Berry Brook – Getting to 10%
Dover, New Hampshire:

- Population 30,665
- Old Textile Mill Community
- Two major rivers; Bellamy and Cochecho, which flow into the Great Bay
- Split fresh water and tidal
- Sewer Separation project during the 1970’s - mainly installed new sanitary mains
Participants at the Beginning:

- City of Dover Staff
- UNH Stormwater Center
- NH Department of Environmental Services
- Environmental Protection Agency
Berry Brook Watershed Management Plan – Implementation Projects Phase III

Final Report to
The New Hampshire Department of Environmental Services
Submitted by
The City of Dover and the UNH Stormwater Center
December, 2017

https://www.unh.edu/unhsc/berry-brook-project
Funding and Results

Funding: 3 watershed assistance grants and 1 aquatic resource mitigation grant with match from the city.

<table>
<thead>
<tr>
<th>Berry Brook Project: Getting to 10%</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$1,322,000</td>
</tr>
<tr>
<td>Grant Funds</td>
<td>$793,000</td>
</tr>
<tr>
<td>Match (min estimate)</td>
<td>529,000</td>
</tr>
<tr>
<td>BMPs</td>
<td>26</td>
</tr>
<tr>
<td>DCIA Reduced</td>
<td>37 acres</td>
</tr>
<tr>
<td>TSS Reductions (lb./yr.)</td>
<td>57,223</td>
</tr>
<tr>
<td>TP Reductions (lb./yr.)</td>
<td>201</td>
</tr>
<tr>
<td>TN Reductions (lb./yr.)</td>
<td>1,127</td>
</tr>
</tbody>
</table>
BMPs

Installations include:
• 12 bioretention systems,
• a tree filter,
• a subsurface gravel wetland,
• one acre of new wetland,
• day lighted and restored 1,100 linear feet of stream at the headwaters and restored 500 linear feet of stream at the confluence including two new geomorphically-designed stream crossings
• 3 grass-lined swales
• 2 subsurface gravel filters
• an infiltration trench system
• 3 innovative filtering catch basin designs
BMPs – at the elementary school
BMPs – “undersized”
BMPs
New Definitions to Learn:

BMP – Best Management Practice

LID – Low Impact Development

OMDB – Over My Dead Body

RG – Rain Garden

NDP – No Damn Plants
More Definitions...

GW – Gravel Wetland

MHA – Must Have Access

MS4 – More Sh#@ 4 me

BACB – Big Ass Catch Basin

SWMP – Stormwater Management Plan

RMP – Right Maintenance Plan
Still More Definitions...

TMDL – Too Much Damn Litigation

IDDE - ????

PEDDI – Public Excrement Dumping Directly In

NOI – Never Own It
Out of space
Need for Innovation

- “Boulanginator” (subsurface gravel filter) mimics performance of PA with regular pavement.
- The hydraulic inlet and outlets are controlled through perforated pipes and underdrains.
- treat runoff from 1.96 acres and 0.61 acres DCIA
Need for Innovation

- In HSG A installed an infiltration trench between two conv CBs
- A simple but effective adaptation instead of solid pipe.
- Treats runoff from 3.36 acres and 1.04 acres DCIA
Need for Innovation

Sectional Media Box Filter Design – version 3
Need for Innovation

Sectional Media Box Filter Design – version 3
August 2017

• Filtering Catch Basin Designed to replace conv DSCB where applicable
• This system was the third iteration
• The City has purchased four additional filtering catch basins and will install them in other areas throughout the city.
• The system is designed to treat 0.5 acres (0.25 acres/section) of IC per section and costs 2,400 per
In Operation
Part of the Solution – Watershed approach all communities can access
2016 EPA Merit Award
EIC Reduction Target Rates for Berry Brook, Dover, NH

- 2010 Existing
- 2011 (16.9 Ac/yr)
- 2012 (7.1 Ac/yr)
- 2013 (1.6 Ac/yr)
- 2014 (0.8 Ac/yr)
- 2015 (0.8 Ac/yr)
- 2015 (10.1 Ac/yr)
- IC Target
Comparison of Pollutant Removal Efficiency
Planted vs Grassed Bioretention

- **Pollutants:**
  - TSS
  - TP
  - DIN
  - TN

- **Removal Efficiency:**
  - TSS: Plant Bio (Avg. 3) 90%, Grassed Bio 80%
  - TP: Plant Bio 10%, Grassed Bio 20%
  - DIN: Plant Bio 50%, Grassed Bio 40%
  - TN: Plant Bio 30%, Grassed Bio 20%
Grassed vs Planted Surface IR

Average Infiltration Rates of a Planted (blue) versus Grassed (green) Bioretention Systems Over Time
Hydrology

\[ y = 0.0865x + 0.4376 \quad R^2 = 1 \]

\[ y = \ln(x) + 0.1609 \ln(x) + 0.5076 \quad R^2 = 0.6974 \]

\[ y = -0.0037x^2 + 0.119x + 0.3722 \quad R^2 = 0.9891 \]
Modeled Water Quality

Results for Berry Brook at Station Drive

1-Inch Storm, $I_a = 0.05$ S

<table>
<thead>
<tr>
<th>Year</th>
<th>% IC</th>
<th>P (in)</th>
<th>Q (in)</th>
<th>S (in)</th>
<th>CN</th>
<th>Q Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>30</td>
<td>1.00</td>
<td>0.153</td>
<td>3.59</td>
<td>74</td>
<td>45.3%</td>
</tr>
<tr>
<td>2012</td>
<td>20</td>
<td>1.00</td>
<td>0.084</td>
<td>5.54</td>
<td>64</td>
<td>64.0%</td>
</tr>
<tr>
<td>2015</td>
<td>14</td>
<td>1.00</td>
<td>0.055</td>
<td>7.02</td>
<td>59</td>
<td>64.0%</td>
</tr>
</tbody>
</table>

“Runoff Curve Number Method: Examination of the Initial Abstraction Ratio”

<table>
<thead>
<tr>
<th>Year</th>
<th>A</th>
<th>P</th>
<th>CN</th>
<th>TSS (lbs)</th>
<th>TP (lbs)</th>
<th>TN (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-20011</td>
<td>185</td>
<td>56.14</td>
<td>74</td>
<td>92,719</td>
<td>188</td>
<td>2,428</td>
</tr>
<tr>
<td>20012-2016</td>
<td>185</td>
<td>42.20</td>
<td>62</td>
<td>27,575</td>
<td>38</td>
<td>1,762</td>
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<tr>
<td>Annual Reduction (lb./yr.)</td>
<td>65,144</td>
<td>149</td>
<td>667</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simple Method (lb./yr.)</td>
<td>57,223</td>
<td>201</td>
<td>1,127</td>
<td></td>
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</tbody>
</table>
Measured Water Quality
mg/L/yr/in

<table>
<thead>
<tr>
<th>Monitoring Location</th>
<th>TSS (mg/L)/ (in)</th>
<th>Zinc (mg/L)/ (in)</th>
<th>Nitrate-N (mg/L)/ (in)</th>
<th>Total Nitrogen (mg/L)/ (in)</th>
<th>Total Phosphorus (mg/L)/ (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>Mid</td>
<td>Post</td>
<td>Pre</td>
<td>Mid</td>
<td>Post</td>
</tr>
<tr>
<td>Roosevelt</td>
<td>794</td>
<td>167</td>
<td>60</td>
<td>0.07</td>
<td>0.04</td>
</tr>
<tr>
<td>% Difference</td>
<td>120%</td>
<td>168%</td>
<td>10%</td>
<td>56%</td>
<td>121%</td>
</tr>
<tr>
<td>Station</td>
<td>167</td>
<td>69</td>
<td>85</td>
<td>0.07</td>
<td>0.04</td>
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<tr>
<td>% Difference</td>
<td>83%</td>
<td>65%</td>
<td>64%</td>
<td>56%</td>
<td>64%</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
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One degree day is a day when the average stream temperature is one degree Fahrenheit above 65 degrees F. This is important as the temperature that a Brook Trout begins to feel heat stress is 65 °F. Therefore a day with an average daily stream temperature of 71 degrees would represent 6 degree days.
Conclusions

- Green infrastructure implementation was effective at reducing EIC with respect to hydrologic, water quality at the watershed scale.

- Modeling, stream gauging and water quality sampling results indicate that storm event hydrology and water quality parameters have improved in Berry Brook.

- Having the community involved with decisions/design transferred ownership which led to innovations that decreased costs and improved system maintainability.

- Berry Brook project should help both regulators and municipalities adapt their mitigation and restoration efforts toward opportunistic implementation and resiliency planning.