PORT CORPUS CHRISTI

March 14, 2023

Amy Nunez
Corpus Christi Coastal Operations Office
Texas General Land Office
602 N. Staples Street, Suite 240
Corpus Christi, Texas 78401

Subject: **State-Owned Lands Lease and Easement Application for Proposed Harbor Island Desalination Facility Intake**
Port of Corpus Christi Authority of Nueces County

Dear Ms. Nunez,

The following letter and related attachments serve as the application for use of Texas State-owned Lands as per Title 31 of the Texas Administrative Code §155.21(b) for purposes of constructing an intake structure associated with the proposed desalination facility on Harbor Island. The Port of Corpus Christi Authority of Nueces County, Texas (Port Authority) requests a surface lease for a water intake structure on State Tract No. 849 in the Gulf of Mexico (GOM) and an easement for a proposed tunnel route and alignment, which generally follows the alignment of the pipeline project called Bluewater Texas Terminal for approximately 2.7 of its total 3.1 miles before the alignments separate approximately 0.4 miles from the intake location. The Port Authority has proposed a project comprised of 1) a State Water intake structure in the GOM and 2) a large diameter tunnel to withdraw and transport State Water from the GOM by gravity flow to a Port Authority desalination facility located on Harbor Island. The facility will produce desalinated water as a reliable source for the Coastal Bend region consistent with the TWDB's approved State Water Plan. The offshore location reduces environmental concerns and potential impacts from impingement and entrainment related to the proposed diversion of State Water. This application is being submitted concurrently with permit applications for State Water Rights and placement of structures in Waters of the U.S.

1. Agent Contact Information

Ms. Sarah Garza, Director of Environmental Planning and Compliance will serve as the point of contact between the Port Authority and the Texas General Land Office on technical matters.

Sarah Garza
Director of Environmental
Planning and Compliance
(361) 885-6163
400 Harbor Drive
Corpus Christi, TX 78401

The individual authorized to execute this agreement for the Port Authority is Mr. Sean Strawbridge, Chief Executive Officer (CEO) for the Port Authority. It is necessary that the final execution of the agreements will require approval by the Port Commission at a regular Port Authority Board meeting.

2. Eligibility to Qualify as a Navigation District

The Port Authority is a political subdivision of the State of Texas operating as a navigation district under Article XVI, Section 59 of the Texas Constitution and the laws of the State of Texas (particularly Chapters

60 and 62 of the Texas Water Code). **Attachment A** contains a copy of the Order of the Nueces County Commissioners Court establishing the Nueces County Navigation District No. 1, which is now the Port of Corpus Christi Authority of Nueces County, Texas. Later, the Port Authority converted to a navigation district operating under Article 16, Section 59 of the Texas Constitution. The Port Authority codified its special district laws in Chapter 5016 of the Texas Special District Local Laws Code.

3. Submerged Lands Proposed for Lease

The Port Authority requests a surface lease for a water intake structure on State Tract No. 849 in the GOM and an easement for a proposed tunnel route and alignment on State Tract Nos. 848, 849, 650, 651, 306, and 654 (see maps provided in **Attachment B**).

4. Utilization of the Submerged Lands and Time Table

The submerged property will be used for the construction of an intake structure and associated pipe (tunnel) to draw seawater from the GOM to the desalination facility on Harbor Island. The intake structure will consist of a system of pipes and protected openings secured to the sea bed and connected to a tunnel to the Harbor Island facility. The intake structure will have a manifold arrangement with approximately four or five branches, each topped with a velocity cap intake to minimize entrainment of marine life. The branches will be evenly spread apart to obtain even flow distribution without interference from each other. The intake openings will be approximately 5 to 10 ft above the sea bed to avoid intake of sediments and benthic organisms, and more than 20 ft below the sea surface to minimize intake of sensitive marine species and accounting for sensitive life stages. The velocity caps will have an entrance velocity of ≤0.5 ft/sec and are considered the best technology available to minimize the entrainment of marine life by high volume water intakes. It is anticipated that only the velocity caps and vertical riser pipes will be above the sea bed. The riser pipes will connect to a manifold and convey seawater to Harbor Island through a large-diameter gravity tunnel constructed by tunnel boring machine from Harbor Island. The tunnel is expected to be at least 25 ft below the seabed from the intake to Harbor Island.

Activity	**Estimated Start Date**	**Estimated Completion Date**
Construction of intake and intake tunnel.	1/5/2024	12/20/24

Additional information is provided in the attachments to this correspondence.

5. Environmental Impact Statement

As per Texas Water Code Chapter 61 (c)(3), a draft environmental impact statement is not required if the proposed use requires no dredging, filling, or bulk heading.

6. Convenience and Necessity For Acquisition

The acquisition of State-owned lands for construction of the intake tunnel and the intake structure is necessary due to:

1. The need to draw State water for use in the desalination process

2. The intent by the Port Authority to place the intake in the GOM to reduce the potential impacts to larval fish and other marine species

7. Additional Information

Additional information has been provided in the attachments and includes the maps (**Attachment B**), applications for a lease and easement of State-owned lands (**Attachment C**), Basis of Design Memo

(**Attachment D**), Proposed Construction Methods for Harbor Island Desalination Facility Intake Tunnel (**Attachment E**), and Evaluation of Potential Impingement and Entrainment Associated with the Intake Structure for the Proposed Harbor Island Desalination Facility (**Attachment F**).

If you have any questions or require additional information, please do not hesitate to contact me by phone at (361) 885-6163 or email at sarah@pocca.com.

Sincerely,
PORT OF CORPUS CHRISTI AUTHORITY

Sarah Garza
Director of Environmental
Planning and Compliance

Enclosures:

cc: Sean Strawbridge, Chief Executive Officer, Port of Corpus Christi Authority
Jeff Pollack, Chief Strategy & Sustainability Officer, Port of Corpus Christi Authority
Omar Garcia, Chief External Affairs Officer, Port of Corpus Christi Authority
Harrison McNeil, Senior Environmental Permitting Specialist, Port of Corpus Christi Authority
Yvonne Dives-Gomez, Environmental Permitting Specialist, Port of Corpus Christi Authority

PORT CORPUS CHRISTI

Attachment A
Navigation District Qualifying Documents

Mr. Savage: Q. Does anyone like to ask Mr. Kleberg any questions with reference to the hearing?
A. I go further to say that under the law under which they are now trying to operate their powers are very limited and under the law under which you are trying to place them their powers will be those to a large extent of a business corporation and they will have much wider powers and can manage things much more effectively.

Mr. Eckhardt: "Do any of you wish to discuss the evidence put before the Committee?"
Mr. Lawrence: "It looks pretty good to me."
Mr. Eckhardt: "Any further discussion? We want this matter discussed thoroughly." I will entertain a motion to pass the following order, which I will read." Reads the following order, to wit:

THE STATE OF TEXAS I
COUNTY OF NUECES. I

On this, the 23rd day of April, A. D. 1931, before the Navigation Board of Nueces County Navigation District No. 1in and for Nueces County, Texas, came on to be heard the hearing upon the question of the conversion of Nueces County Navigation District No. 1 from a navigation district organized and operating under Section 52 of Article 3 of the Constitution of the State of Texas to a navigation district operating under Section 59, Article 16, of such State Constitution, which hearing was called by the Navigation Board by resolution passed by said Navigation Board on the 6th day of April, A. D. 1931, duly entered upon the Minutes of said Navigation Board, and it appearing to said Navigation Board that due legal notice of said hearing had been issued and published in the manner provided by law and the resolution passed by said Navigation Board, the Navigation Board proceeded to hear testimony of all interested persons within said District present at said hearing and desiring to be heard for or against the proposal contained in the resolution for the conversion of said districtand after hearing all of said testimony of all of said persons desiring to be heard and there being no other interested persons present desiring to be heard either for or against said proposal, said hearing was closed.

After considering all of said testimony for and against said proposal for the conversion of said district and after considering said proposal upon its merits, the Navigation Board finds as follows:

1. That said hearing was duly and legally called by resolution of the Navigation Board passed on the 6th day of April, A. D. 1931, and that due notice of said hearing was issued and published, for the time and in the manner required by law and the resolution of said Navigation Board.

2. That the preponderance of the testimony of the interested parties present and testifying at said hearing is to the effect and shows that it is for the best interest of such Nueces County Navigation District No. 1 and will be a benefit to the lands and property included in said District that said district become a district operating under the provisions of Article 16, Section 59 of the Constitution of the State of Texas.

3. That it is the opinion and judgment of the Navigation Board that it would be to the best interest of the District and would be a benefit to the lands and property situated in said district for said Nueces County Navigation District No. 1 to be converted into a Navigation District under Section 59 of Article 16 of the Constitution of Texas. It is, therefore, considered, ordered, adjudged and decreed by the Navigation Board of Nueces County Navigation District No.1 in and for Nueces County, Texas, on this the 23rd day of April, A. D. 1931, a quorum of said Board being present and acting, that Nueces County Navigation District No. 1 be and the same is hereby converted from a Navigation District organized and operating under Section 52 of Article 3 of the Constitution of the State of Texas to a navigation district under Article 16, Section 59 of the Constitution of the Stateof Texas, and that said navigation district shall become and be constituted a navigation district under the provisions of Section 59, Article16 of the Constitution of the State of Texas and shall hereafter be governed by said provisions and any amendments thereafter adopted and the laws enacted thereunder and shall hereafter have and may hereafter exercise all the powers, authority, functions and privileges in the manner and to the same extent as if said navigation district had been originally organized under the provisions of said Section 59, Article 16 of the Constitution of the State of Texas, within the territorial limits of said district as originally created, which are and shall be co-extensive with the territorial limits of Nueces County as defined by law.

4. It is further ordered that the County Clerk of Nueces County, Texas, as Clerk of this Navigation Board, enter this order upon the Minutes of this Board.

Mr. Lawrence: "I make the motion that the order be adopted as read and approved by the Navigation Board as the order of the Board." This motion seconded by Mr. Baldwin.
Mr. Eckhardt: "Those in favor of the motion please say 'Aye'. Those opposed- the contrary." Motion unanimously passed.
Mr. King to Board: "If we consider passing any bond issue on the financial matters every one will be fully advised. I am a farmer myself and familiar with the time one has who attempts to make a living off a farm."
Mr. Eckhardt: "Mr. King and members of the Navigation Board have the utmost confidence of the Commissioners Court and of the people of Nueces County in conducting the affairs of the Board and I believe that we could nothave the matter in any more competent hands."

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There being no further business to come before the meeting, it was moved, seconded and carried that the meeting stand adjourned.

Marcellus G. Eckhardt
County Judge, Nueces County, Texas.

ATTEST: [signature]
County Clerk Nueces County, Texas.

STATE OF TEXAS
COUNTY OF NUECES

The above and foregoing is a true and correct copy of the same appears on file and/or recorded in the appropriate records of Nueces County, Texas.

Hereby certified, on Feb. 2, 1994

County Clerk
Nueces County, Texas

THE STATE OF TEXAS ⟩

COUNTY OF NUECES ⟩

I, MRS. HENRY E. GOUGER, Clerk of the County Court of Nueces County, Texas, do hereby certify that the above and foregoing is a true and correct copy of ____________________ an Order Creating Nueces County Navigation District No. 1 as the same [illegible] appears of record in Volume L on pages 110-11, of the Commissioners' Court Minutes of Nueces County, Texas; said proceedings being held at a Regular, Term of said Court on November 13th, A. D., 1922.

TO CERTIFY WHICH, WITNESS my hand and official seal of the Commissioners' Court of Nueces County, Texas, at my office in the City of Corpus Christi, Texas, this the 5th day of September, A. D., 1958.

MRS. HENRY E. GOUGER, COUNTY CLERK &
EX-OFFICIO CLERK OF THE COMMISSIONERS'
COURT OF NUECES COUNTY, TEXAS

By Minerva Leal, Deputy.

The State of Texas) Commissioners' Court of Nueces County,
County of Nueces.) Texas, Special Term, A.D. 1922.

On this the 13th day of November, A.D. 1922, at a regular term of the Commissioners' Court of Nueces County, Texas, set as the date of canvassing the vote of that certain elec[illegible] held on October 31st, 1922 in accordance with order made by the Navigation Board on September 29, 1922, in the matter of petition of C.W.Gibson and thirty-five others, praying for the establishment of a Navigation District and issuance of bonds and levy of taxes in said peti[illegible] fully described and designated, by the name of Nueces County Navigation District No. 1, and it appearing to the Commissioners' Court that said election was held in accordance with said order and notice thereof made and issued heretofore on September 29, 1922, and that the presiding judge and officers at each polling place have made returns of the result of said election in accordance with law and that at said election more than a two-thirds majority of those voting at such election have been cast in favor of the Navigation District and the issuance of bonds and levy of taxes and the Court so finds and makes the following order, to-wit:

"Commissioners' Court of Nueces County, Texas, regular Term A.D. 1922, in the matter of the petition of C.W.Gibson and thirty-five others, praying for the establishment of a Navigation District, and issuance of bonds and levy of taxes in said petition described and designated by the name of Nueces County Navigation District No. 1: Be it known that an election called for that purpose in said district held on the 31st day of October, A.D. 1922, a two-thirds majority of the resident property taxpayers voting thereon voted in favor of the creation of said Navigation District, and the issuance of bonds and the levy of tax.

Now therefore, it is considered and ordered by the court that said Navigation District be, and the same is hereby established by the name of Nueces County Navigation District No. 1, and that bonds of said district in the amount of one million dollars be issued, and a tax of forty-five cents on the one hundred dollars valuation, or so much thereof as may be necessary, be levied upon all property within said district, whether real, personal, mixed or otherwise, sufficient in amount to pay the interest on such bonds and provide a sinking fund to redeem them at maturity, and that if said tax shall at any time become insufficient for such purposes

Same shall be increased until same is sufficient.

The metes and bounds of said Navigation District being as follows, to-wit:

The metes and bounds of said proposed Navigation District are the same as those of Nueces County, Texas, as the proposed Navigation District is co-extensive with the present County of Nueces, State of Texas; that Nueces County, Texas, and said Navigation District is bounded on the North by San Patricio and Aransas Counties, on the East by the Gulf of Mexico, on the South by Kleberg County and on the West by Jim Wells County; that reference is hereby made to the Acts of Legislature of the State of Texas defining the boundaries of Nueces County and reference is also made to the Acts of Legislature creating the Counties of Jim Wells and Kleberg and defining the limits of each, and each and every of said acts of the Legislature defining said Nueces County, Texas, and eliminating portions thereof are each respectively for all purposes made a part hereof."

It is further considered and ordered by the Court that this order be entered in the minutes record book of Nueces County Navigation District No. 1.

Attachment B
Maps

J:\451\451565 Baker Wotring\HarborIslandIntake\GIS\GLO_Permit_Maps\ExhibitA_intake.mxd

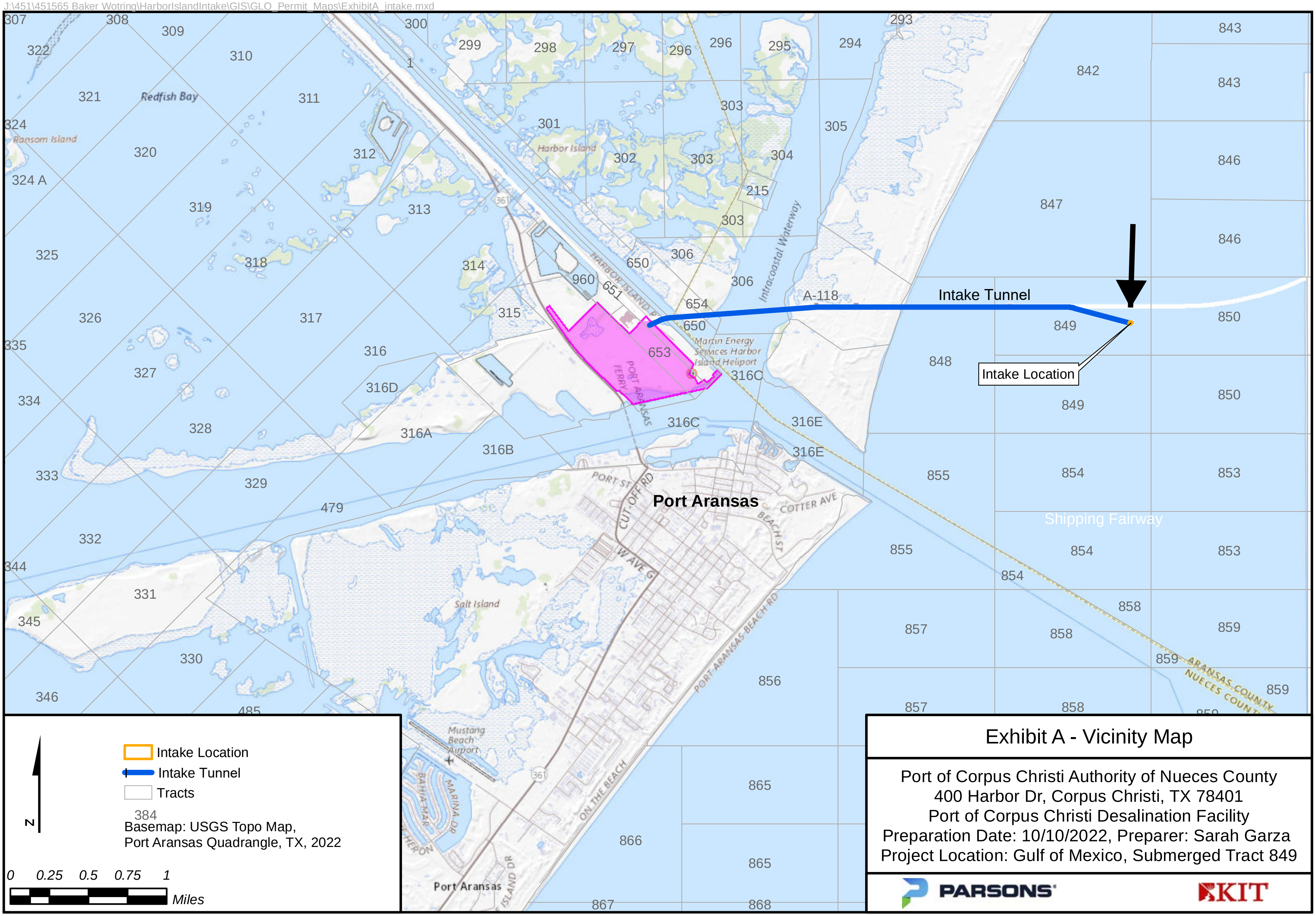

Exhibit A - Vicinity Map

Port of Corpus Christi Authority of Nueces County
400 Harbor Dr, Corpus Christi, TX 78401
Port of Corpus Christi Desalination Facility
Preparation Date: 10/10/2022, Preparer: Sarah Garza
Project Location: Gulf of Mexico, Submerged Tract 849

PARSONS KIT

J:\451\451565 Baker Wotring\HarborIslandIntake\GIS\GLO_Permit_Maps\ExhibitB_intake.mxd

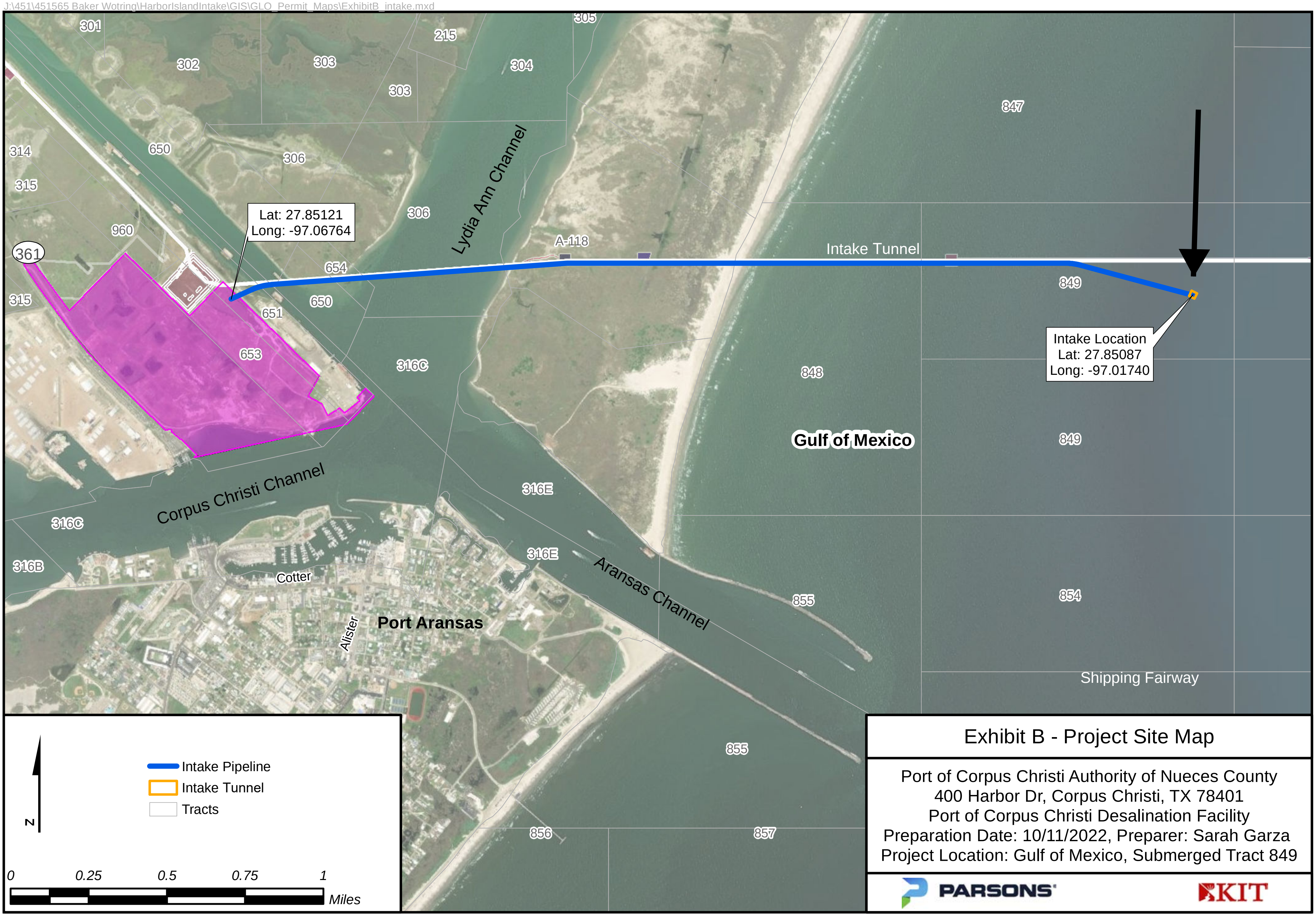

Exhibit B - Project Site Map

Port of Corpus Christi Authority of Nueces County
400 Harbor Dr, Corpus Christi, TX 78401
Port of Corpus Christi Desalination Facility
Preparation Date: 10/11/2022, Preparer: Sarah Garza
Project Location: Gulf of Mexico, Submerged Tract 849

PARSONS

KIT

PORT CORPUS CHRISTI

Attachment C
Surface Lease Application
& Easement Application

State of Texas
Texas General Land Office
Application for State Land Use Lease
Surface Lease (SL) - Coastal

FOR GLO USE ONLY

Working File #	
Staff Initials	
Lease #	

Applicant/Official Company Name

Individual, Company, Partnership or Trust Name: Port of Corpus Christi Authority of Nueces County

Contact (Title, First Name, Last Name, Salutation): Ms. Sarah Garza

Work #: +1 (361) 885-6163 Mobile #:

c/o or Attn:

Street Address: 400 Harbor Dr

City: Corpus Christi State: TX Zip Code: 78401-1115

Country: USA Email: sarah@pocca.com

☐ **Authorized Agent** ☒ **Company Contact**

Individual, Company, Partnership or Trust Name:

Agent/Company Contact (Title, First Name, Last Name, Salutation): ☐ Send contracts to Agent/ Company Contact

Work #: Mobile #:

c/o or Attn:

Street Address:

City: State: Zip Code:

Country: Email:

CORPORATE APPLICANTS, FILL OUT THE FOLLOWING:

Type of Business: State of Domicile:

Tax Id #: If LP Name Of General Partner:

Name of President: Name of Secretary:

LOCATION OF PROJECT

Name of Affected Body(ies) of Water: Gulf of Mexico

State Tract No(s). in which rights are requested: 849

County(ies): Aransas

GPS Coordinates (if known): 27°51 ’3.142”N 97°01 ’2.644"W

Legal Description: Gulf of Mexico State Tract No. 849

Adjacent Landowners

First: Last:
Address:
City: State: Zip Code:

First: Last:
Address:
City: State: Zip Code:

PROJECT DESCRIPTION

If additional space is needed, please continue the descriptions on page 3.

Purpose of Proposed Lease

The Port of Corpus Christi Authority of Nueces County, Texas (Port Authority) requests a surface lease for a water intake structure on State Tract No. 849 in the Gulf of Mexico (GOM). The Port Authority has proposed a project comprised of 1) a State Water intake structure in the GOM and 2) a large diameter tunnel to withdraw and transport State Water from the GOM by gravity flow to a Port Authority desalination facility located on Harbor Island. The facility will produce desalinated water as a reliable source for the Coastal Bend region consistent with the TWDB’s approved State Water Plan. The offshore location reduces environmental concerns and potential impacts from impingement and entrainment related to the proposed diversion of State Water.

Description of structure(s) and the materials to be used

The intake structure will consist of a system of pipes and protected openings secured to the sea bed and connected to a tunnel to the Harbor Island facility. The intake structure will have a manifold arrangement with approximately four or five branches, each topped with a velocity cap intake to minimize entrainment of marine life. The branches will be evenly spread apart to obtain even flow distribution without interference from each other. The intake openings will be approximately 5 to 10 ft above the sea bed to avoid intake of sediments and benthic organisms, and more than 20 ft below the sea surface to minimize intake of sensitive marine species and accounting for sensitive life stages. The velocity caps will have an entrance velocity of ≤0.5 ft/sec and are considered the best technology available to minimize the entrainment of marine life by high volume water intakes. It is anticipated that only the velocity caps and vertical riser pipes will be above the sea bed. The riser pipes will connect to a manifold and convey seawater to Harbor Island through a large-diameter gravity tunnel constructed by tunnel boring machine from Harbor Island. The total horizontal dimensions of the intake structure are expected to be less than 100 ft by 100 ft, centered on the GPS coordinates above. The intake velocity caps will be constructed of 316 stainless steel or similar material. Pipe materials will be determined during final design. Please see the attached basis of design report and construction methods memo (in Attachment D) for more details, including figures.

Description of facilities associated with the structure

The desalination facility will be connected by an approximately 3.1-mile-long large diameter tunnel, which will travel from Harbor Island, under the Aransas Channel and Lydia Ann Channel, San Jose Island and the Gulf of Mexico sea bed to a point approximately 1.3 miles offshore from San Jose Island per the application GPS coordinates. At this point, the tunnel will connect to the intake structure described above. The final design of the project will consider the geotechnical study and the respective review of and final permitting action by the TCEQ, TXGLO and USACE.

Method of installation, type of equipment to be used, and how it will be brought to the project site

The tunnel route and alignment are proposed to follow the pipeline project called “Bluewater Texas Terminal” from Harbor Island for approximately 2.7 of its total 3.1 miles before the alignments separate approximately 0.4 mile from the intake location in the GOM. The tunnel will be excavated using a tunnel boring machine (TBM). The proposed tunnel will begin and end at two vertical shafts. The primary tunnel work shaft will be constructed at Harbor Island near the proposed desalination Facility. The offshore tunnel terminal shaft will be constructed at sea using barge/platform vessels. A caisson will be lowered to access and isolate the sea bed. A vertical shaft will then be drilled down to the tunnel terminus, where a connection will be made. The intake structure will include a riser pipe connecting to the tunnel, a manifold on the riser pipe, and approximately four or five branch pipes and vertical risers connecting to velocity cap intakes.

It is anticipated that all tunnel and intake structures will be installed below the sea bed except for the velocity cap intakes and part of their vertical riser pipes. All excavated material from tunneling will be extracted through the Harbor Island primary work shaft. Other than the installation of the intake structure offshore in the GOM, we expect no surface disturbances to State lands. Based on the TBM construction method, no disturbance to wetlands or seagrass beds is anticipated. See the attached basis of design report and construction method memo (in Attachment D) for more details.

If a petroleum related activity:

- ☐ the product is derived in-state
- ☐ the product is derived out-of-state

Amount of State land involved: 10,000 sq. ft.

Corps of Engineers Permit No.:

Date if Known:

Describe Present Project Area

	Yes	No		
Marshes	☐	☒	Area	
Submerged Grasses	☐	☒	Area	
Oyster Reefs	☐	☒	Area	
Habitat Survey Done	☐	☒	Date	

Water depth: approximately 35 ft ft.

PROJECT DESCRIPTION (continued)

Please indicate which description you are expanding on in the space provided below.

Not used.

PROJECT PLANS AND LOCATION MAP

Attach two copies of project plans and location map as described in the 'General Instructions for all Applicants' below. Copies of plans submitted for any Army Corps of Engineers permit may be used if they meet the specifications in 'General Instructions'.

Anticipated Start Date 01/05/2024 Expected Completion Date 12/20/2024

Desired Term 50 yrs

☒ By clicking this box, I verify that I have read the Instructions and Exhibit Preparation Information included in this application.

FEES AND ATTACHMENTS

A. No fees are due at this time. See attached Rate and Fee schedule.
B. Upon submission, include two completed copies of this application, including project maps and all applicable attachments

[signature] 3/14/2023

Signature of Applicant/Agent Date

Please include documentation to support authorization to sign on behalf of a Corporation, LLC, LP, LLP, or GP.

Information collected by electronic mail and by web form is subject to the Public Information Act, Chapter 552, Government Code.

Submit by Email | Print Form

State of Texas
Texas General Land Office
Application for State Land Use Lease
Miscellaneous Easement/Right-of-Way - New

Easement No.

Grantee/Official Company Name/Applicant

Company, Partnership, Individual or Trust Name

Port of Corpus Christi Authority of Nueces County

Mailing Address: 400 Harbor Dr

City: Corpus Christi State: Tx Zip Code: 78401-1115

Work #: 361-885-6163 Fax #: NA

Country: USA Website: https://portofcc.com/

Email: sarah@pocca.com

☐ **Authorized Agent** ☒ **Company Contact**

Individual, Company, or Consultant Information

Sarah Garza
Director of Environmental Planning & Compliance

Agent/Company Contact (Title, First Name, Last Name, Salutation) ☐ Send contracts to Agent/ Company Contact

Work # Mobile #

Street Address

City State Zip Code

Country Email

Type of Business and State of Incorporation of Grantee

Type of Business: Loading and Unloading Cargo to and From

State of Incorporation: Texas

Tax Id #: 746000609

If LP, Name Of GP:

COE # if known: Date:

Location of Right-of-Way for tidally influenced projects

County(ies): Aransas, Nueces

Waterbody(ies)	State Tract No.(s)
Gulf of Mexico	848, 849
Aransas Channel	650, 651
Lydia Ann Channel	306, 654

Water Depth: approx. 35 ft at intake location in GOM

For ROW crossing State-owned Uplands

County Abstract #

Survey/Section # Block # Town. #

Survey Name

State-owned Uplands

County Abstract #

Survey/Section # Block # Town. #

Survey Name

State-owned Riverbed/Navigable Stream NOT tidally influenced

River or Navigable Stream crossed by proposed line

County Abstract #

Survey/Section # Block # Town. #

Survey Name

River or Navigable Stream crossed by proposed line

County Abstract #

Survey/Section # Block # Town. #

Survey Name

River or Navigable Stream crossed by proposed line

County Abstract #

Survey/Section # Block # Town. #

Survey Name

If the pipeline route will cross a state-owned tract held by a state Mineral Lease or covered by a Pooling Agreement, please fill out the information below:

Tract #	Mineral Lease #	Lease Holder	Held by Lease?	Held by Pooling?

**** Please note: For Oil and Gas-related Pipelines ONLY there is the option for a 10 year or 20 year term***

Select Term: ☑ **10 Year Term** ☐ **20 Year Term**

Pipeline Information

Company's name for this pipeline: Port of Corpus Christi Authority of Nueces County

RRC T-4 Permit No. if known:

Pipe outside diameter (in.): 168

Easement length of pipeline on state land (rods): 457

Permanent ROW width in feet - Normally 30 ft: 42

Name of product being transported: State Water from the Gulf of Mexico

Method of burial and equipment to be used (dredging, jetting, plowing, backhoe, trenching machine, directional drill, etc.): Tunnel boring machine (TBM)

Transmission Line Information

Company's name for this transmission line:

If electric power, provide KV rating:

If communication line, designate type:

Copper Cable	Other (explain)

If above ground installation, give description:

If below ground installation (minimum 24"):

Burial Depth	Cable Diameter	Casing Diameter

Method of burial and equipment to be used: (dredging, jetting, plowing, backhoe, trenching machine, directional drill, etc.)

Easement length of line on state land (rods):

Permanent ROW width in feet:

Anticipated Start Date: 01/05/24

Expected Completion Date: 12/20/24

☑ By clicking this box, I verify that I have read the General Information and Instructions included in this application.

[signature]
Signature of Applicant/Agent

Sarah Garza
Name (please print or type)

Director of Environmental Planning & Compliance
Title

03/14/2023
Date

Easement No.

Sub-Surface Easement Information

For the purpose of this application, a "sub-surface easement" is defined as a directionally drilled well bore for the exploration and production of crude oil, natural gas, and/or other mineral products.

Company's name for this well bore:

Total length of well bore on state land (rods):

Outside diameter of drill casing (in.)

Exterior Casing	Interior Casing (if applicable)

Name of product being transported:

Other Activities or Notes: If this is for a project other than those listed above, such as water lines, fiber-optic lines, roads, etc., fill in the boxes below. Also, please use this section for additional notes if needed.

Activity Description
Explain briefly what work you propose to conduct on state land

An intake structure and tunnel will be constructed to withdraw and transport State Water from the Gulf of Mexico (GOM) to a Port of Corpus Christi Authority desalination facility located on Harbor Island, where it will be used to produce desalinated product water that will be distributed on a wholesale basis to municipal and industrial entities. The intake tunnel will transport seawater and be buried approximately 28 ft or more below the GOM sea bed and transverse under San Jose Island as well as nearby channels.

Technical Specifications
Describe technical aspects of the proposed activity (width, length, depth, etc.)

A large diameter intake tunnel will transport State Water from the GOM from the intake structure (located approximately 1.3 miles off San Jose Island in the GOM) for a distance of approximately 3.1 miles to a desalination facility on Harbor Island. The planned top-of-tunnel elevation is approximately -64 ft NAVD88, and the tunnel will be buried approximately 28 ft or more below the GOM sea bed and transverse under the Aransas Channel, Lydia Ann Channel and San Jose Island. Except for the installation of the intake structure offshore in the GOM, no surface disturbances to State lands, wetlands or seagrass beds are expected. A separate surface lease application has been prepared for the intake structure which will be located in approximately 35 ft of water depth. Please see the attached basis of design report in Exhibit C for more detail.

Construction Details
Describe methods, equipment, and timing for project completion

The proposed tunnel route and alignment follows the alignment of the pipeline project called Bluewater Texas Terminal for approximately 2.7 of its total 3.1 miles before the alignments separate approximately 0.4 miles from the intake location. The tunnel will be excavated using an earth-pressure balance tunnel boring machine (TBM). The primary tunnel work shaft will be constructed on Harbor Island near the proposed desalination facility. From there the TBM will tunnel out to a second vertical shaft in the GOM where an intake structure will be installed. The intake structure will be composed of a vertical riser connected to the tunnel, a manifold, and pipes connecting to several velocity cap intakes. Excavated material will be extracted at the Harbor Island work shaft. It is anticipated that all tunnel and intake structures will be below the sea bed except for the velocity cap intakes and approximately 5 to 10 feet of riser pipe. The construction of the tunnel and intake structure is anticipated to be started and completed during 2024. See the attached basis of design report and construction methods memo for more construction details.

PORT CORPUS CHRISTI

Attachment D
Basis of Design Memo

PORT OF CORPUS CHRISTI
PROPOSED INTAKE FOR DESALINATION PLANT
BASIS OF DESIGN REPORT
HARBOR ISLAND, CORPUS CHRISTI, TEXAS

Prepared for:

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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.

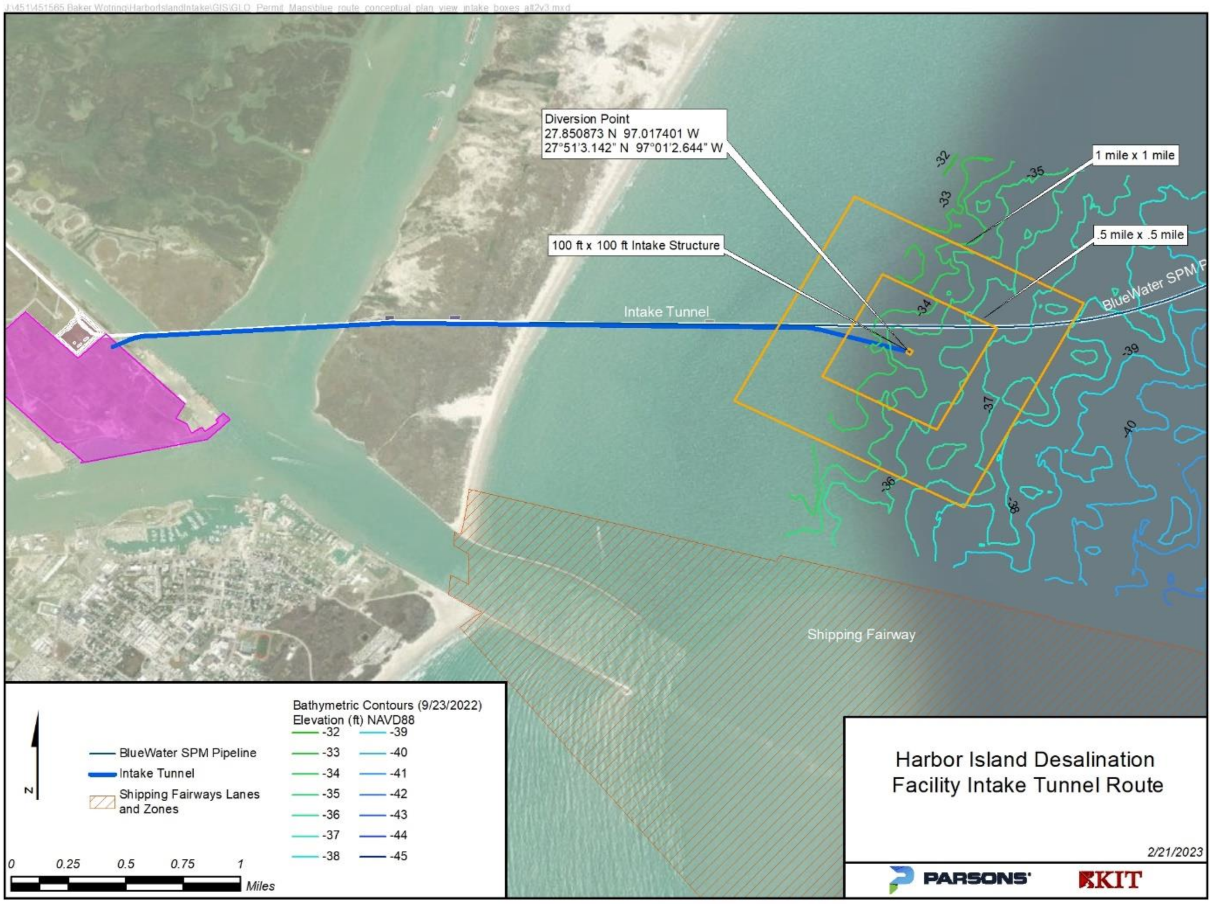

Figure 1a. Proposed Intake Location and Tunnel Route

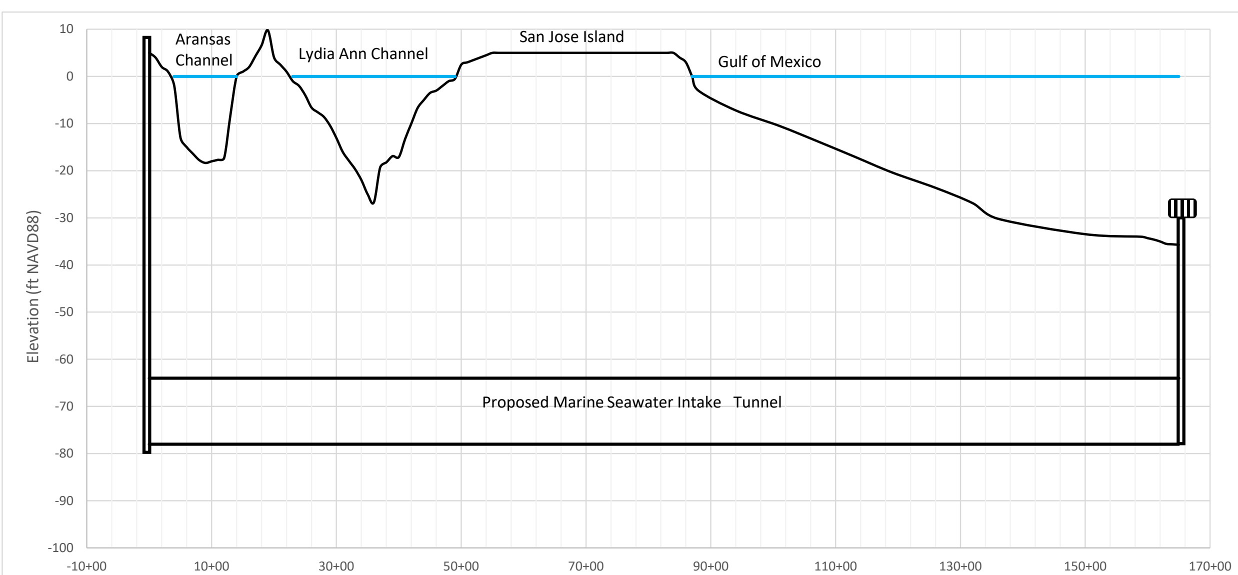

Figure 1b. Profile of Proposed Seawater Intake Tunnel

4.2 Seawater Intake Structure

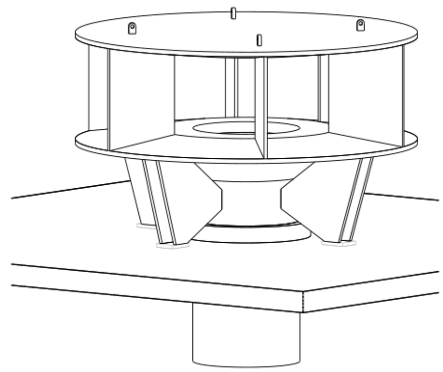
Figure 2. Velocity Cap

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.

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.

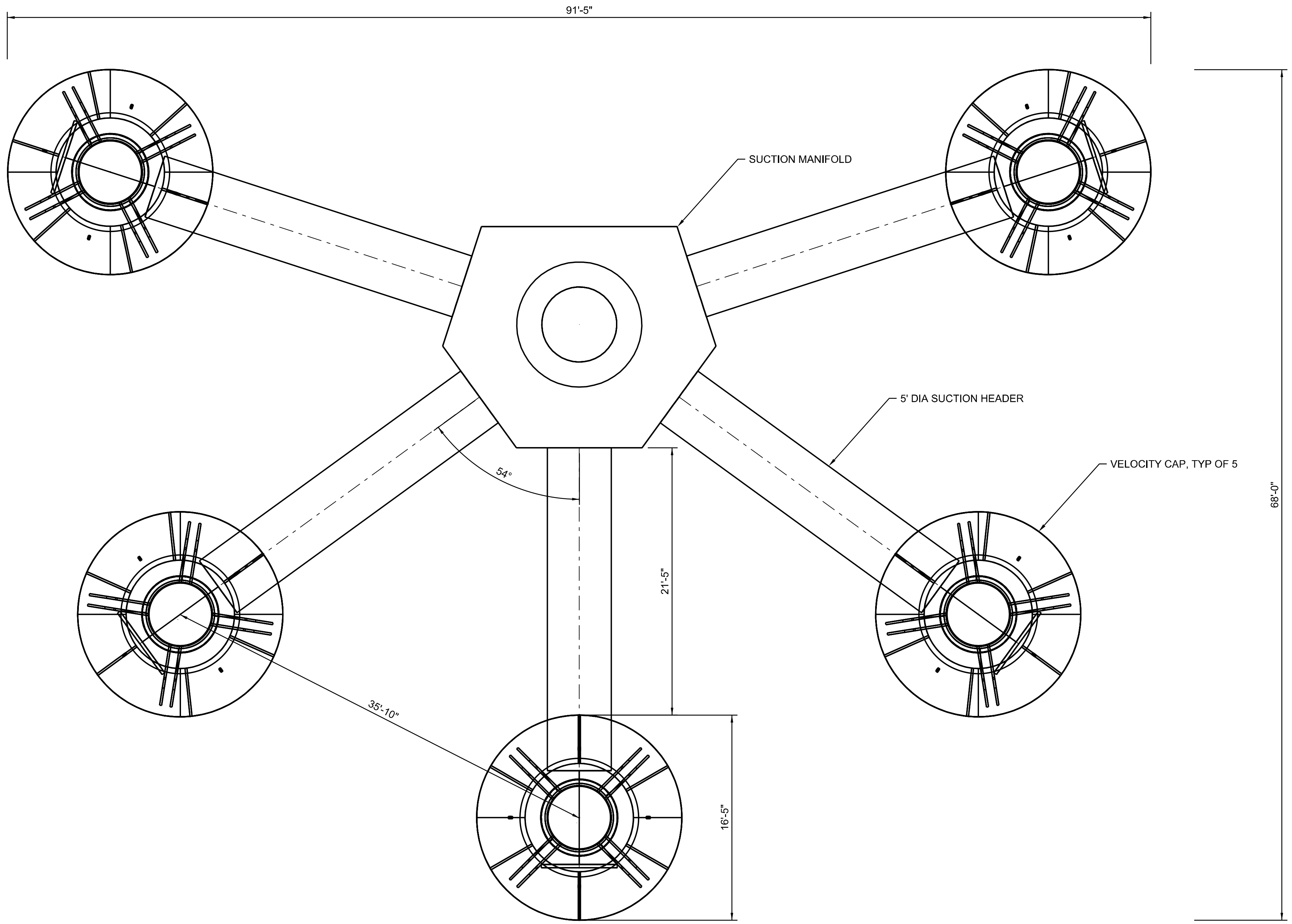

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FIGURE 3
INTAKE AND MANIFOLD PLAN

OCT 2022

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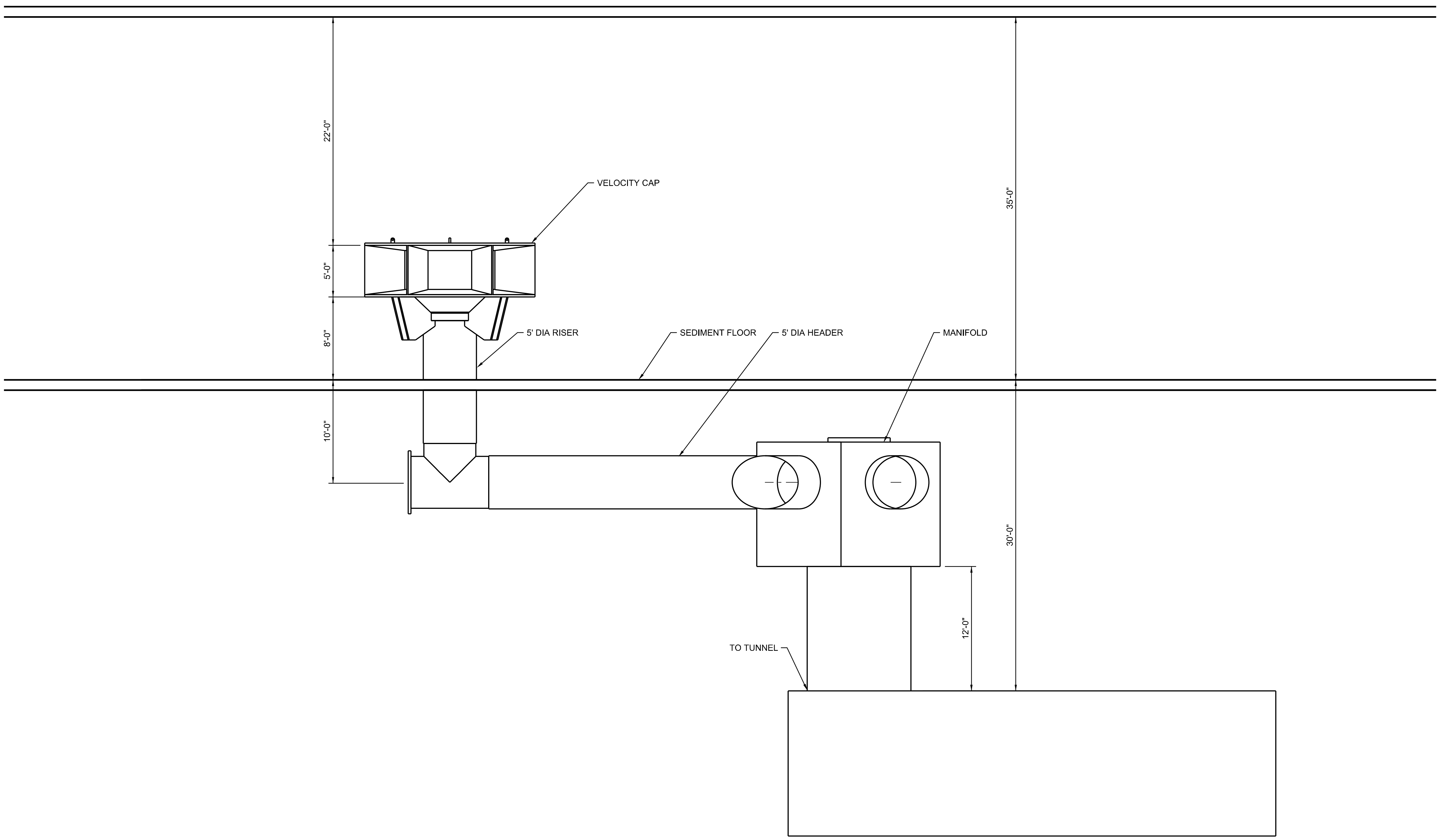

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FIGURE 4

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.

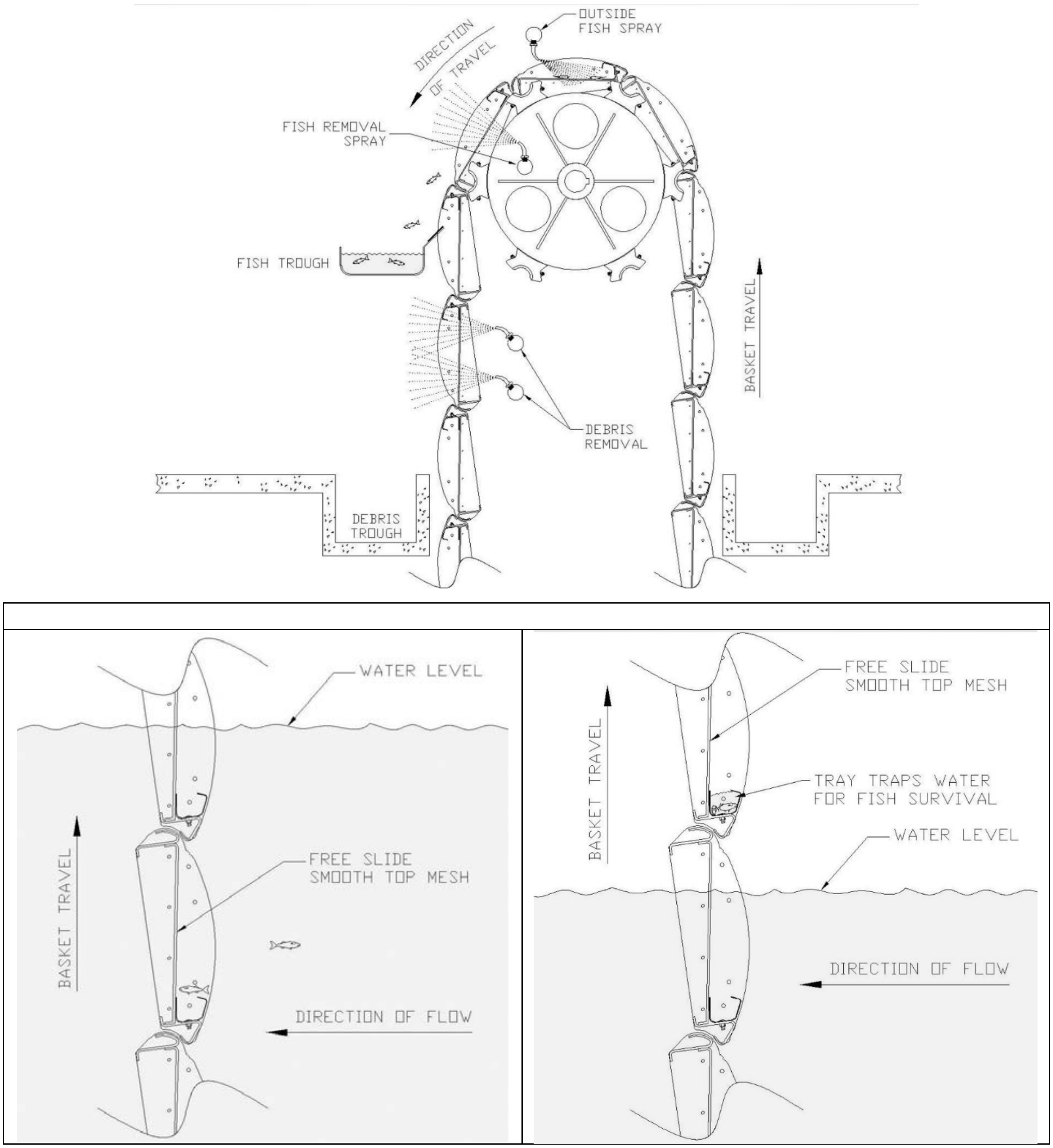

Figure 5. Traveling screen sketch and illustration of fish removal

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.

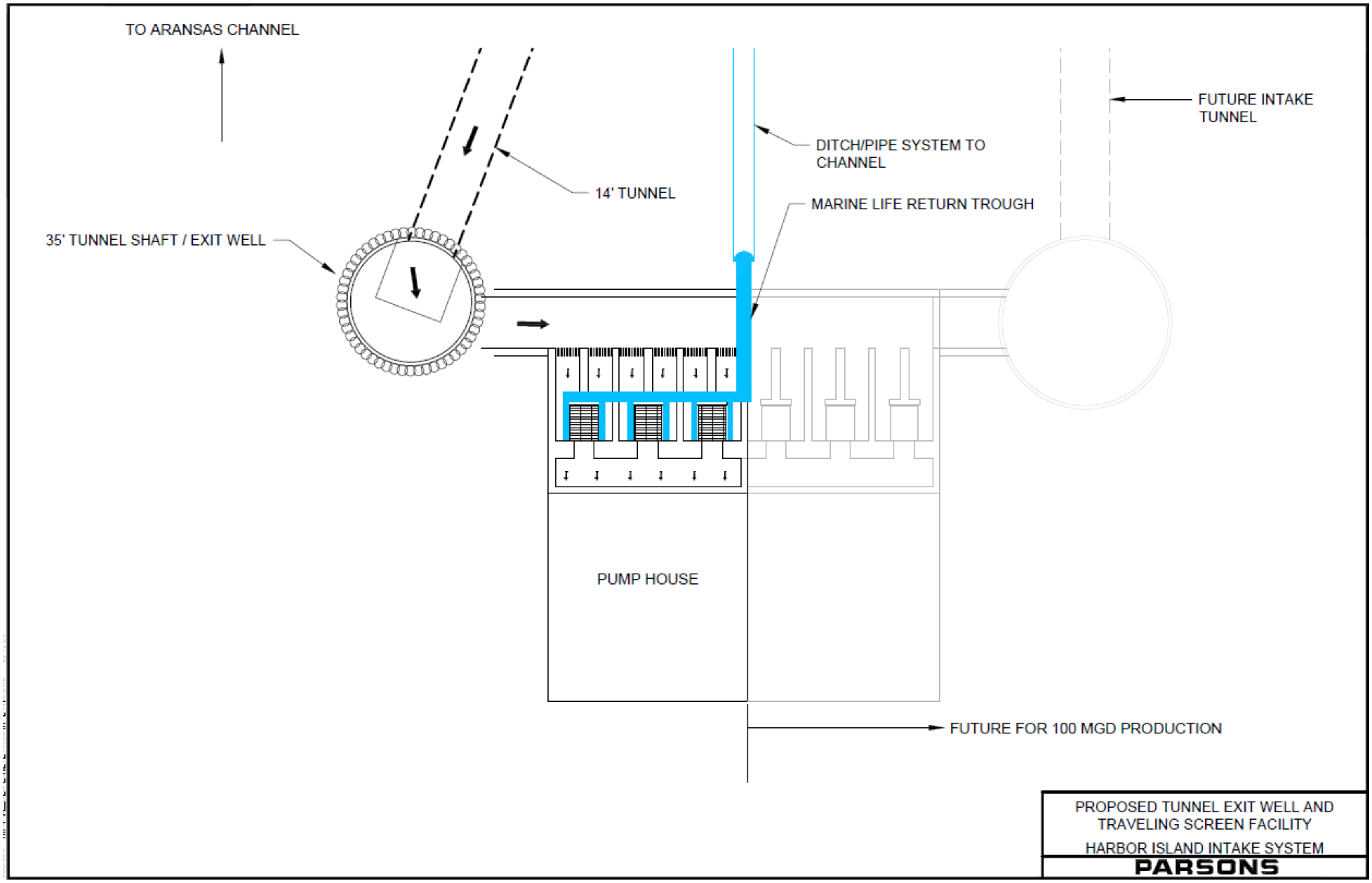

Figure 6a. Plan View of Proposed Marine Life Screening Facility

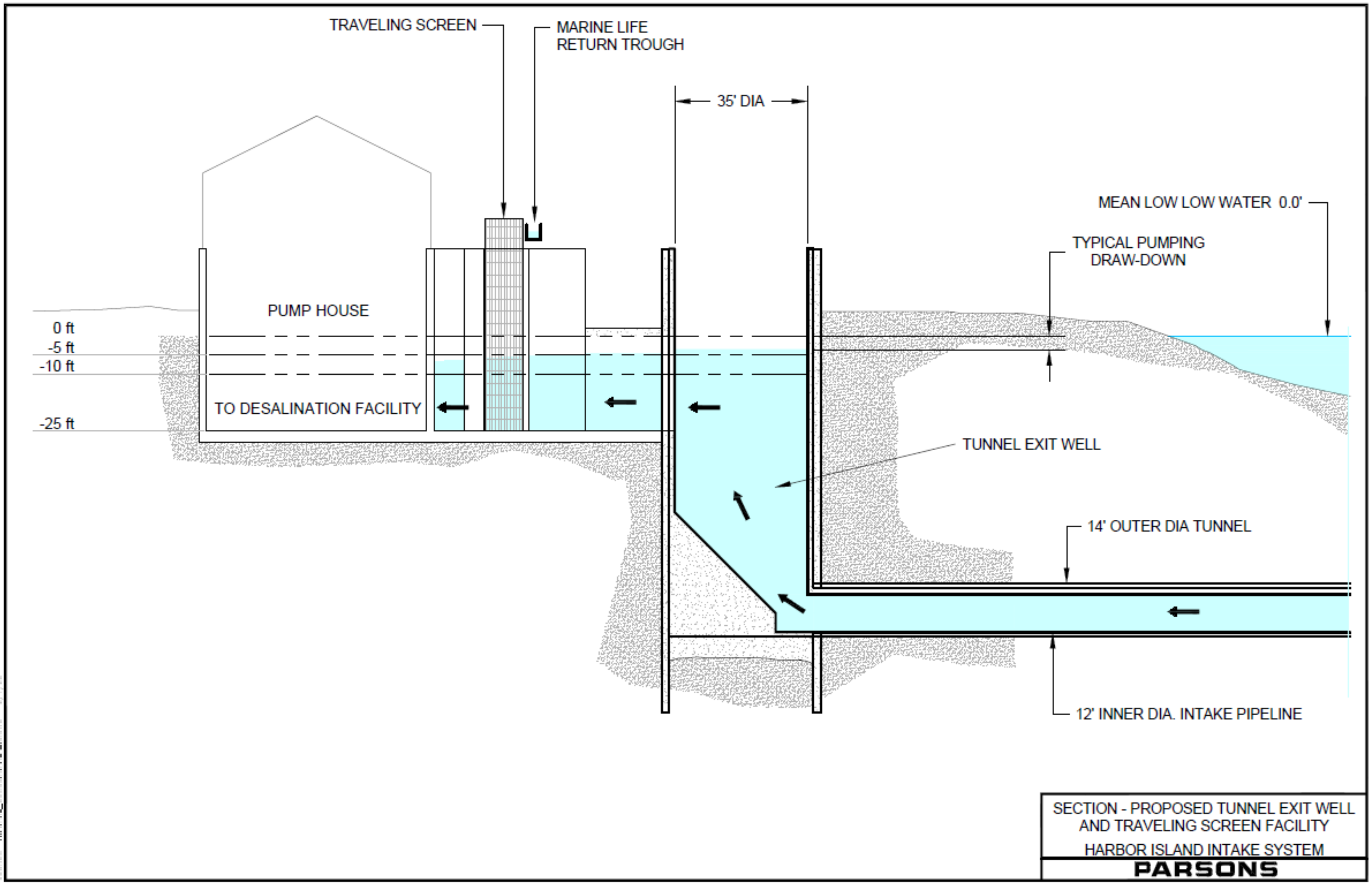

Figure 6b. Cross-Section of Proposed Marine Life Screening Facility

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.

PORT CORPUS CHRISTI

Attachment E
Construction Methods for 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.

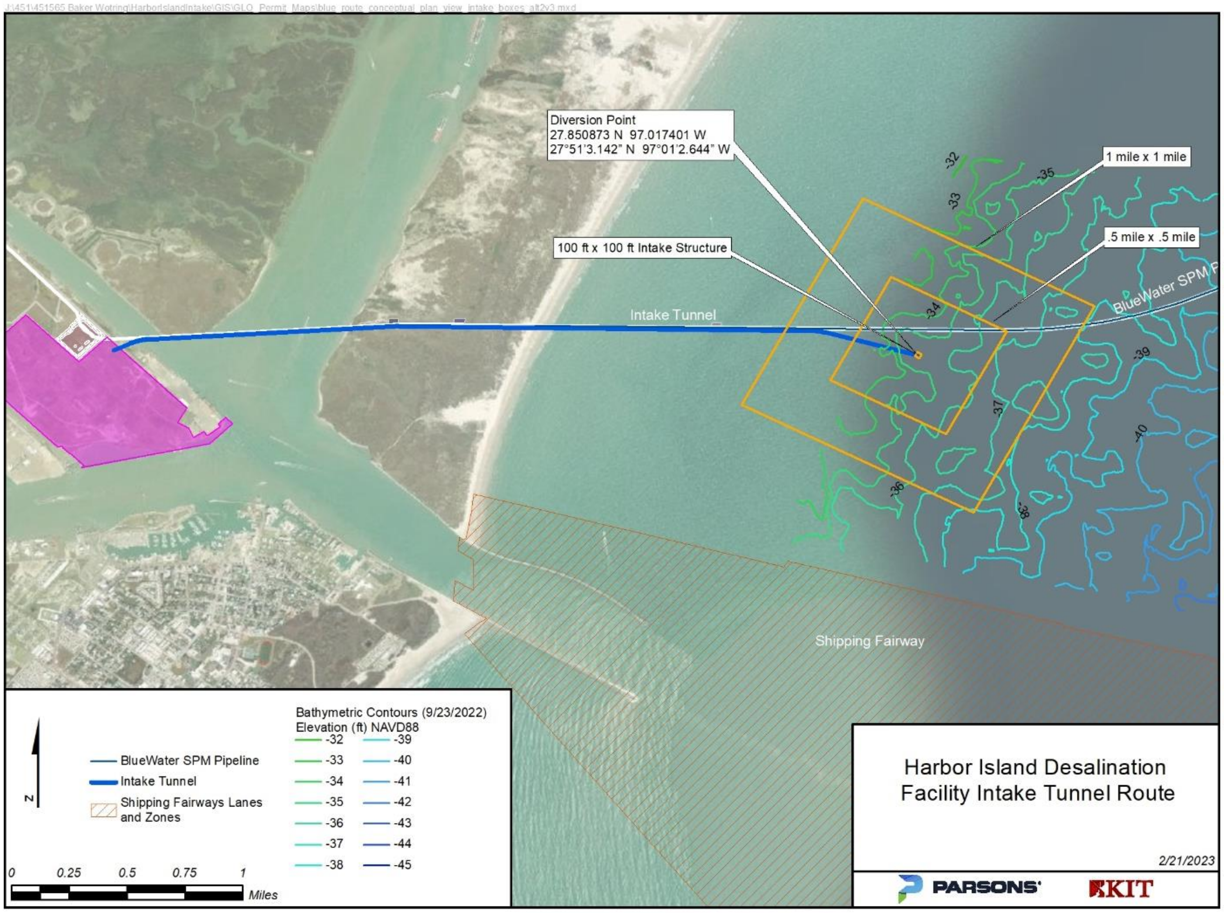

Figure 1. Alignment of Proposed Seawater Intake Tunnel

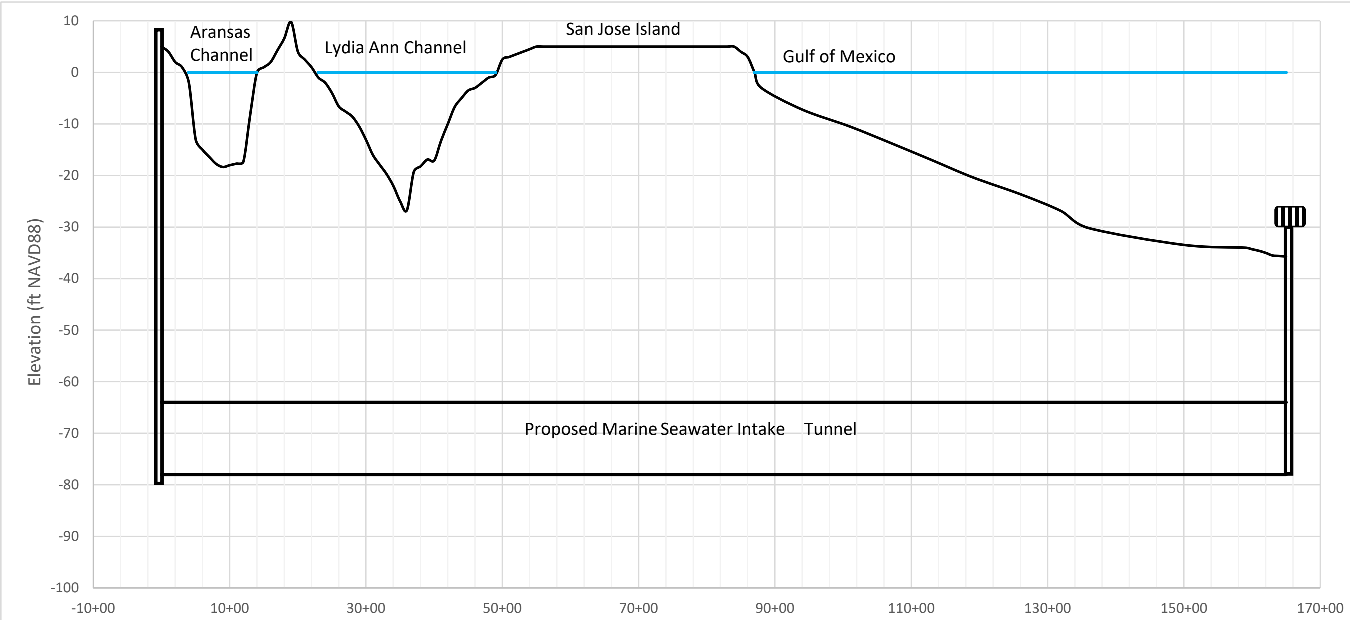

Figure 2. Profile of Proposed Seawater Intake Tunnel

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.

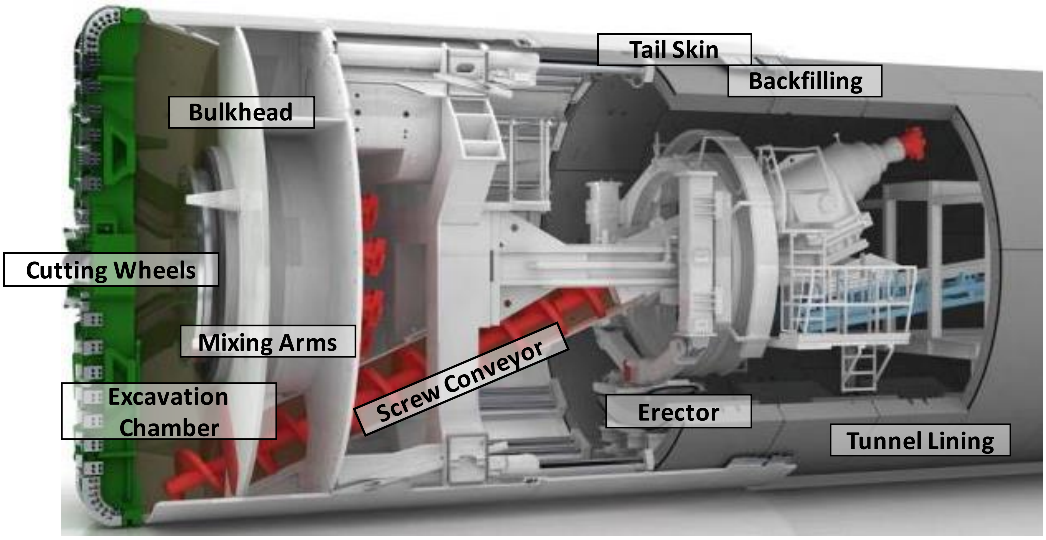

Figure 3. Earth Pressure Balanced (EPB) TBM
(Modified from https://www.herrenknecht.com/en/products/core-products/tunnelling/epb-shield.html)

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.

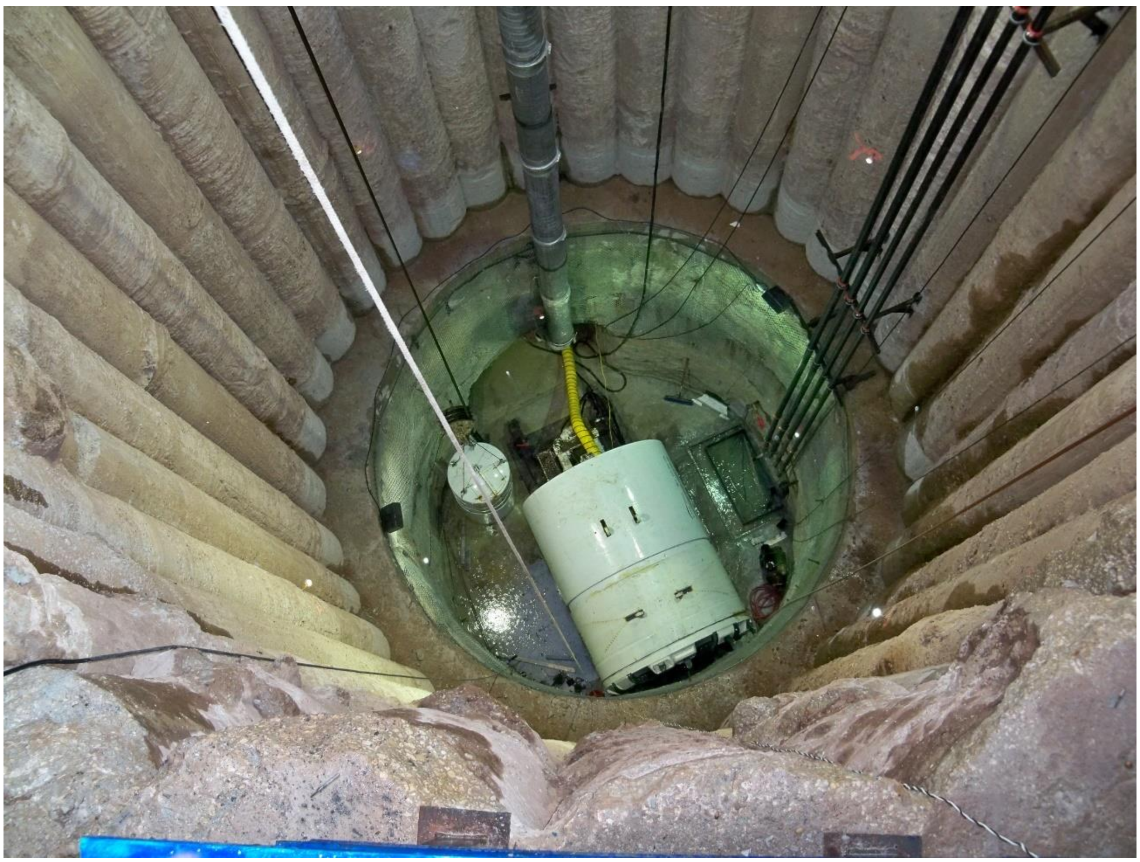

Figure 6. Example of Secant Pile Shaft with 10 ft diameter TBM

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.

PORT CORPUS CHRISTI

Attachment F
Impingement & Entrapment Report

Evaluation of Potential Impingement and Entrainment Associated with the Intake Structure for the Proposed Harbor Island Desalination Facility

Prepared for

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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;

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[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:

$$20{,}854{,}167\ ft^3/d \div 10{,}471{,}633{,}770\ ft^3/d = 0.00199149$$

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]

[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:

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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 approximately 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.

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Figures

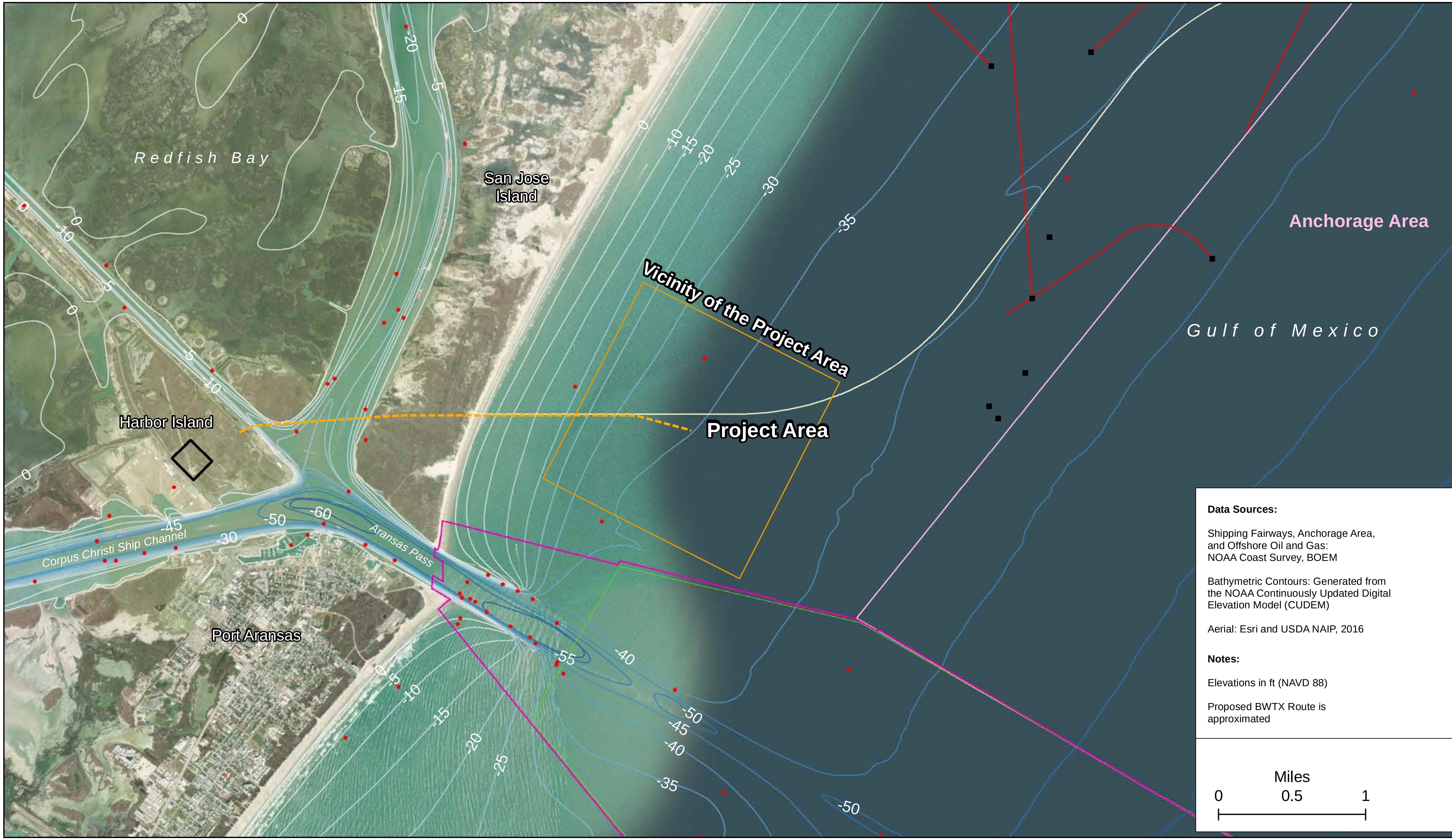

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Figure 1-1
Approximate Locations of the Proposed Desalination Facility, the State Water Intake Structure, and the Intake Tunnel

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

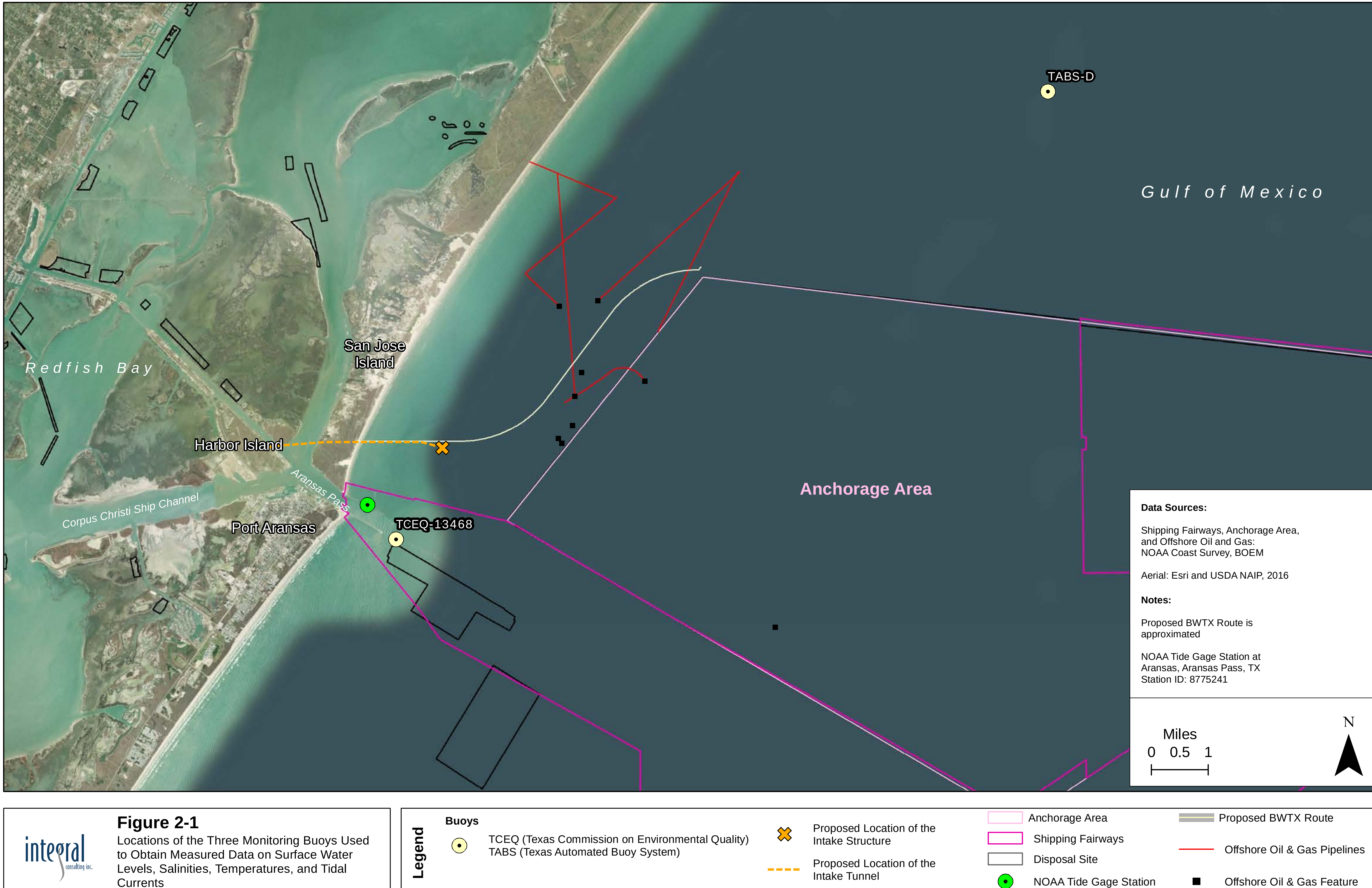

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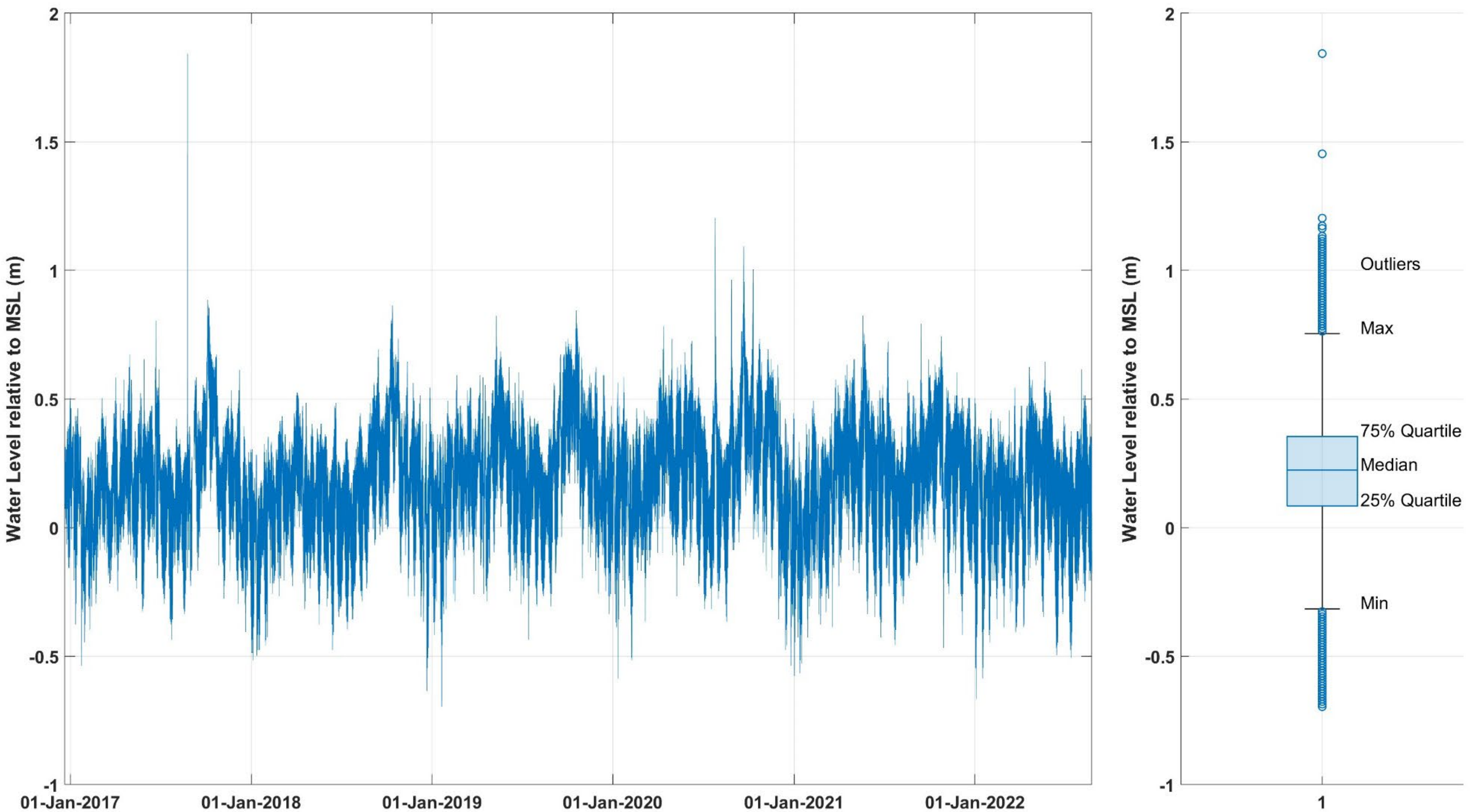
Figure 2-1
Locations of the Three Monitoring Buoys Used to Obtain Measured Data on Surface Water Levels, Salinities, Temperatures, and Tidal Currents



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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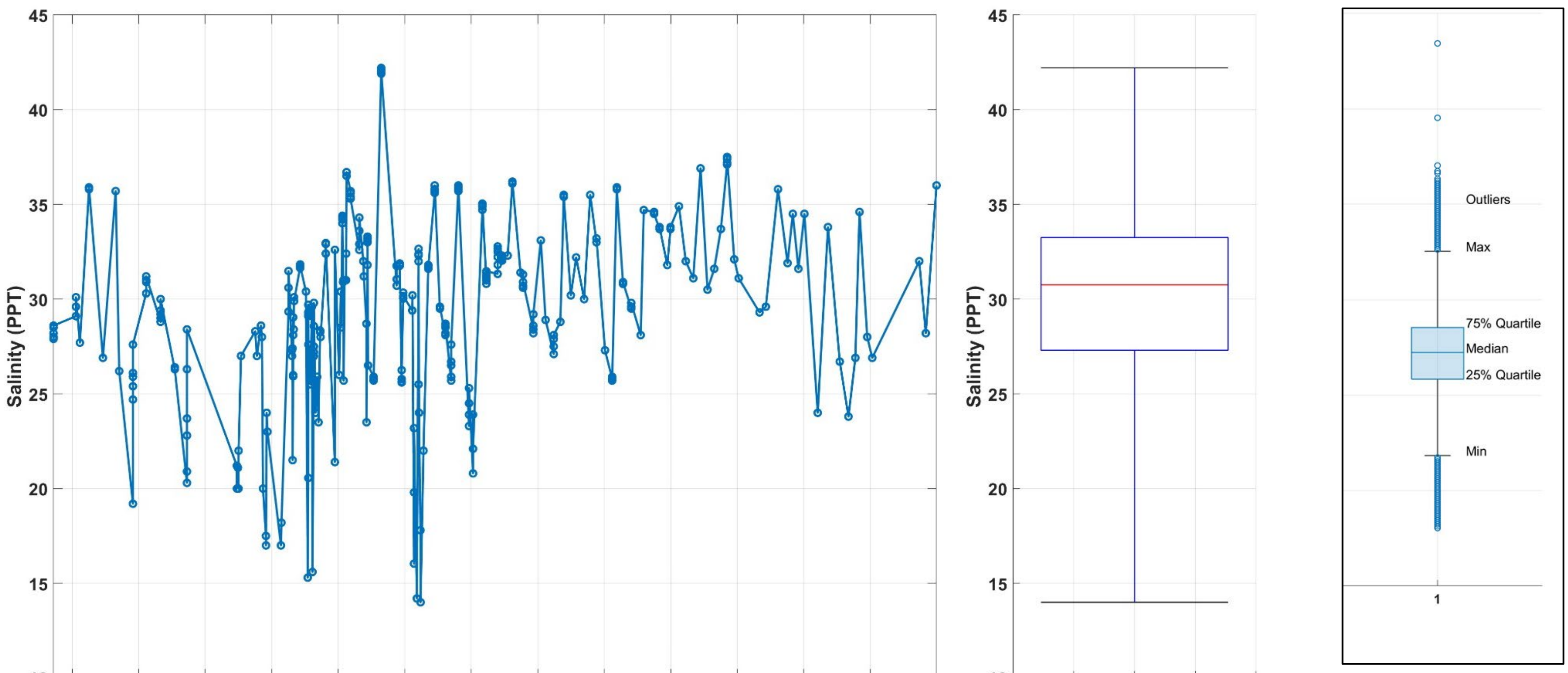
Figure 2-2.
Surface Water Levels Measured in the Gulf of Mexico at Aransas Inlet between 2017 and 2022



Box-chart reference guide

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)

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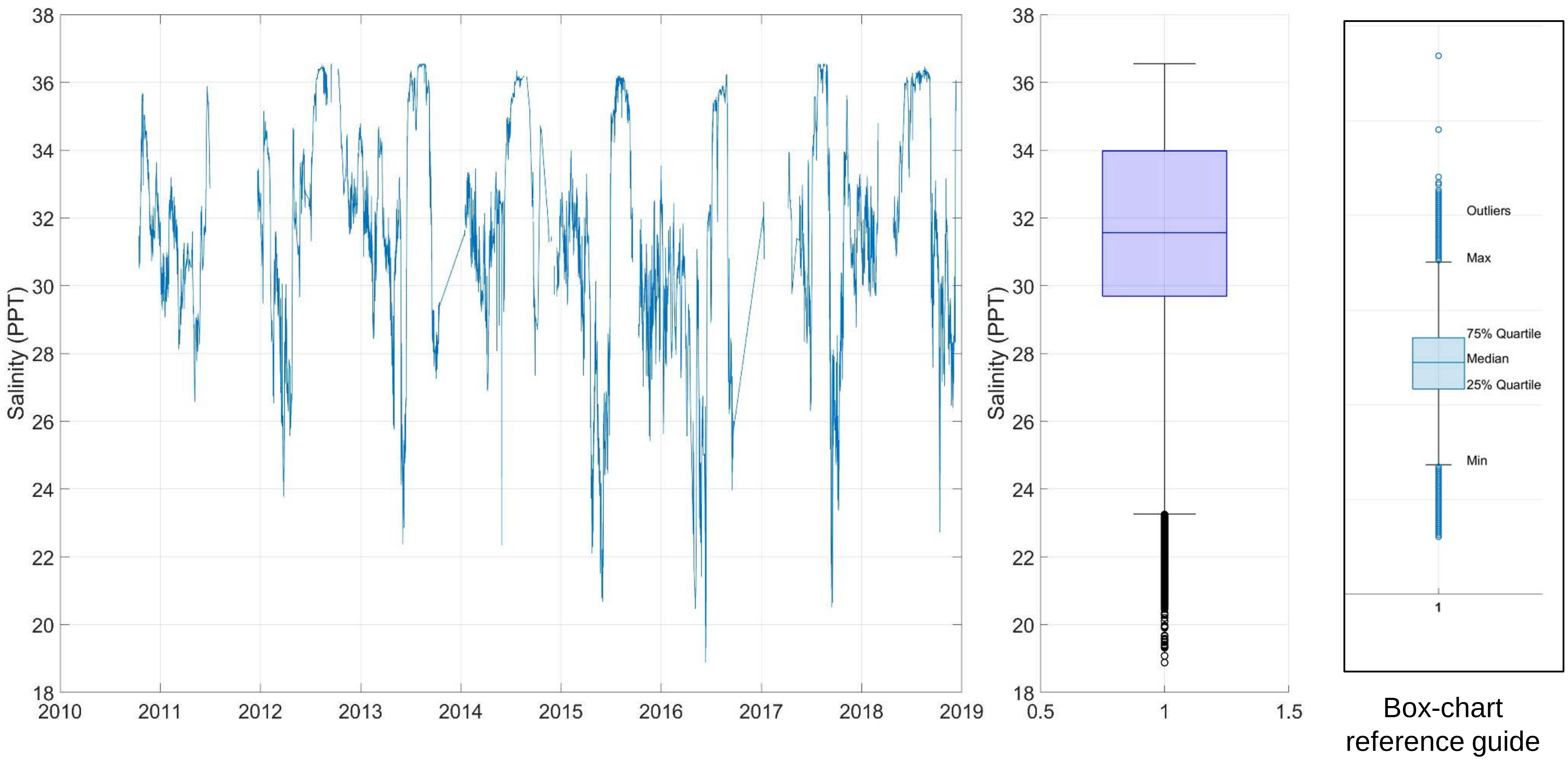
Figure 2-3.
Monthly Variations in the Surface Water Salinities Measured in the Gulf of Mexico at Aransas Inlet between 1989 and 2022



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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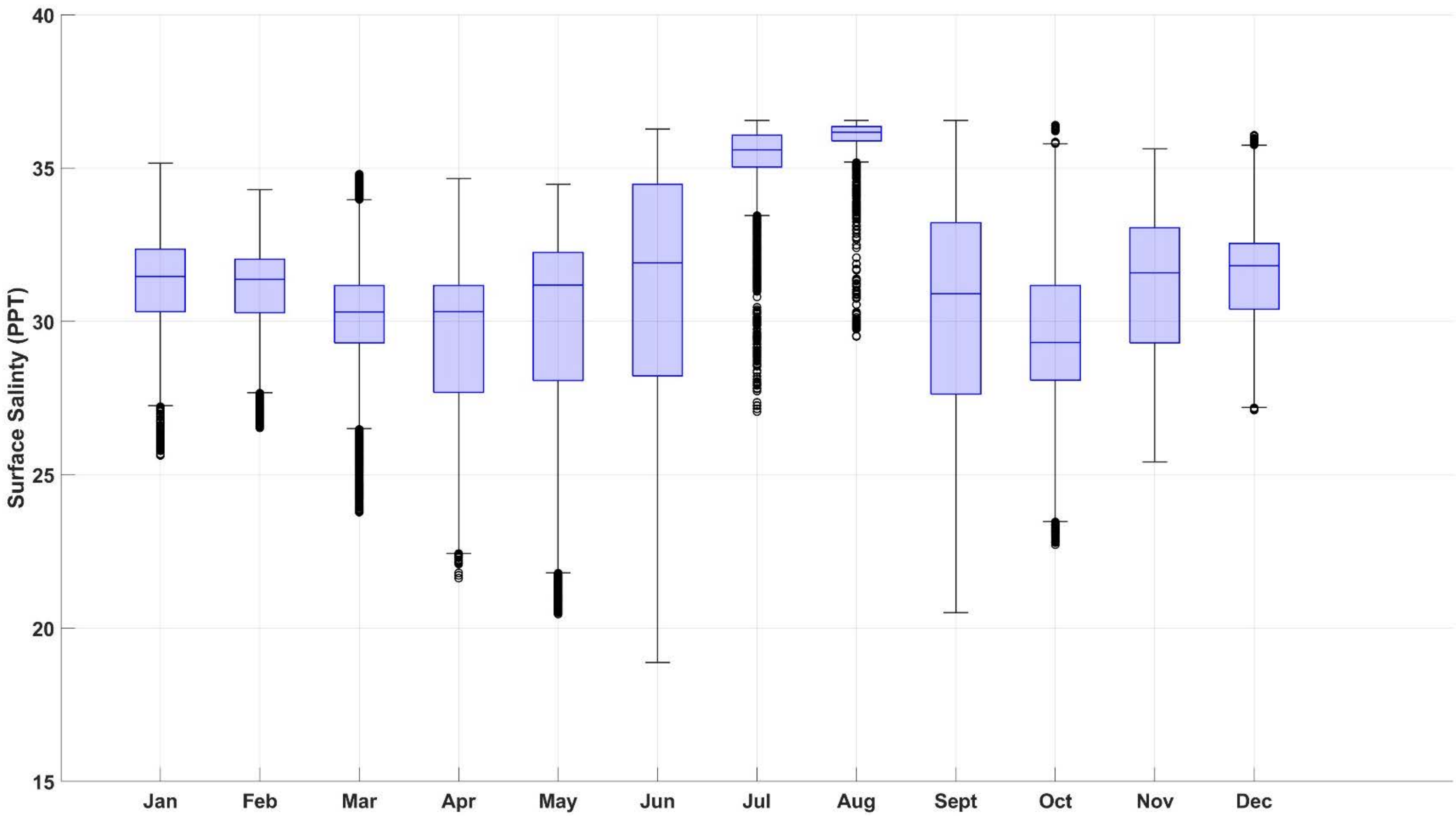
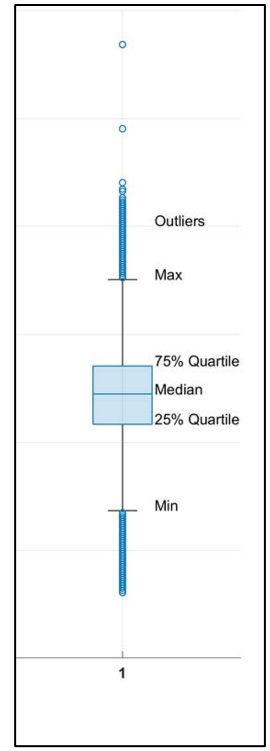
Figure 2-4.
Surface Salinities Measured in the Gulf of Mexico at the TABS Buoy D between 2010 and 2019

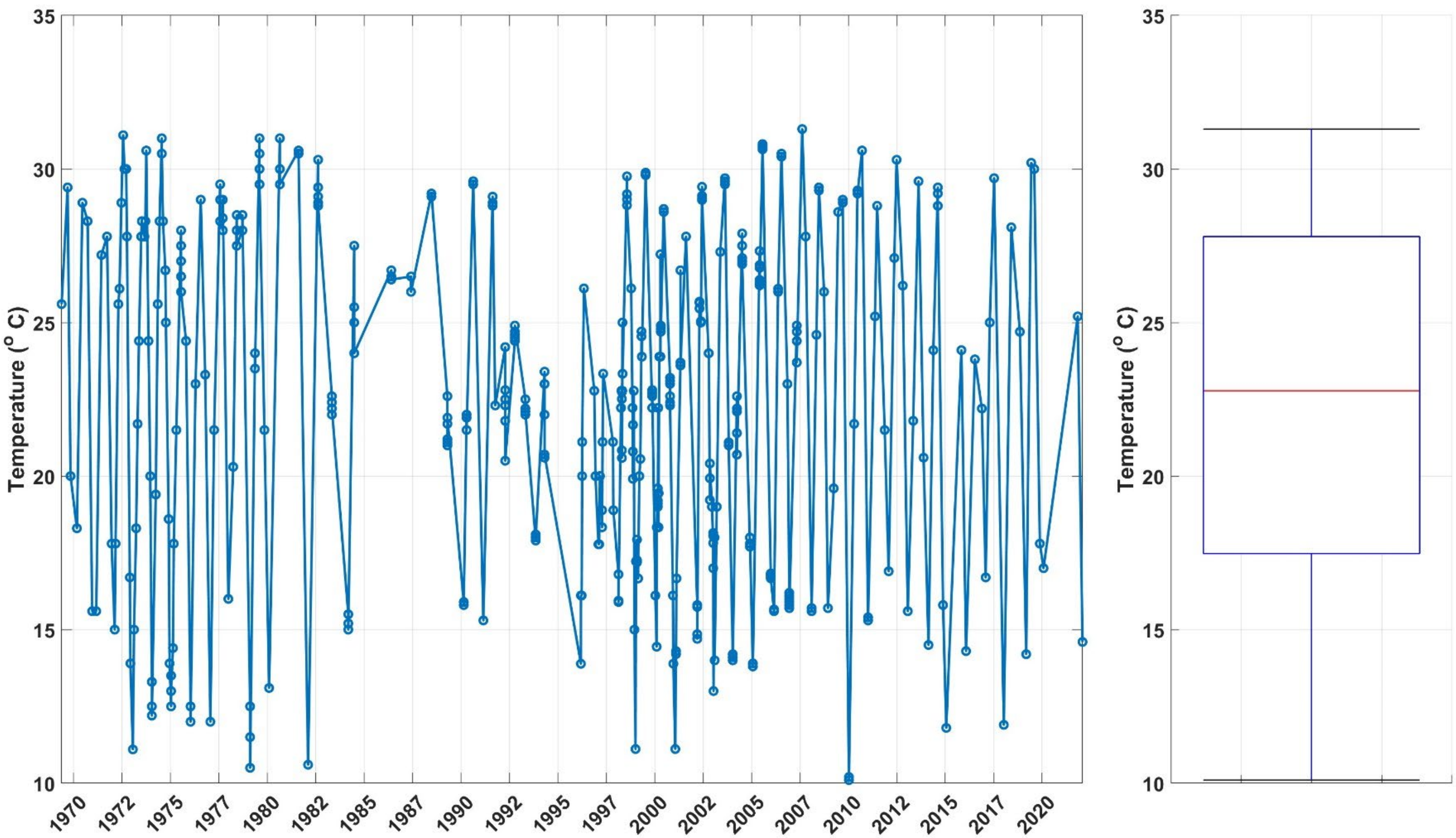


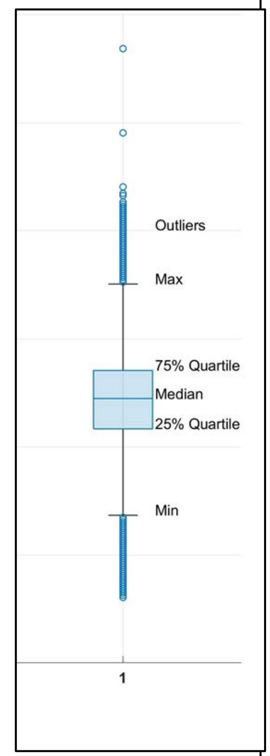


Box-chart reference guide

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.

Figure 2-5.
Range of Monthly Surface Salinities Measured in the Gulf of Mexico at TABS buoy D between 2011 and 2019





Box-chart reference guide

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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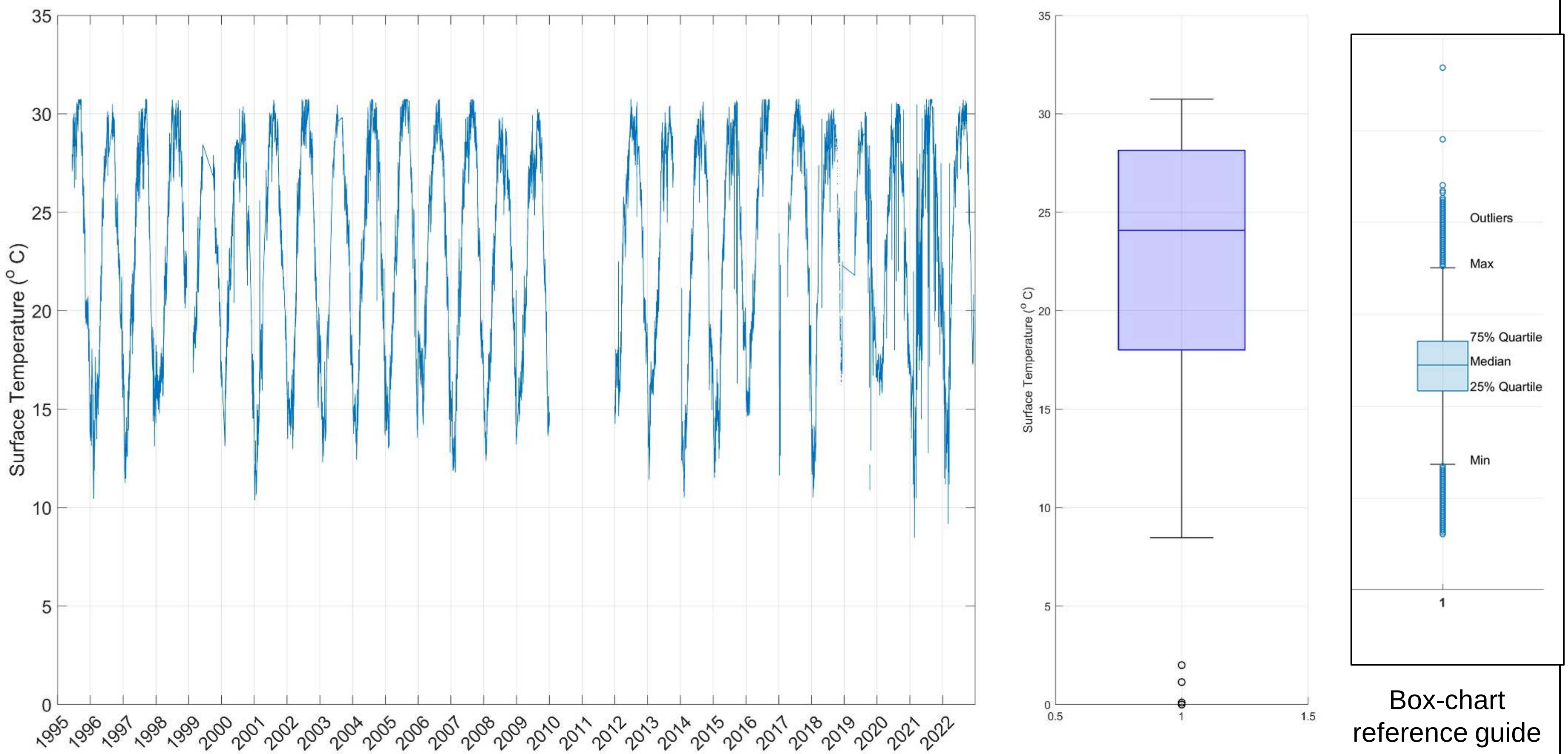
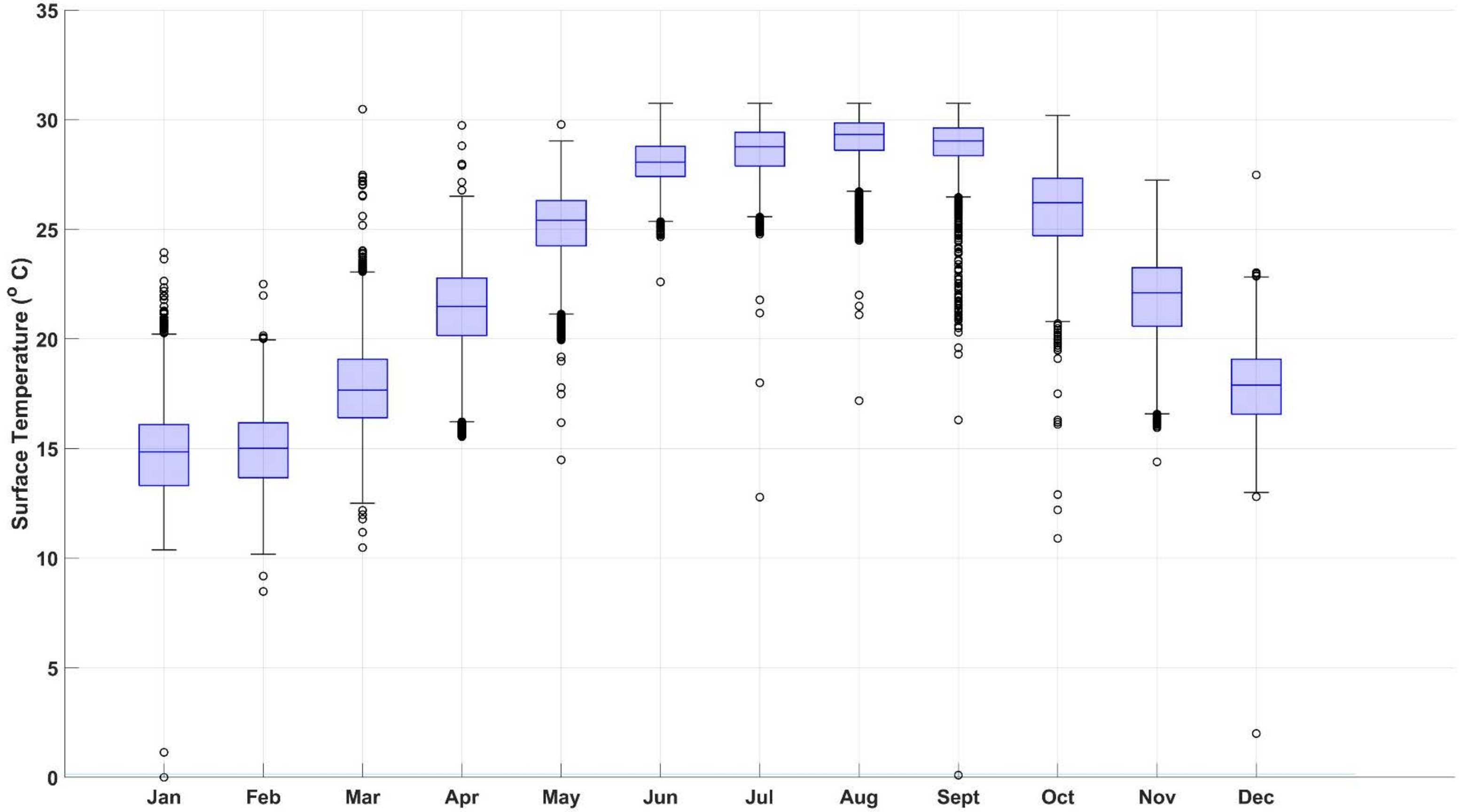
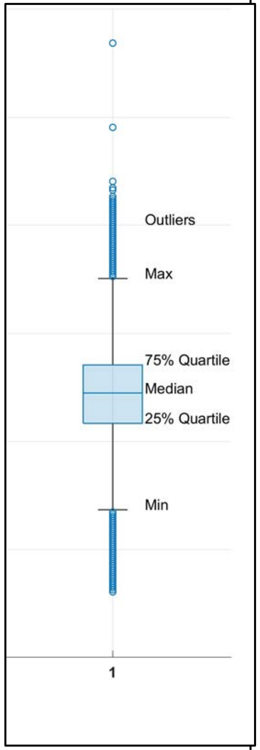
Figure 2-6.
Monthly Variations in Surface Water Temperatures Measured in the Gulf of Mexico at Aransas Inlet between 1989 and 2022



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.

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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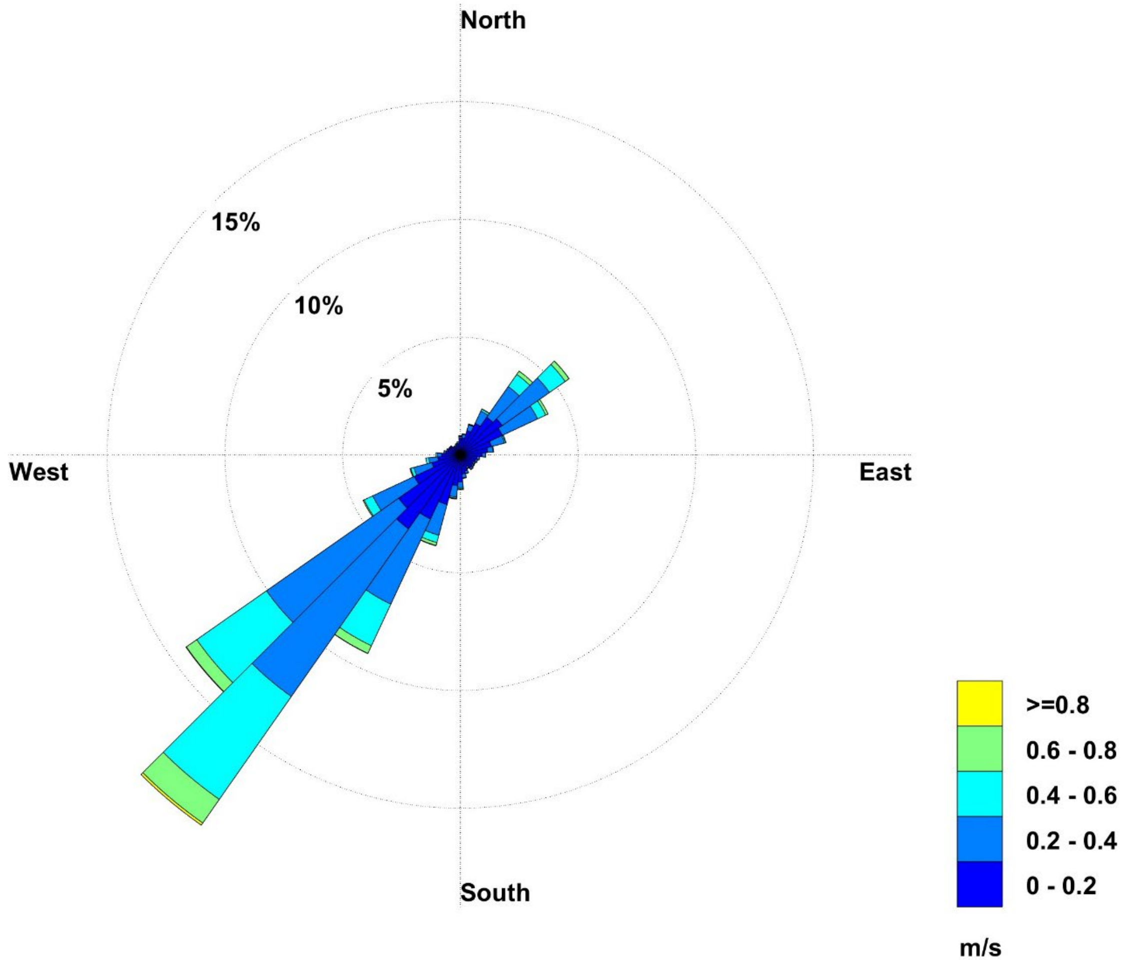
Figure 2-8.
Range of Monthly Surface Temperatures Measured in the Gulf of Mexico at TABS Buoy D between 2011 and 2019



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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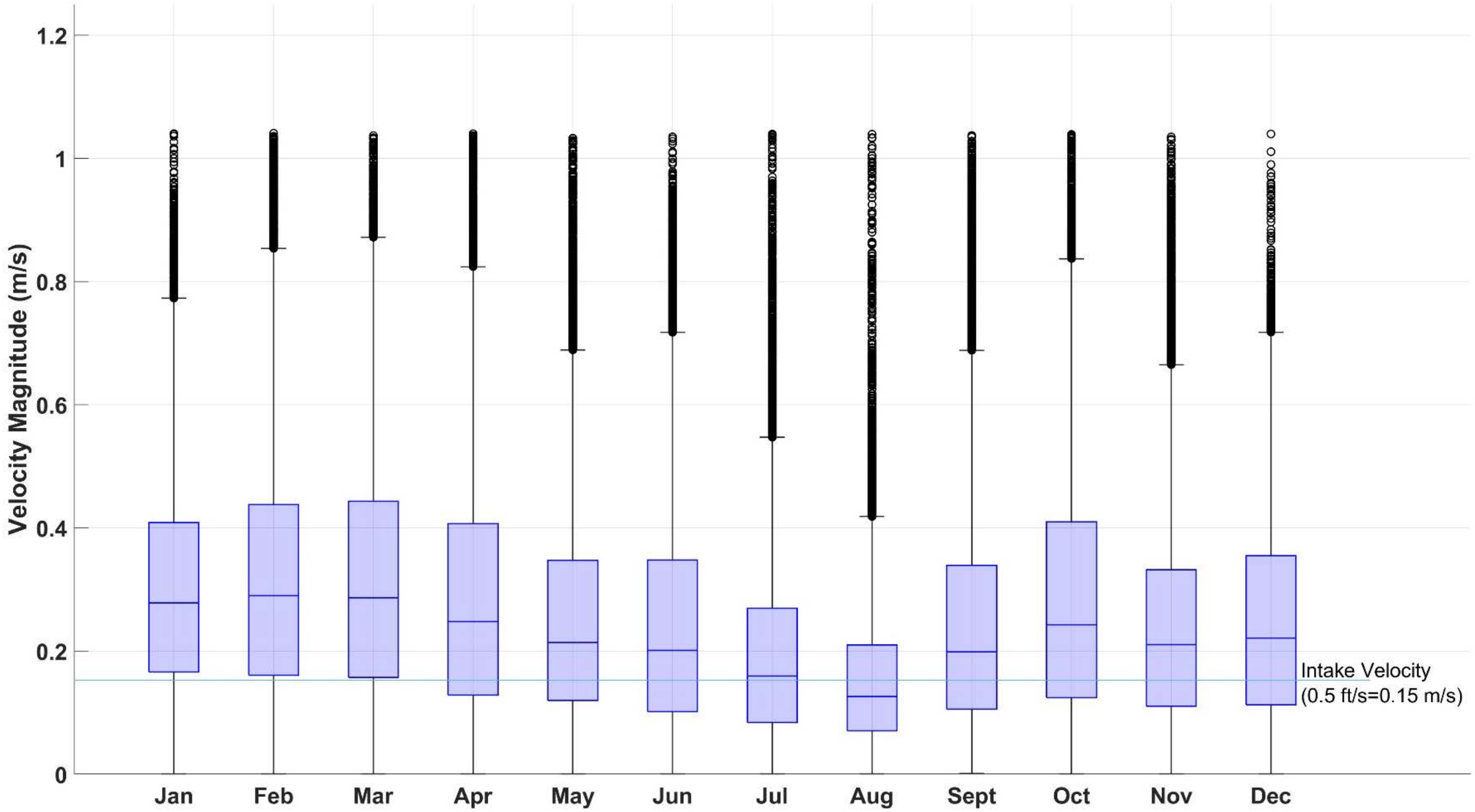
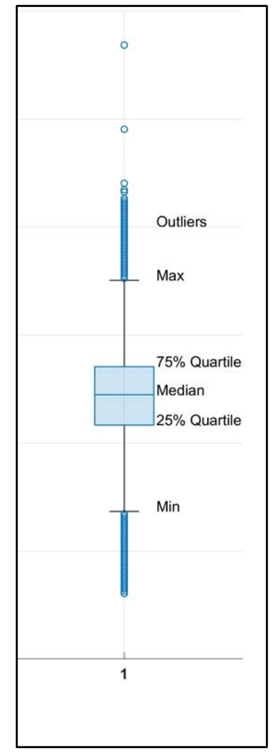
Figure 2-9.
Velocity Rose Showing Variations in the Speed, Magnitude, and Flow Direction of the Tidal Currents Measured in the Gulf of Mexico at the TABS-D Buoy over a 27-year Period





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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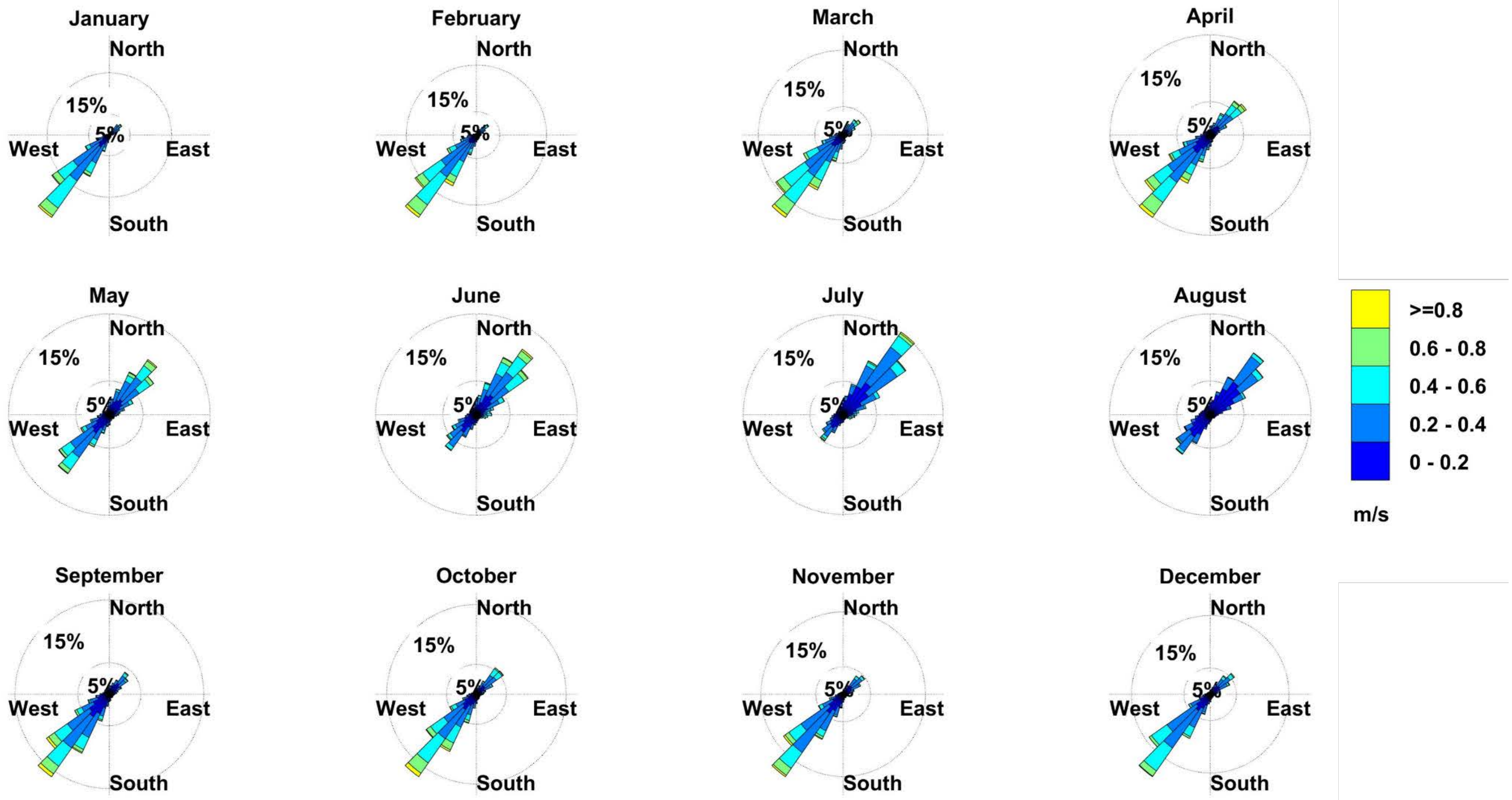
Figure 2-10.
Range of Monthly Velocity Magnitudes Measured in the Gulf of Mexico at TABS Buoy D over a 27-year period



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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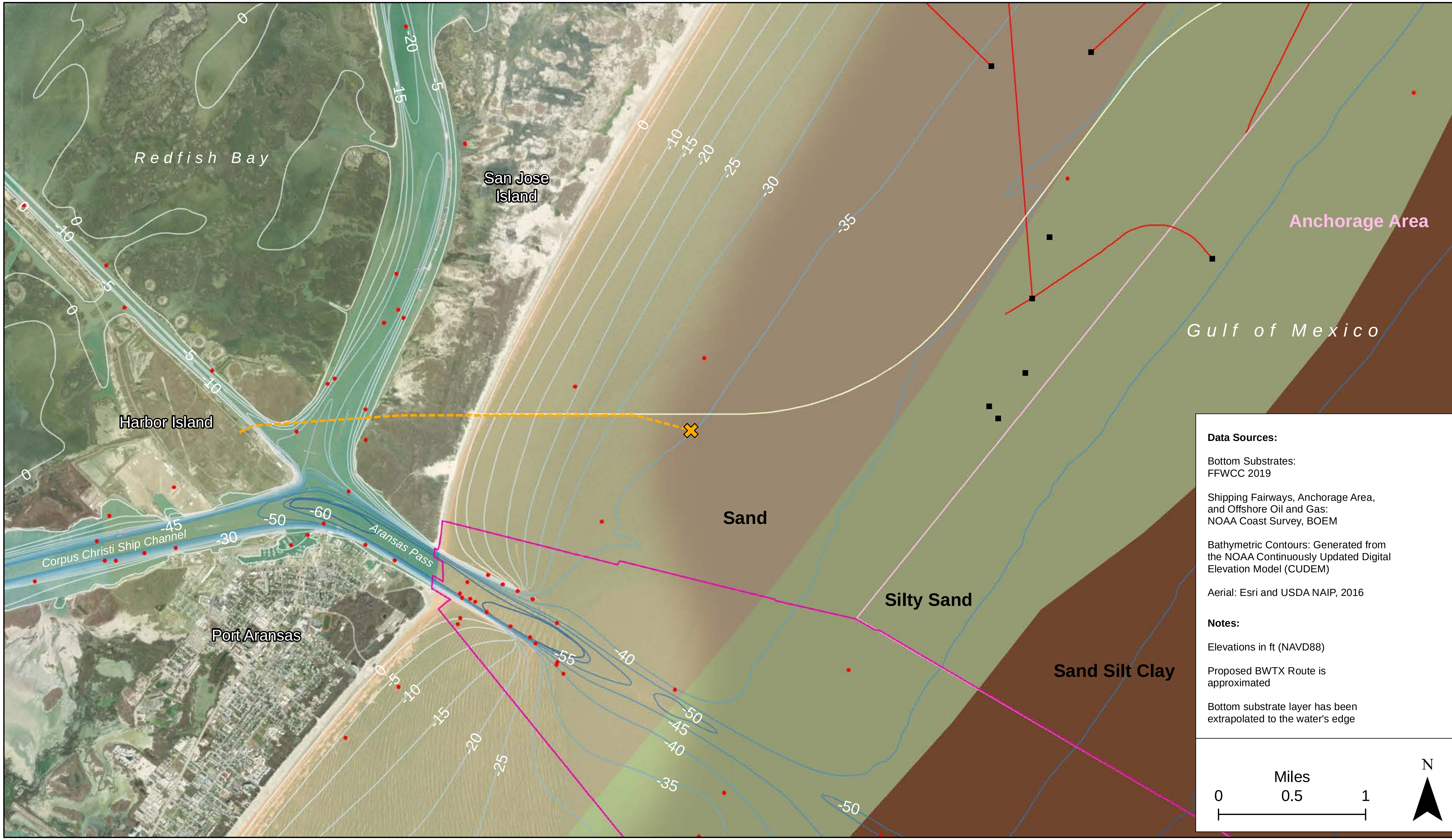
Figure 2-11.
Monthly variations in the Speed, Magnitude, and Direction of the Tidal Currents Measured in the Gulf of Mexico at the TABS-D Buoy over a 27-year period



Data Sources:

Bottom Substrates:
FFWCC 2019

Shipping Fairways, Anchorage Area, and Offshore Oil and Gas:
NOAA Coast Survey, BOEM

Bathymetric Contours: Generated from the NOAA Continuously Updated Digital Elevation Model (CUDEM)

Aerial: Esri and USDA NAIP, 2016

Notes:

Elevations in ft (NAVD88)

Proposed BWTX Route is approximated

Bottom substrate layer has been extrapolated to the water's edge

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Figure 2-12
General Substrate Composition in the Gulf of Mexico Outside of the Aransas Inlet

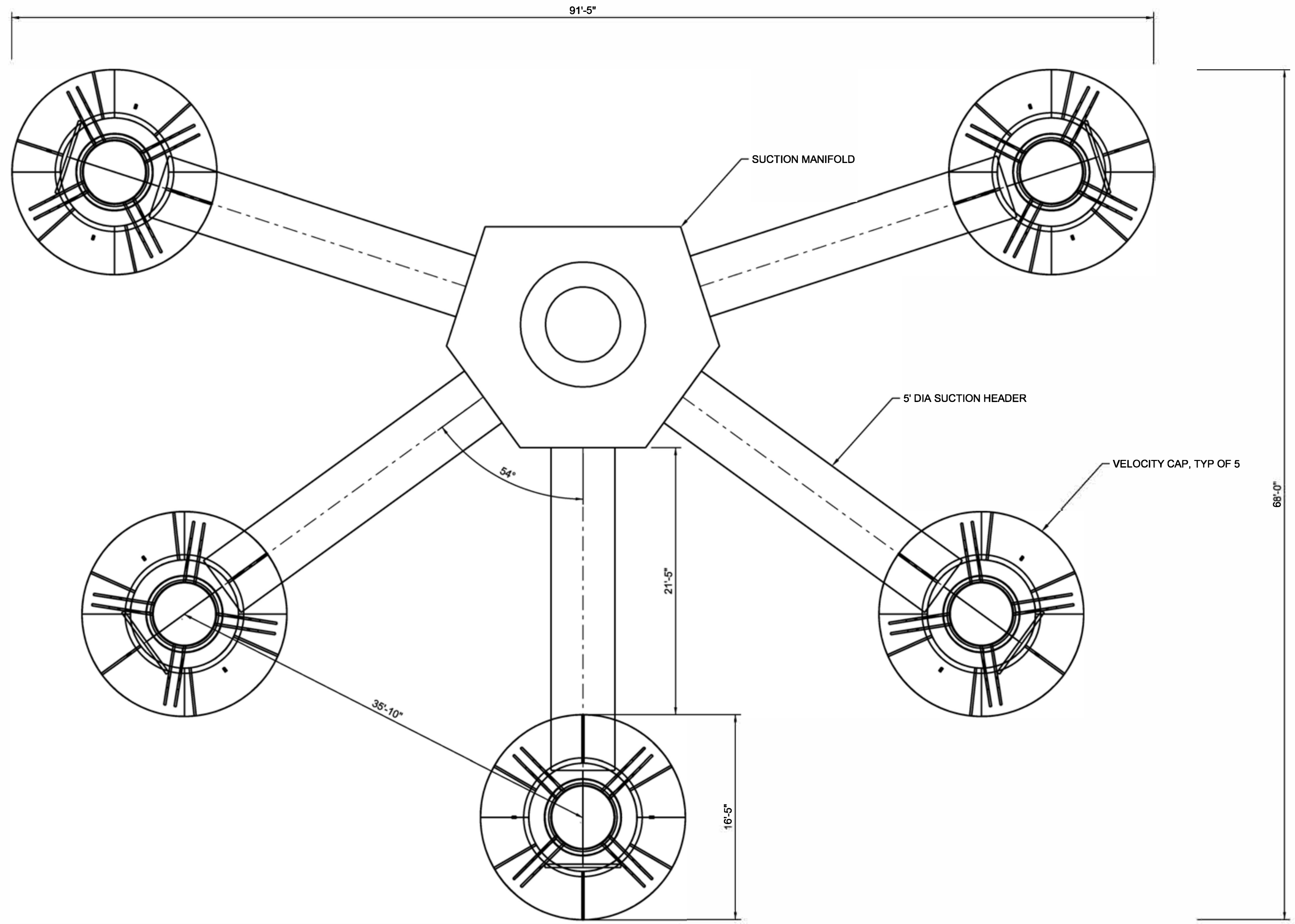
Legend

Bottom Substrate Classification

- Sand
- Sand Silt Clay
- Silty Sand
- 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

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

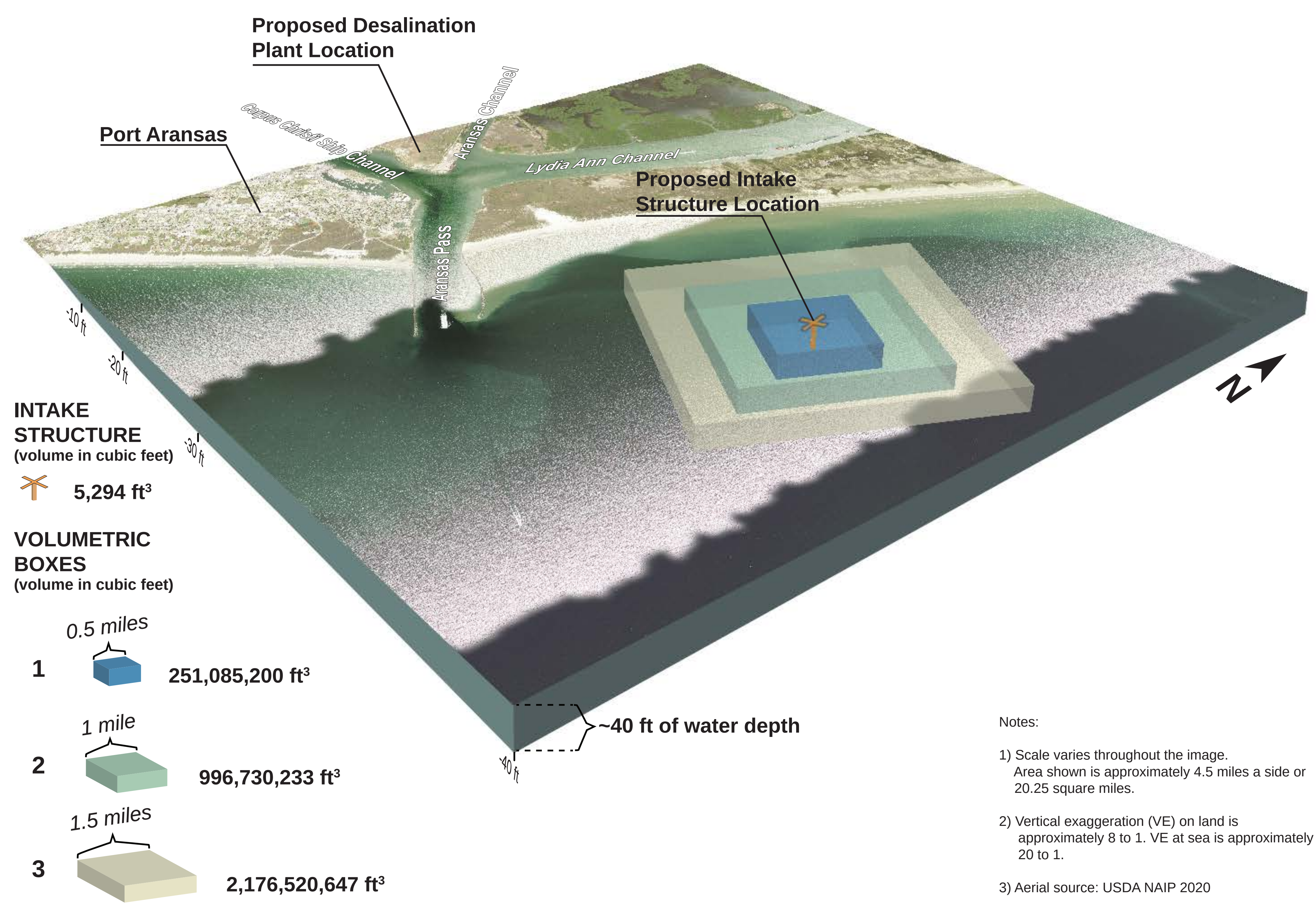

Figure 3-2.
Location of the Proposed State Water Intake Structure with the Three Volumetric Boxes

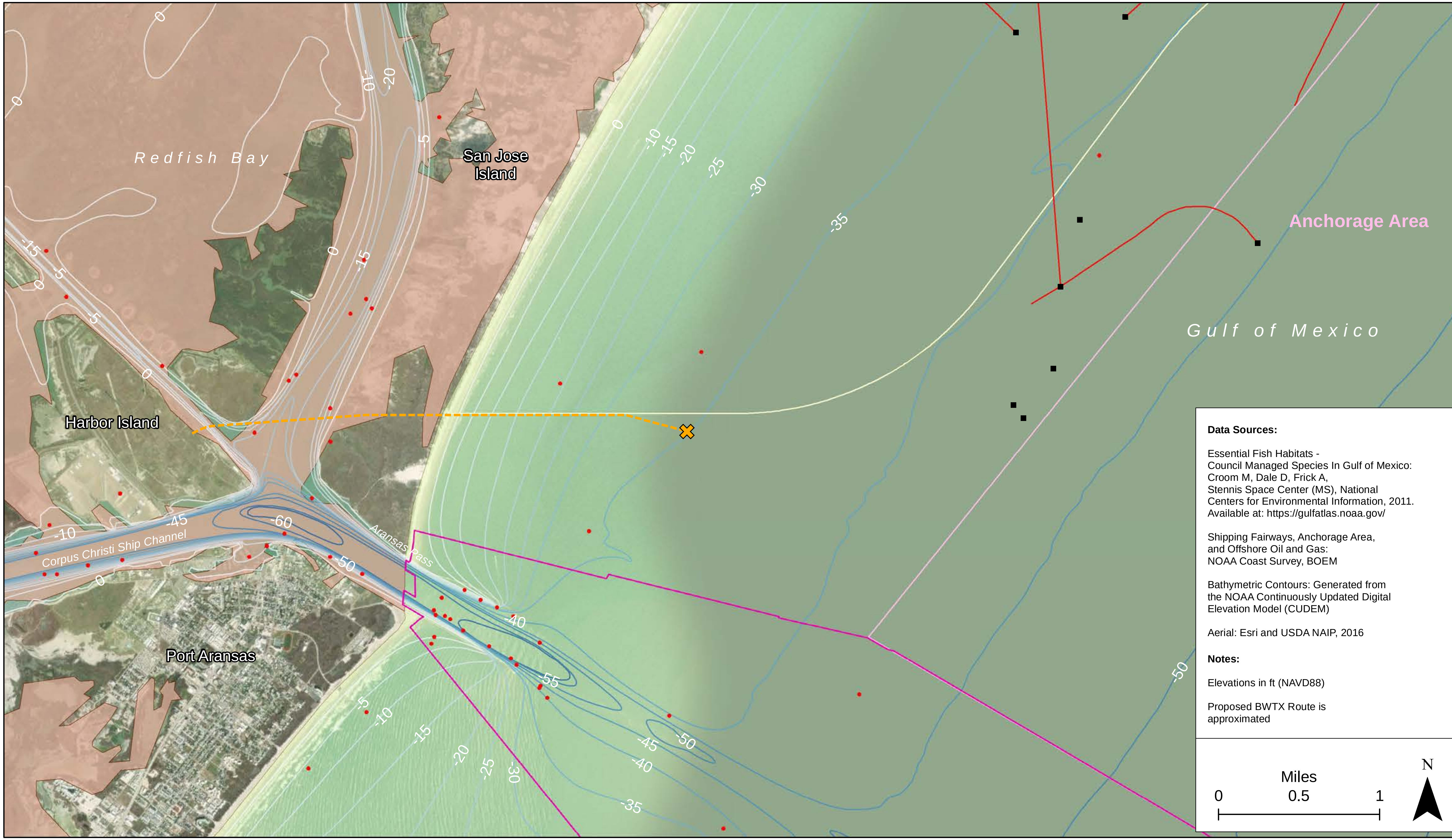

Figure 4-1
Essential Fish Habitat, Harbor Island Desalination Facility, Port Aransas, TX

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

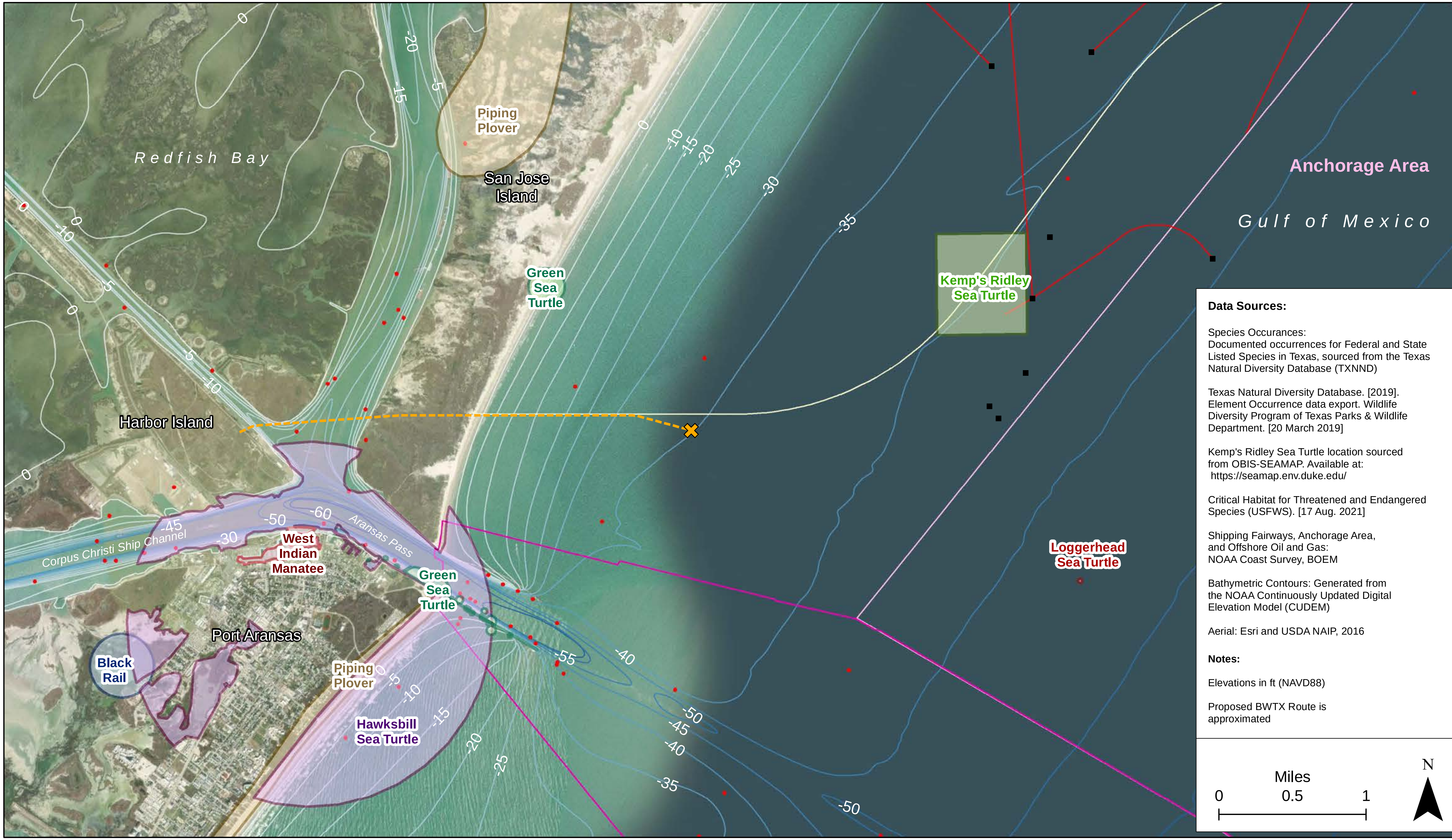

Figure 4-2
Reported Presence of Threatened and Endangered Marine Species, Harbor Island Desalination Plant, Port Aransas, TX

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 Ichthyoplankton Density[a] (organisms/ft^3)	Estimated Number of Ichthyoplankton in Intake Structure and Volumetric Boxes[b]			
			Volumetrix Boxes		
		Intake Structure	1	2	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

		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
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 ≥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 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.

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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]	

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
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]	

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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

ALERT: This email came from an external source. Do not open attachments or click on links in unknown or unexpected emails.

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

[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:

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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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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

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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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