Increasing the Resilience of Vulnerable Infrastructure in the Face of Climate Change – A Tale of Two Communities

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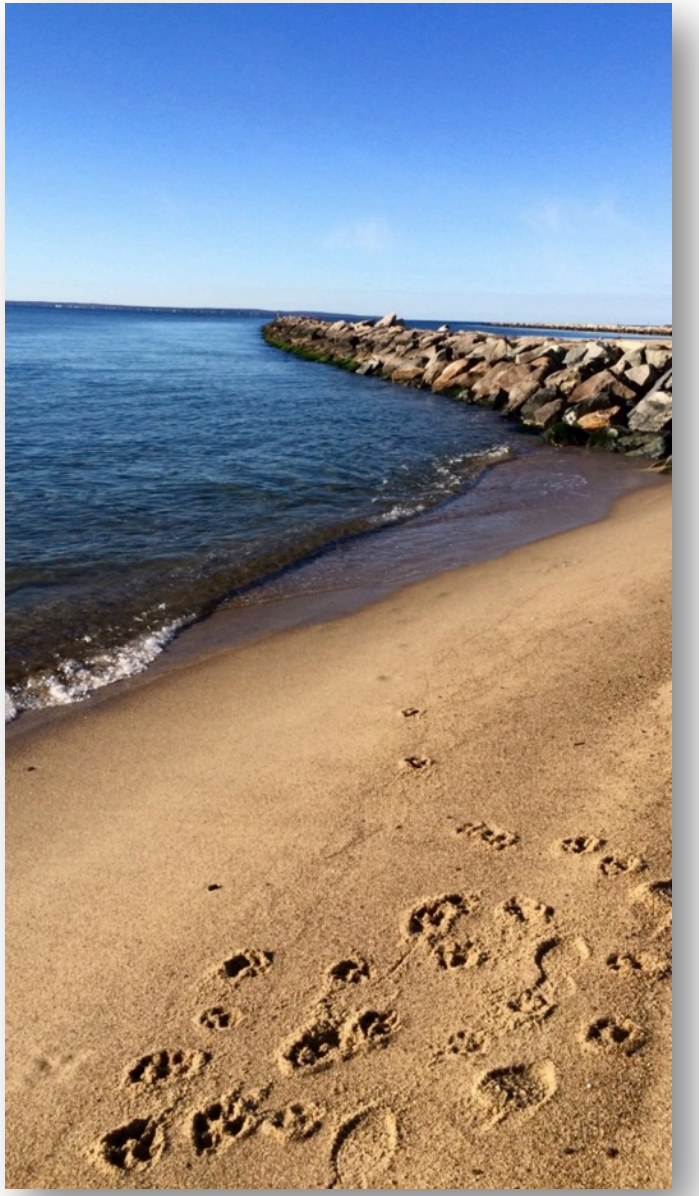
January 2018

Overview

1. Background

2. Two Case Studies
    1. Town of Uxbridge, MA
    2. Town of Chatham, MA

3. Questions



Background

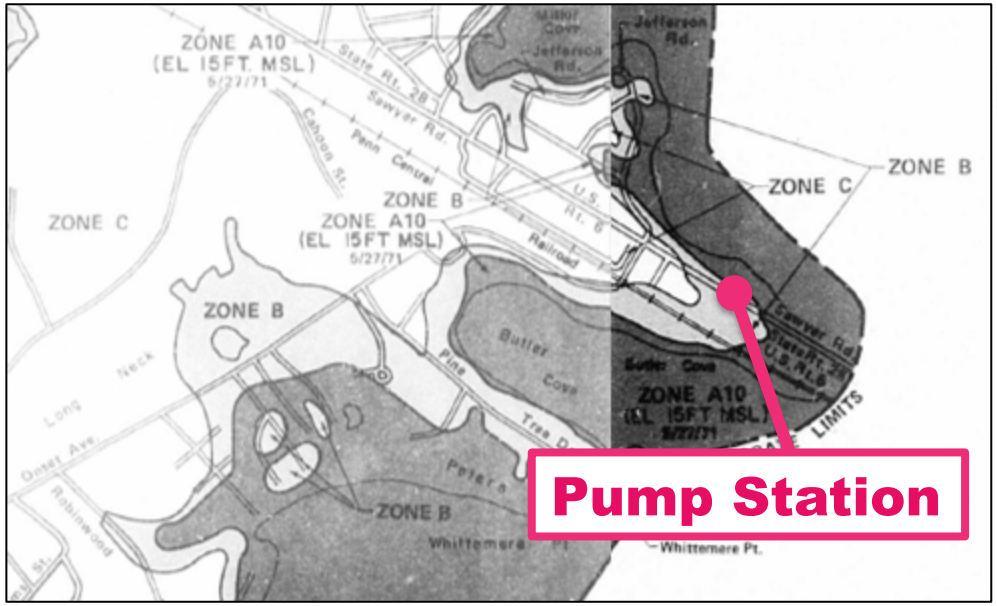
Vulnerability to Flooding Events

- Financial damages
  - FEMA: **8 out of the top 10 natural disasters** in the United States were caused by coastal storms
  - Climate.gov: ‘Inland floods cause more damage **annually** than any other severe weather event’
- Change in frequency and intensity of storms
  - Global sea level rise
  - Warmer temperatures projected to increase precipitation intensity
  - Updated FEMA FIRM Maps

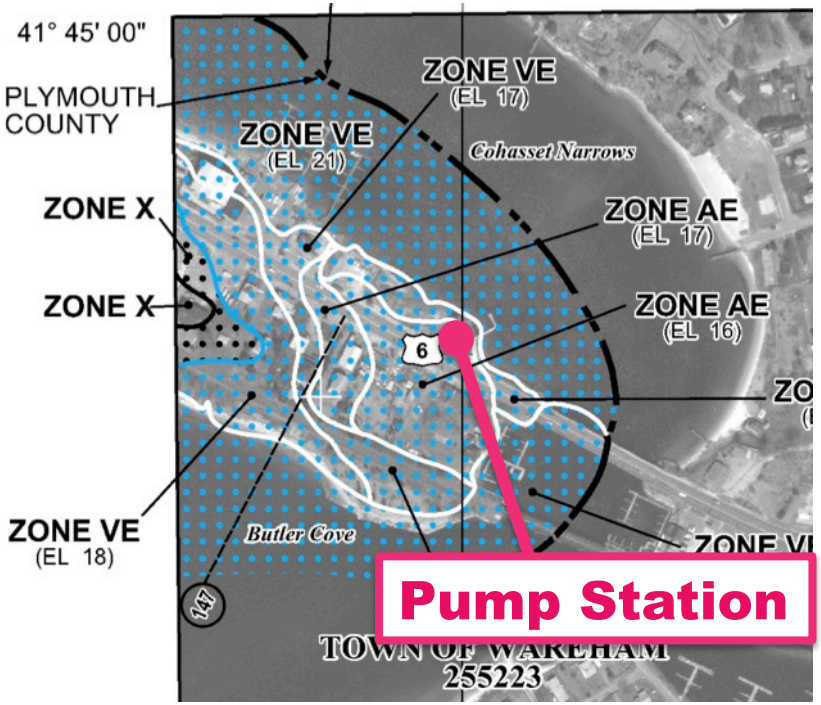
	Seasonal Outlook	Actual
Named storms	14-19	17
Hurricanes	5-9	10
Major Hurricanes	2-5	6

U.S. Army Corps of Engineers

Vulnerability to Flooding Events



- 1983 FEMA Firm Map
- Zone A10 = 15 ft MSL
- Zone B = Area between 100 yr and 500 yr flood
- Zone C = Areas outside 500 yr flood



- 2012 FEMA Firm Map
- AE Zones = 16, 17
- VE Zones = 17, 21, 22

Freeboard Requirements

Previous design standard

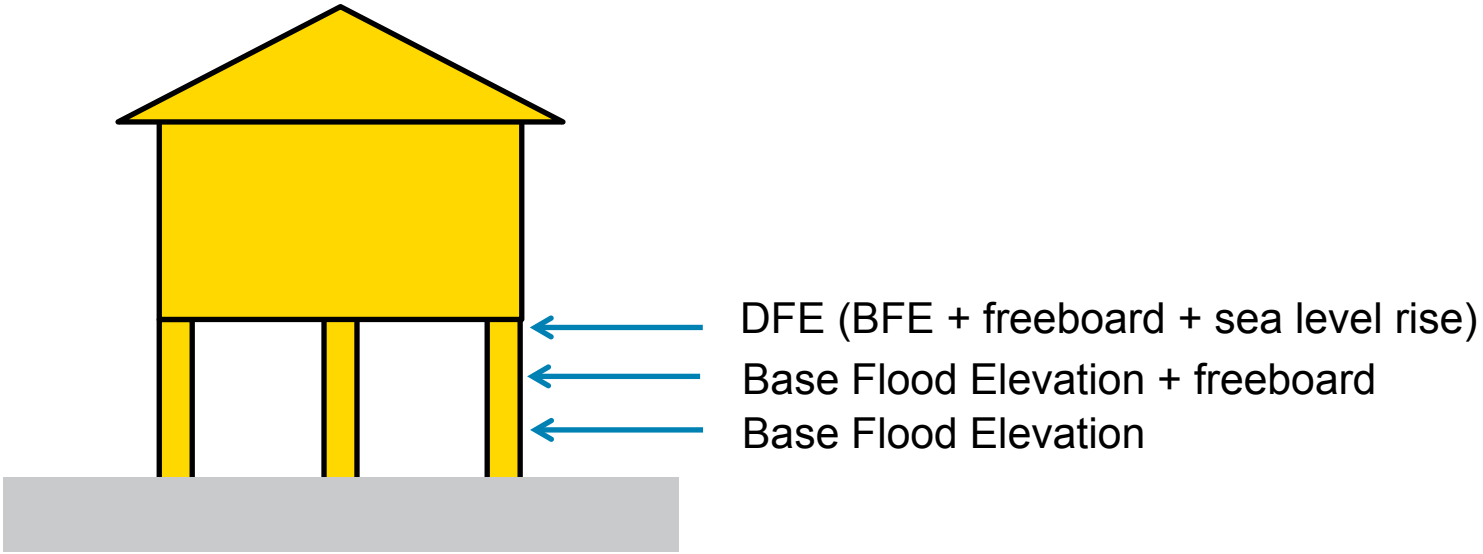
- Design to 100 year flood elevation
- No required minimum freeboard

Updated design standards

- More stringent minimum freeboard requirements
- TR-16
  - Critical equipment = 3 ft
  - Non-critical equipment = 2 ft
- ASCE 24-14 – Flood Resistant Design and Construction, 2014
  - Requirement of Massachusetts 9th Building Code
  - Specifies minimum freeboard requirements based on criticality of infrastructure

Design approach – determine design flood elevation

Design Flood Elevation (DFE) =
Base Flood Elevation (BFE) + Freeboard + {Optional - Sea Level Rise (Coastal)}



Freeboard Requirements

Mass Building Code and ASCE 24-14

- **Flood Design Class 1 Structures -** Example – temporary structures, minor storage facilities

- **Flood Design Class 2 Structures -** Example – most residential, commercial and industrial buildings

- **Flood Design Class 3 Structures -** Buildings and structures that pose a high risk to the public and a significant disruption to the community if they are unable to perform their intended function due to flooding. **ASCE 24-14 specifically includes water and sewage treatment in this category.**

- **Flood Design Class 4 Structures -** Buildings and structures that contain essential facilities and services necessary for emergency response and recovery and **ancillary structures that allow continuous functioning of a Flood Design Class 4 facility after an emergency.**

Condition		ASCE 24-14 Minimum Freeboard Requirement	
		Flood Design Class 3	**Flood Design Class 4**
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, whoever is higher

Source: ASCE 24-14: Flood Resistant Design and Construction
Notes:
(1) The DFE is obtained from a community adopted flood hazard map if a community has adopted a flood hazard map that depicts flood hazard areas in addition to the SFHA's shown on FEMA's FIRM maps.

Flood Resilience Strategies

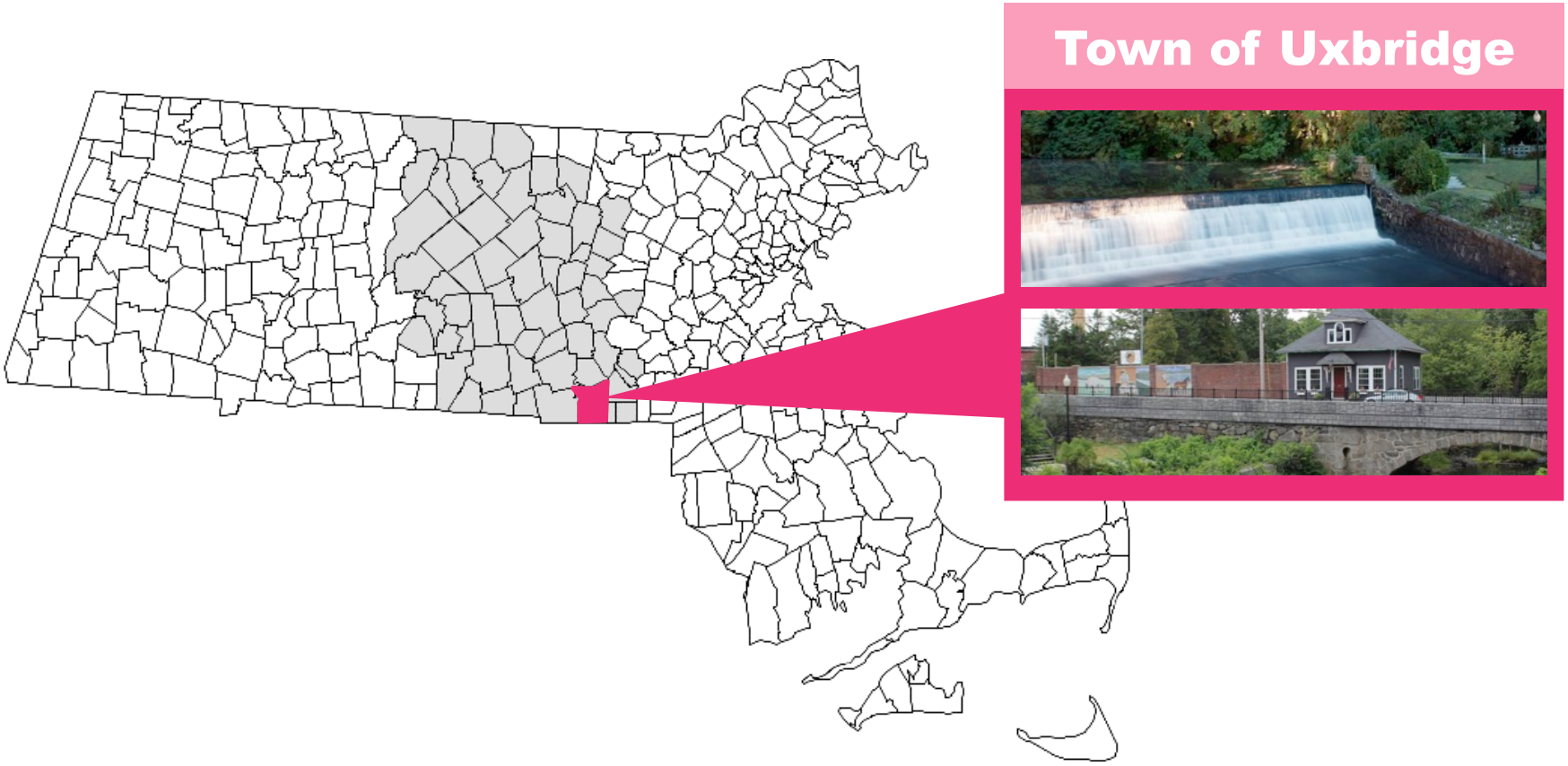
Mitigation Measures

- Protect critical equipment from water damage (elevate or floodproof)
- Ensure structures withstand hydrostatic flood load
- Provide emergency generation capacity
- Provides means to bypass critical infrastructure if it fails

Two Case Studies

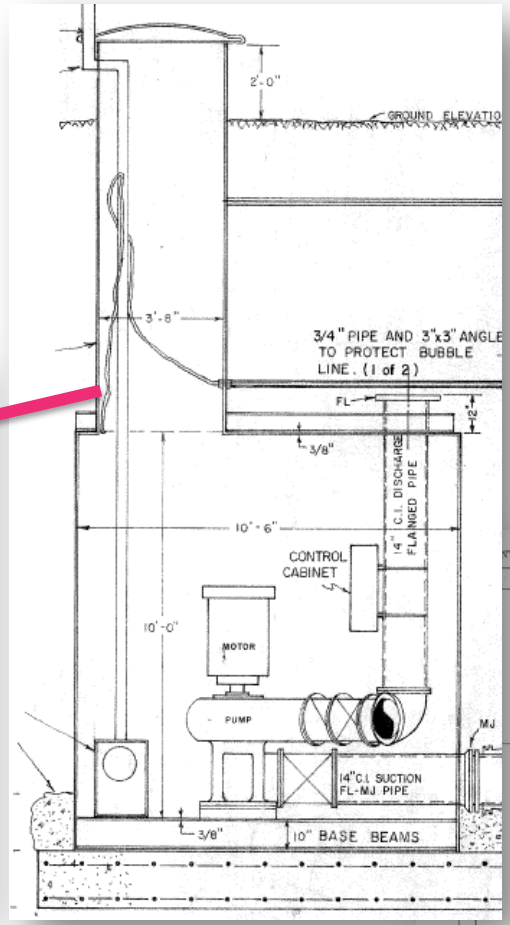
Inland Case Study | Town of Uxbridge, MA

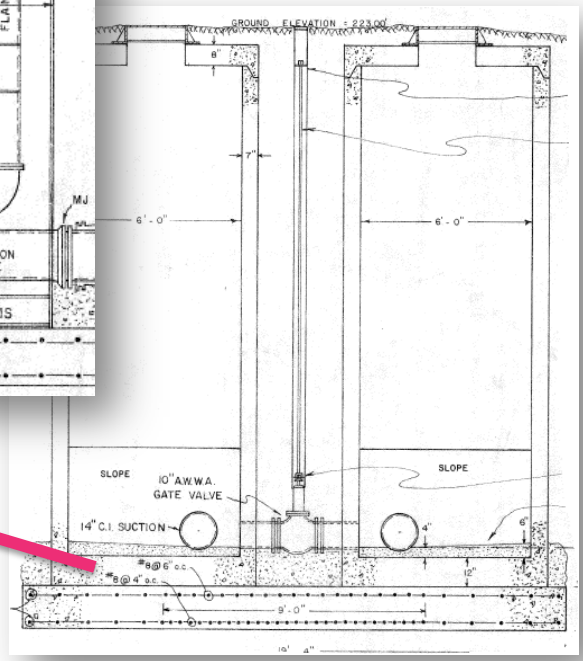
- **5** pump stations and **1** wastewater treatment plant
- **1** pump station in 100 year **flood zone**



West River Pumping Station

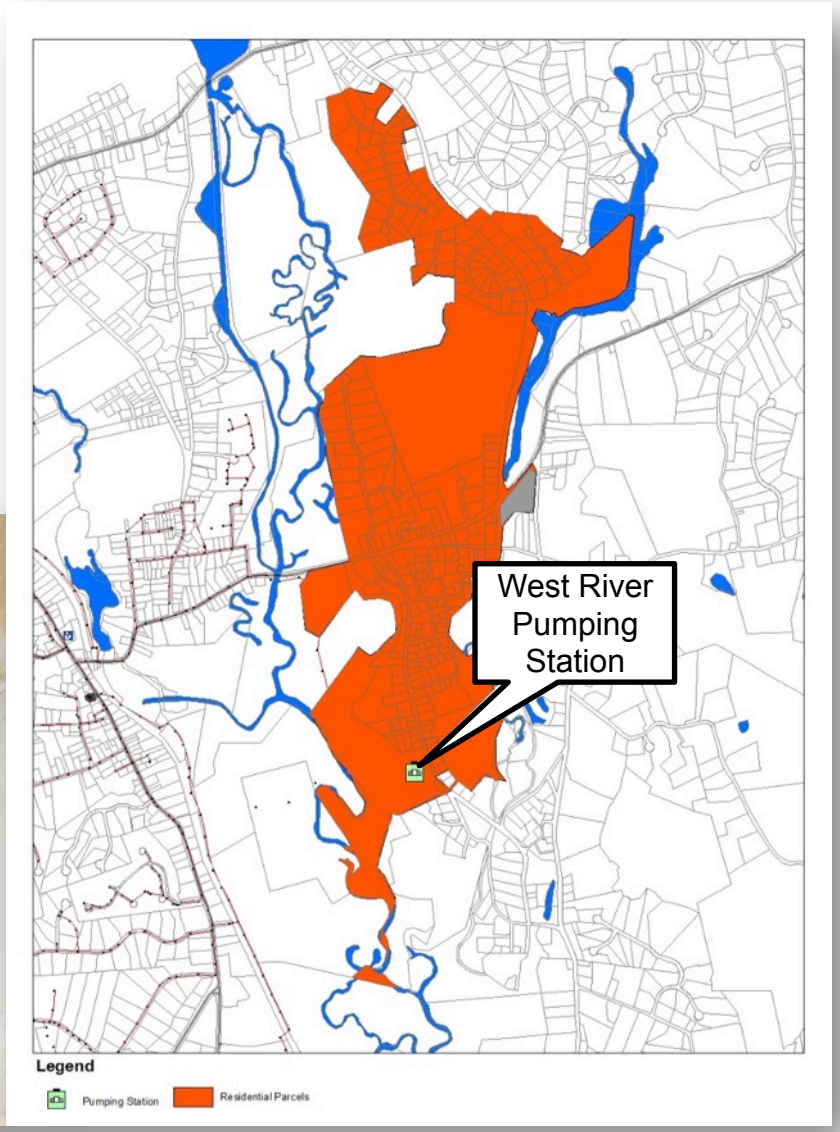
- Below-grade package pumping station





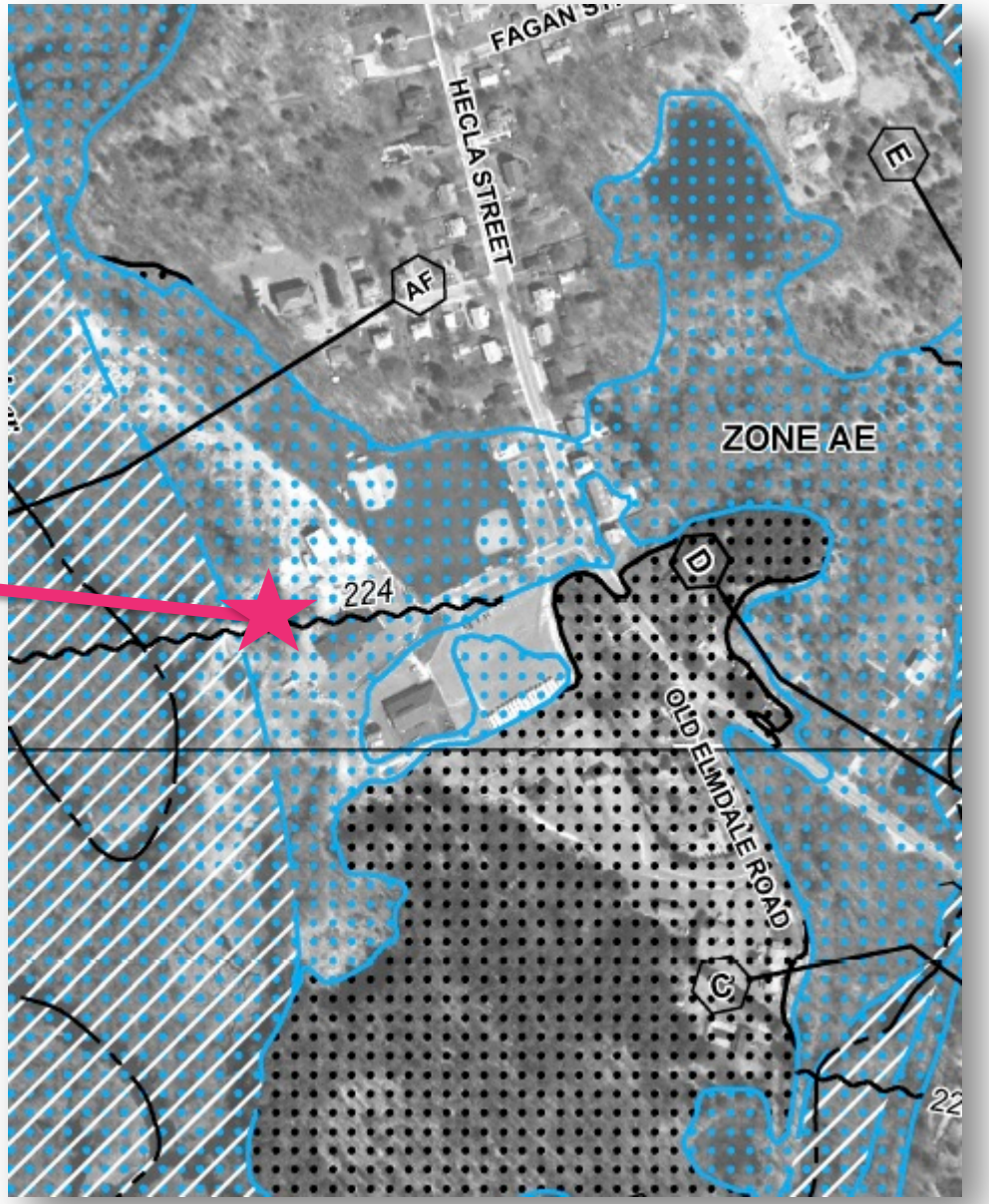
West River Pumping Station

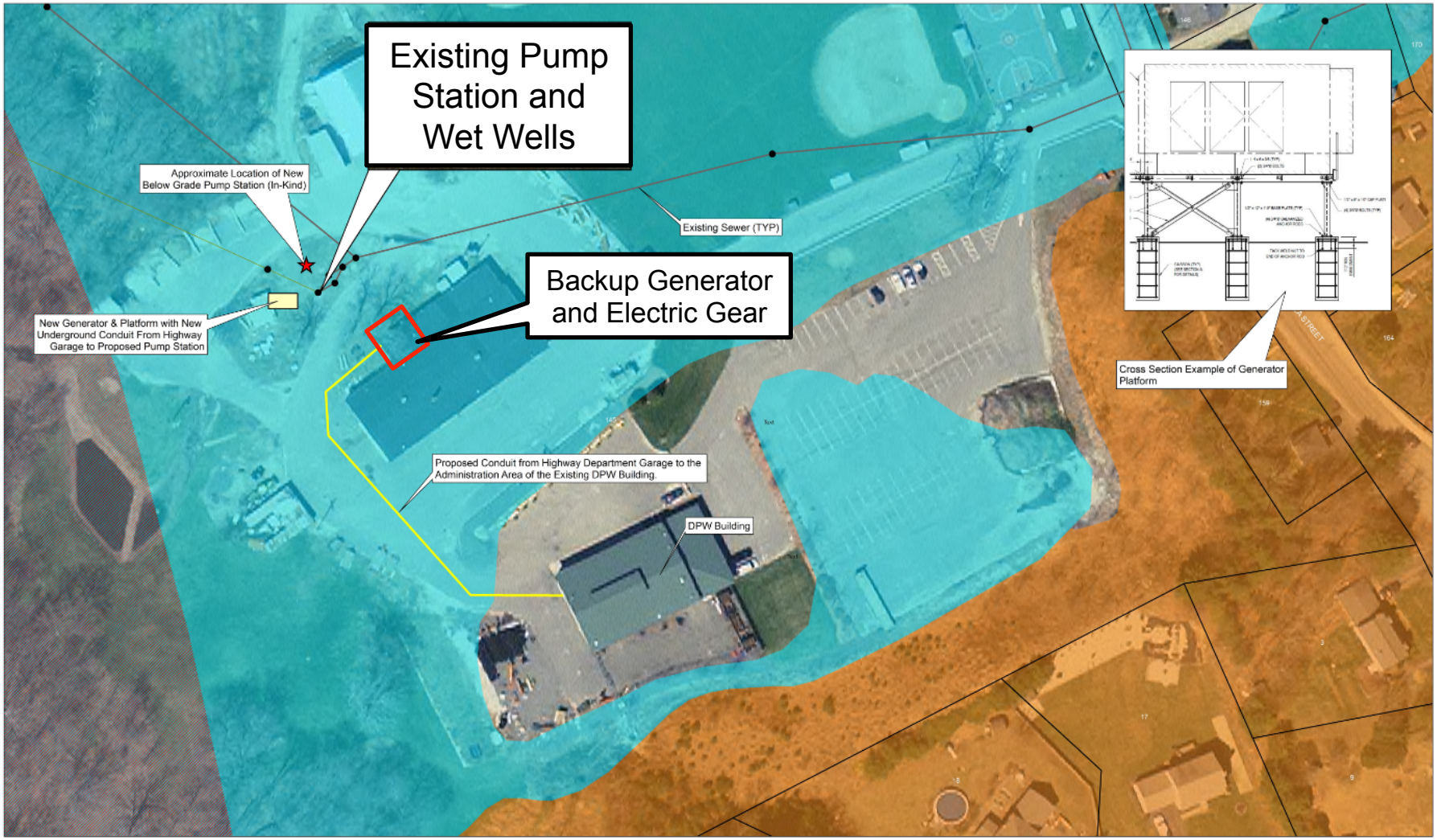
- Serves 272 residential and 1 industrial parcel
- Flood Design Class 3
- Placed in service in late 1970's



FEMA Flood Elevation

- Zone AE
- BFE = 224 feet





Town of Uxbridge, Massachusetts
145 Hecla Street
Public Works Facility
West River Pumping Station Upgrade

Job Number 86-18922
Revision A
Date 09 Sep 2016

Figure 5-1

1545 Iyannough Road, Hyannis Massachusetts 02601 USA T 1 508 362 5680 F 1 508 362 5884 E hyannis@ghd.com W www.ghd.com

Base Flood (100 Year Flood)

- BFE = 224 feet
  - No freeboard

- **During Base Flood Event:**
  - Station has does not have watertight hatch
  - Conduit penetrations in access tube are not watertight

Base Flood (100 Year Flood)

- **During Base Flood Event:**
  - Electrical panel and emergency generator below BFE
  - Pre-engineered building not designed to withstand hydrostatic pressure

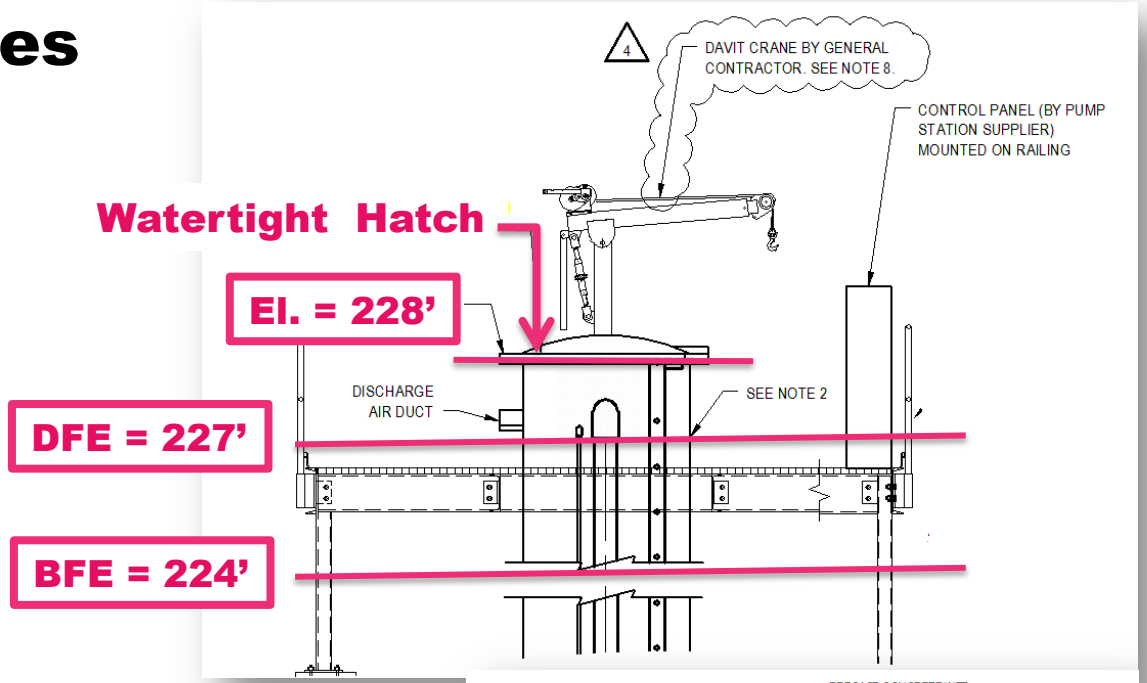
Mitigation Measures

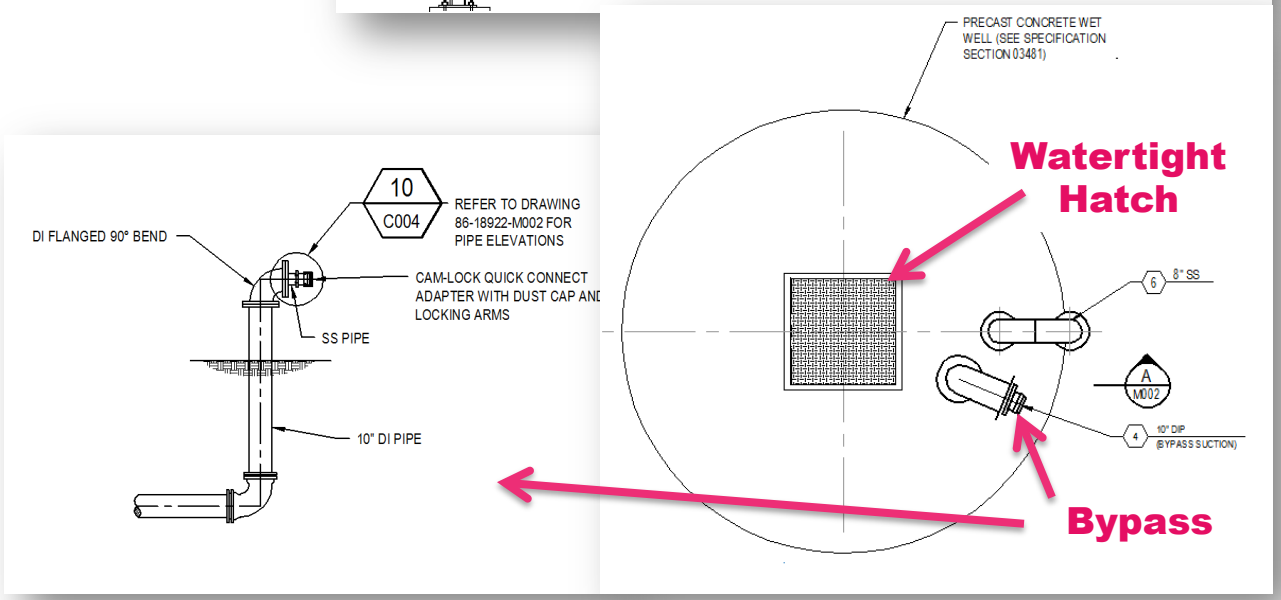
Pumping Station Access

- Access above flood elevation
- Watertight hatch

Wet Well

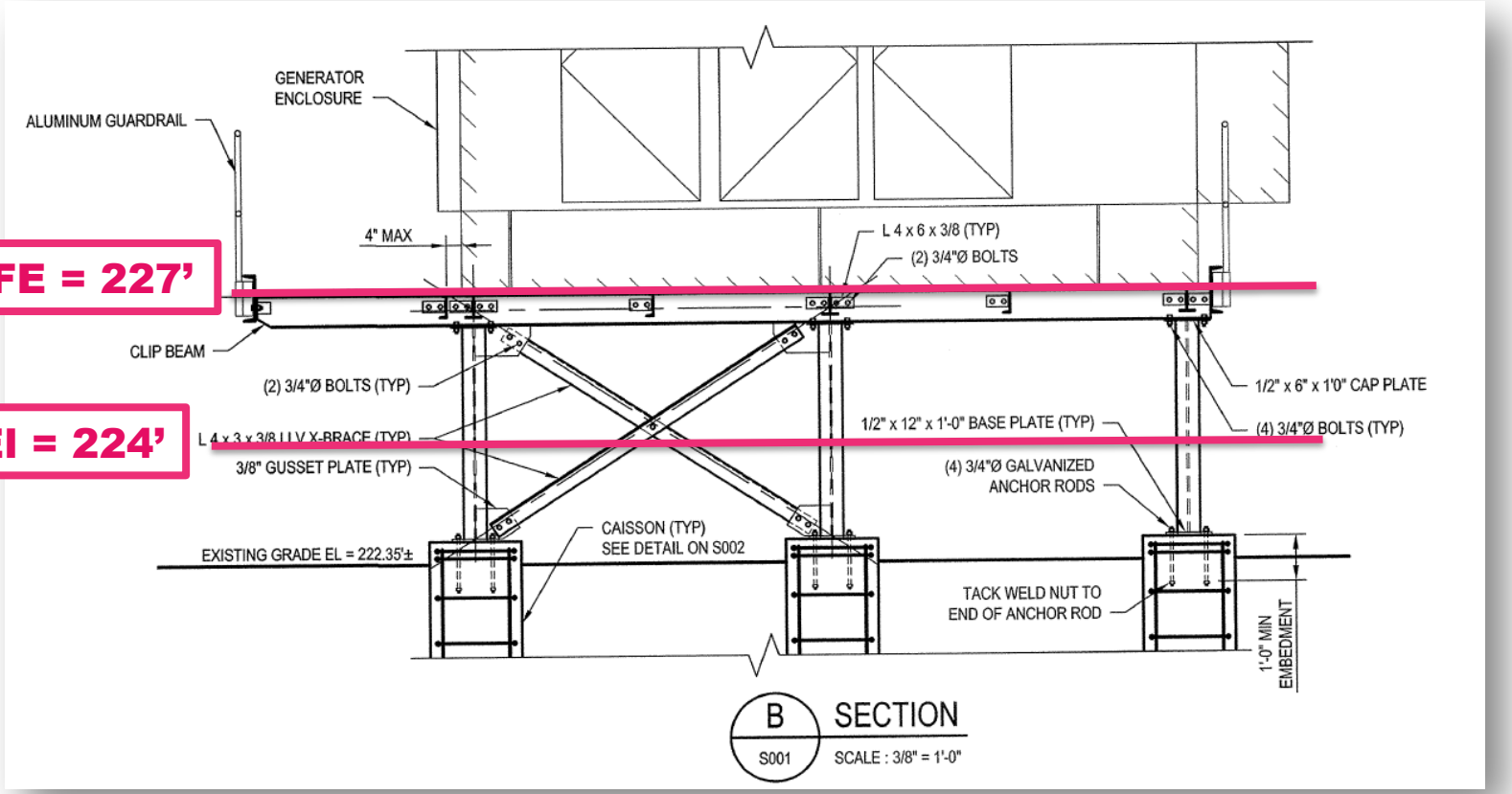
- Watertight hatch
- Bypass





Mitigation Measures

Emergency Generator



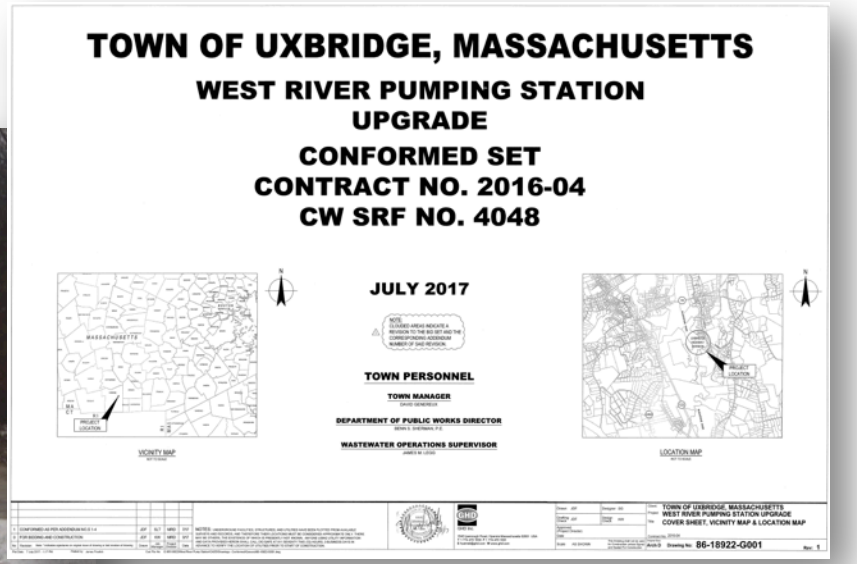
Mitigation Measures

Emergency Generator

DFE

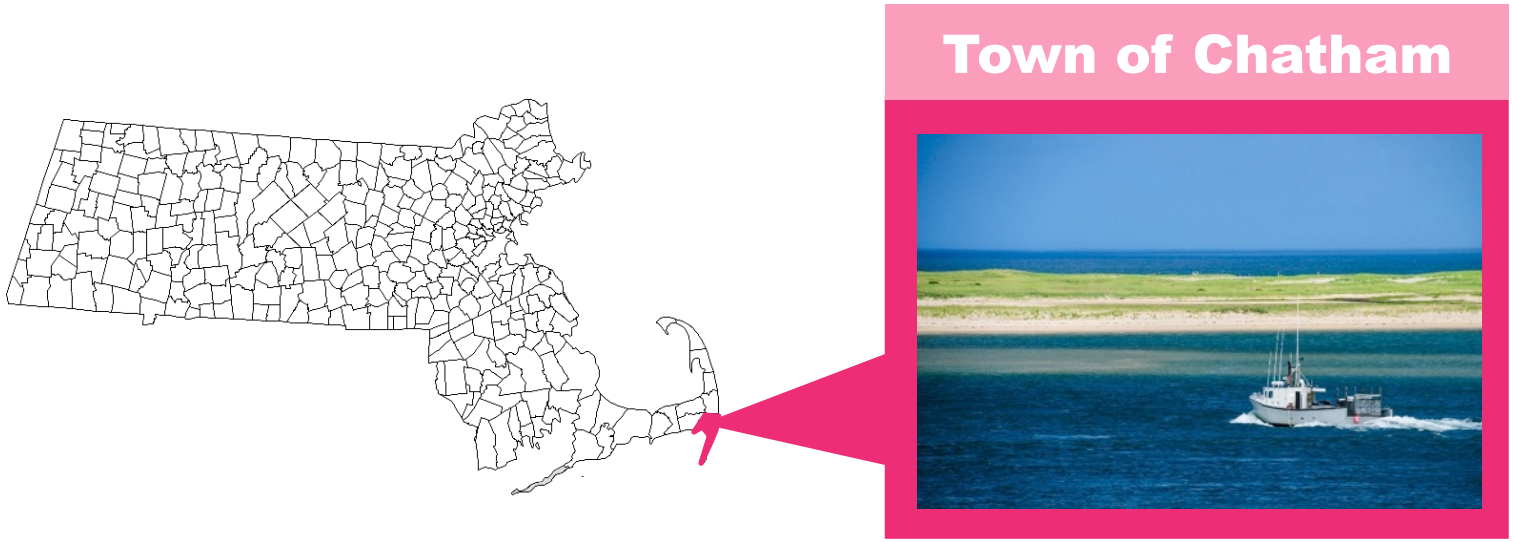
Project Status

- Contract Awarded
- Equipment being fabricated
- Break ground in Spring of 2018



Coastal Case Study | Town of Chatham, MA

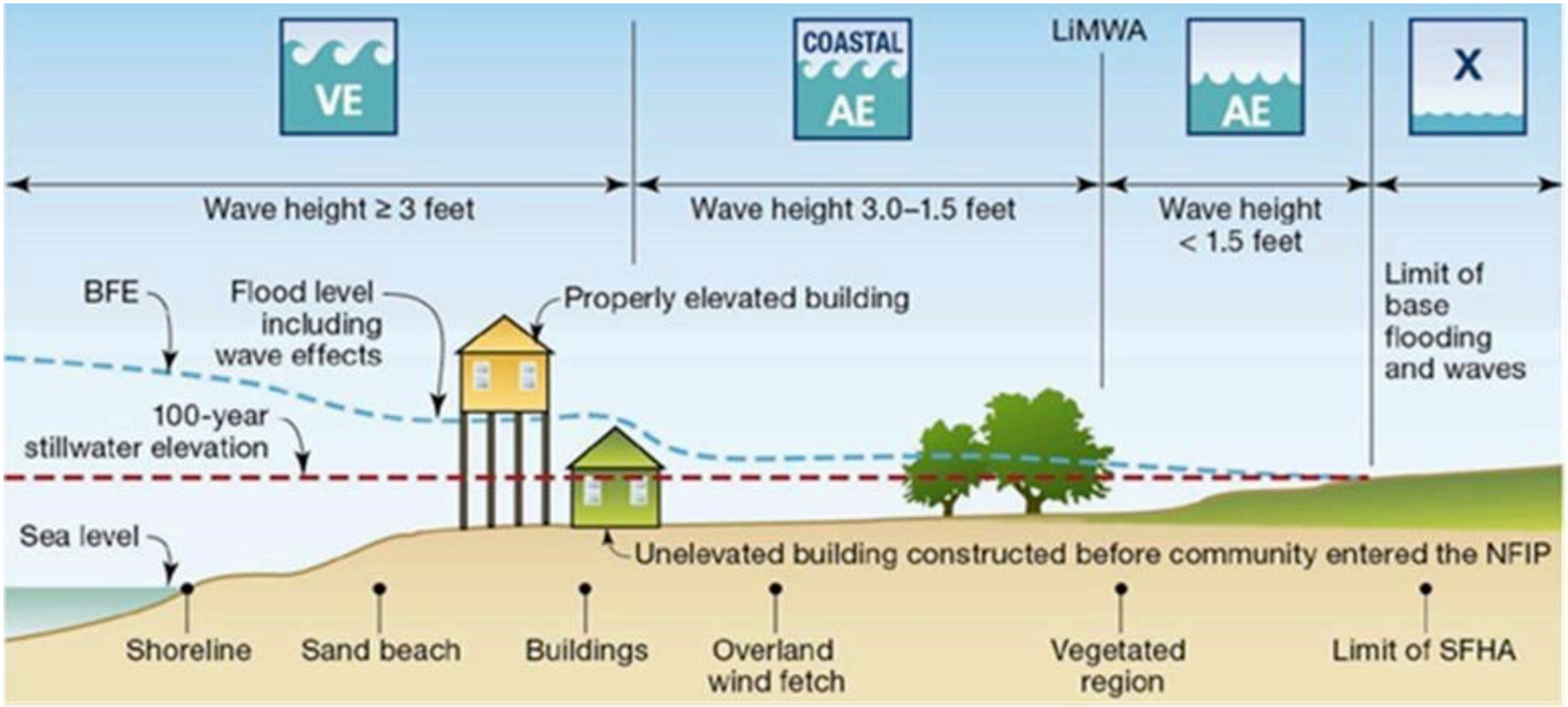
- Small coastal community
- Year-round population of 5,126 (2010 Census)
- Summer population is 3x year-round



Mill Pond Pumping Station

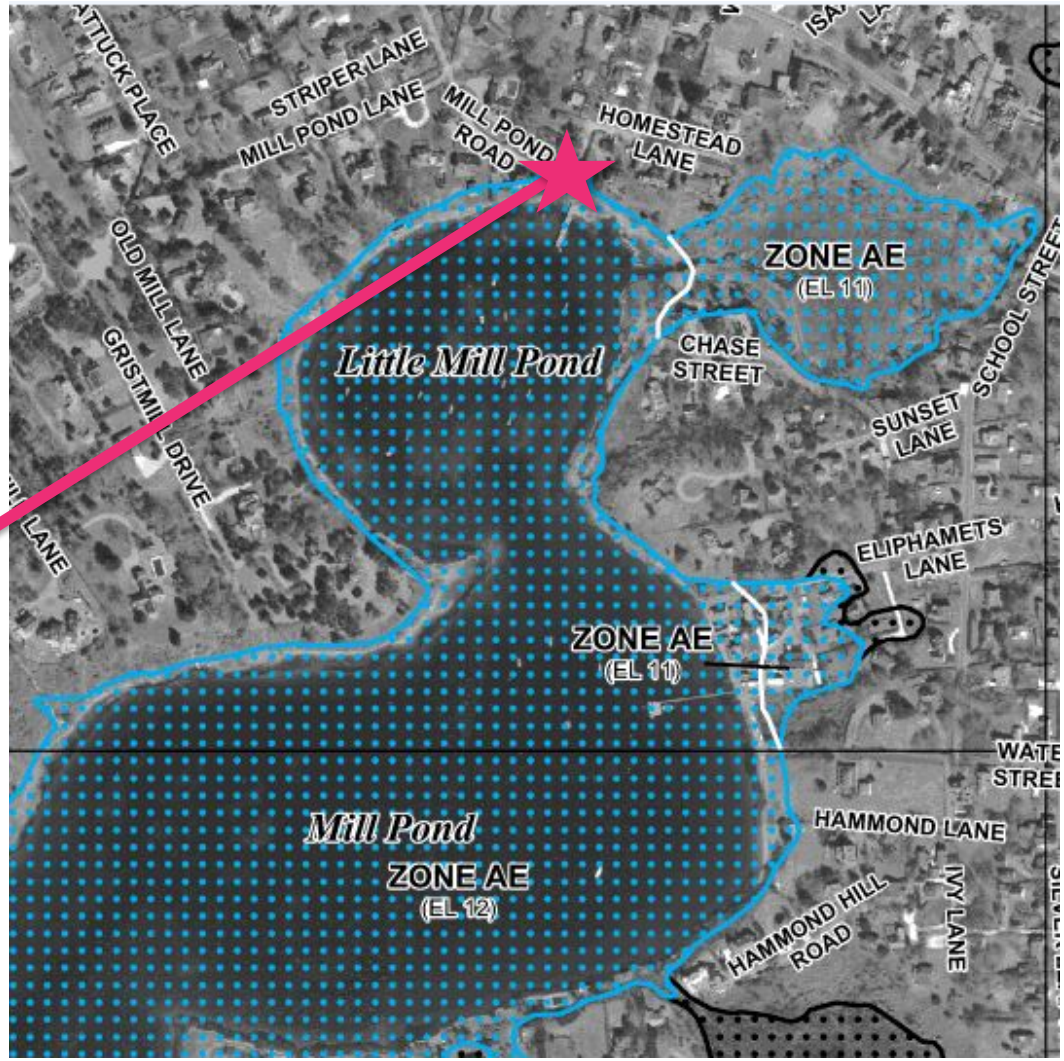
- Existing Ejector Station located along saltwater embayment
- Two-level structure, primarily below grade
- Placed in service in 1972
- Currently serves approximately 15 homes
- Future sewershed – approximately 100 residential properties
- Considered Flood Design Class 3

FEMA coastal flood hazard zones/base flood elevation



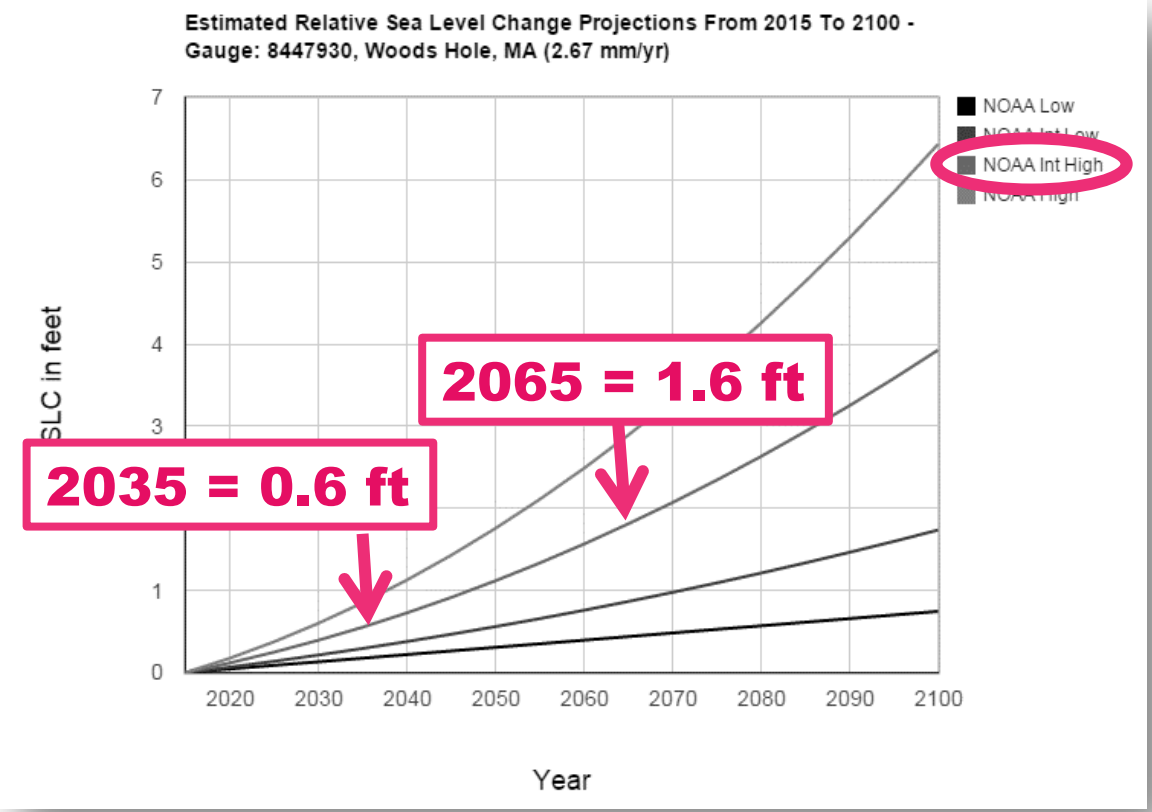
FEMA Flood Elevation

- Zone AE
- BFE = 12 feet



Sea level rise projections

- NOAA sea level change projections
- **20** year projection used for all proposed mechanical improvements
- **50** year projection used for all proposed structural improvements



NOAA = National Oceanic and Atmospheric Administration

Base Flood (100 Year Flood)

- **During Base Flood Event:**
  - Station has watertight hatch
  - Electrical panel and emergency compressor connection below DFE

Mitigation Measures

- Convert to submersible pump station
- New building to house:
  - Emergency Generator
  - Electrical Equipment
- Currently in design

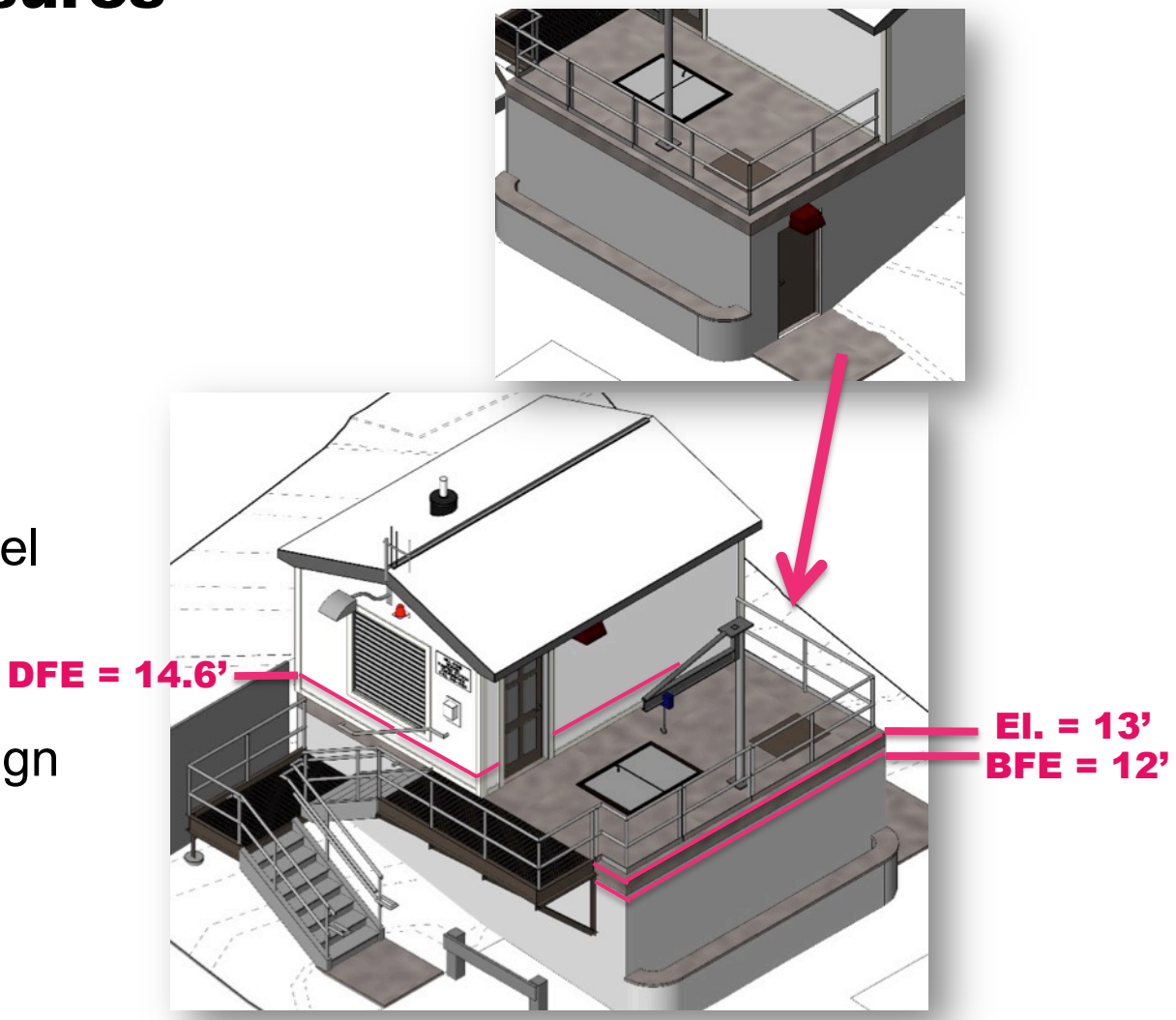
Mitigation Measures

Wet Well

- Watertight hatch

Electrical Room

- DFE incorporates freeboard and sea level rise
- Stoplog system
- All louvers above design flood elevation
- Valve vault door watertight
- Concrete lip



Project Status

- In design
- Town working on obtaining easements
- Permits in progress

Summary

- Existing infrastructure is vulnerable to flooding events
  - Increasing storm frequency and severity
  - Update FEMA maps
- Affects inland and coastal communities
- Increasing importance of flood proof mitigation measures to strengthen resilience of critical infrastructure

National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Search NOAA sites

NEWS & FEATURES

Above-normal Atlantic hurricane season is most likely this year

'Weak or non-existent' El Nino is a factor

Weather | forecasting hurricanes

SHARE

UPDATED: May 25, 2017. *Audio from today's media call is posted to the "Resources" section below.*

May 25, 2017 — Forecasters at NOAA's Climate Prediction Center say the Atlantic could see another above-normal hurricane season this year.

Acknowledgements

Jim Legg, NEWEA Alfred E. Peloquin Awardee | Town of Uxbridge, MA

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Questions?

Thank you!

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