Stormwater BMP Performance in Meeting Chesapeake Bay TMDL Goals in Prince George’s County MD

December 11, 2019

Millbrook, Submerged Gravel Wetland
The Clean Water Partnership

• A 30-year partnership between Prince George’s County, Maryland and Corvias to identify, design, build, finance, operate and maintain stormwater assets.

• Based on the Community-Based Public Private Partnership (CBP3) model as developed by the USEPA Region III.

• Intentionally developed to provide multiple, overlying benefits (socioeconomic, environmental, implementation efficiency, local uplift, compliance surety)
Partnership Goals

**Scalable**
Implementation strategy for distributed stormwater infrastructure across public and private properties

**Affordable**
Implementation strategy to achieve County’s cost of compliance

**Maintainable**
Long term compliance and operability of distributed stormwater infrastructure

**Community Benefit and Uplift**
Incorporation of broader policy performance objectives inclusive of investment in local, small and disadvantaged businesses, community outreach and public engagement
Integrated Delivery Partner

• HDR is responsible for the management of design, procurement, and construction toward the completion of projects with a view towards impervious acre credits in support of the County MS4 Permit and TMDL requirements
Agenda

1. Program Introduction
2. Performance Summary
3. Phase 1: Breakdown by Class
4. Phase 1: Device Performance Breakdown
5. Next Steps
PROGRAM INTRODUCTION
The Chesapeake Bay Program

**Goal:**
Restore water quality to meet recreation and aquatic uses

- Started with 1983 Chesapeake Bay Agreement
- TMDL established in 2010, to be met by 2025
- Chesapeake Bay characteristics
  - 6 states and the District of Columbia
  - 64,000-square-mile watershed
  - 18.2 million residents
TMDL Requirements for Prince George’s County MS4

Just under 500 square miles

CB TMDL target = 15,000 acres of impervious area treated by 2025

Stormwater enters Chesapeake Bay through Anacostia and Patuxent Rivers

2017 population was about 920,000
## Clean Water Partnership CBP3 Goals

<table>
<thead>
<tr>
<th>Goal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrofit 4,000 impervious acres</td>
<td>Design, build, operate, and maintain</td>
</tr>
<tr>
<td>Design, build, operate, and maintain</td>
<td>Third-party inspection and certification</td>
</tr>
<tr>
<td>Third-party inspection and certification</td>
<td>30 year full lifecycle partnership</td>
</tr>
<tr>
<td>Outreach to community and property stakeholders</td>
<td>Commitment to using local, small, and minority-owned businesses to perform 30–40% of work</td>
</tr>
<tr>
<td>Community and social economic development through alternative compliance with nonprofit groups, mentor protégé program, and workforce development</td>
<td></td>
</tr>
</tbody>
</table>
TMDL Strategy

- Capital improvement projects
- Alternative BMPs
- Urban stormwater retrofit programs

Schools

Stream restoration

Faith-based and other private nonprofit community land

Existing pond retrofits

Municipal and county sites

Scotchtown Elementary School, Swales
## General Overview of Retrofit Program

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site selection</td>
<td></td>
</tr>
<tr>
<td>Project design and permitting</td>
<td></td>
</tr>
<tr>
<td>Construction procurement</td>
<td></td>
</tr>
<tr>
<td>Target class</td>
<td></td>
</tr>
<tr>
<td>Construction management</td>
<td></td>
</tr>
<tr>
<td>Outreach and compliance</td>
<td></td>
</tr>
<tr>
<td>Project closeout and certification</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
</tr>
</tbody>
</table>

Largo Kettering Library, Micro-Bio
PERFORMANCE SUMMARY
Key Achievements in Phase 1

Nutrient Removal:
- Total Nitrogen (TN): 34,000 lb
- Total Phosphorous (TP): 3,500 lb
- Total Suspended Solids (TSS): 1,990,000 lb

Total Projects Completed: 96
Total Devices Constructed: 246

Total Design and Construction Cost: $63.4 million

Total Impervious Area Treated
Credits (IATs):
- 2,142 acre credit

Drainage Area Treated:
- Total: 7,442 acres
- Impervious: 2,147 acres

St. Michael's Truth, Micro-Bioretention
PHASE 1: BREAKDOWN BY PROJECT CLASS
## Data Breakdown - Class

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
<th>Cost per Item</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ACP</strong></td>
<td>83 devices, $24,000/device</td>
<td>$34,000/lb TN removed</td>
<td>59.7 lb TN removed</td>
</tr>
<tr>
<td><strong>MUN</strong></td>
<td>66 devices, $165,000/device</td>
<td>$6,000/lb TN removed</td>
<td>1,960.2 lb TN removed</td>
</tr>
<tr>
<td><strong>School</strong></td>
<td>65 devices, $129,000/device</td>
<td>$22,000/lb TN removed</td>
<td>376.2 lb TN removed</td>
</tr>
<tr>
<td><strong>Ponds</strong></td>
<td>27 devices, $1,560,000/device</td>
<td>$1,000/lb TN removed</td>
<td>31,751 lb TN removed</td>
</tr>
</tbody>
</table>

*Costs do not include program management*
PHASE 1: DEVICE PERFORMANCE BREAKDOWN
BMP Types

Nine (9) BMP types were built in the program

Examples of Micro-Scale Practice:
- Micro-Bio Retention (MMBR)
- Rooftop Disconnection (NDNR)
- Impervious Area to Pervious (IMPP)

Examples of Small-Scale Practice:
- Bioretention Filter (FBIO)
- Sand/Organic Filter (FSND)
- Regenerative Step Pool Storm Conveyance (SPSC)
- Grass Swale (MSWG)

Wet Ponds (PWET) can be implemented on a large or small scale, depending on site conditions.
## Phase 1 Data Breakdown – Micro to Small Scale

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Number of Devices built</th>
<th>TN Removed (lb/yr)</th>
<th>TP Removed (lb/yr)</th>
<th>TSS Removed (lb/yr)</th>
<th>Impervious Area Credits (IATs) Received</th>
<th>Total Design &amp; Construction Spent*</th>
<th>$$/IAT</th>
<th>$$/Device</th>
<th>$$/TN Removed</th>
<th>$$/TP Removed</th>
<th>$$/TSS Removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro-Bio Retention (MMBR)</td>
<td>49</td>
<td>155.70</td>
<td>16.82</td>
<td>9,007</td>
<td>13.1</td>
<td>$4,612,049</td>
<td>$353,000</td>
<td>$94,000</td>
<td>$30,000</td>
<td>$274,000</td>
<td>$512</td>
</tr>
<tr>
<td>Sand Filter (FSND)</td>
<td>18</td>
<td>313.09</td>
<td>35.83</td>
<td>21,232</td>
<td>28.1</td>
<td>$5,568,014</td>
<td>$198,000</td>
<td>$309,000</td>
<td>$18,000</td>
<td>$155,000</td>
<td>$262</td>
</tr>
<tr>
<td>Bio-Retention (FBIO)</td>
<td>6</td>
<td>81.27</td>
<td>7.91</td>
<td>4,131</td>
<td>6.12</td>
<td>$1,775,002</td>
<td>$290,000</td>
<td>$296,000</td>
<td>$22,000</td>
<td>$225,000</td>
<td>$430</td>
</tr>
<tr>
<td>Rooftop Runoff Disconnect (NDRR+NDNR)</td>
<td>100</td>
<td>11.47</td>
<td>1.47</td>
<td>813</td>
<td>1.50</td>
<td>$616,943</td>
<td>$412,000</td>
<td>$6,000</td>
<td>$54,000</td>
<td>$420,000</td>
<td>$759</td>
</tr>
<tr>
<td>Impervious Area to Pervious (IMPP)</td>
<td>17</td>
<td>5.81</td>
<td>1.49</td>
<td>873</td>
<td>0.97</td>
<td>$468,503</td>
<td>$483,000</td>
<td>$28,000</td>
<td>$81,000</td>
<td>$315,000</td>
<td>$537</td>
</tr>
<tr>
<td>Grass Swales (MSWB)</td>
<td>6</td>
<td>52.39</td>
<td>5.21</td>
<td>2,802</td>
<td>3.61</td>
<td>$660,389</td>
<td>$183,000</td>
<td>$110,000</td>
<td>$13,000</td>
<td>$127,000</td>
<td>$236</td>
</tr>
<tr>
<td>Infiltration Trench (ITRN)</td>
<td>1</td>
<td>1.49</td>
<td>0.18</td>
<td>101</td>
<td>0.16</td>
<td>$75,396</td>
<td>$471,000</td>
<td>$75,000</td>
<td>$51,000</td>
<td>$417,000</td>
<td>$746</td>
</tr>
<tr>
<td>Step Pool Storm Conveyance (SPSC)</td>
<td>1</td>
<td>42.12</td>
<td>5.39</td>
<td>2,975</td>
<td>0.91</td>
<td>$40,297</td>
<td>$44,000</td>
<td>$40,000</td>
<td>$1,000</td>
<td>$7,000</td>
<td>$14</td>
</tr>
<tr>
<td>Outfall Stabilization</td>
<td>1</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>0.94</td>
<td>$40,297</td>
<td>$43,000</td>
<td>$40,000</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Costs do not include program management*
Nutrient Reduction: TN – Micro to Small Scale

Cost vs Nitrogen Reduction

Construction Cost

$0 $200,000 $400,000 $600,000 $800,000

TN Reduced (lb/yr)

R² = 0.7477

$/lb TN removed

1-A-MMBR
2-A-FSND
3-A-FBIO
4-A-NDNR
5-A-IMPP
Linear (6-A-)

MMBR
FSND
FBIO
NDNR
IMPP
Nutrient Reduction: TP – Micro to Small Scale

Cost vs. Phosphorus Reduction

Construction Cost

TP Reduced (lb/yr)

$0  $100,000  $200,000  $300,000  $400,000  $500,000  $600,000  $700,000

$0  $50,000  $100,000  $150,000  $200,000  $250,000  $300,000  $350,000  $400,000  $450,000

$/lb TP removed


R² = 0.7809

Nutrient Reduction: TP – Micro to Small Scale

Stormwater Committee Seminar | December 11, 2019
Nutrient Reduction: TSS – Micro to Small Scale

Cost vs. TSS Reduction

Construction Cost

TSS Reduced (lb/yr)

$0 $200,000 $400,000 $600,000 $800,000

$0 500 1,000 1,500 2,000 2,500 3,000 3,500 4,000

Linear (6-A-)

R² = 0.7747

$/lb TSS removed

MMBR  FSND  FBIO  NDNR  IMPP


4-A-NDNR  5-A-IMPP
IAT Credits – Micro to Small Scale

Construction Cost

R² = 0.8116

Credits

$0 $100,000 $200,000 $300,000 $400,000 $500,000 $600,000 $700,000

$/lb TN removed

1-A-MMBR
2-A-FSND
3-A-FBIO
4-A-NDNR
5-A-IMPP

Linear (6-A-)

100,000
200,000
300,000
400,000
500,000
600,000

Stormwater Committee Seminar | December 11, 2019
# BMP Type Performance Breakdown

<table>
<thead>
<tr>
<th>Type</th>
<th>Details</th>
<th>Cost per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MMBR</strong></td>
<td>49 devices, $94,000/device</td>
<td>$94,000/device</td>
</tr>
<tr>
<td></td>
<td>155.7 lb TN removed, $30,000/lb TN removed</td>
<td>$30,000/lb TN removed</td>
</tr>
<tr>
<td></td>
<td>13.1 IAT credits, $353,000/IAT credit</td>
<td>$353,000/IAT credit</td>
</tr>
<tr>
<td><strong>FSND</strong></td>
<td>18 devices, $309,000/device</td>
<td>$309,000/device</td>
</tr>
<tr>
<td></td>
<td>313.1 lb TN removed, $18,000/lb TN removed</td>
<td>$18,000/lb TN removed</td>
</tr>
<tr>
<td></td>
<td>28.1 IAT credits, $198,000/IAT credit</td>
<td>$198,000/IAT credit</td>
</tr>
<tr>
<td><strong>FBIO</strong></td>
<td>6 devices, $296,000/device</td>
<td>$296,000/device</td>
</tr>
<tr>
<td></td>
<td>81.27 lb TN removed, $22,000/lb TN removed</td>
<td>$22,000/lb TN removed</td>
</tr>
<tr>
<td></td>
<td>6.12 IAT credits, $290,000/IAT credit</td>
<td>$290,000/IAT credit</td>
</tr>
<tr>
<td><strong>NDNR</strong></td>
<td>100 devices, $6,000/device</td>
<td>$6,000/device</td>
</tr>
<tr>
<td></td>
<td>54,000 lb TN removed, $1,000/lb TN removed</td>
<td>$1,000/lb TN removed</td>
</tr>
<tr>
<td></td>
<td>1.50 IAT credits, $412,000/IAT credit</td>
<td>$412,000/IAT credit</td>
</tr>
</tbody>
</table>

*Costs do not include project management*
Nitrogen Reduction - Ponds

Small Ponds (zoomed in)

Construction Cost

Nitrogen Reduction (lb/year)

$0  $200,000  $400,000  $600,000  $800,000  $1,000,000  $1,200,000

PWET < 20 ac  PWET >20 ac  Linear (PWET < 20 ac)

R² = 0.9106
Smaller ponds: Nutrient reduction highly correlated with construction cost, lower cost per device, higher per pound nutrient reduction.
- 8 devices, $501,000/device
- 485 lb TN removed, $8,000/lb TN removed
- 37.5 IAT credits, $107,000/IAT credit

Large ponds: Site specific, was able to perform minimal retrofit at large ponds to maximize return, outliers make statistic correlation very weak.
- 34 devices, $1,329,000/device
- 33,049 lb TN removed, $1,000/lb TN removed
- 2,054 IAT credits, $22,000/IAT credit
- Should see more correlation in Phase 2

Costs do not include project management
Comparison of Projects – One Device vs. Multiple Devices

Overall projects with multiple devices see lower cost per lb of nutrients removed

- Projects with multiple devices are approximately 2/3 of unit cost of projects with 1 device because of shared mobilization/demobilization and other construction costs
NEXT STEPS
Phase 2 Underway

2,000 Acres

90+ Projects

Performance-based Design Contracts

Collaboration with General Contractors

Three years until June 2021
Questions or Comments?

Oxon Hill Library, Micro-Bioretention
For Additional Information about the Clean Water Partnership

Visit the website at https://thecleanwaterpartnership.com

CONNECT WITH CLEAN WATER PARTNERSHIP

@PGCCWP

@pgccleanwater

@PGCCWP

Look for our channel: The Clean Water Partnership