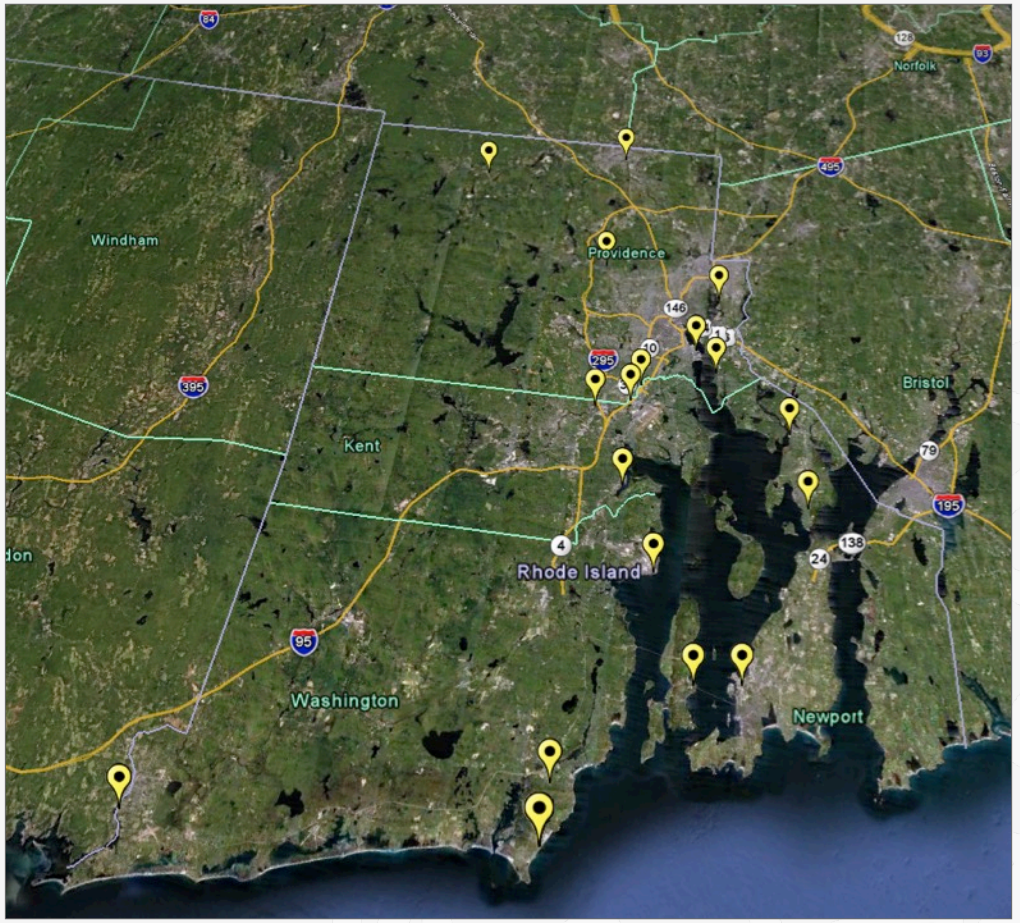
How the Goal of Resiliency is Influencing Rhode Island's Wastewater Projects

NEWEA Spring Conference
Newport, RI

Jan Greenwood, PE | Woodard & Curran
Jon Himlan, PE | Woodard & Curran

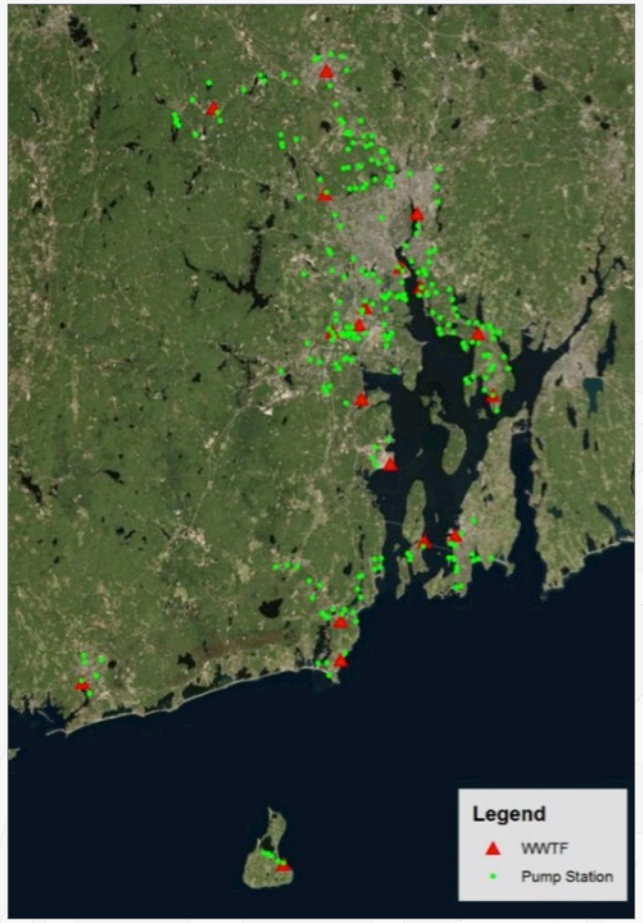
Wastewater Treatment Facility Vulnerability

- WWTFs and pump stations are built in low lying areas
- Infrastructure is subject to coastal and riverine inundation
- Structures, wet wells, open tanks, equipment, and staff are vulnerable
- Overflows discharge into adjacent surface waters



RIDEM's Statewide Approach to Resiliency Planning for Wastewater Infrastructure

- Major modifications to WWTFs require long term planning
- Benefit to collaborative partnership among state agencies and local communities
- Improving WWTF reliability under changing climate conditions requires implementation at the local level
- Resulting Scope had state-wide and local components:
  - Statewide assessment of 19 WWTFs and major collection components
  - Identify vulnerabilities
  - Identify short-term and long-term adaptive strategies



In Parallel …

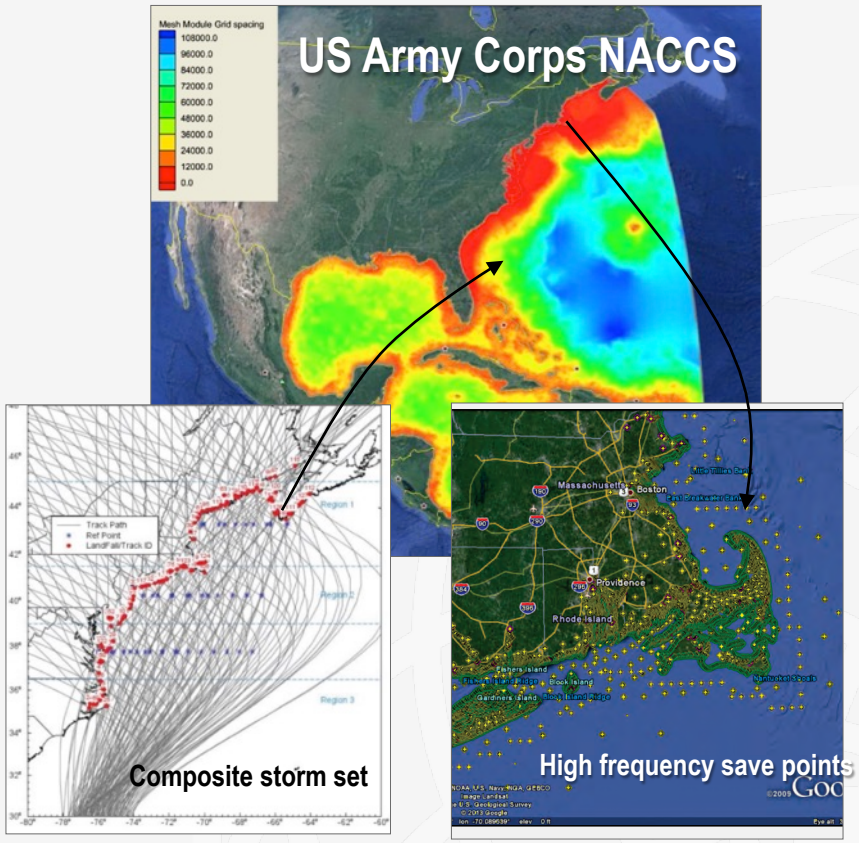
The Warren WWTF planned improvements offered an opportunity to implement RIDEM's climate resiliency planning study

- The upgrade was 30% designed when the RIDEM WWTF climate resiliency study began
- The RIDEM study findings informed design modifications that incorporated climate resiliency into the planned improvements
- The Warren project drove the development of RIDEM's state-wide guidance for WWTFs to address climate change in planning and design

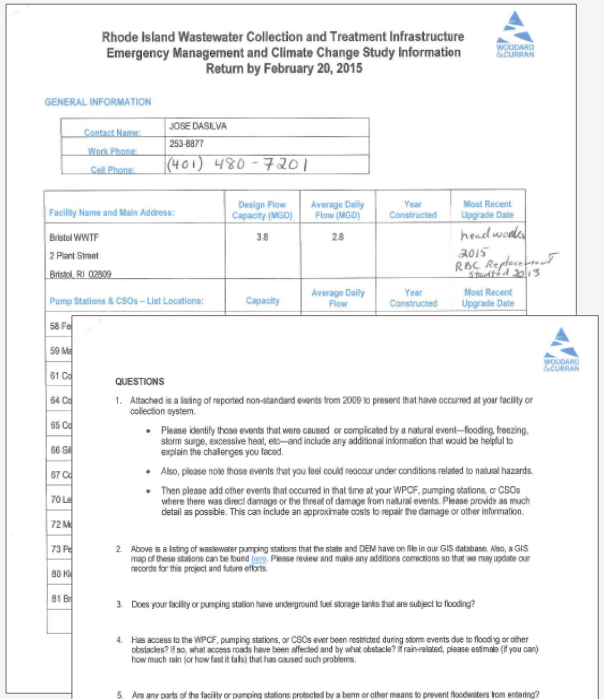
Preliminary Assessment of Climate Change Impacts to Rhode Island WWTFs

1. Data Collection From Facility Operators

2. Statewide Modeling Applications



Preliminary Assessment – Operator Input



Rhode Island Wastewater Collection and Treatment Infrastructure
Emergency Management and Climate Change Study Information
Return by February 20, 2015

GENERAL INFORMATION

Contact Name:	JOSE DASILVA
Work Phone:	253-8877
Cell Phone:	(401) 480-7201

Facility Name and Main Address:	Design Flow Capacity (MGD)	Average Daily Flow (MGD)	Year Constructed	Most Recent Upgrade Date
Bristol WWTF 2 Plant Street Bristol, RI 02809	3.8	2.8		Headworks 2015 RBC Replacement Started 2013

Pump Stations & CSOs – List Locations:	Capacity	Average Daily Flow	Year Constructed	Most Recent Upgrade Date
58 Fe				
59 Me				
61 Co				
64 Co				
65 Co				
66 Gl				
67 Co				
70 La				
72 Mc				
73 Pe				
80 Ki				
81 Br				

QUESTIONS

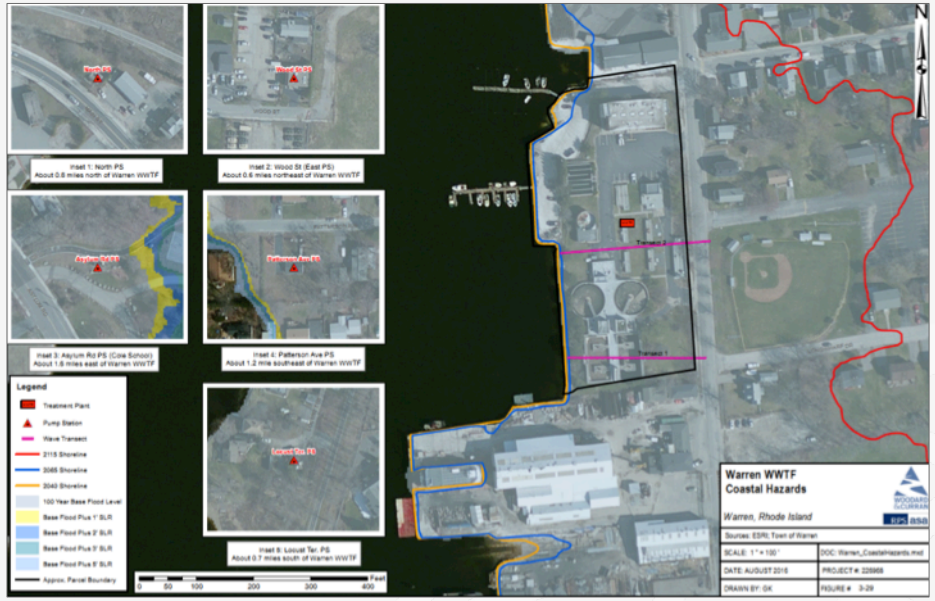
1. Attached is a listing of reported non-standard events from 2009 to present that have occurred at your facility or collection system.
   - Please identify those events that were caused or complicated by a natural event—flooding, freezing, storm surge, excessive heat, etc—and include any additional information that would be helpful to explain the challenges you faced.
   - Also, please note those events that you feel could reoccur under conditions related to natural hazards.
   - Then please add other events that occurred in that time at your WPCF, pumping stations, or CSOs where there was direct damage or the threat of damage from natural events. Please provide as much detail as possible. This can include an approximate costs to repair the damage or other information.
2. Above is a listing of wastewater pumping stations that the state and DEM have on file in our GIS database. Also, a GIS map of these stations can be found here. Please review and make any additions corrections so that we may update our records for this project and future efforts.
3. Does your facility or pumping station have underground fuel storage tanks that are subject to flooding?
4. Has access to the WPCF, pumping stations, or CSOs ever been restricted during storm events due to flooding or other obstacles? If so, what access roads have been affected and by what obstacle? If rain-related, please estimate (if you can) how much rain (or how fast it falls) that has caused such problems.
5. Are any parts of the facility or pumping stations protected by a berm or other means to prevent floodwaters from entering?
6. What process constraints are you aware of that have been (or may be) worsened by natural events, such as increased precipitation, drought, etc?
7. Have any site mitigation projects been done at your facility or pump stations? (i.e. roof replacement, storm windows/doors, moving electrical equipment to higher locations, etc.) in response to the March 2010 floods or other events? If so, please summarize.
8. How would you like to improve standby power capabilities at your plant or stations?
9. Do you have access to spare pumps, generators, of other support from other utilities for use in an emergency? Have you had to acquire and use such equipment in the past?
10. What are some other major issues that your facility is facing or has faced in the past? In other words, what worries you the most about maintaining the ongoing operations at your plant? List other information that you feel is important to share.

3

Facility	Location on FEMA FIRM	Value	Hazard History	Value	Documented losses and costs since 2009	Value	Value	Infrastructure Inundation	Value	Projection of Inundation	Value	TOTAL
East Providence WWTF	Within V Zone	3	More than 3 since 2009	3	Major Repairs	3	0	Greater than 50% system capacity loss under 5-ft scenario	3	Greater than 50% system capacity loss for 1-ft impacts	3	15
Warren United Water	Within V Zone	3	2-3 since 2009	2	None	1	0	Greater than 50% system capacity loss under 5-ft scenario	3	Greater than 50% system capacity loss for 1-ft impacts	3	12
Cranston WPCF	Within A Zone	2	2-3 since 2009	2	Major Repairs	3	0	Between 10% and 50% system capacity loss under 5-ft scenario	2	Between 10% and 50% system capacity loss for 1-ft impacts	2	11
Quonset Development Corporation	Within V Zone	3	1 or less since 2009	1	None	1	0	Greater than 50% system capacity loss under 5-ft scenario	3	Greater than 50% system capacity loss for 1-ft impacts	3	11
Bristol WWTF	Within X Zone	1	2-3 since 2009	2	Major Repairs	3	0	Between 10% and 50% system capacity loss under 5-ft scenario	2	Between 10% and 50% system capacity loss for 1-ft impacts	2	10
East Greenwich WWTF	Within A Zone	2	1 or less since 2009	1	None	1	0	Greater than 50% system capacity loss under 5-ft scenario	3	Greater than 50% system capacity loss for 1-ft impacts	3	10
West Warwick Regional WWTF	Within A Zone	2	1 or less since 2009	1	Major Repairs	3	0	Greater than 50% system capacity loss under 5-ft scenario	3	Less than 10% system capacity loss for 1-ft impacts	1	10
NBC Bucklin Point WWTF	Within X Zone	1	1 or less since 2009	1	None	1	0	Greater than 50% system capacity loss under 5-ft scenario	3	Greater than 50% system capacity loss for 1-ft impacts	3	9
NBC Fields Point WWTF	Within X Zone	1	1 or less since 2009	1	None	1	0	Greater than 50% system capacity loss under 5-ft scenario	3	Greater than 50% system capacity loss for 1-ft impacts	3	9
Newport WWTF	Within X Zone	1	More than 3 since 2009	3	None	1	0	Between 10% and 50% system capacity loss under 5-ft scenario	2	Between 10% and 50% system capacity loss for 1-ft impacts	2	9
Warwick Sewer Authority	Within X Zone	1	1 or less since 2009	1	Major Repairs	3	0	Between 10% and 50% system capacity loss under 5-ft scenario	2	Between 10% and 50% system capacity loss for 1-ft impacts	2	9
Westerly United Water	Within X Zone	1	2-3 since 2009	2	Major Repairs	3	0	Less than 10% system capacity loss under 5-ft scenario	1	Between 10% and 50% system capacity loss for 1-ft impacts	2	9
Jamestown Sewer Division	Within X Zone	1	2-3 since 2009	2	Miscellaneous Expenses	2	0	Less than 10% system capacity loss under 5-ft scenario	1	Between 10% and 50% system capacity loss for 1-ft impacts	2	8
Narragansett WWTF	Within V Zone	3	2-3 since 2009	2	None	1	0	Less than 10% system capacity loss under 5-ft scenario	1	Less than 10% system capacity loss for 1-ft impacts	1	8
South Kingstown Regional WWTF	Within X Zone	1	2-3 since 2009	2	None	1	0	Between 10% and 50% system capacity loss under 5-ft scenario	2	Between 10% and 50% system capacity loss for 1-ft impacts	2	8
Woonsocket WWTF	Within X Zone	1	1 or less since 2009	1	Major Repairs	3	0	Less than 10% system capacity loss under 5-ft scenario	1	Less than 10% system capacity loss for 1-ft impacts	1	7
Burrillville WWTF	Within A Zone	2	1 or less since 2009	1	None	1	0	Less than 10% system capacity loss under 5-ft scenario	1	Less than 10% system capacity loss for 1-ft impacts	1	6
New Shoreham Sewer Division	Within X Zone	1	1 or less since 2009	1	None	1	0	Less than 10% system capacity loss under 5-ft scenario	1	Less than 10% system capacity loss for 1-ft impacts	1	5
Smithfield Veolia Water	Within X Zone	1	1 or less since 2009	1	None	1	0	Less than 10% system capacity loss under 5-ft scenario	1	Less than 10% system capacity loss for 1-ft impacts	1	5

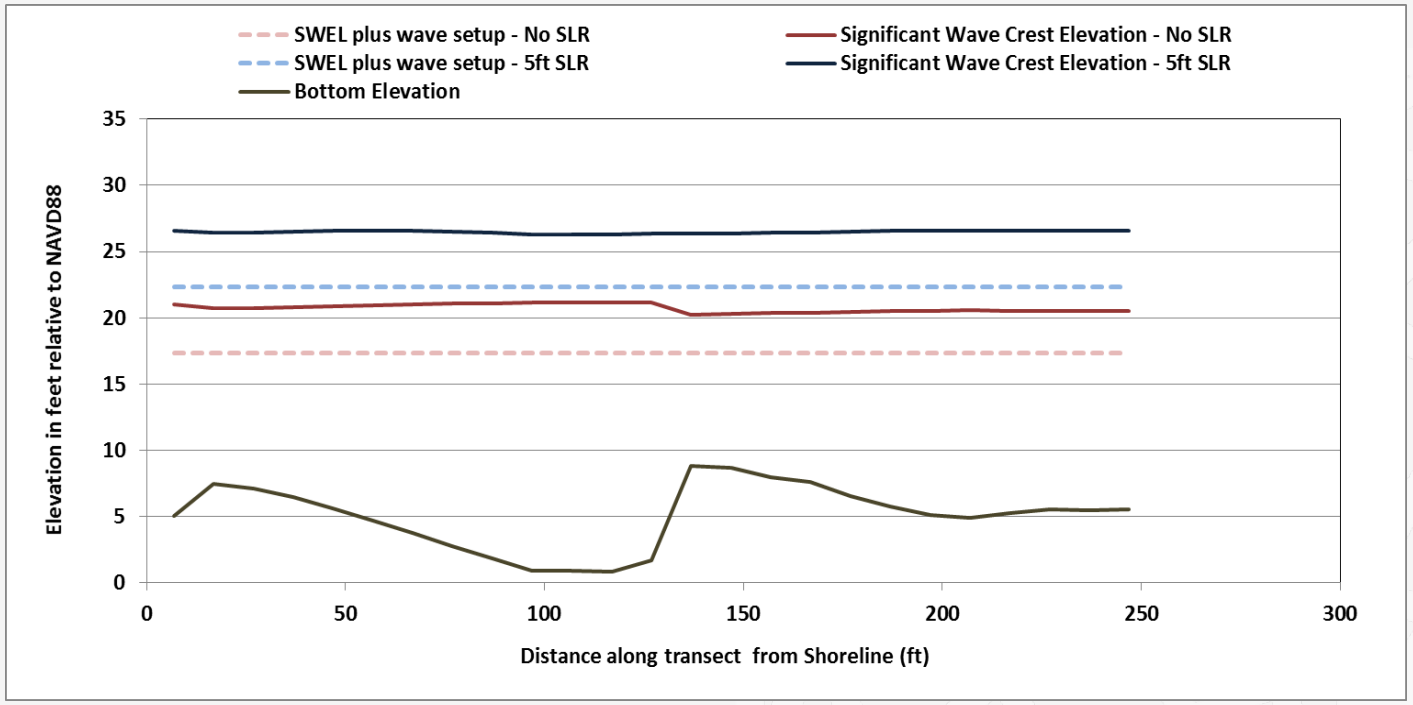
Preliminary Assessment – Coastal Hazards

- Applied University of Rhode Island STORMTOOLS data as a broad planning tool
- WWTF infrastructure at risk to inundation by storm surge and SLR:
  - 11 WWTFs
  - 49 Pump stations
- Inundation of entire Warren WWTF and beyond during a 100-year storm



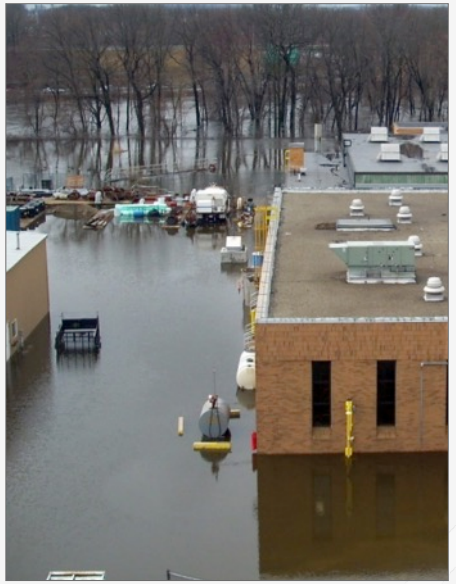
Preliminary Assessment – Wave Hazards

- Wave Height Analysis for Flood Insurance Studies (WHAFIS) predictions for total water level at 8 WWTFs (19 transects)



Recommended Adaptive Strategies

- Hardening
- Relocation
- Readily Repairable/Replaceable
- Redundancy
- Wet Weather Bypass



Budgetary Implementation Costs

- Help communities plan and budget for climate change resiliency projects

Adaptive Strategies				
System	**Hardening**	**Relocating**	**Readily Repairable/ Replaceable**	**Mitigation Strategy**
Primary Settling Tank		B		Allow primary settling tanks to flood. Locate collector drives above flood elevation.[1] Store replacement drive components on site. Pumps may be temporarily augmented.[2]
Electrical Switchgear and Motor Control Centers		C		Relocate above flood elevation. [1]
Disinfection System (Chlorine Contact Tanks)		B		Locate mixer drive above flood elevation or install submersible mixer. [1]
Operations Building		B	B	Allow pumps in station basement to flood. Electrical switchgear, MCCs and SCADA equipment above flood elevation. [1]

[1] Adaptive measures planned for implementation in the near term as part of the proposed WWTF Upgrades project.
[2] Adaptive measures that the Town of Warren may consider implementing at a future time.
A = <$50,000 B = $50,000 - $250,000 C = $250,000 - $1,000,000 D = > $1,000,000

RIDEM Actions Resulting from this Study

- Issued state-wide guidance to address climate change in WWTF planning and design
- Established a cost-benefit analyses approach to implement adaptation measures
- Implemented a requirement for all RIPDES permit renewals to prepare a Climate Resiliency Plan

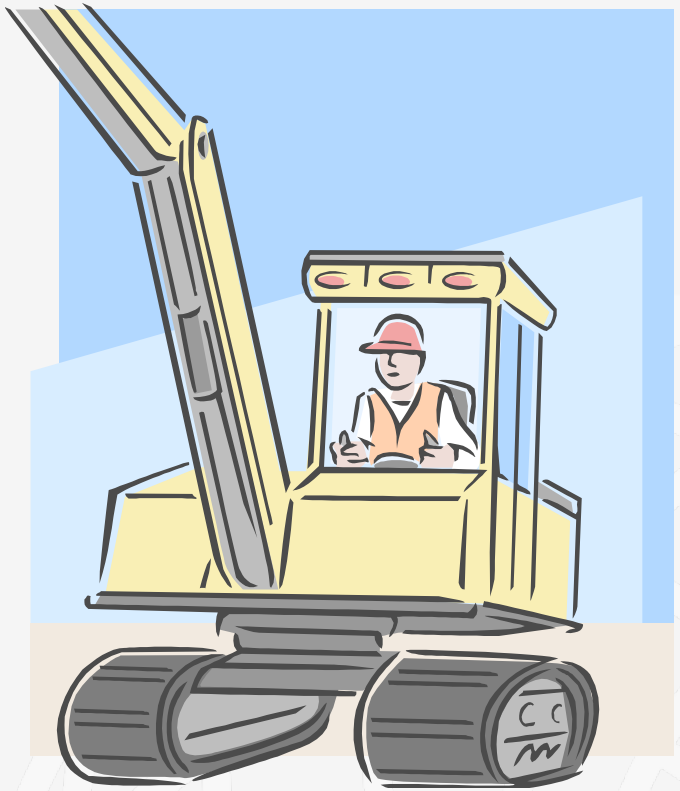
Warren WWTF became the first facility in RI to integrate flood protection measures from the RIDEM climate change study

Warren WWTF

2 MGD Facility on the tidally influenced Warren River

Summary of Planned Treatment Improvements

- Influent Screening
- Upgrade Primary Settling
- Expand Secondary Reactor Capacity and New Equipment for Nitrogen Removal
- Upgrade Secondary Clarification
- Disinfection Improvements
- New Electrical Service, Generator and Switchgear
- SCADA Upgrades

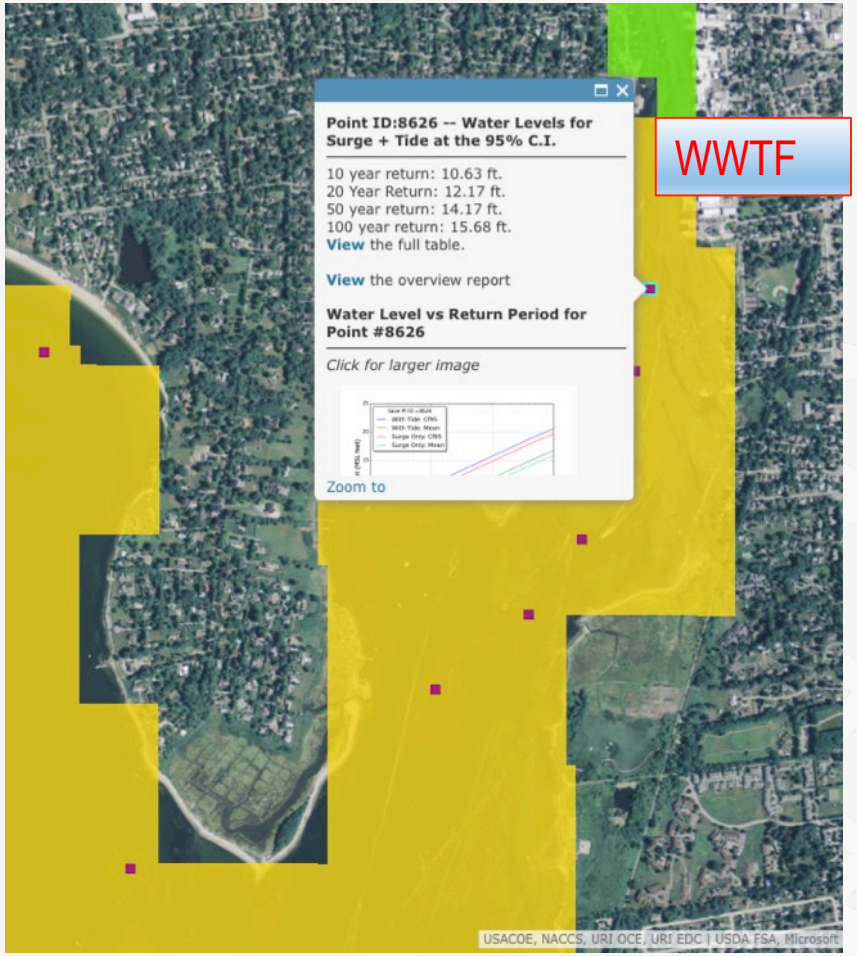


Reassessed Design to Consider Climate Change

- Town wanted to make sure the $20M investment was appropriately addressing vulnerability to flooding and climate change
- Collaborated with RIDEM and CRMC to establish design flood conditions for the project
  - STORMTOOLS
  - Federal Flood Risk Management Standard
  - North Atlantic Coast Comprehensive Study – 100-year flood elevation (storm surge plus tide)
  - ST Wave Analysis by University of Rhode Island
  - Sea Level Rise Projections (2065) by National Oceanic and Atmospheric Administration

North Atlantic Coast Comprehensive Study

- Two-year study by Army Corp of Engineers to address coastal storm and flood risk
- Areas in the United States' North Atlantic region affected by Hurricane Sandy
- Hydrodynamic model predictions for synthetic tropical storms
- Model includes 1,000 grid locations in Narragansett Bay and RI Shoreline
- One of the grid locations is approximately ½ mile from the WWTF

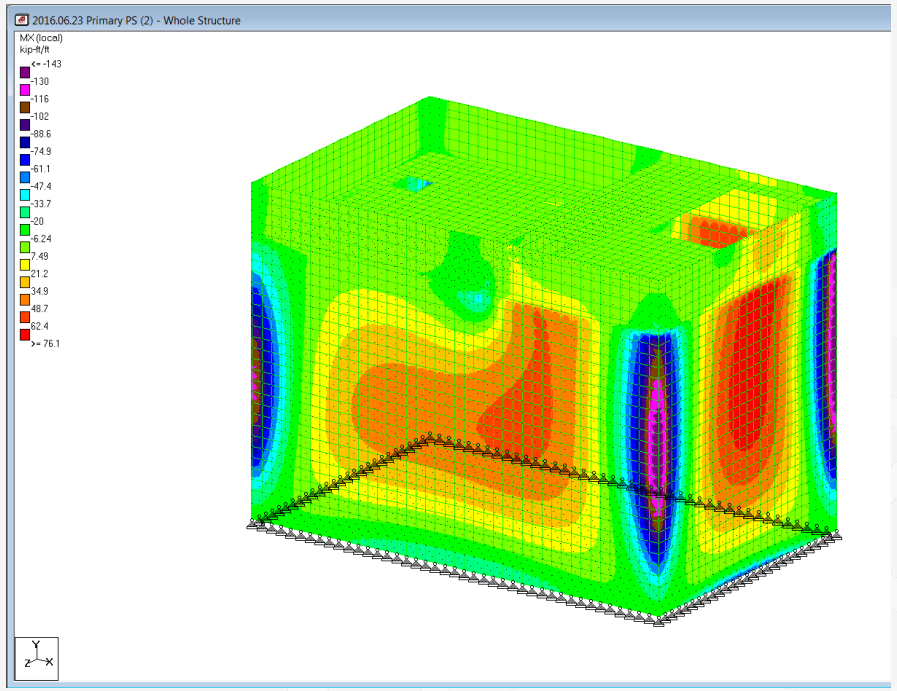


Revised Flood Criteria Effect on Improvements

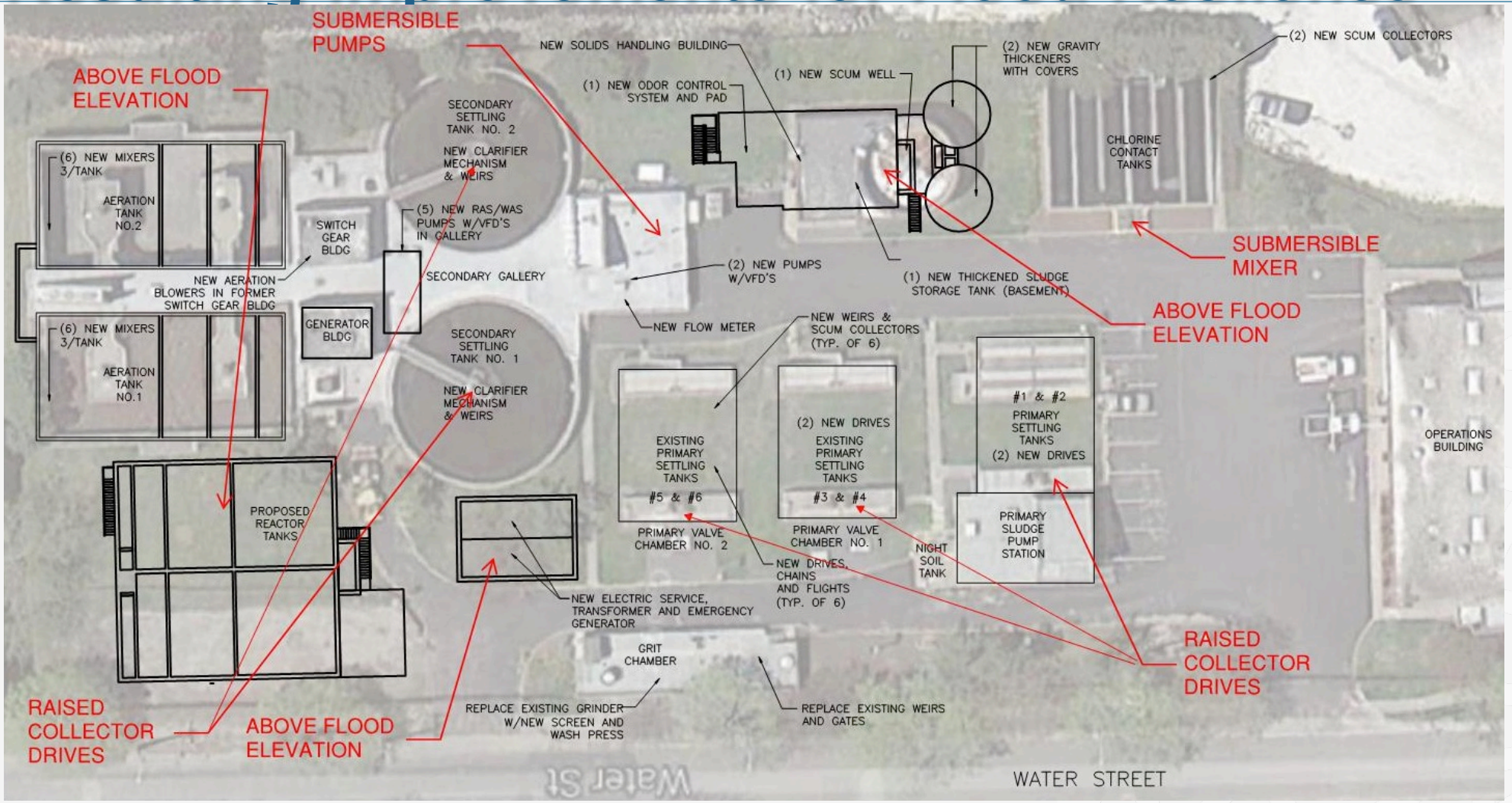
- Warren worked with RIDEM and utilized the New England Interstate Water Pollution Control Commission, revised TR-16 Guidance (May 2016) to perform a cost benefit approach to selecting adaptation measures.
- Effect on Wastewater Facility Improvements Design
  - New structures - flood resilient at 1% probability (100-year) flood with Sea Level Rise (SLR)
  - Existing tanks - flood resilient at 1% flood with SLR
  - Existing buildings and galleries will flood at the 1% flood with SLR

Cost Benefit Analysis

- Analysis to establish that the existing facilities were being "*improved to the maximum extent possible for flood protection*" based on cost-benefit criteria
- Protection from Damage to Structural and Electrical
  - Base-case measures (relatively minor in cost)
  - Analysis of additional structural improvements
    - Buoyancy
    - Hydrostatic forces
  - **More cost effective to repair equipment** vs. make structural improvements to keep water out

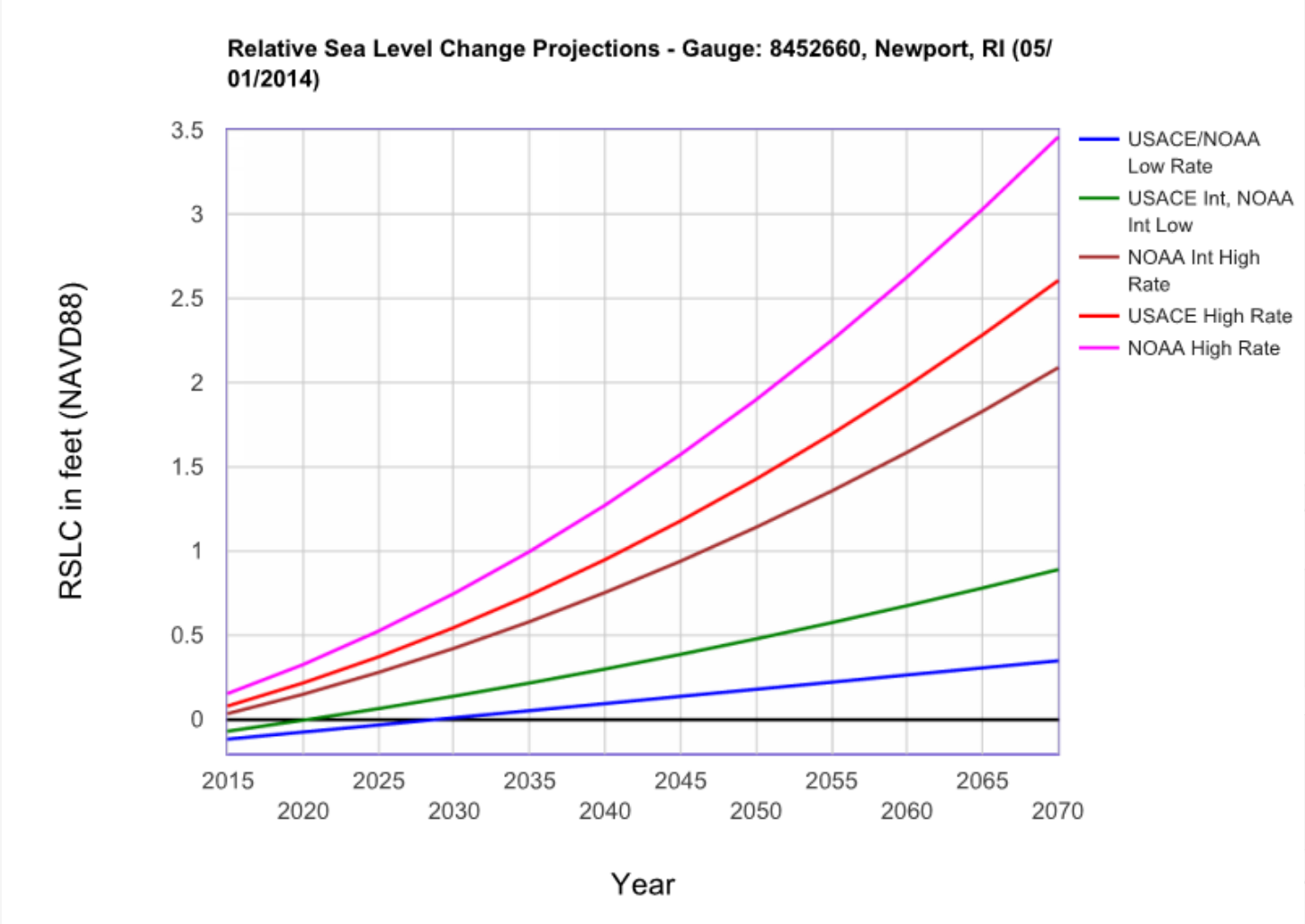


Resulting Improvements for Flood Reslience



Questions

Sea Level Rise Projections

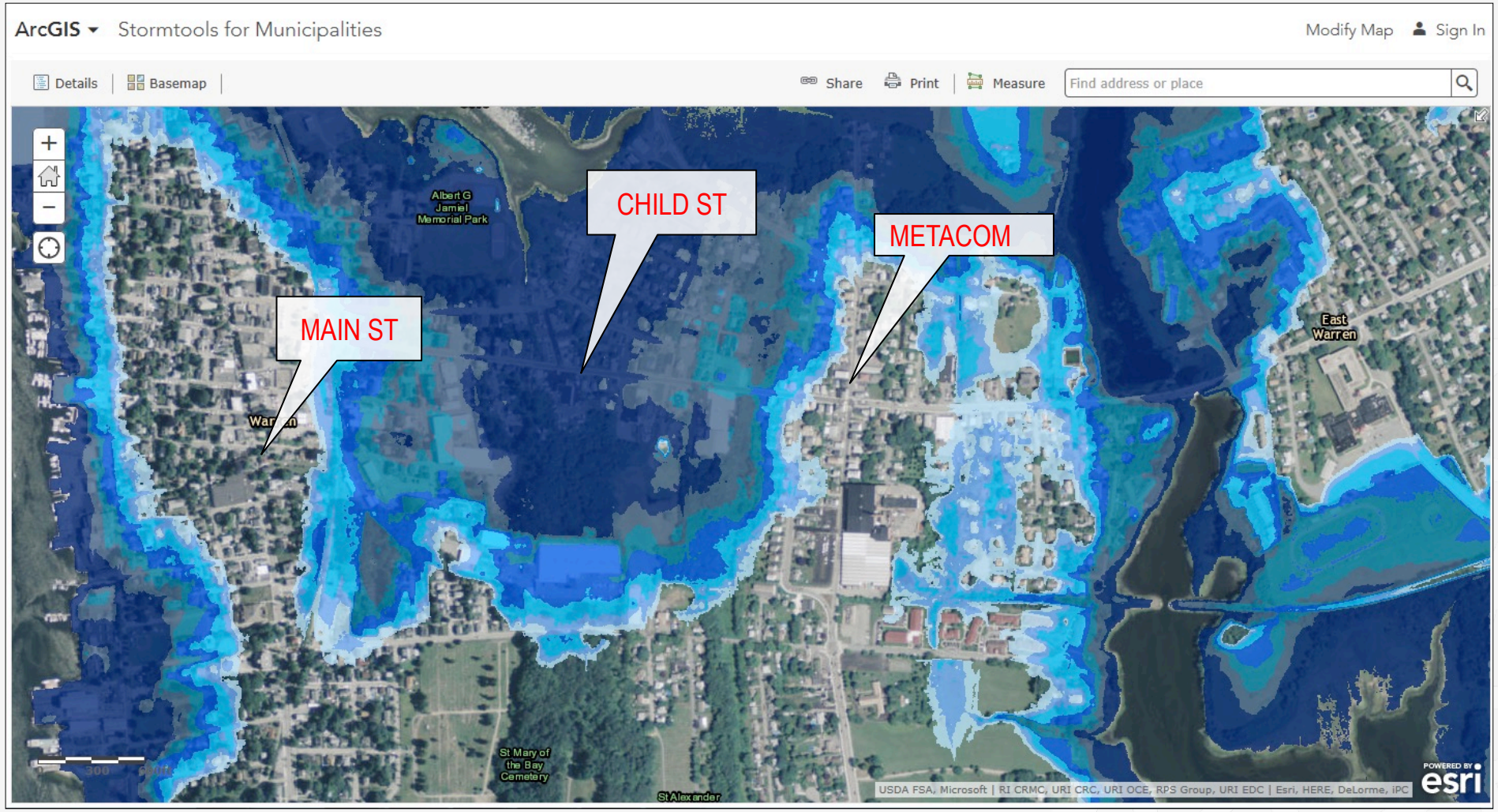


1 Percent Flood Elevations at the WWTF

		FEMA Stillwater	FEMA Wave Crest	NACCS Storm Surge w/ SLR (Design)	STORM-TOOLS Storm Surge	WHAFIS Model Wave Crest
WWTF Structures	Elevation	11.4	13.4	16	18	21
Ground Surface (average)	8	-3.4	-5.4	-8	-10.0	-13.0
Headworks	11.7	0.3	-1.7	-4	-6.3	-9.3
Primary Sludge Pump Station, Intermediate Pump Station, Secondary Gallery, Secondary Clarifiers	14.5	3.1	1.1	-1.5	-3.5	-6.5
Operations Building 1st Floor, New Sludge Handling Building, New Generator Pad	15.2	3.8	1.8	-1	-2.8	-5.8
Aeration Tanks	17.7	6.3	4.3	2	-0.3	-3.3
New Reactor Tank	20.5	9.1	7.1	4.5	2.5	-0.5

Positive values (black) represent distance above water level.
Negative values (red) represent distance below water level.

Stormtools 1-Percent Flood with 1 Foot of Sea Level Rise



Comparison of Climate Change Resiliency Measures

The highlighted items are measures Woodard & Curran has added since the January 9th meeting, making resiliency essentially equivalent to the original design

Structure	Climate Change Resiliency Measures Original Design	Climate Change Resiliency Measures Rebid Scope (Measures are in Base Bid Unless Noted)
Operations Building	Electrical switch gear located on the second floor. Motor control centers (MCCs) located on second floor Control panels (SCADA) above 16 feet	Electrical switch gear above 16 feet MCCs safe at 16 feet* Control panels above 16 feet
Headworks	Control panels above 16 feet	Control panels above 16 feet
Primary Sludge Pump Station	MCC on concrete pad above 16 feet NAVD88	MCC safe at 16 feet*
Primary Settling Tanks	Locate collector drives above 16 feet	Original design **(bid alternate 2)**
Intermediate Pump Station	Install two new dry-pit submersible pumps Control panels above 16 feet	Original design **(bid alternate 1)**
Existing Generator Building – repurposed to house new MCC	MCC on elevated slab located above 16 feet	Original design
Switch Gear Building	MCC on elevated slab located above 16 feet	Modifications to prevent water from entering building (bid alternate 1)
Secondary Clarifiers	Locate collector drives above elevation 16 feet	Original design
Chlorine Contact Tank	Install submersible mixer	Original design **(bid alternate 1)**
New Sludge Handling Building	Constructed above elevation 16 feet	Original design **(bid alternate 4)**
New Reactor Tank	Constructed above elevation 16 feet	Original design
New Generator Pad	Constructed above elevation 16 feet	Original design

**MCCs will require cleaning and inspection (if water elevation greater than 15.5 feet occurs)*