Cost/Benefit Analysis of Stream Restoration as a Nutrient and Sediment Offset

An examination of the monetary impacts that occurs within a range of variables associated with nutrient reduction estimates from TMDL based stream projects in Maryland and Virginia

Josh Running - Associate

February 17, 2017
Presentation Outline

1. Brief Introduction
2. Background on the use of SR as a Nutrient Offset
3. Costs associated with SR (Case Studies)
4. Conclusions/Discussions/Questions
Josh Running

• Sr Environmental Planner/Associate
• Williamsburg, VA
• 17 years experience
Note: The purpose of this presentation is focused on costs and the application of stream restoration as a nutrient reduction offset. However, it is recognized that there are many other benefits to a stable stream and that doing restoration purely for the nutrient benefit is not the intention of CBPO or its partners.
Quick Ches-BAY Download

The Chesapeake Bay

- **1983**: CB Agreement leading to formation of CB Program Office and CB Executive Council
- **1987 & 2000**: CB Landmark Agreements
- **2009**: E. O. declaring CB a National Treasure
- **2010**: CB TMDL established; 6 Bay States and DC begin WIP development to achieve 2025 goals
- **2013**: Regulatory changes in Virginia alter way MS4 localities & agencies plan and develop in the Bay
- **2018 & 2023**: Incremental Numeric Reduction Target dates for VA MS4s ~1.25% & ~8.75%
- **2025 Target Date**: Reduction of Pollution Levels by **20-25%** over 2009 levels*

*Cost estimated at $7-10 Billion.

Costs are for SWM only (Total = $13.6-15.7B if include Ag, WW) and are attributed to Local Governments and State Agency in Virginia. Costs (source: VA Senate Finance Committee).

Largest Polluter in the Chesapeake is Sediment. Also Carries with it other Macro Nutrients (N & P)
The Role of Stream Restoration

- Degraded and Eroding Urban streams are and can be a significant source of sediments and nutrients. Some estimates have found:
  
  “almost ¾ of the sediment...in streams...comes from channel and bank erosion with only about ¼...coming from upland soil erosion”. (Osmond et al. 2012 summarizing several watershed studies)

- Stream restoration is very cost effective solution ($/lb basis compared to traditional SWM)

- CBPO estimates that 418 miles of Urban Stream Restoration will be implemented in VA and MD alone by 2025*

*(NOTE: estimates include historical projects and is derived from Phase 2 WIP submissions to EPA in 2012 and summarized by Jeff Sweeney of EPA CBPO.)
CBPO Stream Restoration Expert Panel Report

WEG (Stantec) invited to “test drive” Report
~May 2013 – Oct 2013

Developed to outline methods to quantify sediment and nutrient reductions from individual projects in an effort to “credit” projects to help offset reduction requirements

Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects

Joe Berg, Josh Burch, Deb Cappuccitti, Solange Filoso, Lisa Fraley-McNeal, Dave Goerman, Natalie Hardman, Sujay Kaushal, Dan Medina, Matt Meyers, Bob Kerr, Steve Stewart, Bettina Sullivan, Robert Walter and Julie Winters

Accepted by Urban Stormwater Work Group (USWG): February 19, 2013
Approved by Watershed Technical Work Group (WTWG): April 5, 2013
Final Approval by Water Quality Goal Implementation Team (WQGIT): May 13, 2013

Test-Drive Revisions Approved by the USWG: January 1st, 2014
Test-Drive Revisions Approved by the WTWG: August 28, 2014
Test-Drive Revisions Approved by the WQGIT: September 8, 2014

Prepared by:
Tom Schuler, Chesapeake Stormwater Network and Bill Stack, Center for Watershed Protection
Methods to Quantify Reductions:

- Default Removal Rate
  - Fixed rate of TN, TP, TSS reductions per L.F. of stream restoration (ex: 0.068 lbs/LF/yr x 1,000 LF = 68 lbs TP/yr)

OR

- Application of 4 Protocols from Expert Panel Report...they are:

<table>
<thead>
<tr>
<th>Source</th>
<th>TN</th>
<th>TP</th>
<th>TSS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revised Default Rate</td>
<td>0.075</td>
<td>0.068</td>
<td>44.88 non-coastal plain</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15.13 coastal plain</td>
</tr>
</tbody>
</table>

OR

- **P1** - Credit for Prevented Sediment During Storm Flow
- **P2** - Credit for Instream & Riparian Nutrient Processing within the Hyporheic Zone During Base Flow
- **P3** - Credit for Floodplain Reconnection Volume
- **P4** - Dry Channel RSC as an Upland Stormwater Retrofit

Figure 2. Hyporheic box that extends the length of the restored reach.
Focus on Protocol 1 (BANCS)

Using BANCS and Standard P Concentration
3 Costs associated with Stream Restoration and Nutrient Removal
Costs for removal – Traditional Stormwater

Table 2. Properties of BMPs Selected for Cost Estimation

<table>
<thead>
<tr>
<th>BMP ID</th>
<th>BMP Type</th>
<th>4 digit HUC</th>
<th>Impervious Area Treated (acres)</th>
<th>WQV Treated (ft³)</th>
<th>Annual Phosphorus Removal (lbs)</th>
<th>Removal Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Extended detention basin</td>
<td>York</td>
<td>2.44</td>
<td>8414.34</td>
<td>1.38</td>
<td>35%</td>
</tr>
<tr>
<td>2</td>
<td>Extended detention basin</td>
<td>York</td>
<td>2.66</td>
<td>8638.16</td>
<td>1.94</td>
<td>35%</td>
</tr>
<tr>
<td>3</td>
<td>Extended detention basin</td>
<td>York</td>
<td>3.01</td>
<td>27522.48</td>
<td>6.08</td>
<td>35%</td>
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<tr>
<td>4</td>
<td>Extended detention basin</td>
<td>Potomac</td>
<td>4.27</td>
<td>14725.10</td>
<td>3.24</td>
<td>35%</td>
</tr>
<tr>
<td>5</td>
<td>Extended detention basin</td>
<td>Potomac</td>
<td>7.33</td>
<td>25917.51</td>
<td>5.27</td>
<td>35%</td>
</tr>
<tr>
<td>6</td>
<td>Extended detention basin</td>
<td>Potomac</td>
<td>7.42</td>
<td>25878.87</td>
<td>5.64</td>
<td>35%</td>
</tr>
<tr>
<td>7</td>
<td>Extended detention basin</td>
<td>Potomac</td>
<td>13.15</td>
<td>52244.78</td>
<td>11.21</td>
<td>35%</td>
</tr>
<tr>
<td>8</td>
<td>Infiltration system</td>
<td>Potomac</td>
<td>4.40</td>
<td>7566.70</td>
<td>6.31</td>
<td>69%</td>
</tr>
<tr>
<td>9</td>
<td>Extended detention enhanced basin</td>
<td>Potomac</td>
<td>9.29</td>
<td>39726.30</td>
<td>9.68</td>
<td>50%</td>
</tr>
</tbody>
</table>

BMP = best management practice; HUC = hydrologic unit code; WQV = water quality volume.
* Functional class: rural collector rolling undivided
* Functional class: rural principal arterial
* Functional class: urban minor arterial

Table 3. Component Costs of BMPs Selected for Cost Estimation

<table>
<thead>
<tr>
<th>BMP ID</th>
<th>Pre-Construction</th>
<th>Construction</th>
<th>Lifetime O&amp;M</th>
<th>ROW</th>
<th>Total Including ROW</th>
<th>Total Excluding ROW</th>
<th>Per Pound of Annual Phosphorus Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$1,457.99</td>
<td>$23,999.69</td>
<td>$5,461.28</td>
<td>$24,081.55</td>
<td>$44,368.87</td>
<td>$48,400.43</td>
<td>$18,945.89</td>
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<tr>
<td>1</td>
<td>$15,042.90</td>
<td>$93,000.01</td>
<td>$6,500.88</td>
<td>$35,681.84</td>
<td>$58,076.33</td>
<td>$104,768.33</td>
<td>$35,527.32</td>
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<td>2</td>
<td>$20,083.53</td>
<td>$92,761.02</td>
<td>$5,337.26</td>
<td>$20,077.16</td>
<td>$82,181.30</td>
<td>$112,234.96</td>
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BMP = best management practice; O&M = operation and maintenance; ROW = right of way

Phosphorus Credit Cost

Fixed prices for 1-pound phosphorus credits in the James, Potomac, Rappahannock, and York watersheds were provided by VDOT’s Location and Design Division. The cost of a 1-pound phosphorus credit in the James and Potomac watersheds is $10,430 and $18,700, respectively. The cost of a 1-pound phosphorus credit in the York and Rappahannock watersheds is on a sliding scale from $17,000 to $20,000 and $14,700 to $16,450, respectively. The cost of credits in the York and Rappahannock watersheds decreases as more credits are purchased. The credits are managed through a clearinghouse, which generates the credits by converting agricultural land to forest land or building urban BMPs.
Project A  Spotsylvania County, VA (400 LF)

- Phosphorous Removed – 111 LB/YR
- Total Project Cost - 700K
- Per Pound of P - $6,306
- Value in Watershed – 1.65 Million (15k/LB x 111lbs)
Project B
York County, VA

Phosphorus Removed – 141 LB/YR
Total Project Cost 1.2 Million

Per Pound of P - $8,511
Value in Watershed – 2.4 Million
(17k LB X 141 LBS)

York County, Virginia
800 LF
Project C
Harford, MD (5288 LF)

Phosphorous Removed – 2575 LB/YR
Total Project Cost 6.6 Million +/-
Estimated – Not constructed yet

Per Pound of P - $2,563
Value in Watershed – N/A
## Nutrient Removal Cost Summary

<table>
<thead>
<tr>
<th>Method</th>
<th>Cost Range per LB P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Stormwater</td>
<td>$20-75K per LB P</td>
</tr>
<tr>
<td>Nutrient Bank (in VA only)</td>
<td>$15-20K per LB P</td>
</tr>
<tr>
<td>Project A*</td>
<td>$6,306 per LB P</td>
</tr>
<tr>
<td>Project B**</td>
<td>$8,511 per LB P</td>
</tr>
<tr>
<td>Project C***</td>
<td>$2,563 per LB P</td>
</tr>
</tbody>
</table>

* Construction completed. Numbers reflect actual measured bank recession and soil concentration rates. Project efficiency was 90% (not 50%).

** Construction completed. Numbers reflect actual measured soil concentration rates but utilized NC Curve. Project efficiency was 50%.

*** Construction cost estimated. Numbers reflect actual measured soil concentrations, bulk densities and recession rates. Project efficiency was 50%.
4 Conclusions/Discussion/Questions

- The Chesapeake Bay has undertaken a massive cleanup effort, similar to the Mobile Estuarine Program goals.
- Case studies and monitoring point to the most cost effective way to reduce pollution, stream restoration.
- Clients have been able to get stretched dollars and get almost twice as many projects in the ground then when using traditional stormwater techniques.