Perspectives on Managing Nutrients in the Chesapeake Watershed

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Chesapeake Stormwater Network

OCTOBER 13, 2015
Outline for Talk Today

- Factoids on the Chesapeake Bay Watershed
- Update on the TMDL and the New Regulatory Landscape
- Recipes for the Pollution Diet (Urban)
- Challenges Encountered So Far

What Makes Sense to Export to the Upper Midwest? ... What Should be Discarded?
Speaker Caveat

- My role in the Chesapeake Bay Program

- Opinions expressed today are solely those of myself, and probably don’t reflect those of EPA, the states, and pretty much everybody else in the watershed!
The Chesapeake Bay Watershed, by the numbers

- 64,000 square miles in area
- **Forest** is about 58% of the area
- **Row Crops** are about 10%
- About 10% is **turf** and 5% is **paved**
- The **rest** is pasture, meadow, wetlands and open land
- About 3.2 million **animal units** (chicken/hogs) and 40 million tons of manure
- ~ 500 **wastewater plants** that discharge 3 billion gallons per day
Technical Support for the TMDL

Under development for 30+ years

Phase 6 of the CBWM being upgraded now

Watershed model feeds into an estuarine water quality model to simulate how nutrient inputs affect the dead zone in the main stem of the Bay

Watershed model used to allocate state nutrient load reductions

As you might expect, both models attract a lot of technical and political controversy
Politics in the Watershed

- Six States and the District of Columbia
- Two EPA Regions, and many federal agencies and Facilities
- Chesapeake Bay Partnership is more than 35 years old
- Shifting from Voluntary to a Regulatory Program
Population of 18 million (2013)
25 Phase 1 MS4 Permitees
~700 Phase 2 MS4 Permitees
About 30% of population is non-regulated
Numeric TMDL requirements now reflected in many MS4 permits
  % impervious cover treated
  5/40/55 load reduction,
  10% sediment reduction
Cost of restoration primarily falls on local governments
Chesapeake Bay Management Structure

Complicated management structure: 40+ workgroups

Inclusive decision-making process operates by consensus (except when it doesn’t)

40,000 person hours of teleconferences per year

Update on the Chesapeake Bay TMDL:
A Pollution Diet for All Sectors and Sources
TN, TP and TSS Load Reductions for the Entire Watershed

Pollution Delivered to the Bay (million pounds/year)

- Nitrogen
- Phosphorus
- Sediment

2017 Interim target
2025 Planning Target (amt. allowed in Bay)
Key Sectors Involved in the Bay Pollution Diet

Agriculture: Farms and Feedlots
Wastewater Treatment
Forest (60% of CBW)
Air Deposition
Urban and Suburban Runoff
Urban BMPs a Major Component of Most States
Strategies to Reduce Nutrient Loads thru 2025

<table>
<thead>
<tr>
<th>State</th>
<th>N</th>
<th>P</th>
<th>TSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delaware</td>
<td>13%</td>
<td>12%</td>
<td>5%</td>
</tr>
<tr>
<td>D.C.</td>
<td>13%</td>
<td>22%</td>
<td>16%</td>
</tr>
<tr>
<td>Maryland</td>
<td>24%</td>
<td>28%</td>
<td>29%</td>
</tr>
<tr>
<td>New York</td>
<td>8%</td>
<td>20%</td>
<td>10%</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>41%</td>
<td>45%</td>
<td>50%</td>
</tr>
<tr>
<td>Virginia</td>
<td>13%</td>
<td>21%</td>
<td>30%</td>
</tr>
<tr>
<td>West Virginia</td>
<td>3%</td>
<td>44%</td>
<td>50%</td>
</tr>
</tbody>
</table>

* From existing Development.......Source: Antos, 2013
Chesapeake Bay TMDL Based on 7 State Watershed Implementation Plans
1. Watershed Implementation Plans identify nutrient and sediment targets that meet water quality standards.

2. 2-Year Milestones with programmatic and pollutant reduction commitments

3. Track and Assess Progress implementing WIPs and milestones

4. Federal Action if insufficient Watershed Implementation Plans or 2-year milestones

Source: Chesapeake Bay TMDL Section 7
The Clock is Ticking
5 years into this 15 Year Bay TMDL

- 2017: Mid Point Assessment (are we on track?)
- 2017: Revise Chesapeake Bay Watershed Model
- 2016: State Protocols for BMP Verification
- 2018: Phase 3 Watershed Implementation Plans
- 2016: Linking MS4 Permits to the TMDL
- 2016: Appeal to Supreme Court
- 2025: Achieve TMDL
CBP-Approved Urban BMPs for the Bay Pollution Diet

1. New State Performance Standards
2. Redevelopment Credits
3. Stormwater Retrofits
4. Residential Stewardship Practices
5. Urban Nutrient Management
6. Stream Restoration
7. Enhanced Erosion and Sediment Control
8. Illicit Discharge Removal
9. Street and Storm Drain Cleaning
10. Shoreline Management
11. Septic System Upgrades
Urban Expert Panels Still in the Works

- Floating Treatment Wetlands
- Impervious Cover Disconnection
- Urban Tree Canopy
- Performance Enhancing Devices for LID Practices
- Policy on Manufactured Treatment Devices
Expert Panel Process

- Detailed BMP Review Protocol for all panels
- Experts include researchers/practitioners and program administrators (10 to 15)
- Development of definitions and methods and/or protocols to derive nutrient/sediment removal rates
- Take about 9-12 months each
- Further state and EPA review before approval
The Bay BMP Compliance Recipe

- Add 3 parts of mixed stormwater retrofits
- Chop up new stormwater practices and sprinkle over new development
- Add LID practices to season all redevelopment projects
- Add two or more protocols of stream restoration and make sure to combine with upland restoration practices
- Use only low fat urban nutrients, and apply equally to public and private lands
Combine everything in a medium sized subwatershed pan, and let simmer for 1 to 2 years, or until practices are gradually implemented.

Skim off any grey nutrient discharges that float to the top

Sweep off any street crumbs with a vacuum sweeper

Season with a dash of enhanced erosion controls, shoreline management and homeowner BMPs to taste

EPA and the states will let you know when it is ready to eat.
Stormwater Retrofits

Retrofits will probably comprise about 50% your MS4 Restoration effort

Requires investigation of the inventory of older stormwater practices in the community

Hundreds are called, dozens are chosen

Retrofits of existing legacy ponds most cost effective

Retrofits provide multiple community benefits, including local stream protection
Retrofit Categories

A. **New Retrofit Facilities**
   1. Near Existing Stormwater Outfalls
   2. Within the Conveyance System
   3. Adjacent to Large Parking Lots
   4. Green Street Retrofits
   5. On-site LID Retrofits

B. **Existing BMP Facilities**
   1. BMP Conversions
   2. BMP Enhancements
   3. BMP Restoration
Residential Stewardship Practices
Residential Stewardship Practices

A Category of New Retrofits

Tools developed for streamlined reporting and tracking

Strong financial incentives and technical assistance for homeowners

Programs being expanded to small businesses and houses of faith

Good supplemental strategy to build retrofits on private land
Pollutant Removal for LID Practices Built for New Development to Meet New State Stormwater Performance Standards

- The recommendations of this Expert Panel should be transferable to the upper Midwest, given the recent MIDS effort, as well as the similarities to the MN stormwater manual
- Also applies to retrofits as well
- Shift from individual BMPs to BMP systems
Stormwater Performance Standards for New Development

These practices “hold the line” in terms of preventing an increase in local nutrient loads due to future growth and development.....unless you are clearing a lot of forest

The good news is there is nothing locals need to compute, as load changes are calculated by the model

**Biggest MS4 impact:** need to develop a local reporting, tracking and verification system to maintain credit for new and historic BMPs
All practices sorted into 2 categories: Runoff Reduction (RR) OR Stormwater Treatment (ST)

<table>
<thead>
<tr>
<th>Runoff Reduction Practices (RR)</th>
<th>Stormwater Treatment Practices (ST)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioretention</td>
<td>Constructed Wetlands</td>
</tr>
<tr>
<td>Dry Swale</td>
<td>Filtering Practices</td>
</tr>
<tr>
<td>Infiltration</td>
<td>Proprietary Practices</td>
</tr>
<tr>
<td>Permeable Pavement</td>
<td>Wet Swale</td>
</tr>
<tr>
<td>Green Roof</td>
<td>Wet Ponds</td>
</tr>
</tbody>
</table>

Achieve at least 25% reduction of annual runoff volume

Traditional Practices
Removal Rates

BMP removal rates are a function of runoff depth captured and the amount of stormwater treatment (ST) or runoff reduction (RR) achieved by the practice.
Redevelopment BMP Credits

• Use of LID practices on redevelopment projects earns a local pollutant reduction credit

• Individual credits are modest, but they can collectively add up over a decade or more (maybe 10% of WIP requirement)

• Good incentive to promote green infrastructure on private and public sector redevelopment projects
<table>
<thead>
<tr>
<th>STATE</th>
<th>REDEVELOPMENT REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC</td>
<td>On-site retention of runoff from the 1.2 rainfall event</td>
</tr>
<tr>
<td>DE</td>
<td>50% reduction in existing effective impervious for the site</td>
</tr>
<tr>
<td>EPA</td>
<td>On-site runoff reduction for the 95% rainfall event</td>
</tr>
<tr>
<td>MD</td>
<td>Reduce existing imperviousness by 50%, or treat runoff from 1.0 inch of rainfall, or combination</td>
</tr>
<tr>
<td>NY</td>
<td>Reduce by 25% through IC reduction, BMPs or alternative practices</td>
</tr>
<tr>
<td>PA</td>
<td>20% WQ treatment for the site</td>
</tr>
<tr>
<td>VA</td>
<td>Reduce existing phosphorus load by 10 to 20% depending on disturbed area</td>
</tr>
<tr>
<td>WV</td>
<td>0.25 - 0.8 inch of on-site runoff reduction</td>
</tr>
</tbody>
</table>
Urban Stream Restoration

Restoration of degraded urban streams can achieve major nutrient reduction, in communities that are sophisticated enough to implement these projects.

Can use NCD, RSC, LSR approaches for restoration projects.

Must meet stringent qualifying conditions for credits, major environmental permits and must demonstrate stream functional improvement.
Stream Restoration Protocols

Protocol 1.
1. Prevented sediment approach

Protocol 2.
2. In-stream de-nitrification

Protocol 3.
3. Flood plain reconnection

Dry Channel RSC
4. The “tweener” Dry Channel RSC
Functional Uplift in Streams

1. HYDROLOGY = Transport of water from the watershed to the channel
2. HYDRAULIC = Transport of water in the channel, on the floodplain, and through sediments
3. GEOMORPHOLOGY = Transport of wood and sediment to create diverse bed forms and dynamic equilibrium
4. PHYSICOCHEMICAL = Temperature and oxygen regulation; processing of organic matter and nutrients
5. BIOLOGY = Biodiversity and the life histories of aquatic and riparian life
How portable is the stream restoration protocol?

Probably requires major modification for upper Midwest, given:

- Differences in stream types from Mid-Atlantic (alluvial)
- Effect of glaciations and bedrock control
- Nutrient content of stream bank and flood plain soils
- Non-tidal wetlands are less prevalent in the mid-Atlantic region
1.5 million acres of home lawn are fertilized in the watershed

Credits Offered for:

Statewide Fertilizer Laws & Site Based Urban Nutrient Management Plans
State-wide Fertilizer Law Credit

Automatic P Reduction from pervious lands in States that enacted state fertilizer laws.

Due to Industry Phase-out of P, even states that did not pass laws get some credit

Largest reduction effect of any urban BMP so far

<table>
<thead>
<tr>
<th>Bay State</th>
<th>TP Reduction (million pounds)</th>
<th>% Change in Pervious Load</th>
<th>% Change in Urban Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA</td>
<td>0.125</td>
<td>-26.7</td>
<td>-10.2</td>
</tr>
</tbody>
</table>
Phasing in an approach where nutrient reductions are based on actual non-farm fertilizer statistics.
Panel came up with 10 core UNM principles, as well as high risk factors for nutrient runoff.

The UNM Credit can be for a Plan or a Pledge.

Localities should apply UNM plans to all of their public land, regardless of whether it is fertilized or not.

Use GIS capability to map out HIGH RISK lawns to target for intensive outreach (and higher credit).

Need to find a good retail delivery partner (e.g., Extension, SCDs, Master gardeners).
N and P Reduction Achieved for Qualifying Urban Nutrient Management Plans

<table>
<thead>
<tr>
<th>Risk Type</th>
<th>% TN Reduced per Acre</th>
<th>% TP Reduced per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>20 %</td>
<td>10 %</td>
</tr>
<tr>
<td>Low</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Blended</td>
<td>9</td>
<td>4.5</td>
</tr>
</tbody>
</table>
Core UNM Practices

1. Maintain a **dense** cover of grass on the lawn to reduce runoff, prevent erosion and retain nutrients

2. Choose not to fertilize, **OR** adopt a reduce rate/monitor approach **OR** apply less than 1 pound N/1000 sf in any single application.

**If you choose to fertilize:**

3. Do not apply fertilizer before spring green up or after the grass becomes dormant

4. Maximize use of slow release N fertilizer during the growing season

5. Immediately sweep off any fertilizer that lands on a paved surface

6. Never apply fertilizer within 15 to 20 feet of a water feature and manage this zone as a grass, meadow or forest buffer
Core UNM Practices

Regardless of whether you fertilize or not:

- Retain clippings and mulched leaves on the yard and keep them out of streets and storm drains
- Set mower height at 3 inches or taller
- Use disconnections and other practices that to increase the porosity and infiltration capability of your lawn in order to treat stormwater runoff.
- Consult an expert to see if you have a high risk factors and get advice on growing a Bay-friendly lawn
Meaningless Photo to Break up Monotonous Word Slides
Construction In the Bay Watershed

- Highest Unit Area Sediment Load of any Bay Land Use
- About 84,500 acres of construction in any given year
- About 16% of delivered sediment load from urban sector
Enhanced Erosion and Sediment Controls

More stringent ESC practices has led to sharp drop in sediment discharged from construction sites from historic levels.

Still, they discharge just under 2 tons/ac/year which is higher than most Bay land uses.
ESC Practices Are Effective in Reducing Sediment

- Current ESC Practices Provide a High Level of Sediment Removal From Construction Sites

<table>
<thead>
<tr>
<th>ESC Scenario</th>
<th>Discharged Load</th>
<th>Removal Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESC Sites Operating at Level 1</td>
<td>3.1 t/ac/yr</td>
<td>74%</td>
</tr>
<tr>
<td><strong>ESC Sites Operating at Level 2</strong></td>
<td><strong>1.75 t/ac/yr</strong></td>
<td><strong>85%</strong></td>
</tr>
<tr>
<td>ESC Sites Operating at Level 3</td>
<td>1.25 t/ac/yr</td>
<td>90%</td>
</tr>
</tbody>
</table>
But Not Nutrients!

Bad news is that they have the highest nutrient load of any Bay land use, and have zero removal efficiency

<table>
<thead>
<tr>
<th>ESC Stabilization Recommendations</th>
<th>Formulation (N-P-K)</th>
<th>Application Rate lbs/ac</th>
<th>N Rate N lbs/ac</th>
<th>P Rate * P lbs/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary Stabilization</td>
<td>10-10-10</td>
<td>500-600</td>
<td>50</td>
<td>27</td>
</tr>
<tr>
<td>Permanent Stabilization</td>
<td>10-20-10</td>
<td>500-1000</td>
<td>65</td>
<td>48</td>
</tr>
<tr>
<td>Total Fertilizer Application</td>
<td>600 to 1500</td>
<td></td>
<td>115</td>
<td>75</td>
</tr>
</tbody>
</table>
Dry weather nutrient discharges collectively account for as much as 20 to 40% of the annual nutrient load in urban watersheds, depending on the age and condition of its grey infrastructure.
Advanced Nutrient Discovery Programs Provides a Cost-Effective Nutrient Credit

The Program Credit is Capped in terms of the Maximum Nutrient Load (0.2% of Load from Urban Pervious Land)

Most MS4s Can Qualify for the Program Credit through Minor Adjustments to Existing IDDE programs

The big payoff is when locals can get credit for removal of individual nutrient discharges, starting in 2017
# 8 Types of Discharges Can be Fixed for Credit

<table>
<thead>
<tr>
<th>No.</th>
<th>Discharge Type</th>
<th>Protocol Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-1</td>
<td>Laundry Wash Water</td>
<td>1</td>
</tr>
<tr>
<td>N-2</td>
<td>Commercial Car Wash</td>
<td>1</td>
</tr>
<tr>
<td>N-3</td>
<td>Floor Drains</td>
<td>1</td>
</tr>
<tr>
<td>N-4</td>
<td>Misc. High Nutrient Discharges</td>
<td>1</td>
</tr>
<tr>
<td>N-5</td>
<td>Sanitary Direct Connection</td>
<td>1</td>
</tr>
<tr>
<td>N-6</td>
<td>Sewer Pipe Exfiltration</td>
<td>2</td>
</tr>
<tr>
<td>N-7</td>
<td>Drinking Water Transmission Loss</td>
<td>2</td>
</tr>
<tr>
<td>N-8</td>
<td>Dry Weather Sanitary Sewer Overflows</td>
<td>3</td>
</tr>
</tbody>
</table>
Street and Storm Drain Cleaning

- Offer credits for both street and storm drain cleaning
- Sweeper technology very important in removal rate
- Relied a lot on research and modeling from upper Midwest
WinSLAMM used to evaluate 960 street cleaning scenarios

<table>
<thead>
<tr>
<th>Land Use: Residential</th>
<th>Total Area: 3.92</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source Area: Street Area 1</td>
<td></td>
</tr>
</tbody>
</table>

**Street Cleaning Control Device**

<table>
<thead>
<tr>
<th>Line Number</th>
<th>Street Cleaning Date</th>
<th>Street Cleaning Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td></td>
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<td>5</td>
<td></td>
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<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
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<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Type of Street Cleaner**
- Mechanical Broom Cleaner
- Vacuum or Regenerative Air Cleaner

**Street Cleaner Productivity**
1. Coefficients based on street texture, parking density and parking controls
2. Other (specify equation coefficients)
   - Equation coefficient M (slope, $M < 1$)
   - Equation coefficient B (intercept, $B > 1$)

- Parking Densities
  - 1. None
  - 2. Light
  - 3. Medium
  - 4. Extensive (short term)
  - 5. Extensive (long term)

Are Parking Controls Imposed?
- Yes
- No
More Street Sweeping Options Can be Credited

Source: Tetra Tech, 2015
### Estimating Pollutant Reduction by Local Street Cleaning Program

<table>
<thead>
<tr>
<th>Lane Miles/Acres</th>
<th>SCP</th>
<th>Removal Rate (%)</th>
<th>Mass Removed (lbs)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>TSS</td>
<td>TN</td>
<td>TP</td>
<td>TSS</td>
<td>TN</td>
</tr>
<tr>
<td>150</td>
<td>SCP-2</td>
<td>16</td>
<td>3</td>
<td>8</td>
<td>31,200</td>
<td>69.8</td>
</tr>
<tr>
<td>50</td>
<td>SCP-7</td>
<td>7</td>
<td>1</td>
<td>4</td>
<td>4,550</td>
<td>7.8</td>
</tr>
<tr>
<td>25</td>
<td>SCP-4</td>
<td>6</td>
<td>1</td>
<td>4</td>
<td>1,950</td>
<td>3.8</td>
</tr>
<tr>
<td>75</td>
<td>SCP-9</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>9.75</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total for Community</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>37,710</strong></td>
<td><strong>81.4</strong></td>
</tr>
</tbody>
</table>
Still Debating Significance of Street Trees and Fall Leaf Litter Inputs
Nowak’s Baltimore Tree Analysis:
- 1194 lbs/acre/yr of TOC leaf drop
- 28.8 lbs/acre/yr of TN leaf drop
- 2.95 lbs/acre/yr of TP leaf drop

Photo Credit: Ken Belt
Data from the Upper Midwest Are Intriguing (Kalinosky, 2014)
Some Real Help from Air Quality Improvements

Progressively stronger air pollution controls are reducing the amount of N deposition on open waters of the Bay and on impervious cover.
A steady decline in N deposition to this point in time

Trend of estimated average nitrate and ammonia deposition concentrations to the Chesapeake watershed.

Source: Linker et al, 2013
Challenge Encountered so Far

- “Nutri-centrism”
- Limited BMP Comprehension
- Reporting and Verification
- BMP Costs are Poorly Understood
- Nutrient Trading Across Sectors Has Yet to Occur
- Hard to make Long-Term Investment Decisions w/o Certainty About the Rules
- Will EPA Actually Throw a Flag or Just Let the States Play?
“Nutri-centrism:” The myopic focus on nutrient reduction in the Chesapeake Bay crowds out other priority water quality and habitat protection concerns:

Bacteria, trash, PCBs, Hg, pesticides, intersex fish, wetland loss, etc.

N and P are not particularly cuddly, scary or photogenic
Limited Urban BMP Comprehension

- Most of us are really struggling to learn enough about all these BMPs to make good decisions on which ones to actually use in our communities.

- Not surprising, as a lot of technical stuff to matter and the “rules” are still being developed.
Financing and Nutrient Trading

Restoration price tag not fully understood, but is in the multi-billion dollar range

Local stormwater financing is not yet adequate (rain tax)

State trading programs are still in an embryonic stage
BMP Verification: Compare the relative accountability we have in the stormwater profession with what we expect from a sewage treatment plant.

Wastewater Treatment Plant

Klingon Stormwater BMP w/ cloaking device
“Consequences” When States all Short of the Mark: What will EPA look Like?
CSN Resources

www.chesapeakestormwater.net

- Approved Expert Panel Reports
- Urban BMP Verification Protocols
- Bioretention Illustrated: The Visual Indicators
- College of Stormwater Knowledge
- Do it Yourself Rain Garden Guide
QUESTIONS