Framework for Accounting and Tracking of Nutrient Loads and Reductions

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Topics for Discussion

- **Background & Context**: Watershed Nutrient Issues & NPDES Stormwater Permitting
- **General Approach and Framework**
  - Nutrient Source Characterization
  - Quantify reduction credits from control practices
  - Delivery Factors to reflect system losses
  - Permitting Framework to reflect Adaptive Management Approach
Watershed Nutrient Loading & Cultural Eutrophication

- Excessive nutrient loading leads to cultural (anthropogenic) eutrophication
- Many examples of impaired waters due to excessive nutrient loads:
  - Long Island Sound, Lake Champlain, Great Bay, Numerous Mass Bays, Charles River, MA, and numerous lakes throughout NE
Watershed Nutrient Management

- Non-Point Source (NPS) and stormwater (SW) nutrient loads are significant contributors to impaired water quality and non-attainment of adopted Water Quality Standards in many watershed.
- Reductions on point sources such as POTWs and WWTFs are needed, but
- In many cases - achieving reductions in nutrient loads from SW and NPS sources will also be necessary to meet WQS.
NPDES SW Permitting
Addressing Excessive Nutrient Loads

• In accordance with permitting regulations, EPA Region 1 has proposed SW permit requirements to achieve nutrient load reductions consistent with wasteload allocations in EPA approved TMDLs

• Others are interested in integrated watershed management planning that would evaluate management of regulated and non-regulated sources to achieve water quality goals
Components of the SW Permitting Process to Addressing Excessive Nutrient Loads

- Determination of needed SW load reductions
- Straightforward accounting methodology to:
  - guide planning and implementation activities; and
  - demonstrate progress and permit compliance
- Permitting framework to provide opportunities for updating information and management approaches
Accounting Methodology

- The Accounting methodology must:
  - Be based on credible information for quantifying sources and reduction credits for various control practices;
  - Allow for accounting across jurisdictional and sub-watershed boundaries within the watershed of interest;
  - Apply “Delivery Factors” as needed to account for losses due to watershed processes
  - Be re-visited from time to time to update information and incorporate new information
Nutrient Source Characterization and Quantification

- **Phosphorus**: EPA Region 1 has undergone the process for phosphorus and has proposed phosphorus load export rates for various source categories.

- **Nitrogen**: EPA has begun work for nitrogen and is ready to share information with those working on watershed nitrogen issues.
  - EPA sees value in collaborative effort of developing nitrogen load rates:
    - Greater access to expertise in the field
    - Avoid duplicating efforts
    - Increasing robustness of datasets and information considered
Goals of Nutrient Source Characterization and Quantification

- Characterize sources in appropriate units to reflect water quality impacts (e.g., kg/ha/yr)
  - Eutrophication is tied to long-term nutrient loading
- Export rates should reflect regional hydrology and precipitation patterns
- Export rates should reflect regional SW quality conditions and pollutants of concern
Develop Phosphorus Load Export Rates to be used in Permitting Process

Weight of evidence approach to estimate annual average phosphorus load export rates (PLERs) for several source categories

Information considered includes:

- Regional PLERs (similar to those used in the Stormwater Management Model and P8 Model)
- The basis of the PLERs is summarized in the fact sheet to the draft NH Small MS4 permit >>
- \( \text{Fundamentals of Urban Runoff Management, Shaver, et al., 2007} \)
- \( \text{http://www.flickr.com/photos/johnnyvulkan/3167452677/} \)
Table 1. Proposed Phosphorus Load Export Rates (PLER) for various stormwater runoff source categories

<table>
<thead>
<tr>
<th>Phosphorus Source Category by Land Use</th>
<th>Land Surface Cover</th>
<th>Phosphorus Load Export Rate, Kg/ha/yr</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial (Com) and Industrial (Ind)</td>
<td></td>
<td></td>
<td>Derived using a combination of the Lower Charles USGS Loads study and NSWQ dataset. This PLER is approximately 75% of the HDR PLER and reflects the difference in the distributions of SW TP EMCs between Commercial/Industrial and Residential.</td>
</tr>
<tr>
<td>Multi-Family (MFR) and High-Density Residential (HDR)</td>
<td>Impervious</td>
<td>2.6</td>
<td>Largely based on loading information from Charles USGS loads, SWMM HRU modeling, and NSWQ data set</td>
</tr>
<tr>
<td>Medium-Density Residential (MDR)</td>
<td>Impervious</td>
<td>2.2</td>
<td>Largely based on loading information from Charles USGS loads, SWMM HRU modeling, and NSWQ data set</td>
</tr>
<tr>
<td>Low Density Residential (LDR) - &quot;Rural&quot;</td>
<td>Impervious</td>
<td>1.0</td>
<td>Derived from Mattson Issac and subsequent modeling by Tetra Tech for Optimization study (composite rate 0.3 kg/ha/yr)</td>
</tr>
<tr>
<td>Highway (HWY)</td>
<td>Impervious</td>
<td>1.5</td>
<td>Derived from Shaver et al and subsequent modeling by Tetra Tech for Optimization study (composite rate 0.9 kg/ha/yr)</td>
</tr>
<tr>
<td>Forest (For)</td>
<td>Impervious</td>
<td>1.0</td>
<td>Derived from Mattson Issac and subsequent modeling by Tetra Tech for Optimization study (composite rate 0.13 kg/ha/yr)</td>
</tr>
<tr>
<td>Agriculture (Ag)</td>
<td></td>
<td></td>
<td>Table C-4 of NH Lake TMDL Reports (Cited source: Reckhow et al. 1980)</td>
</tr>
<tr>
<td>*Developed Land Pervious (DevPERV) - Hydrologic Soil Group A/B</td>
<td>Pervious</td>
<td>0.2</td>
<td>Derived from SWMM HRU modeling with assumed representative TP concentration of 0.3 mg/L for pervious runoff from developed lands. TP of 0.3 mg/L is based on NSWQ dataset, TB-9 (CSN, 2011), and other PLER literature.</td>
</tr>
<tr>
<td>*Developed Land Pervious (DevPERV) - Hydrologic Soil Group C</td>
<td>Pervious</td>
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</tr>
<tr>
<td>*Developed Land Pervious (DevPERV) - Hydrologic Soil Group D</td>
<td>Pervious</td>
<td>0.8</td>
<td></td>
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</tbody>
</table>
Stormwater (SW) Nitrogen Source Characterization Process: Overview

- Step 1: Compile and Analyze SW quality data
- Step 2: Develop Hydrologic Response Units
- Step 3: Identify sources and determine representative SW nitrogen concentrations
- Step 4: Estimate Annual SW Nitrogen Load Export Rates (NLEs)
- Step 5: Calculate SW Nitrogen Source Loads - Watershed GIS Spreadsheet Analysis
### Stormwater Total Nitrogen EMC Data Analysis

**National Stormwater Quality Database (NSQD)**

- Large database with SW data from region with similar rainfall patterns
- A variety of analyses to identify distinct source categories

#### Summary of Stormwater Event Mean Concentration (EMCs) Data for Rainfall Regions 1 & 2 (Mid-Atlantic and Northeast)

<table>
<thead>
<tr>
<th>Category</th>
<th>Count (n)</th>
<th>mean</th>
<th>median</th>
<th>geomean</th>
<th>standard deviation</th>
<th>25th%</th>
<th>75th%</th>
</tr>
</thead>
<tbody>
<tr>
<td>All land uses in database</td>
<td>1308</td>
<td>2.49</td>
<td>1.90</td>
<td>1.98</td>
<td>2.25</td>
<td>1.32</td>
<td>3.00</td>
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<tr>
<td>commercial</td>
<td>309</td>
<td>2.62</td>
<td>2.04</td>
<td>2.03</td>
<td>2.06</td>
<td>1.30</td>
<td>3.30</td>
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<tr>
<td>industrial</td>
<td>204</td>
<td>2.28</td>
<td>1.69</td>
<td>1.73</td>
<td>2.49</td>
<td>1.13</td>
<td>2.52</td>
</tr>
<tr>
<td>residential</td>
<td>686</td>
<td>2.41</td>
<td>1.94</td>
<td>1.96</td>
<td>2.07</td>
<td>1.36</td>
<td>2.93</td>
</tr>
<tr>
<td>open</td>
<td>32</td>
<td>2.05</td>
<td>1.61</td>
<td>1.73</td>
<td>1.28</td>
<td>1.24</td>
<td>2.35</td>
</tr>
</tbody>
</table>
### Summary of Stormwater Event Mean Concentrations

**Total Nitrogen, mg/L**

*(Sum of TKN, NO₃ + NO₂)*

<table>
<thead>
<tr>
<th>Data set description</th>
<th>count</th>
<th>arithmetic mean</th>
<th>median</th>
<th>geometric mean</th>
<th>standard deviation</th>
<th>25th %</th>
<th>75th %</th>
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<tbody>
<tr>
<td>1) Rain Region 1&amp;2, all precip. events</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 a) all land uses - all storm events</td>
<td>1308</td>
<td>2.49</td>
<td>1.90</td>
<td>1.98</td>
<td>2.25</td>
<td>1.32</td>
<td>3.00</td>
</tr>
<tr>
<td>1 b) all commercial &amp; industrial</td>
<td>507</td>
<td>2.50</td>
<td>1.89</td>
<td>1.92</td>
<td>2.26</td>
<td>1.22</td>
<td>3.10</td>
</tr>
<tr>
<td>1 c) commercial &amp; mixed commercial</td>
<td>309</td>
<td>2.62</td>
<td>2.04</td>
<td>2.03</td>
<td>2.06</td>
<td>1.30</td>
<td>3.30</td>
</tr>
<tr>
<td>1 d) industrial &amp; mixed industrial</td>
<td>204</td>
<td>2.28</td>
<td>1.69</td>
<td>1.73</td>
<td>2.49</td>
<td>1.13</td>
<td>2.52</td>
</tr>
<tr>
<td>1 e) all residential</td>
<td>686</td>
<td>2.41</td>
<td>1.94</td>
<td>1.96</td>
<td>2.07</td>
<td>1.36</td>
<td>2.93</td>
</tr>
<tr>
<td>1 f) open</td>
<td>32</td>
<td>2.05</td>
<td>1.61</td>
<td>1.73</td>
<td>1.28</td>
<td>1.24</td>
<td>2.35</td>
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<tr>
<td>2) Rain Region 1&amp;2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2 a) all data - precipitation &lt; 0.5 in</td>
<td>602</td>
<td>2.70</td>
<td>2.11</td>
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<td>2.32</td>
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<td>490</td>
<td>2.78</td>
<td>2.28</td>
<td>2.18</td>
<td>2.46</td>
<td>1.40</td>
<td>3.51</td>
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<tr>
<td>2 b) all data - precipitation &lt; 0.3 in</td>
<td>356</td>
<td>3.05</td>
<td>2.44</td>
<td>2.38</td>
<td>2.70</td>
<td>1.54</td>
<td>3.73</td>
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<tr>
<td>2 d) all data - precipitation &lt; 0.2 in</td>
<td>211</td>
<td>3.36</td>
<td>2.46</td>
<td>2.49</td>
<td>3.27</td>
<td>1.58</td>
<td>3.90</td>
</tr>
<tr>
<td>3) Rain Region 1&amp;2 , precip. &lt; 0.3 in</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 a) all data</td>
<td>356</td>
<td>3.05</td>
<td>2.44</td>
<td>2.38</td>
<td>2.70</td>
<td>1.54</td>
<td>3.73</td>
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<tr>
<td>3 b) all commercial &amp; industrial</td>
<td>158</td>
<td>3.01</td>
<td>2.32</td>
<td>2.26</td>
<td>2.88</td>
<td>1.37</td>
<td>3.70</td>
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<tr>
<td>3 c) all commercial &amp; mixed commercial</td>
<td>100</td>
<td>3.05</td>
<td>2.59</td>
<td>2.37</td>
<td>2.27</td>
<td>1.46</td>
<td>3.89</td>
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<tr>
<td>3 d) all industrial &amp; mixed industrial</td>
<td>57</td>
<td>2.97</td>
<td>2.13</td>
<td>2.04</td>
<td>3.78</td>
<td>1.13</td>
<td>3.51</td>
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<tr>
<td>3 e) all residential</td>
<td>167</td>
<td>2.80</td>
<td>2.41</td>
<td>2.35</td>
<td>1.84</td>
<td>1.62</td>
<td>3.54</td>
</tr>
<tr>
<td>3 f) open</td>
<td>6</td>
<td>1.96</td>
<td>1.77</td>
<td>1.74</td>
<td>1.12</td>
<td>1.60</td>
<td>1.78</td>
</tr>
<tr>
<td>4) Rain Region 1&amp;2, precip. &lt; 0.3 in, IDP &gt; 7days</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 a) all data</td>
<td>67</td>
<td>3.30</td>
<td>2.94</td>
<td>2.78</td>
<td>1.89</td>
<td>1.76</td>
<td>4.33</td>
</tr>
<tr>
<td>4 b) all commercial &amp; industrial</td>
<td>29</td>
<td>3.44</td>
<td>3.40</td>
<td>2.92</td>
<td>1.85</td>
<td>1.90</td>
<td>4.66</td>
</tr>
<tr>
<td>4 c) all commercial &amp; mixed commercial</td>
<td>24</td>
<td>3.41</td>
<td>3.45</td>
<td>2.86</td>
<td>1.90</td>
<td>1.45</td>
<td>4.62</td>
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<tr>
<td>4 d) all industrial &amp; mixed industrial</td>
<td>6</td>
<td>3.57</td>
<td>3.00</td>
<td>3.29</td>
<td>1.59</td>
<td>2.35</td>
<td>4.95</td>
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<tr>
<td>4 e) all residential</td>
<td>34</td>
<td>3.14</td>
<td>2.85</td>
<td>2.59</td>
<td>2.00</td>
<td>1.61</td>
<td>3.91</td>
</tr>
<tr>
<td>5) Rain Region 1&amp;2, precip. &lt; 0.3 in, IDP &lt; 7days</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 a) all data</td>
<td>114</td>
<td>2.77</td>
<td>2.26</td>
<td>2.35</td>
<td>1.79</td>
<td>1.62</td>
<td>3.38</td>
</tr>
<tr>
<td>5 b) all commercial &amp; industrial</td>
<td>47</td>
<td>2.83</td>
<td>2.14</td>
<td>2.25</td>
<td>2.16</td>
<td>1.41</td>
<td>3.93</td>
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<tr>
<td>5 c) all commercial &amp; mixed commercial</td>
<td>34</td>
<td>2.65</td>
<td>1.87</td>
<td>2.05</td>
<td>2.28</td>
<td>1.35</td>
<td>3.20</td>
</tr>
</tbody>
</table>
Median Stormwater Total Nitrogen Event Mean Concentrations (EMC) for Two Major Land-use Groups - Commercial& Industrial and Residential

(Data source: Rainfall region 1 & 2 - National Stormwater Quality Database, Pitt, 2008)
### Summary of Stormwater Data for Total Nitrogen Event Mean Concentrations (EMCs) Collected in MA and Vermont

<table>
<thead>
<tr>
<th>Location (source)</th>
<th>land use</th>
<th>Station</th>
<th>Count (n)</th>
<th>mean</th>
<th>median</th>
<th>geomean</th>
<th>Standard deviation</th>
<th>25th%,</th>
<th>75th%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Charles River Watershed, MA (USGS, Breault et. al., 2002)</td>
<td>Single-family residential</td>
<td>USGS - 01104630</td>
<td>8</td>
<td>3.16</td>
<td>2.60</td>
<td>3.16</td>
<td>2.14</td>
<td>1.50</td>
<td>4.15</td>
</tr>
<tr>
<td>Lower Charles River Watershed, MA (USGS, Breault et. al., 2002)</td>
<td>Multifamily residential</td>
<td>USGS-01104673</td>
<td>8</td>
<td>2.19</td>
<td>2.15</td>
<td>2.19</td>
<td>1.05</td>
<td>1.60</td>
<td>2.60</td>
</tr>
<tr>
<td>Lower Charles River Watershed, MA (USGS, Breault et. al., 2002)</td>
<td>Commercial (01104677)</td>
<td>USGS-01104677</td>
<td>8</td>
<td>2.28</td>
<td>2.15</td>
<td>2.28</td>
<td>1.35</td>
<td>1.20</td>
<td>3.40</td>
</tr>
<tr>
<td>MA Highways - Low traffic volume (USGS, Smith &amp; Granato, 2009)</td>
<td>Highway</td>
<td>Rte 119-P 424209071545 201</td>
<td>17</td>
<td>0.81</td>
<td>0.59</td>
<td>0.59</td>
<td>0.69</td>
<td>0.40</td>
<td>0.86</td>
</tr>
<tr>
<td>MA Highways - Medium traffic volume (USGS, Smith &amp; Granato, 2009)</td>
<td>Highway</td>
<td>Route 2 - P 423027071291 301</td>
<td>18</td>
<td>1.42</td>
<td>1.09</td>
<td>1.17</td>
<td>1.01</td>
<td>0.73</td>
<td>1.57</td>
</tr>
<tr>
<td>MA Highways High traffic volume (USGS, Smith &amp; Granato, 2009)</td>
<td>Highway</td>
<td>Interstate 95 - P 422620071153 301</td>
<td>18</td>
<td>1.96</td>
<td>1.53</td>
<td>1.69</td>
<td>1.31</td>
<td>1.21</td>
<td>2.25</td>
</tr>
<tr>
<td>Englsby Watershed, Burlington, VT, (UVM, J. Nipper, 2012)</td>
<td>Residential</td>
<td>Inlet to Wet Pond</td>
<td>47</td>
<td>1.54</td>
<td>1.36</td>
<td>1.37</td>
<td>0.83</td>
<td>0.99</td>
<td>1.82</td>
</tr>
<tr>
<td>Tedeschi Parking Lot, Durham, NH (UNH 2011-12)</td>
<td>Commercial</td>
<td>Inlet to SW Control</td>
<td>8</td>
<td>2.49</td>
<td>1.85</td>
<td>1.94</td>
<td>2.18</td>
<td>1.08</td>
<td>2.68</td>
</tr>
</tbody>
</table>
Hydrologic Response Modeling Analysis

- Continuous hydrologic model simulations to estimate long-term average runoff conditions for several watershed surface types – (e.g., impervious, varying soil conditions, and vegetative cover)
  - Stormwater Management Model (SWMM)
  - P8 – Curve Number Method
- Representative of our climate conditions (e.g., hourly precipitation and daily temperature)
**SWMM Modeling and Calculated TN Export Rates**

- Spreadsheet generated table of export rates for various curve numbers and pollutant concentrations

Export rate = runoff yield (MG/ha/yr) x concentration (mg/L) x 3.7854 x 10^6/L/MG x 1 kg/10^6 mg

<table>
<thead>
<tr>
<th>Watershed surface</th>
<th>Description</th>
<th>Annual Runoff Yield, MG/ha/yr</th>
<th>0.25</th>
<th>0.50</th>
<th>1.00</th>
<th>1.50</th>
<th>2.00</th>
<th>2.50</th>
<th>3.00</th>
<th>4.00</th>
<th>5.00</th>
<th>8.00</th>
<th>10.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pervious area HSG A</td>
<td>well drained soils</td>
<td>0.07</td>
<td>0.06</td>
<td>0.13</td>
<td>0.25</td>
<td>0.38</td>
<td>0.51</td>
<td>0.64</td>
<td>0.76</td>
<td>1.02</td>
<td>1.27</td>
<td>2.04</td>
<td>2.55</td>
</tr>
<tr>
<td>Pervious area HSG B</td>
<td>moderately drained soils</td>
<td>0.21</td>
<td>0.20</td>
<td>0.40</td>
<td>0.79</td>
<td>1.19</td>
<td>1.59</td>
<td>1.98</td>
<td>2.38</td>
<td>3.17</td>
<td>3.97</td>
<td>6.35</td>
<td>7.94</td>
</tr>
<tr>
<td>Pervious area HSG C</td>
<td>limited permeability</td>
<td>0.41</td>
<td>0.39</td>
<td>0.77</td>
<td>1.54</td>
<td>2.31</td>
<td>3.08</td>
<td>3.85</td>
<td>4.62</td>
<td>6.16</td>
<td>7.70</td>
<td>12.32</td>
<td>15.40</td>
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<tr>
<td>Pervious area HSG D</td>
<td>poorly drained soils</td>
<td>0.69</td>
<td>0.65</td>
<td>1.30</td>
<td>2.60</td>
<td>3.90</td>
<td>5.20</td>
<td>6.49</td>
<td>7.79</td>
<td>10.39</td>
<td>12.99</td>
<td>20.78</td>
<td>25.98</td>
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<td>2.45</td>
<td>4.90</td>
<td>9.79</td>
<td>14.69</td>
<td>19.58</td>
<td>24.48</td>
<td>29.37</td>
<td>39.16</td>
<td>48.95</td>
<td>78.33</td>
<td>97.91</td>
</tr>
</tbody>
</table>


HSG= Hydrologic Soil Group, MG= million gallons, ha = hectare (1 ha= 2.47 acres)
P8 Model – Curve Number Method and calculated TN export rates

- Spreadsheet generated table of export rates for various curve numbers and pollutant concentrations

Export rate = runoff yield (MG/ha/yr) x concentration (mg/L) x 3.7854 x 10^6L/MG x 1 kg/10^6 mg

<table>
<thead>
<tr>
<th>P8 model simulations - Boston, MA hourly precipitation, 1998-2002</th>
<th>Runoff yield, MG/ha/yr</th>
<th>Annual Nitrogen Load Export Rate, kg/ha/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Average Annual Flow Weighted Total Nitrogen Concentration, mg/l</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td>curve number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>0.00</td>
<td>0.01</td>
</tr>
<tr>
<td>40</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>50</td>
<td>0.05</td>
<td>0.09</td>
</tr>
<tr>
<td>60</td>
<td>0.10</td>
<td>0.20</td>
</tr>
<tr>
<td>70</td>
<td>0.21</td>
<td>0.39</td>
</tr>
<tr>
<td>80</td>
<td>0.39</td>
<td>0.73</td>
</tr>
<tr>
<td>90</td>
<td>0.79</td>
<td>1.49</td>
</tr>
<tr>
<td>98</td>
<td>1.85</td>
<td>3.50</td>
</tr>
<tr>
<td>100% by P8</td>
<td>2.60</td>
<td>4.92</td>
</tr>
</tbody>
</table>

MG = million gallons, Average annual rainfall = 43.5 inches
Examples of TN Loading for Differing Watershed Surfaces

<table>
<thead>
<tr>
<th>Watershed Surface</th>
<th>Representative Annual SW TN Concentration</th>
<th>Annual Nitrogen Load Export Rate, kg/ha-yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impervious surface</td>
<td>2.0 mg/L**</td>
<td>19.58***</td>
</tr>
<tr>
<td>Turf-poorly drained &amp; fertilized</td>
<td>2.5 mg/L*</td>
<td>3.66****</td>
</tr>
<tr>
<td>Turf-poorly drained &amp; not fertilized</td>
<td>1.5 mg/L*</td>
<td>2.20****</td>
</tr>
<tr>
<td>Turf - well drained &amp; fertilized</td>
<td>2.5 mg/L*</td>
<td>0.15****</td>
</tr>
<tr>
<td>Turf - well drained &amp; not fertilized</td>
<td>1.5 mg/L*</td>
<td>0.09****</td>
</tr>
<tr>
<td>Forest - poorly drained</td>
<td>0.6 mg/L*</td>
<td>0.80****</td>
</tr>
<tr>
<td>Forest - well drained</td>
<td>0.6 mg/L*</td>
<td>0.01****</td>
</tr>
</tbody>
</table>

* From CSN TECHNICAL BULLETIN No. 9, Nutrient Accounting Methods to Document Local Stormwater Load Reductions in the Chesapeake Bay Watershed Version 1.0- REVIEW DRAFT, 2011

** USGS Lower Charles River Loads Study, 2002

*** Calculated using SWMM (for IA) for hourly precipitation 1998-2002, Boston, MA

**** Calculated using P8 model (CN Method) for hourly precipitation 1998-2002, Boston, MA
Median Stormwater Total Nitrogen EMCs for MA Highways with varying daily traffic counts -
Taken from Quality of Stormwater Runoff Discharged from MA Highways, 2005-2007, Kirk Smith and Gregory Granato, USGS

Approx. NLE* = 16 kg/ha-yr
Approx. NLE* = 11 kg/ha-yr
Approx. NLE* = 5 kg/ha-yr

* If median concentration is representative of annual flow-weighted average concentration (i.e., “representative concentration” but is it?????)
Goals of Stormwater Control Reduction Credit Assessments

• Identify structural and non-structural control practices worthy of credit
• Quantify reduction credits based on expected long-term cumulative performance
  • Cumulative effectiveness for all rain events not just “design storms”
  • Estimate cumulative effectiveness of various structural controls with varying capacities (small to large)*
  *Important for Retrofitting considerations*
• Base on credible data and information
Reduction Credits for Structural Controls

Develop estimates of long-term cumulative performance using regional performance and climate data.

Stormwater Best Management Practices Performance Analysis by Tetra Tech Inc.

- Develop and calibrate models to UNHSCWC performance data
- Simulate long term performance varying the capacity of controls

Validate results with literature review.
Size BMPs from established curves developed from calibrated models and detailed performance data.

Provides long-term cumulative performance estimates based on BMP design capacity.

Eliminates the need for detailed modeling and evaluation in individual applications (improves consistency).
Scheme for BMP Performance Curve Development

Precipitation

Land simulation (SWMM)
Surface runoff generation and pollutant wash off

BMP simulation (SUSTAIN/BMPDSS)
BMP Treatment

BMP Performance Curve: Gravel Wetland
Land Use: Commercial

Depth of Runoff Treated (inches)

Pollutant Removal

- TSS
- TP
- Zn
BMP Performance Curves
Surface Infiltration Practices
rain gardens, swales, basins, etc.
(Saturated Soil Infiltration Rate 0.52 in/hr)

Cumulative Phosphorus Load Removal

Physical Storage Design Capacity, Runoff Depth (inches)

Runoff Volume Reduction

Cumulative Phosphorus Load Removal

Physical Storage Design Capacity, Runoff Depth (inches)

- TP
- Volume
Generation of BMP Performance Curves for New England Region

BMPs

Surface Infiltration
(6 infiltration rates)

Infiltration trenches
(6 infiltration rates)

Bio-filtration

Porous pavement with underdrain

WQ Swales
(non-infiltration)

Gravel wetland

Enhanced Bio-retention*
* Optimized for N and P removal
- Curves not yet final
Draft Performance Curves for Enhanced Biofiltration system at Tedeschi in Durham NH

- System designed, installed and monitored by the University of New Hampshire Storm Water Center
- Modeling and development of performance curve by Tetra Tech Inc
- Much of the work funded by US EPA Region 1

Not Final
Enhanced Non-Structural BMPs
Eligible for Phosphorus and Nitrogen Reduction Credits

Enhanced non-structural BMPs

- Enhanced sweeping program
  (1-10% credit for P, 3-10% for TN)
- Catch basin cleaning
  (2% credit for P, 6% TN)
- No application of fertilizers with phosphorus
  (33% credit for P from lawns - pervious runoff only)
- Weekly leaf litter and organic debris collection (5% credit for P)

Attachment 2 to App. F to Draft NH Small MS4 Permit provides methodology for calculating default phosphorus reduction credits for enhanced non-structural Best Management Practices
EPA Region 1’s On-going Work Related to Reduction Credits

- Finalizing performance curves for:
  - Enhanced biofiltration systems;
  - rooftop storage disconnection;
  - impervious area disconnections; and
  - removal of impervious area
- Tracking credit work in the Chesapeake Bay area
- Participating in a research project to develop nitrogen removal curves for gravel wetlands
Delivery Factors and Nitrogen

- Nitrogen sources and associated reduction credits must be adjusted to account for losses in downstream system
- Applying delivery factors or coefficients based on geographic location and possibly source type is needed
Delivery Ratios for N Sources

Figure 2. Trading ratios for municipalities in Connecticut.

Hypothetical Permitting Framework & Adaptive Management Approach

- Provide framework for updating and refining information at regular intervals (e.g., 5 yr permit term)
- Allow for phasing of implementation
  - Phase 1 plan developed by yr 5, implemented years 6-10;
  - Phase 2 plan developed by yr 10, implemented yrs 11-15, etc.
- Update and incorporate new source and credit estimates prior to development of each successive implementation plan
  - by yr 4 for Ph 2 plan;
  - by yr 9 for ph 3 plan etc.
Questions?

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617.918.1537
voorhees.mark@epa.gov

Thank you
Links to BMP Performance Information

- Spreadsheet tool for using the curves and instructions.
  [http://www.epa.gov/region1/topics/water/swtoolsresources.html](http://www.epa.gov/region1/topics/water/swtoolsresources.html)
New England Region Rainfall Patterns Important Points

• Most rain events are small in size;
• Occur regularly (average about once every three days)
• The total volume and event size distribution are relatively consistent across New England Region
Percentage of Total Number of Rainfall Events Based on Size of Rain Events - Boston, MA (1948-2004)

0.0 - 0.2 inches: 55%
0.2-0.6 inches: 27%
0.6-1.0 inches: 10%
1.0-1.5 inches: 5%
1.5-2.0 inches: 2%
2.0 inches and above: 1%
Stormwater Phosphorus & Nitrogen

**Phosphorus**
- Highly associated with very fine particles ~ 40 microns
- Fine particles readily washed from impervious surfaces with small amounts of rainfall
- Stormwater controls must have filtration component to be effective

**Nitrogen**
- N Oxides are readily washed off in early portion of rain events (first flush is typical).
- Organic nitrogen can be a significant part of N load
- High removals of SW nitrogen may require de-nitrification