would be the same as described in Alternative 2.

Logistics

The alternative would have access to existing major highways and ports for delivery of construction equipment and materials.

Physical Site Characteristics

The locations selected for the intake and outfall systems are outside of areas designated for navigation and anchorage. The center of the diffuser will be approximately 9,800 ft from shore at its nearest point, and approximately one-half mile (810 m) from the Harbor Island Desalination Facility intake to avoid entrainment of the diluted brine plume.

A generalized understanding of the geology in the Corpus Christi area supports a conclusion that only sands and clays are present at the elevations at which the tunnel will be constructed.

These conditions are characterized as "soft ground," that is, in laymen's terms, soils and not rock. Pipes placed beneath CCSC should be placed a minimum of 3 pipe diameters below the authorized project depth of the channel. All tunneling will occur at elevations well below sea level. The top of the tunnel would be at an elevation of approximately -100 feet NAVD88.

Constructability

This added depth needed to construct Alternative 3 would increase the volume of muck and increase the construction timing and required materials.

Timing Constraints/Regulatory Uncertainties

The proposed intake and outfall route would traverse under the CCSC and the City of Port Aransas. This would require a high number of easements or leases be obtained from many property owners in Port Aransas, which would increase the time needed to authorize the Project and undermine efficiency.

Additionally, the Gulf outfall south of the Aransas Pass channel would require TCEQ authorization of the discharge under the TPDES program, which requires an extensive technical review; opportunity for public comment and contested case hearing requests; if contested, an evidentiary hearing before an administrative law judge (ALJ); and, commission consideration of the ALJ's recommended decision on issuance of the discharge permit. This process adds considerable delay to the Project's ability to meet critical water-supply needs in the Coastal Bend Region. On the other hand, incorporation of the existing TPDES permit authorization for the CCSC outfall brings regulatory certainty that would allow Project development.

Moreover, the location of the Gulf outfall for Alternative 3 (south of Aransas Pass channel) would likely result in even further delay than Alternative 2 because the south location involves more challenging conditions to meet regulatory standards. Alternative 3 involves a large degree of regulatory uncertainty that could impact the overall Project purpose with respect to efficiency.

For the cost and logistical considerations noted above, Alternative 3 was determined to *not* be a practicable alternative in light of the overall Project purpose.

5.6 Alternative 4: (100 MGD) (Preferred Alternative) – Offshore Intake, Dual Offshore and Inshore Outfalls

Alternative 4, PCCA's Preferred Alternative, combines aspects of Alternative 1 and Alternative 2 for a 100MGD Project, with future scalability to 150MGD as necessary, a seawater intake system and outfall system located in the Gulf (north of the Aransas Pass Channel), as well as inclusion of the CCSC outfall, which best meets the overall purpose of the Project through efficiency, future scalability, and reliability, as well as resilience (Figure 5). This Alternative:

- Brings regulatory certainty and expediency by incorporating an outfall with an existing TPDES permit (CCSC outfall), which allows the Project to meet its overall purpose of *efficiently* establishing a reliable, drought-proof water supply. The critical water need for the region exists <u>now.</u>
- Enhances operational *reliability* for the water supply, creating optionality in the relative utilization of the outfalls in the case of maintenance or damage.
- Accommodates optionality, incrementality, and *scalability* as needed to meet future water needs.
- Bolsters the Project's overall *environmental protectiveness* by enabling flexibility and adaptability in managing brine discharge between two outfalls—including one that that has been authorized (TCEQ) as protective of state water quality—in response to seasonal fluctuations and real-time monitoring (see Section 6.6), including the option for continuous discharges at lower rates, from both outfalls, during critical life stages for endemic species.

This alternative was determined to be practicable and the Preferred Alternative because it is available to the applicant and best satisfies all criteria related to cost, existing technology, and logistics in light of the overall Project purpose (see Table 1).

<u>Cost</u>

Constructing intake and outfall systems in the Gulf will be a higher cost; however, the optionality of a Gulf outfall for brine discharge will add to resilience, reliability, and environmental protectiveness. For instance, in times of maintenance or damage of one outfall, the Desalination Facility could continue producing its critically needed water supply by utilizing the other outfall.

The addition of a second outfall (the CCSC outfall) also increases cost, but contributes to the overall Project purpose through efficiency, reliability, and scalability.

Existing Technology

The technology would be the same as described in Alternatives 1 (CCSC outfall) and 2 (Gulf intake and outfall structures).

Logistics

The alternative would have access to existing major highways and ports for delivery of construction equipment and materials.

Physical Site Characteristics: The Physical site Characteristics would be the same as Alternatives 1 (CCSC outfall) and 2 (Gulf intake and outfall structures).

Constructability: The constructability would be the same as Alternatives 1 (CCSC outfall) and 2 (Gulf intake and outfall structures).

Timing Constraints/Regulatory Uncertainties

After a multi-year application and hearing process, the TCEQ issued a TPDES permit for the CCSC outfall incorporated in Alternative 4, deeming the proposed discharge protective of state water quality, the marine ecosystem, and aquatic life. The TPDES permit was subject to rigorous technical review and extensive public participation. Alternative 4's inclusion of the CCSC outfall, in addition to the Gulf outfall, maximizes regulatory certainty and Project efficiency, while also maximizing reliability and scalability. This regulatory certainty would allow faster development of the Project and achievement of its overall purpose—to meet the critical water need currently being experienced by the Coastal Bend Region, which is anticipated to only grow as time goes on.

5.7 Comparative Analysis of the Siting Alternatives

Table 1, below, is a summary of the practicability evaluation of the four Siting Alternatives. Alternative 3 was deemed impracticable for cost and logistics in light of the overall Project purpose, and this option will not be analyzed further. Alternatives 1, 2, and 4 were deemed practicable, with PCCA selecting Alternative 4 as the Preferred Alternative.

Table 1: Siting Alternatives Evaluation Summary - Practicability

Criteria	Practicability Factor	Alternative 1 (50MGD)	Alternative 2 (100MGD)	Alternative 3 (100MGD)	Preferred Alternative 4 (100MGD)
Cost	Practicable cost?	YES	YES	NO	YES
Existing Technology	Feasibility of existing technology?	YES	YES	YES	YES

Logistics	Logistically feasible?	YES[2]	YES[3]	NO	YES
Physical Site Characteristics	Site conditions suitable for construction?	YES	YES	YES	YES
Constructability	Feasibility of construction methods?	YES	YES	NO	YES
Timing Constraints/ Regulatory Uncertainties	Could project proceed?	YES	YES[4]	YES[5]	YES
Practicable?		**YES**	**YES**	**NO**	**YES**

Each of these Siting Alternatives will use the same route for the treated water pipelines (see Section 4.1.2); practicable construction alternatives for that route are discussed in more detail in Section 6.2.2.

[2] But, limited scalability (only 50MGD) and no reliability from two outfalls.
[3] But, smaller scalability (only 100MGD) and no reliability from two outfalls.
[4] But, no existing TPDES authorization—considerable delay in project development.
[5] But, no existing TPDES authorization—considerable delay in project development.

6. ENVIRONMENTAL ASSESSMENT

Following initial screening and identification of practicable alternatives, a comparison of which of those alternatives is the least damaging to the aquatic ecosystem is required. (40 CFR § 230.10(a)). The Port evaluated the following environmental considerations to compare each Siting Alternative's impact on the aquatic system (and "other significant adverse environmental consequences"):

- Presence and potential impact to WOTUS
- Presence of endangered species or critical habitat
- Distance to sea grass beds or oyster reefs
- Presence of cultural resources
- Factors from Subparts C, D, and E of USACE's 404(b)(1) Guidelines[6]

This analysis begins with assessing the environmental impacts of the two construction alternatives for the treated water pipelines which, as discussed in Section 4.1.2, only has one practicable route.

Next, the analysis compares and evaluates impacts to the aquatic ecosystem for Alternative 1 (50 MGD, Inshore Only – Aransas Pass Channel Intake and CCSC Outfall), Alternative 2 (100 MGD, Offshore Only – North Gulf Intake and Outfall), and the Preferred Alternative, Alternative 4 (100 MGD – Offshore Intake, Dual Offshore and Inshore Outfalls).

This section establishes the Preferred Alternative, Alternative 4, as the LEDPA because (1) its offshore seawater intake structure minimizes potential Impingement and Entrainment (I&E) impacts compared to the inshore Essential Fish Habitat (EFH) alternative; and (2) its dual-approach for discharge outfalls—one in the Gulf and the other adjacent to the CCSC—allows for flexibility and adaptability in distributing brine discharges between two locations (*e.g.*, adjusting volume distributions to account for seasonal fluctuations or real-time conditions; diminishing discharge rates between two outfalls). The CCSC outfall discharge is already authorized under TPDES Permit WQ005253000 following a rigorous technical review and contested case hearing process, and the existence of this permit brings regulatory certainty that will drive the Project's overall goal of *efficiently* establishing a drought-proof water supply. Moreover, the dual-outfall approach will add *reliability* by allowing discharge optionality during times of maintenance.

6.1 Methodology

Geosyntec conducted a desktop analysis of the Siting Alternatives using Environmental Systems Research Institute's (ESRI) ArcMap geographic information systems (GIS) software and available federal and state digital datasets, including Natural Resources Conservation Service (NRCS) soil surveys, ESRI aerial imagery, U.S. Geological Survey (USGS) topographic maps, Light Detection and Ranging (LiDAR) terrain elevational models, USFWS National Wetland Inventory (NWI)

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[6] Criteria evaluated in the LEDPA analysis (from 404(b)(1) Guidelines) includes: suspended particulate/turbidity, aquatic ecosystems and organisms, threatened and endangered species, benthos, coral and oyster reefs, vegetated shallows, effects on aquatic sites, effects on essential fish habitat, salinity effects on aquatic organisms, effects on other wildlife, and actions taken to minimize impacts.

polygons, USGS National Hydrography Dataset (NHD) datasets and other publicly-available data depicting protected area boundaries and designated features of note. This review provided an understanding of the ecology, land use, and general setting of the Siting Alternatives. In addition, Geosyntec completed field verifications for the Desalination Facility and the treated water pipelines. The intake and outfall options will all be installed utilizing trenchless technologies with limited surface disturbances. The results of the desktop assessment and field verifications, and the analysis of impacts for each Siting Alternative deemed practicable (Alternatives 1, 2, and 4) are provided in this section.

6.2 Project Components Common to all Siting Alternatives

As discussed above, the location of the Desalination Facility and the route for the treated water pipelines remain consistent in each Siting Alternative, as these locations constitute the only practicable options for the Project in light of its overall purpose.

6.2.1 Desalination Facility – No adverse impacts to the aquatic ecosystem

The proposed Desalination Facility will occupy approximately 31 acres within Harbor Island. The USACE issued an Approved Jurisdictional Determination on February 25, 2022 (AJD), for the wetlands within the project area. Consistent with the AJD, construction of the Desalination Facility will not impact jurisdictional wetlands (see Figure 6.3, incorporating AJD).

6.2.2 Treated Water Pipelines

The proposed route for the treated water pipelines runs from the Desalination Facility to an existing water distribution tie-in in Aransas Pass. Two practicable alternatives exist for constructing the treated water pipelines: HDD/microtunneling and bridging.

HDD/microtunneling Method

The HDD/microtunneling method involves drilling or tunneling a curved borehole underground to install a pipe without trenching, which minimizes surface disturbance and allows for crossings under environmentally sensitive areas. The HDD construction method would avoid all impacts to marine wetlands from the treated water pipelines. The HDD method would also be conducted in onshore areas of shrub/scrub wetlands, avoiding permanent impacts. Within herbaceous wetlands, the pipelines would be installed via open trench and standard best management practices, resulting in temporary impacts (no permanent impacts).

Bridging Method

The bridging construction method would install permanent piers or pilings to suspend the pipelines over the marine areas and trenching the wetland areas. The piers and pilings would be designed to span or avoid wetlands and marine areas to minimize impacts to tidal waters to the greatest amount practicable; however, permanent impacts would occur at the pier locations and during in-water construction activities.

The below analysis highlights comparisons of the treated water pipelines construction alternatives for (1) WOTUS; (2) cultural resources; and (3) proposed impacts to the aquatic ecosystem. PCCA’s full analysis of each 404(b)(1) factor for each alternative is summarized in Table 3.

6.2.2.1 WOTUS

To evaluate the potential for impacts to WOTUS from each construction method for the treated water pipelines, a review of the USFWS National Wetlands Inventory (NWI) database was performed. Based on a field verification survey conducted by Geosyntec, the proposed Project could temporarily impact approximately 2.5 acres of PEM wetlands, one pond, and one stream along the treated water pipelines route. Approximately 13.4 acres of wetlands would be crossed, of which 3.3 acres are assumed to be jurisdictional. Additionally, minor impacts (approximately 0.1 acres) would occur to a jurisdictional stream and pond. Mapped jurisdictional wetlands crossed by the treated water line route are summarized in Table 3 and shown in Figures 6.1-6.3.

Table 2 summarizes the NWI wetlands and waterbodies that would need to be crossed by the proposed treated water line:

Table 2: Summary of Treated Water Line Wetlands

Wetland Type	Wetland Acreage Present (acres)	Treated Water Line impacts via "HDD" (acres)	Treated Water Line impacts via "Bridge"* (acres)
Estuarine and Marine Wetland	2.30	0.0 (HDD)	<2.30
Freshwater Emergent Wetland	0.21	0.21 (temporary)	<0.21 (temporary)
Estuarine Shrub/Scrub Wetland	0.80	0 (HDD)	<0.80
Freshwater Pond	0.02	<0.02 (temporary)	<0.20 (temporary)
Total (Wetlands and Waterbodies)	3.33	<0.02	<3.33

Note: * Piers or pilings to bridge water crossings or wetlands have not been fully designed. Impacts are noted as less than (<) the total amount present and will be spanned and avoided if possible; however, impact quantities from physical piers or pilings have not yet been calculated.

For both construction methods, impacts to wetlands for the treated water line would be minimal. However, the HDD method is able to avoid permanent impacts, whereas the bridging method may result in permanent impacts to jurisdictional wetlands.

6.2.2.2 Cultural Resources

To evaluate the potential for impacts to cultural resources from the treated water line and each intake and outfall alternative, a review of the Texas Historical Commission (THC) online database was performed. This review showed no known cultural resources along the treated water line route. An updated review of potential cultural resources along the proposed treated water line alignment may be recommended prior to construction.

6.2.2.3 Aquatic Ecosystem

Substrate in the Project Area is primarily sand with some silt and clay. Temporary impacts would occur to the natural substrate present along the route of the treated water line during construction in either method.

HDD/microtunneling Method

The use of HDD/microtunneling for construction would avoid aquatic ecosystem impacts by eliminating any impact on turbidity, benthic invertebrates, oyster beds, vegetated shallows, essential fish habitat, and other sensitive environmental factors.

Bridging Method

Minor temporary impacts, including impacts to turbidity, would occur during construction using the bridging method. Additionally, permanent impacts, including potential impacts to wetlands, seagrass beds, and oyster beds, would be associated with the permanent piers or pilings for the treated water pipelines bridge.

6.2.2.4 Summary

Table 3 provides a summary of the proposed impacts associated with the two construction alternatives analyzed for the treated water line. **Of these two practicable alternatives, construction by HDD/microtunneling is the preferred alternative and part of the LEDPA, as it results in less adverse impacts to the aquatic ecosystem**.

Table 3: Analysis of Treated Water Line Impacts by Construction Method

Criteria	Treated Water Line Construction via HDD/microtunneling	Treated Water Line Construction via Bridge
Wetlands/WOTUS	No impact, HDD would avoid wetlands, minor temporary impacts to a freshwater pond	Impact depending on pier/pile locations. Design would avoid wetlands to the extent practicable; minor temporary impacts to a freshwater pond
Cultural Resources	No known sites along waterline route.	No known sites along waterline route.
Aquatic Ecosystem	No/low impact; limited to HDD entry and exit points which would avoid aquatic ecosystem and organisms	Temporary impact associated with bridge construction; permanent impact from pier structure.
Threatened and Endangered Species	No/low impact; limited to HDD entry and exit points which would be on land outside of T&E critical habitat	Temporary impact associated with bridge construction; Minimal permanent impact from pier structure
Water Circulation, Fluctuation and Salinity	No impact. HDD would avoid.	No impact, construction of pier or pile would not affect
Suspended Particulate/ Turbidity	No/low impact; limited to HDD land based entry and exit	Temporary impact associated with bridge construction

Criteria	Treated Water Line Construction via HDD/microtunneling	Treated Water Line Construction via Bridge
	points and minimized by SWPPP BMP	
Benthos	No/low impact; limited to HDD entry and exit points which would be on land outside of benthic environment	Temporary impact associated with pier construction; Minimal permanent impact from pier structure, will be designed to avoid impacts to the extent practicable.
Coral and Oyster Reefs	No/low impact; limited to HDD entry and exit points which would be on land outside oyster beds	Temporary impact associated with pier construction; Minimal permanent impact from pier structure, pier will be designed to avoid impacts to mapped oyster beds to the extent practicable.
Vegetated Shallows	No/low impact; limited to HDD entry and exit points which would be on land outside of shallow vegetation	Temporary impact associated with pier construction; Minimal permanent impact from pier structure, pier will be designed to avoid impacts to mapped sea grass to the extent practicable.
Effects on Aquatic sites	No/low impact; limited to HDD entry and exit points which would be on land not in aquatic habitat	Moderate (high?) impact associated with bridge construction through aquatic habitat
Effects on Essential Fish Habitat	No/low impact; limited to HDD entry and exit points which would be on land not in EFH	The entire area of the project is EFH. Impacts would be temporary during construction and minimal permanent impact.
Salinity effects on aquatic organisms	No increase in salinity from treated water line HDD	No increase in salinity from construction of bridge for treated water pipelines
Effects on other wildlife	No/low impact; limited to HDD entry and exit points which would be sited away from known wildlife habitat	Moderate impact associated with bridge construction across inland waters

6.3 Alternative 1: (50 MGD) Inshore Only – Aransas Pass Channel Intake and CCSC Outfall

This alternative proposes an intake structure in the Aransas Pass channel immediately northeast of the Desalination Facility and one discharge outfall southeast of the Desalination Facility adjacent to the CCSC. This alternative proposes no impacts to wetlands and minimal impacts to tidal waters.

However, because the intake structure would be located within designated inshore Essential Fish Habitat with higher potential for impacts from I&E, this alternative does not constitute the LEDPA.

The below analysis highlights PCCA's analysis of Alternative 1 for (1) WOTUS; (2) cultural resources; and (3) proposed impacts to the aquatic ecosystem. PCCA's full analysis of each 404(b)(1) factor is summarized in Table 5.

6.3.1 WOTUS

Construction of the intake structure in the Aransas Pass channel would not involve wetland impacts. Construction of the outfall pipe and intake structure adjacent to the CCSC requires creation of a pipe bench by removing sediment from the dredge slope (where there are no seagrass beds or other areas of environmental significance), which may temporarily disturb WOTUS through increased turbidity but will not otherwise affect the aquatic ecosystem. Although a jurisdictional wetland is located along the shoreline of Harbor Island and the CCSC (Figure 6.3), construction of the outfall pipe and structure would use HDD or microtunnelling, thereby avoiding any wetland impacts. Roughly 500 cubic yards of rock would be placed around the diffuser, presenting minimal but permanent impacts to approximately 400 square feet of unvegetated bay bottom.

6.3.2 Cultural Resources

To evaluate the potential for impacts to cultural resources from Alternative 1, a review of the THC online database was performed. This review identified two THC-listed cultural resource sites, both in the offshore waters of the GOM (Figure 9). There are no known cultural resources associated with Alternative 1.

6.3.3 Potential Impacts to the Aquatic Ecosystem

In evaluating Alternative 1's potential impacts on the aquatic ecosystem, PCCA considered the suite of environmental factors contemplated under the 404(b)(1) Guidelines. Those findings are summarized and compared with the other Siting Alternatives in Table 4. Because the Siting Alternatives differ in largest part by the location of the intake and outfall structures, the biggest environmental considerations associated with those structures, namely, I&E for intake and salinity for outfall, are synthesized below.

Intake structure – Aransas Pass Channel

Construction of the intake structure in the Aransas Pass channel would cause temporary and minimal effects on the aquatic ecosystem through increased turbidity and minor disturbances of substrate within the channel. These construction-related impacts would not adversely affect substrate functions or services or other aspects of the aquatic ecosystem after construction. The intake structure is located near, but not in, areas of seagrass and oyster beds (see Figure 6.3).

The intake structure design includes multiple layers of protection to minimize I&E and other impacts on the aquatic ecosystem. The design includes 3-inch mesh bar screens at the entrances of the velocity caps to eliminate any potential impact on juvenile turtles, adult sea turtles, larger fish, marine mammals, and other aquatic life. The intake opening will be approximately 5 to 10 feet above the seabed to minimize the potential withdrawal of sediments or benthic organisms. The velocity cap opening will be designed to have an entrance velocity of ≤0.5 feet per second (ft/s) to reduce the intake of fish and other marine organisms into the intake. The velocity caps redirect the gravity-fed intake flow horizontally, which allows marine life to easily detect the low-flow entrance velocity and swim away.

The location of the Alternative 1 intake structure is within inshore Essential Fish Habitat (EFH) for red drum, shrimp, reef fish, and coastal migratory pelagics. Highly migratory species known to travel the area for Alternative 1 include tunas, swordfishes, sharks, and billfishes. Adverse effects to EFH are considered to be possible with the intake structure being within inshore EFH, and localized impacts are expected in the vicinity of intake structures.

As compared to the Alternatives 2 and 4 with a Gulf seawater intake location, siting the intake structure in bay habitat near Harbor Island would likely result in greater impacts to diverse EFH types and multiple life stages of managed fishery species. While both the Gulf and bay areas contain benthic and water column EFH, the bay contains additional sensitive EFH categories that are not found at the proposed Gulf intake location. Seagrasses, oyster beds, and tidal marshes found in the bay provide the necessary resting, foraging, and nursery habitats for larval, juvenile, and adult life stages.

Further, EFH in the bay is exposed to a greater concentration of baseline disturbance within a smaller geographic area, relative to the Gulf. Active navigation channels, commercial and recreational boat activity, and proximity to a high-traffic roadway produce disturbance throughout bay EFH, which is geographically bound by surrounding shorelines and barrier islands. Siting the intake structure in the bay would create additional disturbance to a confined area of ecologically productive EFH. Comparatively, the proposed Gulf intake location for Alternatives 2 and 4 is surrounded by extensive acreage of similar open water and benthic EFH, and siting an intake structure in the Gulf would likely produce fewer aquatic impacts.

Outfall structure – CCSC

Construction of the outfall structure adjacent to the CCSC would cause temporary and minimal effects on the aquatic ecosystem through increased turbidity and minor disturbances of substrate within the channel. These construction-related impacts would not adversely affect substrate functions or services or other aspects of the aquatic ecosystem after construction. The outfall structure is not located near areas of seagrass or oyster beds.

Salinity Gradient

Alternative 1 contemplates a Desalination Facility that will produce desalinated water at a rate of 50 MGD and will discharge 95 MGD of brine through a high-rate diffuser to the CCSC. The hydrodynamic conditions in the CCSC near the Aransas Pass consist of high tidal velocities that generate high turbulence and maintain a deep channel turning into the Corpus Christi Bay. Average tidal flow measured in the CCSC has been estimated at 47,000 MGD (Parsons Environmental and Infrastructure, Inc. 2021). The proposed discharge of 95 MGD is 0.2% of the tidal flow and would be expected to rapidly mix in with the ambient tidal flow. Consequently, higher salinity around the CCSC diffuser represents only a small fraction of the total aquatic habitat area available in the ship channel.

Because of the marine and estuarine habitats present, natural salinity fluctuations characteristic of estuaries occur in the CCSC. Large fluctuations in salinity occur naturally in this system on a day-to-day basis and throughout the year. Daily salinities can fluctuate from < 1 ppt to > 5 ppt, as well as experience large up or down changes over periods of days or weeks in response to droughts, excessive rainfall, or seasonal changes.

Based on CORMIX modeling, at the Alternative 1 outfall discharge location, the initial effluent salinity is expected to rapidly dilute in the surrounding water column as a result of PCCA's installation of high-rate diffusers. Salinity modeling indicates that the maximum increase in receiving water salinity will be less than or equal to 2 ppt at a distance of 100 meters from the diffuser ports at the critical hydrologic condition.

This relatively small salinity increase falls well within the natural salinity fluctuations measured in the estuarine environment of Corpus Christi Bay. Although the Alternative 1 outfall is located adjacent to the CCSC and not in the bay system (Nueces Estuary), tidal exchange will result in transport of a portion of the desalination facility effluent into the Corpus Christi Bay system. A SUNTANS hydrodynamic model of the Corpus Christi Bay system (LREWater, LLC 2019) was developed by PCCA to evaluate the CCSC discharge location. Results suggest that a maximum of 1 ppt salinity could result in the Corpus Christi Bay system away from the outfall, a highly saline water layer along the channel bottom will not occur, and salinity increases will be mitigated by the strong tidal force constantly driving water movement within the vicinity of the discharge. Based on modeling results, effluent discharges will not cause estuary-wide shifts of salinity gradients in view of the wide range of natural salinity variations that occur continuously in the Nueces Estuary.

The predicted changes in salinity will not be of sufficient magnitude or duration to cause effects on existing salinity gradients. Higher salinity from the effluent will be rapidly dispersed in the water column of the CCSC. A localized area of elevated salinity will occur at a limited distance from the diffusers before dispersion to background salinity concentrations.

Salinity and the Aquatic Ecosystem

Although salinity effects will occur in localized portions of the water column around the outfall, these effects fall within ranges deemed to be protective of the aquatic ecosystem. USEPA has provided salinity levels that reflect acceptable changes in salinity for the protection of habitats and estuarine organisms. The USEPA maximum salinity level is an increase of 4 ppt above ambient concentrations (USEPA 1986), and a salinity increase of no more than 2 ppt over ambient concentrations measured at 100 meters from the outfall has been recommended by TPWD and Texas General Land Office (TPWD 2018). Salinity increases at the mixing zone boundary for the Alternative 1 outfall are well within the salinity levels established by USEPA. Salinity modeling indicates that the maximum increase in receiving water salinity will be less than or equal to 2 ppt at 100 meters from the diffuser ports.

Aquatic species, including threatened and endangered species, are not expected to be affected by the localized increases in salinity that will not exceed a salinity limit of 2.0 ppt (TPWD 2018a), which is considered protective of the marine environment, aquatic life, and wildlife, including spawning eggs and larval migration. Increased salinity is also within the range of natural salinity fluctuations that occur continuously in the Nueces Estuary.

Potential for salinity impacts will also be limited due to the typical limited duration of exposure to increased salinity over ambient concentrations for aquatic species moving through the water column. Based on the general shape and depth of the effluent plume, as well as the spatial extent of the zone of initial dilution and the chronic aquatic life mixing zone in front of the diffuser, it is estimated that only a small fraction (<1%) of species moving through the ship channel at any one time has the potential of contacting the elevated salinity from the effluent for even this limited amount of time. Finally, the width of the zone of initial dilution represents a small fraction of the total width of the CCSC.

Based on these factors, the direct impacts of salinity alteration on water column EFH are anticipated to be permanent but insignificant, without adversely affecting populations of managed species in area.

6.3.4 Alternative 1 does not constitute the LEDPA.

As described above, the intake and outfall locations for Alternative 1 will not result in significant adverse effects on the aquatic ecosystem, or other significant adverse environmental consequences. However, because the intake structure location for Alternative 1 is located in the Aransas Pass Channel, in inshore EFH, closer to environmentally significant areas such as seagrasses and oyster beds, impacts to the aquatic ecosystem from I&E may be higher than Alternatives 2 and 4, which contemplate offshore seawater intake. For this reason, Alternative 1 does not constitute the LEDPA.

6.4 Alternative 2: (100MGD) Offshore Only – North Gulf Intake and Outfall

This alternative proposes a seawater intake structure in the Gulf and one outfall structure in the Gulf, both located north of the Aransas Pass channel. This alternative proposes no impacts to wetlands and minimal, temporary impacts to other WOTUS, as well as permanent but insignificant impacts to WOTUS from the placement of fill material in the Gulf to build the intake and outfall structures.

However, because this alternative provides for only one outfall location, it does not constitute the LEDPA because one outfall does not provide for resilience, flexibility, and adaptability in managing and distributing brine discharge; nor does the Gulf outfall benefit from an existing state permit authorizing that outfall as protective of water quality, the marine ecosystem, and aquatic life.

The below analysis highlights PCCA's analysis of Alternative 2 for (1) WOTUS; (2) cultural resources; and (3) proposed impacts to the aquatic ecosystem. PCCA's full analysis of each 404(b)(1) factor is summarized in Table 5.

6.4.1 WOTUS

Alternative 2, as designed, will avoid impacts to wetlands through tunneling technology. Construction of the intake and outfall structures in the Gulf will cause temporary impacts to WOTUS from increased sedimentation and turbidity, to be managed by best practices. Additionally, installation of the intake and outfall structures will cause permanent but insignificant impacts to the seafloor through the placement of approximately 15,300 cubic yards of stone, affecting approximately 11,300 square feet of seafloor for the intake structure and 55,000 square feet of seafloor for the outfall structure. These proposed impacts would not adversely affect substrate functions or services after construction, and it is expected that benthic invertebrates would recolonize the area after construction.

6.4.2 Cultural Resources

To evaluate the potential for impacts to cultural resources from Alternative 2, a review of the THC online database was performed. This review identified two THC-listed cultural resource sites, both in the offshore waters of the GOM (Figure 9). One of the sites overlaps with the alignment of the intake and outfall pipes in the GOM in Alternative 2. However, the Project will use tunneling technology below the seafloor and to avoid impacts to the mapped cultural resource site. Best management practices will be used during construction to avoid impacts to this cultural resource site.

6.4.3 Potential Impacts to the Aquatic Ecosystem

In evaluating Alternative 2's potential impacts on the aquatic ecosystem, PCCA considered the suite of environmental factors contemplated under the 404(b)(1) Guidelines. Those findings are summarized and compared with the other Siting Alternatives in Table 4 below. Because the Siting Alternatives differ in largest part by the location of the intake and outfall structures, the biggest environmental considerations associated with those structures, namely, I&E for intake and salinity for outfall, are synthesized below.

Intake Structure – Gulf

Construction of the intake structure in the Gulf would cause temporary and minimal effects on the aquatic ecosystem through increased turbidity and minor disturbances of substrate. These construction-related impacts would not adversely affect substrate functions or services or other aspects of the aquatic ecosystem after construction. The intake structure is located on Gulf seafloor away from areas of seagrass or oyster beds. During construction of the proposed intake and outfall structures, mitigation measures used to control the movement of suspended sediment particles may include silt screens, weighted turbidity curtains, and other appropriate methods specifically designed to minimize impacts.

The intake structure design includes multiple layers of protection to minimize I&E and other impacts on the aquatic ecosystem. The design includes 3-inch mesh bar screens at the entrances of the velocity caps to eliminate any potential impacts on juvenile turtles, adult sea turtles, larger fish, marine mammals, and other aquatic life. The intake opening will be approximately 5 to 10 feet above the seabed to minimize the potential withdrawal of sediments or benthic organisms. The velocity cap opening will be designed to have an entrance velocity of ≤0.5 feet per second (ft/s) to reduce the intake of fish and other marine organisms into the intake. The velocity caps redirect the gravity-fed intake flow horizontally, which allows marine life to easily detect the low-flow entrance velocity and swim away.

Critical habitat for threatened and endangered species near the intake location is provided on Figure 7. Tunneling will avoid impacts along intake and outfall pipes. While the Gulf intake location is located within designated critical habitat for loggerhead turtle, the intake design criteria will avoid impacts.

Locating the intake structure in the Gulf provides additional protection from I&E. The prevailing tidal velocities in the Gulf are generally higher than the entrance velocity of 0.5 ft/s at the intake structure. This combination suggests that, on average, eggs and larvae are more likely to pass by the velocity caps instead of being drawn in by them. Moreover, the location of the intake structure is approximately 1.3 miles offshore of San Jose Island, away from shallow shoreline habitat (including seagrass beds) that comprises areas that may be used more widely by smaller species or for spawning and nursery habitat.

The intake structure will be submerged at depth with approximately 20 to 25 feet of water overlying the velocity caps. This deeper placement will greatly limit or eliminate the withdrawal of positively buoyant eggs found at or near the surface of the Gulf. Additionally, the intake structure entrances will be at least 5 feet above the seafloor. This design feature will greatly limit or eliminate the withdrawal of demersal eggs and other benthic marine life species.

I&E of eggs and larvae will be highly localized and will represent a small fraction of the total number of eggs and larvae present in the local aquatic ecosystem. Also, the vast majority of eggs and larvae would never encounter the proposed intake structure.

Because phytoplankton and zooplankton populations grow quickly, the small amount of biomass removed daily by the proposed water intake structures is expected to be replaced in a short amount of time. The proposed volume of desalination water withdrawal is very low relative to the total volume of the Gulf source water, and, therefore, any impacts to phytoplankton and zooplankton are too low to be demonstrable.

The overwhelming majority of early life stages (ELSs) of the aquatic species present in the Gulf will not be impacted. In addition, none of the adult aquatic species or adult wildlife will be adversely affected.

As shown by decades of research on the effects of I&E, the impacts caused by I&E on fish populations and communities are small compared to other environmental impacts, such as overfishing, habitat destruction, pollution, or the introduction of invasive species. Specifically, reducing I&E has not been shown to result in measurable improvements in recreational or commercial fish populations (Barnthouse 2013).

In sum, locating the seawater intake structure in the Gulf, as opposed to an inshore location, minimizes potential impacts to aquatic ecosystems because of prevailing tidal velocities in the Gulf, the low relative volumes of I&E compared to the source water, and the considerable distance from shoreline habitat used for spawning and nurseries.

Outfall structure – Gulf

Construction of the outfall structure in the Gulf would cause temporary and minimal effects on the aquatic ecosystem through increased turbidity and minor disturbances of substrate within the channel. These construction-related impacts would not adversely affect substrate functions or services or other aspects of the aquatic ecosystem after construction. The outfall structure is not located near areas of seagrass or oyster beds. Any permanent impacts from the introduction of stone to the seafloor would be minimal, with benthic organisms expected to recolonize the area after construction.

Salinity Gradient

In Alternative 2, the Desalination Facility will produce desalinated water at a rate of 100 MGD and will discharge 191.2 MGD of brine to the Gulf through the high-rate Gulf diffuser. The hydrodynamic conditions in the Gulf (median ambient current is 0.27 meters per second) would result in rapid dilution of the proposed discharge, which would mix with the ambient tidal flow.

Based on CORMIX modeling, the initial effluent salinity is expected to rapidly dilute in the surrounding water column as a result of PCCA's installation of high-rate diffusers. Salinity modeling indicates that the maximum increase in receiving water salinity will be less than or equal to 2 ppt at a distance of 100 meters from the diffuser ports at the critical hydrologic condition.

The predicted changes in salinity will not be of sufficient magnitude or duration to cause effects on existing salinity gradients. Higher salinity from the effluent will be rapidly dispersed in the water column of the Gulf. A localized area of elevated salinity will occur at a limited distance from the diffusers before dispersion to background salinity concentrations.

Salinity and the Aquatic Ecosystem

Although salinity effects will occur in localized portions of the water column around the outfall, these effects fall within ranges that reflect acceptable changes in salinity for the protection of habitats and estuarine organisms. The USEPA maximum salinity level is an increase of 4 ppt above ambient concentrations (USEPA 1986), and a salinity increase of no more than 2 ppt over ambient concentrations measured at 100 meters from the outfall has been recommended by TPWD and Texas General Land Office (TPWD 2018). Salinity increases at the mixing zone boundary are well within the salinity levels established by USEPA. Salinity modeling for this Project indicates that the maximum increase in receiving water salinity will be less than or equal to 2 ppt at 100 meters from the diffuser ports. Aquatic species are not expected to be affected by the localized increases in salinity that will not exceed a salinity limit of 2.0 ppt (TPWD 2018a), which is considered protective of the marine environment, aquatic life, and wildlife, including spawning eggs and larval migration. Increased salinity is also within the range of natural salinity fluctuations that occur continuously the Gulf, which can vary up to approximately 10 ppt or more throughout any given year.

Potential for salinity impacts will also be limited due to the very short duration of exposure to increased salinity over ambient concentrations for aquatic species moving through the water column. Additionally, based on the general shape and depth of the effluent plume, as well as the spatial extent of the zone of initial dilution and the chronic aquatic life mixing zone in front of the diffuser, it is estimated that only a small fraction of aquatic species moving through the Gulf at any one time has the potential of contacting the elevated salinity from the effluent for even this limited amount of time. Finally, the zone of initial dilution represents a miniscule fraction of the total volume of the Gulf.

Based on these factors, the direct impacts of salinity on aquatic organisms is anticipated to be permanent but insignificant, without adversely affecting populations of managed species in the area around the proposed outfall for Alternative 2.

6.4.1 Alternative 2 does not constitute the LEDPA.

As described above, the intake and outfall locations for Alternative 2 will not result in significant adverse effects on the aquatic ecosystem, or other significant adverse environmental consequences. When compared to Alternative 1, the intake location for Alternative 2 is likely to have less adverse impact from I&E due to its distance from seagrass, oyster beds, and shoreline habitats and nurseries, as well as the tidal velocities of the Gulf and the low relative volumes of I&E when compared to the source area. However, Alternative 2 provides for only one outfall location. As discussed in more detail in Section 6.6.4 below, one outfall location does not provide for flexibility and adaptability in managing and distributing brine discharge; nor does the proposed Gulf outfall benefit from an existing state permit authorizing that outfall as protective of water quality. For this reason, Alternative 2 does not constitute the LEDPA.

6.5 Alternative 3: (100MGD) Offshore Only – South Gulf Intake and Outfall

This alternative was deemed not practicable due to cost and logistics in light of the Project's overall purpose. Environmental impacts were not separately analyzed.

6.6 Alternative 4: (100 MGD) (Preferred Alternative) – Offshore Intake, Dual Offshore and Inshore Outfalls

Alternative 4—PCCA's Preferred Alternative—combines the Alternative 1 outfall (CCSC outfall) with the Alternative 2 Gulf intake and Gulf outfall. This alternative proposes no impacts to wetlands and minimal, temporary impacts to WOTUS, as well as minor permanent but insignificant impacts to WOTUS from the placement of fill material in the Gulf to build the intake and outfall structures.

This alternative leverages Alternative 2's lower-impact intake location with a combination of Alternative 1's permitted CCSC outfall and Alternative 2's offshore outfall. In doing so, Alternative 4 constitutes the LEDPA by (1) avoiding potentially higher I&E impacts related to inshore seawater intake and (2) maximizing flexibility and adaptability in brine discharges with the optionality of two outfalls, including one that has already received state authorization as being protective of water quality.

The below analysis highlights PCCA's analysis of Alternative 4 for (1) WOTUS; (2) cultural resources; and (3) proposed impacts to the aquatic ecosystem. PCCA's full analysis of each 404(b)(1) factor is summarized in Table 5.

6.6.1 WOTUS

Alternative 4, as designed, will avoid impacts to wetlands through tunneling technology. Temporary construction best management practices (BMPs) will be implemented to limit adverse effects on wetlands along the intake and outfall pipe routes during and after construction.

Construction of the intake and outfall structures in the Gulf, as well as the CCSC outfall structure, will cause temporary impacts to WOTUS from increased sedimentation and turbidity, to be managed by best practices. Additionally, installation of the Gulf intake and outfall structures will cause permanent but insignificant impacts to the seafloor through the placement of approximately 15,300 cubic yards of stone, affecting approximately 11,300 square feet of seafloor for the intake structure and 55,000 square feet of seafloor for the outfall structure. These proposed impacts would not adversely affect substrate functions or services after construction, and it is expected that benthic invertebrates would recolonize the area after construction.

6.6.2 Cultural Resources

To evaluate the potential for impacts to cultural resources from Alternative 4, a review of the THC online database was performed. This review identified two THC-listed cultural resource sites, both in the offshore waters of the GOM (Figure 9). One of the sites overlaps with the alignment of the intake and outfall pipes in the GOM in Alternative 4. However, the Project will use tunneling technology below the seafloor and to avoid impacts to the mapped cultural resource site. Best management practices will be used during construction to avoid impacts to this cultural resource site.

6.6.3 Potential Impacts to the Aquatic Ecosystem

In evaluating Alternative 4's potential impacts on the aquatic ecosystem, PCCA considered the suite of environmental factors contemplated under the 404(b)(1) Guidelines. Those findings are summarized and compared with the other Siting Alternatives in Table 4 below. Because the Siting Alternatives differ in largest part by the location of the intake and outfall structures, the biggest environmental considerations associated with those structures, namely, I&E for intake and salinity for outfall, are synthesized below.

Intake Structure – Gulf

Construction and operation of the intake structure follows the same analysis described in Section 6.4.3 above, which concludes that the Gulf intake structure minimizes potential impacts to aquatic ecosystems because of its design, prevailing tidal velocities in the Gulf, the low relative volumes of I&E compared to the source water, and the considerable distance from shoreline habitat used for spawning and nurseries.

Outfall Structure – Gulf

Construction and operation of the Gulf outfall structure follows the same analysis described in Section 6.4.3 above, which concludes that the Gulf outfall location and design minimizes impacts to the aquatic ecosystem through rapid dispersion and mixing of brine discharges. Any localized increases in salinity fall below federal and state limits that establish protectiveness for the marine environment, aquatic life, and wildlife, including spawning eggs and larval migration.

Outfall Structure – CCSC

Construction and operation of the CCSC outfall structure follows the same analysis described in Section 6.3.3 above, which concludes that the CCSC outfall location and design minimizes impacts to the aquatic ecosystem through rapid dispersion and mixing of brine discharges. Any localized increases in salinity fall below federal and state limits that establish protectiveness for the marine environment, aquatic life, and wildlife, including spawning eggs and larval migration.

Moreover, the TCEQ has performed extensive technical analysis of this outfall with robust public participation, concluding in its issuance of TPDES Permit No. WQ0005253000 that this location and discharge includes "all appropriate and necessary requirements to protect the marine environment, aquatic life, wildlife, recreational activities, commercial fishing, and fisheries."

Operation of two outfalls rather than one outfall would not result in “other significant adverse environmental consequences” because the distance (3.32 miles) and hydrodynamics separating the two outfall locations avoid any interaction between the two separate brine plumes. The tidal dynamics at the Gulf diffuser location are such that the dilute brine plume would be rapidly swept away parallel to the shoreline, not towards the CCSC entrance. Similarly, the volume and current of water exchanges near the CCSC diffuser would result in brine dilution that matches ambient conditions before reaching the mouth of the CCSC at the Gulf. The location and designs of the diffusers make any interplay between the two outfalls extremely unlikely.

6.6.4 Alternative 4, the Preferred Alternative, is the LEDPA.

As described above, Alternative 4 combines the least damaging environmental aspects of the practicable alternatives—the Gulf intake, as well as the Gulf and CCSC outfalls—to configure the Project in a manner that minimizes adverse impacts to the aquatic ecosystem.

Inclusion of the Gulf seawater intake structure, as opposed to an inshore intake structure, minimizes adverse impacts from I&E by providing considerable distance from shoreline spawning and nursery EFH habitats, as well as relying on tidal velocities in the Gulf and the low relative volumes of I&E compared to the source water.

Inclusion of the CCSC outfall relies on a discharge location and methodology that TCEQ has already vetted as being protective of the aquatic ecosystem and water quality. Design and location of that outfall minimizes adverse impacts through rapid dispersion that keeps any localized salinity increases below federal and state limits for protecting the marine environment, aquatic life, and wildlife, including spawning eggs and larval migration.

Inclusion of the Gulf outfall likewise minimizes adverse impacts through design and location that uses rapid dispersion to keep localized salinity levels sufficiently low to protect the aquatic ecosystem. Importantly, the optionality of two outfalls also provides a level of flexibility and adaptability that is not possible with just one outfall, providing general ecological benefits as well as logistical benefits. Two operational outfalls allows operators to adjust flow rates seasonally or based on real-time monitoring to minimize adverse environmental impacts. Two outfalls also allows for continuous discharges at lower rates between two locations, which would lessen impacts on the types of rate fluctuations that impact marine life’s ability to acclimate.

Alternative 4 will result in the least adverse impacts to the aquatic ecosystem.

6.7 Table Comparisons of each practicable Siting Alternative

For ease of comparison, Table 4 provides a high-level summary of the above environmental considerations:

Environmental Consideration	Alternative 1	Alternative 2	Alternative 4
WOTUS	No permanent wetland impacts; 500 CY stone discharged with minimal impacts to unvegetated bay bottom near CCSC outfall	No permanent wetland impacts; 15,300 CY stone discharged with minimal impacts to unvegetated Gulf seafloor for intake and outfall	No permanent wetland impacts; 15,800 CY stone discharged with minimal impacts to unvegetated seafloor and bay bottom for intake and outfalls
Cultural Resources	No known sites, no impact	Two known sites in GOM, avoid via tunneling	Two known sites in GOM, avoid via tunneling
Intake – I&E	Higher potential for I&E where intake is located in inshore EFH	Minimal potential for I&E where intake is located in Gulf	Minimal potential for I&E where intake is located in Gulf
Outfall – Salinity	Diffuser design and CCSC location minimizes adverse impacts to aquatic ecosystem; one outfall limits flexibility and adaptability in managing brine	Diffuser design and Gulf location minimizes adverse impacts to aquatic ecosystem; one outfall limits flexibility and adaptability in managing brine	Diffuser design and locations minimize adverse impacts to aquatic ecosystem; two outfalls provide additional layer of protectiveness by allowing for flexible, adaptive management of brine discharge locations during seasonal or real-time conditions

For ease of comparison, **Table 5** summarizes the potential environmental impacts for each of the alternatives under the 404(b)(1) Guidelines.

Table 5: Analysis of Impacts by Alternative

Environmental Resource	Alternative 1	Alternative 2	Alternative 4
WOTUS	Avoided by HDD and bench design; insignificant WOTUS impacts from discharge of stones to unvegetated bay bottom	Avoided by tunneling; insignificant WOTUS impacts from discharge of stones to seafloor for Gulf intake/outfall	Avoided by tunneling; insignificant WOTUS impacts from discharge of stones to seafloor for Gulf intake/outfall
Threatened and Endangered Species	No critical habitat present, but within proposed critical habitat	Critical habitat avoided by tunneling and conservation measures	Critical habitat avoided by tunneling and conservation measures
Suspended Particulate/ Turbidity	Impacts minimized by design and construction methods	Impacts minimized by design and construction methods	Impacts minimized by design and construction methods
Water Circulation, Fluctuation, Salinity	Minimal impact: The proposed discharge is 0.2% of the tidal flow and would be expected to rapidly mix in with the ambient tidal flow.	Minimal impact: rapid dilution of the proposed discharge would mix with the ambient Gulf tidal flow via high rate diffusers.	Rapid dilution of proposed discharge at both locations; flexibility and adaptability in brine discharge with two outfalls
Aquatic Ecosystem and Organisms	Minimized by design and construction methods	Minimized by design and construction methods	Minimized by design and construction methods
Benthos	Minimized by design and construction methods	Minimized by design and construction methods	Minimized by design and construction methods
Coral and Oyster Reefs	Oyster beds adjacent to intake	Avoided by tunneling	Avoided by tunneling
Vegetated Shallows	Seagrass beds adjacent to intake	Avoided by tunneling	Avoided by tunneling
Effects on Aquatic sites	Minimized by design and construction methods	Minimized by design and construction methods	Minimized by design and construction methods

Environmental Resource	Alternative 1	Alternative 2	Alternative 4
Effects on Essential Fish Habitat	Higher potential for I&E impacts with the intake structure being within inshore EFH	Minimized by design and construction methods	Minimized by design and construction methods
Salinity effects on aquatic organisms	Higher salinity around the CCSC diffuser represents only a small fraction of the total aquatic habitat area available in the ship channel; falls below federal and state ppt limits for environmental protectiveness. The Designed Diffuser further minimizes impacts from salinity.	Higher salinity around the Gulf diffuser represents only a small fraction of the total aquatic habitat area available in the Gulf; falls below federal and state ppt limits for environmental protectiveness. The Designed Diffuser further minimizes impacts from salinity.	Higher salinity around the Gulf and CCSC diffusers represents only a small fraction of the total aquatic habitat area available; falls below federal and state ppt limits for environmental protectiveness. The Designed Diffuser further minimizes impacts from salinity.
Effects on other wildlife	Minimized by design and construction methods	Minimized by design and construction methods	Minimized by design and construction methods
Actions taken to minimize impacts	In water – diffuser design and low intake flow/velocity caps. On land - Sensitive area avoidance via siting, use of HDD and tunneling. Potential seasonal restrictions for sensitive biological species.	In water – diffuser design and low intake flow/velocity caps. On land - Sensitive area avoidance via siting, use of HDD and tunneling. Potential seasonal restrictions for sensitive biological species.	In water – diffuser design and low intake flow/velocity caps.

7. CONCLUSION AND RECOMMENDATION

After evaluating the practicable locations for the Desalination Facility, treated water pipelines route and construction methods, and intake and outfall locations for the Project, the Preferred Alternative is Alternative 4: a combination of Alternatives 1 and 2 that incorporates offshore seawater intake and two outfall locations, as well as the use of HDD/microtunneling for installation of the treated water pipelines. Alternative 4 meets the Project need and overall purpose while also minimizing environmental impacts. The Preferred Alternative proposes *no* permanent impacts to wetlands and only minor impacts to WOTUS through environmentally insignificant placement of rocks onto the Gulf seafloor and unvegetated bay bottom. The Preferred Alternative relies on HDD and tunneling to avoid adverse impacts to the aquatic ecosystem and other environmental resources.

The Preferred Alternative meets the Project's overall purpose. In including the optionality of two outfalls, this alternative maximizes future *scalability* to meet increasing water need, *reliability* through having a secondary outfall option during times of maintenance, and *efficiency* through the regulatory certainty of TPDES Permit WQ0005253000. The Preferred Alternative is the LEDPA because offshore seawater intake minimizes I&E impacts while two outfalls, one offshore and one near the CCSC (which has been fully vetted for water quality-related impacts pursuant to TCEQ permitting procedures), minimize salinity impacts through design and location, while also providing the ability to manage brine discharge in a flexible, adaptive manner that accounts for seasonality and real-time conditions.

Given these considerations, the Preferred Alternative, Alternative 4, provides the most comprehensive solution to balance operational improvements with environmental stewardship, making it the most favorable choice for the Project. Through this alternative, the Project can best meet the need and overall purpose of this endeavor: to efficiently establish a reliable, drought-proof water supply for the Coastal Bend Region through scalable marine desalination.

8. REFERENCES

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual. Department of the Army, Waterways Experiment Station. Vicksburg, Mississippi. 117 pages.

Environmental Laboratory. 2010. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain (Version 2.0). Department of the Army. U.S. Army Corps of Engineer Research and Development Center. Vicksburg, Mississippi. 182 pages.

Geosyntec, 2025. Biological Assessment. Harbor Island Seawater Desalination Facility. USACE Permit Application SWG-2019-00245. February

Geosyntec, 2025. Draft Individual Permit Application

Lloyd Engineering, 2021. Essential Fish Habitat Assessment for Bluewater SPM Project. August

FIGURES

Project Disturbance Footprint

Proposed Treated Pipelines/Intake and Outfall Pipes

Harbor Island Desalination Plant
Overview of Alternatives

Corpus Christi, Texas

Geosyntec consultants

Figure

1

TXE10785 | February 2025

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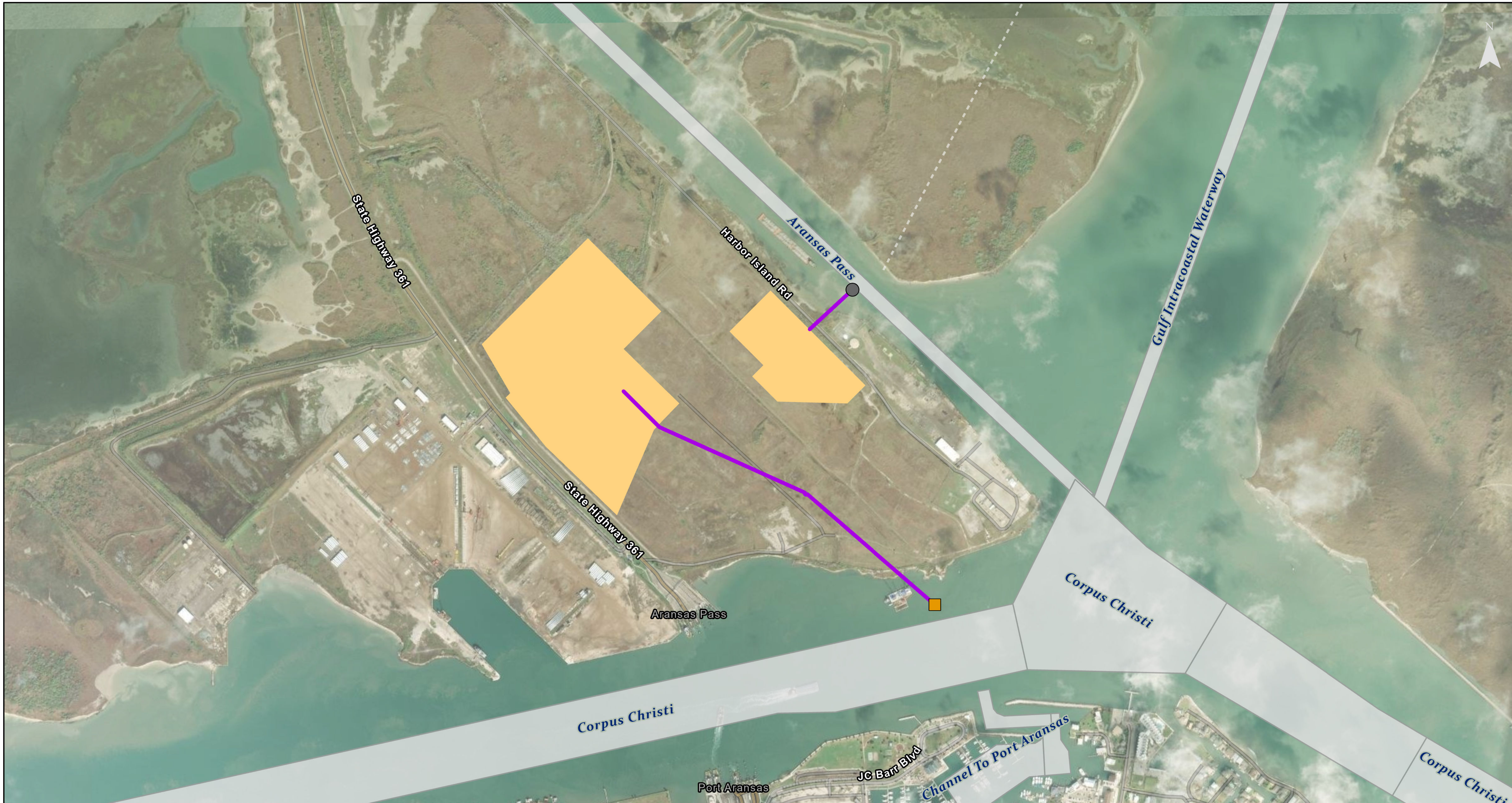

Intake
Outfall
Alternative 1
Desalination and Staging Areas
Navigation Channel

0 0.13 0.25 0.5 Miles

Harbor Island Desalination Plant
Intake and Outfall Configuration
Alternative 1

Corpus Christi, Texas

Geosyntec consultants

Figure

2

TXE10785 | February 2025

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- Intake
- Outfall
- Alternative 2
- Desalination and Staging Areas
- Navigation Channel

0 0.13 0.25 0.5 Miles

Harbor Island Desalination Plant
Intake and Outfall Configuration
Alternative 2

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TXE10785	February 2025	**Figure** 3

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- Intake
- Outfall
- Alternative 3
- Desalination and Staging Areas
- Navigation Channel

0 0.13 0.25 0.5 Miles

Harbor Island Desalination Plant Intake and Outfall Configuration Alternative 3

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TXE10785	February 2025	Figure 4

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- Intake
- Outfall
- Alternative 4
- Desalination and Staging Areas
- Navigation Channel

0 0.25 0.5 Miles

Harbor Island Desalination Plant
Intake and Outfall Configuration
Alternative 4

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Figure 5

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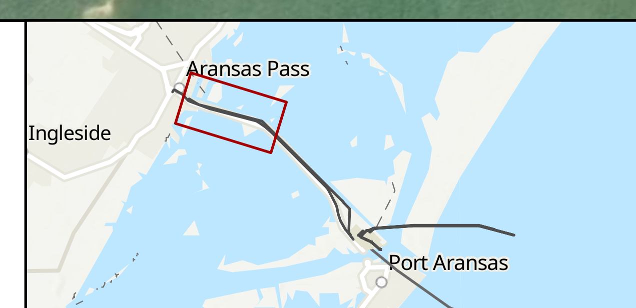
Proposed Pipeline
Impacted Jurisdictional Wetland
Delineated Wetland
Jurisdictional
Deepwater Habitat
Seagrass
Marsh
Potential Oyster Bed



Harbor Island Desalination Plant
Project Environmental Features

Corpus Christi, Texas

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Figure 6.1

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Proposed Pipeline
Impacted Jurisdictional Wetland
Delineated Wetland
Jurisdictional
Deepwater Habitat
Seagrass
Marsh
Potential Oyster Bed

Harbor Island Desalination Plant
Project Environmental Features

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TXE10785	February 2025	**Figure 6.2**

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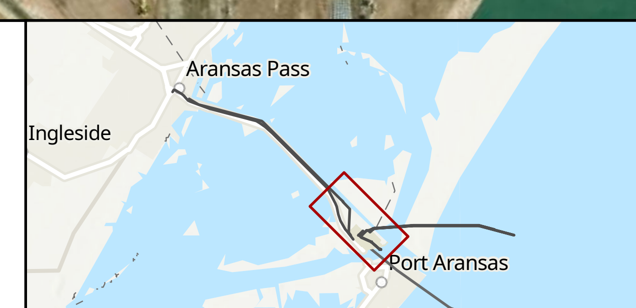
Proposed Pipeline
Alternatives
Desalination Plant
Property Boundary
Staging Area
Impacted Jurisdictional Wetland

Delineated Wetland
Jurisdictional
Non-jurisdictional

Deepwater Habitat
Seagrass
Marsh
Potential Oyster Bed



Harbor Island Desalination Plant Project Environmental Features

Corpus Christi, Texas

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February 2025

Figure 6.3

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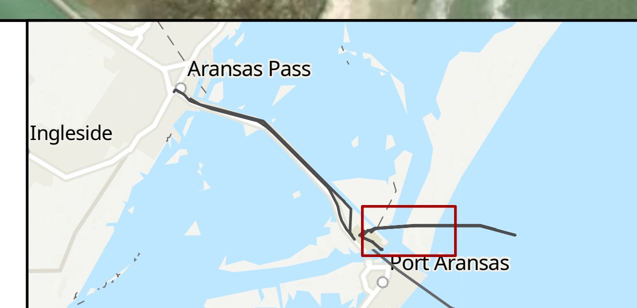
— Proposed Pipeline
— Alternatives
Desalination Plant
Property Boundary
Staging Area

Impacted
Jurisdictional Wetland

Delineated Wetland
Jurisdictional
Non-jurisdictional

Deepwater Habitat
Seagrass
Potential Oyster Bed



Harbor Island Desalination Plant
Project Environmental Features

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TXE10785	February 2025	**Figure** **6.4**

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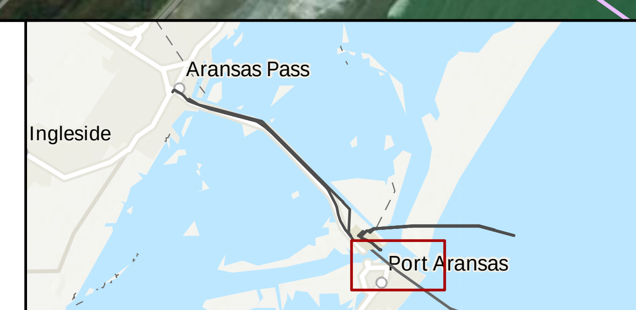
Alternatives
Desalination Plant
Property Boundary

Impacted Jurisdictional Wetland

Delineated Wetland
Jurisdictional
Non-jurisdictional



Harbor Island Desalination Plant Project Environmental Features

Corpus Christi, Texas

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Figure 6.5

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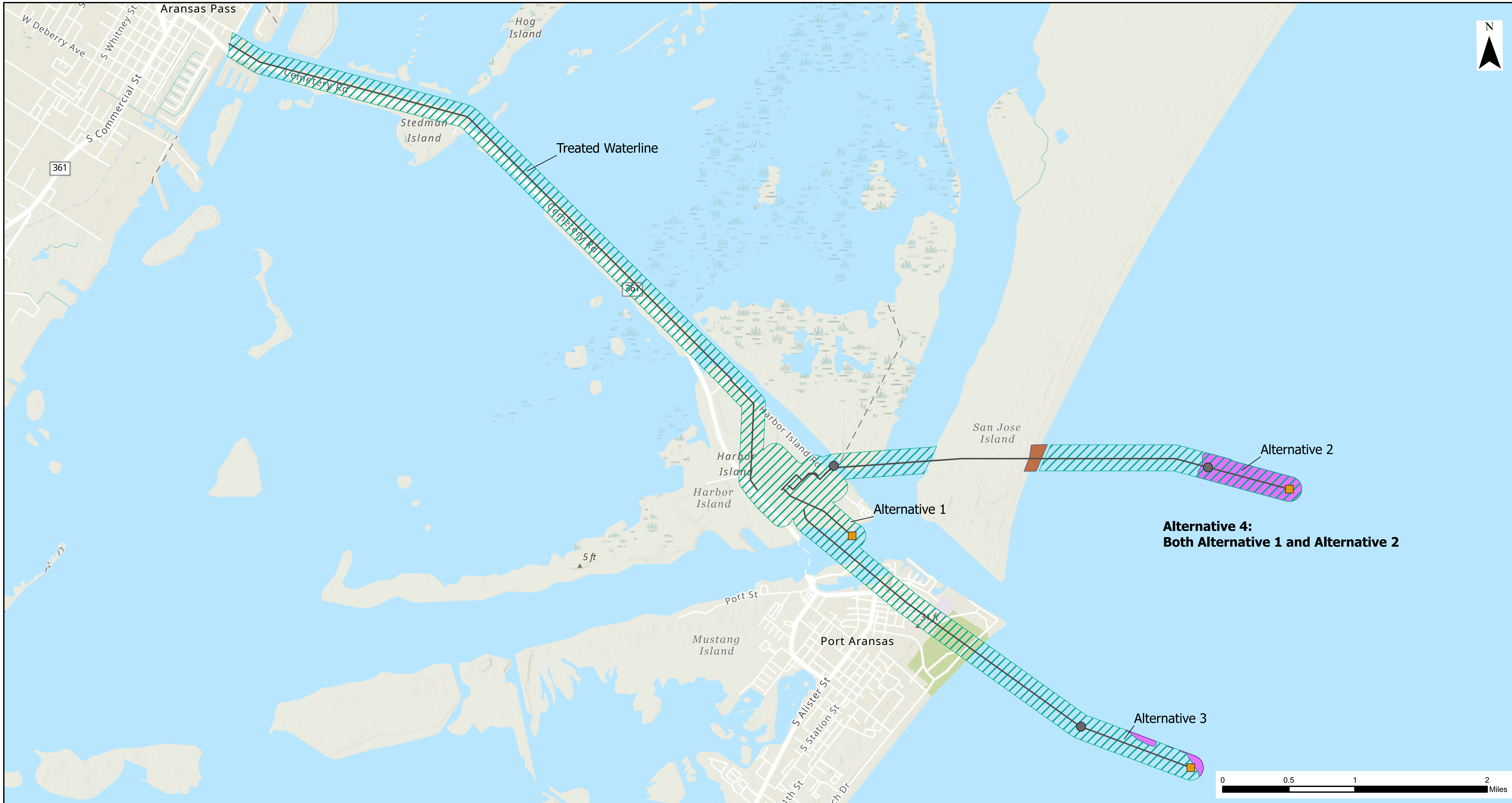

Proposed Pipelines
Intake
Outfall

Critical Habitat within 500 Ft

Green Sea Turtle - Proposed
Piping Plover - Designated
Loggerhead Sea Turtle - Designated

Harbor Island Desalination Plant Threatened and Endangered Species Critical Habitat

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TXE10785	February 2025	Figure 7

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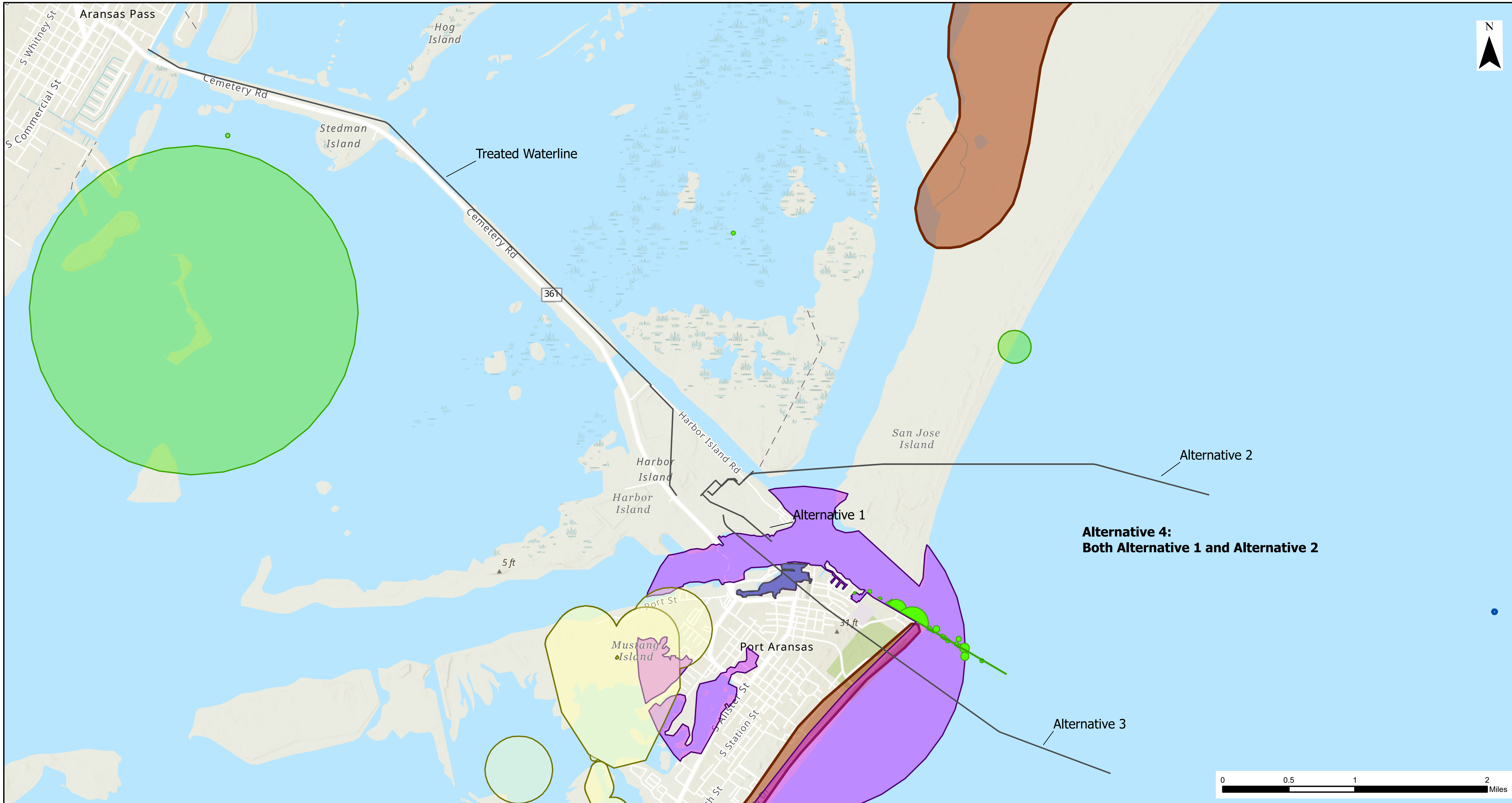

Proposed Pipelines

Species Occurrences (Last Observed Year)

- Piping plover (1991)
- Green sea turtle (2008)
- Whooping crane (2024)
- Loggerhead sea turtle (2004)
- West Indian manatee (2016)
- Atlantic hawksbill sea turtle (1958)

Data obtained from the Texas Natural Diversity Database. Records were filtered to show only species listed as endangered or threatened under the Endangered Species Act. Data accessed February 2025.

Harbor Island Desalination Plant Threatened and Endangered Species Occurrence Records

Corpus Christi, Texas

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Figure 8

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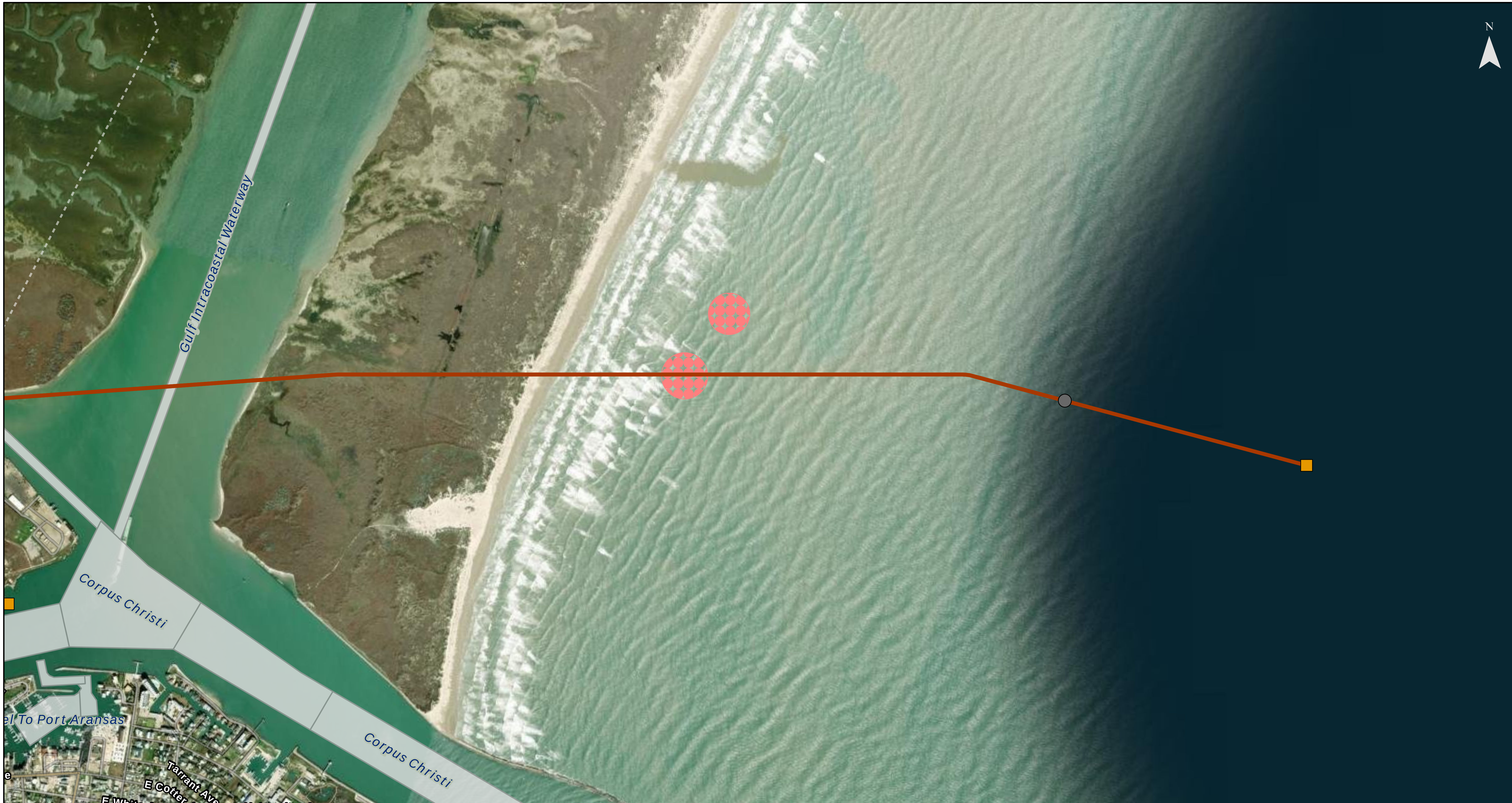


Alternatives 2 and 4
Cultural Sensitive Area
Navigation Channel
Intake
Outfall

0 0.13 0.25 0.5 Miles

Harbor Island Desalination Plant
Cultural Resources

Corpus Christi, Texas

Geosyntec consultants

TXE10785 | February 2025

Figure 9

Z:\AUSTIN\Port_Corpus\Pro_Corpus_Christi\Pro_POCC_AltAnalysis_figures.aprx\AltAnlysis_Cultural 2/5/2025 9:43 PM (JGillespie)

- Project Disturbance Footprint
- Redfish Bay Scientific Area

Other Protected Areas

- Local Conservation Area
- Local Park
- Local Recreation Area
- Marine Protected Area
- Private Conservation

Harbor Island Desalination Plant Protected Lands

Corpus Christi, Texas

Geosyntec consultants

TXE10785	February 2025	Figure 10

Z:\AUSTIN\Port_Corpus\Pro_Corpus_Christi\Pro_POCC_IP.aprx\Protected Areas 2/6/2025 12:07 AM (JGillespie)

APPENDIX K

Statement of Consistency with the Coastal Management Program

Consistency with the Texas Coastal Management Program

The Applicant Should Sign This Statement And Return With Application Packet To:

TEXAS GENERAL LAND OFFICE
COASTAL RESOURCES-FEDERAL CONSISTENCY
1700 NORTH CONGRESS AVENUE, ROOM 330
AUSTIN, TEXAS 78701-1495
federal.consistency@glo.texas.gov

For USACE Use Only:

Permit #: ____________________

Project Mgr: ____________________

Applicant's Name And Address (Please Print):

Title: Director First: Sarah Last: Garza Suffix:

Mailing Address: 400 Charles Zahn, Jr. Drive

Home:

Work: 361.885.6163

City: Corpus Christi State: Texas Zip Code: 78401 Mobile:

Country: USA Email: Sarah@pocca.com Fax:

The Texas Coastal Management Program (CMP) coordinates state, local, and federal programs for the management of Texas coastal resources. Activities within the CMP boundary must comply with the enforceable policies of the Texas Coastal Management Program and be conducted in a manner consistent with those policies. The boundary definition is contained in the CMP rules (31 TAC §27.1).

- To determine whether your proposed activity lies within the CMP boundary, please contact GLO Federal Consistency Staff at federal.consistency@glo.texas.gov

Project Description:

Is the proposed activity at a waterfront site or within coastal, tidal, or navigable waters? ☑ Yes ☐ No

If Yes, name affected coastal, tidal, or navigable waters: Gulf of Mexico; Corpus Christi Ship Channel

Is the proposed activity water dependent? ☑ Yes ☐ No (31 TAC §26.3(a)(14))
https://tinyurl.com/TXCMPdefinitions

Please briefly describe the project and all possible effects on coastal resources:

The Port of Corpus Christi Authority is proposing to construct a 100-million gallons per day marine seawater desalination facility and associated infrastructure to produce a sustainable and drought-proof finished water supply for the Coastal Bend region. This will include construction of a seawater intake pipe, two discharge outfall pipes with diffuser infrastructure, and a finished water distribution pipeline that will run from the facility north to Aransas Pass. It will require seawater collection, and will return effluent water to the Corpus Christi Ship Channel and to the Gulf of Mexico. Additionally, during construction temporary impacts will occur to jurisdictional wetlands located along the distribution pipeline.

Indicate area of impact: 31 ☑ acres or ☐ square feet

Additional Permits/ Authorizations Required:

- ☑ Coastal Easement - Date application submitted: application in process
- ☑ Coastal Lease - Date application submitted: application in process
- ☑ Stormwater Permit- Date application submitted: to be completed
- ☐ Water Quality Certification - Date application submitted:
- ☑ Other state/federal/local permits/authorizations required:

Discharge permit for 100MGD outfall in Gulf - application in process

The proposed activity must not adversely affect coastal natural resource areas (CNRAs).

PLEASE CHECK ALL COASTAL NATURAL RESOURCE AREAS THAT MAY BE AFFECTED:

- ☐ Coastal Barriers
- ☐ Coastal Historic Areas
- ☐ Coastal Preserves
- ☐ Coastal Shore Areas
- ☑ Coastal Wetlands
- ☐ Critical Dune Areas
- ☐ Critical Erosion Areas
- ☐ Gulf Beaches
- ☑ Hard Substrate Reefs
- ☐ Oyster Reefs
- ☐ Special Hazard Areas
- ☑ Submerged Lands
- ☐ Submerged Aquatic Vegetation
- ☐ Tidal Sand or Mud Flats
- ☑ Waters of Gulf of Mexico
- ☑ Waters Under Tidal Influence

The applicant affirms that the proposed activity, its associated facilities, and their probable effects comply with the relevant enforceable policies of the CMP, and that the proposed activity will be conducted in a manner consistent with such policies.

PLEASE CHECK ALL APPLICABLE ENFORCEABLE POLICIES:

https://tinyurl.com/TXCMPpolicies

☐	§26.15 Policy for Major Actions
☐	§26.16 Policies for Construction of Electric Generating and Transmission Facilities
☐	§26.17 Policies for Construction, Operation, and Maintenance of Oil and Gas Exploration and Production Facilities
☐	§26.18 Policies for Discharges of Wastewater and Disposal of Waste from Oil and Gas Exploration and Production Activities
☐	§26.19 Policies for Construction and Operation of Solid Waste Treatment, Storage, and Disposal Facilities
☐	§26.20 Policies for Prevention, Response and Remediation of Oil Spills
☐	§26.21 Policies for Discharge of Municipal and Industrial Wastewater to Coastal Waters
☐	§26.22 Policies for Nonpoint Source (NPS) Water Pollution
☐	§26.23 Policies for Development in Critical Areas
☑	§26.24 Policies for Construction of Waterfront Facilities and Other Structures on Submerged Lands
☐	§26.25 Policies for Dredging and Dredged Material Disposal and Placement
☐	§26.26 Policies for Construction in the Beach/Dune System
☑	§26.27 Policies for Development in Coastal Hazard Areas
☑	§26.28 Policies for Development Within Coastal Barrier Resource System Units and Otherwise Protected Areas on Coastal Barriers
☐	§26.29 Policies for Development in State Parks, Wildlife Management Areas or Preserves
☐	§26.30 Policies for Alteration of Coastal Historic Areas
☐	§26.31 Policies for Transportation Projects
☐	§26.32 Policies for Emission of Air Pollutants
☐	§26.33 Policies for Appropriations of Water
☐	§26.34 Policies for Levee and Flood Control Projects

Please explain how the proposed project is consistent with the applicable enforceable policies identified above. Please use additional sheets if necessary. *For example: If you are constructing a pier with a covered boathouse, then the applicable enforceable policy is: §26.24 Policies for Construction of Waterfront Facilities and Other Structures on Submerged Lands. The project is consistent because it will not interfere with navigation, natural coastal processes, and avoids/minimizes shading.*

The construction of intake and outfall pipes, along with effluent outfall diffusers, have been designed in accordance with the guidelines of TAC §26.24 to ensure minimal impact on coastal resources. The structures will be placed to avoid critical environmental areas and to reduce interference with public access to the Corpus Christi Ship Channel and the Gulf of Mexico. Construction methods will minimize adverse effects on water quality and marine ecosystems by incorporating best practices for erosion control, pollution prevention, and minimizing disruption to natural habitats. The intake and outfall systems will be constructed using materials and techniques that limit the potential for long-term environmental degradation, and they will not be visible at the surface of the water. Additionally, measures are in place to ensure the structures do not prohibit or restrict public access to the waterfront, and that the recreational value of the area is not diminished.

The project has been designed and will be constructed in adherence to the policies outlined in TAC §26.27 and TAC §26.28, which focus on protecting and enhancing the environmental and recreational quality of Texas's coastal zone. In accordance with TAC §26.27, the project will incorporate environmentally responsible design features to minimize adverse effects on water quality, wildlife habitats, and sensitive coastal ecosystems. The siting of the intake and outfall structures have been selected to avoid critical habitats and reduce the risk of disrupting marine life, such as fish and shellfish populations.

The project will align with TAC §26.28, which emphasizes maintaining the ecological productivity of the region by ensuring that water withdrawals and discharges do not significantly alter the natural balance of bay and estuary systems. Fish impingement and entrainment preventatives have been designed and will be constructed around the seawater intake structure to prevent marine organism impacts. At the proposed discharge location and with the 50-port discharge diffuser design, at a horizontal distance of 100 meters from the diffuser, models indicate salinity within the Gulf of Mexico will be < 2 parts per thousand (ppt) above the ambient salinity at any given time. The project will also ensure compliance with water conservation efforts and will work to preserve the long-term sustainability of the coastal environment.

BY SIGNING THIS STATEMENT, THE APPLICANT IS STATING THAT THE PROPOSED ACTIVITY COMPLIES WITH THE TEXAS COASTAL MANAGEMENT PROGRAM AND WILL BE CONDUCTED IN A MANNER CONSISTENT WITH SUCH PROGRAM

Sarah L. Garza | Digitally signed by Sarah L. Garza
Date: 2025.02.24 20:25:38 -06'00' | 2/24/2025

Signature of Applicant/Agent | Date

Any questions regarding the Texas Coastal Management Program should be referred to:

Texas General Land Office
Coastal Resources Division
1700 North Congress Avenue, Room 330
Austin, Texas 78701-1495
Phone: (512) 463-7497
Toll Free: 1-800-998-4GLO
federal.consistency@glo.texas.gov

Print Form

APPENDIX L

Desalination Brine Discharge Modeling – Corpus Christi Bay System

Desalination Brine Discharge Modeling – Corpus Christi Bay System

To:	Sarah L. Garza, Director of Environmental Planning & Compliance Port of Corpus Christi
From:	Jordan Furnans, PhD, PE, PG LRE Water, LLC
Copy	Ben R. Hodges, PhD The University of Texas at Austin
Date:	October 21, 2019

STATE OF TEXAS
JORDAN E. FURNANS
97316
LICENSED
PROFESSIONAL ENGINEER

Executive Summary

The objective of this modeling project was to determine whether the proposed discharge of brine from desalination operations would likely result in environmental conditions that are potentially damaging to the Corpus Christi Bay ecosystem. Specifically, we strove to determine whether a proposed desalination brine discharge within the Corpus Christi Ship Channel near Harbor Island would result in either the formation of a high-salinity water layer along the channel bottom, or would result in an overall or accumulating increase in salinity throughout the Corpus Christi Bay system.

To meet this objective, LRE Water, LLC in conjunction with researchers at The University of Texas at Austin, developed a SUNTANS hydrodynamic model of the Corpus Christi Bay system. The model was modified from an existing system model used to predict the fate and transport of oil spills, and it was specifically designed to simulate the cumulative salinity impacts of a proposed desalination brine discharge into the Corpus Christi Ship Channel near Harbor Island. The SUNTANS model assumes the discharge diffuser will produce a 1% increase in salinity relative to ambient conditions at 400' from the discharge as per the modeling performed and detailed in the representative permit application.

The SUNTANS model was applied to the January 1, 2010-December 31, 2011 period. This period includes a "wet" year (2010) with periodic large freshwater inflows into the bay system, as well as a "dry" year (2011) with prolonged periods of low inflows. These simulation periods were selected to demonstrate the cumulative effect on the transport and mixing of the modeled discharge during both wet and dry conditions. As noted in Longley (1994), the Corpus Christi Bay system has a residence time of 1.4 years. This indicates that the 2-year modeled simulation period (2010-2011) included in this study would have provided sufficient duration for all water within the bay system to have been replaced by inflows.

Limited field data were available for use in validating the SUNTANS model results. Comparisons between observed and measured salinity profiles (collected in 2010 within the center of the Corpus Christi Bay system 13.5 miles from the proposed Harbor Island discharge location) suggest the model tends to over-predict salinity yet reasonably predicts water column stratification. The

SUNTANS model also tends to suggest more uniform vertical mixing than indicated by field data. Comparisons between modeled and observed salinity and temperature time series data from the Corpus Christi Ship Channel adjacent to The University of Texas Marine Science Institute indicate that SUNTANS reasonably predicts changes in salinity over time, yet under-predicts the observed variations in salinity data. The model also tends to over-predict water temperatures during winter months. Analysis of the salinity and temperature time-series comparisons indicates that the SUNTANS model likely under-determines the extent of mixing and water circulation within the Corpus Christi Bay system, at least in the vicinity of the proposed Harbor Island discharge location.

Simulation results during both the 2010 "wet" year and 2011 "dry" years indicate that the desalination brine discharge increases computed salinity by 0-1 ppt in the vicinity of the discharge and throughout the Corpus Christi Bay system, with daily tidal fluctuations continuously mixing the discharge so that stratification is never persistent. This increase is small relative to the 8 ppt modeled variation in salinity resulting from seasonal fluctuations, alternating dry and wet periods, and periods with longer-term variations in tidal elevations. This indicates that inflows, tidal fluctuations, evaporation, and other natural features of the Corpus Christi Bay system play a larger role in determining local salinity than does the proposed desalination brine discharge.

Freshwater inflow events were shown to impact the salinity at the Harbor Island location, with larger inflow events resulting in generally system-wide reductions in computed salinity. However, the inflow events had equal effects on salinities computed with and without simulating the Harbor Island desalination brine discharge, thus indicating that the discharge did not affect the modeled response to the inflow events.

Modeled salinity stratification resulting from the freshwater inflows is prevalent throughout the Corpus Christi Bay system, especially soon after larger freshwater inflow events. Modeled stratification, however, diminishes over time during periods of relatively low freshwater inflows, suggesting that surface winds and tidal fluxes are sufficient to keep the system well mixed from the surface to the bay bottom. Salinity stratification does occur near the Harbor Island discharge, yet only as a result of larger freshwater inflow events. Tidal forcing from the Gulf of Mexico drives much of the diurnal flux of water through the Corpus Christi Ship Channel, and the flux is often stronger near the discharge location due to the relative proximity with the Gulf of Mexico. The stronger tidal flux typically keeps the water column well mixed near the proposed Harbor Island discharge location and tends to rapidly eliminate any stratification that arises after larger freshwater inflow events.

SUNTANS modeling results indicate that within the vicinity of the Harbor Island discharge, vertical mixing of the water column is sufficient to prevent the formation of a persistent high-salinity water layer along on the channel bottom. Results also indicate that the diurnal tidal mixing and water circulation patterns within the Corpus Christi Bay system are such that bottom salinity values increase by 0-1 ppt as a result of the modeled discharge, yet this increase in salinity remains stable over time and does not accumulate. Large freshwater inflow events will tend to cause salinity stratification within the water column near the Harbor Island discharge location, yet the daily, tidally-driven flow of water through the channel tends to rapidly reduce and eliminate stratification resulting from the large freshwater inflow events. The SUNTANS modeling results do NOT indicate that large freshwater inflow events are needed to maintain a vertically-well mixed water column in the vicinity of the proposed Harbor Island discharge.

Based on the SUNTANS modeling presented herein, the Harbor Island discharge location appears suitable in that the saline discharge as proposed in the permit application will not lead to a continual increase in ambient salinity over time in the Corpus Christi Bay System and will not cause the formation of a high-saline layer of water along the channel bottom. Modeling suggests that the proposed discharge will increase ambient salinities by 0-1ppt, and that increases are mitigated by the strong tidal forcing constantly driving water movement within the vicinity of the discharge location. Large freshwater inflow events are not needed to prevent salinity build-up due to the proposed discharge, as daily tidal fluctuations are sufficient for such purposes.

Refinements to the SUNTANS model are recommended if the model is to be used to simulate potential brine discharges at other locations throughout the Corpus Christi Bay system. The proximity of the Harbor Island discharge to the Gulf of Mexico makes these recommended refinements unnecessary for simulating the likely effects of the Harbor Island desalination brine discharge.

Based on the SUNTANS model results presented in this document, LRE Water, LLC concludes that the proposed Harbor Island desalination brine discharge will not lead to the formation of a highly-saline water layer along the channel bottom, nor to an ever-increasing average bottom salinity within the Corpus Christi Bay system. We conclude that the Harbor Island desalination brine discharge, if properly constructed and maintained, will not likely result in environmental conditions that are potentially damaging to the Corpus Christi Bay ecosystem.

Introduction

The objective of this modeling project was to determine whether the proposed discharge of brine from desalination operations would likely result in environmental conditions that are potentially damaging to the Corpus Christi Bay ecosystem. To assess this objective, we revised a previously existing SUNTANS model of the Corpus Christi Bay System (Figure 1) so that the model better represents salinity transport through the bay, including both open water and channel locations. The original SUNTANS model of the Corpus Christi Bay System was developed by researchers at The University of Texas at Austin to support oil spill modeling. SUNTANS was similarly applied to model circulation within Galveston Bay, as documented in Rayson et al (2015).

We simulated the proposed discharge at Harbor Island (Figure 1) to determine: 1) the extent to which the discharge increases the ambient salinity over time, 2) the spatial extent of any salinity increases resulting from the discharge, and 3) the temporal extent of any salinity increases, including the determination of whether the discharge would result in the accumulation of salt over time in the vicinity of the discharge. We also attempted to identify how factors driving bay circulation (namely freshwater inflows and tidal forcing) dictate the fate and transport of the desalination brine discharge. For all simulations, we modeled the discharge as being a constant 95 MGD ("Million Gallons per Day") with a salinity of 48 PPT ("Parts Per Thousand"). Within the permit application for the Harbor Island discharge, the depth of the diffuser is stated to be 63 ft, with the rise to the ports equaling 12 ft. We simulated the depth of the discharge to be 53 ft, which is the current average depth of the Corpus Christi ship channel in the vicinity of the modeled discharge.

Simulations were run for the time period between and including January 1, 2010 to December 31, 2011. This period included a generally "wet" year (2010) with numerous freshwater inflow events exceeding 3,000 cfs as well as an extremely dry year (2011) when inflows remained below 20 cfs for a majority of the year. Tidal forcing was also relatively mild in 2011, which would affect the exchange of water between the bay system and the Gulf of Mexico and could alter the fate and transport of desalination brine discharge.

Model simulations were performed both with and without including the desalination brine discharge. Comparing model results therefore allows for the discernment of salinity variations resulting solely from natural environmental conditions, as well as those resulting from the brine discharge.

The remainder of this report details the revision of the SUNTANS Corpus Christi Bay system model, and our analysis regarding potential impacts of the proposed desalination brine discharge.

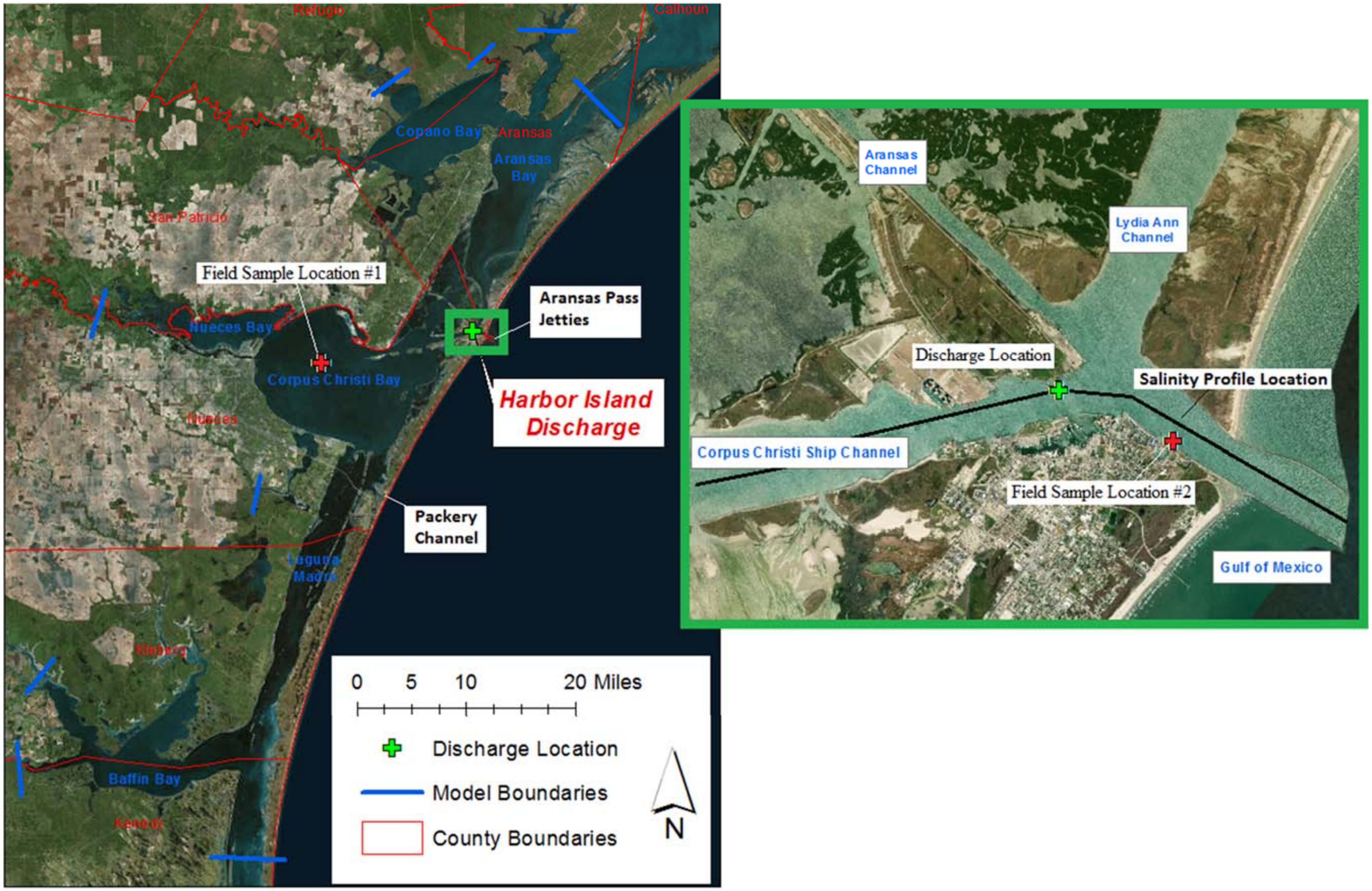


Figure 1 – Corpus Christ System Model Domain showing model boundaries and the location of the Harbor Island desalination brine discharge.

SUNTANS MODEL – Corpus Christi Bay System

As shown in Figure 1, the SUNTANS model of the Corpus Christi Bay system extends from the Northern end of Aransas Bay to Laguna Madre south of Baffin Bay. It simulates water movement through the following bays/waterbodies: Copano Bay, Aransas Bay, Redfish Bay, Corpus Christi Bay, Nueces Bay, Oso Bay, Laguna Madre, and Baffin Bay. Water exchange with the Gulf of Mexico occurs through the Aransas Pass jetties as well as through the Packery Channel. Atmospheric conditions (winds, solar radiation, etc.) were obtained from publically available sources and were identical to those used and incorporated into the SUNTANS model of the system developed for oil spill analysis purposes. The SUNTANS model code is open source, and can be freely obtained from the github page maintained by the model developer, Dr. Oliver Fringer of Stanford University (https://github.com/ofringer/suntans as of 7/1/2019).

SUNTANS Model Modifications

To properly model the proposed desalination brine discharge within the Corpus Christi Bay ship channel, the SUNTANS model required multiple modifications. These modifications included both alterations to the Corpus Christi Bay system representation in the model, as well as alterations to the SUNTANS model code itself. In the following sections, we detail modifications made both to the SUNTANS algorithms, as well as to the model setup for the Corpus Christi Bay system.

SUNTANS Model Modification – Point Source Discharges

The grid cell size surrounding the proposed diffuser site is too large to resolve the complex fluid dynamics in the near field mixing with SUNTANS – that is, near the diffuser the model cannot actually solve how the mixing is occurring, but instead represents the net effects of mixing assuming the diffuser is operating as specified in the instructions LRE was given. We added a new algorithm to SUNTANS to represent the diffuser inflow using the design specification that it always mixes to 1% above ambient, with ambient being defined as the salinity at 51 ft above the bottom for the Harbor Island discharge. In each time step, the additional salinity is handled in a mass-conservative, layer-based mixing routine that serves to mix the incoming salinity with the ambient to achieve the salinity target in the near field. Note that the SUNTANS model cannot predict failure of the diffuser to meet its design specifications when the flow around the diffuser is inadequate. If such conditions occur, the SUNTANS model will predict more mixing than will actually occur. Understanding the interactions of flow with the near-field and far-field will require more comprehensive modeling than undertaken in this project.

SUNTANS Model Modification – Hotstart Capabilities

Prior to use on this project, the SUNTANS model did not have the capability to start in "hotstart" mode. Model "hotstarts" allow for simulations to start using results obtained at the end of previous simulations. Without hotstart capabilities, models are started using assumed initial conditions (water levels, temperatures, salinities, velocities, etc), and then the model is "spun-up" over multiple timesteps until computed model results become independent upon the assumed initial conditions. Results obtained during the "spin-up period" are not to be considered accurate and should not be used in reporting and analyses. For example, when spinning-up the SUNTANS model on the Corpus Christi Bay system, it is necessary to run the model for 2-4 simulated days before results may be trusted. As such, to model January 1-30, for example, it is first needed to model December 27-31, even though the results from the December modeled time period are not to be reported. Adding 2-4 days of spin-up time to each model simulation requires large amounts of physical time, and is both wasteful and inefficient.

To avoid the spin-up problem, researchers at The University of Texas at Austin revised the SUNTANS model source code so that model runs would be initiated with results from previous simulations. This "hotstart" capability now allows for the efficient execution of multiple models that combine to simulate a longer time period. As reported herein, SUNTANS was used to simulate water circulation for the period from January 1, 2010 through December 31, 2011. Having the hotstart capability reduced model execution times by between 20% and 25%.

Corpus Christi Bay System Setup Modifications - Bathymetry

A major driving force in determining water circulation patterns within the Corpus Christi Bay system is the shape of the system, defined by the numerical grid and bathymetric data within the SUNTANS model. Bathymetric data is defined as model input, with the model user supplying the depth (below mean sea level) to the bottom within all grid cells in the simulation. The final bathymetry used in this modeling is shown in Figure 2, which also depicts the entire model domain.

Bathymetry used within the SUNTANS model of the Corpus Christi Bay system is largely identical to that included in the similar SUNTANS model developed for oil spill modeling purposes. However, modifications to the oil spill model bathymetry were needed to make the revised model suitable for desalination brine discharge modeling.

As shown in Figure 2, the SUNTANS model bathymetry contains representations of all channels located within the Corpus Christi Bay system. This includes modeling of the Corpus Christi Ship Channel, La Quinta Channel, Gulf Coast Intracoastal Waterway (GIWW), Aransas Channel, and Lydia Ann Channel. These channels provide conduits for the movement of water, especially in transferring tidal fluxes into and from the Gulf of Mexico. Bathymetry used in depicting the system channels was derived from hydrographic survey data publically available from the U.S. Army Corps of Engineers.

Specific bathymetric modifications included:

- Increasing the depth of the Corpus Christi Ship Channel to 16.08m (52.75 ft)
- Increasing the depth of the La Quinta Channel to 15.0m (49.2 ft)
- Incorporating the GIWW into the model bathymetry, from Aransas Bay southward through Laguna Madre
- Improved connectivity between model grid cells representing the various ship channels
- Improved generalized bathymetry with the bay systems immediately adjacent to the various ship channels.

Figure 3 provides a comparison of the original and revised bathymetry for the portion of the bay system in the vicinity of the Harbor Island discharge location. As evident within Figure 3A, the original bathymetry included a disjointed representation of the Corpus Christi Ship channel, with a depth of only 45 ft (on average). The original bathymetry also did not include the La Quinta Channel, the GIWW, Aransas Channel, or the Lydia Ann Channel. Within the revised bathymetry (Figure 3B), all channels are incorporated into the model, with channel depths reflective of the recent surveys conducted by the USACE. The depth of the Corpus Christi ship channel was increased to 52.75 ft, and the La Quinta Channel was deepened to 49.2 ft. The GIWW was modeled with a depth of approximately 16 ft, and similar depths were imposed within the Aransas and Lydia Ann Channels.

Figure 4 presents the bathymetry of the Corpus Christi ship channel in the vicinity of the proposed Harbor Island discharge location, as measured during 2019 USACE hydrographic surveys. As shown, depths range from 50-60 ft to the west of the discharge, then increase to 90 ft near the discharge location, and return to 50-60 ft to the east of the discharge. These depth changes occur over a distance (west to east) of approximately 2,000 feet.

Within Figure 4, SUNTANS model grid cells (black triangles) are overlain on the bathymetry, with the modeled discharge location located at the center of the horizontal extent representing a single grid cell. In developing the SUNTANS model, each grid cell is assigned a single depth value, and the depths are constant along the entire horizontal extent of the grid cell. For the cell containing the discharge, actual physical depths (based on the available bathymetric data) range from 0 ft to 92 ft. and the depth of the actual bathymetric surface represented by the grid cell is not well-defined using a single depth value. Figure 5 presents the depth options considered when assigning a depth to the cell containing the modeled discharge.

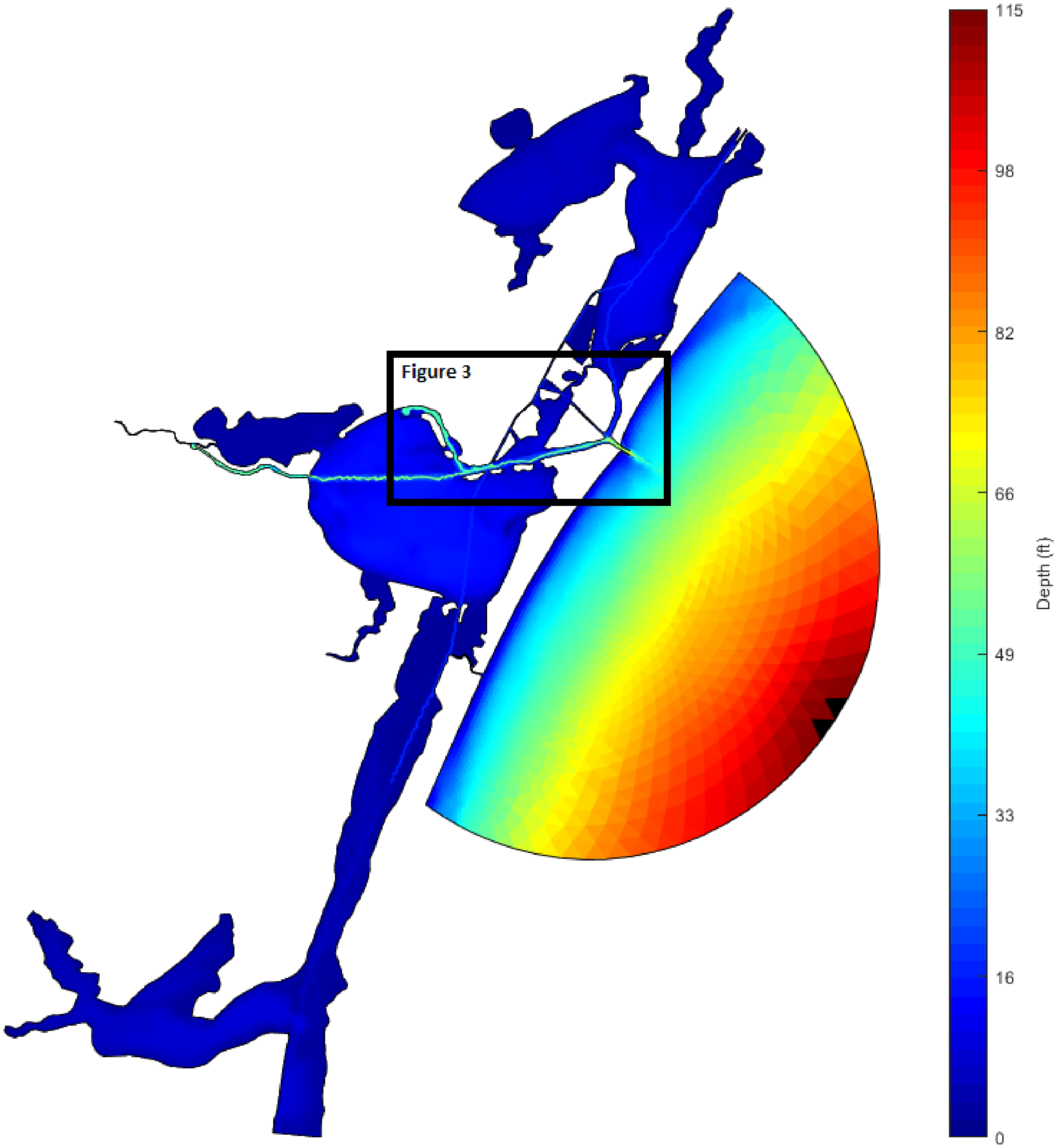


Figure 2 – Final Model Bathymetry for the Corpus Christi Bay System. Bathymetry includes existing ship channels, including the Gulf Intracoastal Water Way (GIWW), the Corpus Christi Ship Channel, and the La Quinta channel. Channel depths were based on hydrographic survey data from recent U.S. Army Corps of Engineers (USACE) surveys, yet modeled channel locations were modified to conform with the existing SUNTANS model grid. Channel widths within the SUNTANS model are generally comparable to the physical widths of the channels, thereby maintaining equality between the modeled and physical conveyance capacity of the channels.

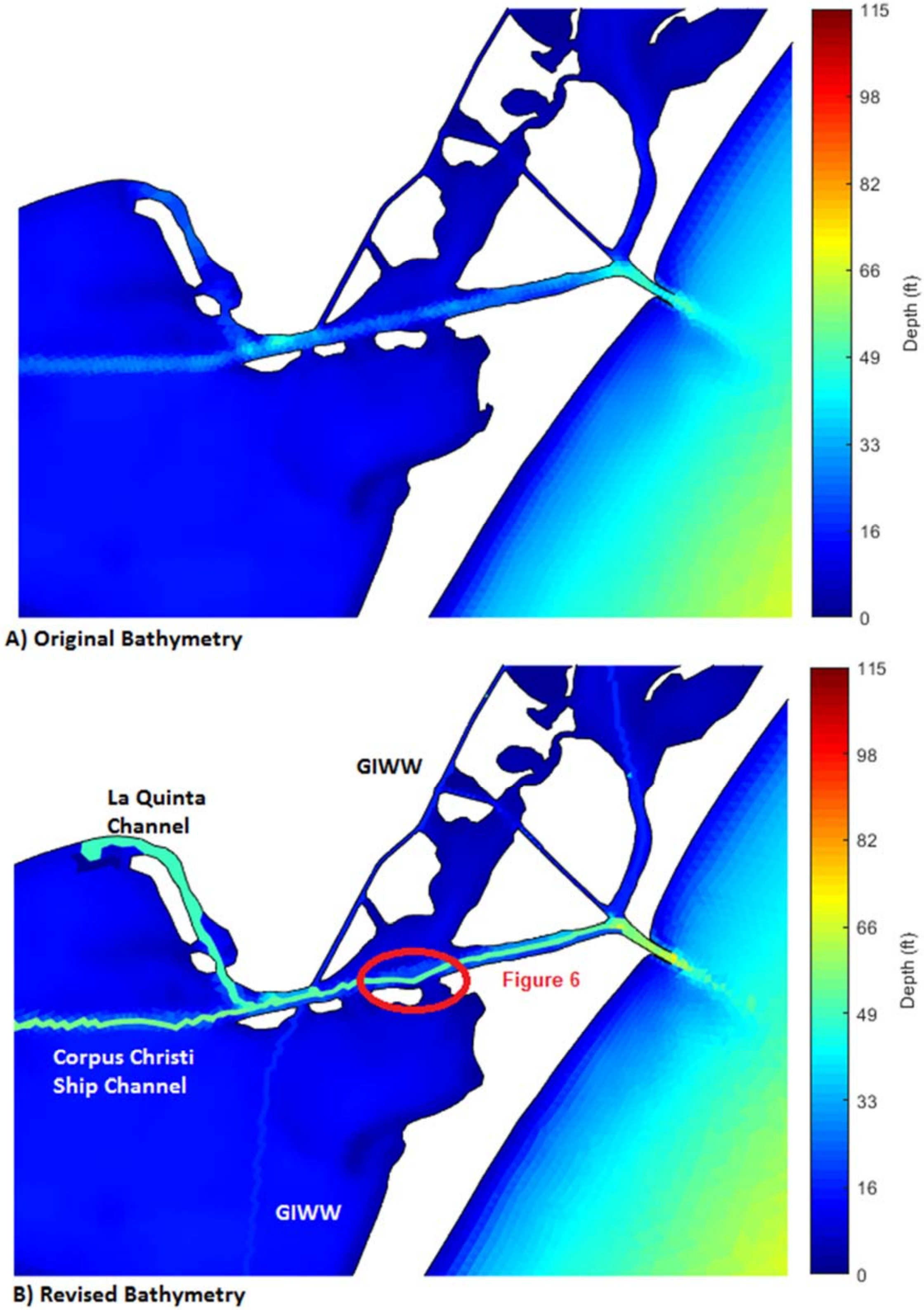


Figure 3 – Original and Revised Bathymetry revisions within the vicinity of the Harbor Island Discharge. A) Original bathymetry from the oil spill model, B) revised bathymetry better representing various ship channels.

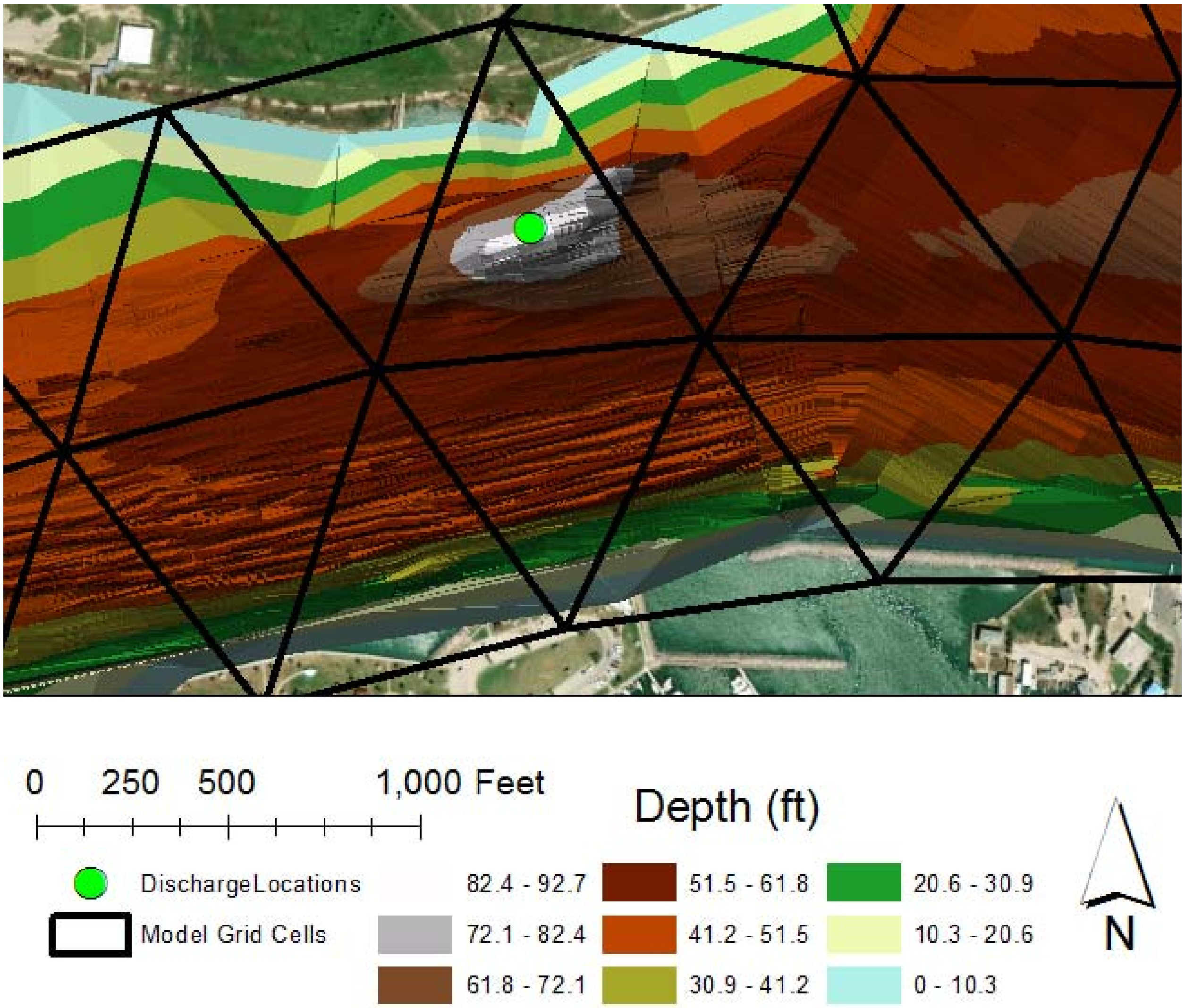


Figure 4 – Bathymetry and model grid cells in the vicinity of the Harbor Island discharge location, from 2019 USACE survey data.

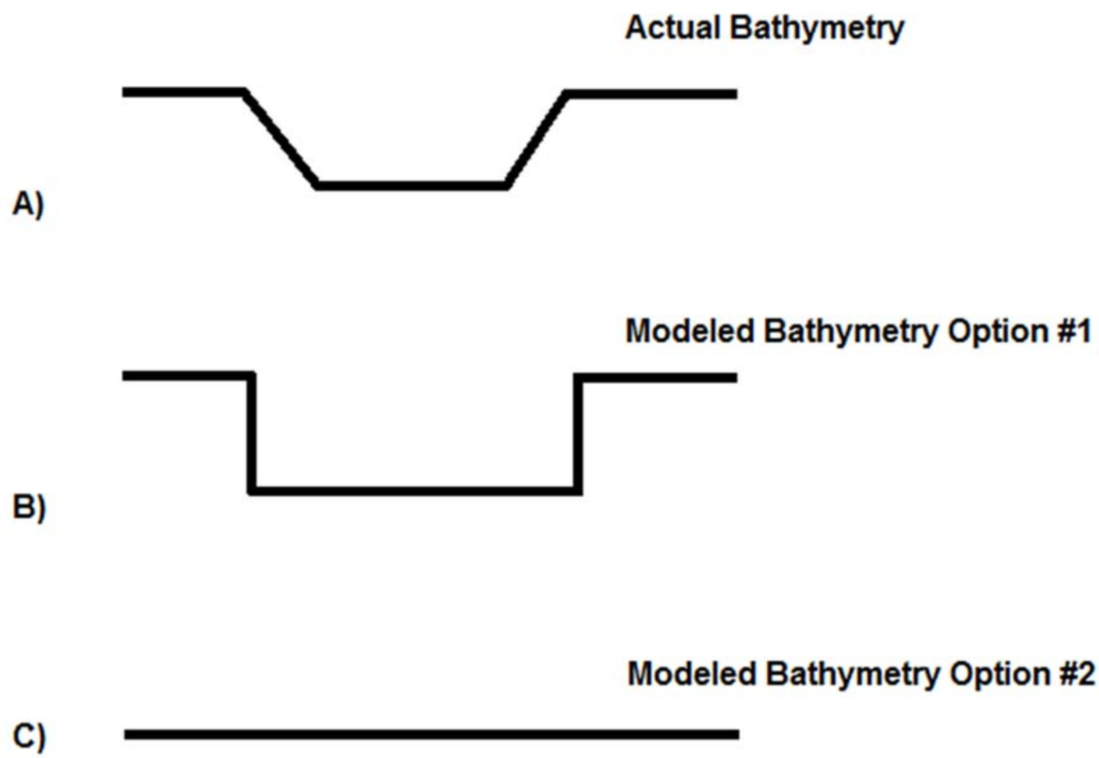


Figure 5 – Possible bathymetric configurations for a W-E cross section through the proposed discharge location. A) the actual bathymetry with a basic trapezoidal shape, B) modeled bathymetry option #1 with vertical walls along the edge of the grid cell containing the discharge, and C) modeled bathymetry option #2 which keeps the channel depth constant and ignores the increase in depth within the terrain spanned by the discharge cell.

The true bathymetry through the discharge location follows an approximate trapezoidal pattern similar to that shown in Figure 5A. It is likely that actual water movement across this portion of the channel is highly turbulent, with flows first decelerating across the depth expansion and then accelerating across the depth contraction. Such accelerations and decelerations would work to enhance vertical mixing of any saline plume from the discharge location, and would lead to plume dispersal throughout both the horizontal and vertical extent of the water column. Modeling this true bathymetry would require significant refinement to the numerical grid used in SUNTANS, and would necessitate decreasing the triangular grid cell size by a factor of 10 (at minimum) to properly simulate the trapezoidal shape. Such grid refinement would have been required throughout the entire model domain, and (while possible) would have resulted in significantly slower model run-times. Such grid refinement was outside the scope of this project.

To better represent the true bathymetry, LRE also considered "Modeled Bathymetry Option #1," which consists of modeling the cell containing the discharge as having a depth approximately 30 ft greater than the depths of the surrounding grid cells. In such a scenario (Figure 5B), water flowing through the channel would simply pass over the deeper portion of the grid cell, and negligible circulation is to be expected within the portion of the discharge-cell's water column that extends below the depths of the neighboring cells. Modeling the discharge in this deeper portion of the water column, however, would still show vertical mixing across the water column, per the methodology developed to simulate the discharge. It is possible that higher salinity water would accumulate in the isolated bottom waters within the deeper discharge cell, yet LRE believes this unlikely due to the diffuser design and rapid horizontal transport of water through the ship channel at this location.

LRE selected "Modeled Bathymetry Option #2" (Figure 5C) as the best option for simulating the Harbor Island discharge conditions. This option included assigning the discharge cell a depth equal to that of the surrounding grid cells making up the Corpus Christi Bay Ship Channel. With a uniform cross section, vertical mixing is only enhanced by any vertical shear (i.e. differences in velocities with depth) within the channel water column. This vertical mixing likely under-represents the actual mixing that would occur as a result of both the vertical shear in the water column and the flow acceleration and deceleration resulting from the true bathymetry (trapezoidal shape – Figure 5A). Thus by modeling a bathymetry likely to under-represent the extent of vertical mixing within the vicinity of the Harbor Island discharge, model results are likely to under-represent processes that will lead to the prevention of saline layer formation along the benthos. LRE selected Modeled Bathymetry Option #2 as the conservative approach to simulating the vicinity of the discharge. This approach also did not require refinement of the model grid.

Along with adjusting the channel depths, bathymetric revisions required continuity in depths between adjacent model grid cells representing ship channels, as well as continuity in depths of cells immediately adjacent to the ship channels. This ensures that the channels are represented in the model as efficient conduits of water movement, rather than as adjacent shallow and deep cells included within the original bathymetry.

To ensure continuity between adjacent cells representing ship channels, it was often required to adjust the channel locations within the SUNTANS model grid. This is evident in

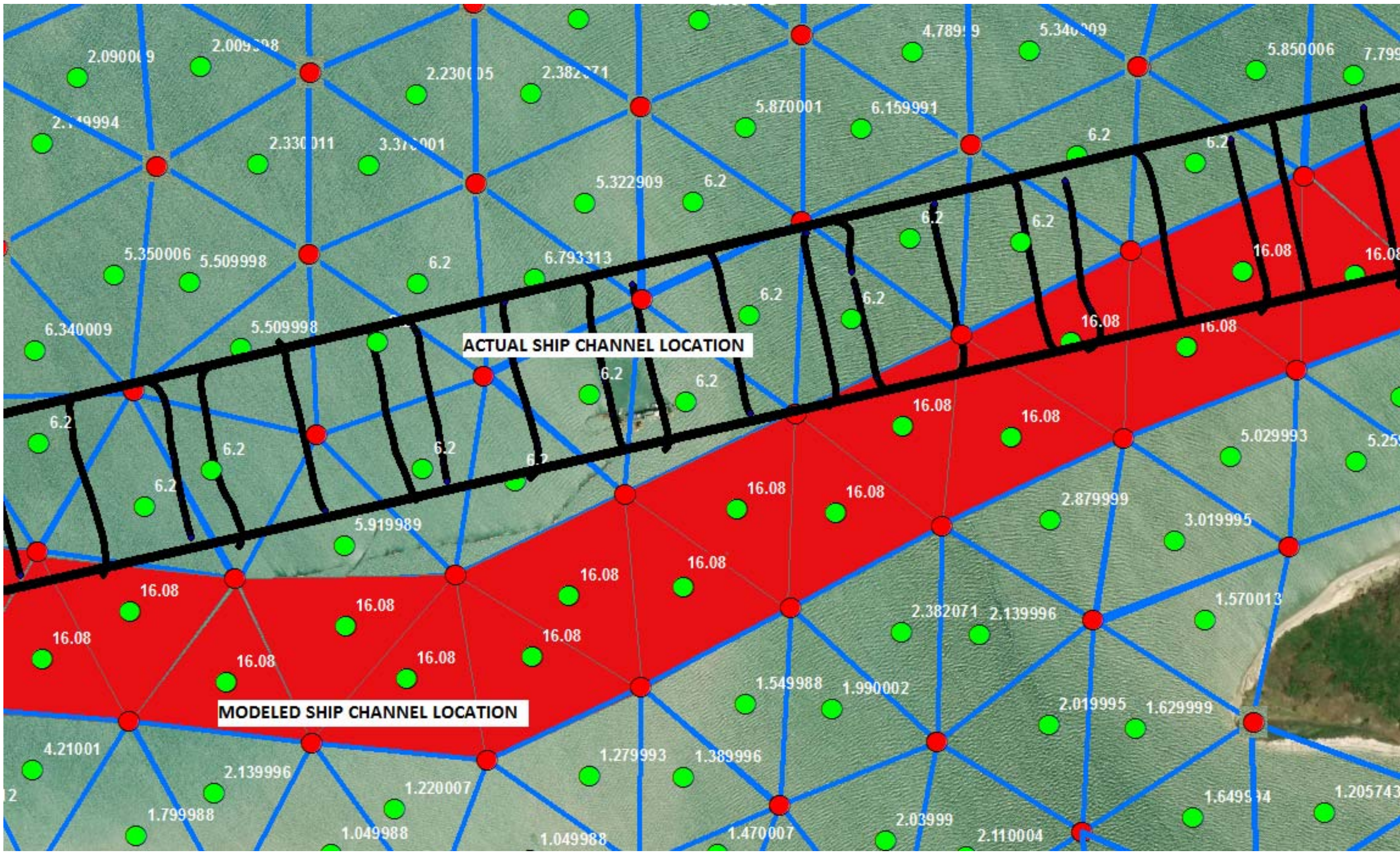


Figure 6, which shows the separation between the modeled and physical location of the Corpus Christi ship channel. The separation was required in order to keep the width of the modeled ship channel approximately equal to the physical ship channel width, and to maintain a rather uniform width along the channel length.

Figure 6 shows the surveyed location of the Corpus Christi Channel (Black lines), in comparison with the modeled channel location (Red Triangular polygons). In the right side of the image (closer to the Gulf of Mexico), the modeled channel location and width coincides well with the surveyed location and width. However, upon moving to the right across the image, the deviation between modeled and physical channel location increases, yet the modeled width remains constant. This separation was required based on the location of the triangular grid cells used to model the SUNTANS bathymetry. Forcing the modeled ship channel to be located at the physical channel location would have required either a substantial revision to the model grid, or would have resulted in an artificially wide and irregularly shaped channel. The artificially wide and irregularly shaped channel would not have accurately represented the physical movement of water within the channels. By maintaining consistency between the modeled and physical channel widths, we ensure that the modeled channel will convey approximately equal quantities of water as the physical channel. Water velocities within the modeled channel, however, are likely to be lower than those in the actual physical channel, as a result of energy loss due to the modeled channel bends.

Revising the model grid to better incorporate ship channel locations was outside the scope of this project, yet is recommended should further modeling efforts be undertaken.

LRE Water does not expect that grid revisions will significantly alter the computed fate and transport of the Harbor Island desalination brine discharge. However, an improved model grid will be important in accurately representing flow through the La Quinta, Aransas, and Lydia Ann channels. As modeled herein, these channels are generally wider than their physical counterparts, which would result in lower modeled in-channel velocities and could impact computed mixing and salinity profiles.

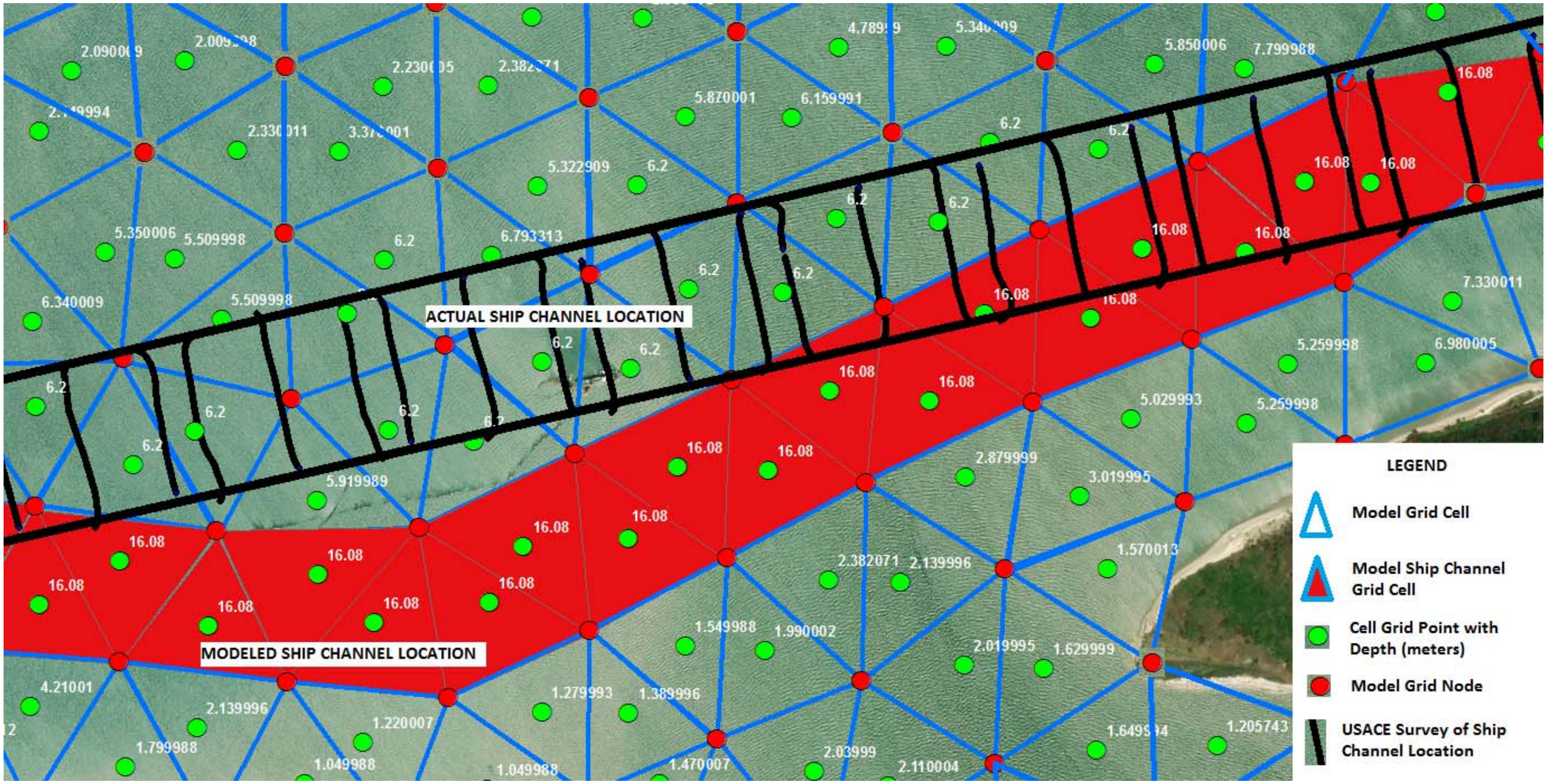


Figure 6 - – Modeled vs. Actual location of the Corpus Christi Ship Channel. The modeled channel (red cells) are located slightly to the south of the actual ship channel, and the modeled channel includes bends not present within the actual channel. The separation between modeled and actual channel locations, as well as the bends in the model channel, result from the coarse triangular model grid used within SUNTANS. The modeled channel retains the approximate width of the actual channel, which ensures that the modeled channel will convey similar quantities of water as the actual channel. Bends in the channel, however, will result in reduced velocities in the modeled channel compared to those expected to exist in the actual channel.

SUNTANS Model Setup - Inflows

Along with bathymetry, water circulation and salinity levels are largely dictated by the freshwater inflows entering into the Corpus Christi Bay system. Inflows are specified as model inputs, and within the SUNTANS Corpus Christi Bay system the following inflow sources are included:

- Oso Creek at Corpus Christi, TX (USGS Gauge #08211520)
- Copano Creek near Refugio, TX (USGS Gauge #08189200)
- Nueces River near Mathis, TX (USGS Gauge #08211000)
- Aransas River near Skidmore, TX (USGS Gauge #08189700)
- Mission River at Refugio, TX (USGS Gauge #08189500)
- Rincon Bayou Channel near Calallen, TX (USGS Gauge #08211503)

Inflows entering the bay system at each of these locations will vary in time, and will introduce freshwater at different rates, resulting in variable mixing and flushing impacts throughout the bay system. Figure 7 depicts the total modeled freshwater inflows into the Corpus Christi Bay system for the modeled period from January 1, 2010 to December 31, 2011. This model period was selected in part due to the large variation in inflow conditions that occurred during this time. For example, 2010 was generally considered a “wet” year across Texas, and as shown in Figure 7 contained four inflow events that approached or exceeded 4,000 cfs. These events, including the large 20,000 cfs inflow event that occurred from mid-September to early October 2010, are likely to lower salinities throughout the bay, including those that may result from the modeled desalination brine discharge. Aside from these high inflow events, 2010 also included periods of low inflows, during which salinity increases are likely. Modeling 2010 is therefore likely to produce information related to salinity accumulation and flushing frequency during wet periods.

In contrast to 2010, 2011 is often considered as the single worst drought year in recorded Texas history. Figure 7 demonstrates the difference between inflows in 2011 and 2010, with 2011 only having two small inflow events, and with having long periods of total inflows less than 20 cfs. Modeling 2011 is therefore likely to produce information related to salinity accumulation during long dry periods. Inflow conditions in 2011 are likely to represent a “worst case” scenario for assessing the impact of the Harbor Island desalination brine discharge on salinity levels within the bay system.

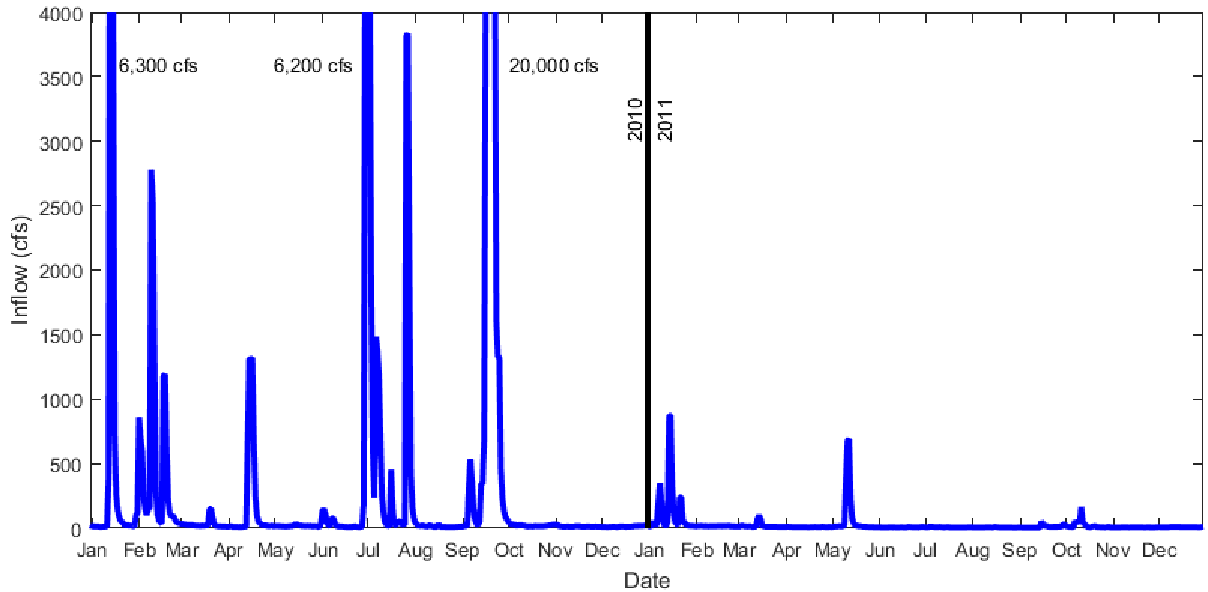


Figure 7 – Total Modeled Freshwater Inflow (2010-2011) into the Corpus Christi Bay System

SUNTANS Model Setup – Tidal Forcing

Along with bathymetry and freshwater inflows, water circulation and salinity levels are largely dictated by the tidal forcing, which governs the exchange of water between the bay systems and the Gulf of Mexico. Within the Corpus Christi Bay system SUNTANS model, tidal forcing is specified as modeled input water levels at the outermost model cells representing the Gulf of Mexico (Figure 1). Water levels uses as model input were based on data recorded at Bob Hall Pier and available through the TCOON network and other sources.

Figure 8 presents the time-series of water levels driving tidal forcing within the Corpus Christi Bay System SUNTANS model. Similar to the freshwater inflow data (Figure 7), water levels in 2010 were different than those in 2011, and the contrast in levels between the two periods will likely yield differing effects with regard to the system's ability to assimilate the desalination brine discharge. Water levels in 2010 exhibit a larger seasonal variation than those in 2011, and include higher water levels generally from April through August. Higher water levels indicate periods of greater influx of seawater into the bay system, which could tend to enhance mixing within the Corpus Christi Ship Channel where the Harbor Island discharge is located. In contrast, water levels in 2011 remain fairly constant, indicating only a limited exchange of water between the bay system and the Gulf of Mexico. This limited exchange could lead to a reduction in tidal mixing and a possible accumulation of salinity resulting from the brine discharge.

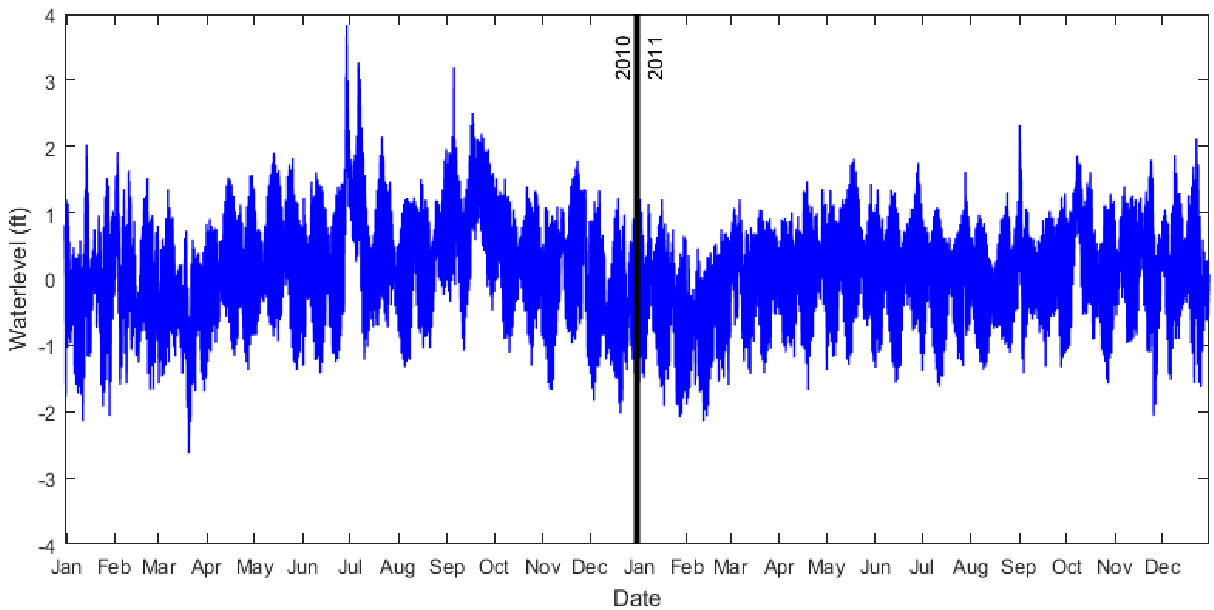


Figure 8 – Water levels used to impose tidal forcing within the Corpus Christi Bay system SUNTANS model.

SUNTANS Model Validation

Prior to assessing SUNTANS model results with regard to the Harbor Island discharge, it is necessary to establish that the model is capable of reasonably representing the physical conditions driving water circulation and salinity distribution within the Corpus Christi Bay system. Model validation often requires detailed comparison between modeled and measured parameters, should sufficient measured data be available. The goal of the model validation effort is to establish that the SUNTANS model is capable of reproducing results (i.e. water velocities, temperatures, and salinity profiles) that are reasonably accurate with respect to measured results.

Model validation was not originally part of the scope of this project, as it was assumed that the SUNTANS model of Corpus Christi Bay developed for oil spill modeling (from which this model was based) had been already validated against measured field data. During the course of this project effort, LRE could not verify that the SUNTANS model had been validated in this manner, and as such we decided to perform a limited model validation exercise to provide greater confidence in the model results presented herein. The model validation exercise presented herein is to be considered "limited" because only two datasets were available for comparing modeled and measured data, and the measured field data was NOT collected within the vicinity of the proposed Harbor Island discharge.

To partially validate the SUNTANS model, LRE obtained two datasets of field measurements: 1) profiles of salinity with depth, collected from within the Corpus Christi Ship Channel in the main body of the bay by researchers during a 2011 project by the Texas Water Development Board (TWDB), and 2) a time-series of water temperature and salinity collected within the Corpus Christi

Ship Channel adjacent to The University of Texas Marine Science Institute. Both field sampling locations are shown as red crosses in Figure 1. Data from field measurements #1 are documented in TWDB contract report No. 1004831013 (Hodges, 2011). Data from field measurements #2 are publicly available at https://cdmo.baruch.sc.edu/ under the site name "MARSCWQ."

Figure 9 presents a comparison of modeled and observed salinities with depth at TWDB waypoint 30 within the Corpus Christi ship channel in the main body of Corpus Christi Bay. As shown, the SUNTANS model produced salinity values that were up to 2.5 ppt greater than measured values. Both measured and modeled data indicate salinity stratification with depth, with the difference between surface and bottom salinities each equal to 2.5 ppt. The modeled salinity profile, however, indicates larger stratification within the first few feet below the surface but greater mixing through the water column overall. The general agreement between the modeled and observed salinities at depths exceeding 45-ft is encouraging in that the SUNTANS model is reproducing the observed properties of the bay system along the benthos. A 0.75 ppt difference between observed and modeled salinities below 45 ft is less important than the fact that both profiles exhibit minimal change in values with depth below 45 ft.

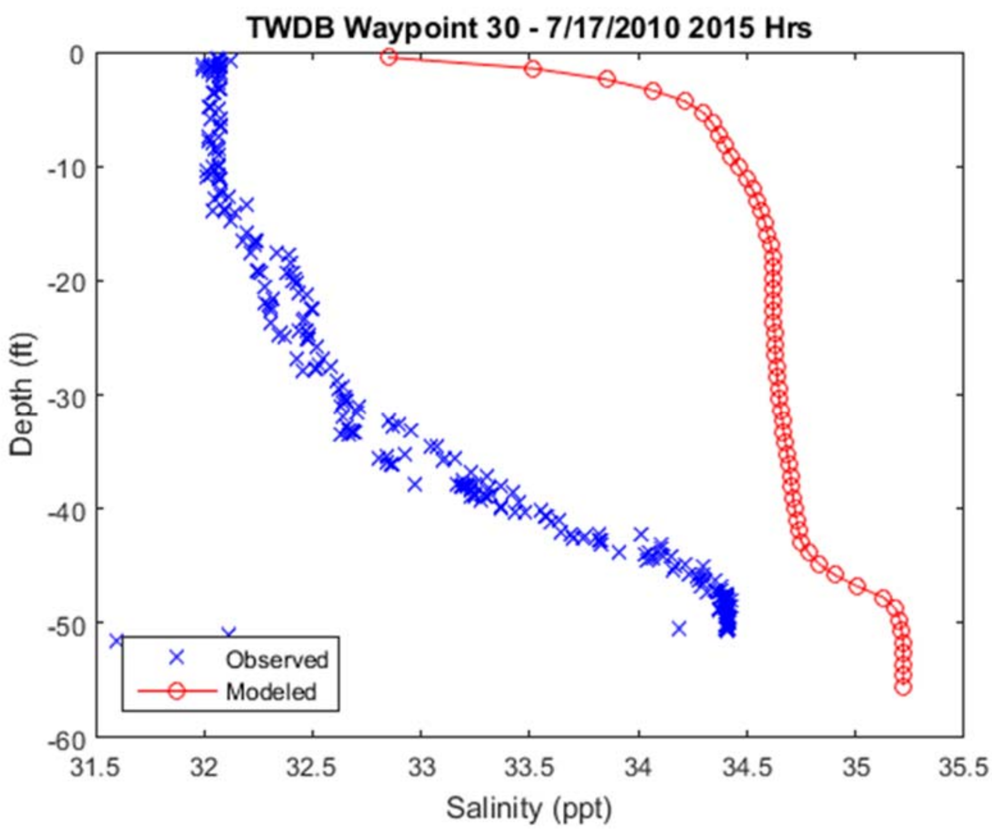


Figure 9 – Modeled and observed salinity profiles with depth from 7/17/2010 at TWDB waypoint 30 within the Corpus Christi Bay ship channel.

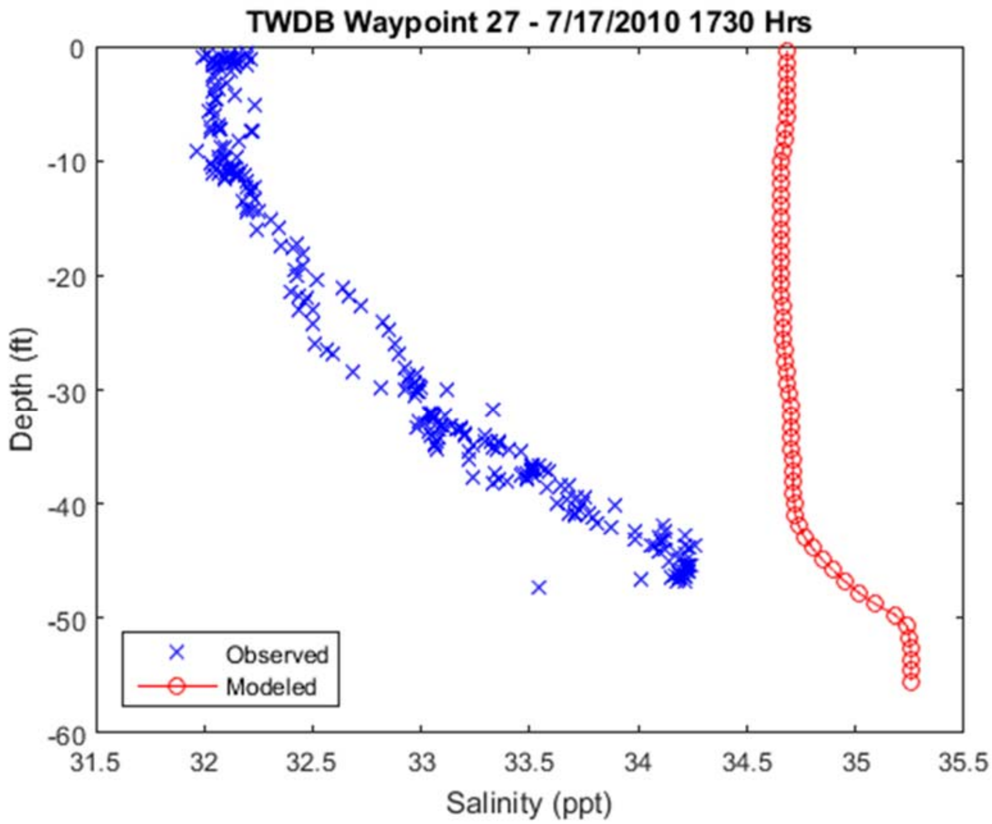


Figure 10 - – Modeled and observed salinity profiles with depth from 7/17/2010 at TWDB waypoint 27 within the Corpus Christi Bay ship channel.

Figure 10 presents a comparison of modeled and observed salinity profiles from a second location within the Corpus Christi Ship Channel, located approximately1.3 miles east of TWDB waypoint 30 (Figure 9). At this location, the SUNTANS model over-predicted the bay salinity by 2.5 ppt near the surface, and by 1.25 ppt at depth. The model also under-calculated water column stratification, as modeled stratification only occurred below 40 ft depths, whereas observed stratification began at a depth of 10 ft. Both the model and observed data demonstrated uniform salinity profiles from the surface to 10ft depths.

Given the limited extent of available field data, it is not possible to develop quantitative metrics for assessing the SUNTANS model’s performance. However, comparisons between modeled and observed data from Figure 9 and Figure 10 provide confidence that the SUNTANS model is reasonably able to predict salinity stratification, and suggest that the model may over-predict actual bay salinity. It should be noted that TWDB Waypoint 30 and TWDB Waypoint 27 are 13.5 and 12.2 miles, respectively, from the Harbor Island discharge, and therefore these modeled vs. observed comparisons may not be indicative of similar comparisons that would be made at the Harbor Island discharge location (if measured data were available).

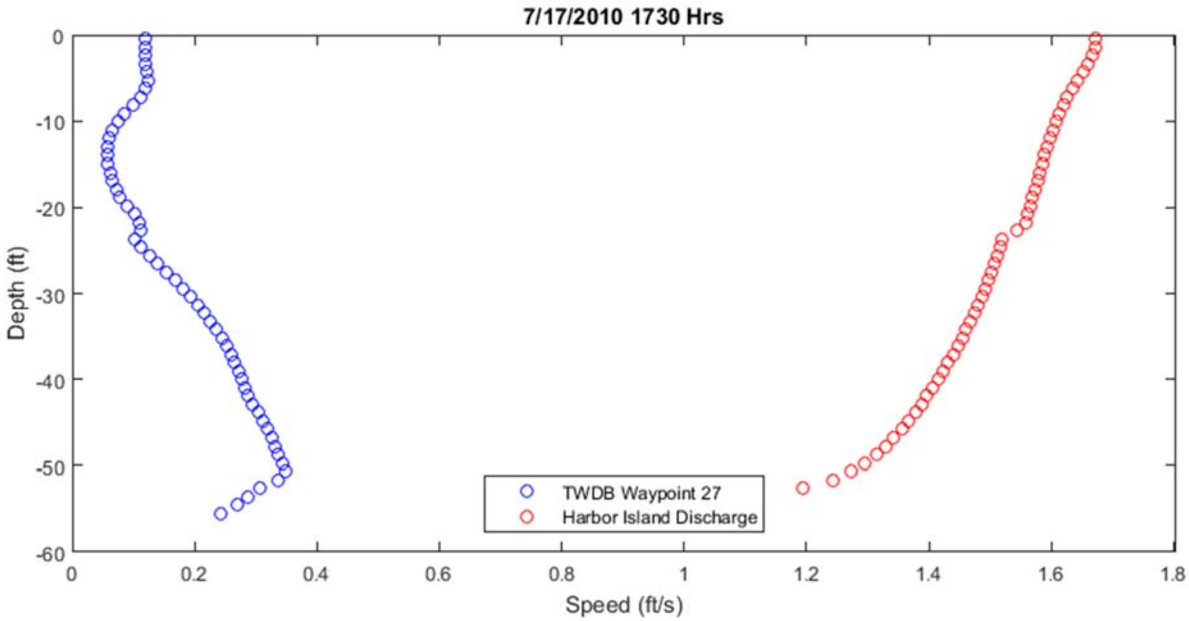


Figure 11 – Modeled water velocities at TWDB waypoint 27 (Figure 10) and at the Harbor Island discharge location.

Figure 11 presents a comparison of velocity profiles modeled at the TWDB waypoint 27 and Harbor Island discharge location. As indicated, water velocities at the discharge location range from 1.6 ft/s to 1.2 ft/s, whereas those at the TWDB waypoint range from 0.05 ft/s to 0.35 ft/s. The greater velocities at the Harbor Island discharge location are reflective of the tidal influence on water movement at that location. There is also notable velocity shear within the water columns at both locations, suggesting strong vertical mixing in both areas. The larger velocities shown in Figure 11for the Harbor Island location support the notion that model validation conclusions drawn from Figure 9 and Figure 10 may not be valid for the area in the vicinity of the proposed desalination brine discharge.

Figure 12 presents a time-series record of salinity measures at 5.5m depth within the Corpus Christi Ship Channel adjacent to The University of Texas Marine Science Institute. Data is plotted at 15-minute intervals from late 2007-late 2017. As shown, salinity variations from 15 to 40 ppt have occurred, with generally higher salinities recorded in summer months when freshwater inflows are often lower and evaporation is often higher. Figure 13 presents a comparison of the modeled and measured salinities at this location for the 2010-2011 time period. As shown, the modeled salinities are generally in-line with measured values, yet are less variant than the observed values. This suggests that the SUNTANS model is not able to capture the large temporal variations in salinity within the Corpus Christi Ship Channel. These large variations are likely due to strong freshwater inflow or tidal variations driving more water circulation than suggested from the SUNTANS model. Thus Figure 12 would indicate that the SUNTANS model generally under-predicts water mixing and movement within the Corpus Christi Bay Ship Channel.

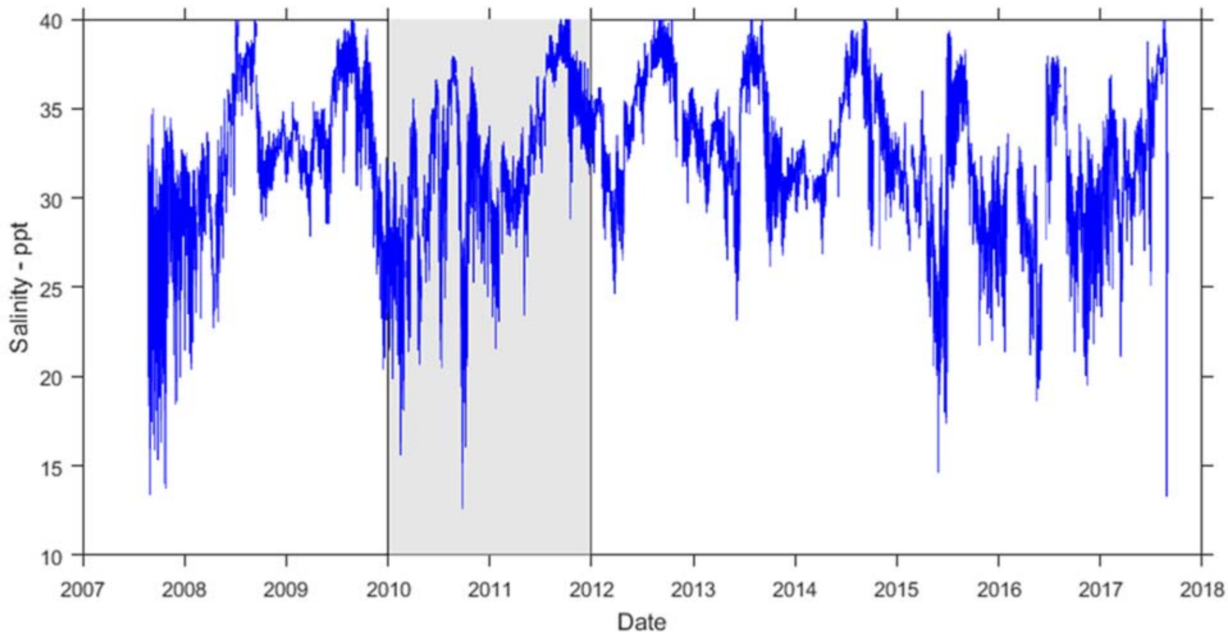


Figure 12 – Measured salinity at 5.5m depth within the Corpus Christi Ship Channel adjacent to The University of Texas Marine Science Institute. Grey area indicates the period of SUNTANS modeling.

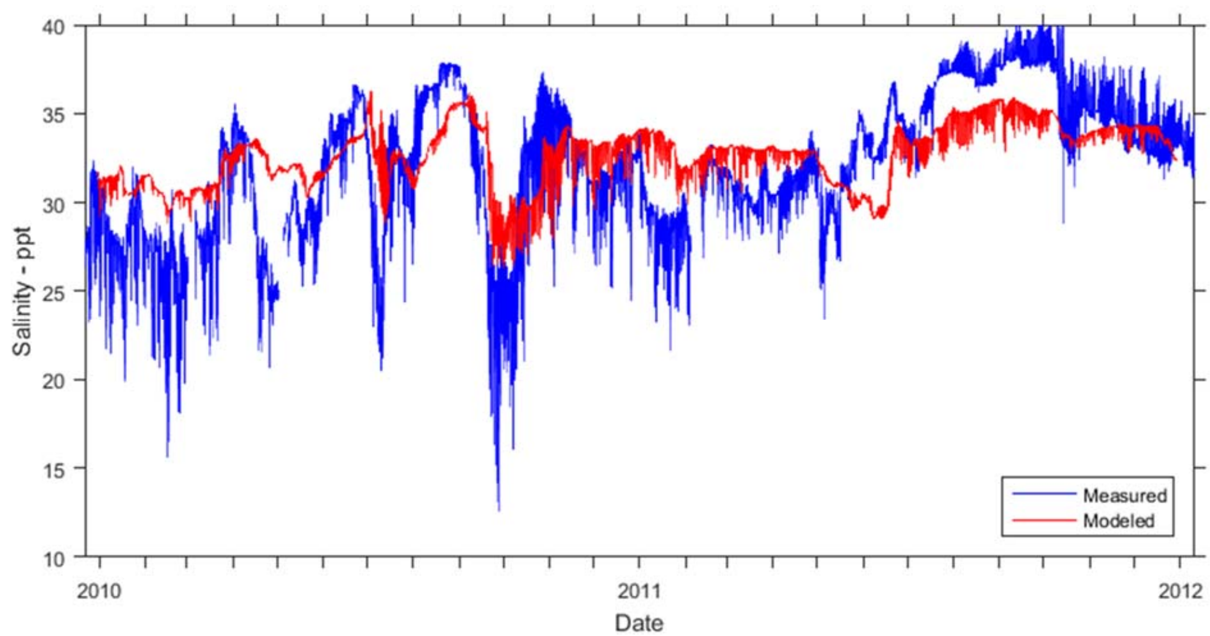


Figure 13 – Measured and modeled salinity at 5.5m depth within the Corpus Christi Ship Channel adjacent to The University of Texas Marine Science Institute.

Figure 14 presents a time-series plot of recorded temperature at 5.5m depth within the Corpus Christi Ship Channel adjacent to The University of Texas Marine Science Institute. As shown, temperatures show regular fluctuations over the calendar year, and generally range from 50 °F to 90 °F. Temperature fluctuations measured in 2010-2011 are similar in range and magnitude as for other years for which data are available.

Figure 15 presents a comparison of the modeled and measured temperatures at 5.5m depth within the Corpus Christi Ship Channel adjacent to The University of Texas Marine Science Institute for the period from 2010 to 2012. As shown, for 2010 modeled temperatures nearly always exceeded measured temperatures, yet each dataset indicated similar daily and seasonal patterns. Modeled temperatures tended to exceed measured temperatures to the greatest degree during the winter months, suggesting that the SUNTANS model does not release heat energy appropriately at these times. For 2011, measured and modeled temperatures tended to agree more (than in 2010), with modeled temperatures often 1-5 degrees below the measured temperatures. For the period in late 2011, modeled temperatures exceeded measured temperatures, providing further indication that the SUNTANS model retains too much heat energy during the cooler months.

Overall, the general agreement between measured and modeled temperatures shown in Figure 15 suggests that SUNTANS is reasonably able to model the complex thermodynamic mechanisms dictating temperature changes within the Corpus Christi Bay system. SUNTANS algorithms could likely be improved to better model the cooler months, and such modifications could influence computed salinity distributions and water circulation patterns. Such adjustments could yield more variability within the computed salinity values, and could lead to better agreement between modeled and observed salinity results (Figure 13).

Based on the limited available data for use in model validation, LRE concludes that the current SUNTANS model is likely to under-predict mixing of the proposed desalination brine discharge. This conclusion stems on the model's inability to reproduce the large salinity variations present within the Corpus Christi Ship Channel (Figure 13), as these large variations would be the result of greater mixing and circulation of water through the area around the discharge. It is also notable that while SUNTANS over-predicted salinity values within the main body of Corpus Christi Bay (Figure 9, Figure 10), this over-prediction was not constant over time and was less common near the discharge location (Figure 13). Considering the available model validation data, it is likely that any SUNTANS-computed increase in salinity as a result of the Harbor Island discharge would be overstated as field data indicates greater mixing and water movement than do model results.

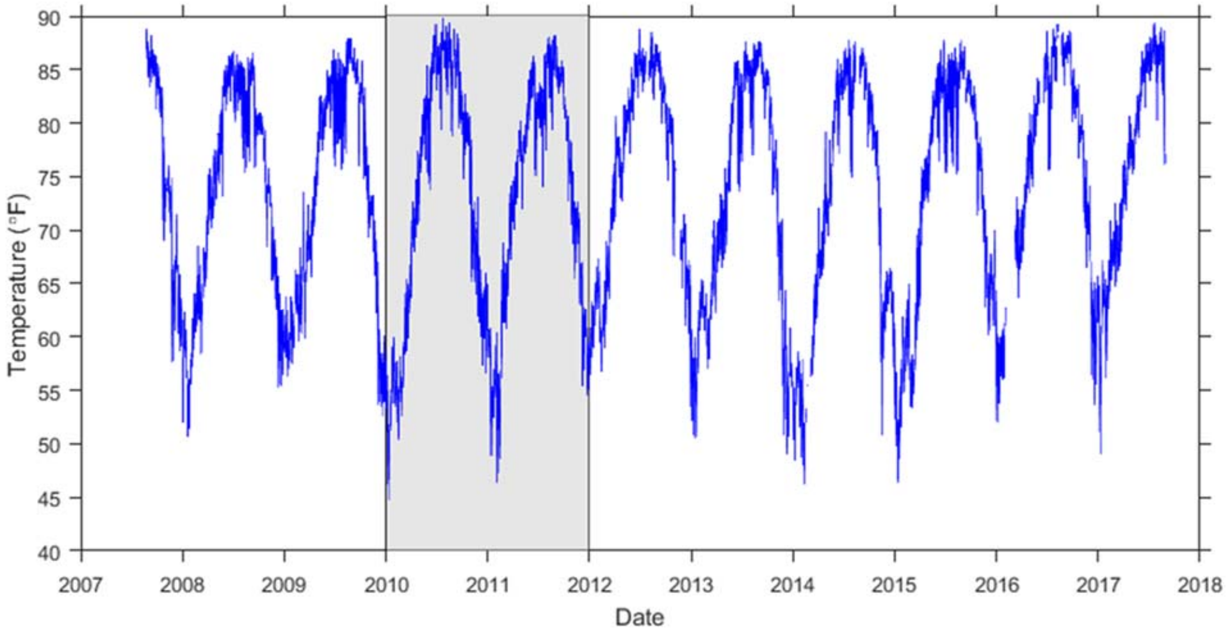


Figure 14 – Measured water temperature at 5.5m depth within the Corpus Christi Ship Channel adjacent to The University of Texas Marine Science Institute. Grey area indicates the period of SUNTANS modeling.

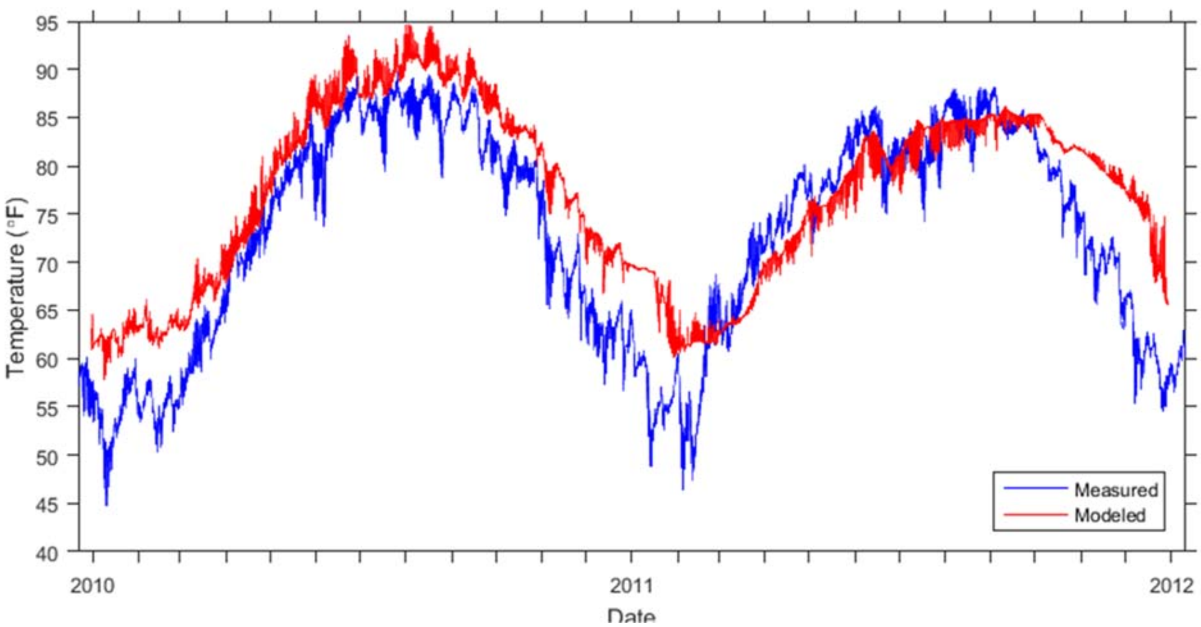


Figure 15 Measured and modeled water temperature at 5.5m depth within the Corpus Christi Ship Channel adjacent to The University of Texas Marine Science Institute.

SUNTANS Model Results

Modeled Salinity Near the Harbor Island Discharge

SUNTANS model results can be displayed in a variety of ways, and the results presented herein were chosen as they are illustrative of the impact of the desalination discharge. Figure 16 presents the computed bottom salinity at the Harbor Island discharge location for the period from January 1, 2010 to December 31, 2011. Time series of plotted results include results obtained with (red) and without (blue) the modeled discharge.

For the 2010-2011 modeled period, salinities computed with the brine discharge are generally between 0 and 1 ppt greater than those computed without the discharge (Figure 16B). This trend was evident during periods of prolonged low inflows and periodic high inflows, indicating that the salinity increase resulting from the brine discharge was not largely effected by the freshwater inflows to the bay system. However, during and after the large inflow event from September 2010, modeled salinities with the discharge would periodically be lower than those computed without the discharge. The cause for this result was not fully identified, yet is likely due to the reduced local mixing in the non-discharge scenario.

For 2010, modeled bottom salinities with and without the discharge started at approximately 31.5 ppt on January 1 and decreased to just under 30 ppt as a result of the two large inflow events in January and February. Modeled salinities increased to 34 ppt during the dry period between March and July, with a slight temporary decrease evident due to the small inflow event that occurred in mid-April. Modeled salinities decreased to under 30 ppt as a result of the 6,300 cfs inflow event in early July, then increased to 36 ppt in April. The large inflow event (20,000 cfs) in September reduced the modeled salinity to between 28 ppt and 31 ppt, where it remained during October. At the end of October, salinities rapidly increased to approximately 34 ppt, where they remained through December.

For 2011, modeled salinity values with and without the discharge continued to follow a similar pattern, with a slight decrease resulting from the small inflow event in mid-May. Modeled values increased to near 36 ppt from July through September and remained between 34 ppt and 36 ppt for the rest of the year without significant freshwater inflows to drive the salinity lower. The difference in salinity between the modeled and without-modeled discharge continuously fluctuated, but never exceeded 1 ppt for all of 2011.

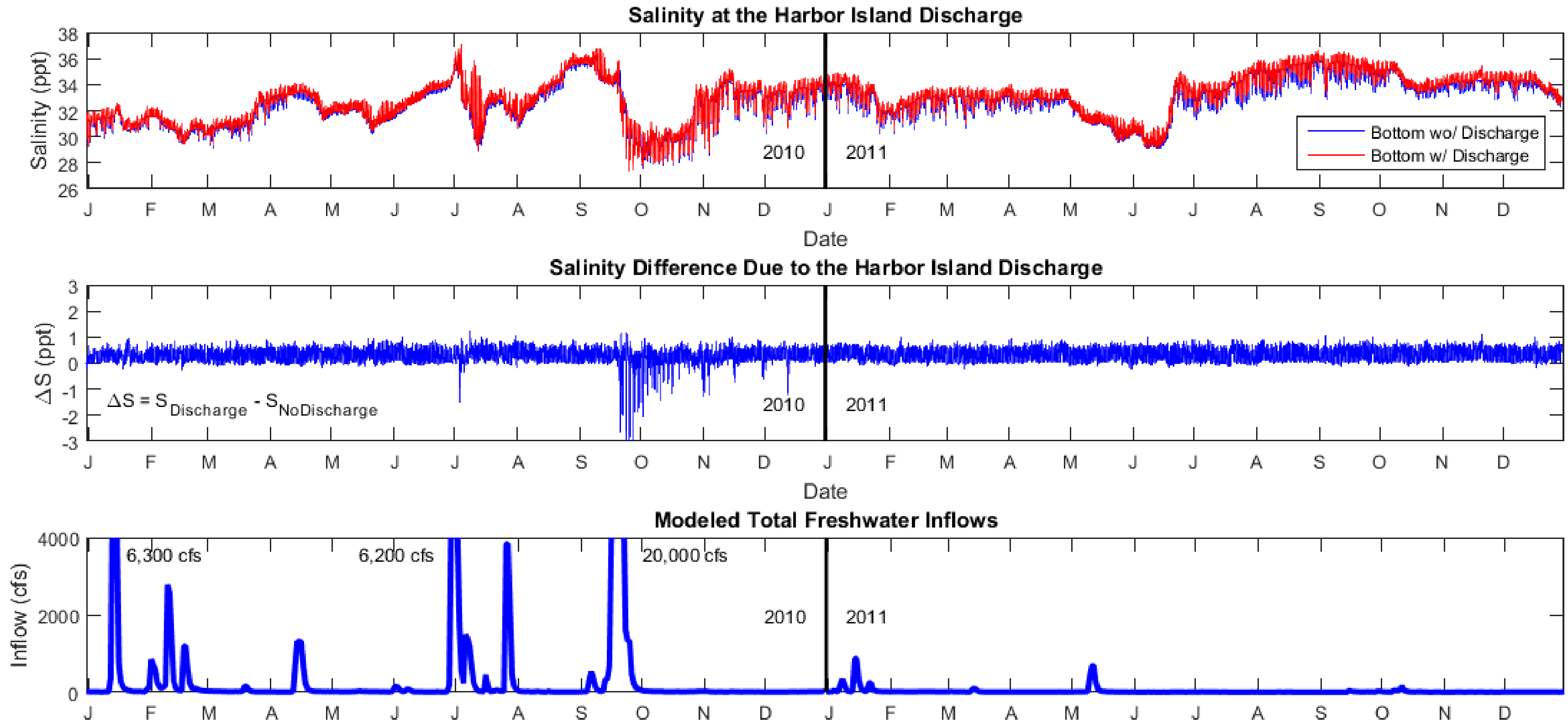


Figure 16 – Modeled Bottom Salinity values at the Harbor Island discharge location, January 1, 2010 to December 31, 2011. A) Salinity time series, including computed salinities with and without the brine discharge. B) salinity difference between simulations with and without the discharge B) Modeled freshwater inflows, repeated from Figure 7.

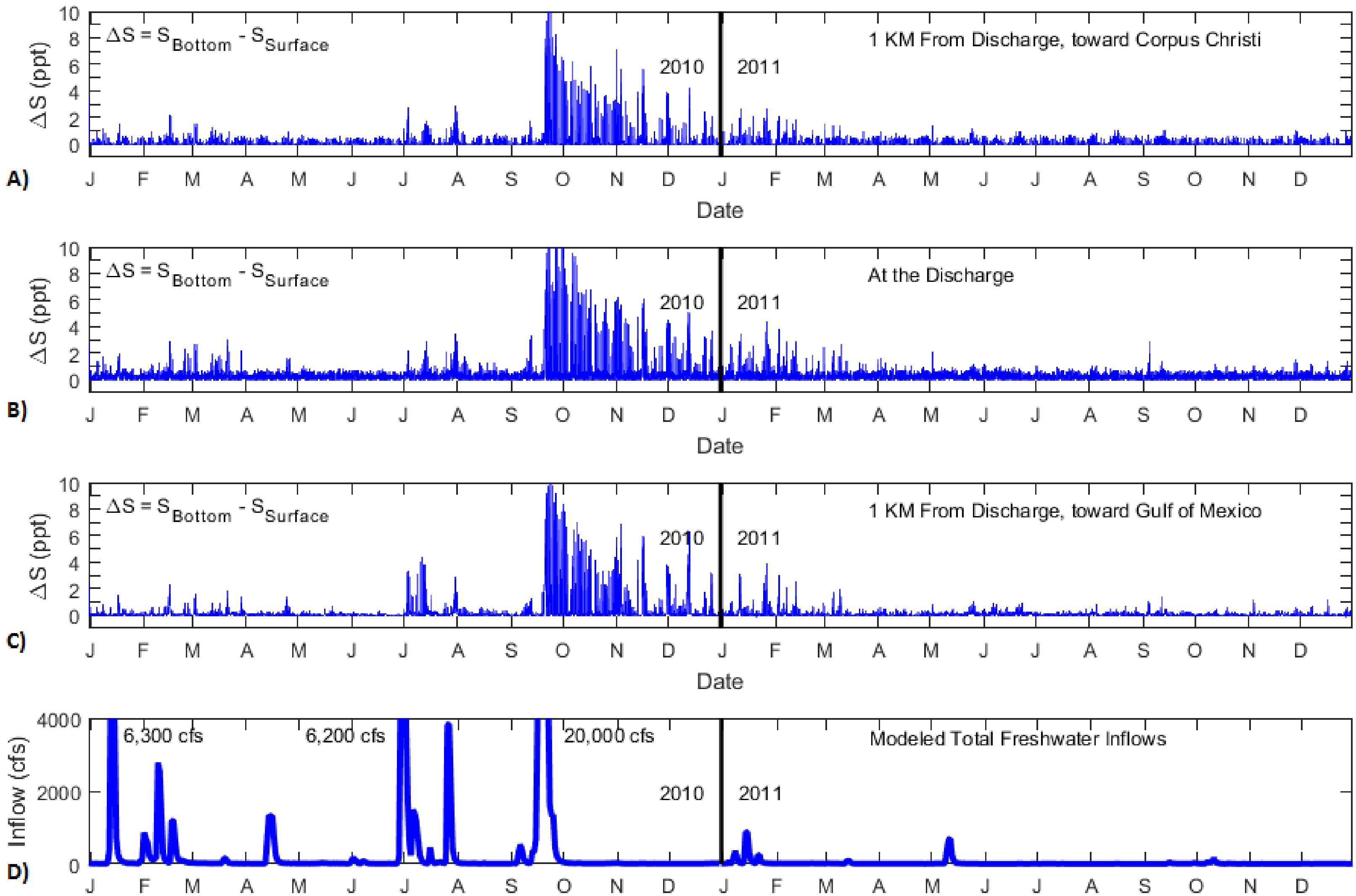


Figure 17 – Modeled salinity stratification for 2010-2010 , defined as the difference between bottom and surface salinities- A) stratification at a location 1-kilometer "up-channel" from the Harbor Island discharge (toward Corpus Christi). B) stratification at the Harbor Island discharge location. C) stratification at a location 1-kilometer "down-channel" from the Harbor Island discharge (toward the Gulf of Mexico). D) Modeled freshwater inflows, repeated from Figure 7.

Figure 17 presents model calculated salinity water-column stratification (defined as the salinity difference between the bottom and surface layers) for the modeled period (2010-2011) for locations 1 kilometer upstream (toward Corpus Christi) and downstream (toward the Gulf of Mexico) from the Harbor Island discharge, as well as at the discharge location. As shown, stratification is greatest at the discharge location, and diminishes in magnitude at the locations away from the discharge. The large inflow event in September 2010 caused a stratification of approximately 10 ppt as fresher, lower salinity water traveled along the surface on top of the denser higher salinity water near the bottom. Modeled stratification from this freshwater inflow event diminished yet persisted through March of 2011 as evident at each of the three locations plotted in Figure 17. Stratification is less pronounced toward the Gulf of Mexico, indicating that daily tidal forcing causes the water column to generally remain well mixed, thus preventing the creation of high-salinity layers along the channel bottom, and preventing the buildup of high salinity resulting from the brine discharge.

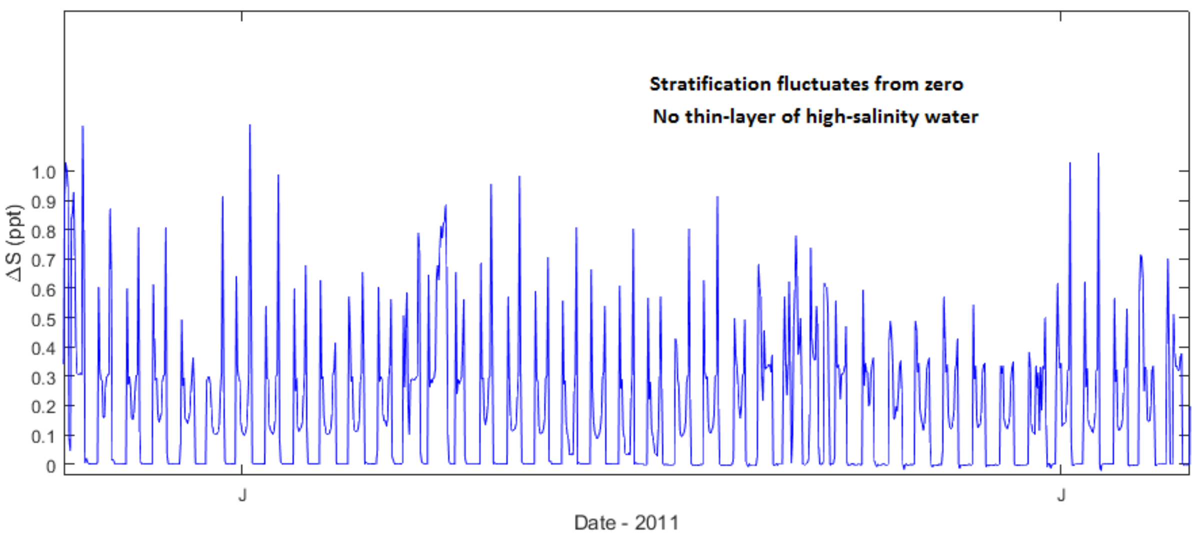


Figure 18 – Stratification at the Harbor Island discharge location for June, 2011, showing fluctuations varying based on the daily tidal influence.

Figure 18 presents a "zoomed-in" view of the computed salinity stratification at the Harbor Island discharge location for the month of June, 2011. This was a period of low freshwater inflows, and water column mixing was dominated by the diurnal tidal forcing. As shown, stratification occasionally exceeded 1.0 ppt, yet always fluctuated back to zero due to the tidal mixing. This demonstrates that the modeled brine discharge does not create a durable, persistent high-salinity layer along the channel bottom. Mixing dynamics at the discharge location are such that the brine discharge yields minimal impacts on ambient salinity.

It is notable that for the Harbor Island location, salinity values with and without the modeled brine discharge varied uniformly, with each time series increasing and decreasing at the same time and in approximately the same magnitude (Figure 16). This indicates that the brine discharge itself does not significantly affect the local salinities, and that the higher salinity resulting from the discharge does not continuously accumulate over time.

It is also notable that the 2010 variation in salinity (ranging from 28 to 36 ppt) greatly exceeds the salinity increase (0-1ppt) resulting from the brine discharge. This indicates that inflows, tidal fluctuations, evaporation, and other natural features of the Corpus Christi Bay system play a larger role in determining local salinity than does the proposed desalination brine discharge. The 2010-2011 results suggest that the discharge of high-salinity brine into the Corpus Christi ship channel does not produce an increase of over 1 ppt change in local salinity values, whether or not large freshwater inflow events periodically occur. An analysis of how a 1 ppt increase in salinity due to the brine discharge may affect the local ecosystem was outside the scope of this investigation.

Modeled Bottom Salinity Throughout the Corpus Christi Bay System

To assess the spatial and temporal impact of the modeled Harbor Island desalination brine discharge, it is necessary to compare over time how computed salinities differ from models with and without the simulated discharge. The SUNTANS model discussed within this report includes two simulated desalination brine discharges: 1) the proposed Harbor Island discharge, and 2) a "conceptual estimated" discharge from a potential desalination facility located at the northern end of the La Quinta Channel (Figure 3). Results shown in Figure 19-Figure 24 show the computed INCREASE in bottom salinity resulting from both of these modeled desalination brine discharges. LRE notes that these results will be refined in the future when the planned the La Quinta Channel desalination facility is fully designed. It is not possible within the current SUNTANS model results to distinguish between the effects of either the Harbor Island or La Quinta Channel discharges, except that computed salinity increases in the vicinity of each discharge are only the result of the modeled discharge at that location.

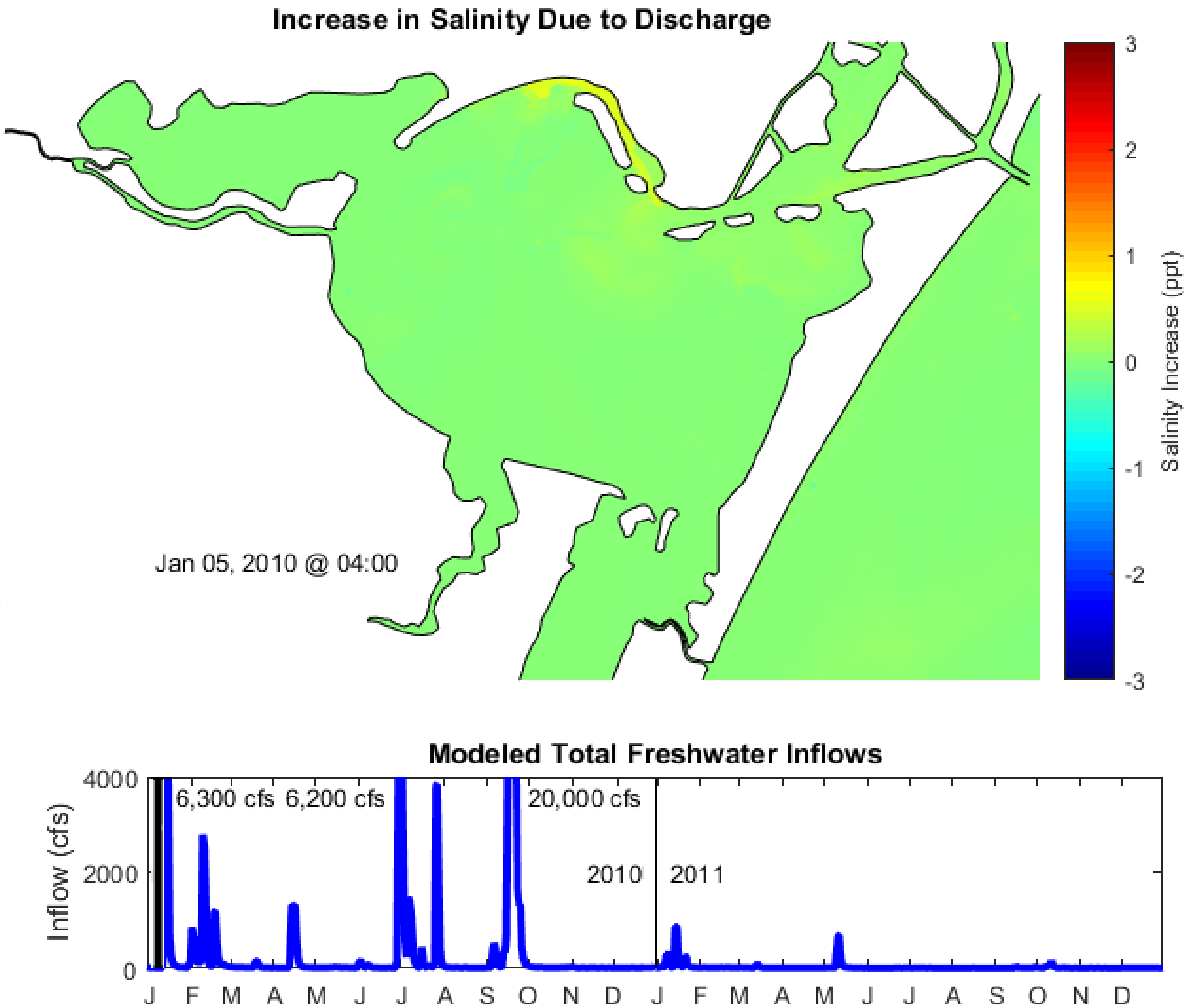


Figure 19 – Modeled Bottom Salinity Increase Resulting from Proposed Harbor Island & La Quinta Channel desalination brine discharges, shown for January 5, 2010. Increase is defined as the difference in bottom salinity between models including and excluding the desalination brine discharges. Note: the SUNTANS model does properly simulate the La Quinta Channel discharge due to the coarse model grid in the vicinity of the channel. The modeled La Quinta Channel discharge is estimated as the diffuser design for the proposed facility has yet to be finalized.

Figure 19 presents the modeled increase in bottom salinity resulting from the Harbor Island and La Quinta Channel discharges for the date of January 5, 2010. This date represents a time when the modeled discharges would have been occurring for only 5 consecutive days, and is prior to a time when any large freshwater inflow events may affect the computed salinity distribution within the bay system. As shown, bottom salinity increases are near-zero throughout the majority of the bay system. Increases approaching 1 ppt are evident around the La Quinta Channel discharge location and within the La Quinta Channel until the channel's intersection with the Corpus Christi Ship Channel. Figure 19 does not indicate any increase in bottom salinity in the region surrounding the proposed Harbor Island discharge location.

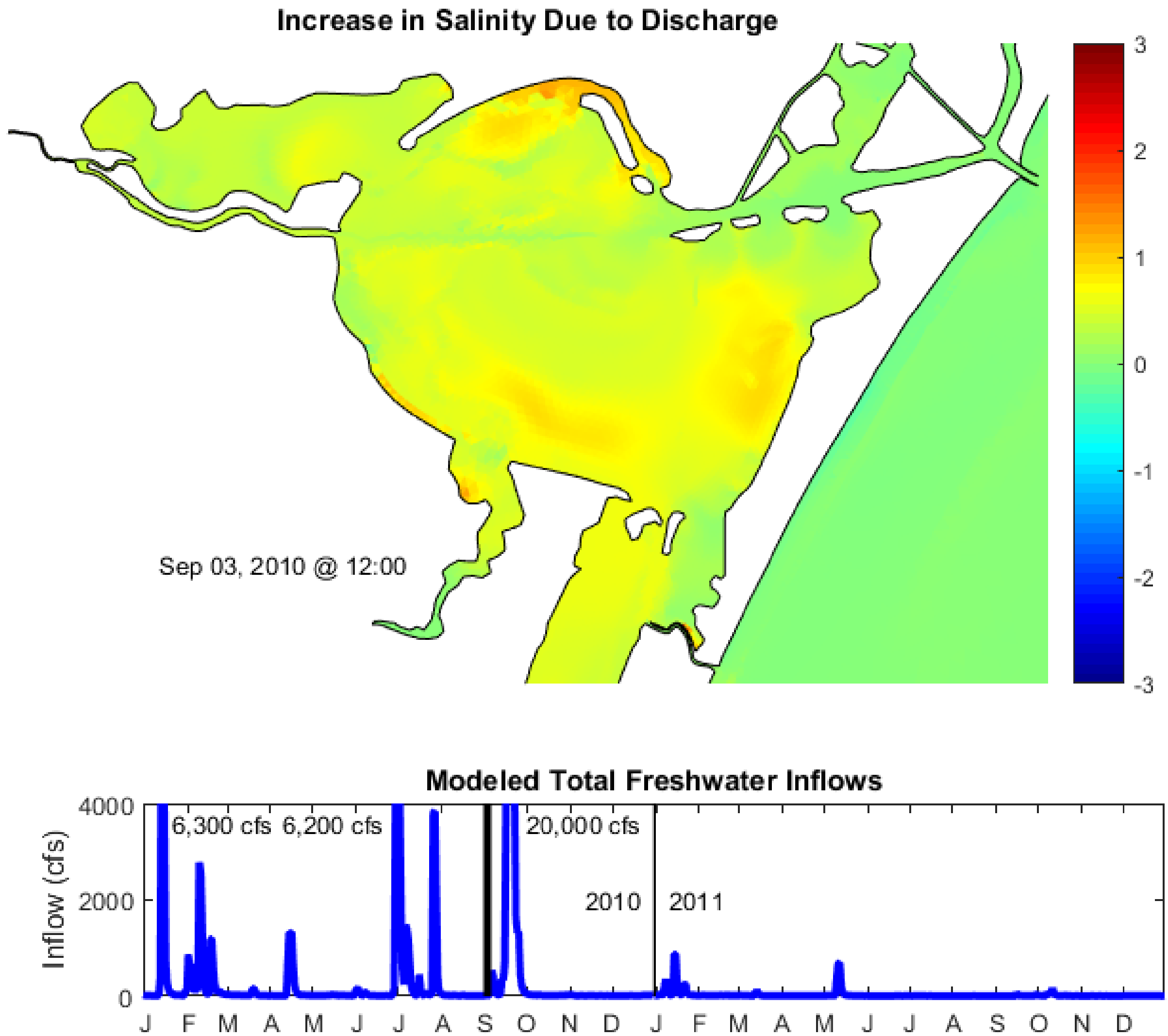
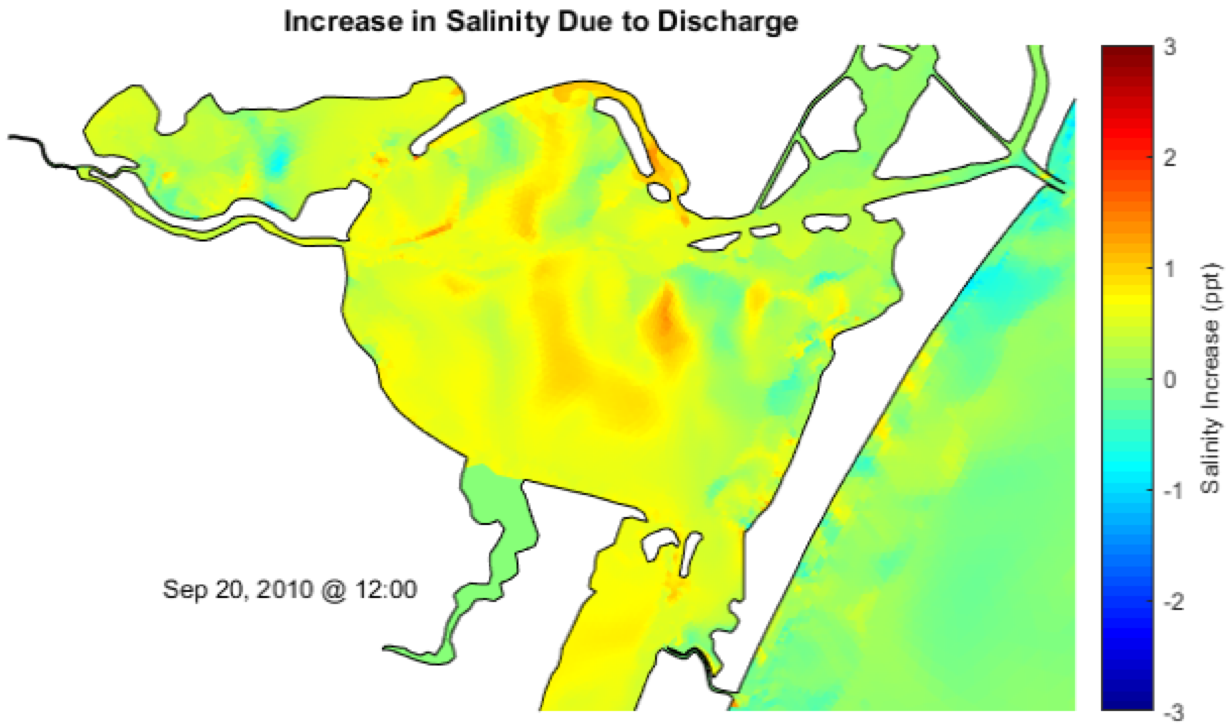


Figure 20 - Modeled Bottom Salinity Increase Resulting from Proposed Harbor Island & La Quinta Channel desalination brine discharges, shown for September 3, 2010, prior to the large inflow event. Increase is defined as the difference in bottom salinity between models including and excluding the desalination brine discharges. Note: the SUNTANS model does properly simulate the La Quinta Channel discharge due to the coarse model grid in the vicinity of the channel. The modeled La Quinta Channel discharge is estimated as the diffuser design for the proposed facility has yet to be finalized.

Figure 20 presents the modeled increase in bottom salinity resulting from the Harbor Island and La Quinta Channel discharges for the date of September 3, 2010. This date represents a time when the modeled discharges would have been occurring for 8 full months, and is prior to the large freshwater inflow event that occurred in September 2010. As shown, bottom salinity increases range from 0-1 ppt throughout the majority of the Corpus Christi Bay system, with higher salinity increases located within and around the La Quinta Channel. Figure 20 does not indicate any increase in bottom salinity in the region surrounding the proposed Harbor Island discharge location, and does not indicate any interaction between the two modeled discharges.



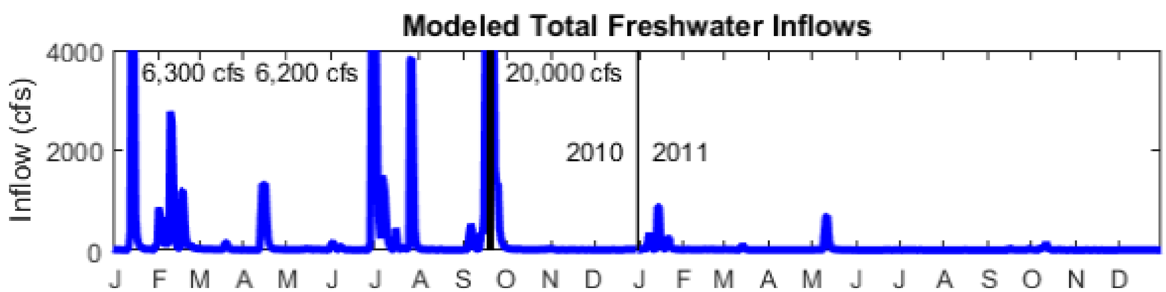


Figure 21 - Modeled Bottom Salinity Increase Resulting from Proposed Harbor Island & La Quinta Channel desalination brine discharges, shown for September 20, 2010, during the large inflow event. Increase is defined as the difference in bottom salinity between models including and excluding the desalination brine discharges. Note: the SUNTANS model does properly simulate the La Quinta Channel discharge due to the coarse model grid in the vicinity of the channel. The modeled La Quinta Channel discharge is estimated as the diffuser design for the proposed facility has yet to be finalized.

Figure 21 presents the modeled increase in bottom salinity resulting from the Harbor Island and La Quinta Channel discharges for the date of September 20, 2010, representing a time during the large freshwater inflow event that occurred in September 2010. As shown, bottom salinity increases range from 0-1 ppt throughout the majority of the Corpus Christi Bay system, and the freshwater inflows have altered the locations where higher salinity water is found. The freshwater inflows also appear to have resulted in the formation of "pockets" of higher-bottom salinity" water on both the north and south side of the Corpus Christi Ship Channel within the main body of Corpus Christi Bay. Figure 21 does not indicate any increase in bottom salinity in the region surrounding the proposed Harbor Island discharge location, and does not indicate any interaction between the two modeled discharges.

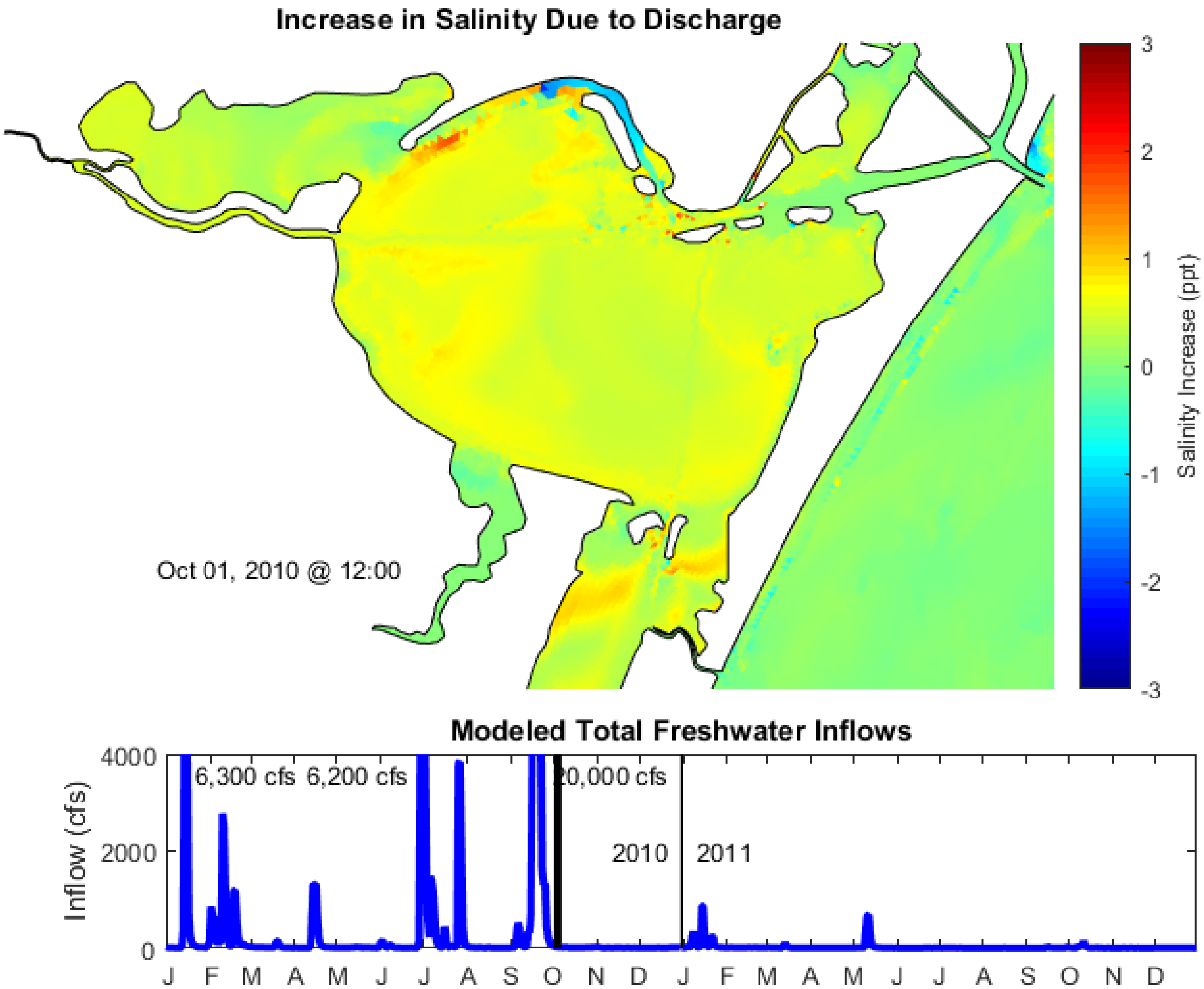


Figure 22 - Modeled Bottom Salinity Increase Resulting from Proposed Harbor Island & La Quinta Channel desalination brine discharges, shown for October 1, 2010, after the large inflow event. Increase is defined as the difference in bottom salinity between models including and excluding the desalination brine discharges. Note: the SUNTANS model does properly simulate the La Quinta Channel discharge due to the coarse model grid in the vicinity of the channel. The modeled La Quinta Channel discharge is estimated as the diffuser design for the proposed facility has yet to be finalized.

Figure 22 presents the modeled increase in bottom salinity resulting from the Harbor Island and La Quinta Channel discharges for the date of October 1, 2010, representing a time after the large freshwater inflow event that occurred in September 2010. As shown, bottom salinity increases range from 0-1 ppt throughout the majority of the Corpus Christi Bay system, yet pockets of higher increases exist near the interface with Nueces Bay and within Laguna Madre. Also evident is that the large freshwater inflow event has causes a salinity decrease within the Corpus Christi Channel (signifying the salinity with the discharges is now less than it would be without the discharges). This decrease in salinity is interesting and warrants further future investigation. Figure 22 indicates only a slight increase (<0.5 ppt) in bottom salinity in the region surrounding the proposed Harbor Island discharge location, and does not indicate any interaction between the two modeled discharges.

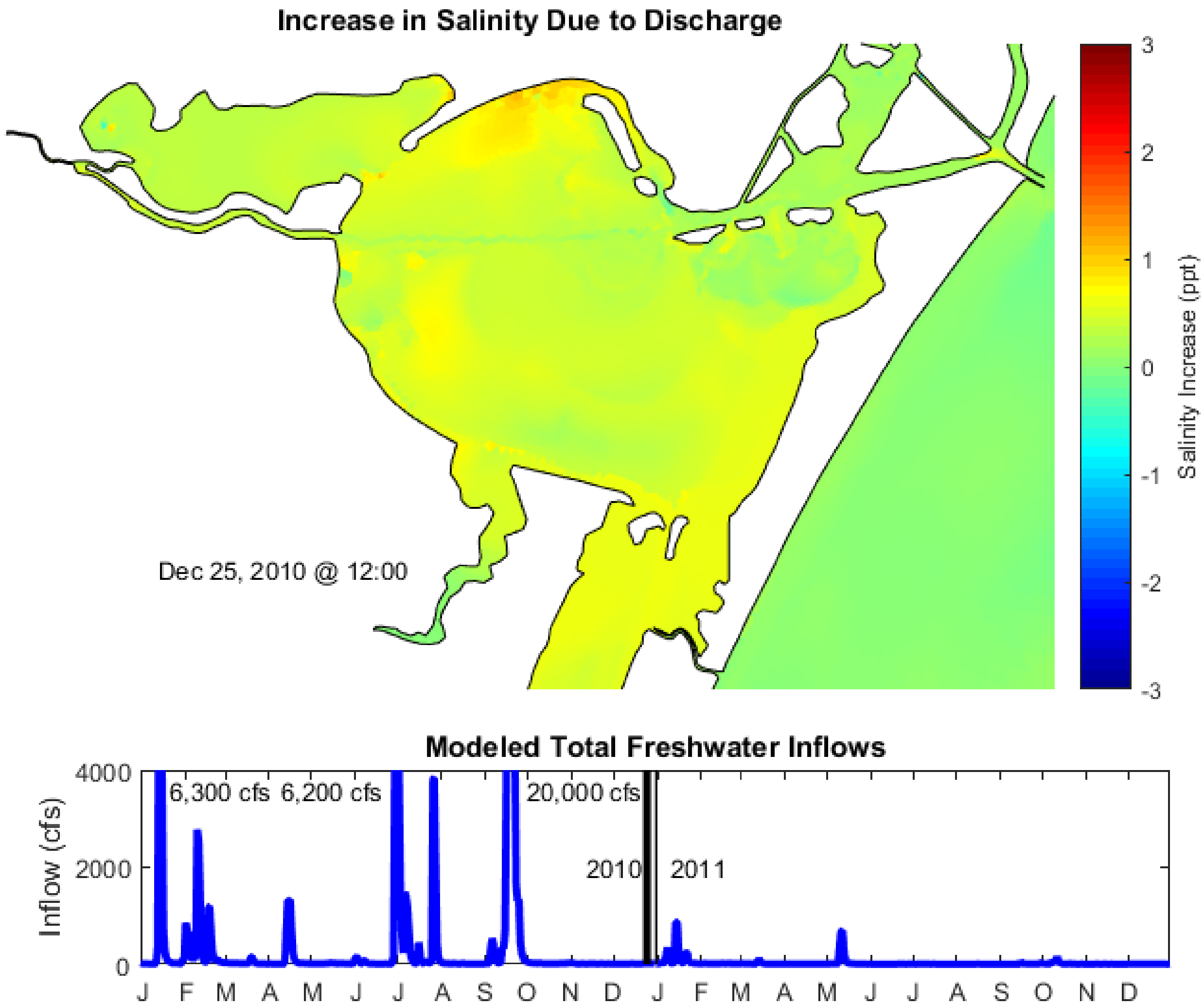


Figure 23 - Modeled Bottom Salinity Increase Resulting from Proposed Harbor Island & La Quinta Channel desalination brine discharges, shown for December 25, 2010, months after the large inflow event. Increase is defined as the difference in bottom salinity between models including and excluding the desalination brine discharges. Note: the SUNTANS model does properly simulate the La Quinta Channel discharge due to the coarse model grid in the vicinity of the channel. The modeled La Quinta Channel discharge is estimated as the diffuser design for the proposed facility has yet to be finalized.

Figure 23 presents the modeled increase in bottom salinity resulting from the Harbor Island and La Quinta Channel discharges for the date of December 25, 2010, representing a time nearly 3-months after the large freshwater inflow event that occurred in September 2010. As shown, bottom salinity increases range from 0-1 ppt throughout the majority of the Corpus Christi Bay system, pockets of lower increases (<0.5 ppt) throughout the bay (especially south of the islands separating the channel from the bay). Higher increases are evident around the La Quinta Channel discharge location. Figure 23 indicates an increase (<1.0 ppt) in bottom salinity in the region surrounding the proposed Harbor Island discharge location, yet this increase is consistent with the periodic increases shown in Figure 18, and does not indicate any interaction between the two modeled discharges.

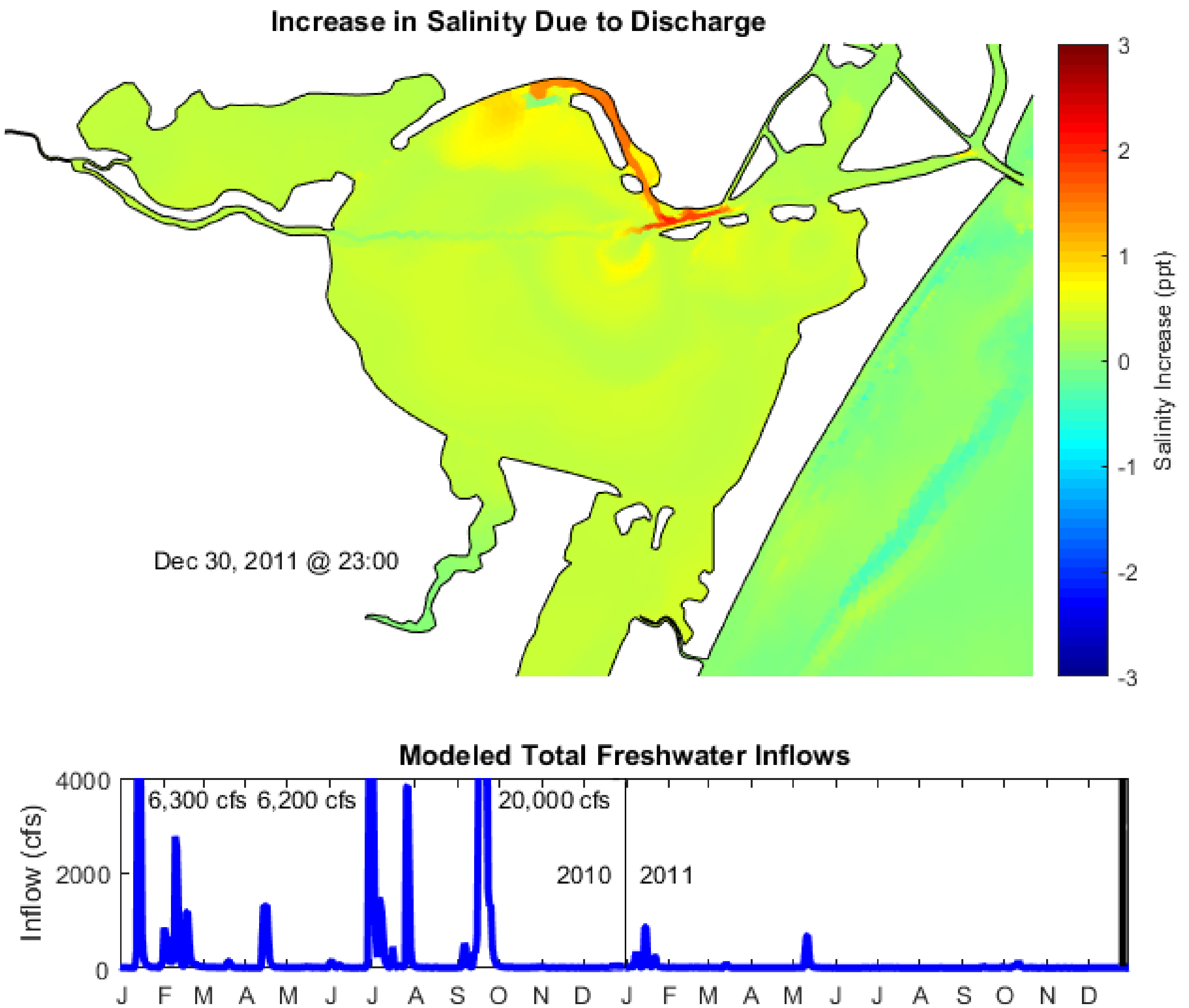


Figure 24 - Modeled Bottom Salinity Increase Resulting from Proposed Harbor Island & La Quinta Channel desalination brine discharges, shown for December 30, 2011, 15 months after the large inflow event. Increase is defined as the difference in bottom salinity between models including and excluding the desalination brine discharges. Note: the SUNTANS model does properly simulate the La Quinta Channel discharge due to the coarse model grid in the vicinity of the channel. The modeled La Quinta Channel discharge is estimated as the diffuser design for the proposed facility has yet to be finalized.

Figure 24 presents the modeled increase in bottom salinity resulting from the Harbor Island and La Quinta Channel discharges for the date of December 30, 2011, representing a time nearly 15-months after the large freshwater inflow event that occurred in September 2010. As shown, bottom salinity increases range from 0-1 ppt throughout the majority of the Corpus Christi Bay system. Increases of up to 2.5 ppt are evident within the La Quinta Channel, and in portions of the Corpus Christi Channel near the intersection with the La Quinta Channel. Figure 24 indicates an increase (<1.0 ppt) in bottom salinity in the region surrounding the proposed Harbor Island discharge location, yet this increase is consistent with the periodic increases shown in Figure 18, and does not indicate any interaction between the two modeled discharges.

Figure 19-Figure 24 demonstrate that bottom salinity values throughout the Corpus Christi Bay system will be expected to increase by 0-1ppt as a result of the combined effects of brine discharges from both the La Quinta Channel and Harbor Island desalination facilities. This accumulation level was calculated before, during, and after freshwater inflow events, including after a period in which low inflows had occurred for over 15 months. These results indicate that salt levels are not likely to continuously accumulate along the bottom of Corpus Christi Bay as a result of the modeled desalination brine discharges. These results also indicate that the distribution of higher salinity bottom water throughout the bay system changes over both time and space depending on the freshwater inflows and tidal forcing. Figure 24 does indicate a 2.5 ppt increase in salinity along and within the La Quinta Channel, yet LRE Water does not believe the current SUNTANS model bathymetry and numerical grid are properly refined to accurately determine the fate and transport of a desalination discharge in this location. It is evident, however, that after a two-year simulation, the modeled La Quinta Channel and Harbor Island discharges are not interacting within each other (Figure 24).

Modeled Salinity Stratification & Effect of Freshwater Inflow Events

Figure 25 - Figure 28 depict model results from simulations including the brine discharge, shown at specific instances before, during, and after the large inflow event in September 2010. Each image shows a map of computed salinity stratification within Nueces and Corpus Christi Bay, along with salinities versus depth along a profile running from 2 miles inland from the Harbor Island discharge to the Aransas Pass jetties at the Gulf of Mexico. This profile extent is shown on Figure 1.

Figure 25 shows results from September 3, just prior to the onset of the large inflow event that occurred for the majority of the month. As shown within the salinity profile, the Corpus Christi Ship Channel was well-mixed at approximately 36 ppt, with nearly equal salinities at all depths and locations along the profile. Salinity stratification was non-existent across most of the Corpus Christi Bay system, except in locations within Upper Nueces Bay and within the Corpus Christi ship channel upstream from the main bay-body.

Figure 26 shows results from September 20, 2010 during the middle of the high-inflow event. At this time, overall salinities along the ship channel profile decreased from 36 ppt to 32-33 ppt, yet the profile is no longer well mixed in the vertical or horizontal directions. The profile indicates pockets of higher-salinity water, including a pocket of 35-36 ppt water located 1-mile from the discharge toward the Gulf of Mexico. Higher salinity water is also visible at the discharge location. This suggests that the large freshwater inflow reduces salinities throughout the bay system, yet does not initially do so uniformly or result in a vertically well-mixed condition. The large inflow event also resulted in salinity stratification at locations within the system where the freshwater is entering the larger bays. Stratification is evident in Nueces Bay, the Corpus Christi ship channel as it enters into Corpus Christi Bay from the west, and at the mouth of Oso Bay.

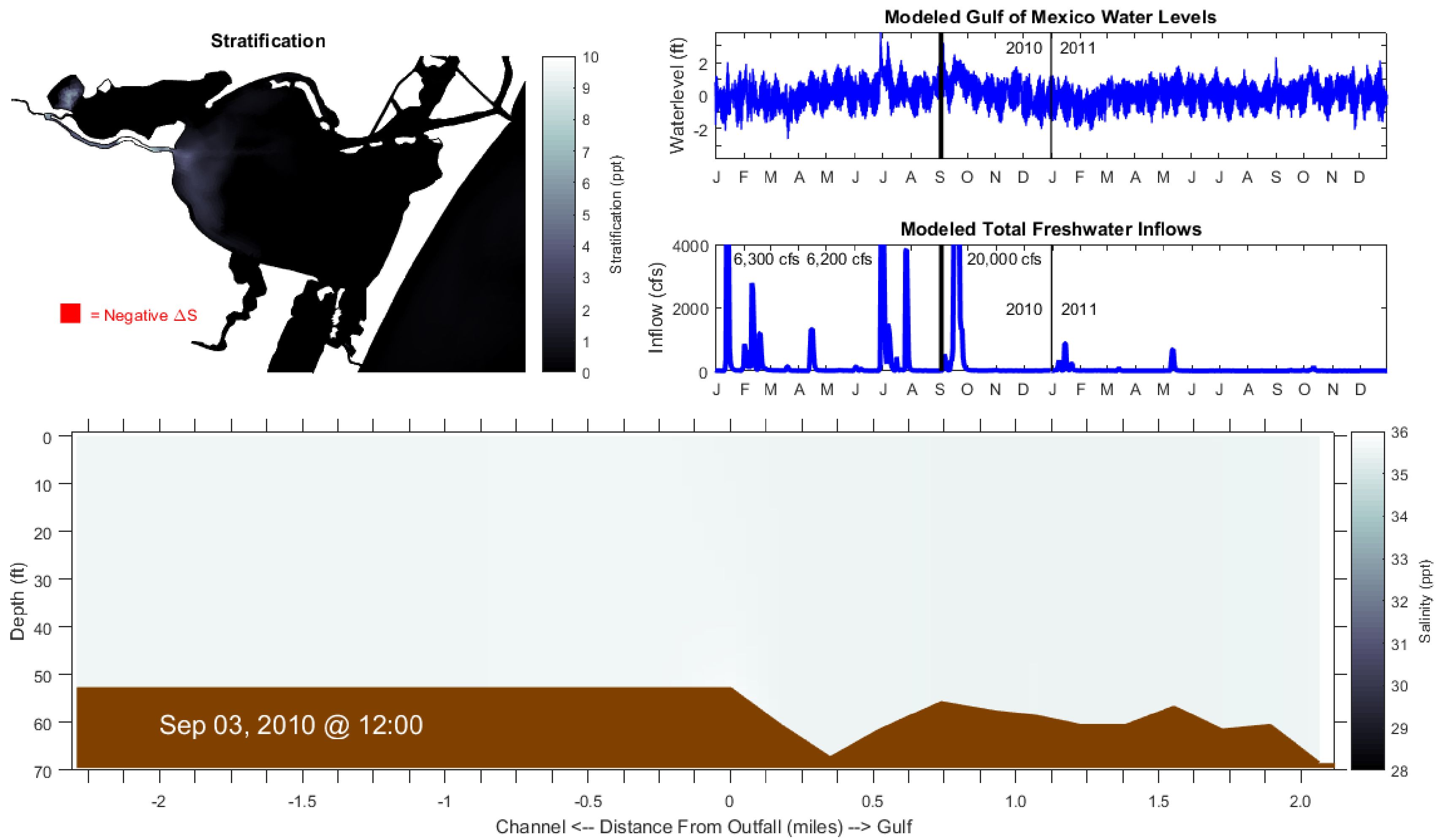


Figure 25 – Model results including the Harbor Island discharge for September 3, 2010, prior to the large freshwater inflow event.

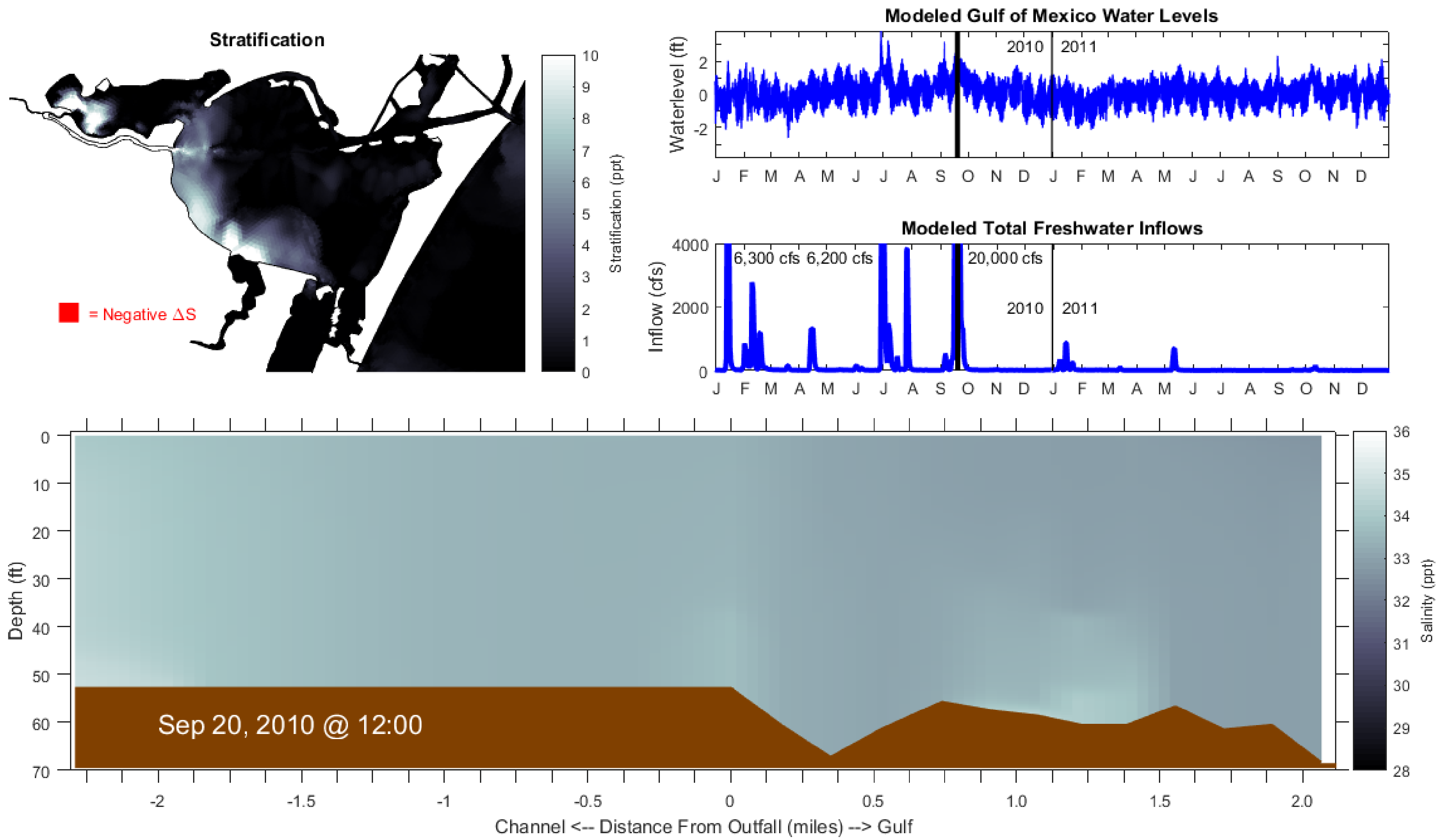


Figure 26 – Model results including the Harbor Island discharge for September 20, 2010, during the large freshwater inflow event.

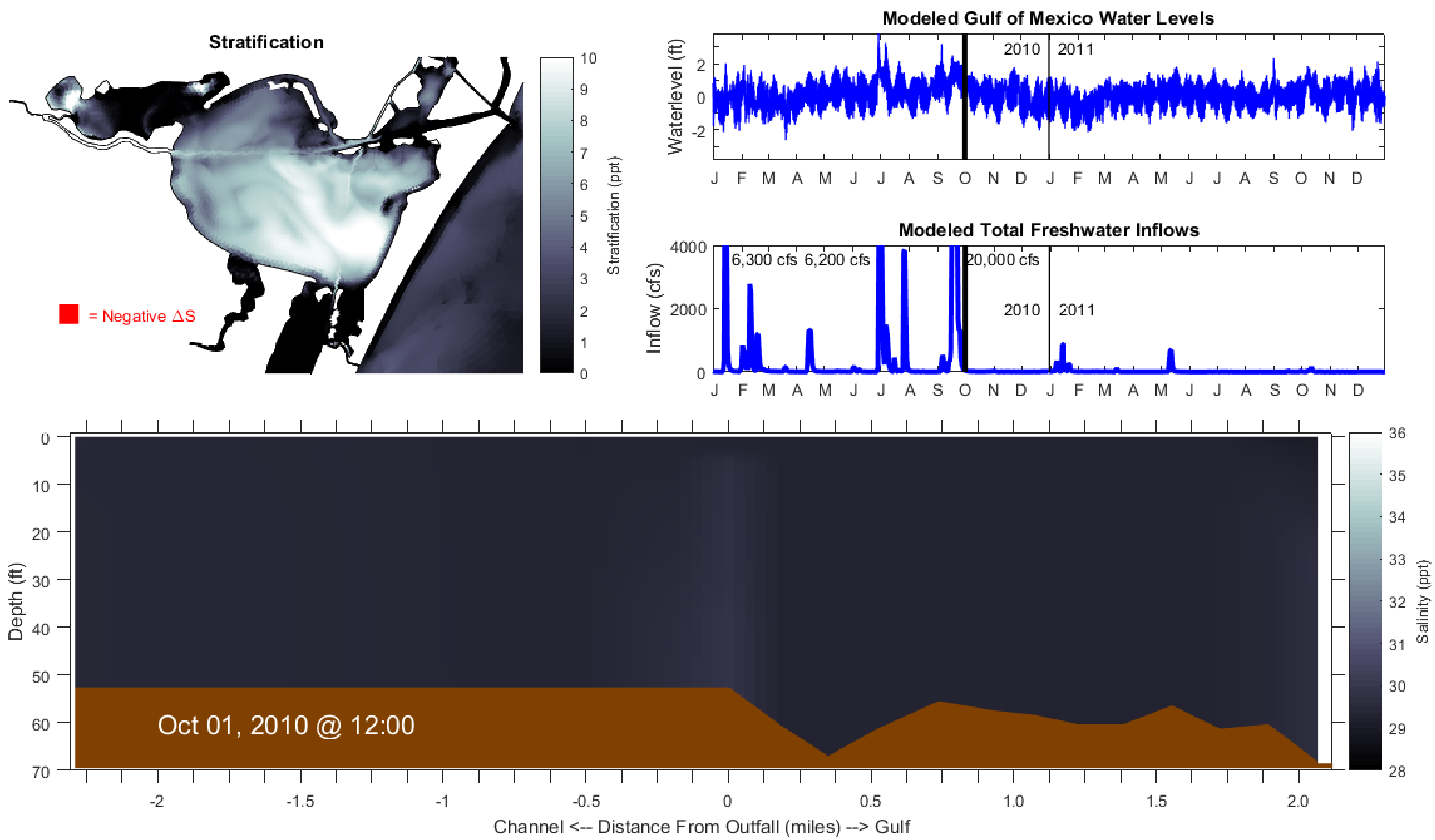


Figure 27 – Model results including the Harbor Island discharge for October 1, 2010, just after the large freshwater inflow event.

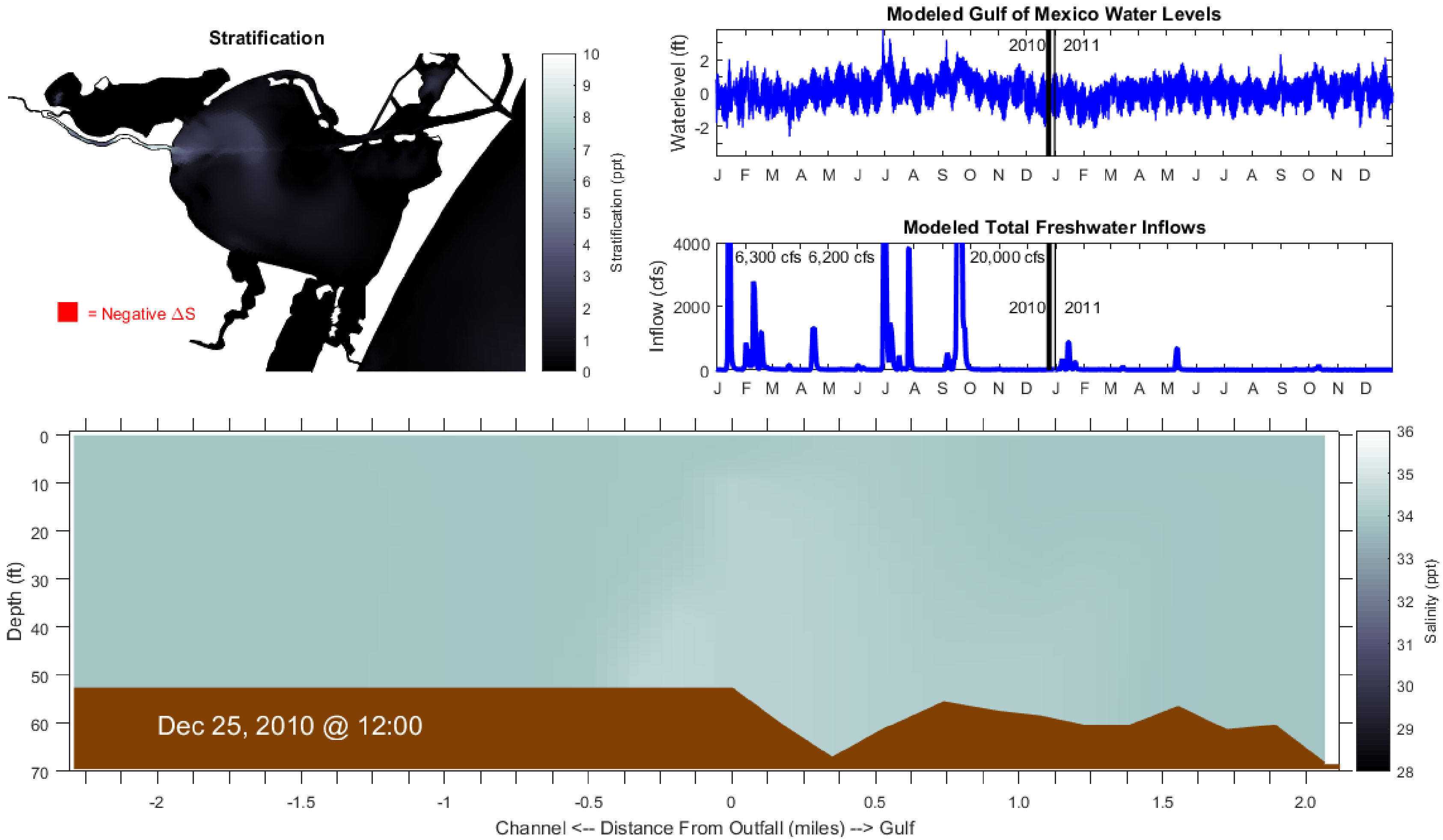


Figure 28 – Model results including the Harbor Island discharge for December 25, 2010, after nearly 3-months of low inflows following the large inflow event in September

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Figure 27 shows computed salinities on October 1, 2010 just after the end of the large inflow event. Within the Corpus Christi ship channel, salinities are now uniformly well mixed to 28-29 ppt, yet higher discharges around the Harbor Island discharge are evident and higher salinity water along the channel bottom is evident 1.5 miles up-channel from the discharge. Stratification is evident throughout much of Corpus Christi Bay, as the freshwater continues to mix with the saltier bay water. Stratification is minimal at the Harbor Island discharge location, indicating that the location is minimally influenced by even larger freshwater inflow events. Its proximity to the Gulf and the resulting strong tidal forcing causes rapid water column mixing and destruction of salinity stratification that would result from large inflow events.

Figure 28 shows model results from December 25, 2010, nearly three dry months after the large inflow event in September. Salinity values within the Corpus Christi Ship Channel have increased to 34 ppt, with some higher salinities located around the modeled discharge. During the three-month period since the large inflow event, circulation processes have returned nearly the entire bay to a vertically well-mixed state, with stratification only evident in the up-channel portion of the Corpus Christi ship channel.

In combination, Figure 25-Figure 28 demonstrate the impact of large inflows and tidal fluxes on mixing and circulation within the Corpus Christi Bay system. These results indicate that large inflow events will reduce system-wide salinity and mask salinity increases resulting from the desalination brine discharge. It is also evident, however, that prolonged periods with low inflows result in increases in salinities within the Corpus Christi ship channel. These increases, however, do not result solely from the desalination brine discharge, as similar increases are observed when the models include or exclude the simulation of the discharge.

Based on the modeling results presented herein, the proposed brine discharge from the Harbor Island desalination facility will result in an increase in ambient salinity of 0-1 ppt. The SUNTANS model indicates that the increase in ambient salinity (resulting from the Harbor Island desalination brine discharge) will not continuously increase over time in the vicinity of the discharge. The tidal forcing near the discharge location is sufficiently strong to result in near-constant water column mixing, which minimizes any increases in salinity resulting from the brine discharge. Similar bottom salinity increases of 0-1 ppt were determined to occur throughout the Corpus Christi Bay system as a result of both the Harbor Island and La Quinta Channel desalination brine discharges. LRE Water suspects, but did not calculate, that lower bottom salinity increases would occur if only the Harbor Island discharge were modeled.

Further Modeling Recommendations

The SUNTANS model presented herein is a well-developed model capable of determining the likely impact of the proposed desalination brine discharge at Harbor Island. LRE Water does not expect the SUNTANS model to produce significantly different results with regard to the proposed Harbor Island discharge if the numerical model grid were sufficiently refined enough to resolve the complex bathymetry in the vicinity of the discharge location.

Further model improvements would be necessary, however, to model brine discharges at other locations within the Corpus Christi Bay system, including the La Quinta Channel. Specifically, the model's triangular grid should be refined to better represent the true width of smaller channels within the system. The model grid would also need to be refined to better represent the island located immediately to the south of the proposed discharge within the La Quinta Channel.

In addition, LRE recommends review of the SUNTANS algorithms determining salinity and temperature within the water column. It appears that these algorithms may inappropriately retain heat energy during cooler months, and may produce artificially high-salinity values in shallow portions of the Corpus Christi Bay system.

References

Longley, W.L. ed. 1994. "Freshwater inflows to Texas bays and estuaries: ecological relationships and methods for determination of needs." Texas Water Development Board and Texas Parks and Wildlife Department, Austin, TX. 386 pp.

Rayson, M., Gross, E., and Fringer, O. 2015. "Modeling the tidal and sub-tidal hydrodynamics in a shallow, micro-tidal estuary." Ocean Modeling 89, pg 29-44.

APPENDIX M

USFWS Information for Planning and Consultation (IPaC) Report

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Texas Coastal & Central Plains Esfo
17629 El Camino Real, Suite 211
Houston, TX 77058-3051
Phone: (281) 286-8282 Fax: (281) 488-5882

In Reply Refer To: 11/26/2024 21:44:43 UTC
Project Code: 2025-0024909
Project Name: Harbor Island Desalination Facility

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The U.S. Fish and Wildlife Service (Service) field offices in Clear Lake, Corpus Christi, Fort Worth, and Alamo, Texas, have combined administratively to form the Texas Coastal Ecological Services Field Office. All project related correspondence should be sent to the field office address listed below responsible for the county in which your project occurs:

Project Leader; U.S. Fish and Wildlife Service; 17629 El Camino Real Ste. 211; Houston, Texas 77058
Angelina, *Austin*, *Brazoria*, *Brazos*, *Chambers, Colorado, Fayette, Fort Bend, Freestone, Galveston, Grimes, Hardin, Harris, Houston, Jasper, Jefferson, Leon, Liberty, Limestone, Madison, Matagorda, Montgomery, Newton, Orange, Polk, Robertson, Sabine, San Augustine, San Jacinto, Trinity, Tyler, Walker, Waller, and Wharton.*

Assistant Field Supervisor, U.S. Fish and Wildlife Service; 4444 Corona Drive, Ste 215; Corpus Christi, Texas 78411
Aransas, Atascosa, Bee, Brooks, Calhoun, De Witt, Dimmit, Duval, Frio, Goliad, Gonzales, Hidalgo, Jackson, Jim Hogg, Jim Wells, Karnes, Kenedy, Kleberg, La Salle, Lavaca, Live Oak, Maverick, McMullen, Nueces, Refugio, San Patricio, Victoria, and Wilson.

U.S. Fish and Wildlife Service; Santa Ana National Wildlife Refuge; Attn: Texas Ecological Services Sub-Office; 3325 Green Jay Road, Alamo, Texas 78516
Cameron, Hidalgo, Starr, Webb, Willacy, and Zapata.

For questions or coordination for projects occurring in counties not listed above, please contact arles@fws.gov.

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2) (c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at: http://www.fws.gov/media/endangered-species-consultation-handbook.

Non-Federal entities may consult under Sections 9 and 10 of the Act. Section 9 and Federal regulations prohibit the take of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined (50 CFR § 17.3) to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. "Harass" is defined (50 CFR § 17.3) as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Should the proposed project have the potential to take listed species, the Service recommends that the applicant develop a Habitat Conservation Plan and obtain a section 10(a)(1)(B) permit. The Habitat Conservation Planning Handbook is available at: https://www.fws.gov/library/collections/habitat-conservation-planning-handbook.

Migratory Birds:
In addition to responsibilities to protect threatened and endangered species under the Act, there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts visit: https://www.fws.gov/program/migratory-birds.

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable National Environmental Policy Act (NEPA) documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures see https://www.fws.gov/library/collections/threats-birds.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List
- Bald & Golden Eagles
- Migratory Birds
- Marine Mammals
- Coastal Barriers
- Wetlands

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

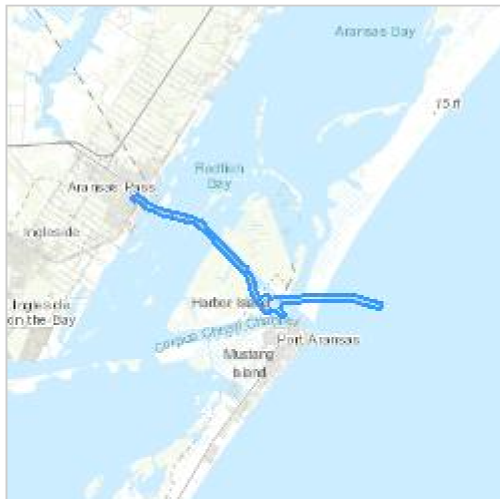
This species list is provided by:

Texas Coastal & Central Plains Esfo
17629 El Camino Real, Suite 211
Houston, TX 77058-3051
(281) 286-8282

PROJECT SUMMARY

Project Code: 2025-0024909
Project Name: Harbor Island Desalination Facility
Project Type: Water Supply Facility - Desalination Plant Ops
Project Description: Proposed desalination facility
Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@27.8732198,-97.0920999381772,14z



Counties: Aransas , Nueces , and San Patricio counties, Texas

ENDANGERED SPECIES ACT SPECIES

There is a total of 16 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

MAMMALS

NAME	STATUS
Tricolored Bat *Perimyotis subflavus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/10515	Proposed Endangered
West Indian Manatee *Trichechus manatus* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. ***This species is also protected by the Marine Mammal Protection Act, and may have additional consultation requirements.*** Species profile: https://ecos.fws.gov/ecp/species/4469	Threatened

BIRDS

NAME	STATUS
Attwater's Greater Prairie-chicken *Tympanuchus cupido attwateri* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/7259	Endangered
Eastern Black Rail *Laterallus jamaicensis ssp. jamaicensis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/10477	Threatened
Northern Aplomado Falcon *Falco femoralis septentrionalis* Population: Wherever found, except where listed as an experimental population No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/1923	Endangered
Piping Plover *Charadrius melodus* Population: [Atlantic Coast and Northern Great Plains populations] - Wherever found, except those areas where listed as endangered. There is **final** critical habitat for this species. Your location overlaps the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/6039	Threatened
Rufa Red Knot *Calidris canutus rufa* There is **proposed** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/1864	Threatened
Whooping Crane *Grus americana* Population: Wherever found, except where listed as an experimental population There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/758	Endangered

REPTILES

NAME	STATUS
Green Sea Turtle *Chelonia mydas* Population: North Atlantic DPS	Threatened

NAME	STATUS
There is **proposed** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/6199	
Hawksbill Sea Turtle *Eretmochelys imbricata* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3656	Endangered
Kemp's Ridley Sea Turtle *Lepidochelys kempii* There is **proposed** critical habitat for this species. Species profile: https://ecos.fws.gov/ecp/species/5523	Endangered
Leatherback Sea Turtle *Dermochelys coriacea* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/1493	Endangered
Loggerhead Sea Turtle *Caretta caretta* Population: Northwest Atlantic Ocean DPS There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/1110	Threatened

INSECTS

NAME	STATUS
Monarch Butterfly *Danaus plexippus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9743	Candidate

FLOWERING PLANTS

NAME	STATUS
Slender Rush-pea *Hoffmannseggia tenella* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/5298	Endangered
South Texas Ambrosia *Ambrosia cheiranthifolia* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/3331	Endangered

CRITICAL HABITATS

There is 1 critical habitat wholly or partially within your project area under this office's jurisdiction.

NAME	STATUS
Piping Plover *Charadrius melodus* https://ecos.fws.gov/ecp/species/6039#crithab	Final

BALD & GOLDEN EAGLES

Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act[1] and the Migratory Bird Treaty Act[2].

Any person or organization who plans or conducts activities that may result in impacts to bald or golden eagles, or their habitats[3], should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

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1. The Bald and Golden Eagle Protection Act of 1940.
2. The Migratory Birds Treaty Act of 1918.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

THERE ARE NO BALD AND GOLDEN EAGLES WITHIN THE VICINITY OF YOUR PROJECT AREA.

MIGRATORY BIRDS

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats[3] should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the PROBABILITY OF PRESENCE SUMMARY below to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
American Golden-plover *Pluvialis dominica* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/10561	Breeds elsewhere

NAME	BREEDING SEASON
American Oystercatcher *Haematopus palliatus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8935	Breeds Apr 15 to Aug 31
Black Scoter *Melanitta nigra* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10413	Breeds elsewhere
Black Skimmer *Rynchops niger* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/5234	Breeds May 20 to Sep 15
Black-legged Kittiwake *Rissa tridactyla* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10459	Breeds elsewhere
Brown Pelican *Pelecanus occidentalis* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/6034	Breeds Jan 15 to Sep 30
Chimney Swift *Chaetura pelagica* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9406	Breeds Mar 15 to Aug 25
Common Loon *gavia immer* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/4464	Breeds Apr 15 to Oct 31
Dickcissel *Spiza americana* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9453	Breeds May 5 to Aug 31
Double-crested Cormorant *phalacrocorax auritus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/3478	Breeds Apr 20 to Aug 31

NAME	BREEDING SEASON
Forster's Tern *Sterna forsteri* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/11953	Breeds Mar 1 to Aug 15
Gull-billed Tern *Gelochelidon nilotica* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9501	Breeds May 1 to Jul 31
Hudsonian Godwit *Limosa haemastica* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9482	Breeds elsewhere
King Rail *Rallus elegans* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8936	Breeds May 1 to Sep 5
Le Conte's Sparrow *Ammospiza leconteii* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9469	Breeds elsewhere
Least Tern *Sternula antillarum antillarum* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/11919	Breeds Apr 25 to Sep 5
Lesser Yellowlegs *Tringa flavipes* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9679	Breeds elsewhere
Long-billed Curlew *Numenius americanus* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/5511	Breeds elsewhere
Long-tailed Duck *Clangula hyemalis* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/7238	Breeds elsewhere
Magnificent Frigatebird *Fregata magnificens* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9588	Breeds elsewhere

NAME	BREEDING SEASON
Marbled Godwit *Limosa fedoa* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9481	Breeds elsewhere
Painted Bunting *Passerina ciris* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9511	Breeds Apr 25 to Aug 15
Pectoral Sandpiper *Calidris melanotos* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9561	Breeds elsewhere
Pomarine Jaeger *Stercorarius pomarinus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10458	Breeds elsewhere
Prairie Loggerhead Shrike *Lanius ludovicianus excubitorides* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/8833	Breeds Feb 1 to Jul 31
Prothonotary Warbler *Protonotaria citrea* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9439	Breeds Apr 1 to Jul 31
Red Knot *Calidris canutus roselaari* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8880	Breeds elsewhere
Red-breasted Merganser *Mergus serrator* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10693	Breeds elsewhere
Red-necked Phalarope *Phalaropus lobatus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10467	Breeds elsewhere

NAME	BREEDING SEASON
Reddish Egret *Egretta rufescens* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/7617	Breeds Mar 1 to Sep 15
Ring-billed Gull *Larus delawarensis* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10468	Breeds elsewhere
Royal Tern *Thalasseus maximus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10471	Breeds Apr 15 to Aug 31
Ruddy Turnstone *Arenaria interpres morinella* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/10633	Breeds elsewhere
Sandwich Tern *Thalasseus sandvicensis* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9731	Breeds Apr 25 to Aug 31
Short-billed Dowitcher *Limnodromus griseus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9480	Breeds elsewhere
Sooty Tern *Onychoprion fuscatus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10695	Breeds Mar 10 to Jul 31
Sprague's Pipit *Anthus spragueii* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8964	Breeds elsewhere
Surf Scoter *Melanitta perspicillata* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10463	Breeds elsewhere

NAME	BREEDING SEASON
Swallow-tailed Kite *Elanoides forficatus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8938	Breeds Mar 10 to Jun 30
Whimbrel *Numenius phaeopus hudsonicus* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/11991	Breeds elsewhere
White-winged Scoter *Melanitta fusca* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10462	Breeds elsewhere
Willet *Tringa semipalmata* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/10669	Breeds Apr 20 to Aug 5
Wilson's Plover *Charadrius wilsonia* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9722	Breeds Apr 1 to Aug 20

PROBABILITY OF PRESENCE SUMMARY

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

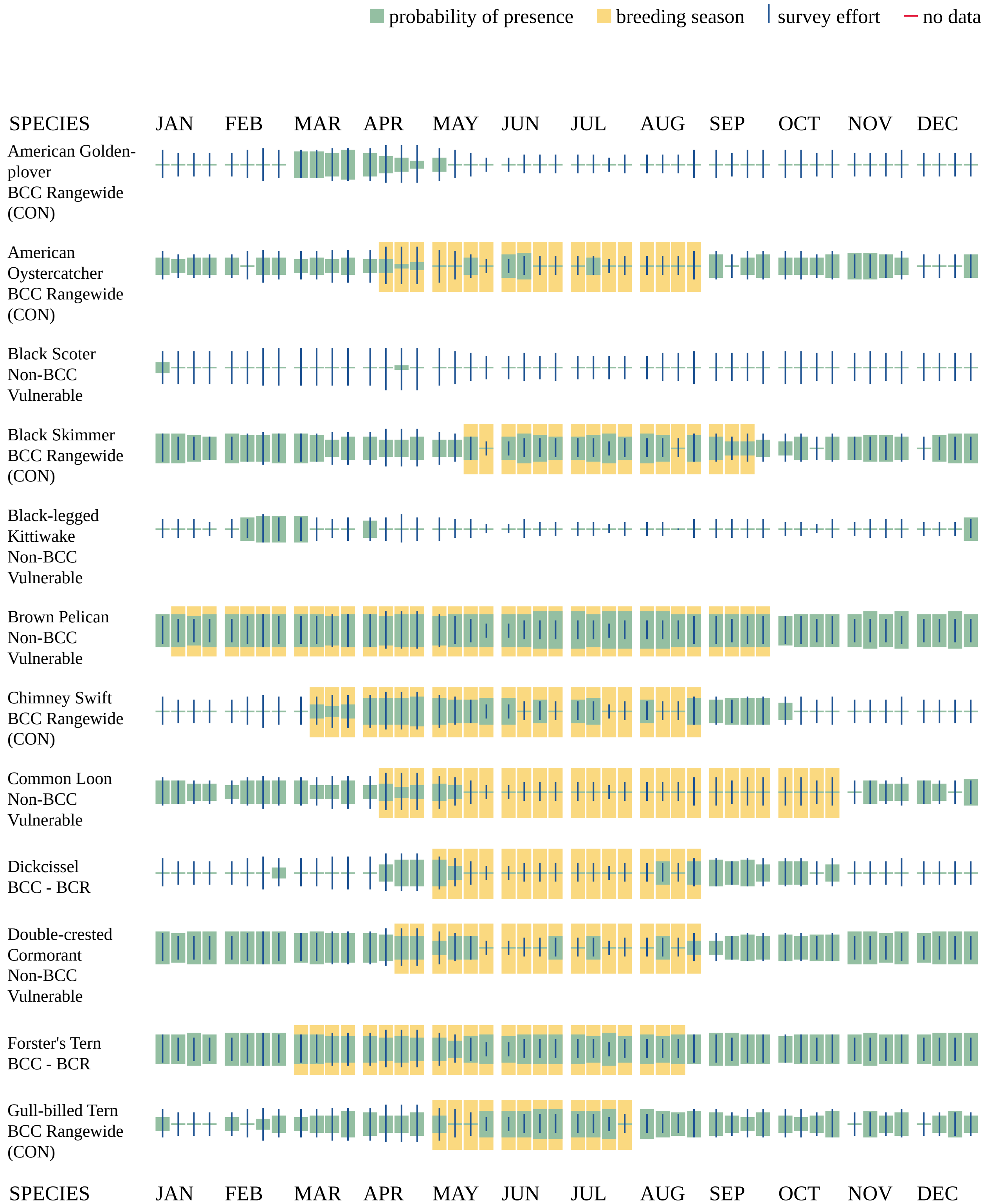
Green bars; the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during that week of the year.

Breeding Season (■)
Yellow bars; liberal estimate of the timeframe inside which the bird breeds across its entire range.

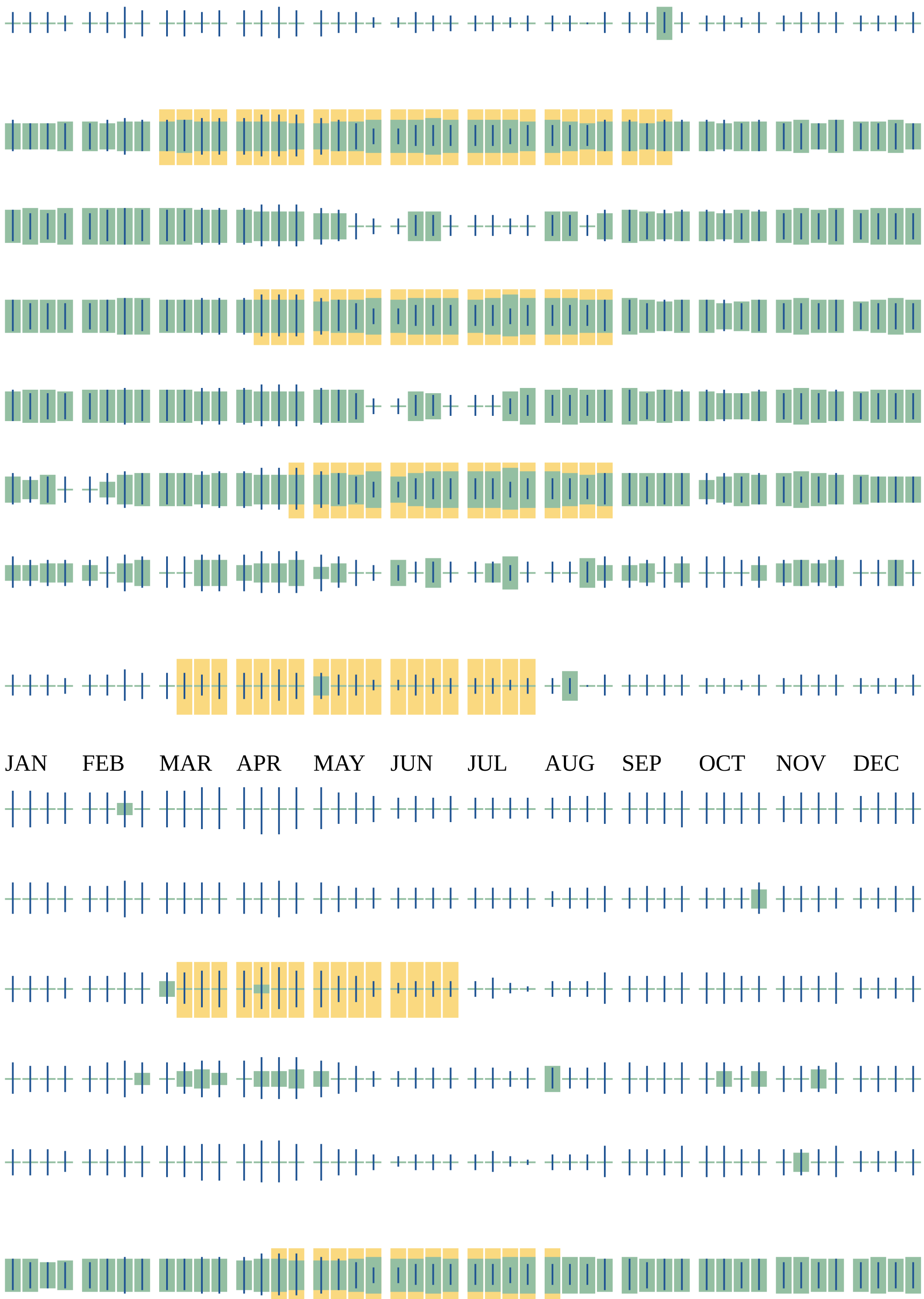
Survey Effort (|)
Vertical black lines; the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data (–)

A week is marked as having no data if there were no survey events for that week.




Hudsonian Godwit
BCC Rangewide
(CON)
King Rail
BCC Rangewide
(CON)
Le Conte's Sparrow
BCC Rangewide
(CON)
Least Tern
BCC Rangewide
(CON)
Lesser Yellowlegs
BCC Rangewide
(CON)
Long-billed Curlew
BCC - BCR
Long-tailed Duck
Non-BCC
Vulnerable
Magnificent
Frigatebird
BCC - BCR
Marbled Godwit
BCC Rangewide
(CON)
Painted Bunting
BCC - BCR
Pectoral Sandpiper
BCC Rangewide
(CON)
Pomarine Jaeger
Non-BCC
Vulnerable
SPECIES
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Prairie Loggerhead
Shrike
BCC - BCR
Prothonotary
Warbler
BCC Rangewide
(CON)
Red Knot
BCC Rangewide
(CON)
Red-breasted
Merganser



Non-BCC
Vulnerable

Red-necked Phalarope
Non-BCC
Vulnerable

Reddish Egret
BCC Rangewide (CON)

Ring-billed Gull
Non-BCC
Vulnerable

Royal Tern
Non-BCC
Vulnerable

Ruddy Turnstone
BCC - BCR

Sandwich Tern
BCC - BCR

Short-billed Dowitcher
BCC Rangewide (CON)

Sooty Tern
Non-BCC
Vulnerable

SPECIES JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Sprague's Pipit
BCC Rangewide (CON)

Surf Scoter
Non-BCC
Vulnerable

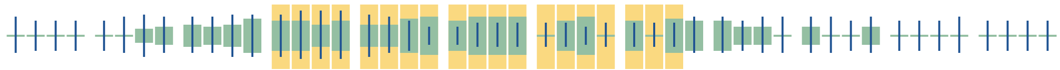
Swallow-tailed Kite
BCC Rangewide (CON)

Whimbrel
BCC - BCR

White-winged Scoter
Non-BCC
Vulnerable

Willet
BCC Rangewide (CON)

Wilson's Plover
BCC Rangewide
(CON)



Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

COASTAL BARRIERS

Projects within the John H. Chafee Coastal Barrier Resources System (CBRS) may be subject to the restrictions on Federal expenditures and financial assistance and the consultation requirements of the Coastal Barrier Resources Act (CBRA) (16 U.S.C. 3501 et seq.). For more information, please contact the local Ecological Services Field Office or visit the CBRA Consultations website. The CBRA website provides tools such as a flow chart to help determine whether consultation is required and a template to facilitate the consultation process.

SYSTEM UNIT (SU)

Most new Federal expenditures and financial assistance, including Federal flood insurance, are prohibited within System Units. ***Federally-funded projects within System Units require consultation with the Service.*** *Consultation is not required for projects using private, state, or local funds.*

OTHERWISE PROTECTED AREA (OPA)

OPAs are denoted with a "P" at the end of the unit number. The only prohibition within OPAs is on Federal flood insurance. ***CBRA consultation is not required for projects within OPAs.*** *However, agencies providing disaster assistance that is contingent upon a requirement to purchase flood insurance after the fact are advised to disclose the OPA designation and information on the restrictions on Federal flood insurance to the recipient prior to the commitments of funds.*

UNIT	NAME	TYPE	SYSTEM UNIT ESTABLISHMENT DATE	FLOOD INSURANCE PROHIBITION DATE
T08	San Jose Island	SU	10/18/1982	10/1/1983
T08P	San Jose Island	OPA	N/A	11/16/1991

MARINE MAMMALS

Marine mammals are protected under the Marine Mammal Protection Act. Some are also protected under the Endangered Species Act[1] and the Convention on International Trade in Endangered Species of Wild Fauna and Flora[2].

The responsibilities for the protection, conservation, and management of marine mammals are shared by the U.S. Fish and Wildlife Service [responsible for otters, walruses, polar bears, manatees, and dugongs] and NOAA Fisheries[3] [responsible for seals, sea lions, whales, dolphins, and porpoises]. Marine mammals under the responsibility of NOAA Fisheries are **not** shown on this list; for additional information on those species please visit the Marine Mammals page of the NOAA Fisheries website.

The Marine Mammal Protection Act prohibits the take of marine mammals and further coordination may be necessary for project evaluation. Please contact the U.S. Fish and Wildlife Service Field Office shown.

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1. The Endangered Species Act (ESA) of 1973.
2. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is a treaty to ensure that international trade in plants and animals does not threaten their survival in the wild.
3. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

NAME

West Indian Manatee *Trichechus manatus*
Species profile: https://ecos.fws.gov/ecp/species/4469

WETLANDS

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

ESTUARINE AND MARINE DEEPWATER

- E1UBLx
- E1AB3L

- M1UBL
- E1UBL

FRESHWATER EMERGENT WETLAND

- PEM1Ah
- PEM1/SS1Fx
- PEM1C
- PEM1Fh
- PEM1A

ESTUARINE AND MARINE WETLAND

- E2USP
- E2USN
- M2USP
- M2USN
- E2EM1P
- E2EM1N

LAKE

- L2USCh

FRESHWATER POND

- PUBF

APPENDIX N

Biological Assessment

Geosyntec consultants

engineers | scientists | innovators

Biological Assessment

Harbor Island Seawater Desalination Facility
Corpus Christi, Texas

USACE Individual Permit Application

Prepared for

The Port of Corpus Christi Authority
Charles Zahn, Jr. Drive
Corpus Christi, Texas 78401

Prepared by

Geosyntec Consultants, Inc.
8627 N Mopac Expy, Suite 300
Austin, Texas 78759

Project No. TXE10785

February 2025

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LIST OF ACRONYMS

Acronym	Term
ANWR	Aransas National Wildlife Refuge
AWBP	Aransas-Wood Buffalo population
BA	Biological Assessment
BMP(s)	Best Management Practice(s)
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
ESA	Endangered Species Act
FMP	Fishery Management Plan
GMFMC	Gulf of Mexico Fishery Management Council
HAPC	Habitat areas of particular concern
HDD	horizontal directional drilling
HMSD	Highly Migratory Species Division
INJ	auditory injury
IPaC	Information for Planning and Consultation
MGD	million-gallon-per-day
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NITS	noise-induced threshold shift
NMFS	National Marine Fisheries Service
PBF(s)	Physical and biological feature(s)
PCCA	Port of Corpus Christi Authority
PCE(s)	Primary constituent element(s)
ppt	parts per thousand
PTS	permanent threshold shift
SAV	Submerged aquatic vegetation
TCEQ	Texas Commission on Environmental Quality
TPWD	Texas Parks and Wildlife Department
TTS	temporary threshold shift
TxDOT	Texas Department of Transportation
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service

1. INTRODUCTION

This Biological Assessment (BA) is prepared on behalf of The Port of Corpus Christi Authority (PCCA) for the proposed Harbor Island Seawater Desalination Facility (Project) in support of U.S. Army Corps of Engineers (USACE) Individual Permit application. The purpose of this BA is to evaluate the Project's potential effects on federally listed and proposed species and designated or proposed critical habitats under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS), pursuant to Section 7(a)(2) of the Endangered Species Act (ESA). This document also includes an assessment of potential Project effects on Essential Fish Habitat (EFH) under the jurisdiction of NMFS, pursuant to Section 305(b)(2) the Magnuson-Stevens Fishery Conservation and Management Act (MSA).

1.1 Proposed Action Overview

The Project proposes construction of a 100-million-gallon-per-day (MGD) marine seawater desalination facility and associated infrastructure, aimed at providing a sustainable and drought-resilient water supply. The Project will include construction of a sea water intake structure, two outfall structures, upland desalination facility, and a product freshwater pipeline (collectively, "Site"). The Site is located on Harbor Island, near Port Aransas, Nueces County, Texas, and consists of a 31-acre area for the desalination facility and associated infrastructure.

1.1.1 Project Purpose and Need

The Project need and purpose is developed based on statements in the Coastal Bend Regional Water Planning Area, Region N, by the Coastal Bend Regional Water Planning Group ("2011 Regional Water Plan"). The Project is proposed to address a known "water supply need in a manner that is consistent with the state water plan..." and addresses a "water supply need" specific to the 2011 Regional Water Plan. Diversion of Gulf of Mexico seawater for the purpose of desalination is expressly considered in the Regional Plan for the proposed facility at Harbor Island.

1.1.2 Federal Action

Federal agencies proposing to authorize, fund, or carry out an action must ensure that their actions are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat, pursuant to ESA Section 7(a)(2). Further, federal agencies proposing to authorize, fund, or carry out an action must ensure their action is not likely to adversely affect EFH, pursuant to MSA Section 305(b)(2).

The Project proposes impacts to USACE jurisdictional waters, and PCCA is reapplying for authorization under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. The requested USACE authorization serves as a federal nexus that triggers ESA and MSA consultation requirements for this Project.

1.2 Structure of this Biological Assessment

This BA is prepared in accordance with the Endangered Species Consultation Handbook (USFWS and NMFS 1998). Consolidation of ESA and MSA EFH assessments within this BA is done in accordance with 50 CFR 600.920(f) and NMFS Procedure 03-201-05 (NMFS 2001). Assessments of species, critical habitat, and EFH under separate jurisdictions of USFWS and NMFS are addressed within this document as follows:

Sections applicable to both USFWS and NMFS review: **Sections 1, 2, 3, and 7.**

Section applicable only to USFWS review: **Section 4** (ESA-regulated species and critical habitat).

Sections applicable only to NMFS review: **Section 5** (ESA-regulated species and critical habitat) and **Section 6** (MSA-regulated EFH and managed species).

1.2.1 Effect Determinations

Assessments of ESA-regulated species and critical habitat are concluded with an effect determination. Effect determinations are based on standardized terminology in the Endangered Species Consultation Handbook (USFWS and NMFS 1998), defined below:

- *No effect* – the appropriate conclusion when the proposed action will not affect listed species or critical habitat.
- *May affect, is not likely to adversely affect* – the appropriate conclusion when effects on listed species are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects on the species or habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.
- *May affect, is likely to adversely affect* – the appropriate conclusion if any adverse effect to listed species may occur as a direct or indirect result of the proposed action.

For critical habitat in the Action Area, the assessment will evaluate if any impacted areas contain the physical and biological features (PBFs; also referred to as "primary constituent elements," or PCEs) that are essential for the conservation of the species and assess potential Project effects on these locations.

The EFH assessment also provides an effect determination, dictating whether the Project will or will not result in an "adverse effect" to EFH. In the context of the EFH evaluation, "adverse effect" is defined in 50 CFR 600.910(a) as "*any impact that reduces the quality and/or quantity of EFH" and may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components*."

2. PROPOSED ACTION

2.1 Project Components and Construction Details

2.1.1 Intake Structure

An intake structure will be located 1.3 miles off San Jose Island in the Gulf of Mexico at a depth of -35 feet NAVD88. The intake will have a manifold arrangement with approximately four to five branches situated 30 feet apart. The intake opening will be approximately 5 to 10 feet above the seabed to minimize potential withdrawal of sediments or benthic organisms. The intake will have an entrance velocity of ≤0.5 feet per second (ft/s) to reduce the intake of fish or other marine organisms. The velocity caps redirect the gravity-fed intake flow horizontally, allowing marine life to easily detect the low-flow entrance velocity and swim away. A three-inch mesh bar screen will be installed around the velocity caps to exclude larger marine organisms. Only riser pipes and velocity caps are proposed to be above the seabed, with intake pipes placed underground.

2.1.2 Intake Pipe

From the intake structure, seawater will be transported to the Harbor Island desalination facility via a large diameter pipe of approximately 14 feet outer diameter and 12 feet inner diameter. Approximately 2.7 miles of the proposed intake pipe alignment will use the existing alignment of the "Bluewater Texas Terminal" project (SWG-2019-00174). The intake pipe will be constructed using a trenchless, tunnel boring method to be installed below two maritime channels, a privately owned island, and the Gulf of Mexico seabed. Pending the completion of a geotechnical survey, the top of the 14-foot pipe is expected to be at approximately -64 feet NAVD88.

The intake tunnel will be installed via a subterranean tunnel boring machine beginning at Harbor Island. This methodology will completely avoid disturbances aboveground. Soil spoil removed from the tunnel will be re-used as structural fill for the facility on Harbor Island. All materials to construct the tunnel interior support and conveying pipe will be inserted at the main tunnel shaft entrance on Harbor Island. Construction equipment to accomplish this Project component includes heavy equipment, tunnel boring machine, shields, cutterheads, offshore platform, jack-up barge, and dewatered caisson or similar structure.

2.1.3 Marine Life Handling System

Seawater will flow into an intake bay and two to four screen channels, approximately 8 to 10 feet wide each and equipped with a traveling screen. The screens will have revolving mesh panels with 2- to 6-millimeter openings to capture larval, juvenile, or adult fish. The screens are designed to humanely capture marine organisms, lift them from the seawater, and gently discharge organisms to a fish trough using low-pressure jet sprays, which returns the organisms back to the Aransas Channel.

2.1.4 Desalination Facility

A pump station will be installed downstream of the marine life handling system to pump seawater to the treatment facility. The pumps will discharge to a common force main that delivers screened seawater to the desalination treatment systems, which will operate using reverse osmosis. Reverse osmosis results in a recovery rate of 40-50%, and the concentrate effluent produced from the desalination process will discharge into the Gulf of Mexico and to a secondary outfall in the Corpus

Christi Ship Channel via outfall diffusers. Once the seawater is desalinated and stabilized (i.e., made noncorrosive), product water will be stored onsite in tanks prior to distribution.

2.1.5 Corpus Christi Ship Channel Outfall

A pipe will connect a reverse osmosis concentrate effluent holding tank at the southeast corner of the desalination facility. From there, a buried/submerged 60-inch pipe will transport stored effluent water to a multiport diffuser approximately 230 feet offshore of Harbor Island. Installation of this line will occur via horizontal directional drilling (HDD) or tunnel boring. The diffuser will be comprised of a 48-inch-diameter barrel with 20 180-millimeter-diameter ports, each at 1.5-meter spacing, resulting in a total diffuser length of 30 meters. To install the diffuser barrel, a bench must be excavated in the channel side slope (outside the channel template) and will result in the removal of approximately 903 cubic yards of sediment. Effluent will pass through a diffuser installed perpendicular to the outfall pipe and parallel to the shoreline before mixing with the water column of the Corpus Christi Ship Channel. The Texas Commission on Environmental Quality (TCEQ) authorized the discharge from this outfall on December 22, 2022.

2.1.6 Gulf of Mexico Outfall and Discharge Pipe

The proposed discharge pipe is approximately 3.6 miles long and would parallel the intake pipe to a point approximately 0.5-mile beyond the intake structure, where a multiport diffuser will be installed. The conceptual design of the diffuser is a 50-port diffuser with 160-millimeter (6.3-inch) diameter ports, with minimum port exit velocities greater than or equal to 3 meters/second. This minimum port exit velocity will generate sufficient momentum and energy in the effluent discharge to assure rapid mixing of the effluent and receiving water. The total water depth at the center of the diffuser barrel will be approximately 37 feet NAVD88.

The proposed construction method for this pipe is an earth pressure balance tunnel boring machine, which pressurizes the excavation safely to account for anticipated soft soils throughout this alignment. Muck soils removed during tunneling will be maintained onsite during construction and dewatered similarly to dredge material, with a dewatering outfall structure into Redfish Bay adjacent to Aransas Channel. Dewatering of muck will be permitted prior to proceeding, as part of the TCEQ 401 Water Quality Certification. Sufficiently dewatered material will then be used on-site as grading material. By using the earth pressure balance tunnel boring methodology, work will primarily remain below the seafloor and surface disturbance for this component will only occur in two locations: the vertical work shafts at the discharge point in the Gulf of Mexico and on Harbor Island.

2.1.7 Finished Water Pipelines

Finished water from the desalination facility will be transported to Aransas Pass via pipelines following the Redfish Bay Causeway (Highway 361) and ending at State Highway 35 Business. The finished water will be transported by up to two pipelines proposed to be 48 to 52 inches in diameter, constructed of steel, pre-stressed concrete cylinder pipe (PCCP) material, or high-density polyethylene (HDPE) material. The pipelines will total approximately 30,500 linear feet (LF), of which 21,500 LF would be buried within the PCCA property. Water crossings along this route will be installed using HDD or similar trenchless construction technology to reduce aquatic impacts.

2.2 Action Area

The Action Area as defined in 50 CFR 402.02 means *all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.* The Action Area of this Project includes the footprint necessary to construct all Project components, as well as a 500-foot buffer from the construction footprint to account for effects that extend beyond the immediate work area, such as noise, light, and sediment disturbances.

Only one Action Area encompassing all affected Project areas will be referenced throughout this document in both ESA and EFH evaluations (Figure 1). Description of the habitat and baseline conditions of the Action Area is included in Section 3 of this BA, and locations of critical habitat and EFH are shown in Figures 2 and 3.

2.3 Project Duration and Timing

The Project will be scheduled following local, state, and federal permitting approvals to proceed. Further, Project scheduling will take place in accordance with any time restriction conditions applicable to protected species, such as outside of turtle or bird nesting seasons, as required by special permit conditions.

2.4 Avoidance and Minimization Measures

The Project has been designed to minimize impacts to the greatest extent practicable through its site selection and analysis of alternative sites, construction techniques, proposed Best Management Practices (BMPs), avoidance measures, and conservation techniques. Discussion of measures to reduce impacts to protected species and their suitable habitats are further discussed in the respective effects analysis sections, below.

3. ENVIRONMENTAL BASELINE CONDITIONS

Discussion of the Action Area's baseline environmental setting is provided as context for the effects determinations under current site conditions. For both terrestrial and aquatic habitats, "Past and Current Activities" describe the baseline level of past or ongoing disturbance (noise, light, air emissions, movement, visual harassment, human presence, etc.), based on the severity and recurrence of past or ongoing activity. No portions of the Action Area are entirely undisturbed.

Geosyntec Consultants (Geosyntec) conducted a site assessment of habitats throughout the Action Area on 5 November 2024 to evaluate characteristics of the baseline environmental setting. Discussion and descriptions of environmental baseline are further supplemented by a combination of past studies conducted by others within and around the Action Area; published data or studies by government agencies and research groups; and desktop review of publicly available Geographic Information Systems (GIS) datasets.

3.1 Ecoregion and Climate

The Action Area is in the U.S. Environmental Protection Agency's (USEPA) Level IV Mid-coast Barrier Islands and Coastal Marshes Ecoregion (34h), which begins at Corpus Christi Bay and extends north to Galveston Island. This ecoregion experiences an average annual precipitation ranging from 34-36 inches and serves as a climatic transitional zone between semiarid southern regions and significantly humid northeast regions.

Characteristic physiography in this ecoregion include saline, brackish, and freshwater marshes, barrier islands with minor washover fans, bays, estuaries, dunes, and tidal flats. Saline zones are dominated by vegetative species such as smooth cordgrass (*Spartina alterniflora*), marshhay cordgrass (*Spartina patens*), and coastal saltgrass (*Distichlis spicata*). Grasslands may be composed of native vegetation like seacoast bluestem (*Schizachyrium scoparium var. littorale*), sea-oats (*Uniola paniculata)*, common reed (*Phragmites australis*), and gulfdune paspalum (*Paspalum monstachyum*). South of Port O'Connor, black mangrove (*Avicennia germinans*) begins to appear. Land development throughout this region is primarily driven by infrastructure to support commercial and recreational fishing, energy resources, and commercial/residential occupancy (Griffith, Bryce, Omernik, and Rogers 2007, 83).

3.2 Terrestrial Habitat

Terrestrial land cover in the Action Area is found onshore in Aransas Pass, along the Redfish Bay Causeway corridor, and on Harbor Island. Terrestrial land cover includes barren land (rock/sand/clay substrates), developed land, herbaceous grasslands, shrub-scrub uplands, and isolated tree cover, primarily palms. Palustrine wetlands are found throughout portions of Harbor Island, as well as tidally influenced estuarine wetlands which are further described in Section 3.3.

Further, the Action Area crosses the southern end of San Jose Island where the proposed water intake pipe is proposed for installation beneath the island. San Jose Island is an undeveloped barrier island that is largely inhabited and serves as important terrestrial habitat for a variety of species. The southern extent of San Jose Island is bound to the northwest by the Lydia Ann Channel and to the south by the Corpus Christi Ship Channel. PCCA will employ a combination of avoidance measures, including tunnel boring and/or HDD construction techniques to install the intake pipe below the island and prevent disturbances to protected species or suitable habitats on San Jose Island. As such, no Project effects are anticipated to occur through portions of the Action Area crossing San Jose Island.

3.2.1 Locations of Terrestrial Habitat in Action Area

Aransas Pass. Terrestrial habitat is predominantly intensively developed land intermixed with roadside grassy areas. Grass-dominated areas are typically mowed and maintained, associated with commercial or residential landscaping, or roadside verge, and isolated tree cover occurs intermittently through this area. Development in this location mainly consists of commercial, residential, and industrial buildings and complexes, as well as their attendant features such as parking lots, roadways, walkways, and utility structures.

Redfish Bay Causeway Corridor. Terrestrial habitat is a mix of developed land, barren land, shrub-scrub uplands, roadside grasslands, and limited, isolated tree cover. Developed land cover includes Highway 361 from Aransas Pass to the Aransas Pass Ferry and limited residential and commercial development on either side of the road. Barren land cover is found on either side of Highway 361 as upland areas near the shoreline of Redfish Bay that lack vegetative cover and consist of various rock, sand, and clay sediments. Many barren land areas appear to serve as unimproved road access routes to the bay, as evidenced by persistent tire rutting in the substrate. Grass-dominated habitats immediately adjacent to the roadside are typically mowed as part of maintenance for the existing road easement. Beyond this maintained area, herbaceous habitats often transition to denser shrub-scrub habitat in upland areas further from the roadway. Throughout this corridor, both palustrine and tidally influenced estuarine wetlands may be found.

Harbor Island: Undeveloped habitat on Harbor Island consists of herbaceous grasslands, scrub-shrub uplands, and barren land/unvegetated substrates. Both isolated and hydrologically connected palustrine and estuarine wetlands occur throughout undeveloped portions of Harbor Island and along portions of its shorelines. Areas developed for industrial and commercial use are at the southeastern corner and southwestern portions of the island, adjacent to the Corpus Christi Ship Channel. Both improved and unimproved access roads occur throughout Harbor Island for access to the existing developments and the undeveloped shoreline areas.

3.2.2 Past and Current Activities

Aransas Pass. The northwestern terminus of the Action Area occurs in previously developed portions of Aransas Pass. Significant residential and commercial development is concentrated through this corridor. High levels of vehicle and pedestrian traffic generates consistent anthropogenic disturbances from noise, light, vehicle movement, and human activity.

Redfish Bay Causeway Corridor. Since Highway 361 is the arterial route for land-based access to northern Mustang Island and Port Aransas, ongoing vehicle traffic on Highway 361 generates consistent levels of noise, light, movement, and vehicle emission disturbances. Moderate disturbances (daily to weekly presence of humans in low concentrations) are likely to occur along the limited development areas on either side of Highway 361. Limited development areas include a few residential/commercial buildings, fishing piers, recreational walking/biking paths, and small boat ramps along the bay shoreline, as well as their access roads and driveways. These areas allow vehicular access off the paved roadway to locations for bay-side recreation or small watercraft launches, and the frequency of disturbance here may fluctuate seasonally. Sporadic visitors, business operators, or residents of the bayside residential and commercial structures produce a moderate degree of baseline activity in the area. Existing transmission lines are present along this road corridor and require ongoing maintenance, as needed. Mowing and other vegetative management procedures occur regularly to maintain the road easement, and contiguous patches of herbaceous grassland habitat are often fragmented by access roads or driveways, limiting habitat connectivity. The Action Area is near Highway 361's southernmost terminus at the Port Aransas Ferry, which operates 24 hours a day for seven days a week and uses between two to six ferries to shuttle traffic onto Mustang Island, generating consistent noise disturbances.

Harbor Island. Intensive industrial development historically occurred throughout Harbor Island, which was used for storage of crude oil tanks. Harbor Island has since been decommissioned as a storage facility, with all tanks removed and the area properly remediated. The island is situated near the confluence of three active ship channels, and is bisected by the Redfish Bay Causeway, including its terminus at the Port Aransas Ferry. Operations activities occur consistently within developed commercial and industrial portions of the island. Though undeveloped areas of Harbor Island have re-naturalized following remediation, the proximity to major land- and water-based transportation corridors and nearby industrial activity exposes this location to frequent noise, lighting, movement, and other anthropogenic disturbances. Further, portions of Harbor Island are contained within existing chain-link fencing, restricting habitat connectivity and the free movement of ground-moving species, and mowing occurs regularly throughout the property.

3.3 Estuarine and Marine Habitat

Aquatic environments throughout the Action Area contain specific habitat elements categorized as EFH. The Gulf of Mexico Fishery Management Council (GMFMC) describes three geographic habitat zones with EFH: **Estuarine** (inside barrier islands and estuaries or bays); **Nearshore** (marine waters 60-feet or less in depth); and **Offshore** (marine waters greater than 60-feet deep). Amongst the three habitat zones, EFH is subdivided into 12 habitat type categories: **Submerged Aquatic Vegetation, Mangroves, Drifting Algae, Emergent Marshes, Sand/Shell Bottoms, Soft Bottoms, Hard Bottoms, Oyster Reefs, Banks/Shoals, Reefs, Shelf Edge/Slope, and Water Column Associated** (GMFMC and NMFS 2016).

The Action Area contains estuarine habitat throughout Redfish Bay and Corpus Christi Bay and overlaps with the Redfish Bay State Scientific Area. Multiple navigational channels occur within estuarine habitats in the Action Area, including the Aransas, Harbor Island, Lydia Ann, and Corpus Christi Ship channels. Nearshore marine habitat occurs in the Gulf of Mexico beyond the eastern shorelines of San Jose Island. The baseline condition of EFH within the Action Area is described below, and an assessment of Project effects on EFH is further discussed below in Section 6.

3.3.1 Past and Current Activities

Aquatic habitats throughout the Action Area are exposed to a variety of disturbances from nearby commercial, industrial, and recreational uses. Commercial and recreational boat traffic frequently pass through Redfish Bay and the surrounding navigational channels. Redfish Bay is a significant recreational fishing area, attracting pedestrian activity both to in-water areas and its shorelines. Much of the Action Area is publicly accessible by water and land, and consistently experiences disturbances from noise, lighting, debris, pollutants, and human activity.

3.3.2 Types of EFH in the Action Area

The shallow estuarine waters of Redfish Bay and Corpus Christi Bay contain multiple categories of EFH. Submerged aquatic vegetation (SAV, seagrass) beds, oyster beds, and tidally influenced wetlands can be found in the Action area along portions of the Redfish Bay Causeway corridor. These habitats provide a variety of ecological services, functioning as important resting, foraging, and nursery grounds for numerous aquatic species. Seagrasses occurring in the Action Area include shoal grass (*Halodule wrightii*) and turtle grass (*Syringodium filiforme*). The Project is designed to completely avoid impacts to seagrass, oyster beds, and tidally influenced wetlands by using HDD and/or tunnel boring techniques to install the finished water pipeline component.

Additional types of EFH found throughout the estuarine and nearshore portions of the Action Area include soft and sand/shell-bottom benthic habitat, water column habitat, and drift algae (*Sargassum*) communities. Drift algae communities are ephemeral in nature, influenced by currents throughout the Gulf of Mexico. The Project has been designed to reduce impacts to benthic, water column, and *Sargassum* EFH communities, in both its initial construction measures and in its ongoing operations.

4. USFWS: ESA SPECIES AND CRITICAL HABITAT ASSESSMENT

The purpose of this section is to evaluate the Project's potential effects on federally listed and proposed species and designated or proposed critical habitats under the jurisdiction of USFWS pursuant to ESA Section 7(a)(2).

4.1 Species and Critical Habitat of Interest

The Project site was evaluated using the USFWS Information for Planning and Consultation (IPaC) system to identify species and critical habitat under USFWS jurisdiction with potential to be affected by Project activities. An IPaC Official Species List (Appendix A) was generated, which identifies 16 listed or proposed species with potential to occur within the Action Area.

4.1.1 Species and Critical Habitat to be Evaluated

Of the 16 species identified in the IPaC report, six species and/or critical habitats will be evaluated within this BA due to potential presence or suitable habitat within the Action Area. The species to be evaluated are:

- Rufa red knot (*Calidris canutus rufa*)
- Piping plover (*Charadrius melodus*), and final critical habitat
- Northern aplomado falcon (*Falco femoralis septentrionalis*)
- Whooping crane (*Grus americana*)
- Eastern black rail (*Latterallus jamaicensis ssp. Jamaicensis)*
- West Indian manatee (*Trichechus manatus*)

4.1.2 Species with Anticipated "No Effect" Determination

The remaining ten species in the IPaC report are not expected to occur within the Action Area due to lack of suitable habitat. The species anticipated to experience "No Effect" from the Project and will not be evaluated in this section of the BA are:

- Attwater's greater prairie-chicken (*Tymanuchus cupido attwateri*)
- South Texas ambrosia (*Ambrosia cheiranthifolia*)
- Slender rush-pea (*Hoffmannseggia tenella*)
- Loggerhead sea turtle (*Caretta caretta*) (nesting)
- Green sea turtle (*Chelonia mydas* (nesting)
- Leatherback sea turtle (*Dermochelys coriacea*) (nesting)
- Hawksbill sea turtle (*Eretmochelys imbricata)* (nesting)
- Kemp's ridley sea turtle (*Lepidochelys kempii)* (nesting)
- Monarch butterfly (*Danaus plexippus)*
- Tricolored bat (*Perimyotis subflavus*)

ESA responsibilities regarding listed sea turtles are jointly administered by both USFWS and NMFS (USFWS and NMFS 2015). A "No Effect" determination for the five listed sea turtles addressed in Section 4 of this BA only regards sea turtles, including their nesting behaviors and habitats, within the terrestrial environment under USFWS jurisdiction. An effect analysis of sea turtles and their habitats within the aquatic environment under NMFS jurisdiction is discussed in Section 5 of this BA.

4.2 Rufa red knot

4.2.1 Species Description

The rufa red knot is a medium-sized, highly migratory shorebird that ranges across nearly the full latitude gradient of the Western hemisphere. Rufa red knot annual migrations occur from their central Canadian arctic breeding grounds to four primary wintering regions, which includes the Northwest Gulf of Mexico along the Texas coast (USFWS 2023a). Within coastal Texas wintering habitats, rufa red knots forage on beaches, oyster reefs, and exposed bay bottoms and roost on high sandflats and other areas shielded from high tides (USFWS 2014a). Population abundance estimates for rufa red knots are uncertain due to insufficient data from inconsistent survey and modeling efforts; however, the 2023 USFWS Recovery Plan for Rufa Red Knot estimates the Texas and Northern Mexico coastal wintering areas may support a population of 2,000-4,000 individuals (USFWS 2023a, 8).

4.2.1.1 Species Status and Critical Habitat

The USFWS designated threatened species status for rufa red knot, effective January 12, 2015 (79 FR 73705), and published a revised rule to propose critical habitat on April 13, 2023 (88 FR 22530). The proposed critical habitat does not intersect the Action Area, but the northern-most terminus of proposed critical habitat unit TX-4 Mustang Island is within 1-mile of the Project, located in Port Aransas.

The proposed critical habitat rule identifies PBFs that are essential for conservation of the species (USFWS 2023b, 22533). PBFs identified by USFWS for rufa red knot include:

- Beaches and tidal flats used for foraging
- Upper beach areas used for roosting, preening, resting, or sheltering
- Ephemeral and/or dynamic coastal features used for foraging or roosting
- Ocean vegetation deposits or surf cast wrack (natural material like seaweed, algae, invertebrates that wash on beach) used for foraging or roosting
- Intertidal peat banks for foraging or roosting
- Features landward of beaches supporting foraging/roosting
- Any artificial habitat mimicking natural conditions/maintaining any features mentioned above

4.2.1.2 Population Threats

Due to its extensive migratory range, rufa red knots face threats influenced by numerous geographic and temporal factors. The USFWS determined three categories of threats affecting rufa red knots: primary, "high severity" threats driving rufa red knot's status as threatened species under ESA; individual secondary, "moderate severity" threats not expected to have effects at the level of the listed taxon, but in cumulation, may exacerbate primary threats; and "low severity" threats concluded as not contributing to the rufa red knot's threatened status under ESA (USFWS 2023a, 10).

Table 1 summarizes these threats below. Of the listed examples, plausible threats relative to the Project may include loss of breeding/nonbreeding habitat and human disturbance.

Table 1. Rufa red knot threats matrix (USFWS 2023a, 10).

Threat Type	Threat Severity		
	Low	Moderate	High
Loss of breeding/nonbreeding habitat			X
Disruption of natural predator cycles on breeding grounds			X
Reduced prey availability in nonbreeding range			X
Asynchronous timing of migratory cycle relative to favorable food and weather conditions			X
Predation in nonbreeding areas		X	
Algal blooms		X	
Human disturbance		X	
Oil spills		X	
Coastal wind energy development		X	
Beach cleaning	X		
Agriculture	X		
Research activities	X		
Disease	X		

4.2.2 Species Assessment Area

The assessment area for rufa red knots in the Action Area includes bayside shorelines, algal mats, wrack deposits, and herbaceous wetlands within the proposed facility footprint on Harbor Island and roadside areas adjacent to the finished water pipeline route along Highway 361.

4.3 Piping plover

4.3.1 Species Description

The piping plover is a small migratory shorebird with three distinct North American breeding populations found in the Northern Great Plains, Great Lakes, and Atlantic Coast regions (USFWS 2001a). Piping plovers from all three regions occupy the Texas Gulf Coast during their non-breeding wintering season, typically between mid-July and mid-May. The Texas wintering population census indicates a fluctuating to increasing trend in populations from 1,904 plovers in 1991, to 2,145 plovers in 2011; however, census fluctuations may be influenced by localized effects of weather conditions; changes in roosting, foraging, or nesting habitats; or variance in survey efforts among observers (Haig et al. 2005; USFWS 2012).

Coastal Texas wintering habitat includes beaches, mud flats, sand flats, algal flats, and washover passes (areas where breaks in the sand dunes result in an inlet), and individuals will often use a mosaic of ephemeral habitats in response to local weather and tidal conditions (USFWS 2001a). Data suggests that piping plovers prefer bay side habitats when available but also rely on beach habitats when bay water levels are high (Newstead and Vale 2014; USFWS 2020a, 12-13). Wrack material deposited on beaches or bay shores is identified as an important roosting habitat component for plovers throughout their wintering range. Foraging within wintering habitats often targets prey items such as polychaete marine worms, various crustaceans, insects, and occasionally bivalve mollusks that are found on or just below the surface of wet sand, mud, or fine shell substrates (USFWS 2001a).

4.3.1.1 Species Status and Critical Habitat

The USFWS designated threatened species status for piping plovers throughout their wintering and migration range, effective January 10, 1986 (50 FR 50726). Final critical habitat for wintering piping plovers was designated on July 10, 2001 (66 FR 36087) and revised for units located in Texas on May 19, 2009 (74 FR 23476).

The Action Area intersects portions of piping plover final critical habitat on San Jose Island, identified as habitat unit TX-15 North Pass. Work in this portion of the Action Area will be limited to tunnel boring beneath San Jose Island and the critical habitat, thereby completely avoiding impacts to piping plovers and their critical habitat at the surface.

TX-15 is an 805-acre bayside unit in Aransas County that contains PCEs in the appropriate spatial arrangement essential to conservation of piping plovers. Eight PCEs were identified as essential components of wintering habitat, which includes surf-cast algae for feeding (PCE 3), sparsely vegetated backbeach (PCE 4), salterns within mangrove ecosystems (PCE 6), and artificial habitats that mimic natural conditions of sparse vegetation with little topographic relief (PCE 8). Not all critical habitat units contain every PCE; the three PCEs identified in TX-15 include:

- Intertidal sand flats with no or very sparse emergent vegetation for feeding (PCE 1)
- Unvegetated or sparsely vegetated sand flats above high tide for roosting (PCE 2)
- Unvegetated washover areas with little or no topographic relief for feeding and roosting (PCE 7)

Specific threats to PCEs in TX-15 that may require special management of protections are identified as residential and commercial development; recreational use, including human, vehicle, and domestic animal disturbance, and predation.

4.3.1.2 Population Threats

The USFWS Inter-Regional Piping Plover Recovery Team identified threats to migrating and wintering piping plover populations and ranked these threats based on their potential impact on population size, summarized in Table 2 below. The Recovery Team acknowledges there are differences in relative importance of each threat at a regional scale, however, the chart represents an overall ranking on the wintering population based on the amount of information currently known, the amount of habitat affected, and the difficulty in reducing the threat (USFWS 2015, 22-23).

Table 2. Piping plover wintering grounds threats matrix (USFWS 2015, 22-23).

Threat Type	Threat Level			
	Low	Medium	High	Unknown
Loss, modification, and degradation of habitat				
Development and construction			X	
Dredging and sand mining			X	
Inlet stabilization and relocation			X	
Groins			X	
Seawalls and revetments			X	
Sand replacement projects		X		
Loss of macroinvertebrate prey base due to shoreline stabilization		X		
Invasive vegetation			X	
Wrack removal and beach cleaning		X		
Accelerating sea level rise and other climate change impacts			X	
Weather events				
Storm events	X			
Severe cold weather	X			
Disturbance from recreational activties		X		
Oil spills and other contaminants				
Oil spills		X		
Pesticides and other contaminants	X			
Energy Development				
Land-based oil and gas exploration and development	X			
Wind turbines				X
Predation	X			
Military operations	X			
Disease	X			

4.3.2 Species Assessment Area

The assessment area for piping plovers in the Action Area includes bayside shorelines, algal mats, wrack deposits, and herbaceous wetlands within the proposed facility footprint on Harbor Island and roadside areas adjacent to the finished water pipeline route along Highway 361.

The Action Area also crosses final critical habitat for piping plover on San Jose Island where the proposed intake pipe will be installed beneath the island. Based on the tunnel boring construction techniques and avoidance measures proposed to prevent impacts to San Jose Island, no effects are anticipated for piping plover critical habitat and therefore, suitable habitat on San Jose Island will not be discussed as part of the species assessment area for piping plover.

4.4 Northern aplomado falcon

4.4.1 Species Description

The Northern aplomado falcon is a medium sized raptor that occupies a limited range in portions of Arizona, New Mexico, Texas, and Mexico. The species appears non-migratory within their United States range and mated falcon pairs remain together year-round, behaving cooperatively during hunting and nest incubation. Nesting chronology records are variable between January through September, with egg-laying most commonly occurring between March and May. Northern aplomado falcons do not build their own nests and instead, use existing nests built by other large raptors or corvids, meaning they are dependent upon the nesting activities and habitat requirements of other stick-nest building birds (USFWS 2014b, 6). Small birds and insects comprise the majority of northern aplomado falcon diets, but other prey species include a variety of rodents, small snakes, and lizards. Preferred habitat consistently contains an open grassland component with either scattered islands of shrubs/trees or wooded borders, allowing for perching and nesting sites and a greater abundance of diverse prey species (TPWD n.d., a)

On the Texas coast, two known populations are identified as the Brownsville population (includes 19 pairs within a tract extending approximately 35 miles north from the Mexico border) and the Rockport population (includes 12-14 pairs distributed along the length of Matagorda Island and adjacent San Jose Island) (USFWS 2014b, 10-11). Additional sightings of aplomado falcon pairs have been documented through iNaturalist citizen science submissions in 2023-2024, located south of Port Aransas extending along Mustang Island (iNaturalist 2024).

4.4.1.1 Species Status and Critical Habitat

The USFWS designated endangered status for Northern aplomado falcon, effective March 27, 1986 (51 FR 6686). No locations have been designated or proposed as critical habitat for northern aplomado falcon, and therefore, no PCEs or PBFs have been published by USFWS. The 2014 USFWS 5-Year Review denotes that while Northern aplomado falcon habitat is variable throughout its range, consistent essential habitat elements within these variations include open terrain with scattered trees, low ground cover, abundant prey insects and small- to medium-sized birds, and a supply of suitable nest sites (USFWS 2014b, 13).

4.4.1.2 Population Threats

Historic causes for decline include widespread shrub encroachment in former grasslands, caused by range fire suppression practices, agricultural development, and intense overgrazing. Exposure to persistent pesticides and bioaccumulation of toxic pollutants is also suspected to have contributed to the species' population decline. Current limitations to population recovery are primarily associated with the continued degradation of suitable grassland habitats, which is exacerbated by long-term drought conditions, agricultural conversion, and encroachment of woody shrubs and non-native vegetation. Population recovery is further limited by reduced abundance of grassland bird communities, an important prey resource for the northern aplomado falcon (USFWS 2014b, 33).

4.4.2 Species Assessment Area

The assessment area for Northern aplomado falcon in the Action Area includes contiguous grassland areas and herbaceous palustrine and estuarine wetlands within the proposed facility footprint on Harbor Island. Isolated trees and existing anthropogenic structures suitable for perching sites may also occur in the Harbor Island facility footprint and on roadside areas adjacent to the finished water pipeline route along Highway 361.

4.5 Whooping crane

4.5.1 Species Description

The whooping crane is a large migratory wading bird found only within North America. The Aransas-Wood Buffalo population (AWBP) is a wild, self-sustaining population of whooping crane that migrates annually over the Great Plains between its Canadian nesting grounds around Wood Buffalo National Park and coastal Texas wintering grounds around Aransas National Wildlife Refuge (ANWR). Whooping crane occupancy on their wintering grounds typically lasts from late October through early April (CWS and USFWS 2007). Aerial abundance surveys conducted by USFWS over ANWR during winter 2022-2023 resulted in observations of approximately 536 AWBP individuals (USFWS and CWS 2024, 3).

Wintering habitat in and around ANWR important for foraging and roosting activities include brackish bays, marshes, and salt flats on mainland edges and nearby barrier islands. These areas support the whooping crane's primary winter diet of blue crabs, clams, and wolfberry plants (*Lycium carolinianum*). Upland sites with freshwater sources may occasionally be used for drinking and a variety of snail, crayfish, and insect prey items. Although close association with other whooping cranes can be tolerated within wintering grounds, monogamous pairs and family groups will typically occupy and defend discrete territories, and small flocks of subadult or unpaired adult cranes will use areas outside of occupied territories (CWS and USFWS 2007, 7-8).

4.5.1.1 Species Status and Critical Habitat

The USFWS classified whooping crane as "threatened with extinction" in 1967 (32 FR 4001) and endangered in 1970 (35 FR 8491); these classifications were grandfathered in to support whooping crane's final endangered status under the Endangered Species Act in 1973. The USFWS designated final critical habitat for whooping crane throughout its range, effective June 14, 1978 (43 FR 20938).

The Action Area does not intersect any final critical habitat units. The nearest critical habitat unit for whooping crane is located approximately 17.5 miles northeast of the Action Area within Aransas National Wildlife Refuge and its surrounding vicinity.

4.5.1.2 Population Threats

The USFWS 2007 revised International Whooping Crane Recovery Plan summarizes threats that limit the recovery of whooping cranes. Specific factors with applicability to the AWBP and their coastal Texas wintering grounds include:

- Human settlement/development within migration corridors and wintering grounds
- Alteration or reductions of freshwater inflows necessary to maintain productive estuarine communities
- Increased human disturbance within easily accessible wintering grounds
- Limited genetic diversity within the AWBP

- Susceptibility to contaminant spills
- Climate-related degradation of coastal wetlands, such as changes in erosion, salinity, microclimate, groundwater tables, sea level rise, and increased intensity and frequency of damaging weather events.

4.5.2 Species Assessment Area

The assessment area for whooping cranes in the Action Area includes herbaceous palustrine and estuarine wetlands, ephemeral water features, grassland areas, and bayside shorelines within the proposed facility footprint on Harbor Island and roadside areas adjacent to the finished water pipeline route along Highway 361. Isolated trees and existing anthropogenic structures suitable for perching sites may also occur in the Harbor Island facility footprint and on roadside areas adjacent to the finished water pipeline route along Highway 361.

4.6 Eastern black rail

4.6.1 Species Description

The Eastern black rail is a small marsh bird occurring in salt, brackish, and freshwater wetlands in portions of the United States (east of the Rocky Mountains), Mexico, Brazil, Central America, and the Caribbean. The quality and quantity of survey data surrounding the Eastern black rail population size and distribution are variable throughout the United States, and the nature of migration for this species is poorly understood. Relative to coastal Texas specifically, preliminary study results suggest there is a migratory population breeding in Colorado and Kansas and wintering in Texas, and a non-migratory year-round population in Texas (USFWS 2019).

It is understood that Eastern black rail habitat is primarily composed of fine-stemmed emergent vegetation (rushes, grasses, sedges) that provides dense, herbaceous overhead cover and allows for quick, running ground movements. Suitable substrate is considered moist to saturated soils, interspersed with or adjacent to very shallow water or scattered small pools (USFWS 2019). Well-vegetated wetland-upland ecotones are also an important habitat component for Eastern black rail, as they provide important higher elevation refugia during high tides or flooding events (Evens and Page 1986).

For year-round occupants on the Texas coast, it is presumed that wintering habitat is similar to breeding habitat (Watts 2016). Live and dead fine-stemmed emergent vegetation is used to construct bowl-shaped ground nests. These habitats support all life stages of Eastern black rail and are essential in providing abundant foraging resources such as aquatic and terrestrial invertebrates and seeds (USFWS 2019, 16-21).

4.6.1.1 Species Status and Critical Habitat

The USFWS designated threatened status for Eastern black rail, effective November 9, 2020 (85 FR 63764). This listing rule states that designation of critical habitat for Eastern black rail is not prudent in accordance with 50 CFR 424.12(a)(1), as designation can reasonably be expected to increase the degree of these threats to the subspecies and its habitat by making location information more readily available. Since no critical habitat is designated for eastern black rail, no PCEs or PBFs have been published by USFWS

4.6.1.2 Population Threats

The USFWS determined four primary threats that are driving the status and future viability of eastern black rail: 1) Habitat fragmentation and conversion, 2) sea level rise and tidal flooding, 3) land management practices (i.e., incompatible fire management, grazing, and mechanical treatment), and 4) stochastic events (i.e., extreme floods, hurricanes) (USFWS 2020b, 63767). Additional stressors that may cause localized impacts (but are not the primary drivers of the species threatened status) include human disturbance (such as excessive playback calls used by hobbyist birders), contaminant spills, disease, predation, and food web disruptions resulting from invasive species.

4.6.2 Species Assessment Area

The assessment area for Eastern black rail in the Action Area includes palustrine and estuarine herbaceous wetlands, ephemeral waterbodies, and wetland-upland transitional zones within the proposed facility footprint on Harbor Island.

4.7 West Indian manatee

4.7.1 Species Description

The West Indian manatee, which includes the Florida manatee subspecies (*Trichechus manatus latirostris*), is a large marine mammal occurring throughout coastal waters, estuaries, and freshwater river systems in the southeastern United States. Populations are largely confined to peninsular Florida, especially during cold temperatures where West Indian manatees rely on Florida's concentrated seagrass forage and warmer waters produced by natural springs and power plant outfalls. During warmer seasons, transient individuals may occasionally be found along the Texas coast. A 2005 study summarizes Texas' prior manatee records consisting of 53 sightings, 8 carcasses, and 5 captures (Fertl et al 2005), and irregular occurrences have continued to be reported along the Texas coast in recent years as well.

West Indian manatees are opportunistic herbivores that will feed on a wide variety of floating, submerged, and emergent vegetation, with seagrasses appearing to be a staple of manatee diets in coastal areas. Preferred feeding areas in coastal and riverine habitats include shallow grass beds with access to deeper channels, and West Indian manatees often use canals, creeks, embayments, and lagoons, particularly near the mouths of coastal rivers and sloughs, for feeding, resting, cavorting, mating, and calving (USFWS 2001b)

4.7.1.1 Species Status and Critical Habitat

The USFWS currently designates the West Indian manatee with threatened species status under the ESA, effective May 5, 2017 (82 FR 16668). Further protections are placed upon West Indian manatees under the Marine Mammal Protection Act. The species was initially classified as endangered in 1967 (32 FR 4001) and downlisted from endangered to threatened in April 2017 (82 FR 16668). As of October 2023, the West Indian manatee is under review for uplisting back to endangered status (88 FR 70634).

The USFWS designated final critical habitat for West Indian manatee effective September 22, 1977 (42 FR 47840). A proposal to revise the critical habitat was published in September 2024 (89 FR 78134). The Action Area does not intersect any final or proposed critical habitat units, which concentrate along the east and west coasts of Florida in bays, estuaries, and inland along large river systems (Florida subspecies) or along the coasts of Puerto Rico (Antillean subspecies).

4.7.1.2 Population Threats

The 2024 proposed critical habitat revision groups primary threats into six categories, to include warm-water habitat loss, habitat loss/degradation other than warm-water areas, algal blooms, climate change impacts, contaminants, and tropical storms and hurricanes (USFWS 2024a). The 2024 Draft Species Status Report for the Florida manatee subspecies notes that within the United States, collisions with watercraft have been identified as the most significant anthropogenic threat to Florida manatees (USFWS 2024b, 36).

4.7.2 Species Assessment Area

The assessment area for West Indian manatee within the Action Area includes estuarine open waters in Redfish Bay and Corpus Christi Bay along the finished water pipeline route, at the location of the Corpus Christi Ship Channel outfall, and nearshore marine waters at the location of the intake structure, intake pipe, and Gulf of Mexico outfall and pipe.

4.8 Effect Analysis

This section will discuss the potential Project effects on rufa red knot, piping plover, Northern aplomado falcon, whooping crane, Eastern black rail, and West Indian manatee, as well as their suitable habitats within the Action Area. Effects produced by the Project are assessed relative to the ambient baseline conditions existing in the Action Area. Further, this effect analysis considers that species' responses to an action may vary based on the intensity or severity of the action, the species' recovery rate and tolerance threshold, and factors such as proximity, distribution, timing, nature, and duration of the disturbing action.

4.8.1 Direct Effects

Direct effects on a species or its habitat are those effects caused by the action and occur at the same time and place as the action. They are dependent upon the actual presence of individuals or habitat occurring in the Action Area; for the purpose of this BA, the analysis of direct effects is written assuming the listed species occur or potentially occur in the Action Area.

Occupied Habitat Loss:

<u>Rufa red knot:</u> Wintering rufa red knots have potential to occur within the proposed facility footprint on Harbor Island and roadside areas adjacent to the finished water pipeline route along Highway 361. Free-moving ground access in and out of the facility may be restricted by the existing fencing around portions of the property, though flying piping plovers may still access the site. Habitat impacts in roadside habitats will be minimized by using HDD and/or tunnel boring methods to install the pipeline. Relative to the availability of similar suitable habitats on nearby barrier islands and baseline condition of the Action Area, only a small proportion of potentially suitable habitat will be affected. Thus, occupied habitat loss is not anticipated to be an adverse effect on rufa red knots.

<u>Piping plover and final critical habitat</u>: Wintering piping plovers have potential to occur within the proposed facility footprint on Harbor Island and roadside areas adjacent to the finished water

pipeline route along Highway 361. Free-moving ground access in and out of the facility may be restricted by the existing fencing around portions of the property, though flying piping plovers may still access the site. Habitat impacts in roadside habitats will be minimized by using HDD and/or tunnel boring methods to install the pipes/pipeline. Further, tunnel boring construction techniques and avoidance measures are proposed to prevent impacts to San Jose Island and will not affect piping plover critical habitat.

Relative to the availability of similar suitable habitats on nearby barrier islands and baseline condition of the Action Area, only a small proportion of potentially suitable habitat will be affected. Thus, occupied habitat loss is not anticipated to be an adverse effect on piping plovers or their critical habitat.

Northern aplomado falcon: Direct effects to suitable nesting and roosting structures (i.e., trees or artificial structures containing the nests of falcons or other previously constructed large raptor nests) will be avoided. Therefore, loss of occupied habitat is not expected to be a direct, permanent adverse effect on Northern aplomado falcon.

Whooping crane: Whooping cranes have potential to occur in herbaceous palustrine and estuarine wetlands, ephemeral water features, grassland areas, and bayside shorelines within the proposed facility footprint on Harbor Island and roadside areas adjacent to the finished water pipeline route along Highway 361. Habitat impacts in roadside habitats will be minimized by using HDD and/or tunnel boring methods to install the pipes/pipeline. Relative to the availability of similar suitable habitats on nearby barrier islands and baseline condition of the Action Area, only a small proportion of potentially suitable habitat will be affected. Thus, occupied habitat loss is not anticipated to be an adverse effect on whooping cranes.

Eastern black rail: The assessment area for Eastern black rail in the Action Area includes palustrine and estuarine herbaceous wetlands, ephemeral waterbodies, and wetland-upland transitional zones within the proposed facility footprint on Harbor Island. The baseline condition of habitats in this area includes disturbance through frequent mowing and maintenance, which does not allow sufficiently high, dense herbaceous cover to establish for many portions of the year. Further, free-moving ground access in and out of the facility may be restricted by the existing fencing around portions of the property, though flying Eastern black rails may still access the site. Relative to the baseline condition of habitat within the Action Area and availability of similar suitable habitats on nearby barrier islands, only a small proportion of potentially suitable habitat will be affected. Thus, occupied habitat loss is not anticipated to be an adverse effect on Eastern black rail.

West Indian manatee: Transient manatees are occasionally found along the Texas coast and have potential to occur in estuarine and marine open waters in Redfish Bay, Corpus Christi Bay, and the Gulf of Mexico portions of the Action Area. Further, seagrass beds near the Action Area are suitable manatee foraging habitats. The Project is employing HDD and/or tunnel boring construction techniques to avoid seagrass beds, so no loss of active foraging habitat will occur. Minimal loss of open water area at the site of the Gulf of Mexico intake and outfall structure is unlikely to adversely affect manatees, given the availability of surrounding open water habitat in the Gulf and low distribution of manatees occupying the region of the Project. Thus, occupied habitat loss is not anticipated to be an adverse effect on West Indian manatees.

Killing or Wounding:

Rufa red knot, piping plover, Northern aplomado falcon, whooping crane, Eastern black rail: Road mortality and collisions with construction equipment or vehicles during flight or on the ground are not anticipated to be a significant risk to these species or continued existence of their populations. Relative to baseline levels of vehicle traffic throughout the Action Area, individuals of these species are regularly exposed to the effects of a busy transportation corridor and active industrial, commercial, and recreational area. Further, PCCA will employ conservation and avoidance measures (Section 4.8.5) to minimize risks of killing or wounding should an individual of the above species enter the Project area during work. Thus, killing or wounding via vehicle/equipment collision is not an anticipated adverse effect for rufa red knot, piping plover, Northern aplomado falcon, whooping crane, or Eastern black rail.

West Indian manatee: As mentioned above, collisions with watercraft are noted as a significant anthropogenic threat to manatees. To reduce the potential for vessel strikes that may result in killing or wound of West Indian manatee, the Project will adhere to the *USFWS Standard Manatee Conditions for In-Water Work* (USFWS 2011), further described in Section 4.8.5. Based on the limited occurrences of manatees in Texas coastal waters and the in-water work conditions proposed to avoid vessel strikes to manatees, killing or wounding is not an anticipated adverse effect for West Indian manatee.

Construction Noise and Human Activity:

Rufa red knot, piping plover, Northern aplomado falcon, whooping crane, Eastern black rail: Noise levels and human activities above the ambient baseline may elicit short-term reactionary behaviors in bird species, such as flushing and crouching, and divert energetic resources away from normal foraging or roosting behavior. Baseline anthropogenic noises reach the Harbor Island and Highway 361 portions of the Action Area due to vehicle traffic, pedestrian activity, nearby industrial and commercial facility operations, and watercraft traffic from smaller recreational vessels, barges, ships, and ferries. Construction activities on Harbor Island are likely to elevate noise and activity levels above the ambient baseline but effects will be temporary in nature. Individuals of these species may temporarily relocate to other nearby habitat areas should noise levels in the Action Area exceed their tolerance levels but are likely to resume normal behavior once work is complete or noise levels return to baseline levels. By restricting work to daylight hours, the normal roosting behaviors of these species will not be affected.

West Indian manatee: Exposure to noise from construction activities, including tunnel boring machines, can physically injure manatees and alter their behaviors. Exposure to sound with sufficient duration and sound pressure level may result in an elevated hearing threshold (i.e., sudden loss of hearing sensitivity) called noise-induced threshold shift (NITS). If the threshold returns to normal, the NITS is a temporary threshold shift (TTS), or if it remains elevated after an extended time, the NITS is a permanent threshold shift (PTS). In some cases, intense noise exposures have caused auditory injury (INJ).

An acoustic effects analysis from the U.S. Navy defined numeric thresholds for predicting auditory effects on sirenian species such as manatees and dugongs when exposed to both impulsive and non-impulsive (i.e., steady state) noises. When exposed to non-impulsive noise, the study determined manatees have a TTS threshold of 180 dB re 1 μPa^2 and an INJ threshold of 200 dB re 1 μPa^2 (NMFS 2024c, Table A.E-2).

The noise produced from the Project's proposed HDD and tunnel boring methodology are considered non-impulsive sound sources. Non-impulsive sources typically do not have high peak sound pressure and are considered less injurious than impulsive sounds, which are often brief with a rapid rise/decay time and can often lead to mechanical damage of the inner ear (NMFS 2024c).

Estimates of underwater sound produced from HDD and tunnel boring methods vary based on substrate conditions, depth, size of tunnel, and specific equipment used. Generally, acoustic studies for projects using this construction technique estimated the following underwater sound levels:

- (National Highways Limited 2022) Lower Thames Crossing - Tunnel Boring Machine: Maximum of 130 dB re 1 μPa^2

- (Connel Wagner 2008, 26) Adelaide Desalination Project - Tunnel Boring Machine: 140 dB re 1μPa^2 at 1m; 120 dB re 1μPa^2 at 10m; and inaudible past 100m

Further, baseline conditions of the Action Area are subject to frequent vessel traffic, especially near the active maritime channels. While sound levels produced by watercraft varies based on the vessel type, length, speed, and materials, source levels for many vessels are within range of 150-170 dB re 1 μPa·m, with larger ships producing sounds between 175-195 dB re 1 μPa·m (Center for Marine Acoustics 2023, 54). The Project will likely result in noise levels that are temporarily elevated above baseline conditions but will not significantly deviate from the area's current noise conditions.

Based on these variables, the Project's noise effects are expected to remain below the threshold for TTS or INJ for West Indian manatees that may transiently occur in the Project area, and adverse effects from noise disturbances are not anticipated to occur.

Lighting:

<u>Rufa red knot, piping plover, Northern aplomado falcon, whooping crane, Eastern black rail, West Indian manatee:</u> Effects of lighting during construction will be avoided for all species by conducting work activities during daylight hours, thus eliminating the need for additional lighting that may disrupt normal resting behaviors or natural predator-prey cycles. The desalination facility on Harbor Island is likely to introduce small amounts of permanent external lighting in the Action Area once the facility is constructed and operational. Due to Harbor Island's proximity to Port Aransas to the south and existing industrial facilities on its eastern and southwestern shorelines, this portion of the Action Area is already subject to artificial lighting effects. Additional lighting from the Harbor Island facility is not anticipated to produce illumination effects that are significantly higher than the baseline condition in the Action Area, or that would adversely affect species potentially occurring in nearby habitats. Thus, lighting effects from the Project are not anticipated to produce a significant adverse effect on rufa red knot, piping plover, Northern aplomado falcon, whooping crane, Eastern black rail, or West Indian manatee.

4.8.2 Indirect Effects

Indirect effects are those that are reasonably certain to occur at a later time and/or place due to the proposed Action. Indirect effects are those that may continue after construction is over and have a resulting consequence that is certainly reasonable to occur.

Unoccupied Habitat Loss or Alteration:

Rufa red knot, piping plover, whooping crane, Eastern black rail: The Harbor Island desalination facility will occupy 31-acres, and much of the remaining infrastructure consists of underground pipes/pipelines. Due to this design, losses of unoccupied terrestrial habitat that could be used for overwintering, nesting, roosting, foraging, and migration behaviors are minimal, given the availability of surrounding suitable habitats and baseline condition of existing habitat that is proposed for development. Migratory individuals of rufa red knot, piping plover, whooping crane, and Eastern black rail may need to use other nearby habitats for roosting or foraging; the Action Area is not within nesting range for migrant populations of these species, so impacts to nesting habitat are not anticipated. Due to mowing in the proposed Harbor Island facility footprint, loss of unoccupied nesting habitat for non-migratory Eastern black rails is an unlikely effect of the Project. Disturbances to bayside areas that could support foraging for these species could occur; however, given the availability of suitable nearby habitats, it is unlikely to produce significant adverse effects. Thus, unoccupied habitat loss or alteration is not anticipated to be an adverse effect on rufa red knot, piping plover, whooping crane, or Eastern black rail.

Northern aplomado falcon: Similar to other listed bird species in the Action Area, losses of unoccupied terrestrial habitat that could be used by Northern aplomado falcon for nesting, roosting, and foraging are minimal, given the Project site location and construction methods, availability of surrounding suitable habitats, and baseline condition of existing habitat. Northern aplomado falcons use existing nests constructed by other large raptors and are dependent on emergent grassland habitats that support their prey species. Construction of the desalination facility on Harbor Island will result in limited removal of emergent grassland habitats, which may support prey species used by aplomado falcons; however, only a small and fragmented component of suitable prey habitat will be removed, relative to the availability of similar suitable habitats in vicinity of the Project. No suitable, unoccupied raptor nesting structures are available in the Action Area. Removal of shrub-scrub and woody vegetation may slightly reduce nest building materials available for other raptors to construct nests that could then be used by Northern aplomado falcons; however, the effects of this are minimal and will not significantly affect the species. Thus, unoccupied habitat loss or alteration is not anticipated to be an adverse effect on Northern aplomado falcon.

West Indian manatee: As described above, seagrass beds near the Action Area are suitable manatee foraging habitats but will be avoided using HDD and/or tunnel boring construction techniques. Areas where seabed disturbance occurs will experience temporary, localized sediment and turbidity effects. These turbidity effects will cease once construction is complete and suspended sediments redeposit, which will not affect unoccupied manatee habitat long-term. Normal operations of the pipes/pipelines will not result in impacts on surface water quality.

Alteration of salinity gradients from the effluent outfall are a consideration of this Project once the desalination facility is operational. USEPA has provided salinity levels that reflect acceptable changes in salinity for the protection of habitats and estuarine organisms. The USEPA maximum salinity level is an increase of 4 parts per thousand (ppt) above ambient concentrations (USEPA 1986), and a salinity increase of no more than 2 ppt over ambient concentrations measured at 100 meters from the outfall has been recommended by TPWD and Texas General Land Office (TPWD 2018). Salinity modeling for this Project indicates that the maximum increase in receiving water salinity will be less than or equal to 2 ppt at 100 meters from the diffuser ports. Further, manatees use aquatic environments across a wide gradient of salinity ranges and are unlikely to be affected by a localized area of slightly elevated salinity, should they encounter it. Based on these factors, and the West Indian manatee's limited range in Texas, alteration of salinity or turbidity parameters in manatee habitat is not expected to produce adverse effects on West Indian manatee.

Post-construction Operations Activities:

Following construction, the currently undeveloped Harbor Island portion of the Action Area may experience increased human presence and noise due to facility operations. Since Harbor Island is located in the vicinity of active commercial and industrial facilities, a busy water- and land-based transportation corridor, and active recreational areas, it is unlikely the operations of the desalination facility will produce effects that are significantly higher than the area's baseline condition. Any species occurring in this area are likely habituated to consistent exposure to anthropogenic disturbances. Thus, post-construction operations activities are not anticipated to have a significant adverse effect on rufa red knot, piping plover, whooping crane, Eastern black rail, Northern aplomado falcon, or West Indian manatee.

4.8.3 Interdependent and Interrelated Action Effects

The Project may introduce a minimal level of additional vessel traffic for maintenance of the pipes/pipeline infrastructure, as needed. Maintenance necessary for safe operations of the desalination facility and pipes/pipelines would require future construction work to occur along portions of the Project footprint and may require isolation of the workspace from other vessel traffic. Maintenance work is assumed to occur in the future but would only occur occasionally and as needed.

4.8.4 Cumulative Effects

Potential cumulative effects include other planned seawater desalination facilities in the Corpus Christi, Texas, area. Environmental permits for four other facilities have been submitted and are under review by TCEQ, and a fifth desalination facility, Corpus Christi Polymers, located on the Inner Harbor, is already permitted but not yet operational.

The site selection and constructions methods for this Project have been designed to minimize effects on terrestrial species and their suitable habitats. The cumulative effects of this Project in relation to construction of additional desalination facilities in the area, or other planned developments, are believed to be no more than minimal. Further, the proposed Project is not expected to have significant adverse impacts on the aquatic environment when considering the cumulative effects of other planned seawater desalination facilities. Most impacts will be temporary and localized within the construction areas of the intake and outfalls but are not expected to result in significant cumulative effects to the aquatic ecosystem.

4.8.5 Avoidance, Minimization, and Conservation Measures

PCCA is proposing a variety of avoidance, minimization, and conservation measures to avoid impacts to listed species and their suitable habitats. Planned avoidance measures have been incorporated since initial Project siting and planning, such as an analysis of alternative sites in the area, multiple realignments and adjustments to the infrastructure layout, and use of previously disturbed and developed areas to reduce the amount of undisturbed habitat impacted.

During construction, a combination of conservation measures and BMPs will be employed throughout various stages of the Project. These conservation measures are based on USFWS and NMFS recommended practices, as well as voluntary measures recommended by other agencies or groups, such as Texas Department of Transportation’s (TxDOT) voluntary conservation measures for Eastern black rail (TxDOT 2024).

Measures that may be employed during the Project to minimize the potential for effects on terrestrial species and habitat include:

- Minimization of excavation and vegetation removal by using previously disturbed areas, as available
- Construction methods and access routes will be selected to reduce the movement of heavy equipment, soil disturbance, and persistent tracks or tire ruts
- Minimization of vehicular traffic and equipment to only what is necessary, and operating equipment and vehicles at slow speeds to avoid direct mortality
- Use of silt fencing to delineate and protect potential nesting or foraging habitat and wetlands in or around the project area. Silt fencing will be properly maintained during all phases of construction and removed entirely following completion of work.
- Minimization of light disturbances as practicable, including turning off temporary construction site lights when work is not occurring and restricting work activities to daylight hours
- Employing a “soft-start” to construction activities after period of on-site inactivity by gradually increasing the intensity of work activities over a 30 minute period to allow individuals to relocate as needed
- Prior to starting work, on-site personnel may engage in a pre-construction meeting regarding use of conservation measures, information on identifying protected species and habitats potentially occurring in the project area, and a review of work strategies and other permit requirements necessary avoid impacts
- Use of biological monitors on-site to observe operations ahead of heavy machinery
- If individuals, nests, or eggs are observed by biological monitors or personnel on-site, USFWS Texas Coastal Ecological Field Services will be notified immediately. If individuals enter the Project area, work will cease immediately until the animal leaves on its own.

For West Indian manatee specifically, the Project will incorporate measures from the USFWS Standard Manatee Conditions for In-Water Work (USFWS 2011). Measures to avoid impacts to manatees include:

- Prior to work, all on-site personnel will be informed of the potential presence of manatees on-site and the risks associated with vessel strikes, and the responsibility of personnel to observe in-water activities for the presence of manatees
- Vessels will follow routes of deep water when practicable, and operate at "Idle Speed/No Wake" in construction areas and sites with low bottom-clearance (less than four feet)
- Siltation/turbidity barriers will be properly secured and made of materials that do not allow manatees to become entangled, entrapped, or otherwise impeded of free movement
- In-water operations and vessels must cease if a manatee comes within 50 feet of the operation, per USFWS guidance (USFWS 2011). The individual must not be herded away or harassed into leaving, and activities may not resume until the manatee has moved beyond the 50-foot radius or until 30 minutes have elapsed if the manatee has not reappeared within 50 feet of the operation.
- Collisions with or injuries to manatees will be reported immediately. As amended for the Project's location in Texas, any observation of a manatee in the Project vicinity will be reported to the Texas Marine Mammal Stranding Network at 1-800-9MAMMAL, and include the location information, condition, and photos, when possible. Collisions and/or injuries will be reported the USFWS Texas Coastal Ecological Services Field Office – Dayma Wasmund, at 361-533-6053 or 361-225-7318.

4.9 Species and Critical Habitat Effects Conclusion

This BA presents an assessment of potential Project effects on federally listed species under USFWS jurisdiction that have potential to occur in the Action Area. Factors considered in this evaluation include the species' life history and habitat requirements, habitats available on-site, Project components and construction methods, avoidance measures, and potential direct, indirect, and cumulative effects the Project may produce.

Based on this evaluation, this report concludes that the Project "*may affect, but is not likely to adversely affect"* the following listed species under USFWS jurisdiction:

- Rufa red knot (*Calidris canutus rufa*)
- Piping plover (*Charadrius melodus*), and final critical habitat
- Northern aplomado falcon (*Falco femoralis septentrionalis*)
- Whooping crane (*Grus americana*)
- Eastern black rail (*Latterallus jamaicensis ssp. Jamaicensis)*
- West Indian manatee (*Trichechus manatus*)

Further, based on a lack of suitable habitat in the Action Area, this report anticipates the Project will result in a determination of "*No effect"* for the following listed species under USFWS jurisdiction:

- Attwater's greater prairie-chicken (*Tymanuchus cupido attwateri*)
- South Texas ambrosia (*Ambrosia cheiranthifolia*)
- Slender rush-pea (*Hoffmannseggia tenella*)
- Loggerhead sea turtle (*Caretta caretta*) (nesting)
- Green sea turtle (*Chelonia mydas* (nesting)
- Leatherback sea turtle (*Dermochelys coriacea*) (nesting)
- Hawksbill sea turtle (*Eretmochelys imbricata)* (nesting)
- Kemp's ridley sea turtle (*Lepidochelys kempii)* (nesting)
- Monarch butterfly (*Danaus plexippus)*
- Tricolored bat (*Perimyotis subflavus*)

5. NMFS: ESA SPECIES AND CRITICAL HABITAT ASSESSMENT

The purpose of this section is to evaluate the Project's potential effects on federally listed and proposed species and designated or proposed critical habitats under NMFS, pursuant to ESA Section 7(a)(2).

5.1 Species and Critical Habitat of Interest

The Project site was evaluated to identify species and critical habitat under NMFS jurisdiction with potential to be affected by Project activities. The site was assessed by compiling a species list using generated reports and geospatial species range data from the USFWS IPaC tool and NMFS Southeast Region ESA Section 7 map application (ver. 2a).

5.1.1 Species and Critical Habitat to be Evaluated

Based on a review of the sources above, a species list was compiled of listed or proposed threatened or endangered species and critical habitats with potential presence or suitable habitat within the Action Area. The species and critical habitats to be evaluated are:

- Loggerhead sea turtle (*Caretta caretta;* Northwest Atlantic Distinct Population Segment [DPS]) and final critical habitat
- Green sea turtle (*Chelonia mydas;* North Atlantic DPS) and proposed critical habitat
- Hawksbill sea turtle (*Eretmochelys imbricata*)
- Leatherback sea turtle (*Dermochelys coriacea*)
- Kemp's ridley sea turtle (*Lepidochelys kempii)*
- Giant manta ray (*Mobula birostris*)

ESA responsibilities regarding listed sea turtles are jointly administered by both USFWS and NMFS (USFWS and NMFS 2015). A "No Effect" determination for the five listed sea turtles addressed within Section 4 of this BA is solely regarding sea turtles, including their nesting behaviors and habitats, within the terrestrial environment under USFWS jurisdiction. This Section will solely discuss an effect analysis of sea turtles and their habitats within the aquatic environment under NMFS jurisdiction.

5.2 Loggerhead sea turtle

5.2.1 Species Description

Loggerhead sea turtles of the Northwest Atlantic DPS exhibit a complex life cycle with several life stages occurring across wide-spread and diverse habitats. Along the Texas coast specifically, loggerhead sea turtles may be found in the Gulf of Mexico and as an occasional visitor to the Texas coast. Only minor and solitary nesting has been recorded along the Texas coast (TPWD n.d., b), with the majority of nesting (approximately 90%) taking place along Florida's coastlines (NMFS and USFWS 2023, 19).

Hatchlings emerge from subterranean beach nests and rapidly advance toward the sea, orienting into the waves to reach offshore currents. Post-hatchlings are primarily associated with floating patches of consolidated organic materials, specifically *Sargassum* species (brown algae), which provides food and shelter. Young juvenile loggerheads typically inhabit a range of offshore waters throughout the North Atlantic Ocean and Mediterranean Sea, with some older juveniles returning to neritic habitats after several years. Adult loggerheads also demonstrate a variety of habitat use patterns in both oceanic and neritic waters but are generally found in deeper offshore areas. Preferred prey items vary based on life stage and habitat type, encompassing a range of conchs, clams, crabs, shrimp, sea urchins, sponges, jellyfish, squids, and small animals or invertebrates living on floating *Sargassum* mats (NMFS and USFWS 2023).

5.2.1.1 Species Status and Critical Habitat

Loggerhead sea turtles were listed as threatened in the July 28, 1978 Federal Register (43 FR 32800). The population with proximity to the Action Area was subdivided into the Northwest Atlantic DPS on September 22, 2011.

NMFS designated final critical habitat for Northwest Atlantic DPS of loggerhead sea turtle effective August 11, 2014 (79 FR 39855). The Action Area overlaps one critical habitat unit identified as LOGG-S-02 (*Sargassum*), which encompasses an area from the western Gulf of Mexico to the eastern edge of the Loop Current. The expansive geographic area captured by this habitat unit is due to the dynamic and widespread nature of *Sargassum* habitat, which moves inconsistently based on currents and weather conditions (NMFS 2014).

The PBF of loggerhead *Sargassum* habitat is "developmental and foraging habitat for young loggerheads where surface waters form accumulations of floating material, especially *Sargassum*." The final rule identifies PCEs that support this habitat as the following (NMFS 2014):

- Convergence zones, surface-water downwelling areas, the margins of major boundary currents (Gulf Stream), and other locations where there are concentrated components of the *Sargassum* community in water temperatures suitable for the optimal growth of *Sargassum* and inhabitance of loggerheads
- *Sargassum* in concentrations that support adequate prey abundance and cover
- Available prey and other material associated with *Sargassum* habitat including but not limited to, plants and cyanobacteria and animals native to the *Sargassum* community such as hydroids and copepods
- Sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by *Sargassum* for post-hatchling loggerheads, i.e., >10 m depth

5.2.1.2 Population Threats

The 2023 5-year review of the Northwest Atlantic DPS of loggerhead sea turtles lists incidental bycatch in both U.S. and international fisheries as the greatest threat to populations. Habitat modification is noted as a major threat as well. Specifically related to aquatic habitats, influential factors include artificial lighting, pollution/contaminants/spills, and ingestion or entanglement with derelict fishing gear, plastics, and other marine debris. Habitat modification threats are further exacerbated by climate change effects, which alter parameters of the aquatic environment including ocean temperature, circulation, and oxygen levels. Additional anthropogenic threats to the species include vessel strikes, poaching, predation, disease, and dredging (NMFS and USFWS, 43).

5.2.2 Species Assessment Area

The assessment area for loggerhead sea turtle will consist of all estuarine and nearshore waters within the Action Area.

5.3 Green sea turtle

5.3.1 Species Description

Green sea turtles of the North Atlantic DPS spend most of their lives in coastal foraging grounds, which include shallow waters of both open coastline and protected bays or lagoons with abundant seagrass or marine algae food resources. Similar to other sea turtle species, green sea turtle post-hatchlings are closely associated with floating mats comprised of *Sargassum* and other accumulated material in offshore waters. Use of offshore oceanic habitats may continue during earlier juvenile life stages before returning to neritic zones to mature into adulthood. Significant nesting beaches in the Gulf region are concentrated along the coasts of Costa Rica, Mexico, Cuba, and Florida. In Texas, green sea turtles may be found occasionally using beaches for nesting. In-shore and nearshore waters under 20 meters deep along the Texas coast provide important benthic foraging and resting habitats, especially for juvenile green sea turtles (NPS 2024; NMFS 2015; NMFS 2023, 46584).

5.3.1.1 Species Status and Critical Habitat

Green sea turtles were listed as threatened in the July 28, 1978 Federal Register (43 FR 32800). The population that could occur in the Action Area was subdivided into the threatened North Atlantic DPS on May 6, 2016 (81 FR 20057).

NMFS proposed critical habitat for the North Atlantic DPS of green sea turtle on July 19, 2023 (88 FR 46572). The Action Area crosses two proposed critical habitat units for green sea turtle: Unit TX01 (Texas) and Unit NA01 (*Sargassum* habitat).

TX01 is an area from the Mexico border to/including Galveston Bay that encompasses all nearshore areas from the mean high-water line to 20 meters in depth, which contain benthic foraging/resting essential features. Essential features of benthic foraging/resting include underwater refugia and food resources (seagrasses, macroalgae, invertebrates) of sufficient condition, distribution, diversity, abundance, and density to support survival development, growth, and/or reproduction (NMFS 2023).

NA01 includes surface-pelagic areas from 10 meters in depth to the outer boundary of the U.S. Exclusive Economic Zone for *Sargassum* habitat, which contains surface-pelagic foraging/resting essential features. Essential features of surface-pelagic foraging/resting include convergence zones, frontal zones, surface-water downwelling areas, boundary current margins, and other areas resulting in concentrated *Sargassum*-dominated drifts, as well as currents that carry turtles to *Sargassum* drifts. This PBF primarily supports the survival and development of post-hatchling and surface-pelagic juvenile life stages (NMFS 2023).

5.3.1.2 Population Threats

The 2015 5-year review of the North Atlantic DPS lists major population threats to green sea turtles as vessel strikes and incidental bycatch from fishing. Post-hatchling and juvenile life stages are especially vulnerable to ingestion of contaminants and debris that accumulates in *Sargassum* mats. In essential nearshore foraging areas, boat scarring and degradation of sea grass beds are especially harmful to the green sea turtle's primary food source (NMFS 2015, 96-98)

5.3.2 Species Assessment Area

The assessment area for green sea turtles will consist of all estuarine and nearshore waters within the Action Area.

5.4 Hawksbill sea turtle

5.4.1 Species Description

The juvenile, subadult, and adult life stages of hawksbill sea turtle typically occupy shallower neritic waters with features supporting foraging and resting behaviors. Coral reefs are a common habitat type used by hawksbill sea turtles, as well as areas with underwater ledges, caves, rock outcrops, and high-energy shoals, which provide shelter for resting and are optimum sites for sea sponge growth, a primary prey item. Where coral reefs are absent, hawksbill sea turtles may also occupy mangrove-lined bays, estuaries, seagrass beds, and rock jetties. In the post-hatchling stage, hawksbills primarily occupy oceanic environments, sheltering in floating *Sargassum* and debris mats that accumulate at convergence zones (NMFS and USFWS 1993).

On the Texas coast, juvenile hawksbill sea turtles may occur in nearshore waters and areas associated with stone jetties. Jetties near the Aransas, Packery, and Mansfield Channels have been used for feeding on sponges and wedging between rocks for resting. Most hawksbill turtles found in Texas are post-hatchlings washed ashore in *Sargassum* mats or juveniles entangled in debris, and post-hatchlings found in Texas waters are presumed to have been passively transported there by currents passing near southern nesting sites in Mexico. Texas is not within the typical nesting range for hawksbill sea turtles, with only rare occurrences reported (NPS 2023; NMFS and USFWS 1993).

5.4.1.1 Species Status and Critical Habitat

The hawksbill sea turtle was originally listed as endangered throughout its range on June 2, 1970 in 35 FR 8491. The Action Area does not overlap designated final or proposed critical habitat for hawksbill sea turtles.

5.4.1.2 Population Threats

Anthropogenic threats to hawksbill sea turtle populations are linked to fisheries bycatch, illegal tortoiseshell trade, and watercraft collisions. Ingestion and entanglement with marine debris is a common threat to all life stages, with the potential to reduce food intake or digestive capacity and to cause direct injury or mortality. Relative to the aquatic environments used by hawksbill sea turtles, degradation of reefs and other shallow benthic areas via sedimentation/siltation, water contamination, and anchor scarring reduces the available habitats that support essential foraging and resting behaviors (NMFS and USFWS 1993; NMFS and USFWS 2013a).

5.4.2 Species Assessment Area

The assessment area for hawksbill sea turtles will consist of all estuarine and nearshore waters within the Action Area.

5.5 Leatherback sea turtle

5.5.1 Species Description

Leatherback sea turtles within range of the Action Area are within the Northwest Atlantic DPS. Apart from onshore nesting and hatching, leatherback sea turtles are understood to primarily spend most life stages across a global range of offshore areas for development, foraging, migrating, and mating. It is believed that all life stages forage on gelatinous prey such as jellyfish (Cnidaria), tunicates (Tunicata/Urochordata), and ctenophores (Ctenophora) (NMFS and USFWS 2020, 14). Leatherback sea turtles must consume large quantities of food to meet their energetic demands, requiring access to areas of high productivity. Foraging behavior believed to align with prey distribution and abundance, which allows leatherback sea turtles to use a diverse array of aquatic environments, including coastal and pelagic waters in the Gulf of Mexico. A generalist use of foraging habitats is likely to provide leatherback sea turtles with resilience against localized reductions in prey availability, such as periods following a natural or anthropogenic catastrophic event (NMFS and USFWS 2020; NMFS and USFWS 2013b).

Along the Texas coast, leatherback sea turtles are rarely observed but may occur transiently (TPWD n.d., c). The most recent sighting of leatherback sea turtles in proximity to the Action Area is believed to occur in 2023, when the University of Texas Marine Science Institute reported three individuals struck by boat propellers near the ship channels outside of Port Aransas (Williams and Schaff 2023).

5.5.1.1 Species Status and Critical Habitat

The leatherback sea turtle was originally listed as endangered throughout its range on June 2, 1970 in 35 FR 8491. The Action Area does not overlap designated final or proposed critical habitat for leatherback sea turtle

5.5.1.2 Population Threats

The 2020 status review of leatherback sea turtles identifies the primary threat to the Northwest Atlantic DPS as bycatch in pelagic and coastal fisheries, followed closely by onshore nesting threats. Significant threats with potential to occur in the marine environment also include vessel strikes throughout developed areas, which affects population abundance and productivity, and ingestion/entanglement in marine debris, which may result in injury, compromised health, and/or mortality (NMFS and USFWS 2020).

5.5.2 Species Assessment Area

The assessment area for leatherback sea turtles will consist of all estuarine and nearshore waters within the Action Area.

5.6 Kemp's ridley sea turtle

5.6.1 Species Description

Kemp's ridley sea turtles occur within a restricted distribution range throughout the Gulf of Mexico and northwest Atlantic Ocean. In the United States, Kemp's ridley sea turtles primarily nest along the Texas coast, with occasional nesting occurrences throughout other southeastern Gulf states (NMFS and USFWS 2015, 10). During nesting seasons, adult female Kemp's ridleys reside in Texas's nearshore waters, followed by post-nesting migration in corridors extending throughout Gulf coastal areas that are typically less than 50 meters deep. Hatchling dispersal is believed to be influenced by ocean currents in the western Gulf, which transport post-hatchlings to offshore oceanic foraging grounds. Juveniles spend approximately two years in oceanic habitats, typically either within the current system circulating the northern and western Gulf of Mexico or in the Gulf Stream of the northwest Atlantic Ocean and can be associated with *Sargassum* communities during this stage. Juveniles have also been found in coastal neritic habitats, including tidal passes and bays, which provide abundant prey and favorable water temperatures for development. Prey resources favored by Kemp's ridley turtles are primarily crabs, and can also include a variety of other invertebrates, mollusks, fin fish, and jellyfish (NMFS and USFWS 2015; NMFS, USFWS, and SEMARNAT 2011).

5.6.1.1 Species Status and Critical Habitat

The Kemp's ridley sea turtle was listed as endangered throughout its range on December 2, 1970 in 35 FR 18320. The Action Area does not overlap designated final or propose critical habitat for the Kemp's ridley sea turtle.

5.6.1.2 Population Threats

Primary threats to Kemp's ridley sea turtles include fisheries bycatch and onshore nesting effects, such as egg harvest or predation and degradation of nesting habitat. Significant threats with potential to occur in the marine environment also include vessel strikes near ports and along developed coastlines, oil or pollutant spills, and ingestion/entanglement in marine debris, which may result in injury, compromised health, and/or mortality. Due to the limited geographic distribution of Kemp's ridley sea turtles, changes in the marine environment that alter the abundance and distribution of food resources have potential to affect migratory and foraging behaviors (NMFS 2024a).

5.6.2 Species Assessment Area

The assessment area for Kemp's ridley sea turtle will consist of all estuarine and nearshore waters within the Action Area.

5.7 Giant manta ray

5.7.1 Species Description

The giant manta ray is a migratory species with an extensive global range, which includes the Gulf of Mexico. Due to this extensive range and infrequent observations of this species, long-term research and specific data surrounding many of the essential habitat features, abundance, and life history characteristics is still largely unknown (NMFS 2019). The giant manta ray may be found in both offshore oceanic habitats and productive, nearshore coastal zones. Using a variety of filter feeding techniques, giant manta rays capture a variety of planktonic prey items, such as euphausiids, copepods, mysids, decapod larvae, and shrimp (NMFS 2017a, 19). Giant manta rays have also been observed in estuarine waters near oceanic inlets, where these waters may be used as potential nursery grounds. Data on specific habitats used by neonate and juvenile life stages is still limited at this time. A long gestation period (estimated 12-13 months) and low fecundity (one pup per litter) result in low overall productivity and low recovery in response to threats or population decreases (NMFS 2017a; NMFS 2019).

5.7.1.1 Species Status and Critical Habitat

NMFS released a final rule listing giant manta ray with threatened status in 83 FR 2916, effective February 21, 2018. At the time of this rule, NMFS found that critical habitat for giant manta ray is not determinable due to insufficient data necessary to determine PBFs essential to species conservation, identify specific geographic areas containing PBFs, and assess the impacts of critical habitat designation.

5.7.1.2 Population Threats

The final listing rule for giant manta ray identifies the most significant threat to the species as overutilization for commercial use via incidental fisheries bycatch and intentional harvest for international trade. It is noted that this threat primarily occurs in waters outside of U.S. jurisdiction, as current U.S. fishery regulations prohibit retention of manta rays by persons under U.S. jurisdiction. Therefore, NMFS determined that protective regulations under section 4(d) of the ESA are not necessary and advisable for species conservation (NMFS 2018, 2916). Additional potential threats to the species to be monitored include entanglement, vessel strikes, marine debris/pollution, climate change, and tourism (NMFS 2024b).

5.7.2 Species Assessment Area

The assessment area for giant manta ray will consist of all estuarine and nearshore waters within the Action Area.

5.8 Effect Analysis

This section will discuss the potential Project effects on loggerhead sea turtle, green sea turtle, hawksbill sea turtle, leatherback sea turtle, Kemp’s ridley sea turtle, and giant manta ray, as well as their suitable habitats within the Action Area. Effects produced by the Project are assessed relative to the ambient baseline conditions existing in the Action Area, described in Section 3. Further, this effect analysis considers that species’ responses to an action may vary based on the intensity or severity of the action, the species’ recovery rate and tolerance threshold, and factors such as proximity, distribution, timing, nature, and duration of the disturbing action.

5.8.1 Direct Effects

Direct effects on a species or its habitat are those effects caused by the action and occur at the same time and place as the action. They are dependent upon the actual presence of individuals or habitat occurring in the Action Area; for the purpose of this BA, the analysis of direct effects is written assuming the listed species occur or potentially occur in the Action Area.

Vessel Strike

Injury or mortality via vessel strike is a significant threat to populations of all five protected turtle species. While occurrences are less common for giant manta ray, vessel strikes may still occur and cause significant injury or mortality to individuals while working in open water. Risks of vessel strike to both sea turtles and giant manta rays during in-water construction will be minimized by adhering to the NMFS *Sea Turtle and Smalltooth Sawfish Construction Conditions* (NMFS 2006), described in Section 5.8.5. Further, all open water portions of the Action Area are subject to consistent, daily vessel traffic. By using conservation practices, such as operating vessels at "no wake/idle" speeds in the construction areas, the construction activities are unlikely to significantly elevate risks of vessel strike above the area's current baseline. Thus, the Project is not anticipated to produce vessel strike effects on protected sea turtles or giant manta ray.

Construction Noise

Exposure to noise from construction activities, including tunnel boring machines, can physically injure sea turtles and alter their behaviors. Exposure to sound with sufficient duration and sound pressure level may result in an elevated hearing threshold (i.e., sudden loss of hearing sensitivity; NITS). If the threshold returns to normal, the NITS is considered temporary (TTS), or if it remains elevated after an extended time, the NITS considered permanent (PTS). In some cases, intense noise exposures have caused auditory injury (INJ).

NMFS provides the numeric thresholds for predicting auditory effects on sea turtle species when exposed to both impulsive and non-impulsive (i.e., steady state) noises. When exposed to non-impulsive noise, the study determined sea turtles have a PTS threshold of 220 dB re 1 μPa^2s and an TTS threshold of 200 dB re 1 μPa^2s (NMFS 2024d).

The noise produced from the Project's proposed HDD and tunnel boring methodology are considered non-impulsive sound sources. Non-impulsive sources typically do not have high peak sound pressure and are considered less injurious than impulsive sounds, which are often brief with a rapid rise/decay time and can often lead to mechanical damage of the inner ear (NMFS 2024c).

Estimates of underwater sound produced from HDD and tunnel boring methods vary based on substrate conditions, depth, size of tunnel, and specific equipment used. Generally, acoustic studies for projects using this construction technique estimated the following underwater sound levels:

- (National Highways Limited 2022) Lower Thames Crossing - Tunnel Boring Machine: Maximum of 130 dB re 1 μPa^2
- (Connel Wagner 2008, 26) Adelaide Desalination Project - Tunnel Boring Machine: 140 dB re 1μPa^2 at 1m; 120 dB re 1μPa^2 at 10m; and inaudible past 100m

Further, baseline conditions of the Action Area are subject to frequent vessel traffic, especially near the active maritime channels. While sound levels produced by watercraft varies based on the vessel type, length, speed, and materials, source levels for many vessels are within range of 150-170 dB re 1 µPa·m, with larger ships producing sounds between 175-195 dB re 1 µPa·m (Center for Marine Acoustics 2023, 54). The Project will likely result in noise levels that are temporarily elevated above baseline conditions but will not significantly deviate from the area's current noise conditions.

Based on these variables, the Project's noise effects are expected to remain below the threshold for TTS or PTS for protected sea turtles that may occur in the Project area, and adverse effects from noise disturbances are not anticipated to occur.

Turbidity and Water Quality

Short-term, localized turbidity effects in sea turtle and giant manta ray habitats are possible during in-water construction. Construction of the pipe/pipelines could result in potential increases in turbidity and sedimentation during bay crossings, and dewatering of the drilling mud from the tunneling operation could lead to temporary minor impacts to turbidity in the bay along Aransas Channel. HDD and/or tunnel boring installation of estuarine water crossings will minimize the impact of construction on suspended sediment and water quality. Nearshore pipe/pipelines may result in temporary, minor turbidity increases due to suspension of seafloor sediments in the immediate vicinity; however, impacts will subside quickly. Normal operation of the pipe/pipelines will not result in impacts on surface water quality. Localized resuspension of sediments resulting in elevated turbidity will occur during construction of the intake and outfall structures.

Impacts on water quality in the Action Area will be temporary and minimal and are not expected to produce substantial long-term effects on protected sea turtles or giant manta ray. BMPs such as silt screens and weighted turbidity curtains may be utilized to reduce suspended sediments. Use of in-water BMPs have the potential for related entanglement effects on protected sea turtles or rays in the Project area; however, the equipment used will be made of materials that reduce the potential for animal entanglement and will be properly secured and monitored. Siltation barriers will be used in accordance with NMFS sea turtle construction conditions (NMFS 2006). Based on the temporary and localized nature of the anticipated construction turbidity, and measures proposed to mitigate these risks, turbidity and water quality are not believed to be an adverse effect on sea turtles or giant manta rays.

Salinity

Alteration of salinity gradients from the effluent outfall are a consideration of this Project once the desalination facility is operational. USEPA provided salinity levels that reflect acceptable changes in salinity for the protection of habitats and estuarine organisms. The USEPA maximum salinity level is an increase of 4 ppt above ambient concentrations (USEPA 1986), and a salinity increase of no more than 2 ppt over ambient concentrations measured at 100 meters from the outfall has been recommended by TPWD and Texas General Land Office (TPWD 2018). Salinity increases at the mixing zone boundary are well within the salinity levels established by USEPA. Salinity modeling for this Project indicates that the maximum increase in receiving water salinity will be less than or equal to 2 ppt at 100 meters from the diffuser ports.

Potential for salinity impacts will also be limited due to the typical limited duration of exposure to increased salinity over ambient concentrations of aquatic species moving through the water column. Based on the general shape and depth of the effluent plume, as well as the spatial extent of the zone of initial dilution and the chronic aquatic life mixing zone in front of the diffuser, it is estimated that only a small fraction (<1%) of the target aquatic species moving through the ship channel at any one time has the potential of contacting the elevated salinity from the effluent for even this limited amount of time. Finally, the width of the zone of initial dilution represents a small fraction of the total width of the Corpus Christi Ship Channel and surrounding areas in the Gulf of Mexico. Based on the limited spatial extent of effluent effects and minimal elevation of salinity levels, adverse effects on sea turtles and giant manta rays are not anticipated from this Project due to altered salinity gradients.

<u>Intake Impingement and Entrainment</u>

Sea turtles and rays in the vicinity of the Project have the potential to interact with the intake structure. Strong swimming abilities and large body sizes of adult individuals will prevent most impingement or entrainment effects from occurring. Further, the potential for neritic individuals to be affected by the velocity caps is minimal. The design of the intake structure will include 3-inch mesh size bar screens at the entrances of the velocity caps to eliminate any potential of accidental "take" of juvenile turtles. This mitigation measure will also prevent adult sea turtles or larger fish from entering the velocity caps.

The design intake flow velocity at the entrance to the intake structure will fall below the USEPA-established limit of ≤0.5 ft/s (0.34 miles per hour) for power plants in other contexts, which is expected to drastically reduce the amount of marine life entering the velocity caps. The prevailing tidal velocities in the Gulf of Mexico are generally higher than the entrance velocity of 0.5 ft/s at the intake structure, suggesting that intake flows are unlikely to affect swimming individuals. Based on the Project design measures, it is unlikely that sea turtles and giant manta rays will encounter adverse effects from impingement and entrainment.

5.8.2 Indirect Effects

Indirect effects are those that are reasonably certain to occur at a later time and/or place due to the proposed Action. Indirect effects are those that may continue after construction is over and have a resulting consequence that is certainly reasonable to occur.

<u>Effects on Foraging Resources and *Sargassum*</u>

Preferred prey vary across the five species of protected sea turtles in the Action Area, and include conchs, clams, crabs, shrimp, fin fish, sea urchins, sponges, jellyfish, squids, and invertebrates. The Project is designed with a low-flow intake structure that allows many swimming prey species to bypass the intake. For live prey species that enter the intake system, the Project's marine life handling system is designed to humanely capture marine organisms, lift them from the seawater, and gently discharge organisms to a fish trough using low-pressure jet sprays, which returns the organisms back to the Aransas Channel. The selected Project construction methodology avoids impacts to ecologically sensitive and productive estuarine areas in Redfish Bay, which minimizes impacts on important sea turtle prey species and habitats.

Sargassum communities are an important resting and foraging source for many hatchling and juvenile sea turtles, particularly for green and loggerhead sea turtles, which are associated with *Sargassum* critical habitat units in the Action Area. These floating algal mats may intermittently occur in or around the Action Area, depending on tides and water conditions. Operations of the desalination facility and its infrastructure are not anticipated to affect the availability of *Sargassum* communities, including areas of critical habitat, in the Action Area. During construction, personnel on-site will be made aware of these features when working in open water and informed that

Sargassum communities can be associated with hatchling or juvenile sea turtles in the vicinity. Based on the proposed Project design and construction methods, adverse effects on sea turtle foraging resources, including *Sargassum* communities and associated critical habitat units, are not anticipated.

Regarding giant manta ray, the capture of its preferred planktonic prey items in the seawater intake is unavoidable due to the nature of the Project and size of the organisms. Because phytoplankton and zooplankton populations grow quickly, the small amount of biomass removed daily by the proposed water intake structures is expected to be replaced in a short amount of time. The proposed volume of desalination water withdrawal is very low relative to the total volume of the Gulf of Mexico source water, and, therefore, any impacts to phytoplankton and zooplankton are too low to be demonstrable. The migratory nature of giant manta rays allows them to forage across a wide spatial range. Based on these factors, loss of foraging resources is not anticipated to be an adverse effect on giant manta rays.

5.8.3 Interdependent and Interrelated Action Effects

The Project may minimally increase vessel traffic for maintenance of the pipes/pipeline infrastructure, as needed. Maintenance necessary for safe operations of the desalination facility and pipes/pipelines would require future construction work to occur along portions of the Project footprint and may require isolation of the workspace from other vessel traffic. Maintenance work is assumed to occur occasionally in the future on an as needed basis.

5.8.4 Cumulative Effects

Potential cumulative effects include other planned seawater desalination facilities in the Corpus Christi, Texas, area. Four other facilities have submitted environmental permits that are under review by TCEQ, and a fifth desalination plant, Corpus Christi Polymers, located on the Inner Harbor, is already permitted but not yet operational.

The proposed Project is not expected to have significant adverse impacts on the aquatic environment when considering the cumulative effects of other planned seawater desalination facilities. Most impacts will be temporary and localized within the construction areas of the intake and outfalls. The proposed Project in combination with other planned projects, either recently completed, ongoing, or proposed within the project area, are not expected to result in significant cumulative effects to the aquatic ecosystem.

5.8.5 Avoidance, Minimization, and Conservation Measures

PCCA is proposing a variety of avoidance, minimization, and conservation measures to avoid impacts to listed species and their suitable habitats. Planned avoidance measures have been incorporated since initial Project siting and planning, such as an analysis of alternative sites in the area, multiple realignments and adjustments to the infrastructure layout, and use of previously disturbed and developed areas to reduce the amount of undisturbed habitat impacted. The following measures have been incorporated into the Project plans to reduce the potential for adverse impacts to protected species:

- Use of tunnel boring and/or HDD techniques to avoid ecologically sensitive habitats, such as seagrass beds, oyster beds, wetlands, and marsh

- Design of the water intake and outfall structures to minimize the effects on salinity and impingement/entrainment of aquatic organisms, at all life stages
- Scheduling of construction outside of sea turtle nesting season
- Analysis of alternative sites and adjustments to the proposed site layout to limit impacts to sensitive aquatic habitats
- Use of environmental monitors during construction, as necessary or required in permit conditions
- Use of appropriate BMPs during all phases of in-water construction to minimize water quality effects. BMPs, such as turbidity curtains, will be properly secured and monitored to reduce risks of entanglement or entrapment of aquatic species.

Specifically, regarding protected sea turtles, PCCA will adhere to NMFS *Sea Turtle and Smalltooth Sawfish Construction Conditions*, as applicable and required. These include the following measures, with amendments to include discussion of giant manta ray:

- Personnel associated with the Project will be informed of the potential presence of the five listed sea turtle species and giant manta ray, and the need to avoid collisions and vessel strikes. All personnel on-site must observe in-water activities for the presence of these species.
- In-water BMPs, such as siltation and turbidity barriers, must be made of materials that do not allow animals to become entangled, must be properly secured, and must be monitored. Barriers will not block entry or exit to critical habitat units.
- Vessels will operate at "no wake/idle" speeds while in construction areas and in areas of low-bottom clearance (less than four feet). Deep-water routes will be followed when possible.
- Work will cease if sea turtles or giant manta rays are observed within 50 feet of work operations. Activities may resume once the individual has departed the Project area on its own
- Any collision with and/or injury to sea turtles or giant manta rays will be reported immediately to the NMFS Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization

5.9 Species and Critical Habitat Effects Conclusion

This BA presents an assessment of potential Project effects on federally listed species under NMFS jurisdiction that have potential to occur in the Action Area. Factors considered in this evaluation includes the species' life history and habitat requirements, habitats available on-site, Project components and construction methods, avoidance measures, and potential direct, indirect, and cumulative effects the Project may produce.

Based on this evaluation, this report concludes that the Project "*may affect, but is not likely to adversely affect*" the following listed species and critical habitats under NMFS jurisdiction:

- Loggerhead sea turtle (*Caretta caretta;* Northwest Atlantic Distinct Population Segment [DPS]) and final critical habitat
- Green sea turtle (*Chelonia mydas;* North Atlantic DPS) and proposed critical habitat
- Hawksbill sea turtle (*Eretmochelys imbricata*)
- Leatherback sea turtle (*Dermochelys coriacea*)
- Kemp's ridley sea turtle (*Lepidochelys kempii)*
- Giant manta ray (*Mobula birostris*)

6. NMFS: MSA ESSENTIAL FISH HABITAT ASSESSMENT

6.1 Introduction

The purpose of this EFH Assessment is to evaluate the Project's potential to adversely affect EFH and managed species under NMFS jurisdiction, pursuant to MSA Section 305(b)(2). Under the MSA, eight Fishery Management Councils are responsible for protecting and managing certain marine fish stocks within specific geographic jurisdictions. The councils are required to prepare fishery management plans (FMPs) for target species and to define the EFH used by these species are various life stages. EFH is defined in 50 CFR 600.10 as "waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity," and specifically includes the "physical, chemical, and biological properties" of those waters.

FMPs within the Action Area are managed by the GMFMC, as well as the NMFS Highly Migratory Species Division (HMSD) for species that cross domestic and international boundaries. Discussion of EFH categories found within the Action Area and their baseline condition is located above in Section 3.3.

6.2 Fisheries with EFH in Action Area

The Action Area intersects designated EFH for 11 species under Shrimp, Reef Fish, Coastal Migratory Pelagic Resource, and Red Drum FMPs managed by the GMFMC. The Action Area also crosses designated EFH for 10 species under the Atlantic Highly Migratory Species FMP, which is managed by the NMFS HMSD.

Habitat areas of particular concern (HAPC) are localized subsets of EFH that are rare, stressed by development, ecologically important for federally managed species, and/or especially vulnerable to anthropogenic degradation. HAPCs were not identified within the Action Area and will not be discussed in this BA.

A summary of the FMPs and life stages of managed species identified in the Action Area are presented below in Table 3. The resources used to evaluate the Action Area for EFH and managed fisheries include the NMFS Southeast Region EFH Mapper / Inland EFH Mapper and NOAA Fisheries Essential Fish Habitat Mapper.

Table 3. Fishery Management Plans and Managed Species with EFH in the Action Area.

Fishery Management Council	Fishery Management Plan	Managed Species		Life Stage						
		Common Name	Scientific Name	Eggs	Larvae	Post-larvae	Juveniles	Sub-adults	Adults	Spawning Adults
Gulf of Mexico Fishery Management Council	Shrimp	Brown shrimp	*Farfantepenaeus aztecus*			X	X	X		
		Pink shrimp	*Farfantepenaeus duorarum*				X	X		
		White shrimp	*Litopenaeus setiferus*			X	X	X	X	X
	Reef Fish	Goliath grouper	*Epinephelus itajara*				X			
		Red grouper	*Epinephelus morio*				X[1]			
		Gray snapper	*Lutjanus griseus*						X	
		Lane snapper	*Lutjanus synagris*		X	X	X			
		Yellowmouth grouper	*Mycteroperca interstitialis*				X			
	Coastal Migratory Pelagic Resources	Cobia	*Rachycentron canadum*	X	X					
		Spanish mackerel	*Scomberomorus maculatus*				X[1,2]		X	
	Red Drum	Red drum	*Sciaenops ocellatus*	X	X	X	X[1,2]	X	X	X
NMFS Highly Migratory Species Division	Atlantic Highly Migratory Species			**Neonate**	**Juvenile**	**Adult**				
		Blacknose shark	*Carcharhinus acronotus*		X	X				
		Spinner shark	*Carcharhinus brevipinna*	X	X	X				
		Finetooth shark	*Carcharhinus isodon*	X	X	X				
		Bull shark	*Carcharhinus leucas*	X	X	X				
		Blacktip shark	*Carcharhinus limbatus*	X	X	X				
		Lemon shark	*Negaprion brevirostris*	X	X					
		Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	X	X	X				
		Bonnethead shark	*Sphyrna tiburo*	X	X	X				
		Atlantic sailfish	*Istiophorus platypterus*		X	X				
		Scalloped hammerhead shark	*Sphyrna lewini*	X						

[1] Early juveniles
[2] Late juveniles

6.2.1 Shrimp

Three managed shrimp species may be found in EFH throughout the Action Area, with juveniles primarily in the varied habitats found in estuarine waters and later life stages found in deeper waters where spawning occurs (Table 4).

Table 4. EFH Used by Shrimp FMP Species in Action Area

Species	Life Stage				
	Post-larvae	Juveniles	Sub-adults	Adults	Spawning Adults
Brown shrimp	Water column associated	Submerged aquatic vegetation; emergent marsh; oyster reef; soft bottom; sand/shell	Soft bottom; sand/shell		
Pink shrimp		Submerged aquatic vegetation; soft bottom; sand/shell; mangroves; oyster reef	Submerged aquatic vegetation; soft bottom; sand/shell; mangroves		
White shrimp	Water column associated	Emergent marsh; submerged aquatic vegetation; oyster reef; soft bottom; mangroves	Soft bottom; sand/shell	Soft bottom	Soft bottom

6.2.2 Reef Fish

Species managed under the reef fish FMP typically include fishes associated with hard-bottom reef habitats. Species within the reef fish FMP often use other categories of EFH throughout their various life stages (Table 5).

Table 5. EFH Used by Reef Fish FMP Species in Action Area

Species	Life Stage			
	Larvae	Post-larvae	Juveniles	Adults
Goliath grouper			Soft bottom; oyster reef; mangroves	
Red grouper			Submerged aquatic vegetation; hard bottom	
Gray snapper				Hard bottom; soft bottom; reef; sand/shell; banks/shoals; emergent marsh

Lane snapper	Water column associated	Water column associated; submerged aquatic vegetation	Submerged aquatic vegetation; sand/shell; soft bottom; banks/shoals; mangrove	
Yellowmouth grouper			Mangrove	

6.2.3 Coastal Migratory Pelagic Resources

Cobia and Spanish mackerel are managed within the fishery for coastal migratory pelagic resources, a group of species that typically migrate within the Gulf of Mexico and South Atlantic. In the Action Area, water column EFH occurs for cobia larvae and eggs and Spanish mackerel juveniles and adults. These life stages of Spanish mackerel are also associated with shallower estuarine EFH (Table 6).

Table 6. EFH Used by Coastal Migratory Pelagic Resource FMP Species in Action Area

Species	Life Stage			
	Eggs	**Larvae**	**Juveniles[1]**	**Adults**
Cobia	Water column associated	Water column associated		
Spanish Mackerel			Estuarine; water column associated	Estuarine; water column associated; mostly oceanic

[1]Both early and late juveniles

6.2.4 Red Drum

Red drum occurs throughout a variety of habitats and depth ranges throughout the Gulf (Table 7). Eggs are present in open waters from late summer through early fall, hatching primarily outside of estuaries. Estuaries and waters with grassy or soft bottoms are used by red drum in their larval, juvenile, and adult life stages, though adults and spawning adults often move into deeper offshore waters with maturation. Prey item preferences transition throughout all life stages and include a variety of copepods, shrimp, marine worms, insects, fish, bivalves, and crabs. Designated EFH for red drum in the Action Area includes coastal estuarine habitat in the corridor between Aransas Pass and San Jose Island and nearshore habitats of the Gulf of Mexico.

Table 7. EFH Used by Red Drum FMP Species in Action Area

Species	Life Stage				
	Eggs	Larvae	Post-larvae	Juveniles	Adults
Red Drum	Water column associated	Submerged aquatic vegetation; soft bottom; water column	Submerged aquatic vegetation; emergent marsh; soft bottom	Submerged aquatic vegetation; soft bottom; sand/shell; hard bottom (early juveniles); emergent marsh (late juveniles)	Submerged aquatic vegetation; emergent marsh; soft bottom; hard bottom; sand/shell

6.2.5 Atlantic Highly Migratory Species

Since species managed under the Atlantic Highly Migratory Species FMP occur over a wide geographic range and often are not closely associated with fixed habitat types or characteristics, NMFS has determined EFH based on broad geographic areas tied to species distribution data. Where sufficient data was available, NMFS incorporated specific habitat requirements into the EFH descriptions for the species' various life stages, such as substrate or water quality parameters. For species with insufficient habitat information, data for more or more life stages may have been combined to identify EFH based on one comprehensive dataset (NMFS 2017b, 19). Table 8 summarizes the life stages and habitat characteristics of the 10 managed species with EFH in the Action Area.

Table 8. EFH Used by Atlantic Highly Migratory FMP Species in Action Area

Species	Life Stage		
	Neonate	Juvenile	Adult
Blacknose shark*		Water temperatures 20.8 to 33.6 °C, average salinity of 32.1 ppt, and average water depth 3.7 m	
Spinner shark	Sandy bottoms with sea surface temperatures 24.5 to 30.5 °C and mean salinity around 36 ppt	Extends from shore to 20 m depths (Juveniles) and shore to 90 m depths (Adults)	
Finetooth shark	Coastal areas of Texas, including portions of Corpus Cristi Bay, Aransas and Copano Bays, San Antonio Bay, Espiritu Santo Bay, Matagorda Bay, Galveston Bay, and Trinity Bay (19.2-30.6 °C, 16-36 m depth), and beaches of the southeastern Texas coast (2.1-5.5 m depth)		
Bull shark	Shallow depths (less than 9 m) in lower salinity estuaries and river mouths (as low as 0.9 ppt) until water temperatures reach 21 °C.	Freshwater creeks, ocean inlets, and seagrass. Temperatures as low as 16.4 °C; salinities between 1.7 to 41.1 ppt; DO concentrations between 4 and 7 mg/L; and shallow depths less than 9 m.	

Blacktip shark*	Coastal areas and estuaries, out to 30 m depths. Water temperatures from 20.8 to 32.2 °C, salinities from 22.4 to 36.4 ppt, water depths from 0.9 to 7.6 m, and DO ranging from 4.32 to 7.7 mg/L in silt, sand, mud, and seagrass habitats	Coastal areas out to 100 m depths. Water temperatures from 19.8 to 32.2 °C, salinities from 7.0 to 36.8 ppt, water depth from 0.7 to 9.4 m, and DO from 4.28 to 8.30 mg/L. Includes multiple substrates, such as silt, sand, mud, and seagrass.	
Lemon shark	Coastal areas along Texas between Galveston Island and the Texas/Mexico border. Include seagrass beds in shallows less than 2 m deep.	Bathymetric depth limit of 200m and includes coastal areas along Texas	
Atlantic sharpnose shark*	All major bay systems along the Gulf coast of Texas from Galveston Bay to lower Laguna Madre and coastal Texas waters (temperature of 16 - 32 °C, salinity of 10-38 ppt)		
Bonnethead shark*	All major bay systems along the Gulf coast of Texas from Sabine Lake to Lower Laguna Madre (temperature of 18-33.5 °C).	All major bay systems along the Gulf coast of Texas from Sabine Lake to Lower Laguna Madre.	Coastal areas along Texas
Atlantic sailfish		Localized EFH in the central and northern Gulf of Mexico, between Apalachicola and southern Texas	Offshore pelagic habitats associated with the continental shelf westward to the coast of Texas.
Scalloped hammerhead shark	Temperatures of 23.2 to 30.2 °C, salinities of 27.6 to 36.3 ppt, DO of 5.1 to 5.5 mg/L, depths between 5 to 6 m, and mud and seagrass substrate.		

*Gulf of Mexico stock
Source: NMFS 2017b

6.3 EFH Effects Analysis

The primary EFH effects of concern for the Project are turbidity and sedimentation, salinity, and impingement and entrainment effects in the water column, discussed below.

EFH categories that occur in the Action Area but that will not be affected based on the proposed construction methodology and Project design include seagrass beds, oyster beds, and tidal wetlands throughout estuarine areas in Redfish Bay. In-water work will be avoided for these habitats by using HDD and/or tunnel boring methods to install the finished water pipeline between Harbor Island and Aransas Pass. Further, effects are not anticipated for *Sargassum* habitat that may occur intermittently in the Gulf of Mexico or estuarine waters.

6.3.1 Water Column EFH: Turbidity and Sedimentation

Temporary sedimentation effects may occur in localized areas of water column EFH for land-based work on Harbor Island, such as dewatering of sediments excavated during tunnel boring activities. Sedimentation effects will be reduced through use of appropriate BMPs. For suspended sediments that enter the water column during dewatering, water quality impacts will be localized to a limited spatial extent and will return to baseline conditions once sediments re-deposit.

Similarly, construction of the Corpus Christi Ship Channel outfall and the Gulf of Mexico intake and outfall structures will result in localized temporary effects to water column EFH. Increased sediment loads in the water column will be minimized as practicable using in-water turbidity reduction measures, such as silt screens and weighted turbidity curtains. Elevated turbidity in the water column may temporarily displace managed species from the Project area, but they can return to the area once in-water work is discontinued and suspended sediments redeposit. Alternatively, disturbed sediments may have an effect of attracting some species to the disturbed areas. This effect may increase food sources for certain species but may also result in temporary disruptions of natural predator-prey interactions. Deposition of suspended sediments may also result in limited mortality to some species in their egg or larval life stages. However, substantial population impacts are not anticipated due to the temporary nature of the effect and localized extent of the impact.

Based on these factors, the direct impacts of turbidity and sedimentation on water column EFH are anticipated to be temporary and insignificant, without adversely affecting populations of managed species in the Action Area.

6.3.2 Water Column EFH: Salinity

Permanent salinity effects will occur in localized portions of water column EFH around the two outfall diffusers, once the Project is constructed and operational. USEPA has provided salinity levels that reflect acceptable changes in salinity for the protection of habitats and estuarine organisms. The USEPA maximum salinity level is an increase of 4 ppt above ambient concentrations (USEPA 1986), and a salinity increase of no more than 2 ppt over ambient concentrations measured at 100 meters from the outfall has been recommended by TPWD and Texas General Land Office (TPWD 2018). Salinity increases at the mixing zone boundary are well within the salinity levels established by USEPA. Salinity modeling for this Project indicates that the maximum increase in receiving water salinity will be less than or equal to 2 ppt at 100 meters from the diffuser ports.

Potential for salinity impacts will also be limited due to the typical limited duration of exposure to increased salinity over ambient concentrations for aquatic species moving through the water column. Based on the general shape and depth of the effluent plume, as well as the spatial extent of the zone of initial dilution and the chronic aquatic life mixing zone in front of the diffuser, it is estimated that only a small fraction (<1%) of the target aquatic species moving through the ship channel at any one time has the potential of contacting the elevated salinity from the effluent for even this limited amount of time. Finally, the width of the zone of initial dilution represents a small fraction of the total width of the Corpus Christi Ship Channel and surrounding areas in the Gulf of Mexico.

Based on these factors, the direct impacts of salinity alteration on water column EFH are anticipated to be permanent but insignificant, without adversely affecting populations of managed species in the Action Area.

6.3.3 Water Column EFH: Impingement and Entrainment

Permanent effects may occur in localized portions of water column EFH around the intake structure once the Project is constructed and operational. Species near the Project area have the potential to interact with the seawater intake structure. Although some intake of marine life is inevitable, the following considerations indicate that potential effects of impingement and entrainment to marine species and their local populations are expected to be minor:

- Intake flow velocity will fall below the USEPA-established limit of ≤0.5 ft/s (0.34 miles per hour) for power plants in other contexts, which is expected to drastically reduce the amount of marine life entering velocity caps
- Prevailing tidal velocities in the Gulf of Mexico are generally higher than the entrance velocity of 0.5 ft/s at the intake structure, suggesting that, on average, eggs and larvae are more likely to pass through the velocity caps instead of being withdrawn by them.
- The intake structure is approximately 1.3 miles offshore of San Jose Island, away from shallow shoreline habitat (including seagrass beds) that may be used more widely by smaller species or for spawning and nursery habitat.
- The intake structure will be submerged at depth with approximately 20 to 25 feet of water overlying the velocity caps, greatly limiting or eliminating the withdrawal of buoyant eggs found at or near the water's surface.
- The intake structure entrances will be at least 5 feet above the seabed, greatly limiting or eliminating the withdrawal of demersal eggs and other benthic marine life species.
- Impingement and entrainment of eggs and larvae will be highly localized and will represent a small fraction of the total number of eggs and larvae present in the local aquatic ecosystem, as most eggs and larvae will never encounter the proposed intake structure.
- For live prey species that enter the intake system, the Project's marine life handling system is designed to humanely capture marine organisms, lift them from the seawater, and gently discharge organisms to a fish trough using low-pressure jet sprays, which returns the organisms back to the Aransas Channel.

Based on these factors and Project design considerations the direct impacts of impingement and entrainment on species occupying water column EFH are anticipated to be permanent but minor, without adversely affecting populations of managed species in the Action Area.

6.4 Conclusion

The Project site and construction methodology is proposed as the alternative with the fewest environmental impacts. Much of the pipes/pipeline alignments will be installed below ground using HDD and/or tunnel boring methods, which avoids a variety of ecologically sensitive and productive sites containing EFH. The Project design also incorporates features to minimize direct impingement and entrainment effects on aquatic species that may interact with the intake structure. Overall, most effects on EFH will either be temporary, or permanent yet minor in nature and spatially limited to insignificant, localized areas in the Gulf of Mexico or an existing navigational ship channel. Based on this assessment, it is anticipated that the Project will not result in significant adverse effects on EFH.

7. REFERENCES

Canadian Wildlife Service [CWS] and USFWS. 2007. International Recovery Rlan for the Whooping Crane. Ottawa: Recovery of Nationally Endangered Wildlife (RENEW), and U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Center for Marine Acoustics. 2023. Sound source list: a description of sounds commonly produced during ocean exploration and industrial activity. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 69 p. Report No.: BOEM OCS 2023-016.

Connell Wagner. 2008. Adelaide Desalination Project Technical Studies & Investigations, Technical Report – Underwater Noise & Vibration. October.

Evens, J. and Page, G. 1986. Predation on Black Rails during High Tides in Salt Marshes. *The Condor*, Volume 88, Issue 1.Pages 107–109. February. https://doi.org/10.2307/1367769

Fertl, D., Schiro, A., Regan, G., Beck, C., Adimey, N., Price-May, L., Amos, A., Worthy, G., and Crossland, R. 2005. Manatee Occurrence in the Northern Gulf of Mexico, West of Florida. Gulf and Caribbean Research 17 (1): 69-94. DOI: https://doi.org/10.18785/gcr.1701.07

Griffith, G., Bryce, S., Omernik, J. and Rogers, A. 2007. Ecoregions of Texas. December.

Gulf of Mexico Fishery Management Council (GMFMC) and National Marine Fisheries Service (NMFS). 2016. Final Report, 5-Year Review of Essential Fish Habitat Requirements. December.

Haig, S., Ferland, C., Cuthbert, F., Dingledine, J., Goosen, J., Hecht, A., and McPhillips, N. 2005. A complete species census and evidence for regional declines in piping plovers. Journal of Wildlife Management 69:160-173.

iNaturalist. 2024. Search query for Northern aplomado falcon near Port Aransas, Texas and surrounding areas. Accessed October 8, 2024. https://www.inaturalist.org

National Highways Limited. 2022. Lowers Thames Crossing - 6.3 Environmental Statement Appendices. Appendix 9.1 Assessment of ground-borne noise and vibration, and underwater noise from the tunnel boring machine at marine receptors. October.

NMFS. 2001. Guidance for Combining Magnuson-Stevens Fishery Conservation and Management Act EFH Consultations with Endangered Species Act Section 7 Consultations. Revised, 2022. NMFS Procedure 03-201-05.

NMFS. 2006. Sea Turtle and Smalltooth Sawfish Construction Conditions. March.

NMFS. 2014. Endangered and Threatened Species: Critical Habitat for the Northwest Atlantic Ocean Loggerhead Sea Turtle Distinct Population Segment (DPS) and Determination Regarding Critical Habitat for the North Pacific Ocean Loggerhead DPS. Final rule. Federal Register 79 (132).

NMFS. 2015. Status Review of the Green Turtle (Chelonia mydas) Under the U.S. Endangered Species Act. NOAA Technical Memorandum, NOAA NMFS-SWFSC-539. March.

NMFS. 2017a. Endangered Species Act Status Review Report: Giant Manta Ray (*Manta biostris*), Reef Manta Ray (*Manta alfredi*). September.

NMFS. 2017b. FINAL Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan: Essential Fish Habitat and Environmental Assessment.

NMFS. 2018. Endangered and Threatened Wildlife and Plants; Final Rule to List the Giant Manta Ray as Threatened Under the Endangered Species Act. Federal Register 83 (14).

NMFS. 2019. Giant Manta Ray Recovery Outline. December.

NMFS. 2023. Endangered and Threatened Wildlife and Plants: Proposed Rule to Designate Marine Critical Habitat for Six Distinct Population Segments of Green Sea Turtles. Federal Register 88 (137).

NMFS. 2024a. Kemp's ridley turtle species page. Available at https://www.fisheries.noaa.gov/species/kemps-ridley-turtle

NMFS. 2024b. Giant manta ray species page. Available at https://www.fisheries.noaa.gov/species/giant-manta-ray

NMFS. 2024c. Update to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 3.0): Underwater and In Air Criteria for Onset of Auditory Injury and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-71, 182 p.

NMFS. 2024d. National Marine Fisheries Service: Summary of Endangered Species Act Acoustic Threshold (Marine Mammals, Fishes, and Sea Turtles). October.

NMFS and USFWS. 1993. Recovery plan for hawksbill turtles in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico (*Eretmochelys imbricata*). St. Petersburg, Florida.

NMFS and USFWS. 2013a. Hawksbill Sea Turtle (*Eretmochelys imbricata*) 5-Year Review: Summary and Evaluation.

NMFS and USFWS. 2013b. Leatherback Sea Turtle *(Dermochelys coriacea*) 5-Year Review: Summary and Evaluation

NMFS and USFWS. 2015. Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) 5-Year Review: Summary and Evaluation.

NMFS and USFWS. 2020. Endangered Species Act Status Review of the Leatherback Turtle (*Dermochelys coriacea*).

NMFS and USFWS. 2023. Loggerhead Sea Turtle (*Caretta caretta*) Northwest Atlantic Ocean DPS 5-Year Review: Summary and Evaluation.

NMFS, USFWS, and SEMARNAT. 2011. Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*), Second Revision. Silver Spring, Maryland.

National Park Service (NPS). 2023. Hawksbill sea turtle. Available at https://www.nps.gov/pais/learn/nature/hawksbill.htm.

NPS. 2024. Green sea turtles. Available at https://www.nps.gov/pais/learn/nature/green.htm

Newstead, D., and Vale, K. 2014. Protecting important shorebird habitat using Piping Plovers and an indicator species. Final Report to U.S. Fish and Wildlife Service in accordance with FWS Cooperative Agreement No. 1448-20181-A-J839.

United States Environmental Protection Agency (USEPA). 1986. Quality criteria for water. Environmental Protection Agency, Washington, DC: EPA 440/5-86-001.

USFWS. 2001a. Endangered and Threatened Wildlife and Plants; Final Determination of Critical Habitat for Wintering Piping Plovers. Final rule. Federal Register 66 (132).

USFWS. 2001b. Florida Manatee Recovery Plan (*Trichechus manatus latirostris*), Third Revision. Atlanta, Georgia. October.

USFWS. 2011. Standard Manatee Conditions for In-Water Work. Atlanta, Georgia.

USFWS. 2012. Comprehensive Conservation Strategy for the Piping Plover (*Charadrius melodus*) in its Coastal Migration and Wintering Range in the Continental United States. East Lansing, Michigan. December.

USFWS. 2014a. Rufa Red Knot Background Information and Threats Assessment. U.S. Fish and Wildlife Service, Northeast Region, New Jersey Field Office, Pleasantville, New Jersey. November.

USFWS. 2014b. Northern Aplomado Falcon (*Falco femoralis septentrionalis*) 5-Year Review: Summary and Evaluation. August.

USFWS. 2015. Volume II: Draft Revised Recovery Plan for the Wintering Range of the Northern Great Plains Piping Plover and Comprehensive Conservation Strategy for the Piping Plover (*Charadrius melodus*) in its Coastal Migration and Wintering Range in the Continental United States. East Lansing, Michigan. July.

USFWS. 2019. Species Status Assessment Report for the Eastern Black Rail (*Laterallus jamaicensis jamaicensis*). Version 1.3. Atlanta, Georgia. August.

USFWS. 2020a. Piping Plover (*Charadrius melodus*) 5-Year Review: Summary and Evaluation. March.

USFWS. 2020b. Endangered and Threatened Wildlife and Plants; Threatened Species Status for Eastern Black Rail with a Section 4(d) Rule. Final rule. Federal Register 85 (196).

USFWS. 2023a. Recovery Plan for the Rufa Red Knot (Calidris canutus rufa). U.S. Fish and Wildlife Service, Northeast Region, Hadley, Massachusetts. March.

USFWS. 2023b. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Rufa Red Knot. Proposed rule. Federal Register 88 (71).

USFWS. 2024a. Endangered and Threatened Wildlife and Plants; Critical Habitat Designations for Florida Manatee and Antillean Manatee. Proposed rule. Federal Register 89 (185).

USFWS. 2024b. Species Status Assessment Report for the Florida manatee (*Trichechus manatus latirostris*). Version 1.1. Draft. April.

USFWS and CWS. 2024. Whooping Crane Recovery Activities: 2022 Breeding Season to 2023 Spring Migration. Annual report. January.

USFWS and NMFS. 1998. Endangered Species Consultation Handbook: Procedures for conducting consultation and conference activities under Section 7 of the Endangered Species Act.

USFWS and NMFS. 2015. Defining the Roles of the U.S. Fish and Wildlife Service and the National Marine Fisheries Service in Joint Administration of the Endangered Species Act of 1973 as to Sea Turtles. Memorandum of Understanding. September.

Texas Department of Transportation (TxDOT). 2024. Guidance, Assessing Project Impacts to Eastern Black Rail (Laterallus jamaicensis *ssp.* jamaicensis). Version 1. June. Available at https://www.txdot.gov/content/dam/docs/environmental/toolkit/310-04-gui.pdf

Texas Parks and Wildlife Department (TPWD). n.d.,a. Northern Aplomado Falcon. Available at https://tpwd.texas.gov/publications/pwdpubs/media/pwd_bk_w7000_0013_northern_aplomado_falcon.pdf

TPWD. n.d.,b. Loggerhead Sea Turtle (*Caretta caretta*). Available at https://tpwd.texas.gov/huntwild/wild/species/logghead/.

TPWD. n.d.,c. Leatherback Sea Turtle (*Dermochelys coriacea*). Available at https://tpwd.texas.gov/huntwild/wild/species/lethback/

Texas Parks and Wildlife. 2018. Marine Seawater Desalination Diversion and Discharge Zone Study. 84th Texas Legislature. HB 2031.

Watts, B. 2016. Status and distribution of the eastern black rail along the Atlantic and Gulf Coasts of North America. The Center for Conservation Biology Technical Report Series, CCBTR-16-09. College of William and Mary/Virginia Commonwealth University, Williamsburg, VA. 148 pp.

Williams, H. and Schaff, B. 2023. "'Rare visitor': Wildlife officials ask boaters to be aware of leatherback turtles on South Texas coast". *KIII-TV*, June 8, 2023. https://www.kiiitv.com/article/news/local/leatherback-turtles-port-aransas/503-a064a859-0f35-48c2-a09a-d92db24b5c5

FIGURES

Legend

- Project Footprint
- Action Area (500 ft Buffer)

N

0 2,000 Feet

Harbor Island Desalination Plant
Aerial Overview of Action Area

Corpus Christi, Texas

Geosyntec consultants

TXE10785 | November 2024

Figure

1

\\az-ctxfs-t3\EPP\AUSTIN\Port_Corpus\Port_Corpus_BA\POCC_BA Screening.aprx\Fig 1_Action Area Overview 11/26/2024 9:13 PM (Mackenzie.Wallace)

Legend

- Project Footprint
- Action Area (500 ft Buffer)
- Piping Plover Critical Habitat
- Green Sea Turtle Critical Habitat
- Loggerhead Sea Turtle Critical Habitat

N

0 2,000 Feet

Harbor Island Desalination Plant
Critical Habitat in Action Area

Corpus Christi, Texas

Geosyntec consultants

TXE10785	November 2024	**Figure 2**

\\az-ctxfs-t3\EPP\AUSTIN\Port_Corpus\Port_Corpus_BA\POCC_BA Screening.aprx\Fig 2_Critical Habitat 11/26/2024 9:13 PM (Mackenzie.Wallace)

Legend

- Project Footprint
- Action Area (500 ft Buffer)
- Atlantic Highly Migratory Species EFH
- Gulf Species EFH (Red Drum, Reef Fish, Coastal Migratory Pelagic, Shrimp)

N

0 2,000 Feet

Harbor Island Desalination Plant
Essential Fish Habitat in Action Area

Corpus Christi, Texas

Geosyntec consultants

TXE10785 | November 2024

Figure 3

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APPENDIX A
USFWS IPaC Official Species List

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Texas Coastal & Central Plains Esfo
17629 El Camino Real, Suite 211
Houston, TX 77058-3051
Phone: (281) 286-8282 Fax: (281) 488-5882

In Reply Refer To: 11/26/2024 21:44:43 UTC
Project Code: 2025-0024909
Project Name: Harbor Island Desalination Facility

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The U.S. Fish and Wildlife Service (Service) field offices in Clear Lake, Corpus Christi, Fort Worth, and Alamo, Texas, have combined administratively to form the Texas Coastal Ecological Services Field Office. All project related correspondence should be sent to the field office address listed below responsible for the county in which your project occurs:

Project Leader; U.S. Fish and Wildlife Service; 17629 El Camino Real Ste. 211; Houston, Texas 77058
Angelina, *Austin*, *Brazoria*, *Brazos*, *Chambers, Colorado, Fayette, Fort Bend, Freestone, Galveston, Grimes, Hardin, Harris, Houston, Jasper, Jefferson, Leon, Liberty, Limestone, Madison, Matagorda, Montgomery, Newton, Orange, Polk, Robertson, Sabine, San Augustine, San Jacinto, Trinity, Tyler, Walker, Waller, and Wharton.*

Assistant Field Supervisor, U.S. Fish and Wildlife Service; 4444 Corona Drive, Ste 215; Corpus Christi, Texas 78411
Aransas, Atascosa, Bee, Brooks, Calhoun, De Witt, Dimmit, Duval, Frio, Goliad, Gonzales, Hidalgo, Jackson, Jim Hogg, Jim Wells, Karnes, Kenedy, Kleberg, La Salle, Lavaca, Live Oak, Maverick, McMullen, Nueces, Refugio, San Patricio, Victoria, and Wilson.

U.S. Fish and Wildlife Service; Santa Ana National Wildlife Refuge; Attn: Texas Ecological Services Sub-Office; 3325 Green Jay Road, Alamo, Texas 78516
Cameron, Hidalgo, Starr, Webb, Willacy, and Zapata.

For questions or coordination for projects occurring in counties not listed above, please contact arles@fws.gov.

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2) (c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at: http://www.fws.gov/media/endangered-species-consultation-handbook.

Non-Federal entities may consult under Sections 9 and 10 of the Act. Section 9 and Federal regulations prohibit the take of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined (50 CFR § 17.3) to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. "Harass" is defined (50 CFR § 17.3) as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Should the proposed project have the potential to take listed species, the Service recommends that the applicant develop a Habitat Conservation Plan and obtain a section 10(a)(1)(B) permit. The Habitat Conservation Planning Handbook is available at: https://www.fws.gov/library/collections/habitat-conservation-planning-handbook.

Migratory Birds:
In addition to responsibilities to protect threatened and endangered species under the Act, there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts visit: https://www.fws.gov/program/migratory-birds.

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable National Environmental Policy Act (NEPA) documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures see https://www.fws.gov/library/collections/threats-birds.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List
- Bald & Golden Eagles
- Migratory Birds
- Marine Mammals
- Coastal Barriers
- Wetlands

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

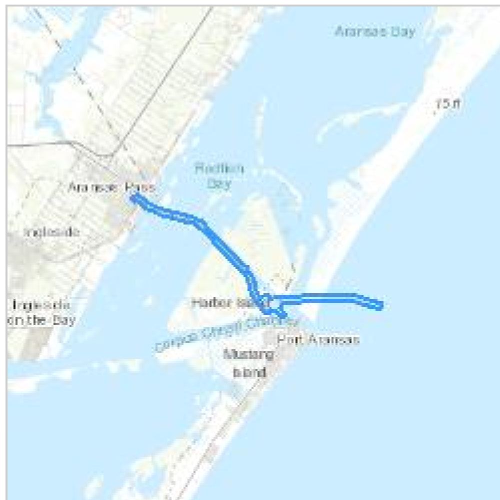
This species list is provided by:

Texas Coastal & Central Plains Esfo
17629 El Camino Real, Suite 211
Houston, TX 77058-3051
(281) 286-8282

PROJECT SUMMARY

Project Code: 2025-0024909
Project Name: Harbor Island Desalination Facility
Project Type: Water Supply Facility - Desalination Plant Ops
Project Description: Proposed desalination facility
Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@27.8732198,-97.0920999381772,14z



Counties: Aransas , Nueces , and San Patricio counties, Texas

ENDANGERED SPECIES ACT SPECIES

There is a total of 16 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

MAMMALS

NAME	STATUS
Tricolored Bat *Perimyotis subflavus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/10515	Proposed Endangered
West Indian Manatee *Trichechus manatus* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. ***This species is also protected by the Marine Mammal Protection Act, and may have additional consultation requirements.*** Species profile: https://ecos.fws.gov/ecp/species/4469	Threatened

BIRDS

NAME	STATUS
Attwater's Greater Prairie-chicken *Tympanuchus cupido attwateri* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/7259	Endangered
Eastern Black Rail *Laterallus jamaicensis ssp. jamaicensis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/10477	Threatened
Northern Aplomado Falcon *Falco femoralis septentrionalis* Population: Wherever found, except where listed as an experimental population No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/1923	Endangered
Piping Plover *Charadrius melodus* Population: [Atlantic Coast and Northern Great Plains populations] - Wherever found, except those areas where listed as endangered. There is **final** critical habitat for this species. Your location overlaps the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/6039	Threatened
Rufa Red Knot *Calidris canutus rufa* There is **proposed** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/1864	Threatened
Whooping Crane *Grus americana* Population: Wherever found, except where listed as an experimental population There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/758	Endangered

REPTILES

NAME	STATUS
Green Sea Turtle *Chelonia mydas* Population: North Atlantic DPS	Threatened

NAME	STATUS
There is **proposed** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/6199	
Hawksbill Sea Turtle *Eretmochelys imbricata* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3656	Endangered
Kemp's Ridley Sea Turtle *Lepidochelys kempii* There is **proposed** critical habitat for this species. Species profile: https://ecos.fws.gov/ecp/species/5523	Endangered
Leatherback Sea Turtle *Dermochelys coriacea* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/1493	Endangered
Loggerhead Sea Turtle *Caretta caretta* Population: Northwest Atlantic Ocean DPS There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/1110	Threatened

INSECTS

NAME	STATUS
Monarch Butterfly *Danaus plexippus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9743	Candidate

FLOWERING PLANTS

NAME	STATUS
Slender Rush-pea *Hoffmannseggia tenella* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/5298	Endangered
South Texas Ambrosia *Ambrosia cheiranthifolia* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/3331	Endangered

CRITICAL HABITATS

There is 1 critical habitat wholly or partially within your project area under this office's jurisdiction.

NAME	STATUS
Piping Plover *Charadrius melodus* https://ecos.fws.gov/ecp/species/6039#crithab	Final

BALD & GOLDEN EAGLES

Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act[1] and the Migratory Bird Treaty Act[2].

Any person or organization who plans or conducts activities that may result in impacts to bald or golden eagles, or their habitats[3], should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

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1. The Bald and Golden Eagle Protection Act of 1940.
2. The Migratory Birds Treaty Act of 1918.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

THERE ARE NO BALD AND GOLDEN EAGLES WITHIN THE VICINITY OF YOUR PROJECT AREA.

MIGRATORY BIRDS

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats[3] should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the PROBABILITY OF PRESENCE SUMMARY below to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
American Golden-plover *Pluvialis dominica* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/10561	Breeds elsewhere

NAME	BREEDING SEASON
American Oystercatcher *Haematopus palliatus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8935	Breeds Apr 15 to Aug 31
Black Scoter *Melanitta nigra* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10413	Breeds elsewhere
Black Skimmer *Rynchops niger* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/5234	Breeds May 20 to Sep 15
Black-legged Kittiwake *Rissa tridactyla* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10459	Breeds elsewhere
Brown Pelican *Pelecanus occidentalis* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/6034	Breeds Jan 15 to Sep 30
Chimney Swift *Chaetura pelagica* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9406	Breeds Mar 15 to Aug 25
Common Loon *gavia immer* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/4464	Breeds Apr 15 to Oct 31
Dickcissel *Spiza americana* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9453	Breeds May 5 to Aug 31
Double-crested Cormorant *phalacrocorax auritus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/3478	Breeds Apr 20 to Aug 31

NAME	BREEDING SEASON
Forster's Tern *Sterna forsteri* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/11953	Breeds Mar 1 to Aug 15
Gull-billed Tern *Gelochelidon nilotica* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9501	Breeds May 1 to Jul 31
Hudsonian Godwit *Limosa haemastica* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9482	Breeds elsewhere
King Rail *Rallus elegans* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8936	Breeds May 1 to Sep 5
Le Conte's Sparrow *Ammospiza leconteii* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9469	Breeds elsewhere
Least Tern *Sternula antillarum antillarum* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/11919	Breeds Apr 25 to Sep 5
Lesser Yellowlegs *Tringa flavipes* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9679	Breeds elsewhere
Long-billed Curlew *Numenius americanus* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/5511	Breeds elsewhere
Long-tailed Duck *Clangula hyemalis* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/7238	Breeds elsewhere
Magnificent Frigatebird *Fregata magnificens* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9588	Breeds elsewhere

NAME	BREEDING SEASON
Marbled Godwit *Limosa fedoa* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9481	Breeds elsewhere
Painted Bunting *Passerina ciris* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9511	Breeds Apr 25 to Aug 15
Pectoral Sandpiper *Calidris melanotos* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9561	Breeds elsewhere
Pomarine Jaeger *Stercorarius pomarinus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10458	Breeds elsewhere
Prairie Loggerhead Shrike *Lanius ludovicianus excubitorides* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/8833	Breeds Feb 1 to Jul 31
Prothonotary Warbler *Protonotaria citrea* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9439	Breeds Apr 1 to Jul 31
Red Knot *Calidris canutus roselaari* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8880	Breeds elsewhere
Red-breasted Merganser *Mergus serrator* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10693	Breeds elsewhere
Red-necked Phalarope *Phalaropus lobatus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10467	Breeds elsewhere

NAME	BREEDING SEASON
Reddish Egret *Egretta rufescens* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/7617	Breeds Mar 1 to Sep 15
Ring-billed Gull *Larus delawarensis* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10468	Breeds elsewhere
Royal Tern *Thalasseus maximus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10471	Breeds Apr 15 to Aug 31
Ruddy Turnstone *Arenaria interpres morinella* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/10633	Breeds elsewhere
Sandwich Tern *Thalasseus sandvicensis* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9731	Breeds Apr 25 to Aug 31
Short-billed Dowitcher *Limnodromus griseus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9480	Breeds elsewhere
Sooty Tern *Onychoprion fuscatus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10695	Breeds Mar 10 to Jul 31
Sprague's Pipit *Anthus spragueii* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8964	Breeds elsewhere
Surf Scoter *Melanitta perspicillata* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10463	Breeds elsewhere

NAME	BREEDING SEASON
Swallow-tailed Kite *Elanoides forficatus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8938	Breeds Mar 10 to Jun 30
Whimbrel *Numenius phaeopus hudsonicus* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/11991	Breeds elsewhere
White-winged Scoter *Melanitta fusca* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/10462	Breeds elsewhere
Willet *Tringa semipalmata* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/10669	Breeds Apr 20 to Aug 5
Wilson's Plover *Charadrius wilsonia* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9722	Breeds Apr 1 to Aug 20

PROBABILITY OF PRESENCE SUMMARY

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

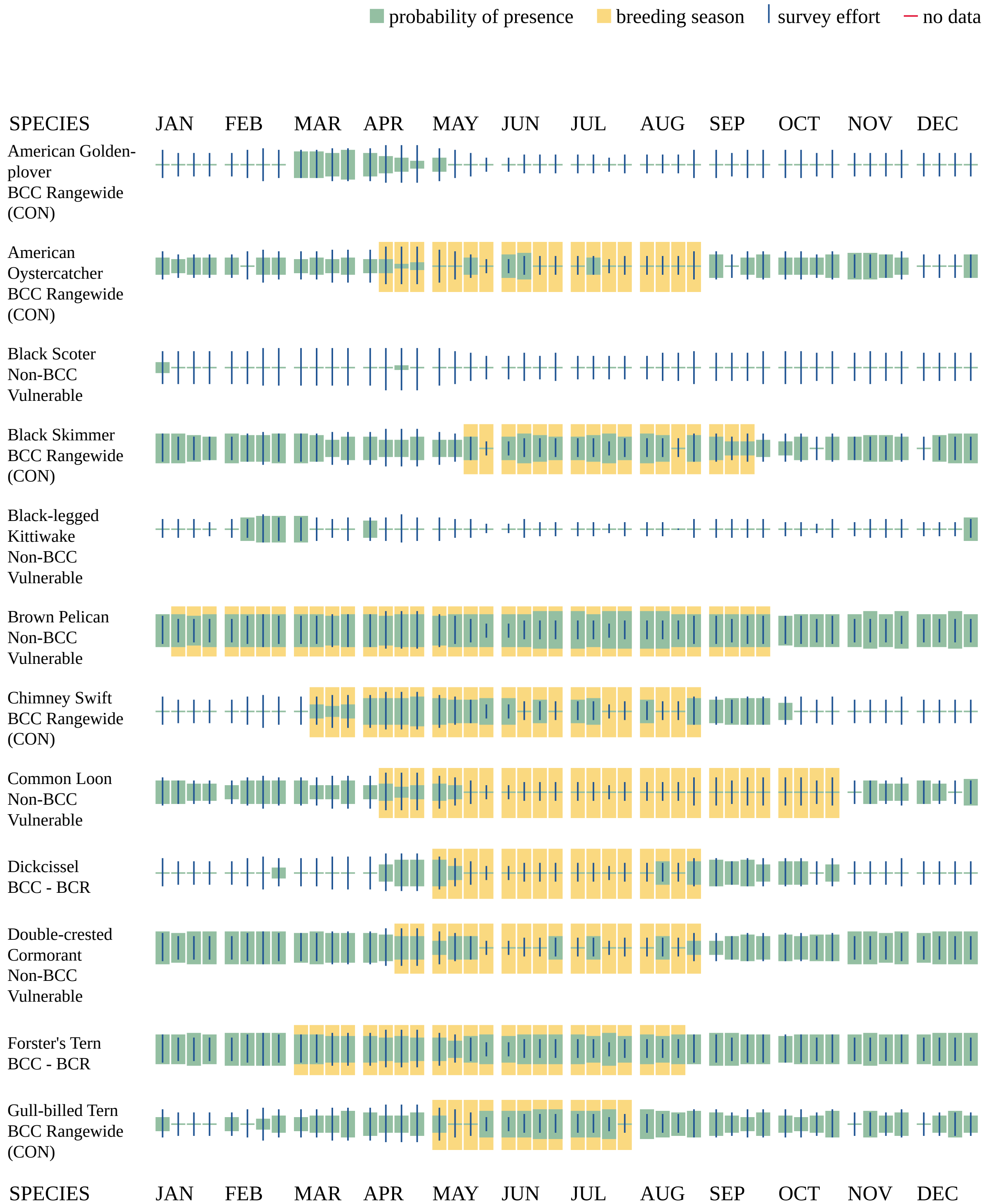
Green bars; the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during that week of the year.

Breeding Season (■)
Yellow bars; liberal estimate of the timeframe inside which the bird breeds across its entire range.

Survey Effort (|)
Vertical black lines; the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data (–)

A week is marked as having no data if there were no survey events for that week.



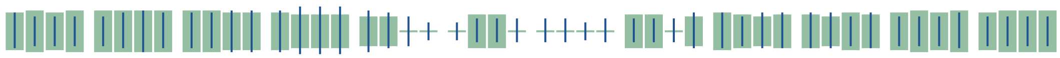

Hudsonian Godwit
BCC Rangewide
(CON)
King Rail
BCC Rangewide
(CON)
Le Conte's Sparrow
BCC Rangewide
(CON)
Least Tern
BCC Rangewide
(CON)
Lesser Yellowlegs
BCC Rangewide
(CON)
Long-billed Curlew
BCC - BCR
Long-tailed Duck
Non-BCC
Vulnerable
Magnificent
Frigatebird
BCC - BCR
Marbled Godwit
BCC Rangewide
(CON)
Painted Bunting
BCC - BCR
Pectoral Sandpiper
BCC Rangewide
(CON)
Pomarine Jaeger
Non-BCC
Vulnerable
SPECIES
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Prairie Loggerhead
Shrike
BCC - BCR
Prothonotary
Warbler
BCC Rangewide
(CON)
Red Knot
BCC Rangewide
(CON)
Red-breasted
Merganser

Non-BCC
Vulnerable

Red-necked
Phalarope
Non-BCC
Vulnerable

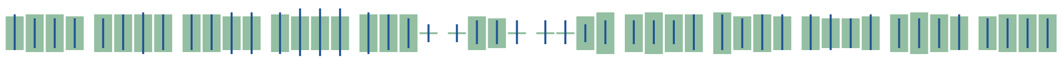
Reddish Egret
BCC Rangewide
(CON)

Ring-billed Gull
Non-BCC
Vulnerable



Royal Tern
Non-BCC
Vulnerable

Ruddy Turnstone
BCC - BCR



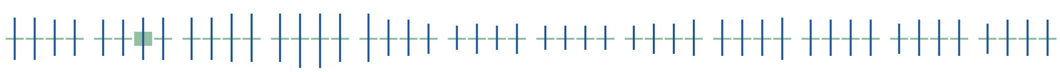
Sandwich Tern
BCC - BCR

Short-billed
Dowitcher
BCC Rangewide
(CON)

Sooty Tern
Non-BCC
Vulnerable

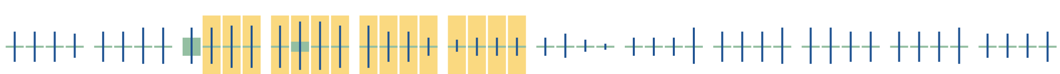
SPECIES JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Sprague's Pipit
BCC Rangewide
(CON)



Surf Scoter
Non-BCC
Vulnerable

Swallow-tailed Kite
BCC Rangewide
(CON)

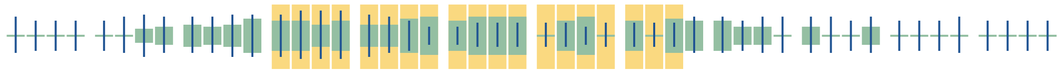


Whimbrel
BCC - BCR

White-winged
Scoter
Non-BCC
Vulnerable

Willet
BCC Rangewide
(CON)

Wilson's Plover
BCC Rangewide
(CON)



Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

COASTAL BARRIERS

Projects within the John H. Chafee Coastal Barrier Resources System (CBRS) may be subject to the restrictions on Federal expenditures and financial assistance and the consultation requirements of the Coastal Barrier Resources Act (CBRA) (16 U.S.C. 3501 et seq.). For more information, please contact the local Ecological Services Field Office or visit the CBRA Consultations website. The CBRA website provides tools such as a flow chart to help determine whether consultation is required and a template to facilitate the consultation process.

SYSTEM UNIT (SU)

Most new Federal expenditures and financial assistance, including Federal flood insurance, are prohibited within System Units. ***Federally-funded projects within System Units require consultation with the Service.*** *Consultation is not required for projects using private, state, or local funds.*

OTHERWISE PROTECTED AREA (OPA)

OPAs are denoted with a "P" at the end of the unit number. The only prohibition within OPAs is on Federal flood insurance. ***CBRA consultation is not required for projects within OPAs.*** *However, agencies providing disaster assistance that is contingent upon a requirement to purchase flood insurance after the fact are advised to disclose the OPA designation and information on the restrictions on Federal flood insurance to the recipient prior to the commitments of funds.*

UNIT	NAME	TYPE	SYSTEM UNIT ESTABLISHMENT DATE	FLOOD INSURANCE PROHIBITION DATE
T08	San Jose Island	SU	10/18/1982	10/1/1983
T08P	San Jose Island	OPA	N/A	11/16/1991

MARINE MAMMALS

Marine mammals are protected under the Marine Mammal Protection Act. Some are also protected under the Endangered Species Act[1] and the Convention on International Trade in Endangered Species of Wild Fauna and Flora[2].

The responsibilities for the protection, conservation, and management of marine mammals are shared by the U.S. Fish and Wildlife Service [responsible for otters, walruses, polar bears, manatees, and dugongs] and NOAA Fisheries[3] [responsible for seals, sea lions, whales, dolphins, and porpoises]. Marine mammals under the responsibility of NOAA Fisheries are **not** shown on this list; for additional information on those species please visit the Marine Mammals page of the NOAA Fisheries website.

The Marine Mammal Protection Act prohibits the take of marine mammals and further coordination may be necessary for project evaluation. Please contact the U.S. Fish and Wildlife Service Field Office shown.

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1. The Endangered Species Act (ESA) of 1973.
2. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is a treaty to ensure that international trade in plants and animals does not threaten their survival in the wild.
3. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

NAME

West Indian Manatee *Trichechus manatus*
Species profile: https://ecos.fws.gov/ecp/species/4469

WETLANDS

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

ESTUARINE AND MARINE DEEPWATER

- E1UBLx
- E1AB3L

- M1UBL
- E1UBL

FRESHWATER EMERGENT WETLAND

- PEM1Ah
- PEM1/SS1Fx
- PEM1C
- PEM1Fh
- PEM1A

ESTUARINE AND MARINE WETLAND

- E2USP
- E2USN
- M2USP
- M2USN
- E2EM1P
- E2EM1N

LAKE

- L2USCh

FRESHWATER POND

- PUBF

IPAC USER CONTACT INFORMATION

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