Narragansett Bay Commission: Providing Wastewater Treatment, Improving Water Quality

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Environmental Scientists
Narragansett Bay Commission

The Greene School NBC Visit
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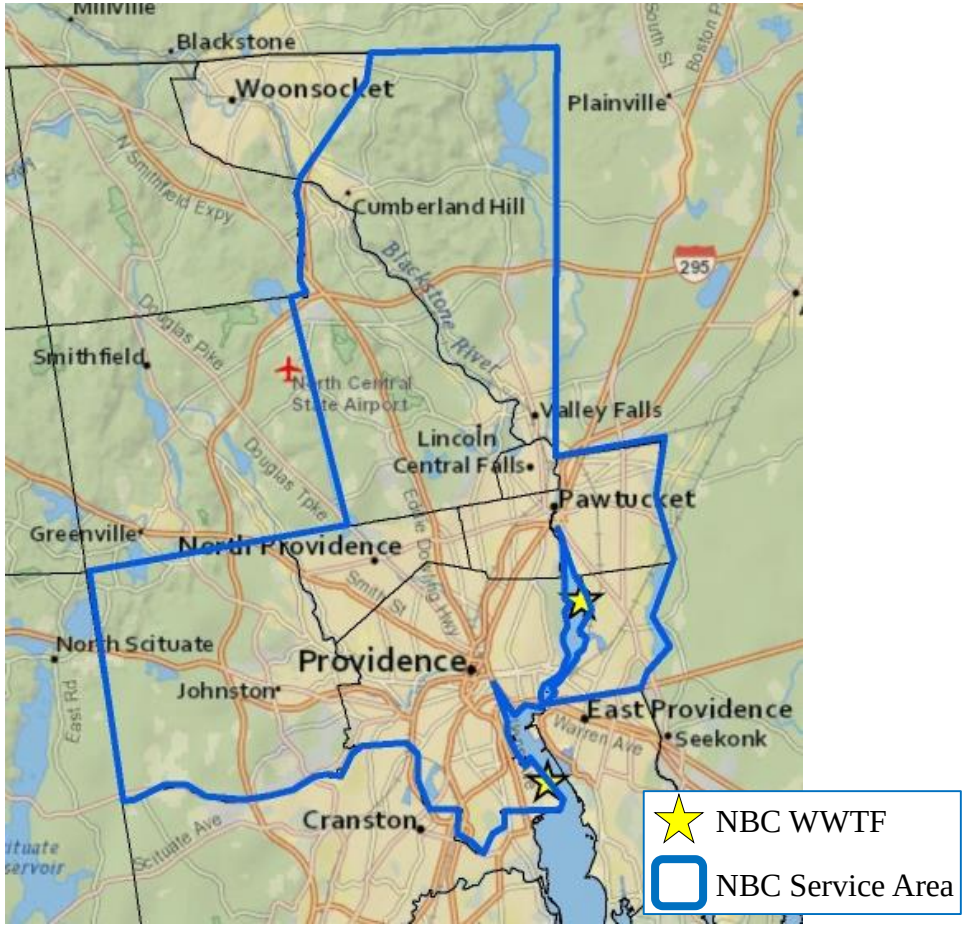
Narragansett Bay Commission Mission Statement

*To maintain a leadership role in the **protection and enhancement of water quality in Narragansett Bay** and its tributaries by providing safe and reliable wastewater collection and treatment services to its customers at a reasonable cost.*


Where is the water treated?



Map: National Geographic World Basemap

Narragansett Bay Commission Wastewater Treatment Facilities (WWTFs)

- Owner and operator of two major WWTFs in the state of Rhode Island.
  - Field's Point
  - Bucklin Point
- Serve 360,000+ residents and 8,000+ businesses in ten RI communities

Average flow: 38 MGD

Field's Point

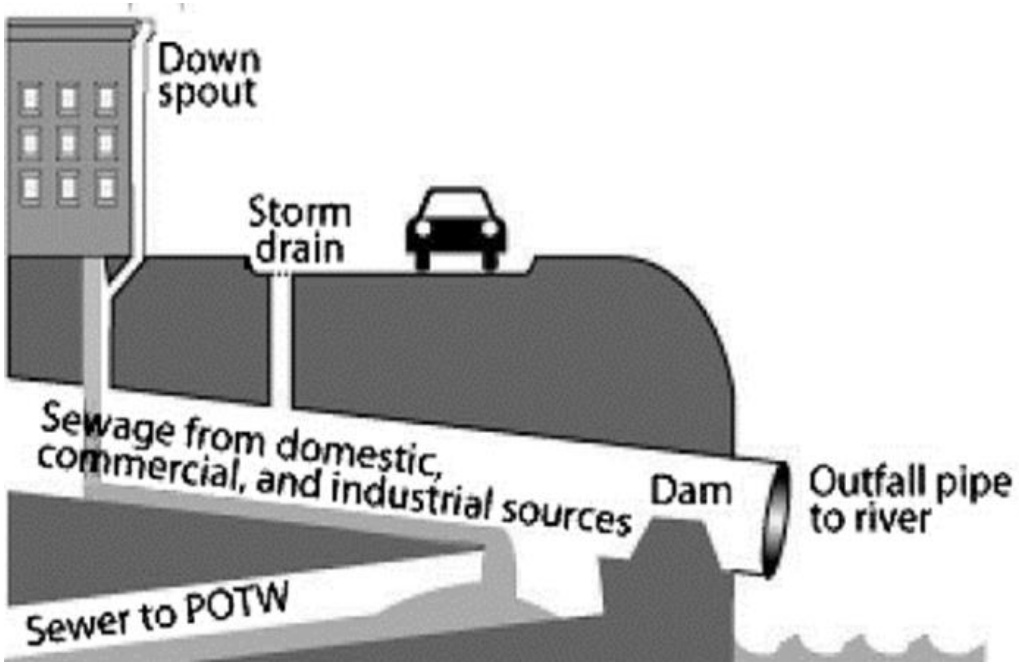
- **Primary treatment:** 123 MGD
- **Secondary treatment:** 77 MGD
- 80 miles of interceptors
- *Cities served:* Providence, Johnston, North Providence, Lincoln (Cranston, Smithfield)

Average flow: 16.25 MGD

Bucklin Point

- **Primary treatment:** 116 MGD
- **Secondary treatment:** 46 MGD
- 30 miles of interceptors
- *Cities served:* Pawtucket, Central Falls, Cumberland, East Providence


How does the wastewater get to the treatment plant?

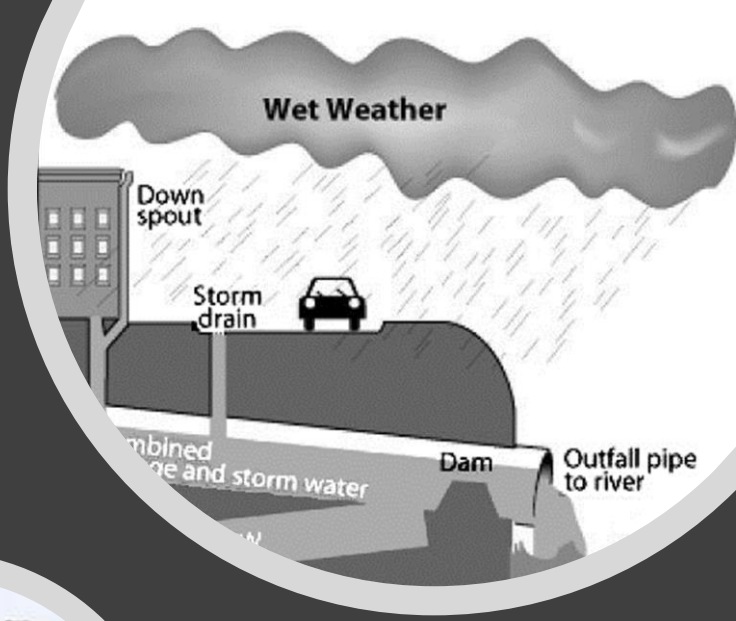


US EPA, 2004

Working for a clean Bay…

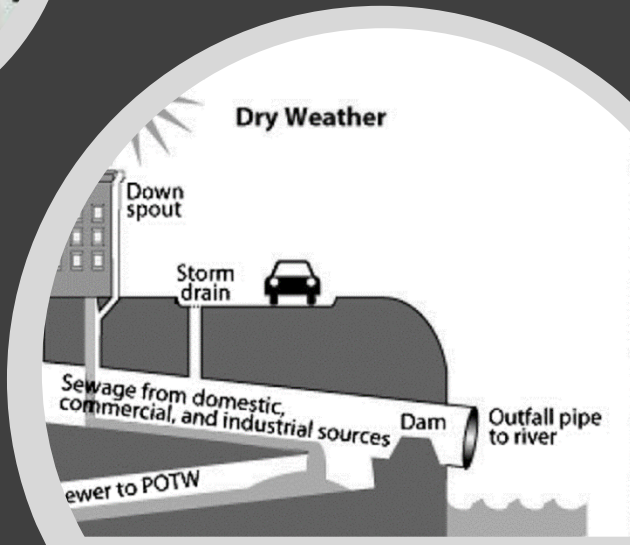
- Waste from buildings is transferred to a system of sewer pipes
- Waste travels to wastewater treatment facilities
- Water is treated and cleaned to remove bacteria and pollutants
- Treated water is released to the Bay

Combined Sewers



US EPA, 2004

- Overflows = stormwater overwhelms capacity of sewer pipes
  - Excess combined sewage discharges into local rivers
- Discharge of 2.2 billion gallons/year
  - Public health & water quality issues
  - Violate Clean Water Act
- CSO Abatement Project: reduce discharge by 98%




How is the water treated?

Wastewater Treatment Process

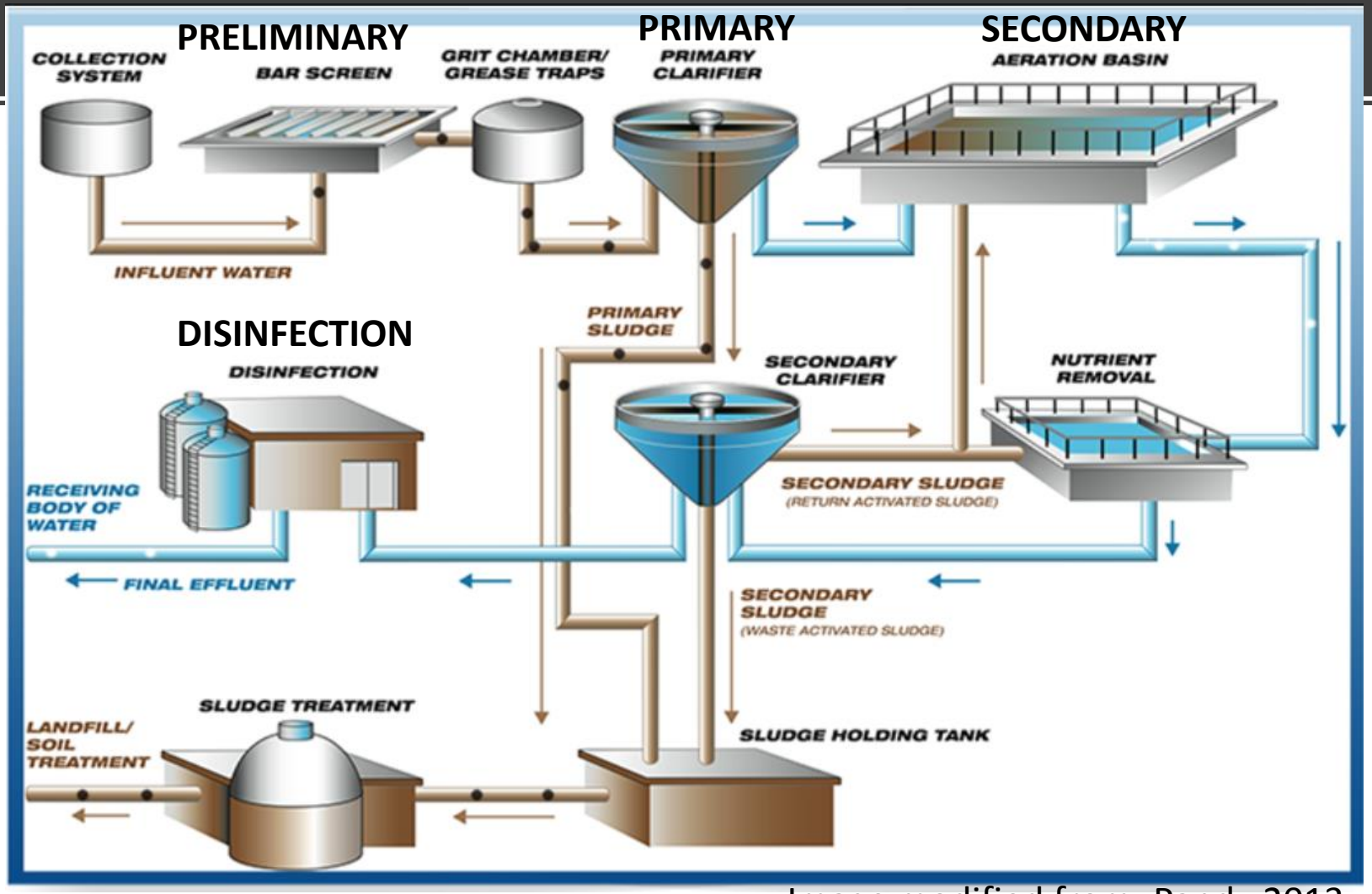


Image modified from: Pandy 2013

NBC's Field's Point

1. PRELIMINARY Screening and Coarse Grit Removal

2. PRIMARY Clarifiers

3. SECONDARY Biological Nutrient Removal

4. SECONDARY Clarifiers

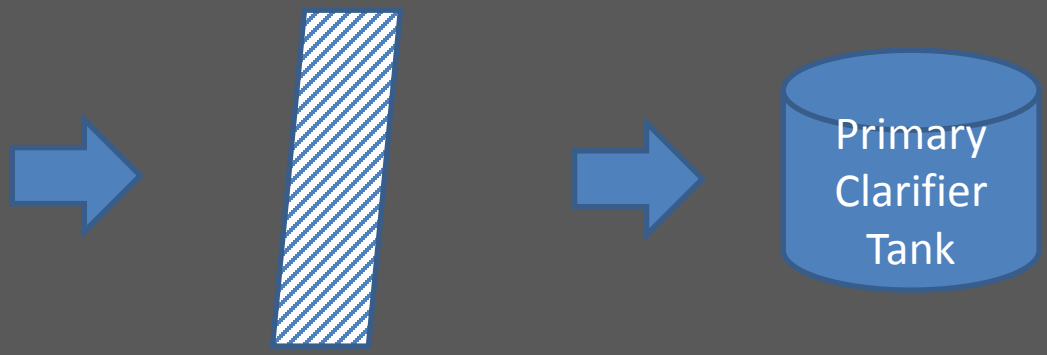
5. DISINFECTION

Preliminary and Primary Treatment

Coarse particle removal via screening and settling

Screening/Coarse
Grit Removal

INFLUENT



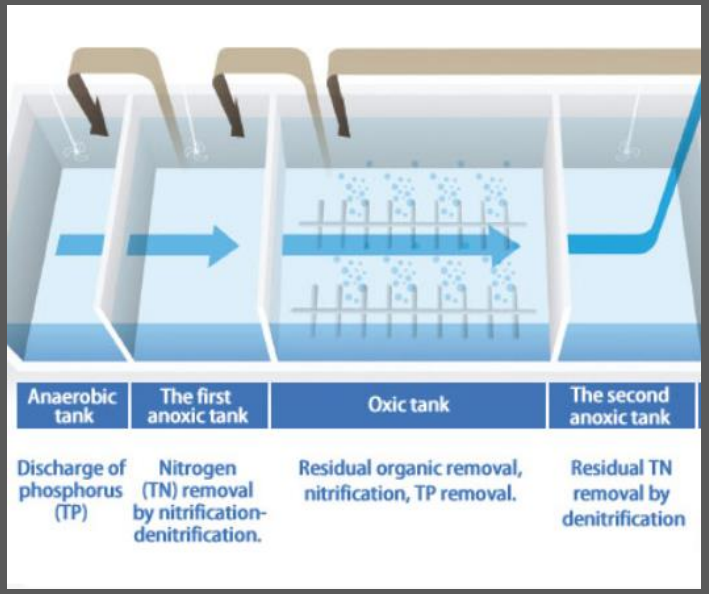
Sustainable Sanitation

T.L.M. Engineers

Monroe Environmental

Secondary Treatment

Advanced Secondary Treatment – Advanced nutrient removal and further settling – tanks have microbes and specific environmental conditions



Econity

Biological Nutrient Removal (BNR) → Secondary Clarifier

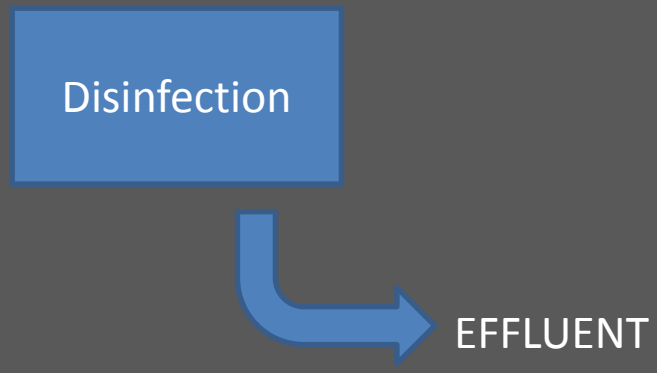
**Solids that have settled out are thickened and trucked offsite for disposal (landfill or incineration)

Disinfection

Western Virginia Water Authority

American Air and Water

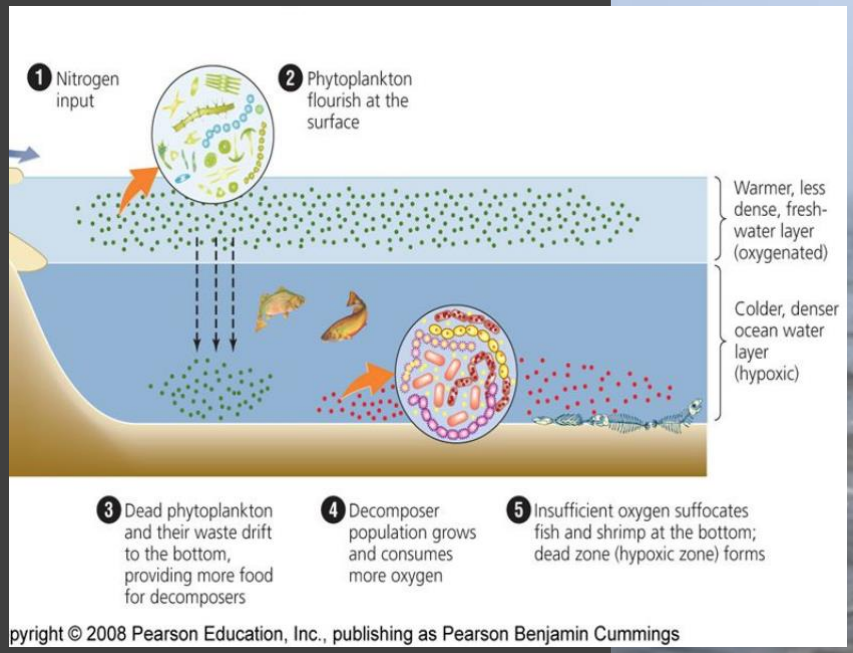
Disinfection – Via chlorination/dechlorination or UV light exposure



How does wastewater treatment affect water quality in Narragansett Bay?

WWTFs and the Bay: Nitrogen

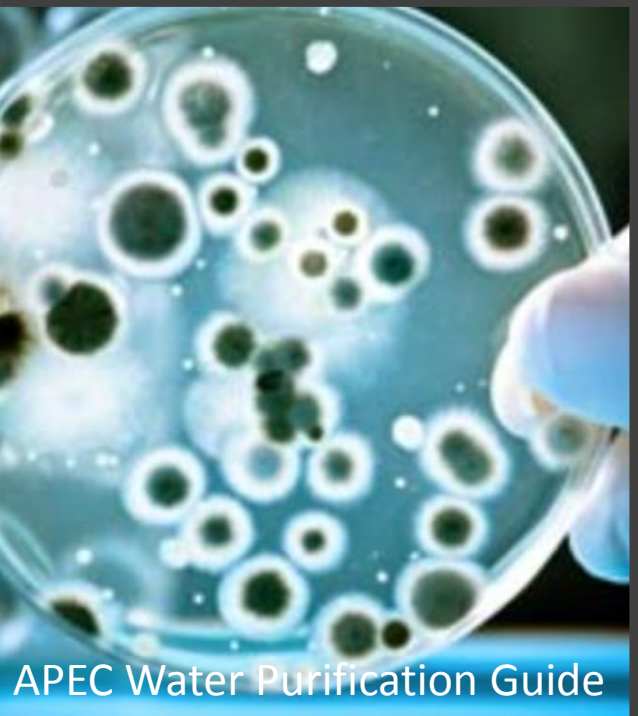
- WWTFs are a source of **nitrogen**
- Excess **nitrogen** loading can disrupt the estuarine environment via algal blooms
  - Microbes decomposing blooms remove oxygen from the water = fish kills



China.org.cn

Peter Blasl, Riverhead Local

New York SeaGrant


APEC Water Purification Guide

WWTFs and the Bay: Bacteria

- **Bacteria** can harm human health
  - Prevent swimming, shellfishing

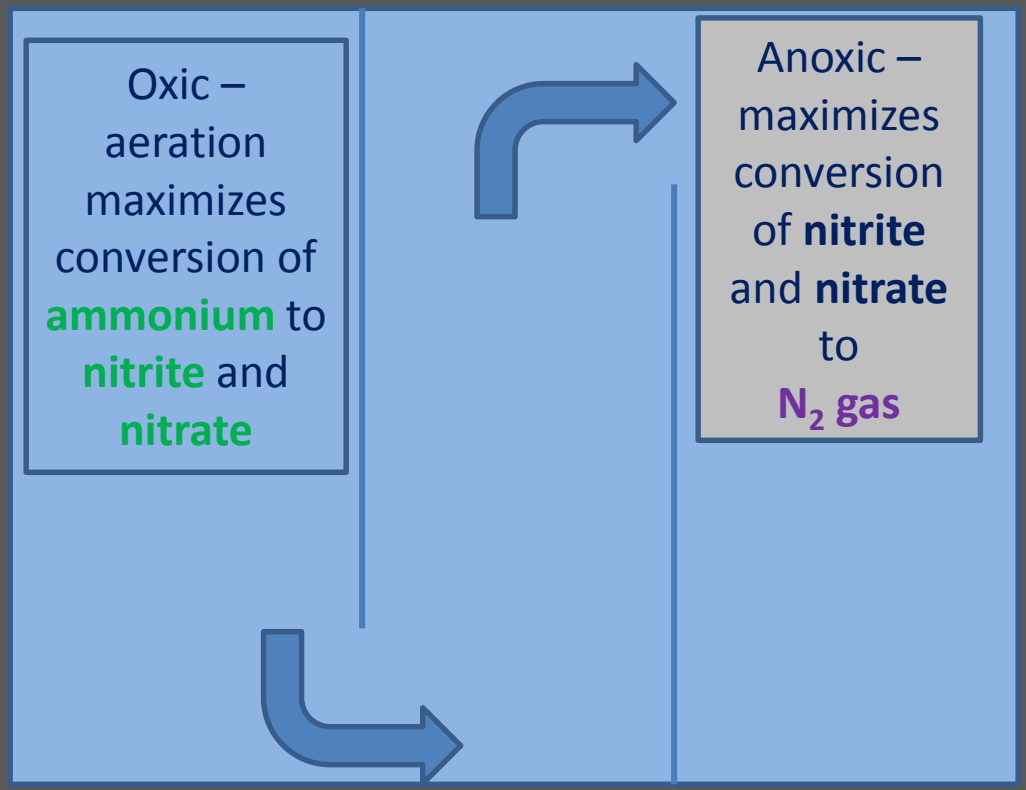
Rob Kent, The LOST Blog


How are we addressing nitrogen from WWTFs?

Biological Nutrient Removal During Secondary Treatment

From Primary Treatment: Total Nitrogen Average **27 mg/L**

Use microbes to clean the water! Convert nutrients (ammonium and nitrate) to gas!



To Secondary Clarifiers: Total Nitrogen Average **< 5 mg/L**

Nitrification

$NH_4^+ \rightarrow NO_2^- \rightarrow NO_3^-$

$N_2 \leftarrow N_2O \leftarrow NO \leftarrow NO_2^- \leftarrow NO_3^-$

Denitrification

geoweb.princeton.edu

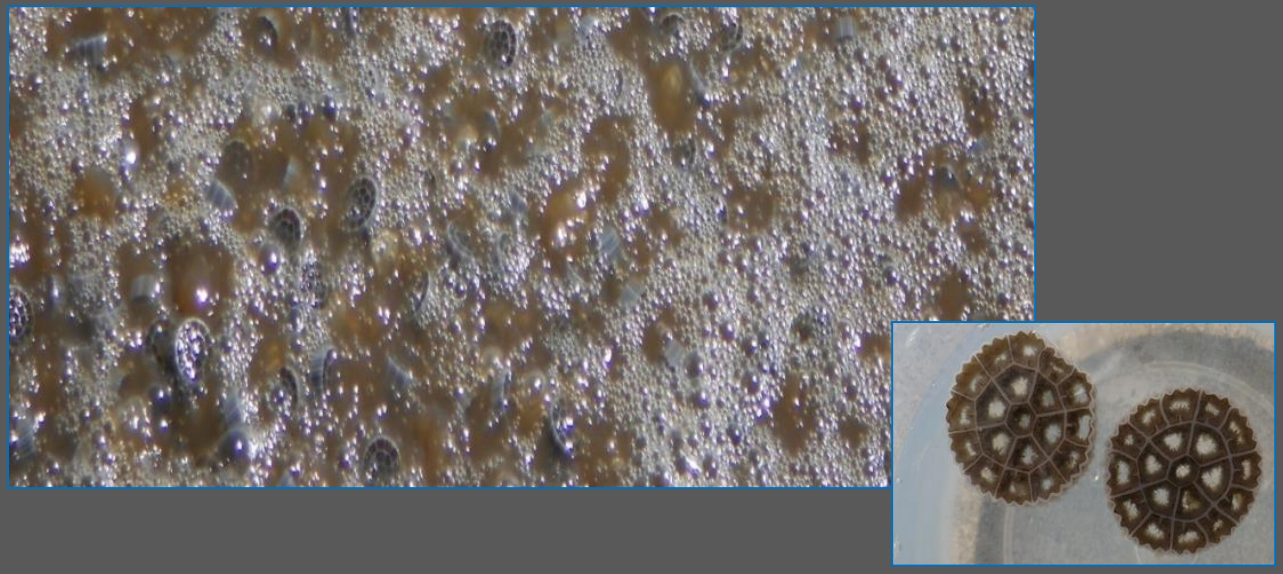
Biological Nutrient Removal (BNR)

- Optimize conditions for nitrification and denitrification
- NBC Permit limit (5 mg/L) in effect May – October

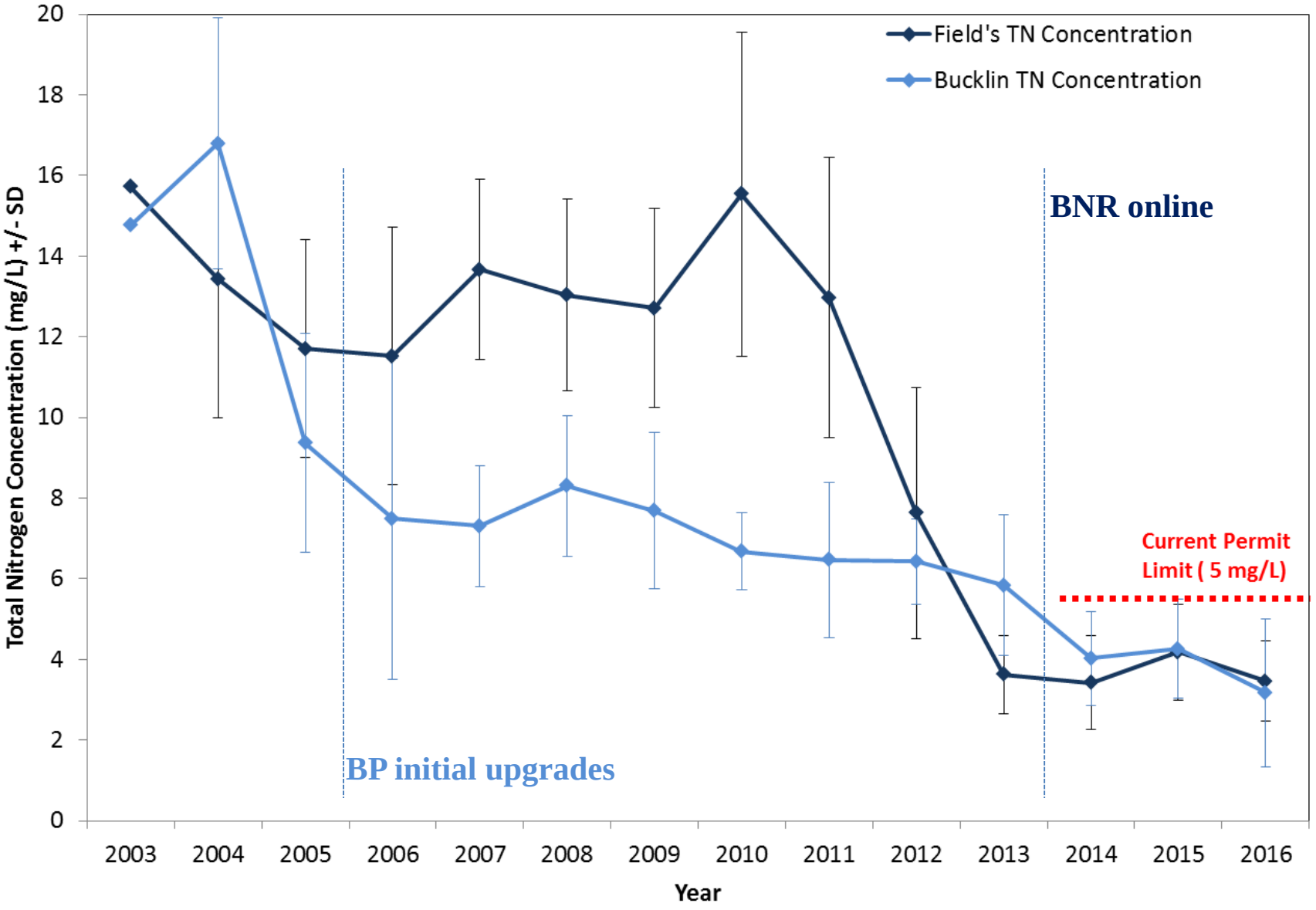
Total NBC Upgrade Cost: $44 Million

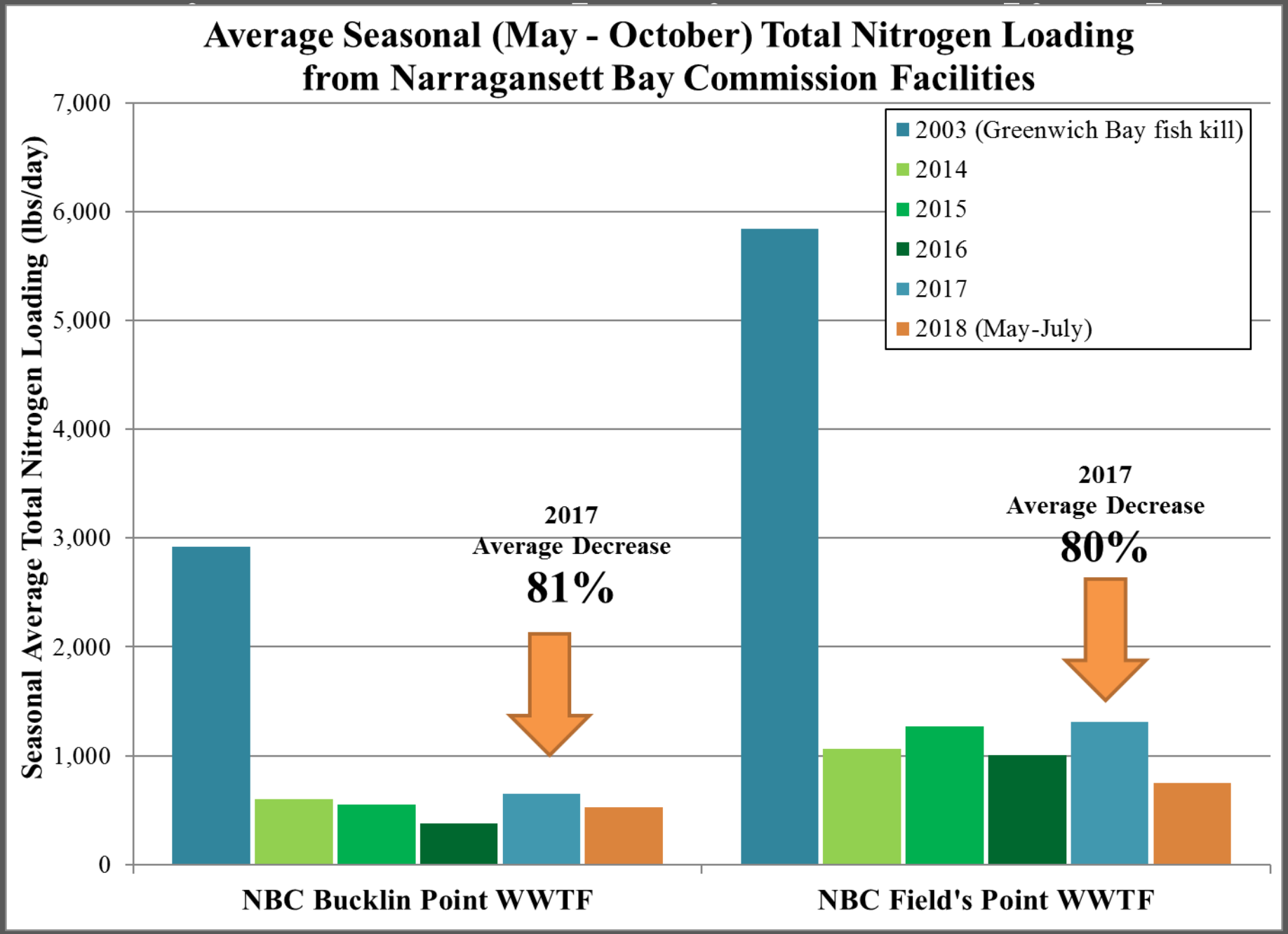
Field's Point

- Integrated Fixed Film Activated Sludge (IFAS) – May 2014



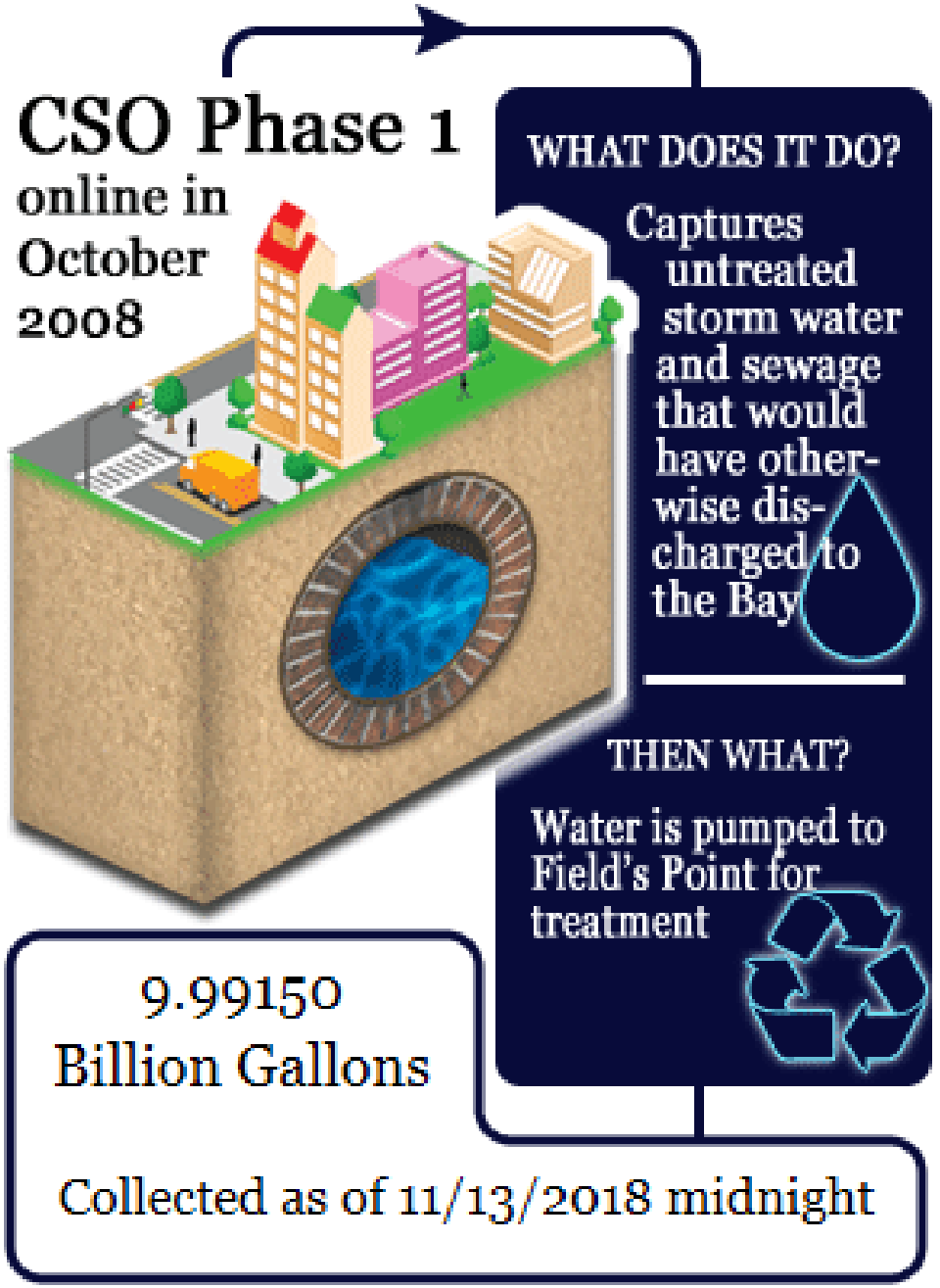
Field's Point and Bucklin Point
Seasonal (May - Oct) Average Effluent Total Nitrogen




Average Seasonal (May - October) Total Nitrogen Loading from Narragansett Bay Commission Facilities
Seasonal Average Total Nitrogen Loading (lbs/day)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2003 (Greenwich Bay fish kill)
2014
2015
2016
2017
2018 (May-July)
2017 Average Decrease 81%
2017 Average Decrease 80%
NBC Bucklin Point WWTF
NBC Field's Point WWTF


How are we addressing bacteria from WWTFs?

Tunnel to store waste from combined sewers to prevent release of sewage to bay



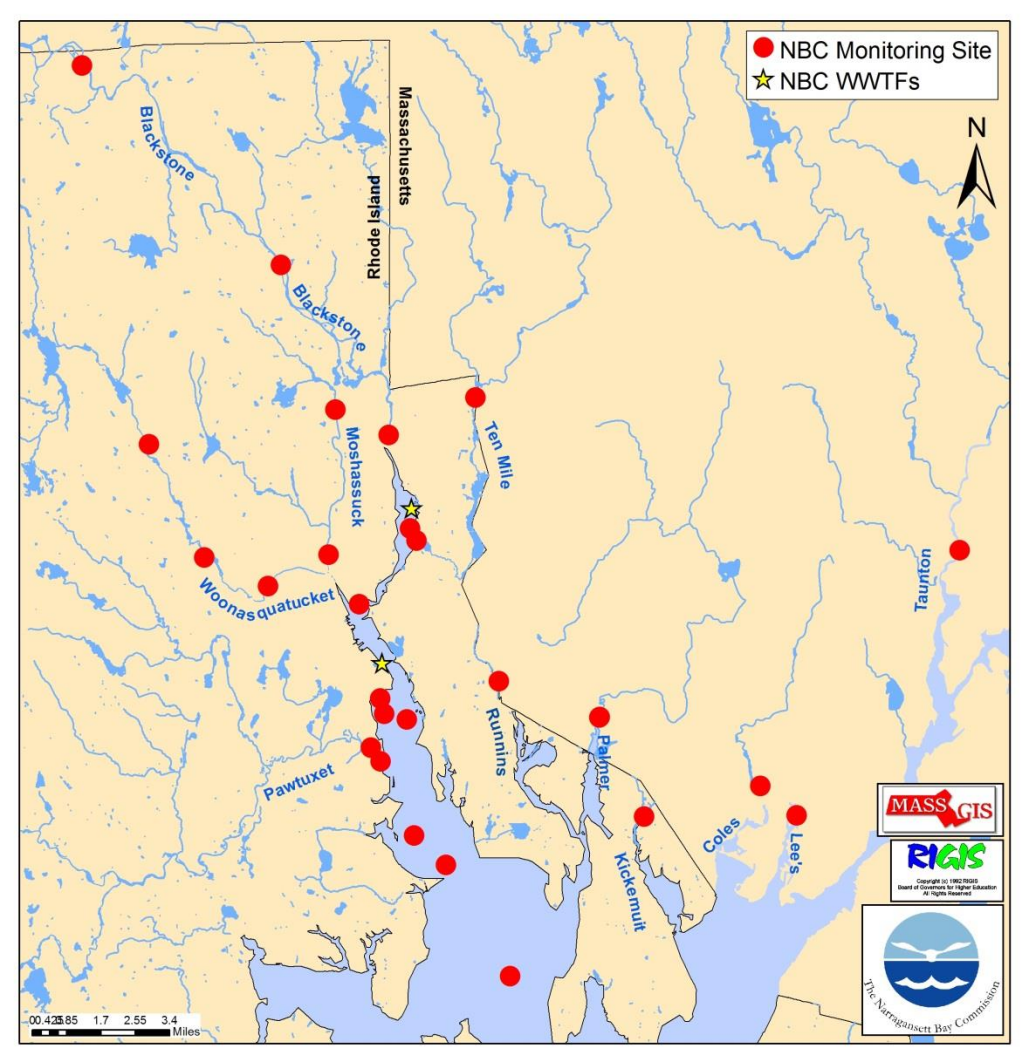

How do we track our progress in improving water quality?

NBC Water Monitoring

- **Why:**
  - To support decision-making for future infrastructure investments
- **What:**
  - Dissolved inorganic nitrogen (DIN) = nitrite, nitrate, ammonium
  - Bacteria
- **When:**
  - Every two weeks (weather permitting)

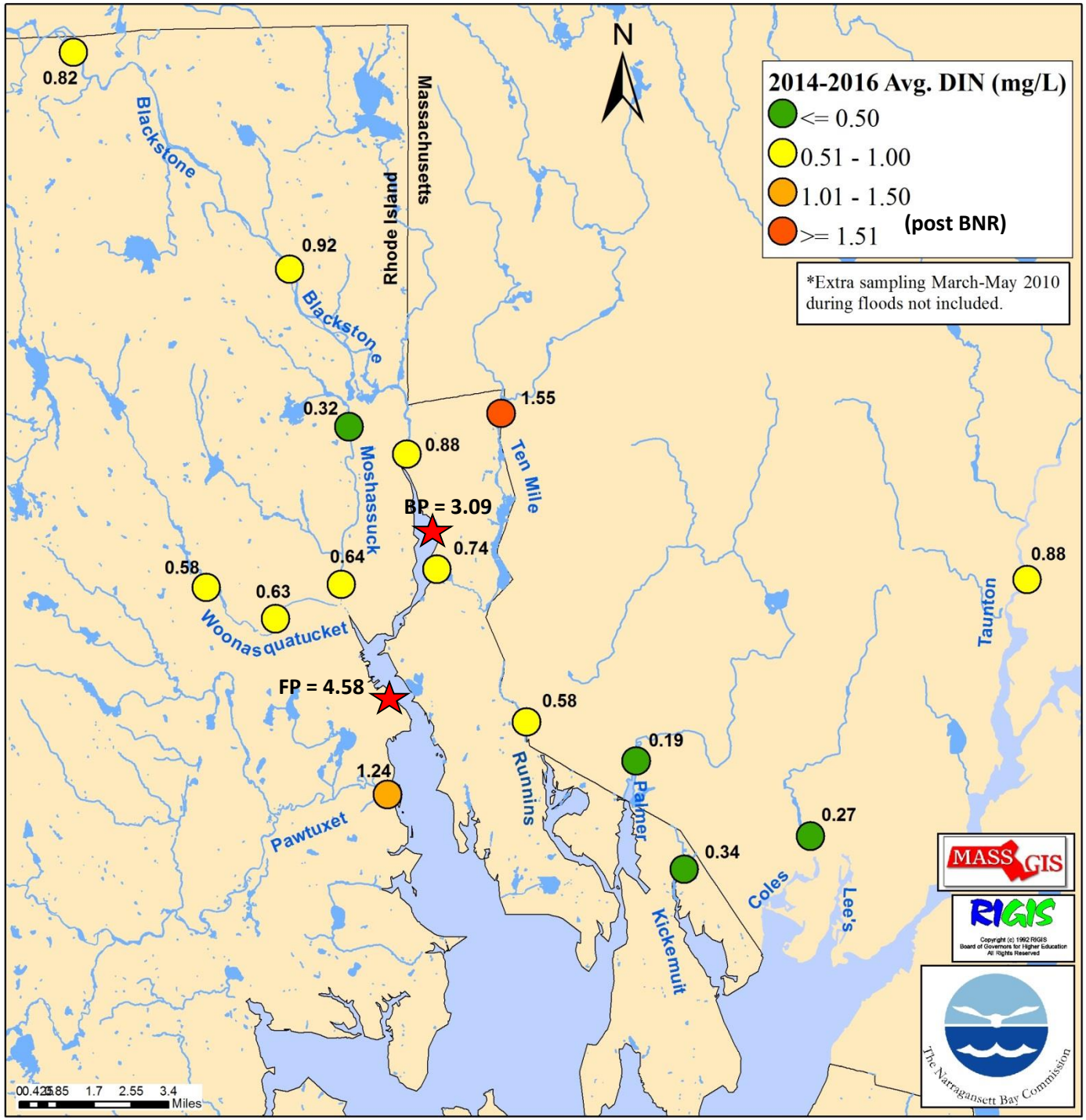
Data available online: http://snapshot.narrabay.com

NBC Monitoring



- **Where:**
  - River Monitoring:
    - 15 sites in RI and MA;
    - 11 Rivers
  - Bay Monitoring:
    - 7 sites in the Seekonk and Providence River estuaries

Data available online: http://snapshot.narrabay.com



River Nitrogen

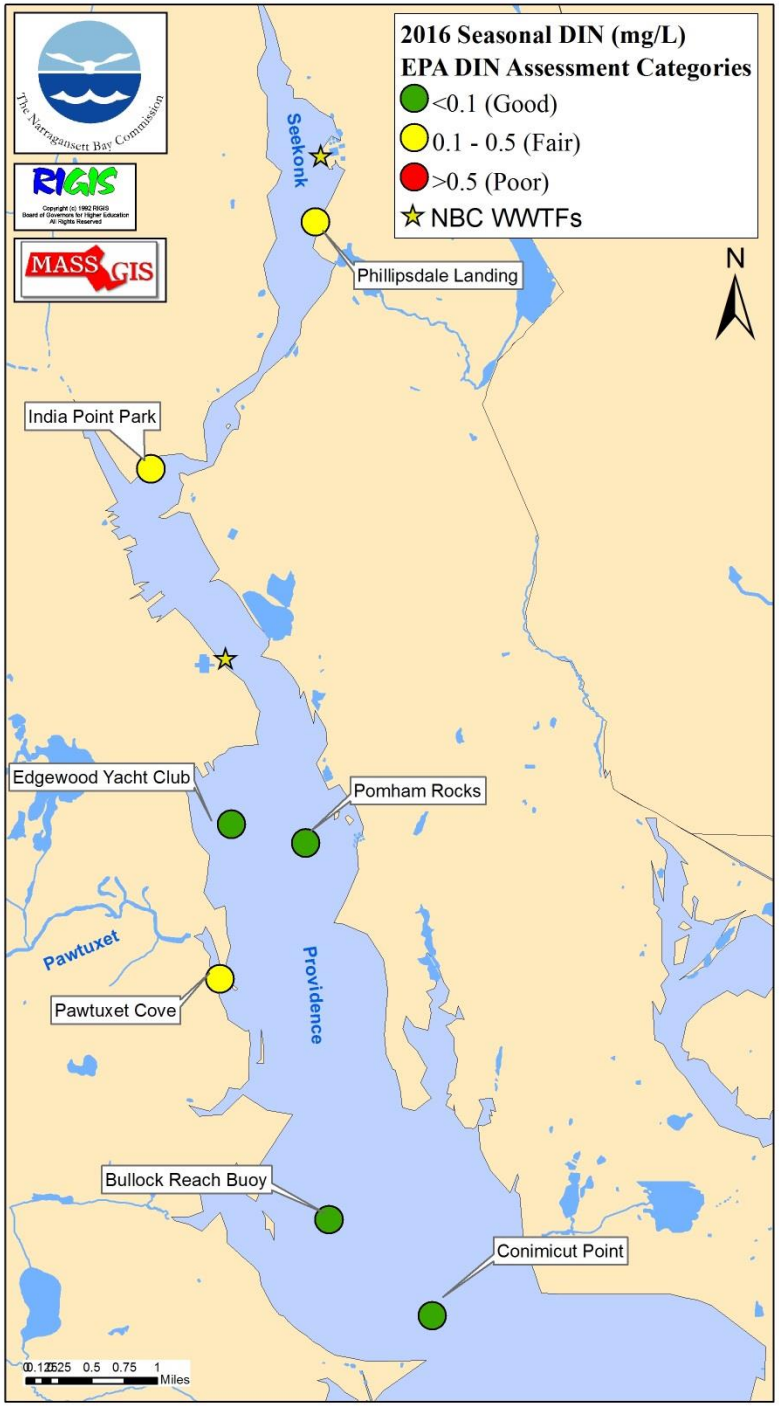
- Post-BNR conc. at WWTFs still highest
- Relatively high concentrations at Ten Mile River and Pawtuxet River.
- Moderately high at Blackstone River and Taunton

Bay Nitrogen

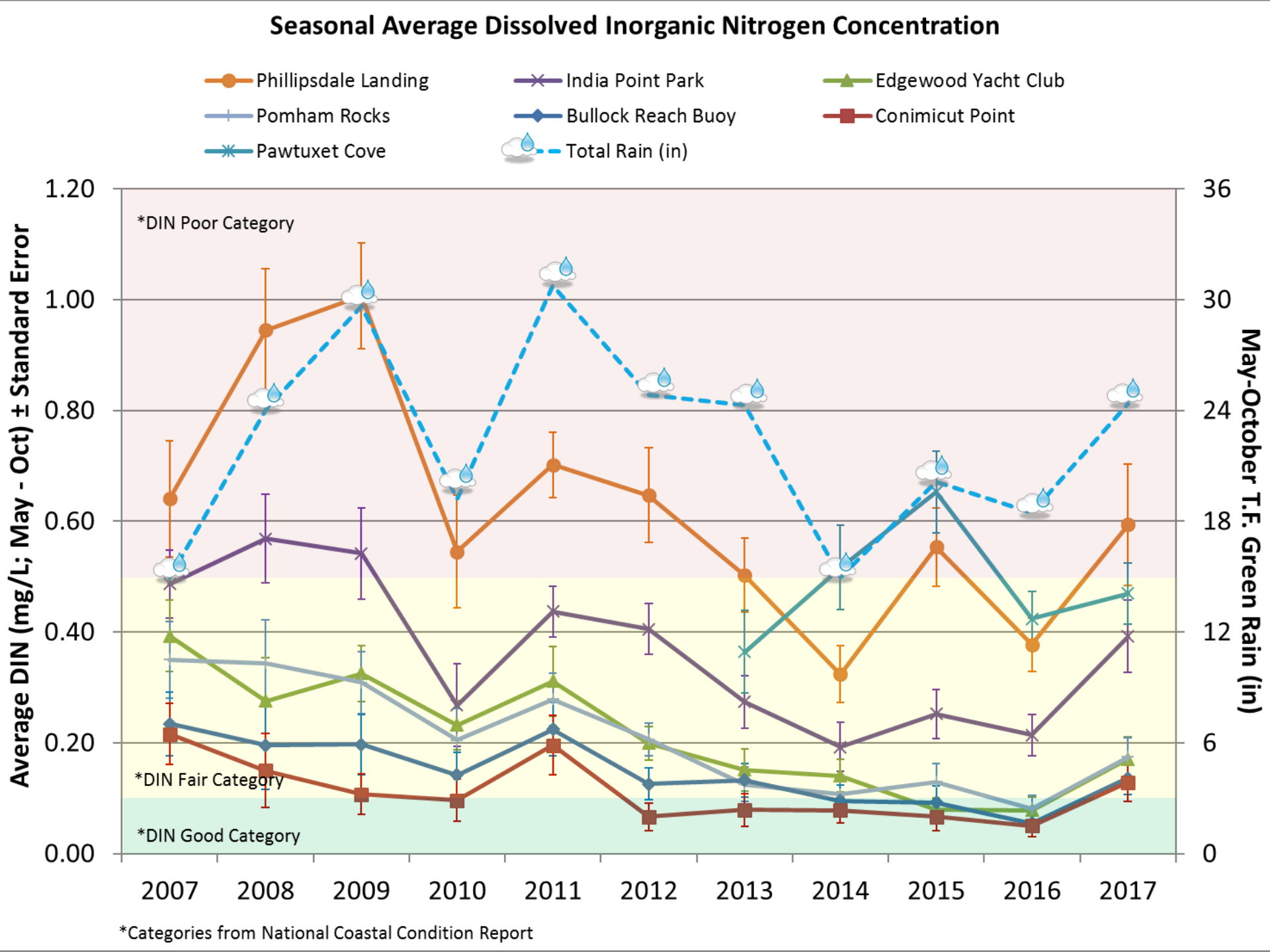
May – October 2016
Rainfall Total: 18.46 inches

Station	DIN (mg/L)	EPA CCR Category
DIN (mg/L) Good <0.1 Fair 0.1-0.5 Poor >0.5		
Phillipsdale Landing	0.38	
India Point Park	0.21	
Edgewood Yacht Club	0.08	
Pomham Rocks	0.08	
Pawtuxet Cove	0.42	
Bullock's Reach	0.05	
Conimicut Point	0.05	

EPA's Coastal Condition Assessment Guidelines



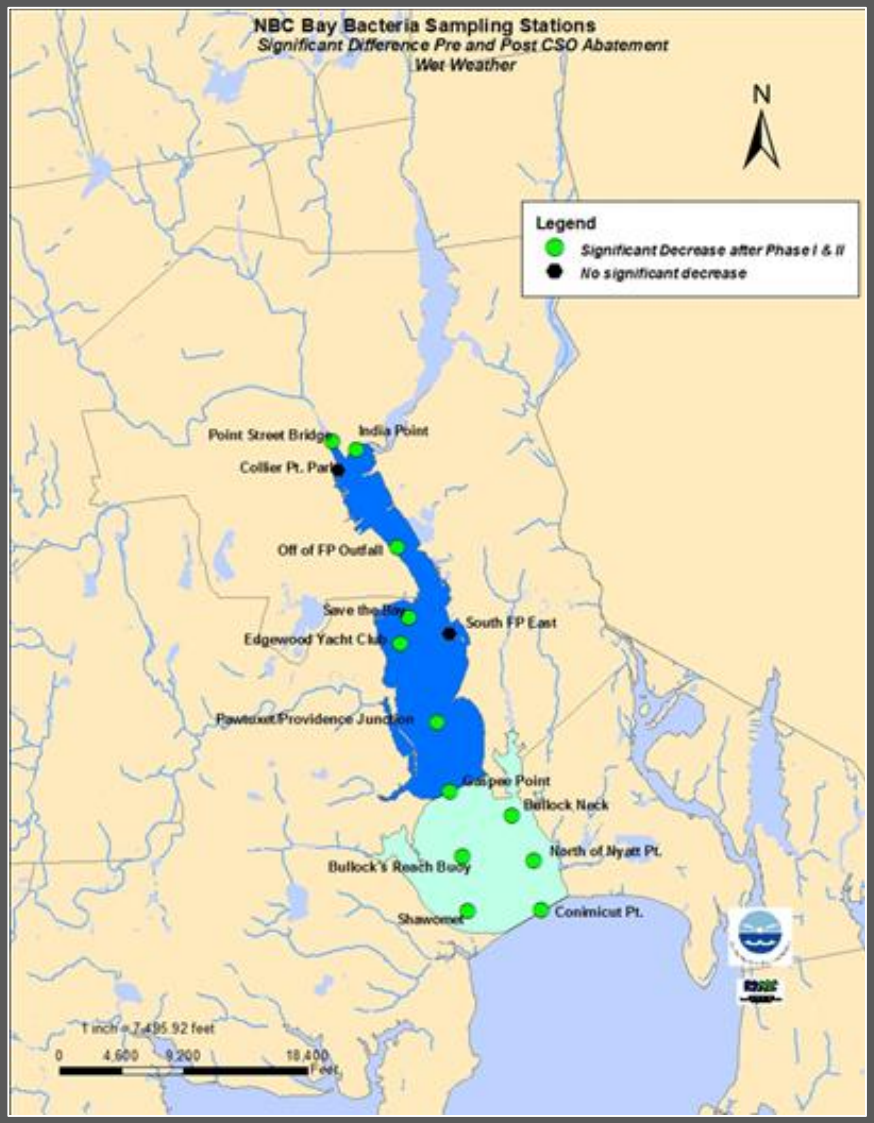
Seasonal Average Dissolved Inorganic Nitrogen Concentration

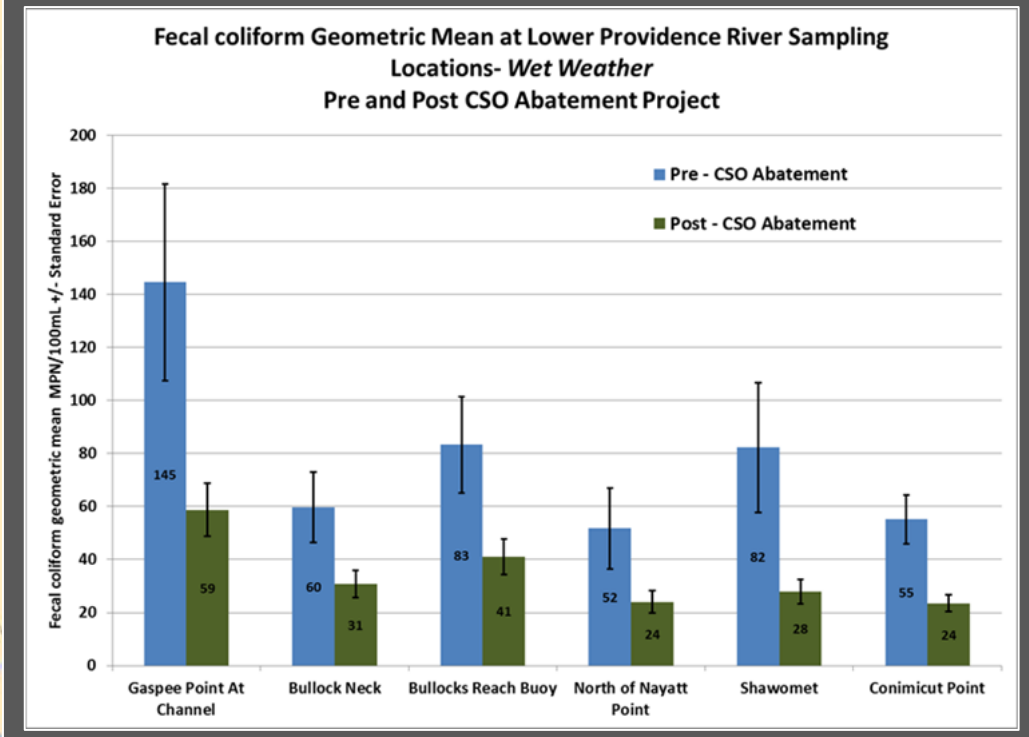


*Categories from National Coastal Condition Report

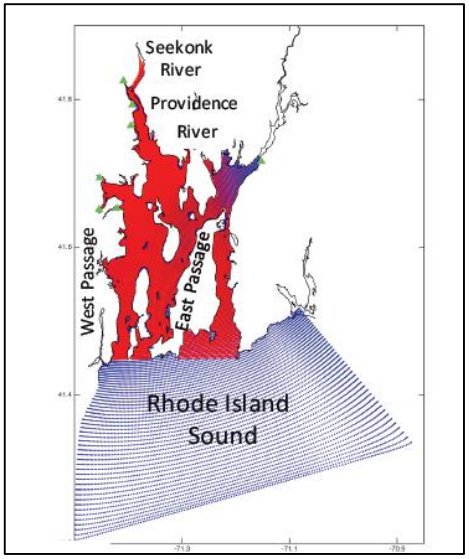
Bacteria Monitoring in the Bay

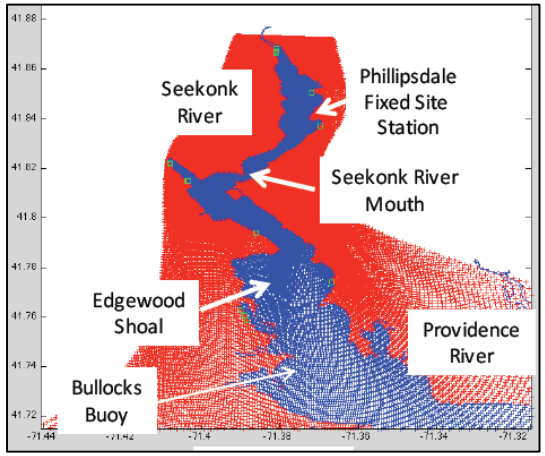
CSO Abatement and Water Quality

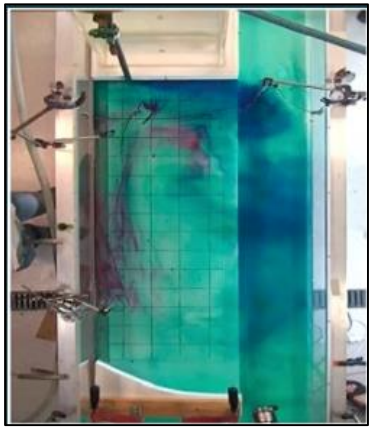





How can we plan for the future?



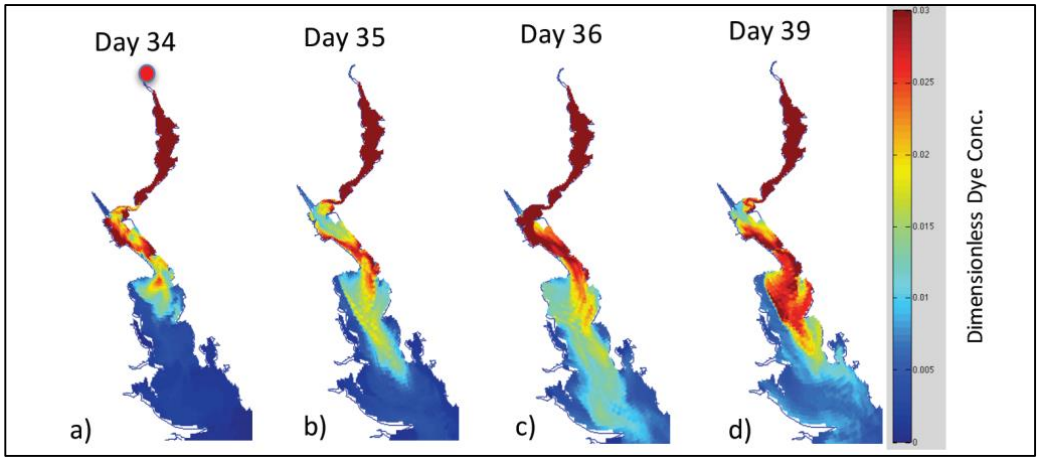




Regional Ocean Modeling System (ROMS)

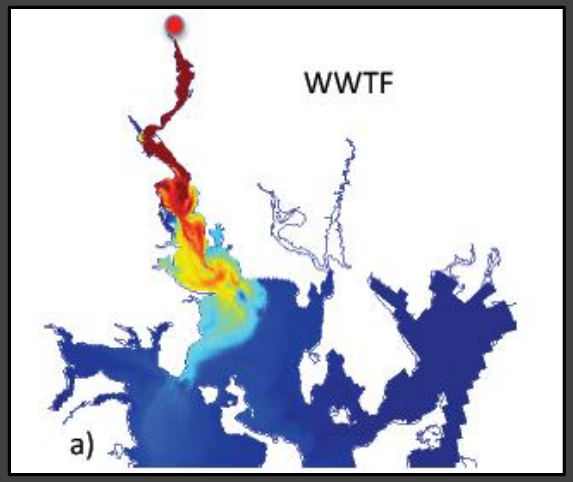
- Models movement of water (ocean circulation), nutrient dynamics, and phytoplankton blooms
- Uses a grid and a series of equations
- Can run different **nutrient scenarios** to understand how inputs from WWTFs and rivers impact algal bloom formation and oxygen conditions in the Bay

Images: Dr. Chris Kincaid, URI



Regional Ocean Modeling System (ROMS)

Nutrient Modeling



- Blackstone WWTF outputs in February 2010: down-bay dispersion patterns evident

Images: Dr. Chris Kincaid, URI

TAKE HOME MESSAGES

- WWTFs play an important role in **enhancing and protecting water quality of Narragansett Bay**
- **Biological nutrient removal** = reduced point-source nitrogen loadings
- **CSO abatement plans** = reduced bacteria levels
- Challenge: how do we address all pollutant sources in the watershed?
- Future approaches to improving water quality
  - Address non-point sources through fertilizer/stormwater controls
  - Restoration of shellfish (oyster reefs), wetlands, eel grass to increase ecosystem resilience

Acknowledgements

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- **University of Rhode Island – Graduate School of Oceanography** – Dr. Chris Kincaid's Hydrodynamics Laboratory

THANK YOU FOR YOUR ATTENTION
QUESTIONS?

View our data and blog posts here:
http://snapshot.narrabay.com/app/