

# Five Years and 5 Billion Gallons: Evaluating the Narragansett Bay Commission CSO Abatement Project



Narragansett Bay Commission

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# CSOs – What's the Problem?

## CSO outfall discharges:

- Contain everything that is typically flushed or poured down the drain
- Contain residential, industrial & commercial business discharges
- Contain Stormwater and runoff pollutants, like oils, grease, heavy metals, nutrients, road salt, sand, animal waste, litter, plastics...
- 772 US Cities have CSOs





# CSOs – What's the Problem?

## CSO outfall discharges:

- Cause Aesthetic impacts - Floatables
- Cause beach closures due to bacterial contamination
- Cause shellfishing bed closures
- Adversely impact human and aquatic health,
- Cause violations of water quality standards – Bacteria, DO, Clarity
- Can promote Algae growth and reduce oxygen levels in the water.





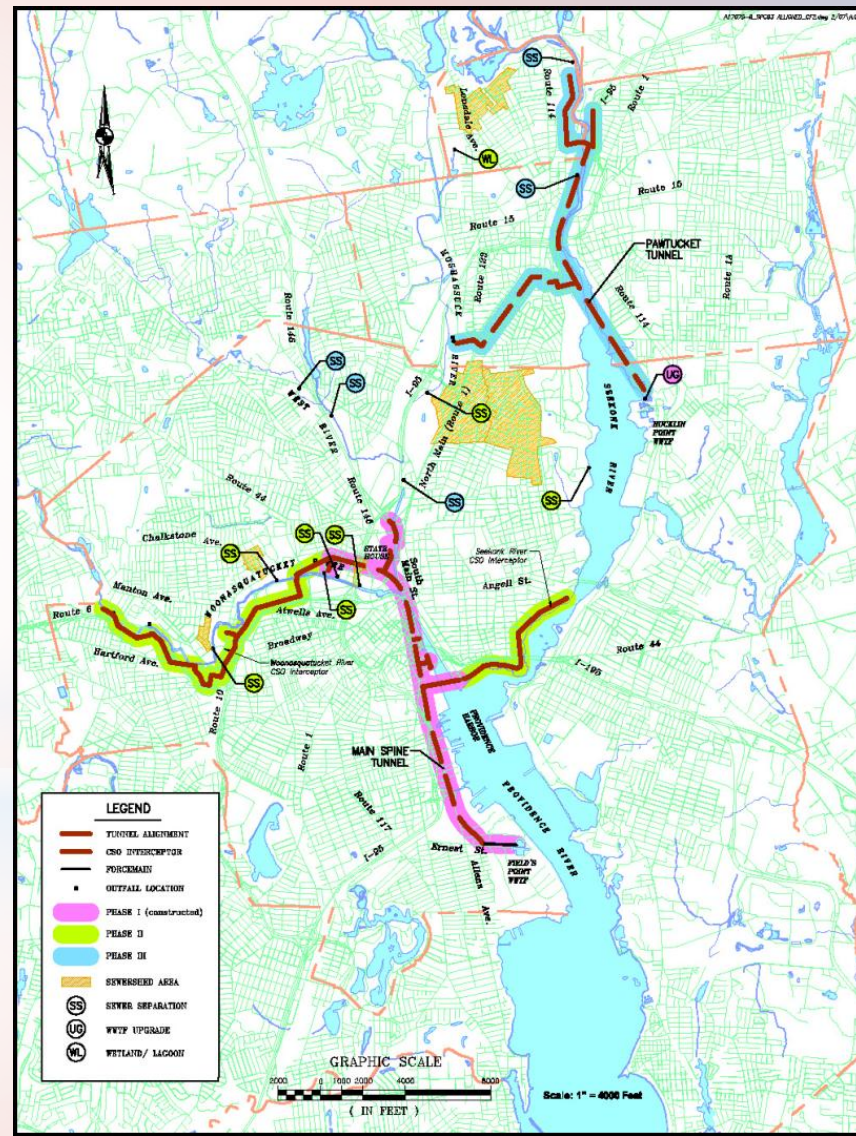
# CSO Abatement Project: 3 Phases - ~\$1.2 Billion

## Three Phases over 20 years

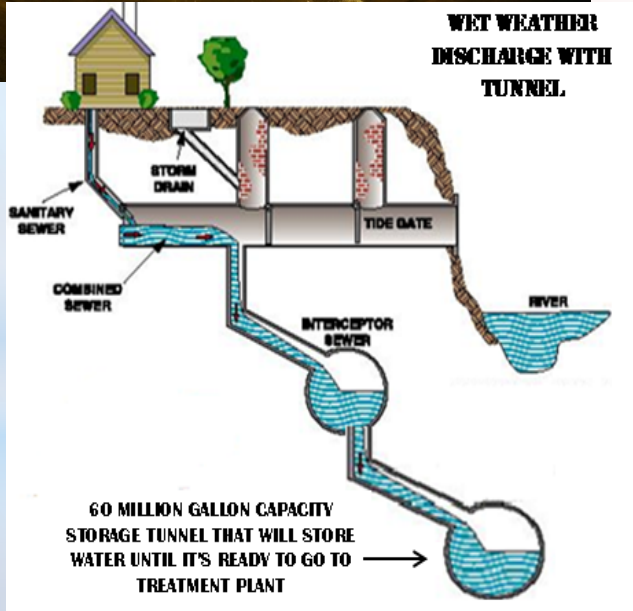
- Design storm: 3-month -1.6 inches of rain in 6 hours

### PHASE 1 (2001 – Nov 2008)

- 26 ft diameter deep rock tunnel
- 3+ mile long, 300 ft. below ground
- 62 MG design capacity (actual~65 MG)
- 7 drop shafts to divert flow to tunnel
- Diversion structures at 8 CSOs
- Relief structures at 2 interceptors
- Collects sewer/stormwater from 12 CSOs in FP area
- ~\$359 million



# CSO Abatement Tunnel: Phase I



## Expected benefits:

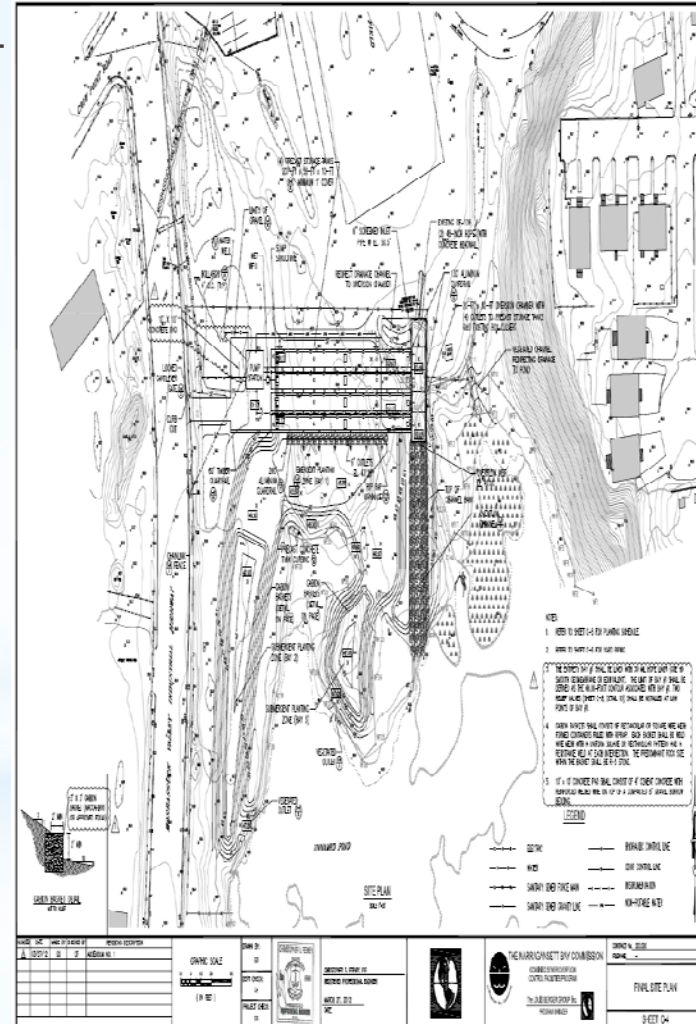
- Reduce annual CSO volume by 39%
- Reduce fecal coliform bacteria load by 40%
- Reduce TSS by 30%
- Reduce BOD by 31%
- Reduce the acre-days of shellfish closure in northern half of Upper Narragansett Bay by 47% and 77% in southern half.

*Combined system with the 65 million gallon CSO Tunnel, which captures & stores stormwater until it can be treated at the WWTF.*

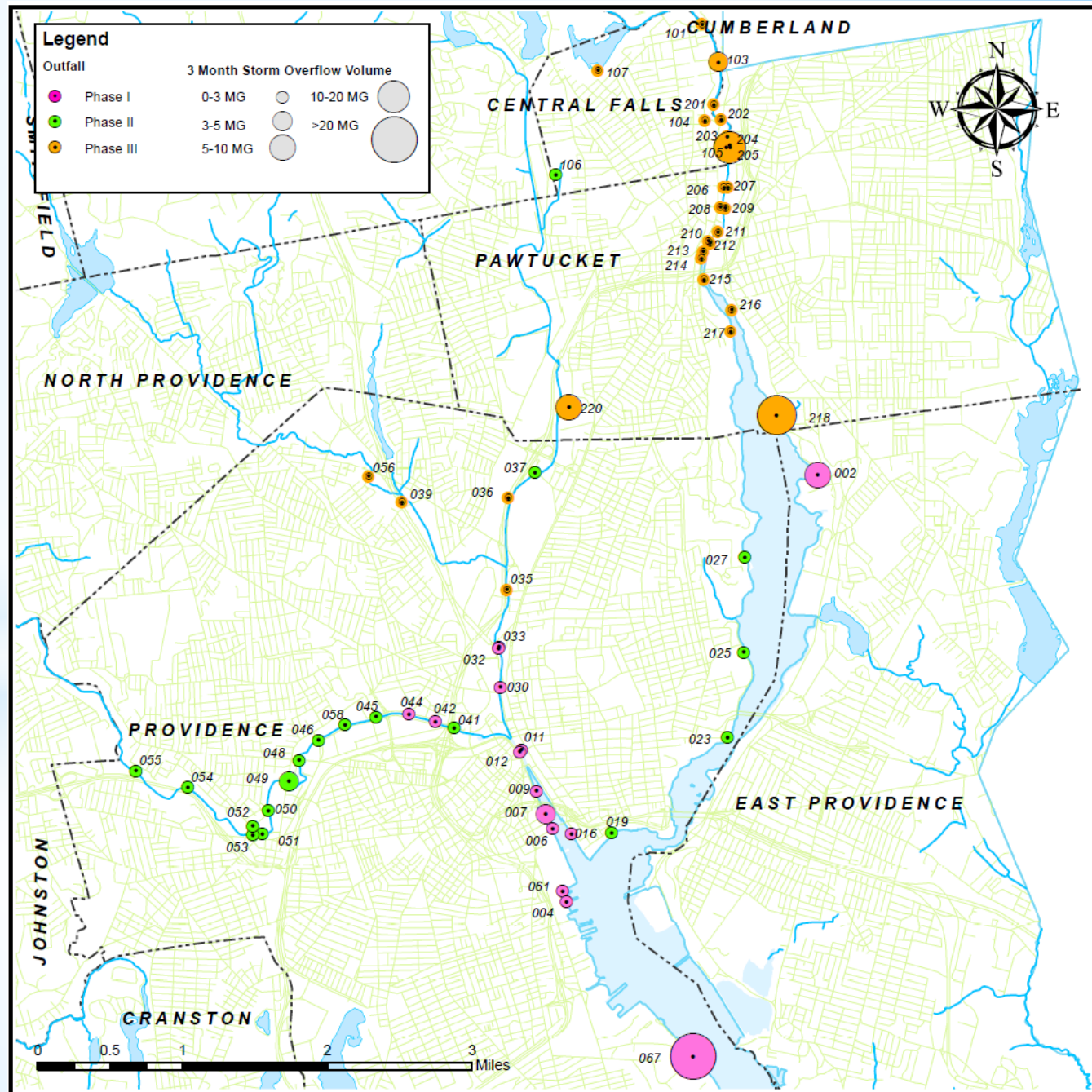


# CSO Abatement Project Phase II and Phase III

- Phase II construction to be complete by end of 2014
- Reevaluation of Phase III underway, scheduled to be completed 2020
- Expected benefits after all Phases complete:
  - ✓ Reduce annual # overflows by 95%
  - ✓ Reduce annual overflow volume 98%
  - ✓ Reduce annual CSO fecal coliform load 98%
  - ✓ Reduce CSO TSS & BOD loads 78% and 80%
  - ✓ Reduce acre days of shellfish closure by 65% in northern upper Bay, 95% in southern upper Bay
  - ✓ Eliminate floatables
- Estimate Costs: \$1.2 - \$1.3 Billion
  - Phase I = \$359 million
  - Phase II = \$270 million
  - Phase III = \$603 million

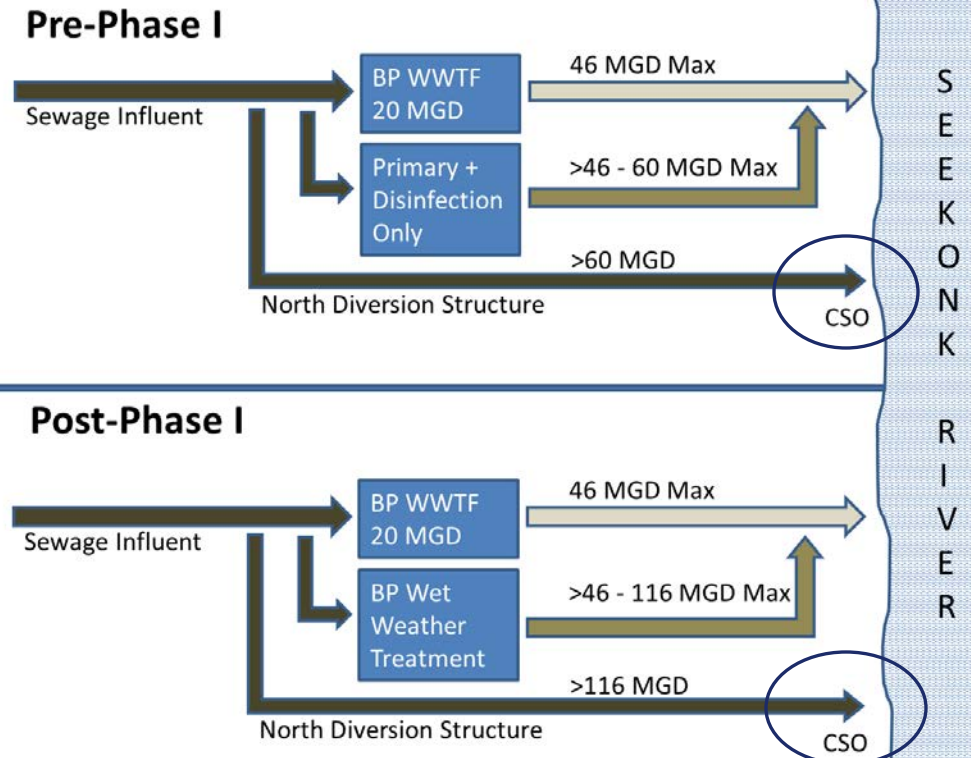


# Combined Sewer Overflow Volumes





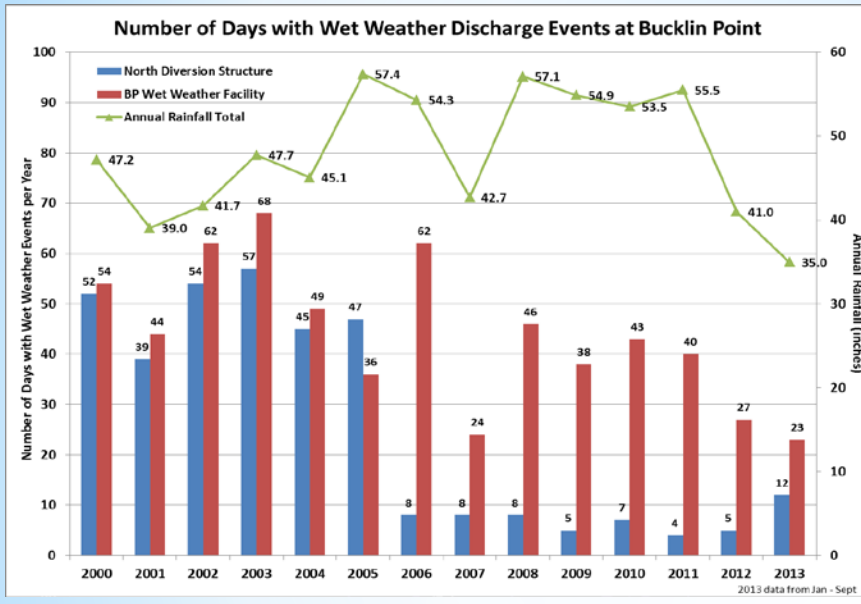
# Phase I Bucklin Point Treatment Facility Improvements



- Wet weather treatment facility constructed in **2006** (part of Phase I project)
- Prior to 2006: Flows > 60 MGD Bypassed Treatment via diversion structure directly to river
- Wet Weather Facility can now treat flows up to 116 MGD before bypass

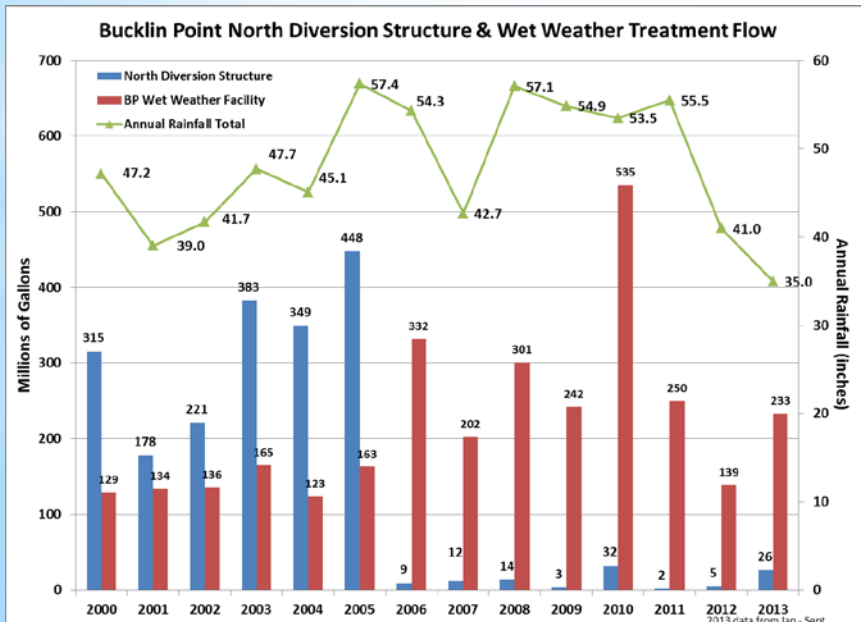


# Bucklin Point Wet Weather Treatment



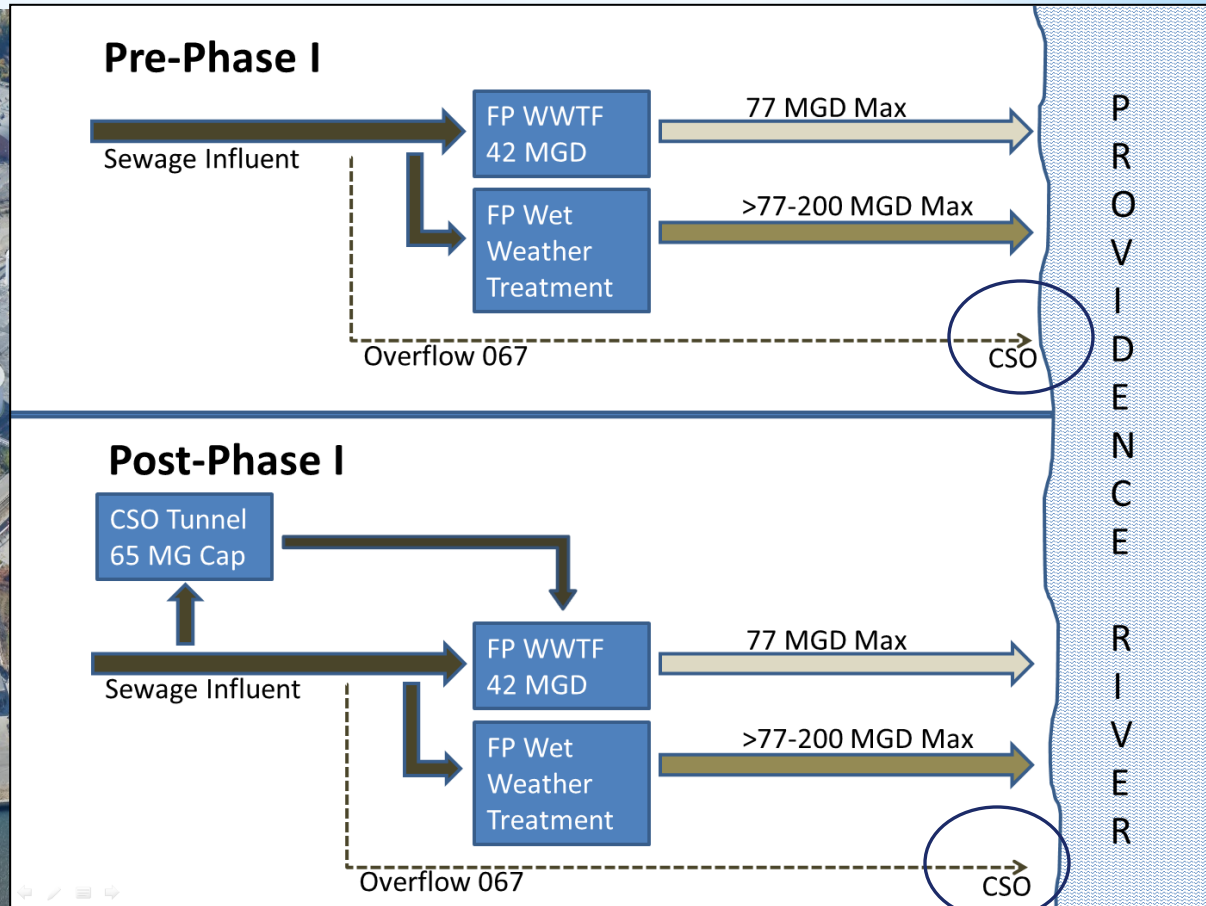
- Average # diversion structure discharges/year reduced:

Pre-Wet Weather Treatment	Post-Wet Weather Treatment
49	7



- Annual diversion structure overflow volume reduced by 95% after wet weather treatment went online

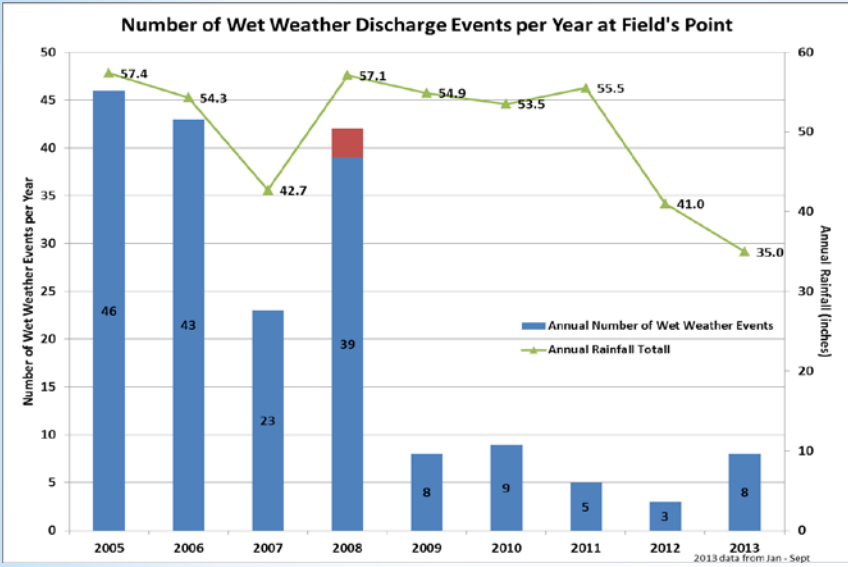
# Phase I Fields Point Treatment Facility Improvements



- Overflow 067 Volume Significantly Reduced due to Tunnel
- Overflow 067 Flows Collected in Tunnel until it fills, then can bypass

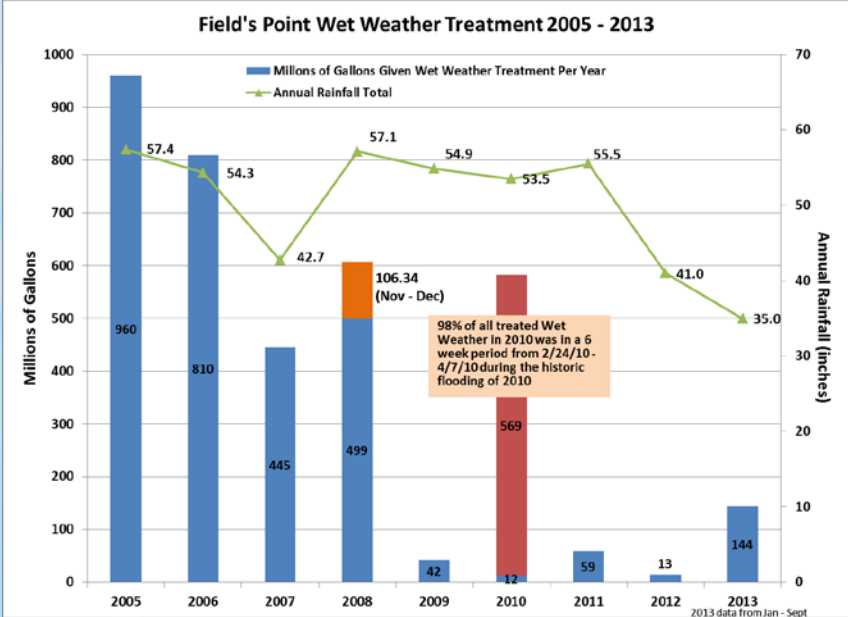


# Field's Point Wet Weather Treatment



- Average # Wet Weather events/year reduced:

Pre-Tunnel	Post-Tunnel
38	7



- FP WWTF - Reduced annual volume of wet weather discharge by 94% (84% if Mar 2010 storms included)

# Pollutants Removed Due To Tunnel

- Tunnel captured ~5.5 billion gallons of CSO flow over past 5 years
- Captured Flow is pumped to FP WWTF and receives full secondary and tertiary treatment
- ~1.1 billion gallons/year captured
  - 50% of the CSO volume captured and treated annually (based on design model)
  - 50% Bacteria Load Reduction!!!
- Millions of pounds of pollutants prevented from being discharged
  - >2 Million Pounds TSS
  - >1.3 Million Pounds BOD
  - ~134,000 Pounds Nitrogen

Contaminant	Average Concentration CSO Tunnel Effluent		Total Pounds Removed by Capture in Tunnel & Treatment at Field's Point
Total Volume Captured in Tunnel	5,537,250,000 gallons		
Total Suspended Solids	52.18	mg/L	134,889
Biochemical Oxygen Demand	32.06	mg/L	1,309,169
Total Nitrogen	8.86	mg/L	134,436
Cyanide	6.29	µg/L	224
Aluminum	248	µg/L	10,211
Cadmium	1.98	µg/L	84
Chromium	8.24	µg/L	317
Copper	13.19	µg/L	435
Iron	1,357	µg/L	47,955
Lead	9.13	µg/L	373
Nickel	16.43	µg/L	138
Silver	3.15	µg/L	135
Zinc	34.23	µg/L	1,117



# Urban River Bacteria Sampling

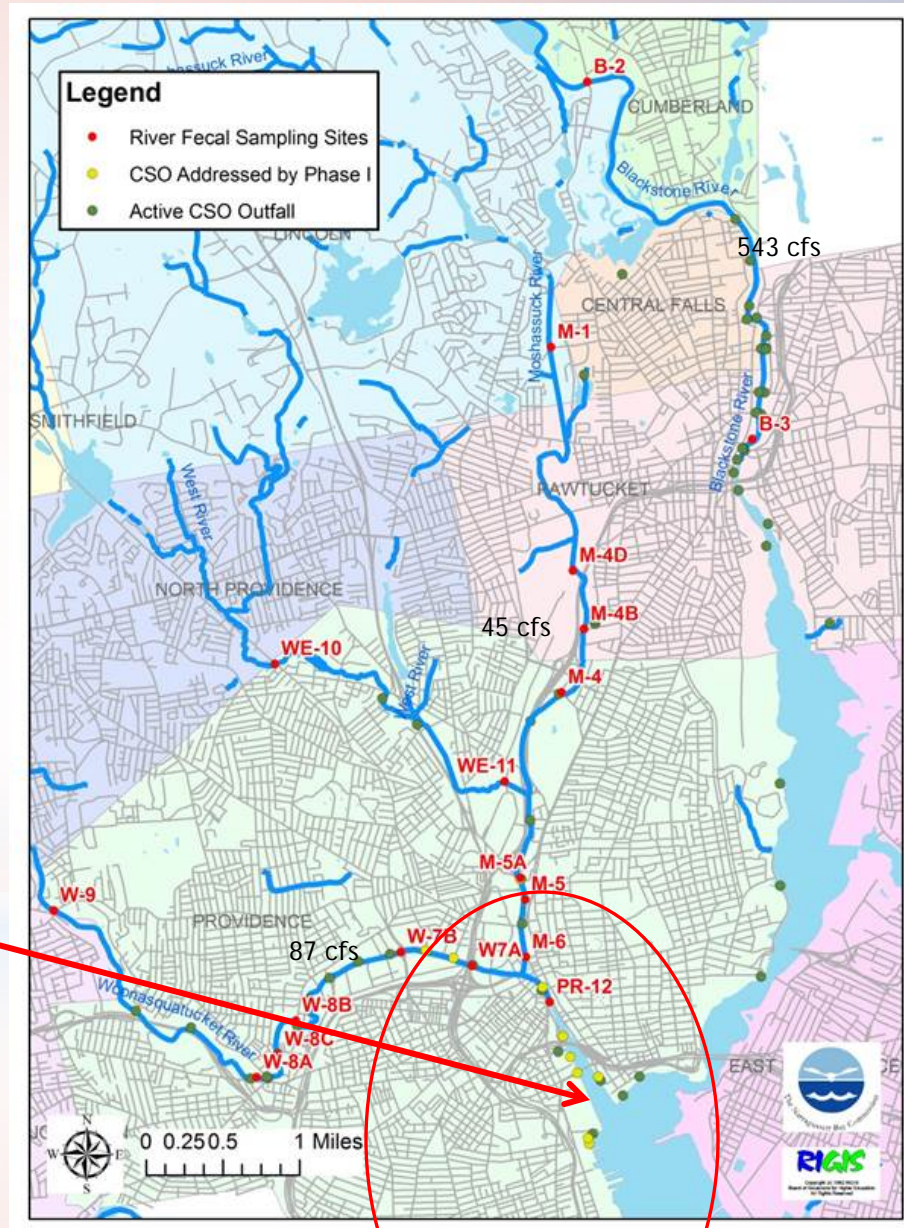


## Monitoring

- NBC monitors rivers for Bacteria
- Required by DEM RIPDES Permits (CSO 9 Minimum Controls Program)
- Monitor Up/Downstream of CSOs
- 1 station on Pawtuxet River as baseline for non CSO river

## Areas affected by Phase I Tunnel Project

- Upper Providence River - Majority of CSOs tied into the Phase I tunnel
- Moshassuck River – 1 CSO tied in
- Woonasquatucket River - 2 modifications to regulator structures

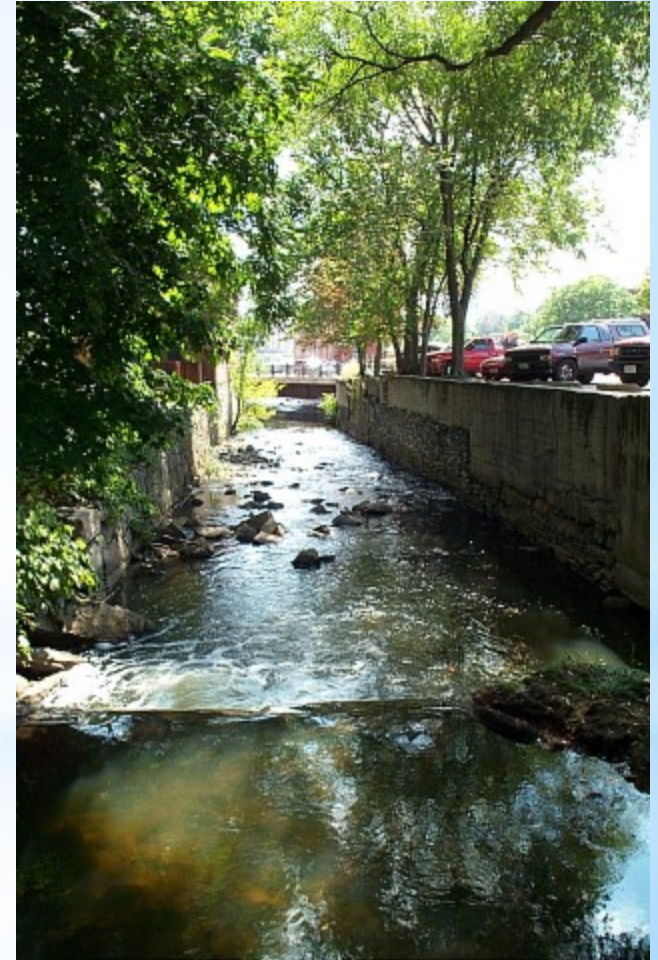


# Freshwater Bacteria Water Quality Standards (Urban Rivers)

- **Freshwater Fecal Coliform Bacteria Criteria**

Primary Contact Recreational/Swimming Criteria:

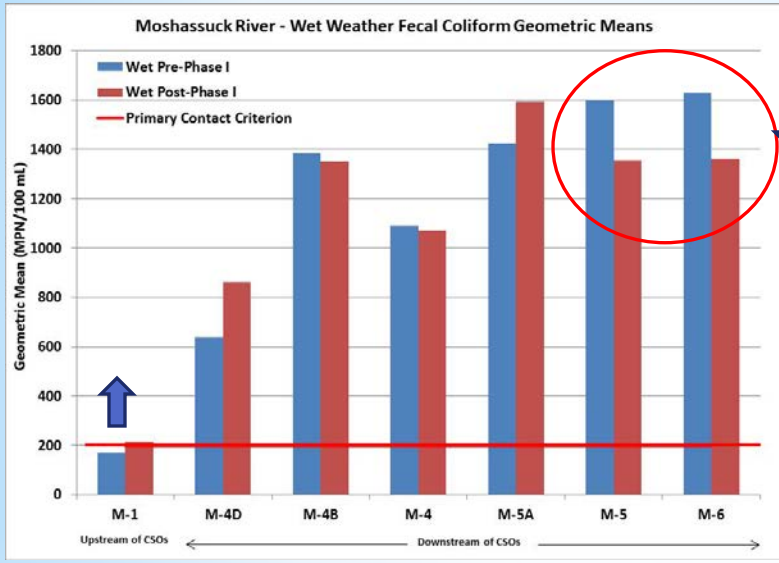
- Geometric mean value **Not More than 200 MPN/100 ml**, and
- **Not more than 10% of the total samples shall exceed 400 MPN/100 ml**
- Fecal values apply when enterococci data are not available.



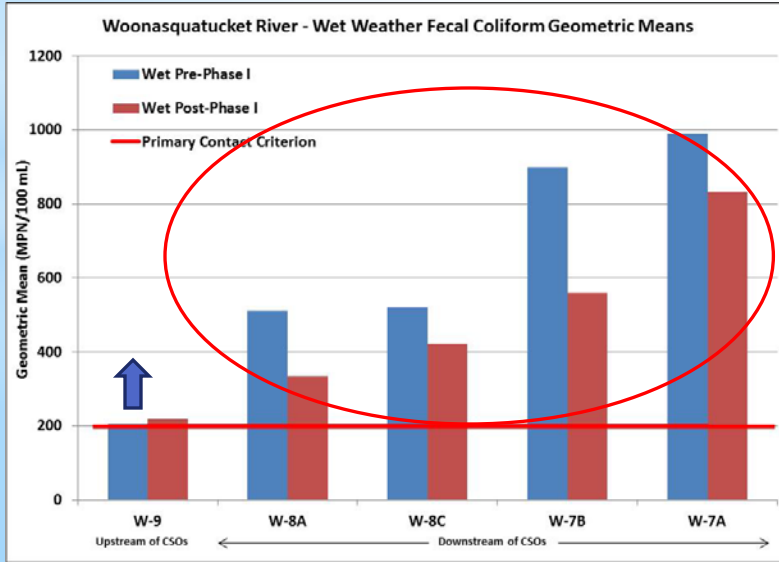


# Urban River Bacteria Data Analysis

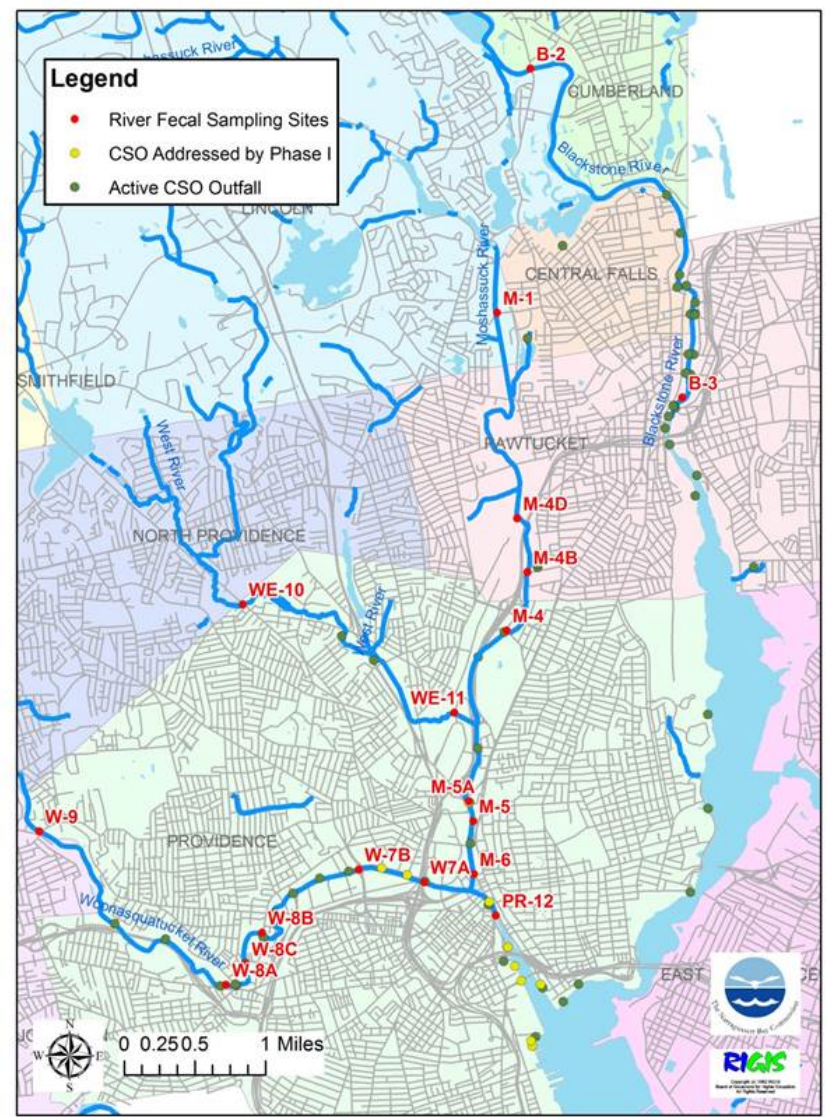
## Wet Weather Results Pre vs Post Phase I Tunnel



15-16%

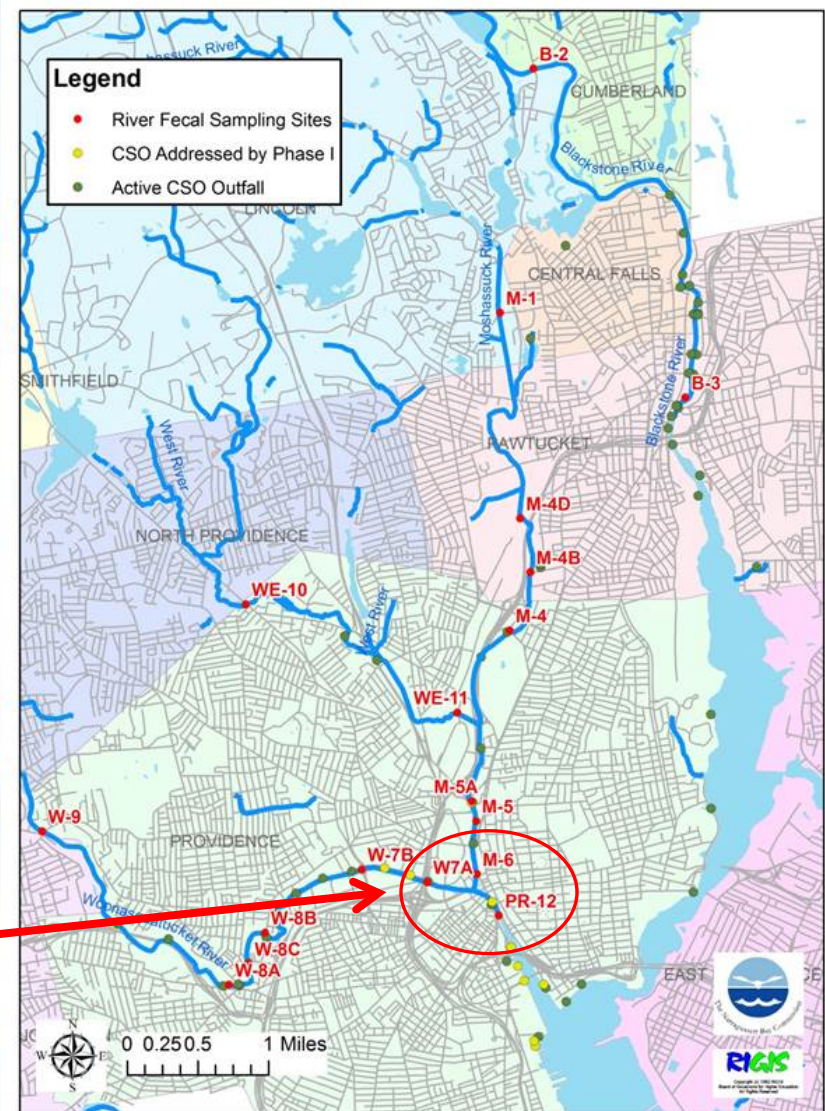
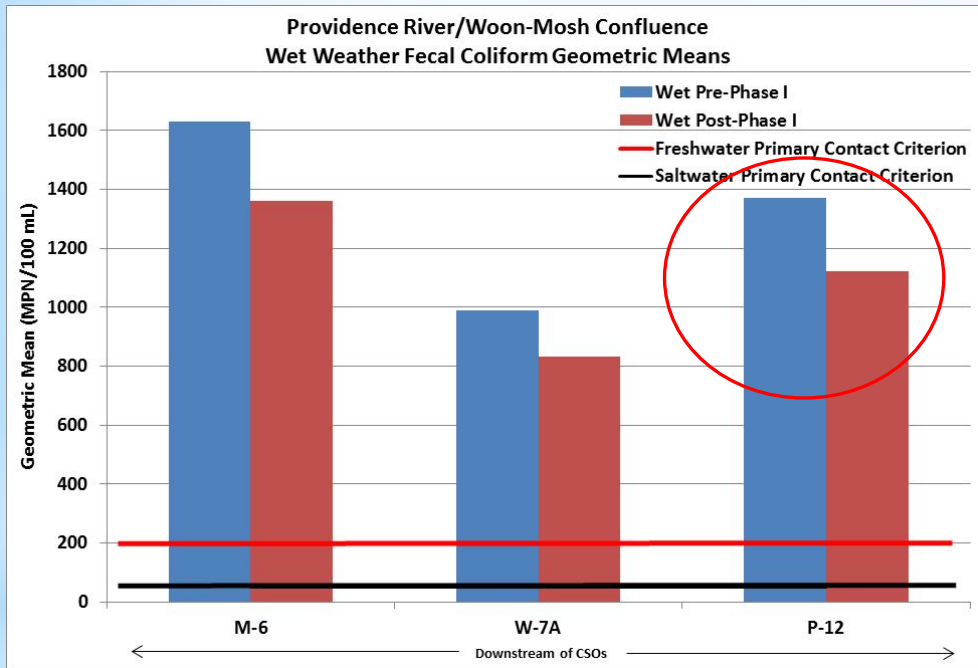


16-38%



# Urban River Bacteria Data Analysis

## Wet Weather Results Pre vs Post Phase I Tunnel

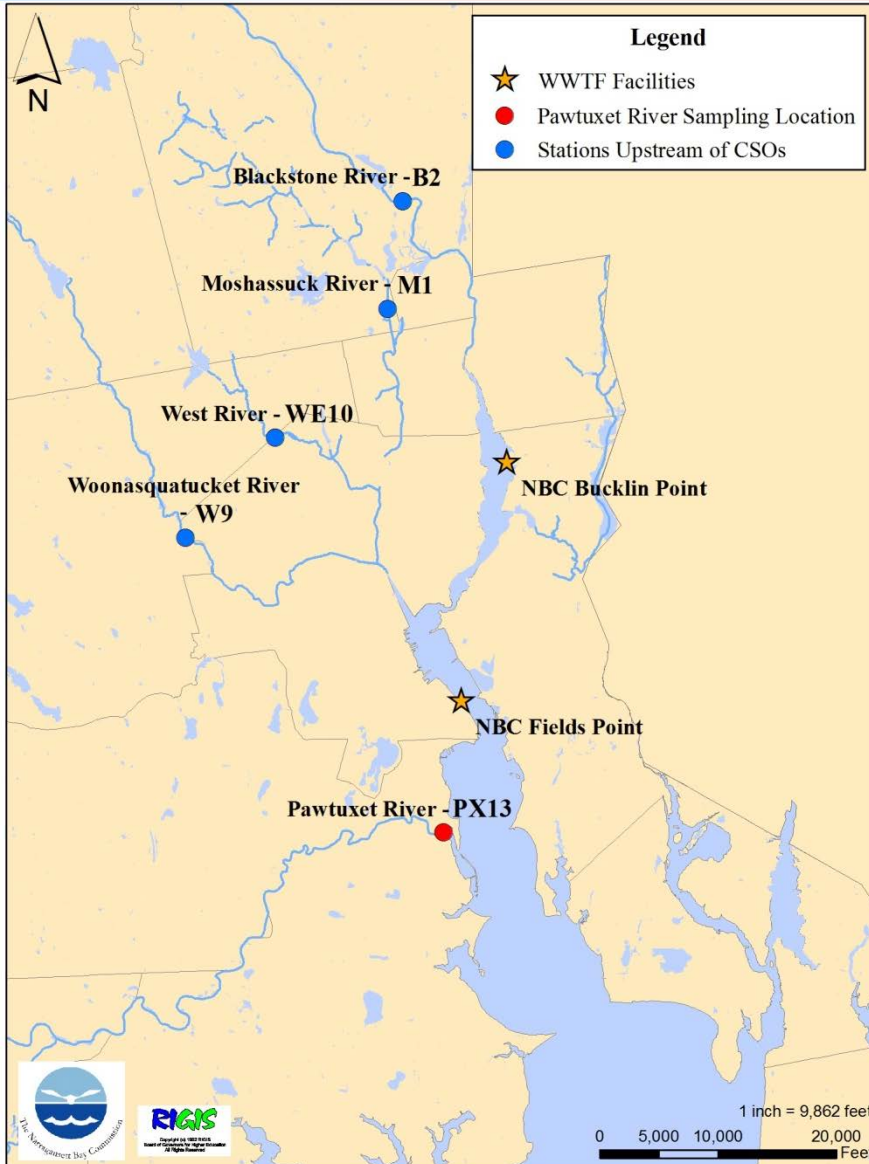


- Moshassuck River mouth ↓ 16%
- Woonasquicket River mouth ↓ 16%
- Providence River headwaters ↓ 18%



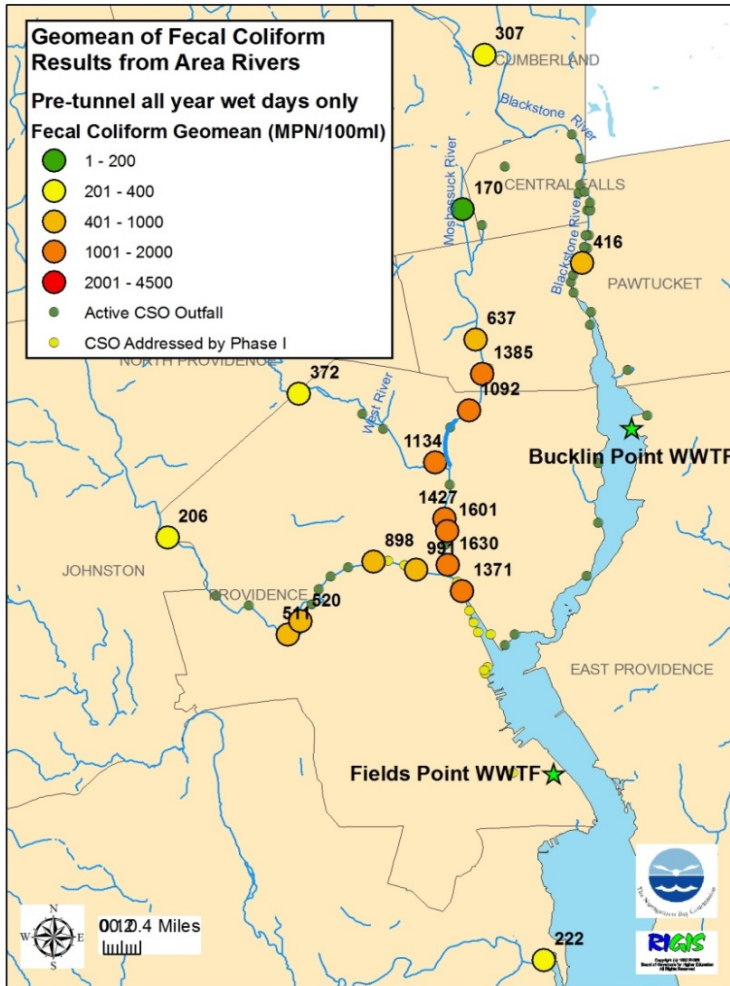


# Monitoring Stations Upstream of NBC CSOs

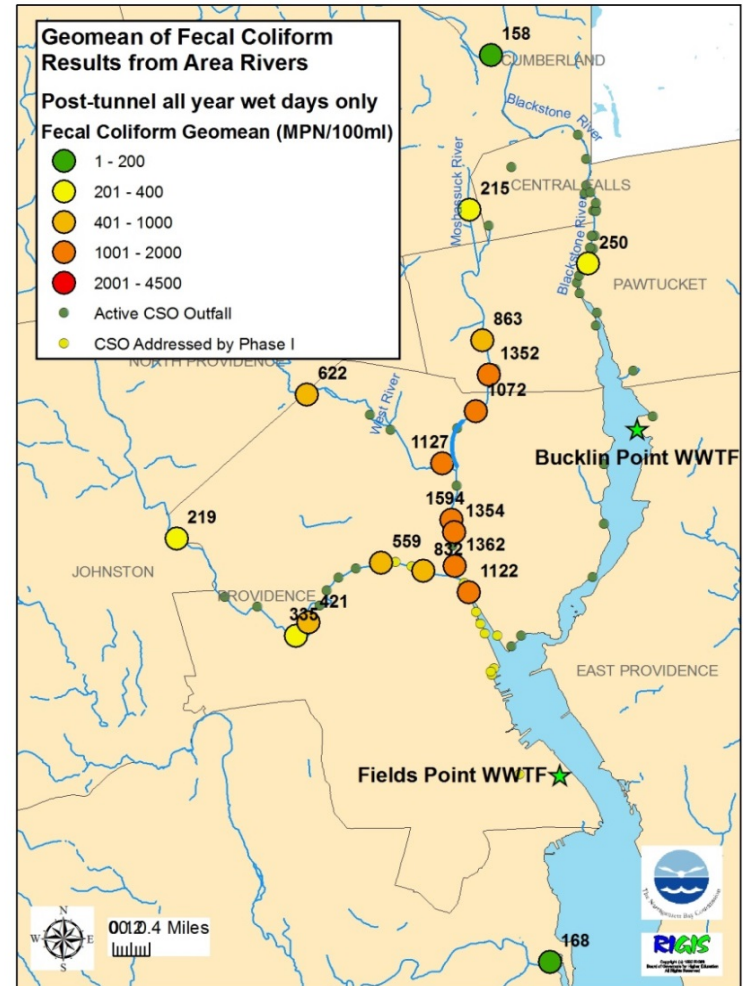


- NBC monitors stations upstream of CSOs
- Also samples Pawtuxet River (no CSOs on this river)
- NBC Data shows frequent water quality violations at all stations

# River Wet Weather Bacteria Levels



Pre-Phase I  
2004 – October 2008



Post-Phase I  
October 2008 – September 2013



# Urban River Bacteria Data Analysis

## Meeting Water Quality Standards?

- **No stations met primary contact criteria in all weather conditions (Wet and Dry)**
- Some stations met criteria using only dry weather results, but only in some years
  - Woonasquatucket River station met standards upstream of CSOs in 2008 in dry weather
  - Blackstone River station met upstream of CSOs in 2005-2010, 2013 in dry weather
  - Blackstone River station met downstream of CSOs in 2012 in dry weather
  - Pawtuxet River station met in 2008, 2009
- **Stations unaffected by CSOs are not meeting criteria...other pollution sources upstream of CSOs need to be addressed**



# River Water Quality Data for Locations Unaffected by CSOs

<b>Percent of Years Fecal Coliform Geomeans Met WQ Criteria</b>			
<b>River *</b>	<b>All Weather</b>	<b>Wet Weather</b>	<b>Dry Weather</b>
Moshassuck River	0%	0%	0%
West River	0%	0%	0%
Woonasquatucket River	0%	0%	10%
Blackstone River	0%	0%	70%
Pawtuxet River	0%	0%	22%

\*Data reviewed for May to October Season for 2004 - 2013. The Pawtuxet River station is located on a river without any NBC CSOs and is included for reference.



# Stormwater Impairments

Stormwater Dishcharge Data 2013

Constituent	Units	India Point - East	India Point - West	India Point - Average
Fecal Coliform	MPN/100 mL	24,000	819,756*	252,654
Enterococcus	MPN/100 mL	>2,420	>2,420	2,420
Total Suspended Solids	mg/L	130.00	118.00	124.00
Total Nitrogen	mg/L	4.65	2.74	3.70
Total Kjeldahl Nitrogen	mg/L	3.37	1.60	2.49
Nitrite + Nitrate	mg/L	1.28	1.14	1.21
Ammonia	mg/L	1.92	0.85	1.39
Dissolved Aluminum	µg/L	57.54	69.03	63.29
Dissolved Silver	µg/L	<0.02	<0.02	<0.02
Dissolved Cadmium	µg/L	0.09	0.10	0.10
Dissolved Chromium	µg/L	1.64	4.38	3.01
Dissolved Copper	µg/L	51.68	59.65	55.67
Dissolved Iron	µg/L	169.30	196.60	182.95
Dissolved Nickel	µg/L	1.75	2.42	2.08
Dissolved Lead	µg/L	36.15	27.16	31.66
Dissolved Zinc	µg/L	93.05	140.80	116.93
Total Metals Silver	µg/L	0.07	0.19	0.13
Total Metals Cadmium	µg/L	0.24	0.30	0.27
Total Metals Chromium	µg/L	2.57	9.19	5.88
Total Metals Copper	µg/L	91.95	152.78	122.36
Total Metals Iron	µg/L	1,898	1,757	1,828
Total Metals Nickel	µg/L	<10	<10	<10
Total Metals Lead	µg/L	121.86	194.38	158.12
Total Metals Zinc	µg/L	290.50	220.86	255.68
Total Metals Arsenic	µg/L	1.59	1.49	1.54
Total Metals Selenium	µg/L	1.06	0.56	0.81
Total Metals Aluminum	µg/L	1,446	921	1,184
Total Metals Molybdenum	µg/L	1.35	2.52	1.93



- Stormwater lines at India Point Park sampled on August 22, during a storm of 0.49 inches of rainfall
- Stormwater lines have treatment systems (Vortech systems)
- Variation in some parameters between the outfalls
- Fecal coliform:
  - Range from 24,000 to >24,000,000 MPN/100 mL
  - Exceeded primary contact criteria
- All Enterococci samples were >2,420 MPN/100 mL

\* Geomean of replicate samples: >24,000,000 & 28,000 MPN/100 mL

# Saltwater Bacteria Water Quality Standards

## ● Saltwater Fecal Coliform Bacteria Criteria

### Shellfishing Criteria:

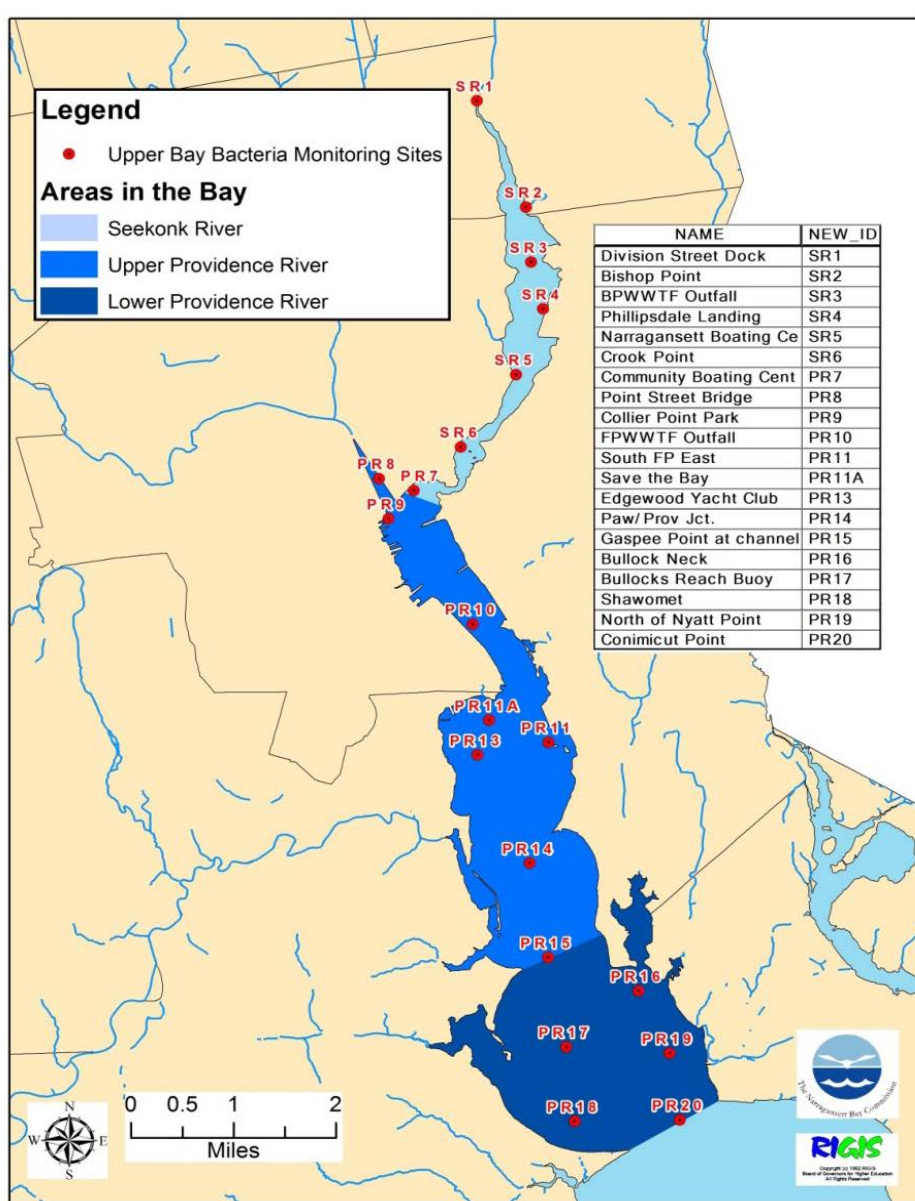
- Geometric mean **Not to exceed 14 MPN/100 ml**, and
- **No more than 10% of the samples shall exceed 49 MPN/100 ml**

### Primary Contact Recreational/Swimming Criteria:

- Geometric mean **Not to exceed 50 MPN/100 ml**, and
- **No more than 10% of the total samples taken shall exceed 400 MPN/100 ml**,
- Fecal values apply when enterococci data are not available.



# Upper Bay Bacteria Monitoring



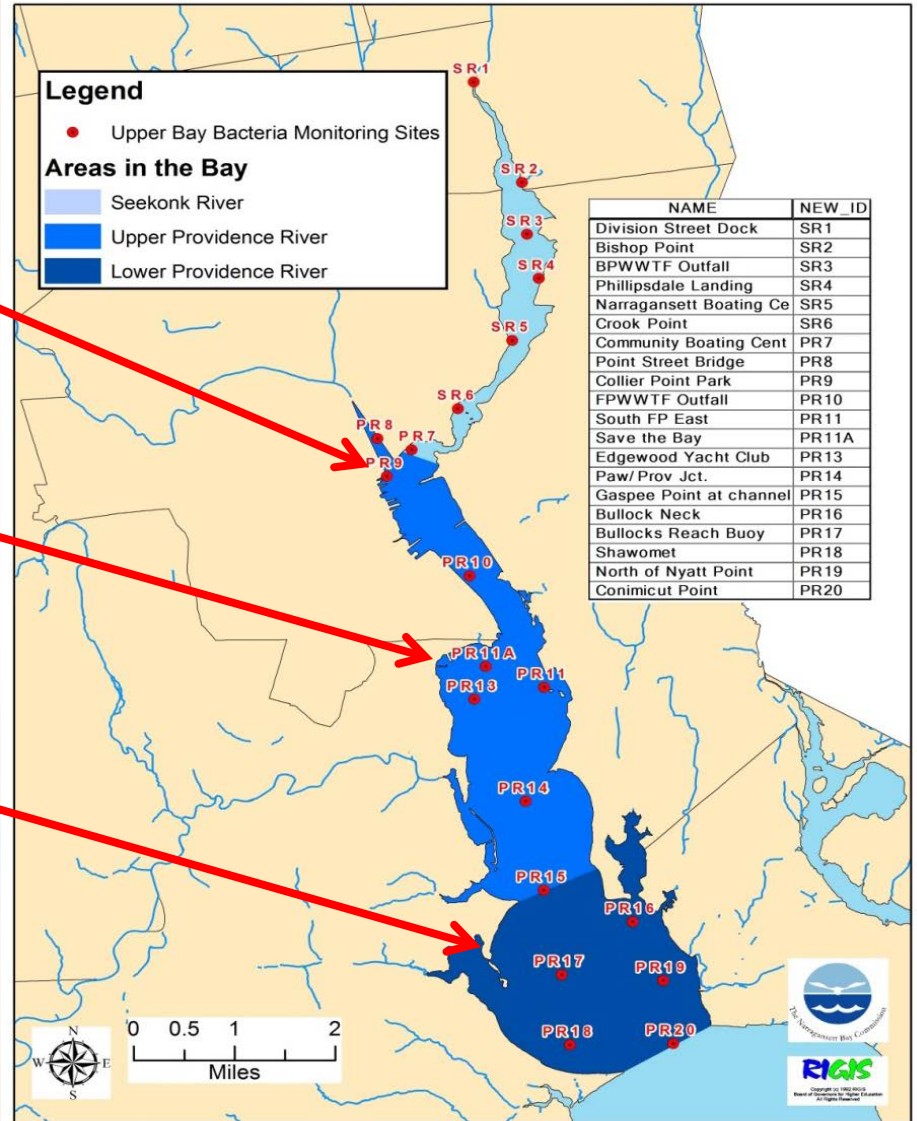
- 20 NBC Bay monitoring stations in Seekonk and Providence “Rivers”
- Biweekly throughout year for fecal coliform bacteria
- Data from 2004 - Present
- Majority of CSOs tied into the Phase I tunnel were in the upper Providence River

# Upper Bay Bacteria Data Analysis

## Meeting Water Quality Standards?

### Providence River

- Upper Providence River did not meet WQ Standards
- FP WWTF outfall to Gaspee Point met more frequently after Phase I
- Lower Providence River met both criteria most years, improved post Phase I
  - 65% of years met pre Phase I
  - 84% of years met post Phase I

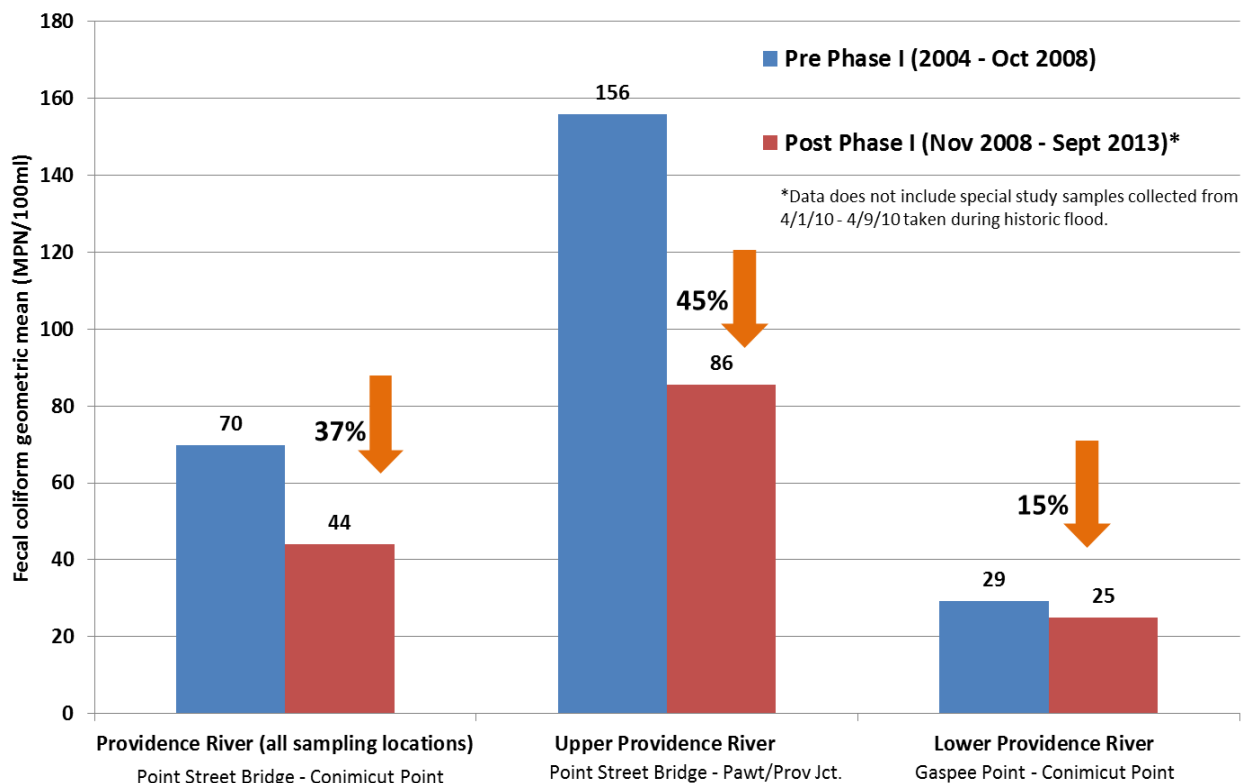




# Upper Bay Bacteria Data Analysis

## Providence River

Providence River Fecal coliform Geometric Mean  
Pre and Post Phase I Project Completion

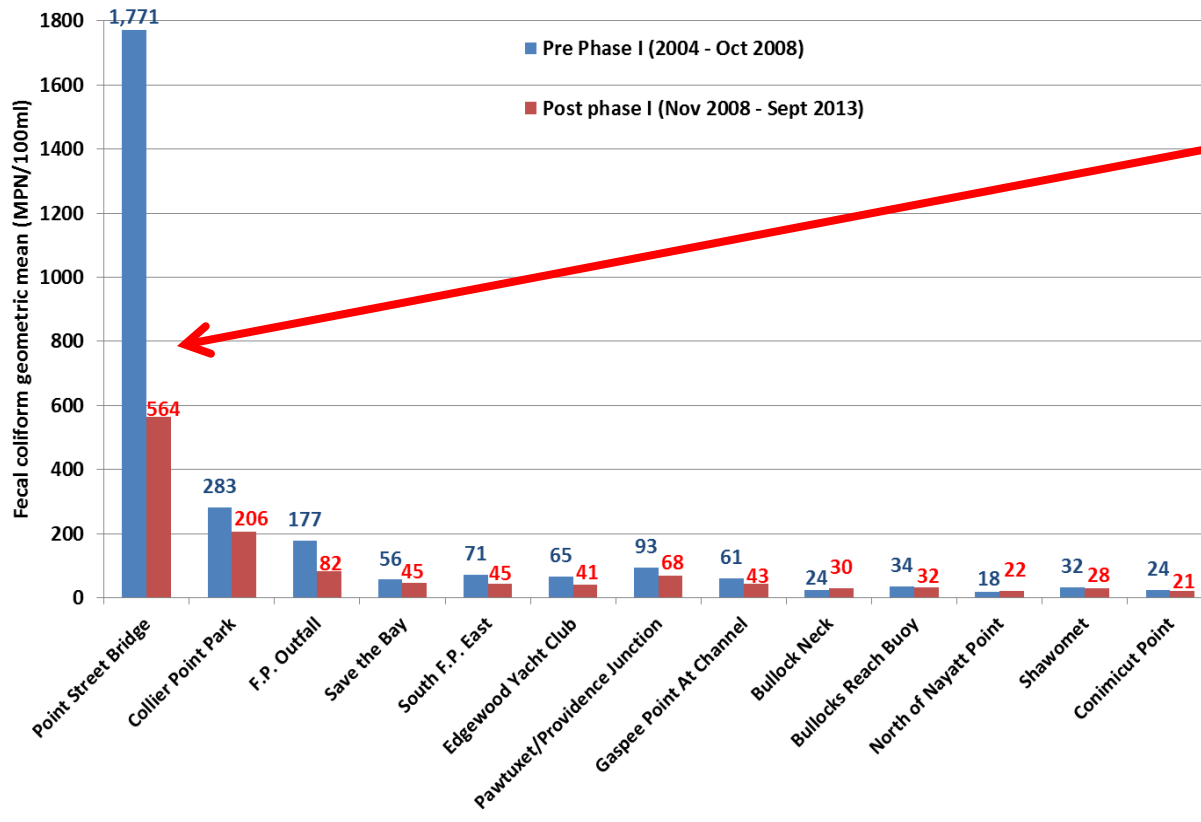


- Overall 37% decrease in bacteria levels in all weather
- 41% Overall decrease in Wet Weather
- 45% decrease in Upper Providence River
- 15% decrease in Lower Providence River

# Upper Bay Bacteria Data Analysis

## Providence River

Fecal coliform Geometric Mean Pre and Post Phase I  
by Sampling Location



Point Street Bridge  
closest to CSOs tied  
into Tunnel

Biggest impact on  
bacteria levels!

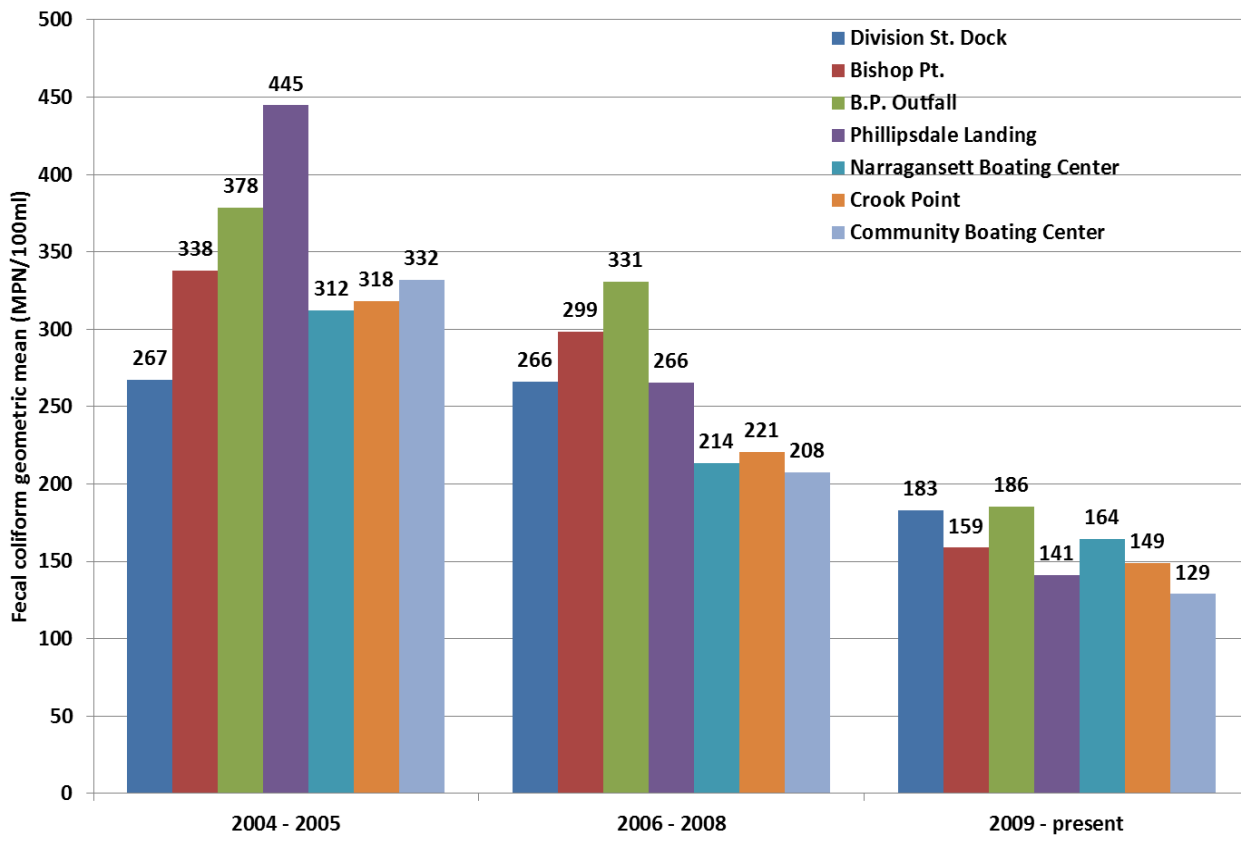
(68% decrease)



# Upper Bay Bacteria Data Analysis

## Seekonk River

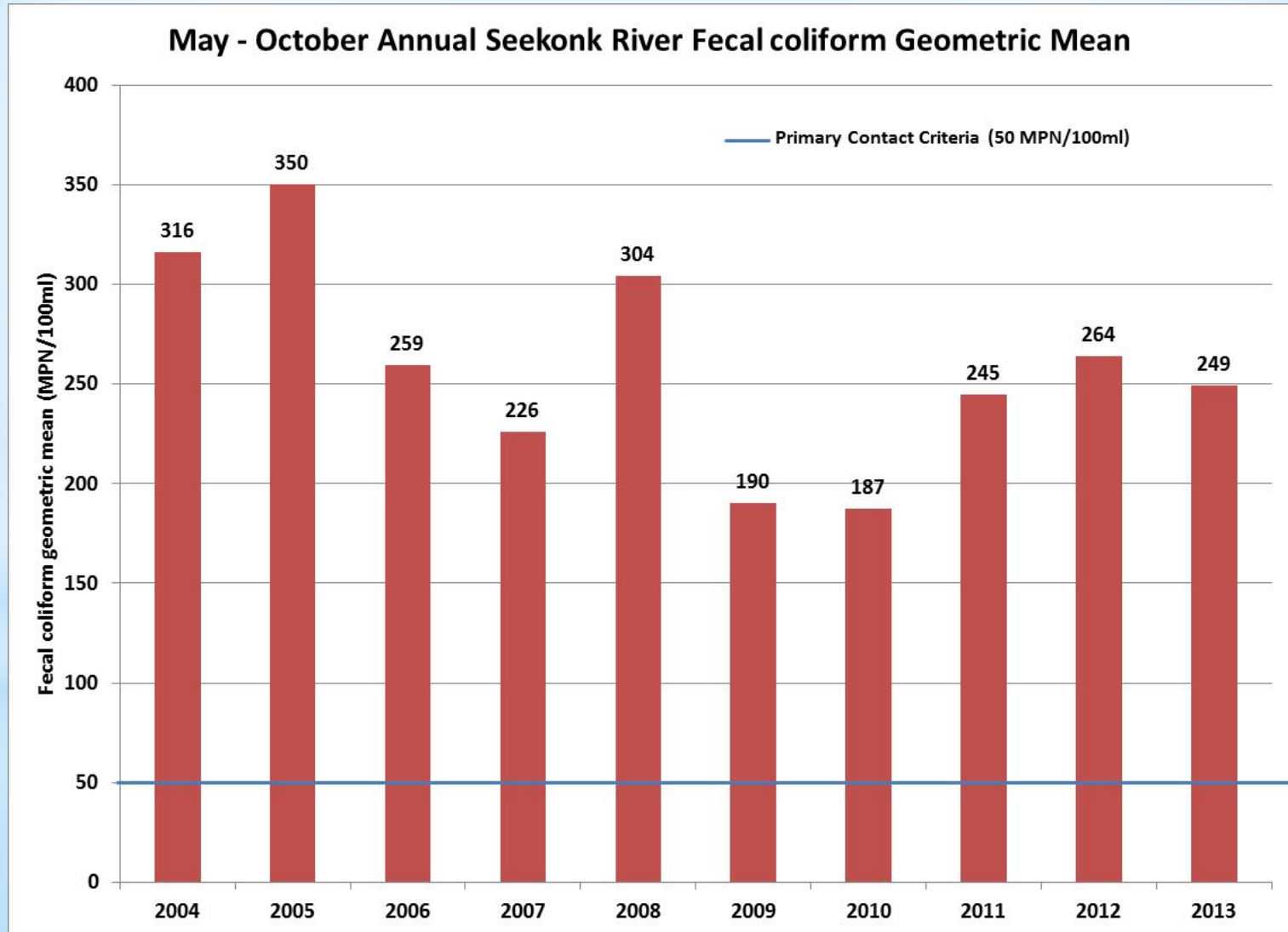
Seekonk River Fecal coliform Geometric Mean  
Pre and Post Phase I Upgrades



- NBC Samples 6 Locations on the Seekonk River
- All Locations decreased in 2006 -2008 due to BP wet weather treatment (23%)
- Decreased again in 2009 due to Phase I Tunnel (39%)
- Seekonk tidally influenced by Providence River bacteria levels
- Overall, decrease **47%** 2004-05 to 2009-2013 in wet weather, **46%** for all weather data

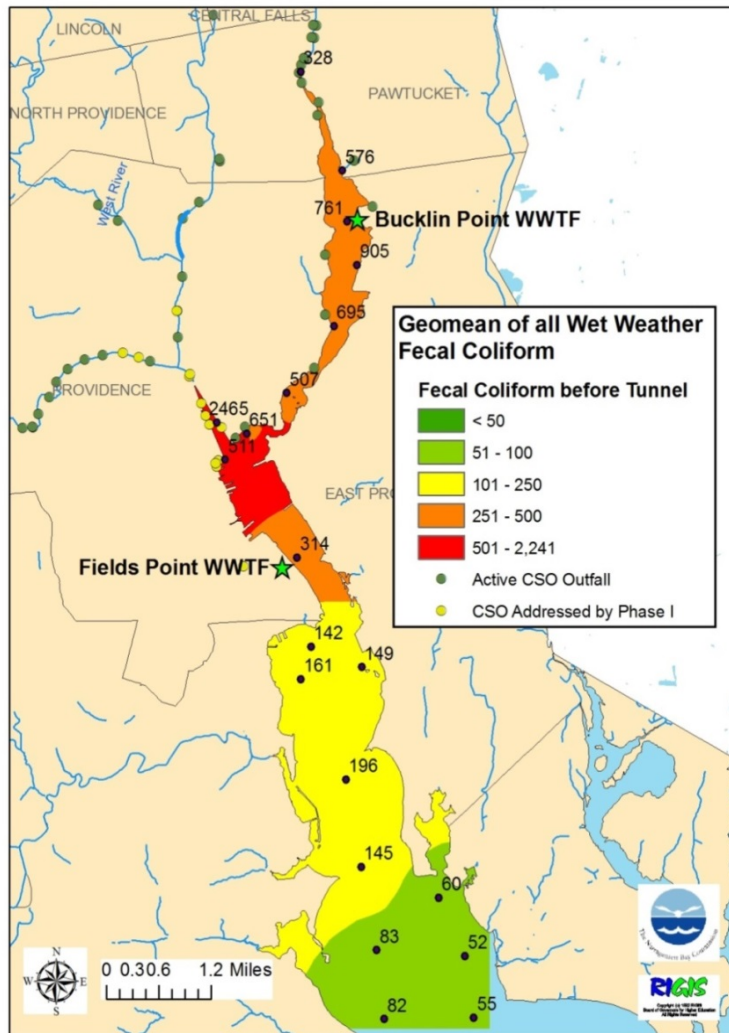
# Upper Bay Bacteria Data Analysis

## Meeting Water Quality Standards? – Seekonk River

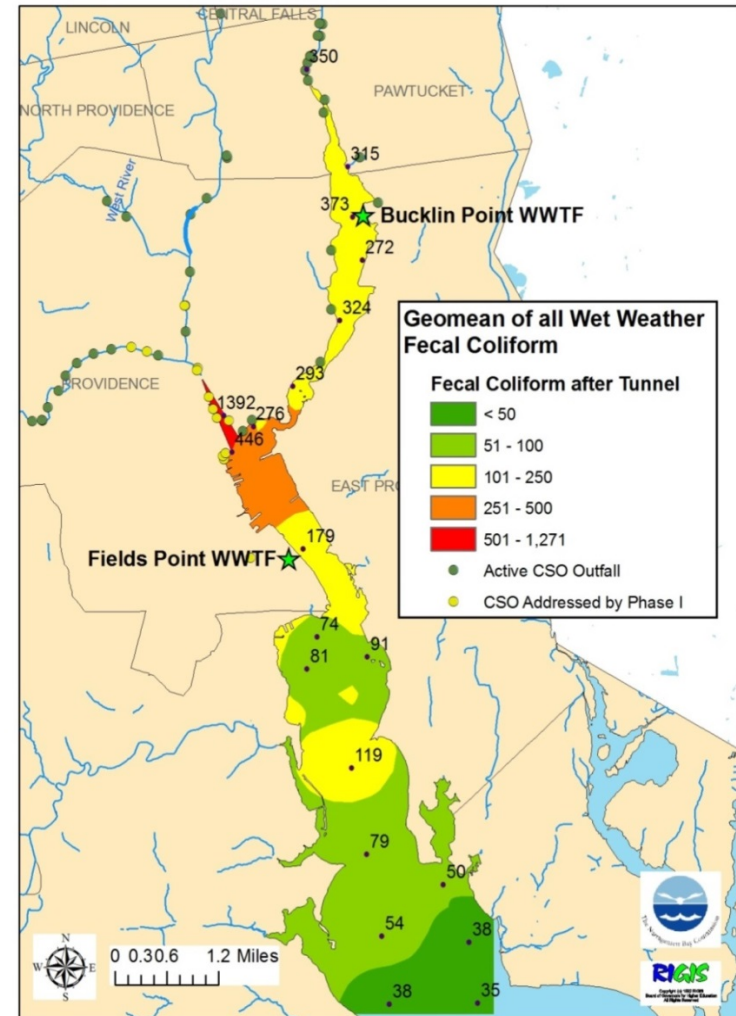




# Upper Bay Wet Weather Bacteria Levels



Pre-Phase I  
2004 - October 2008



Post-Phase I  
October 2008 - September 2013

# Shellfishing Analysis

## Has Phase I Improved Upper Bay Shellfisheries?

- **Shellfishing Standard**

- Geometric mean Not to exceed 14 MPN/100 ml, and
- No more than 10% of the samples shall exceed 49 MPN/100 ml

- **Before Phase I:**

- Cond. Area A closed for week with 0.5 inches of rainfall within a 24 hour period
- Cond. Area B closed with 1.0 inch of rain

- **Regulations Relaxed in 2011:**

- Cond. Area A closed with 0.8 inches of rain
- Cond. Area B with 1.5 inches of rain

- Area A expected to be open 65 more days/yr and Area B is projected to be open 45 more days/yr

- RIDEM attributes closure changes to success of Phase I CSO Project





# DOH Upper Bay Beach Closure Analysis



## RIDOH Report

- Evaluated WQ at Bristol, Barrington & Conimicut Beaches for 2006 vs 2010 (similar rain)
- Found closure events decreased by 44%,
- Found closure days decreased by 82%
- Attributed to Phase I Tunnel Project

## “Urban Beach Initiative” Report

- RIDOH sampled 3 beaches in the Providence River - Sabin Point, Rosa Larisa Park & Gaspee Point
- Evaluated for potential use as licensed beaches
- ~85% compliance rate with pathogen standards
- compliance, varied with rainfall
- Compliance rates similar to what was found in beaches in areas not impacted by CSO's

**Phase I has Improved water quality of Upper Bay Beaches**

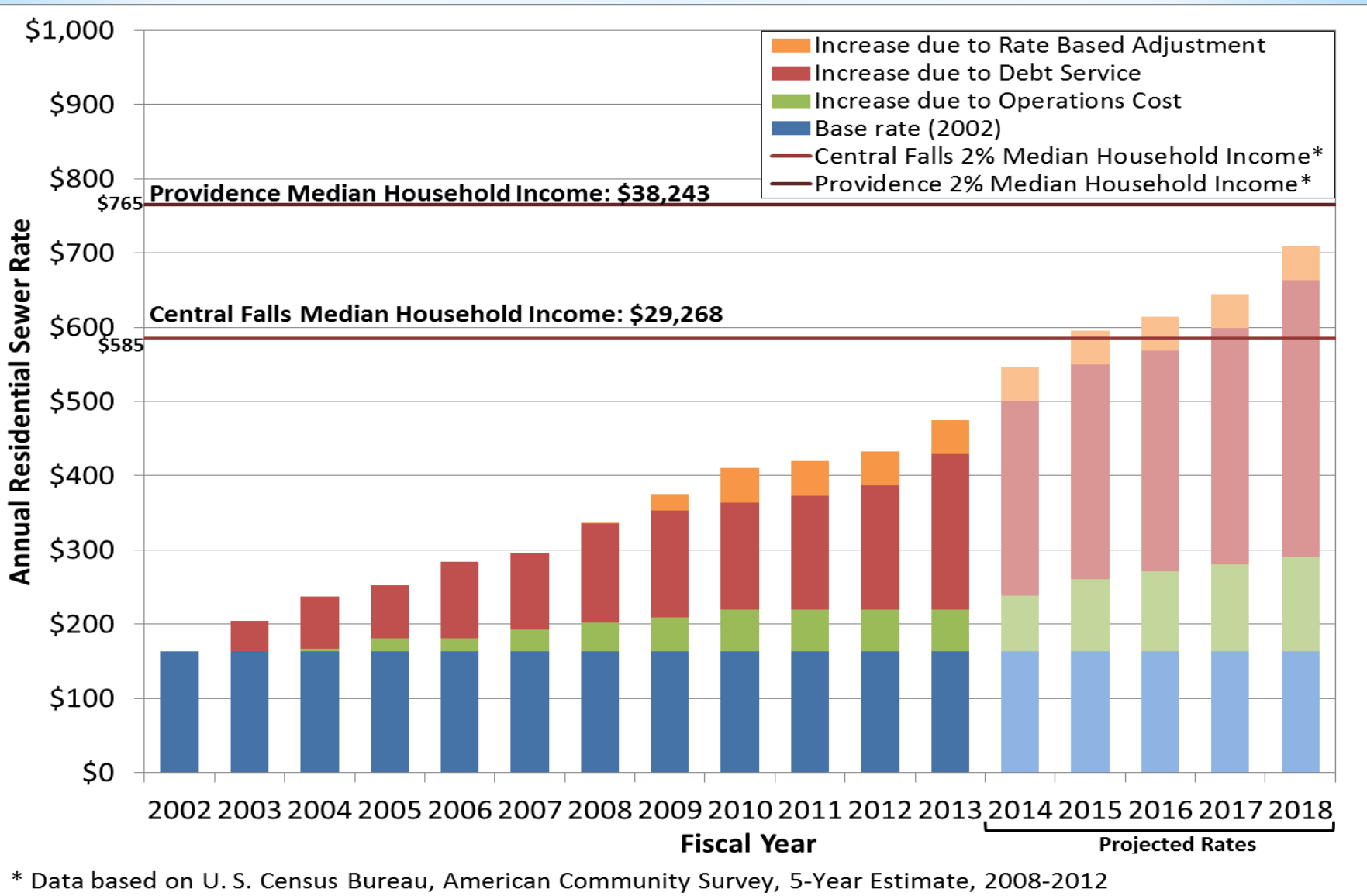
# CSO Abatement Tunnel: Phase I

## Were the Goals Achieved?

Expected benefits:	Were the Goals Met???
Reduce annual CSO volume by 39%	YES, ~50% Reduction Achieved
Reduce fecal coliform bacteria load by 40%	YES, ~50% Reduction Achieved
Reduce TSS by 30%	YES, ~45% Reduction Calculated
Reduce BOD by 31%	YES, ~44% Reduction Calculated
Reduce the acre-days of shellfish closure in northern half of Upper Narragansett Bay by 47% and 77% in southern half.	No! DEM did not change the Shellfishing regulations until May 2011 and the closure acres has not changed, but the Rainfall Closure Criteria has been relaxed, providing more fishing days.



# NBC User Fees



# Conclusions

## Phase I CSO Tunnel Project has:

- Captured ~1.1 Billion Gallons/Year of CSO Flow
- Reduced CSO Volume and Bacteria Loads by ~50%
- Reduced bacterial contamination levels in our Urban Rivers and Upper Bay
- Prevented millions of pounds of pollutants from discharging to our rivers and Narragansett Bay
- DOH Reports: Upper Bay Beaches meet bacteria standards 85% of summer season & 3 new Upper Bay beaches could open
- DEM Relaxed Shellfishing Closure standards due to Phase I success
- But, monitoring stations unaffected by CSOs are not meeting standards
- NBC CSO Abatement Program **WILL NOT** make waters fishable & swimmable unless other pollution problems are addressed





# Thank you!

*Thank you to:*

- ▶ *Cathy Oliver, Christine Comeau, Pamela Reitsma, Jim Kelly & John Motta*
- ▶ *NBC Monitoring Staff*
- ▶ *NBC Laboratory Staff*



## Any Questions?

Data is available on NBC Website at  
<http://snapshot.narrabay.com>