
# Scituate Wastewater Collection System

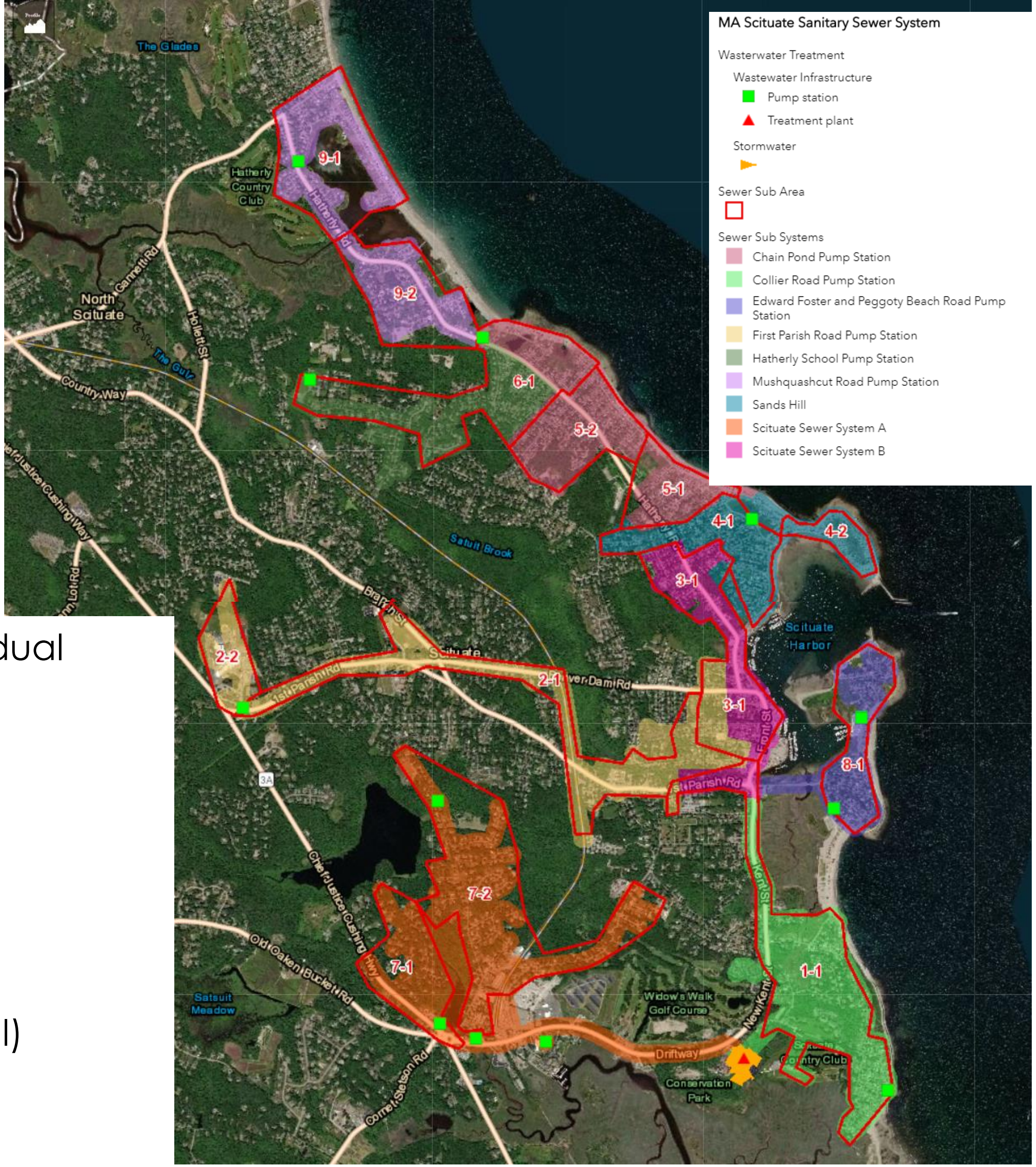
## Resilience Feasibility Study – Project Update Meeting

May 31, 2019

GZA GeoEnvironmental, Inc.
Known for excellence. Built on trust.

# Scituate Sewer Collection and Treatment System

- +/-32 miles of sanitary sewer
- +/- 1071 sanitary manholes
- 9 pump stations/collection areas
- 14 drainage subareas
- 1 treatment plant




Scituate Wastewater Treatment Plant (WWTP) – individual SSCs

- Plant constructed: 1965
- Plant upgraded: 1984, 2000
- Serves about 7,500 people (+/- 20% population)
- Permitted daily flow capacity: 1.6 mgd
- Average daily flow: 1.31 mgd
- Peak hourly flow capacity: 4.34 mgd (3.6 mgd actual)
- Peak daily flow capacity 3.33 mgd
- Discharges to Herring River/North River Estuary

# Why Perform Study

- ✓ Critical Lifeline System - part of Town Resilience Planning
- ✓ System is vulnerable to coastal flooding
- ✓ Vulnerability will increase in the future due to sea level rise/climate change
- ✓ System upgrades are on-going – need to consider flood vulnerability
- ✓ System expansion – needs to consider flood vulnerability
- ✓ Near and Long term planning – understand system resilience and potential financial liability
- ✓ Benefit/Cost of flood mitigation system improvements
- ✓ Set priorities
- ✓ Position Town for outside funding (e.g., FEMA grants)

# Study Objectives

## System Vulnerability Assessment:

- ✓ Characterize the flood hazard (flood elevations, water depths, duration and flood-related loads)
- ✓ Assess the wastewater treatment system flood vulnerability to different probability flood events
- ✓ Estimate flood-related losses

## Flood Mitigation/Resilience Planning:

- ✓ Identify flood risk mitigation strategies and alternatives
- ✓ Perform benefit/cost analyses
- ✓ Recommend a flood risk mitigation strategy and measures

# Risks

1. **Direct damage** due to: 1) flood inundation; b) corrosion; c) mold; and d) environmental flood loads (hydrostatic, hydrodynamic and wave loads).
2. **Loss of service** (operational disruption) due to temporary or permanent *direct damage*.
3. **Loss of service** (operational disruption) due to *excessive flow* (exceeding system capacity, causing internal flooding and/or managed system shutdown to avoid damage).
4. **Indirect Effects**:
    - Increased costs (user, capital, operating, insurance)
    - Limitations to system expansion
    - Environmental Impacts
    - Licensing and permitting
    - Municipal Bond rating

# Characterize Risk: Compare to Industry Standards and Regulations

**1. TR-16 Guides for the Design of Wastewater Treatment Works:**

- New Facility Design:
  - Piping Inflow and Infiltration (I/I): piping protected from I/I during wet weather conditions within 100-year floodplain
  - Pump Stations and Treatment Plant:
    - uninterrupted service during 100-year recurrence interval flood
    - first floors, tank walls and structural openings should be protected against damage to the 100-year recurrence interval flood elevation
    - critical equipment should be protected against damage up to a water elevation that is 3 feet above the 100-year flood elevation (100-year recurrence interval flood level + 3 feet)
    - non-critical equipment should be protected against damage up to a water surface elevation that is 2 feet above the 100-year flood elevation
    - SCADA system components and instrumentation used to monitor and control facility operation should be protected from flood conditions to the maximum extent practical
    - furnish the backup power supply for critical equipment: run under full load or peak flow for at least 48 hours, or under normal operating conditions for at least 96 hours

# Characterize Risk: Compare to Industry Standards and Regulations

**1. TR-16 Guides for the Design of Wastewater Treatment Works:**

- New Facility Design:
  - Hydraulic Capacity:
    - allow for peak hourly flows, including associated sidestream flows, to be passed through the plant with the largest of longest flow path of each unit process removed from service and with the receiving water at the 100-year recurrence interval flood elevation (including considerations of climate change)

- Existing Facility Flood Mitigation:
  - Develop in *consideration of risk and benefit/cost*. Existing pump stations and treatment facilities that are planned for upgrade or expansion should be improved to the maximum extent possible to meet the flood protection criteria for new facilities

# Characterize Risk: Compare to Industry Standards and Regulations

2. **Massachusetts Building Code:**
   - New Facility Design:
     - Flood Class 3 Structures
     - FEMA Coastal A Zones and Coastal High Hazard Areas:
       - The minimum elevation of the bottom of the lowest supporting horizontal member of the lowest floor, relative to the FEMA Base Flood Elevation (BFE) or Design Flood Elevation (DFE) shall be the BFE plus 2 feet or the DFE, whichever is higher.
     - FEMA Flood Areas not identified as Coastal A Zones and Coastal High Hazard Areas:
       - The minimum elevation of the top of the lowest floor, relative to the FEMA Base Flood Elevation (BFE) or Design Flood Elevation (DFE) shall be the BFE plus 1 foot or the DFE, whichever is higher.

# Characterize Risks: Risk Assessment

1. **Probability** – Likelihood and frequency of occurrence
2. **Disruption of Service:**
    - Duration
    - % system impacted
3. **Damage/Financial Loss:**
    - Average Annualized Loss (AAL)
    - Service Life Loss
    - Effects on:
        - facility operating budget
        - Town general budget
        - Property owner costs
4. **Environmental Impacts**

# GZA Methodology

Asset Inventory:
Systems, Structures and Components

Flood Hazard Characterization

Flood Vulnerability Assessment

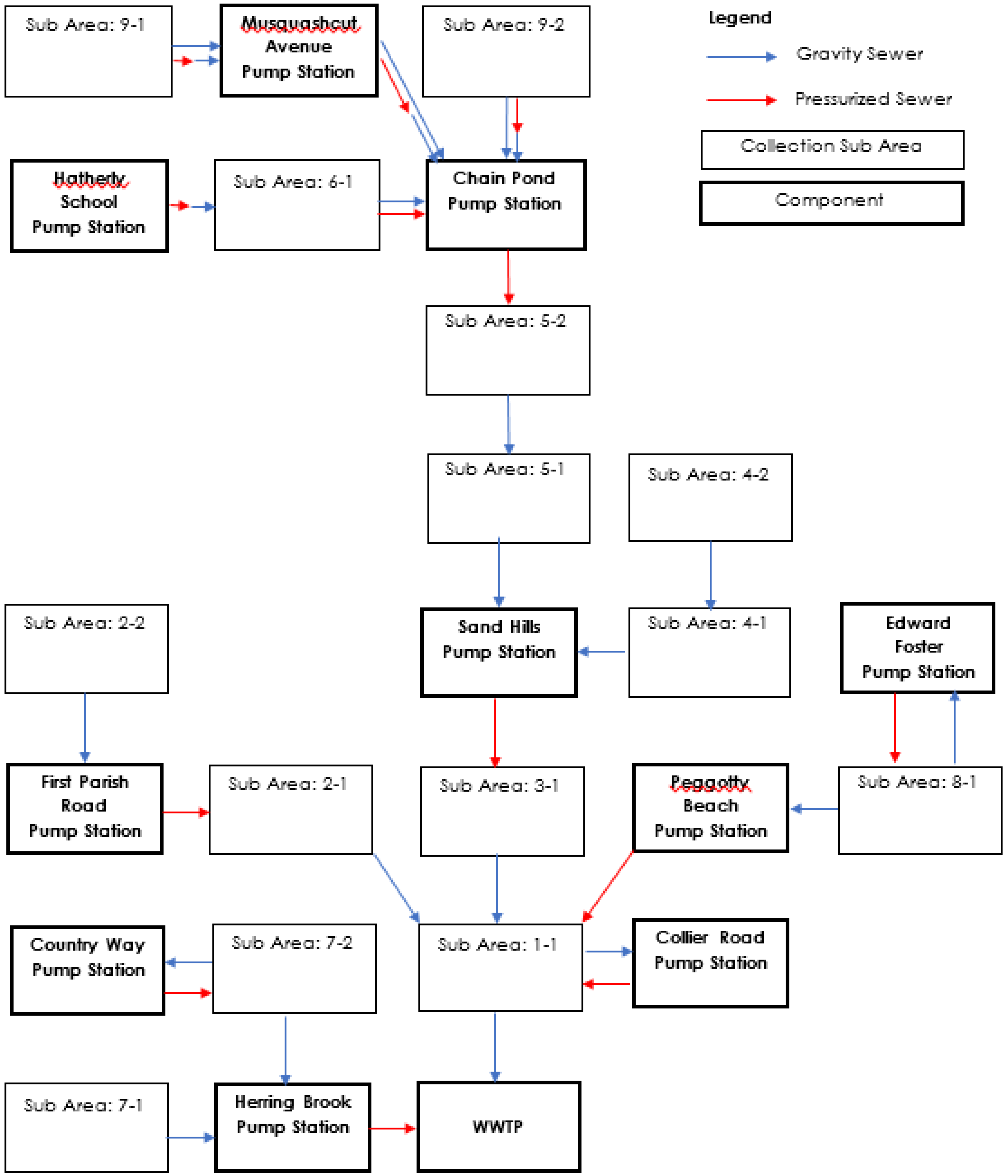
Risk-Based Framework:
- Flood Frequency
- System Response

## Analysis and Feasibility Planning:
- Flood Mitigation Strategy
- Flood Mitigation Measures Alternatives
- Benefit/Cost Analyses
- Recommendations
- Implementation

Consistent with: EPA Flood Resilience: Basic Guide for Water and Wastewater Utilities

# System Analysis

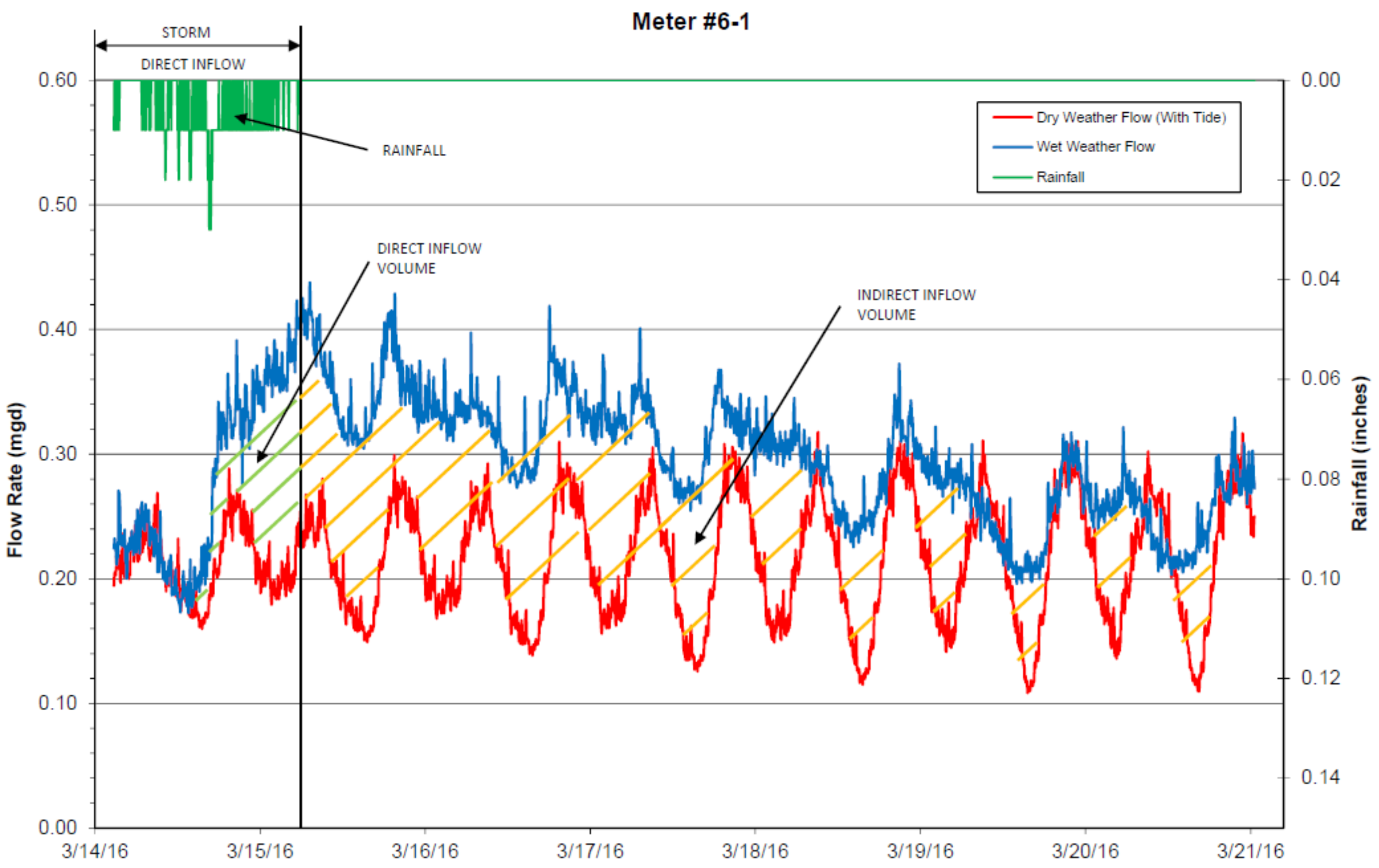
| Name | Area (sqft) | Acres | Parcels | Buildings | Struct | Force Mains | Collector | Stub |
|---|---|---|---|---|---|---|---|---|
| Chain Pond Pump Station | 9,620,707 | 220.86 | 737 | 657 | 161 | 2,705 | 34,229 | 0 |
| First Parish Road Pump Station | 12,187,516 | 279.79 | 355 | 371 | 129 | 3,435 | 27,423 | 164 |
| Edward Foster and Peggoty Beach Road Pump Station | 4,219,770 | 96.87 | 170 | 159 | 68 | 3,913 | 10,016 | 0 |
| Scituate Sewer System A (Country Way and Herring Brook) | 16,583,837 | 380.71 | 361 | 399 | 201 | 12,612 | 34,205 | 27 |
| Collier Road Pump Station | 10,469,346 | 240.34 | 337 | 356 | 151 | 1,064 | 151 | 47 |
| Scituate Sewer System B | 5,571,309 | 127.90 | 312 | 274 | 83 | 206 | 17,057 | 11 |
| Sands Hill | 6,684,319 | 153.45 | 549 | 495 | 116 | 873 | 21,524 | 0 |
| Mushquashcut Road Pump Station | 8,297,452 | 190.48 | 348 | 334 | 99 | 11,204 | 15,943 | 53 |
| Hatherly School Pump Station | 5,815,602 | 133.51 | 250 | 258 | 63 | 5,079 | 12,436 | 0 |



# Findings: System Vulnerability

1. **Inflow/Infiltration (I/I):** piping protected from I/I during wet weather conditions within 100-year floodplain:
    - 8 drainage subareas are partially within FEMA 100-year floodplain
    - CDM Smith completed I/I study during 2016
    - I/I due to:
        - Base (groundwater) infiltration
        - Tidal (groundwater) infiltration
        - Inflow (connected sources such as roof leaders, catch basins, sumps, drains)
    - I/I increases during wet weather (precipitation) events
    - **I/I also increases during coastal storm events (flood inundation and increased tidal effects)**

# Inflow Analysis



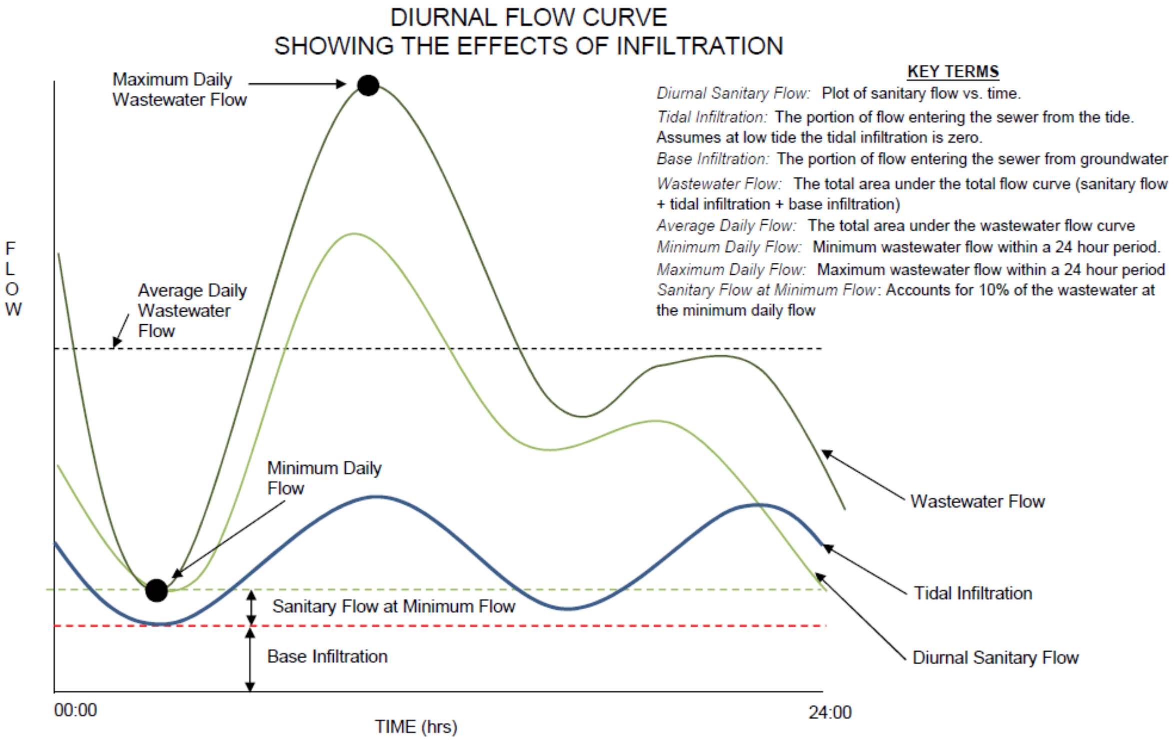

| Inflow Subarea Rank | Sub Area | Volume Event Net Inflow (gal) | Volume Event Direct Net Inflow (gal) | Volume Event Indirect Net Inflow (gal) | Inch-Miles (in-mi) | Inflow Severity (g/in-mi) | Cumulative Inflow Volume Event (gal) | Cumulative Inflow Volume Event (%) |
|---|---|---|---|---|---|---|---|---|
| 1 | 4-2 | 185,290 | 38,985 | 146,305 | 7.56 | 24,516 | 185,290 | 9% |
| 2 | 6-1 | 332,670 | 43,162 | 289,508 | 32.10 | 10,364 | 517,960 | 25% |
| 3 | 5-1 | 210,670 | 6,648 | 204,022 | 21.28 | 9,898 | 728,629 | 35% |
| 4 | 4-1 | 201,348 | 5,113 | 196,236 | 23.01 | 8,751 | 929,978 | 45% |
| 5 | 5-2 | 258,964 | 30,618 | 228,346 | 31.64 | 8,184 | 1,188,942 | 57% |
| 6 | 1-1 | 391,158 | 77,789 | 313,369 | 77.25 | 5,064 | 1,580,100 | 76% |
| 7 | 7-2 | 139,867 | 26,672 | 113,196 | 30.59 | 4,572 | 1,719,967 | 83% |
| 8 | 2-1 | 214,212 | 36,356 | 177,856 | 47.74 | 4,487 | 1,934,179 | 93% |
| 9 | 3-1 | 102,209 | 85,342 | 16,867 | 49.54 | 2,063 | 2,036,388 | 98% |
| 10 | 7-1 | 23,948 | 4,795 | 19,152 | 14.09 | 1,700 | 2,060,335 | 99% |
| 11 | 2-2 | 10,412 | 5,063 | 5,348 | 7.60 | 1,370 | 2,070,747 | 99% |
| 12 | 8-1 | 10,923 | 5,871 | 5,052 | 14.98 | 729 | 2,081,670 | 100% |
| System Total | | 2,081,670 | 366,413 | 1,715,257 | | | | |
| | | | 17.60% | 82.40% | | | | |

7 drainage sub areas (65% of total sewer piping) contribute 83% of total inflow:

- 4-2; 6-1; 5-1; 4-1; 5-2; 1-1; 7-2
- Majority of inflow is indirect (82% vs 18% direct)

Ref. CDM Smith

# Infiltration Analysis




5 drainage sub areas have infiltration greater than 4,000 gpd per inch pipe diameter per mile

- 2-1; **4-1; 4-2; 5-1; 6-1 Bold** indicates most susceptible to tidal effects

Ref. CDM Smith

| Infiltration Subarea Rank | Subarea | Length (LF) | Inch-Miles (in-mi) | Gross Infiltration (gpd) | Net Infiltration (gpd) | Infiltration Severity (gpd/in-mi) |
|---|---|---|---|---|---|---|
| 1 | 5-1 | 9,223 | 21.28 | 423,904 | 203,279 | 9,551 |
| 2 | 4-2 | 4,724 | 7.56 | 49,439 | 49,439 | 6,541 |
| 3 | 6-1 | 21,068 | 32.10 | 173,964 | 173,964 | 5,420 |
| 4 | 4-1 | 14,735 | 23.01 | 164,085 | 114,647 | 4,983 |
| 5 | 2-1 | 19,424 | 47.74 | 207,443 | 199,652 | 4,182 |
| 6 | 3-1 | 18,930 | 49.54 | 669,981 | 81,991 | 1,655 |
| 7 | 5-2 | 15,999 | 31.64 | 220,625 | 46,662 | 1,475 |
| 8 | 7-1 | 9,298 | 14.09 | 19,039 | 19,039 | 1,351 |
| 9 | 1-1 | 29,971 | 77.25 | 959,768 | 81,977 | 1,061 |
| 10 | 7-2 | 20,190 | 30.59 | 31,368 | 31,368 | 1,025 |
| 11 | 2-2 | 5,015 | 7.60 | 7,791 | 7,791 | 1,025 |
| 12 | 8-1 | 9,889 | 14.98 | 368 | 368 | 25 |

**SYSTEM TOTAL = 1,010,174 gpd**

Average

| Infiltration Subarea Rank | Subarea | Length (LF) | Inch-Miles (in-mi) | Gross Infiltration (gpd) | Net Infiltration (gpd) | Infiltration Severity (gpd/in-mi) |
|---|---|---|---|---|---|---|
| 1 | 5-1 | 9223 | 21.3 | 503,608 | 228,499 | 10,736 |
| 2 | 4-1 | 10852 | 20.4 | 206,722 | 171,587 | 7,457 |
| 3 | 6-1 | 21068 | 32.1 | 218,310 | 218,310 | 6,801 |
| 4 | 4-2 | 10072 | 15.7 | 35,135 | 35,135 | 4,649 |
| 5 | 2-1 | 19424 | 47.7 | 209,030 | 206,603 | 4,328 |
| 6 | 5-2 | 15,999 | 31.6 | 275,108 | 56,798 | 1,795 |
| 7 | 7-1 | 9,298 | 14.1 | 16,001 | 16,001 | 1,136 |
| 8 | 7-2 | 20,190 | 30.6 | 34,689 | 34,689 | 1,134 |
| 9 | 3-1 | 17,465 | 44.0 | 745,232 | 34,902 | 704 |
| 10 | 2-2 | 5,015 | 7.6 | 2,426 | 2,426 | 319 |
| 11 | 1-1 | 29,971 | 77.2 | 978,152 | 23,360 | 302 |
| 12 | 8-1 | 9,889 | 15.0 | 531 | 531 | 35 |

**SYSTEM TOTAL = 1,028,841 gpd**

High Tide

# Findings: System Vulnerability

## 1. Inflow/Infiltration (I/I) Effects/Implications:

CDM Smith study concluded:

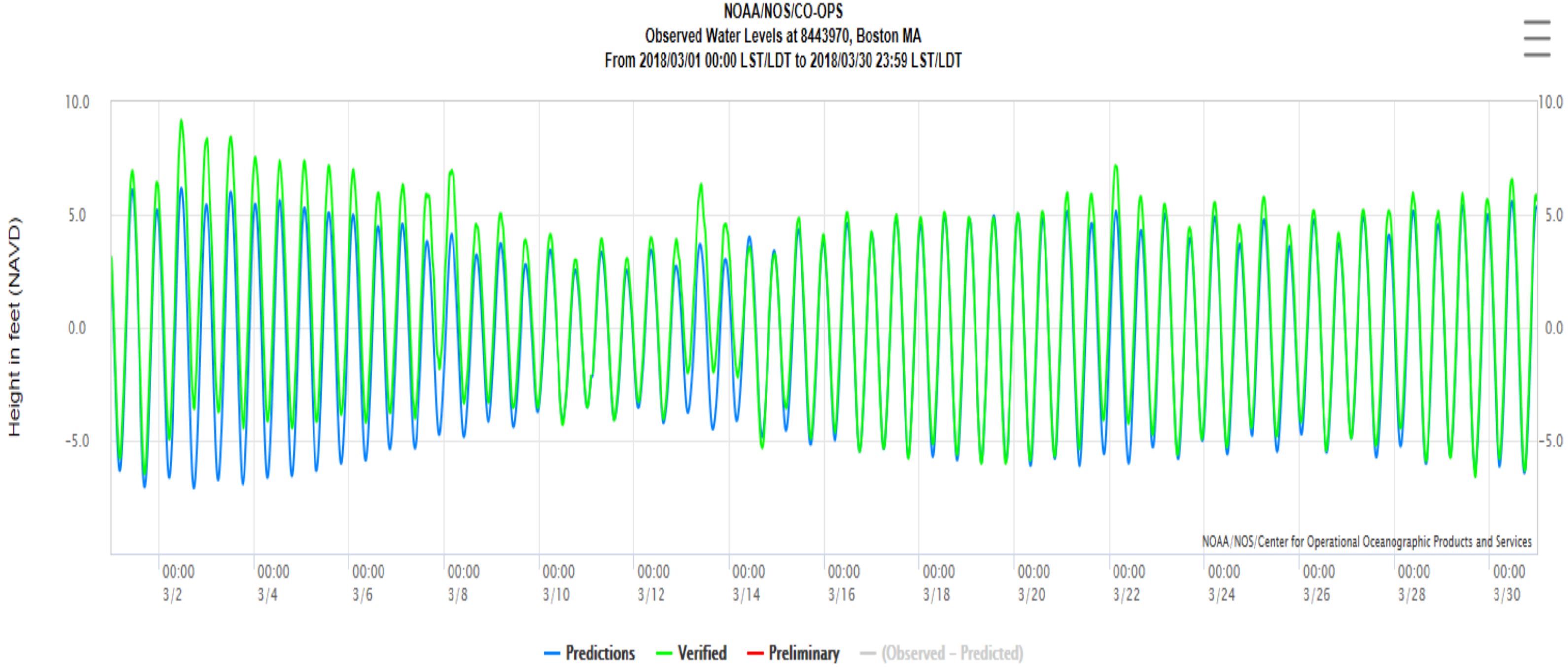
- System I/I concentrated in certain drainage sub-areas
- I/I consists mostly of groundwater/tidal infiltration and indirect inflow (sumps, foundation drains)
- High priority mitigation areas include: 4-1,**4-2**, 5-1 and **6-1 (Bold** indicates previously repaired)

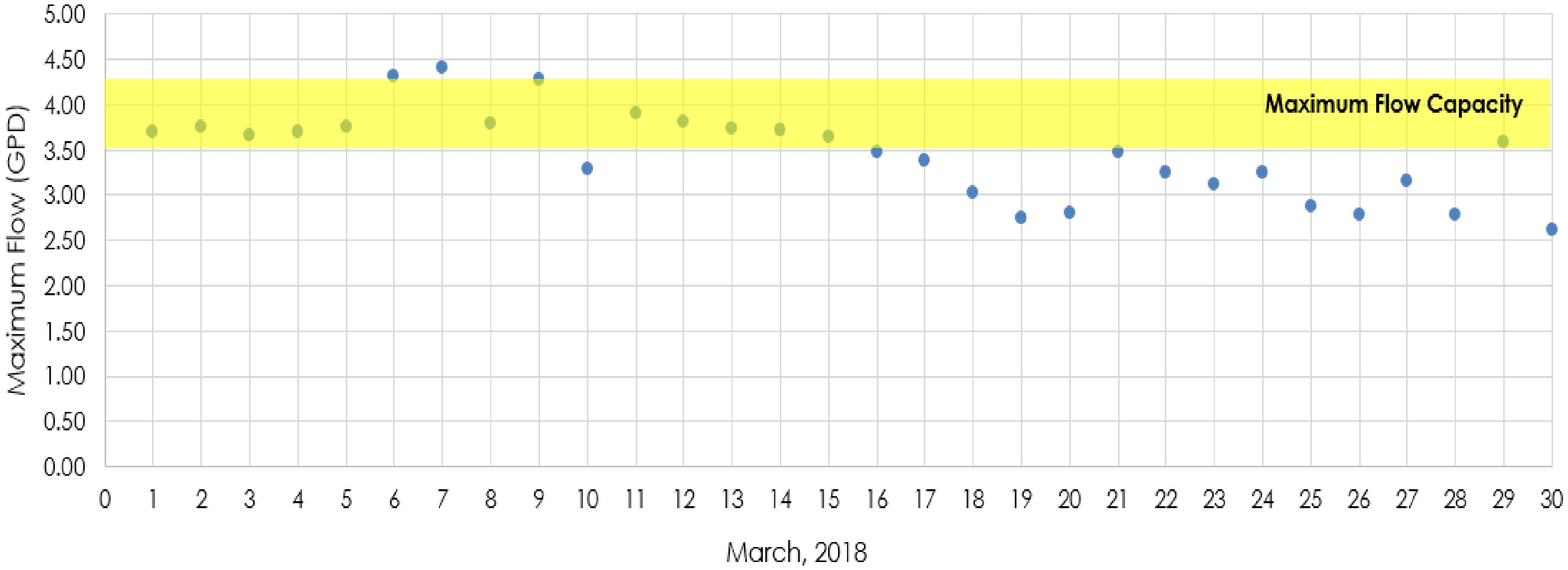
1. I/I contributes to increased flows and can exceed pumping and collection system capacity
2. System-wide I/I can result in flows during storm events that exceed plant treatment capacity
3. Effects will increase during coastal flood events and over time due to sea level rise
4. Can result in: disruption of service; pump damage; system surcharge; internal (wastewater) flooding at pump stations and treatment plant; external (wastewater) flooding; unplanned environmental release; and financial loss

# Findings: System Vulnerability

1. Inflow/Infiltration (I/I)Coastal Storm Effects:

Sand Hills Pump Station March 1-3, 2018



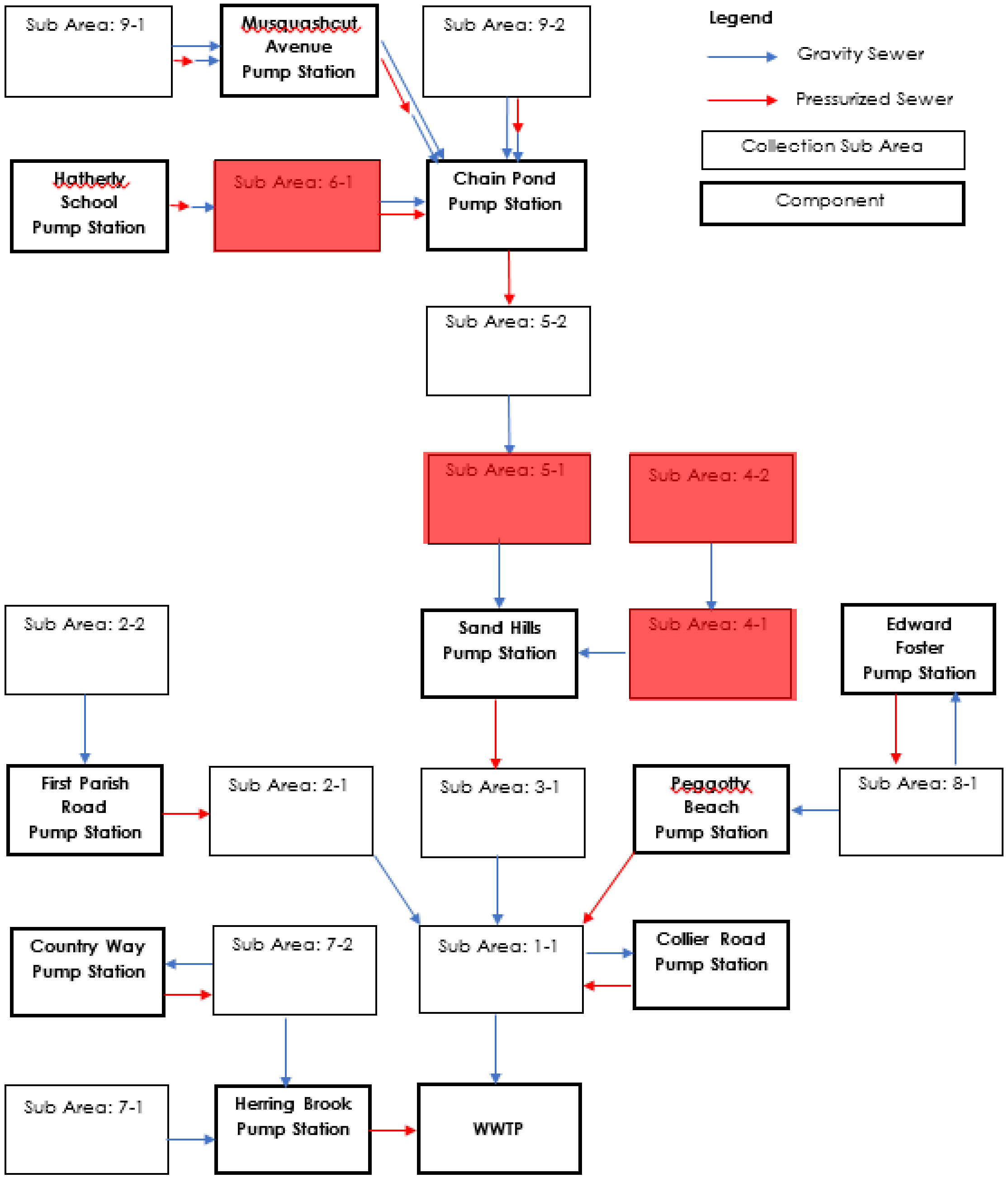
# Findings: System Vulnerability

## 1. Inflow/Infiltration (I/I)Coastal Storm Effects:

| Pump Station | Dry Average (GPD) | Wet Average (GPD) | Design Capacity (GPM) | March 2108 Peak (GPD) |
|---|---|---|---|---|
| **Musquashcut** | 10,000 | 13,000 | 600 | 55,000[1] |
| **Peggotty Beach** | 10,000 | 25,000 | 280 | 108,000 |
| **Herring Brook** | 35,000 | 70,000 | 1,000 | 120,000[2] |
| **Country Way** | 6,500 | 15,000 | 260 | 14,000 |
| **Chain Pond** | 200,000 | 250,000 | 1,200 | 525,000 |
| **Sand Hills** | 600,000 | 1,000,000 | 1,600 | 2,250,000 |

Preliminary Conclusion:

- Collection system and treatment capacity probably is reached during a coastal flood event with stillwater elevation on the order of 9 feet NAVD88 (+/- 50 year recurrence interval in 2019).



# Findings: System Vulnerability

## 2. Pump Station Vulnerability:

- Pump stations located within FEMA flood hazard areas:
    - Musquashicut (GS=7 ft NAVD88; AE 13 ft NAVD88 )
    - Chain Pond (GS=11 to 12 ft NAVD88; AE 14 ft NAVD88 )
    - Sands Hill (GS=5 to 7 ft NAVD88; AE 15 ft NAVD88)
    - Edward Foster (GS=9 to 10 ft NAVD88; AE 16 ft NAVD88)
    - Peggotty Beach (GS=9 to 10 ft NAVD88; VE 17 ft NAVD88)
    - Herring Brook (GS=9 to 10 ft NAVD88; AE 16 ft NAVD88)
    - Collier Road (GS=15.5 to 16 ft NAVD88; outside but close to FEMA AE, El. 16 ft NAVD88)

# Detailed Asset Inventory: Pump Stations

## Topographic and Site Setting

Sand Hills Pump Station:

**Latitude:** 42°12'29.2"N
**Longitude:** 70°43'33.0"W

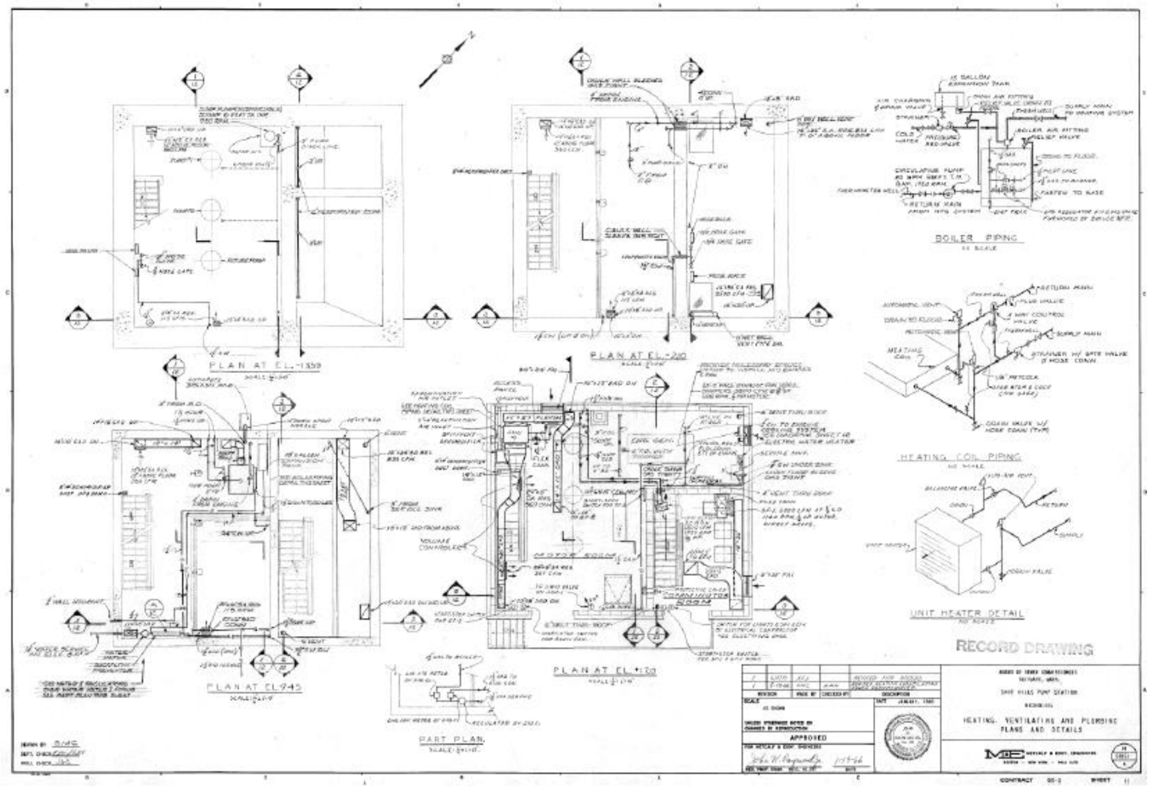
Facility Location and Ground Surface Elevation:

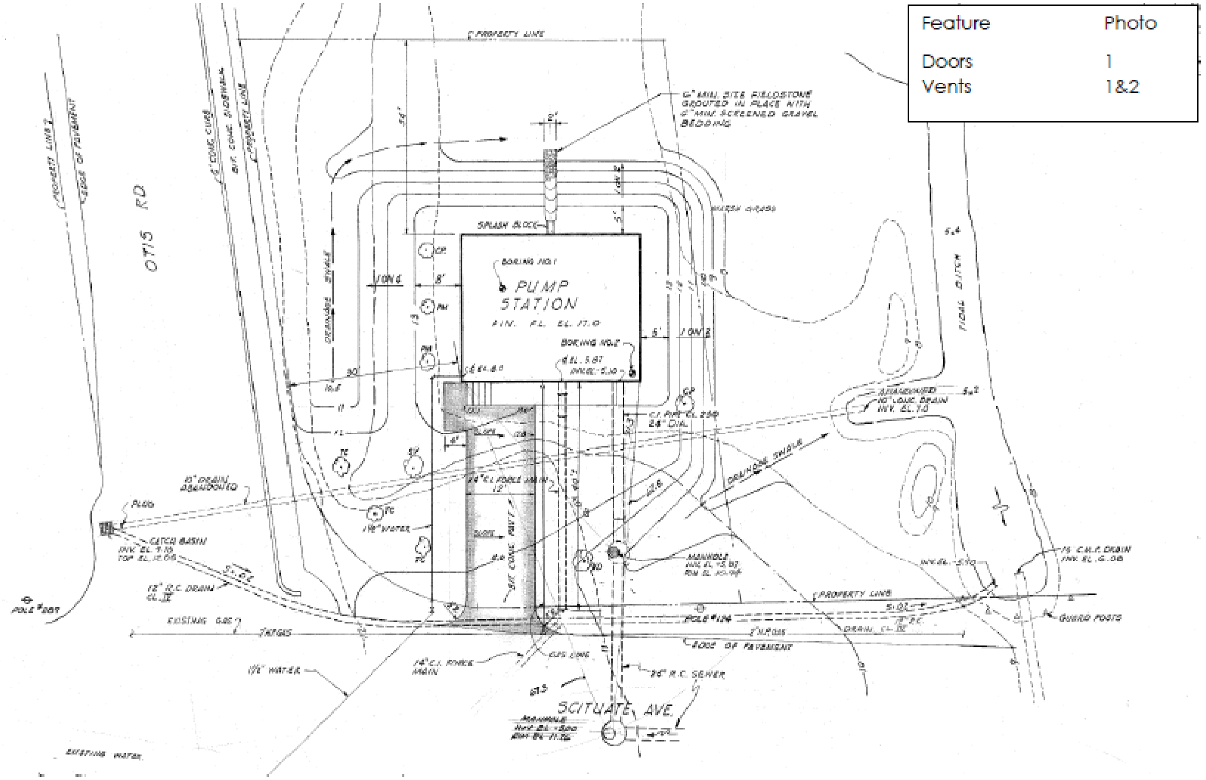

Site Location


Elevation, feet NAVD88

# Detailed Asset Inventory: Pump Stations

## Facility Plans




| Feature | Photo |
|---|---|
| Doors | 1 |
| Vents | 1&2 |

Source: Sheet 1 – Sand Hill Pump Station Civil Site Plan

# Detailed Asset Inventory: Pump Stations

Site Reconnaissance



# Detailed Asset Inventory: Pump Stations

## Water Entry Point Inventory

Sand Hills Pump Station: Water Entry Elevation Table

| Water Entry Points | ID | Description Critical Elevation | Elevation (feet, NGVD29) | Elevation (feet, NAVD88) |
|---|---|---|---|---|
| Windows: | | None Observed | | |
| Doors (Personnel and Public): | | | | |
| Personnel entryway | 1 | Door Threshold elev. | 12.2± | 11.4± |
| Personnel entryway | 2 | Door Threshold elev. | 12.2± | 11.4± |
| Vents: | | | | |
| 18" x 88" Vent | Vent 1 | Bottom of Vent | 12.2± | 11.4± |
| 28" x 40" Vent | Vent 2 | Bottom of Vent | 16.7± | 15.9± |
| 28" x 40" Vent | Vent 3 | Bottom of Vent | 16.7± | 15.9± |
| 28" x 88" Vent | Vent 4 | Bottom of Vent | 12.2± | 11.4± |
| 28" x 88" Vent | Vent 5 | Bottom of Vent | 12.2± | 11.4± |
| 8" x 8" Vent | Vent 6 | Bottom of Vent | 12.4± | 11.6± |
| 8" x 8" Vent | Vent 7 | Bottom of Vent | 14.0± | 13.2± |
| Other | | | | |
| Outside Electric Meter Panel | | Lowest Elevation | 13.9± | 13.1± |
| Pipe Wall Penetrations to daylight or unsealed vaults/manholes | | None Observed | | |
| Exterior Stairs | | Bottom of Step | 8.1± | 7.3± |
| Electrical Conduit North Wall Penetrations | | Wall Penetration | 19.3± | 18.5± |
| Electrical Conduit East Wall Penetrations | | Wall Penetration | 16.1± | 15.3± |
| Outside Gas Pressure Regulator | | Lowest Elevation | 8.2± | 7.4± |
| Gas Connection | | Wall Penetration | 8.8± | 8.0± |
| Generator Exhaust | | Invert of Pipe | 18.8± | 18.0± |
| Roof Drain | | Invert of Pipe | 8.8± | 8.0± |
| Wet well Manhole/Hatch Rim | | None Observed | | |
| Wet well Vent Pipe | | None Observed | | |

# Detailed Asset Inventory: Pump Stations

## Building Structure and Critical Equipment Inventory

Building, System and Component Details: Sand Hills Pump Station

Year Constructed: 1966

Building Type:

- Concrete foundation wall; concrete slab-below-grade
- Building frame: concrete walls
- Structure tie-downs: Yes
- Door Type: Metal
  - Waterproof Door: No

System Components:

**Building Interior:**

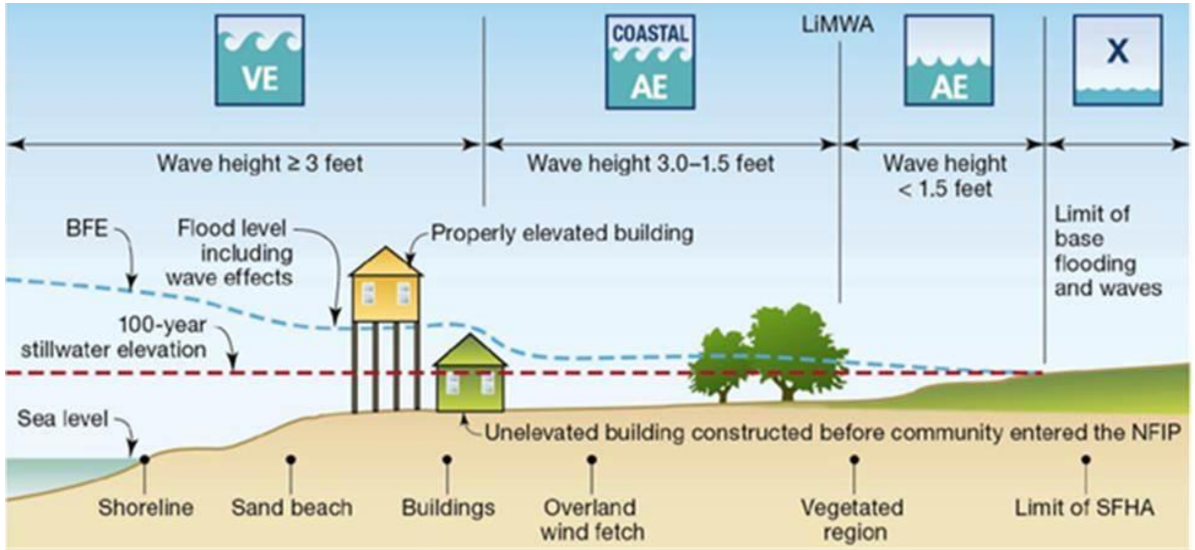
- Air intake vents and Motor-Operated Dampers:
  - 18'' by 88''
  - 28" by 40"
  - 28" by 88"
- Wall-mounted and Floor Electrical and Pump Control Panels
- Sink:
  - Backflow preventer: Unknown
- Back-up Generator: Gas
- Building Heater: Gas

**Well and Pump Details:**

- Two Internal wet wells,
  - Bottom elevation: -19± (NAVD88)
- Three Vertical turbine pumps in dry well, (operable if submersed)
  - Bottom elevation: -19± (NAVD88)
- Comminutor mounted above wet wells.

| Interior Components | Elevation (feet, NGVD29) | Elevation (feet, NAVD88) |
|---|---|---|
| **Critical** | | |
| Inside Generator Skid Top Elev. | 12.7± | 11.9± |
| Floor Mounted Control Panel | 12.2± | 11.4± |
| Circuit Breaker | 16.7± | 15.9± |
| Pump Motors | 12.5± | 11.7± |
| | | |
| **Non-Critical** | | |
| Boiler | 2.7± | 1.9± |
| Water Heater | 12.7± | 11.9± |
| Comminutor Motor | 12.5± | 11.7± |
| | | |

# Flood Hazard Characterization: Pump Stations




Coastal Flood:

- Stillwater
- Wave set-up
- Wave height
- Wave run-up

Coastal Flood Effects:

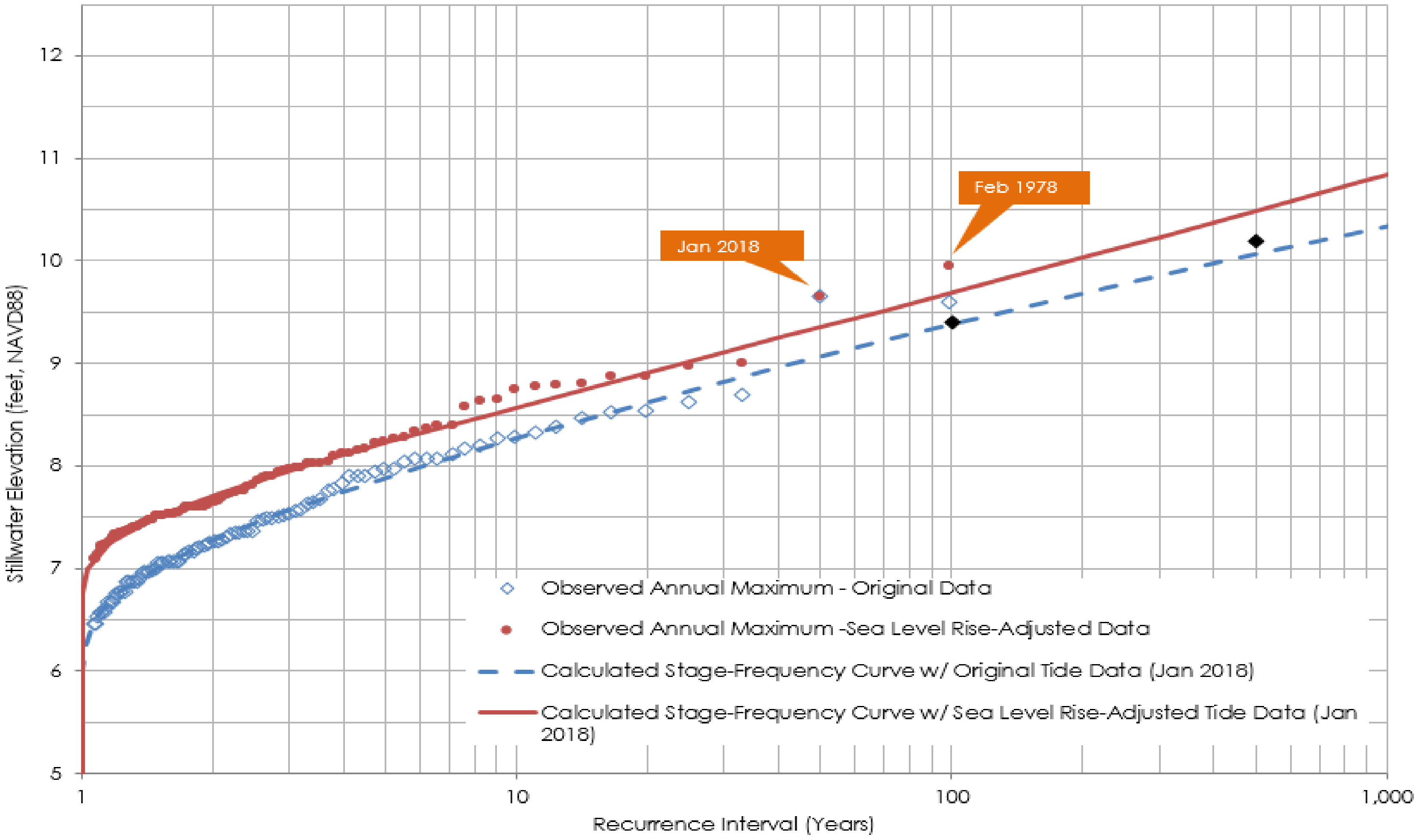
- Flood inundation
- Flood Loads on structure
- Corrosion, mold, etc.


Sands Hill Pump Station

# Flood Hazard Probability

Annual Exceedance Probability (AEP)/ Recurrence Interval

Boston NOAA Tide Station Flood-Frequency Curve



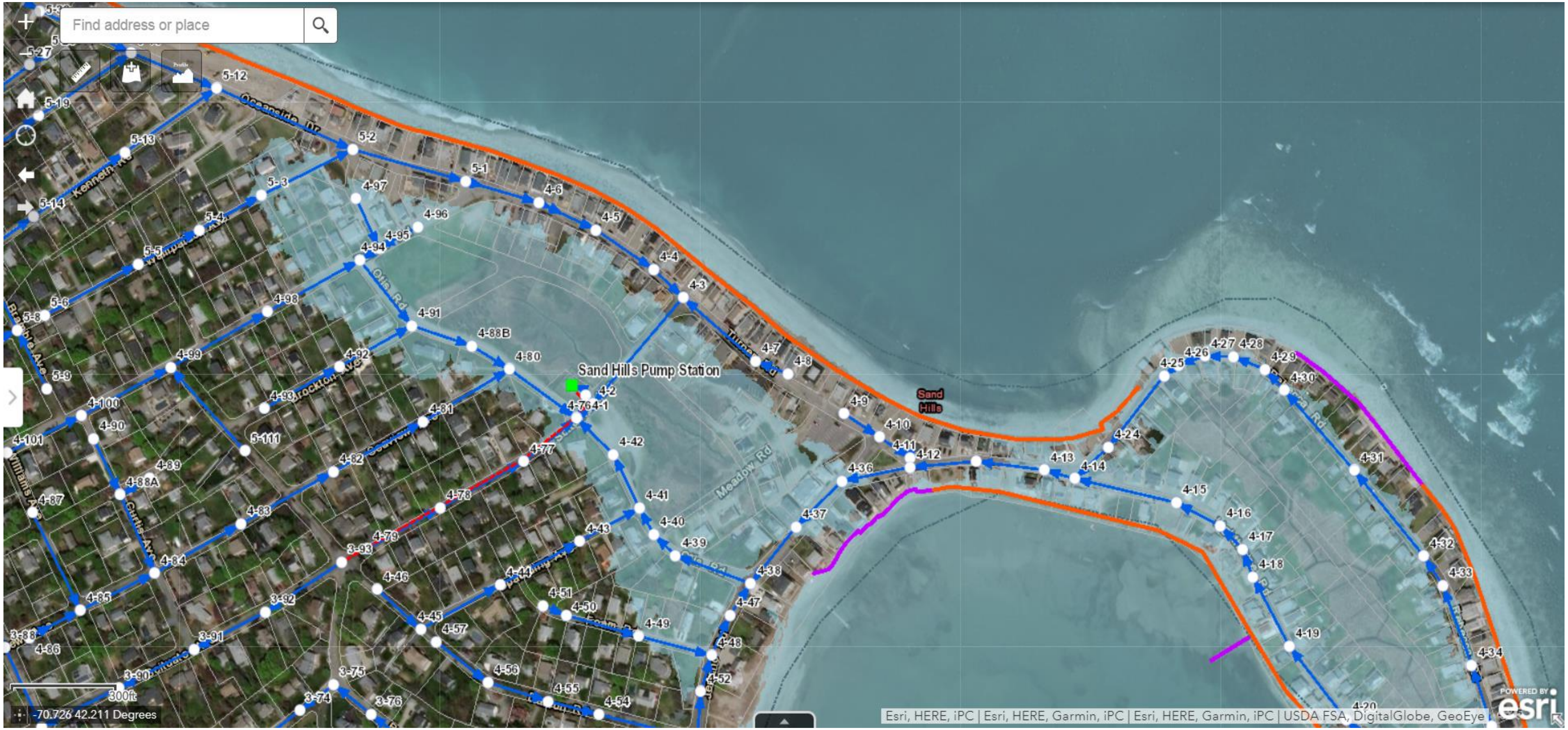
# Service Life Flood Probability

| Recurrence Interval (years) | ≥ No. of Event Occurrences: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| **5** | | 100.0% | 99.9% | 99.7% | 99.0% | 97.1% | 93.3% | 87.0% | 78.0% | 78.0% | 54.2% |
| **10** | | 99.5% | 96.1% | 87.7% | 73.3% | 55.7% | 38.2% | 23.6% | 13.1% | 6.6% | 3.0% |
| **20** | | 92.3% | 71.8% | 46.2% | 24.8% | 11.4% | 4.7% | 1.9% | 0.9% | 0.6% | 0.3% |
| **50** | | 63.6% | 26.8% | 8.4% | 2.3% | 0.7% | 0.4% | 0.4% | 0.3% | 0.3% | 0.3% |
| **100** | | 39.5% | 9.2% | 1.6% | 0.3% | 0.0% | 0 | 0 | 0 | 0 | 0 |
| **500** | | 9.5% | 0.5% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Probability of Meeting or Exceeding Multiple Events during 50 year Service Life

# Flood Hazard Characterization: Pump Stations

# Flood Hazard Characterization: Pump Stations




Flood Inundation at Sands Hill Pump Station (Floodwater = 10 feet NAVD88)

# Flood Hazard Characterization: Pump Stations

| Stillwater Elevation (feet; NAVD88) | Depth-Limited Wave Height (feet)(1) | Est. Wave Set-up (feet)(1,4) | Est. Total Water Level (feet; NAVD88) | Est. Wave Crest Elevation (feet; NAVD88)(2) | Est. Mean Recurrence Interval (years)(3) | | | Flood Inundation due to Total Water Level | Wave Run-up and Overtopping(2) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Current | 2040 | 2070 | | |
| **6** | - | - | 6 | - | 1 | >1 | >1 | Yes | No |
| **7** | 1.5 | - | 7 | 8.1 | 4 | 2 | >1 | Yes | No |
| **8** | 2.5 | 0.4 | 8.4 | 10.2 | 10 | 5 | 1 | Yes | No |
| **9** | 3.0 | 0.5 | 9.5 | 11.6 | 50 | 20 | 3 | Yes | No |
| **10** | 4.0 | - | 10.5 | 12.6 | 500 | 100 | 10 | Yes | Yes |
| **11** | 4.7 | - | 11.5 | 13.6 | 2,000 | 1,000 | 50 | Yes | Yes |
| **12** | 5.5 | - | 12.5 | 14.6 | - | 2,000 | 500 | Yes | Yes |
| **13** | 6.2 | - | 13.5 | 15.6 | - | - | - | Yes | Yes |
| **14** | 7.0 | - | 14.5 | 16.6 | - | - | - | Yes | Yes |
| **15** | 7.8 | - | 15.5 | 17.6 | - | - | - | Yes | Yes |

Notes:

1. Depth-limited wave height adjacent to pump station (+/- Elevation 5 to 7 feet NAVD88). Note that wind fetch within flooded area is small and that depth-limited waves of about >3 feet will not be achieved.

2. Adjacent to pump station (+/- Elevation 5 feet NAVD88). Wave run-up from broken Sand Hill Beach ocean waves may occur within the area of the pump station.

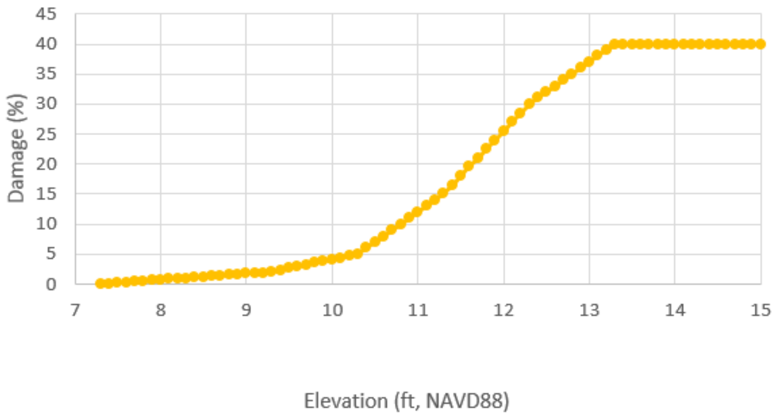
3. Based on NOAA 2017 Intermediate Sea Level Rise Projection.

4. Wave set-up estimated at 0.15 times depth-limited wave height.

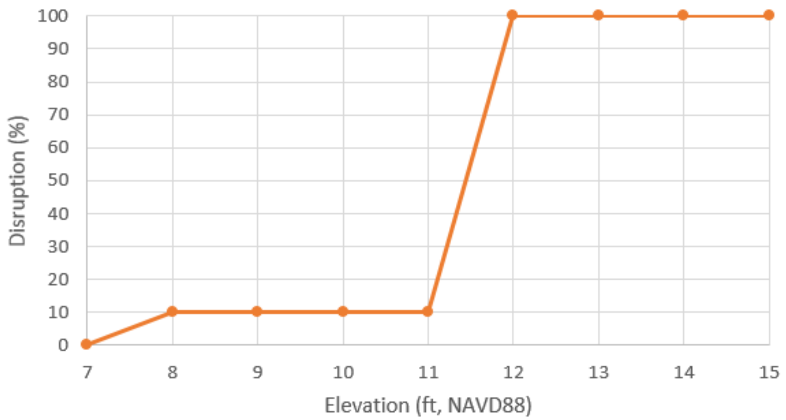
# Asset Vulnerability: Pump Stations

## Pump Station Flood Response

Pump Station Elevation-Damage Curves




Pump Station Elevation-Disruption Curves




| Water Entry Points | ID | Description Critical Elevation | Elevation (feet, NGVD29) | Elevation (feet, NAVD88) | Flood Elevation, feet NAVD88 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| Windows: | | None Observed | | | | | | | | | | | | | |
| Doors (Personnel and Public): | | | | | | | | | | | | | | | |
| Personnel entryway | 1 | Door Threshold elev. | 12.2± | 11.4± | | | | | | | | | | | |
| Personnel entryway | 2 | Door Threshold elev. | 12.2± | 11.4± | | | | | | | | | | | |
| Vents: | | | | | | | | | | | | | | | |
| 18″ x 88″ Vent | Vent 1 | Bottom of Vent | 12.2± | 11.4± | | | | | | | | | | | |
| 28″ x 40″ Vent | Vent 2 | Bottom of Vent | 16.7± | 15.9± | | | | | | | | | | | |
| 28″ x 40″ Vent | Vent 3 | Bottom of Vent | 16.7± | 15.9± | | | | | | | | | | | |
| 28″ x 88″ Vent | Vent 4 | Bottom of Vent | 12.2± | 11.4± | | | | | | | | | | | |
| 28″ x 88″ Vent | Vent 5 | Bottom of Vent | 12.2± | 11.4± | | | | | | | | | | | |
| 8″ x 8″ Vent | Vent 6 | Bottom of Vent | 12.4± | 11.6± | | | | | | | | | | | |
| 8″ x 8″ Vent | Vent 7 | Bottom of Vent | 14.0± | 13.2± | | | | | | | | | | | |
| Other | | | | | | | | | | | | | | | |
| Outside Electric Meter Panel | | Lowest Elevation | 13.9± | 13.1± | | | | | | | | | | | |
| Pipe Wall Penetrations to daylight or unsealed vaults/manholes | | None Observed | | | | | | | | | | | | | |
| Exterior Stairs | | Bottom of Step | 8.1± | 7.3± | | | | | | | | | | | |
| Electrical Conduit North Wall Penetrations | | Wall Penetration | 19.3± | 18.5± | | | | | | | | | | | |
| Electrical Conduit East Wall Penetrations | | Wall Penetration | 16.1± | 15.3± | | | | | | | | | | | |
| Outside Gas Pressure Regulator | | Lowest Elevation | 8.2± | 7.4± | | | | | | | | | | | |
| Gas Connection | | Wall Penetration | 8.8± | 8.0± | | | | | | | | | | | |
| Generator Exhaust | | Invert of Pipe | 18.8± | 18.0± | | | | | | | | | | | |
| Roof Drain | | Invert of Pipe | 8.8± | 8.0± | | | | | | | | | | | |
| Wet Well Manhole/Hatch Rim | | None Observed | | | | | | | | | | | | | |
| Wet Well Vent Pipe | | None Observed | | | | | | | | | | | | | |
| Critical Interior Components | | | | | | | | | | | | | | | |
| Inside Generator Skid Top Elev. | | Lowest Elevation | 12.7± | 11.9± | | | | | | | | | | | |
| Floor Mounted Control Panel | | Lowest Elevation | 12.2± | 11.4± | | | | | | | | | | | |
| Circuit Breaker | | Lowest Elevation | 16.7± | 15.9± | | | | | | | | | | | |
| Pump Motors | | Lowest Elevation | 12.5± | 11.7± | | | | | | | | | | | |
| Non-Critical Interior Components | | | | | | | | | | | | | | | |
| Boiler | | Lowest Elevation | 2.7± | 1.9± | | | | | | | | | | | |
| Water Heater | | Lowest Elevation | 12.7± | 11.9± | | | | | | | | | | | |
| Comminutor Motor | | Lowest Elevation | 12.5± | 11.7± | | | | | | | | | | | |

10 yr

50/100 yr

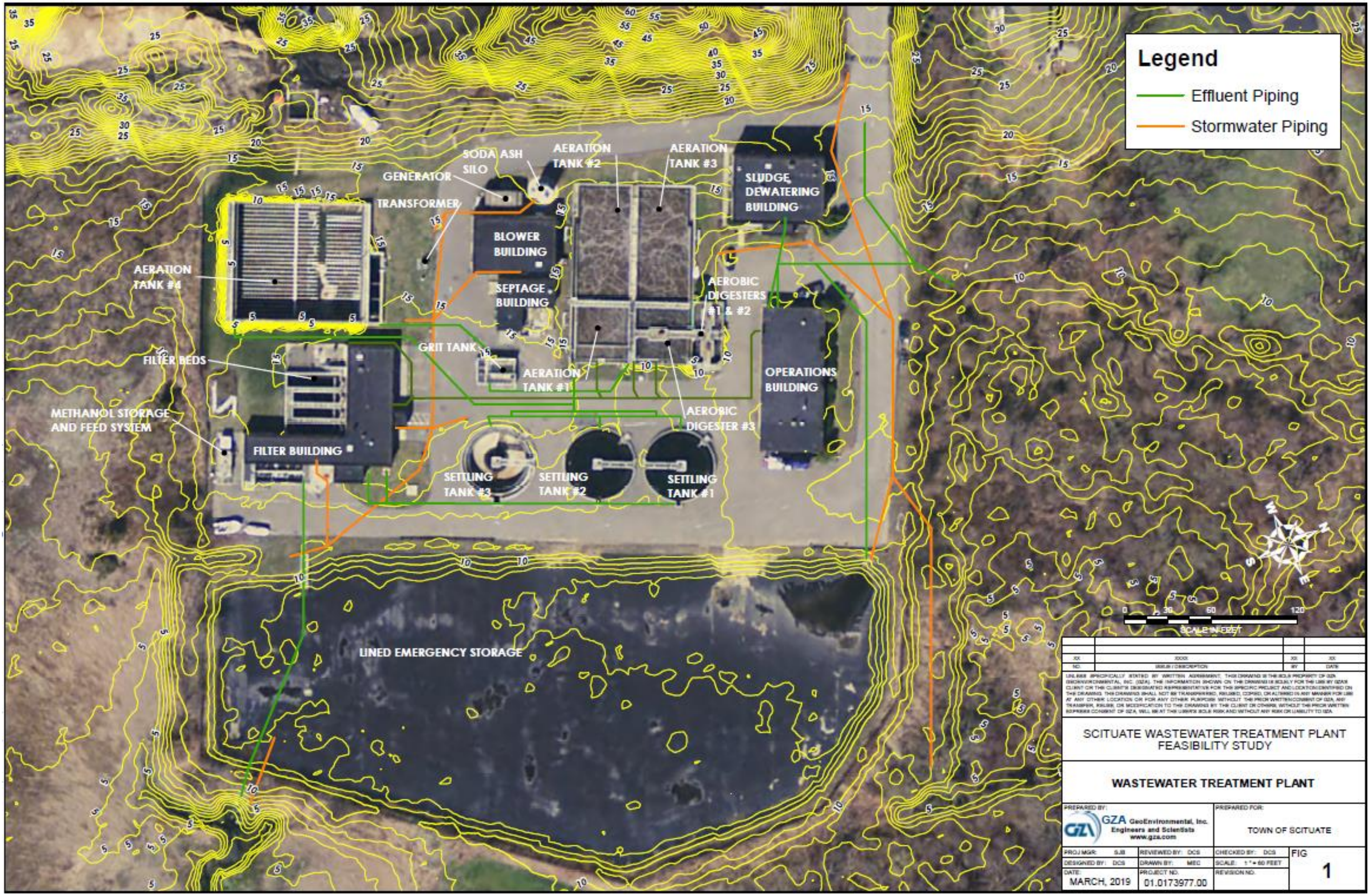
FEMA BFE

# Findings: System Vulnerability

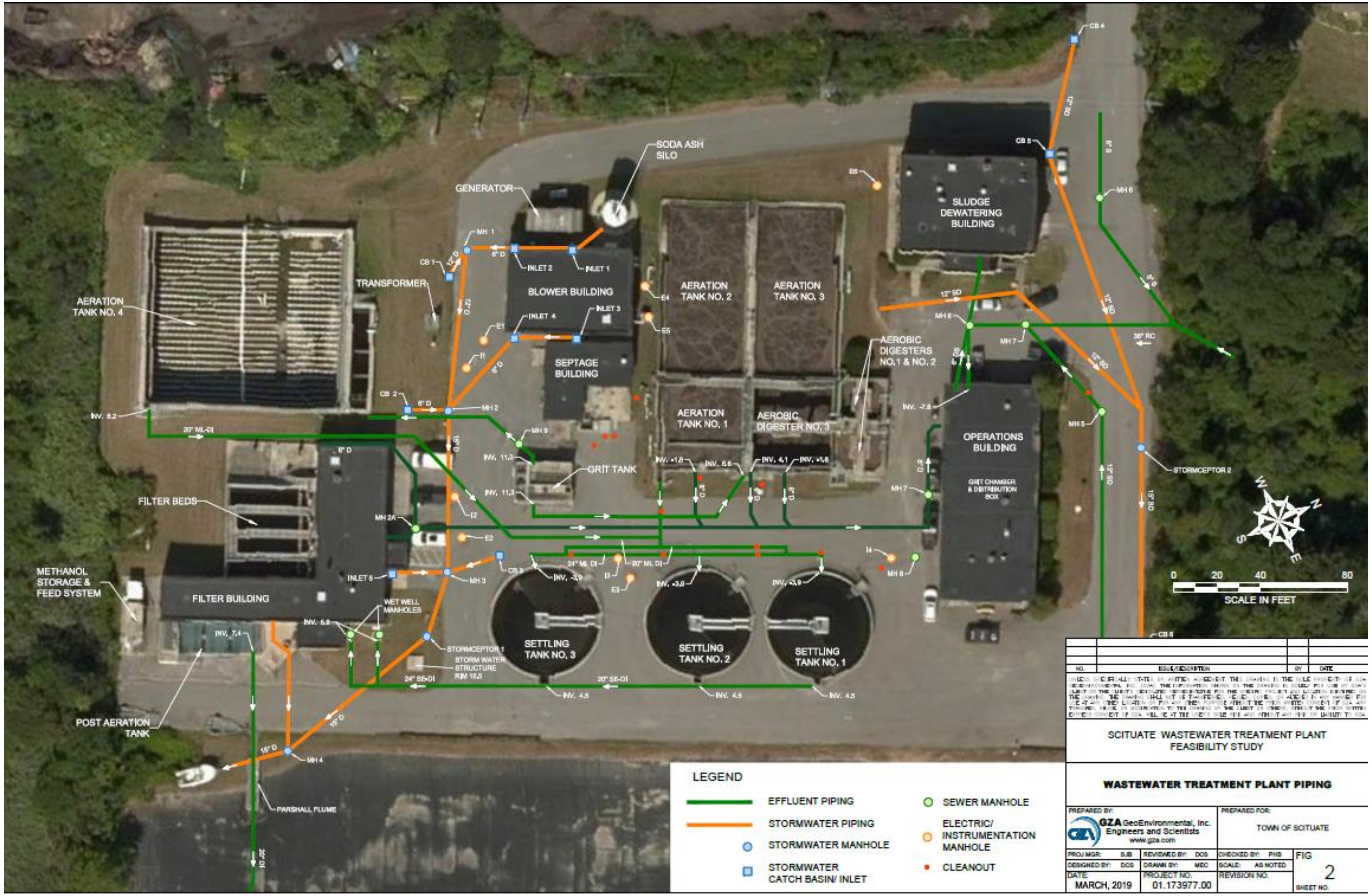
## 3. Treatment Plant Vulnerability:

- Treatment Plant located within FEMA flood hazard areas (AE El 16 ft NAVD88
- Ground surface +/- 11 to 15 feet NAVD88
- Impacts to plant start at flood water elevation +/- 10 feet (+/- 20 to 50 yr rec. int.)
- Significant impacts at flood water elevation +/- 12 feet (+/- 50 to 100 yr rec. int./with waves)
- Failure impacts  at flood water elevation +/- 13 feet (+/- 100 yr rec. int./with waves)
- Hydraulic system flow capacity impacts - potentially starting at at flood water elevation +/- 10 feet (+/- 20 to 50 yr rec. int.)

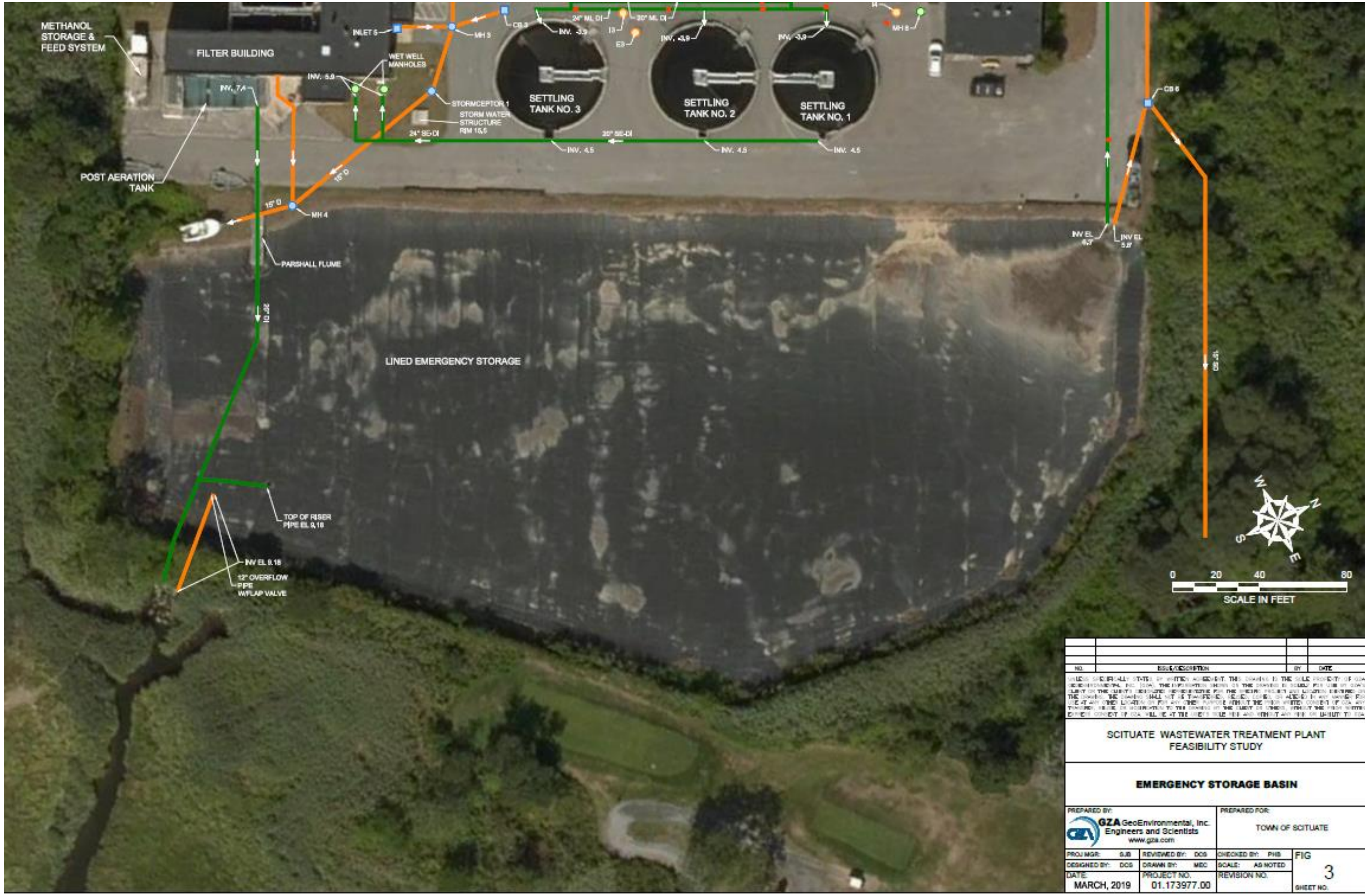
# Detailed Asset Inventory: Treatment Plant



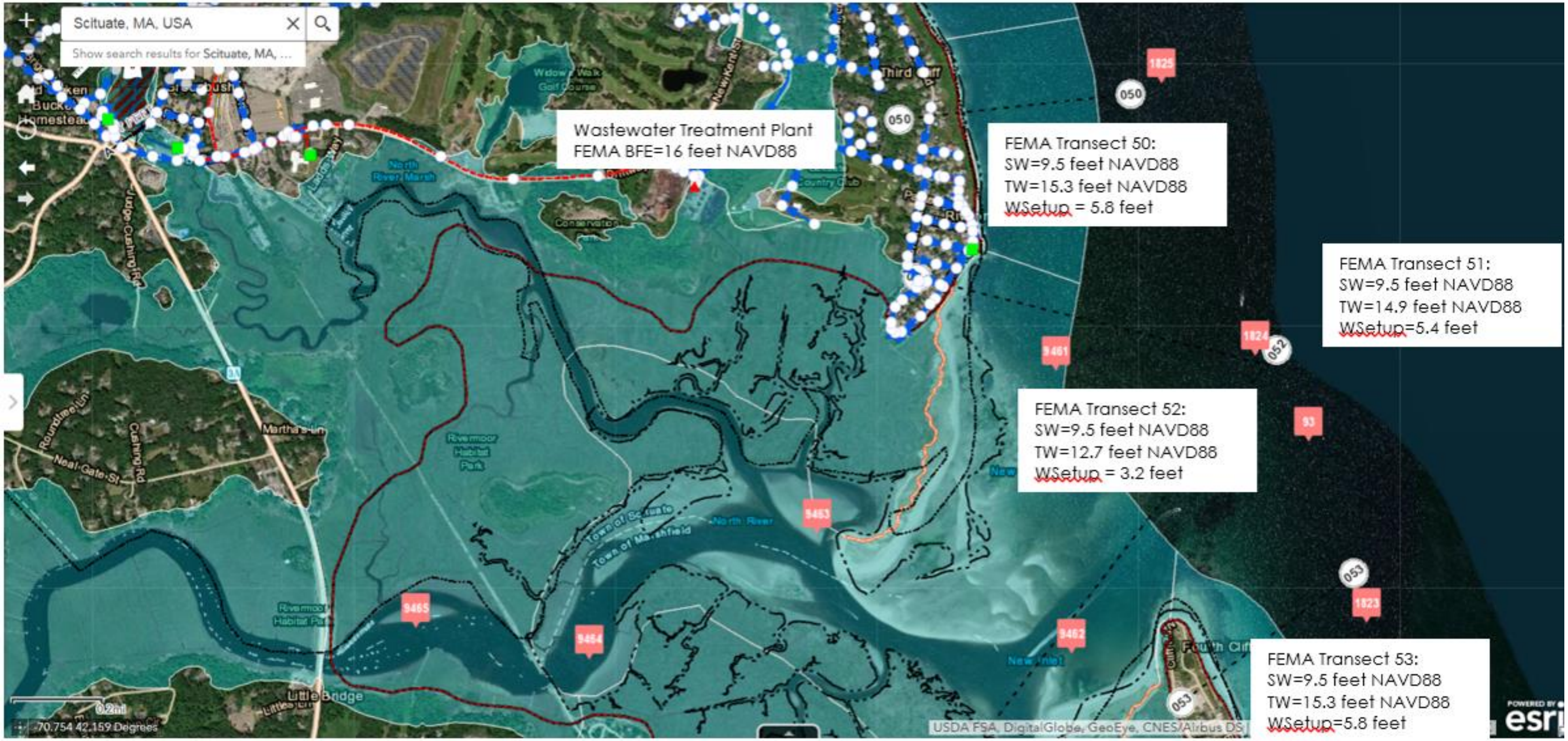
# Detailed Asset Inventory: Treatment Plant



# Detailed Asset Inventory: Treatment Plant



# Flood Hazard Characterization: Treatment Plant

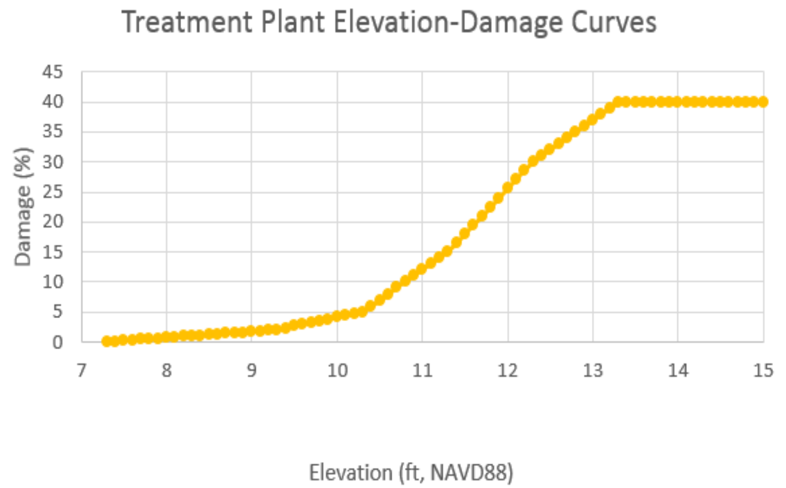


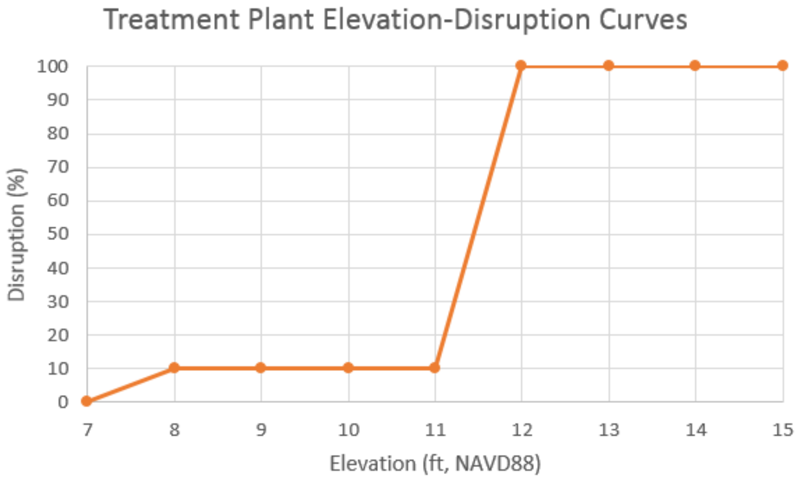

FEMA Flood Insurance Rate Map (FIRM) at Wastewater Treatment Plant

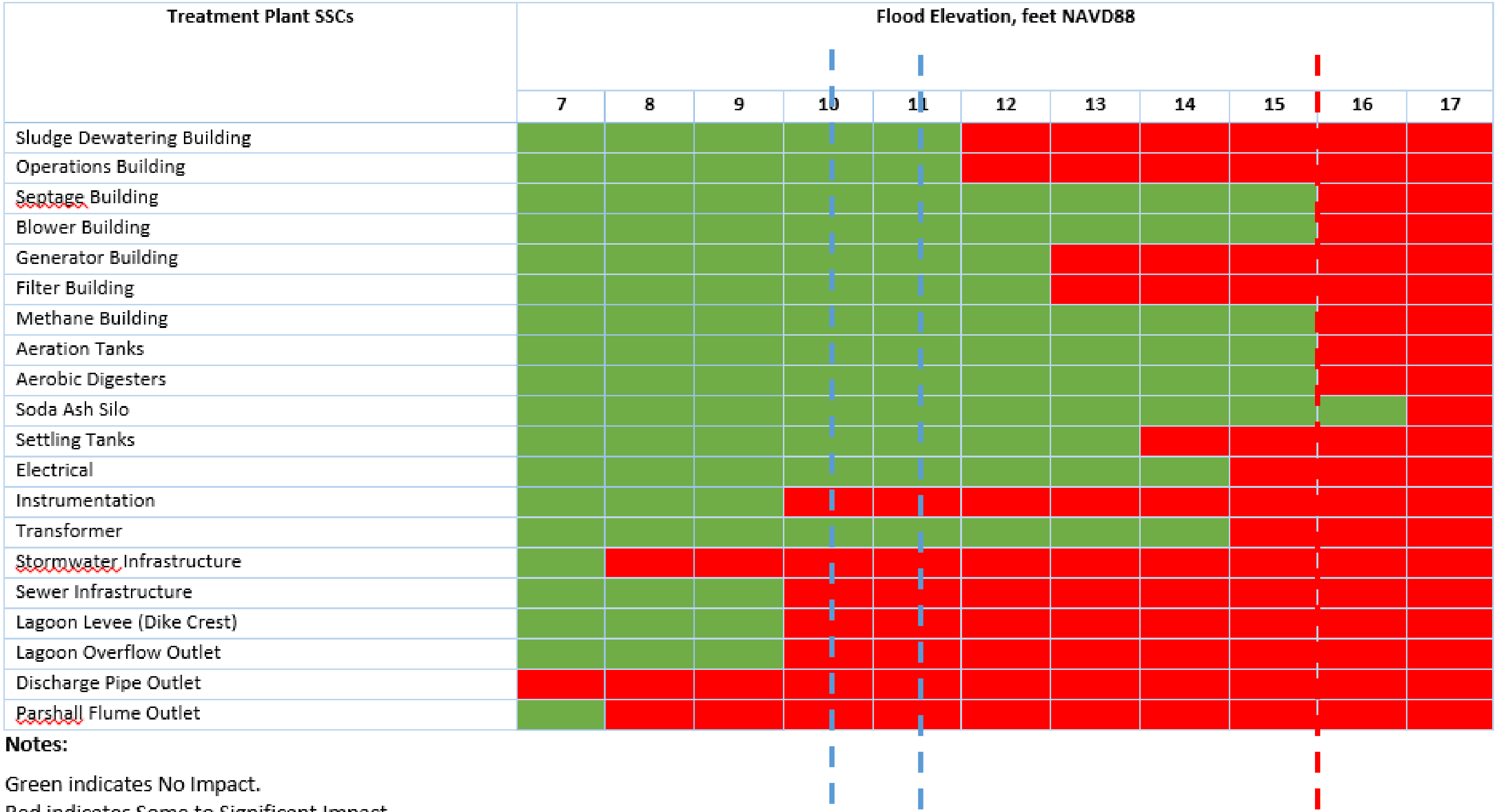
# Flood Hazard Characterization: Pump Stations


Flood Inundation (Floodwater = 11 feet NAVD88)

# Asset Vulnerability: Treatment Plant




**Notes:**

Green indicates No Impact.
Red indicates Some to Significant Impact.
Bold SSC indicates that structure is critical to complete treatment plant failure.

100 yr TWL

50 yr+/-

FEMA BFE

# Hydraulic Capacity: Treatment Plant

Allow for peak hourly flows to be passed through the plant with the receiving water at the 100-year recurrence interval flood elevation (including considerations of climate change):

- Design: El. 9.5 NAVD88

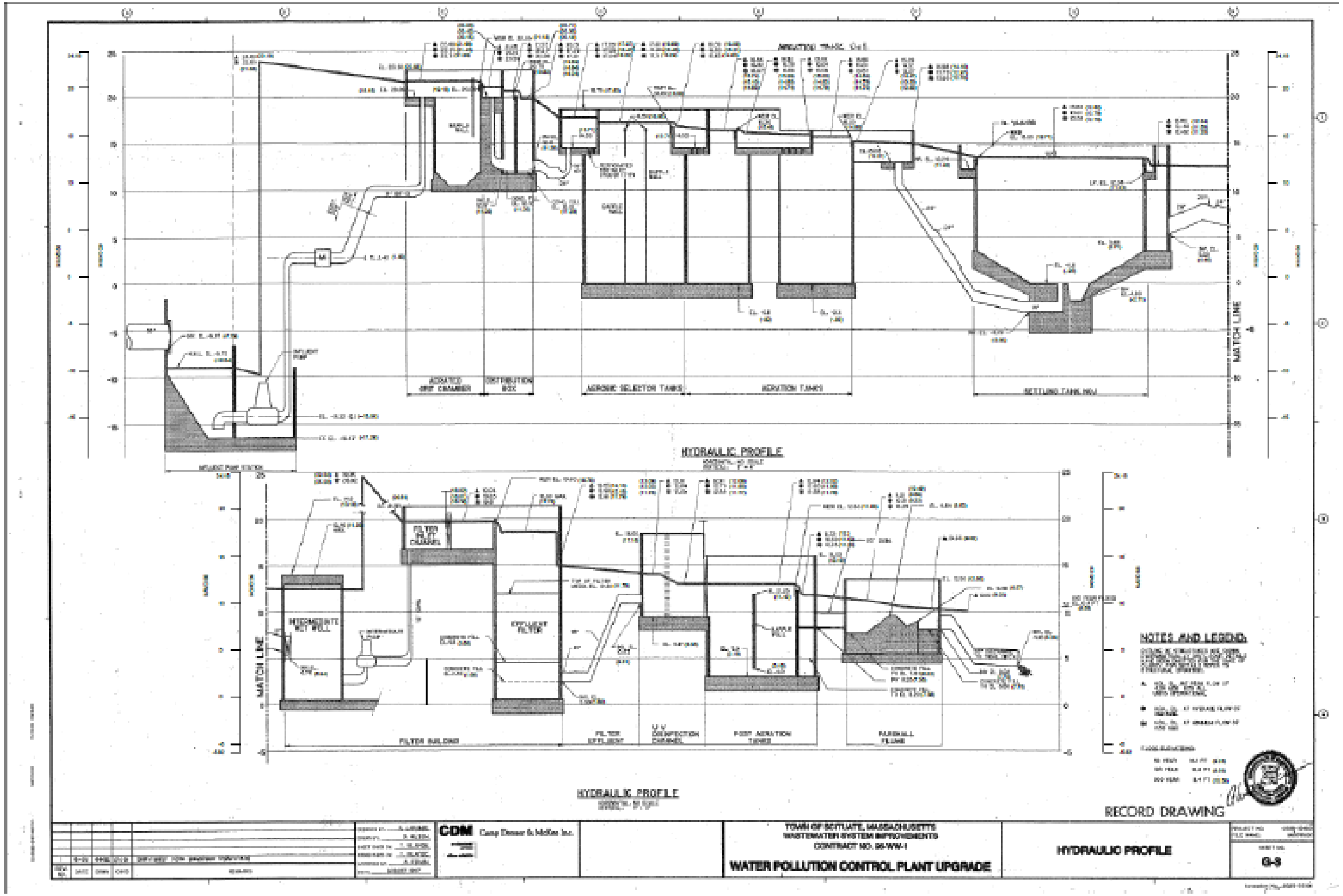
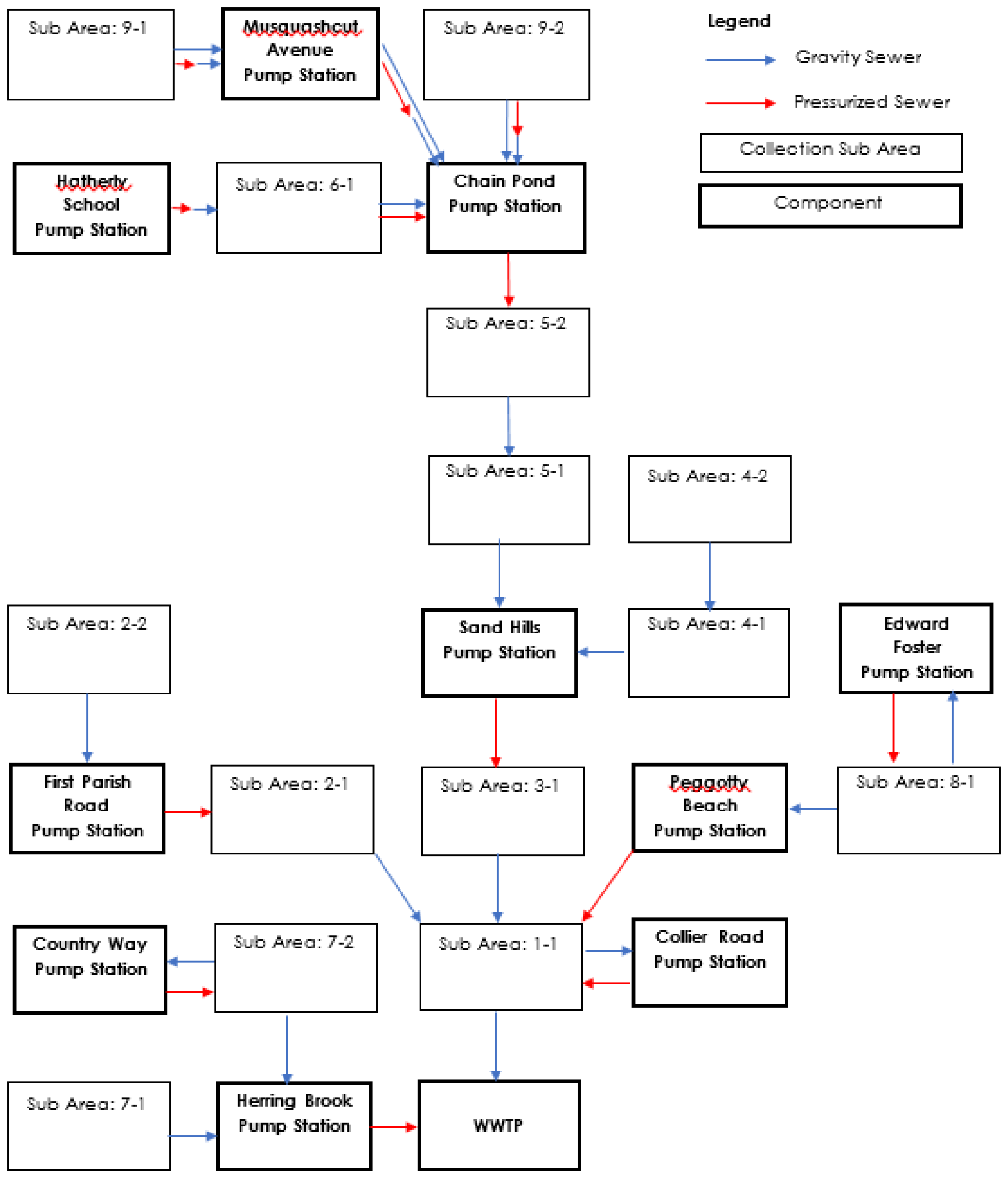



Figure 3-10 Hydraulic Profile

# Findings: System Vulnerability



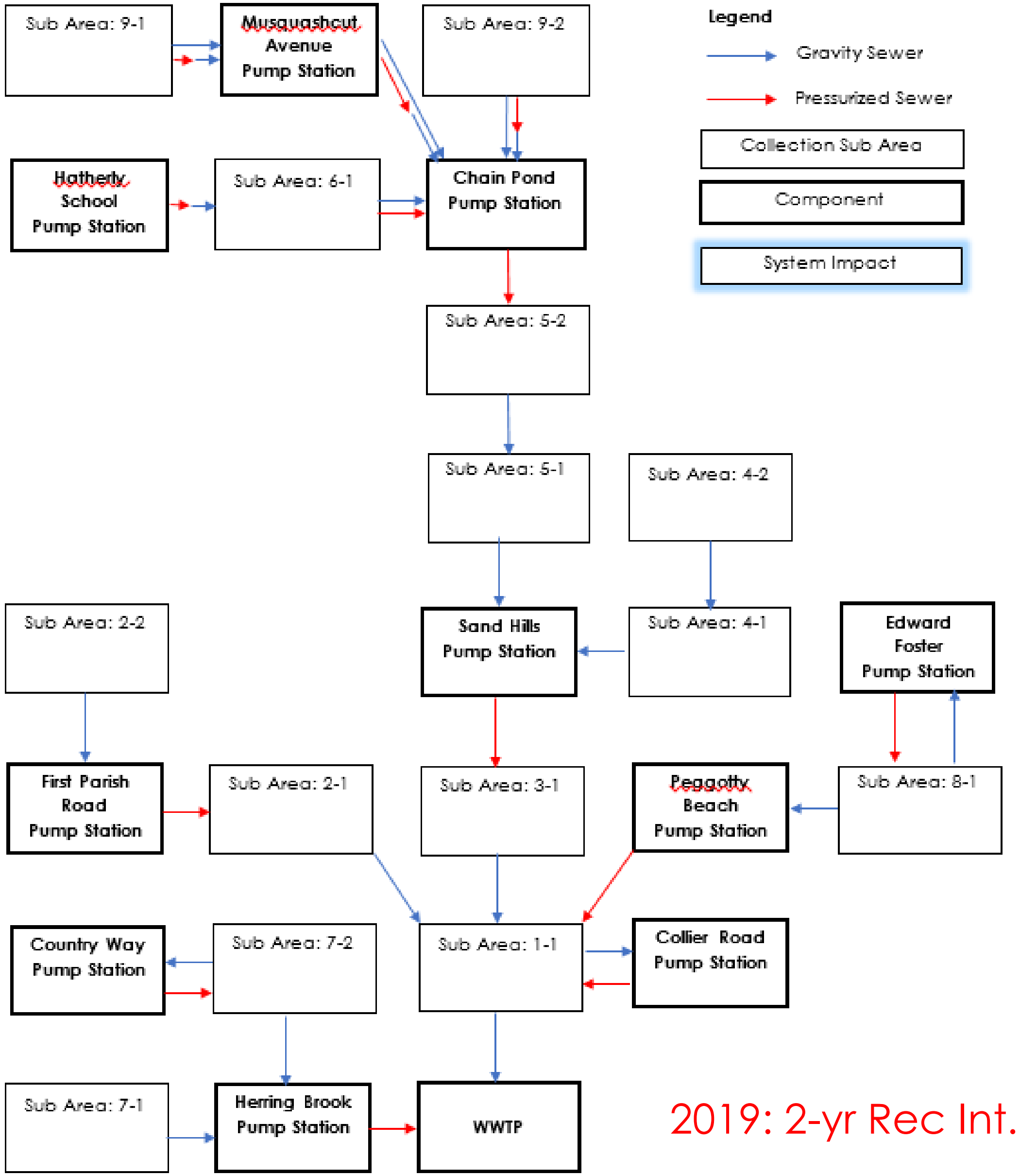



Figure 3: Schematic Chart of Scituate Wastewater Collections System: 2 -year recurrence interval (2019)

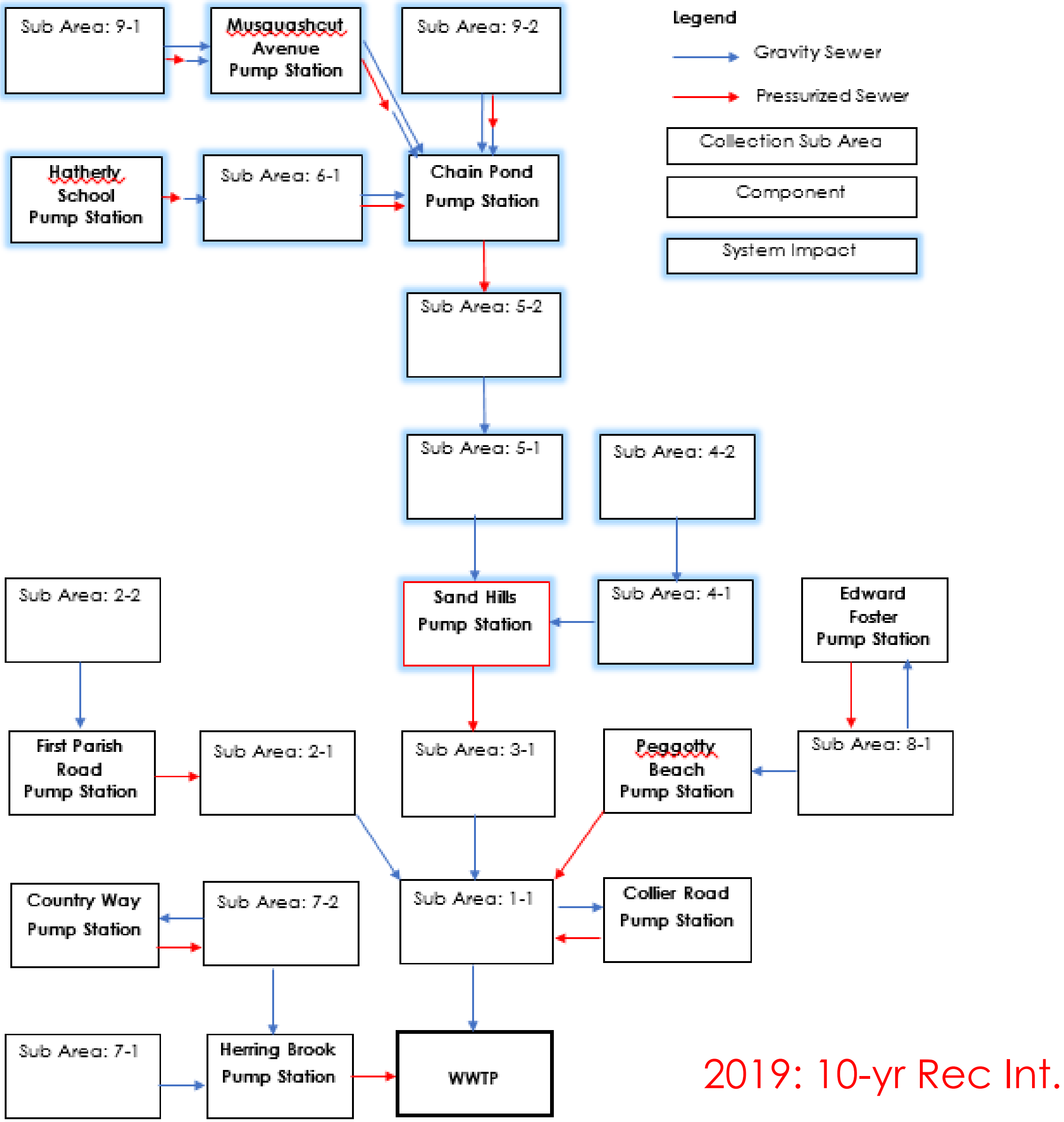
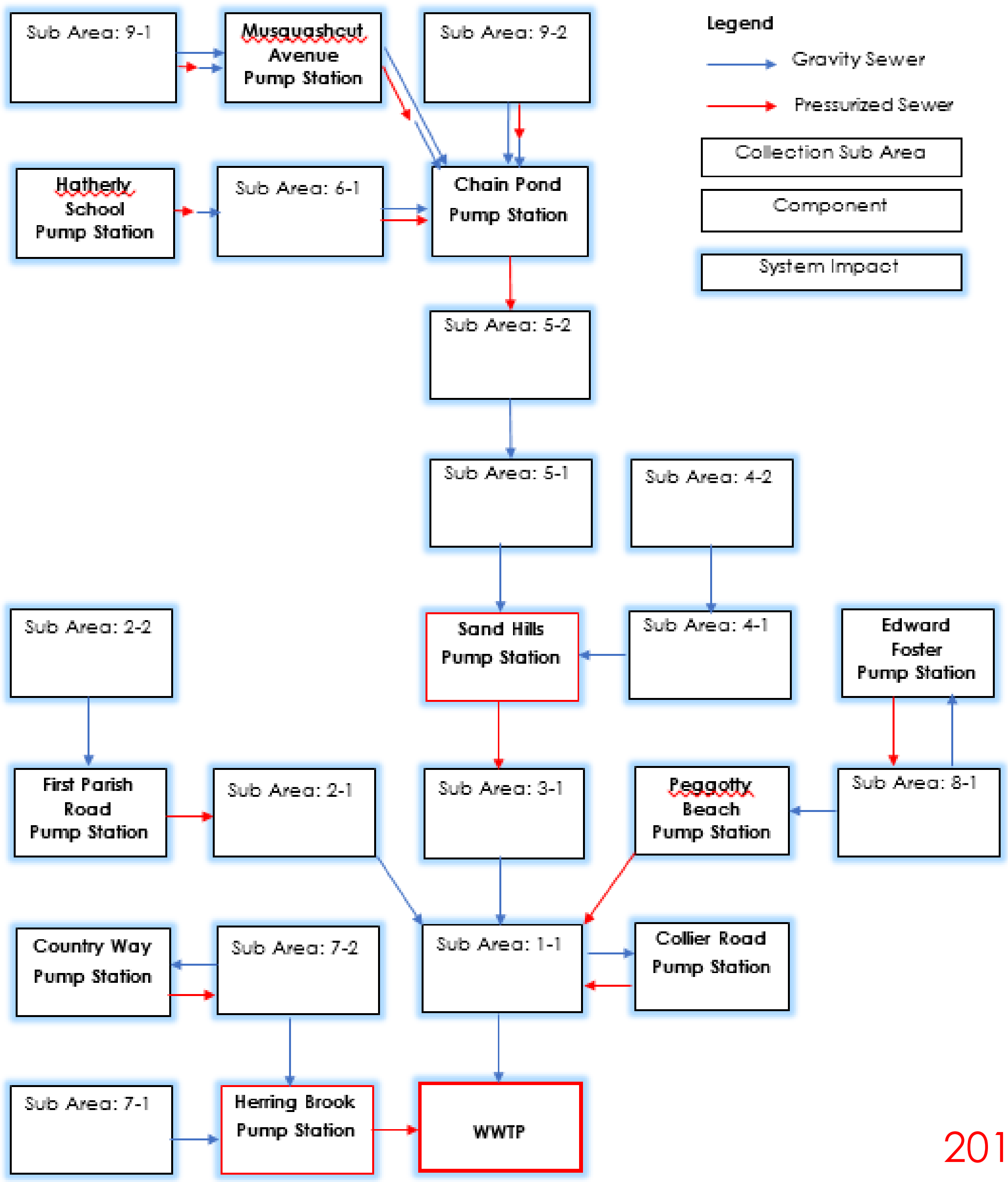



Figure 4: Schematic Chart of Scituate Wastewater Collections System: 10-year recurrence interval (2019)

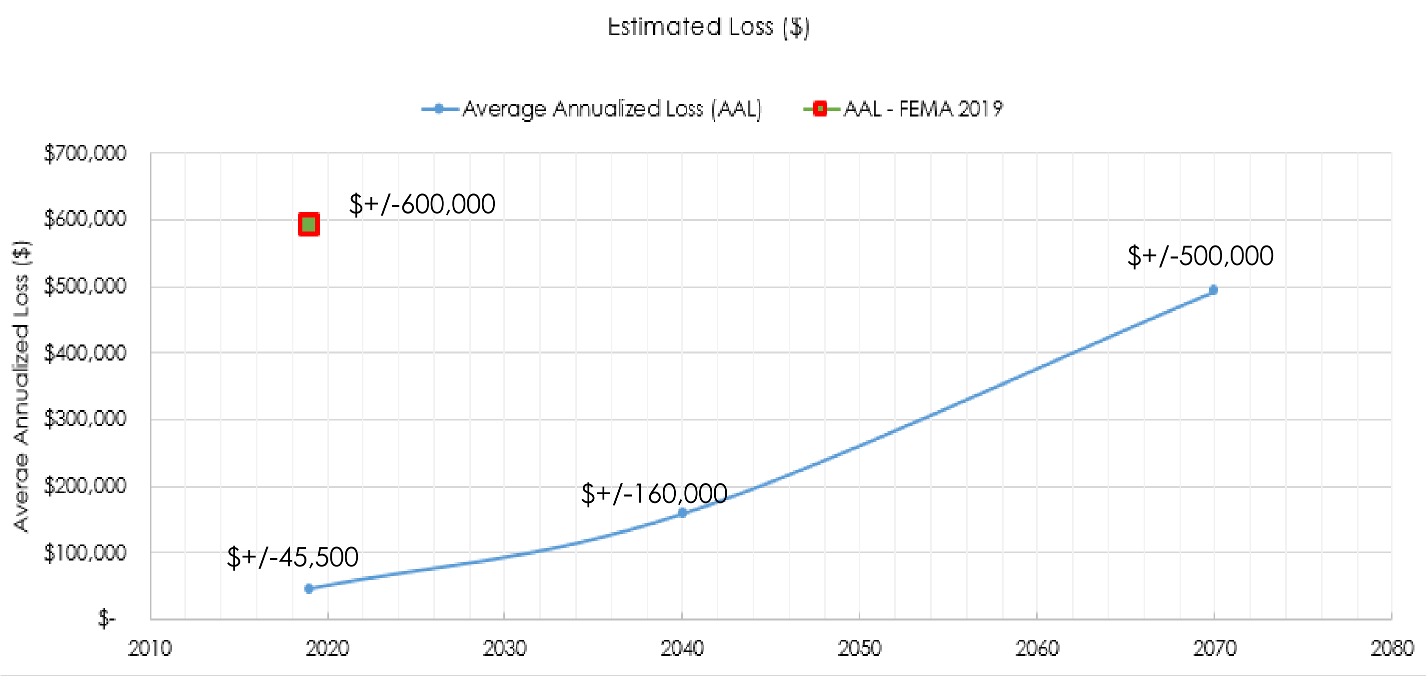



2019: +/- 50-yr Rec Int.

Figure 5: Schematic Chart of Scituate Wastewater Collections System: 50-year recurrence interval (2019)

# Findings: Predicted Financial Loss

Average Annualized Loss ($)




**Preliminary**

Approximate AAL per sewered building:

Best Estimate 2019: +/-$20

FEMA 2019: +/- $180

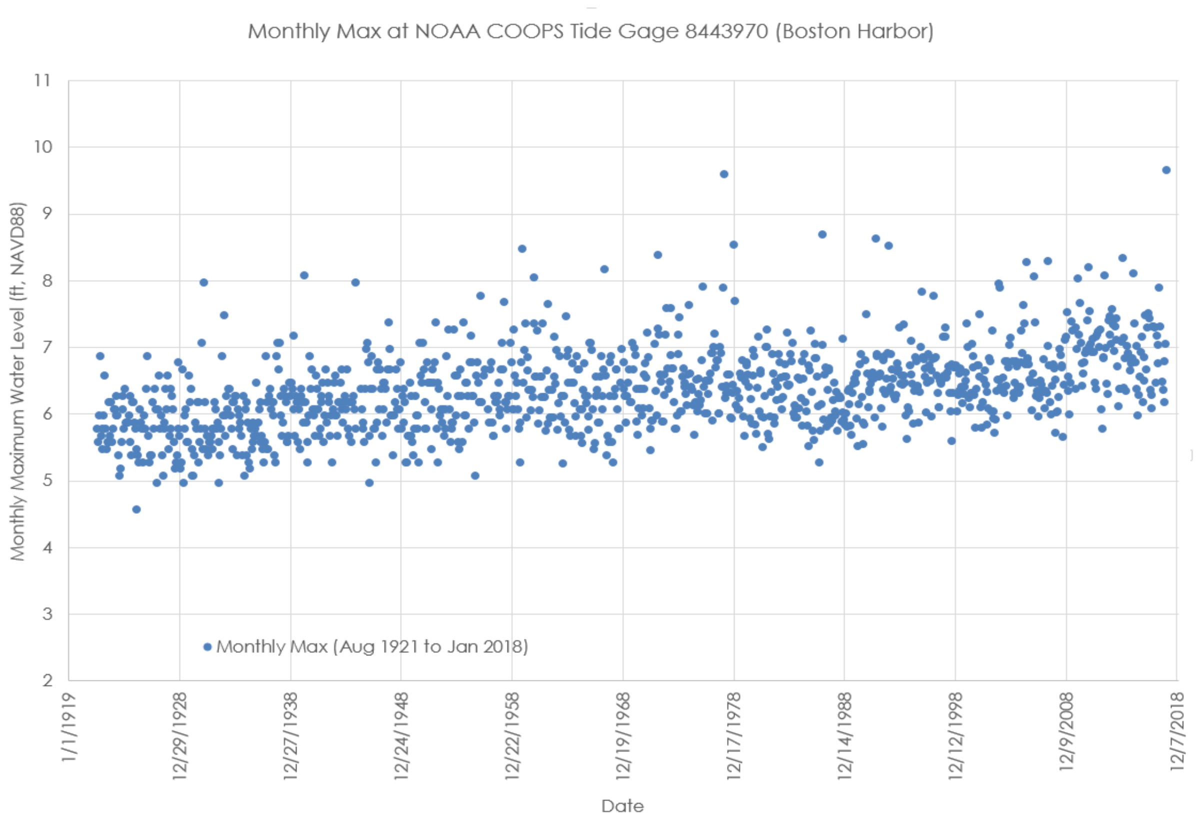
Best estimate 2040: +/- $50

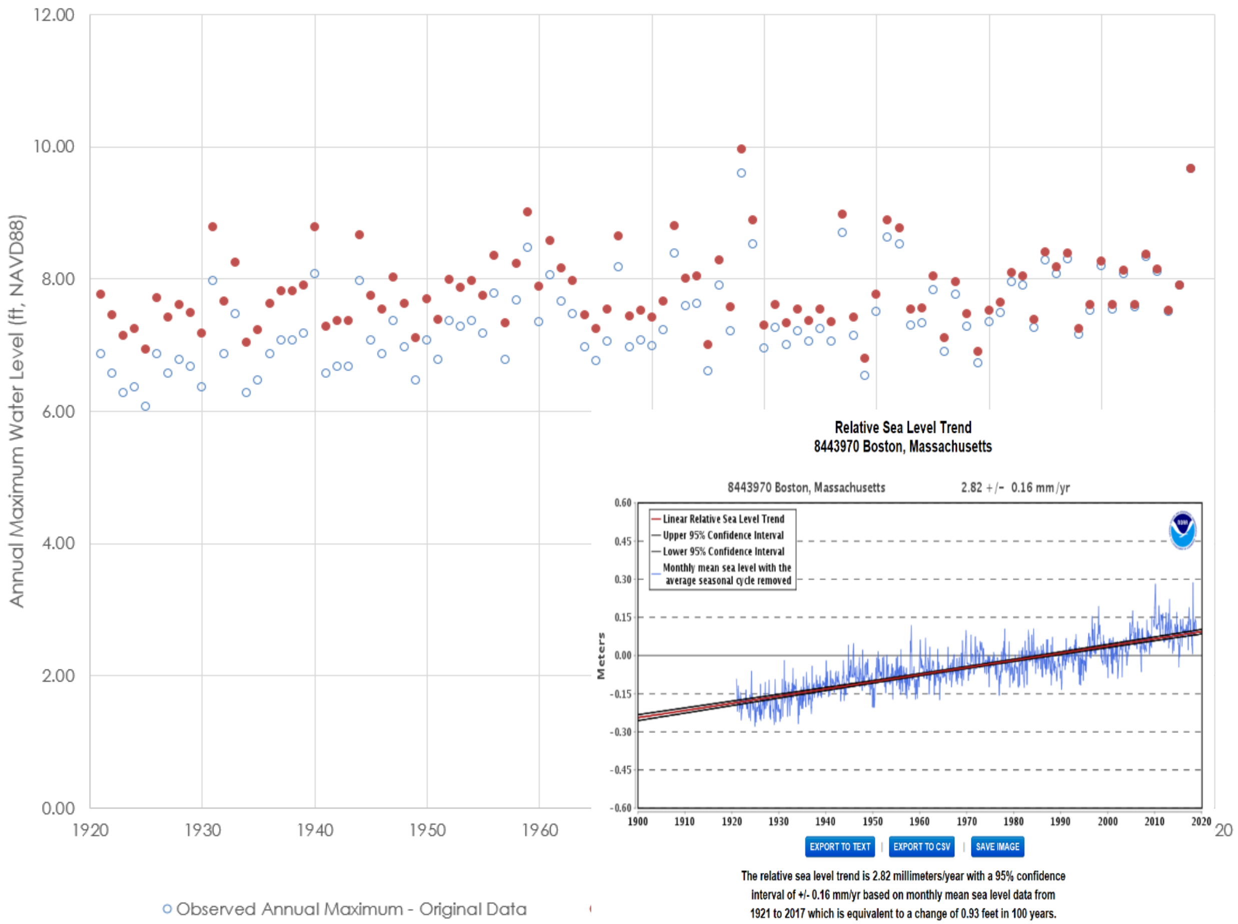
Best Estimate 2070: +/- $150

- Increased capital costs
- Increased operating costs
- Increased debt service
- Increased user rates

# Effects of Sea Level Rise

NOAA Boston Tide Gage Monthly and Annual Maximum Water Levels:



# Predicted Sea Level Rise(NOAA 2017 at Boston Tide Gage) – Corrected to 2020

| Year | NOAA2017 VLM | NOAA2017 Low | NOAA2017 Int-Low | NOAA2017 Intermediate | NOAA2017 Int-High | NOAA2017 High | NOAA2017 Extreme |
|---|---|---|---|---|---|---|---|
| 2020 | - | - | - | - | - | - | - |
| 2030 | 0.03 | 0.13 | 0.17 | 0.29 | 0.4 | 0.55 | 0.62 |
| 2040 | 0.05 | 0.26 | 0.36 | 0.62 | 0.92 | 1.31 | 1.48 |
| 2050 | 0.08 | 0.42 | 0.56 | 1.05 | 1.51 | 2.13 | 2.49 |
| 2060 | 0.11 | 0.62 | 0.79 | 1.51 | 2.17 | 3.15 | 3.74 |
| 2070 | 0.13 | 0.79 | 0.99 | 1.97 | 2.92 | 4.16 | 5.12 |
| 2080 | 0.16 | 0.85 | 1.12 | 2.46 | 3.71 | 5.25 | 6.5 |
| 2090 | 0.18 | 0.98 | 1.28 | 2.98 | 4.56 | 6.59 | 8.27 |
| 2100 | 0.21 | 1.05 | 1.45 | 3.54 | 5.55 | 8.07 | 10.14 |