Narragansett Bay Commission Construction & Upper Narragansett Bay Water Quality Update

Thomas Uva
Director of Planning, Policy & Regulation
Narragansett Bay Commission

Upper Bay Issues & Impairments

- Bacterial Contamination
- Dissolved Oxygen Impairments – Hypoxic and Anoxic conditions
- Excessive nutrient loads
- Contaminated Sediments
- Loss of Wetlands, Habitat & Eel Grass
- NBC Construction Projects address Nitrogen Enrichment and Bacteria Impairments

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.

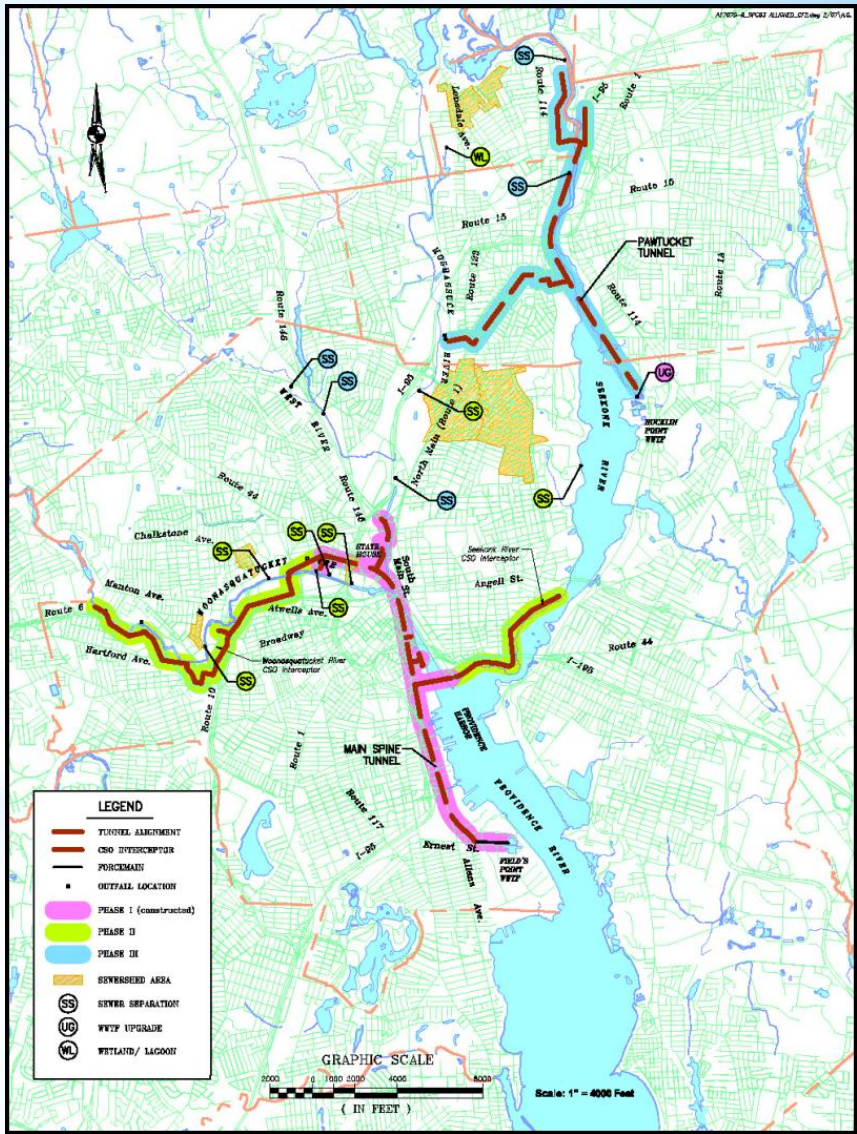
CSO Abatement Project: 3 Phases - ~$1.2 Billion

Three Phases over 20 years

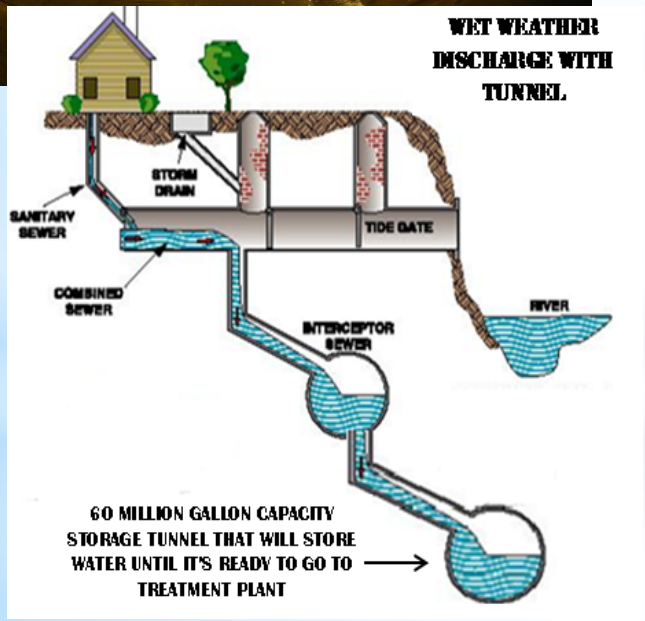
- Design storm: 3-month -1.6 inches of rain in 6 hours

PHASE I (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
- **Actual Cost: ~$359 million**



CSO Abatement Tunnel: Phase I



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

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.

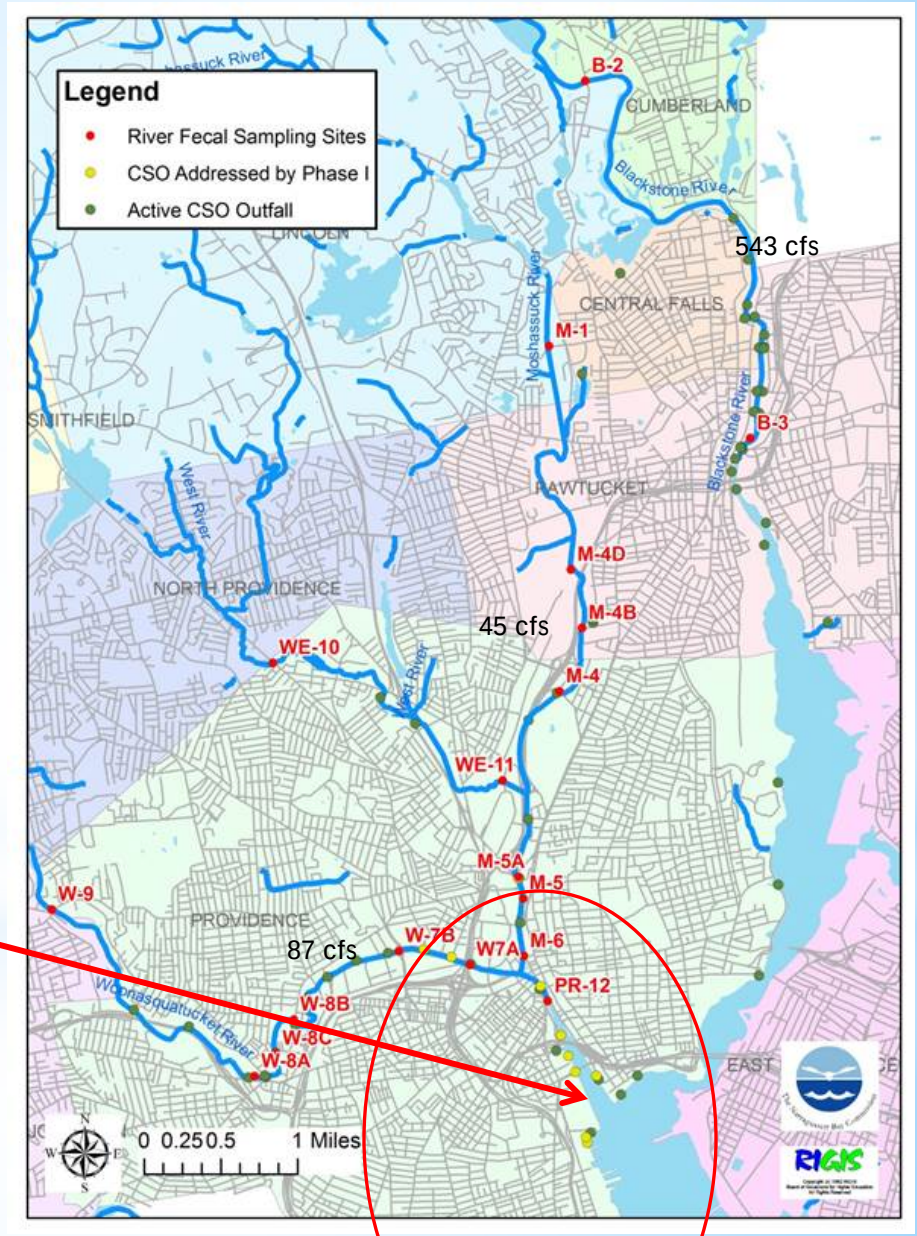
Urban River Bacteria Sampling

Monitoring

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

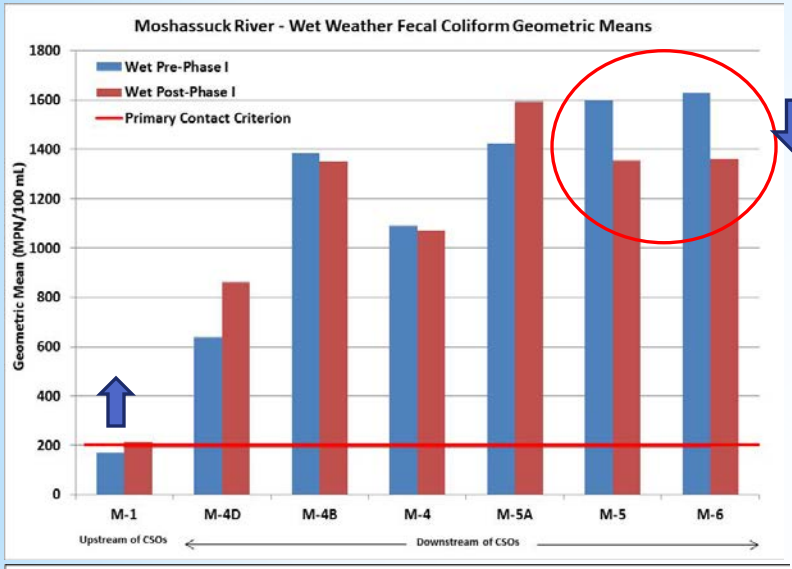
Areas affected by Phase I Tunnel Project

- 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

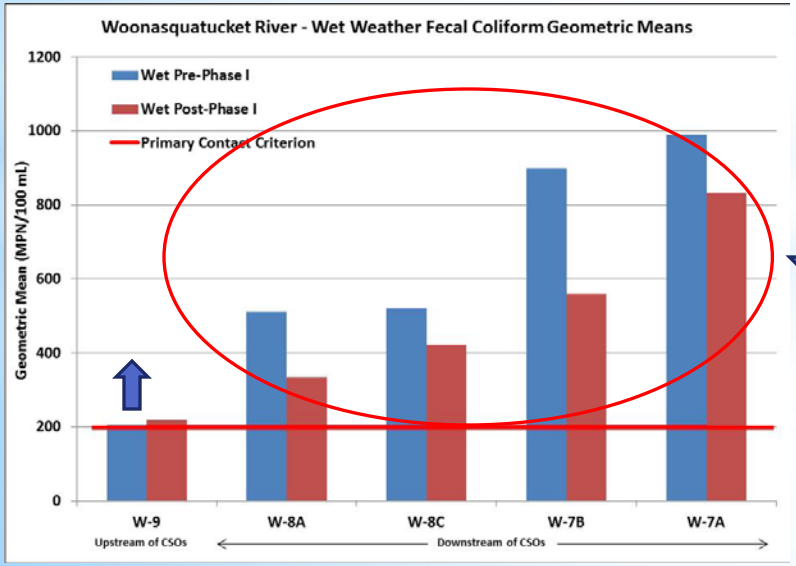


Urban River Bacteria Data Analysis

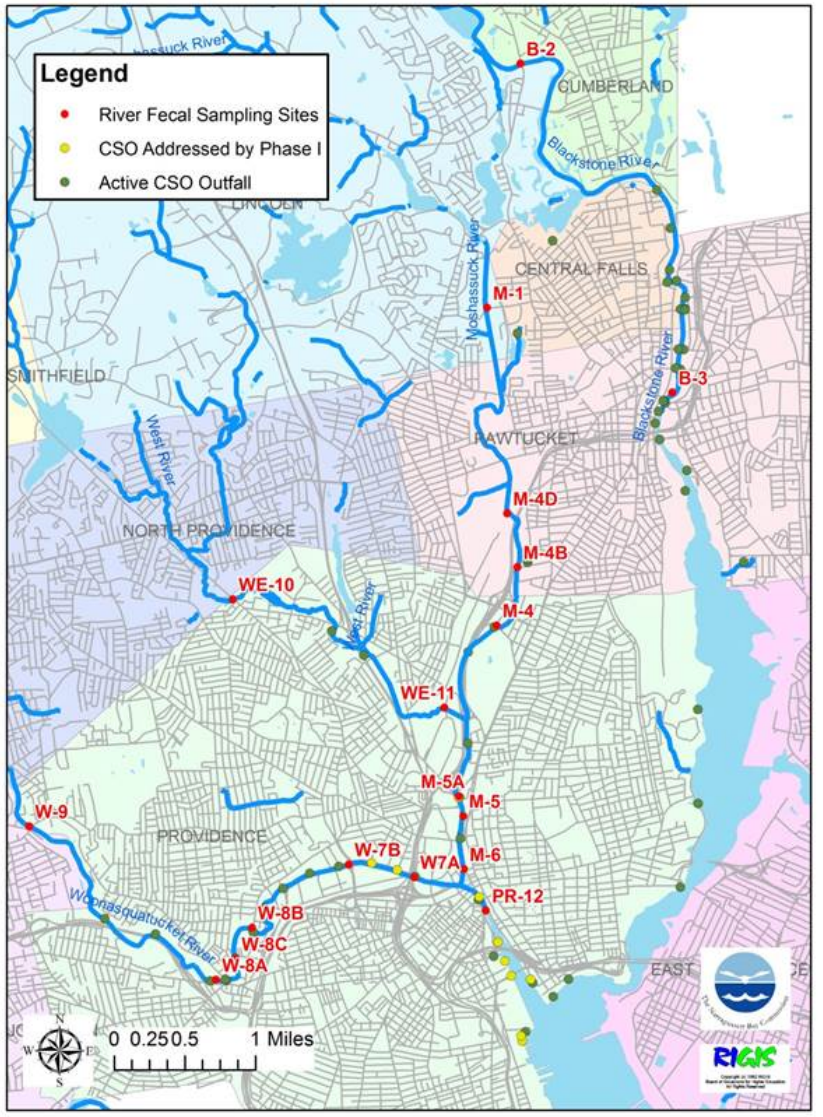
Wet Weather Results Pre vs Post Phase I Tunnel



15-16%

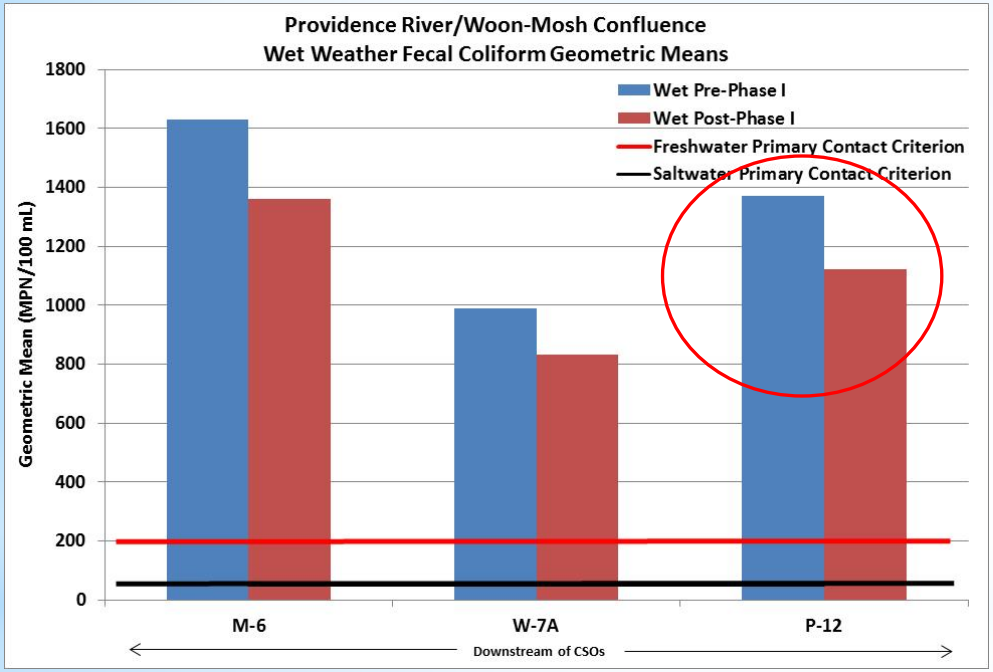


16-38%

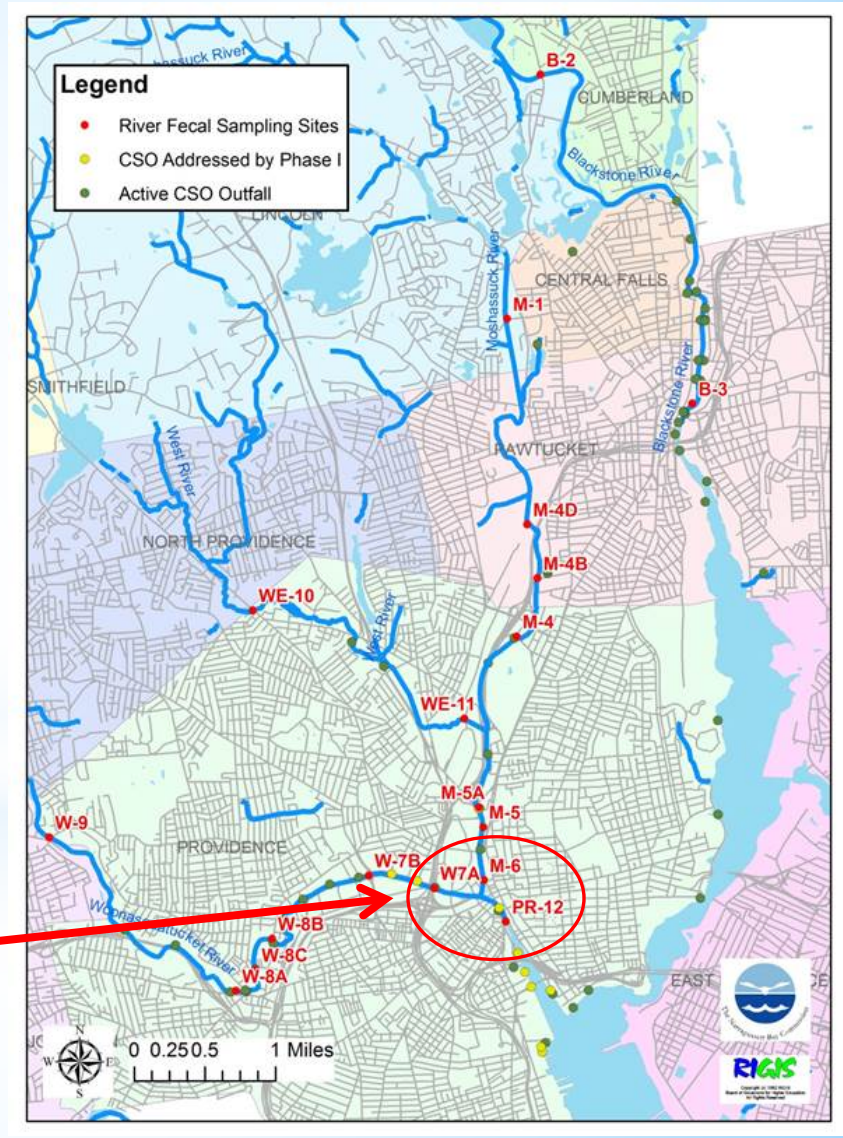


Urban River Bacteria Data Analysis

Wet Weather Results Pre vs Post Phase I Tunnel



- Moshassuck River mouth ⇩ 16%
- Woonasquatucket River mouth ⇩ 16%
- Providence River headwaters ⇩ 18%

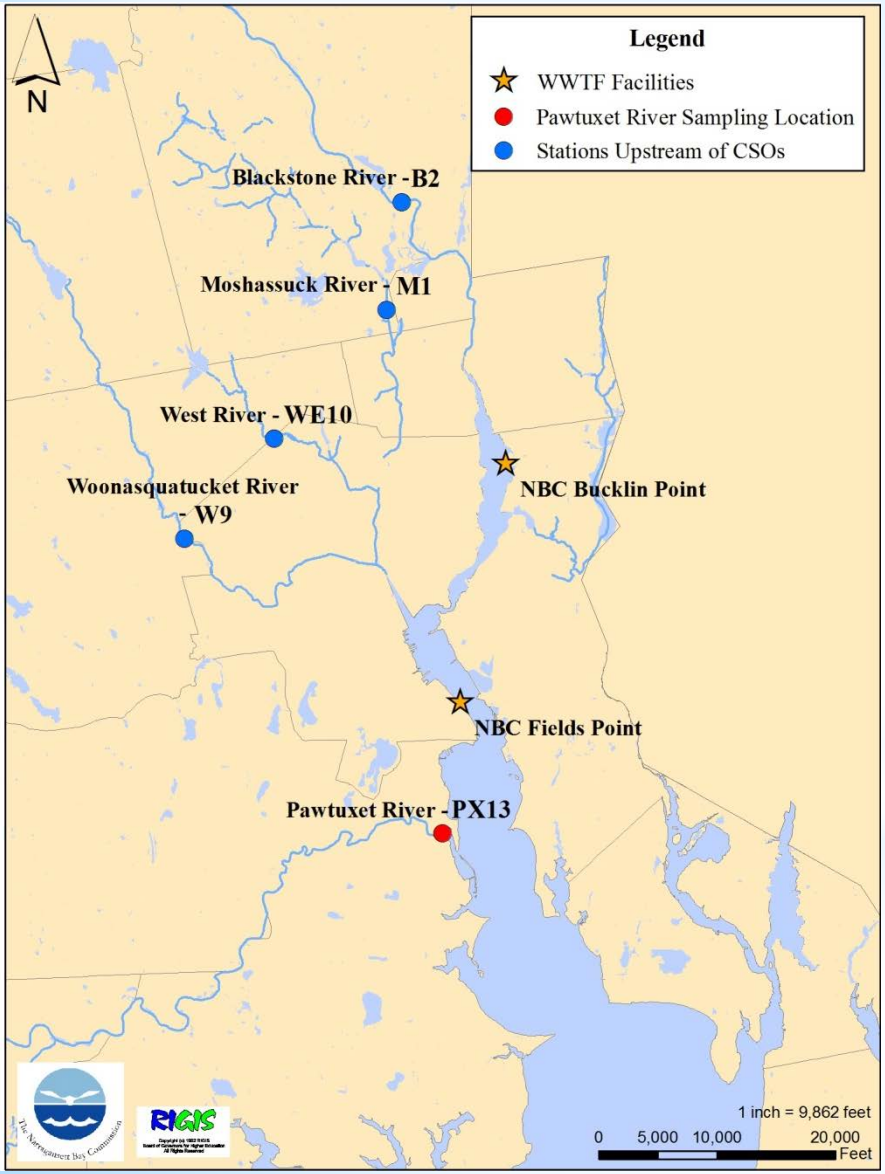


Urban River Bacteria Data Analysis

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

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 Water Quality Data for Locations Unaffected by CSOs

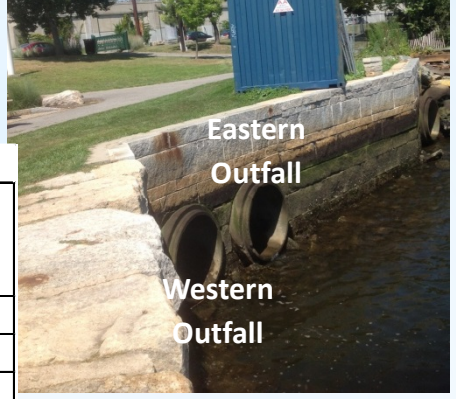
Percent of Years Fecal Coliform Geomeans Met WQ Criteria			
River *	**All Weather**	**Wet Weather**	**Dry Weather**
Moshassuck River	0%	0%	0%
West River	0%	0%	0%
Woonasquatucket River	0%	0%	10%
Blackstone River	0%	0%	70%
Pawtuxet River	0%	0%	22%

*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

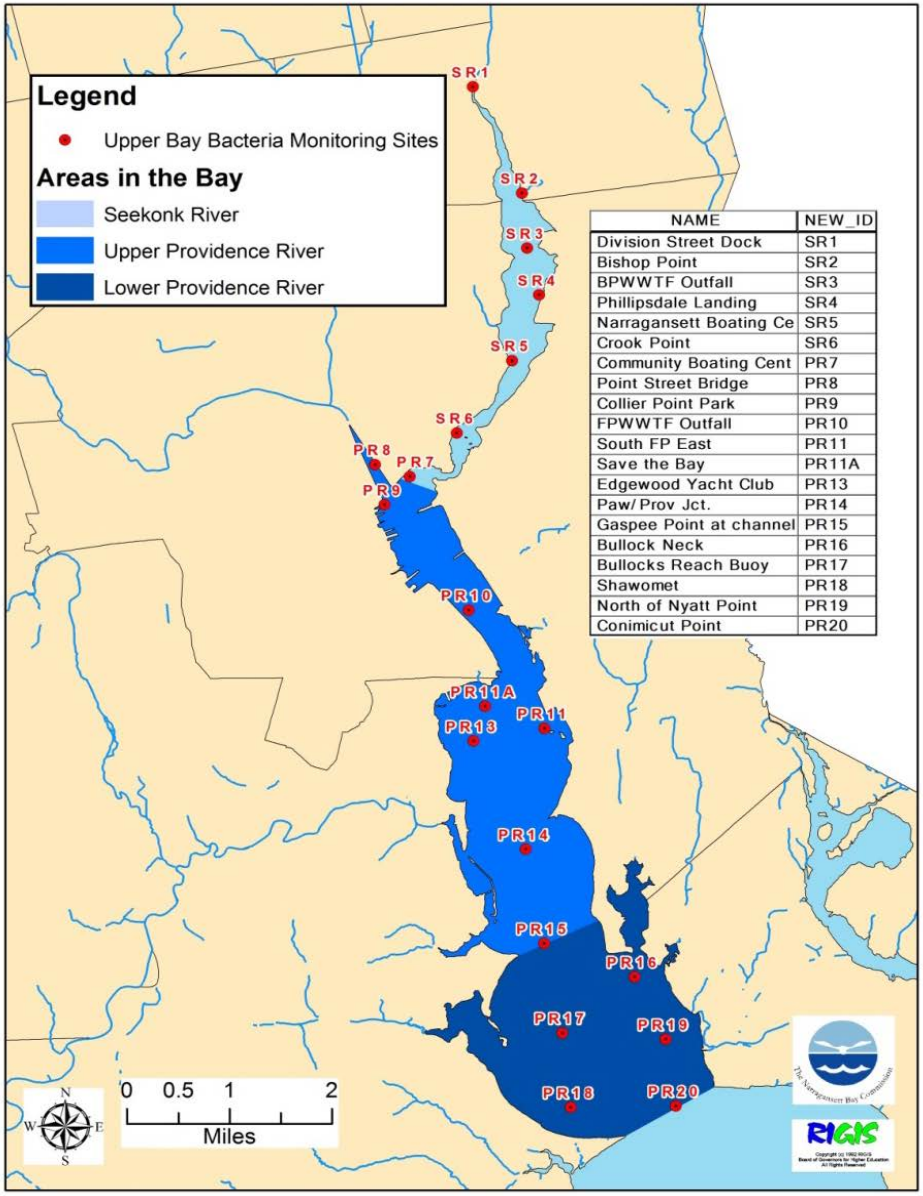
Constituent	Units	India Point - East	India Point - West	India Point - Average
Fecal Coliform	MPN/100 mL	24,000	819,756*	252,654
Enterococcus	MPN/100 mL	>2,420	>2,420	2,420
Total Suspended Solids	mg/L	130.00	118.00	124.00
Total Nitrogen	mg/L	4.65	2.74	3.70
Total Kjeldahl Nitrogen	mg/L	3.37	1.60	2.49
Nitrite + 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 (Vortechnics 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

Upper Bay Bacteria Monitoring



NAME	NEW_ID
Division Street Dock	SR1
Bishop Point	SR2
BPWWTF Outfall	SR3
Phillipsdale Landing	SR4
Narragansett Boating Ce	SR5
Crook Point	SR6
Community Boating Cent	PR7
Point Street Bridge	PR8
Collier Point Park	PR9
FPWWTF Outfall	PR10
South FP East	PR11
Save the Bay	PR11A
Edgewood Yacht Club	PR13
Paw/ Prov Jct.	PR14
Gaspee Point at channel	PR15
Bullock Neck	PR16
Bullocks Reach Buoy	PR17
Shawomet	PR18
North of Nyatt Point	PR19
Conimicut Point	PR20

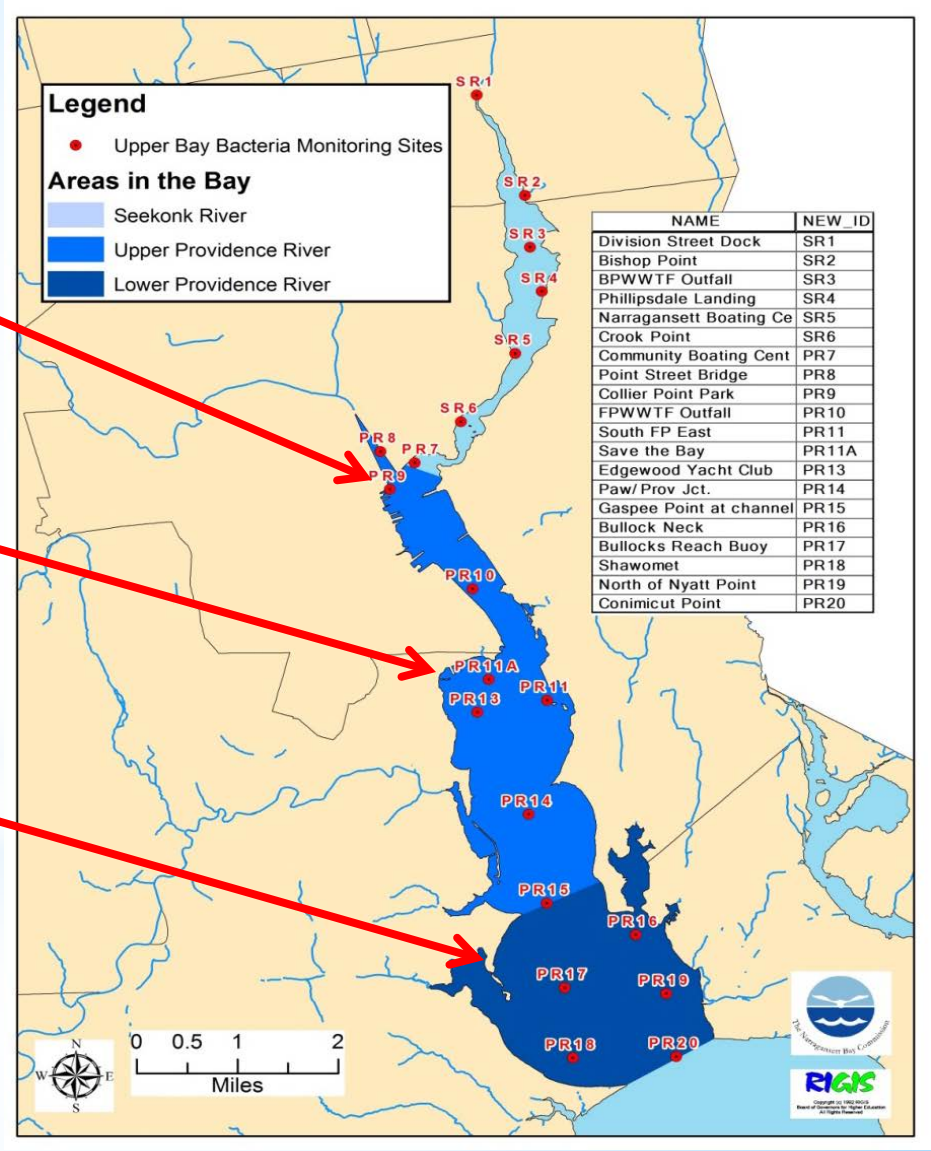
- 20 NBC Bay monitoring stations in Seekonk and Providence "Rivers"
- Biweekly throughout year for fecal coliform bacteria
- Data from 2004 – Present
- Majority of CSOs tied into the Phase I tunnel were in the upper Providence River

Upper Bay Bacteria Data Analysis

Meeting Water Quality Standards?

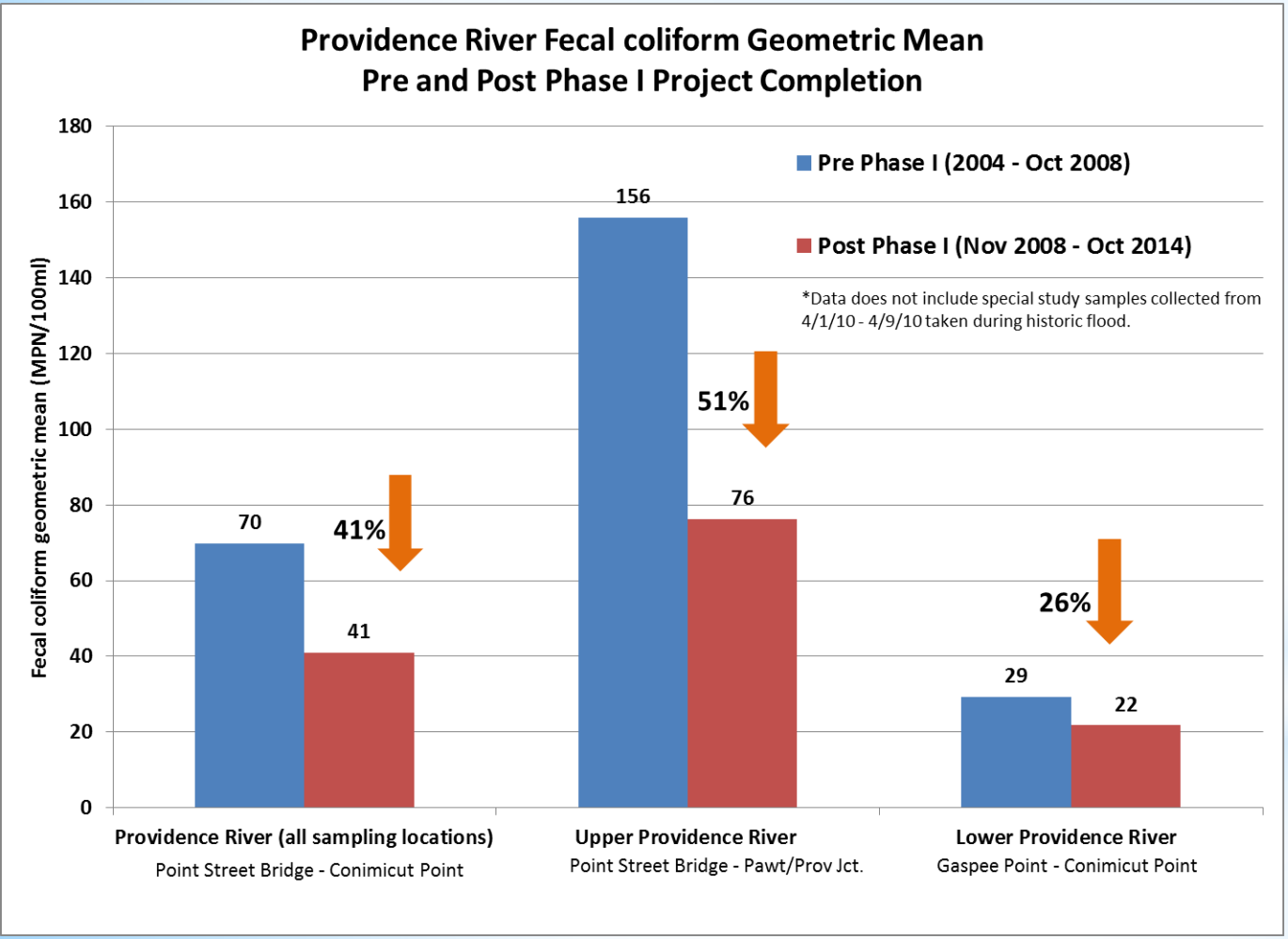
Providence River

- 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

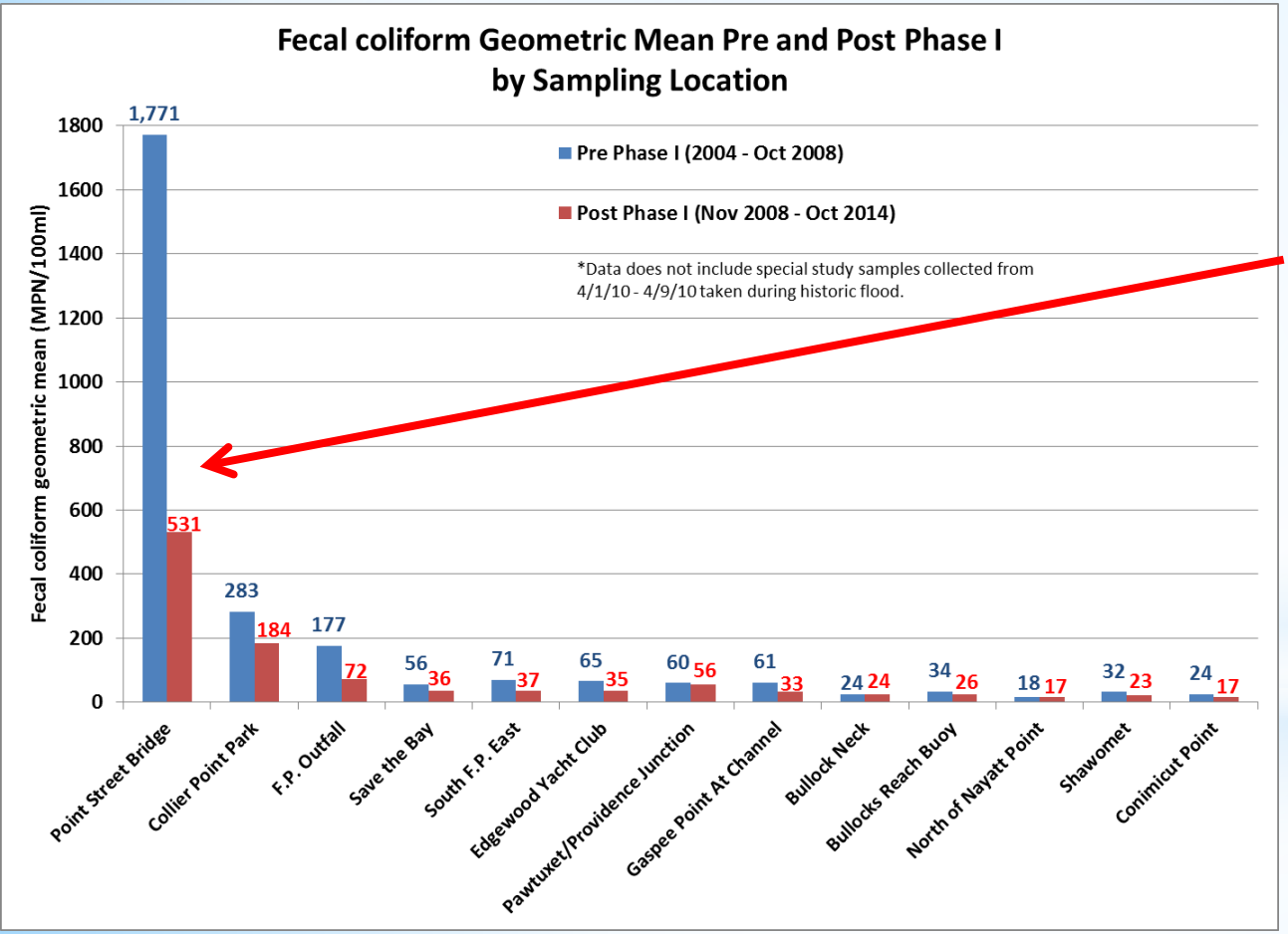
Providence River



- Overall 41% decrease in bacteria levels in all weather
- 47% decrease in wet weather
- 51% decrease in Upper Providence River
- 26% decrease in Lower Providence River

Upper Bay Bacteria Data Analysis

Providence River

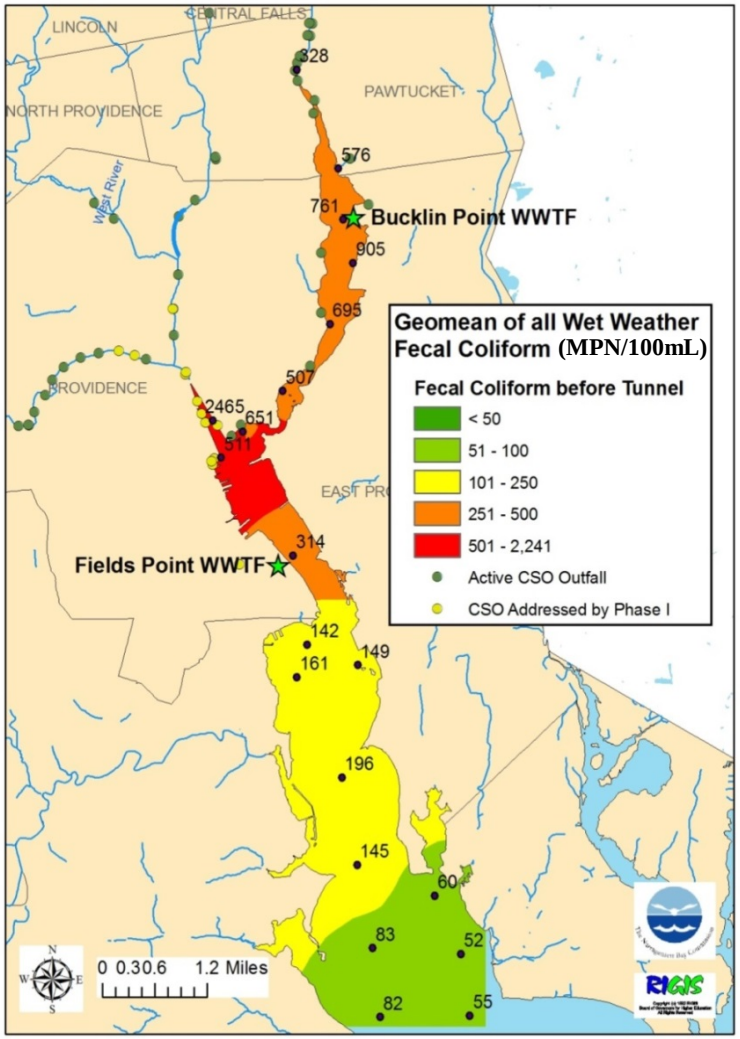


Point Street Bridge closest to CSOs tied into Tunnel

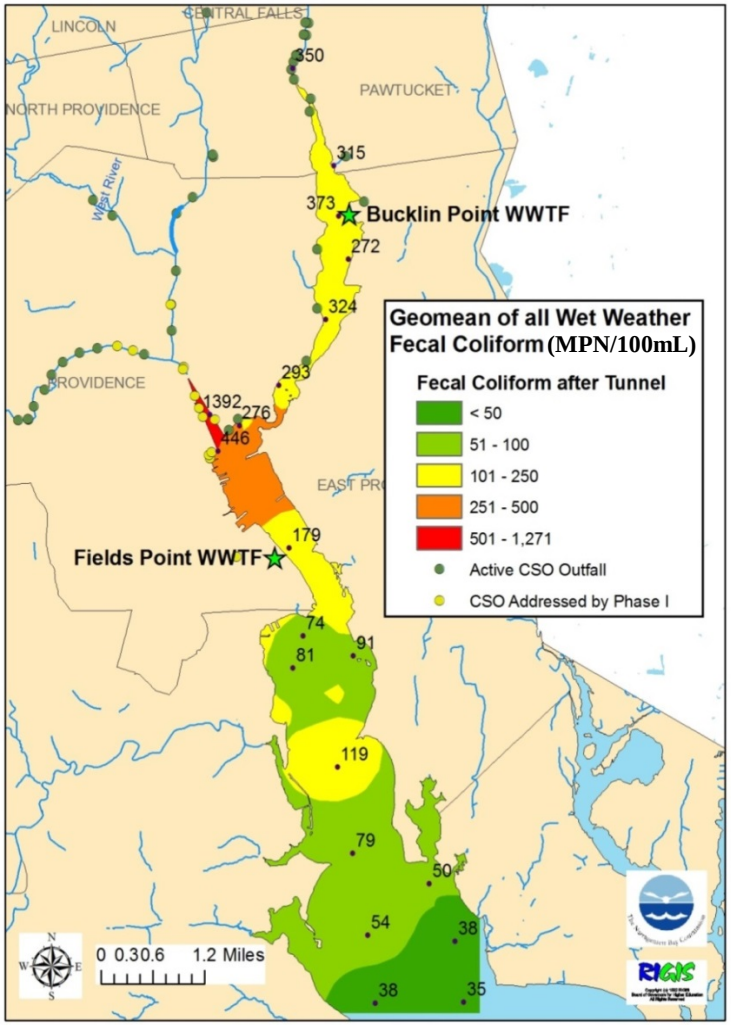
Biggest impact on bacteria levels!

(70% decrease)

Upper Bay Wet Weather Bacteria Levels



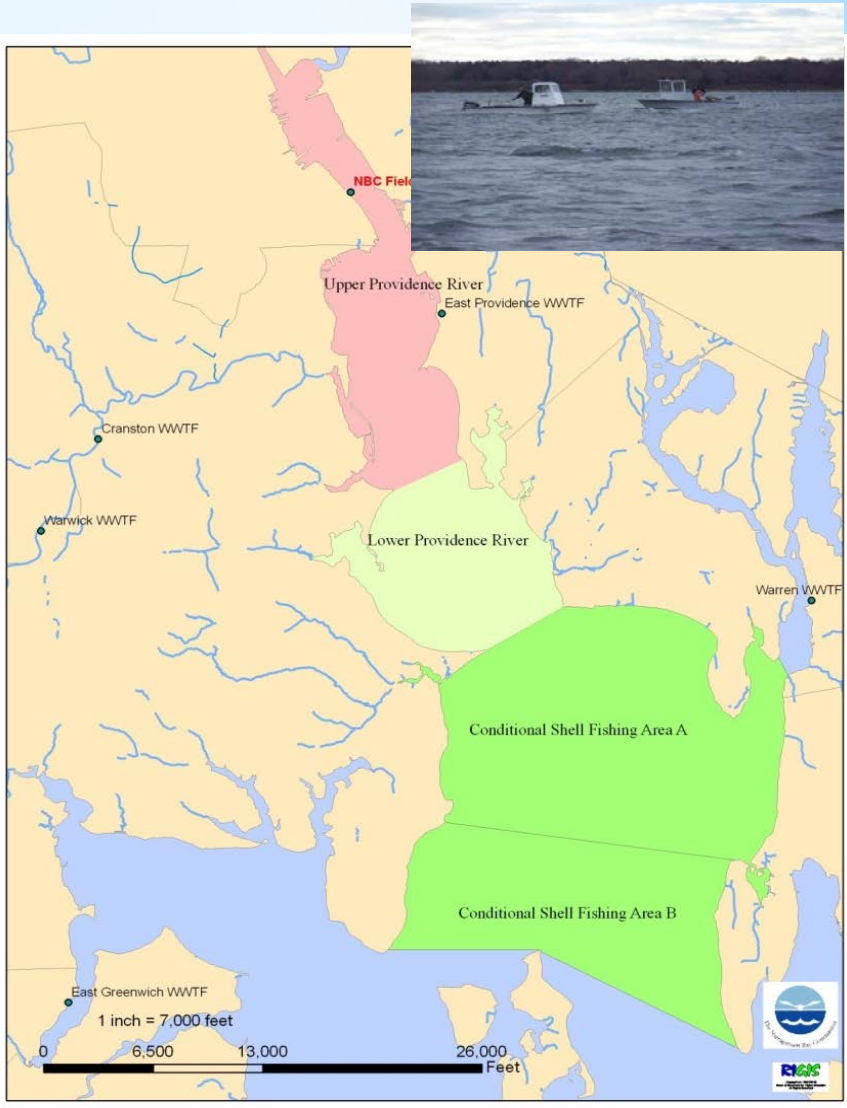
Pre-Phase I
2004 - October 2008



Post-Phase I
October 2008 - September 2013

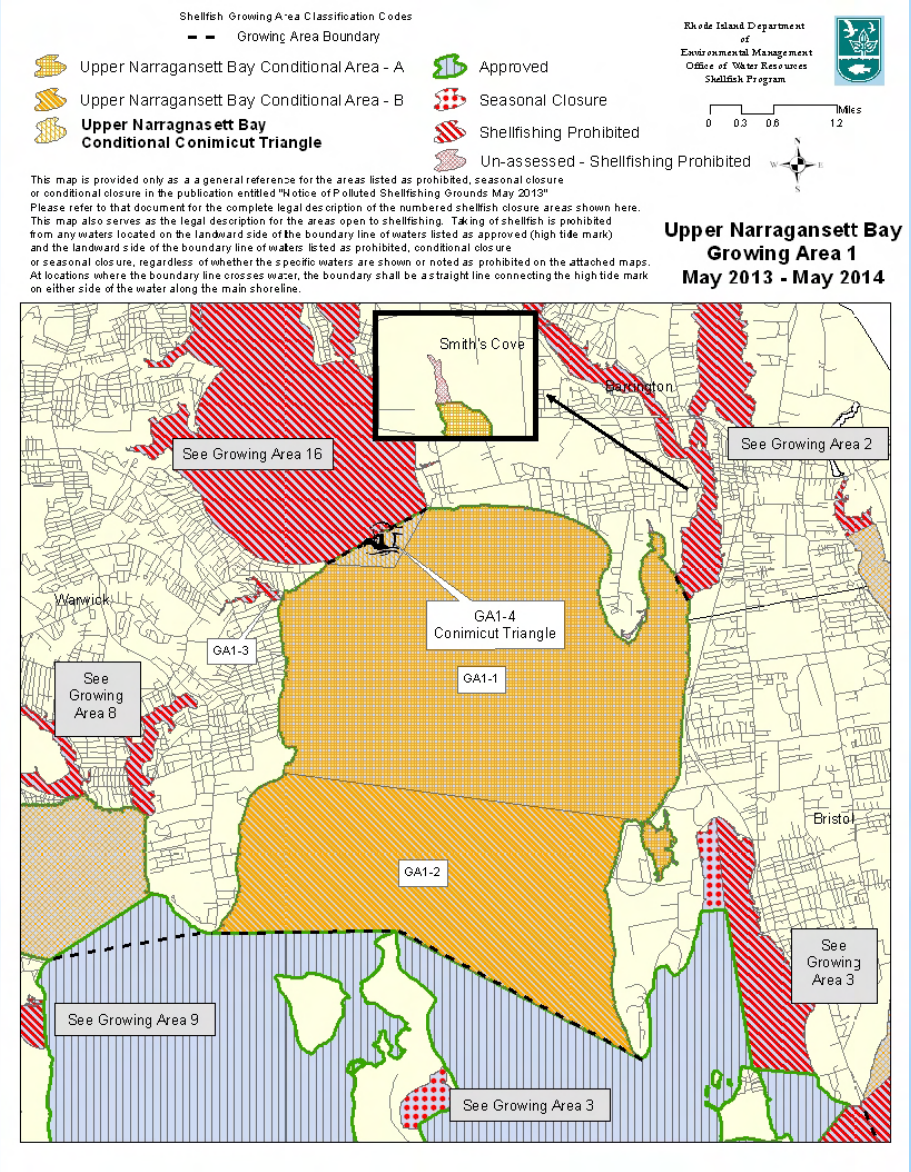
Shellfishing Analysis
Has Phase I Improved Upper Bay Shellfisheries?

- **Shellfishing Standard**
  - Geometric mean Not to exceed 14 MPN/100 mL
  - 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 rainfall
- **Regulations Relaxed in 2011:**
  - Cond. Area A closed with 0.8 inches of rainfall
  - Cond. Area B with 1.5 inches of rainfall
- RIDEM attributes closure changes to success of Phase I CSO Project
- After Phase II, DEM will reevaluate the criteria

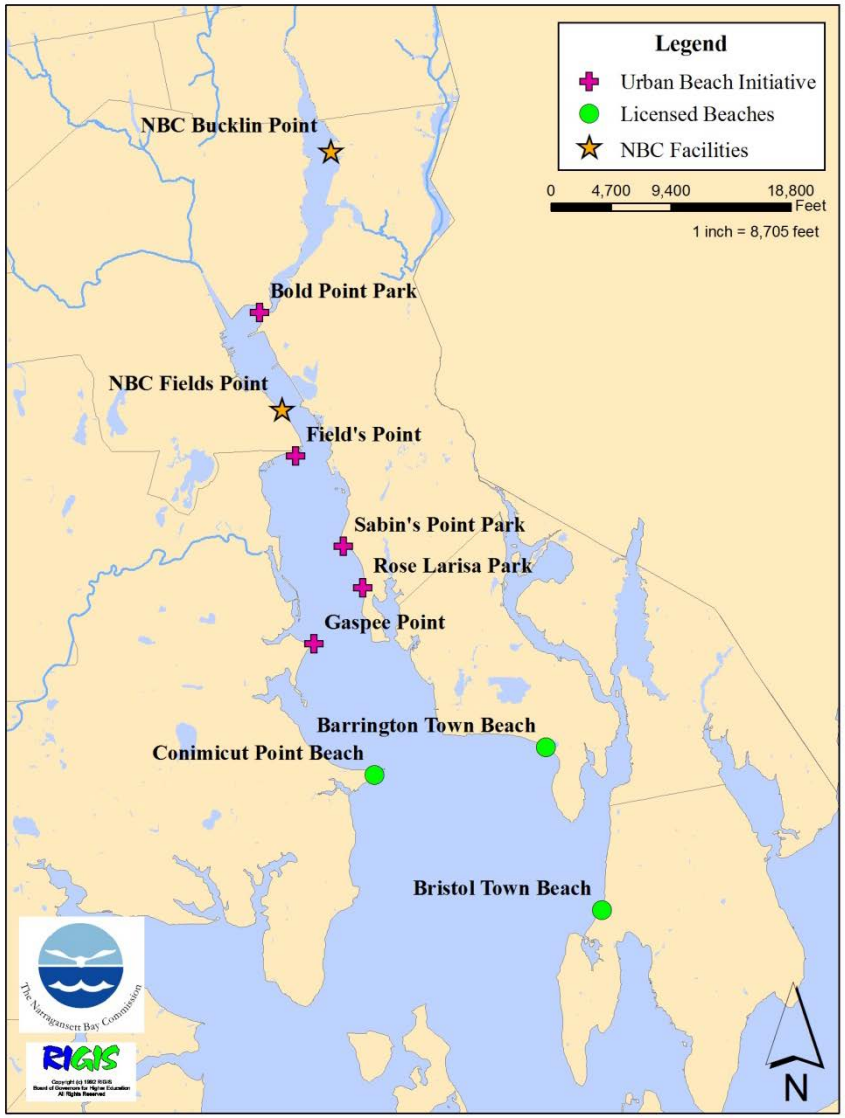


Shellfishing Analysis

- Conditional Area A expected to be open 65 more days/year
- Conditional Area B is projected to be open 45 more days/year
- 36% increase in number of acre-days that Conditional Areas were open in 2013 compared to 2004 (years of similar rainfall)
- This is important because, in 2012….
  - 45% of the quahog harvest came from Areas A & B
  - Totaling 17.5 million clams
  - Equaling $2.48 million



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, Rose 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
- East Providence moving forward to open Sabin Point Beach to bathing!!!

Phase I has Improved water quality of Upper Bay Beaches

Pollutants Removed Due To Tunnel

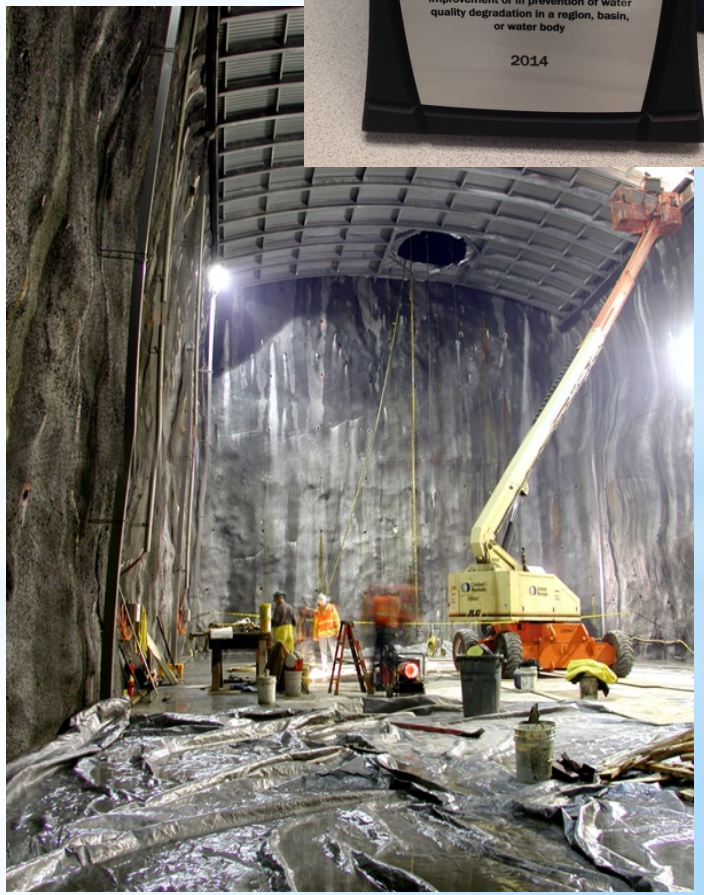
- **Tunnel captured ~6 billion gallons** of CSO flow over past 5 years
- Captured Flow is pumped to FP WWTF and receives full secondary and tertiary treatment
- **~1.1 billion gallons/year** captured
  - 50% of the CSO volume captured and treated annually (based on design model)
  - 50% Bacteria Load Reduction!!!
- Millions of pounds of pollutants prevented from being discharged
  - >2.3 Million Pounds TSS
  - >1.4 Million Pounds BOD
  - ~234,000 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	5,953,200,000 gallons		
Total Suspended Solids	50.54	mg/L	2,316,067
Biochemical Oxygen Demand	32.15	mg/L	1,484,284
Total Nitrogen	8.50	mg/L	233,966
Cyanide	6.29	µg/L	241
Aluminum	240	µg/L	11,276
Cadmium	1.27	µg/L	60
Chromium	5.67	µg/L	244
Copper	11.52	µg/L	480
Iron	1,432	µg/L	60,691
Lead	9.38	µg/L	423
Nickel	17.48	µg/L	267
Silver	2.02	µg/L	96
Zinc	30.98	µg/L	1,149

Phase I Summary

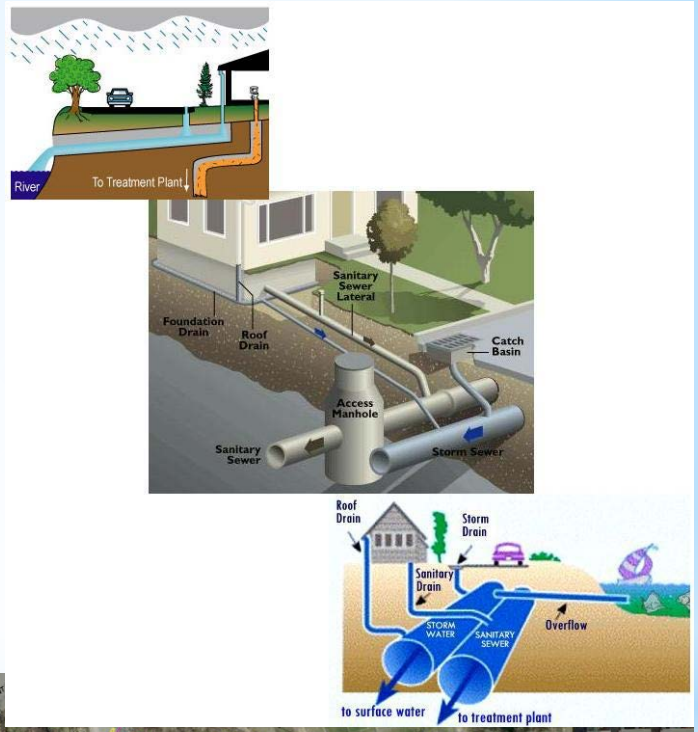
Phase I CSO Tunnel Project has:

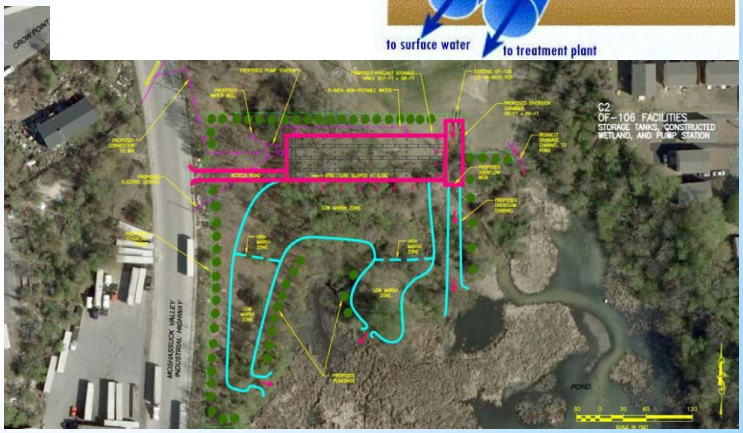
- Captured ~1.1 Billion Gallons/Year of CSO flow
- Reduced CSO volume and bacteria loads by ~50%
- Reduced bacterial contamination levels in our Urban Rivers and Upper Bay
- Prevented millions of pounds of pollutants from discharging to our rivers and Narragansett Bay
- DOH Reports: Upper Bay Beaches meet bacteria standards 85% of summer season & 3 new Upper Bay beaches could open
- Allowed DEM to relax Shellfishing Closure standards
- **NBC Received Water Environment Federation's National Water Quality Improvement Award**
- But, monitoring stations unaffected by CSOs are not meeting standards
- **NBC CSO Abatement Program WILL NOT meet water quality standards:**
  - ✓CSO System will still overflow ~ 4 times per year
  - ✓Other Sources of Bacterial Pollution Needs to be addressed



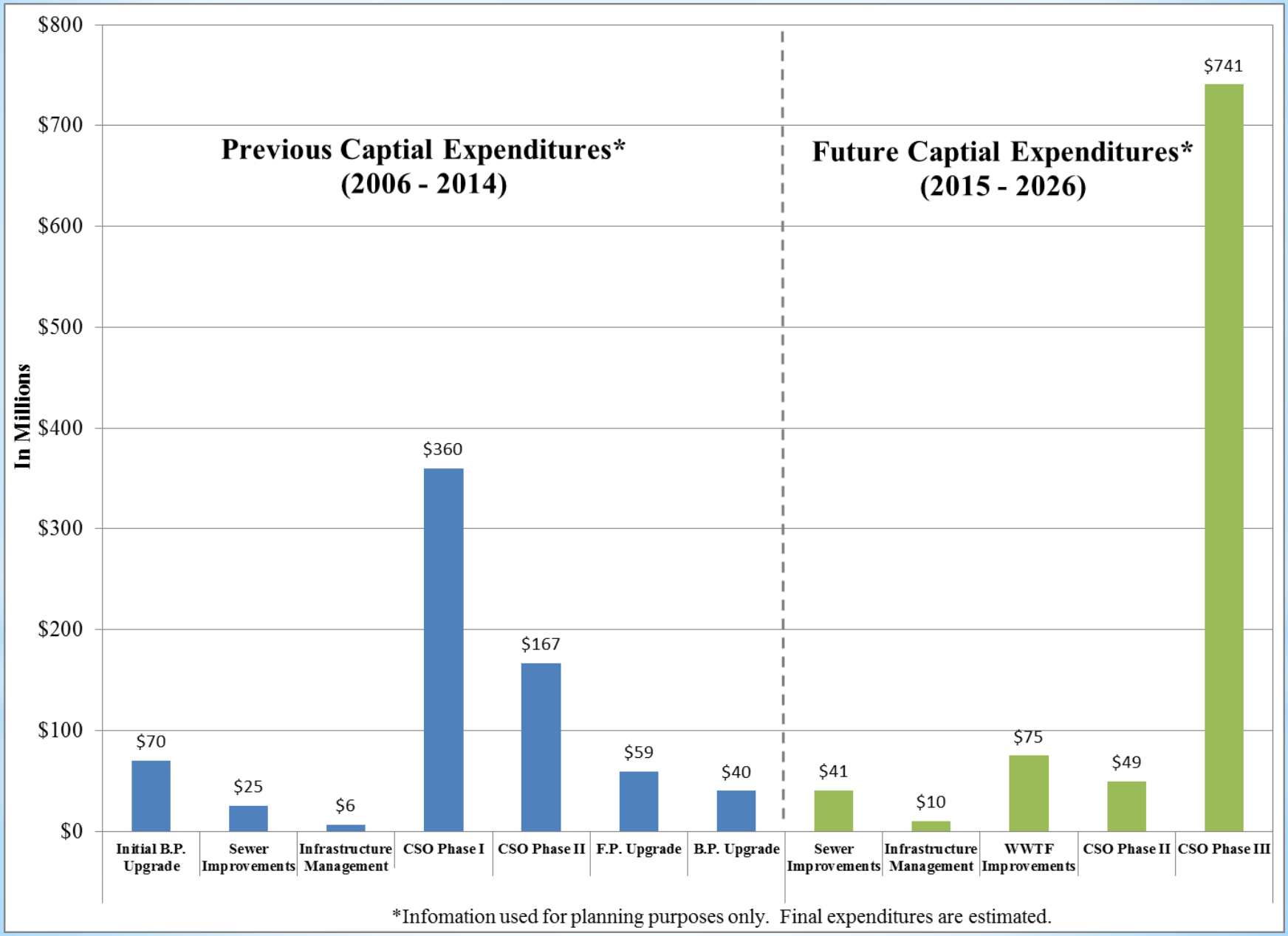
Phase II of CSO Abatement

- Woonasquatucket & Seekonk interceptors constructed to transport flow to the CSO tunnel
- Will Improve WQ of Urban Rivers
- Two sewer separations –
  - ✓ Construct new storm sewers via conventional open-cut trenching methods
  - ✓ Extensive utility impacts
    - ✓ $3.6 million for gas main replacement
    - ✓ $4.25 million for water main replacement
- Constructed wetlands facility
  - ✓ 0.32 MG of storage
  - ✓ Pumped to sanitary sewer after rain event
  - ✓ Overflows to wetlands when tanks are full
- Flows to interceptors end of 2014
- Whole project completed 2015
- Projected costs: **$213 million**

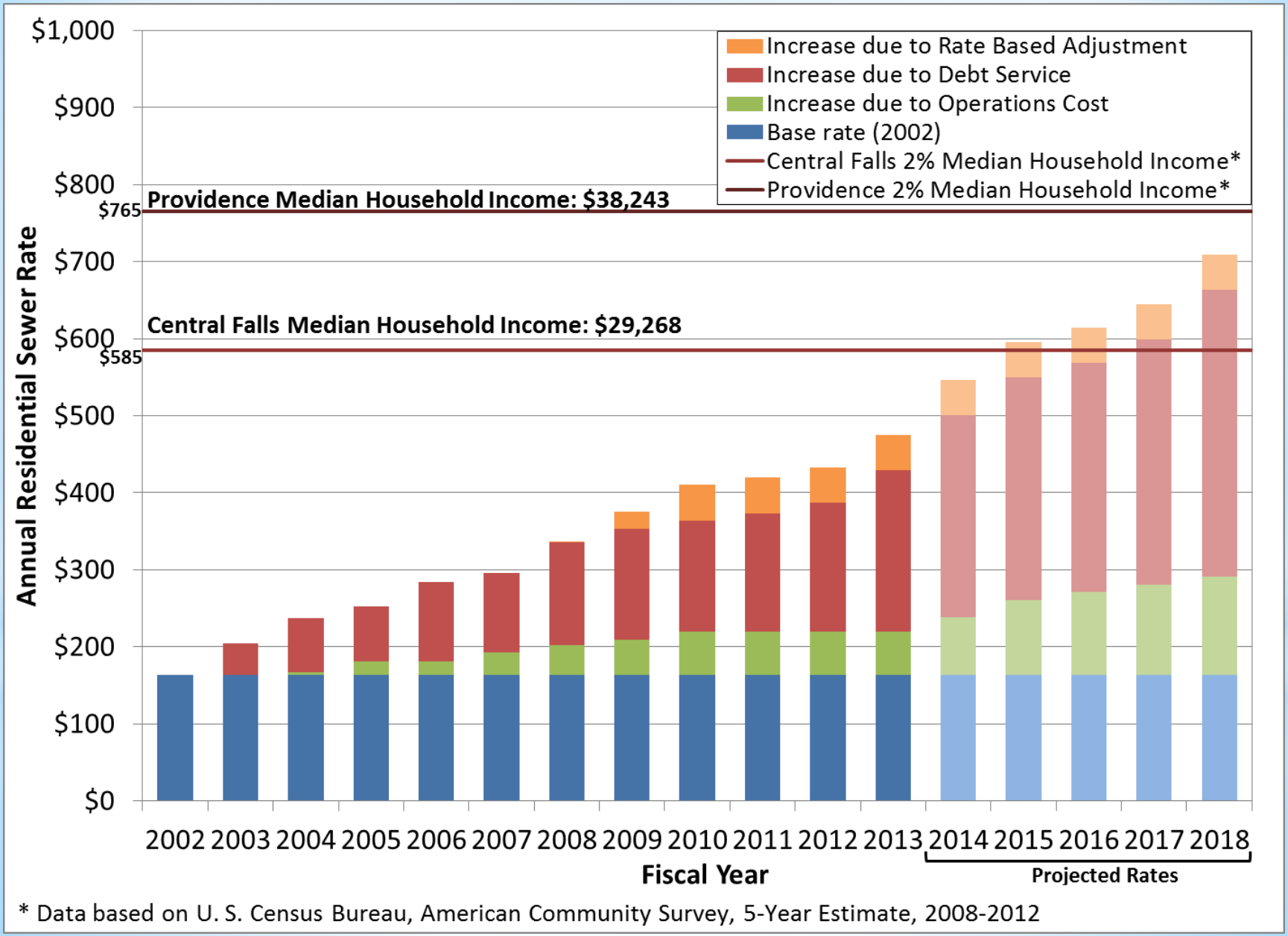




NBC Capital Project Expenditure Overview



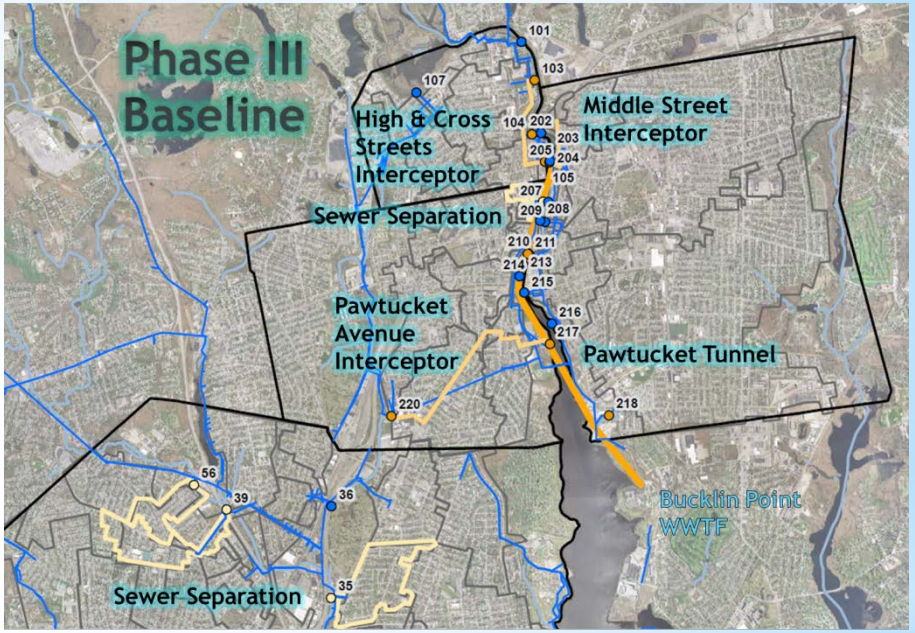
NBC User Fees



* Data based on U. S. Census Bureau, American Community Survey, 5-Year Estimate, 2008-2012

Phase III of CSO Abatement

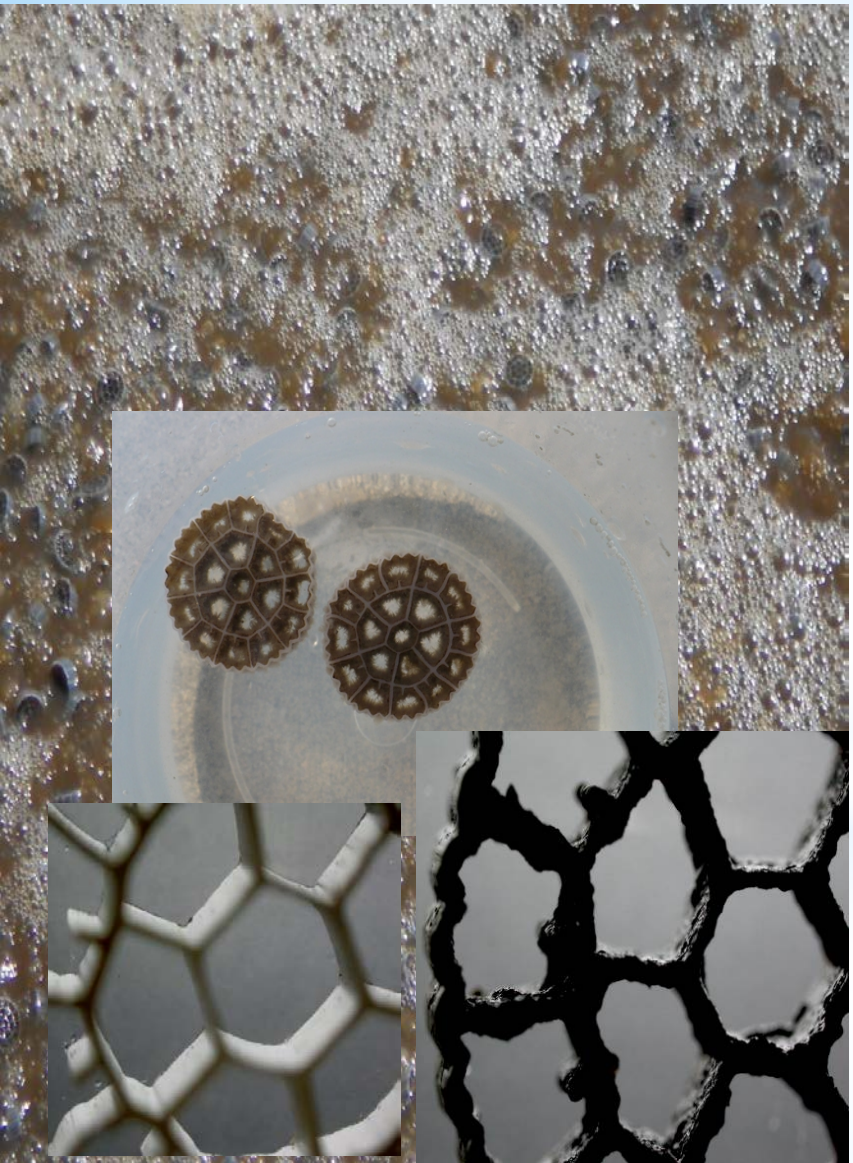
- Stakeholder process to re-evaluate original plans for Phase III
- Consultants: MWH Global & PAR Engineering
- Re-evaluation tasks are:
  - Develop sewer hydraulic model for Bucklin Point Service Area
  - Evaluate water quality since completion Phase I & expected water quality upon completion of Phases II & III
  - Evaluate recommended abatement method for each overflow
  - Develop & analyze alternative methods, particularly green infrastructure
  - Estimate impacts on sewer rates & conduct an affordability analysis



- Next Stakeholder meeting: December 4th at 9am
- Issue revised plan to RIDEM after Stakeholder input
- Initial Cost Estimate: $605 million; **$740M in 2018 Dollars**
- Go to www.narrabay.com for more information

NBC Nitrogen Reduction Projects

Field's Point POTW- Biological Nutrient Removal Upgrade for Total Nitrogen



- ✓Use IFAS system to meet 5 ppm TN
- ✓Largest IFAS Plant in World!
- ✓Construction completed in 2013
- ✓Permit Limits began 2014 season of May - October
- ✓Achieved 2014 seasonal average of 3.4 ppm!!
- ✓Already reduced 4,782 lbs TN/day at FP since fish kill based on 2014 data (-82%)

➢ **Nitrogen Upgrade Cost ~$31 million of $59M Facility Upgrade**

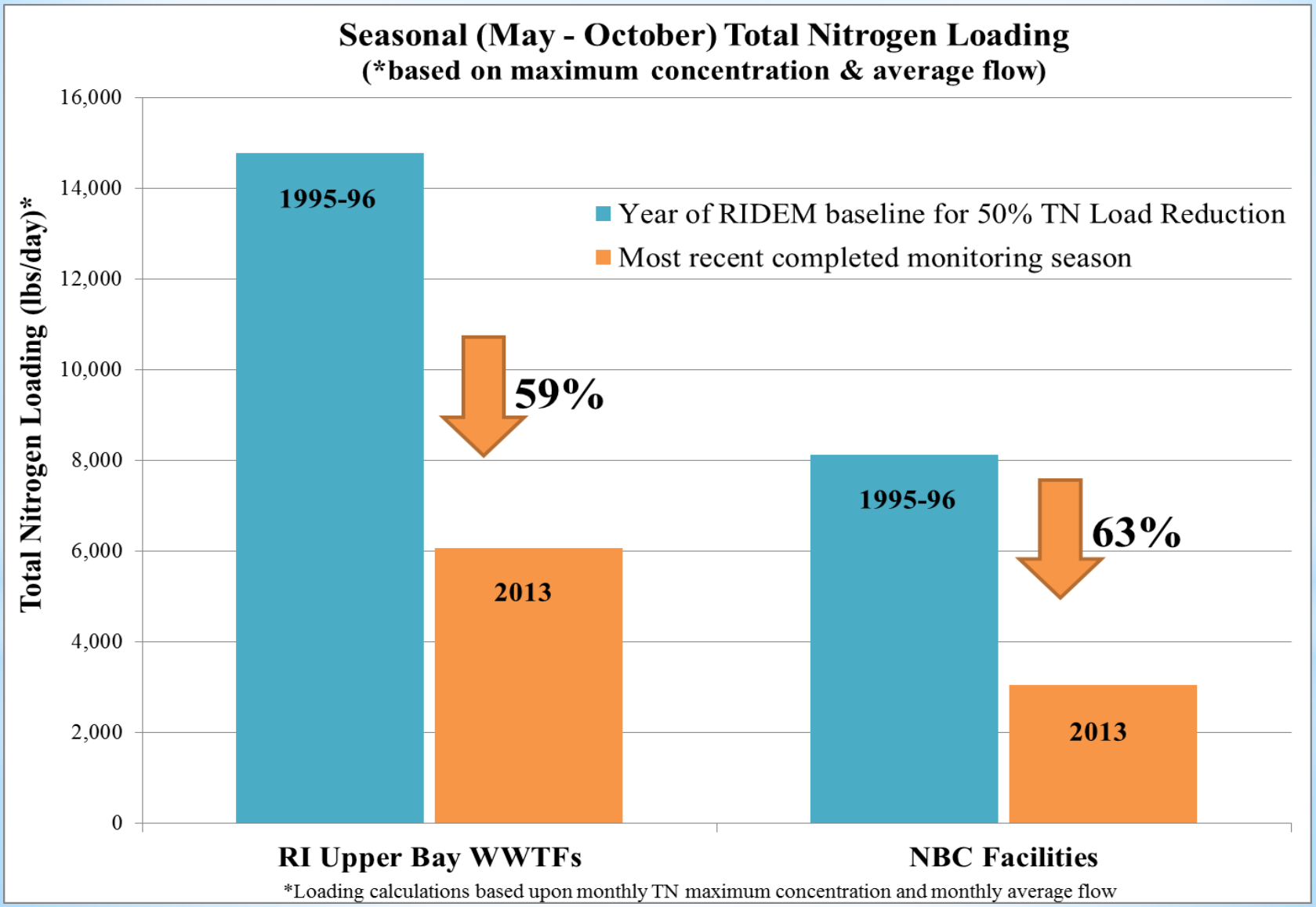
Bucklin Point POTW- Biological Nutrient Removal Upgrade for Total Nitrogen

- Built to meet 8.5 ppm TN in 2005/2006
- **$8.3M of $70M project for initial nitrogen upgrade**
- Upgrade to 5 ppm complete summer of 2014, permit in effect on July 15th.
- 2014 seasonal average was 4.0 ppm TN (-80% since 2003)
- Since permit: 3.66 ppm TN average

➢ **Upgrade cost ~$13 M for 5ppm TN to reduce ~158 additional lbs TN/day**

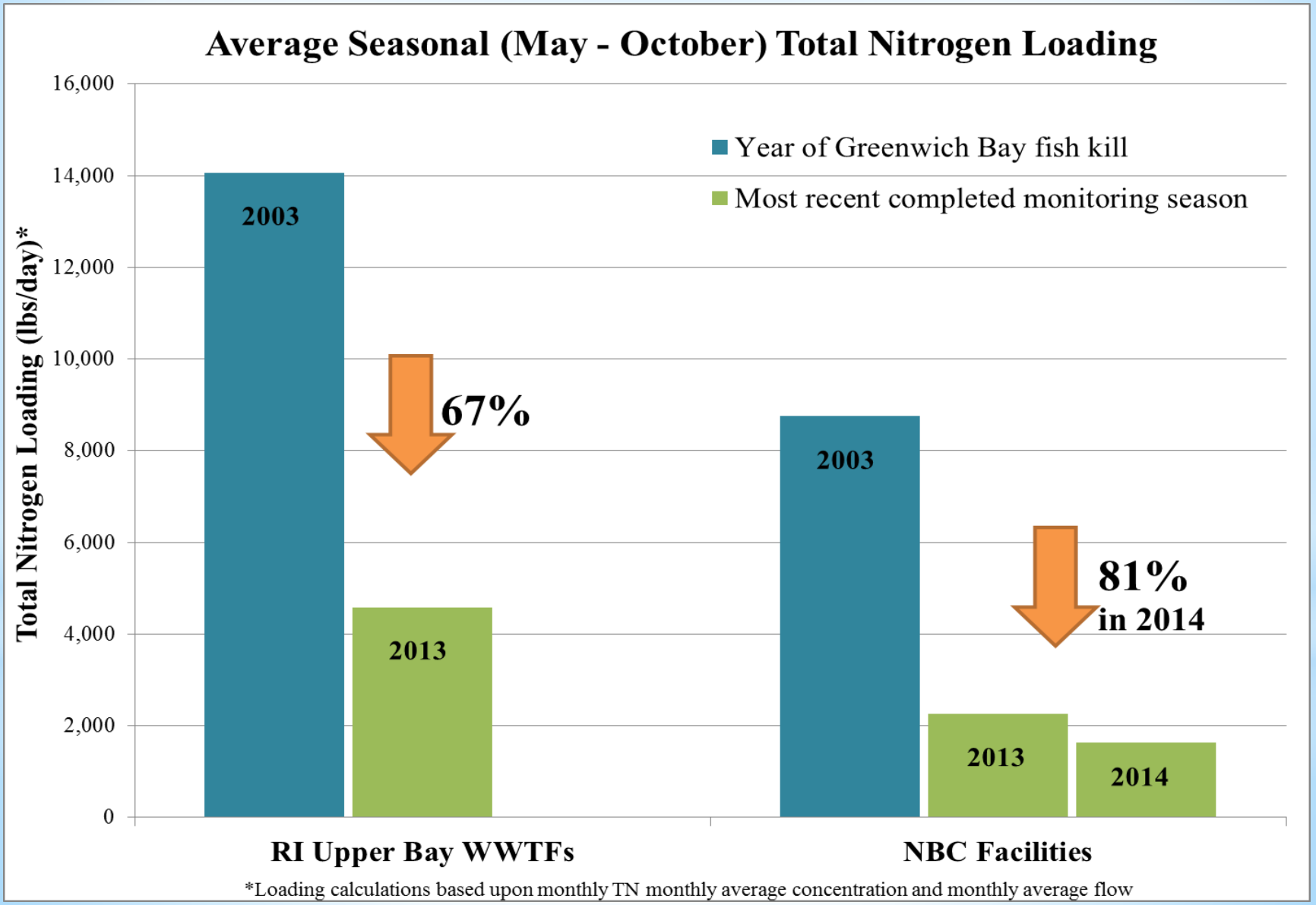
Significant Nitrogen Reductions Realized

Comparison with State 50% Reduction Mandate



Significant Nitrogen Reductions Realized

Comparison with 2003 – Year of Greenwich Bay Fish Kill

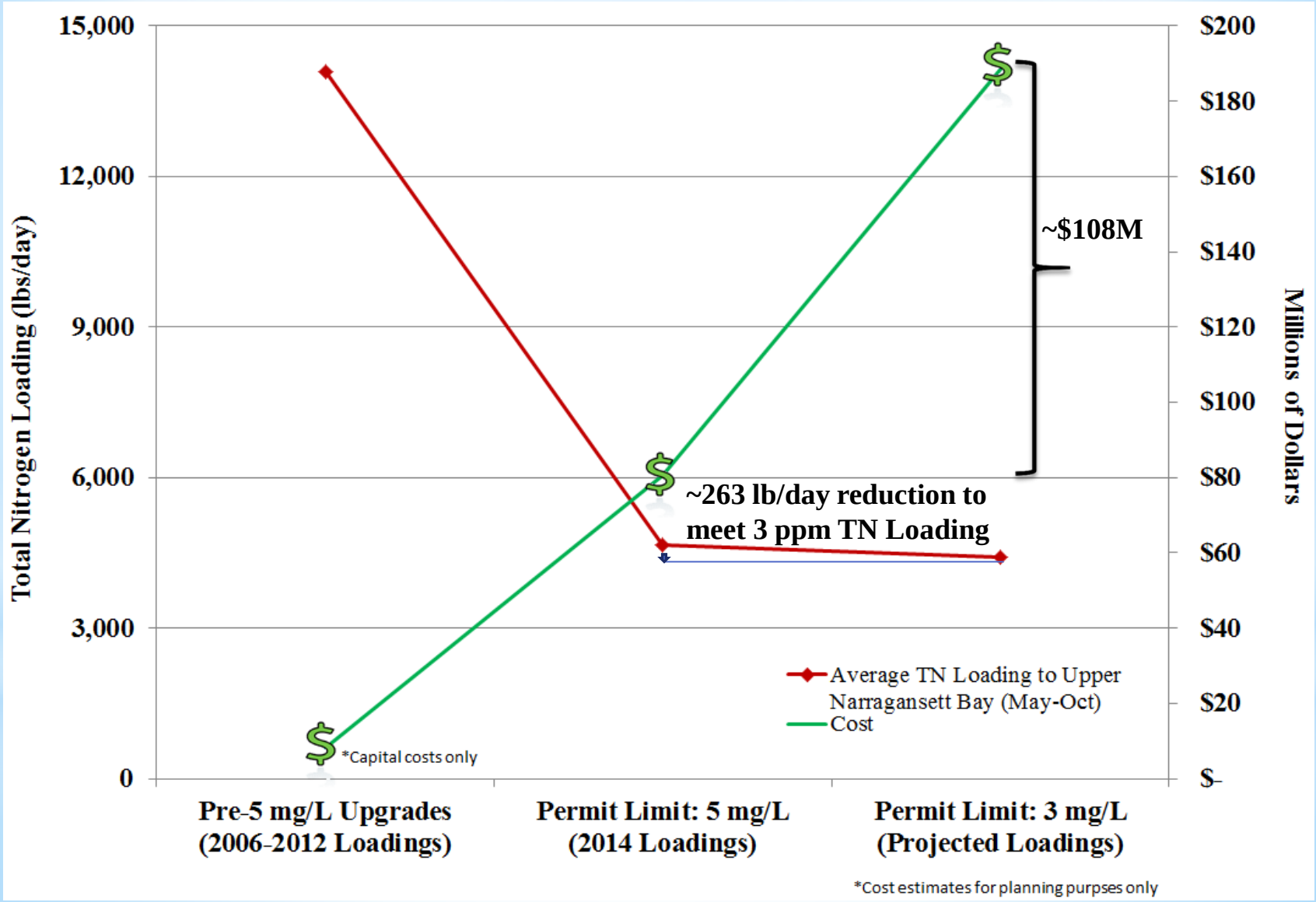


NBC Nitrogen Loading to Upper Bay (May – Oct) updated

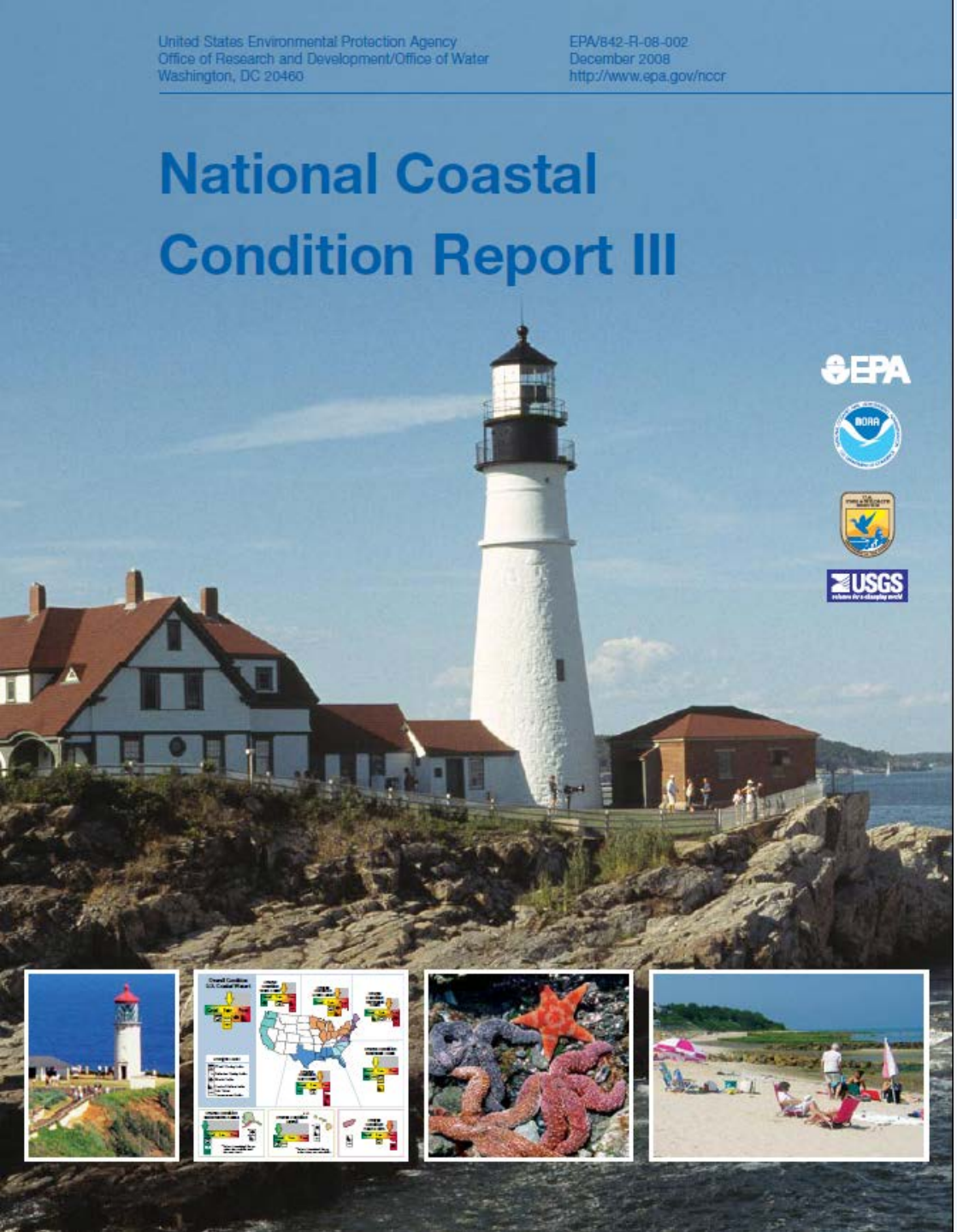
	Concentration (ppm)	Loading (lbs/day)	Percent Reduction (Loading)
Field's Point TN Loading			
Year of Fish Kill (2003)	15.7	5,834	
May - Oct 2014	3.4	1,051	82%
IFAS Upgrade (5 ppm)	5.0	1,572	73%
If plant achieves 3 ppm	3.0	943	84%
Bucklin Point TN Loading			
Year of Fish Kill (2003)	14.8	2,908	
May - Oct 2014	4.0	590	80%
Upgrade (5 ppm)	5.0	725	75%
If plant achieves 3 ppm	3.0	435	85%
Combined NBC Facilities			
2003	BP=14.8, FP=15.7	8,741	
May - Oct 2014	BP=4.0, FP=3.4	1,641	81%
FP&BP Upgrade to 5 ppm	BP=5.0, FP=5.0	2,297	74%
FP&BP Upgrade to 3 ppm	BP=3.0, FP=3.0	1,378	84%

Upgrade to 3ppm TN will reduce ~263 Pounds of Nitrogen per Day

Total Nitrogen Loading to Upper Narragansett Bay vs. Estimated NBC Cost to Achieve Proposed TN Limit



(This is input from point & nonpoint sources north of Conimicut Point)



Nitrogen TMDL has NOT been Developed Yet!!! So...

Table 1-2. Criteria for Assessing Dissolved Inorganic Nitrogen (DIN)

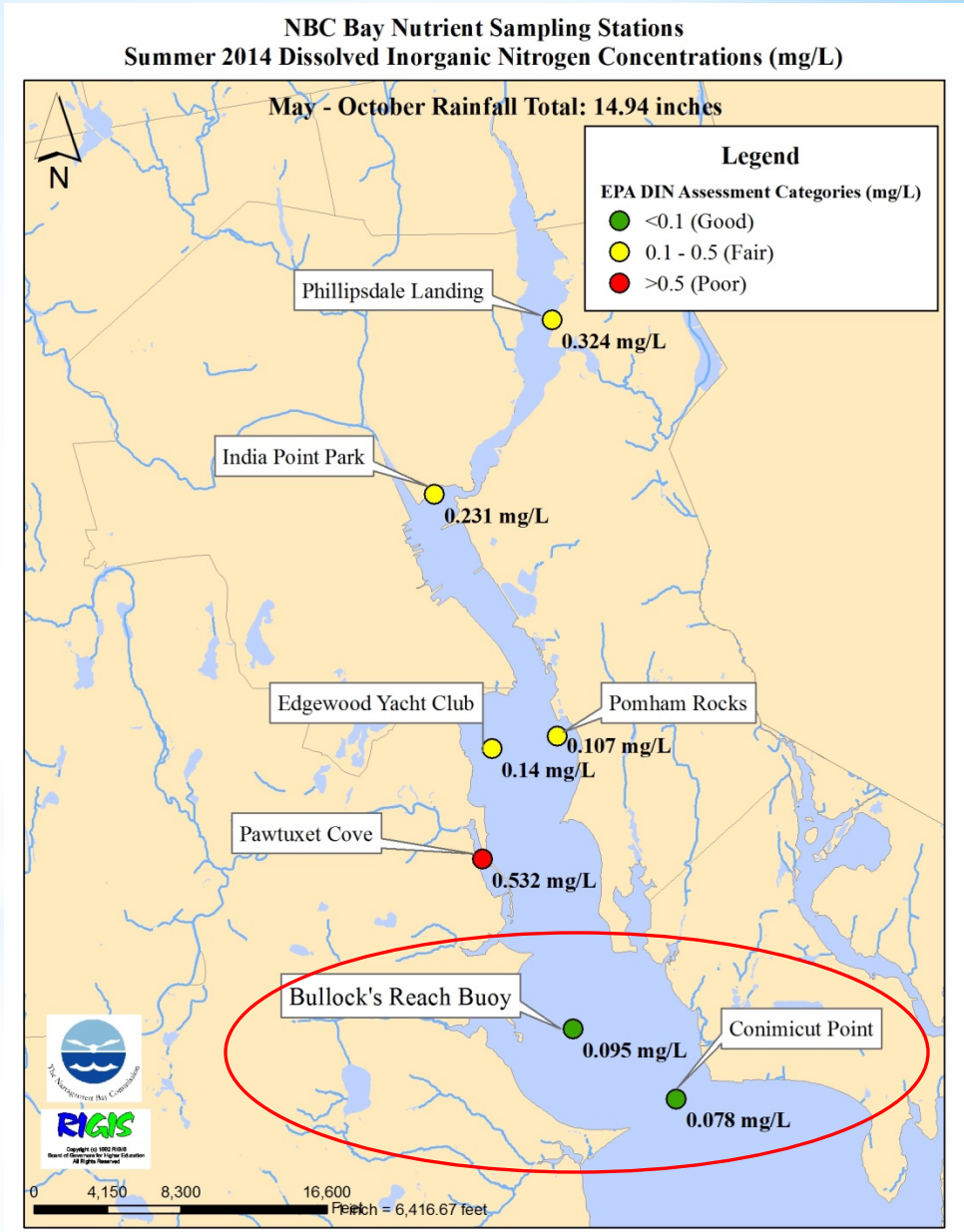
Area	Good	Fair	Poor
Northeast, Southeast, and Gulf Coast sites	< 0.1 mg/L	0.1–0.5 mg/L	> 0.5 mg/L
West Coast and Alaska sites	< 0.5 mg/L	0.5–1.0 mg/L	> 1 mg/L
Hawaii, Puerto Rico, and Florida Bay sites	< 0.05 mg/L	0.05–0.1 mg/L	> 0.1 mg/L
Regions	Less than 10% of the coastal area is in poor condition, and more than 50% of the coastal area is in good condition.	10% to 25% of the coastal area is in poor condition, or more than 50% of the coastal area is in combined poor and fair condition.	More than 25% of the coastal area is in poor condition.

2014 Dissolved Inorganic Nitrogen Conc.

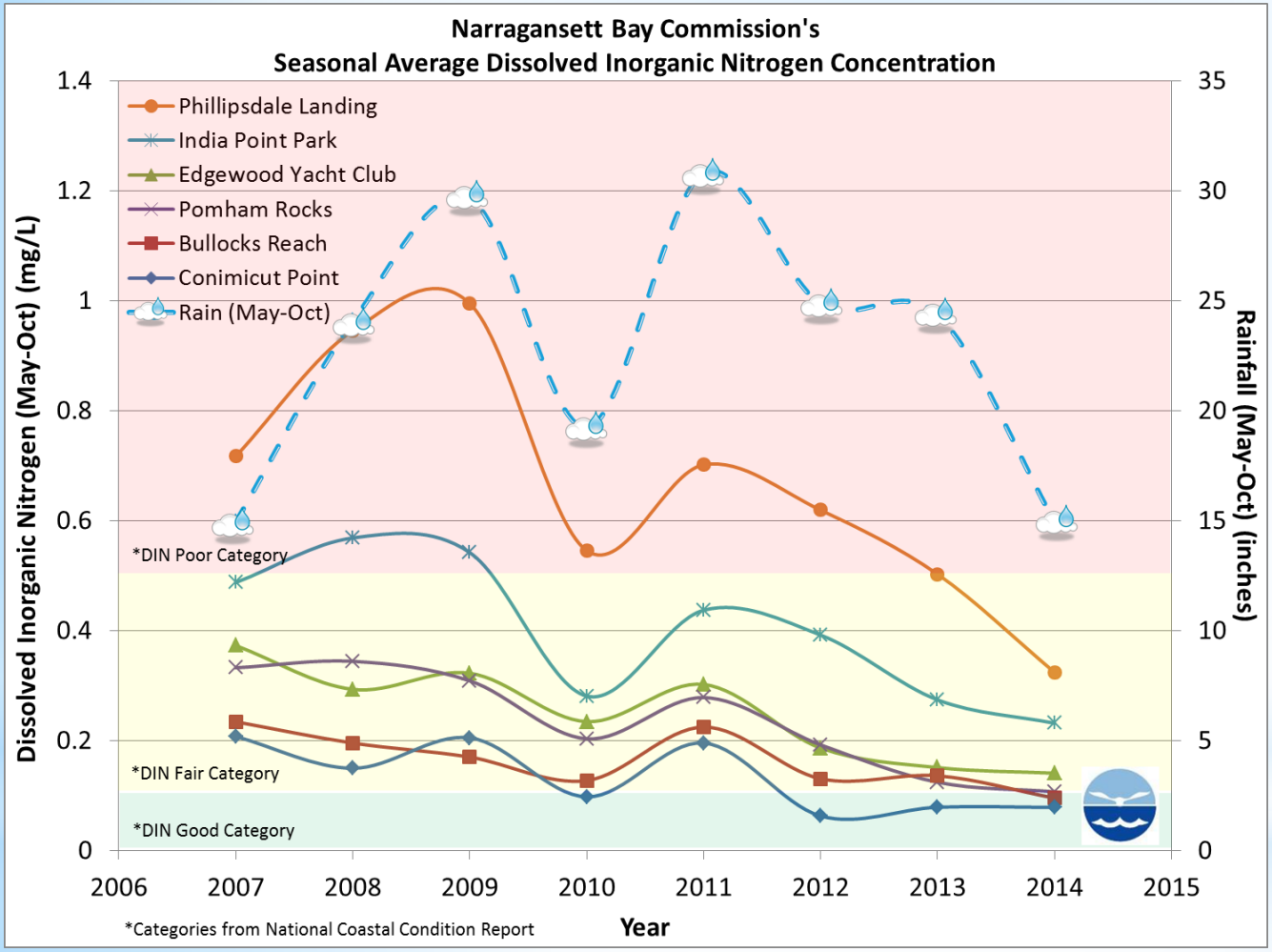
May – October

Rainfall Total: **14.94 inches**

Station	DIN (mg/L) Good <0.1 Fair 0.1-0.5 Poor >0.5	DIN (mg/L)	EPA NEP criteria
Phillipsdale Landing		0.324	Fair
India Point Park		0.231	Fair
Edgewood Yacht Club		0.140	Fair
Pomham Rocks		0.107	Fair
Bullock's Reach		0.095	Good
Conimicut Point		0.078	Good

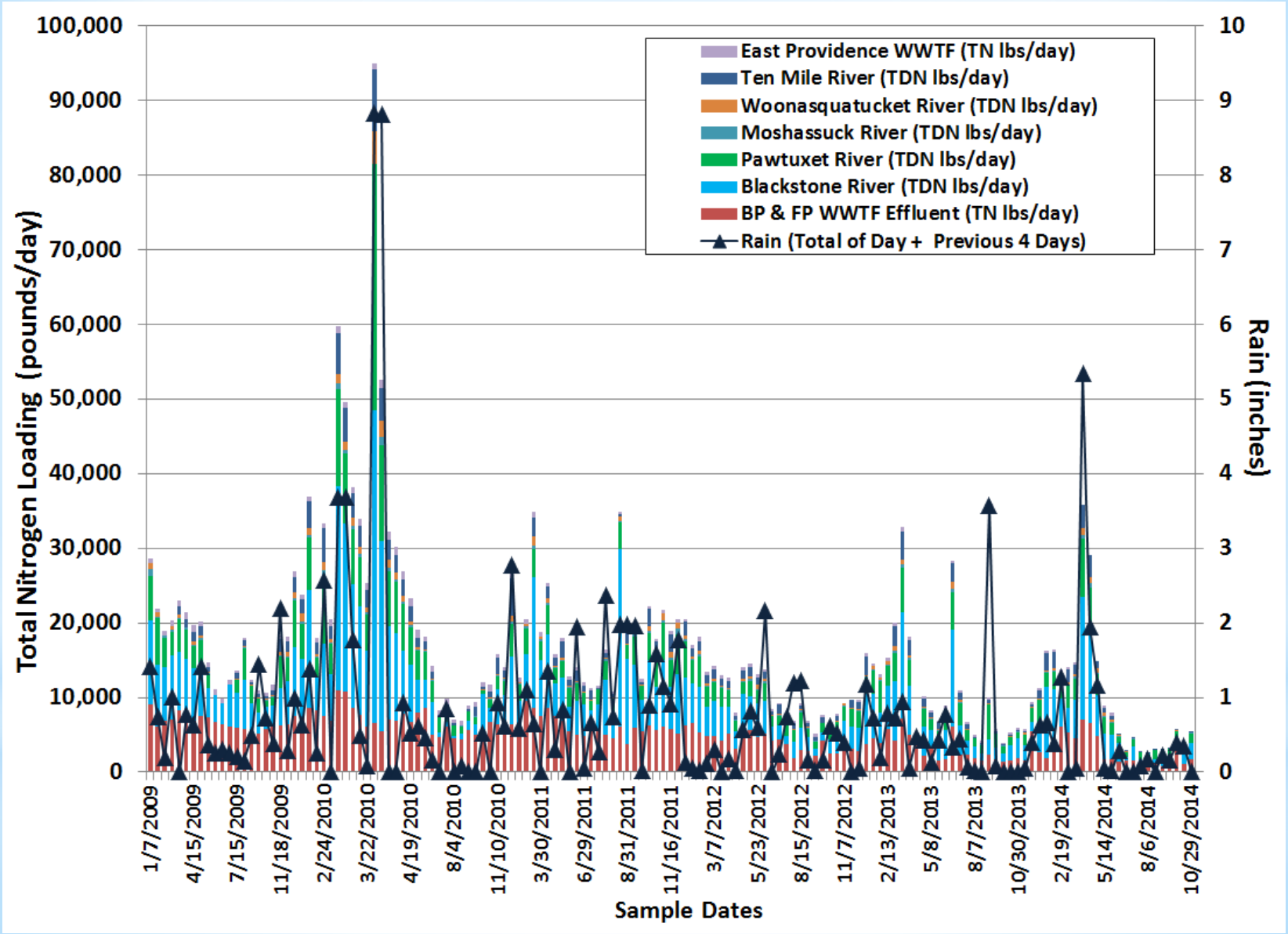


Total Nitrogen Status in the Bay



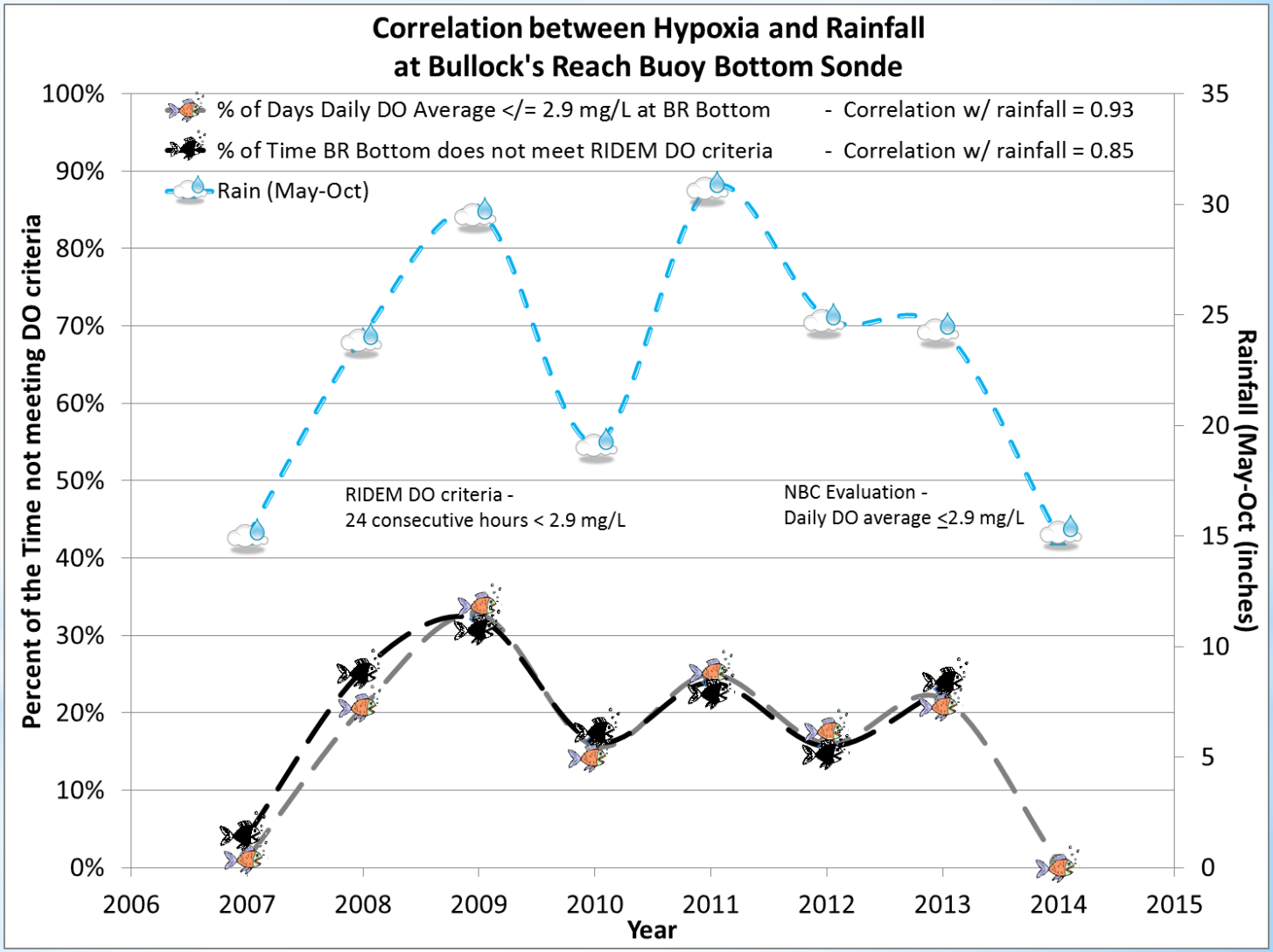
- With TN Loads to Upper Bay greatly reduced, DIN levels are dropping
- Conimicut Pt <0.1 ppm DIN for past 3 years – Good Category!!!!!
- Bullocks Point in Good Category for first time!
- Phillipsdale lowest DIN concentration EVER!
- DIN conc. trends with annual rainfall

Upper Bay Total Nitrogen Loading & Rainfall



Strong Correlation Between DO Impairment and Rainfall

- Strong correlation between rainfall and Bullock's Reach DO Impairment Time
- Will further TN reductions eliminate DO impairments?
- Is Rainfall and Stormwater a major cause?
- Only 1 day with a daily average of <=2.9 mg/l from May - October



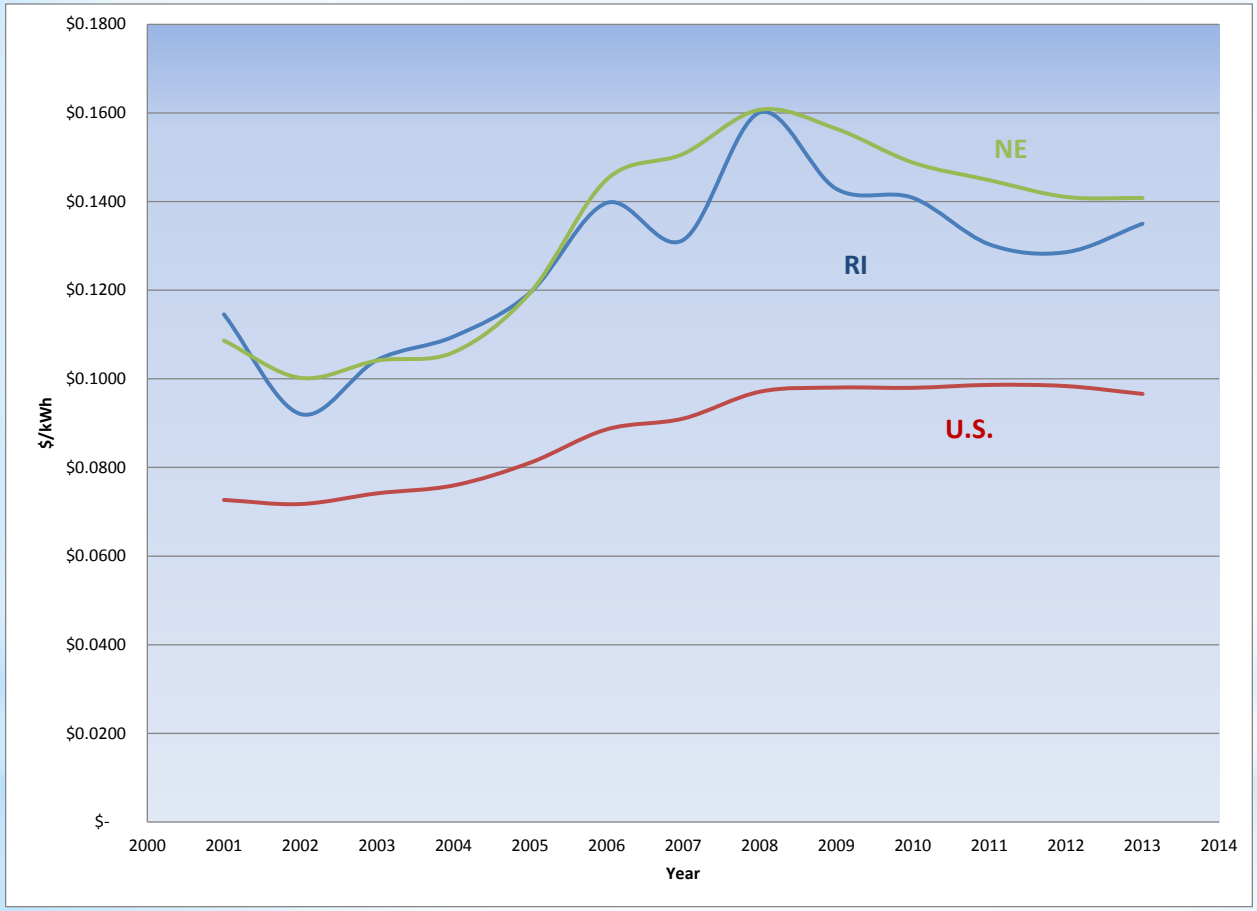
NBC Benthic Monitoring

- NBC conducts video transects in upper Bay
- Extensive mudflats, amphipod tube mats, some macroalgae
- Megabenthic and infaunal invertebrates
- Vast areas of upper Bay lack structure for fish habitat

Libinia sp., spider crab
between Bullock's Reach buoy and Shawomet

Video Benthic Monitoring

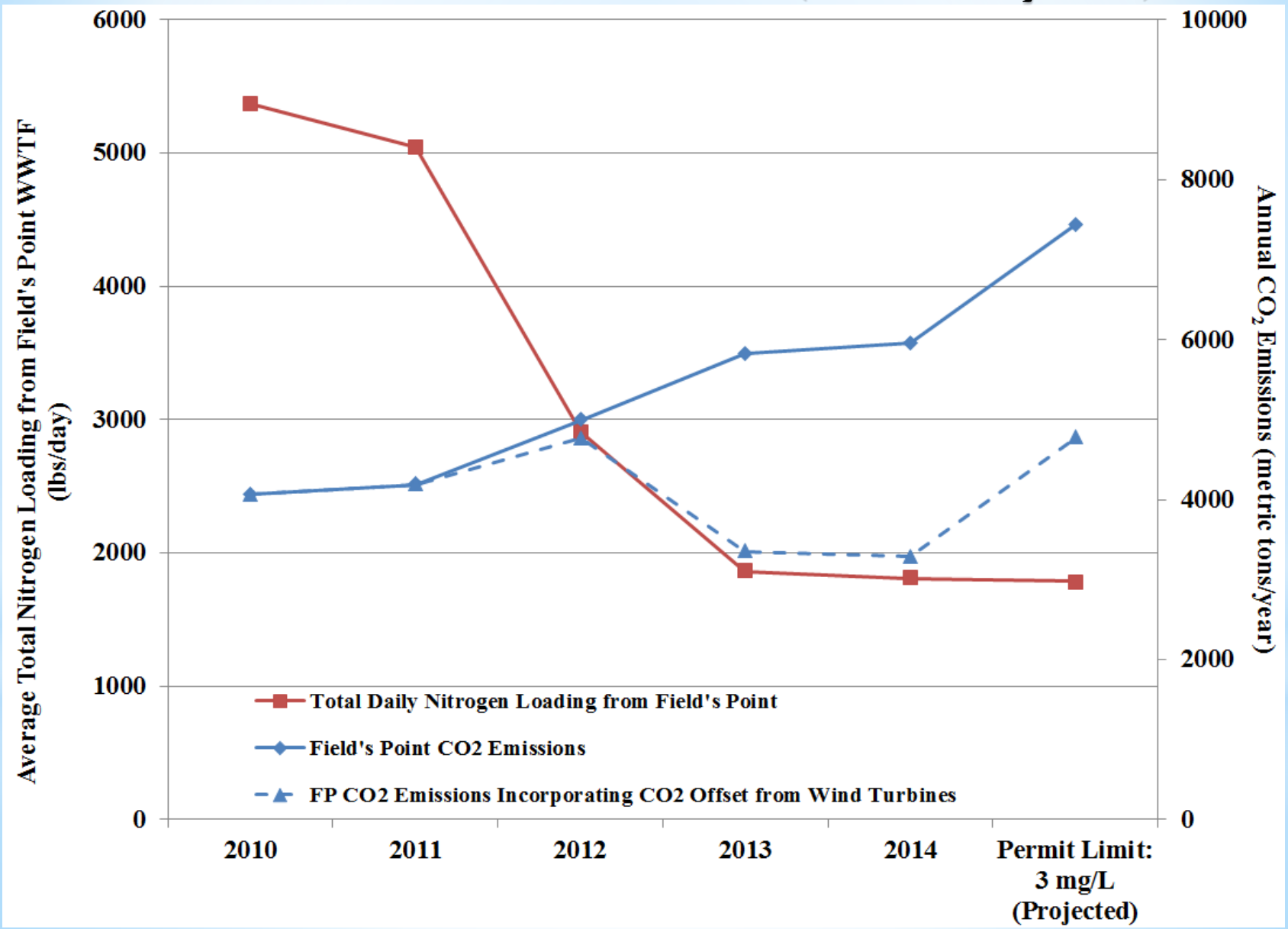
Electricity Costs Comparison



Source: Energy Information Administration - www.eia.doe.gov

- New England Electric Rates 51% above National average
- Rhode Island Electric Rates 44% above National average
- NBC aggressively pursues energy conservation and alternative energy opportunities

Total Nitrogen Loading at Field's Point vs. Estimated Greenhouse Gas Emissions (Electricity Use)

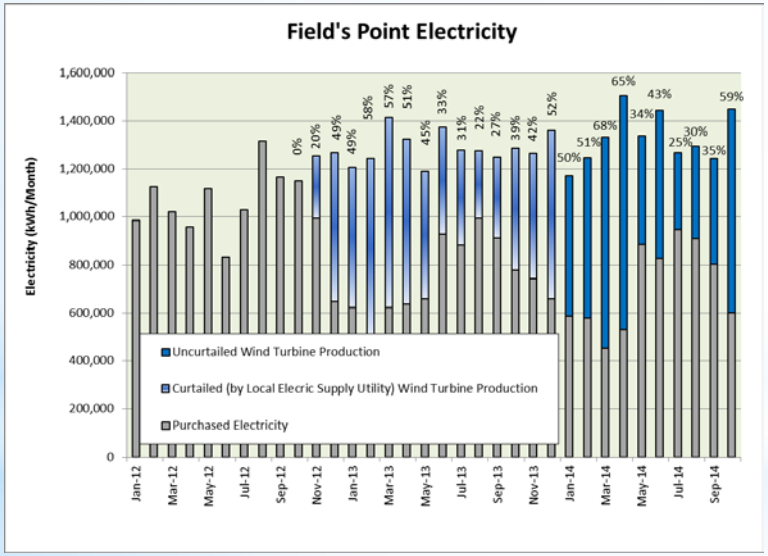


Field's Point Wind Energy

Wind Energy:

- Field's Pont 4.5 MW Wind Farm
- Installed - February 2012
- Operational - October 2012
- Provides 45% of Facility Energy Demand

Field's Point Energy Consumption and Wind Energy Production



Wind Energy Production and Energy Demand

Future Renewable Energy Projects

Biogas Combined Heat and Power

- 600 kW Combined Heat and Power (CHP) System Designed
- ~37% of Bucklin Point Electricity Demand
- Construction Project will go to bid soon

Solar Photovoltaic System

- 1 – 2.6 MW Array on Closed Sludge Landfill
- Provide 8.5% - 22% of BP Electricity Demand
- RFQP to perform feasibility study will be issued soon

Any Questions?

Special Thanks to:

- *Christine Comeau, Pamela Reitsma, Eliza Moore, Jim Kelly, John Motta & Barry Wenkowicz,*
- *NBC Monitoring, Lab & ESTA Staff*

Data and Presentations are available on NBC Website at http://snapshot.narrabay.com