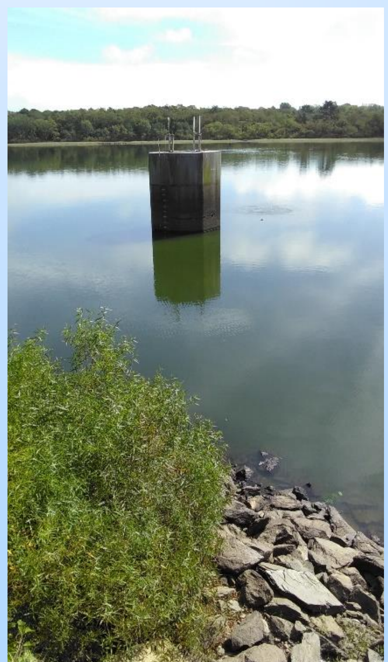
Newport Water Supply Reservoirs

Total Phosphorus and Total Organic Carbon TMDLs



RIDEM
Office of Water Resources
June 23, 2021 3-5 PM

Overview of Meeting

- Federal Clean Water Act Requirements
- Overview of Newport Reservoir TMDL Study Area
- Water Quality Problems Addressed by TMDL
- Overview of Draft TMDL Study
  - Development of total phosphorus targets
  - Determining existing phosphorus loads
  - Calculating load capacities
  - Allocating TMDLs between point and non-point sources
  - Evaluating sources/source categories of phosphorus
  - Identifying and describing actions to reduce phosphorus loads
- Overview of RIDEM Watershed Planning for Aquidneck Island

Federal Clean Water Act

Restore and maintain the chemical, physical, and biological integrity of the nation's waters.

Clean Water Act
Water Quality Standards Program

Establish Water Quality Standards for the State's Surface Waters
Designating uses for waterbodies
Water Quality Criteria (numeric or narrative)

Monitor and Assess each Waterbody

Identify Waters not Meeting Water Quality Criteria
303(d) List
Prioritize List for TMDL development

Develop TMDL (or Equivalent)
Submit TMDL to EPA for Approval

Designated Uses for Class AA Drinking Water Supplies

Designated Use	Applicable Classifications	Designated Use Definitions
Drinking Water Supply	AA	Supply safe drinking water with conventional treatment.
Primary Contact Recreation/Swimming	All surface waters	Swimming, water skiing, surfing or other recreational activities with prolonged and intimate contact by the human body with water.
Secondary Contact Recreation/Boating	All surface waters	Boating, canoeing, fishing, kayaking or other recreational activities with minimal contact by the human body with the water and the probability of ingestion of the water is minimal.
Aquatic Life Support/ Fish, other Aquatic Life and Wildlife	All surface waters	Waters suitable for the protection, maintenance, and propagation of a viable community of aquatic life and wildlife.
Fish Consumption	All surface waters	Supports fish free from contamination that could pose a human health risk to consumers.

2014 303(d) Listings that TMDL addresses

All nine reservoirs identified as impaired:

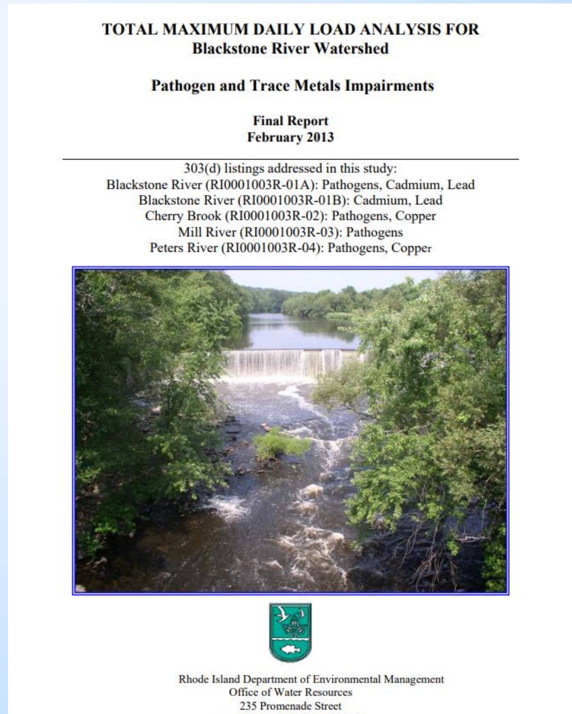
- Drinking Water Use Support (assessed by RIDOH CDWQ)
  - Total Organic Carbon *(contributes to elevated levels of trihalomethanes in finished drinking water)*

- Aquatic Life Use Support (assessed by RIDEM utilizing 2011 and 2012 data)
  - Total Phosphorus *(contributes to periodic low dissolved oxygen levels and frequent and excessive algal and cyanobacteria blooms)*

TMDL – Plans for Restoring Impaired Waters

What is a Total Maximum Daily Load?

- Federally mandated Water Quality Restoration Study for an Impaired Waterbody
- Determines maximum amount of a pollutant(s) that a body of water can receive and still meet water quality standards



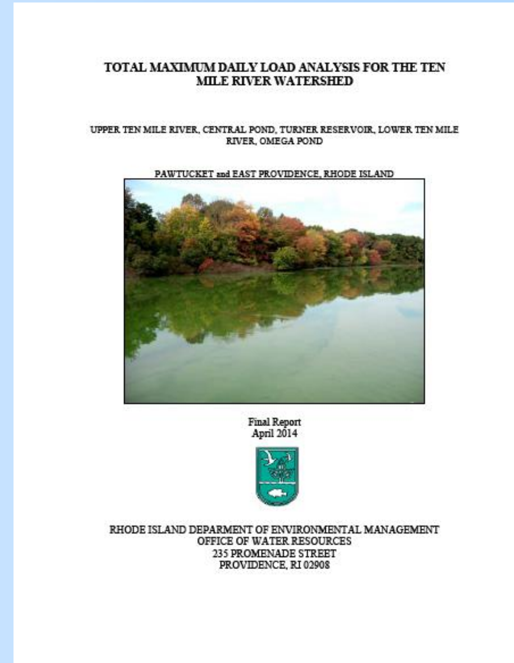
TOTAL MAXIMUM DAILY LOAD ANALYSIS FOR
Blackstone River Watershed

Pathogen and Trace Metals Impairments

Final Report
February 2013

303(d) listings addressed in this study:
Blackstone River (RI0001003R-01A): Pathogens, Cadmium, Lead
Blackstone River (RI0001003R-01B): Cadmium, Lead
Cherry Brook (RI0001003R-02): Pathogens, Copper
Mill River (RI0001003R-03): Pathogens
Peters River (RI0001003R-04): Pathogens, Copper

Rhode Island Department of Environmental Management
Office of Water Resources
235 Promenade Street
Providence, Rhode Island 02908



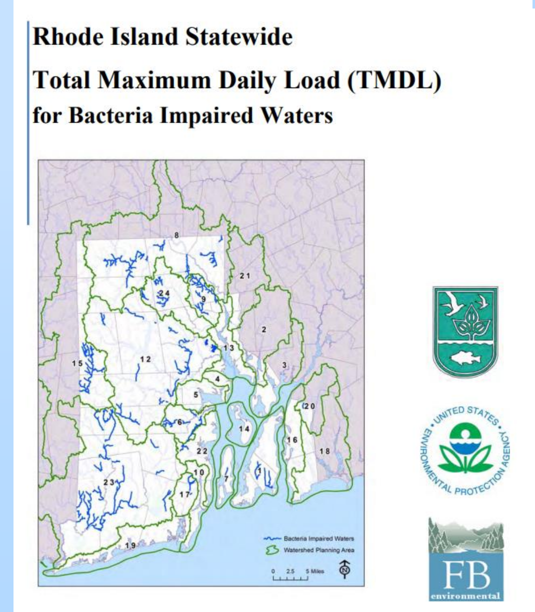
TOTAL MAXIMUM DAILY LOAD ANALYSIS FOR THE TEN MILE RIVER WATERSHED

UPPER TEN MILE RIVER, CENTRAL POND, TURNER RESERVOIR, LOWER TEN MILE RIVER, OMEGA POND

PAWTUCKET and EAST PROVIDENCE, RHODE ISLAND

Final Report
April 2014

RHODE ISLAND DEPARMENT OF ENVIRONMENTAL MANAGEMENT
OFFICE OF WATER RESOURCES
235 PROMENADE STREET
PROVIDENCE, RI 02908



Rhode Island Statewide

Total Maximum Daily Load (TMDL)
for Bacteria Impaired Waters

TMDL Equation

TMDL	=	WLA	+	LA	+	MOS
Total Maximum Daily Load (Total Loading Capacity)		Wasteload Allocation ("Point Sources")		Load Allocation ("Nonpoint Sources")		Margin of Safety
The amount of pollution a waterbody can receive and still meet water quality standards.		Achieved by required permits or other regulations.		Achieved by regulatory or Non-regulatory methods. Requires "reasonable assurances"		Accounts for uncertainty
		Examples Wastewater Discharges Municipal Separate Storm Sewer Systems (MS4s) RIDOT Stormwater Landfill Permit		**Examples** Agricultural runoff OWTS failures Natural Background (Forest, atm) Non-point sources contributing to water quality violations Channel erosion		

TMDL Study Area

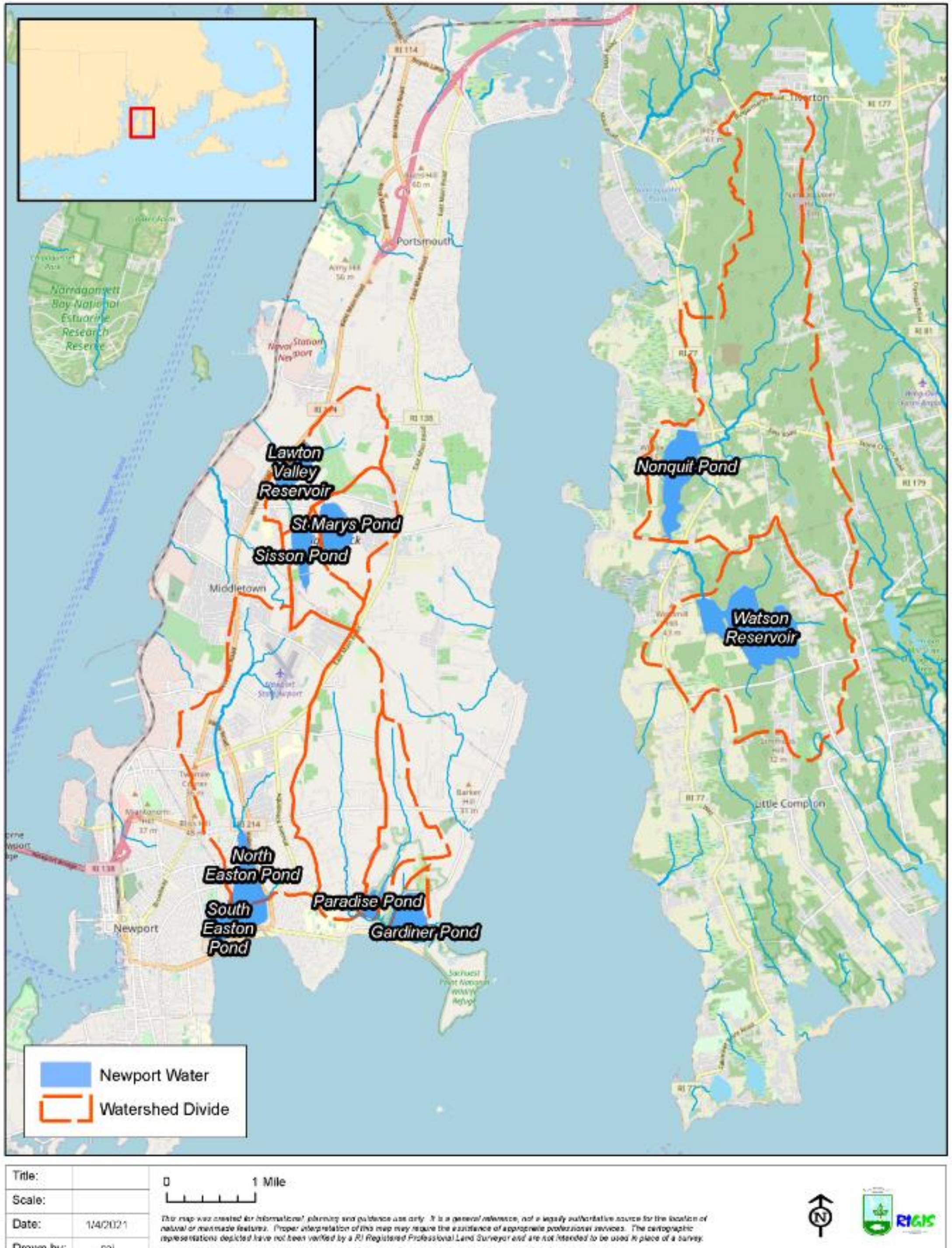
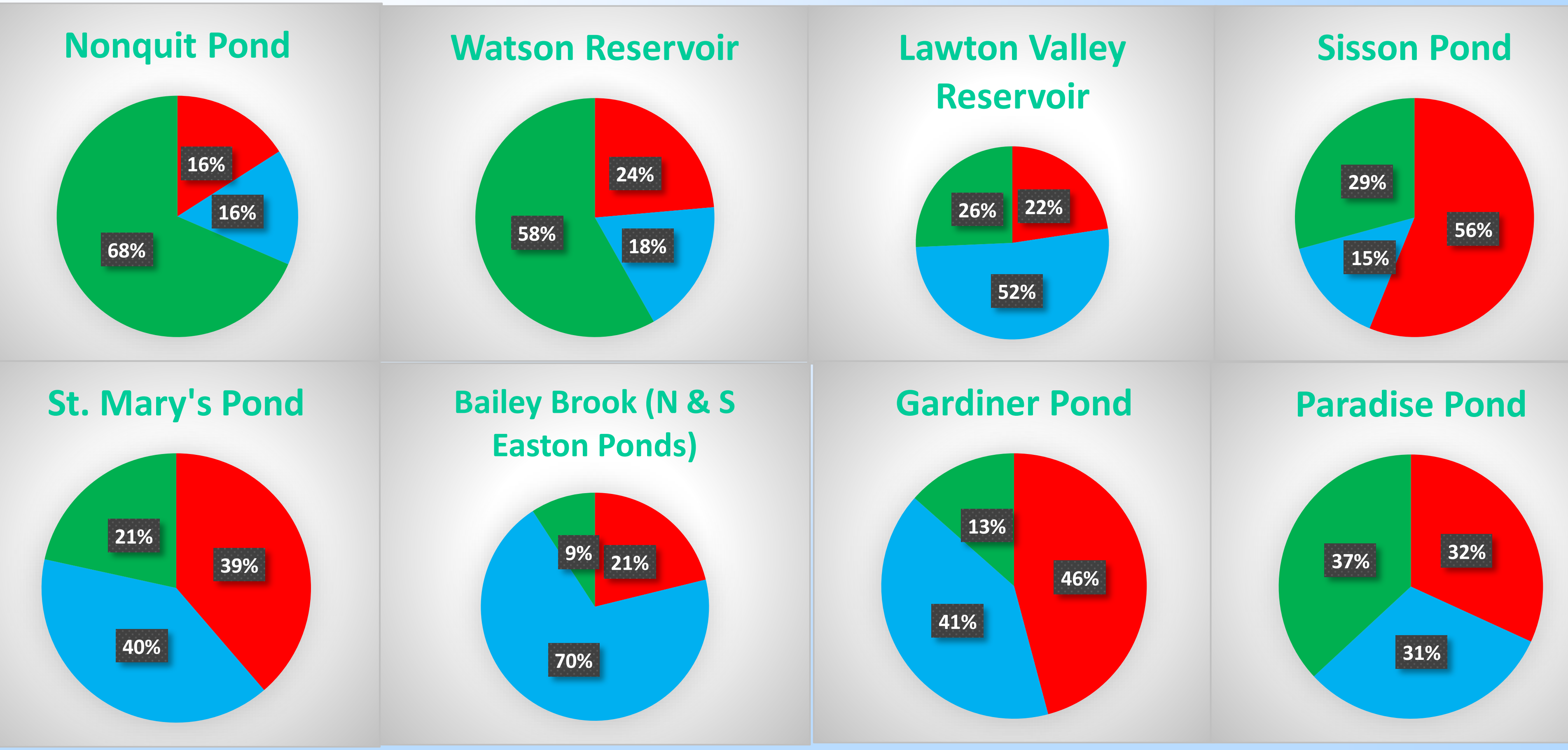


Table 2.2. Newport Water Supply Reservoir interconnection summaries.

Reservoir	Source of Inflow	Outflow Transfer Method	Destination of Outflow
Nonquit Pond	Watershed Drainage Quaker Brook Borden Brook Unnamed tributaries	Sakonnet Pumping Station and Pipeline	St. Marys Pond Lawton Valley WTP North Easton Pond via Bailey Brook
Watson Reservoir	Watershed Drainage Unnamed tributaries	Sakonnet Pumping Station and Pipeline	St. Marys Pond Lawton Valley WTP North Easton Pond via Bailey Brook
Lawton Valley Reservoir	Watershed Drainage Sisson Pond via Lawton Valley Brook Watson Reservoir	Pumping Station and Pipeline	Lawton Valley WTP
Sisson Pond	Watershed Drainage St. Marys Pond	Sisson Pond Stream Unnamed stream to	Lawton Valley Reservoir Bailey Brook
St. Marys Pond	Watershed Drainage Watson Reservoir Nonquit Pond	St. Marys Pumping Station and Pipelines Reservoir spillage to Sisson Pond	Lawton Valley WTP North Easton Pond via Bailey Brook
North Easton Pond	Watershed Drainage Bailey Brook St. Marys Pond Paradise Pond Gardiner Pond Sisson Pond	Pumping Station and Pipeline South Easton Pond	Station 1 WTP (at North Easton Pond
South Easton Pond	Watershed Drainage North Easton Pond Paradise Pond Gardiner Pond	Pumping Station and Pipeline	Station 1 WTP (at North Easton Pond)
Paradise Pond	Watershed Drainage Paradise Brook Maidford River Gardiner Pond	Paradise Pump Station and Pipeline	Station 1 WTP Gardiner Pond North Easton Pond
Gardiner Pond	Watershed Drainage Maidford River Paradise Pond	Paradise Pump Station and Pipeline	Station 1 WTP Paradise Pond North Easton Pond

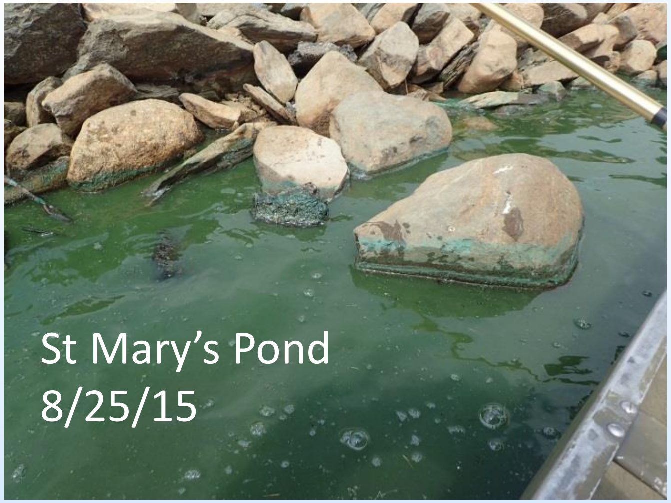
General Land Use Summaries

Urban · Agriculture · Forest/Wetland



DEM
RHODE ISLAND

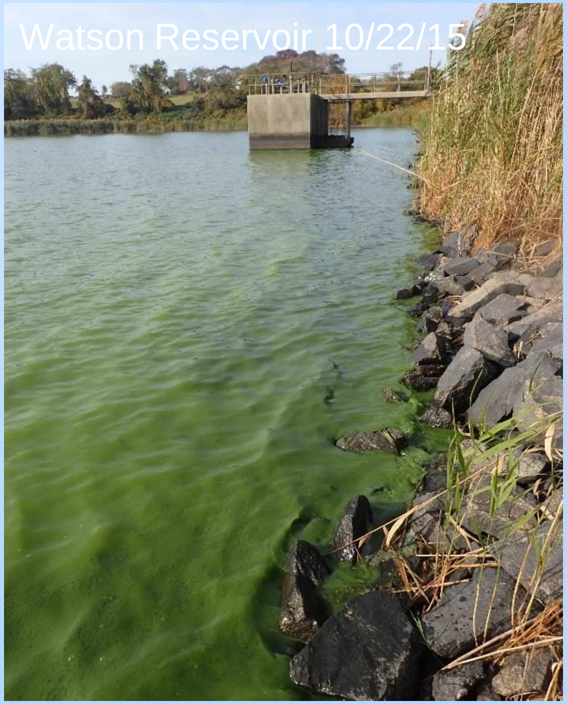
Water Quality Condition of Newport's Water Supply Reservoirs



St Mary's Pond 8/25/15

Gardiner Pond Fish Kill 9/15/15

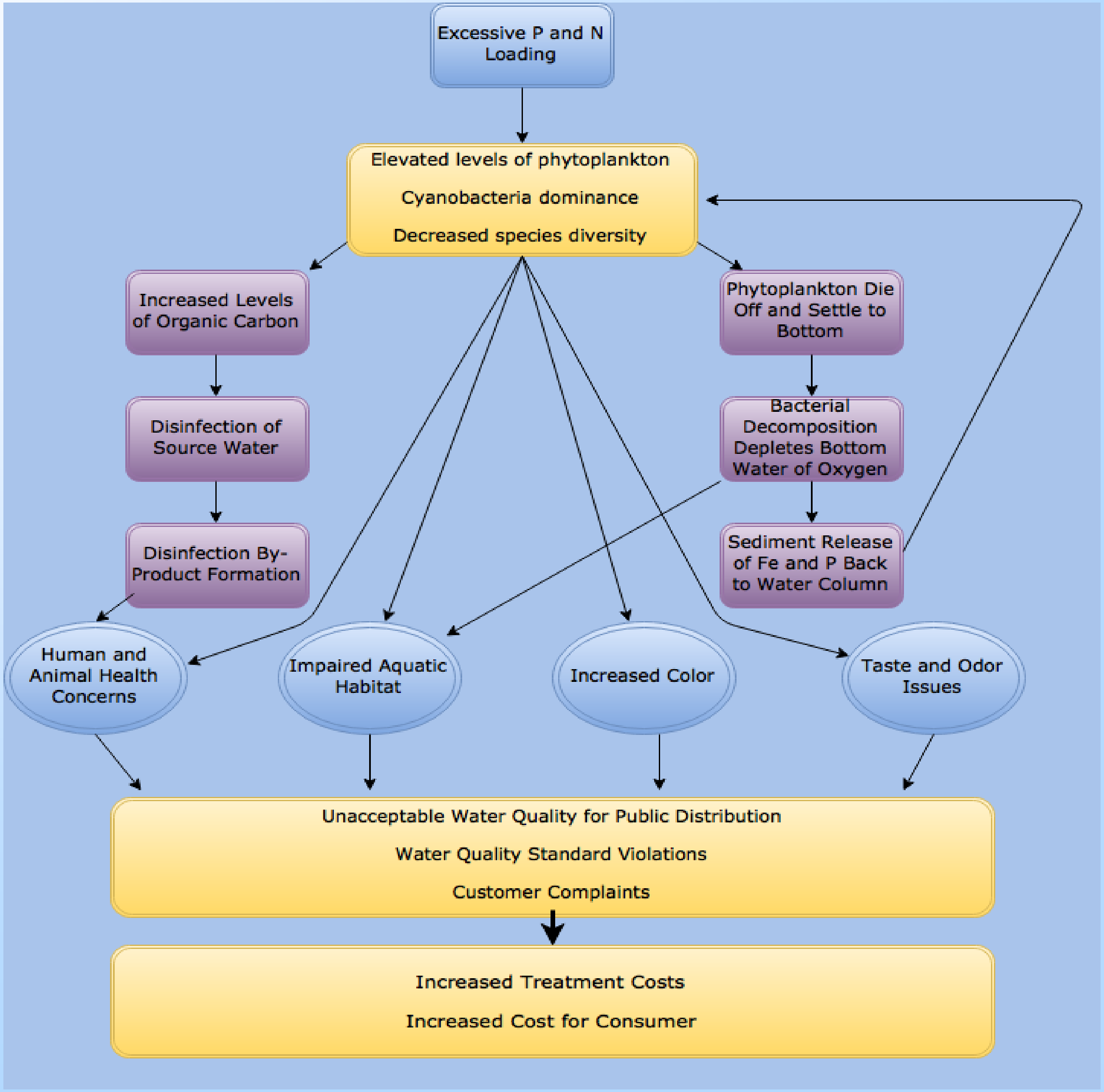
Paradise Pond 6/29/15



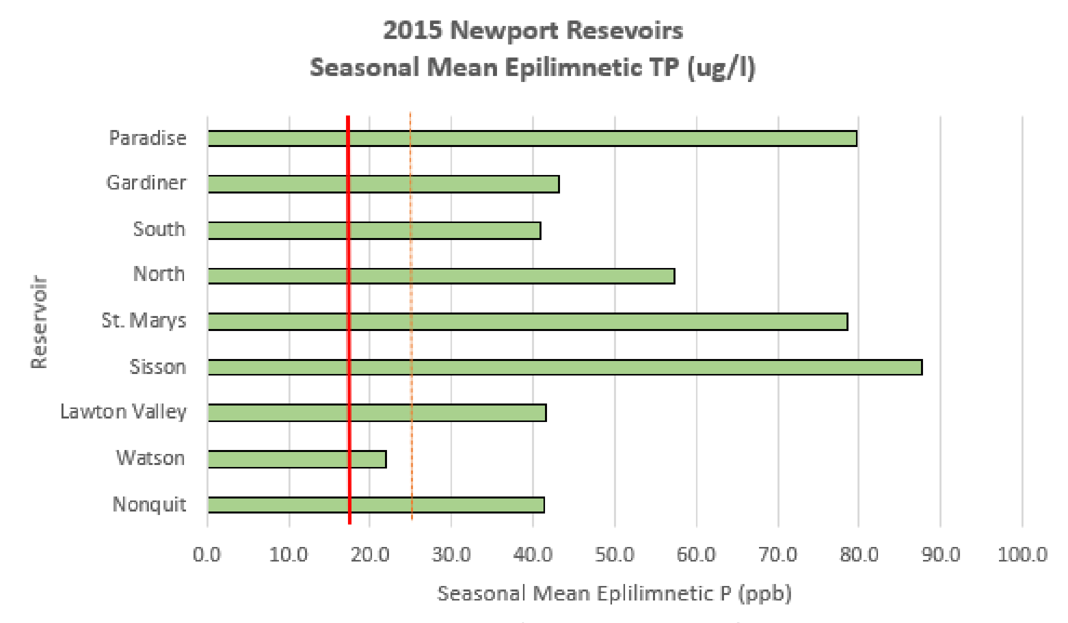
Watson Reservoir 10/22/15

Sisson Pond 8/25/15

Nutrient Enrichment in Drinking Water Supplies



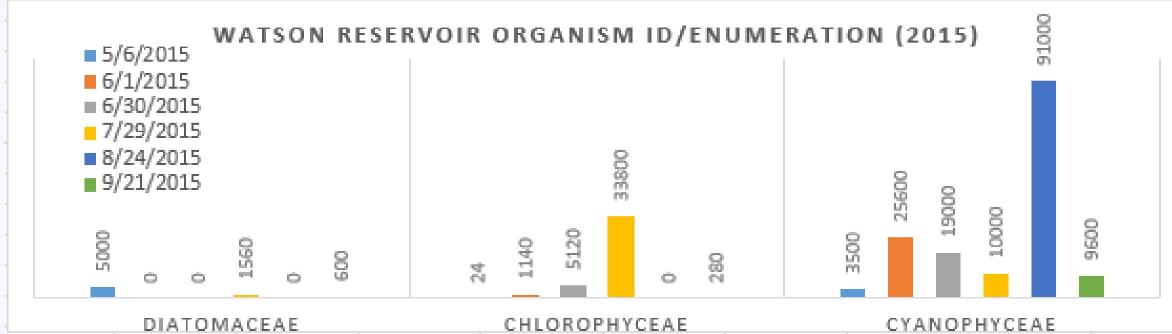
Total Phosphorus and Chlorophyll-a levels in the Water Supply Reservoirs

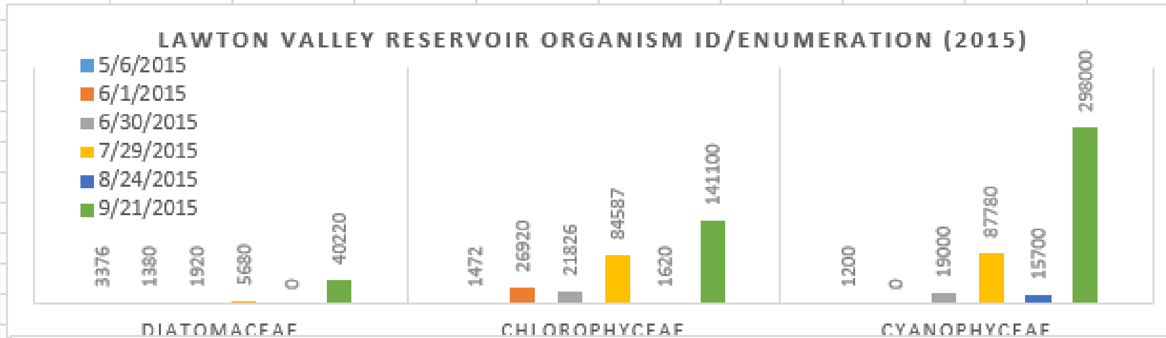


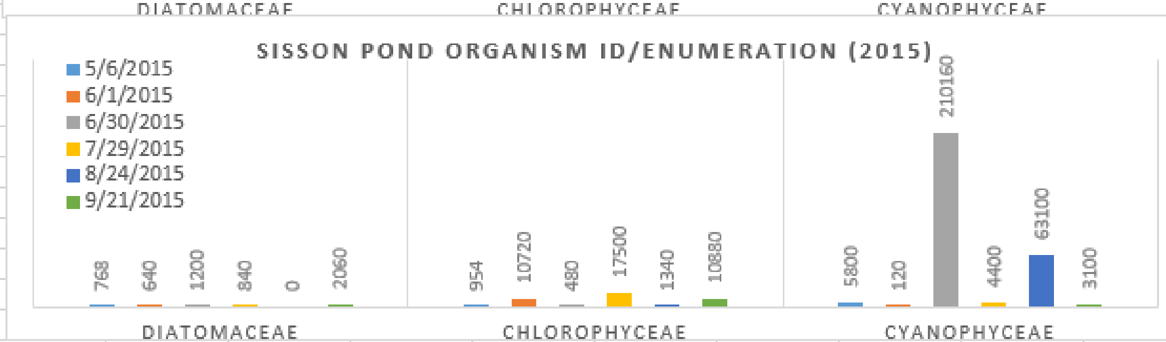
Reservoir	Growing Season Mean (ug/l)	Growing Season Maximum (ug/l)
Nonquit	16	64
Watson	14	33
Lawton Valley	35	80
Sisson	56	132
St. Marys	38	139
North Easton	45	70
South Easton	31	53
Gardiner	37	107
Paradise	37	69

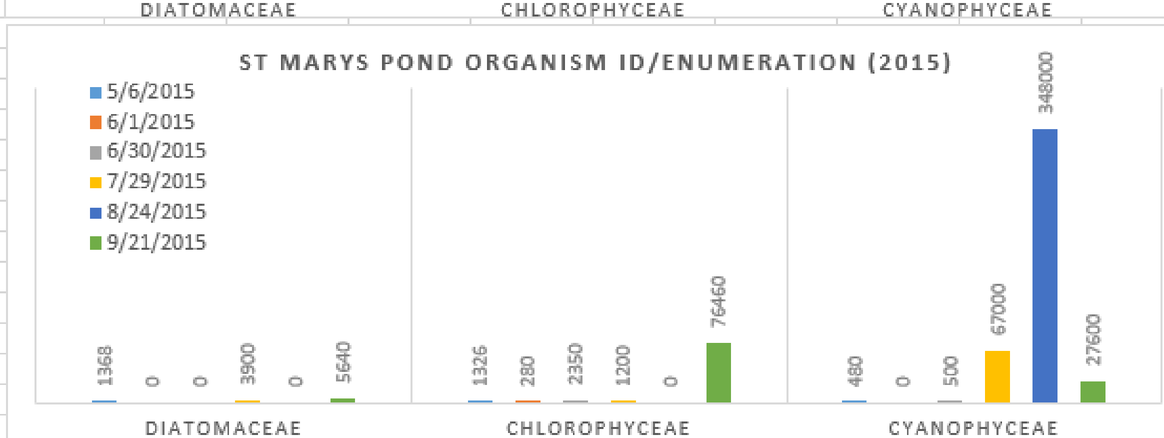
RHODE ISLAND DEM

Newport Reservoir Phytoplankton Summaries 2015

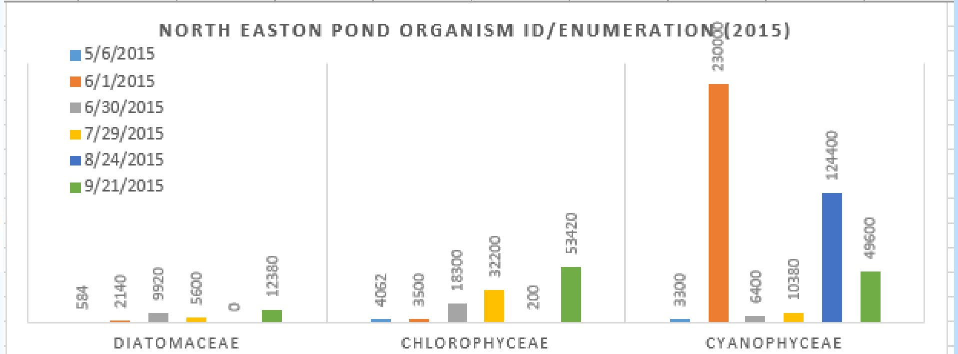


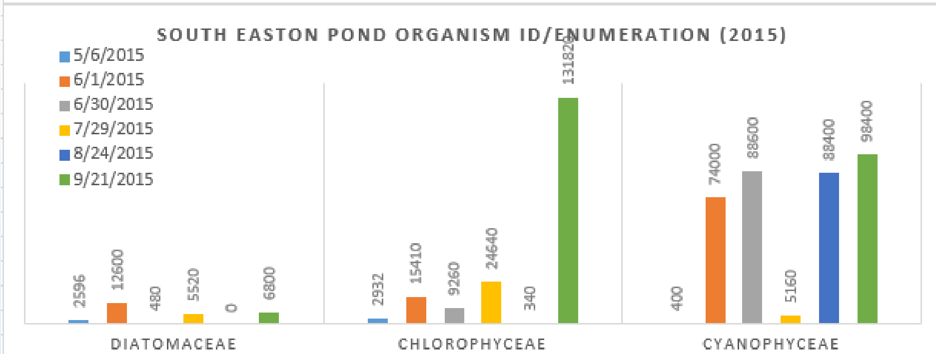


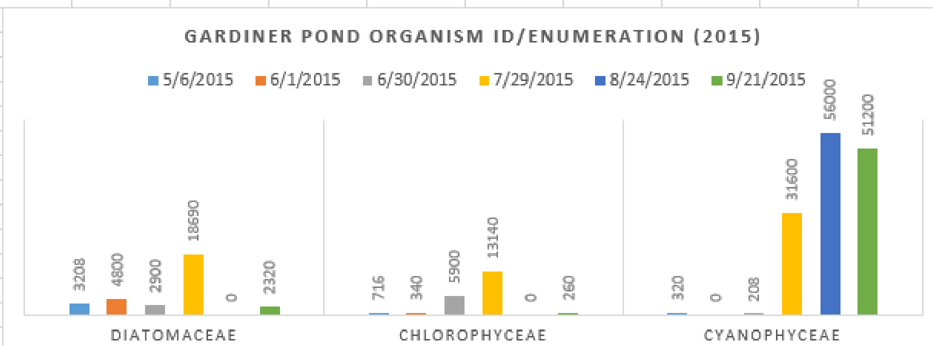


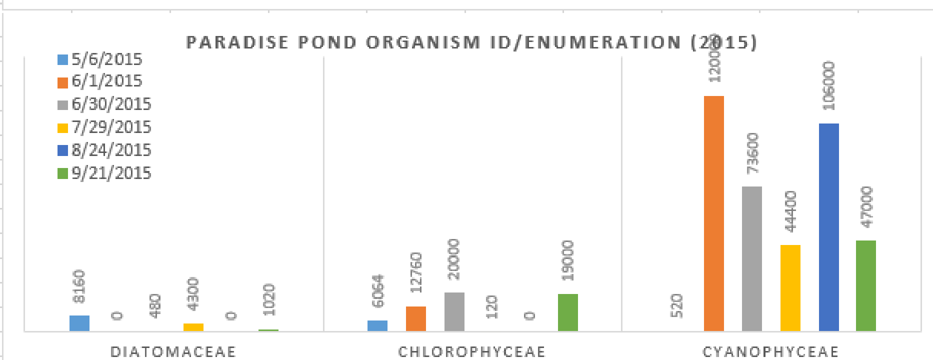


Newport Reservoir Phytoplankton Summaries 2015

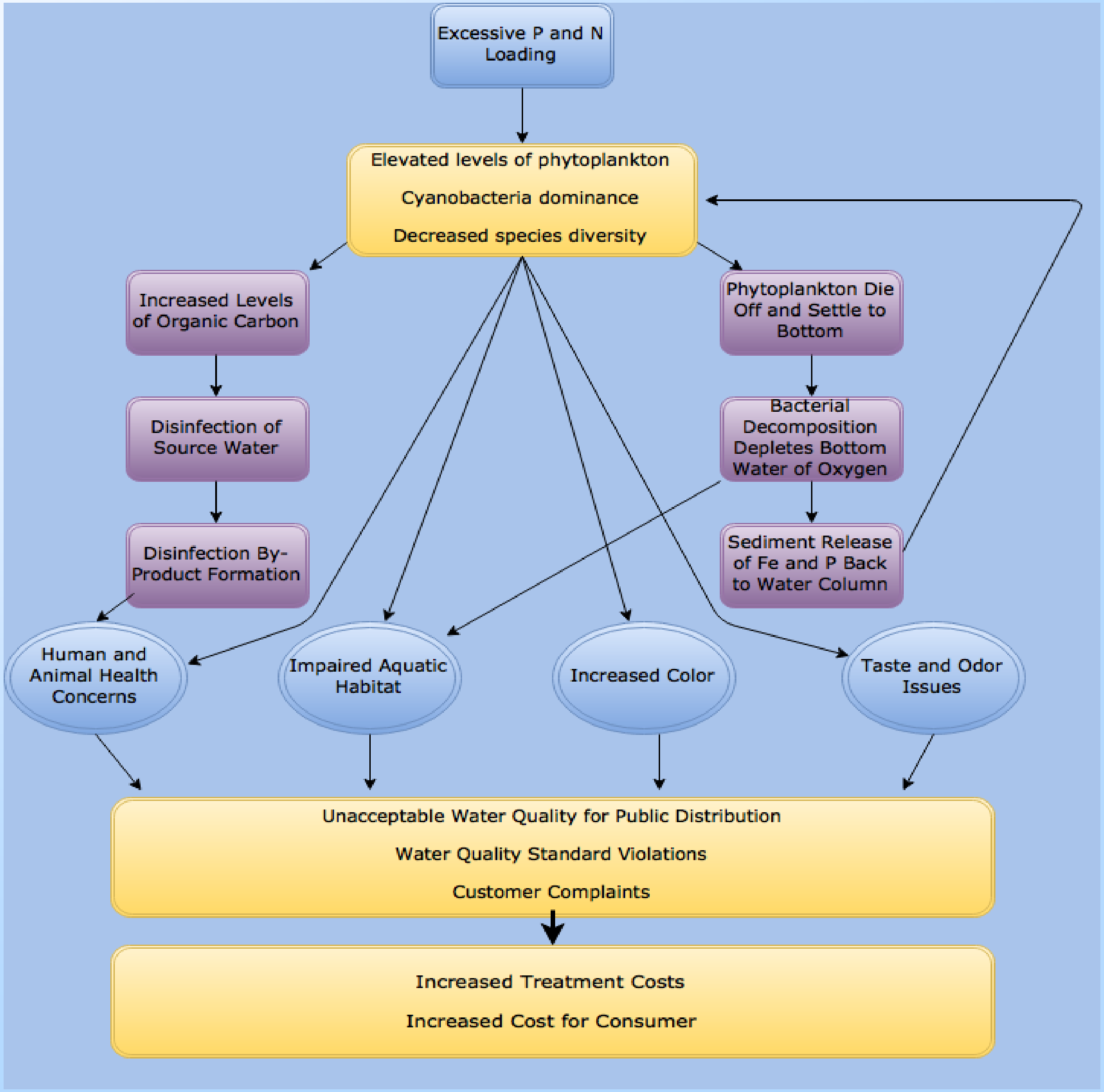








Objective of the TMDL



Source Water Protection

- While Newport Water is responsible for providing safe drinking water (and does) it has little to no control over activities that may pollute the reservoirs.
  - They have taken steps to secure and protect land in the watershed
- The reservoirs are all located in developed watersheds- with roadways, commercial, industrial, residential, and agricultural land uses- all of which generate pollutants which may find their way into the reservoirs.
- As of 2014 significant improvements to the treatment facilities have been made (~$85 million)
- Quality of finished water has significantly improved. An essential investment to ensure safe drinking water for Aquidneck Island.

The quality of the raw source water varies throughout the year due to several factors creating challenges for drinking water treatment and leading to frequent shifting of sourcing and algaecide treatment

TMDL Development Summary

1) Establishing total phosphorus and chlorophyll-a targets.

2) Determining existing phosphorus loads and load capacities.

3) Allocating the TMDLs between point and non-point sources.

4) Identifying/Evaluating sources/source categories of phosphorus.

5) Identifying/describing actions to reduce phosphorus loads.

1. Establishing Target Phosphorus Concentrations in the Reservoirs

- USEPA initiated a National Nutrient Strategy in 1998 that called on states to establish numeric nutrient criteria (NNC) in an effort to address the adverse effects nutrient enrichment has on designated uses.

- Rhode Island has numerical TP criteria (25 ug/l) designed to be protective of aquatic life use. Should that apply to DWS?

- Few states have identified drinking water supplies as specific targets for NNC (or developed NNC). Some that have include VT, CO, NY, VA, KS, OK, MO, TX, NYC DWS

- Reasonable/prudent to evaluate potential TP targets to address nutrient enrichment in drinking water supplies.

- Regulatory Authority

Final Report
for the
Disinfection By-Product / Algal Toxin
Study

Prepared for
United States Environmental Protection Agency - Region 2

Note: This is the first in a series of two related reports. This report is intended to address the issue of nutrient criteria for potable *ponded waters* (lakes and reservoirs). A second companion report entitled *River Disinfection By-Product / Algal Toxin Study* addresses the equivalent issue for *flowing* waters (rivers and streams).

Author: Clifford W. Callinan, P.E.

Date: September 2009

Basis for Interim Value to Protect Direct Use Water Supplies

WQCD PREHEARING STATEMENT – EXHIBIT 10

12/9/2011

1. Establishing Target Phosphorus Concentrations in the Reservoirs

DEM RHODE ISLAND

Replicate NYSDEC study

Research Objectives

- Investigate relationships between:
  TP, algal abundance, DOC, and TTHM

Monitoring Specifics

- Bi-weekly sampling of 9 reservoirs during May-Oct 2015
- Single location, multiple water column samples based on stratification (epilimnion, thermocline, hypolimnion)
- Nutrients (P and N) , DOC, Chl-*a*, algal/cyano ID-enumeration, toxin analysis, DBP formation, temperature & oxygen profiles, clarity (secchi depth)

Review

- EPA Approved QAPP, Data QA-QC, Data Report, Study Report, Technical Review (Edits), NYSDEC review

Development of Numeric Phosphorus and Chlorophyll-a
Targets for the Newport Water Supply Reservoirs

Rhode Island Department of Environmental Management
Office of Water Resources
Dec 2018

http://www.dem.ri.gov/programs/water/quality/restoration-studies/reports.php

1. Establishing Target Phosphorus Concentrations in the Reservoirs

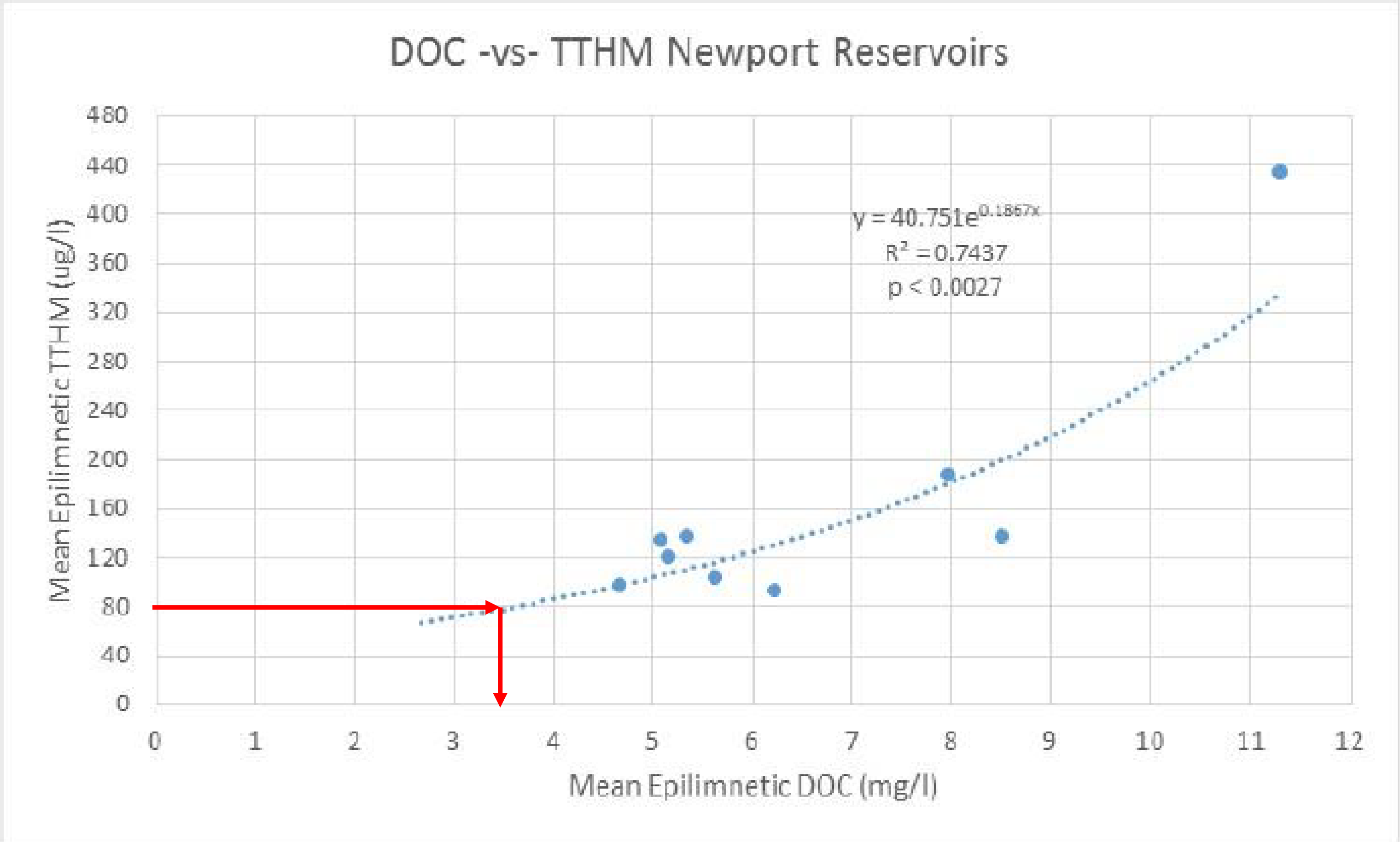
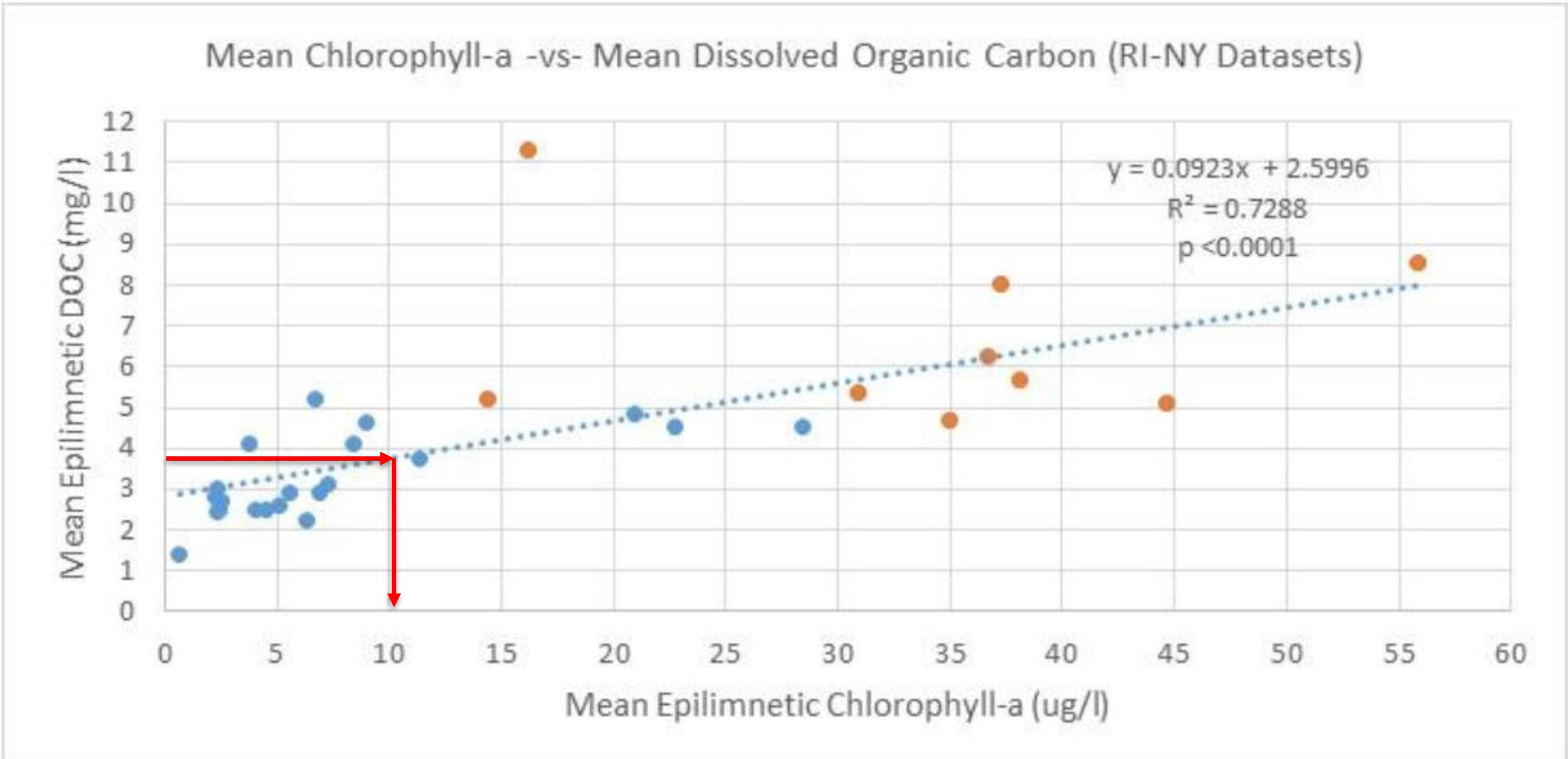
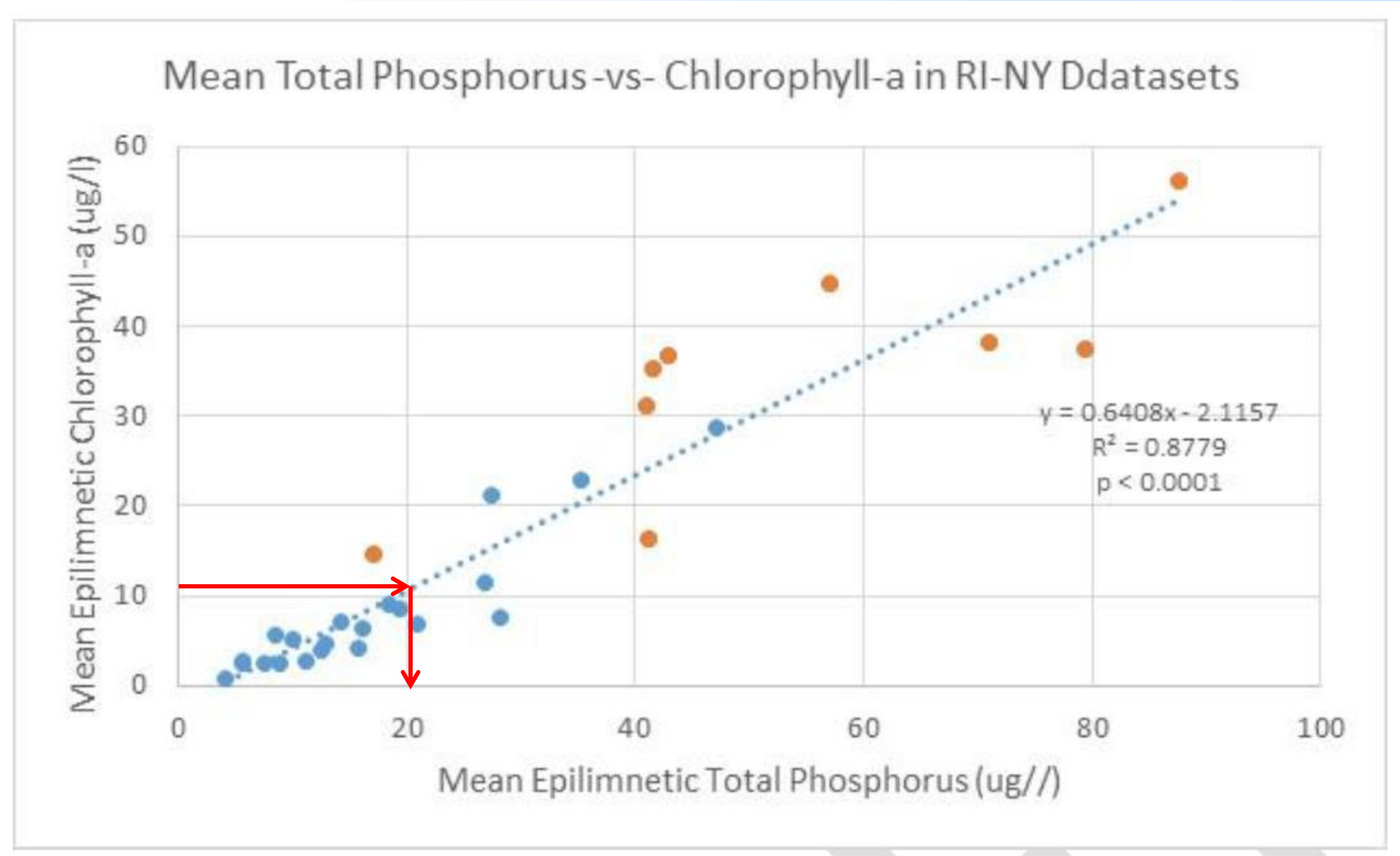


Figure 3. Mean epilimnetic DOC versus TTHM- Newport Reservoirs 2015.

1. Establishing Target Phosphorus Concentrations in the Reservoirs



1. Establishing Target Phosphorus Concentrations in the Reservoirs



2. Determining Existing Phosphorus Loads and Load Capacities

- Application of empirical lake loading-response models to each reservoir

- Dillon and Rigler (1974) and Canfield and Bachmann (1981)
  - Reservoir Total Phosphorus Concentration
  - Reservoir Surface Area
  - Reservoir Mean Depth
  - Annual Flushing Rate/Residence Time
  - P retention coefficient

2. Determining Existing Phosphorus Loads and Load Capacities

Reservoir	Existing TP Load (lbs/yr)*	Loading Capacity TMDL (lbs/yr)
Nonquit Pond	1537	616
Watson Reservoir	196	154
Lawton Valley Reservoir	401	148
Sisson Pond	190	30
St. Marys Pond	470	66
North Easton Pond	347	94
South Easton Pond	218	87
Gardiner Pond	168	61
Paradise Pond	209	39

Determining Existing Total Phosphorus Loads

Watershed Treatment Model

Watershed Treatment Model (WTM) 2013 User's Guide

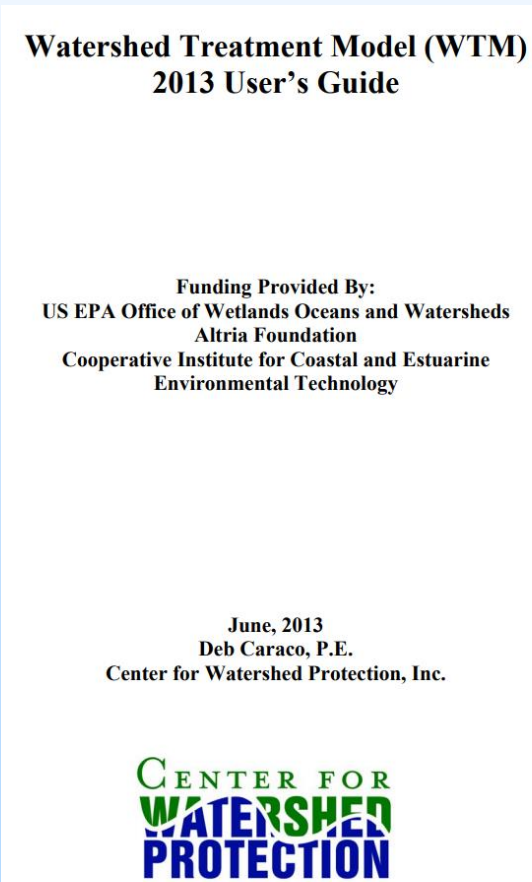
Funding Provided By:
US EPA Office of Wetlands Oceans and Watersheds
Altria Foundation
Cooperative Institute for Coastal and Estuarine Environmental Technology

June, 2013
Deb Caraco, P.E.
Center for Watershed Protection, Inc.

1. Spreadsheet-based model
2. Predicts annual rates of TN, TP, TSS, FC, and runoff volume
3. Sources:
    1. Primary Sources
        1. Determined entirely from land use/cover
            1. Residential
            2. Commercial
            3. Industrial
            4. Forest
            5. Rural (Agriculture)
    2. Secondary Sources
        1. CSOs, SSOs
        2. Septic Systems
        3. Channel Erosion
        4. Livestock

Sources/Source Categories of Phosphorus in Reservoir Watersheds

Watershed Treatment Model



Watershed Treatment Model (WTM) 2013 User's Guide

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Altria Foundation
Cooperative Institute for Coastal and Estuarine Environmental Technology

June, 2013
Deb Caraco, P.E.
Center for Watershed Protection, Inc.

Center for Watershed Protection

1. Evaluate sources/source categories of phosphorus generated from various land uses within each watershed and acquire information as to the relative importance (i.e. magnitude) of each source.

2. Help apportion the allowable annual total phosphorus load to various source categories (i.e. urban, agricultural, forest/wetland.) within each reservoir's catchment.

- √ Was previously applied to Watson Reservoir, St. Marys Pond, Maidford River and Paradise Brook watersheds (City of Newport and Town of Middletown)

Sources/Source Categories of Phosphorus in Reservoir Watersheds

1

GIS/Field work

2

3

Table 5.8. Compartmentalized land use categories in the Newport reservoir watersheds.

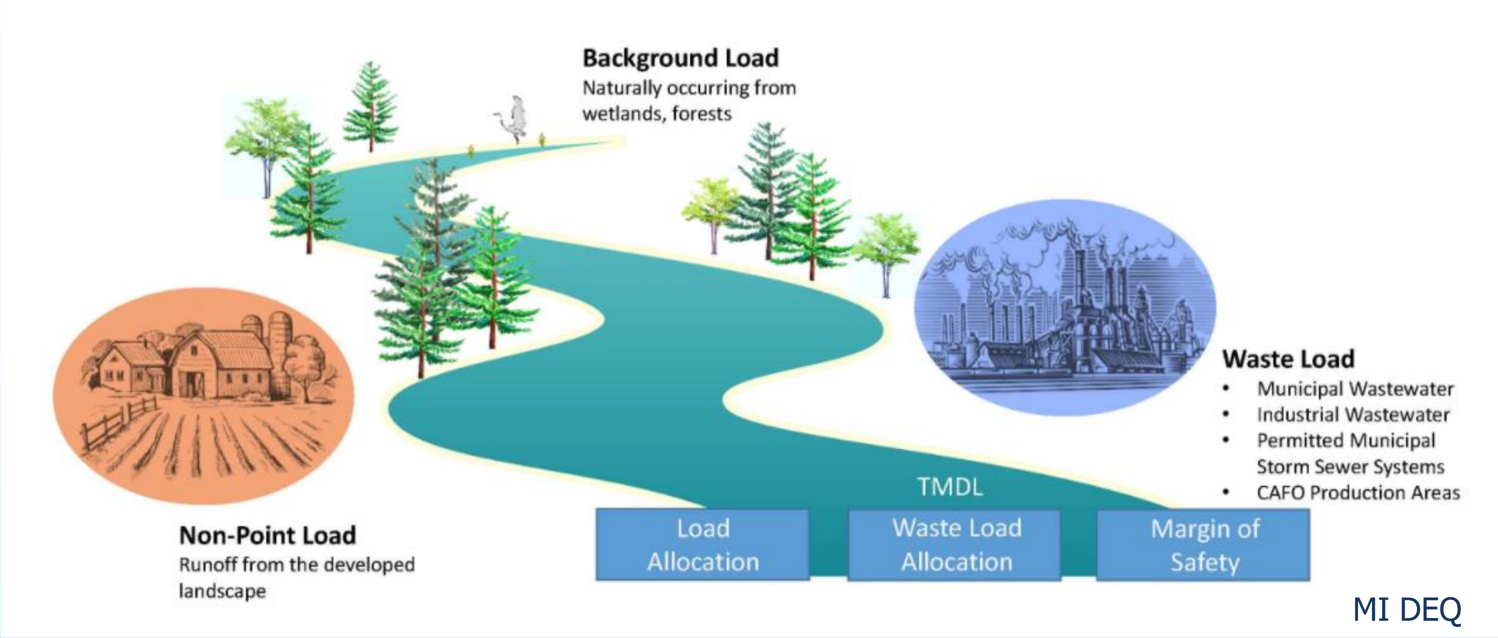
Urban Land Use	(Point Source) Wasteload Allocation (WLA)
Low Density Residential	
Medium Density Residential	
High Density Residential	
Transportation (all roadways)	
Commercial	
Industrial	
Institutional	
Tiverton Landfill	
Onsite Wastewater Treatment Systems (OWTS)	Load Allocation (LA) (Non-Point Source)
Agricultural Land Use	(Non-Point Source) Load Allocation (LA)
Livestock	
Hay/Brushland	
Meadow	
Nursery	
Orchard	
Vineyard	
Tree Farm	
Pasture	
Quarry	
Row Crop	
Managed Grass	
Transitional	
	LA (Natural Background) (subtracted from existing P and N loads to each reservoir) Not expected to change. N-controls for atmospheric are beyond scope of TMDL and expected to remain static
Natural Background	
Forestland	
Wetland	
Atmospheric Deposition	

Sources/Source Categories of Phosphorus in Reservoir Watersheds

WTM Land Use Modeling Results

Waterbody	% TP Load from Urban Land Uses	% TP Load from Agricultural Land Uses	% TP Load from OWTS failure to surface water	% TP Load from Forest and Atmospheric (Natural Background)
Nonquit Pond	41%	27%	2%	30%
Watson Reservoir	52%	29%	1%	18%
Lawton Valley Reservoir	70%	22%	3%	5%
Sisson Pond	34%	61%	0%	5%
St. Marys Pond	57%	32%	5%	6%
North and South Easton Ponds	88%	10%	1%	2%
Gardiner Pond	24%	10%	0%	67%
Paradise Pond	33%	55%	3%	9%
Maidford River	67%	32%	0%	1%

TMDL(each reservoir) = ΣWLA + ΣLA + MOS



RHODE ISLAND DEM

Sample of How TP Loads were estimated

SISSON POND

Table 5.16. WTM results and adjusted empirical model estimated TP loads to Sisson Pond.

Sisson Pond Source Category	WTM Predicted Annual P load (lbs/yr)	% of Total P Load	Empirical Model Predicted TP load (lbs/yr)	Adjusted Total P Load (lbs/yr)
Urban	99	34	190	65
Agriculture	176	61		115
OWTS failure to surface water	1	0.3		-
Natural Background	14	5		9

Example Allocation of TMDL

SISSON POND

Table 5.17. Existing and Allocated Annual Total Phosphorus Loads- Sisson Pond.

Existing total phosphorus load to Sisson Pond				190 lbs
Natural Background (Forest + Atmospheric) Load				9 lbs
Anthropogenic phosphorus load (Existing Load - Natural Background)- (190 lbs – 9 lbs lbs)				181 lbs
Allowable Total Phosphorus Load				30 lbs
Allowable Total Phosphorus Load – Natural Background Load- (30 lbs – 9 lbs)				21 lbs
Required Reduction from Anthropogenic Sources- (181 lbs – 21 lbs)				160 lbs
Expressed as a Percent				**88 %**
An 88 % reduction is required between all anthropogenic source categories				
Land Use Category	**Existing Annual TP Load (lbs)**	**Allowable Annual TP Load (lbs)**	**WLA**	**LA**
Urban	65	8	100%	
Agriculture	115	13		100%
Forest/Wetland/Atmospheric	9	9		Natural Background

Allocation of Phosphorus Loads Summary

Reservoir	Existing P Load (lbs/yr)	TMAL Load (lbs/yr)	Reduction TP Load Reduction (%)	WLA	LA	Natural Background Load	MOS
				(lbs P/yr)	(lbs P/yr)	(lbs P/yr)	
Nonquit Pond	1537	616	85	98	65	453	10% explicit
Watson Reservoir	196	154	25	76	43	35	10% explicit
Lawton Valley Reservoir	401	148	65	98	30	21	10% explicit
Sisson Pond	190	30	88	8	13	9	10% explicit
St. Marys Pond	470	66	91	25	14	27	10% explicit
North Easton Pond	347	94	74	79	9	5	10% explicit
South Easton Pond	218	87	61	75	9	3	10% explicit
Gardiner Pond	168	61	65	35	21	4	10% explicit
Paradise Pond	209	39	84	21	12	5	10% explicit

Sources/Source Categories of Phosphorus in Reservoir Watersheds

Table 4.14. Summary of Phosphorus Sources to the Newport Reservoir Watersheds.

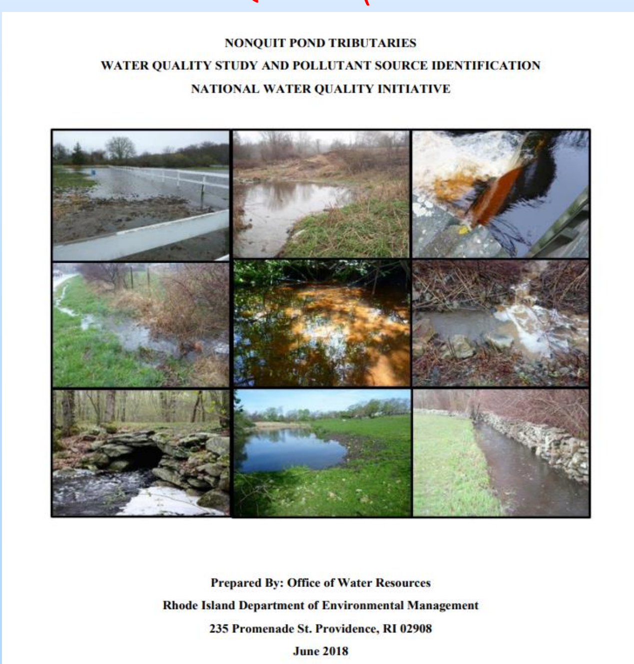
Sources of Phosphorus to the Newport Reservoirs	Method(s) of Identification	Section
Urban and Residential Runoff	WTM results, Field Observations, Outfall Information	4.2
Agricultural Runoff and other agricultural-related activities	WTM results, Field Observations, NWQI investigations	4.3
Loss or Riparian Buffer Streambank/Streambed Erosion.	Field Observations, Previous Investigations, NWQI investigations	4.4
Excessive populations of resident geese utilizing reservoir shorelines	Field Observations	4.5
Onsite Wastewater Treatment System (OWTS) Contributions	WTM results	4.6
Internal Cycling of Nutrients from Reservoir Sediments	Sediment sampling, Water column sampling, Oxygen-Temperature Profiles	4.7
Natural Background Sources	Literature Review, WTM Results	4.8
Tiverton Landfill*	RIDEM staff observations, NWQI Investigations	4.9

*The Tiverton Landfill drains to Quaker Creek, which flows into Nonquit Pond.

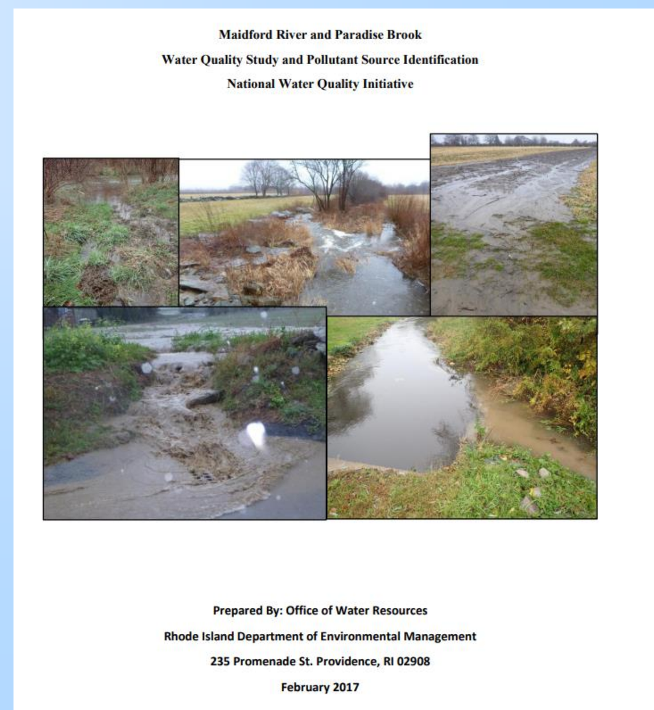
Agricultural-Related Sources/
Stream Erosion/Lack of Riparian Buffers

PHOSPHORUS SOURCE IDENTIFICATION

- **N**ational **W**ater **Q**uality **I**nitiative Studies
  - Established in 2012 as a joint initiative with RIDEM, NRCS and EPA to address agricultural sources of water pollution, including nutrients, sediment, pesticides, and pathogens related to agricultural production in priority watersheds.
  - Selection of Priority Watersheds
    - Nonquit Pond tributaries
    - Maidford River
    - Paradise Brook
  - Follow up work included extensive Ag-investigations outside of scope of NWQI work (RIDEM and ERICD)


NONQUIT POND TRIBUTARIES
WATER QUALITY STUDY AND POLLUTANT SOURCE IDENTIFICATION
NATIONAL WATER QUALITY INITIATIVE

Prepared By: Office of Water Resources
Rhode Island Department of Environmental Management
235 Promenade St. Providence, RI 02908
June 2018


Maidford River and Paradise Brook
Water Quality Study and Pollutant Source Identification
National Water Quality Initiative

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Rhode Island Department of Environmental Management
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February 2017

- **N**ational **W**ater **Q**uality **I**nitiative studies

Figure 1. Nonquit Pond Tributary Sampling Station Locations.

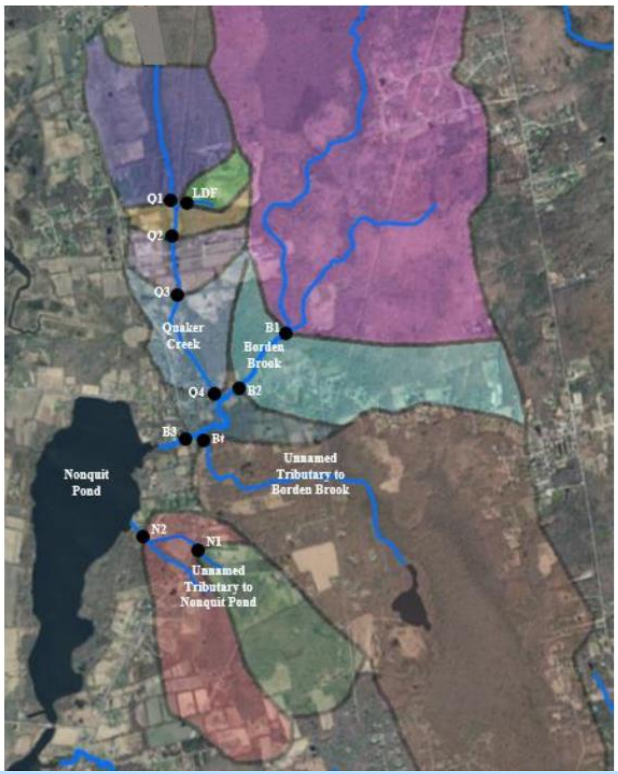


Figure 1. Maidford River Sampling Locations.

Figure 2. Paradise Brook Proposed Sampling Locations.

http://www.dem.ri.gov/programs/water/quality/restoration-studies/reports.php

DEM
RHODE ISLAND

- Lack of Riparian Buffers
- Flooded paddocks
- Erosion/Runoff from Agricultural/Urban Areas
- Exposed silage piles

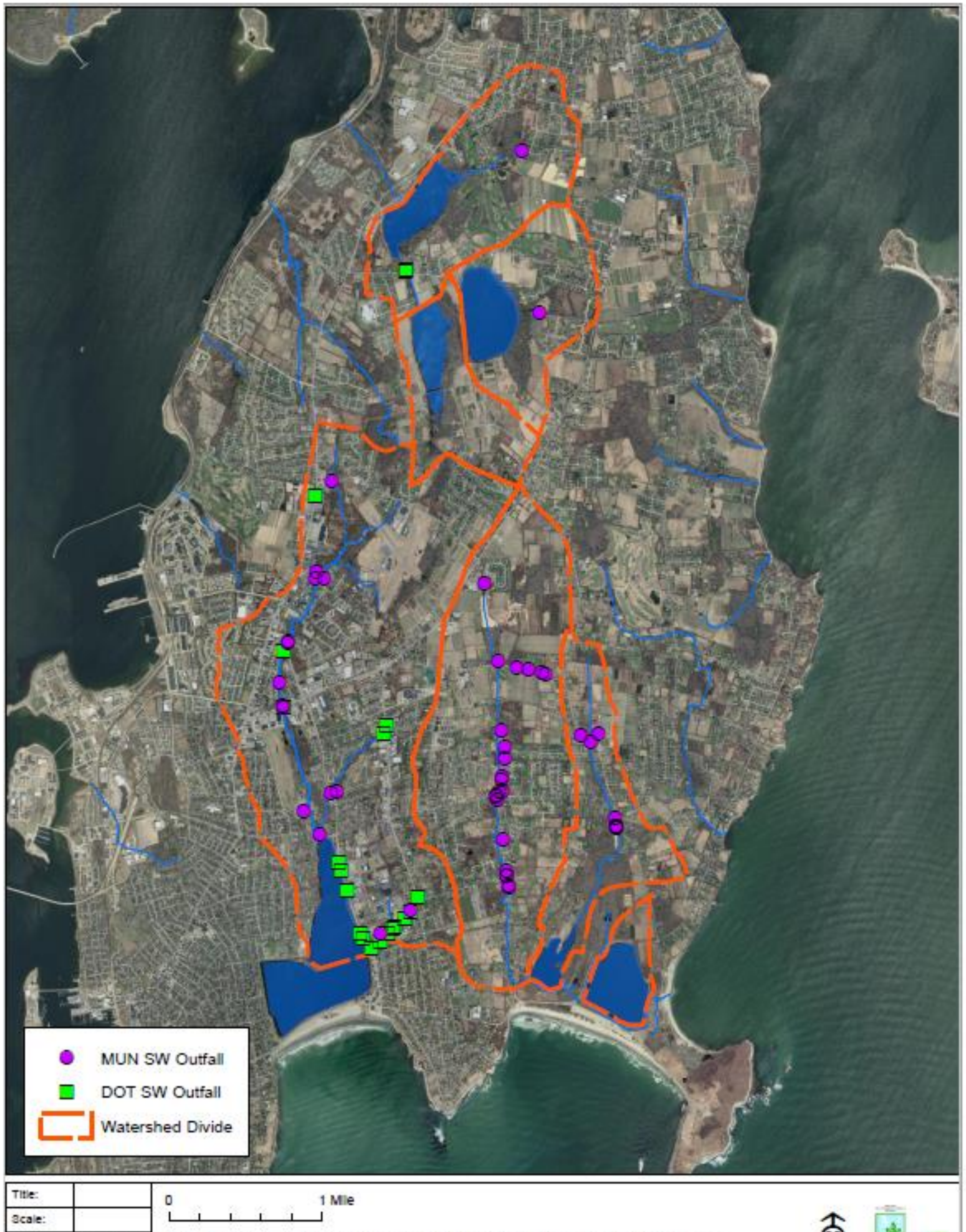
DEM
RHODE ISLAND

DEM
RHODE ISLAND

Urban
Runoff

i.e.
Stormwater

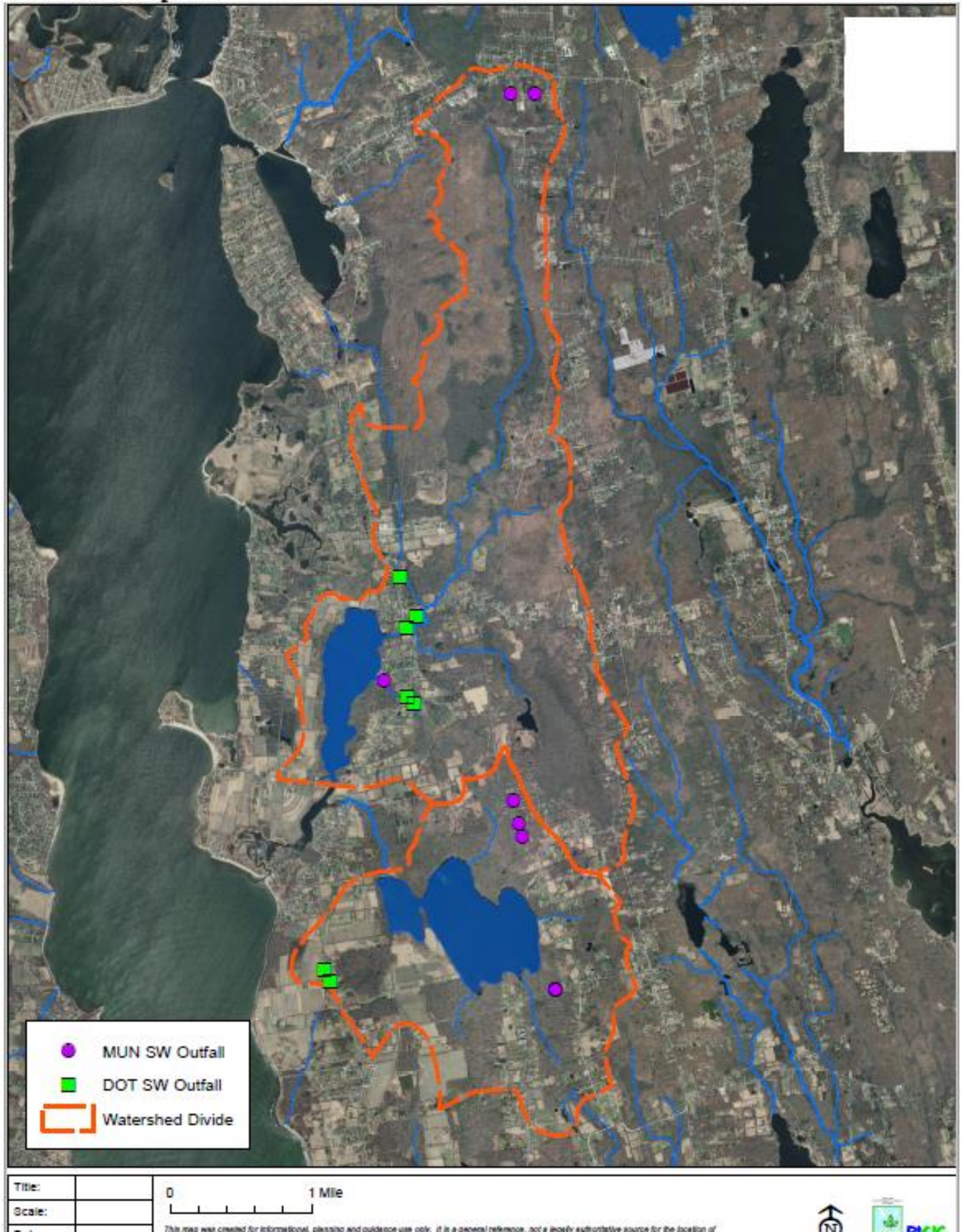
Figure 4.4. Schematic of municipal and RIDOT outfalls in Newport Reservoir Watersheds-Aquidneck Island.



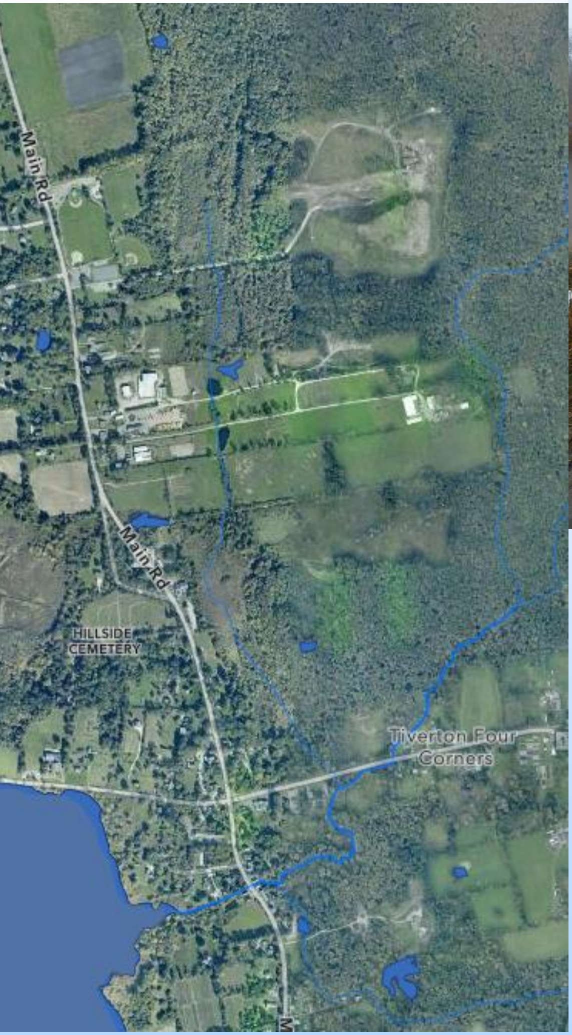
Urban Runoff

i.e. Stormwater

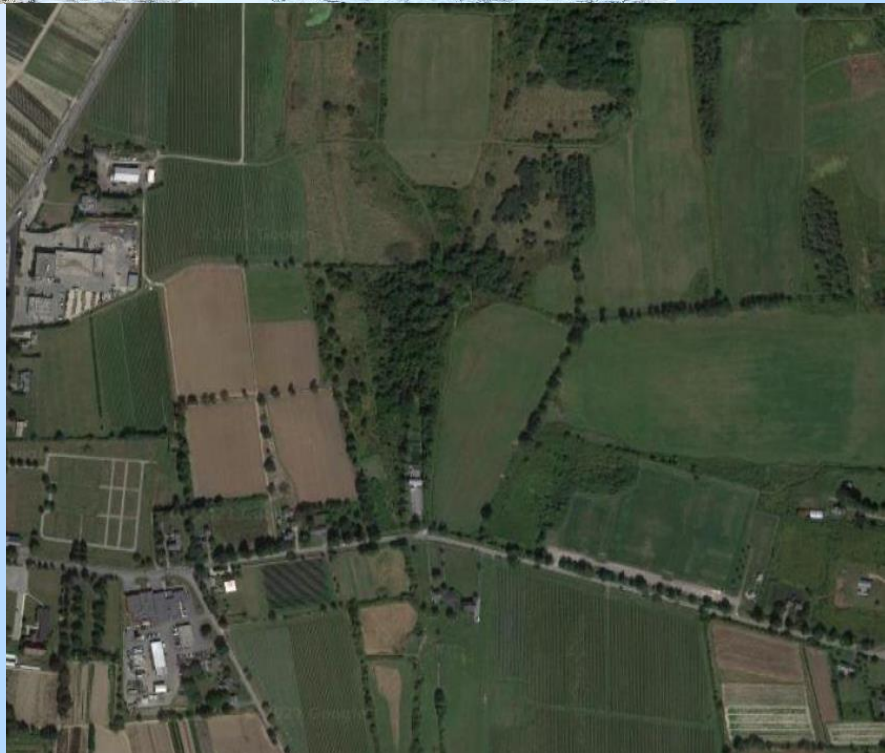
Figure 4.5. Schematic of municipal and RIDOT outfalls in Newport Reservoir Watersheds-Tiverton and Little Compton.



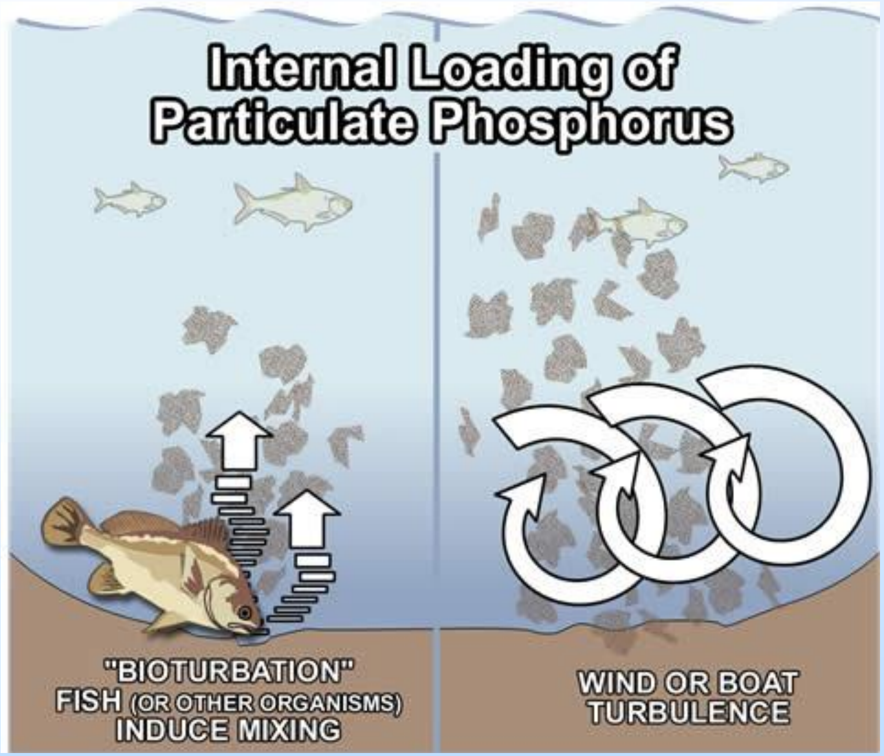
NONQUIT POND-
Tiverton Landfill

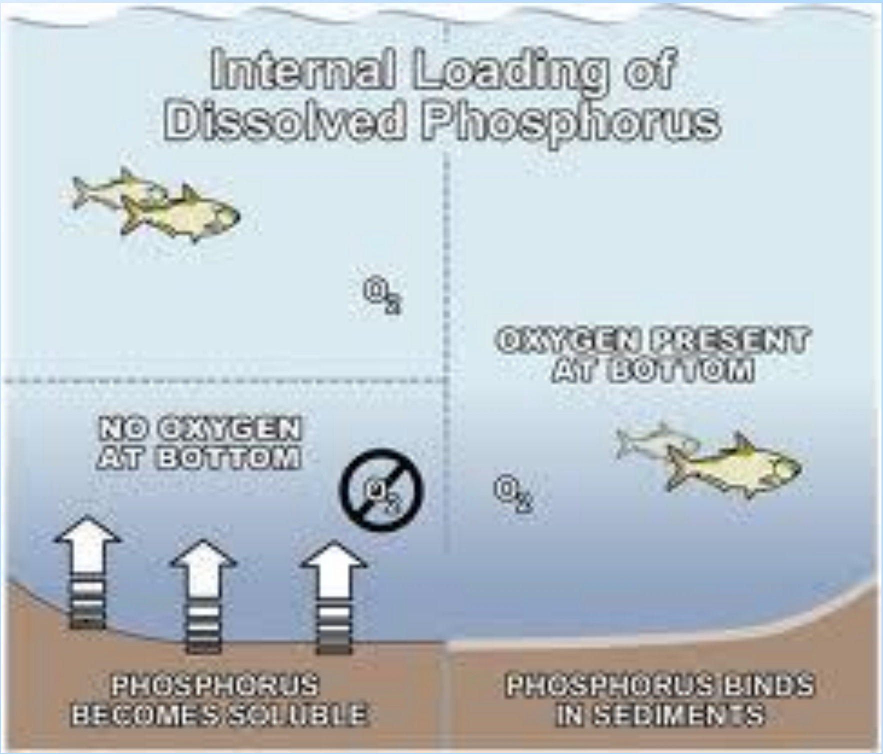


Goose Waste/Erosion/Lack of Buffers



Internal Cycling of Phosphorus from Sediments





Lakes of Missouri Volunteer Program 2006 Waterline Pub.

TMDL Implementation Basics

1. **Point Sources**-CWA requires that permits be consistent with relevant TMDL Provisions
    1. Use RIPDES permit tools to implement
        1. MS4 Permit issued in 2003 established requirements for MS4s to provide plans describing how they intend to implement TMDL Provisions.
        2. Town of Tiverton application for RIPDES permit (i.e. Tiverton Landfill)

2. **Non-Point Sources**- BMP Recommendations and possible enforcement actions
    1. Use grants and public education to promote voluntary actions
    2. Where documented WQ violations, use existing enforcement tools (i.e. water quality regulations).

Overview of Pollution Reduction Measures

TMDL Implementation Section (Section 6.0)

The Implementation Section of this TMDL describes water quality improvement activities in the Newport reservoir watersheds that have been or are being implemented by various agencies/entities. This section also outlines additional required and recommended best management practices (BMP's) that will need to be implemented to meet the water quality targets established in this TMDL.

Non-TMDL related water quality improvement activities

- Source Water Phosphorus Reduction Feasibility Plan- City of Newport
- Maidford River Watershed Assessment and BMP Design- Town of Middletown
- Aquidneck Island Water Quality Initiative- Multiple partners
- Maidford River and Paradise Brook Watershed Conservation Plan- Aquidneck Land Trust
- North Easton Pond Stormwater Attenuation and Source Reduction Strategy
- Hoogendorn Nursery BMP Implementation- NRCS and RIDEM

Overview of Pollution Reduction Measures
Point Sources

Urban Stormwater- Towns of Middletown, Portsmouth, Tiverton, and Little Compton, and RIDOT

- Continue ongoing efforts to manage stormwater to prevent discharge of phosphorus through pollution prevention and non-structural measures.
  - Construction and Post Construction Controls
  - Storm drain cleaning and street sweeping
  - Public education
- Implement structural retrofits to drainage systems to reduce phosphorus and stormwater runoff volumes.
- Consistent with EPA and DEM consent decrees, stormwater from RIDOT outfalls must be managed such that impervious cover is eliminated or treated to act as if it were eliminated to reach a target impervious cover of 10% (include TMDL requirements)

Overview of Pollution Reduction Measures
Point Sources

Tiverton Landfill

Landfill Closure Plan approved by RIDEM in 2020

- Accept final wasteload on or before Nov 2022
- 4 Phase Closure
  - Landfill Capping (installation of stormwater detention basins) in 4 phases covering different areas of landfill
- Phase 4 capping 2023

Tiverton Application for RIPDES Permit (2021)

- Effluent limitations and monitoring requirements for seven (7) outfalls on the landfill site that discharge to Quaker Creek and/or wetlands connected to Quaker Creek and Borden Brook.
- Effluent limitations for outfalls will be based on the 18 ug/l total phosphorus targets established in this TMDL.
- Anticipated that the town of Tiverton will have to comply with a Stormwater Management Plan (SWMP). This Plan includes, but is not limited to, a description of the sedimentation and erosion controls as well as maintenance activities necessary to properly control storm water runoff.

Overview of Pollution Reduction Measures
Non-Point Sources

Where documented WQ violations, use existing enforcement tools.

Additional Implementation for NPS Controls

- Section 6.1 Overview of existing water quality improvement activities/plans
- Section 6.2.2 Agricultural best management strategies
- Section 6.2.3 Recommended additional goose abatement strategies
- Section 6.2.4 Protection and re-introduction/expansion of riparian buffers
- Section 6.2.7 Control of internal loading of phosphorus from reservoir sediments

DEM ACCEPTING Comments on Draft TMDL

The draft TMDL is available on the RIDEM website at:

www.dem.ri.gov/tmdl-newport

Comments accepted through 4pm August 6th 2021

Written Comments on the draft TMDL may be submitted to:

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brian.zalewsky@dem.ri.gov

2. Determining Existing and Allowable Phosphorus Loads

Dillon and Rigler empirical equation (as written by Maine DEP 2000):

- **$L = P\,(A \cdot z \cdot p)\,/\,(1-R)$**

- Where:
- **L** = external total phosphorus load (kg/yr)
- **P** = spring overturn total phosphorus concentration (ppb)
- **A** = lake basin surface area (km^2)
- **z** = mean depth of lake basin (m)
- **p** = annual flushing rate (flushes/yr)
- **R** = phosphorus retention coefficient, where:

- **R = 1/(1+ SQRT(p)) (Larsen and Mercier 1976)**

2. Determining Existing and Allowable Phosphorus Loads

Canfield and Bachmann (1981) empirical equation:

- **TP= (L/1000) / 0.305 X *Z* (0.114 (L/Z)$^{0.589}$ +1/*T***
- Where:

- **TP** = mean total phosphorus concentration for each reservoir in mg/l
- **L** = loading rate in mg/m^2
- **Z** = mean depth of reservoir in feet
- **T** = residence time of water in years

2. Determining Existing and Allowable Phosphorus Loads

p (reservoir flushing rate): Flushing rate is calculated as the inverse of detention time (DT). Except for Nonquit Pond, the detention time for each reservoir was calculated using the following formula:

2015 Mean reservoir volume (MG) / Total loss (outflow) recorded in 2015 (MG) = detention time (DT) (yrs)

P (total phosphorus concentration): Bi-weekly samples were collected in each reservoir by RIDEM at 2-3 discrete depths during the 2015 sampling season (n=12). Additional total phosphorus data were collected in St. Marys Pond and Watson Reservoir in 2015 as part of a study contracted by the Newport Water Department .

z (mean depth): Mean reservoir depth was calculated by dividing the reservoir volume at full capacity by the reservoir surface area (at full capacity).

A (surface area): the surface area used was calculated as surface area at full capacity.

R (phosphorus retention coefficient) is the fraction of inflowing phosphorus that is retained in the sediments.

R = 1/(1+ SQRT(p)) (Larsen and Mercier 1976)

Sources/Source Categories of Phosphorus in Reservoir Watersheds

NWQI/RIDEM and RIDEM-ERICD Summaries

1. NWQI investigations in 2015 and 2018 resulted in the Office of Water Resources (OWR) requesting the Office of Compliance and Inspection (OCI) to initiate formal enforcement action for violations of specific WQ regulations.

2. Led to issuance of RIPDES permit for Tiverton Landfill and additional stormwater abatement control requirements as part of closure plan.

3. Additional site investigations of numerous agricultural land use related parcels of land.
    1. Visits by RIDEM Division of Agriculture and Eastern RI Conservation District Staff.
    2. Engagement with land owners regarding various changes to land use to mitigate Nonpoint sources of nutrients to waterways.
        a. Removing livestock/equine access to waterways and wetlands.
        b. Removal of silage pile from wetland/waterway
        c. Erosion/sediment control plans