

Assessing the Threats from Climate Change to Marion's Vulnerable Wastewater Pumping Infrastructure

Board of Selectman Meeting

Frannie Bui, P.E.

Jesse Herman

October 24, 2018

Revised: Dec 10, 2018



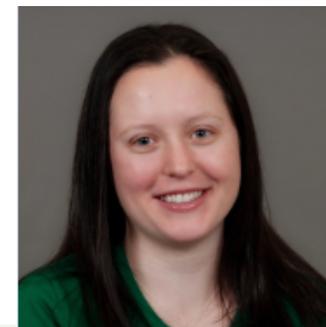
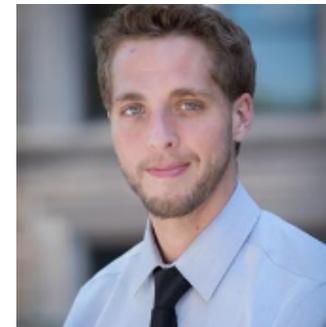
**CDM
Smith**

Agenda

- Project Team
- Study Objective
- Funding Source
- Scope
 - Task 1 – Review and Compilation of Data
 - Data Compilation
 - Pump Station Site Visit
 - Desktop Analysis / Climate Change Assessment
 - Public Outreach
 - Task 2 – Vulnerability and Risk Assessment
 - Project Progress Meeting #1 (Task 5B)
 - Task 3 – Action for Each Pump Station
 - Project Progress Meeting #2 (Task 5C)
 - Task 4 – Report Development
 - Task 5 – Meetings and Outreach
 - Public Meeting (Task 5D)
- Schedule

Project Team

- Lauren Klonsky – Project Manager
- Frannie Bui – Mitigation Engineer
- Jesse Herman – Civil / Environmental Engineer
- Bryan Bucchianeri – Plumbing / HVAC Engineer
- Beth Charis-Molling – Electrical Engineer
- Caitlin Carbonello – Structural Engineer



Study Objective

- Complete a vulnerability assessment of eight critical pump stations and grinder pump neighborhoods, and recommend improvements and climate adaptation strategies for each pumping station

Funding Source

- Awarded under the Coastal Resilience Grant 2018 by the Office of Coastal Zone Management and the Executive Office of Energy and Environmental Affairs



Scope - Task 1

Task 1 – Data Compilation

Goal: Obtain a complete understanding of present and future conditions at each pumping station by collecting and reviewing readily available information and data.

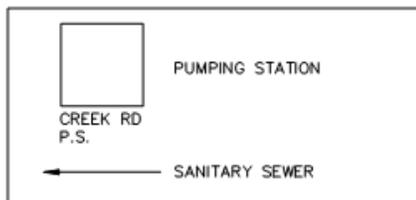
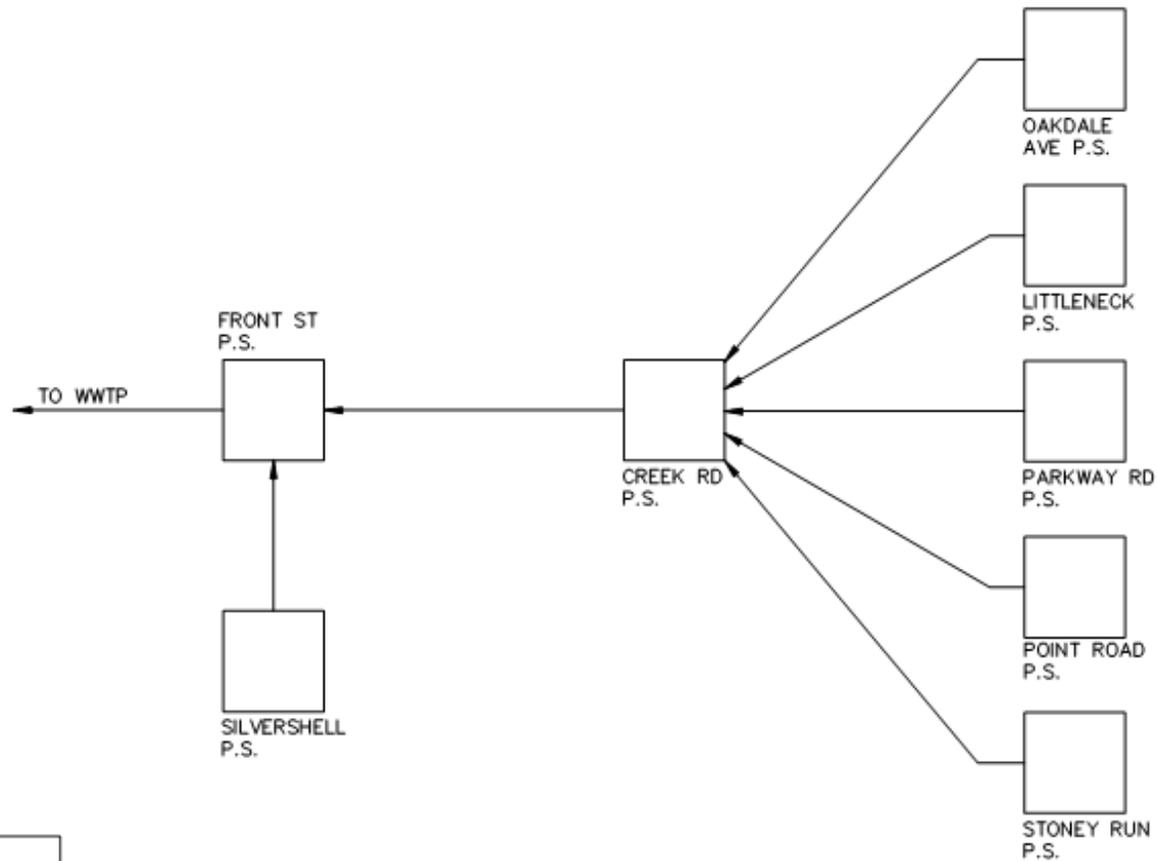
Operations Staff Interviews: Interview questions to be provided to Gil & Frank to review. Survey Monkey as a potential way to compile information or in person during site visit.

Datasets to consider:

- FEMA Flood Studies
- Massachusetts Downscaled Climate Projections for Marion
- Marion Financial Sustainability Study
- Marion Asset Management Plan
- Marion MVP Risk Matrix & Report
- Marion Wastewater Pumping Stations, Force Mains and Low Pressure Sewers Issues and Impacts Memorandum

Task 1 – Data Compilation

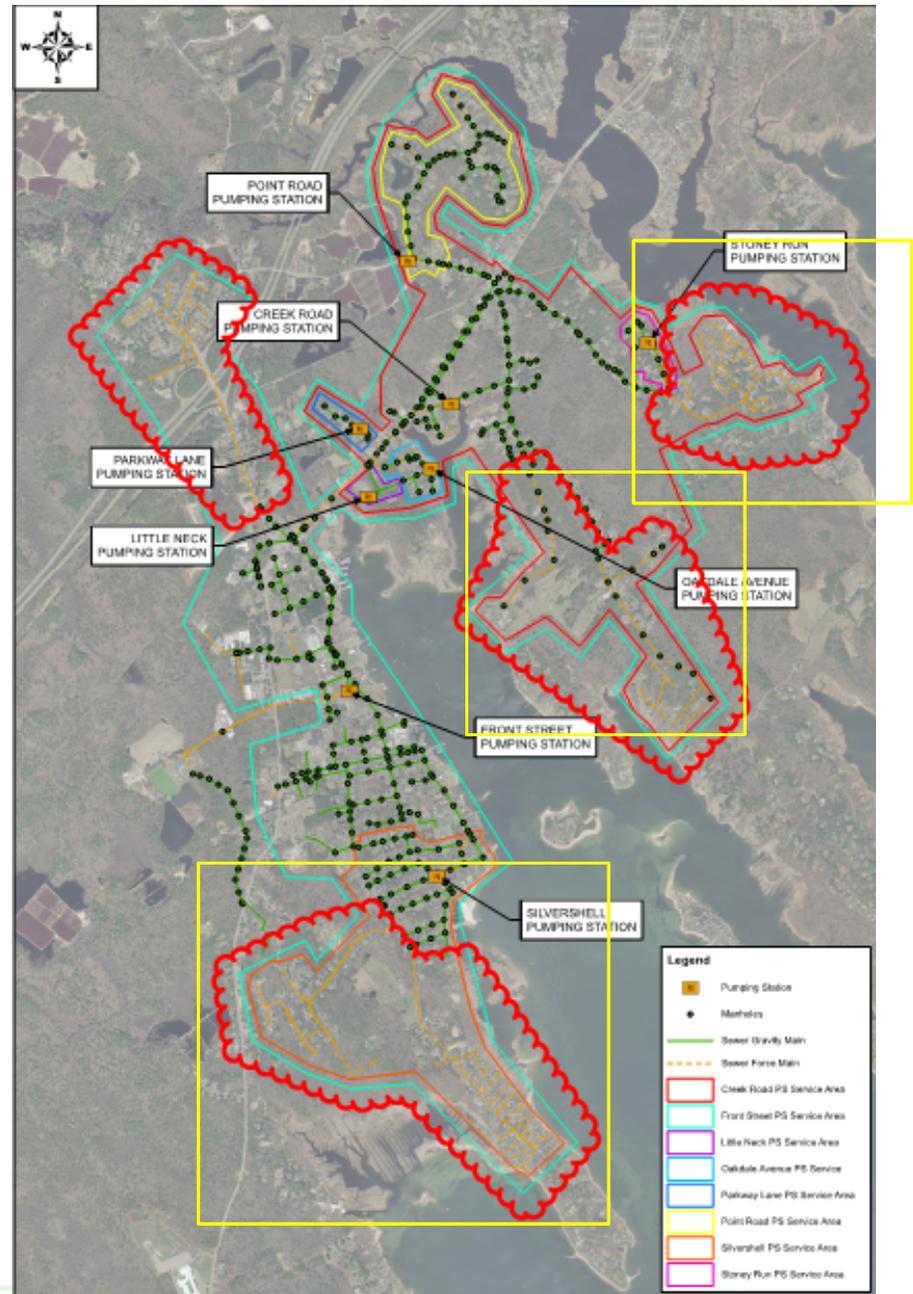
Marion Wastewater Pumping Station System Schematic:



Task 1 – Data Compilation

Grinder Pump Neighborhoods

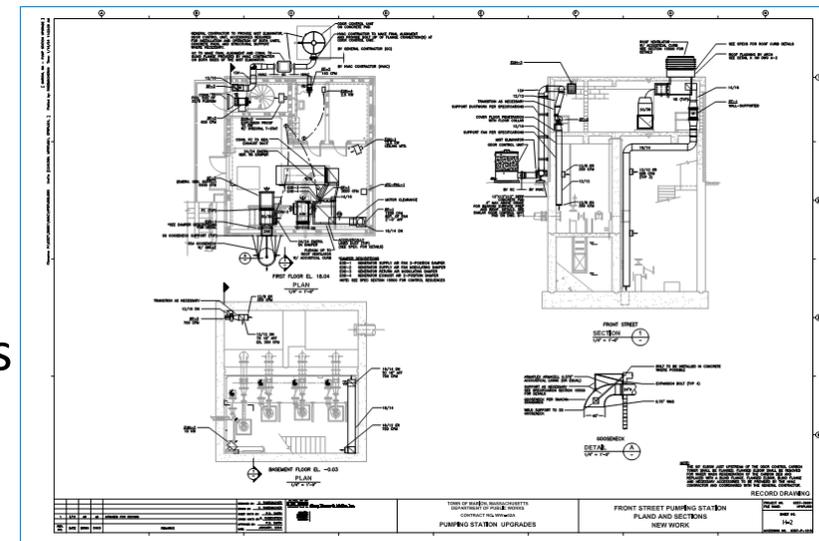
Private



Task 1 – Pump Station Site Visit

- Goal: Visit 8 pump stations
- Target Date: December 10
- Survey: NGVD29
- Obtain CAD record drawings of pump stations
- Site Visit Materials:
 - Field Sheets
 - Design Flood Elevation
 - Record Drawings of Pump Stations
 - Survey Information
 - List of potential management measures

Marion Field Sheet Parkway Lane P.S.		Address: 22 Parkway Lane Marion, MA	Date of Site Visit: _____ Time of Site Visit: _____ Team Member: _____
Location/Aerial/General Information Latitude: 41.721612 Longitude: -70.764499 Google Maps Link: https://www.google.com/maps/d/u/0/edit?mid=11ZB8PC8oIRh-GaTrk3PxtSe9oGixEDAK&ll=41.7215552603718%2C-70.76500469110232&z=19 Year Constructed: 1986 List of Assets/Locations of Concern: <ol style="list-style-type: none"> 1. Submersible pumps (2) 2. Check valves (2) 3. Main station feed 4. Non-automatic transfer switch 5. Pump control panel 		Street View / Photograph 	
FEMA Flood Map – Zone AE (El. 16.84 Feet (NGVD 29)) 		Topographic Survey Elevations (NGVD 29) <ul style="list-style-type: none"> • PL-01 – 13.06' • PL-02 – 15.04' • PL-03 – 13.53' • Electric panel bottom – 15.95' • Ground 1 – 13.12' • Ground 2 – 12.72' • Ground 3 – 12.98' • Sewer manhole – 12.98' 	
		Design Flood Elevation and SLR/Year (NGVD 29) <ul style="list-style-type: none"> • 2045 DFE for critical facilities – 22.24' • 2045 DFE for non-critical facilities – 21.24' • 2080 DFE for critical facilities – 25.44' • 2080 DFE for non-critical facilities – 24.44' 	
Operator Survey Notes			



Task 1 – Desktop Analysis / Climate Change Assessment - Wareham Example

All recommended mitigation measures presented in this report should be designed to withstand the Base Flood, plus additional sea level rise estimated for the end of that mitigation measures useful life.

2.2 Design Flood Elevation

The DFE for mitigation measures is determined by the following equation:

$$\text{DFE} = \text{BFE} + \text{SLR} + \text{ASCE 24-14 Minimum Freeboard Requirement}$$

DFE = Design Flood Elevation

BFE = Base Flood Elevation (commonly known as the 100 year storm)

SLR = Sea Level Rise

Table 3 ASCE 24-14 Minimum Freeboard Requirements for Flood Design Class 3 and Flood Design Class 4 Structures

Condition		ASCE 24-14 Minimum Freeboard Requirement	
		Flood Design Class 3	Flood Design Class 4
Minimum elevation below which flood damage-resistance materials shall be used.	Zone AE	BFE + 1 foot or DFE, whichever is higher.	BFE +2 feet or DFE, or 500 year flood elevation, whichever is higher.
	Zone VE and Coastal Zone AE	BFE + 2 feet or DFE, whichever is higher.	BFE +2 feet or DFE, or 500 year flood elevation, whichever is higher.
Minimum elevation of utilities and equipment.	Zone AE	BFE + 1 foot or DFE, whichever is higher.	BFE +2 feet or DFE, or 500 year flood elevation, whichever is higher.
	Zone VE and Coastal Zone AE	BFE + 2 feet or DFE, whichever is higher.	BFE +2 feet or DFE, or 500 year flood elevation, whichever is higher.
Minimum elevation of dry flood-proofing of non-residential portions of mixed-use buildings.	Zone AE	BFE + 1 foot or DFE, whichever is higher.	BFE +2 feet or DFE, or 500 year flood elevation, whichever is higher.
	Zone VE and Coastal Zone AE	Not permitted.	Not permitted.
Minimum elevation of wet flood-proofing.	Zone AE, Zone VE and Coastal Zone AE	BFE + 1 foot or DFE, whichever is higher.	BFE +2 feet or DFE, or 500 year flood elevation, whichever is higher.

Task 1 – Task 1 – Desktop Analysis / Climate Change Assessment - TR-16

- *“The evaluation of flood conditions, potential impacts and warranted improvements should consider all potential impacts on flood-water elevations including... potential future sea level rise”*
- *“The design of wastewater conveyance and treatment facilities as well as related flood mitigation measures should reflect projections of future flooding over the planned services life of a wastewater facility”*
- *“Existing pump stations or treatment facilities that are planned for upgrade or expansion should be improved to the maximum extent possible to meet the flood protection criteria noted herein for new facilities”*
- *“New pump stations... should
 - (1) provide for uninterrupted operation of all units during conditions of a 100-year (1% annual chance) flood and
 - (2) be placed above, or protected against the structural, process, and electrical equipment damage that might occur in an event that results in a water elevation above the 100-year (1% annual chance) flood.”*
- *“The level of protection depends on how critical a component of the facility is to operation of the facility. Specifically, critical equipment of these facilities should be protected against damage up to a water surface elevation that is 3 feet above the 100-year flood elevation. Non-critical equipment should be protected against damage up to a water surface elevation that is 2 feet above the 100-year flood elevation”*

Task 1 – Desktop Analysis / Climate Change Assessment - Proposed Approach

Based on TR-16:

$$\begin{array}{l} \text{Design} \\ \text{Flood} \\ \text{Elevation} \end{array} = \begin{array}{l} \text{FEMA 1\% Annual} \\ \text{Chance Stillwater} \\ \text{elevation @ end of} \\ \text{design life including} \\ \text{sea level rise} \end{array} + \begin{array}{l} \text{FEMA 1\% Annual} \\ \text{Chance Wave @} \\ \text{end of design life} \\ \text{including sea level} \\ \text{rise} \end{array} + \begin{array}{l} \text{Freeboard (+3'} \\ \text{for critical} \\ \text{facilities \& +2' for} \\ \text{non-critical} \\ \text{facilities)} \end{array}$$

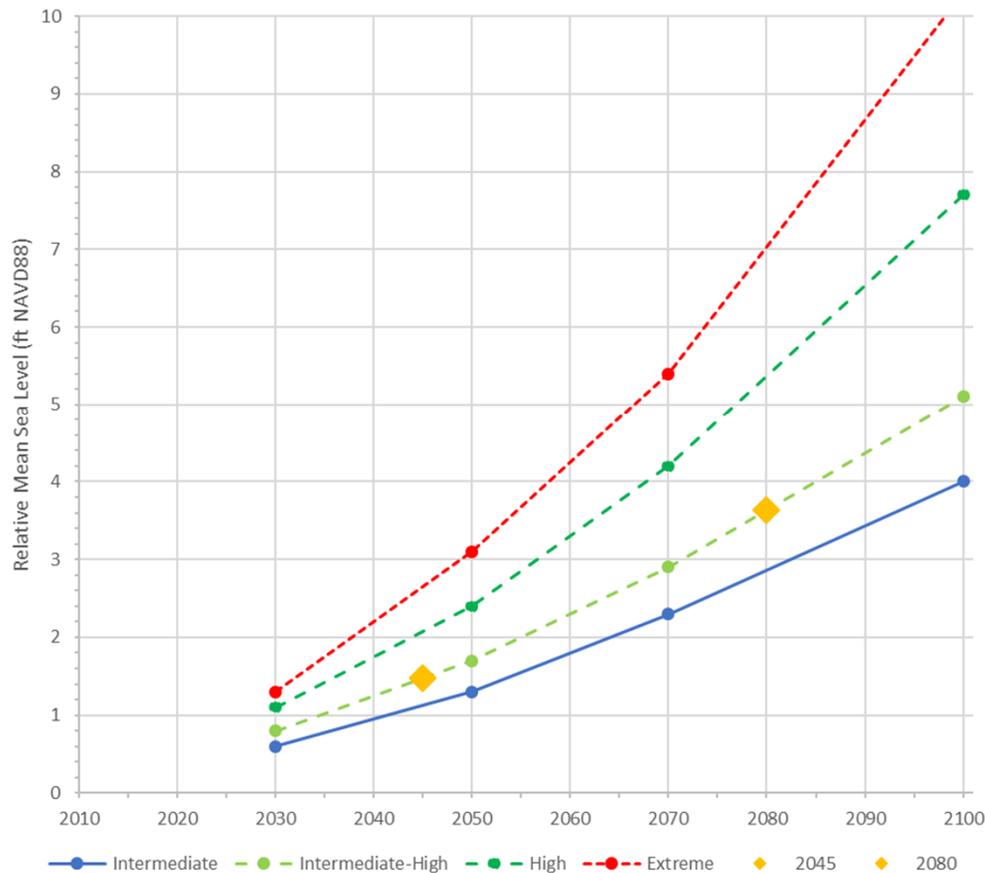
Based on TR-16

*Critical Equipment: includes conveyance and treatment system components identified for protection including, but not limited to, **all electrical, mechanical, and control systems associated with pump stations that are responsible for conveyance of wastewater to and through the treatment facility to maintain primary treatment and disinfection during the flood event.** Other equipment that, if damaged by flood conditions, will prevent the facility from returning to pre-event operation after cessation of flood conditions is also critical equipment.*

Task 1 – Desktop Analysis / Climate Change Assessment

Sea Level Rise (based on the Massachusetts Climate Change Projections)

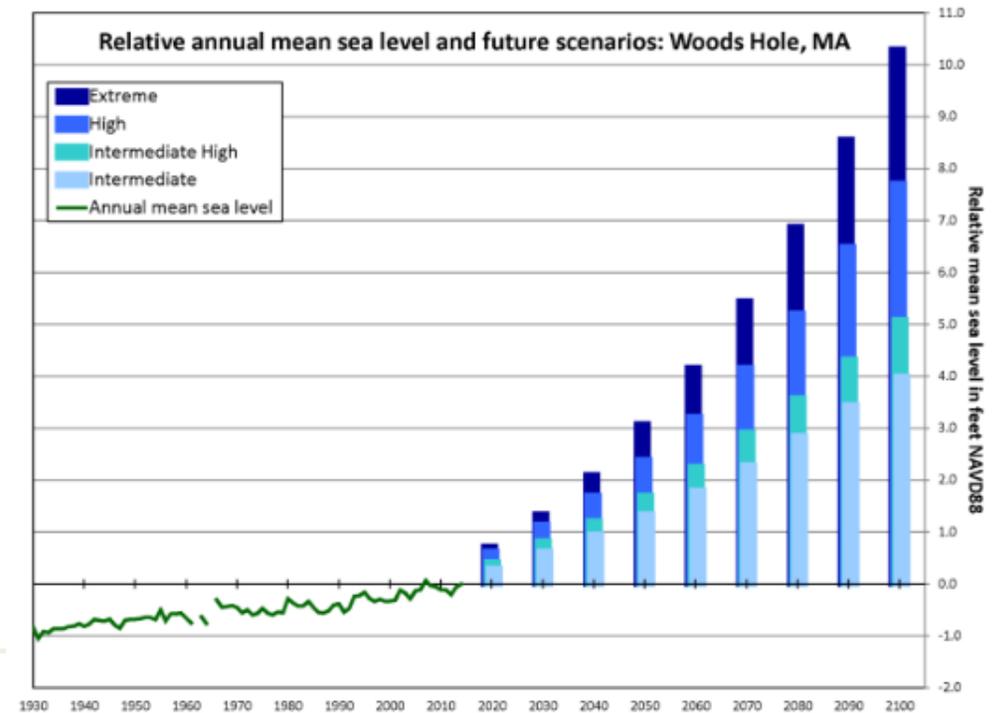
Relative Mean Sea Level (ft NAVD88) for Woods Hole, MA



Relative mean sea level (feet NAVD88) for Woods Hole, MA

Scenario	Probabilistic projections	2030	2050	2070	2100
Intermediate	Unlikely to exceed (83% probability) given a high emissions pathway (RCP 8.5)	0.6	1.3	2.3	4.0
Intermediate- High	Extremely unlikely to exceed (95% probability) given a high emissions pathway (RCP 8.5)	0.8	1.7	2.9	5.1
High	Extremely unlikely to exceed (99.5% probability) given a high emissions pathway (RCP 8.5)	1.1	2.4	4.2	7.7
Extreme (Maximum physically plausible)	Exceptionally unlikely to exceed (99.9% probability) given a high emissions pathway (RCP 8.5)	1.3	3.1	5.4	10.3

Relative annual mean sea level and future scenarios: Woods Hole, MA



Task 1 – Desktop Analysis / Climate Change Assessment

Wastewater infrastructure components typically have the following life expectancies:

- Mechanical equipment, wooden buildings – 20 years
- Concrete and masonry – 50+ years

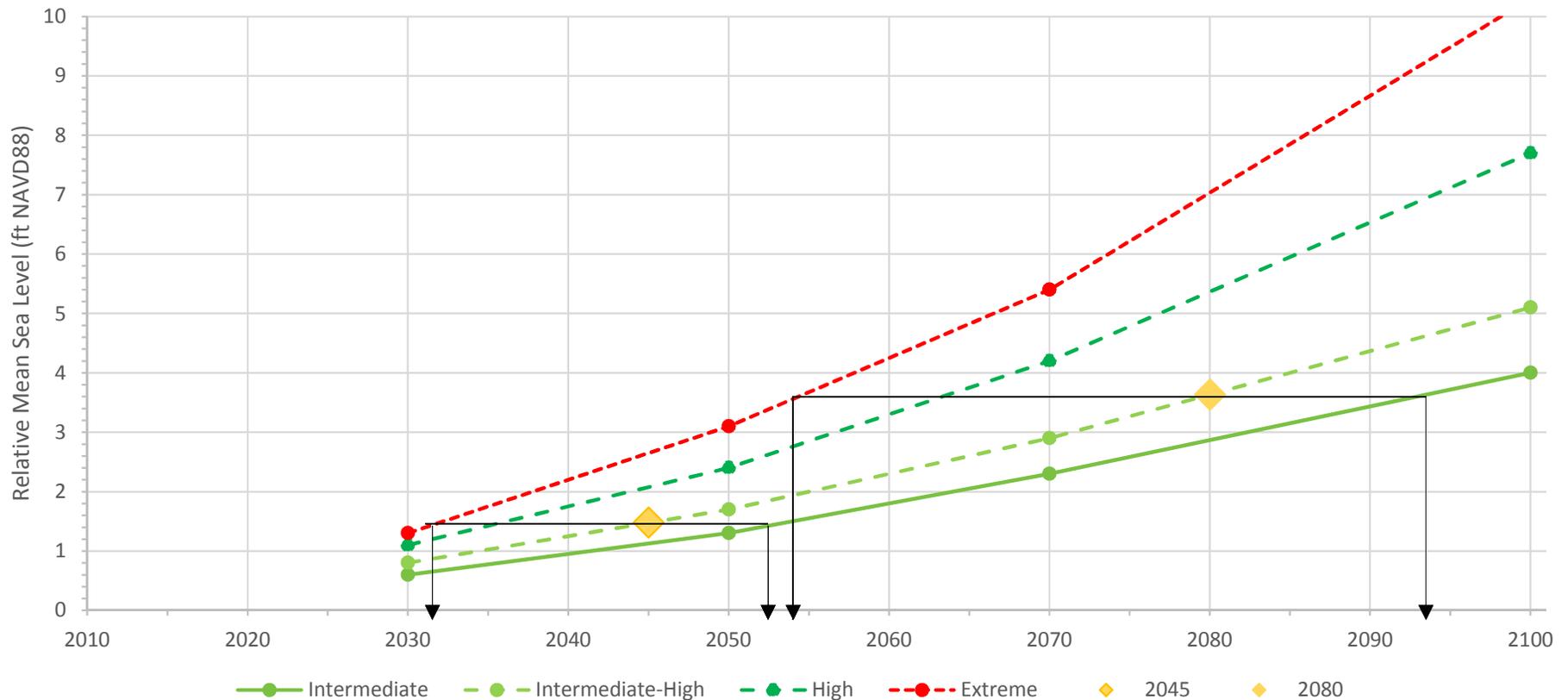
Assuming all mechanical equipment is replaced by 2025

(design for conditions through 2045) = 1.47'

Assume all concrete and masonry is replaced by 2030

(design for conditions through 2080) = 3.63'

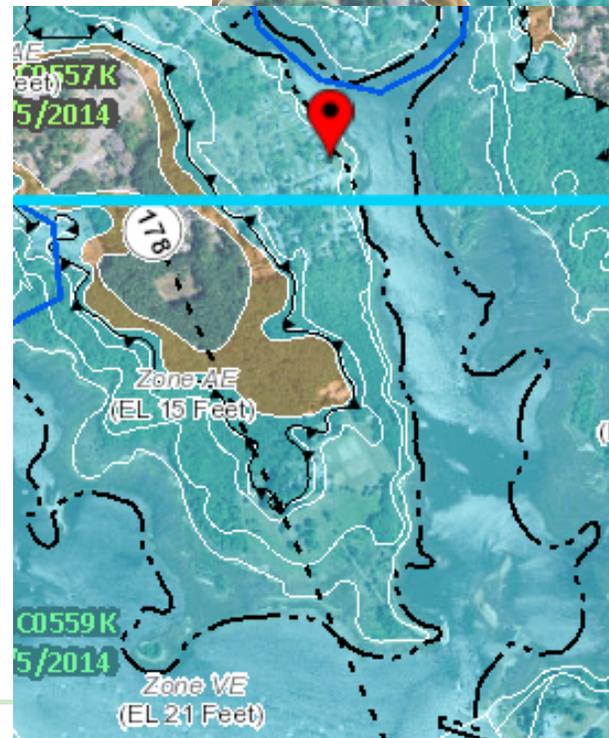
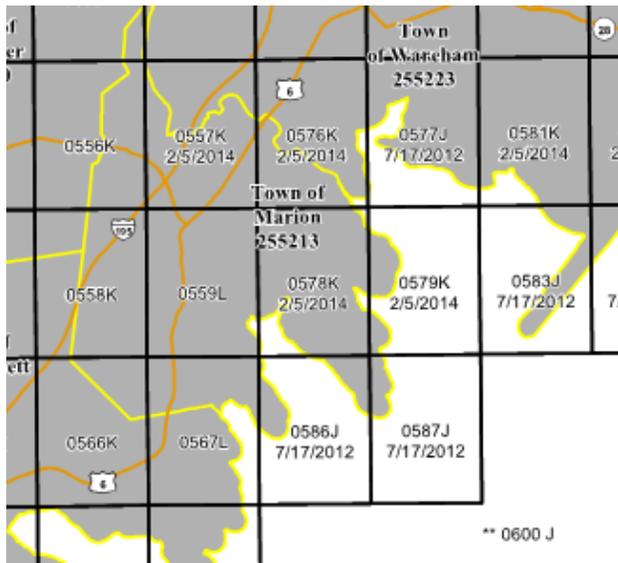
Relative Mean Sea Level (ft NAVD88) for Woods Hole, MA



Task 1 – Desktop Analysis / Climate Change Assessment : Example

- Oakdale Avenue

Current 1% Annual
Chance Base Flood
Elevation
= VE 17' NAVD88

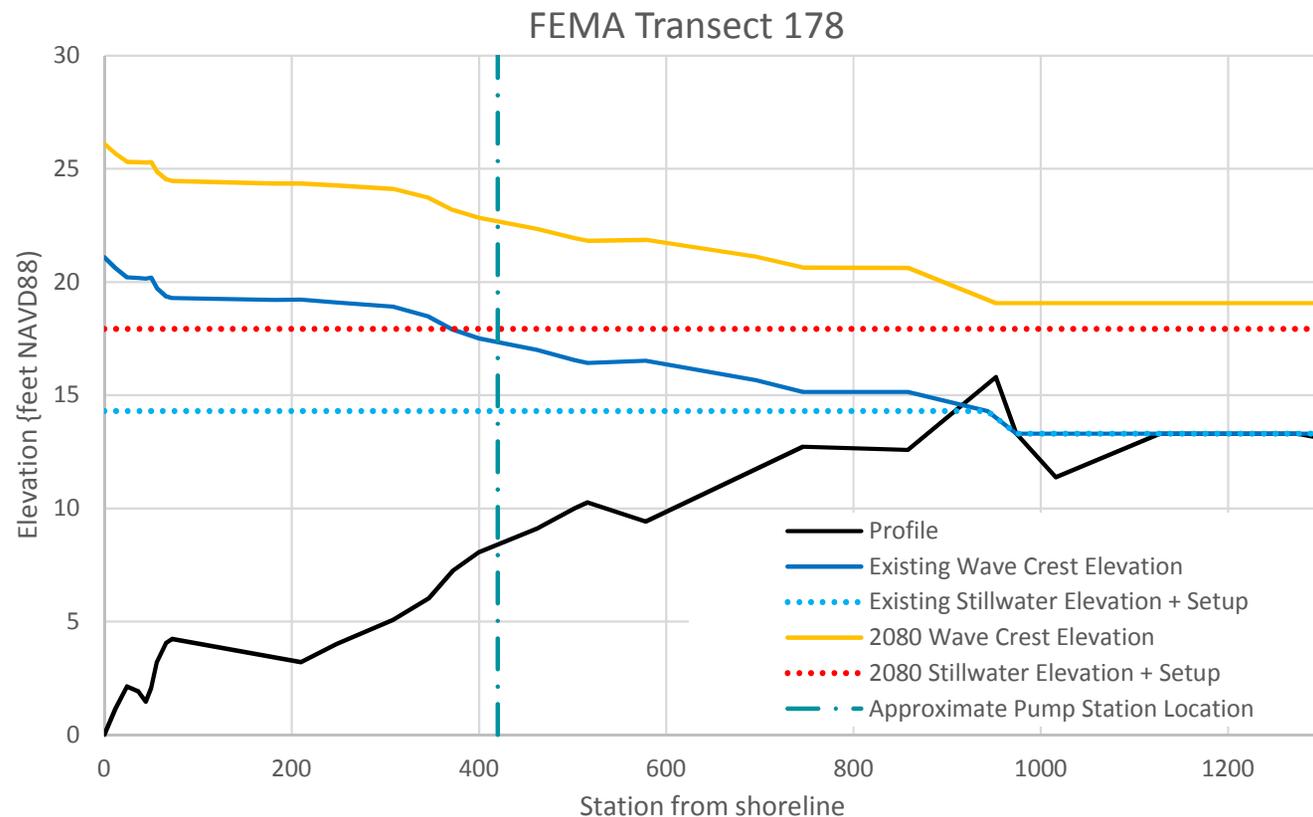


Task 1 – Desktop Analysis / Climate Change Assessment : Example

■ Oakdale Avenue

Current BFE = VE 17' NAVD88 | With SLR = VE 21' NAVD88

Assume all concrete and masonry is replaced by 2030 (design for conditions through 2080)



Task 1 – Desktop Analysis / Climate Change Assessment - Example

■ Oakdale Avenue

Design Flood Elevation = FEMA 1% Annual Chance Stillwater elevation @ end of design life including sea level rise + FEMA 1% Annual Chance Wave @ end of design life including sea level rise + Freeboard (+3' for critical facilities & +2' for non-critical facilities)

Design Flood Elevation =  22.7' NAVD88 + 3' Freeboard for critical facilities

Design Flood Elevation = 25.7' NAVD88 = 26.5' NGVD29

Task 1 – Public Outreach

- October 9, 2018 – King Tide Event
- Photos collected
- MyCoast Publication
- CDM Smith to review information to be posted on Town of Marion Website.

Task 1 Summary

- Data will be collected and detailed information at each pump station will be obtained, and general grinder pump neighborhood information will be collected, to help assess pump station and grinder pump vulnerability and potential mitigation measures.



Scope - Task 2

Task 2 – Vulnerability and Risk Assessment with Respect to Coastal Flooding

- Approach to be discussed further at Progress Meeting #1
- Determine Vulnerability
 - Identify and evaluate stresses from coastal flooding
 - Evaluate sensitivity to each location / grinder pump neighborhoods
 - Assess the adaptive capacity
- Assess Risk
- Develop Report Section

THIS IS FOR DEMONSTRATIVE PURPOSES ONLY											
SCORING DEVELOPED IN CONSULTATION WITH THE TOWN											
Pumping Station	Longitude	Latitude	FEMA Flood Zone	Impact to Pump Station (Damages Avoided)	Impact to Wastewater System Operations	Impact to Critical Facilities	Impact to Private Properties	Impact to Environmental Resources	Exposure	Vulnerability	Risk Score
Creek Road	-70.7575	41.72297	VE 17	5	2	1	3	3	14	0.01	0.14
Oakdale Avenue	-70.7591	41.71931	VE 17	5	5	4	2	1	17	0.01	0.17
Silvershell Beach	-70.7589	41.69598	AE 16	4	4	4	3	3	18	0.01	0.18
Front Street	-70.7655	41.70664	AE 13	1	3	5	4	1	14	0.01	0.14
Parkway Lane	-70.7645	41.72161	AE 16	4	1	5	4	2	16	0.01	0.16
Point Road	-70.7607	41.7264	AE 16	4	2	3	5	2	16	0.01	0.16
Stoney Run	-70.7425	41.7264	AE 16	3	5	2	2	3	15	0.01	0.15
Little Neck	-70.7639	41.71772	AE 15	2	2	3	1	3	11	0.01	0.11

Impact to Pump Station (Damages Avoided): Based on the expected cost of assets damaged during a future 1% annual chance event

Impact to Wastewater System Operations: Based on the interdependencies of the system as a whole and the system capacity, if the pump station were to fail.

Impact to Critical Facilities: Based on the number of critical facilities within the sewershed for the pump station, if the pump station were to fail.

Impact to Private Properties: Based on the number of private properties within the sewershed of the pump station, if the pump station were to fail.

Impact to Environmental Resources: Based on the location of combined sewer overflows, if the pump station were to fail.



Scope - Task 3

Task 3 – Action for Each Pumping Station & Grinder Pump Service Area

- To be discussed further at Progress Meeting #2
- Menu of options will be identified
- Relevant Report Sections to be drafted

Option	Mitigation Measure	Unit Cost
A	Install flood door.	2-foot flood door - \$30,000 Full flood door - \$60,000
B	Install watertight hatch on a submersible station.	\$30,000
C	Flood-proof painting.	\$200,000
D	Raise control panel above the DFE.	Relocate existing panel - \$30,000 Replace panel - \$50,000
E	Raise generator above the DFE.	Less than 1-foot - \$50,000 1-foot to 3-feet - \$125,000
F	Raise vent above DFE.	\$5,000
G	Install a louver to allow water to enter the station and equalize hydrostatic pressure.	\$150,000
H	Raise louver above the DFE or install a flood door in front of louver to protect to the DFE.	\$150,000

Potential Grinder Pump

Actions:

- Pre-storm communications
- Retrofits
- Post-storm restoration of operations

Scope - Task 4



Task 4 – Report Development

- Draft report sections will be developed as part of Task 2 & Task 3.
- Will use the Wareham Report as an example for this report.
- Draft report will be delivered for comment.
- Comments from Town of Marion, public, and Massachusetts Coastal Zone Management will be considered for incorporation into final report.



Scope - Task 5

Task 5 – Public Meetings & Outreach

- Kickoff Meeting
- Progress Meeting #1 – discuss the vulnerability/risk assessment approach (mid January 2019)
- Progress Meeting #2 – discuss the adaptation strategy identification approach (end February 2019)
- Public Meeting – CDM Smith to help prepare any materials and provide a 1-page handout which will also be delivered to CZM (May 2019)



Schedule

Schedule

Task	Estimated Delivery Date
MyCoast Public Outreach	End Oct 2018
Pumping Station Site Visits	Early Dec 2018
Desktop Analysis / Data Compilation / Climate Change Assessment	Early Jan 2019
Progress Meeting #1 – Discuss Vulnerability / Risk Assessment Approach	Mid Jan 2019
Draft Report Section On Vulnerability and Risk Assessment	Mid Feb 2019
Progress Meeting #2 – Discuss Adaptation Strategy Identification	End Feb 2019
Draft Report Section Summarizing Adaptation Actions	Mid Mar 2019
Prepare Draft Report & Cost Estimates	Mid April 2019
Hold Public Meeting	Mid May 2019
Prepare Final Report	Mid June 2019
Prepare Final Case Study Report For CZM	End June 2019



QUESTIONS?