

**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.

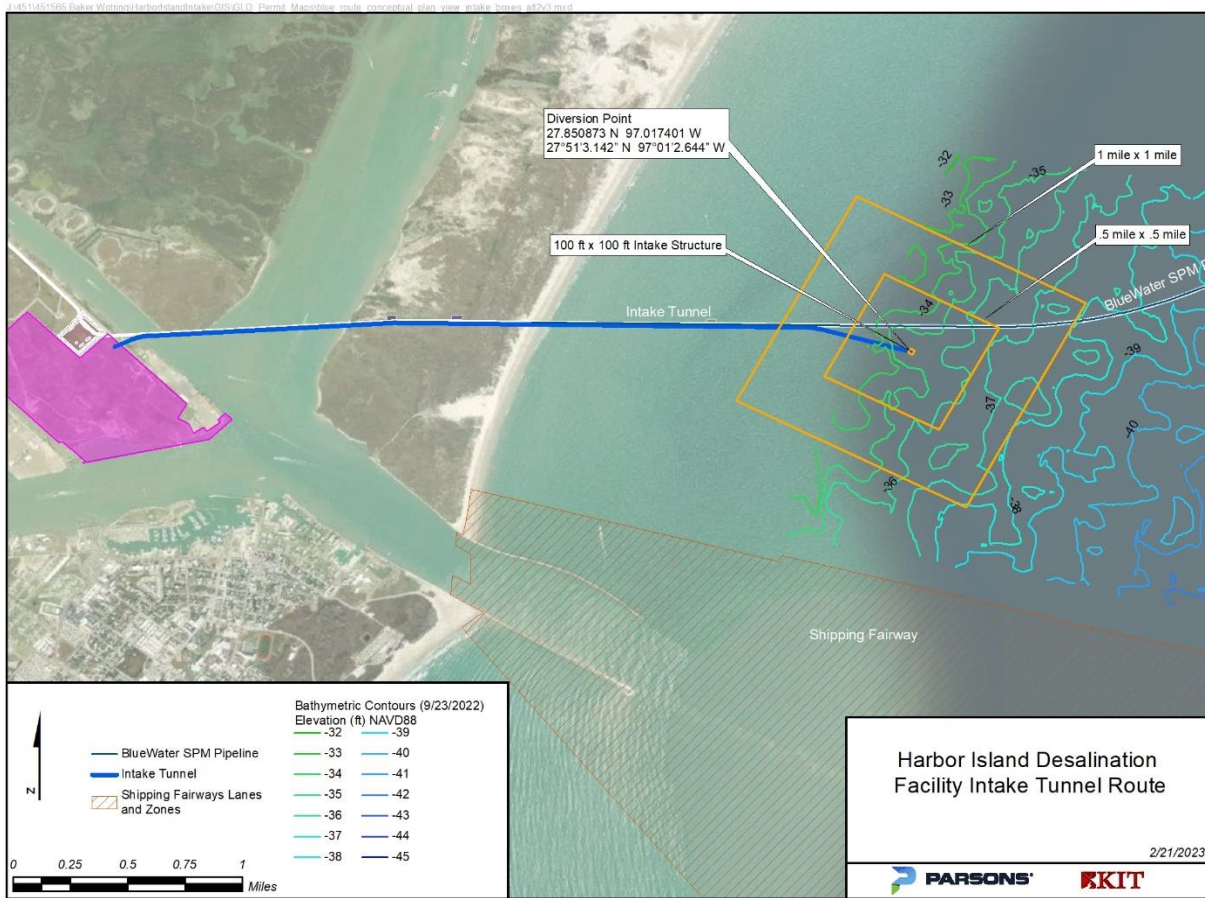


Figure 1a. Proposed Intake Location and Tunnel Route

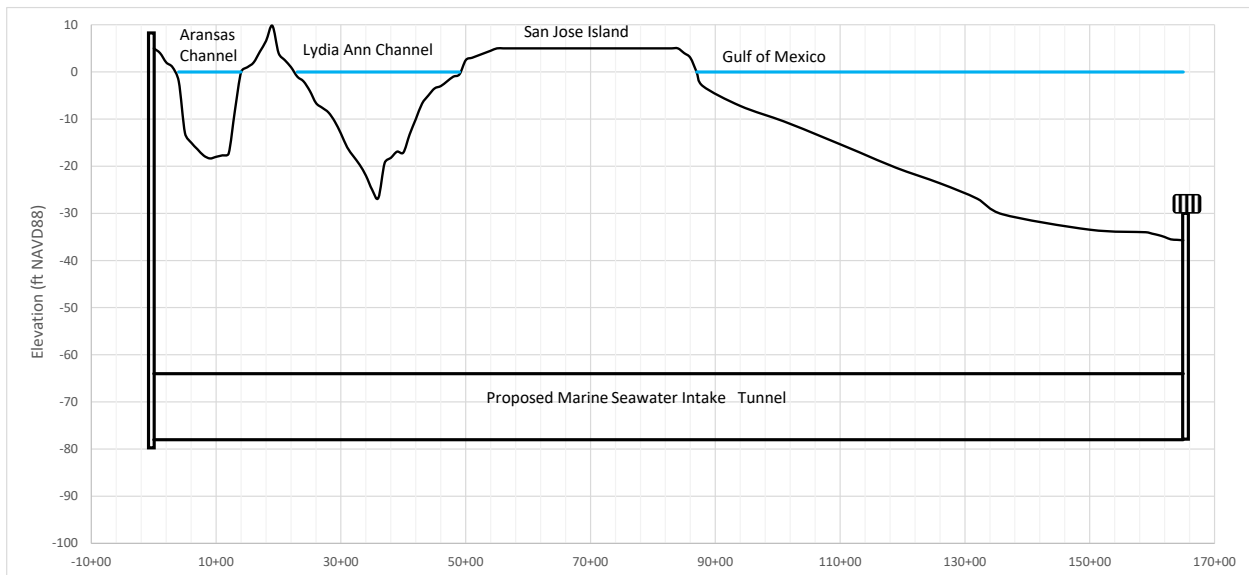


Figure 1b. Profile of Proposed Seawater Intake Tunnel

4.2 Seawater Intake Structure

For an initial production of 50 mgd, the intake structure will have a manifold arrangement with approximately four to five branches¹ to the velocity caps. All the branches will be evenly spread approximately 30 ft apart to obtain even flow distribution without interference from each other. The intake opening will be approximately 5 to 10 ft above the sea bed to minimize the potential for sediments or benthic organisms to be drawn into the intake structure. The velocity cap opening will be designed to have ≤ 0.5 ft/sec entrance velocity to reduce the intake of fish and other marine organisms into the intake and mitigate impingement. Figure 2 shows the typical structure of a single velocity cap. Figures 3 and 4 show the plan and section of the velocity cap array, respectively. It is anticipated that all intake piping will be placed underground with only the velocity caps and a riser pipe above the sea bed. The riser pipes from each velocity cap tie-in to a common discharge box and convey water flow to Harbor Island through a large-diameter gravity tunnel as explained in Section 4.3.

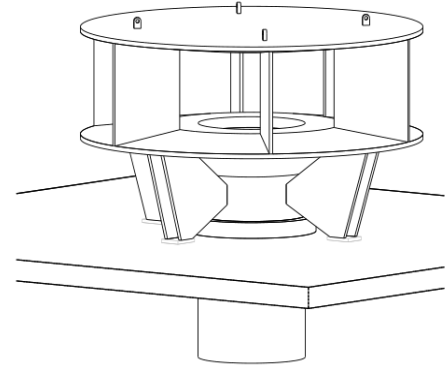


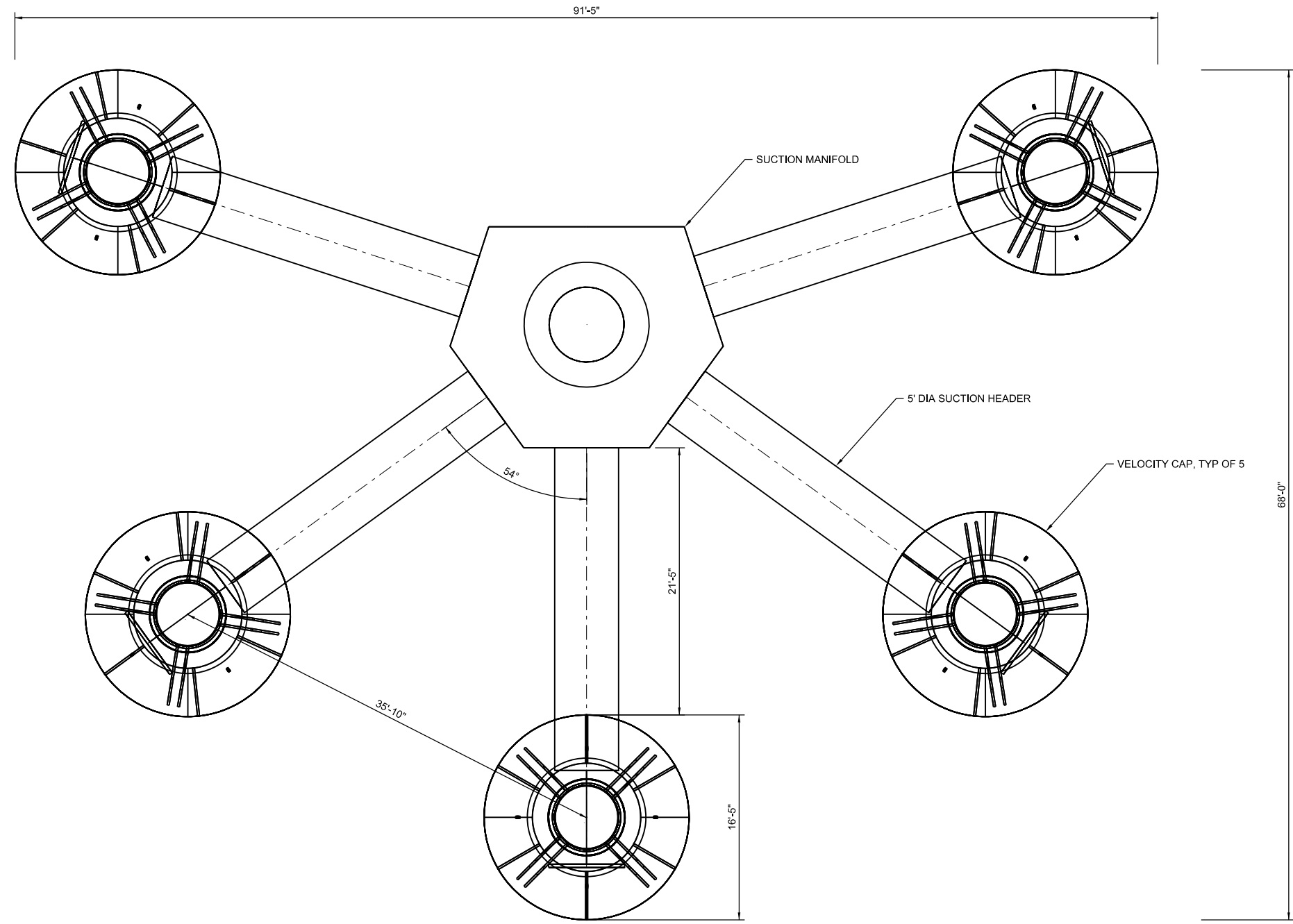
Figure 2. Velocity Cap

For the potential expansion that would increase the intake capacity to 312 mgd, a second manifold structure would be constructed in parallel. Having two intake structures each of approximately 156 mgd capacity will provide redundancy and make maintenance more efficient.

¹ The number, size, and spacing of velocity caps may be adjusted to meet the design velocity requirement and prevent flow interference. The final design will be based on manufacturer's specifications and recommendations.

GENERAL NOTES

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



PLAN
3/16"=1'-0"

WARNING
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

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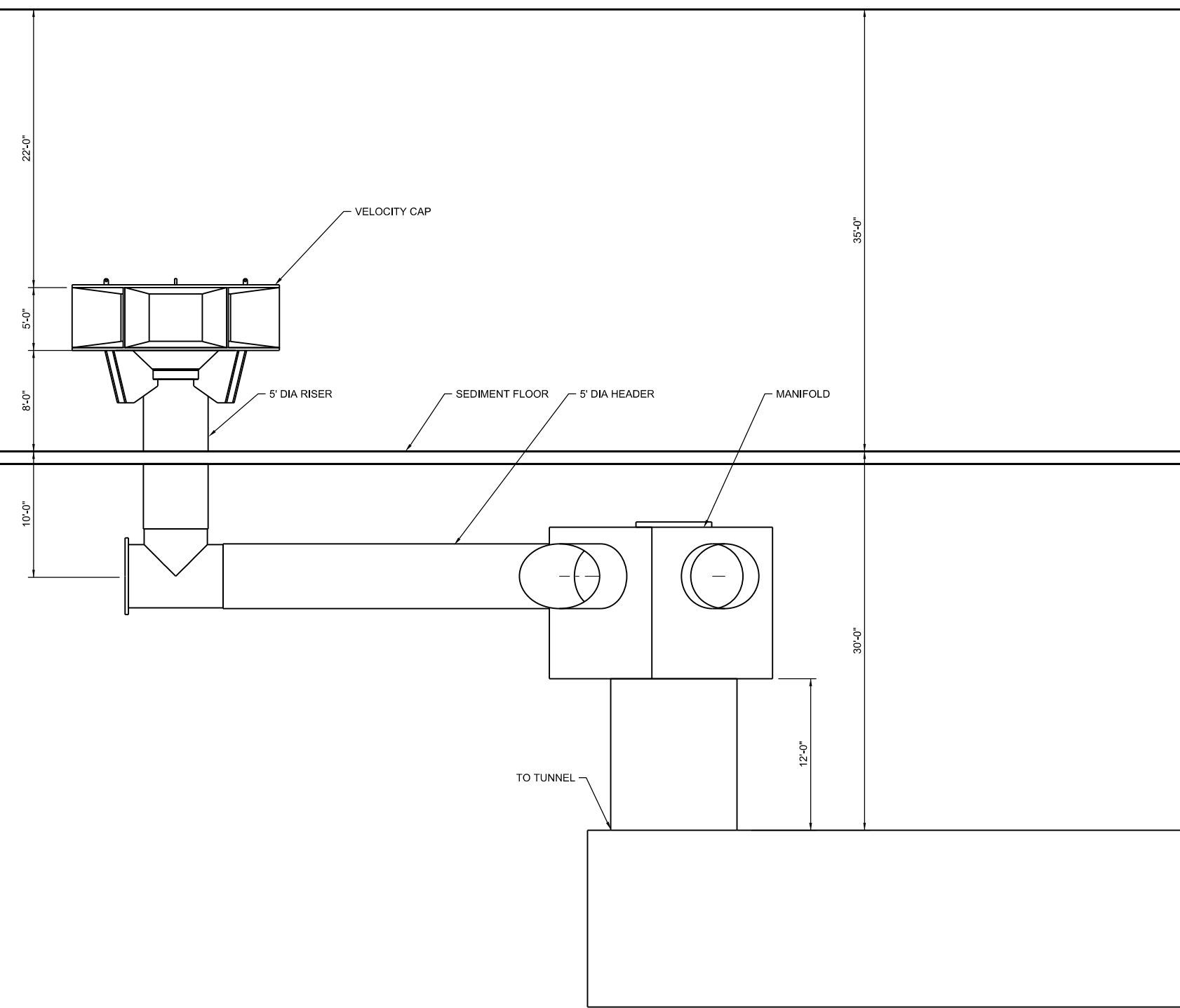
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FIGURE 3
INTAKE AND MANIFOLD PLAN

OCT 2022

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SECTION
3/16"=1'-0"

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FIGURE 4
INTAKE AND MANIFOLD SECTION

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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 NAVD88². 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.

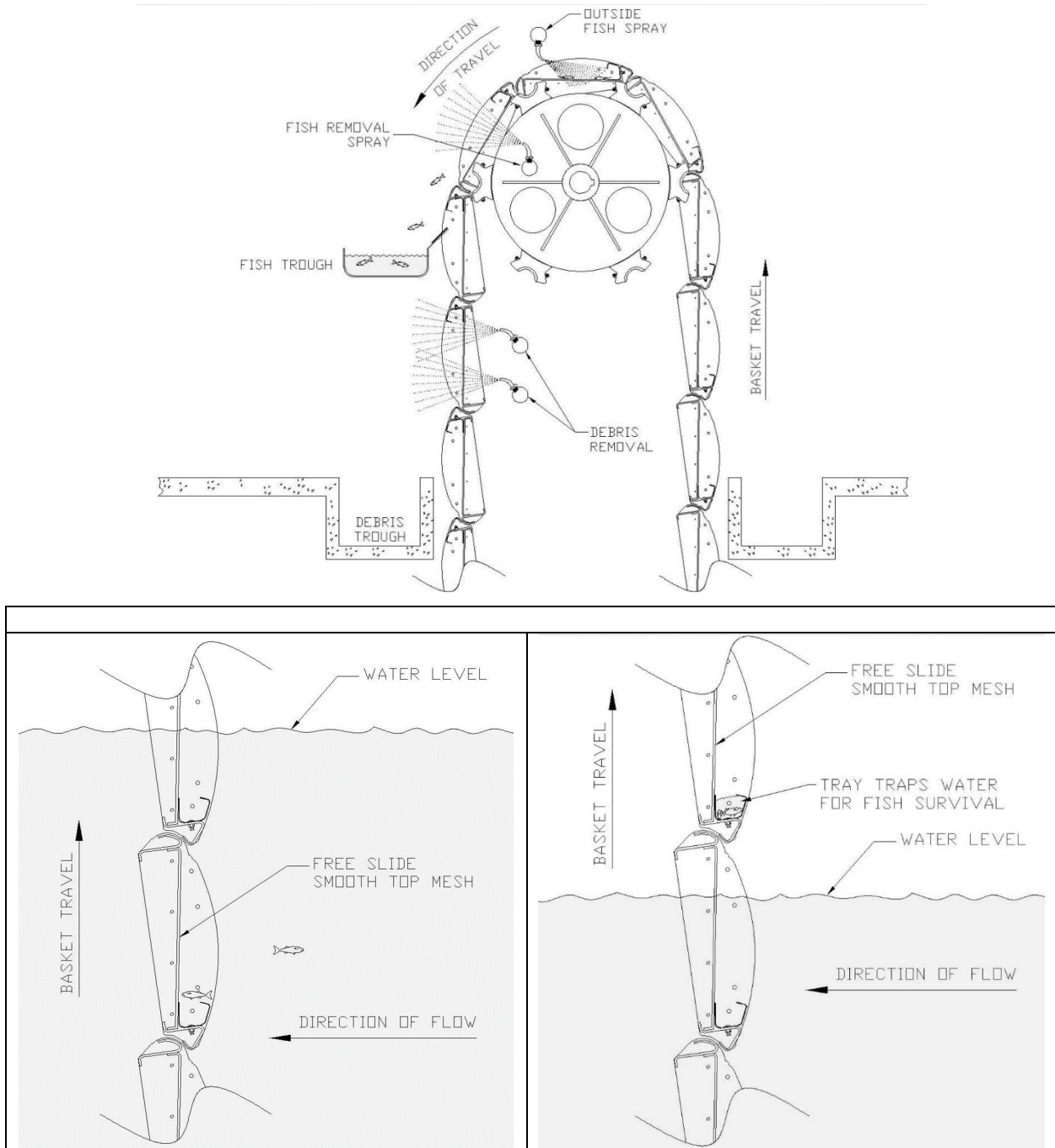


Figure 5. Traveling screen sketch and illustration of fish removal

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.

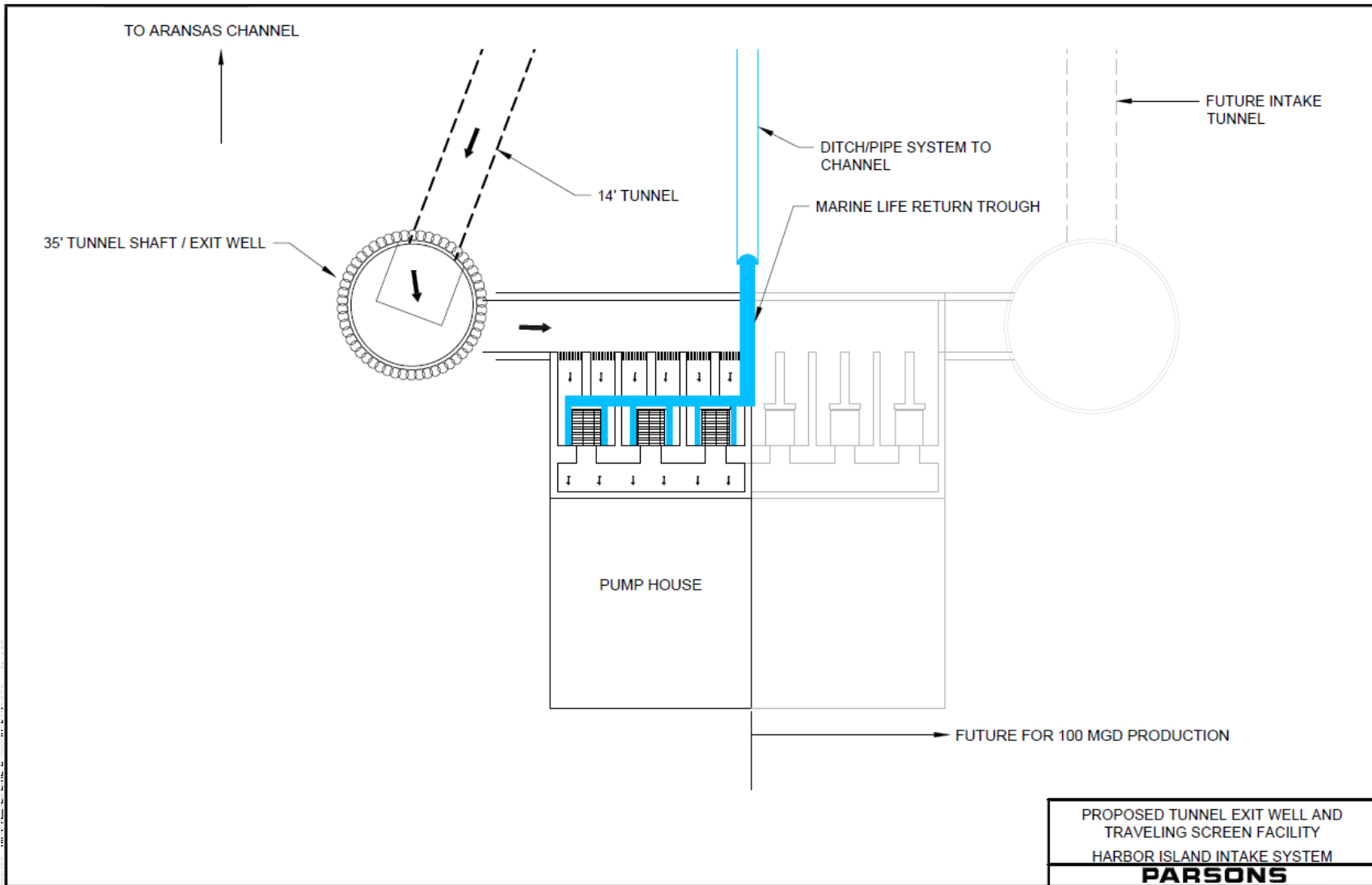


Figure 6a. Plan View of Proposed Marine Life Screening Facility

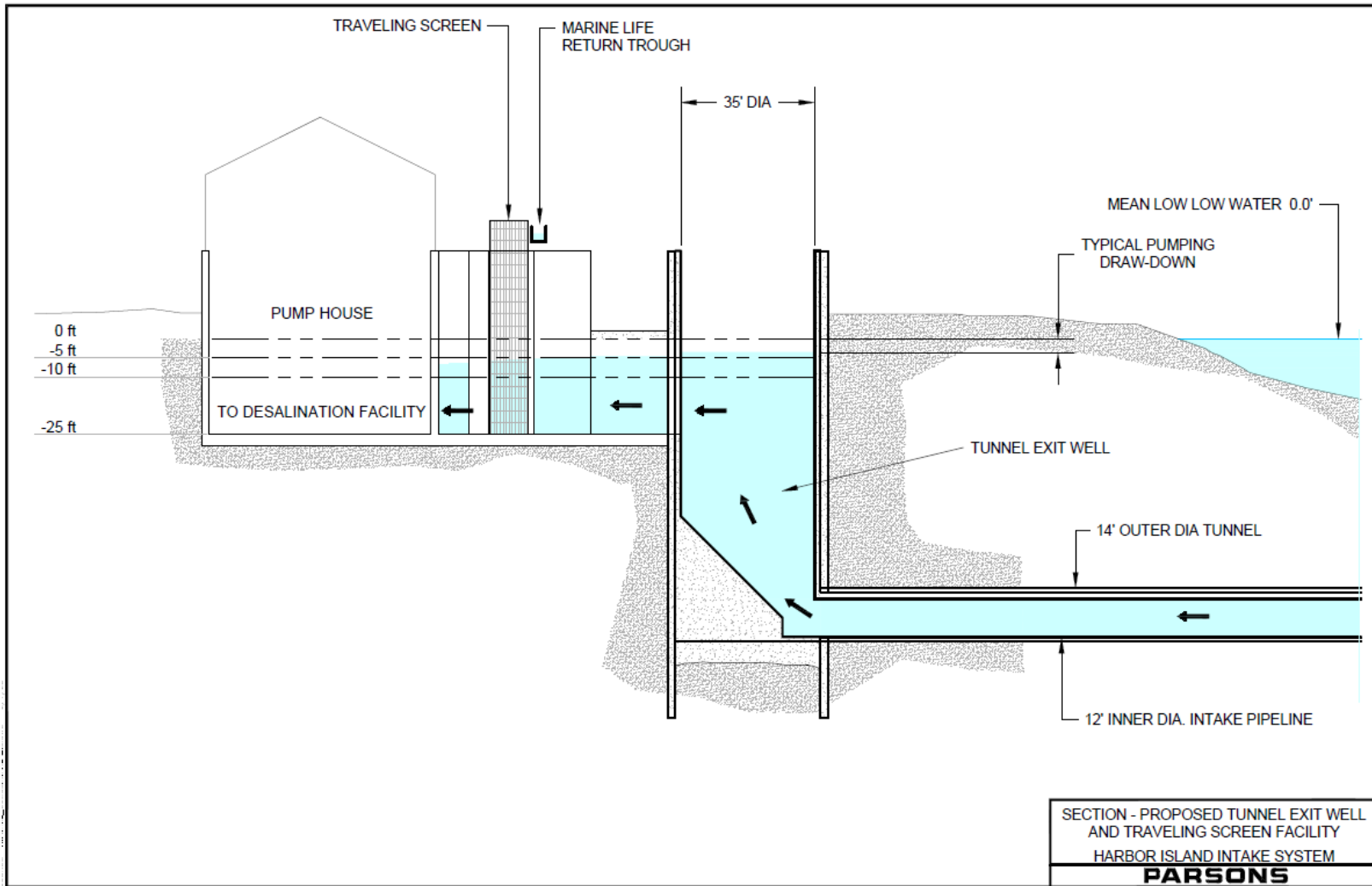


Figure 6b. Cross-Section of Proposed Marine Life Screening Facility

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.