WT0202151016NJO

Drainage Investigation and Flood Analysis

Wellington Avenue and Bridge Street

Project No. 15-037

Please visit our project website at:
www.newportdrainageinvestigation.com

Public Informational Meeting #3

Alternatives Evaluation Results

Presented by:

ch2m

December 15, 2015

Introductions

- City of Newport
  - » Julia Forgue, PE – Director of Utilities
  - » Rob Schultz, PE – Deputy Director of Engineering
  - » JR Frey, PE – Water Pollution Control
- CH2M
  - » Peter von Zweck, PE – Project Manager
  - » Becky Weig – Public Involvement
  - » Bill McMillin, PE – Senior Technologist, Climate Change & Sea Level Rise
  - » Greg Brenner – Hydraulic Modeling Engineer

Agenda

- Introductions & Agenda Overview
- Review of Progress to Date
- Overview of Alternatives Evaluation Process
- Evaluation of Wellington Avenue Short-term and Long-term Control Options
- Evaluation of Bridge Street Short-term and Long-term Control Options
- Planning for Future Climate Conditions
- Next Steps

Review of Progress to Date

Project Background

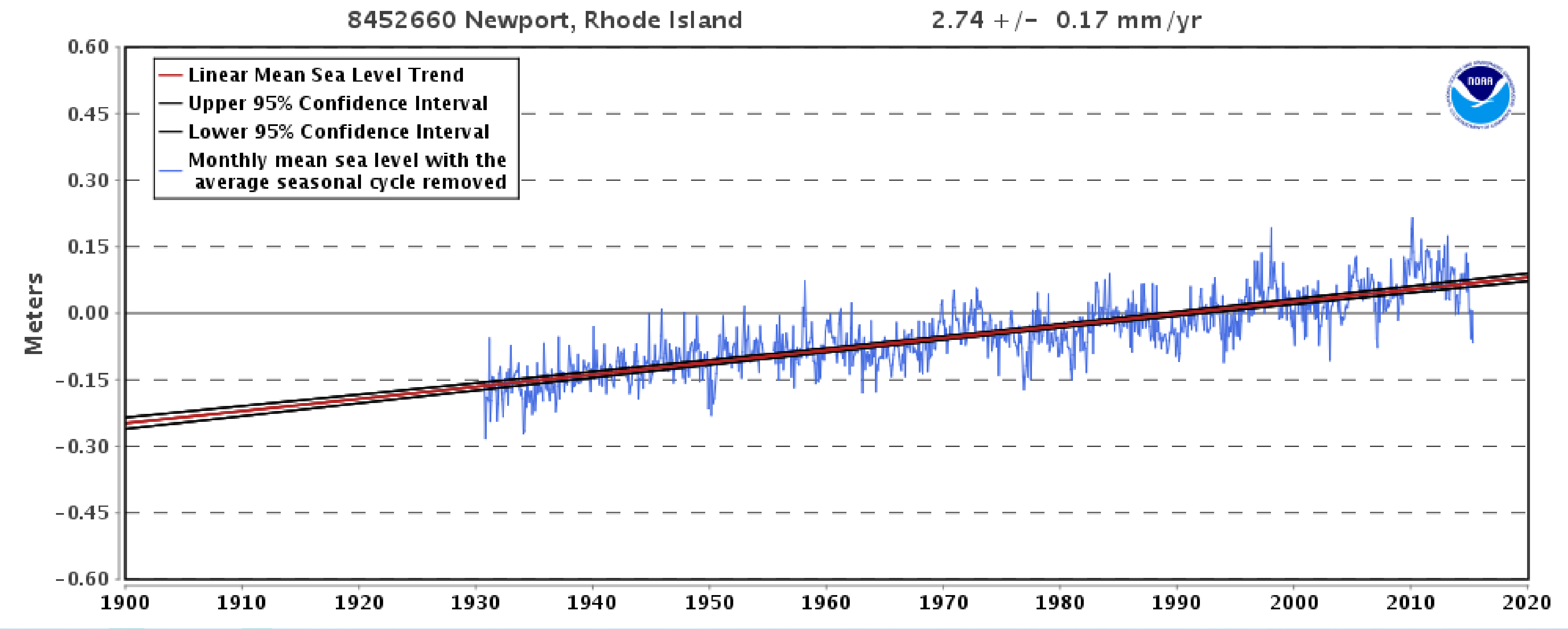
- Historical tidal or "sunshine" flooding
- Precipitation events coinciding with high tide create a compound problem
- Previous measures not 100% effective – example, tide gates at 2nd & 3rd Streets installed in November 2011
- Sea level rise and more intense and frequent storms are already being experienced….there is more projected to come

Tidal flooding at Wellington Avenue in 2011

Tidal flooding compounded by precipitation along 2nd Street in 2011

Water Levels Are Rising in Newport

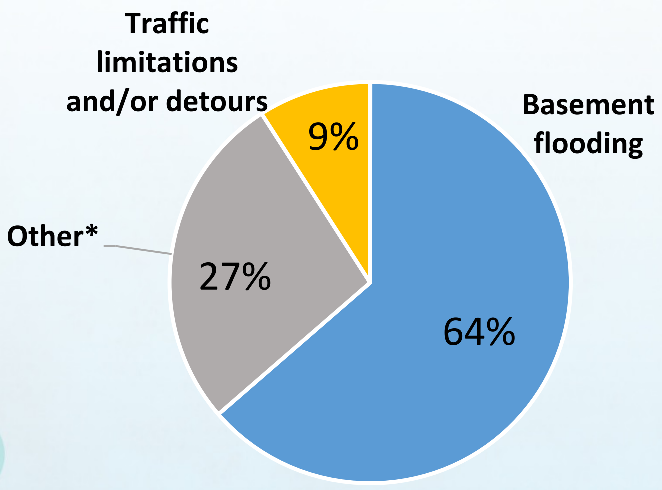
Historic sea level rise is 0.1 inch/year



Survey Results – What Is Important to Stakeholders

Which best describes your greatest concern with regards to drainage and flooding issues in your area?

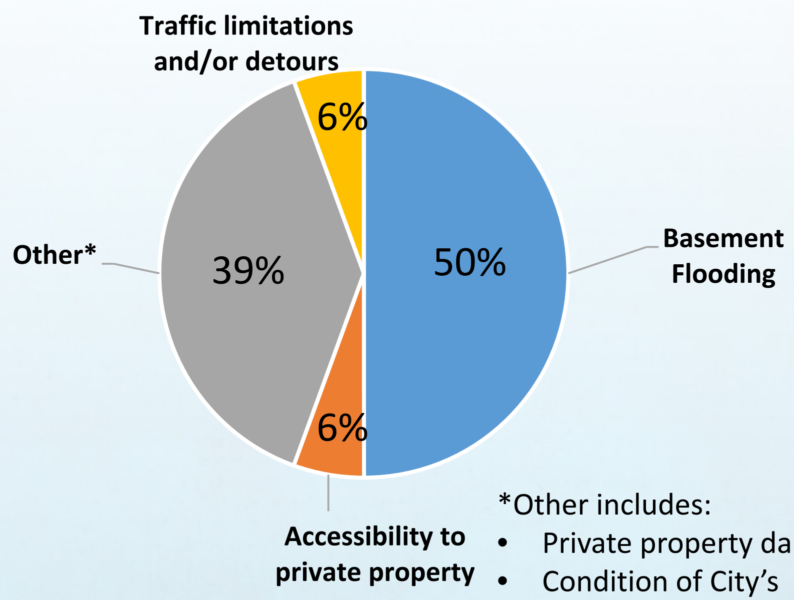
Wellington Avenue



*Other Includes:

- Overall property flooding
- Water damage caused by cars driving through street flooding

Bridge Street



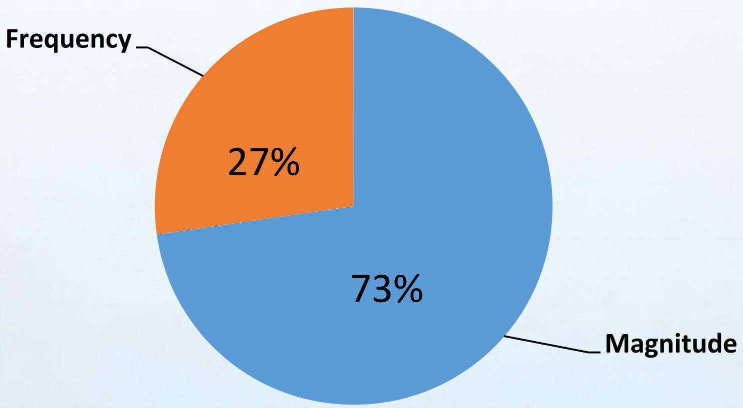
*Other includes:

- Private property damage
- Condition of City's infrastructure
- Management of City's infrastructure relating to sea level rise

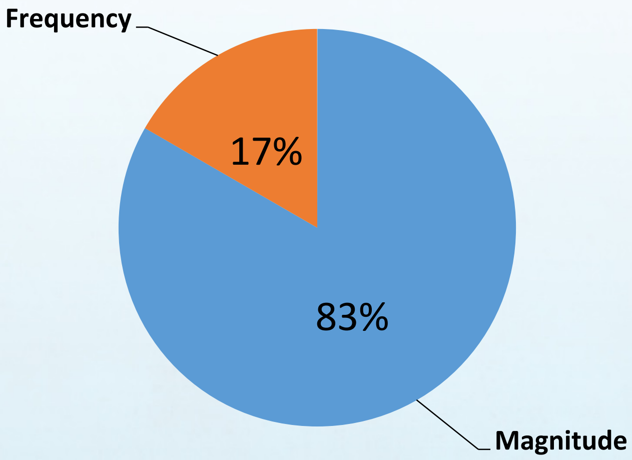
Survey Results – What Is Important to Stakeholders

Which best describes your greatest concern with regards to the flooding events?

Wellington Avenue

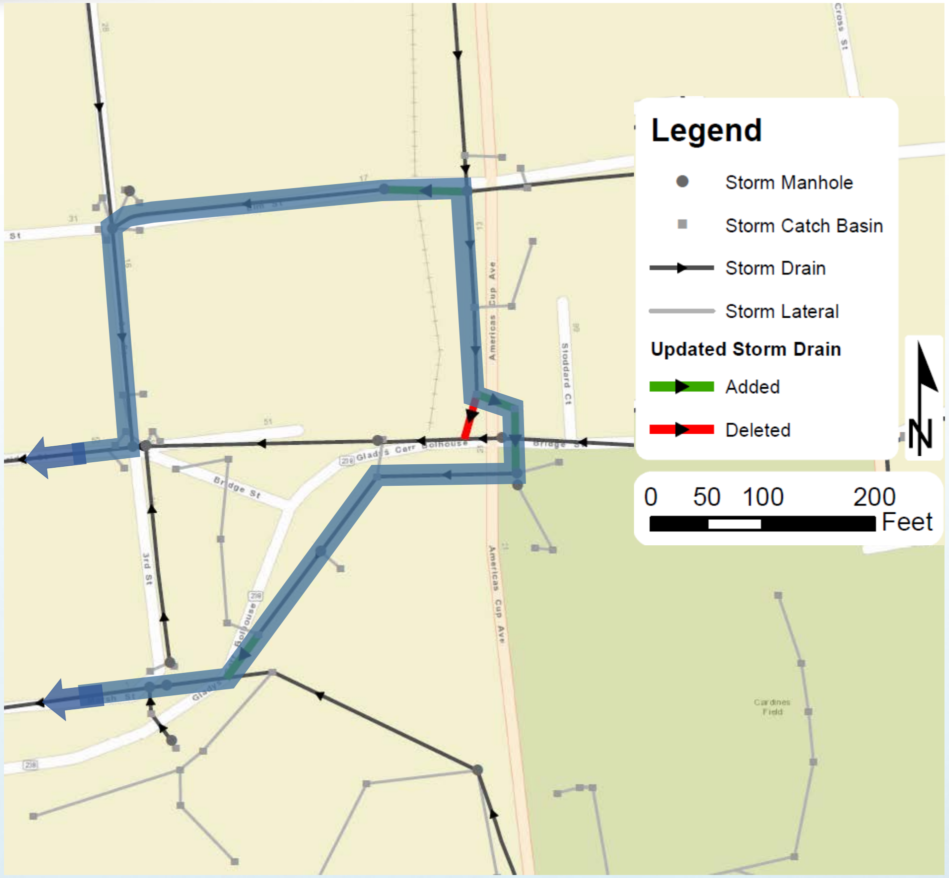


Bridge Street



Field Investigations Were Completed in Both Study Areas

- Inspected Drainage Manholes
  - » Collect invert elevations
  - » Record pipe sizes
  - » Check pipe conditions/ sediment levels
  - » Check connectivity to neighboring systems
  - » Update GIS
- Observed High Tide Events
  - » Check tidal influence/tide gate effectiveness
  - » Record water stage for model calibration



An indirect cross connection was identified between the Bridge Street and Marsh Street lines.

Models Were Developed and Calibrated

- Developed EPA SWMM Models
  - » Bridge St. Study Area
  - » Wellington Ave. study area
- Models calibrated to observed flood depths
  - » Sunshine flooding
  - » Range of rainfall events
  - » Used photos of observed events from 2010 to 2015

Wellington Avenue study area model calibration run example is also posted on the project website.

How Tide Gates Work and Potential Operations Issues

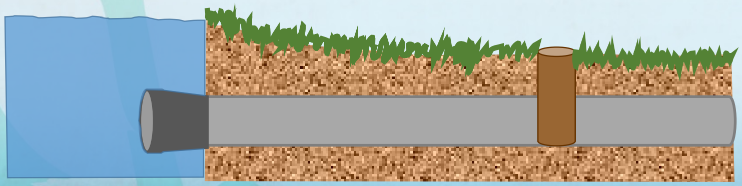
One-way Valve

» Let water out, don't let water in

MeasureIT Technologies Ltd. “Tideflex Valves: Pumped Discharge to River” 2014 <https://www.youtube.com/watch?v=btC6eHEWakc>

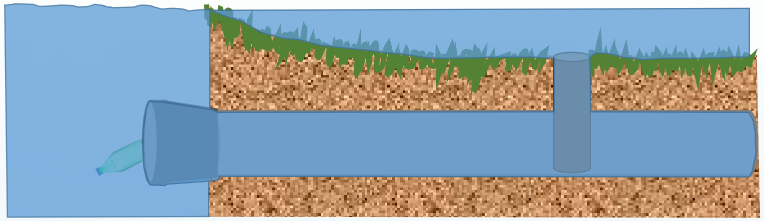
Tide Gate Working Properly

» Prevent harbor water from flooding low lying areas



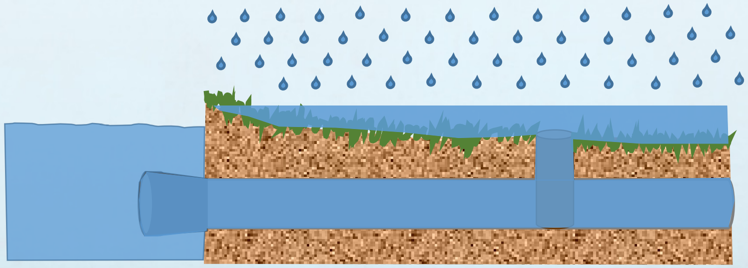
Debris Can Affect Operations

» Sticks, soda bottles, garbage etc. can prop open the tide gate letting tide water in



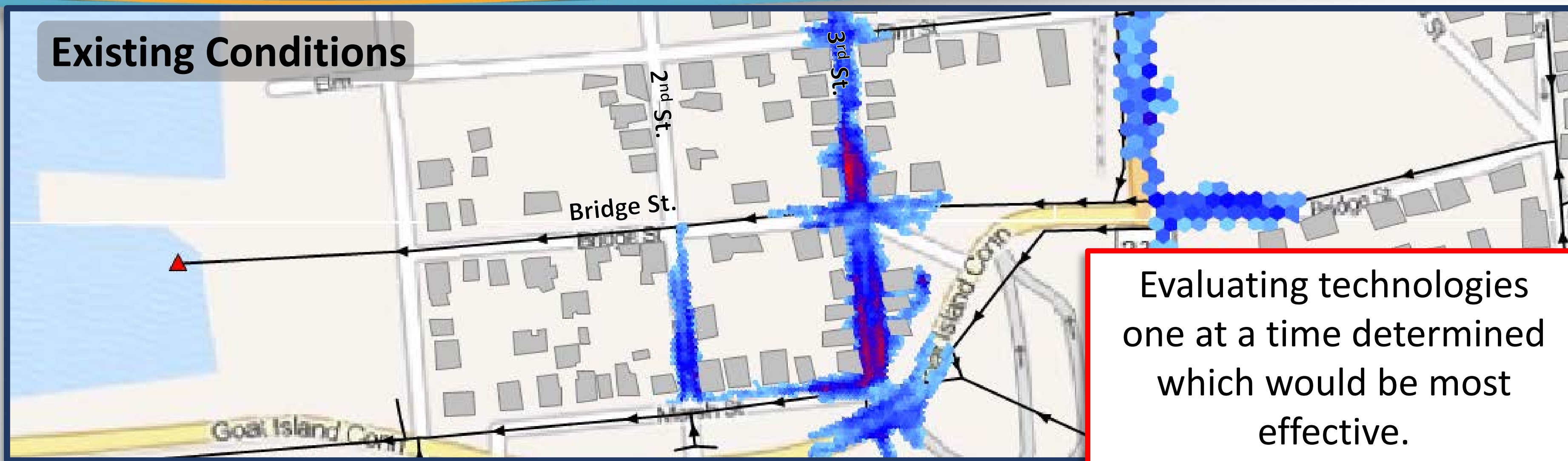
Tide Gates Can't Help When Rain & High Tide Coincide

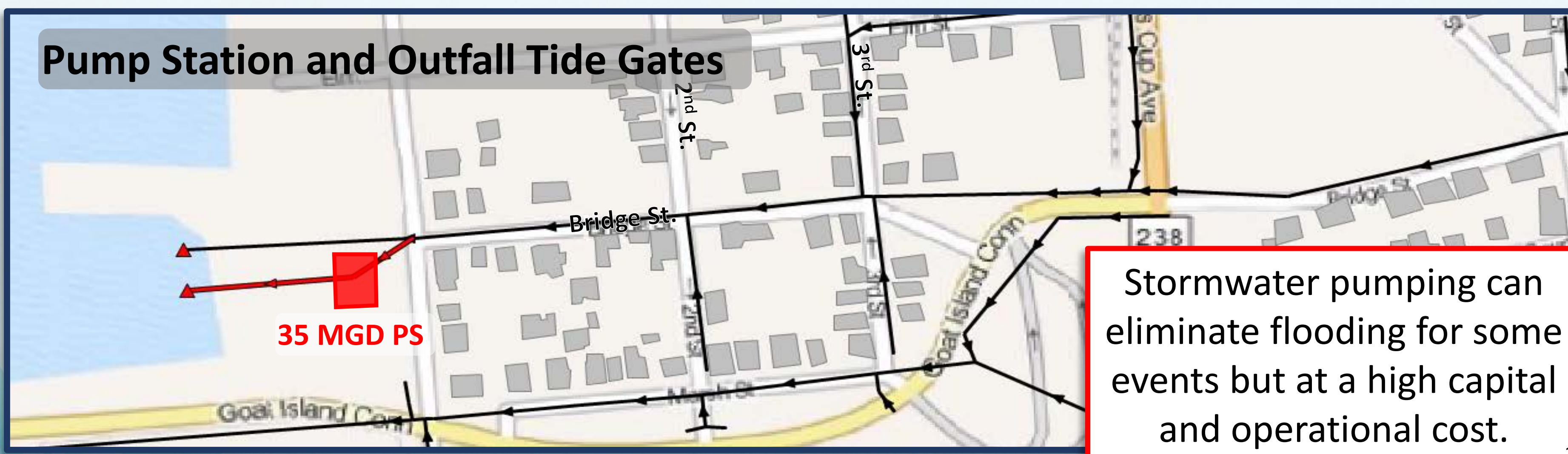
» Requires pressure (head) to open the tide gate.



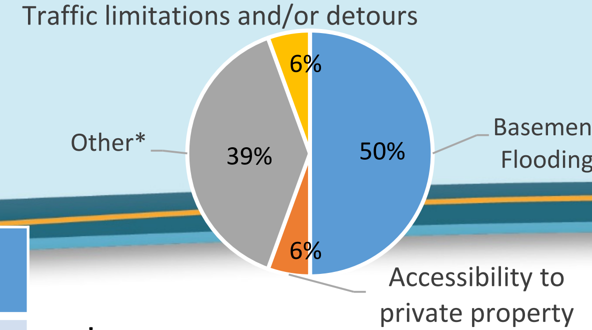
Exaggerated for demonstration purposes

Calibrated Models used to Evaluate the Effectiveness of Control Technologies in Each Study Area





Results from Screening of Potential Control Technologies for Both Study Areas



*Other includes:
- Private property damage
- Condition of City's infrastructure
- Management of City's infrastructure relating to sea level rise

	Evaluation Criteria			
Red: Technology not effective for achieving criteria Yellow: Technology moderately effective for achieving criteria alone or in combination Green: Technology effective for achieving criteria	Runoff Reduction (Reduce Volume)	Improved Conveyance (Reduce Volume and Frequency)	Tidal Protection (Reduce Frequency)	Reduce Public Impacts
Potential Technologies				
Tide Gate Structures	Red	Yellow	Green	Green
~~Larger Diameter Pipes~~	Red	Yellow	Red	Red
Pipe System Improvements/Rerouting	Red	Green	Red	Yellow
Sediment Removal & Catch Basin Sumps	Red	Yellow	Red	Green
Green Infrastructure	Green	Red	Red	Red
Pump Stations	Red	Green	Yellow	Green

Tying Evaluation Criteria to Stakeholder Priorities

Reduced Volume
- Improved accessibility to private property
- Reduced risk of private property damage

Reduced Frequency
- Reduced basement flooding
- Reduced traffic detours
- Improved accessibility to private property

Overview of Alternatives Evaluation Process

Objectives for Implementing Short-term Controls

- Key Objectives
  - » Address today's climate conditions
    - – Precipitation and tide events for a typical year
  - » Reduce observed/historic flooding issues
- Effectiveness
  - » Technologies with largest benefit
    - – Reduction in number of flooding events
    - – Reduction in magnitude of flooding events
- Implementation Considerations
  - » Shorter Implementation Schedule
    - – Minimal technical or legal barriers
    - – Capital costs ranging from $1.5M - $6M
  - » Complimentary to long-term plans
  - » Increased Operations & Maintenance costs and effort

Implementation Schedule Considerations

- Inclusion in CIP
- Funding approval
- Procurement (4-6 months)
- Design (9-12 months)
- Permitting (3-6 months)
- Bidding & Award (3-4 months)
- Construction (12-24 months)

Once funding has been procured and approved it could take up to 5 years to implement short-term controls.

Objectives for Implementing Long-term Controls

- Key Objectives
  - Address current flooding issues that may not be mitigated by short-term controls
    - Large rain events at high tide
  - Address future conditions related to climate change
    - Sea level rise
    - Increased volumes and intensity of precipitation
- Effectiveness
  - Technologies with largest benefit
    - Reduction in number of flooding events
    - Reduction in magnitude of flooding events
  - Sized to handle a 5-year storm
- Implementation Considerations
  - Controls that take longer to implement
    - Technical and legal barriers
    - Capital costs ranging from $13M - $46M
    - Time period for financial planning
  - Significant additional Operations & Maintenance cost and effort

Implementation Schedule Considerations

- Inclusion in CIP
- Funding planning and procurement
  - Grants
  - FEMA
- Land acquisition and/or easements
- Procurement (4-6 months)
- Design (9-12 months)
- Permitting (3-6 months)
- Bidding & Award (3-4 months)
- Construction (12-24 months)

It could take 20 to 25 years to implement long-term controls

Used the Calibrated Model to Evaluate the Performance of Future System Improvements

In order to identify alternatives that best meet the community's objectives it is important that potential improvements be evaluated for a wide range of realistic conditions.

Use of historic data for a typical year provides:

- Wide range of rain events from small to large
- Storms with small and large peak intensities
- Data on observed tides and sea level
- Realistic input on the frequency of rain events that occur at high tide

Study Areas were Evaluated for a 10-Year Period of Record

Wellington Avenue

Year	Total Rainfall (in)	Total Flooding Events	Wet Weather Events	Dry Weather Events
2006	44.8	63	37	26
2007	33.6	49	27	22
2008	38.3	49	26	23
2009	37.9	57	27	30
2010	27.0	82	21	61
2011	36.4	83	36	47
2012	26.2	77	25	52
2013	27.0	70	32	38
2014	37.2	71	22	49
2015*	25.1	37	17	20
* through Oct 3				

Bridge Street

Year	Total Rainfall (in)	Total Flooding Events	Wet Weather Events	Dry Weather Events
2006	44.8	15	6	9
2007	33.6	16	6	10
2008	38.3	14	3	11
2009	37.9	26	7	19
2010	27.0	43	7	36
2011	36.4	50	7	43
2012	26.2	46	9	37
2013	27.0	31	7	24
2014	37.2	25	6	19
2015*	25.1	11	3	8
* through Oct 3				

2013 includes 74 precipitation events ranging from trace amounts to 3.7 inches in depth, includes a 2 year storm, and a storm with peak intensity of 2.4 inches per hour.

* More information about the selection of the typical year is located on the project website.

Evaluation of Wellington Avenue Short-term and Long-term Control Options

Wellington Ave. Study Area
Short-term Controls

- Tide gates
- Outfall dredging
- Sediment removal
- Catch basin sumps and rehabilitation
- Pipe system improvements

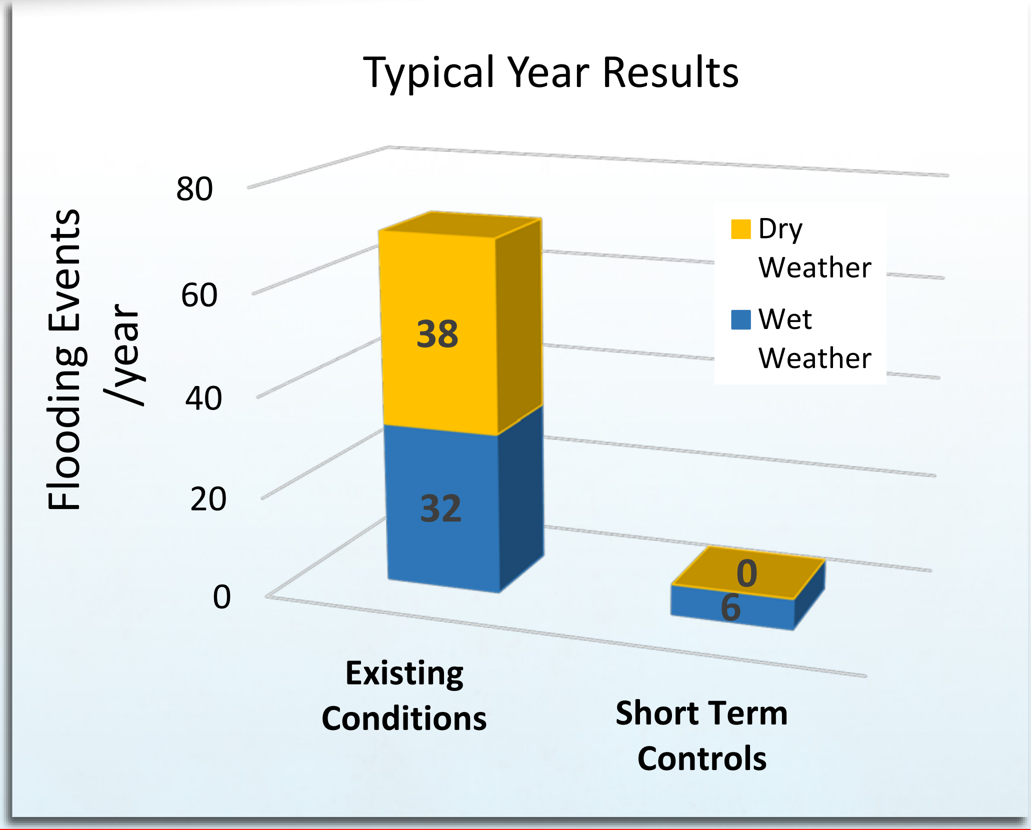
Wellington Ave. Study Area
Short-term Controls Map
Conceptual Layout

Wellington Ave. Study Area

With all Short-term Controls in Place

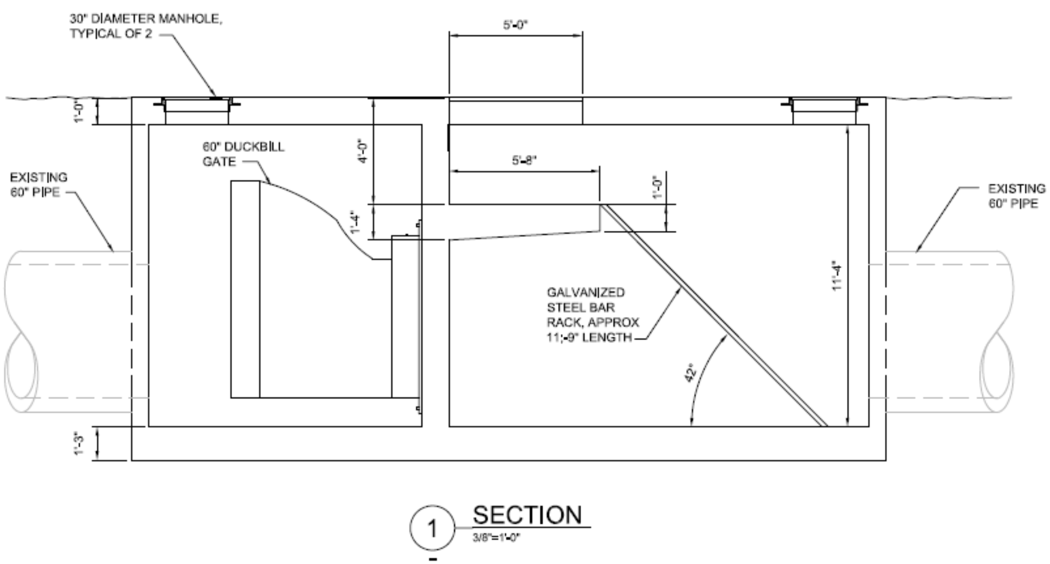
Performance for a Typical Year 2013

- Existing Conditions
  - » 70 flooding events/yr
  - » 5.8 million gallons/yr
  - » 62 hours flooded/yr
- Short-Term Controls
  - » 6 flooding events/yr
  - » 0.2 million gallons/yr
  - » 5 hours flooded/yr

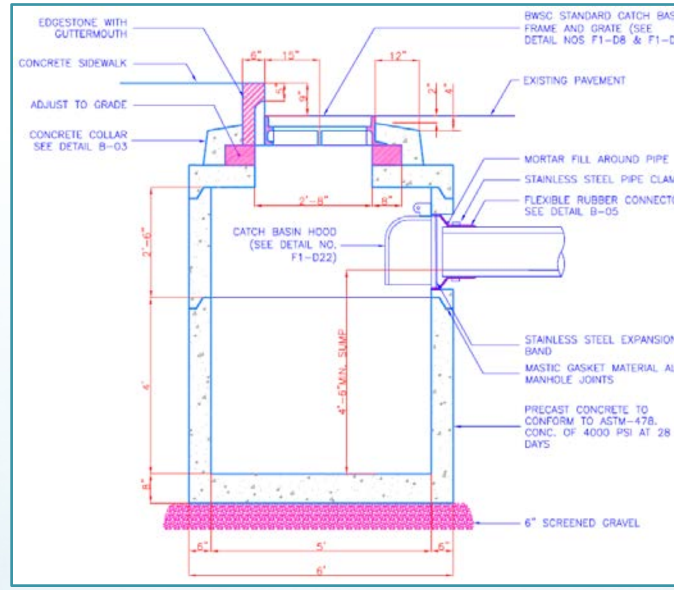


Short-term alternatives eliminate dry weather flooding and reduce wet weather flooding by 81%. Remaining wet weather events are due to rain events coinciding with high tide.

Wellington Short Term Controls

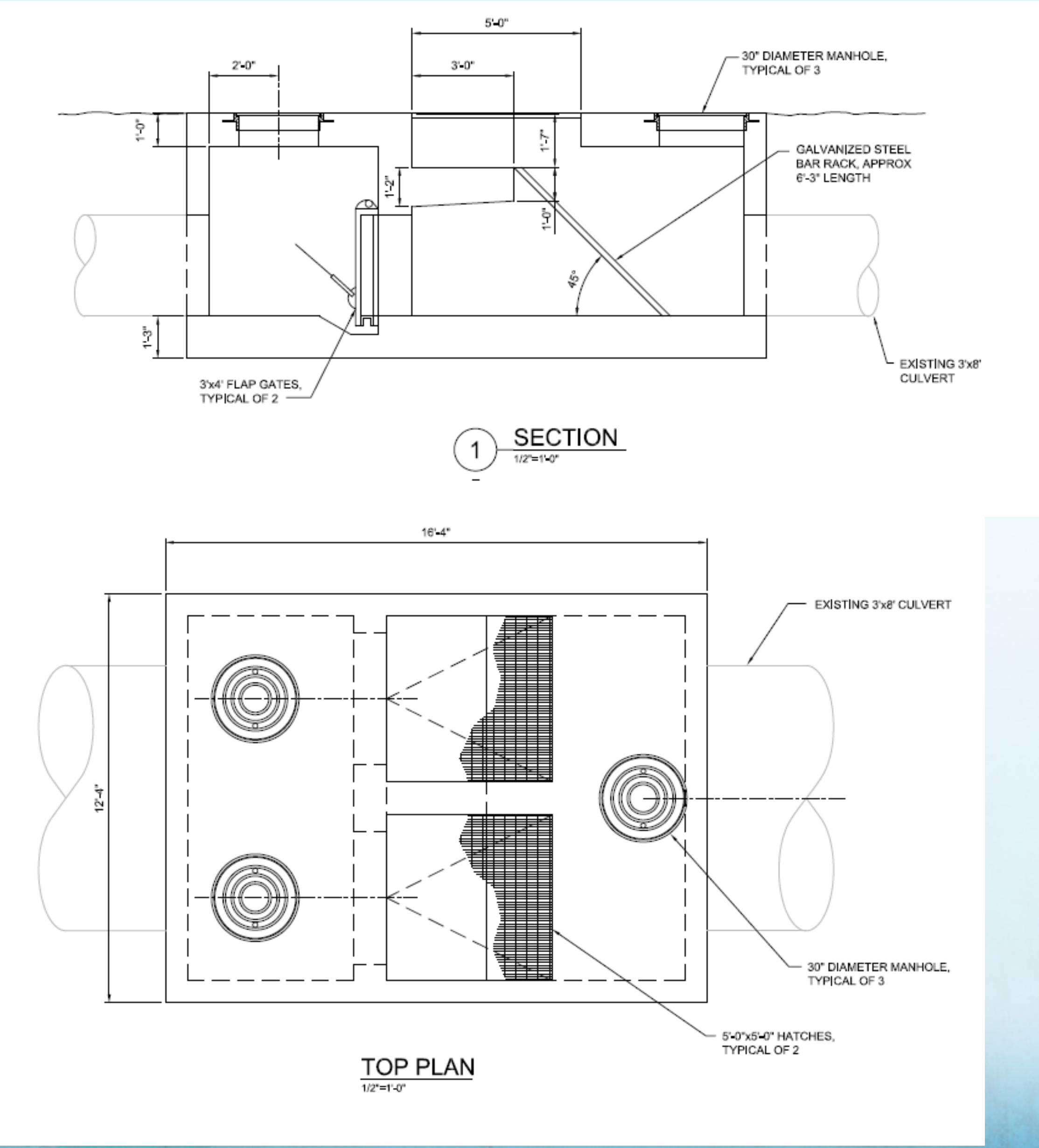


Conceptual sketch of duckbill tide gate structure for 60" circular line



Conceptual sketch for a catch basin with sump

Wellington Short Term Controls



Conceptual sketches of a flap tide gate structure for 3'X8' box culvert

Wellington Avenue Study Area
Short-term Costs

Wellington Avenue Short-term Control Option Components	Quantities	Capital Cost* (-25% to +50%)	Additional Annual O&M Cost
3'X8' Box Culvert Tide Gate Structure	1 structure including trash rack and 2 4'X4' flap tide gates	$850,000 $638,000 - $1.3M	$9,000/yr
60" Duckbill Tide Gate Structure	1 structure including trash rack and 1 60" duckbill tide gate	$800,000 $600,000 - $1.2M	$9,000/yr
Storm Drain Cleaning	6,288 ft. (1.2 miles)	$1.1M $575,000 - $1.7M	$75,000/yr
Catch Basin Rehabilitation & Addition of Sumps	23 Catch Basins	$561,000 $421,000 - $842,000	$1,600/yr
Harbor Dredging* * Assumes material not hazardous	4,500 cy sediment removed	$536,000 $402,000 - $804,000	
Reroute Houston St. Catch Basins	75 ft. new pipe Block 18" pipe	$81,000 $61,000 - $122,000	
Total		**$3.9M** **$2.7M - $6.0M**	**$94,600/yr**

* Total capital cost includes design, construction, services during construction.

Potential additional costs: Permitting, Easement acquisition, Future harbor dredging, Hazardous materials testing and disposal

Wellington Ave. Study Area
Long-term Controls

- All short-term controls
- Additional tide gate
- Green infrastructure
- Stormwater pump station
  - 55 MGD
  - Sized for a 5-year storm

Pumps for pump station will be located below ground.

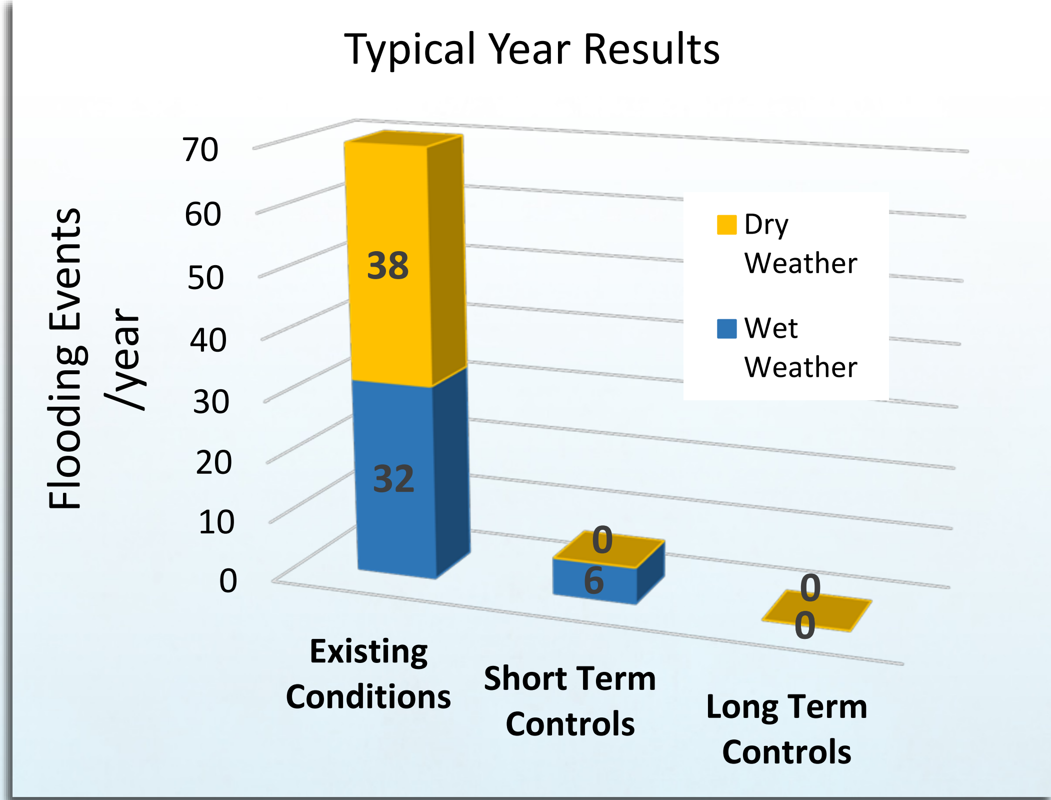
Wellington Ave. Study Area
Long-term Controls Map
Conceptual Layout

Wellington Ave. Study Area

With all Long-term Controls

Performance for a Typical Year 2013

- Existing Conditions
  - » 70 flooding events/yr
  - » 5.8 million gallons/yr
  - » 62 hours flooded/yr
- Long-Term Controls
  - » 0 flooding events/yr
  - » 0 million gallons/yr
  - » 0 hours flooded/yr

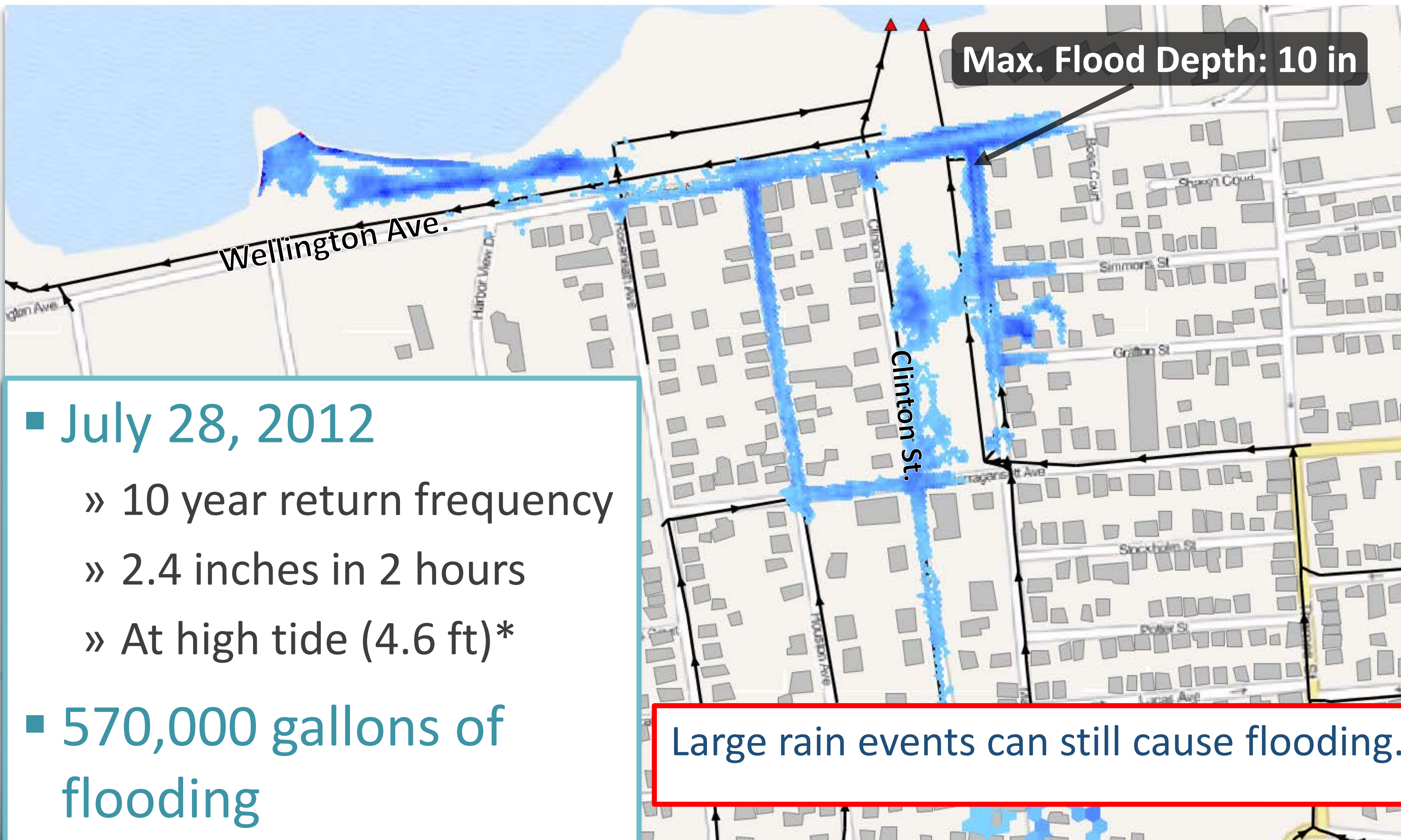


Long-term alternatives eliminate all flooding during a typical year because there were no storm events with greater than a 5-year return in 2013.

Wellington Ave. Study Area

Large Storms vs. Design Storm

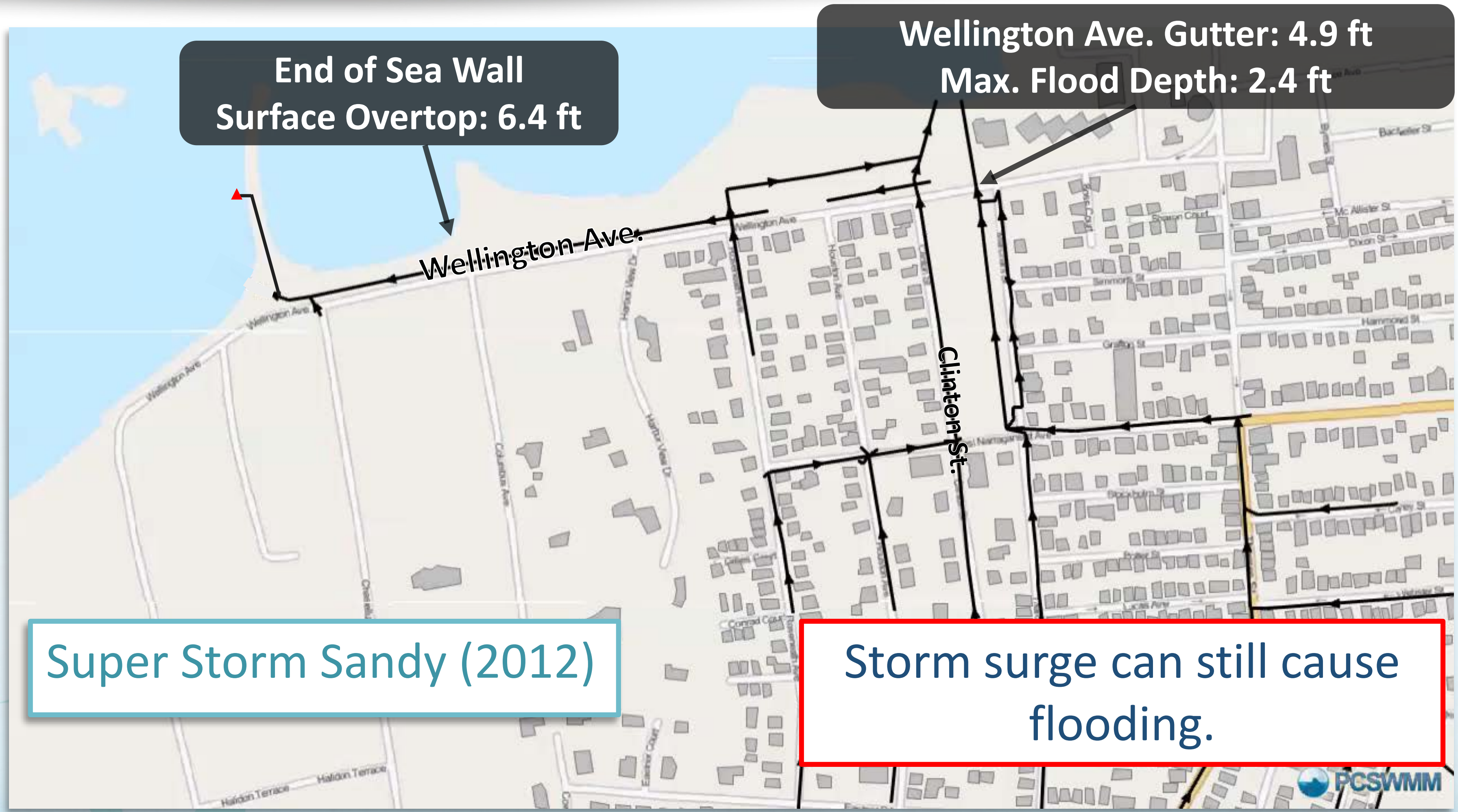
With all Long-term Controls



- July 28, 2012
  - » 10 year return frequency
  - » 2.4 inches in 2 hours
  - » At high tide (4.6 ft)*
- 570,000 gallons of flooding

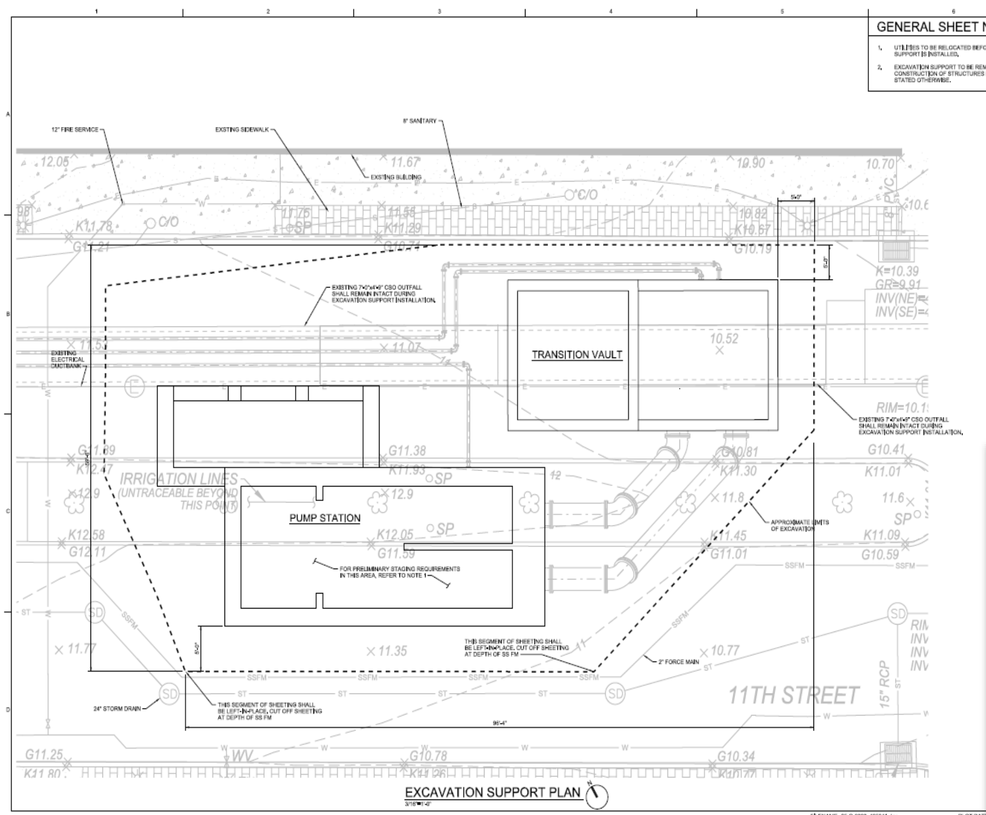
Large rain events can still cause flooding.

Wellington Ave. Study Area
Super Storm Sandy
With all Long-term Controls and Repaired Seawall



Wellington Avenue Study Area

Long-term Controls



Profile sketch of an underground pump station

Permeable Pavement

Green Infrastructure: Bio-Retention Cell

Wellington Avenue Study Area

Long-term Costs

Potential additional costs: Permitting, Easement acquisition, Future harbor dredging, Hazardous materials testing and disposal

Wellington Avenue Long-term Control Option Components	Quantities	Capital Cost* (-25% to +50%)	Additional Annual O&M Cost
3'X8' Box Culvert Tide Gate Structure	1 structure including trash rack and 2 - 4'X4' flap tide gates	$850,000 $638,000 - $1.3M	$9,000/yr
60" Duckbill Tide Gate Structure	1 structure including trash rack and 1 - 60" duckbill tide gate	$800,000 $600,000 - $1.2M	$9,000/yr
Storm Drain Cleaning	6,288 ft. (1.2 miles)	$1.1M $575,000 - $1.7M	$75,000/yr
Catch Basin Rehabilitation & Addition of Sumps	23 Catch Basins	$561,000 $421,000 - $842,000	$1,600/yr
Harbor Dredging* * Assumes material not hazardous	4,500 cy sediment removed	$536,000 $402,000 - $804,000	
Reroute Houston St. Catch Basins	75 ft. new pipe Block 18" pipe	$81,000 $61,000 - $122,000	
Green Infrastructure	54,000 sf bioretention 73,000 sf permeable pavement	$6.5M $4.9M - $9.8M	$65,000/yr $48,000 - $81,000/yr
18" Duckbill Tide Gate Structure	1 structure including trash rack and 1 - 18" duckbill tide gate	$614,000 $461,000 – $921,000	$9,000/yr
Pump Station	1 - 55 MGD Pump Station	$19.7M $14.8M - $29.6M	$40,000/yr
Total		**$30.7M** **$22.9M - $46.3M**	**$208,600/yr**

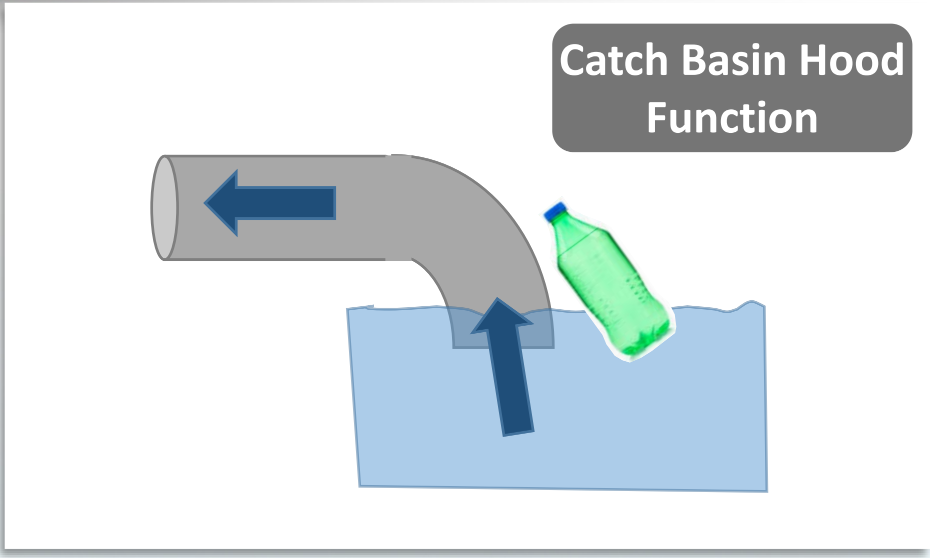
* Total capital cost includes design, construction, services during construction.

Discussion

Evaluation of Bridge Street Short-term and Long-term Control Options

Bridge St. Study Area
Short-term Controls

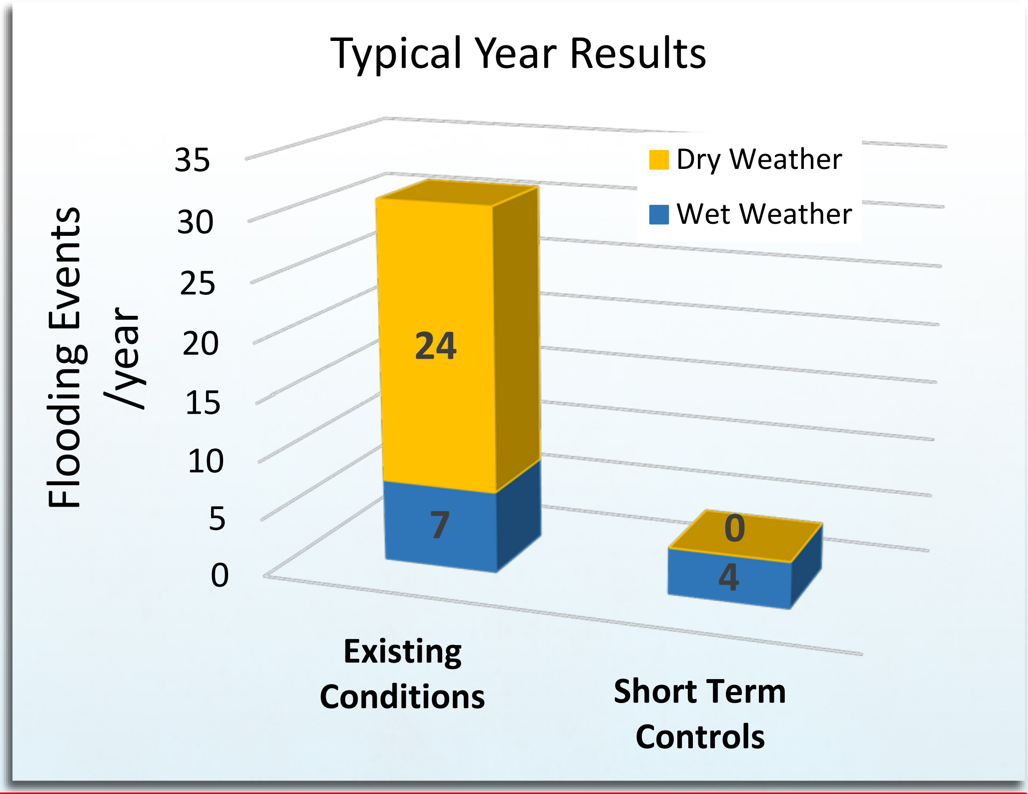
- New tide gate
- Remove old tide gates
- Sediment removal
- Catch basin sumps and rehabilitation



Bridge St. Study Area
Short-term Components Map
Conceptual Layout

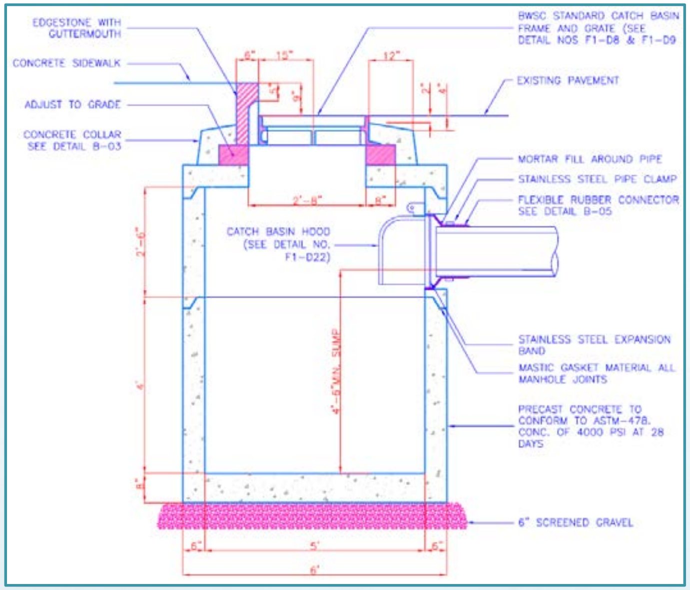
Bridge St. Study Area
With all Short-term Controls
Performance for a Typical Year 2013

- Existing Conditions
  - » 31 flooding events/yr
  - » 1.0 million gallons/yr
  - » 32 hours flooded/yr
- Short-Term Controls
  - » 4 flooding events/yr
  - » 0.1 million gallons/yr
  - » 2.1 hours flooded/yr

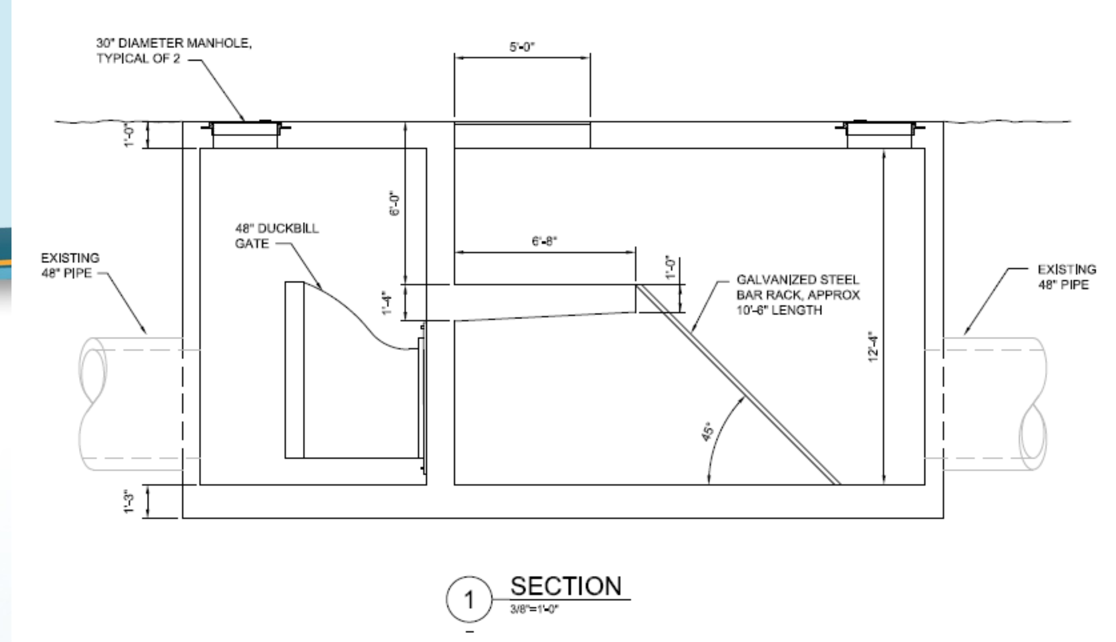


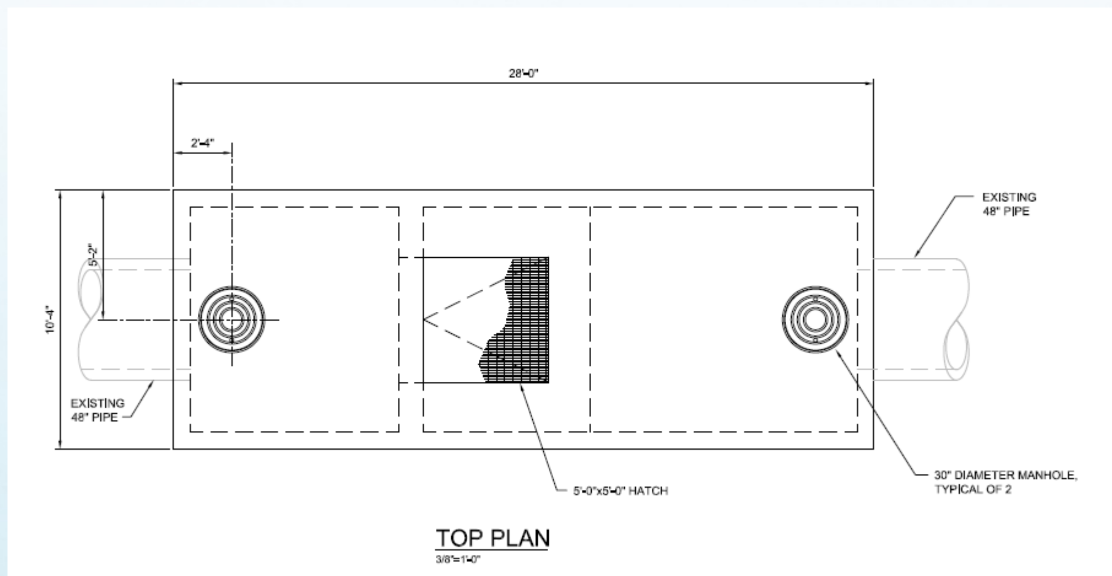
Short-term alternatives eliminate dry weather flooding and reduce wet weather flooding by 43%. Remaining wet weather events are due to rain events coinciding with high tide.

Bridge Street Study Area
Short-term Controls



Conceptual sketch for a catch basin with sump





Conceptual sketch for a 48" duckbill tide gate structure

Bridge Street Study Area

Short-term Costs

Bridge Street Short-term Control Option Components	Quantities	Capital Cost* (-25% to +50%)	Additional Annual O&M Cost
48” Duckbill Tide Gate Structure	1 structure including trash rack and 1 48” duckbill tide gate	$850,000 $638,000 - $1.3M	$9,000/yr
Storm Drain Cleaning	4,167 ft (0.8 miles)	$723,000 $542,000 - $1.1M	$50,000/yr
Catch Basin Rehabilitation & Addition of Sumps	20 Catch Basins	$479,000 $359,000 - $719,000	$1,400/yr
Total		**$2.1M** **$1.5M - $3.1M**	**$60,400/yr**

* Total capital cost includes design, construction, services during construction.

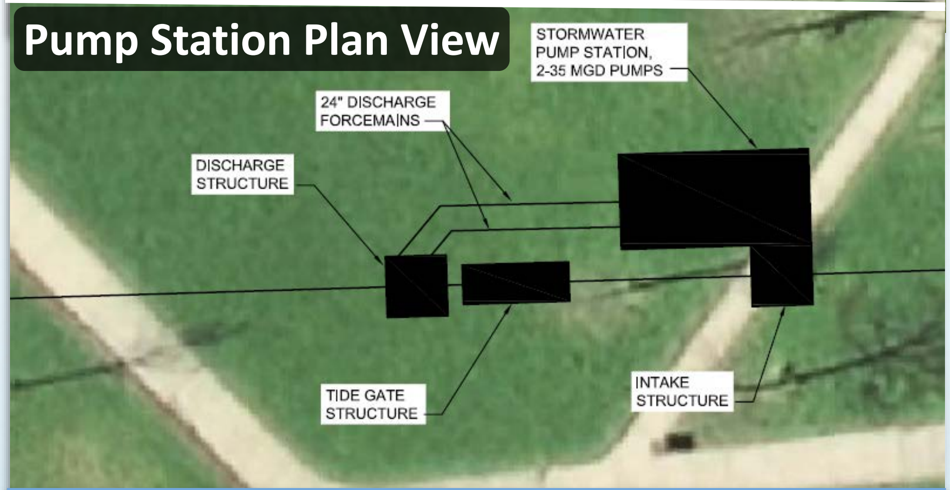
Potential additional costs: Permitting, Easement acquisition

Bridge St. Study Area
Long-term Controls

- All short-term controls
- Green infrastructure
- Stormwater pump station
  - » 35 MGD
  - » Sized for a 5-year Storm


Green Infrastructure: Permeable Pavement


Pump Station Footprint



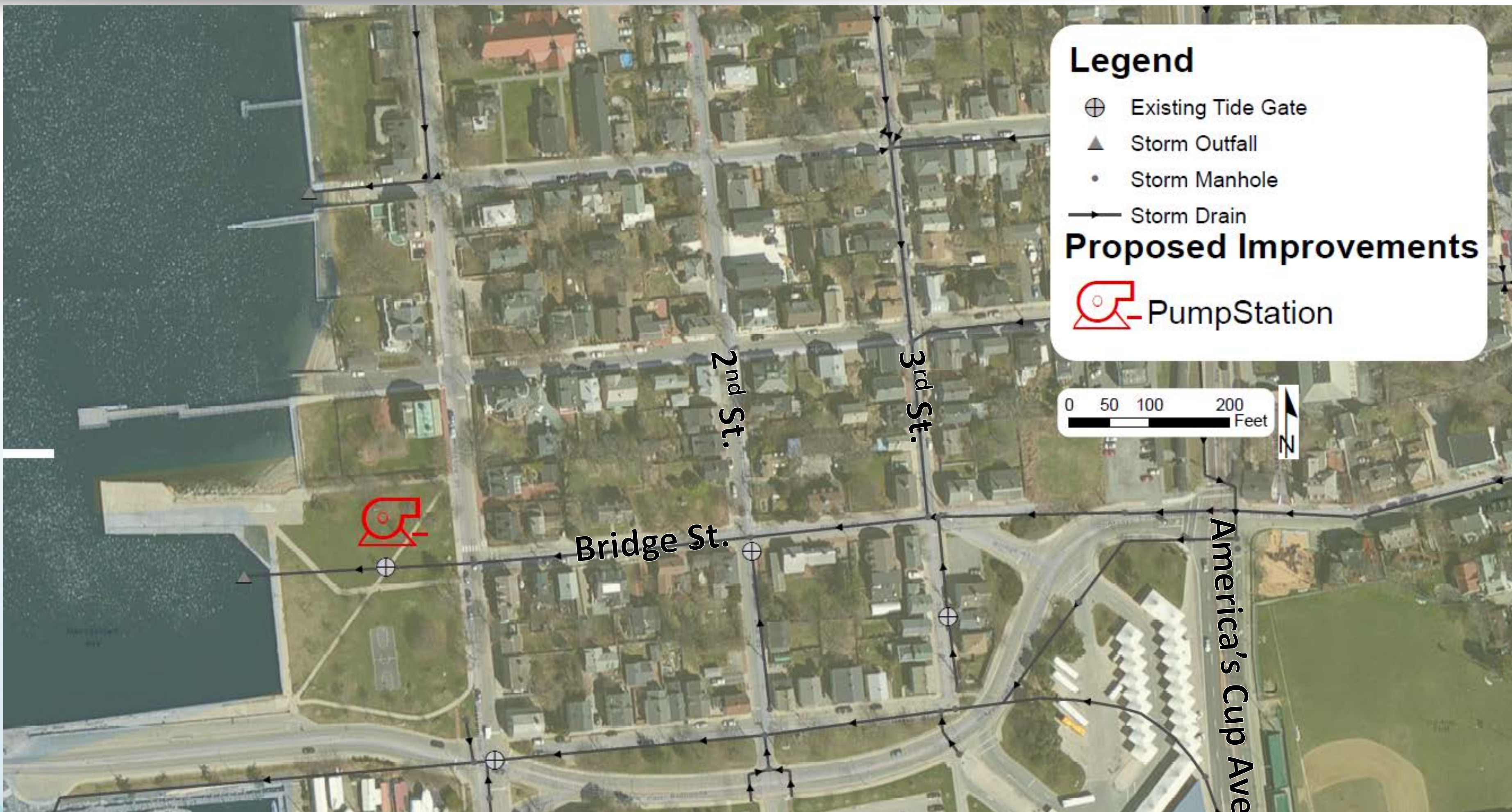
Pump Station Plan View

Pumps for pump station will be located below ground.

Bridge St. Study Area

Long-term Controls Map

Conceptual Layout

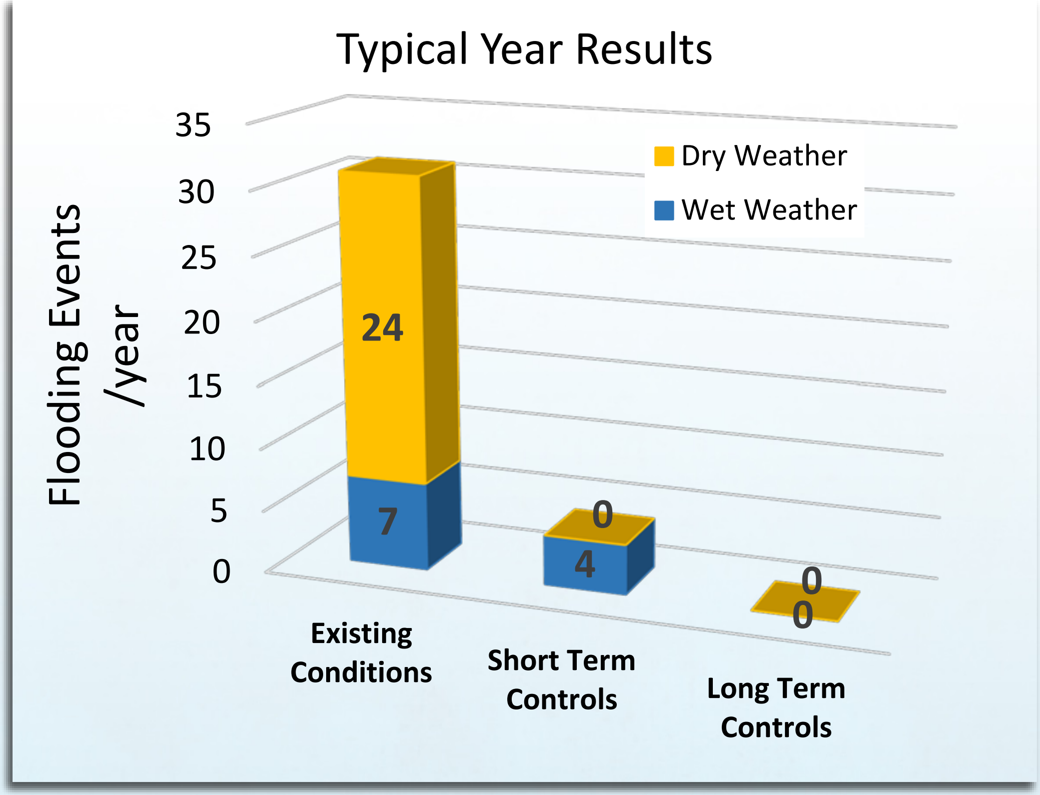


Bridge St. Study Area

With all Long-term Controls

Performance for a Typical Year 2013

- Existing Conditions
  - » 70 flooding events/yr
  - » 5.8 million gallons/yr
  - » 62 hours flooded/yr
- Long Term Controls
  - » 0 flooding event/yr
  - » 0 million gallons/yr
  - » 0 hours flooded/yr



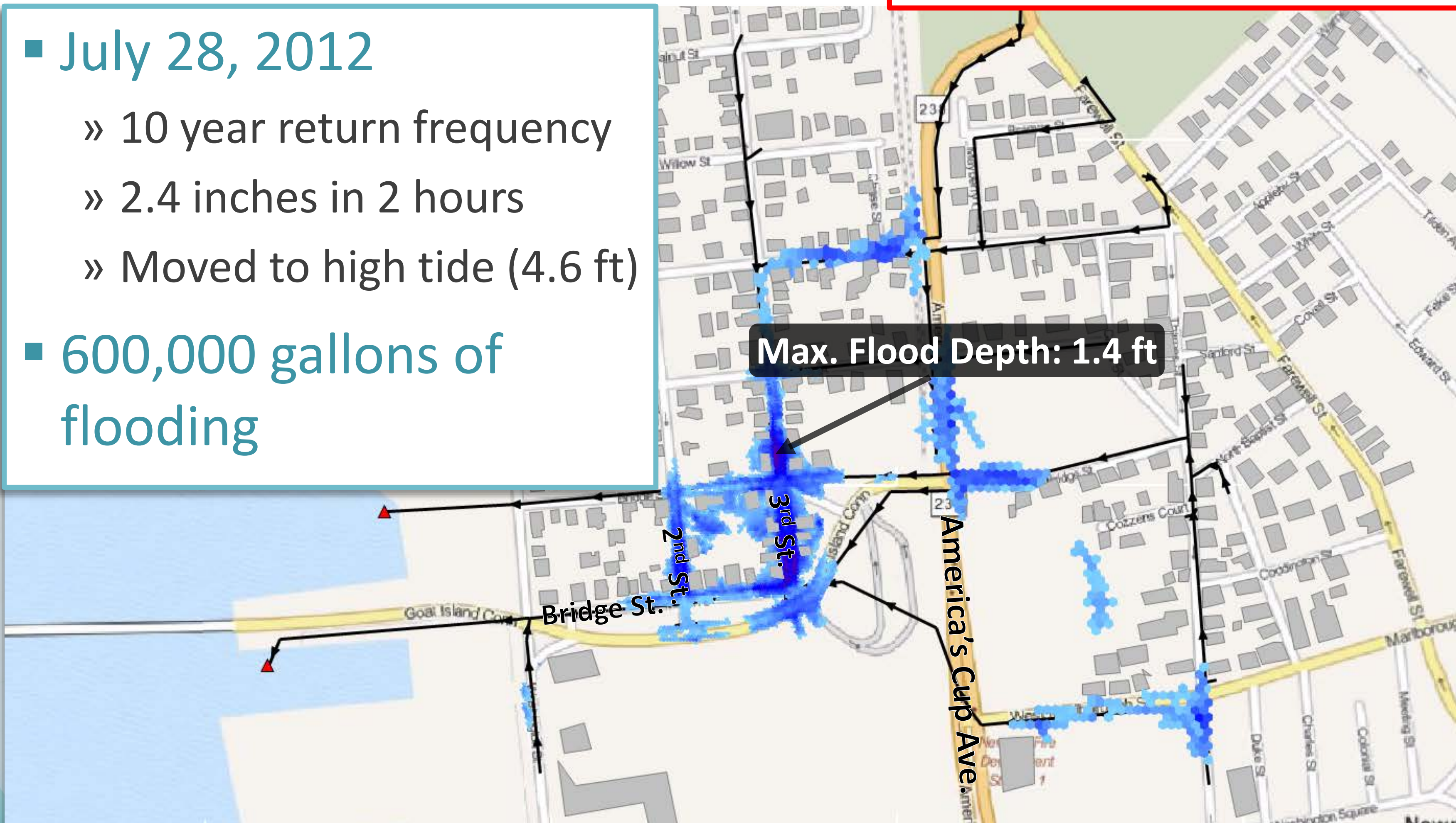
Long-term alternatives eliminate all flooding during a typical year because there were no storm events with greater than a 5-year return in 2013.

Bridge St.

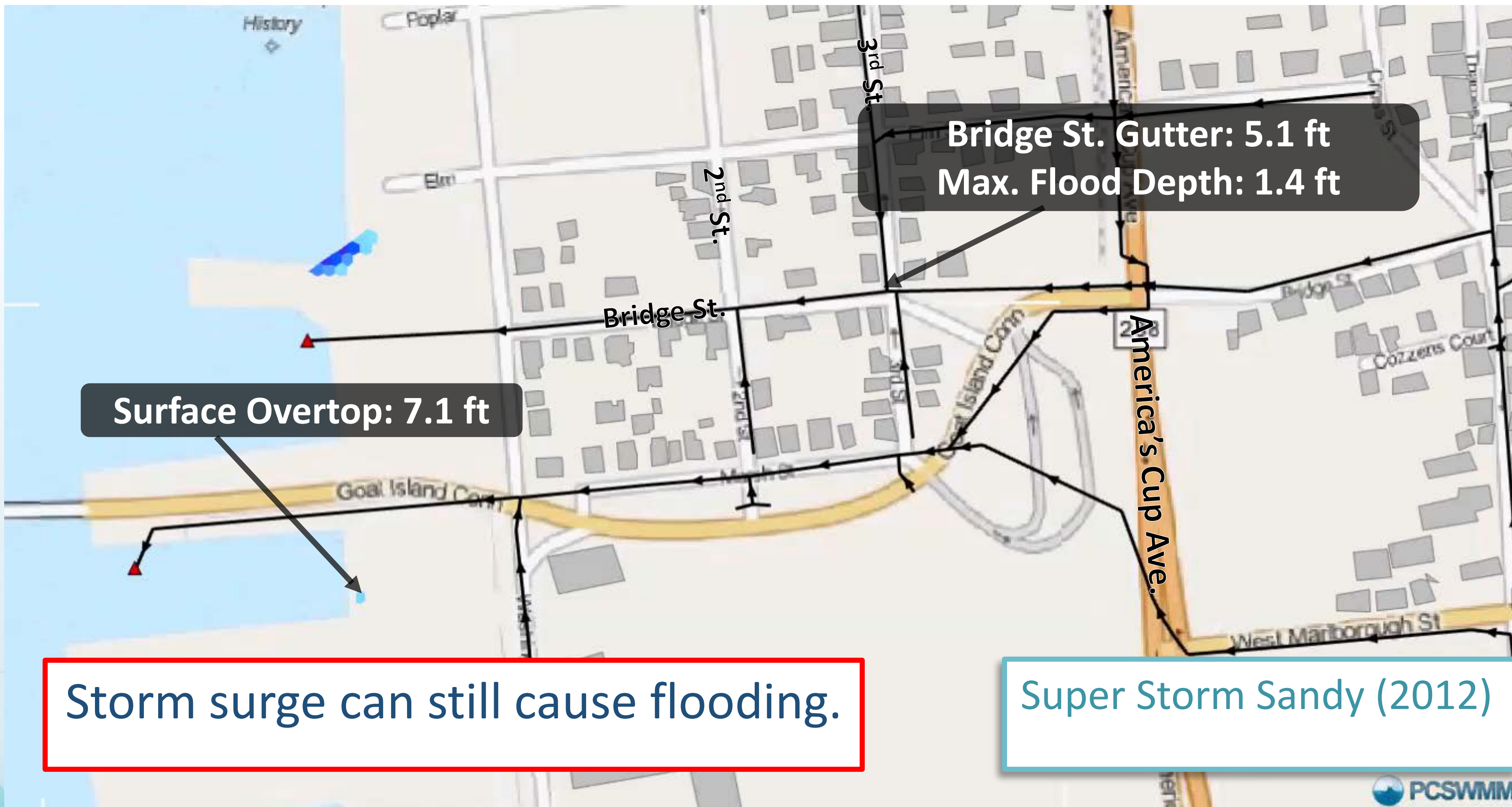
Large Storms vs. Design Storm With all Long-term Controls

Large rain events can still cause flooding.

- July 28, 2012
  - » 10 year return frequency
  - » 2.4 inches in 2 hours
  - » Moved to high tide (4.6 ft)
- 600,000 gallons of flooding

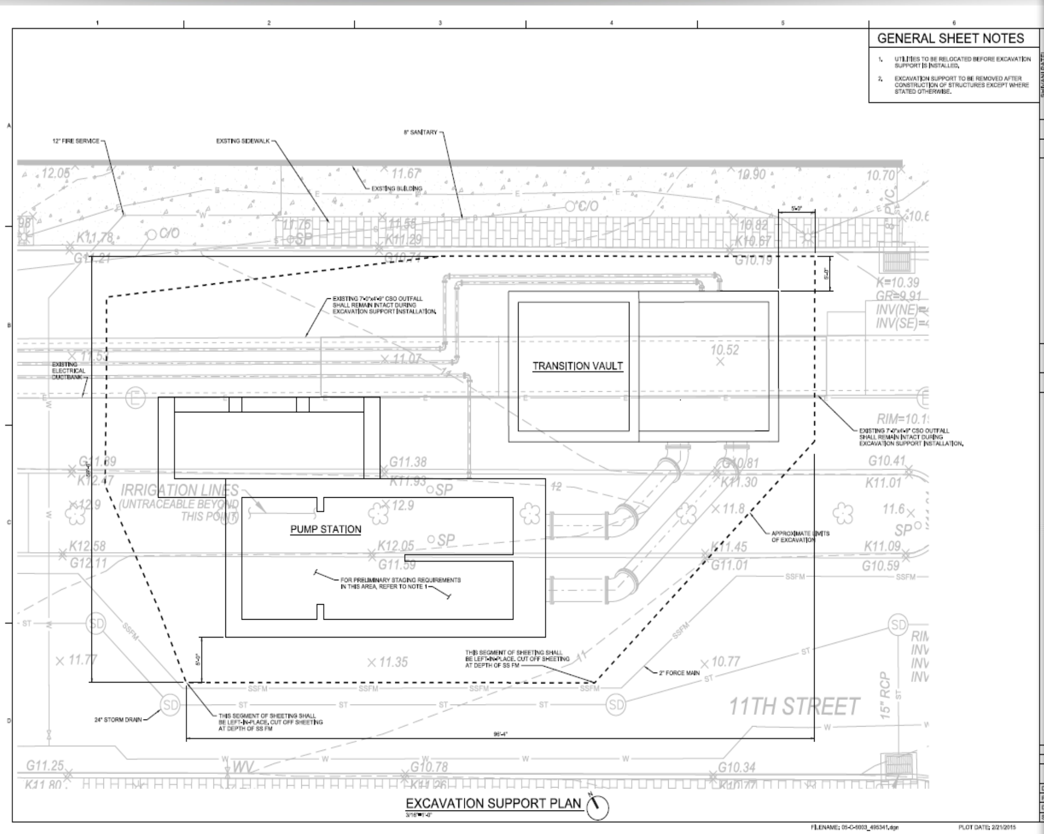


Bridge St.
Super Storm Sandy
With all Long-term Controls



Bridge Street Study Area

Long-term Controls



Profile sketch of similar pump station currently under construction

Bridge Street Study Area
Long-term Costs

Bridge Street Short-term Control Option Components	Quantities	Capital Cost* (-25% to +50%)	Additional Annual O&M Cost
48" Duckbill Tide Gate Structure	1 structure including trash rack and 1 - 48" duckbill tide gate	$850,000 $638,000 - $1.3M	$9,000/yr
Storm Drain Cleaning	4,167 ft (0.8 miles)	$723,000 $542,000 - $1.1M	$50,000/yr
Catch Basin Rehabilitation & Addition of Sumps	20 Catch Basins	$479,000 $359,000 - $719,000	$1,400/yr
Green Infrastructure	30,000 sf bioretention 21,000 sf permeable pavement	$2.9M $2.2M - $4.4M	$29,500/yr $22,000 - $37,000/yr
Pump Station	1 - 35 MGD Pump Station	$12.2M $9.2M - $18.3M	$36,000/yr
Total		**$17.2M** **$12.9M - $25.8M**	**$125,900/yr**

* Total capital cost includes design, construction, services during construction.

Potential additional costs: Permitting, Easement acquisition

Discussion

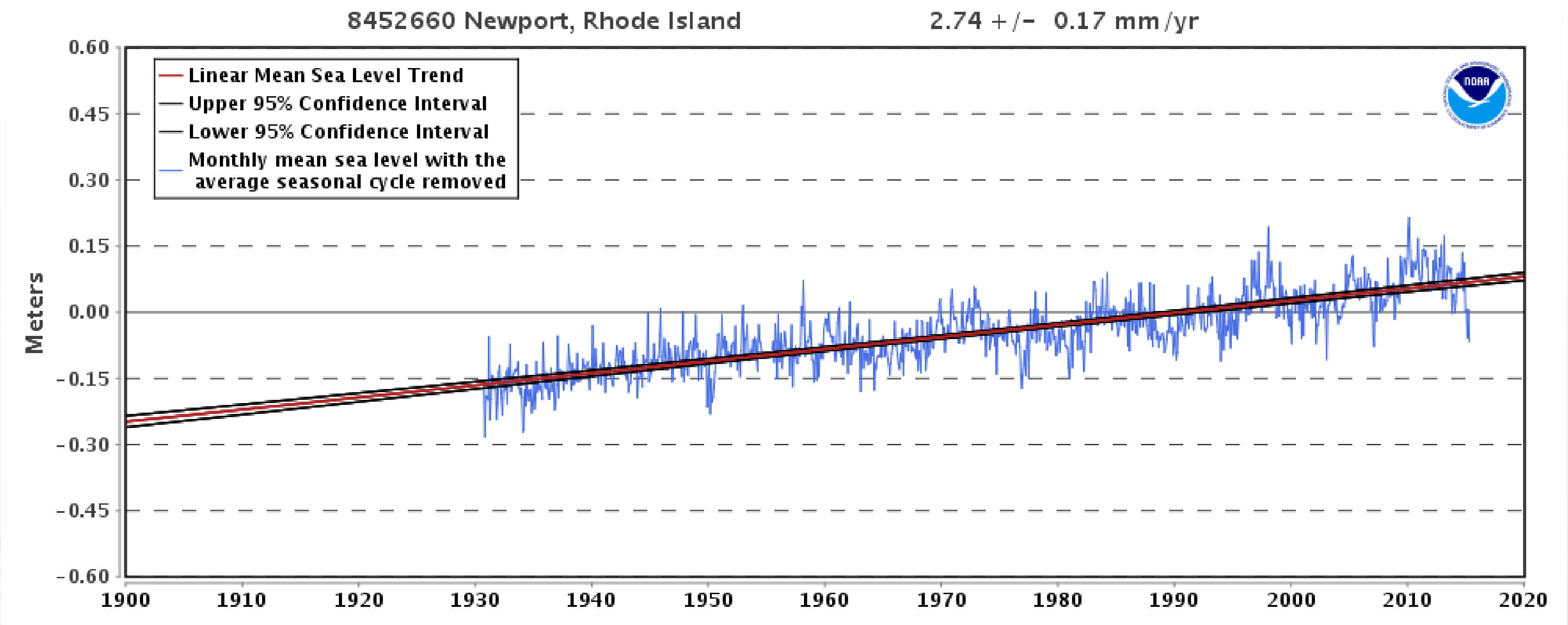
Planning for Future Climate Conditions

Improving Resiliency for Future Climate Change

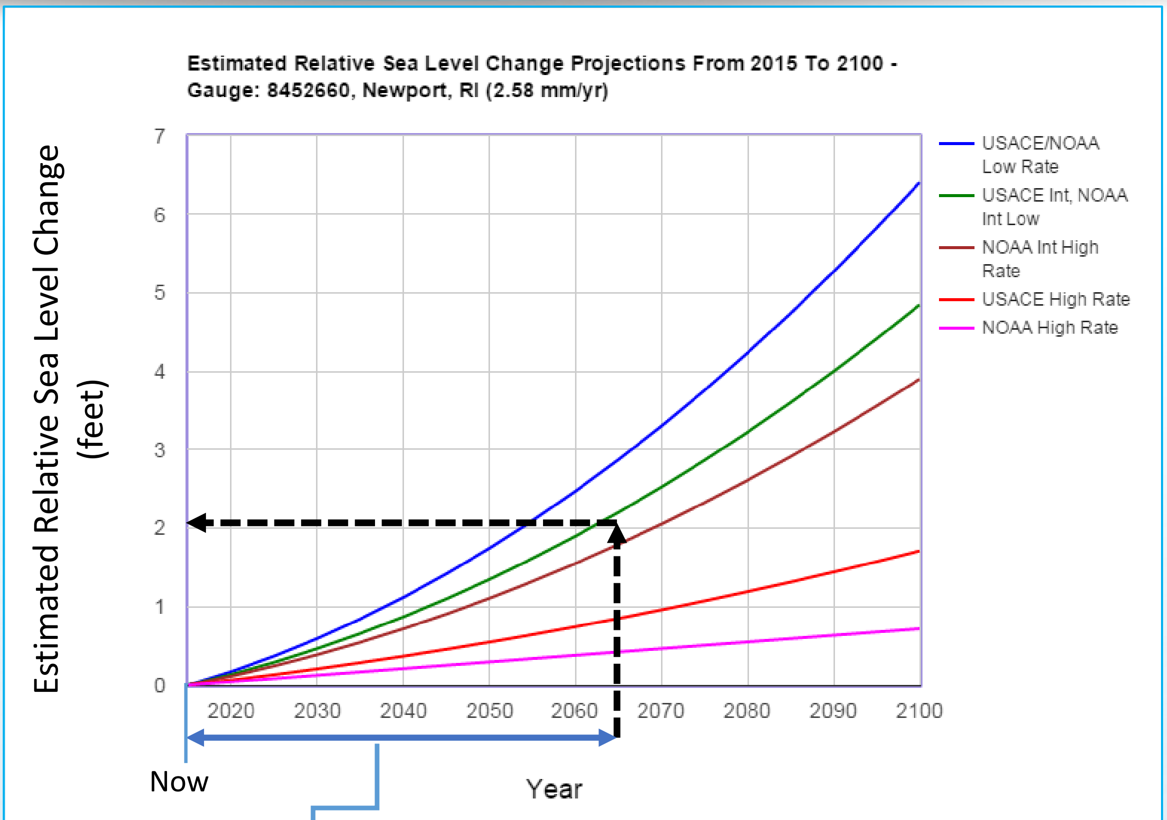
- Long-term Drainage Resiliency Planning Takes Us 50 years into the Future – to 2065
- Future Sea Level Rise and Storm Surge
  - » Sea level rise may increase the elevation of the storm surge and the areas that will flood.
  - » Sewer systems may be inundated in flooded areas.
  - » Pump stations may be flooded and disabled.
  - » More streets may be flooded if the water has nowhere to go.
- Cities and their Utilities are:
  - » Identifying climate threats
  - » Evaluating risks to assets and operations
  - » Developing short- and long-term strategies to improve their resiliency

Water Levels Are Rising in Newport

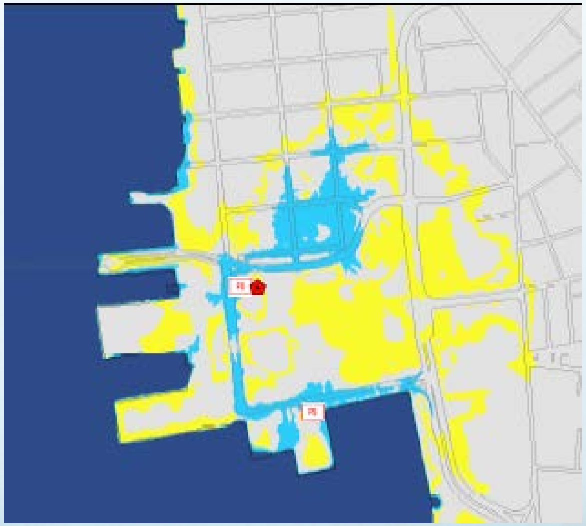
Sea Levels Have Risen ~1 foot in the Past 100 years and will Likely Continue to Rise at the Same Rate at a Minimum



Future Newport High Tides with Climate Change



Life Cycle of Project – 50 years = 2 feet of Sea Level Rise

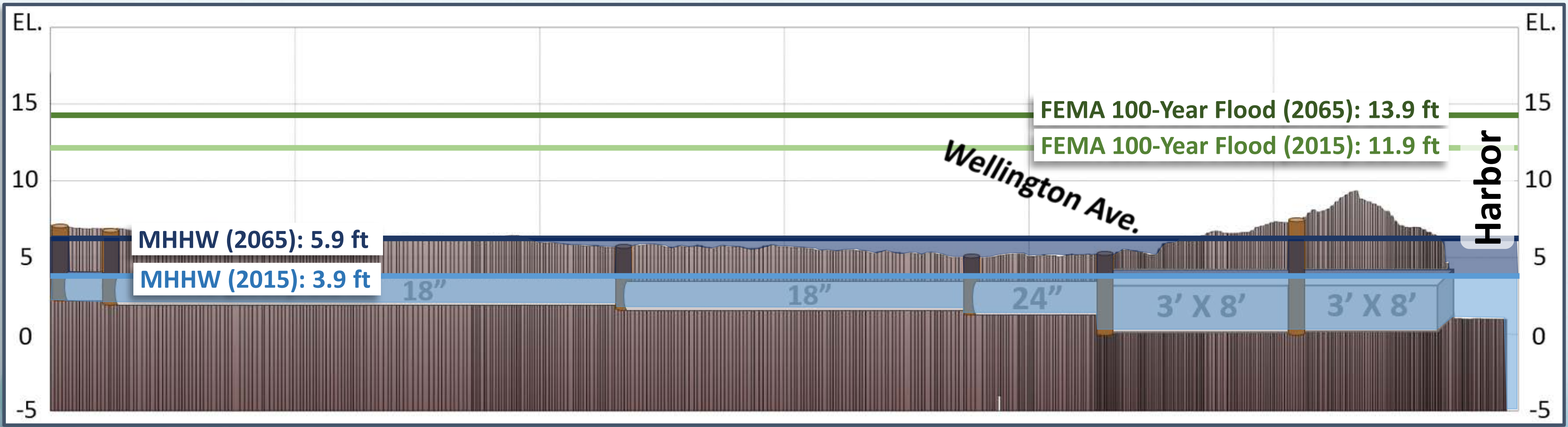


Legend
Newport Sea Level Rise (SLR)
- Mean Higher High Water (MHHW)
- MHHW plus 1' Sea Level Rise
- MHHW plus 3' SLR
- MHHW plus 5' SLR
- Waterbodies

Sea Level Rise Scenarios provided by the URI EDC

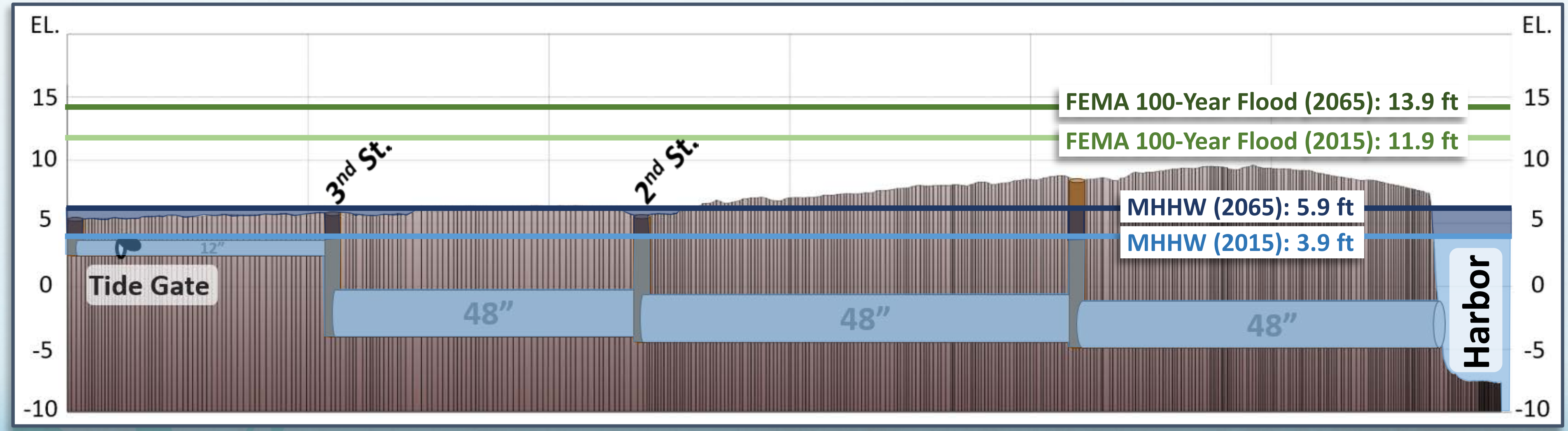
Future Profile Marchant Street – Year 2065

- In 2065, higher high tides will be above some ground surfaces
- The current 100-year storm surge inundates streets over bulkheads. In 2065, the surge will be 2 feet higher



Bridge St.
Future Profile – Year 2065

- In 2065, higher high tides will be above some ground surfaces
- The current 100-year storm surge inundates streets over bulkheads. In 2065, the surge will be 2 feet higher



Projected Flood Events for a Typical Year Tides – 50 Years from Today Without Rainfall

Wellington Avenue Study Area

- Based on LIDAR data, overtopping elevation, tide data and the projected sea level rise to the area will flood 157 times per year
- Long-term controls to the drainage system will not prevent these flooding events
- Extending the sea wall 500 ft can eliminate all dry weather flooding events in a typical year in 2065

Bridge Street Study Area

- Based on LIDAR data, overtopping elevation, tide data and the projected sea level rise the area will flood 27 times per year
- Long-term controls to the drainage system will not prevent these flooding events

Future Flood Protection for Climate Change Achieved by Performing the Following Steps:

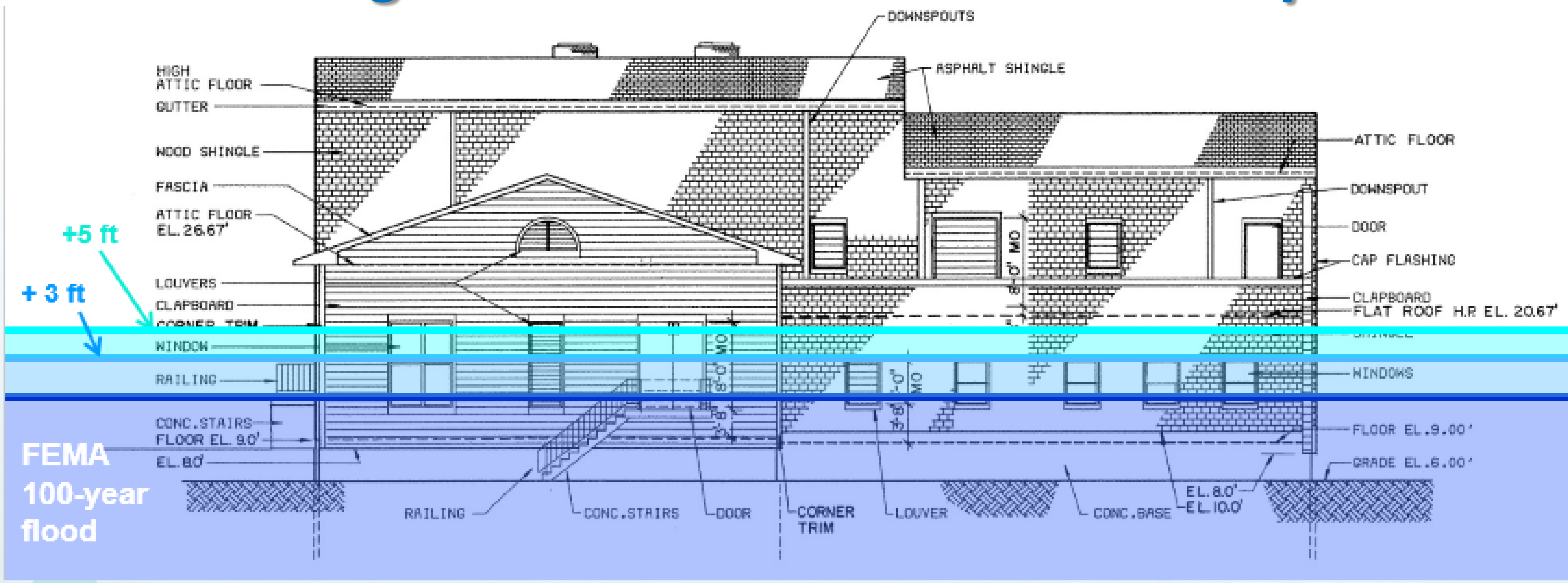
- Identify regional efforts and guidelines related to climate change.
- Define the process and considerations for planning.
- Define climate change scenarios for rainfall, sea level, storm surge and rivers.
- Evaluate sewer and storm drain system performance with climate change.
- Evaluate flooding vulnerabilities to sea level rise, storm surge and rivers.
- Develop strategies and design standards.
- Monitor changes over time and be prepared to adjust.

Newport Department of Utilities Climate Resiliency Evaluations, Strategies and Implementation

- Planning Criteria
  - » Current FEMA Flood Zones
  - » Flood Zone Design Criteria
  - » Sea Level Rise
- Evaluated Current and Future Asset Vulnerabilities
  - » Water Pollution Control Plant (WPCP)
  - » Long Wharf Pump Station
  - » Wellington Avenue CSO Treatment Facility
  - » Washington Street CSO Treatment Facility
- Developed Design Recommendations
- Integrating Floodproofing into Facility Improvement Projects When Implemented
  - » Will update design criteria based on experiences and data trends

Utility Planning in Newport Includes Consideration of Future Design Flood Elevations

Washington Street CSO Treatment Facility

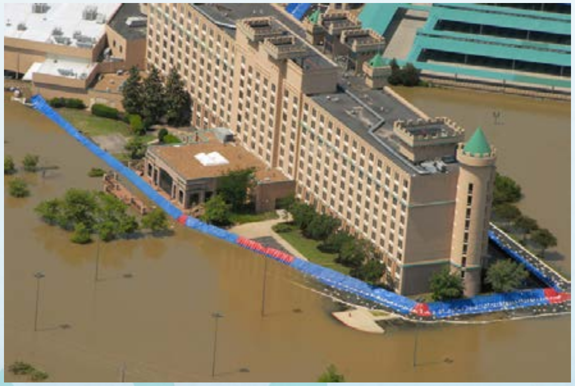


Design Flood Elevation = FEMA 100-year flood zone plus 1 foot of freeboard and 1 foot of sea level rise

This evaluation identified attainable levels of protection for the Bridge Street and Wellington Avenue study areas

- High high-tides, Sea Level Rise, Storm surge

Permanent and Temporary Flood Protection



Ann Street Pier

Discussion

Next Steps

Next Steps for the Drainage System Investigation and Flooding Analysis Project

Deliver Final Feasibility Report

- Post presentation to website
- Review comments from residents and city staff
  - Instructions for sending comments by December 31 will be on website
- Prepare a report to document key findings
  - Existing Conditions
  - Model Development and Calibration
  - Screening and Evaluation of Mitigation Alternatives
  - Planning Level Cost Estimates
- Submit final report in January 2016

Implementation

- Incorporate projects into capital planning
- Funding source
- Solicit design
- Design period
- Permitting
- Solicit construction
- Construction period

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Thank You

Please visit our project website at:

www.newportdrainageinvestigation.com