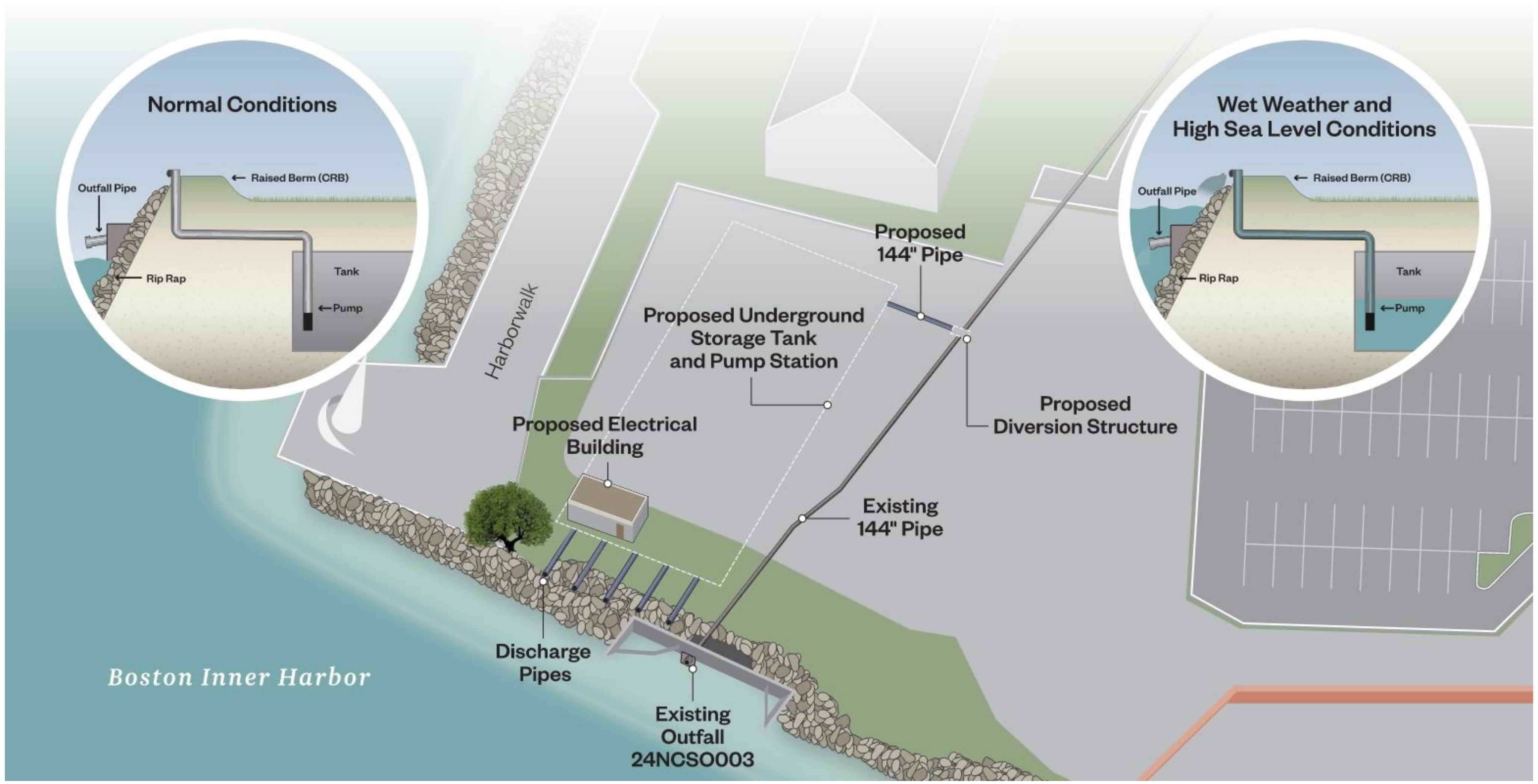
Airport Pump Station *Concept Overview*



Conceptual Solution

The conceptual solution herein includes a stormwater storage (peak flow shaving) tank and pump station to discharge excess wet weather flow when tide levels are high. The tank and pump station are located at the southwest corner of Boston Logan Airport. If a high tide level begins to reduce the ability of existing outfall 24NCSO003 to discharge by gravity, the existing storm sewer will begin to surcharge. A diversion structure with a static weir directs excess flow from the existing sewer to the storage tank. The storage tank is connected directly to the pump station. The pump station includes four duty and one standby pump. The pump station utilizes electric submersible pumps to minimize the above ground footprint of the station and mitigate negative visual and auditory impacts from diesel engine driven pumps. Each pump is designed with a formed suction inlet and non-manifolded discharge (each pump discharges separately). An additional stormwater outfall owned by the Massachusetts Port Authority (Massport) is located near the existing BWSC owned outfall; the feasibility of adding this outfall to the concept could be evaluated in the future.

Type: Storage and Pumping

Total Drainage Area: 625 acres

Coastal Flood Vulnerable Drainage Area Protected: 598 acres

Concept Elements:

- Subsurface Pump Station
- Subsurface Storage Tank
- Diversion Structure

Outfalls Included in Concept:

- 24NCSO003

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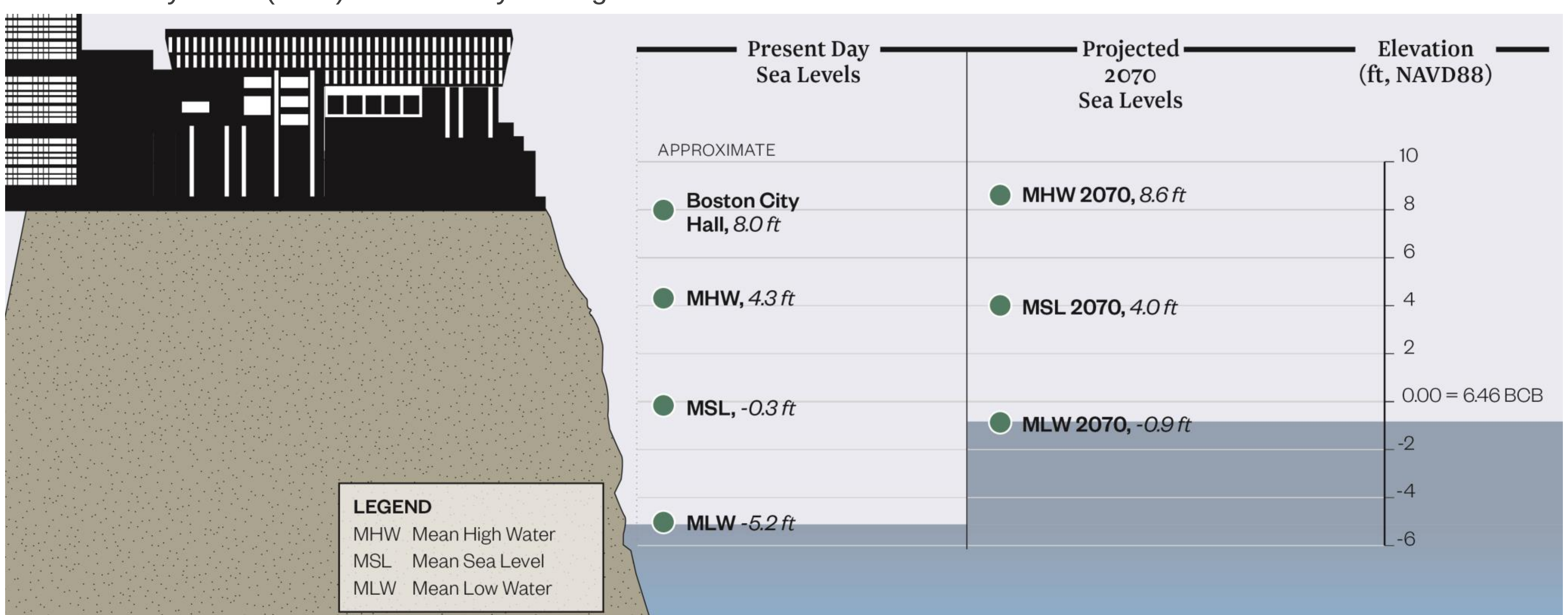
Assumptions

Sea Level Rise and Datum

The Airport Pump Station concept was designed for consistency with Climate Ready Boston (CRB) proposed adaptations and analyzed based on sea level rise (SLR) projections in the Massachusetts Coastal Flood Risk Model (MC-FRM). The SLR values applied in MC-FRM are consistent with the standards for the State of Massachusetts developed by Coastal Zone Management. The MC-FRM utilizes a “High” SLR scenario. This scenario is based on the relative SLR projections under Relative Concentration Pathway (RCP) 8.5 (a “worst case scenario” of increasing atmospheric carbon concentrations) and represents elevations that have a 99.5% probability of not being exceeded within the respective timeframes. In 2030, that amounts to an increase of 1.3 feet in Boston from a baseline condition (2008 centered tidal epoch), and in 2070 that amounts to an increase of 4.3 feet.

The concept developed in this project was analyzed using coastal conditions that include 2070 projected SLR and storm surge resulting from a 100-year tropical storm. The peak water surface elevation (WSE) predicted by the MC-FRM during these conditions is approximately 13.8 feet NAVD88 (varies by location). In mid 2022, the Greater Boston Research Advisory Group (BRAG) issued an updated report with new SLR projections. The report acknowledges that long term SLR projections are associated with significant uncertainty, and that updated projections include less SLR by 2100 (compared to earlier projections in the 2015 BRAG report.) According to the report, the likely range of SLR by 2070 under an RCP 8.5 scenario is 1.4 – 2.8 feet. Based on this information, projections from the MC-FRM that were utilized in this project are conservative and appropriate for long term planning purposes.

Unless otherwise noted, all elevations are based on the NAVD88 vertical datum. Elevations given in NAVD88 can be converted to Boston City Base (BCB) elevation by adding 6.46 feet.



Climate Ready Boston and Shoreline Protection

The Airport Pump Station concept was developed to maintain consistency with possible Climate Ready Boston (CRB) adaptations based on the latest available information at the time they were developed. As the CRB program continues to evolve, it is anticipated that proposed concepts will need to be adapted.

The concept was developed to be consistent with stated neighborhood design flood elevations. In East Boston, where the stated design flood elevation is 16.0 feet, pumps were designed to discharge to a minimum elevation of 16.0 feet.

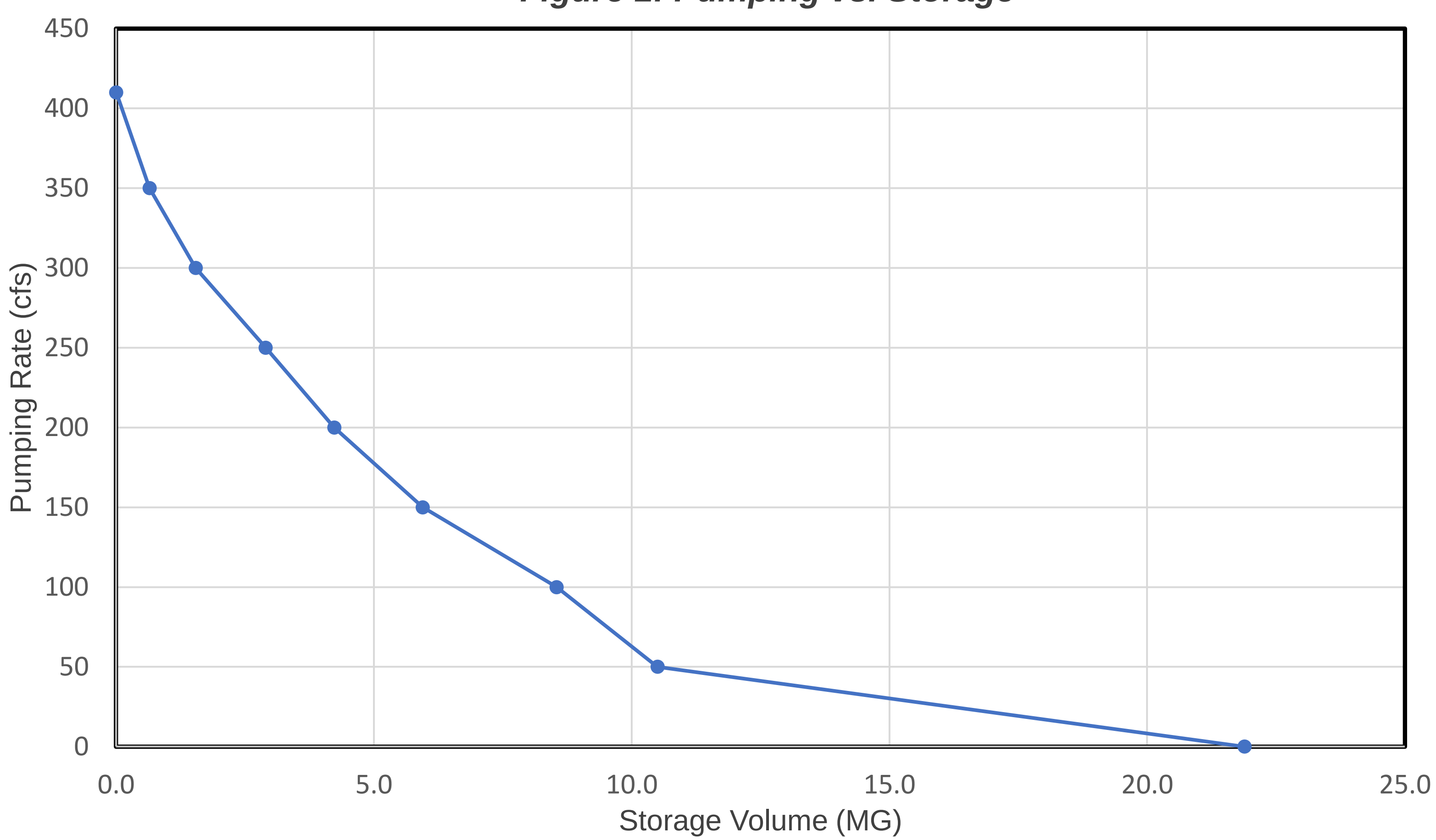
At the time of this project, many CRB concepts were in early planning stages and not fully defined. **In consideration of this, it was assumed the shoreline protection around the City of Boston is 100% effective for all modeling evaluations.** This assumption eliminates overland coastal flooding from model predictions, allowing for isolation of flooding that results only from rainfall and stormwater that cannot be discharged due to high sea levels. It is important to recognize that additional flooding, beyond what is depicted herein, would be expected if 100% effective shoreline protection is not implemented.

Basis of Design

Storage and Pumping

Model simulations were conducted to determine the maximum Hydraulic Grade Line (HGL) that occurs at Outfall 24NCSO003 with the current tide cycle. Analyses were then conducted to determine the acceptable combinations of storage volume and pumping rate required to maintain the existing HGL with 2070 projected sea level rise and 100-year storm surge, as shown in Figure 1. The City of Boston's Parcel database was used to identify publicly owned parcels near the existing outfall. An analysis of the pump station was performed to identify a pump rate and physical dimensions that are hydraulically viable. It was found that a 1.2 MG storage tank ~26 feet deep could fit within the property with a 320 CFS pump station. The pump station and storage tank occupy an area of 8,750 ft^2. The Airport pump station utilizes four duty pumps, one standby pump, and two dewatering pumps. The pump station is configured with vertical, axial electric submersible pumps in parallel bays. The pumps are configured to discharge into individual, non-manifolded force mains, which travel horizontally underground from the pump station to the proposed elevated shoreline project (TBD by CRB), at which point they discharge into the harbor onto an energy dissipation structure.

Figure 1: Pumping vs. Storage



Rainfall and Coastal Conditions

The Commission currently utilizes a 10-year, 24-hour design storm to establish its target level of service. For the purpose of sizing new piping and evaluating storage capacity, a projected 2070 10-year, 24-hour design storm was developed. For consistency with Climate Ready Boston, performance of the Airport pump station concept was also evaluated with projected rainfall from a 100-year tropical event (developed during the Commission’s Inundation Model Project. The Airport pump station was evaluated using a 100-year return period coastal boundary condition. Data for this condition were obtained from the MC-FRM. For the purpose of evaluating the effectiveness of the concept, it was further assumed that complete shoreline protection was implemented, preventing flow of water between the Airport pump station tributary area and Boston Harbor. Table 2 contains a summary of the coastal conditions that were analyzed.

Table 1: Rainfall Conditions

Scenario	Purpose	Rainfall Depth (in)	Peak Intensity (in/hr)
Present Day 10-year, 24-hr design storm	Baseline Conditions	5.15	3.32
Projected 2070 10-year, 24-hr design storm	Design Conditions	6.18	4.08
100-year Tropical Storm	Damage Analysis	9.58	0.84

Table 2: Coastal Conditions

Scenario	Purpose	Peak Water Surface Elevation (ft, NAVD88)	Source
Present Day	Baseline Conditions	3.7	BWSC Existing Model (April 2016 Tide Cycle)
2070,100-year Tropical Storm	Damage Analysis	13.8	MC-FRM

Flood Modeling and Damage Analysis

Figure 2: Estimated Replacement Cost

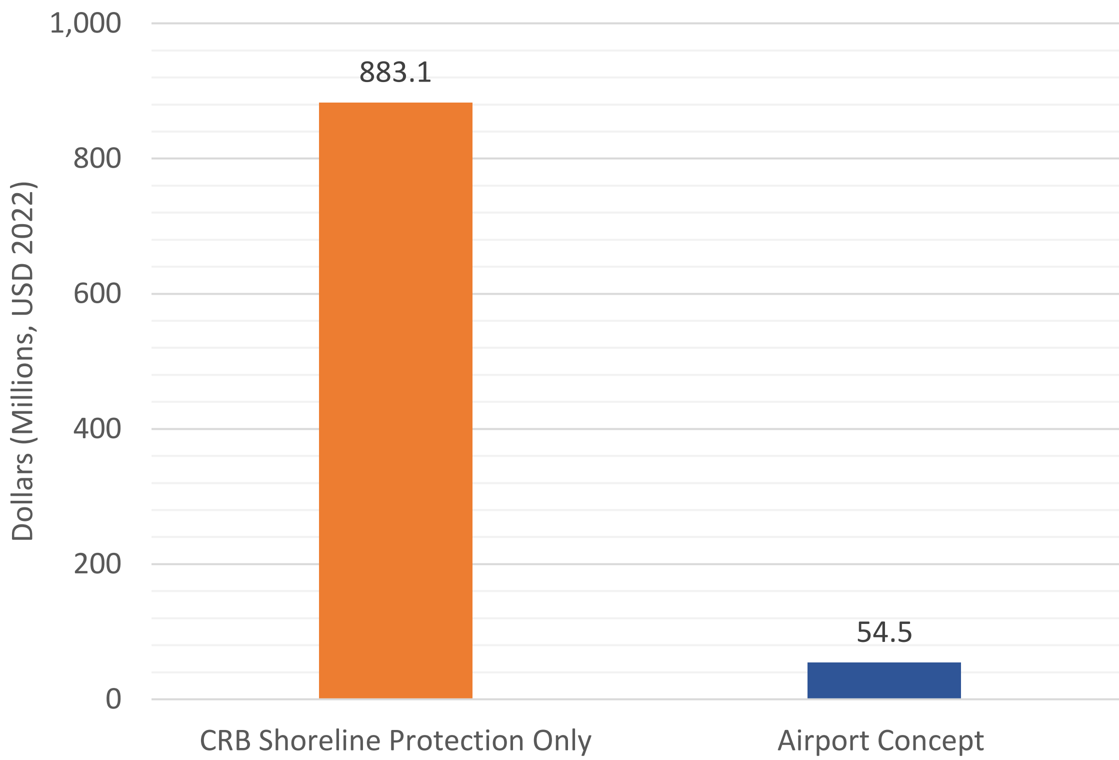


Figure 3: Loss of GDP

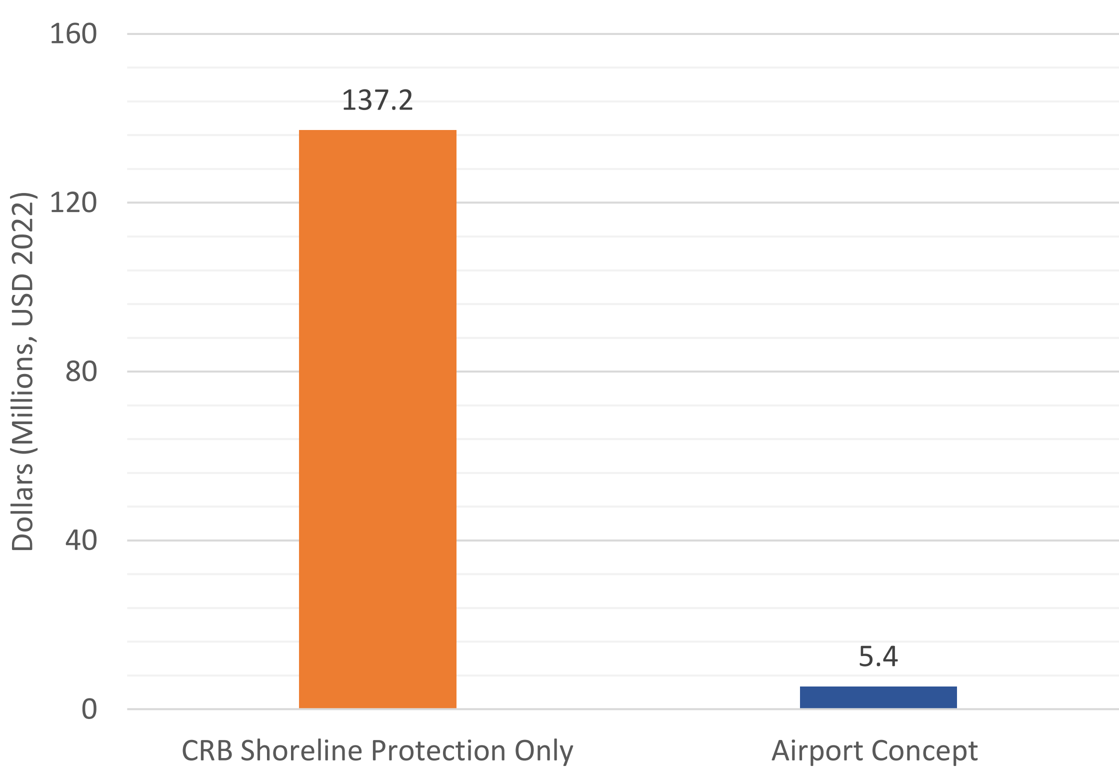
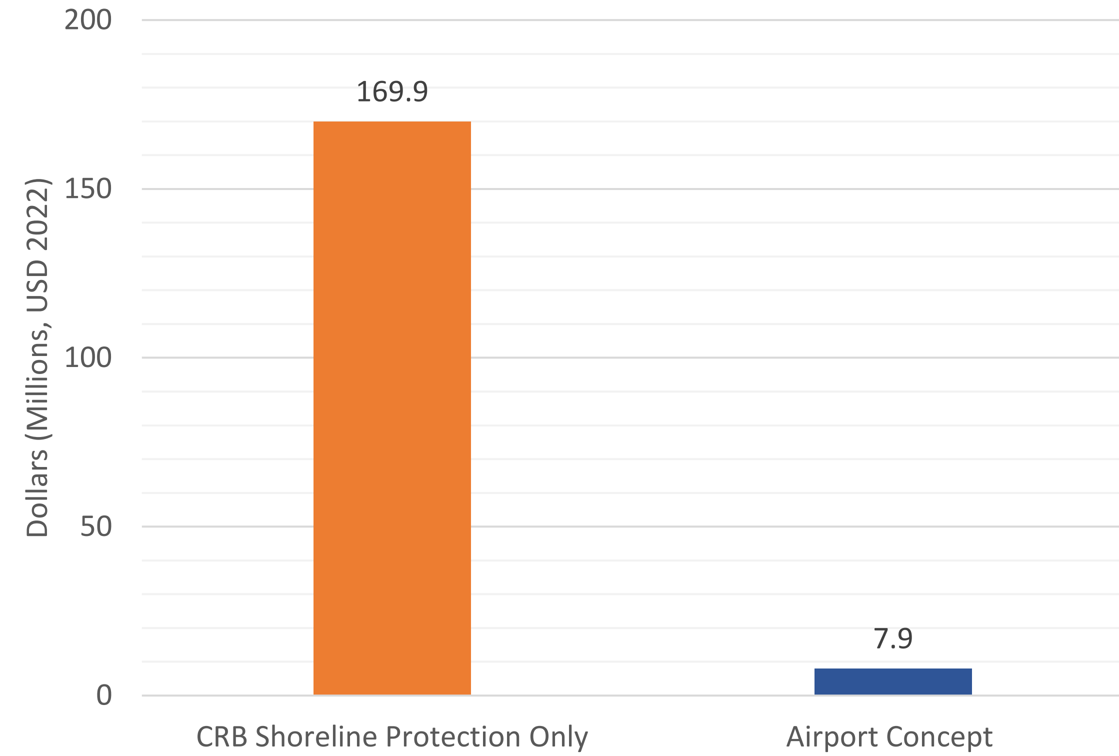


Figure 4: Physical Damage



The flood reduction benefits of the Airport Pump Station concept were evaluated using the Commission’s 2D Inundation Model by simulating a 100-year tropical storm event with 2070 SLR and storm surge. The figures on the following page depict the peak flooding that was predicted in the Airport Pump Station drainage area with shoreline protection only and with the pump station and tide gates on all vulnerable BWSC owned outfalls. An analysis of economic losses/physical impacts from flooding under both scenarios was performed by risQ Inc.

Model predictions indicate that the Airport Pump Station concept reduces physical damage by **$162.0 million**, avoids **$828.6 million** in rebuilding costs, and mitigates a GPD loss of **$131.8 million** during a 100-year tropical storm event in 2070.

Note: replacement values include the total value of impacted buildings in flooded areas (e.g., impacted buildings are fully replaced), whereas physical damage includes estimated costs to repair flood damage based on predicted flood depths and building characteristics. The values shown are the average of minimum and maximum calculated losses. Refer to the Project's Final Report for more information.

2070 SLR + 100yr Tropical Storm + Storm Surge
Shoreline Protection Only

2070 SLR + 100yr Tropical Storm + Storm Surge
Airport Pump Station and Tide Gates

Legend

- Flood Depth > 4 in and < 1 ft
- Flood Depth > 1 ft and < 2 ft
- Flood Depth > 2 ft
- Drainage Area Analyzed

Simulation Parameters

Storm Type	100yr Tropical Storm
Rainfall Depth	9.6 inches
Peak WSE 2070 SLR + 100yr Surge	13.8 feet NAVD88

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Damage Analysis

Capital Cost Estimate

A construction cost estimate for the Airport Pump Station concept was developed for planning purposes. Assumptions for the cost estimate include 15-year escalation to the mid-point of construction and the inclusion of a 50% design contingency. Utility hookup costs were not included.

Table 3: Airport Pump Station Cost Estimate Subtotals

Remaining Design Development & Construction Administration (*assumed 20% of total less design contingency*)	$3,666,000
Direct Construction Costs	$7,236,248
Indirect Construction Costs	$1,447,250
Mark-Up *(Including 50% design contingency)*	$18,479,502
Total	**$30,829,000**

Social Vulnerability and FEMA BRIC Funding

FEMA BRIC funding prioritizes disadvantaged communities. Table 4 contains a summary of several indicators for the Airport tributary area that could be used help characterize the community for future FEMA funding applications and prioritization of projects that benefit disadvantaged communities.

Table 4: Airport Tributary Area Social Vulnerability Indicators

Low Income & Persistent Poverty	
Per Capita Income	$32,827
Below Poverty Line	12%
High Housing Cost Burden	
Stressed Renters (>40% rent-to-income)	33%
Households With Food Insecurity	14%
Racial and Ethnic Segregation	
Asian Population	3%
Black Population	3%
Hispanic Population	63%
White Population	53%
Education and Employment	
Adults Age 25+ Without High School (or equivalent) Degree	29%
Unemployment Rate (Age 16+)	6%

Data provided by risQ inc. from the US census and American Community Survey

Planting Palette

A planting palette was developed for the Airport concept. The planting palette can be applied to the greenspace surrounding the proposed airport electrical building and discharge pipes. After construction, planting of native plant species could help conceal concept utilities from the public and provide environmental benefits associated with native species.

Trees

Amelanchier arborea
common serviceberry

Juniperus virginiana
eastern red cedar

Magnolia virginiana
sweet bay magnolia

Quercus rubra
northern red oak

Shrubs

Rosa carolina
pasture rose

Rhus copallinum
winged sumac

Aronia melanocarpa
black chokeberry

Morella pensylvanica
bayberry

Herbaceous and Grasses

Panicum virgatum
switchgrass

Schizacharium scoparium
little bluestem

Eutrochium purpureum
Joe-Pye-Weed

Solidago sempervirens
seaside goldenrod

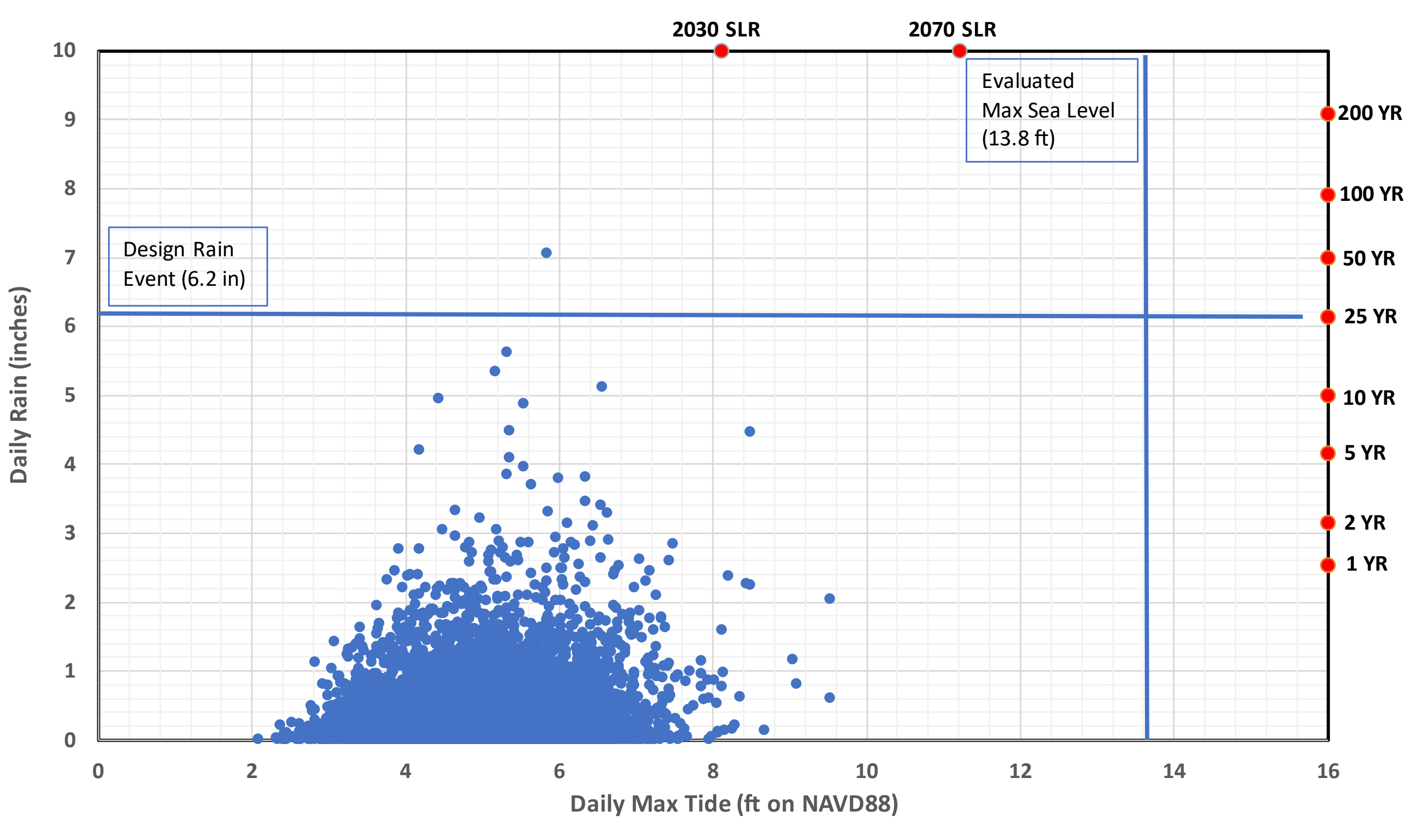
Adaptability and Implementation

Adaptability

Figure 5 below depicts historical daily rainfall totals and tide levels. As shown in this figure, the conditions that were used to design and analyze and design the Airport pump station are conservative and represent more extreme conditions than have occurred historically. Regardless, the following measures could be implemented to adapt the concept to more severe conditions (additional SLR, more intense rainfall, etc.) in the future:

- Increase the size of installed electric submersible pumps.
- Utilize the standby pump as a duty pump during extreme conditions.
- Increase the size of the peak shaving tank.
- Consider construction of a larger storage and pump facility at the large privately owned parking lot nearby.
- Increase the size of the concept to manage wet weather flow from the adjacent outfall owned by Massport.

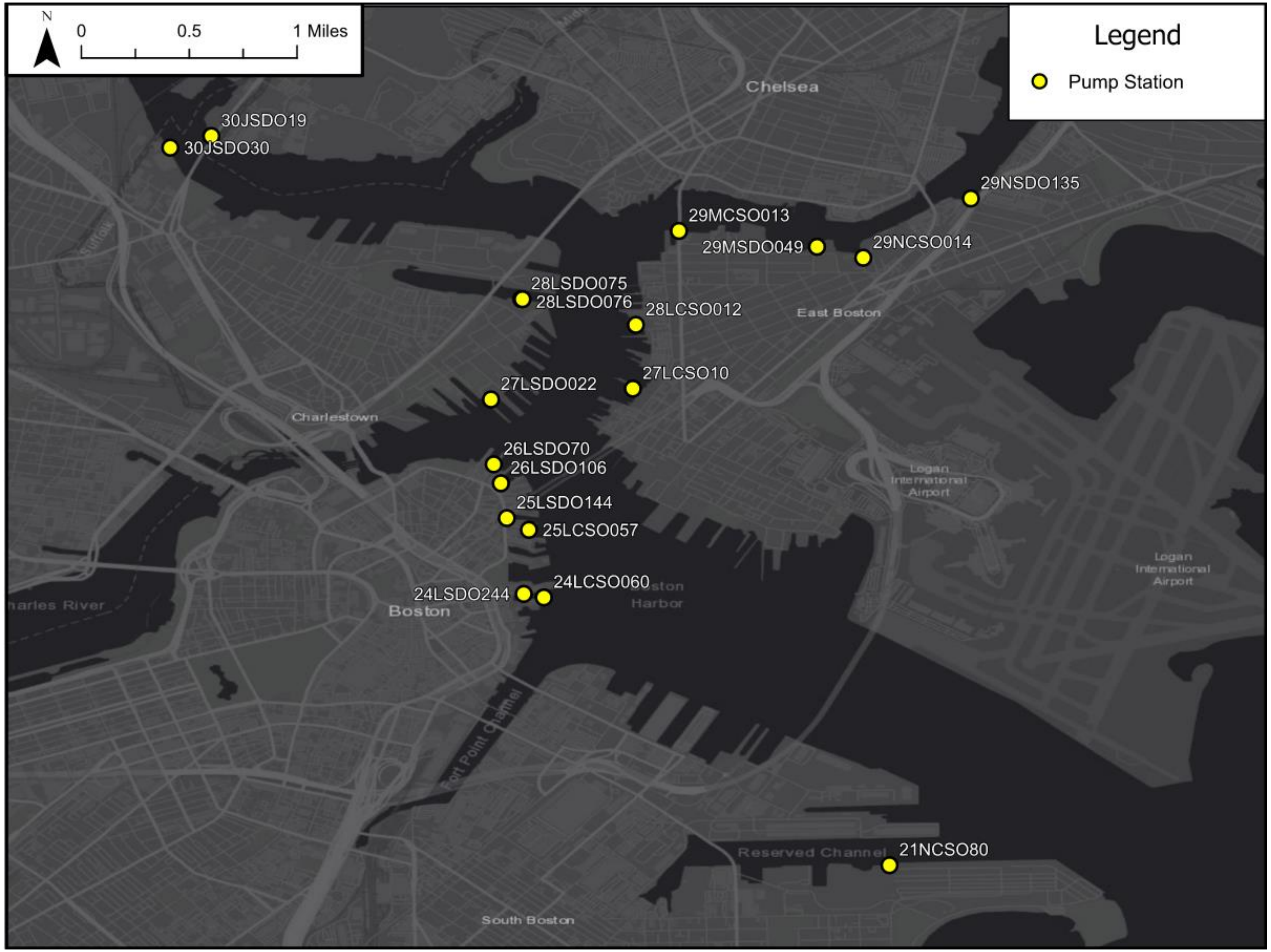
Figure 5: Design and Analysis Conditions vs. Historical Tide and Rainfall



Implementation Considerations

- Coordination with CRB is necessary to implement shoreline protection. The pump station should not be implemented without shoreline protection to prevent coastal flooding within the area tributary to it. The discharge structure may need to be modified depending on the exact nature of the shoreline protection chosen by CRB.
- Community engagement with stakeholders may help build project support by documenting the need for the storage tank and pump station.
- A comprehensive permitting evaluation should be conducted to evaluate possible impacts from construction and operation of the pump station to the receiving water.
- The Airport Pump Station currently serves a CSO outfall. It is the Commission's intention to separate the drainage area and use the outfall for stormwater flow in the future. The size and pump capacity of the facility should be re-evaluated to consider sewer separation in the future.
- Coordination with Massport would be necessary to construct the pump station. The concept could be modified to manage wet weather flow from the adjacent outfall owned by Massport.
- The existing outfall receives flow from a large 144" conduit. Analyses should be conducted to determine if this conduit has excess capacity after planned sewer separation projects are completed. If it is found that there is additional capacity, other storm drains that are connected to coastal flood vulnerable outfalls could be diverted to Outfall 24NCSO003 and the Airport Pump Station.

Replicability and Implementation Timeline



Summary of Similar Concepts

Number of Sites: 18

Vulnerable Area: 422 acres

The map on this sheet depicts other vulnerable outfalls that could be adapted with electric submersible pump stations. In some locations, several outfalls could be consolidated with a new conduit that conveys flow to a single pump station.

Additional detail about these outfalls can be found in the Commission's Coastal Stormwater Discharge Analysis Implementation Timeline.

ATTACHMENT A
AIRPORT PUMP STATION CONCEPTUAL DESIGN DRAWINGS

A-1: Overview Plan and Pump Station Plan
A-2: Pump Station Section View

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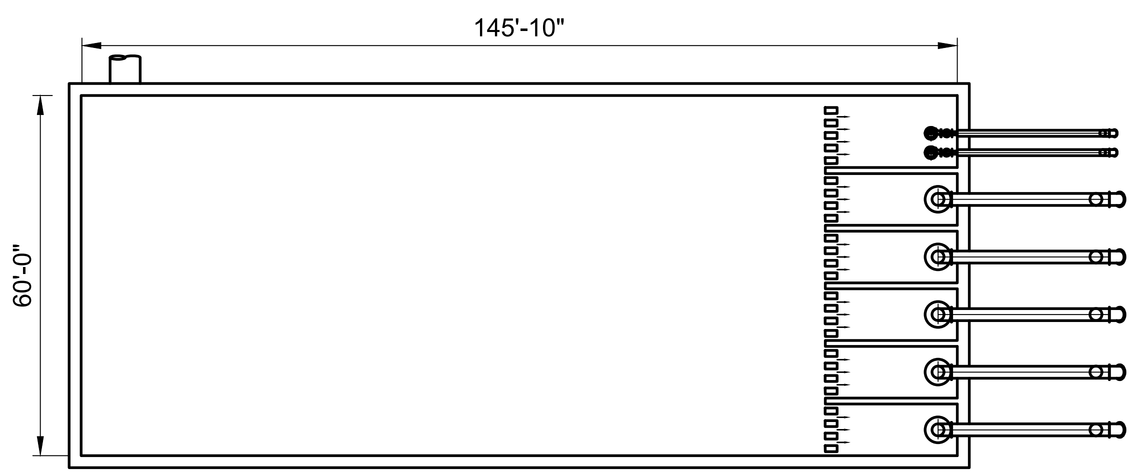
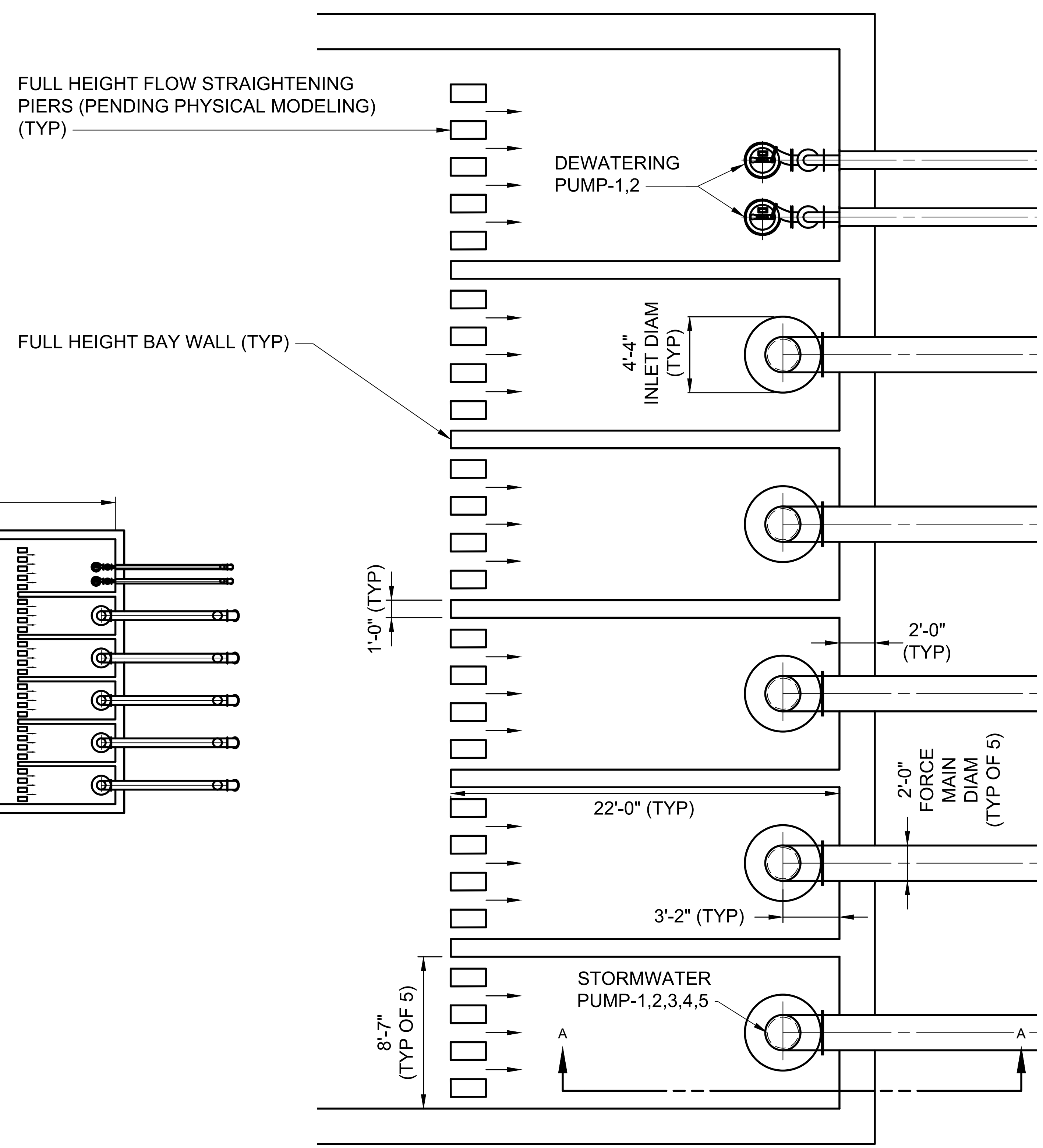
Conceptual Design – Not for Construction

Airport Stormwater Pump Station



OVERVIEW PLAN
SCALE: NTS



PUMP STATION PLAN
SCALE: NTS

NOTES

1. FOR WATER SURFACE ELEVATIONS REFER TO OPERATIONAL TABLE.
2. ALL ELEVATIONS USE THE NAVD88 VERTICAL DATUM UNLESS OTHERWISE STATED.
3. CONCEPTUAL DRAWING, NOT FOR CONSTRUCTION.

STORMWATER PUMP-1,2,3,4,5 OPERATIONAL PARAMETERS	
FLOW RATE, CFS	80
STATIC HEAD RANGE, FT	13.3 - 20.5
DESIGN FLOOD ELEVATION, FT	16.0

STORMWATER PUMP-1,2,3,4,5 OPERATIONAL WSE TABLE

NOTE	OPERATION	ELEVATION, FT
A	HIGH LEVEL ALARM	2.7
B	LAG PUMP ON	1.0
C	LEAD PUMP ON	-0.5
D	LEAD PUMP OFF	-1.5
E	LOW LOW ALARM	-2.5
G	MIN PUMP SUBMERGENCE	-3.5

COASTAL STORMWATER DISCHARGE ANALYSIS

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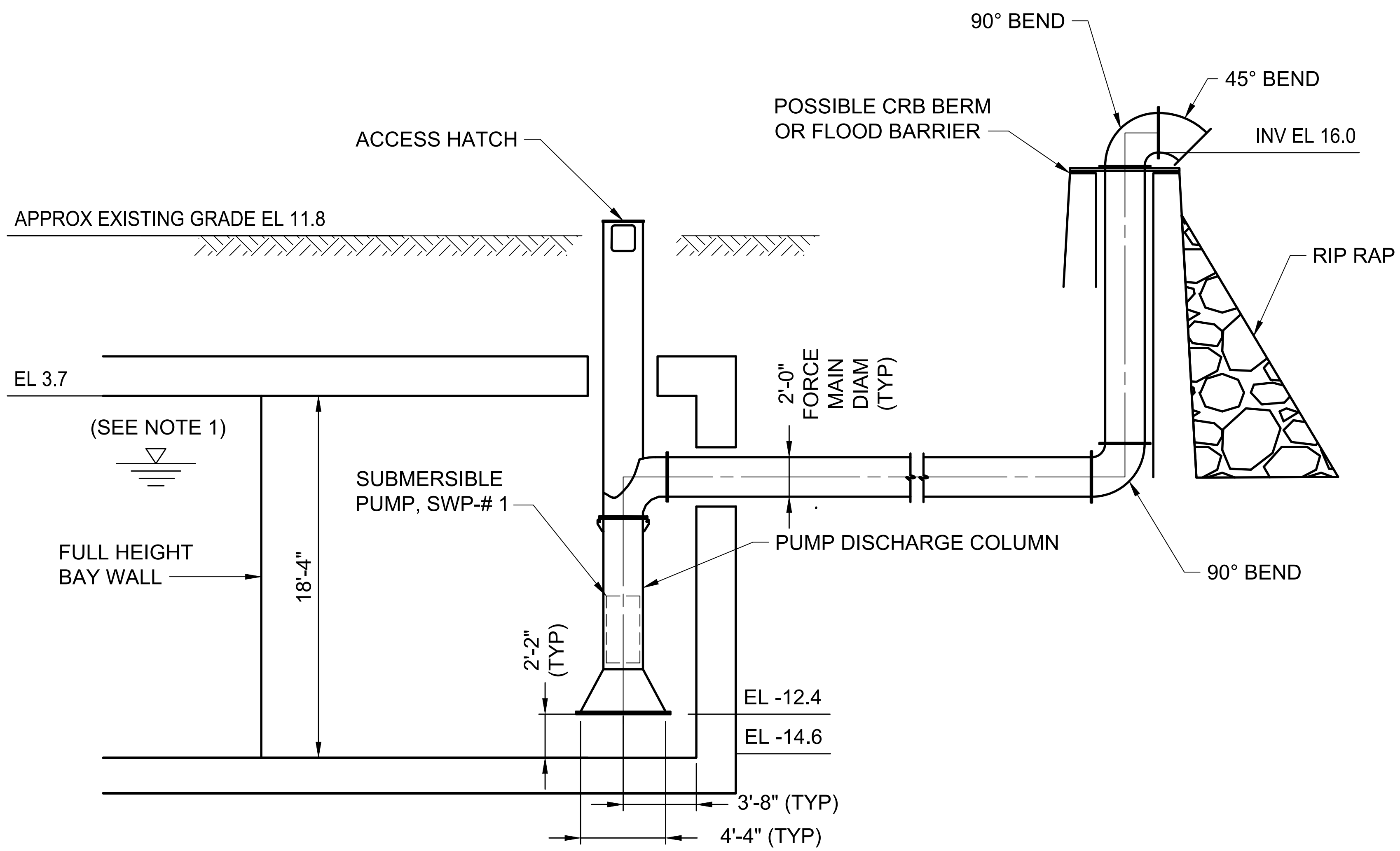
Airport Stormwater Pump Station



SECTION
SCALE: NTS

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