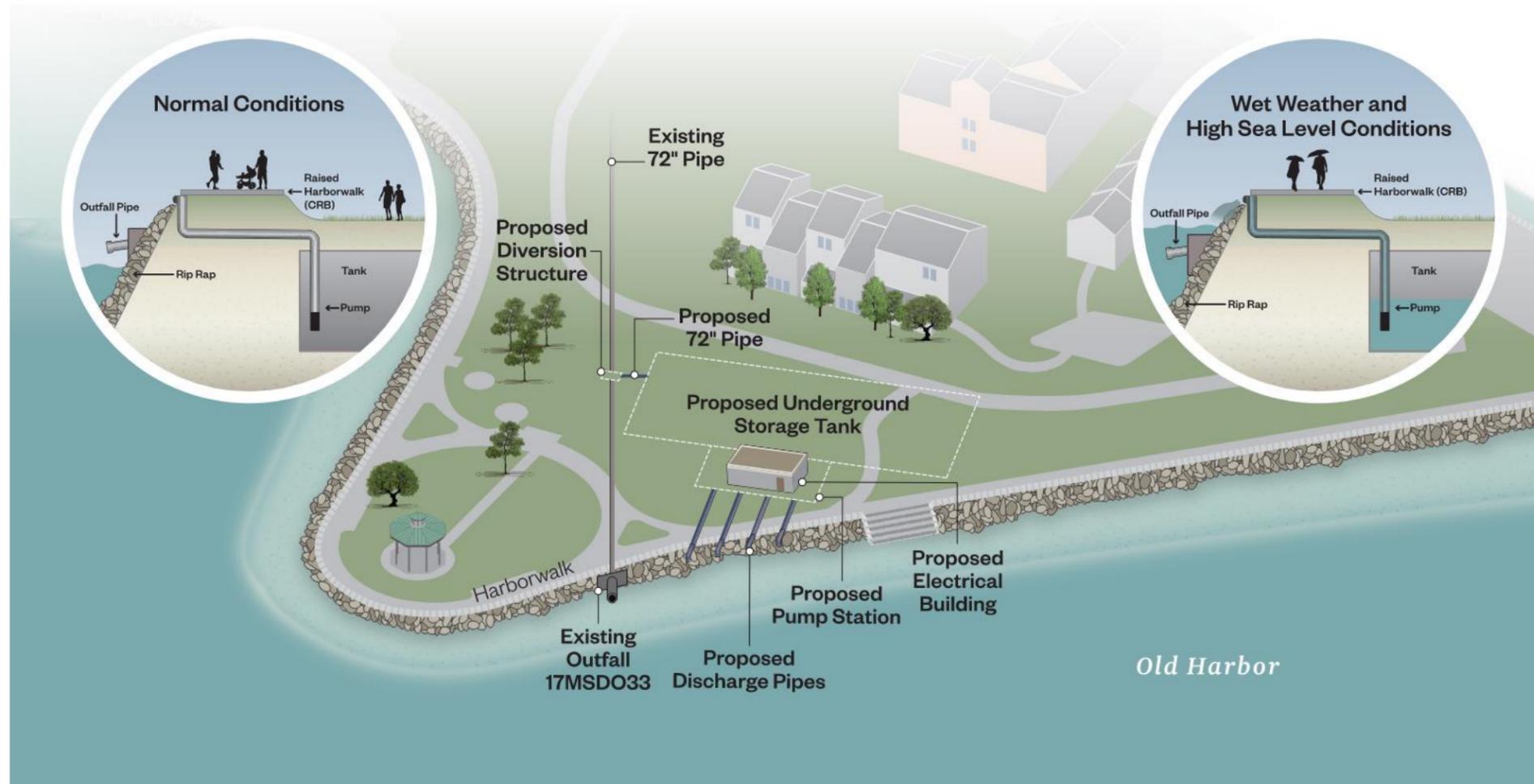


Old Harbor Park Pump Station Concept Overview



Legend

- Outfall
- Tributary Area
- City of Boston



Conceptual Solution

The conceptual solution herein includes a stormwater storage (peak flow shaving) tank and pump station to discharge wet weather flow when tide levels are high. The tank and pump station are located at Old Harbor Park. If a high tide level begins to reduce the ability of existing outfall 17MSDO33 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 three duty, one standby, and two dewatering pumps. 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 discharges into a force main that travels horizontally underground from the pump station to a potential shoreline elevation project (TBD by CRB), at which point they discharge into the harbor onto an energy dissipation structure.

Type: Storage and Pumping

Total Drainage Area: 81 acres

Coastal Flood Vulnerable Drainage Area Protected: 81 acres

Concept Elements:

- Subsurface Pump Station
- Subsurface Storage Tank
- Diversion Structure

Outfalls Included in Concept:

- 17MSDO33

Coastal Stormwater Discharge Analysis
Old Harbor Park Pump Station



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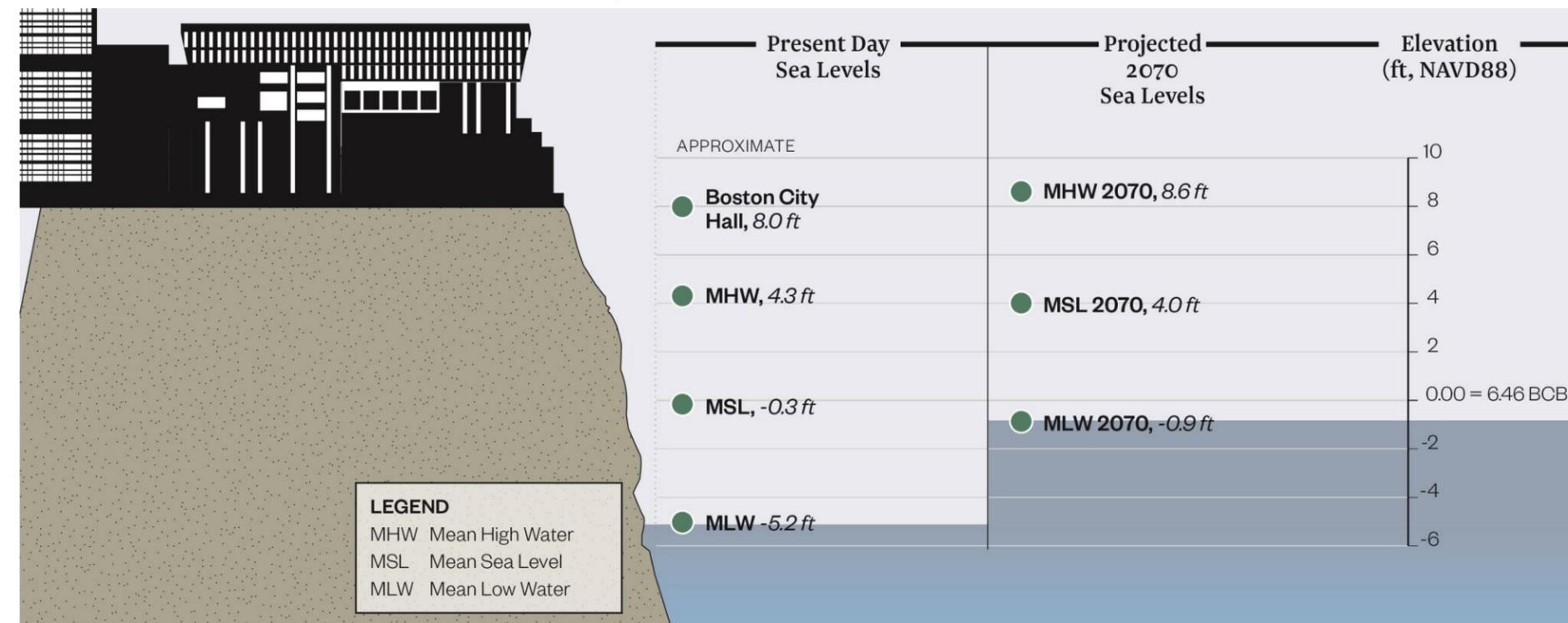
Assumptions

Sea Level Rise and Datum

The Old Harbor Park 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 Old Harbor Park 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 the Columbia Point and Morrissey Boulevard Zone (location of Old Harbor Point Park), where the stated design flood elevation is 16.2 feet, pumps would be designed to discharge to a minimum elevation of 16.2 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.

Coastal Stormwater Discharge Analysis
Old Harbor Park Pump Station



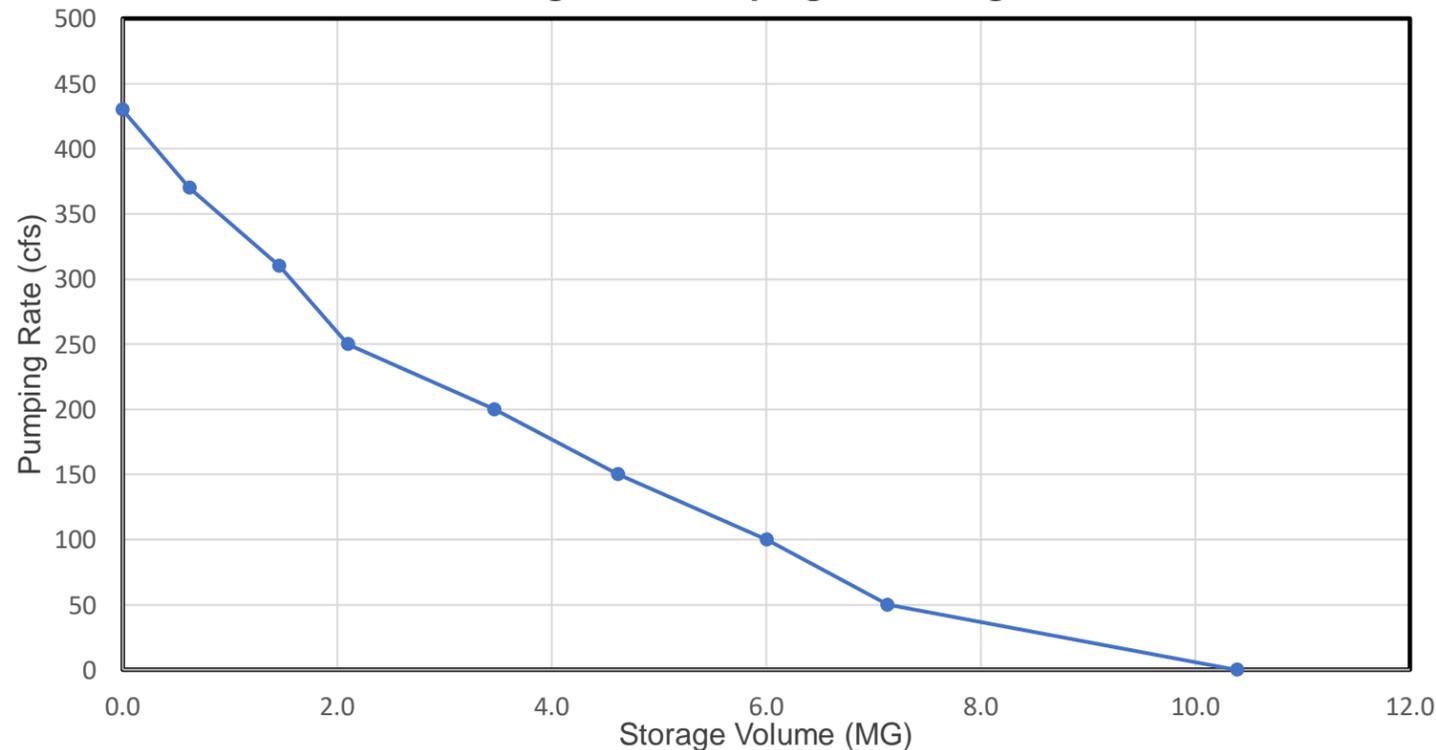

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Basis of Design

Storage and Pumping

Model simulations were conducted to determine the maximum Hydraulic Grade Line (HGL) that occurs at Outfall 17MSDO033 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 1.4 MG storage tank ~25 feet deep could fit within the property with a 306 CFS pump station. The pump station and storage tank occupy an area of 11,260 ft². The Old Harbor Park Pump station utilizes three 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 storage concept was also evaluated with projected rainfall from a 100-year tropical event (developed during the Commission's Inundation Model Project). The DBB 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 land and the harbor/Neponset River. 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

Coastal Stormwater Discharge Analysis
Old Harbor Park Pump Station



Flood Modeling and Damage Analysis

Figure 2: Estimated Replacement Cost

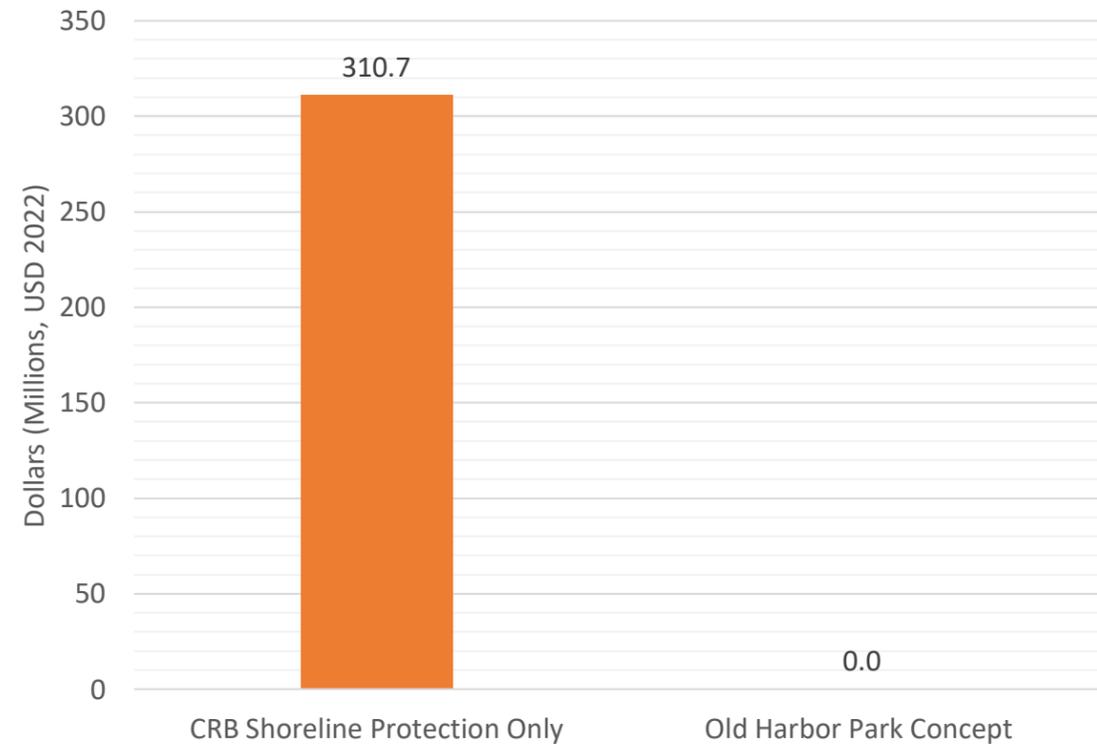


Figure 3: Loss of GDP

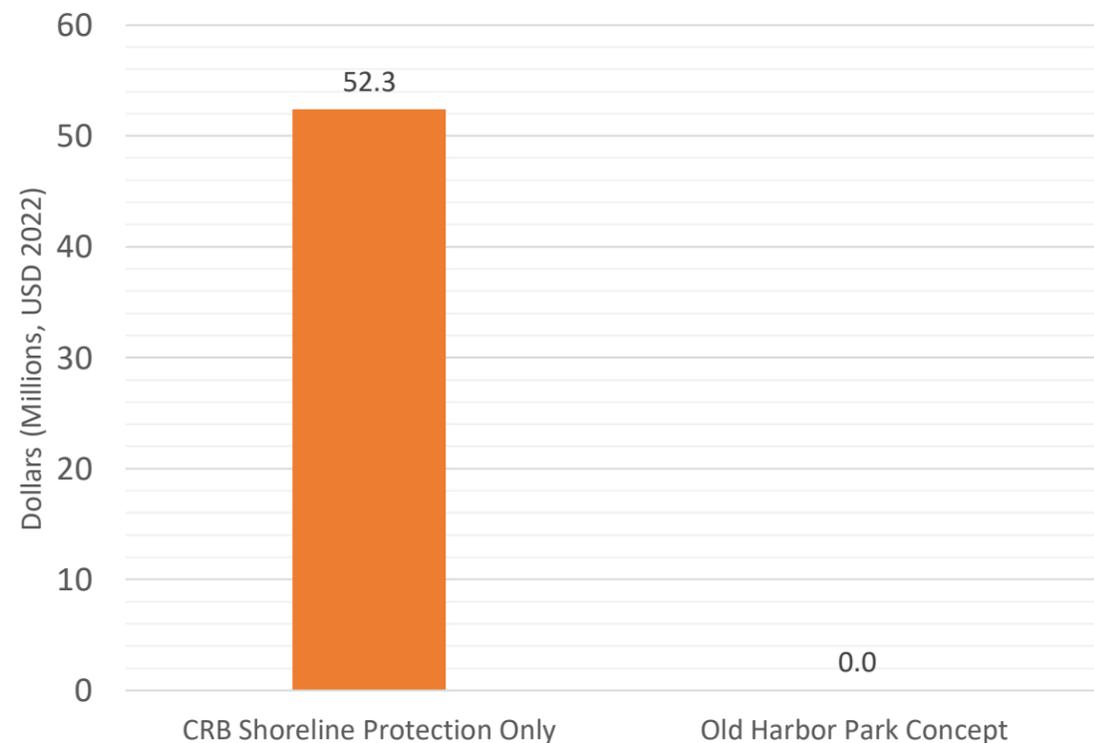
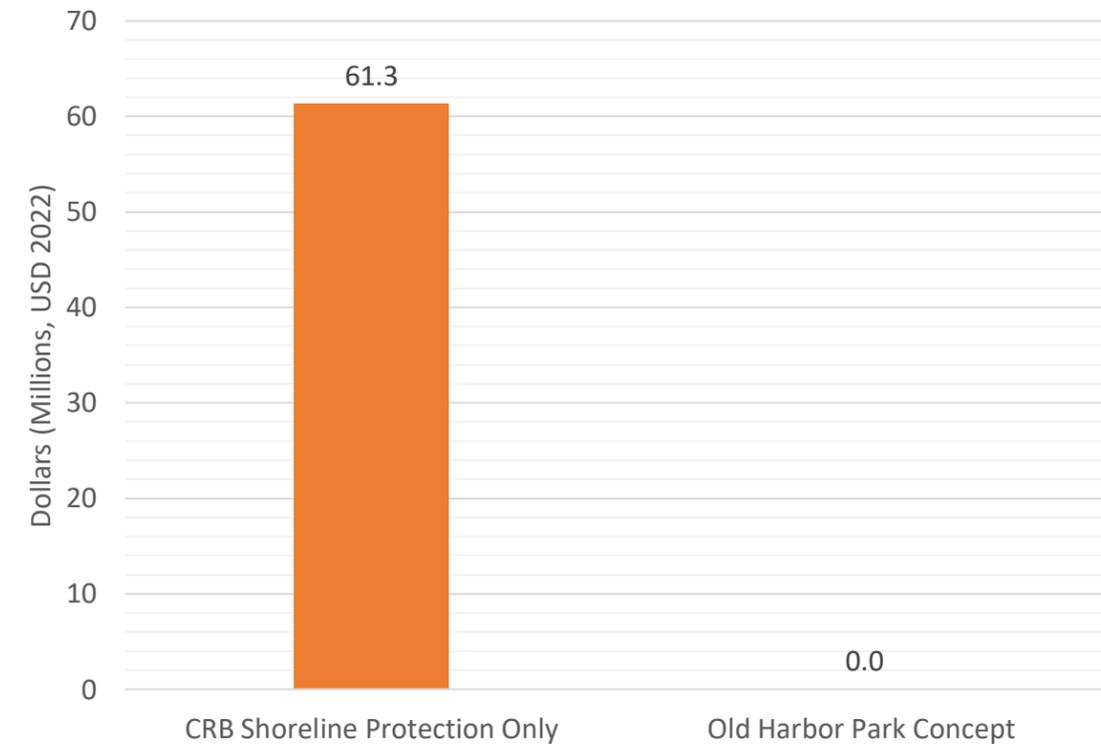


Figure 4: Physical Damage



The flood reduction benefits of the Old Harbor Park 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 Old Harbor Park 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 Old Harbor Park Pump Station concept reduces physical damage by \$61.3 million, avoids \$310.7 million in rebuilding costs, and mitigates a GDP loss of \$52.3 million** during a 100-year tropical storm event in 2070 compared to shoreline protection only.

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.

Coastal Stormwater Discharge Analysis
Old Harbor Park Pump Station



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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

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

2070 SLR + 100yr Tropical Storm + Storm Surge
Harbor Park Pump Station

Cost Estimate and FEMA BRIC Considerations

Capital Cost Estimate

A construction cost estimate for the Old Harbor Park 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: Old Harbor Park Pump Station Cost Estimate Subtotals

Remaining Design Development & Construction Administration (assumed 20% of total less design contingency)	\$3,547,000
Direct Construction Costs	\$7,012,000
Indirect Construction Costs	\$1,402,000
Mark-Up (Including 50% design contingency)	\$17,865,000
Total	\$29,826,000

Social Vulnerability and FEMA BRIC Funding

FEMA BRIC funding prioritizes disadvantaged communities. Table 4 contains a summary of several indicators for the Old Harbor Park Pump Station 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: Old Harbor Park Pump Station Tributary Area Social Vulnerability Indicators

Low Income & Persistent Poverty	
Per Capita Income	\$19,522
Below Poverty Line	49%
High Housing Cost Burden	
Stressed Renters (>40% rent-to-income)	52%
Households With Food Insecurity	14%
Racial and Ethnic Segregation	
Asian Population	29%
Black Population	14%
Hispanic Population	29%
White Population	36%
Education and Employment	
Adults Age 25+ Without High School (or equivalent) Degree	12%
Unemployment Rate (Age 16+)	6%

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

Coastal Stormwater Discharge Analysis
Old Harbor Park Pump Station



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Planting Palette

A planting palette was developed for the Old Harbor Park concept. After construction, planting of native plant species could create an enhanced green space with the associated environmental benefits of native plants and conceal concept utilities such as the electrical building.

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

Coastal Stormwater Discharge Analysis
Old Harbor Park Pump Station



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November 2022

Adaptability and Implementation

Adaptability

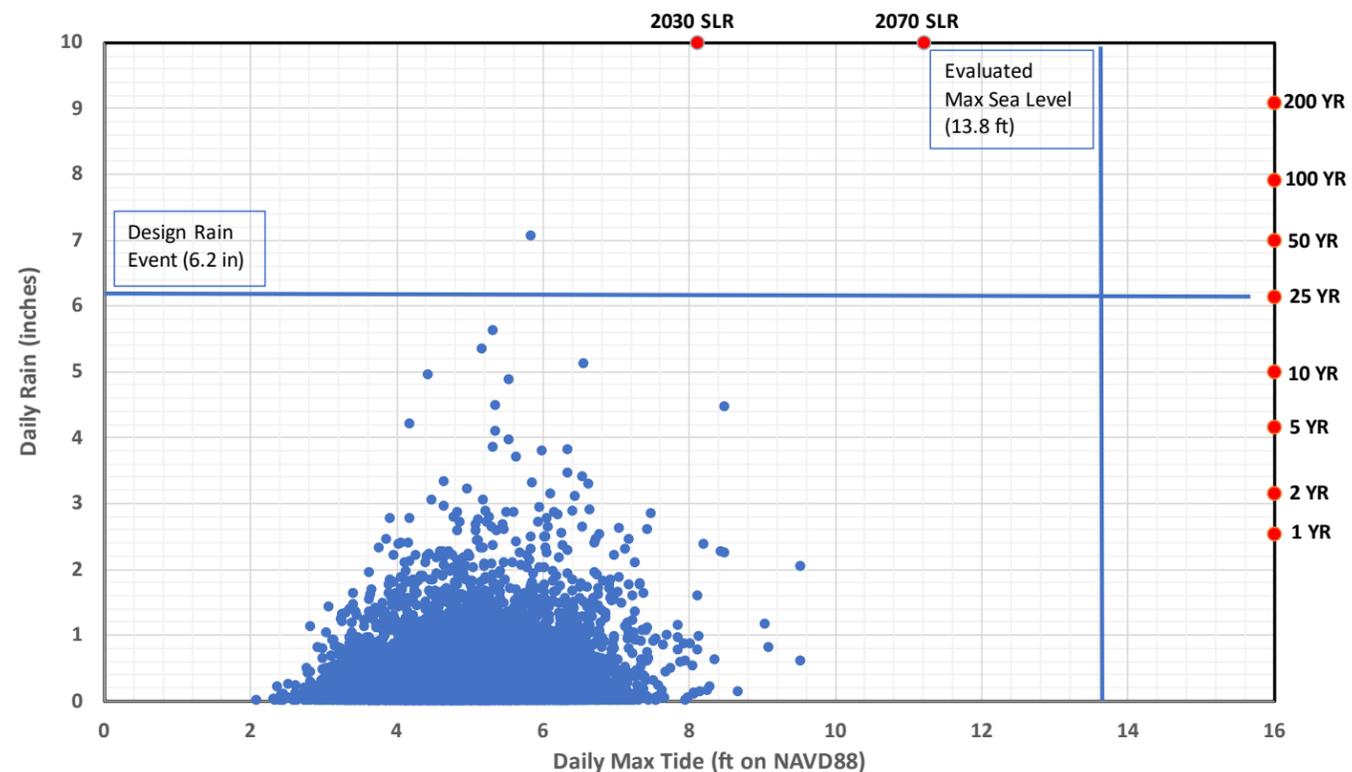
Figure 5 below depicts historical daily rainfall totals and tide levels. As shown in this figure, the conditions that were used to design and analyze the Harbor Park pump station are conservative and represent more extreme conditions than have occurred historically. Regardless, the following measures 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 peak shaving tank

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.
- Planting of native plant species and other green features will provide an improved public amenity and preserve the “look and feel” of the greenway.
- Community engagement with stakeholders may help build project support by illustrating the flood control benefits of the 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 (recreation area).
- A thorough analysis of constructability should be conducted at this location. Methods to minimize disruptions to residents should be considered during the design process.

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



Coastal Stormwater Discharge Analysis
Old Harbor Park Pump Station

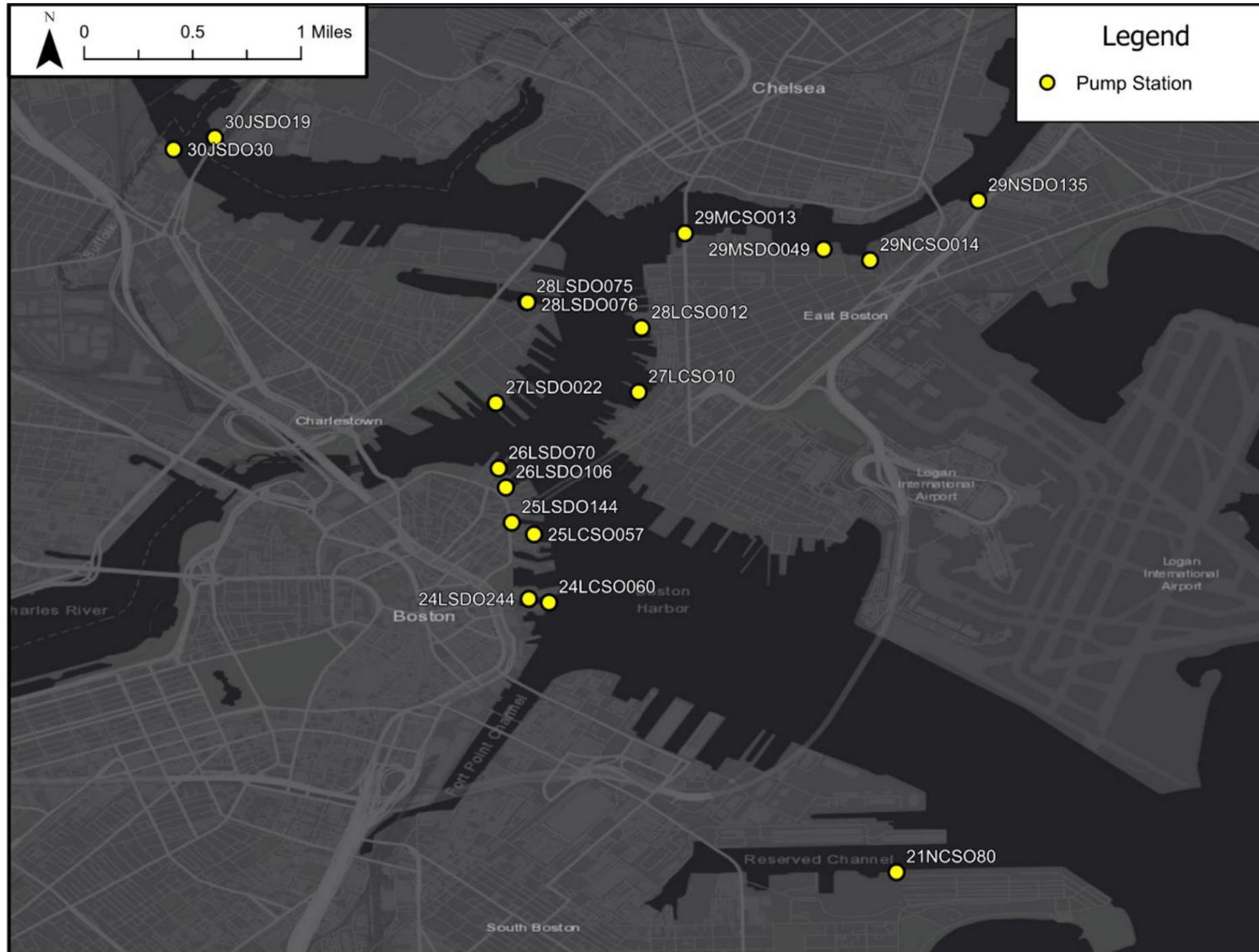


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Replicability and Implementation Timeline



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.

Coastal Stormwater Discharge Analysis
Old Harbor Park Pump Station



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November 2022

ATTACHMENT A
OLD HARBOR PARK PUMP STATION CONCEPTUAL DESIGN DRAWINGS

A-1: Overview Plan and Pump Station Plans

A-2: Pump Station Section View

Coastal Stormwater Discharge Analysis
Old Harbor Park Pump Station



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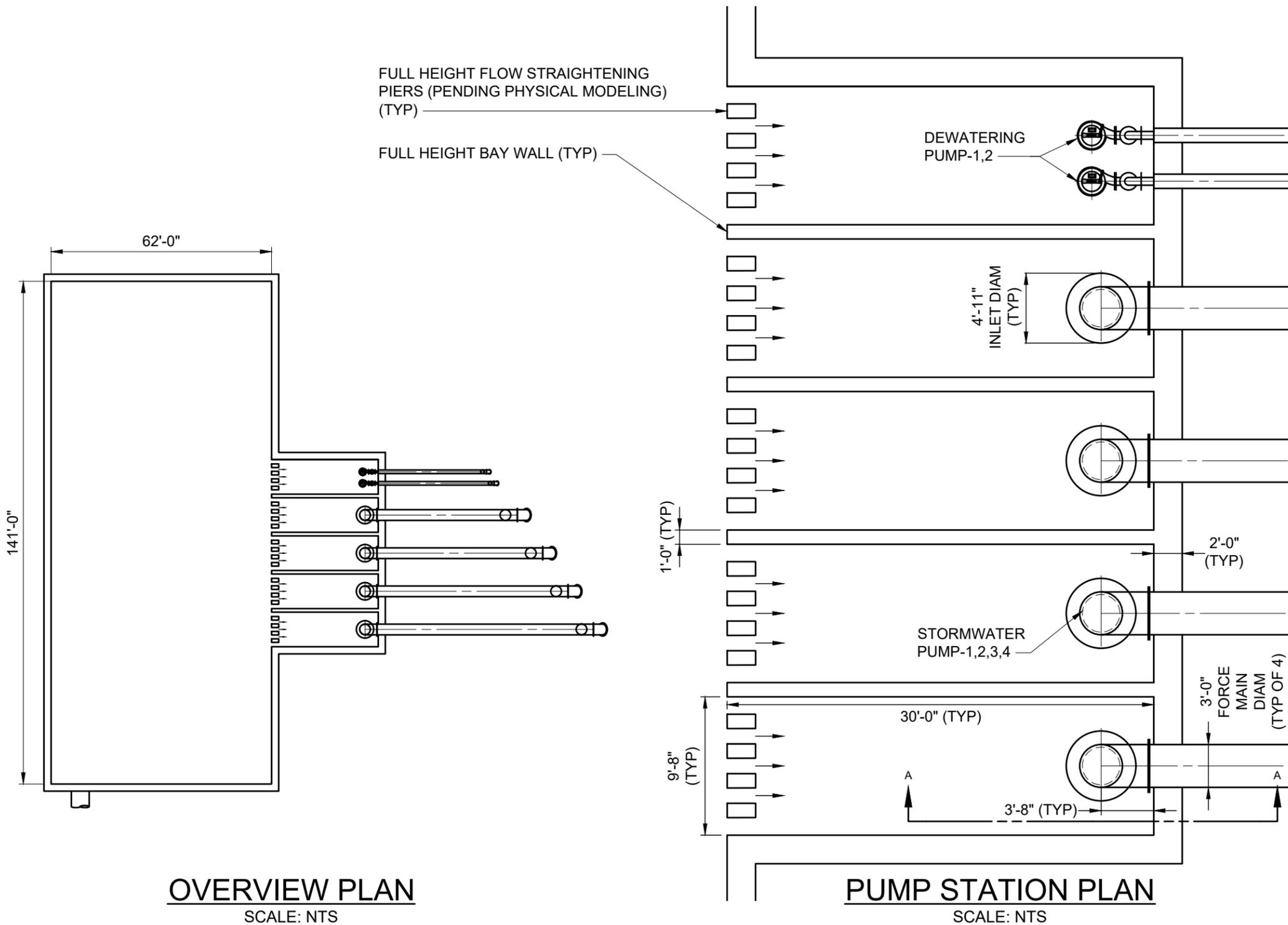
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Old Harbor Park Stormwater Pump Station

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 OPERATIONAL PARAMETERS	
FLOW RATE, CFS	102
STATIC HEAD RANGE, FT	14.3 - 20.2
DESIGN FLOOD ELEVATION, FT	16.5

STORMWATER PUMP-1,2,3,4 OPERATIONAL WSE TABLE		
NOTE	OPERATION	ELEVATION, FT
A	HIGH LEVEL ALARM	2.8
B	LAG PUMP ON	1.8
C	LEAD PUMP ON	0.8
D	LEAD PUMP OFF	-0.2
E	LOW LOW ALARM	-1.2
G	MIN PUMP SUBMERGENCE	-2.2

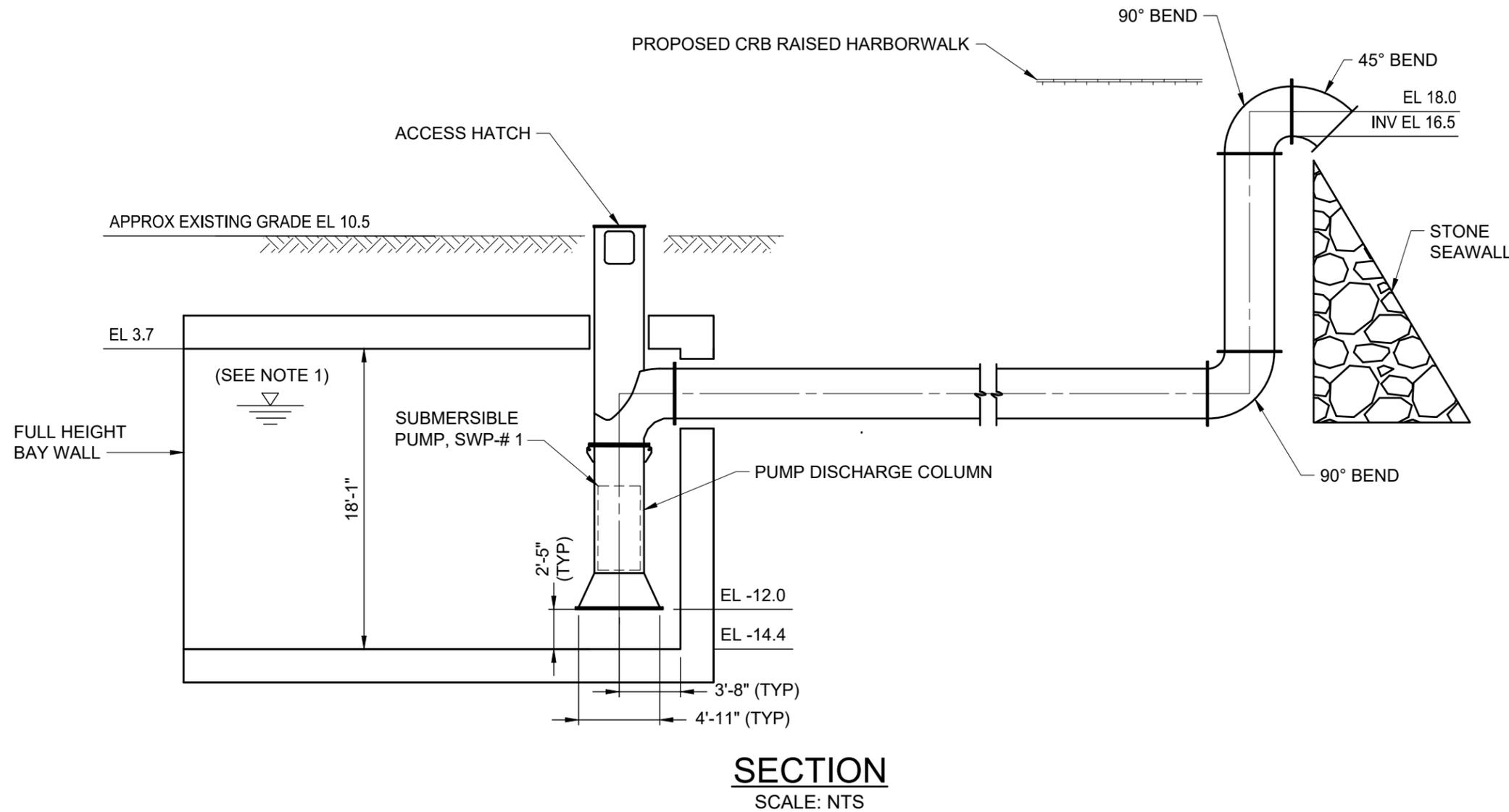
COASTAL STORMWATER DISCHARGE ANALYSIS	
	
A-1	November 2022

Old Harbor Park Stormwater Pump Station

NOTES

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STORMWATER PUMP-1,2,3,4 OPERATIONAL PARAMETERS	
FLOW RATE, CFS	102
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DESIGN FLOOD ELEVATION, FT	16.5

STORMWATER PUMP-1,2,3,4 OPERATIONAL WSE TABLE		
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D	LEAD PUMP OFF	-0.2
E	LOW LOW ALARM	-1.2
G	MIN PUMP SUBMERGENCE	-2.2

COASTAL STORMWATER DISCHARGE ANALYSIS	
	
A-2	November 2022