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.
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

<table>
<thead>
<tr>
<th>Designated Use</th>
<th>Applicable Classifications</th>
<th>Designated Use Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Contact Recreation/Swimming</td>
<td>All surface waters</td>
<td>Swimming, water skiing, surfing or other recreational activities with prolonged and intimate contact by the human body with water.</td>
</tr>
<tr>
<td>Secondary Contact Recreation/Boating</td>
<td>All surface waters</td>
<td>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.</td>
</tr>
<tr>
<td>Aquatic Life Support/Fish, other Aquatic Life and Wildlife</td>
<td>All surface waters</td>
<td>Waters suitable for the protection, maintenance, and propagation of a viable community of aquatic life and wildlife.</td>
</tr>
<tr>
<td>Fish Consumption</td>
<td>All surface waters</td>
<td>Supports fish free from contamination that could pose a human health risk to consumers.</td>
</tr>
</tbody>
</table>
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*)
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
TMDL Equation

\[
\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}
\]

**Total Maximum Daily Load (Total Loading Capacity)**

- **Wasteload Allocation**
  - (“Point Sources”)
  - Achieved by required permits or other regulations.
  - Examples:
    - Wastewater Discharges
    - Municipal Separate Storm
    - Sewer Systems (MS4s)
    - RIDOT Stormwater
    - Landfill Permit

- **Load Allocation**
  - (“Nonpoint Sources”)
  - Achieved by regulatory or non-regulatory methods.
  - Requires “reasonable assurances”
  - Examples:
    - Agricultural runoff
    - OWTS failures
    - Natural Background (Forest, atm)
    - Non-point sources contributing to water quality violations
    - Channel erosion

- **Margin of Safety**
  - Accounts for uncertainty
<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Source of Inflow</th>
<th>Outflow Transfer Method</th>
<th>Destination of Outflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonquit Pond</td>
<td>Watershed Drainage&lt;br&gt;Quaker Brook&lt;br&gt;Borden Brook&lt;br&gt;Unnamed tributaries</td>
<td>Sakonnet Pumping Station and Pipeline</td>
<td>St. Marys Pond&lt;br&gt;Lawton Valley WTP&lt;br&gt;North Easton Pond via Bailey Brook</td>
</tr>
<tr>
<td>Watson Reservoir</td>
<td>Watershed Drainage&lt;br&gt;Unnamed tributaries</td>
<td>Sakonnet Pumping Station and Pipeline</td>
<td>St. Marys Pond&lt;br&gt;Lawton Valley WTP&lt;br&gt;North Easton Pond via Bailey Brook</td>
</tr>
<tr>
<td>Lawton Valley Reservoir</td>
<td>Watershed Drainage&lt;br&gt;Sisson Pond via Lawton Valley Brook&lt;br&gt;Watson Reservoir</td>
<td>Pumping Station and Pipeline</td>
<td>Lawton Valley WTP</td>
</tr>
<tr>
<td>Sisson Pond</td>
<td>Watershed Drainage&lt;br&gt;St. Marys Pond</td>
<td>Sisson Pond Stream&lt;br&gt;Unnamed stream to</td>
<td>Lawton Valley Reservoir&lt;br&gt;Bailey Brook</td>
</tr>
<tr>
<td>St. Marys Pond</td>
<td>Watershed Drainage&lt;br&gt;Watson Reservoir&lt;br&gt;Nonquit Pond</td>
<td>St. Marys Pumping Station and Pipelines&lt;br&gt;Reservoir spillage to Sisson Pond</td>
<td>Lawton Valley WTP&lt;br&gt;North Easton Pond via Bailey Brook</td>
</tr>
<tr>
<td>North Easton Pond</td>
<td>Watershed Drainage&lt;br&gt;Bailey Brook&lt;br&gt;St. Marys Pond&lt;br&gt;Paradise Pond&lt;br&gt;Gardiner Pond&lt;br&gt;Sisson Pond</td>
<td>Pumping Station and Pipeline&lt;br&gt;South Easton Pond</td>
<td>Station 1 WTP (at North Easton Pond)</td>
</tr>
<tr>
<td>South Easton Pond</td>
<td>Watershed Drainage North Easton Pond&lt;br&gt;Paradise Pond&lt;br&gt;Gardiner Pond</td>
<td>Pumping Station and Pipeline</td>
<td>Station 1 WTP (at North Easton Pond)</td>
</tr>
<tr>
<td>Paradise Pond</td>
<td>Watershed Drainage&lt;br&gt;Paradise Brook&lt;br&gt;Maidford River&lt;br&gt;Gardiner Pond</td>
<td>Paradise Pump Station and Pipeline</td>
<td>Station 1 WTP&lt;br&gt;Gardiner Pond&lt;br&gt;North Easton Pond</td>
</tr>
<tr>
<td>Gardiner Pond</td>
<td>Watershed Drainage&lt;br&gt;Maidford River&lt;br&gt;Paradise Pond</td>
<td>Paradise Pump Station and Pipeline</td>
<td>Station 1 WTP&lt;br&gt;Paradise Pond&lt;br&gt;North Easton Pond</td>
</tr>
</tbody>
</table>
General Land Use Summaries

Urban  Agriculture  Forest/Wetland

Nonquit Pond
- Urban: 16%
- Agriculture: 16%
- Forest/Wetland: 68%

Watson Reservoir
- Urban: 24%
- Agriculture: 18%
- Forest/Wetland: 58%

Lawton Valley Reservoir
- Urban: 26%
- Agriculture: 22%
- Forest/Wetland: 52%

Sisson Pond
- Urban: 29%
- Agriculture: 15%
- Forest/Wetland: 56%

St. Mary's Pond
- Urban: 21%
- Agriculture: 39%
- Forest/Wetland: 40%

Bailey Brook (N & S Easton Ponds)
- Urban: 9%
- Agriculture: 21%
- Forest/Wetland: 70%

Gardiner Pond
- Urban: 13%
- Agriculture: 41%
- Forest/Wetland: 46%

Paradise Pond
- Urban: 37%
- Agriculture: 32%
- Forest/Wetland: 31%
Water Quality Condition of Newport’s Water Supply Reservoirs

St Mary’s Pond 8/25/15

Paradise Pond 6/29/15

Gardiner Pond Fish Kill 9/15/15

Sisson Pond 8/25/15

Watson Reservoir 10/22/15

CAUTION

Water that looks like this may contain toxic algae. This algae can harm you and your pets. Dangerous algae can live in sediment, which can make water look clear even after it rains. If you or your pets come into contact with this algae, get medical attention right away and wash your skin and clothing thoroughly. Do not drink this water. Do not use this water to irrigate vegetation.
Nutrient Enrichment in Drinking Water Supplies

Excessive P and N Loading

Elevated levels of phytoplankton
Cyanobacteria dominance
Decreased species diversity

Increased Levels of Organic Carbon

Phytoplankton Die Off and Settle to Bottom

Disinfection of Source Water

Bacterial Decomposition Depletes Bottom Water of Oxygen

Disinfection By-Product Formation

Sediment Release of Fe and P Back to Water Column

Human and Animal Health Concerns

Increased Aquatic Habitat

Impaired Aquatic Habitat

Increased Color

Taste and Odor Issues

Unacceptable Water Quality for Public Distribution
Water Quality Standard Violations
Customer Complaints

Increased Treatment Costs
Increased Cost for Consumer
Total Phosphorus and Chlorophyll-a levels in the Water Supply Reservoirs

2015 Newport Reservoirs
Seasonal Mean Epilimnetic TP (μg/l)

- Paradise
- Gardiner
- South
- North
- St. Marys
- Sisson
- Lawton Valley
- Watson
- Nonquit

Seasonal Mean Epilimnetic P (ppb)

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Growing Season Mean (μg/l)</th>
<th>Growing Season Maximum (μg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonquit</td>
<td>16</td>
<td>64</td>
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<tr>
<td>Watson</td>
<td>14</td>
<td>33</td>
</tr>
<tr>
<td>Lawton Valley</td>
<td>35</td>
<td>80</td>
</tr>
<tr>
<td>Sisson</td>
<td>56</td>
<td>132</td>
</tr>
<tr>
<td>St. Marys</td>
<td>38</td>
<td>139</td>
</tr>
<tr>
<td>North Easton</td>
<td>45</td>
<td>70</td>
</tr>
<tr>
<td>South Easton</td>
<td>31</td>
<td>53</td>
</tr>
<tr>
<td>Gardiner</td>
<td>37</td>
<td>107</td>
</tr>
<tr>
<td>Paradise</td>
<td>37</td>
<td>69</td>
</tr>
</tbody>
</table>
### Newport Reservoir Phytoplankton Summaries 2015

#### North Easton Pond Organism ID/Enumeration (2015)

<table>
<thead>
<tr>
<th>Date</th>
<th>Diatomaceae</th>
<th>Chlorophyceae</th>
<th>Cyanophyceae</th>
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</thead>
<tbody>
<tr>
<td>5/6/2015</td>
<td>594</td>
<td>116.0</td>
<td>0</td>
</tr>
<tr>
<td>6/1/2015</td>
<td>2,140</td>
<td>1,900</td>
<td>0</td>
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<tr>
<td>6/30/2015</td>
<td>5,550</td>
<td>3,520</td>
<td>0</td>
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<tr>
<td>7/29/2015</td>
<td>12,320</td>
<td>2,200</td>
<td>2,340</td>
</tr>
<tr>
<td>8/24/2015</td>
<td>23,400</td>
<td>2,200</td>
<td>4,960</td>
</tr>
<tr>
<td>9/21/2015</td>
<td>29,000</td>
<td>4,900</td>
<td>17,400</td>
</tr>
</tbody>
</table>

#### South Easton Pond Organism ID/Enumeration (2015)

<table>
<thead>
<tr>
<th>Date</th>
<th>Diatomaceae</th>
<th>Chlorophyceae</th>
<th>Cyanophyceae</th>
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<tr>
<td>5/6/2015</td>
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<tr>
<td>6/1/2015</td>
<td>1,520</td>
<td>1,500</td>
<td>0</td>
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<tr>
<td>6/30/2015</td>
<td>1,500</td>
<td>5,020</td>
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<tr>
<td>7/29/2015</td>
<td>2,640</td>
<td>5,460</td>
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<td>8/24/2015</td>
<td>4,000</td>
<td>7,600</td>
<td>5,900</td>
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<tr>
<td>9/21/2015</td>
<td>4,000</td>
<td>7,600</td>
<td>5,900</td>
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</tbody>
</table>

#### Gardiner Pond Organism ID/Enumeration (2015)

<table>
<thead>
<tr>
<th>Date</th>
<th>Diatomaceae</th>
<th>Chlorophyceae</th>
<th>Cyanophyceae</th>
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<tbody>
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<td>6/1/2015</td>
<td>8,300</td>
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<td>0</td>
</tr>
<tr>
<td>6/30/2015</td>
<td>18,020</td>
<td>2,320</td>
<td>0</td>
</tr>
<tr>
<td>7/29/2015</td>
<td>13,400</td>
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<td>0</td>
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<tr>
<td>8/24/2015</td>
<td>31,620</td>
<td>3,200</td>
<td>0</td>
</tr>
<tr>
<td>9/21/2015</td>
<td>36,300</td>
<td>3,200</td>
<td>12,100</td>
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</table>

#### Paradise Pond Organism ID/Enumeration (2015)

<table>
<thead>
<tr>
<th>Date</th>
<th>Diatomaceae</th>
<th>Chlorophyceae</th>
<th>Cyanophyceae</th>
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<tbody>
<tr>
<td>5/6/2015</td>
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<td>0</td>
</tr>
<tr>
<td>6/1/2015</td>
<td>4,300</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6/30/2015</td>
<td>10,000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7/29/2015</td>
<td>17,900</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8/24/2015</td>
<td>10,000</td>
<td>4,440</td>
<td>0</td>
</tr>
<tr>
<td>9/21/2015</td>
<td>10,000</td>
<td>4,440</td>
<td>0</td>
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</tbody>
</table>
Objective of the TMDL

Excessive P and N Loading

Elevated levels of phytoplankton
Cyanobacteria dominance
Decreased species diversity

Increased Levels of Organic Carbon

Disinfection of Source Water

Disinfection By-Product Formation

Phytoplankton Die Off and Settle to Bottom

Bacterial Decomposition Depletes Bottom Water of Oxygen

Sediment Release of Fe and P Back to Water Column

Human and Animal Health Concerns

Impaired Aquatic Habitat

Increased Color

Taste and Odor Issues

Unacceptable Water Quality for Public Distribution
Water Quality Standard Violations
Customer Complaints

Increased Treatment Costs
Increased Cost for Consumer
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
1. Establishing Target Phosphorus Concentrations in the Reservoirs

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-\(\alpha\), 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

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

![Graph showing the relationship between Mean Epilimnetic Chlorophyll-a (μg/l) and Mean Epilimnetic Dissolved Organic Carbon (mg/l). The graph includes a linear regression line with the equation y = 0.0923x + 2.5996, R² = 0.7288, and p < 0.0001. The data points are plotted on the graph.]
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

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Existing TP Load (lbs/yr)*</th>
<th>Loading Capacity TMDL (lbs/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonquit Pond</td>
<td>1537</td>
<td>616</td>
</tr>
<tr>
<td>Watson Reservoir</td>
<td>196</td>
<td>154</td>
</tr>
<tr>
<td>Lawton Valley Reservoir</td>
<td>401</td>
<td>148</td>
</tr>
<tr>
<td>Sisson Pond</td>
<td>190</td>
<td>30</td>
</tr>
<tr>
<td>St. Marys Pond</td>
<td>470</td>
<td>66</td>
</tr>
<tr>
<td>North Easton Pond</td>
<td>347</td>
<td>94</td>
</tr>
<tr>
<td>South Easton Pond</td>
<td>218</td>
<td>87</td>
</tr>
<tr>
<td>Gardiner Pond</td>
<td>168</td>
<td>61</td>
</tr>
<tr>
<td>Paradise Pond</td>
<td>209</td>
<td>39</td>
</tr>
</tbody>
</table>
Determining Existing Total Phosphorus Loads

Watershed Treatment Model

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
Watershed Treatment Model

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

<table>
<thead>
<tr>
<th>Urban Land Use</th>
<th>(Point Source)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Density Residential</td>
<td>Wasteload Allocation (WLA)</td>
</tr>
<tr>
<td>Medium Density Residential</td>
<td></td>
</tr>
<tr>
<td>High Density Residential</td>
<td></td>
</tr>
<tr>
<td>Transportation (all roadways)</td>
<td></td>
</tr>
<tr>
<td>Commercial</td>
<td></td>
</tr>
<tr>
<td>Industrial</td>
<td></td>
</tr>
<tr>
<td>Institutional</td>
<td></td>
</tr>
<tr>
<td>Tiverton Landfill</td>
<td></td>
</tr>
<tr>
<td>Onsite Wastewater Treatment Systems (OWTS)</td>
<td>Load Allocation (LA) (Non-Point Source)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Agricultural Land Use</th>
<th>(Non-Point Source)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livestock</td>
<td>Load Allocation (LA)</td>
</tr>
<tr>
<td>Hay/Brushland</td>
<td></td>
</tr>
<tr>
<td>Meadow</td>
<td></td>
</tr>
<tr>
<td>Nursery</td>
<td></td>
</tr>
<tr>
<td>Orchard</td>
<td></td>
</tr>
<tr>
<td>Vineyard</td>
<td></td>
</tr>
<tr>
<td>Tree Farm</td>
<td></td>
</tr>
<tr>
<td>Pasture</td>
<td></td>
</tr>
<tr>
<td>Quarry</td>
<td></td>
</tr>
<tr>
<td>Row Crop</td>
<td></td>
</tr>
<tr>
<td>Managed Grass</td>
<td></td>
</tr>
<tr>
<td>Transitional</td>
<td></td>
</tr>
<tr>
<td>Natural Background</td>
<td></td>
</tr>
<tr>
<td>Forestland</td>
<td>LA (Natural Background)</td>
</tr>
<tr>
<td>Wetland</td>
<td>(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</td>
</tr>
<tr>
<td>Atmospheric Deposition</td>
<td></td>
</tr>
</tbody>
</table>
### Sources/Source Categories of Phosphorus in Reservoir Watersheds

#### WTM Land Use Modeling Results

<table>
<thead>
<tr>
<th>Waterbody</th>
<th>% TP Load from Urban Land Uses</th>
<th>% TP Load from Agricultural Land Uses</th>
<th>% TP Load from OWTS failure to surface water</th>
<th>% TP Load from Forest and Atmospheric (Natural Background)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonquit Pond</td>
<td>41%</td>
<td>27%</td>
<td>2%</td>
<td>30%</td>
</tr>
<tr>
<td>Watson Reservoir</td>
<td>52%</td>
<td>29%</td>
<td>1%</td>
<td>18%</td>
</tr>
<tr>
<td>Lawton Valley Reservoir</td>
<td>70%</td>
<td>22%</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>Sisson Pond</td>
<td>34%</td>
<td>61%</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>St. Marys Pond</td>
<td>57%</td>
<td>32%</td>
<td>5%</td>
<td>6%</td>
</tr>
<tr>
<td>North and South Easton Ponds</td>
<td>88%</td>
<td>10%</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>Gardiner Pond</td>
<td>24%</td>
<td>10%</td>
<td>0%</td>
<td>67%</td>
</tr>
<tr>
<td>Paradise Pond</td>
<td>33%</td>
<td>55%</td>
<td>3%</td>
<td>9%</td>
</tr>
<tr>
<td>Maidford River</td>
<td>67%</td>
<td>32%</td>
<td>0%</td>
<td>1%</td>
</tr>
</tbody>
</table>
TMDL (each reservoir) = ΣWLA + ΣLA + MOS
Sample of How TP Loads were estimated

SISSON POND

<table>
<thead>
<tr>
<th>Source Category</th>
<th>WTM Predicted Annual P load (lbs/yr)</th>
<th>% of Total P Load</th>
<th>Empirical Model Predicted TP load (lbs/yr)</th>
<th>Adjusted Total P Load (lbs/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>99</td>
<td>34</td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>Agriculture</td>
<td>176</td>
<td>61</td>
<td></td>
<td>115</td>
</tr>
<tr>
<td>OWTS failure to surface water</td>
<td>1</td>
<td>0.3</td>
<td>190</td>
<td>-</td>
</tr>
<tr>
<td>Natural Background</td>
<td>14</td>
<td>5</td>
<td></td>
<td>9</td>
</tr>
</tbody>
</table>
### Example Allocation of TMDL

**SISSON POND**

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

<table>
<thead>
<tr>
<th>Land Use Category</th>
<th>Existing Annual TP Load (lbs)</th>
<th>Allowable Annual TP Load (lbs)</th>
<th>WLA</th>
<th>LA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>65</td>
<td>8</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>115</td>
<td>13</td>
<td></td>
<td>Natural Background</td>
</tr>
<tr>
<td>Forest/Wetland/Atmospheric</td>
<td>9</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reservoir</td>
<td>Existing P Load (lbs/yr)</td>
<td>TMAL Load (lbs/yr)</td>
<td>Reduction TP Load Reduction (%)</td>
<td>WLA</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------</td>
<td>--------------------</td>
<td>---------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Nonquit Pond</td>
<td>1537</td>
<td>616</td>
<td>85</td>
<td>98</td>
</tr>
<tr>
<td>Watson Reservoir</td>
<td>196</td>
<td>154</td>
<td>25</td>
<td>76</td>
</tr>
<tr>
<td>Lawton Valley Reservoir</td>
<td>401</td>
<td>148</td>
<td>65</td>
<td>98</td>
</tr>
<tr>
<td>Sisson Pond</td>
<td>190</td>
<td>30</td>
<td>88</td>
<td>8</td>
</tr>
<tr>
<td>St. Marys Pond</td>
<td>470</td>
<td>66</td>
<td>91</td>
<td>25</td>
</tr>
<tr>
<td>North Easton Pond</td>
<td>347</td>
<td>94</td>
<td>74</td>
<td>79</td>
</tr>
<tr>
<td>South Easton Pond</td>
<td>218</td>
<td>87</td>
<td>61</td>
<td>75</td>
</tr>
<tr>
<td>Gardiner Pond</td>
<td>168</td>
<td>61</td>
<td>65</td>
<td>35</td>
</tr>
<tr>
<td>Paradise Pond</td>
<td>209</td>
<td>39</td>
<td>84</td>
<td>21</td>
</tr>
</tbody>
</table>
Table 4.14. Summary of Phosphorus Sources to the Newport Reservoir Watersheds.

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

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

• National Water Quality Initiative 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)
- National **Water Quality** Initiative studies

http://www.dem.ri.gov/programs/water/quality/restoration-studies/reports.php
• Lack of Riparian Buffers
• Flooded paddocks
• Erosion/Runoff from Agricultural/Urban Areas
• Exposed silage piles
Urban Runoff
i.e.
Stormwater
Urban Runoff

i.e. Stormwater
NONQUIT POND-
Tiverton Landfill
Goose Waste/Erosion/Lack of Buffers
Internal Cycling of Phosphorus from Sediments
Overview of Pollution Reduction Measures

TMDL Implementation Basics

1. **Point Sources** - CWA requires that permits be consistent with relevant TMDL Provisions
   1. Use RIPDES permit tools to implement
   2. MS4 Permit issued in 2003 established requirements for MS4s to provide plans describing how they intend to implement TMDL Provisions.
   3. 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).
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.
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:
Brian Zalewsky
DEM/Office of Water Resources
235 Promenade Street, Providence, RI 02908
brian.zalewsky@dem.ri.gov
2. Determining Existing and Allowable Phosphorus Loads

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

- \[ L = \frac{P \cdot (A \cdot z \cdot p)}{(1-R)} \]

- 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:
    - \( R = \frac{1}{1 + \sqrt{p}} \) (Larsen and Mercier 1976)
Canfield and Bachmann (1981) empirical equation:

\[ TP = \frac{(L/1000)}{0.305 \times Z \left(0.114 \left(\frac{L}{Z}\right)^{0.589} + \frac{1}{T}\right)} \]

Where:

- \( TP \) = mean total phosphorus concentration for each reservoir in mg/l
- \( L \) = loading rate in mg/m²
- \( Z \) = 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:

\[
\frac{2015 \text{ Mean reservoir volume (MG)}}{\text{Total loss (outflow) recorded in 2015 (MG)}} = \text{detention time (DT) (yrs)}
\]

**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.

\[
R = \frac{1}{1 + \sqrt{p}} \quad \text{(Larsen and Mercier 1976)}
\]
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